University of Würzburg
Dept. of Distributed Systems
Prof. Dr. P. Tran-Gia

ITG INFORMATIONSTECHNISCHE GESELLSCHAFT IM VDE

A. Binzenhöfer, D. Schlosser

A Self-Organizing Management Environment to Analyze the End-to-End Quality of VoIP Calls

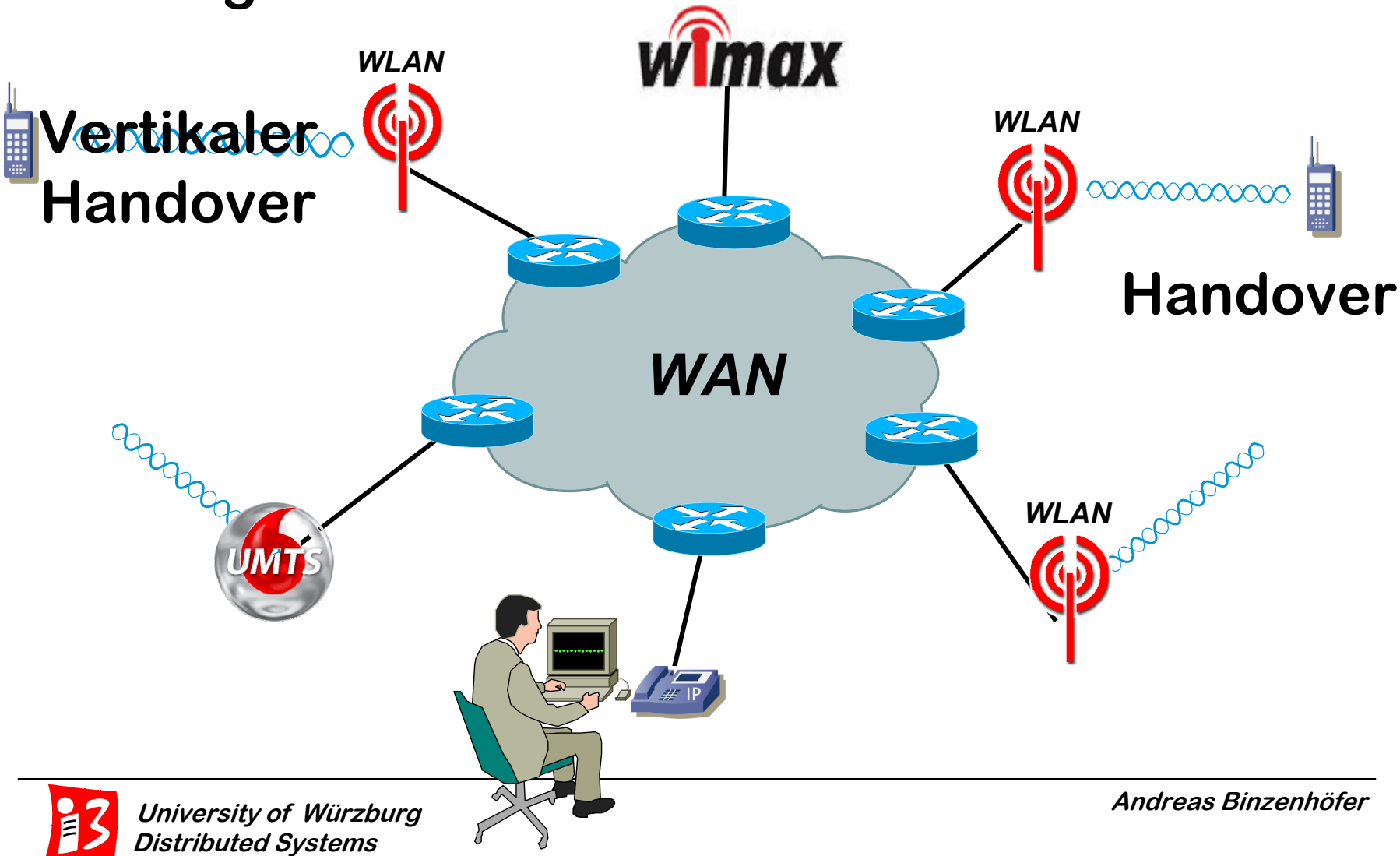
19th VDE/ITG Section 5.2.4 Meeting

University of Wuerzburg, May 15-16 2006

VoIP im mobilen Umfeld

