application
note

GPRS Mobile Phones - An Overview For Test Professionals

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Understanding General Packet Radio Service mobile technology is critical for test professionals. The wireless data revolution has arrived. Are you ready for the next generation of data enabled GSM/GPRS phones?

I. Introduction

In this application note we will cover many aspects about GPRS. The objective is to provide you with a comprehensive view of how GPRS works, and what is required to test GPRS mobile devices. This application note is not designed to take the place of the standard, as there is much more to the operation of GPRS than can be covered in one application note.

Since GPRS is similar to GSM in many ways, much of this application note will focus on the differences between GPRS and GSM. It will also give you a good understanding of how GPRS operates and how IFR has taken a lot of the mystery out of GPRS testing with the 2935 GPRS test option.

II. What Is GPRS?

GPRS stands for General Packet Radio Service. GPRS is a technology where mobile phone users can transfer data using "packets" of information rather than conventional "circuit switched" communications. Packet communication systems have an inherent advantage over circuit switched systems due to the fact that packet based wireless communications networks can provide data services "on demand" to the subscriber, without being tied down to a dedicated connection.

Within cellular standards, the Global System for Mobile Communications or GSM family includes the GPRS standard and both are Time Division Multiple Access or TDMA technologies. Within TDMA technology, the user is allocated a particular radio channel and is then assigned to one particular timeslot within that channel. With GSM and GPRS, there are 8 users that are assigned time slots 0 through 7, on that particular radio channel.

Until GPRS was introduced, voice and digital data were transferred over conventional GSM networks using "circuit switched" technology where the user was allocated a particular time slot whether data was present on the slot or not. With GPRS, however, that restriction is lifted and data is now "packet routed" and sent as system resources allow. This is a big improvement in efficiencies in the cellular network and a primary reason that operators are moving towards packet routed systems.

As we look at the transmission of data within a cellular network, it is important to understand the relationship between information that is dependent upon a constant time interval, such as voice communications or live video data, and data transmissions that are not timing dependent. Digitized voice and real time digitized video data require a data connection that is based on a “fixed” rate of transmission that allows the transmission of voice or video data and the subsequent recovery of that data without significant delays or "latency".

Any variation in the transmission of more than a few milliseconds would cause unacceptable information dropouts and time shifts of the information, making seamless communication difficult at best.

Non-voice or non-real-time video data, on the other hand, does not care if the data received or transmitted is a few milliseconds late. This is where packet routed networks achieve a huge efficiency advantage over circuit switched networks. With packet data services, packets of information do not require a dedicated circuit path since they are sent as requirements and system capacity dictate. With packets, the transmitting and receiving entities are assigned IP addresses and the packet routing network figures out how to "route" packets to the appropriate device.

Figure 1.0 shows how a circuit switched network operates. Within a circuit switched network, there is a physical requirement for a connection from Point "A" to Point "E" before information can flow between the two users. The switches at each switch point (B, C and D) must be connected to the next segment or the circuit is considered to be "open" and no information (voice or data) can flow.

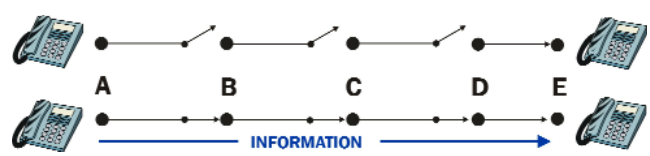

Figure 1.0 Circuit Switched Network

Figure 2.0, on the other hand, shows a simplified version of how a "packet routed" network operates. A packet network operates in a similar manner to the way that your "mail" or postal system operates. Just like a letter that you send in the "mail", information is placed into a packet (envelope) and then sent on its way. The packet of information then goes through a number of different routing centers (nodes) before being delivered to the final end user. Just like a letter sent through the postal system, "To:" is the address of the final destination of the letter, and "From:" indicates the origination point of the letter.

Once placed into the "system" it is then left up to the "operations" department (the network) to decide what is the most efficient path to transmit that information from point "A" to point "E". Notice that the data in "information packet A" takes a different route than the data in "information packet B", however they both arrive at the same destination because the network determines the best route for the packet, based on capacity and utilization.

