Lucent Technologies is the world-class force behind the next generation of wireless networks. Innovation is at the heart of our business. The GSM/UMTS Centre of Excellence in Swindon UK, and the facilities of Bell Labs Research worldwide are shaping the ways we can unite our world. With unchallenged market leadership in CDMA radio access and IP/ATM backbone networking technology, Lucent was the first to trial 3G networks on four continents with NTT DoCoMo in Japan, Vodafone AirTouch in Europe, Sprint PCS/Bell Atlantic Mobile and AT&T Wireless Services in the USA and Telstra in Australia.

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Brochure Number GSM MIG 10/00

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Lucent Technologies
Bell Labs Innovations

A Guide to GSM Network Migration

Why Lucent Technologies should be your partner of choice.

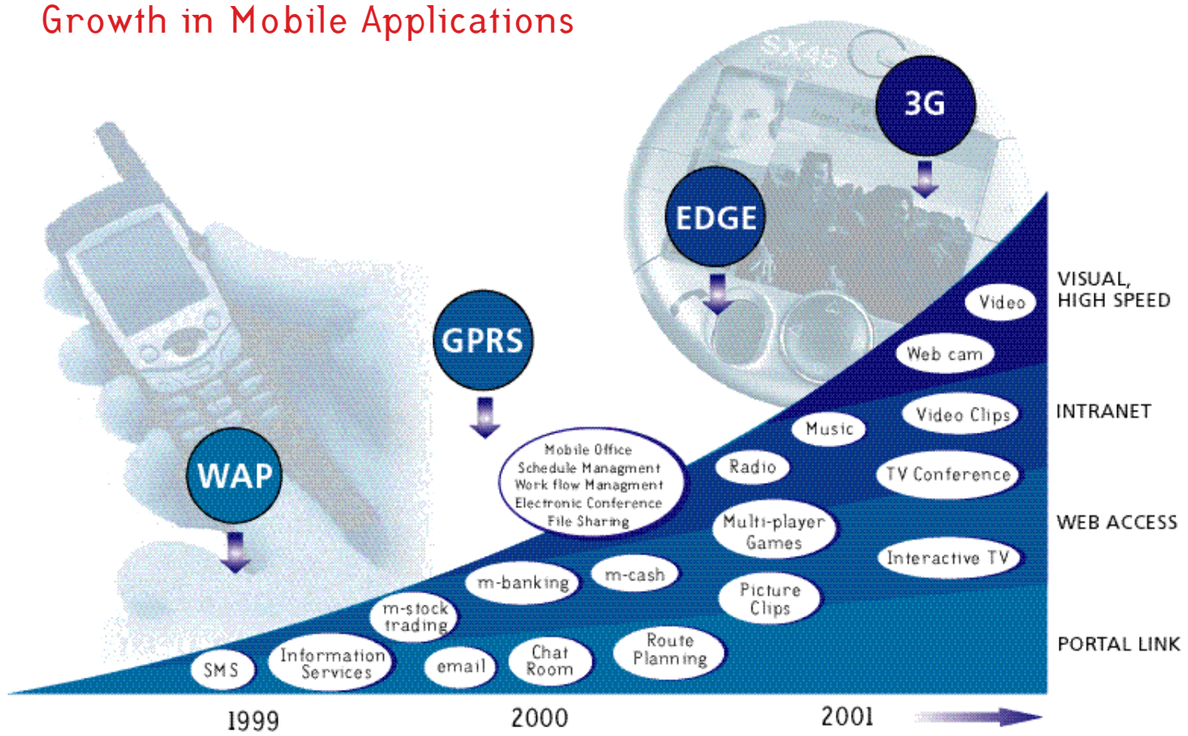
The rapid growth of mobile applications, including the meteoric rise in the use of SMS messaging, has outstripped the ability of today's voice-centric networks to keep pace. This has further fuelled the current world-wide activity on the specification and design of third-generation Mobile communications technology, often referred to as 3G, in accordance with the ITU's IMT-2000 initiative. 3G systems will provide access 'anywhere, anytime' to a broad range of data-centric services and applications, as well as seamlessly handling voice-based communications.



Such a broad-reaching target is not achieved overnight. In response to the rapidly rising demands for higher bandwidth, the mobile communications industry and international standards bodies have wisely chosen a number of 'technology stepping stones' along the way to 3G services. These will not only minimise the disruptive impact on Operators, and allow the technology to mature, but will crucially also allow much earlier deployment of mobile data applications with the corresponding revenue-generating opportunities.

