Pakistan Internet Exchange:
Traffic Prediction and Voice Quality Assessment

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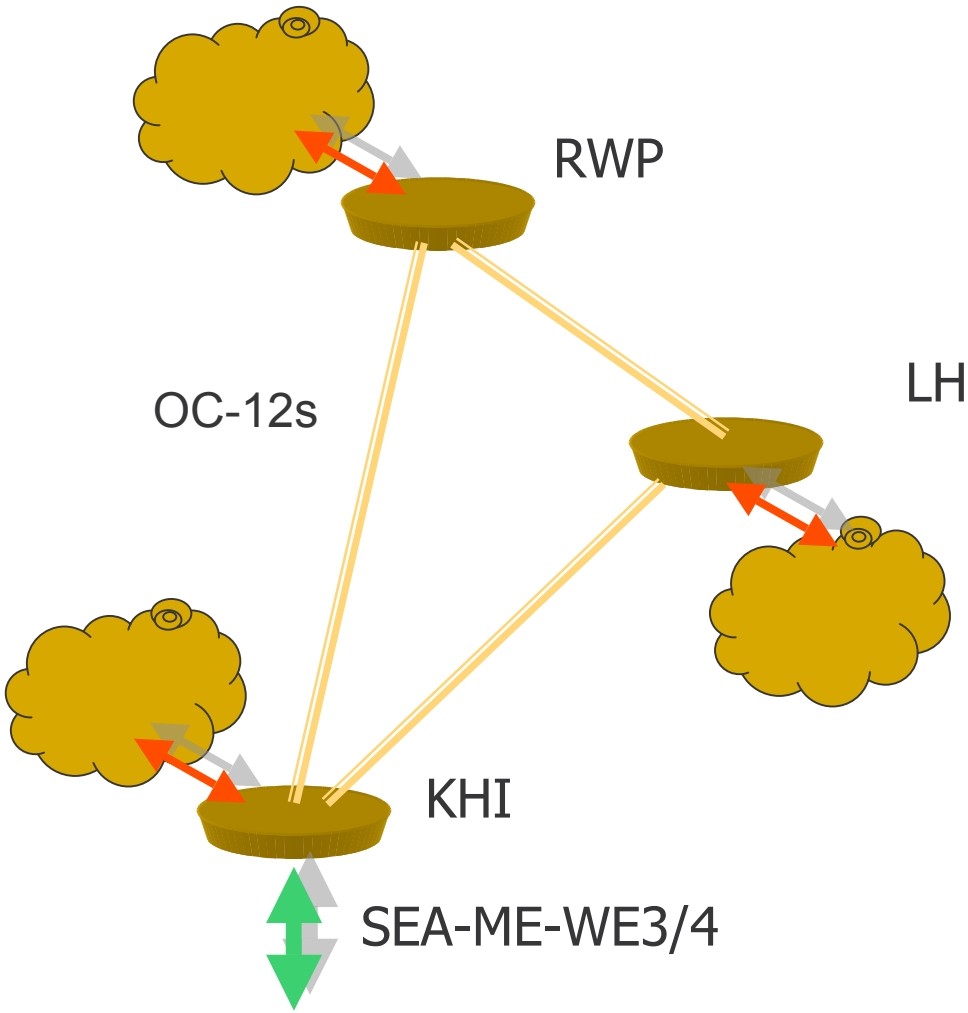
Outline

- Background
  - PIE
  - Motivation
  - Preliminaries
- Our Work
  - i) Traffic Models
  - ii) VoIP quality assessment
  - Conclusions

The Pakistan Internet Exchange ('backbone')

