
Assessment of VoIP quality across ADSL downlinks

Technische Universität Dresden

Chair of Telecommunications

Qin Dai

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- Introduction and motivation
- VoIP quality vs. ADSL downlinks
 - VoIP challenges
 - Delay in downlink
 - Packet dropping
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- Conclusions



Introduction and motivation

- Background: VoIP application gains more and more interest both from ISPs and users.
- Goal of this study: guarantee VoIP quality when across ADSL downlinks
 - Constructing the simulation model
 - Assessing VoIP quality (in downlink direction)
 - Approaches for improving VoIP quality



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VoIP challenges

■ Delay

- one way delay $\leq 150\text{ms}$ (ITU-T G.114)
- the “only one” biggest obstacle

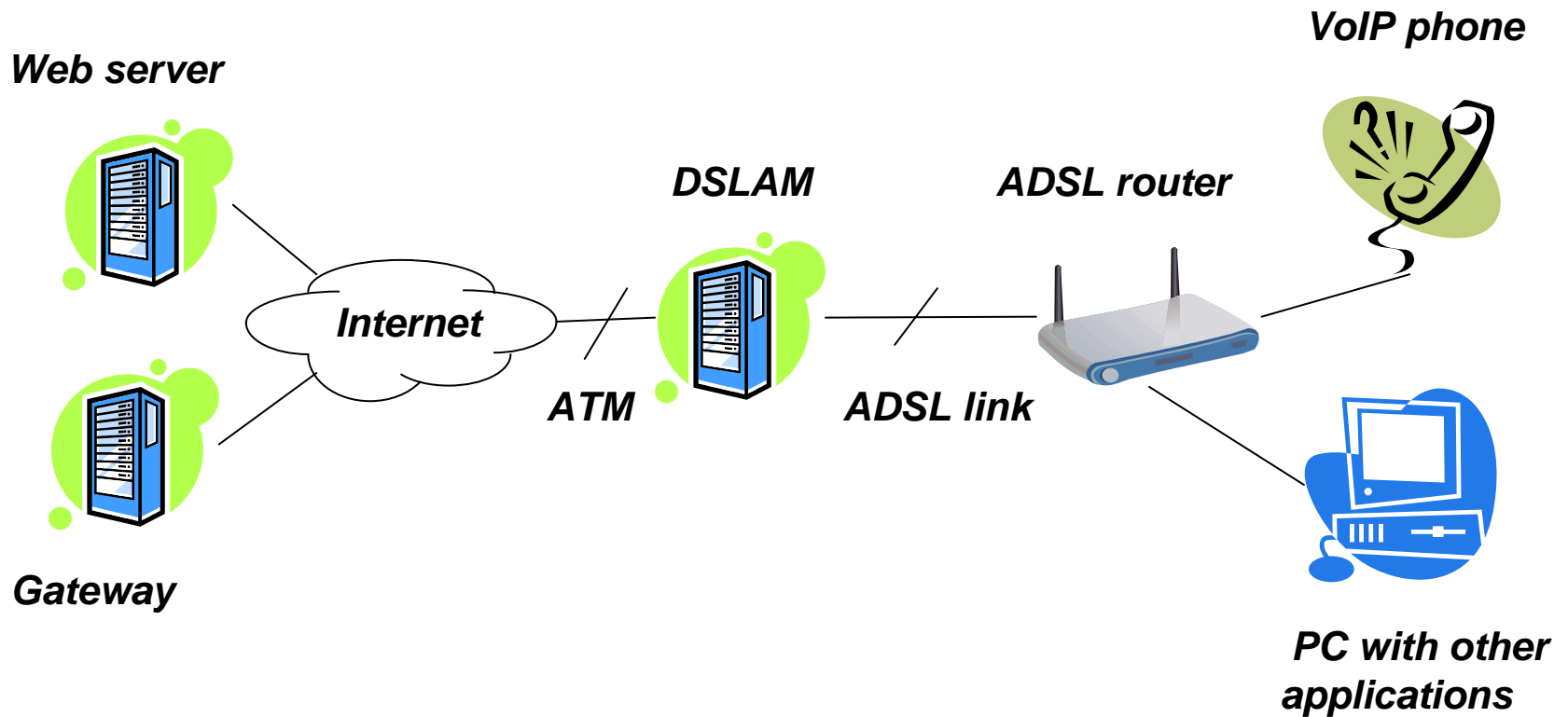
■ Jitter (delay variation)