Do We Really Need To Change?

Growth in Mobile Applications



The mobile market has grown way beyond our hopes and expectations, with more than 450 million mobile users world-wide – Industry analysts Ovum have predicted that this figure will reach 1 Billion by the end of 2002. The introduction of revolutionary pre-paid services alone has prompted enormous growth - Vodafone AirTouch, for example, predict that up to 95% of users may be pre-paid by 2002.

The success of SMS demonstrates a staggering growth in messaging, with more than 9 billion GSM SMS messages sent during August 2000 (source: GSM Association Sept 2000). This is widely acknowledged to be a sign of things to come, and data could represent more than 45% of all mobile traffic by 2003 (Merrill Lynch). A recent survey by Allied Business Intelligence forecast that the total world wireless data subscriber base would grow from around 26 million currently to more than 240 million by 2005.

Also note that most of the growth applications are those that will thrive in a mobile environment, such as mobile Internet, E-commerce or M-Commerce, entertainment, information, location-based services, as well as communications. These insatiable Internet-based applications will help raise the ARPU (Average Revenue Per User) and ensure the success of the more dynamic operators.

These are not merely industry forecasts – the evolution has already started. Japan, for example, has recently announced that it now has more than 15 million subscribers to cell phones with Internet access, out of a total cell-phone population of around 54 million.

The new generation of Operators and Service Providers will be able to add value and revenue through launch and support of these new services, and through advanced billing concepts which enable charging by data and/or content delivered, not just by call duration.

Content will become increasingly important to revenue generation – a fact which has prompted Lucent's strategy of providing the 'Killer Environment' in which Operators and Service Providers can develop their 'Killer Applications'. Realising that some operators and providers do not have all the in-house capabilities themselves, Lucent has already entered into over 100 application-developing partnerships, and has further demonstrated it's closeness and commitment to the market by creating a number of Mobile Internet Innovation Centres in key locations around the globe. Existing and prospective clients are encouraged to use these centres to help develop their new applications.

Mobility is already seen as a necessity, not a luxury, for both business and social users. However, existing networks are already stretched – particularly in Europe. The dramatic increase in users, and the ever-increasing growth in data usage and applications, call for network evolution or revolution rather than simple scaling-up of existing networks.

What Steps Do We Need To Take?

During the specification stage, it has always been a major design objective to enable smooth migration from 2G/GSM through 2.5G (GPRS, or GPRS + EDGE) and if desired on to 3G/UMTS.

GPRS, or General Packet Radio Service, is an essential and integral step in evolving the networks so they will support the explosive growth in mobile data applications and mobile commerce already underway. By introducing packet-switching capability, it allows operators and service providers to generate revenue NOW as more and more applications come 'on-line', and will also fuel the development of even more applications by bringing the vision of the future one step closer.



EDGE (originally standing for Enhanced Data rate for GSM Evolution) will enhance this data capability further, by the use of advanced modulation and coding techniques in the radio interface to provide higher data rates (up to 384Kb/s). EDGE, also referred to as EGPRS (Edge-enhanced GPRS), upgrades the air interface between the Base Station and the mobile terminals. (Lucent's Flexent™ Macrocell Base Station is already EDGE-ready.) The GPRS network hardware needs no modifications, although significant use of the higher band-width available with EDGE may necessitate some additional backbone bandwidth to handle the extra (revenue- generating) load. With Lucent's scaleable and flexible solution, this can be added incrementally as the demand rises. Note that, as with GPRS, there are a number of options available whereby the Operator can make 'trade-offs' between data rate, error protection and bandwidth availability. EDGE technology is also being promoted for up-grading TDMA networks - another demonstration of technology convergence - in this case the acronym itself evolves to Enhanced Data for Global Evolution.

When fully developed, EDGE will also enable real-time IP-based services over GSM networks equipped with GPRS and EDGE upgrades. Yet another acronym springs into existence at this point, in the form of GERAN, which stands for GPRS/EDGE Radio Access Network. Operators can then choose to offer 3G-like services with their upgraded legacy networks, rather than convert to all-new UMTS 3G networks. This can be a very attractive option where Operators do not have access to a 3G license, or where it is more cost-effective, at least initially, to only install UMTS in the heavily-populated areas. In fact the U.S. market is treating EDGE-enhanced TDMA as a 3G technology.

