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white paper

# HSPA, the undisputed choice for mobile broadband

Building on existing HSPA networks is the best way to establish mobile broadband that can be delivered to a global mass market everywhere.

ERICSSON

TAKING YOU FORWARD

# Introduction

The internet is a true global marketplace, where people can find the products and services they desire. It is also a global "town square," where people can meet, chat and blog. It is a world-wide library and information repository that is unprecedented in the history of mankind. The internet is our doctor, lawyer, banker, government official – providing us with a direct channel to government authorities, health services and local communities. It is becoming the entertainment channel of choice; offering us an unparalleled selection of music, TV, video and news at our fingertips.

The internet will continue to develop as *the* place for information, communication, interaction and media consumption.

However, to enjoy the complete benefits of the internet, people need a broadband connection. As a consequence, internet broadband connectivity has become one of the most widespread communications developments ever and the growth in demand for high-speed internet connections is set to continue. Currently there are over 700 million broadband users: by 2012 this figure is forecast to grow to over 1.8 billion, as illustrated in Figure 1.

Furthermore, in the not too distant future, people will be so dependent on their broadband internet connection that they will want it wherever they may be. This means broadband cannot be limited to only a fixed connection at a physical address. People will want broadband that connects them to their services all the time, whatever their device type or location.

There are several technologies competing to deliver commercial mobile broadband services. By far the most successful is HSPA, which has been commercially deployed by over 200 operators in more than 100 countries. By 2010, when the number of wireless broadband connections is estimated to reach more than 600 million, HSPA will be the technology behind over 70 percent of mobile broadband connections, as shown in Figure 2. HSPA is a state-of-the art technology that provides mobile and wireless broadband services for the vast majority of the market, with unsurpassed performance and economies of scale.

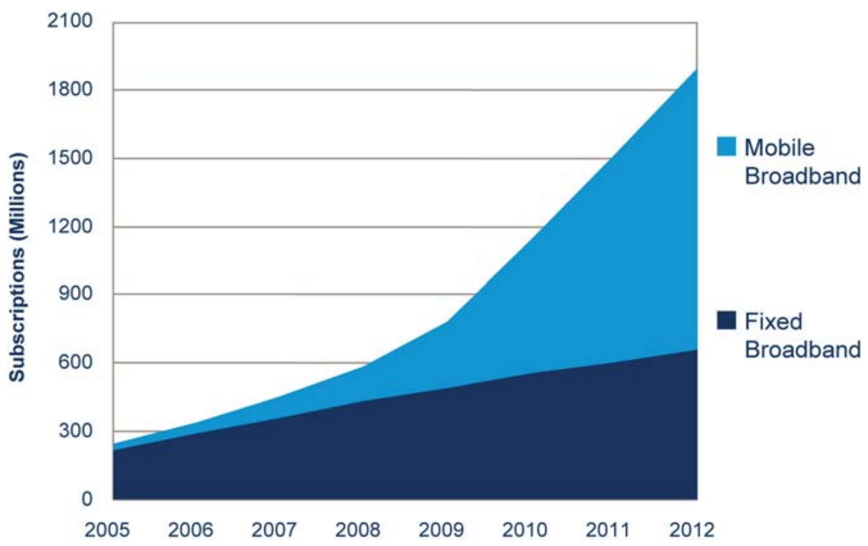



*Figure 1: Forecasted broadband growth based on reported subscriptions*

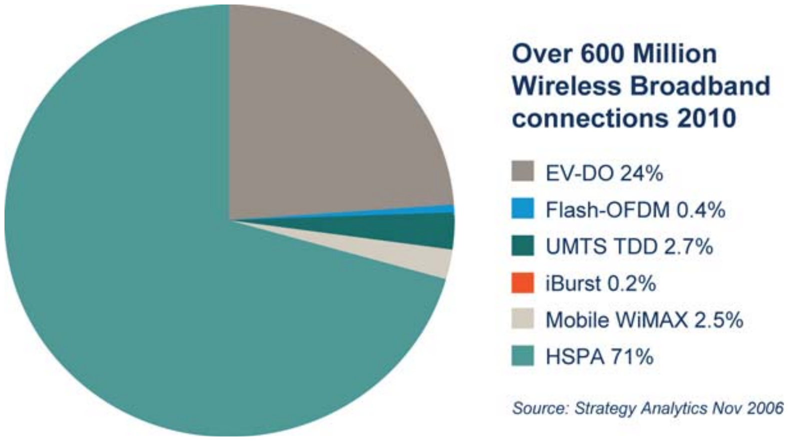



*Figure 2: Market share of various mobile broadband technologies*

## The market

Over the last 15 years, mobile communications have revolutionized how we stay in touch with each other – and broadband has connected the world in an unprecedented way. The market is set to continue its expansion thanks to broadband everywhere for individuals, enterprises and society as a whole.

Broadband access is already a natural part of many people's daily lives and an integral part of business, thanks to the convenience and benefits of "always on" high-speed internet access. Governments are keen to drive the expansion of broadband and many will continue to sponsor new initiatives, encouraging broadband's further penetration to boost national productivity, realize strategic advantages and close the "digital divide."

