

TCP Level Aggregated Communication over Heterogeneous Access Networks

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G-Lab “Convergence of the Internet and Cellular Systems (CICS)” Project

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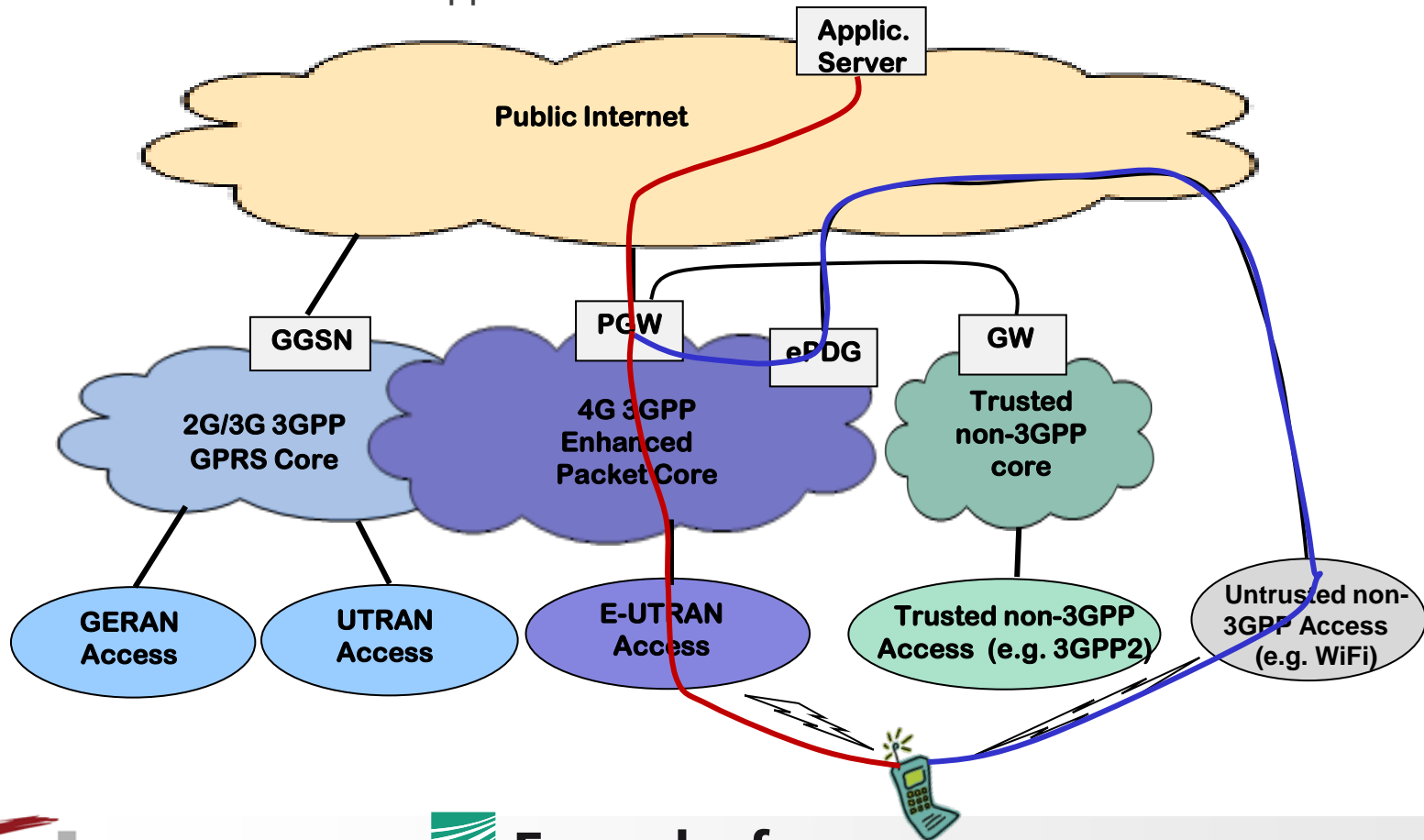
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Motivation

- ▶ Advanced interworking between different wireless systems becomes a key issue of future communication systems
- ▶ Today's smart mobile devices already (partially) support the concurrent use of multiple radio access technologies
 - e.g. HSPA, LTE and WiFi
- ▶ Parallel use of access networks provides advantages:
 - increased throughput
 - improved resilience
 - better resource utilization and load balancing
- ▶ This talk presents an approach to aggregate the bandwidth of multiple radio access systems based on the Multipath Transmission Control Protocol (MPTCP)