■ Loss

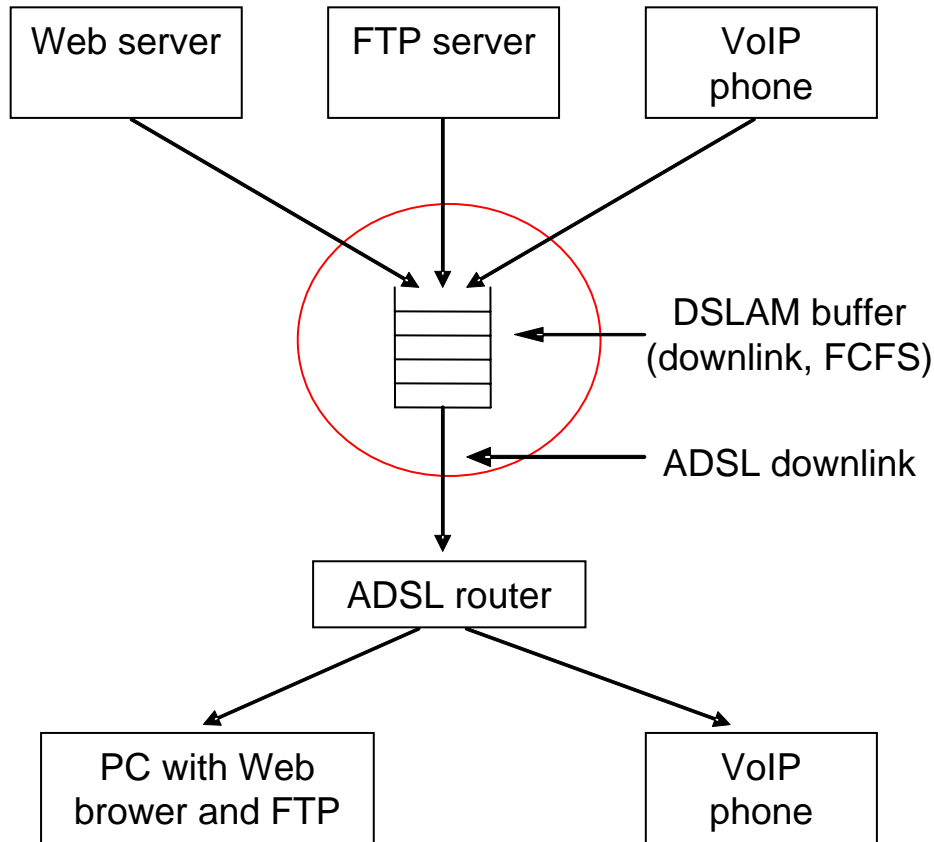
- Loss ratio (in packet) $< 1 \sim 5\%$ (according to different codec and PLC (packet loss concealment) function)
- Loss bursts impact more than random loss



System architecture



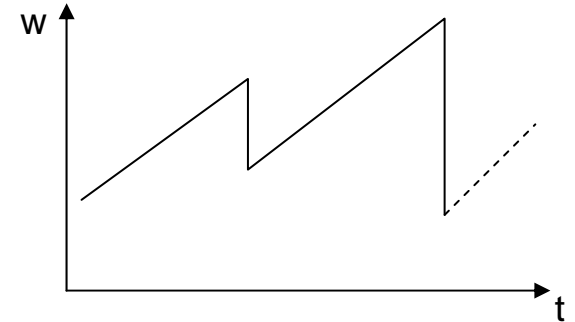
Downlink model



- **Main problem**
 - **Large queueing delay in DSLAM**
- **Method**
 - **limit the number of data packets can be placed in the DSLAM queue**

Approaches

- TCP packet dropping
 - TCP: “window-based” protocol
 - Enforce the TCP sender to close its congestion window size by introducing packet loss.
 - Simple but effective
 - Can result in poor TCP application behavior with high dropping rate
- Other approaches
 - Can still maintain good TCP performance

