A

Seminar report

On

3G vs. Wi-Fi

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

SUBMITTED TO:
www.studymafia.org

SUBMITTED BY:
www.studymafia.org

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

Preface

I have made this report file on the topic **3G vs. Wi-Fi**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Contents

1. ABSTRACTS

This article compares and contrasts two technologies for delivering broadband wireless Internet access services: ‘‘3G’’ vs. ‘‘Wi-Fi’’. The former, 3G, refers to the collection of third-generation mobile technologies that are designed to allow mobile operators to offer integrated data and voice services over mobile networks.

The latter, Wi-Fi, refers to the 802.11b wireless Ethernet standard that was designed to support wireless LANs. Although the two technologies reflect fundamentally different service, industry, and architectural design goals, origins, and philosophies, each has recently attracted a lot of attention as candidates for the dominant platform for providing broadband wireless access to the Internet.

It remains an open question as to the extent to which these two technologies are in competition or, perhaps, may be complementary. If they are viewed as in competition, then the triumph of one at the expense of the other would be likely to have profound implications for the evolution of the wireless Internet and structure of the service-provider industry.

Keywords: Internet; Broadband; Wireless; 3G; WLAN; Ethernet; Access; Spectrum; Economics; Industry structure

2. Introduction

The explosive parallel growth of internet and mobile telephony had a great impact on telecommunication over the past decade. Now, these two entirely different worlds are converging. The union of these two offers the benefit of the
Internet multimedia with the flexibility and mobility of wireless. To provide high speed internet connection without the restriction of boundaries is the main idea.

Third generation mobile technology was developed to achieve this goal. There is another wireless technology which was designed to provide connectivity to the portable devices for local area network which is known as Wi-Fi, had emerged in the last decade.

The goal of this report is to compare 3G and Wi-Fi technologies which are likely to play a role in this convergence. This report will focus on 3G which is IMT-2000 standard versus most popular and widely used wireless LAN standard IEEE 802.11b/g or Wi-Fi. These technologies which have an entirely different philosophy are used by this report as a reference to focus on how wireless internet access might evolve. Billions of pounds of investment have been made to obtain licenses and to purchase expensive equipment to support high speed data rates. Equipment manufacturers are developing base stations and handsets for large scale deployments for 3G services. On the other hand, Wi-Fi operates in the unlicensed ISM band which does not require huge amount of investment, at least to acquire licenses. Equipment is cheap as compared to 3G base stations. What it does require, is the deployment over a large scale.

This report will not discuss other technologies which are considered to important to provide wireless internet such as WiMAX, Satellite, DVB-S/DVB-RCS or other fixed wireless alternatives. However, this report will provide a brief introduction of mobile generations in the initial sections but detailed comparison of these generations such as 2.5G GPRS or EDGE is beyond the scope of this report. The focus will be on 3G and Wi-Fi (802.11b/g) as a point of discussion that have distinct origins and entirely different histories.

In focusing on 3G and WiFi, we are ignoring many other technologies that are likely to be important in the wireless Internet such as satellite services, LMDS, MMDS, or other fixed wireless alternatives. We also ignore technologies such as BlueTooth or HomeRF, which have at times been touted as potential rivals to WiFi, at least in home networking environments.

Moreover, we will not discuss the relationship between various transitional, or ‘‘2.5G’’ mobile technologies such as GPRS or EDGE, nor will we discuss the myriad possibilities for ‘‘4G’’ mobile technologies. While all of these are interesting, we have only limited space and our goal is to tease out what we believe are important themes/trends/forces shaping the industry structure for next-generation wireless services, rather than to focus on the technologies themselves.7 We use 3G and WiFi as shorthand for broad classes of related technologies that have two quite distinct industry origins and histories.

