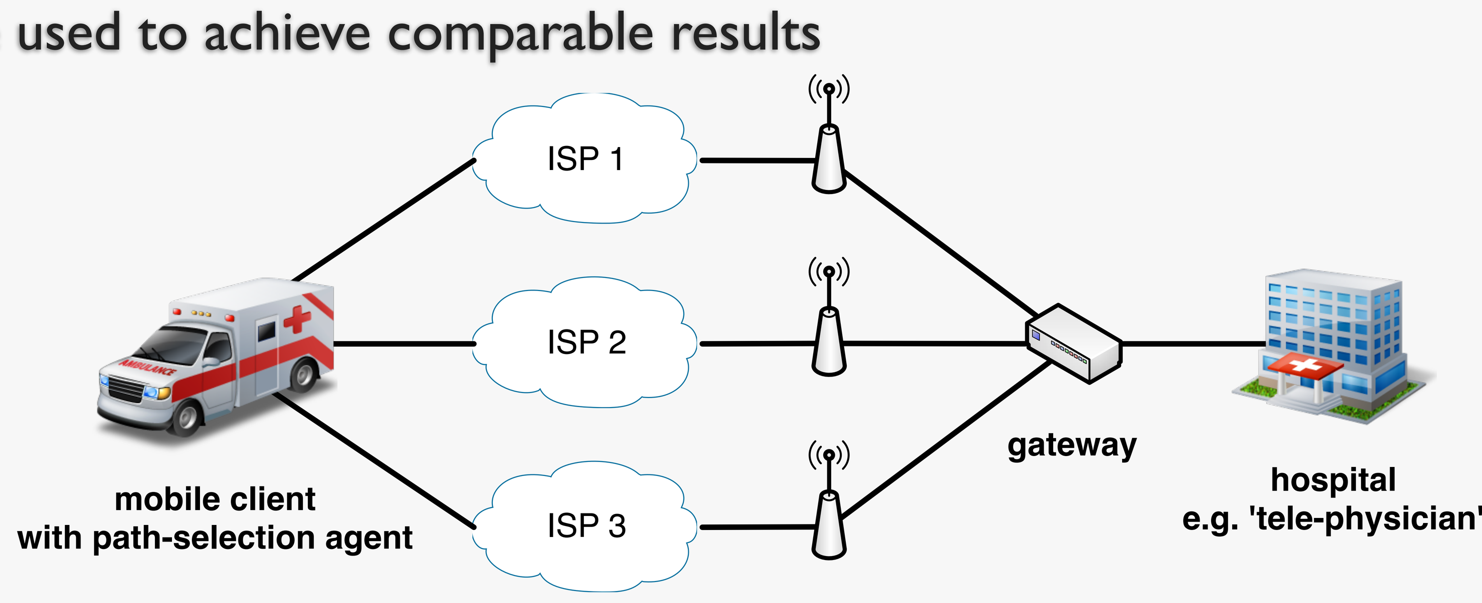
Multihoming and Adaptive Multipath Transmission using off-the-shelf Components in Preclinical Medical Care

Oliver Michel, David Stezenbach, Kurt Tutschku
University of Vienna

Motivation

- multihoming and multipath transmission becoming an important capability of today's networks
- improving availability, resilience and performance
- existing protocols such as MPTCP or SCTP usually rely on significant modifications in both the operating system's networking stack as well as in the application layer
- it remains unanswered how and to what extent today's technologies may be used to achieve comparable results



Demand in mobile medical applications

- telemedicine becoming decisive part of modern health-care esp. in preclinical care (e.G. tele-consultation for EMS staff)
- not yet widely deployed due to deficient and constrained mobile connectivity
- need for enhanced, more resilient and failure-resistant mobile connectivity

Off-the-shelf mobile multipath setup

IDEA

- framework allowing mobile multihoming and multipath transmission based on today's protocols and operating system features

PRO

- immediate deployability without a need for modifications in legacy applications and operating systems

