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Enabling mobile infrastructures on the road to 3G

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Abstract

The demand for higher speed data transfer and richer technologies that support multimedia services over mobile networks seemingly has accentuated the development of third generation (3G) standards, mainly touted as the enabling infrastructure for future mobile services. 3G which comes mainly in three standards -- UMTS (WCDMA), TDSCDMA and CDMA2000 -- are claiming superiority over the existing second generation (2g and 2.5G) standards, mainly GSM services, the most stable mobile infrastructure standard as of today. In this paper, we have explored the transition process from the 2G to 3G, especially the technological infrastructure that claims to be superior to GSM. Further, we have synthesized some of the 3G commercial launches worldwide to capture the enthusiasm and promises to deliver worldwide, to derive a preliminary outlook for its future. Given the dynamic nature of these evolving technologies, the information reported in this paper is restricted by a time frame i.e. end of 2003. However, it hopes to be an informative source of comparison of the evolving infrastructures, especially between GSM and 3G -- to provide some relevant insights to industry sectors/service providers involved, in addition to informing academia.

Keywords: Mobile multimedia, GSM, 3G, 2.5G, UMTS, WCDMA, TDSCDMA, CDMA2000, FOMA, DoCoMo, iDEN

Introduction

Liberalization of the telecommunications sector, the development/rapid adoption of the Internet and advances in related technologies have led to digital convergence – merging voice, video and data communications. The adoption of mobile communications is fast overtaking the growth of fixed line networks in many economies (ITU, 2002). As wireless technologies continue to evolve, mobile revolution is dramatic bringing in fundamental momentous changes to the world (Siau and Sixing, 2003). Data services such as GPRS (General Packet Radio Service) that enabled Internet browsing and email; SMS (Short Messaging Service) technology that enabled short messaging; and MMS or multimedia messaging services (PCwebopedia, 2002a) that allowed presentation of the message to be coded into the presentation file so that the images, sounds and text are displayed in a predetermined order as one singular message – launched mobile multimedia services over mainly GSM (Global Systems for Mobile Communication).
networks – the 2G infrastructure standard adopted by 197 countries. With the popularity of mobile multimedia messaging, the demand for high speed data transfer and richer technologies became imminent. The development of so called 2.5G data services GPRS and EDGE (Enhanced Data for Global Evolution) and lately the development of 3G or third generation standard were to address this demand.

3G which is perceived to be the enabling infrastructure for mobile multimedia services in the future comes in three standards: UMTS or WCDMA, TDSCDMA and CDMA2000 (see section 3) with some variations (3G Australia, 2003). These three standards are now claiming supremacy over the 2G standards – mainly GSM services - the most stable mobile infrastructure standard as of today. New services, with interdependent market players identifying their roles and presenting composite user-friendly services with complex underlying technology and billing principles (Sigurdson, 2003) seem to be the key.

This paper is an attempt to capture the transition process to 3G, especially the technologies that which claim to be superior to GSM. Further, we have briefly attempted to evaluate what 3G promises to deliver, by synthesizing its commercial launches worldwide and providing a brief outlook with future research possibilities. However, the research has the limitation of being exploratory and captured within a given time frame.

Research Methodology

Our research has been driven by the post-positivist critical realistic approach where an attempt is made to explain behaviors on the basis of observable facts and preliminary inferences from these observations (Ticehurst and Veal, 2001). While positivists believe in discoverable reality through scientific empirical research and conclusive deductions (Blaikie, 1993), this novel approach (Trochim, 2002) suggests that all observations are fallible and therefore, may need to be revised periodically. Given that our research is exploring an evolving phenomenon, this approach was found particularly suitable.

A topic that is new, evolving or where less information is available warrants exploratory research (Jarvenpaa, 1991) method. The goals of this research was for the researchers to get familiar with the topic, gather/formulate issues for more systematic inquiry and develop a sense of direction for future research – which lead to the choice of exploratory method and the short time frame meant that a cross-sectional research was the best possible. The data collected was a synthesis of existing statistics or previously collected information, often in the form of web based reports, surveys, white papers, outlook figures, predictions and so forth and the synthesized data was content analyzed (Neuman, 1997) for developing a correlated body of material. To base our initial synthesis of literature, theoretical constructs of change management was drawn upon (Jick and Peiperl, 2003). These constructs defined the framework for the technological evolution described in the next section.

This research paper is structured as follows. A brief introduction and explanation of methodology/rationale is followed by a section that offers technological comparisons
between GSM and 3G to analyse the capabilities of 3G over GSM infrastructure. The next section synopsizes some of the commercial launches, and analyses a cross-section—namely EU—as a representative of issues/expectations. The subsequent section provides a critical outlook for 3G.

