Impact of SGSN Pooling on Signaling

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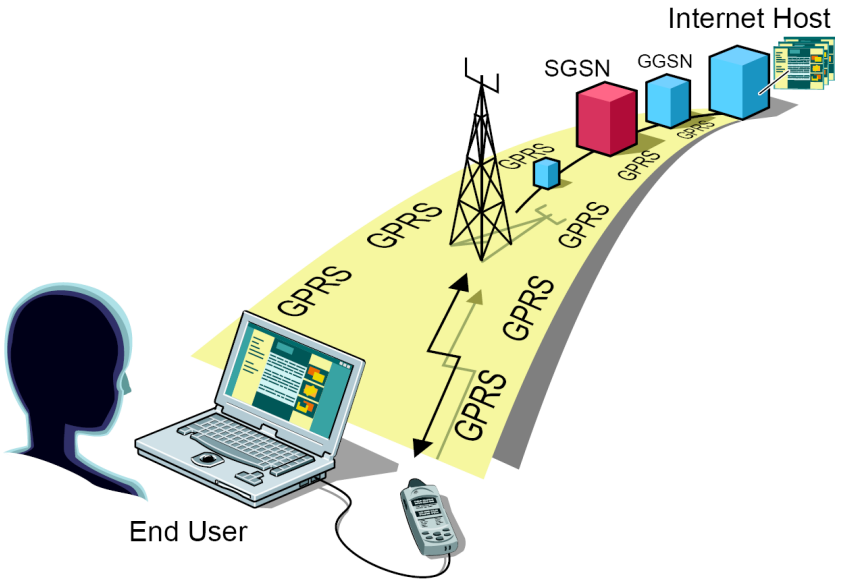
Introduction

- Work was done during 2007 at Oy LM Ericsson Ab in Kirkkonummi
- Objective of the thesis was to find out the impact of Serving GPRS Support Node (SGSN) Pooling on the signaling traffic
- We chose to build a real SGSN pool in a test lab for measuring the impact

3G PS Core Network Structure

- Packet core network provides GPRS services
- GPRS services are a prerequisite for several other services:
  - WAP
  - Mobile Internet
  - MMS
- The GPRS core network is the connecting network between the radio network and packet-based data networks (Internet, corporate networks)
- In the PS domain, the most important core network nodes are the SGSN and the GGSN

