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Backgrounder for the press

Navigating the Path Towards 3G

Content

The wireless mobile market is shared by a growing number of radio access technologies. Understanding the positioning and the interrelationship of the various technologies available today and evolving in the future, like EDGE, W-CDMA or WiMAX, helps in choosing the right path for network evolution. GSM (TDMA) and UMTS (FDD or W-CDMA) are the dominant standards for at least the next five years for cellular mobile applications. However, for higher bit rates and for low mobility or fixed wireless **applications** there is a clear move to OFDM as a transmission technique (e.g. WiMAX).

Introduction – the Changing Landscape of Mobile Networks

Wireless communication is heading towards mobile data at an increasing pace. Industry forecasts show a growing demand for all categories of data applications, from mobile B2B services to mobile infotainment. The resulting need for more bandwidth and cell capacity has pushed the enhancement of cellular mobile radio systems with advanced bearer technologies and has resulted in systems of the Third Generation (3G).

Looking at mobility as a driver for the implementation of wireless systems, a wide range of mobility needs can be observed ranging from fixed, through nomadic, to high speed vehicular. Fixed wireless access is becoming a simple use case of the sophisticated 3G systems. Mobility and bandwidth are a trade off which has been maximised in the UMTS system. Generally, higher mobility speeds mean lower bandwidth. UMTS is achieving state of the art bit

rates comparable to wireline DSL speeds at high mobility. As opposed to UMTS, OFDM based systems e.g. WiMAX represent a new generation of systems also targeting the wireline speeds but at the lower end of the mobility range (Wireless-DSL). It follows, that standardization bodies are now focusing on the increasing demand for wireless mobile data services for which user rates comparable to today's wire-line subscribers (DSL) are needed. This includes 3GPP for cellular UMTS standard as well as the IEEE802 group for wireless LAN (IEEE802.11) more commonly known as WiFi, and the wireless MAN (IEEE802.16) more commonly known as WiMAX.

Examining the various technologies available today, it can be seen that EDGE, the evolution of the GSM standard after GPRS is a distinct step along the pathway towards higher user data rates at a slight cost in mobility and is known as 2.5G. EDGE is closely followed by the UMTS W-CDMA standard with its evolutionary HSDPA step. These provide a quantum leap in user data rates even in the higher mobility range. The GSM and UMTS standards are seen to be dominant in the world today and are forecasted to represent more than 90% of the 3G market.

More than 100 operators world wide have been awarded 3G spectrum so far. The vast majority will deploy UMTS W-CDMA, either based on an own decision, or due to regulatory requirements. UMTS W-CDMA clearly marks

the mainstream. Many GSM operators have upgraded their networks with the GSM/GPRS system and are already in the process of implementing EDGE with the advantage of world wide roaming and service continuity. This world wide trend is continued with W-CDMA as GSM/UMTS dual-mode handsets are becoming increasingly available. Thus all operators will automatically benefit from the dominant market position of UMTS. Resulting economies of scale will ensure ongoing cost efficiency of the co-existing technologies.

Mobile Data: Driving the Need for Advanced Networks

The growing competition from a multi-operator environment in most countries has provoked a decline in tariffs and together with the advent of prepaid and mass market penetration of mobile telephony, pressure is continuously being put on the average revenue per user (ARPU). Industry analysts predict that mobile data services will reverse the ARPU trend and stimulate the willingness to pay. Today, the mobile data market is in its initial phase of growth. Estimations show that data services will steadily grow and contribute about 30% to the ARPU in 2008 in Western Europe. Data services will continuously evolve with lifestyle requirements of users so that basic voice and short message services are already being complemented by advanced communication services. The convergence of mobile and internet technology enables the sending and receiving of emails, attachments and videos. Other service categories show similar evolution paths by adding value to the currently available applications. Users' spending directly relates to the

perceived value of a service. In order to assure a high level of user satisfaction ease-of-use and quality of service are crucial. The latter directly translates into a need for bandwidth. The advanced network technologies of 2.5G and 3G, offer sufficiently high transmission speeds to meet user expectations of a multimedia-driven future.

Migrating Towards 3G

The tremendous success of the mobile markets in the 90's was based on the large uptake of the mobile voice service and SMS. The major mobile communication systems in place today are GSM and IS-95. These technologies were originally designed to transmit voice. In order to sustain the profitability of 2G systems when migrating to 3G, a future-proof solution is needed. This is inherently provided by the migration from GSM via GPRS/EDGE to W-CDMA and is seen to be the dominant path to 3G opposed to other options such as the evolution of IS-95 systems towards the cdma2000 family. This is not only due to the sheer dominance of the GSM standard world wide today but is influenced by a number of factors:

- **Installed 2G infrastructure:**

  GSM systems are the most wide spread mobile network technology and are successfully operating in all five continents. More than one Billion subscribers are connected to the GSM networks today. The

evolution of GSM has already started with GPRS, followed by EDGE in a smooth upgrade path which fully re-uses the installed infrastructure. Similarly, W-CDMA is overlaid again by re-using the complete infrastructure. In a next step the W-CDMA system is enhanced with HSDPA. Recent decisions by IS-95 TDMA operators demonstrate that an increasing number of operators in North and South America are opting to join the widespread GSM/EDGE community. IS-95 systems are primarily operated in North and Latin America as well as in South Korea.

