PMIPv6 based 3GPP/WLAN inter-working MAEMO support challenges

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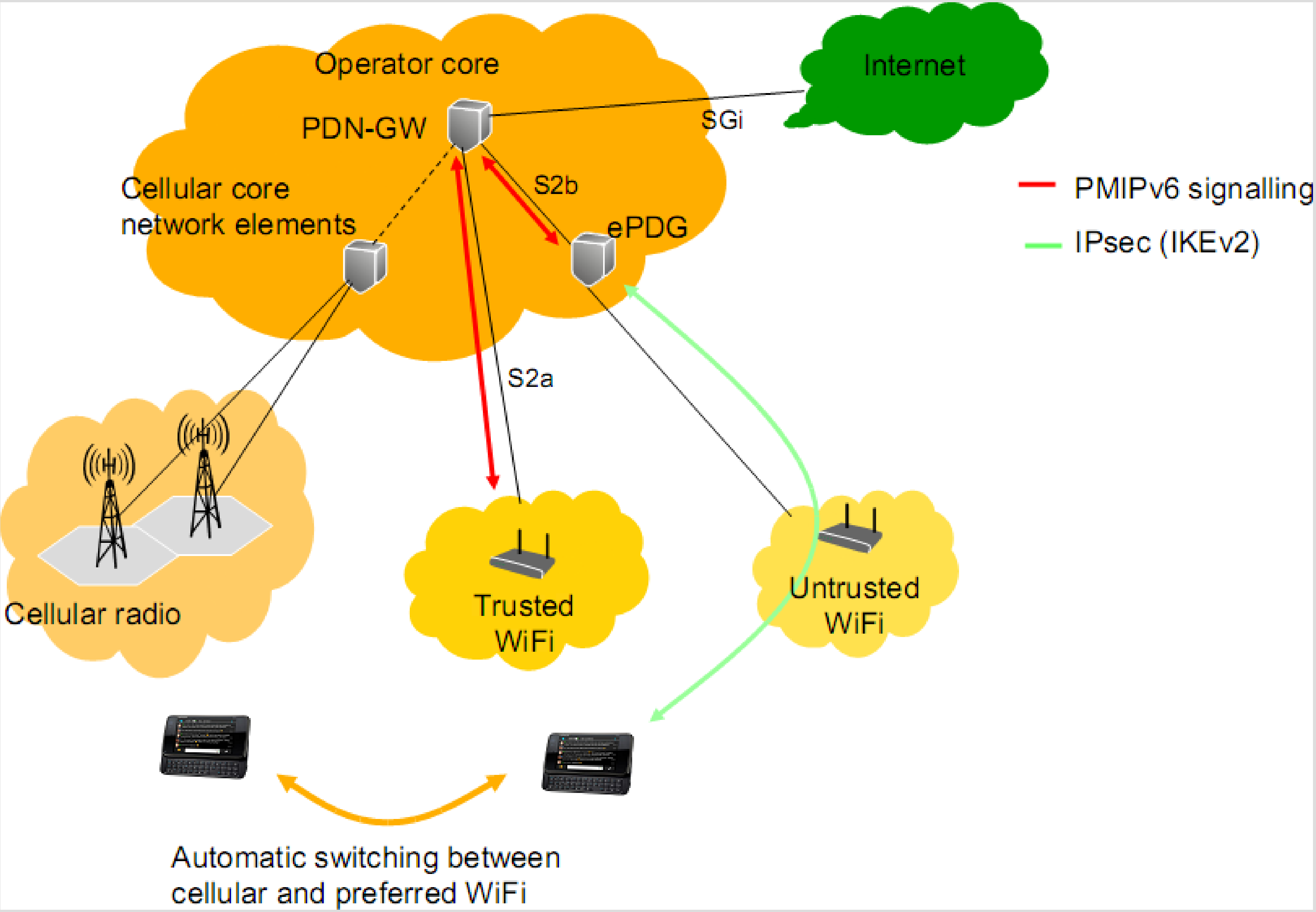
Overview: 3GPP PMIPv6 based service continuity when moving between cellular and WiFi



Main Tasks

- Develop N900 and/or Linux laptop PC device support for PMIPv6 based mobility between 3GPP/WiFi
- ANDSF + automatic switching between 3GPP/WiFi
  - Develop ANDSF (Access Network Discovery and Selection Function) type of functionality for Linux laptop PC
- We conducted preliminary research on offload in 3GPP/WLAN networks
  - "How does PMIPv6 perform?"

