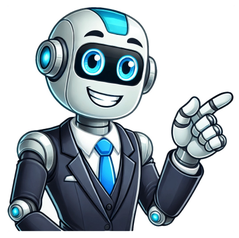
Click to prove you're human



Police polygraph exam questions

Reddit and its partners use cookies and similar technologies to provide you with a better experience. By accepting all cookies, you agree to our use of cookies to deliver and maintain our services and site, improve the quality of Reddit, personalize Reddit content and advertising, and measure the effectiveness of advertising. By rejecting non-essential cookies, Reddit may still use certain cookies to ensure the proper functionality of our platform. For more information, please see our Cookie Notice and our Privacy Policy. Joseph Libowsky,former Special Agent A polygraph, commonly referred to as a “lie detector,” may be required when you apply for a law enforcement job, depending on the specific agency and job you are applying for. Jobs requiring a top-secret clearance usually polygraph during the hiring process, as do many state and local law enforcement agencies. Often job announcements will list if a polygraph is required. Taking a polygraph is one of the most nerve-wracking parts of the law enforcement application process. It is possible for applicants who are telling the truth to appear like they are not. However, opting out of a required polygraph is not an option if you want to continue in the hiring process. If you fail a polygraph, you must disclose that when applying to a law enforcement agency in the future, even if that agency does not require a polygraph. This may negatively impact your chance of being hired, which is why it is vital to pass the polygraph in the first “go.” Agencies may polygraph candidates to: Verify the information the candidate already provided Find out information they are not disclosing Determine if they are honest and trustworthy In the academy, they can teach you offensive driving, how to shoot a firearm, and other physical tactics, but they cannot teach you integrity. That is why agencies go to great lengths to find candidates who are honest and trustworthy. The polygraph is usually one of the final stages of the application process because administering the test can be expensive. It usually happens after you pass the police written test, oral board interview, and physical agility test. Before taking the polygraph, you will be given a background questionnaire. Make sure to answer truthfully since the information you provide will be compared to the answers you provided elsewhere during the application process.   Try a Simulated, Interactive Polygraph Exam Some of the topics the questionnaire and polygraph may cover include: Personal history Negative information from other agencies (such as previously failing a polygraph) Employment background Criminal behavior Financial information Illegal drug use Alcohol use Illegal or deviant sexual behavior The online course Mastering the Polygraph, developed by Sgt. Godoy, will provide you with the tips and techniques you need to pass your polygraph honestly. (It does NOT teach you how to lie during a polygraph.) The course is mobile-friendly and provides unlimited use! Mastering the Polygraph will cover: – How the polygraph works – How the exam is conducted – Questions that may be asked during the polygraph – Bonus: an interactive, practice polygraph to help you prepare for the actual test! If you have a polygraph exam coming up, you may feel anxious about the questions your examiner has lined up for the test. Note that standard procedure requires polygraphers to conduct pre-test interviews before administering the polygraph exam. During the preliminary interviews, an experienced polygraph examiner will inform the examinees of the topic they’ll be queried over. The polygrapher will also seek the defendant’s unreserved consent, without which the entire test is null and void. But while it’s important to know the polygraph topic you’ll be queried over in advance, professional polygraphers won’t disclose the exact questions to the examinees until the D-date. Fortunately, you can make an intelligent guess based on the topic at hand. Read below as we uncover frequently asked questions in various lie detector tests. Despite the theme topic, any lie detector test would involve a series of related questions. Moreover, it is prudent to note that all the questions will be reviewed with the examinee prior to the data collection phase. There would be no surprise questions asked during the test. The queries broadly fall into the following categories: Most polygraph exams begin with general questions. The idea is to make the defendant comfortable in the examination room and counter check specific facts gathered during the pre-test interviews. For instance, asking someone, “Is your alias “Bingo?” helps confirm their identity and credibility, particularly if they already shared this information. General questions may further be split into personal and professional. If a defendant is embroiled in a robbery case at their former workplace, an examiner may ask, “Do you work with Lindsay Printing Press.” The question can help elicit a more genuine response than simply asking, “Were you involved in a robbery at Lindsay Company.” This expression is a misnomer, as all polygraph questions should be topic-relevant. A more appropriate term would be case-related questions. Case-related questions target the core of the interview. They provide invaluable clues on whether the defendant had a direct involvement in the matter under investigation. After being asked a series of case-related queries, most polygraph examinees will naturally develop unease. That’s where irrelevant questions come in. Irrelevant questions pose the least risks of self-incrimination. They allow the defendant to revert to their physiological baselines, helping to prevent false negatives. Control questions are employed to gauge varying levels of salience by asking questions related to the test issue but not exactly covering the test issue.   Suppose the relevant question is “Did you shoot John Smith?” In that case, the control question would be “Are you the kind of person who would shoot John Smith?” Did you wilfully submit to being polygraphed? – Confirms the defendant’s knowledge of and consent to the lie detector test. Is your nickname “Wrangler” – Confirms a piece of personal information previously disclosed. Are you at least 18 years of age? – The age of majority is a critical consideration before administering lie detector tests. Are you in Manhattan right now? – An important polygraph question rule that verifies the examinee understands their whereabouts and what’s going on. Do you study at (SCHOOL NAME), or do you work at (COMPANY NAME)? On (ENTER DATE), did you shoot Martin Brown? – The most direct question concerns the defendant’s involvement with the crime. Do you know who shot Martin Brown? – Uncovers if more people were involved in the crime. Were you 100% truthful on your job application – It helps uncover early evidence of deception. Have you ever been sacked from a job? – An affirmative answer could be an indictment of the examinee’s efficiency or integrity. Are you seeking to join our company for other reasons besides genuine employment? – They could be spies for all you know. Have you deliberately lied about any questions I asked? – An intelligent way to double-check their responses. Have you engaged in any form of sexual activity or conversation with anyone besides your current spouse since your relationship started? Have you ever lied to someone about your current relationship status? Do you have a secret dating profile? During the past year, have you used any illegal or scheduled substances? Polygraph questions should be brief and framed. To formulate the best response, an examinee must understand each query outright. Besides, keep the questions topic-relevant. While slightly deviating from the principal issue is allowed (such as while asking control questions), sticking to the topic enhances the test’s accuracy by sifting out irrelevant responses. In the same vein, only ask questions that require flat-out ‘Yes’ or No’ answers. Make A Good First ImpressionYour examiner's subjective opinion about you may influence the outcome of your Polygraph/CVSA interrogation. Look your best. Make sure you're clean shaven and have a conservative haircut. Dress professionally, polish your shoes. If you're a woman, dress conservatively.Be friendly. Smile, but don't overdo it. Keep good eye contact with your examiner, but don't stare. Your examiner may interpret avoidance of eye contact as a sign of deception. Answer questions directly with confidence and without hesitation - but be natural.Don't Be LateIf you're late you'll instantly make a bad impression. Your examiner may think being late is a subconscious attempt to avoid the exam - increasing his suspicion of you even before he asks his first question. Pseudoscientific device that attempts to infer lying For other uses, see Polygraph (disambiguation). "Lie Detector" redirects here. For other uses, see Lie Detector (disambiguation). American inventor Leonarde Keeler testing his improved polygraph on Arthur Koehler, a former witness for the prosecution at the 1935 trial of Richard Hauptmann A polygraph, often incorrectly referred to as a lie detector test,[1][2][3] is a pseudoscientific[4][5][6] device or procedure that measures and records several physiological indicators such as blood pressure, pulse, respiration, and skin conductivity while a person is asked and answers a series of questions.[7] The belief underpinning the use of the polygraph is that deceptive answers will produce physiological responses that can be differentiated from those associated with non-deceptive answers; however, there are no specific physiological reactions associated with lying, making it difficult to identify factors that separate those who are lying from those who are telling the truth.[8] In some countries, polygraphs are used as an interrogation tool with criminal suspects or candidates for sensitive public or private sector employment. Some United States law enforcement and federal government agencies,[9][10] as well as many police departments, use polygraph examinations to interrogate suspects and screen new employees. Within the US federal government, a polygraph examination is also referred to as a psychophysiological detection of deception examination.[11] Assessments of polygraphy by scientific and government bodies generally suggest that polygraphs are highly inaccurate, may easily be defeated by countermeasures, and are an imperfect or invalid means of assessing truthfulness.[12][13][6][14] A comprehensive 2003 review by the National Academy of Sciences of existing research concluded that there was "little basis for the expectation that a polygraph test could have extremely high accuracy."[6] The American Psychological Association states that "most psychologists agree that there is little evidence that polygraph tests can accurately detect lies."[8] For this reason, the use of polygraphs to detect lies is considered a form of pseudoscience, or junk science.[15] See also: Lie detection § Questioning and testing techniques The examiner typically begins polygraph test sessions with a pre-test interview to gain some preliminary information which will later be used to develop diagnostic questions. Then the tester will explain how the polygraph is supposed to work, emphasizing that it can detect lies and that it is important to answer truthfully. Then a "stim test" is often conducted: the subject is asked to deliberately lie and then the tester reports that he was able to detect this lie. Guilty subjects are likely to become more anxious when they are reminded of the test's validity. However, there are risks of innocent subjects being equally or more anxious than the guilty.[16] Then the actual test starts. Some of the questions asked are "irrelevant" ("Is your name Fred?"), others are "diagnostic" questions, and the remainder are the "relevant questions" that the tester is really interested in. The different types of questions alternate. The test is passed if the physiological responses to the diagnostic questions are larger than those during the relevant questions.[17] Criticisms have been given regarding the validity of the administration of the Control Question Technique. The CQT may be vulnerable to being conducted in an interrogation-like fashion. This kind of interrogation style would elicit a nervous response from innocent and guilty suspects alike. There are several other ways of administering the questions.[18] An alternative is the Guilty Knowledge Test (GKT), or the Concealed Information Test, which is used in Japan.[19] The administration of this test is given to prevent potential errors that may arise from the questioning style. The test is usually conducted by a tester with no knowledge of the crime or circumstances in question. The administrator tests the participant on their knowledge of the crime that would not be known to an innocent person. For example: "Was the crime committed with a .45 or a 9 mm?" The questions are in multiple choice and the participant is rated on how they react to the correct answer. If they react strongly to the guilty information, then proponents of the test believe that it is likely that they know facts relevant to the case. This administration is considered more valid by supporters of the test because it contains many safeguards to avoid the risk of the administrator influencing the results.[20] Assessments of polygraphy by scientific and government bodies generally suggest that polygraphs are inaccurate, may be defeated by countermeasures, and are an imperfect or invalid means of assessing truthfulness.[6][12][13] Despite claims that polygraph tests are between 80% and 90% accurate by advocates,[21][22] the National Research Council has found no evidence of effectiveness.[13][23] In particular, studies have indicated that the relevant–irrelevant questioning technique is not ideal, as many innocent subjects exert a heightened physiological reaction to the crime-relevant questions.[24] The American Psychological Association states "Most psychologists agree that there is little evidence that polygraph tests can accurately detect lies."[8] In 2002, a review by the National Research Council found that, in populations "untrained in countermeasures, specific-incident polygraph tests can discriminate lying from truth telling at rates well above chance, though well below perfection". The review also warns against generalization from these findings to justify the use of polygraphs—"polygraph accuracy for screening purposes is almost certainly lower than what can be achieved by specific-incident polygraph tests in the field"—and notes some examinees may be able to take countermeasures to produce deceptive results.[25] In the 1998 US Supreme Court case United States v. Scheffer, the majority stated that "There is simply no consensus that polygraph evidence is reliable [...] Unlike other expert witnesses who testify about factual matters outside the jurors' knowledge, such as the analysis of fingerprints, ballistics, or DNA found at a crime scene, a polygraph expert can supply the jury only with another opinion." The Supreme Court summarized their findings by stating that the use of polygraph was "little better than could be obtained by the toss of a coin."[26] In 2005, the 11th Circuit Court of Appeals stated that "polygraphy did not enjoy general acceptance from the scientific community".[27] In 2001, William Iacono, Professor of Psychology and Neuroscience at the University of Minnesota, concluded: Although the CQT [Control Question Test] may be useful as an investigative aid and tool to induce confessions, it does not pass muster as a scientifically credible test. CQT theory is based on naive, implausible assumptions indicating (a) that it is biased against innocent individuals and (b) that it can be beaten simply by artificially augmenting responses to control questions. Although it is not possible to adequately assess the error rate of the CQT, both of these conclusions are supported by published research findings in the best social science journals (Honts et al., 1994; Horvath, 1977; Kleinmuntz & Szucko, 1984; Patrick & Iacono, 1991). Although defense attorneys often attempt to have the results of friendly CQTs admitted as evidence in court, there is no evidence supporting their validity and ample reason to doubt it. Members of scientific organizations who have the requisite background to evaluate the CQT are overwhelmingly skeptical of the claims made by polygraph proponents.[28] Polygraphs measure arousal, which can be affected by anxiety, anxiety disorders such as post-traumatic stress disorder (PTSD), nervousness, fear, confusion, hypoglycemia, psychosis, depression, substance-induced states (nicotine, stimulants), substance-withdrawal state (alcohol withdrawal) or other emotions; polygraphs do not measure "lies".[16][29][30] A polygraph cannot differentiate anxiety caused by dishonesty and anxiety caused by something else.[31] Since the polygraph does not measure lying, the Silent Talker Lie Detector inventors expected that adding a camera to film microexpressions would improve the accuracy of the evaluators. This did not happen in practice according to an article in the Intercept.[32] In 1983, the US Congress Office of Technology Assessment published a review of the technology[33] and found that there is at present only limited scientific evidence for establishing the validity of polygraph testing. Even where the evidence seems to indicate that polygraph testing detects deceptive subjects better than chance, significant error rates are possible, and examiner and examinee differences and the use of countermeasures may further affect validity.[34] In 2003, the National Academy of Sciences (NAS) issued a report entitled "The Polygraph and Lie Detection". The NAS found that "overall, the evidence is scanty and scientifically weak", concluding that 57 of the approximately 80 research studies that the American Polygraph Association relied on to reach their conclusions were significantly flawed.[35] These studies did show that specific-incident polygraph testing, in a person untrained in counter-measures, could discern the truth at "a level greater than chance, yet short of perfection". However, due to several flaws, the levels of accuracy shown in these studies "are almost certainly higher than actual polygraph accuracy of specific-incident testing in the field".[36] By adding a camera, the Silent Talker Lie Detector attempted to give more data to the evaluator by providing information about microexpressions. However adding the Silent Talker camera did not improve lie detection and was very expensive and cumbersome to include according to an article in the Intercept.[37] When polygraphs are used as a screening tool (in national security matters and for law enforcement agencies for example) the level of accuracy drops to such a level that "Its accuracy in distinguishing actual or potential security violators from innocent test takers is insufficient to justify reliance on its use in employee security screening in federal agencies." The NAS concluded that the polygraph "may have some utility but that there is "little basis for the expectation that a polygraph test could have extremely high accuracy".[6] The NAS conclusions paralleled those of the earlier United States Congress Office of Technology Assessment report "Scientific Validity of Polygraph Testing: A Research Review and Evaluation".[38] Similarly, a report to Congress by the Moynihan Commission on Government Secrecy concluded that "The few Government-sponsored scientific research reports on polygraph validity (as opposed to its utility), especially those focusing on the screening of applicants for employment, indicate that the polygraph is neither scientifically valid nor especially effective beyond its ability to generate admissions".[39] Despite the NAS finding of a "high rate of false positives," failures to expose individuals such as Aldrich Ames and Larry Wu-Tai Chin, and other inabilities to show a scientific justification for the use of the polygraph, it continues to be employed.[37] Several proposed countermeasures designed to pass polygraph tests have been described. There are two major types of countermeasures: "general state" (intending to alter the physiological or psychological state of the subject during the test), and "specific point" (intending to alter the physiological or psychological state of the subject at specific periods during the examination, either to increase or decrease responses during critical examination periods).[29] General state: asked how he passed the polygraph test, Central Intelligence Agency officer turned KGB mole Aldrich Ames explained that he sought advice from his Soviet handler and received the simple instruction to: "Get a good night's sleep, and rest, and go into the test rested and relaxed. Be nice to the polygraph examiner, develop a rapport, and be cooperative and try to maintain your calm".[40] Additionally, Ames explained, "There's no special magic... Confidence is what does it. Confidence and a friendly relationship with the examiner... rapport, where you smile and you make him think that you like him".[41] Specific point: other suggestions for countermeasures include for the subject to mentally record the control and relevant questions as the examiner reviews them before the interrogation begins. During the interrogation the subject is supposed to carefully control their breathing while answering the relevant questions, and to try to artificially increase their heart rate during the control questions, for example by thinking of something scary or exciting, or by pricking themselves with a pointed object concealed somewhere on the body. In this way the results will not show a significant reaction to any of the relevant questions.[42] Law enforcement agencies and intelligence agencies in the United States are by far the biggest users of polygraph technology. In the United States alone most federal law enforcement agencies either employ their own polygraph examiners or use the services of examiners employed in other agencies.[43] In 1978 Richard Helms, the eighth Director of Central Intelligence, stated: We discovered there were some Eastern Europeans who could defeat the polygraph at any time. Americans are not very good at it, because we are raised to tell the truth and when we lie it is easy to tell we are lying. But we find a lot of Europeans and Asiatics can handle that polygraph without a blip, and you know they are lying and you have evidence that they are lying.[44] Susan McCarthy of Salon said in 2000 that "The polygraph is an American phenomenon, with limited use in a few countries, such as Canada, Israel and Japan."[45] In Armenia, government administered polygraphs are legal, at least for use in national security investigations. The National Security Service (NSS), Armenia's primary intelligence service, requires polygraph examinations of all new applicants.[46] Polygraph evidence became inadmissible in New South Wales courts under the Lie Detectors Act 1983. Under the same act, it is also illegal to use polygraphs for the purpose of granting employment, insurance, financial accommodation, and several other purposes for which polygraphs may be used in other jurisdictions.[47] In Canada, the 1987 decision of R v Béland, the Supreme Court of Canada rejected the use of polygraph results as evidence in court, finding that they were inadmissible. The polygraph is still used as a tool in the investigation of criminal acts and sometimes employed in the screening of employees for government organizations.[48] In the province of Ontario, the Employment Standards Act, 2000 prohibits employers from asking or requiring employees to undergo a polygraph test.[49][50] Police services are permitted use polygraph tests as part of an investigation if the person consents.[51] In a majority of European jurisdictions, polygraphs are generally considered to be unreliable for gathering evidence, and are usually not used by local law enforcement agencies. Polygraph testing is widely seen in Europe to violate the right to remain silent.[52]: 62ff In England and Wales a polygraph test can be taken, but the results cannot be used in a court of law to prove a case.[53] However, the Offender Management Act 2007 put in place an option to use polygraph tests to monitor serious sex offenders on parole in England and Wales;[54] these tests became compulsory in 2014 for high risk sexual offenders currently on parole in England and Wales.[55] The Supreme Court of Poland declared on January 29, 2015, that the use of polygraph in interrogation of suspects is forbidden by the Polish Code of Criminal Procedure. Its use might be allowed though if the suspect has been already accused of a crime and if the interrogated person consents of the use of a polygraph. Even then, the use of polygraph can never be used as a substitute of actual evidence.[56] As of 2017, the justice ministry and Supreme Court of both of the Netherlands and Germany had rejected use of polygraphs.[52]: 62ff[57] According to the 2017 book Psychology and Law: Bridging the Gap by psychologists David Canter and Rita Žukauskienė Belgium was the European country with the most prevalent use of polygraph testing by police, with about 300 polygraphs carried out each year in the course of police investigations. The results are not considered viable evidence in bench trials, but have been used in jury trials.[52]: 62ff In Lithuania, "polygraphs have been in use since 1992",[58] with law enforcement utilizing the Event Knowledge Test (a "modification"[59] of the Concealed Information Test) in criminal investigations. In 2008, an Indian court adopted the Brain Electrical Oscillation Signature Profiling test as evidence to convict a woman who was accused of murdering her fiancé.[60] It was the first time that the result of polygraph was used as evidence in court.[61] On May 5, 2010, The Supreme Court of India declared use of narcoanalysis, brain mapping and polygraph tests on suspects as illegal and against the constitution if consent is not obtained and forced.[62] Article 20(3) of the Indian Constitution states: "No person accused of any offence shall be compelled to be a witness against himself."[63] Polygraph tests are still legal if the defendant requests one.[64] The Supreme Court of Israel, in Civil Appeal 551/89 (Menora Insurance v. Jacob Sdovnik), ruled that the polygraph has not been recognized as a reliable device. In other decisions, polygraph results were ruled inadmissible in criminal trials. Polygraph results are only admissible in civil trials if the person being tested agrees to it in advance.[65] The results of polygraph tests are inadmissible in court in the Philippines.[66][67] The National Bureau of Investigation, however, uses polygraphs in aid of investigation.[68] Brochure of the Defense Security Service (DSS) about polygraph testing Demonstrating the administration of the polygraph, the polygrapher making notes on the readouts. 1970s "The Truth About the Polygraph" (National Security Agency (NSA)-produced video on the polygraph process) In 2018, Wired magazine reported that an estimated 2.5 million polygraph tests were given each year in the United States, with the majority administered to paramedics, police officers, firefighters, and state troopers. The average cost to administer the test is more than $700 and is part of a $2 billion industry.[69] In 2007[update], polygraph testimony was admitted by stipulation in 19 states, and was subject to the discretion of the trial judge in federal court. The use of polygraph in court testimony remains controversial, although it is used extensively in post-conviction supervision, particularly of sex offenders. In Daubert v. Merrell Dow Pharmaceuticals, Inc. (1993),[70] the old Frye standard was lifted and all forensic evidence, including polygraph, had to meet the new Daubert standard in which "underlying reasoning or methodology is scientifically valid and properly can be applied to the facts at issue." While polygraph tests are commonly used in police investigations in the US, no defendant or witness can be forced to undergo the test unless they are under the supervision of the courts.[71] In United States v. Scheffer (1998),[72] the US Supreme Court left it up to individual jurisdictions whether polygraph results could be admitted as evidence in court cases. Nevertheless, it is used extensively by prosecutors, defense attorneys, and law enforcement agencies. In the states of Rhode Island, Massachusetts, Maryland, New Jersey, Oregon, Delaware and Iowa it is illegal for any employer to order a polygraph either as conditions to gain employment, or if an employee has been suspected of wrongdoing.[73][74] The Employee Polygraph Protection Act of 1988 (EPPA) generally prevents employers from using lie detector tests, either for pre-employment screening or during the course of employment, with certain exemptions.[75] As of 2013, about 70,000 job applicants are polygraphed by the federal government on an annual basis.[76] In the United States, the State of New Mexico admits polygraph testing in front of juries under certain circumstances.[77] In 2010 the NSA produced a video explaining its polygraph process.[78] The video, ten minutes long, is titled "The Truth About the Polygraph" and was posted to the website of the Defense Security Service. Jeff Stein of The Washington Post said that the video portrays "various applicants, or actors playing them—it's not clear—describing everything bad they had heard about the test, the implication being that none of it is true."[79] AntiPolygraph.org argues that the NSA-produced video omits some information about the polygraph process; it produced a video responding to the NSA video.[78] George Maschke, the founder of the website, accused the NSA polygraph video of being "Orwellian".[79] The polygraph was invented in 1921 by John Augustus Larson, a medical student at the University of California, Berkeley and a police officer of the Berkeley Police Department in Berkeley, California.[80] The polygraph was on the Encyclopædia Britannica 2003 list of greatest inventions, described as inventions that "have had profound effects on human life for better or worse."[81] In 2013, the US federal government had begun indicting individuals who stated that they were teaching methods on how to defeat a polygraph test.[76][82][83] During one of those investigations, upwards of 30 federal agencies were involved in investigations of almost 5000 people who had various degrees of contact with those being prosecuted or who had purchased books or DVDs on the topic of beating polygraph tests.[84][85][86] In 1995, Harold James Nicholson, a Central Intelligence Agency (CIA) employee later convicted of spying for Russia, had undergone his periodic five-year reinvestigation, in which he showed a strong probability of deception on questions regarding relationships with a foreign intelligence unit. This polygraph test later led to an investigation which resulted in his eventual arrest and conviction. In most cases, however, polygraphs are more of a tool to "scare straight" those who would consider espionage. Jonathan Pollard was advised by his Israeli handlers that he was to resign his job from American intelligence if he was ever told he was subject to a polygraph test.[citation needed] Likewise, John Anthony Walker was advised by his handlers not to engage in espionage until he had been promoted to the highest position for which a polygraph test was not required, to refuse promotion to higher positions for which polygraph tests were required, and to retire when promotion was mandated.[6] In 1983, CIA employee Edward Lee Howard was dismissed when, during a polygraph screening, he truthfully answered a series of questions admitting to minor crimes such as petty theft and drug abuse. In retaliation for his perceived unjust punishment for minor offenses, he later sold his knowledge of CIA operations to the Soviet Union.[87] Polygraph tests may not deter espionage. From 1945 to the present, at least six Americans have committed espionage while successfully passing polygraph tests. Notable cases of two men who created a false negative result with the polygraphs were Larry Wu-Tai Chin, who spied for China, and Aldrich Ames, who was given two polygraph examinations while with the CIA, the first in 1986 and the second in 1991, while spying for the Soviet Union/Russia. The CIA reported that he passed both examinations after experiencing initial indications of deception.[88] According to a Senate investigation, an FBI review of the first examination concluded that the indications of deception were never resolved.[89] Ana Belen Montes, a Cuban spy, passed a counterintelligence scope polygraph test administered by the US Defense Intelligence Agency (DIA) in 1994.[90] Despite these errors, in August 2008, the DIA announced that it would subject each of its 5,700 prospective and current employees to polygraph testing at least once annually.[91] This expansion of polygraph screening at DIA occurred while DIA polygraph managers ignored documented technical problems discovered in the Lafayette computerized polygraph system.[92] The DIA uses computerized Lafayette polygraph systems for routine counterintelligence testing. The impact of the technical flaws within the Lafayette system on the analysis of recorded physiology and on the final polygraph test evaluation is currently unknown.[93] In 2012, a McClatchy investigation found that the National Reconnaissance Office was possibly breaching ethical and legal boundaries by encouraging its polygraph examiners to extract personal and private information from US Department of Defense personnel during polygraph tests that purported to be limited in scope to counterintelligence matters.[94] Allegations of abusive polygraph practices were brought forward by former NRO polygraph examiners.[95] Most polygraph researchers have focused more on the exam's predictive value on a subject's guilt. However, there have been no empirical theories established to explain how a polygraph measures deception. A 2010 study indicated that functional magnetic resonance imaging (fMRI) may benefit in explaining the psychological correlations of polygraph exams. It could also explain which parts of the brain are active when subjects use artificial memories.[clarification needed][96] Most brain activity occurs in both sides of the prefrontal cortex, which is linked to response inhibition. This indicates that deception may involve inhibition of truthful responses.[97] Some researchers believe that reaction time (RT) based tests may replace polygraphs in concealed information detection. RT based tests differ from polygraphs in stimulus presentation duration and can be conducted without physiological recording as subject response time is measured via computer. However, researchers have found limitations to these tests as subjects voluntarily control their reaction time, deception can still occur within the response deadline, and the test itself lacks physiological recording.[98] Earlier societies utilized elaborate methods of lie detection which mainly involved torture. For instance, in the Middle Ages, boiling water was used to detect liars, as it was believed honest men would withstand it better than liars.[99] Early devices for lie detection include an 1895 invention of Cesare Lombroso used to measure changes in blood pressure for police cases, a 1904 device by Vittorio Benussi used to measure breathing, the Mackenzie-Lewis Polygraph first developed by James Mackenzie in 1906 and an abandoned project by American William Moulton Marston which used blood pressure to examine German prisoners of war (POWs).[100] Marston said he found a strong positive correlation between systolic blood pressure and lying.[16] Marston wrote a second paper on the concept in 1915, when finishing his undergraduate studies. He entered Harvard Law School and graduated in 1918, re-publishing his earlier work in 1917.[101] Marston's main inspiration for the device was his wife, Elizabeth Holloway Marston.[99] "According to Marston's son, it was his mother Elizabeth, Marston's wife, who suggested to him that 'When she got mad or excited, her blood pressure seemed to climb'" (Lamb, 2001). Although Elizabeth is not listed as Marston's collaborator in his early work, Lamb, Matte (1996), and others refer directly and indirectly to Elizabeth's work on her husband's deception research. She also appears in a picture taken in his polygraph laboratory in the 1920s (reproduced in Marston, 1938).[102] Despite his predecessors' contributions, Marston styled himself the "father of the polygraph". (Today he is often equally or more noted as the creator of the comic book character Wonder Woman and her Lasso of Truth, which can force people to tell the truth.)[103] Marston remained the device's primary advocate, lobbying for its use in the courts. In 1938 he published a book, The Lie Detector Test, wherein he documented the theory and use of the device.[104] In 1938 he appeared in advertising by the Gillette company claiming that the polygraph showed Gillette razors were better than the competition.[105][106][107] A device recording both blood pressure and breathing was invented in 1921 by John Augustus Larson of the University of California and first applied in law enforcement work by the Berkeley Police Department under its nationally renowned police chief August Vollmer.[108] Further work on this device was done by Leonarde Keeler.[109] As Larson's protege, Keeler updated the device by making it portable and added the galvanic skin response to it in 1939. His device was then purchased by the FBI, and served as the prototype of the modern polygraph.[99][108] Several devices similar to Keeler's polygraph version included the Berkeley Psychograph, a blood pressure-pulse-respiration recorder developed by C. D. Lee in 1936[110] and the Darrow Behavior Research Photopolygraph, which was developed and intended solely for behavior research experiments.[110][111][112] A device which recorded muscular activity accompanying changes in blood pressure was developed in 1945 by John E. Reid, who claimed that greater accuracy could be obtained by making these recordings simultaneously with standard blood pressure-pulse-respiration recordings.[110][113] Lie detection has a long history in mythology and fairy tales; the polygraph has allowed modern fiction to use a device more easily seen as scientific and plausible. Notable instances of polygraph usage include uses in crime and espionage themed television shows and some daytime television talk shows, cartoons and films. Numerous TV shows have been called Lie Detector or featured the device. The first Lie Detector TV show aired in the 1950s, created and hosted by Ralph Andrews. In the 1960s Andrews produced a series of specials hosted by Melvin Belli. In the 1970s the show was hosted by Jack Anderson. In early 1983 Columbia Pictures Television put on a syndicated series hosted by F. Lee Bailey.[114] In 1998 TV producer Mark Phillips with his Mark Phillips Philms & Telephision put Lie Detector back on the air on the FOX Network—on that program Ed Gelb with host Marcia Clark questioned Mark Fuhrman about the allegation that he "planted the bloody glove". In 2005 Phillips produced Lie Detector as a series for PAX/ION; some of the guests included Paula Jones, Reverend Paul Crouch accuser Lonny Ford, Ben Rowling, Jeff Gannon and Swift Boat Vet, Steve Garner.[115] In the UK, shows such as The Jeremy Kyle Show used polygraph tests extensively. The show was ultimately canceled when a participant committed suicide shortly after being polygraphed. The guest was slated by Kyle on the show for failing the polygraph, but no other evidence has come forward to prove any guilt. Producers later admitted in the inquiry that they were unsure on how accurate the tests performed were.[116] In the Fox game show The Moment of Truth, contestants are privately asked personal questions a few days before the show while hooked to a polygraph. On the show they asked the same questions in front of a studio audience and members of their family. In order to advance in the game they must give a "truthful" answer as determined by the previous polygraph exam.[117] Daytime talk shows, such as Maury Povich and Steve Wilkos, have used polygraphs to supposedly detect deception in interview subjects on their programs that pertain to cheating, child abuse, and theft.[118] In episode 93 of the US science show MythBusters, the hosts attempted to fool the polygraph by using pain when answering truthfully, in order to test the notion that polygraphs interpret truthful and non-truthful answers as the same. They also attempted to fool the polygraph by thinking pleasant thoughts when lying and thinking stressful thoughts when telling the truth, to try to confuse the machine. However, neither technique was successful for a number of reasons. Michael Martin correctly identified each guilty and innocent subject. Martin suggested that when conducted properly, polygraphs are correct 98% of the time, but no scientific evidence has been offered for this.[119] The history of the polygraph is the subject of the documentary film The Lie Detector, which first aired on American Experience on January 3, 2023.[120] A hand-held lie detector is being deployed by the US Department of Defense according to a report in 2008 by investigative reporter Bill Dedman of NBC News. The Preliminary Credibility Assessment Screening System, or PCASS, captures less physiological information than a polygraph, and uses an algorithm, not the judgment of a polygraph examiner, to render a decision whether it believes the person is being deceptive or not. The device was first used in Afghanistan by US Army troops. The Department of Defense ordered its use be limited to non-US persons, in overseas locations only.[121] Polygraphy has been faulted for failing to trap known spies such as double-agent Aldrich Ames, who passed two polygraph tests while spying for the Soviet Union.[91][122] Ames failed several tests while at the CIA that were never acted on.[123] Other spies who passed the polygraph include Karl Koecher,[124] Ana Montes,[125] and Leandro Aragoncillo.[126] CIA spy Harold James Nicholson failed his polygraph examinations, which aroused suspicions that led to his eventual arrest.[127] Polygraph examination and background checks failed to detect Nada Nadim Prouty, who was not a spy but was convicted for improperly obtaining US citizenship and using it to obtain a restricted position at the FBI.