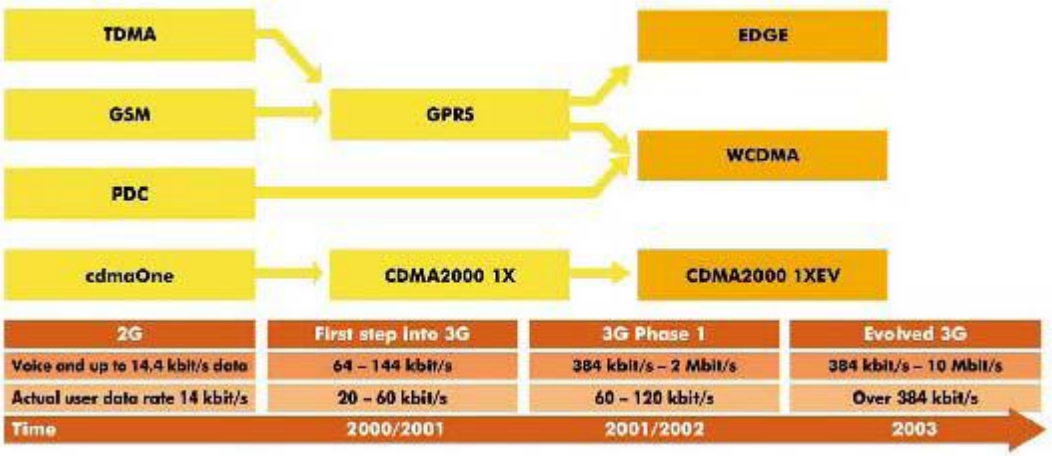


Fig. 1. Adopted from GSA (Global Mobile Suppliers Association), shows the evolution of mobile generations.

3. 3G

Third generation mobile phone technology was designed to provide mobile phone users access to anything, anywhere and anytime.
3G is a technology for mobile service providers. Mobile services are provided by service providers that own and operate their own wireless networks and sell mobile services to end-users, usually on a monthly subscription basis. Mobile service providers10 use licensed spectrum to provide wireless telephone coverage over some relatively large contiguous geographic serving area. Historically, this might have included a metropolitan area.

Today it may include the entire country. From a user perspective, the key feature of mobile service is that it offers (near) ubiquitous and continuous coverage. That is, a consumer can carry on a telephone conversation while driving along a highway at 100 km/h. To support this service, mobile operators maintain a network of interconnected and overlapping mobile base stations that hand-off calls as those customers move among adjacent cells. Each mobile base station may support users up to several kilometers away. The cell towers are connected to each other by a backhaul network that also provides interconnection to the wireline public switched telecommunications network (PSTN) and other services. The mobile system operator owns the end-to-end network from the base stations to the backhaul network to the point of interconnection to the PSTN (and, perhaps, parts thereof).
3G is an integration of fixed and mobile communication networks, internet and broadcasting,

For example; Television broadcasts can be seen using a mobile phone. This can only be achieved with the higher data rate.

The data rates supported by 3G are:

- 2Mbps (Indoors, Max. speed up-to 10 km/h)
- 384 Kbps (sub urban, Max. speed up-to 120 km/h)
- 144 Kbps (Rural, Max. speed up-to 500 km/h)

Development efforts were started in 1988 when International Telecommunications Union defined requirements for 3G. In 1992 World Administrative Radio Conference (WARC) defined frequencies for Future Public Land Mobile Communications which is now known as IMT- 2000. In June 1998, 10

satellites based and 5 terrestrial based radio interface solutions were submitted
to ITU. Finally three of them were selected, W-CDMA from Europe, cdma2000
from USA and TD-SCDMA from China. Ideally there should be only one standard
throughout the world as one of the reason behind the great success of GSM technology was that it was a single standard at least in Europe, “how good it would be if they carry on the same spirit throughout the world”[9].

In December 1998 third generation partnership project (3GPP) was established. 3GPP is an agreement of collaboration between a number of telecommunications bodies like Association of

Radio Industries Association (ARIB Japan), China Communications Standards Association (CCSA), Alliance for Telecommunications Industry Solutions (ATIS) and Telecommunication Technology Committee (TTC).

According to 3GPP,"The original scope of 3GPP was to produce globally applicable Technical Specifications and Technical Reports for a 3rd Generation Mobile System based on evolved GSM core networks and the radio access technologies that they support (i.e., Universal Terrestrial Radio Access (UTRA) both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes).