We expect this paper to be able to inform academia of the dynamic and evolving nature of 3G deployments, technologies and standards and provide commercial insights to the industry sector/service providers involved in the transition to 3G. However, the research reported in this paper is limited by few reasons. For the purposes of reporting, we have frozen the information available to late 2003. With the dynamic nature of the subject, there may be further developments in the area which are therefore, not reported in this paper. In addition, academically authoritative literature on 3G was rather limited or not available to the researchers at the time of reporting. Therefore, much reliance has been on available, nevertheless reliable sources such as white papers, industry reports and other relevant material. We propose to build on this exploratory research and identify components in the 3G mobile market, to further investigate the relationships among them, as proposed in the Outlook section.

**Technological evolution to 3G — A taxonomy thru’ the Change Model Lens**

This section synthesizes the current generation of mobile technologies known as 2G, 2.5G and thereafter explores 3G technologies, for the purpose of studying the evolution presented in figure 1.

![Figure 1: Technology Evolution to 3G (adapted from 3G (2003a))](image-url)
Jick and Peiperl (2003) presents an improvisational model for managing technological change based on extensive research done on open ended continuously evolving information technologies. This model rests on the concepts that technological change being an ongoing process cannot be anticipated ahead of time and, there is no steady or stabilising state to return to. The model as presented in figure 2 recognizes anticipated, emergent and opportunity based changes. *Anticipated changes* are planned ahead of time and intended while *emergent changes* arise spontaneously from local innovation, unintended. *Opportunity based changes* are not anticipated ahead of time but are introduced purposefully and intentionally during the change process in response to an unexpected opportunity or even a break down. Iteratively, over time, these three types of changes build on each other.

![Figure 2](image)

*Figure 2  An Improvisation model of change over time*
(Adapted from Jick and Peiperl, 2003)

The above framework was helpful in synthesising the technological evolution from current technologies to 3G standards. We have applied these as necessary in the following paragraphs.

The first generation of systems for mobile telephony was analogue; circuit switched, and only carried voice traffic. The analogue phones used in this generation were less secure and prone to interference where the signal was weak. Subsequently, the second generation or 2G mobile telephony systems uses digital encoding. 2G networks support high bit rate voice, limited data communications (current 2G phones send and relieve data at only 9.6 Kilobits per second) and different levels of encryption. They can support text messaging or Short Messaging Services (Searchnetworking, 2002) and include GSM, TDMA and CDMA standards.

We purport that the first generation mobile systems were introduced in response to the technological evolutions during the time. It is perhaps correct to suggest that these were rather *opportunity based* changes, not really anticipated ahead of time, but were introduced purposefully and intentionally during the transitional changing period. The second generation could be a combination of both *emergent and opportunity based*
change. The onset of digital era offered an opportunity for new generation mobile systems, and also built on emergent innovations, which were unintended.

GSM (Global Systems for Mobile) is the leading mobile standard in the world. It uses narrowband time division multiple access technology -- which allows eight simultaneous calls on the same radio frequency. First introduced in 1991, GSM service has been adopted as a standard by 197 countries, and has become the de facto standard in Europe, Asia, South America and Africa, by April 2003 (GSM World, 2003). While GSM standard was introduced as an anticipated change, it had built on emergent changes that arose from innovations during the period.

IDMA (Time Division Multiple Access) is a technology for delivering digital wireless service using time division multiplexing or IDM (PC webopedia, 2002b). It works by dividing a radio frequency into time slots and then allocating slots to multiple calls. In this way, a single frequency can support multiple, simultaneous data channels. This technology was resultant of an emergent change which built on evolving technologies; and built on the opportunity based change of using radio frequencies. CDMA (Code-Division Multiple Access) is a digital cellular technology that uses spread-spectrum techniques. CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence (Qualcomm, 2002). This technology emerged from the military background, and an opportunity based change was foreseen in its utilisation within mobile telephony systems.

HSCSD (High Speed Circuit Switched Data) technology offering speed rates up to 64Kbps was developed with the progress of text/multimedia messaging and improved data transfer rates (Rysavy, 1999). HSCSD offered data rates up to five times as fast as GSM by aggregating a number of GSM channels. Unfortunately, these aggregated channels only allowed for a single user at any one time. HSCSD thus swamped available bandwidth very much like the old analogue mobile phone system (3G Australia, 2003). Therefore, HSCSD is rather an anticipated change which built on emergent changes.

The 2.5 generation of technologies providing higher speed data transfer uses packet switching technology (Rysavy 2002a, 2002b). 2.5G extends 2G systems, adding features such as packet-switched connection and enhanced data rates. 2.5G networks include EDGE and GPRS. These networks better support WAP, MMS, SMS mobile games, search and directory (Rysavy, 1999). These technologies are also rather anticipated changes which built on emergent changes in technology.