[128] The polygraph also failed to catch Gary Ridgway, the "Green River Killer". Another suspect allegedly failed a given lie detector test, whereas Ridgway passed.[16] Ridgway passed a polygraph in 1984; he confessed almost 20 years later when confronted with DNA evidence.[129] Conversely, innocent people have been known to fail polygraph tests. In Wichita, Kansas in 1986, Bill Wegerle was suspected of murdering his wife Vicki Wegerle because he failed two polygraph tests (one administered by the police, the other conducted by an expert that Wegerle had hired), although he was neither arrested nor convicted of her death. In March 2004, evidence surfaced connecting her death to the serial killer known as BTK, and in 2005 DNA evidence from the Wegerle murder confirmed that BTK was Dennis Rader, exonerating Wegerle.[130] Prolonged polygraph examinations are sometimes used as a tool by which confessions are extracted from a defendant, as in the case of Richard Miller, who was persuaded to confess largely by polygraph results combined with appeals from a religious leader.[131] In the Watts family murders, Christopher Watts failed one such polygraph test and subsequently confessed to murdering his wife.[132] In the 2002 disappearance of seven-year-old Danielle van Dam of San Diego, police suspected neighbor David Westerfield; he became the prime suspect when he allegedly failed a polygraph test.[133] United States portal Bogus pipeline Cleve Backster Doug Williams (polygraph critic) Ecological fallacy Ronald Pelton Voice stress analysis P300 (neuroscience)#Applications ^ "lie detector test". Legal Information Institute. June 2020. Archived from the original on March 5, 2022. Retrieved July 27, 2022. ^ "The Truth About Lie Detectors (aka Polygraph Tests)". American Psychological Association. 2004. Archived from the original on March 5, 2022. Retrieved July 27, 2022. ^ Robinson, Bryan (July 14, 2001). "Polygraphs Accurate But Not Foolproof". ABC News. Archived from the original on April 20, 2021. Retrieved July 27, 2022. ^ "United States v. Scheffer: A U.S. Supreme Court Ruling on Polygraph Testing". Federation of American Scientists. March 31, 1998. Archived from the original on November 11, 2023. Retrieved November 11, 2023. ^ Saxe, Leonard (July 1991). "Science and the CQT polygraph". Integrative Physiological and Behavioral Science. 26 (3): 223–231. doi:10.1007/BF02912514. PMID 1954162. ^ a b c d e f Board on Behavioral, Cognitive, and Sensory Sciences and Education (BCSSE) and Committee on National Statistics (CNSTAT) (March 19, 2013). The Polygraph and Lie Detection. National Research Council. doi:10.17226/10420. ISBN 978-0-309-26392-4. Archived from the original on November 11, 2023. Retrieved November 11, 2023.{{cite book}}: CS1 maint: multiple names: authors list (link) ^ J P Rosenfeld (1995). "Alternative Views of Bashore and Rapp's (1993) alternatives to traditional polygraphy: a critique". Psychological Bulletin. 117: 159–166. doi:10.1037/0033-2909.117.1.159. ^ a b c "The Truth About Lie Detectors (aka Polygraph Tests)". apa.org. American Psychological Association. ^ Stromberg, Joseph (December 15, 2014). "Lie detectors: Why they don't work, and why police use them anyway". Vox. Archived from the original on August 16, 2014. Retrieved September 13, 2022. ^ Flock, Elizabeth (September 25, 2012). "NSA Whistleblower Reveals How To Beat a Polygraph Test". U.S. News & World Report. Archived from the original on August 13, 2022. Retrieved September 13, 2022. ^ "Federal Psychophysiological Detection of Deception Examiner Handbook" (PDF). Antipolygraph.org. Retrieved 15 May 2019. ^ a b "Scientific Validity of Polygraph Testing: A Research Review and Evaluation". Washington, DC: U.S. Congress Office of Technology Assessment. 1983. Retrieved 2008-02-29. ^ a b c "Monitor on Psychology – The polygraph in doubt". American Psychological Association. July 2004. Retrieved 2008-02-29. ^ LaMotte, Sandee (September 7, 2018). "The shaky science of lie detectors". CNN. Archived from the original on November 5, 2023. Retrieved November 5, 2023. ^ Tavel, Morton E. (January 2016). "The 'Lie Detector' Test Revisited: A Great Example of Junk Science". Skeptical Inquirer. Archived from the original on May 12, 2025. Retrieved May 12, 2025. ^ a b c d Lewis, J. A.; Cuppari, M. (2009). "The polygraph: The truth lies within". Journal of Psychiatry and Law. 37 (1): 85–92. doi:10.1177/009318530903700107. S2CID 152221286. ^ The Polygraph and Lie Detection. Washington, DC: The National Academies Press. 2003. pp. 253–254. doi:10.17226/10420. ISBN 978-0-309-13313-5. ^ "Appendix A: Polygraph Questioning Techniques". The Polygraph and Lie Detection. The National Academies Press. 2003. pp. 253–258. doi:10.17226/10420. ISBN 978-0-309-13313-5. ^ Don Sosunov (October 14, 2010). "The Admissibility of Polygraph Evidence in Criminal Courts". Haifa University. Archived from the original on November 6, 2018. Retrieved November 1, 2012. ^ For more info on the Guilty Knowledge Test, see The Guilty Knowledge Test (GKT) as an Application of Psychophysiology: Future Prospects and Obstacles Archived 2008-05-28 at the Wayback Machine ^ Evans, Gareth (October 4, 2018). "How credible are lie detector tests?". BBC News. "If the examiner is well-trained, if the test is properly carried out, and if there's proper quality controls, the accuracy is estimated between 80%-90%". ^ Warmelink, Lara (January 24, 2020). "Polygraph lie detector tests: can they really stop criminals reoffending?". The Conversation. There have been several reviews of polygraph accuracy. They suggest that polygraphs are accurate between 80% and 90% of the time. ^ "A scanner to detect terrorists". BBC News. July 16, 2009. ^ Iacono, W. G. (2008). "Effective policing: Understanding how polygraph tests work and are used". Criminal Justice and Behavior. 35 (10): 1295–1308. doi:10.1177/0093854808321529. S2CID 143302792. ^ National Research Council (2003); Pages 4 - 5 ^ "United States v. Scheffer". Cornell Law School. March 31, 1998. Retrieved May 12, 2025. ^ "United States v. Henderson" (PDF). United States Court of Appeals for the Eleventh Circuit. May 23, 2005. Archived from the original (PDF) on November 27, 2007. Retrieved August 31, 2007. [PDF] ^ Iacono, William G. (2001). "Forensic 'Lie Detection': Procedures Without Scientific Basis". Journal of Forensic Psychology Practice. 1 (1): 75–86. doi:10.1300/J158v01n01_05. S2CID 143077241. ^ a b "Archived copy" (PDF). Archived from the original (PDF) on 2011-06-05. Retrieved 2014-01-06. {{cite web}}: CS1 maint: archived copy as title (link) ^ Eggen, Dan; Vedantam, Shankar (May 1, 2006). "Polygraph Results Often in Question". The Washington Post. ^ "Lie Detector Roulette". Mother Jones. ^ Gallagher, Ryan (26 July 2019). "We Tested Europe's New Lie Detector for Travelors-and Immediately Triggered a False Positive". The Intercept. Retrieved 17 March 2023. ^ "Scientific Validity of Polygraph Testing: A Research Review and Evaluation – A Technical Memorandum" (PDF). (Washington, DC: U.S. Congress, Office of Technology Assessment (OTA-TM-H-15). November 1983. Retrieved 3 September 2016. ^ Dunning, Brian. "Skeptoid #422: Lie Detection". Skeptoid. Retrieved 3 September 2016. ^ "Conclusions and Recommendations". The Polygraph and Lie Detection (2003), National Academies Press. p. 212 ^ National Research Council (2013); Chapter 8: Conclusions and Recommendations, p. 212) ^ a b Randi, James (2017). "A Consistently Erroneous Technology". Skeptical Inquirer. 41 (5): 16–19. Archived from the original on 2018-07-28. Retrieved 28 July 2018. ^ Office of Technology Assessment (November 1983). "Scientific Validity of Polygraph Testing: A Research Review and Evaluation". ^ IV Personnel Security: Protection Through Detection Archived 2011-06-12 at the Wayback Machine quoting Ralph M. Carney, SSBI Source Yield: An Examination of Sources Contacted During the SSBI (Monterey: Defense Personnel Security Research Center, 1996), 6, affirming that in 81% of cases, the derogatory informations were obtained through questionnaire and/or interrogation. ^ Weiner, Tim, David Johnston, and Neil A. Lewis, Betrayal: The Story of Aldrich Ames, an American Spy, 1995. ^ "Ames: Separated Spy, Agent Lives". tribunedigital-dailypress. 29 April 1994. Archived from the original on 2013-12-12. Retrieved 2012-06-01. ^ Lykken, David T. A Tremor in the Blood: Uses and Abuses of the Lie Detector, 2nd ed., New York: Plenum Trade, 1998, pp. 273–279. ^ Van Aperen, Steven (February 29, 2000). "The polygraph as an investigative tool in criminal and private investigations". Net-Trace. ^ "Testimony of Richard Helms, Former Director of Central Intelligence, Former Ambassador to Iran, and Presently a Business Consultant in Washington, D.C., and Represented by Gregory B. Craig, of Williams & Connelly". mcadams.posc.mu.edu. 2001-01-29. Archived from the original on July 1, 2002. Retrieved 2015-04-19. ^ McCarthy, Susan. "The truth about the polygraph." Salon. March 2, 2000. Retrieved on July 5, 2013. ^ "How to become an employee of the NSS". www.sns.am. Retrieved 2023-02-15. ^ "Lie Detectors Act 1983 (NSW)". Legislation.nsw.gov.au. Archived from the original on 2018-10-03. Retrieved 2018-10-02. ^ "Pre-Employment Polygraph". Royal Canadian Mounted Police. 2016-05-10. Archived from the original on 2021-02-26. Retrieved 2018-04-17. ^ "Lie Detector Tests". Ontario Ministry of Labour. ^ Employment Standards Act, 2000, S.O. 2000, c. 41, Part XVI (Employment Standards Act, 2000 at Ontario e-Laws) ^ "Behavioural Assessment", Toronto Police Service, retrieved 2025-05-04 ^ a b c Meijer, Ewout H; van Koppen, Peter J (2017). "Chapter 3. Lie Detectors and the Law: The Use of the Polygraph in Europe". In Canter, David; Žukauskiene, Rita (eds.). Psychology and Law : Bridging the Gap. Routledge. ISBN 978-1351907873. ^ "How widely are lie detectors used in the UK?". BBC News. British Broadcasting Corporation. 29 June 2019. Retrieved 28 August 2020. ^ Grossman, Wendy (25 August 2020). "Letter to America: The Black Box that Wouldn't Die". Skeptical Inquirer. Retrieved 28 August 2020. ^ Bowcott, Owen (8 August 2014). "Lie detector tests introduced to monitor released sex offenders". The Guardian. Retrieved 28 August 2020. ^ "SN: tylko bez wariografu w przesłuchaniu I KZP 25/14". Czasopismo Lege Artis (in Polish). 2015-01-30. Retrieved 2021-07-09. ^ Bundesgerichtshof: Entscheidungen vom 17.12.1998, 1 StR 156/98, 1 StR 258/98 ^ Saldžiūnas, Vitas; Kovalenko, Aleksandras (2008). "The Event Knowledge Test (EKT)" (PDF). European Polygraph. 1 (3): 21. ^ Saldžiūnas, Vitas; Kovalenko, Aleksandras (2015). "Selecting the Most Optimal Conditions for the Polygraph Examination" (PDF). European Polygraph. 9 (2 (32)): 70. doi:10.1515/ep-2015-0003. S2CID 148000927. ^ Gaudet, Lyn M (2011). "Brain Fingerprinting, Scientific Evidence, and "Daubert": A Cautionary Lesson from India". Jurimetrics: The Journal of Law, Science & Technology. 51 (3): 293–318. JSTOR 41307131. ^ Giridharadas, Anand (September 14, 2008). "India's Novel Use of Brain Scans in Courts is Debated". The New York Times. Retrieved 2008-09-15. ^ Mahapatra, Dhananjay (May 5, 2010). "No narcoanalysis test without consent, says SC". The Times of India. Retrieved 2010-05-05. ^ Mittal, Akshat; Mishra, Aakarsh (2021). "Right against Self-Incrimination: A Detailed Study & Analysis of Laws Prevailing in India". International Journal of Law Management and Humanities. Archived from the original on April 11, 2021. Retrieved December 21, 2021.{{cite journal}}: CS1 maint: multiple names: authors list (link) ^ Bose, Joydeep (March 17, 2021). "Polygraph test can only be conducted with consent of the accused: Karnataka HC". Hindustan Times. Archived from the original on March 17, 2021. Retrieved December 21, 2021. ^ Weinglass, Simona (March 6, 2016). "When a job interview turns into an interrogation". Times of Israel. Archived from the original on March 7, 2016. Retrieved November 16, 2021. ^ Patag, Kristine Joy (27 May 2018). "How forensic science is making a breakthrough in the Philippines". The Philippine Star. Retrieved 9 September 2023. ^ "G.R. Nos. 116196-97: Philippines vs. Pablo Adoviso". Supreme Court E-Library. Supreme Court of the Philippines. Retrieved 9 September 2023. ^ Mayol, Ador Vincent; Bongcac, Doris C.; Pateña, Patricia Andrea (20 January 2012). "Polygraph tests start for Ballesteros, center staff". Philippine Daily Inquirer. Retrieved 9 September 2023. ^ Harris, Mark (October 1, 2018). "The Lie Generator: Inside the Black Mirror World of Polygraph Job Screenings". Wired. Retrieved October 2, 2018. ^ "Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993)". Cornell University. ^ Vance, Stephen. "Looking at the Law: An Updated Look at the Privilege Against Self-Incrimination in PostConviction Supervision" (PDF). Federal Probation. 75 (1). ^ "United States v. Scheffer, 523 U.S. 303 (1998)". Cornell University. ^ "General Law – Part I, Title XXI, Chapter 149, Section 19B". malegislature.gov. Retrieved 2019-04-03. ^ "2013 Maryland Code :: Labor and Employment :: § 3-702 – Lie detector tests". Justia Law. Retrieved 2019-04-03. ^ "Compliance Assistance By Law – The Employee Polygraph Protection Act (EPPA)". dol.gov. Archived from the original on 2005-09-23. ^ a b Taylor, Marisa and Cleve R. Wootson Jr. "Seeing threats, feds target instructors of polygraph-beating methods". McClatchy Newspapers. August 16, 2013. Retrieved August 31, 2013. ^ "New Mexico Rules of Evidence" (PDF). New Mexico State University, Southwest Regional Training Centre. Archived from the original (PDF) on 24 September 2020. Retrieved 30 March 2019. ^ a b Nagesh, Gautham (June 14, 2010). "NSA video tries to dispel fear about polygraph use during job interviews". The Hill. Retrieved June 15, 2013. ^ a b Stein, Jeff. "NSA lie detectors no sweat, video says". The Washington Post. June 14, 2010. Retrieved on July 5, 2013. ^ "Polygraph/Lie Detector FAQs". International League of Polygraph Examiners. ^ "Encyclopædia Britannica's Great Inventions". Encyclopædia Britannica Almanac 2003, via Wayback Machine. Archived from the original on May 19, 2012. Retrieved 5 August 2014. ^ ""Owner of 'Polygraph.com' Indicted for Allegedly Training Customers to Lie During Federally Administered Polygraph Examinations". Department of Justice, November 14, 2014. Accessed March 19, 2018. ^ Taylor, Marisa. "Indiana man gets 8 months for lie-detector fraud". The Seattle Times. McClatchy Newspapers. September 6, 2013. Retrieved on September 8, 2013. ^ "Coach who taught people how to beat lie detectors headed to prison". Ars Technica. 2013-09-09. ^ "Washington: Americans' personal data shared with CIA, IRS, others in security probe". McClatchy DC. ^ "Indiana man gets 8 months for lie-detector fraud". The Seattle Times. ^ "RPCV and CIA defector Edward Howard dies in Moscow". Peace Corps Online. 2002-07-22. ^ "The Adrich H. Ames Case: An Assessment of CIA's Role, Oct. 21, 1994 Memorandum for Heads of Agency Offices from Director of Central Intelligence". Archived from the original on July 5, 2009. ^ "An Assessment of the Aldrich H. Ames Espionage Case and Its Implications for U.S. Intelligence – Senate Select Committee on Intelligence – 01 November 1994 – Part One". fas.org. ^ "Magazine". The Washington Post. ^ a b Hess, Pamela, "Pentagon's Intelligence Arm Steps Up Lie-Detector Efforts", Arizona Daily Star, August 24, 2008. Also in Fox News via AP [1] ^ "Glitch in widely used polygraph can skew results". McClatchy DC. Archived from the original on 2013-05-27. Retrieved 2013-05-26. ^ "McClatchy – The Polygraph Files". mcclatchydc.com. Archived from the original on 2013-05-27. Retrieved 2013-05-26. ^ "The IG complaint of Mark Phillips concerning the NRO". McClatchy DC. ^ Taylor, Marisa, "Sen. Charles Grassley Seeks Probe Of Polygraph Techniques At National Reconnaissance Office", The McClatchy Company, 27 July 2012 ^ Bell, B. G.; Grubin, D. (2010). "Functional magnetic resonance imaging may promote theoretical understanding of the polygraph test". Journal of Forensic Psychiatry and Psychology. 21 (1): 52–65. doi:10.1080/14789940903220676. S2CID 144428132. ^ Langleben, DD; Schroeder, L; Maldjian, JA; Gur, RC; McDonald, S; Ragland, JD; O'Brien, CP; Childress, AR (2002). "Brain activity during simulated deception: an event-related functional magnetic resonance study". NeuroImage. 15 (3): 727–732. doi:10.1006/nimg.2001.1003. PMID 11848716. S2CID 14676750. ^ Verschuere, B.; Crombez, G.; Degrootte, T.; Rosseel, Y. (2010). "Detecting concealed information with reaction times: Validity and comparison with the polygraph". Applied Cognitive Psychology. 24 (7): 991–1002. doi:10.1002/acp.1601. ^ a b c Grubin, D.; Madsen, L. (2005). "Lie detection and the polygraph: A historical review". Journal of Forensic Psychiatry and Psychology. 16 (2): 357–369. doi:10.1080/14789940412331337353. S2CID 144898901. ^ "History of CVSA". nitv1.com. Archived from the original on 2007-12-03. ^ Marston, William M (1917). "Systolic Blood Pressure Changes in Deception". Journal of Experimental Psychology. 2 (2): 117–163. doi:10.1037/h0073583. ^ National Research Council (2013); Page 292 ^ Lepore, Jill. The Secret History of Wonder Woman, New York: Alfred A. Knopf, 2014, ISBN 978-0385354042, pp. 183–209. ^ Marston, William Moulton. The Lie Detector Test. New York: Richard R. Smith, 1938. ^ "William Marston's Secret Identity". Reason magazine. May 2001. ^ "Lie Detector Charts Emotional Effects of Shaving – 1938 Gillette Advertisement" (PDF). Archived from the original (PDF) on 2018-10-10. Retrieved 2007-01-10. ^ FBI File of William Moulton Marston Archived 2007-06-21 at the Wayback Machine(including report on Gillette advertising campaign) ^ a b Katherine To for Illumin. Fall 2003. Lie Detection: The Science and Development of the Polygraph ^ "Leonarde Keeler and his Instruments". lie2me.net. ^ a b c Inbau, Fred E. Lie Detection and Criminal Interrogation, The Williams & Wilkins Company, 1948 ^ Troville, P.V. (1939). "A History of Lie Detection". Journal of Criminal Law and Criminology. 29 (6): 848. ^ Troville, P.V. (1939). "A History of Lie Detection". Journal of Criminal Law and Criminology. 30 (1): 104. ^ Reid, J. E. (1945). "Simulated Blood Pressure Responses in Lie-Detection Tests and a Method for Their Deception". Journal of Criminal Law and Criminology. 36 (1): 201–215. ^ "IMPAC: F. Lee Bailey bio". Archived from the original on October 24, 2008. ^ Segrave, Kerry (November 18, 2014). Lie Detectors: A Social History. McFarland. ISBN 9780786481613 – via Google Books. ^ Barr, Sabrina (June 25, 2019). "Jeremy Kyle producer unable to say how accurate lie detector tests were". The Independent. Archived from the original on June 26, 2019. Retrieved December 15, 2022. ^ James Hibberd (2007-11-25). "Darnell in Defense of the 'Truth': Fox Executive Talks About the Network's Controversial Lie Detector Show". TV Week. Archived from the original on 2008-02-21. Retrieved 2008-03-11. ^ O'Dell, Cary (November 12, 2013). "The Tested Truth About 'Maury Povich'". Pop Matters. Retrieved 9 December 2014. ^ For critical commentary on this episode, see Maschke, George (December 7, 2007). "Mythbusters Beat the Lie Detector Episode featuring Michael Martin". AntiPolygraph.org. ^ Robinson, Jennifer (December 20, 2022). "American Experience: The Lie Detector". KPBS. Archived from the original on January 2, 2023. Retrieved January 4, 2023. ^ Dedman, Bill (April 9, 2008). "New anti-terror weapon: Hand-held lie detector". NBC News. Retrieved May 12, 2025. ^ Ames provides personal insight into the U.S. Government's reliance on polygraphy in a 2000 letter to Steven Aftergood of the Federation of American Scientists at Ames, Aldrich (November 28, 2000). "A Letter from Aldrich Ames on Polygraph Testing". Federation of American Scientists. ^ Ronald Kessler (March 8, 1994). "Spies, Lies, Averted Eyes". The New York Times. Retrieved March 19, 2018. ^ Kessler, Ron (April 17, 1988). "Moscow's Mole in the CIA: How a Swinging Czech Superspy Stole America's Most Sensitive Secrets". Washington Post. p. C1. ^ Bachelet, Pablo (October 13, 2006). "Book outlines how spy exposed U.S. intelligence secrets to Cuba". McClatchy Washington Bureau. She first came under U.S. suspicion in 1994, when Cuba detected a highly secret electronic surveillance system. Montes took a polygraph test and passed it. ^ Ross, Brian & Richard Esposito (October 6, 2005). "Investigation Continues: Security Breach at the White House". ABC News. Officials say Aragoncillo passed several lie detector tests that are routinely given to individuals with top secret clearances. ^ "Dept. of Energy, Office of Counterintelligence". Harold James Nicholson Dossier. Archived from the original on 2008-09-21. Retrieved 2009-06-01. ^ Warrick, Joby; Eggen, Dan (2007-11-14). "Ex-FBI Employee's Case Raises New Security Concerns Sham Marriage Led to U.S. Citizenship". Washington Post. Retrieved May 22, 2010. ^ "What made Ridgway kill still a riddle". The News Tribune. 2003-11-09. ^ "BTK: Out Of The Shadows". 48 Hours Mysteries. October 1, 2005. CBS News. ^ "United States of America versus William Galbreth" (PDF). 1995-03-09. Archived from the original (PDF) on 2008-02-27. Retrieved 2008-02-24. ^ "Chris Watts: Wife killed our girls, so I strangled her". Houston: KTRK-TV. August 20, 2018. Retrieved February 2, 2019. ^ Roth, Alex (January 9, 2003). "Westerfield failed polygraph test badly: 'Greater than 99%' chance he was lying, examiner says on tape". San Diego Union-Tribune. Archived from the original on September 29, 2012. Aftergood, Steven (2000). "Essays on Science and Society: Polygraph Testing and the DOE National Laboratories". Science. 290 (5493): 939–940. doi:10.1126/science.290.5493.939. PMID 17749189. S2CID 153185280. Alder, Ken (2007). The Lie Detectors. New York: Free Press. ISBN 978-0-7432-5988-0. Bunn, Geoffrey C. The Truth Machine: A Social History of the Lie Detector (Johns Hopkins University Press; 2012) 256 pages Blinkhorn, S. (1988) "Lie Detection as a psychometric procedure" In "The Polygraph Test" (Gale, A. ed. 1988) 29–39. Cumming, Alfred (Specialist in Intelligence and National Security). "Polygraph Use by the Department of Energy: Issues for Congress." (Archive) Congressional Research Service. February 9, 2009. Harris, Mark (October 1, 2018). "The Lie Generator: Inside the Black Mirror World of Polygraph Job Screenings". Wired. Jones, Ishmael (2008). The Human Factor: Inside the CIA's Dysfunctional Intelligence Culture. New York: Encounter Books. ISBN 978-1-59403-382-7. Lykken, David (1998). A Tremor in the Blood. New York: Plenum Trade. ISBN 978-0-306-45782-1. Maschke, G.W. & Scalabrini, G.J. (2018) The Lie Behind the Lie Detector. 5th ed. Available on-line at Learn How to Pass (or Beat) a Polygraph Test. McCarthy, Susan. "Passing the polygraph." Salon. March 2, 2000. Roese, N. J.; Jamieson, D. W. (1993). "Twenty years of bogus pipeline research: A critical review and meta-analysis". Psychological Bulletin. 114 (2): 363–375. doi:10.1037/0033-2909.114.2.363. Sullivan, John (2007). Gatekeeper. Potomac Books Inc. ISBN 978-1-59797-045-7. Taylor, Marisa (Tish Wells contributed). "Feds expand polygraph screening, often seeking intimate facts." McClatchy. December 6, 2012. Woodrow, Michael J. "The Truth about the Psychophysiological Detection of Deception Examination 3rd Edition" Lulu Press. New York ISBN 978-1-105-89546-3 Wikimedia Commons has media related to Polygraphs. AntiPolygraph.org Archived 2019-09-05 at the Wayback Machine, a website critical of polygraph The Polygraph Museum Historical photographs and descriptions of polygraph instruments. The North American Polygraph and Psychophysiology: Disinterested, Uninterested, and Interested Perspectives by John J. Furedy, International Journal of Psychophysiology, Spring/Summer 1996 Trial By Ordeal? Polygraph Testing In Australia "Thought Wave Lie Detector Measures Current in Nerves" Popular Mechanics, July 1937 Mikkelson, David (July 11, 2011). "Next case on the Legal Colander". Snopes. Retrieved from " 2Broadband cellular network standard For other uses, see 5G (disambiguation). 3GPP logo of 5G Part of a series on theWireless network technologies Analog 0G1G (1.5G) Digital 2G (2.5G, 2.75G, 2.9G)3G (3.5G, 3.75G, 3.9G/3.95G)4G (4G/4.5G, 4.5G, 4.9G)5G (5.5G)6G Mobile telecommunicationsvte An Android phone, showing that it is connected to a 5G networkIn telecommunications, 5G is the "fifth generation" of cellular network technology, as the successor to the fourth generation (4G), and has been deployed by mobile operators worldwide since 2019. Compared to 4G, 5G networks offer not only higher download speeds, with a peak speed of 10 gigabits per second (Gbit/s),[a] but also substantially lower latency, enabling near-instantaneous communication through cellular base stations and antennae.[1] There is one global unified 5G standard: 5G New Radio (5G NR),[2] which has been developed by the 3rd Generation Partnership Project (3GPP) based on specifications defined by the International Telecommunication Union (ITU) under the IMT-2020 requirements.[3] The increased bandwidth of 5G over 4G allows them to connect more devices simultaneously and improving the quality of cellular data services in crowded areas.[4] These features make 5G particularly suited for applications requiring real-time data exchange, such as extended reality (XR), autonomous vehicles, remote surgery, and industrial automation. Additionally, the increased bandwidth is expected to drive the adoption of 5G as a general Internet service provider (ISP), particularly through fixed wireless access (FWA), competing with existing technologies such as cable Internet, while also facilitating new applications in the machine-to-machine communication and the Internet of Things (IoT), the latter of which may include diverse applications such as smart cities, connected infrastructure, industrial IoT, and automated manufacturing processes. Unlike 4G, which was primarily designed for mobile broadband, 5G can handle millions of IoT devices with stringent performance requirements, such as real-time sensor

data processing and edge computing. 5G networks also extend beyond terrestrial infrastructure, incorporating non-terrestrial networks (NTN) such as satellites and high-altitude platforms, to provide global coverage, including remote and underserved areas. 5G deployment faces challenges such as significant infrastructure investment, spectrum allocation, security risks, and concerns about energy efficiency and environmental impact associated with the use of higher frequency bands. However, it is expected to drive advancements in sectors like healthcare, transportation, and entertainment. Mobile base station at Hatta city, UAE 5G networks are cellular networks,[5] in which the service area is divided into small geographical areas called cells. All 5G wireless devices in a cell communicate by radio waves with a cellular base station via fixed antennas, over frequencies assigned by the base station. The base stations, termed nodes, are connected to switching centers in the telephone network and routers for Internet access by high-bandwidth optical fiber or wireless backhaul connections. As in other cellular networks, a mobile device moving from one cell to another is automatically handed off seamlessly. The industry consortium setting standards for 5G, the 3rd Generation Partnership Project (3GPP), defines "5G" as any system using 5G NR (5G New Radio) software—a definition that came into general use by late 2018. 5G continues to use OFDM encoding. Several network operators use millimeter waves or mmWave called FR2 in 5G terminology, for additional capacity and higher throughputs. Millimeter waves have a shorter range than the lower frequency microwaves, therefore the cells are of a smaller size. Millimeter waves also have more trouble passing through building walls and humans. Millimeter-wave antennas are smaller than the large antennas used in previous cellular networks. The increased data rate is achieved partly by using additional higher-frequency radio waves in addition to the low- and medium-band frequencies used in previous cellular networks. For providing a wide range of services, 5G networks can operate in three frequency bands—low, medium or high. 5G can be implemented in low-band, mid-band or high-band millimeter-wave. Low-band 5G uses a similar frequency range to 4G smartphones, 600–900 MHz, which can potentially offer higher download speeds than 4G: 5–250 megabits per second (Mbit/s).[6][7] Low-band cell towers have a range and coverage area similar to 4G towers. Mid-band 5G uses microwaves of 1.7–4.7 GHz, allowing speeds of 100–900 Mbit/s, with each cell tower providing service up to several kilometers in radius. This level of service is the most widely deployed, and was deployed in many metropolitan areas in 2020. Some regions are not implementing the low band, making Mid-band the minimum service level. High-band 5G uses frequencies of 24–47 GHz, near the bottom of the millimeter wave band, although higher frequencies may be used in the future. It often achieves download speeds in the gigabit-per-second (Gbit/s) range, comparable to co-axial cable Internet service. However, millimeter waves (mmWave or mmW) have a more limited range, requiring many small cells.[8] They can be impeded or blocked by materials in walls or windows or pedestrians.[9][10] Due to their higher cost, plans are to deploy these cells only in dense urban environments and areas where crowds of people congregate such as sports stadiums and convention centers. The above speeds are those achieved in actual tests in 2020, and speeds are expected to increase during rollout.[6] The spectrum ranging from 24.25 to 29.5 GHz has been the most licensed and deployed 5G mmWave spectrum range in the world.[11] Rollout of 5G technology has led to debate over its security and relationship with Chinese vendors. It has also been the subject of health concerns and misinformation, including discredited conspiracy theories linking it to the COVID-19 pandemic. The ITU-R has defined three main application areas for the enhanced capabilities of 5G. They are Enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Communications (URLLC), and Massive Machine Type Communications (mMTC).[12] Only eMBB is deployed in 2020; URLLC and mMTC are several years away in most locations.[13] Enhanced Mobile Broadband (eMBB) uses 5G as a progression from 4G LTE mobile broadband services, with faster connections, higher throughput, and more capacity. This will benefit areas of higher traffic such as stadiums, cities, and concert venues.[14] 'Ultra-Reliable Low-Latency Communications' (URLLC) refers to using the network for mission-critical applications that require uninterrupted and robust data exchange. Short-packet data transmission is used to meet both reliability and latency requirements of the wireless communication networks. Massive Machine-Type Communications (mMTC) would be used to connect to a large number of devices. 5G technology will connect some of the 50 billion connected IoT devices.[15] Most will use the less expensive Wi-Fi. Drones, transmitting via 4G or 5G, will aid in disaster recovery efforts, providing real-time data for emergency responders.[15] Most cars will have a 4G or 5G cellular connection for many services. Autonomous cars do not require 5G, as they have to be able to operate where they do not have a network connection.[16] However, most autonomous vehicles also feature tele-operations for mission accomplishment, and these greatly benefit from 5G technology.[17][18] The 5G Automotive Association has been promoting the C-V2X communication technology that will first be deployed in 4G. It provides for communication between vehicles and infrastructures.[19] A real time digital twin of the real object such as a turbine engine, aircraft, wind turbines, offshore platform and pipelines. 5G networks helps in building it due to the latency and throughput to capture near real-time IoT data and support digital twins. Mission-critical push-to-talk (MCPTT) and mission-critical video and data are expected to be furthered in 5G.[20] Fixed wireless connections will offer an alternative to fixed-line broadband (ADSL, VDSL, fiber optic, and DOCSIS connections) in some locations. Utilizing 5G technology, fixed wireless access (FWA) can deliver high-speed internet to homes and businesses without the need for extensive physical infrastructure. This approach is particularly beneficial in rural or underserved areas where traditional broadband deployment is too expensive or logistically challenging. 5G FWA can outperform older fixed-line technologies such as ADSL and VDSL in terms of speed and latency, making it suitable for bandwidth-intensive applications like streaming, gaming, and remote work.[21][22][23] Sony has tested the possibility of using local 5G networks to replace the SDI cables currently used in broadcast camcorders.[24] The 5G Broadcast tests started around 2020 (Orkney, Bavaria, Austria, Central Bohemia) based on FeMBMS (Further evolved multimedia broadcast multicast service).[25] The aim is to serve unlimited number of mobile or fixed devices with video (TV) and audio (radio) streams without these consuming any data flow or even being authenticated in a network. Main article: Voice over NR 5G networks, like 4G networks, do not natively support voice calls traditionally carried over circuit-switched technology. Instead, voice communication is transmitted over the IP network, similar to IPTV services. To address this, Voice over NR (VoNR) is implemented, allowing voice calls to be carried over the 5G network using the same packet-switched infrastructure as other IP-based services, such as video streaming and messaging. Similarly to how Voice over LTE (VoLTE) enables voice calls on 4G networks, VoNR (Vo5G) serves as the 5G equivalent for voice communication, but it requires a 5G standalone (SA) network to function.[26] This article possibly contains unsourced predictions, speculative material, or accounts of events that might not occur. Information must be verifiable and based on reliable published sources. Please help improve it by removing unsourced speculative content. (January 2022) (Learn how and when to remove this message) 5G is capable of delivering significantly faster data rates than 4G (5G is approximately 10 times faster than 4G),[27][28] with peak data rates of up to 20 gigabits per second (Gbps).[29] Furthermore, average 5G download speeds have been recorded at 186.3 Mbit/s in the U.S. by T-Mobile,[30] while South Korea, as of May 2022[update], leads globally with average speeds of 432 megabits per second (Mbps).[31][32] 5G networks are also designed to provide significantly more capacity than 4G networks, with a projected 100-fold increase in network capacity and efficiency.[33] The most widely used form of 5G, sub-6 GHz 5G (mid-band), is capable of delivering data rates ranging from 10 to 1,000 megabits per second (Mbps), with a much greater reach than mm Wave bands. C-Band (n77/n78) was deployed by various U.S. operators in 2022 in the sub-6 bands, although its deployment by Verizon and AT&T was delayed until early January 2022 due to safety concerns raised by the Federal Aviation Administration. The record for 5G speed in a deployed network is 5.9 Gbit/s as of 2023, but this was tested before the network was launched.[34] Low-band frequencies (such as n5) offer a greater coverage area for a given cell, but their data rates are lower than those of mid and high bands in the range of 5–250 megabits per second (Mbps).[7] In 5G, the ideal "air latency" is of the order of 8 to 12 milliseconds i.e., excluding delays due to HARQ retransmissions, handovers, etc. Retransmission latency and backhaul latency to the server must be added to the "air latency" for correct comparisons. Verizon reported the latency on its 5G early deployment is 30 ms.[35] Edge Servers close to the towers have the possibility to reduce round-trip time (RTT) latency to 14 milliseconds and the minimum jitter to 1.84 milliseconds.[36] Latency is much higher during handovers; ranging from 50 to 500 milliseconds depending on the type of handover[citation needed]. Reducing handover interruption time is an ongoing area of research and development; options include modifying the handover margin (offset) and the time-to-trigger (TTT). 5G uses an adaptive modulation and coding scheme (MCS) to keep the block error rate (BLER) extremely low. Whenever the error rate crosses a (very low) threshold the transmitter will switch to a lower MCS, which will be less error-prone. This way speed is sacrificed to ensure an almost zero error rate. The range of 5G depends on many factors: transmit power, frequency, and interference. For example, mmWave (e.g.: band n258) will have a lower range than mid-band (e.g.: band n78) which will have a lower range than low-band (e.g.: band n5) Given the marketing hype on what 5G can offer, simulators and drive tests are used by cellular service providers for the precise measurement of 5G performance. Initially, the term was associated with the International Telecommunication Union's IMT-2020 standard, which required a theoretical peak download speed of 20 gigabits per second and 10 gigabits per second upload speed, along with other requirements.[29] Then, the industry standards group 3GPP chose the 5G NR (New Radio) standard together with LTE as their proposal for submission to the IMT-2020 standard.[37][38] 5G NR can include lower frequencies (FR1), below 6 GHz, and higher frequencies (FR2), above 24 GHz.[39] However, the speed and latency in early FR1 deployments, using 5G NR software on 4G hardware (non-standalone), are only slightly better than new 4G systems, estimated at 15 to 50% better.[40][41] The standard documents are organized by 3rd Generation Partnership Project (3GPP),[42][43] with its system architecture defined in TS 23.501.[44] The packet protocol for mobility management (establishing connection and moving between base stations) and session management (connecting to networks and network slices) is described in TS 24.501.[45] Specifications of key data structures are found in TS 23.003.[46] DECT NR+ is a related, non-cellular standard of 5G based on DECT-2020 specifications based on a mesh network.[47][48] Further information: Fronthaul and Common Public Radio Interface IEEE covers several areas of 5G with a core focus on wireline sections between the Remote Radio Head (RRH) and Base Band Unit (BBU). The 1914.1 standards focus on network architecture and dividing the connection between the RRU and BBU into two key sections. Radio Unit (RU) to the Distributor Unit (DU) being the NGFI-I (Next Generation Fronthaul Interface) and the DU to the Central Unit (CU) being the NGFI-II interface allowing a more diverse and cost-effective network. NGFI-I and NGFI-II have defined performance values which should be compiled to ensure different traffic types defined by the ITU are capable of being carried.[page needed] The IEEE 1914.3 standard is creating a new Ethernet frame format capable of carrying IQ data in a much more efficient way depending on the functional split utilized. This is based on the 3GPP definition of functional splits.[page needed] Main article: 5G NR 5G NR (5G New Radio) is the de facto air interface developed for 5G networks.[49] It is the global standard for 3GPP 5G networks.[50] The study of 5G NR within 3GPP started in 2015, and the first specification was made available by the end of 2017. While the 3GPP standardization process was ongoing, the industry had already begun efforts to implement infrastructure compliant with the draft standard, with the first large-scale commercial launch of 5G NR having occurred at the end of 2018. Since 2019, many operators have deployed 5G NR networks and handset manufacturers have developed 5G NR enabled handsets.[51] 5Gi is an alternative 5G variant developed in India. It was developed in a joint collaboration between IIT Madras, IIT Hyderabad, TSDSI, and the Centre of Excellence in Wireless Technology (CEWiT) [citation needed]. 5Gi is designed to improve 5G coverage in rural and remote areas over varying geographical terrains. 5Gi uses Low Mobility Large Cell (LMLC) to extend 5G connectivity and the range of a base station.[52] In April 2022, 5Gi was merged with the global 5G NR standard in the 3GPP Release 17 specifications.[53] 5G TF: American carrier Verizon used a pre-standard variation of 5G known as 5G TF (Verizon 5G Technical Forum) for Fixed Wireless Access in 2018. The 5G service provided to customers in this standard is incompatible with 5G NR. Verizon has since migrated to 5G NR.[54] 5G-SIG: KT Corporation had a pre-standard variation of 5G developed called 5G-SIG. This was deployed at the Pyeongchang 2018 Winter Olympics.[55] In the Internet of things (IoT), 3GPP is going to submit the evolution of NB-IoT and eMTC (LTE-M) as 5G technologies for the LPWA (Low Power Wide Area) use case.[56] Standards are being developed by 3GPP to provide access to end devices via non-terrestrial networks (NTN), i.e. satellite or airborne telecommunication equipment to allow for better coverage outside of populated or otherwise hard to reach locations.[57][58] The enhanced communication quality relies on the unique properties of Air to Ground channel. Several manufacturers have announced and released hardware that integrates 5G with satellite networks: Samsung Electronics introduced a standardized 5G NTN modem technology in Korea in February 2023,[59] simulated on their Exynos Modem 5300, facilitating smartphone-satellite communication. MediaTek launched the world's first commercially available 5G IoT-NTN chipset, MT6825, capable of automatic satellite message receipt and extensive power efficiency.[60][61] Qualcomm, in collaboration with Skylo, announced new satellite IoT solutions on June 22, 2023, including the Qualcomm 212S and 9205S modems, supporting the Qualcomm Aware platform for real-time asset tracking and device management.[62] Motorola's Defy Satellite Link hotspot, powered by MediaTek's MT6825, became available in June 2023, providing a portable satellite messaging solution with robust battery life and built-in GPS.[63][64] Rakuten Symphony, in collaboration with Supermicro, announced high-performing Open RAN technologies and storage systems for operators of cloud-based mobile services.