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**ITG** INFORMATIONSTECHNISCHE  
GESELLSCHAFT IM VDE

A. Binzenhöfer, D. Schlosser

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

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*19th VDE/ITG Section 5.2.4 Meeting*

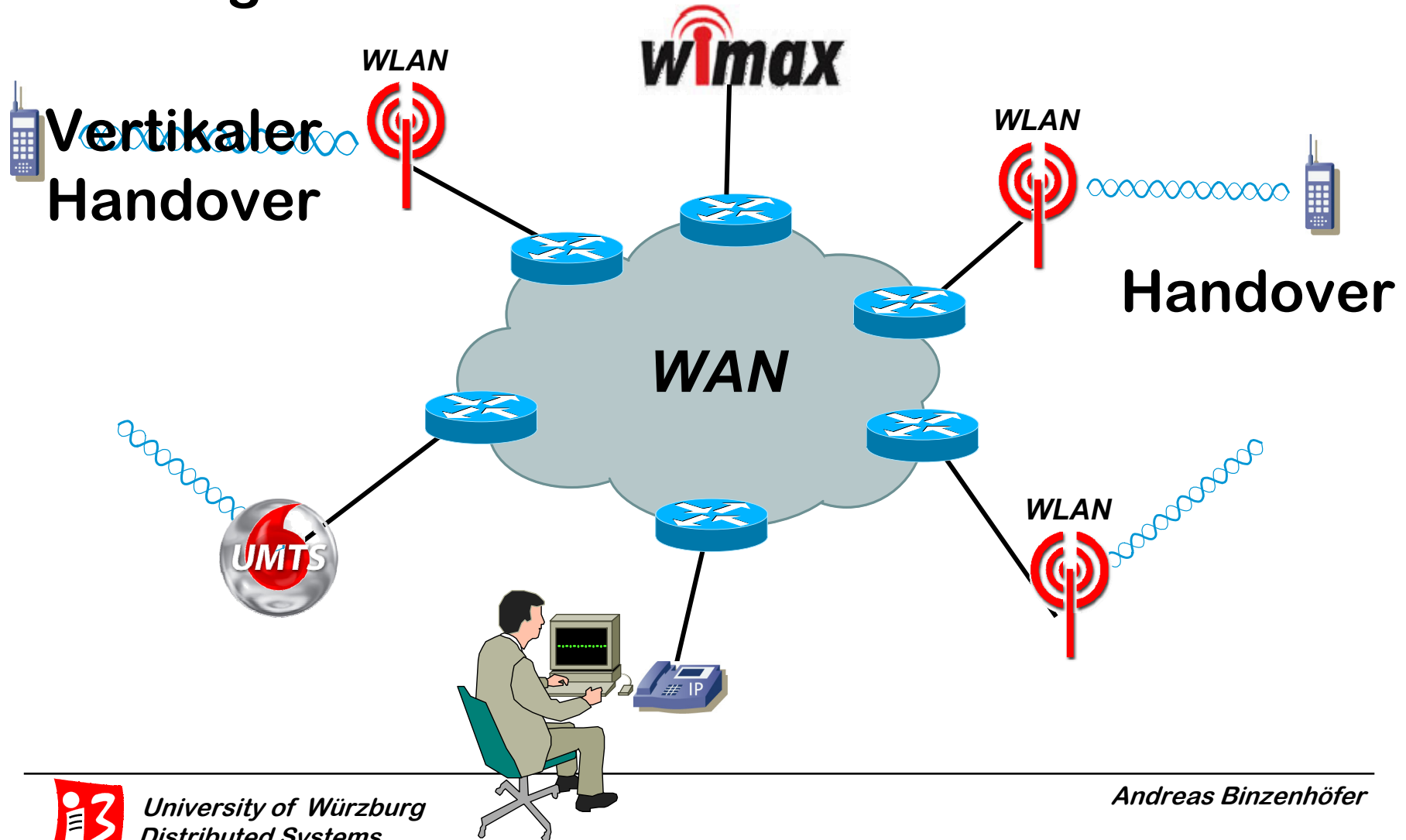
University of Wuerzburg, May 15-16 2006



# VoIP im mobilen Umfeld

Heterogene Technik

Mobile Endnutzer

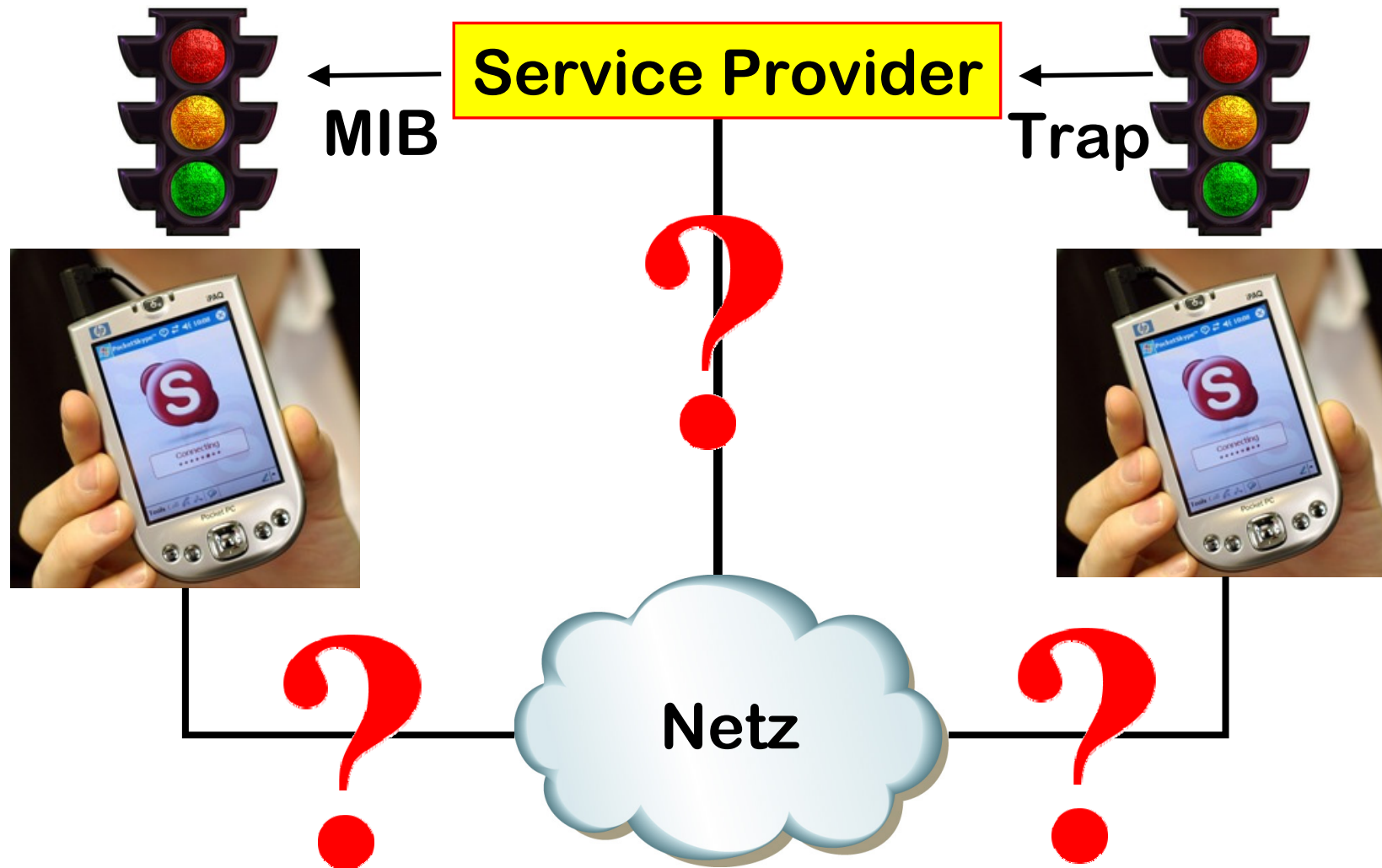


