217

THE BENEFITS OF MOBILE DATA HOW CAN THEY BE REALISED ?

Task Force
35.07

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TASK FORCE
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CONTENTS

1. OBJECTIVES

The idea for a Task Force to examine mobile data in the utility sectors came from the Study Group 35 Session at the Paris Congress in September 2000.

Many commercial companies are being subjected to claims from network operators and suppliers of hardware and software as to the benefits which mobile data can bring to their operation. As with many new products which are in their infancy, there is a variety of technical terms, services and applications. These reflect new possibilities but also serve to bring confusion and misunderstanding as to the actual performance of many products. This is compounded by a lack of common standards.

This short study was set up to:

- examine the needs of utility companies for mobile data services
- provide an overview of telecommunications system and services which can support data services
- illustrate some practical examples where benefits have already been realized by utility companies and commercial organizations.

The aim is to provide utility company Managers and Technical staff with a view of what has been achieved to date using a range of telecommunication technologies and to look at emerging technologies in order to understand what options will be available in the foreseeable future. The report is not restricted to the telecommunications elements of mobile data, it seeks to look at the business drivers within utility companies and to explain how these needs can be met by the implementation of new technology.

2. EXECUTIVE SUMMARY

2.1 Background

A common theme in utility companies, be they Government or investor owned, is the containment or reduction of the cost base whilst maintaining and in many cases improving business efficiency and performance.

The realisation of resultant changes in working practices is forcing utility companies to review the communication networks and services that support their businesses.

These business drivers are forcing companies to re-evaluate their mobile communications needs for both voice and data. To date, utilities have generally made little use of mobile data, but the pressure to push desktop IT solutions into the field is expected to greatly increase the requirement for mobile data solutions.

Significant business benefits can be derived from the implementation of effective mobile data solutions. These solutions can help improve efficiency, productivity, integrity of data, speed of communication and safety, through the accurate, timely and cost effective delivery of information to and from remote operatives, locations, customers and sales-forces.

This paper is the result of work carried out by CIGRE Task Force 35.07 (TF35.07) to investigate the feasibility and opportunity for the use of mobile data systems in the utility sector.

2.2 Technologies

Traditionally utility companies have built and maintained their own private mobile radio systems to serve their specific operational communication needs. However, many have mature analogue systems that are struggling to deliver the functionality (particularly data) that business demands. Until recently there was no realistic alternative to private mobile systems, however, over the last ten years, public cellular and satellite systems have made major advances, in terms of land mass coverage, reliability and functionality.

The task force has identified several significant technologies and associated equipment and applications that could provide solutions to the needs of utilities for mobile data systems. These include;

- GSM (including GPRS)
- 3G
- Tetra (including TetraPol and Tetra II)
- Analogue Systems
- Satellite Systems.

Whilst this list is not exhaustive it includes the major technologies which are or will become available to utilities. The primary features and facilities of the above systems are outlined and their capability to support mobile data is detailed.

The TF has made no judgement on the relative merits or demerits of the various technologies covered in the document. However the TF has identified the operational concerns which must be considered when evaluating the technologies including operational issues such as reliability, availability, coverage and security. Whereas availability, network access and network resilience are very critical for mobile voice networks, this may not be true for all mobile data. Data applications must be checked to confirm whether these are needed or even used during emergency work. Costs have been address through an examination of the major issues and; in the case of public services, a brief overview of the various tariff structures used by network operators.

To illustrate the benefits of mobile data solutions the TF identified case studies from utility and service organisations. These case studies look at the business needs of various organisations, which drive the requirements and detail the solutions implemented.

The case studies outline applications for supply companies, commercial organisations, CRM organisations and core utility organisations and provide practical examples of where mobile data has produced significant business benefits.

2.3 Conclusions

It is apparent from the work carried out by TF35.07 that trends in the utility sector towards rationalisation, efficiency and improved service are driving the need for the adoption of mobile data applications. Redesigned business processes are being made possible by the developments in mobile data technology.

Mobile technologies are maturing in terms of availability, functionality and cost allowing for deeper deployment within the utilities business. However the burning questions of availability coverage and access still remain. The deployment of mobile data technologies in mission critical applications will still depend on the utilities' attitude to risk, especially where issues of safety and network security are concerned. Data applications must be checked to confirm whether these are needed or even used during emergency work. If this is the case then the same standards, which apply to traditional voice applications, must also be applied.

Due to the diverse requirements of utilities it is unlikely that a single solution will be available to meet all needs within the short to medium term, if ever. However as can be seen from the case studies significant benefits and improvements can be achieved with mobile data solutions.

From the work of the task force it is obvious that there is a need for mobile data solutions in utility companies and that the technologies are available to meet this requirement. However, a major obstacle to a company realising the efficiencies mobile data cab bring is the need for substantial change in business processes.

3. INTRODUCTION TO DOCUMENT

Utility companies around the world are in the forefront of change in the way they operate their business. Shareholders are pressurising those companies in the private domain to increase company value. Regulatory regimes are also monitoring company performance through a range of parameters designed to ensure customers receive value and an increasing level of service.

These business drivers are forcing companies to re-evaluate their mobile communications needs for both voice and data. To date, utilities have generally made little use of mobile data, but the pressure to push desktop IT solutions into the field is expected to greatly increase the requirement for mobile data applications.

Traditionally utility companies have built and maintained their own private mobile radio systems to serve their specific operational communication needs. However, many have mature analogue systems that are struggling to deliver the functionality (particularly data) that businesses demand. Until recently there was no realistic alternative to private mobile systems, however, over the last ten years, public cellular systems have made major advances, in terms of land mass coverage, reliability and functionality.

Most recently in Europe, huge amounts of money have been paid by prospective third generation (3G) mobile operators in order to secure licences to build 3G networks. This situation presents Utility companies with difficult choices when considering their future mobile strategy and how to deliver voice and data services which are:

- cost effective
- reliable
- provide access to IT services and
- future-proofed to avoid obsolescence.

3.1 Scope of Study

The scope of the study is:

- To examine the capability of existing analogue and new digital mobile systems to support mobile data technologies. It is not the intention to address all forms of technology which are capable of providing limited mobility e.g. WLAN, Bluetooth etc. However it is recognized that DECT/PHS solutions can provide mobile data solutions, particularly within limited geographic areas and we have referenced a CIGRE Paper presented at the Paris 2002 Congress in bibliography. Readers interested in the design of limited area solutions may find this of special interest.
- To identify how field staff and remote workers in electricity organizations, within the medium term, can access systems and applications.
- To consider the interfaces for system access through WAP/browser technologies and any appropriate alternatives

- To identify those business processes that would benefit from the implementation of data services to the field force and how the benefits could be delivered within the business

- Provide practical examples of where mobile data has produced significant business benefits.

3.2 Model (Applications and Networks)

3.2.1 Categories of Mobile Data Networks

There are many ways to characterise mobile data networks into categories. Here the aspects of mobility, technology and transport principle are used.

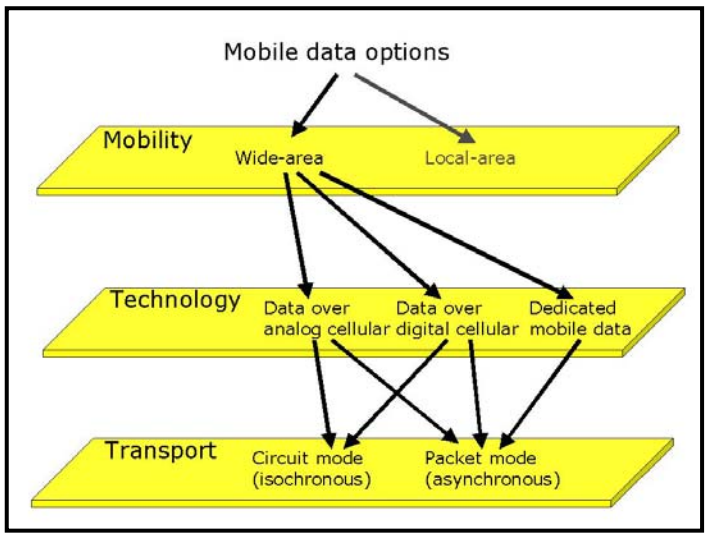

Figure 3.1: Categories of Mobile Data Networks

a) **Mobility**

The mobility-service characteristics of wireless data networks can be divided in two groups, wide-area networks and local-area networks. There is no clear separation between these two groups as e.g. Wireless LANs, a local-area technology, are used in so called "hot spots" to offer services with increased capacity and coverage, but these still offer a limited mobility compared to GSM-networks with nation wide or even international coverage. In general wide-area networks allow lower data rates than local-area networks. This report is focussed on wide-area networks whereas local-area networks are beyond the scope.

b) **Technology**

The technology view of mobile data networks again shows two major groups - networks dedicated for mobile data and non-dedicated networks. Utilities are unlikely to consider private mobile networks dedicated for data only, however in several countries public dedicated data networks exist which may be used for utility applications.

The broader range of mobile networks is not dedicated for data only but transport data and voice. To this group belong all analogue mobile

radio systems made “data ready” and all data services provided over digital cellular systems whether private systems – like TETRA or public systems like GSM enabled for data services like HSCD or GPRS. Voice and data convergence will become a reality with 3G services where the network technology will be voice and data independent, through the use of the IP protocol.

c) **Transport Principle**

The most important discriminator for data services is the transport mode used. Services using circuit (isochronous) mode have the requirement, that a connection has to be established before being able to transport user data as we are familiar with for voice services. Networks using packet (asynchronous) mode transport user data in entities of a specified size, called packets. These sessions avoid call set-up times but cannot guarantee constant transmission delay.

3.2.2 Architecture

a) **Network Architecture**

Although the architecture of every category of mobile data networks differs to each other some common principles may be seen.

As with every cellular mobile voice network, dedicated data networks rely on a tree structured multi layered network architecture. The numerous base station transceivers ensuring the needed coverage are connected to one or more switching centres mostly via intermediate nodes concentrating the traffic of several base stations by use of land line or radio links.

In networks using circuit mode be they analogue or digital, the same network structure used for voice traffic is also used for data traffic. Data traffic is routed by setting up a connection between the mobile terminal and data centre, connected to the central switch over the public or private phone network.

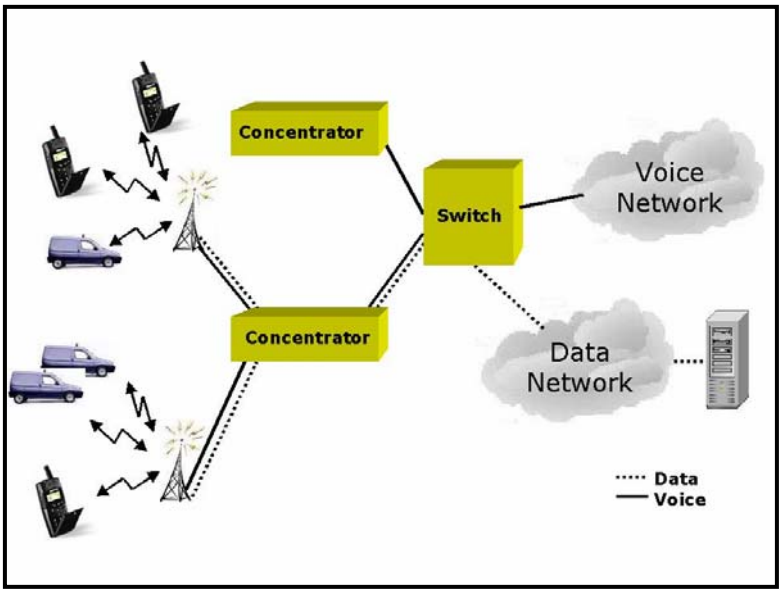

Figure 3.2: "Data Enhanced" Voice Network

In networks using packet mode, the same network structure used for voice traffic may be used for data. However in general data traffic is separated from the voice network at every base station or at least at the intermediate nodes, concentrating the traffic between base stations and switch. This is then fed into a separate dedicated wide area data network, which is either IP based or packet switched.