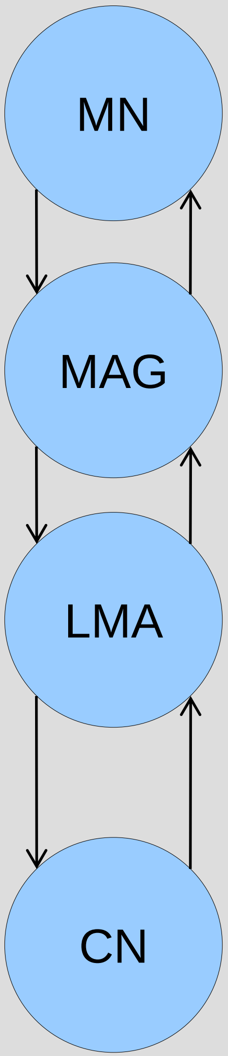
Research Goal

- Study offload in heterogeneous MANETs consisting of 3GPP and WLAN nodes
- Seamless: Connectivity → max
  (Offload time → min)
- Resource-friendly:
  - Extra bandwidth utilization → min
  - Base stations' load → min

What Has Been Done

- There are various protocols. 3GPP supports MIPv4 in FA mode, PMIPv6, DSMIPv6
- We evaluated performance of PMIPv6 protocol in simulation
- *Crude* simplifications:
  - Only WLAN nodes
  - No base stations (flat routing)
  - UDP-based client-server

How It Works: PMIPv6



Mobile Node: moves from one network to another. Connects to CN (Correspondent Node)

Mobile Access Gateway: provides network access to MN. Informs LMA of MN's position.

Local Mobility Anchor: keeps information about MN's location and its current MAG. Tunnels packets sent to MN through appropriate MAG.

Correspondent Node: Provides services MN connects to.

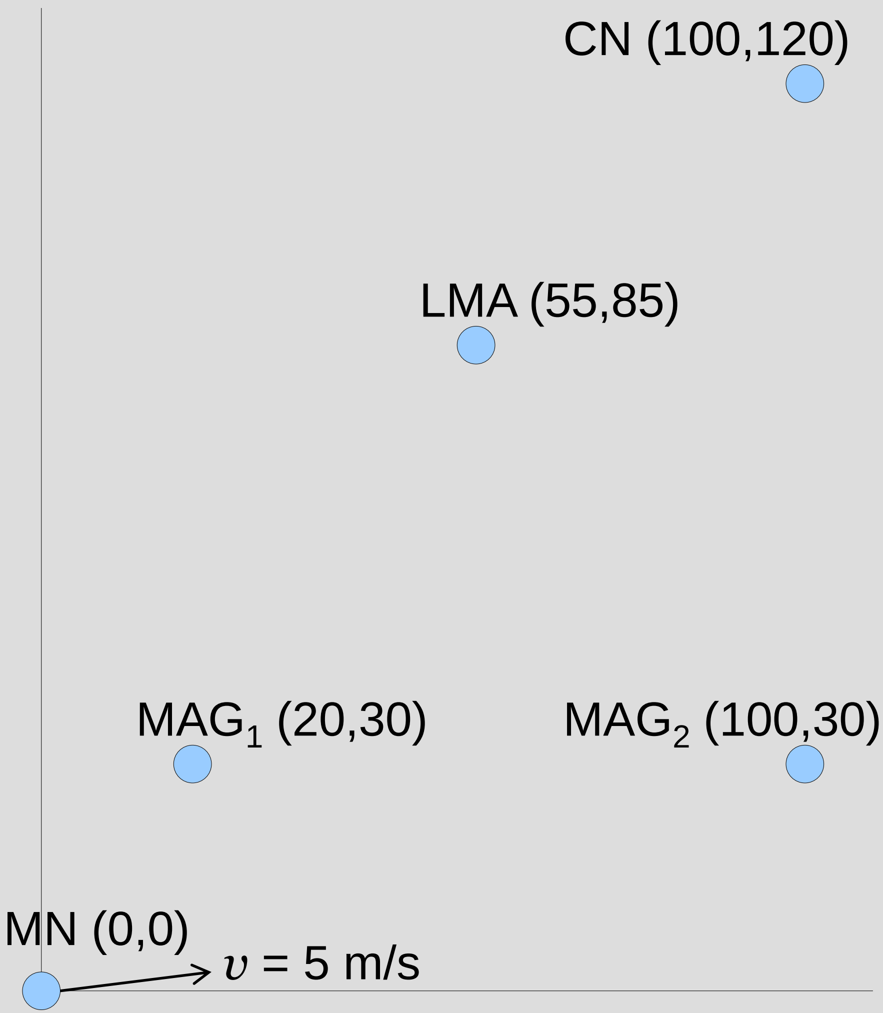
Seamlessness

- In our simulation, we found offload time to be rather small (0.1..0.3 s)
- This could be improved by employing Smart Buffering[3] (detecting MAG switch, caching unsent packets to MN on the old MAG, and re-sending them to the new MAG when it has been established)
  - Possible area of research

