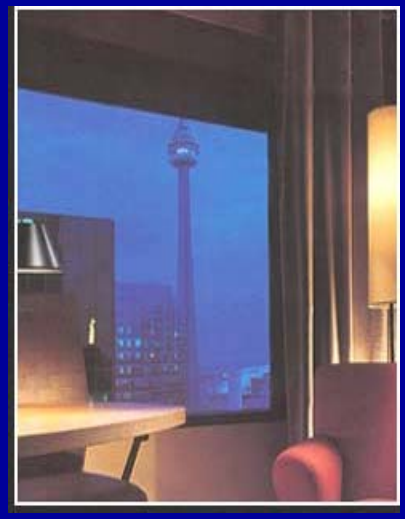
Integrating UMTS and 802.11 WLAN Networks

Muhammad Jaseemuddin

Ryerson University, Toronto, Canada

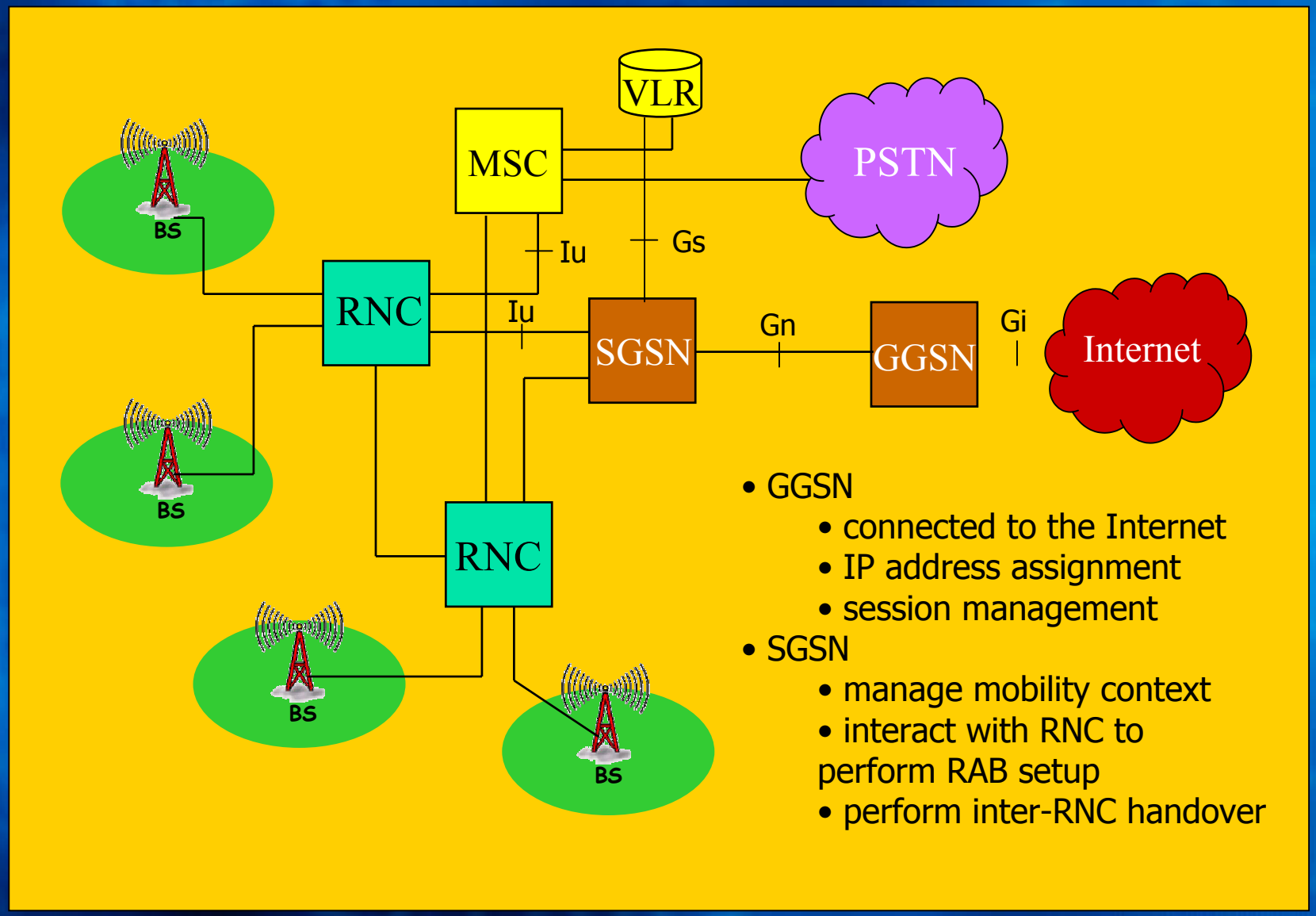
Why Cellular + WLAN?

- Cellular
  - Outdoor
  - Wide area mobility
  - Moderate to high mobility
  - Moderate bandwidth
  - High cost
  - Good for everywhere except hotspots



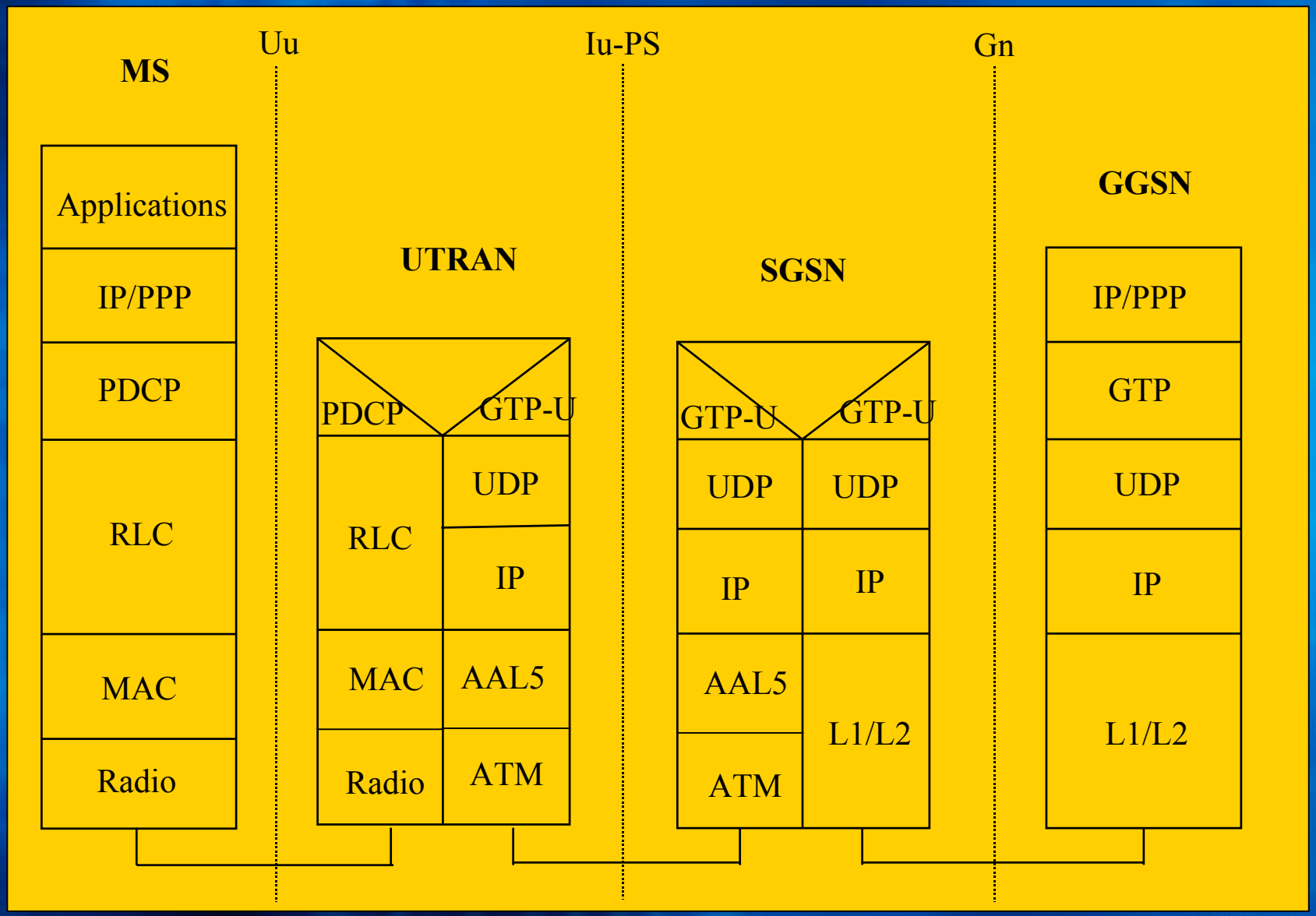
- WLAN
  - Indoor
  - Small area mobility
  - Low mobility
  - High bandwidth
  - Low cost
  - Good for hotspots of high-bandwidth activity

