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Distributed Admission Control for Voice over IP

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ITG Workshop

IP Netzplanung, IP Netzmanagement und Optimierung

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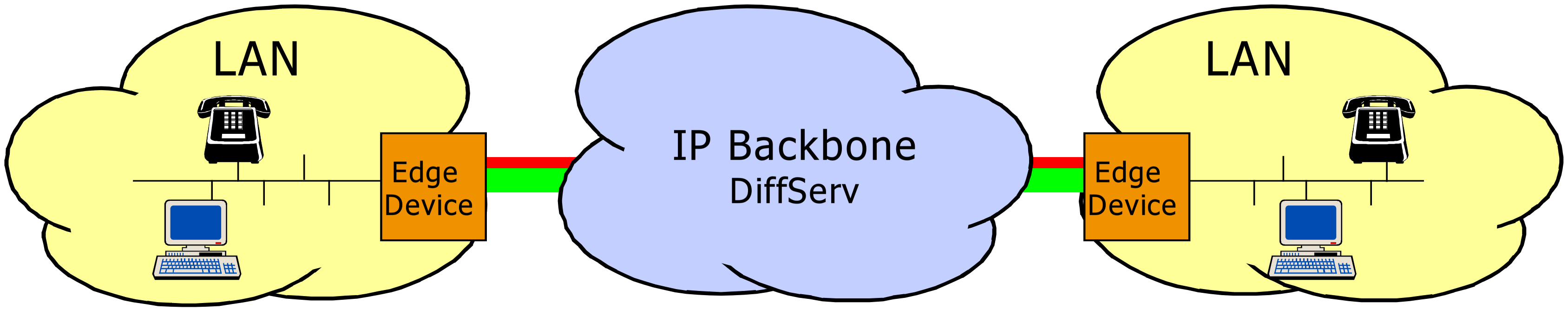
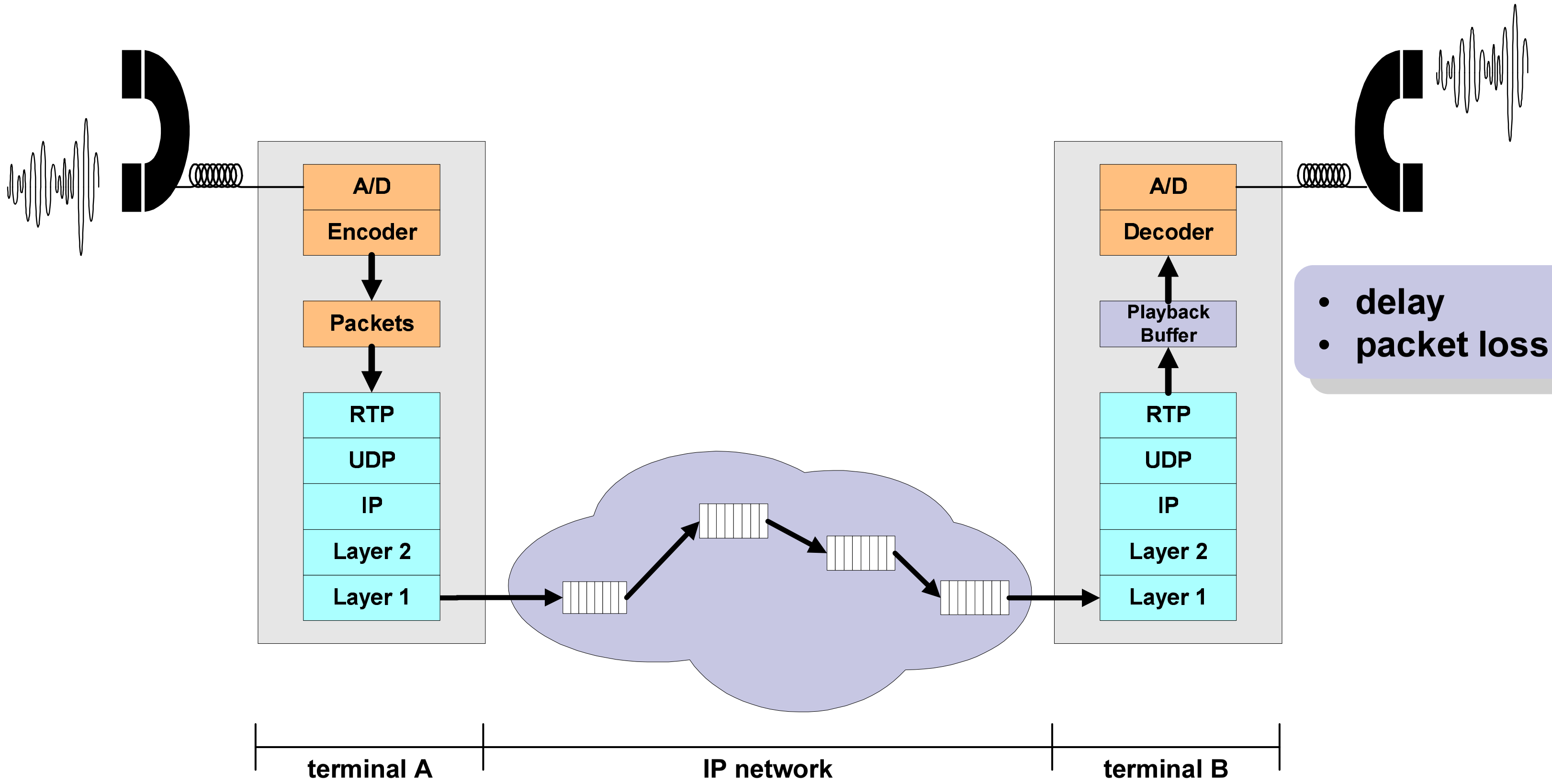


Outline

- Voice over IP
- Admission Control
- Dimensioning
- Simulation Model
- Simulation Results
- Conclusions

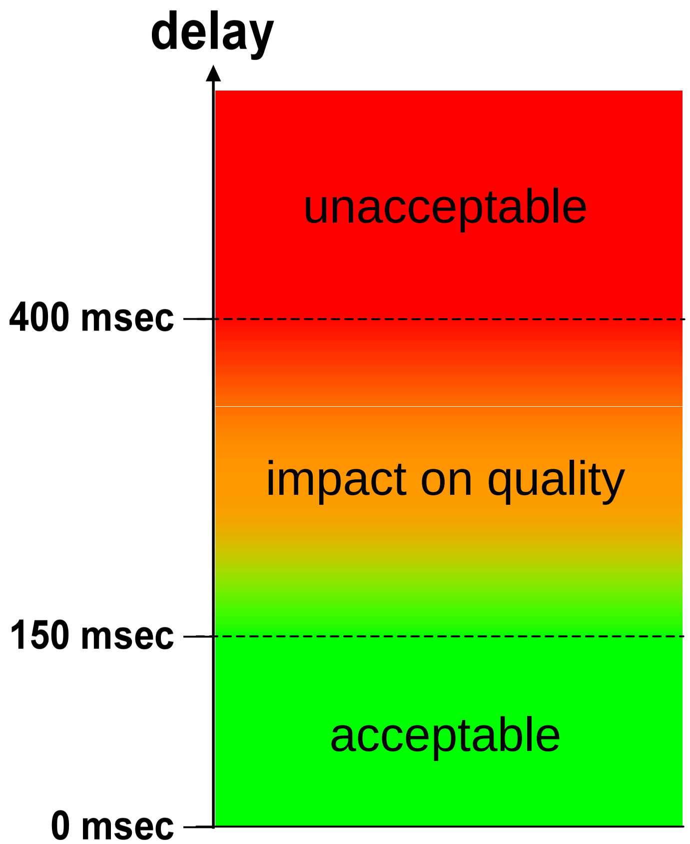
Voice over IP and QoS Problems



- delay
- delay jitter
- packet loss

- delay
- packet loss

G.114: One-Way Transmission Time (ITU-T)