In an increasingly global economy, businesses are under intense pressure to perform. The need to control costs, boost productivity and enhance customer satisfaction has never been greater. New technologies are providing the solutions to meet these challenges. Telecoms is reshaping business models – and the boundaries between enterprise and carrier, wireline and wireless, voice and data are increasingly blurred. Mobilizing a business improves efficiency, creates more flexible working conditions and provides a competitive edge.

Person-to-person communication is being enriched in a number of ways, using images, text, sounds, video and voice in appealing combinations. As the distribution of content on physical media (for example, CDs, DVDs) continues to decline, content distribution over networks is growing quickly, which is having a profound effect on the market. Broadband connections are becoming the key interface for delivering and managing media, as well as for enjoying entertainment services such as TV, music and gaming.

Like many other new services that started in the fixed networks, broadband is migrating into the mobile world. Mobile broadband will be a larger part of this future broadband growth – helping to deliver the "broadband everywhere" vision.

# The global technology of choice

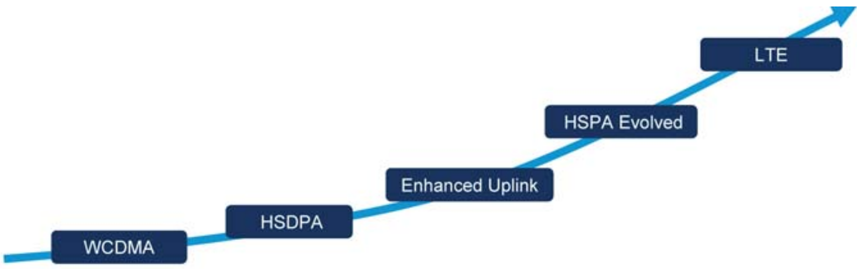
Meeting these challenges and the expectations of consumers requires cost-effective, proven and reliable solutions. Only one technology has the proven track record, economies of scale, global reach and innovation ecosystem to meet these needs: the GSM/WCDMA/HSPA family of standards.

The 3GPP family of standards has undergone continuous evolution and improvement since its introduction in 1991 – with a 1000-fold increase in peak data rates in the past few years, as shown in Figure 3. It is worth noting that consecutive releases of the 3GPP standard are always backward-compatible with previous releases.

The principal factor for industry success is economy of scale. There are currently 3.5 billion GSM/WCDMA mobile subscriptions worldwide. It is predicted that there will be around 5 billion mobile subscriptions worldwide by the end of 2011, and the vast majority of these subscribers will communicate via the 3GPP family of standards and include data connectivity in the form of EDGE and HSPA.

The unparalleled economies of scale for HSPA benefit all players in the ecosystem, making HSPA the natural choice not just for traditional mobile terminals, but also for personal consumer devices such as notebooks, ultra-mobile PCs, cameras, portable game consoles and music players.

The substantial production volumes drive down manufacturing costs and generate sales income that feeds back an unrivalled investment in research and development. This maintains the competitive advantage of the 3GPP family of standards as the technology of choice for mobile broadband.




| 3GPP | R99/1999 | R5/2002 | R6/2005 | R7/2007* | R8/2008** |
|---|---|---|---|---|---|
| Peak | 0.384 Mbps DL | 14 Mbps DL | 14 Mbps DL | 28/42 Mbps DL* | 160 Mbps DL |
| Data Rate | 0.064 Mbps UL | 0.384 Mbps UL | 6 Mbps UL | 12 Mbps UL | 50 Mbps UL |
| Commercial Availability | 2001 | 2005 | 2006 | 2008 | 2009 |

*Expected: 28Mbps with MIMO, 42 Mbps with MIMO + 64QAM
**Expected: LTE specification ready end 2007

*Figure 3: Evolution of the 3GPP family of standards*

# User devices

One of the key market trends is the shift of the PC from being an office or household device (desktop or laptop) to being a personal device (notebook or ultra-mobile PC) with a built-in mobile broadband connection.

Currently, the main built-in wireless connection for these devices is Wireless LAN (WiFi). However this usually tethers the end user to being within a few meters of a fixed broadband connection. The next generation of broadband consumers will want connectivity wherever they are, and this implies the need for a wide-area mobile broadband technology to be embedded in these devices (like the one shown in Figure 4).

The complexity and cost of including mobile broadband connectivity in consumer devices is comparable for all wide-area wireless technologies. However, low cost embedded modules are already available for HSPA and the global success of the GSM/WCDMA/HSPA family has created unmatchable volumes and economies of scale for HSPA.

Another advantage of using HSPA as the mobile broadband connection is the seamless service between GPRS, EDGE, WCDMA and HSPA – which provides unprecedented global service coverage. Mobile broadband enabled devices, with GSM/WCDMA/HSPA multi-access capability, ensure that the user is always connected to the best available service, and can seamlessly switch between them while on the move. With mobile broadband connectivity based on HSPA available worldwide, HSPA is the natural choice for personal devices like notebooks or ultra-mobile PCs.

The trend towards personal broadband is not limited to PCs. The latest generation of consumer devices – including cameras, music players, and portable games consoles – include Wireless LAN (WiFi) connectivity. It is inevitable that, in time, these devices will also require connectivity wherever they are, which will be globally and cost-effectively delivered by HSPA.

