

# TeliaSonera

Mobile IP - what does it mean? - Mobility management

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# Presentation Outline

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- Introduction(s)
  - What this presentation is about
- Mobile IP Overview
  - Basic Mobile IP
  - Operator grade deployments
- Mobility Management
  - Types of “Mobility Management”
- Summary

# Introduction(s)

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- In this presentation Mobile IP means Mobile IPv4
  - Mobile IPv6 is interesting but currently commercial relevancy is not as important as Mobile IPv4 has
- Assumed: Basic knowledge what Mobile IP is...
- Based on own experiences building up Mobile IP infrastructure on top of existing network architecture – operator controlled GSM/GPRS/WLAN/LAN network environment
- Concentrate on management side of the Mobile IP not so much on the interesting enhancements :)
- Everything is observed from an operator point of view
  - No free rides!
- Disclaimer 1) A lot of borrowed/Modified pictures from Web!!
- Disclaimer 2) Mobile IP is not the only existing solution to solve IP mobility

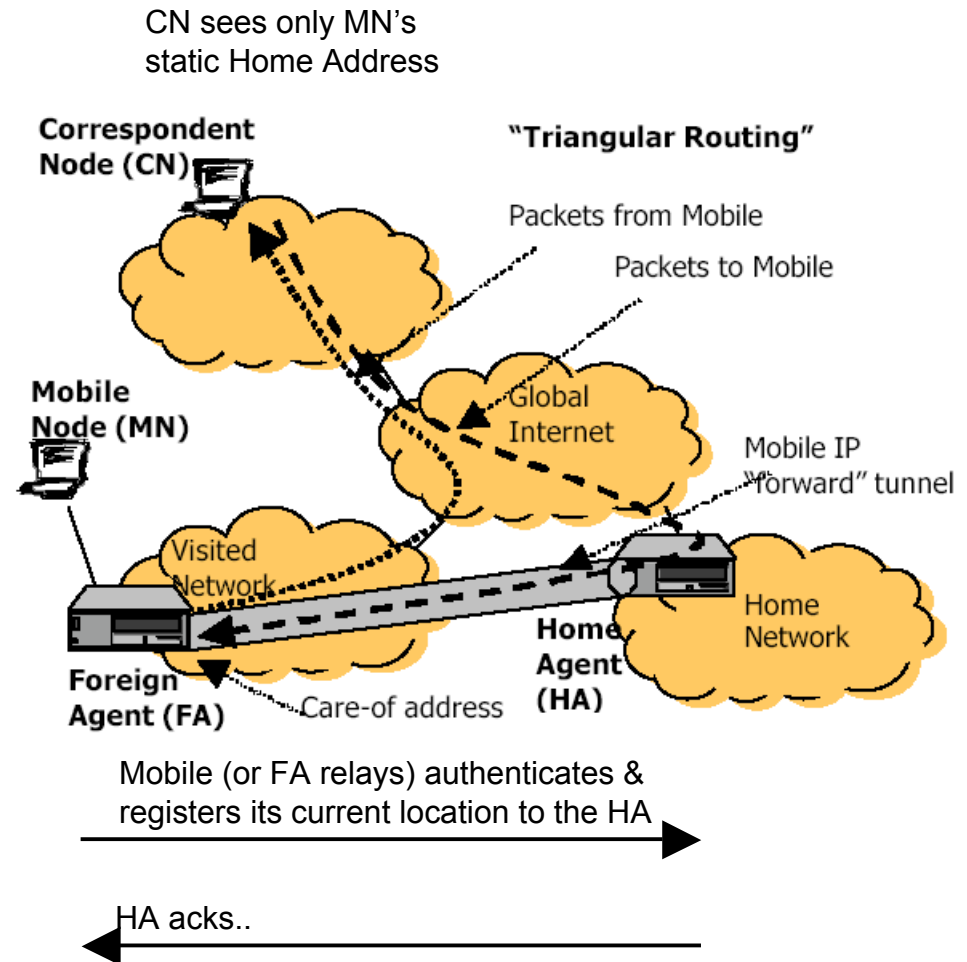
# Mobile IP – Why ?

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- Heterogeneous and overlaid networks are here to stay!
  - We are able to access & attach to multiple networks simultaneous
- Current “Internet Architecture” and majority of protocols overload the use of IP addresses:
  - IP addresses are not only used for routing but also for session identifiers and host identities -> ok for static hosts
  - Host’s permanent address that applies to the above is the *Home Address*
- Typically IP addresses change when a Mobile Node moves from a access network to another -> problems
  - A Mobile Host has a local address from the access network i.e. the *Care-of-Address*
- Mobile IP considers the Mobility problem as a Routing problem
  - Managing the point of attachment to the network – i.e. a dynamically set up tunnel between the Mobile Node’s current Care-of-Address and the (static) Home Address
  - Of course there is a lot more...

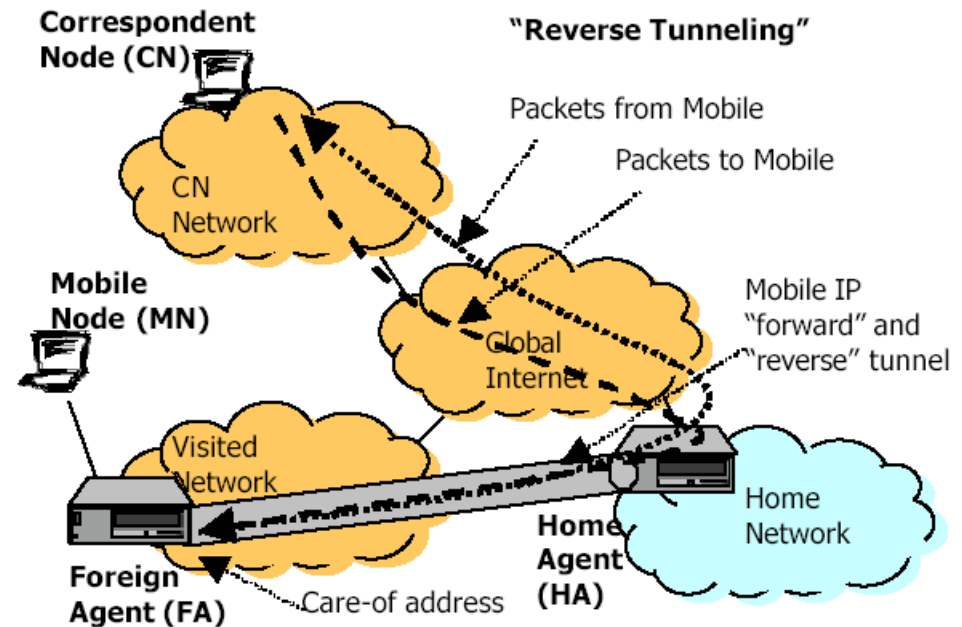
# Mobile IP Basics – the “Reference Model”