3G UMTS Architecture

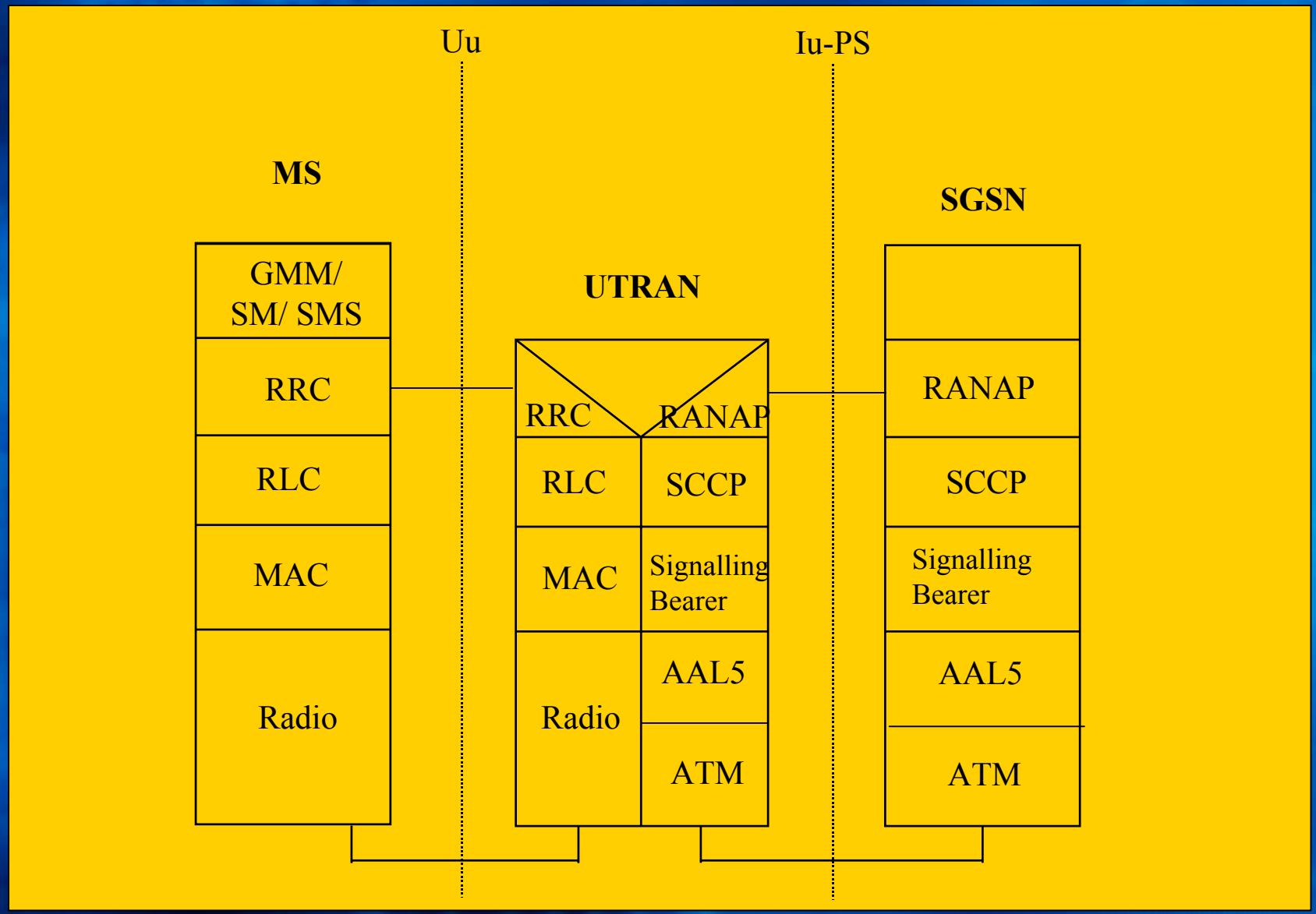


- GGSN
  - connected to the Internet
  - IP address assignment
  - session management
- SGSN
  - manage mobility context
  - interact with RNC to perform RAB setup
  - perform inter-RNC handover