UMTS is the ETSI-defined standardisation proposal for Third Generation cellular systems (3G), defining the Universal Mobile Telecommunications System, and covers the European and Asian ETSI-based realisation of the ITU's IMT-2000 vision of global mobile access. Although not specified exclusively, Wideband-CDMA is the favoured air interface standard to be used to achieve this vision, and IP over ATM is the favoured core network structure. Lucent Technologies is the leading supplier of wireless CDMA network equipment in the world, based on subscriber connections, and has unequalled experience in network installation and management. Lucent are also clear market leader in the supply of ATM access equipment (C.P.E. and C.O.) with around 72% of sales during Q1 2000 (Synergy Research Group report - June 2000), and is the leading provider of VoIP networks to carriers, ISPs and enterprises.

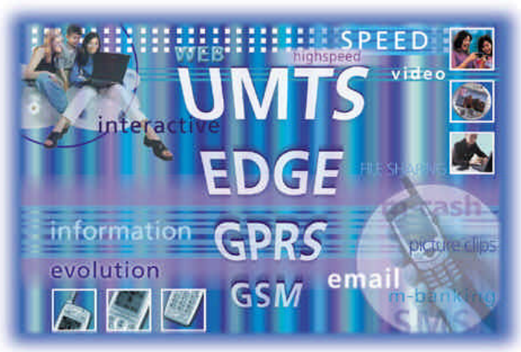
UMTS spectrum licenses are already being assigned by auction around the globe, and many new operators are challenging the existing ones for position. There is little doubt that UMTS will eventually provide superior performance for a given cost compared with legacy networks, even after upgrading with GPRS and EDGE. However, many Operators are unwilling to take the risk of widespread customer desertion while they wait for UMTS systems to become fully available. This explains the strong forecast take-up rates for both GPRS and EDGE, and why Lucent offers solutions to support all migration paths.

Of course, it is not just GSM networks that are undergoing the 3G revolution/evolution. CDMA and TDMA are also evolving. Lucent Technologies is one of very few vendors which can offer solutions that cover all these migration strategies in a coherent and structured way, whatever the current level of installed equipment.

The two 'stepping stone' technologies which enable and smooth this transition towards 3G services are GPRS and EDGE.

GPRS is an ETSI-defined data-enabling technology upgrade for GSM cellular infrastructures. GPRS is being trialled and deployed around the world NOW, using the proven benefits of packet switching technology (as used in the Internet, Frame Relay, ATM, Ethernet, etc..) to add true mobile data capability to digital cellular networks.

This not only solves today's problems (how can I carry on working on the move, is there a good restaurant nearby, I need that customer presentation downloaded NOW....), but is literally creating a new dimension for mobile connectivity, for both professional and social mobile users and service providers.



GPRS adds this extra dimension by creating a link from your mobile voice network to an IP-based data network. This not only provides an essential route for the growing volume of data traffic, but also forms the first link in the path towards an all-integrated third generation multi-media mobile network.

Why GPRS? Why another data standard?

GPRS has been designed specifically for the efficient transmission and management of mobile data, and offers all the advantages of packet switching – for example, efficiently-shared network resources, 'permanently connected' so very fast call set up time, Internet compatibility, transition to IP and/or ATM networks, etc. It not only supports today's fast-growing applications, but also enables rapid and very cost-effective deployment of 'Next Generation' services, and is an essential step on the road to 3G.

Can you explain the term Packet-Switching?

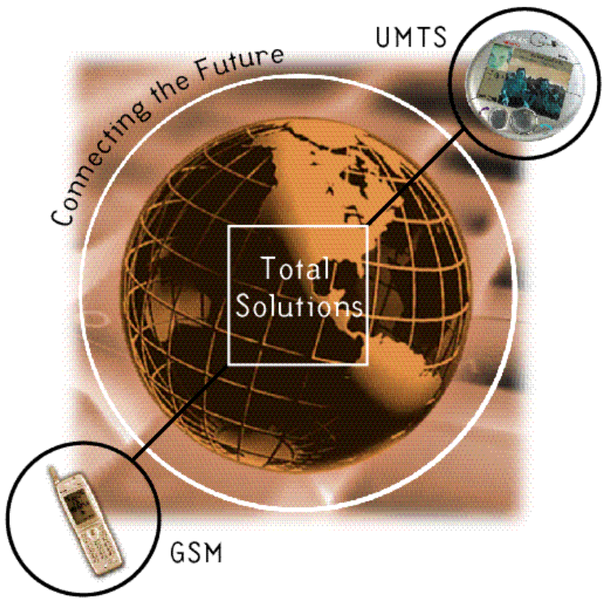
Voice networks to date have been constructed with circuit-switched technology – when you set up a call, you literally connect a dedicated circuit between the parties. This inevitably means that most of the resource associated with that circuit path is unavailable to anyone else for the duration of that call. This may be tolerated, if not particularly efficient, with voice-only traffic as there are not many silent (unused) periods. It would be totally unacceptable for, say, browsing the internet, where a lot of data is typically downloaded to the user in a burst, who then studies it as his leisure with the comms link now idle.