Heterogene Technik

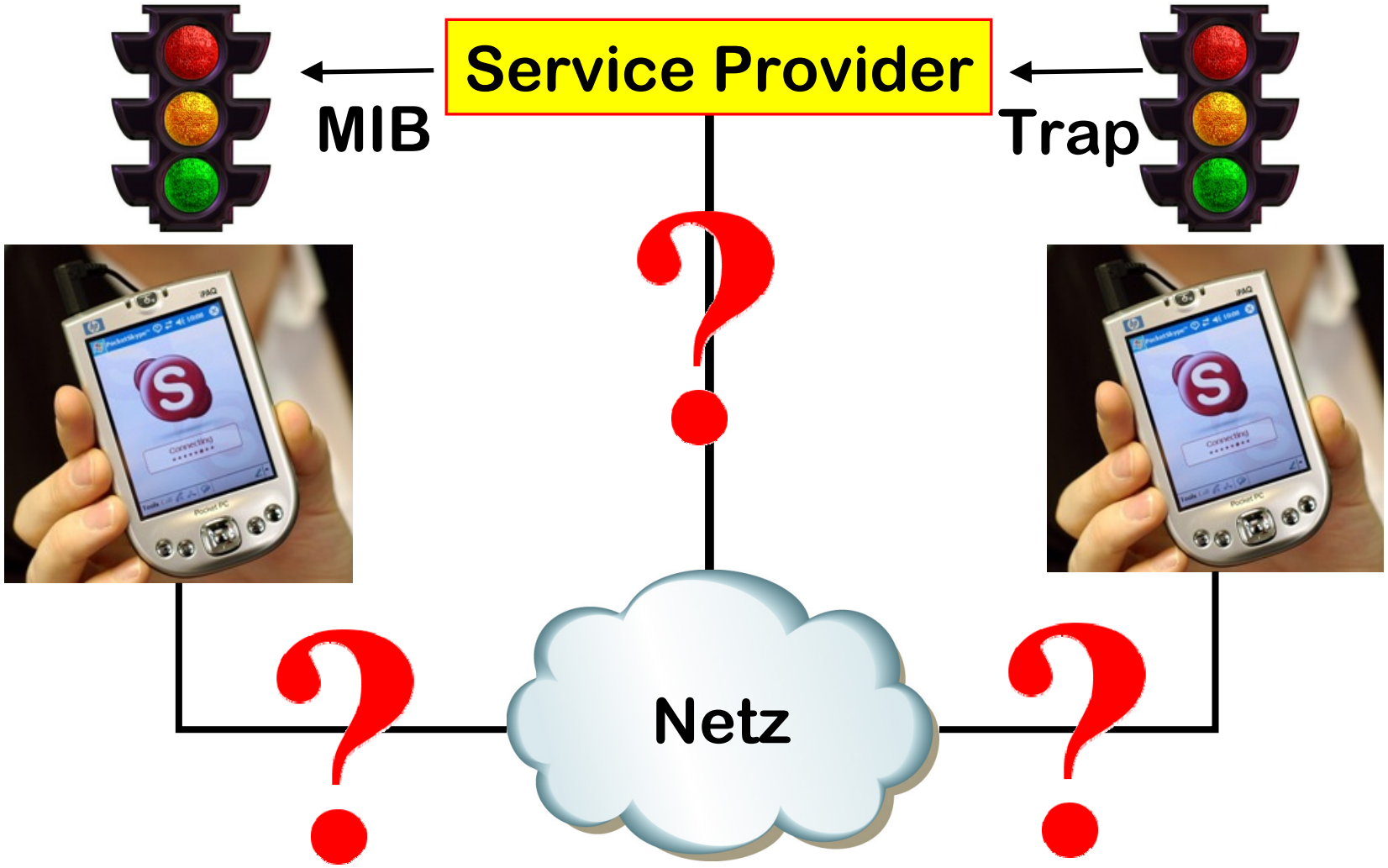
Mobile Endnutzer



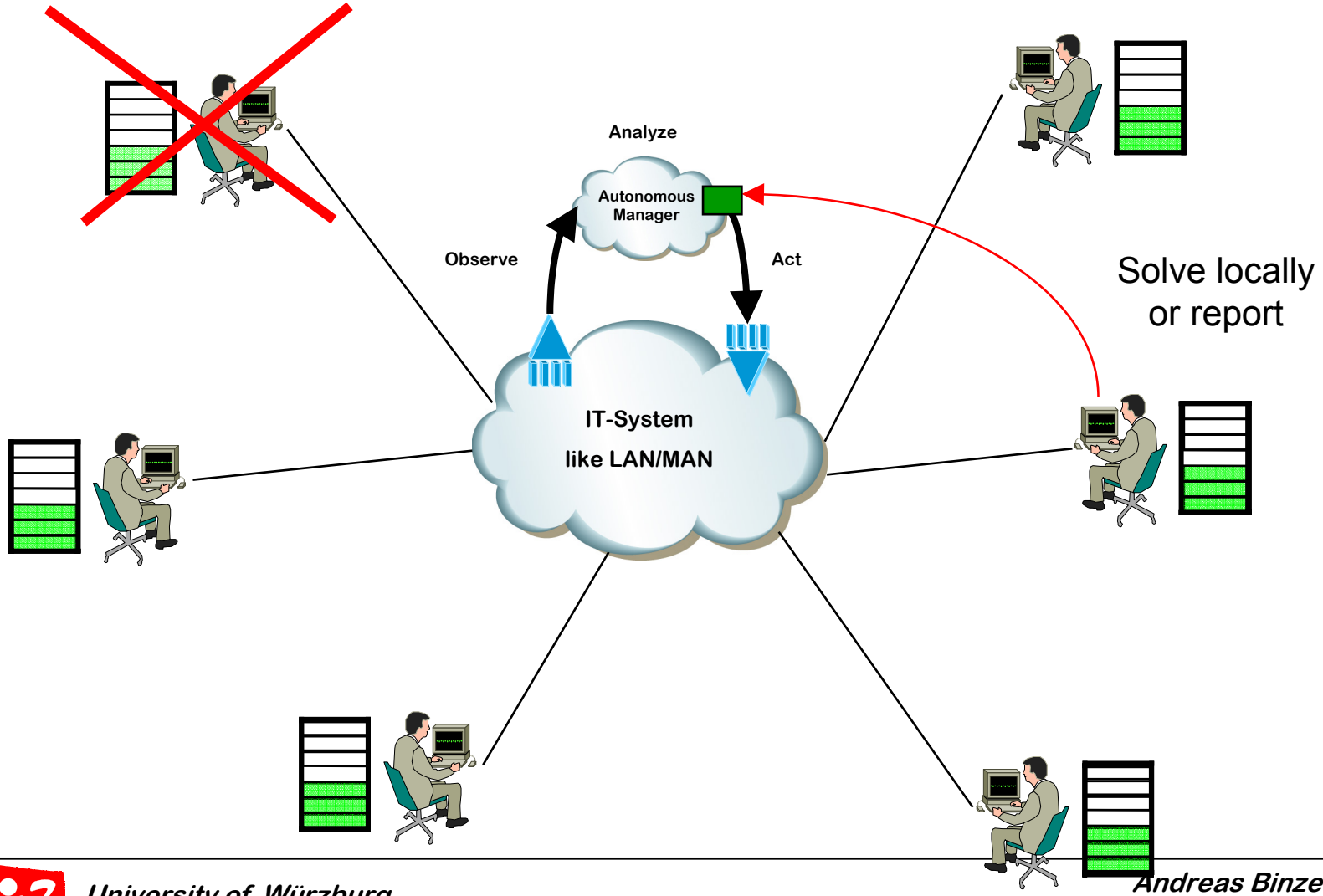
Übersicht

- Einführung und Motivation
- Autonomic Networking
  - Definition
  - Verteiltes Netzwerkmanagement
  - Vorstellung unseres Prototypen
- Messung der Ende-zu-Ende Qualität
- Ergebnisse und Visualisierung der Messungen
- Zusammenfassung und Ausblick