CONTRA

- present-day protocols not designed for challenges coming with multipath-transmission such as out-of-order delivery and path-selection

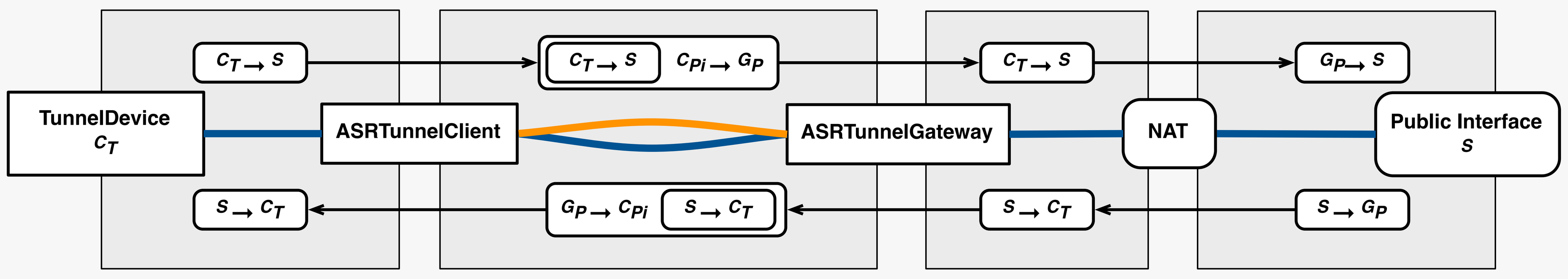


Figure 1: Packet flow and encapsulation

- use of Linux tun/tap drivers to create a logical network interface
- Linux IP Rules and iptables for application-specific routing
- user-space C++ application reads packets from tun-device, performs active probing and distributes encapsulated packets over multiple physical links and vice-versa
- gateway machine closer to the network core reads encapsulated packets from tunnel, performs network-address translation and forwards packets to actual destination
- transparent transport of any packets through tunnel
- NAT traversal
- experiments using a Raspberry Pi as mobile gateway device connected to multiple wireless providers providing Internet connectivity over Ethernet