GPRS User Plane Stack

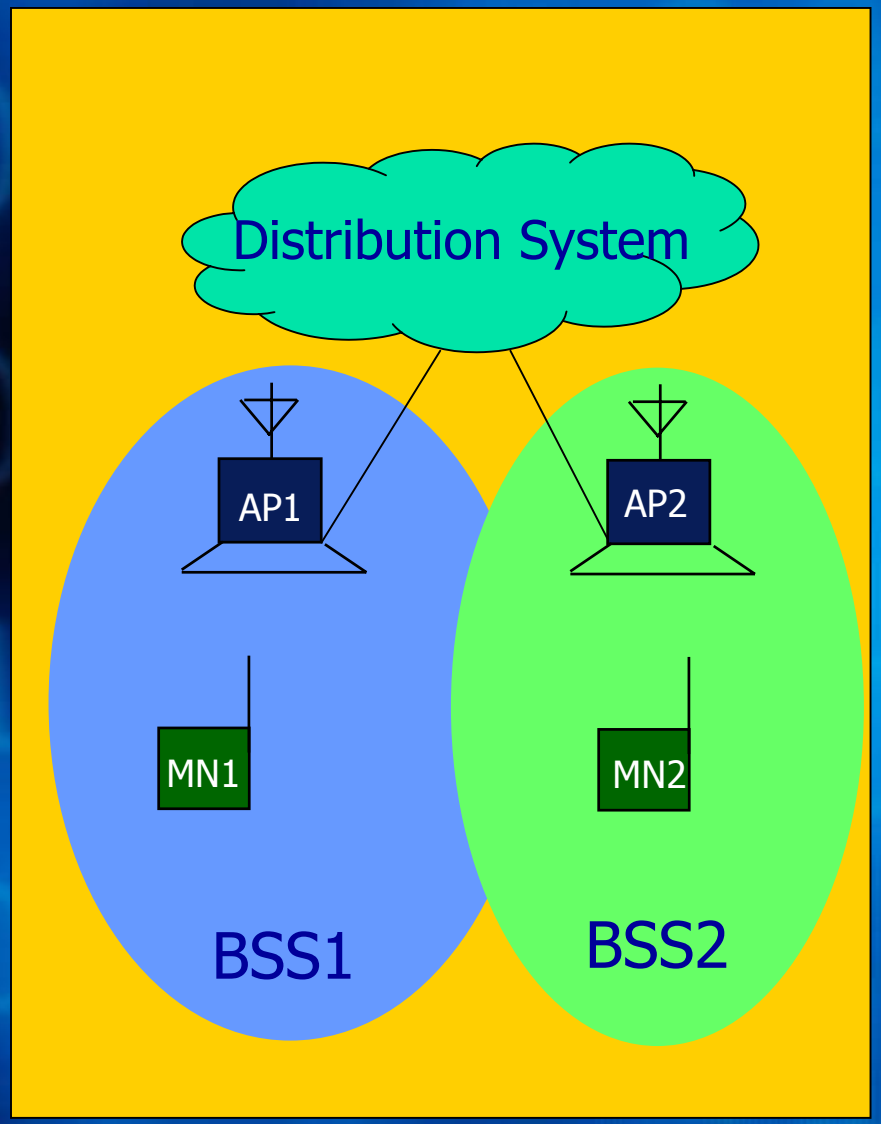


GPRS Control Plane Stack

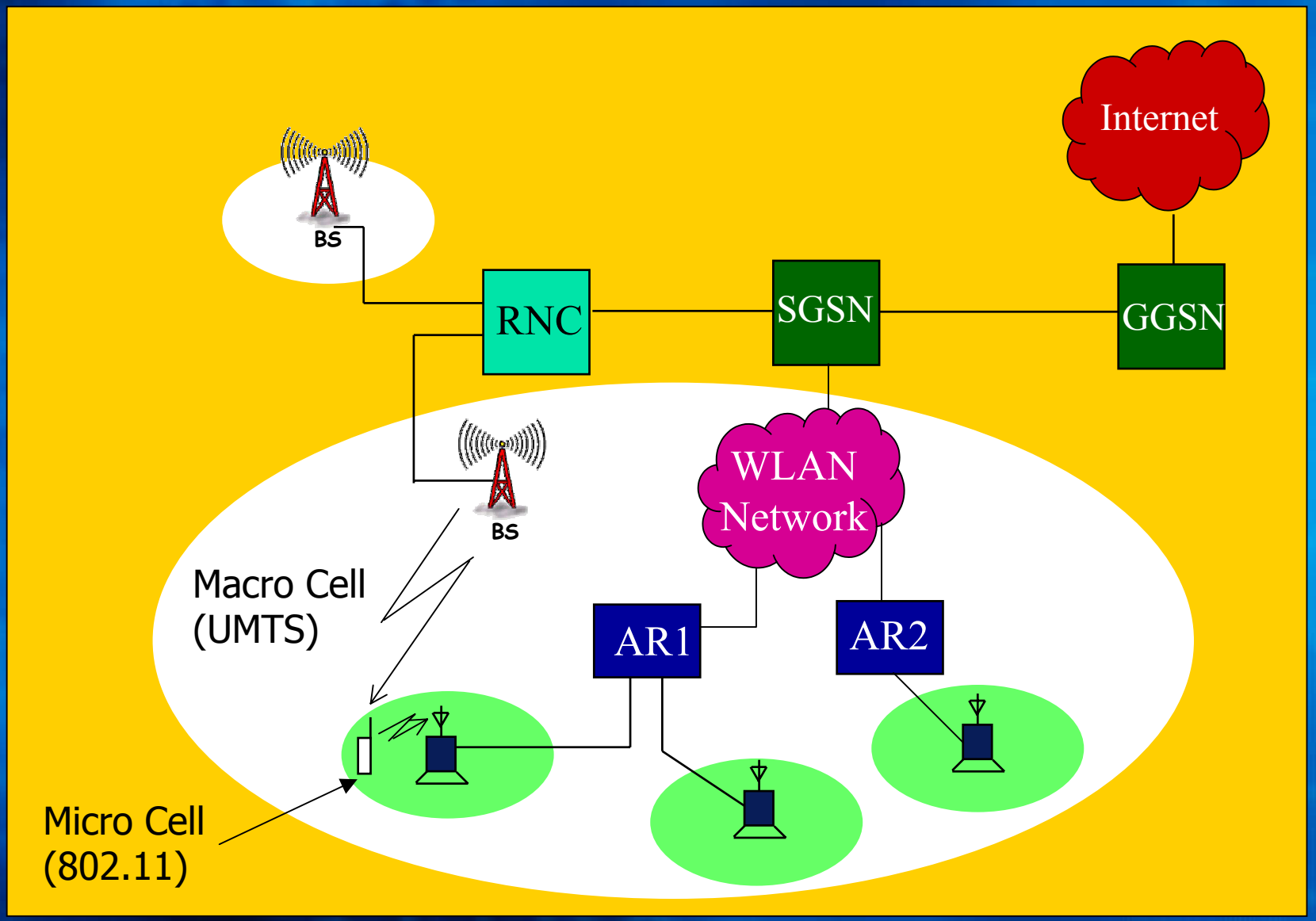


802.11 WLAN

- Infrastructure Mode
  - Association Point (AP)
    - Base station
  - Basic Service Set
    - Cell
    - 100-300 meters
  - Every MN is associated to at most one AP
- MAC
  - Distributed Coordinated Function (DCF)
    - CSMA/CA
  - Point Coordinated Function (PCF)
    - Polling
- IAPP for Roaming

