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Wireless Data Networking Standards Support Report: General Packet Radio Service

Final

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General Packet Radio Service (GPRS) is a technology platform that supports the transfer of data across a mobile telephone network. It is based on the global system for mobile communications (GSM), the most prominent digital cellular standard in the world, and is an element of 2.5 generation (2.5G) technology. GPRS is a European Telecommunications Standards Institute standard and is often referred to as a stopgap for the next wave of voice and data improvements. Two of the most important aspects of GPRS are its support of Internet Protocol (IP)-based core architectures and reliance on IP standards. These IP-based architectures for data applications continue to be used and expanded upon for the deployment of third-generation (3G) services such as integrated voice and data applications. One of the main benefits and differences of GPRS is that it reserves radio resources only when there is data to be sent. This on-demand usage reduces the reliance on traditional circuit-switched network components. The increased functionality offered by GPRS should decrease the incremental cost associated with the provision of wireless data services. As costs decrease, the penetration of wireless data services into business and consumer markets should increase.

The unique applications that could be developed with GPRS will likely appeal to a broad range of mobile users. In addition, GPRS will support improved quality of data services measured in terms of reliability, response time, and functionality. However, these new services will require increases in the size of GSM networks with regards to the number of radios, base-stations, and other network components. GPRS is an important step in the migration of existing networks towards 3G technologies. Although comparable 2.5G technologies exist, this paper highlights the initial rollout of GPRS for the consumer and investigates potential applications for the public safety community.

GPRS Applications

GPRS will enable a variety of new and potentially unique service offerings for the mobile wireless user. First among them is that GPRS will support both voice and data communications in a mobile environment. Second is the ability to access information on an immediate basis, with little or no latency due to extended login sequences. Further, GPRS applications developers are slated to provide the ability to localize information to subscribers based upon their present location.

In addition to mobile Internet capabilities, GPRS offers the user voice capabilities, e-mail access, two-way text messaging, unified messaging (voice mail and e-mail in the same box) voice mail and multiparty calling. The user can have the ability to multitask, (i.e., flipping back and forth) between a voice call and accessing the Internet or e-mail without a loss of connection. Commercial service providers are marketing this wireless Web access technology to business users as well as the “generic” consumer.

Technology Overview

Widely used in Europe and other parts of the world, GSM is a digital mobile telephone system. It uses a variation of time division multiple access in either the 900 megahertz (MHz) or 1,800 MHz frequency band. GPRS is the overlay of a packet-based air interface onto an existing

circuit-switched GSM network. Information is split into related "packets," is transmitted, and then reassembled at the final destination point. The GPRS overlay network and the GSM foundation network are shown in Figure 1.

