



ENABLING EFFICIENT AND OPERATIONAL MOBILITY IN LARGE HETEROGENEOUS IP NETWORKS

# State of the art on IP mobility and related applicability scenarios: vision of the IST ENABLE project



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Mobility Technologies in the Internet

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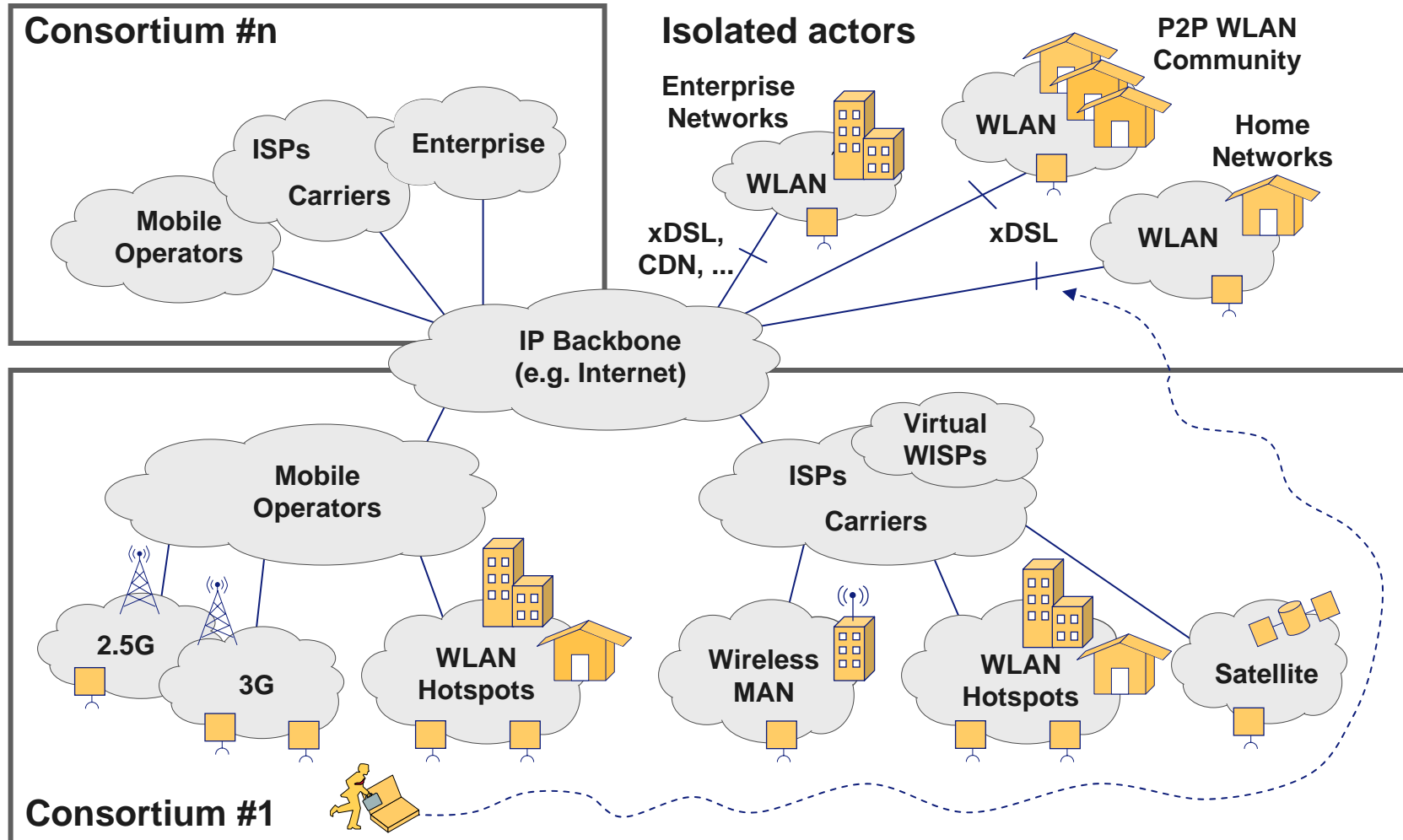


# A global mobility perspective

- Users are asking to stay always connected and enjoy voice, data and multimedia services anywhere with performance significantly better than today
  - the driver is the rapid diffusion of portable terminals like laptops, PDAs, smart phones, etc.
- The integration of heterogeneous access infrastructures is the key to cope with these needs
  - cheaper than a global coverage based on a single radio technology
  - different access technologies are optimized for different scenarios and using them together improves the overall user experience