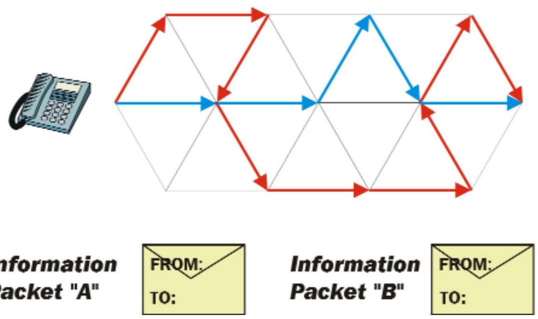

Figure 2.0 Packet Routed Network

III. Why Do Users Want Or Need GPRS?

The predominant use for GPRS services is for data services where users place a high value on the ability to transmit data in a mobile environment. This can be as diverse as a "chat session" for a teenager to "e-mail" and "stock quotes" for a businessman. Examples of data services that are available or that are being prepared for GPRS include:

Text and visual information such as share prices, sports scores, weather, flight information, news headlines, prayer reminders, lottery results, jokes, horoscopes, traffic, location sensitive services and so on. This information need not necessarily be textual - it may be maps, graphs or other types of visual information.

Still images such as photographs, pictures, postcards, greeting cards, presentations and static web pages can also be sent and received over the mobile network as they are across fixed telephone networks.

Moving Images. For mobile communication to continue its aggressive growth, much of the content will be less textual and more visual. Moving images in a mobile environment have several applications including monitoring sites for intruders and remote monitoring of elderly or medical patients. Videoconferencing applications, in which sales people can have a regular sales meeting without having to go to a particular physical location, are another application for moving images.

Other applications such as web browsing, document sharing and audio downloads show the diverse nature of the uses for GPRS.

IV. By The Way - What Is WAP?

WAP stands for Wireless Application Protocol. It is not specifically a GPRS function, and can be used by a number of wireless technologies as the intermediate layer between the application and the mobile device. Mobile devices do not enjoy the graphical display or memory overhead associated with conventional "fixed" computer resources or laptops. WAP was designed to provide a global standard for delivering Internet features to GPRS devices simply and efficiently.

V. When Will GPRS Happen?

As of 2002, 96 operators in 45 countries have operational GPRS networks. GPRS enabled handsets will grow from a scant 10 million in 2001 to over 280 million in 2005. Figure 3.0 shows the anticipated growth of GPRS enabled devices over the next three years.

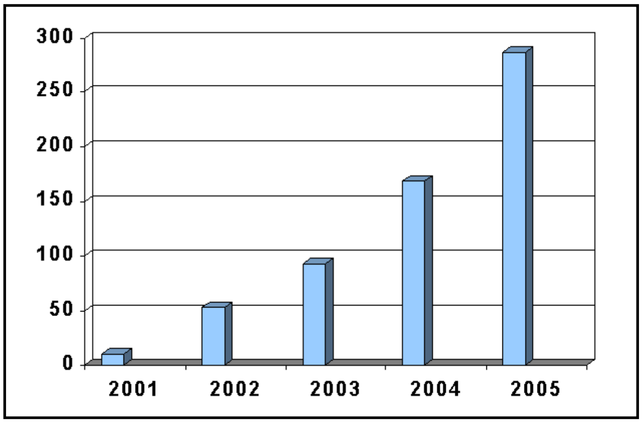

Figure 3.0 Growth of GPRS Enabled Handsets

VI. GPRS Network Operation

GPRS deployment involves overlaying a packet-based air interface onto the existing circuit switched GSM network. This gives the user an option to use a packet-based data service or conventional voice services. To supplement a circuit switched network architecture with packet routing is a significant upgrade. Adding GPRS to an existing GSM network requires the network operator to add new infrastructure nodes and add software upgrades to existing network elements.

A GPRS network operates in a mode called "Always On". This doesn't mean that the GPRS mobile is constantly transmitting to the network and is chewing up battery reserve along the way. The GPRS mobile device initiates a "GPRS attach sequence" upon power-up or GPRS mode operation. During the GPRS attach sequence, the mobile establishes its location to the network and its corresponding "address" through the use of the Temporary Logical Link Identifier or TLLI.

After the GPRS attach is completed, the mobile can then send and receive packets. The TLLI serves as the mobile's identifier to route packets to and from the GPRS network.

The GPRS network controls the flow of the packets to and from the mobile. This is accomplished by the use of the Packet Control Unit or PCU, the Serving GPRS Support Node or SGSN and the Gateway GPRS Support Node or GGSN.

The PCU provides the interface between the Base Station Subsystem or BSS and the rest of the network by converting packet traffic to PCU frames that have the same configuration as the Transcoder Rate Adaptor Unit or TRAU frames used by GSM networks for transferring circuit switched data. Thus, the BSS can now route both traffic types, packet and circuit switched information. The PCU controls such things as cell change orders, paging the mobile, packet power control and timing advance, packet time slot configuration and frequency hopping parameters.