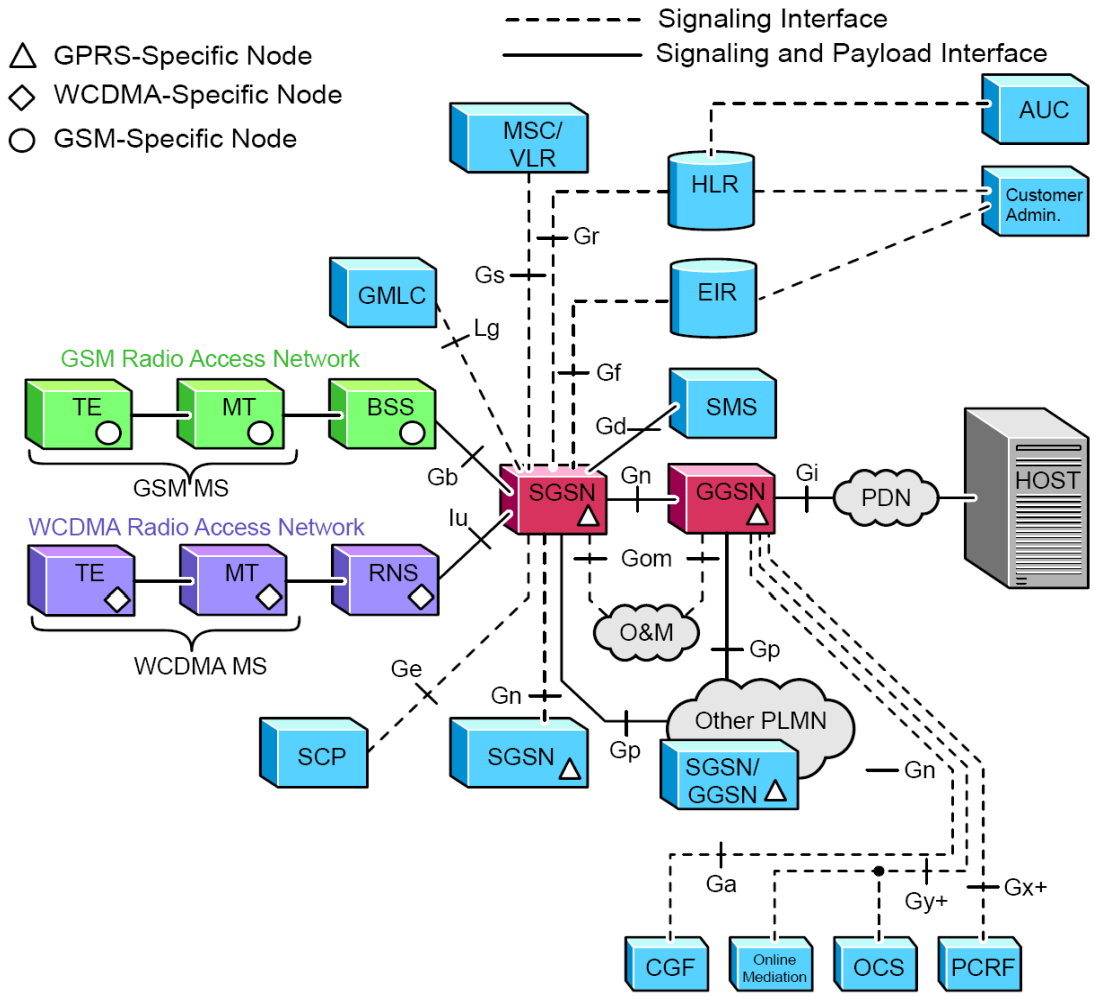


3G PS Core Network Structure

- The SGSN forwards incoming and outgoing IP packets addressed to/from an MS that is attached within the SGSN service area
  - also mobility management, session management, authentication, ciphering and charging responsibilities
- The GGSN is the gateway between the mobile core network and the external packet data networks, such as the Internet
  - tunnel and de-tunnel the packets originated by or destined to the MS
  - also access control, session management and charging responsibilities
- The HLR is a database containing subscription data for each of the subscribers in that HLR