[65] 5G-Advanced (also known as 5.5G or 5G-A) is an evolutionary upgrade to 5G technology, defined under the 3GPP Release 18 standard. It serves as a transitional phase between 5G and future 6G networks, focusing on performance optimization, enhanced spectral efficiency, energy efficiency, and expanded functionality. This technology supports advanced applications such as extended reality (XR), massive machine-type communication (mMTC), and ultra-low latency for critical services, such as autonomous vehicles.[66][67][68] 5G-Advanced would offer a theoretical 10 Gbps downlink, 1 Gbps uplink, 100 billion device connections and lower latency.[69] Additionally, 5G-Advanced integrates artificial intelligence (AI) and machine learning (ML) to optimize network operations, enabling smarter resource allocation and predictive maintenance. It also enhances network slicing, allowing highly customized virtual networks for specific use cases such as industrial automation, smart cities, and critical communication systems. 5G-Advanced aims to minimize service interruption times during handovers to nearly zero, ensuring robust connectivity for devices in motion, such as high-speed trains and autonomous vehicles. To further support emerging IoT applications, 5G-Advanced expands the capabilities of RedCap (Reduced Capability) devices, enabling their efficient use in scenarios that require low complexity and power consumption.[70][71] Furthermore, 5G-Advanced introduces advanced time synchronization methods independent of GNSS, providing more precise timing for critical applications. For the first time in the development of mobile network standards defined by 3GPP, it offers fully independent geolocation capabilities, allowing position determination without relying on satellite systems such as GPS. The standard includes extended support for non-terrestrial networks (NTN), enabling communication via satellites and unmanned aerial vehicles, which facilitates connectivity in remote or hard-to-reach areas.[72] In December 2023, Finnish operator DNA demonstrated 10 Gbps speeds on its network using 5G-Advanced technology.[73][74] The Release 18 specifications were finalized by mid-2024.[75][76] On February 27, 2025, Elisa announced its deployment of the first 5G-Advanced network in Finland.[77] In March 2025, China Mobile started deployment of 5G-Advanced network in Hangzhou.[78] See also: List of 5G NR networks 5G 3.5 GHz cell site of Deutsche Telekom in Darmstadt, Germany 5G 3.5 GHz cell site of Vodafone in Karlsruhe, Germany Beyond mobile operator networks, 5G is also expected to be used for private networks with applications in industrial IoT, enterprise networking, and critical communications, in what being described as NR-U (5G NR in Unlicensed Spectrum)[79] and Non-Public Networks (NPNs) operating in licensed spectrum. By the mid-to-late 2020s, standalone private 5G networks are expected to become the predominant wireless communications medium to support the ongoing Industry 4.0 revolution for the digitization and automation of manufacturing and process industries.[80] 5G was expected to increase phone sales.[81] Initial 5G NR launches depended on pairing with existing LTE (4G) infrastructure in non-standalone (NSA) mode (5G NR radio with 4G core), before maturation of the standalone (SA) mode with the 5G core network.[82] As of April 2019, the Global Mobile Suppliers Association had identified 224 operators in 88 countries that have demonstrated, are testing or trialing, or have been licensed to conduct field trials of 5G technologies, are deploying 5G networks or have announced service launches.[83] The equivalent numbers in November 2018 were 192 operators in 81 countries.[84] The first country to adopt 5G on a large scale was South Korea, in April 2019. Swedish telecoms giant Ericsson predicted that 5G Internet will cover up to 65% of the world's population by the end of 2025.[85] Also, it plans to invest 1 billion reals ($238.30 million) in Brazil to add a new assembly line dedicated to fifth-generation technology (5G) for its Latin American operations.[86] When South Korea launched its 5G network, all carriers used Samsung, Ericsson, and Nokia base stations and equipment, except for LG U Plus, who also used Huawei equipment.[87][88] Samsung was the largest supplier for 5G base stations in South Korea at launch, having shipped 53,000 base stations at the time, out of 86,000 base stations installed across the country at the time.[89] The first fairly substantial deployments were in April 2019. In South Korea, SK Telecom claimed 38,000 base stations, KT Corporation 30,000 and LG U Plus 18,000; of which 85% are in six major cities.[90] They are using 3.5 GHz (sub-6) spectrum in non-standalone (NSA) mode and tested speeds were from 193 to 430 Mbit/s down.[91] 260,000 signed up in the first month and 4.7 million by the end of 2019.[92] T-Mobile US was the first company in the world to launch a commercially available 5G NR Standalone network.[93] Nine companies sell 5G radio hardware and 5G systems for carriers: Altiostar, Cisco Systems, Datang Telecom/Fiberhome, Ericsson, Huawei, Nokia, Qualcomm, Samsung, and ZTE.[94][95][96][97][98][99][100] As of 2023, Huawei is the leading 5G equipment manufacturer and has the greatest market share of 5G equipment and has built approximately 70% of worldwide 5G base stations.[101]:182 Large quantities of new radio spectrum (5G NR frequency bands) have been allocated to 5G.[102] For example, in July 2016, the U.S. Federal Communications Commission (FCC) freed up vast amounts of bandwidth in underused high-band spectrum for 5G. The Spectrum Frontiers Proposal (SFP) doubled the amount of millimeter-wave unlicensed spectrum to 14 GHz and created four times the amount of flexible, mobile-use spectrum the FCC had licensed to date.[103] In March 2018, European Union lawmakers agreed to open up the 3.6 and 26 GHz bands by 2020.[104] As of March 2019[update], there are reportedly 52 countries, territories, special administrative regions, disputed territories and dependencies that are formally considering introducing certain spectrum bands for terrestrial 5G services, are holding consultations regarding suitable spectrum allocations for 5G, have reserved spectrum for 5G, have announced plans to auction frequencies or have already allocated spectrum for 5G use.[105] 5G connectivity on a Samsung Galaxy S10 In March 2019, the Global Mobile Suppliers Association released the industry's first database tracking worldwide 5G device launches.[106] In it, the GSA identified 23 vendors who have confirmed the availability of forthcoming 5G devices with 33 different devices including regional variants. There were seven announced 5G device form factors: (telephones (×12 devices), hotspots (×4), indoor and outdoor customer-premises equipment (×8), modules (×5), Snap-on dongles and adapters (×2), and USB terminals (×1)).[107] By October 2019, the number of announced 5G devices had risen to 129, across 15 form factors, from 56 vendors.[108] In the 5G IoT chipset arena, as of April 2019 there were four commercial 5G modem chipsets (Intel, MediaTek, Qualcomm, Samsung) and one commercial processor/platform, with more launches expected in the near future.[109]An Apple iPhone showing that it is connected to a 5G Network On March 4, 2019, the first-ever all-5G smartphone Samsung Galaxy S10 5G was released. According to Business Insider, the 5G feature was showcased as more expensive in comparison with the 4G Samsung Galaxy S10e.[110] On March 19, 2020, HMD Global, the current maker of Nokia-branded phones, announced the Nokia 8.3 5G, which it claimed as having a wider range of 5G compatibility than any other phone released to that time. The mid-range model is claimed to support all 5G bands from 600 MHz to 3.8 GHz.[111] Google Pixel smartphones support 5G starting with the 4a 5G and Pixel 5,[112] while Apple smartphones support 5G starting with the iPhone 12.[113][114] See also: 5G NR frequency bands The air interface defined by 3GPP for 5G is known as 5G New Radio (5G NR), and the specification is subdivided into two frequency bands, FR1 (below 6 GHz) and FR2 (24–54 GHz). Otherwise known as sub-6, the maximum channel bandwidth defined for FR1 is 100 MHz, due to the scarcity of continuous spectrum in this crowded frequency range. The band most widely being used for 5G in this range is 3.3–4.2 GHz. The Korean carriers use the n78 band at 3.5 GHz. Some parties used the term "mid-band" frequency to refer to higher part of this frequency range that was not used in previous generations of mobile communication. The minimum channel bandwidth defined for FR2 is 50 MHz and the maximum is 400 MHz, with two-channel aggregation supported in 3GPP Release 15. Signals in this frequency range with wavelengths between 4 and 12 mm are called millimeter waves. The higher the carrier frequency, the greater the ability to support high data-transfer speeds. This is because a given channel bandwidth takes up a lower fraction of the carrier frequency, so high-bandwidth channels are easier to realize at higher carrier frequencies. 5G in the 24 GHz range or above use higher frequencies than 4G, and as a result, some 5G signals are not capable of traveling large distances (over a few hundred meters), unlike 4G or lower frequency 5G signals (sub 6 GHz). This requires placing 5G base stations every few hundred meters in order to use higher frequency bands. Also, these higher frequency 5G signals cannot penetrate solid objects easily, such as cars, trees, walls, and even humans, because of the nature of these higher frequency electromagnetic waves. 5G cells can be deliberately designed to be as inconspicuous as possible, which finds applications in places like restaurants and shopping malls.[115] Cell types Deployment environment Max. number of users Output power (W) Max. distance from base station 5G NR FR2 Femtocell Homes, businesses Home: 4–8Businesses: 16–32 indoors: 0.01–0.1outdoors: 0.2–1 tens of meters Pico cell Public areas like shopping malls,airports, train stations, skyscrapers 64 to 128 indoors: 0.1–0.25outdoors: 1–5 tens of meters Micro cell Urban areas to fill coverage gaps 128 to 256 outdoors: 5−10 few hundreds of meters Macro cell Urban areas to provide additional capacity more than 250 outdoors: 10−20 hundreds of meters Wi-Fi(for comparison) Homes, businesses fewer than 50 indoors: 0.02–0.1outdoors: 0.2–1 few tens of meters See also: Multi-user MIMO MIMO (multiple-input and multiple-output) systems use multiple antennas at the transmitter and receiver ends of a wireless communication system. Multiple antennas use the spatial dimension for multiplexing in addition to the time and frequency ones, without changing the bandwidth requirements of the system. Spatial multiplexing gains allow for an increase in the number of transmission layers, thereby boosting system capacity. Massive MIMO antennas increases sector throughput and capacity density using large numbers of antennas. This includes Single User MIMO and Multi-user MIMO (MU-MIMO). The antenna array can schedule users separately to satisfy their needs and beamform towards the intended users, minimizing interference.[116] Main article: Multi-access edge computing Edge computing is delivered by computing servers closer to the ultimate user. It reduces latency, data traffic congestion[117][118] and can improve service availability.[119] Main article: Small cell Small cells are low-powered cellular radio access nodes that operate in licensed and unlicensed spectrum that have a range of 10 meters to a few kilometers. Small cells are critical to 5G networks, as 5G's radio waves can't travel long distances, because of 5G's higher frequencies.[120][121][122][123] Main article: Beamforming There are two kinds of beamforming (BF): digital and analog. Digital beamforming involves sending the data across multiple streams (layers), while analog beamforming shaping the radio waves to point in a specific direction. The analog BF technique combines the power from elements of the antenna array in such a way that signals at particular angles experience constructive interference, while other signals pointing to other angles experience destructive interference. This improves signal quality in the specific direction, as well as data transfer speeds. 5G uses both digital and analog beamforming to improve the system capacity.[124][125] One expected benefit of the transition to 5G is the convergence of multiple networking functions to achieve cost, power, and complexity reductions. LTE has targeted convergence with Wi-Fi band/technology via various efforts, such as License Assisted Access (LAA; 5G signal in unlicensed frequency bands that are also used by Wi-Fi) and LTE-WLAN Aggregation (LWA; convergence with Wi-Fi Radio), but the differing capabilities of cellular and Wi-Fi have limited the scope of convergence. However, significant improvement in cellular performance specifications in 5G, combined with migration from Distributed Radio Access Network (D-RAN) to Cloud- or Centralized-RAN (C-RAN) and rollout of cellular small cells can potentially narrow the gap between Wi-Fi and cellular networks in dense and indoor deployments. Radio convergence could result in sharing ranging from the aggregation of cellular and Wi-Fi channels to the use of a single silicon device for multiple radio access technologies.[126] NOMA (non-orthogonal multiple access) is a proposed multiple-access technique for future cellular systems via allocation of power.[127] Main articles: Software-defined networking, SD-WAN, Network function virtualization, and 5G network slicing Initially, cellular mobile communications technologies were designed in the context of providing voice services and Internet access. Today a new era of innovative tools and technologies is inclined towards developing a new pool of applications. This pool of applications consists of different domains such as the Internet of Things (IoT), web of connected autonomous vehicles, remotely controlled robots, and heterogeneous sensors connected to serve versatile applications.[128] In this context, network slicing has emerged as a key technology to efficiently embrace this new market model.[129] The 5G Service-Based architecture replaces the referenced-based architecture of the Evolved Packet Core that is used in 4G. The SBA breaks up the core functionality of the network into interconnected network functions (NFs), which are typically implemented as Cloud-Native Network Functions. These NFs register with the Network Repository Function (NRF) which maintains their state, and communicate with each other using the Service Communication Proxy (SCP). The interfaces between the elements all utilize RESTful APIs.[130] By breaking functionality down this way, mobile operators are able to utilize different infrastructure vendors for different functions, and the flexibility to scale each function independently as needed.[130] 5G Network Functions [131] NF Name NF Acronym Analogous EPC element Authentication Server Function AUSF MME / HSS (Authentication) Access and Mobility Management Function AMF MME Unstructured Data Storage Function UDSF N/A Network Exposure Function NEF N/A Network Slice Specific Authentication and Authorization Function NSSAAF N/A Network Slice Selection Function NSSF N/A Policy Control Function PCF PCRF Session Management Function SMF MME / PGW-C Unified Data Management UDM HSS (DB Front End) Unified Data Repository UDR HSS (User Database) User Plane Function UPF SGW-U / PGW-U UE radio Capability Management Function UCMF N/A Application Function AF AF (IMS) Network Data Analytics Function NWDAF N/A CHarging Function CHF CSCF In addition, the standard describes network entities for roaming and inter-network connectivity, including the Security Edge Protection Proxy (SEPP), the Non-3GPP InterWorking Function (N3IWF), the Trusted Non-3GPP Gateway Function (TNGF), the Wireline Access Gateway Function (W-AGF), and the Trusted WLAN Interworking Function (TWIF). These can be deployed by operators as needed depending on their deployment. The channel coding techniques for 5G NR have changed from Turbo codes in 4G to polar codes for the control channels and LDPC (low-density parity check codes) for the data channels.[132][133] In December 2018, 3GPP began working on unlicensed spectrum specifications known as 5G NR-U, targeting 3GPP Release 16.[134] Qualcomm has made a similar proposal for LTE in unlicensed spectrum. 5G wireless power is a technology based on 5G standards that transfers wireless power.[135][136] It adheres to technical standards set by the 3rd Generation Partnership Project, the International Telecommunication Union, and the Institute of Electrical and Electronics Engineers. It utilizes extremely high frequency radio waves with wavelengths from one to ten millimeters, also known as mmWaves.[137][138] Up to 6μW of power has been demonstrated being captured from 5G signals at a distance of 180m by researchers at Georgia Tech.[135] Internet of things devices could benefit from 5G wireless power technology, given their low power requirements that are within the range of what has been achieved using 5G power capture.[139] See also: Concerns over Chinese involvement in 5G wireless networks and Criticism of Huawei § Espionage and security concerns A report published by the European Commission and European Agency for Cybersecurity details the security issues surrounding 5G. The report warns against using a single supplier for a carrier's 5G infrastructure, especially those based outside the European Union; Nokia and Ericsson are the only European manufacturers of 5G equipment.[140] On October 18, 2018, a team of researchers from ETH Zurich, the University of Lorraine and the University of Dundee released a paper entitled, "A Formal Analysis of 5G Authentication".[141][142] It alerted that 5G technology could open ground for a new era of security threats. The paper described the technology as "immature and insufficiently tested," and one that "enables the movement and access of vastly higher quantities of data, and thus broadens attack surfaces". Simultaneously, network security companies such as Fortinet,[143] Arbor Networks,[144] A10 Networks,[145] and Voxility[146] advised on personalized and mixed security deployments against massive DDoS attacks foreseen after 5G deployment. IoT Analytics estimated an increase in the number of IoT devices, enabled by 5G technology, from 7 billion in 2018 to 21.5 billion by 2025.[147] This can raise the attack surface for these devices to a substantial scale, and the capacity for DDoS attacks, cryptojacking, and other cyberattacks could boost proportionally.[142] In addition, the EPS solution for 5G networks has identified a design vulnerability. The vulnerability affects the operation of the device during cellular network switching.[148] Due to fears of potential espionage of users of Chinese equipment vendors, several countries (including the United States, Australia and the United Kingdom as of early 2019)[149] have taken actions to restrict or eliminate the use of Chinese equipment in their respective 5G networks. A 2012 U.S. House Permanent Select Committee on Intelligence report concluded that using equipment made by Huawei and ZTE, another Chinese telecommunications company, could "undermine core U.S. national security interests".[150] In 2018, six U.S. intelligence chiefs, including the directors of the CIA and FBI, cautioned Americans against using Huawei products, warning that the company could conduct "undetected espionage".[151] Further, a 2017 investigation by the FBI determined that Chinese-made Huawei equipment could disrupt U.S. nuclear arsenal communications.[152] Chinese vendors and the Chinese government have denied claims of espionage, but experts have pointed out that Huawei would have no choice but to hand over network data to the Chinese government if Beijing asked for it because of Chinese National Security Law.[153] In August 2020, the U.S. State Department launched "The Clean Network" as a U.S. government-led, bi-partisan effort to address what it described as "the long-term threat to data privacy, security, human rights and principled collaboration posed to the free world from authoritarian malign actors". Promoters of the initiative have stated that it has resulted in an "alliance of democracies and companies", "based on democratic values". On October 7, 2020, the UK Parliament's Defence Committee released a report claiming that there was clear evidence of collusion between Huawei and Chinese state and the Chinese Communist Party. The UK Parliament's Defence Committee said that the government should consider removal of all Huawei equipment from its 5G networks earlier than planned.[154] In December 2020, the United States announced that more than 60 nations, representing more than two thirds of the world's gross domestic product, and 200 telecom companies, had publicly committed to the principles of The Clean Network. This alliance of democracies included 27 of the 30 NATO members; 26 of the 27 EU members, 31 of the 37 OECD nations, 11 of the 12 Three Seas nations as well as Japan, Israel, Australia, Singapore, Taiwan, Canada, Vietnam, and India. Parts of this article (those related to 5G, short for the fifth generation of wireless technology, employs a range of higher-frequency radio waves than its predecessors.) need to be updated. Please help update this article to reflect recent events or newly available information. (January 2022) The spectrum used by various 5G proposals, especially the n258 band centered at 26 GHz, will be near that of passive remote sensing such as by weather and Earth observation satellites, particularly for water vapor monitoring at 23.8 GHz.[155] Interference is expected to occur due to such proximity and its effect could be significant without effective controls. An increase in interference already occurred with some other prior proximate band usages.[156][157] Interference to satellite operations impairs numerical weather prediction performance with substantially deleterious economic and public safety impacts in areas such as commercial aviation.[158][159] The concerns prompted U.S. Secretary of Commerce Wilbur Ross and NASA Administrator Jim Bridenstine in February 2019 to urge the FCC to delay some spectrum auction proposals, which was rejected.[160] The chairs of the House Appropriations Committee and House Science Committee wrote separate letters to FCC chairman Ajit Pai asking for further review and consultation with NOAA, NASA, and DoD, and warning of harmful impacts to national security.[161] Acting NOAA director Neil Jacobs testified before the House Committee in May 2019 that 5G out-of-band emissions could produce a 30% reduction in weather forecast accuracy and that the resulting degradation in ECMWF model performance would have resulted in failure to predict the track and thus the impact of Superstorm Sandy in 2012. The United States Navy in March 2019 wrote a memorandum warning of deterioration and made technical suggestions to control band bleed-over limits, for testing and fielding, and for coordination of the wireless industry and regulators with weather forecasting organizations.[162] At the 2019 quadrennial World Radiocommunication Conference (WRC), atmospheric scientists advocated for a strong buffer of −55 dBW, European regulators agreed on a recommendation of −42 dBW, and US regulators (the FCC) recommended a restriction of −20 dBW, which would permit signals 150 times stronger than the European proposal. The ITU decided on an intermediate −33 dBW until September 1, 2027, and after that a standard of −39 dBW.[163] This is closer to the European recommendation but even the delayed higher standard is much weaker than that requested by atmospheric scientists, triggering warnings from the World Meteorological Organization (WMO) that the ITU standard, at 10 times less stringent than its recommendation, brings the "potential to significantly degrade the accuracy of data collected".[164] A representative of the American Meteorological Society (AMS) also warned of interference,[165] and the European Centre for Medium-Range Weather Forecasts (ECMWF), sternly warned, saying that society risks "history repeat[ing] itself" by ignoring atmospheric scientists' warnings (referencing global warming, monitoring of which could be imperiled).[166] In December 2019, a bipartisan request was sent from the US House Science Committee to the Government Accountability Office (GAO) to investigate why there is such a discrepancy between recommendations of US civilian and military science agencies and the regulator, the FCC.[167] The United States FAA has warned that radar altimeters on aircraft, which operate between 4.2 and 4.4 GHz, might be affected by 5G operations between 3.7 and 3.98 GHz. This is particularly an issue with older altimeters using RF filters[168] which lack protection from neighboring bands.[169] This is not as much of an issue in Europe, where 5G uses lower frequencies between 3.4 and 3.8 GHz.[170] Nonetheless, the DGAC in France has also expressed similar worries and recommended 5G phones be turned off or be put in airplane mode during flights.[171] On December 31, 2021, U.S. Transportation Secretary Pete Buttigieg and Steve Dickinson, administrator of the Federal Aviation Administration asked the chief executives of AT&T and Verizon to delay 5G implementation over aviation concerns. The government officials asked for a two-week delay starting on January 5, 2022, while investigations are conducted on the effects on radar altimeters. The government transportation officials also asked the cellular providers to hold off their new 5G service near 50 priority airports, to minimize disruption to air traffic that would be caused by some planes being disallowed from landing in poor visibility.[172] After coming to an agreement with government officials the day before,[173] Verizon and AT&T activated their 5G networks on January 19, 2022, except for certain towers near 50 airports.[174] AT&T scaled back its deployment even further than its agreement with the FAA required.[175] The FAA rushed to test and certify radar altimeters for interference so that planes could be allowed to perform instrument landings (e.g. at night and in low visibility) at affected airports. By January 16, it had certified equipment on 45% of the U.S. fleet, and 78% by January 20.[176] Airlines complained about the avoidable impact on their operations, and commentators said the affair called into question the competence of the FAA.[177] Several international airlines substituted different planes so they could avoid problems landing at scheduled airports, and about 2% of flights (320) were cancelled by the evening of January 19.[178] Further information: C band (IEEE) A number of 5G networks deployed on the radio frequency band of 3.3–3.6 GHz are expected to cause interference with C-Band satellite stations, which operate by receiving satellite signals at 3.4–4.2 GHz frequency.[179] This interference can be mitigated with low-noise block downconverters and waveguide filters.[179] In regions like the US and EU, the 6 GHz band is to be opened up for unlicensed applications, which would permit the deployment of 5G-NR Unlicensed, 5G version of LTE in unlicensed spectrum, as well as Wi-Fi 6e. However, interference could occur with the co-existence of different standards in the frequency band.[180] There have been concerns surrounding the promotion of 5G, questioning whether the technology is overhyped. There are questions on whether 5G will truly change the customer experience,[181] ability for 5G's mmWave signal to provide significant coverage,[182][183] overstating what 5G can achieve or misattributing continuous technological improvement to "5G",[184] lack of new use case for carriers to profit from,[185] wrong focus on emphasizing direct benefits on individual consumers instead of for Internet of Things devices or solving the last mile problem,[186] and overshadowing the possibility that in some aspects there might be other more appropriate technologies.[187] Such sort of concerns have also led to consumers not trusting information provided by cellular providers on the topic.[188] Main article: 5G misinformation Further information: Wireless device radiation and health There is a long history of fear and anxiety surrounding wireless signals that predates 5G technology. The fears about 5G are similar to those that have persisted throughout the 1990s and 2000s. According to the US Centers for Disease Control and Prevention (CDC) "exposure to intense, direct amounts of non-ionizing radiation may result in damage to tissue due to heat. This is not common and mainly of concern in the workplace for those who work on large sources of non-ionizing radiation devices and instruments."[189] Some advocates of fringe health claim the regulatory standards are too low and influenced by lobbying groups.[190] An anti-5G sticker in Luxembourg There have been rumors that 5G mobile phone use can cause cancer, but this is a myth.[191] Many popular books of dubious merit have been published on the subject[additional citation(s) needed] including one by Joseph Mercola alleging that wireless technologies caused numerous conditions from ADHD to heart diseases and brain cancer. Mercola has drawn sharp criticism for his anti-vaccinationism during the COVID-19 pandemic and was warned by the Food and Drug Administration to stop selling fake COVID-19 cures through his online alternative medicine business.[190][192] According to The New York Times, one origin of the 5G health controversy was an erroneous unpublished study that physicist Bill P. Curry did for the Broward County School Board in 2000 which indicated that the absorption of external microwaves by brain tissue increased with frequency.[193] According to experts[vague] this was wrong, the millimeter waves used in 5G are safer than lower frequency microwaves because they cannot penetrate the skin and reach internal organs. Curry had confused in vitro and in vivo research. However Curry's study was widely distributed on the Internet. Writing in The New York Times in 2019, William Broad reported that RT America began airing programming linking 5G to harmful health effects which "lack scientific support", such as "brain cancer, infertility, autism, heart tumors, and Alzheimer's disease". Broad asserted that the claims had increased. RT America had run seven programs on this theme by mid-April 2019 but only one in the whole of 2018. The network's coverage had spread to hundreds of blogs and websites.[194] In April 2019, the city of Brussels in Belgium blocked a 5G trial because of radiation rules.[195] In Geneva, Switzerland, a planned upgrade to 5G was stopped for the same reason.[196] The Swiss Telecommunications Association (ASUT) has said that studies have been unable to show that 5G frequencies have any health impact.[197] According to CNET,[198] "Members of Parliament in the Netherlands are also calling on the government to take a closer look at 5G. Several leaders in the United States Congress have written to the Federal Communications Commission expressing concern about potential health risks. In Mill Valley, California, the city council blocked the deployment of new 5G wireless cells."[198][199][200][201][202] Similar concerns were raised in Vermont[203] and New Hampshire.[198] The US FDA is quoted saying that it "continues to believe that the current safety limits for cellphone radiofrequency energy exposure remain acceptable for protecting the public health".[204] After campaigning by activist groups, a series of small localities in the UK, including Totnes, Brighton and Hove, Glastonbury, and Frome, passed resolutions against the implementation of further 5G infrastructure, though these resolutions have no impact on rollout plans.[205][206][207] Low-level EMF does have some effects on other organisms.[208] Vian et al., 2006 finds an effect of microwave on gene expression in plants.[208] A meta-analysis of 95 in vitro and in vivo studies showed that an average of 80% of the in vivo research showed effects of such radiation, as did 58% of the in vitro research, but that the results were inconclusive as to whether any of these effects pose a health risk.[209] Main article: COVID-19 misinformation § 5G mobile-phone networks The World Health Organization published a mythbuster infographic to combat the conspiracy theories about COVID-19 and 5G As the introduction of 5G technology coincided with the time of the COVID-19 pandemic, several conspiracy theories circulating online posited a link between COVID-19 and 5G.[210] This has led to dozens of arson attacks being made on telecom masts in the Netherlands (Amsterdam, Rotterdam, etc.), Ireland (Cork,[211] etc.), Cyprus, the United Kingdom (Dagenham, Huddersfield, Birmingham, Belfast and Liverpool),[212][213] Belgium (Pelt), Italy (Maddaloni), Croatia (Bibinje)[214] and Sweden.[215] It led to at least 61 suspected arson attacks against telephone masts in the United Kingdom alone[216] and over twenty in The Netherlands. In the early months of the pandemic, anti-lockdown protesters at protests over responses to the COVID-19 pandemic in Australia were seen with anti-5G signs, an early sign of what became a wider campaign by conspiracy theorists to link the pandemic with 5G technology. There are two versions of the 5G-COVID-19 conspiracy theory:[190] The first version claims that radiation weakens the immune system, making the body more vulnerable to SARS-CoV-2 (the virus that causes COVID-19). The second version claims that 5G causes COVID-19. There are different variations on this. Some claim that the pandemic is coverup of illness caused by 5G radiation or that COVID-19 originated in Wuhan because that city was "the guinea-pig city for 5G". Main articles: 5G Evolution, LTE Advanced Pro, and LTE AdvancedThis section needs expansion. You can help by adding to it. (October 2023) In various parts of the world, carriers have launched numerous differently branded technologies, such as "5G Evolution", which advertise improving existing networks with the use of "5G technology".[217] However, these pre-5G networks are an improvement on specifications of existing LTE networks that are not exclusive to 5G. While the technology promises to deliver higher speeds, and is described by AT&T as a "foundation for our evolution to 5G while the 5G standards are being finalized", it cannot be considered to be true 5G. When AT&T announced 5G Evolution, 4x4 MIMO, the technology that AT&T is using to deliver the higher speeds, had already been put in place by T-Mobile without being branded with the 5G moniker. It is claimed that such branding is a marketing move that will cause confusion with consumers, as it is not made clear that such improvements are not true 5G.[218] With the rollout of 5G, 4G has become more available and affordable, with the world's most developed countries having >90% LTE coverage.[219] Because of this, 4G is still not obsolete even today.[220] 4G plans are sold alongside 5G plans on US carriers,[221] with 4G being cheaper than 5G.[222] This section needs to be updated. Please help update this article to reflect recent events or newly available information. (April 2019) Cellular network standards and generation timeline. In April 2008, NASA partnered with Geoff Brown and Machine-to-Machine Intelligence (M2Mi) Corp to develop a fifth generation communications technology approach, though largely concerned with working with nanosats.[223] That same year, the South Korean IT R&D program of "5G mobile communication systems based on beam-division multiple access and relays with group cooperation" was formed.[224] In August 2012, New York University founded NYU Wireless, a multi-disciplinary academic research centre that has conducted pioneering work in 5G wireless communications.[225] On October 8, 2012, the UK's University of Surrey secured £35M for a new 5G research centre, jointly funded by the British government's UK Research Partnership Investment Fund (UKRPIF) and a consortium of key international mobile operators and infrastructure providers, including Huawei, Samsung, Telefónica Europe, Fujitsu Laboratories Europe, Rohde & Schwarz, and Aircom International. It will offer testing facilities to mobile operators keen to develop a mobile standard that uses less energy and less radio spectrum, while delivering speeds higher than current 4G with aspirations for the new technology to be ready within a decade.[226][227][228][229] On November 1, 2012, the EU project "Mobile and wireless communications Enablers for the Twenty-twenty Information Society" (METIS) started its activity toward the definition of 5G. METIS achieved an early global consensus on these systems. In this sense, METIS played an important role in building consensus among other external major stakeholders prior to global standardization activities. This was done by initiating and addressing work in relevant global fora (e.g. ITU-R), as well as in national and regional regulatory bodies.[230] That same month, the iJOIN EU project was launched, focusing on "small cell" technology, which is of key importance for taking advantage of limited and strategic resources, such as the radio wave spectrum. According to Günther Oettinger, the European Commissioner for Digital Economy and Society (2014–2019), "an innovative utilization of spectrum" is one of the key factors at the heart of 5G success. Oettinger further described it as "the essential resource for the wireless connectivity of which 5G will be the main driver".[231] iJOIN was selected by the European Commission as one of the pioneering 5G research projects to showcase early results on this technology at the Mobile World Congress 2015 (Barcelona, Spain). In February 2013, ITU-R Working Party 5D (WP 5D) started two study items: (1) Study on IMT Vision for 2020 and beyond, and; (2) Study on future technology trends for terrestrial IMT systems. Both aiming at having a better understanding of future technical aspects of mobile communications toward the definition of the next generation mobile.[232] On May 12, 2013, Samsung Electronics stated that they had developed a "5G" system. The core technology has a maximum speed of tens of Gbit/s (gigabits per second). In testing, the transfer speeds for the "5G" network sent data at 1.056 Gbit/s to a distance of up to 2 kilometers with the use of an 8*8 MIMO.[233][234] In July 2013, India and Israel agreed to work jointly on development of fifth generation (5G) telecom technologies.[235] On October 1, 2013, NTT (Nippon Telegraph and Telephone), the same company to launch world's first 5G network in Japan, wins Minister of Internal Affairs and Communications Award at CEATEC for 5G R&D efforts.[236] On November 6, 2013, Huawei announced plans to invest a minimum of $600 million into R&D for next generation 5G networks capable of speeds 100 times higher than modern LTE networks.[237] On April 3, 2019, South Korea became the first country to adopt 5G.[238] Just hours later, Verizon launched its 5G services in the United States, and disputed South Korea's claim of becoming the world's first country with a 5G network, because allegedly, South Korea's 5G service was launched initially for just six South Korean celebrities so that South Korea could claim the title of having the world's first 5G network.[239] In fact, the three main South Korean telecommunication companies (SK Telecom, KT, and LG Uplus) added more than 40,000 users to their 5G network on the launch day.[240] In June 2019, the Philippines became the first country in Southeast Asia to roll out a 5G broadband network after Globe Telecom commercially launched its 5G data plans to customers.[241] AT&T brings 5G service to consumers and businesses in December 2019 ahead of plans to offer 5G throughout the United States in the first half of 2020.[242][243][244] In 2020, AIS and TrueMove H launched 5G services in Thailand, making it the first country in Southeast Asia to have commercial 5G.[245][246] A functional mockup of a Russian 5G base station, developed by domestic specialists as part of Rostec's digital division Rostec.digital, was presented in Nizhny Novgorod at the annual conference "Digital Industry of Industrial Russia".[247][248] 5G speeds have declined in many countries since 2022, which has driven the development of 5.5G to increase connection speeds.[249]