The SGSN performs the mobility management function. It controls routing of the packets between the PCU and the GGSN and buffers many megabytes of packet data. It controls and routes unacknowledged packets to the SGSN during a cell change of the mobile station and provides session management between the mobile and the GGSN. Compression and charging information is also handled at the SGSN.

The GGSN is the "Gateway" between the GPRS network and the Internet. While the mobile is roaming throughout the GPRS network, the GGSN is the fixed point for packet data transmission. By configuring the "packets" for the transmission to the Internet the GGSN acts as the interface between the GPRS network and the rest of the IP world using X.25, IP or PPP based networks.

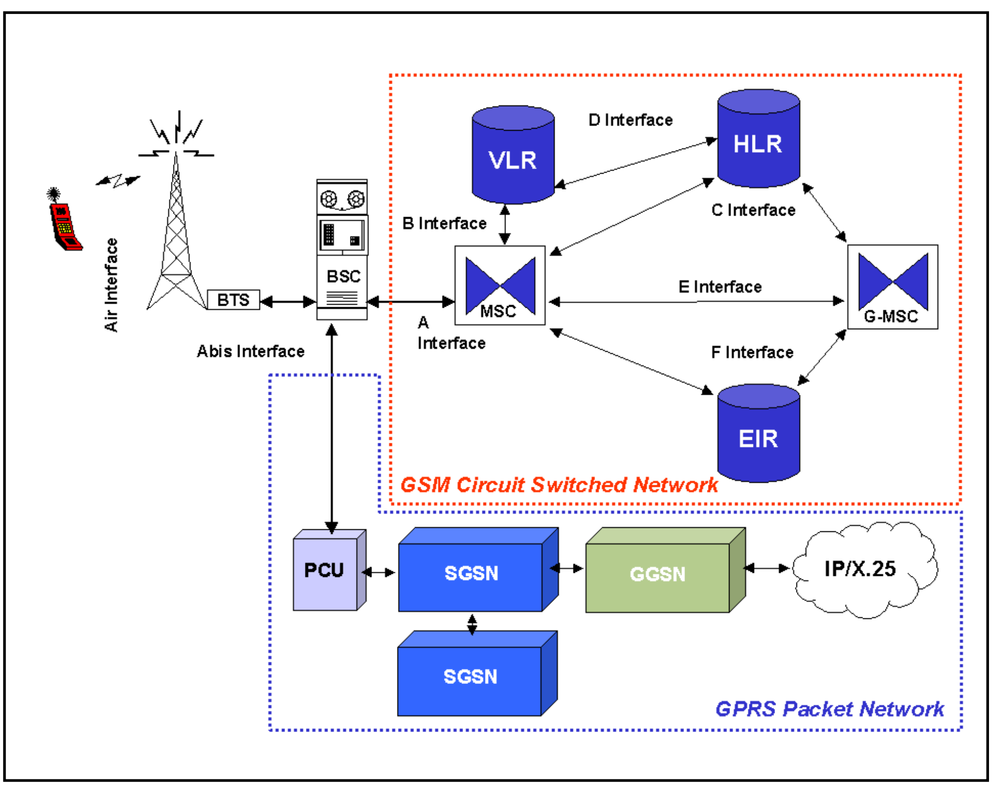

Figure 4.0 A GPRS Network Overlay on a GSM Network

The GSM BSS comprising the Base Tranceiver Station or BTS and Base Station Control or BSC remains virtually unchanged when GPRS is added to the network. Since GPRS uses the same modulation scheme (GMSK) as GSM, there is little to change from a RF hardware perspective. Software needs to be updated to handle the packet data traffic and accompanying interfaces to the PCU, SGSN and GGSN.

Figure 4.0 shows a typical GSM network with the GPRS packet control units and SGSN and GGSN added.

VII. How Does a GPRS Mobile Transfer Packet Data?

1. The GPRS Attach Sequence

The GPRS mobile establishes communication with the network through a process called a GPRS attach. The GPRS attach session includes a dialog of packets sent between the mobile and the base station. The mobile, upon power up or being placed into a GPRS mode, will automatically initiate an attach sequence.

There are two different types of GPRS attach sequences that can occur. One is called simply, GPRS Attach. This applies to all classes of mobiles, either A, B or C. (See section VIII, 2. Mobile Station Class). The GPRS attach allows the mobile to attach to the network and then, if needed, begin packet data traffic.