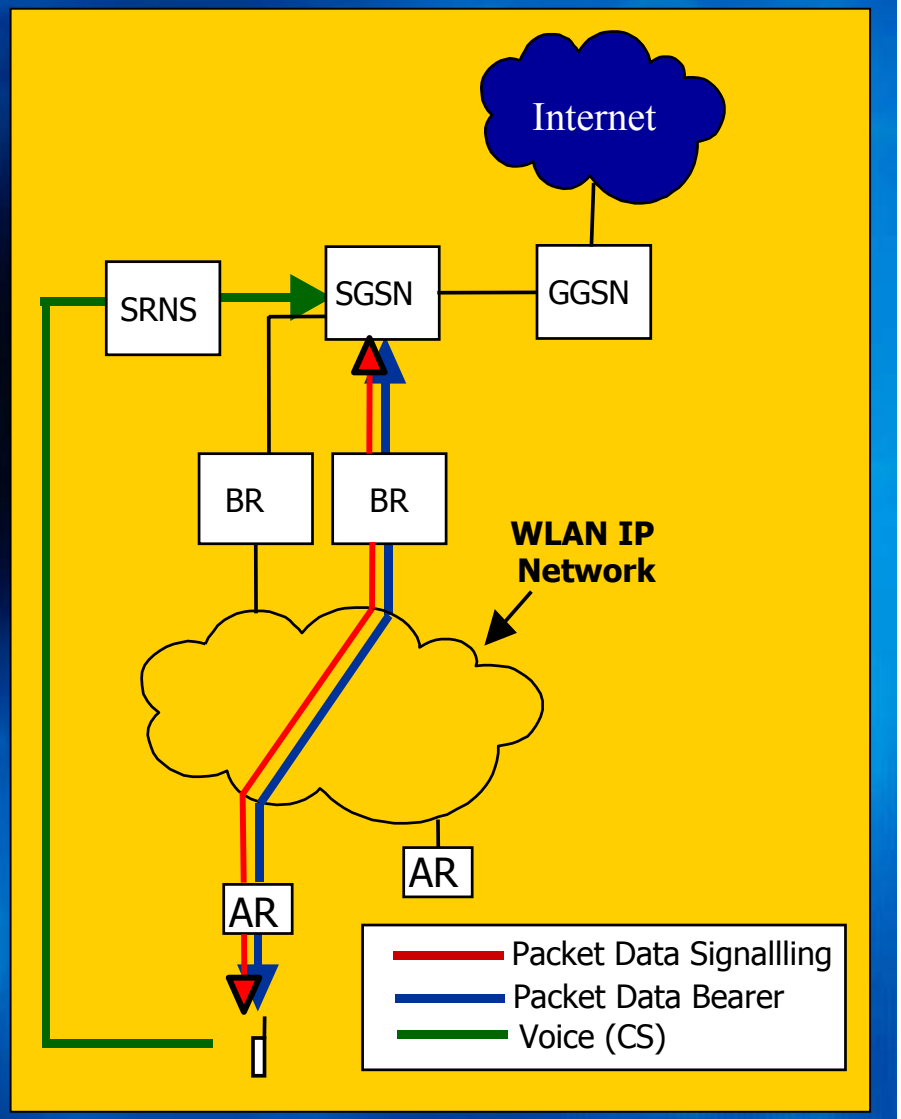


Integration Architecture



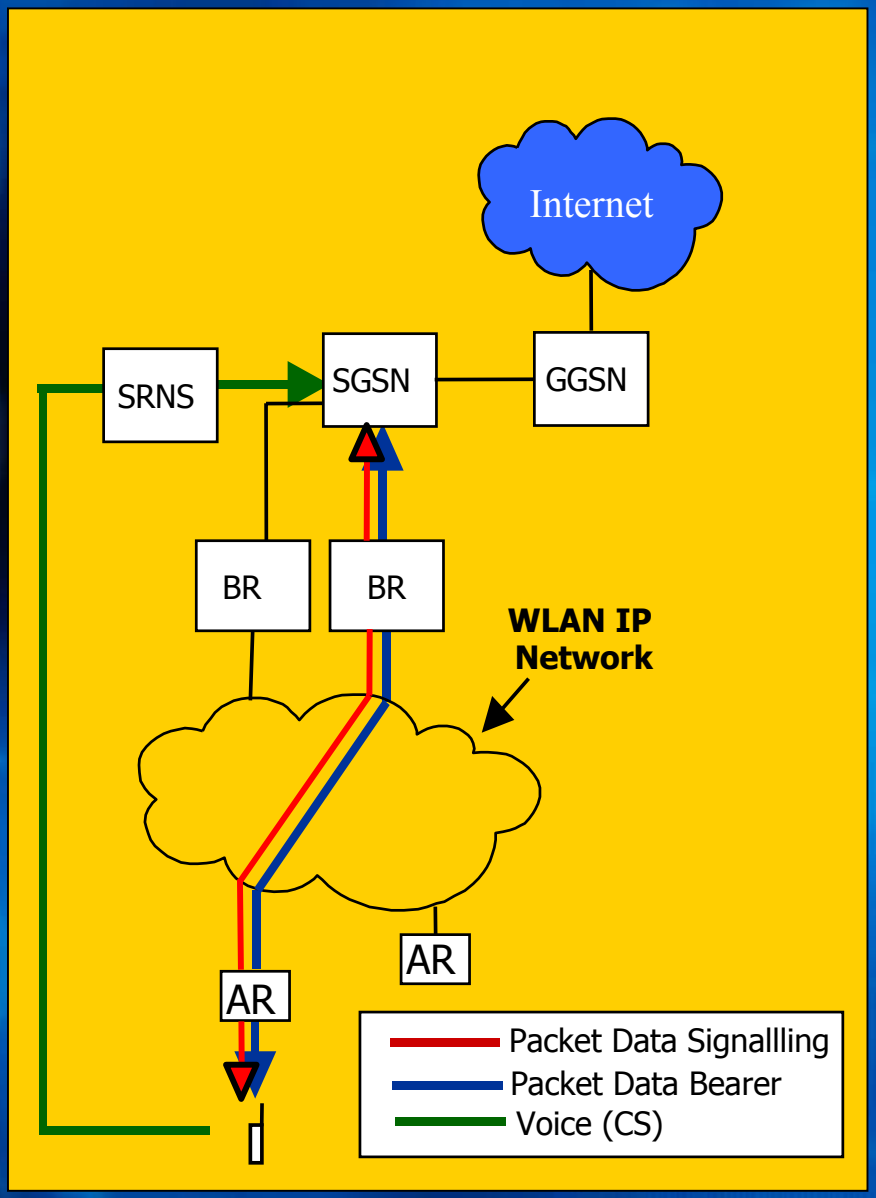
IA: Features

- WLAN is an IP network
  - All IETF standard protocols
  - IP Local Mobility Management (LMM)
- IP level integration
- SGSN is the integration point
  - SGSN maintains mobility context that can be modified to include MN's mobility state in WLAN
  - No need to update HLR/VLR when MN is in WLAN
- MN in a BSS with multiple interfaces can access:
  - Packet switched services through WLAN
  - Circuit switched services through UMTS



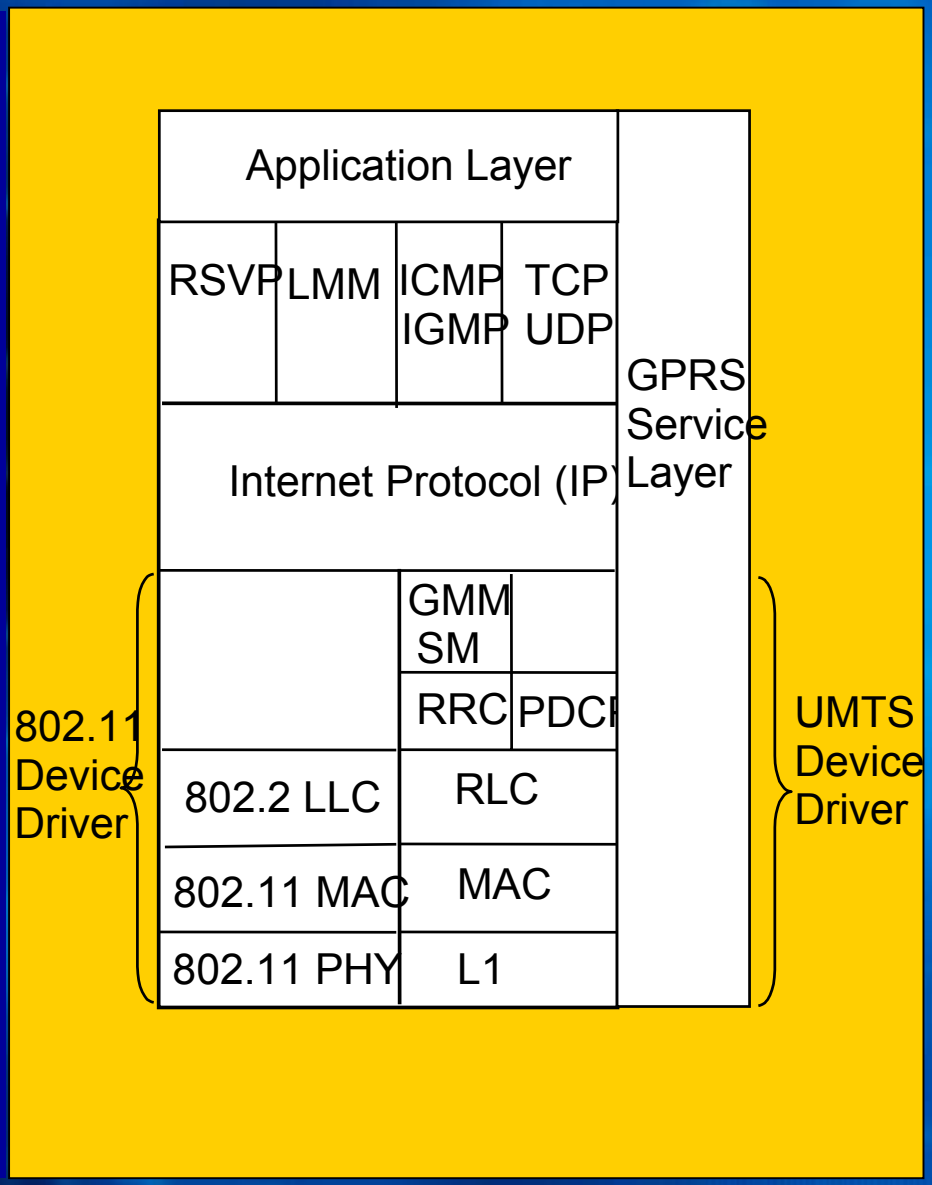
IA: Challenges

- Synchronization between SGSN and WLAN
  - For mobility management
  - For session management
- GPRS is connection oriented, whereas WLAN network is connection-less
- GPRS is a single-hop IP network and WLAN is a multi-hop IP network
- Mobility management in WLAN network is qualitatively different
  - GPRS is essentially tunneled-based
  - WLAN could be tunnel-based or routing-based
- Terminal Model
  - How to maintain connection between MN and SGSN through WLAN?



