WHY WIRELESS?

Imagine getting this assignment from your company management: Find a cost-effective way to monitor energy usage remotely and in real time at thousands of customer sites. When a problem occurs, locate and dispatch an appropriate repair vehicle with all the necessary data (including multimedia maps, customer records, circuit diagrams and safety procedures) to repair the problem. After the repair team arrives, give them the option to communicate with headquarters by voice or data link, depending on the nature of the problem. And by the way, the whole thing needs to be built on a flexible, future-proof technology because we can't anticipate all the new services customers will expect or the new business opportunities well dream up along the way. Among the options we're considering giving field crews the option to communicate via live video using this same system.

This paper explains how wireless data systems based on the Global System for Mobile communications (GSM) are the only viable solution for challenging scenarios such as thisæand this is just one example from the many industries now adopting GSM to improve communications. We'll start with a closer look at GSM itself to explain why it's the best choice among the technologies vying for your wireless business. After that, we'll explore the voice, data and messaging features GSM offers today, followed by the advanced features that will start appearing within months. Next is a quick comparison with other wireless technologies, along with some thoughts on the variables to consider when choosing a wireless strategy.

WHY GSM?

GSM is the telecommunication success story of the decade. The number of GSM customers around the globe has already reached 150 million and is expected to continue growing exponentially. Forecasts predict 250 million users by 2000, heading to 400 million by 2002. There is only one way for a technology to reach that magnitude and become the technology of choice for so many businesses and consumers. GSM was designed from the ground up as an open platform, provides unmatched fraud prevention and privacy, and has a clear evolution path to third-generation wireless solutions.

While other technologies, such as CDMA, have been tied up in battles over proprietary rights and technological patents, GSM is moving full steam ahead and paving the way for the rest of the industry. The success of GSM technology is based on several key factors:

• Superior services and functionality. GSM provides integrated voice, high speed data, fax, paging and short message services capabilities.

- Proven technology. From fleet monitoring to security to energy management, GSM is already delivering feature-rich solutions all over the world.
- Secure communications. GSM offers call security and fraud prevention with full digitally encrypted transmission.
- Voice quality. GSM uses superior channel coding and error correction techniques which translate to near-wireline voice quality.
- National and international roaming. The GSM architecture supports full network interoperability, no matter where your business takes you.
- Clear evolution path. GSM has a clearly defined evolution path from today's solution sets to third generation wireless.

THE HISTORY OF GSM

During the early 1980's European countries experienced rapid telecommunications growth, but individual countries were developing unique and incompatible cellular systems. With such close geographical proximity, incompatible systems would have not only have been costly to develop and main-



Figure 1: Global GSM map, showing GSM's nearly universal service coverage

tain, but also would have made cross-country communication impossible. To avoid such a mess, interested parties formed a study group called Group Special Mobile (GSM). This group went on to make recommendations for a network that later adopted the name GSM.

The GSM consortium's goal was developing the world's best open communications system. The open architecture sparked competitive innovation among all developers, yet provided enough standardization to ensure

erage compatibility across the system. The result was

a superior network which has gone on to become the leading wireless digital technology in the world (Figure 1).

GSM networks are in place in more than 130 countries, and it is the only technology that can provide international roaming. Although GSM got its start in Europe, users in Asia were quick to adopt the standard as well. In North America, GSM reached the two-million user mark in half the time of any competing technology, and GSM services are springing up all across the continent. Today's services and enhancements now in development will continue to build on GSM's existing network to ensure that GSM customers, operators and equipment makers stay on the forefront of wireless technology.

GSM's Hybrid Technology

As a system designed from the ground up for cost-effective, global transmission of digital data, GSM sidesteps the inherent disadvantages of other technologies. Nothing in GSM is tacked on or adapted for digital use; the entire system is purpose-built for digital data.

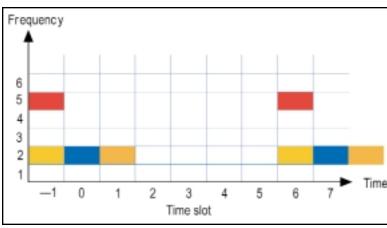


Figure 2: GSM uses a hybrid TDMA and FDMA design.

