# *Mobile Communications*

## *Mobility Management*

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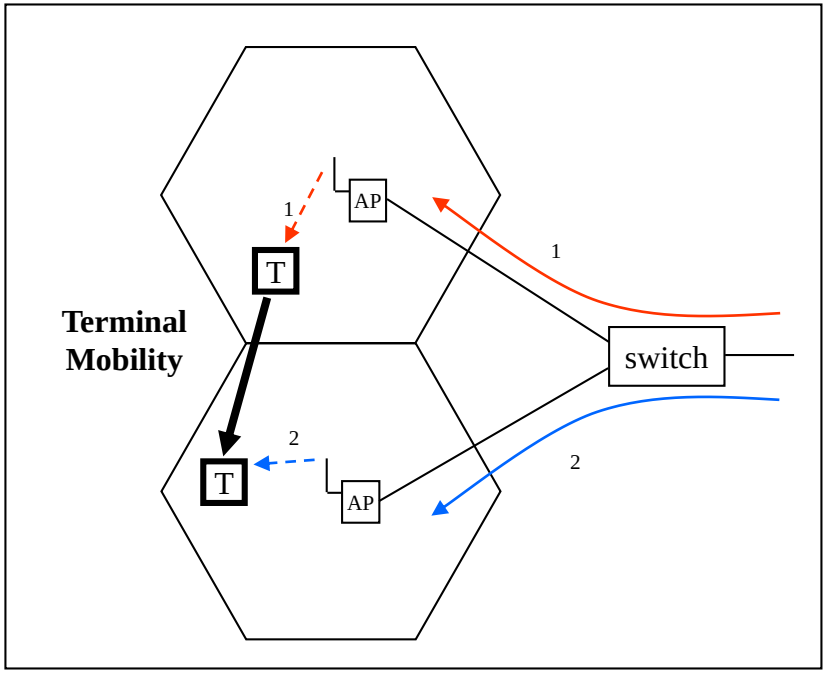
- *What is the functionality associated to Mobility Management?*
- *What are the solutions defined by IETF for micro-mobility?*
- *How is terminal mobility managed in the 3GPP networks?*

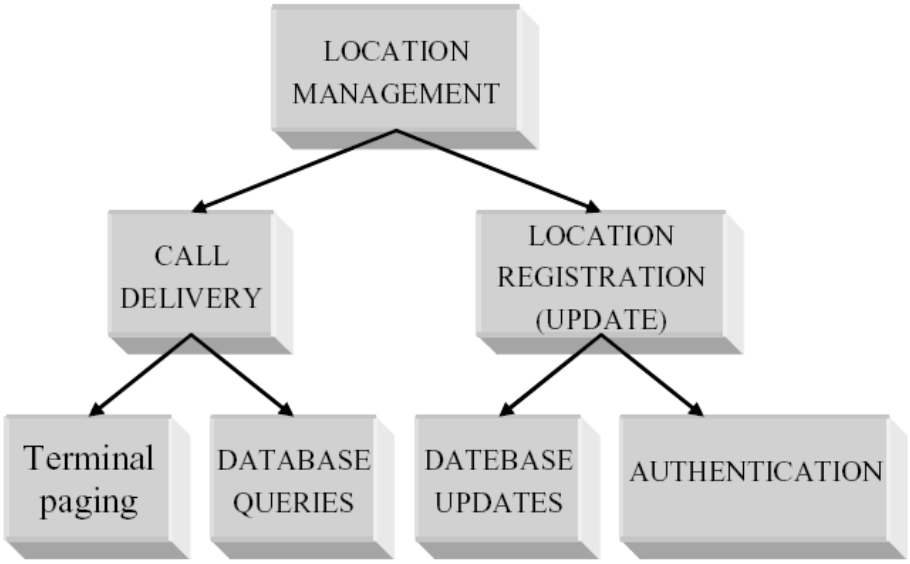
# *Mobility Management*

- Enables network to be aware of the terminal location
- Maintains the route/connection when terminal moves

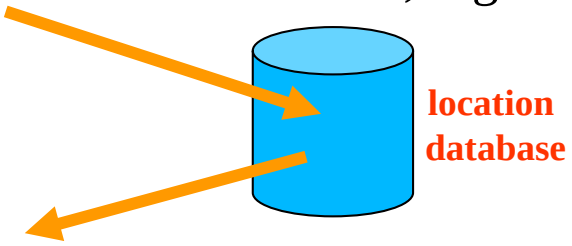
- Consists of 2 main functions
  - » Location management
  - » Handoff management



# *Location Management*




- Location registration/update
  - » Terminal informs network about its current Access Point; regularly
  - » Network updates terminal location



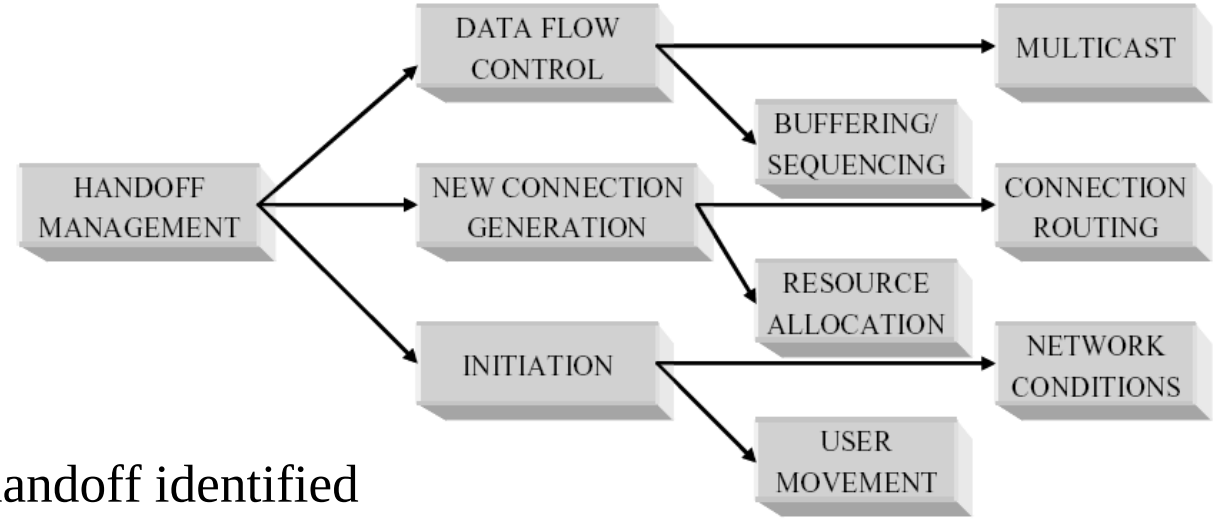

- New Call/Session delivery
  - » When a new Call/Session arrives to terminal's home network

    network is requested to find the terminal location,

    by querying location database and paging the terminal

# *Handoff Management*

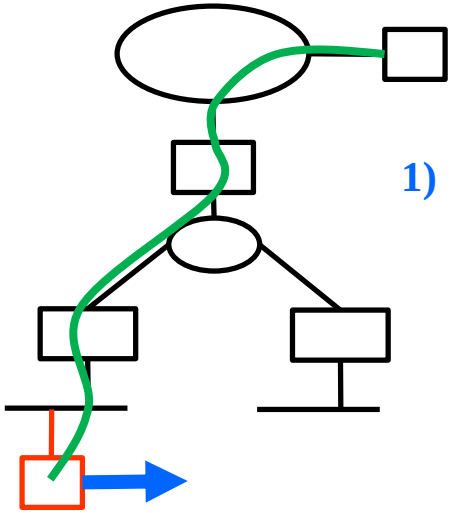
- Maintains terminal connection/routes when terminal moves



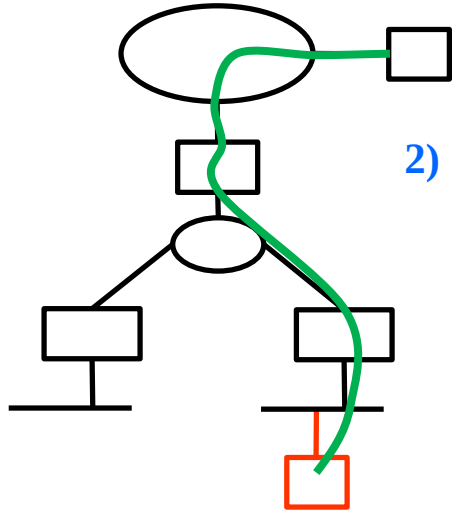

- Initiation: need for handoff identified
- New connection/route generation
  - » Radio Resources found for the handoff connection
    - – In Network-Controlled Handoff (NCHO) → the network finds the resources
    - – In Mobile-Controlled Handoff (MCHO) → terminal finds resources, network approves
  - » Routing operations performed
- Data-flow control: delivery of data from old to new path, maintaining QoS