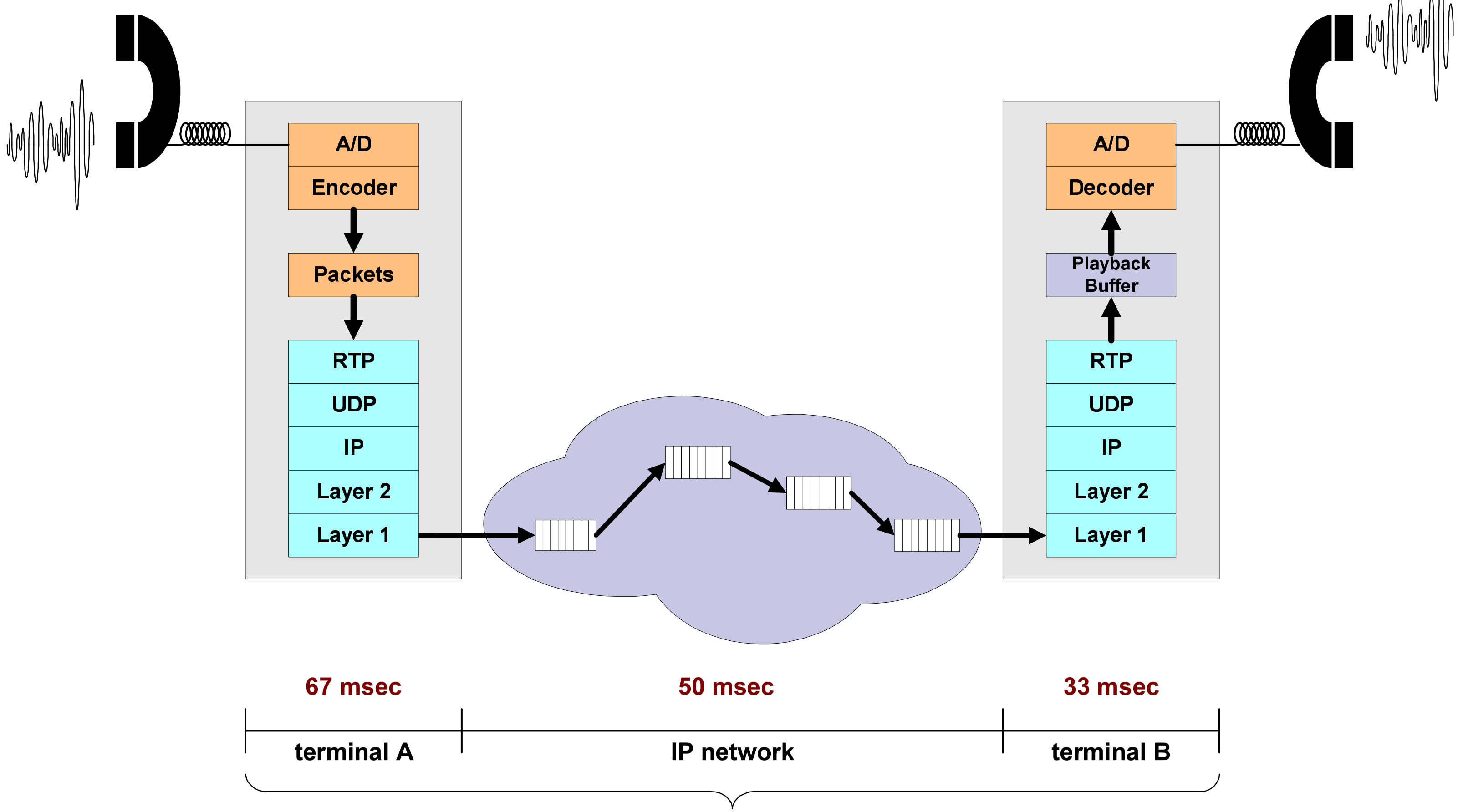


Voice Codecs

	G.723.1	G.729
Delay Encoder / msec		
• frame size	30,0	10
• lookahead	7,5	5
• processing	30,0	10
Delay Decoder / msec	32,5	12
Σ delay / msec	**100,0**	**37**

Data Rate Coder / Kbps	5,3 / 6,4	8
Frame Size / Byte	20 / 24	10
Overhead (IP, UDP, RTP) / Byte	40	40
IP data rate / Kbps	15,9 / 17	40

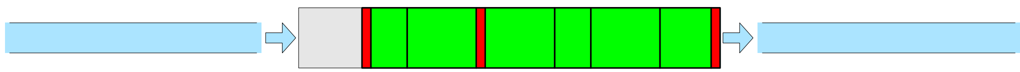
VoIP



ITU, G.114: end-to-end delay < 150 msec

Differentiated Services (DiffServ)

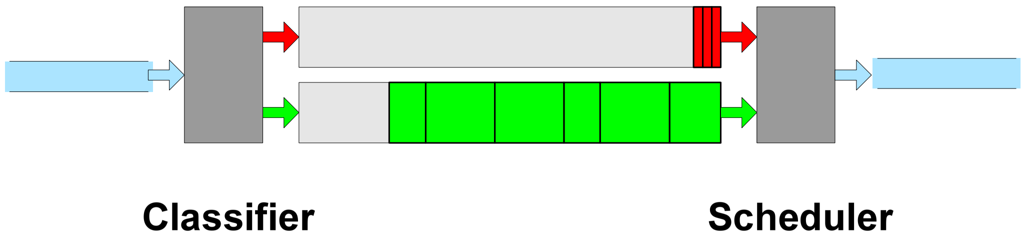
IP today:



single service:
- best effort

traffic:
- essentially TCP

DiffServ:



