

Wireless Carrier Broadband Data

Prepared for
Snohomish County Emergency Radio System
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Summary and Background:

During the months of August and September of 2009, three commercial wireless carrier meetings were held at Sparling's Lynnwood office for Snohomish County agencies and other regional public safety entities. The purpose of these meetings was to understand each of the commercial carrier's data capabilities and their respective long term plans for wireless data, as well as exploring concepts for development of joint public-private wireless data networks. A key goal was to determine the viability of leveraging present and future commercial wireless data networks as part of a long-term wireless data network strategy for public safety entities throughout Snohomish County and the Puget Sound region.

Based on their market presence and engagement with public safety users in the region, three wireless carriers were invited to present. The invited carriers were Verizon, AT&T, and Sprint-Nextel. At the time T-Mobile did not have a public safety marketing group. As a result, T-Mobile was not invited to present. Sparling provided each carrier with strict guidelines concerning the topics to be presented. The carriers were asked to present on topics relating to their existing backhaul network, public safety support, and over-the-air wireless data technology, as well as their future plans for their infrastructure. It was strongly suggested that the carriers not concentrate the presentation on user devices and software applications. The carriers presented on the following dates:

Dates	Carrier	Network Technology in Use and Wireless Data Technology Direction
August 17, 2009	Verizon	CDMA network; data currently EVDO, Future LTE.
September 3, 2009	AT&T	GSM-UMTS WCDMA/ HSPA, Future LTE
September 11, 2009	Sprint-Nextel	CDMA network; data currently EVDO, Future WiMAX

All three wireless carriers currently have in place third generation (3G) data networks, based on either CDMA EV-DO, or on WCDMA HSPA. As these carriers move to their next generation technology over the coming years, they will be using either LTE or WiMAX as their fourth generation wireless data technology.

Long Term Evolution (LTE) is a 3GPP standard for the wireless data systems. WiMAX is an IEEE standard. Both technologies have many technological similarities. LTE is supported by the Association of Public-Safety Communications Officials (APCO) and the National Emergency Number Association (NENA). The National Public-Safety Telecommunications Council (NPSTC) also endorsed LTE, but is also supporting competing technologies, such as WiMAX.

Sparling has also included updated information in this report that addresses the current status of 700 MHz radio spectrum that has the capability of facilitating deployment of new public safety broadband wireless data networks. This same spectrum is usable for purely public safety-owned systems, deployment of joint public-private systems or deployment of commercial systems that have been optimized for public safety use on a priority basis.

Wireless Carrier Sessions

Verizon Wireless

Verizon was the first wireless carrier to present. Verizon Wireless was also the wireless carrier used in the 2008 Snohomish Wireless Data Pilot Project. Verizon presented a very informative overview of the basics of LTE technology and their future wireless data technology migration path. However, they revealed very limited technical information regarding the details of their network infrastructure.

Verizon current utilizes Evolution Data-Optimized or EV-DO technology for their wireless data services. This is a CDMA2000 based data technology, with an over-the-air link maximum operating transfer rate of 3.1 megabits per second (using EV-DO rev A). Verizon's wireless data technology strategy is to migrate from CDMA2000 based EVDO to 3GPP's Long Term Evolution (LTE) operating on former television broadcast channels at 700 MHz. It is Sparling's understanding that deployment of LTE technology will require what amounts to deployment of an entirely new LTE infrastructure overlay "on top of" the present voice network.

The current Verizon wireless data coverage will cover the majority of the populated Snohomish County. Verizon has backup power (usually batteries with limited operating times rather than batteries and generators) at many sites and backhaul redundancy on most of their cellular sites. Additionally, Verizon Wireless has a number of Cellular on Wheel Sites (CoWS) and Cellular on Light Truck Site (CoLTS) available for emergency scenarios requiring deployment of temporary sites throughout the Puget Sound region.

The following is a map of Verizon's current data coverage in Snohomish County.



Verizon refers to their 3G Data network as their "Broadband" network

Verizon is currently in the process of testing and prototyping next generation LTE systems at limited locations throughout the US. Although Seattle is one such test location, this process is still in its early stages. For example, during a Verizon LTE demo attended by Sparling staff, there were no actual manufactured LTE devices used as a part of the demonstration, only LTE "lab" kits. The over-the-air capabilities of LTE were not presented at this demonstration. Only the IP Multimedia Subsystem (IMS) was demonstrated as a network framework that can deliver IP content over an LTE network. Sparling observes that this demonstrates that LTE is still very much in its infancy.