# *Data Flow Control – Models Commonly Used (I, II)*

I)

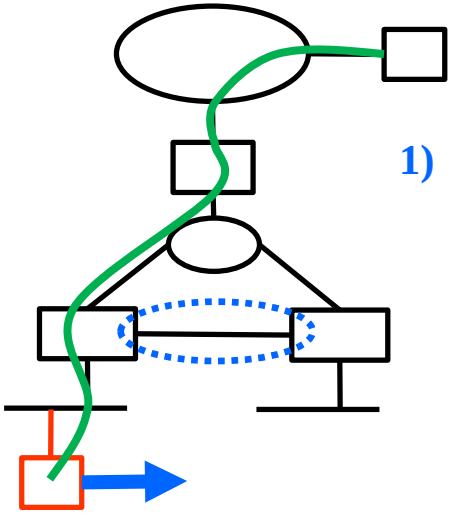


1)

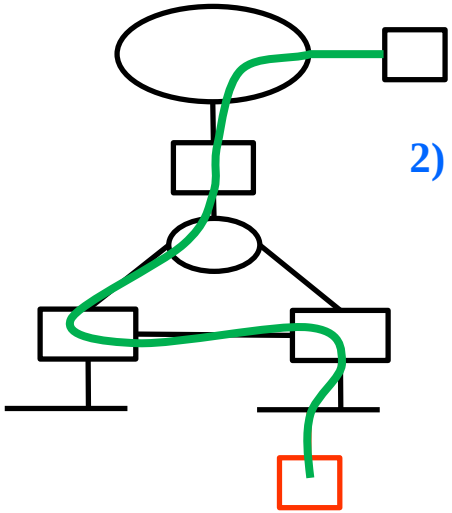


2)

II)



1)



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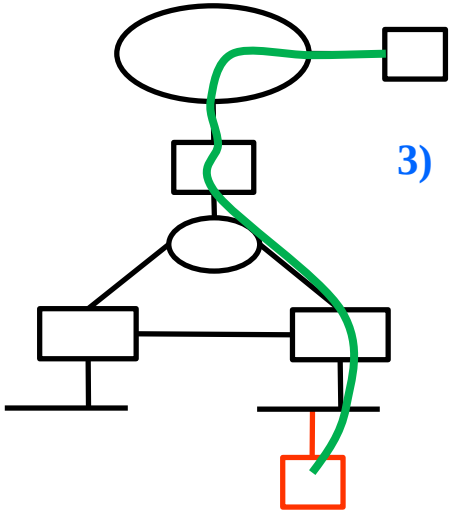
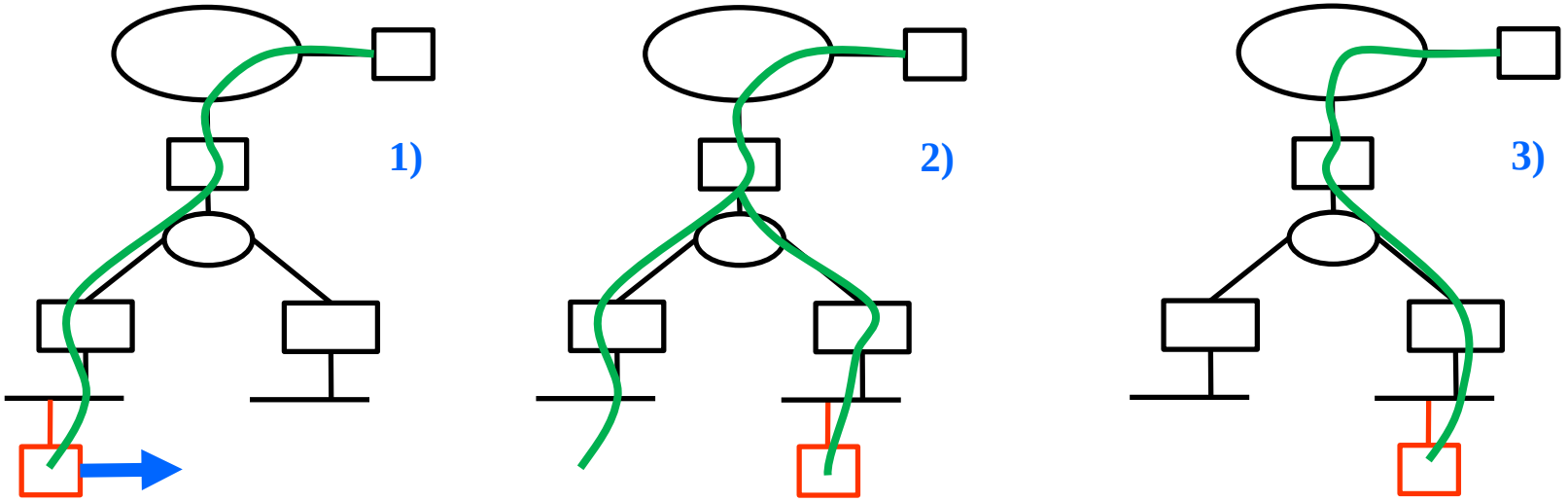


3)

# *Data Flow Control – Multicast model (not commonly used)*

III)



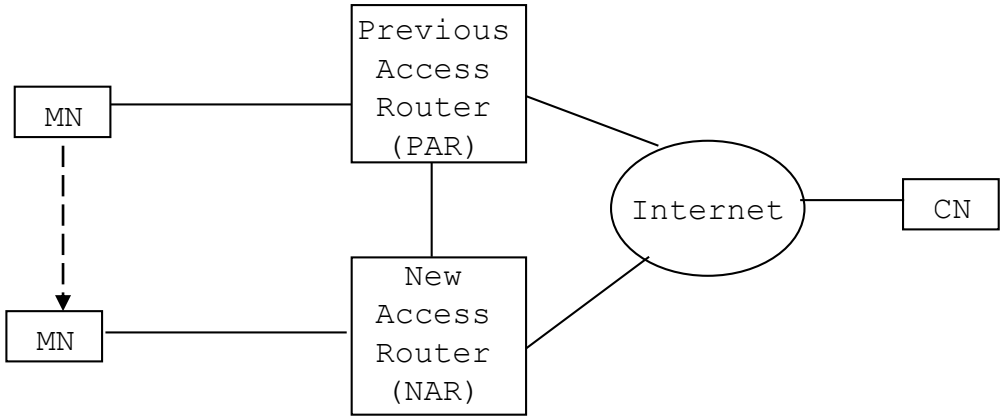
*Micro-mobility solutions defined by IETF*

# *Micro-mobility solved at the IP Layer*

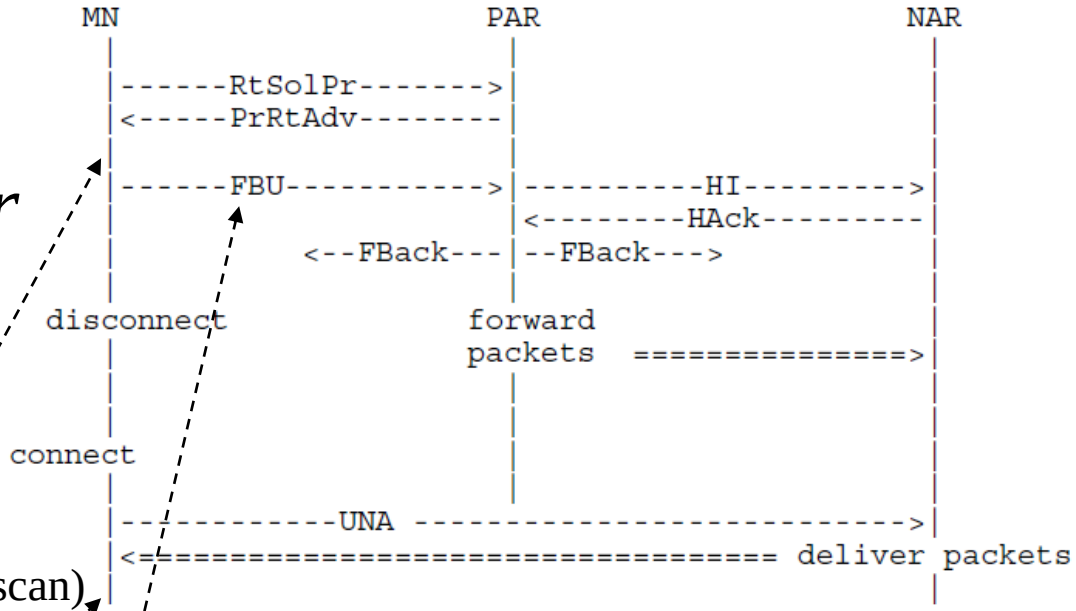
- Micro-mobility → frequent movements in an IP domain
- Problems of using Mobile IPv6 in micro-mobility scenarios
  - » Time to detect the new network
  - » Time for the terminal to configure CoA
  - » Time to update new location (BindingUpdate) in the HomeAgent
  - » Frequent movement → lots of signaling
- Micro-mobility solutions *(examples)*
  - » FastHandover
  - » ProxyMIP