Packet-switching operates by splitting your data stream into a set of containers called packets, which are transmitted with other user's packets over a common circuit, before being separated and re-constituted at the far end. (You can think of this in much the same way that a set of railway cars can carry a number of different containers over long distances, but each is routed to its own destination at the far end).

This sharing of resources leads to a much more cost effective transmission system, particularly for data-based applications. This in turn leads to lower installation and operating costs, and the ability to upgrade to revolutionary, usage-based billing schemes (high-rate users pay more than occasional users, like domestic electricity, gas or water metering).

So exactly how do I add GPRS to my GSM network?

1. GPRS uses the same air interface (i.e radio transmission system) as 2G GSM, be it GSM900, 1800 or 1900 – so no change is needed there. It is also suitable for the 450MHz and 700MHz bands currently under discussion.
2. Voice traffic will continue to be sent over the existing infrastructure – again no change is required. (In the near future some voice traffic may be sent over the 'new dimension' data network - Lucent was the first company to successfully demonstrate voice over a GPRS network.)
3. The base stations will need upgrading to separate the voice and data traffic – with Lucent's solution this is a simple, software-only upgrade, giving minimum service disturbance.
4. Connection to the overlay GPRS Backbone Network (GBN). Data is routed over standards-based interfaces to the GPRS Support Nodes, which form the gateways to the GBN. Data is then routed through the IP-based core network to the required destination, the Internet, a corporate Intranet, ISP, etc. (The exact choice of core network is flexible, but an ATM-based core will guarantee easy migration towards UMTS.)



What does this do to my existing voice traffic?

The introduction of GPRS only requires the use of one 200kHz channel - the time slots are then aggregated to provide user data rates up to an absolute maximum of 171kb/s. In practice this rate will rarely be available to the user, as some of this bandwidth is usually needed for 'house-keeping' and error protection functions. (It is for this reason that 115kb/s is often quoted as the maximum possible data rate for GPRS.) Typical user rates are more likely to be around the 25-56kb/s level, which exceeds that currently achieved by many PC modems over land-lines.

The data rate available will depend on a number of factors, and there are a number of options available whereby the Operator can make 'trade-offs' between data rate, error protection and bandwidth availability.

In the near future some of the ever-increasing voice traffic may also be able to be transmitted over the GPRS data backbone – another step towards the fully integrated network. Lucent Technologies offer solutions to make these transitions in a smooth and cost-efficient manner to match network growth with the availability of new technology.

Is GPRS gaining wide acceptance, and if so what timescales are involved?

The recent GSM2000 Industry Survey showed that between 50 and 70% of operators who responded plan to launch GPRS services within the next 12 months, with 80-95% planning to have launched by the end of a further 12 months. 26% are 'pilot testing' already, and 27% within Western Europe plan to launch services within the next 6 months. GPRS is widely quoted as being 'the Wireless Revolution of the year 2000.'

Are GPRS terminals readily available?

GPRS mobile terminals are being developed by most of the leading GSM handset manufacturers, and also by many new generation suppliers targeting the new wave of services and applications. Lucent has launched the first GPRS handset to the market with Samsung, and also has strong working relationships with Sony, Siemens and several others. Lucent has deliberately chosen to work closely with a number of market-leading handset and terminal providers in order to provide a wide range of terminal devices that therefore have proven compatibility. This guarantees that the consumer will have the widest choice of fully-interoperable equipment depending on his needs, in true consumer marketing fashion – we see this as particularly important because the trend in 2.5G and 3G will be towards multi-purpose mobile terminals rather than simple telephones. Our technical know-how and advanced ASIC capability has already produced GPRS chip sets which are being integrated into a number of the leading manufacturers handsets.

Expect great things.[SM]



Inventing the Things That Make Communications Work.