The other sequence is called a Combined Attach. This applies to Mobile Station Class A or B. (See also section VIII, 2. Mobile Station Class). In this instance the mobile informs the network that it wishes to be both IMSI-attached for circuit switched operation as well as GPRS-attached for packet data services. This is similar to a GSM registration process where the mobile has performed a location area update and IMSI attach, along with the GPRS attach.

Now dealing with packets of data, the network controls when those packets are sent. It can also control the quantity of packets sent, depending on the capabilities of the mobile. It also allows for the GPRS mobile to continuously be "attached" to the network, although being "attached" doesn't mean that data is flowing.

To attach to the network, the mobile starts with an "attach request" message to the network, which includes the mobiles International Mobile Subscriber Identifier or IMSI, which is then processed by the network into a Packet-Temporary Mobile Sub-scriber Identity or P-TMSI and resent back to the mobile. The P-TMSI forms the basis of what is called a Temporary Logical Link Identifier or TLLI , used to track the mobile from the SGSN through the network. As part of the Combined Attach procedure, the mobile is authenticated with the mobile's Home Location Register or HLR. After authentication, the SGSN does an update of the GPRS location and sends an "Attach Accept" message to the mobile, and the mobile responds with an "Attach Complete". The mobile is now "attached" to the network, and due to the TLLI, packets can be routed to and from the network.

Figure 5.0 shows the Mobility Management messaging between the mobile and the SGSN for a GPRS attach sequence.

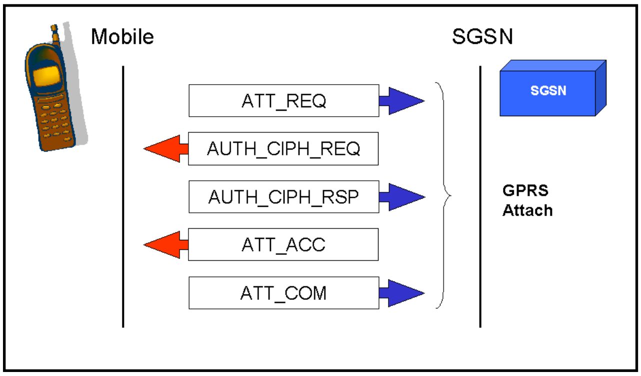

Figure 5.0 A GPRS Data Message Sequence Chart

2. Sending and Receiving Packets

Since the mobile has now been assigned a TLLI and is attached to the network, packet data can be sent. With a mobile originated data session, the mobile issues a channel request. The network sees the channel request and issues an immediate assignment. The immediate assignment points the mobile to a Packet Data Traffic Channel or PDTCH and data blocks are then sent to and from the mobile.

The network, knowing the location and TLLI of the mobile can also initiate a data session by simply issuing an immediate assignment. This is part of the Radio Resource messaging sent between the BSS and the mobile.

VIII. Types of GPRS Mobiles

1. Type 1 MS versus Type 2 MS

The "Types" of MS are the same as in GSM. A Type 1 MS is not required to transmit and receive at the same time.

Type 2 MS are required to be able to transmit and receive at the same time.

Almost all GSM/GPRS mobiles are a type 1 MS. This means that, although they operate in a frequency offset mode, (45 MHz - GSM/GPRS 900 MHz Band, 95 MHz - GSM/GPRS 1800 MHz Band, 80 MHz - GSM/GPRS 1900 MHz Band) they are not technically in a true duplex mode. This is because they do not transmit and receive data at the same time.

A good example of a type 2 MS is an analog phone, where the phone has a diplexer and is capable of transmitting and receiving concurrently.

2. Mobile Station Class

The GPRS mobile is going to fall into one of three categories called Mobile Station Class. As we go through these illustrations, we will refer to circuit switched operation as GSM and packet routed operation as GPRS.

Mobile Station Class A mobiles supports both GSM and GPRS operation and monitoring concurrently, allowing the user to be in a GSM call or GPRS data session and then monitor the applicable paging channel of the other service and be able to react upon it appropriately.

Mobile Station Class B mobiles supports GSM or GPRS operation - but not concurrently. Once the user is in either mode, it is not required to monitor the paging channel for the other service and therefore, is not required to respond if a page is sent to that mobile from the network.

Mobile Station Class C mobiles support only GPRS or GSM data. These types of mobiles are typically modems. No provision is made for the mobile to monitor or react to pages from either mode. By default, GSM circuit switched data mobiles are Mobile Station Class C mobiles.

