Future Prospects for High Speed Mobile Internet Access

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Background

The Internet is truly one of the most awesome artifacts of the modern world, a communications medium that empowers and advances business, recreation and lifestyle. Internet presence and usage is becoming so ubiquitous that the United Nations is pushing for access to become a human right [2], in some countries such as Estonia and Finland this has already happened.

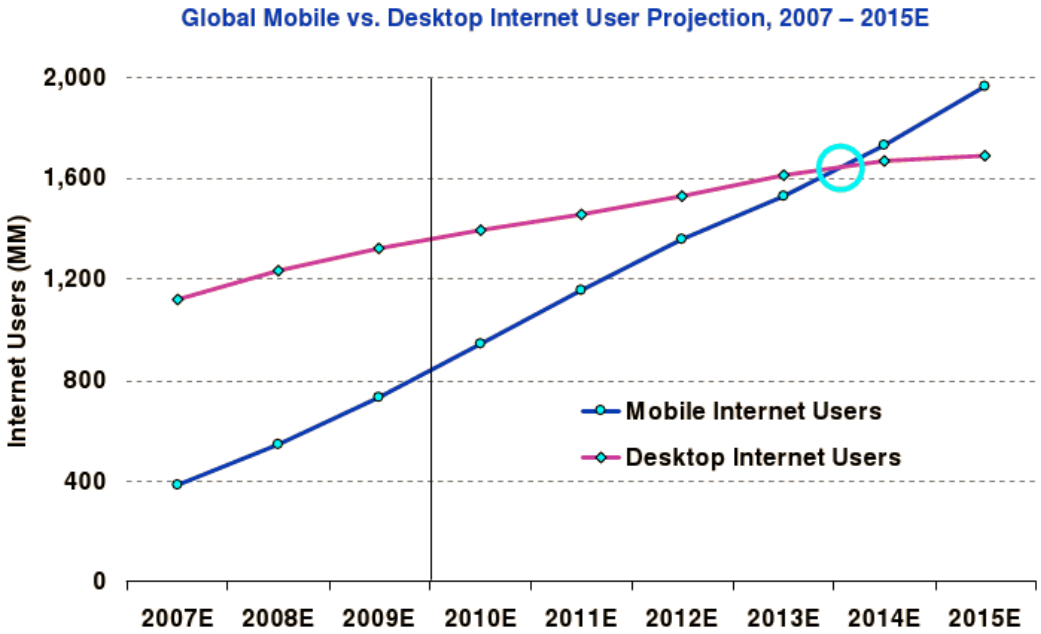

Figure 1: Chart illustrating the significant growth of mobile broadband. *Image Source: Morgan Stanley Research, Mary Meeker on Internet Trends, April 2010)*

Statistics released in April 2010 suggest the uptake of mobile broadband is greater than the uptake of desktop Internet access at its fastest rate of growth1. In recent years the development of consumer devices such as smart phones, handheld gaming consoles and similar electronic devices has led to popularity of mobile Internet access. Already it's possible to purchase pocket wireless access points ("Mi-Fi") or install smartphone applications that can share a 3G connection, enabling other devices to share a single portable connection, which indicates that we can expect to see a growth in mobile broadband requirements. These devices also provide a platform upon which many developers create Internet related applications, further contributing to increased usage of mobile Internet. Most modern devices also possess wireless Internet capability via Wi-Fi. Unfortunately due to the short range nature of Wi-Fi access points, users often desire a more readily available (more mobile) means of connectivity. Alternatively, some users may seek mobile broadband as an alternative to ineffective fixed line broadband based on old telephone infrastructure.

Common access used by these devices has involved a number of mediums and has developed in a generational fashion over the years, there are a number of mobile telephony standards that have been used such as TACS (1G), GSM (2G), GPRS (2G transitional), UMTS (3G) and the emerging HSPA (3G transitional), WiMAX (4G). This report looks at the prominent technologies on the horizon of consumer mobile broadband, how they differ and what is likely to emerge over the coming years.

The Last Mile

"The Last Mile" between an end user and their local telephone exchange is often considered one of the most expensive segments of a network due to the cost of replacing cables. Whilst wireless is usually considered to be a means of providing network access to mobile devices, wireless over the last mile may desirable for fixed connections in many scenarios. Delivery of Internet access in a wireless form could enable providers to improve services without the significant costs for installing fibre optic or similar infrastructure.