GPRS (General Packet Radio Service) is the European 2.5G standard, an enhancement to GSM which overlays a packet-switched architecture onto the GSM circuit-switched architecture. GPRS offers high speed packet data with transmission speeds over 100 Kbps, with most user devices offering about 56 kbps (Rysavy, 2003). It is regarded as a useful evolutionary step on the road to 3G because it provides network operators the experience of operating packet networks, and charging for packet data (Prandini and Sims, 2000). Yet again, this was an anticipated change that built on emergent changes.
EDGE (Enhanced Data rates for GSM Evolution) is yet another 2.5G development from GSM (3G Australia, 2003). It uses the same TDMA frame structure, logic channel and 200 KHz carrier bandwidth as today’s GSM networks, which allows existing cell plans to remain intact. EDGE data rates are three times faster than GPRS. Realistically, the maximum rate that EDGE will be able to achieve will be 150Kbps. As EDGE appears to be cheaper than a full 3G solution, it is attractive, especially for operators which cannot afford a license for the full 3G radio spectrum (3G Australia, 2003). Perhaps, EDGE is better slotted in the opportunity based change bracket.

In North America, there were two principal 2G systems, a TDMA-based system from AT&T Wireless (IS-136), and a CDMA system called CDMA one (IS-95A) from Sprint and Verizon. EDGE was attractive for American network operators as it is possible to upgrade to EDGE from both TDMA (IS-136) networks as well as from GSM. However, in November 2001, AT&T along with Nokia launched EDGE data calls, migrating to GSM network environment (Nokia, 2001). This has made the TDMA based system more or less redundant. AT&T has claimed a maximum data rate of 384Kbps with EDGE. Cingular, the second largest wireless carrier in the United States announced at the same time that it plans to deploy GSM/GPRS with plans to migrate to EDGE. The GSM Association has estimated that GSM and its evolution to next-generation EDGE and 3G or WCDMA will account for over 85% of next-generation subscribers, showing continued growth due to conversions from TDMA and CDMA (Nokia, 2001). Nokia believes that a single network solution offering GSM/GPRS/EDGE and WCDMA will allow carriers to benefit from GSM global economies of scale, including higher revenue streams, increased network efficiency and lower overall costs. These illustrate how anticipated, emergent and opportunity based changed built on one another.

CDMAone (IS-95B) is the 2.5G development from CDMA (IS-95A which adds packet-switched capability. It offers data rates up to 115Kbps (3G Australia, 2003). Yet another emergent change that built on an anticipated change. IDEN (Integrated Digital Enhanced Network) is a specialized wireless or mobile radio network technology patented by Motorola, that combines two-way radio, telephone, text messaging and data transmission into one network (DEVX, 2003). IDEN operates in the 800 MHz, 900 MHZ, and 1.5GHz bands and is based on TDMA (GSM) architecture. It uses Motorola’s Vector Sum Excited Linear Predictors (VSELP) Vocoder for voice compression and QAM modulation to deliver 64Kbps over a 25 KHz channel (Motorola, 2003). Currently IDEN systems work in more than a dozen countries and Motorola has successfully launched IDEN based services in Argentina, Brazil, Mexico, Peru, Columbia and South Korea (searchnetworking, 2002). Conference call up to 200 users connecting to 1 call is possible through IDEN. This technology is ideally classified as an opportunity based change.

This brings us to the 3G standards. The development of 3G multimedia communication systems, with their ability to process real-time multi-media applications and their large bandwidths, is greatly enhancing the mobile multimedia and mobile application environments (Frene and Huret, 2002). According to the International Telecommunications Union, the 3G is defined by its high data transmission rates or speed (ITU, 2002). It supports applications such as full-motion video, providing high speed data transmissions of 144 Kbps or higher. It promises increased bandwidth, up to 2 mbps in
fixed applications, 384 Kbps when a device is moving at pedestrian speed, and 128 Kbps in a car (Rysavy 2002b, 3G 2003) and works over GSM, TDMA, and CDMA. According to the model, 3G standards and technologies could be opportunity based changes which built on anticipated and emergent changes over time.

