# Moving towards Seamless Mobility: State of the Art and Emerging Aspects in Standardization Bodies

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# Executive Summary

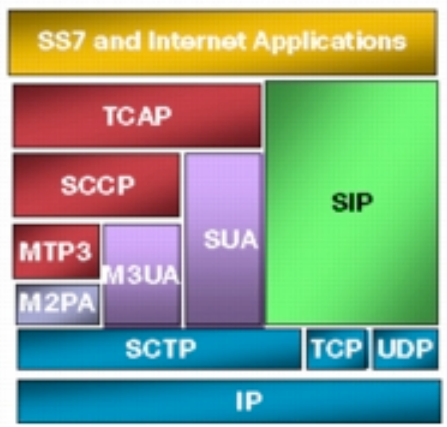
This presentation summarizes schemes enabling seamless mobility as currently discussed in standardization bodies.

Considered work includes amendments to IEEE 802.11 (TG k and TG r) and IEEE 802.16 (TG e), IEEE 802.21, as well as IETF internet drafts (SEAMOBY, DNA, NETLMM, MONAMI working groups). Aspects to couple 3GPP networks with IP-based network technologies are paraphrased in the end.

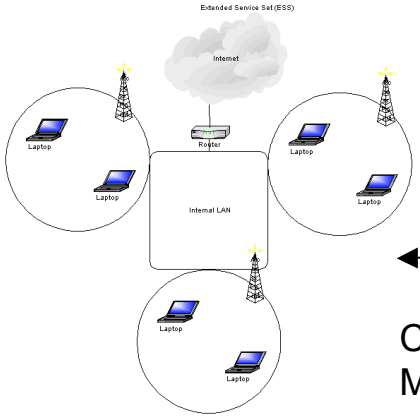
The presentation concludes with open issues and challenges towards seamless mobility support.