Since the frequency spectrum is a limited resource, numerous techniques have been developed in an attempt to maximize the number of users occupying a common spectrum. GSM uses a combination of frequency division multiple access (FDMA) and time division multiple access (TDMA). Figure 2 shows how the two work together. Down the vertical axis you can see two duplex channel pairs, each 200 kHz wide. In each channel pair, one channel holds for the uplink and one for the downlink. (The downlink is the

communication path that is used to send data from network to you, the end user. The uplink is the communication channel that you use to send data to the network.) As we move forward in time, TDMA further divides the carrier frequencies into eight timeslots, with each user being assigned a timeslot. During his or her designated timeslot, each user can transmit or receive data.

In GSM networks today, a 200 kHz channel is capable of transmitting 271 Kbps of data, which after equal division into eight timeslots, provides 34 Kbps per timeslot. Of this 34 Kbps, 20 Kbps or more is devoted to protocol and error correction, leaving 9.6 to 14.4 Kbps for data, ensuring virtually error-free transmission.

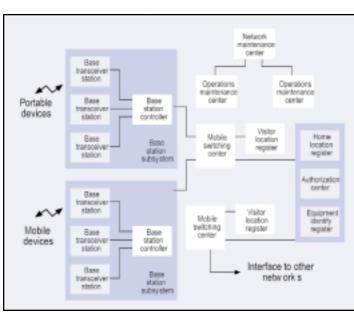


Figure 3: Components of the GSM network.

THE GSM NETWORK

The basic GSM architecture involves three major components: the base station subsystem, the network subsystem, and the operations and maintenance subsystem (Figure 3).

The base station subsystem (BSS) is responsible for providing transmission and coverage to the end user and includes the base station transceiver unit (BTS) and the base station controller (BSC). In its simplest form, a BTS consists of an antenna for the transmission and reception of signals and a bank of radio channel cards responsible for carrying the signal of each user. Each BTS covers a designated geographic area known as a cell. These BTSs and their cells are strategically placed to provide seamless radio coverage in a

given area. The BSC manages the radio resources in each BSC including channel assignment, handoffs, and channel termination. Also located in the base station subsystem is a transcoder unit that converts the speech or data into a format and data rate compatible with the landline connection.

The network subsystem consists of the mobile switching center (MSC), home location register (HLR), the visitor location register (VLR), the equipment identity register (EIR) and the authentication center (AuC). These entities manage the call roaming, call routing, and the security/authentication features of the GSM network. A number of BSSs report to a given MSC. The MSC performs two main functions: switching between the BTSs when a call needs to be handed over and communicating with the external networks, such as public switched telephone network (PSTN). There is typically one HLR per GSM network. The HLR can be thought of as a database containing all the administration information, such as the list of services available, for each mobile. The VLR is a scaled down version of the HLR and contains administrative information for only the mobiles that are currently in the local geographic area.

Lastly, as its name implies, the operations and maintenance subsystem handles all the management and administration functions, from call tracking and billing to network monitoring and repair.

ERROR CORRECTION AND DATA PROTECTION

Thanks to the potential for interference that is a fact of life in wireless transmission, the data or voice traveling on the GSM network must be protected from errors. It is GSM's superior error correction scheme that gives it un-

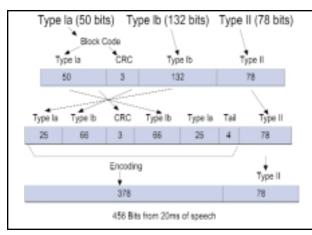


Figure 4: Channel coding prioritizes data blocks to ensure clearer voice transmissions.

matched voice clarity and data accuracy. GSM uses *channel coding* and *diagonal interleaving* to protect the data and increase the chance of reconstructing any damaged data.

