# 3G-WLAN Mobility

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# Introduction

- History and facts
  - With the introduction of mobile phones and the mobile networks as Global System for Mobile Communications (GSM) came the notion of always connected. One of the main factors of success for GSM was that operators have a roaming agreement between them in all over the world.
  - At the same time when voice services through GSM, the uses of IP based services has increased in the last 10 years. Before the development of General Packet Radio Services (GPRS) the uses of these IP based services was not possible with wireless equipments
  - The main problem of GPRS is the connection speed. Therefore the needs of develop a new cheaper and faster way to access IP based services were needed. That is, development of what today's known as (3G) cellular systems, such as Universal Mobile Telecommunications (UMTS) and cdma 2000 in USA.
  - In parallel with the evolution of cellular systems, a number of other access technologies have emerged and become part of our everyday. Wireless local area networks (WLAN) specified by IEEE 802.11 deployed in hot spot areas give us Internet access at offices, home, airports and conference centres with a acceptable speed and using a free frequency which had a very big impact on the development and end user interest on this technology.
  - Wireless LAN (WLAN) access technology has strong potential to provide a perfect broadband complement to Third Generation (3G) Wireless Systems. This has raised much interest in the integration and inter-operation of 3G and WLAN.

# 3G Mobility Management

## PMM-DETACHED State

In the PMM-DETACHED state there is no communication between the MS and the 3G-SGSN. The MS and SGSN contexts hold no valid location or routeing information for the MS. The MS MM state machine does not react on system information related to the 3G-SGSN. The MS is not reachable by a 3G-SGSN, as the MS location is not known

## PMM-IDLE State

The MS location is known in the 3G-SGSN with an accuracy of a routeing area. Paging is needed in order to reach the MS, e.g. for signalling. ‘

The MS shall perform a routeing area update if the RA changes. Signalling towards the HLR is needed if the 3G-SGSN does not have an MM context for this MS.

The MS and 3G-SGSN shall enter the PMM-CONNECTED state when the PS signalling connection is established between the MS and the 3G-SGSN.

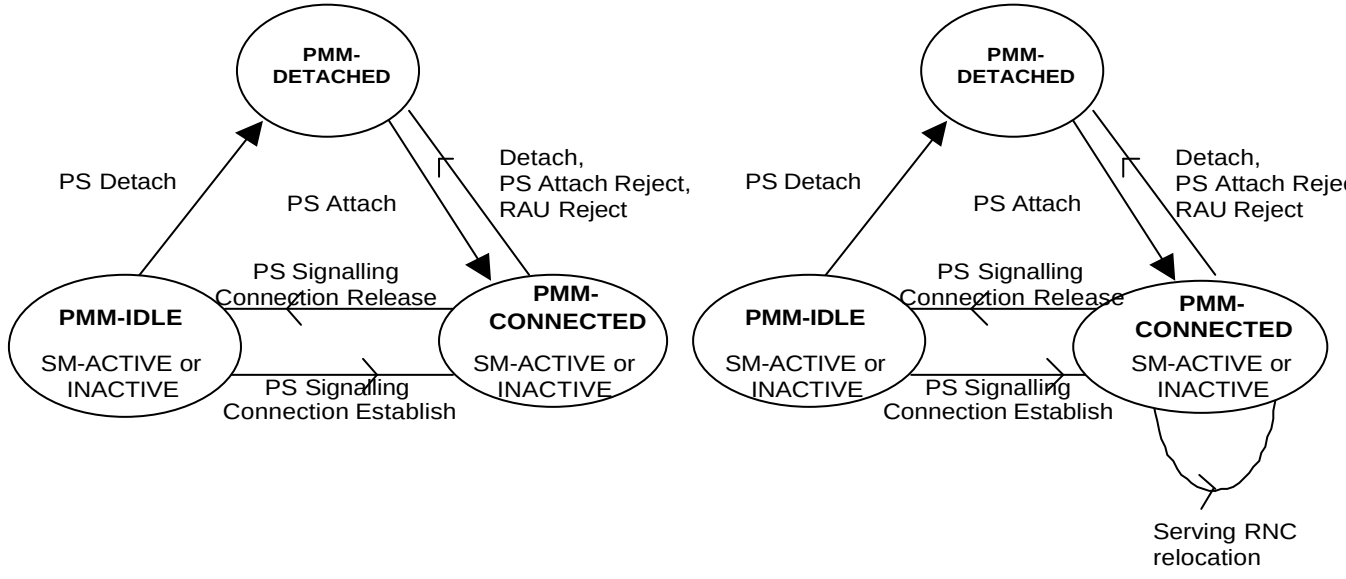
## PMM-CONNECTED State

The MS location is known in the 3G-SGSN with an accuracy of a serving RNC.

In the PMM-CONNECTED state, the location of the MS is tracked by the serving RNC.

The MS performs the routeing area update procedure when RAI in the MM system information changes.

When an MS and a 3G-SGSN are in the PMM-CONNECTED state, a PS signalling connection is established between the MS and the 3G-SGSN.




