GRX Testing

Introduction to GRX Networks

GPRS Roaming eXchange (GRX) Networks are an integral part of roaming within GPRS networks. They are used to backhaul user IP traffic from the visitor network to the home network. UMTS is expected to make use of the same type of dedicated interconnecting IP network.

1. Possible GPRS Roaming Options

In order to understand GRX networks, it is essential to understand the two roaming options open to GPRS network operators:

- **GGSN independent roaming**
- **GGSN dependent roaming**

1.1 GGSN Independent Roaming

GPRS roamers can use local GGSNs in the host network to obtain IP addresses, making users free to access the Internet and host network specific services offered by the local GGSN. In this case, the user's home network is not utilized for anything except HLR signaling and billing. All IP traffic is handled in the host network.

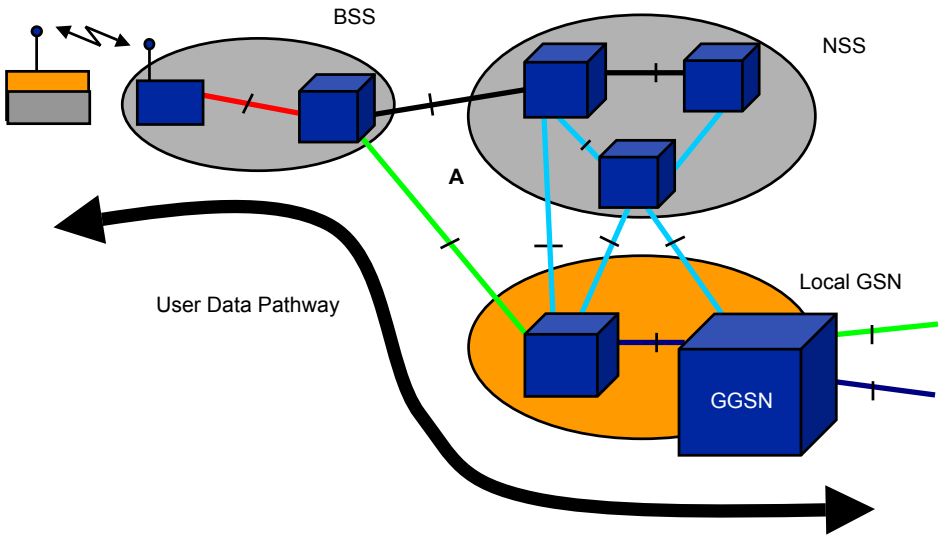

Figure 1: GGSN Independent Roaming

1.2 GGSN Dependent Roaming

GPRS roamers do not use the local GGSN in the host network; instead they go all the way back to their home network to be assigned an IP address. Once assigned the IP address in their home GGSN, the user is free to access services specific to their service provider and the Internet through their home GGSN or “access point”.

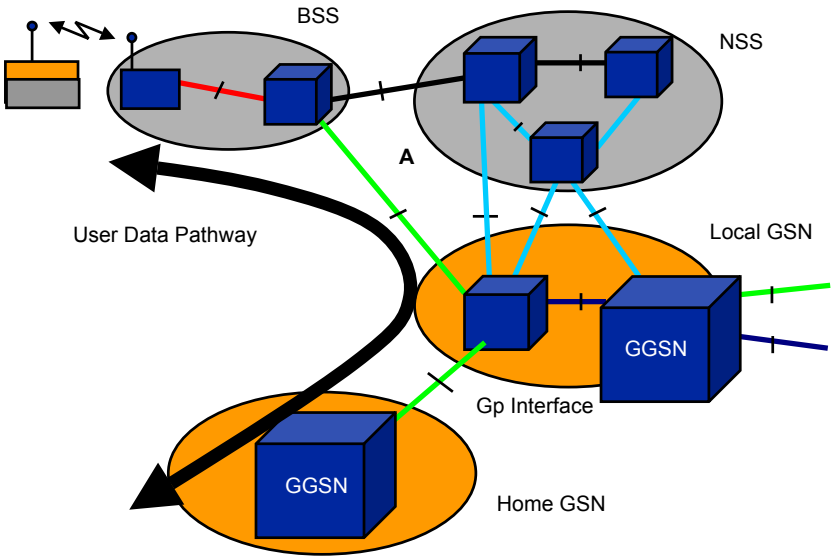

Figure 2: GGSN Dependent Roaming

1.3 Choosing a GGSN

The user is allowed to identify which GGSN they want to use by applying an “Access Point Name”. Access Point Names (APNs) are essentially the same as web domain names, which can be stored in a DNS and resolved to the IP address of a GGSN. An example of an APN is “stocks.operator.gprs”. This name is stored in the phone or dial-up PC program, and may or may not be changed by the user. If the user does not care which GGSN is used for roaming, the special APN “*” may be used, however the network may or may not allow the user to use this wildcard.