Channel Coding

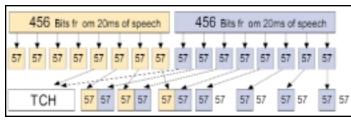
GSM processes data and voice in 20 ms portions, and channel coding is the means by which each 20 ms slice of data is prioritized and protected. The prioritization scheme is based on research that determined which bits in human speech were most important to comprehension. Based on these studies, three levels of bit

classification evolved: class Ia (50 bits) – the most important, Ib (132 bits) – moderately important, and II (78 bits) – the least important.

Class Ia bits are accompanied by a 3 bit cyclic redundancy code (CRC) added for error detection. The CRC is a known set of bits added to the data stream when the signal is sent across the network. At the destination, the actual CRC bits received are compared with the known and expected CRC bits. If any discrepancy exists, the bits are considered damaged and are discarded and replaced by a modified version of the previous frame. Figure 4 shows the process in more detail.

Diagonal Interleaving

Diagonal interleaving further protects the bits in a GSM transmission. First, the 456 bits are separated into 57-bit chunks. Each chunk is then interleaved with a 57-bit chunk from a previous speech sample and then



placed on the traffic channel (TCH). By interleaving the data in this way, if one TCH is lost, error-correction algorithms can use the previous TCH to estimate and reconstruct the lost data (see Figure 5).

Figure 5: Diagonal interleaving combines old and new data to give the error correction algorithm a chance to recover corrupted data if needed.

Transparent and Non-Transparent Transmission

GSM supports two data transfer modes to offer flexibility in terms of error rates and data throughput. The transparent data mode delivers service with a variable error rate but with guaranteed throughput and delay, whereas the non-transparent mode delivers a constantly low error rate without a guaranteed throughput or delay. Transparent mode supports services that require a constant, dedicated bit rate and a predictable delay. The non-transparent service delivers performance that is closest to using a modem over a fixed PSTN line. The majority of the data traffic on the GSM network is nontransparent, meaning bit rates can be changed without compromising the integrity of the data. (Note that GSM offers extensive error correction, so the transmission errors discussed here do not necessarily translate into errors at the receiving end.)

GSM SECURITY AND ENCRYPTION

Fraud and privacy are concerns whenever data, voice or video are loaded onto any network. Cloned cell phones and eavesdropped conversations make headlines with alarming regularity. Fortunately, the security and authentication mechanisms employed by GSM make it the most secure communication standard available today and make the scenarios described above impossible. GSM's world-class security includes both physical and algorithmic barriers.

Subscriber Identity Modules

GSM mobiles and terminals are activated by unique subscriber identity module (SIM) cards. The SIM card is a "plug and play" device whose physical appearance resembles a small credit card. Each subscriber simply inserts his or her card into any GSM cell phone or terminal and enters a PIN code to access voice, data and messaging services. The card also identifies each subscriber's GSM network and provides security functions along with a store of personal information such as abbreviated dialing lists. The SIM card provides subscriber mobility, flexibility and security unmatched by any other technology. One of the most powerful features of the SIM approach is remote activation, which lets the service provider enable or disable a GSM terminal or device remotely.

Authentication

Since the radio spectrum can be accessed by anybody, user authentication is a critical part of GSM security. Authentication is a challenge-response process by which the GSM network system verifies the identity of the mobile subscriber. In a challenge-response process, all sensitive information and calculations are computed at either the mobile station or the network, thus eliminating the need for any sensitive information to be passed across the air interface.

Authentication involves the SIM card in the mobile terminal and the AuC in the network subsystem. During authentication, the AuC generates and sends the mobile station a 128-bit random number (RAND). The mobile subscriber uses the RAND with the authentication algorithm (A3) and its subscriber authentication key (Ki) to compute a 32-bit signed response (SRES). When the GSM network receives the signed response from the mobile unit, it repeats the calculation to verify the identity of the subscriber. Since the subscriber authentication key and A3 algorithm are present in the user's SIM and in the network's AuC, HLR, and VLR locations, it is not necessary to send any sensitive information over the radio channel. If the received SRES agrees with the network's calculated value, the authentication process is complete. If the values do not match, the connection is terminated and a failure response is returned to the subscriber.