UMTS (Universal Mobile Telecommunications System) represents an evolution in terms of services and data speeds from second generation mobile networks. As a key member of the "global family" of third generation mobile technologies identified by the International Telecommunication Union, it is the natural evolutionary choice for operators of GSM networks, currently representing a customer base of more than 800 million end users in various countries (Rysavy 2003, Frene and Huret 2002). UMTS was named after the group with the same name, which was an offshoot of or International Mobile Technologies 2000 forum i.e.IMT2000 which defines standards for third generation (3G) wireless communications, based on a set of interdependent ITU Recommendations (ITU, 2002). It provides a framework for worldwide wireless access by linking the diverse systems of terrestrial and/or satellite based networks, exploiting the potential synergy between digital mobile telecommunications technologies and systems for fixed and mobile wireless access systems. Like many international standards the current 3G "standard" emerged after quite difficult negotiations under IMT-2000 and there are only three different standards that can be regarded as full 3G solutions: W-CDMA, CDMA2000, and TD-SCDMA (Rysavy 2003, Prandini and Sims, 2000). UMTS as in the case of 3G standards could be an opportunity based change, which built on anticipated and emergent changes.

W-CDMA (Wideband-Code Division Multiple Access) also known as UMTS is being promoted as the successor to the successful 2G standard - namely GSM - in Europe. UMTS adoption was agreed for Europe and Japan as an upgrade to GSM and in May 2000, it was adopted as a standard by the ITU under the name IMT2000 direct spread (Rysavy 2003, Prandini and Sims, 2000). UMTS is being sold as the 3G standard (3G and UMTS are sometimes used synonymously, in some sources). In W-CDMA, signals are spread over a wide frequency range several hundred times broader than that of conventional systems, allocating single time slots to each user. Because this spread-spectrum method allows all users to share the broad-bandwidth, splitting up of the bandwidth is rendered unnecessary, and transmission efficiency is dramatically improved. Spread data transmission is robust against disturbance and noise, and use of a common frequency in all cells minimizes jamming and interference. This cancels the need for frequency-switching when the user moves from the coverage of one station to another, and makes high-quality communications possible (3G 2003, Rysavy 2003). The most critical requirement for W-CDMA has been its potential to handle the massive content. Employed to accomplish this was the multirate transmission method. This automatically selects the optimum communication speed and route in accordance with the type and size of information, ensuring high-speed and high-quality processing of content including voice, still images and video (Rysavy 2002b, 3G 2003, Rysavy, 2003). We purport that W-CDMA is an emergent change.
i-mode is the network from DoCoMo (meaning ‘anywhere’ in Japanese) -- a subsidiary firm of NTT and Japan’s biggest mobile service provider with 31 million subscribers as early as June 2000 (NTTdocomo, 2003). i-mode network allows subscribers continuous access to the Internet via mobile telephone. Specifically, users could send/receive email, exchange photographs, do online shopping and banking, download personalized ring tones for their phones, and navigate Web sites (NTTdocomo, 2003). In May 2001, the company launched the introductory phase of the world’s first 3G mobile service, named "FOMA" and it began fully commercialized service in October 2001. Supported by NTT DoCoMo W-CDMA air interface and built upon the success of the introductory phase, FOMA now offers advanced services by combining more refined sound and picture quality with higher transmission speeds. It has been developed for seamless use around the world - giving international operators the ability to adopt it with ease, and promote a significant increase in data traffic (NTTdocomo, 2003). iMode is perhaps best classified as opportunity based change and FOMA an emergent change.

CDMA2000, the main 3G global competitor to UMTS or W-CDMA, was developed in the USA by Qualcomm (Qualcomm, 2002). The standardization work for CDMA2000 is being carried-out under the supervision of the 3GPP2 (Third Generation Partnership Project 2) - a partnership consisting of five telecommunications standards bodies: CWTS in China, ARIB and TTC in Japan, TTA in Korea and TIA in North America. Although the ‘CDMA’ bit is common in both W-CDMA and CDMA2000, they are completely different systems using different technologies. It is hoped that mobile devices may be able to use either of the two systems, despite the visible competition at present (3G Australia, 2003). There are various types of CDMA2000 types, such as CDMA2000 1X-EV, CDMA2000 1X-EV-DO, CDMA2000 1X-EV-DV, and CDMA2000 3X (Rysavy 2003, Qualcomm, 2002). Being developed based on anticipated change, but introduced as an opportunity based change, CDMA 2000 consolidates also emergent changes.

CDMA2000 1X-EV technology supports both voice and data services over a standard (1X) CDMA channel (Rysavy 1999). It provides up to twice the capacity of earlier CDMA systems (with even bigger gains over TDMA and GSM), helping to accommodate the continuing growth of voice services as well as new wireless Internet services. It is also known as High Rate Packet Data Air Interface Specification and it provides peak data rates of up to 140 kbps (and up to 307 kbps in the future), without sacrificing voice capacity for data capabilities and while occupying a very small amount of spectrum (1.25 MHz per carrier). CDMA2000 1X phones also feature longer standby times. Since it is backward-compatible with earlier CDMA technology, CDMA2000 1X provides an upgrade path for both carriers and consumers (Siau and Zixing, 2003, Rysavy 2003, Prandini and Sims, 2000, Qualcomm 2002).

