Contents

Introduction

This document describes a specific scenario where Extended Bit Rate Parameter is suppressed by Serving GPRS Supporting Node (SGSN). This problem is reported on Cisco Aggregrated Service Routers (ASR) 5x00.

Problem

The roaming subscribers are unable to establish Packet Data Protocol (PDP) context when roaming in particular circle because SGSN rejects PDP with Cause Code field having insufficient resources, due to which 3G roaming calls are not setup properly. Roaming Home Location Register (HLR) sends 0 kbps values in Max Bit Rate Down Link (DL) and also adds Extended Quality of Service(QoS) irrespective of Radio Access Type (RAT) Type. But SGSN ignores the Extended QOS and sends Create PDP Request message to the Gateway GPRS Supporting Node (GGSN) with 0 kbps, resulting in Radio Access Bearer(RAB) assignment failure.

Scenarios

As per 3rd Generation Partnership Project (3GPP) Technical Specification (TS) 24.008 Specification, its clearly stated that:

Maximum bit rate for downlink, octet 9 (see 3GPP TS 23.107 [81])
Coding is identical to that of Maximum bit rate for uplink.
If the sending entity wants to indicate a Maximum bit rate for downlink higher than 8640 kbps, it shall set octet 9 to "11111110", i.e. 8640 kbps, and shall encode the value for the Maximum bit rate in octet 15.

In this version of the protocol, for messages specified in the present document, the sending entity shall not request 0 kbps for both the Maximum bitrate for downlink and the Maximum bitrate for uplink at the same time. Any entity receiving a request for 0 kbps in both the Maximum bitrate for downlink and the Maximum bitrate for uplink shall consider that as a syntactical error (see clause 8).

Scenario 1.

HLR sends 8640 kbps and the behavior of SGSN is based on RAT Type.

For 2G:

For 3G:

Scenario 2.

HLR is sending 8640 kbps.

```
 Thursday October 02 2014
INBOUND>>>>> 23:43:34:993 Eventid:87113(0)

===> GSM Mobile Application (MAP) (0x94) (148 bytes)

MAP Insert Subscriber Data Request
Parameter Sequence Tag

Ext-QoS Subscribed
Tag : 0x80
Length : 9 (0x09)
Value : 0x01 6b 96 eb fe 74 01 00 00
Allocation/Retention Priority : 1 (0x01)
011. .... Traffic Class : Interactive Class (0x3)
...0 1... Delivery Order : With delivery order ('yes') (0x1)
.... .011 Delivery of Erroneous SDUs : Erroneous SDUs are not delivered ('no') (0x3)
Maximum SDU Size : 1500 octets (0x96)
Max. bit rate for Uplink : 7424 kbps (0xeb)
```
Max. bit rate for Downlink : 8640 kbps (0xfe)
```
0111 .... Residual BER : 1*10-5 (0x7)
.... 0100 SDU Error Ratio : 1*10-4 (0x4)
0000 00.. Transfer Delay : Reserved (0x0)
.... ..01 Traffic Handling Priority : Priority Level 1 (0x1)
Guaranteed bit rate for Uplink : Reserved (0x00)
Guaranteed bit rate for Downlink : Reserved (0x00)
Ext2-QoS Subscribed
Tag : 0x82
Length : 3 (0x03)
Value : 0x00 50 00
000. .... Spare : 0
...0 .... Signalling Indication : Not optimised for signalling traffic
.... 0000 Source Statistics Descriptor : Unknown (0x0)
```
Maximum bit rate for Downlink (Extended) : 22 mbps (0x50)
```
Guaranteed bit rate for Downlink (Extended) : Use the value indicated by the Guaranteed bit rate
for downlink (0x00)

Thursday October 02 2014
<<<<OUTBOUND 23:43:41:388 Eventid:116004(3)
GTPC Tx PDU, from 223.224.40.249:19001 to 223.224.40.1:2123 (168)
TEID: 0x00000000, Message type: GTP_CREATE_PDP_CONTEXT_REQ_MSG (0x10)
Sequence Number:: 0x217C (8572)
CHARGING CHARACTERISTIC ENDS.
END USER ADDRESS FOLLOWS:
PDP Type Organisation: IETF
PDP Type Number: IPv4
Address: Empty
```

```
END USER ADDRESS ENDS.
Access Point Name: airtelgprs.com
Max bit rate for uplink: 0xEB (7424 kbps)
Max bit rate for downlink: 0xFE (8640 kbps)
Residual BER: 0x7 (1/100 000 = 1x10^-5)
SDU error ratio: 0x4 (1/10 000 = 1x10^-4)
Source Statistics Descr: 0x0 (Unknown)
Ext Max bit rate (DL): 0x50 (22000 kbps)  <<<<<< Included in the message.
Ext Guaranteed bit rate(DL): 0x00 (Reserved)
QOS PROFILE ENDS.
COMMON FLAGS END.
Radio Access Technology: UTRAN
```

