



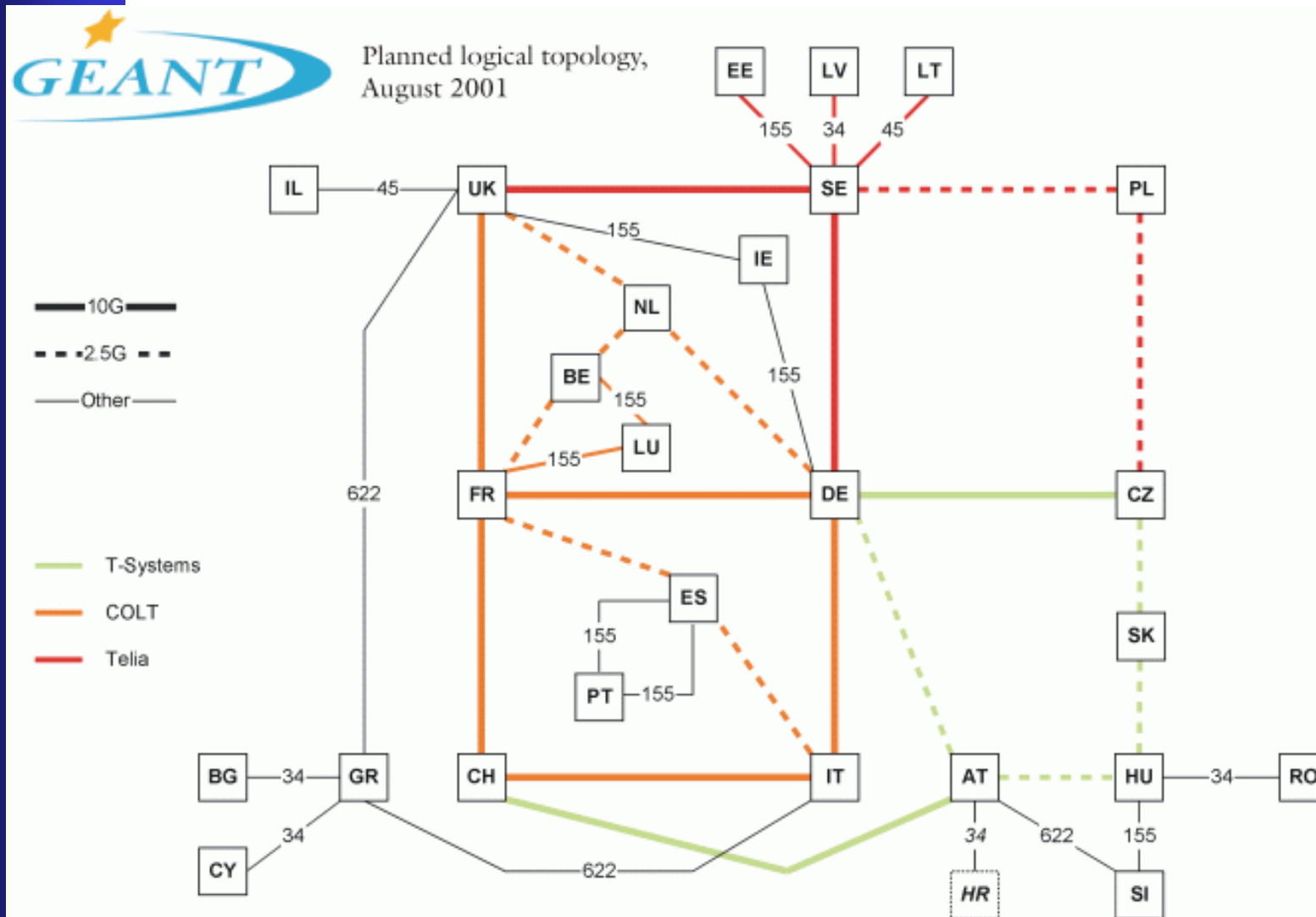
# Anello metropolitano al Gigabit e misure di parametri di QoS end-to-end