Application Architecture

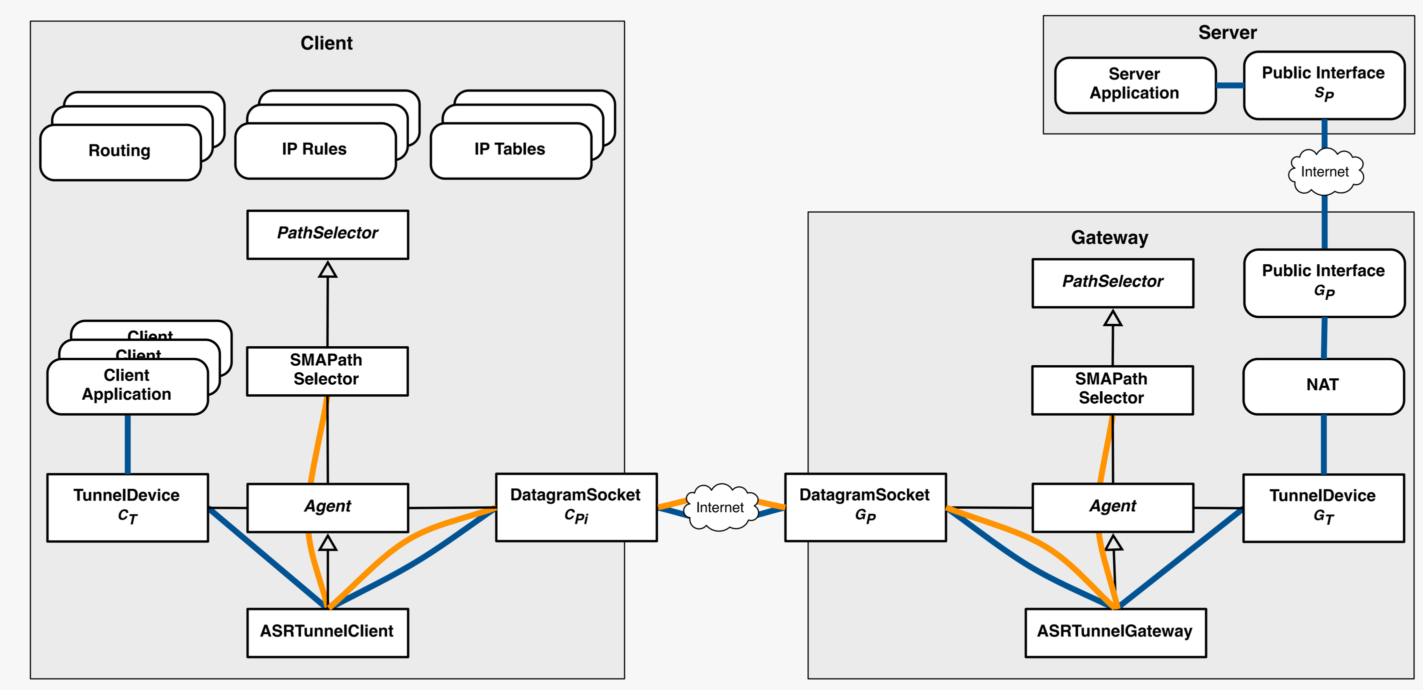
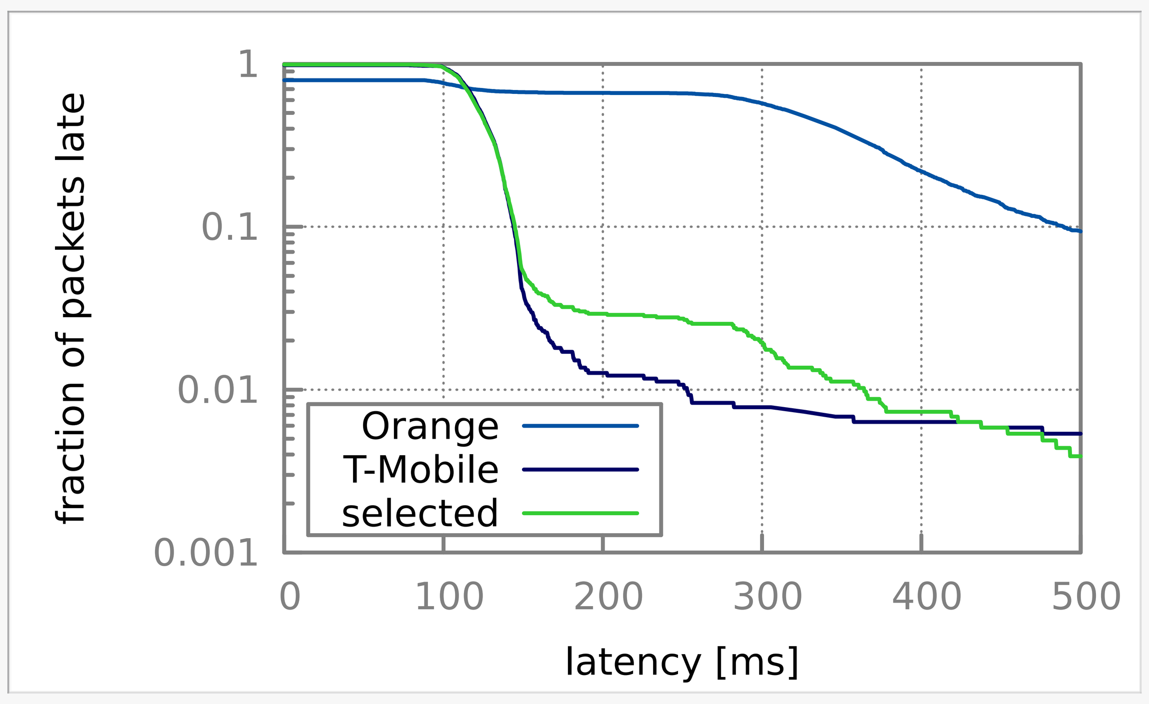


