Fachhochschule
Gelsenkirchen

Internet Availability System
→ Idea and Realization

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if(is) internet security.

Content

- Aim and outcomes of this lecture
- Idea/Concept of the Internet Availability System
- Routing
- Implementation
- Results
- Summary

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Internet Availability System (IVS)
→ Aims and outcomes of this lecture

Aims

- To introduce an Internet Early Warning System with an availability approach
- To explore the structure of the Internet Availability System
- To visualize the routing of the Internet
- To analyze the results of the Internet Availability System

At the end of this lecture you will be able to:

- Understand what is meant by the Internet Availability System.
- Know something of the structure of the Internet Availability System.
- Know what could be the results of the Internet Availability System.
- Understand the capabilities and limitations of the Internet Availability System.

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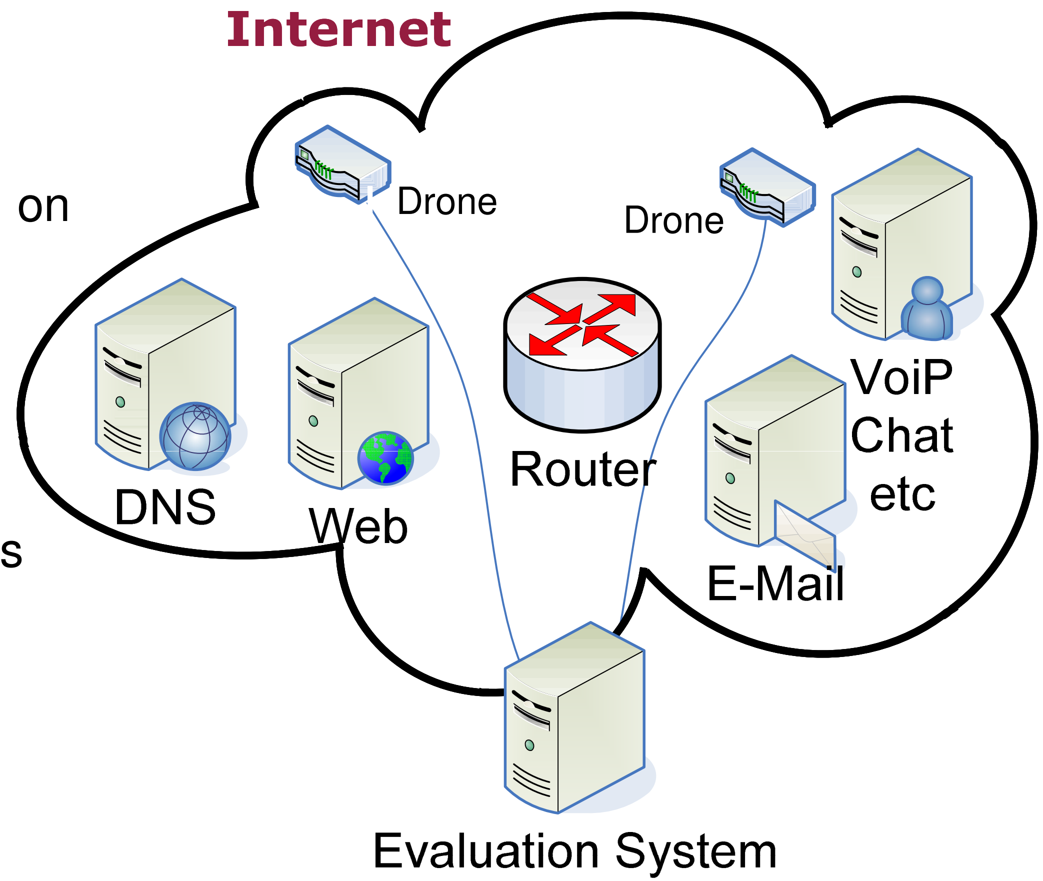
Internet Availability System (IVS) → Idea

- Observation of the critical infrastructure **„Internet“.**
- **Drones** are placed in strategically selected spots to gather information on availability.
- Different types of availability data could gathered
  - Important websites
  - DNS service
  - Communication routes of routers
  - E-Mail Services and Server
- **Parameter:** Quality of Service: Bandwidth, Bit Error Rate, Jitter, Delay, Packet Loss Rate
- A centrally managed **Evaluation System** is used to analyze the raw data and to display the detailed results in an intuitive manner.



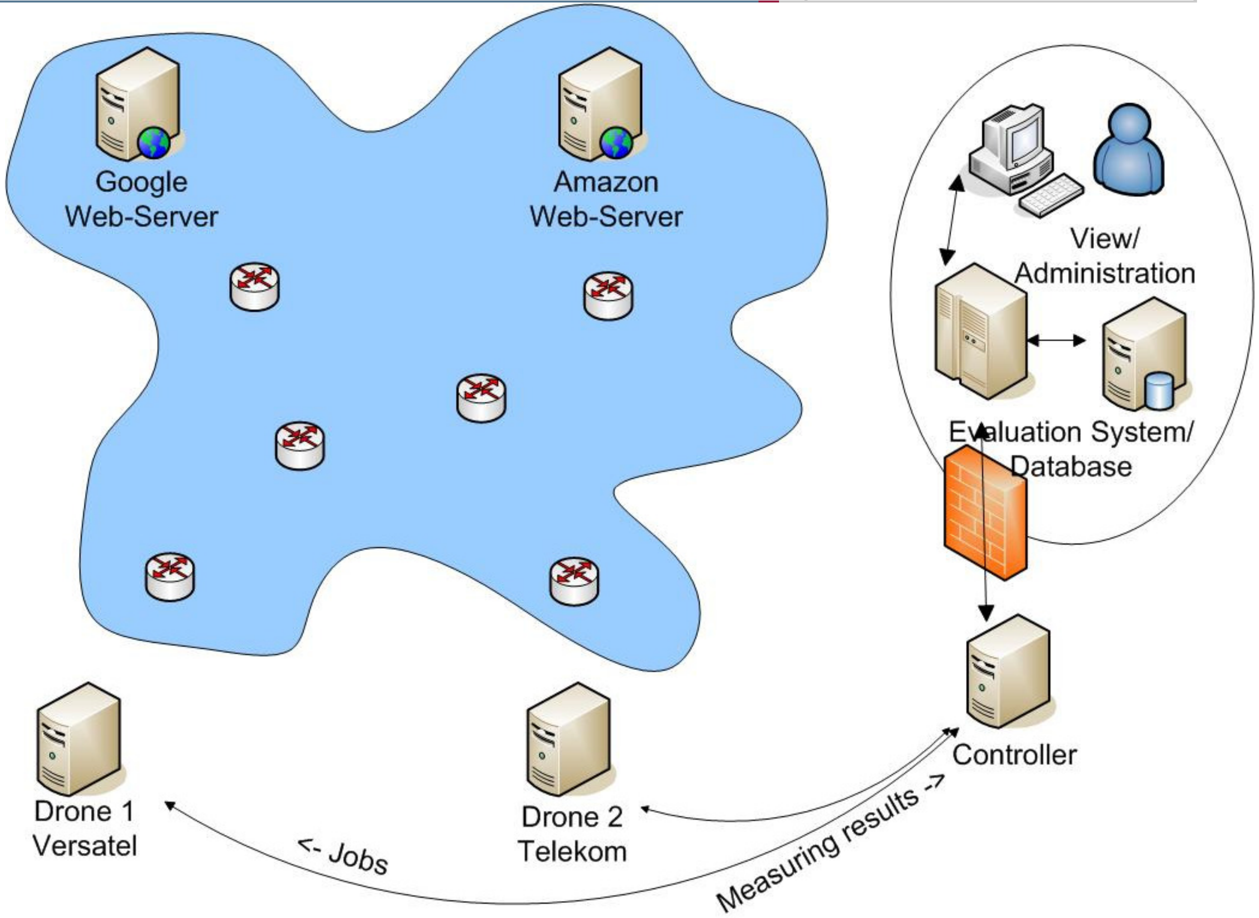
IVS

Drone: active Probe

Placement of the drones is done independent from third parties!

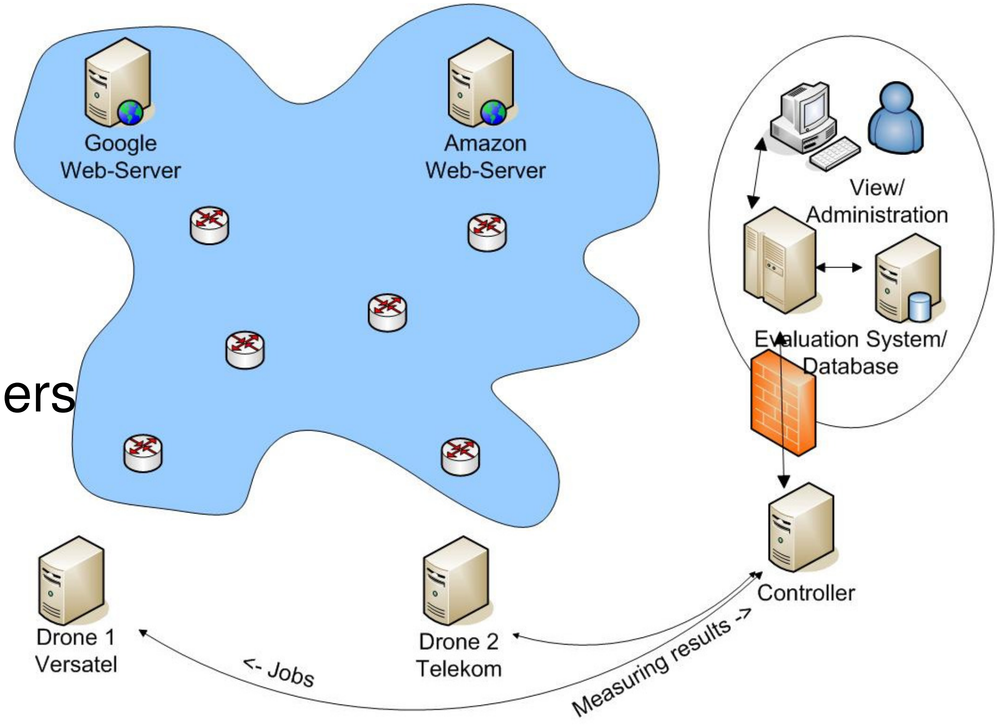
Internet Availability System (IVS)
→ Concept (1/3)

- Modules currently implemented for measurement
  - **HTTP**
    - Any file over HTTP
      - Welcome page
      - Dynamic linked page
    - Domain (www.heise.de)
    - Address (193.99.144.85)
  - **Traceroute (TR)**
    - Domain
    - Address



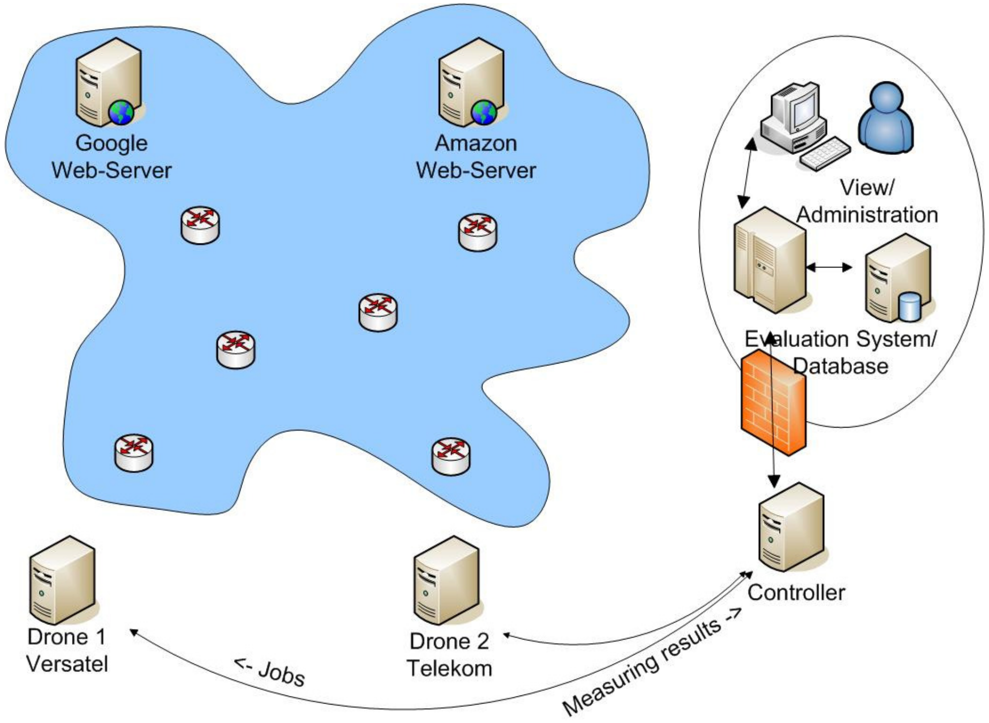
Internet Availability System (IVS)
→ Concept (2/3)

