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

M. Emmelmann(*), S. Wiethoelter(*),
A. Koepsel(*), C. Kappler(**), and A. Wolisz(*)

(*) Technical University Berlin (**) Siemens Communications

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Executive Summary

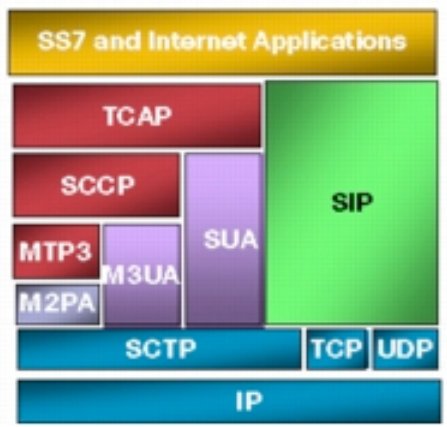
This presentation summarizes schemes enabling seamless mobility as currently discussed in standardization bodies.

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.

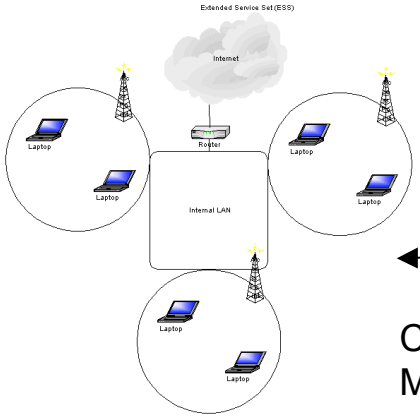
The presentation concludes with open issues and challenges towards seamless mobility support.