# Übersicht

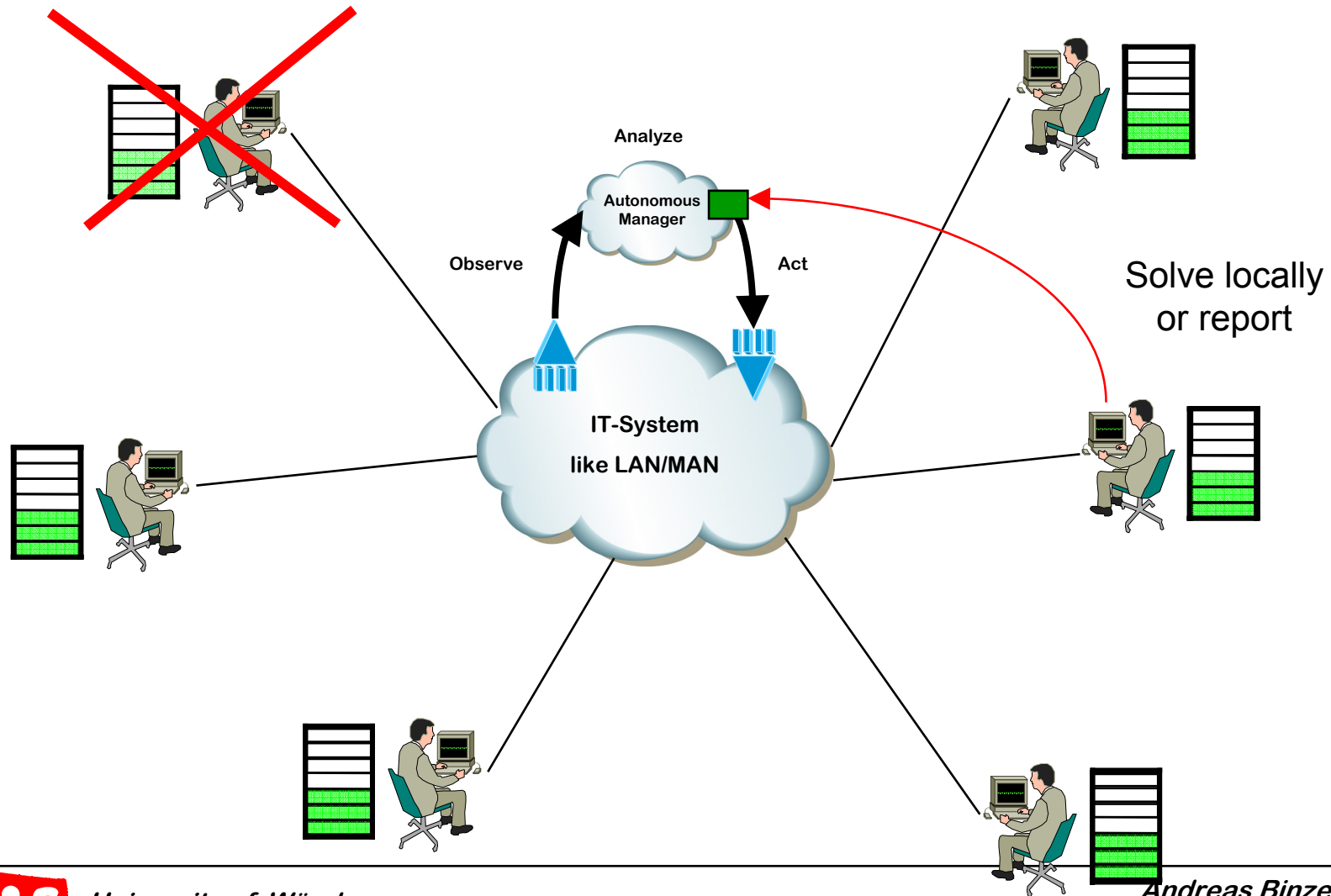
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- ▷ Einführung und Motivation
  
- ▷ Autonomic Networking
  - Definition
  - Verteiltes Netzwerkmanagement
  - Vorstellung unseres Prototypen
  
- ▷ Messung der Ende-zu-Ende Qualität
  
- ▷ Ergebnisse und Visualisierung der Messungen
  
- ▷ Zusammenfassung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

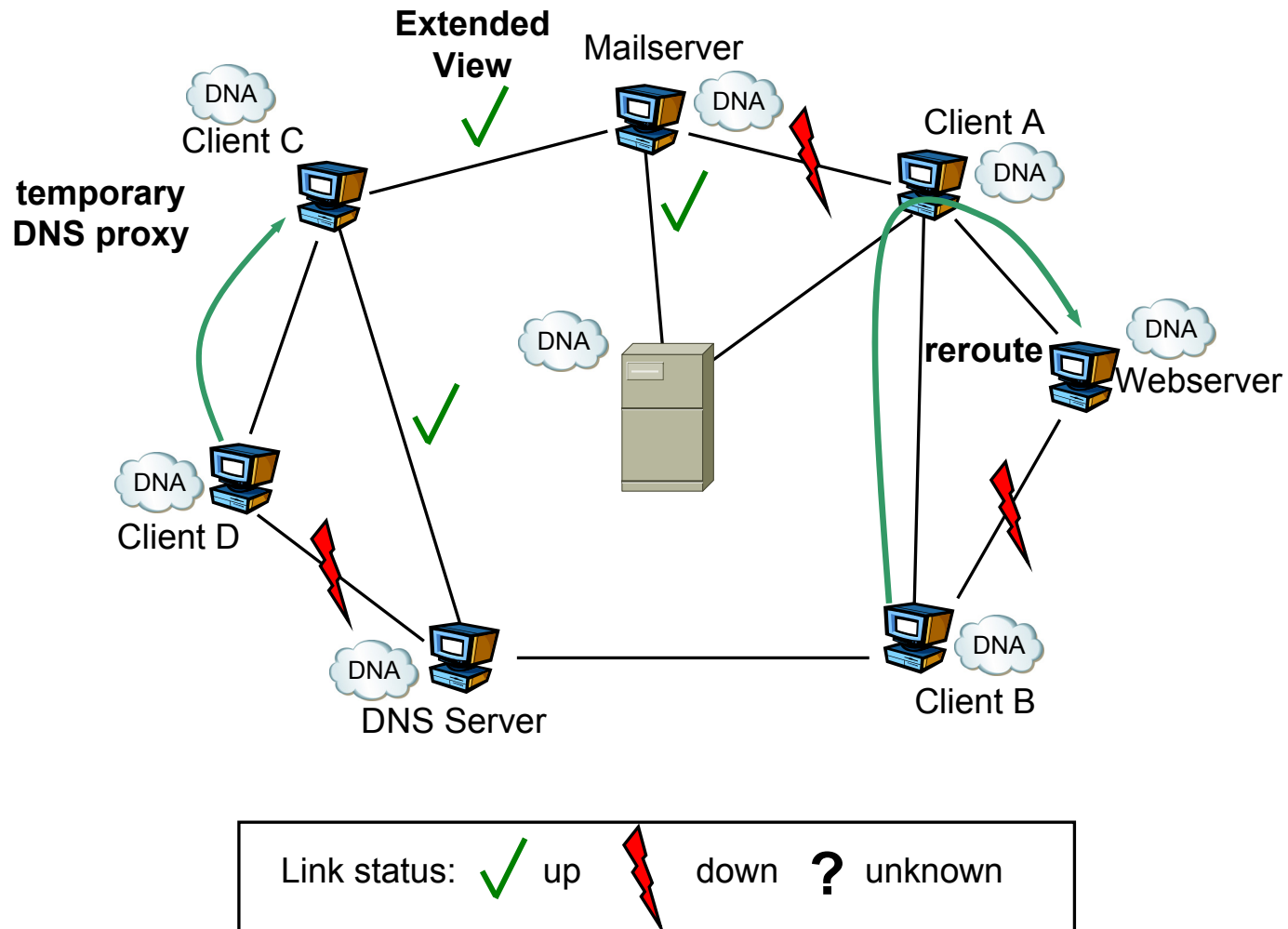
# Verbindungsqualität aus Endnutzersicht