HLR sends 0 kbps

```
Tag : 0x94 Length : 9 (0x09) Value : internet Ext-QoS Subscribed Tag : 0x80 Length : 9 (0x09)
Value : 0x01 71 96 fe ff 74 f9 ff ff Allocation/Retention Priority : 1 (0x01) 011. .... Traffic
Class : Interactive Class (0x3) ...1 0... Delivery Order : Without delivery order ('no') (0x2)
.... .001 Delivery of Erroneous SDUs : No detect ('-') (0x1) Maximum SDU Size : 1500 octets
(0x96) Max. bit rate for Uplink : 8640 kbps (0xfe) Max. bit rate for Downlink : 0 kbps (0xff)
>>>> Here sending entity is requesting 0kbps which is less than 8640 kbps and that is why SGSN
ignores the Extended QoS and does not forward it to GGSN
                          0111 .... Residual BER : 1*10-5 (0x7)
                          .... 0100 SDU Error Ratio : 1*10-4 (0x4)
                          1111 10.. Transfer Delay : 4000 ms (0x3e)
                          .... ..01 Traffic Handling Priority : Priority Level 1 (0x1)
                          Guaranteed bit rate for Uplink : 0 kbps (0xff)
                          Guaranteed bit rate for Downlink : 0 kbps (0xff)
                      Ext2-QoS Subscribed
                        Tag    : 0x82
                        Length : 3 (0x03)
                        Value  : 0x00 4f 00
                          000. .... Spare : 0
                          ...0 .... Signalling Indication : Not optimised for signalling
traffic
                          .... 0000 Source Statistics Descriptor : Unknown (0x0)
                          Maximum bit rate for Downlink (Extended) : 21 mbps (0x4f)
                          Guaranteed bit rate for Downlink (Extended) : Use the value
indicated by the Guaranteed bit rate for downlink (0x00)


<<<<OUTBOUND  16:01:37:890 Eventid:116004(3)
GTPC Tx PDU, from 223.224.40.249:19134 to 112.110.244.80:2123 (169)
TEID: 0x00000000, Message type: GTP_CREATE_PDP_CONTEXT_REQ_MSG (0x10)
Sequence Number:: 0x07AC (1964)
MSISDN ENDS.
QOS PROFILE FOLLOWS (Length = 13)
 Alloc./Retention priority: 0x01 (1)
             Spare Octet1: 0x0 (0)
               Delay class: 0x4 (Delay class 4 (best effort))
         Reliability class: 0x3 (Unack. GTP/LLC, Ack. RLC, Protected data)
           Peak throughput: 0x09 (Up to 256 000 octets/s)
             Spare Octet2: 0x0 (0)
         Precedence class: 0x2 (Normal priority)
             Spare Octet3: 0x0 (0)
           Mean throughput: 0x1F (Best effort)
            Traffic class: 0x3 (Interactive class)
            Delivery order: 0x2 (Without delivery order ('no'))
 Delivery of erroneous SDU: 0x1 (No detect ('-'))
          Maximum SDU size: 0x96 (1500 octets)
   Max bit rate for uplink: 0xFE (8640 kbps)
 Max bit rate for downlink: 0xFF (0 kbps)
```

```
               Residual BER: 0x7 (1/100 000 = 1x10^-5)
           SDU error ratio: 0x4 (1/10 000 = 1x10^-4)
            Transfer delay: 0x3E (4000 ms)
 Traffic handling priority: 0x1 (Priority level 1)
  Guaranteed bit rate (UL): 0xFF (0 kbps)
  Guaranteed bit rate (DL): 0xFF (0 kbps)
              Spare Octet4: 0x0 (0)
     Signalling Indication: 0x0 (No)
   Source Statistics Descr: 0x0 (Unknown)
QOS PROFILE ENDS.
COMMON FLAGS FOLLOW:
 Prohibit Payload Compression: no
           MBMS Service Type: Multicast Service
        RAN Procedures Ready: no
  MBMS Counting Information: no
          No QoS negotiation: no
                        NRSN: no
       Upgrade QoS Supported: no
    Dual Address Bearer Flag: no
COMMON FLAGS END.
   Radio Access Technology: UTRAN
USER LOCATION INFORMATION FOLLOWS:
            LOCATION TYPE: SAI
                      MCC: 404
                      MNC: 70
                      LAC: 39012
                CI/SAC/RAC: 23017
USER LOCATION INFORMATION ENDS.
             MS Time Zone: +5:30
     Daylight Saving Time: +0 hour
                IMEI(SV): 3565340544016110
INFORMATION ELEMENTS END.
```