The scope was subsequently amended to include the maintenance and development of the Global System for Mobile communication (GSM) Technical Specifications and Technical Reports including evolved radio access technologies (e.g. General Packet Radio Service (GPRS) and Enhanced Data rates forGSM Evolution (EDGE))".
This is a very brief history of the great efforts which have been made to provide up-to 2 Mbps to a mobile device.

4. WI-FI

Wi-Fi is the popular name for the wireless Ethernet 802.11b standard for WLANs. Wire line local area networks (LANs) emerged in the early 1980s as a way to allow collections of PCs, terminals, and other distributed computing devices to share resources and peripherals such as printers, access servers, or shared storage devices. One of the most popular LAN technologies was Ethernet.

Over the years, the IEEE has approved a succession of Ethernet standards to support higher capacity LANs over a diverse array of media. The 802.11x family of Ethernet standards are for wireless LANs. Wi-Fi provides broadband to Wi-Fi enabled devices by using back haul Internet connection

Wi-Fi LAN operates in 2.4/5 GHz unlicensed ISM (Industrial, Scientific and Medical) band. The current generation of WLANs support up to 11 Mbps data rates within 100m of the base station. Discussion about all the standards related to 802.11 is beyond the scope of this report. Only 802.11 a/b/g are intended to be discussed. IEEE 802.11a operates in 5 GHz ISM band and can achieve up-to 54 Mbps data rate. IEEE 802.11b and 802.11g operates in 2.4 GHz ISM spectrum and can support data-rate up-to 11Mbps and 54Mbps respectively. IEEE 802.11g is also backward compatible with IEEE 802.11b, which means that devices based on 802.11b can connect to 802.11g and vise versa. 802.11g is the most popular due to dual mode operations and simplified RF design. 802.11a required much more complex and expensive RF circuitry to operate at 5 GHz Frequency and hence did not catch up.

In general Wi-Fi can provide a coverage up-to 10s of meters. Multiple base stations can be used in order to increase the range of coverage. Each area served by a particular base station is known as a Hot Spot.
There could be several hotspots in a building and hundreds of them in a city. Universities and a large number of corporations had deployed their hotspots to various locations such as Airports, Hotels, coffee shops and train stations all over Europe and America.

In the last 2 years, we have seen the emergence of a number of service providers that are offering WiFi services for a fee in selected local areas such as hotels, airport lounges, and coffee shops. In addition, there is a growing movement of so-called ‘‘FreeNets’’ where individuals or organizations are providing open access to subsidized WiFi networks.

Recently a UK based company named ‘The Cloud’ has announced city-wide Wi-Fi coverage in the nine major cities in the UK including London, Manchester and Birmingham. Wi-Fi has also reached to trains and coaches for example a US based company ‘WiRan’ is providing broadband

connection to the coach passengers using Wi-Fi and EDGE. Wi-Fi does not provide hand-offs between base stations. A user has to remain in the same cell in order to receive continuous service.

It is widely seen that Wi-Fi is used for data-services such as web-browsing, e-mail clients and file transfers. However, it is also possible to use wireless LANs to transport real time voice and video traffic as well, which enables Wi-Fi to support
Voice telephony services over Wireless LANs.

5. How are 3G and WI-FI same

It might appear that 3G and WiFi address completely different user needs in quite distinct, non-overlapping markets. While this was certainly more true about earlier generations of mobile services when compared with wired LANs or earlier versions of WLANs, it is increasingly not the case.
The end-user does not care what technology is used to support his service. What matters is that both of these technologies are providing platforms for wireless access to the Internet and other communication services.
The ways in which the two technologies may be thought of as similar,

5.1. **Both are wireless**

Both technologies are wireless, which

(1) avoids the need to install cable drops to each device when compared to wireline alternatives and

(2) facilitates mobility. Avoiding the need to install or reconfigure wired local distribution plant can represent a significant cost saving, whether it is within a building, home, or in the last -kilometre distribution plant of a wireline service provider.

Moreover, wireless facilities can provide scalable infrastructure when penetration will increase only slowly over time (e.g., when a new service is offered or in an overbuild scenario). New base stations are added as more users in the local area join the wireless network and cells are resized.
Wireless infrastructure may be deployed more rapidly than wireline alternatives to respond to new market opportunities or changing demand. These aspects of wireless may make it attractive as an overbuild competitor to wireline local access, which has large sunk/fixed costs that vary more with the homes passed than the actual level of subscribership. The high upfront cost of installing new wireline last-kilometer facilities is one of the reasons why these may be a natural monopoly, at least in many locations.