different service classes:
- voice
- best effort

traffic:
- TCP
- UDP / RTP

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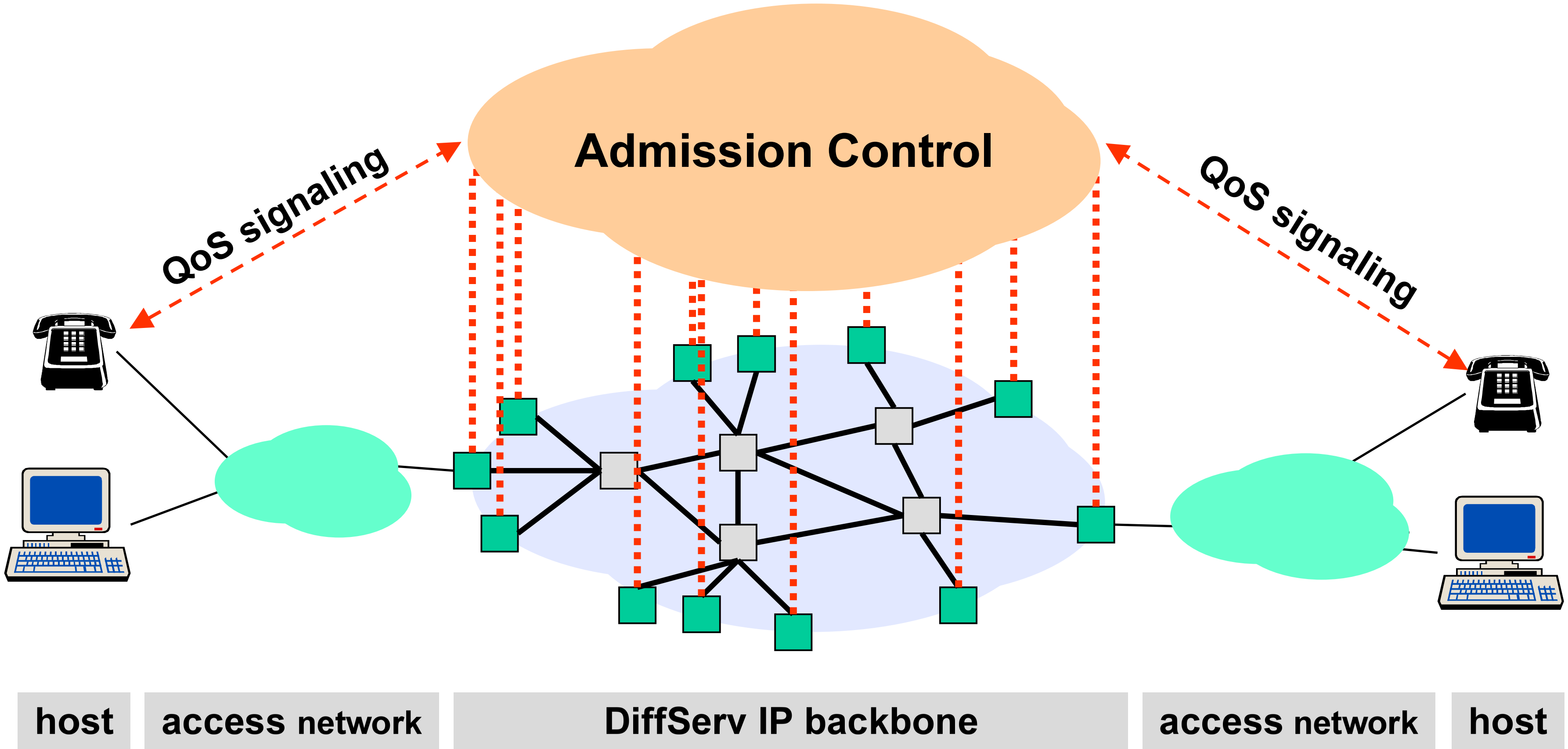
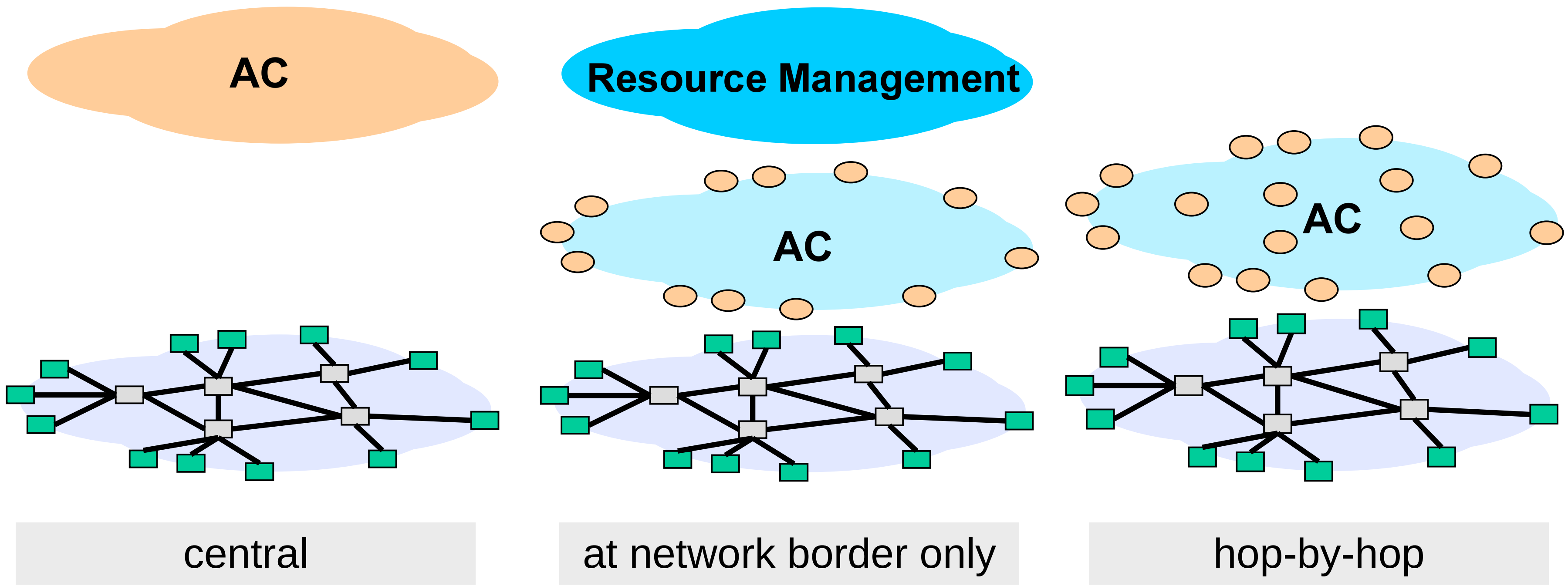
Network Scenario