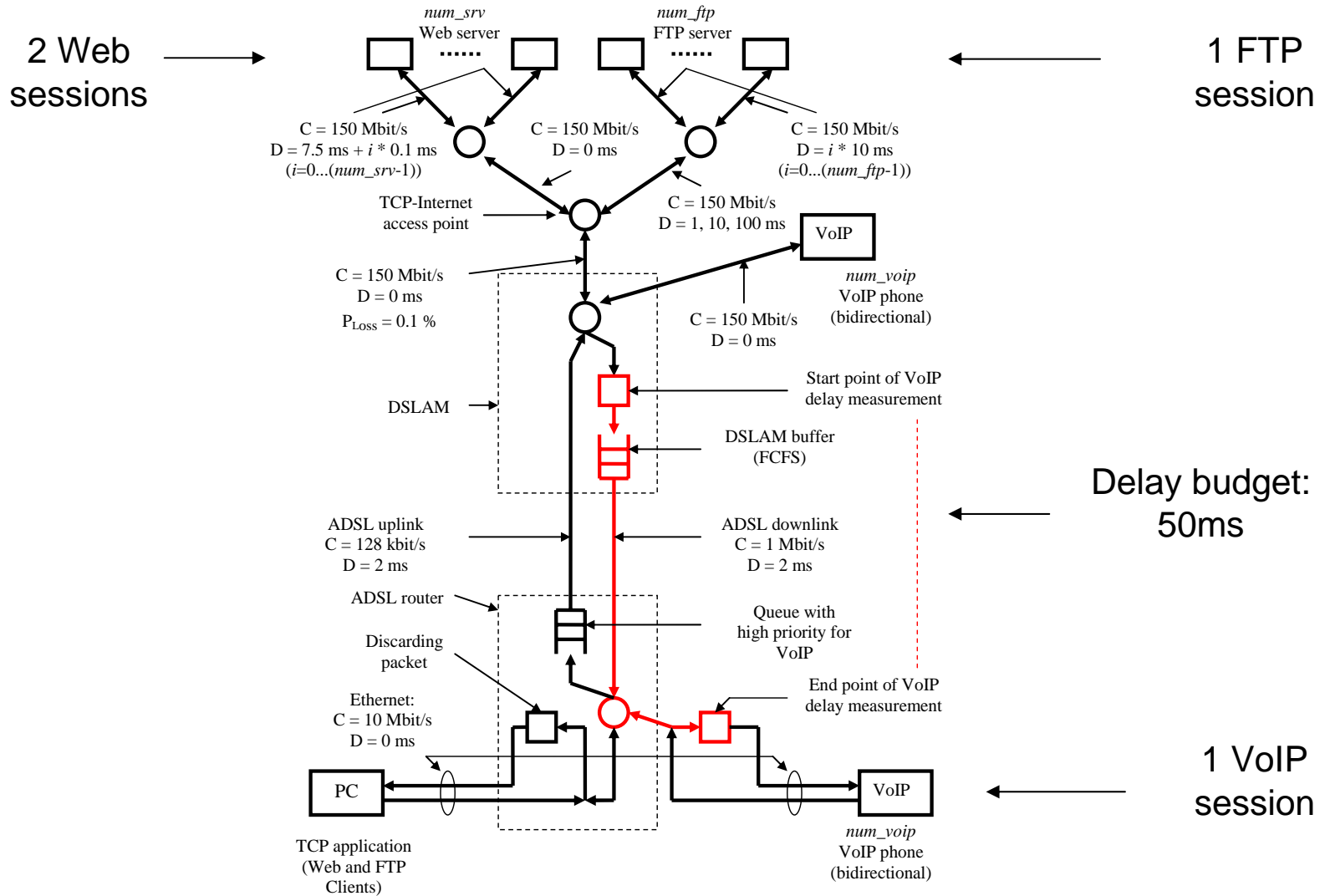


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Simulation model 1 – network model