Personal broadband is about enabling internet access on consumer devices with the same user experience that a customer expects from a fixed broadband connection, but with the added flexibility of internet access anywhere. The volumes generated by sales of mobile terminals will ensure that HSPA technology reaches the price points necessary for inclusion in notebooks, ultra-mobile PCs and consumer devices such as games consoles and music players. Coupled with its multi-access capability and the world-wide availability of networks, HSPA is the natural technology choice for mobile broadband connectivity in all devices.


*Figure 4: Sony Vaio SZ ultra-portable notebook with HSPA connectivity and Samsung VLUUi70 digital camera, with built in HSPA connectivity*

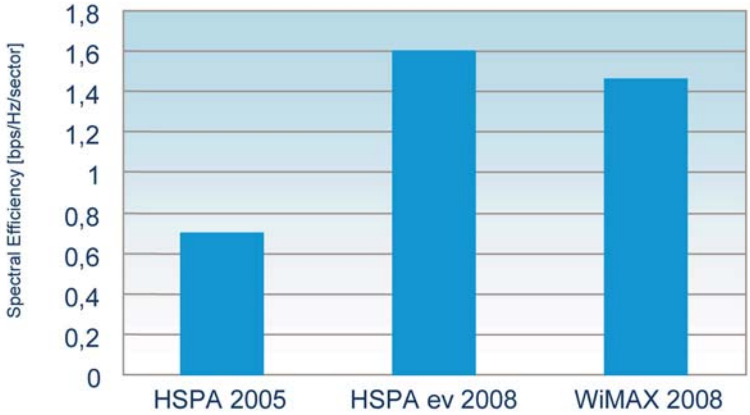
# HSPA and Mobile WiMAX

Comparing radio technologies is never a straightforward undertaking. Every technology has its own unique characteristics and implementation, which means an “apples-with-apples” comparison is not easy.

HSPA and Mobile WiMAX are designed for high-speed packet data services and share many similar technology enablers. However, there are differences that lead to variations in the uplink bit-rates, architecture and coverage they provide.

## Peak data rate and spectral efficiency

Theoretically, it is possible to calculate the upper limits of performance that HSPA and Mobile WiMAX can achieve. The key performance data for each technology is summarized in Figure 5.




| | **HSPA (2 x 5 MHz)** | | **WiMAX (10 MHz)** | |
|---|---|---|---|---|
| | HSPA | HSPA evolution | TDD (2:1) | TDD (1:1*) |
| Peak Data Rate (Mbps) DL | 14 | 42 | 40 | 32 |
| UL | 5.8 | 11 | 5.6 | 7.1 |

*1:1 ratio 50% of the time the channel is used for the uplink
50% of the time the channel is used for the downlink

*Source: Ericsson 2007*

*Figure 5: Overview of HSPA and Mobile WiMAX performance*

## Network architecture

The IEEE 802.16 standardization only covers basic connectivity up to Media Access Control (MAC) layer; the WiMAX Forum also addresses network architecture issues for WiMAX networks.

The first WiMAX Forum network reference architecture specification (release 1.0) is focused on delivering a wireless internet service, with mobility, as the first step (Figure 6). Release 1.5 will add support for telecom-grade mobile services, supporting full IMS interworking, carrier-grade VoIP, broadcast applications like mobile TV and over-the-air provisioning.

In comparison, 3GPP handles GSM and WCDMA standardization for a complete mobile system, including terminal aspects, radio access networks, core networks, and parts of the service network. 3GPP networks already support IMS-based services, carrier-grade voice, regulatory requirements like E911 and lawful intercept, broadcast applications like mobile TV and over-the-air provisioning for user terminals.

The overall complexity of the different network architectures is very similar – which is not surprising as the goal is to deliver the same functionality, as can be seen in Figure 7.