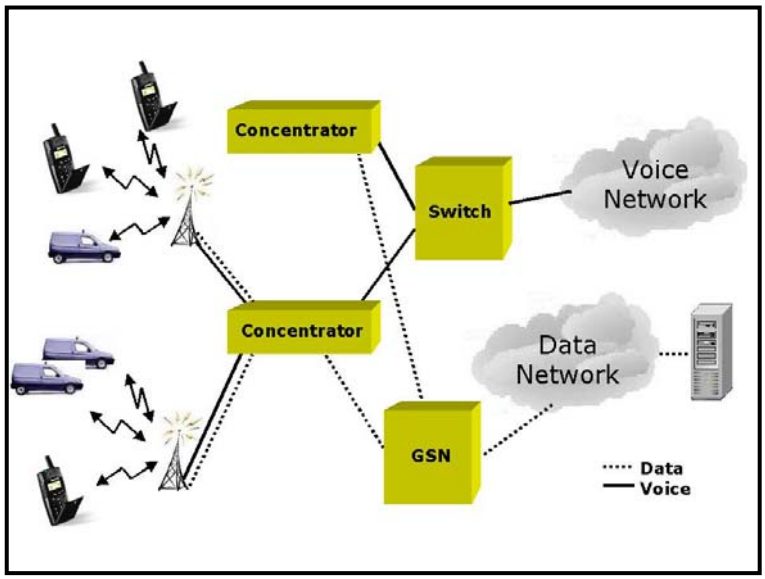

Figure 3.3: GPRS System Architecture

b) **Protocol Architecture**

The protocol architecture of different types of mobile data services differs widely. State of the art data services e.g. GPRS on GSM networks use a layered protocol structure according to the ISO-OSI-Model and separate application and transport layers to allow one and the same application to be used on different transmission networks. By inserting a special "convergence layer" between the network and link layers as implemented in GPRS different network protocols may be used simultaneously over one and the same logical link.

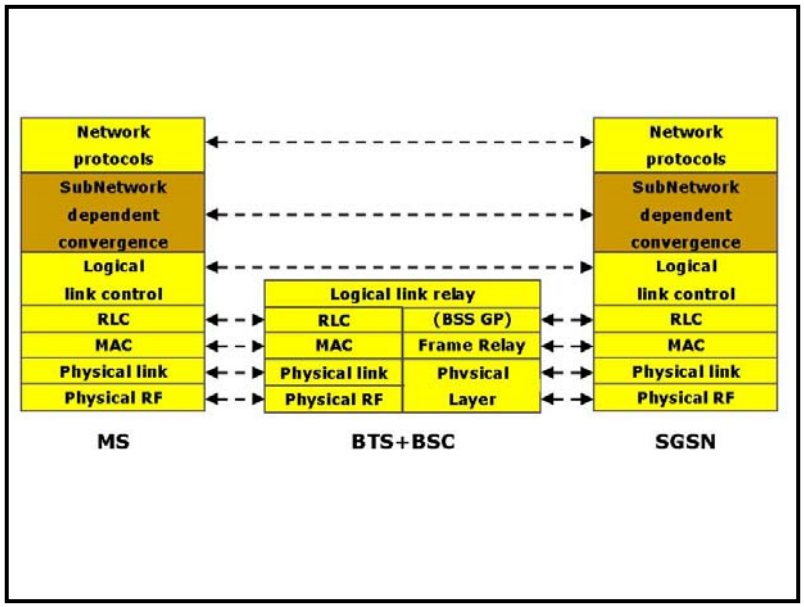

Figure 3.4: GPRS Protocol Architecture

4. BUSINESS DRIVERS FOR MOBILE DATA

A common theme in all utility sectors whether they are Government owned or investor owned companies is the containment or reduction of the cost base whilst maintaining and in many cases improving business efficiency and performance.

Privatisation of the core utility businesses and the deregulation of energy/supply businesses in order to promote competition is creating unprecedented change in the industry. In some countries restructuring and industry mergers are being used to deliver the reductions in the cost base. These rationalisation programmes are driving staff reductions, greater centralisation of many functions and larger operational regional areas.

These business changes raise the following issues that can only be solved by the increased use of technology:

- An increase in the number of staff using mobile communications producing an increase in mobile traffic
- Greater use of computerised systems in all aspects of work - e.g. work management, scheduling, dispatching
- Centralisation of engineering and management functions, giving rise to the need for mobile communications for management, engineering and supervisory staff, whose needs are quite different to the needs of a traditional mobile radio user
- Field staff covering larger regional boundaries
- Field staff must communicate with a small number of dispatch centres located far from the area where the work is taking place
- Smaller crew sizes, including larger numbers of 'isolated (lone) workers'
- Greater demands for mobile data for applications such as substation control, meter reading and differential GPS for vehicle positioning.

The above are core business issues, other requirements for mobile data exist in other parts of the industry e.g., energy sector.

- Remote access for sales staff subject to the pressures of the retail industry
- Workforce management of service staff working in a commercial environment
- Remote access facilities to call centres.

The realisation of these changes in working practices will force utility companies to review the communication networks and services which support their businesses. The increase in administrative areas is giving rise to difficulties due to the way that existing PMR networks have been designed.

Some traditional communication networks are adequate for data services such as low speed SCADA/telemetry applications but have limited capability to deliver higher speed applications such as access to work management systems.

From an operational cost perspective, maintenance issues with existing PMR systems are increasing and availability of spares is reducing with equipment being discontinued. The traditional systems are becoming expensive to support.

4.1 Business Benefits

Significant business benefits can be derived from the implementation of effective mobile data solutions. These solutions can help improve efficiency, productivity, integrity of data, speed of communication and safety, through the accurate, timely and cost effective delivery of information to and from remote operatives, locations, customers and salesforces.

Improvements in Customer Relationship management can be achieved by providing real time access to account data and technical data for agents visiting customers.

When applied to operational aspects of the business mobile data systems allow greater flexibility in utilisation of staff and greater access to power network information. The availability of this information can greatly improve the effectiveness of staff in the field.

Ultimately significant benefits will only realised if organisations change they way they work. This will require an examination of business processes. It is likely that this would be necessary in any case due to the pressures from investors and regulators mentioned earlier.

However in the short to medium term a mobile data deployment need **not** be a change in how an organisation does its business it can simply address the reality that whilst office based staff in the field are fully computerised remote staff are not. It is the lack of remote access to/from the system that maintains costs at high levels and inhibits improvements in the overall efficiency of the organisation.

Support staff often spend time doing tasks that are really those of the remote staff, again reducing their time on their own tasks and activities, which in turn are often frustrated by lack of detail and/or mistakes in paperwork from the remote staff in the first place.

For an organisation with remote sales staff the reduction in cash outstanding can be considerable with the combined benefits of low or no errors and fast invoicing pulling in credit lines and monies owing faster.

The following sections outline in bullet format the areas where an organisation can derive business benefits from a mobile data implementation.

There are four main areas that benefit which can be summarised as follows;

- The remote staff, Service, Sales etc
- The support or backend office staff
- Customer care and relationships
- Overall financial benefits, including time and attendance reports for engineers.

4.1.1 Remote Staff Benefits.

- Reduced time on voice calls taken from support staff with task details
- Reduction or elimination of time spent on calls to support staff to clarify task details
- Reduction or elimination of time spent on paperwork – hence more productivity
- No time wasting at client site, regarding further task details not taken down correctly
- Accurate tracking of tasks as they are completed - "Ready for Invoice".
- Safety / Legislation issues - less "talking/writing while driving" time etc.

4.1.2 Support Staff Benefits

- Reduced or eliminated calls out to remote staff with task details
- Reduced call answering re clarifications/repetition of above detail
- Accurate updated status of task detail visible on system - automatically
- Accurate and faster invoicing, "direct from remote" invoicing possibility
- Reduced time lost due to incomplete task completion reports.

4.1.3 Customer Benefits

- Increase in confidence due to visibility of task detail with remote staff
- Reduction in comfort calls to support staff
- Access to accurate task completion detail from support staff
- Accurate invoice detail - no follow-up for clarifications.

4.1.4 Overall Financial Benefits

- Drop in cost of mobile billing from remote staff and control of costs
- Drop in cost of calls to mobiles - remote staff
- Gain in time/resource previously lost re incomplete or missing paper work
- Decrease "debtor days period" due to faster, accurate invoicing
- Accurate "Sign on/off" of remote staff
- More productivity from remote and support staff, due to efficient work practices.

Whilst each mobile data deployment will be different all the above benefits are common in that they address problems that exist in and take from the bottom line in almost all organisations.

5. MOBILE DATA TECHNOLOGIES

5.1 Introduction

This section outlines the basic principles of the major mobile network technologies which may be used by utilities for mobile data.

5.2 Communication Networks

The network technologies considered in this section are GSM, 3G, TETRA, TETRAPOL, Analogue systems, Satellite and Paging.

5.2.1 GSM

GSM, formerly known as 'Groupe Spéciale Mobile' is a standard for PAN-European digital mobile communications and has been approved by the European Telecommunication Standard Institute (ETSI).

It is a phenomenal success for voice applications, and more and more is it used as a medium for data-applications, for instance the millions of small messages (SMS) that are sent daily. One of GSM's strengths is its international roaming facilities which covers more than 160 countries. Today, there are more than 300 million subscribers in Europe and Asia.

a) **GSM Service**

Improvements in technology have now cost-reduced and miniaturised mobile data technology into handsets of the public cellular industry. Up to 1998, data communications on cellular radio used paging and dial-up sessions. The paging facility is embedded within GSM and is known as Short Message Service (SMS), each message comprising upto 160 characters. SMS messages can be sent/received both when the mobile is idle or during a call. Dial-up data sessions are supported on GSM with embedded mobile modem protocols of up to 9.6 kbps.

GSM phase 1 was standardised with a range of data speeds up to 9.6 kbps, selectable depending on the quality of the radio link. A circuit switched call is allocated one radio resource (timeslot) of the eight available on each transceiver in the base station.

SMS functionality is now widely used for example to deliver simple messaging such as:

- Metering information
- Workforce availability
- Power network management.

Dial-up data sessions consume the same amount of radio resource as a voice circuit, and users of this service are well versed in sending pre-prepared data messages and then hanging up the circuit, such that the call duration is minimised. With a call set-up time of the order five seconds this becomes tiring. Such caller behaviour also loads the operator's network equipment with frequent call set-up and tear down overheads. Applications such as Internet access can only be attempted by leaving the circuit-switched call open for the entire duration of the www (world-wide-wait) download, and this is clearly not efficient.

b) **GSM Phase 2+**

Two developments towards higher speed data have been incorporated into GSMph2+. The first is a faster transmission speed, enabling 14.4 kbps. The second, HSCSD, is to allow concatenation of radio resources, such that the mobile is allocated up to 4 timeslots. Combing these two features together, HSCSD and 14.4kbps, a circuit switched mobile could communicate at 56kbps.

A GPRS mobile using multi-slot capability would be able to handle the packets at rates up to 100kbps. However, the aggregate rate would depend on the shared occupancy of the GPRS resources.

With the introduction of EDGE in GSMph2+ existing services such as GPRS and HSCSD are enhanced by offering faster data rates. The services themselves are not modified. The new services may be referred to in the jargon as EGPRS and ECSD.

EDGE will enable users to experience the so-called third generation (3G) services such as mobile e-mail, mobile file transfer, mobile web browsing, where the faster data EDGE transfer rates will make these services credible. EDGE technology will be available towards the end of 2003.

GPRS allows data users to be attached to their destination server continuously while only paying for the volume of data transferred. A radio resource allocated to GPRS is shared to accommodate many users, such that the aggregate data transmission of data packets to/from individual users will be sufficient to support most data applications such as e-mails, file download, short messages, status messages, and so on. For the operator, specific equipment is used to manage the GPRS radio resource to provide the demanded service to the subscriber only when data is available to transmit and receive. This way, the allocated channel is used in the most efficient manner. Users will be charged for the amount of data they are handling, because they occupy the resource only when necessary. The subscriber practice of call set-up and tear-down for circuit switched data calls is replaced by the use of GPRS mobile terminals.

GPRS mobiles are defined in three classes: A, B and C. Class A is simultaneous voice and packet data; class B devices can automatically select either voice or data, but not simultaneously; and class C can manually select either voice or data, but not both at the same time. A packet data only mobile terminal is a special case within class C.

In most countries, GPRS services are already operational. A possible connection scheme is showed below.