CDMA2000 1X EV-DO is projected as the next development of CDMA and is a data-optimized version of CDMA2000. 1X EV-DO offers higher-speed or higher capacity data services, providing peak rates of over 2 Mbps, with an average throughput of over 700 kbps - comparable to wire line DSL services and fast enough to support even demanding applications such as streaming video and large file downloads. 1X EV-DO devices will provide "always-on" packet data connections, helping to make wireless access simpler, faster and more useful than ever. 1X EV-DO is also known as High Rate Packet Data Air
Interface. CDMA2000 1X EV-DV also known as EV-DV, or 1X-EV Phase Two is intended to integrate voice and data on the same frequency band. EV-DV promises data speeds ranging from 3Mbps to 5Mbps. There are as many as eight proposals submitted to the 3GPP2 standards committee for the design of EV-DV ([Siau and Zixing, 2003, Rysavy 2003, Prandini and Sims, 2000, Qualcomm 2002]. CDMA2000 3X is an ITU-approved, IMT-2000 (3G) standard. It is part of what the ITU has termed IMT-2000 CDMA MC. It uses 5 MHz spectrum (3x 1.25 MHz channels) to give speeds of around 2-4 Mbps. South Korea's SK Telecom launched the world's first 3G system in October 2000, with their system based on CDMA2000 1X. Subsequently, the two Korean telecoms, LG Telecom and KT Freetel have also launched the same standard ([Siau and Zixing, 2003, Rysavy 2003, Prandini and Sims, 2000, Qualcomm 2002, 3G, 2003a).

Operational 3G systems based on CDMA2000 1X is now appearing around the world. For instance KDDI Corp. and Okinawa Cellular announced on April 10th 2003 that the total cumulative number of users for their CDMA2000 1X third-generation mobile phones has surpassed seven million. Sales of CDMA2000 1X au mobile phones began on April 1, 2002. The seven million mark was surpassed twelve months after the original release. In April 2003, about a half of all their mobile subscribers were using 3G mobile phones. Verizon has launched CDMA2000 1X in major east and west coast markets in the USA (their so-called Wireless Express), and have started trials of 1X EV-DO in the Washington, D.C. area. Sprint have launched the first nationwide CDMA2000 1X service called PCS Vision. This service allows the user to play games, transmit digital photos, and surf the web on a wide range of funky devices (Rysavy, 2003, Prandini and Sims, 2000, Pewebopedia 2002b, Nokia, 2001).

The UMTS standard also contains another radio transmission standard which is rarely mentioned: TD-CDMA (a.k.a. TDD UTRA because it is the TDD component of UTRA). While W-CDMA is an FDD technology (requiring paired spectrum), TD-CDMA is a TDD technology and thus can use unpaired spectrum. TDD is well-suited to the transmission of Internet data. China which has more mobile phones in the country than anywhere uses a national 3G standard called TDD similar to TD-CDMA – known as TD-SCDMA - developed by the China Academy of Telecommunications Technology (CATT) in collaboration with Siemens ([Siau and Zixing, 2003, Rysavy 2003). This is perhaps yet another emergent change that built on anticipated changes, but introduced as a potential opportunistic change.

Thus, it can be seen how the various technologies and standards built on one another, as based on the model provided in figure 2. In the next section, we propose to capture the enthusiasm of 3G commercial launches or opportunity based changes.

3G Commercial Launches

Over the last two year period, there have been trials and launches of 3G over the world. Some of these launches have been further developed into full phased nationwide launches, while others have been developed from 2.5 G networks. Table 1 represents a
Considering the dynamic nature of these launches, the limitation is that updated and all commercial launches may not be included in the synopsis.