Outline

Higher Layer Mobility

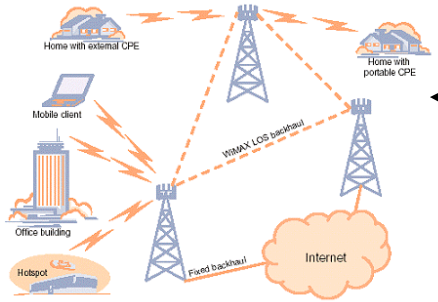


IEEE 802.21



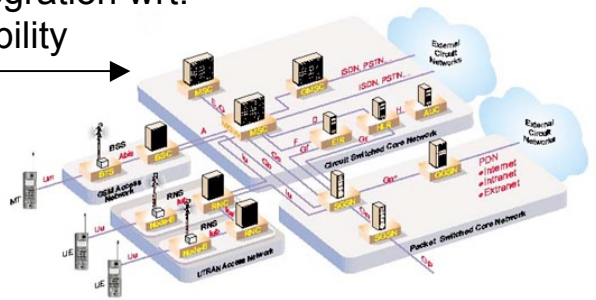
IEEE 802.11

Comparison of Mobility Support



IEEE 802.16

Integration wrt. Mobility



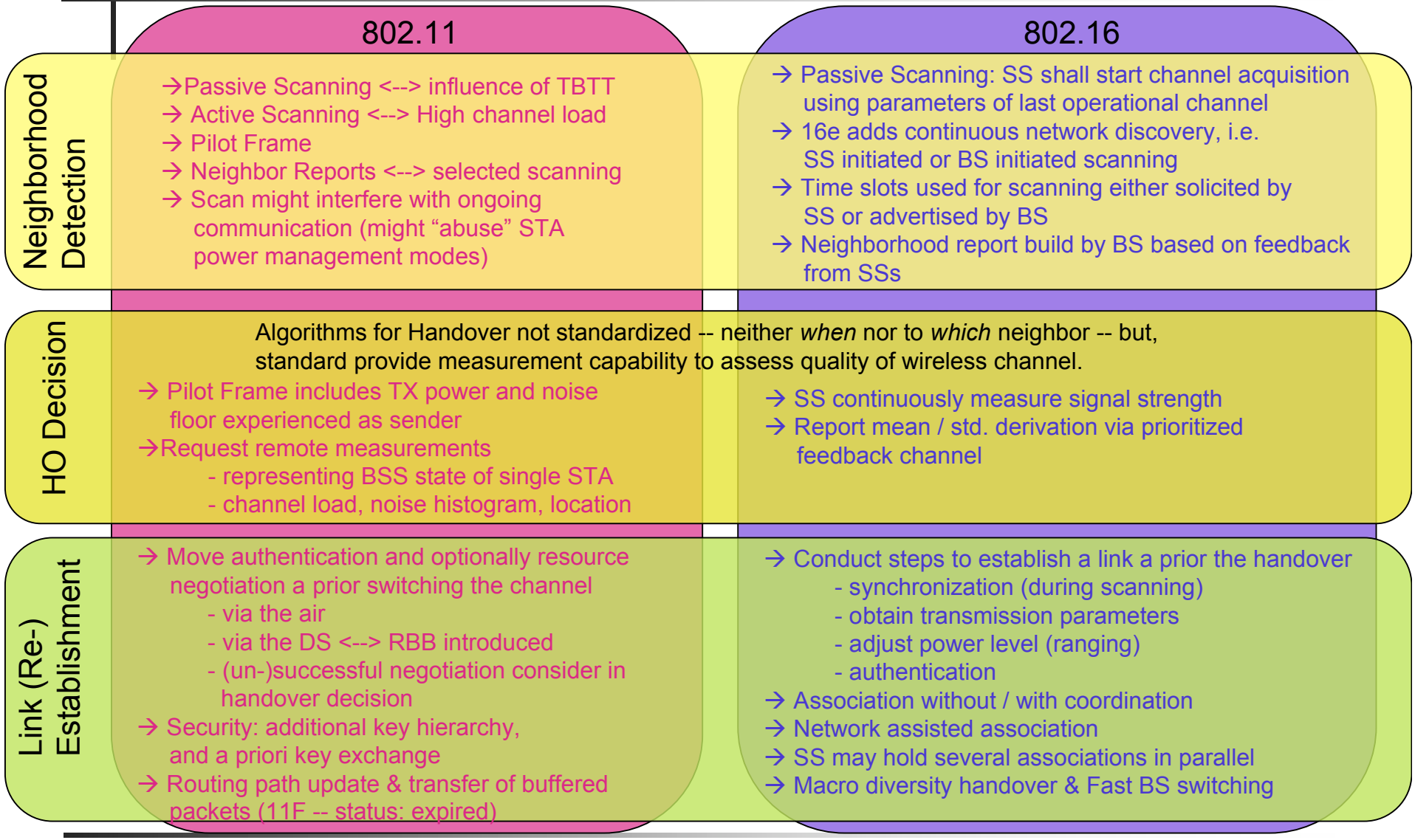
IP based networks

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

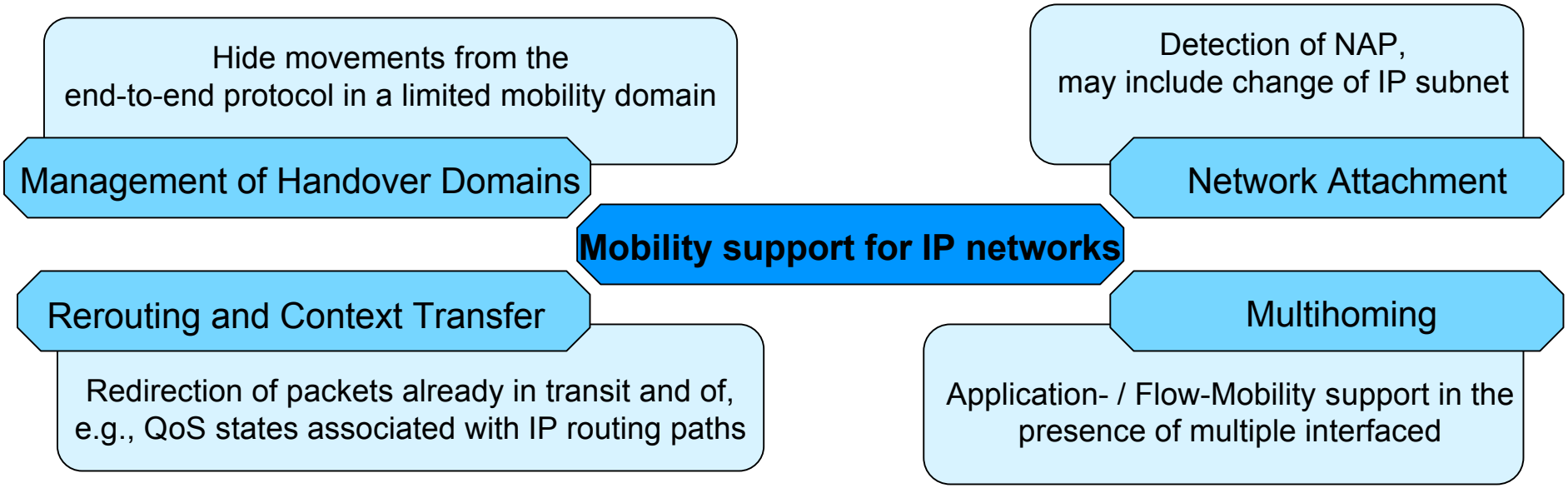
- Well known solutions:
  - Assign additional address representing the NAP
    --> mobile IP care-of-address
  - Separate namespace to identify host
    --> Host Identity Protocol (HIP)
  - Decouple stream identifier of transport protocols from IP
    --> Stream Control Transport Protocol (SCTP)

- 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)