# Outline

Higher Layer Mobility

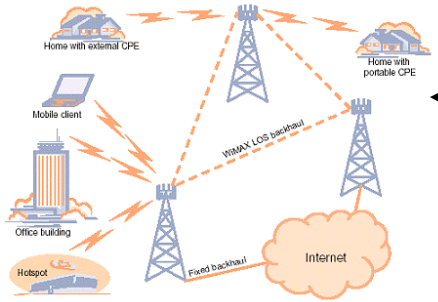



IEEE 802.21



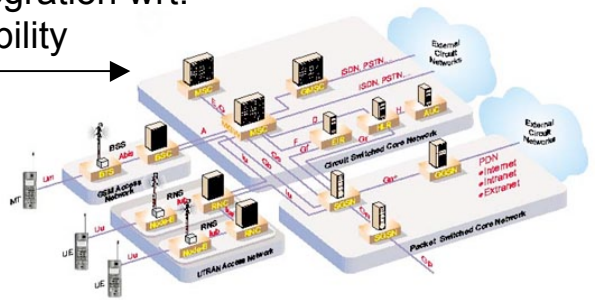

IEEE 802.11

Comparison of Mobility Support




IEEE 802.16

Integration wrt. Mobility



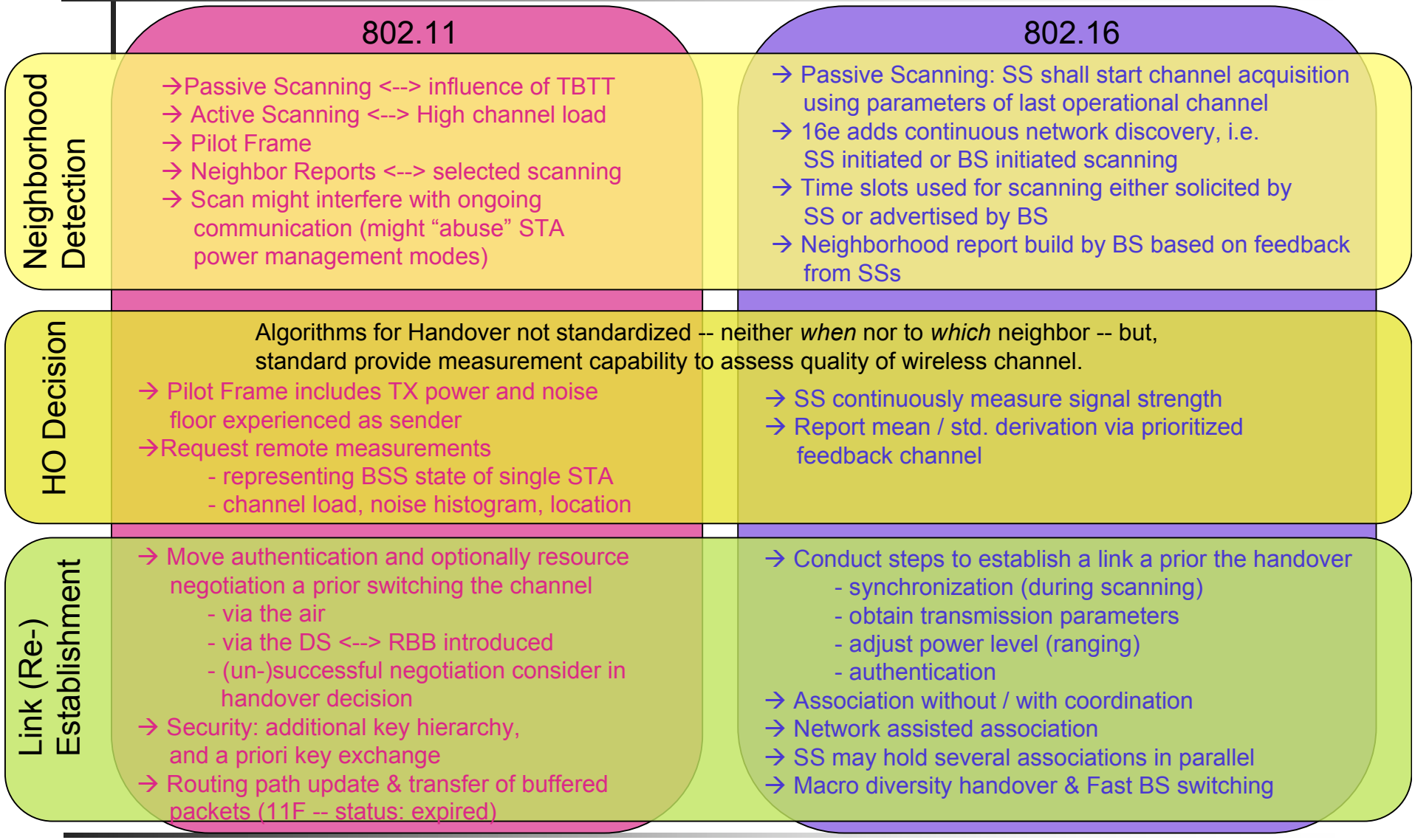
IP based networks

3GPP

# Generic mobility functions

- Detection of available radio cells
  - Mobile driven detection: active / passive scanning
  - Network assistance: provide (verified) information on available cells
- Criteria for handover decision
  - How to  decide: algorithm to decide on transition
  - Acquisition of input for this algorithm
- Re-establishment of link layer connectivity:
  everything that allows me to exchange user data via the MAC
  - synchronization PHY
  - authentication
  - when to start / stop transmitting packets via which AP

# Lower Layer Mobility: IEEE 802.11 & .16



# Higher Layer End-to-End Mobility Support

- Semantic Overloading
  - IP Address used for
    - routing purposes (representing the NAP) and for
    - node identification (ID of transport endpoint)
  - Problem: Change of L3 NAP breaks established transport connections