SGSN behaves as per specification, based on access type and maximum QOS is supported. SGSN includes Extended Max Bit Rate DL.

As per specification, Octet 15 is included only if User Equipment (UE)/Radio Network Controller (RNC) supports more than 8640 kbps.

In case of 2G, Base Station Controller (BSC) does not support higher QOS, the extended bit rate is not included.

In the Roaming Scenario, HLR itself sends 0 kbps and as per 3GPP specification HLR cannot send 0 kbps as DL Bit Rate.

Why Radio Access Bearer (RAB) Assignment Fails?

```
Tag : 0x94 Length : 9 (0x09) Value : internet Ext-QoS Subscribed Tag : 0x80 Length : 9 (0x09)
Value : 0x01 71 96 fe ff 74 f9 ff ff Allocation/Retention Priority : 1 (0x01) 011. .... Traffic
Class : Interactive Class (0x3) ...1 0... Delivery Order : Without delivery order ('no') (0x2)
.... .001 Delivery of Erroneous SDUs : No detect ('-') (0x1) Maximum SDU Size : 1500 octets
(0x96) Max. bit rate for Uplink : 8640 kbps (0xfe) Max. bit rate for Downlink : 0 kbps (0xff)
>>>> Here sending entity is requesting 0kbps which is less than 8640 kbps and that is why SGSN
ignores the Extended QoS and does not forward it to GGSN
                       0111 .... Residual BER : 1*10-5 (0x7)
                       .... 0100 SDU Error Ratio : 1*10-4 (0x4)
```

```
                                 1111 10.. Transfer Delay : 4000 ms (0x3e)
                                 .... ..01 Traffic Handling Priority : Priority Level 1 (0x1)
                                 Guaranteed bit rate for Uplink : 0 kbps (0xff)
                                 Guaranteed bit rate for Downlink : 0 kbps (0xff)
                             Ext2-QoS Subscribed
                                Tag    : 0x82
                                Length : 3 (0x03)
                                Value  : 0x00 4f 00
                                   000. .... Spare : 0
                                   ...0 .... Signalling Indication : Not optimised for signalling
traffic
                                   .... 0000 Source Statistics Descriptor : Unknown (0x0)
                                 Maximum bit rate for Downlink (Extended) : 21 mbps (0x4f)
                                 Guaranteed bit rate for Downlink (Extended) : Use the value
indicated by the Guaranteed bit rate for downlink (0x00)


<<<<OUTBOUND  16:01:37:890 Eventid:116004(3)
GTPC Tx PDU, from 223.224.40.249:19134 to 112.110.244.80:2123 (169)
TEID: 0x00000000, Message type: GTP_CREATE_PDP_CONTEXT_REQ_MSG (0x10)
Sequence Number:: 0x07AC (1964)
MSISDN ENDS.
QOS PROFILE FOLLOWS (Length = 13)
 Alloc./Retention priority: 0x01 (1)
              Spare Octet1: 0x0 (0)
                Delay class: 0x4 (Delay class 4 (best effort))
          Reliability class: 0x3 (Unack. GTP/LLC, Ack. RLC, Protected data)
           Peak throughput: 0x09 (Up to 256 000 octets/s)
              Spare Octet2: 0x0 (0)
          Precedence class: 0x2 (Normal priority)
              Spare Octet3: 0x0 (0)
          Mean throughput: 0x1F (Best effort)
             Traffic class: 0x3 (Interactive class)
            Delivery order: 0x2 (Without delivery order ('no'))
 Delivery of erroneous SDU: 0x1 (No detect ('-'))
          Maximum SDU size: 0x96 (1500 octets)
   Max bit rate for uplink: 0xFE (8640 kbps)
 Max bit rate for downlink: 0xFF (0 kbps)
               Residual BER: 0x7 (1/100 000 = 1x10^-5)
           SDU error ratio: 0x4 (1/10 000 = 1x10^-4)
            Transfer delay: 0x3E (4000 ms)
 Traffic handling priority: 0x1 (Priority level 1)
  Guaranteed bit rate (UL): 0xFF (0 kbps)
  Guaranteed bit rate (DL): 0xFF (0 kbps)
              Spare Octet4: 0x0 (0)
     Signalling Indication: 0x0 (No)
   Source Statistics Descr: 0x0 (Unknown)
QOS PROFILE ENDS.
COMMON FLAGS FOLLOW:
 Prohibit Payload Compression: no
          MBMS Service Type: Multicast Service
        RAN Procedures Ready: no
   MBMS Counting Information: no
         No QoS negotiation: no
                       NRSN: no
      Upgrade QoS Supported: no
    Dual Address Bearer Flag: no
COMMON FLAGS END.
   Radio Access Technology: UTRAN
USER LOCATION INFORMATION FOLLOWS:
             LOCATION TYPE: SAI
                        MCC: 404
                        MNC: 70
                        LAC: 39012
```

```
                   CI/SAC/RAC: 23017
USER LOCATION INFORMATION ENDS.
           MS Time Zone: +5:30
    Daylight Saving Time: +0 hour
              IMEI(SV): 3565340544016110
INFORMATION ELEMENTS END.
```