# *Fast Handover in MIP6*

- MN learns about new router (NAR) while connected to previous router (PAR)
  - » Fast detection of the New Access Router (NAR)
  - » Auto-configuration of new CoA can be made while MN is associated to PAR
- MN can move to NAR and continue to use PAR
  - » By using a tunnel between NAR-PAR
  - » While BindingUpdate for nCoA (MIP6, HomeAgent, CNs) is being performed



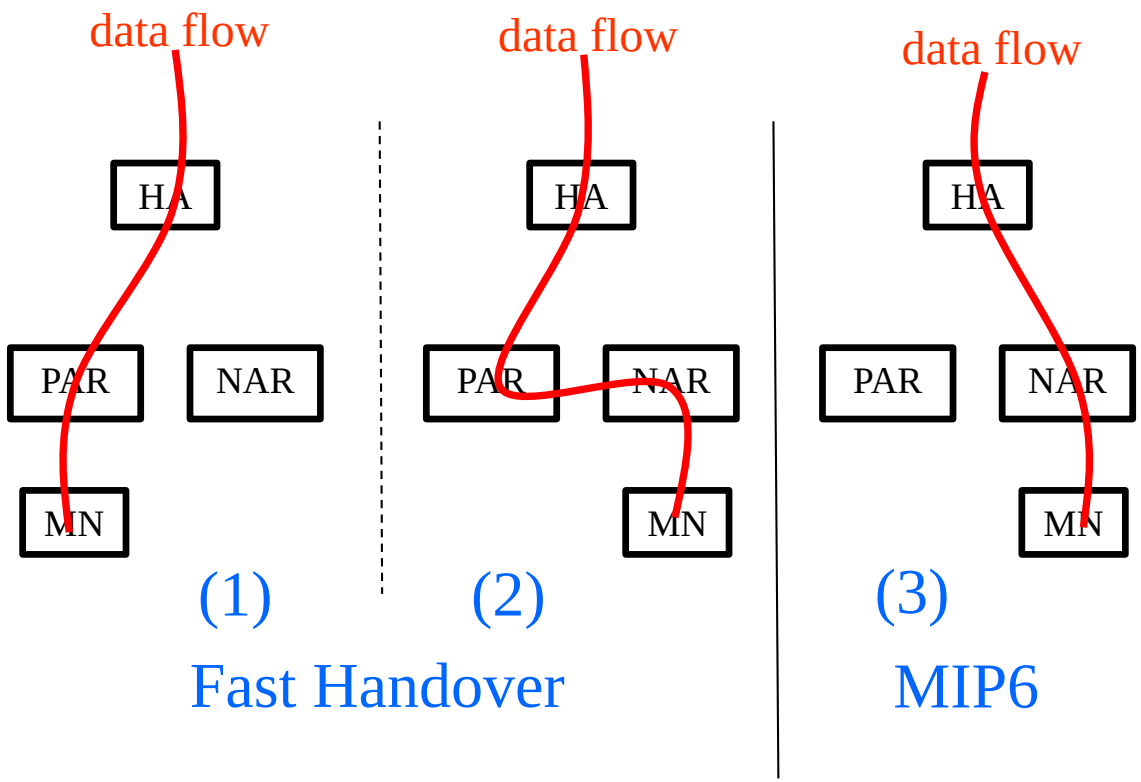
# *FastHandover – Predictive Handover*




- MN discovers NAR
  - » Using layer 2 mechanisms (e.g. scan)
  - » By exchanging messages
    - – RouterSolicitationforProxyAdvertisment (RtSolPr)
    - – ProxyRouterAdvertisment (PrRtAdv)
- MN forms NCoA
  - After receiving PrRtAdv
- MN requests tunnel establishment between PCoA e NCoA
  - By sending FastBindingUpdate (FBU) to PAR
- MN starts exchanging packets through NAR
  - After sending Unsolicited Neighbor Advertisement (UNA) to NAR

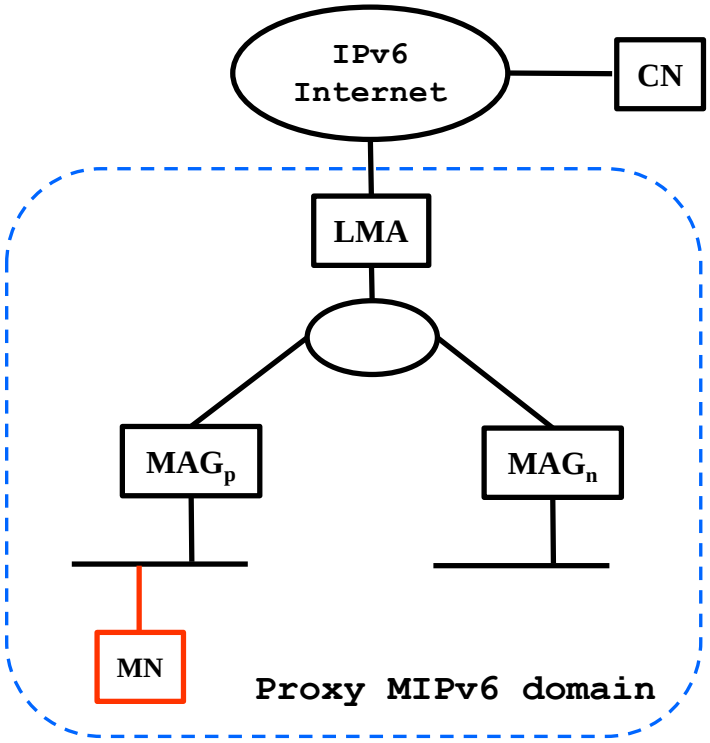
# *Fast Handover is Combined with MIP6*

MNs shall also execute MIPv6 BindingUpdate, so that packets can be sent directly to NAR



# *Proxy MIPv6*

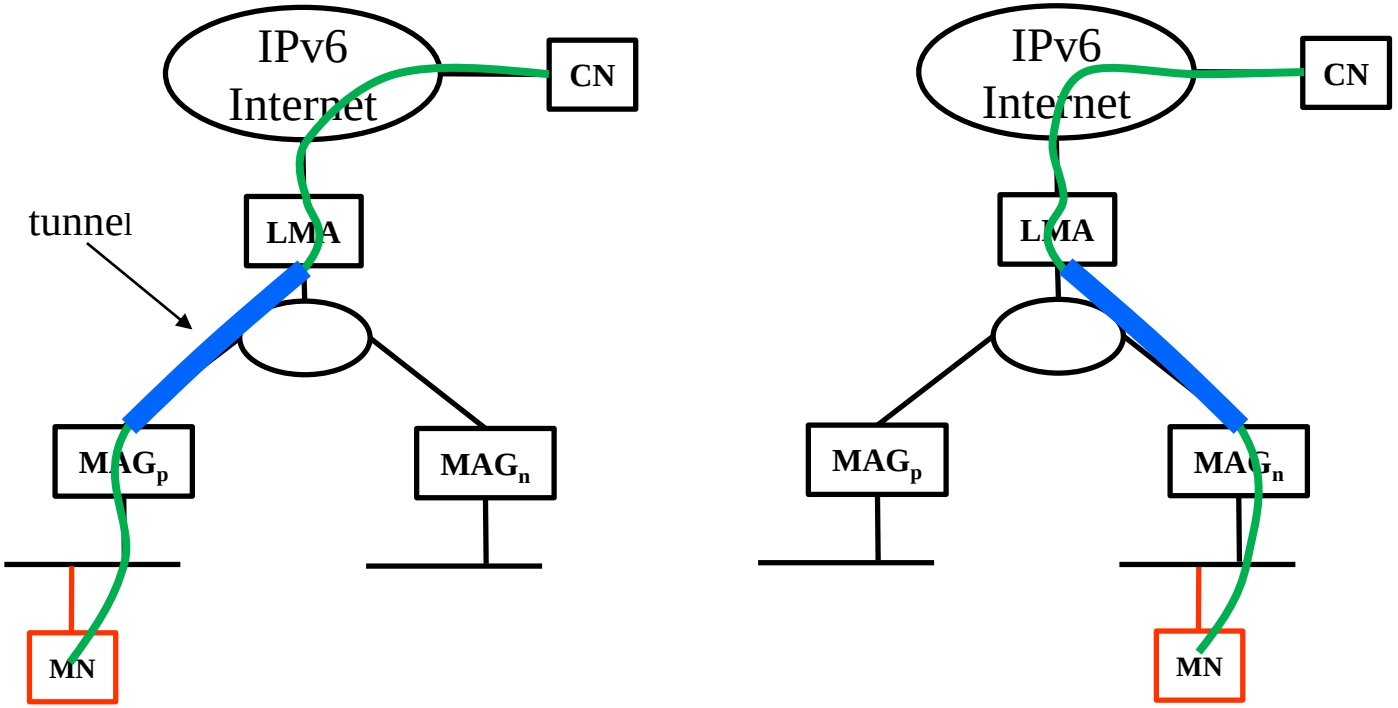
- MN mobility is managed by the network
- MN moves and *believes* it continues in the same (host) link
- Router in new link emulates the behavior of router in home link
- MAG is the MN proxy