- **Drone**
  - The Drone is a measurement device and has modules (HTTP,TR)
  - Placed at Internet connections by various Internet Service Providers
  - Measures at a given interval
  - Communication only initialized by drone (no adaptation to firewall/NAT necessary)
    - Drone pulls jobs from controller
    - Sends results to controller
- **Controller**
  - Is the intermediate of the drone and the evaluation System
  - Placed at the DMZ of the operator of IVS



Internet Availability System (IVS)
→ Concept (3/3)

- **Evaluation System / Database**
  - Communicates with controller and administrator
  - Prepares data to be displayed by the view
  - Persistent storage of measuring results and of additional management data



- **View / Administration**
  - Over a GUI the user can administrate jobs for specific drones
  - Drawing graphs and evaluation of the statistical results for a defined period
  - Indicates the current status of the drones, server and jobs

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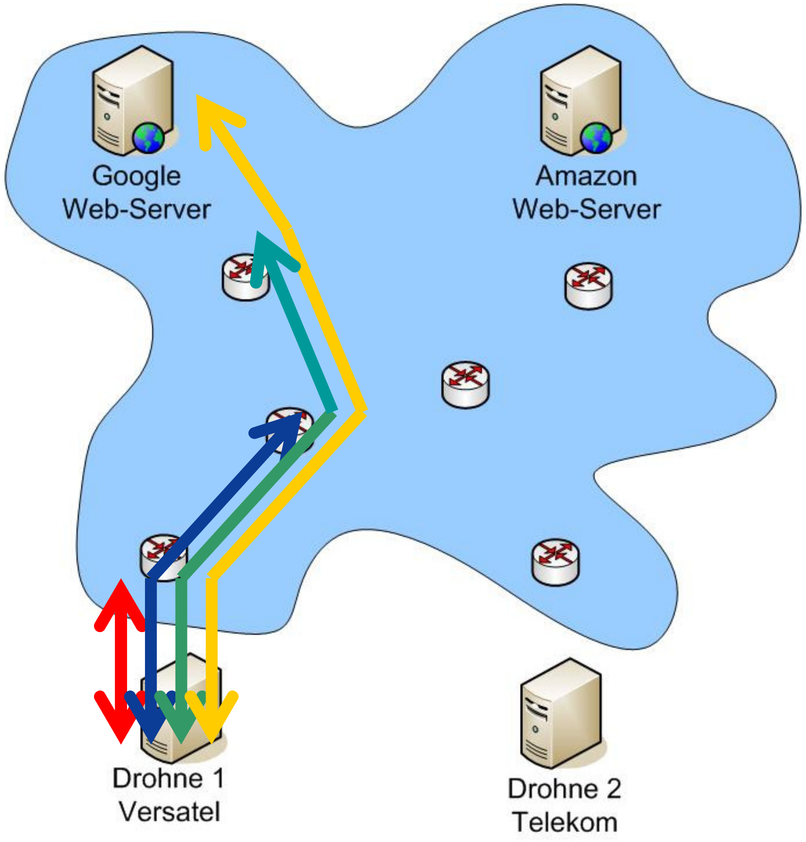
Internet Availability System (IVS)
→ How does traceroute work?

- The time-to-live field (TTL) of an IP packet is initialized by the original sender starting with the value “one”, which will allow only the packet to reach the first active hardware component (router).
- Each intermediate router (active component) decrements the value by one.
- If the field is decremented to zero, the packet is discarded and an error indication packet (ICMP “time exceeded”) is sent back to the original sender.
- The TTL value is incremented with each TR packet extending the range of the route.
- The source address of the ICMP “time exceeded” identifies the router that discarded the data packet.



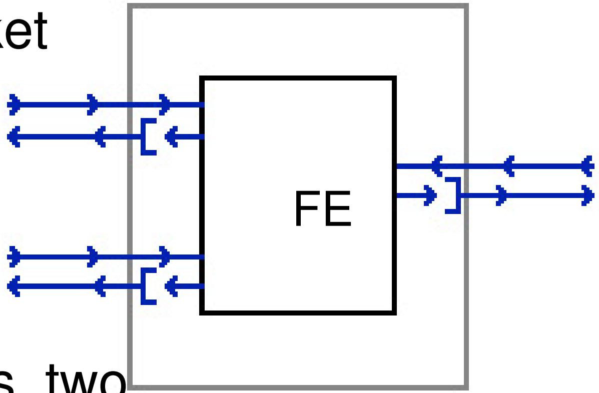
- So, if packets are sent to the final destination, but with the ttl set to n, the router n hops along the path is forced to identify itself.
- TR can be implemented with TCP/UDP or ICMP

Internet Availability System (IVS)
→ Traceroute

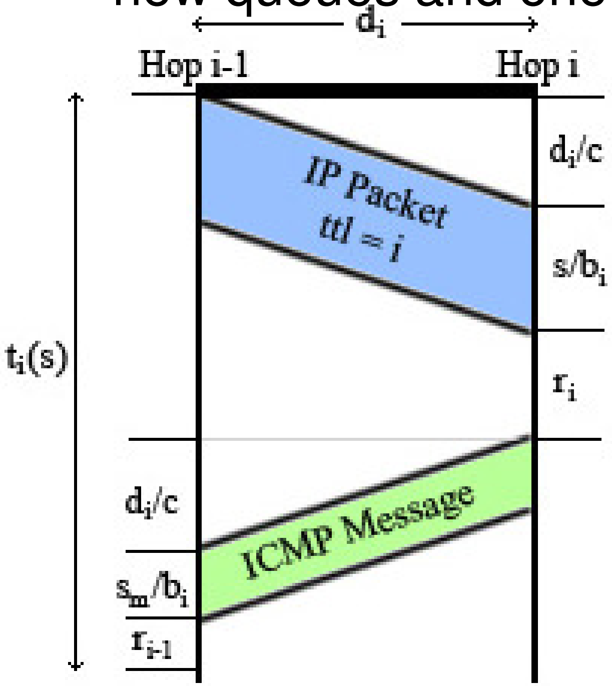
Traceroute

```
vmsuse80:/ # traceroute www.heise.de
traceroute to www.heise.de (193.99.144.71), 30 hops max, 40 byte packets
 1  gw502_48.informatik.fh-ge.de (172.16.48.2)  1 ms  1 ms  1 ms
 2  fb5gwint.informatik.fh-ge.de (172.16.0.5)  1 ms  1 ms  1 ms
 3  172.16.16.3 (172.16.16.3)  2 ms  2 ms  2 ms
 4  fb5gw.informatik.fh-gelsenkirchen.de (194.94.127.2)  3 ms  3 ms  3 ms
 5  193.175.172.2 (193.175.172.2)  3 ms  3 ms  3 ms
 6  ar-essen2.g-win.dfn.de (188.1.44.33)  6 ms  5 ms  5 ms
 7  cr-essen1-ge0-0.g-win.dfn.de (188.1.86.1)  5 ms  5 ms  5 ms
 8  cr-frankfurt1-po8-1.g-win.dfn.de (188.1.18.89)  16 ms  16 ms  16 ms
 9  ir-frankfurt2-po3-0.g-win.dfn.de (188.1.80.38)  15 ms  15 ms  15 ms
10  de-cix2.ffm.plusline.net (80.81.193.132)  16 ms  16 ms  15 ms
11  c22.f.de.plusline.net (213.83.57.53)  16 ms  16 ms  16 ms
12  www.heise.de (193.99.144.71)  16 ms  16 ms  17 ms
vmsuse80:/ #
```

Internet Availability System (IVS)
→ Round Trip Time (RTT)



- The time period between transmitting the TR IP packet and receiving the ICMP reply message is called Round Trip Time (RTT)
- A router contains links, queues and a forwarding engine (FE).
- Each time the TTL is increased by one, two new links, two new queues and one new forwarding engine are measured



- The RTT depends on the **distance d**, the **size of the packets s**, the **bandwidth b** and the **forwarding-** and **queue-time r** of the router
- **Forwarding time for hop n:**

$c = 3 \cdot 10^8$m/s
(the speed of light)

$$T(n,s)=\sum_{i=1}^{n}\left[\frac{s}{b_i}+\frac{d_i}{c}+r_i\right]$$

- **RTT between two hops:**

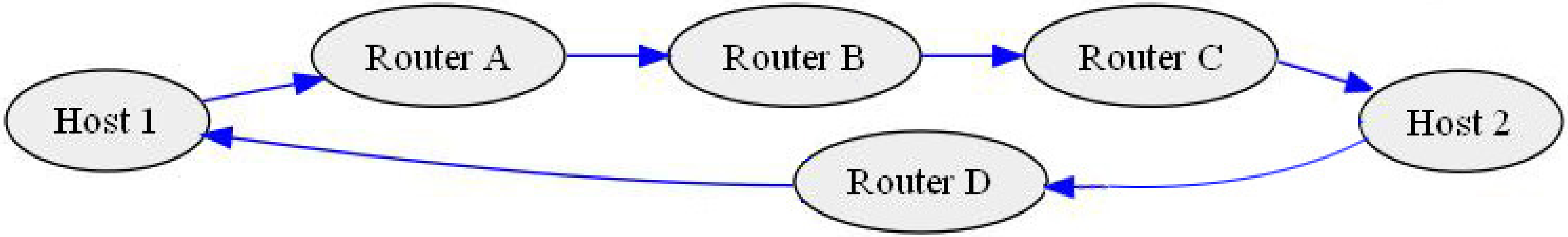
$$t_i(s)=\frac{s}{b_i}+r_i+\frac{s_m}{b_i}+r_{i-1}+\frac{2*d_i}{c}$$

Internet Availability System (IVS) → Asynchronous routing

- While the **forwarding time f** of each router is nearly the same the **queue time q** is **not predictable** (**r** = **q** + **f**)
- The **minimum RTT** to each router over time helps to get the time between two hosts by minimum influence of queue time

$$t_i(s) \approx \frac{s+s_m}{b_i} + 2[\frac{d_i}{c} + fi] \qquad if\ (f_{(i-1)} \approx f_i) \wedge (q_i \rightarrow 0)$$

- Normally, the routing is synchronous and the forwarding time of a packet is half of the Round Trip Time (RTT)
- But it is possible that the routing is asynchronous!

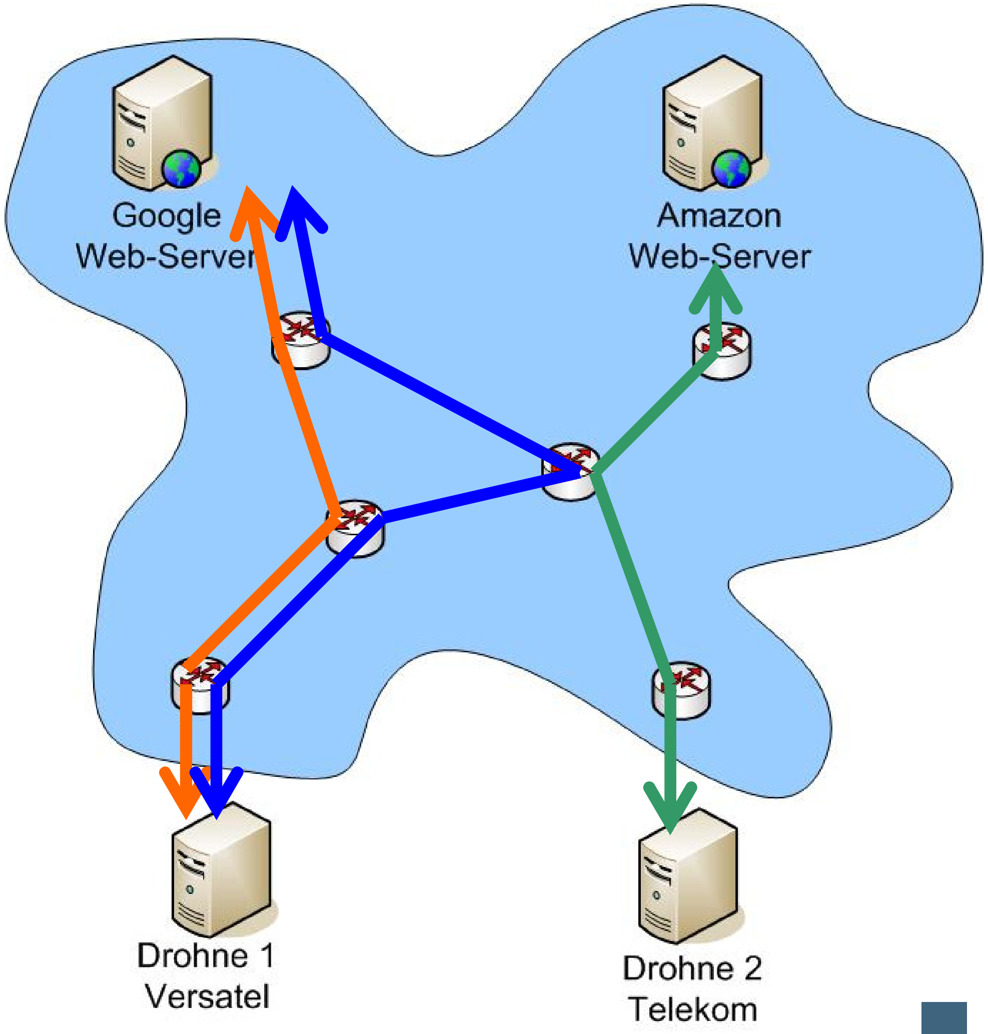


- Latency period (measured only in one direction) with complex time sync of both hosts could help

