

Misura delle prestazioni degli accessi ad Internet da postazione fissa offerti dagli Operatori in Italia



Ing. Luca Rea

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Summary

QoS fixed-line broadband connection monitoring

- QoS fixed-line broadband connection monitoring, the Italian approach

(AGCOM resolution n.244/08/CSP)

- Network monitoring architecture
- Broadband evaluation problems

QoS fixed-line broadband connection monitoring

The Italian approach- Main aspects -

Two set of measures:

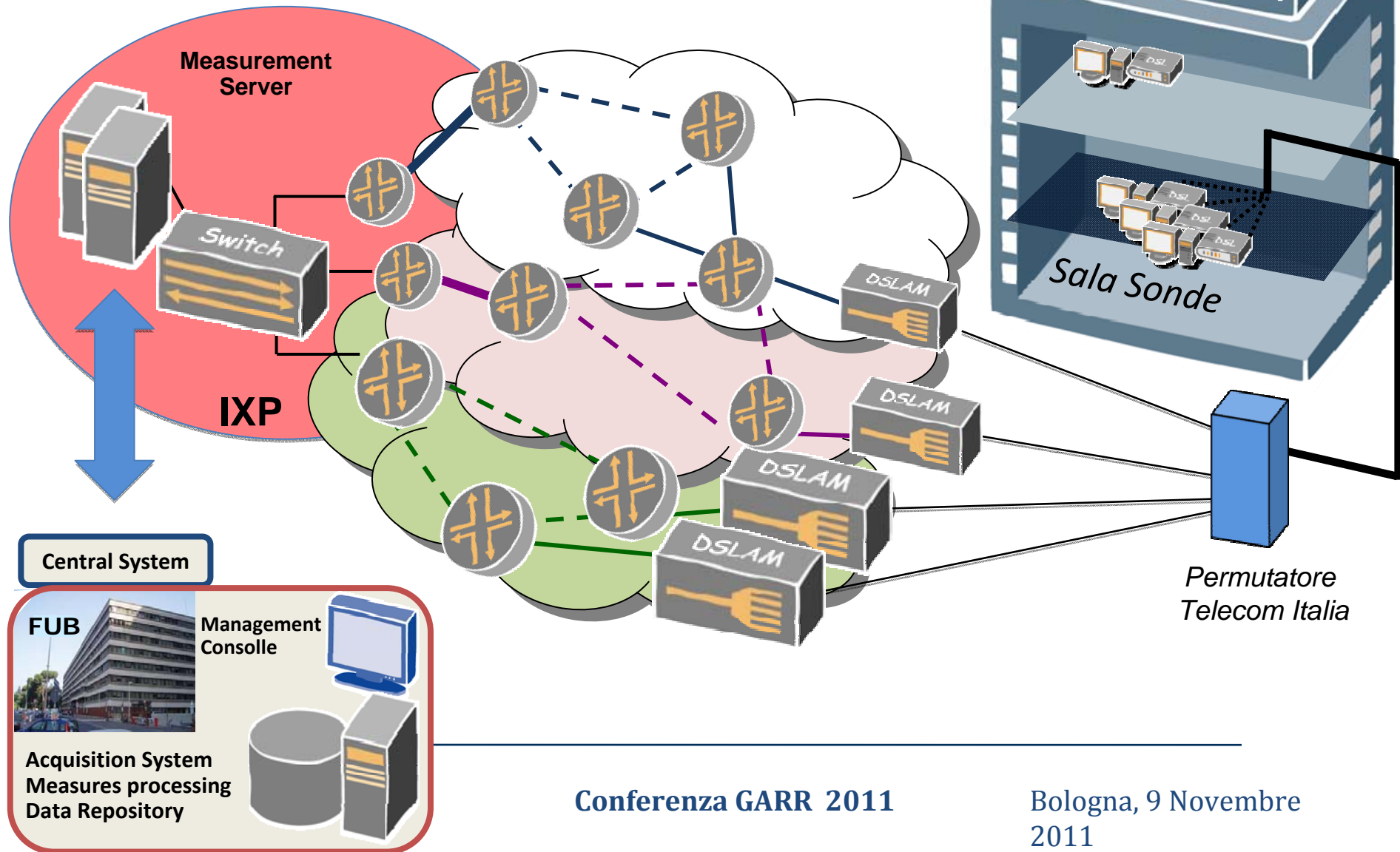
- **ISP measurements:** Number of measures to help consumers in understanding more on broadband service they are going to buy. The average values obtained by “ISP measurements” will become the advertised values, declared by each ISP (Provider) to help consumers in understanding more on broadband service they are going to buy
- **End users measurements:** By means of the software Ne.Me.Sys (Network Measurement System) every end user can evaluate its own fixed line Quality of Service. Results could be compared with ISP’s promised ones

Architecture:

- **Architecture:** Both ISP Measurements and End-user measurements employ a Client/Server architecture, based on several Measurement Server located into Italian Internet Exchange Points and software agent Ne.Me.Sys
 - located into Measurements hardware Probes (ISP measurements) or
 - downloaded into User’s PC (End users measurements)

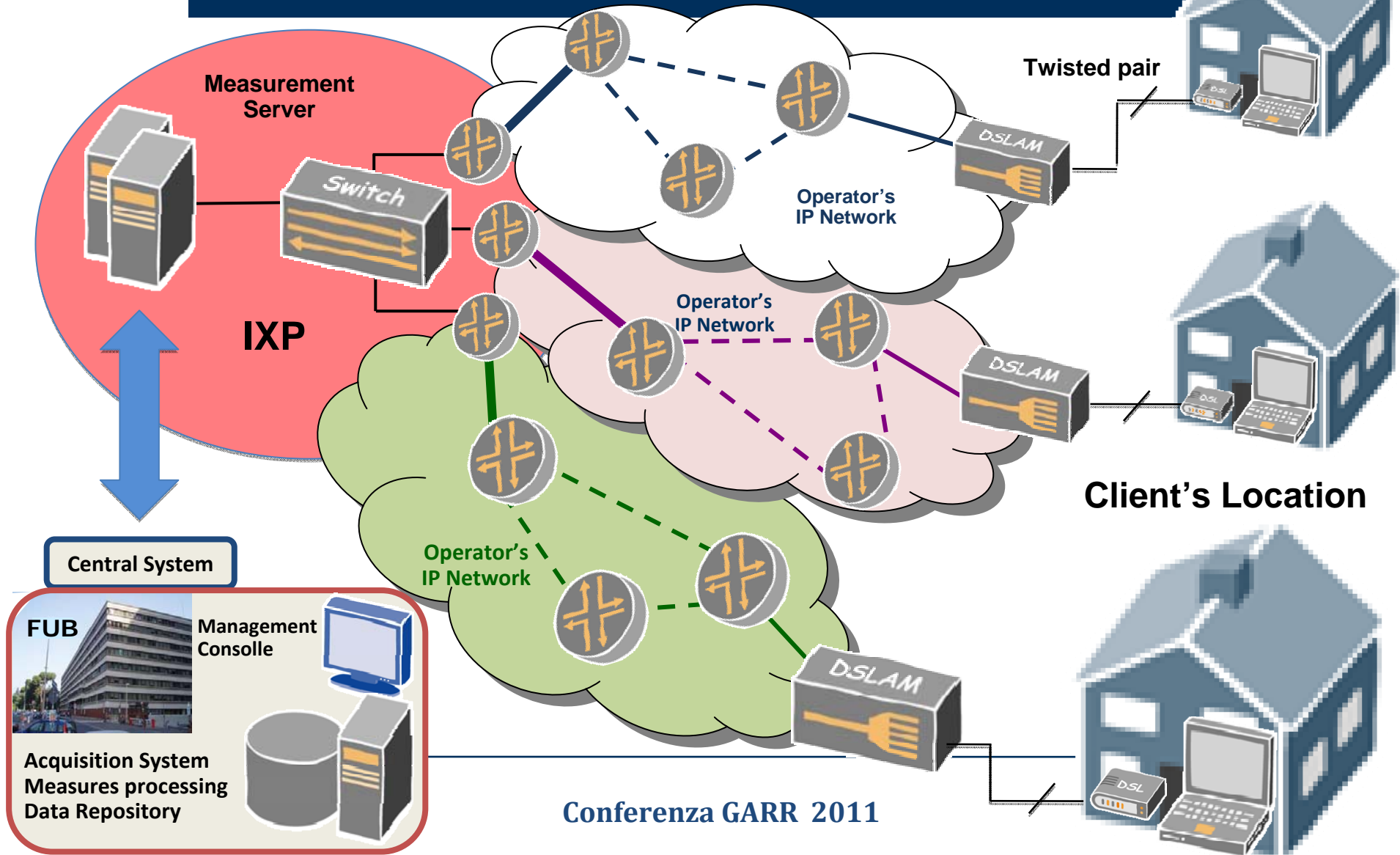
Network Monitoring Architecture

ISP – “valori statistici”