Wireless technologies also facilitate mobility. This includes both

(1) The ability to move devices around without having to move cables and furniture and
(2) The ability to stay continuously connected over wider serving areas.

We refer to the first as local mobility and this is one of the key advantages of WLANs over traditional wireline LANs.
The second type of mobility is one of the key advantages of mobile systems such as 3G. WLANs trade the range of coverage for higher bandwidth, making them more suitable for ‘‘local hot spot’’ service.

5.2. **Both are access technologies**

Both 3G and WiFi are access or edge-network technologies. This means they offer alternatives to the last-kilometer wireline network.
Beyond the last kilometer, both rely on similar network connections and transmission support infrastructure. For 3G, the wireless link is from the end user device to the cell base station which may be at a distance of up to a few kilometers, and then dedicated wireline facilities to interconnect base stations to the carrier’s backbone network and ultimately to the Internet cloud. The local backhaul infrastructure of the cell provider may be offered over facilities owned by the wireless provider (e.g., microwave links) or leased from the local wireline telephone service provider (i.e., usually the incumbent local exchange carrier or ILEC). Although 3G is conceived of as an end-to-end service, it is possible to view it as an access service.

For Wi-Fi, the wireless link is a hundred meters from the end-user device to the base station. The base station is then connected either into the wireline LAN or enterprise network infrastructure or to a wireline access line to a carrier’s backbone network and then eventually to the Internet. For example, Wi-Fi is increasingly finding application as a home LAN technology to enable sharing of DSL or cable modem residential broadband access services among multiple PCs in a home or to enable within-home mobility . Wi-Fi is generally viewed as an access technology, not as an end-to-end service.

Because both technologies are access technologies, we must always consider the role of backbone wireline providers that provide connectivity to the rest of the Internet and support transport within the core of the network. These wireline providers may also offer competing wireline access solutions.

For example, one could ask whether a local wireline telephone company might seek to offer WiFi access as a way to compete with a 3G provider; or a 3G provider might expand their offerings (including integrating WiFi) to compete more directly with a wireline service provider.

Finally, focusing on the access nature of 3G and WiFi allows us to abstract from the other elements of the value chain. Wireless services are part of an end-to-end value chain that includes, in its coarsest delineation at least
First the Internet back bone (the cloud);
the second kilometre network providers (wireline telephone, mobile, cable, or a NextGen carrier); and

the last kilometer access facilities (and, beyond them, the end-user devices). The backbone and the second kilometer may be wireless or wireline, but these are not principally a ‘‘wireless’’ challenge. It is in the last kilometer—the access network—that delivering mobility, bandwidth, and follow-meanywhere/ anytime services are most challenging.

5.3. Both offer broadband data service

Both 3G and WiFi support broadband data service, although as noted earlier, the data rate offered by WiFi (11 Mbps) is substantially higher than the couple of 100 kbps expected from 3G services. Although future generations of wireless mobile technology will support higher speeds, this will also be the case for WLANs, and neither will be likely to compete with wireline speeds (except over quite short distances).

The key is that both will offer sufficient bandwidth to support a comparable array of services, including real-time voice, data, and streaming media, that are not currently easily supported over narrowband wireline services. In this sense, both will support ‘‘broadband’’ where we define this as ‘‘faster than what we had before’’.

Both services will also support ‘‘always on’’ connectivity which is another very important aspect of broadband service. Indeed, some analysts believe this is even more important than the raw throughput supported.

6. How they are different

There are several of the important ways in which the Wi-Fi and 3G approaches to offering broadband wireless access services are substantively different.

6.1. Current business models/deployment are different

- 3G represents an extension of the mobile service-provider model. This is the technology of choice for upgrading existing mobile telephone services to expand capacity and add enhanced services.

  In contrast, Wi-Fi comes out of the data communications industry (LANs) which is a byproduct of the computer industry.