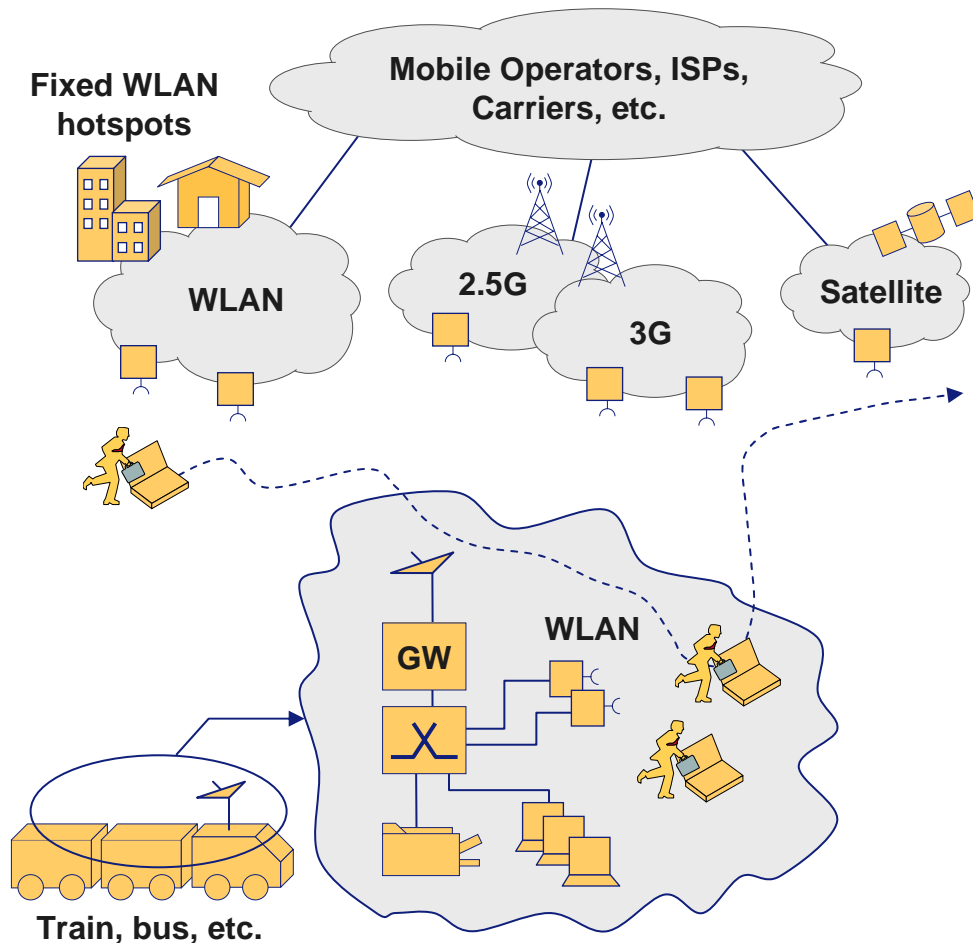


# Reference scenario (I)





## Reference scenario (II)



- The access networks can also be moving ones
  - on-board networks placed on ships, cars, buses, etc.
  - typically WLAN networks (IEEE 802.11x)
  - the purpose is the delivery of services to the travelers
    - ❑ Internet browsing
    - ❑ access to local content