As per 24.008, Octet 15 or Extended Max Bitrate DL is included in Create PDP context request only when Max Bit Rate DL is more than 8640 kbps(Octet 9). In Evolved High-Speed Packet Access (HSPA+), SGSN support upto 21 mbps, so if you are connected to High-Speed Packet Access

Extension Information Element (IE) for Max Bit Rate (MBR) downlink/uplink is used if SGSN asks for downlink/uplink of more than 8700 kbps. Since the regular messeage size does not allow sending more than 8640 kbps value, extended MBR IE is used to send the additional value. If MBR extended is not sufficient then you can even use MBR Ext-2.

In previous example, the regular MBR uses one octet to send 0xFE (translated to 8640 kbps) but once the MBR-ext octet of 0x50 is multiplied with the original MBR octet, it becomes 22000 kbps.

In case of Roaming Scenario, HLR provides 0 kbps as its Maximum Bit Rate DL.

As per Spec 23.107, Maximum Bit Rate (kbps): Maximum number of bits delivered by Universal Mobile Telecommunication System (UMTS) and to UMTS at a Service Access Point (SAP) within a period of time, divided by the duration of the period. The traffic is conformant with the Maximum bitrate as long as it follows a token bucket algorithm where token rate equals Maximum bitrate and bucket size equals maximum Service Data Unit (SDU) size.
The conformance definition should not be interpreted as a required implementation algorithm. The token bucket algorithm is described in annex B.
The Maximum bitrate is the upper limit a user or application can accept or provide. All RAB attributes can be fulfilled for traffic up to the maximum Bit Rate depending on the network conditions.

Purpose:

1) To limit the delivered Bit Rate to applications or external networks with such limitations

2) To allow maximum wanted RAB bitrate to be defined for applications able to operate with different rates (for example applications with adapting codecs.)

If HLR gives upper limit of 0 kbpsto the roaming subscriber, then SGSN does not include extended Bit rate as per the mentioned restriction in 24.008 Specification.

Workaround

You can chose to provide default QOS by mapping to default Access Point Name (APN), in case making changes in HLR is not feasible.