# Unsere Vision: „Autonomic Networks“

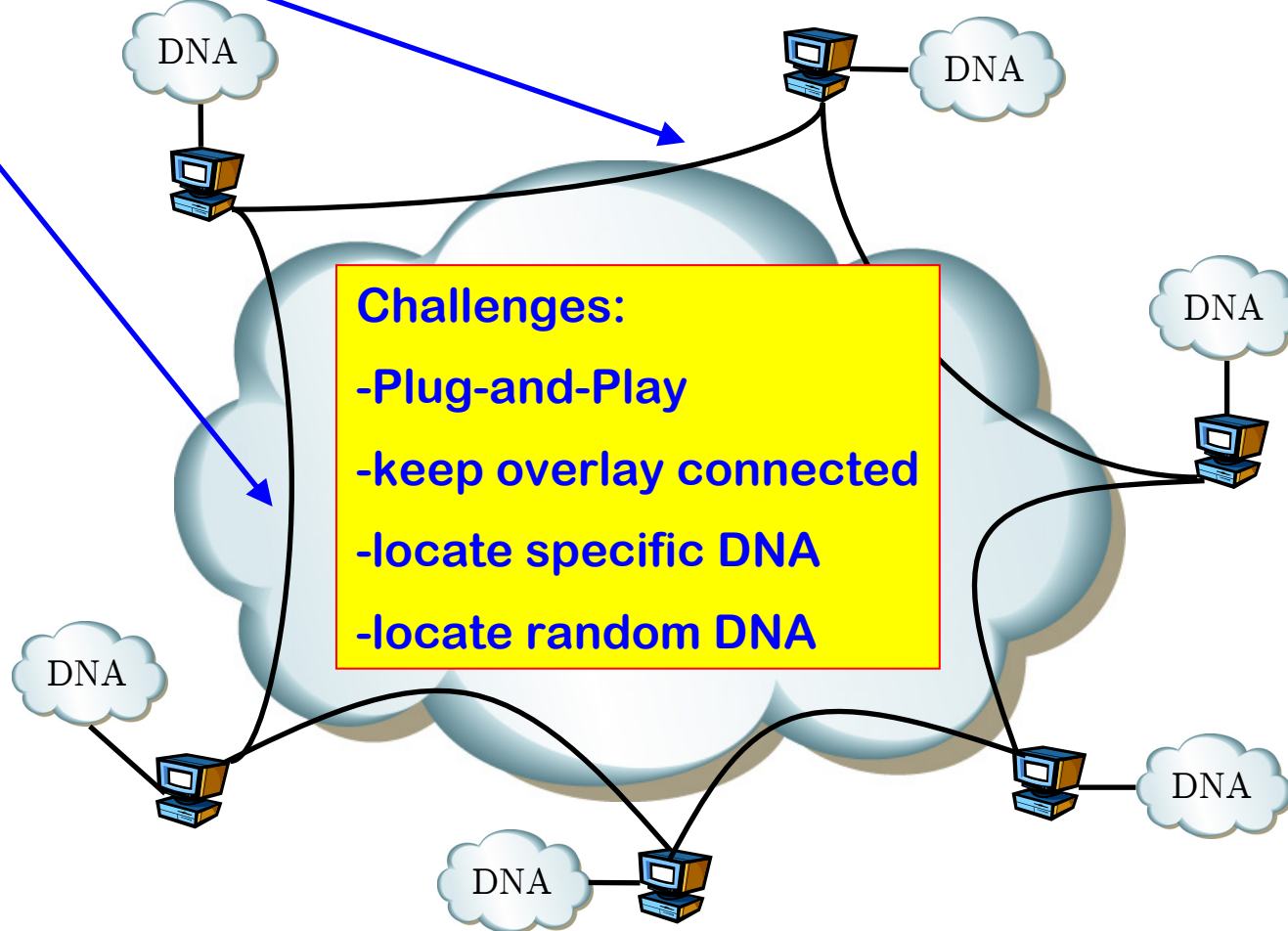


# Advantages of Distributed Network Monitoring



# Distributed Network Application (DNA)

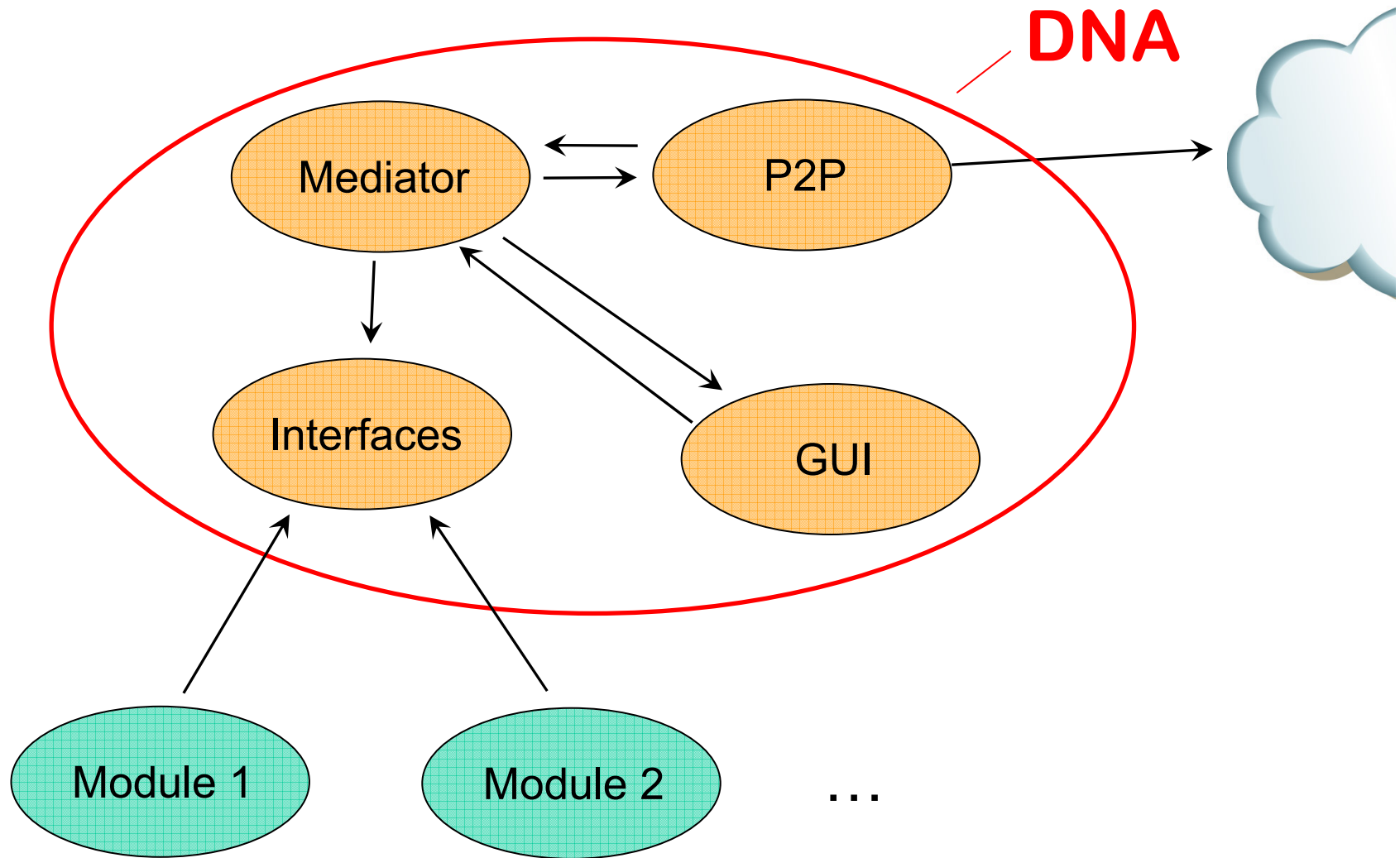
P2P overlay network



Use of a Kademlia-based overlay network

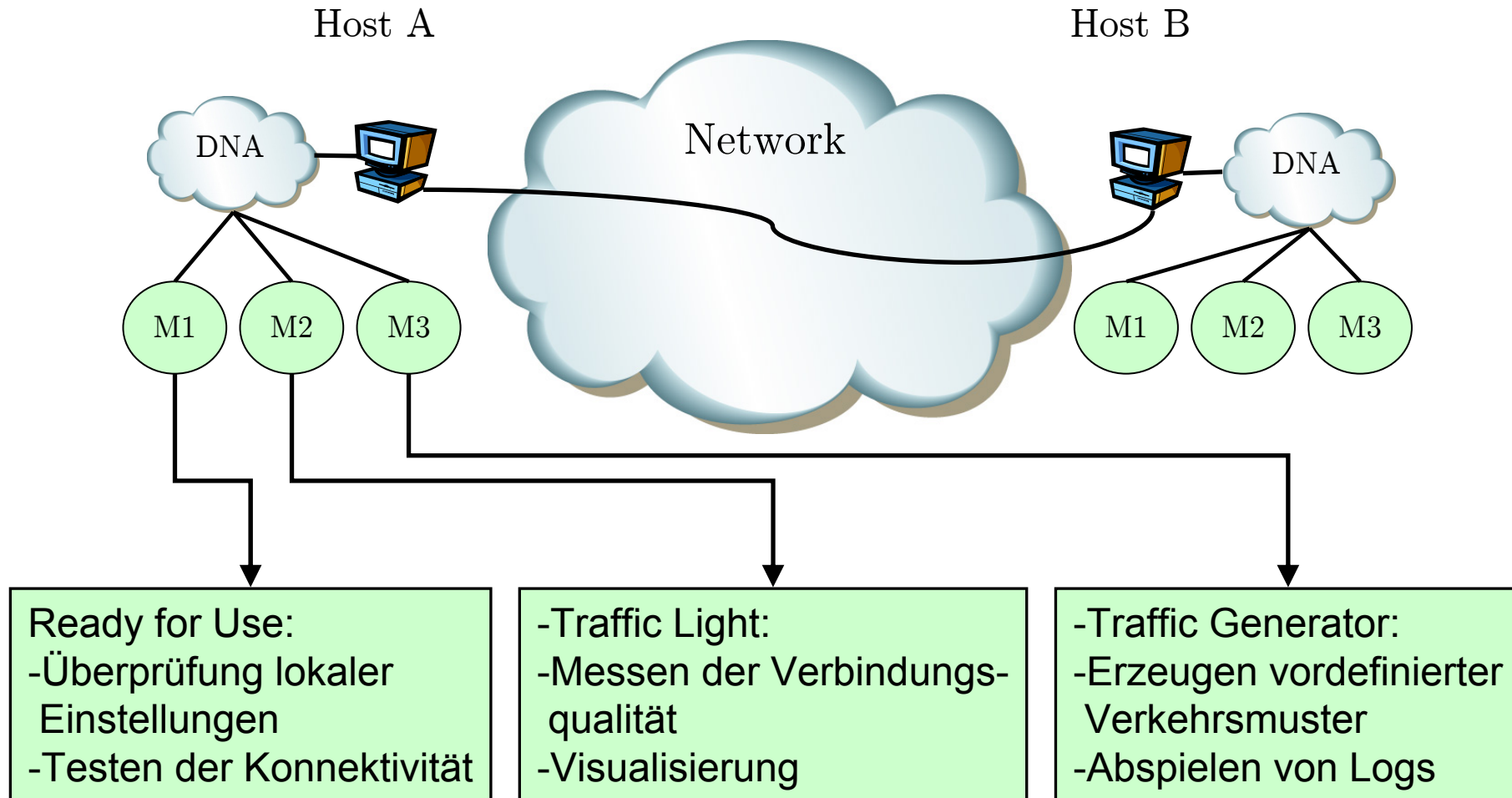


# The DNA Framework

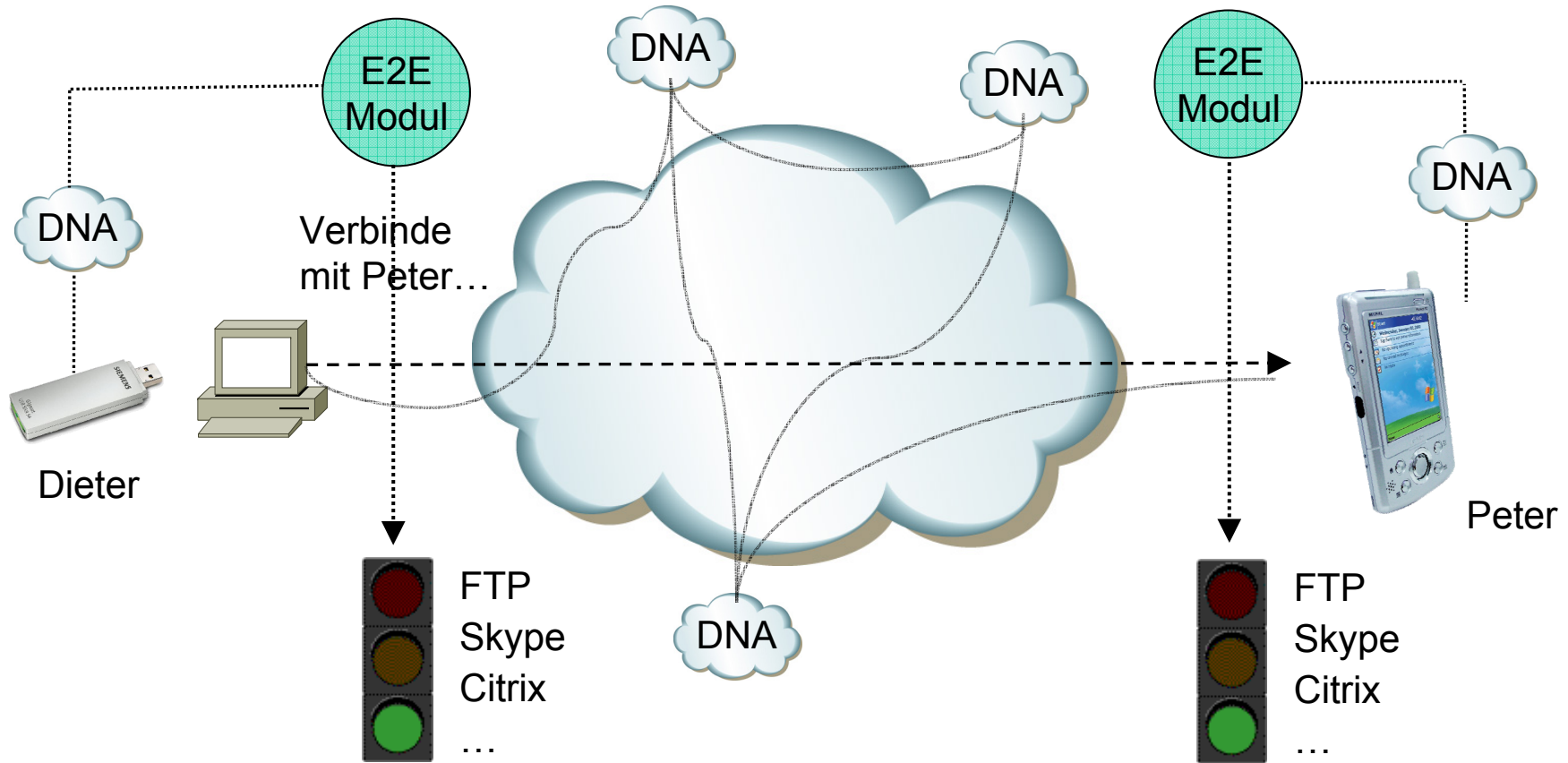




# Das Ende-zu-Ende Modul



# Selbstorganisation der Ende-zu-Ende Messung



# Technische Umsetzung des E2E Moduls

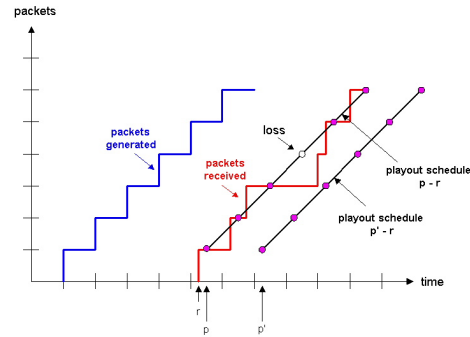
## Messen

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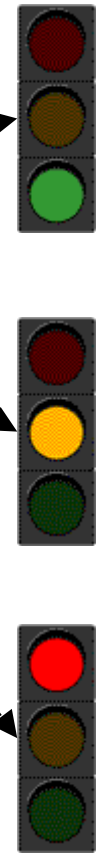
Command Prompt - windump - i3
09:19:49.232522 IP 132.187.106.252.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=standby group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.255523 00:0d:be:be:f1:76 (oui Unknown) > 01:50:0b:2c:ec:cc (oui Unknown
) > snap u3/C
09:19:49.385180 IP 132.187.106.251.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=active group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.424576 IP 132.187.106.252.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=standby group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.568638 IP 132.187.106.251 > OSPF-ALL.MCAST.NET: OSPFv2, Hello, Length:
0
09:19:49.584627 IP 132.187.106.251.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=active group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.616530 IP 132.187.106.252.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=standby group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.625521 app who has win3005.informatik.uni-wuerzburg.de tell win3061.inf
osmatik.uni-wuerzburg.de
09:19:49.776604 IP 132.187.106.251.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=active group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.816602 IP 132.187.106.252.1985 > ALL-ROUTERS.MCAST.NET.1985: HSRPv0-he
lo 20: state=standby group=0 addr=ubh1101-in3.informatik.uni-wuerzburg.de
09:19:49.847235 <NOV-ETH11> IPX 00000000.00:c0:ae:13:29:23.4006 > 00000000.ff:ff
ff:ff:ff:ff.0452: ipx:sap:nearest_req:FileServer
09:19:49.891765 app who has win3042.informatik.uni-wuerzburg.de tell win3019.inf
osmatik.uni-wuerzburg.de
09:19:49.900499 IP
    