^ When there is only one user in the network ^ Hoffman, Chris (January 7, 2019). "What is 5G, and how fast will it be?". How-To Geek website. How-To Geek LLC. Archived from the original on January 24, 2019. Retrieved January 23, 2019. ^ "5G NR | 5g New Radio Standard | Qualcomm". www.qualcomm.com. Retrieved February 27, 2025. ^ "3GPP meets IMT-2020". www.3gpp.org. Retrieved February 26, 2025. ^ "5G explained: What it is, who has 5G, and how much faster is it really?". CNN. Archived from the original on November 27, 2021. Retrieved November 27, 2021. ^ Segan, Sascha (May 16, 2022). "What Is 5G?". PCMAG. Retrieved April 12, 2025. ^ a b Horwitz, Jeremy (December 10, 2019). "The definitive guide to 5G low, mid, and high band speeds". VentureBeat online magazine. Archived from the original on November 5, 2020. Retrieved April 23, 2020. ^ a b De Looper, Christian; Jansen, Mark (April 22, 2022). "Is 5G as fast as they're saying? We break down the speeds". Digital Trends. Archived from the original on May 27, 2023. Retrieved May 27, 2023. ^ Davies, Darrell (May 20, 2019). "Small Cells – Big in 5G". Nokia. Archived from the original on November 1, 2020. Retrieved August 29, 2020. ^ Violette, E. J.; Espeland, R. H.; DeBolt, R. O.; Schwering, F. K. (May 1988). "Millimeter-wave propagation at street level in an urban environment". IEEE Transactions on Geoscience and Remote Sensing. 26 (3). IEEE: 368–380. Bibcode:1988ITGRS..26..368V. doi:10.1109/36.3038. Archived from the original on June 23, 2021. Retrieved March 19, 2021. For non-line-of-sight (non-LOS) paths obstructed by buildings of several common materials, results that showed signal attenuations in excess of 100 dB. When the LOS followed a path directly through clear glass walls, the attenuation was small at all probe frequencies. However, when the glass wall had a metalized coating to reduce ultraviolet and infrared radiation, the attenuation increased by 25 to 50 dB for each metallized layer. In most cases no signals could be detected through steel reinforced concrete or brick buildings. ^ Ganji, Venkata Siva Santosh; Lin, Tzu-Hsiang; Espinal, Francisco A.; Kumar, P. R. (January 5, 2021). "UNBLOCK: Low Complexity Transient Blockage Recovery for Mobile mm-Wave Devices". 2021 International Conference on COMmunication Systems & NETworkS (COMSNETS). IEEE. pp. 501–508. arXiv:2104.02658. doi:10.1109/COMSNETS51098.2021.9352816. ISBN 978-1-7281-9127-0. S2CID 231976614. ^ "FCC Auction 102 – 24 GHz". fcc.gov. Federal Communications Commission. ^ "5G – Its Not Here Yet, But Closer Than You Think". October 31, 2017. Archived from the original on January 6, 2019. Retrieved January 6, 2019. ^ "Managing the Future of Cellular" (PDF). March 20, 2020. Archived (PDF) from the original on September 23, 2020. Retrieved September 24, 2020. ^ Yu, Heejung; Lee, Howon; Jeon, Hongbeom (October 2017). "What is 5G? Emerging 5G Mobile Services and Network Requirements". Sustainability. 9 (10): 1848. Bibcode:2017Sust....9.1848Y. doi:10.3390/su9101848. ^ a b "Intel Accelerates the Future with World's First Global 5G Modem". Intel Newsroom. Archived from the original on September 6, 2018. Retrieved November 21, 2019. ^ "Ford: Self-driving cars "will be fully capable of operating without C-V2X"". wirelessone.news. Archived from the original on October 27, 2020. Retrieved December 1, 2019. ^ "5GAA Tele-Operated Driving (ToD): Use Cases and Technical Requirements Technical Requirements" (PDF). 5G Automotive Association. Archived (PDF) from the original on March 3, 2021. Retrieved February 8, 2021. ^ "Smooth teleoperator: The rise of the remote controller". VentureBeat. August 17, 2020. Archived from the original on February 7, 2021. Retrieved February 8, 2021. ^ "5GAA, Audi, Ford and Qualcomm Showcase C-V2X Direct Communications Interoperability to Improve Road Safety". newswire.ca. Archived from the original on January 6, 2019. Retrieved January 14, 2019. ^ "The Promise of 5G for Public Safety". EMS World. Archived from the original on December 16, 2018. Retrieved January 14, 2019. ^ Fulton III, Scott. "What is 5G? All you need to know about the next generation of wireless technology". ZDNet. Archived from the original on April 21, 2019. Retrieved April 21, 2019. ^ "5G Fixed Wireless Access (FWA) technology | What Is It?". 5g.co.uk. Archived from the original on April 21, 2019. Retrieved April 21, 2019. ^ "Capture value with 5G Fixed Wireless Access in a world of opportunities". ^ "Sony and Verizon Demonstrate 5G transmission for covering live sports". January 11, 2020. Archived from the original on November 7, 2020. Retrieved March 22, 2020. ^ "Technology behind the project". 5g-today.de. Archived from the original on January 18, 2022. Retrieved April 8, 2022. ^ "In One Minute, What is VoNR?". academy.qualcomm.com. Retrieved April 12, 2025. ^ "What is 5G | Everything You Need to Know About 5G | 5G FAQ | Qualcomm". www.qualcomm.com. Retrieved April 12, 2025. ^ "5G explained: What it is, who has 5G, and how much faster is it really?". www.cnn.com. Retrieved April 12, 2025. ^ a b "Minimum requirements related to technical performance for IMT-2020 radio interface(s)" (PDF). Archived (PDF) from the original on January 8, 2019. Retrieved August 16, 2019. ^ "Opensignal declares T-Mo US fastest 5G carrier, again". January 30, 2023. Retrieved April 12, 2025. ^ Wyrzykowski, Robert (January 2023). "Mobile Network Experience 5G Report – USA". OpenSignal. Archived from the original on May 27, 2023. Retrieved May 27, 2023. ^ Fogg, Ian (June 22, 2022). "Benchmarking the Global 5G Experience – June 2022". OpenSignal. Archived from the original on May 27, 2023. Retrieved May 27, 2023. ^ I, Chih-Lin; Han, Shuangfeng; Bian, Sen (2020). "Energy-efficient 5G for a greener future". Nature Electronics. 3 (4): 182–184. doi:10.1038/s41928-020-0404-1. S2CID 257095960. ^ "Faroese Telecom and Ericsson claim 5G mmWave downlink speed record". www.telecoms.com. Retrieved April 12, 2025. ^ "What is the Latency of 5G?". www.verizon.com. February 2, 2020. Retrieved April 12, 2025. ^ Vanichchanunt, Pisit; Yamyuan, Ittipon; Sasithong, Pruk; Wuttisittikulkij, Lunchakorn; Paripurana, Sukritta (January 11, 2023). "Implementation of Edge Servers on an Open 5G Core Network". 2023 International Conference on Information Networking (ICOIN). IEEE. pp. 642–645. doi:10.1109/ICOIN56518.2023.10049000. ISBN 978-1-6654-6268-6. ^ Gartenberg, Chaim (December 21, 2017). "The first real 5G specification has officially been completed". The Verge. Archived from the original on January 7, 2019. Retrieved June 25, 2018. ^ Flynn, Kevin. "Workshop on 3GPP submission towards IMT-2020". 3gpp.org. Archived from the original on January 7, 2019. Retrieved January 6, 2019. ^ Wu, Hao (March 17, 2020), "A Brief Overview of CRC Implementation for 5G NR", Moving Broadband Mobile Communications Forward - Intelligent Technologies for 5G and Beyond, IntechOpen, ISBN 978-1-83962-344-8, retrieved April 12, 2025 ^ Dave. "5G NR Only 25% to 50% Faster, Not Truly a New Generation". wirelessone.news. Archived from the original on June 20, 2018. Retrieved June 25, 2018. ^ Teral, Stephane (January 30, 2019). "5G best choice architecture" (PDF). ZTE. Archived (PDF) from the original on February 2, 2019. Retrieved February 1, 2019. ^ "Specification Numbering". 3GPP. Archived from the original on February 17, 2022. Retrieved February 17, 2022. ^ "3GPP Specification Status Report". 3GPP. Archived from the original on January 27, 2022. Retrieved February 26, 2022. ^ "ETSI TS 123 501 V16.12.0 (2022–03). 5G; System architecture for the 5G System (5GS) (3GPP TS 23.501 version 16.12.0 Release 16)" (PDF). ETSI and 3GPP. Archived (PDF) from the original on April 19, 2022. Retrieved April 6, 2022. (TS 23.501) ^ "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3. (3GPP TS 24.501 version 16.10.0 Release 16) TS 24.501 release 16.10.0" (PDF). ETSI and 3GPP. Archived (PDF) from the original on February 17, 2022. Retrieved February 26, 2022. (TS 24.501) ^ "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Numbering, addressing and identification (3GPP TS 23.003 version 16.8.0 Release 16)" (PDF). ETSI and 3GPP. Archived (PDF) from the original on February 26, 2022. Retrieved February 26, 2022. (TS 23.003) ^ "DECT NR+". www.nordicsemi.com. Retrieved February 27, 2025. ^ Rowe, Martin (August 16, 2023). "The first non-cellular 5G standard: DECT NR+". 5G Technology World. Retrieved February 27, 2025. ^ Kavanagh, Sacha. "What is 5G New Radio (5G NR)". 5g.co.uk. Archived from the original on November 8, 2018. Retrieved November 8, 2018. ^ "Making 5G New Radio (NR) a Reality – The Global 5G Standard – IEEE Communications Society". comsoc.org. Archived from the original on November 8, 2018. Retrieved January 6, 2019. ^ ctrfantennas (August 24, 2021). "Status And Future Of 5G New Radio Technology - C&T RF Antennas Manufacturer". Retrieved April 12, 2025. ^ Sha, Arjun (August 3, 2022). "What is India's 5Gi Standard? Explained!". Beebom. Retrieved April 12, 2025. ^ Das, Aditi (April 29, 2022). "TSDSI 5Gi standard merged with 3GPP 5G". India's Telecom SDO. Retrieved April 12, 2025. ^ Kastrenakes, Jacob (December 7, 2018). "Is Verizon's 5G home internet real 5G?". The Verge. Archived from the original on December 7, 2018. Retrieved October 7, 2019. ^ "Mobile industry eyes 5G devices in early 2019". telecomasia.net. Archived from the original on January 6, 2019. Retrieved January 6, 2019. ^ "With LTE-M and NB-IoT You're Already on the Path to 5G". sierrawireless.com. Archived from the original on January 6, 2019. Retrieved January 6, 2019. ^ Munira Jaffar & Nicolas Chuberre (July 1, 2022). "NTN & Satellite in Rel-17 & 18". 3rd Generation Partnership Project (3GPP). ^ Xingqin Lin; Stefan Rommer; Sebastian Euler; Emre A. Yavuz; Robert S. Karlsson (2021). "5G from Space: An Overview of 3GPP Non-Terrestrial Networks". arXiv:2103.09156 [cs.NI]. ^ "Samsung Electronics Introduces Standardized 5G NTN Modem Technology To Power Smartphone-Satellite Communication". news.samsung.com. Retrieved June 30, 2023. ^ MediaTek (April 12, 2025). "MediaTek to Showcase its Groundbreaking Satellite Connectivity...". MediaTek. Retrieved April 12, 2025. ^ "5G Satellite (NTN)". MediaTek. Retrieved June 30, 2023. ^ "Qualcomm Launches New Satellite IoT Solutions to Provide Uninterrupted Remote Monitoring and Asset Tracking". www.qualcomm.com. Retrieved June 30, 2023. ^ Amadeo, Ron (June 29, 2023). "Motorola's "Satellite Link" hotspot lets you send messages via outer space". Ars Technica. Retrieved June 30, 2023. ^ "Motorola Defy Satellite Link". Motorola Rugged USA. Retrieved June 30, 2023. ^ "Supermicro and Rakuten Symphony Extend Their Collaboration and Offer Complete 5G, Telco, and Edge Solutions For Cloud Based Open RAN Mobile Networks". www.prnewswire.com. Retrieved April 12, 2025. ^ "Release 18". www.3gpp.org. Archived from the original on November 25, 2021. Retrieved November 25, 2021. ^ "The 5G Advanced, an evolution towards 6G". ericsson.com. Retrieved April 12, 2025. ^ "5G-Advanced explained". nokia.com. September 15, 2023. ^ "TDD Multi-Carrier Aggregation Builds Foundation For New 5G Advanced Experiences". www.counterpointresearch.com. Retrieved March 3, 2025. ^ "5G-Advanced's system architecture begins taking shape at 3GPP". Nokia. Archived from the original on November 25, 2021. Retrieved November 25, 2021. ^ "Four ways 5G-Advanced will transform our industry". Nokia. Archived from the original on November 26, 2021. Retrieved November 26, 2021. ^ Fattah, Hossam Abdel (February 3, 2024). "Non-Terrestrial Networks in 3GPP Release 18 for Global IoT Expansion". 5G HUB TECHNOLOGIES, INC. Retrieved April 12, 2025. ^ Mavrakis, Dimitris. "2024 Will Be the Year of 5G-Advanced". www.abiresearch.com. Retrieved April 12, 2025. ^ "体验为王！DNA现网演示吹响5G-A欧洲商用号角 - 业界资讯 — C114(通信网)" [Experience is king! DNA's live network demonstration heralds the commercial launch of 5G-A in Europe - Industry News — C114 (Communications Network)]. www.c114.com.cn. Retrieved April 12, 2025. ^ Tomás, Juan Pedro (June 30, 2023). "Huawei to launch full set of commercial 5.5G network equipment in 2024". RCR Wireless News. Retrieved September 14, 2023. ^ "5G Advanced positioning in 3GPP Release 18". ericsson.com. Retrieved April 12, 2025. ^ Turner, Annie (March 31, 2025). "Elisa launches 'world first' 5.5G network for Finnish consumers". Mobile Europe. Retrieved May 10, 2025. ^ "爱立信支持中国移动全球首发5G-A商用部署" [Ericsson supports China Mobile in the world's first commercial deployment of 5G-A.]. ericsson.com (in Chinese (China)). Retrieved April 12, 2025. ^ "NR-U Transforming 5G – Qualcomm Presentation". GSA. January 18, 2018. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "The Private LTE & 5G Network Ecosystem: 2023 – 2030". www.snstelecom.com. Retrieved August 14, 2023. ^ "Japan wants TSMC, Sony to build 20 nanometre chip plant -Nikkan Kogyo". Reuters. Archived from the original on June 2, 2021. Retrieved April 12, 2025. ^ "[ケータイ用語の基礎知識]第941回：NSA・SA方式とは" [[Basic Knowledge of Mobile Terminology] Episode 941: What are NSA and SA Architectures?]. ケータイ Watch. February 19, 2020. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "LTE and 5G Market Statistics". GSA. April 8, 2019. Archived from the original on November 18, 2020. Retrieved April 24, 2019. ^ "5G Investments: Trials, Deployments, Launches". GSA. Archived from the original on April 2, 2019. ^ Taylor, Chloe (November 25, 2019). "5G coverage will span two thirds of the global population in 6 years, Ericsson predicts". CNBC. Archived from the original on November 29, 2019. Retrieved November 29, 2019. ^ Mello, Gabriela (November 25, 2019). "Ericsson to invest over $230 million in Brazil to build new 5G assembly line". Archived from the original on October 27, 2020. Retrieved May 6, 2020. ^ "Telecom's 5G revolution triggers shakeup in base station market". Nikkei Asian Review. Archived from the original on April 21, 2019. Retrieved April 21, 2019. ^ "Samsung Electronics supplies 53,000 5G base stations for Korean carriers". RCR Wireless News. April 10, 2019. Archived from the original on April 12, 2019. Retrieved April 13, 2019. ^ " 5G 53000 ... 5 '"'. . April 10, 2019. Archived from the original on November 7, 2020. Retrieved April 21, 2019. ^ "Samsung dominates Korea 5G deployments". Mobile World Live. April 10, 2019. Archived from the original on April 10, 2019. Retrieved April 11, 2019. ^ "Fast but patchy: Trying South Korea's new 5G service". Nikkei Asian Review. Archived from the original on April 12, 2019. Retrieved April 11, 2019. ^ "Korea 5G Falls by Half. Miracle Over?". wirelessone.news. Archived from the original on October 27, 2020. Retrieved March 27, 2020. ^ "T-Mobile Launches World's First Nationwide Standalone 5G Network". T-Mobile Newsroom. Archived from the original on January 30, 2022. Retrieved January 30, 2022. ^ "Japan allocates 5G spectrum, excludes Chinese equipment vendors". South China Morning Post. April 11, 2019. Retrieved April 12, 2025. ^ "Huawei Launches Full Range of 5G End-to-End Product Solutions". huawei. Archived from the original on April 13, 2019. Retrieved April 13, 2019. ^ "Japan allocates 5G spectrum to carriers, blocks Huawei and ZTE gear". VentureBeat. April 10, 2019. Archived from the original on April 13, 2019. Retrieved April 13, 2019. ^ "Samsung signals big 5G equipment push, again, at factory". January 4, 2019. Archived from the original on April 13, 2019. Retrieved April 13, 2019. ^ "Nokia says it is the one-stop shop for 5G network gear | TechRadar". techradar.com. February 26, 2019. Archived from the original on April 13, 2019. Retrieved April 13, 2019. ^ "5G radio – Ericsson". Ericsson.com. February 6, 2018. Archived from the original on April 13, 2019. Retrieved April 13, 2019. ^ Riccardo Barlaam (February 21, 2019). "HHN TECH". Il Sole 24 Ore (in Italian). Archived from the original on

July 25, 2019. Retrieved July 24, 2019. ^ Parzyan, Anahit (2023). "China's Digital Silk Road: Empowering Capabilities for Digital Leadership in Eurasia". China and Eurasian Powers in a Multipolar World Order 2.0: Security, Diplomacy, Economy and Cyberspace. Mher Sahakyan. New York: Routledge. ISBN 978-1-003-35258-7. OCLC 1353290533. ^ "5G Spectrum Recommendations" (PDF). Archived from the original (PDF) on December 23, 2018. Retrieved October 7, 2019. ^ "FCC Spectrum Frontier Proposal". NYU Wireless. July 15, 2016. Archived from the original on May 26, 2017. Retrieved May 18, 2017. ^ Chee, Foo Yun (March 3, 2018). "EU countries, lawmakers strike deal to open up spectrum for 5G". Reuters. Archived from the original on January 7, 2019. Retrieved March 3, 2018. ^ "Spectrum for Terrestrial 5G Networks: Licensing Developments Worldwide". GSA. March 2019. Archived from the original on April 2, 2019. ^ "GSA launches first global database of commercial 5G devices". Total Telecom. Archived from the original on April 2, 2019. ^ "5G Device Ecosystem Report". GSA. Archived from the original on April 2, 2019. ^ "5G Devices: Ecosystem Report". GSA. September 2019. Archived from the original on October 13, 2019. ^ "LTE, 5G and 3GPP IoT Chipsets: Status Update". GSA. April 2019. Archived from the original on October 30, 2020. Retrieved April 24, 2019. ^ "5G is making the smartphones we love more expensive than ever". Business Insider. March 14, 2020. Archived from the original on August 18, 2020. Retrieved March 16, 2020. ^ Collins, Katie (March 19, 2020). "The Nokia 8.3 is the 'first global 5G phone.' Here's what that means for you". CNET. Archived from the original on October 27, 2020. Retrieved March 19, 2020. ^ "Google Pixel 5". GSMArena. Archived from the original on October 17, 2022. Retrieved October 27, 2022. ^ "What consumers need to know about this week's AT&T-Verizon 5G rollout". CBS News. January 20, 2022. Archived from the original on February 26, 2022. Retrieved February 26, 2022. ^ "iPhone 12 and 5G: All the answers to your questions about the super-fast connectivity". CNET. Archived from the original on February 26, 2022. Retrieved February 26, 2022. ^ "5G speed vs 5G range-What is the value of 5G speed,5G range". rfwireless-world.com. Archived from the original on April 21, 2019. Retrieved April 21, 2019. ^ Manivasagam; Garima; Shukla, Meenu (December 19, 2023). "Massive MIMO in 5G Networks: Trends and Challenges". 2023 International Conference on Power Energy, Environment & Intelligent Control (PEEIC). IEEE. pp. 1456–1460. doi:10.1109/PEEIC59336.2023.10450543. ISBN 979-8-3503-5776-9. ^ "IT Needs to Start Thinking About 5G and Edge Cloud Computing". February 7, 2018. Archived from the original on June 12, 2018. Retrieved June 8, 2018. ^ "Mobile Edge Computing – An Important Ingredient of 5G Networks". IEEE Softwarization. March 2016. Archived from the original on February 24, 2019. Retrieved February 24, 2019. ^ Brand, Aron (September 20, 2019). "3 Advantages of Edge Computing". medium.com. Archived from the original on January 22, 2023. Retrieved September 20, 2019. ^ "Scenarios and requirements for small cell enhancements for E-UTRA and E-UTRAN (3GPP TR 36.932 version 16.0.0 Release 16)" (PDF). ETSI and 3GPP. Archived (PDF) from the original on February 26, 2022. Retrieved February 26, 2022. (TR 36.932) ^ "5G small cells: everything you need to know". 5gradar.com. February 18, 2021. Archived from the original on February 26, 2022. Retrieved February 26, 2022. ^ "Small Cells – Big in 5G". Nokia. Archived from the original on November 1, 2020. Retrieved August 29, 2020. ^ "Small Cell". Ericsson. Archived from the original on February 26, 2022. Retrieved February 26, 2022. ^ Rappaport, Theodore S.; Sun, Shu; Mayzus, Rimma; Zhao, Hang; Azar, Yaniv; Wang, Kevin; Wong, George N.; Schulz, Jocelyn K.; Samimi, Mathew; Gutierrez, Felix (2013). "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!". IEEE Access. 1: 335–349. Bibcode:2013IEEEA...1..335R. doi:10.1109/ACCESS.2013.2260813. ISSN 2169-3536. ^ "What is 5G Beamforming?". Verizon Enterprise. Archived from the original on October 25, 2021. Retrieved September 6, 2022. ^ "Article – 5G | Solwise Ltd". www.solwise.co.uk. Archived from the original on May 16, 2022. Retrieved December 18, 2022. ^ Ghafoor, Umar; Ali, Mudassar; Khan, Humayun Zubair; Siddiqui, Adil Masood; Naeem, Muhammad (August 1, 2022). "NOMA and future 5G & B5G wireless networks: A paradigm". Journal of Network and Computer Applications. 204: 103413. doi:10.1016/j.jnca.2022.103413. ISSN 1084-8045. S2CID 248803932. ^ "WS-21: SDN5GSC – Software Defined Networking for 5G Architecture in Smart Communities". IEEE Global Communications Conference. May 17, 2018. Archived from the original on March 8, 2019. Retrieved March 7, 2019. ^ Ordonez-Lucena, J.; Ameigeiras, P.; Lopez, D.; Ramos-Munoz, J. J.; Lorca, J.; Folgueira, J. (2017). "Network Slicing for 5G with SDN/NFV: Concepts, Architectures, and Challenges". IEEE Communications Magazine. 55 (5): 80–87. arXiv:1703.04676. Bibcode:2017arXiv170304676O. doi:10.1109/MCOM.2017.1600935. hdl:10481/45368. ISSN 0163-6804. S2CID 206456434. ^ a b "What is a Service Based Architecture?". September 9, 2021. ^ "System architecture for the 5G System (5GS)" (PDF). ETSI. October 2020. ^ "5G Channel Coding" (PDF). Archived from the original (PDF) on December 6, 2018. Retrieved January 6, 2019. ^ Maunder, Robert (September 2016). "A Vision for 5G Channel Coding" (PDF). Archived from the original (PDF) on December 6, 2018. Retrieved January 6, 2019. ^ "5G NR 3GPP | 5G NR Qualcomm". Qualcomm. December 12, 2018. Archived from the original on April 22, 2019. Retrieved April 15, 2019. ^ a b Eid, Aline; Hester, Jimmy G. D.; Tentzeris, Manos M. (January 12, 2021). "5G as a wireless power grid". Scientific Reports. 11 (1). Nature Portfolio. 636. doi:10.1038/s41598-020-79500-x. ISSN 2045-2322. LCCN 2011250880. OCLC 732869387. PMC 7804946. PMID 33436681. ^ Linder, Courtney (April 30, 2021). "We Could Really Have a Wireless Power Grid That Runs on 5G". Popular Mechanics. Retrieved February 23, 2022. ^ Wagih, Mahmoud; Weddell, Alex S.; Beeby, Steve (October 1, 2020). Nikita, Konstantina S. (ed.). "Millimeter-Wave Power Harvesting: A Review". IEEE Open Journal of Antennas and Propagation. 1. Institute of Electrical and Electronics Engineers: 568–578. doi:10.1109/OJAP.2020.3028220. eISSN 2637-6431. ^ Khan, Talha Ahmed; Heath, Robert W. Jr. (December 21, 2018). "Wireless Power Transfer in Millimeter Wave". In Ng, Derrick Wing Kwan; Duong, Trung Q.; Zhong, Caijun; Schober, Robert (eds.). Wireless Information and Power Transfer (1 ed.). Wiley. pp. 139–156. doi:10.1002/9781119476863.ch8. ISBN 9781119476863. S2CID 116385421. Retrieved February 23, 2022. ^ Georgia Tech (March 23, 2021). Leveraging the 5G Network to Wirelessly Power IoT Devices (Videotape). Retrieved February 23, 2022. ^ Duckett, Chris (October 10, 2019). "Europe warns 5G will increase attack paths for state actors". ZDNet. Archived from the original on November 17, 2020. Retrieved January 12, 2020. ^ Basin, David; Dreier, Jannik; Hirschi, Lucca; Radomirovic, Saša; Sasse, Ralf; Stettler, Vincent (2018). "A Formal Analysis of 5G Authentication". Proceedings of the 2018 ACM SIGSAC Conference on Computer and Communications Security – CCS '18. pp. 1383–1396. arXiv:1806.10360. doi:10.1145/3243734.3243846. ISBN 9781450356930. S2CID 49480110. ^ a b "How to Prepare for the Coming 5G Security Threats". Security Intelligence. November 26, 2018. Archived from the original on July 22, 2019. Retrieved July 22, 2019. ^ Maddison, John (February 19, 2019). "Addressing New Security Challenges with 5G". CSO Online. Archived from the original on July 22, 2019. Retrieved July 22, 2019. ^ "NETSCOUT Predicts: 5G Trends for 2019". NETSCOUT. Archived from the original on July 22, 2019. Retrieved July 22, 2019. ^ "The Urgency of Network Security in the Shared LTE/5G Era". A10 Networks. June 19, 2019. Archived from the original on July 22, 2019. Retrieved July 22, 2019. ^ "Security concerns in a 5G era: are networks ready for massive DDoS attacks?". scmagazineuk.com. Archived from the original on October 28, 2020. Retrieved July 22, 2019. ^ "State of the IoT 2018: Number of IoT devices now at 7B – Market accelerating". August 8, 2018. Archived from the original on July 24, 2019. Retrieved July 22, 2019. ^ Attar, Hani; Issa, Haitham; Ababneh, Jafar; Abbasi, Mahdi; Solyman, Ahmed A. A.; Khosravi, Mohammad; Said Agieb, Ramy (October 11, 2022). "5G System Overview for Ongoing Smart Applications: Structure, Requirements, and Specifications". Computational Intelligence and Neuroscience. 2022: 1–11. doi:10.1155/2022/2476841. ISSN 1687-5273. PMC 9578857. PMID 36268153. ^ Proctor, Jason (April 29, 2019). "Why Canada's decisions on who builds 5G technology are so important". CBC News. Canadian Broadcasting Corporation. Archived from the original on July 22, 2019. Retrieved July 31, 2019. ^ "Investigative Report on the U.S. National Security Issues Posed by Chinese Telecommunications Companies Huawei and ZTE" (PDF). US House Permanent Select Committee on Intelligence. October 8, 2012. Archived (PDF) from the original on December 30, 2022. Retrieved January 6, 2023. ^ "Huawei: China's Controversial Tech Giant". Council on Foreign Relations. Archived from the original on December 30, 2022. Retrieved December 30, 2022. ^ Lillis, Katie Bo (July 23, 2022). "CNN Exclusive: FBI investigation determined Chinese-made Huawei equipment could disrupt US nuclear arsenal communications | CNN Politics". CNN. Archived from the original on December 30, 2022. Retrieved December 30, 2022. ^ Kharpal, Arjun (March 5, 2019). "Huawei says it would never hand data to China's government. Experts say it wouldn't have a choice". CNBC. Archived from the original on May 29, 2019. Retrieved December 30, 2022. ^ Corera, Gordon (October 7, 2020). "Huawei: MPs claim 'clear evidence of collusion' with Chinese Communist Party". BBC News. Archived from the original on October 14, 2020. Retrieved October 7, 2020. ^ "What's needed to keep 5G from compromising weather forecasts". GCN. September 29, 2020. Archived from the original on December 4, 2021. Retrieved December 4, 2021. ^ Misra, Sidharth (January 10, 2019). "The Wizard Behind the Curtain? – The Important, Diverse, and Often Hidden Role of Spectrum Allocation for Current and Future Environmental Satellites and Water, Weather, and Climate". 15th Annual Symposium on New Generation Operational Environmental Satellite Systems. Phoenix, AZ: American Meteorological Society. Archived from the original on May 5, 2019. Retrieved May 5, 2019. ^ Lubar, David G. (January 9, 2019). "A Myriad of Proposed Radio Spectrum Changes – Collectively Can They Impact Operational Meteorology?". 15th Annual Symposium on New Generation Operational Environmental Satellite Systems. Phoenix, AZ: American Meteorological Society. Archived from the original on May 5, 2019. Retrieved May 5, 2019. ^ Witze, Alexandra (April 26, 2019). "Global 5G wireless networks threaten weather forecasts". Nature. 569 (7754): 17–18. Bibcode:2019Natur.569...17W. doi:10.1038/d41586-019-01305-4. PMID 31040411. S2CID 140396172. ^ Brackett, Ron (May 1, 2019). "5G Wireless Networks Could Interfere with Weather Forecasts, Meteorologists Warn". The Weather Channel. Archived from the original on May 5, 2019. ^ Samenow, Jason (March 8, 2019). "Critical weather data threatened by FCC 'spectrum' proposal, Commerce Dept. and NASA say". The Washington Post. Archived from the original on March 31, 2019. Retrieved May 5, 2019. ^ Samenow, Jason (March 13, 2019). "FCC to auction off wireless spectrum that could interfere with vital weather data, rejecting requests from U.S. House and science agencies". The Washington Post. Archived from the original on May 9, 2019. Retrieved May 29, 2019. ^ Paul, Don (May 27, 2019). "Some worry 5G may pose huge problems for weather forecasting". The Buffalo Post. Archived from the original on May 30, 2019. Retrieved May 29, 2019. ^ Witze, Alexandra (November 22, 2019). "Global 5G wireless deal threatens weather forecasts". Nature. 575 (7784): 577. Bibcode:2019Natur.575..577W. doi:10.1038/d41586-019-03609-x. PMID 31772363. S2CID 208302844. ^ "WMO expresses concern about radio frequency decision" (Press release). Geneva, Switzerland: World Meteorological Organization. November 27, 2019. Retrieved November 30, 2019. ^ Freedman, Andrew (November 26, 2019). "Global 5G deal poses significant threat to weather forecast accuracy, experts warn". The Washington Post. Archived from the original on November 27, 2019. Retrieved December 1, 2019. ^ "ECMWF statement on the outcomes of the ITU WRC-2019 conference" (Press release). Reading, UK: European Centre for Medium-Range Weather Forecasts. November 25, 2019. Archived from the original on January 8, 2021. Retrieved December 1, 2019. ^ Freedman, Andrew (December 11, 2019). "'We are deeply concerned': House Science Committee seeks investigation of how 5G could hurt weather forecasting". The Washington Post. Archived from the original on December 12, 2019. Retrieved December 12, 2019. ^ "5G altimeter interference: aviation versus telecoms". 5G Technology World. December 23, 2021. Archived from the original on January 18, 2022. Retrieved January 19, 2022. ^ "U.S. FAA Issues Safety Alert on 5G Interference to Aircraft". Bloomberg News. November 2, 2021. Archived from the original on December 4, 2021. Retrieved December 4, 2021. ^ "Europe rolled out 5G without hurting aviation. Here's how". CNN. January 19, 2022. Archived from the original on January 19, 2022. Retrieved January 19, 2022. ^ "5G phones may interfere with aircraft: French regulator". France 24. February 16, 2021. Archived from the original on December 15, 2021. Retrieved December 15, 2021. ^ Shields, Todd; Levin, Allan (December 31, 2021). "Buttigieg Asks AT&T, Verizon to Delay 5G Over Aviation Concerns". Bloomberg News. Archived from the original on January 2, 2022. Retrieved January 2, 2022. ^ "Wireless carriers to limit 5G near airports after airlines warn of major disruptions". Washington Post. January 18, 2022. Archived from the original on January 19, 2022. Retrieved January 22, 2022. ^ "Verizon 5G Gets Activated Despite Warnings About Airport Problems; AT&T 5G Follows Suit". TechTimes. January 19, 2022. Archived from the original on January 22, 2022. Retrieved January 22, 2022. ^ "AT&T and Verizon are limiting C-band 5G expansion around airports even more". The Verge. January 18, 2022. Archived from the original on January 22, 2022. Retrieved January 22, 2022. ^ Federal Aviation Administration (January 21, 2022). "5G and Aviation Safety". Archived from the original on January 22, 2022. Retrieved January 22, 2022. ^ Von Drehle, David (January 18, 2022). "Opinion: The FAA's 5G freakout raises a big red flag — about its competence". Washington Post. Archived from the original on January 19, 2022. Retrieved January 22, 2022. ^ "Airlines cancel some flights after reduced 5G rollout in US". MSN. Archived from the original on January 22, 2022. Retrieved January 22, 2022. ^ a b "SatMagazine". www.satmagazine.com. Archived from the original on December 4, 2021. Retrieved December 4, 2021. ^ Naik, Gaurang; Park, Jung-Min; Ashdown, Jonathan; Lehr, William (December 15, 2020). "Next Generation Wi-Fi and 5G NR-U in the 6 GHz Bands: Opportunities and Challenges". IEEE Access. 8: 153027–56. arXiv:2006.16534. Bibcode:2020IEEEA...8o3027N. doi:10.1109/ACCESS.2020.3016036. S2CID 220265664. Archived from the original on December 15, 2021. Retrieved December 4, 2021 – via IEEE Xplore. ^ Johnson, Allison (April 29, 2021). "Dear wireless carriers: the 5G hype needs to stop". The Verge. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ Morris, Iain (February 28, 2017). "Vodafone CTO 'Worried' About 5G mmWave Hype". Light Reading. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ Chamberlain, Kendra (April 22, 2019). "T-Mobile says 5G mmWave deployments 'will never materially scale'". Fierce Wireless. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ Blackman, James (December 5, 2019). "Why the 5G revolution is over-hyped nonsense – in every respect except one". Enterprise IoT Insights. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "Cutting through the 5G hype | McKinsey". mckinsey.com. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "Expert Round Up: Is 5G Worth All the Hype? – GeoLinks.com". February 21, 2019. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "5G isn't for everyone: How Alternate IoT Solutions come into play | Industrial Ethernet Book". iebmedia.com. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "Consumers Want to Cut Through the Hype About 5G". PCMAG. April 15, 2019. Archived from the original on February 9, 2022. Retrieved February 9, 2022. ^ "The Electromagnetic Spectrum: Non-Ionizing Radiation". United States Centers for Disease Control and Prevention. December 7, 2015. Archived from the original on December 31, 2015. Retrieved August 21, 2021. ^ a b c Meese, James; Frith, Jordan; Wilken, Rowan (2020). "COVID-19, 5G conspiracies and infrastructural futures". Media International Australia. 177 (1): 30–46. doi:10.1177/1329878X20952165. PMC 7506181. ^ "Do mobile phones, 4G or 5G cause cancer?". Cancer Research UK. February 8, 2022. ^ "FDA warns Mercola: Stop selling fake COVID remedies and cures". Alliance for Science. Cornell University. March 15, 2021. Archived from the original on March 16, 2021. Retrieved August 21, 2021. ^ Broad, William J. (July 16, 2019). "The 5G Health Hazard That Isn't". The New York Times. Archived from the original on October 1, 2019. Retrieved December 16, 2021. ^ Broad, William J. (May 12, 2019). "Your 5G Phone Won't Hurt You. But Russia Wants You to Think Otherwise". The New York Times. Archived from the original on May 20, 2019. Retrieved May 12, 2019. ^ "Brussels halts 5G plans over radiation rules". FierceWireless. April 8, 2019. Archived from the original on April 9, 2019. Retrieved April 11, 2019. ^ "Schweiz: Genf stoppt Aufbau von 5G-Mobilfunkantennen" (in German). April 11, 2019. Archived from the original on April 14, 2019. Retrieved April 14, 2019. ^ "5G Mobile Technology Fact Check" (PDF). asut. March 27, 2019. Archived (PDF) from the original on April 3, 2019. Retrieved April 7, 2019. ^ a b c "5G phones and your health: What you need to know". CNET. June 20, 2019. Archived from the original on June 22, 2019. Retrieved June 22, 2019. ^ "Radiation concerns halt Brussels 5G development, for now". The Brussels Times. April 1, 2019. Archived from the original on July 14, 2019. Retrieved July 19, 2019. ^ "Kamer wil eerst stralingsonderzoek, dan pas 5G-netwerk". Algemeen Dagblad. April 4, 2019. Archived from the original on December 16, 2020. Retrieved July 19, 2019. ^ "Switzerland to monitor potential health risks posed by 5G networks". Reuters. April 17, 2019. Archived from the original on July 29, 2019. Retrieved July 19, 2019. ^ "Bay Area city blocks 5G deployments over cancer concerns". TechCrunch. September 10, 2018. Archived from the original on December 30, 2020. Retrieved July 19, 2019. ^ Dillon, John (May 7, 2019). "Broadband Bill to Be Amended to Address Concerns Over 5G Technology". Vermont Public Radio (VPR). Archived from the original on May 7, 2019. Retrieved July 19, 2019. ^ "5G: What is it and how it will help us". Archived from the original on December 25, 2020. Retrieved July 29, 2019. ^ Humphries, Will (October 12, 2019). "Councils block 5G as scare stories spread". The Times. London. Archived from the original on October 14, 2019. Retrieved October 25, 2019. ^ "Brighton and Hove City Council join growing list of local authorities banning 5G masts". itpro.co.uk. October 14, 2019. Archived from the original on October 25, 2019. Retrieved October 25, 2019. ^ "5G 'no more dangerous than talcum powder and pickled vegetables', says digital minister Matt Warman". The Telegraph. London. Archived from the original on October 18, 2019. Retrieved October 25, 2019. ^ a b Levitt, Blake; Lai, Henry; Manville, Albert (2021). "Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment". Reviews on Environmental Health. 37 (1). Walter de Gruyter GmbH: 81–122. doi:10.1515/reveh-2021-0026. ISSN 0048-7554. PMID 34047144. S2CID 235219718. ^ Simkó; Mattsson (September 13, 2019). "5G Wireless Communication and Health Effects—A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz". International Journal of Environmental Research and Public Health. 16 (18). MDPI AG: 3406. doi:10.3390/ijerph16183406. ISSN 1660-4601. PMC 6765906. PMID 31540320. ^ Warren, Tom (April 4, 2020). "British 5G towers are being set on fire because of coronavirus conspiracy theories". The Verge. Archived from the original on December 25, 2020. Retrieved April 5, 2020. ^ Murphy, Ann (April 23, 2020). "Update: Arson attack on Cork mast linked to false 5G conspiracy theory". Echo Live. Archived from the original on October 28, 2020. Retrieved April 30, 2020. ^ Fildes, Nic; Di Stefano, Mark; Murphy, Hannah (April 16, 2020). "How a 5G coronavirus conspiracy spread across Europe". Financial Times. Archived from the original on December 13, 2020. Retrieved April 16, 2020. ^ "Mast fire probe amid 5G coronavirus claims". BBC News. April 4, 2020. Archived from the original on January 17, 2021. Retrieved April 5, 2020. ^ "Bibinje: Nepoznati glupani oštetili odašiljač za kojeg su mislili da je 5G". Seebiz (in Croatian). April 15, 2020. Archived from the original on November 7, 2020. Retrieved April 21, 2020. ^ Cerulus, Laurens (April 26, 2020). "5G arsonists turn up in continental Europe". Politico. Archived from the original on January 4, 2021. Retrieved April 30, 2020. ^ Osborne, Charlie (April 30, 2020). "5G mast arson, coronavirus conspiracy theories force social media to walk a fine censorship line". ZD Net. Archived from the original on October 18, 2020. Retrieved May 2, 2020. ^ Cheng, Roger (April 19, 2018). "AT&T brings higher speeds with pre-5G tech to 117 cities". CNET. Archived from the original on January 6, 2019. Retrieved January 6, 2019. ^ Gartenberg, Chaim (April 25, 2017). "AT&T announces it will build a fake 5G network". The Verge. Archived from the original on November 21, 2018. Retrieved January 6, 2019. ^ "Share of the population covered by at least a 4G mobile network | Access Indicators". OECD Going Digital Toolkit. Retrieved December 29, 2024. ^ Mangino, Melina (March 6, 2024). "4G vs. 5G: Which is Best for Industrial IoT Gateways?". The Safety Connection | MSA FieldServer Blog. Retrieved December 29, 2024. ^ "With the launch of 5G, will 4G continue to exist?". support.totalwireless.com. Retrieved December 29, 2024. ^ Expert, AT&T (December 30, 2023). "Does 5G Cost More? - AT&T National". get-service.us. Retrieved December 29, 2024. ^ Curie, M.; Mewhinney, M.; Cooper, S. (April 24, 2008). "NASA Ames Partners With M2MI For Small Satellite Development". NASA. Archived from the original on April 8, 2019. Retrieved April 8, 2019. ^ Sunitha, C.; Krishnan, Deepika G.; Dhanya, V. A. (January 2017). "Overview of Fifth Generation Networking" (PDF). International Journal of Computer Trends and Technology. 43 (1). Archived from the original (PDF) on February 11, 2020. Retrieved October 7, 2020. ^ "The world's first academic research center combining Wireless, Computing, and Medical Applications". NYU Wireless. June 20, 2014. Archived from the original on March 11, 2016. Retrieved January 14, 2016. ^ Kelly, Spencer (October 13, 2012). "BBC Click Programme – Kenya". BBC News Channel. Archived from the original on April 10, 2019. Retrieved October 15, 2012. Some of the world biggest telecoms firms have joined forces with the UK government to fund a new 5G research center. The facility, to be based at the University of Surrey, will offer testing facilities to operators keen to develop a mobile standard that uses less energy and less radio spectrum, while delivering faster speeds than current 4G technology that's been launched in around 100 countries, including several British cities. They say the new tech could be ready within a decade. ^ "The University Of Surrey Secures £35M For New 5G Research Centre". University of Surrey. October 8, 2012. Archived from the original on October 14, 2012. Retrieved October 15, 2012. ^ "5G research centre gets major funding grant". BBC News. BBC News Online. October 8, 2012. Archived from the original on April 21, 2019. Retrieved October 15, 2012. ^ Philipson, Alice (October 9, 2012). "Britain aims to join mobile broadband leaders with £35m '5G' research centre". The Daily Telegraph. London. Archived from the original on October 13, 2018. Retrieved January 7, 2013. ^ "METIS projet presentation" (PDF). November 2012. Archived from the original (PDF) on February 22, 2014. Retrieved February 14, 2014. ^ "Speech at Mobile World Congress: The Road to 5G". March 2015. Archived from the original on October 28, 2020. Retrieved April 20, 2015. ^ "5G Mobile Network Technology". April 2017. Archived from the original on May 18, 2017. Retrieved May 18, 2017. ^ ", 5 " [Samsung Electronics develops key technology for 5G mobile communications, a world-first.]. May 12, 2013. Archived from the original on September 19, 2018. Retrieved May 12, 2013. ^ "General METIS presentations available for public". Archived from the original on February 22, 2014. Retrieved February 14, 2014. ^ "India and Israel have agreed to work jointly on development of 5G". The Times Of India. July 25, 2013. Archived from the original on September 10, 2016. Retrieved July 25, 2013. ^ "DoCoMo Wins CEATEC Award for 5G". October 3, 2013. Archived from the original on October 13, 2018. Retrieved October 3, 2013. ^ Embley, Jochan (November 6, 2013). "Huawei plans $600m investment in 10Gbps 5G network". The Independent. London. Archived from the original on March 31, 2019. Retrieved November 11, 2013. ^ "South Korea to seize on world's first full 5G network". Nikkei Asian Review. Archived from the original on April 17, 2019. Retrieved April 17, 2019. ^ "US dismisses South Korea's launch of world-first 5G network as 'stunt' – 5G – The Guardian". amp.theguardian.com. April 4, 2019. Archived from the original on April 17, 2019. Retrieved April 17, 2019. ^ "5G 4 가...3가 가" [From the first day of 5G, 40,000 subscribers ... 3 subscription points]. Asia Business Daily. April 6, 2019. Archived from the original on April 17, 2019. Retrieved April 17, 2019. ^ "Globe 5G – The Latest Broadband Technology". globe.com.ph. Archived from the original on September 3, 2019. Retrieved June 21, 2019. ^ "AT&T Begins Extending 5G Services Across the U.S." about.att.com. Archived from the original on November 18, 2020. Retrieved November 23, 2019. ^ Blumenthal, Eli. "AT&T's next 5G network is going live in December, but don't expect big jumps in speed". CNET. Archived from the original on November 23, 2019. Retrieved November 23, 2019. ^ GUL, NAJAM (December 26, 2022). "5G! GOOD OR BAD?". deep curious. Archived from the original on January 5, 2023. Retrieved January 5, 2023. ^ Stuart Corner (March 16, 2022). "The state of 5G in Southeast Asia 2022, country-by-country guide". networkworld.com. ^ Phoonphongphiphat, Apornrath (May 20, 2020). "Thailand leads ASEAN in 5G rollout due to pandemic". Nikkei Asia. Retrieved April 18, 2023. ^ "Назаров Александр: биография заместителя генерального директора "Ростеха"" [Alexander Nazarov: Biography of the Deputy General Director of "Rostec".]. theperson.pro. Retrieved June 4, 2023. ^ "Назаров Александр Юрьевич и Игорь Анатольевич Шумаков подписали соглашение" [Alexander Yurievich Nazarov and Igor Anatolievich Shumakov signed an agreement.]. www.kremlinrus.ru. Retrieved June 4, 2023. ^ Strumpf, Dan. "5G Not Enough? Telecom Companies Look to 5.5G". The Wall Street Journal. Retrieved June 5, 2024. Karipidis, Ken; Mate, Rohan; Urban, David; Tinker, Rick; Wood, Andrew (July 2023). "5G mobile networks and health—a state-of-the-science review of the research into low-level RF fields above 6 GHz". Journal of Exposure Science & Environmental Epidemiology. 31 (4): 585–605. doi:10.1038/s41370-021-00297-6. ISSN 1559-064X. PMC 8263336. PMID 33727687. Wikimedia Commons has media related to 5G. Internet portalTelecommunication portal 5G Multi-Antenna Concepts Preceded by4th Generation (4G) Mobile telephony generations Succeeded by6th Generation (6G) Retrieved from " 3First generation of wireless cellular technology For other uses, see 1G (disambiguation). "Analog network" redirects here and is not to be confused with Analog modulation. Not to be confused with GPRS, a 2G mobile internet speed displayed as "G" on most Android and iPhone devices. Part of a series on theWireless network technologies Analog 0G1G (1.5G) Digital 2G (2.5G, 2.75G, 2.9G)3G (3.5G, 3.75G, 3.9G/3.95G)4G (4G/4.5G, 4.5G, 4.9G)5G (5.5G)6G Mobile telecommunicationsvte 1G refers to the first generation of mobile telecommunications standards, introduced in the 1980s. This generation was characterized by the use of analog audio transmissions, a major distinction from the subsequent 2G networks, which were fully digital. The term "1G" itself was not used at the time, but has since been retroactively applied to describe the early era of cellular networks.

