4G

**4G** refers to the fourth generation of cellular wireless standards. It is a successor to [3G](http://en.wikipedia.org/wiki/3G) and [2G](http://en.wikipedia.org/wiki/2G)standards, with the aim to provide [ultra-broadband](http://en.wikipedia.org/wiki/Mobile_broadband) (gigabit-speed) internet access to mobile as well as stationary users. Although 4G is a broad term that has had several different and more vague definitions, this article uses 4G to refer to **IMT Advanced** (*International Mobile Telecommunications Advanced*), as defined by [ITU-R](http://en.wikipedia.org/wiki/ITU-R).

A 4G cellular system must have target peak data rates of up to approximately 100 Mbit/s for high mobility such as mobile access and up to approximately 1 Gbit/s for low mobility such as nomadic/local wireless access, according to the ITU requirements. A 4G system is expected to provide a comprehensive and secure all-IP based solution where facilities such as [IP telephony](http://en.wikipedia.org/wiki/IP_telephony), ultra-broadband Internet accessand [HDTV](http://en.wikipedia.org/wiki/HDTV) streamed multimedia should be provided to users.

The pre-4G technology [3GPP Long Term Evolution](http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution) (LTE) is often branded "4G", but the first LTE release does not fully comply with the IMT-Advanced requirements. LTE has a theoretical capacity of up to 100 Mbit/s in the downlink and 50 Mbit/s in the uplink. Most major mobile carriers in the United States and several worldwide carriers have announced plans to convert their networks to LTE beginning in 2009. The world's first publicly available LTE-service was opened in the two Scandinavian capitals [Stockholm](http://en.wikipedia.org/wiki/Stockholm) and[Oslo](http://en.wikipedia.org/wiki/Oslo) on the 14 December 2009, and branded 4G. The physical radio interface was at an early stage named *High Speed*[*OFDM*](http://en.wikipedia.org/wiki/OFDM)*Packet Access* (HSOPA), now named [Evolved UMTS Terrestrial Radio Access](http://en.wikipedia.org/wiki/Evolved_UMTS_Terrestrial_Radio_Access) (E-UTRA).

[LTE Advanced](http://en.wikipedia.org/wiki/LTE_Advanced) (Long-term-evolution Advanced) is a candidate for IMT-Advanced standard, formally submitted by the [3GPP](http://en.wikipedia.org/wiki/3GPP) organization to ITU-T in the fall 2009, and expected to be released in 2011. The target of 3GPP LTE Advanced is to reach and surpass the ITU requirements. LTE Advanced should be compatible with first release LTE equipment, and should share frequency bands with first release LTE.

The [Mobile WiMAX](http://en.wikipedia.org/wiki/Mobile_WiMAX) (IEEE 802.16e-2005) mobile wireless broadband access (MWBA) standard is sometimes branded 4G, and offers peak data rates of 128 Mbit/s downlink and 56 Mbit/s uplink over 20 MHz wide channels. The [IEEE 802.16m](http://en.wikipedia.org/wiki/IEEE_802.16m) evolution of 802.16e is under development, with the objective to fulfill the IMT-Advanced criteria of 1000 Mbit/s for stationary reception and 100 Mbit/s for mobile reception.

UMB ([Ultra Mobile Broadband](http://en.wikipedia.org/wiki/Ultra_Mobile_Broadband)) was the brand name for a discontinued 4G project within the [3GPP2](http://en.wikipedia.org/wiki/3GPP2)standardization group to improve the [CDMA2000](http://en.wikipedia.org/wiki/CDMA2000) mobile phone standard for next generation applications and requirements. In November 2008, [Qualcomm](http://en.wikipedia.org/wiki/Qualcomm), UMB's lead sponsor, announced it was ending development of the technology, favoring LTE instead. The objective was to achieve data speeds over 275 Mbit/s downstream and over 75 Mbit/s upstream.

In all these suggestions for 4G, the [CDMA](http://en.wikipedia.org/wiki/CDMA) [spread spectrum](http://en.wikipedia.org/wiki/Spread_spectrum) radio technology used in 3G systems and[IS-95](http://en.wikipedia.org/wiki/IS-95) is abandoned and replaced by [frequency-domain equalization](http://en.wikipedia.org/wiki/Frequency-domain_equalization) schemes, for example multi-carrier transmission such as [OFDMA](http://en.wikipedia.org/wiki/OFDMA). This is combined with [MIMO](http://en.wikipedia.org/wiki/MIMO) (i.e. multiple antennas), [dynamic channel allocation](http://en.wikipedia.org/wiki/Dynamic_channel_allocation) and [channel-dependent scheduling](http://en.wikipedia.org/wiki/Channel-dependent_scheduling).

