

WWAN TECHNOLOGY AND MARKET TRENDS



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1. 2G GSM technology - GPRS, EDGE

- **Technology development status:** mainly finalized, some vendors / carriers continue to do enhancements. The enhancements revolve around introduction of dual carrier with down/uplink maximum speed of 592 Kbps / 237 Kbps. Another enhancement is called EDGE-2 that supports up to 1.2 Mbps / 474 Kbps in down/up link direction. Example of a vendor who promotes this enhancement is Ericsson. At this time, there is no confirmation though about any carrier plan to implement these enhancements.

- **Typical throughput rates:**

Technology	Data rate (uplink)	Data rate (downlink)
GPRS	40 Kbps	60 Kbps
EDGE	59 Kbps	236 Kbps
Dual carrier EDGE	592 Kbps	237 Kbps
EDGE-2	1.2 Mbps	474 Kbps

- **Market statistics:** 79% worldwide market share with 2.1 billion connections globally in 2006; 70% market share by 2013 (Gartner & ABI). Global GSM subscriber growth is expected to slow from 22% year-over-year in 2006 and 2007 to 14% in 2008 and 2009. The slowdown will mainly be due to increased migration to UMTS 3G technologies, which experienced 83% growth year-over-year during 2006 and 2007. GSM subscriber figures will begin showing negative growth starting in 2013 as GSM becomes less attractive than cheaper 3G services.
- **Market trends:** Operators understand the need to ensure the best user experience for their customers. Most 3G/WCDMA mobile network operators rely on GSM/EDGE for service continuity (e.g. rural areas, urban in-building). This strategy ensures users receive a good experience of most 3G services; EDGE-delivered data services create a broadband-like experience, with lower CAPEX and OPEX for the operator. More than 35% of WCDMA devices launched also support EDGE. As virtually all WCDMA operators evolve to HSPA, the complementary fit of EDGE is evident; 118 of 198 commercial HSDPA networks (60.2%) also launched EDGE (GSA survey: May 18, 2008). The end-user performance with EDGE is good enough to make all existing services more attractive, e.g. e-mail, web browsing, music downloads, mobile TV. As HSPA network deployments expand globally and data speeds increase, HSPA is a key driver for EDGE Evolution.

2. 3G GSM/UMTS technology –WCDMA, HSDPA, HSUPA, HSPA+

- **Technology development status:** a number of operators continue to enhance existing 3GSM networks. For example, AT&T plan for completion of the nation's first High Speed Uplink Packet Access (HSUPA)-enabled network by the end of 2008. Telstra continue to enhance existing UMTS HSPA network to increase data rate to 1.4 Mbps / 1.9 Mbps downstream / upstream. Some Western European operators do enhancement of their networks to increase speed of HSPA.

- **Typical throughput rates:**

Technology	Data rate (uplink)	Data rate (downlink)
WCDMA	384 Kbps	384 Kbps
HSDPA	N/A	1.8, 3.6, 7.2, 14.4 Mbps
HSUPA	.73, 1.46, 2.93, 5.76, 11.5 Mbps	N/A
HSPA+	Up to 22 Mbps	Up to 42 Mbps

- **Market statistics:** 105 HSDPA networks launched in Europe; HSDPA now launched in all 27 EU member states. 125 HSDPA operators launched 3.6 Mbps; 45 launched 7.2 Mbps (peak) HSDPA. There are 166 HSDPA networks now available in more than 73 countries around the world.

HSPA rollout becomes widespread with the number of networks now offering commercial HSPA services jumped 44% between May 2007 and March 2008. There are now more than 467 HSPA-enabled devices available, including mobile handsets, notebook PCs, data cards, wireless routers and USB modems. UMTS takes 6.7% of the global market share with 200 million connections in 2007; 1.02 billion connections in 2011; market share of 24.7% in 2012 (Gartner)

- **Market trends:** HSPA has a sub-evolutionary path of its own - moving towards HSPA+ which can support data rates of up to 28.8Mbps - and there are signs that many operators intend to squeeze as much performance from their HSPA networks as they can before eventually biting the bullet and committing to LTE.

Some operators opt to delay releasing LTE for HSPA+, which will have many which many benefits similar to LTE. This is due to operators facing a dilemma, as their 3G licenses are just starting to show a return on investment, and the new technology may not justify the expense.

AT&T has installed High Speed Uplink Packet Access (HSUPA) in 275 markets across the US with an estimated 350 readied by year-end. Services using the sparkling new network are expected to reach consumers by mid 2008. AT&T has also pledged support for the Long Term Evolution (LTE) standard, which is due to be fully documented by the end of this year. Given the near-term investment in HSPA, it is unlikely that AT&T will throw that away and crank up LTE services quickly. The HSPA evolutionary path can enable LTE speeds in a similar amount of spectrum over the coming years.

