Applicability of IETF Mobility Solutions to the 3GPP All IP Network

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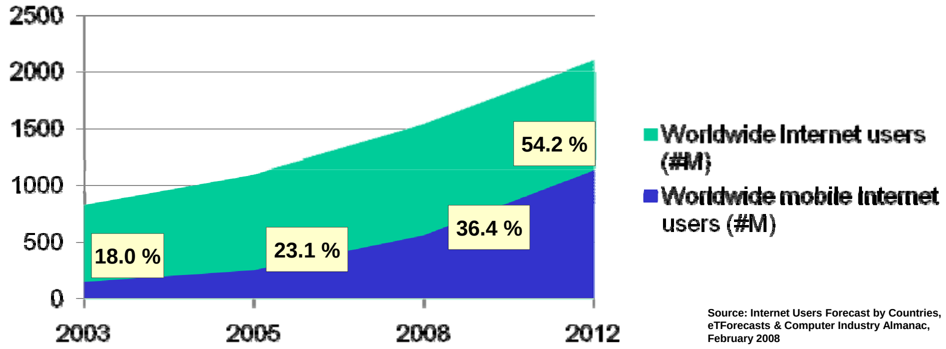
Outline

- Motivation
- All-IP paradigm in 3GPP LTE network
- Survey of candidate IETF protocols for IP mobility
  - DS-MIPv6
  - PMIP
  - SHIM6
  - MPTCP
- Requirements definition
- Comparison of the considered protocols against considered requirements

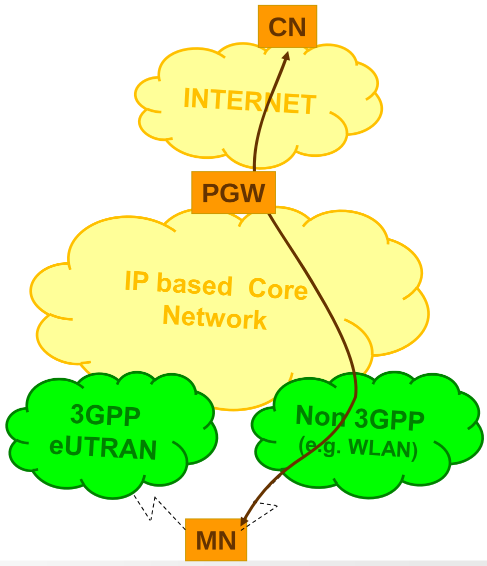
Motivation



- Over 4 billion cellular subscriptions
  - Over 3 billion of these based on 3GPP standardized technology
- Increase of IP based services accessed by users through 3GPP device
- 3GPP solution: definition of all-IP network

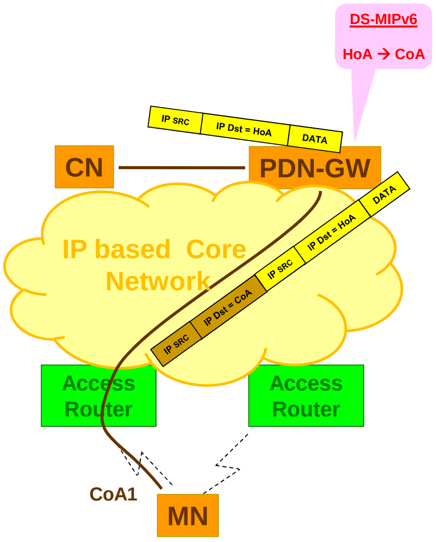
All-IP network paradigm as seen by 3GPP

- 3GPP developed a network architecture based on the All-IP paradigm
  - Mobile Node (MN) communicates with any other end point (Correspondent Node – CN) through IP protocol
  - Full integration of other non-3GPP technologies
- Packet Data Network gateway
  - Element providing access to the offered services (e.g. Internet)
  - Mobility Anchor
    - IETF IP mobility protocols are used
      - Proxy Mobile IP
      - Dual Stack Mobile IPv6
- All-IP network opens the door to further developments (e.g. local break out, multiple access connectivity)
- **Here: analysis of the applicability of other protocols defined in IEFT to the 3GPP all-IP network**



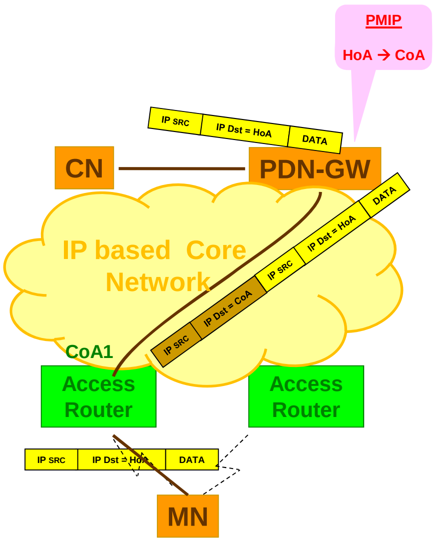
Dual stack Mobile IPv6 overview

- Extension of MIPv6 to enable MN to work with IPv4 access networks (as well as with IPv4 applications)
- Elements involved
  - MN
  - Home Agent (mobility anchor)
    - Home Agent usage for the data packet communication can be avoided using Route Optimization
- MN uses 2 IP addresses
  - IP address routable to the access network the MN is attached to
    - The IP address is called Care-of Address (CoA)
    - The CoA is changed anytime the MN connects to a new access router
  - IP address routable to the Home Agent (HA)
    - The IP address is called Home Address (HoA)
    - The HoA never changes while MN roams to different access routers
    - The HoA is the IP address use for applications
      - Sockets are bound to the HoA
- MN dynamically binds its CoA with the HoA
- Routing of packets
  - Packets destined to the MN are routed to the HA
  - HA intercepts the packets
  - HA encapsulate the packets to the registered CoA
  - Packets are delivered to the MN