Objective and approach

**Objectives**

4G is being developed to accommodate the [QoS](http://en.wikipedia.org/wiki/Quality_of_service" \o "Quality of service) and rate requirements set by further development of existing 3G applications like wireless broadband access, [Multimedia Messaging Service](http://en.wikipedia.org/wiki/Multimedia_Messaging_Service) (MMS), [video chat](http://en.wikipedia.org/wiki/Videoconferencing), [mobile TV](http://en.wikipedia.org/wiki/Mobile_TV), but also new services like [HDTV](http://en.wikipedia.org/wiki/High-definition_television) content, minimal services like voice and data, and other services that utilize bandwidth. It may be allow roaming with wireless local area networks, and be combined with [digital video broadcasting](http://en.wikipedia.org/wiki/Digital_video_broadcasting) systems.

The 4G working group has defined the following as objectives of the 4G wireless communication standard:

* Flexible channel bandwidth, between 5 and 20 MHz, optionally up to 40 MHz.
* A [spectrally efficient](http://en.wikipedia.org/wiki/Spectral_efficiency) system (in bits/s/Hz and bits/s/Hz/site),
* High network capacity: more simultaneous users per cell,
* A nominal data rate of 100 Mbit/s while the client physically moves at high speeds relative to the station, and 1 Gbit/s while client and station are in relatively fixed positions as defined by the [ITU-R](http://en.wikipedia.org/wiki/ITU-R),
* A data rate of at least 100 Mbit/s between any two points in the world,
* Smooth [handoff](http://en.wikipedia.org/wiki/Handoff) across heterogeneous networks,
* Seamless connectivity and global [roaming](http://en.wikipedia.org/wiki/Roaming) across multiple networks,
* High quality of service for next generation multimedia support (real time audio, high speed data, HDTV video content, mobile TV, etc)
* Interoperability with existing wireless standards, and
* An all IP, [packet switched](http://en.wikipedia.org/wiki/Packet_switched) network.

]**Approaches**

As described in 4G consortia including [WINNER](http://www.ist-winner.org/), *WINNER - Towards Ubiquitous Wireless Access*, and [WWRF](http://www.wireless-world-research.org/), a key technology based approach is summarized as follows, where Wireless-World-INitiative-NEw-Radio (WINNER) is a consortium to enhance mobile communication systems.

**Consideration points**

* Coverage, radio environment, spectrum, services, business models and deployment types, users.

**Principal technologies**

* Physical layer transmission techniques
  + No [CDMA](http://en.wikipedia.org/wiki/CDMA).
  + [MIMO](http://en.wikipedia.org/wiki/MIMO): To attain ultra high spectral efficiency by means of spatial processing including multi-antenna and multi-user MIMO
  + *Frequency-domain-equalization*, for example *Multi-carrier modulation (*[*OFDM*](http://en.wikipedia.org/wiki/OFDM)*) or* single-carrier frequency-domain-equalization *(SC-FDE) in the downlink: To exploit the frequency selective channel property without complex equalization.*
  + Frequency-domain staistical multiplexing, for example ([OFDMA](http://en.wikipedia.org/wiki/OFDMA)) or (Single-carrier FDMA) (SC-FDMA, a.k.a. Linearly precoded OFDMA, LP-OFDMA) in the uplink: Variable bit rate by assigning different sub-channels to different users based on the channel conditions
  + [Turbo principle](http://en.wikipedia.org/wiki/Turbo_code) [error-correcting codes](http://en.wikipedia.org/wiki/Error-correcting_code): To minimize the required [SNR](http://en.wikipedia.org/wiki/Signal-to-noise_ratio) at the reception side
* [Channel-dependent scheduling](http://en.wikipedia.org/wiki/Channel-dependent_scheduling): To utilize the time-varying channel.
* [Link adaption](http://en.wikipedia.org/w/index.php?title=Link_adaption&action=edit&redlink=1): [Adaptive modulation](http://en.wikipedia.org/wiki/Adaptive_modulation) and error-correcting codes
* Relaying, including fixed relay networks (FRNs), and [the cooperative relaying concept](http://en.wikipedia.org/wiki/Cooperative_wireless_communications), known as multi-mode protocol