IX. Channel Coding Schemes

Channel coding schemes are an important part of GPRS operation. Channel coding in a wireless cellular network is how the digital data (either voice from the vocoder or data for non-voice applications) from the mobile or base station is formatted to deal with the inherent problem of transmitting information across a radio channel. Channel coding includes parity generation, convolutional coding, puncturing and interleaving. These processes are structured so that either the mobile or the base station can receive a stream of data bits with corrupted values and still have a high likelihood of decoding the bit stream correctly.

A good analogy is packing a fragile gift prior to shipment in the post. You add layer upon layer of protective covering, paper, bubble wrap or whatever protective medium you choose to protect the integrity of the gift. Much as we would "protect" the gift and the recipient "unpacks" the gift, channel coding "protects" the data that is being transmitted to and from the mobile and base station where it is "unpacked".

In GPRS we have four different channel coding schemes. The reason for having multiple schemes is to provide for varying degrees of data rates, dependent upon the Quality Of Service or QOS requirements. QOS takes into account the mobile user's required data rates (graphics or text) and the channel conditions to and from the mobile. The coding used can be extensive, (CS1) where we get the most protection for the data and correspondingly lower data rates - to very little (CS4) where the data rates are much higher, since fewer of the transmitted "bits" are used for error correction.

Again, using our "fragile gift" analogy, the channel coding can vary from no packaging, because the delivery address is right next door to our home, to extensive packaging, since the package is going around the world to some exotic location located miles from any paved road.

GPRS channel coding schemes with their appropriate data rates are shown in table 1.0:

	Slot Combinations		
Channel Coding Scheme	***1 Slot***	***4 Slots***	***8 Slots***
CS1	9.2 kbps	36.8 kbps	73.6 kbps
CS2	13.55 kbps	54.2 kbps	108.4 kbps
CS3	15.75 kbps	63 kbps	126 kbps
CS4	21.55 kbps	86.2 kbps	172.4 kbps

Table 1.0 GPRS Channel Coding Schemes and Associated Data Rates

X. Multi-Slot Classes

Recall from GSM that the mobile is sending uplink bursts to the base station during its allocated time slot every frame. Each frame contains 8 time slots, therefore allowing up to 8 users for that particular radio channel. The burst time is 577 microseconds, which equates to a frame length of 4.615 milliseconds (8 times 577 microseconds). These frames are part of a larger multi-frame, which in GSM is equal to 26 frames. Bursts are sent in a duplex mode where one burst position (time slot) is assigned for mobile communication in the downlink and uplink per frame. The uplink is offset from the downlink by 3 time slots. Only one time slot is used for voice communications, since the sampling rates are set to occur every 4.615 milliseconds. See figure 6.0 for an example of a GSM frame.

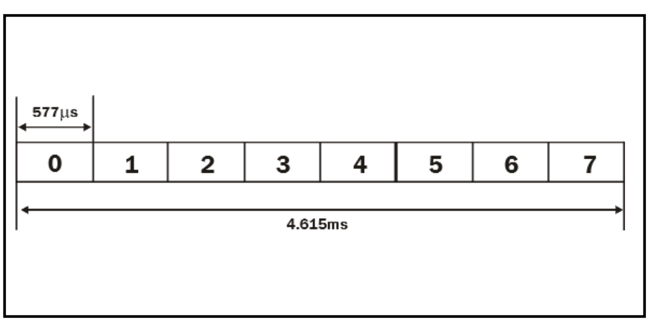

Figure 6.0 A GSM Frame

1. Downlink and Uplink Slots

With GPRS no longer tied down to using only one slot, the GPRS mobile can handle both multiple downlink slots as well as send multiple uplink slots. The burst structure and frame structure remains the same as GSM, however the multiframe has been expanded to 52 frames.

In GPRS mobile terminology, the term Multi-Slot Class refers to the number of downlink and uplink slots the mobile can appropriately handle. For example, Multi-Slot Class 1 means that the mobile can handle one slot on the downlink and transmit one slot on the uplink per frame. Multi-Slot Class 10, on the other hand, provides 4 slots on the downlink and 2 on the uplink. Table 2.0 shows the different Multi-Slot class configurations.

Where:

Rx: Rx describes the maximum number of receive timeslots that the Multi-Slot or MS can use per GSM TDMA frame.

Tx: Tx describes the maximum number of transmit timeslots that the MS can use per GSM TDMA frame.