1.4 The Gp Interface

The Gp interface is a logical connection between an SGSN and a GGSN that are not within the same operator. This interface is identical to the Gn interface in all other respects, except perhaps that the Gn interface is normally a point-to-point Ethernet connection.

In order to exchange data from the host SGSN to the home GGSN specified by the APN in the GPRS network architecture, the SGSN needs to have IP connectivity to every GGSN within its partner’s networks. It is not practical to create direct connections to each roaming partner; an external IP network used to backhaul this traffic is more realistic.

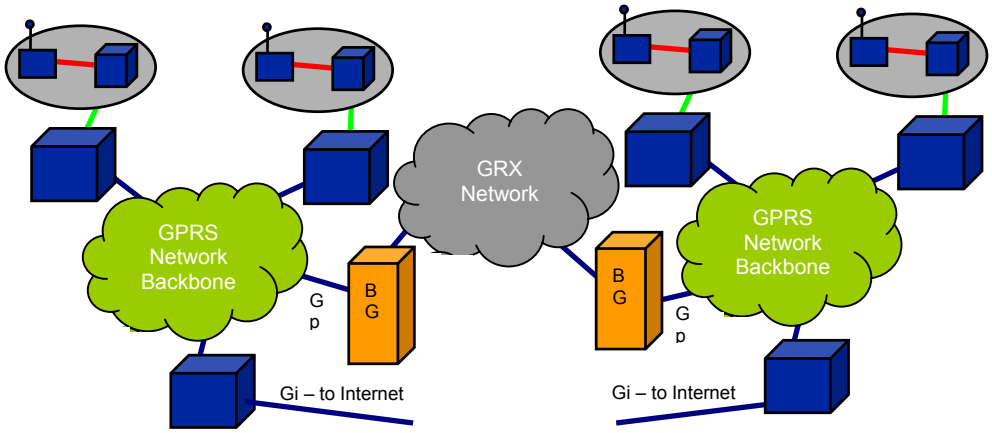

Figure 3: GRX Connections Between Operators – the Gp Interface

Internal GPRS network backbones (the Gn interface) are connected to the backbones of other operators by means of the GRX, and they are buffered from this external network by Border Gateways (BGs). The function of BG is to tunnel packets between the two operators, usually after encrypting it. This could be achieved through any sort of commercial Virtual Private Network (VPN), however due to the seriousness of the security needed, the connection is normally isolated from the Internet.

Since GSM network operators can be found in virtually every country in the world, as well as to allow for competition between different GRX operators in well serviced areas, it is possible to connect multiple GRX operators together as shown below.

Many operators can be serviced by one GRX network, and roaming amongst these GPRS operators is handled entirely within the GRX. GRXs are interconnected in the same way that multiple Internet Service Providers (ISPs) are connected to one another. IP routing within and between GRXs is handled by BGP4.

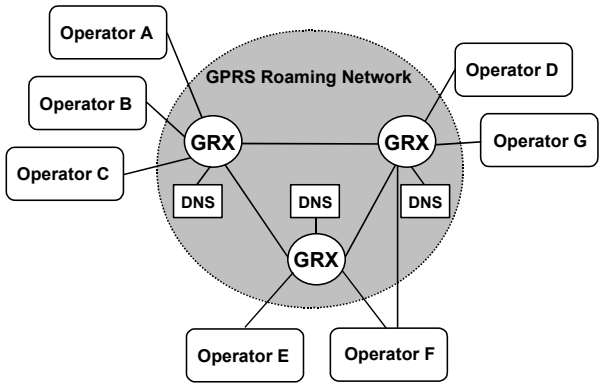

Figure 4: GRX Network

Each GRX has a DNS associated with it. This is to enable the resolution of APNs to IP addresses within the global GRX domain.

