Non-Intrusive Monitoring of VoIP Call Quality

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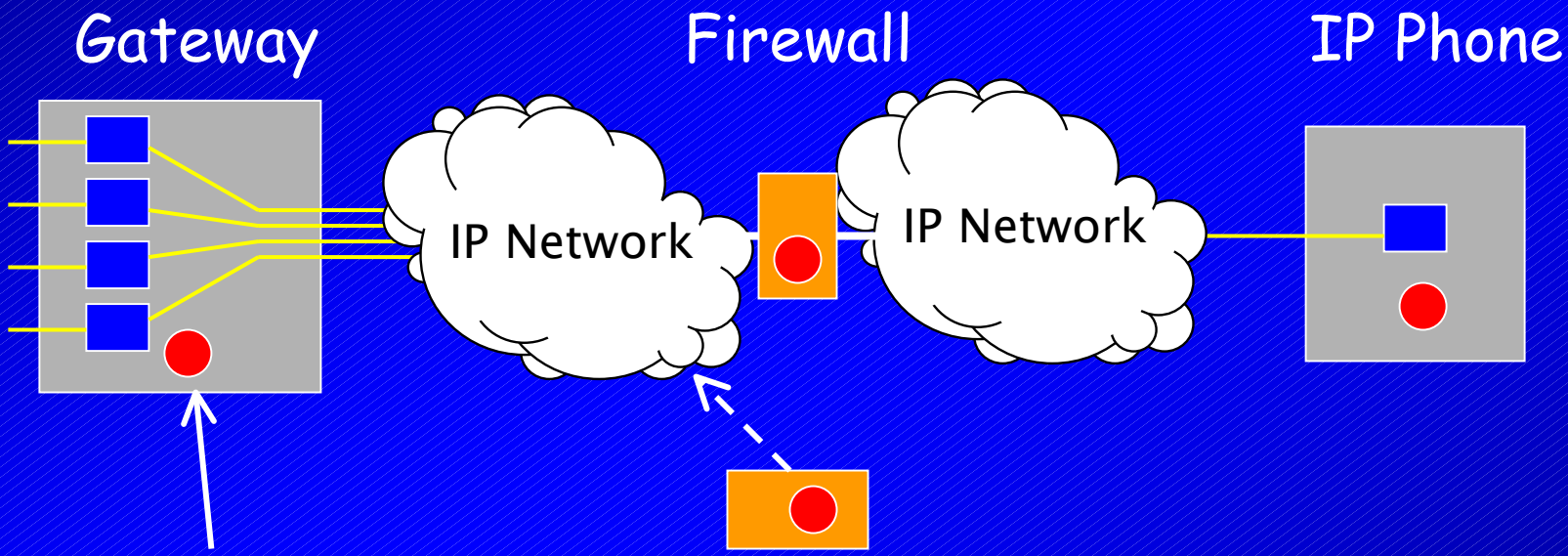
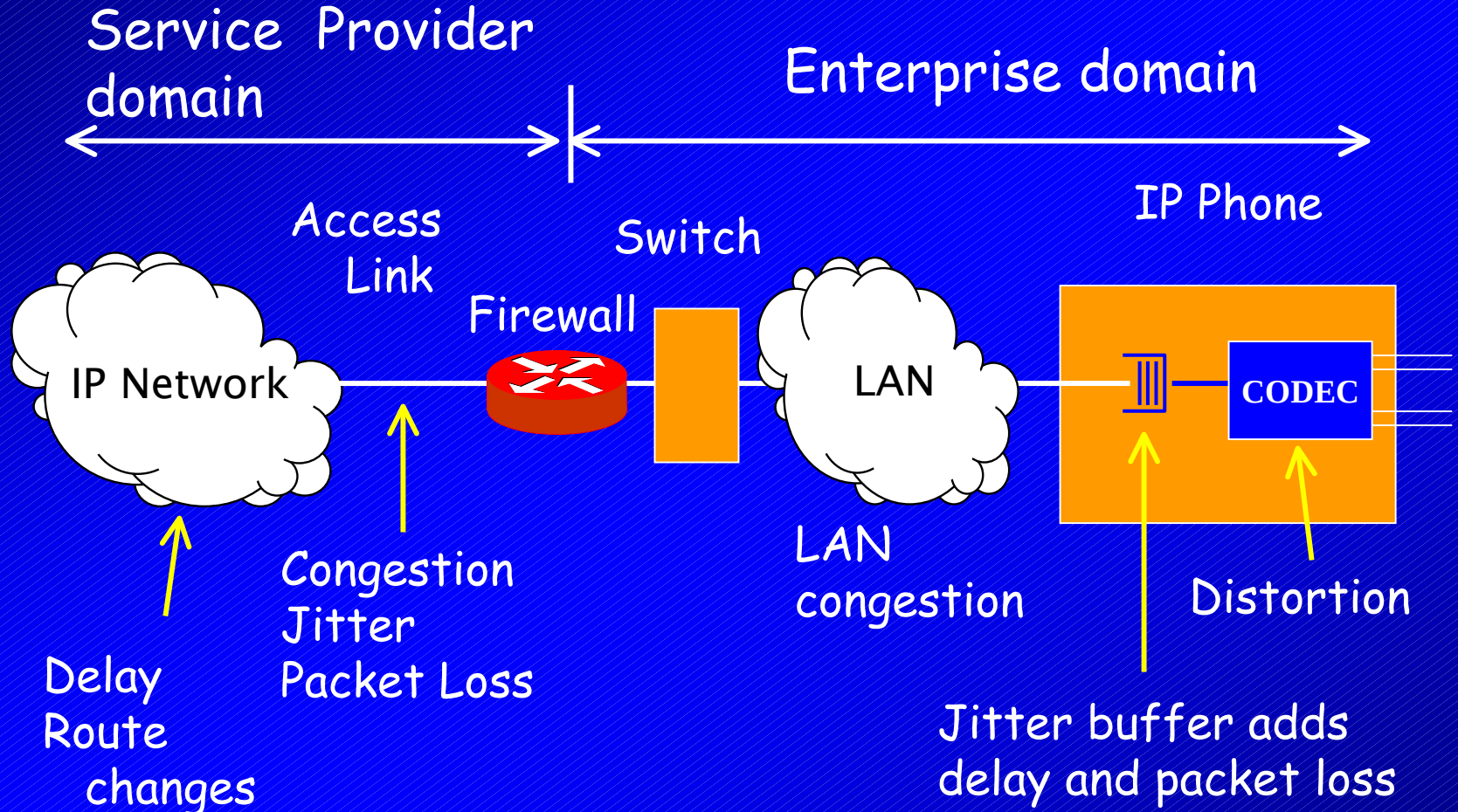
Problem Addressed