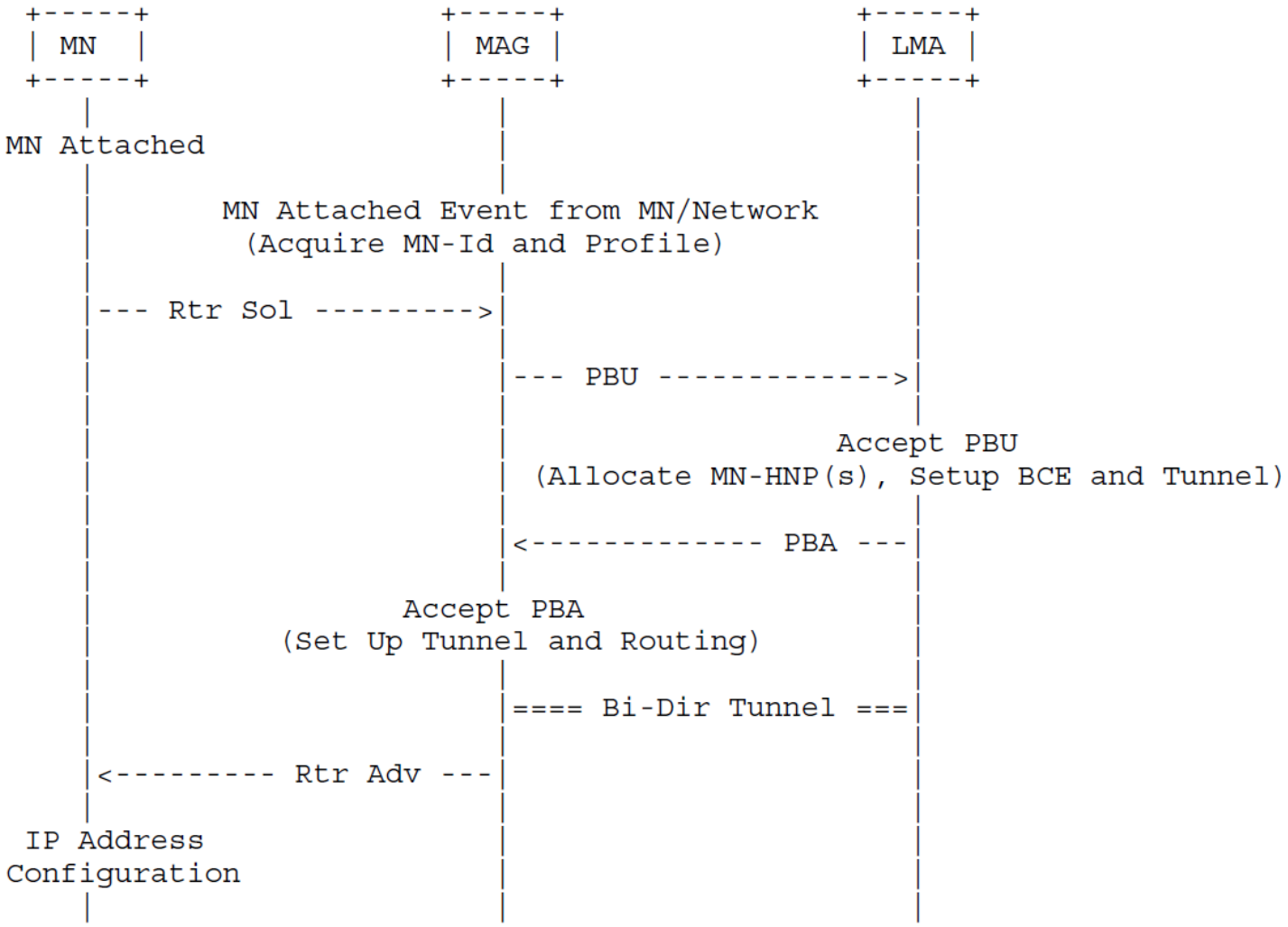

**LMA – Local Mobility Anchor**
***Home Agent***

**MAG – Mobile Access Gateway**
***Access router with***
***proxy mobility function***

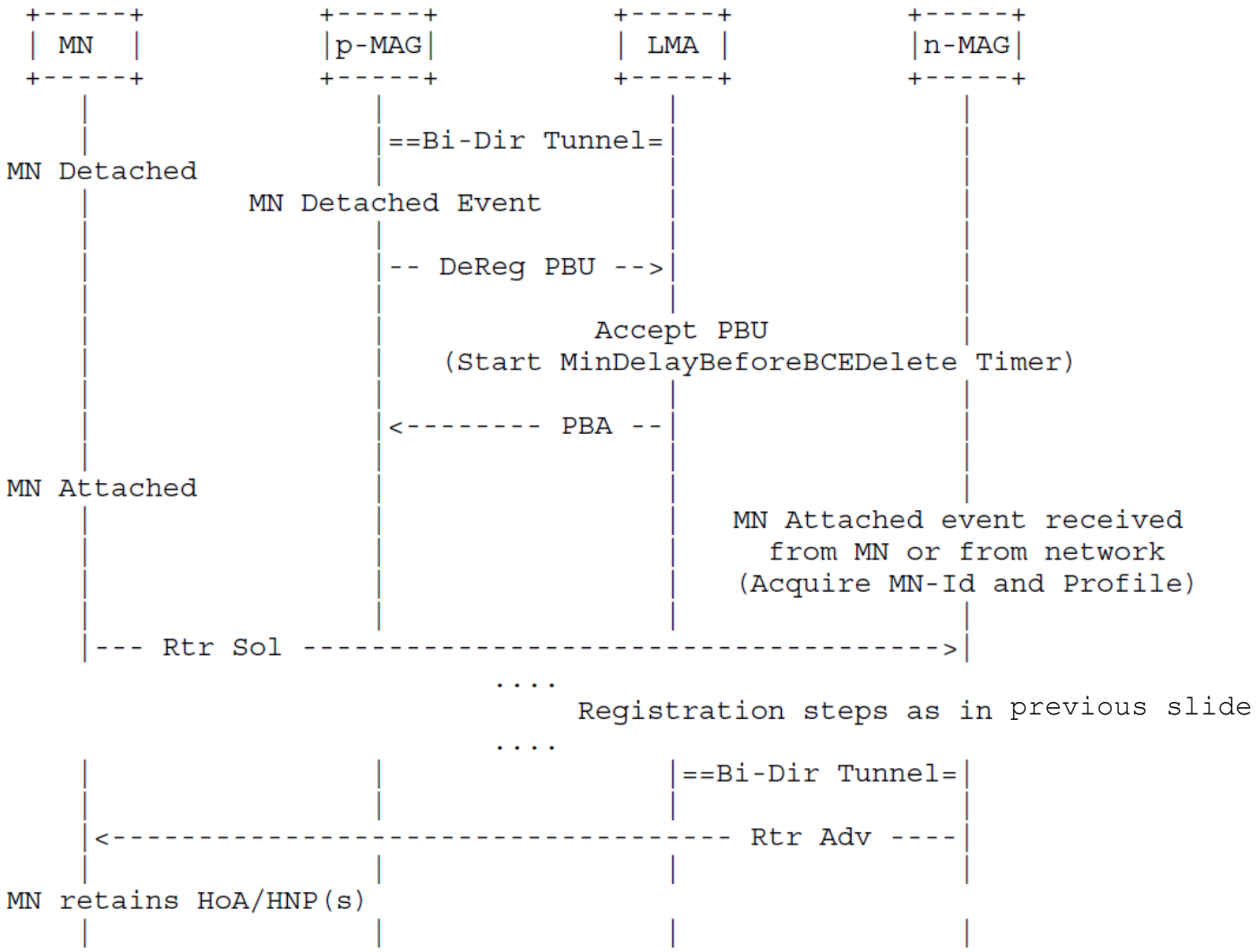
# *Proxy MIPv6 – Data Flows*



# *Proxy MIPv6 - Signaling in Mobile Node Attachment*



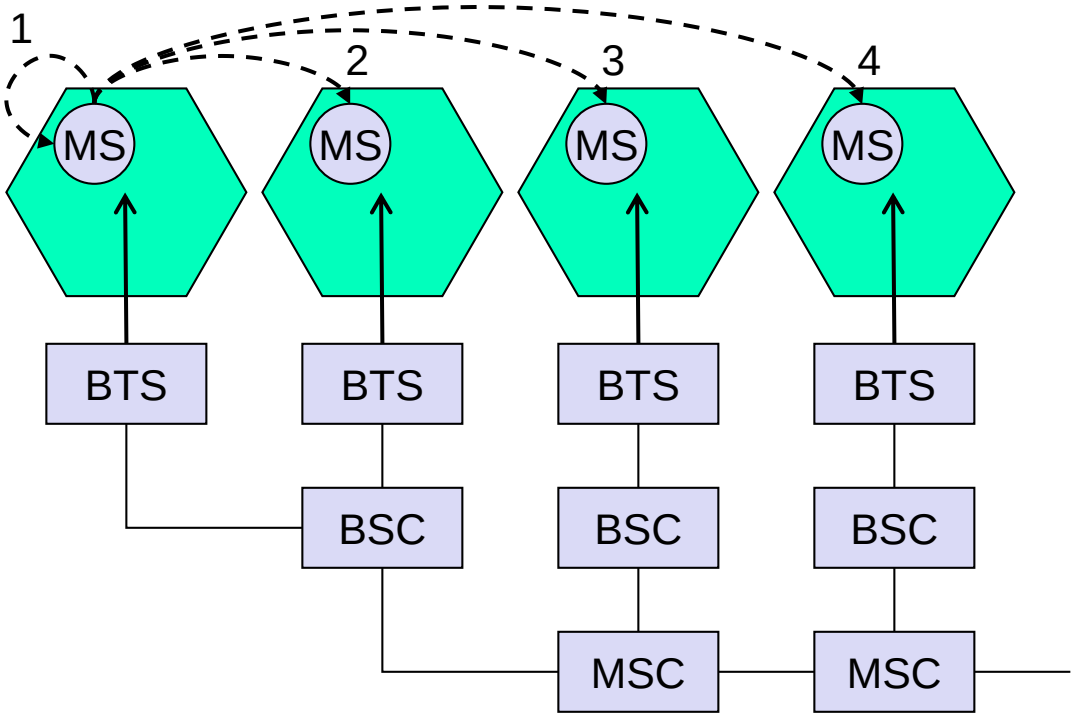
# *Proxy MIPv6 – Signaling During Mobile Node Handoff*