**Stefano Giordano**

**Tango Project – WP2**  
**7-8 Luglio 2003, Cefalù**



# The European GEANT Project



# The Italian National Research Network in Italy: GARR-G



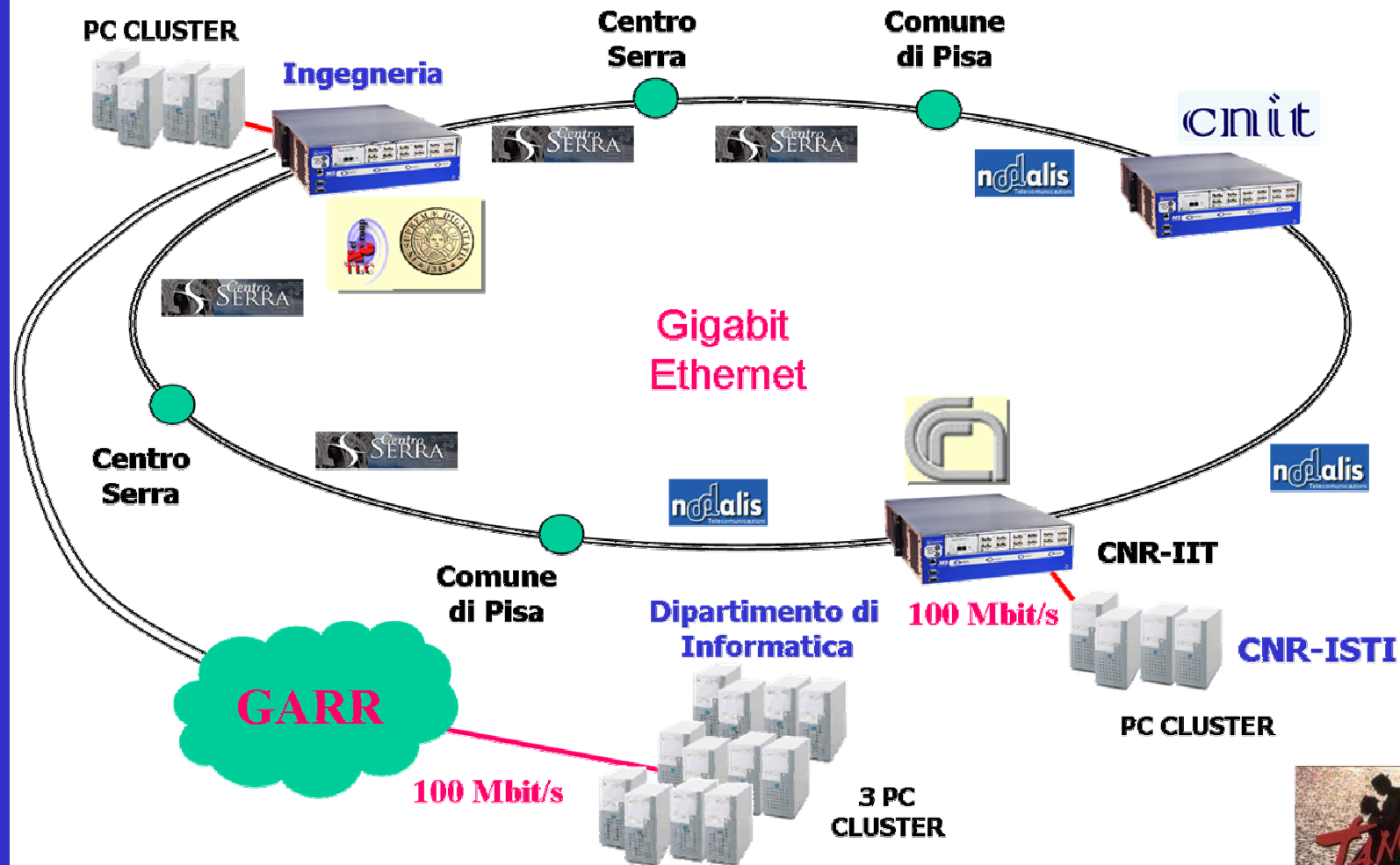
2.5 Gigabit/s



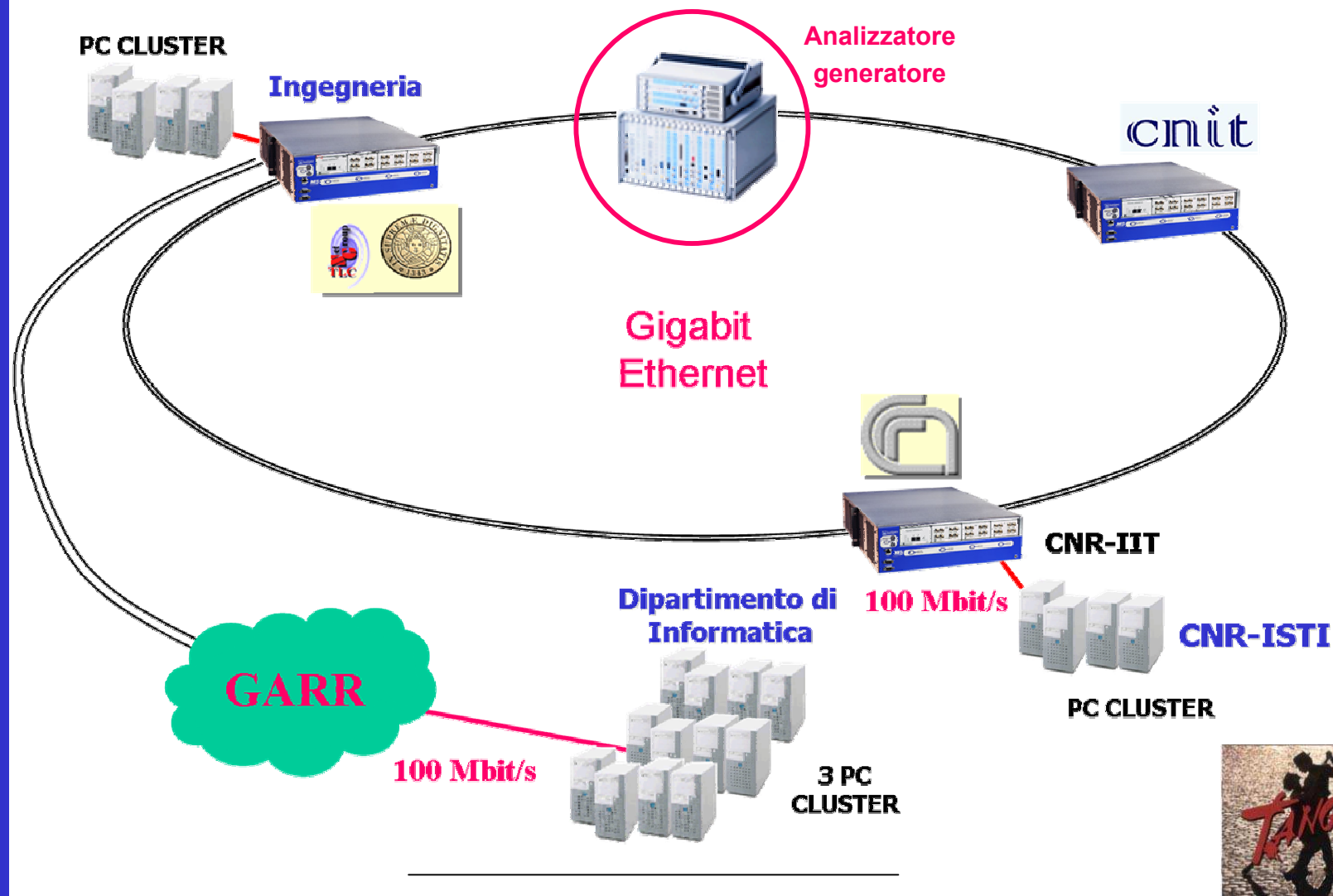
2.5 Gigabit/s



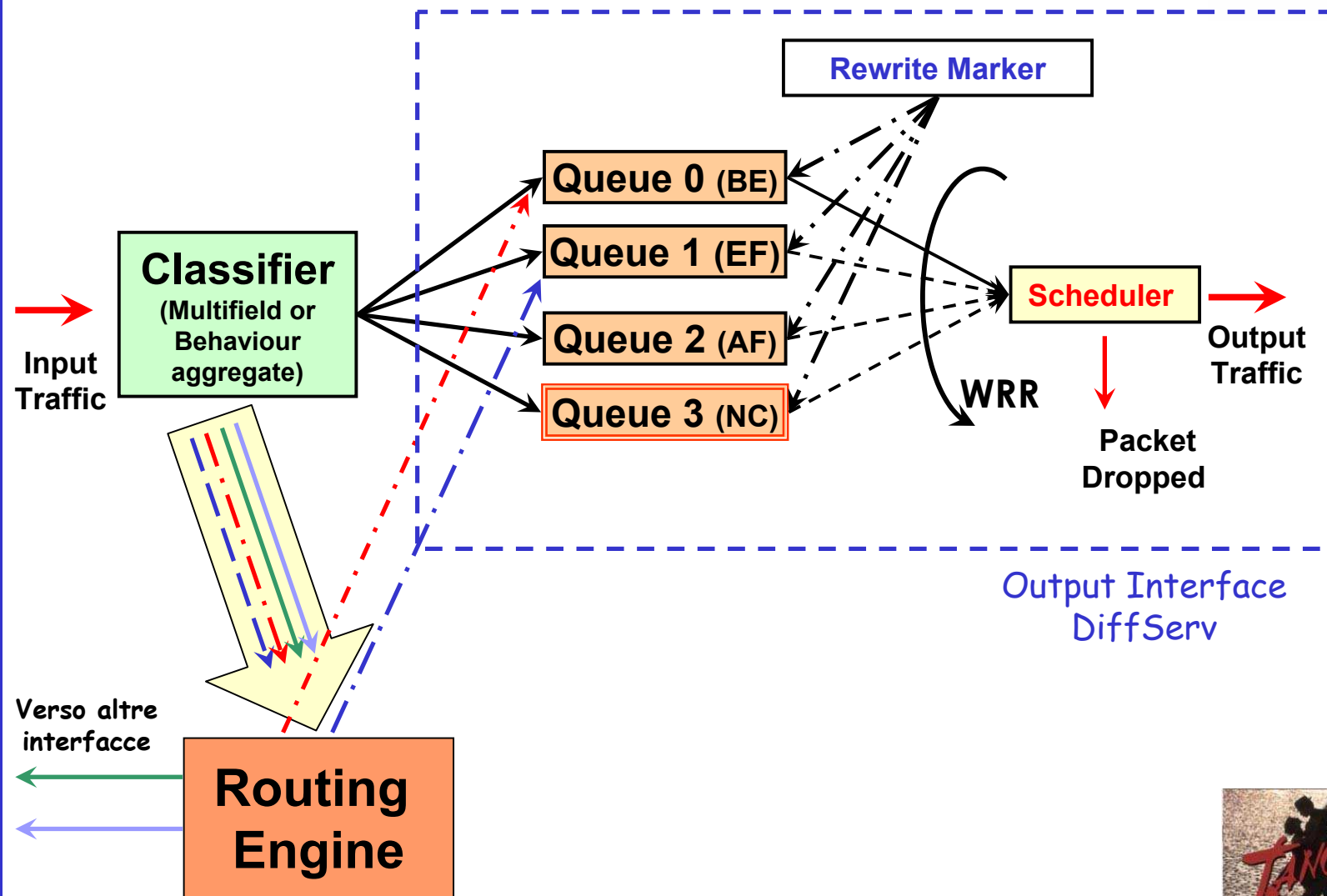
# Rete al Gigabit/s in area metropolitana