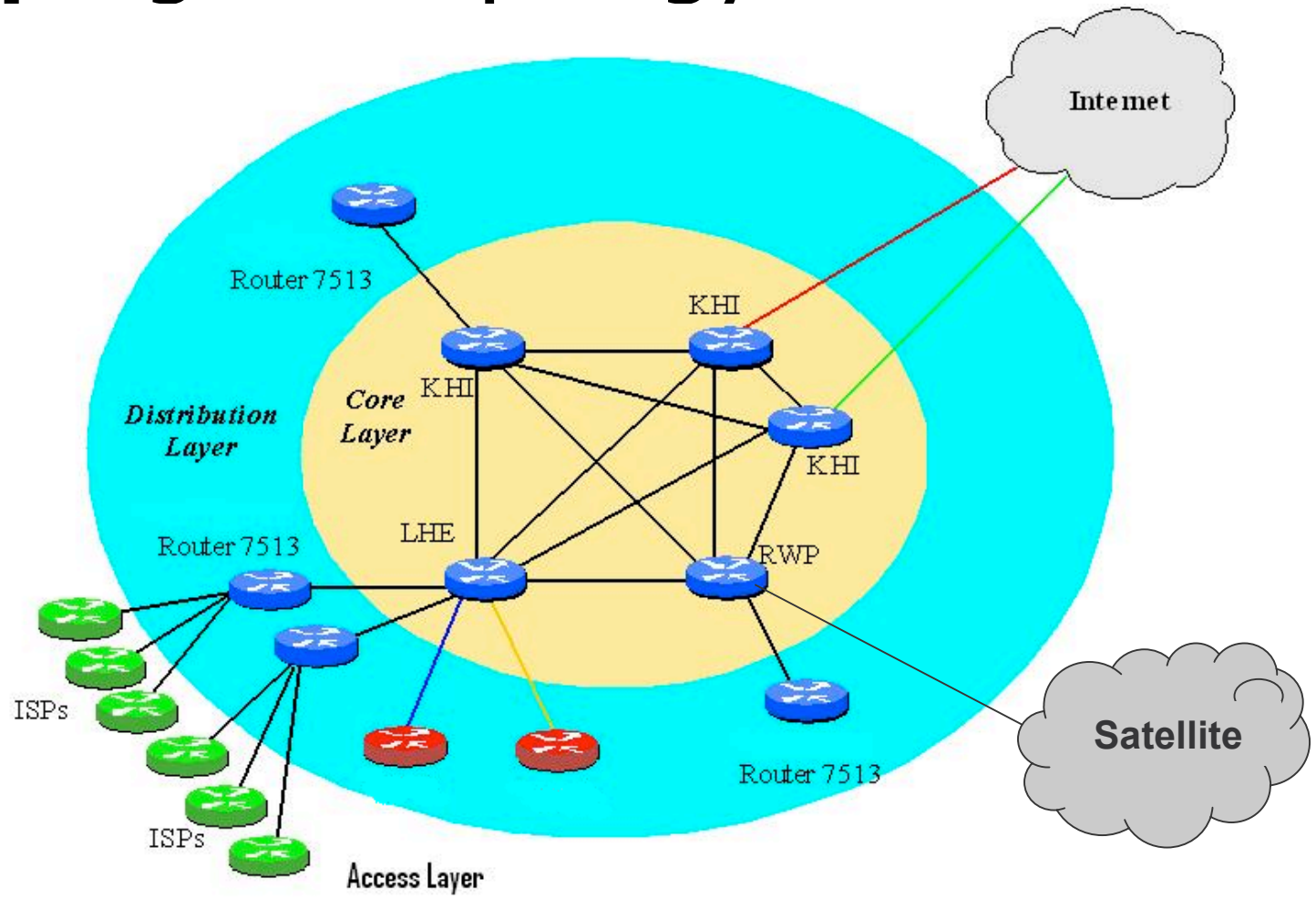


Upstream ISPs

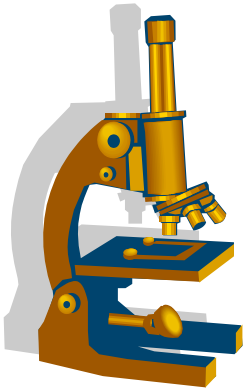
BT, MCI, TIS, STIX, TG

_ 2.33 Gbps

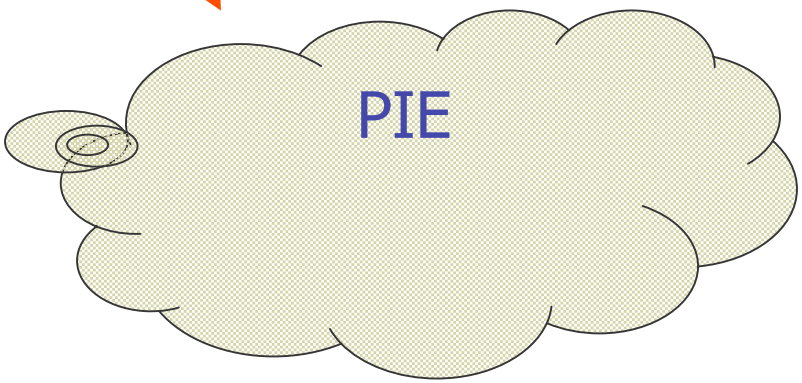
Logical Topology of PIE



Motivation



Traffic Prediction based on current trends is a useful indicator of the growth …

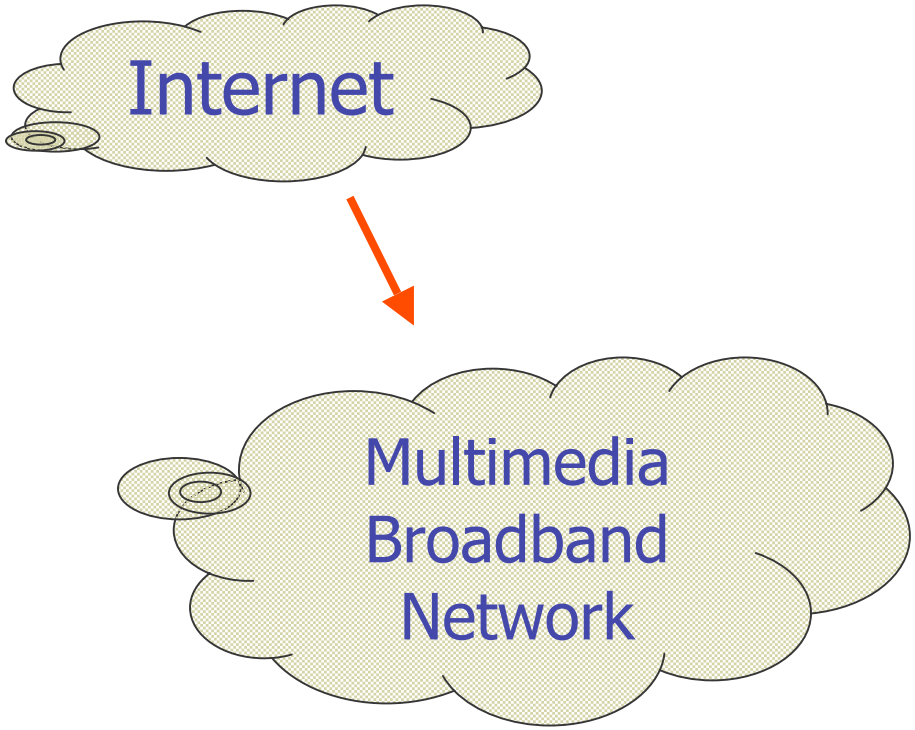


What's out there?

How much?

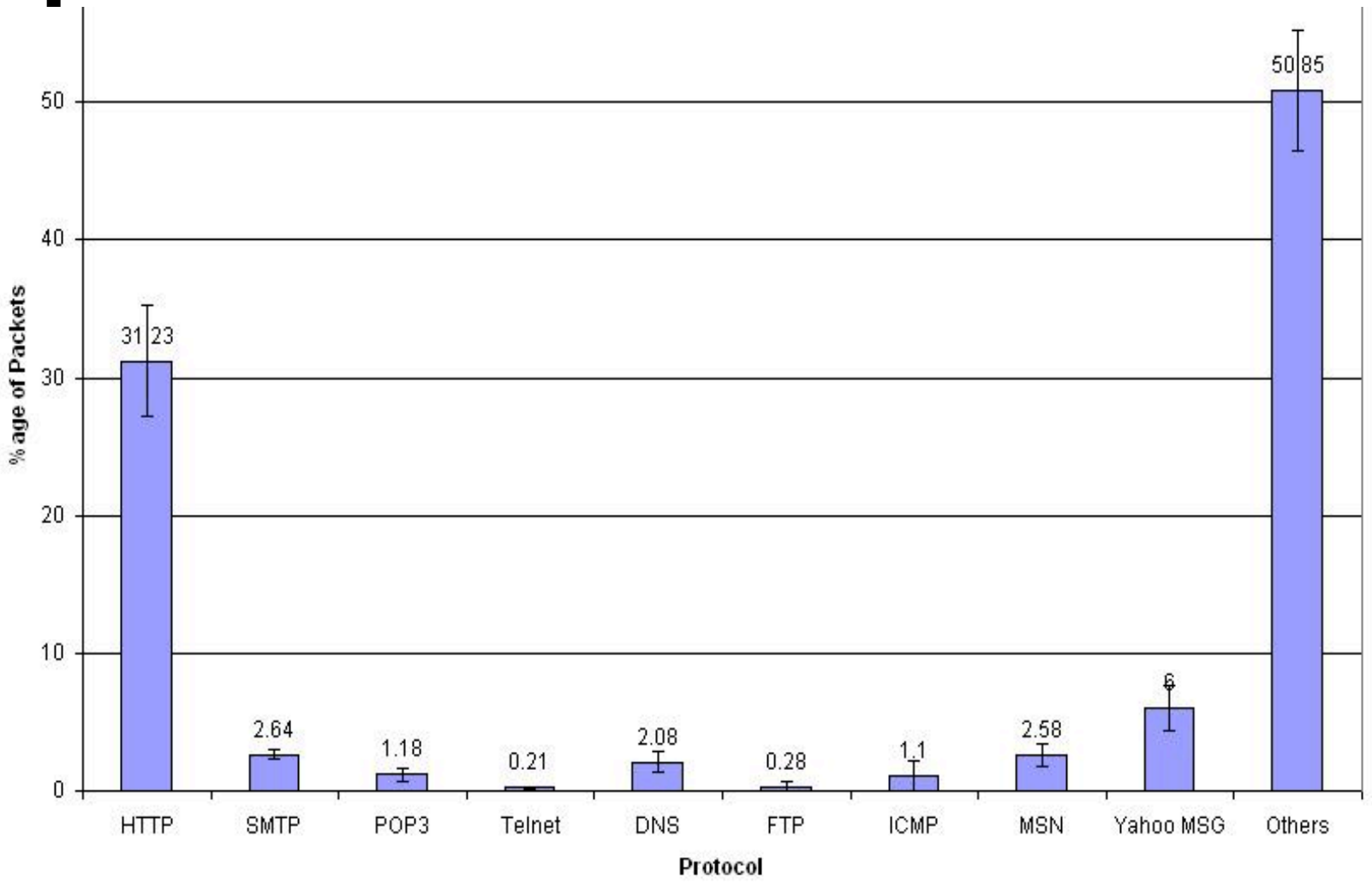
Is it good enough?

Motivation – (2)



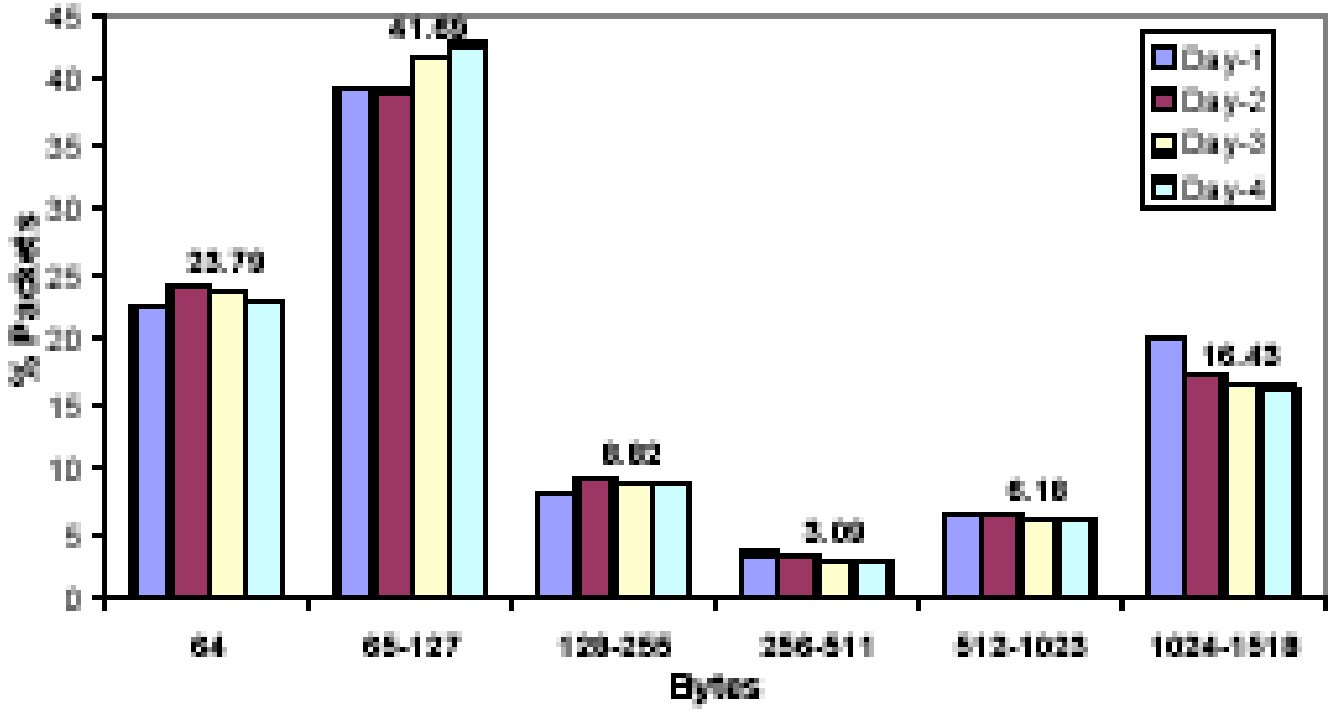
Similar QoS

Protocol Wise Break-up (March-May 2005): What's there?