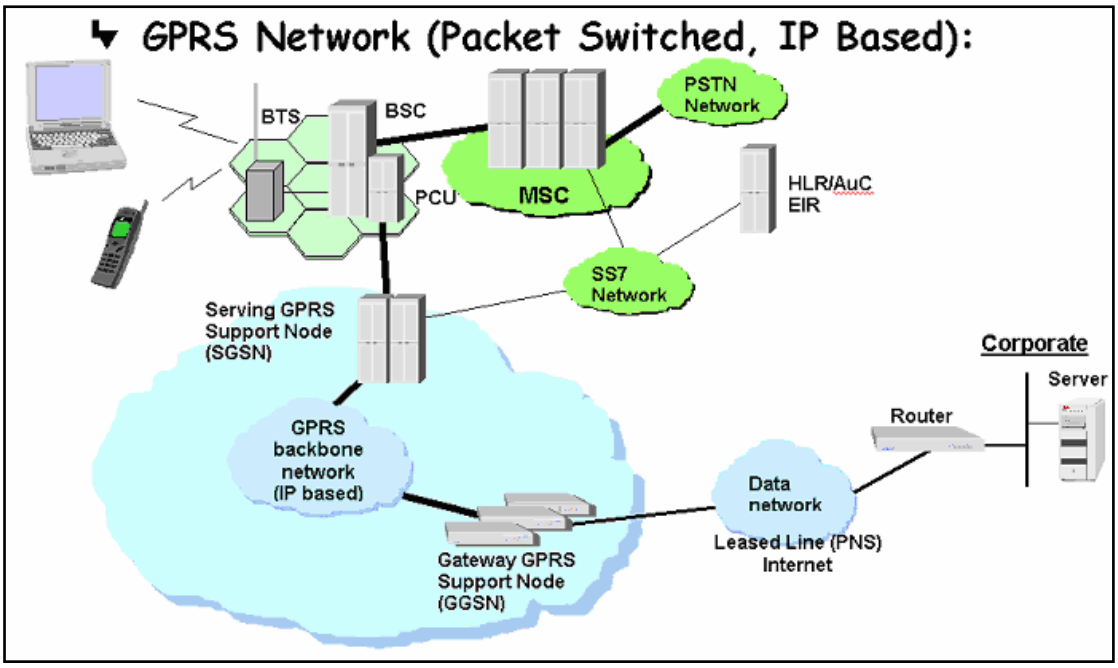

Figure 5.1: GPRS Network

Having concentrated several data users into one radio-resource so that data users pay only for the volume of data, it will probably follow that an upsurge in mobile data use will occur. Of course, more data users would require more radio-resources to be allocated; this then starts to reduce the radio resources left to handle voice calls.

One solution to above problem is for the packets of data to be shipped across the radio interface much quicker, say three times as fast, so that three times as many packet data users can share a radio resource. Enhanced Data rates for GSM Evolution (EDGE) provides this facility by using a new radio modulation scheme requiring new modulation equipment in both the base station and the mobile.

EDGE can also be applied to circuit switched data transactions, enabling faster file downloads, and opening up high bandwidth applications such as video.

Data sessions, of either circuit or packet switched, employ various application programs between the terminal and the target server. Within a company LAN, various application programs are required to use customised databases and e-mail servers. The use of http and the availability of browsers for accessing the Internet, such as Microsoft's 'Internet Explorer' and Netscape's 'Navigator' products, have opened up applications' user friendliness. Internet access using http has proliferated the amount of 'packaging' around the informative data, making most Internet transactions high data volume and slow, such that waiting 25 seconds for a page of teletext (1024 bytes of precision data) on a TV has now become an accepted experience.

c) **WAP**

To use GSM as a medium to interact with the world of Internet, a specific browser was needed that could easily be used as a replacement/addition to the Internet browsers of the PC's. This browser had to bring Internet content and advanced services to wireless handsets and terminals. Therefore a global wireless protocol had to be specified.

So the wireless industry (manufacturers as well as network operators) chose WAP (Wireless Application Protocol) as the solution, based on Internet standards like XML (eXtensible Markup Language) and IP. The industry has formed the WAP forum, an organisation that created and constantly improves the standards for WAP, with version 1.1 launched in March 2000.

What should be expected:

This WAP browser must be as easy as a phone to use - and thus much easier to use than a browser of a PC.

- All the WAP devices have normally very limited CPU power, memory and display sizes.
- The user demands a long battery life, thus a low power consumption and a fast connection. Traditionally, the speed with GSM's is 9600 B/s but with GPRS, higher speeds will be available. UMTS networks will boost up this connection speed.
- The client make use of a WAP device, connected via a WAP gateway to the WEB server.

What functionality does the browser provide to users;

- Location based services, real-time traffic reporting, event/restaurant recommendations
- Enterprise solutions such as e-mail access and database interrogations
- Financial services like banking, stock trading, ...
- Travel services, schedules and rescheduling, reservations, ...
- Entertainment like online games, multi-player actions, ...
- Information services such as news around the clock, weather forecasts, yellow pages, ...

d) **Standard Data Interfaces**

Handsets usually provide a customised data access port, proprietary in both mechanical and electrical interconnectivity. Accessories for families of mobile phones are plentiful, and a mainstream vendor of mobile phones would jeopardise its marketing if a full range of accessories were not available for a particular model of phone at its launch. Third party vendors also flood the market with compatible accessory products. A typical data adapter would provide RS 232 connectivity, or perhaps a link to a PCMIA card in a laptop, or even provide infra-red connection to PDAs and laptops. Such data adapter kits are typically supplied with a CD ROM containing software for the computing platform to provide 'Windows' type interaction with features in the phone, such as its phone book.

More and more see we that manufacturers equip their PDA's with communication modules. Or we can add for instance on an Ipaq a GPRS module, or simply use a Bluetooth card to communicate with the users' GSM instrument, which can do the GPRS communication. Being always online either by PC or via a PDA is heavily promoted by the industry.

5.2.2 Third Generation Mobile

Universal Mobile Telephone System (UMTS) is being standardised and developed to deliver multi-media services, from messaging, through voice, to high quality video, with varying Quality of Service to support various types of service and subscriptions demanded. From its launch, the new UMTS service has to be at least as good as GSM, and to this end, dual mode, GSM/UMTS mobiles will be developed. In the case that a user drops out of UMTS coverage, the handset will revert to GSM. UMTS will appear in networks from 2002 onwards.

Third Generation (3G) Mobile can be described as an evolution of all the key aspects of today's 2G (GSM/GPRS) systems. New radio spectrum, network infrastructure, user terminals and market players will combine together to enable new multimedia services.

Within Europe, 3G Systems will be based upon the specifications created by the Third Generation Partnership Project (3GPP) and transposed into standards by ETSI. The 3GPP Technical Specifications and Technical Reports are based on evolved GSM core networks and the radio access technologies that they support.

The following sections provide a brief analysis of 3G technology.

The key benefits of a 3G service are expected to be:

- service bearers will support data rates up to 384kb/s in wide-area environments.
- The technology will enable the provision of broadband communication, information, commerce and entertainment services to the business and consumer mass market.
- The new radio spectrum issued for 3G systems will increase the overall traffic capacity of cellular systems within Europe.
- It will provide users with a Virtual Home Environment, enabling service mobility across terminals and borders and providing the user with the same personalized features and user interface regardless of location.
- It will enable terminal location services to an accuracy of 50metres, enabling location-based services.
- It will drive convergence between telecommunications, IT, media and content industries, leading to delivery of novel services and creation of new revenue-generating opportunities for operators and third parties.

Obstacles which must be over come before 3G is widely deployed.

- 3G networks are highly expensive to deploy due to the significant license costs and new technology costs. According to an industry report, rolling out a wireless network will cost an operator anywhere between $1 billion and $5.5 billion.
- The embryonic state of the technology raises the risk of delayed equipment deliveries, especially in the area of user terminals.
- 3G networks are highly complex to design and operate, involving significantly more complex planning processes, notably Wideband CDMA in the radio network and IPv6 in the core network. There is significant risk of delayed service launches due to deployment and planning problems.
- The headline data rate of 2Mb/s can only be achieved when using indoor pico-cells and when few other users are present.
- The whole Telecoms sector has become less attractive to financial investors in line with a worldwide downturn in TMT stocks. Lack of investment will limit the scale of initial 3G rollouts and the development of 3G services, thus weakening the overall business case.

In conclusion, whilst 3G may appear the natural evolution from 2G, there is no guarantee that 3G will enjoy the same phenomenal success. 2G satisfied a huge pent-up demand for personal and business mobile telephony and it is by no means certain that there will be a similar demand for 3G services. It is considered unlikely that 3G will achieve the same land mass coverage as 2G systems and this will be a major issue for utility companies wanting to take advantage of the enhanced data services.

5.2.3 TETRA

a) **Introduction**

TETRA is a digital mobile radio technology based on a set of standards defined by ETSI. It was designed to primarily satisfy the needs of the emergency services, utilities and other similar organisations for higher capacity mobile voice and data communications. It was intended as a replacement for older, legacy analogue private mobile radio systems.

b) **System Description**

TETRA, has been developed by ETSI as an open European standard for PMR systems. The TETRA specifications offer all the functionality expected from users of PMR in safety critical areas such as the emergency services, utility and railway companies. Supplementary services of the type usually associated with cellular telephony systems, will also be offered by TETRA.

c) **TETRA Voice + Data**

TETRA systems use a Time Division Multiple Access (TDMA) technique to produce 4 logical channels within a single 25kHz carrier. The carrier transmits data at a rate of 36kbps. After taking out some signalling, error correction and synchronisation overhead the maximum usable data rate is 28.8 kbps or 4 logical channels using 7.2 kbps each.

d) **Voice Communication**

In order to transmit speech, a voice codec is used to turn the analogue voice into a digital data stream. To facilitate an 'Open' standard, one codec was chosen for all equipment to be used within the ETSI standard.

A base station transmits a continuous carrier ie, all four timeslots one after the other, and the mobiles decode whichever slot they are told to listen to. In the return path, the mobile only transmits in one slot, which means it has to switch very quickly between transmit and receive mode. This allows 'pseudo' duplex voice communications.

e) **Data Communication**

If a slot is used for data, the process is the same except that the codec is not used. If a single timeslot is used for data, the unprotected data rate is 7.2kbps. It is possible that two or more consecutive timeslots can be used to increase the effective data throughput. With this technique, the system can offer data bandwidth on demand up to a total of 28.8kbps.

TETRA does not specify any data 'applications', only the data bearer services. In circuit mode both protected and unprotected data services are available. In protected mode, either a high or low level of protection is available. A high level of protection offers data rates in multiples of 2.4kbps up to a maximum of 9.6kbps. Low protected circuit data modes offer data rates in multiples of 4.8kbps up to a maximum of 19.2kbps.

Unprotected data rates are 7.2kbps per timeslot up to a maximum of 28.8kbps. More recently, IP packet data has been included in the standard and has become the focus for data applications, so much so that circuit mode data is no longer supported by some manufacturers.

TETRA has the capability of transferring circuit switched and connectionless packet data, in point to point mode between both fixed line stations and mobiles. The standards specify that operation is possible in point to point mode, point to multi-point mode and broadcast mode.

f) **Features and Facilities**

In addition to the full range of speech calls used in analogue trunking systems, the voice+data standard will support a number of supplementary services including priority, include calls, group assignments and enhanced telephony services such as call forwarding, barring, waiting and hold.

g) **Simultaneous Voice and Data**

By allowing a mobile to make use of multiple timeslots, TETRA can support simultaneous voice and data communication. In this mode of operation, each one of the timeslots can deliver circuit switched data in multiples of 7.2kbps whilst another timeslot carries a voice call.

h) **Current Status of the Voice+Data Standards**

All of the core elements of the standards exist and are in sufficient detail to enable different manufacturers to design, develop, manufacture and deliver real systems that will provide a high degree of functionality to users. However, some TETRA functionality, such as concurrent voice and data calls has not yet been delivered.

i) **TETRA Packet Data Optimised**

TETRA Packet Data Optimised was originally envisaged as an alternative standard for data only TETRA networks. Whilst this could offer a slightly higher data throughput than standard 'Voice and Data' TETRA, the subsequent inclusion of IP packet data into the 'Voice and Data' standard effectively made TETRA PDO obsolete and detailed standardisation has never been completed.

j) **TETRA2**

It has been recognised that during the development of the current (Release 1) TETRA standards, new applications services have been identified by TETRA users and there has been an explosion in the use of internet/IP, affecting all market segments. There is a requirement to meet these needs and in particular for high speed data but also in other areas that will be important in the 3G mobile telecommunications environment. As a result of this, further enhancements to the TETRA standard, referred to as Release 2, are being produced by ETSI. The development has been split into a number of areas:

i) High Speed data, itself split into two streams, TETRA Advanced Packet Services (TAPS), consisting of a separate EDGE overlay network and TETRA Enhanced Data Services (TEDS), aimed at providing an integrated high speed data service.
ii) Improved CODEC - offering interworking with GSM/3G (no transcoding) and voice quality improvements
iii) Air Interface enhancements - improving spectrum efficiency, capacity and system performance, improving terminal characteristics, optimisation of frame structures and protocols, location services and extended range
iv) Inter-working - TETRA users (on home system) can communicate with users on another system and a roaming mobile terminal operating on a foreign network
v) SIM - Universal SIM concept, access rights and additional Features and Functions.