Sum: Sum is the total number of uplink and downlink TS that can actually be used by the MS per TDMA frame.

Multi-Slot class	Maximum number of slots			Minimum number of slots			
	Rx	Tx	Sum	Tta	Ttb	Tra	Trb
1	1	1	2	3	2	4	2
2	2	1	3	3	2	3	1
3	2	2	3	3	2	3	1
4	3	1	4	3	1	3	1
5	2	2	4	3	1	3	1
6	3	2	4	3	1	3	1
7	3	3	4	3	1	3	1
8	4	1	5	3	1	2	1
9	3	2	5	3	1	2	1
10	4	2	5	3	1	2	1
11	4	3	5	3	1	2	1
12	4	4	5	2	1	2	1

Table 2.0 Multi-Slot Class Configurations

More information can be obtained by going to the standard 3GPP TS 05.02.

2. Relationship of Downlink to Uplink Slots

When looking at table 2.0, under the heading "minimum number of slots" the terms Tta, Ttb, Tra and Trb are seen. These terms refer to timing relationship between the downlink and uplink slots. This is because the mobile is periodically required to monitor channel conditions and then report them back to the network to determine if a cell change is required, what channel coding scheme would be best utilized, power levels, etc. The mobile needs to perform channel quality measurements during an idle slot and the utilization of transmit to receive offsets allows the mobile sufficient time to accomplish this task.

Where:

Tta: Tta relates to the time needed for the MS to perform adjacent cell signal level measurement and get ready to transmit.

For type 1 MS it is the minimum number of timeslots that will be allowed between the end of the previous transmit or receive TS and the next transmit TS when adjacent cell signal level measurements are to be performed between. It should be noted that, in practice, the minimum time allowed may be reduced by amount of timing advance.

Ttb: Ttb relates to the time needed for the MS to get ready to transmit. This minimum requirement will only be used when adjacent cell power measurements are not required by the service selected.

For type 1 MS it is the minimum number of timeslots that will be allowed between the end of the last previous receive TS and the first next transmit TS or between the previous transmit TS and the next transmit TS when the frequency is changed in-between. It should be noted that, in practice, the minimum time allowed may be reduced by the amount of the timing advance.

Tra: Tra relates to the time needed for the MS to perform adjacent cell signal level measurement and get ready to receive.

For type 1 MS it is the minimum number of timeslots that will be allowed between the previous transmit or receive TS and the next receive TS when measurement is to be performed between.

Trb: Trb relates to the time needed for the MS to get ready to receive. This minimum requirement will only be used when adjacent cell power measurements are not required by the service selected.

For type 1 MS it is the minimum number of timeslots that will be allowed between the previous transmit TS and the next receive TS or between the previous receive TS and the next receive TS when the frequency is changed in-between.

XI. Testing a GPRS Mobile

1. What is the Difference Between GSM and GPRS Tests?

GSM and GPRS utilize the same bandwidth, bit rates and modulation formats. The digital modulation format is called Gaussian Minimum Shift Keying or GMSK. The primary difference is that with GPRS, packet data is sent on multiple slots in either the uplink or downlink direction using different channel coding schemes as discussed earlier.

Recall from past GSM experience that sensitivity was tested using Bit Error Rate or BER tests based on the class of bits (more on this later). GPRS does not assign weighting to those different classes of bits; rather it uses a similar method of checking sensitivity called block error rate or BLER.

2. Transmitter Tests

Transmitters are the most tested part of either a mobile or base station. This is due to the inherent inter-modulation products and the spectral efficiency issues that accompany modern digital modulation techniques and the corresponding requirement to "co-exist" with other mobile transmitters in a given spectrum. Here are the most common tests for a GSM digital mobile RF transmitter:

Spurious Emissions and Spectral Measurements: Spurious signals can be defined as inter-modulation products in and out of channel or band, and are usually caused by non-linear amplifiers, I/Q mixer balance and spectral re-growth. These emissions can be tracked with a good quality spectrum analyzer by looking at in-band and out-of-band emissions.