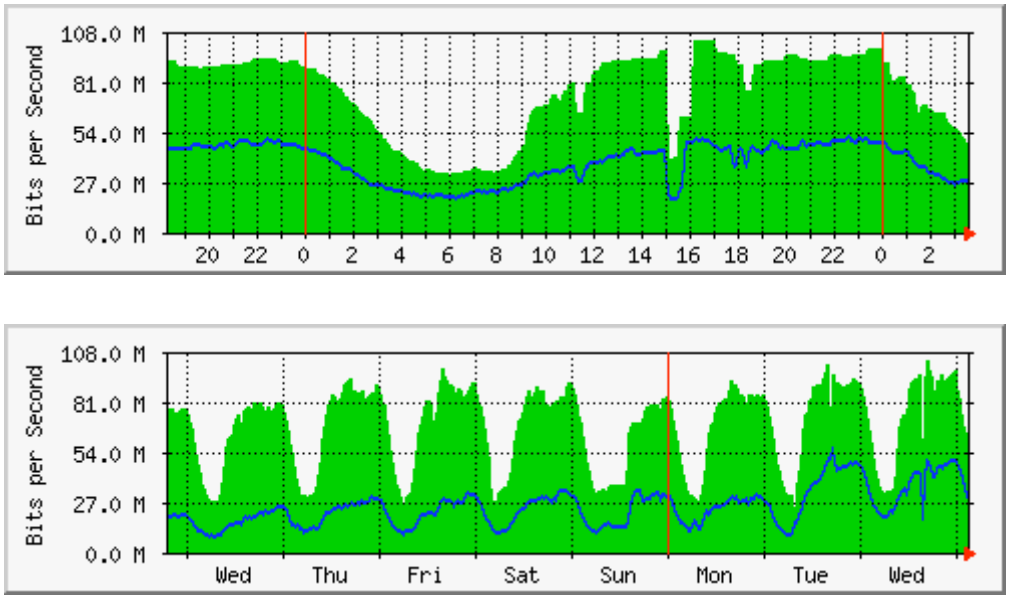
Packet Size Distribution:

What's out there?



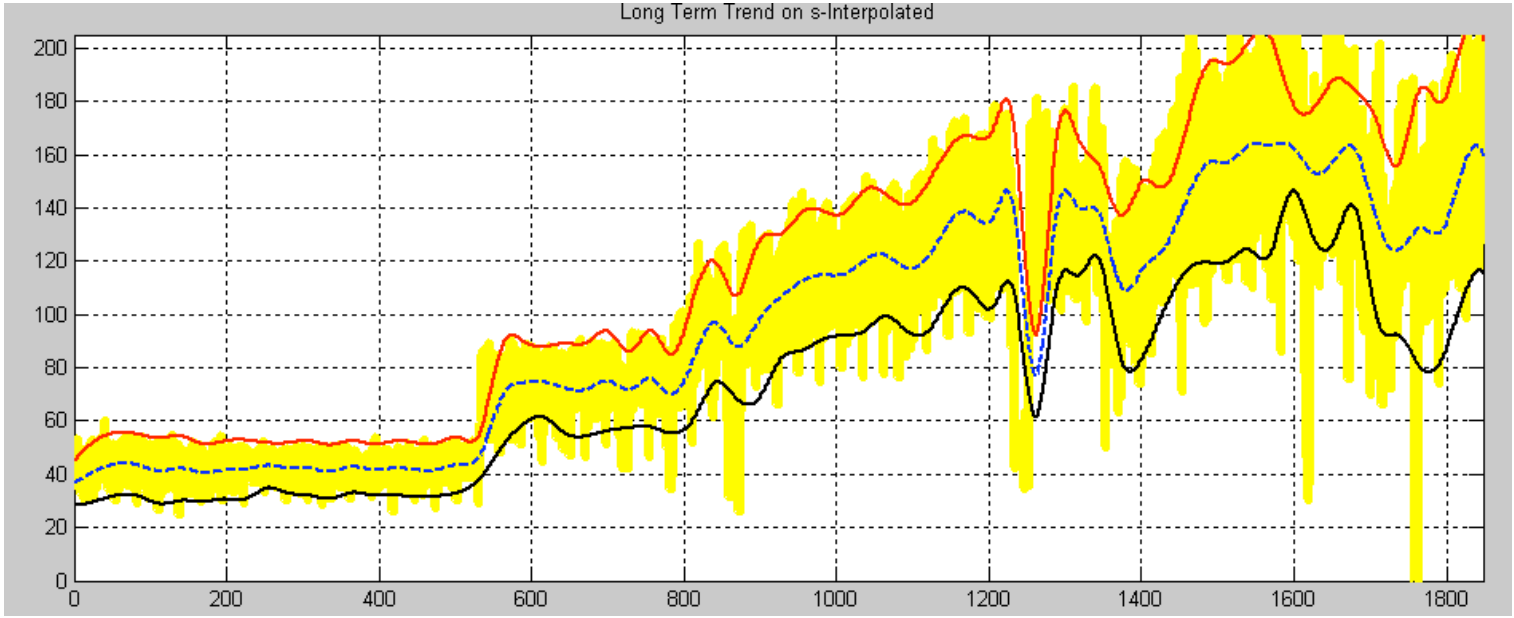
PTCL's Data: How Much?

- MRTG
- Dec' 2003 – Dec' 2005



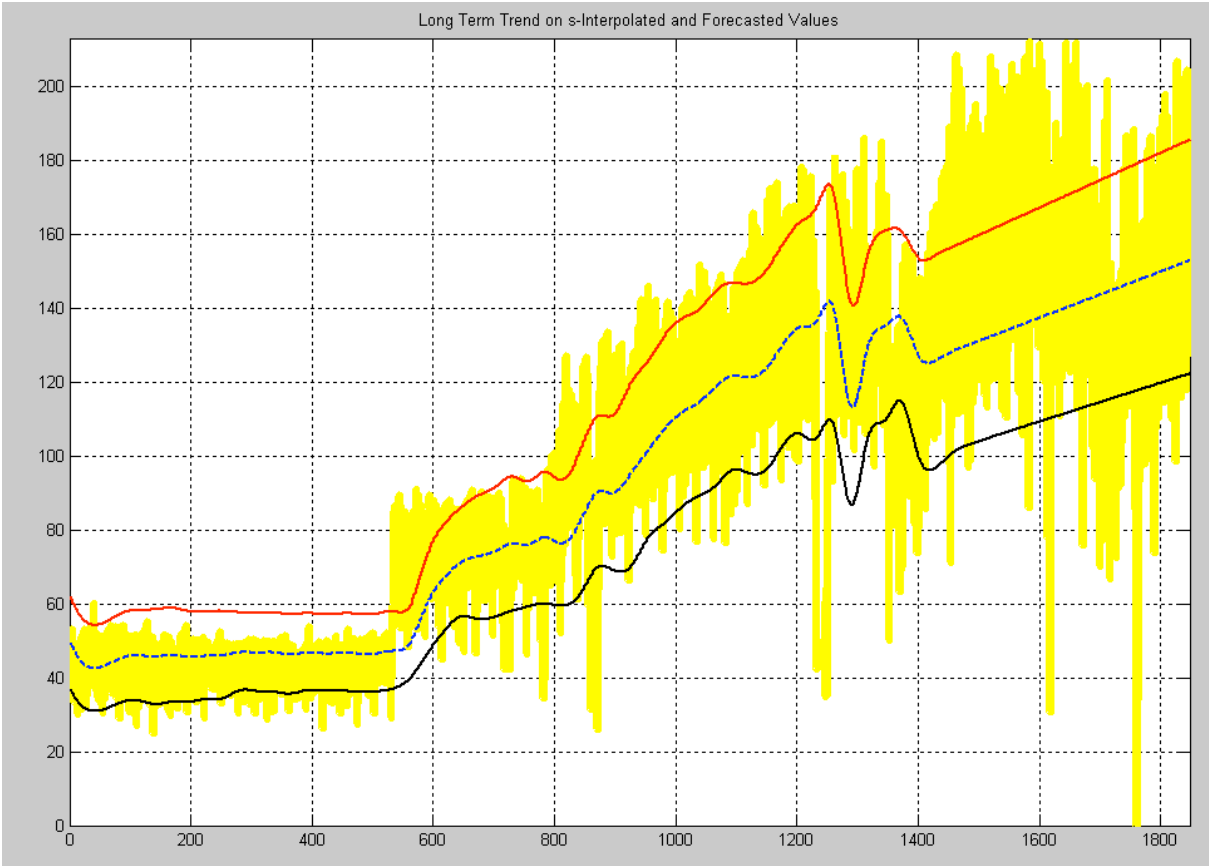
Traffic Models: How Much?