MS MM States

3G-SGSN MM States

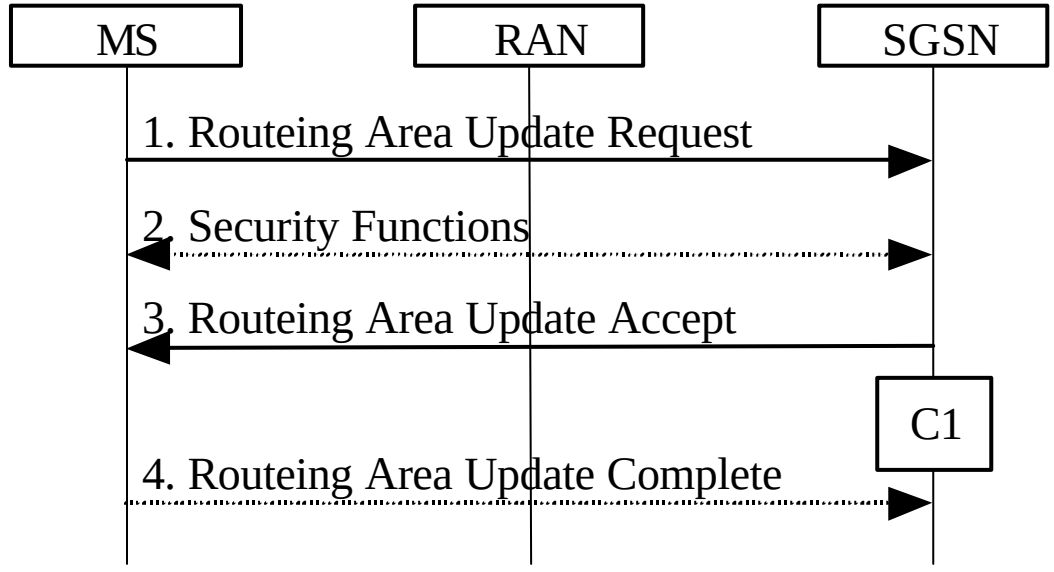
# 3G Intra SGSN Routing Area Update

1) The MS sends a Routeing Area Update Request (P-TMSI, old RAI, old P-TMSI Signature, Update Type) to the SGSN. Update Type shall indicate RA update or periodic RA update. The BSS shall add the Cell Global Identity including the RAC and LAC of the cell where the message was received before passing the message to the SGSN, see GSM 08.18

2) Security functions may be executed. These procedures are defined in subclause "Security Function".

3) The SGSN validates the MS's presence in the new RA. If, due to regional subscription restrictions, the MS is not allowed to be attached in the RA, or if subscription checking fails, the SGSN rejects the routeing area update with an appropriate cause. If all checks are successful, the SGSN updates the MM context for the MS. A new P-TMSI may be allocated. A Routeing Area Update Accept (P-TMSI, P-TMSI Signature) is returned to the MS.

4) If P-TMSI was reallocated, the MS acknowledges the new P-TMSI by returning a Routeing Area Update Complete message to the SGSN



# 3G Inter SGSN Routing Area Update

1. The MS sends a Routeing Area Update Request to the new SGSN. Update Type shall indicate RA update or periodic RA update. The BSS shall add the Cell Global Identity including the RAC and LAC of the cell where the message was received before passing the message to the SGSN.
2. The new SGSN sends SGSN Context Request (old RAI, TLLI, old P-TMSI Signature, New SGSN Address) to the old SGSN to get the MM and PDP contexts for the MS
3. Security functions may be executed.
4. The new SGSN informs the old SGSN that the new SGSN is ready to receive data packets belonging to the activated PDP contexts
5. The old SGSN duplicates the buffered N-PDUs and starts tunnelling them to the new SGSN
6. The new SGSN sends Update PDP Context Request and GGSN answers it.
7. The new SGSN informs the HLR of the change of SGSN by sending Update Location
8. The HLR sends Cancel Location. This allows the old SGSN to complete the forwarding of N-PDUs.
9. The new SGSN validates the MS's presence in the (new) RA.
10. The HLR acknowledges the Update Location.
11. The new SGSN validates the MS's presence in the new RA
12. The MS acknowledges the new P-TMSI by returning a Routeing Area Update Complete (Receive N-PDU Number) message to the SGSN