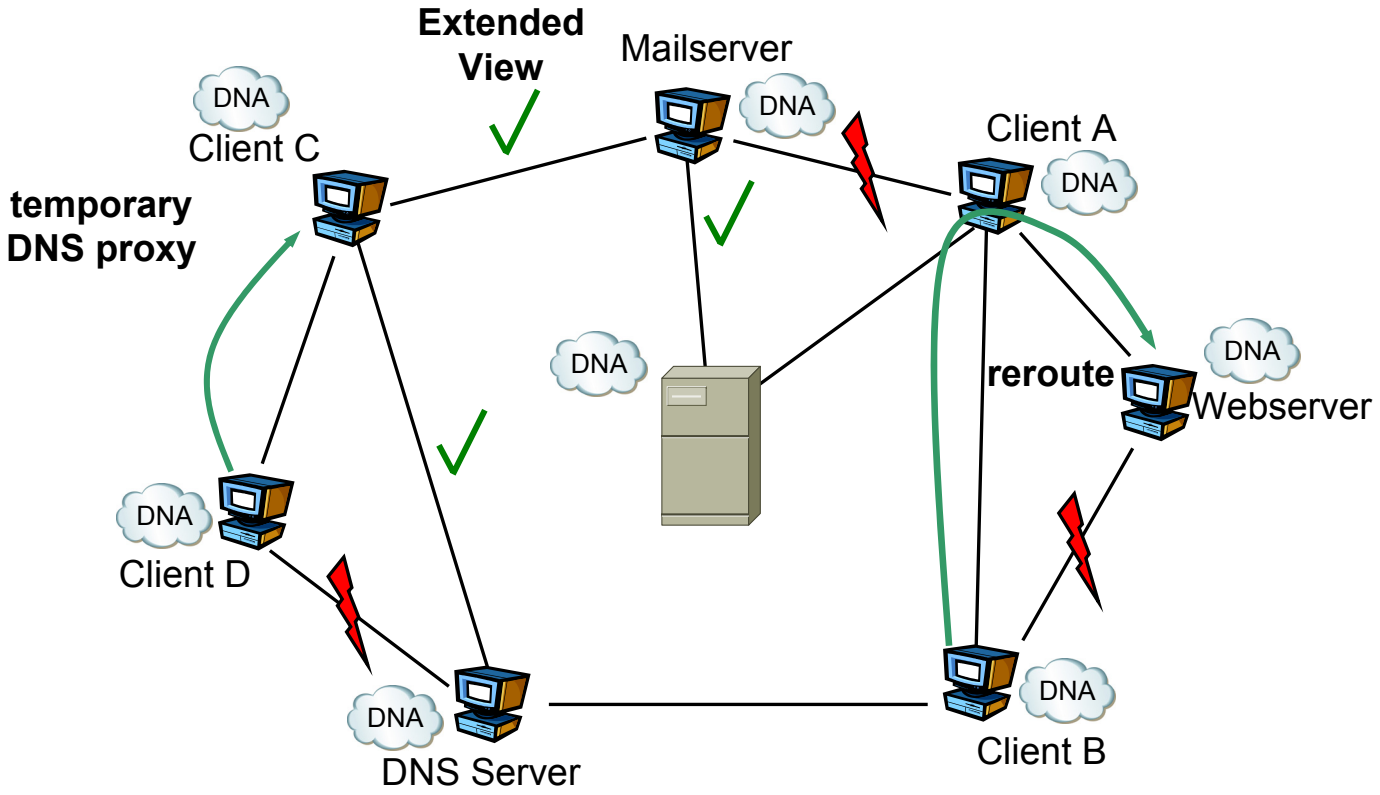
Verbindungsqualität aus Endnutzersicht



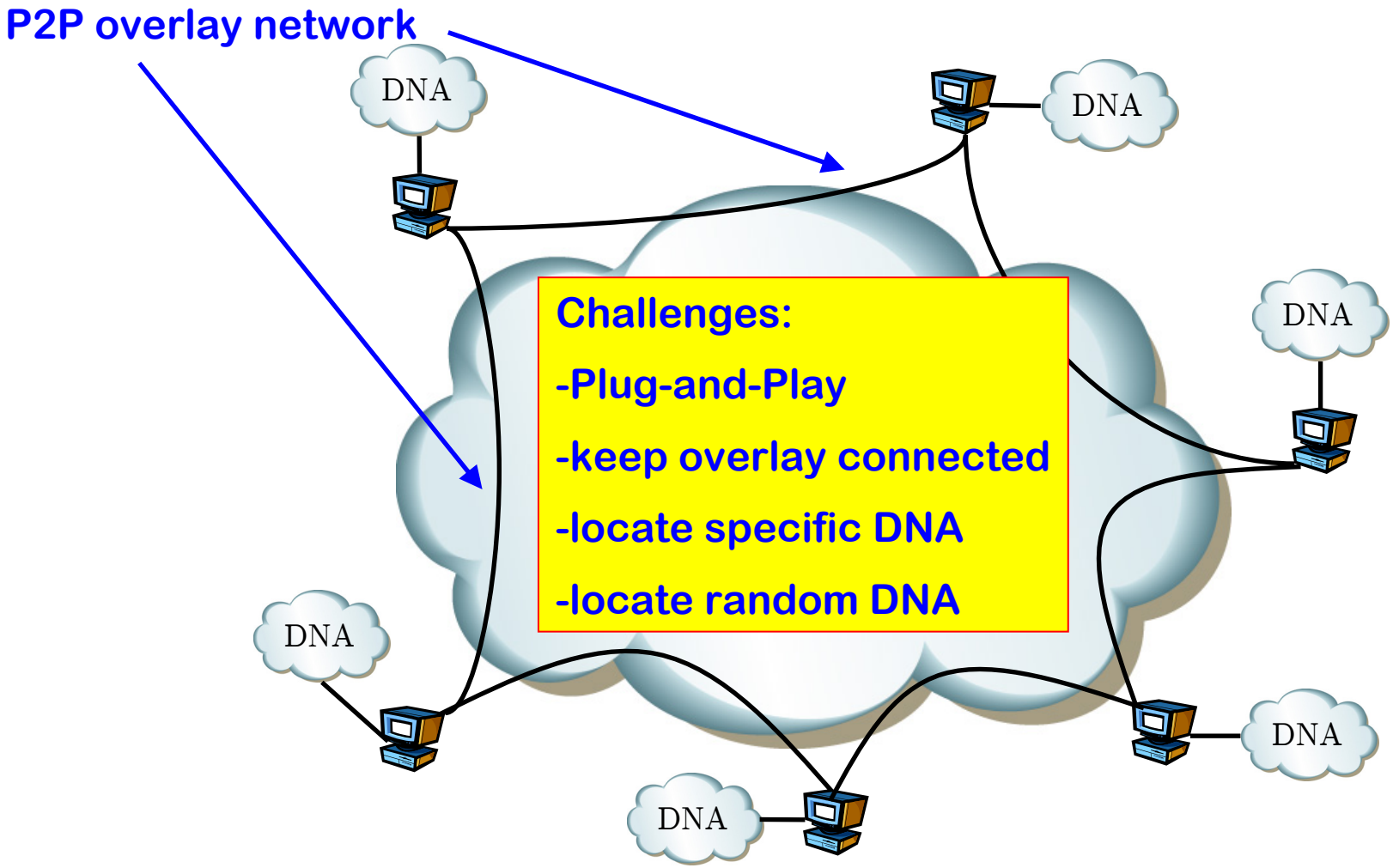
Unsere Vision: „Autonomic Networks“



Advantages of Distributed Network Monitoring

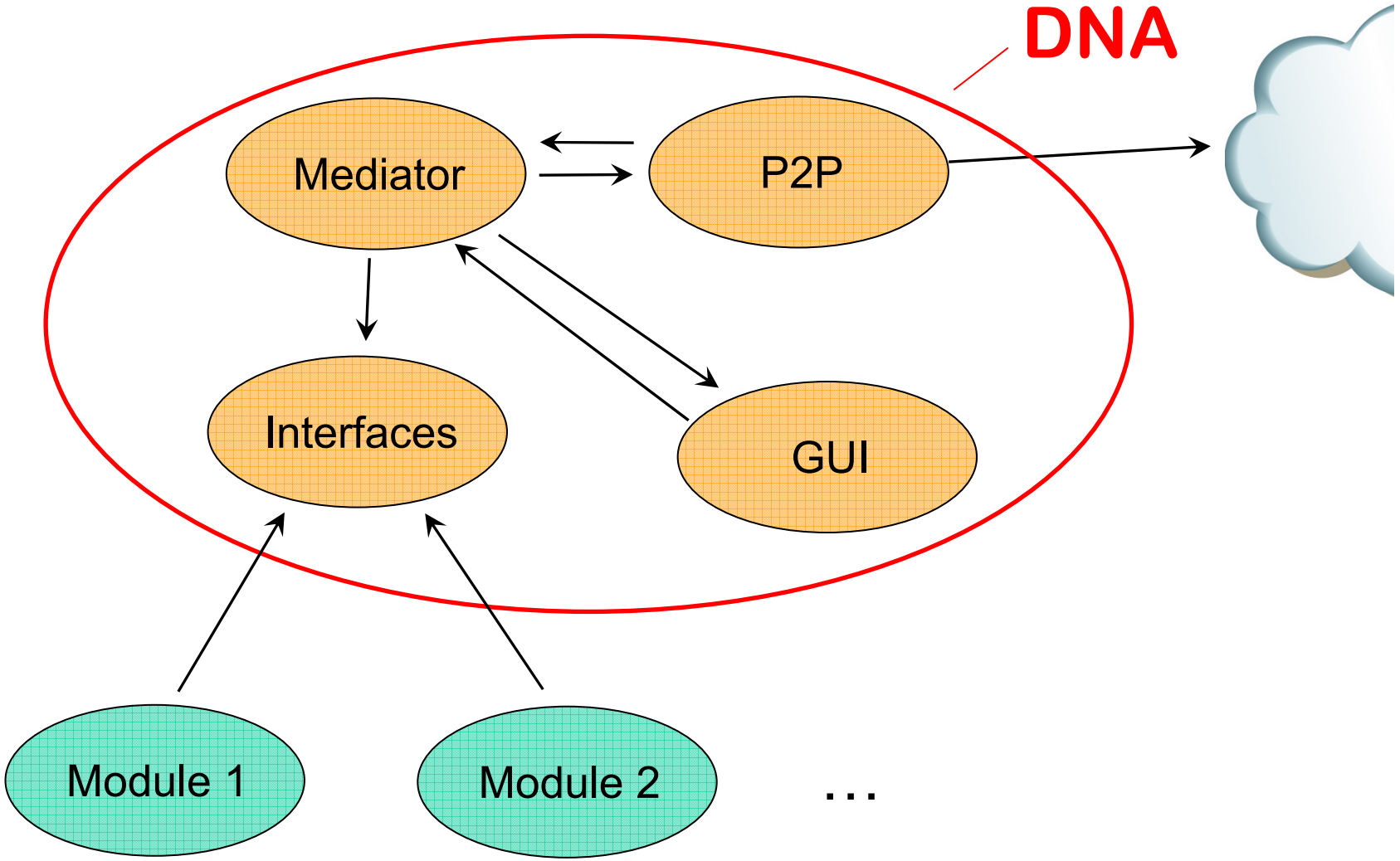


Distributed Network Application (DNA)