- Time series ARIMA
- Wavelet



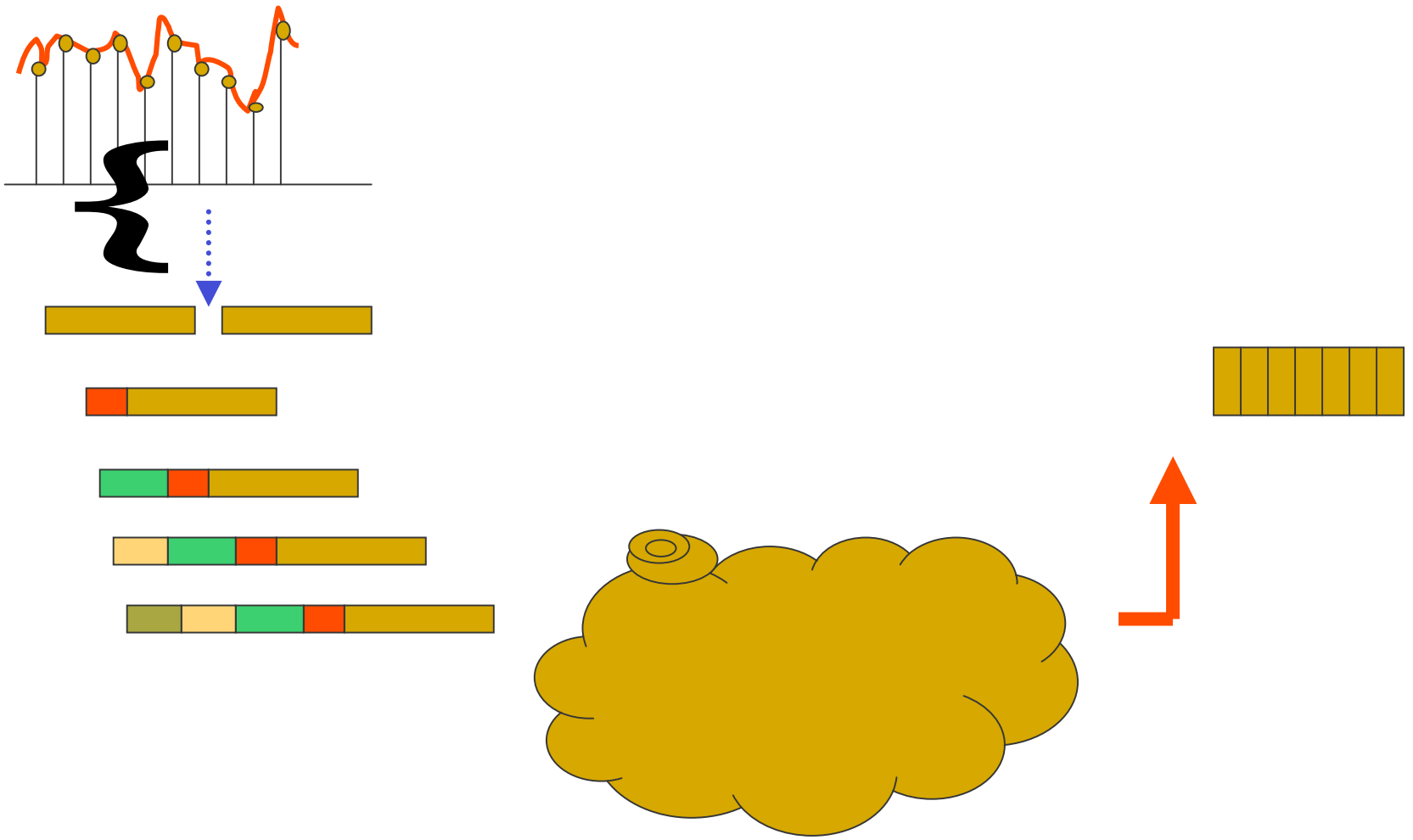
Predictions – (LHE-KHI link)

How Much?



Currently approx 2 Mbps per week!

VoIP



Voice Quality

Is it good enough?

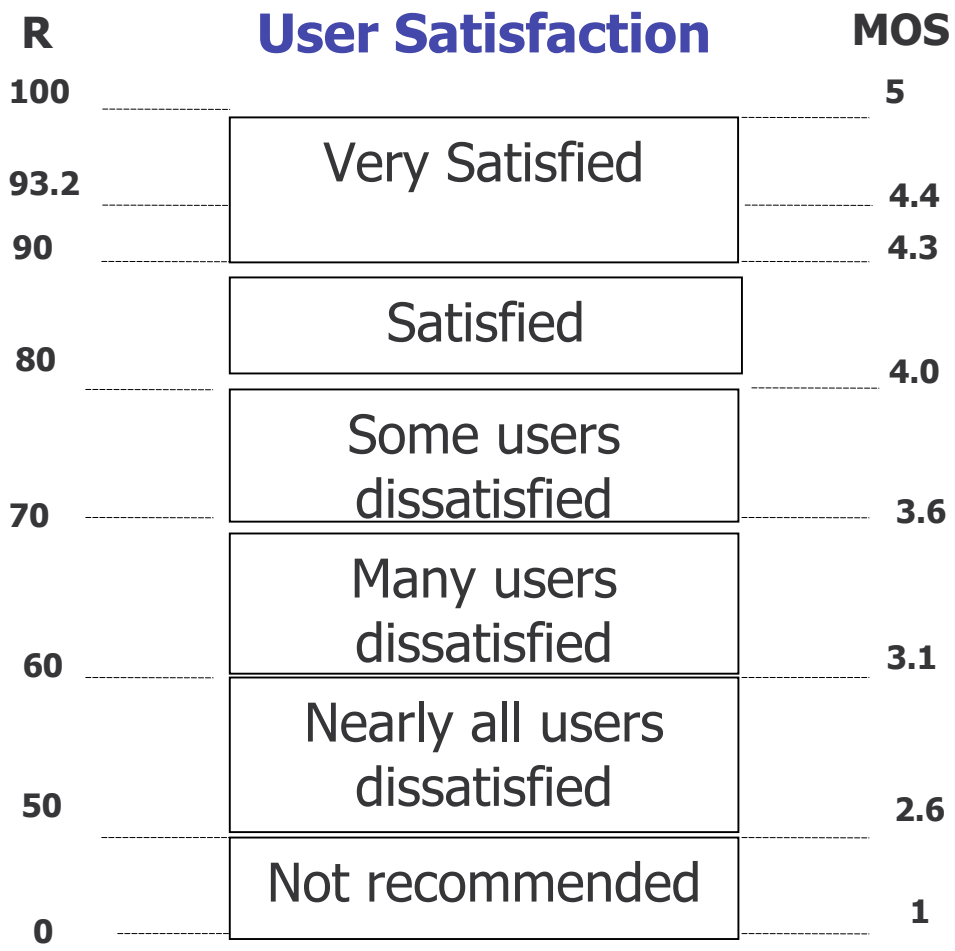
- "Perceptual"
  - Mean Opinion Scores (MOS)
  - Quality Models
    - Simulate human rating behavior
      - PSQM (ITU-T P.861)
      - PESQ (ITU-T P.862)
    - The E-model (ITU-T G.107)