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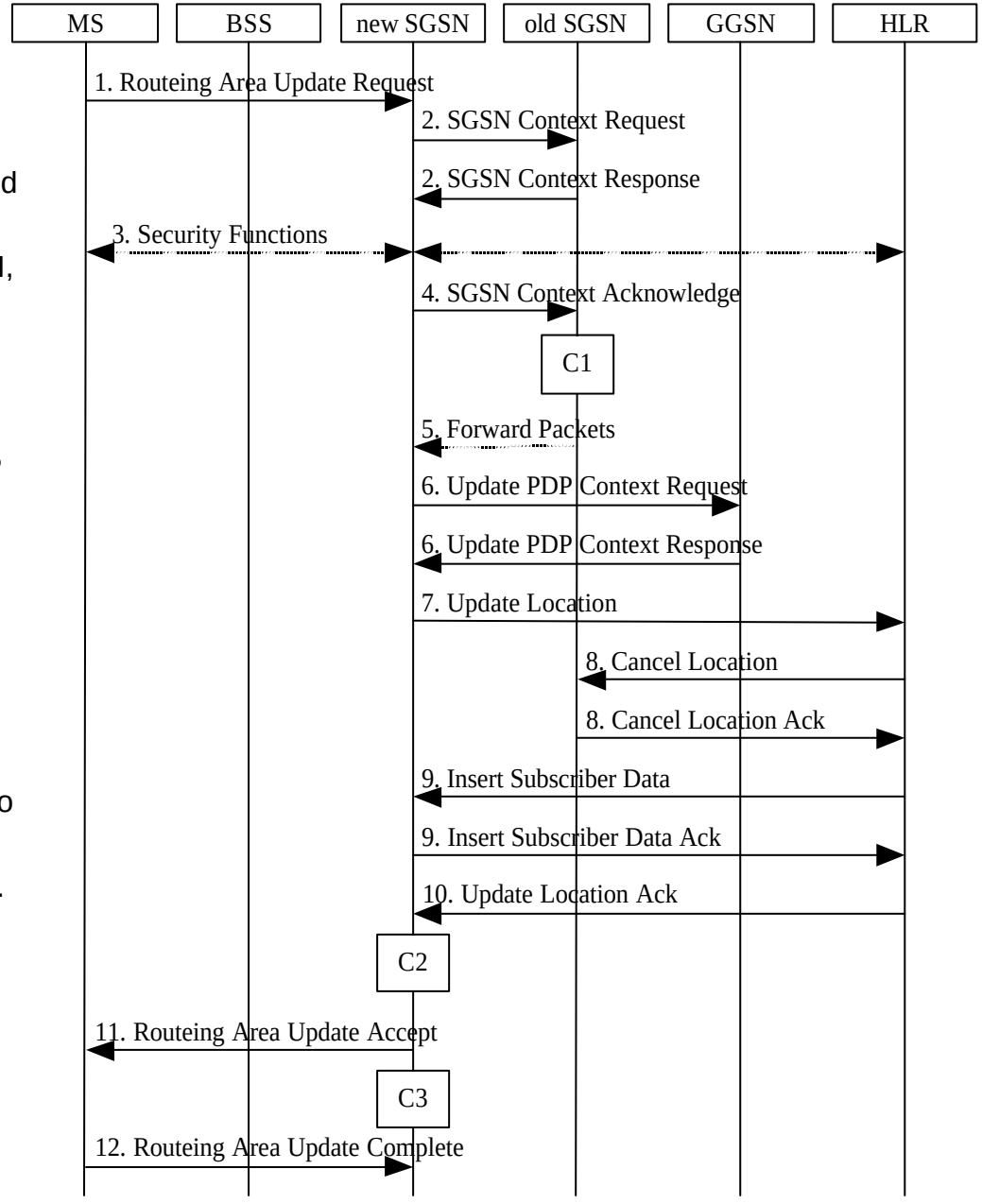


# IP Mobility

**Two types of mobility are distinguished**:

- Personal: Refers to a user moving to a different terminal and remaining in contact. 3G networks have a form of personal mobility, because users can remove their SIM card and put it in another terminal. For others access technologies as WLAN Session Initiation Protocol (SIP) is recommended.
- Terminal : Refers to a mobile to changing its point of attachment to the network. This is where we are concentrating in this study.

**The problem of IP Mobility:**

- Solve the problem at Layer 2 - This view holds that the problem is one of mobility to be solved by a specialist layer 2 protocol, and that the movement should be hidden from the Ip layer. *Such protocols can be fast, they do not scale to large number of terminals and the solution is for a particular layer 2, so inter-technology hand-over will be hard*
- Solve the problem at application layer - This view similarly holds that Ip layer should not be affected by the mobility, but instead solves the problem above Ip layer. *The implementation of DNS need to be changed and some applications and protocols need to be changed*
- Solve the problem at the Ip layer – This view holds that Ip mobility is a new problem that requires a specialist solution at the Ip layer. *Since IP layer is about delivering packets, then from purist point of view, the IP layer is the correct place to handle mobility. From practical point of view, it should then mean that other Internet protocols will work correctly (TCP,RTP)*

# Terminal Mobility

**Two types of terminal Mobility are consider**:

- Micromobility: Usually is referred to a mobility within the same administrative domain (AD). In this case a mobile host does not need to be re-authenticated because both access networks belong to the same administrator. The same IP address can be used because Ip address is own by the same administrator.
- Macromobility : In this case the mobile is moving from one administrative domain (AD) to another. This implies re-authentication, because the security/trust relationship is much weaker between Ads than within one, a different Ip address must be used, issues as speed and performance of the handover are less relevant and there is not guarantee of mobility support in the new AD.

The access network and AD may correspond to each other, but they may not; for example operator could design an AN on technical grounds. Looks like macro mobility protocol is fully adequate to handle this.

Macromobility can be named as inter-access network mobility.