Simulation Setup: Tools

- Simulator: ns-2.33[1] patched to support PMIPv6 (patch[2] reworked from 2.29)
- Visualizer: iNSpect 4.0b3 [4]
- Grapher: xgraph

Simulation Setup: Topology



- 150×150 m rectangular grid
- Flat routing (no base stations)
  - AODV
- Radio visibility 85.3 m

Simulation Setup: Timing & Movement

- Simulation lasts 100.0 s
- MN moves W $\leftrightarrow$ E, $v = 5$ m / s
- Handoff takes place twice, at 50.0 s and 63.0 s
- We take samples of MN link throughput (Kbits sent to CN) every 0.1 s

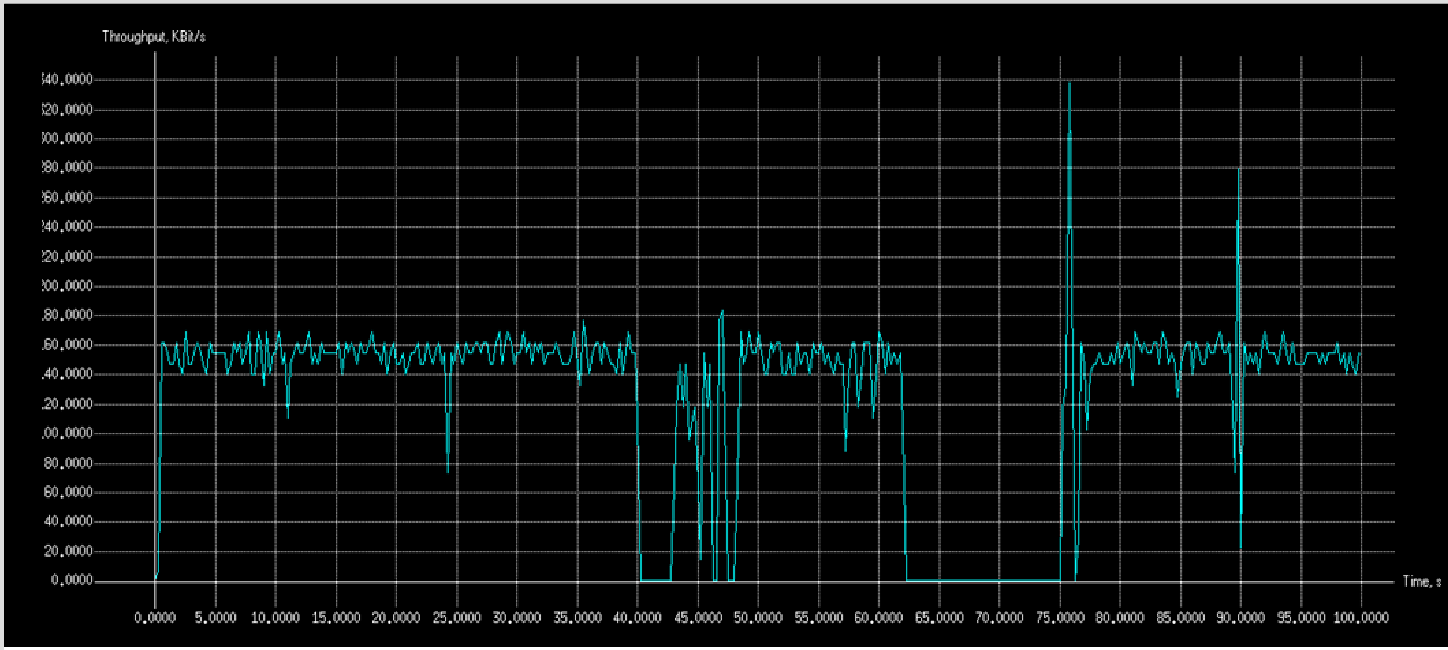
Simulation Setup: Traffic

- Correspondent Node was a UDP constant-bitrate server
- Bitrate: 1 Mbit/s
- Packet size: 1 KB
- Mobile Node was a UDP constant-bitrate client