Encryption

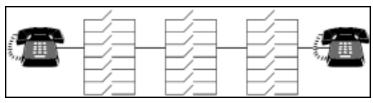
The SIM card also contains a ciphering key generating algorithm known as A8 that is used to compute the 64-bit ciphering key (Kc). The same RAND from the authentication process is applied to the A8 algorithm with the subscriber authentication key (Ki) to produce the ciphering key (Kc). The mobile station encrypts and decrypts data using the ciphering key and another cyphering algorithm known as A5. Again, no sensitive information is sent across the network.

GSM's speech and data coding schemes, combined with its authentication and encryption mechanisms, make GSM the most secure and reliable communication standard available today.

WHAT CAN GSM DELIVER TODAY?

GSM currently offers a full suite of enhanced voice and data functions. Data transmission choices include both circuit switched data and short message service.

CIRCUIT SWITCHED DATA



Circuit switched data is the most widespread and traditional means of data and voice transmission available today. A circuit switched connection occupies one network line for the entire length of data transmission and during this time no other user may

Figure 6: In circuit switched communications, each call fully occupies a transmission channel for the entire duration of the call.

access this network line. A circuit switched

connection (Figure 6) is the optimal means for transmitting any continuous amount of data, such as video transmission or voice.

A common example of a circuit switched network is the telephone system. When person A picks up the telephone and dials the number of person B, the network determines and assigns a path for that transmission. The signal travels through each assigned circuit switch to complete the connection. Once the signal has reached person B, a continuous two-way transmission path has been established. On a long distance call, for example, many circuits would need to be connected together to make the call possible. These circuits are dedicated to the call for the duration of the transmission and cannot be shared by other users. This requires substantial network resources to be allocated per user. GSM's circuit-switched networks and transparent data mode are ideal for voice and other applications that require a non-interrupted and constant bit rate.

SHORT MESSAGE SERVICE

To accommodate smaller messages, GSM uses short message service (SMS) for efficient and timely data transmission and data retrieval. SMS is a point-to-point service that is used in data transmissions such as paging, notification, news flashes, and information retrieval. Short messages can carry up to 140 8-bit characters and can be sent and received simultaneously with a voice or data call. Short messages are sent above and beyond the voice or data in the overhead signaling path. Although it seems similar in concept to traditional paging, SMS is not geographically restricted, as paging systems are. Moreover, the GSM network stores and resends the message if the receiver's handset is turned off (if a pager is turned off, the message is simply lost).

In order to understand how SMS works it is first necessary to understand the framework of a typical GSM traffic channel. The channel multiframe consists of 26 frames: 24 of these frames carry speech or data, one is an idle frame, and the other one is a *slow access control channel* (SACCH). On the downlink, the SACCH is normally used to communicate non-urgent regular control information to the mobile or terminal. When a short message needs to be sent to a terminal that already has a voice or data call up, GSM temporarily borrows this channel to send the message.

The second scenario occurs when the mobile or terminal is in idle state. Under these conditions, the short message is sent on the *fast access control channel* (FACCH). Normally, the FACCH is used when urgent control information needs to get to a mobile such as a handoff request or a power change. When sending a short message, the FACCH replaces the traffic channel to send the message.

All GSM networks that support SMS are equipped with a *short message service center*. When a message is sent to an end user, it always passes through the message center. The message center determines where the receiver of the message is located, adds the date, time, and sender information, and then forwards it on to the recipient. The message center also acts as a "store and forward" service by storing messages until they can be delivered to the recipient. Unlike a pager, where the information is lost if the pager is out of the service area or turned off, SMS messages are saved until your mobile or end terminal can receive them. Furthermore, your SIM card can store messages enabling you to save, recall, edit and resend messages. SMS also works seamlessly with the Internet, meaning you can configure your email to automatically forward messages to your mobile phone via SMS.

SMS not only improves efficiency and reliability of your business communications but also saves you time and money. The cost to send a SMS message is a typically a small fraction of the cost involved in occupying airtime to dial up and transmit the same message via voice.

GSM Tomorrow

While circuit-switched connections answer many current needs, emerging data and multimedia application will require additional bandwidth. Xircom is among the technology leaders developing higher speed services with the deployment of high-speed circuit switched data and general packet radio service.