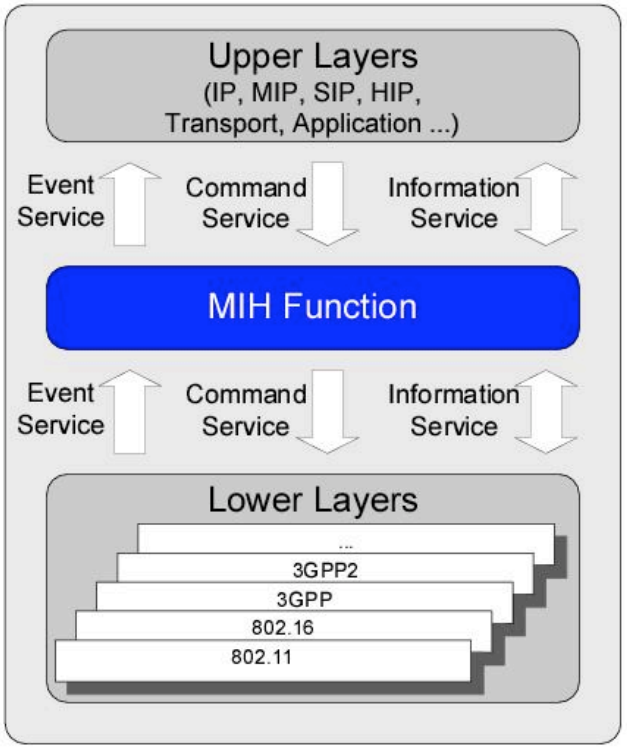
Media Independent Handover Services

- 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

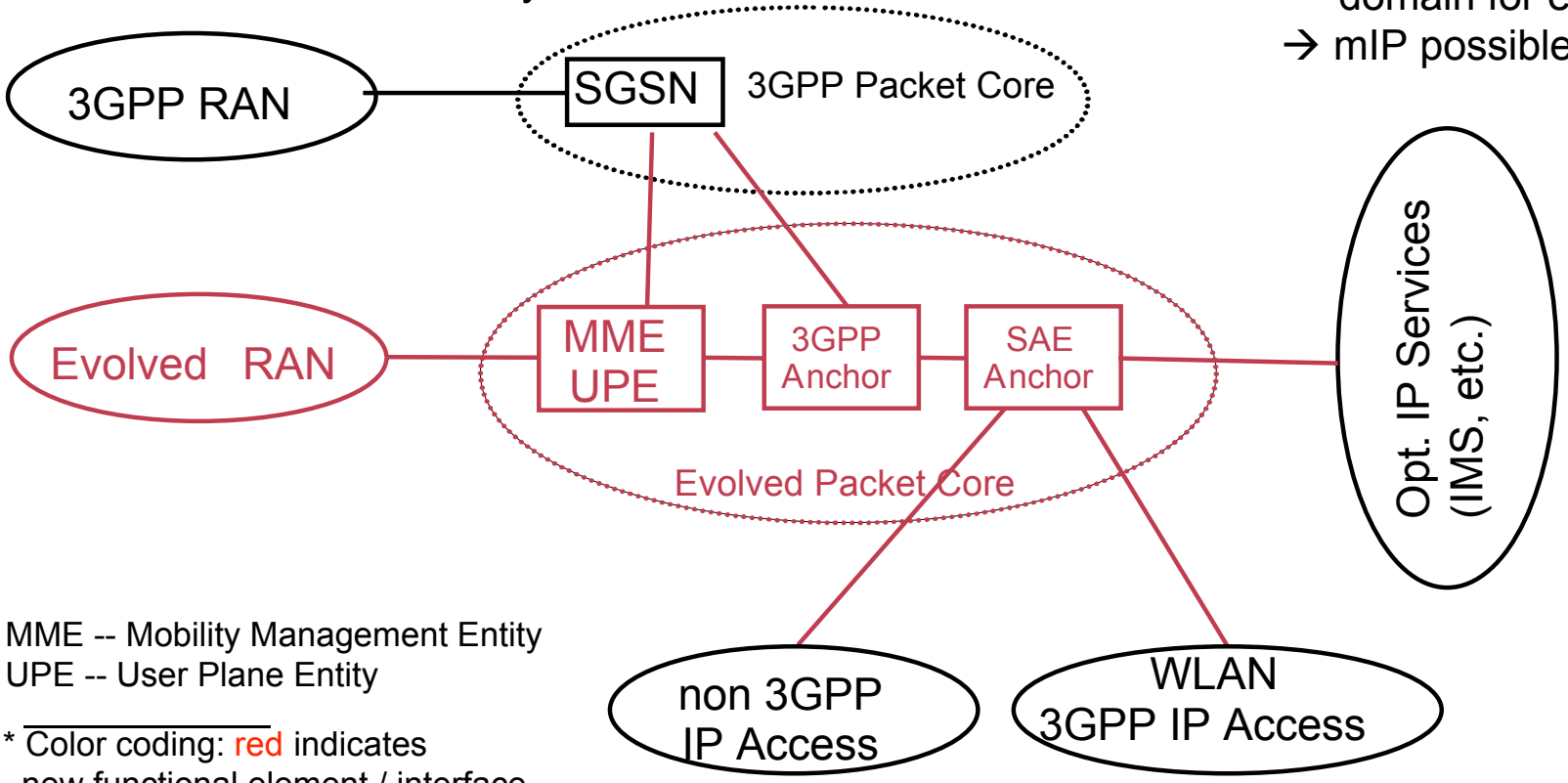
Current mobility scheme:

- 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