- Home Agent as a Mobility anchor and management point
- Foreign Agents in place
- Triangular routing
- Does not really exist in real world deployment for multiple reasons...
  - FAs are problematic
  - Ingress filtering
  - NATs
  - Too “lightweight”
  - Access networks are problematic but various AAA mechanisms



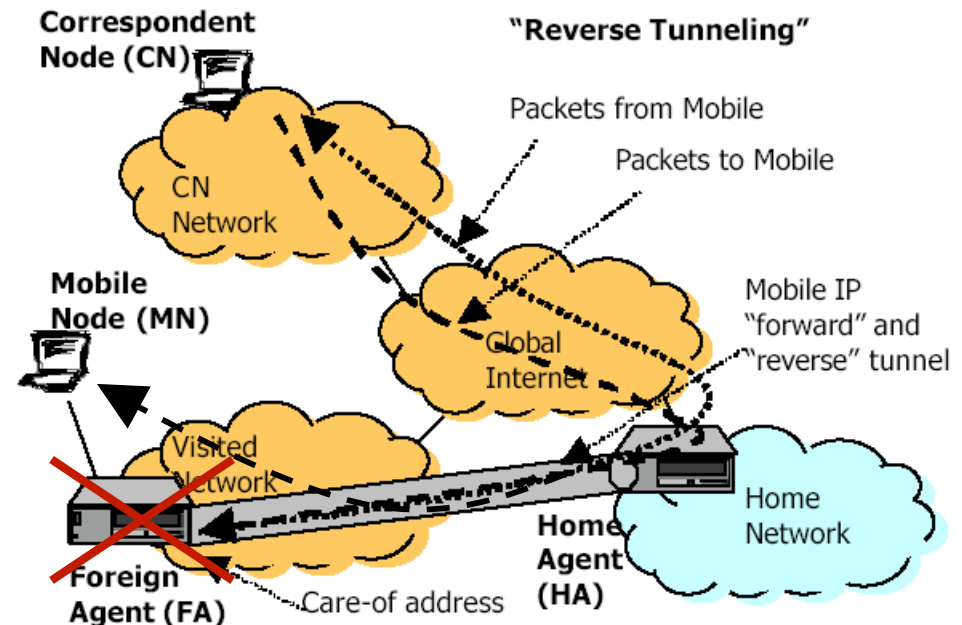
# Mobile IP Basics – Closer to Reality

- Add reverse tunneling:
  - Fix ingress filtering
  - Allow private home networks
  - Screws up routing...
  - Not really FireWall friendly

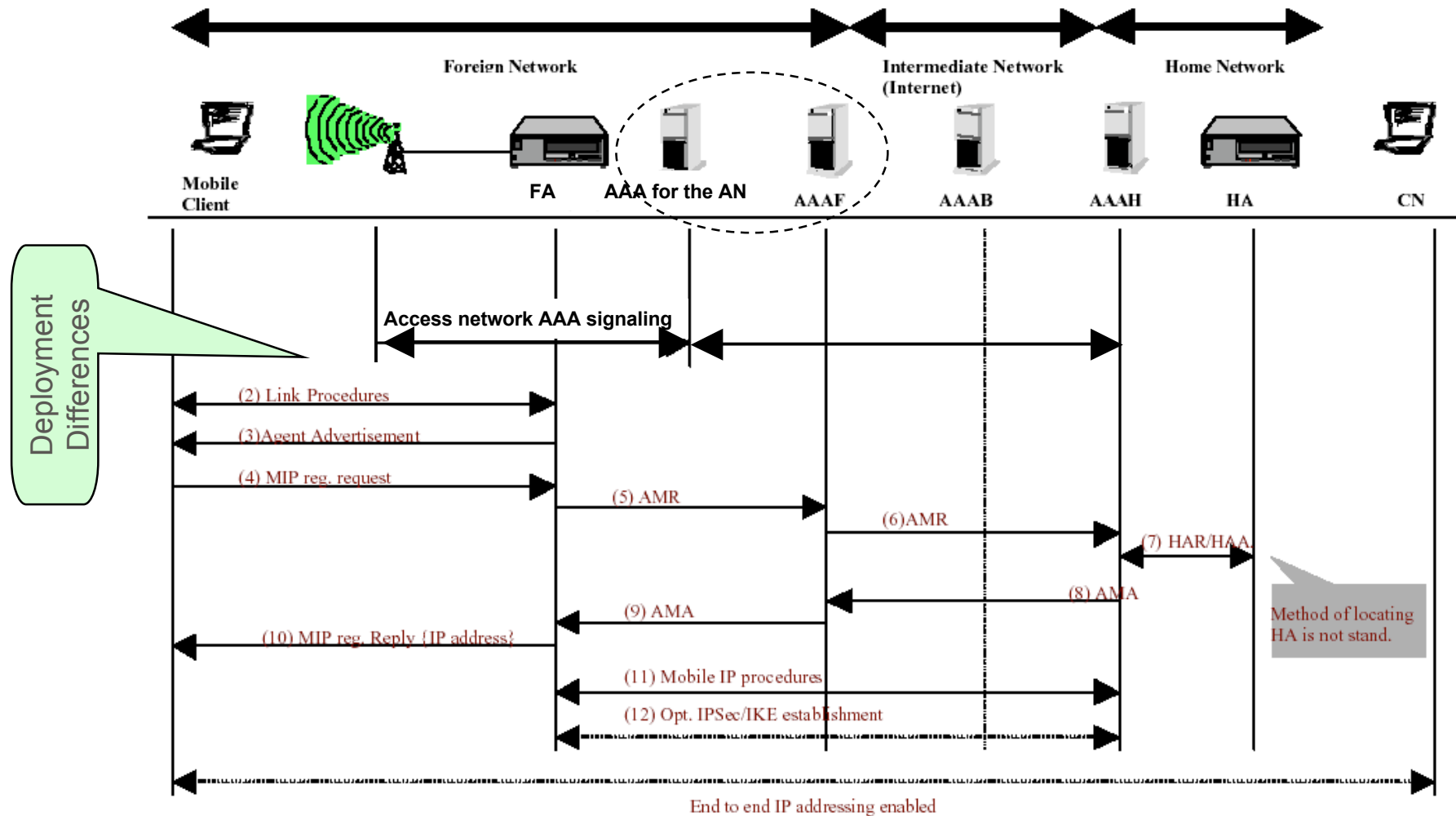


# Mobile IP Basics – and Make It Work

- Add NATT traversal
  - UDP based tunneling
  - Also helps with FireWalls
- Skip FAs in foreign networks
  - One cannot expect them to be there in all cases
  - Adding FAs into existing network infrastructure is sometimes not easy
  - Yet another access authentication method
- ...Still missing the AAA part
  - E.g. public WLAN access authentication is currently very MIP unfriendly