☐ **Spectrum award and license requirements:**

The 3G spectrum comprises paired and unpaired bands with the vast majority of licenses include a combination of both. The UMTS solution for the air interface covers both modes of operation. European operators together have opted for implementing W-CDMA and later TDD. In most countries there are requirements associated with the issue of the license such as the payment of a license fee and the prescription of a certain technology by the regulatory body. Coverage requirements and national roaming are often also defined.

☐ **Economies of scale, service continuity, terminal availability:**

Further important factors are economies of scale, service continuity and terminal availability/variety. As already mentioned, the

EDGE/UMTS route has a competitive edge due to the sheer dominance all over the world. Already today, more than 80% of the subscribers worldwide are connected to GSM systems. In future, more than 90% will belong to the family of GSM/GPRS/EDGE and UMTS W-CDMA. This then also ensures service continuity providing the end-user with a seamless access to 3G services. Handover as well as national and international roaming has its roots in GSM and is inherently part of a particular networks evolution to 3G. It can already be seen that the dominant position of GSM/UMTS is stimulating the terminal market in terms of availability and variety. Following industry forecasts, there will be 200 million UMTS handsets worldwide in 2005 and over 1 Billion UMTS subscribers by 2009. This market size will guarantee supply and variety with interoperability to legacy systems. The standardization in 3GPP has secured a smooth migration from the voice-driven GSM/TDMA standards to the mobile data world of 3G.

3G and the Broadband Wireless Environment

Various technological solutions are appearing in the market, which all aim at providing a technological response to the requirements for higher bandwidth and various levels of mobility. These will of course also enable operators to address new market segments, such as wireless DSL, on a technically and economically attractive basis. Deployment of these technologies within the next few years will lead to heterogeneous networks. The main new

technologies next to UMTS with its downlink and uplink enhancements (HSDPA and EUDTCH) are the OFDM based technologies such as WiMAX and FlashOFDM.

The biggest question facing cellular operators, who have already established networks, will be what benefit can be gained from investment in parallel technologies. Since acquiring new base station sites may be costly, co-siting for example the WiMAX base station equipment with installed cellular equipment is of high interest. Although from an architectural point of view the WiMAX network is an overlay, some practical arrangements for re-use of several network elements, e.g. transport, are possible. This is of particular benefit, if the backbone network is an IP network. In addition, this approach allows for a more stringent convergence of O&M of both networks resulting in substantial OPEX reductions (especially when the transport links are included).

Several levels of integration of both networks are considered to be viable:

- Co-siting of base stations with common use of transport capabilities, optionally in combination with common antenna usage
- Co-housing of the different technologies within the same base stations – including further effects as described above

- Integration of different technologies (carriers) on the same platform and control by the same controlling unit etc
- Integration of subscriber authorization and authentication

The path and grade of “integration” is dependent on for example, the grade of IP based transport. For a mobile network operator such a scenario could have some advantages:

- Additional competitive advantage by using single subscription capability for the existing cellular users
- Creating more traffic and thus more revenue
- Adding up network capacity in particular in hot spot areas
- Saving operational cost