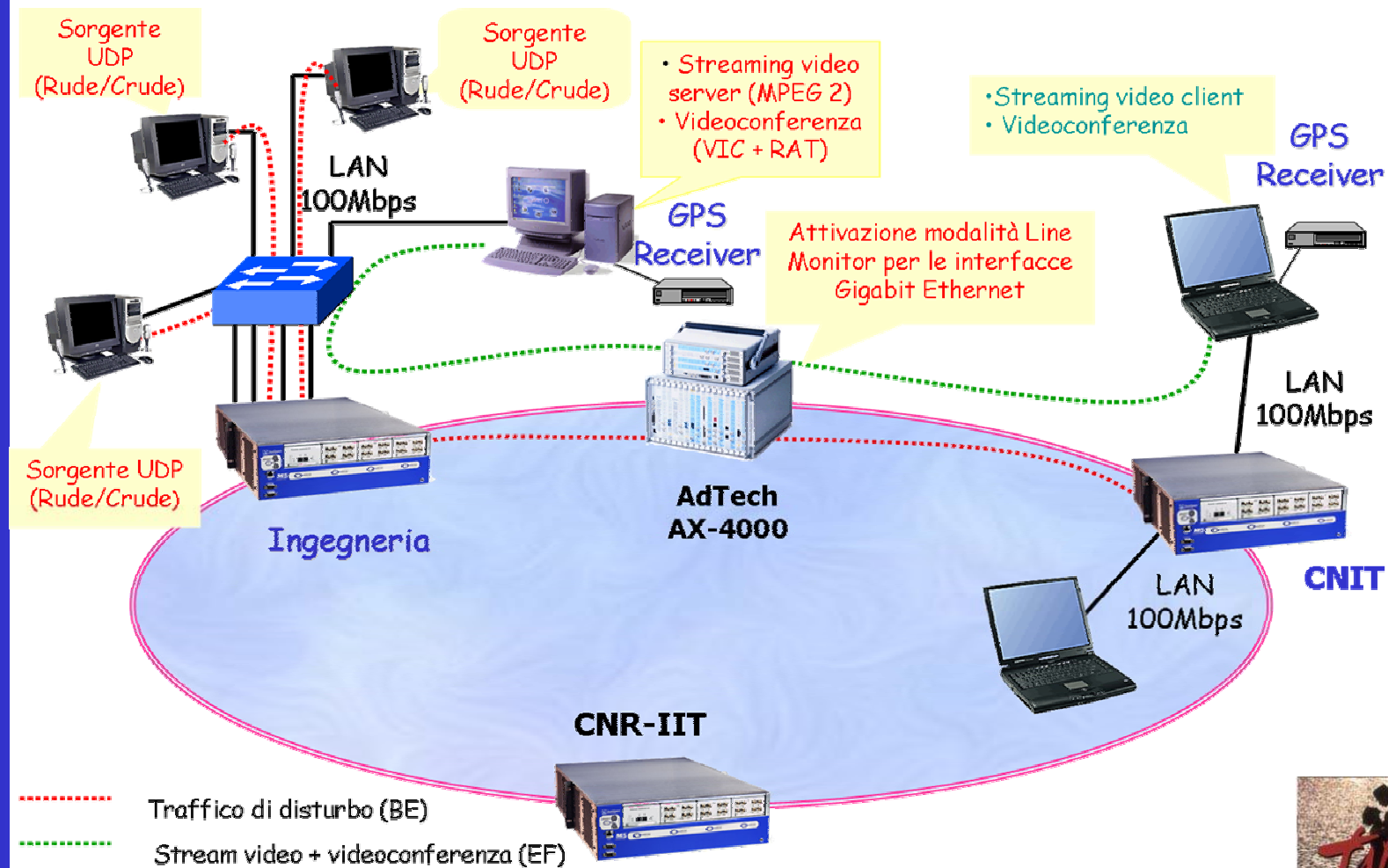
# Scenario di misura



# Schema Diffserv Router M10



# Misure QoS in ambito Diffserv



# Parametri QoS



I parametri misurabili in questo scenario sono:

- One-way delay
- Delay jitter
- Packet Loss
- Throughput

Sincronizzazione GPS



Ricevitore GPS Motorola Ut+ Oncore  
Linux kernel 2.4.16 + patch PPSkit 2.0.1

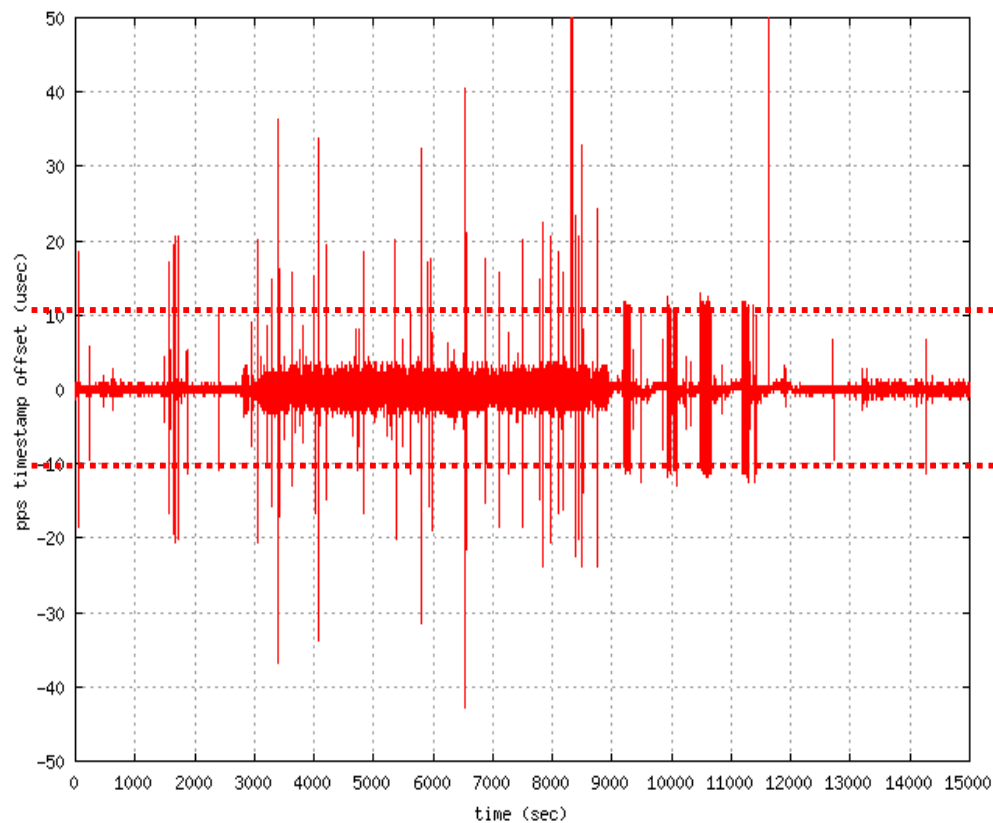




# Sincronizzazione



- Pulse per Second timestamp offset ( $\mu\text{sec}$ ) vs Time (sec)