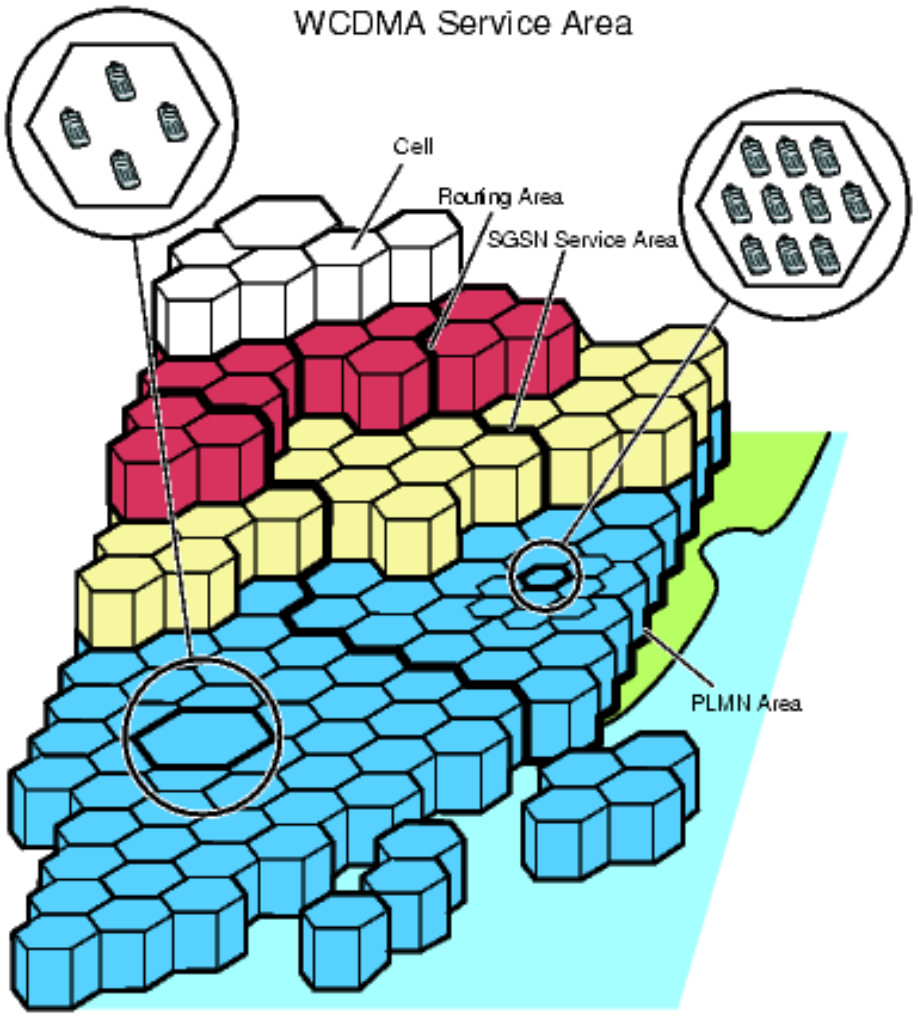
3G PS Core Network Structure

- The RNCs connected to the SGSNs through Iu interface
  - ATM or IP
- HLR provides subscription data through Gr interface to the SGSN
  - E1, ATM or IP
- The SGSNs are connected to the GGSN through Gn interface
  - IP