Most focus on the standardisation to date has been on high speed data. TAPS is intended to be absorbed into the standard GSM specifications as 'TETRA' variant, much has been done with GSM-R. Therefore, in practice, TAPS, which uses standard EDGE technology, has little to do with TETRA other than occupying the spectrum designated for TETRA networks. TAPS can offer data rates of up to 384 kbps but has a requirement for contiguous spectrum of at least 2.4 MHz plus guard bands. Given the large amount of investment that would be required to build a complete overlay network, it is difficult to see at the present time any commercial market for TAPS equipment.

TEDS is aimed at Public Safety users as it is intended to be highly integrated with the current voice and data TETRA networks as well as being more suited to introduction in the current 380-400MHz band. Data rates were originally expected to be upto 400kbps, but more recent developments suggest somewhat lower rates, perhaps up to 100kbps, in order to minimise the additional base stations required to give high-speed data coverage. The TEDS standard is still being written and the best estimate for the availability of equipment is sometime in 2005.

The other areas of TETRA2, namely CODEC, air interface, interworking and SIM are expected to start to become available in a number of phases, starting towards the end of 2004.

k) **Standard Data Interfaces**

TETRA specifies a standard interface, the 'Peripheral Equipment Interface' for the connection of external data terminal equipment to TETRA terminals. It includes various different bearer types such as serial cable, Ethernet and bluetooth. Currently only wired RS232 type cable connection is available. Whilst the interface is based mainly on GSM, it does include additional commands for the TETRA specific features. Simple applications, such using PDAs to check vehicle licence databases have been demonstrated. However, because of the smaller and more specialised market for TETRA compared to GSM, the availability of 'of the shelf' application s for TETRA is likely to be more limited.

Take up of TETRA has primarily been confined to emergency services within Europe. Utilities are examining the case for private TETRA networks, whilst others would prefer to buy the service from a commercial organisation.

5.2.4 Tetrapol

a) **Background**

This PMR technology is also aimed primarily at public safety organisations. It was originally developed by Matra (now EADS Telecommunications), but it has been made 'publicly available' and is supported by the Tetrapol Forum.

b) **Availability**

The technology is more mature than TETRA, the first Tetrapol network having been launched in 1992, and equipment is readily available from EADS. Whilst a number of suppliers are named in the Tetrapol Forum, in reality the technology remains dominated by EADS. The only notable alternative supplier is Siemens (who has, to date, been offering badged EADS equipment).

Frequency bands covered span from low-band VHF (70 MHz) to ~900 MHz, although recent development has tended to be concentrated on equipment operating at UHF in the vicinity of 400 MHz.

Some 41 networks are in operation in Europe (especially France) and across the globe, mainly by public safety organizations, but including others such as rail and airport users. Numbers of current users are in excess of 200,000, rising to some 700,000 once networks currently being implemented are complete. Recent Tetrapol orders include one made by the UK Ministry of Defence.

c) **Satisfaction of the User Requirement**

A utility's needs for mobile voice services could be met with a suitable network design using Tetrapol equipment. However it should be noted that Tetrapol does not support full duplex operation. There are no dual-mode Tetrapol/GSM terminals available.

Circuit switched (7.2 kbit/s unprotected) and packet mode data are supported as well as status and text messaging. Gross air interface rate is 8kbps and speech is encoded at 6kbps. Data rates are in the range of 3.2kbps to 6 kbps depending upon the level of error correction. The use of IP packet data would reduce the overall throughput because of the IP overhead.

The Tetrapol Forum has been keen to stress that Tetrapol's range (large cell size), its ability to operate in quasi-synchronous mode, and the availability of equipment at VHF would make it economical for systems covering wide areas with relatively low traffic density.

There are no multi-carrier Tetrapol radios available and therefore it is not possible to concatenate carriers to get a higher overall data rate whereas with TETRA, according to the specification, it should be possible to concatenate upto four timeslots.

5.2.5 Analogue Systems

a) **MPT 1327**

Current PMR systems which conform to the UK Department of Trade and Industry (DTI) MPT1327 standard have a range of data transfer mechanisms available. It is a standard which specifies how radio units operate within an analogue trunked system. Systems complying with this standard have been operating successfully for a number of years.

This data functionality includes the provision of:

- Status
- Short data messages
- Non-prescribed data.

Status: The system's control channel is used to send status codes, of which 32 are available.

Short Data Messages: These are defined within the MPT specification. The message structure supports the transmission of 184 bits of free format data.

Non-Prescribed Data (NPD). Longer messages can be sent as data over a voice channel, using a number of modulation schemes and proprietary protocols. Data rates of 1200bps can be normally expected. However, it may be possible to achieve data rates of 2400bps and even 9600bps through the utilisation of more modern modulation techniques, for example, GMSK and Linear Modulation.

b) The availability of status messaging is inherent in the system and may be utilised by both mobile and proprietary dispatcher terminals. The system utilises the system control channel to transport status and short data messages, which forms an efficient means of transfer, especially where the number of channels is limited. However, it should be noted that the system control channel still offers a finite resource and that its heavy use for data services may cause problems, especially when the control channel is time-shared over a number of sites.

c) Other Analogue Systems

The basic analogue systems are designed for voice. They use two frequencies to communicate between the mobile and the relay. The frequency spacing is mostly 12,5 kHz and the 5 tones CCIR signalling. There are a variety of other proprietary systems designed to meet the specific requirements of individual utilities. It is possible to couple the relays using analogue or PSTN links. These systems can be used for data transmission using audio sub-carriers which are frequency or

phase modulated. This type of system can support low speed data rates of 200, 600 and sometimes 1200bps.

For example, EDF uses this type of network to control some 20,000 circuit breakers on its MV network. EDF also used the system to send commands originated directly from an on-board radio system called SECORA, for local control of the power network. These systems are widely used for voice but most of the owners of such networks are looking to replace them.

In addition, Telecommunications Regulatory issues, including difficulties obtaining spectrum, requirements to move or change frequency bands and increasing licensing costs, are adding to the pressures utilities are experiencing in managing and maintaining existing Private Mobile Radio systems. For example, CEPT decision DEC/ERC(96)04 obliges signatory countries to designate spectrum within four bands for commercial TETRA services, thereby influencing the amount of spectrum available for private mobile systems.

5.2.6 Satellite Systems

Satellite communication is mainly used as a backup to GSM networks or where GSM coverage is unavailable.

Satellite systems can be utilised as a viable backup to overcome some of the inherent weaknesses of using GSM as a PMR replacement, in a utility environment.

The use of satellite communications is similar to the use of GSM communications, except that the satellite receiver has to have a visual contact with the satellite itself.

The table below outlines the key features of the major satellite service operators.

Operator	GSM Compatibility	Data Speeds	Coverage	Pre-pay Cards
Iridium	No	2400 bits/sec	Global	No
Globalstar	Yes	9600 bits/sec	Europe, Middle East, Asia, America	No
Inmarsat	No	64 kbps	Global	Yes
Eutelsat	No	2 MB/s	Global	No
Thuraya	Yes	9600 bits/sec	Europe, Middle East, Asia	Yes

Table 5.1: Key Features of Major Satellite Service Operators

5.2.7 Paging

Paging may be considered as the oldest of the mobile data services used by utilities. In some countries, paging has still the best coverage among all public networks, but in other countries paging networks have been shut down completely, as the majority of customers have moved to GSM-SMS services.

Where still available, paging has the advantages of being cheap and easy to use as data entry is possible manually, by phone, or also by automated equipment.

The major disadvantage of paging is that it is a simple broadcast service for alerts, numerical or alphanumerical messages, which does not ensure that the message transmitted is received by the recipient.

Using GSM-SMS has the advantage of end-to-end confirmation. So the system ensures, that a message will be received as long as the receiver is within coverage of the network.

As a consequence paging is currently used as a back-up service to support GSM networks in respect of major network failures.

5.3 Terminals

Selection of terminals for mobile data applications is not a simple matter as a range of competing criteria have to be considered in order to find an optimal solution for any given application.

The main selection criteria are

- Form factor
- Display
- Availability of terminals for the considered data network
- Availability of accessories
- Power supply/ battery life
- Ruggedised design.

5.3.1 Form Factor

The first selection criteria of course will be the form factor of the terminals. Requirements such as mobile or portable operations, monochrome or colour display, text or graphic display, display size and method for user data entry must be considered.

Vehicle usage will allow bigger display sizes, and easier data entry for the user but limits the portability of the device. Installation costs are generally higher and need greater consideration when staff use their private vehicles on duty. The lifecycles of private vehicles are dramatically lower than those of company cars. Mounting mobile terminals in vehicles becomes more and more

difficult as security devices like airbags limit the space available for additional equipment. Therefore implementation of data services may also have influence on the size of vehicles employed.

Portable devices have limitations in size and may have to be more ruggedised than those mounted in vehicles

5.3.2 Display

Semiconductor based colour display technology (e.g. TFT) is widely available and decreasing in cost. Although use of monochrome displays still makes sense for alphanumeric displays with few characters only. Special attention is required for the operating temperature range specification on data displays for mobile/portable as this is still critical for semiconductor based displays. Excessive temperatures present in sun heated cars or direct sunlight may cause damage. Gas discharge displays have advantages in this area, but are heavier and need more power. So they are suited only for pure mobile applications.

Touch screen technology is becoming more common for user data entry and will supersede keyboards (besides some function keys) on portable units in general and will extend to vehicle mounted units.

5.3.3 Availability of Terminals Data Networks

Terminals with the highest market share will have the lowest unit price. This means that terminals that are data network independent should be preferred.

Depending on the required form factor a variety of portable and handheld computing devices are available in the mass market and are therefore inexpensive:

a) **Personal Digital Assistant (PDA)**

PDAs are portable devices with graphic monochrome or colour display and touch screen for data entry. Standard firmware normally has basic functions for scheduler, phone book, and notes included. Application interfaces allow easy and cost efficient design of mobile data applications.

Physical interface to mobile radio equipment is provided by serial interface (standard on most units) and preferably by interface slots either for PCMCIA or Compact Flash (CF). Some brands have the interfaces included on board and some as an accessory (so called “jacket”). Radio cards for GSM, CDMA and several public data networks with PCMCIA interface allow integration of the radio part into the data terminal, which is very suitable for portable units. A new GPRS enabled data card from Nokia ™ even combines GPRS and wireless LAN (IEEE802.11b) functionality in one unit. So the terminal may be used within the company’s intranet in the office and via GSM during travel.

Figure 5.4: Examples of PDAs

Operating systems for the units are processor dependent. Palm Inc. with its "Palm OS™" operating system and Microsoft Inc. with Windows CE (at present named "Windows for Pocket PC 2002™"), are the market leaders in this field.

For Windows CE the whole suite of Microsoft Office ™ is available, but with the drawback, that all data files have to be converted to a special "pocket" data format to be used on portable devices. Palm OS™ and other operating systems also have the same problems.

b) **Smartphone**s

Smartphones are mobile phones with integrated PDA functionality. The major disadvantage at present – very small display sizes – may be overcome in the near future. Smartphones with same display sizes as available on PDA will be called "wireless digital assistants" (WDA).

Convergence of the two types of devices. PDA and Smartphone, will blur the boundaries between them.

Figure 5.5: Examples of Smart Phones

c) **Handheld PC**

Handheld PCs are similar to PDAs in that they are terminals with colour graphic display and touch screen for data entry, just with a bigger display size of 800x600 pixels and more.

As handheld PCs also come with serial interfaces and PCMCIA slots, the same interface technologies as for PDA's are available.

Units running standard Windows™ 9x/ME/XP/NT/2000 operating system have the advantage that the whole variety of application software existing for desktop PCs may also be used on the handheld. Units with Windows CE for Handheld PC 2000™, Windows CE .NET™ or other operating systems have a limited number of applications available to them. However software development kits for these operating systems are available.