Network Monitoring Architecture

End users – “utenti finali”

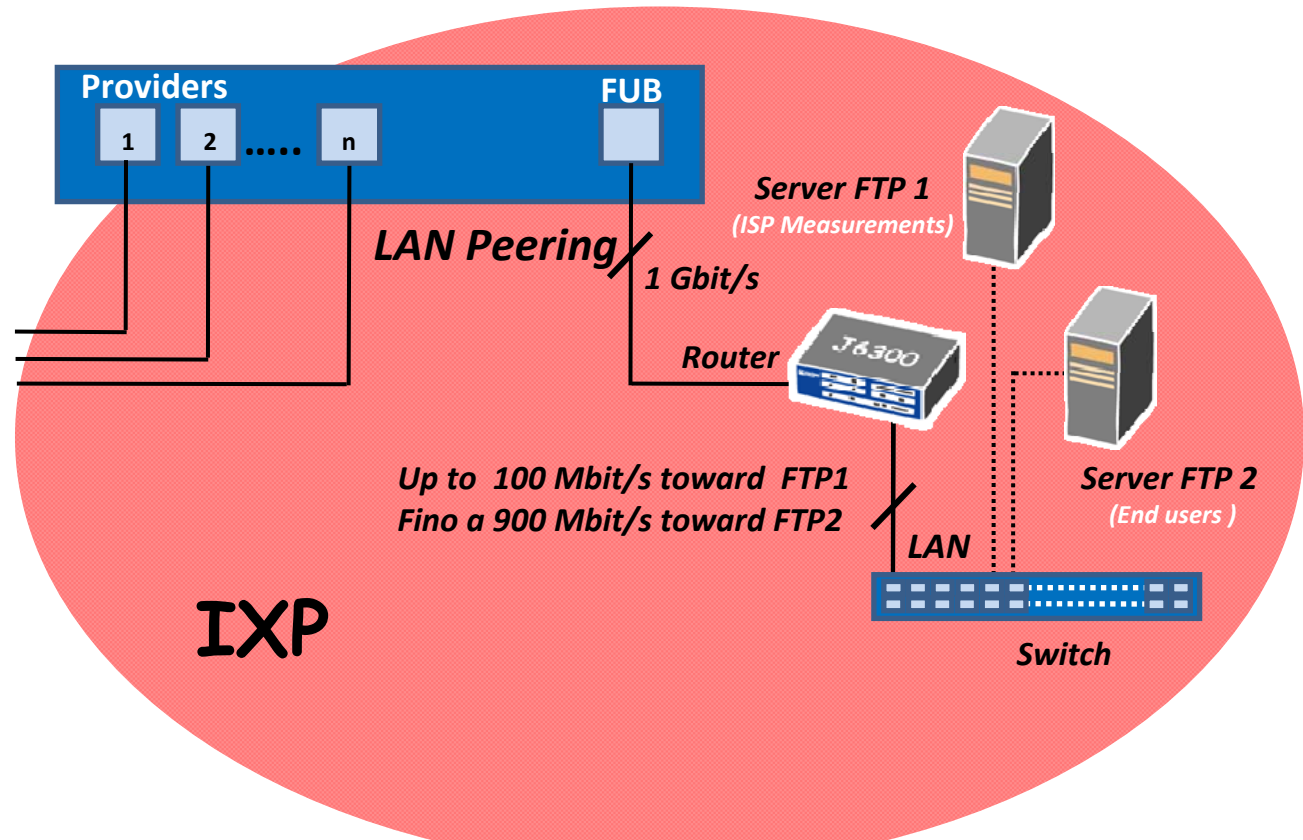


IXP (Internet eXchange Point)

Milan (MiX) architecture

One or more network switch, connecting the participating ISPs to each other.

- It is a physical infrastructure through which ISPs exchange Internet traffic between their networks (autonomous systems).
- The primary purpose of an IXP is to allow networks to interconnect directly, via the exchange, rather than through one or more 3rd party networks



Through a measurement server located in IXP, it is guaranteed that each client measures only performances related to its own ISP Network. This approach has been chosen since it allows for comparable and reproducible results

QoS parameters involved

ETSI EG 202 057 v.1.2.1

List of QoS parameters defined by ETSI Guide EG 202 057 057-4

- **Data transmission speed**

- ✓ Data transmission rate achieved separately for downloading and uploading specified test files between a remote server and a user's computer

- **Packet Delay (one way transmission time)**

- ✓ half the time in milliseconds, needed for an ICMP Echo Request/Reply Packet (Ping Command) to a valid IP address

- **Packet loss ratio**

- ✓ the ratio between the number of not replied Ping commands to the total number of sent Ping commands

- **Unsuccessful data transmission ratio**

- ✓ the ratio of unsuccessful data transmissions to the total number of data transmission attempts in a specified time period

QoS parameters involved

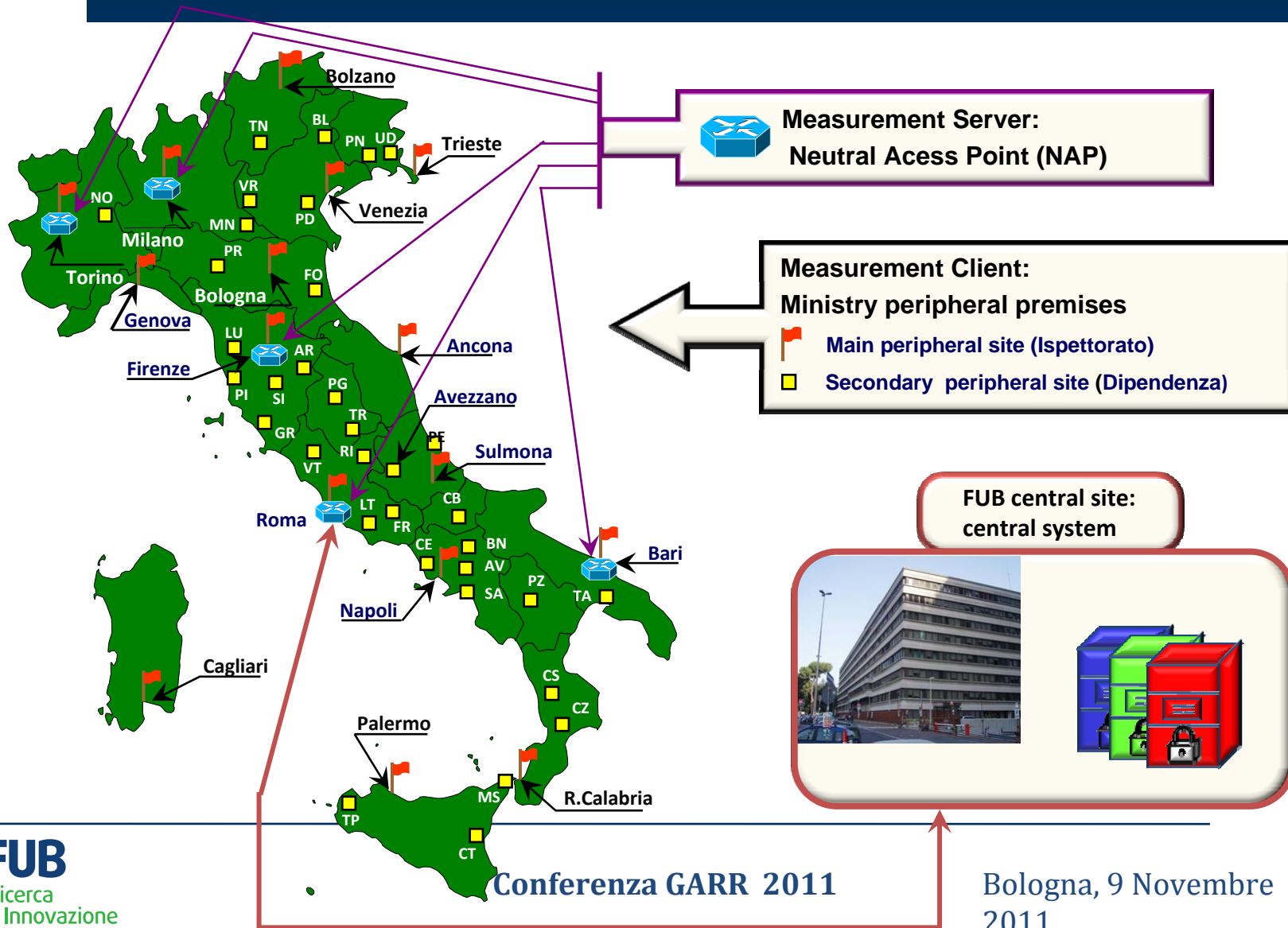
ETSI EG 202 057 v.1

- Regarding data transmission speed, for both download and upload direction, the following values are computed:
 - *95 th percentile in kbit/s*
 - *5 th percentile in kbit/s*
 - *The mean value in kbit/s*
 - *The standard deviation in kbit/s*
- The following two values are computed relative to delay (one way transmission time):
 - *The mean value in milliseconds*
 - *The standard deviation*