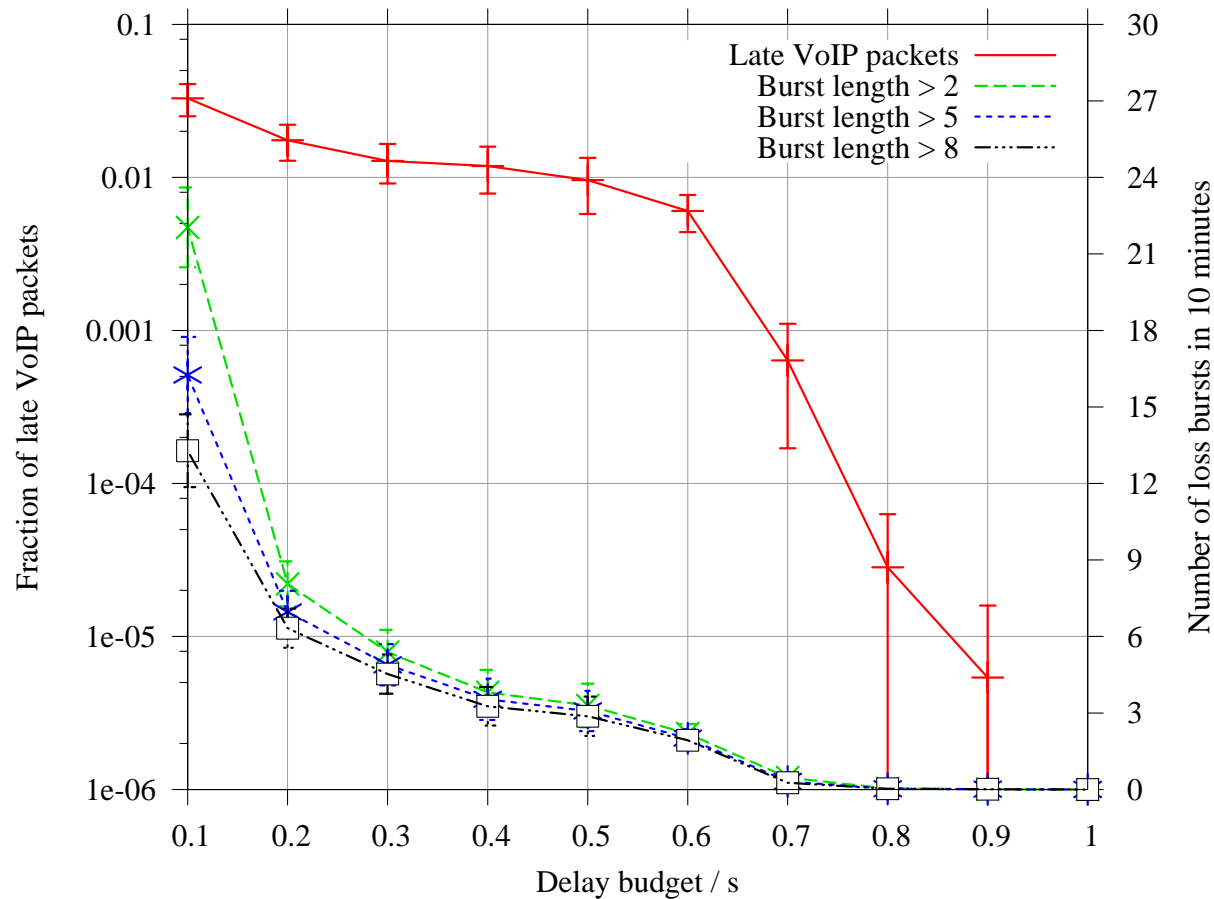


Simulation 1 -- Performance metrics

- VoIP quality
 - Fraction of late VoIP packets
 - No more than 1%
 - Number of loss bursts in 10 minutes (burst length > 2,5,8)
 - The number of loss burst (burst length>5) no more than 2
 - debatable
- TCP quality
 - Web response time
 - FTP throughput (one-way network delay about 1ms,10ms,100ms)

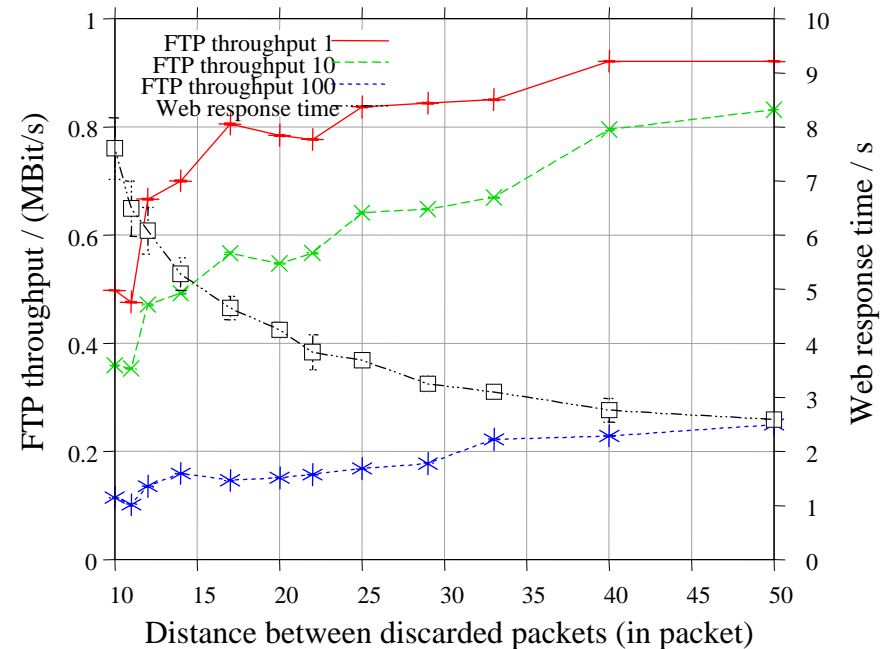
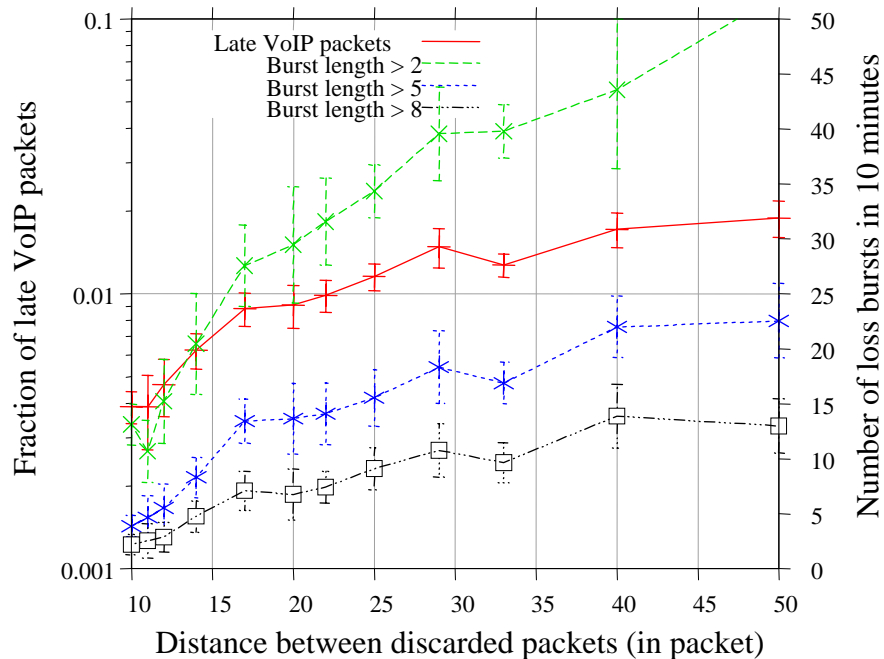