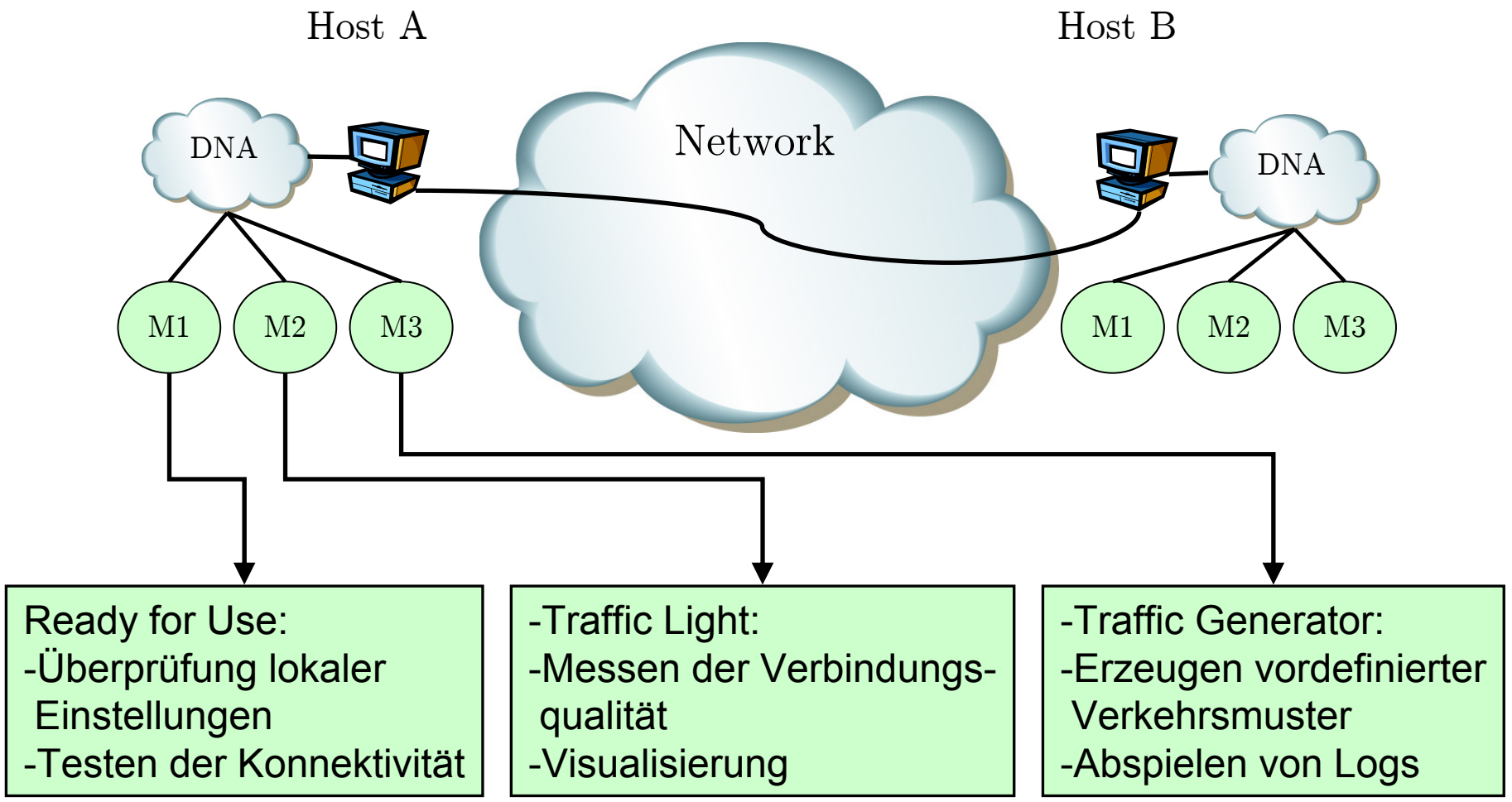


Use of a Kademlia-based overlay network

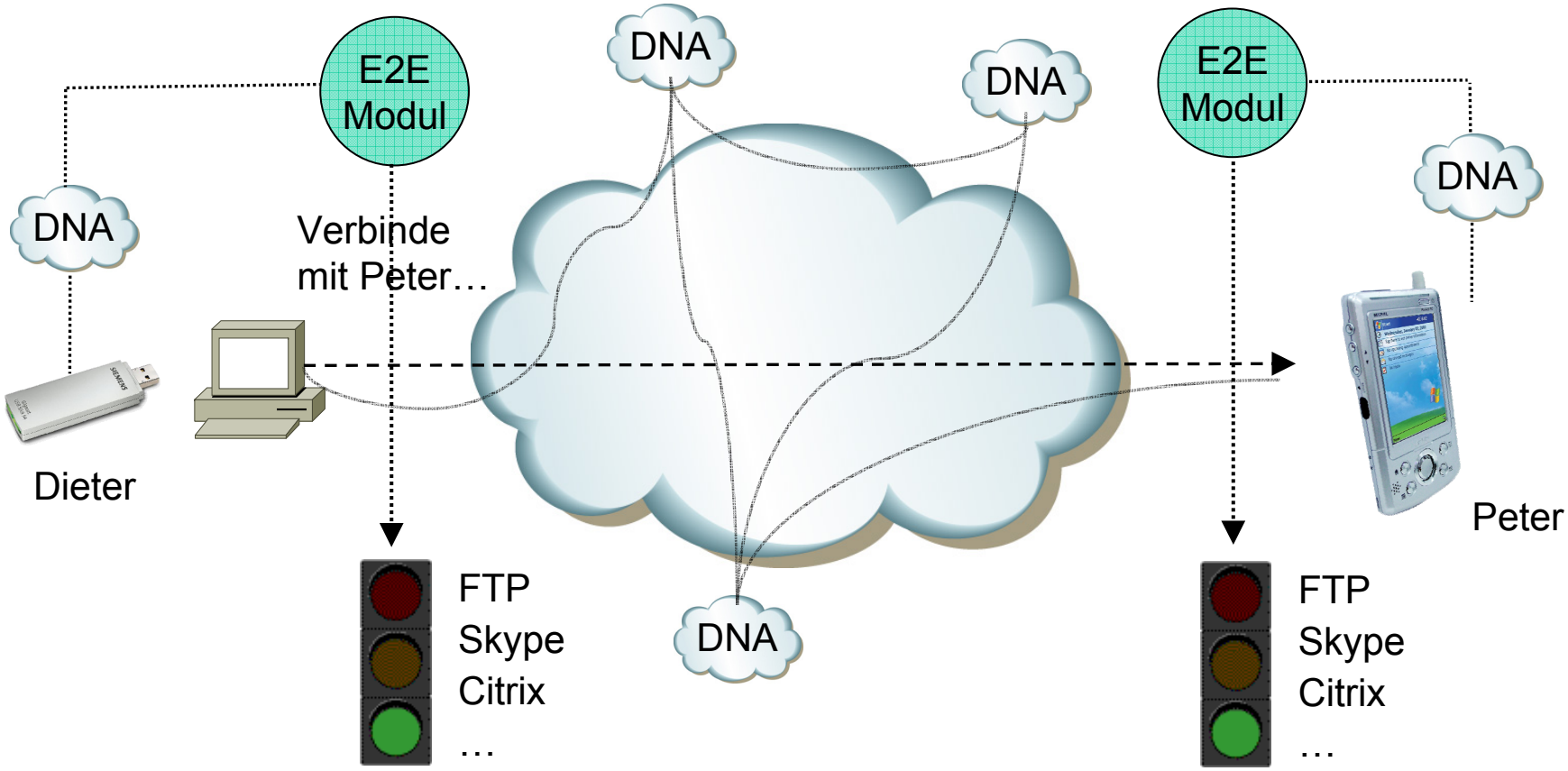
The DNA Framework



Das Ende-zu-Ende Modul

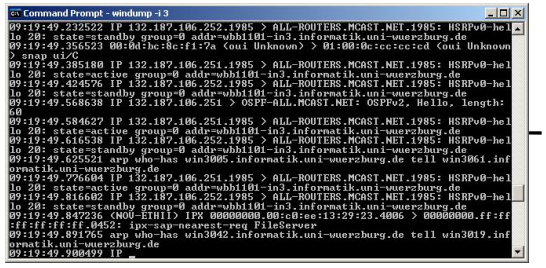


Selbstorganisation der Ende-zu-Ende Messung



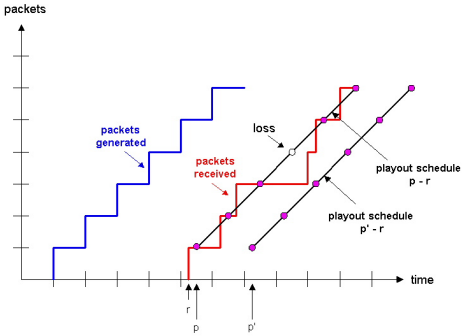
Technische Umsetzung des E2E Moduls

Messen



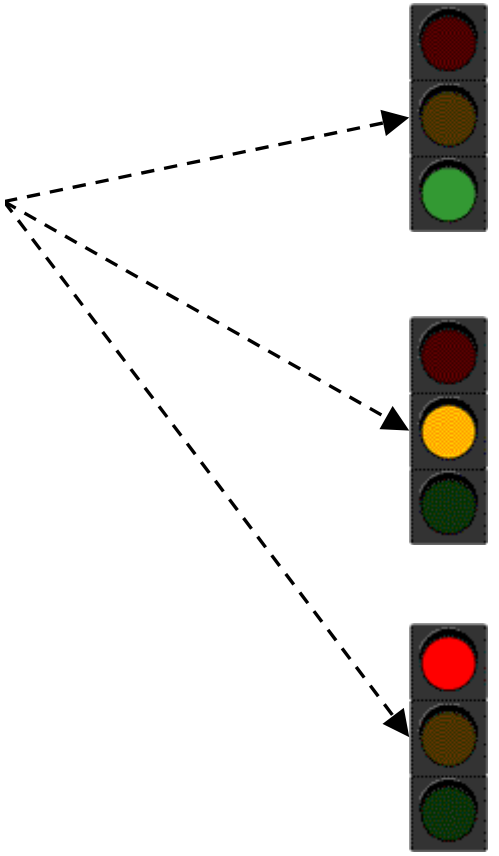
IP – ID
Zeitstempel
Größe

Analysieren



Paketverlust
Jitter
Delay

Visualisieren



One way Packet loss

Name	Size	Description
SP_S	1 bit	0 for a summary packet, 1 for a summary packet response
C	2 bit	Color of downlink traffic light of host B
encoding	1 bit	0 if $\Delta t^B_{out}(i)$ are 16 bit integers, 1 if $\Delta t^B_{out}(i)$ are 32 bit integers
S_{ID}	4 bit	summary packet ID
$t^B_{out}(1)$	8 byte	time stamp of first outgoing packet
$\Delta t^B_{out}(i)$	2/4 byte	times between outgoing packets i and $i-1$, if $i > 1$, 0 otherwise
$ID^B_{out}(i)$	2 byte	IP-ID of packet i

- Periodischer Austausch der lokalen Messungen
- Paketverlust direkt ablesbar

One Way Jitter

- Abschätzung über Formel aus Real Time Protocol (RTP)