Verizon has stated that they will start early network deployment sometime in 2010 and indicates that nationwide LTE deployment will take place over the 2013-2014 period. The first deployments of LTE will be on modem and network bridge-like devices suitable for mobile computing, with embedded and truly miniaturized data modems being offered later in time.

AT&T Wireless

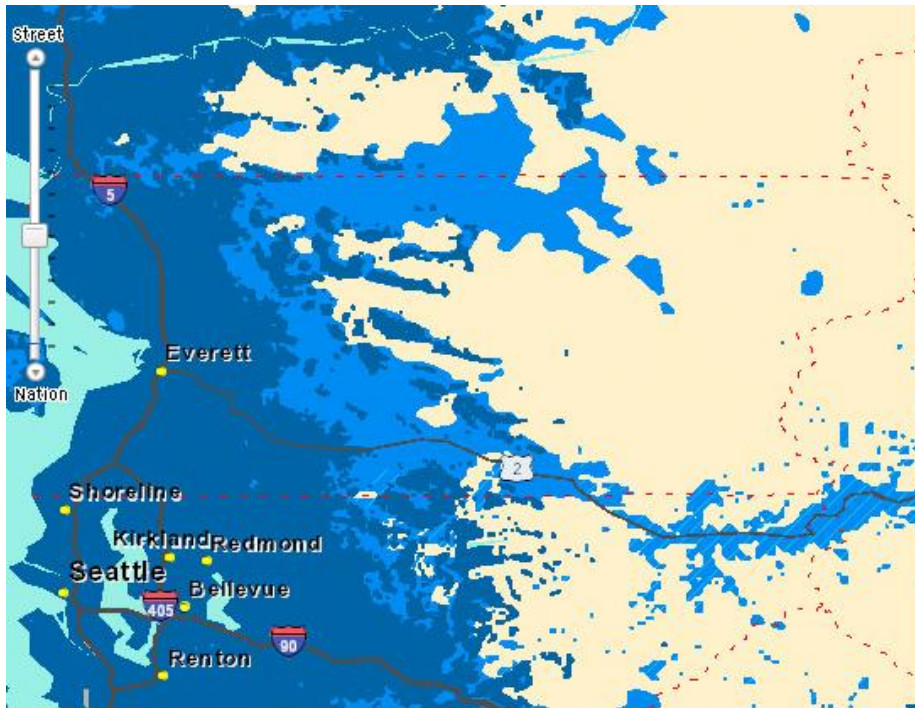
AT&T Wireless was the second carrier to present to the group. AT&T provided the most detailed and technical presentation of all of the wireless carriers. AT&T gave a good presentation on their future wireless technology direction, their supporting infrastructure and appeared to have a good grasp on concepts relating to public-private wireless data network partnerships.

In contrast to Verizon and Sprint, AT&T currently utilizes the 3GPP's technology path for supporting wireless data services instead of CDMA2000. There are two different types of wireless data network that AT&T currently operates. The first is Enhanced Data rates for GSM Evolution (EDGE) and the second is High Speed Packet Access (HSPA). EDGE provides an over-the-air downlink maximum operating transfer rate of 384 kilobits per second, while the current revision of HSPA provides a downlink of up to 3.6 megabits per second.

Similar to Verizon, AT&T's will also migrate to the 3GPP's Long Term Evolution (LTE) technology operating on former television broadcast channels at 700 MHz. Before the deployment and transition to LTE, AT&T will enhance HSPA to a newer revision of HSPA with maximum downlink rates of 7.2 megabits per second.

The current AT&T wireless data service will cover the majority of the populated Snohomish County. However, AT&T's data services in outlying areas of the county are limited to EDGE in many areas. AT&T also has limited backup power at sites and backhaul redundancy is only available at cellular sites in more developed areas of Snohomish County. Like Verizon, AT&T wireless has a number of Cellular on Wheel Sites (CoWS) and Cellular on Light Truck Sites (CoLTS) available for emergency scenarios throughout the Puget Sound area.

The following is a map of AT&T's current data coverage in Snohomish County.



Data Coverage Legend

- 3G/Mobile Broadband* (in select areas), Video Share*, DataConnect Pass
- EDGE/GPRS*, DataConnect Pass
- Partner EDGE^
- Partner GPRS^
- No Service Available

*Supports optional features such as AT&T Media, including Cellular Video.
 ^Supports optional features AT&T Media, excluding Cellular Video.
 *Capable handsets required.