# Requirements

## User's perspective

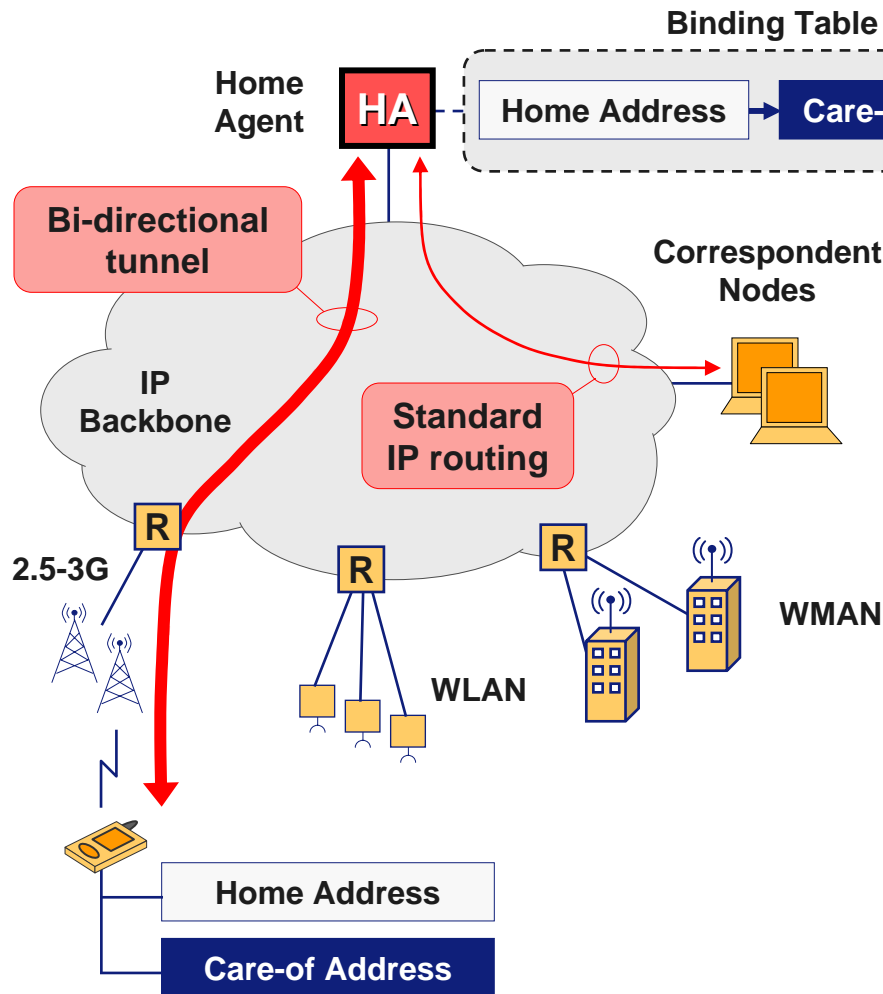
- **Network complexity has to be transparent to the user**
  - home services accessible anywhere with the highest available performance
  - movements should not disrupt on-going applications (browsing, VoIP, etc.)
  - mobility should not require any manual intervention
  - automatic discovery of local services available in the visited area (e.g. airport)

## Operator's perspective

- **Control of mobility service**
  - delivery of premium features only to authorized users
  - availability of charging data in any scenario
- **Optimal usage of network resources**
- **Smooth deployment**
- **High scalability**
  - support for a growing number of users and terminals (PDAs, phones, sensors, etc.)
- **High reliability**



# Mobile IP: a key enabling technology



- Same design principles for IPv4 and IPv6
  - mobile node has two addresses
    - ❑ Home Address: identity
    - ❑ Care-of Address: location (changes at every movement)
  - Home Agent handles packet re-routing using tunneling
- Avoidance of triangle routing possible with Mobile IPv6
  - route optimization

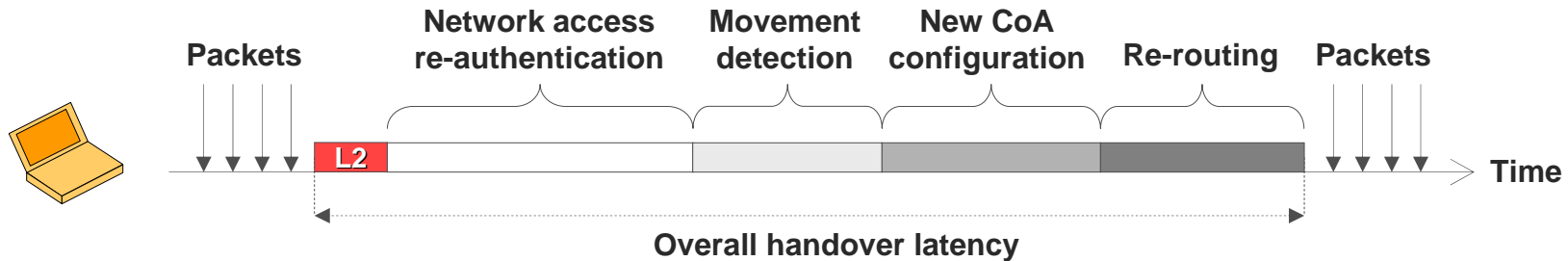
# Status of Mobile IP standardization

- Base protocol available for both IPv4 and IPv6
- On-going work in IETF to address deployment issues
  - **bootstrapping and authorization of mobility service**
    - ❑ autoconfiguration of MNs and HAs leveraging the AAA platform of the provider
    - ❑ some building blocks available for MIPv4, others being developed for MIPv6
  - **mobility across IPv4-only and IPv6-capable access networks**
    - ❑ dual-stack Mobile IPv4 and dual-stack Mobile IPv6 are being specified
  - **interworking with middleboxes (FWs, VPNs)**
  - **reliability of mobility service**
    - ❑ on-going work on failover mechanisms for Mobile IPv6
    - ❑ the idea is to make it possible for the mobile node to perform a soft switch to a backup HA in case of failure of the primary HA