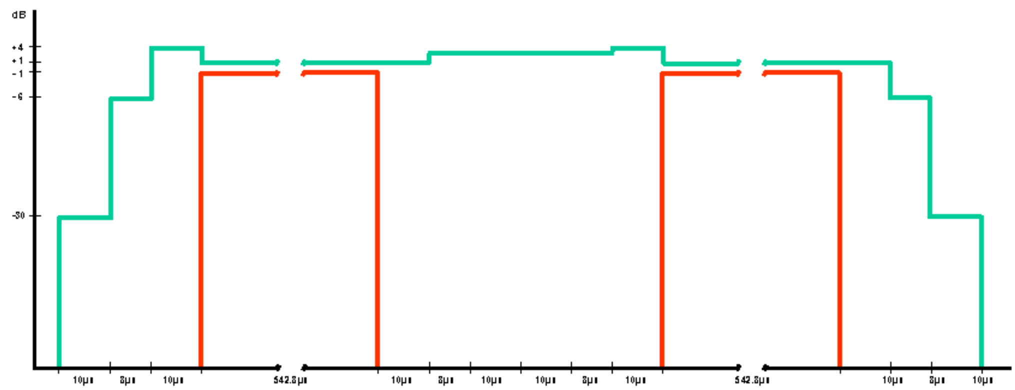

Figure 8.0 Normal GPRS Burst Structure for Two Uplink Slots

Power versus Time - The GMSK Burst Structure: Recall from section IX that the GPRS mobile can send multiple bursts within one frame on the uplink depending on its multi-slot classification. If a mobile is capable of this, then the test equipment manufacturer can devise tests that allow for power profile analysis of the GMSK burst in each of the slots utilized by the mobile. Keep in mind that the mobile will only send multiple bursts per frame on a consecutive basis (i.e. slot 1, slot 2, slot 3, etc...) and will not send them on an alternate slot basis (i.e. slot 1, slot 3, slot 7, etc...).

Begin by looking at a normal GMSK burst utilized in either a GSM or GPRS function. Figure 7.0 shows a Power versus Time template for a normal burst format.

Compare this to a GPRS uplink that has two consecutive bursts side by side as shown in figure 8.0. This would be consistent with a mobile that conforms to Multi-Slot Classes 3, 5, 6, 9, 10, 19, 24 per table 2.0. Notice that the time between the two bursts allows for variation in the power. The mobile can either power down, or continue transmitting random data. It is up to the designer to make this decision but it must conform to the power versus time template to ensure that it does not cause interfering emissions. Most mobiles today only support one slot uplink.

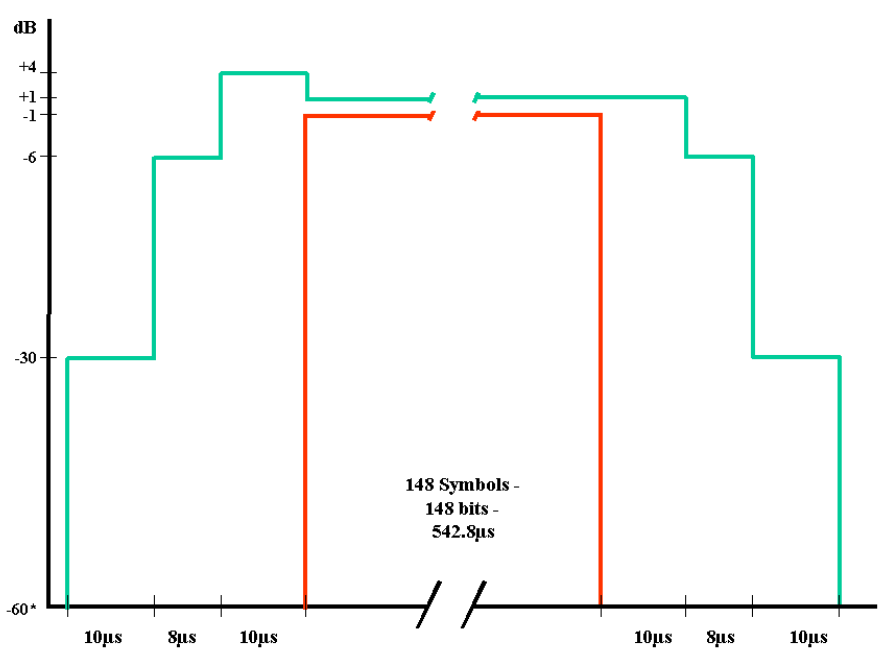

Figure 7.0 Normal GPRS Burst Structure

RMS and Peak Phase Error: For GMSK modulation, this checks the modulation accuracy of the transmitter in the Mobile Under Test. It is made on the useful part (information or data) of the burst and is usually averaged over a predetermined number of bursts. Peak is the worst case measurement of the burst phase error.

Frequency Error: A test of the stability of the mobile's transmitter to keep on frequency regardless of modulation format.

Bit Timing: This test checks the accuracy of the mobile's transmission timing. To accommodate for near-far effect, the network can request that the mobile advance its burst by a predetermined number of bits.