The E-model

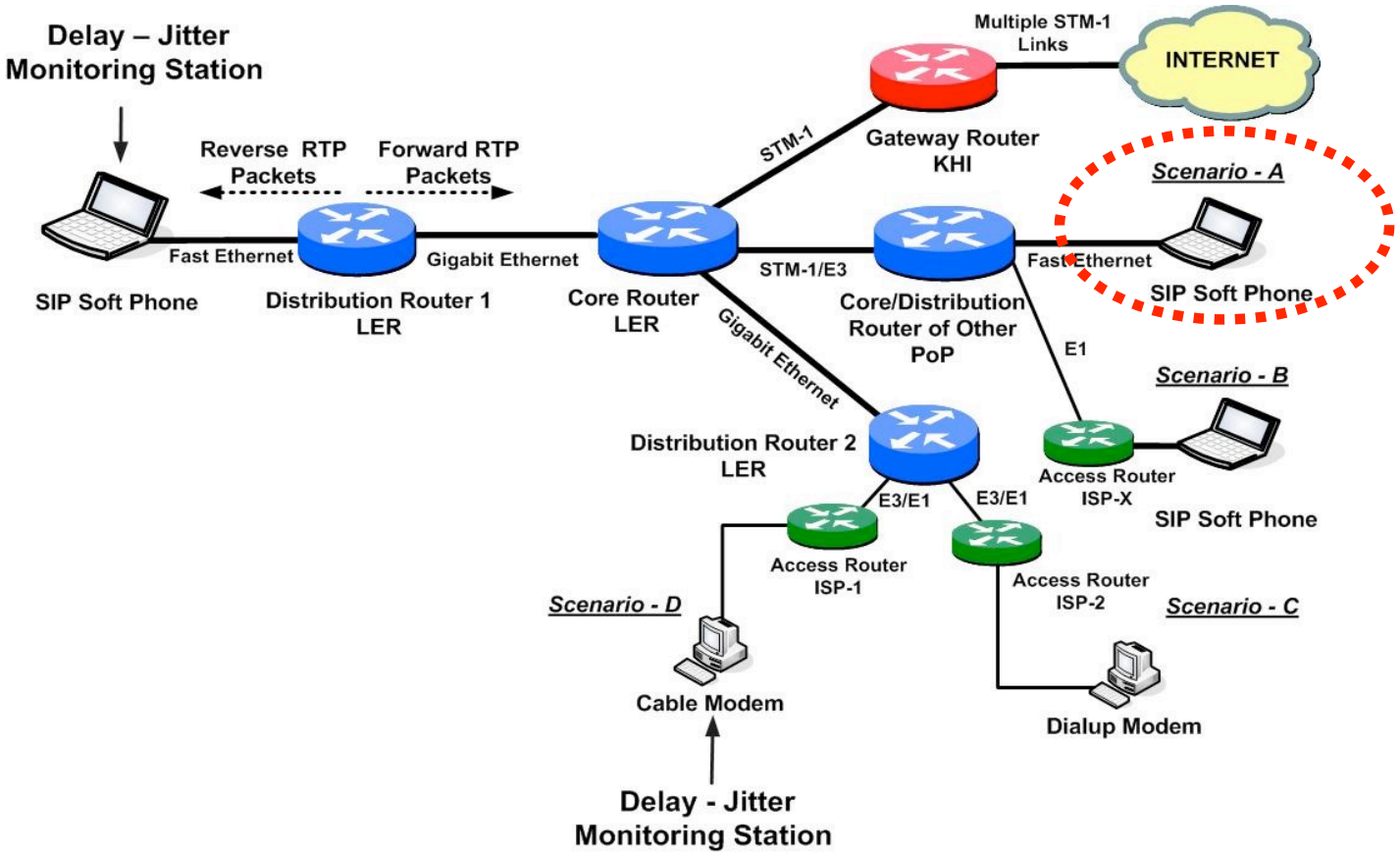
$$R = R_0 - I_s - I_d - I_{e-eff} + A$$

R_0	Signal to noise ratio
I_s	Simultaneous impairments
I_d	Delay impairments
I_{e-eff}	Equipment impairments
A	Advantage Factor