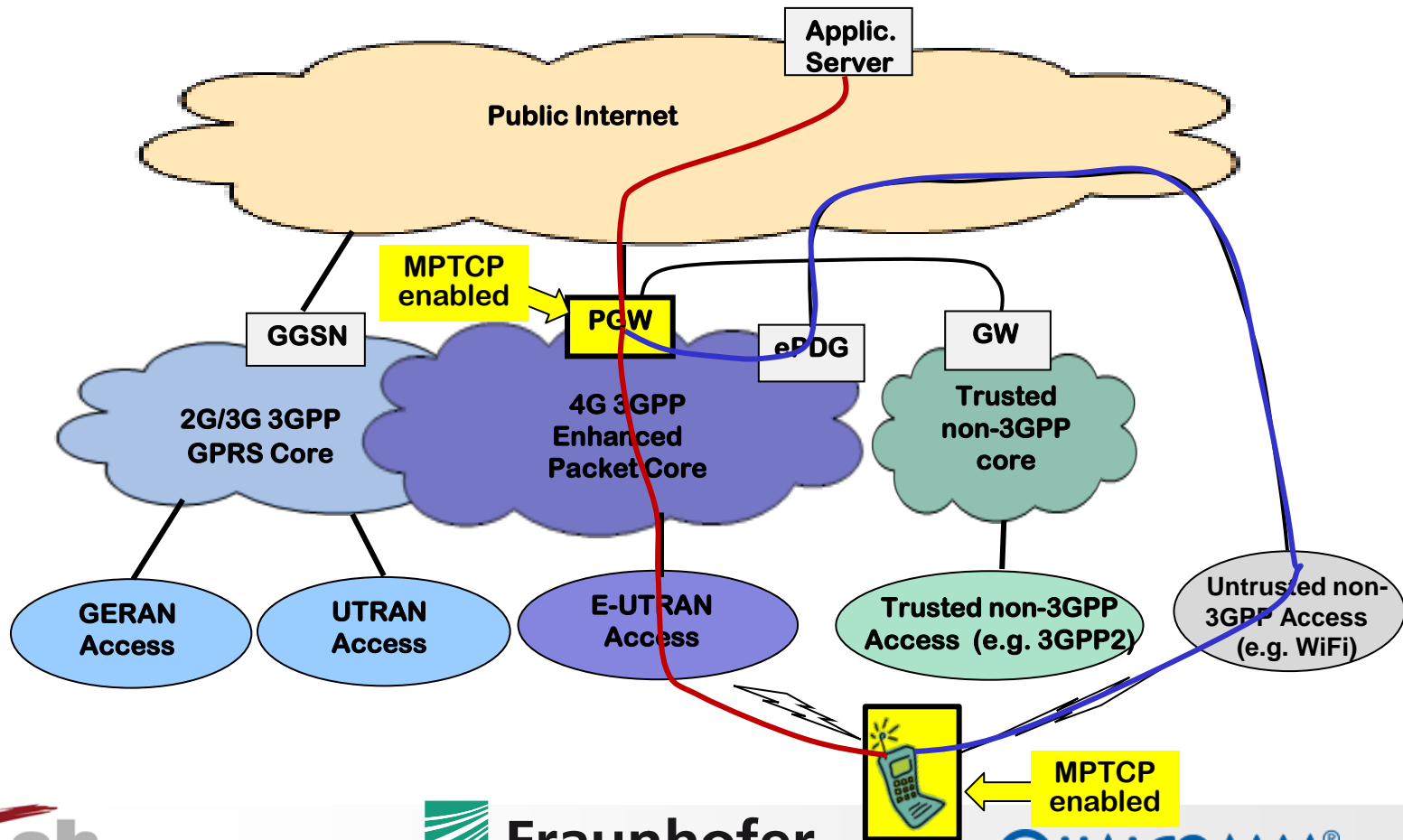
Today's 3G/4G Radio System Architecture

- ▶ Supports interworking, e.g. inter-system handoff
 - user's IP address does not change when access system changes
 - Packet Data Network Gateway (PGW) represents „anchor point“ of the connection to the application server