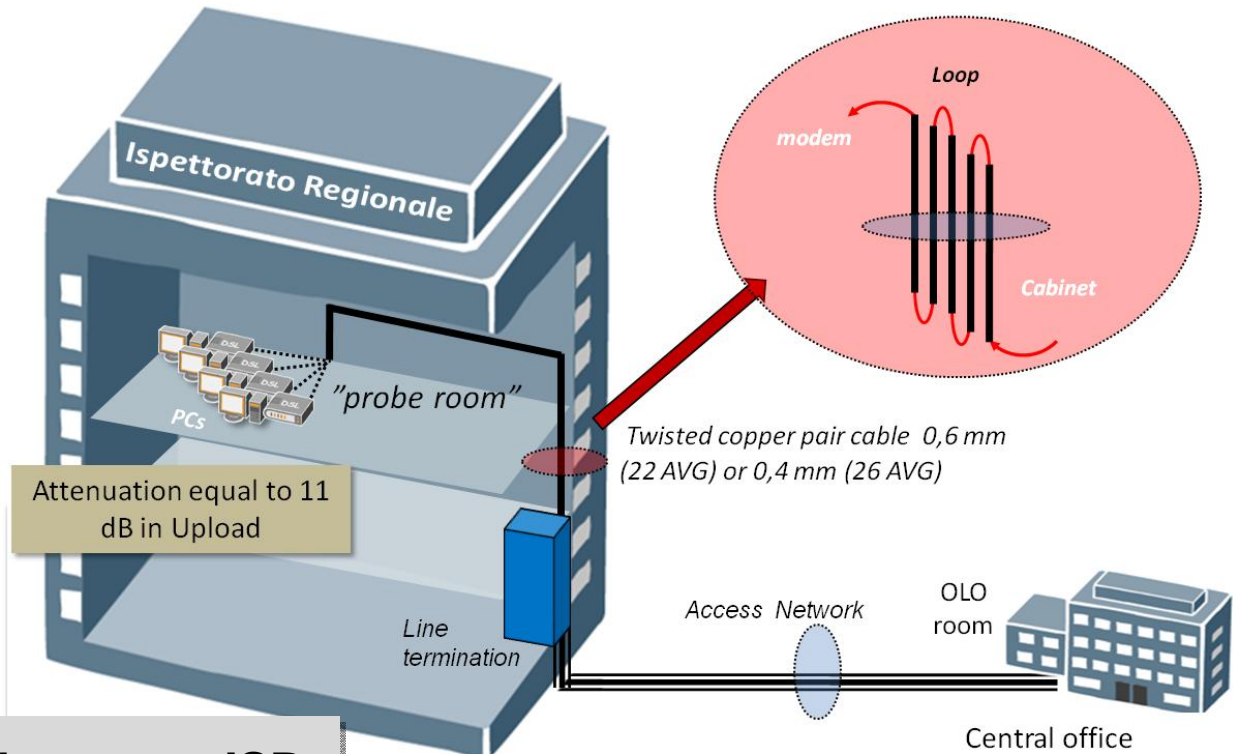
Advertised Values	Formula	
Mean	$avg = \frac{1}{N} \sum_{k=1}^N \frac{(\text{exchanged_byte}_k) \times 8}{\text{result}_k}$	Kbps
Standard Deviation	$dev = \sqrt{\frac{\sum_{k=1}^N \left(\frac{(\text{exchanged_byte}_k) \times 8}{\text{result}_k} - avg \right)^2}{N - 1}}$	Kbps

ISP measurements network architecture

Network deployed on the whole Italian Country



- Upload line attenuation is considered because it is less affected by frequency depending.
- The Italian average distance between customers and exchange is about 1,2 km and the corresponding average upload Line Attenuation is 11 db
- 11 db in upload line attenuation & 1,2 km between users and Central Office (Exchange) regards 50 % of xDSL consumers in Italy



To have a comparison between ISP performances also Line Attenuation must be the same

Network Monitoring System



Gestione Sonde



Home Monitoring Logout

Client: 150				
ID CLIENT	OPERATORE	REGIONE	PROGRESSIVO OPERATORE	PROFILO
200	Operatore	sicilia	00820107	7Mbps/256Kbps
171	Operatore	toscana	00480202	7Mbps/832Kbps
203	Operatore	sardegna	00920109	7Mbps/256Kbps
187	Operatore	marche	00420204	7Mbps/832Kbps
197	Operatore	veneto	00270206	7Mbps/832Kbps
170	Operatore	toscana	00480101	7Mbps/256Kbps
201	Operatore	sicilia	00820208	7Mbps/832Kbps

Network Monitoring System

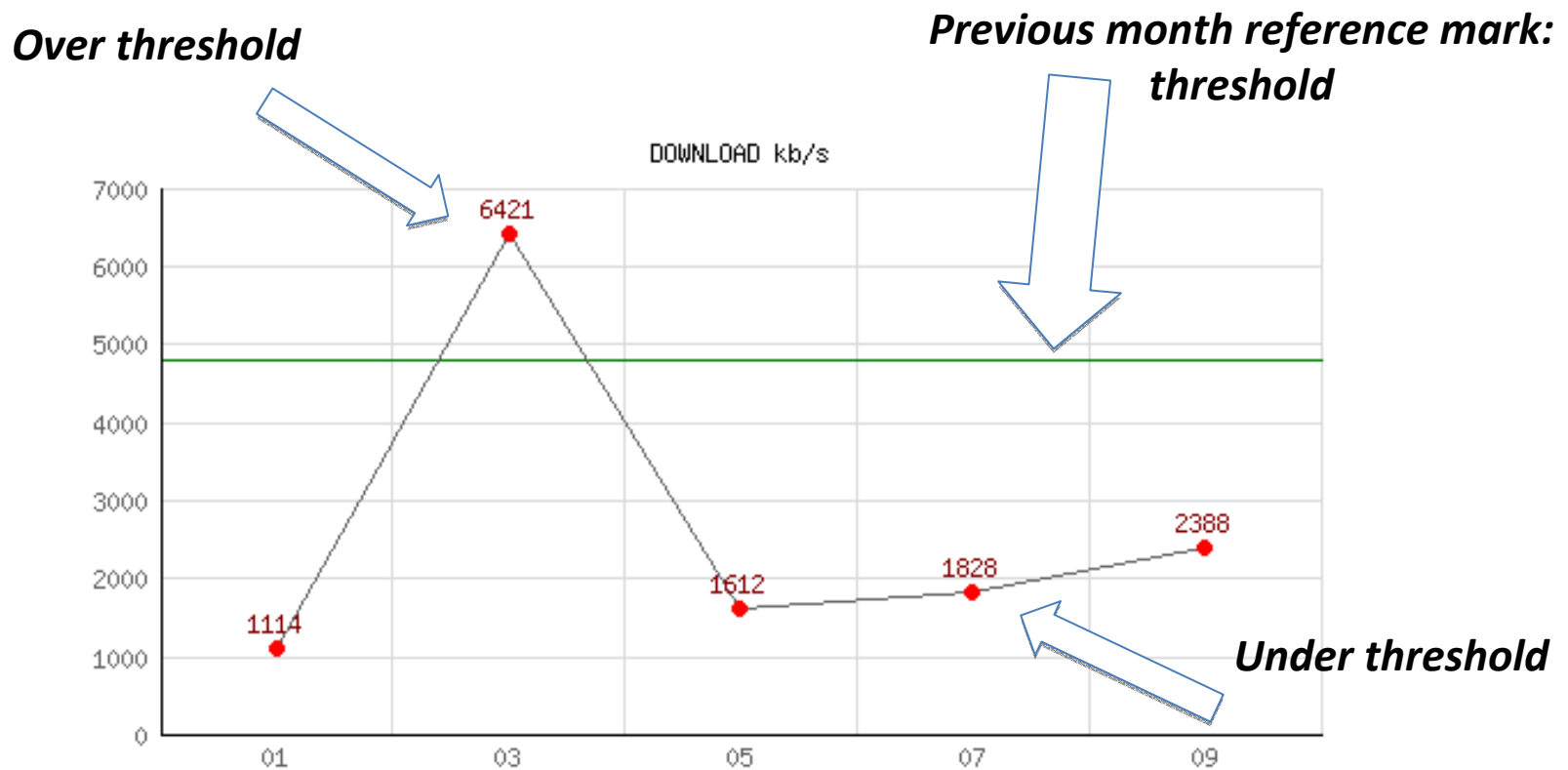
Operatore	Regione	ID Client	Profilo	Stato	Grafico	Elaborazioni
Operatore	veneto	48	1,2Mbps/256Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	veneto	49	8Mbps/512Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	puglia	52	1,2Mbps/256Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	puglia	53	8Mbps/512Kbps	NON MISURA	Grafico	Elaborazioni
Operatore	sardegna	54	1,2Mbps/256Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	sardegna	55	8Mbps/512Kbps	VALORI NULLI	Grafico	Elaborazioni
Operatore	sicilia	143	1,2Mbps/256Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	sicilia	144	8Mbps/512Kbps	VALORI ANOMALI	Grafico	Elaborazioni
Operatore	marche	158	1,2Mbps/256Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	toscana	51	8Mbps/512Kbps	ATTIVO	Grafico	Elaborazioni
Operatore	marche	159	8Mbps/512Kbps	ATTIVO	Grafico	Elaborazioni