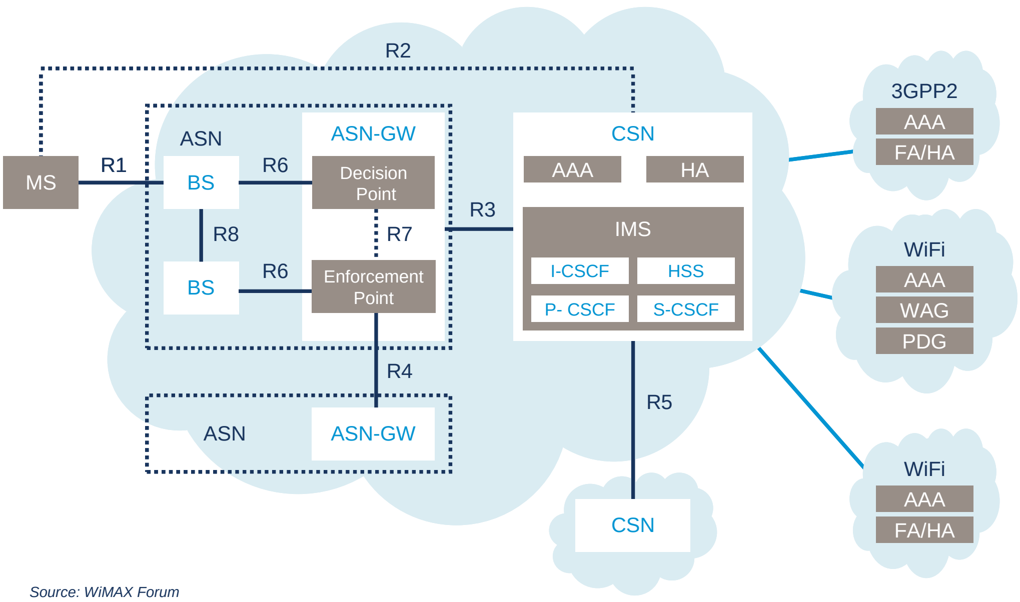



*Figure 6: Overview of WiMAX Forum network reference architecture*

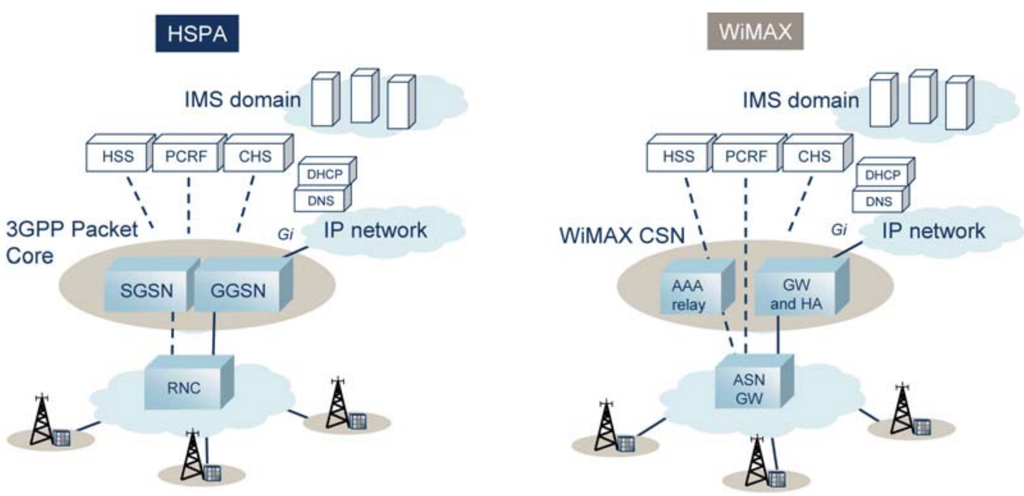



*Figure 7: Overview of network architecture for HSPA and Mobile WiMAX*

The major part of the core network investments (IMS, charging, AAA) is largely independent of radio access technology. To deliver the same services and fulfill the same regulatory requirements, the two network architectures are comparable. The differences in network architecture between HSPA and Mobile WiMAX are mainly in the details of how the functionality is split between the core network and radio network.

## Coverage

HSPA is a Frequency Division Duplex (FDD) technology, in which the uplink and downlink are in separate frequency channels (usually denoted as 2x5MHz). Mobile WiMAX is a Time Division Duplex (TDD) technology, in which there is just one frequency channel that is shared between the uplink and the downlink. The ratio between the uplink and the downlink defines how they share the frequency channel in time. A 1:1 ratio indicates time split 50/50 between the uplink and the downlink, as outlined in Figure 8.

One of the drawbacks of any TDD technology is discontinuous transmission and reception, which reduces the average power of a TDD system. As it is difficult to increase the output power of the terminals and the base stations, this translates into a need for more base station sites to deliver the same peak bandwidth (see Figure 9).