4G features

According to the members of the 4G working group, the infrastructure and the terminals of 4G will have almost all the standards from 2G to 4G implemented. Although legacy systems are in place to adopt existing users, the infrastructure for 4G will be only packet-based (all-IP). Some proposals suggest having an open Internet platform. Technologies considered to be early 4G include: [Flash-OFDM](http://en.wikipedia.org/wiki/Flash-OFDM), the 802.16e mobile version of [WiMax](http://en.wikipedia.org/wiki/WiMax" \o "WiMax) (also known as [WiBro](http://en.wikipedia.org/wiki/WiBro" \o "WiBro) in South Korea), and HC-SDMA (see [iBurst](http://en.wikipedia.org/wiki/IBurst" \o "IBurst)).

Components

**Access schemes**

As the wireless standards evolved, the access techniques used also exhibited increase in efficiency, capacity and scalability. The first generation wireless standards used plain [TDMA](http://en.wikipedia.org/wiki/Time_division_multiple_access) and [FDMA](http://en.wikipedia.org/wiki/FDMA). In the wireless channels, TDMA proved to be less efficient in handling the high data rate channels as it requires large guard periods to alleviate the multipath impact. Similarly, FDMA consumed more bandwidth for guard to avoid inter carrier interference. So in second generation systems, one set of standard used the combination of FDMA and TDMA and the other set introduced an access scheme called [CDMA](http://en.wikipedia.org/wiki/CDMA). Usage of CDMA increased the system capacity, but as a drawback placed a soft limit on it rather than the hard limit (i.e. a CDMA network will not reject new clients when it aproaches its limits, resulting in a denial of service to all clients when the network overloads). Data rate is also increased as this access scheme (providing the network is not reaching its capacity) is efficient enough to handle the multipath channel. This enabled the third generation systems to use CDMA as the access scheme IS-2000, UMTS, HSXPA, 1xEV-DO, TD-CDMA and TD-SCDMA. However, the issue with CDMA is that it suffers from poor spectrum flexibility and scalability.

Recently, new access schemes like [Orthogonal FDMA](http://en.wikipedia.org/wiki/OFDMA) (OFDMA), [Single Carrier FDMA](http://en.wikipedia.org/wiki/SC-FDMA) (SC-FDMA),[Interleaved FDMA](http://en.wikipedia.org/w/index.php?title=Interleaved_FDMA&action=edit&redlink=1) and [Multi-carrier CDMA](http://en.wikipedia.org/wiki/MC-CDMA) (MC-CDMA) are gaining more importance for the next generation systems. [WiMax](http://en.wikipedia.org/wiki/WiMax" \o "WiMax) is using OFDMA in the downlink and in the uplink. For the [next generation UMTS](http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution), OFDMA is being considered for the downlink. By contrast, IFDMA is being considered for the uplink since OFDMA contributes more to the [PAPR](http://en.wikipedia.org/wiki/Crest_factor) related issues and results in nonlinear operation of amplifiers. IFDMA provides less power fluctuation and thus avoids amplifier issues. Similarly, MC-CDMA is in the proposal for the [IEEE 802.20](http://en.wikipedia.org/wiki/802.20) standard. These access schemes offer the same efficiencies as older technologies like CDMA. Apart from this, scalability and higher data rates can be achieved.

The other important advantage of the above mentioned access techniques is that they require less complexity for equalization at the receiver. This is an added advantage especially in the [MIMO](http://en.wikipedia.org/wiki/MIMO" \o "MIMO)environments since the [spatial multiplexing](http://en.wikipedia.org/wiki/Spatial_multiplexing) transmission of MIMO systems inherently requires high complexity equalization at the receiver.

In addition to improvements in these multiplexing systems, improved [modulation](http://en.wikipedia.org/wiki/Modulation) techniques are being used. Whereas earlier standards largely used [Phase-shift keying](http://en.wikipedia.org/wiki/Phase-shift_keying), more efficient systems such as 64[QAM](http://en.wikipedia.org/wiki/QAM) are being proposed for use with the [3GPP Long Term Evolution](http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution) standards.