*Mobility management in 3GPP networks*

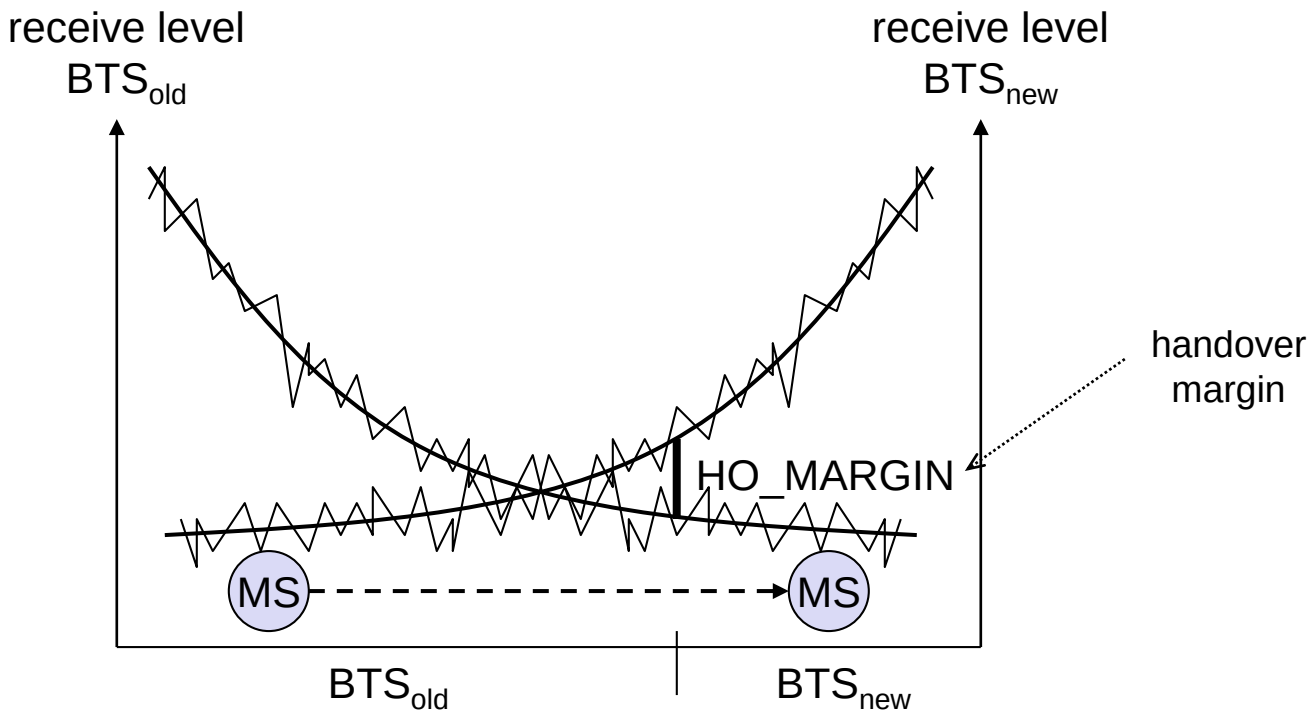
GSM

# *Four Types of Handover*



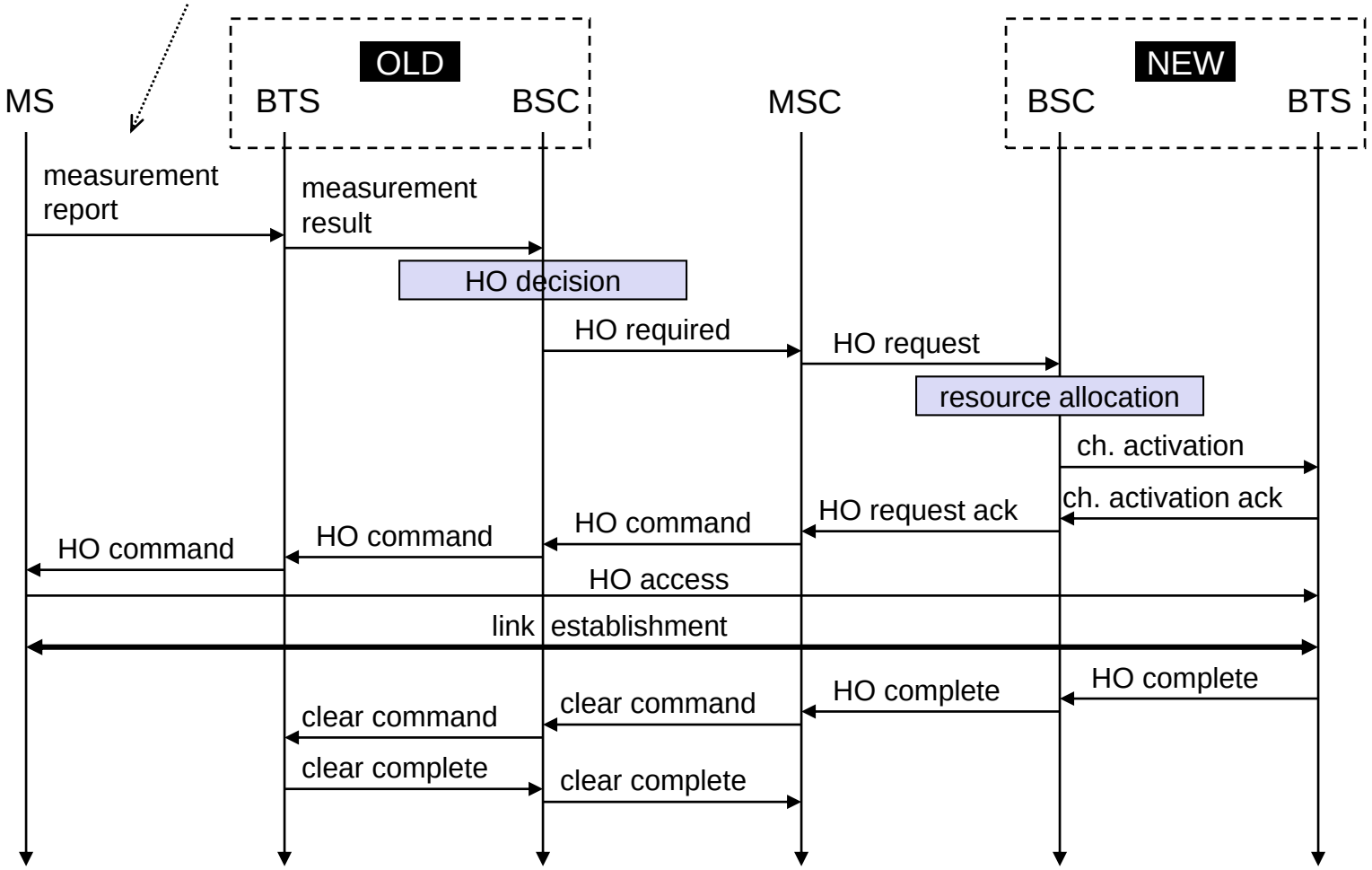

1 - between different sectors of the same cell
2 - between different cells within the same BSC domain
3 - between different BSC domains within the same MSC domain
4 - between different MSC domains

# *Handover decision*



# *Mobile-Assisted Handover (MAHO)*

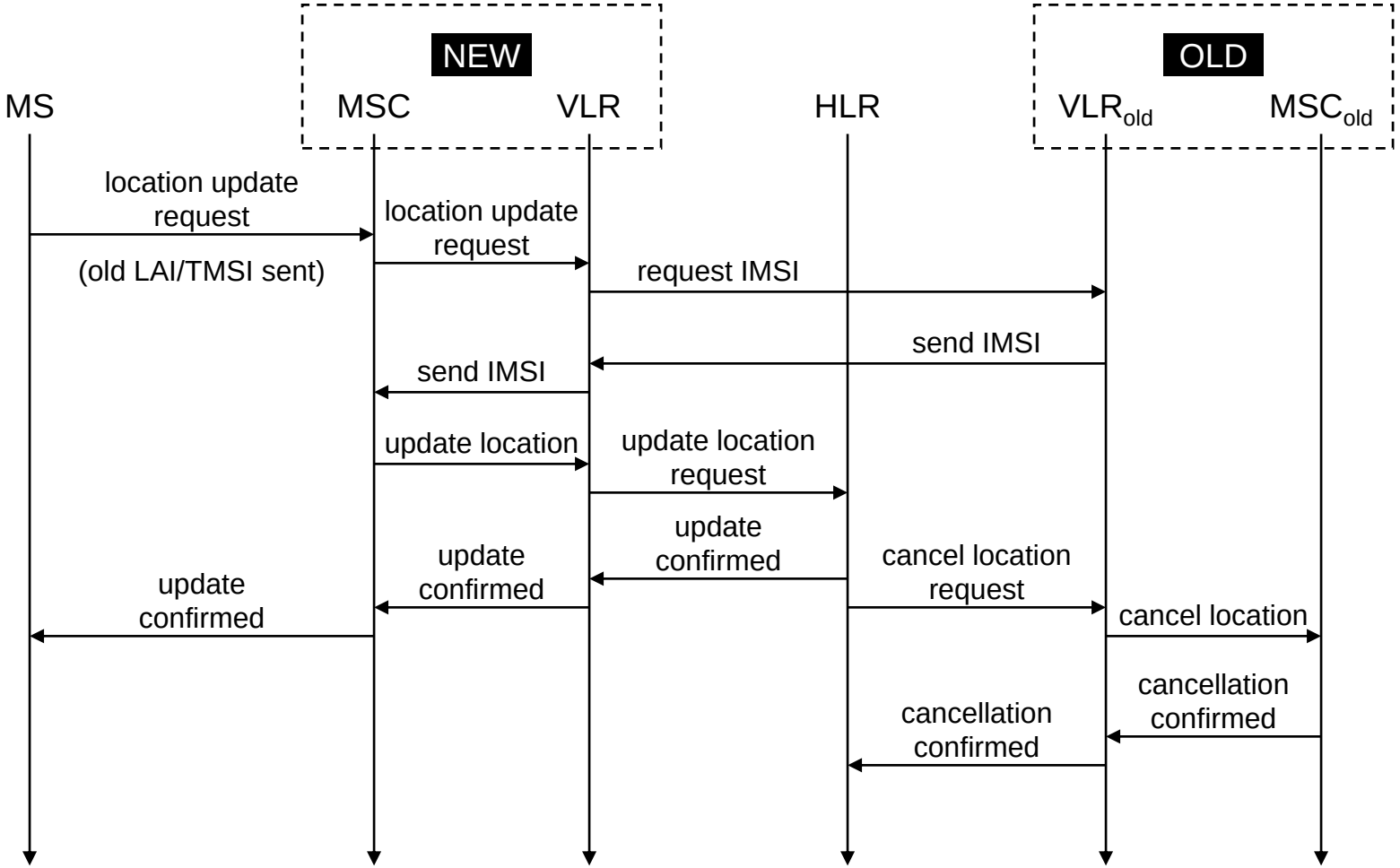
*MS scans, measures and reports power received from several RF carrier based on BCCH information*



# *Location update*

- MS is aware of location
  - » BTS broadcasts Location Area Identification (LAI) on BCCH
  - » SIM stores current LAI
- Events which determine a current location update
  - » MS is switched on and current LAI equals the stored LAI
  - » a timer set by the network expires and MS reports position
- Events which determine a new location update
  - » MS is switched on and current LAI differs from stored LAI
  - » MS enters a new location area