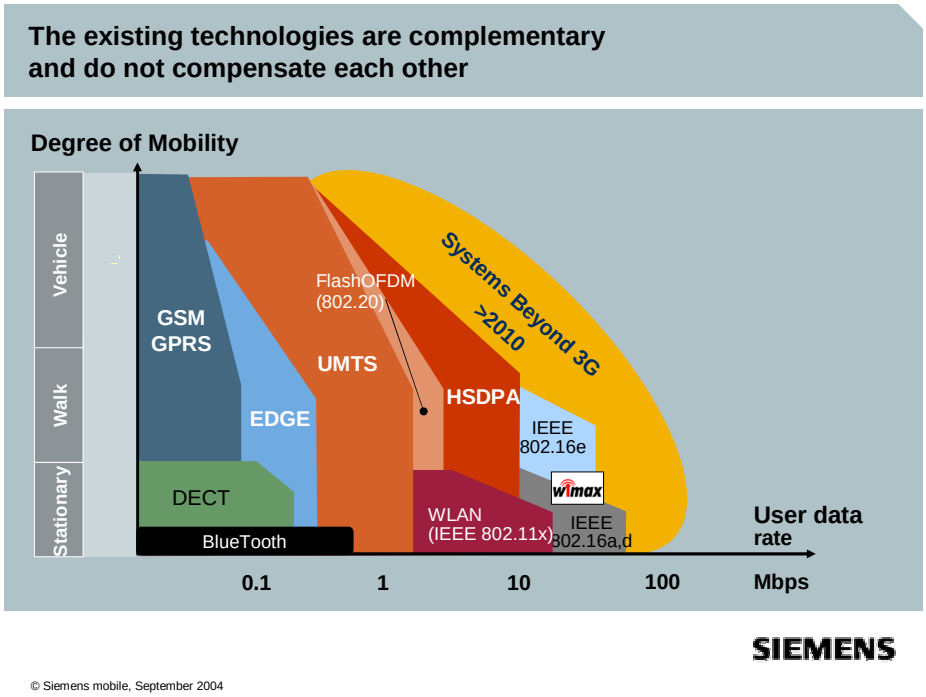

Figure: Comparing degree of mobility versus user data rate of various radio standards

All these considerations lead to a future scenario, where UMTS plays the central role for mobile operators including broadband wireless solutions. UMTS will be complemented by additional data focused technologies such as WiMAX and FlashOFDM. Hence, subscribers will expect integrated network solutions that ensure an access agnostic usage of services with a deep backend integration in terms of authentication, authorization, accounting and billing principles for service delivery across various technologies.

The decisive factors for success of a technology in a broadband wireless environment can be summarized as follows:

- **Time to market:**

  Technological maturity, standardization and availability of terminals are major factors determining opportunities for an early and successful time to market. New technologies such as FlashOFDM have achieved a lot of attention due to an early availability of a technology that provides attractive throughput and latency times. Based on such success, FlashOFDM for example will still need to continue on an evolutionary path towards a standardized and commercially scalable solution to achieve a broader footprint in the market. WiMAX with similar promising characteristics can benefit from a relative broad vendor support for standardization activities. Nevertheless, time will be needed to evolve to a true nomadic or even mobile wireless system, which is presumed to happen around 2007 or 2008. Actual progress will still depend on standardization progress and clarification of compatibility issues between various 802.16 variants. Intel´s strong backing for chipsets will help to overcome these hurdles and ensure strong terminal solutions especially in the PC and PDA area. Considering the hurdles, which still need to be taken by FlashOFDM and WiMAX, UMTS with HSDPA is likely to retain advantages over FlashOFDM and WiMAX for the next years to come, which will most

likely lead us into networks with a complementary integration and usage of UMTS and WiMAX or FlashOFDM. The fact that HSDPA has already been standardized since two years shows the broad vendor support in 3GPP. This forms a solid basis for a mature availability both of infrastructure and terminals in the year 2005 with volume market ramp-up in 2006 on a worldwide basis. FlashOFDM can clearly benefit from an early availability of mobility characteristics coupled with excellent throughput and latency times, while it still needs to prove that it can retain these advantages when moving towards a standardized solution to increase worldwide acceptance. WiMAX is poised to deliver to the same or similar promises. HSDPA enhancements will soon allow for UMTS to enter into the broadband wireless arena and leverage an excellent throughput and improved latency times based on its traditional strengths as a fully standardized, global cellular solution that provides carrier grade services with high Quality of Service for both voice and data. Its performance in terms of cellular efficiency and throughput will be close to future WiMAX and FlashOFDM solutions (assuming similar used bandwidth). But other than WiMAX and FlashOFDM, it will be able to support a broad range of legacy and innovative new services including multimedia and real-time applications.

- **Functional attractiveness:**

Examining the DSL market it can be observed, that different users needs are to be addressed:

"Fill in DSL": The customer in this case requires a higher data rate than his existing analog/ISDN wireline access is providing. The most obvious choice is a cellular subscription using e.g. a PCMCIA data card in a laptop (mobile data service bundle). The benefit is a service with highest mobility, high bandwidth, ease of installation and handling. W-CDMA/HSDPA can provide this. An alternative is if the customer is more focussed on bandwidth than on mobility. Then technologies such as WiMAX might be preferred with limitations in terms of handling but with advantages in positioning in terms of price per usage.

"Swap out DSL": This scenario is all about bandwidth, because the user might already have an fixed DSL subscription. The mobile operator could offer WiMAX at an attractive price to convince the customer to churn. The additional customer benefit compared to the fixed net is then the "playground" of "fixed/mobile convergence features" (e.g. "single numbering ", "virtual office" etc.)

"On the move": This scenario is all about mobility. Cellular technologies such as W-CDMA/HSDPA are providing optimum mobility (with fall back to 2.5G EDGE services) coupled with attractive throughput and carrier grade multimedia services. These have been designed to efficiently support voice and data with high quality of

service. Worldwide availability means that the user can have access with his device anywhere. This means ease of handling, seamless access authorization features and charging on 1 telephone bill.