```

IP – ID  
Zeitstempel  
Größe

## Analysieren



## Visualisieren



# One way Packet loss

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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 $\Delta t_{out}^B(i)$ are 16 bit integers, 1 if $\Delta t_{out}^B(i)$ are 32 bit integers
$S_{IP}$	4 bit	summary packet ID
$t_{out}^B(1)$	8 byte	time stamp of first outgoing packet
$\Delta t_{out}^B(i)$	2/4 byte	times between outgoing packets $i$ and $i-1$ , if $i > 1$ , 0 otherwise
$ID_{out}^B(i)$	2 byte	IP-ID of packet $i$

- ▷ Periodischer Austausch der lokalen Messungen
- ▷ Paketverlust direkt ablesbar

# One Way Jitter

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- ▷ Abschätzung über Formel aus Real Time Protocol (RTP)

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

- ▷ 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

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- ▷ 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:

$$D'_{BA}(i) = D_{BA}(i) - clock_{drift} \cdot (t_{in}^A(i) - t_{in}^A(1)).$$

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

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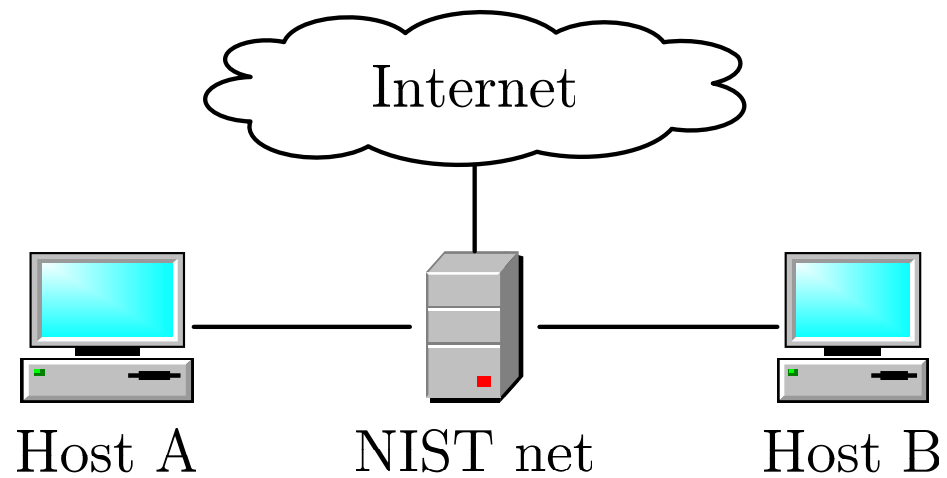
- ▷ Mapping muss pro Service geschehen
  - Utility Functions
  - Abschnittsweise definierte Funktionen
  - Multidimensionale Matrix
  - E-Model
  
- ▷ Beispiel VoIP (ITU-T G.114)

	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

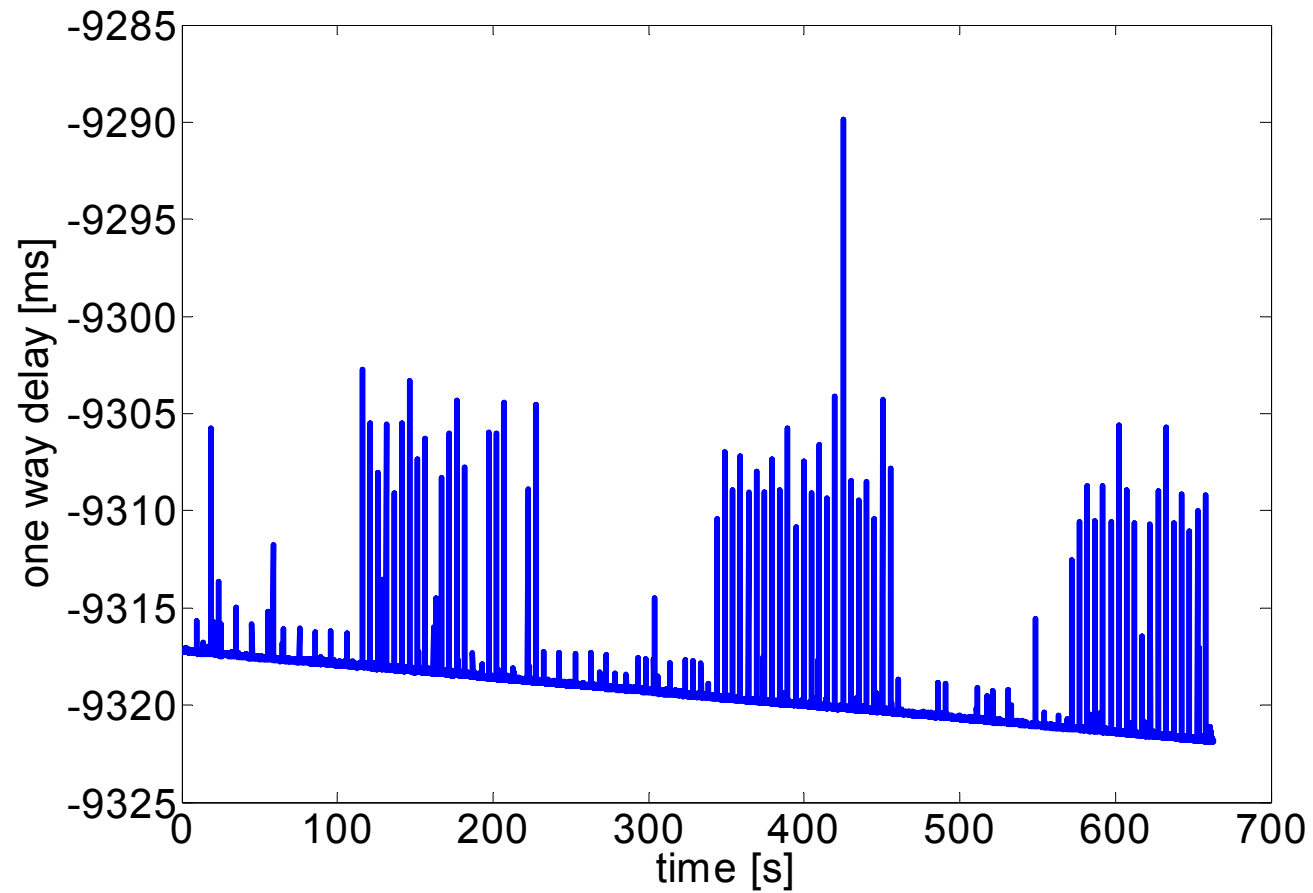
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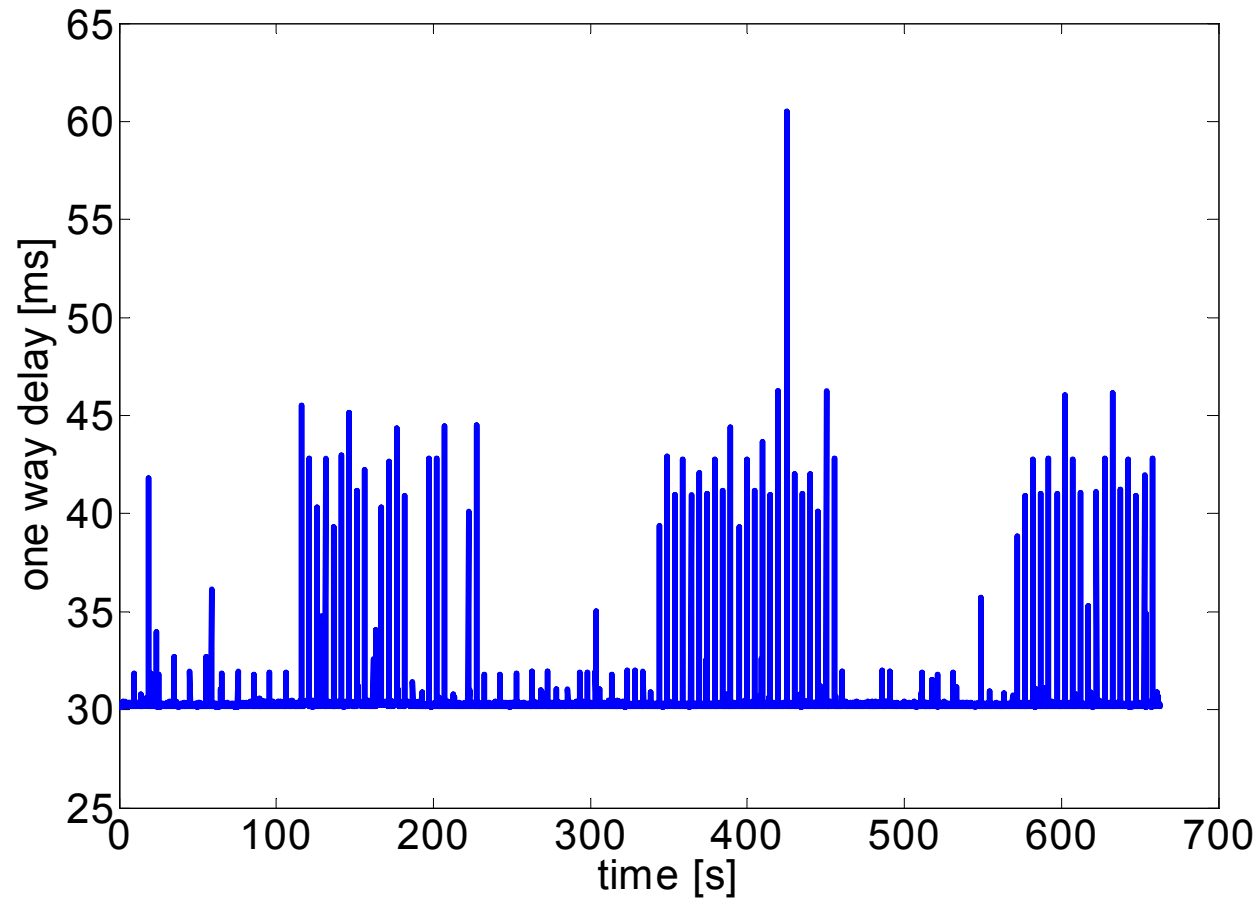
# One Way Delay Messung

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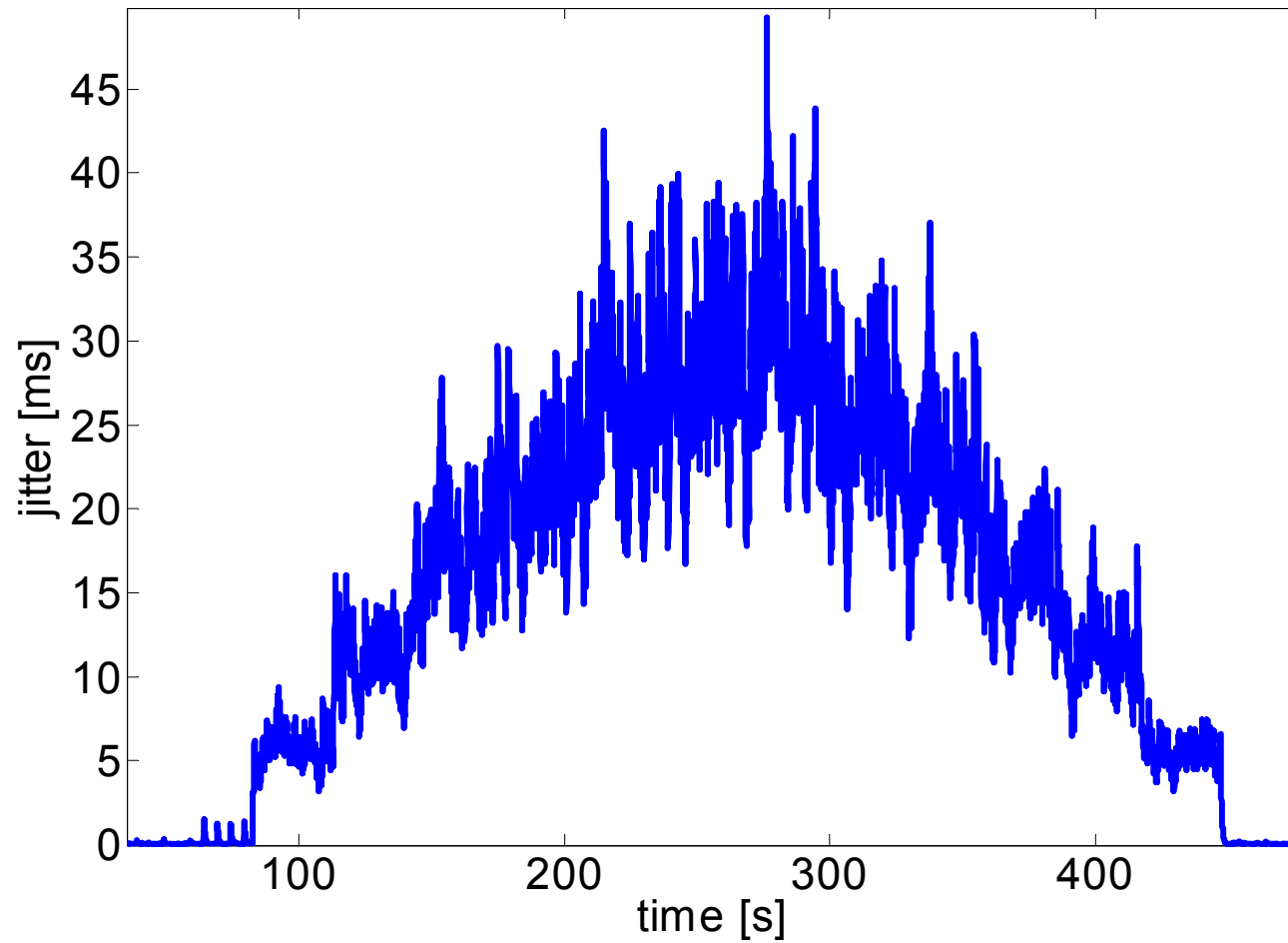