- The basic business model is the telecommunications services model in which service providers own and manage the infrastructure (including the spectrum) and sell service on that infrastructure.

  In contrast the basic business model is one of equipment makers who sell boxes to consumers. The services provided by the equipment are free to the equipment owners.

- With respect to deployment, 3G will require substantial investment in new infrastructure to upgrade existing 2G networks, however, when deployed by an existing mobile provider, much of the 2G infrastructure (e.g., towers and backhaul network) will remain useable. For WiFi, it is hoped that deployment can piggyback on the large existing base of WLAN equipment already in the field. In both cases, end-users will need to buy (or be subsidized) to purchase suitable interface devices (e.g., PC cards for 3G or WiFi access).

  In contrast to 3G, Wi-Fi wireless access can emerge in a decentralized, bottom–up fashion (although it is also possible for this to be centrally coordinated and driven by a wireline or mobile service provider). While the

  prevailing business model for 3G services and infrastructure is vertically integrated, this need not be the case for WiFi. This opens up the possibility of a more heterogeneous and complex industry value chain.

6.2 Spectrum policy and management

- One of the key distinctions between 3G and WiFi that we have only touched upon lightly thus far is that 3G and other mobile technologies use licensed spectrum, while WiFi uses unlicensed shared spectrum. This has important implications for
  (1) cost of service;
  (2) quality of service (QoS) and congestion management; and
  (3) industry structure.

- First, the upfront cost of acquiring a spectrum license represents a substantial share of the capital costs of deploying 3G services. This cost is not faced by Wi-Fi which uses the shared 2.4GHz unlicensed, shared spectrum. The cost of a spectrum license represents a substantial entry barrier that makes it less likely that 3G services (or other services requiring licensed spectrum) could emerge in a decentralized fashion.

  Of course, with increased flexibility in spectrum licensing rules and with the emergence of secondary markets that are being facilitated by these rules, it is possible that the upfront costs of obtaining a spectrum license could be shared to allow decentralized infrastructure deployment to proceed.

  Under the traditional licensing approach, the licensing of the spectrum, the construction of the network infrastructure, and the management/operation of the service were all undertaken by a single firm. Moreover, rigid licensing rules (motivated in part by interference concerns, but also in part, by interest group politics) limited the ability of spectrum license holders to flexibly innovate with respect to the technologies used, the services offered, or their mode of operation. In the face of rapid technical progress, changing supply and demand dynamics, this lack of flexibility increased the costs and reduced the efficiency of spectrum utilization.

- Second, while licensed spectrum is expensive, it does have the advantage of facilitating QoS management. With licensed spectrum, the licensee is protected from interference from other service providers. This means that the licensee can enforce centralized allocation of scarce frequencies to adopt the congestion management strategy that is most appropriate.

  In contrast, the unlicensed spectrum used by Wi-Fi imposes strict power limits on users (i.e., responsibility not to interfere with other users) and forces users to accept interference from others. This makes it easier for a 3G provider to market a service with a predictable level of service and to support delay-sensitive services such as real-time telephony.

  In contrast, while a Wi-Fi network can address the problem of congestion associated with users on the same Wi-Fi network, it cannot control potential interference from other Wi-Fi service providers or other RF sources that are sharing the unlicensed spectrum (both of which will appear as elevated background noise). This represents a serious challenge to supporting delay-sensitive services and to scaling service in the face of increasing competition from multiple and overlapping service provider.

- Third, the different spectrum regimes have direct implications for industry structure. For example, the FreeNet movement is not easily conceivable in the 3G world of licensed spectrum. Alternatively, it seems that the current licensing regime favors incumbency and, because it raises entry barriers, may make wireless-facilities-based competition less feasible.

6.3 Status of technology development different

The two technologies differ with respect to their stage of development in a number of ways. These are discussed in the following subsections.

6.3.1. **Deployment status**

- In most OECD countries, cell phone penetration of 2G services is quite high, and consumers have a choice among multiple facilities-based providers in most markets. Additionally, most of the 2G mobile service providers have announced plans to offer 3G broadband data services. Nevertheless, 3G services are emerging only slowly. There are a number of reasons for this, including the high costs of obtaining 3G licenses, the lack of 3G handsets, increased deployment cost expectations, and diminished prospects for short-term revenue.