Speech



# Improvement of Mobile IP performance (I)



- **Minimization of re-authentication latency**

- **fast re-authentication**

- ❑ supported by several EAP methods (e.g. EAP-SIM)

- **pre-authentication**

- ❑ solutions available for WLANs and WMANs (e.g. IEEE 802.11i)
- ❑ on-going IETF work on pre-authentication mechanisms for EAP

Speech

- **Minimization of movement detection delay**

- IETF work on DNA and optimistic DAD

- **layer 2 triggers and network-controlled handover commands**

- ❑ possibility to leverage the IEEE 802.21 framework

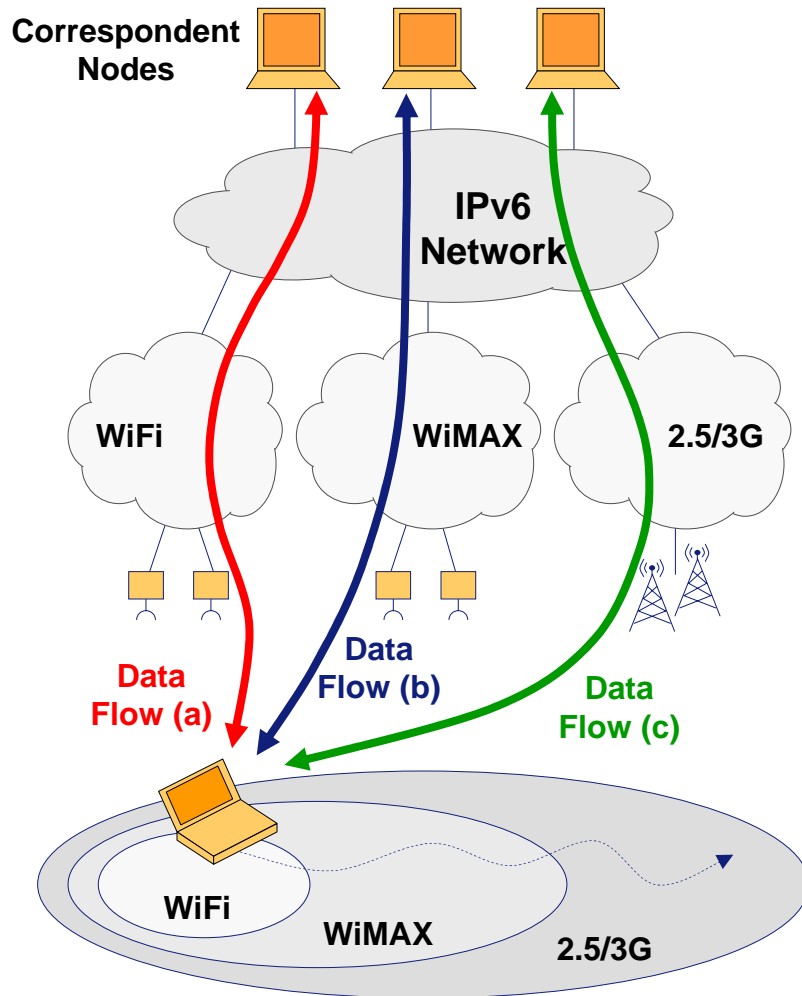
Speech

## Improvement of Mobile IP performance (II)

- Minimization of new care-of address configuration and re-routing latencies
  - Hierarchical Mobile IPv6 (HMIPv6)
    - ❑ local movements are managed locally, without involving the HA
  - Fast Handovers for Mobile IPv6 (FMIPv6)
    - ❑ proactive mobility management
    - ❑ needs layer 2 triggers
- Both HMIPv6 and FMIPv6 are still experimental efforts due to outstanding security and authorization issues
  - work in progress in IETF on solutions to set-up and manage the security associations between MNs and local mobility agents
    - ❑ AAA-based and CGA-based approaches are being investigated