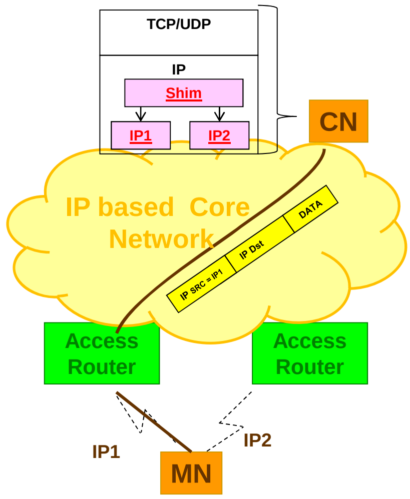
Proxy Mobile IPv6 overview

- Historically it is an extension of MIPv6
- Elements involved
  - MN
  - Access router
  - Home Agent (mobility anchor)
- PMIP uses 2 IP addresses as CoA and HoA in DS-MIPv6
  - CoA is an address configured on the access router
- The access router binds its CoA with the HoA of the MN
  - The Access router communicates to the HA its CoA and binds it with the HoA of the MN
  - The HA associates the received CoA to the HoA of the MN
- Routing of packets
  - Packets destined to the MN are routed to the HA
  - HA intercepts the packets
  - HA encapsulate the packets to the registered CoA
  - Packets are delivered to the MN



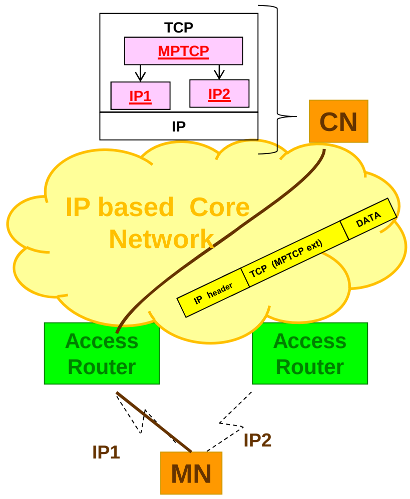
Level 3 Shim for IPv6 (SHIM6) overview

- Defines an extension to the IP layer (called “SHIM layer”)
- Elements involved
  - Two end points of the communication (MN and CN)
- The shim layer manages the change of the IP addresses used for communication between the 2 end points
  - The two end nodes exchange all the list of available IP addresses
  - Dynamic update of IP addresses
- Each end point uses the first IP address received from the other end point as identifier for applications
  - That address is bound to the socket
- Routing of packets
  - Any of the registered IPv6 addresses can be used to send packets
  - No addition of extensions to data packets from SHIM6 layer
  - When a packet is received by an end point the shim6 layer uses the list of registered IP addresses to demultiplex the data to the proper socket



Multipath TCP (MPTCP) overview

- Defines an extension to TCP protocol
  - Can be seen as the equivalent of SHIM6 “pushed to TCP layer”
- Elements involved
  - Two end points of the communication (MN and CN)
- Each flow can be split into multiple sub-flows
  - Different sub-flows can be mapped to different IP addresses
  - The two end nodes exchange all the list of available IP addresses during TCP 3-way handshake
  - IP addresses can be added and removed during the ongoing communication
- Routing of packets
  - Any of the registered addresses can be used to send packets
  - Each packet includes a MPTCP extension
  - When a packet is received by an end point the MPTCP layer uses the extensions included in the packet to demultiplex the data to the proper socket



Considered requirements

- Supported IP version:
  - Both IPv4 and IPv6 addressing schemes are supported by 3GPP architectures.
  - IP address functionality
    - At the identifier level
      - IP address used as identifier for sockets
      - IP address used as locator
- Double jump support:
  - Mobility solutions should support the scenario where both end points of the communication perform handover concurrently.
    - This scenario can have impacts to control plane and potentially can break the communication
- Minimal impacts on the core network:
  - Current IP based mobility solutions adopted by 3GPP rely on the usage of a mobility anchor deployed in the network.
    - Deployment and maintenance costs increase directly with number of "boxes"
- Packet loss:
  - Robustness of considered protocols towards packet loss during handover must be taken into account

Comparison against defined requirements

	DS-MIPv6	PMIP	SHIM6	MPTCP
Supported IP version	IPv4 and IPv6 addresses are supported (route optimization supports IPv6 only)	IPv4 and IPv6 addresses are supported	IPv6 addresses are supported	IPv4 and IPv6 addresses are supported
Double jump support	Supported	Supported	Not supported	Not supported
Impacts on core network	Requirement of Mobility Anchor	Requirement of Mobility Anchor	No requirement on the network	No requirement on the network
Packet loss	New functionalities limiting packet loss can be added to mobility anchor	New functionalities limiting packet loss can be added to mobility anchor	No dedicated elements in the network to enable packet loss reduction	No dedicated elements in the network to enable packet loss reduction

Conclusion

- Outlined All-IP network paradigm under 3GPP prospective
- Analysis of 4 protocols defined in IETF
- Definition of requirements derived from 3GPP architecture
- Comparison of considered protocols against defined requirements

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Abbreviations:

3GPP: 3rd Generation Partnership Project
CN: correspondent node
DSMIPv6: Dual Stack Mobile IPv6
E-UTRAN: Evolved UMTS Terrestrial Radio Access Network
IETF: Internet Engineering Task Force
IP: Internet Protocol
LTE: Long Term Evolution
MN: Mobile Node
MPTCP: multipath TCP
PDN: Packet Data Network
PGW: PDN Gateway
PMIPv6: Proxy Mobile IPv6
TCP: Transport Control Protocol
UDP: user datagram protocol
WLAN: Wireless Local Area Network

THANK YOU!