Figure 5.6: Example of Handheld PC

d) **Dedicated Mobile Data Terminals**

A full range of dedicated mobile data terminals is available on the market depending on the customer's needs. These range from small, dashboard-mounted units with alphanumeric display with a few keys for status entry to distributed units with full size graphic colour display, portable keyboard with infrared link and separated CPU unit.

Dedicated mobile radio terminals have the advantage of being designed especially for the mobile environment e.g. higher temperature range, low power consumption, more ruggedised design but have the disadvantage of smaller market share and therefore higher cost.

Figure 5.7: Example of an Alphanumeric Mobile Data Terminal

Figure 5.8: Example of a Compact Colour Graphic Mobile Data Terminal

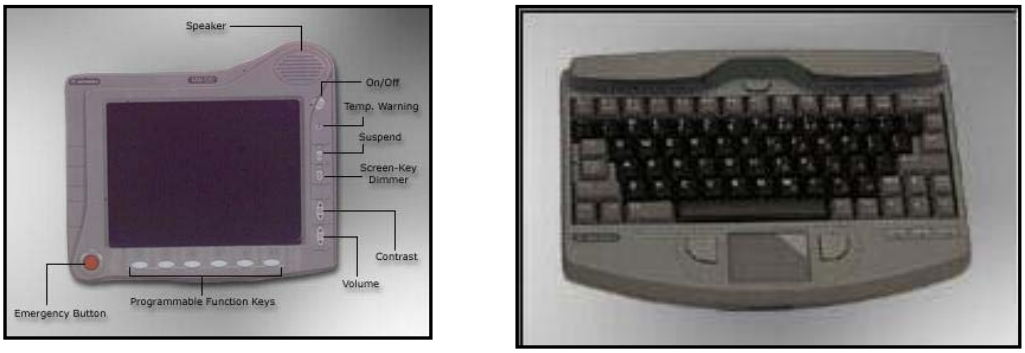

Figure 5.9: Example of a Mobile Data Terminal with Portable Keyboard

e) **The Mobile Phone**

If limited text and graphics is all that is required, then the basic GSM phone or Tetra terminal may satisfy these needs depending on the network employed.

The first TETRA terminals were fairly bulky and heavy and aimed at public safety users.

Figure 5.2: Examples of First Generation Terminals

Second generation terminals are now available which are smaller, lighter and with more functionality than the first generation models. Some second generation terminals are based on a GSM hardware architecture, particularly the compact 'GSM lookalike' models and indeed have a similar menu based man machine interface. However, the much smaller market means that TETRA terminals will always lag somewhat behind their GSM cousins.

Figure 5.3: Examples of Second Generation Terminals

At least one manufacturer has indicated that they will produce a dual mode TETRA and GSM phone, although the availability date is uncertain.

No manufacturers have yet indicated their intention to produce integrated PDA type compact TETRA terminals.

5.3.4 Availability of Accessories

Besides selection of the terminal itself, availability of needed accessories has to be considered, which again is related to market share. For non-dedicated terminals e.g. PDAs, handheld PCs a broader range of accessories is available at lower prices than for dedicated mobile terminal units.

Available accessories are:

a) **Printers**

For customer care applications it may be necessary to be able to hand over data to customers in written form.

Where mobile workforces are commanded to operate electrical switchgear manually it may be convenient, for safety reasons, to have a paper copy. This could act as a proof of instructions received.

Thermal printers have the advantage of simple design and therefore increased stability, but the disadvantage that the contrast of the paper copy fades with time. For applications where readability of the output has to be guaranteed for several months or even years, small ink jet printers for mobile use are available.

b) **Bar Code Readers**

May be convenient to avoid the need for manual copying of numbers e.g. for inventory or meter reading applications.

c) **GPS-Receivers**

GPS receivers enable mobile data terminals to be used for location tracking in fleet/workforce management or inventory applications.

For PDAs, handheld PCs etc. a variety of street navigation programs are available which may be implemented to give mobile workforce an aid for faster access to substations or customer locations.

5.3.5 Power Supply/Battery Life

Although power consumption of modern mobile data terminal developments is decreasing continuously, operating time - especially on portable units – is still a critical factor. Modern battery types e.g. lithium ion technology provide excellent size/capacity ratio and fast charge possibilities. Mobile terminal specifications have to be checked carefully, to determine whether the provided operation/charge cycle is sufficient for the considered applications.

5.3.6 Ruggedised Design

Ruggedised designs are required for applications to be used in the operational environment. Units designed for office locations are not always suitable for use in the field. Operational staff may require units designed to withstand mechanical shocks, humidity and temperature existing in hostile environments.

Figure 5.10: Example of a Ruggedised Portable Data Terminal:

5.4 IT Applications

There are many data applications that could deliver benefits to the business by being available to the company's mobile workforce. Some examples are:

- **Information resource based services** - flow of information to and from the field such as:
  - **Graphical Geographic Information Systems (GIS)** - network records, network diagrams, handbooks and specifications
  - **Asset management** - recording of work carried out on specific assets, update of records, maintenance history.

5.4.1 Process Management Systems

- **Despatch** - despatch of fault teams for network restoration

  The dispatch process currently revolves around the management of resources in emergency or on-going work scenarios. The function is primarily carried out using a mixture of voice communications and latterly data methods. It requires that the dispatcher has up to date information on location of resources and resource capability to allow appropriate location and assignment of resources. Effective communications is essential to an efficient dispatch process.

- **Scheduling** - scheduled maintenance, outages, contractors

  Scheduling is closely related to the dispatch process in that information on location and type of resource is essential. In the scheduling process the real time nature of the requirement is not as vital as in the dispatch process. Nevertheless adequate communications are necessary for the efficient allocation of resources.

- **Fault repair updates** - 'Troublecall' type systems

  The fault repair update process requires effective communication from initial reporting of the fault, through the lifecycle of the fault, including confirmation, diagnosis, repair, reintroduction into service of the repaired element and confirmation of restoration of service. In the utility environment where it is often the case that multiple teams may be working on a fault accurate, upto date information on the status of a fault is vital from many perspectives including safety, financial and speed to resolution.

5.4.2 Control and Measurements

- **Remote Control and Indication - pole-top devices etc**

  Electricity distribution companies have, for a long period of time, been looking at economical methods of extending telemetry/SCADA functionality to the distribution high voltage network. Demands to improve quality of service to all customers has meant that specific focus has been given by Government and where applicable, Industry Regulators, to assess the overall performance measures relating to HV distribution networks.

  In assessing the capital and operational expenditure associated with remote control and rural automation schemes, a primary concern has always been, the reliability and costs of a communications network or service. Remote control schemes could involve the implementation of many thousands of devices such as pole top switches, isolators and electricity fault transponders. Such schemes need to operate over low cost reliable networks which can deliver relatively low speed, low volume data transfer but which are also resilient to power failures.

  Inevitably the communication networks considered for rural schemes are based on radio technologies such as public cellular, third party data providers or the companies Private Mobile Radio (PMR) systems.

- **Power Quality Monitoring**

  Electric energy has to be delivered to a quality within the specifications stated under the product description. Therefore utilities need to measure quality parameters such as outage times, voltage variations, transients etc. on several points on the distribution grid. This must be done either continuously for quality control or on demand in the case of customer inquiries.

  Recording of the events, where quality parameters are out of limits, is normally done by transient recorders. Quality parameters are measured continuously and a value which is out of limits triggers storage of time-stamped measured values for a predetermined period of time. Usage of "first in-first out" (FIFO) buffers allows recording of a certain amount of values before the trigger occurred.

  The memory of the transient recorder has to be emptied before running full to avoid data loss. To avoid travel to the different locations, transient recorders can be equipped with modem interfaces to enable remote control of the unit including memory dumps.

  Using GSM networks for data transmission is a very convenient solution where measurements from multiple remote sites are required. In this case, data enabled GSM terminals are connected to transient recorders via a serial interface. Data enabled private mobile radio networks may also be used for this purpose.

- **Power Cable Sag Monitoring**

  On power cables the monitoring of the sag of the lines is crucial to:

  - avoid line fractures (mostly by ice load)
  - maximise transport capacity (especially during the summer)
  - comply with safety regulations and measurements.

  A possible solution and an alternative for the complex transmission of measured data could be to clamp a satellite module on the power line on which there is a GPS receiver that transmits data via the satellite module to a control center. In this control center the received data is analysed with the known position of the GPS receiver and so the sag can be calculated. It is evident that clamping a small unit on the power line is a relatively easy task and can be done by means of a helicopter on a live power line (hot installation).

  With this method the accuracy is very good (less than 1 cm fault tolerance) and the instrumentation is very simple.

There is no need to invest in a data communication network since an existing satellite network is used, the coverage and the network availability is quasi 100% and the installation is relatively simple.

- **Remote Metering Systems**

  Regarding the speed of deploying a mass installation of electricity meters, the long waiting period for leased or PSTN line installation, the additional charges to accompany the public telecom-operator on site and the huge monthly fee for the copper line, could justify investment in an all-in-cabinet solution. Hundreds of these cabinets are simply stored in the stockroom and can be ready for installation at the clients as soon as there is a need to.

  In each cabinet is the meter with telemetry contact and a GSM module. Every time-interval value is stored in the meter, and once a day (typically at night) the meter is interrogated, via GSM, by the central metering computer. In accordance with the closed contracts between clients and suppliers, the correct metering data is delivered to the supplier as well as the invoice for the supplementary costs of transporting energy over the power cables.

- **Phase Comparison Systems**

  Medium voltage lines are normally operated in a ring topology to minimize outages in case of failures or maintenance work. If 3-phase power lines are used in a ring topology, it has to be ensured that the conductors at every point where ring connections can be made are in phase. Therefore the utility has to ensure that the three phases of every element (line, transformer, switchgear) are marked and connected consistently according to a reference point (which is normally derived from the national grid).

In cases where new medium voltage lines are established or existing ones had to be mechanically disconnected, the right phasing situation has to be checked. This is only possible by getting a phase reference from a distant point (e.g. next substation etc.).

In one example, using analogue private or public mobile radio, this was easily done by using an audio sub-carrier, modulated in amplitude or frequency by the reference grid voltage. This sub-carrier was then transmitted via mobile radio to the point of measurement, demodulated and a phase comparison done between this signal and the grid pole in question. As the transmission delay was well below 120 degrees of a 50/60 Hz mains signal the correct phase could be determined unambiguously.

Also, nowadays, the use of digital public or private mobile radios is possible. However, as transmission delay is much more than 120 degrees of one 50/60 Hz mains cycle, a very exact time reference is needed on both points. This can be derived from the GPS satellite system, for example. The absolute time of zero crossings of the voltage of the reference phase is transmitted via a data enabled mobile radio network (e.g. GSM) and compared to the times measured for the zero crossings of the voltage at the mains grid pole in question.

5.4.3 Lone Worker Monitoring - Personnel Safety Systems

With pressure to reduce the workforce it is becoming more common for staff to be expected to work alone, sometimes in remote locations.

To comply with Health and Safety regulations, companies are expected to be able to monitor the well being of staff working in such circumstances.

There is a need for simple reliable communication services, probably using radio technology that requires an individual working in remote locations to identify to a central location, on a repetitive basis their work status. The aim is for a central location to be able to monitor a remote worker through an action (sending a status message) initiated by the lone worker. Failure of the remote worker to repeatedly action the message within a predetermined timeframe will create an alarm at the central location. On notification of an alarm the staff at the central location can take remedial actions. Typically, this may take the form of regular status updates through the use of Short Data Messages in a PMR system to use of the SMS messages in a GSM service.

5.4.4 Location Based Services

- **Real Time Tracking Location of Vehicles and Personnel**

  Real time tracking systems sometimes known as location based services allow for location of personnel, vehicles and equipment via mobile communications systems. Some use inherent features such as location based on cell triangulation, whereas others use external systems such as GPS combined with mobile data services. These systems allow for real time tracking of vehicle positions and personnel location as well as the management of vehicles through alarms, alerts and driver text messaging. Updates on vehicles can be accessed via the Internet, text messages, WAP or connected internal systems.

5.4.5 Remote Office

Typical office based systems, access to which would greatly enhance the effectiveness of the mobile worker are listed below.

- E-mail
- Printing services
- Timesheet systems
- Word processing and spreadsheets etc.
- Access to office environment such as CRM data.

So-called "remote office" or "mobile workplace" solutions enable mobile workforces to access their office applications via data networks without requiring any modifications.

