

POTENTIAL SCENARIOS AND DRIVERS OF THE 4G EVOLUTION

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Abstract:

Nowadays, the mobile Internet communications can play a significant role in the Telecommunications Sector resolving certain issues and bottlenecks of the personal communications with most European countries close to 100% penetration and a global projection of 4 billion mobile users by 2011. As we are moving to the next generation, we are still lacking the precise definition of the architecture and the successful deployment path of the 4G technology. Several theories have been developed looking at different standards and aiming to select and develop the most promising one. In this paper we are introducing a study that aims to explain a new concept of “4G readiness” revealing long run national strategies for 4G deployment and suggesting some critical metrics that could indicate the future of this environment. We describe the methodology, scenarios and the expected results based on defined theories, historical observations and already developed criteria from other studies such as the E-readiness study.

Introduction

In a world of increasing technological needs, the mobile Internet can play a significant role resolving the user's capacity and connectivity needs. There is lots of research and suggestions around the 4G concept, where vendors and operators are trying to define it based on their preferred technology and strategic planning.

At the end of 2007, the total mobile subscribers were 3 billion, with GSM based users to grow over 2 billion. Several research reports are predicting that the WiMAX will commercially be deployed by 2009 and the LTE (Long Term Evolution) by 2015. However, the standards battle towards the 4G establishment is a major concern. ITU and IEEE are trying to secure a smooth transition into the new technology. (Figure 1)

There is no formal definition for 4G. It is a term used to describe the next step in wireless communication. Several terms are also describing the concept, such as “Super 3G” or “Next Generation Wireless”. ITU is committed to announce the 4G definition during 2008, but certainly we are looking for a new converged system that will provide at least 100Mbps connectivity to the broadband users. 4G is expected to offer data rates of 100 Mbps for mobile applications and 1 Gbps for nomadic applications and should be achievable by the year 2010.

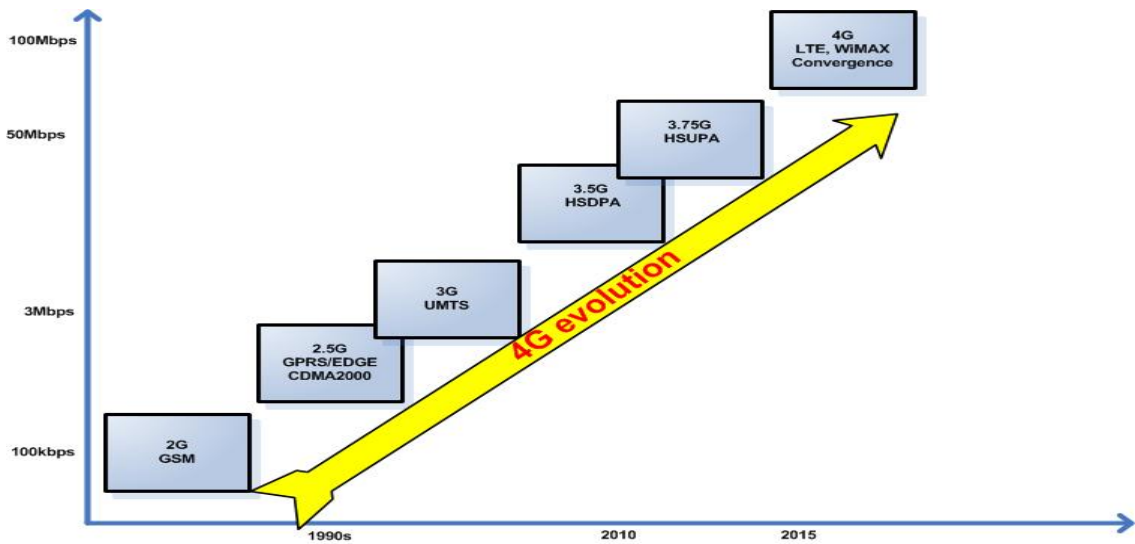


Figure 1: 4G evolution into convergence [1],[2],[3]

The current defined objectives for 4G include [1],[2], [3],[4],[5]:

- Fully integrated IP solution
- “Anytime, Anywhere”
- Seamless connectivity- wireless and wireline
- Global access and interconnection
- Interoperability
- Data rates of at least 100Mbps
- Spectrally efficient system

There are several applications that could be supported and leveraged in the 4G due to the advanced environment. These include mobile commerce with a dimension to mobile banking, peer-to-peer networking and full usage of the advanced Internet services in the converged cloud. This cloud be defined as a communications technology ecosystem (Figure 2) with a plethora of different services that will give users a more convenient and easy lifestyle.