# Mobile IP Basics – One AAA Example

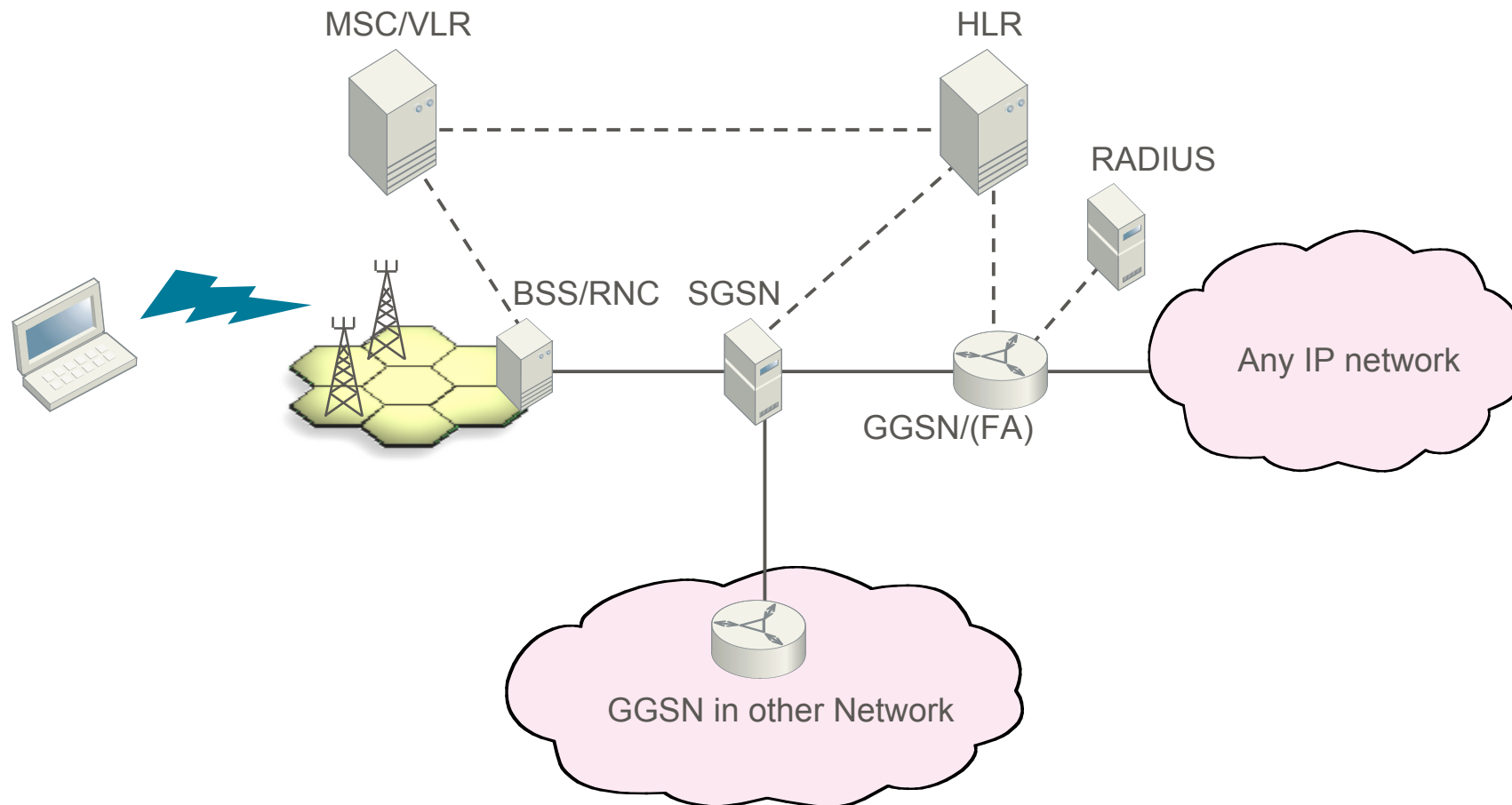


# Mobile IP – as Part of Operator Network

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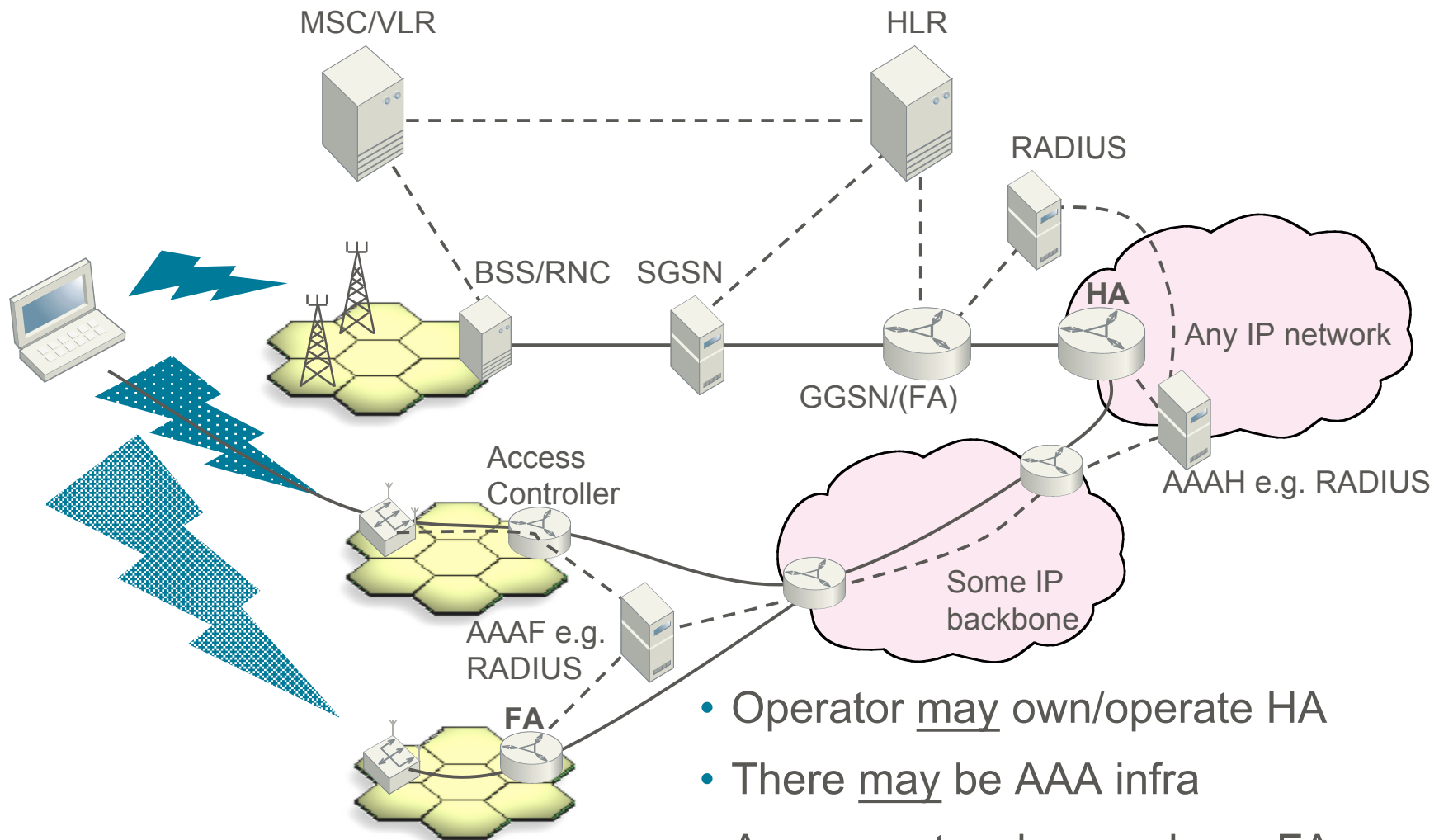
- Cellular access, WLAN, LAN, xDSL, whatever... Almost anyone could operate – but in a big world we want control and a proper billing!
- Option in 3GPP (e.g. GPRS) networks (as for Rel-6)
  - GGSN may have Foreign Agent build in
  - Generally always build loosely on top of existing and deployed networks architecture
  - ...thought pressure coming from I-WLAN side to support mobility
- Widely deployed e.g. in 3GPP2 (CDMA2000) networks
  - Tightly build in to the core architecture
- 3GPP Rel-7 may change the situation
  - “Seamless Mobility” across heterogeneous access networks