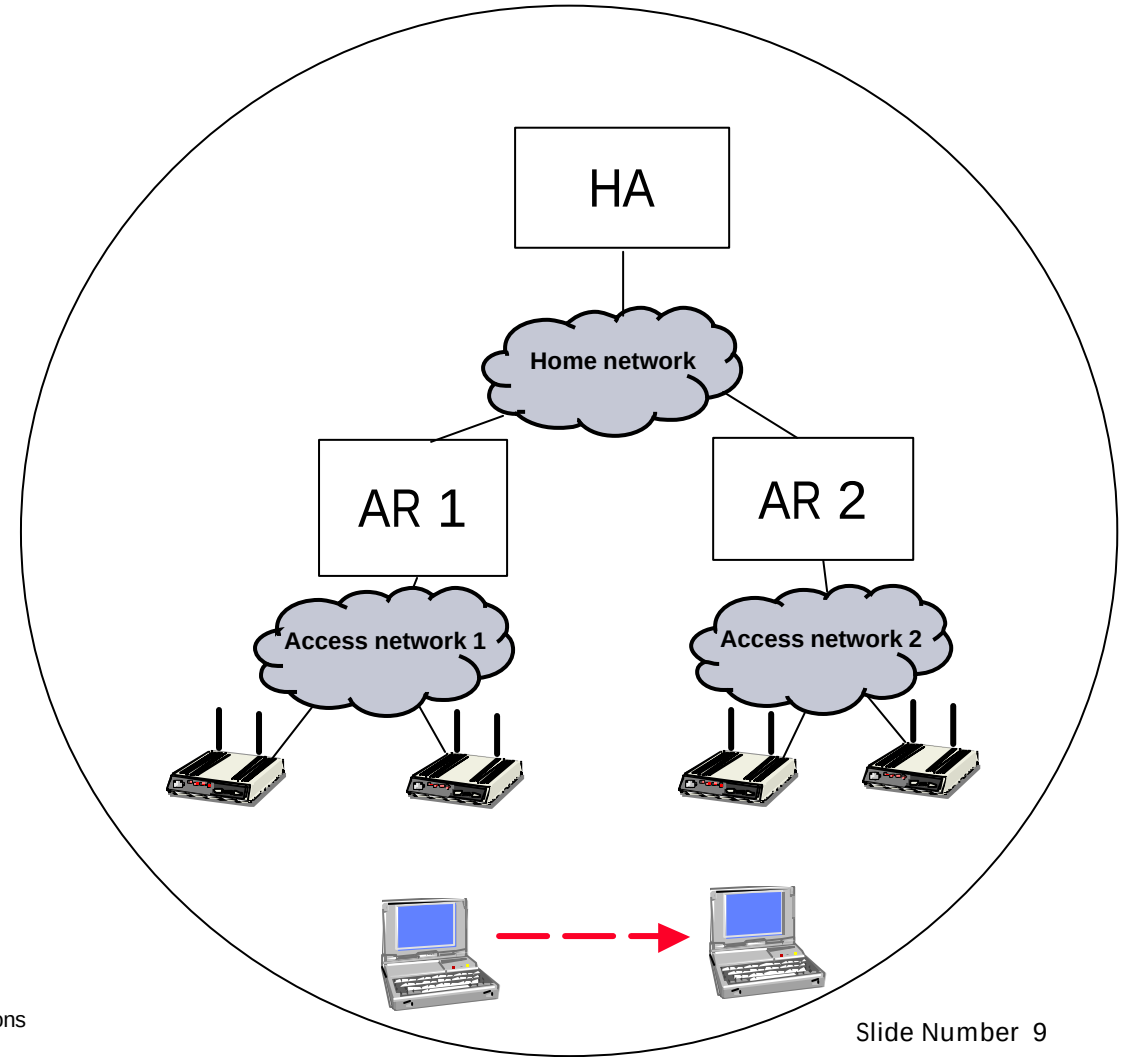
# Mobile IP- Solution for Terminal Macromobility

- The best-known proposal for handling macromobility handovers.

The Key functional entity in IP Mobile is the Home Agent (HA), which is a specialised router that maintains the mapping between a mobile's home and Care of Addresses (CoA)

Each time the mobile moves on to a new access network, it obtains a new CoA and register it with the HA.

Between mobile and HA usually IP-in-IP encapsulation is used.