**Max Error**  
**10  $\mu\text{s}$**

10  $\mu\text{s}$

-10  $\mu\text{s}$



# Test effettuati



- Constant Bit Rate (CBR)
  - End-to-end delay, jitter e packet loss per traffici CBR
    - Al variare del rate in ingresso
    - Al variare del maximum\_buffer\_delay in situazione di congestione sulla classe EF
    - Al variare della dimensione dei pacchetti in situazione di congestione sulla classe EF
- Variable Bit Rate (VBR)
  - End-to-end delay per traffici reali ( VIC, RAT)
    - Al variare del maximum\_buffer\_delay



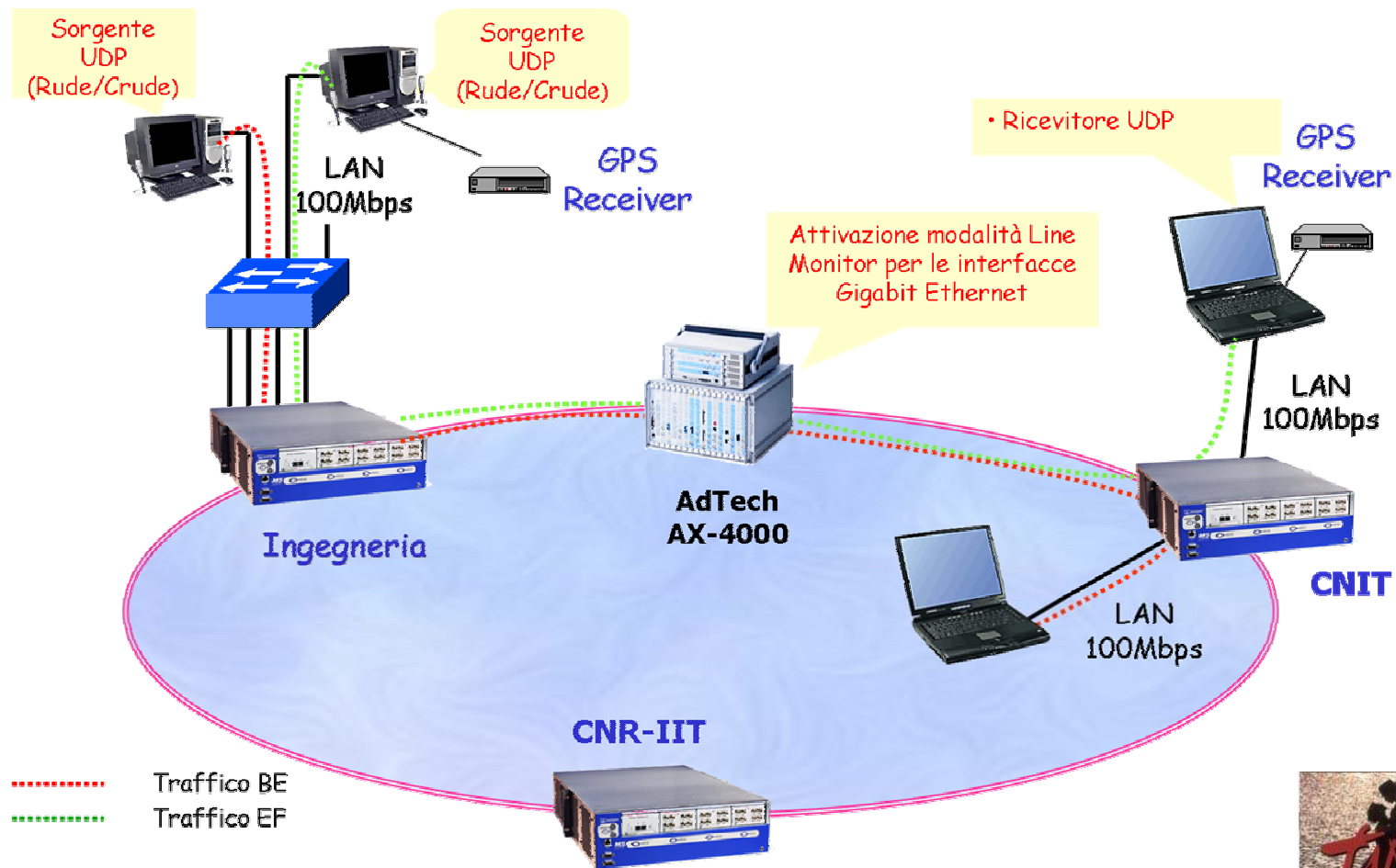
# Constant Bit Rate



- Obiettivo
  - Valutare come variano delay, jitter e packet loss della classe EF con la variazione di bit rate di traffici CBR
- Caratteristiche
  - Traffico EF
    - Generatore di traffico: RUDE
    - Dimensione dei pacchetti fissa (512 byte)
    - Bit/rate fissa (1Mbps, 2Mbps, 4Mbps, 8Mbps, 10.5Mbps)
    - Parametri dello scheduler WRR per la classe EF sul router:
      - Service-rate: 10Mbps exact
  - Traffico BE
    - Generatore di traffico: RUDE
    - Bit/rate: 100 Mbps
    - Dimensione dei pacchetti fissa: 512 bytes
    - Parametri dello scheduler WRR per la classe BE sul router
      - Service-rate: 100Mbps exact



# Constant Bit Rate (2)



# Constant Bit Rate (3)



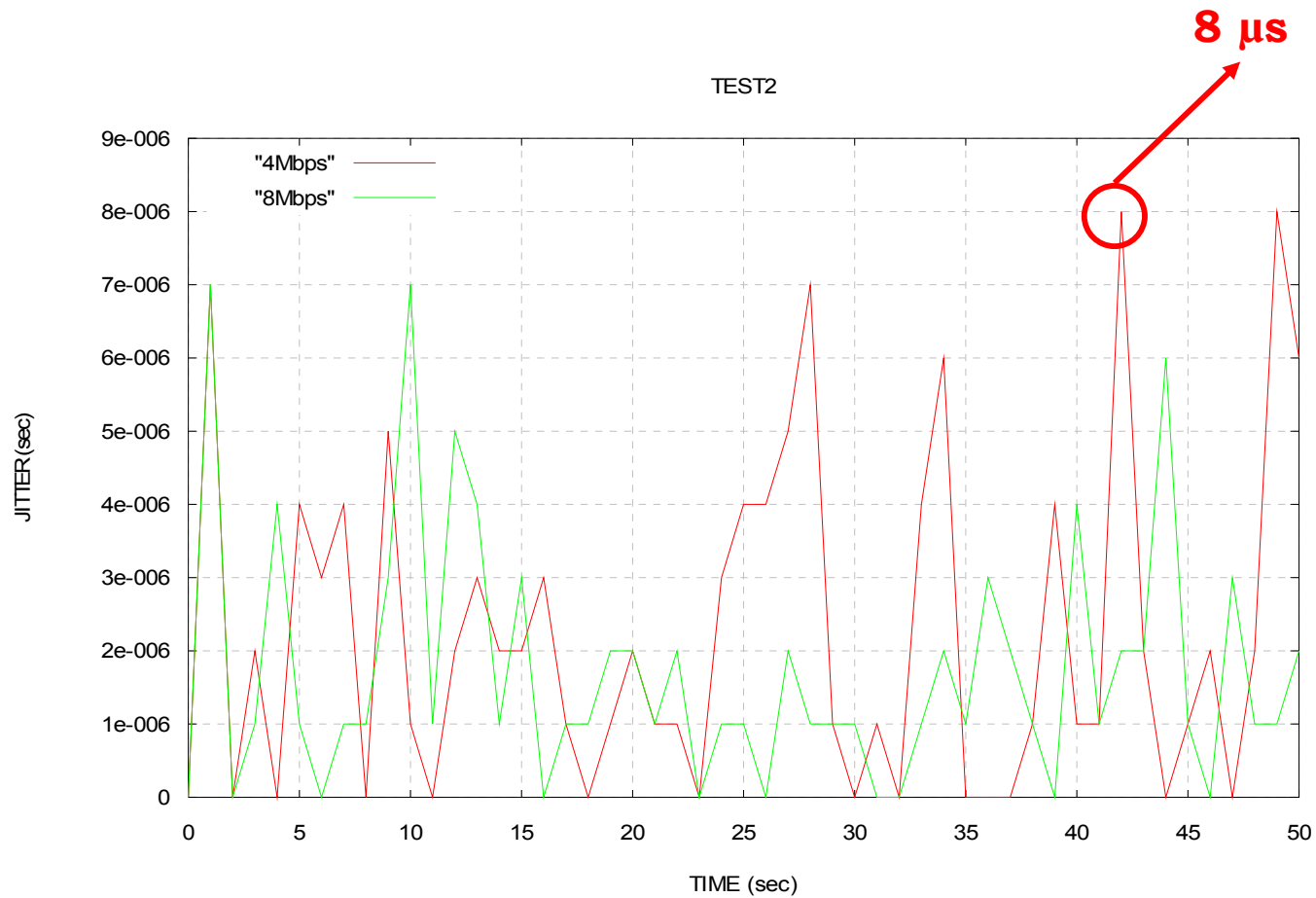
- Delay (sec) vs Time (sec)