# 3GPP Architecture – Heavily Simplified



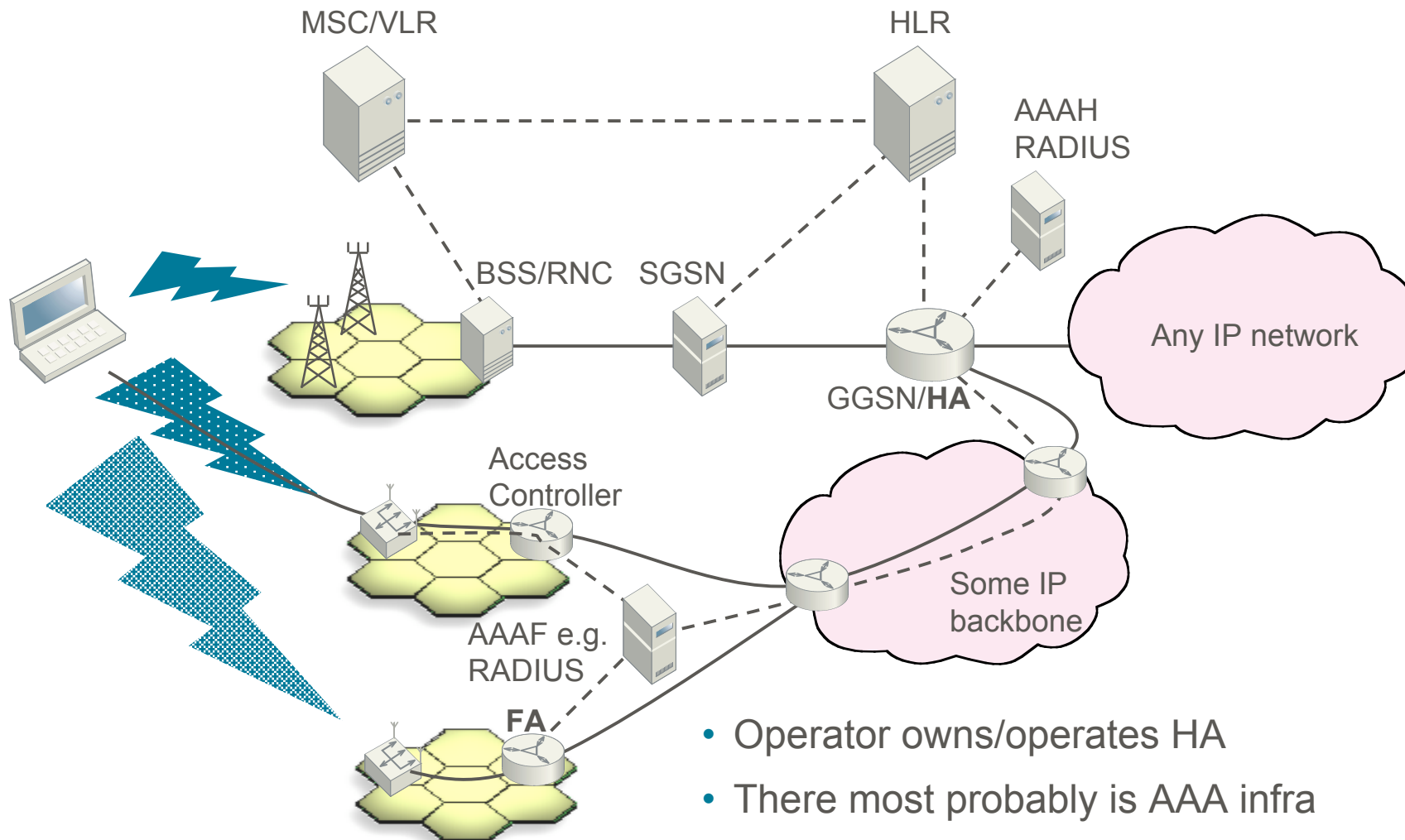
- GGSN may contain FA functionality

# GPRS & WLAN Architecture – and Mobile IP



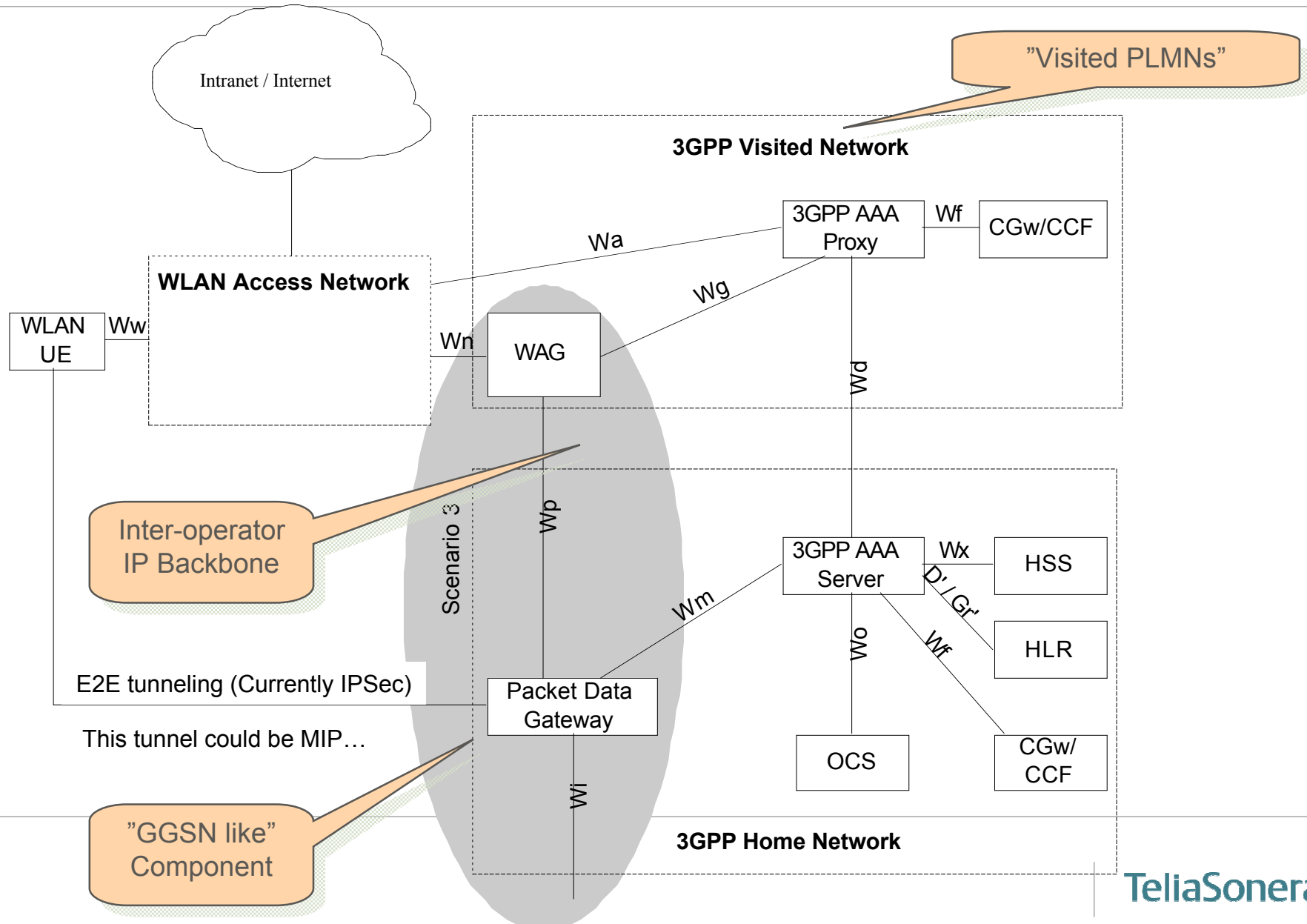
- Operator may own/operate HA
- There may be AAA infra