VoIP quality in downlinks



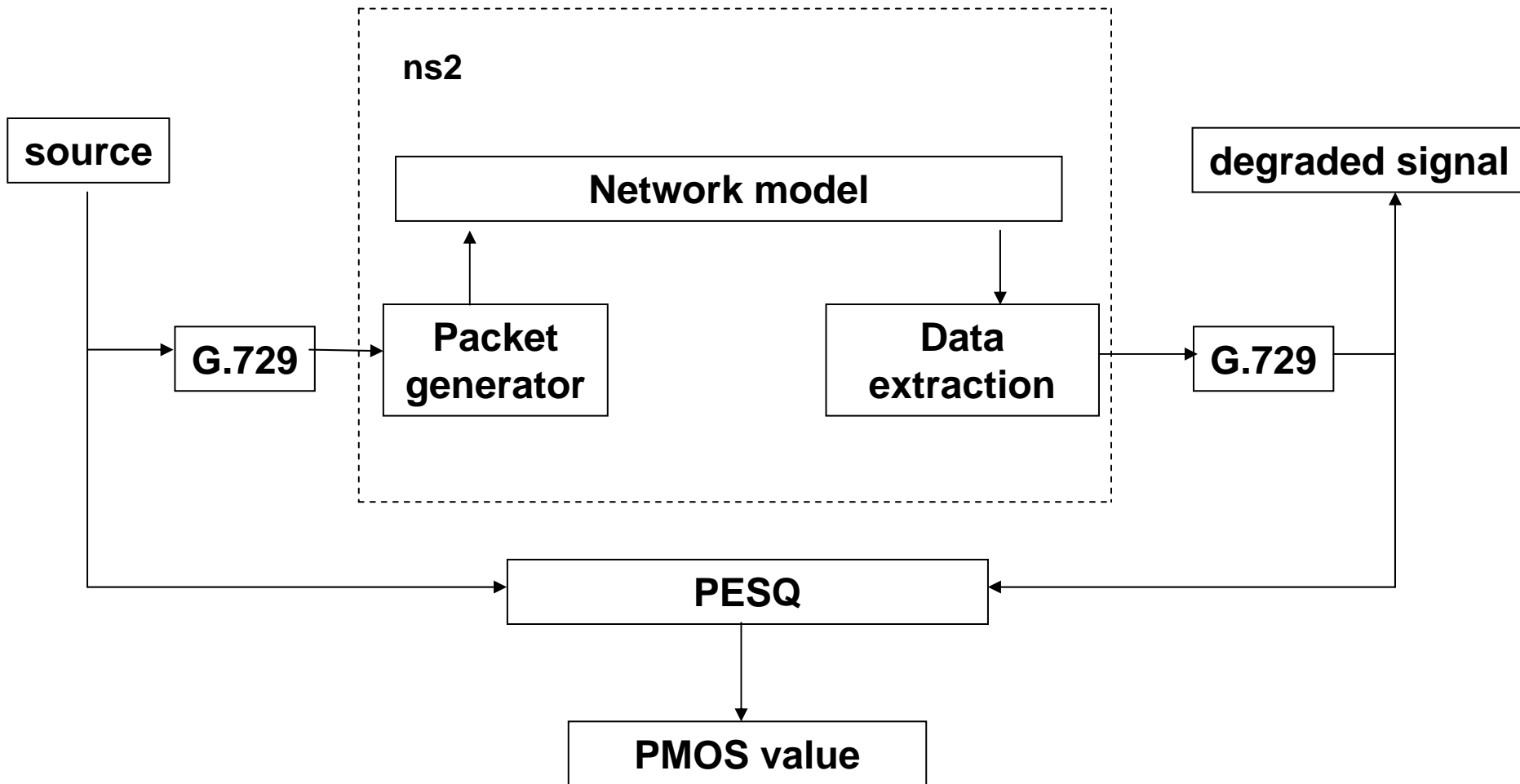
- **High delay is necessary (more than 200ms) for guarantee acceptable loss ratio (1%)**

TCP packet drop (delay budget 50ms)