**IPv6 support**

Unlike 3G, which is based on two parallel infrastructures consisting of [circuit switched](http://en.wikipedia.org/wiki/Circuit_switched) and [packet switched](http://en.wikipedia.org/wiki/Packet_switched) network nodes respectively, 4G will be based on packet switching *only*. This will require [low-latency](http://en.wikipedia.org/wiki/Lag) data transmission.

By the time that 4G is deployed, the process of [IPv4 address exhaustion](http://en.wikipedia.org/wiki/IPv4_address_exhaustion) is expected to be in its final stages. Therefore, in the context of 4G, [IPv6](http://en.wikipedia.org/wiki/IPv6) support is essential in order to support a large number of wireless-enabled devices. By increasing the number of [IP addresses](http://en.wikipedia.org/wiki/IP_address), IPv6 removes the need for [Network Address Translation](http://en.wikipedia.org/wiki/Network_Address_Translation) (NAT), a method of sharing a limited number of addresses among a larger group of devices, although NAT will still be required to communicate with devices that are on existing [IPv4](http://en.wikipedia.org/wiki/IPv4)networks.

As of June 2009, [Verizon](http://en.wikipedia.org/wiki/Verizon) has posted [specifications](https://www22.verizon.com/opendev/Forum/LTE_Document_Archives.aspx) that require any 4G devices on its network to support IPv6.

**Advanced Antenna Systems**

The performance of radio communications depends on an antenna system, refer to [smart](http://en.wikipedia.org/wiki/Smart_antenna) or [intelligent antenna](http://en.wikipedia.org/wiki/Intelligent_antenna). Recently, [multiple antenna technologies](http://en.wikipedia.org/wiki/Multiple_antenna_research) are emerging to achieve the goal of 4G systems such as high rate, high reliability, and long range communications. In the early 90s, to cater the growing data rate needs of data communication, many transmission schemes were proposed. One technology, [spatial multiplexing](http://en.wikipedia.org/wiki/Spatial_multiplexing), gained importance for its bandwidth conservation and power efficiency. Spatial multiplexing involves deploying multiple antennas at the transmitter and at the receiver. Independent streams can then be transmitted simultaneously from all the antennas. This increases the data rate into multiple folds with the number equal to minimum of the number of transmit and receive antennas. This is called [MIMO](http://en.wikipedia.org/wiki/MIMO) (as a branch of [intelligent antenna](http://en.wikipedia.org/wiki/Intelligent_antenna)). Apart from this, the reliability in transmitting high speed data in the fading channel can be improved by using more antennas at the transmitter or at the receiver. This is called*transmit* or *receive diversity*. Both transmit/receive diversity and transmit spatial multiplexing are categorized into the space-time coding techniques, which does not necessarily require the channel knowledge at the transmit. The other category is closed-loop multiple antenna technologies which use the channel knowledge at the transmitter..

**Software-Defined Radio (SDR)**

[SDR](http://en.wikipedia.org/wiki/Software-defined_radio) is one form of open wireless architecture (OWA). Since 4G is a collection of wireless standards, the final form of a 4G device will constitute various standards. This can be efficiently realized using SDR technology, which is categorized to the area of the radio convergence.