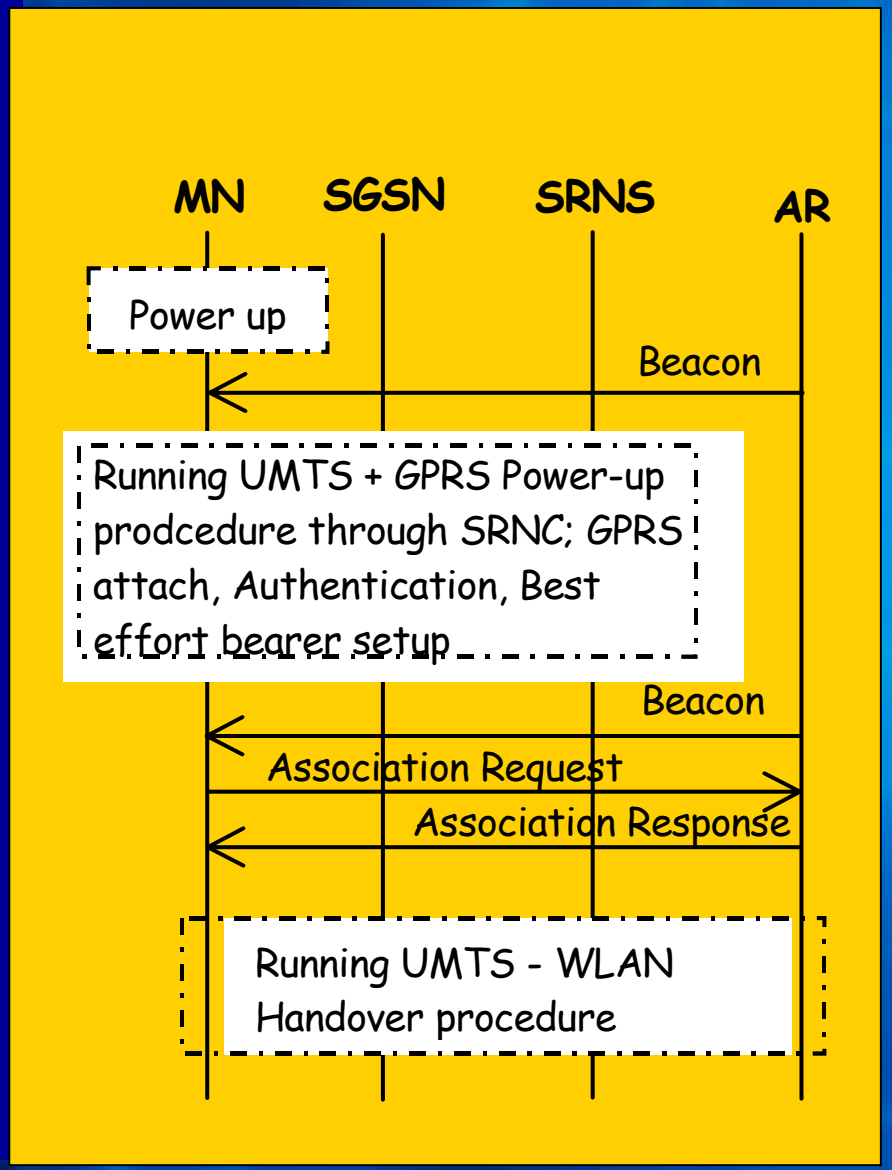
Terminal Architecture

- Mobile Node is equipped with two interfaces
  - UMTS-GPRS interface
  - 802.11 WLAN interface
- GPRS specific protocols are implemented at the device driver level
- Applications
  - GPRS applications can access GPRS-aware services through GPRS service layer
  - IP applications use IP protocols through IP stack
- Mobility Management and QoS signaling protocols
  - LMM and RSVP



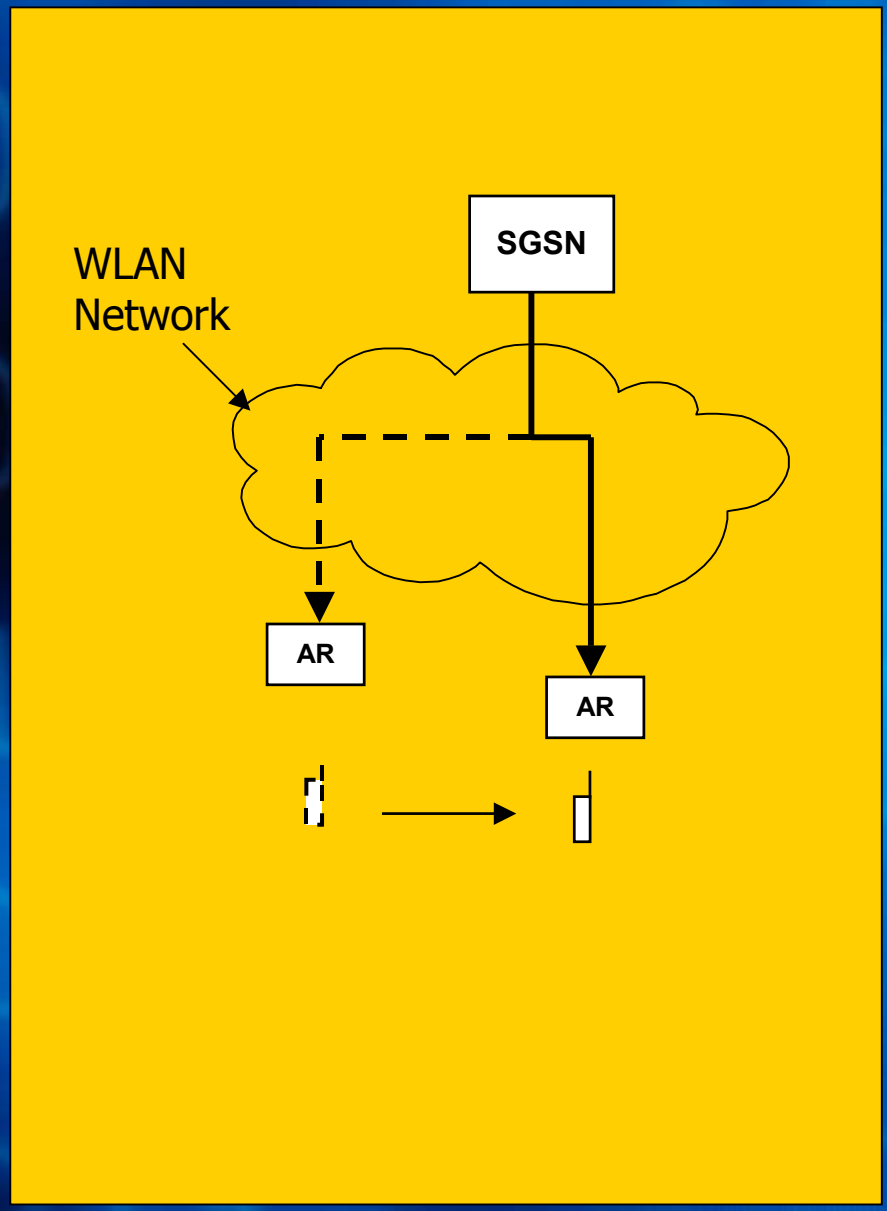
Power up Procedure

- Power up in WLAN is a two step process:
  - MN power up in UMTS cell
  - Then, handover to WLAN using inter-system handover
- UMTS AAA service can be used to authorize the user
  - Avoid duplication of AAA service
  - Get the benefit of single user management plane, especially when UMTS AAA service is moving towards using IETF standard protocols