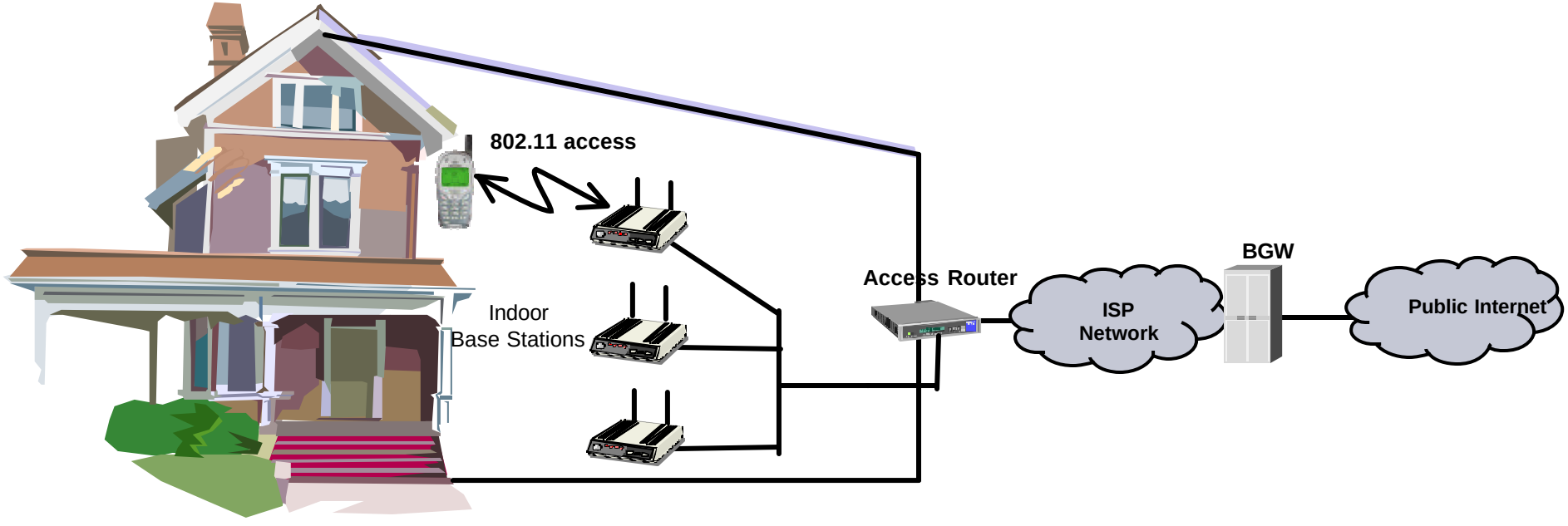
# Terminal Micromobility

There has been a huge amount of work on the micromobility problem, with many different ideas and protocols suggested. Broadly speaking, there are two ways of dealing with micromobility:

1. ***Mobile IP based schemes***: These extend basic mobile IP. They are characterised by the use of tunnelling, and in general the mobile acquired a new CoA each time it moves. Two complementary threats of work:
   - *Local Mobility Agents:* They assume that IP's problems arise only from the potentially long distance signalling back to the HA when the mobile is moving.
   - *Fast and Smooth*: This refers to a variety of tricks introduced to try to make mobile IP handover seamless. The main steps are to acquire a new CoA that the mobile can use as soon as it moves to the new AR, and to build a temporary tunnel between old and new AR.
2. ***Per-host Forwarding schemes:*** These introduce a dynamic layer 3 routing protocol in the access network (AN). In general, the mobile keeps its CoA whilst is remains in the AN.
   - *MANET-based schemes:* Where originally designed for Mobile Ad hoc NETworks, where both host and routers are mobile, i.e. there is not fixed infrastructure and the network topology change often.
   - *Multicast-based schemes:* The basic idea is that the protocol builds a multicast cloud centred on the mobile hosts current location but which may also cover where it is about to move to.