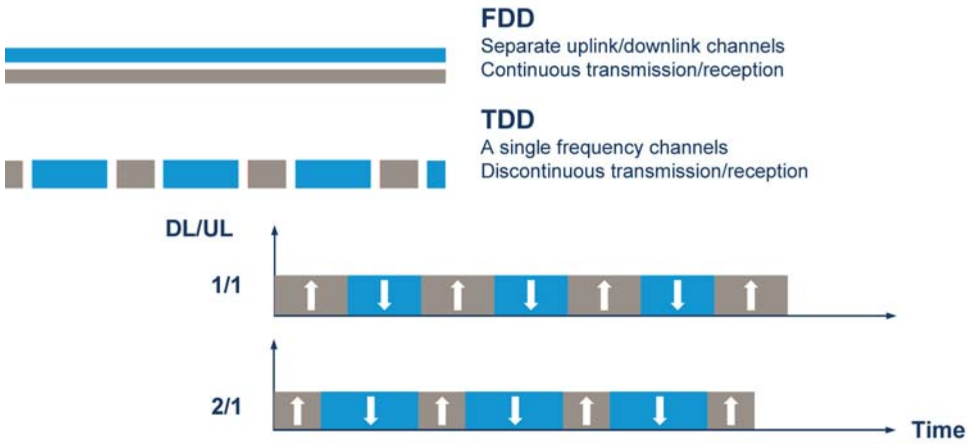



*Figure 8: Overview of FDD and TDD*

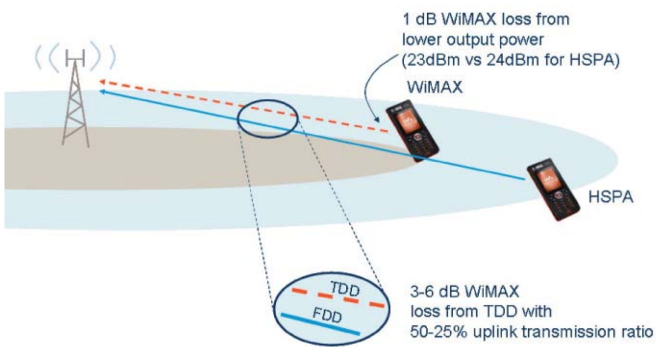
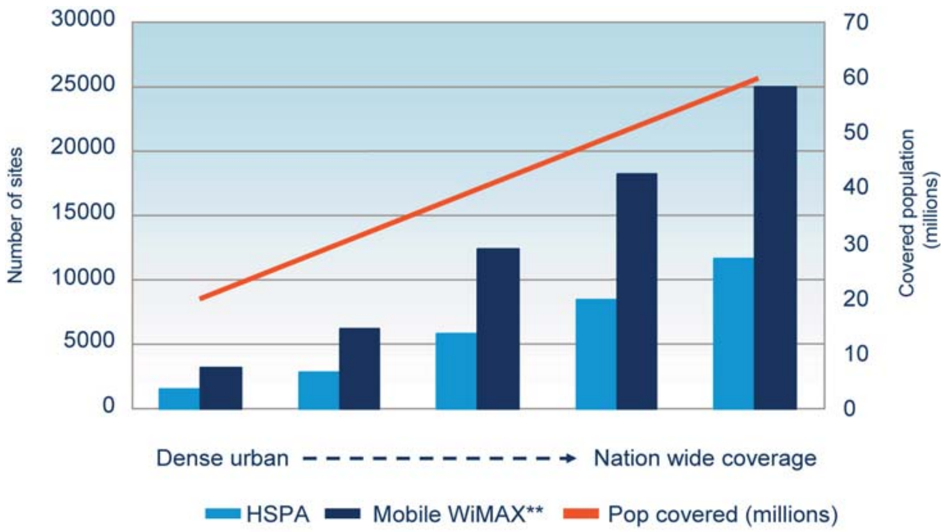



*Figure 9: Overview of the path loss of TDD and FDD*

Ericsson has performed radio network planning for a number of different cases. The number of sites needed to deliver capacity and coverage using the different frequencies and technologies for a real-life network in Asia is shown in Figure 10.

The performance of HSPA and Mobile WiMAX technologies is comparable: Mobile WiMAX does not offer any technology advantage over HSPA. Both technologies offer similar peak data rates, spectral efficiency and network complexity. However, Mobile WiMAX requires more sites to offer the same coverage and capacity as HPSA. This is an important conclusion when calculating the total cost of ownership for a radio access network.




** HSPA using 2.1 GHz band; Mobile WiMAX using 2.6 GHz band*
***Estimated performance*

*Figure 10: Example deployment for HSPA and Mobile WiMAX*

# Total Cost of Ownership

When calculating the Total Cost of Ownership (TCO) for a radio access network, it is the site costs that dominate. The costs for a typical base station site is split 20 percent for the base station itself and 80 percent for the rent, power, transmission, civil works and so on, whichever radio technology is used. In other words, if the total cost for a site is 100 units, 20 units relates to equipment cost and 80 units to the site costs, which remains the same for all technologies.

All other things being equal – the same power output, frequency and capacity – Mobile WiMAX requires at least 1.7 times more sites than HSPA for the same coverage area, because of the lower average uplink power for TDD terminals[1]. Even if the Mobile WiMAX base station itself cost nothing, the cost for coverage using the two technologies would be:

HSPA coverage = 100 sites * 100 = 10,000

Mobile WiMAX coverage = 170 sites * 80 = 13,600

The actual cost of the base station equipment is only a fraction of the operator's TCO for the whole network (as illustrated in Figure 11). Overall, the radio access network costs (and therefore the total network costs) are very dependent on the number of radio sites. Power and premises costs dominate at radio sites, while transmission costs vary dramatically with topography, network structure and market pricing. The TCO for the radio access network is significantly larger than the TCO for the core and service layer networks. The distribution between CAPEX (yearly depreciation) and OPEX is roughly 50/50. Product quality-related costs are a significant factor.

Overall HSPA requires fewer sites than Mobile WiMAX – leading to a radio access network with much lower TCO.

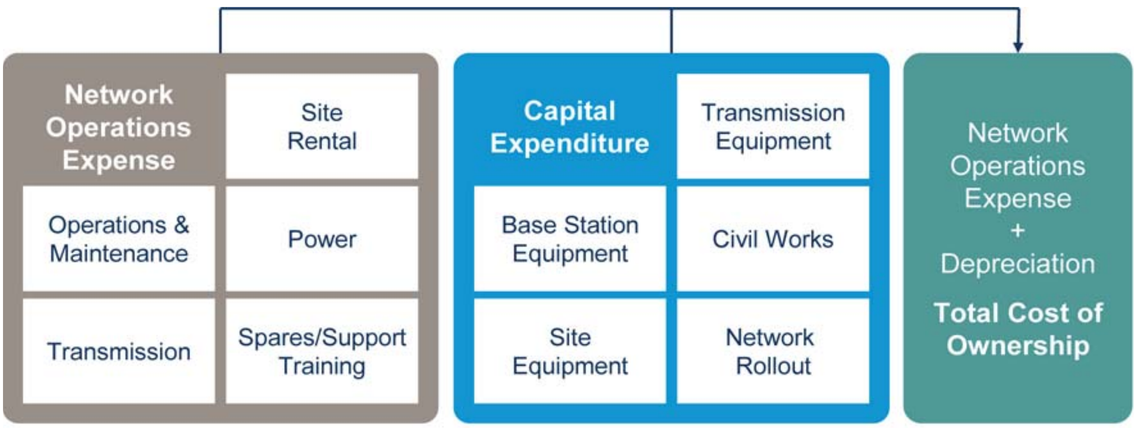



*Figure 11: Overview of the total cost of ownership model*

[1]*Ericsson estimates 2007*

# Intellectual Property Rights

While lower Intellectual Property Rights (IPR) costs are often cited as a benefit of Mobile WiMAX, there is unlikely to be much difference between the IPR costs for Mobile WiMAX and HSPA.