Internet Availability System (IVS) → Routing

- The path of a route is changing over time

- **Cause of changing:**
  - Drop out of a router
  - High utilization of a router
  - Network management of network carrier
    - Commercial interests
    - Cost interests
  - …



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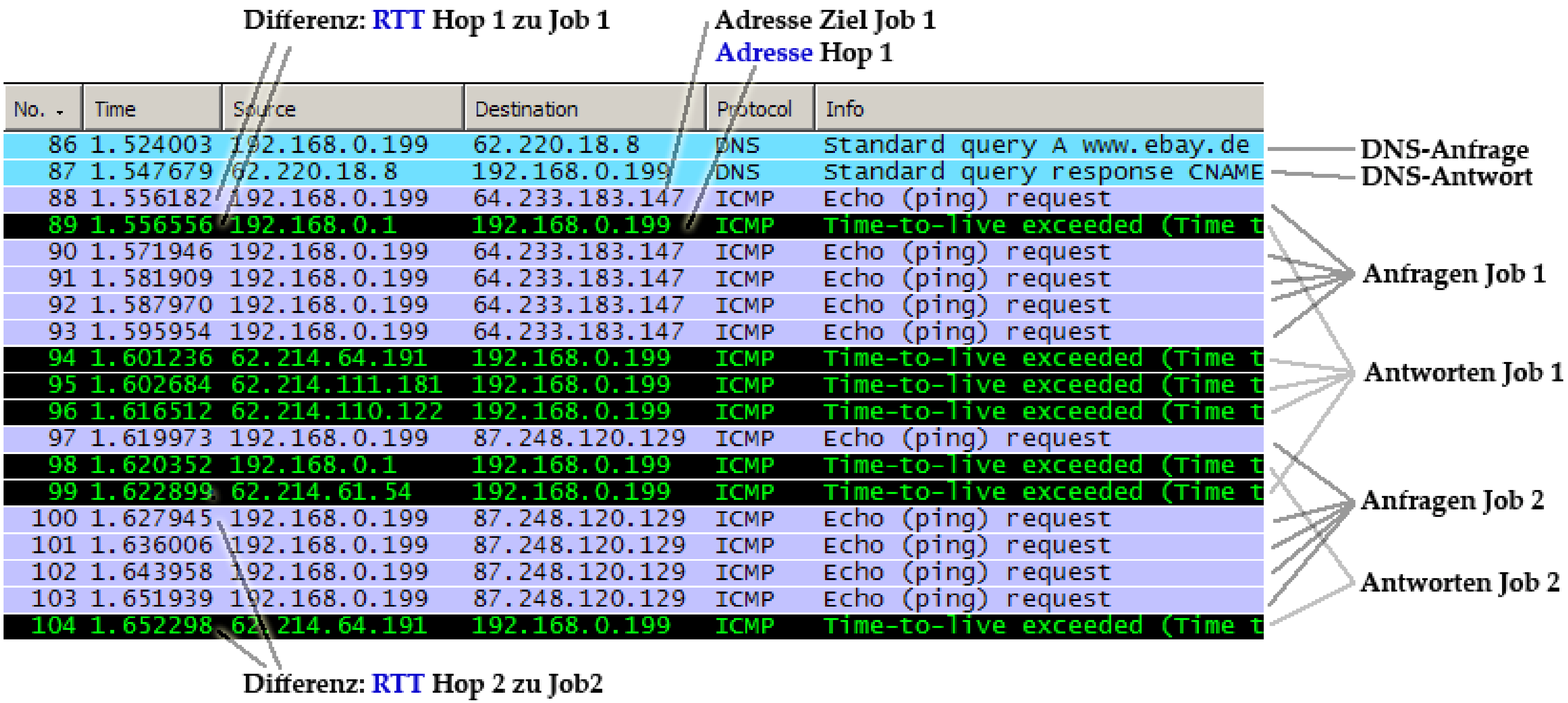
Internet Availability System (IVS) → Measured values

- **Traceroute**
  - RTT (min, max, avg, mdev)
    - Variable amount of IP packets can be sent (standard:3 per Hop)
  - IP, Hop-No.

- **HTTP**
  - ***Window-Size=0*** (remote station is overloaded at moment)
  - ***Downloaded bytes,*** download time => bandwidth
  - ***Packets lost,*** packets send => Packet Loss Rate
  - ***Syn-Ack Time*** (3 way handshake)
  - TSval, TSecr (Timestamp of Server/Host – TCP-Option)
    - Not transmitted by most (safety risk)
  - ***HTTP-Status-Code***

Internet Availability System (IVS)
→ Traceroute Modul



Differenz: RTT Hop 1 zu Job 1

Adresse Ziel Job 1
Adresse Hop 1

No.	Time	Source	Destination	Protocol	Info
86	1.524003	192.168.0.199	62.220.18.8	DNS	Standard query A www.ebay.de
87	1.547679	62.220.18.8	192.168.0.199	DNS	Standard query response CNAME
88	1.556182	192.168.0.199	64.233.183.147	ICMP	Echo (ping) request
89	1.556556	192.168.0.1	192.168.0.199	ICMP	Time-to-live exceeded (Time t
90	1.571946	192.168.0.199	64.233.183.147	ICMP	Echo (ping) request
91	1.581909	192.168.0.199	64.233.183.147	ICMP	Echo (ping) request
92	1.587970	192.168.0.199	64.233.183.147	ICMP	Echo (ping) request
93	1.595954	192.168.0.199	64.233.183.147	ICMP	Echo (ping) request
94	1.601236	62.214.64.191	192.168.0.199	ICMP	Time-to-live exceeded (Time t
95	1.602684	62.214.111.181	192.168.0.199	ICMP	Time-to-live exceeded (Time t
96	1.616512	62.214.110.122	192.168.0.199	ICMP	Time-to-live exceeded (Time t
97	1.619973	192.168.0.199	87.248.120.129	ICMP	Echo (ping) request
98	1.620352	192.168.0.1	192.168.0.199	ICMP	Time-to-live exceeded (Time t
99	1.622899	62.214.61.54	192.168.0.199	ICMP	Time-to-live exceeded (Time t
100	1.627945	192.168.0.199	87.248.120.129	ICMP	Echo (ping) request
101	1.636006	192.168.0.199	87.248.120.129	ICMP	Echo (ping) request
102	1.643958	192.168.0.199	87.248.120.129	ICMP	Echo (ping) request
103	1.651939	192.168.0.199	87.248.120.129	ICMP	Echo (ping) request
104	1.652298	62.214.64.191	192.168.0.199	ICMP	Time-to-live exceeded (Time t

DNS-Anfrage

DNS-Antwort

Anfragen Job 1

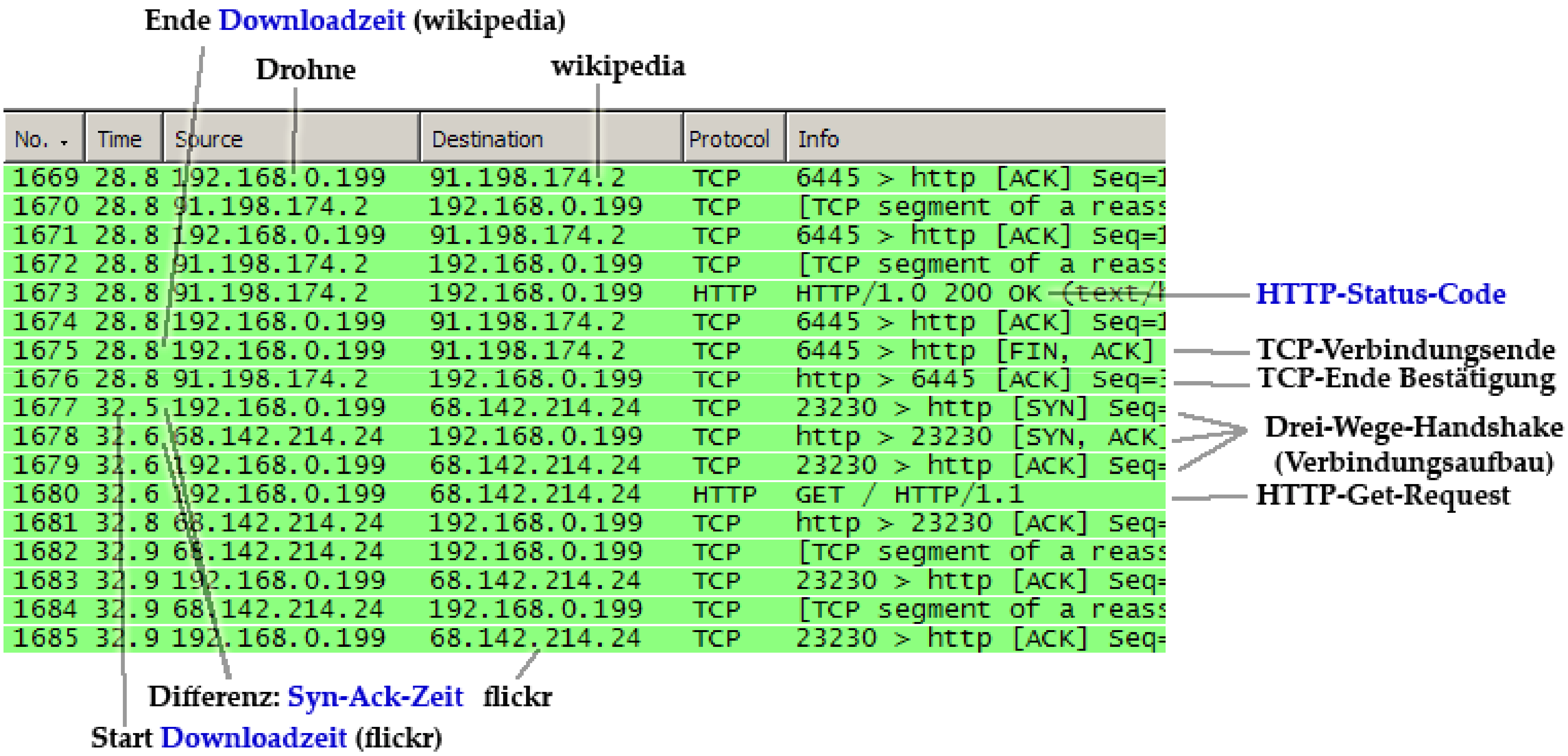
Antworten Job 1

Anfragen Job 2

Antworten Job 2

Differenz: RTT Hop 2 zu Job2

Internet Availability System (IVS) → HTTP Modul



Ende Downloadzeit (wikipedia)