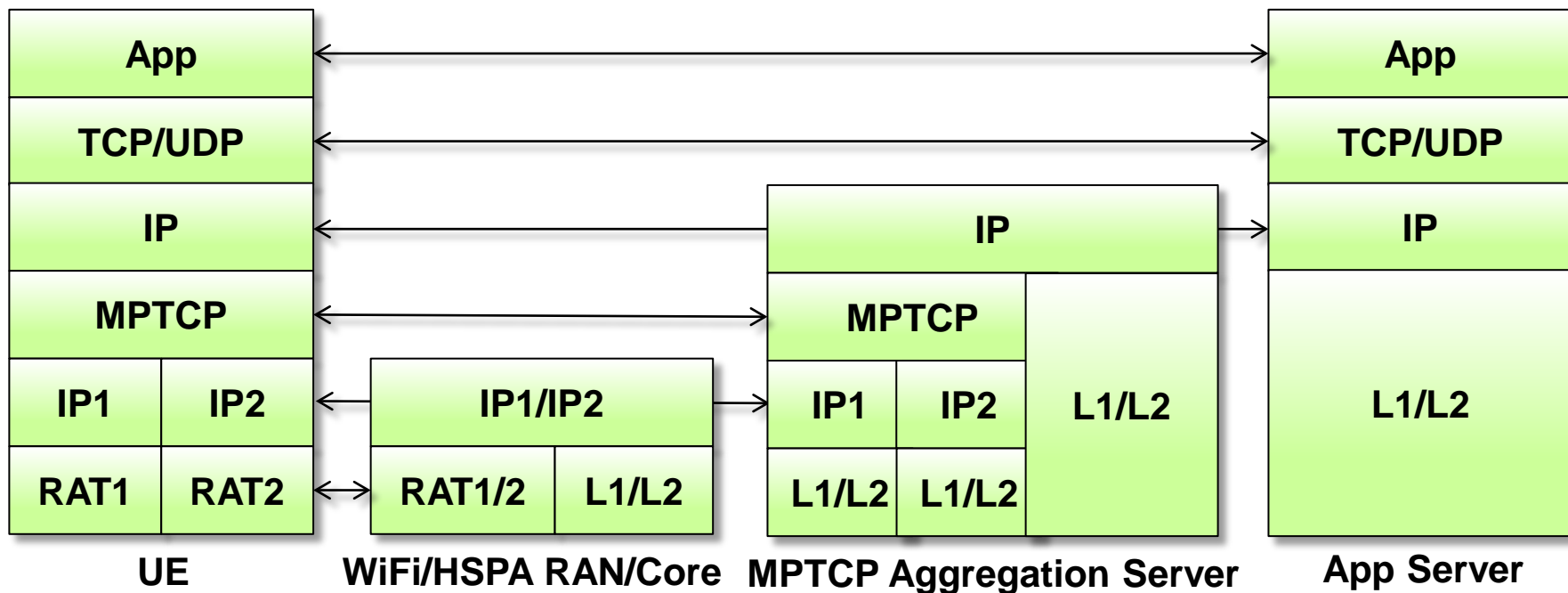
Envisaged Aggregation Solution

- ▶ Solution avoids changes in existing Application Servers
- ▶ Changes limited to the existing anchor node (PGW) and to the terminal



Protocol Architecture

- ▶ User device extended with MPTCP
- ▶ MPTCP Aggregation server as stand-alone function
 - ideally to be collocated with the PGW (or GGSN)



MPTCP – Multipath TCP

- ▶ MPTCP is the protocol chosen for aggregation
 - defines extensions to TCP to support multipath operation
 - enables the simultaneous use of several IP-addresses
- ▶ MPTCP is an IETF protocol in experimental status
<http://tools.ietf.org/wg/mptcp/>
- ▶ MPTCP implementation in the Linux Kernel available as open source
 - published by IP Networking Lab of Louvain University (Belgium)
 - initial MPTCP implementation and architecture for the Linux OS is from Sébastien Barré starting 2009