History of 4G and pre-4G technologies

* In 2002, the strategic vision for 4G — which [ITU](http://en.wikipedia.org/wiki/ITU) designated as IMT-Advanced — was laid out.
* In 2005, [OFDMA](http://en.wikipedia.org/wiki/OFDMA) transmission technology is chosen as candidate for the [HSOPA](http://en.wikipedia.org/wiki/HSOPA) downlink, later renamed 3GPP Long Term Evolution (LTE) air interface [E-UTRA](http://en.wikipedia.org/wiki/E-UTRA).
* In mid-2006, [Sprint Nextel](http://en.wikipedia.org/wiki/Sprint_Nextel) announced that it would invest about US$ 5 billion in a [WiMAX](http://en.wikipedia.org/wiki/WiMAX" \o "WiMAX) technology buildout over the next few years[[16]](http://en.wikipedia.org/wiki/4G#cite_note-sprint-15) ($5.29 billion in [real](http://en.wikipedia.org/wiki/Real_versus_nominal_value_(economics)) terms). Since that time Sprint has faced many setbacks, that have resulted in steep quarterly losses. On [May 7, 2008](http://en.wikipedia.org/w/index.php?title=May_7,_2008&action=edit&redlink=1), [Sprint](http://en.wikipedia.org/wiki/Sprint), [Imagine](http://en.wikipedia.org/wiki/Imagine_Communications" \o "Imagine Communications),[Google](http://en.wikipedia.org/wiki/Google), [Intel](http://en.wikipedia.org/wiki/Intel), [Comcast](http://en.wikipedia.org/wiki/Comcast), [Bright House](http://en.wikipedia.org/wiki/Bright_House_Networks), and [Time Warner](http://en.wikipedia.org/wiki/Time_Warner) announced a pooling of an average of 120 MHz of spectrum and merged with [Clearwire](http://en.wikipedia.org/wiki/Clearwire" \o "Clearwire) to form a company which will take the name Clear.
* In February 2007, the [Japanese company](http://en.wikipedia.org/wiki/Japanese_company) [NTT DoCoMo](http://en.wikipedia.org/wiki/NTT_DoCoMo) tested a 4G communication system prototype with 4x4 [MIMO](http://en.wikipedia.org/wiki/MIMO) called [VSF-OFCDM](http://en.wikipedia.org/wiki/VSF-OFCDM) at 100 [Mbit](http://en.wikipedia.org/wiki/Mbit" \o "Mbit)/s while moving, and 1 [Gbit](http://en.wikipedia.org/wiki/Gbit" \o "Gbit)/s while stationary. NTT DoCoMo completed a trial in which they reached a maximum packet transmission rate of approximately 5 Gbit/s in the downlink with 12x12 MIMO using a 100 MHz frequency bandwidth while moving at 10 km/h, and is planning on releasing the first commercial network in 2010.
* In September 2007, NTT Docomo demonstrated e-UTRA data rates of 200 Mbit/s with power consumption below 100 mW during the test.
* In January 2008, a U.S. [FCC](http://en.wikipedia.org/wiki/Federal_Communications_Commission) [spectrum auction](http://en.wikipedia.org/wiki/Spectrum_auction) for the 700 MHz former analog TV frequencies began. As a result, the biggest share of the spectrum went to Verizon Wireless and the next biggest to AT&T. Both of these companies have stated their intention of supporting [LTE](http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution).
* In January 2008, EU commissioner [Viviane Reding](http://en.wikipedia.org/wiki/Viviane_Reding) suggested re-allocation of 500–800 MHz spectrum for wireless communication, including WiMAX.
* February 15, 2008 - Skyworks Solutions released a front-end module for e-UTRAN.
* In April 2008, LG and Nortel demonstrated e-UTRA data rates of 50 Mbit/s while travelling at 110 km/h.
* In 2008, [ITU-R](http://en.wikipedia.org/wiki/ITU-R) established the detailed performance requirements of IMT-Advanced, by issuing a Circular Letter calling for candidate Radio Access Technologies (RATs) for IMT-Advanced.
* April 2008, just after receiving the circular letter, the 3GPP organized a workshop on IMT-Advanced where it was decided that LTE-Advanced, an evolution of current LTE standard, will meet or even exceed IMT-Advanced requirements following the ITU-R agenda.
* In December 2009, Sprint began advertising 4G service in selected cities in the United States, despite maximum download speeds of only 10Mbit/s
* On December 14, 2009, the first commercial LTE deployment was in the Scandinavian capitals[Stockholm](http://en.wikipedia.org/wiki/Stockholm) and [Oslo](http://en.wikipedia.org/wiki/Oslo) by the Swedish-Finnish network operator [TeliaSonera](http://en.wikipedia.org/wiki/TeliaSonera" \o "TeliaSonera) and its Norweigan brandname [NetCom (Norway)](http://en.wikipedia.org/wiki/NetCom_(Norway)" \o "NetCom (Norway)). TeliaSonera branded the network "4G". The modem devices on offer were manufactured by [Samsung](http://en.wikipedia.org/wiki/Samsung) (dongle GT-B3710), and the network infrastructure created by [Huawei](http://en.wikipedia.org/wiki/Huawei" \o "Huawei)(in Oslo) and [Ericsson](http://en.wikipedia.org/wiki/Ericsson) (in Stockholm). TeliaSonera plans to roll out nationwide LTE across Sweden, Norway and Finland[[28]](http://en.wikipedia.org/wiki/4G" \l "cite_note-27)[[29]](http://en.wikipedia.org/wiki/4G#cite_note-28). Although LTE should provide physical layer [net bitrates](http://en.wikipedia.org/wiki/Net_bitrate) of up to 100 Mbit/s downlink and 50 Mbit/s in the uplink, introductory tests showed a [TCP](http://en.wikipedia.org/wiki/TCP) [goodput](http://en.wikipedia.org/wiki/Goodput" \o "Goodput) of 42.8 Mbit/s downlink and 5.3 Mbit/s uplink in Stockholm.[[30]](http://en.wikipedia.org/wiki/4G#cite_note-29)