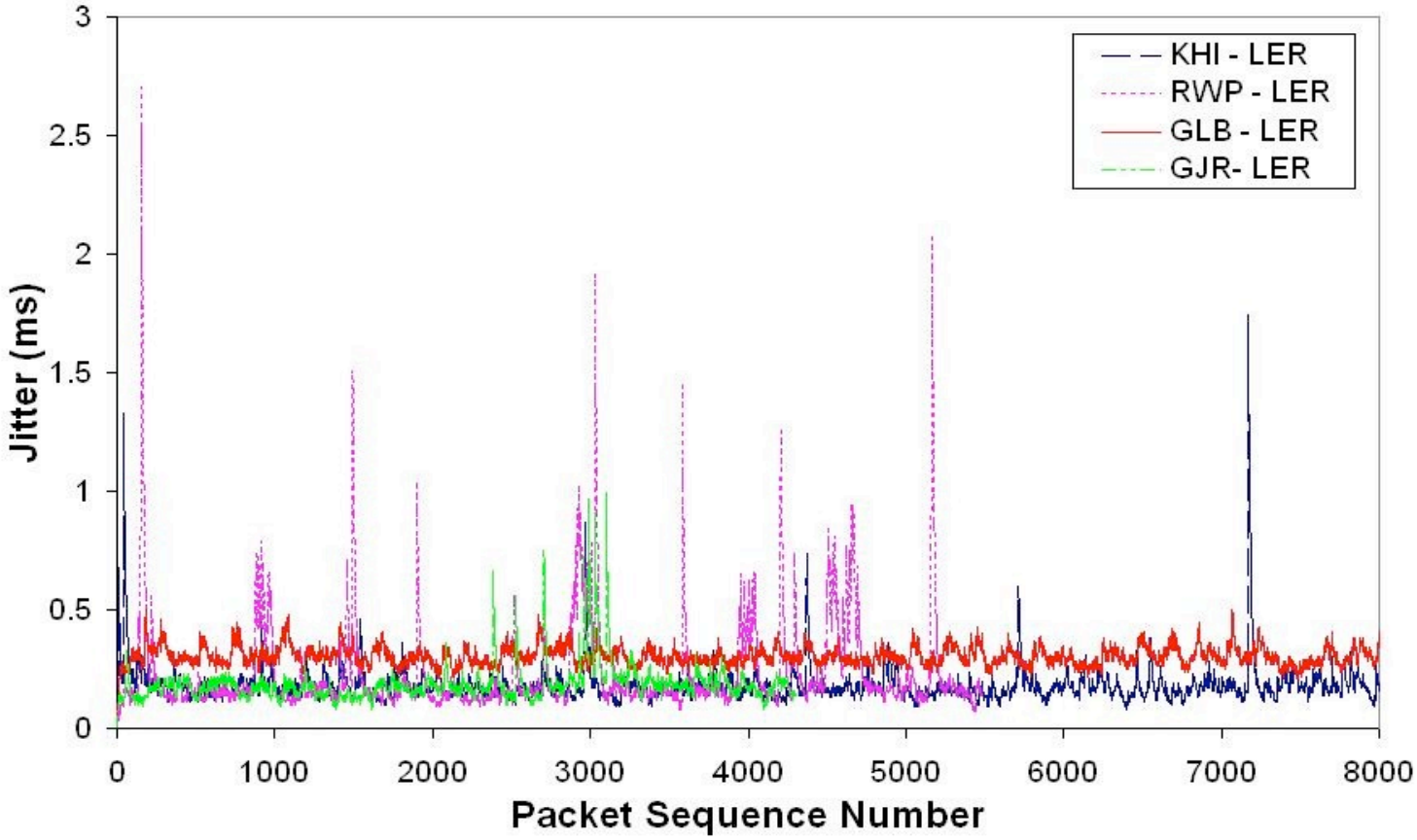
Voice Quality Classes



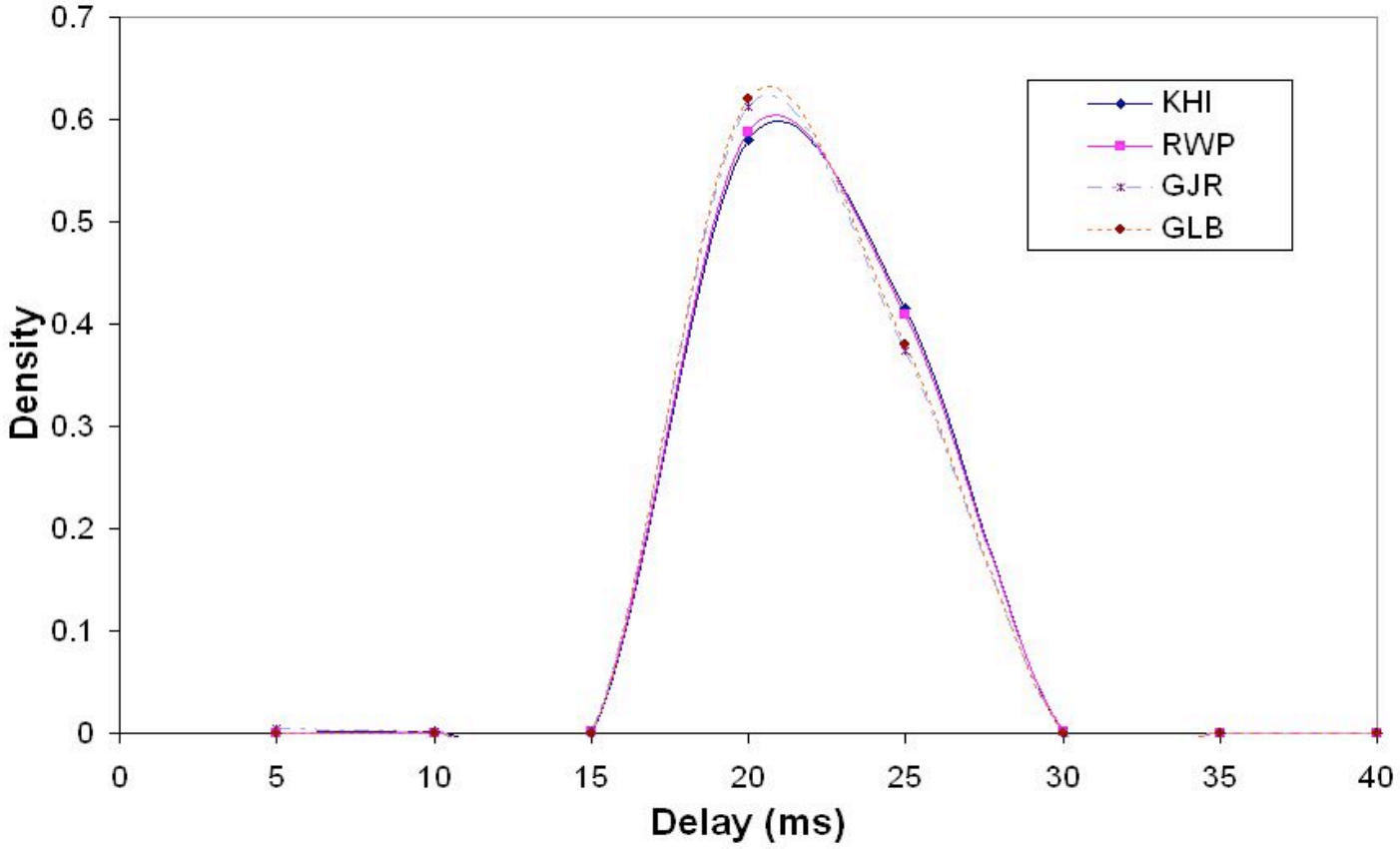
Experiments



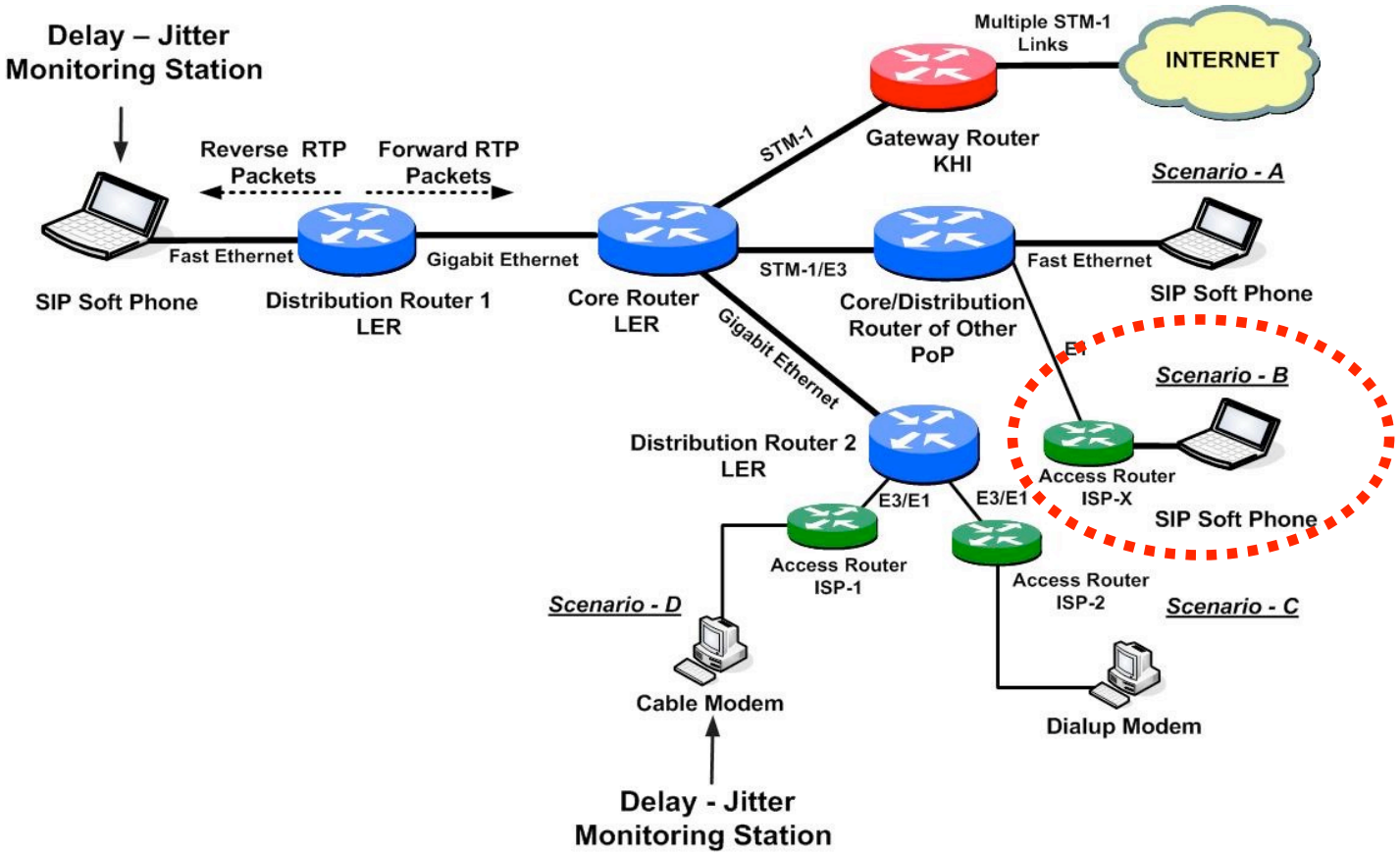
Scenario - A


KHI - LER
RWP - LER
GLB - LER
GJR- LER
Jitter (ms)
Packet Sequence Number
0
0.5
1
1.5
2
2.5
3
0
1000
2000
3000
4000
5000
6000
7000
8000

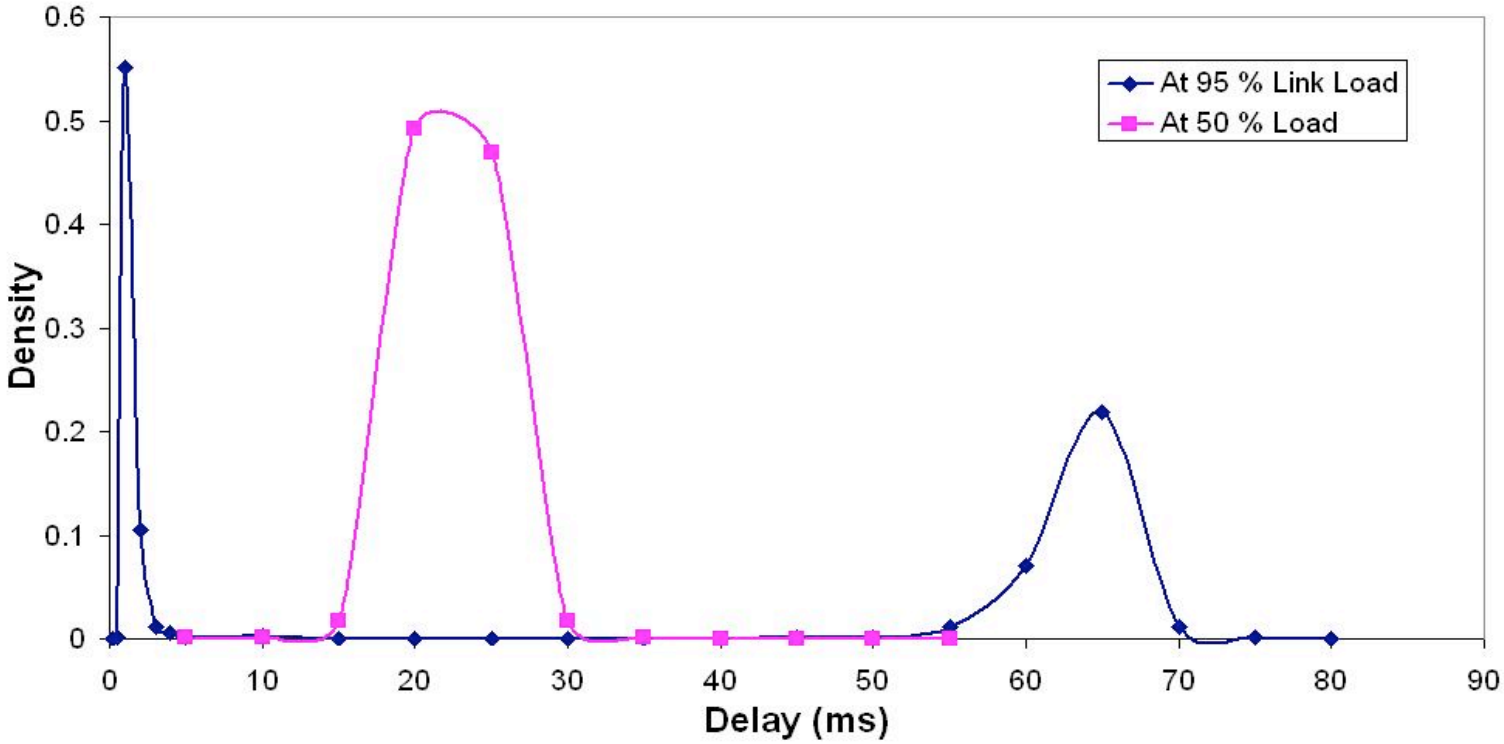
Scenario – A (contd)