*Last month graph,
daily rate*

*Last week graph,
hourly rate*

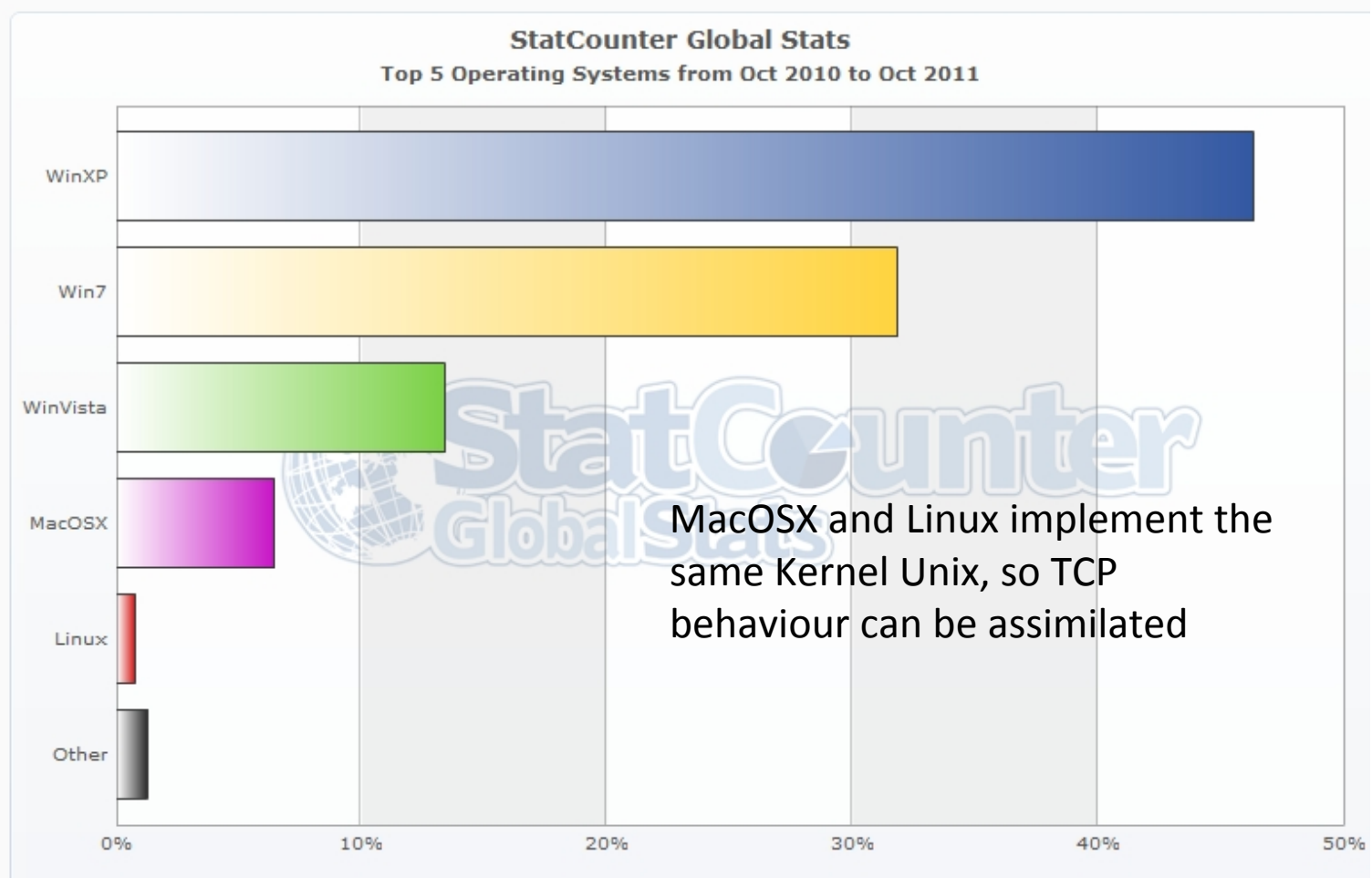
Network Monitoring System

example



Broadband evaluation problems

Most popular OSes

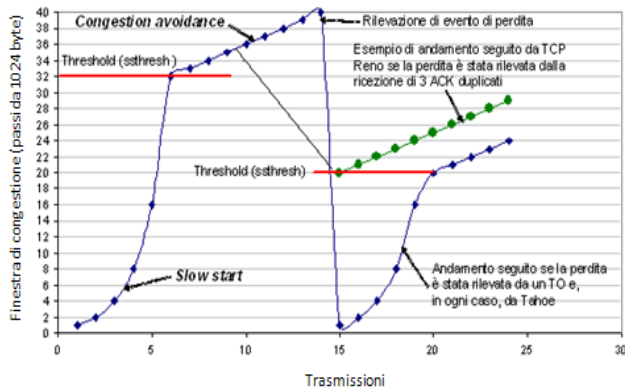


Broadband evaluation problems

- Most popular TCP/IP stacks implementation -

Windows XP SP3

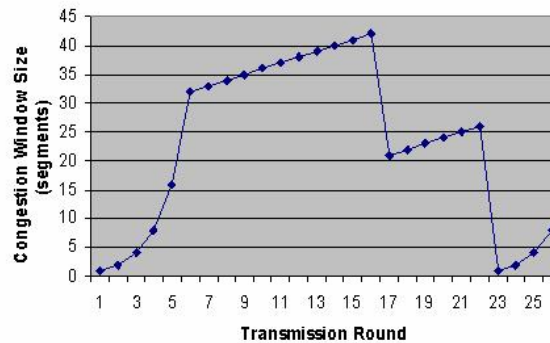
TCP Reno



- MaxRwnd=65535byte
- Window Scale = 0

Windows 7

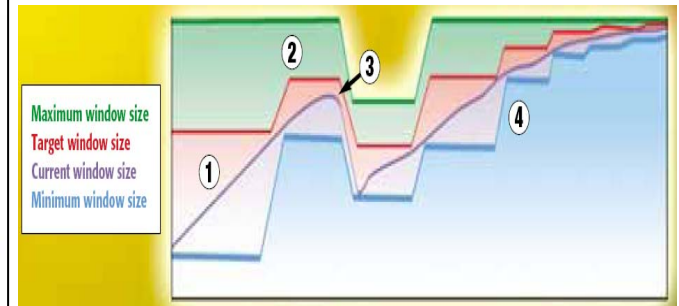
TCP New Reno (multiple loss)



- Autotuning
- Rwnd follows BDP

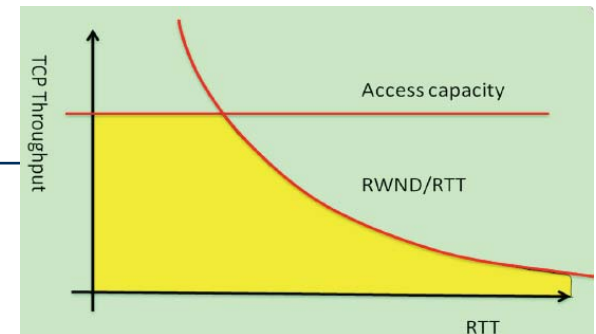
Linux

TCP Cubic



- Autotuning
- Considers PC's RAM

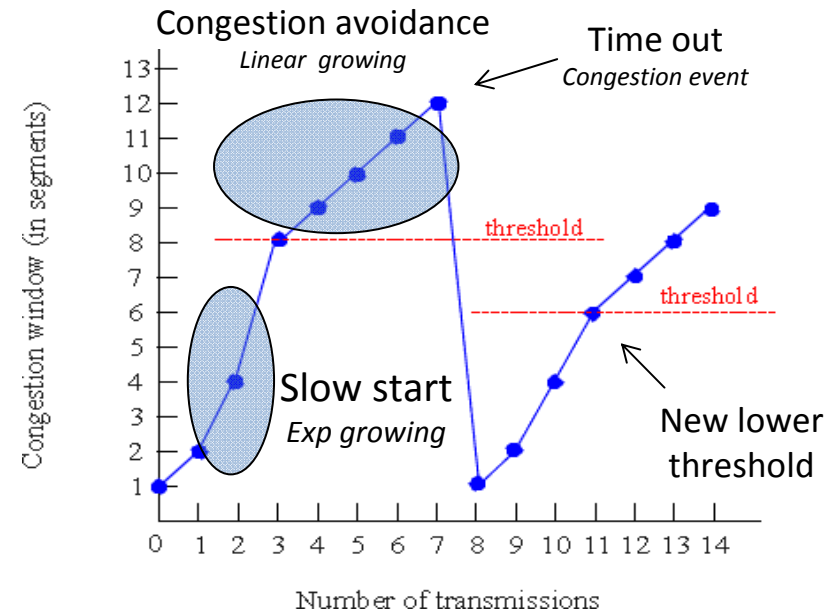
$$TCP\ Throughput \leq \frac{\min(rwnd, cwnd)}{\max(RTND, RTT)}$$