The office applications of the different users are in this case executed on a central server that provides a virtual operating system (e.g. Windows 2000™ or Windows NT™) for every user. The client program running on the mobile users data terminal only transmits keystrokes and mouse events to the server application and receives changes in the screen image from the application running on the server. The client software provides only some kind of graphic terminal emulation.

This can be accomplished without redeveloping applications or changing current application-server hardware.

Where graphical display-images have to be transmitted to the mobile terminal, care has to be taken to optimise software set-up on the server side to accommodate the lower bandwidth constraints on the mobile data network. For example reduce colour depth to 16 colours where possible, avoid background pictures on the desktop, avoid graphic start-up screens of software packages etc.

As office applications in general are based on common resolutions of PC screens, a minimum resolution of 800x600 should also be used on the mobile terminal side. Handheld PCs are suitable. Although client software is also available for PDAs, having only a part of the applications screen image displayed at a time is not convenient.

There are two products with major market share available. "Windows Terminal Server™" from Microsoft Inc. and "Meta Frame™" from Citrix Inc.

Advantages of mobile office solutions are:

- Configure, manage and enable application access from one centralized location, reducing the cost of provisioning branch offices individually.
- Improve time-to-value for business expansion with accelerated delivery of ERP, CRM, Web and office productivity applications.
- Eliminate the need to dispatch IT staff to service remote locations with centralized applications management.
- Use mobile data networks to deploy applications securely with less bandwidth at lower telecommunication and network costs.
- Enhance customer service with centralized business-critical databases.

5.4.6 Interfaces to IT Applications

Use Existing IT Platform

By making business critical applications mobile, companies can bring resources and services closer to the customer, enabling quicker response times, better service, and more efficient resource management. However, accessing business data and processes often leads companies into application servers and distributed objects.

Today's *n*-tier architectures include a business object layer based upon a distributed object technology such as Common Object Request Broker Architecture (CORBA), Distributed Common Object Model (DCOM), or Enterprise Java Beans (EJB). Distributed object architectures and application servers have taken over the business object tier because they solve many real-life business and technical problems such as application distribution and security. For these reasons, application servers and distributed objects alongside server based computing have become the mainstream method for accessing business data.

The question now posed is how do we merge these technologies. The answer to this dilemma can be middleware; middleware is essentially software that connects applications, allowing them to exchange data. It offers several advantages over hardwiring applications together using Enterprise Application Integration tools (EAI). Middleware adds an independent third party to the transaction, a translator.

The common solution for accessing business data on a PDA is based upon the copy and sync architecture. Data copied and edited on the PDA is later synchronised with the main system by either serial connection, Bluetooth or IrDA over your chosen mobile communication service. This type of architecture does have drawbacks, the applications tend to be large and resource intensive and the data resides on the local device increasing security concerns. If multiple users make changes to a copy of their database offline and then synchronise back to the main data store, the organisation may suffer from data inconsistency.

Applications that are deployed to the PDA need to either utilise server based computing architectures, (meaning the user has to be connected to the servers hosting the applications permanently, thus increasing the overall connection charges), or access to distributed objects is provided via an Internet Enabled PDA.

Development tools and standards are slowly emerging to allow effective use of the PDA operating systems, and interoperability between systems, such as Microsoft's .NET architecture and the standard J2EE, although these systems/standards are relatively immature, they are gaining massive momentum for the deployment of mobile applications and alleviating some of the headaches associated with 'gelling' together two applications over a wireless infrastructure.

Figure 5.11 depicts a typical scenario whereby middleware and web technology provides a key mechanism for the exchange of data.

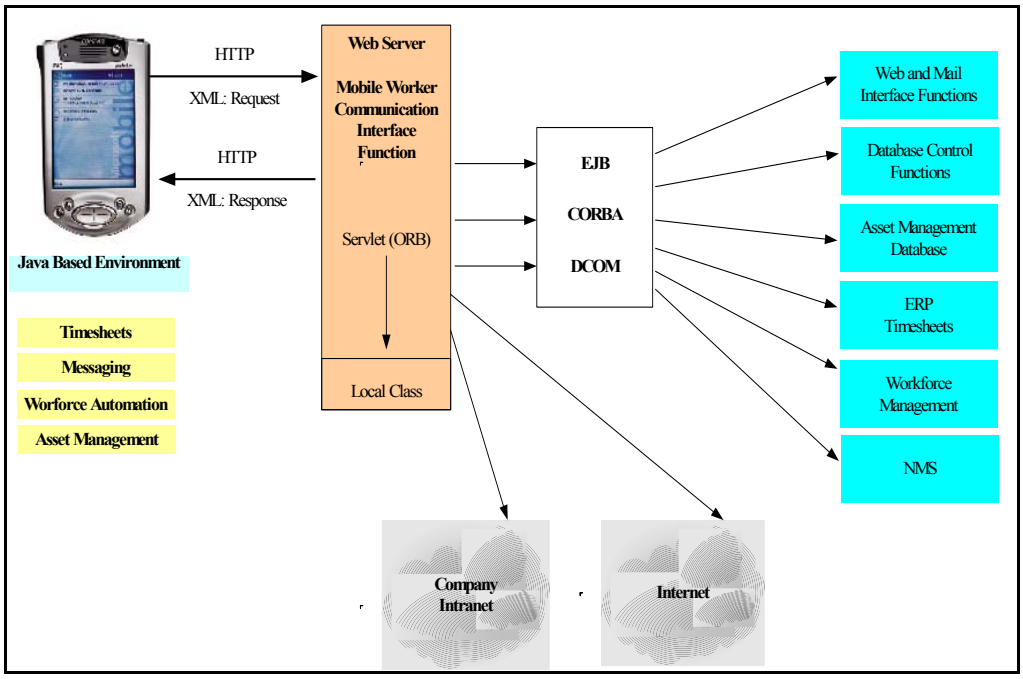

Figure 5.11: Typical Scenario

In this example the architecture is based around a Java Environment such as Waba (Java Based Toolkit for Pocket PC and Palm OS), HTTP, XML and Java Servlets. The main web server provides the gateway to the applications and acts as a Java servlet. Using HTTP and XML, the client sends a request to the servlet (ORB) to call a method of an object. The servlet parses the request, processes it and returns the response. XML in this example is used to describe the client request and the server response, whereas XML is commonly used for the description of a documents structure.

The benefits of this approach are:

- Anywhere, Anyplace and Any Device access to business critical applications
- Based upon open standards, and hence will be supported in the future with tools such as .NET and J2EE standards
- Highly scalable by deploying further web farms
- Using HTTP does not mean a further port needs to be opened of the corporate firewall.

6. COST ISSUES

With private systems potential costs of developing an implementing data services can be defined and assessed. Costs will be affected by the decision to modify an existing system or to build a new system. This will primarily involve capital investment with ongoing costs being minimised.

Pricing of the basic features of public networks, such as handsets, subscription and usage, can be determined on a competitive basis, based on projected usage figures provided by the customer. However, costs for the more advanced facilities and the more onerous requirements, from the operator's point of view, will be more complex.

When using public networks costs cannot be so easily defined because ultimately they are dependant on individual tariffs, traffic volumes and operator strategy.

In the marketplace there are several pricing strategies which can be considered.

- **Volume based**
  Volume based pricing is based on the principle of charging for the quantity of data transferred. In this strategy the operator only charges for data transferred.

- **Time based**
  Time based or duration based charging is based on the principle of charging for the length of time the user is connected during a data session, irrespective of the volume of data transferred.

- **Subscription based**
  Subscription based pricing is based on the principle of the user paying a fixed fee for a period of time irrespective of the length of time the user is connected or the amount of data transferred.

- **Application based**
  Application based pricing is similar to subscription based pricing but limits the user to particular access types or particular applications.

- **Transaction based pricing**
  Transaction based pricing is based on the principle of charging the user for carrying out a particular transaction, typically downloading information from content servers.

- **Hybrid**
  Typically most public mobile data carriers will operate a hybrid strategy where users will pay a monthly subscription, which provides for a defined amount of data or time after which they will pay either volume of time based fees.

In general when using public networks capital costs are low, but on-going costs can be high, difficult to control and are a function of usage. Companies must examine their applications and determine which strategy best suits their needs. For example if an application requires long connection times with small amounts of data beinf transferred then a volume based pricing strategy should be pursued.

7. OPERATIONAL ISSUES

The strategic importance of utility services becomes very apparent during extreme weather conditions or during times of national or local emergency. Whenever such conditions prevail the need for reliable communications across the area affected is of paramount concern to the operational staff within a utility company.

These concerns lead to the dilemma relating to the provision of mobile services through public or private service provision. When a utility makes an investment in private provision it retains control over the operating conditions of the service and will ensure the level of service availability is suitable for it's needs.

Should a utility consider a public service, such as GSM, then there is a need to ensure that the service meets three critical criteria, namely:

- Adequate radio coverage is provided over the utilities area
- The workforce can gain access to radio resources under extreme operating conditions, whether these be the result of extreme weather or incidents relating to local or national emergencies
- That the radio service being provided is resilient to long power outages particularly in the rural environment.

The same philosophy may not be true for voice and data services. In the utility environment current business processes are centred around voice communications. If there is a move towards mobile data business processes will need to be modified to maximise the benefits.

7.1 Use of Data Services – Availability Issues

Whereas availability, network access and network resilience are very critical for mobile voice networks, this may not be true for all mobile data. Data applications must be checked to confirm whether these are needed or even used during emergency work.

If data applications are not needed during emergency work, public mobile networks may be adequate for data services taking advantage of the higher bandwidth, and lower capital and operational costs. For example asset management functionality or mobile office applications may not be used during emergency work and therefore lack of availability would not be a problem during power outages.

Where mobile data applications are critical in emergency situations the same criteria for availability, network access and network resilience have to be met as for the voice network. This will be true for example for dispatch functionality, remote control of substation etc.

7.2 Confidentiality Issues

With the application of mobile data communication, security becomes an important item. This is especially the case with services such as GPRS and the future UMTS, which are ‘always-on’ and the potential risk of intrusion grows with the online time. This risk is not only at the company’s LAN side, but also on the user’s side where the mobile terminal normally has no protection besides virus protection.

If a public data network is used between the mobile data network and the intranet of the company the same security policy has to be in place as for internet connections, e.g. distributed firewall’s etc.

Implementation of virtual private network (VPN) technology is strongly recommended to provide end to end security between the mobile terminal and the company intranet.

In addition, to avoid data access on mobile terminals by unauthorised people, mobile data terminals should be locked automatically after a short period of inactivity e.g. by implementing password-protected screensavers.

8. CASE STUDIES

8.1 Introduction

This section illustrates by means of working examples how and where mobile data implementations have produced real business benefits to utility and service organisations. The case studies look at the business needs, which drive the requirements and detail the solutions implemented.

The case studies look at applications for supply companies, commercial organisations, CRM organisations and core utility organisations.

8.2 Utility Study

8.2.1 Metering Project in Flanders;

Origin:

As a direct consequence of European Union regulations the Flemish Energy minister has opened up the electricity market on a phased basis. From January 2001 the market for customers with a consumption of greater than 1 GWh has been opened to competition, from January 02 the market for customers with a connection capacity greater than 56kVA was opened to competition and from January 2003 the market will be totally opened to competition. This opening of the market to competition has generated the need for innovative solutions in the area of supply and metering.

Business Driver:

In Flanders over 1700 clients are now free to shop for their energy. In the following a further 4300 clients will be free to select an alternative supplier. As a consequence of this, the distribution activities in the electricity market were split in an infrastructure and supply and companies were created to carry out these activities. The infrastructure company manages the medium voltage system transformers and cables. An independent metering company has also been created. The function of this organisation is to deliver the accurate and timely data to the appropriate the supply companies who can then invoice their clients. This avoids the need for suppliers to install their own meters on the client's premises. It is also is more reliable and easier for the infrastructure company to charge the different suppliers who use the existing infrastructure.

Solution:

The metering company was presented with significant challenges in providing a solution that was effective and cost efficient. One option was to continue with a manual system, however due to the need for daily readings and the numbers involved this was quickly seen to be too expensive. An automated and remote data collection system was required.

Speed and cost of deployment were major barriers to the use of a PSTN or leased line based solution as the long waiting period to have a leased line or a PSTN line installed, the additional charges to accompany the public telecom-operator on site and the huge monthly fee for the copper line ruled out this option. This led the metering company to invest in an integrated single cabinet mobile-based solution. Hundreds of these cabinets are simply stored in the

stockroom and are ready to be installed at the client's premises as soon are entitled to access the competitive market.