The majority of 3G/UMTS i.e. WCDMA-HSPA systems deployments are in the 2100 MHz band, particularly in Europe, Asia Pacific, Middle East and Africa. Radio propagation path-loss at 900 MHz is much lower. Deployment of UMTS systems at this lower frequency band (UMTS 900) results in better coverage both in terms of extended coverage, as well as significantly improved indoor coverage, at much lower cost. For the same service offering and coverage, the number of base station sites in the 900 MHz band can be reduced by 60% compared to that needed for 2100 MHz, and reduce rollout time. WCDMA-HSPA at 900 MHz can complement 2100 MHz deployments by improving coverage, reducing CAPEX, improving Quality of Service and the user experience. 3G UMTS 900 systems have entered commercial service, in Estonia, Finland and Thailand. Several more UMTS 900 networks are in deployment, planned or under consideration in Australia, Finland, France, Germany, Greece, Iceland, New Zealand, Portugal, Singapore, Spain, Switzerland, and the UK.

3. 3G CDMA technology - EVDO 1xRel.0, EVDO Rel.A, EVDO Rel.B

- **Technology development:** 2007 was a critical year for CDMA as the number of CDMA2000 1xEV-DO Revision A (Rev. A) deployments increased significantly. At the beginning of the year, only three operators had deployed Rev. A technology. By the end of 2007, 26 operators worldwide have upgraded to Rev. A and another 31 operators are in the process of upgrading. At this time there is not a single EVDO Rel.B network commercially available yet.

- **Typical throughput rates:**

Technology	Data rate (uplink)	Data rate (downlink)
EVDO 1xRel.0	.15 Mbps	2.45 Mbps
EVDO Rel.A	1.8 Mbps	3.1 Mbps
EVDO Rel.B	3.6 Mbps	9.6 Mbps

- **Market statistics:** 12% of the global market share with 394 million connections in 2007; market share of 10% with 479 million connections in 2011 (Gartner)
- **Market trends:** One of the largest CDMA carriers in US, Verizon recently confirmed its intention to use LTE for its next generation instead of UMB (4G standard of CDMA technology). It was noted though that CDMA based network / services will continue to be supported by Verizon for many years after LTE implementation. At this time, Telstra finally shut down its CDMA network in favor of a new built UMTS one.

Telus is considering a switch from its CDMA to the rival GSM technology. The move is thought to be mainly to secure an increasing share of international roaming revenues and expand the company's handset offering. China Telecom has announced its decision to abandon CDMA for LTE in 2-3 years. It is to be seen, if this carrier wants to continue using CDMA as a complementary to LTE technology similar to what Verizon has decided to do. US CDMA operator Sprint has abandoned UMB in favor of mobile WiMAX.

There are also, a number of CDMA carriers are building (or have already built) UMTS/HSDPA overlays for their networks: KTF Korea, SKT Korea, Telecom New Zealand, Pelephone Israel, Zapp Romania.

4. 3/4G technology - WiMAX (802.16e) / WiMAX II (802.16m)

- **Technology development:** 802.16e mobile standard was ratified in 2005; 802.16m is the next generation standard beyond 802.16e-2005 and will become of WiMAX once the standard is completed in the 2009 time frame. Motorola remains the leader in equipment deployed for both WiMAX CPE and Base Stations.

- **Typical throughput rates:**

Technology	Data rate (uplink)	Data rate (downlink)
WiMAX (802.16e)	6.4 Mbps	9.5 Mbps
WiMAX II (802.16m)	=>130 Mbps	=>130 Mbps

- **Market statistics:** 0.8 million subscribers in 2007; 134 million users globally by 2012 (WiMAX forum); By 2011, fewer than 10 international mobile operators will deploy today's WiMAX standard as their primary wireless broadband strategy (Gartner)
- **Market trends:** It is important to note that, despite all the hype, the current WiMAX 802.16e standard does not offer any great advantages over the evolved 3G standards HSPA and EV-DO. The advantage of WiMAX 802.16e is that it becomes commercially available in 2008 with certified equipment. Furthermore, Intel's investment in installing chips in laptops makes the standard appealing.

However, one of the biggest technical concerns of WiMAX is if the next version, 802.16m, will be backward-compatible to 802.16e. If 802.16m is backward-compatible, today's 802.16e version can be supported with the same devices/laptops and the same radio access infrastructure (likely to be a software upgrade only). It is likely that WiMAX deployment will be limited in mature cellular markets; however, it may have a more-important role to play in countries where there is no fixed broadband alternative, for example in Vietnam and India. The Indian government expects the rollout of WiMAX and

3G networks to start by January 2009; it has also set a target of 20 million broadband subscribers by 2010.

One of the largest and successful WiMAX deployments to date is Mobile WiMAX, called WiBRo in Korea. The total subscriber count was 106,000 in December 2007. One projection is that there will be 2.5 million users by 2011.

802.16d fixed WiMAX might well die in the trough of disillusionment and might be replaced by mobile WiMAX 802.16e in fixed installations, which will deliver greater economies of scale.

WiMAX in Europe will face big problem due to its high operating frequency of 3.5GHz, which will require more base stations and cause problems with in-building coverage, though the situation is improving with some 2.5GHz licences now being issued.