☐ **Economic performance**

Economic performance is driven by many factors, which include equipment cost and basic physics of applied technologies. WiMAX and FlashOFDM are therefore likely to gain a place in the market for data overlay oriented solutions. But UMTS with HSDPA is set to play the main role in the future market as it covers both voice and data solutions within one system. UMTS HSDPA will thus be economically competitive to WiMAX and FlashOFDM. This is also due to the fact that it will be available to UMTS incumbents based on efficient upgrade approaches. The used frequencies in most countries are very likely to be lower than those to be used by the alternative technologies, which due to physics means a higher degree of coverage (reach). It is also interesting to note that expected refarming of GSM900 frequencies for UMTS will increase network and economic efficiency, as cell ranges and related potential for indoor coverage have to be seen as a major driver for economic efficiency. In this context, it is interesting to see that UMTS can not only economically perform for traditional cellular solutions, but also for most wireless broadband scenarios.

Network Infrastructure Development Cycles and Systems Beyond 3G

Research on mobile communication technologies to follow UMTS has been under way since the end of the nineties. This may sound astounding, considering the fact that UMTS networks have only just gone into operation in many countries of the world and that, in many other countries, UMTS licenses are still to be issued. Although development cycles are getting shorter, the history of mobile communication teaches us that research has always preceded market launch by up to 10 years. As analog mobile communication systems were introduced worldwide at the start of the eighties, it had already been recognized that digitalization would also play an important role in mobile communication, and the development of the second generation, GSM (Global System for Mobile Communication) began. The first GSM networks were set up ten years later, at the start of the nineties. The paramount goals of GSM were to establish mobile voice telephony for the masses, international roaming, provision of adequate wide-scale coverage, followed by expansion of system capacity due to the rapidly growing number of subscribers, and finally optimization of the networks. As market deployment of the GSM networks began, research work started on the network technologies of the third generation (3G). Since about the year 2000, licenses have been issued throughout the world, and 3G networks have been under construction with the first networks already in operation in 2003. The development of subscriber figures for 3G services corresponds to that for the

introduction of GSM more than ten years earlier. In Japan the growth of 3G is even greater than in Europe.

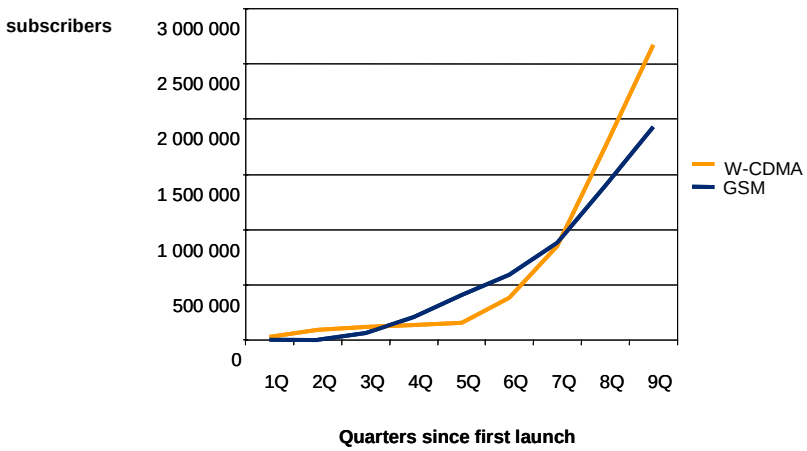

Figure: W-CDMA/GSM subscriber development when systems were beginning to be established.

Source: EMC Database, press and Finnish Communications Regulatory Agency, 2004

As already mentioned, the main motivation for development of the third generation was to support broadband data services up to a peak data rate of over 2 Mbit/s for multimedia applications of course coupled with international roaming. 3G systems address a mass market for mobile communication and expanded data services, including national and international roaming across various networks. These systems represent substantial progress in attainable throughput and flexibility. So looking back at the history of mobile telephony shows what long development cycles are needed to develop and standardize

new systems, to identify new spectrum, and also for regulatory matters, such as licensing processes. Thus it is understandable that discussions and initial research work for further development of mobile communication beyond 3G already began at the end of the nineties. These new manifold technologies, whose market launch is expected after the year 2012, are referred to collectively by the term “Systems beyond 3G”.

Communication technology has developed from voice-focused analog systems to digital data-oriented systems. In contrast to earlier mobile telephony generations in the development of systems beyond 3G, application scenarios are now the center of interest in research.