As technology advances hurdles become visible on the horizon, one consideration is that if telecoms companies were to deploy wireless infrastructure to the last mile it is likely they would wish to transition customers to Internet based telephony and remove the need for cable altogether. But there are legal and ethical requirements in place for voice communications; for example "five nines" (99.999%) availability - the idea that telephone service should never be out for more than 5.26 minutes a year. These are considerations that will need to be addressed as the long term consequences of such services is currently unclear.

Prominent Technologies

Internet users have expectations of service depending on their application, at their simplest, these expectations are immediate access with reasonable speed and functionality. Mobile users may tolerate slower speeds for email but expect omnipresent connectivity, whilst home users only require less coverage but may want a more responsive connection for video streaming. Some users may expect to be able to transfer vast amounts of data. Both technical factors can directly can affect how a consumer is served or more indirectly have financial concerns that ultimately impact upon consumers. These varying requirements leads to development of varying technologies with varying capabilities and drawbacks.

The three most important factors for a mobile Internet service are:

- Speed - is content delivered in a usable and reasonable time?
- Coverage - can users access the network within a reasonable area of coverage?
- Handover - can users easily move between regions of coverage?

One technical detail that is important to contrast between technologies is the media access control layer, as some technologies (ie. WiMAX) have a more extensive form of control than others, which can come at a performance cost.

High Speed Packet Access (HSPA)

HSPA describes the combination of two protocols - High Speed Downlink Packet Access and High Speed Uplink Packet Access. It is commercially available, commonly used in mobile telephony and can provide speeds of up to 14 MBit/s. HSPA is a robust technology geared towards mobile users. The media access control is Carrier Sense Multiple Access with Collision Avoidance (CSMA/CD), in essence the same means by which traditional ethernet devices share cable (although they are Collision Detecting) which is a proven and effective means of sharing the medium.

The use of HSPA is already widespread and is offered by many telecoms providers and supported by many devices.

Evolved HSPA (HSPA++) seeks to increase download speeds to 84 MBit/s and is designed to be low power to enable mobile devices to have an "always on" Internet connection. It is the next evolution of perhaps the most prominent mobile Internet protocol and so should be a big player in the near future. It is backwards compatible with existing HSPA devices which will make deployment of the new technology cheaper for providers as it can still be used by customers with older devices.

Long Term Evolution (LTE) Advanced

LTE Advanced is a tree representing the latest development of the 3G transitional LTE standard which was the basis of GSM and HSPA technologies and represents the cutting edge of mobile networking. The project is a part of the 3rd Generation Partnership Project; a collection of telecommunication entities [1, 12] and will eventually represent fourth generation (4G) wireless telecommunications, though it is currently described as pre-4G.

LTE is strongly geared towards the mobile user rather than just wireless, with support for fast handover between base stations, support for fast moving stations and low latency. The interface platform is e-UMTS which replaces HSDPA. Some commercial deployments have already been made, which improve significantly upon HSPA. LTE Advanced is expected to provide up to 100 Mbit/s for mobile users.

Worldwide interoperability for Microwave Access (WiMAX)

IEEE 802.16 is a working group to create a collection of standards specifying a wireless standard for metropolitan area networks, chief among them is 802.16e "Mobile Broadband Wireless Access System".

It is sometimes mistakenly thought that WiMAX is an enhanced version of Wi-Fi, but the 802.11 and 802.16 are fundamentally different from their medium access control (data link layer). 802.16 specifies superior quality of service (QoS) and is designed for control and centralisation [10]. Superior QoS is achieved through the media access control which involves the allocation of access slots to clients, the time of these access slots can be modified based upon various criteria. Rather than use CSMA/CD like Wi-FI, WiMAX uses a connection based control [6] that may suffer from scalability issues. WiMAX and Wi-Fi provide similar but non-competing services.

WiMAX is being heavily encouraged by many as a medium for the last mile (that is the connection between an end user and their nearest exchange) [4]. Current performance puts WiMAX at 40 Mbit/s with the upcoming 802.16m revision promising around 1GB/s. Depending on environment and conditions, the technology can be effective up to approximately 30 miles, although the quality of access may be significantly diminished after more than 10 miles from the base station.

In South Korea an 802.16e compatible service known as WiBro is available that demonstrates the effectiveness of the standard [8] for consumers, with successful performance and low usage costs.