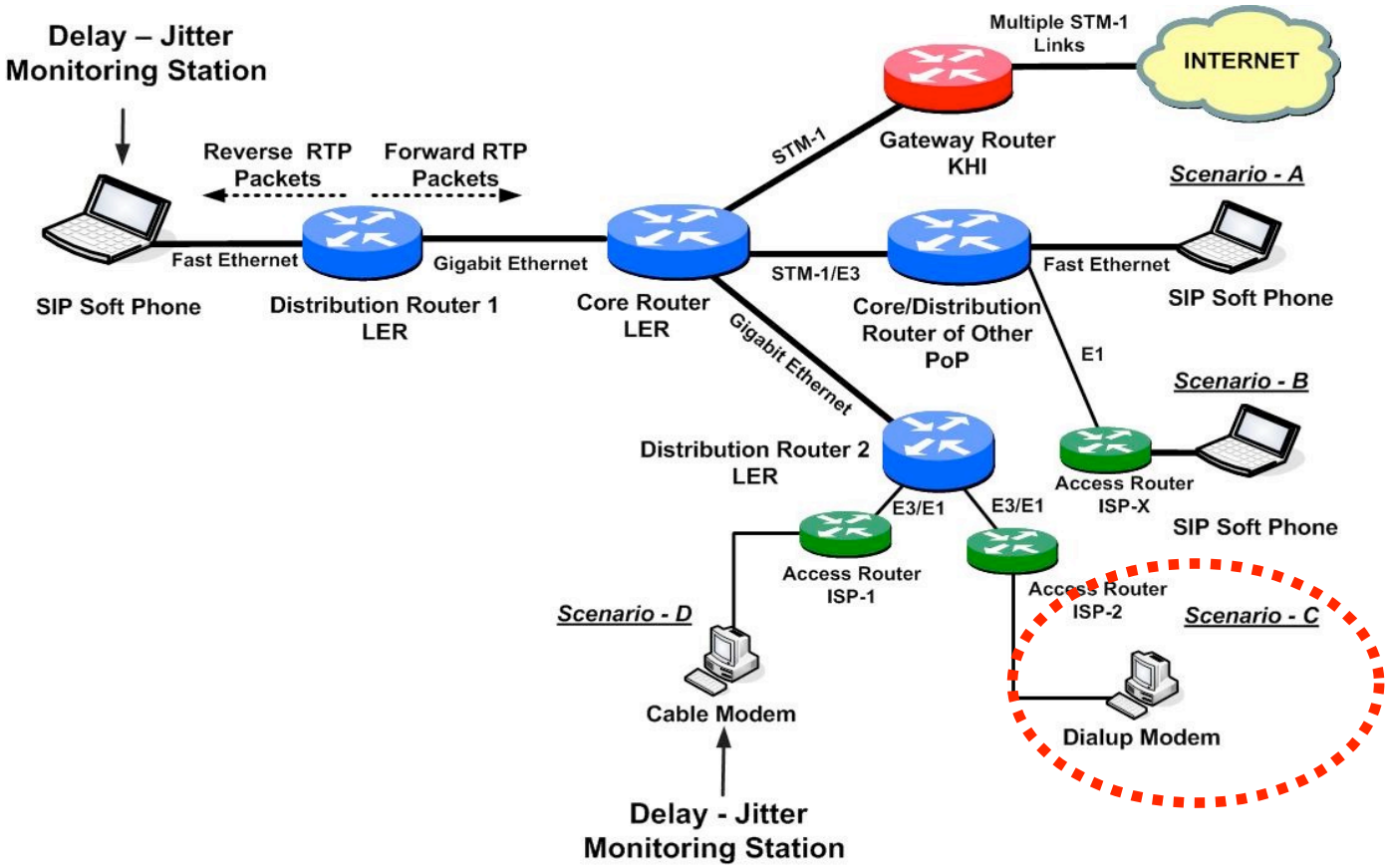
Experiments



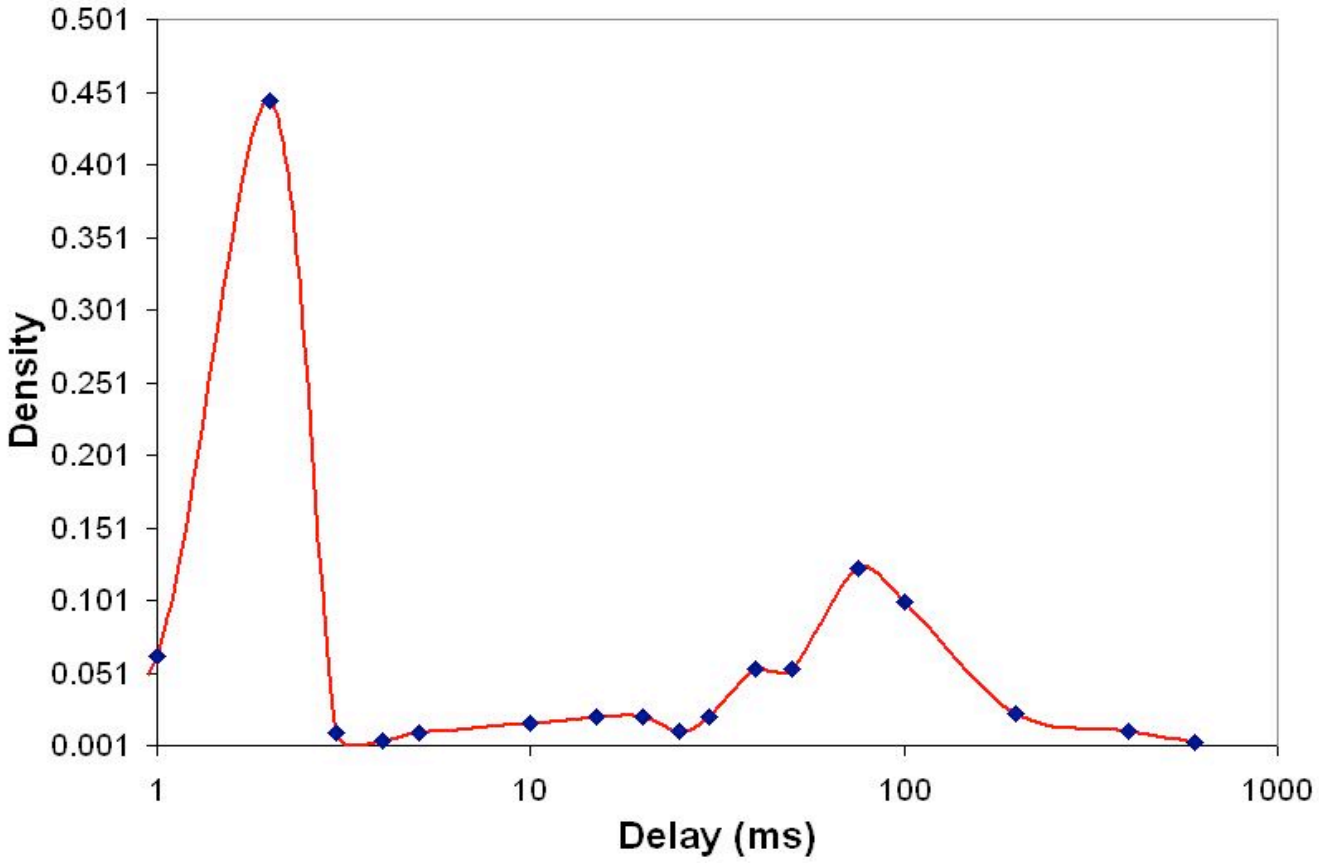
Scenario - B


0.6
0.5
0.4
0.3
0.2
0.1
0
Density
0
10
20
30
40
50
60
70
80
90
Delay (ms)
At 95 % Link Load
At 50 % Load