# Constant Bit Rate (4)



- Jitter (sec) vs Time (sec)



# Constant Bit Rate (5)



Cosa accade se il rate del traffico in ingresso satura la banda associata dallo scheduler alla classe di servizio ?



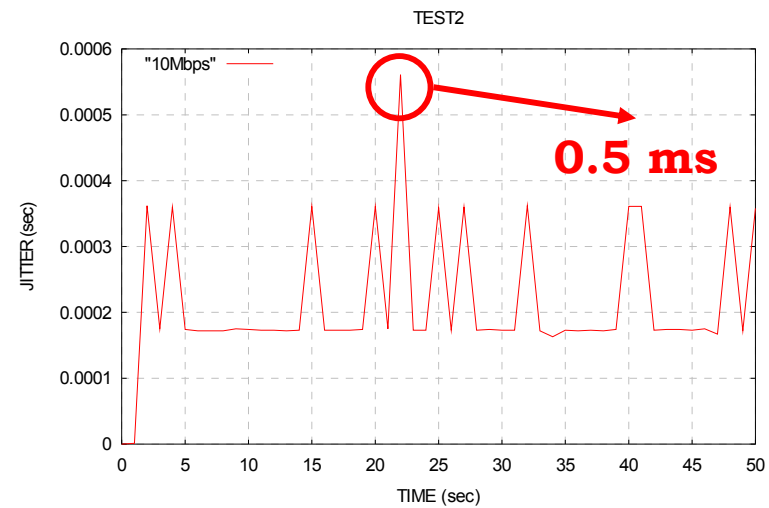
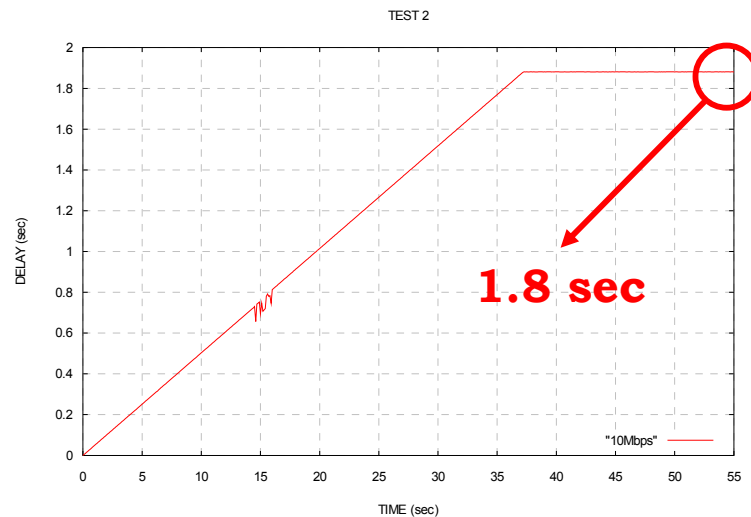
Aumento del delay in relazione al max buffer delay



Aumento di jitter e pacchetti persi in relazione alla dimensione dei pacchetti



# Constant Bit Rate (6)



- Delay (sec) vs Time (sec)

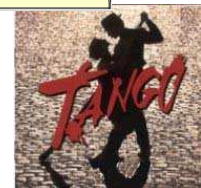
Maximum\_buffer\_delay: 10%

Packet size: 512 byte

Rate 10.5 Mbit/s

- Jitter ( $\mu$ sec) vs Time (sec)

Bit Rate (Mbps)	Mean (s)	Std. Dev. (s)
1	3.7E-6	8E-6
2	3.8E-6	8.2E-6
4	2.5E-6	6E-6
8	2E-6	5.4E-6
10.5	0.00025	0.0001