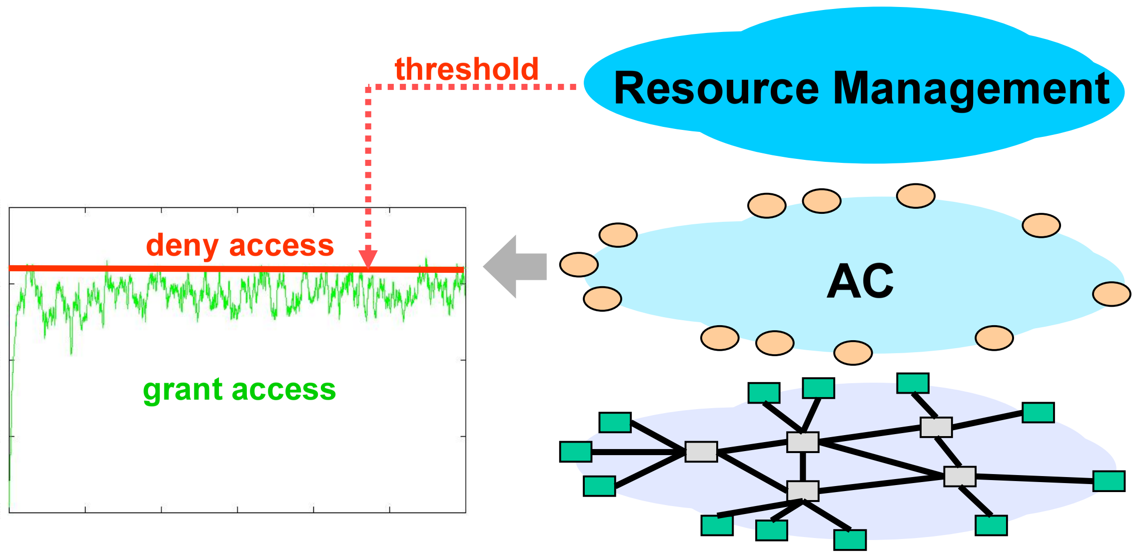
Admission Control



Admission Control

- **local bandwidth table:**
  - ☞ available bandwidth for each egress edge device: C_E
    - **provided by resource management**
    - **will be adapted to changing conditions by resource management**
    - **Erlang formula**
      - **traffic matrix**
      - **B = 0.01**
  - ☞ bandwidth in use: A_E

- **local decision:**
  - ☞ if ($A_E + a_E \leq C_E$)
    then grant access
    else deny access



Dimensioning

Method A

- calculate bandwidth demand for each end-to-end traffic stream
  - ☞ end-to-end traffic matrix
  - ☞ Erlang formula with B=0.01
- accumulate bandwidth demand for each link

conservative

overprovisioing

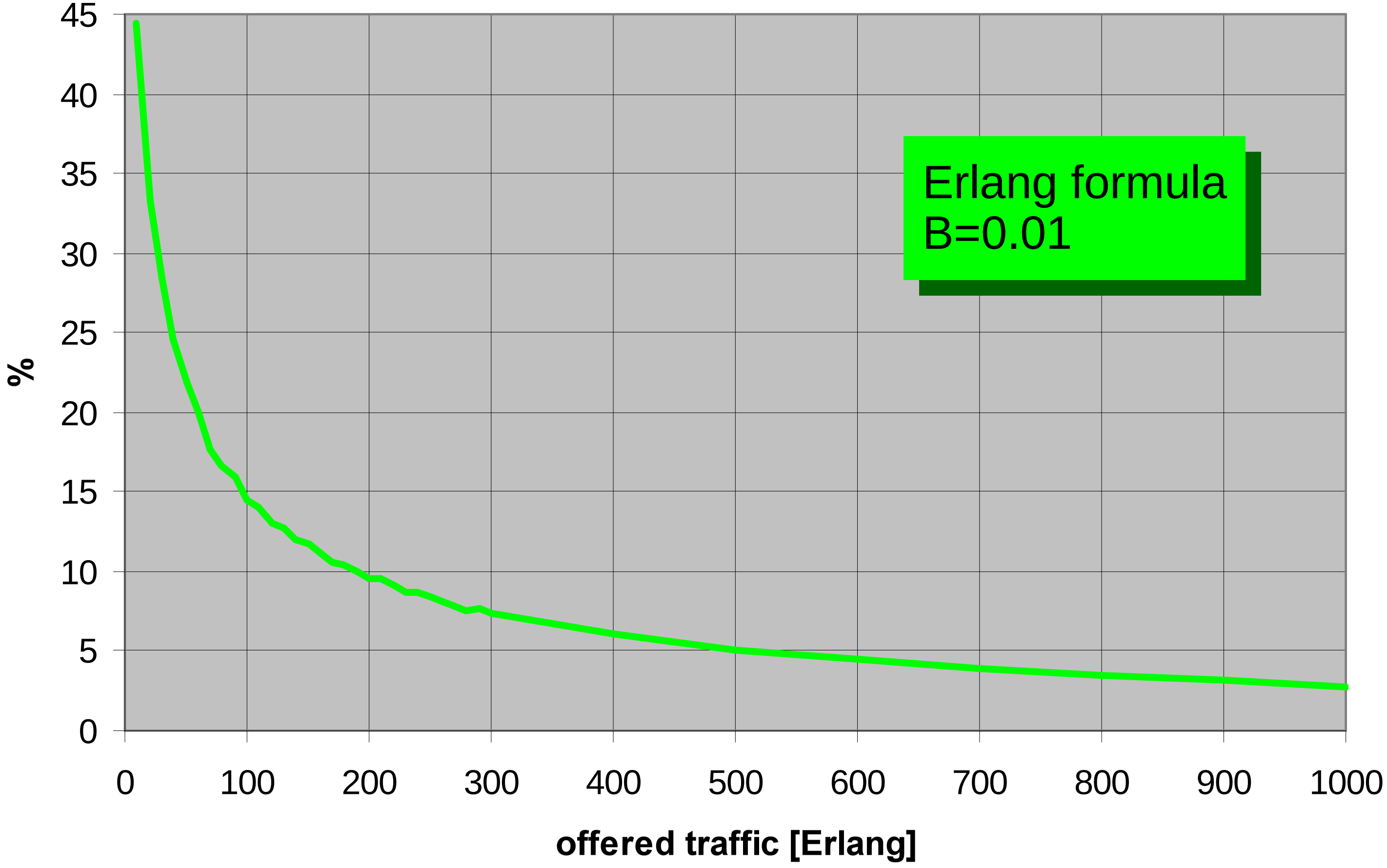
Method B

- accumulate offered traffic for each link
  - ☞ end-to-end traffic matrix
- calculate bandwidth demand of each single link
  - ☞ Erlang formula with B=0.01

multiplex gains

probes level of resource optimization

An Upper Limit for Multiplex Gain
of Dimensioning Method B



Voice Traffic Model

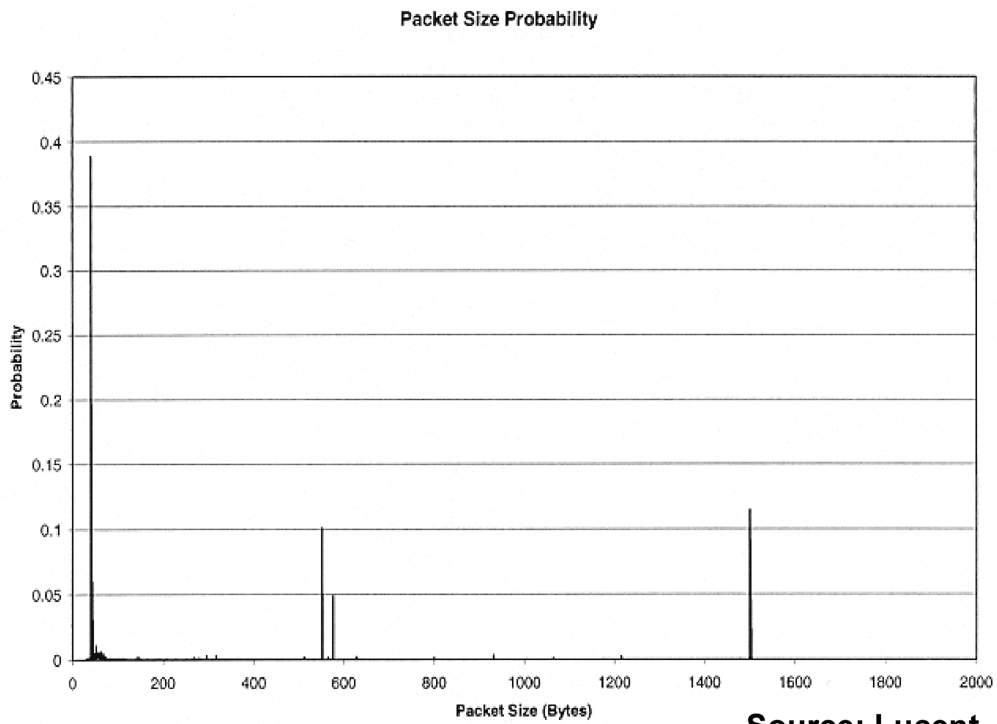
- **Voice Codec**
  - **G.723.1**
- **IP Packets**
  - **3 voice frames per packet**
  - **112 Byte**
  - **8 kbps CBR**
- **Voice Activity**
  - **Poisson Model**
  - **exponential holding times, mean 180 sec**
  - **exponential inter-arrivel times**