<table>
<thead>
<tr>
<th>Country</th>
<th>Data/Month</th>
<th>Operator/Network</th>
<th>Coverage</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1/3/2002</td>
<td>Telecoms Consortium-M.net</td>
<td>Adelaide City 6-months trial only for World Congress showcase</td>
<td>CDMA</td>
</tr>
<tr>
<td></td>
<td>3/12/2002</td>
<td>Telstra</td>
<td>Business Customers only Metropolitan and selected regional locations</td>
<td>CDMA 1X CDMA 1xrtt</td>
</tr>
<tr>
<td>Croatia</td>
<td>12/05/2003</td>
<td>Vipnet/Ericsson</td>
<td>4 major cities trialed</td>
<td>UMTS</td>
</tr>
<tr>
<td>Spain</td>
<td>First quarter 2002</td>
<td>Vodafone/Nortel (3GPP project)</td>
<td>23 cities and 98 municipalities and all cities with &gt;250,000 population</td>
<td>UMTS</td>
</tr>
<tr>
<td>Austria</td>
<td>29/09/2002</td>
<td>Mobikom Austria Ericsson</td>
<td>25% of Austrian geographic area</td>
<td>UMTS</td>
</tr>
<tr>
<td>Finland</td>
<td>1/1/2002</td>
<td>Sonera</td>
<td>Greater Helsinki area, Tampere, Turku, Oulu</td>
<td>UMTS</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1/05/2003</td>
<td>Tele2AB-Tango</td>
<td>90% of population and 70% of territory</td>
<td>UMTS</td>
</tr>
<tr>
<td>Ireland</td>
<td>2/05/2003</td>
<td>Vodafone</td>
<td>Initially open to key business partners representing wide geographic spread across provinces</td>
<td>UMTS</td>
</tr>
<tr>
<td>India</td>
<td>1/05/2003</td>
<td>Reliance Infocomm/Reliance India Mobile Qualcomm</td>
<td>92 cities, over one million customers</td>
<td>CDMA20001X</td>
</tr>
<tr>
<td>Isle of Man</td>
<td>9/12/2002</td>
<td>Manx Telecom NEC/Siemens</td>
<td>Europe’s first fully operational network, 85% of the island</td>
<td>UMTS</td>
</tr>
<tr>
<td>Japan</td>
<td>October 2001</td>
<td>NTT DoCoMo</td>
<td>Initially limited to 30 km radius around Tokyo.</td>
<td>IMT-2000 W-CDMA (small/significant differences from European version)</td>
</tr>
<tr>
<td></td>
<td>4/12/2002</td>
<td>J-PHONE Vodafone (3GPP project)</td>
<td>Initially available in Tokyo metropolitan area and enablers global roaming</td>
<td>UMTS Cards 3GPP standards W-CDMA/GSM dual mode handsfree service</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>5/02/2003</td>
<td>Verizon Wireless Qualcomm</td>
<td>Nationwide subscribers</td>
<td>CDMA20001X</td>
</tr>
<tr>
<td>Brazil</td>
<td>31/10/2002</td>
<td>Vesper Nortel</td>
<td>17 states in the SE/Northern region</td>
<td>CDMA20001X EVDO (data optimized)</td>
</tr>
<tr>
<td>Columbia</td>
<td>7/10/2002</td>
<td>EPM-Bogotia Airtel</td>
<td>City of Bogota, 89,000 lines</td>
<td>CDMA2000 1X</td>
</tr>
<tr>
<td>Mexico</td>
<td>24/01/2003</td>
<td>Grupo Iusacell SA de C.V Lucent</td>
<td>Nationwide subscribers.</td>
<td>CDMA2000 1X</td>
</tr>
<tr>
<td>Russia</td>
<td>6/1/2002</td>
<td>Delta Telecom Lucent SM/LINK</td>
<td>Northwest region Planned to offer coverage in all licensed territories.</td>
<td>CDMA2000 1X IMT-MC 450</td>
</tr>
<tr>
<td>Taiwan</td>
<td>8/10/2002</td>
<td>Ericsson Mobility World and 5 license operators</td>
<td>Transition nationwide from GSM/GPRS standard.</td>
<td>W-CDMA</td>
</tr>
<tr>
<td>USA</td>
<td>20/1/2002</td>
<td>Verizon Wireless Express/Lucent</td>
<td>East and West Coast</td>
<td>3G1XRTT</td>
</tr>
<tr>
<td></td>
<td>9/8/2002</td>
<td>Sprint PCS Vision(SM)</td>
<td>Nationwide (upgrade to network)</td>
<td>CDMA 1X</td>
</tr>
<tr>
<td></td>
<td>30/10/2002</td>
<td>Monet Mobile Network LG</td>
<td>Duluth MN</td>
<td>CDMA2000 1xEV-DO</td>
</tr>
</tbody>
</table>

Table 1  Synopsis of 3G Commercial Launches (as of late 2003).
In many economies, one of the network operators have either piloted or launched 3G services as early as 2001 (see Japan). However, all the economies have adopted different technologies, and launched services of 3G at different times – due to a variety of reasons including regulations and framework. We chose to take a cross-section of this synopsis, and focus on EU to analyze the situation – as it may represent a wider perspective on the issues and concerns relating to transition. The EU countries are grouped together in the Table 1, and it may be observed that they are all on the UMTS standard.