Broadband evaluation problems

File size choice

- File size is a very important aspect to measure broadband speed
- Such a parameter affects TCP slow start mechanism
- File size should allow Congestion window to grow up in order to good exploit network capability

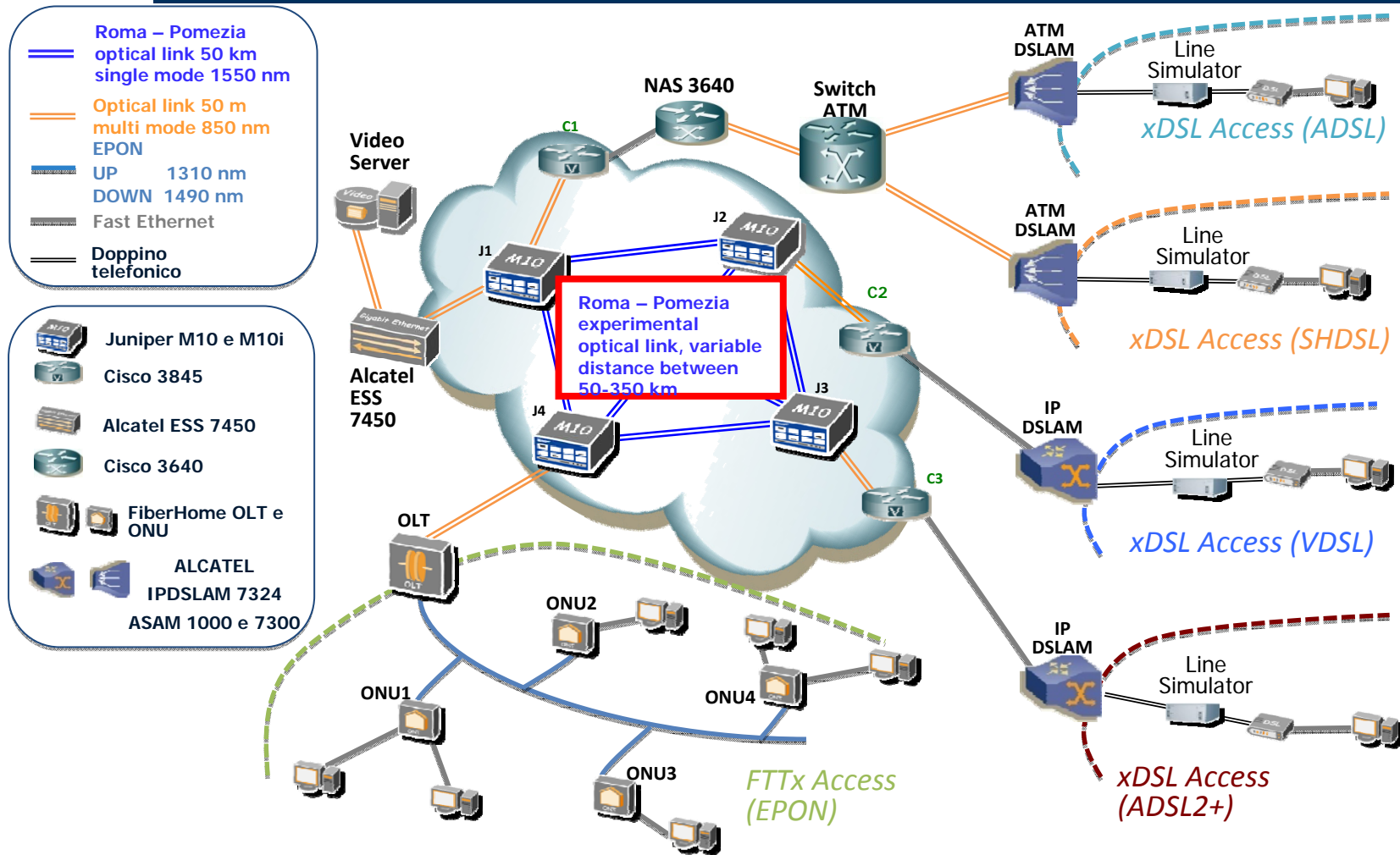


- ✓ *Little file size does not allow TCP to exploit all line capability: obtained results could be lower than network capabilities*