AT&T stated in their presentation that they will begin LTE deployment in 2011.

AT&T representatives offered a unique public safety cooperative option in using and developing wireless data coverage during their presentation. They suggested a partnership with governmental entities to share facilities. This could involve sharing at many different levels, from backhaul redundancy, through shared base stations and site to roaming between separate systems. There are many different ways this could assist in deployment of government broadband networks, most notably with cost sharing and creating larger system footprints using a common technology. Such a partnership could involve priority access for first responders on commercial systems when that technology becomes available and roaming between commercial and government networks, if the governmental entities were to build private network infrastructure. This would provide a high level of redundancy and coverage flexibility and is an area where considerable attention will be paid by agencies on both a regional and a national level.

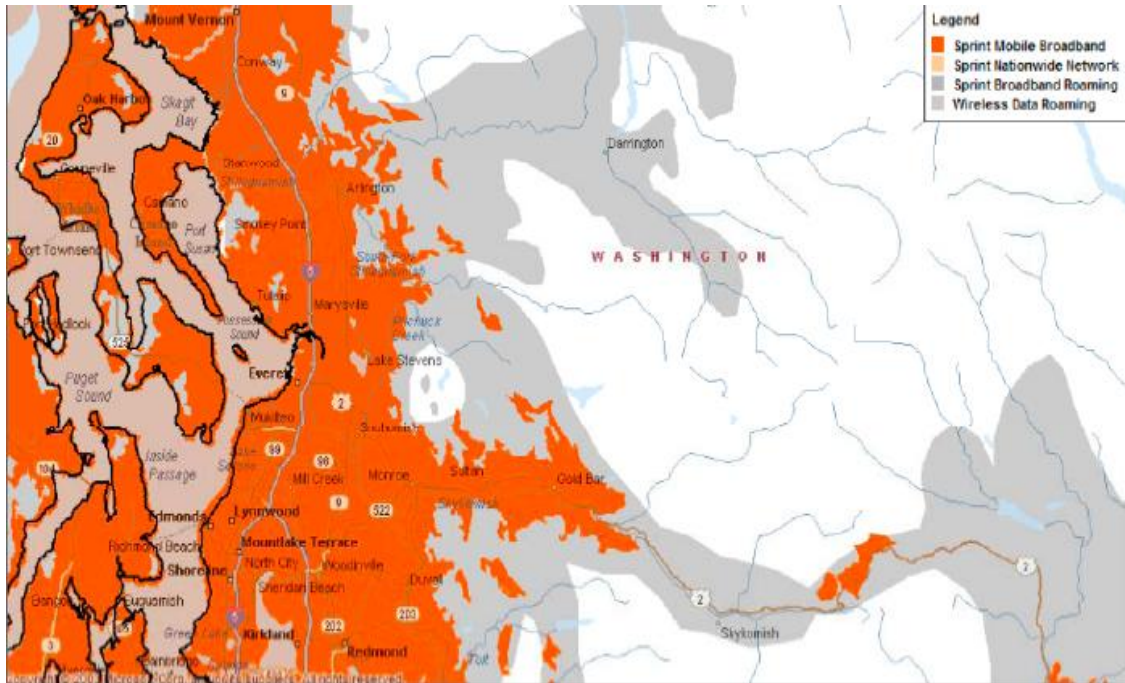
Sprint-Nextel/Clearwire

Sprint was the final wireless carrier presenter. Sprint also provided what attendees observed to be the weakest presentation out of the carriers. While Sprint presented a very informative overview of the WiMAX technology and their future wireless direction, there was far less useful technical information offered when compared with the other carriers. Sprint is deploying a WiMAX network in partnership with Clearwire, and this technology is being marketed as a "4G" or fourth generation network technology.