- Access networks may have FAs
- WLANs may support roaming

# GPRS & WLAN Architecture – Mobile IP & iGGSN



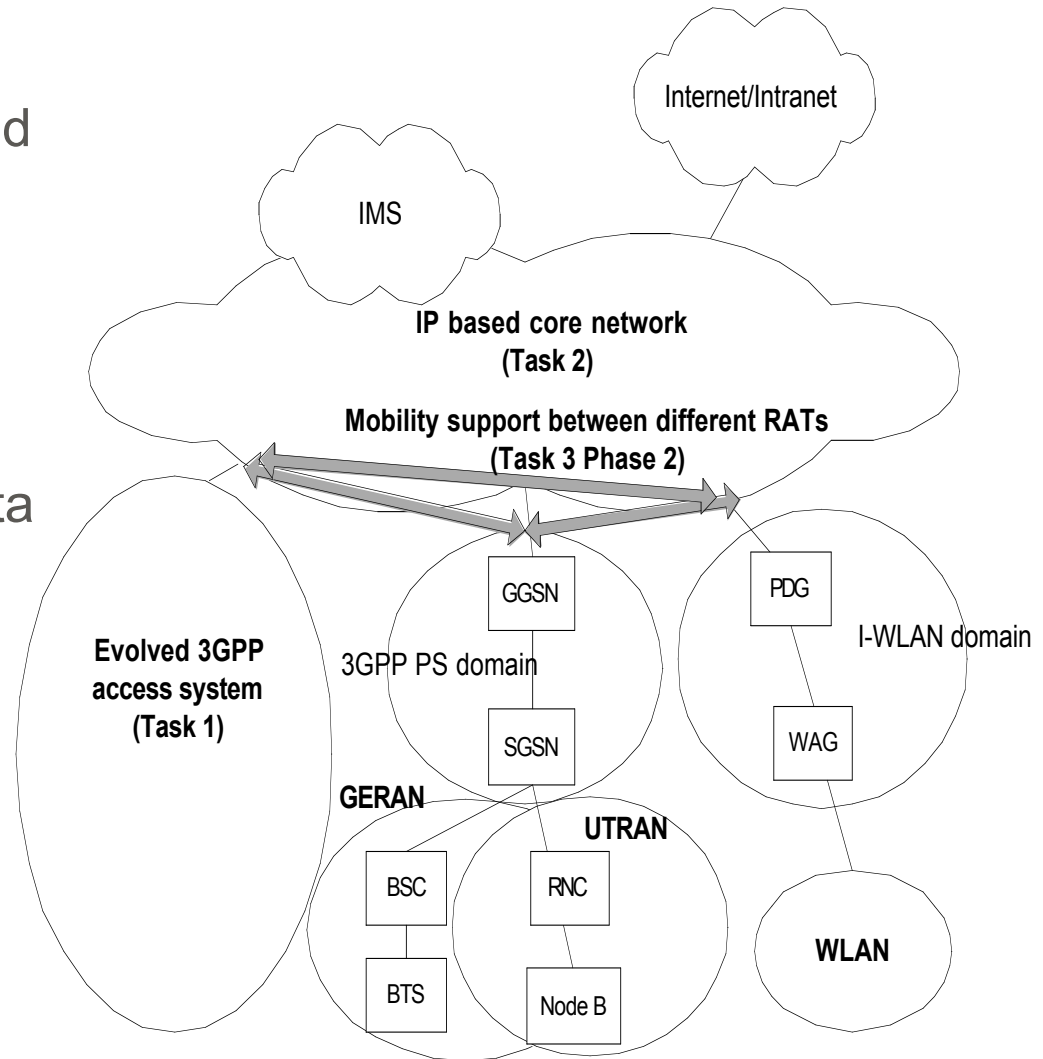
- Operator owns/operates HA
- There most probably is AAA infra
- Access networks may have FAs
- WLAN may support roaming in general