Each cabinet consists of meter with telemetry contact and a GSM module. Each quarter value is stored in the meter, and once a day (mostly at night) the meter is interrogated via GSM by the central metering computer. According to the closed contracts between clients and suppliers, the right metering data is delivered to them as well as the invoice of supplementary costs of transporting the energy over the power cables.

To prevent the misuse and even the theft of those GSM modules in the cabinet, the SIM card is a data only card, with no voice capability and therefore not open to misuse.

8.2.2 Field Service Application

Origin:

A mobile operators' 30 field force engineers tour Ireland to clear faults on the network. It was a time consuming process. Each engineer received their weekly schedule by driving, for up to an hour, to the nearest WAN hub to access the works order management solution that the operator uses to manage their work schedules. Then they would routinely visit one site after another, resolving each issue in turn.

Business Driver:

While this system worked well, the operator wanted to extend their market lead, improve customer service levels improve efficiency and minimise costs by implementing a solution to give them stronger competitive advantage.

The Solution:

The operator chose Citrix as the optimal platform for its mobile data requirements.

Using High Speed Data Cards slotted into the engineers' existing laptops, the wireless solution enables them dial into the server from wherever they are. They can also receive schedules, access network statistics for fast problem resolution and then email back the job status once complete.

In addition, as they can also access relevant corporate and network applications, they can receive any new application automatically, send important network information back to Head Office and have real time logon access to view faults as they are reported, all without leaving the field.

- Reduction of 75% of time taken to retrieve schedules giving each engineer 6-7 hours savings per week
- Engineers can now dial into the network wherever they are, at any time, to receive their schedules
- Real time access to network statistics for faster problem resolution
- Response times to faults on the network have been reduced by 20%
- Ability to proactively prevent issues on the network by predictive maintenance has significantly improved customer service.

8.2.3 Location Based Services

Origin:

ESB has many valuable vehicles which must be retained on site during civil works such as Substation construction and maintenance. These vehicles are difficult to secure and are open to unauthorised removal from the work location. ESB required a method of tracking the location of these vehicles, the provision of and alarm were these vehicles to be removed without authorisation and a means of tracking their location in such circumstances.

Business Driver:

Whilst security systems provided some measure of protection ESB needed some means of tracking the location of its vehicles in the event of unauthorised removal from site. The obvious drivers being savings on replacement vehicles and on costs due to unavailability of vehicles and delays due to unavailability of vehicles.

The Solution:

Fleet Manager is a cost-effective and powerful vehicle management solution. It allows for real time tracking of vehicle positions as well as the management of vehicles through alarms, alerts and driver Text Messaging. Updates on vehicles can be accessed via the Internet, text messages or WAP.

With Fleet Manager has online access to the exact position of its vehicles at anytime. The application has three main areas of functionality:

- Vehicle tracking
- Driver messaging
- Alerts and Alarms.

A combined GPS/GSM unit was placed on the vehicle, which interacts with satellites to determine the exact location of the vehicle. The co-ordinates are transmitted by text message over the GSM network. Access to the application is provided over the Internet and the location of the vehicle is displayed on a password protected website.

Alerts and Alarms:

The GPS/GSM Unit can support direct electrical connections to the vehicle, both input and outputs. For example, alerts can be sent to and from the refrigeration unit, the ignition, the engine management and central locking.

8.2.4 Workforce Management Case Study

Origin:

In support of a major restructuring of the national workforce that was required to respond to reports of gas escapes a gas company developed and implemented a national mobile data solution.

Business Driver:

There was a business requirement to centralise the control and management of a national field workforce of approximately 3000 field staff. The process of responding to reports from customers of suspected gas escapes had been dealt with on a regional basis using a voice based service operating over, initially, a wide area PMR service and subsequently a MPT1327 trunked network.

The major restructuring within the industry sector was able to benefit from the introduction of a trunking PMR system. This was achieved by designing and implementing a mobile data service such that the vast majority of gas reports (potentially 25,000+ calls/day) were dispatched to field technicians, within very stringent time constraints, with virtually no operator intervention.

The Solution:

The solution centred on three resilient call taking centres located in different areas within the UK. Customer reports of potential gas escapes were registered with one of these centres and all customer details entered onto a database. The central computer system was then responsible for ensuring the calls were distributed to the field service staff most appropriate to deal with the investigation of each report.

The criteria used in the decision process included:

- The time the report was logged onto the system, there is a statutory obligation to respond within a short timeframe
- The matching of the nearest available field technician with the location of the incident in order to maximise utilisation of resources at minimal cost, the approximate location of field resources was identified from knowledge of the cell the mobile radio was registered on within the PMR system
- To track resources 'logging on' and 'logging off' the working day
- To escalate the report if it had not been delivered to an available technician within predetermined timeframes, ultimately, the escalation process required operator intervention to ensure the report would be actioned within the statutory timeframe

To enable the central system to communicate with the PMR system the gas company developed 'in-house' a central computer gateway and a common mobile interface gateway which allowed interoperation with a number of differing manufacturers of MPT 1327 trunking mobile systems. There was no commercial gateway solution available in the marketplace.

The solution took advantage of the different data functions available within the MPT 1327 radio system protocol with the size of the message determining the data service functionality used for the data transfer. In this way the most efficient radio transfer mechanism was used for each message transaction, ensuring the minimum radio resource was used on each occasion.

Whilst meeting all the primary criteria relating to the central management of the field workforce the system is also able to provide arrange of performance parameters relating to job progress updating and to an individuals work performance. This includes:

- Field staff work from home, no reporting to depot/office location at start/end of day
- Technicians 'logged on' and 'logged off' at the start and end of their working day
- Field staff 'pull' jobs from the system as required
- Job progress can be reported and monitored
- Time to reach job and 'time to repair' can be monitored
- Stores items can be rescheduled for the restocked of vehicles.

The system proved to be a major success meeting all the performance parameters that were established at the outset. Additional benefits were realised in the management of the workforce. The system was able to provide a range of performance characteristics relating to the whole service chain, from those required to log call reports through to the field staff, to the overall costs of providing the service on a national basis.

8.3 Commercial Organisation

8.3.1 A Solution for Road Transportation

Origin:

The companies, which specialised in transport, wanted to upgrade their efficiency and customer satisfaction. They needed a real time tracking system for their parcels.

Business Driver:

A French mobile phone operator wanted to offer value added services on their network. The operator decided to propose a system to track the delivery of goods in real time on its GSM / GPRS network.

Solution:

The system enables communication between vehicles and the applications platform so that it is possible to trace the delivery of the parcels. It offers confidentiality for the data exchanged and identification of the users. It is based on the GSM/GPRS network of the operator. The type of information system used depends on the level of integration needed. The basic one is to use a web gateway to interact with the system, the second is to exchange files between the IT systems of the company and operators' application platform. The third option is to integrate the IT application with the operators platform.

From the platform, it is possible:

- to personalise the labels of the parameters : task to be done, type of goods transported, name of the drivers, type of lorry,…
- to take the customers orders
- to give new task to the workforce
- to group tasks for a same driver
- to monitor the progress of the task.

The interface for the driver is a WAP phone (GSM, GPRS, later UMTS) where he can:

- receive and display orders
- get the address of the place to deliver/take the goods
- visualise the parameters of the delivery
- communicate the elements of the transportation : beginning/end loading, problems, etc…

It is also possible to build special services if the IT application is integrated with the system.

Currently this solution represents about 2 000 mobiles.

8.4 Customer Relationship Study

8.4.1 CRM Application

Origin:

An on-line sales company developed the idea of offering a web based Customer Relationship -Management (CRM) application for SME and Enterprise companies. Sold only as a subscription-based service, it is run entirely online on the web, and is accessed by using a standard Internet web browser.

The on-line CRM operation is hosted at a secure data centre, allowing clients of the company to enter their customer information, sales leads, forecasts, accounts etc directly into the system. This incoming data is processed immediately and is available for viewing in a variety of ways, for example by identifying market trends or assessing the effectiveness of product campaigns.

Business Driver:

With CRM data being constantly updated and available online for their client base, it was important to underpin the effectiveness of the innovation. By demonstrating that the live data could be accessed anywhere, there was now little need to be chained to an office desk in order to input or retrieve valuable corporate data.

Traditional CRM client/server applications are limited to time-consuming software installation, training and maintenance. The collated data, (once processed) can be at best several hours old, and at its worst may only be accurate to the last month of trading. By then, advantages in identifying trends have largely disappeared, and sales opportunities can be lost. In addition to using CRM for its own client base, the company consistently emphasises and promotes the real-time nature of the service. By embracing a mobile data solution, this brings much needed commercial intelligence to the people in the front line, the mobile sales-force.

The Solution:

The company uses a GSM High Speed Circuit Switched Data service as the primary enabler in bringing a mobile connection directly to the end user. By using a Cardphone with a standard laptop, it instantly gives a wireless connection over the mobile network, capable of supporting data speeds up to 43.2kbps. This benefits the end user by allowing shorter call times, resulting in lower call charges.

The benefits of the solution include:

- Client data is available in real-time and collaborative information can be widely disseminated to all authorised parties
- Information may be viewed entered and modified using a standard browser irrespective of the client's chosen product platform
- The attraction of accessing company-critical data any place, any where at any time. Time-zones and distance from office systems are no longer an issue
- Information is shared immediately with all who need to access it

Core Business

8.5.1 Line Sag Monitoring

Origin:

On power cables the monitoring of line sag is crucial to:

- avoiding line fractures (mostly by ice load)
- maximizing transport capacity (especially during the summer))
- meeting safety regulations and measurements.

Business Driver:

The sag of the line has to be measured and this data has to be transmitted to a control center. Typically, the transmission medium used was a small UHF transmitter from the measurement point to the nearest substation and from there continuing over the classical transmission lines to the control center. This is a complex way to transmit data from a high voltage pylon to the control center, and the measurement of the sag itself is very difficult because it is achieved only by indirect methods. Finding a method to measure the sag of the line via a simple operation and without cutting the power line was required.

Solution:

However, an easy approach is possible as follows:

Figure 8.1: Sag Monitoring by Satellite

A solution that has been proposed is to clamp a satellite module on the power line on which there is an GPS receiver that transmits its data via the satellite module to a control center. In this control center the received data is analyzed with the known position of the GPS receiver and so the sag can be calculated. It's evident that clamping a small unit on the power line is an easy task and can be done by means of a helicopter on a live power line (hot installation).

To obtain a better measurement than the classical GPS accuracy, we can add the function of differential GPS by adding, at the control center, a correction vector process related to a selected reference satellite. It must be ensured that the reference satellite does not change(locking the GPS to that same satellite).

With this method the accuracy is very good (less than 1 cm fault tolerance) and the instrumentation is very simple.

There is no need to invest in a data communication network since an existing satellite network is used, the coverage and the network availability is quasi 100% and the installation is very simple.

8.5.2 Rural Automation/Control

Origin:

Many electricity distribution companies are seeking to improve the quality of service they offer their customers. In an attempt understand the capability and reliability of a Private Mobile Radio network for the transmission of data messages to and from an RTU as part of an remote control scheme, a UK Regional Electricity Company implemented a trial scheme using the PMR network.

The Solution:

Companies are seeking to reduce the supply outages on their 11 kV distribution networks. There are many varied factors that determine the reliability of power networks. However once an interruption has occurred the most effective way to minimise the number of customers affected, is to have a high level of control over multiple sections of network.

A primary requirement for the extension of this network control philosophy is the provision of a reliable cost effective communications network which operates satisfactorily in remote areas of the rural networks.

This case study describes a scheme that uses an MPT1327 trunked analogue radio network as the communications medium.