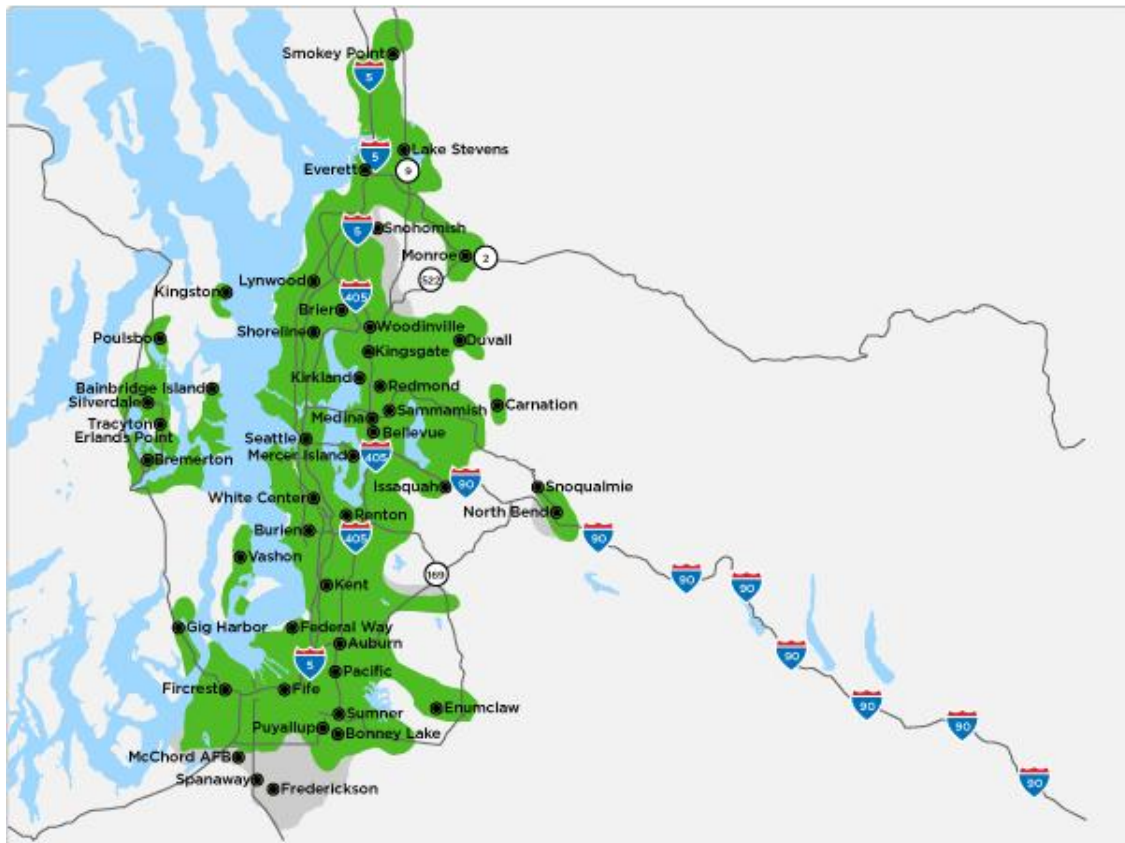
Sprint presently utilizes Evolution Data-Optimized (EV-DO) technology for their wireless data services. This is similar to Verizon's current wireless data technology. Sprint will continue to maintain their existing EV-DO network as well as deploying WiMAX, along with Clearwire, as their next generation wireless data strategy. WiMAX is based on the IEEE 802.16e standard, operating on former Microwave Distribution Service channels at 2.5 GHz. Clearwire is currently deploying WiMAX systems in populous areas of Snohomish County.

The current Sprint wireless data service covers a majority of populated Snohomish County but offers very limited service in the rural areas of the county. Sprint's backup power and network redundancy are only available at its cellular sites in the urban and denser suburban areas of Snohomish County. Like Verizon and AT&T, Sprint has a number of Cellular on Wheel Site (CoWS) and Cellular on Light Truck Site (CoLTS) available for emergency scenarios throughout the Puget Sound.

The following is a map of Sprint's current 3G EV-DO data coverage in Snohomish County.



Below is a map of Clearwire's WiMAX network



Sprint's WiMAX deployment is currently in progress and operation is expected to begin in 2010. The Seattle area was to be upgraded to the latest revision of WiMAX in the later part of 2009.

As mentioned above, the higher frequencies utilized by the WiMAX limit it to the more populated areas. Sparling notes that effective rural area coverage would be more difficult to achieve with these spectrum bands than the 700 MHz spectrum to be used by Verizon and AT&T.

Spectrum

Both Verizon and AT&T have blocks of 700 MHz spectrums around the country. This spectrum was recently obtained through auctions in which former broadcast television spectrum was sold to wireless carriers for mobile data services. Verizon purchased the C block of the upper 700 MHz block in a nationwide footprint, excluding Alaska. AT&T bought various blocks throughout the lower 700 MHz spectrum in populated areas. Both carriers will be using this spectrum for their future LTE technology. Sprint has a large number of licenses in the 2.5-2.6 GHz spectrum, which is currently being used for initial WiMAX deployments. Because of the higher frequency band being used for WiMAX, the coverage area is smaller; therefore a much higher number of sites are required to cover the same area as a 700MHz system.