Drohne

wikipedia

No.	Time	Source	Destination	Protocol	Info
1669	28.8	192.168.0.199	91.198.174.2	TCP	6445 > http [ACK] Seq=1
1670	28.8	91.198.174.2	192.168.0.199	TCP	[TCP segment of a reass
1671	28.8	192.168.0.199	91.198.174.2	TCP	6445 > http [ACK] Seq=1
1672	28.8	91.198.174.2	192.168.0.199	TCP	[TCP segment of a reass
1673	28.8	91.198.174.2	192.168.0.199	HTTP	HTTP/1.0 200 OK (text/h
1674	28.8	192.168.0.199	91.198.174.2	TCP	6445 > http [ACK] Seq=1
1675	28.8	192.168.0.199	91.198.174.2	TCP	6445 > http [FIN, ACK]
1676	28.8	91.198.174.2	192.168.0.199	TCP	http > 6445 [ACK] Seq=1
1677	32.5	192.168.0.199	68.142.214.24	TCP	23230 > http [SYN] Seq=
1678	32.6	68.142.214.24	192.168.0.199	TCP	http > 23230 [SYN, ACK]
1679	32.6	192.168.0.199	68.142.214.24	TCP	23230 > http [ACK] Seq=
1680	32.6	192.168.0.199	68.142.214.24	HTTP	GET / HTTP/1.1
1681	32.8	68.142.214.24	192.168.0.199	TCP	http > 23230 [ACK] Seq=
1682	32.9	68.142.214.24	192.168.0.199	TCP	[TCP segment of a reass
1683	32.9	192.168.0.199	68.142.214.24	TCP	23230 > http [ACK] Seq=
1684	32.9	68.142.214.24	192.168.0.199	TCP	[TCP segment of a reass
1685	32.9	192.168.0.199	68.142.214.24	TCP	23230 > http [ACK] Seq=

HTTP-Status-Code

TCP-Verbindungsende

TCP-Ende Bestätigung

Drei-Wege-Handshake (Verbindungsaufbau)

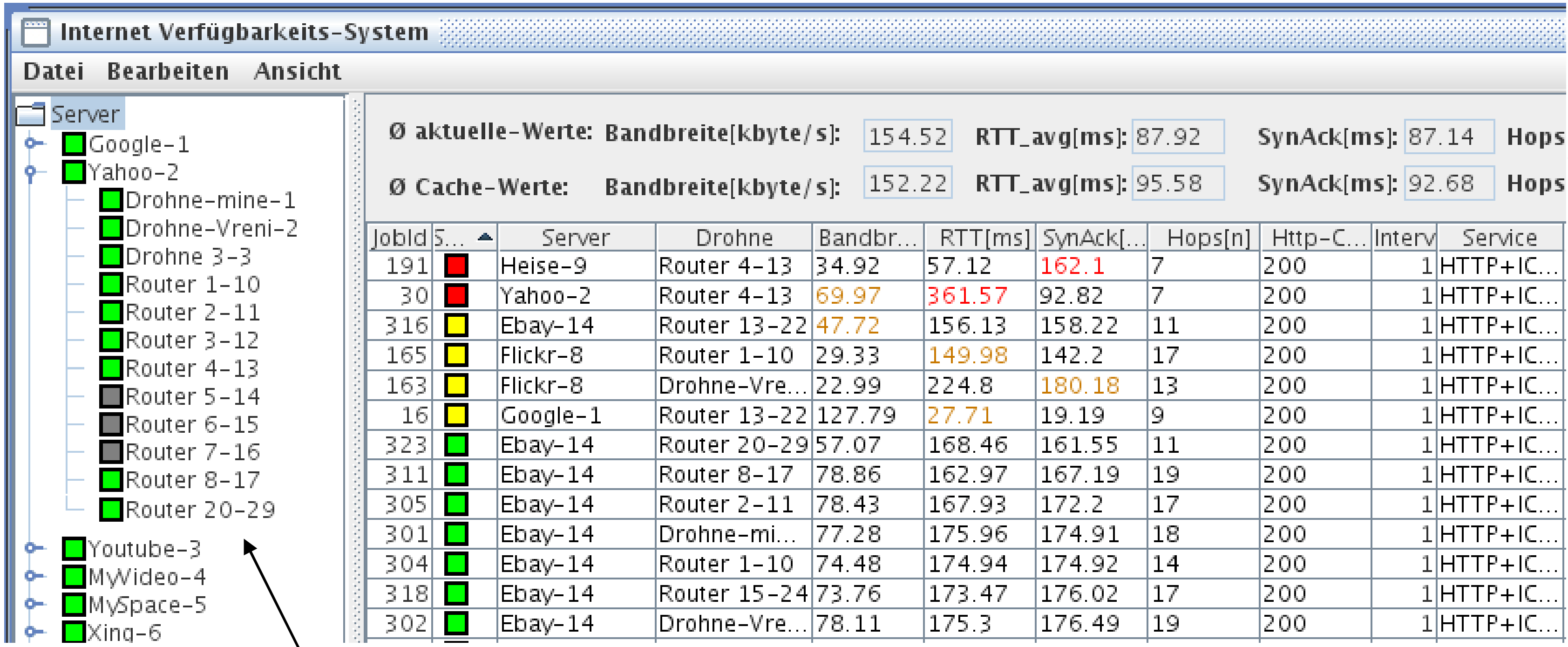
HTTP-Get-Request

Differenz: Syn-Ack-Zeit

flickr

Start Downloadzeit (flickr)

Internet Availability System (IVS) → View/Administration(1/3)



Internet Verfügbarkeits-System

Datei Bearbeiten Ansicht

- Server
  - 🟩 Google-1
  - 🟩 Yahoo-2
    - 🟩 Drohne-mine-1
    - 🟩 Drohne-Vreni-2
    - 🟩 Drohne 3-3
    - 🟩 Router 1-10
    - 🟩 Router 2-11
    - 🟩 Router 3-12
    - 🟩 Router 4-13
    - ⬛ Router 5-14
    - ⬛ Router 6-15
    - ⬛ Router 7-16
    - 🟩 Router 8-17
    - 🟩 Router 20-29
  - 🟩 Youtube-3
  - 🟩 MyVideo-4
  - 🟩 MySpace-5
  - 🟩 Xing-6

Ø aktuelle-Werte: Bandbreite[kbyte/s]: 154.52 RTT_avg[ms]: 87.92 SynAck[ms]: 87.14 Hops

Ø Cache-Werte: Bandbreite[kbyte/s]: 152.22 RTT_avg[ms]: 95.58 SynAck[ms]: 92.68 Hops

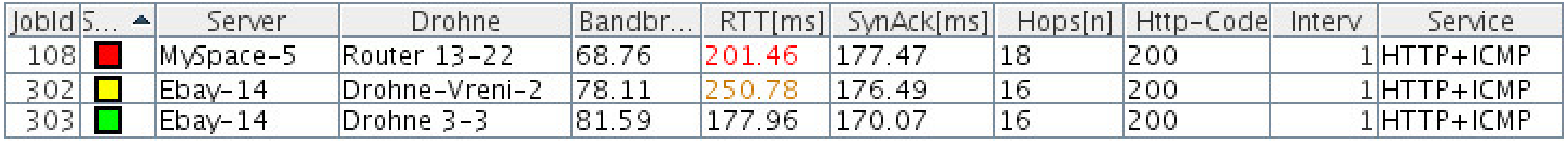
JobId	S...	Server	Drohne	Bandbr...	RTT[ms]	SynAck[...	Hops[n]	Http-C...	Interv	Service
191	🟥	Heise-9	Router 4-13	34.92	57.12	162.1	7	200	1	HTTP+IC...
30	🟥	Yahoo-2	Router 4-13	69.97	361.57	92.82	7	200	1	HTTP+IC...
316	🟨	Ebay-14	Router 13-22	47.72	156.13	158.22	11	200	1	HTTP+IC...
165	🟨	Flickr-8	Router 1-10	29.33	149.98	142.2	17	200	1	HTTP+IC...
163	🟨	Flickr-8	Drohne-Vre...	22.99	224.8	180.18	13	200	1	HTTP+IC...
16	🟨	Google-1	Router 13-22	127.79	27.71	19.19	9	200	1	HTTP+IC...
323	🟩	Ebay-14	Router 20-29	57.07	168.46	161.55	11	200	1	HTTP+IC...
311	🟩	Ebay-14	Router 8-17	78.86	162.97	167.19	19	200	1	HTTP+IC...
305	🟩	Ebay-14	Router 2-11	78.43	167.93	172.2	17	200	1	HTTP+IC...
301	🟩	Ebay-14	Drohne-mi...	77.28	175.96	174.91	18	200	1	HTTP+IC...
304	🟩	Ebay-14	Router 1-10	74.48	174.94	174.92	14	200	1	HTTP+IC...
318	🟩	Ebay-14	Router 15-24	73.76	173.47	176.02	17	200	1	HTTP+IC...
302	🟩	Ebay-14	Drohne-Vre...	78.11	175.3	176.49	19	200	1	HTTP+IC...

Global View

Server Drones Jobs

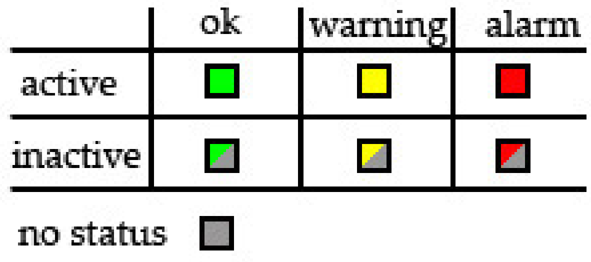
- A Job is a request for a drone to measure one server/service
- Each single job has a status – the status of the server and drones are deduced from their jobs status

Internet Availability System (IVS)
→ View/Administration(2/3)



JobId	S...	Server	Drohne	Bandbr...	RTT[ms]	SynAck[ms]	Hops[n]	Http-Code	Interv	Service
108	🟥	MySpace-5	Router 13-22	68.76	201.46	177.47	18	200	1	HTTP+ICMP
302	🟨	Ebay-14	Drohne-Vreni-2	78.11	250.78	176.49	16	200	1	HTTP+ICMP
303	🟩	Ebay-14	Drohne 3-3	81.59	177.96	170.07	16	200	1	HTTP+ICMP

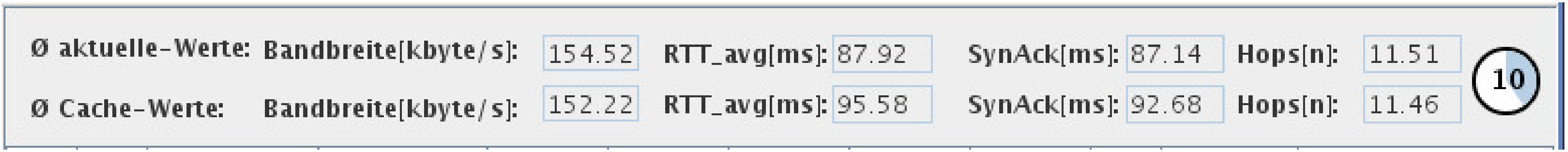
- Each job’s status is calculated by the measured values: bandwidth, RTT, SynAck, Hops and HTTP-Code
- If one value deviate to the 2*Mdev the status turns to warning, if the deviation is over 4*Mdev the status turns to alarm/alert
- The average deviation is calculated by the last 60 values (by interval of 1 min => 60 min)
- If half of the jobs of a server/drone has the status warning/alarm → server/drone obtains the same status



	ok	warning	alarm
active	🟩	🟨	🟥
inactive	◪	◪	◪
no status	⬜		

- Status can only be calculated if the drone sends its results continuously.
- If a drone doesn‘t send within 2*interval the status is set inactive