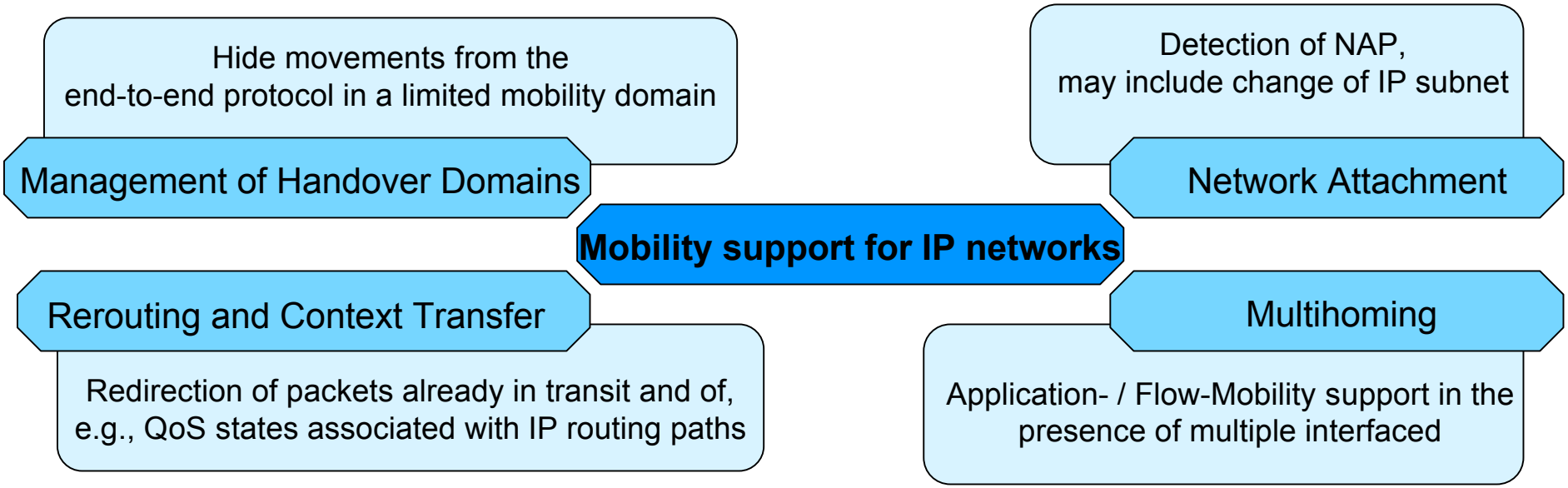
- Well known solutions:
  - Assign additional address representing the NAP
    --> mobile IP care-of-address
  - Separate namespace to identify host
    --> Host Identity Protocol (HIP)
  - Decouple stream identifier of transport protocols from IP
    --> Stream Control Transport Protocol (SCTP)

- Mobility handled at end-host rather than the network
  - Cannot solve all mobility problems (double jump of mobile nodes)
  - Compromise: reduced network complexity vs. signaling load
  - Increased user mobility yields to mobility support of the network

# IETF Mobility Support for IP Networks

**NETLMM** working group:
→ AR advertises prefixes which are routed to the MAP (Dectection of NAP --> DNA group)
→ RS contains (currrent) IP address
→ AR may update routing information at MAP
→ Standard IPv6 / DNA interface at MN

**DNA** working group: find available IPv6 Router (RAs & RSs)
→ Complete RAs (may be very large)
→ Reduce Size of Complete RAs
Landmark option (search prefix) & Identifier prefix




→ **SEAMOBY**
Transfer context state among network nodes
→ **HMIPv6**, **FastMIPv6**, & combinations
Additional hierarchies reduce impact of rerouting

**MONAMI** working group: Select "best" access technology
→load balancing / sharing & reliability etc.
→ links may fail --> find alternatives (DNA)
→ IP address change --> MIP, SIP. HIP
→ Source address selection (routing path)
→ Impact of changing link characteristics (MTU size)
→Register multiple CoAs at mIPv6 HA (draft-wakikawa)
→ Map flows to special CoAs (draft-soliman)