During the 1G era, various regional standards were developed and deployed in different countries, rather than a single global system. Among the most prominent were the Nordic Mobile Telephone (NMT) system and the Advanced Mobile Phone System (AMPS), which were widely adopted in their respective regions.[1] The lack of a unified global standard resulted in a fragmented landscape, with different countries and regions utilizing different technologies for mobile communication. As digital technology advanced, the inherent advantages of digital systems over analog led to the eventual replacement of 1G by 2G networks. While many 1G networks were phased out by the early 2000s, some continued to operate into the 2010s, particularly in less developed regions. The antecedent to 1G technology is the mobile radio telephone (i.e. "0G"), where portable phones would connect to a centralised operator. 1G refers to the very first generation of cellular networks.[2] Cellular technology employ a network of cells throughout a geographical area using low-power radio transmitters.[1] Cellular network standards and generation timeline. The first commercial cellular network was launched in Japan by Nippon Telegraph and Telephone (NTT) in 1979, initially in the metropolitan area of Tokyo. The first phone that used this network was called TZ-801 built by Panasonic.[3] Within five years, the NTT network had been expanded to cover the whole population of Japan and became the first nationwide 1G/cellular network. Before the network in Japan, Bell Laboratories built the first cellular network around Chicago in 1977 and trialled it in 1978.[4] As in the pre-cellular era, the Nordic countries were among the pioneers in wireless technologies. These countries together designed the NMT standard which first launched in Sweden in 1981.[5] NMT was the first mobile phone network to feature international roaming. In 1983, the first 1G cellular network launched in the United States, which was Chicago-based Ameritech using the Motorola DynaTAC mobile phone. In the early to mid 1990s, 1G was superseded by newer 2G (second generation) cellular technologies such as GSM and cdmaOne. Although 1G also used digital signaling to connect the radio towers (which listen to the handsets) to the rest of the telephone system, the voice itself during a call is encoded to digital signals in 2G whereas 1G uses analog FM modulation for the voice transmission, much like a 2-way land mobile radio. Most 1G networks had been discontinued by the early 2000s. Some regions especially Eastern Europe continued running these networks for much longer. The last operating 1G network was closed down in Russia in 2017. After Japan, the earliest commercial cellular networks launched in 1981 in Sweden, Norway and Saudi Arabia, followed by Denmark, Finland and Spain in 1982, the U.S. in 1983 and Hong Kong, South Korea, Austria and Canada in 1984. By 1986 networks had also launched in Tunisia, Malaysia, Oman, Ireland, Italy, Luxembourg, Netherlands, United Kingdom, West Germany, France, South Africa, Israel, Thailand, Indonesia, Iceland, Turkey, the Virgin Islands and Australia.[6] Generally, African countries were slower to take up 1G networks, while Eastern European were among the last due to the political situation.[7] In Europe, the United Kingdom had the largest number of cellular subscribers as of 1990 numbering 1.1 million, while the second largest market was Sweden with 482 thousand.[7] Although Japan was the first country with a nationwide cellular network, the number of users was significantly lower than other developed economies with a penetration rate of only 0.15 percent in 1989.[5] As of January 1991, the highest penetration rates were in Sweden and Finland with both countries above 50 percent closely followed by Norway and Iceland. The United States had a rate of 21.2 percent. In most other European countries it was below 10 percent.[8] Analog cellular technologies that were used were:[6] Advanced Mobile Phone System (AMPS)[9] Nordic Mobile Telephone (NMT) Total Access Communication System (TACS) developed in the United Kingdom and also some other parts of the world C-450 developed in West Germany and also adopted in Portugal and South Africa Radiocom 2000 in France (France Telecom only) RTMI in Italy MCS-L1 and MCS-L2 (developed by NTT) in Japan[10] JTACS (a variant of TACS operated by Daini Denden Planning, Inc. (DDI)) in Japan[10] List of mobile phone generations 2G 3G 3.5G 4G 4.5G 5G 6G Wireless Application Protocol Wireless device radiation and health ^ a b "Chapter 3 - Technology". Wireless Communications in Developing Counties (PDF). pp. 19–32. ^ Shi 2007, p. 56. ^ "Panasonic Japan cell phone shipments hit 100 million units". 3 April 2008. ^ Shi 2007, p. 60. ^ a b Shi 2007, p. 61. ^ a b "To open or not to open a technological system: insights from the history of mobile phones and their application to 5G" (PDF). Charles River Associates. May 2021. ^ a b Shi 2007, p. 63. ^ "Mobile and PSTN Communication Services" (PDF). OECD Digital Economy Papers (13). 1995. doi:10.1787/237485605680. ^ "AMTA". amta.org.au. Archived from the original on 17 April 2008. ^ a b "Answers – The Most Trusted Place for Answering Life's Questions". Answers.com. Shi, Mingtao (2007). Technology Base of Mobile Cellular Operators in Germany and China: A Comparative Study from the Perspective of the Resource Based View. Univerlagtuberlin. ISBN 9783798320574. Glossary: 1G – First Generation wireless technology Glossary: Detailed Description on 1G Technology Preceded by0G Mobile Telephony Generations Succeeded by2G Retrieved from " 4First generation of digital cellular networks For other uses, see 2G (disambiguation). Part of a series on theWireless network technologies Analog 0G1G (1.5G) Digital 2G (2.5G, 2.75G, 2.9G)3G (3.5G, 3.75G, 3.9G/3.95G)4G (4G/4.5G, 4.5G, 4.9G)5G (5.5G)6G Mobile telecommunicationsvte 2G refers to the second-generation of cellular network technology, which were rolled out globally starting in the early 1990s. The main differentiator to previous mobile telephone systems, retrospectively dubbed 1G, is that the radio signals of 2G networks are digital rather than analog, for communication between mobile devices and base stations. In addition to voice telephony, 2G also made possible the use of data services. The most common 2G technology has been the GSM standard, which became the first globally adopted framework for mobile communications. Other 2G technologies include cdmaOne and the now-discontinued Digital AMPS (D-AMPS/TDMA),[1] as well the Personal Digital Cellular (PDC) and Personal Handy-phone System (PHS) in Japan. The transition to digital technology enabled the implementation of encryption for voice calls and data transmission, significantly improving the security of mobile communications while also increasing capacity and efficiency compared to earlier analog systems. 2G networks were primarily designed to support voice calls and Short Message Service (SMS), with later advancements such as General Packet Radio Service (GPRS) enabling always-on packet data services, including email and limited internet access. 2G was succeeded by 3G technology, which provided higher data transfer rates and expanded mobile internet capabilities. In 1990, AT&T Bell Labs engineers Jesse Russell, Farhad Barzegar and Can A. Eryaman filed a patent for a digital mobile phone that supports the transmission of digital data. Their patent was cited several years later by Nokia and Motorola when they were developing 2G digital mobile phones.[2] 2G was first commercially launched in 1991 by Radiolinja (now part of Elisa Oyj) in Finland in the form of GSM, which was defined by the European Telecommunications Standards Institute (ETSI).[3] The Telecommunications Industry Association (TIA) defined the cdmaOne (IS-95) 2G standard, with an eight to ten fold increase in voice call capacity compared to analog AMPS.[4] The first deployment of cdmaOne was in 1995.[5] In North America, Digital AMPS (IS-54 and IS-136) and cdmaOne (IS-95) were dominant, but GSM was also used. Later 2G releases in the GSM space, often referred to as 2.5G and 2.75G, include General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE). GPRS allows 2G networks to achieve a theoretical maximum transfer speed of 40 kbit/s (5 kB/s). EDGE increases this capacity, providing a theoretical maximum transfer speed of 384 kbit/s (48 kB/s). Three primary benefits of 2G networks over their 1G predecessors were: Digitally encrypted phone conversations, at least between the mobile phone and the cellular base station but not necessarily in the rest of the network. Significantly more efficient use of the radio frequency spectrum enabling more users per frequency band. Data services for mobile, starting with SMS text messages then expanding to Multimedia Messaging Service (MMS). Cellular network standards and generation timeline. (Large titles on the colored area refer to the lines to their right. Main article: GPRS 2.5G ("second-and-a-half generation") refers to 2G systems that incorporate a packet-switched domain alongside the existing circuit-switched domain, most commonly implemented through General Packet Radio Service (GPRS).[6] GPRS enables packet-based data transmission by dynamically allocating multiple timeslots to users, improving network efficiency. However, this does not inherently provide faster speeds, as similar techniques, such as timeslot bundling, are also employed in circuit-switched data services like High-Speed Circuit-Switched Data (HSCSD). Within GPRS-enabled 2G systems, the theoretical maximum transfer rate is 40 kbit/s (5 kB/s).[7] Main article: EDGE 2.75G refers to the evolution of GPRS networks into EDGE (Enhanced Data Rates for GSM Evolution) networks, achieved through the introduction of 8PSK (8 Phase Shift Keying) encoding. While the symbol rate remained constant at 270.833 samples per second, the use of 8PSK allowed each symbol to carry three bits instead of one, significantly increasing data transmission efficiency. Enhanced Data Rates for GSM Evolution (EDGE), also known as Enhanced GPRS (EGPRS) or IMT Single Carrier (IMT-SC), is a backward-compatible digital mobile phone technology built as an extension to standard GSM. First deployed in 2003 by AT&T in the United States, EDGE offers a theoretical maximum transfer speed of 384 kbit/s (48 kB/s).[7] Evolved EDGE (also known as EDGE Evolution or 2.875G) is an enhancement of the EDGE mobile technology that was introduced as a late-stage upgrade to 2G networks. While EDGE was first deployed in the early 2000s as part of GSM networks, Evolved EDGE was launched much later, coinciding with the widespread adoption of 3G technologies such as HSPA and just before the emergence of 4G networks. This timing limited its practical application. Evolved EDGE increased data throughput and reduced latencies (down to 80 ms) by utilizing improved modulation techniques, dual carrier support, dual antennas, and turbo codes. It achieved peak data rates of up to 1 Mbit/s, significantly enhancing network efficiency for operators that had not yet transitioned to 3G or 4G infrastructures. However, despite its technical improvements, Evolved EDGE was never widely deployed. By the time it became available, most network operators were focused on implementing more advanced technologies like UMTS and LTE. As of 2016, no commercial networks were reported to support Evolved EDGE. See also: GSM § Discontinuation 2G, understood as GSM and CdmaOne, has been superseded by newer technologies such as 3G (UMTS / CDMA2000), 4G (LTE / WiMAX) and 5G (5G NR). However, 2G networks were still available as of 2023[update] in most parts of the world, while notably excluding the majority of carriers in North America, East Asia, and Australasia.[8][9][10] Many modern LTE-enabled devices have the ability to fall back to 2G for phone calls, necessary especially in rural areas where later generations have not yet been implemented.[11] In some places, its successor 3G is being shut down rather than 2G – Vodafone previously announced that it had switched off 3G across Europe in 2020 but still retains 2G as a fallback service.[12] In the US T-Mobile shut down their 3G services while retaining their 2G GSM network.[13][14] Various carriers have made announcements that 2G technology in the United States, Japan, Australia, and other countries are in the process of being shut down, or have already shut down 2G services so that carriers can re-use the frequencies for newer technologies (e.g. 4G, 5G).[15][16] As a legacy protocol, 2G connectivity is considered insecure.[17] Specifically, there exist well known methods to attack weaknesses in GSM since 2009[18] with practical use in crime.[19] Attack routes on 2G CdmaOne were found later and remain less publicized.[20] Android 12 and later provide a network setting to disable 2G connectivity for the device.[21] iOS 16 and later can disable 2G connectivity by enabling Lockdown Mode.[22] In some parts of the world, including the United Kingdom, 2G remains widely used for older feature phones and for internet of things (IoT) devices such as smart meters, eCall systems and vehicle trackers to avoid the high patent licensing cost of newer technologies.[23] Terminating 2G services could leave vulnerable people who rely on 2G infrastructure unable to communicate even with emergency contacts, causing harm and possibly deaths.[24] Country Status Network Shutdown date Standard Notes Åland Ålcom 2024 GSM 2G availability cannot be guaranteed after 1 Jan 2022, all stations are planned to be shut down in 2024.[25] Anguilla Digicel active GSM 900 MHz: 5 MHz GSM + 5 MHz UMTS1900 MHz: 5 MHz UMTS [26][27][28][29] FLOW 2024-04-22 GSM [30][31] Antigua and Barbuda No Service APUA 2018-04-01 GSM [32] Digicel 2024-05-31 GSM [33] FLOW 2024-07-31 GSM [34] Aruba partiallyunconfirmed Digicel 2024-06-30 GSM [35] SETAR active GSM GSM-900 & GSM-1900 Australia No Service Hutchison 3 2006-08-09 cdmaOne [36][37][38][39][40] Optus 2017-08-01 GSM 2G shut down in WA and NT on 3 Apr 2017.[41][42] Telstra 2008-04-28 cdmaOne [43][44][45][46][47] Telstra 2016-12-01 GSM [48] Vodafone 2018-06-14 GSM [49] Bahamas No Service Aliv N/A (no 2G) BTC 2024-06-30 GSM [50][51][52] Bahrain Batelco 2021-11-30 GSM [53] Barbados partiallyunconfirmed Digicel 2025-03-31 GSM 900 MHz: 6 MHz GSM /1800 MHz: 12 MHz GSM [54] FLOW 2024-04-22 GSM Belgium Orange 2030 GSM [55] Telenet 2027 GSM [56] Proximus 2027 GSM [57] Bermuda Digicel active GSM 1900 MHz: 15 MHz GSM + 15 MHz LTE [58] One active GSM 1900 MHz: 5 MHz GSM + 20 MHz LTE [58] Bonaire partiallyunconfirmed Digicel 2025-03-31 GSM FLOW 2024-04-22 GSM British Virgin Islands CCT active GSM 1900 MHz: 10 MHz GSM + 20 MHz LTE [59] Digicel active GSM 1800 MHz: 15 MHz GSM1900 MHz: 5 MHz GSM + 10 MHz UMTS [59] FLOW 2024-04-22 GSM [60] Brunei No Service UNN 2021-06-01 GSM National Wholesale Network used by DSTCom, Progresif and imagine.[61][62] Canada Bell 2019-04-30 cdmaOne Shutdown of CDMA transmitters commenced in remote areas in 2017, followed by an official announcement in June 2018 that 2G devices will lose service soon.[63][64] Rogers Wireless TBD GSM 1900 MHz shutdown in Jun 2021.850 MHz remains active.[65][66][67][68] SaskTel 2017-07-31 cdmaOne [69][70] Telus Mobility 2017-05-31 cdmaOne [71][72] Cayman Islands partiallyunconfirmed Digicel 2020-07-01 GSM [73][74] FLOW 2024-04-22 GSM China China Mobile active GSM 900 MHz: 15 MHz GSM1800 MHz: 25 MHz GSM [75] China Telecom 2025 cdmaOne Local shutdown commenced on 01 Jun 2020.CDMA2000 1xRTT, EV-DO Rev. A/B (3G) service also terminates.[75][76][77] China Unicom 2025 GSM Local shutdown commenced on 18 Apr 2018.[75][78][79][77][80] Chile Entel 2024 Q3 GSM Local shutdown commenced on 22 Jul 2024 in the Arica and Parinacota Region.[81] Colombia Claro 2023-02-23 GSM [82][83] Tigo 2022-11-01 GSM [84] Curaçao Digicel 2025-03-31 GSM FLOW 2024-02-29 GSM [85][86] Dominica partiallyunconfirmed Digicel 2027-03-31 GSM FLOW 2024-03-?? GSM [87] France Bouygues 2026-12-31 GSM [88] Orange 2026-09 GSM [55] SFR 2026 GSM [89] Germany Deutsche Telekom 2028-06-30 GSM [90] Vodafone 2030-12-31 GSM [91] Telefónica (O2) TBD GSM Grenada unconfirmed Digicel 2024-03-31 GSM FLOW 2024-04-22 GSM Guam unconfirmed GTA Teleguam ? GSM Hong Kong 3 2008-11-20 cdmaOne Shut down due to license expiry. Government originally did not allow the license to be renewed due to unpopularity, however the government later reversed the decision and held an auction for CDMA2000 service, which PCCW-HKT won the auction and provided CDMA2000 service immediately after 3's license expiry. 3 2021-09-30 GSM [92] CMHK active GSM 1800 MHz only CSL 2005 D-AMPS Service previously provided by Pacific Link, which subsequently merged into CSL. Shut down due to license expiry. Government did not allow the license to be renewed due to unpopularity. CSL 2017-10-31 cdmaOne Service previously provided by PCCW. After acquisition of CSL by HKT, its mobile business PCCW Mobile was merged into CSL. No service for local customers, only served incoming roaming tourists.CSL terminated its CDMA family business upon its licence expiry, and CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated along with cdmaOne.[93] CSL 2024-11-08 GSM [94] SmarTone 2022-10-14 GSM [95] Iceland Nova 2025-01-28 GSM [96] Síminn 2025 Q4 GSM [97] Vodafone Mid 2025 GSM [98][99] Israel Hot Mobile 2019-12-31 iDEN [100] 2025 GSM Per government statement.[101] Jamaica No Service Digicel 2024-08-31 GSM [102][103] FLOW 2024-04-15 GSM [104][103][105] Japan No Service au KDDI 2012-07-22 cdmaOne [106] NTT Docomo 2012-03-31 PDC [107] Softbank 2010-03-31 PDC [108] Jordan Umniah 2021-03-11 GSM [109] Luxembourg Orange 2030 GSM [55] Macau No Service CTM 2019-08-01 GSM Service for local customers terminated on 4 Jun 2015, but remained for roaming users.[110][111][112] 3 2019-08-01 GSM Service for local customers terminated on 4 Jun 2015, but remained for roaming users.[110][111] SmarTone 2019-08-01 GSM Service for local customers terminated on 4 Jun 2015, but remained for roaming users.[110][111] Mexico AT&T 2019-09-01 GSM [113]Local shutdown commenced in Q1 2019. Movistar 2021-01-01 GSM [114] Montserrat unconfirmed Digicel ? GSM FLOW 2024-04-22 GSM Netherlands KPN 2025-12-01 GSM [115] T-Mobile 2021-06-01 /2023-11-15 (IoT) GSM [116] New Caledonia OPT-NC 2025 GSM Shutdown commenced in 2022.[117] New Zealand 2degrees 2018-03-15 GSM [118] Spark 2012-07-31 cdmaOne [119][120] Norway Telenor 2027 GSM [121] Telia 2025 GSM [121] Panama Digicel 2022-06-30 GSM Complete shutdown of operations and market exit.[122][123][124][125] Peru Bitel N/A (no 2G) Poland Orange 2030 GSM [55] Romania Orange 2030 GSM [55] Saint Kitts and Nevis Digicel 2027-03-31 GSM FLOW 2024-04-22 GSM [126] Saint Lucia partiallyunconfirmed Digicel 2027-03-31 GSM FLOW 2024-04-22 GSM [127] Saint Vincent and the Grenadines Digicel 2027-03-31 GSM FLOW 2023-09-30 GSM [128][129][130][131] Singapore No Service M1 2017-04-18 GSM [132] Singtel 2017-04-18 GSM [132] StarHub 2017-04-18 GSM [132] Sint Maarten Saba Sint Eustatius No Service TelCell 2019-01-01 GSM [133] FLOW (UTS) 2017-09-26 GSM [134] Slovakia Orange 2030 GSM [55] South Africa TBD GSM Per government statement.[135][136] South Korea No Service KT 2012-03-19 cdmaOne CDMA2000 1xRTT, EV-DO Rel. 0 (3G) service has also terminated.[137] LG Uplus 2021-06-30 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A/B (3G) service has also terminated.[138] SK Telecom 2020-07-27 cdmaOne CDMA2000 1xRTT, EV-DO Rel. 0 (3G) service has also terminated.[139] Spain Orange 2030 GSM [55] Sweden Net4Mobility (Telenor/Tele2) 2025-12-31 GSM 2G network will be shut down by the end of 2025.[140][141][142] Telia 2027 GSM Shutdown pushed back from 2025 to 2027.[143][144] Switzerland No Service Salt 2020-12-31 GSM Shutdown commenced on 1 Jul 2020. A few single 2G-only sites remained until Sep 2023 to preserve CSFB functionality.[145][146][147] Sunrise 2023-01-03 GSM With the introduction of S-RAN in 2018 phaseout was previously postponed to 2022.[148][149][150] Swisscom 2021-04-07 GSM Official shutdown on 31 Dec 2020 (guaranteed availability).[151][152][153] Taiwan No Service Chunghwa Telecom 2017-06-30 GSM [154] FarEasTone 2017-06-30 GSM [154] Taiwan Mobile 2017-06-30 GSM [154] Trinidad and Tobago Digicel 2024-12-31 GSM [155][156][157] bmobile (TSTT) TBD GSM 850 MHz: 2.5 MHz GSM + 5 MHz UMTS [158][159] Turks and Caicos Islands Digicel 2025-06-30 GSM 900 MHz: 9.8 MHz GSM [160] FLOW 2024-04-22 GSM [161] United Arab Emirates No Service Du 2023-12-31 GSM [162] Etisalat 2023-12-31 GSM [163] United Kingdom 2033 GSM Per government statement on confirmation by mobile providers.[164][165][166] United States Puerto Rico US Virgin Islands AT&T 2008-02-18 D-AMPS TDMA (D-AMPS) on 1900 MHz shut down on 15 July 2007.[167] 2017-01-01 GSM [168] Cellcom(US only) 2023-12-01 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.[169] Claro(PR only) 2028-12-31 GSM Commnet Wireless (Choice)(US only) 2022-12-31 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.[170] Copper Valley Wireless 2022-09-30 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.[171] Edge Wireless 2007-06-30 D-AMPS [172] T-Mobile 2025 GSM Shutdown commenced on 9 Feb 2025.[173][174] T-Mobile (Sprint) 2022-05-31 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.Shutdown commenced on 31 Mar 2022.[175][176][177][178] UScellular(US only) 2009-02 D-AMPS [179] UScellular(US only) 2024-01-14 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.[180][181] Verizon(US only) 2022-12-31 cdmaOne CDMA2000 1xRTT, EV-DO Rev. A (3G) service has also terminated.[182] Venezuela Digitel 2024-03-08 GSM Shutdown commenced in May 2021.[183][184] Movilnet 2025 GSM [183] Movistar 2025 GSM Shutdown commenced on 01 Jul 2022.[183] Vietnam No Service Gmobile 2024-10-16 GSM per government regulation[185] Mobifone 2024-10-16 GSM per government regulation[185] Vietnamobile N/A (no 2G) Viettel 2024-10-16 GSM per government regulation[185] Vinaphone 2024-10-16 GSM per government regulation[185] Cliff effect Dropout List of mobile phone generations Mobile radio telephone, also known as 0G 1G 3G 4G 5G 6G Wireless device radiation and health ^ "2G Sunset Brings Faster Speeds, Newer Technologies". 16 January 2017. Retrieved 27 January 2023. ^ US5257397A, Barzegar, Farhad; Eryaman, Can A. & Russell, Jesse E. et al., "Mobile data telephone", issued 1993-10-26 (filed 1990-08-13) ^ "Radiolinja's History". 20 April 2004. Archived from the original on 23 October 2006. Retrieved 23 December 2009. ^ "CDMA Network Technology: A Decade Of Advances And Challenges". www.tek.com. Retrieved 26 February 2025. ^ "4: CDMA - Cellular Technologies for Emerging Markets: 2G, 3G and Beyond [Book]". www.oreilly.com. Retrieved 26 February 2025. ^ "What is Second and a Half Generation (2.5G)". IGI Global. Archived from the original on 6 October 2019. Retrieved 6 October 2019. ^ a b "GPRS & EDGE". 3gpp.org. Archived from the original on 17 April 2020. Retrieved 17 August 2019. ^ "Germany's rural 4G users still spend one-fourth of their time on 3G and 2G networks". Opensignal. 13 June 2019. Retrieved 6 October 2019. ^ "T-Mobile Poland expects to keep 2G for five-to-six years". TeleGeography. 17 July 2019. Archived from the original on 6 October 2019. Retrieved 6 October 2019. ^ "2G phase-out – modernisation of the Swisscom mobile network". Swisscom. Archived from the original on 6 April 2020. Retrieved 6 October 2019. ^ "SUNSET ON 2G/3G MOBILE NETWORKS? NOT EXACTLY..." CSL Group. Retrieved 16 October 2023. ^ Hall, Kat. "Sod 3G, that can go, but don't rush to turn off 2G, UK still needs it – report". The Register. Archived from the original on 26 September 2020. Retrieved 16 October 2023. ^ "T-Mobile Network Evolution". T-Mobile US. Archived from the original on 21 October 2021. Retrieved 19 June 2022. ^ "T-Mobile US to shut down 3G network on 1 July 2022". TeleGeography. 17 September 2021. Archived from the original on 14 April 2022. Retrieved 18 September 2021. ^ Serr, Melanie (5 April 2017). "What You Need To Know About the 2G Network Shutdown". Geotab Blog. Archived from the original on 6 October 2019. Retrieved 6 October 2019. ^ "The status of the 2G/3G network sunset". nae_global. 31 July 2019. Archived from the original on 11 December 2019. Retrieved 11 December 2019. ^ Cooper Quintin and Andrés Arrieta (29 June 2020). "Your Phone Is Vulnerable Because of 2G, But it Doesn't Have to Be". Electronic Frontier Foundation. Archived from the original on 16 April 2024. ^ "The GSM encryption algorithm was broken". GSMArena. Archived from the original on 5 May 2023. Retrieved 16 October 2023. ^ Russon, Mary-Ann (27 March 2014). "China Arrests 1,500 People for Sending Spam Text Messages from Fake Mobile Base Stations". International Business Times UK. Retrieved 16 October 2023. ^ Zhang, Chi; Liu, Jun-Rong; Gu, Da-Wu; Wang, Wei-Jia; Lu, Xiang-Jun; Guo, Zheng; Lu, Hai-Ning (1 September 2019). "Side-Channel Analysis for the Authentication Protocols of CDMA Cellular Networks". Journal of Computer Science and Technology. 34 (5): 1079–1095. doi:10.1007/s11390-019-1961-5. S2CID 203640029. ^ Amadeo, Ron (14 January 2022). "EFF praises Android's new 2G kill switch, wants Apple to follow suit". Ars Technica. Retrieved 14 January 2022. ^ "About Lockdown Mode". Apple. Archived from the original on 20 June 2024. Retrieved 28 June 2024. ^ "Freedom of Information: Right to know request" (PDF). Ofcom. 3 June 2020. Archived (PDF) from the original on 28 December 2023. Retrieved 28 December 2023. ^ Rockman, Simon. "Millions Will Lose Out When Government Kills 2G". Forbes. Archived from the original on 30 November 2020. Retrieved 16 October 2023. ^ "Frågor och svar (FAQ). 2G" (in Swedish). Ålcom. Archived from the original on 12 July 2023. Retrieved 12 July 2023. ^ "License and Frequency Authorisations - Digicel" (PDF). Public Utilities Commission Anguilla. 5 November 2014. Archived (PDF) from the original on 16 June 2024. Retrieved 8 September 2024. ^ "Annual Report 2016" (PDF). Public Utilities Commission Anguilla. 24 August 2017. Archived (PDF) from the original on 23 June 2024. Retrieved 8 September 2024. ^ "Annual Report 2017" (PDF). Public Utilities Commission Anguilla. 22 October 2018. Archived (PDF) from the original on 14 September 2024. Retrieved 14 September 2024. ^ "Agreement Between The Administrations Of Anguilla, France, Sint Maarten And The State Of Netherlands For Saba And St. Eustatius Concerning The Spectrum Coordination Of Land Mobile Radiocommunication Networks In The Frequency Range 698 MHz to 3800 MHz" (PDF). Agence Nationale Des Frèquences (ANFR). 1 March 2023. Archived (PDF) from the original on 15 September 2024. Retrieved 15 September 2024. ^ "License and Frequency Authorisations - Flow" (PDF). Public Utilities Commission Anguilla. 2014. Archived (PDF) from the original on 15 June 2024. Retrieved 8 September 2024. ^ "We're saying goodbye to our 2G mobile network". Flow Anguilla. 17 April 2024. Archived from the original on 10 September 2024. Retrieved 10 September 2024. ^ "APUA Seeks Portion of Premium Spectrum". Antigua Public Utilities Authority. 13 June 2019. Archived from the original on 8 September 2024. Retrieved 8 September 2024. ^ "Digicel Antigua to say good-bye to 2G this month". Loop Caribbean News by Digicel. 23 May 2024. Retrieved 8 September 2024. ^ "FLOW to retire 2G networks, shutdown in phased manner". Associates Times LLC. 7 June 2024. Retrieved 8 September 2024. ^ "Digicel Network Upgrade". Digicel Aruba. 12 December 2023. Retrieved 14 September 2024. ^ "Hutchison to upgrade Orange network". TeleGeography. 26 January 2004. Retrieved 23 December 2016. ^ "Telstra fails to prise Orange from Hutch as 3G network share talks fail". TeleGeography. 20 April 2004. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Hutch to push 2G users to 3G and close Orange network". TeleGeography. 1 February 2006. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Hutch to shut down CDMA network in August". TeleGeography. 10 May 2006. Archived from the original on 21 December 2016. Retrieved 26 July 2014. ^ "2G network closure increases Hutch Australia revenues and losses". TeleGeography. 23 August 2006. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Optus to shutter GSM network in April 2017". TeleGeography. 5 August 2015. Archived from the original on 19 January 2021. Retrieved 23 January 2021. ^ "2G Network Closure Update". Optus. 19 October 2016. Archived from the original on 29 September 2017. Retrieved 6 July 2017. ^ "Telstra plans EV-DO upgrade". TeleGeography. 15 April 2004. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "'CDMA is on the way out,' says Telstra". TeleGeography. 2 May 2006. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Telstra to close CDMA network by Jan 2008". TeleGeography. 6 February 2007. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Telstra's CDMA shutdown: No gain without pain?". ZDNet. 24 April 2008. Archived from the original on 29 August 2024. Retrieved 23 December 2016. ^ "CDMA shut-down delayed 'til April". TeleGeography. 22 January 2008. Archived from the original on 23 December 2016. Retrieved 23 December 2016. ^ "Telstra switches off GSM network". TeleGeography. 2 December 2016. Archived from the original on 18 February 2017. Retrieved 23 January 2021. ^ "Vodafone's 2G Network shutdown starts at the end of this month – are you ready?". Ausdroid. 14 June 2018. Archived from the original on 12 September 2024. Retrieved 12 September 2024. ^ "BTC to commence mobile network optimization project". Eye Witness News. 22 May 2024. Archived from the original on 14 September 2024. Retrieved 14 September 2024. ^ "BTC readies to consolidate mobile network to 4G only". The Tribune - Ellington. 22 May 2024. Archived from the original on 14 September 2024. Retrieved 14 September 2024. ^ "BTC will be transitioning our network from 2G to 3G technology". BTC. Archived from the original on 14 September 2024. Retrieved 14 September 2024. ^ "Batelco to phase out 2G network on 30 November". TeleGeography. 28 September 2021. Retrieved 19 February 2022. ^ "spectrummonitoring.com - Barbados". spectrummonitoring.com. 1 March 2022. Retrieved 15 September 2024. ^ a b c d e f g "Orange selects 5G SA vendors; provides timetable for 2G/3G shutdowns". TeleGeography. 1 March 2022. Archived from the original on 1 March 2022. Retrieved 6 March 2022. ^ "Telenet to switch off 3G from September 2024". TeleGeography. 19 September 2022. Archived from the original on 9 October 2022. Retrieved 26 November 2022. ^ "Proximus to switch off 3G network by end-2024". TeleGeography. 30 November 2022. Archived from the original on 4 December 2022. Retrieved 18 March 2023. ^ a b "spectrummonitoring.com - Bermuda". spectrummonitoring.com. 20 May 2021. Retrieved 15 September 2024. ^ a b "spectrummonitoring.com - British Virgin Islands". spectrummonitoring.com. 6 April 2017. Retrieved 15 September 2024. ^ "Final Announcement 2G Shutdown". FLOW BVI. 17 April 2024. Archived from the original on 17 September 2024. Retrieved 18 September 2024. ^ "Cessation of 2G GSM services in Brunei Darussalam" (PDF). UNN Brunei. 16 April 2021. Archived (PDF) from the original on 8 December 2021. Retrieved 8 December 2021. ^ "FAQs - 2G Network Switch-off". Authority for Info-communications Technology Industry (AITI). Archived from the original on 8 December 2021. Retrieved 8 December 2021. ^ "CDMA Network Discontinuation". Bell Canada. Archived from the original on 23 March 2018. Retrieved 23 January 2021. ^ "Bell completing CDMA shutdown on 30 April". TeleGeography. 1 April 2019. Archived from the original on 2 March 2021. Retrieved 23 January 2021. ^ "Rogers extends availability of GSM/GPRS network to December 2020". MobileSyrup. 4 May 2018. Archived from the original on 10 October 2020. Retrieved 23 January 2021. ^ "Important Notice Regarding Upcoming 2G/3G Changes on the Rogers Network". BULWARK. 15 July 2020. Archived from the original on 21 September 2024. Retrieved 23 January 2021. ^ "1900 MHz Shutdown on our 2G and 3G Wireless Networks". Rogers Communications. 1 March 2021. Archived from the original on 13 May 2023. Retrieved 13 May 2023. ^ "2G and 3G Shutdowns Continue". blog.telegeography.com. 15 February 2023. Archived from the original on 5 May 2023. Retrieved 13 May 2023. ^ "Final countdown for Saskatchewan CDMA". TeleGeography. 6 July 2016. Archived from the original on 26 February 2021. Retrieved 23 January 2021. ^ "SaskTel reminds CDMA customers of network shutdown". Sasktel. 11 January 2017. Retrieved 23 January 2021. ^ "Telus 'shutting CDMA in 2015'". TeleGeography. 21 October 2013. Retrieved 23 January 2021. ^ "CDMA network shut down - Information on the discontinuation of CDMA network support". TELUS. Archived from the original on 11 November 2020. Retrieved 23 January 2021. ^ "2G Network Shut Down". Digicel Cayman. Archived from the original on 17 September 2021. Retrieved 18 March 2022. ^ "Digicel Cayman announces network upgrade, discontinues 2G coverage". TeleGeography. 1 November 2019. Archived from the original on 19 February 2022. Retrieved 19 February 2022. ^ a b c "spectrummonitoring.com - China". spectrummonitoring.com. 21 November 2022. Retrieved 13 October 2024. ^ "China Telecom: 3G Network Will Be Shut down Gradually Starting from June". Montnets. 5 June 2020. Archived from the original on 21 September 2024. Retrieved 14 May 2022. ^ a b "Turning off 2G in China harder than it looks". Light Reading. 29 June 2022. Retrieved 4 December 2022. ^ "China Unicom to roll back 2G network". TechNode. 18 April 2018. Retrieved 13 October 2024. ^ "China Unicom to retire 2G next year". Developing Telecoms Ltd. 13 November 2020. Retrieved 23 January 2021. ^ "China Unicom given green light to refarm 900MHz band for 5G". TeleGeography. 4 November 2022. Archived from the original on 5 November 2022. Retrieved 6 November 2022. ^ "¿Cuándo se hará el recambio de la tecnología 2G en mi región? – Centro de Ayuda - Entel" [When will the 2G technology be switched to in my region?] (in Spanish). Retrieved 7 October 2024. ^ "Claro Colombia targets December 2022 2G shutdown". TeleGeography. 13 May 2022. Archived from the original on 14 May 2022. Retrieved 14 May 2022. ^ "Claro now expects to switch off 2G network by Feb-23". TeleGeography. 20 September 2022. Archived from the original on 9 October 2022. Retrieved 6 October 2022. ^ "Tigo switches off Colombian 2G network". TeleGeography. 2 November 2022. Archived from the original on 5 November 2022. Retrieved 6 November 2022. ^ "Final Announcement 2G Shutdown". Flow Curaçao. 26 February 2024. Retrieved 15 September 2024. ^ "2G service retires February 29". Flow Curaçao. 26 February 2024. Archived from the original on 15 September 2024. Retrieved 15 September 2024. ^ "Flow repurposing its 2G network to bolster 3G & 4". Emonews. 4 March 2024. Retrieved 13 October 2024. ^ "Bouygues Telecom to decommission 2G in 2026, 3G to follow in 2029". TeleGeography. 3 February 2023. Archived from the original on 11 February 2023. Retrieved 11 February 2023. ^ "SFR selects Nokia for 5G SA network; to decommission 2G/3G by 2028". TeleGeography. 27 January 2023. Archived from the original on 28 January 2023. Retrieved 28 January 2023. ^ "Mehr Speed auf alten Frequenzen: 2G-Abschaltung sorgt für besseres Netz" (in German). Deutsche Telekom. 22 October 2024. Retrieved 22 October 2024. ^ "GSM-Abschaltung: Vodafone will 2G-Netze bis Ende 2030 abschalten" (in German). computerbase.de. 24 October 2024. Retrieved 24 October 2024. ^ "3 Hong Kong to close 2G network at end-September". TeleGeography. 29 July 2021. Archived from the original on 29 July 2021. Retrieved 1 August 2021. ^ "不獲批頻譜改作4G LTE 香港電訊入稟司法覆核 - 香港經濟日報" (in Chinese). topick.hket.com. 22 December 2017. Retrieved 9 November 2024. ^ "HKT to terminate 2G services on 8 November 2024 reallocating spectrum resources for advanced mobile services" (PDF). HKT Limited. 2 August 2024. Retrieved 9 November 2024. ^ "SmarTone announces October shutdown for 2G network". TeleGeography. 12 August 2022. Retrieved 19 August 2022. ^ "Bless 2G!" (in Icelandic). NOVA Hlutafélag. Retrieved 28 January 2025. ^ "Lokun 2G & 3G kerfa" (in Icelandic). Siminn. Retrieved 28 January 2025. ^ "Hoppum inn í framtíðina". Vodafone Iceland. Retrieved 28 January 2025. ^ "Tímabili 2G og 3G fer senn að ljúka" (in Icelandic). Viðskiptablaðið. 9 September 2024. Retrieved 28 January 2025. ^ ""מנוי מירס אינו קיים 77350"" (in Hebrew). bizzness.net. 3 September 2019. Retrieved 13 October 2024. [Dear customer, we would like to inform you that according to the directive of the Ministry of Communications, we are forced to stop using the IDEN system frequencies until December 31, 2019. And we will not be able to continue providing the network services after this date.] ^ "Ministry orders shutdown of Israeli 2G, 3G networks by 2025". TeleGeography. 2 July 2021. Archived from the original on 12 August 2022. Retrieved 6 June 2022. ^ "Digicel enters final stage of 2G network shutdown | Loop Jamaica". Loop News. 3 April 2024. Retrieved 14 April 2024. ^ a b "BANGERS, BEGONE!". jamaica-gleaner. 14 April 2024. Retrieved 14 April 2024. ^ "Flow Jamaica 2G shutdown underway". TeleGeography. 5 August 2022. Archived from the original on 5 August 2022. Retrieved 5 August 2022. ^ "Flow retires 2G network". Grove Broadcasting Company Ltd. 15 April 2024. Retrieved 13 October 2024. ^ "Au's "CDMA 1X" finished service on July 22, about 200 types of target models". gigazine.net. 18 April 2012. Retrieved 12 September 2024. ^ "DoCoMo's nine-month profits up 16%, announces 2G shutdown March 2012". TeleGeography. 30 January 2009. Archived from the original on 19 January 2021. Retrieved 23 January 2021. ^ "Discontinuation Notice of 2G Service". Softbank. 24 November 2009. Archived from the original on 30 January 2021. Retrieved 23 January 2021. ^ "Umniah switching off 2G network in Jordan". Developing Telecoms. 11 March 2021. Archived from the original on 17 January 2022. Retrieved 18 September 2024. ^ a b c "Macau mobile users reach 1.56m in 3Q13; 2G users number less than 5,000 as switch off looms". TeleGeography. 29 October 2013. Archived from the original on 30 January 2021. Retrieved 23 January 2021. ^ a b c "Macau to shut down 2G networks for roaming users". TeleGeography. 10 April 2019. Archived from the original on 29 January 2021. Retrieved 23 January 2021. ^ "Govt to allow telecoms to end 2G service". The Macau Post Daily. 9 April 2019. Retrieved 2 July 2024. ^ "AT&T Mexico 2G switch-off imminent, report says". TeleGeography. 16 January 2019. Retrieved 14 April 2021. ^ "Movistar Mexico to switch off 2G on 1 January 2021". TeleGeography. 9 October 2020. Archived from the original on 18 January 2021. Retrieved 14 April 2021. ^ "Faster and safer - Join us on 4G and 5G". Royal KPN N.V. Retrieved 24 December 2024. ^ "T-Mobile Netherlands delays consumer 2G shutdown to Jun-21; M2M 2G continues to Jun-23". TeleGeography. 9 October 2020. Archived from the original on 27 February 2021. Retrieved 23 January 2021. ^ "OPT-NC updates on 2G sunset progress". TeleGeography. 28 July 2022. Archived from the original on 26 November 2022. Retrieved 26 November 2022. ^ "2degrees 2G shuts on 15 March". TeleGeography. 13 February 2018. Retrieved 23 January 2021. ^ "Telecom NZ to close CDMA network by mid-2012". TeleGeography. 8 July 2010. Archived from the original on 27 February 2021. Retrieved 23 January 2021. ^ "Telecom closes CDMA network". TeleGeography. 31 July 2012. Archived from the original on 20 January 2021. Retrieved 23 January 2021. ^ a b "Informasjon om slukking av 2G-nett i 2025". Nasjonal kommunikasjonsmyndighet (Nkom). 4 January 2021. Archived from the original on 15 May 2022. Retrieved 3 May 2021. ^ "Digicel ships out of Panama". GSMA Mobile World Live. 7 April 2022. Archived from the original on 18 September 2024. Retrieved 19 September 2024. ^ "Digicel ditches Panama as M&A kills competition". telecoms.com. 7 April 2022. Retrieved 19 September 2024. ^ "Digicel Leaves Panama After Government Clears C&W-Claro Merger". Nearshore Americas. 30 June 2022. Archived from the original on 18 September 2024. Retrieved 19 September 2024. ^ "Panama snags bite for Digicel's telecoms licence". Developing Telecoms. 17 March 2023. Archived from the original on 17 April 2024. Retrieved 19 September 2024. ^ "Flow to Upgrade Mobile Network 2G Network To Be Retired". SKNVibes. 4 April 2024. Archived from the original on 15 September 2024. Retrieved 15 September 2024. ^ "End of an era: The decommissioning of 2G mobile cellular networks in the caribbean". ICT Pulse & Choice TV Saint Lucia. 6 September 2024. Retrieved 13 October 2024. ^ "Flow plans 2G shutdown in Saint Vincent". Developing Telecoms. 21 August 2023. Archived from the original on 12 September 2024. Retrieved 12 September 2024. ^ "Flow to retire 2G network in Saint Vincent and the Grenadines". Data Centre Dynamics. 23 August 2023. Archived from the original on 7 October 2023. Retrieved 12 September 2024. ^ "Flow retires its 2G network to bolster 3G & 4G". Asbert News Network. 20 August 2023. Archived from the original on 12 September 2024. Retrieved 12 September 2024. ^ "FLOW SVG shutting down 2G network, upgrade to avoid interruption". St. Vincent Times. 21 August 2023. Archived from the original on 12 September 2024. Retrieved 12 September 2024. ^ a b c "IMDA: 2G shutdown will start on 1 April". TeleGeography. 28 March 2017. Archived from the original on 24 January 2021. Retrieved 23 January 2021. ^ "Out with the old on New Year's Eve: TelEm shuts 2G". TeleGeography. 20 December 2018. Archived from the original on 19 February 2022. Retrieved 19 February 2022. ^ "UTS: not turning 2G network back on post-Hurricane Irma". TeleGeography. 26 September 2017. Archived