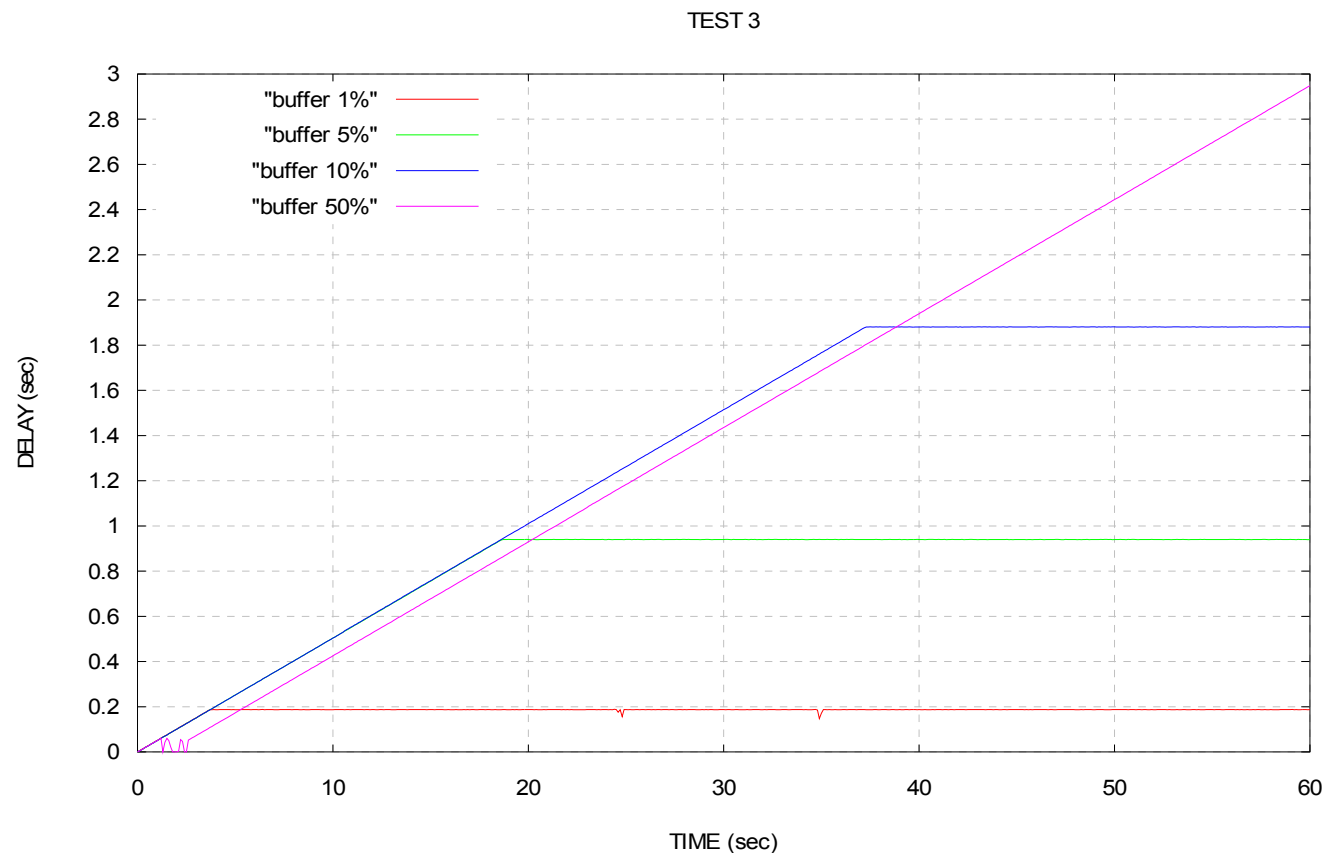




# Constant Bit Rate (7)



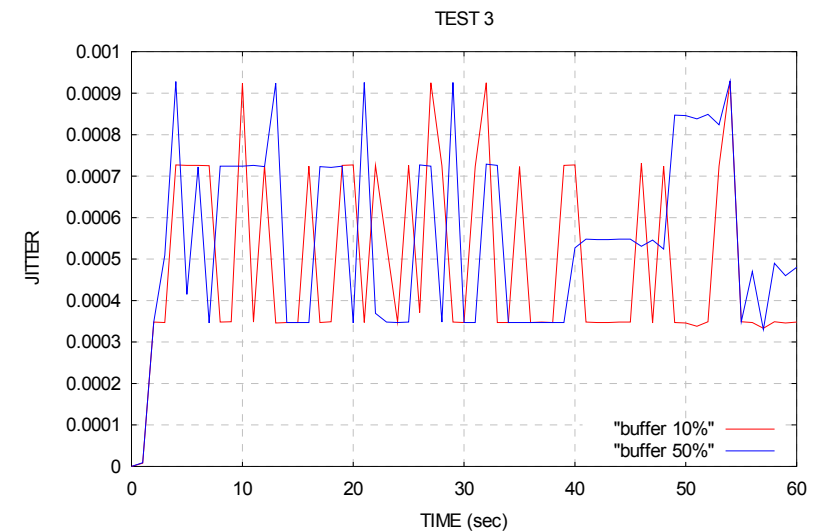
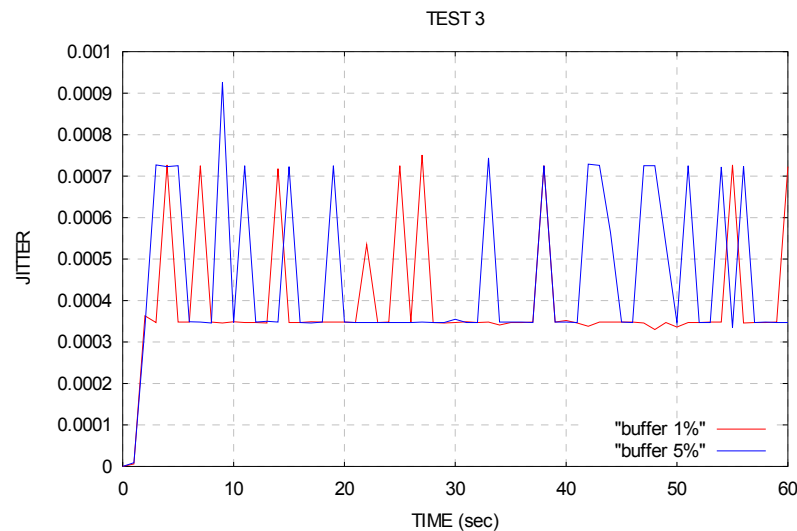
- Delay (sec) vs Time (sec) al variare del max\_buffer\_delay  
Packet size: 512 byte; Rate 10.5 Mbit/s



# Constant Bit Rate (8)



- Jitter (sec) vs Time (sec) al variare del max\_buffer\_delay  
Packet size: 512 byte; Rate 10.5 Mbit/s



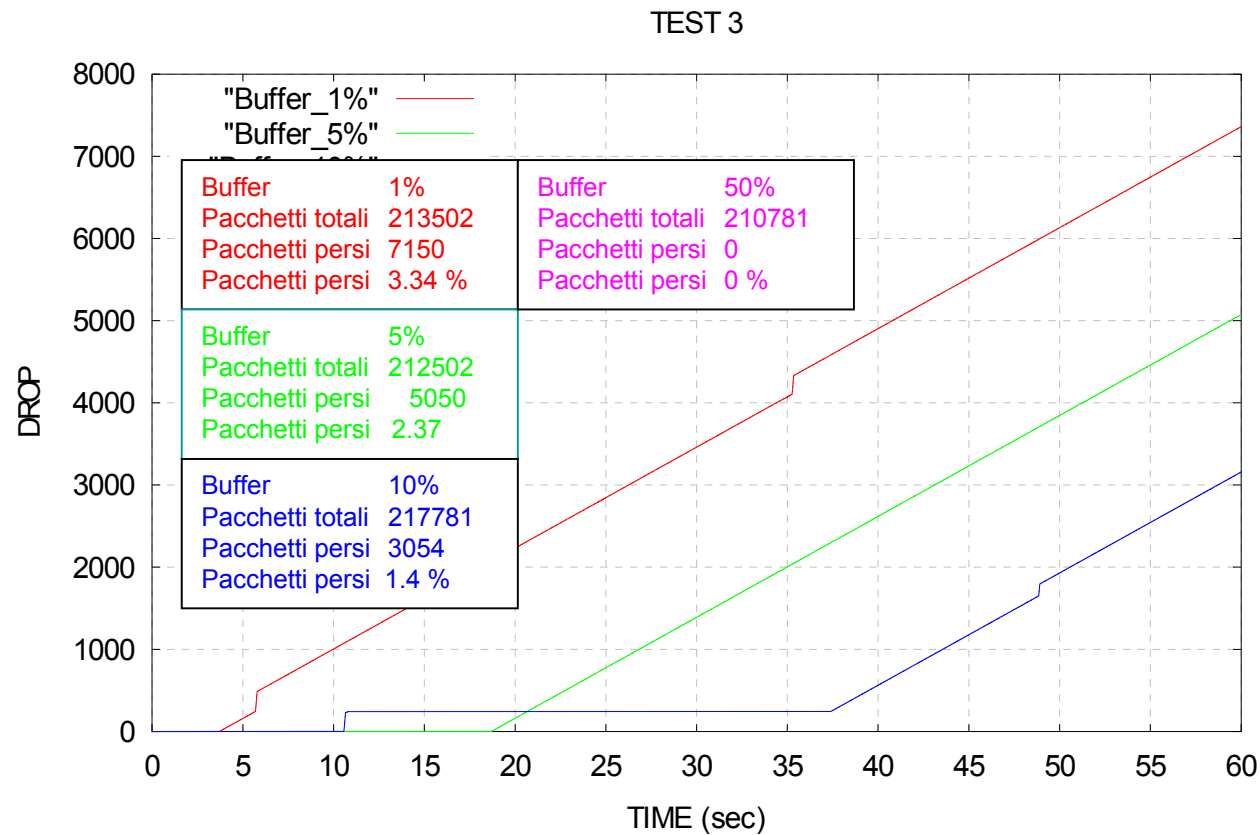
Buffer Size	Mean (s)	Std. Dev. (s).
1%	0.0005 s	0.0003
5%	0.00045 s	0.00025
10%	0.00057 s	0.00032
50%	0.00053 s	0.00033