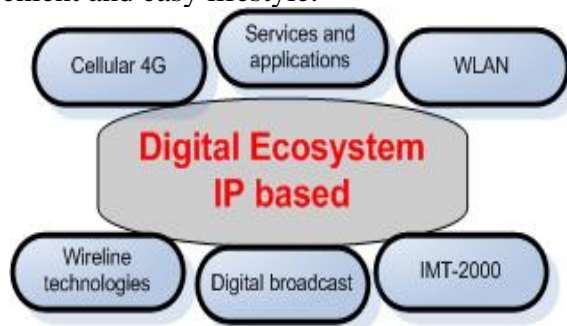


Figure 2: A suggested heterogeneous digital ecosystem [5]

Since 4G is not well defined yet, there is no demand or markets shaped yet. Therefore we are lacking forecasts or precise predictions that could help us to strategically plan for the market in an estimated time table. An interesting approach is to evaluate each country’s readiness to deploy 4G based on different criteria such as technological, business, legal, and policy.

The 3G in most cases and countries has not paid off yet and will not for the next 5 years. However, the operators are trying to decide on the best standard to invest in the long run and will cover their future needs ending up debating between the WiMAX and the LTE.

In this paper we describe an approach to study and evaluate the 4G readiness at a national level and answering the following research questions:

Which countries are closer to 4G adoption? Since the markets are still shaping up, how can we forecast from the operators perspective, using the operators and vendors current trials and knowledge?

Our study aims to describe the new “4G readiness” concept, building upon the literature and the e-readiness concept [14] as well as the non-market factors as described in [16].

Along the same lines, we expect that a country’s 4G high ranking could be more an outcome and indicator of innovation, supported with an advanced digital environment rather than a natural path of technological evolution.

This paper is organized as following: the first section describes the problem, section 2 gives an overview of 4G current issues and technologies, section 3 describes the drivers and challenges for 4G, section 4 describes the suggested study and we close with section 5 as the conclusions.

2. Fourth generation wireless: an overview

2.1 Technological feasibility

There are several technologies suggested to deploy in the 4G and these may include:

- Software Defined Radio (SDR): is a radio communication system where components that have typically been implemented in hardware (i.e. mixers, filters, amplifiers, modulators/demodulators, detectors. etc.) are instead implemented using software on a personal computer or other embedded computing devices.
- Orthogonal frequency-division multiplexing (OFDM): is a frequency-division multiplexing (FDM) scheme utilized as a digital multi-carrier modulation method
- Multiple-input and multiple-output, or MIMO), is the use of multiple antennas at both the transmitter and receiver to improve communication performance.
- Universal Mobile Telecommunications System (UMTS), standardized by 3GPP
- Time Division-Synchronous Code Division Multiple Access, or TD-SCDMA, is a 3G mobile telecommunications standard, being pursued in the People's Republic of China by the Chinese Academy of Telecommunications Technology

All these technologies are typified by high rates of data transmission and packet-switched transmission protocols. 3G technologies, by contrast, are a mix of packet and circuit-switched networks.

2.2 WiMAX vs. LTE

The LTE technology that Nokia and the Third Generation Partnership Project (3GPP) are pushing is an upgrade to existing GSM networks, a fact that makes even the CDMA operator Verizon Wireless to join the 3GPP trials. It is also a strategic decision, in order to be compatible with its European, GSM-based parent company, Vodafone. LTE looks like it can heal the GSM/CDMA rift that has divided the industry, as no major carrier has yet signed on with obvious CMDA 4G upgrade technology, Ultramobile Broadband (UMB).