Handset / radio availability is another challenge. The estimation is that WiMAX handsets with comparable features to today's 3G handsets will become available only by 2011.

Sprint Nextel and Clearwire have pooled their WiMAX assets together to create an independent company with participation of Google, Comcast, Intel and few other players. The new Clearwire is targeting a network deployment that will cover between 120 million and 140 million people in the U.S. by the end of 2010.

The big driver for this network is that it be what Google wanted from the 700 MHz auction--a completely open network, capable of being used for any information from any source. Any device capable of WiMAX can be purchased in a store and added to the network quickly and easily.

There are multiple hurdles on the way to success of this venture though. One is network cost that is expected to be very high due to 2.5 GHz band use that will require over 65,000 sites to cover 75% of US population. Another problem is in terms of time to the market. Continuing delays with a network launch may result in WiMAX timetable advantage over LTE being not necessarily enough.

5. 4G technology - LTE

- **Technology development:** Standardization took place in January 2008. The standard is developed by the Third Generation Partnership Project (3GPP), the same standards body already responsible for the GSM, GPRS, UMTS and HSDPA standards. As for CPE development there has been an announcement by Qualcomm about LTE device chipsets scheduled to sample in Q2 09: MDM9200™ to support UMTS, HSPA+ and LTE; MDM9800™ to support EV-DO Rev. B, UMB, LTE; MDM9600™ to support UMTS, HSPA+, EV-DO Rev. B, UMB, LTE.

- **Typical throughput rates:**

Technology	Data rate (uplink)	Data rate (downlink)
LTE (20 MHz channel)	Up to 86 Mbps	Up to 326 Mbps

- **Market statistics:** 4.2 million in 2011 (ARCchart); Migration to LTE will be a slow evolution over the period 2010 to 2015 and beyond (3GSM). By 2013, the forecast number of global LTE subscribers is 68.9 million with European operators making up 28.8 million of this number followed by 21.5 million in Asia Pacific and 17.5 million in North America.
- **Market trends:** The user demand and business case for 4G are uncertain, although a recent survey of Gartner clients showed demand for gigabit-data-rate handsets. Antenna technologies, such as MIMO, imply physically larger devices; higher frequencies imply a

higher cell density and higher capital expenditure for a network. There may not be a global 4G standard, and many competing network technologies are already being labeled "4G," including WiMAX. There is competition from technologies such as Wi-Fi, WiMAX and LTE. Some of these challenges (such as cell density and capex) may be addressed by lower-cost network architectures using mesh principles.

According to the forecast by ARCchart the first LTE network will be rolled out in Japan in 2010, but subscriber numbers will not start to pick up until 2011, when European and North American operators begin to launch their networks.

Without doubt, the most ambitious operator in the LTE space is NTT DoCoMo which is looking to deploy by 2009. NTT DoCoMo's Super 3G technology is already being tested and the operator is working closely with infrastructure and handset vendors to ensure it meets its tight timeframes. The company is likely to leapfrog HSPA+, so it is vital it fills the technology vacuum as rapidly as possible. Most other operators are looking at 2010 or 2011 at the earliest, with many looking to upgrade their mobile networks with HSPA+.

Many operators – like Vodafone and Orange – will continue to adopt a dual strategy of deploying LTE in their developed markets and WiMAX in developing markets, where subscribers have less access to the Internet. Some commentators have also seen the move into WiMAX by some of the world biggest mobile operators as a political move to maintain pressure on the LTE vendors to accede to their demands.

Recent 700 MHz auction confirmed two major winners, AT&T and Verizon. With the spectrum in their pockets, it seems Verizon and AT&T are in a great place — with the new licenses, the companies will likely enhance their wireless networks to 4G, LTE. There is a distinct advantage of using low frequency band of 700 MHz due to better propagation characteristics and lower network rollout cost. This may make the overall business case more attractive.

A key hurdle on the path to LTE is the growing cost of IPR that has also handicapped 3G operators. Recently Alcatel-Lucent, Ericsson, NEC, NextWave Wireless, Nokia, Nokia Siemens Networks and Sony Ericsson Mobile Communications signed on a "mutual commitment to a framework for establishing predictable and more transparent maximum aggregate costs for licensing intellectual property rights that relate to LTE. This move has shown that they are determined to cap aggregate IPR costs for LTE at what they view as a sustainable level. It remains to be seen how technology developers react, but it will certainly be a key driver of the success (or lack thereof) of LTE.

Another hurdle for Europe is that today, 585 MHz of spectrum has been allocated, but the UMTS forum has forecasted that if everyone is to take advantage of 4G by 2020, another 1,200 to 1,700 MHz of frequency will need to be licensed. This is required in order to support 100 Mbps of throughput per customer. In case of USA availability of 700 MHz band is of big help, but still to get the amount of frequency needed, the industry expects to use the untapped 5 GHz spectrum, which will have "atrocious" coverage and require huge investments in terms of base stations.