# Interworking WLAN Glued to 3GPP – How about Mobility?



# 3GPP Architecture in the Future...

- Combine existing 2.5G and 3G with I-WLAN & future accesses.. somehow
- Access to “telco” services
- Makes everything look & feel like current GPRS data access
- Drives the use of (U)SIM on “any” terminal





# Mobility Enabled Services

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- Are there any explicitly Mobility Services?
  - Not really?
- What is then all this hype about the mobility?
  - Mobility is an enabler.. and should be transparent!
  - Leverage existing and forthcoming access technologies
  - Use of any of several available (overlaid) networks
  - Select the network that fits best to the requested service
  - Always connected
  - Always reachable
  - ...always billable :)
- Requirements for operator grade service?
  - Work out the roaming, interoperability, interworking and AAA

# Mobility Management

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- Roughly three types of mobility management (in my opinion):
  - 1) The “system” is able to provide services (if allowed), reach, follow and charge the Mobile Node -> registrations to Home Agent
  - 2) Mobility management as handling mobility locally, globally and policing the decision of movement -> local management & policies
  - 3) Knowing where the Mobile Node located
- Cases 1) and 2) relate to the same domain
  - IP routing, routing optimizations, local mobility management, handovers, ...
- Case 3) tells the Mobile Node location geographically & administration point of view – not just network topologically
  - Location based services, possibly charging differentiation
- We will skip bootstrapping and node assignment related management

# Mobility Management Case 1

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- Location management and updates in IP and network topology point of view
  - The MN may be close or very far away from the CN in IP point of view
- Mostly deals with AAA
  - Authentication & authorization to the service
  - Registration i.e. location update in IP point of view
- Before the MN registers to the HA, the Access Network dependant AAA has usually already taken place
  - Why not combine the “service” and the “access” AAA? Actually it is being worked on... e.g. by exploiting EAP based authentication
  - Access network AAA may provide location information – more about this in the Case 3)
- The location of the MN is know by the mobility anchor point i.e. the Home Agent – and CN knows the Home Address of the MN -> OK.
  - The MN is now under the control of the Home Network Mobility Management in AAA sense
- Lets call this Macro Mobility

# Mobility Management Case 1 Cont'd

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- Sometimes it might be desirable for CNs to be able to locate and reach the MN from the Network side
  - The MN may have a static Home Address and/or DNS name
  - The MN may have dynamic Home Address during the life time of an “user session”
  - The Mobility Management entity could facilitate some identity/name mapping to the current Home Address e.g. using DYNDNS
- Example stable names/identities
  - Static Home Address
  - DNS name
  - SIP public identity
  - MSISDN (uses ENUM DNS)
  - ...
- The bottom line is that if the MN must be reachable from the network it must have a stable name/identity and some entity must keep IP address and name/identity mapping up to date

# Mobility Management Case 2

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- In a search of Seamless Mobility
  - Fast handovers -> low latency e.g. takes on 20ms
  - Smooth handover -> low loss or delay of packet
- Signaling overhead grows
  - Mobility related signaling between Access Routers and mobility servers
  - Roaming AAA signaling between the visited and home networks
- AAA signaling takes time
  - Access network planning has a huge impact!
  - Security... adds roundtrips and processing
- “Micro mobility” could be handled locally in an access network dependant way – e.g. like in Cellular IP

# Mobility Management Case 2 – AAA Example

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WLAN to WLAN handover signaling times with EAP-SIM authentication build & measured on top of existing network architecture

	UDP+TCP			UDP		
	MAX	MIN	AVG	MAX	MIN	AVG
EAP	2,92	2,23	2,33	2,42	2,14	2,27
<i>IDLE1</i>	3,79	3,01	3,34	3,82	3,19	3,41
DHCP	1,85	0,8	1,53	6,37	1,14	2,08
<i>IDLE2</i>	3,07	2,28	2,71	3,18	2,34	2,75
MIP	5,99	0,22	0,73	1,22	0,11	0,35
<b>Total</b>	<b>12,85</b>	<b>8,54</b>	<b>10,64</b>	<b>17,01</b>	<b>8,92</b>	<b>10,86</b>

- Large idle time due loose integration of system components in Terminal
- With “closed” systems average times around 3-4 seconds are possible

# Mobility Management Case 2 – Methods

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- ”*Low Latency Mobile IPv4 Handoffs*” or Local Mobility Management
- Use of L2 handoff triggers (there’s a lot to exploit :)
  - Pre-registration handoff: MN registers through old-FA with new-FA before L2 handoff – can be either network or mobile initiated
  - Post-registration handoff: new-FA and old-FA communicate before L2 handoff, MN registers after L2 handoff – always network initiated
  - Prepare IP and Transport layers for handover
- Bicasting data to both new-FA and old-FA -> simultaneous bindings, use of multiple networks & access technologies simultaneously
- Transparent buffering of data (does not add delay) -> no loss of packets
- Regional registrations, hierarchical FAs, regional HAs, temporary HAs
- Pre-authenticate MN’s local network access
- Cons:
  - Foreign Agents are more or less required!
  - Hard or impossible to apply on top of existing core