Data Traffic Model

- self-similar traffic
- TCP

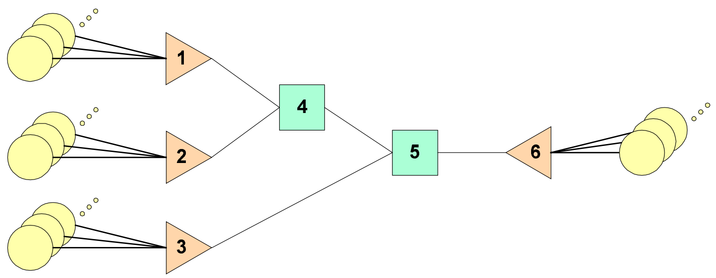
- Pareto distributed file sizes
- exponential distributed inter arrival times

- 3 packet sizes [Byte]:
  - 40 (acknowledgements)
  - 576 (default MTU size)
  - 1500 (Ethernet)



Source: Lucent

Scenario A: Voice over IP



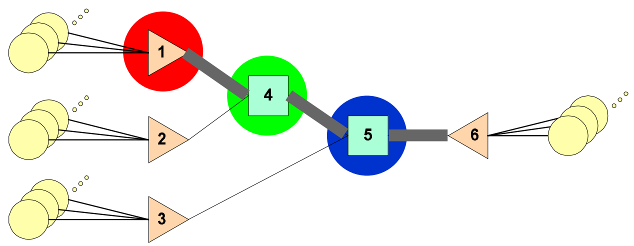
Traffic Load		
link	voice users	mean data rate [kbps]
1 → 6	240	240
2 → 6	480	480
3 → 6	400	400

Queue Size
50 Packets

link	Network Dimensioning				
	A		B		
	rate [kbps]	utilisation [%]	rate [kbps]	utilisation [%]	saving [%]
1 → 4	336	71	336	76	0
2 → 4	600	80	600	80	0
3 → 5	512	78	512	79	0
4 → 5	936	77	856	84	8,5
5 → 6	1448	77	1272	88	12,2

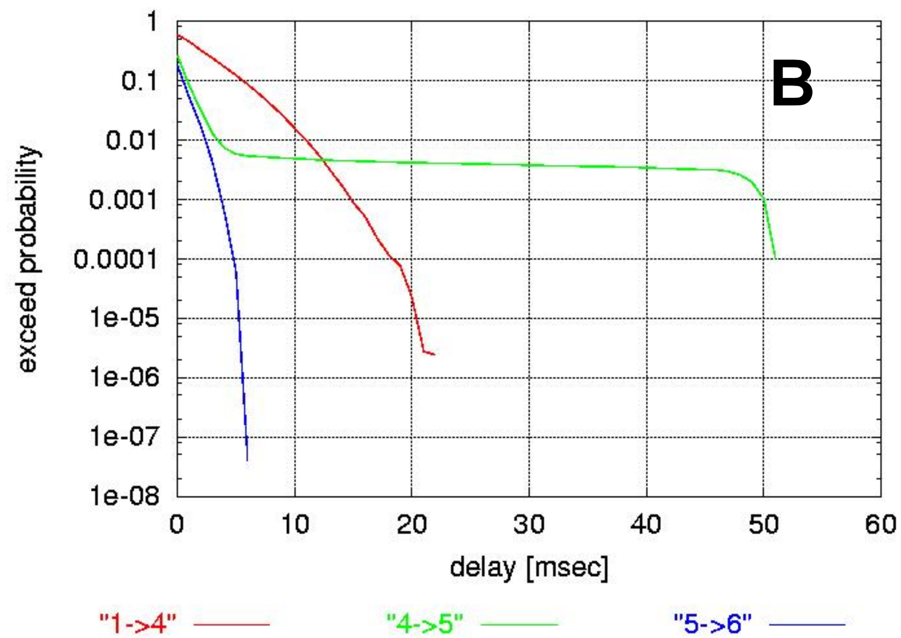
Gatekeeper Thresholds		
GK	A	B
1	42	42
2	75	75
3	64	64
6	181	159

Scenario A: Delay, Packet Loss Rate

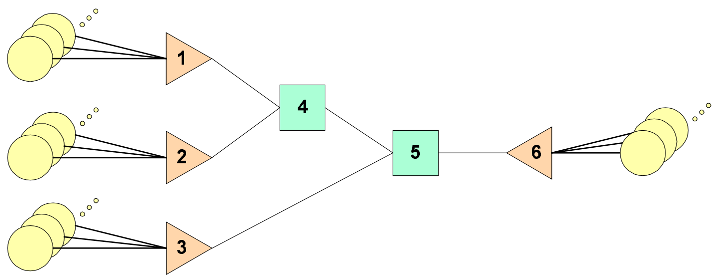


Mean Delay [msec]		
link	A	B
1→4	3,4	2,4
4→5	0,3	0,9
5→6	0,2	0,6

Packet Loss Frequency		
link	A	B
1→4	0	0
4→5	0	$4,4 \cdot 10^{-5}$
5→6	0	0



Scenario B: Voice + Data Traffic



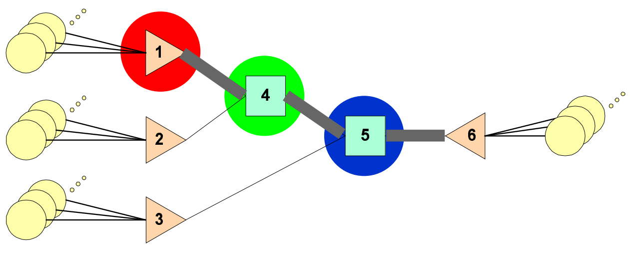
Traffic Load			
link	voice users	mean data rate	
		voice [kbps]	data [kbps]
1 → 6	240	240	270
2 → 6	480	480	480
3 → 6	400	400	410