In GSM, this is accomplished by the BTS measuring the bit shift of the Training Sequence Code or TSC that is found on all uplink normal bursts from the mobile to the BTS. (Remember that with GSM, the mobile is always sending uplink bursts during a voice call). The BTS then sends timing adjustments back to the mobile on the Slow Associated Control Channel or SACCH message where the mobile then adjusts the timing advance. Since the SACCH is mapped over 102 GSM TDMA frames, the mobile receives an update every 480 ms.

With GPRS, this process will not work, since the continuous transmission of uplink bursts is no longer provided. GPRS uses a different method called the

Continuous Timing Advance Update Procedure. The continuous timing update procedure relies on the Packet Timing Control Channel or PTCCH for both the uplink and downlink. Here, the mobile is assigned to one of 16 logical sub-channels that repeat every 416 frames on either the 12th or 38th burst. The mobile sends an access burst to the base station and the BTS can then estimate the distance to the respective mobile and then return the appropriate timing advance message.

Optionally, the BTS may track the shift of the incoming access bursts and normal bursts on the PDTCH from the mobile and determine the distance to the mobile station. Using a method called polling, the PCU sends a polling message to the mobile and the mobile responds with four identically formatted access bursts during a particular uplink radio block (a block is equal to four bursts) assigned by the PCU. The BTS measures the timing advance and forwards this to the PCU, which responds with a corresponding message to the mobile.

3. Receiver Tests:

The receiver tests are used to determine the sensitivity of the receiver, or how low a signal the mobile can process before it causes excessive errors. In analog days, this was a Signal + Noise and Distortion test or SINAD. For digital modulation techniques, however, we need to look at an alternative method to test sensitivity.

Recall from past GSM experience that the bits within the voice data are assigned different "class" codes to determine their relative importance in transmission and were afforded more extensive convolutional coding or "protection" based on their importance. In GSM, we therefore tested the various BER in each of those classes of bits. This gave us BER1, BER2, RBER1b and RBER2 bit error measurements. GSM also tracked Frame Erasure Rates or FER, where the whole frame was lost.

These combined tests, along with a GSM Single-slot TCH loop (A) test allow test equipment manufacturers to accurately test the mobile's sensitivity.

BER compares a known good data stream (bits) transmitted to the mobile from the test system. Typically, the mobile then "loops back" the data stream to the test system, where the data sent is compared to the data received. Those "bits" that do not come back correctly are flagged as errors, hence the name "Bit Error Rate". The measurement is expressed as a ratio of the received "error bits" to the known good bits transmitted. This test is used to determine the sensitivity of the mobile's receiver, where the sensitivity is determined by reducing the power of the received signal until a predetermined BER is reached. Faster tests will set a predetermined pass/fail limit BER and set a particular output level (typically around -104 dBm) and simply check the mobile against the pass/fail parameters.

GPRS utilizes a different method to determine sensitivity of the mobile. This is called Block Error Rate or BLER. A block is defined as four consecutive bursts from the base station to the mobile. GPRS mobiles that support BLER support GPRS test modes A, B and C. BLER means the test system sends random RLC blocks of data to the mobile which replies with ACK/NACK (acknowledge/not acknowledge) responses to the test system. The ratio of NACKs to ACKs determines the block error rate.

A GPRS BER test can also be performed if the GPRS mobile is capable of doing a GPRS Test Mode "B" Loopback test. If the mobile cannot support Test Mode "B", then it must be able to support GPRS Test Mode "A". Mobiles that support both modes are known as supporting GPRS Test Mode "C".

Conclusion - GPRS Now and In The Future

This application note has introduced information about GPRS operation. It has explained various differences between GSM circuit switched operation and GPRS packet operation. GPRS is a fundamentally different way of handling data communications over the air, and is the first step in packet data functionality that sets the basis for packet data operation for next generation technologies including EGPRS (EDGE) and 3G WCDMA.

GPRS will continue to evolve. Currently manufacturers offer a limited range of mobile products that have been carefully matched to the networks that they operate. There are a number of issues that make GPRS mobile and network inter-operation challenging. This requires comprehensive solutions that take the guesswork out of GPRS mobile performance testing.

As we gain experience, many of these issues will fade away. New and different problems will undoubtedly develop to challenge us as data rates and features expand.

IFR will continue to enhance product performance and will be releasing more application notes in the future as GPRS technology evolves. Please check our Website for additional information. www.ifrsys.com

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