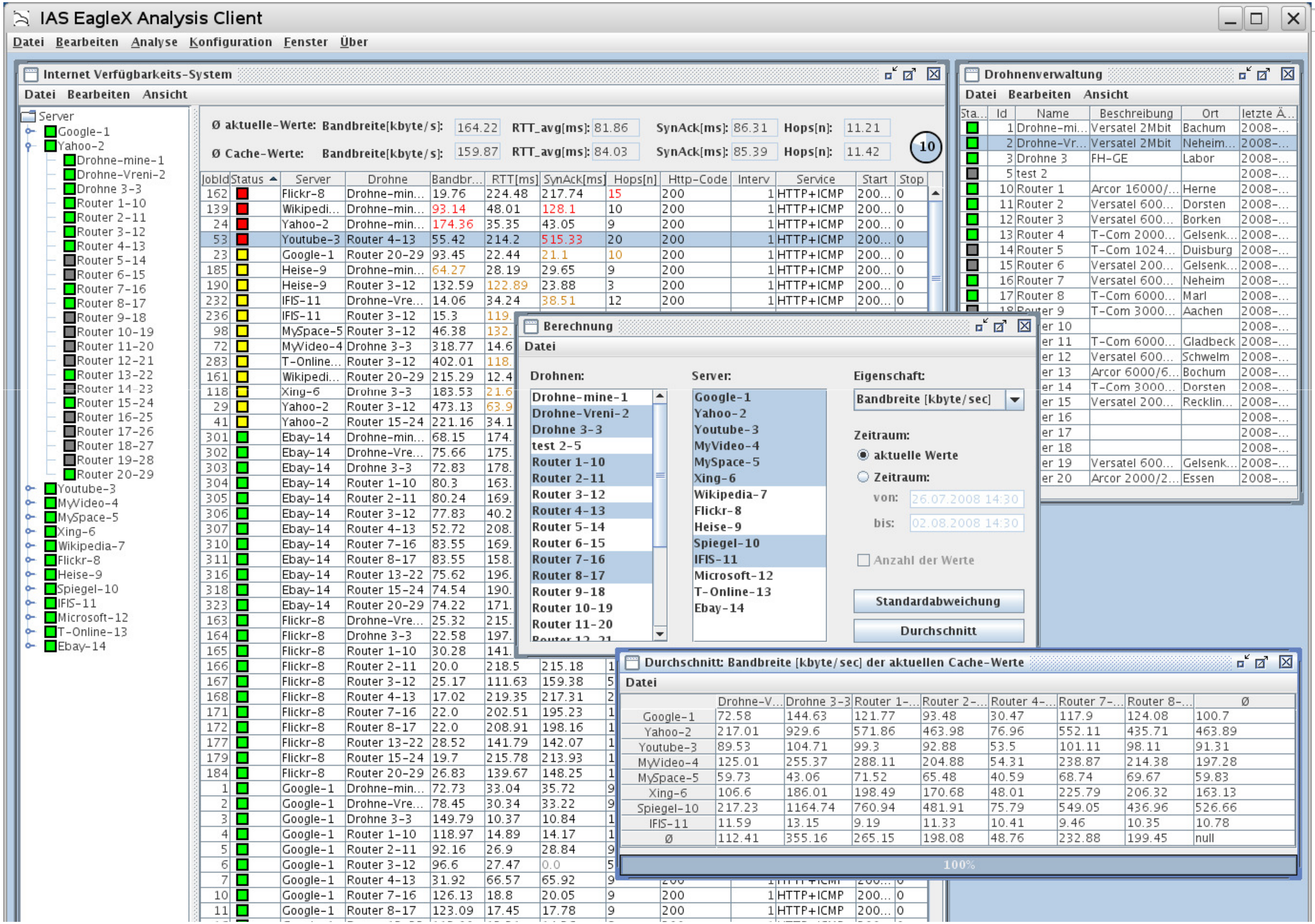
Internet Availability System (IVS)
→ View/Administration(3/3)



Ø aktuelle-Werte:	Bandbreite[kbyte/s]:	154.52	RTT_avg[ms]:	87.92	SynAck[ms]:	87.14	Hops[n]:	11.51	10
Ø Cache-Werte:	Bandbreite[kbyte/s]:	152.22	RTT_avg[ms]:	95.58	SynAck[ms]:	92.68	Hops[n]:	11.46	

- The Global View implies in this context to two average values:
  - the average over all current values of one type like the average bandwidth, RTT, etc. (top row)
  - which can be compared to the average of the last 60 of these values at the bottom row of the figure.
- These values are specific for the Internet connections and servers which are measured
- The values indicate the complete view of all drones and servers and the route to them

Internet Availability System (IVS)
→ Overview



IAS EagleX Analysis Client
Datei Bearbeiten Analyse Konfiguration Fenster Über
Internet Verfügbarkeits-System
Datei Bearbeiten Ansicht

- Server
  - 🟩 Google-1
  - 🟩 Yahoo-2
    - 🟩 Drohne-mine-1
    - 🟩 Drohne-Vreni-2
    - 🟩 Drohne 3-3
    - 🟩 Router 1-10
    - 🟩 Router 2-11
    - 🟩 Router 3-12
    - 🟩 Router 4-13
    - ◼ Router 5-14
    - ◼ Router 6-15
    - ◼ Router 7-16
    - 🟩 Router 8-17
    - ◼ Router 9-18
    - ◼ Router 10-19
    - ◼ Router 11-20
    - ◼ Router 12-21
    - 🟩 Router 13-22
    - ◼ Router 14-23
    - 🟩 Router 15-24
    - ◼ Router 16-25
    - ◼ Router 17-26
    - ◼ Router 18-27
    - ◼ Router 19-28
    - 🟩 Router 20-29
  - 🟩 Youtube-3
  - 🟩 MyVideo-4
  - 🟩 MySpace-5
  - 🟩 Xing-6
  - 🟩 Wikipedia-7
  - 🟩 Flickr-8
  - 🟩 Heise-9
  - 🟩 Spiegel-10
  - 🟩 IFIS-11
  - 🟩 Microsoft-12
  - 🟩 T-Online-13
  - 🟩 Ebay-14

Ø aktuelle-Werte: Bandbreite[kbyte/s]: 164.22 RTT_avg[ms]: 81.86 SynAck[ms]: 86.31 Hops[n]: 11.21

Ø Cache-Werte: Bandbreite[kbyte/s]: 159.87 RTT_avg[ms]: 84.03 SynAck[ms]: 85.39 Hops[n]: 11.42

10

JobId	Status ▲	Server	Drohne	Bandbr...	RTT[ms]	SynAck[ms]	Hops[n]	Http-Code	Interv	Service	Start	Stop
162	🟥	Flickr-8	Drohne-min...	19.76	224.48	217.74	15	200	1	HTTP+ICMP	200...	0
139	🟥	Wikipedi...	Drohne-min...	93.14	48.01	128.1	10	200	1	HTTP+ICMP	200...	0
24	🟥	Yahoo-2	Drohne-min...	174.36	35.35	43.05	9	200	1	HTTP+ICMP	200...	0
53	🟥	Youtube-3	Router 4-13	55.42	214.2	515.33	20	200	1	HTTP+ICMP	200...	0
23	🟨	Google-1	Router 20-29	93.45	22.44	21.1	10	200	1	HTTP+ICMP	200...	0
185	🟨	Heise-9	Drohne-min...	64.27	28.19	29.65	9	200	1	HTTP+ICMP	200...	0
190	🟨	Heise-9	Router 3-12	132.59	122.89	23.88	3	200	1	HTTP+ICMP	200...	0
232	🟨	IFIS-11	Drohne-Vre...	14.06	34.24	38.51	12	200	1	HTTP+ICMP	200...	0
236	🟨	IFIS-11	Router 3-12	15.3	119.							
98	🟨	MySpace-5	Router 3-12	46.38	132.							
72	🟨	MyVideo-4	Drohne 3-3	318.77	14.6							
283	🟨	T-Online...	Router 3-12	402.01	118.							
161	🟨	Wikipedi...	Router 20-29	215.29	12.4							
118	🟨	Xing-6	Drohne 3-3	183.53	21.6							
29	🟨	Yahoo-2	Router 3-12	473.13	63.9							
41	🟨	Yahoo-2	Router 15-24	221.16	34.1							
301	🟩	Ebay-14	Drohne-min...	68.15	174.							
302	🟩	Ebay-14	Drohne-Vre...	75.66	175.							
303	🟩	Ebay-14	Drohne 3-3	72.83	178.							
304	🟩	Ebay-14	Router 1-10	80.3	163.							
305	🟩	Ebay-14	Router 2-11	80.24	169.							
306	🟩	Ebay-14	Router 3-12	77.83	40.2							
307	🟩	Ebay-14	Router 4-13	52.72	208.							
310	🟩	Ebay-14	Router 7-16	83.55	169.							
311	🟩	Ebay-14	Router 8-17	83.55	158.							
316	🟩	Ebay-14	Router 13-22	75.62	196.							
318	🟩	Ebay-14	Router 15-24	74.54	190.							
323	🟩	Ebay-14	Router 20-29	74.22	171.							
163	🟩	Flickr-8	Drohne-Vre...	25.32	215.							
164	🟩	Flickr-8	Drohne 3-3	22.58	197.							
165	🟩	Flickr-8	Router 1-10	30.28	141.							
166	🟩	Flickr-8	Router 2-11	20.0	218.5	215.18	1					
167	🟩	Flickr-8	Router 3-12	25.17	111.63	159.38	5					
168	🟩	Flickr-8	Router 4-13	17.02	219.35	217.31	2					
171	🟩	Flickr-8	Router 7-16	22.0	202.51	195.23	1					
172	🟩	Flickr-8	Router 8-17	22.0	208.91	198.16	1					
177	🟩	Flickr-8	Router 13-22	28.52	141.79	142.07	1					
179	🟩	Flickr-8	Router 15-24	19.7	215.78	213.93	1					
184	🟩	Flickr-8	Router 20-29	26.83	139.67	148.25	1					
1	🟩	Google-1	Drohne-min...	72.73	33.04	35.72	9					
2	🟩	Google-1	Drohne-Vre...	78.45	30.34	33.22	9					
3	🟩	Google-1	Drohne 3-3	149.79	10.37	10.84	1					
4	🟩	Google-1	Router 1-10	118.97	14.89	14.17	1					
5	🟩	Google-1	Router 2-11	92.16	26.9	28.84	9					
6	🟩	Google-1	Router 3-12	96.6	27.47	0.0	5					
7	🟩	Google-1	Router 4-13	31.92	66.57	65.92	9	200	1	HTTP+ICMP	200...	0
10	🟩	Google-1	Router 7-16	126.13	18.8	20.05	9	200	1	HTTP+ICMP	200...	0
11	🟩	Google-1	Router 8-17	123.09	17.45	17.78	9	200	1	HTTP+ICMP	200...	0

Sta...	Id	Name	Beschreibung	Ort	letzte Ä...
🟩	1	Drohne-mi...	Versatel 2Mbit	Bachum	2008-...
🟩	2	Drohne-Vr...	Versatel 2Mbit	Neheim...	2008-...
🟩	3	Drohne 3	FH-GE	Labor	2008-...
◼	5	test 2			2008-...
🟩	10	Router 1	Arcor 16000/...	Herne	2008-...
🟩	11	Router 2	Versatel 600...	Dorsten	2008-...
🟩	12	Router 3	Versatel 600...	Borken	2008-...
🟩	13	Router 4	T-Com 2000...	Gelsenk...	2008-...
◼	14	Router 5	T-Com 1024...	Duisburg	2008-...
◼	15	Router 6	Versatel 200...	Gelsenk...	2008-...
🟩	16	Router 7	Versatel 600...	Neheim	2008-...
🟩	17	Router 8	T-Com 6000...	Marl	2008-...
	18	Router 9	T-Com 3000...	Aachen	2008-...
		er 10			2008-...
		er 11	T-Com 6000...	Gladbeck	2008-...
		er 12	Versatel 600...	Schwelm	2008-...
		er 13	Arcor 6000/6...	Bochum	2008-...
		er 14	T-Com 3000...	Dorsten	2008-...
		er 15	Versatel 200...	Recklin...	2008-...
		er 16			2008-...
		er 17			2008-...
		er 18			2008-...
		er 19	Versatel 600...	Gelsenk...	2008-...
		er 20	Arcor 2000/2...	Essen	2008-...