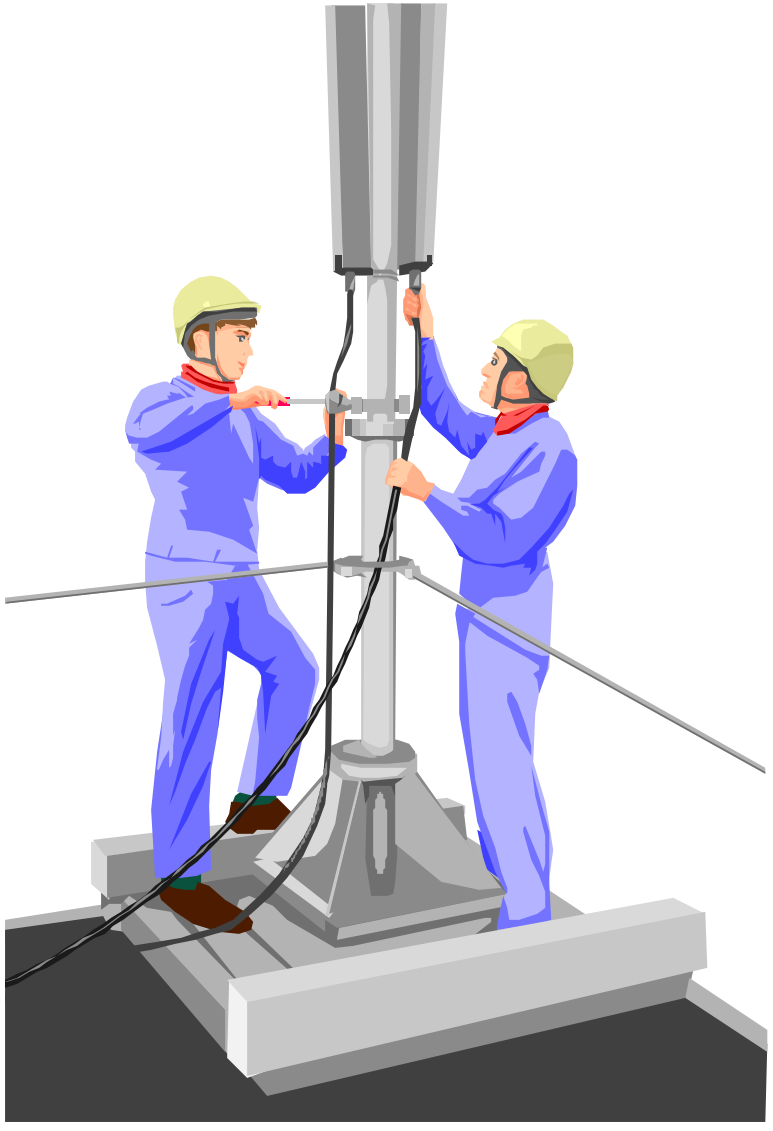
# Current WLAN Mobility

1. In some of current WLAN systems mobility between access points (AP) is supported with a limitation that AP should be under same access router (AR). Layer 2 mobility (inter access point protocol) can be uses because the APs belong to the same sub-network.
2. Mobility Management as a concept is not supported in current WLAN systems.



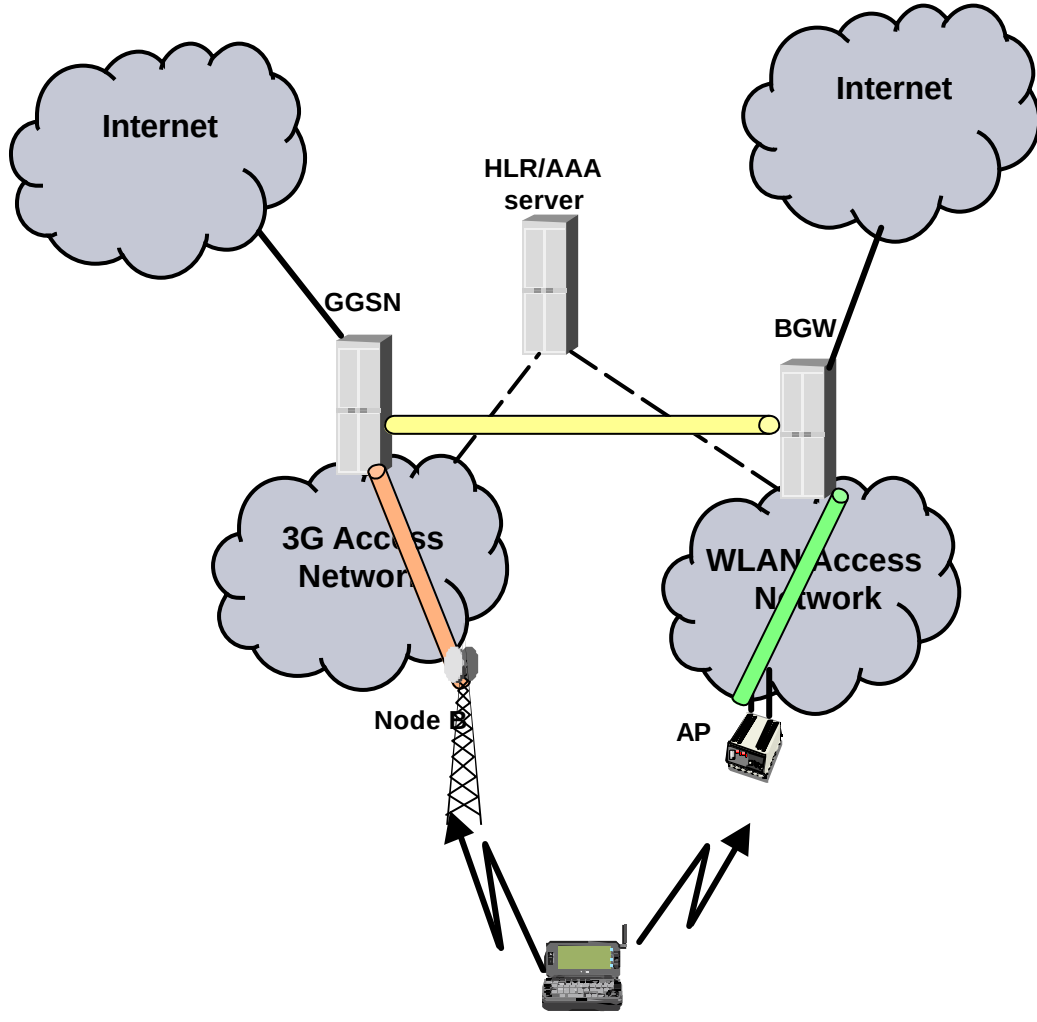
# Mobility between 3G-WLAN networks (1)

- Pre conditions:
  1. Mobile Station is capable to have active connections with 3G and WLAN at the same time
  2. MS is capable to uses several Ip addresses.
  3. 3G network support always on PDP context.
  4. Border gateways support IP-in-IP or GRE tunnel.
  5. Destination based forwarding is uses by Routers.
  6. WLAN is using Mobile IP for macromobility.