# Constant Bit Rate (9)



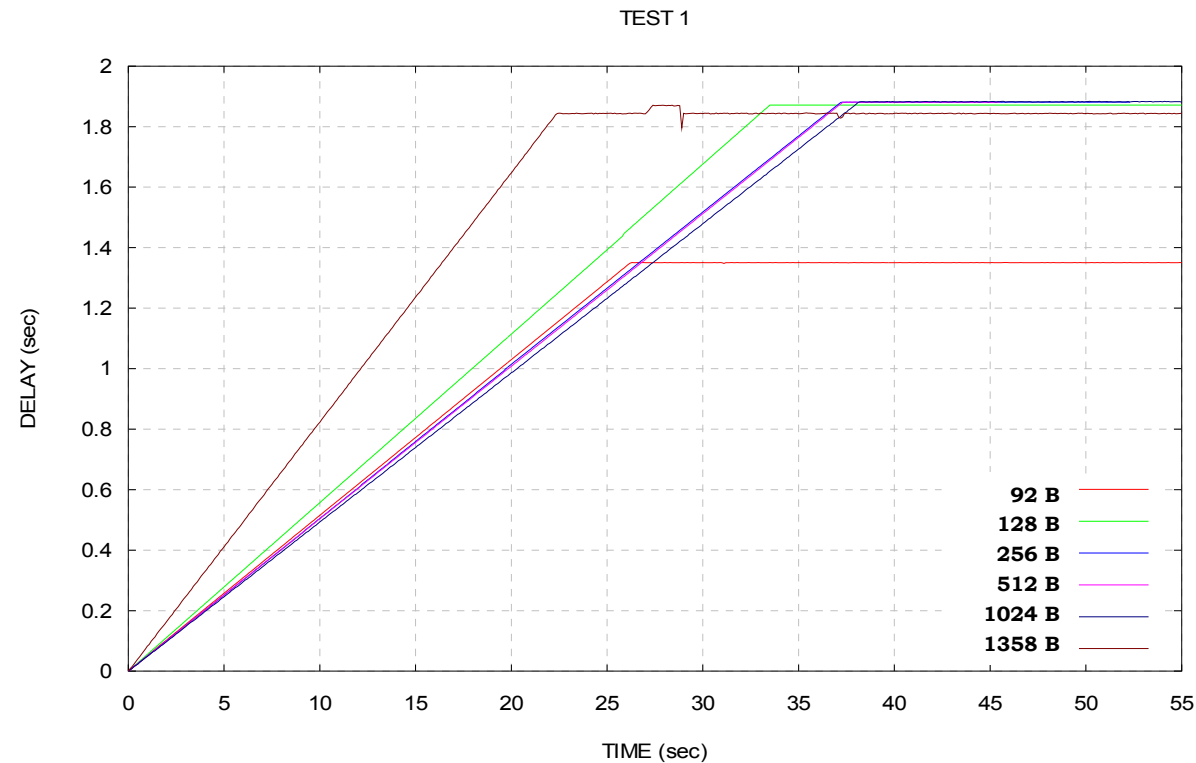
- Packet Loss vs Time (sec) al variare del max\_buffer\_delay  
Packet size: 512 byte; Rate 10.5 Mbit/s



# Constant Bit Rate (10)



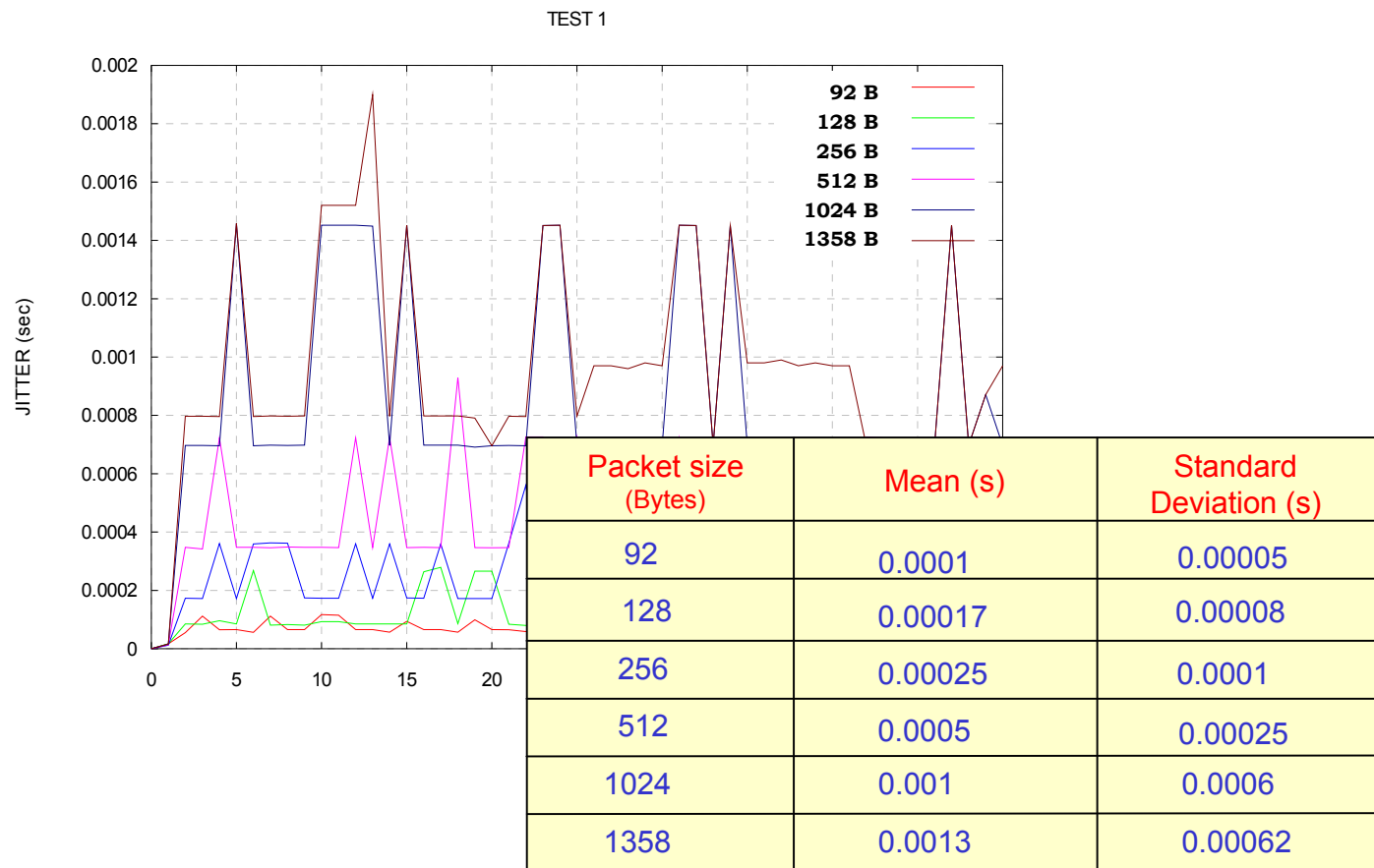
- Delay (sec) vs Time (sec) al variare della dimensione dei pacchetti  
max\_buffer\_delay: 10%; Rate 10.5 Mbit/s



# Constant Bit Rate (11)



- Jitter ( $\mu\text{sec}$ ) vs Time (sec) al variare della dimensione dei pacchetti; max\_buffer\_delay: 10%; Rate 10.5 Mbit/s