$$j_{BA}(i) = j_{BA}(i-1) + \frac{\left|\Delta t^{B}_{out}(i) - \Delta t^{A}_{in}(i)\right| - j_{BA}(i-1)}{16} \quad \text{for } i = 2, ..., i_{max} - 1.$$

- Alle benötigten Informationen im “Summary Packet” enthalten

H. Schulzrinne, S. Casner, R. Frederick, and V. Jacobson, “*RTP: A Transport Protocol for Real-Time Applications*,” 1996. RFC 1889.

One Way Delay

- Negatives Delay gemessen?
  - Nein: Messung direkt übernehmen
  - Ja: Median Uplink und Downlink anpassen

$$D'_{BA}(i) = D_{BA}(i) + \frac{m_{AB} - m_{BA}}{2}.$$

- Hypothesentest für Uhrendrift und ggfs. Anpassung:

$$D'_{BA}(i) = D_{BA}(i) - clock_{drift} \cdot \left(t^A_{in}(i) - t^A_{in}(1)\right).$$

V. E. Paxson, *Measurements and Analysis of End-to-End Internet Dynamics*. PhD dissertation, University of California, Lawrence Berkeley National Laboratory, April 1997.

Mapping: Beispiel Voice-over-IP

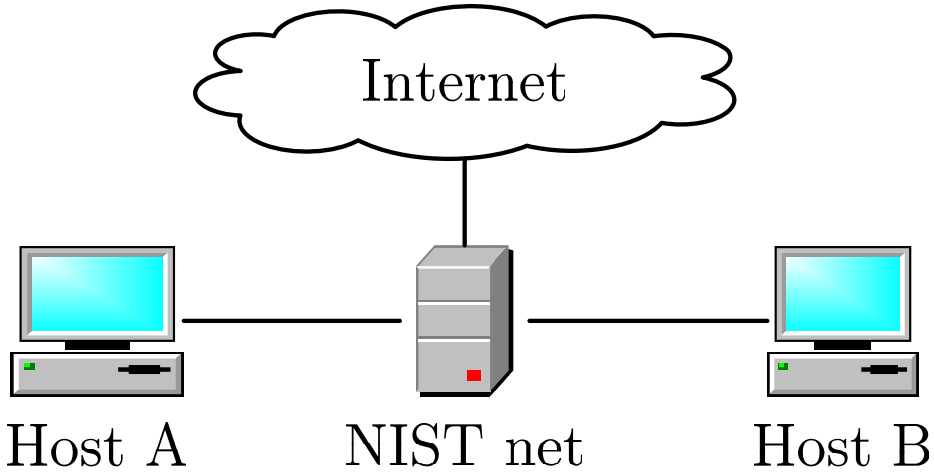
- Mapping muss pro Service geschehen
  - Utility Functions
  - Abschnittsweise definierte Funktionen
  - Multidimensionale Matrix
  - E-Model

- Beispiel VoIP (ITU-T G.114)

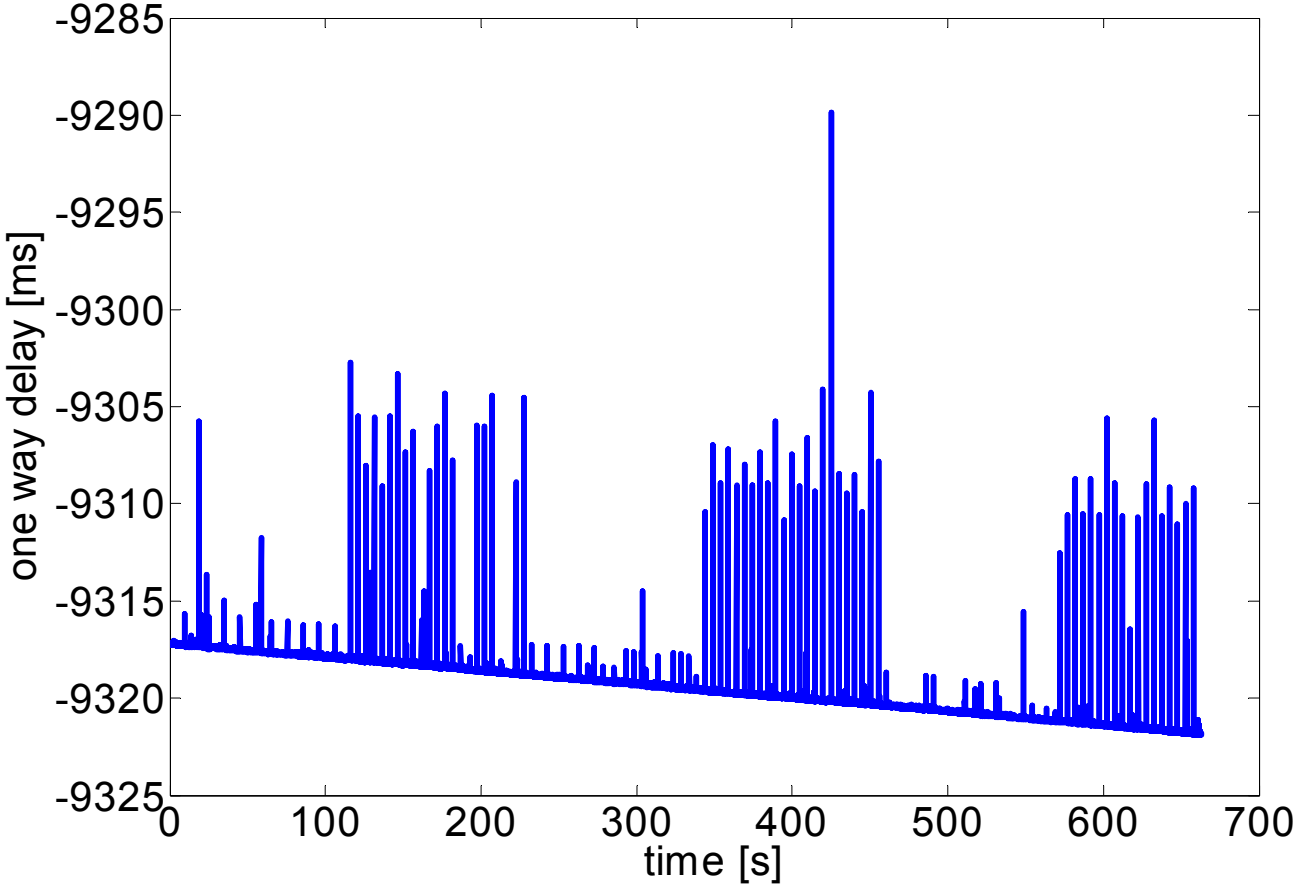
	delay[ms]	packet loss[%]	jitter[ms]
green	<75	<1	<10
yellow	<200	<3	<25
red	>200	>3	>25