  In contrast, we have a large installed base of Wi-Fi networking equipment that is growing rapidly as WiFi vendors have geared up to push wireless home networks using the technology. The large installed base of Wi-Fi provides substantial learning, scale, and scope economies to both the vendor community and end-users. The commoditization of Wi-Fi equipment has substantially lowered prices and simplified the installation and management of WiFi networks, making it feasible for non-technical home users to self-install these networks.

However, although there a large installed base of Wi-Fi equipment, there has been only limited progress in developing the business models and necessary technical and business infrastructure to support distributed service provisioning. In addition, many of the pioneers in offering wireless access services such as Mobilstar and Metricom went bankrupt in 2001 as a consequence of the general downturn in the telecom sector and the drying up of capital for infrastructure investment.

6.3.2. **Embedded support for services**

- Another important difference between 3G and WiFi is their embedded support for voice services. 3G was expressly designed as an upgrade technology for wireless voice telephony networks, so voice services are an intrinsic part of 3G. In contrast, WiFi provides a lower layer data communications service that can be used as the substrate on which to layer services such as voice telephony. For example, with IP running over WiFi it is possible to support voice-over-IP telephony. However, there is still great market uncertainty as to how voice services would be implemented and quality assured over WLAN networks.

- Another potential advantage of 3G over Wi-Fi is that 3G offers better support for secure/private communications than does Wi-Fi. However, this distinction may be more apparent than real.

First, we have only limited operational experience with how secure 3G communications are. Hackers are very ingenious and once 3G systems are operating, we will find holes that we were not previously aware of.

Second, the security lapses of Wi-Fi have attracted quite a bit of attention and substantial resources are being devoted to closing this gap. Although wireless communications may pose higher risks to privacy (e.g., follow-me anywhere tracking capabilities) and security (i.e., passive monitoring of RF transmissions is easier) than do wireline networks, we do not believe that this is likely to be a long-term differentiating factor between 3G and Wi-Fi technologies.

6.3.3. **Standardization**

- It is also possible to compare the two technologies with respect to the extent to which they are standardized. Broadly, it appears that the formal standards picture for 3G is perhaps more clear than for WLAN. For 3G, there is a relatively small family of internationally sanctioned standards, collectively referred to as IMT-2000.36 However, there is still uncertainty as to which of these (or even if multiple ones) will be selected by service providers.

  In contrast, Wi-Fi is one of the family of continuously evolving 802.11x wireless Ethernet standards, which is itself one of many WLAN technologies that are under development. Although it appears that Wi-Fi is emerging as the market winner, there is still a substantial base of HomeRF and other open standard and proprietary technologies that are installed and continue to be sold to support WLANs. Thus, it may appear that the standards picture for WLANs is less clear than for 3G, but the market pressure to select the 802.11x family of technologies appears much less ambiguous—at least today.

  Because ubiquitous WLAN access coverage would be constructed from the aggregation of many independent WLANs, there is perhaps a greater potential for the adoption of heterogeneous WLAN technologies than might be the case with 3G. With 3G, although competing service providers may adopt heterogeneous and incompatible versions of 3G, there is little risk that there will be incompatibilities within a carrier's own 3G network. Of course in the context of a mesh of WLANs, reliance on IP as the basic transport layer may reduce compatibility issues at the data networking level, although these could be significant at the air interface (i.e., RF level). Unless coordinated, this could be a significant impediment to realizing scale economies and network externality benefits in a bottom–up, decentralized deployment of Wi-Fi local access infrastructure.

6.3.4. Service/business model

- 3G is more developed than Wi-Fi as a business and service model. It represents an extension of the existing service-provider industry to new services, and as such, does not represent a radical departure from underlying industry structure. The key market uncertainties and portions of the valuation that remain undeveloped are the upstream equipment and application/content supplier markets and ultimate consumer demand.

In contrast, Wi-Fi is more developed with respect to the upstream supplier markets, at least with respect to WLAN equipment which has become commoditized. Moreover, consumer demand— certainly business demand and increasingly residential broadband home user demand—for WLAN equipment is also well established. However, commercialization of Wi-Fi services as a access service is still in its early stages with the emergence of Boingo and others.