# Mobility between 3G-WLAN networks (2)

- Scenario 1: WLAN and 3G access networks are own by the same operator. End user is an Operator customer




In this case the GGSN could act as HA and the BGW as FA.

HLR/AAA server is responsible for the authentication of the MS for each access network.

In this case is very easy to implement a propriority interface between BGW and GGSN

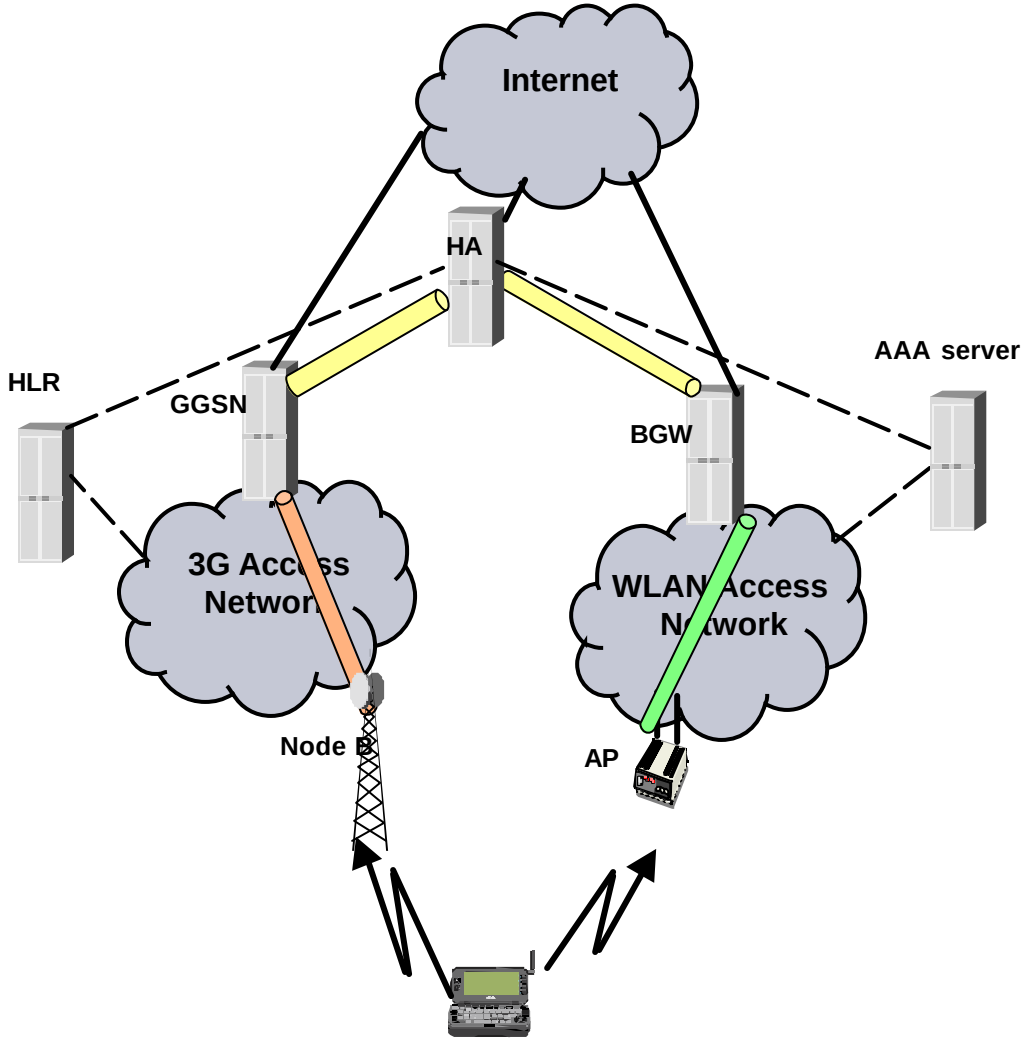
# Mobility between 3G-WLAN networks (3)