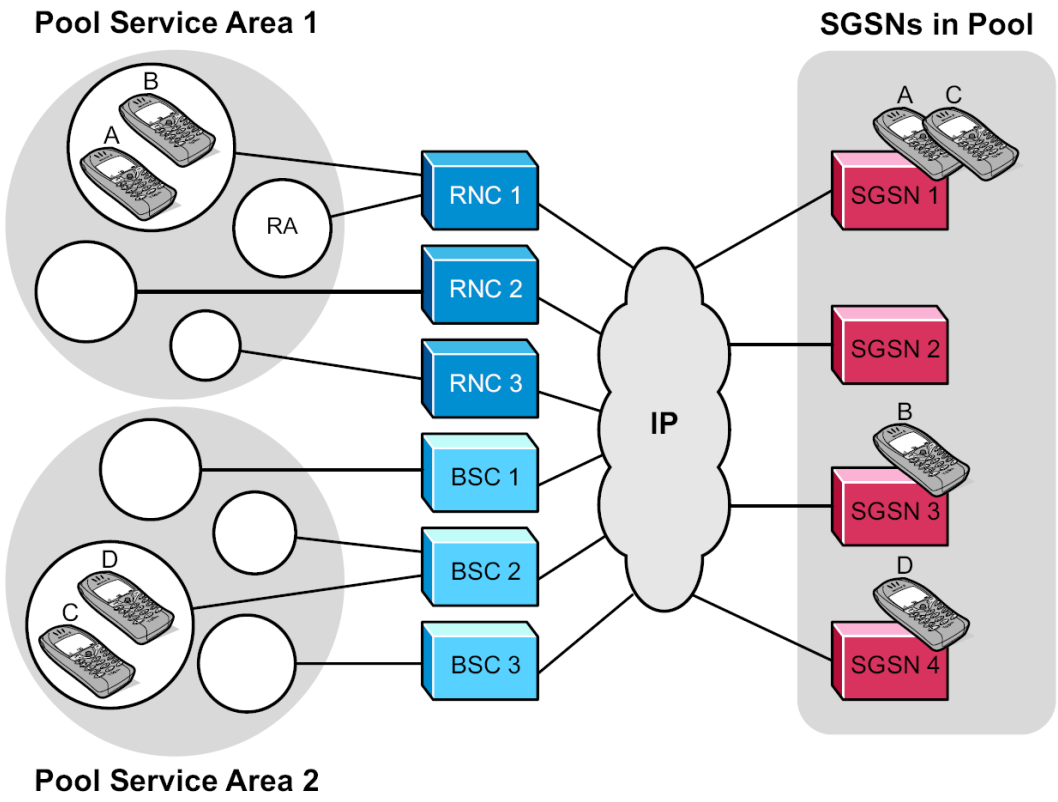
Network Hierarchy

- There are several subscribers in one cell
- Several cells belong to a single routing area (RA)
- Several RAs are served by one SGSN (SGSN Service Area)
- When a subscriber is attached to the network, it causes signaling
  - Even idle subscribers!
  - Moving subscribers even more so



SGSN Pooling

- 3GPP standard TS23.236
- Connecting RNCs to multiple SGSNs is called SGSN pooling
- Several SGSNs form a single logical entity called SGSN pool
- SGSN pool service areas typically larger than SGSN service areas
- Requires upgraded software in RNC and in SGSN
- Compatible with non-pool aware nodes
- Transparent to end user



SGSN Pooling

- SGSN Pooling brings about several benefits:
  - Increased availability: SGSN not a single point of failure anymore, another pool member may take over; node can be taken out of the pool during maintenance
  - Increased scalability: easy to increase capacity by adding SGSN nodes to a pool
  - Reduced signaling: less inter-SGSN routing area updates
- ... but there's always a cost:
  - The RNCs must be connected to all SGSN pool members
  - Enough bandwidth must be allocated between the SGSNs and the RNCs