from the original on 19 February 2022. Retrieved 19 February 2022. ^ "South Africa to ban 2G devices by March 2023". TeleGeography. 16 June 2022. Archived from the original on 16 June 2022. Retrieved 19 June 2022. ^ "SA comms minister proposes 2G/3G switch-offs in 2024/2025". TeleGeography. 6 September 2022. Archived from the original on 21 September 2024. Retrieved 6 September 2022. ^ "Terminating 2G Service in Korea: Policy Issues and Suggestions". International Telecommunications Policy Review. 1 March 2014. Retrieved 23 January 2021. ^ "S. Korea to end 2G network services by June". The Korea Herald. 17 January 2021. Archived from the original on 9 July 2021. Retrieved 23 January 2021. ^ "SK Telecoms shutters 2G service". TeleGeography. 28 July 2020. Archived from the original on 28 February 2021. Retrieved 23 January 2021. ^ "Nedsläckning av 2G och 3G - Tele2". www.tele2.se (in Swedish). Archived from the original on 21 September 2024. Retrieved 21 September 2024. ^ "Sverige släcker 2G och 3G – Telenor med i informationskampanjen Bytnät.nu". www.telenor.se (in Swedish). Archived from the original on 21 September 2024. Retrieved 21 September 2024. ^ "3G-nätet | Telenor". www.telenor.se (in Swedish). Archived from the original on 21 September 2024. Retrieved 21 September 2024. ^ "Telia och övriga i branschen säger adjö till 2G och 3G - byt nät nu!". Mynewsdesk (in Swedish). 30 January 2024. Retrieved 21 September 2024. ^ "Telia skjuter upp nedstängningen av 2G-nätet till 2027". Mynewsdesk (in Swedish). 30 May 2024. Archived from the original on 21 September 2024. Retrieved 21 September 2024. ^ "Salt und Swisscom besiegeln das Aus für Uralt-Handys – 2020 wird das 2G-Netz abgeschaltet" (in German). watson. 7 April 2017. Archived from the original on 29 January 2021. Retrieved 23 January 2021. ^ "Schweiz: GSM-Netz bei Salt noch nicht ganz weg" (in German). Teltarif.de. 23 June 2020. Retrieved 23 January 2021. ^ "GSM-Mobilfunk: Die Schweiz schaltet ab" (in German). heise online. 29 December 2020. Retrieved 20 December 2023. ^ "Sun sets on 2G technology for Swiss cellco". TeleGeography. 20 June 2017. Retrieved 23 January 2021. ^ "Schweiz: Sunrise schaltet 2G vorerst doch nicht ab" (in German). Teltarif.de. 23 November 2018. Archived from the original on 13 April 2021. Retrieved 14 April 2021. ^ "Abschaltung: Die Tage von GSM sind in der Schweiz gezählt" (in German). Teltarif.de. 20 June 2020. Archived from the original on 30 January 2021. Retrieved 23 January 2021. ^ "Swisscom plots the end of 2G as it moves to launch 5G in 2020". Fierce Wireless. 9 October 2016. Archived from the original on 30 January 2021. Retrieved 23 January 2021. ^ "Swisscom schaltet GSM-Netz komplett ab" (in German). Teltarif.de. 13 April 2021. Archived from the original on 13 April 2021. Retrieved 14 April 2021. ^ "Swisscom hat Refarming von GSM abgeschlossen" (in German). Golem.de. 13 April 2021. Archived from the original on 1 May 2021. Retrieved 14 April 2021. ^ a b c "Taiwanese cellcos shutter 2G networks". TeleGeography. 3 July 2017. Archived from the original on 28 January 2021. Retrieved 23 January 2021. ^ "Digicel to decommission 2G network". Loop News by Digicel. 10 November 2023. Retrieved 10 November 2023. ^ "Digicel to shut down Trinidadian 2G network on 31 March 2024". TeleGeography. 13 November 2023. Archived from the original on 18 November 2023. Retrieved 18 November 2023. ^ "Network - Frequently Asked Questions - Why are we decommissioning 2G services on our Network? What are the benefits to the customers?". Digicel Trinidad and Tobago. 31 March 2024. Retrieved 9 November 2023. ^ "spectrummonitoring.com - Trinidad and Tobago". spectrummonitoring.com. 25 November 2022. Retrieved 15 September 2024. ^ "TSTT prepares for 2G sunset". TechNewsTT. 23 August 2018. Archived from the original on 8 September 2024. Retrieved 9 September 2024. ^ "spectrummonitoring.com - Turcks and Caicos Islands (GB)". spectrummonitoring.com. 10 April 2023. Archived from the original on 15 September 2024. Retrieved 15 September 2024. ^ "Flow commences Phased Shutdown of 2G Mobile Network". NewslineTCI. 26 March 2024. Archived from the original on 11 September 2024. Retrieved 11 September 2024. ^ "du - 2G Shutdown". du. Archived from the original on 15 October 2023. Retrieved 7 October 2023. ^ "Etisalat UAE -Goodbye 2G". Etisalat UAE. Archived from the original on 15 October 2023. Retrieved 7 October 2023. ^ "UK 2G and 3G networks will be switched off by 2033". Techradar. 8 December 2021. Retrieved 3 March 2022. ^ "Switching off the UK's 3G mobile networks: what you need to know". Ofcom. Archived from the original on 16 November 2023. Retrieved 16 November 2023. ^ "A joint statement on the sunsetting of 2G and 3G networks and public ambition for Open RAN rollout as part of the Telecoms Supply Chain Diversification Strategy". Gov.uk. 8 December 2021. Archived from the original on 16 November 2023. Retrieved 16 November 2023. ^ "AT&T Starts TDMA Shutdown". Phone Scoop. 19 June 2007. Retrieved 26 February 2025. ^ "AT&T confirms 2G shutdown took place on 1 January". TeleGeography. 18 January 2017. Archived from the original on 23 September 2020. Retrieved 23 January 2021. ^ "Regional US mobile operator Cellcom to switch off 2G on 1 December; 3G was deactivated in March". TeleGeography. 20 September 2023. Archived from the original on 4 October 2023. Retrieved 2 October 2023. ^ "Upgrade Your Device Today". Choice Wireless. Archived from the original on 25 January 2024. Retrieved 5 February 2024. ^ "CDMA Sunset". Copper Valley Telecom. 6 January 2023. Archived from the original on 22 February 2024. Retrieved 22 February 2024. ^ "Edge Wireless - TDMA Network Changing to GSM/GPRS FAQs". Edge Wireless, LLC. 15 March 2007. Retrieved 26 February 2025. ^ "T-Mobile to finally turn off 2G in 2024". LightReading. 15 February 2023. Archived from the original on 3 November 2023. Retrieved 3 November 2023. ^ "T-Mobile kicks off 2G shutdown in US". Data Centre Dynamics Ltd (DCD). 19 February 2025. Retrieved 23 February 2025. ^ "T-Mobile aiming to shut down legacy Sprint networks in 2022". TeleGeography. 10 December 2020. Archived from the original on 4 March 2021. Retrieved 23 January 2021. ^ "T-Mobile US to shut down 3G network on 1 July 2022". TeleGeography. 17 September 2021. Archived from the original on 14 April 2022. Retrieved 18 September 2021. ^ "T-Mobile delays CDMA shutdown by three months". TeleGeography. 25 October 2021. Archived from the original on 14 April 2022. Retrieved 1 November 2021. ^ "T-Mobile US commences CDMA shutdown; expands 5G Home Internet footprint". TeleGeography. 31 March 2022. Archived from the original on 31 March 2022. Retrieved 31 March 2022. ^ "US-Cellular-2009-Annual-Report" (PDF). US-Cellular. 6 April 2010. Retrieved 5 March 2025. ^ "USCellular to Expand Cellular Service in Rural Missouri With USD 5.8 Million Grant". Telecom Talk. 6 November 2023. Archived from the original on 18 November 2023. Retrieved 18 November 2023. ^ "UScellular to switch off CDMA network on 14 January 2024". TeleGeography. 1 December 2023. Archived from the original on 2 December 2023. Retrieved 2 December 2023. ^ "Verizon to shut down 3G CDMA networks on 31 December 2022". TeleGeography. 31 March 2021. Archived from the original on 1 April 2021. Retrieved 14 April 2021. ^ a b c "Venezuela aims to phase out 2G in 2025; targets 1.8m fibre subs by that date". TeleGeography. 27 June 2023. Archived from the original on 8 July 2023. Retrieved 8 July 2023. ^ "Información al usuario" [Information for Users] (in Spanish). Digitel. 1 February 2024. Retrieved 3 April 2025. ^ a b c d "2G network switched off by the end of October 15". VnEconomy. 17 September 2024. Retrieved 12 October 2024. Preceded by1st Generation (1G) Mobile Telephony Generations Succeeded by3rd Generation (3G) Retrieved from " 5Third generation of wireless mobile telecommunications technology For other uses, see 3G (disambiguation). This article needs to be updated. Please help update this article to reflect recent events or newly available information. (April 2021) A USB modem for 3G plugged into a laptop. Part of a series on theWireless network technologies Analog 0G1G (1.5G) Digital 2G (2.5G, 2.75G, 2.9G)3G (3.5G, 3.75G, 3.9G/3.95G)4G (4G/4.5G, 4.5G, 4.9G)5G (5.5G)6G Mobile telecommunicationsvte 3G refers to the third-generation of cellular network technology. These networks were rolled out beginning in the early 2000s and represented a significant advancement over the second-generation (2G), particularly in terms of data transfer speeds and mobile internet capabilities. The major 3G standards are UMTS (developed by 3GPP, succeeding GSM) and CDMA2000 (developed by Qualcomm, succeeding cdmaOne);[1][2] both of these are based on the IMT-2000 specifications established by the International Telecommunication Union (ITU). While 2G networks such as GPRS and EDGE supported limited data services, 3G introduced significantly higher-speed mobile internet and enhanced multimedia capabilities, in addition to improved voice quality.[3] It provided moderate internet speeds suitable for general web browsing and multimedia content including video calling and mobile TV,[3] supporting services that provide an information transfer rate of at least 144 kbit/s.[4][5] Later 3G releases, often referred to as 3.5G (HSPA) and 3.75G (HSPA+) as well as EV-DO, introduced important improvements, enabling 3G networks to offer mobile broadband access with speeds ranging from several Mbit/s up to 42 Mbit/s.[6] These updates improved the reliability and speed of internet browsing, video streaming, and online gaming, enhancing the overall user experience for smartphones and mobile modems in comparison to earlier 3G technologies. 3G was later succeeded by 4G technology, which provided even higher data transfer rates and introduced advancements in network performance. A new generation of cellular standards has emerged roughly every decade since the introduction of 1G systems in 1979. Each generation is defined by the introduction of new frequency bands, higher data rates, and transmission technologies that are not backward-compatible due to the need for significant changes in network architecture and infrastructure. Several telecommunications companies marketed wireless mobile Internet services as 3G, indicating that the advertised service was provided over a 3G wireless network. However, 3G services have largely been supplanted in marketing by 4G and 5G services in most areas of the world. Services advertised as 3G are required to meet IMT-2000 technical standards, including standards for reliability and speed (data transfer rates). To meet the IMT-2000 standards, Third-generation mobile networks, or 3G, must maintain minimum consistent Internet speeds of 144 Kbps.[5] However, many services advertised as 3G provide higher speed than the minimum technical requirements for a 3G service.[7] Subsequent 3G releases, denoted 3.5G and 3.75G, provided mobile broadband access of several Mbit/s for smartphones and mobile modems in laptop computers.[8] 3G branded standards: The UMTS (Universal Mobile Telecommunications System) system, standardized by 3GPP in 2001, was used in Europe, Japan, China (with a different radio interface) and other regions predominated by GSM (Global Systems for Mobile Communications) 2G system infrastructure. The cell phones are typically UMTS and GSM hybrids. Several radio interfaces are offered, sharing the same infrastructure: The original and most widespread radio interface is called W-CDMA (Wideband Code Division Multiple Access). The TD-SCDMA radio interface was commercialized in 2009 and only offered in China. The latest UMTS release, HSPA+, can provide peak data rates up to 56 Mbit/s in the downlink in theory (28 Mbit/s in existing services) and 22 Mbit/s in the uplink. The CDMA2000 system, first offered in 2002, standardized by 3GPP2, used especially in North America and South Korea, sharing infrastructure with the IS-95 2G standard. The cell phones are typically CDMA2000 and IS-95 hybrids. The latest release EVDO Rev. B offers peak rates of 14.7 Mbit/s downstream. The 3G systems and radio interfaces are based on spread spectrum radio transmission technology. While the GSM EDGE standard ("2.9G"), DECT cordless phones and Mobile WiMAX standards formally also fulfill the IMT-2000 requirements and are approved as 3G standards by ITU, these are typically not branded as 3G and are based on completely different technologies. The common standards complying with the IMT2000/3G standard are: EDGE, a revision by the 3GPP organization to the older 2G GSM based transmission methods, which utilizes the same switching nodes, base station sites, and frequencies as GPRS, but includes a new base station and cellphone RF circuits. It is based on the three times as efficient 8PSK modulation scheme as a supplement to the original GMSK modulation scheme. EDGE is still used extensively due to its ease of upgrade from existing 2G GSM infrastructure and cell phones. EDGE combined with the GPRS 2.5G technology is called EGPRS, and allows peak data rates in the order of 200 kbit/s, just like the original UMTS WCDMA versions and thus formally fulfill the IMT2000 requirements on 3G systems. However, in practice, EDGE is seldom marketed as a 3G system, but a 2.9G system. EDGE shows slightly better system spectral efficiency than the original UMTS and CDMA2000 systems, but it is difficult to reach much higher peak data rates due to the limited GSM spectral bandwidth of 200 kHz, and it is thus a dead end. EDGE was also a mode in the IS-136 TDMA system, no longer used. Evolved EDGE, the latest revision, has peaks of 1 Mbit/s downstream and 400 kbit/s upstream but is not commercially used. The Universal Mobile Telecommunications System, created and revised by the 3GPP. The family is a full revision from GSM in terms of encoding methods and hardware, although some GSM sites can be retrofitted to broadcast in the UMTS/W-CDMA format. W-CDMA is the most common deployment, commonly operated on the 2,100 MHz band. A few others use the 850, 900, and 1,900 MHz bands. HSPA is an amalgamation of several upgrades to the original W-CDMA standard and offers speeds of 14.4 Mbit/s down and 5.76 Mbit/s up. HSPA is backward-compatible and uses the same frequencies as W-CDMA. HSPA+, a further revision and upgrade of HSPA, can provide theoretical peak data rates up to 168 Mbit/s in the downlink and 22 Mbit/s in the uplink, using a combination of air interface improvements as well as multi-carrier HSPA and MIMO. Technically though, MIMO and DC-HSPA can be used without the "+" enhancements of HSPA+. The CDMA2000 system, or IS-2000, including CDMA2000 1x and CDMA2000 High Rate Packet Data (or EVDO), standardized by 3GPP2 (differing from the 3GPP), evolving from the original IS-95 CDMA system, is used especially in North America, China, India, Pakistan, Japan, South Korea, Southeast Asia, Europe, and Africa. CDMA2000 1x Rev. E has an increased voice capacity (by three times the original amount) compared to Rev. 0 EVDO Rev. B offers downstream peak rates of 14.7 Mbit/s while Rev. C enhanced existing and new terminal user experience. While DECT cordless phones and Mobile WiMAX standards formally also fulfill the IMT-2000 requirements, they are not usually considered due to their rarity and unsuitability for usage with mobile phones.[9] The 3G (UMTS and CDMA2000) research and development projects started in 1992. In 1999, ITU approved five radio interfaces for IMT-2000 as a part of the ITU-R M.1457 Recommendation; WiMAX was added in 2007.[10] There are evolutionary standards (EDGE and CDMA) that are backward-compatible extensions to pre-existing 2G networks as well as revolutionary standards that require all-new network hardware and frequency allocations. The cell phones use UMTS in combination with 2G GSM standards and bandwidths, but do not support EDGE. The latter group is the UMTS family, which consists of standards developed for IMT-2000, as well as the independently developed standards DECT and WiMAX, which were included because they fit the IMT-2000 definition. While EDGE fulfills the 3G specifications, most GSM/UMTS phones report EDGE ("2.75G") and UMTS ("3G") functionality.[11] Cellular network standards and generation timeline. 3G technology was the result of research and development work carried out by the International Telecommunication Union (ITU) in the early 1980s. 3G specifications and standards were developed in fifteen years. The technical specifications were made available to the public under the name IMT-2000. The communication spectrum between 400 MHz to 3 GHz was allocated for 3G. Both the government and communication companies approved the 3G standard. The first pre-commercial 3G network was launched by NTT DoCoMo in Japan in 1998,[12] branded as FOMA. It was first available in May 2001 as a pre-release (test) of W-CDMA technology. The first commercial launch of 3G was also by NTT DoCoMo in Japan on 1 October 2001, although it was initially somewhat limited in scope;[13][14] broader availability of the system was delayed by apparent concerns over its reliability.[15][16][17][18][19] The first European pre-commercial network was an UMTS network on the Isle of Man by Manx Telecom, the operator then owned by British Telecom, and the first commercial network (also UMTS based W-CDMA) in Europe was opened for business by Telenor in December 2001 with no commercial handsets and thus no paying customers. The first network to go commercially live was by SK Telecom in South Korea on the CDMA-based 1xEV-DO technology in January 2002. By May 2002, the second South Korean 3G network was by KT on EV-DO and thus the South Koreans were the first to see competition among 3G operators. The first commercial United States 3G network was by Monet Mobile Networks, on CDMA2000 1x EV-DO technology, but the network provider later shut down operations. The second 3G network operator in the US was Verizon Wireless in July 2002, also on CDMA2000 1x EV-DO. AT&T Mobility was also a true 3G UMTS network, having completed its upgrade of the 3G network to HSUPA. The first commercial United Kingdom 3G network was started by Hutchison Telecom which was originally behind Orange S.A.[20] In 2003, it announced first commercial third generation or 3G mobile phone network in the UK. The first pre-commercial demonstration network in the southern hemisphere was built in Adelaide, South Australia, by m.Net Corporation in February 2002 using UMTS on 2100 MHz. This was a demonstration network for the 2002 IT World Congress. The first commercial 3G network was launched by Hutchison Telecommunications branded as Three or "3" in June 2003.[21] In India, on 11 December 2008, the first 3G mobile and internet services were launched by a state-owned company, Mahanagar Telecom Nigam Limited (MTNL), within the metropolitan cities of Delhi and Mumbai. After MTNL, another state-owned company, Bharat Sanchar Nigam Limited (BSNL), began deploying the 3G networks country-wide. Emtel launched the first 3G network in Africa.[22] Videotelephony through cellular networks were made possible using 3G technologies Japan was one of the first countries to adopt 3G, the reason being the process of 3G spectrum allocation, which in Japan was awarded without much upfront cost. The frequency spectrum was allocated in the US and Europe based on auctioning, thereby requiring a huge initial investment for any company wishing to provide 3G services. European companies collectively paid over 100 billion dollars in their spectrum auctions.[23] Nepal Telecom adopted 3G Service for the first time in southern Asia. However, its 3G was relatively slow to be adopted in Nepal. In some instances, 3G networks do not use the same radio frequencies as 2G, so mobile operators must build entirely new networks and license entirely new frequencies, especially to achieve high data transmission rates. Other countries' delays were due to the expenses of upgrading transmission hardware, especially for UMTS, whose deployment required the replacement of most broadcast towers. Due to these issues and difficulties with deployment, many carriers could not or delayed the acquisition of these updated capabilities. In December 2007, 190 3G networks were operating in 40 countries and 154 HSDPA networks were operating in 71 countries, according to the Global Mobile Suppliers Association (GSA). In Asia, Europe, Canada, and the US, telecommunication companies use W-CDMA technology with the support of around 100 terminal designs to operate 3G mobile networks. The roll-out of 3G networks was delayed by the enormous costs of additional spectrum licensing fees in some countries. The license fees in some European countries were particularly high, bolstered by government auctions of a limited number of licenses and sealed bid auctions, and initial excitement over 3G's potential. This led to a telecoms crash that ran concurrently with similar crashes in the fibre-optic and dot.com fields. The 3G standard is perhaps well known because of a massive expansion of the mobile communications market post-2G and advances of the consumer mobile phone. An especially notable development during this time is the smartphone (for example, the iPhone, and the Android family), combining the abilities of a PDA with a mobile phone, leading to widespread demand for mobile internet connectivity. 3G has also introduced the term "mobile broadband" because its speed and capability made it a viable alternative for internet browsing, and USB Modems connecting to 3G networks, and now 4G became increasingly common. By June 2007, the 200 millionth 3G subscriber had been connected of which 10 million were in Nepal and 8.2 million in India. This 200 millionth is only 6.7% of the 3 billion mobile phone subscriptions worldwide. (When counting CDMA2000 1x RTT customers—max bitrate 72% of the 200 kbit/s which defines 3G—the total size of the nearly-3G subscriber base was 475 million as of June 2007, which was 15.8% of all subscribers worldwide.) In the countries where 3G was launched first – Japan and South Korea – 3G penetration is over 70%.[24] In Europe the leading country[when?] for 3G penetration is Italy with a third of its subscribers migrated to 3G. Other leading countries[when?] for 3G use include Nepal, UK, Austria, Australia and Singapore at the 32% migration level. According to ITU estimates,[25] as of Q4 2012 there were 2096 million active mobile-broadband[vague] subscribers worldwide out of a total of 6835 million subscribers—this is just over 30%. About half the mobile-broadband subscriptions are for subscribers in developed nations, 934 million out of 1600 million total, well over 50%. Note however that there is a distinction between a phone with mobile-broadband connectivity and a smart phone with a large display and so on—although according[26] to the ITU and informatandm.com the US has 321 million mobile subscriptions, including 256 million that are 3G or 4G, which is both 80% of the subscriber base and 80% of the US population, according[25] to ComScore just a year earlier in Q4 2011 only about 42% of people surveyed in the US reported they owned a smart phone. In Japan, 3G penetration was similar at about 81%, but smart phone ownership was lower at about 17%.[25] In China, there were 486.5 million 3G subscribers in June 2014,[27] in a population of 1,385,566,537 (2013 UN estimate). Since the increasing adoption of 4G networks across the globe, 3G use has been in decline. Several operators around the world have already or are in the process of shutting down their 3G networks (see table below). In several places, 3G is being shut down while its older predecessor 2G is being kept in operation; Vodafone UK is doing this, citing 2G's usefulness as a low-power fallback.[28] EE in the UK, plans to switch off their 3G networks in early 2024.[29] In the US, Verizon shutdown their 3G services on 31 December 2022,[30] T-Mobile shut down Sprint's networks on 31 March 2022 and shutdown their main networks on 1 July 2022,[31] and AT&T has done so on 22 February 2022.[32] Currently 3G around the world is declining in availability and support. Technology that depends on 3G for usage are becoming inoperable in many places. For example, the European Union plans to ensure that member countries maintain 2G networks as a fallback[citation needed], so 3G devices that are backwards compatible with 2G frequencies can continue to be used. However, in countries that plan to decommission 2G networks or have already done so as well, such as the United States and Singapore, devices supporting only 3G and backwards compatible with 2G are becoming inoperable.[33] As of February 2022, less than 1% of cell phone customers in the United States used 3G; AT&T offered free replacement devices to some customers in the run-up to its shutdown.[34] It has been estimated that there are almost 8,000 patents declared essential (FRAND) related to the 483 technical specifications which form the 3GPP and 3GPP2 standards.[35][36] Twelve companies accounted in 2004 for 90% of the patents (Qualcomm, Ericsson, Nokia, Motorola, Philips, NTT DoCoMo, Siemens, Mitsubishi, Fujitsu, Hitachi, InterDigital, and Matsushita). Even then, some patents essential to 3G might not have been declared by their patent holders. It is believed that Nortel and Lucent have undisclosed patents essential to these standards.[36] Furthermore, the existing 3G Patent Platform Partnership Patent pool has little impact on FRAND protection because it excludes the four largest patent owners for 3G.[37][38] ITU has not provided a clear[39][vague] definition of the data rate that users can expect from 3G equipment or providers. Thus users sold 3G service may not be able to point to a standard and say that the rates it specifies are not being met. While stating in commentary that "it is expected that IMT-2000 will provide higher transmission rates: a minimum data rate of 2 Mbit/s for stationary or walking users, and 348 kbit/s in a moving vehicle,"[40] the ITU does not actually clearly specify minimum required rates, nor required average rates, nor what modes[clarification needed] of the interfaces qualify as 3G, so various[vague] data rates are sold as '3G' in the market. In a market implementation, 3G downlink data speeds defined by telecom service providers vary depending on the underlying technology deployed; up to 384 kbit/s for UMTS (WCDMA), up to 7.2 Mbit/sec for HSPA, and a theoretical maximum of 21.1 Mbit/s for HSPA+ and 42.2 Mbit/s for DC-HSPA+ (technically 3.5G, but usually clubbed under the tradename of 3G).[citation needed] See also: Mobile security § Attacks based on the GSM networks 3G networks 3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is the intended one and not an impersonator.[41] 3G networks use the KASUMI block cipher instead of the older A5/1 stream cipher. However, a number of serious weaknesses in the KASUMI cipher have been identified. In addition to the 3G network infrastructure security, end-to-end security is offered when application frameworks such as IMS are accessed, although this is not strictly a 3G property. The bandwidth and location capabilities introduced by 3G networks enabled a wide range of applications that were previously impractical or unavailable on 2G networks. Among the most significant advancements was the ability to perform data-intensive tasks, such as browsing the internet seamlessly while on the move, as well as engaging in other activities that benefited from faster data speeds and enhanced reliability. Beyond personal communication, 3G networks supported applications in various fields, including medical devices, fire alarms, and ankle monitors. This versatility marked a significant milestone in cellular communications, as 3G became the first network to enable such a broad range of use cases.[42] By expanding its functionality beyond traditional mobile phone usage, 3G set the stage for the integration of cellular networks into a wide array of technologies and services, paving the way for further advancements with subsequent generations of mobile networks. Both 3GPP and 3GPP2 are working on the extensions to 3G standards that are based on an all-IP network infrastructure and using advanced wireless technologies such as MIMO. These specifications already display features characteristic for IMT-Advanced (4G), the successor of 3G. However, falling short of the bandwidth requirements for 4G (which is 1 Gbit/s for stationary and 100 Mbit/s for mobile operation), these standards are classified as 3.9G or Pre-4G. 3GPP plans to meet the 4G goals with LTE Advanced, whereas Qualcomm has halted UMB development in favour of the LTE family.[43] On 14 December 2009, TeliaSonera announced in an official press release that "We are very proud to be the first operator in the world to offer our customers 4G services."[44] With the launch of their LTE network, initially they are offering pre-4G (or beyond 3G) services in Stockholm, Sweden and Oslo, Norway. Country Status Network Shutdown date Standard References Notes Argentina Personal TBD UMTS [45] Local shutdowns commenced in Q1 2023. Australia No Service Optus 2024-10-28 UMTS [46][47] Telstra 2024-10-28 UMTS [48][49][47] 2100 MHz band shutdown on 25 Mar 2019. TPG / Vodafone 2023-12-15 UMTS [50][51] Austria Magenta Telekom 2024 (est.) UMTS [52] Belgium Orange 2025-12-31 (est.) UMTS [53][54] Local shutdowns commenced in Jan 2024. Telenet 2024-09-30 (est.) UMTS [55] Local shutdowns commenced in Sep 2024. Proximus 2024-12-31 (est.) UMTS [56] Canada Bell 2025-12-31 (est.) UMTS [57] Rogers 2025-07-31 UMTS [57][58][59][60][61][62] 1900 MHz shutdown in Jun 2021.850 MHz remains active until 31 July 2025. Telus 2025-12-31 (est.) UMTS [57] Videotron 2025-07-31 UMTS [63] China China Mobile TBD TD-SCDMA [64][65][66][67] Local shutdowns commenced on 16 Mar 2016. China Telecom 2025 (est.) CDMA2000 [68][69][70] CDMA2000 1X, 1xEV-DO Rev. ALocal shutdowns commenced on 16 Jun 2020. China Unicom TBD UMTS [71] Local shutdowns commenced in Q4 2022. Croatia HT 2025 (est.) UMTS [72] Local shutdown commenced in Dec 2023. Czech Republic No Service O2 2021-11-30 UMTS [73] T-Mobile 2021-11-30 UMTS [73] Vodafone 2021-03-31 UMTS [74] Denmark 3 2025-12-01 (est.) UMTS [75] Local shutdowns commenced in 2019. TDC TBD UMTS [76] Local shutdown commenced in 2022. TT-Netværket(Telenor, Telia) 2023-03-20 UMTS [77][78] Service on the 2100 MHz band ended in 2021.Shutdown on the 900 MHz band commenced in summer 2022. Estonia Elisa 2024-11-26 UMTS [79] Tele2 2025-12-31 (est.) UMTS [80] Telia Eesti 2023-12-13 UMTS [81][82][83][84] Finland No Service DNA 2024-01-25 UMTS [85][86][87][88] Local shutdowns commenced in May 2023. Elisa 2023-11-30 UMTS [89] Local shutdowns commenced in Apr 2023. Finnish Shared Network [fi] 2024-12 UMTS [90] Joint company by Telia and DNA to manage networks in Northern and Eastern Finland. Telia 2024-10-28 UMTS [91][92][93] Local shutdowns commenced on 9 Sep 2023. France Bouygues 2029 (est.) UMTS [94] Orange 2028-12-31 (est.) UMTS [53] SFR 2028 (est.) UMTS [95] Germany No Service Deutsche Telekom 2021-07-01 UMTS [96] O2 2021-12-31 UMTS [97][98][99] Vodafone 2021-06-30 UMTS [100] Greece No Service Cosmote 2021-12-31 UMTS [101] NOVA 2023-03-27 UMTS [102][103][104][105] Vodafone 2023-05-31 UMTS [106] Greenland Tusass TBD UMTS [107] Hong Kong 3 active UMTS CMHK 2025-06-30 (est.) UMTS [108] CSL 2017-10-31 CDMA2000 [109] CDMA2000 1X, 1xEV-DO Rev. A.Service previously provided by PCCW. After acquisition of CSL by HKT,its mobile business PCCW Mobile was merged into CSL.No service for local customers, only served incoming roaming tourists.CSL terminated its CDMA family business upon its licence expiry,and cdmaOne service has also terminated along with CDMA2000. CSL active UMTS Smartone active UMTS Hungary No Service Magyar Telekom 2022-06-30 UMTS [110][111][112] Yettel Hungary 2023-11-13 UMTS [110][112][113] Vodafone Hungary 2023-03-31 UMTS [114][112] Iceland Nova 2025-12-31 (est.) UMTS [115][116] Síminn 2025-12-31 (est.) UMTS [116] Vodafone 2025-12-31 (est.) UMTS [116] India Airtel 2020-03-31 UMTS [117][118] Vodafone Idea 2022-10-06 UMTS [119] Complete network refarming to 4G/LTE. Indonesia Smartfren 2017-11-13 CDMA2000 [120] CDMA2000 1X, 1xEV-DO Rel. 0, 1xEV-DO Rev. A, EV-DO Rev. B Telkomsel 2023-06-23 UMTS [121] Indosat 2022-12-31 UMTS [122] XL Axiata TBD UMTS [123][124] Local shutdowns commenced in June 2021. Ireland Vodafone TBD UMTS [125] Local shutdowns commenced in Feb 2023. Israel 2025-12-31 (est.) [126] Per government statement Italy Iliad 2025 (est.) UMTS [127] TIM 2022-10-21 UMTS [128][129][130][131] Vodafone 2021-02-28 UMTS [132] Wind Tre 2025 (est.) UMTS [127] Japan KDDI 2022-03-31 CDMA2000 [133][134][135] CDMA2000 1X, 1xEV-DO Rel. 0, 1xEV-DO Rev. A, EV-DO Rev. B NTT docomo 2026-03-31 (est.) UMTS [136] Softbank 2024-04-15 UMTS [137][138][139] Kazakhstan Tele2 TBD UMTS [140][141] Local shutdown commenced on 28 Mar 2024. Lithuania Telia 2022-12-15 UMTS [142][143][144] Tele2 2025-12 (est.) UMTS [145] Luxembourg Orange 2025-12-31 (est.) UMTS [53] Tango / Telindus 2024-01-31 UMTS [146] Macau China Telecom 2025-06-04 (est.) CDMA2000 [147][148][149] CDMA2000 1X, 1xEV-DO Rev. A CTM 2025-06-04 (est.) UMTS [149] 3 2025-06-04 (est.) UMTS [149] Smartone 2024-11-11 UMTS [150] Smartone ceased operations in Macau and returned its license. Malaysia No Service Celcom 2021-12-31 UMTS [151][152] Maxis 2021-12-31 UMTS [153] U Mobile 2021-12-31 UMTS [153] Digi 2021-12-31 UMTS [153][152] Moldova Interdnestrcom 2023-08-01 CDMA2000 [154] Montenegro Crnogorski Telekom 2024-01-22 UMTS [155][156] Netherlands KPN 2023-05-10 UMTS [157][158][159] Local shutdown commenced on 31 Mar 2022. Vodafone 2020-02-04 UMTS [160] New Zealand 2degrees 2025 Q4 (est.) UMTS [161] One 2025-12-31 (est.) UMTS [162][163][164] Local shutdown will commence by 31 Mar 2025. Spark 2025-12-31 (est.) UMTS [165][166] Local shutdown will commence "towards the end of 2025". Norway No Service Telia 2021-11-11 UMTS [167] Telenor 2021-01-31 UMTS [168] Oman Omantel 2024 Q3 (est.) UMTS [169][170] Pakistan No Service Jazz 2024-11-18 UMTS [171][172] Philippines Smart (PLDT) TBD UMTS [173] Globe TBD UMTS [174] Shutdown commenced in Oct 2020. Poland T-Mobile 2023-04 (est.) UMTS [175][176][177] Shutdown commenced in Apr 2023. Orange 2025-12-31 (est.) UMTS [53][178][179] Local shutdown commenced on 26 Sep 2023. Portugal MEO 2024-01-31 UMTS [180] Local shutdown commenced on 4 Sep 2023. Vodafone 2024-07 (est.) UMTS [181] NOS 2024-05 (est.) UMTS [182] Shutdown commenced in May 2024. Romania Digi 2023-08-29 UMTS [183] Orange 2025-12-31 (est.) UMTS [53] Telekom 2023-03-31 UMTS [184] Vodafone 2025-07-01 (est.) UMTS [185] Russia Beeline 2025 (est.) UMTS [186] Shutdown commenced in Moscow in Feb 2023. MTS 2025 (est.) UMTS [187] Shutdowns commenced in Saint-Petersburg in Oct 2024. Saudi Arabia stc 2022-12-31 UMTS [188] Singapore No Service M1 2024-08-01 UMTS [189][190] Singtel 2024-11-01 UMTS [189][190] StarHub 2024-11-01 UMTS [189][190] Slovakia O2 TBD UMTS [191] Local shutdown commences in Jan 2024. Orange 2024-02-22 UMTS [53][192][193] Telekom 2023-11-23 UMTS [194][195] Local shutdown commenced on 3 Oct 2023. Slovenia Telekom Slovenije 2022-09-30 UMTS [196] A1 Slovenija 2023-06-30 UMTS [197] South Africa 2025-03 (est.) [198][199] Per government statement South Korea KT 2012-03-19 CDMA2000 [200][201][202] CDMA2000 was also referred to as "2G" in South Korea, besides cdmaOne (IS-95).