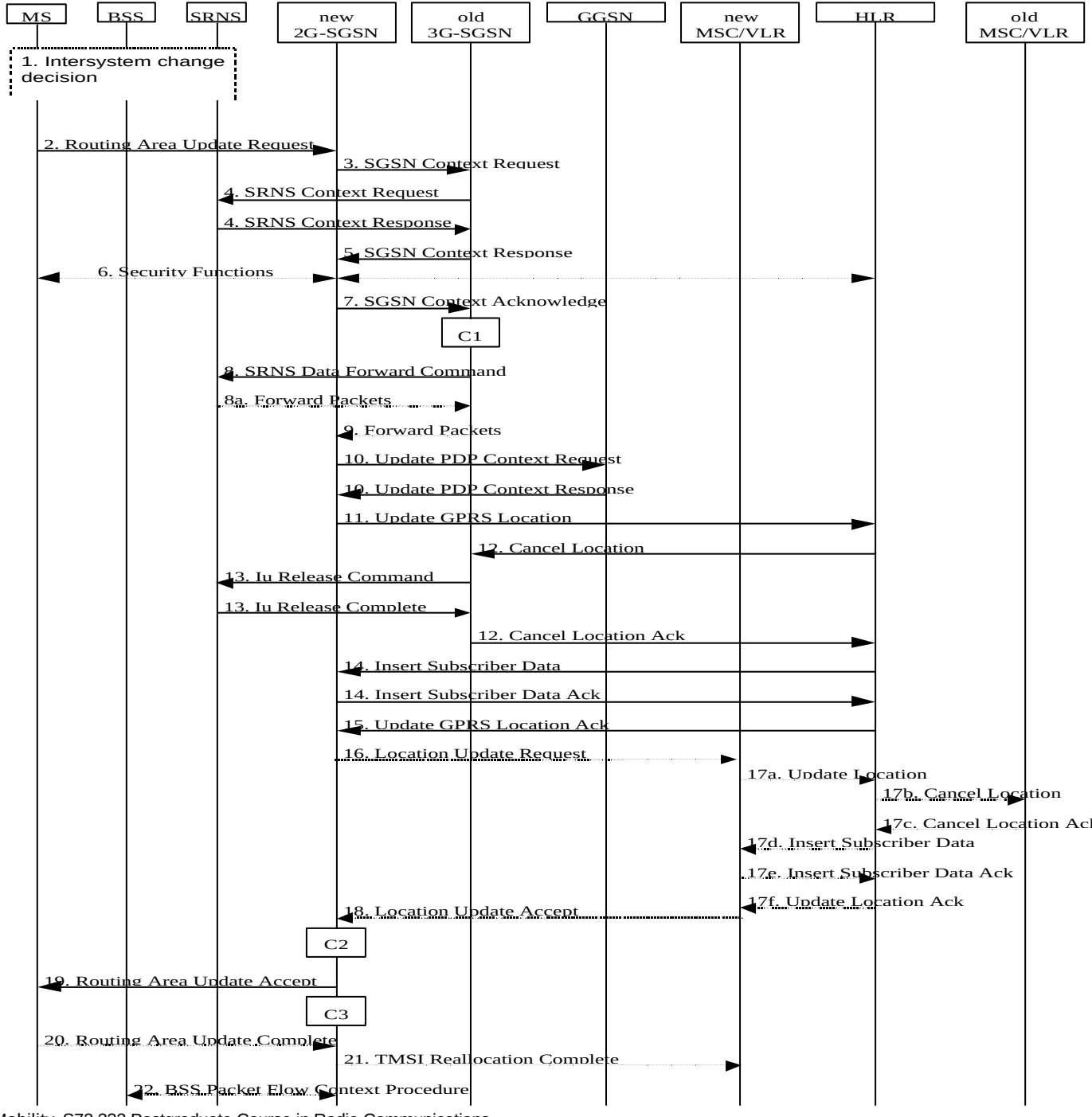
- Scenario 1: WLAN and 3G access networks are own by different administrators.

In this case authentication shall be done for each access network and for the common access separated

Using this architecture is up to the MS through which access network he/she wants to access Ip services. MS could uses HA only for services that are needed independent from the access network

As in the previous case routing optimisation could be uses




MS
BSS
SRNS
new 2G-SGSN
old 3G-SGSN
GGSN
new MSC/VLR
HLR
old MSC/VLR
1. Intersystem change decision
2. Routing Area Update Request
3. SGSN Context Request
4. SRNS Context Request
4. SRNS Context Response
5. SGSN Context Response
6. Security Functions
7. SGSN Context Acknowledge
C1
8. SRNS Data Forward Command
8a. Forward Packets
9. Forward Packets
10. Update PDP Context Request
10. Update PDP Context Response
11. Update GPRS Location
12. Cancel Location
13. Iu Release Command
13. Iu Release Complete
12. Cancel Location Ack
14. Insert Subscriber Data
14. Insert Subscriber Data Ack
15. Update GPRS Location Ack
16. Location Update Request
17a. Update Location
17b. Cancel Location
17c. Cancel Location Ack
17d. Insert Subscriber Data
17e. Insert Subscriber Data Ack
17f. Update Location Ack
18. Location Update Accept
C2
19. Routing Area Update Accept
C3
20. Routing Area Update Complete
21. TMSI Reallocation Complete
22. BSS Packet Flow Context Procedure

# Summary

- 3G networks were designed for a big range of mobility.
- IETF has made a big effort to solve the mobility problem for wireless access.
- Mobile IP with a combination of SIP protocol and later 2 mobility has been studied.
- Mobile IP based architecture for mobility between 3G and WLAN has been analysed.
- Anyhow is not clear the business case for the handover between theses two access technologies (3G-WLAN).

# References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4. 3GPP, “Group Services and Systems Aspects; 3GPP systems to Wireless Local Area Network (WLAN) Interworking; System Description (release 6)“, TS 23.234 v2.4.0

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6. ftp://ftp.3gpp.org/Specs/latest/Rel-6/23_series/ (Link for the 3GPP uses references)

# Home Work

1. In 3G network, what is the network element that is responsible for mobility management ?
2. What are the already known problems with micromobility using Mobile IP?