LTE will have the following advantages:

- Fast, with peak data rates of 100 Mbps download and 50 Mbps upload
- It makes CDMA and GSM debates moot
- It offers both FDD and TDD duplexing, which means the upload and download speeds don't have to be synchronous, so operators can better optimize their networks to use more upload channels
- LTE will have lower latency, which makes real-time interaction on high band-width applications using mobiles possible

3GPP LTE, one of the most advanced mobile communication technologies to date, is currently undergoing 4G technology standardization by the 3GPP. This is the most likely technology to become the 4G standard, as many of the world's major operators and telecommunications companies are members of LTE/SAE (Long Term Evolution/System Architecture Evolution) Trial Initiative (LSTI). These companies include operators, such as Vodafone, Orange, T-Mobile, NTT DoCoMo, China Mobile and Telecom Italia and vendors, Ericsson, Nortel, Alcatel-Lucent, Nokia Siemens and LG Electronics. These are also the companies that will be considered to have the advantage in deploying first the 4G services.

WiMAX has certain advantages mainly over the Fiber to the home (FTTH) technology. When bundled with broadband internet access and IPTV, a WiMAX triple play becomes very attractive to residential subscribers. Given the QoS, security and reliability mechanisms built into WiMAX, the users will find WiMAX VoIP as good as or even better than voice services from the telephone company. It also offers a cost effective infrastructure with efficient use of spectrum. Currently, the average cost of WiMAX 802.16-2004 baseband has decreased from \$35 to almost \$20 today per subscriber [8].

4G proponents will serve as complements or upgrades to advance the 3G limitation to deliver video/TV and high speed Internet access. For WiMAX, there is a limitation of wireless bandwidth. For use in high density areas, it is possible that the bandwidth may not be sufficient to cater to the needs of a large clientele, driving potentially the costs high. But the main competitor for WiMAX today is the fiber and the wireline network that especially in the US is a real challenge for the residential users as the operators are deploying and growing really fast.

2.3 Trials and status

In 2008, Nokia installed a prototype base station for ongoing LTE tests at the top of the Heinrich Hertz Institut building in the center of Berlin, where interference typically degrades bandwidth. The first-of-its-kind test featured multiple users connected to the new base station, giving the 173Mbps throughput number some credibility as a real-world peak. Nokia also tested LTE throughput by putting terminals into cars and driving them up to 1km away from the base station. Verizon and AT&T are also testing it with Motorola equipment [6].

WiMAX on the other hand is ahead of LTE as a personal broadband option. CDMA-based operator Sprint-Nextel, for its part, is banking on WiMAX as a 4G solution. The Sprint-Nextel's WiMAX-based Xohm service in Chicago indicate that the bandwidth and pings are excellent (roughly 3Mbps/1.5Mbps and 70ms, respectively), but the numbers are nowhere near the +100Mbps /50Mbps that LTE promises in both directions. [6]

2.4 4G Vendors and players

A market restructuring with aggressive joint ventures and new players in broadband wireless will be the highlights. The major 4G Key Players are the current 3G players [7] that invest on R&D and sources to the future of the mobile wireless. Recently, Alcatel-Lucent and Japan's NEC Corp formed a joint venture around LTE trials. Similarly, China Mobile joined Verizon Wireless and Vodafone in LTE standardization trials. China is a very interesting case, since they haven't any 3G networks yet, although soon the government will issue three licenses for high-speed third-generation mobile phone services and called for a merger of China Unicom and Netcom, two of its four biggest telecoms providers.

One of the WiMAX weaknesses was the lack of certification. The ITU recommendation adding WiMAX as an official 3G protocol is boosting the investment and the new spectrum auctions as in the US, for example, addressing the 700MHz auctions. More than 100 WiMAX devices have been announced in 2008 and the fixed /portable wireless access equipment market has grown from \$562 million to \$1.2 billion in 2007. Additionally, Cisco is targeting WiMAX development at smart distributed wireless networking [8],[9].

3. 4G drivers and scenarios

The rise of mobile subscribers by 2011 estimating over 4 billion in a combination with the converged systems and application are the main contributors of the 4G evolution.[17]

The new mobile user's lifestyle is increasing needs capacity, although the 'walled garden' might still be a limitation restricting the customer's experience. The users are changed from consumers into producers of content such as photos, videos etc. Several applications will drive the mobile broadband market globally, including:

- Web 2.0,
- Online blogs,
- Mobile music,
- Location Based Services (LBS),
- Multimedia messaging,
- Gambling and
- Mobile TV.