Drohnen:
Drohne-mine-1
Drohne-Vreni-2
Drohne 3-3
test 2-5
Router 1-10
Router 2-11
Router 3-12
Router 4-13
Router 5-14
Router 6-15
Router 7-16
Router 8-17
Router 9-18
Router 10-19
Router 11-20
Router 12-21

Server:
Google-1
Yahoo-2
Youtube-3
MyVideo-4
MySpace-5
Xing-6
Wikipedia-7
Flickr-8
Heise-9
Spiegel-10
IFIS-11
Microsoft-12
T-Online-13
Ebay-14

Eigenschaft: Bandbreite [kbyte/sec]

Zeitraum:
● aktuelle Werte
○ Zeitraum:
von: 26.07.2008 14:30
bis: 02.08.2008 14:30

□ Anzahl der Werte

Durchschnitt: Bandbreite [kbyte/sec] der aktuellen Cache-Werte

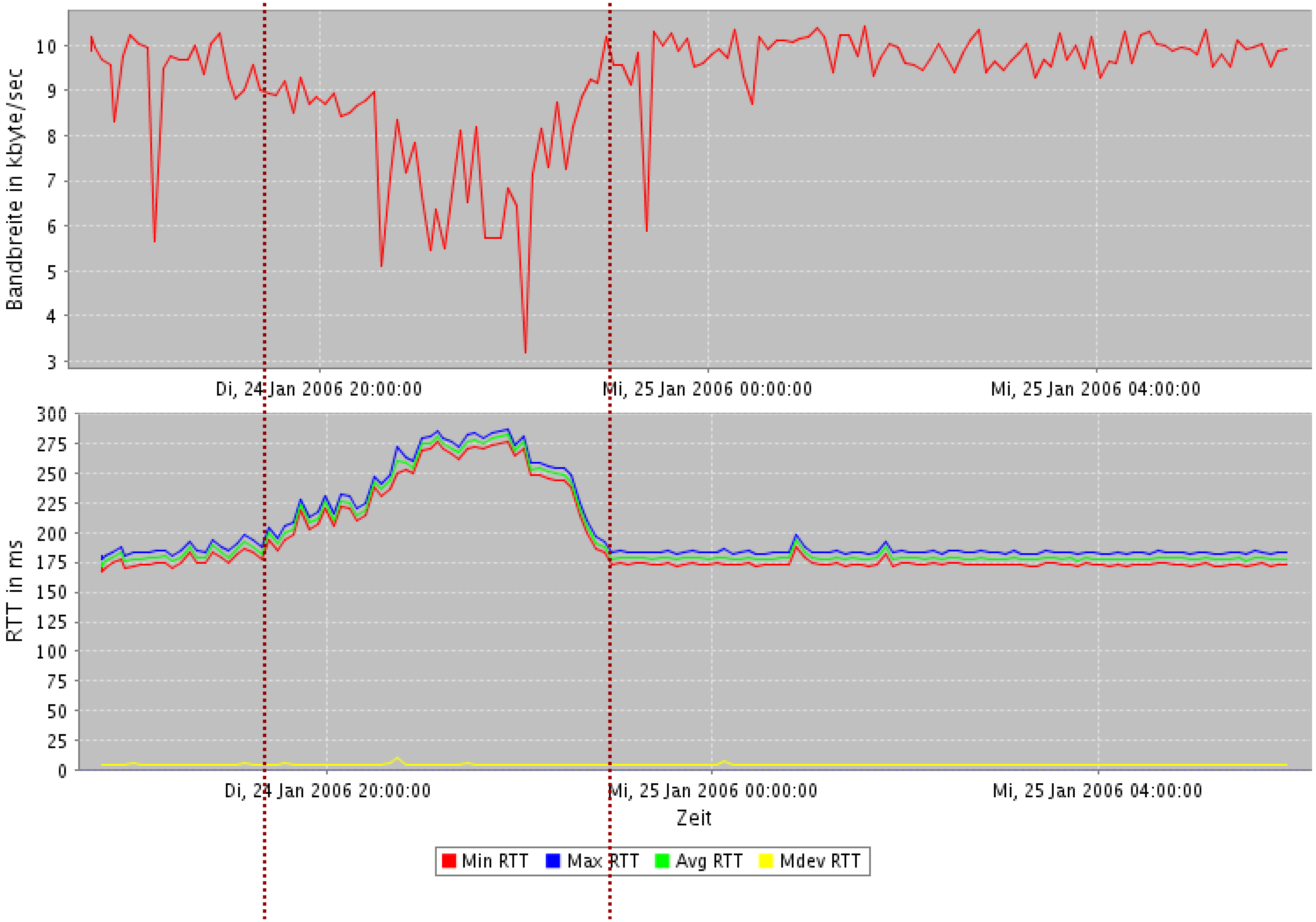
	Drohne-V...	Drohne 3-3	Router 1-...	Router 2-...	Router 4-...	Router 7-...	Router 8-...	Ø
Google-1	72.58	144.63	121.77	93.48	30.47	117.9	124.08	100.7
Yahoo-2	217.01	929.6	571.86	463.98	76.96	552.11	435.71	463.89
Youtube-3	89.53	104.71	99.3	92.88	53.5	101.11	98.11	91.31
MyVideo-4	125.01	255.37	288.11	204.88	54.31	238.87	214.38	197.28
MySpace-5	59.73	43.06	71.52	65.48	40.59	68.74	69.67	59.83
Xing-6	106.6	186.01	198.49	170.68	48.01	225.79	206.32	163.13
Spiegel-10	217.23	1164.74	760.94	481.91	75.79	549.05	436.96	526.66
IFIS-11	11.59	13.15	9.19	11.33	10.41	9.46	10.35	10.78
Ø	112.41	355.16	265.15	198.08	48.76	232.88	199.45	null

Content

- Aim and outcomes of this lecture
- Idea/Concept of the Internet Availability System
- Routing
- Implementation
- **Results**
- Summary