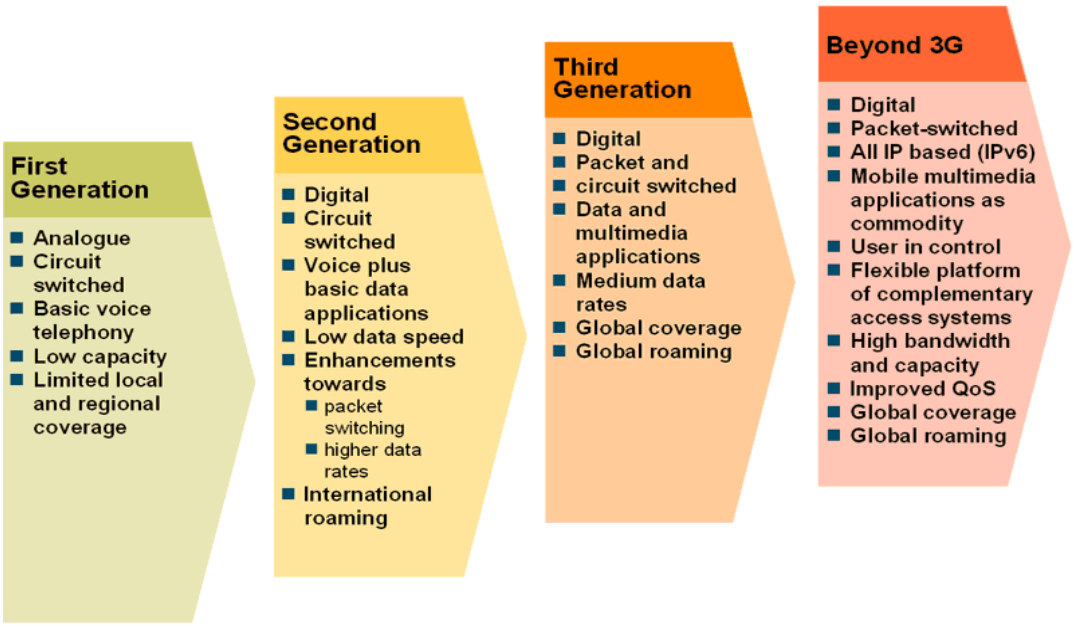

Figure: Paradigm shift from the first mobile communication generation to “Systems Beyond 3G“

Heterogeneous Networks Enable Migration and Evolution

Based on the today's envisaged service requirements, traffic expectations and radio access technologies the ITU-R (International Telecommunication Union – Radio Sector) is working on a heterogeneous system architecture. Such a concept enables a migration and evolution path for network operators from todays networks to systems beyond third generation (so called 'Beyond IMT-2000' in ITU) by reusing deployed investment. New access components can be added where and when needed for economic reasons. This ensures the requested scalability of the system. Possible new radio interface components are part of the concept. Different complementary access schemes will be part of systems beyond third generation. The different access systems cooperate in terms of vertical handover and seamless service provision. Reconfigurable terminal devices and network infrastructure will be an essential part of such architecture.

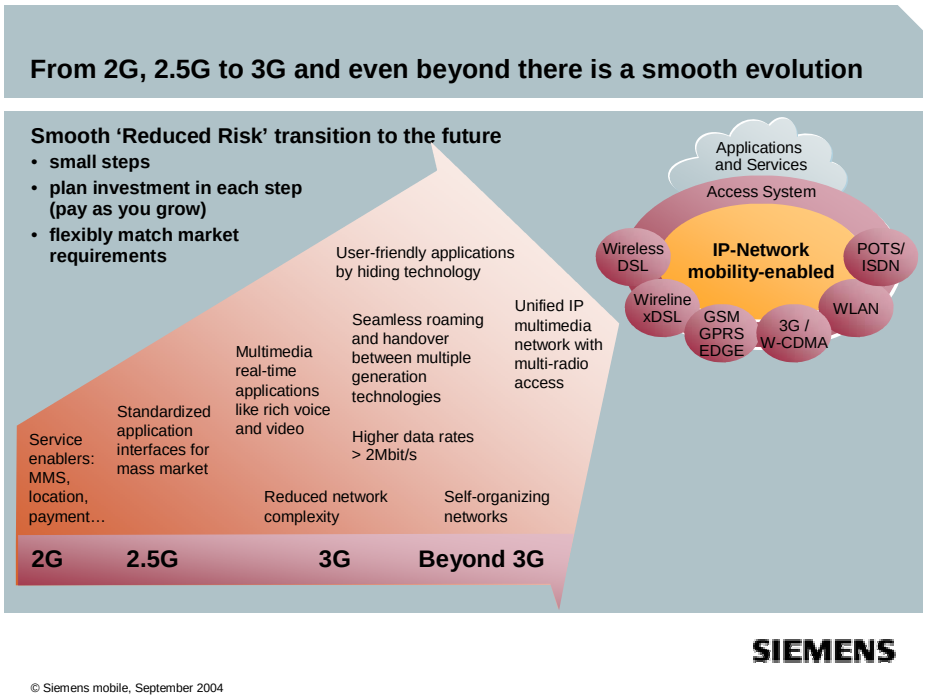

Figure: Seamless future network including a variety of interworking access systems

The different access systems will use already allocated and identified frequency bands and potential new frequency bands for the new elements. Therefore, no direct interference between different technologies is to be expected. All access systems will be connected to an IP based network. As interest in the market for mobile data and multimedia solutions increases, demand for higher throughput and improved system response times (latency) rises as well. At the same time opportunities arise to expand the mobile world into a broadband wireless solutions area.