During the more than 100 years that it was a part of AT&T, Lucent Technologies invented the telephone, transistor, satellite, cellular radio, and countless other innovations that have forever changed the way people live, work, and play. Today, Lucent Technologies is one of the fastest growing telecommunications companies in the world, harnessing Bell Labs innovations to offer customers creative solutions that meet their evolving needs. From communications to motion pictures and television, from aerospace to outer space, Bell Labs has been a driving force in our modern world. Notable 'firsts' include the transistor, the laser, Shannon's Information Theory, the UNIX operating system, and many, many more.

Lucent Technologies designs, manufactures, and markets total-system solutions for the global communications industry, and provides network infrastructure to 23 out of the top 25 network operators world-wide.

Lucent is the only vendor to achieve 6 x '9's availability (99.9999%) for 5 consecutive years (FCC ARMIS 1999 data) with its '5ESS' core network switch. This figure equates to a factor of 20 times less 'downtime' than the other three major network suppliers, and helps to explain why the 5ESS is the most highly deployed switch in the world.

Lucent's Wireless Networks Group is the major provider of wireless infrastructure in North America, and strives to be the major global supplier that delivers wireless solutions for ALL current air interface standards – GSM, CDMA, TDMA, and AMPS. Lucent is committed to supporting the migration of these standards towards the provision of 3G services.

Lucent's 2G GSM equipment has gained an enviable reputation for reliability and rapid, trouble-free deployment, and uses the strength of the 5ESS switch to provide true, carrier-class service. The product portfolio has been designed to implement and support the migration towards 3G services, with total commitment to GPRS and EDGE technologies.

Lucent has been the critical partner in T-Mobil's recent launch of one of the world's first operational GPRS networks, which will provide high-speed mobile Internet and data services to T-Mobil's 13 million customers in Germany. The Flexent™ GSM Macrocell base station is already GPRS and EDGE-ready, offers very significant cost and space savings to Operators, and it's speed and ease of deployment are setting new standards in the industry.

Every day, all over the world, Lucent Technologies is changing the way we live. In the race towards 3G mobile networks, Lucent is uniquely placed to become the next-generation leader, thanks to our unmatched network design and deployment expertise across all digital air interfaces. Lucent is the world's largest communications equipment supplier, the undisputed market leader in wireless CDMA networks (on which UMTS is based), and the leading supplier of IP/ATM packet switching networks to service providers.

Lucent therefore excels in all the technologies chosen for 3G systems, and not surprisingly were the first vendor to commence 3G equipment trials on four continents.

Expect great things.℠

Lucent 3G solutions are based on a range of future-proof, innovative, yet standards-based platforms under the Flexent™ banner which are fully upgradable to support all envisaged 3G migration and convergence paths, whatever the air interface. Our Flexent™ GSM Macrocell Base Station is already winning us business around the world.

Our capabilities do not stop there – our Mobile Internet group is focused on supporting the enormous growth in mobile data applications, and the breadth of our in-house expertise together with our many business partnerships enable us to offer an unparalled application development environment.

Lucent Technologies offers complete, end-to-end solutions, which are scaleable, modular, flexible and reliable. You are guaranteed minimum service interruption and start-up times with Lucent, because the equipment capability can be increased seamlessly as demand grows, giving maximum ease of deployment, minimum downtime, and maximum revenue generation capability throughout.

Our policy of working with a number of well-known handset providers ensures that our customers can choose fully compatible products from a variety of world-class suppliers, such as Samsung, Sony and Siemens. Despite capabilities unmatched within the industry, Lucent recognised that even we could not offer everything needed to fulfill the intense breadth of market demand, hence our programme of acquisitions and strategic partnerships with other best-in-class solution providers, most notably Ascend, Kenan, Logica, Optimay, Phone.Com, Quadritek, Qualcomm, Sun and Symmetry. When added to Lucent's armoury, this makes a truly formidable technology arsenal with which we can lead the way with smooth migration towards 3G services.

We have already achieved a very significant number of 'firsts', including:

- First GPRS multi-slot data application demonstration
- First GPRS handset/mobile terminal on market, with Samsung
- First voice over GPRS demo Telecom 99
- First live national GPRS switchover
- First 1Mb/s data call over UMTS air interface
- First vendor selected for 3G trials on 4 continents
- Lucent Microelectronics leading edge Sceptre® 3 chipset.
- Leader in converged billing solutions

Our best-in-class performance in IP/ATM/packet data networking, our strength in all global cellular technologies, coupled with our undisputed world-leading position in CDMA wireless systems and telecommunications solutions, puts Lucent in pole position to deliver the next generation of mobile networks.