Members of standardization bodies such as ETSI or IEEE voluntarily commit to license essential patents they hold on fair, reasonable and non-discriminatory terms (known as FRAND or RAND). In practice, this means there are reasonable accumulated IPR costs for any new player entering the market, where the contributors to the standards are compensated in proportion to their patent portfolio.

The main players in the HSPA vendor space have also invested heavily in the GSM and WCDMA standards. As the main patent holders for these technologies, these players can negotiate lower IPR costs for their sales and as a result pass on the savings to the operators. It is less clear which Mobile WiMAX players will win large market share, and their IPR costs will ultimately depend on the strength of their own patent portfolio.

IPR is not a differentiator between HSPA and Mobile WiMAX, because they both rely on the principle of FRAND. However, for Mobile WiMAX the situation regarding IPR costs is more uncertain compared to HSPA as the market share of the major patent holders is currently not clear.

# Regulatory aspects

Any regulatory framework determines the regulatory parameters for the telecom business for many years and should therefore be able to cope with market changes. Stable and predictable regulations are important prerequisites for the significant investments that are needed to deploy mobile broadband infrastructure and services.

The social and economic impact of services reliant on radio spectrum is significant. These services not only benefit the general economy through reduced transaction costs and improved access to commercial and social services, but also provide personal security and enhance quality of life.

These benefits primarily arise from providing interoperable and low-cost ubiquitous access to the services across the whole population. This demands equipment and service standardization and access to globally and locally harmonized spectrum with interference protection.

Harmonized spectrum arrangements and coordinated regulatory conditions are the cornerstones of efficient spectrum use. Protection and coexistence criteria are crucial for a successful regulatory framework. This means the regulatory conditions need to be coordinated in recognized international forums and aligned with the global market to ensure economy of scale.

Some caution is called for when allocating and licensing radio spectrum, which is a valuable commercial resource. When harmonized, spectrum can contribute significantly to the socio-economic well-being of society. Over the past 15 years, GSM and UMTS/IMT-2000 have contributed significantly to improvements in society.

A 2006 study by Booz-Allen-Hamilton shows that pursuing “flexibility” would actually reduce the consumer benefits of wide-area roaming systems like GSM and UMTS/IMT-2000.

All forecasts predict continuing traffic growth in GSM and UMTS/IMT-2000 with mobile traffic to grow tenfold by 2012[2]. Voice traffic will continue to increase, but information-based services are expected to increase even faster, and match voice traffic by 2010. This suggests a need for substantial new spectrum resources and for efficient and flexible spectrum management.

A policy that enables any technology to be used for mobile broadband risks creating fragmented spectrum and markets. Although no technology should be discriminated against, the benefits of standardization should be preserved. Preserving the value of spectrum and ensuring its efficient use means having clear regulatory conditions – licensed spectrum with well-specified conditions – that eliminate the risk of harmful interference in the frequency bands identified for public mobile communications.

The CEPT/CEE decision and the ITU and CITEL recommendations should be implemented for the allocation of 2x70MHz (FDD) and 1x50MHz (FDD or TDD) in the 2.50-2.69GHz band. Regulatory measures must protect the existing FDD allocations in order to maximize spectrum efficiency, facilitate international roaming and benefits from economies of scale, and minimize spectrum wastage in the form of guard bands. See Figure 12.