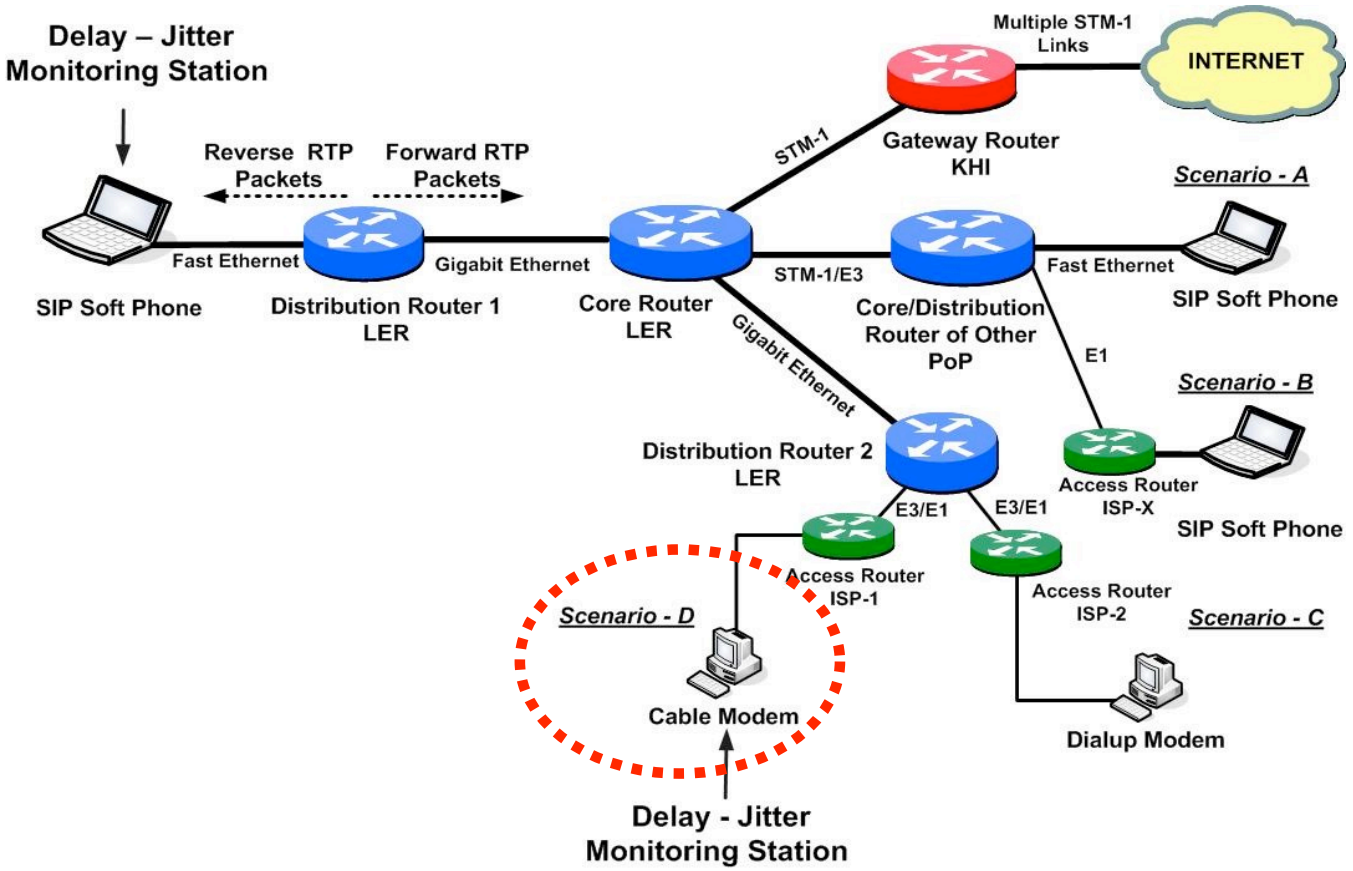
Experiments



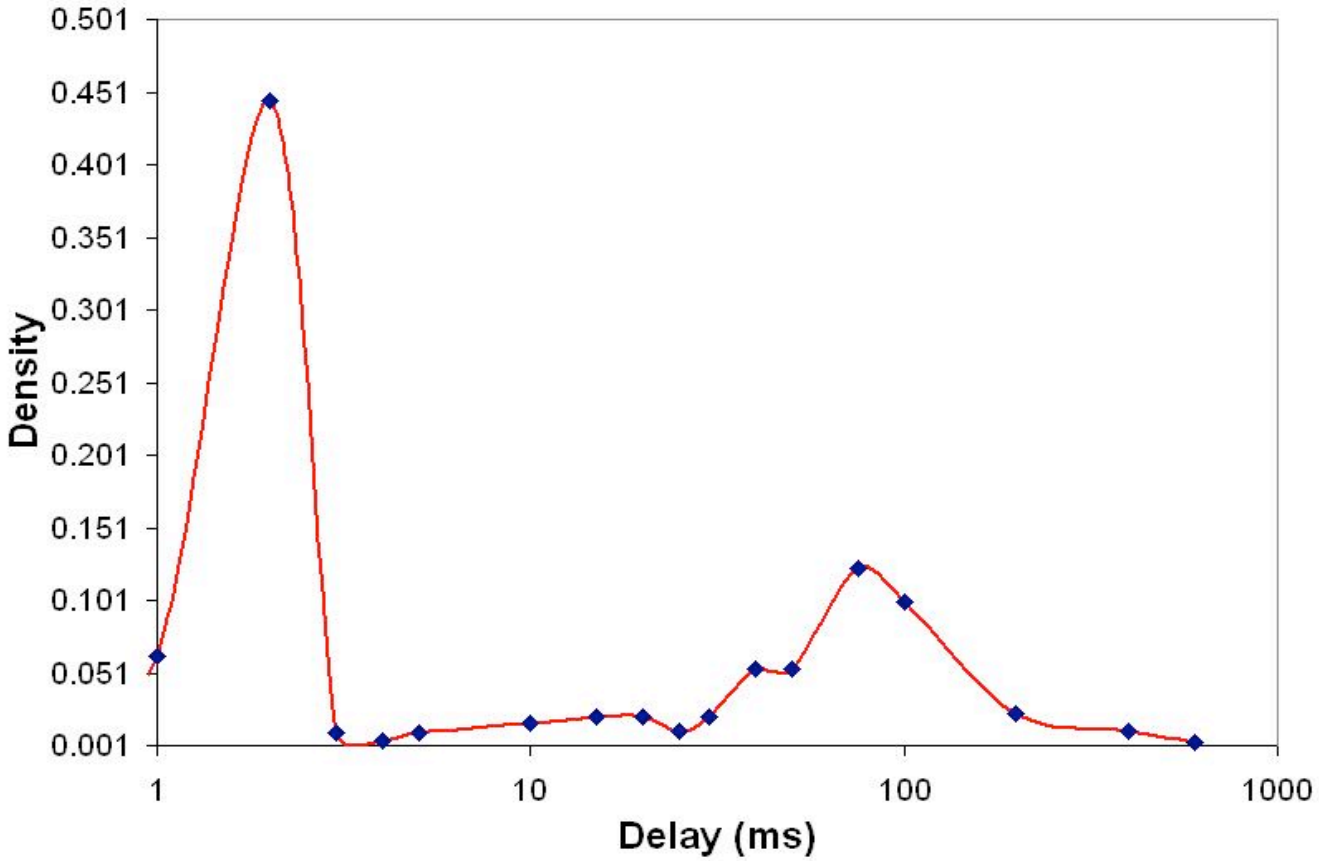
Scenario - C


0.501
0.451
0.401
0.351
0.301
0.251
0.201
0.151
0.101
0.051
0.001
Density
1
10
100
1000
Delay (ms)

Experiments



Scenario - D


0.501
0.451
0.401
0.351
0.301
0.251
0.201
0.151
0.101
0.051
0.001
Density
1
10
100
1000
Delay (ms)

Perceptual quality assessment for VoIP for the PIE backbone

Scenario	*Codec*	*Link*	I_e	P_{pl}	B_{pl}	I_{e-eff} [G.113 I]	μ ms	σ ms	P %	I_{e-eff} [G.107]	R	MOS
A	G.711 (with no PLC)	KHI-LER	0	0.07	4.3	1.52	20	2.32	0.41	8.20	85.00	4.20
		RWP-LER	0	0.11	4.3	2.37	20	0.75	0.15	3.10	90.10	4.34
		GJR-LER	0	0.03	4.3	0.66	20	2.77	0.51	10.06	83.14	4.14
		LGB-LER	0	0	4.3	0	20	0.43	0.01	0.25	92.95	4.4
B	G.711 (with no PLC)	50%	0	0	4.3	0	20	2.24	0.31	6.46	86.74	4.25
		95%	0	2.5	4.3	34.9	20	27.8	49.59	87.42	5.78	1.00
C	G.723.1	dial-up	15	2.57	16.1	26.01	30	49.31	68.38	79.75	13.45	1.09
D	G.729a	48%	11	0	19	11	20	1.46	0.13	11.58	81.62	4.08
		97%	11	0	19	11	20	6.16	2.37	20.32	72.88	3.72

Results

- In the 4 scenarios studied:
  - The backbone links exhibit **low** mean jitter
  - Access links present **congestion hot spots**
- A satisfactory QoS cannot be achieved on an end to end basis because of **bottlenecks** in the access links

Conclusions

End to End QoS for VoIP can not be achieved unless an end to end QoS architecture is deployed.