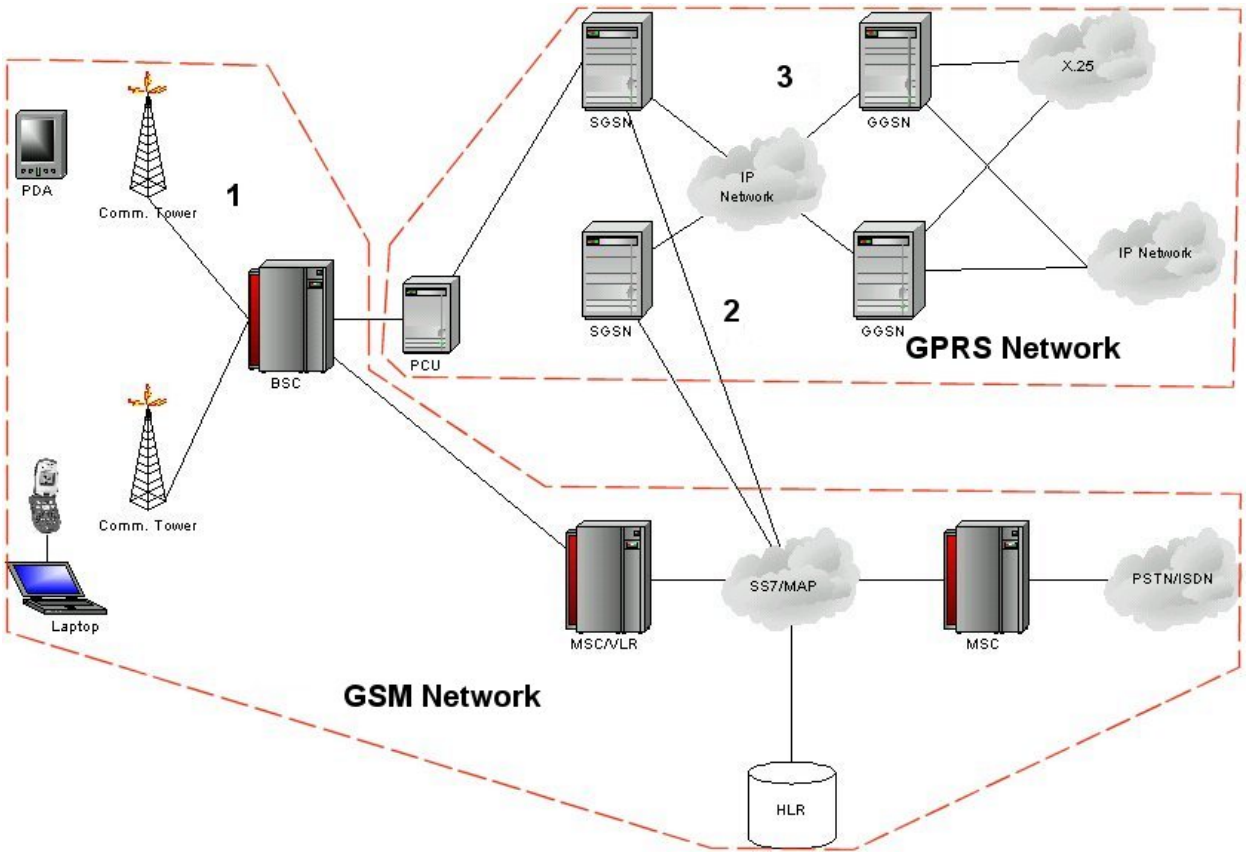

Figure 1
System Block Diagram—GPRS Network

The following discussion of Figure 1 focuses on the process used to distinguish a GPRS call from a voice call and the primary pieces of infrastructure associated with this process.

1. When a GPRS call is initiated, the packet is routed from the communications tower to the base station controller (BSC) and next to the packet control unit (PCU).

2. The PCU sends packets to the Gateway GPRS Service Node (GGSN), which authenticates the sender as an authorized user and sends the packet on to the Signaling System 7 (SS7) for billing notification. The SS7 is important in this process because it serves as the primary point for setting up and tearing down a call, as well as being a common means for billing notification for cellular systems.

3. Finally, the packet is sent out over the IP network, or the X.25 network, to the intended recipient. The Serving GPRS Support Node (SGSN) supports the packet routing for users assigned to the SGSN service area. GGSNs serve as access points for other packet data networks while SGSNs serve as the access points for GPRS telephones.

GPRS transfers short message service (SMS) traffic over internal radio channels. For voice calls, packets are forwarded from the BSC directly to the message switching center (MSC) on the GSM network. The service load and network operator preferences influence the dynamic sharing of resources in the GPRS network.

Aside from cost savings, there are other advantages that can be gained from the use of GPRS including—

- The simultaneous use of voice and data channels
- A usage-based fee structure, where billing is a function of the volume of transferred packets, not length of connection time
- High-speed access to data services (e.g., the Internet, e-mail, and text messaging), i.e., projected speeds can be 30–40 kilobits per second (Kbps)
- User-specific quality of service profiles
- Security services including authentication, access control, user identity and information confidentiality.