Nationwide Public Safety Wireless Broadband Network Updates

There has been a concerted push over the last few years to develop a nationwide broadband network for public safety agencies around the country. Such a network would allow for high-speed data services that are becoming a requirement of many government agencies. A nationwide network would allow for interoperability between agencies as they deploy to assist in event of major functions or catastrophic events.

The first step towards this network involved a push to build a privately funded wireless data network using unauctioned 700 MHz spectrum exclusively for public safety use. Although the proposed system type would be used by public safety agencies, being privately owned and controlled would be unique and could bring with it some unique operational and policy challenges. As with any commercial service, there are concerns that the incentives to expend capital to construct a network where the agencies need coverage may be based more on financial concerns than on public safety requirements. Nonetheless, the FCC and Congress moved forward with the attempted auction of spectrum that would have these public-private partnership stipulations tied to the spectrum. This auction, commonly referred to as the "D-Block" auction, was ultimately unsuccessful, as the price to build an effective public safety grade wireless network was much higher than private firms were willing to pay.

After the unsuccessful auction process, different proposals were brought forward on methods of moving forward with a nationwide broadband network for public safety agencies. Some of the more recent proposals include taking the spectrum that had been put up for auction and combining it with public safety spectrum immediately adjacent to create a larger block for the sole use of public safety agencies seeking to deploy broadband technologies. This spectrum block could then be licensed to regional entities for use in

regional networks that would be funded by local government entities. The benefit of this method would be that regions with available funding could move forward with building a network to meet their immediate needs. Critics have said that this approach could create problems of interoperability between different regional networks, each using different and potentially incompatible technologies. Selection of differing technologies also fragments the total market size, meaning that infrastructure and user device costs increase as a result of the lessened economies of scale present.

However, one way to ensure interoperability is to standardize on a particular network technology that could then be built region by region as funding became available. This would ensure that government agencies could assist others when required while allowing for the quick buildout of networks where funds are available. As a result of this interoperability concern, APCO and others have endorsed deployment of systems that use the LTE technology being deployed for use by commercial wireless carriers.

Although it appears that the notion of having a private company build out a nationwide network for government agencies is not financially feasible, there are still advantages to partnering with private entities. The first obvious advantage is that many commercial carriers have large networks that could be used, at a minimum, to provide backhaul redundancy. Secondly, were the public safety entity to begin build-out of their own broadband data network, the commercial network could be used for fill-coverage. Thirdly, if the public safety entity were able to build out such a network throughout their required coverage area, such a partnership would allow for redundancy (roaming onto commercial networks) and flexibility in locations where the governmental network is not present. As noted in the discussion about AT&T's presentation, there are many different advantages to having such a partnership.

Updated "D-Block" Information

Urgent Communications Magazine has reported that an appropriations bill presently in committee at Congress contains language that appears to direct the FCC to attempt to re-auction the D-Block. This direction is vague and may represent historical language that was developed in previous years, prior to the unsuccessful first attempt to auction the D-Block/Public Safety as a combined spectrum block. It is assumed that were this direction current, that the commission would either re-auction only the commercial allocation (the D-Block proper) or would auction both the D-Block and the public safety segment together, with requirements for priority public safety access similar to the original D-Block auction (though with reduced requirements being placed on carriers in order to encourage bidding).

A second auction would likely take place as the US economy is on a slight upswing and with the right balance between carrier responsibilities and spectrum sale price, could entice wireless carriers to bid on spectrum that previously was unattractive. It is significant that the larger carriers that are 'spectrum rich' have all come out in support of returning the spectrum to public safety including the commercial D-Block. Their rationale is two-fold. Firstly, they see an opportunity to partner with local governments and secure users on the present commercial networks. Secondly (and perhaps most importantly), these businesses seek to prevent market entry by smaller competitive wireless providers who currently are

not a part of the "spectrum club". By preventing access to the D-Block, the spectrum-rich carriers create an impenetrable barrier to market entry.

The Obama administration and the new FCC Chair show a very strong interest in wireless broadband and are expending considerable energy in researching spectrum availability for new entrants into the wireless broadband space. Given this background of improving economic conditions, an activist pro-competition FCC and eagerness on the part of potential new entrants into the wireless broadband market, Sparling views direct re-allocation of the D-Block to government use as unlikely.