Discussion of the Various Radio Technologies

GPRS – The Door-Opener to Mobile Data

GPRS is the first evolution step of GSM. GSM belongs to the TDMA group of Radio Standards. D-AMPS (Americas) and PDC (Japan) are other 2G standards based on TDMA technologies. GPRS introduces packet transport with data rates up to 172kbit/s (typically 10 to 20 kbit/s per time slot). The General Packet Radio Service (GPRS) operates in the GSM band and allows the efficient use of the air interface by packet-oriented data transfer rather than permanent channel occupation. Concatenation of channels results in potential peak data rates of more than 100 kbps, depending on cell load and interference levels. GPRS networks are already in place in many countries worldwide. Due to the low upgrade effort in the radio access network, the GPRS services are offered in urban and rural areas. Using four out of eight timeslots already an average user data rate of about 40 kbps, is possible (four times higher than GSM/TDMA rates).

EDGE – Running Multimedia Services in Existing Spectrum

The Enhanced Data Rates for GSM Evolution (EDGE) is an upgrade of a GSM/GPRS infrastructure using the same radio resources. EDGE is the approved 3G standard in existing GSM frequency bands and supports data rates up to 384 kbit/s (typically 40 to 60 kbit/s per time slot). Due to the advanced modulation schemes a higher data rate is achievable compared to

GPRS; 474 kbps is feasible under optimal radio conditions. In general one speaks of average bit rates between 100 and 300 kbps. With these data rates it is possible to offer 3G services based on 2G systems. Therefore, EDGE is the ideal solution for operators that do not own a 3G license but have sufficient spectrum available. In a subsequent step an upgrade towards W-CDMA remains an option. EDGE is also attractive to operators owning 3G spectrum as it complements the UMTS technology and is seen as enhanced GPRS. Especially for rural areas where W-CDMA may initially not be deployed due to economic reasons, EDGE allows the provision of multimedia services nationwide. Additionally, EDGE increases the cell capacity for voice services. From an investment point of view, EDGE can easily be introduced to GSM systems. It is primarily a software upgrade of the latest GSM base station systems.

GERAN – Seamless Multimedia Mobility

The GSM/EDGE Radio Access Network (GERAN) is defined in the 3GPP Release5 and forms the latest step in the evolution of EDGE. The design goal of GERAN is the alignment with UMTS. GERAN allows the connection of the EDGE radio access network to the UMTS Core Network. The alignment with UMTS results in full support of all four bearer services defined for UMTS. Real-time and non-real time services can be offered to the end-user. Roaming between the GERAN and UMTS networks will be seamless. With respect to the voice service, GERAN is able to double the capacity of an EDGE network with the use of quarter-rate channels.

UMTS (FDD/W-CDMA, TDD/TD-SCDMA) – Steps to Multimedia Services

The UMTS air interface comprises two access modes, FDD and TDD. Both access technologies are based on CDMA techniques with enough bandwidth for a smooth provision of real-time and non-real-time services. The Frequency Division Duplex mode (FDD) – also called Wideband CDMA (W-CDMA) – operates on paired spectrum, using 2 x 5 MHz carriers. In the license auctions and beauty contests paired and unpaired spectrum was awarded to the operators, typically as a combination of both within one license. Most operators with new spectrum will start to roll-out their network with W-CDMA technology providing macro cell coverage for peak data rates of 384 kbps in urban areas. Due to the worldwide acceptance of GSM/W-CDMA dual mode handsets will be available in high quantity and variety. UMTS is the consequent evolution of the narrowband GSM technology using CDMA transmission based radio access techniques. This copes with rising demand on more capacity and user data rates whilst building on a proven core network concept. The UMTS FDD (Frequency Division Duplex) mode also known as W-CDMA is defined for peak data rates of 2Mbit/s in low mobility applications but currently is limited to 384kbit/s. W-CDMA is currently being rolled out in Europe and the Asia Pacific region. In Japan, it is commercially in operation under the brand FOMA. The UMTS TDD (Time Division Duplex) mode has High Chip Rate (5MHz) and Low Chip Rate (1,6 MHz) variants (both with 2Mbit/s peak data rates) for hot spot and mobility applications respectively. A special scenario has arisen in China, where an