# *Location Update – New Location*



LTE

# *LTE Handover Principles*

- Handovers are network controlled

  E-UTRAN decides when to make the handover and what is the target cell

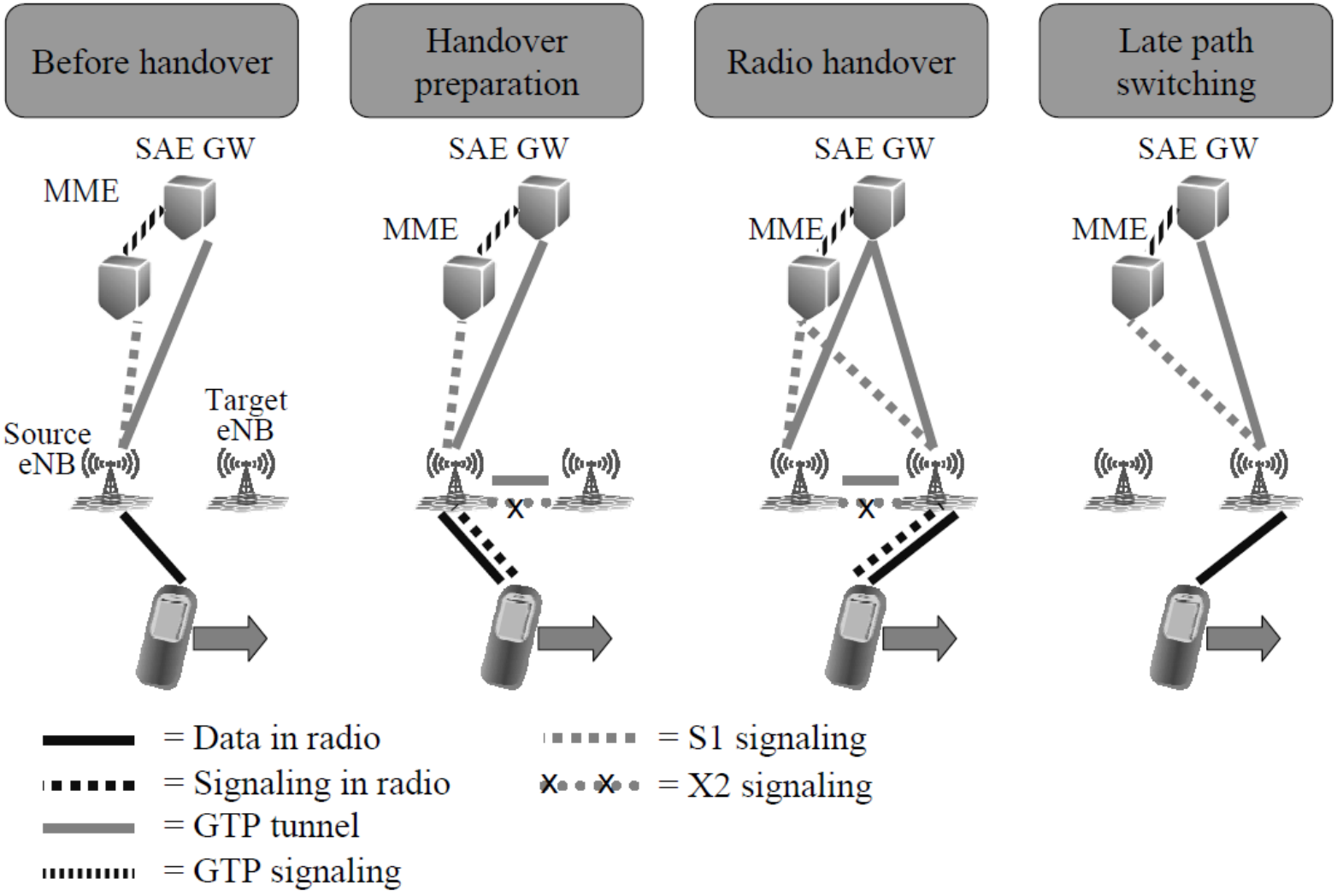
- Handovers are based on the UE measurements

- Handovers in E-UTRAN (4G) aim to be lossless

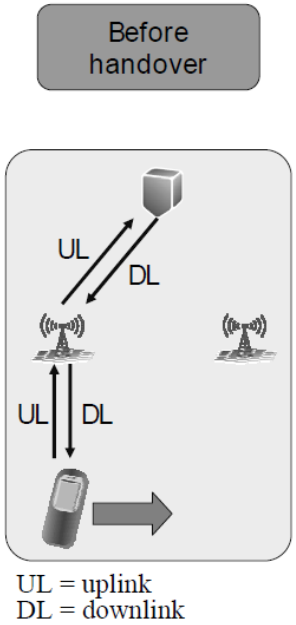
  by using packet forwarding between Source eNodeB and Target eNodeB

- Core network updated after radio handover is completed
  - » The *late path switch* concept
  - » Core network has no control over handovers