There are a few scenarios discussed in [3] including WiBro and [10], which all agree that 4G will evolve during 2010 and 2015 and attempting to cover different markets as of restructuring and transition into 4G. For the next 5 years Verizon needs will evolve into 28Mbps download speed, raising a really early 4G LTE adoption compared to Vodafone [11].

These scenarios could be summarized as following:

1. Independent 4G system with one standard, the 3GPP LTE
2. Transition from 3G into 4G with existing (3GPP LTE) or new service providers WiMAX and WiBro
3. Co-existence of different standards
4. Spread of open transmission

To explain the above cases, we claim that history matters and the path dependent concept can really explain the long-term outcome based on initial conditions, as in our case. The 4G development depends

on the initial conditions as shaped from 3G in most of the cases. Based on the ‘Increasing Returns’ [13], and ‘Path Dependency’ [14], [15] where alternatives are possible, and regarding the standards, “the one selected and heavily invested is ‘good enough’ or even optimal and remains in use because it becomes established in use”. This theory is matching the scenario of different standards co-existence that will interact in the ecosystem and complement each other referring to an LTE+ and WiMAX that will be established and standardized as 802.16e that offers advanced mobility. This is what usually occurs in technological development scenarios.

4. 4G wireless – suggested study

4.1. 4G readiness theory

The need for strategic planning and new services has led new studies that could give us an idea of the current 4G status of the countries and towards the future 4G deployment.

The 4G readiness concept is a new term defined in this proposed study deriving from the e-readiness. “E-readiness is a measure of the quality of a country’s information and communications technology (ICT) infrastructure and the ability of its consumers, businesses and governments to use ICT to their benefit. The measure of a country’s ability to leverage digital channels for communication, commerce and government in order to further economic and social development”

Based on the above definition, we develop the 4G readiness concept. Consequently, the 4G readiness is the “state of play” of a country’s mobile wireless 4G preparation status, and the ability of its potential and existing consumers, businesses and governments to use in the future the mobile wireless to their benefit. Based on the 4G readiness criteria we will rank the countries and estimate how soon they will close the gap to new 4G technological environment.

Also to describe our study we are going to use a theory, to measure each country’s innovation using the Motivation/Ability framework (Figure 3). In this framework, we are describing the 4 different sections and how they are adjusted into our problem. The Motivation means that the 4G including the digital convergence should be the pot of gold and the new opportunity waiting for the winners, the first movers. The Ability describes the resources needed to develop 4G and craft them into business models for new products and services.

In the “Looking for a target” section, the operators are still undecided regarding the more beneficial choice or are lacking the spectrum to develop a new market. This hesitation also can derive from the “Looking for the Money” section, since the players are still expecting the 3G to pay off before they move into a new investment or wait for the LTE+, in order to upgrade the GSM networks that might also include smaller cost, much less than developing a WiMAX solution. “The Dilemma” is what we can quantify using our 4G readiness metric and estimate it per country, assuming basic innovation and ability. Finally “The Hotbed” is addressing all the innovative countries that feel confident and in the right path for the 4G adoption in the near future.