HIGH-SPEED CIRCUIT SWITCHED DATA

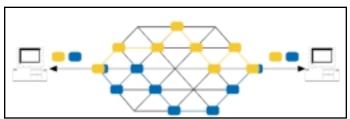
Because circuit-switched applications monopolize the transmission line during the connection, thus providing a guaranteed bandwidth and continuous connection, this sort of connection is ideal for voice and large data streams. However, current wireless data networks providing 9.6 to 14.4 Kbps can't handle newer high-speed applications such as multimedia. By early 2000, high-speed circuit switched data (HSCSD) will have the potential to boost GSM networks to data rates not yet achievable with any other technologies. The increased data rate would be made possible by using a new channel coding scheme to boost the speed of the existing timeslot. HSCSD could further increase data speeds by combining timeslots. A single user could use multiple timeslots during a single transmission and achieve data rates up to 57.6 Kbps.

The HSCSD design also supports both symmetrical and asymmetrical transfer modes, providing more bandwidth for the downlink if needed. In most Web surfing situations, for instance, the bulk of the data is being received from the Web on the downlink, while minimal data is being sent from the user on the uplink. HSCSD's asymmetrical mode provides the flexibility to combine timeslots differently for each link.

To the user, HSCSD would look like familiar 9.6 Kbps service, only much faster. Applications that are impractical at lower data rates, such as Web browsing and file transfer, could become a reality with HSCSD. These services could be accessed anywhere and anytime over the GSM mobile network.

GENERAL PACKET RADIO SERVICE

GSM is constantly evolving to keep itself ahead of the demand for data services. By implementing a new packet-switching technology, known as general packet radio services (GPRS), GSM will offer speed and flexibility unmatched by any other competing technology. To help you understand the technology behind GPRS, let's start with a look at packet switching.



How Packet Switching Works

Packet switching is a means of segmenting data into smaller pieces of information before sending them over the network. These packets travel across the network independently from one another and using independent routes to arrive at the final destination. At the final destination, all

Figure 7: In a packet-switched network, individual packets travel independent paths during transmission.

the packets are reassembled in their correct order again. Figure 7 shows several packets traveling

through the network.

Each packet has the same structure, with the header and trailer bits carrying control information. Each packet also contains its own unique source and destination address, which allows it to share the network without interfering with other packets traveling in the network. Once the data have been formatted into packets, they are routed across a complex mesh of nodes in the network. Each of these nodes is essentially a small computer that stores the packet temporarily in memory, reads the packet's destination address, and then sends the packet on to the next node. Because the packets represent a very small amount of information, they require little time to pass through each node and the process can take place very quickly.

Packet switching offers three significant benefits. First, since the packets are short they use network resources for a short period of time. Second, since the transmission does not require a dedicated path to be established, multiple users can share the same network resources. Third, there are no call setup or teardown delays in a packet system; a GSM terminal can begin sending packets in a little as 500 milliseconds.

How GPRS Uses Packet Switching

Most of the wireless data applications today are operating on network rates of 9.6 Kbps. However, as the industry moves towards more Web-based applications and advanced multimedia needs, higher transmission speeds are a must. GPRS will increase data transmission speeds from the current 9.6 Kbps to over 115 Kbps.

The fundamental factor that makes GPRS superior to other competing technologies is that it can combine up to eight of the timeslots together for a single transmission. Doing the math, this gives an individual user access to up to eight slots at 14.4 Kbps each, resulting in speeds up to 115.2 Kbps. The system is notified at the time of transmission how many timeslots or Kbps are needed for transmission. The ability to combine only the required number of timeslots for each transmission gives GPRS the flexibility to support both low-speed and high-speed data applications in a single network.