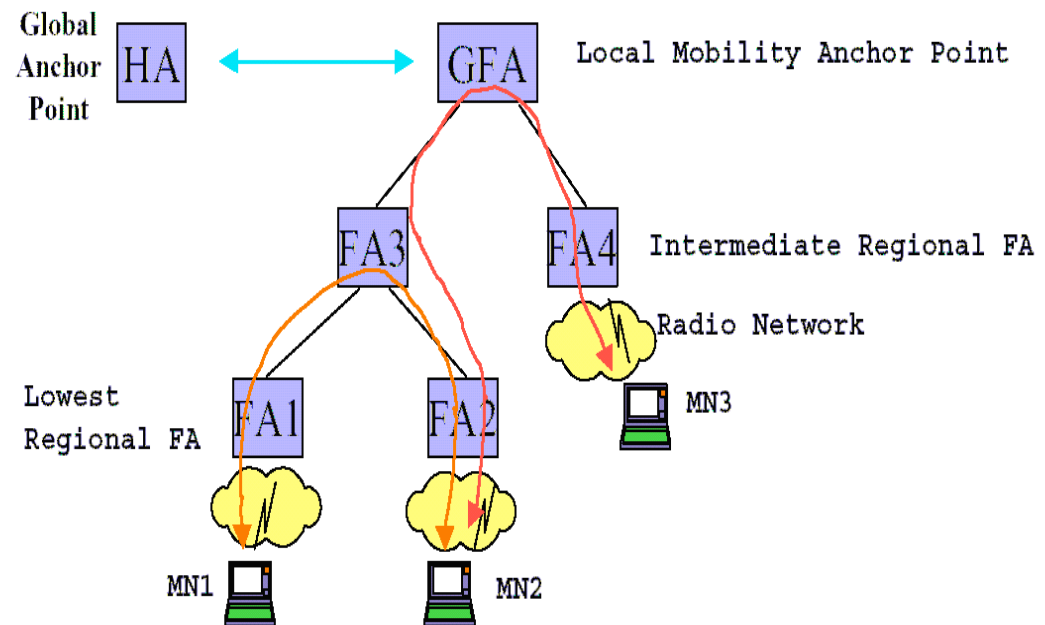
# Mobility Management Case 2 – Methods Cont'd

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- Route optimization
- Context transfer e.g. required cryptographic keys, compression state etc – hard to achieve across administrative domains
- Enhanced signaling e.g. for QoS
  - Prepare the path and middle boxes (NSIS, RSVP, etc)
- Handover indications and signaling
  - Inform middle boxes about handover e.g. using QuickStart type of solutions – piggybacking
  - Propagate handover indication up to transport layer and then perform e.g. TCP specific tricks to keep data transfer as good as possible
  - Important because even if the handover is fast but the network characteristics change confuse the transport layer -> final service suffers anyway
  - L2 triggers
- Adaptive applications and services
  - It takes some effort to squeeze an elephant through a 2 inch pipe...
- Who defines handover policies? How those are signaled?

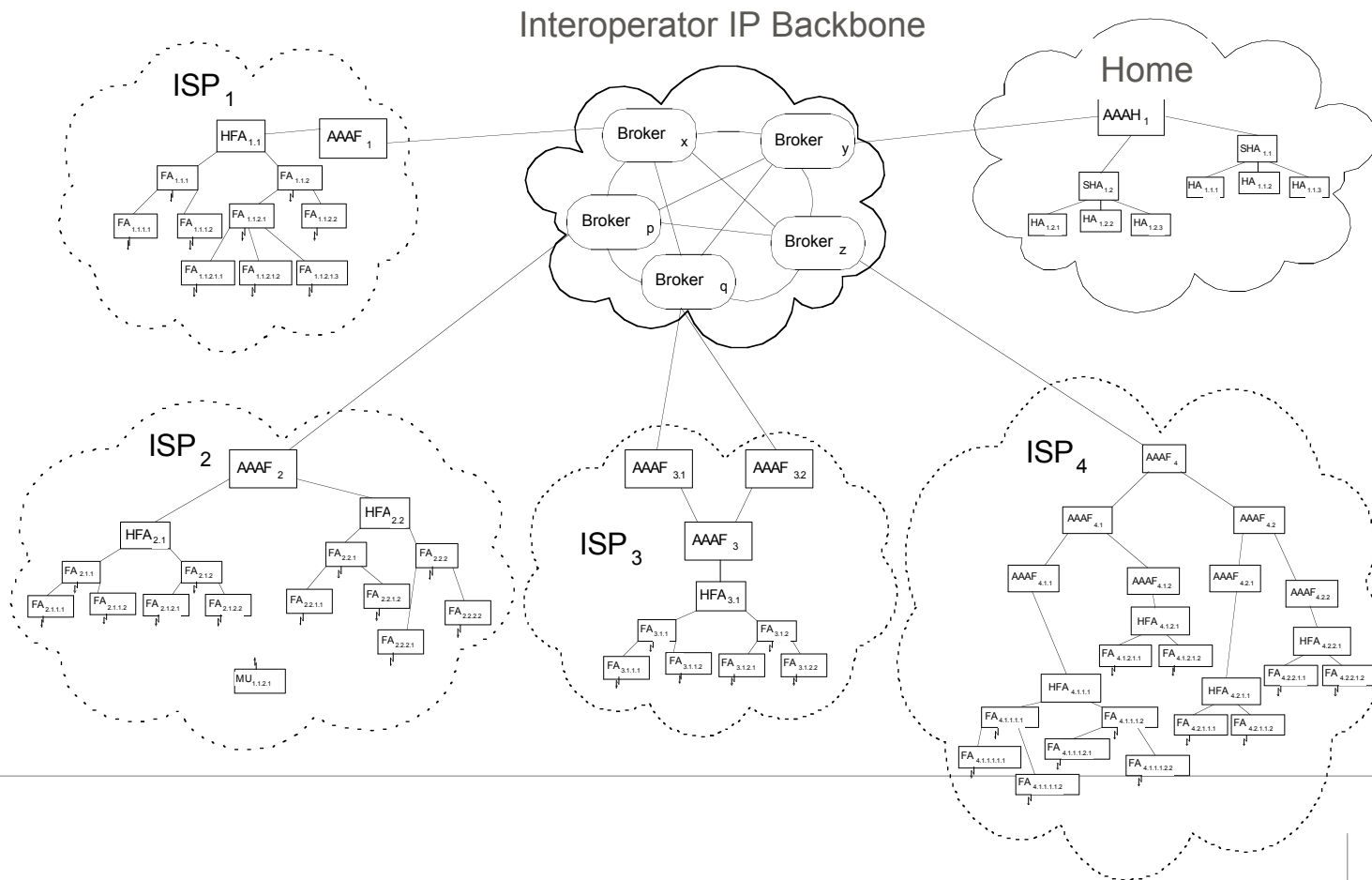
# Mobility Management Case 2 – Hierarchical MIP

- The MN registers with local FAs
- Gateway FA registers with the HA
- All signaling stays local as long as the MN is under the same GFA
- Good optimization if HA is topologically far away
- Reduces signaling between foreign and home network
  - Think big... e.g. millions of Mobile Phones