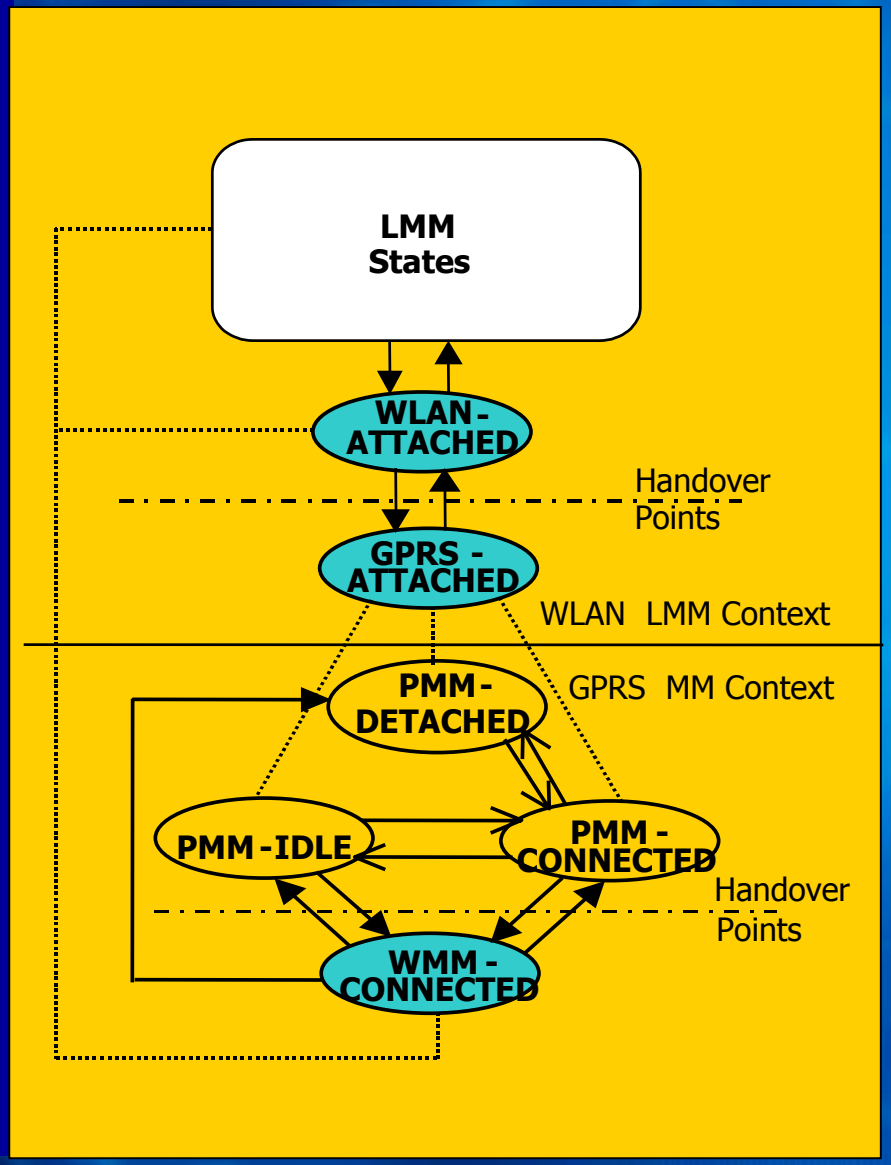
Addressing and Tunneling

- GPRS Address - Globally routable address
- WLAN Address
  - Care of Address (COA)
  - Routable from SGSN to within WLAN network (can use private IP address space)
  - Serve as GTP Tunnel End point
- Packets are tunneled between the SGSN and the mobile node
  - GTP tunnel can be used
- Downlink tunnel: GTP Tunnel from the SGSN to the Mobile Node
  - De-tunnel point could be either AR or the MN (if co-located address)
- Uplink tunnel: GTP Tunnel from the Mobile Node to the SGSN
  - Tunnel's SA is the COA and DA is the SGSN Address
- WLAN network can use any LMM protocol to ensure packet delivery to the mobile node



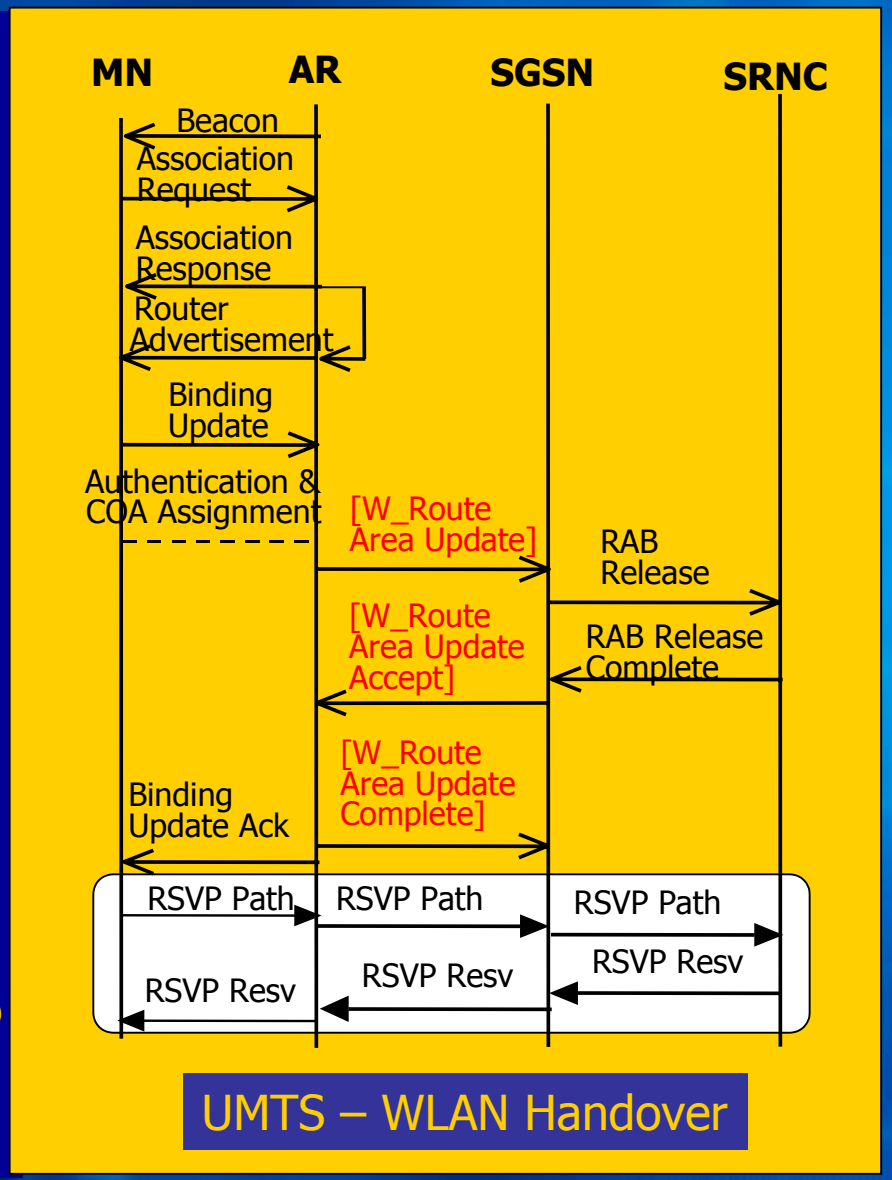
Mobility Management

- LMM state machine is augmented with two new states
  - WLAN-attached stated: a transition point from GPRS to WLAN network
  - GPRS-attached state: representing the MN is disassociated from WLAN
- GPRS state machine is augmented with one new state
  - WMM-connected state: MN is receiving PS service from WLAN, hence no RAB is set up for PDP contexts in UTRAN