Seattle Implementation

Although it is not known whether the local vendor community or technology-savvy residents served as the impetus, the City of Seattle, Washington is experiencing one of the first large-scale implementations of GPRS. In July 2001, several vendors launched GPRS as a packet data solution in the region. Considered one of the most "digital cities" in the Digital Cities Survey developed by TekInsight, Seattle has more than 3 million residents in the greater metropolitan area. The region is also home to large offices for both VoiceStream Wireless and the AT&T Wireless Group. The following table depicts some of the initial GPRS service providers and service plans available in the Seattle area.

Table 1
Initial Service Plans Available in the Seattle Region

GPRS SERVICE PROVIDER	SERVICE PLAN OVERVIEW
AT&T	• Plan starts at $50.00 and includes 1 megabyte of data transfer and 400 voice minutes. Users pay $.0075 for every kilobyte beyond the first megabyte.
Cingular	• Wireless Internet Express data rate plans are offered as feature add-ons; air time does not count against voice rate plan minutes. $14.99 is the lowest available price and includes 100 interactive messages.
VoiceStream	• The iStream plan includes 1 megabyte of data and e-mail access for up to 10 different accounts. Additional megabytes of data cost $10.00 more.

Currently the Motorola Timeport™ wireless telephone, shown in Figure 2, is one of the common media used to offer combined voice and data services. The Timeport™ handset employs a tri-band Wireless Application Protocol 1.1 Enabled Microbrowser to connect the user to the Web via a GPRS service provider. The telephone is limited to a 128 by 100 pixel display—translating into 6 lines of text, 1 row of icons, and 1 row of soft key functions. Timeport™ also features voice activation, a voice recorder, an Infrared Data Association connection, a data port, and the capability to link to a personal computer. The average cost of the telephone is $199.00. Note that Nokia and other manufacturers have developed or are developing wireless cellular telephones and other handheld devices well suited for GPRS technology.

Figure 2
Motorola Timeport™ Handset Offered by VoiceStream

Expansion of GPRS

GPRS may eventually be used across the United States and the 170 countries that have implemented the GSM standard for their cellular networks. The following vendors are deploying GPRS services in the United States—

- VoiceStream Wireless Corporation is marketing its GPRS service under the brand name iStream.

- AT&T Corporation is offering GPRS service in Detroit, Las Vegas, Phoenix, Seattle, and Portland. AT&T has announced plans to deploy GPRS in all of the markets it serves by the end of 2003.

- Cingular Wireless LLC has rolled out GPRS services in Las Vegas and parts of the Carolinas, Tennessee, and Georgia. Cingular plans to extend GPRS to all its customers by early 2003.

Applications for the Public Safety Community

Public safety organizations regularly use commercial wireless services for administrative and operational activities. However, the use of GPRS, an always-on mobile Internet connection, offers a broader set of communications opportunities that may be applicable in the public safety arena. When contemplating the use of GPRS, public safety officials should be aware of the following considerations:

- **Network Design.** Voice and GPRS calls use some of the same network resources. Generally, cellular networks are designed with call-blocking rates of two percent, which may result in fast-busy signals for voice calls and unacceptable data transmission rates during peak call times. In the event of a crisis, the service demands placed on commercial networks will likely prevent public safety agencies from using this mechanism to communicate. Until Priority Access Service[1] (PAS) is fully deployed, the public safety community may consider the use of GPRS technology as implausible, with an unacceptable risk associated with call blocking. However, several cellular companies dedicate specific resources for public safety use within their cellular networks. Prior to implementing a GPRS-based solution, it is of paramount importance for public safety agencies to negotiate specific agreements with commercial providers regarding routine and emergency access to the networks.