On the 18th of February 2003, on behalf of Swedish Post and Telecom Agency (PTS), Northstream has performed an analysis of the 3G rollout situation and prepared a descriptive/analytical overview of the status in European Union and Norway (3G, 2003b). The European Commission and national regulators share powers of regulation over the mobile telecommunications sector in Europe. While many regulators have made no alterations, at national regulator level licence conditions that have been altered/clarified include timing of service launch, timing of coverage milestones, network sharing, and extension of the licence period and revision of payments for fees associated with the licence. These indicate there is some limited flexibility to the industry, and a slight change of regulatory focus from market liberalisation to 3G market facilitation (3G, 2003b).

The actual reasons for delay rest on a balance between handset availability and network functionality. In Europe the number of operators has generally increased in comparison to the 2G market situation, but not to the extent that was anticipated at the time of 3G licensing. There is a Europe-wide trend for fewer 3G operators than originally anticipated. Operator announcements show that 3G is delayed across Europe; operators expect initial launches in mid-2003. Some operators indicate ‘soft launches’, i.e. non-mass market launches, without major revenues at that stage. Multi-national operator groups tend to co-ordinate delays. With reduced credit ratings, and lower than anticipated profits, operators find that the 3G commitments they’ve previously committed to will require greater external financing, at a higher cost. This impacts their capacity to rollout networks (3G, 2003b).

In the current European market the variety of services is lower than expected, with service development increasingly dependent on operators. This is reflected in changed industry expectations - revenue forecasts made in 2002 are approximately 25% lower than those made in 2001. Industry forecasts from 2001 to 2002 show a slower 2G/3G conversion pace than originally anticipated. Market take up is heavily dependent on handset and service availability. Incumbent operators are likely to be 3G rollout status less impacted by the delay than new entrants, as new entrants still have to secure a customer base. Northstream concludes that evidence confirms that the European 3G market is delayed, with many players waiting to roll-out ‘soft-launches’ in mid 2003. In addition that market has qualitatively changed. There are differences from original expectations in terms of competitors, services and revenues, which show that operators are operating in an unanticipated market environment (3G, 2003b).

In July 2001, KPN Telecom was engaged in talks with several firms regarding sharing the costs of developing 3G mobile networks for Germany. An agreement was proposed to
be reached between KPN and Telefonica as they were partners in 2G networks. There was an agreement on network sharing already by BT and T-Mobile in June 2001. Telecom experts estimated infrastructure sharing in Germany would total about 25 to 30 per cent. In the German auction 17th August 2000, Telefonica won one of six available licences through the Group 3G consortium for $8.3bn which also includes Sonera of Finland. KPN's won a licence for $7.7bn. T-Mobile and mmO2 entered into agreements to share 3G site infrastructures ('site sharing') and to roam on their 3G networks in the UK and Germany. In February 2002, the parties asked the European Commission (EC) for clearance or, alternatively, an exemption of their agreements under the antitrust rules (Cellular, 2003).

The EC adopted a favourable decision in relation to the UK Agreement of the two parties on 30 April 2003 and on July 16th, 2003 the Commission took a favourable decision on 3G mobile network sharing in Germany, allaying fears that site sharing raises competition concerns. The Commission's investigation has revealed that the German agreement on site sharing does not restrict competition because the agreement is limited to sharing basic network infrastructure such as masts, power supply, racking and cooling. It is also widely promoted for environmental and health reasons as a matter of public policy at national and EU level (3G, 2003c).

The investigation also confirmed that national roaming between licensed network operators' benefits consumers by allowing the operators to offer quicker 3G coverage, especially for less built up and rural areas of Germany. The agreement on national roaming is exempted from the competition rules. Although, national roaming between the network providers does on the one hand limit network-based competition with respect to coverage, retail prices, quality and transmission speeds, on the other hand it also promotes market entry which leads to better and quicker 3G service coverage. For example, roaming in rural areas will allow in particular O2 Germany, the smallest operator on the German market for mobile telephony, to compete as a nationwide 3G operator. Roaming in urban areas is limited to O2 Germany's customers and it can be exempted during a short start-up period until it has set up its own network. In addition, roaming by O2 Germany's customers on T-Mobile's network may also be exempted from competition rules with respect to urban areas, however, for a more limited period (3G, 2003c).