ITU-T Recommendation G.114, "*One way transmission time*," May 2003.

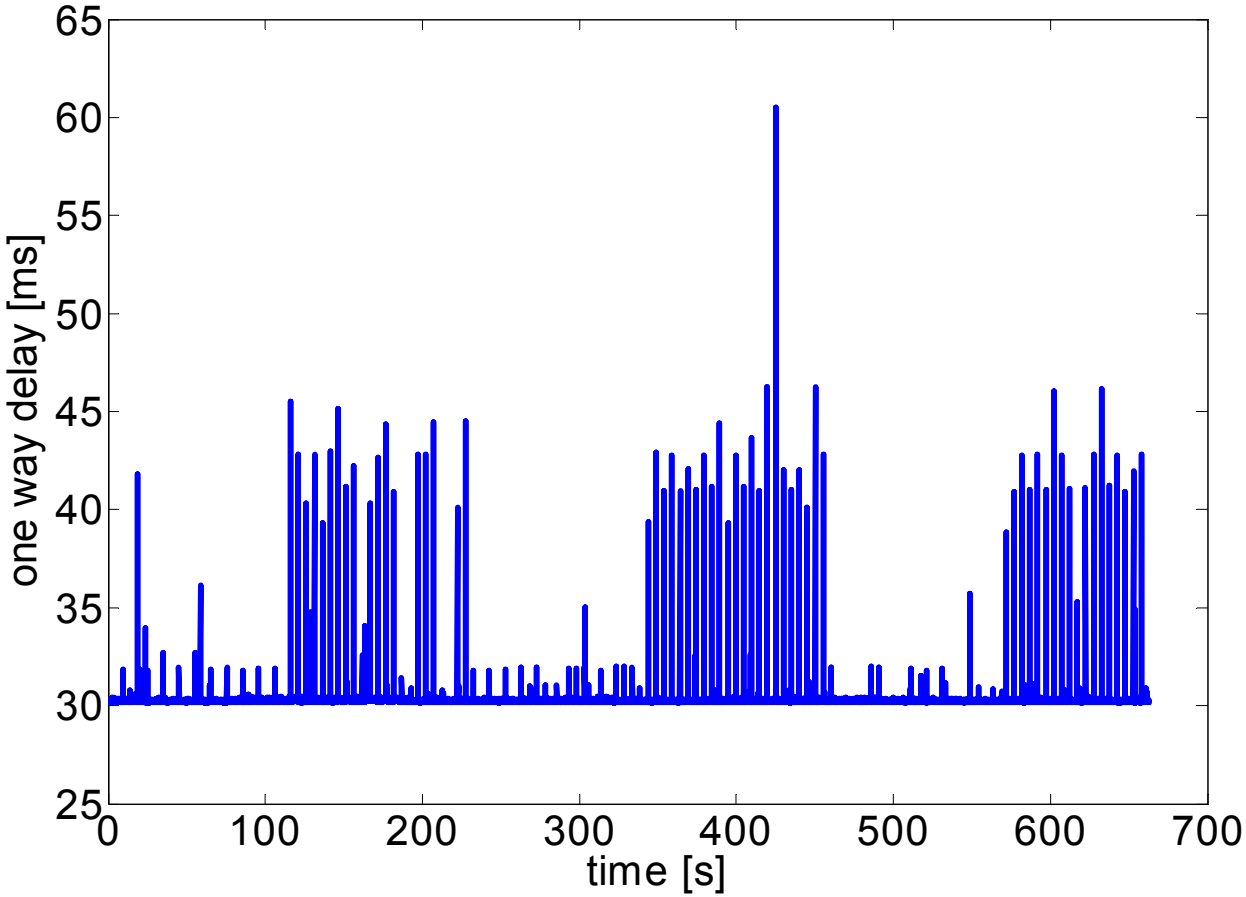
Aufbau der Messumgebung



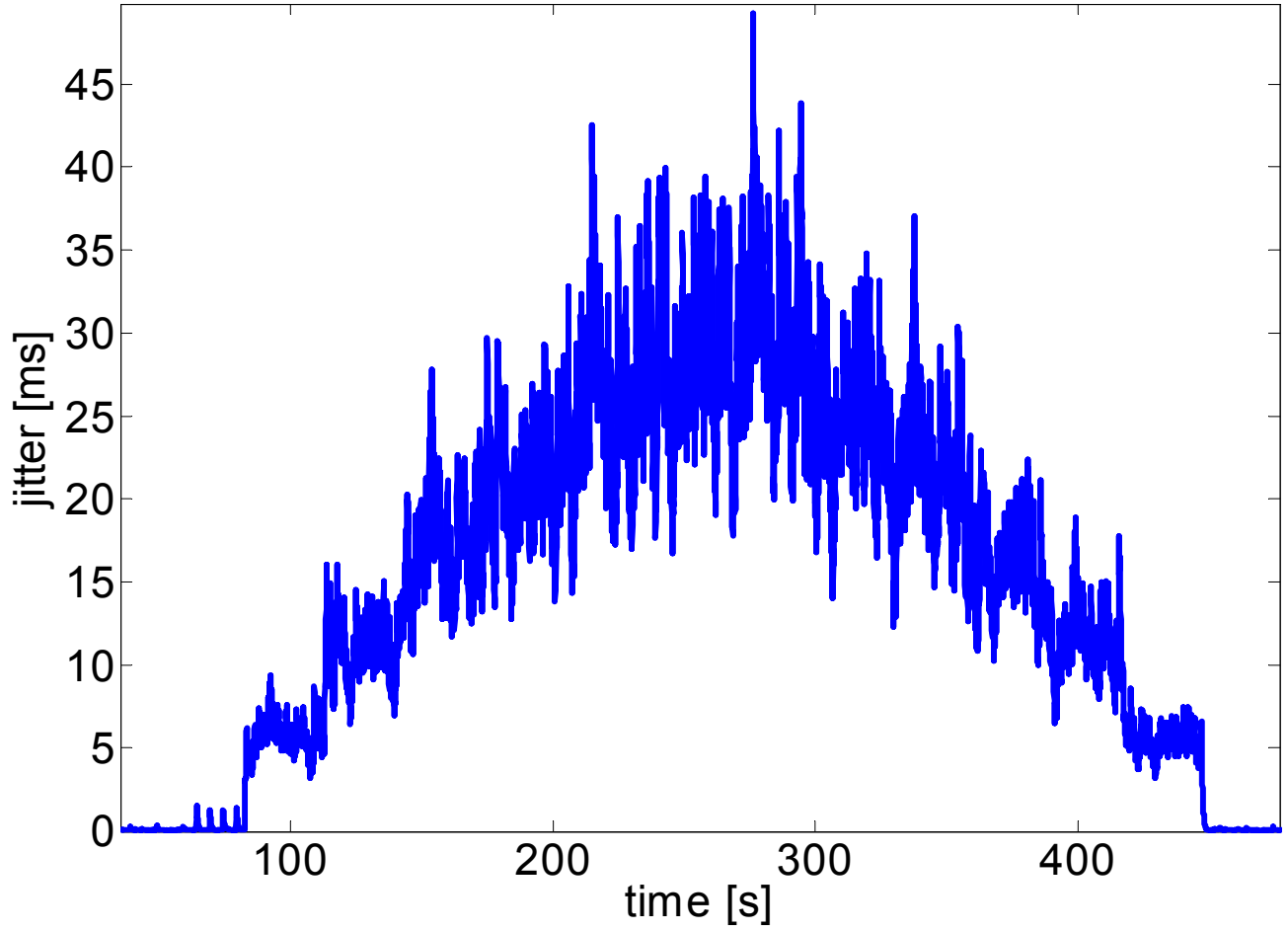