UMTS-WLAN Handover

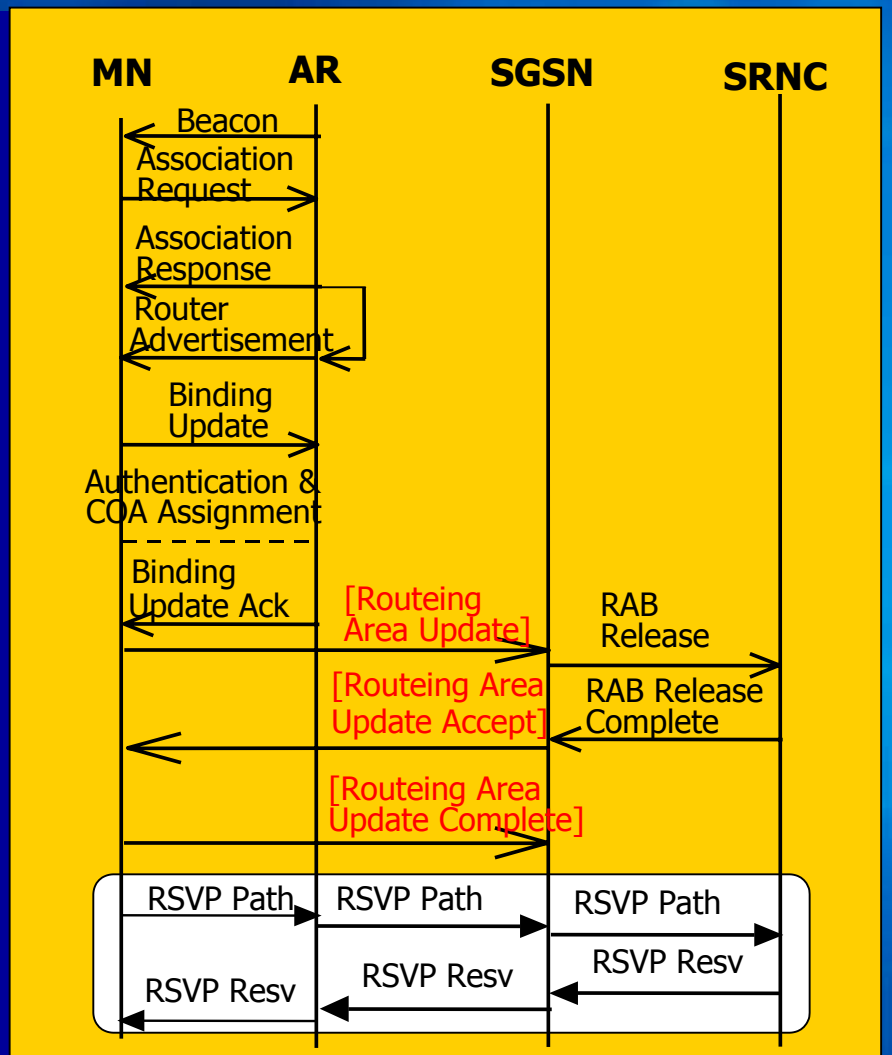
- **Handover signalling through WLAN**
  - Avoid keeping separate signalling connection through UTRAN
  - Support abrupt disconnection
- **SGSN can implement modified mobility agent functionality to allow Mobile IP signalling between AR and SGSN**
  - W_Route Area Update may not be a new signalling protocol, it may be BU with some extensions
  - It is shown differently here to show explicit transaction between WLAN and UMTS
- **Resource Reservation following HO may be required to adjust QoS parameters and acquire resources in WLAN network including 802.11 radio resources when it offers QoS**



UMTS – WLAN Handover

UMTS-WLAN Handover

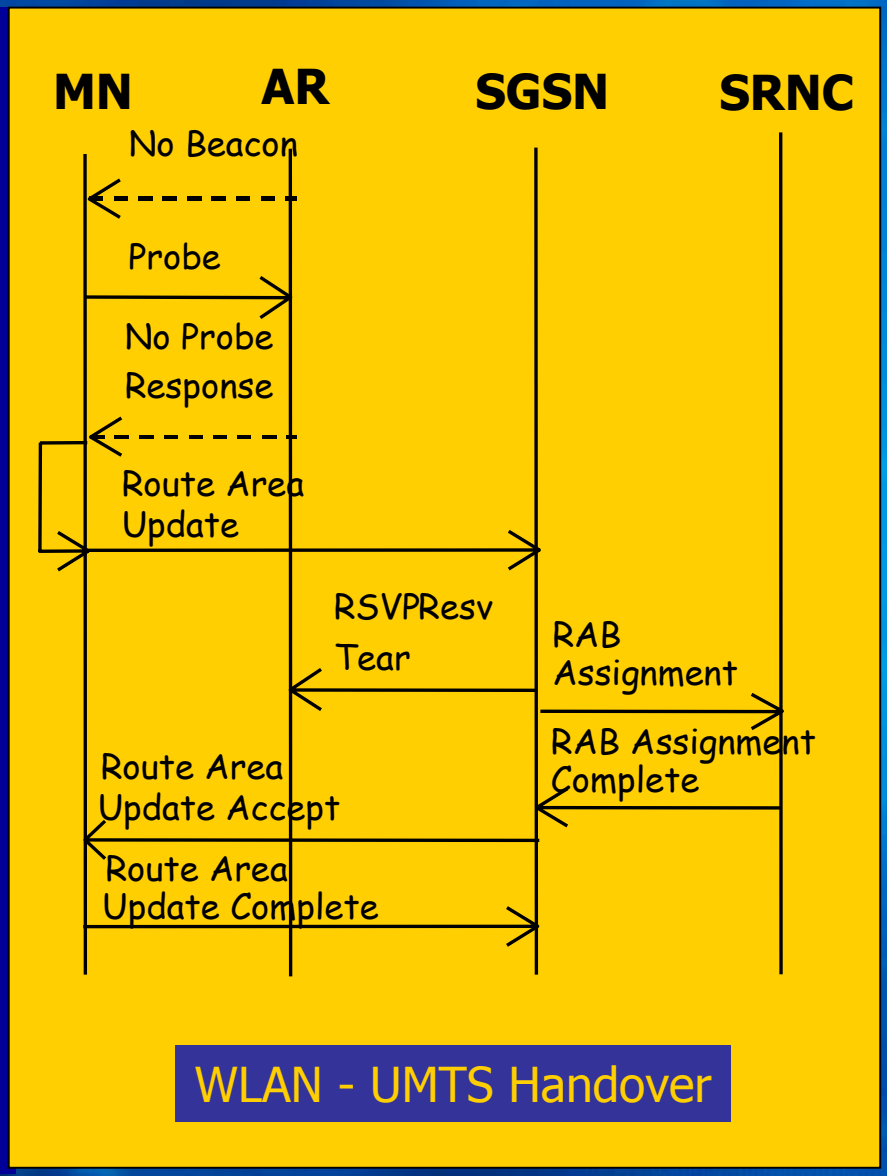
- **Handover signalling through UTRAN**
  - Minimal handover signalling
  - Use existing Iu connection
  - Avoid complicated modification into GMM implementation at SGSN
  - No further use of Iu connection with SGSN
- **SGSN implements modification into GPRS mobility function**
  - MN uses existing RRC (Iu) connection with SGSN to send Routeing Area Update
  - Routeing Area Update contains new RAI for WLAN, which causes transition to WMM-Connected state in SGSN
- **Resource Reservation following HO may be required to adjust QoS parameters and acquire resources in WLAN network including 802.11 radio resources when it offers QoS**