Measuring the Impact on Signaling

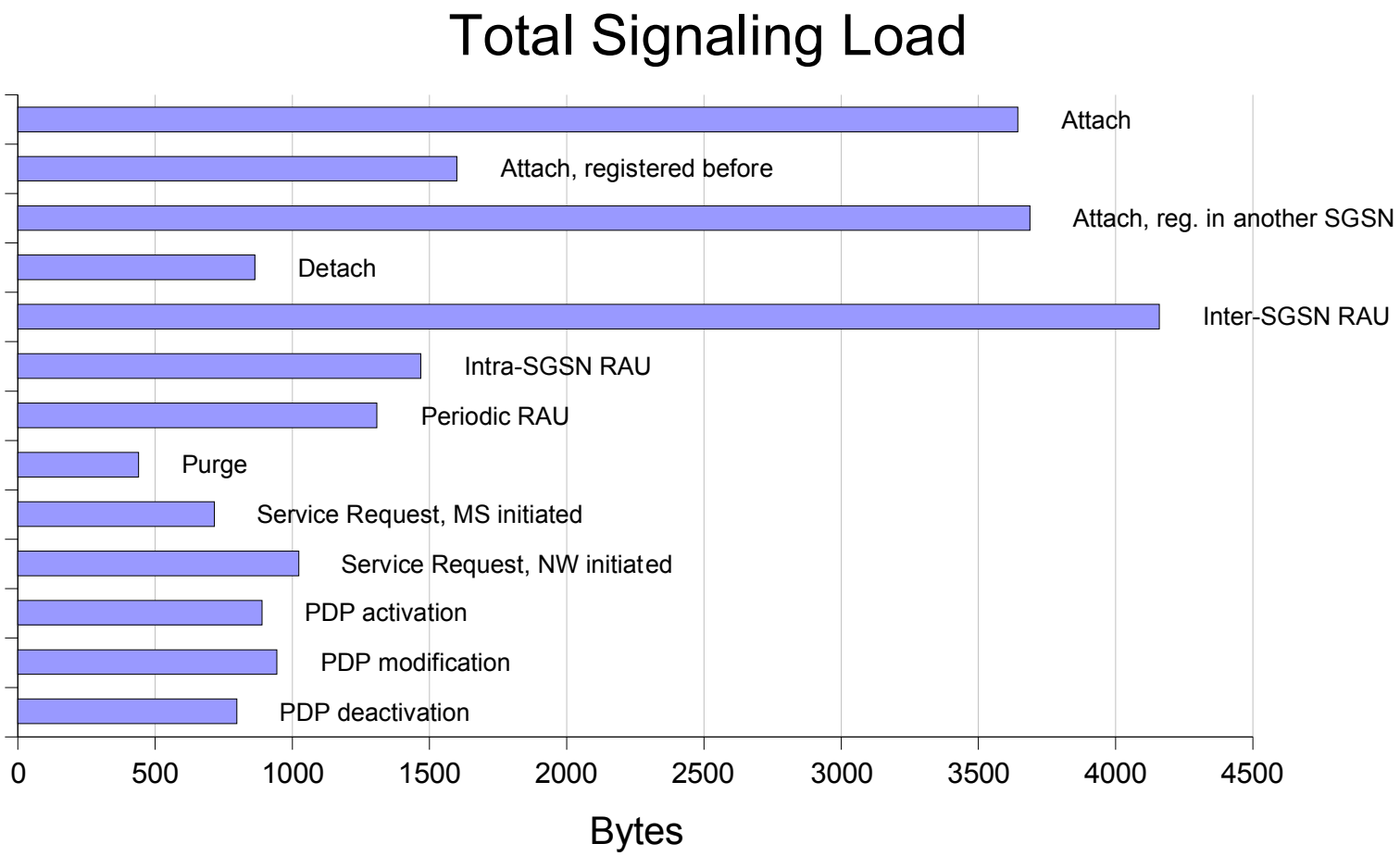
- Objective of this thesis was to find out the measurable reduction in signaling, when SGSN pooling was introduced
- We measured the impact on signaling by creating a network of 2 SGSNs in the test plant
  - IP network planning (cabling, routing, connectivity) was required
- Real SGSNs were used, but radio network, HLR, GGSN and the public data network were simulated
- The signaling load of each individual operation was measured with Wireshark for all interfaces in 2 different scenarios: with SGSN pooling and without
- When this data was combined with pre-existing performance management data from existing GPRS networks, we could estimate the total effect

Performance Management Data

- Lists the relative amount of events in real live networks
- When the signaling load caused by each event is known, it is possible to combine the PM data and the measurement results

SAU		
Simultaneously attached subscribers	500000	SAU
Active subscribers to SAU ratio	0,16	
WCDMA subscribers	1	
Payload		
IP User traffic	260	kByte/active subs.
Average uplink packet size	155	bytes
Average downlink packet size	660	bytes
Uplink-to-total packets ratio	0,4	
Session management		
PDP activations	0,21	per SAU
PDP modification	0,005	per SAU
PDP deactivations	0,21	per SAU
Mobility management		
Attach	0,04	per SAU
Attach, registered before	0,14	per SAU
Attach, registered before in another SGSN	0,01	per SAU
Detach	0,16	per SAU
Inter-SGSN RAU	0,22	per SAU
Intra-SGSN RAU	0,8	per SAU
Perioidic RAU	0,2	per SAU
Purge	0,05	per SAU
Service Request, MS initiated	0,85	per SAU
Service Request, NW initiated	0,25	per SAU