One Way Delay Messung



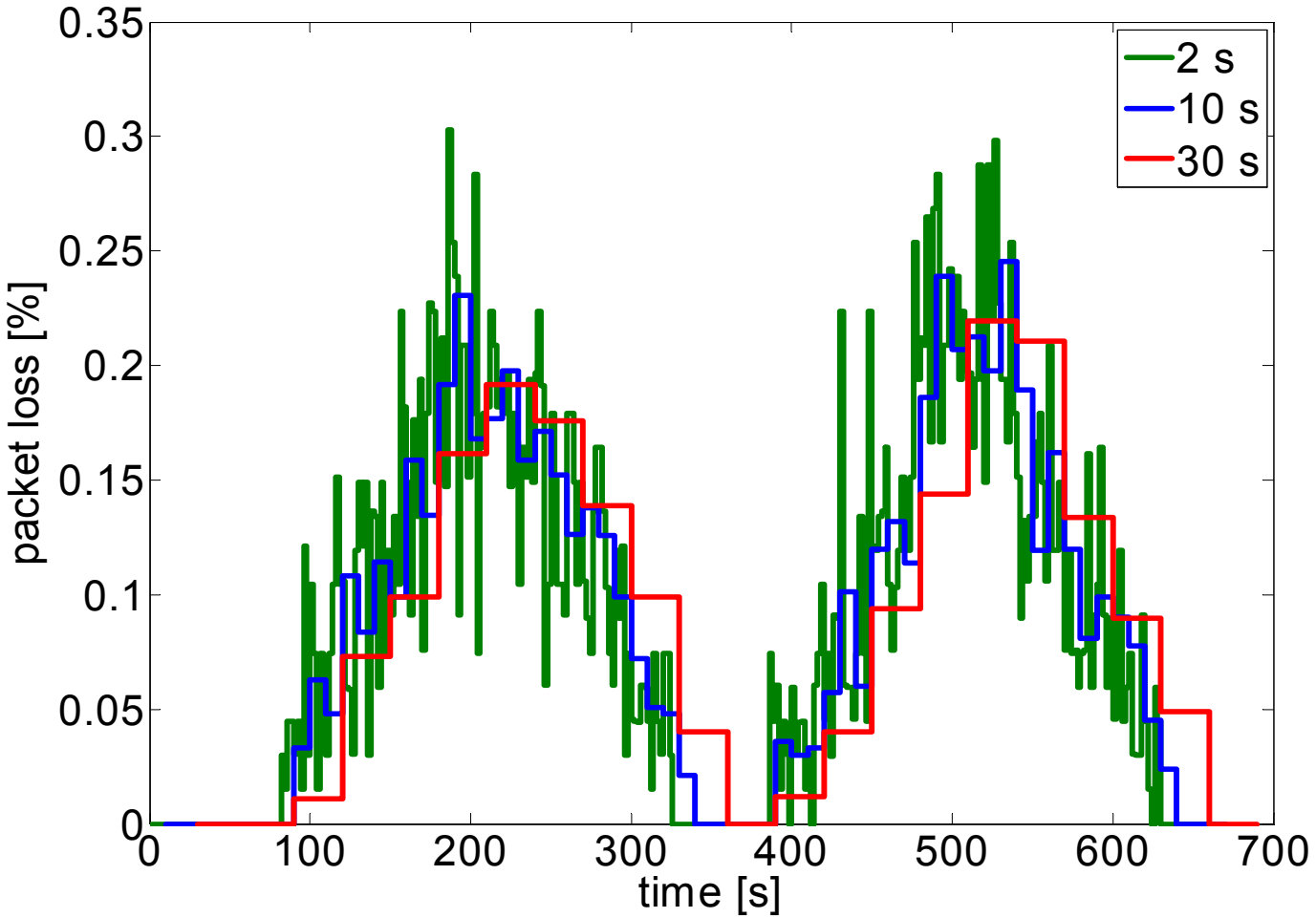
Angepasste One Way Delays



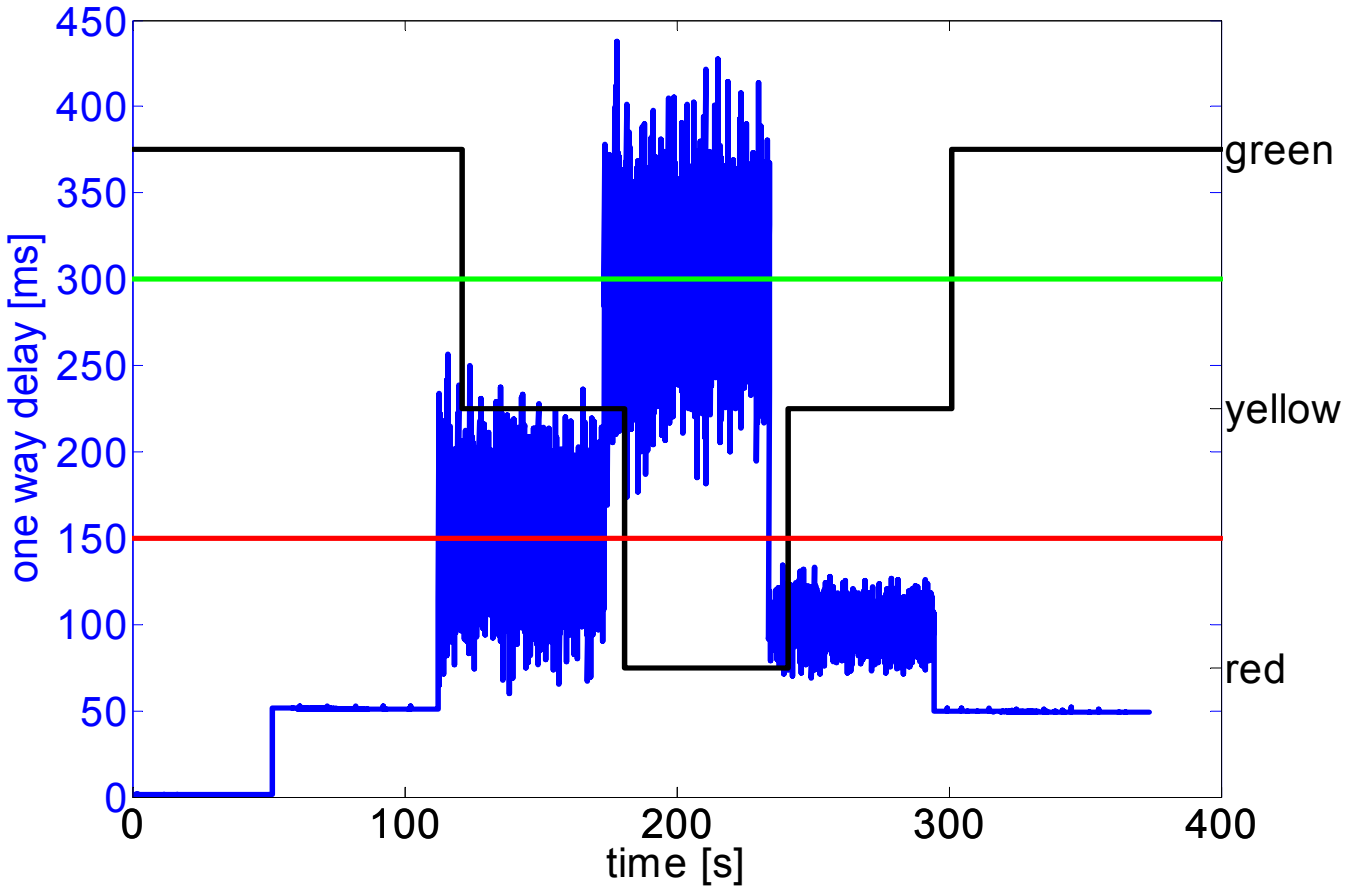
Jitter Messung