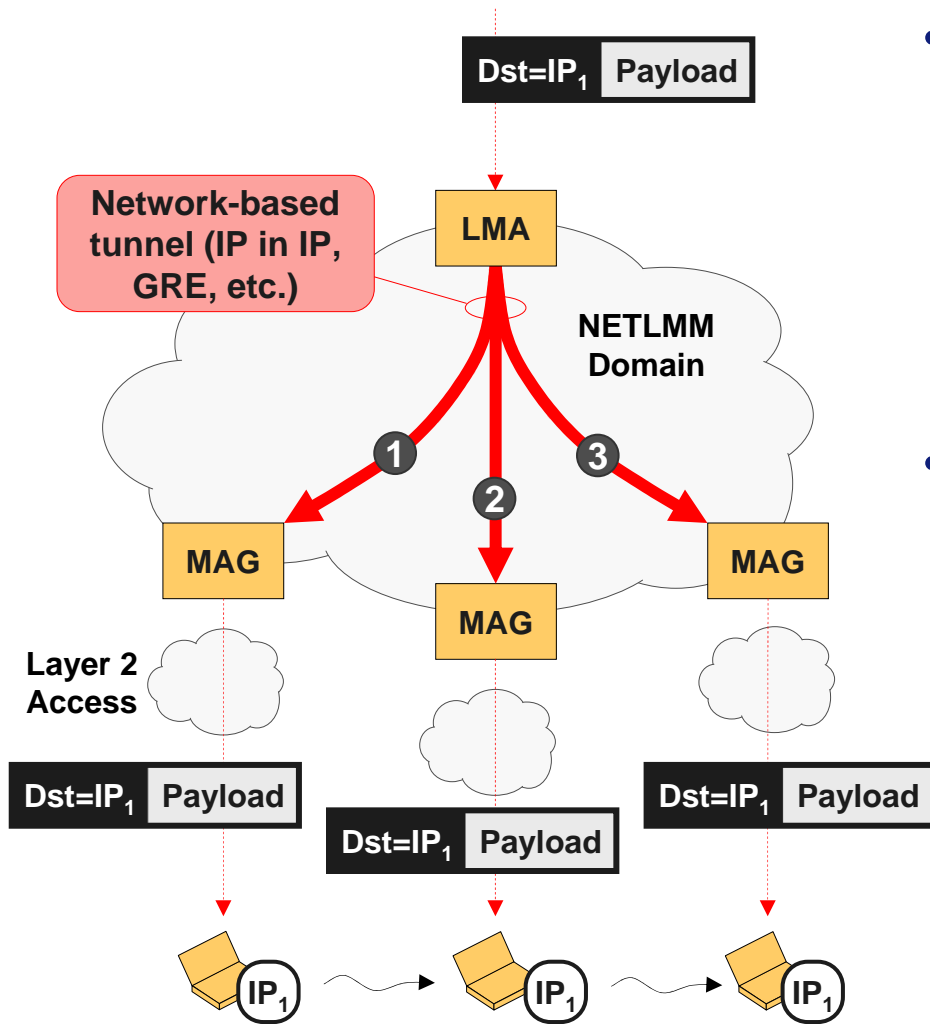
# Multi-interface terminals



- Simultaneous connectivity through all available radio accesses
  - performance optimization
- On-going work in IETF to design the necessary Mobile IPv6 extensions
  - registration of multiple Care-of Addresses on the Home Agent
    - for receiving traffic through all radio interfaces
  - registration of explicit filtering rules on the Home Agent
    - for redirecting specific traffic flows on specific access networks
- More work needed to achieve network control on multi-homing capabilities



# Network-based solutions



## • Key idea

- IP address does not change across movements as long as the user stays within a “local” domain
- mobility is handled by routers with minimum terminal involvement

## • Implementations of the concept

- some non standard proposals on Proxy Mobile IPv4/v6
- NETLMM protocol

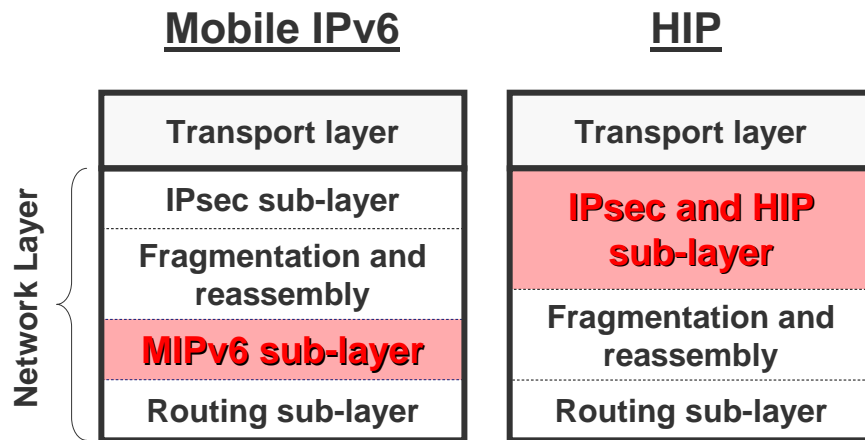
## Expected benefits

- reduced overhead over the air
- improved support for devices with limited processing capabilities