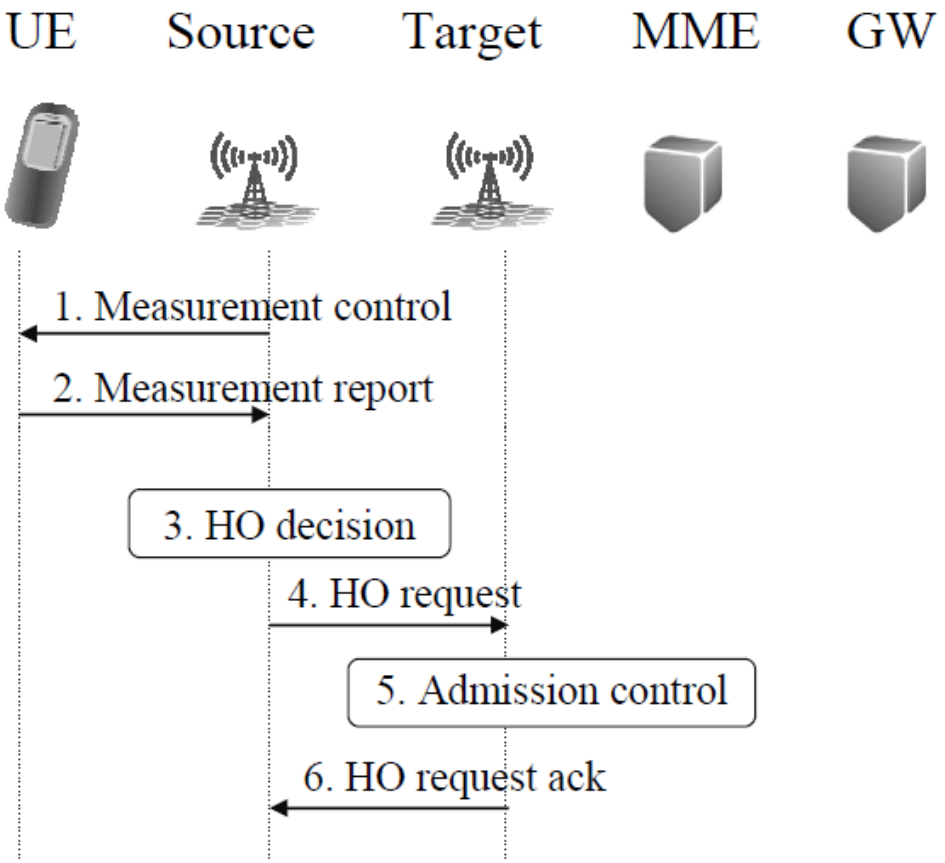
# *Handover Procedure*



# *Handover Preparation*

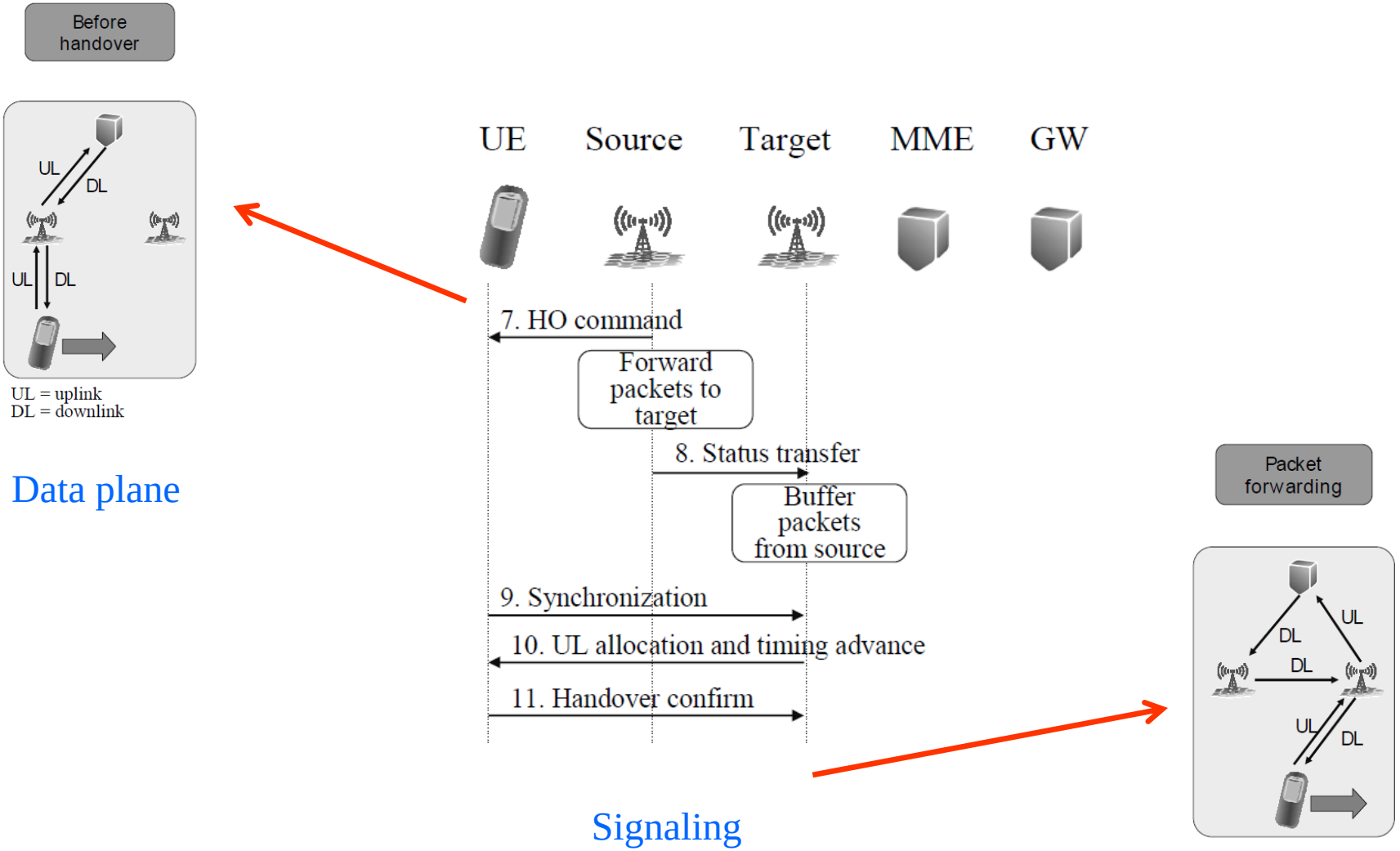



Data plane

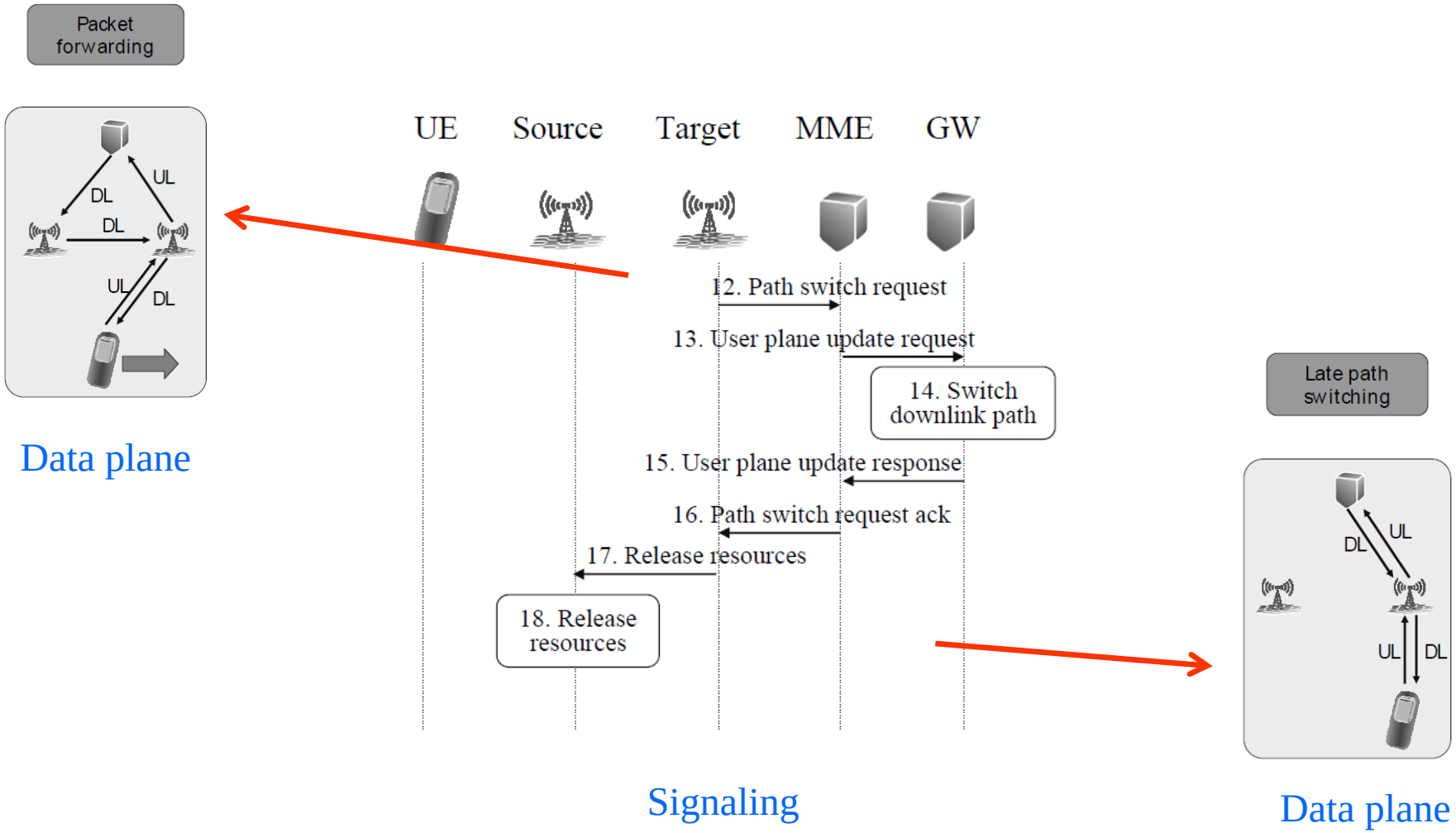



Signaling

# *Handover Execution*



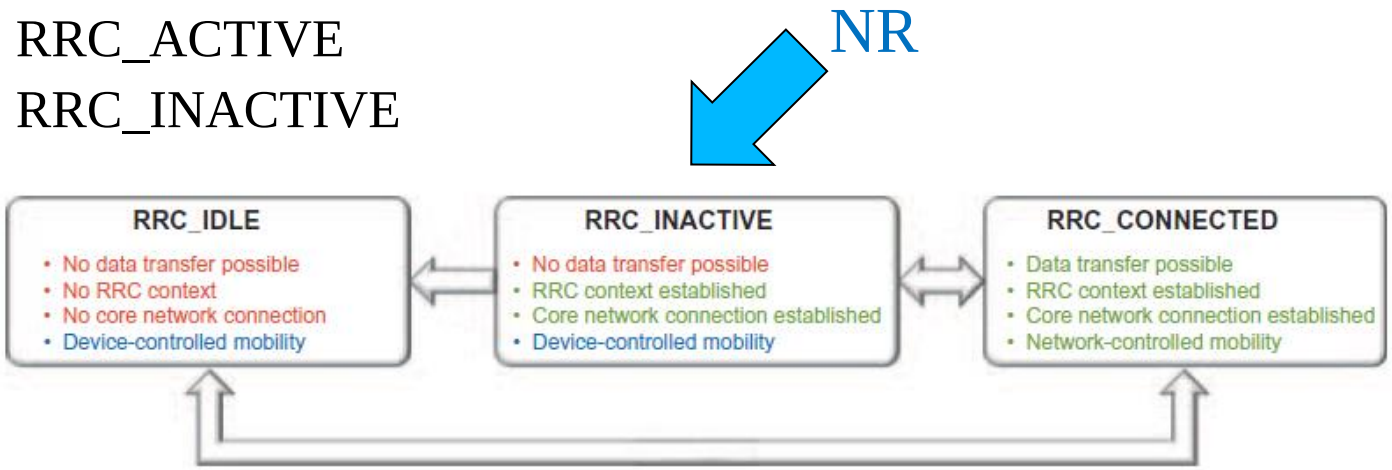
# *Handover Completion*



5G

# *RRC State Machine – Mobility Perspective*

- In New Radio (NR) the device can be in one of 3 RRC states
  - » RRC_IDLE
  - » RRC_ACTIVE
  - » RRC_INACTIVE




- RRC_IDLE, RRC_CONNECTED: similar to LTE /4G
- RRC_INACTIVE: new state introduced in NR
  - » Support for frequent transmission of small packets (current applications)
  - » Avoid significant amounts of signaling in the core network

# *Mobility*

- Idle-State, Inactive-State
  - » Ensure that a device is reachable by the network
  - » Network notifies the device by a paging message
  - » Devices are tracked on a cell-group level:
    - – The network receives new information about the device location if the device moves to a new cell group
    - – Paging message is broadcast in all cells of the group
- Connected-State
  - » Device has a connection established to the network
  - » Device reports the result of the measurements to the network
  - » Based on this reporting the network decides about handover to a new cell

# *Homework*

1. Review slides

2. Answer questions at moodle

# *References*

- IETF
  - Mobile IPv6 Fast Handovers, RFC 5268
  - Proxy Mobile IPv6, RFC 5213

- 3GPP
  - GSM mobility: Schiller's book
  - LTE: Harri Holma, Antti Toskala, "LTE for UMTS-OFDMA and SC-FDMA based radio access", Wiley, 2009