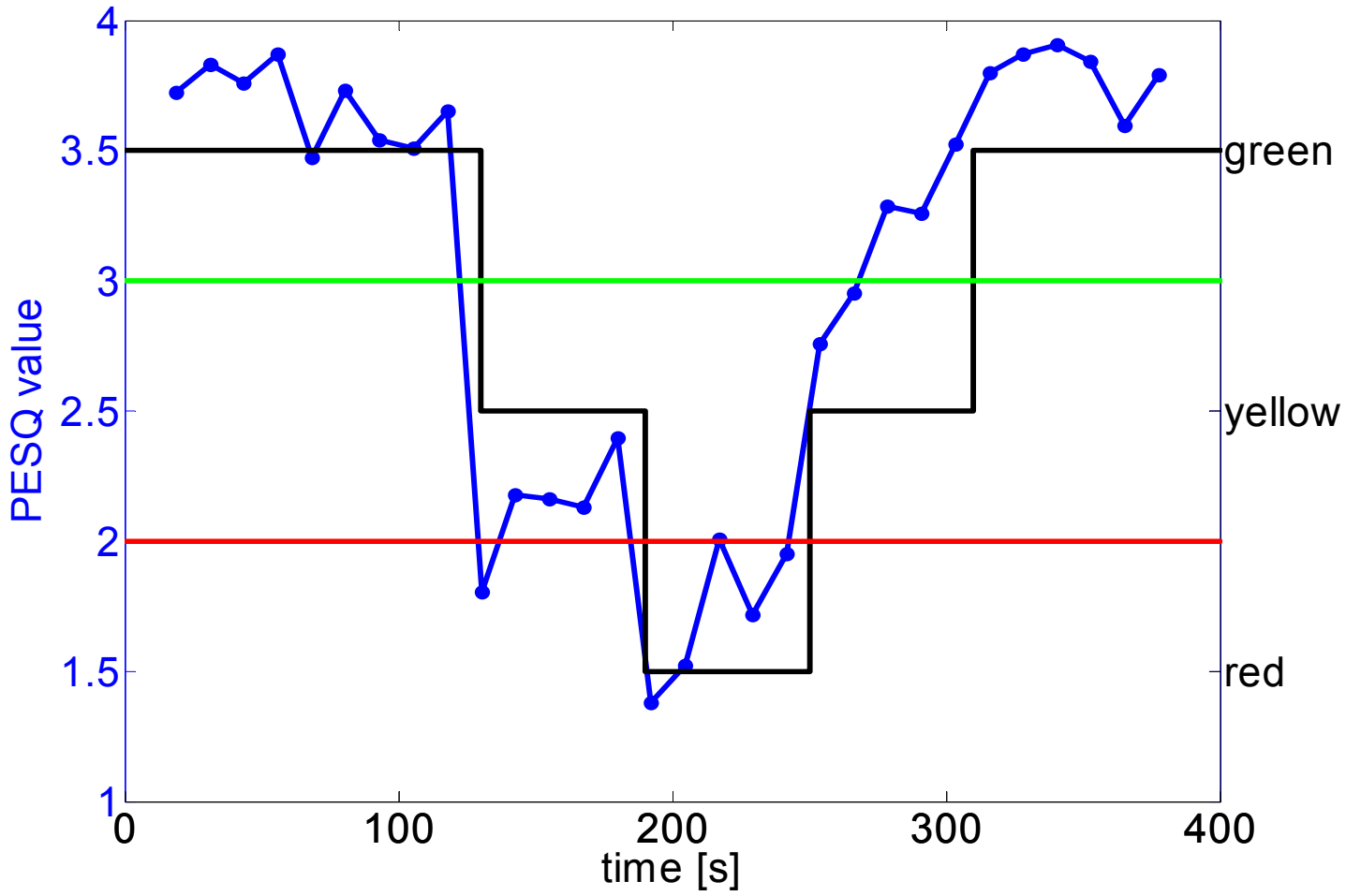
Paketverlustmessung



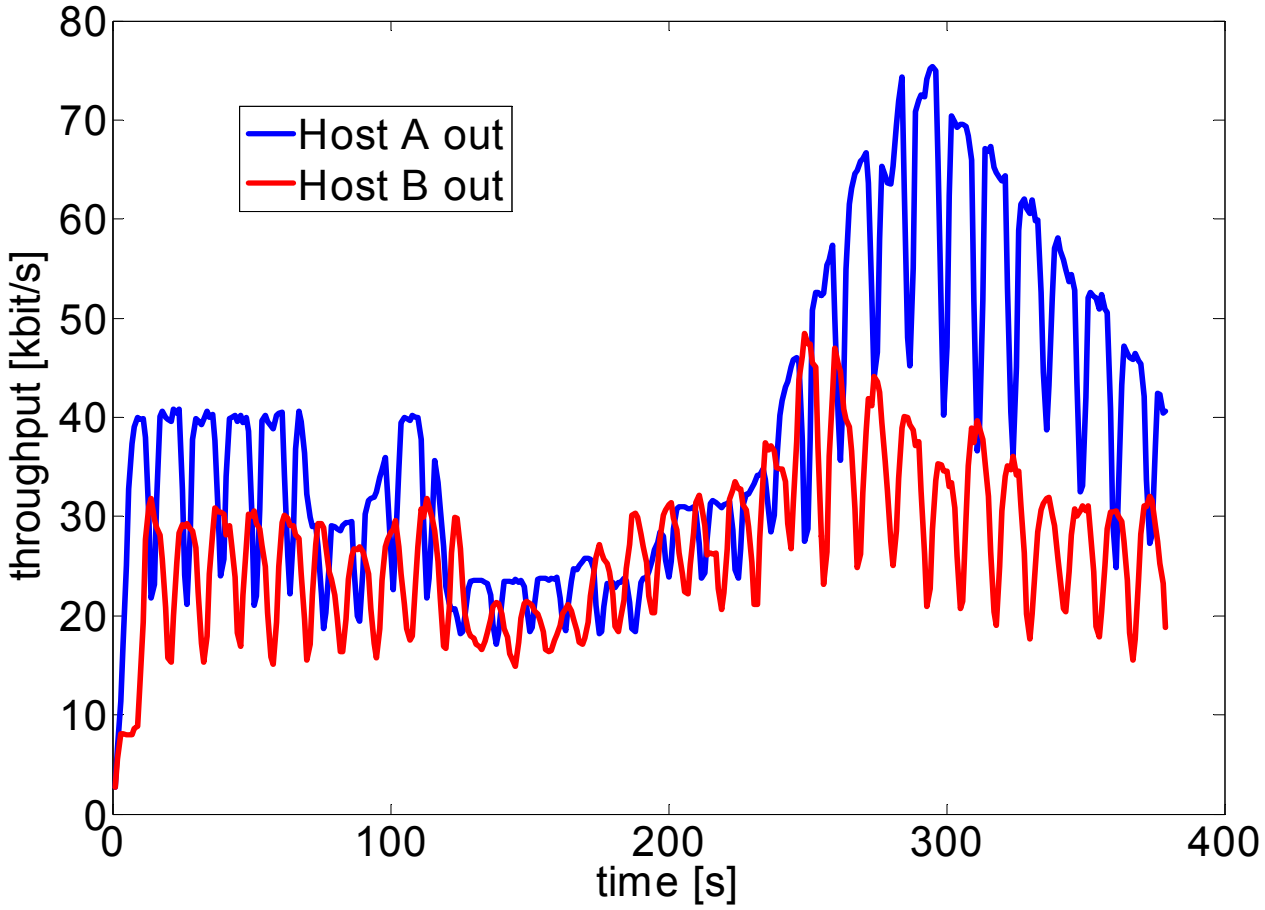
Validierung des Ampel Konzeptes



Ampelsystem vs. PESQ



Skypeverkehr



Thank you

Q&A