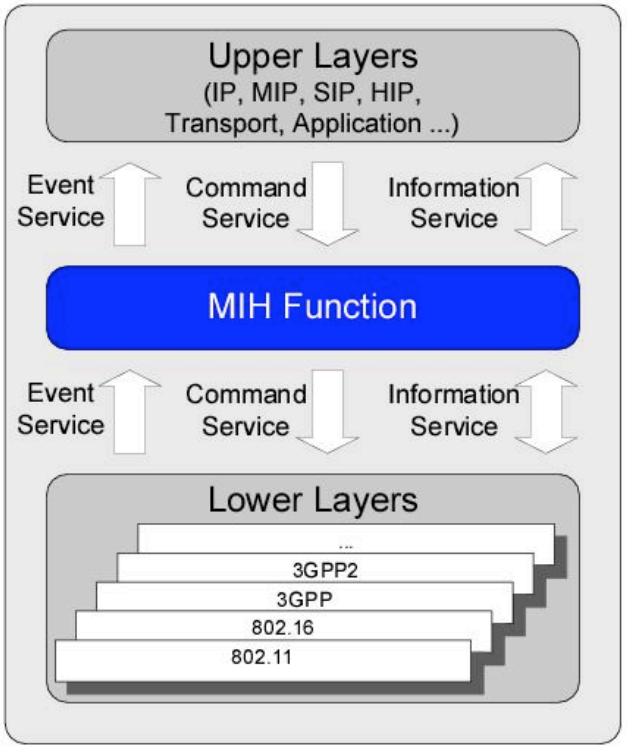
# Media Independent Handover Services

- Future situation:
  - Mobile Terminals (MT) equipped with multiple, heterogeneous NICs like 3GPP/3GPP2/802.11/802.16,
  - Simultaneous connectivity to several wireless access networks,
  - Change of access technology during on-going session.
- Requirement: Assistance for Management and Mobility support of
  - mobile terminals and
  - involved wireless access networks:
    - Points of attachments (e.g. AP, RNC),
    - Network management entities.
- Approach: Generic interface on top of Link Layer
  - Information exchange,
  - Control Possibility,
  - Event detection, notification, delivery.

  } within protocol stack, between MTs and networks.
- Media Independence by
  - Generic SAPs between MIHF and higher layers,
  - Enhanced technology-specific SAPs.

# IEEE 802.21: Media Independent Handover (MIH) Function

- Event Service:
  - Detects and signals that a handover is required,
  - MIH or Link event detection and trigger delivery,
  - From local as well remote MIHFs.
- Command Service:
  - Enables higher layers to control LLC, MAC and PHY,
  - Higher-layer handover Command Set allows link configuration and selection.
- Information Service:
  - Network discovery and information provision of neighbor cells,
  - Informational support for HOs,
  - E.g., geographical conditions, neighbor reports.



# How does 3GPP add into this puzzle

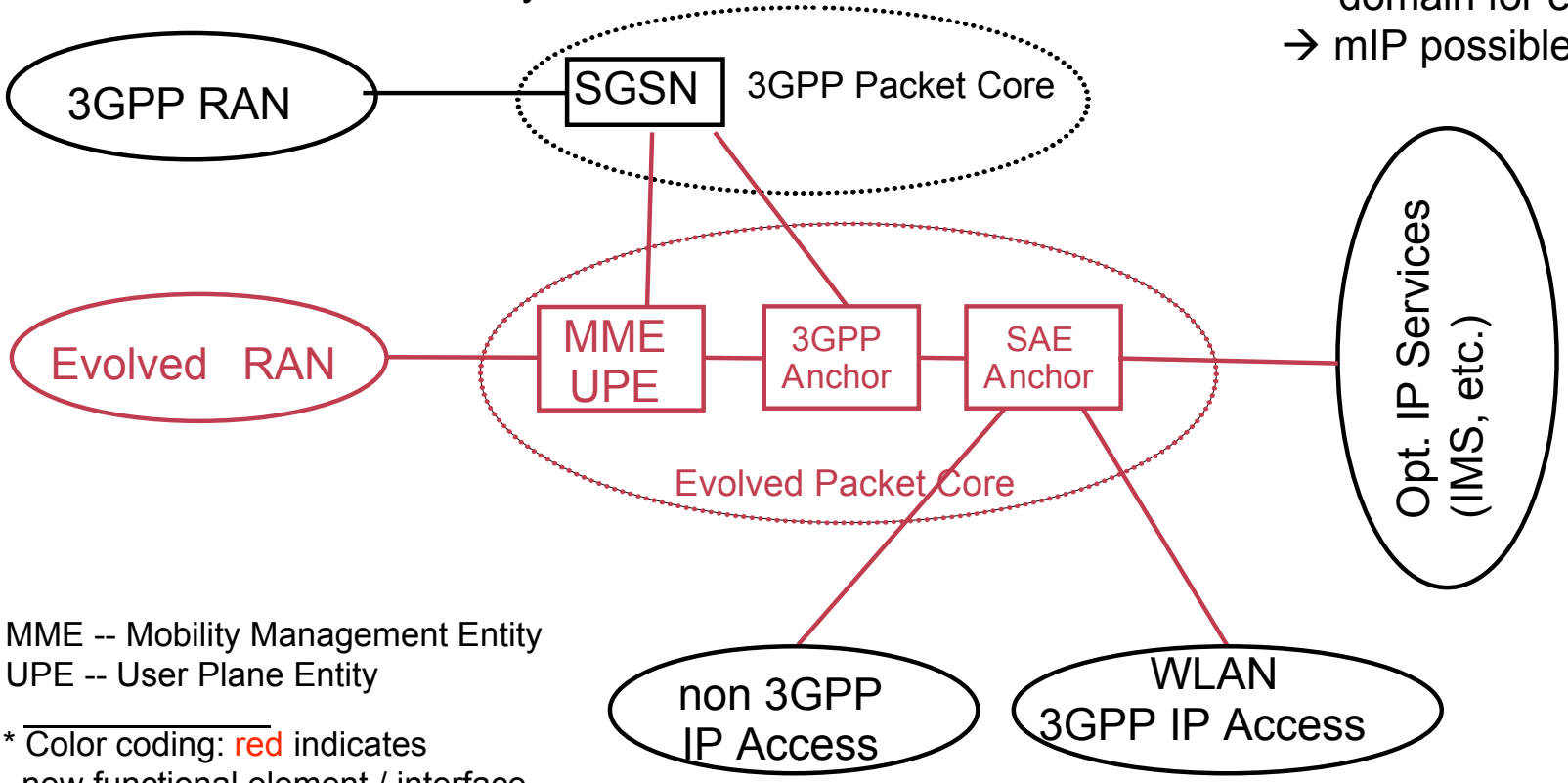
Current mobility scheme:

- Offers seamless mobility based on GTP
  - One protocol integrating mobility, QoS, security, charging
  - Mobility only within 3GPP network
- Neighborhood detection
  - MN measures radio conditions
- Handover decision
  - Network decides to add / remove access points
- Reestablishment
  - Network signals on behalf of MN
  - Seamlessness supported by macrodiversity

# Mobility support in 3GPP SAE

Conservative Approach:
- → GTP within 3GPP networks
- → mIP for interworking
- → SAE anchor acts as HA, UE as MN
- → Problem: Interaction GTP / IP, and mobility control moved to UE / MN

Progressive Approach:
- → GTP within 3GPP
- → NETLMM within 3GPP evolved 3GPP, and non-3GPP networks
- → at least one mobility domain for each
- → mIP possible on top




MME -- Mobility Management Entity
UPE -- User Plane Entity

* Color coding: red indicates new functional element / interface

# Challenges / Open Issues

- Mobility support beyond 3g: high data rate, small coverage area, highest velocity
- Upcoming architectures: vehicular & meshed networks
- Interoperability: PPP context transfer between 3GPP and IP networks
- Network vs. terminal controlled mobility
  - How to achieve a compromise between less complex network architecture and network-based mobility support required for seamless handover?
  - Resource optimization / network management in both schemes
  - Freedom of choice to select a network: user vs. operator interest
- Performance evaluation & comparison of different approaches:
  - Network vs. session layer mobility support (mIP -- SIP)
  - Network vs. lower layer approaches (e.g.: NETLMM vs. FBSS in 802.16)
- Security schemes might not optimally support mobility
  - How to improve existing ones
  - Accept mobility as an omnipresent aspect and consider this in the future designs
- Cross-Layer design and optimization:
  - Each abstraction level (i.g. 802.21) steals information.
    What information exchange is needed for further optimization?
    - Analysis of L2 events & triggers
    - Feedback on user specific mobility information
- Predictive handover preparation:
  - True prediction or just an "ahead-notification"
  - Accuracy, cost, complexity of algorithms

# Thank's for Your Attention.

# References

[1] V. Gupta et. al.: *IEEE 802.21 Overview of Standard for Media Independent Handover Services*. IEEE 802 Plenary, San Diego Tuesday, July 18 2006