additional 120 MHz spectrum has been dedicated for TDD in addition to the normal IMT-2000 bands (total TDD spectrum in China therefore 155 MHz) as a result of the TD-SCDMA standard (Low Chip Rate) being accepted in IMT2000. TDD is the optimized solution for unpaired spectrum: Uplink and downlink traffic can be transmitted on the same carrier frequencies but in different time slots. The technology more commonly known as TD-SCDMA now, is a combination of TDMA and CDMA principles with other capacity enhancing techniques such as smart antenna technology and advanced digital signal processing. TD-SCDMA is a full 3G Radio Standard approved by the International Telecommunication Union (ITU) in its IMT-2000 family. 3GPP incorporated TD-SCDMA in March 2001 as art of UMTS Release 4. This has made TD-SCDMA a truly global standard that covers all radio deployment scenarios, from rural area macro cells to dense urban pico cells. It supports all application types: voice and data, low (pedestrian) and high mobility. With data rates up to 2Mbit/s, TD-SCDMA offers sufficient bandwidth to handle the data traffic for multimedia and internet applications. Its TDD nature allows TD-SCDMA to master asymmetric services (Internet download) very efficiently. Adapting the uplink/downlink ratio according to data load within a single unpaired frequency band optimizes the capacity of the air interface, thus utilizing the spectrum more efficiently. TD-SCDMA offers a smooth and seamless way of introducing 3G mobile networks and services. A UMTS-operator with FDD and TDD spectrum can opt to deploy TD-SCDMA as a complement to W-CDMA. Such deployments are called TDD-LCR, a fully 3GPP Release 4 compliant solution. It is expected that the

first commercial TD-SCDMA networks will be deployed in China in 2005/2006; at that time multi-mode GSM/GPRS/TD-SCDMA terminals will become available. The mass deployment in the world's largest market will ensure significant economies of scale and make the standard attractive to other countries in Europe and in the rest of the world. Outside China, TDD has not yet become reality, as operators seem to have sufficient network capacity with GSM and W-CDMA (UMTS FDD Mode) for some years to come. TDD is also currently being trialed as a data only product in Europe where it supports only the packet-switched data part of the standard to address the WLAN-like hot-spot market with high-speed mobile Internet access.

HSDPA - The Step Beyond W-CDMA

High Speed Downlink Packet Access (HSDPA) is an enhancement of W-CDMA. 3GPP has foreseen this access technology in its specifications of UMTS Release 5. HSDPA increases the spectral efficiency by using higher order modulation schemes. User data rates of over 10Mbps (theoretical peak of 14,4 Mbps) on the downlink can be achieved. Typically under interference conditions this is between 1 and 3 Mbps which is comparable to Wireline DSL. Primarily, HSDPA will be deployed for dense urban and indoor coverage. The solution is able to cope with the growing demand for higher cell capacity. HSDPA will be commercially available in early 2005. HSDPA is the high speed downlink component. In order to balance the up-and

downlink, the 3GPP is in the process of standardizing the corresponding uplink, namely EUDTCH which will provide up to 1,5 Mbps on the uplink.

cdma2000

IS-95 and cdma2000 are the counterparts to GSM and UMTS respectively. The market comprises mainly USA, Korea, as well as China and Japan. Market estimations indicate, that the market share will maximally reach 20% of the total subscriptions worldwide. The cdma2000 family of systems forms the technical evolution path towards 3G for the IS-95 systems. It comprises the following radio transmission technologies (RTT): 1xRTT,1xEV-DO and 1xEV-DV. In the first phase of cdma2000,1xRTT provides data transmission capability with peak data rates of up to around 144 bps, comparable to GPRS. The data rate and cell capacity can be increased using the future developments xEVDO (data only) and 1xEV-DV (data/voice). When deciding about the most profitable migration from 2G to 3G not only mere technical factors are taken into account but also economic issues. With respect to economies of scale and terminal availability UMTS/EDGE has clear advantages over the cdma2000 solution as it can be argued that UMTS will be the dominant 3G technology on a global scale.

OFDM Transmission Based Radio Access Techniques

OFDM (Orthogonal Frequency Division Multiplex) is now finding wide application as a result of recent advances in digital signal processing

capabilities. OFDM promises a higher efficiency on the air interface due to the its inherent interference canceling nature.

The IEEE 802.xx family of standards are nearly all based on OFDM.

IEEE802.11a/g – WLAN: is a short range access technology for wireless indoor (home and office) usage with data rates up to max. 54Mbit/s. It is an extension of Ethernet LANs. Due to low ranges, unlicensed spectrum and security issues, WLAN is useful only in limited hot spot applications, i.e. not suitable for public wide area broadband services. Currently much useful work is being done to couple WLAN with mobile networks (bundled services, authentication and billing). Note: IEEE802.11b is not an OFDM based technology but otherwise the same applies as for a/g.

IEEE802.16a/d – WiMAX: is aimed at fixed wireless access and WLL market (point-to-multipoint) with peak data rates of max. 70Mbit/s.

IEEE802.16e – is an extension of 802.16a/d introducing mobility functions and allows nomadic CPE (customer premises equipment). This technology may soon establish itself as a data only technology and wide area complement to 802.11 hotspots.