Queue Size
50 Packets

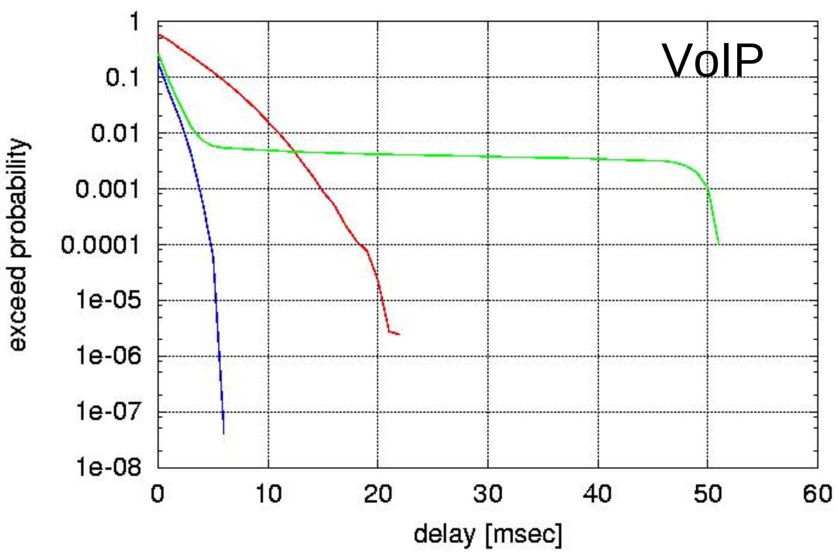
link	Network Dimensioning				
	A		B		
	rate [kbps]	utilisation [%]	rate [kbps]	utilisation [%]	saving [%]
1 → 4	672	76	672	76	0
2 → 4	1200	80	1200	80	0
3 → 5	1024	79	1024	79	0
4 → 5	1872	79	1792	82	4,3
5 → 6	2896	79	2720	84	6,1

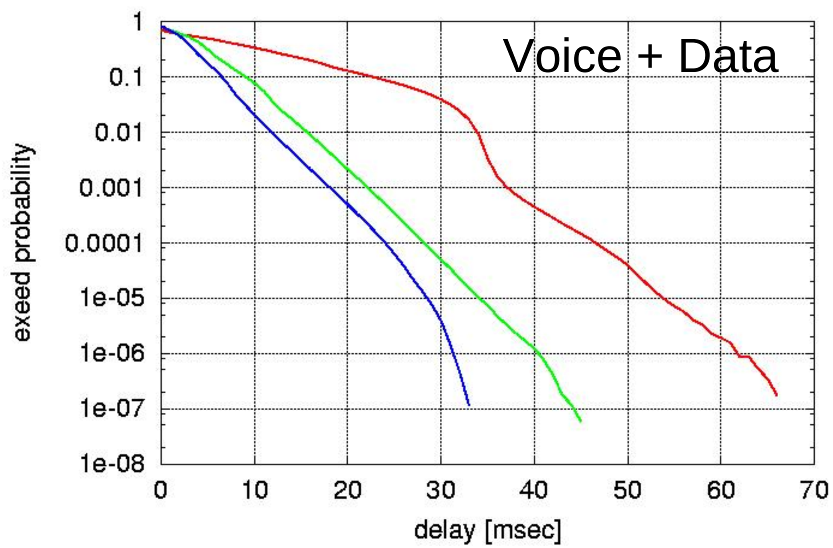
Gatekeeper Thresholds		
GK	A	B
1	42	42
2	75	75
3	64	64
6	181	159

Influence of Data Traffic

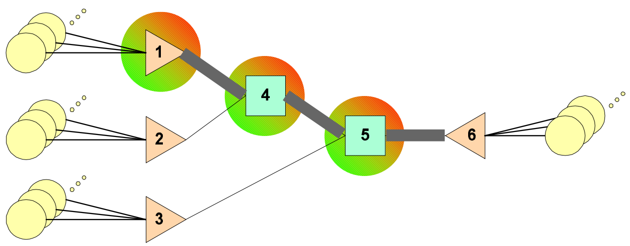


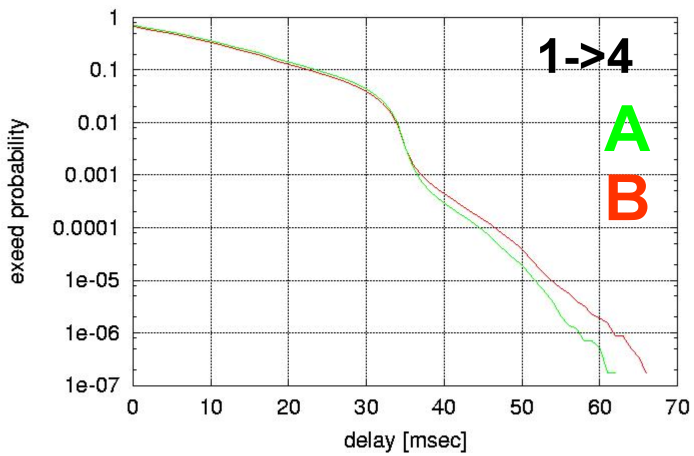
link	Mean Delay [msec]		Packet Loss Rate	
	VoIP	IVDoIP	VoIP	IVDoIP
1→4	2,4	8,7	0	0
4→5	0,9	4,6	$4{,}4 \cdot 10^{-5}$	0
5→6	0,6	3,6	0	$1{,}5 \cdot 10^{-7}$

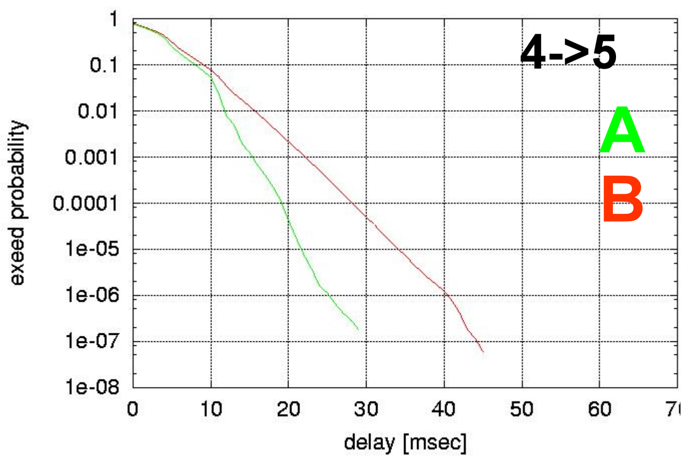


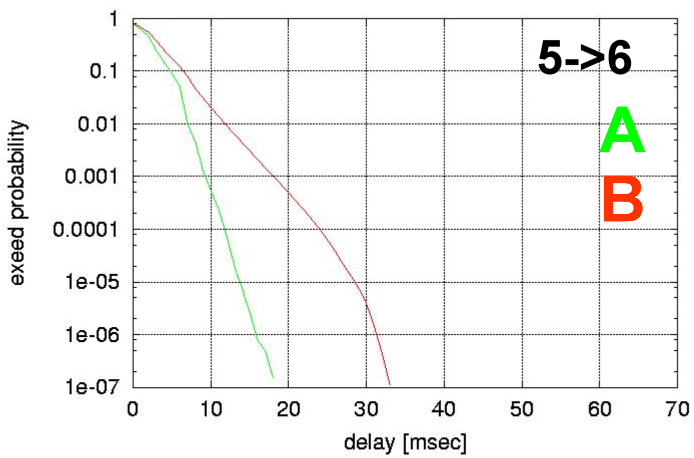


Comparision of Dimension Methods (1)