[2] *Ericsson Capital Markets Day, May 9, 2007, Stockholm*

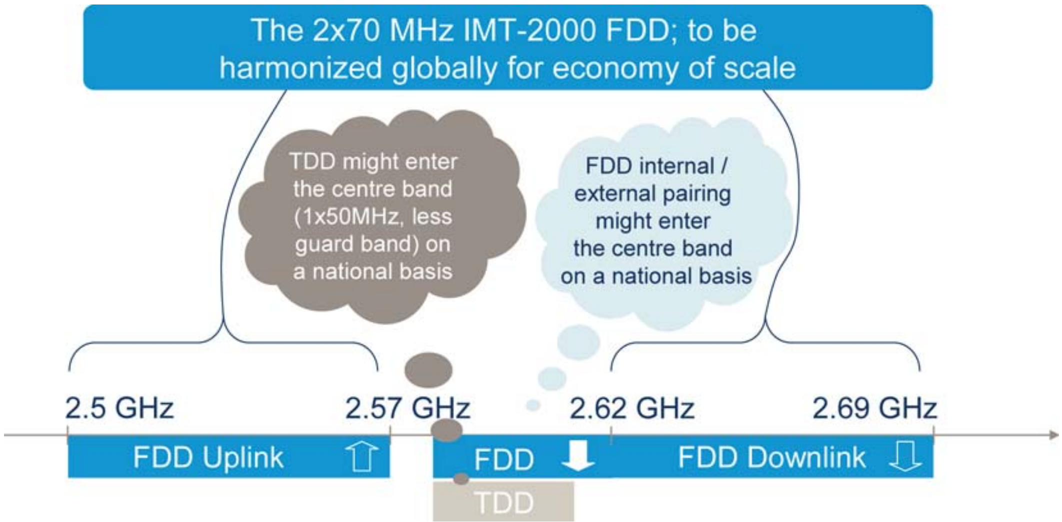



*Figure 12: Overview of the ITU-R recommendation for 2.5-2.69GHz band*

# 3GPP evolution

HSPA is at least four years ahead of other mobile broadband technologies. It supports the delivery of mobile broadband and fixed wireless broadband services in any of the mobile spectrum bands (850MHz, 900MHz, 1800MHz, 1900MHz, 2.1GHz and 2.6GHz).

However, HSPA is only one step in the evolution of mobile broadband. Delivering peak rates of 14Mbps in the downlink and 5.8Mbps in the uplink today, its evolution adds support for MIMO and 64QAM that will deliver 42Mbps in the downlink and 11.5Mbps in the uplink. In parallel, LTE will deliver further enhancements in peak rates (exceeding 100Mbps), in addition to scalable channel bandwidths using OFDMA with both TDD and FDD operation. LTE and HSPA-evolved offer maximum spectrum flexibility while delivering true high-speed, high-quality 4G performance.

Delivering mobile and wireless broadband services not only places demands on the radio interface, but on the entire network to be able deliver low-latency, jitter-free, high-bandwidth multimedia services – with the quality of service and in-service performance that users expect from a public telecom network. Therefore, 3GPP's focus is not only on specifying the radio interface, but also on the requirements, interfaces and architecture for the end-to-end network.

The next step in the architecture evolution specified together with LTE in 3GPP – the System Architecture Evolution (SAE) – will deliver optimized, flat two-node architecture for an optimized payload path, simplified QoS, excellent scalability and cost-efficient deployment for the delivery of IP services.

Further, for operators evolving to LTE/SAE from GSM/WCDMA/HSPA, this approach will maintain full backward compatibility with legacy networks. The SAE architecture has also been considered for non-3GPP access technologies.

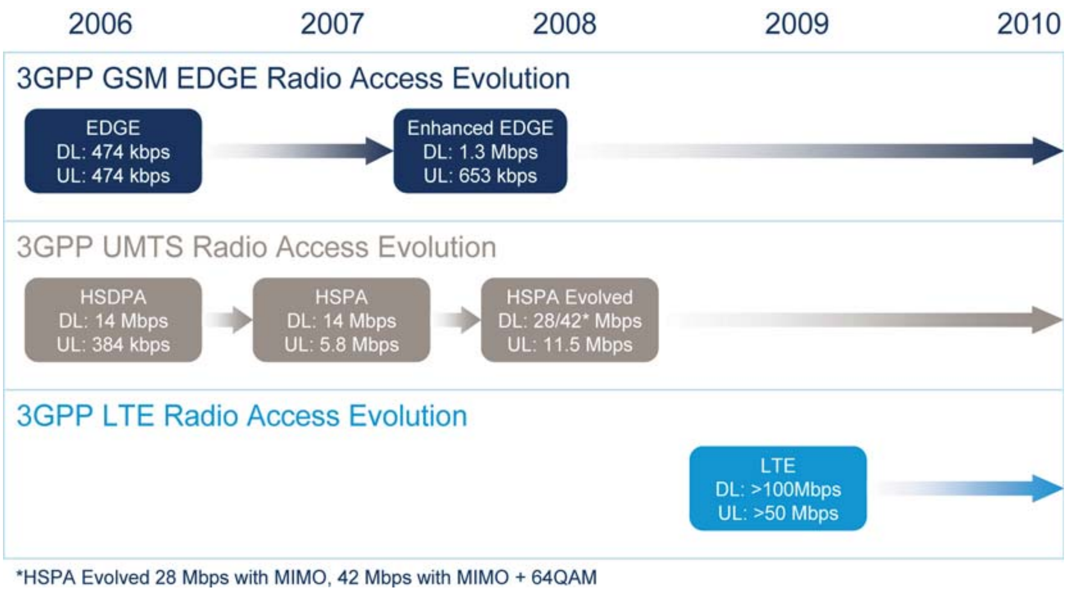



*Figure 13: Evolution of 3GPP radio technologies*

In just 10 years, the 3GSM technology track (GSM/WCDMA/HSPA) has provided a 1,000-fold increase in the data bit-rate, while maintaining full backward compatibility with the very first mobile phones released on the market. 3GPP technologies will continue to evolve and enhance its capability, with a clear roadmap of reaching 42Mbps with HSPA Evolved and exceeding 100Mbps in the near future with LTE.