[203]CDMA2000 1X, 1xEV-DO Rel. 0KT also operates an UMTS "3G" network. LG U+ 2021-06-30 CDMA2000 [204][205][200][206] CDMA2000 1X, 1xEV-DO Rev. A, EV-DO Rev. B SK Telecom 2020-07-27 CDMA2000 [207][202][200][208] CDMA2000 was also referred to as "2G" in South Korea, besides cdmaOne (IS-95).[203]CDMA2000 1X, 1xEV-DO Rel. 0SKT also operates an UMTS "3G" network. Spain Movistar 2025 (est.) UMTS Orange 2025-12-31 (est.) UMTS [53] Vodafone España 2024-10-29 (est.) UMTS [209][210] Sri Lanka Airtel 2022-06-12 UMTS [211] Dialog Axiata TBD UMTS [212] Sweden Telenor 2025-12 (est.) UMTS [213] Telia 2025 (est.) UMTS [214] Three 2025-12-01 (est.) UMTS [215][216] Local shutdown for 2100 MHz commenced in late 2021. Switzerland Sunrise 2025-06 (est.) UMTS [217] Swisscom 2025-12-01 (est.) UMTS [218] Taiwan No Service Asia Pacific Telecom 2017-12-31 CDMA2000 [219][220] CDMA2000 1X, 1xEV-DO Rev. A Chunghwa Telecom 2018-12-31 (Data)2024-06-30 (Voice) UMTS [221][222][223] Far EasTone 2018-12-31 (Data)2024-06-30 (Voice) UMTS [221][222][223] Taiwan Mobile 2018-12-31 (Data)2024-06-30 (Voice) UMTS [221][222][223] Taiwan Star 2018-12-31 (Data)2024-06-30 (Voice) UMTS [221][222][223] United Kingdom EE 2024-02-25 UMTS [224][225][226][227] Three 2024-12-31 UMTS [228] O2 2025-12-31 (est.) UMTS [229][230] Local shutdown commenced in Apr 2025. Vodafone 2024-02-28 UMTS [231][232][233][234] Local shutdown commenced in Jun 2023. United States Puerto Rico US Virgin Islands No Service Appalachian Wireless 2023-01-03 CDMA2000 [235][236][237] CDMA2000 1X, 1xEV-DO Rev. A AT&T 2022-02-22 UMTS [238][239] Cellcom 2023-03-31 CDMA2000 [240] Cellular One of North East Arizona 2023-05-04 UMTS [241] Commnet Wireless (Choice) 2022-12-31 CDMA2000 [242] Liberty 2022-02-22 UMTS [243] Silver Star 2022-12-30 CDMA2000 [244][245] CDMA2000 1X & 1xEV-DO Rev. A Strata Networks 2022-12-31 CDMA2000 [246] T-Mobile 2022-07-01 UMTS [247][248][249][250] T-Mobile (Sprint) 2022-05-31 CDMA2000 [251][247][248][249][252][253] CDMA2000 1X, 1X Adv. (Rev.E), 1xEV-DO Rel. 0, 1xEV-DO Rev. AShutdown commenced on 31 Mar 2022. UScellular 2024-01-14 CDMA2000 [254][255][256] CDMA2000 1X1xEV-DO (Rel. 0 & Rev. A) shutdown commenced in 2021. Verizon 2022-12-31 CDMA2000 [257][258][259] CDMA2000 1X, 1xEV-DO Rel. 0, 1xEV-DO Rev. A Vietnam 2028-09 (est.) [260] per government statement List of mobile phone generations Mobile radio telephone (also known as "0G") Mobile broadband Wireless device radiation and health 1G 2G 4G 5G 6G LTE (telecommunication) ^ "Mobility and Session Management: UMTS vs. CDMA2000" (PDF). IEEE Wireless Communications. August 2004. ^ Nunno, Richard (September 2003). "Migration to 3G Technology Standards: A Comparison of Selected Countries" (PDF). FCC. ^ a b "All about the Technology=2011-04-04". itu.int. Retrieved 17 August 2019. ^ "3G CELLULAR STANDARDS WITH PATENTS". projectsatbangalore.com. 24 June 2014. Retrieved 17 August 2019. ^ a b "3G vs. 4G: What's the Difference?". PC Magazine. 10 February 2015. Retrieved 17 August 2019. ^ "HSPA - About Us". GSMA. 9 July 2017. Archived from the original on 9 July 2017. Retrieved 29 November 2024. ^ "Download Speeds: Comparing 2G, 3G, 4G & 5G Mobile Networks". Ken's Tech Tips. 23 November 2019. Retrieved 17 August 2019. ^ "HSPA". 3gpp.org. Retrieved 17 August 2019. ^ "HTC – Touch Phone, PDA Phone, Smartphone, Mobile Computer". 22 November 2008. Archived from the original on 22 November 2008. Retrieved 17 August 2019. ^ "ITU Radiocommunication Assembly approves new developments for its 3G standards" (Press release). ITU. Archived from the original on 19 May 2009. Retrieved 1 June 2009. ^ "EDGE, 3G, H+, Etc: What Are All These Mobile Networks?". MakeUseOf. 15 February 2019. Retrieved 17 August 2019. ^ "A Brand New Mobile Millennium Ericsson/CATT/DoCoMo jointly demonstrate pioneering W-CDMA technology at PT/Wireless" (Press release). NTT DOCOMO Global. 9 November 1999. Archived from the original on 6 February 2012. Retrieved 30 October 2012. ^ "Economists' Pick". HKTDC Research. Archived from the original on 31 March 2020. Retrieved 12 January 2020. ^ "3G grinds to a start". broadbandmag.co.uk. Archived from the original on 23 April 2009. Retrieved 7 April 2009. ^ "DoCoMo Delays 3G Launch". Wired. 24 April 2001. ^ Charny, Ben (1 October 2001). "World's first 3G phone network goes live". ZDNet. Retrieved 16 August 2019. ^ McCarthy, Kieren (1 October 2001). "World's first 3G network live today". theregister.co.uk. Retrieved 16 August 2019. ^ "THE EVOLUTION TO 3G MOBILE – STATUS REPORT". itu.int. 29 July 2003. Retrieved 16 August 2019. ^ "First 3G mobiles launched in Japan". 1 October 2001. Retrieved 16 August 2019. ^ "3G in UK". 3g.co.uk. ^ "About Hutchison". Hutchison Telecommunications (Australia) Limited. 11 June 2008. Retrieved 7 April 2012. ^ "Emtel | Africa Outlook Magazine". Africa Outlook Magazine. Archived from the original on 3 February 2018. Retrieved 3 February 2018. ^ "Radiocommunications Agency : The Auction of Radio Spectrum for the Third Generation of Mobile Telephones – National Audit Office (NAO) Report". National Audit Office. 19 October 2001. Retrieved 17 August 2019. ^ "Plus 8 Star presentation, "Is 3G a Dog or a Demon – Hints from 7 years of 3G Hype in Asia"". Plus8star.com. 11 June 2008. Archived from the original on 18 February 2012. Retrieved 6 September 2010. ^ a b c "Global mobile statistics 2013 Part A: Mobile subscribers; handset market share; mobile operators". mobiThinking. May 2013. Archived from the original on 6 September 2014. Retrieved 15 October 2013. ^ "The 100 million club: the top 10 mobile markets by number of mobile subscriptions". mobiThinking. 13 December 2012. Archived from the original on 26 September 2013. Retrieved 15 October 2013. ^ Steven Millward (29 July 2014). "China now has 486.5 million 3G subscribers, but only 14 million on new 4G network". Tech in Asia. Retrieved 4 August 2014. ^ Hall, Kat. "Sod 3G, that can go, but don't rush to turn off 2G, UK still needs it – report". www.theregister.com. ^ "We're Switching Off Our 3G Network". EE. Retrieved 2 January 2024. ^ "3G CDMA Network Shut off date set for December 31, 2022". www.verizon.com. 30 March 2021. Retrieved 2 January 2024. ^ "T-Mobile Network Evolution". T-Mobile Support. Retrieved 2 January 2024. ^ Kelly, Samantha Murphy (22 February 2022). "AT&T is shutting down its 3G network. Here's how it could impact you | CNN Business". CNN. Retrieved 2 January 2024. ^ arsyline.cz. "2G and 3G networks are shutting down globally?!". SECTRON s.r.o. Retrieved 26 February 2022. ^ Kelly, Samantha Murphy (22 February 2022). "AT&T is shutting down its 3G network. Here's how it could impact you". CNN. ^ "3G CELLULAR STANDARDS AND PATENTS". engpaper.com. 13 June 2005. Retrieved 24 June 2012. ^ a b David J. Goodman (13 June 2005). "3G CELLULAR STANDARDS AND PATENTS" (PDF). IEEE Wireless com. Polytechnic Institute of New York University. Archived from the original (PDF) on 20 June 2015. Retrieved 24 June 2012. ^ "Study on the Interplay between Standards and Intellectual Property Rights (IPRs)" (PDF). European Commission. 18 July 2009. Archived from the original (PDF) on 24 December 2012. Retrieved 24 June 2012. Pools that cover only a fraction of the actual IPR for a standard are not very useful. It is essential that the large licensees sign up. Examples of pools that have little impact are the 3G Licensing pool (which excludes the four largest IPR owners for 3G) and the 802.11 pool by ViaLicensing. ^ "Possible 'showstoppers' shadow 3G patent pool". eetimes.com. 21 May 1999. Retrieved 24 June 2012. Even so, Qualcomm (San Diego) is still a wild card in the patent-pooling effort. Qualcomm was a member of the UMTS group when it was formed in February 1998, but deactivated its membership last September. ^ "3G Licensing Workshop (19–21 September 2001)". www.itu.int. Retrieved 17 June 2021. ^ "Cellular Standards for the Third Generation". ITU. 1 December 2005. Archived from the original on 24 May 2008. ^ "Security for the Third Generation (3G) Mobile System" (PDF). Network Systems & Security Technologies. Archived from the original (PDF) on 12 September 2003. ^ Ashworth, Boone. "3G Service Is Going Away Next Year. Here's What That Means". WIRED. Retrieved 26 February 2022. ^ Qualcomm halts UMB project, Reuters, 13 November 2008 ^ "first in the world with 4G services". TeliaSonera. 14 December 2009. Retrieved 6 September 2010. ^ "Personal to commence 3G shutdown in 1Q23". TeleGeography. 2 November 2022. Retrieved 13 November 2022. ^ "We're upgrading our network with changes to 3G". Optus. Retrieved 16 February 2023. ^ a b "Australian 3G Network Shutdown: Everything you need to know". whistleOut. 6 May 2024. Retrieved 4 July 2024. ^ "3G Service Closure". Telstra. Archived from the original on 21 November 2019. Retrieved 25 June 2021. ^ "How Telstra, Optus and Vodafone Will Deal With the 3G Shutdown". Gizmodo Australia. 13 December 2021. Retrieved 12 April 2022. ^ "TPG Telecom confirms it will switch off 3G network in December 2023". TeleGeography. 27 September 2022. Retrieved 6 October 2022. ^ "Vodafone Australia poised to switch off its 3G network tomorrow". TeleGeography. 14 December 2023. Retrieved 14 December 2023. ^ "Magenta will start 3G shutdown in 2024". TeleGeography. 8 April 2022. Retrieved 18 April 2022. ^ a b c d e f g "Orange selects 5G SA vendors; provides timetable for 2G/3G shutdowns". TeleGeography. 1 March 2022. Retrieved 6 March 2022. ^ "Orange Belgium to kick off 3G shutdown in January 2024". TeleGeography. 5 June 2023. Retrieved 6 June 2023. ^ "Telenet to switch off 3G from September 2024". TeleGeography. 16 September 2022. Retrieved 6 March 2022. ^ "Proximus to switch off 3G network by end-2024". TeleGeography. 30 November 2022. Retrieved 4 December 2022. ^ a b c "What's the 3G Sunset and How Will It Affect Existing IoT Deployments?". hologram.io. Retrieved 24 October 2020. ^ "Important Notice Regarding Upcoming 2G/3G Changes on the Rogers Network". Bulwark. 15 July 2020. Retrieved 24 October 2020. ^ "1900 MHz Shutdown on our 2G and 3G Wireless Networks". Rogers Communications. 1 March 2021. Retrieved 13 May 2023. ^ "2G and 3G Shutdowns Continue". blog.telegeography.com. 15 February 2023. Retrieved 13 May 2023. ^ "3G Alarm Systems Need To Be Upgraded". alarmtech.ca. 6 August 2024. Retrieved 19 October 2024. ^ "3G Network retirement – Everything you need to know". rogers.ca. Retrieved 29 November 2024. ^ "3G phase-out in Canada". Videotron. Retrieved 3 February 2025. ^ "China's 3G failure". Fierce Network. 30 March 2008. Retrieved 29 August 2024. ^ "China Mobile Not Serious About TD-SCDMA, Betting Big on TD-LTE". TechNode. 9 May 2011. Retrieved 29 August 2024. ^ "China Mobile starts to turn off 3G base stations". GSM Association (GSMA), Mobile World Live. 16 March 2016. Retrieved 22 January 2022. ^ "China Mobile to shut down 3G network". China Daily. 13 March 2019. Retrieved 29 August 2024. ^ "CDMA2000 Operators - China Telecom". CDG. Retrieved 7 July 2023. ^ "China Telecom: 3G Network Will Be Shut down Gradually Starting from June". Montnets. 5 June 2020. Retrieved 14 May 2022. ^ "Turning off 2G in China harder than it looks". Light Reading. 29 June 2022. Retrieved 4 December 2022. ^ "China Unicom given green light to refarm 900MHz band for 5G". TeleGeography. 4 November 2022. Retrieved 6 November 2022. ^ "HT to begin 3G shutdown soon". TeleGeography. 7 December 2023. Retrieved 14 December 2023. ^ a b "T-Mobile, O2 switch off Czech 3G networks". TeleGeography. 3 December 2021. Retrieved 6 December 2021. ^ "Začala bombasticky s vrtulníkem, skončí v tichosti za dva týdny. 3G síť Vodafonu" [It started bombastically with a helicopter, ending in silence in two weeks. Vodafone's 3G network] (in Czech). mobilmania.zive.cz. 17 March 2021. Retrieved 14 April 2021. ^ "3 Denmark trials 3G switch-off at Roskilde Festival". Telecompaper. 4 July 2019. Retrieved 7 September 2024. ^ "Udfasningen af 3G-nettet - Danmarks bedste mobilnetværk fremtidssikres - farvel til 3G fra slutningen af 2022" (in Danish). TDC. 2022. Retrieved 7 September 2024. ^ "Telenor Denmark launching 5G SA in 2022, shutting 3G in late summer". TeleGeography. 9 February 2022. Retrieved 11 April 2022. ^ "Telia, Telenor decommission their 3G networks in Denmark". TeleGeography. 20 April 2023. Retrieved 23 April 2023. ^ "Elisa Estonia completes 3G shutdown". Data Centre Dynamics Ltd. 26 November 2024. Retrieved 24 December 2024. ^ "Tele2 Estonia to close 3G network by end-2025". TeleGeography. 24 August 2022. Retrieved 27 August 2022. ^ "Telia Eesti plans 3G shutdown by end-2023". TeleGeography. 28 May 2021. Retrieved 11 April 2022. ^ "Telia Estonia to start 3G shutdown at end-February". TeleGeography. 17 January 2023. Retrieved 17 January 2023. ^ "Telia switches off 3G in capital Tallinn". TeleGeography. 22 September 2023. Retrieved 2 October 2023. ^ "Telia completes Estonian 3G shutdown". TeleGeography. 13 December 2023. Retrieved 14 December 2023. ^ "Schedule published: This is how DNA's 3G network will be shut down in 2023–2024". DNA Oyj. Retrieved 12 July 2023. ^ "DNA confirms next areas for 3G shutdown". TeleGeography. 16 November 2023. Retrieved 19 November 2023. ^ "DNA will densify 4G with 3G spectrum after shutdowns". mobileeurope.co.uk. 23 November 2023. Retrieved 3 March 2024. ^ "DNA to Permanently Shut Down its 3G Networks Next Week – Common Devices Will Need to Transition to 2G Network". Alma Media Oyj 2024. 5 January 2024. Retrieved 3 March 2024. ^ "3G network became history - we are investing in faster connections". Elisa Oyj. 30 November 2023. Retrieved 3 March 2024. ^ "Suomen Yhteisverkon 5G-urakka valmistui, vanhat 3G-taajuudet otettu 4G:n käyttöön" (in Finnish). STT Info. 24 March 2025. Retrieved 17 May 2025. ^ "Telia Finland to commence 3G shutdown on 11 September". TeleGeography. 8 September 2023. Retrieved 11 September 2023. ^ "3G-verkko on siirtymässä historiaan" (in Finnish). Telia. Retrieved 3 March 2024. ^ "Telian 3G-verkon viimeiset tukiasemat sammuvat lokakuun lopussa Helsingissä" (in Finnish). Telia. 9 October 2024. Retrieved 17 May 2025. ^ "Bouygues Telecom to decommission 2G in 2026, 3G to follow in 2029". TeleGeography. 3 February 2023. Retrieved 11 February 2023. ^ "SFR selects Nokia for 5G SA network; to decommission 2G/3G by 2028". TeleGeography. 27 January 2023. Retrieved 28 January 2023. ^ "Telekom switches off 3G network". TeleGeography. 6 July 2021. Retrieved 13 July 2021. ^ "Telefonica Deutschland accelerates 3G shutdown". TeleGeography. 19 November 2019. Retrieved 14 April 2021. ^ "Telefonica Deutschland to begin 3G switch-off on 1 July". TeleGeography. 8 June 2021. Retrieved 8 June 2021. ^ "Telefonica accelerates 3G switch-off in Germany". TeleGeography. 27 August 2021. Retrieved 27 August 2021. ^ "Vodafone Germany to switch off 3G on 30 June 2021". TeleGeography. 11 May 2020. Retrieved 14 April 2021. ^ "Cosmote to switch off 3G by end of year". TeleGeography. 15 April 2021. Retrieved 5 February 2022. ^ "Wind Hellas to shut down 3G by end-2022". TeleGeography. 6 July 2021. Retrieved 13 July 2021. ^ "Wind Hellas to begin 3G shutdown". TeleGeography. 4 July 2022. Retrieved 9 July 2022. ^ "NOVA to finalise 3G shutdown in March". TeleGeography. 13 January 2023. Retrieved 13 January 2023. ^ "NOVA hangs up on 3G". TeleGeography. 27 March 2023. Retrieved 31 March 2023. ^ "Vodafone Greece to switch off 3G by mid-2023". TeleGeography. 24 January 2023. Retrieved 28 January 2023. ^ "Tusass to discontinue 3G services in 2023". TeleGeography. 21 December 2022. Retrieved 22 December 2022. ^ "Communications Authority Grants Consent to CMHK to Cease its 3G Services". Office of the Communications Authority, Government of Hong Kong. 28 April 2024. Retrieved 28 April 2024. ^ "不獲批頻譜改作4G LTE 香港電訊入稟司法覆核 - 香港經濟日報" (in Chinese). topick.hket.com. 22 December 2017. Retrieved 9 November 2024. ^ a b "Subsidies offered to customers exchanging 3G phones from Feb-22". CommsUpdate. 13 October 2021. Retrieved 18 April 2022. ^ "Telekom confirms 3G shutdown will complete this month". TeleGeography. 17 June 2022. Retrieved 19 June 2022. ^ a b c "National 2G/3G handset replacement scheme ends; 120,000 devices subsidised". TeleGeography. 20 April 2023. Retrieved 23 April 2023. ^ "Yettel switching off Hungary's last 3G network on 13 November". TeleGeography. 13 October 2023. Retrieved 14 October 2023. ^ "Hírek/Cikkek - Vodafon 3G-hálózat lekapcsolása" (in Hungarian). T.E.L.L. Software Hungaria Kft. 4 October 2022. Retrieved 23 April 2023. ^ "ECOI postpones 2G shutdown to 2025". TelGeography. 24 November 2022. Retrieved 4 December 2022. ^ a b c "Lokun 2G og 3G farsímaþjónustu" (in Icelandic). Fjarskiptastofa. 6 September 2024. Retrieved 28 January 2025. ^ "Airtel begins phasing out Indian 3G networks". TeleGeography. 1 July 2019. Retrieved 1 January 2022. ^ "Bharti Airtel shuts down 3G networks across 11 circles". livemint.com. 5 February 2020. Retrieved 14 April 2021. ^ "Vi Enhances 4G Network Coverage for its Customers in Maharashtra & Goa to Enable Seamless Conversations and Internet Experience" (PDF). Vodafone Idea Limited. 6 October 2022. Retrieved 28 January 2023. ^ "13 November, Smartfren Tutup Sepenuhnya Jaringan CDMA" (in Indonesian). kumparanTECH. 8 November 2017. Retrieved 2 July 2024. ^ "Telkomsel switches off 3G network Nationwide" (in Indonesian). Inilah. 23 June 2023. Retrieved 14 March 2025. ^ "Siap-Siap Indosat Matikan Sinyal 3G Di Akhir 2022". detikcom. 31 May 2022. Retrieved 16 July 2022. ^ "Penataan Ulang Teknologi 3G ke 4G" [Reconfiguring 3G to 4G Technology] (in Indonesian). XL Axiata. Retrieved 25 January 2024. ^ "XL Axiata to expand 4G network across Indonesia with its IDR 8 trillion Capex". Indonesia Business Post. 21 February 2023. Retrieved 25 January 2024. ^ "Vodafone Ireland unveils plans to phase out 3G". TeleGeography. 30 June 2022. Retrieved 3 July 2022. ^ "Ministry orders shutdown of Israeli 2G, 3G networks by 2025". TelGeography. 2 July 2021. Retrieved 6 June 2022. ^ a b "WindTre e Iliad verso il cambiamento definitivo | Possiamo dire addio alla rete storica" (in Italian). Player.it - Dadafree Srl. 4 September 2023. Retrieved 4 December 2024. ^ "TIM to begin 3G shutdown in April". TeleGeography. 3 February 2022. Retrieved 5 February 2022. ^ "TIM to delay 3G shutdown until July". TeleGeography. 9 May 2022. Retrieved 14 May 2022. ^ "TIM 3G switch-off now scheduled for mid-October". TeleGeography. 10 June 2022. Retrieved 19 June 2022. ^ "TIM completes 3G shutdown". TeleGeography. 21 October 2022. Retrieved 22 October 2022. ^ "Vodafone begins 3G switch-off in Italy". TeleGeography. 25 January 2021. Retrieved 14 April 2021. ^ "CDMA2000 Operators - KDDI". CDG. Retrieved 7 July 2023. ^ "KDDI to Discontinue 3G Services in March 2022". nippon.com. 16 November 2018. Retrieved 14 April 2021. ^ "KDDI (au) shutting 3G network today; advises users to upgrade if they wish to keep its services". TeleGeography. 31 March 2022. Retrieved 18 April 2022. ^ "「FOMA」および「iモード」のサービス終了について" [End of service for "FOMA" and "i-mode"] (in Japanese). NTT DOCOMO Inc. 29 October 2019. Retrieved 14 April 2021. ^ "SoftBank confirms date for 3G switch-off". TeleGeography. 21 November 2022. Retrieved 4 December 2022. ^ "SoftBank delays 3G closure due to earthquake". Mobile World Live. 17 January 2024. Retrieved 19 January 2024. ^ "The End of an Era: SoftBank Corp. Closes Curtain on its 3G Services". SoftBank. 15 April 2024. Retrieved 18 May 2024. ^ "Turning off 3G in Almaty and partially Almaty Oblast". Tele2 Kazakhstan. 26 February 2024. Retrieved 6 March 2024. ^ "Tele2/Altel отключит 3G в шести городах Казахстана" [Tele2/Altel to Disable 3G in Six Cities of Kazakhstan] (in Russian). Digital Business KZ. 17 September 2024. Retrieved 31 March 2025. ^ "Telia to commence Lithuanian 3G shutdown in March". TeleGeography. 17 February 2022. Retrieved 19 February 2022. ^ "Telia shuts down a third of 3G base stations". TeleGeography. 6 June 2022. Retrieved 6 June 2022. ^ "Telia switches off 3G network". TeleGeography. 15 December 2022. Retrieved 18 March 2023. ^ "Tele2 is bidding farewell to the old 3G network by the end of 2025". Tele2 LT. 4 March 2024. Retrieved 19 October 2024. ^ "Tango and Telindus to shut down 3G network in January 2024". TeleGeography. 2 March 2023. Retrieved 5 March 2023. ^ "CDMA2000 Operators - China Telecom". CDG. Archived from the original on 13 December 2021. Retrieved 27 August 2024. ^ "China Unicom sells off CDMA arm to China Telecom". ChinaDaily. 29 July 2008. Retrieved 27 August 2024. ^ a b c "Macau will switch off 3G in 2025". Data Centre Dynamics. 9 December 2024. Retrieved 29 April 2025. ^ "Important Customer Notice". Smartone. Retrieved 29 April 2025. ^ "Celcom to shutter 3G network in stages; ready for 5G launch by end-2021". TeleGeography. 8 September 2021. Retrieved 12 September 2021. ^ a b "Digi confirms 3G shutdown timeline". TeleGeography. 26 November 2021. Retrieved 26 November 2021. ^ a b c "3G network to be terminated on Dec 31, users advised to switch to 4G". New Straits Times. 25 November 2021. Retrieved 16 February 2022. ^ "Перспективы развития сети LTE и завершение оказания услуг сотовой связи в стандарте CDMA" [Prospects for the development of the LTE network and the termination of the provision of cellular services in the CDMA standard] (in Russian). Interdnestrcom. 4 August 2023. Retrieved 22 September 2023. ^ "Crnogorski Telekom to shutter 3G network by year-end". TeleGeography. 2 October 2023. Retrieved 2 October 2023. ^ "Crnogorski Telekom to shutter 3G network on 22 January". TeleGeography. 10 January 2024. Retrieved 12 January 2024. ^ "KPN shutting 3G by January 2022". TeleGeography. 27 July 2018. Retrieved 14 April 2021. ^ "More capacity on KPN's mobile network with 3G-frequencies". KPN. 30 March 2022. Retrieved 22 March 2023. ^ "KPN's 3G network has been phased out". Thingsdata. 11 May 2023. Retrieved 12 May 2023. ^ "VodafoneZiggo closing 3G network on 4 February 2020". TeleGeography. 11 December 2019. Retrieved 14 April 2021. ^ "2degrees to shut down 3G services in 2025". TeleGeography. 10 July 2023. Retrieved 9 August 2023. ^ "Vodafone announces 4G or 5G to fully replace 3G in late 2024". TeleGeography. 24 August 2022. Retrieved 27 August 2022. ^ "One NZ reschedules 3G shutdown, plots 2G termination". GSMA Mobile World Live. 4 April 2024. Retrieved 3 October 2024. ^ "The 3G farewell is coming". One NZ. Retrieved 5 March 2025. ^ "Spark to shutter 3G network in late 2025 to clear space for rural 5G". TeleGeography. 29 March 2023. Retrieved 31 March 2023. ^ "3G network closure | Spark NZ". Spark NZ. Retrieved 3 October 2024. ^ "Telia Norge confirms closure of 3G network". TeleGeography. 11 November 2021. Retrieved 12 November 2021. ^ "Vi fornyer mobilnettet – og har sagt farvel til 3G" (in Norwegian). Telenor. 31 January 2021. Retrieved 3 March 2024. ^ "Oman plans 3G shutdown from Q3 2024". TeleGeography. 27 February 2023. Retrieved 7 March 2023. ^ "TRA prepares for 3G shutdown starting Q3 2024". TeleGeography. 17 August 2023. Retrieved 1 September 2023. ^ "Jazz to completely phase out 3G services by Nov". Business Recorder. 9 October 2024. Retrieved 11 October 2024. ^ "Jazz Sunsets 3G in Support of Its '4G for All' Vision, Marking 50 Million 4G Subscribers and Driving Digital Transformation". ProPakistani. 18 November 2024. Retrieved 19 November 2024. ^ "PLDT-Smart to sunset 3G in 2023". TeleGeography. 5 August 2022. Retrieved 19 August 2022. ^ "Globe Removes Consumer 3G SIMs Across Distribution Chains". Globe Telecom. 19 October 2020. Retrieved 20 October 2020. ^ "T-Mobile begins 900MHz 3G migration in Poland". TeleGeography. 2 February 2022. Retrieved 5 February 2022. ^ "T-Mobile Poland to begin 3G switch-off this month". TeleGeography. 14 September 2022. Retrieved 14 September 2022. ^ "T-Mobile Poland to close 3G network in April; no plans for tower sale or fixed access rollout". TeleGeography. 9 January 2023. Retrieved 11 January 2023. ^ "Orange to begin phasing out 3G in Poland in September". TeleGeography. 21 March 2023. Retrieved 31 March 2023. ^ "3G shutdown process to get underway this month at Orange Poland". TeleGeography. 8 September 2023. Retrieved 11 September 2023. ^ "Ajuda e Suporte - Em que data deixarei de ter acesso à rede 3G" (in European Portuguese). MEO. Retrieved 21 October 2023. ^ "Descontinuação 3G" (in European Portuguese). Vodafone Portugal. Retrieved 21 October 2023. ^ "Desligamento da rede 3G em Portugal | Forum NOS". forum.nos.pt (in Portuguese). 4 January 2024. Retrieved 14 February 2024. ^ "DIGI shuts 3G network, refarms 2100MHz spectrum for 4G and 5G". TeleGeography. 29 August 2023. Retrieved 1 September 2023. ^ "Retragere tehnologie 3G" [Withdrawal of 3G technology] (in Romanian). Telekom. Retrieved 27 February 2023. ^ "Modernizare rețea mobilă Vodafone" [Modernisation of Vodafone mobile network] (in Romanian). Vodafone. Retrieved 17 April 2025. ^ "Beeline starts replacing 3G UMTS-900 with LTE in Moscow". TeleGeography. 13 February 2023. Retrieved 18 March 2023. ^ "MTS switching off 3G this year in Moscow city, large parts of Moscow region". TeleGeography. 21 July 2023. Retrieved 9 August 2023. ^ "3G network - How much time do I have to switch to a 4G device?". Saudi Telecom Company. 29 December 2022. Retrieved 29 December 2022. ^ a b c "Singapore MNOs to fully retire 3G services by end-July 2024". TeleGeography. 27 July 2023. Retrieved 9 August 2023. ^ a b c "Farewell 3G: M1 to retire services from August; StarHub, Singtel from November". The Business Times. 24 July 2024. Retrieved 9 November 2024. ^ "O2 Slovakia to start 3G shutdown next month; e& purchase gains local approval". TeleGeography. 5 December 2023. Retrieved 14 December 2023. ^ "4ka warning users of 3G switch-off". TeleGeography. 16 November 2023. Retrieved 19 November 2023. ^ "Orange Slovakia to complete 3G shutdown on 22 February". TeleGeography. 4 January 2024. Retrieved 5 January 2024. ^ "Slovak Telekom to begin 3G shutdown on 3 October". TeleGeography. 27 September 2023. Retrieved 2 October 2023. ^ "Slovak Telekom waves goodbye to 3G". TeleGeography. 23 November 2023. Retrieved 26 November 2023. ^ "Telekom Slovenije 3G shutdown by end-September". TeleGeography. 5 April 2022. Retrieved 18 April 2022. ^ "A1 Slovenia to say goodbye to 3G in June". TeleGeography. 26 April 2023. Retrieved 27 April 2023. ^ "South Africa to ban 2G devices by March 2023". TeleGeography. 16 June 2022. Retrieved 19 June 2022. ^ "SA comms minister proposes 2G/3G switch-offs in 2024/2025". TeleGeography. 6 September 2022. Retrieved 6 September 2022. ^ a b c "cdma users top 30 million". TeleGeography. 19 July 2004. Retrieved 23 January 2021. ^ "Terminating 2G Service in Korea: Policy Issues and Suggestions". International Telecommunications Policy Review. 1 March 2014. Retrieved 23 January 2021. ^ a b "2G Phone Users Create Dilemma for Telecom Carriers ahead of Beginning of 5G Era". BusinessKorea. 27 March 2018. Retrieved 24 April 2022. ^ a b "2G Bows Out, 5G Grows in South Korea - Older Technologies in Decline". TeleGeography Blog. 5 November 2020. Retrieved 15 February 2021. ^ "CDMA2000 Operators - LG U+". CDG. Retrieved 7 July 2023. ^ "LGT plans EV-DO Rev. A tests ahead of commercial launch in 1H07". TeleGeography. 11 October 2006. Retrieved 31 December 2016. ^ "S. Korea to end 2G network services by June". The Korea Herald. 17 January 2021. Retrieved 23 January 2021. ^ "CDMA2000 Operators - SK Telecom". CDG. Retrieved 7 July 2023. ^ "SK Telecoms shutters 2G service". TeleGeography. 28 July 2020. Retrieved 28 July 2020. ^ "Vodafone activa la fase final del apagado del 3G" (in Spanish). BandaAncha. 12 September 2024. Retrieved 10 October 2024. ^ "Vodafone Spain to complete 3G shutdown next month". Data Centre Dynamics Ltd. 16 September 2024. Retrieved 10 October 2024. ^ "Airtel Lanka given go-ahead to shut down 3G network from June". TeleGeography. 29 April 2022. Retrieved 7 May 2022. ^ "Dialog trials 5G mmWave; announces 3G shutdown plan". TeleGeography. 3 January 2023. Retrieved 6 January 2023. ^ "3G-nätet | Telenor" (in Swedish). Telenor. Retrieved 26 November 2023. ^ "Nu släcker vi 3G- och 2G-näten - så påverkas du" (in Swedish). Telia. Retrieved 26 November 2023. ^ "Vi förnyar mobilnätet – vi fasar ut 3G" (in Swedish). Tre. Retrieved 26 November 2023. ^ "Så bör du tänka när 2G och 3G-nätet avvecklas" (in Swedish). Tre. Retrieved 26 November 2023. ^ "Sunrise confirms mid-2025 date for 3G shutdown". TeleGeography. 29 November 2023. Retrieved 4 December 2023. ^ "So long, 3G". Swisscom. ^ "CDMA2000 Operators - Asia Pacific Telecom". CDG. Retrieved 7 July 2023. ^ "FET to decommission 5,000 APT towers post-merger". TeleGeography. 28 March 2023. Retrieved 1 April 2023. ^ a b c d "Taiwan to switch off 3G networks at year end". Telecom Asia. 10 January 2018. Retrieved 14 April 2021. ^ a b c d "Taiwan to shut down 3G networks by year end". ZDNet. 18 December 2018. Retrieved 14 April 2021. ^ a b c d "NCC urges updating old phones ahead of 3G shutdown". The Taipei Times. 28 May 2024. Retrieved 24 August 2024. ^ "EE details plans for upcoming 3G shutdown pilot in Warrington". TeleGeography. 30 May 2023. Retrieved 30 May 2023. ^ "EE's 3G network shutdown to be completed by March 2024". TeleGeography. 19 September 2023. Retrieved 2 October 2023. ^ "EE to commence 3G shutdown in January". TeleGeography. 13 December 2023. Retrieved 14 December 2023. ^ Mark Jackson (26 February 2024). "EE Switches Off Final 3G Mobile Network Site in the UK". ISPreview. Retrieved 26 February 2024. ^ "Three UK confirms it will switch off 3G at the end of 2024". TeleGeography. 12 May 2022. Retrieved 14 May 2022. ^ "VMO2 confirms it will complete 3G switch off by end-2025". TeleGeography. 11 September 2023. Retrieved 11 September 2023. ^ "VM O2 to start 3G switch-off in April". TelcoTitans. 13 January 2025. Retrieved 18 April 2025. Virgin Media O2 (VM O2) has confirmed plans to switch off 3G services from April this year, beginning in the city of Durham. ^ "Vodafone UK to begin retiring its 3G network in 2023". TeleGeography. 26 January 2022. Retrieved 18 April 2022. ^ "Vodafone UK confirms its first 3G network switch-off in two locations". TeleGeography. 13 March 2023. Retrieved 1 April 2023. ^ "Vodafone UK to begin 3G switch-off in June 2023". TeleGeography. 10 May 2023. Retrieved 13 May 2023. ^ "Vodafone UK completes 3G shutdown to enhance 4G/5G services". Telecoms Tech News. 28 February 2024. Retrieved 3 March 2024. ^ "CDMA2000 Operators - Appalachian Wireless". CDG. Retrieved 7 July 2023. ^ "3G Shutdown Information". Appalachian Wireless. 1 December 2022. Retrieved 1 April 2023. ^ "Appalachian Wireless to shut down 3G/CDMA service this month". Mountain Top Media. 4 January 2023. Retrieved 18 March 2023. ^ "AT&T reconfiguring 3G spectrum ahead of February 2022 shutdown". TeleGeography. 21 March 2019. Retrieved 14 April 2021. ^ "AT&T switches off 3G network". TeleGeography. 23 February 2022. Retrieved 23 February 2022. ^ "Regional US mobile operator Cellcom to switch off 2G on 1 December; 3G was deactivated in March". TeleGeography. 20 September 2023. Retrieved 2 October 2023. ^ "Cellular One phases out 3G; transitions to VoLTE". TeleGeography. 4 May 2023. Retrieved 4 May 2023. ^ "Upgrade Your Device Today". Choice Wireless. Retrieved 5 February 2024. ^ "Liberty to switch off Puerto Rican 3G network on 22 February". TeleGeography. 31 January 2022. Retrieved 31 January 2022. ^ "CDMA2000 Operators - Silver Star Communications". CDG. Retrieved 7 July 2023. ^ "Wireless Exit FAQs". Silver Star. 20 April 2022. Retrieved 25 January 2023. ^ "STRATA Announces Plans to Retire 3G Network". 5 August 2021. Retrieved 2 November 2023. ^ a b "T-Mobile's 2G, 3G shutdown dates leaked". TeleGeography. 8 February 2021. Retrieved 14 April 2021. ^ a b "T-Mobile US eyes October 2021 W-CDMA shutdown". TeleGeography. 10 August 2021. Retrieved 11 August 2021. ^ a b "T-Mobile US to shut down 3G network on 1 July 2022". TeleGeography. 17 September 2021. Retrieved 18 September 2021. ^ "Sprint reaches the finishing line: legacy LTE networks switched off by T-Mobile". TeleGeography. 4 July 2022. Retrieved 5 July 2022. ^ "CDMA2000 Operators - Sprint". CDG. Retrieved 7 July 2023. ^ "T-Mobile delays CDMA shutdown by three months". TeleGeography. 25 October 2021. Retrieved 1 November 2021. ^ "T-Mobile US commences CDMA shutdown; expands 5G Home Internet footprint". TeleGeography. 31 March 2022. Retrieved 18 April 2022. ^ "CDMA2000 Operators - U.S. Cellular". CDG. Retrieved 7 July 2023. ^ "UScellular shuts off some 3G services as it upgrades LTE". Fierce Wireless. 4 October 2021. Retrieved 18 March 2023. ^ "UScellular to switch off CDMA network on 14 January 2024". TeleGeography. 1 December 2023. Retrieved 1 December 2023. ^ "CDMA2000 Operators - Verizon Wireless". CDG. Retrieved 7 July 2023. ^ "Verizon to shut down 3G CDMA networks on 31 December 2022". TeleGeography. 31 March 2021. Retrieved 14 April 2021. ^ "Verizon ramps up 5G coverage as 3G shutdown looms". TeleGeography. 6 December 2022. Retrieved 11 December 2022. ^ "Báo VietnamNet" (in Vietnamese). VietnamNet News. 18 July 2024. Retrieved 4 March 2025. Media related to 3G at Wikimedia Commons Preceded by2nd Generation (2G) Mobile Telephony Generations Succeeded by4th Generation (4G) Retrieved from " 6Mobile phone specification system project 3rd Generation Partnership Project 2Abbreviation3GPP2TypeStandards organization The 3rd Generation Partnership Project 2 (3GPP2) was a collaboration between telecommunications associations to make a globally applicable third generation (3G) mobile phone system specification within the scope of the ITU's IMT-2000 project. In practice, 3GPP2 was the standardization group for CDMA2000, the set of 3G standards based on the earlier cdmaOne 2G CDMA technology. The participating associations were ARIB/TTC (Japan), China Communications Standards Association, Telecommunications Industry Association (North America) and Telecommunications Technology Association (South Korea). The agreement was established in December 1998. Ultra Mobile Broadband (UMB) was a 3GPP2 project to develop a fourth-generation successor to CDMA2000. In November 2008, Qualcomm, UMB's lead sponsor, announced it was ending development of the technology, favoring LTE instead.[1] 3GPP2 should not be confused with 3GPP; 3GPP is the standard body behind the Universal Mobile Telecommunications System (UMTS) that is the 3G upgrade to GSM networks, while 3GPP2 was the standard body behind the competing 3G standard CDMA2000 that is the 3G upgrade to cdmaOne networks that was used mostly in the United States (and to some extent also in Japan, China, Canada, South Korea and India). GSM/UMTS were the most widespread 2G/3G wireless standards worldwide. Most countries used only the GSM family. A few countries, including China, the United States, Canada, Ukraine, Trinidad and Tobago, India, South Korea and Japan, used both standards. 3GPP2 had its last activity in 2013,[2] and the group has been dormant ever since. The 3GPP2 website was taken offline in 2023, primarily due to CDMA carriers deploying 3GPP's LTE instead of UMB the decade prior and later shutting down CDMA networks making the 3GPP2 redundant and unneeded. However, as of 2024 the 3GPP2 website has since come back online. ^ Qualcomm halts UMB project, Reuters, 13 November 2008 ^ "3GPP2 Technology Webinar". 3GPP2. 3GPP2 Official Web site About 3GPP2 TIA – U.S. 3GPP2 Standards Developer This article about wireless technology is a stub. You can help Wikipedia by expanding it.vte Retrieved from " 7Mobile telecommunications standards body 3rd Generation Partnership