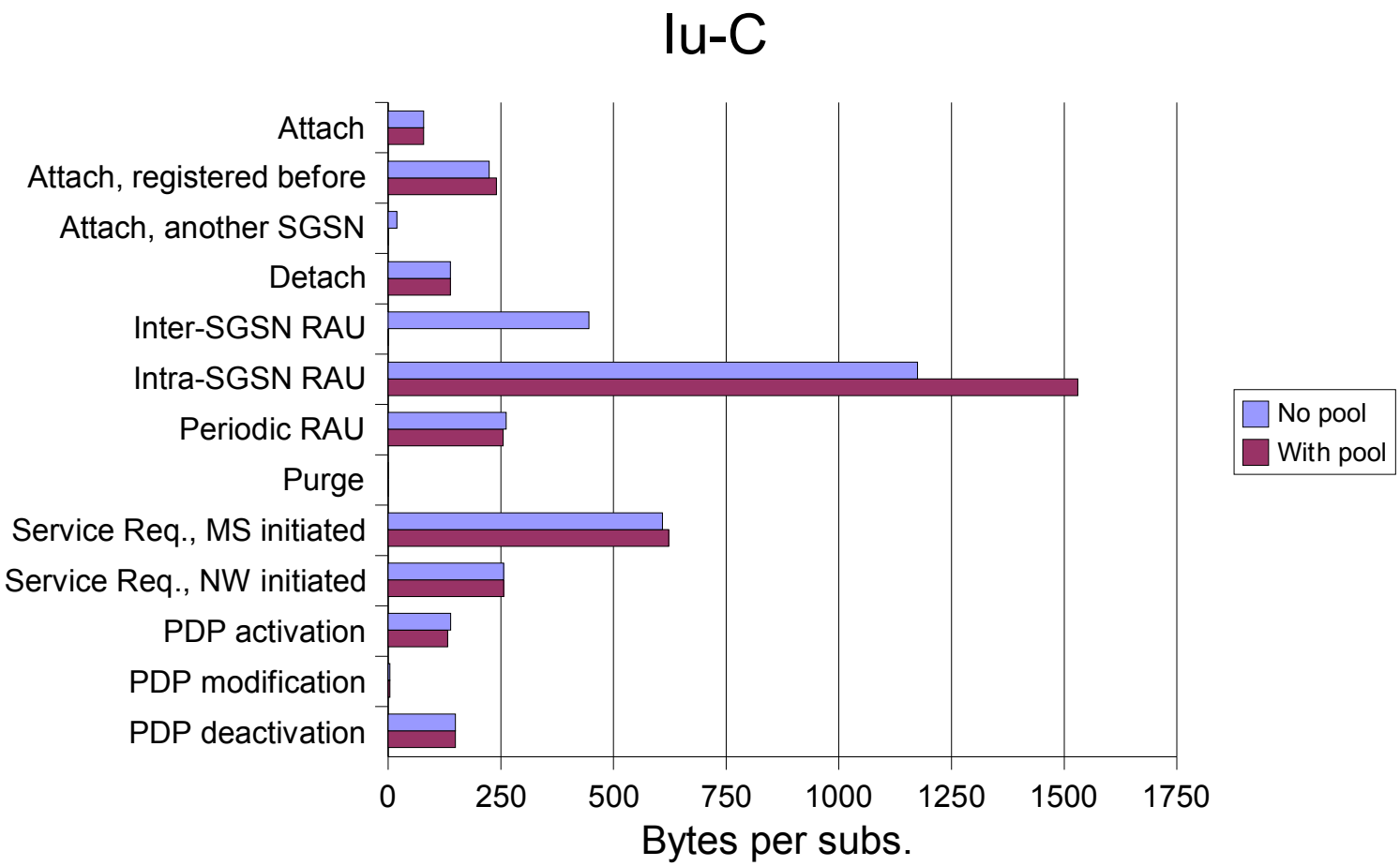
Signaling Load per Operation



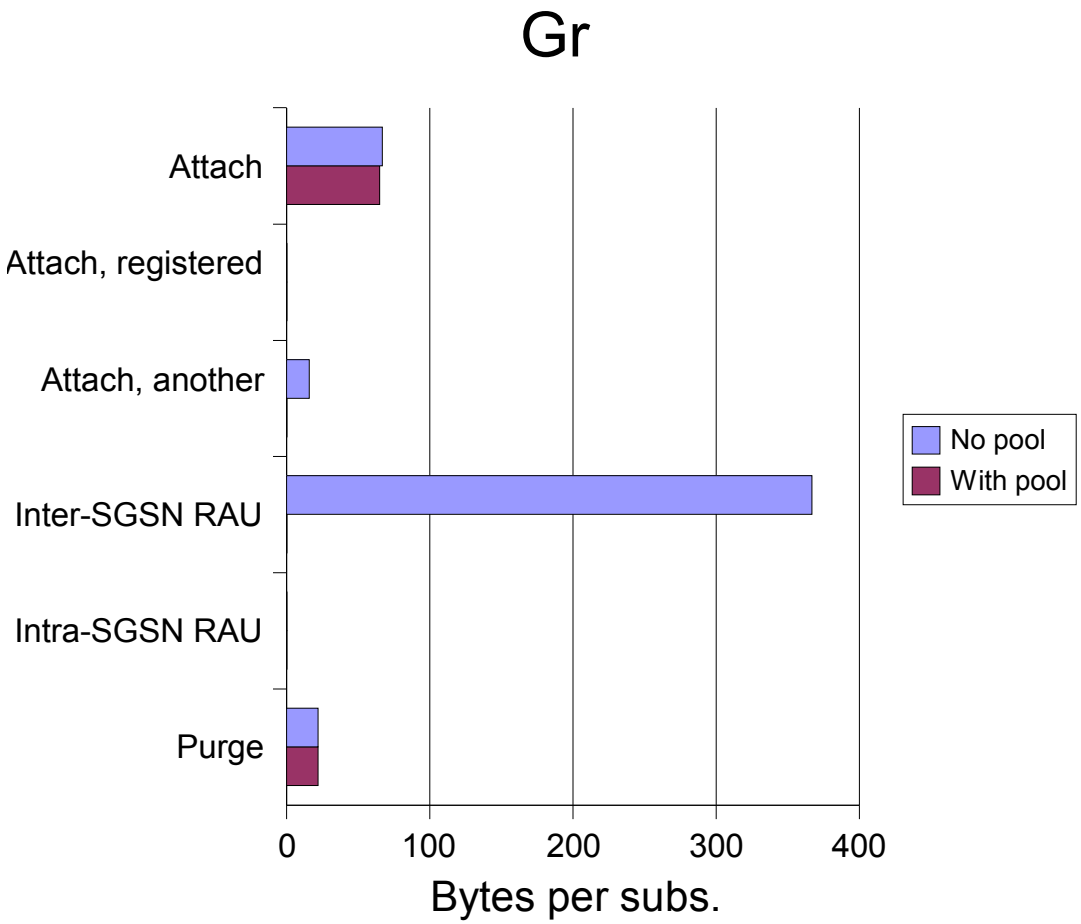
Changes in Signaling Events

- When SGSN pooling is introduced in the network, there are a couple of important changes to the signaling events:
  - When subscribers attach to the network, they are always routed to the same SGSN, where they were attached previosly
  - Because the SGSN pool service area is typically much larger than single SGSN service area, the amount of inter-SGSN routing area updates is reduced as intra-SGSN routing area updates are made instead
    - For small or medium size operators the whole network could be a single pool service area