Of course, both 3G and WiFi access face great supplier and demand uncertainty with respect to what the next killer applications will be and how these services may be used once a rich set of interactive, multimedia services become available.

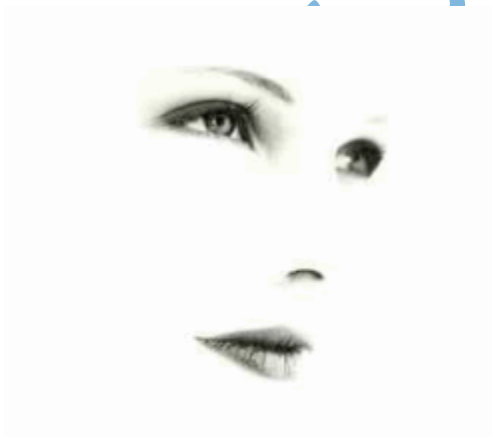
- There are also some form factor issues that may impact the way these services will be used. Initially, it seems likely that the first 3G end-user devices will be extensions of the cell phone while the first Wi-Fi end-user devices are PCs. Of course, there are also 3G PC cards to allow the PC to be used as an interface device for 3G services, and with the evolution of Internet appliances (post- PC devices), we should expect to see new types of devices connecting to both types of networks.

6.4 Other differences

1. 3G will work only your sim is in the phone, while WIFI can work with no sim in Wifi hotspots.

2. 3G is third generation mobile phone telephony, while wifi is a technology like Bluetooth which enable devices to interconnect with other.

3. 3G is telcos stuff run on 2100Mhz. As with telco it usually available in very wide area while, wifi is wireless computer network stuff intended mainly for laptops and computers and usually cover just 30-100m from the wifi hub.mainly run on 2400Mhz .



7. Some implications for industry structure and public policy

In this section we consider some of the implications that emerge from the preceding analysis, as well as offer some speculations on the possible implications for industry structure, competition, and public policy.

7.1. WiFi is good for competition

One implication that emerges from the above analysis is that the success of WiFi wireless local access alternatives is likely to be good for local competition.

- First, if only 3G survives, then it is less likely that we will see non-vertically integrated, decentralized service provisioning. And, the higher entry costs associated with acquiring licensed spectrum and the need to construct a geographically larger network to begin offering service will limit the number of firms that compete in the market. Of course, this does not mean that wireless access services would not be competitive—there may be more than enough competition among existing mobile providers to preclude the exercise of market power.

- Second, if both 3G and WiFi survive, then the diversity of viable networking infrastructure strategies will be conducive to greater facilities-based competition.

- Third, success of the WiFi service model could help unlock the substantial investment in private networking infrastructure that could be used as the basis for constructing an alternative infrastructure to the PSTN and cable wireline networks. As noted above, this will require adding the necessary business functionality and technical support to enable base station owners to bill for WiFi service. Once this is developed, the opportunity to create novel new ways to leverage the existing infrastructure investment will be increased.

- Fourth, if only the WiFi service model survives, then we would expect this to be inherently more competitive because of the lower entry barriers for setting up local access services. The use of unlicensed spectrum means that property rights over the spectrum cannot be used to exclude potential entrants, although congestion—if not appropriately managed—could be just as effective in limiting competition.

7.2 Wi-Fi and 3G can complement each other for a mobile Provide

Yet another alternative might be for WiFi to be integrated into 3G type networks. Actually, this seems like the most likely scenario since there are compelling reasons for why these two technologies may be used together.

Each of the technologies has distinct advantages over the other that would allow each to offer higher quality services under disparate conditions. Putting the two together would allow a service provider to offer a wider set of more valuable services.

The obvious adopter of such a strategy would be a mobile firm since it is easier for 3G to adopt WiFi and incorporate it into its networking strategy than for a WiFi facilities provider to go the other way. The reasons for this are several. First, there is the asymmetry in entry costs discussed earlier. Second, the natural ability of the 3G providers to implement bundled service offerings will make them more likely to be able to take advantage of a more complex infrastructure platform that will allow them to offer bundled services.