IEEE802.20 is intended as a stand-alone cellular standard for ubiquitous coverage. Bit rates may be lower than for WLAN because of a wide band approach. It will have both frequency and time division components. Currently no technology has been chosen. Proprietary systems like Flash-OFDM (Flarion) for paired bands and i-Burst from ArrayComm for unpaired

bands are potential candidates. Both are pure IP-based packet-switched data-only solutions and, therefore imply that 802.20 will be competing with W-CDMA/HSDPA, HCR-TDD or 1xEV-DO from cdma2000. OFDM is also in discussion as the basic transmission technique for all technologies beyond 3G. Data rates of approx. 100 Mbit/s in the low mobility arena are expected by using a broad band approach. Otherwise OFDM is the basis for digital audio broadcast and some fixed wire transmission techniques (xDSL). This is making the required signal processing technology cheaper.

Conclusions

All these considerations let us believe in a future scenario, where UMTS will play the central role for mobile operators including broadband wireless solutions, It will be complemented by additional data focused technologies such as WiMAX and FlashOFDM. Hence, subscribers will expect integrated network solutions that ensure an access agnostic usage of services with a deep backend integration in terms of authentication, authorization, accounting and billing principles for service delivery across technologies.

New technologies such as WiMAX open new opportunities for cost-effective wireless broadband service deployments. Many vendors are going to provide their system solutions and products. WiMAX systems according to the forthcoming standard can be used as stand-alone solutions for incumbent

and green-field fixed network operators or as complementary solutions for mobile network operators with a broad installed base. WiMAX Access System will support real-time and non-real time fixed and nomadic services. It provides an excellent cost-effective, wireless option to wired xDSL systems for delivering broadband services to residential users, small-office-home-office and small-to-medium size enterprises.

Looking at mobility as a driver for the implementation of wireless systems, a wide range of mobility needs can be observed ranging from fixed, through nomadic, to high speed vehicular. Fixed wireless access is becoming a simple use case of the sophisticated 3G systems. Mobility and bandwidth are a trade off which has been maximised in the UMTS system. Generally, higher mobility speeds mean lower bandwidth. UMTS is achieving state of the art bit rates comparable to wireline DSL speeds at high mobility. As opposed to UMTS, OFDM based systems e.g. WiMAX represent a new generation of systems also targeting the wireline speeds but at the lower end of the mobility range (Wireless-DSL). It follows, that standardization bodies are now focusing on the increasing demand for wireless mobile data services for which user rates comparable to today's wire-line subscribers (DSL) are needed. This includes 3GPP for cellular UMTS standard as well as the IEEE802 group for wireless LAN (IEEE802.11) more commonly known as WiFi, and the wireless MAN (IEEE802.16) more commonly known as WiMAX.

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Glossary

1xEV-DO	Evolution of cdma2000 operating with one 1.25 MHz RF carrier for data only
1xEV-DV	Evolution of cdma2000 operating with one 1.25 MHz RF carrier integrating voice and data
1xRTT	The first cdma2000 phase as upgrade from IS-95 for providing 3G services in one 1.25 MHz RF carrier.
2G	Second generation of cellular mobile systems. In contrast to first generation systems based on digital transmission technique and primarily designed for voice communication. Typical 2G radio systems are GSM, IS-95, and D-AMPS.
3G	Third generation of mobile communication system featuring higher data rates (up to 2 Mbps) and packet switched services for wireless Internet. 3G radio standard are for instance W-CDMA and cdma2000.
3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
AMPS	Advanced Mobile Phone Service; US analog standard
CDMA	Code Division Multiple Access
D-AMPS	Digital AMPS; 2G US radio standard based on TDMA
EDGE	Enhanced Data Rates for GSM/Global Evolution
EUDTCH	Enhanced Uplink Data Traffic Channels
FDD	Frequency Division Duplex
GERAN	GSM EDGE Radio Access Network
GPRS	General Packet Radio Service

GSM	Global Standard for Mobile; worldwide 2G radio standard
HSDPA	High Speed Downlink Packet Access; advanced W-CDMA technology for downlink peak data rate of 10 Mbps.
IS-136	Interim Standard #136; 2G US radio standard based on TDMA, also known as D-AMPS
IS-95	Interim Standard #95; 2G US radio standard based on CDMA
MC-CDMA	Multi carrier CDMA; 3G radio standard from cdma2000 family operating with three 1.25 MHz carrier and also referred to as 3xRTT
PDC	Personal Digital Cellular; Japanese 2G radio standard
TD-CDMA	Hybrid Time Division / Code Division Multiple Access; 3G radio technology used for operation in unpaired IMT-2000 bands that is referred to as high chip rate UTRA-TDD with 3GPP standardization
TD-SCDMA	Time Division / Synchronous Code Division Multiple Access; 3G radio technology used for operation in unpaired IMT-2000 bands that is referred to as low chip rate UTRA-TDD with 3GPP standardization
TDMA	Time Division Multiple Access; primarily a multi user access techniques, but often misleadingly used as synonym for D-AMPS
TDD	Time Division Duplex
UMTS	Universal Mobile Telecommunications Systems
UTRA(N)	UMTS Radio Access (Network)
W-CDMA	Wideband CDMA; 3G radio standard that is referred to as UTRA-FDD with 3GPP standard

Contact for the press

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