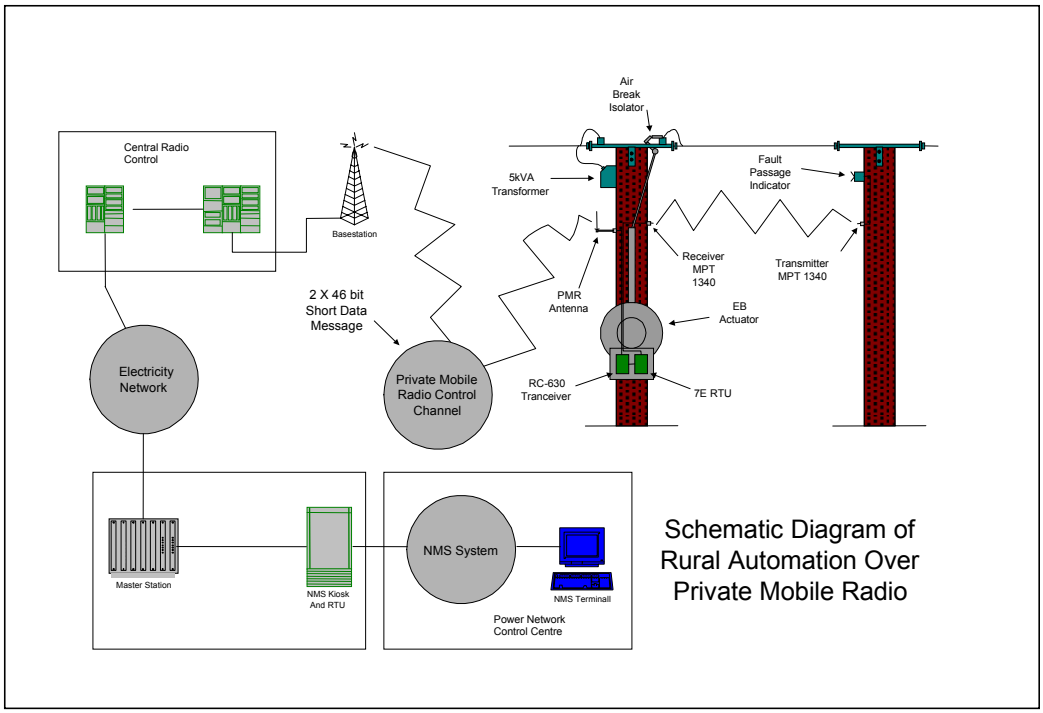

Figure 8.2: Rural Automation over Private Mobile Radio

The PMR system operates on a similar principle as a third party data provider but as the system is owned by the distribution company, there are no air time call charges. However, there is a capital charge associated with the radio units installed at each pole top location.

Electrical power for the radio and telemetry outstation was provided by a 12volt battery. A mains supply was provided by a 5kVA transformer mounted on the pole.

The Communications Channel:

There are several data transfer functions available within the MPT1327 protocol. The most appropriate function for this application was considered to be the Short Data Message that is a function within the control channel in the analogue trunked radio system. The use of the control channel for this application meant that there would not be additional congestion on the traffic channels as a result of this trial. In addition, the control channel performance could be monitored under controlled conditions to ascertain whether the SDM mechanism could support a much larger field implementation scheme. This SDM facility can transfer up to 184bits of free format data to and from a radio unit in the field to a central port within the radio system infrastructure.

During bench tests and subsequent field tests it was found that control centre RSC to mobile data delivery communications took an average 2 seconds to complete and that mobile to control data delivery took between 10 and 20 seconds. This imbalance is a function of the time-shared control channel used in this type of system

It was decided at an early stage in the project that a full telecontrol protocol could not be implemented using this service with SDMs. This is because the extensive handshaking used in a traditional telecontrol protocol would slow the system down further and make it impractical.

Instead, a proprietary protocol was used for the trial that used a single data transfer message One message per switch operation or interrogation was used instead. When a change of state occurs at the outstation a 2 x 46 bit SDM message is generated and sent to the master station. This message contains the complete site status and error checking sequence.

The protocol provides a sequence of retries should messages not be received by the outstation or the central site. Communications s failure is displayed on a Network Management terminal under predefined circumstances

PMR Performance

The use of the Short Data Message facility proved to be successful given that this was purely a trial system. The overall data transfer success rate Central Master Station to Outstation is +99% first time delivery, while Outstation to Master Station success rates averaged 97%. This does not include retries or discarded duplicate messages which occur within the radio system transfer mechanism.

In the radio cell where the trial has taken place, control channel utilisation has not increased significantly and there has not been any adverse effect on the setting up of normal speech calls.

8.5.3 Mobile Data Communication for Alarm Handling

Origin:

Dispatch centres need to have a lot of information on the many high voltage substations nationwide. Therefore each substation is equipped with an RTU to handle the necessary signals, commands and measurements. The physical link between the dispatch and the substation is either fibre or leased line from the public telecom operator. The communication speed is low, 600 or 1200 baud. In the case of failure of the link or the RTU, there is no supervision of the substation, which is inadmissible. Therefore a solution to provide a safe backup for mentioned failures was required.

Business Driver:

When a substation is no longer supervised by the dispatch centre which is always a remote site, there is an obligation for the company to have personnel on the site that can supervise locally. The cost for this is significant, especially when the restoration of the remote supervision takes a long time. In the case of a leased line failure between the dispatch centre and the substation, this could take up to three days (Friday, Saturday and Sunday) to restore it and during that time, the site must be manned. Therefore, an alternative using an automated solution in the above cases provides a very good method of reducing costs and relieving qualified personnel.

Solution:

In the substation all the alarms are grouped into one general signal, for backup purposes. This signal is transmitted to the dispatch centre, using the backup mobile system every time an alarm is generated in the substation and only when the backup system has been remotely activated by the operator.

If the dispatch receives such a signal from the backup equipment, then and only then he asks for a physical intervention in that substation.

9. CONCLUSIONS

It is apparent from the work carried out by TF35.07 that trends in the utility sector towards rationalisation, efficiency and improved service are driving the need for the adoption of mobile data applications. Redesigned business processes are being made possible by the developments in mobile data technology.

Mobile technologies are maturing in terms of availability, functionality and cost allowing for deeper deployment within the utilities business. However the burning questions of availability coverage and access still remain. The deployment of mobile data technologies in mission critical applications will still depend on the utilities' attitude to risk, especially where issues of safety and network security are concerned. Data applications must be checked to confirm whether these are needed or even used during emergency work. If this is the case then the same standards, which apply to traditional voice applications, must also be applied.

Due to the diverse requirements of utilities it is unlikely that a single solution will be available to meet all needs within the short to medium term, if ever. However as can be seen from the case studies significant benefits and improvements can be achieved with mobile data solutions.

From the work of the task force that there is a need for mobile data solutions in utility companies and that the technologies are available to meet this requirement. However, a major obstacle to a company realising the efficiencies mobile data can bring is the need for a substantial change in business processes.

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

3G	Third (**3.**) **G**eneration *(e.g.: UMTS)*
3GPP	Third (**3.**) **G**eneration **P**artnership **P**roject
bluetooth	*wireless communication standard to communicate e.g. with office hardware or cellular phones with an high band width*
BSC	**B**ase **S**tation **C**ontroller (in GSM networks)
BSS	**B**ase **S**tation **S**ystem (Interface) (Standard EN 3013409)
BTS	**B**ase **T**ransceiving **S**tation
CCIR	**C**omité **C**onsultatif **I**nternatinal pour les **R**adio Communications (now ITU)
CD ROM	**C**ompact **D**isk **-R**ead-**O**nly **M**emory
CDMA	**C**ode **D**ivision **M**utiple **A**ccess
CEPT	**C**onférence **E**uropéen des Administrations des **P**ostes et **T**elecommunications
CF	**C**ompact **F**lash Memory
CODEC	**Co**mpression / **Dec**ompression Unit
CORBA	**C**ommon **O**bject **R**equest **B**roker **A**rchitecture
CPU	**C**entral **P**rocessor **U**nit
CRM	**C**ustomer **R**elationship **M**anagement
DCOM	**D**istributed **C**omponent **O**bject **M**odel
DTI	**D**epartment **o**f Trade and **I**ndustry (USA)
EADS	**E**uropean **A**eronautic, **D**efense and **S**pace Company
EAI	**E**nterprise **A**pplication **I**ntegration
EDGE	**E**nhanced **D**ata Rates for **G**SM **E**volution
EIR	**E**quipment **I**dentification **R**egister
EJB	**E**nterprise **J**ava **B**eans
ERC	**E**urpopean **R**adiocommunication **C**ommittee

ERP	**E**ffective **R**adiated **P**ower
ETSI	**E**uropean **T**elecommunication **S**tandard **I**nstitute
FIFO	**F**irst-**I**n-**F**irst-**O**ut (Buffer)
GGSN	**G**ateway **G**PRS **S**upport **N**ode
GIS	**G**eographic **I**nformation **S**ystem
GMSK	**G**aussian **M**inimum **S**hift **K**eying
GPRS	**G**eneral **P**acket **R**adio **S**ervice *(Enhancement of GSM Standard for data transmission EN 3013409)*
GPS	**G**lobal **P**ositioning **S**ystem
GSM	**G**lobal **S**ystem for **M**obile Communication
GSM	**G**roupe **S**péciale **M**obile (*Organisation body within CEPT) (Standardisationgroup for cellular phone network)*
GSM-R	**G**lobal **S**ystem for **M**obile Communication - **R**ailway
GSN	**G**ate **S**erving **N**ode
HLR/AuC	**H**ome **L**ocation **R**egister / **Au**thentication **C**enter
HSCSD	**H**igh **S**peed **C**ircuit **S**witched **D**ata (=ECSD)
http	**H**yper**t**ext **T**ransfer **P**rotocol
HV	**H**igh **V**oltage
IP	**I**nternet Work **P**rotocol *(Standard of the DoD, now RFC 791)*
IrDA	**I**nfra**r**ed **D**ata **A**ssociation
IT	**I**nformation **T**echnology
J2EE	**J**ava **2** **E**nterprise **E**dition
Kbps	Kilo bits per second
LAN	**L**ocal **A**rea **N**etwork
MAC	**M**edia **A**ccess **C**ontrol *(Protocol Layer)*
MPT	**M**inistry of **P**ost and **T**elecommunication
MS	**M**obile **S**tation
MSC	**M**obile Service **S**witching **C**enter

MV	**M**edium **V**oltage
NMS	**N**etwork **M**anagement-**S**ystem
NPD	**N**on-**P**rescribed **D**ata
ORB	**O**bject **R**equest **B**roker
OSI-Model	**O**pen **S**ystem **I**nterconnection
PC	**P**ersonal **C**omputer
PCMCIA	**PC**-**M**emory **C**ard **I**nternational **A**ssociation
PCU	**P**rocess **C**ontrol **U**nit
PDA	**P**ersonal **D**igital **A**ssistent
PMR	**P**rivate / **P**rofessional **M**obile **R**adio
PSTN	**P**ublic **S**witched **T**elephone **N**etwork
RF	**R**adio **F**requency
RLC	**R**OM **L**ocation **C**ounter
ROM	**R**ead **O**nly **M**emory
RS 232	**R**ecommended **S**tandard **232** *(Standardised seriell Interface)*
RSC	**R**egional **S**witching **C**enter
RTU	**R**emote **T**elemetry **U**nit
SCADA	**S**upervisory **C**ontrol and **D**ata **A**cquisition
SDM	**S**hort **D**ata **M**essage
SECORA	System to **Se**nd **Co**mmands originated directly from an on-board **Ra**dio system
SGSN	**S**erving **G**PSR **S**upport **N**ode *(Interface of different cellular phone network providers)*
SIM	**S**ubscriber **I**dentity **M**odule *(chip in the cellular phone)*
SME	**S**hort **M**essage **E**ntity
SMS	**S**hort **M**essage **S**ervice
SS7	**S**ignalling **S**ystem **7** *(EN 302 091)*

TAPS	**T**ETRA **A**dvanced **P**acket **S**ervice
TDMA	**T**ime **D**ivision **M**ultiple **A**ccess
TEDS	**T**ETRA **E**nhanced **D**ata **S**ervices
TETRA PDO	**Te**rrestrial **T**runked **Ra**dio **P**acket **D**ata **O**ptimised
TETRA	**Te**rrestrial **T**runked **Ra**dio *(Standard EN 300 392)*
TF	**T**est **F**acility
TFT	**T**hin **F**ilm **T**ransistor
TMT	**T**echnology, **M**edia and **T**elecommunication
UHF	**U**ltra-**H**igh **F**requency
UK	**U**nited **K**ingdom
UMTS	**U**niversal **M**obile **T**elecommunications **S**ystem
VHF	**V**ery **H**igh **F**requency
VPN	**V**irtual **P**rivate **N**etwork
WAN	**W**ide **A**rea **N**etwork
WAP	**W**ireles **A**pplication **P**rotocol
WDA	**W**ireless **D**igital Assistants
WLAN	**W**ireless **L**ocal **A**rea **N**etwork *(Standard IEEE 802.11)*
www	**w**orld **w**ide **w**eb
XML	E**X**tensible **M**arkup **L**anguage

APPENDIX B

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APPENDIX B