Mobile phones supporting WiMAX are already on the market with popularity expected to increase. 802.16m defines an enhanced version of WiMAX, referred to as WiMAX 2 that promises even more capability. WiMAX MIMO (Multiple Input Multiple Output) has also been developed to enable enhanced performance.

Wi-Fi

Whilst it has a much shorter range, Wi-Fi is already a widespread technology for many applications and improved standards are being created by the IEEE 802.11 working group for WLAN of the IEEE LAN/MAN Committee [9]. Whilst Wi-Fi does not necessarily guarantee Internet access and standards are maintained by the Wireless Local Area Network group, it does provide the capability for such access, typically through a cabled connection. The current standard described in 802.11n operates at 150 MBit/s with an approximate range of 200 metres. As with HSPA, WiFi uses CSMA/CD for medium access. It meets a number of wireless needs but has not yet had a significant impact on the mobile market.

In the developed world, wireless access points are an increasingly common feature, much like the telephone, indeed, many telephony providers also provide broadband services with access points. Many users configure their devices to favour wireless networks over mobile Internet options, if within range of a suitable network the connection is often more reliable and may carry a lower service charge.

Community Based Access

It's not uncommon for WiFi to be provided by coffee shops, libraries, or even home users. Wireless access points may be configured for public use, allowing anyone to connect and access an available Internet connection.

FON Wireless Ltd. is a company based upon the sharing of Internet connectivity through consumer devices. Members of the FON community can configure their wireless device to act as a public access point, in return they receive the use of any other access point run by other users. Alternatively, non-members can pay a fee for short-term usage, which the access point owner will receive partial payment for. This service saw a drastic climb in usage after BT announced all BT Total Broadband routers were a part of the FON network, on an opt-out basis [3].

Unfortunately the success of community initiatives is highly variable and often does not provide contiguous regions of coverage [11]. BT's association with FON has less technically savvy (implicitly, less interested/aware) consumers contributing to the FON community, without further, similar from providers it is unlikely that such communities will ever become sufficient due to varying consumer attitudes and capabilities; people may have concerns about sharing their connection due to contention or abuse.

Mesh Wi-Fi

Wi-Fi can also be utilised to provide high speed mobile Internet access through wireless mesh networking. many wireless access pointers can operate to provide coverage over a much wider area. Mesh Wi-Fi has been employed in several municipal areas to provide Wi-Fi Internet access to an entire community. It goes beyond simple sharing of services through publicly accessible access points and seeks to provide Internet access as a traditional utility such as water. As Wi-Fi operates within an unlicensed band, the most significant costs are typically in the initial construction

of networks. Research has been carried out to improve Wi-Fi for mobile broadband purposes [5], but it is not yet comparable to truer mobile technologies.

Review

Unfortunately there are no suitable benchmarks for conclusively analysing the various technologies, which is not hard to imagine considering the wide variety of factors affecting performance.

Of the technologies presented, Wi-Fi is the only one that operates on unlicensed/publicly permitted radio bands. This allows for easy and inexpensive connectivity in contrast to the technologies using licensed portions of the radio spectrum. Unfortunately, despite its popularity and end user capability, Wi-Fi has been slow to evolve and tasks such as handover between cells and contention is awkward. Were these problems effectively address municipal Wi-Fi might be a more appropriate means of enabling mobile Internet. Because of its high data rates, popularity and potentially free usage, it would be good to see changes to Wi-Fi enabling more contiguous zones with access point crossover that would be feasible for mobile use.

It looks like the most significant competition is between HSPA and WiMAX. Although WiMAX's decision for connection-based access control offers more flexibility it may put significantly increased load on access points, which HSPA's CSMA/CA mechanism does not. One last major consideration is the already widespread use of HSPA in much of the world; whilst WiMAX offers richer features it simply isn't being used as much.

My personal feeling is that the popular HSPA and it's derived protocols (LTE, HSPA++) will continue to gain in popularity due to the number of devices that already support it. WiMAX may see some use in the last mile, but I don't think it is likely to be massively deployed for mobile communications and consumer devices. Further down the line I would expect to see competition between HSPA++ and the future LTE Advanced development. At the same time, Wi-Fi is likely to increase in presence and communities such as FON are likely to grow, enabling users to avoid 3G/4G wireless technology should they have reason.

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