Challenges

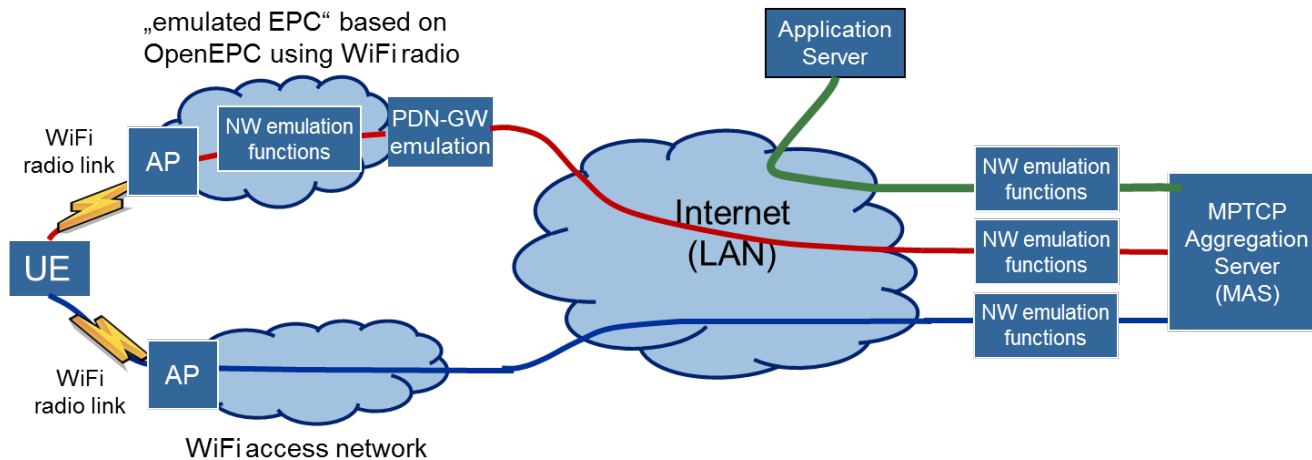
- ▶ Behavior of the considered MPTCP based protocol stack needs to be verified
 - performance evaluation of MPTCP in the reference architecture
 - e.g. behavior of MPTCP with WiFi and HSPA
 - interaction between multiple congestion control protocols within the same device
- ▶ (Possible) definition of extensions to MPTCP protocol or to architecture for performance improvements
- ▶ Test of the system behavior in scenario as realistic as possible

Chosen Approach

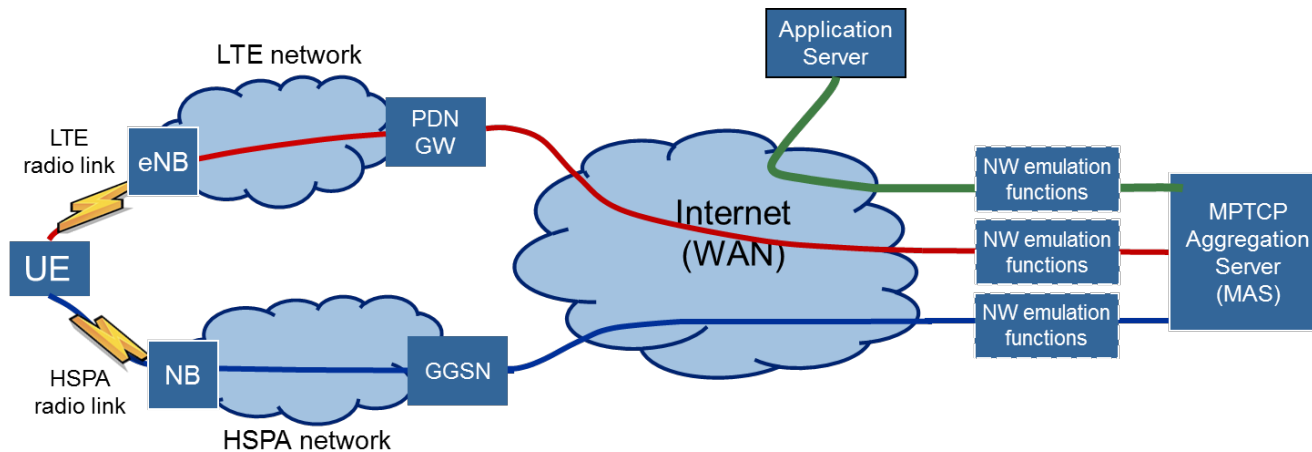
- ▶ Definition of a testbed modeling the considered architecture as follows:
 - usage of WiFi, LTE and HSPA technologies
 - reuse of real networks (if available)
 - e.g. HSPA
 - emulation of network elements which are unavailable or uncontrollable
 - e.g. IP backbone behavior between MPTCP Aggregation Server (MAS) and Application Server
- ▶ Usage of the testbed to evaluate behavior of the considered solution
 - behavior analysis
 - performance evaluation
- ▶ Based on the results (if possible) extend/change MPTCP behavior according to the reference architecture