# Angepasste One Way Delays

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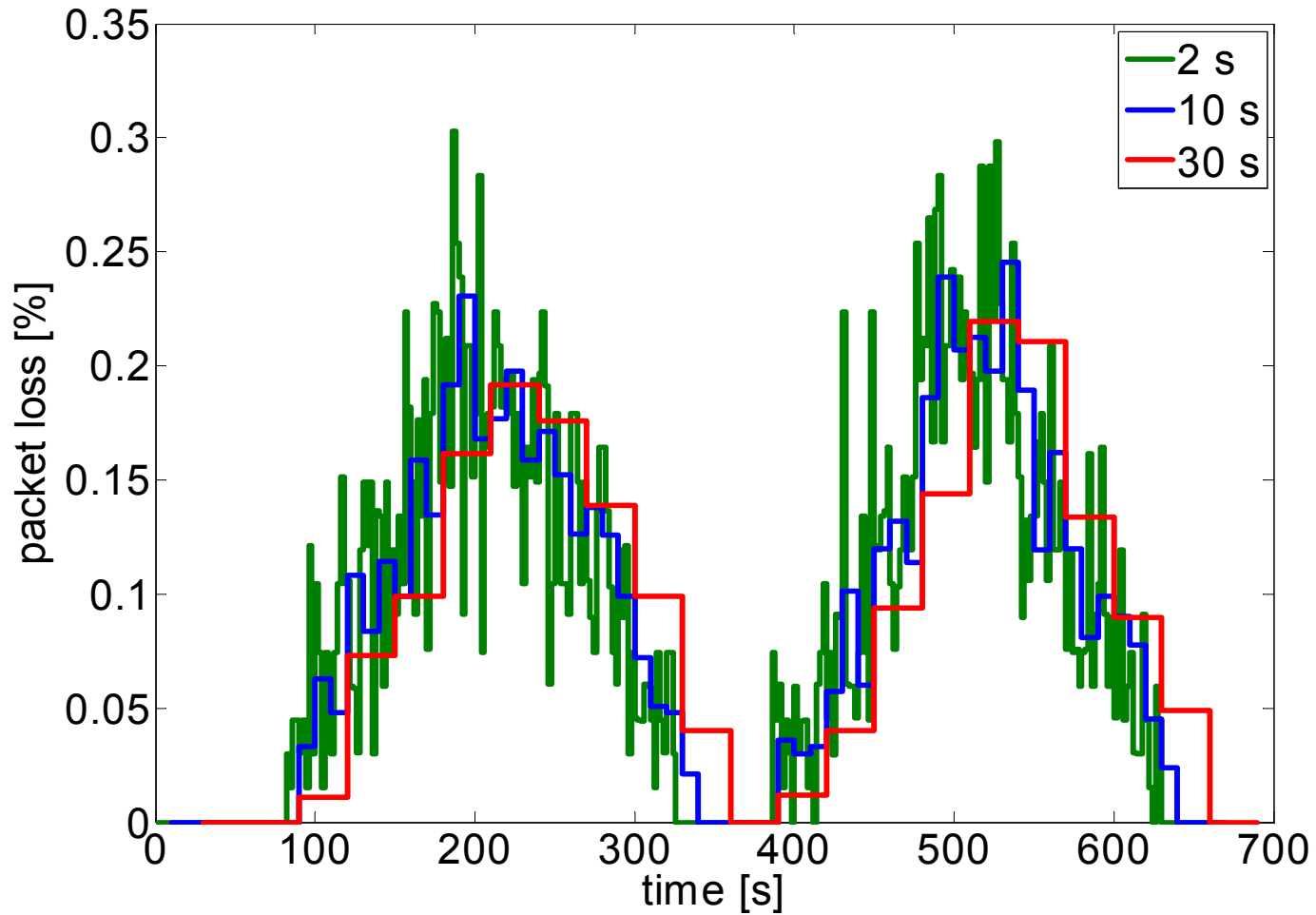


# Jitter Messung

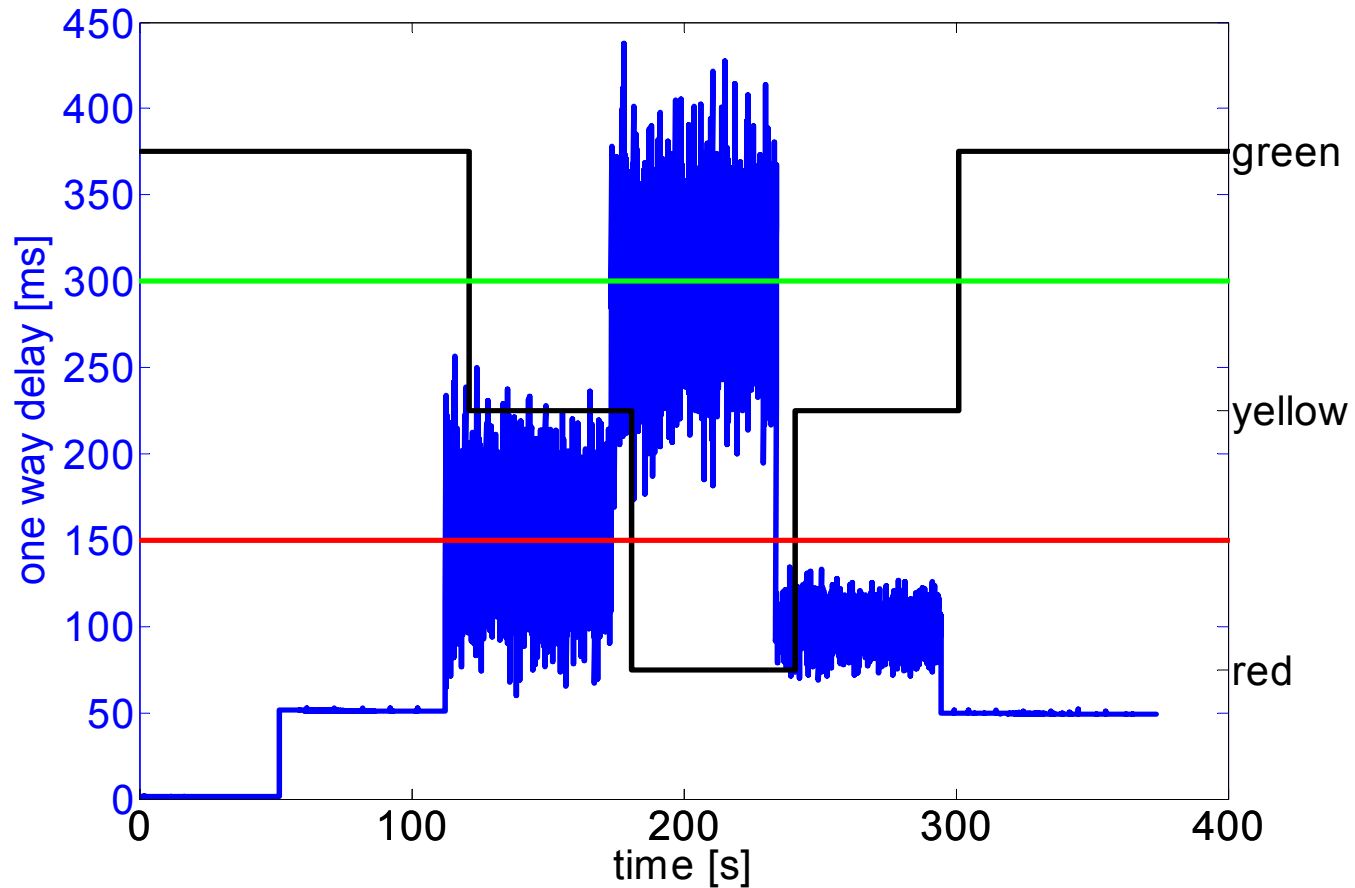
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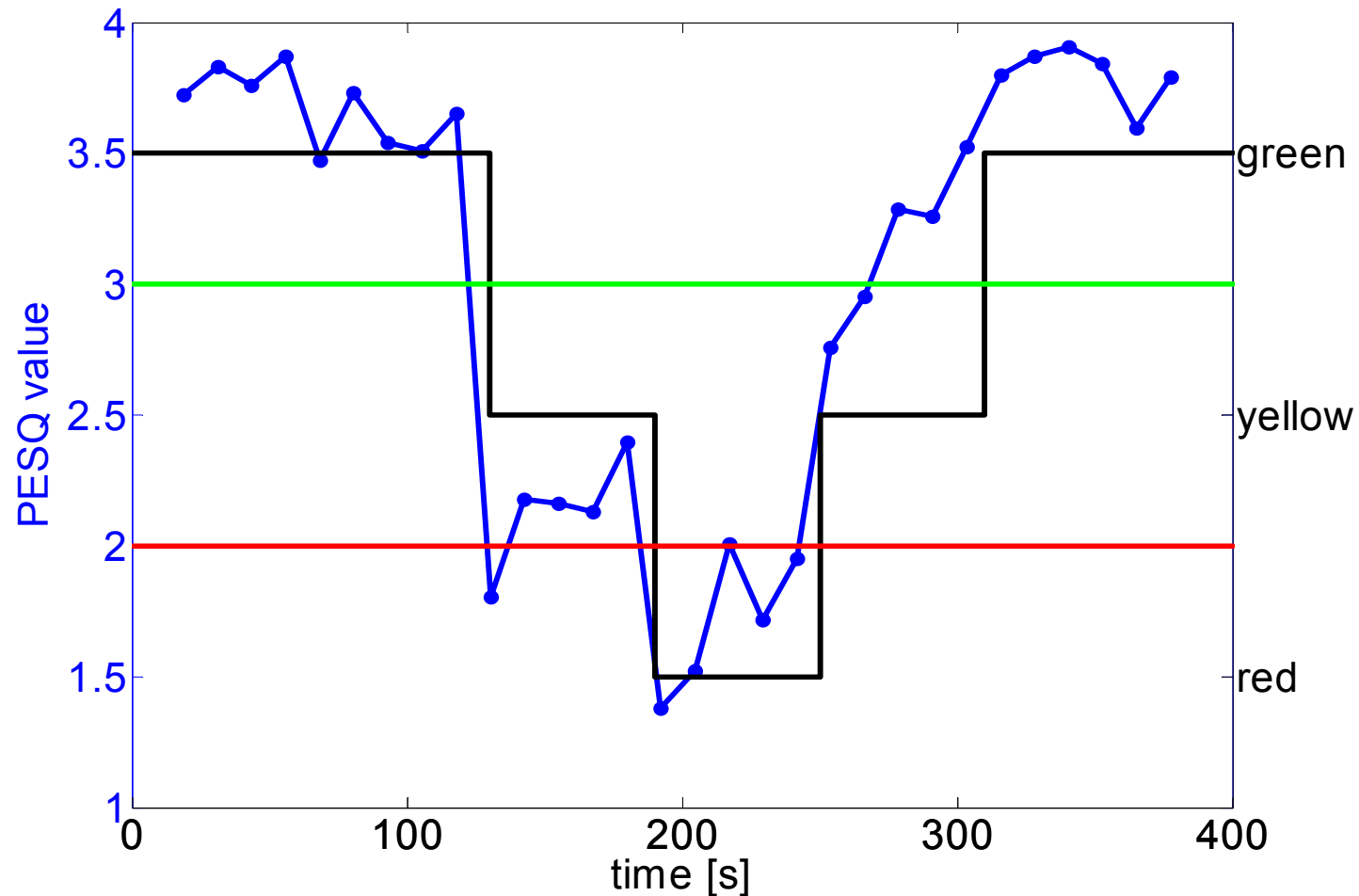
# Paketverlustmessung



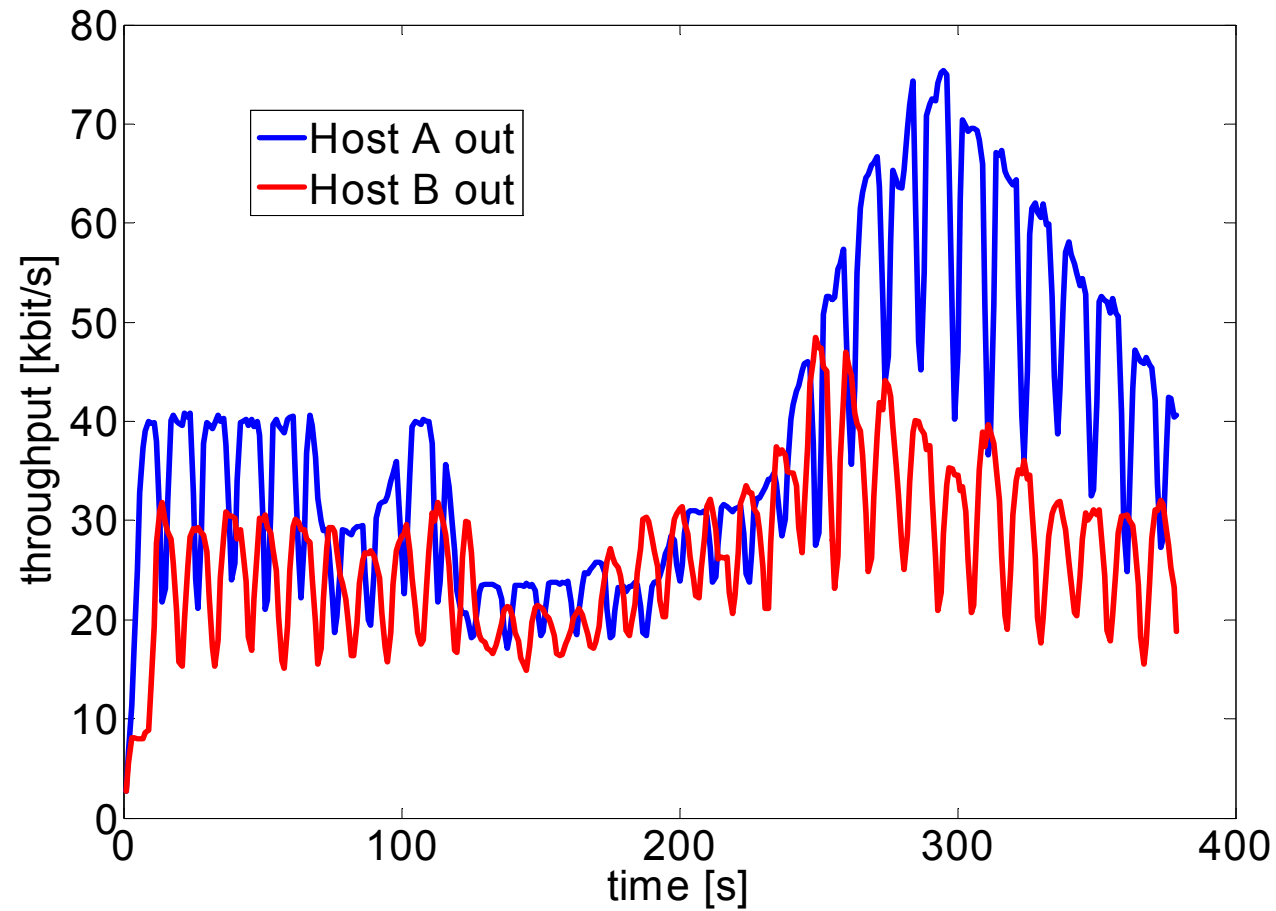
# Validierung des Ampel Konzeptes



# Ampelsystem vs. PESQ



# Skypeverkehr



Thank you

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Q&A