**Deployment plans**

In May 2005, [Digiweb](http://en.wikipedia.org/wiki/Digiweb" \o "Digiweb), an Irish fixed and wireless broadband company, announced that they have received a mobile communications license from the Irish Telecoms regulator, [ComReg](http://en.wikipedia.org/wiki/ComReg" \o "ComReg). This service will be issued the mobile code *088* in Ireland and will be used for the provision of 4G Mobile communications. Digiweb launched a mobile broadband network using FLASH-OFDM technology at 872 MHz.

On September 20, 2007, [Verizon Wireless](http://en.wikipedia.org/wiki/Verizon_Wireless) announced that it plans a joint effort with the [Vodafone Group](http://en.wikipedia.org/wiki/Vodafone_Group)to transition its networks to the 4G standard LTE. On December 9, 2008, [Verizon Wireless](http://en.wikipedia.org/wiki/Verizon_Wireless) announced that they intend to build and begin to roll out an LTE network by the end of 2009.

[Telus](http://en.wikipedia.org/wiki/Telus) and [Bell Canada](http://en.wikipedia.org/wiki/Bell_Canada), the major Canadian [cdmaOne](http://en.wikipedia.org/wiki/CdmaOne" \o "CdmaOne) and [EV-DO](http://en.wikipedia.org/wiki/EV-DO) carriers, have announced that they will be cooperating towards building a fourth generation (4G) LTE wireless broadband network in Canada. As a transitional measure, they are implementing 3G [UMTS](http://en.wikipedia.org/wiki/UMTS) to go live by early 2010.

Sprint offers a 3G/4G connection plan, currently available in select cities in the United States. It delivers rates up to 36 Mbit/s.

[O2](http://en.wikipedia.org/wiki/O2) is to use [Slough](http://en.wikipedia.org/wiki/Slough) as a guinea pig in testing the 4G network and has called upon Chinese company Huawei to install LTE technology in six masts across the town to allow people to talk to each other via HD video conferencing and play PlayStation games while on the move. If the trail is successful we could see 4G coverage available across the country by 2011.

Current research

[Pervasive networks](http://en.wikipedia.org/wiki/Pervasive_network) are an amorphous and at present entirely hypothetical concept where the user can be simultaneously connected to several wireless access technologies and can seamlessly move between them (See [vertical handoff](http://en.wikipedia.org/wiki/Vertical_handoff), [IEEE 802.21](http://en.wikipedia.org/wiki/IEEE_802.21)). These access technologies can be [Wi-Fi](http://en.wikipedia.org/wiki/Wi-Fi), [UMTS](http://en.wikipedia.org/wiki/Universal_Mobile_Telecommunications_System), [EDGE](http://en.wikipedia.org/wiki/Enhanced_Data_Rates_for_GSM_Evolution), or any other future access technology. Included in this concept is also smart-radio (also known as [cognitive radio](http://en.wikipedia.org/wiki/Cognitive_radio) technology) to efficiently manage spectrum use and transmission power as well as the use of [mesh routing](http://en.wikipedia.org/wiki/Mesh_networking) protocols to create a pervasive network.

4G wireless standards

In September 2009 the technology proposals have been submitted to ITU-R as 4G candidates[[36]](http://en.wikipedia.org/wiki/4G#cite_note-35). Basically all proposals are based on two technologies:

1) [LTE Advanced](http://en.wikipedia.org/wiki/LTE_Advanced) standardized by 3GPP

2) 802.16m standardized by IEEE

Considering the huge industry support for 3GPP based technologies as LTE the vision of an almost unified global 4G standard might not be out of reach anymore. A first set of 3GPP requirements on LTE Advanced has been approved in June 2008. LTE Advanced will be standardized in 2010 as part of the Release 10 of the 3GPP specification. LTE Advanced will be fully built on the existing LTE specification Release 10 and not be defined as a new specification series. A summary of the technologies that have been studied as the basis for LTE Advanced is summarized in a technical report.