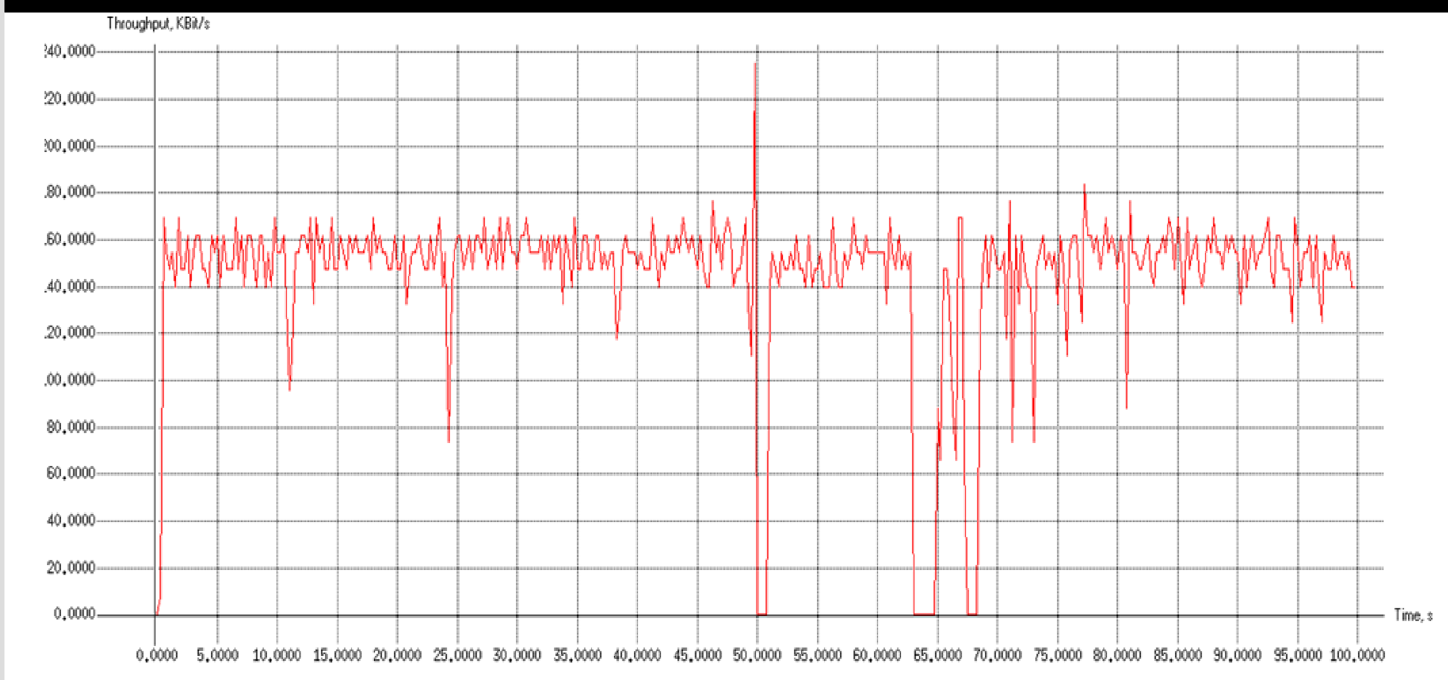
Simulation Results

- Performance of PMIPv6 is good
  - Reduces handoff times from 2..12 s to 0.1..0.3 s
- Peak throughput of MN with PMIPv6 and without it is same (see next slide)
  - Implies effectiveness of PMIPv6 link-layer optimizations?

Results: Bandwidth



PMIPv6
Off



PMIPv6
On

Further Research

- PMIPv6 + other handoff protocols (*e.g.* MIPv4)
- Introducing 3GPP nodes into the model
  - Study effectiveness of 3GPP TS23.402 procedures for handover

Yes!

- We are currently starting FRUCT project for PMIPv6 support on MAEMO

Questions & Answers

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Cited Sources

[1] ns-2. The network simulator, version 2.33. http://www.isi.edu/nsnam/ns/, 2009.

[2] HyonYoung Choi. Proxy Mobile IPv6 in ns-2.29. http://commani.net/pmip6ns, August 2009.

[3] HyonYoung Choi,KwangRyoul Kim, HyoBeom Lee,SungGi Min,and Youn-Hee Han. Seamless handover scheme for proxy mobile ipv6 using smart buffering. In *The International Conference on Mobile Technology, Applications and Systems (Mobility Conference)*. Association for Computer Machinery, September 2008.

[4] Stuart Kurkowski, Tracy Camp, Neil Mushell, and Michael Colagrosso. A visualization and analysis tool for ns-2 wireless simulations: inspect. In *MASCOTS'05: Proceedings of the 13th IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems*, pages 503–506, Washington, DC, USA, 2005. IEEE Computer Society