7.3. Spectrum policy is key

Obviously, spectrum policy has already had and will continue to play a critical role in how our wireless future evolves. One of the key distinguishing features between 3G and WiFi is the use of licensed versus unlicensed spectrum.

Continued progress towards creating secondary spectrum markets will benefit both 3G and WiFi models. For 3G, secondary markets would allow more flexible management of property rights. Secondary markets would allow spectrum to be reallocated more flexibly to higher value uses and could improve dynamic efficiency. For example, to balance localized supply and demand mismatches.
For WiFi, the emergence of spectrum markets may make it possible to adopt a suitable mechanism for addressing congestion issues. Of course, if implemented in the unlicensed band where WiFi currently operates, this would require additional policy changes to implement a market-based resource allocation process. The appropriate protocols and institutional framework for supporting such a market is an interesting topic for research. It may be easier to implement such a mechanism in a WLAN technology that could operate in a licensed band where there are clear property rights.

7.4. Success of Wi-Fi is potentially good for multimedia content
Multimedia content benefits from higher bandwidth services so the ability to support higher speed wireless access may help encourage the development of broadband multimedia content.

On the other hand, the lack of a clear business model for deploying broadband services over a WiFi network may raise concerns for how content would be paid for and/or digital rights management issues. The digital rights management issues are perhaps more difficult to control (from a content provider's perspective) in a more decentralized, end-user-centric environment than in a centralized service-provider network (i.e., contrast Napster to AOL). The vertical integration model of 3G may offer greater control, which might actually encourage more content production.

8. Conclusions

This article offers a qualitative comparison of two wireless technologies that could be viewed simultaneously as substitute and/or complementary paths for evolving to broadband wireless Traditional radios are based on dedicated hardware. By implementing the radio technology in software, it becomes feasible to design more flexible radios that may more readily support multiple protocols and may more easily be upgraded/modified to incorporate new protocols or other features. For additional information, The two technologies are 3G, which is the preferred upgrade path for mobile providers, and WiFi, one of the many WLAN technologies.

The goal of the analysis is to explore two divergent world views for the future of wireless access and to speculate on the likely success and possible interactions between the two technologies in the future.

While the analysis raises more questions than it answers, several preliminary conclusions appear warranted. First, both technologies are likely to succeed in the marketplace. This means that the wireless future will include heterogeneous access technologies so equipment manufacturers, service providers, end-users, and policy makers should not expect to see a simple wireless future.

Second, we expect 3G mobile providers to integrate Wi-Fi technology into their networks. Thus, we expect these technologies to be complementary in their most successful mass-market deployments.

Third, we also expect WiFi to offer competition to 3G providers because of the lower entry costs associated with establishing WiFi networks. This may take the form of new types of service providers (e.g., Boingo), in end-user organized networks (e.g., FreeNet aggregation or municipal networking), or as a low-cost strategy for a wireline carrier to add wireless services. The threat of such Wi-Fi competition is beneficial to prospects for the future of last kilometer competition, and will also encourage the adoption of Wi-Fi technology by 3G providers as a defensive response.

Our analysis also suggests a number of areas where further thought and research

would be beneficial. These include the obvious questions of how to integrate 3G and WiFi networks or how to add the appropriate billing/resource negotiation infrastructure to WiFi to allow it to become a wide-area service-provider platform. These also include several more remote questions such as which style of technology/business approach is favored by the rapid pace of wireless technology
innovation or which is more likely to favor the development of complementary assets such as broadband content.

9. **Bibliography**

1] K. Johansson, A. Furuskar, P. Karlsson, and J. Zander. "Relation between Base Station Characteristics and Cost Structure in Cellular Systems", paper submitted to IEEE PIMRC, 2004.
[2] K. Thompson. "Large Scale Deployment of Public Wireless LANs- a Feasibility Study", MSc Thesis, Royal Institute of Technology (KTH),

1. **http://www.3gpp.org**

2. **http://www.bbc.co.uk**

3. **http://entrepreneurs.about.com/od/businessideas/a/bizopps2005_3.htm**

4. **http://www.itu.int/itunews/issue/2003/06/thirdgeneration.html**

5. http://www.thecloud.net