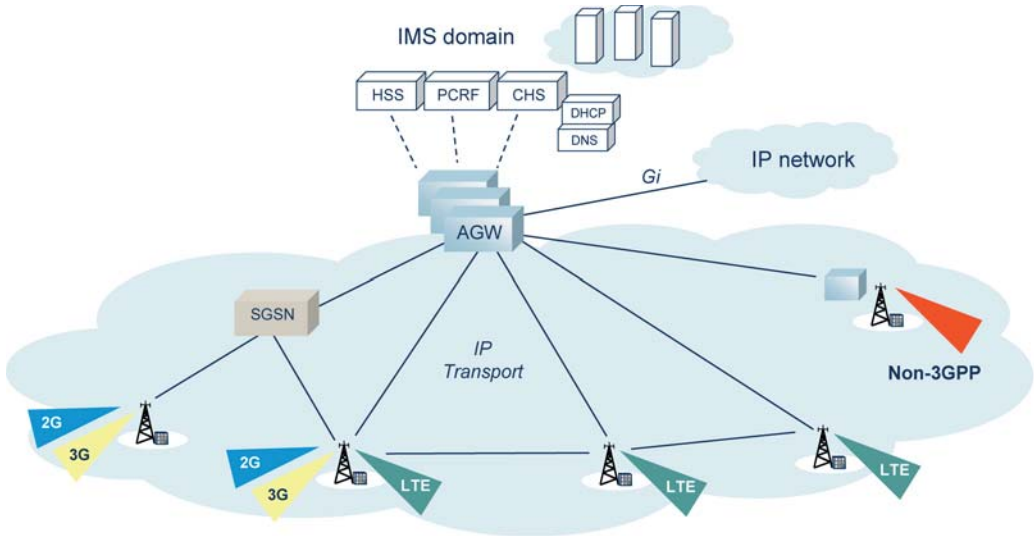



*Figure 14: Overview of Ericsson's System Architecture Evolution*

# Conclusion

HSPA is a proven mobile broadband technology that is already deployed in over 100 commercial networks. It is built on the firm foundation of the 3GPP family, offering the carrier-grade voice services users expect and the broadband speeds they desire. HSPA can be built out using the existing GSM radio network sites and is a software upgrade of the installed WCDMA networks. Together with dual-mode terminals, this ensures nationwide coverage both for voice (GSM/WCDMA) and data (HSPA/EDGE).

Thanks to its heritage, HSPA offers operators a single network for multiple services, with a sound business case built on revenues from voice, SMS, MMS, roaming customers and mobile broadband.

For operators, technology choices made now will influence operations for many years to come. 3GSM technologies are the future-proof choice – from an initial investment standpoint, economies of scale and the ability to extend and continuously enhance the solution.

HSPA is the clear and undisputed choice for mobile broadband services.

# Glossary

| | |
|---|---|
| **3G (third generation)** | Radio technology for wireless networks, telephones and other devices. Narrowband digital radio is the second generation of technology. |
| **3GPP** | 3rd Generation Partnership Project – 3GPP a collaboration agreement that brings together a number of telecommunications standards bodies |
| **3G LTE / SAE** | 3G Long-Term Evolution / System Architecture Evolution |
| **AAA** | authentication, authorization and accounting |
| **AGW** | Application Gateway |
| **ASN** | Autonomous System Number |
| **CEPT** | European Conference of Postal and Telecommunications Administrations |
| **CITEL** | Inter-American Telecommunication Commission |
| **CSCF** | Call Session Control Function |
| **CSN** | Connectivity Service Network |
| **DHCP** | Dynamic Host Configuration Protocol |
| **DNS** | Domain Name System |
| **DSL** | digital subscriber line |
| **EDGE** | Enhanced Data rates for GSM Evolution |
| **ETSI** | European Telecom Standards Institute |
| **EV-DO** | Evolution Data Optimized |
| **FDD** | frequency division duplexing |
| **FRAND** | Fair, Reasonable and Non-discriminatory |
| **GGSN** | Gateway GPRS Support Node |
| **GSM** | Global System for Mobile communications |
| **GPRS** | General Packet Radio Service |
| **GW** | gateway |
| **HSPA** | High Speed Packet Access – a extension of WCDMA to provide high bandwidth and enhanced support for interactive, background and streaming services |
| **HSS** | Home Subscriber Server |
| **IEEE** | Institute of Electrical and Electronics Engineers |
| **IMS** | IP Multimedia Subsystem |
| **IPR** | intellectual property rights |
| **ITU** | International Telecommunication Union |
| **MAC** | Media Access Control |
| **MIMO** | multiple input and multiple output |

| | |
|---|---|
| OFDM | orthogonal frequency division multiplexing – a digital encoding and modulation technology used by 802.16 based product (WiMAX) as the air interface |
| PC | personal computer |
| PCRF | Policy and Charging Rules Function |
| PDG | Packet Data Gateway |
| RAND | reasonable and non-discriminatory |
| RNC | radio network controller |
| SGSN | Service GPRS Support Node |
| TCO | total cost of ownership |
| TDD | time division duplex |
| UMTS | Universal Mobile Telecommunications System |
| VoIP | Voice over Internet Protocol technology, also called IP telephony - enables users to transmit voice calls via the internet using packet-linked routes |
| WAG | WLAN Access Gateway |
| WCDMA | Wideband Code Division Multiple Access, WCDMA - a wideband spread spectrum 3G mobile telecommunication air interface |
| WiMAX | Worldwide Interoperability for Microwave Access, WiMAX - a standardsbased technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL |

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