In addition to the advanced bit rates, GPRS is also distinguished by its support for both TCP/IP and X.25 protocols. TCP/IP, commonly referred

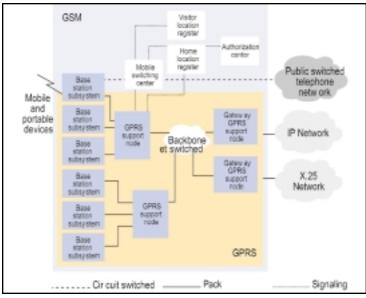


Figure 8: Elements in a GPRS network.

to as the Internet Protocol, is the dominant protocol of most data network applications on the Internet. TCP/IP is a set of protocols developed to allow cooperating computers to share resources across a network.

Two separate protocols are involved when handling TCP/IP data packets. Transmission control protocol (the TCP part) is responsible for dividing the message into manageable packets, retransmitting anything that gets lost or corrupted, and then reassembling the packets at the other end. TCP also places a header, consisting of the destination address, the source address and a checksum at the front of each data packet and then sends the packet on to the Internet protocol (the IP part). The checksum is important in

that it ensures that the data was not damaged during transmission. At the receiving end, the checksum is again computed and verified. If it differs, the data is assumed to be corrupted and the packet is thrown away. IP is responsible for determining the best route for the packet to get to its destination address.

The GPRS support node (SGSN) is responsible for detecting new GPRS mobile stations in the service area, sending and receiving packets from mobile stations, and for recording the locations of mobiles in its area. First, a mobile or terminal transmits packet data to the SGSN using the GPRS air interface protocols. The SGSN encapsulates the packet with a common tunneling protocol required between support nodes and sends it on to the gateway GPRS support node (GGSN). The main function of the GGSN is to maintain support connections with other networks such as the Internet and X.25. When the GGSN receives the packet it decapsulates it, checks the destination address in the original packet and sends it on to the destination network.

GPRS opens up a wide array of new applications and services. GPRS provides superior services for the transmission of small bursty data such as fault indications, utility metering, and burglar alarms. At the higher data speeds, GPRS will be able to provide unmatched multimedia and Internet services.

THIRD GENERATION WIRELESS

By the time third generation systems are forecast to become commercially available, more than 600 million subscribers are expected to use wireless services worldwide. As the industry evolves to third generation systems, GSM leaders are working to assure a seamless upgrade path from current networks. In the late 1980s, the International Telecommunication Union (ITU) formed a group to evaluate and specify requirements for third generation wireless standards delivering high speed and multimedia services. The third generation standard is now called IMT-2000, where IMT stands for International Mobile Telecommunication. All wireless providers agree that the future systems should evolve from the core infrastructures in today's networks.

A good example of these emerging systems is a technology called EDGE, which stands for *enhanced data rates GSM evolution*. EDGE will not only be backward compatible with GSM but will also take advantage of the proven and global GSM network. EDGE will use enhanced modulation techniques to achieve data rates up to 384 Kbps. The core GSM functionality including the 200 kHz carrier bandwidth, TDMA frame structure, and frequency plans will remain unchanged, which means existing networks can be leveraged. EDGE and GSM will continue to be committed to backwards compatibility by designing channels with EDGE functionality that can operate either as an EDGE channel or as a GSM/GPRS channel. By leveraging the existing core network and implementing such backwards compatibility, GSM will be able to offer these advanced services incrementally, providing access to higher speeds far in advance of any other competing networks.

How Does GSM Compare with Other Technologies?

GSM is not the only voice and data technology on the market, of course. Here's a quick look at other approaches:

Phone Lines. Traditional landlines can be restrictive, inconvenient and often more expensive than wireless, both in terms of installation and monthly fees. Plus, the wait for line installation has stretched from weeks to months and even years in some locations. As the market continues to demand mobility and access to information from any location at anytime, wireless will be the only viable solution.

Public Messaging and Paging Technology. Although it enjoys widespread deployment, paging can't provide the data or voice capabilities needed for higher value-added services. With the convergence of voice and data, it is no longer necessary to carry a separate device for each service. GSM combines both voice and paging in one device.

CDPD. Since its introduction in 1994, cellular digital packet data (CDPD) has yet to gain wide marketplace acceptance due to its high cost structure. CDPD was designed to use "channel hopping" as an overlay to existing analog cellular services, where analog calls have a priority. While the transfer of data is reliable when analog call volumes are low, high call volumes can block of CDPD usage and lead to the loss of data during transmission. CDPD backers have promoted data rates of 19.2 Kbps, although practical data rates are typically between 8 and 11 Kbps.