The file size has been chosen 10 times the headline speed

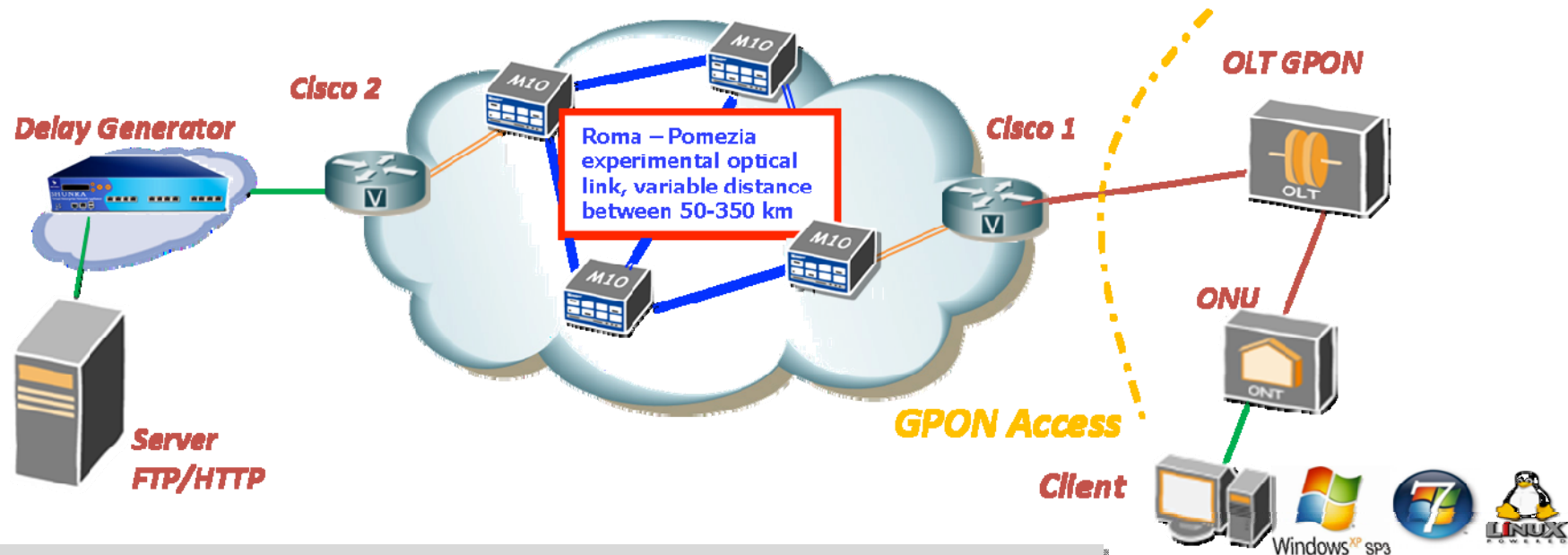
Broadband evaluation problems

FUB-ISCTI test bed



Test bed design

Access Network infrastructure: *Gigabit Passive Optical Network*

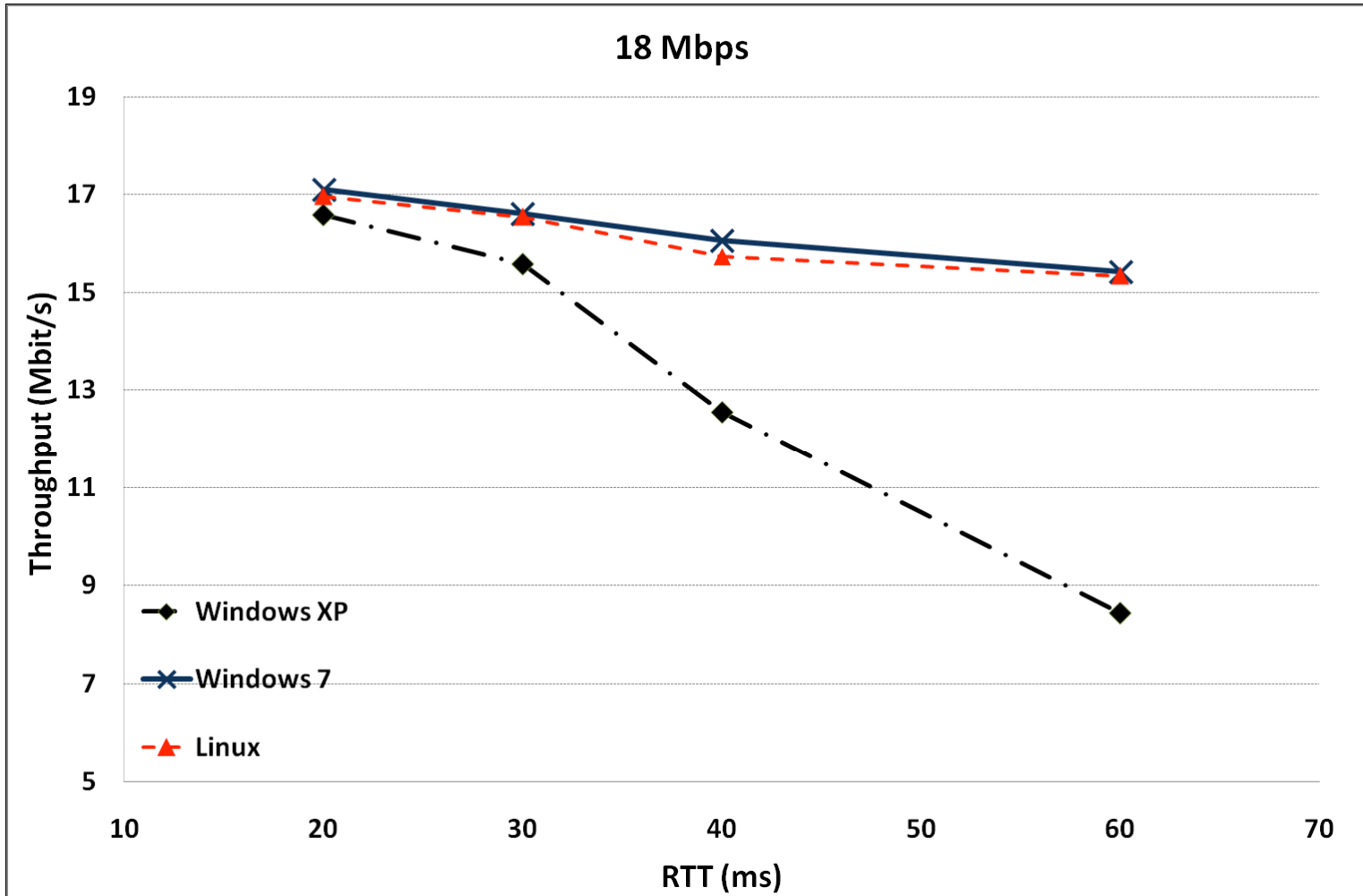


End-to-End bandwidth is guaranteed by mean of a reservation technique employing MPLS LSP features within the network cloud