# Longer term efforts

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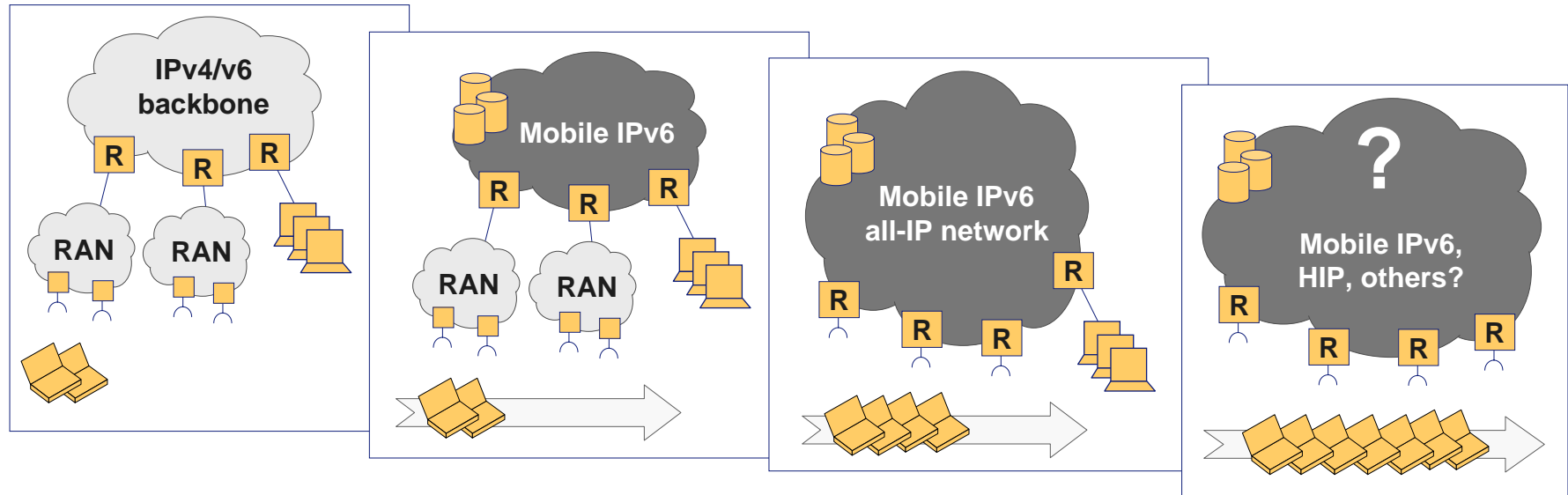


- Host Identity Protocol
  - removes identifier role from IP addresses
    - ❑ Host Identifiers (HI) used instead
    - ❑ HI is a public key of asymmetric public/private key pair
  - support for security, mobility and multi-homing

- Both MIP and HIP are based on “indirection”
  - assume a logical or physical indirection point interposed between sender and receiver (e.g. HA in case of MIP)
- Another option is to use an overlay network (e.g. a p2p overlay) to implement the indirection layer
  - Internet Indirection Infrastructure (I3)



# The ENABLE vision



## Today

**Dedicated RANs optimized for specific services**

- ❑ cellular (2.5-3G)
- ❑ Wireless LAN
- ❑ WMAN (WiMAX)