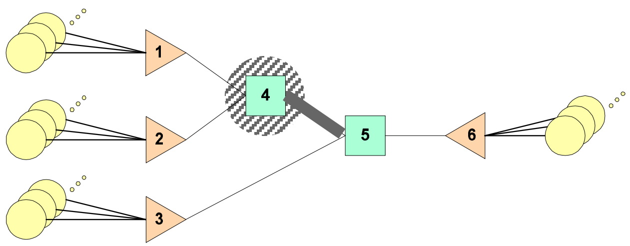




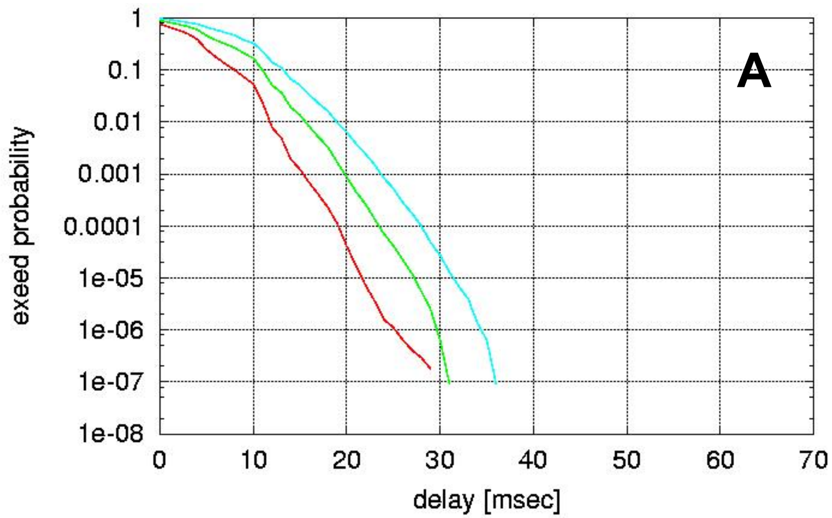


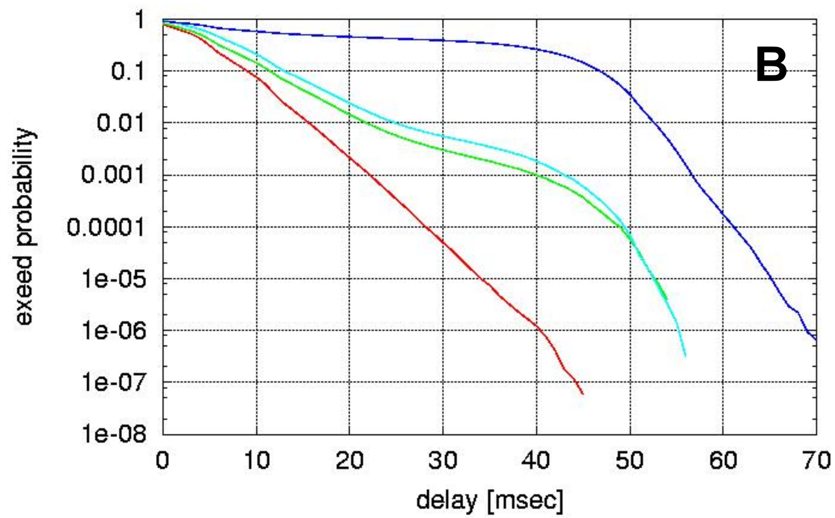


Comparison of Dimension Methods (2): Overload

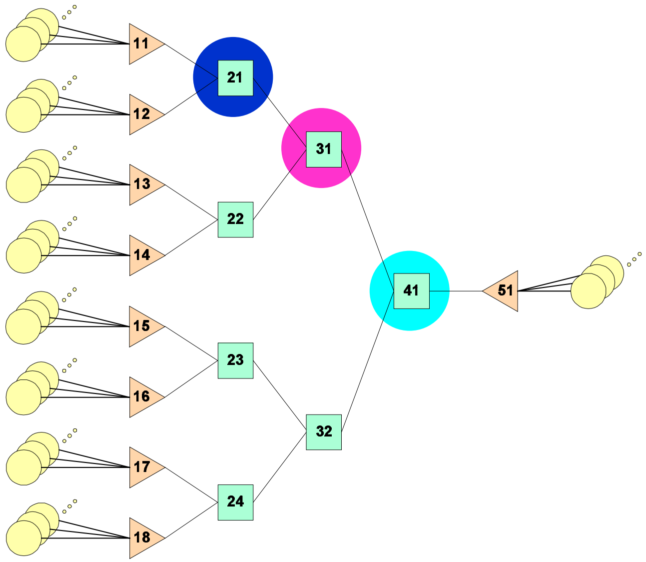


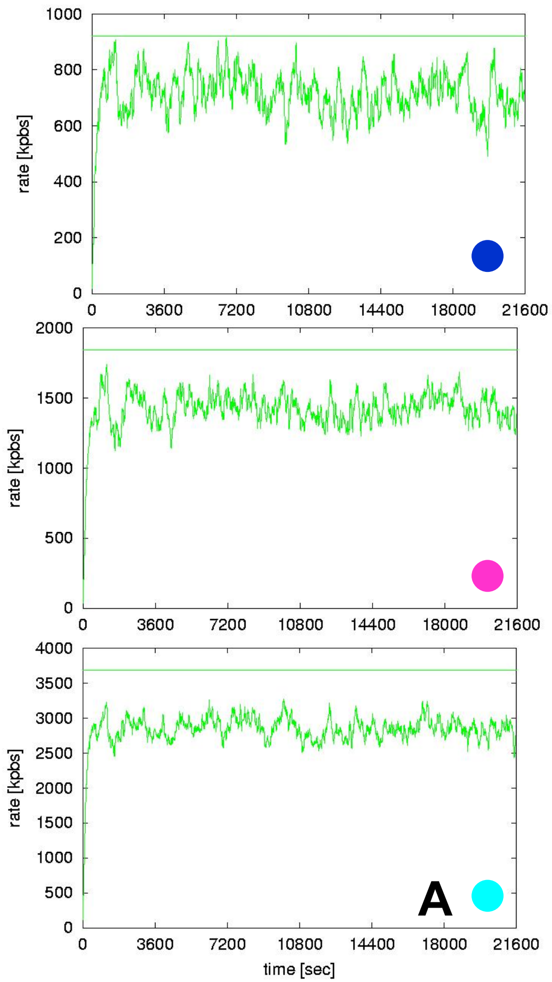
Scenario	Load A voice	Load A data	Load B voice	Load B data
red	79%	80%	82%	80%
green	100%	80%	100%	80%
cyan	100%	160%	100%	160%
blue			Schieflast	80%