Recommendations for Moving Forward

Based on the information presented by the different carriers, the following should be considered for the long-term wireless data strategy for Snohomish County.

- Wireless carrier's data service should be considered as an alternative for everyday use. Additionally, to prepare for the eventuality that these services could potentially become unavailable in a disaster, operational policies and procedures should be developed for agency and dispatch center use.
- Snohomish County should consider taking advantage of the AT&T-offered option of Snohomish County building out remote area public safety cellular data sites, as an enhancement to the AT&T wireless data infrastructure, to fill in rural areas not covered by the AT&T system. This may be a good option to provide wide area coverage of high speed data without the excessive costs associated with development of a solely public safety-built infrastructure. Development of system enhancements along these lines would need to be timed to coincide with deployment of LTE infrastructure and would create some modest contract and legal challenges for public agencies. This same strategy could be used with the other carriers were they interested in such partnerships.
- LTE should be researched further by Snohomish County agencies as a future technology option for the region's public safety wireless data. By using the same data technology as the commercial carriers (which also follows the recommendations of national public safety representative organizations regarding selection of LTE), using commercial carriers' network to fill in the public safety's network becomes a much easier task.
- In the short term, wired infrastructure and connectivity policies should continue to be developed in preparation for the future wireless data network technology.

Glossary

3G (Third Generation Wireless): The current generation of wireless broadband data communications technologies. When available, 3G wireless technologies allow for much higher transmission rates to wireless devices leading to more useful services and a better user experience.

3GPP (3rd Generation Partnership Project): A collaboration between industry associations to create a global mobile network specification based originally on GSM specifications.

4G (Third Generation Wireless): The next generation of wireless broadband communications technologies. 4G wireless technologies will have much higher downlink and uplink speeds than current 3G data technologies and will provide improved capacity and latency, enabling high-bandwidth applications over wireless links. Note that neither LTE or WiMAX as they are currently being implemented qualify for "4G" status as defined by the International Telecommunication Union, but the need to differentiate these services from current offerings has led to them being marketed as such.

CDMA (Code Division Multiple Access): A spread-spectrum digital cellular radio system that uses different 'spreading' codes to distinguish users. Used in the US by Verizon Wireless and Sprint, along with many rural wireless carriers.

EDGE (Enhanced Data for GSM Evolution): A further development of the GSM protocol designed to handle data at speeds up to 384 Kbps. Considered to be 3G wireless technology.

EV-DO (Evolution-Data Optimized or Evolution-Data Only): EV-DO is a commercial wireless data service developed by Qualcomm as an enhanced wireless data service overlay for CDMA cellular systems. EV-DO can provide speeds approaching 'broadband-speed' Internet access (maximum download speed of 3.1 Mbps in Rev. A) and is a part of the CDMA2000 set of CDMA technical standards.

GSM (Global Standard for Mobile): A digital communication technology used by some carriers to provide cellular service. GSM is the digital transmission technique widely adopted throughout the world and is used in the US by AT&T and T-Mobile.

HSPA (High Speed Packet Access): a collection of two protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA) that improve upon existing WCDMA protocols.

IMS (IP Multimedia Subsystem): A framework for delivering IP services over wireless cellular services.

LTE (Long Term Evolution): A new cellular data technology designed to increase capacity and speeds of mobile networks. LTE is an enhancement to the set of standards resulting from the 3GPP and is expected to be first deployed in the US by Verizon Wireless. AT&T will follow soon thereafter.

UMTS (Universal Mobile Telecommunications System): An evolution of GSM technology to 3G. The underlying air-interface transmission standard is WCDMA.

WCDMA (Wideband CDMA): A 3G wireless communications standard evolved from CDMA. The standard, often called UMTS, uses wider 5 MHz channels (vs. 1.25 MHz for CDMA) for increased voice traffic capacity and peak data rates of 384 kbps and higher. WCDMA uses variable rate techniques in digital processing and it can achieve multi-rate transmissions.

WiMAX (Worldwide Interoperability for Microwave Access): WiMAX is a technology based on the IEEE 802.16 standard for a variety of wireless transmission links. WiMAX as utilized by Sprint and Clearwire provides for a high-speed mobile network, much like existing cellular technologies, but with reportedly higher speeds than current 3G technologies.