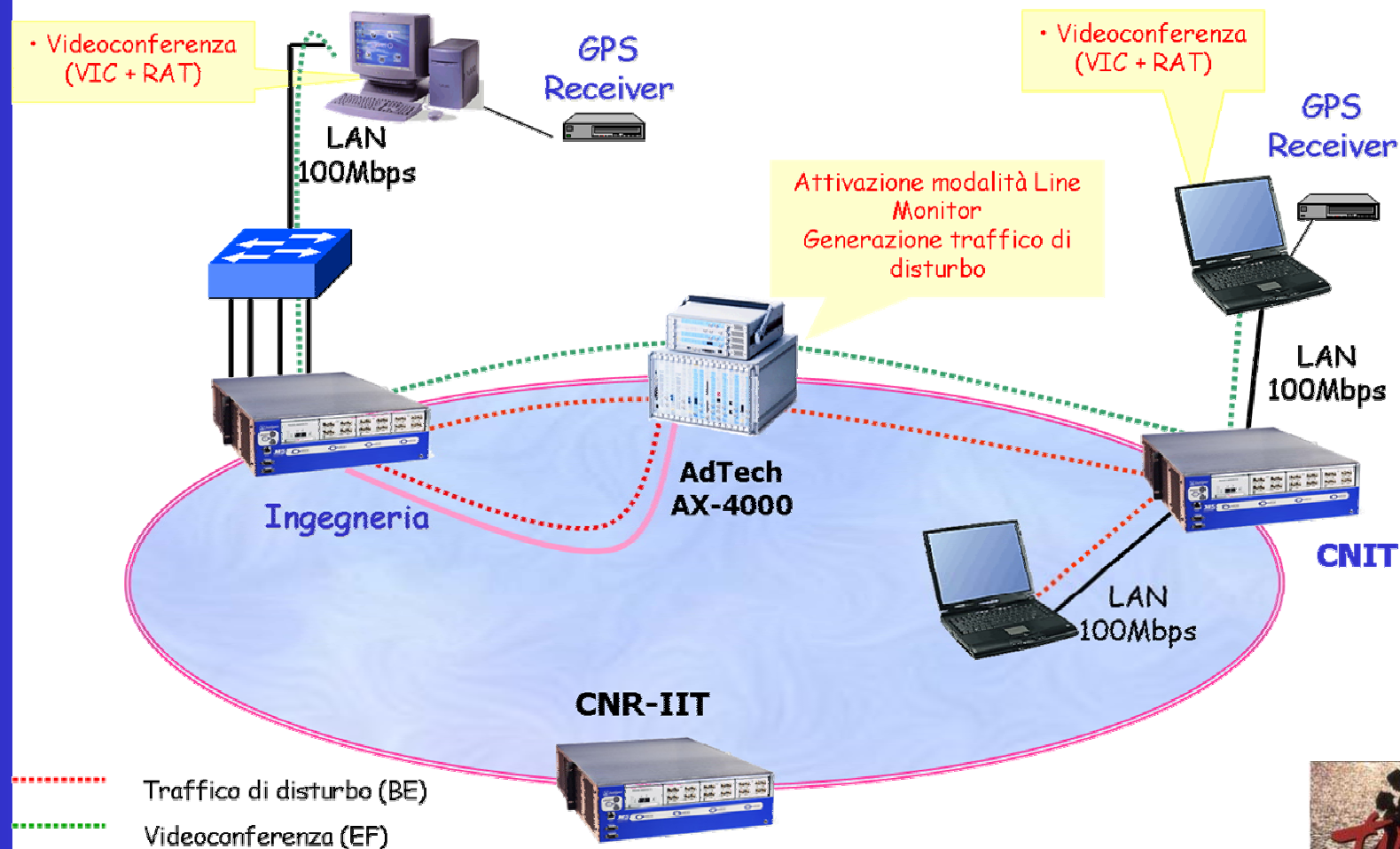
# Variable Bit Rate



- Obiettivo
  - Valutare come varia il delay della classe EF con un traffico a bit rate variabile (traffico reale) al variare delle dimensioni della coda
- Caratteristiche
  - Traffico EF
    - Generatore di traffico: VIC/RAT
    - Dimensione dei pacchetti fissa: variabile (VIC); 658 byte (RAT)
    - Bit/rate variabile
    - Parametri dello scheduler WRR per la classe EF sul router:
      - Service-rate: 8 Mbps exact, Max-buffer-delay variabile
  - Traffico BE
    - Generatore di traffico: AX4000
    - **Bit/rate: 400 Mbps**
    - Dimensione dei pacchetti fissa: 512 bytes
    - Parametri dello scheduler WRR per la classe BE sul router
      - Service-rate: 400Mbps exact



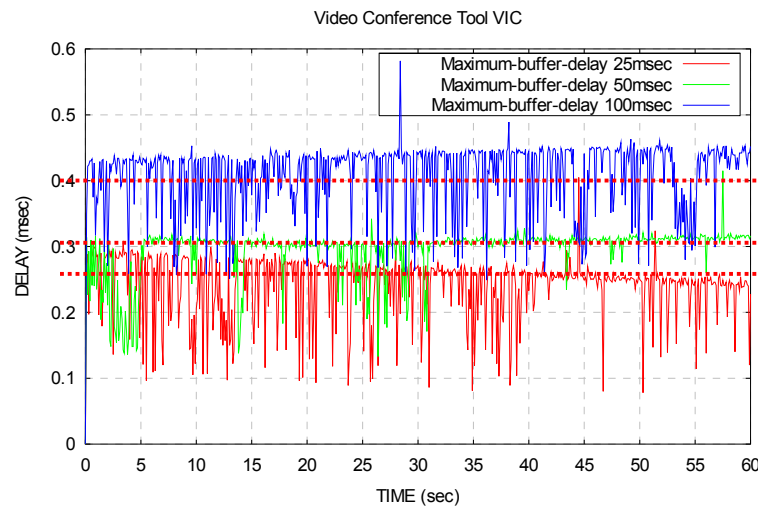
# Variable Bit Rate (2)



# Variable Bit Rate (3)



- Delay (sec) vs Time (sec)

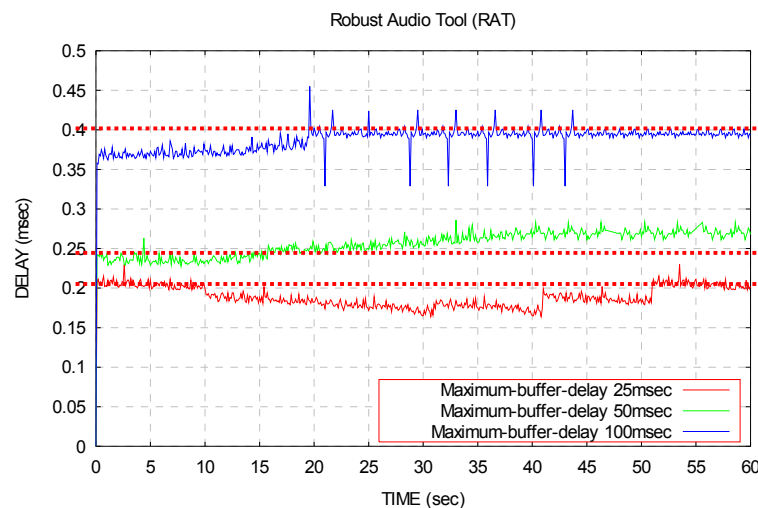


400  $\mu$ s

300  $\mu$ s

250  $\mu$ s

Video Conferencing  
tool



400  $\mu$ s

250  $\mu$ s

200  $\mu$ s

Robust Audio  
Tool