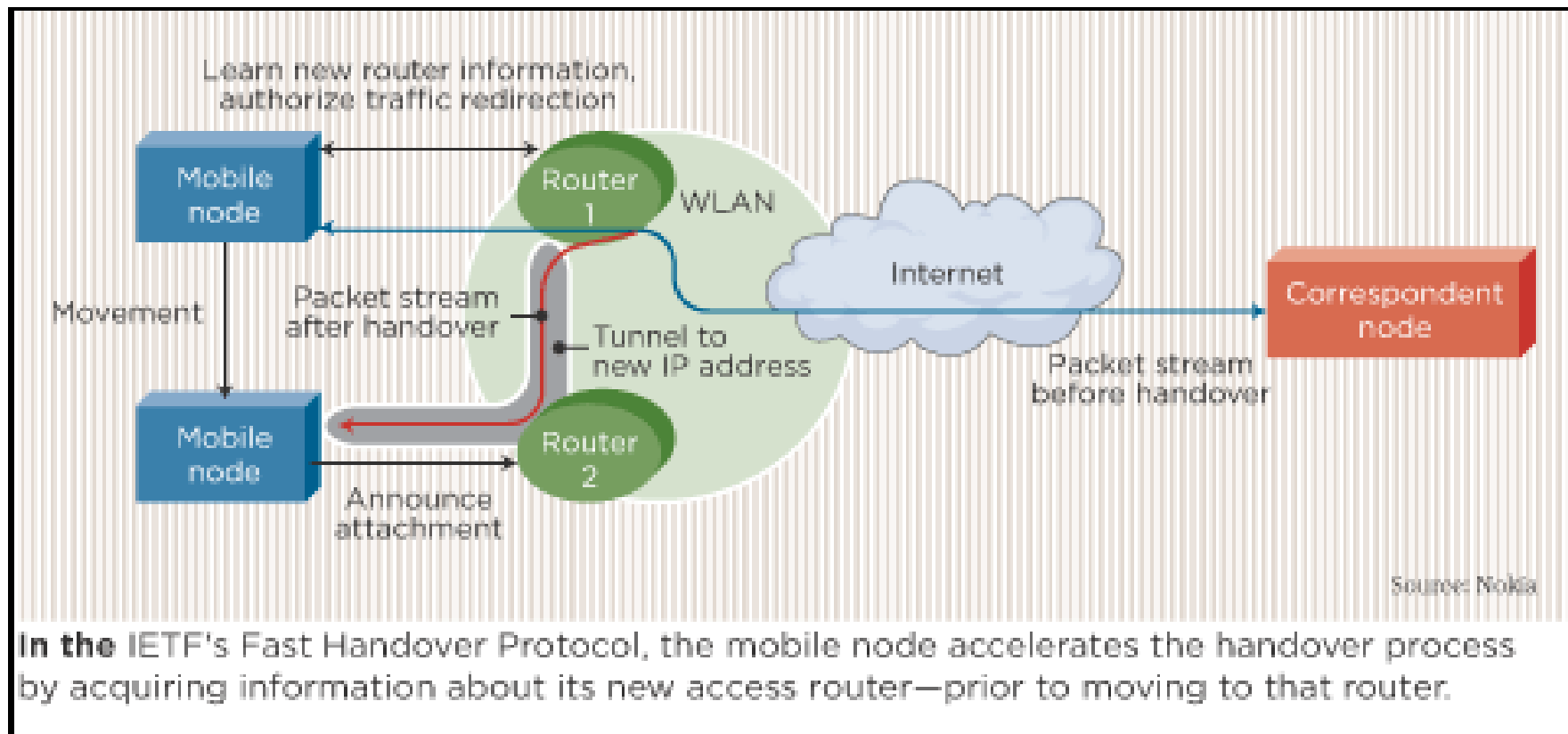
# Mobility Management Case 2 – Hierarchical MIP

- The intermediating proxy network has a significant role
- For QoS.. Internet might not be desired -> closed backbones!



# Mobility Management Case 2 – FastMIP

- E.g. prepare new Access Router before the handover...



# Mobility Management Case 3

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- Mobility Management in the location point of view
  - Geographical location – we are now in HUT/Espoo/Finland
  - Administrative location – visiting network operated by XYZ
- Important but cumbersome management area
  - Operators have regulatory pressures
  - Regulators have desires for subscriber rights...
  - Operators have interoperator tariffing needs
  - Subscribers have anonymity desires but sometimes they want to be found (emergency calls)
  - Location based access control, services and charging
  - Service optimizations based on the location e.g. select between HAs
- More or less must to have feature even if there would not be any end user service utilizing the location information

# Mobility Management Case 3 – Simple Problems

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- Problem 1) How to find the location of the Mobile Node?
  - Access network could tell it during access authentication...
  - Use of external device to locate the Mobile Node e.g. GPS
  - What if the access network does not know its location? :)
- Problem 2) How to signal the location of the Mobile Node?
  - Piggybag as part of access network AAA signaling
  - Local databases of visited networks based on IPs or something similar on box granularity? Dead end!
  - In case of multi-mode terminal... maybe some combination of network access technologies keeps track of the Mobile Node already in home network? Query that box...
- UMA is a nice example how the Unlicensed Network side is located using the GSM network side location information

# Mobility Management Case 3 – Methods Cont'd

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- Access network methods to indicate the location
  - DHCP has location information extension (uses GEOPRIV) -> Mobile Node may use that to find its geographical location
  - AAA signaling (RADIUS) has location information extension (uses GEOPRIV)
  - Cellular networks advertise their location/ownership identifiers -> up to the home core to map those to an exact location
  - AAA signaling (RADIUS) has ownership information extension (again GEOPRIV)
- Signaling of the location
  - At application level using “some method” e.g. for GPS utilizing applications
  - As part of network access AAA e.g. within RADIUS
  - MIP signaling extension?
  - Use existing wide area network (e.g. GSM) location information and tie that to the ongoing session -> useful in multi-access capable terminals
- The goal is that the home network knows the administrative location of the Mobile Node in real-time and geographical location when needed (location information must be saved in any case but not necessarily resolved)

# Summary

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- Mobile IP provides basic functionality for IP mobility
- Operator grade deployments require proper backend support
- Seamless Mobility requires additions to Mobile IP and support from the network infrastructure and terminals
  - Loose vs. tight coupling of mobility support in network architectures and terminal implementations
- Mobility management is combination of technologies to:
  - reach the Mobile Node
  - locate the Mobile Node
  - manage the movement (topology and administration)
- Mobility, heterogeneous networks and multi-access will be fundamental part of future operator networks..