Testbed Architecture

► Evaluation in the lab

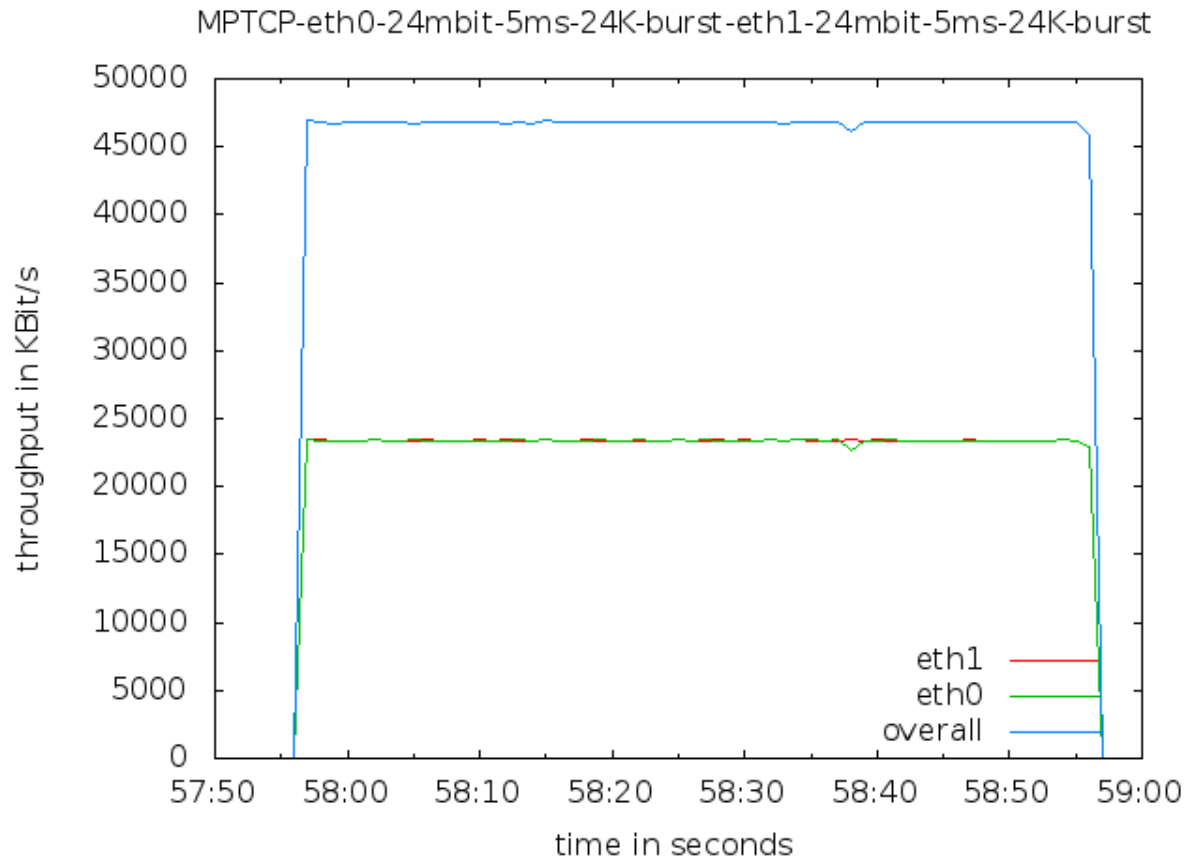


► Evaluation in the field, e.g. HSPA and LTE aggregation



First results

- ▶ First tests at different link rates and emulation of various network performance for the parallel paths (delay, jitter, loss rate)



Summary

- ▶ Novel solution for aggregation of bandwidth across multiple radio accesses using MPTCP
- ▶ Enables
 - doubling of available user bandwidth
 - always best connected
 - load balancing between radio access systems
- ▶ Easy deployment
 - MPTCP transparent to application and network
 - requires relatively simple SW upgrade in UE and PGW
- ▶ Next steps
 - completion of testbed development
 - performance evaluation in lab and field
 - optimization of MPTCP behavior and evaluation in the testbed