## Step 1

**Integration of heterogeneous RANs to offer efficient and cost-effective ubiquitous mobility**

- ❑ MIPv6 is the key

## Step 2

**Smooth migration to an all-IP network architecture**

- ❑ all services over IP
- ❑ MIPv6 with extensions

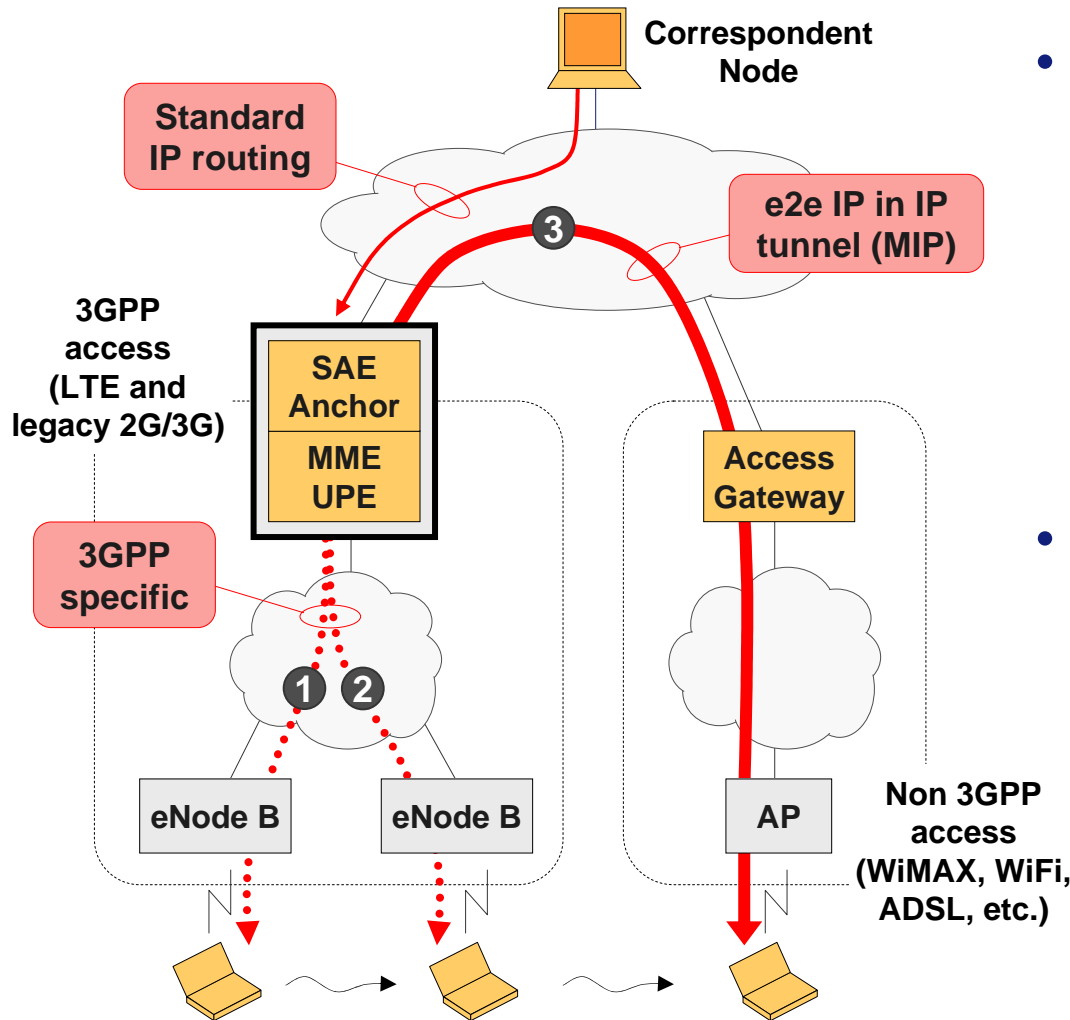
## Step 3

**Fully mobile Internet**

- ❑ tremendous growth in the number of terminals
- ❑ MIPv6 might suffer its age



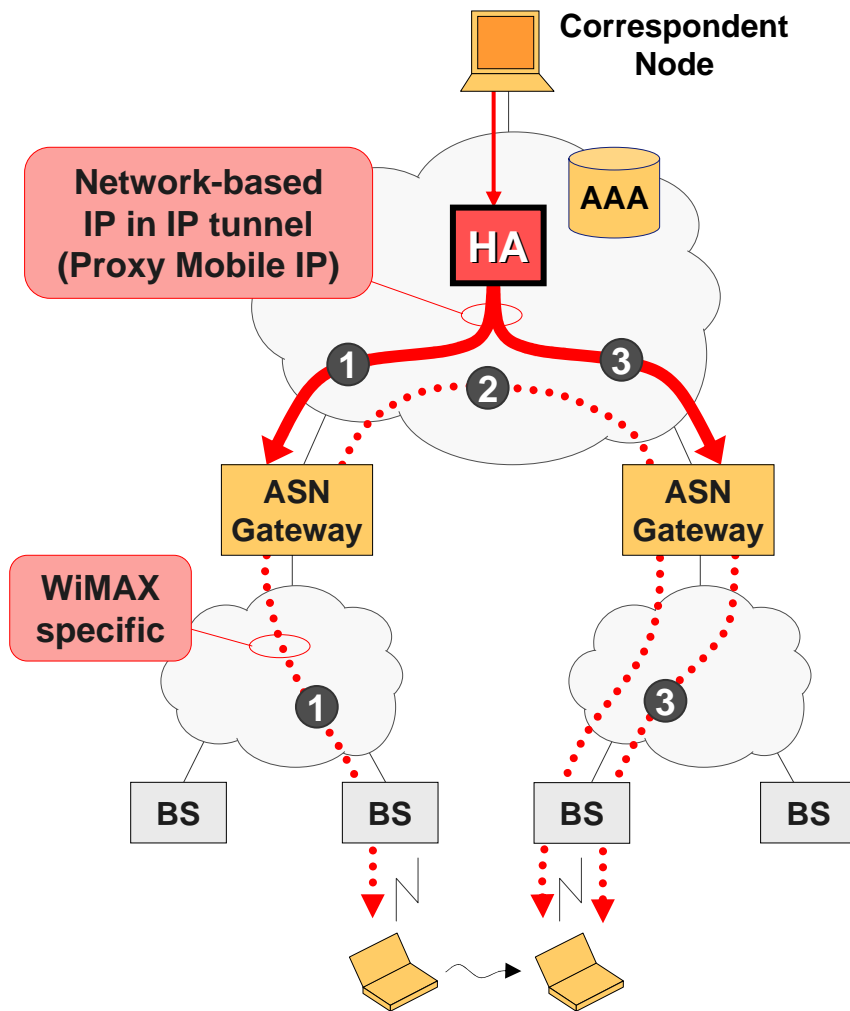
# Applicability scenarios: 3GPP/SAE



- Intra-3GPP mobility is handled in a network based fashion
  - re-use of 3GPP tunneling protocols between UPE and evolved Node B
  - no tunneling over the air in the 3GPP system
- MIPv4/v6 under consideration for 3GPP-non-3GPP mobility
  - SAE Anchor works as HA, with extensions for
    - ❑ authorization and bootstrapping of mobility service
    - ❑ charging and policy control
  - no route optimization for now



# Applicability scenarios: WiMAX Forum



- Intra-system mobility for active mode terminals is network-based
  - the terminal stays anchored with a single ASN Gateway
    - ☐ lower handover latency
- Mobile IP is used for handling vertical handovers and ASN Gateway changes
  - ASN Gateway changes can be triggered by the network while in idle mode
    - ☐ mainly used for optimizing routing and ensure load-sharing across ASN GWs
    - ☐ no strict performance requirements
  - PMIPv4, MIPv4 and MIPv6 are the alternatives considered so far
    - ☐ PMIPv6 still needs work in IETF

## Conclusions

- MIPv4 and MIPv6 protocols are stable, but
  - more work needed on **policy control of mobility** in order to make deployment interesting for operators
    - ❑ mobility decisions cannot be completely terminal-based
    - ❑ operator control is needed to optimize the usage of network resources and ensure the user gets only what he is paying for
- Other more recent IETF/IRTF efforts, like NETLMM and HIP, need more research
  - actual deployment of NETLMM is uncertain
    - ❑ 3GPP and WiMAX Forum are looking at PMIP for network-based mobility