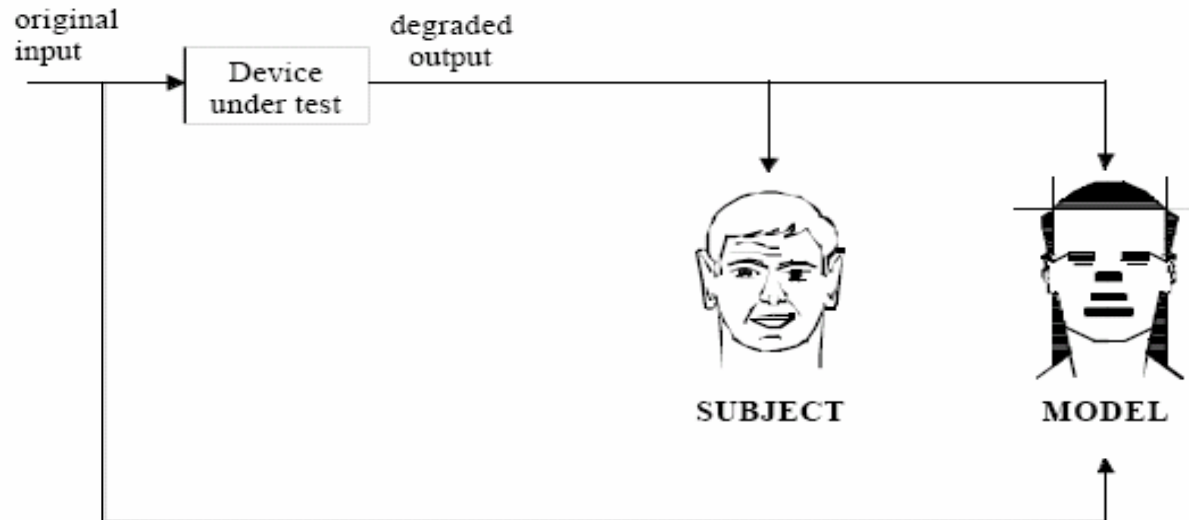


- **High packet dropping rate necessary: more than 10%**
- **Low FTP throughput**
- **High Web response time (more than 8s)**

Simulation model 2 – MOS estimator



VoIP quality estimation – PESQ value



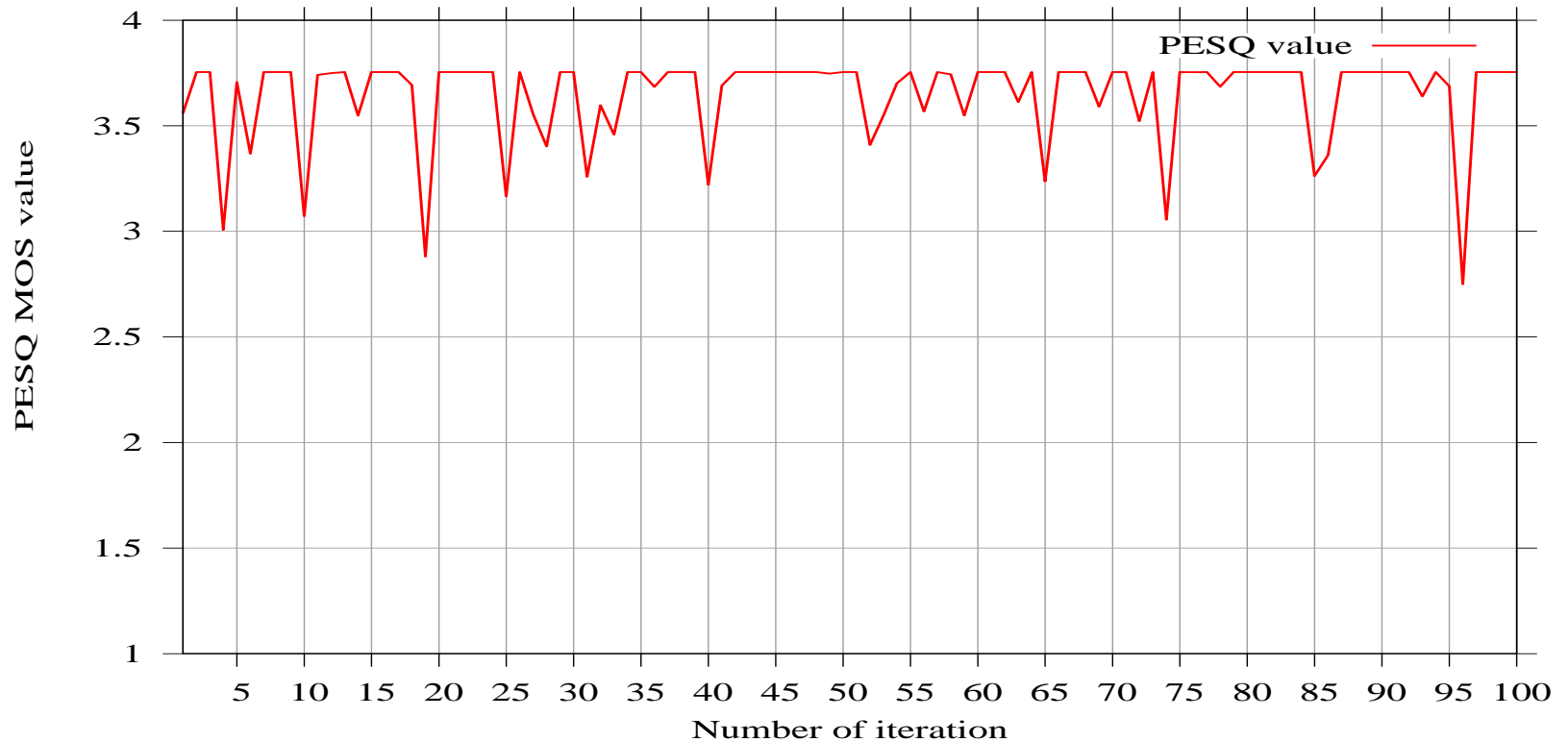
- Perceptual evaluation of speech quality (PESQ): ITU-T Recommendation P.862
- An objective method for speech quality assessment
- Compares an original signal with a degraded signal that is the results of passing through a communication system
- Highly correlated to the subjective scores: 0.935 (random loss?)