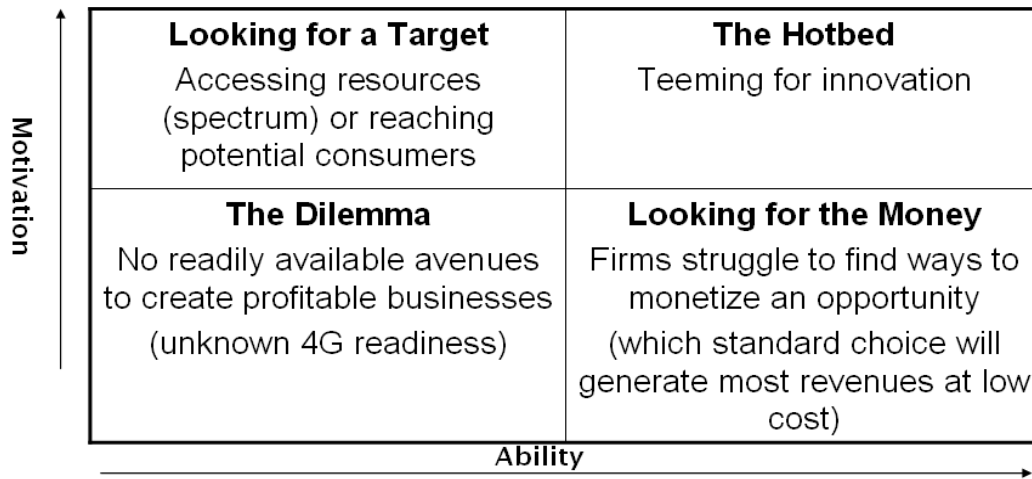


Figure 3: Motivation/Ability Framework [14]

Other important non-market factors for 4G based on the framework development are:

- Industry standards
- Cultural norms
- State of technological development
- Government regulation
- Country's intellectual property infrastructure

We are applying non-market metrics and factors, because there are no markets structured shaped yet and even and the current 3G markets provide very little knowledge to support the new landscape for 10 years from today.

4.2 Categories and Methodology

Our study is based on the e-readiness steps and for consistency; we are planning to rank the top 20 countries in the list:

USA, Hong Kong, Sweden, Australia, Denmark, Netherlands, UK, Germany, Japan, Switzerland, Austria, Finland, South Korea, New Zealand, Bermuda, Taiwan, Belgium, Canada, Norway, Singapore

Also some other countries will be added, such as China due to the China Mobile 4G activity and trials as mentioned before. Other strategic countries should be added in the countries sample: India, Russia, Brazil due to the facts:

- Almost represent half of the world's population
- Showing record in wireless adoption the last few years

Therefore in our methodology we are going to use as input countries with the most efficient digital users, assuming they are more innovative than others technologically. The suggested categories and the data collected will be again similar to the e-readiness study, adjusted more specifically when needed into the mobile wireless dataset, trying to include mostly non-market factors as already described. We assume in most cases that the 4G evolution can be considered as a digital subcategory developing similar categories and criteria.

We are using 6 category weights:

Category Weight	Connectivity and technology infrastructure	Business environment	Social and cultural environment	Legal environment	Consumer and business trend	Government policy and vision
Criteria	1. mobile phone penetration 2. current industry standards	1. number of 4G players, 2. level of 4G development	1. Level of education; 2. level of Internet literacy; 3. degree of entrepreneurship 4. technical skills of workforce; 5. degree of innovation	1. Effectiveness of traditional legal framework; 2. laws covering the spectrum and 3 competition policy	1. Consumer spending on ICT per capita; 2. availability of mobile wireless services for citizens and businesses	1. Government spend on ICT as a proportion of GDP; 2. digital development strategy
Percentage	20%	20%	15%	10%	20%	15%

Table 1: 4G Categories and Weights

Our target is to create a list of countries ranking them on scale 1-10 and compare with the e-readiness study regarding the order.

4.3 Expected results

We expect changes in the ranking of countries with higher mobile wireless penetration level to score higher than the e-readiness table. Similarly countries that have more 4G operators and trials to be placed higher in the list compared to the digital study. The higher the country in the list, it will reveal if they realistically have more R&D investments and trials or there might be other strategic reason that is turning them into a 4G early adapter. We will use the current ranking, and then suggest how the ranking changes over time and what our study can help answer.

5. Conclusions

This study provided an overview of the 4G evolution and technologies. It also described the e-readiness ranking and the approach adopted in this study to adopt e-readiness for 4G readiness. This type of studies and the expected results will shed light into the current operators' strategies and market structuring at a national level. The ranking at country level will help us identify if the biggest players in these countries play a significant role and having an impact as leaders in 4G. The study will reveal which countries have a competitive advantage towards the 4G, the weak countries that might be strong in the digital part but weak in the mobile wireless area and the reasons. Finally we will pay special attention into the strong countries and perhaps identify the path and the strategies that will shape the 4G markets faster and accumulate more capital and investments

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