IVS : Current State of Development

→ Bandwidth/RTT



rapidshare.de

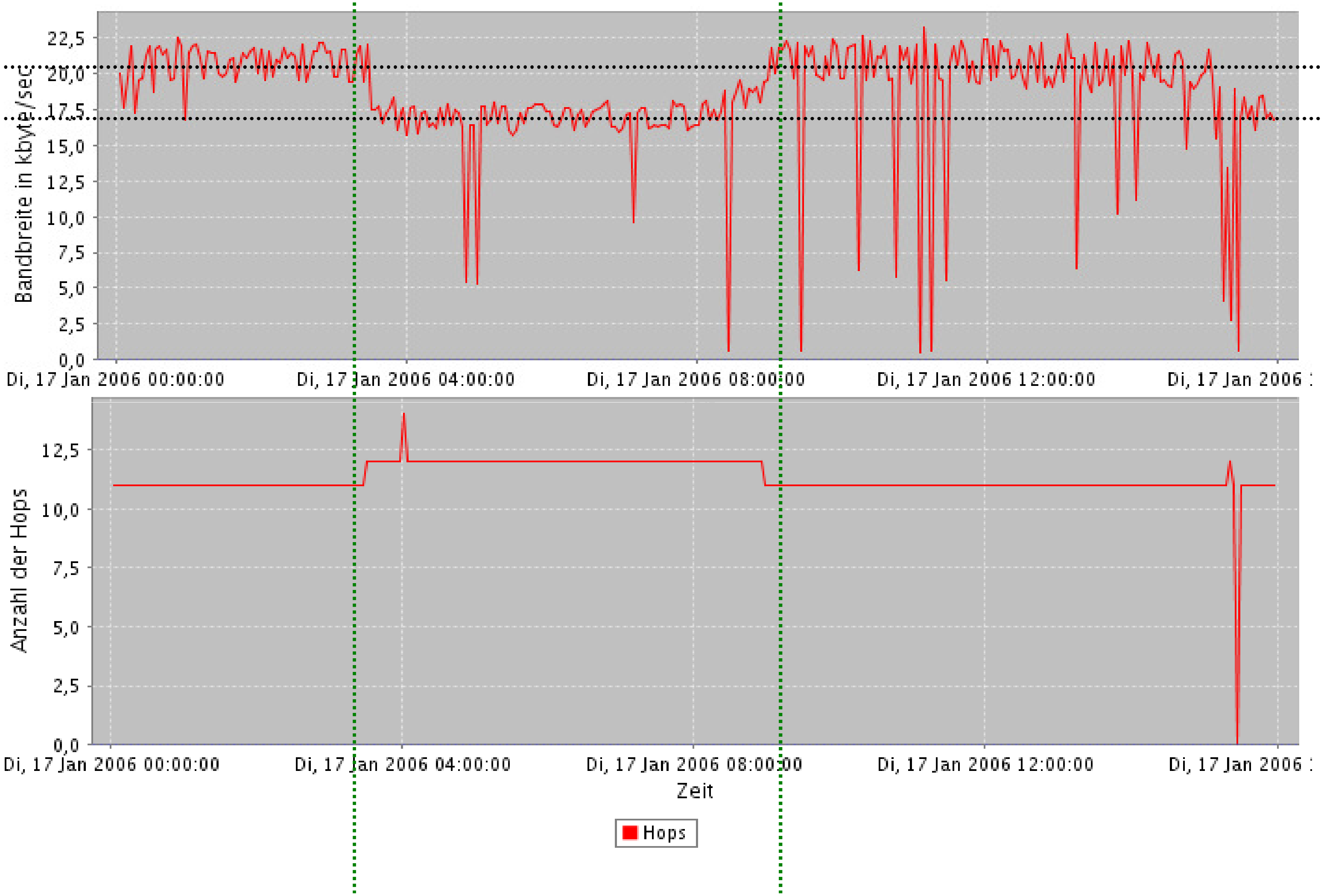
File Sharing Portal

Computer Science Department

The most traffic and the lowest throughput occur between 6pm and 11pm

IVS : Current State of Development

→ Bandwidth/Hops



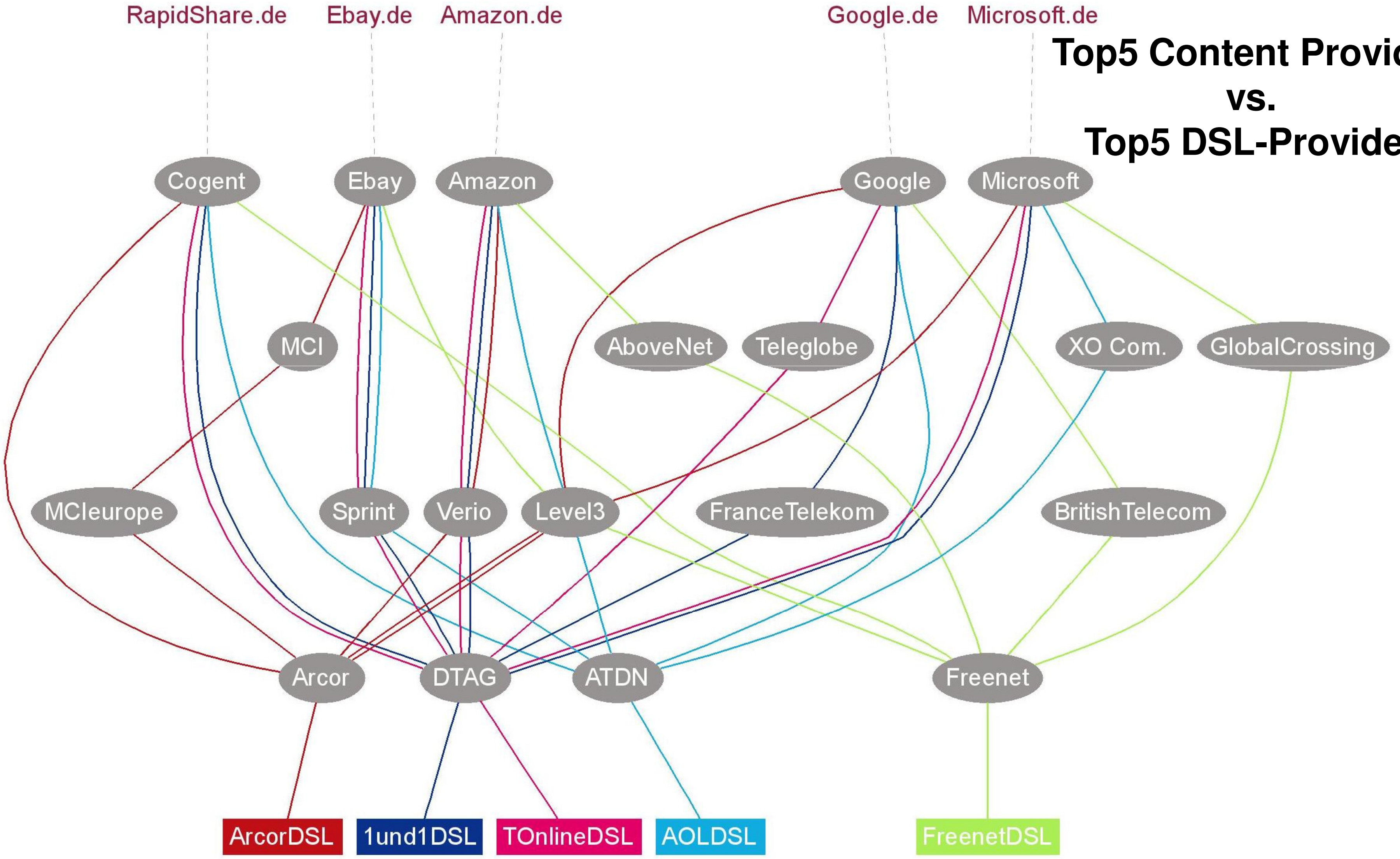
t-online.net

Information Portal

Computer Science Department

Different routings have an influence on the bandwidth

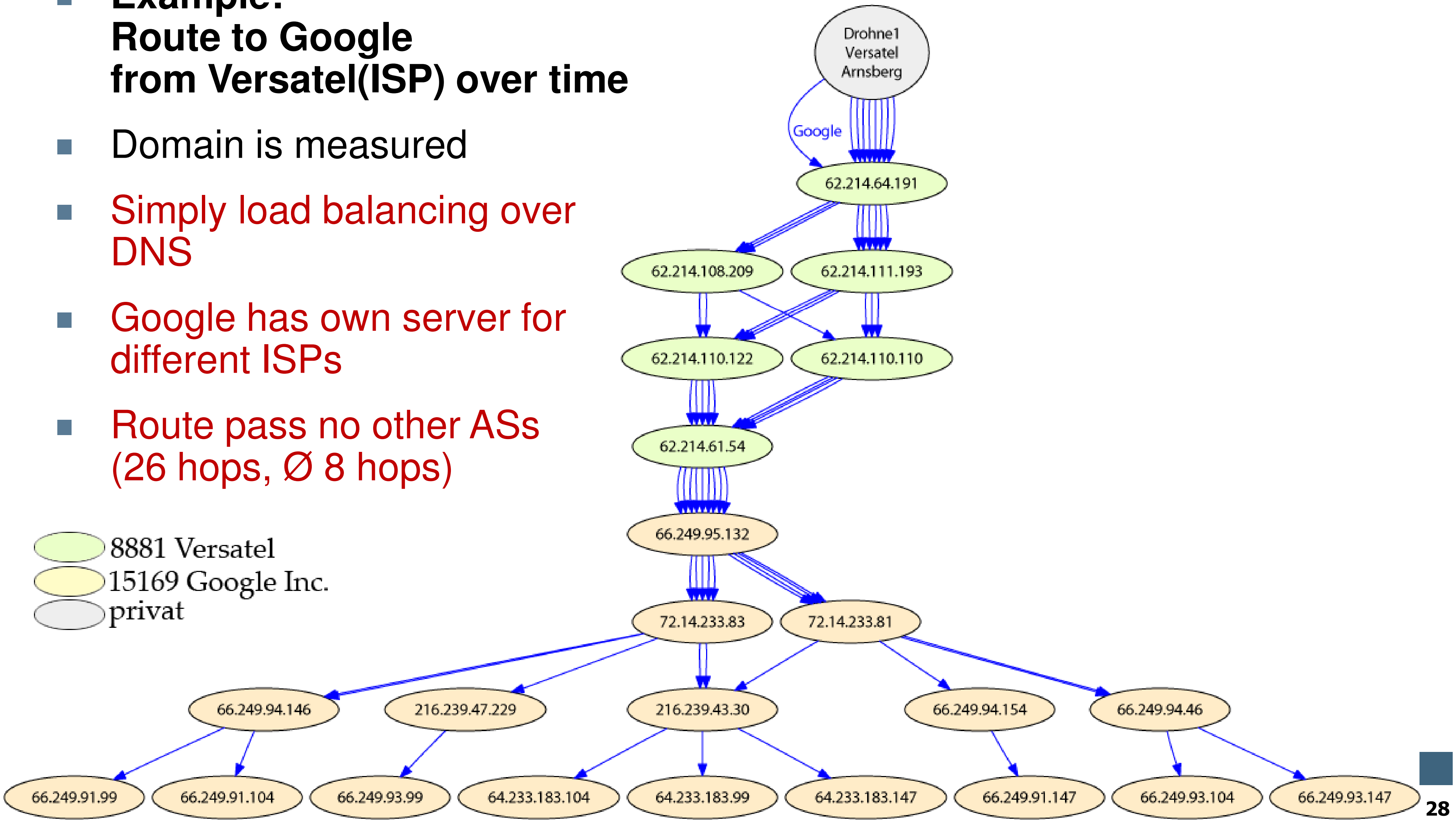
IVS : Outline of the Internet
→ Idea



Top5 Content Provider
vs.
Top5 DSL-Provider

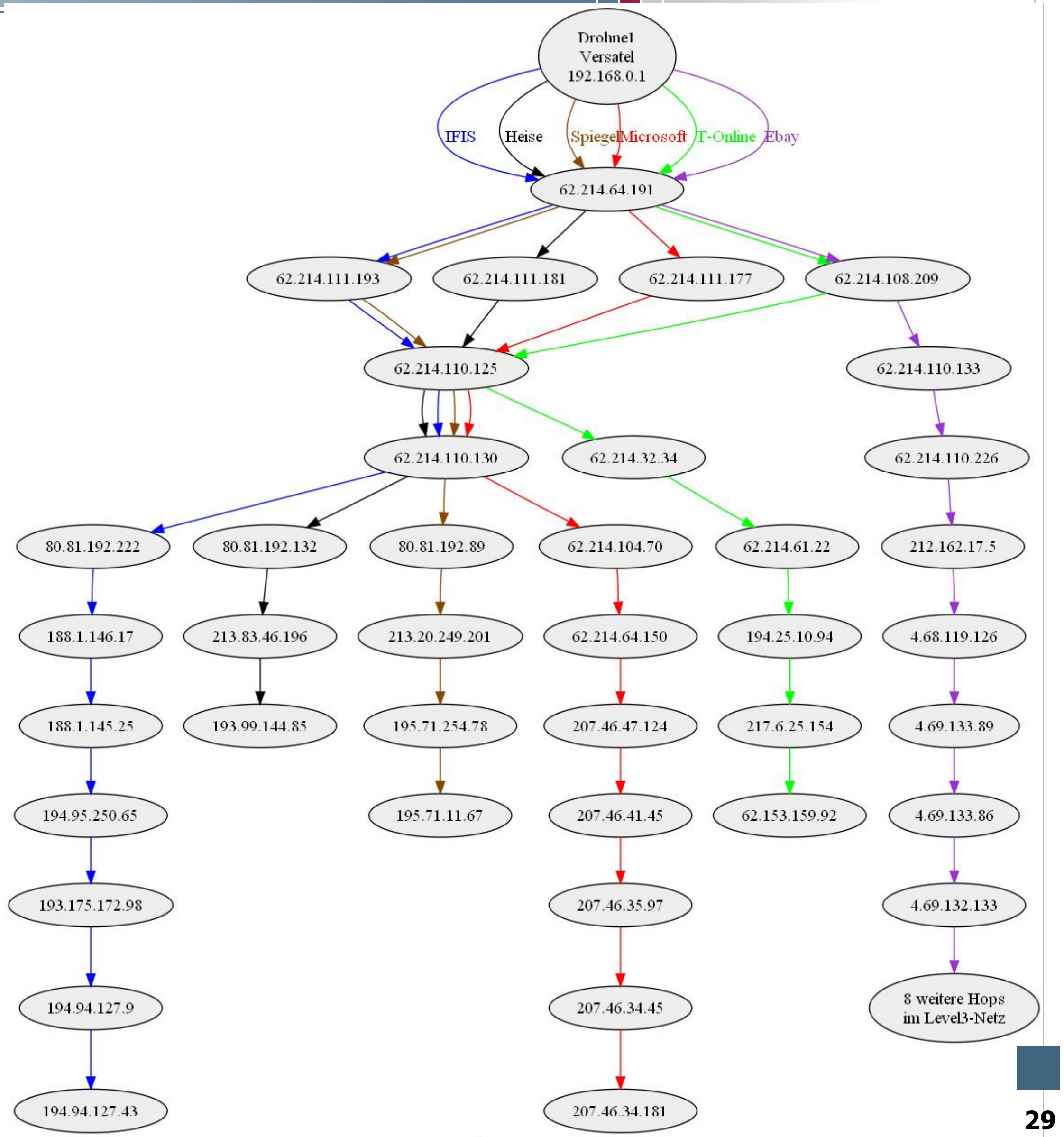
IVS : Outline of the Internet
→ Measurement readings (1/4)

- **Example: Route to Google from Versatel(ISP) over time**
- Domain is measured
- Simply load balancing over DNS
- Google has own server for different ISPs
- Route pass no other ASs (26 hops, Ø 8 hops)



IVS : Outline of the Internet
→ Measurement readings (3/4)

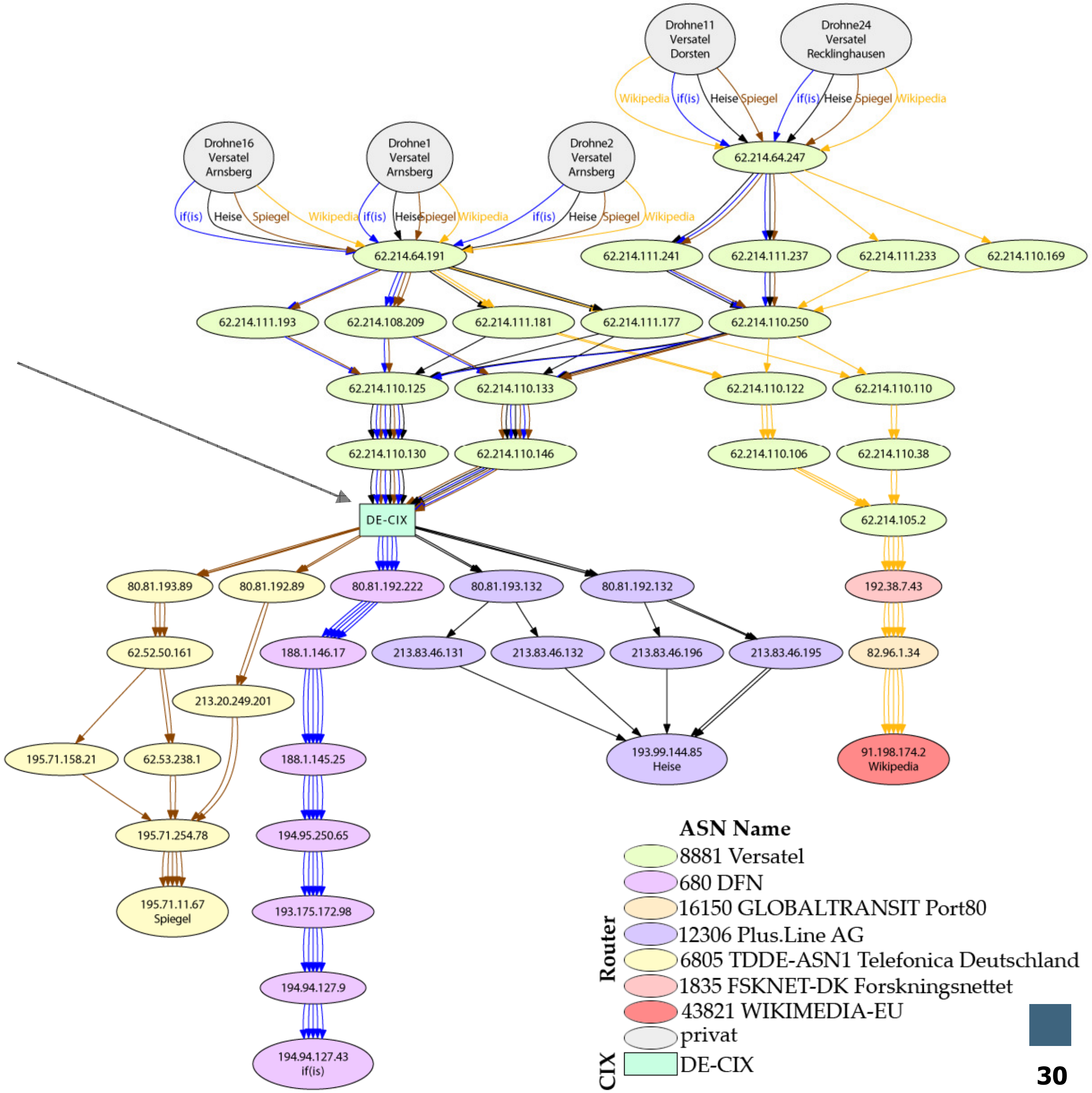
- **Example:**
  Route from a Versatel-Drone to different web server at point of time (few sec)
- Different ways after first AS (Versatel 62.214.x.x)
- High workload of a router (many packets in queue) not in Versatel-net affects only a single service not the entire connection