Performance metrics and simulation setting

- Performance metrics:
 - Fraction of packet loss
 - Fraction of BAD PESQ MOS value (PESQ MOS < 3.5)
 - Number of loss bursts in 20 seconds (burst length > 2)
- Simulation setting:
 - Voice sample: German, male, 20s
 - Codec: G.729, 8kbit/s
 - VoIP packet: 20ms/packet
 - Competing traffic: 2 Web sessions
 - simulation time: 400 times voice sample

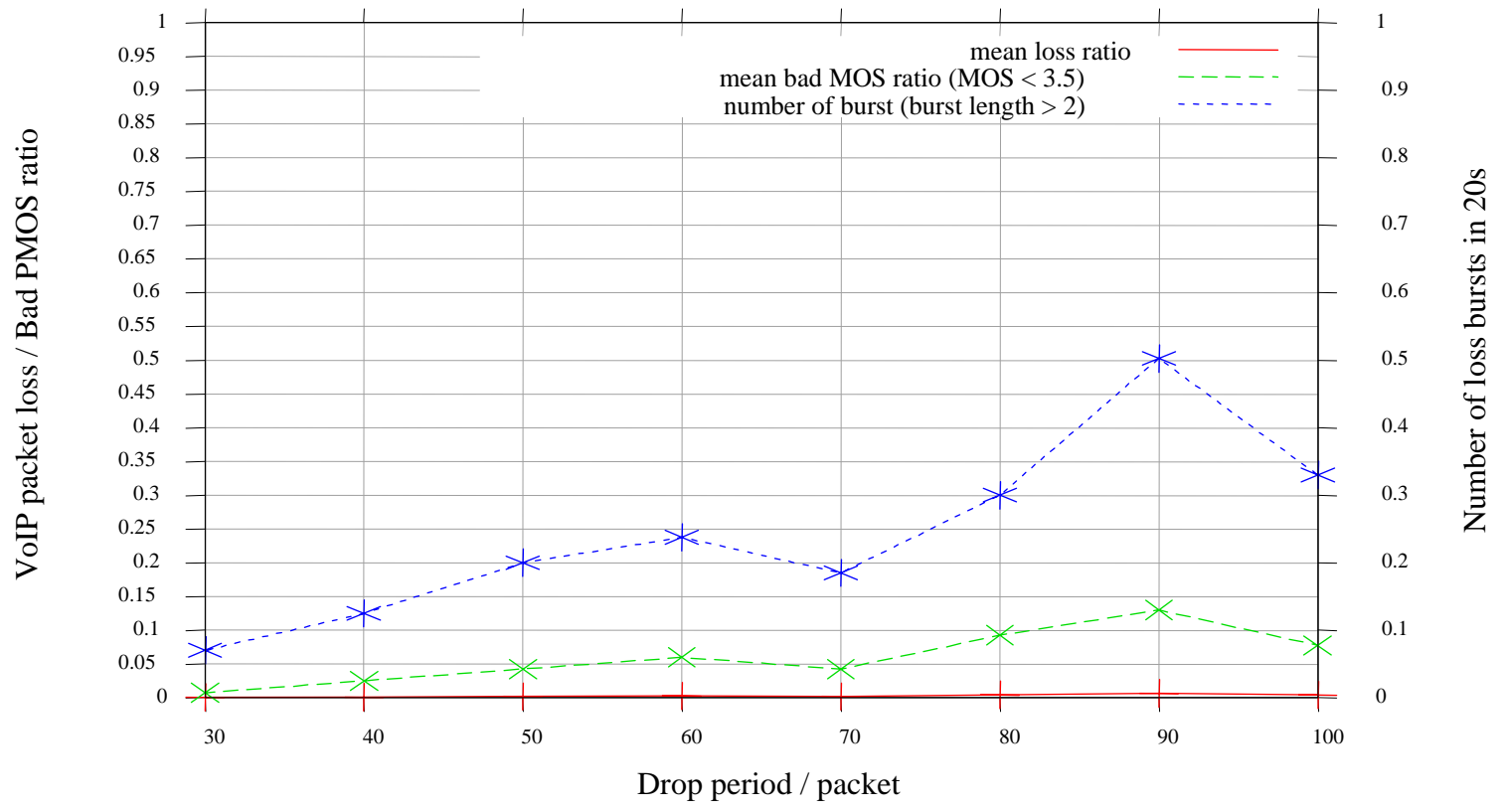


PESQ value in 100 iterations



	original	PMOS 3.754	PMOS 2.750	PMOS 2.987 (random loss)
Voice sample				

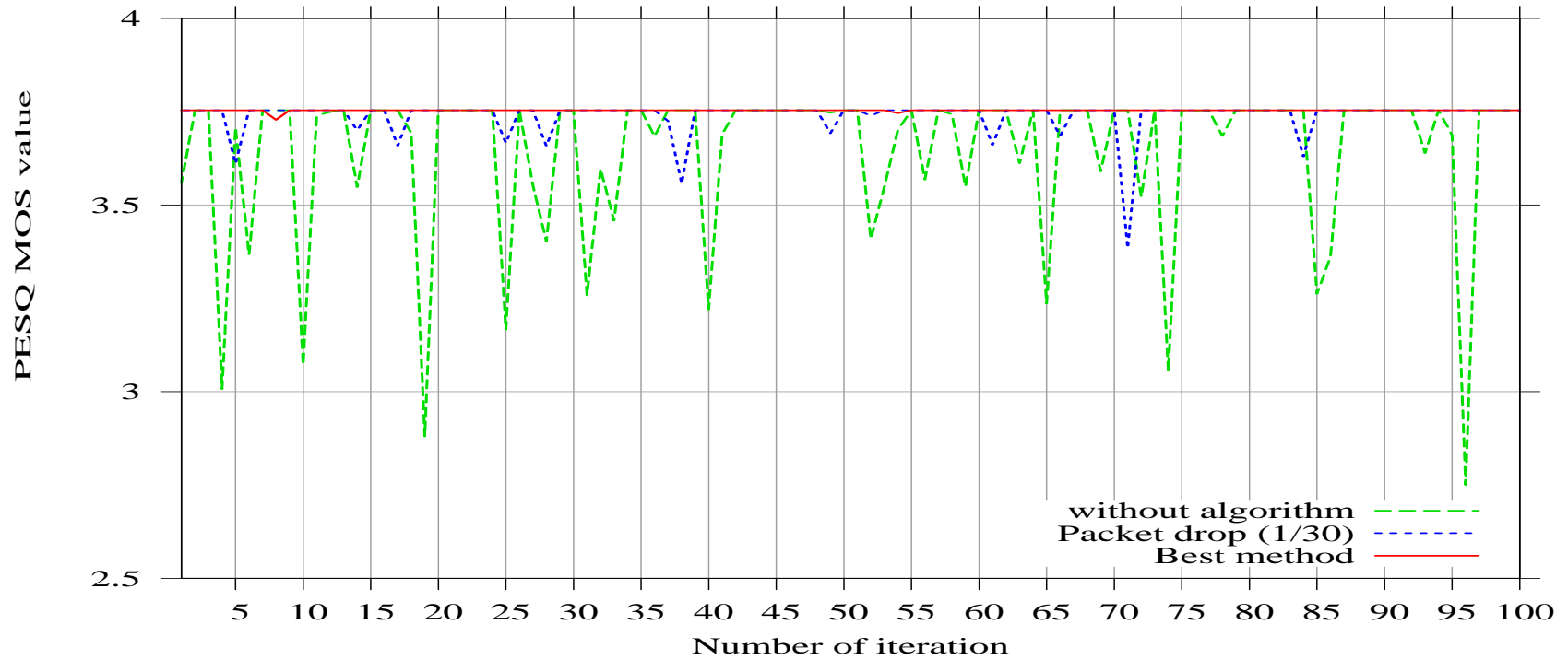
(TCP) Packet dropping



	original	Best (3.754)	Worst (3.319)
Packet drop (1/30)			



PESQ values with algorithms



	Mean	Best	Worst	Bad ratio
no algorithm	3.645	3.754	2.750	0.15
Packet drop (1/30)	3.740	3.754	3.385	0.01
Best method	3.754	3.754	3.728	0



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Conclusions

- In ADSL downlink the VoIP packet can be seriously delayed in DSLAM by the packets from other applications.
- Some methods should be introduced to guarantee the VoIP quality across ADSL downlinks.
- Our proposed algorithms will improve the VoIP quality.



Thanks!



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