  - HIP could be an interesting MIPv6 alternative in the long term, but its architectural implications need to be better understood

## Further information

- Visit ENABLE project website [www.ist-enable.com](http://www.ist-enable.com)
- Contact

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## References (I)

- Mobile IP base protocol
  - Mobile IPv4: rfc3344
  - Mobile IPv6: rfc3775 (base protocol) and rfc3776 (usage of IKE for security)
- Mobile IP extensions to address deployment issues
  - MIPv6 bootstrapping: draft-ietf-mip6-bootstrapping-split-02 (solution for split scenario), draft-ietf-mip6-bootstrapping-integrated-dhc-01 (solution for integrated scenario)
  - AAA interfaces for MIPv6: draft-ietf-mip6-aaa-ha-goals-03 (goals for AAA-HA interf.)
  - mobility across IPv4/IPv6 accesses: draft-ietf-mip6-nemo-v4traversal-02 (dual-stack Mobile IPv6)
  - MIPv6 interworking with FWs: rfc4487 (problem statement)
  - HA failover mechanisms: draft-ietf-mip6-hareliability-00 (HA-HA protocol), draft-ietf-mip6-ha-switch-00 (MN-HA interface)
- Localized Mobility Management
  - Regional Registration: draft-ietf-mip4-reg-tunnel-03
  - Hierarchical Mobile IPv6: rfc4140



## References (II)

- Fast Handovers
  - Fast Handovers for Mobile IPv4: draft-ietf-mip4-fmipv4-01
  - Fast Handovers for Mobile IPv6: rfc4068
- Network-based solutions
  - Proxy Mobile IPv4: draft-leung-mip4-proxy-mode-01
  - NETLMM: draft-ietf-netlmm-nohost-req-04 (goals), draft-ietf-netlmm-nohost-ps-05 (problem statement) draft-giaretta-netlmm-dt-protocol-01 (protocol)
- Longer term efforts
  - HIP: rfc4423 (architecture), draft-ietf-hip-base-06 (base protocol), draft-ietf-hip-mm-04 (mobility and multihoming extensions)
  - I3: I. Stoica, D. Adkins, S. Zhuang, S. Shenker, S. Surana, "Internet Indirection Infrastructure", Proceedings of ACM SIGCOMM, August 2002
- Applicability scenarios
  - 3GPP: TR 23.882 "3GPP System Architecture Evolution: Report on Technical Options and Conclusions (Release 7)"
  - WiMAX Forum: see [www.wimaxforum.org](http://www.wimaxforum.org) (specs not publically available)