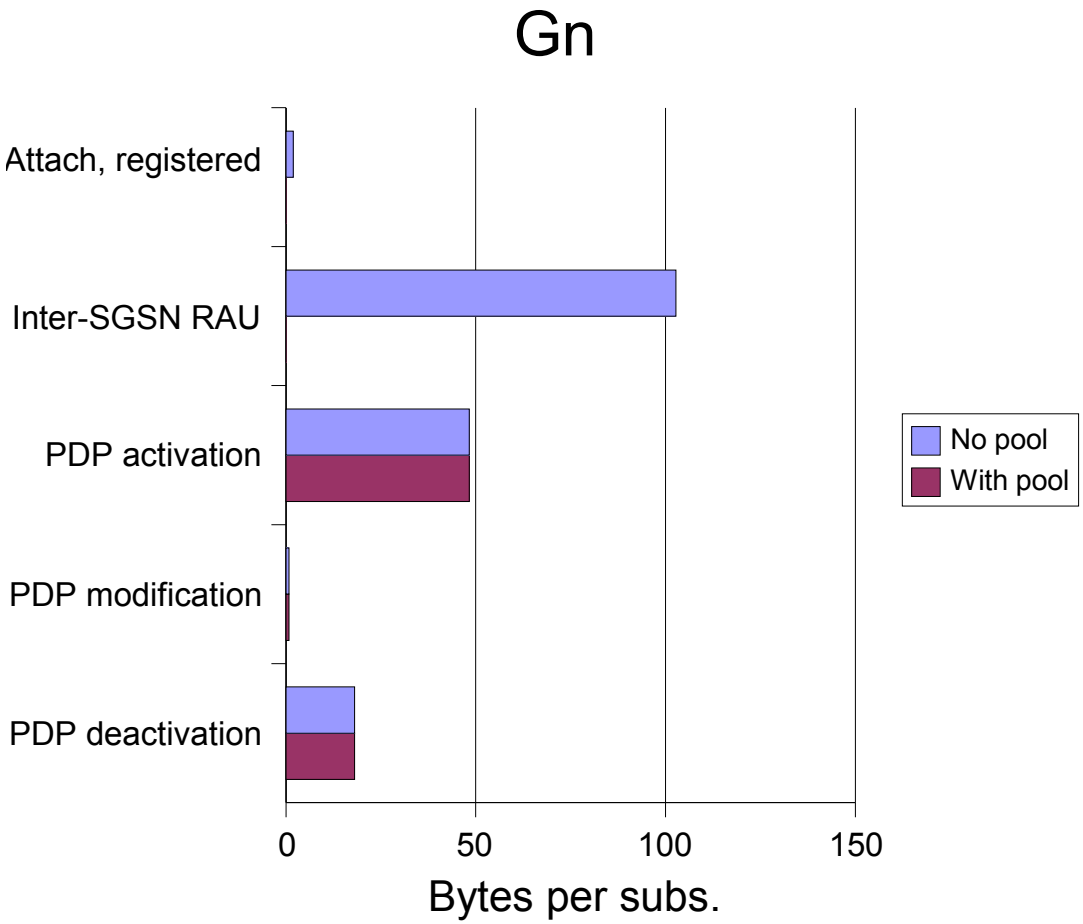
Iu Signaling During Busy Hour



Gr Signaling During Busy Hour



Gn Signaling During Busy Hour



Results

- Clear reduction of signaling traffic seen on each of the interfaces
  - Iu 3%, Inter-SGSN RAUs cause a bit more Iu signaling than Intra-SGSN RAUs
  - Gr 82%, Inter-SGSN RAUs cause a significant portion of HLR signaling, Intra-SGSN RAUs need no Gr signaling!
  - Gn 61%, Inter-SGSN RAUs cause a significant portion of Gn signaling, Intra-SGSN RAUs need no Gn signaling
- The absolute amounts are rather small though
- In the test network 20,9% of the traffic was signaling without SGSN pool and 18,6% with the pool
- The most important is the decrease in the HLR traffic (Gr), as there might be several SGSNs communicating with a single HLR and reducing that signaling by 82% is a potential source of cost savings
- The decrease in Gn is relatively significant, but the absolute amounts of signaling traffic in Gn interface are very limited

Results

- As a conclusion, the reduction in signaling is not alone an important enough a reason to migrate existing networks to SGSN pool solutions
- The results provide measured data to support network dimensioning
- However, there are other benefits to the solution as well: better availability, reliability and flexibility
  - These benefits all translate to better cost-efficiency (a subject for further research!)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