As shown in this example, sample configuration change done for roaming subscribers has a default QoS. In case of 2G, SGSN sends 472kbps by default and its hardcoded:


```
Tag : 0x94 Length : 9 (0x09) Value : internet Ext-QoS Subscribed Tag : 0x80 Length : 9 (0x09)
Value : 0x01 71 96 fe ff 74 f9 ff ff Allocation/Retention Priority : 1 (0x01) 011. .... Traffic
Class : Interactive Class (0x3) ...1 0... Delivery Order : Without delivery order ('no') (0x2)
.... .001 Delivery of Erroneous SDUs : No detect ('-') (0x1) Maximum SDU Size : 1500 octets
(0x96) Max. bit rate for Uplink : 8640 kbps (0xfe) **Max. bit rate for Downlink : 0 kbps (0xff)**
>>>> Here sending entity is requesting 0kbps which is less than 8640 kbps and that is why SGSN
ignores the Extended QoS and does not forward it to GGSN
                             0111 .... Residual BER : 1*10-5 (0x7)
                             .... 0100 SDU Error Ratio : 1*10-4 (0x4)
                             1111 10.. Transfer Delay : 4000 ms (0x3e)
                             .... ..01 Traffic Handling Priority : Priority Level 1 (0x1)
                             Guaranteed bit rate for Uplink : 0 kbps (0xff)
                             Guaranteed bit rate for Downlink : 0 kbps (0xff)
                        Ext2-QoS Subscribed
                           Tag    : 0x82
                           Length : 3 (0x03)
                           Value  : 0x00 4f 00
                             000. .... Spare : 0
                             ...0 .... Signalling Indication : Not optimised for signalling
traffic
                             .... 0000 Source Statistics Descriptor : Unknown (0x0)
                             Maximum bit rate for Downlink (Extended) : 21 mbps (0x4f)
                             Guaranteed bit rate for Downlink (Extended) : Use the value
indicated by the Guaranteed bit rate for downlink (0x00)



<<<<OUTBOUND  16:01:37:890 Eventid:116004(3)
GTPC Tx PDU, from 223.224.40.249:19134 to 112.110.244.80:2123 (169)
TEID: 0x00000000, Message type: GTP_CREATE_PDP_CONTEXT_REQ_MSG (0x10)
Sequence Number:: 0x07AC (1964)
MSISDN ENDS.
QOS PROFILE FOLLOWS (Length = 13)
 Alloc./Retention priority: 0x01 (1)
            Spare Octet1: 0x0 (0)
              Delay class: 0x4 (Delay class 4 (best effort))
        Reliability class: 0x3 (Unack. GTP/LLC, Ack. RLC, Protected data)
          Peak throughput: 0x09 (Up to 256 000 octets/s)
            Spare Octet2: 0x0 (0)
        Precedence class: 0x2 (Normal priority)
            Spare Octet3: 0x0 (0)
        Mean throughput: 0x1F (Best effort)
            Traffic class: 0x3 (Interactive class)
           Delivery order: 0x2 (Without delivery order ('no'))
 Delivery of erroneous SDU: 0x1 (No detect ('-'))
         Maximum SDU size: 0x96 (1500 octets)
    Max bit rate for uplink: 0xFE (8640 kbps)
 Max bit rate for downlink: 0xFF (0 kbps)
             Residual BER: 0x7 (1/100 000 = 1x10^-5)
          SDU error ratio: 0x4 (1/10 000 = 1x10^-4)
           Transfer delay: 0x3E (4000 ms)
 Traffic handling priority: 0x1 (Priority level 1)
  Guaranteed bit rate (UL): 0xFF (0 kbps)
  Guaranteed bit rate (DL): 0xFF (0 kbps)
             Spare Octet4: 0x0 (0)
     Signalling Indication: 0x0 (No)
    Source Statistics Descr: 0x0 (Unknown)
QOS PROFILE ENDS.
COMMON FLAGS FOLLOW:
 Prohibit Payload Compression: no
```

```
           MBMS Service Type: Multicast Service
         RAN Procedures Ready: no
   MBMS Counting Information: no
         No QoS negotiation: no
                       NRSN: no
       Upgrade QoS Supported: no
    Dual Address Bearer Flag: no
COMMON FLAGS END.
    Radio Access Technology: UTRAN
USER LOCATION INFORMATION FOLLOWS:
              LOCATION TYPE: SAI
                        MCC: 404
                        MNC: 70
                        LAC: 39012
                CI/SAC/RAC: 23017
USER LOCATION INFORMATION ENDS.
              MS Time Zone: +5:30
       Daylight Saving Time: +0 hour
                  IMEI(SV): 3565340544016110
INFORMATION ELEMENTS END.
```