CDMA. While backers of code division multiple access (CDMA) continue to voice plans to roll out wireless data, CDMA is still in its infancy and is currently only beginning to launch trails. CDMA data is a circuitswitched service that provides data rates up to 14.4 Kbps.

Private Wireless Networks. Private networks, perhaps most common in the utility industry, leave you captive to a single vendor's proprietary solution and are considerably more expensive than public networks. Private networks will never be able to achieve the economies of scale that allow public networks to charge lower rates. Also, most private networks are analog and lack the security and protection features needed for today's business communication.

CHOOSING THE RIGHT WIRELESS NETWORK

With so many advancements in wireless communications hitting the marketplace one after the other (or promising to hit the market, at least), it can be difficult to wade through all the options and determine the wireless network that best suits your economic and technical needs. Based on the recently acquired Omnipoint Technologies' years of experience designing wireless networks, we suggest you consider five key factors:

Cost

In addition to your own direct costs, what about the costs of the rest of the network; costs that you are likely to share? GSM's open architecture lets multiple vendors offer network components, handsets, and accessories to keep prices as low as possible. As the leading wireless technology in the world, GSM passes on the benefits of economies of scale and provides the richest feature set at lowest possible price. Packet-based switching also provides flexible billing options not previously available with circuit-switched networks. Instead of being billed by the amount of time spent tying up network resources, you are only billed for the amount of data you actually send over the network. Future enhancements, like GPRS, will allow multiple users to share network resources. With more users being serviced on the networks, operating costs per user will continue to decline.

FUNCTION

GSM provides the most comprehensive set of features available in the marketplace today including voice, data, fax, paging and short message service capabilities. The evolution path and commitment to a third generation solution is clear. Research and development is already several years into the development of these next generation solutions and will offer them before the other competing technologies. Being first to market with advanced services will make it possible for our customers to sustain a competitive edge over their competitors.

PERFORMANCE

GSM's full digital encryption schemes, authentication process, and SIM card provide unsurpassed security and protection against fraud. The advanced channel coding and error correction techniques provide near-wireline voice quality and reliable data transfer. Plus, GSM's store-and-forward capability guarantees the delivery of wireless messages, regardless of whether the end terminal is turned on or not.

FLEXIBILITY

An open architecture is one the reasons we decided to build our business on GSM, since it helps our customers choose and use network and terminal components that fit their needs best. At the same time, adherence to a public, global standard ensures that GSM components, systems and networks are compatible across vendors. The economies of scale created by this unified system are enough to justify its implementation, not to mention the convenience of having compatible terminals regardless of national boundaries. GSM also supports both X.25 and TCP/IP (Internet protocol) standards. The SIM card and its "plug and play" feature lets GSM subscribers obtain their same set of services from any GSM terminal, anywhere in the world.

STABILITY

As the most widely deployed and accepted digital network, GSM is securely in place and has a proven track record æ with continuing growth. The GSM community is already hard at work on the next generation standard, which will improve performance while maintaining compatibility with existing products. It is a standard that ensures interoperability without stifling competition and innovation among developers and suppliers. The GSM Alliance provides a forum for the discussion and resolution of GSM issues and ensures seamless roaming across North America.

CONCLUSION

Years of coordinated multivendor development, global standardization and a clear path to the future make GSM a compelling choice for any organization that wants to incorporate wireless technology in its products and services. Wireless data has matured from a nice-to-have to a need-to-have for many customers, and the lines between voice and data communication are blurring with the demand for 24-hour access to people and information. With GSM , wireless customers get the richest set of features and the most advanced digital technology available today. In addition, with millions of new customers added every month, the global GSM network will continue to offer the most convincing economies of scale for any company investing in wireless. Xircom, Inc. 1365 Garden of the Gods Road Colorado Springs, CO 80907 1.888.684.5355 (toll free in U.S.) +1.719.884.2444 (outside of U.S.)

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