Figure 2: Basic Application architecture with data (blue) and probe (orange) traffic flow

Probing & Path Selection



	T-Mobile	Orange	effective
packets lost	1.85%	20.47%	0.87%

Figure 3: Measured and selected latencies and loss rates from wireless 3G experiment

- 3-way probes get sent out every ~Exp(1) seconds measuring path latency, simple moving average with window-size 5 determines best path for actual data transmission
- probes can piggy-back data packets reducing overhead
- periodic bandwidth measurements may be used to also optimize for bandwidth (so far only latency considered)
- different multipath modes (bandwidth aggregation or redundant multipath [Vulimiri et. al. HotNets 2012]) may be implemented

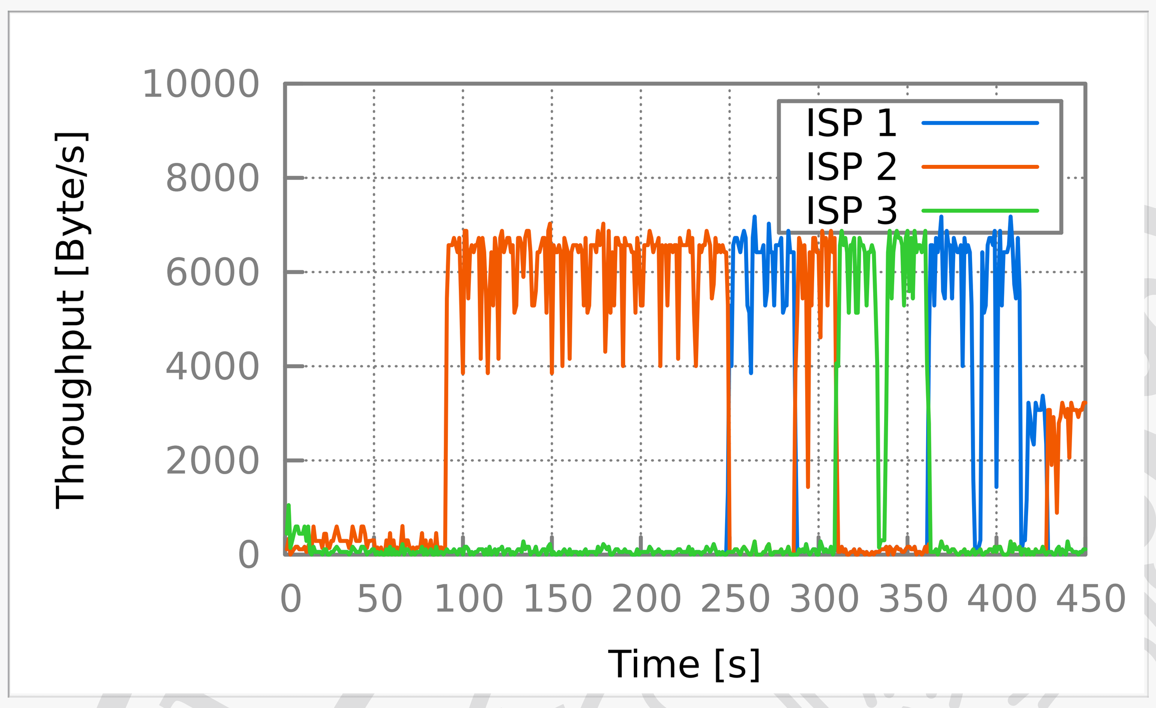


Figure 4: Achieved constant throughput under frequent path-switching in testbed

Conclusion

- based on very early measurements and experience, the proposed approach seems feasible
- although anticipated functionality was achieved, problems with TCP connections arise when switching between paths too frequently
- path-selection solely based on measured latency is reasonable as a first step but probably not sufficient for most applications
- future work: in-depth analysis of TCP throughput and problems due to packet-reordering, optimization for delay, loss or bandwidth, extended mobile experiments, video streaming tests