Server Drohne 1 22.06.08 12:00Uhr

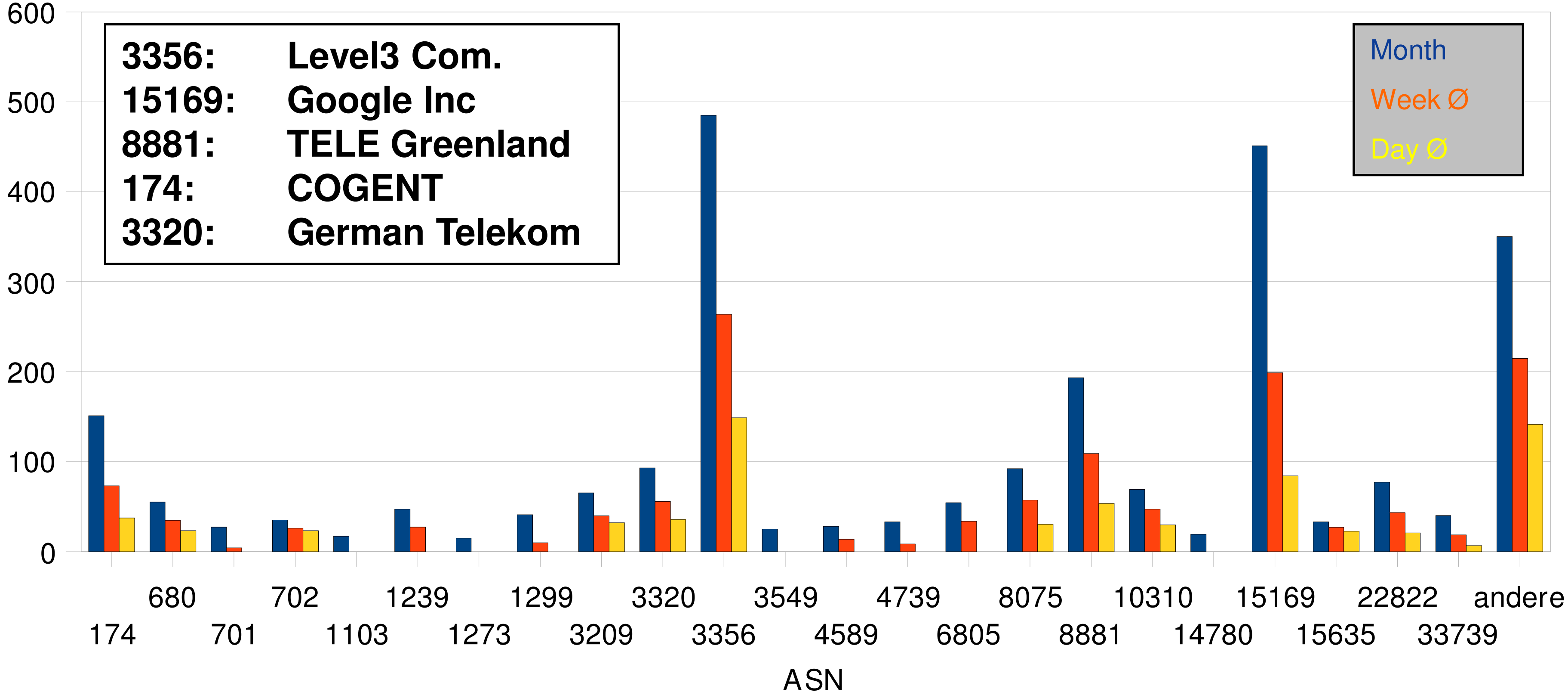
IVS : Outline of the Internet
→ Measurement readings (2/4)

- **Example:** Route to Spiegel, Wikipedia, if(is), Heise from different Versatel access at point of time
- **DE-CIX:** Germans largest Internet-Exchange-Point and second worldwide



Internet Availability System (IVS) → Different Router/Autonomous Systems

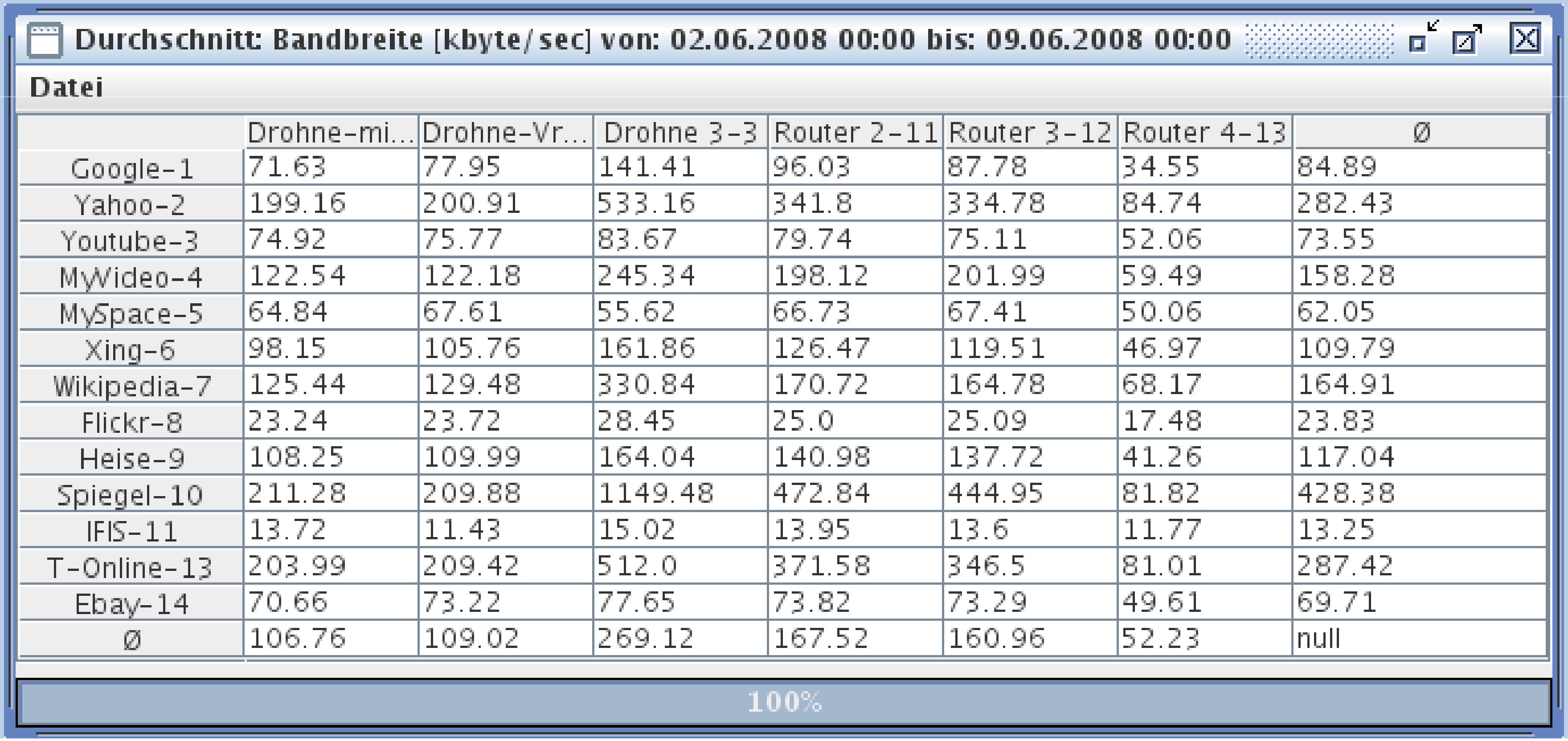
- Number of different routers and ASs (12 drones to 14 domains (35 servers))
  - Month (June 2008): **2495 routers** in **188 ASs**
  - Week (3. in June 2008): **1277 routers** in **122 ASs**
  - Day (2008.06.03): **699 routers** in **54 ASs**
- Hops of a route: **avg:11.76 Hops**, min: 4 Hops if(is), max: 21 Hops MySpace



3356:	**Level3 Com.**
15169:	**Google Inc**
8881:	**TELE Greenland**
174:	**COGENT**
3320:	**German Telekom**

Internet Availability System (IVS)
→ Calculation

- Statements to quality/speed of connections and servers
- The example below shows the average bandwidth of 6 drones to 14 servers over the period of one week
- Interval is 1 min - the average is composed of about 1.080 values
- Last row/column is the average of the entire column/row



Durchschnitt: Bandbreite [kbyte/sec] von: 02.06.2008 00:00 bis: 09.06.2008 00:00

	Drohne-mi...	Drohne-Vr...	Drohne 3-3	Router 2-11	Router 3-12	Router 4-13	Ø
Google-1	71.63	77.95	141.41	96.03	87.78	34.55	84.89
Yahoo-2	199.16	200.91	533.16	341.8	334.78	84.74	282.43
Youtube-3	74.92	75.77	83.67	79.74	75.11	52.06	73.55
MyVideo-4	122.54	122.18	245.34	198.12	201.99	59.49	158.28
MySpace-5	64.84	67.61	55.62	66.73	67.41	50.06	62.05
Xing-6	98.15	105.76	161.86	126.47	119.51	46.97	109.79
Wikipedia-7	125.44	129.48	330.84	170.72	164.78	68.17	164.91
Flickr-8	23.24	23.72	28.45	25.0	25.09	17.48	23.83
Heise-9	108.25	109.99	164.04	140.98	137.72	41.26	117.04
Spiegel-10	211.28	209.88	1149.48	472.84	444.95	81.82	428.38
IFIS-11	13.72	11.43	15.02	13.95	13.6	11.77	13.25
T-Online-13	203.99	209.42	512.0	371.58	346.5	81.01	287.42
Ebay-14	70.66	73.22	77.65	73.82	73.29	49.61	69.71
Ø	106.76	109.02	269.12	167.52	160.96	52.23	null

Internet Availability System (IVS)
→ Evaluation

- **Top X: web server**
- Quite stable, change of the values over the period of several weeks <= 5%

Domain	average [kB/s]	mdev [kB/s]	Mdev [%]	Data size [kB]
Spiegel	373,58	5,27	1,41	154,8
T-Online	286,96	6,4	2,23	94,44
Yahoo	283,04	6,41	2,27	126,3
Wikipedia	177,4	3,54	2	36,17
MyVideo	158,56	7,96	5,02	56,39
Xing	119,16	3,06	2,57	18
Heise	118,82	3,28	2,76	51,54
Google	88,83	2,98	3,35	7,3
Youtube	77,53	2,4	3,09	72
Ebay	70,03	0,73	1,04	67,56
MySpace	62,58	2,74	4,38	63,94
Flickr	23,84	0,39	1,65	9,9
IFIS	13,19	0,17	1,27	23,8

Internet Availability System (IVS)
→ Evaluation

- **Top Y: Internet accesses**

Drohne	ISP	down [Mbit]	average [kB/s]	mdev [kB/s]	mdev [%]
Drohne 3	DFN	100	254,55	2,56	1
Router 13	Arcor	6	195,15	6,07	3,11
Router 7	Versatel	6	191,44	1,67	0,87
Router 8	Telekom	6	172,54	8,22	4,77
Router 2	Versatel	6	157,46	1,56	0,99
Router 3	Versatel	6	149,81	1,86	1,24
Router 11	Telekom	6	111,98	2,73	2,44
Drohne-Vreni	Versatel	2	103,68	1,9	1,83
Router 15	Versatel	2	103,53	1,16	1,12
Drohne-mine	Versatel	2	101,13	1,55	1,54
Router 5	Telekom	1	58,8	1,18	2,01
Router 4	Telekom	2	49,86	1,19	2,38

Content

- Aim and outcomes of this lecture
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- **Summary**

Internet Availability System (IVS)
→ Summary

- **The IVS has drones which measure the availability of servers/services!**
- Drones should be placed at various ISP to measure routes spreading through AS of different providers
- Routing can be asynchronous -> RTT is depending on routing
- The RTT is mainly depending on the queue time which can not easily be predicted
- Routing changes over time (multiples causes like DNS)
- The measured speed of different Internet connections differs although the routes have the same bandwidth
  - Due to small files and TCP mechanisms

Fachhochschule Gelsenkirchen

Internet Availability System
→ Idea and Realization

Thank you for your attention!
Questions?

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http://www.internet-sicherheit.de

if(is)
internet security.

Internet Availability System (IVS)
→ Literature

- [1] T. Ostermann, N. Pohlmann: „Internet-Verfügbarkeitssystem – Welche Qualität hat das Internet?", IT-Sicherheit – Management und Praxis, DATAKONTEXT-Fachverlag, 2/2006
- [2] Thomas Ostermann: Internet-Verfügbarkeitssystem (internet availability system), Diploma Thesis, University of Applied Sciences Gelsenkirchen, 2006
- [3] Kilian Himmelsbach: Konzeption und Umsetzung einer modularen Architektur für das Internet-Verfügbarkeits-System (design and implementation of a modular architecture for the IVS), Diploma Thesis, University of Applied Sciences, Gelsenkirchen, 2008

Links:

Institute for Internet Security:
http://www.internet-sicherheit.de/forschung/aktuelle-projekte/internet-frhwarnsysteme/internet-verfgbarkeits-system/