However, as the roll out of capacity in urban areas will be undertaken at a faster pace, the roaming exemption will be phased out in steps across specific cities and regions covering about 50% of the population in accordance with a strict timetable ending altogether (including rural areas) on 31 December 2008 (3G, 2003c). In February 2002, Deutsche Telecom announced that UMTS will be available in 20 cities by the end of the year. Its T Mobile subsidiary along with Siemens technology was to build the network estimated to be 140 million Euros (USD121.4 million) (Wrolstad, 2002). In Germany alone, six telecom companies spent 50.8 billion euros (US$43 billion) on 3G licenses in 2000 and must invest even more to build the networks that will provide advanced mobile Internet and data services.
Reflective Conclusions

There seem to be interesting momentum in the uptake of 3G across the world, as is evident from the commercial launches. However, the scope of 3G services is yet to be determined. The question arises if 3G will actually live up to its promises of high bandwidth. For example, the W-CDMA network signals are spread over a wide frequency range using the spread-spectrum method that allows all users to share the broad-bandwidth. This, in an ideal situation as this technology cancels the need of frequency switching and optimizes communication speed – to offer speeds from 128 Kbps up to 2Mbps. However, as the number of users who share the broad-bandwidth increases, the network will slow down, and the higher speed transmission may not be possible. This, in turn, would affect the promises made by network providers to subscribers.

On the other hand, the stable 2.5 G services may still hold out. They are able to offer mobile multimedia infrastructure with stable and relatively high transmission speed rate, which is not affected by bandwidth sharing. In addition, technologies such as iDEN can in some aspects easily compete with 3G technologies as business services such as 200 users to one conference call is a possibility within the network.

In a number of countries including the UK and Australia, Hutchison Whompoa has launched their UMTS-based service called, simply, 3 (Hutchinson Australia 3, 2003). They are pushing video calls as their killer application, with person-to-person calls possible from day one. A "walled garden" approach has been taken to content downloadable from the Internet - you can only get content from 3's partners. It is not possible to just browse the Internet and download what is required. According to 3, this is to ensure that the content (e.g., video) is optimized for the handset (Hutchinson UK 3, 2003). The limitation of this model is similar to which was used by some Internet providers, which did not succeed in the early days of browsing the Internet. Although mobile multimedia rich applications or video calls may be a novelty, ultimately, a mobile technology is more of a convenience device that offers 'freedom' and these do not seem to be reflected in the current 3G models.

It might also prove difficult for some 3G operators to lower their subscription rates, given the high license fee paid. Therefore, the strategy of Telstra in Australia of targeting the high paying business segment as a niche market for 3G may help the company in the long term to recover its costs as well as have the market for this new standard. The high paying corporate segment will perhaps be willing to pay the premium for the novelty as well as multimedia rich applications that 3G promises to deliver. Also somewhat limiting the user base will facilitate the promise of high 3G bandwidth. However, as mentioned above, iDEN is yet another standard with the potential to seriously compete with 3G services, and overall it is lower in pricing, offering similar facilities.
Outlook

The future of 3G will be an interesting study. Therefore, we feel that it is worthwhile to keep a close watch on 2.5G services – whether they will co-exist with 3G or eventually which of these would win and become the established standard for high speed, mobile multimedia rich applications. Saying this, the concept of licensing in most countries will make sure that 2.5G services will have a limited lifespan and therefore 3G or later some “4G” will eventually prevail. At this given time, our research is at a preliminary stage and so is the 3G mobile market.

We have inferred and derived from this research (see figure 3) that a number of components such as perceived need (rather than logical reasoning or technology requirement), uneven growth patterns, return of investment concerns, rivalries or disagreements among forums, conflicting opinions etc as variables that determine the transition process of mobile telephony into 3G. In the process, we recognise the need for an action research study involving academia, industry, practitioners and related forums to study the interplay between various components in the transition to 3G. Therefore, we propose to extend on this research by taking the approach suggested by Sayer (1992) and investigate the interplay between these components by recognizing agency structure and causation (see figure 3). This research therefore, becomes a prelude to a future longitudinal study using action research method.

![Figure 3: Research Roadmap](image-url)

Recognising agency structure and causation
References


3G (2003a), Introduction to 3g, 3g-UK online, URL: http://www.3g.co.uk/All%20About%203G.htm, Last accessed 11/7/2003.


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for example, Telstra has paid USD 148,474,752 for 15 MHz of paired spectrum 5MHz of unpaired spectrum in all capital cities and 10 MHz paired in regional areas.

The Australian government had decided to split the paired and unpaired spectrum auctions. Unpaired spectrum is for time-division-duplex (TDD) transmission and paired spectrum for frequency-division multiplex (FDD) transmission. TDD transmission is more efficient than FDD, which wastes valuable spectrum by using separate up and down channels and requiring extra bandwidth to separate them (see also section 3.2). In capital cities of Australia, where there is population density, there is an expectation for higher bandwidth. Therefore, it both paired and unpaired spectrum - in a certain proportion was auctioned for capital cities while regional areas with low demand was restricted to paired spectrum.