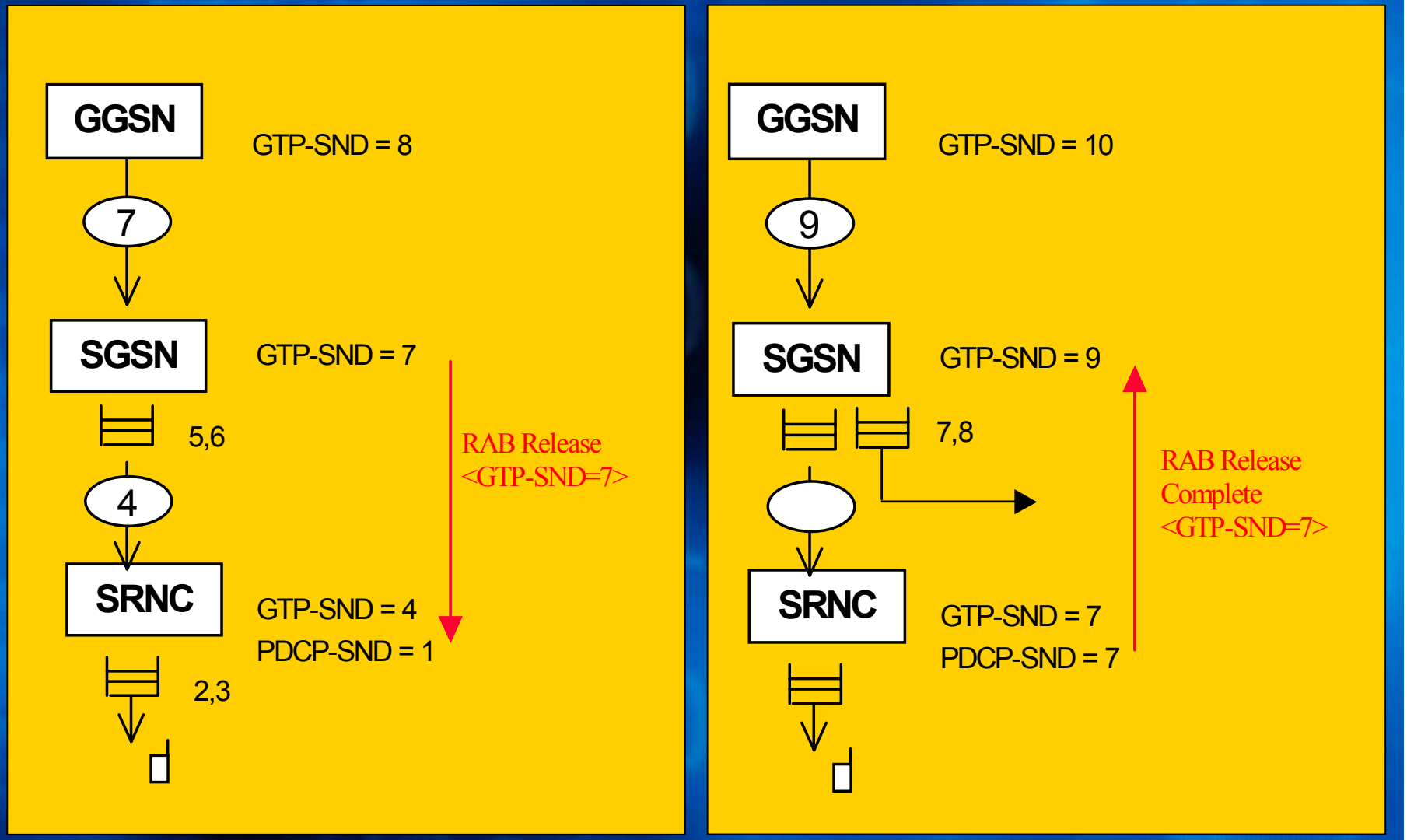
UMTS – WLAN Handover

WLAN-UMTS Handover

- When MN is out of the coverage of WLAN networks, it abruptly detects disconnection by the loss of probe and lack of probe response
  - It uses UTRAN to connect to SGSN and use Route Area Update message to initiate handover
  - WLAN network is considered as a single route area and is assigned a route area ID
- RSVP can be used inside WLAN network to manage 802.11 radio resources (when QoS is available)
- SGSN should send RSVP tear after handover to request the last serving AR (AP) to release the radio resource

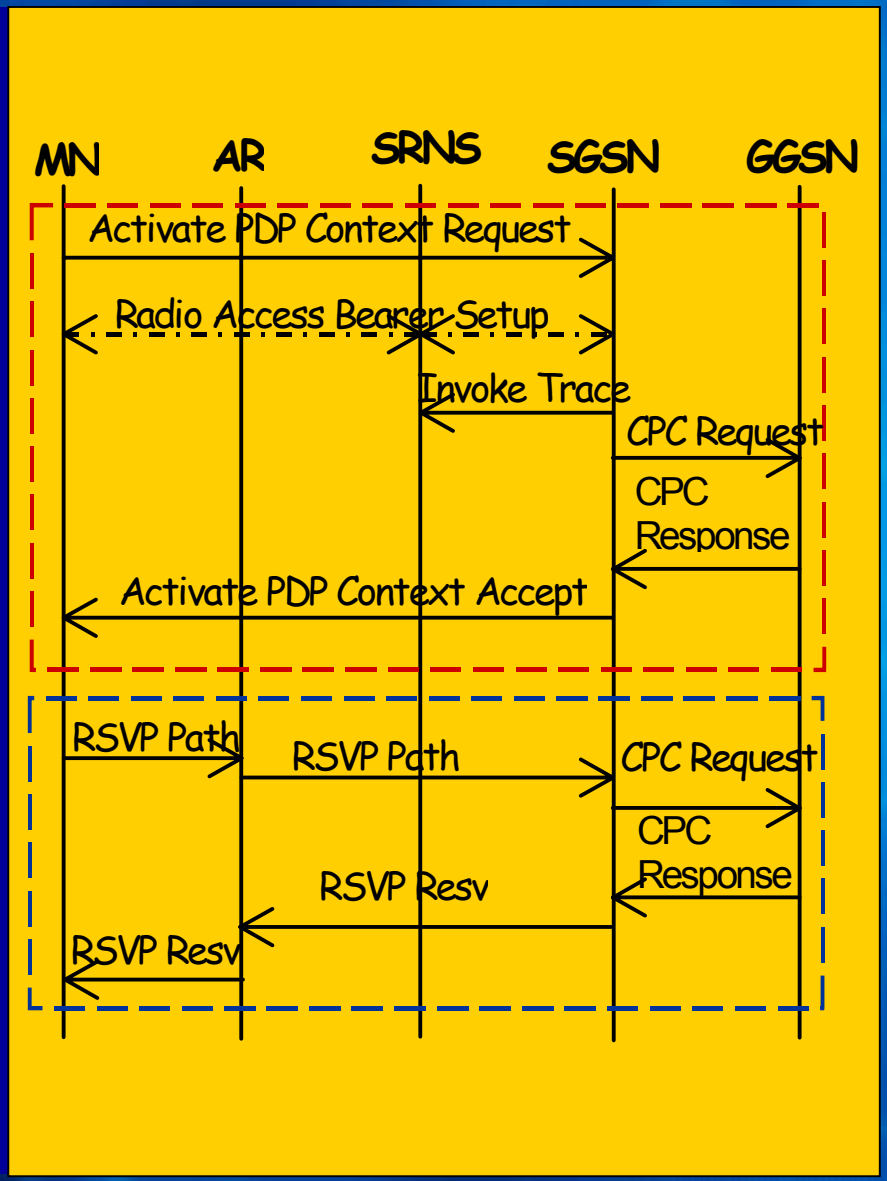


Seamless Handover



Resource Reservation

- **PDP is used for resource reservation in UMTS**
- **RSVP is used for resource reservation in WLAN IP network**
  - The use of RSVP for network resource reservation depends upon the IP network QoS model
  - Since SGSN is not involved in handover within WLAN network, it should not be the one initiating RSVP setup after UMTS to WLAN handover
  - Radio Resource can be allocated by the serving AR while processing RSVP Resv
  - SGSN uses RSVP Resv Tear to de-allocate radio resource in WLAN after WLAN to UMTS handover
- **SGSN initiates PDP context procedure after receiving RSVP Path message from MN**



Concluding Remarks

- An Integration Architecture is proposed, that provides:
  - UMTS macro cells overlaid on 802.11 micro cells
  - Access services through the networks that optimize their delivery
  - Seamless handover between two networks
  - SGSN as integration point
    - Modifications only in SGSN inside the network
    - No gateway functionality in WLAN network
      - Incurs no additional cost to WLAN network deployment
  - IP level inter-system handover
    - No GPRS specific layer-2 level inter-working function in WLAN network
    - Transparency to IP applications
    - IETF standardized protocols in WLAN networks
  - Reuse UMTS AAA infrastructure
- Future Work
  - Simulating seamless handover
  - Emulation of terminal stack
  - Quality of Service and RR in WLAN network
  - Supporting GPRS application in WLAN network