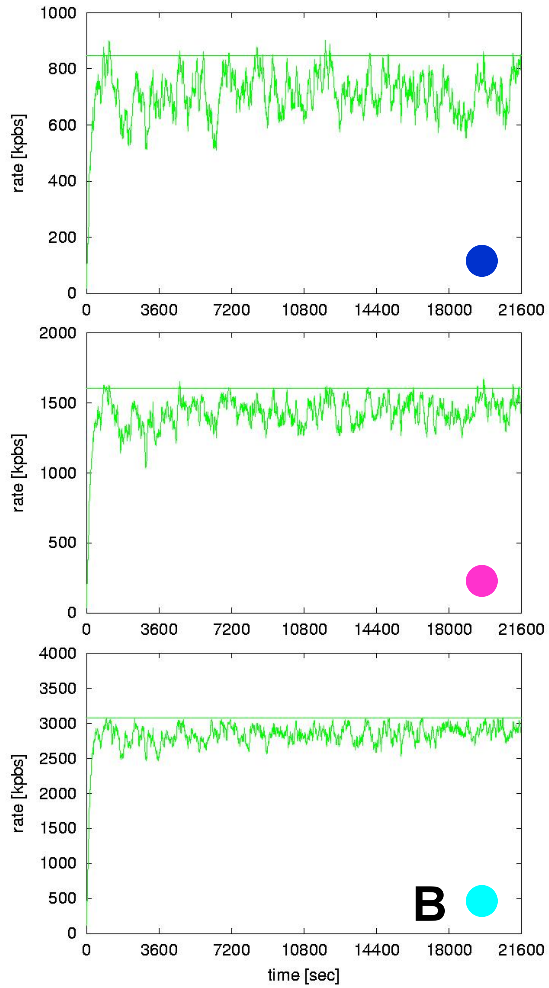




Utilisation (1)

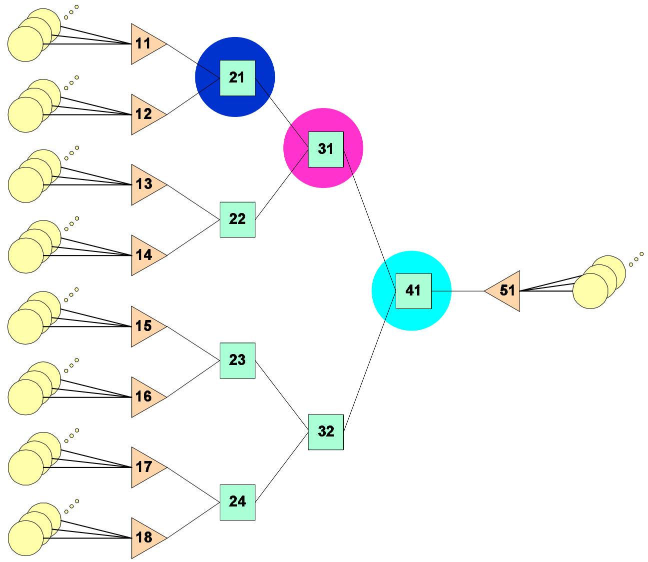


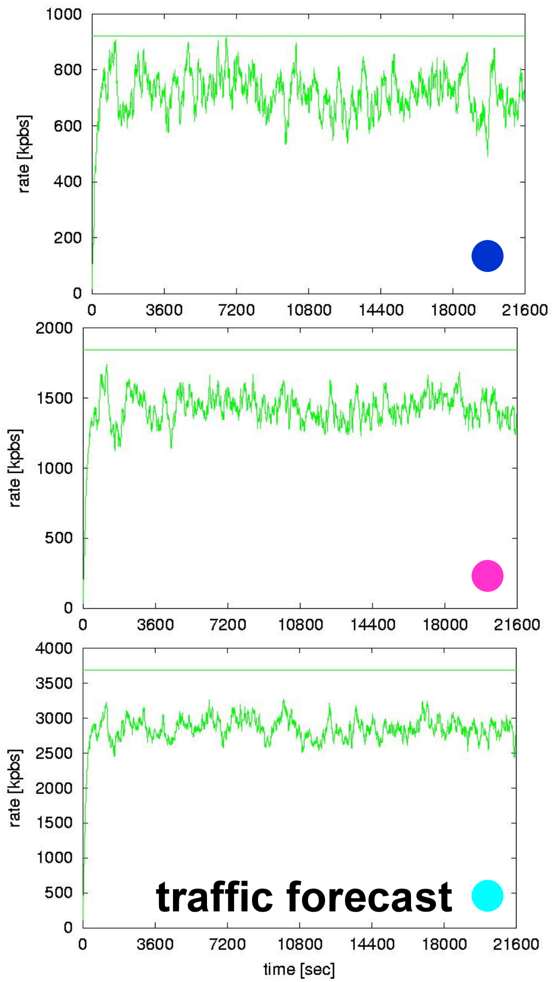


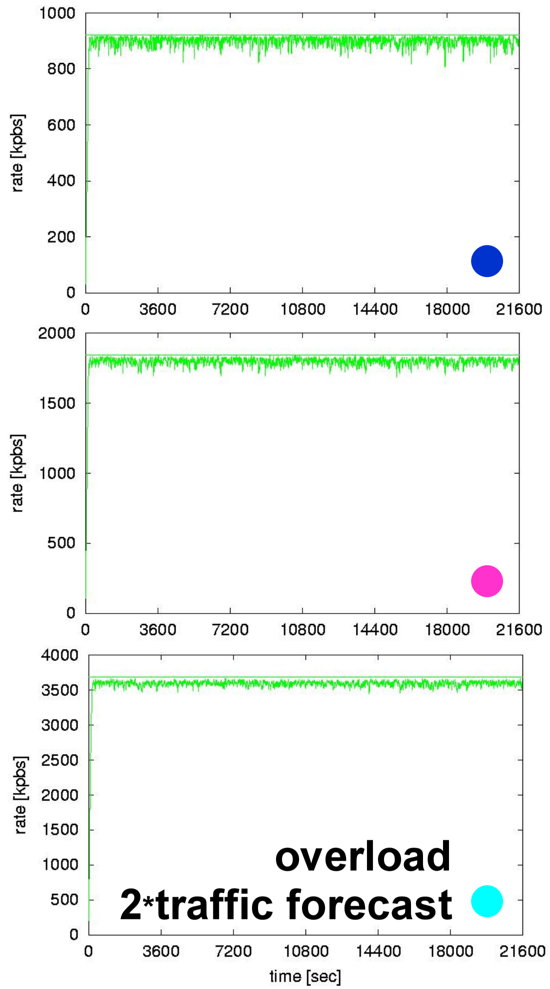


Measured Utilisation

Utilisation (2): Overload







Conclusions (1)

both traffic classes gain from integration

- they “borrow” unused resources

Dimensioning Method A

- good QoS for voice traffic
- QoS is kept in overload scenarios
- no congestion
- overprovisioning

Dimensioning Method B

- capacity saving
- congestion
- light QoS problems if traffic load meets traffic forecast (about 1% of packets are affected)
- heavy QoS problems in overload scenarios

Conclusions (2)

Independent Local Admission Control

- ☞ is feasible
- ☞ user perceived voice quality is very sensitive to resource management

Next Steps

- ☞ signalling for admission control
- ☞ tracking used bandwidth
- ☞ resource management
- ☞ advanced independent local decision schemes