[1] Priority Access Service is intended to provide authorized public safety personnel priority access to wireless networks during crisis situations. The National Communications System (NCS) has established the framework for commercial wireless service providers to support PAS for emergency preparedness personnel with critical communications needs. For more information regarding PAS, log onto the NCS website at www.ncs.gov

- **Security.** It is challenging to monitor and intercept digital cellular communications traffic. The risk of eavesdropping does exist but requires a higher level of sophistication from an unauthorized user. This technology offers no inherent security features. Agencies contemplating any wireless data applications must ensure the security of the information and the transmission medium. To ensure this high level of security, agencies using wireless data services would likely require the use of additional encryption within applications and network access points.

- **Cost.** The current price for "always-on" wireless Web access remains relatively expensive. Although the Government is often offered lower fees for widespread use of commercial services, GPRS may not be cost effective. Currently, significant public safety deployments of GPRS technology have not yet been identified. Agencies contemplating use of GPRS networks should establish agreements with service providers that would allow for unlimited airtime and data transmissions. Otherwise, the use of this type of service may overtax agency budgets. Initially, when cellular digital packet data (CDPD) was first introduced, and then embraced by the public safety community, costs for services were high. As with any technology, over time, costs decreased. Presently, many public safety agencies are using CDPD as the wireless medium for mobile data services. Federal, state, regional, local, and tribal agencies are now enjoying affordable contracts through various CDPD providers.

- **Single Communications Device.** By effectively fulfilling the functions of a portable radio, pager, and cellular telephone, a GPRS-capable device could eliminate the need to carry multiple communications devices. A cellular telephone or personal digital assistant (PDA) (i.e., a term used to describe any small mobile handheld device), configured with GPRS functionality, could fulfill the comprehensive communications requirements necessary for specialized field personnel or senior executives. Proven use of a ruggedized version of a handset or PDA would likely be required prior to a field implementation for the public safety community. Public safety users should be aware that the use of a single communications device forms a single point of failure for all communications.

- **Inability to Send Data to Mobile Terminals.** GPRS calls may not be sent to a mobile telephone. Until the billing system is enhanced to account for incoming GPRS data calls, users are required to initiate the data request. This arrangement is not suitable for the public safety user, who requires immediate notification of administrative, operational, and critical incidents.

- **Applications**. GPRS will support non-critical data applications for the public safety community such as information retrieval from agency-specific databases, and administrative messaging. The IP-based technology will provide mobile wireless connectivity for virtual private networks; intranet Web sites; civil, criminal, hazardous material, and transportation information systems; and

agency-specific applications such as computer-aided dispatch systems and records management system inquiries. Expanding beyond these routine information sources, GPRS will give the public safety user a means to transport still and moving images. For public safety users, the ability to remain mobile while accessing relevant information updates and images related to building floor plans, photographs of suspects, or images from security cameras while at an incident site, may enhance officer safety, maximize operational effectiveness, and improve public service. As the technology matures, public safety agencies will be better positioned to assess its immediate relevance for the public safety mission. In one example of an implementation of GPRS technology, FedEx Express, a unit of FedEx Corporation, has contracted with AT&T Wireless for use of its GPRS network. The FedEx Express implementation can serve as a baseline against which the public safety community may evaluate the capabilities of the technology.

Future of GPRS

Whenever a new technology is introduced, there are several stages of acceptance before it becomes established. For the public safety community, the flexible feature set supported by GPRS may be viewed as a viable evolution from CDPD service. Certainly, specialized field personnel or senior executives may realize several benefits from this "always-on" data connection. However, a wide-scale implementation may not be cost effective or suitable for most agencies until this technology becomes more established and mature within the traditional business community. For those agencies unsatisfied with the capabilities offered by GPRS, Enhanced Data rates for GSM Evolution (EDGE) is the next complementary step in the migration path to 3G technology. EDGE will support relatively high data rates (up to 384 kbps) and is considered the evolutionary standard in the migration path to Universal Mobile Telecommunications Service (UMTS), projected as the full 3G service offering that will take the place of both GPRS and EDGE.