2. Requirements for GRX Operators

Companies that wish to provide this secure IP-based GPRS roaming network must comply with IR.34[1], a specification laid out by the IREG group that defines the requirements to which a GRX network must conform. This section will outline some of the things required by the specification.

Notes

[1] IR.34 “Inter-PLMN Backbone Guidelines” v3.0.1, International Roaming Expert Group, GSM MoU Association

1.5 Connecting to GRX Operators

GRX networks are normally accessed by Frame Relay and ATM networks. Generally, a GRX operator will sell its end customer a router along with the leased line or VPN necessary to connect to the GRX. From the GPRS network operator, this connection point is normally an Ethernet port on the GRX operated router.

1.6 GRX to GPRS Operator Service Level Agreement

GPRS operators that purchase GRX connections will do so under the protection of a Service Level Agreement (SLA). This SLA will typically describe the guaranteed performance of the GRX connection that the GPRS operator subscribes to. Violations of SLAs sometimes lead to penalties on the part of the network operator (depending on the specific agreement), so GRX operators have a vested interest in providing high quality connections.

The IREG group suggests that GPRS operators arrange SLAs with their GRX operators that provide guarantees on the following:

Notes

[1] IR.34 "Inter-PLMN Backbone Guidelines" v3.0.1, International Roaming Expert Group, GSM MoU Association

1.1.1 Availability

The services of the GRX must be guaranteed available a certain percentage of the time. This could among other things consist of IP connectivity, and DNS reachability. IR.34[1] defines it as the following:

"GSM Association and GPRS operators should demand from GRX Service Providers guaranteed reliability of the GRX and backbone connections to other GRXs."[1]
IR.34[1] suggests a value of 99.95% of the time, which allows for just over 4 hours of "down time" per year.

1.1.2 Latency

The delay in propagation for a packet from the BG of one GPRS operator to the BG of another GPRS operator is the latency of the GRX network. The requirement suggested by IREG for latency is that the delay between the BG of the operator and any other BG does not exceed the defined value. IREG suggests that GPRS operators demand latencies no greater than 400 msec.

1.1.3 Jitter

The statistical variation in the latency that occurs in the network is defined to be the jitter. In the case of GRX networks, IREG suggests that the SLA value for jitter be a standard deviation of 20 msec.

1.1.4 Throughput

Throughput is the rate at which bytes (or bits) can be transferred through the network. GPRS operators will normally purchase connections to the GRX based on the aggregate rate of the expected connection to all other operators. Although not recommended specifically by IREG, many GRX operators provide GPRS operators a choice of many different rates, some ranging from as low as 64kps to as high as 34Mbps. This bandwidth must be available to the GPRS network operator at all times.

1.1.5 Packet Loss

IREG states that packets must be lost "rarely", and that a good packet loss threshold to include in the SLA is 0.3%, or three packets in one thousand.

3. Testing GRX Networks

GRX operators need to install IP equipment and maintain IP services with their customers with guarantees on service level. This is no different than an Internet Service Provider (ISP) that wishes to provide commercial IP connectivity.

1.7 GRX Operator Testing

Testing within the GRX operator is kept mainly at the IP level, unless the GRX offers some sort of value-added service to GSM operators. GRX Operators will need to provision new IP connections between GSM operators and between competitive GRX operators. Once installed, the GRX operator is responsible for adherence to SLA agreements, possibly on both ends of each connection. This will involve permanent monitoring of the network and generating reports to end customers. Reliability is key for the GRX, because penalty clauses in the SLA agreements can have a negative influence on revenue.

1.8 GSM Operator Testing

GSM Operators need to be able to monitor the GTP protocol and the data that is being tunneled over GTP to look for signaling errors that will distinguish between local and external PLMN problems. Testing at the Gp interface can reveal how much data is being exchanged between network operators. A report on data exchange levels between operators is valuable because of its value as in reconciling billing of IP data, which is analogous to inter-carrier billing reconciliation in SS7 and GSM.

NetTest A/S
Kirkebjerg Allé 90
DK-2605 Brøndby
Denmark
Tel: +45 72 11 22 00
Fax: +45 72 11 22 10
E-mail: com@nettest.com
web: www.nettest.com

NetTest Sales Offices

Brazil	+55 11 5505 6688	Italy	+39 02 95 12 621
China	+86 10 6467 9888	Singapore	+65 6220 9575
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