ProjectAbbreviation3GPPFormation1998; 27 years ago (1998)TypeStandards organizationRegion served WorldwideWebsitewww.3gpp.org The 3rd Generation Partnership Project (3GPP) is an umbrella term for a number of standards organizations which develop protocols for mobile telecommunications. Its best known work is the development and maintenance of:[1] GSM and related 2G and 2.5G standards, including GPRS and EDGE UMTS and related 3G standards, including HSPA and HSPA+ LTE and related 4G standards, including LTE Advanced and LTE Advanced Pro 5G NR and related 5G standards, including 5G-Advanced An evolved IP Multimedia Subsystem (IMS) developed in an access independent manner 3GPP is a consortium with seven national or regional telecommunication standards organizations as primary members ("organizational partners") and a variety of other organizations as associate members ("market representation partners"). The 3GPP organizes its work into three different streams: Radio Access Networks, Services and Systems Aspects, and Core Network and Terminals.[2] The project was established in December 1998 with the goal of developing a specification for a 3G mobile phone system based on the 2G GSM system, within the scope of the International Telecommunication Union's International Mobile Telecommunications-2000, hence the name 3GPP.[3] It should not be confused with 3rd Generation Partnership Project 2 (3GPP2), which developed a competing 3G system, CDMA2000.[4] The 3GPP administrative support team (known as the "Mobile Competence Centre") is located at the European Telecommunications Standards Institute headquarters in the Sophia Antipolis technology park in France.[5] The seven 3GPP Organizational Partners are from Asia, Europe and North America. Their aim is to determine the general policy and strategy of 3GPP and perform the following tasks: The approval and maintenance of the 3GPP scope; The maintenance of the Partnership Project Description; Take the decision to create or cease a Technical Specification Groups, and approve their scope and terms of reference; The approval of Organizational Partner funding requirements; The allocation of human and financial resources provided by the Organizational Partners to the Project Co-ordination Group; Act as a body of appeal on procedural matters referred to them. Together with the Market Representation Partners (MRPs) perform the following tasks: The maintenance of the Partnership Project Agreement; The approval of applications for 3GPP partnership; Take the decision against a possible dissolution of 3GPP. The Organizational Partners are:[6] Organizational Partners Organization Country/region Website Association of Radio Industries and Businesses (ARIB) Japan ARIB Alliance for Telecommunications Industry Solutions (ATIS) USA ATIS China Communications Standards Association (CCSA) China CCSA European Telecommunications Standards Institute (ETSI) Europe ETSI Telecommunications Standards Development Society (TSDSI) India TSDSI Telecommunications Technology Association (TTA) South Korea TTA Telecommunication Technology Committee (TTC) Japan TTC The 3GPP Organizational Partners can invite a Market Representation Partner to take part in 3GPP, which: Has the ability to offer market advice to 3GPP and to bring into 3GPP a consensus view of market requirements (e.g., services, features and functionality) falling within the 3GPP scope; Does not have the capability and authority to define, publish and set standards within the 3GPP scope, nationally or regionally; Has committed itself to all or part of the 3GPP scope; Has signed the Partnership Project Agreement. As of January 2025[update], the Market Representation Partners are:[6] Market Representation Partners Organization Website 5G-ACIA 5G Automotive Association 5G Americas Deterministic Networking Alliance (5GDNA) 6G Smart Network and Services Industry Association (6G-IA) 5G Slicing Association (5GSA) 5G Media Action Group (5G-MAG) Automotive Edge Computing Consortium (AECC) Broadband India Forum Cellular Operators Association of India (COAI) China Society of Automotive Engineers (CSAE) CTIA Global Satellite Operators Association (GSOA) Global Certification Forum (GCF) Global mobile Suppliers Association (GSA) GSMA IPV6 Forum Next Generation Mobile Networks (NGMN) Public Safety Communication Europe (PSCE) Forum Small Cell Forum TCCA TD Industry Alliance Wireless Broadband Alliance 3GPP standards are structured as Releases. Discussion of 3GPP thus frequently refers to the functionality in one release or another. Version[7] Released[8] Info Phase 1 1992 GSM Features Phase 2 1995 GSM Features, EFR Codec, Release 96 1997 Q1 GSM Features, 14.4 kbit/s User Data Rate, Release 97 1998 Q1 GSM Features, GPRS Release 98 1999 Q1 GSM Features, AMR codec, EDGE, GPRS for PCS1900 Release 99 2000 Q1 Specified the first UMTS 3G networks, incorporating a CDMA air interface[9] Release 4 2001 Q2 Originally called the Release 2000 – added features including an all-IP Core Network[10] Release 5 2002 Q1 Introduced IMS and HSDPA[11] Release 6 2004 Q4 Integrated operation with Wireless LAN networks and adds HSUPA, MBMS, enhancements to IMS such as Push to Talk over Cellular (PoC), GAN[12] Release 7 2007 Q4 Focuses on decreasing latency, improvements to QoS and real-time applications such as VoIP.[13] This specification also focus on HSPA+ (High Speed Packet Access Evolution), SIM high-speed protocol and contactless front-end interface (Near Field Communication enabling operators to deliver contactless services like Mobile Payments), EDGE Evolution. Release 8 2008 Q4 First LTE release. All-IP Network (SAE). New OFDMA, FDE and MIMO based radio interface, not backwards compatible with previous CDMA interfaces. Dual-Cell HSDPA. UMTS HNB. Release 9 2009 Q4 SAES Enhancements, WiMAX and LTE/UMTS Interoperability. Dual-Cell HSDPA with MIMO, Dual-Cell HSUPA. LTE HeNB. Evolved multimedia broadcast and multicast service (eMBMS). Release 10 2011 Q1 LTE Advanced fulfilling IMT Advanced 4G requirements. Backwards compatible with release 8 (LTE). Multi-Cell HSDPA (4 carriers). Release 11 2012 Q3 Advanced IP Interconnection of Services. Service layer interconnection between national operators/carriers as well as third-party application providers. Heterogeneous networks (HetNet) improvements, Coordinated Multi-Point operation (CoMP). In-device Co-existence (IDC). Release 12 2015 Q1 Enhanced Small Cells (higher order modulation, dual connectivity, cell discovery, self configuration), Carrier aggregation (2 uplink carriers, 3 downlink carriers, FDD/TDD carrier aggregation), MIMO (3D channel modeling, elevation beamforming, massive MIMO), New and Enhanced Services (cost and range of MTC, D2D communication, eMBMS enhancements)[14] Release 13 2016 Q1 LTE-Advanced Pro. LTE in unlicensed, LTE enhancements for Machine-Type Communication. Elevation Beamforming / Full-Dimension MIMO, Indoor positioning.[15] Release 14 2017 Q2 Energy Efficiency, Location Services (LCS), Mission Critical Data over LTE, Mission Critical Video over LTE, Flexible Mobile Service Steering (FMSS), Multimedia Broadcast Supplement for Public Warning System (MBSP), enhancement for TV services over eMBMS, massive Internet of Things, Cell Broadcast Service (CBS)[16] Release 15 2018 Q2 First 5G NR ("New Radio") release. Support for 5G Vehicle-to-x service, IP Multimedia Core Network Subsystem (IMS), Future Railway Mobile Communication System[17] Release 16 2020 Q3 The 5G System – Phase 2: 5G enhancements, NR-based access to unlicensed spectrum (NR-U), Satellite access[18] Release 17 2022 Q1 TSG RAN: Several features that continue to be important for overall efficiency and performance of 5G NR: MIMO, Spectrum Sharing enhancements, UE Power Saving and Coverage Enhancements. RAN1 will also undertake the necessary study and specification work to enhance the physical layer to support frequency bands up to 71 GHz. TSG SA groups focused on further enhancements to the 5G system and enablers for new features and services: Enhanced support of: non-public networks, industrial Internet of Things, low complexity NR devices, edge computing in 5GC, access traffic steering, switch and splitting support, network automation for 5G, network slicing, advanced V2X service, multiple USIM support, proximity-based services in 5GS, 5G multicast broadcast services, Unmanned Aerial Systems (UAS), satellite access in 5G, 5GC location services, Multimedia Priority Service...[19] Release 18 2023 Q4 5G-Advanced. Introducing further machine-learning based techniques at different levels of the wireless network. Edge computing, Evolution of IMS Multimedia Telephony Service, Smart Energy and Infrastructure, Vehicle-Mounted Relays, Low Power High Accuracy Positioning for industrial IoT scenarios, Enhanced Access to and Support of Network slicing, Satellite backhaul in 5G...[20][21][19] Release 19 [22] 2025 Q4 5G-Advanced. Each release incorporates hundreds of individual Technical Specification and Technical Report documents, each of which may have been through many revisions. Current 3GPP standards incorporate the latest revision of the GSM standards. The documents are made available without charge on 3GPP's web site. The Technical Specifications cover not only the radio part ("Air Interface") and Core Network, but also billing information and speech coding down to source code level. Cryptographic aspects (such as authentication, confidentiality) are also specified. The 3GPP specification work is done in Technical Specification Groups (TSGs) and Working Groups (WGs).[23] There are three Technical Specifications Groups, each of which consists of multiple WGs: RAN (Radio Access Network): RAN specifies the UTRAN and the E-UTRAN. It is composed of six working groups. WG Shorthand Scope Specifications RAN WG1 RAN1 Radio Layer 1 (Physical layer) List of specs RAN WG2 RAN2 Radio Layer 2 and Radio Layer 3 Radio Resource Control List of specs RAN WG3 RAN3 UTRAN, E-UTRAN, NG-RAN architecture and related network interfaces List of specs RAN WG4 RAN4 Radio performance and protocol aspects List of specs RAN WG5 RAN5 Mobile terminal conformance testing List of specs SA (Service and System Aspects): SA specifies the service requirements and the overall architecture of the 3GPP system. It is also responsible for the coordination of the project. SA is composed of six working groups. WG Shorthand Scope Specifications SA WG1 SA1 Services List of specs SA WG2 SA2 Architecture List of specs SA WG3 SA3 Security List of specs SA WG4 SA4 Codec List of specs SA WG5 SA5 Management, Orchestration and Charging List of specs SA WG6 SA6 Application Enablement and Critical Communication Applications List of specs CT (Core Network and Terminals): CT specifies the core network and terminal parts of 3GPP. It includes the core network – terminal layer 3 protocols. It is composed of five working groups. WG Shorthand Scope Specifications CT WG1 CT1 User Equipment – Core Network protocols List of specs CT WG2 CT2 closed CT WG3 CT3 Interworking with external networks List of specs CT WG4 CT4 Core Network Protocols List of specs CT WG5 CT5 closed CT WG6 CT6 Smart Card Application Aspects List of specs GERAN (GSM/EDGE Radio Access Network): The closure of GERAN was announced in January 2016.[24] The specification work on legacy GSM/EDGE system was transferred to RAN WG, RAN6. RAN6 was closed in July 2020 (. The 3GPP structure also includes a Project Coordination Group, which is the highest decision-making body. Its missions include the management of overall timeframe and work progress. 3GPP standardization work is contribution-driven. Companies ("individual members") participate through their membership to a 3GPP Organizational Partner. As of December 2020, 3GPP is composed of 719 individual members.[25] Specification work is done at WG and at TSG level:[26] the 3GPP WGs hold several meetings a year. They prepare and discuss change requests against 3GPP specifications. A change request accepted at WG level is called "agreed". the 3GPP TSGs hold plenary meetings quarterly. The TSGs can "approve" the change requests that were agreed at WG level. Some specifications are under the direct responsibility of TSGs and therefore, change requests can also be handled at TSG level. The approved change requests are subsequently incorporated in 3GPP specifications. 3GPP follows a three-stage methodology as defined in ITU-T Recommendation I.130:[27] stage 1 specifications define the service requirements from the user point of view. stage 2 specifications define an architecture to support the service requirements. stage 3 specifications define an implementation of the architecture by specifying protocols in details. Test specifications are sometimes defined as stage 4, as they follow stage 3. Specifications are grouped into releases. A release consists of a set of internally consistent set of features and specifications. Timeframes are defined for each release by specifying freezing dates. Once a release is frozen, only essential corrections are allowed (i.e. addition and modifications of functions are forbidden). Freezing dates are defined for each stage. The 3GPP specifications are transposed into deliverables by the Organizational Partners. List of mobile phone generations Universal Mobile Telecommunications System (UMTS) 3GPP Long Term Evolution Evolution to 3G IP Multimedia Subsystem 3GP 3GPP2 – The 3GPP's counterpart in the CDMA2000 sphere. GSM services LoRaWAN Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN) Open Mobile Alliance Service data adaptation protocol Service layer European Telecommunications Standards Institute ^ 3GPP Scope and Objectives, 31 August 2007 ^ "About 3GPP". 3GPP. Retrieved 10 March 2019. ^ "3GPP Background". 7 June 2000. Archived from the original on 6 July 2000. ^ "3rd Generation Partnership Project 2". Archived from the original on 23 January 2004. Retrieved 25 November 2012. ^ "Mobile Competence Centre". 3GPP. Retrieved 10 March 2019. ^ a b "Partners". 3GPP. Retrieved 1 January 2025. ^ Releases ^ "3GPP Specifications – Releases (and phases and stages)". Retrieved 16 September 2010. ^ Overview of 3GPP Release 99, Summary of all Release 99 Features. ETSI Mobile Competence Centre, Version xx/07/04 ^ Overview of 3GPP Release 4, Summary of all Release 4 Features, v.1.1.0 (draft) ETSI Mobile Competence Centre 2004 ^ Summary of all Release 5 Features, ETSI Mobile Competence Centre, Version 9 September 2003 ^ Overview of 3GPP Release 6, Summary of all Release 6 Features, Version TSG #33, ETSI Mobile Competence Centre 2006 ^ Review of the Work Plan at Plenaries #31, 3GPP, SP-060232 3GPP TSG SA#31 Sanya, 13–16 March 2006 ^ "Highlights of 3GPP Release 12". Retrieved 20 November 2014. ^ "Release 13 priorities". Retrieved 20 November 2014. ^ "3GPP Portal > Specifications". portal.3gpp.org. Retrieved 27 October 2016. ^ "3GPP Portal > Specifications". portal.3gpp.org. Retrieved 27 October 2016. ^ "3GPP Portal > Specifications". portal.3gpp.org. Retrieved 14 July 2020. ^ a b "5G evolution toward 5G advanced: An overview of 3GPP releases 17 and 18". Ericsson. Retrieved 25 August 2022. ^ "Release 18". 3gpp.org. Retrieved 25 November 2021. ^ "5G-Advanced's system architecture begins taking shape at 3GPP". Nokia. Retrieved 25 November 2021. ^ "Release 19". 3GPP. Retrieved 8 September 2024. ^ "Specification Groups". Archived from the original on 9 May 2011. Retrieved 11 April 2011. ^ closure of GERAN ^ 3GPP membership ^ 3GPP TR 21.900 Technical Specification Group working methods ^ ITU-T Recommendation I.130 3GPP website 3GPP Standards List of Acronyms & Terminology 3GPP freely published, detailed technical specifications 3GPP releases descriptions ETSI GSM UMTS 3GPP Numbering Cross Reference TS/TR specification numbering Tool for visualizing multiple inter-related 3gpp standards Tool for visualizing, decoding, encoding network protocol messages defined by 3gpp LTE-3GPP.info: online 3GPP messages decoder fully supporting Rel.15 Retrieved from " 8Multimedia file format families 3GPFilename extension .3gp, .3gppInternet media type video/3gpp, audio/3gppUniform Type Identifier (UTI)public.3gppDeveloped by3GPPInitial release4 April 2003; 22 years ago (2003-04-04)[1]Latest release17.0.0[1]7 April 2022; 3 years ago (2022-04-07) Type of formatContainer formatContainer foraudio, video, textExtended fromMPEG-4 Part 12Open format?YesFree format?No 3G2Filename extension .3g2, .3gp2, .3gpp2Internet media type video/3gpp2, audio/3gpp2Uniform Type Identifier (UTI)public.3gpp2Developed by3GPP2Initial releaseJanuary 2004; 21 years ago (2004-01)[2]Latest releaseC.S0050-B v1.0[2]September 2024; 8 months ago (2024-09) Type of formatContainer formatContainer foraudio, video, textExtended fromMPEG-4 Part 12Open format?YesFree format?yes 3GP (3GPP file format) is a digital multimedia container format defined by the Third Generation Partnership Project (3GPP) for 3G UMTS multimedia services. It is very similar to the 3GP file format but consumes less space and bandwidth, and has some extensions and limitations in comparison to 3GP. 3GP is defined in the ETSI 3GPP technical specification.[1] 3GP is a required file format for video and associated speech/audio media types and timed text in ETSI 3GPP technical specifications for IP Multimedia Subsystem (IMS), Multimedia Messaging Service (MMS), Multimedia Broadcast/Multicast Service (MBMS) and Transparent end-to-end Packet-switched Streaming Service (PSS).[3][4][5][6] 3G2 is defined in the 3GPP2 technical specification.[2] The factual accuracy of parts of this article (those related to 3GP codec list (see release 12 of 2016 p.65)) may be compromised due to out-of-date information. The reason given is: 3GP has expanded codec lists while 3G2 has stagnated. Please help update this article to reflect recent events or newly available information. (February 2021) Relations between ISO Base Media File Format, MP4 File Format, 3GPP file format and 3GPP2 file format. Based on the 3GPP2 technical specification published on 18 May 2007.[7] The 3GP and 3G2 file formats are both structurally based on the ISO base media file format defined in ISO/IEC 14496-12 – MPEG-4 Part 12,[8][9][10] but older versions of the 3GP file format did not use some of its features.[7] 3GP and 3G2 are container formats similar to MPEG-4 Part 14 (MP4), which is also based on MPEG-4 Part 12. The 3GP and 3G2 file format were designed to decrease storage and bandwidth requirements to accommodate mobile phones. They are good for lower end smartphones for faster streaming & download. 3GP and 3G2 are similar standards, but with some differences: 3GPP file format was designed for GSM-based phones and may have the filename extension .3gp 3GPP2 file format was designed for CDMA-based phones and may have the filename extension .3g2 Some cell phones use the .mp4 extension for 3GP video. The 3GP file format stores video streams as MPEG-4 Part 2, H.263, or MPEG-4 Part 10 (AVC/H.264), and audio streams as AMR-NB, AMR-WB, AMR-WB+, AAC-LC, HE-AAC v1 or Enhanced aacPlus (HE-AAC v2). 3GPP allowed use of AMR and H.263 codecs in the ISO base media file format (MPEG-4 Part 12), because 3GPP specified the usage of the Sample Entry and template fields in the ISO base media file format as well as defining new boxes to which codecs refer. These extensions were registered by the registration authority for code-points in ISO base media file format ("MP4 Family" files).[11][12] For the storage of MPEG-4 media specific information in 3GP files, the 3GP specification refers to MP4 and the AVC file format, which are also based on the ISO base media file format. The MP4 and the AVC file format specifications described usage of MPEG-4 content in the ISO base media file format.[8] A 3GP file is always big-endian, storing and transferring the most significant bytes first. [citation needed] The 3G2 file format can store the same video streams and most of the audio streams used in the 2007 3GP file format. In addition, 3G2 stores audio streams as EVRC, EVRC-B, EVRC-WB, 13K (QCELP), SMV or VMR-WB, which was specified by 3GPP2 for use in ISO base media file format.[12] The 3G2 specification also defined some enhancements to 3GPP Timed Text. 3G2 file format does not store Enhanced aacPlus (HE-AAC v2) and AMR-WB+ audio streams.[7] For the storage of MPEG-4 media (AAC audio, MPEG-4 Part 2 video, MPEG-4 Part 10 – H.264/AVC) in 3G2 files, the 3G2 specification refers to the MP4 file format and the AVC file format specification, which described usage of this content in the ISO base media file format. For the storage of H.263 and AMR content 3G2 specification refers to the 3GP file format specification.[7] Most 3G capable mobile phones support the playback and recording of video in 3GP format (memory, maximum filesize for playback and recording, and resolution limits exist and vary).[citation needed] Some newer/higher-end phones without 3G capabilities may also playback and record in this format (again, with said limitations).[citation needed] Audio imported from CD onto a PlayStation 3 when it is set to encode to the MPEG-4 AAC format copies onto USB devices in the 3GP format. [citation needed] The Nintendo 3DS used 3GP technology to play YouTube videos. Apple iDevices used to support files for playback only as passthrough files, hence no editing ability, but since iOS 9 this has been deprecated meaning files of this format have to be manually converted to H.264.[citation needed] When transferred to a computer, 3GP movies can be viewed on Microsoft Windows, Apple macOS, and the various Linux-based operating systems; on the former two with Windows Media Player[13] and Apple QuickTime[14] respectively (their built-in media players), and on all three with VLC media player.[15] Programs such as Media Player Classic, K-Multimedia Player, Totem, RealPlayer, MPlayer, and GOM Player can also be used. 3GP and 3G2 files can be encoded and decoded with open source software FFmpeg.[16] Media tags can be read and written on Linux, macOS and Windows using the open source AtomicParsley command-line utility.[17] computer programming portal Comparison of (audio/video) container formats SIF (Source Input Format) CIF (Common Intermediate Format) ^ a b c ETSI 3GPP 3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP) Retrieved on 2009-06-02. ^ a b c "3GPP2 C.S0050, 3GPP2 File Formats for Multimedia Services, File Format for Multimedia Services for cdma2000". 3GPP2. 2003. Retrieved 2009-06-12. ^ ETSI (2009-04) ETSI TS 126 234 V8.2.0 (2009-04); 3GPP TS 26.234; Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs Page 58. Retrieved on 2009-06-02. ^ ETSI (2009-01) ETSI TS 126 140 V8.0.0 (2009-01); 3GPP TS 26.140; Multimedia Messaging Service (MMS); Media formats and codes Page 11. Retrieved on 2009-06-02. ^ "ETSI TS 126 346 V8.3.0 (2009-06); 3GPP TS 26.346; Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs". ETSI. June 2009. p. 85. Retrieved 2009-10-13. ^ ETSI (2009-01) ETSI TS 126 141 V8.0.0 (2009-01); 3GPP TS 26.141; IP Multimedia System (IMS) Messaging and Presence; Media formats and codecs Page 10. Retrieved on 2009-06-02. ^ a b c d "3GPP2 C.S0050-B Version 1.0, 3GPP2 File Formats for Multimedia Services" (PDF). 3GPP2. 18 May 2007. pp. 67, 68. Archived from the original (PDF) on 7 October 2009. Retrieved 2009-06-12. ^ a b "3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP)" (PDF). ETSI 3GPP. 2008-12-11. p. 9. Retrieved 2009-05-30. ^ "ISO Base Media File Format white paper – Proposal". April 2006. Archived from the original on 2008-07-14. Retrieved 2009-12-26. ^ "ISO Base Media File Format white paper – Proposal". Chiariglione. October 2009. Retrieved 2009-12-26. ^ "ISO/IEC 14496-12:2008, Information technology -- Coding of audio-visual objects -- Part 12: ISO base media file format" (PDF). International Organization for Standardization. 2008. p. 95. Retrieved 2009-05-30. ^ a b "Registered types – Codecs". Registration authority for code-points in "MP4 Family" files – mp4ra.org. 2008. Archived from the original on 2009-04-19. Retrieved 2009-05-31. ^ "File types supported by Windows Media Player". Microsoft. Retrieved 2020-07-25. ^ "What's New in QuickTime 6.3 + 3GPP". Apple, Inc. Retrieved 2020-07-25. ^ "VLC Media Player features". VLC. Retrieved 2020-07-25. ^ "FFmpeg, General Documentation, Supported File Formats and Codecs". FFmpeg. Retrieved 2009-06-11. ^ "AtomicParseley". Wez Furlong. Retrieved 2024-06-24. 3GPP codecs specifications; 3G and beyond / GSM, 26 series 3GPP file format (3GP); 3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS) - specification 3GPP2 specifications 3GPP2 File Formats for Multimedia Services; 3GPP2 C.S0050-B Version 1.0 - specification RFC 3839, MIME Type Registrations for 3rd Generation Partnership Project (3GPP) Multimedia files RFC 4393, MIME Type Registrations for 3GPP2 Multimedia Files RFC 4281, The Codecs Parameter for "Bucket" Media Types 3GP & 3G2 File Formats Retrieved from " 9Multimedia file format families 3GPFilename extension .3gp, .3gppInternet media type video/3gpp, audio/3gppUniform Type Identifier (UTI)public.3gppDeveloped by3GPPInitial release4 April 2003; 22 years ago (2003-04-04)[1]Latest release17.0.0[1]7 April 2022; 3 years ago (2022-04-07) Type of formatContainer formatContainer foraudio, video, textExtended fromMPEG-4 Part 12Open format?YesFree format?No 3G2Filename extension .3g2, .3gp2, .3gpp2Internet media type video/3gpp2, audio/3gpp2Uniform Type Identifier (UTI)public.3gpp2Developed by3GPP2Initial releaseJanuary 2004; 21 years ago (2004-01)[2]Latest releaseC.S0050-B v1.0[2]September 2024; 8 months ago (2024-09) Type of formatContainer formatContainer foraudio, video, textExtended fromMPEG-4 Part 12Open format?YesFree format?yes 3GP (3GPP file format) is a digital multimedia container format defined by the Third Generation Partnership Project (3GPP) for 3G UMTS multimedia services, largely based on MPEG-4 Part 12. A 3GP container may consist of H.263 or H.264 video codecs or AMR or AAC-LC audio codecs. 3G2 (3GPP2 file format) is a multimedia container format defined by the 3GPP2 for 3G CDMA2000 multimedia services. It is very similar to the 3GP file format but consumes less space and bandwidth, and has some extensions and limitations in comparison to 3GP. 3GP is defined in the ETSI 3GPP technical specification.[1] 3GP is a required file format for video and associated speech/audio media types and timed text in ETSI 3GPP technical specifications for IP Multimedia Subsystem (IMS), Multimedia Messaging Service (MMS), Multimedia Broadcast/Multicast Service (MBMS) and Transparent end-to-end Packet-switched Streaming Service (PSS).[3][4][5][6] 3G2 is defined in the 3GPP2 technical specification.[2] The factual accuracy of parts of this article (those related to 3GP codec list (see release 12 of 2016 p.65)) may be compromised due to out-of-date information. The reason given is: 3GP has expanded codec lists while 3G2 has stagnated. Please help update this article to reflect recent events or newly available information. (February 2021) Relations between ISO Base Media File Format, MP4 File Format, 3GPP file format and 3GPP2 file format. Based on the 3GPP2 technical specification published on 18 May 2007.[7] The 3GP and 3G2 file formats are both structurally based on the ISO base media file format defined in ISO/IEC 14496-12 – MPEG-4 Part 12,[8][9][10] but older versions of the 3GP file format did not use some of its features.[7] 3GP and 3G2 are container formats similar to MPEG-4 Part 14 (MP4), which is also based on MPEG-4 Part 12. The 3GP and 3G2 file format were designed to decrease storage and bandwidth requirements to accommodate mobile phones. They are good for lower end smartphones for faster streaming & download. 3GP and 3G2 are similar standards, but with some differences: 3GPP file format was designed for GSM-based phones and may have the filename extension .3gp 3GPP2 file format was designed for CDMA-based phones and may have the filename extension .3g2 Some cell phones use the .mp4 extension for 3GP video. The 3GP file format stores video streams as MPEG-4 Part 2, H.263, or MPEG-4 Part 10 (AVC/H.264), and audio streams as AMR-NB, AMR-WB, AMR-WB+, AAC-LC, HE-AAC v1 or Enhanced aacPlus (HE-AAC v2). 3GPP allowed use of AMR and H.263 codecs in the ISO base media file format (MPEG-4 Part 12), because 3GPP specified the usage of the Sample Entry and template fields in the ISO base media file format as well as defining new boxes to which codecs refer. These extensions were registered by the registration authority for code-points in ISO base media file format ("MP4 Family" files).[11][12] For the storage of MPEG-4 media specific information in 3GP files, the 3GP specification refers to MP4 and the AVC file format, which are also based on the ISO base media file format. The MP4 and the AVC file format specifications described usage of MPEG-4 content in the ISO base media file format.[8] A 3GP file is always big-endian, storing and transferring the most significant bytes first. [citation needed] The 3G2 file format can store the same video streams and most of the audio streams used in the 2007 3GP file format. In addition, 3G2 stores audio streams as EVRC, EVRC-B, EVRC-WB, 13K (QCELP), SMV or VMR-WB, which was specified by 3GPP2 for use in ISO base media file format.[12] The 3G2 specification also defined some enhancements to 3GPP Timed Text. 3G2 file format does not store Enhanced aacPlus (HE-AAC v2) and AMR-WB+ audio streams.[7] For the storage of MPEG-4 media (AAC audio, MPEG-4 Part 2 video, MPEG-4 Part 10 – H.264/AVC) in 3G2 files, the 3G2 specification refers to the MP4 file format and the AVC file format specification, which described usage of this content in the ISO base media file format. For the storage of H.263 and AMR content 3G2 specification refers to the 3GP file format specification.[7] Most 3G capable mobile phones support the playback and recording of video in 3GP format (memory, maximum filesize for playback and recording, and resolution limits exist and vary).[citation needed] Some newer/higher-end phones without 3G capabilities may also playback and record in this format (again, with said limitations).[citation needed] Audio imported from CD onto a PlayStation 3 when it is set to encode to the MPEG-4 AAC format copies onto USB devices in the 3GP format. [citation needed] The Nintendo 3DS used 3GP technology to play YouTube videos. Apple iDevices used to support files for playback only as passthrough files, hence no editing ability, but since iOS 9 this has been deprecated meaning files of this format have to be manually converted to H.264.[citation needed] When transferred to a computer, 3GP movies can be viewed on Microsoft Windows, Apple macOS, and the various Linux-based operating systems; on the former two with Windows Media Player[13] and Apple QuickTime[14] respectively (their built-in media players), and on all three with VLC media player.[15] Programs such as Media Player Classic, K-Multimedia Player, Totem, RealPlayer, MPlayer, and GOM Player can also be used. 3GP and 3G2 files can be encoded and decoded with open source software FFmpeg.[16] Media tags can be read and written on Linux, macOS and Windows using the open source AtomicParsley command-line utility.[17] computer programming portal Comparison of (audio/video) container formats SIF (Source Input Format) CIF (Common Intermediate Format) ^ a b c ETSI 3GPP 3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP) Retrieved on 2009-06-02. ^ a b c "3GPP2 C.S0050, 3GPP2 File Formats for Multimedia Services, File Format for Multimedia Services for cdma2000". 3GPP2. 2003. Retrieved 2009-06-12. ^ ETSI (2009-04) ETSI TS 126 234 V8.2.0 (2009-04); 3GPP TS 26.234; Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs Page 58. Retrieved on 2009-06-02. ^ ETSI (2009-01) ETSI TS 126 140 V8.0.0 (2009-01); 3GPP TS 26.140; Multimedia Messaging Service (MMS); Media formats and codes Page 11. Retrieved on 2009-06-02. ^ "ETSI TS 126 346 V8.3.0 (2009-06); 3GPP TS 26.346; Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs". ETSI. June 2009. p. 85. Retrieved 2009-10-13. ^ ETSI (2009-01) ETSI TS 126 141 V8.0.0 (2009-01); 3GPP TS 26.141; IP Multimedia System (IMS) Messaging and Presence; Media formats and codecs Page 10. Retrieved on 2009-06-02. ^ a b c d "3GPP2 C.S0050-B Version 1.0, 3GPP2 File Formats for Multimedia Services" (PDF). 3GPP2. 18 May 2007. pp. 67, 68. Archived from the original (PDF) on 7 October 2009. Retrieved 2009-06-12. ^ a b "3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP)" (PDF). ETSI 3GPP. 2008-12-11. p. 9. Retrieved 2009-05-30. ^ "ISO Base Media File Format white paper – Proposal". April 2006. Archived from the original on 2008-07-14. Retrieved 2009-12-26. ^ "ISO Base Media File Format white paper – Proposal". Chiariglione. October 2009. Retrieved 2009-12-26. ^ "ISO/IEC 14496-12:2008, Information technology -- Coding of audio-visual objects -- Part 12: ISO base media file format" (PDF). International Organization for Standardization. 2008. p. 95. Retrieved 2009-05-30. ^ a b "Registered types – Codecs". Registration authority for code-points in "MP4 Family" files – mp4ra.org. 2008. Archived from the original on 2009-04-19. Retrieved 2009-05-31. ^ "File types supported by Windows Media Player". Microsoft. Retrieved 2020-07-25. ^ "What's New in QuickTime 6.3 + 3GPP". Apple, Inc. Retrieved 2020-07-25. ^ "VLC Media Player features". VLC. Retrieved 2020-07-25. ^ "FFmpeg, General Documentation, Supported File Formats and Codecs". FFmpeg. Retrieved 2009-06-11. ^ "AtomicParseley". Wez Furlong. Retrieved 2024-06-24. 3GPP codecs specifications; 3G and beyond / GSM, 26 series 3GPP file format (3GP); 3GPP TS 26.244; Transparent end-to-end packet switched streaming service (PSS) - specification 3GPP2 specifications 3GPP2 File Formats for Multimedia Services; 3GPP2 C.S0050-B Version 1.0 - specification RFC 3839, MIME Type Registrations for 3rd Generation Partnership Project (3GPP) Multimedia files RFC 4393, MIME Type Registrations for 3GPP2 Multimedia Files RFC 4281, The Codecs Parameter for "Bucket" Media Types 3GP & 3G2 File Formats Retrieved from " 10 The following pages link to 3GP and 3G2 External tools (link count transclusion count sorted list) · See help page for transcluding these entries Showing 50 items. View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)Au file format (links | edit) Data compression (links | edit) GIF (links | edit) H.263 (links | edit) ITU-T (links | edit) JPEG (links | edit) JPEG Network Graphics (links | edit) MP3 (links | edit) Moving Picture Experts Group (links | edit) MPEG-1 (links | edit) MPEG-2 (links | edit) MPEG-4 (links | edit) Multiple-image Network Graphics (links | edit) Ogg (links | edit) PNG (links | edit) QuickTime (links | edit) Run-length encoding (links | edit) Vorbis (links | edit) WAV (links | edit) Windows Media Audio (links | edit) Audio Video Interleave (links | edit) M-law algorithm (links | edit) ATRAC (links | edit) Image compression (links | edit) RealMedia (links | edit) Video codec (links | edit) RealAudio (links | edit) Discrete cosine transform (links | edit) JPEG 2000 (links | edit) Shorten (codec) (links | edit) Interchange File Format (links | edit) Audio Interchange File Format (links | edit) DivX (links | edit) FLAC (links | edit) Dolby Digital (links | edit) G.723.1 (links | edit) G.711 (links | edit) Resource Interchange File Format (links | edit) TIFF (links | edit) Material Exchange Format (links | edit) MPEG-1 Audio Layer II (links | edit) Theora (links | edit) Dirac (video compression format) (links | edit) Monkey's Audio (links | edit) Motion JPEG (links | edit) MPEG-7 (links | edit) MPEG-21 (links | edit) Xvid (links | edit) FFmpeg (links | edit) Advanced Audio Coding (links | edit) View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Retrieved from " WhatLinksHere/3GP_and_3G2" If you’re one of those people who is considering joining the police force, you must have already thought of the tests you have to pass to become a police officer. Not only does qualifying for the job of a police officer involve performing a series of exams and tests, it also consists of passing the same satisfactorily so that you can move forward in the hiring process. Needless to say, policing definitely isn’t an easy career, especially for someone who is terrified of exams and tests. These tests exist to measure your overall mindset and mental stability; it’s not the the agency doesn’t “trust” you…it is about the fact that since the you will hold a position of great responsibility and will carry a firearm with live ammunition, they need to know that you can handle both others as well as yourself, and can respond according to the situation. You will thus have to prove that you’re absolutely fit not only physically but also mentally, which requires you to sit for these tests, and include the polygraph test and a psychological examination. Note however, that passing the polygraph is not a requirement solely for police officers, but also for other agencies like the state police, U.S. Customs and Border Protection, ICE, and candidates for federal agencies like the DEA, ATF and the FBI. Passing the polygraph exam is indeed of utmost importance if you wish to qualify for a career in law enforcement, which is exactly what we will be discussing in this post. According to research studies, polygraph examinations are highly unpopular. Many do not support the use of passing polygraph examination as necessary requirement for gaining entry into law enforcement since they are inadmissible in court. Having personally seen many a capable potential police officers getting disqualified due to (sometimes faulty) polygraph results, I would say that police polygraph tests aren’t really capable of detecting lies and weeding out the liars and fabricators from the pool. However, even as polygraph tests aren’t 100% accurate in detecting lies, they are as of now the best available tool to screen applicants and determine whether or not the applicant was being truthful. Which is pretty much the reason why they are used in the first place. Anyway, since pre-employment polygraph exams aren’t going anywhere anytime soon, you’d be better-off knowing about it in as much detail as possible, complete with tips on how you must prepare for a polygraph test. But first of all, you must have a clear understanding of what a polygraph really is, the reasons why people are indeed afraid of this test, and why in spite of its flaws, it continues to be an integral part of the hiring process. THE POLYGRAPH EXPLAINED So what is a polygraph? The first thing you should know about a polygraph is that it has no way of actually detecting when you are telling a lie. It basically works on the principle that when people lie, their body goes through various physiological upheavals, which is what the polygraph detects. By means of logical deduction, therefore, it can be said that when the polygraph detects such activity, it is most likely that the individual is lying. The polygraph, therefore, records physiological responses, such as the rate of perspiration, pulse, blood pressure and breathing rate. In particular, the polygraph system, which comes in both the antique analog model and the modern computerized model gathers physiological data from three specific areas of your body. The testing process involves 2 rubber tubes which are placed over the candidate’s abdomen and chest to monitor breathing activity, along