A Delay Generator allows to reproduce any Round Trip Time conditions

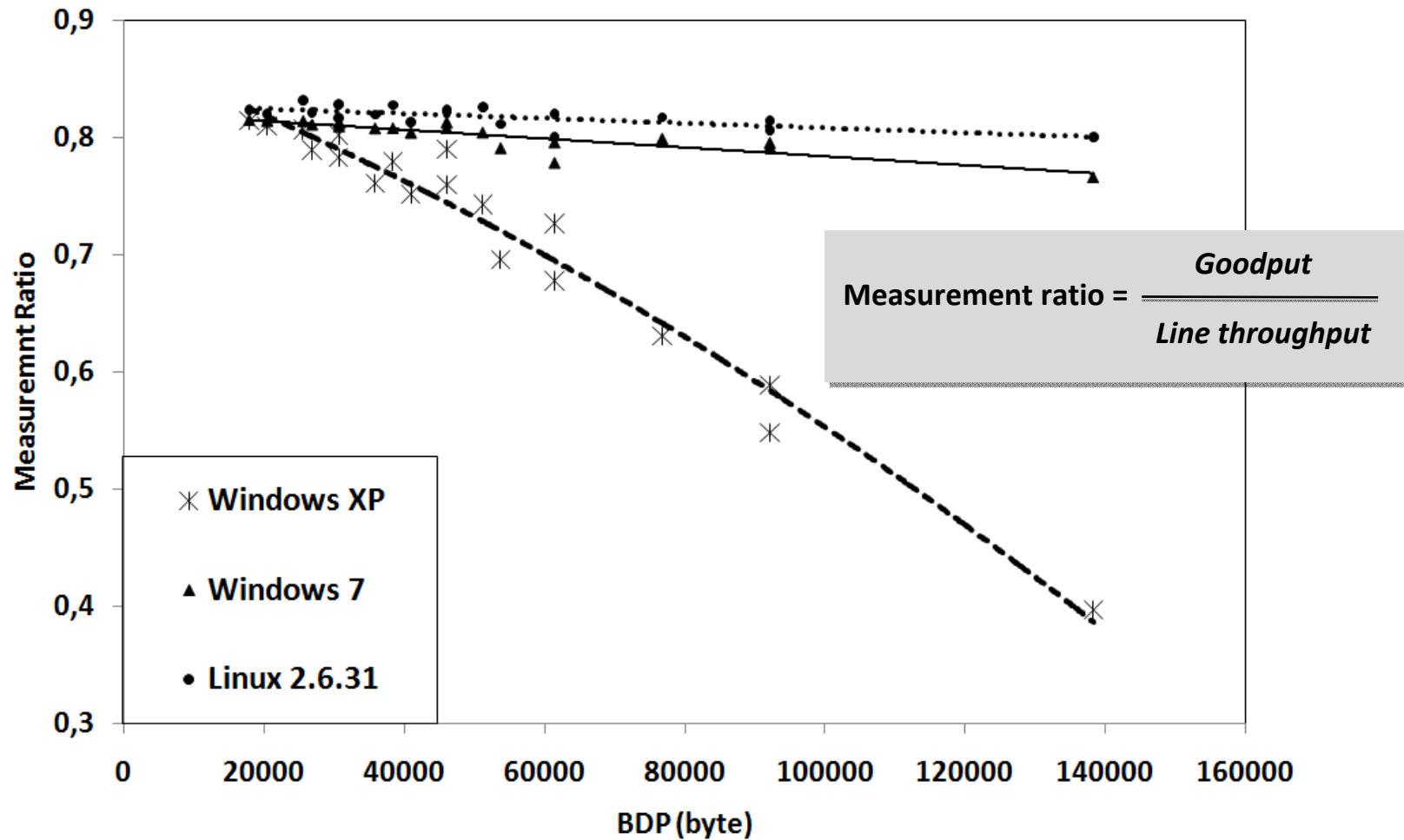
Experimental results

GPON with 128 users -> 18 Mbit/s



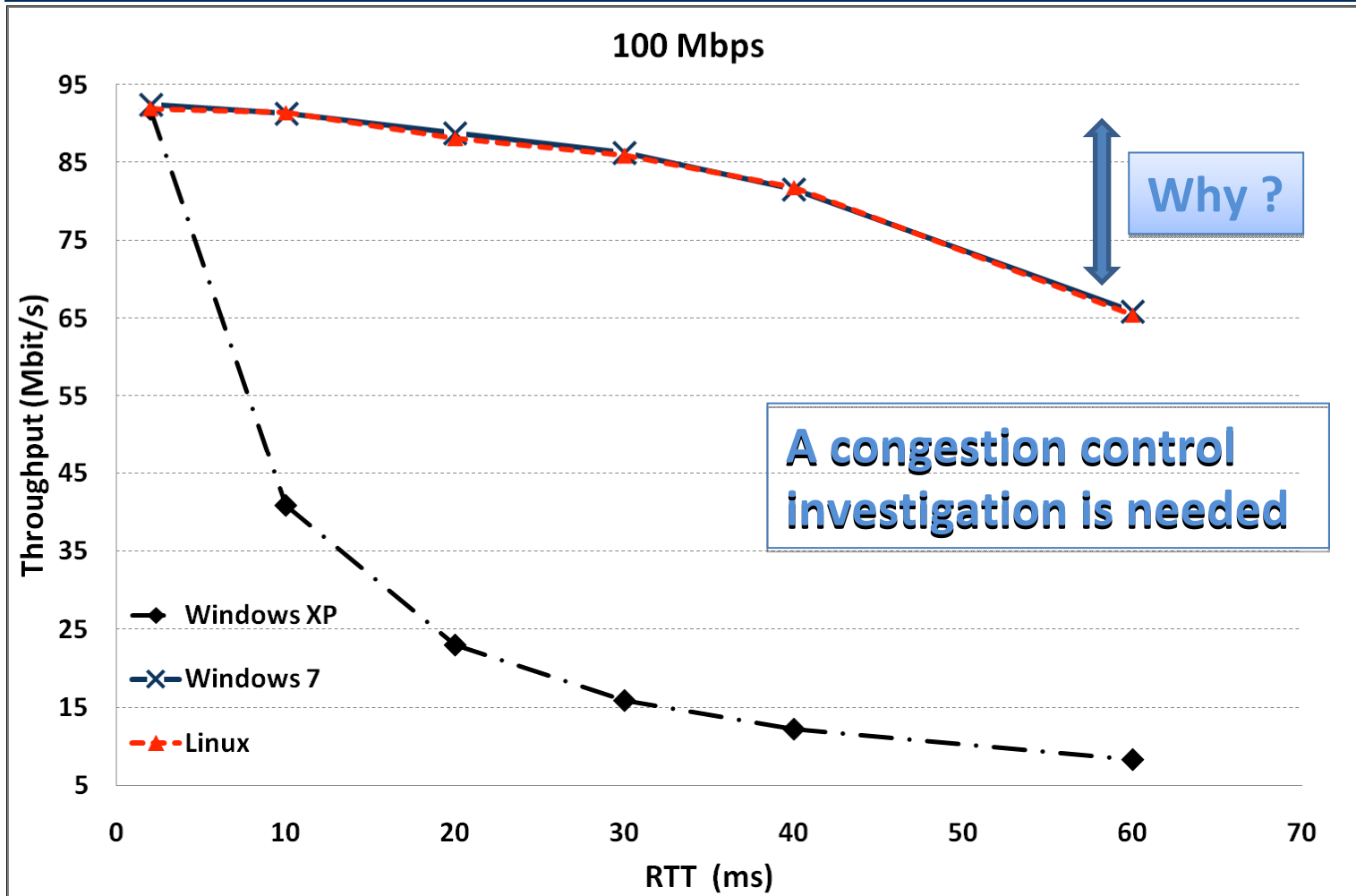
Experimental results

Measurement ratio



Experimental results

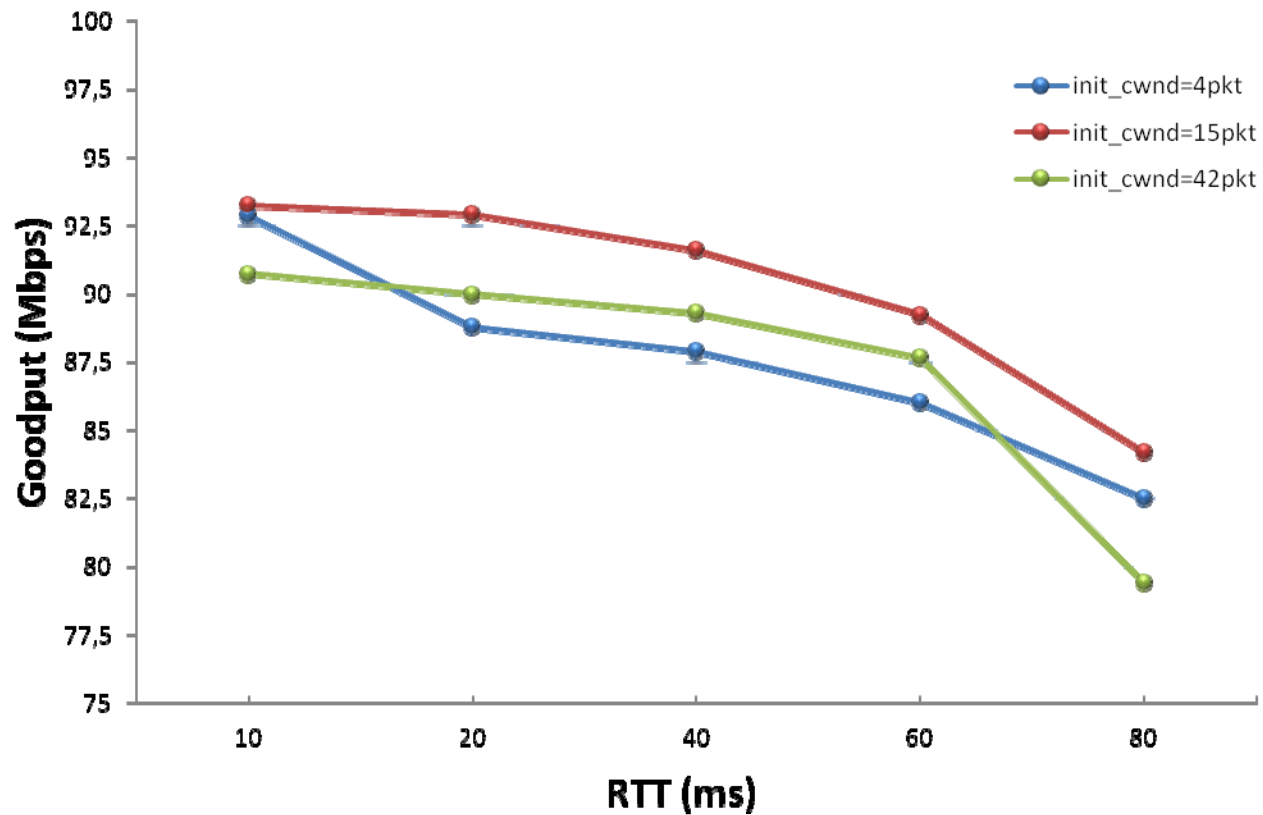
GPON with 32 users -> 100 Mbit/s



Experimental results

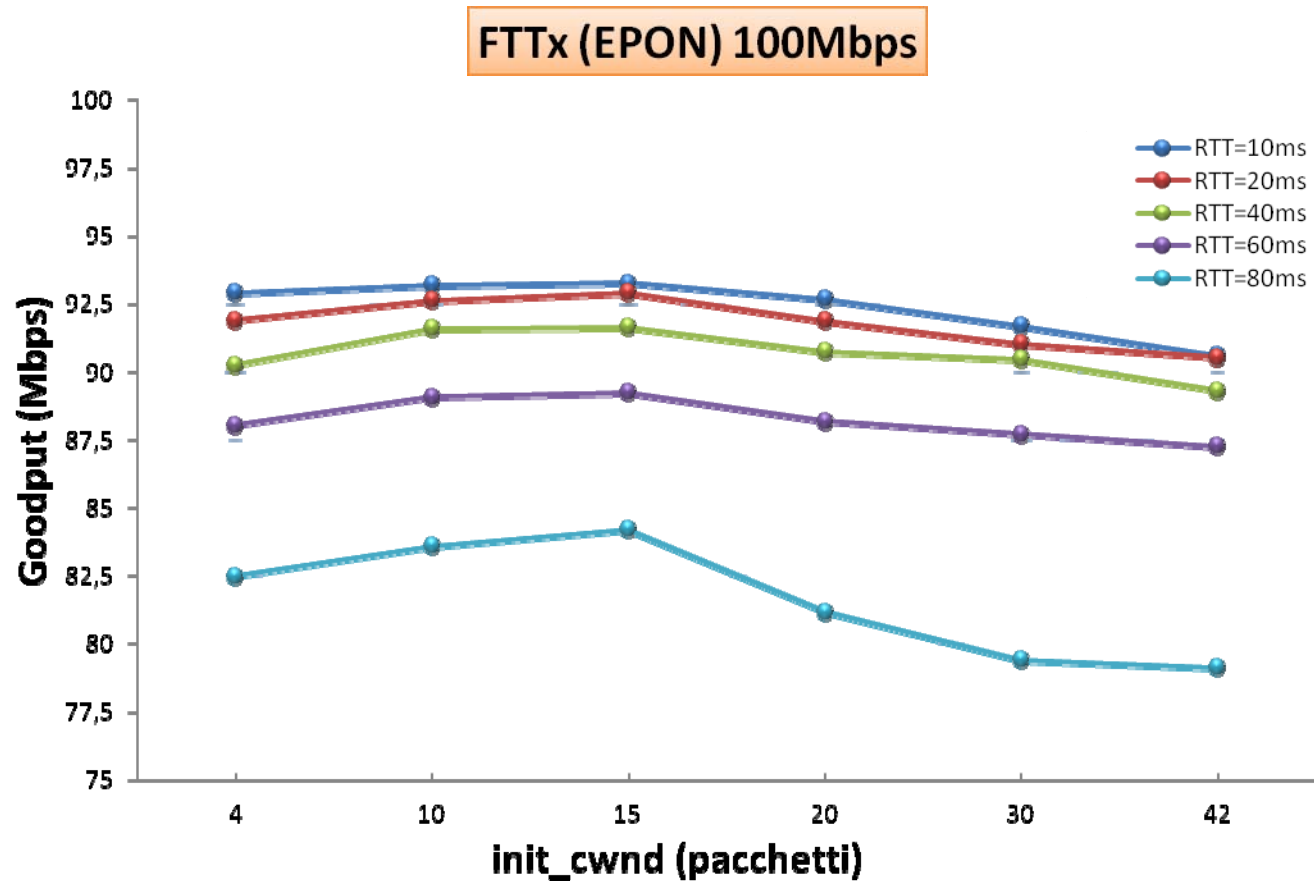
Measured Goodput FTP

FTTx (EPON) 100Mbps



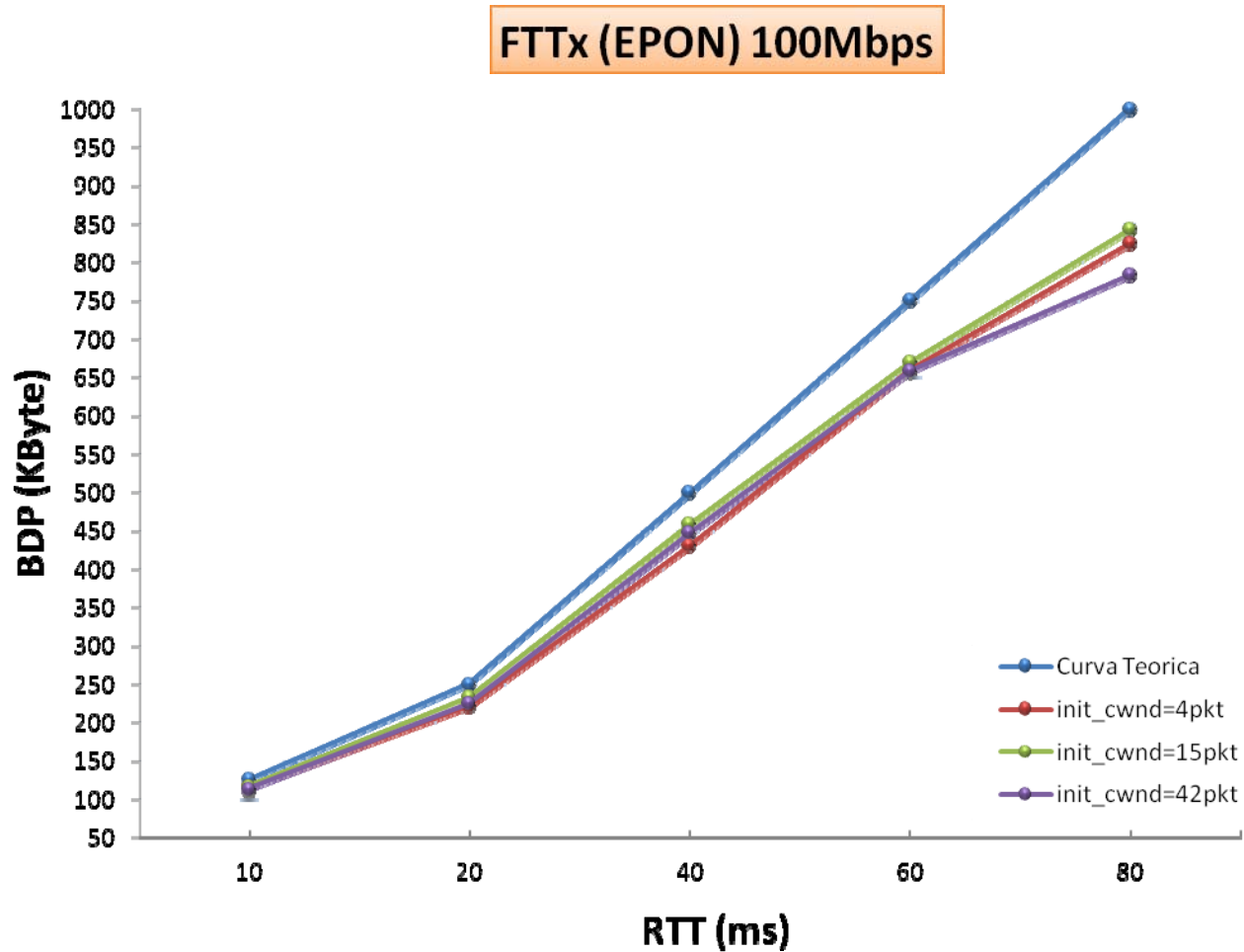
Experimental results

Measured Goodput FTP



Experimental Results

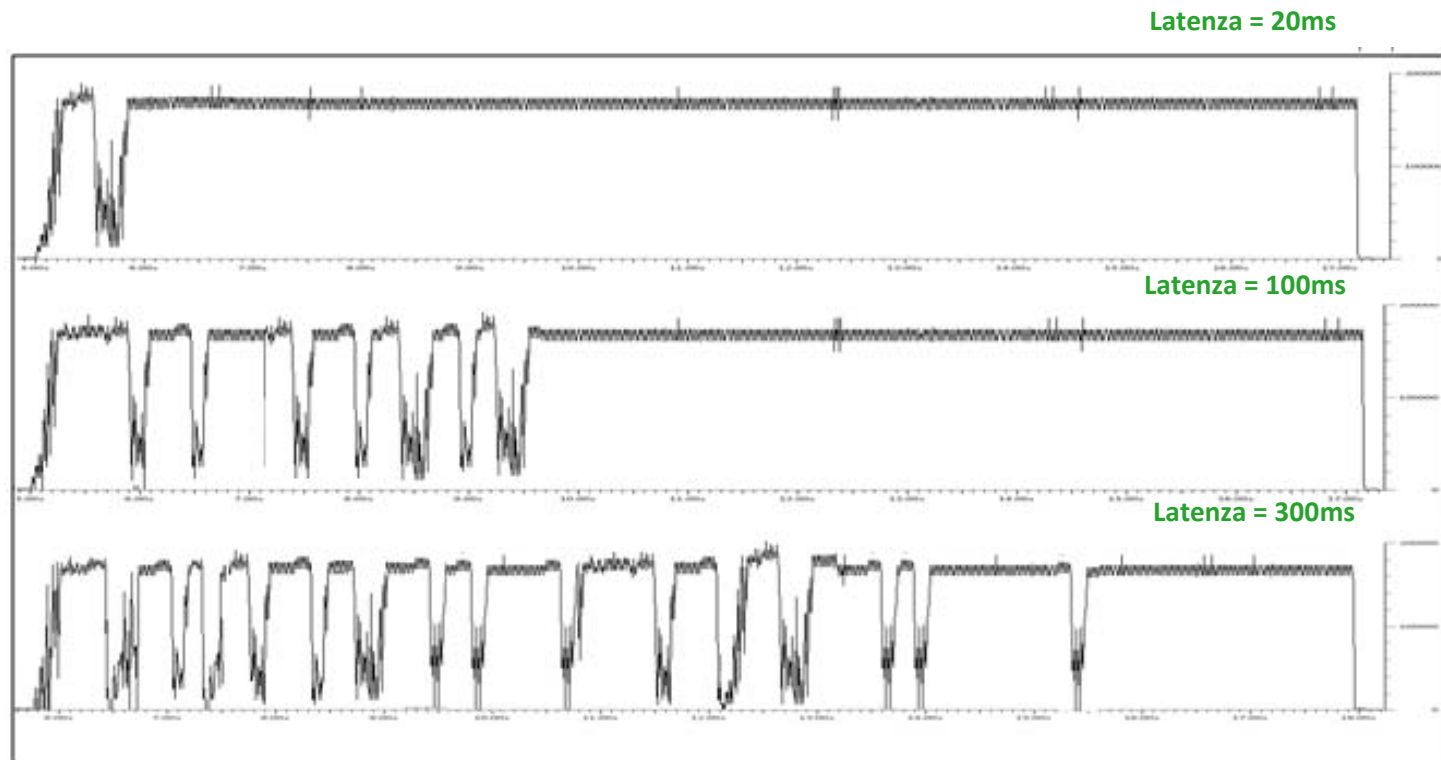
BDP vs init c_wnd



Experimental results

Outsending data

init_cwnd=4pkt
EPON 100Mbps



Conclusions

- We demonstrate the dependence of the QoS on the operating systems and the differences due to the operating systems increase with user bit rates
- A reduction of throughput, with respect to the nominal one, equal to 50 % for 18 Mbit/s profile, and equal to 90% for 100 Mbit/s profile
- Users could be strongly limited in the exploitation of the bandwidth, and such limitation is much relevant in case of optical access networks that should permit very wide bandwidth
- A testing scenario for FTTx accesses needs to be described not only according to the physical parameters, but also paying attention to software implementation factors that could affect the testing results