- Quality monitoring for
  - Service management and billing
  - Inter-domain SLA monitoring
  - Locating and identifying problems affecting service quality

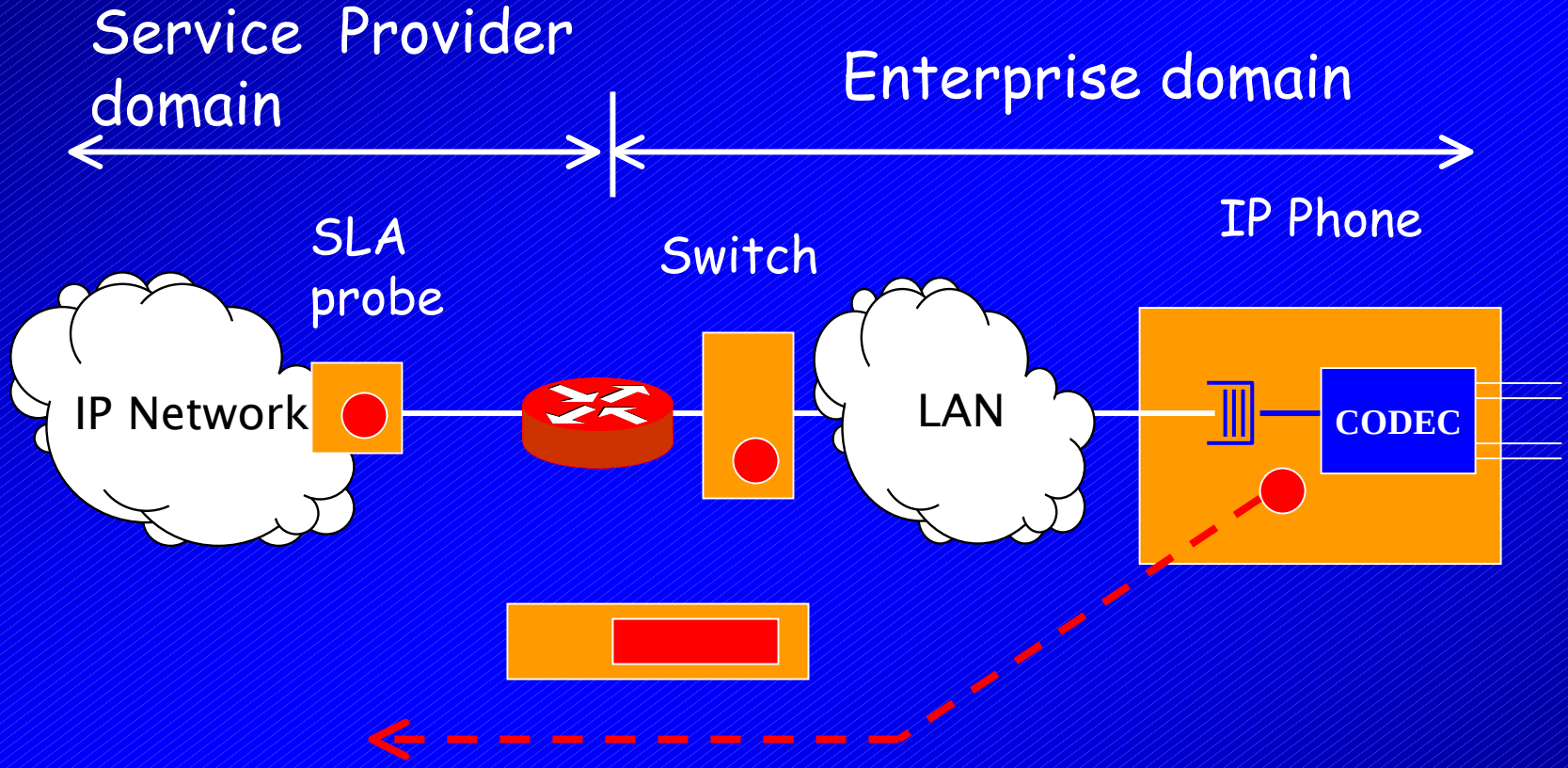
Approach


Gateway
Firewall
IP Phone
IP Network
IP Network
Software based
Embedded
Monitoring Agent
High throughput
test Equipment

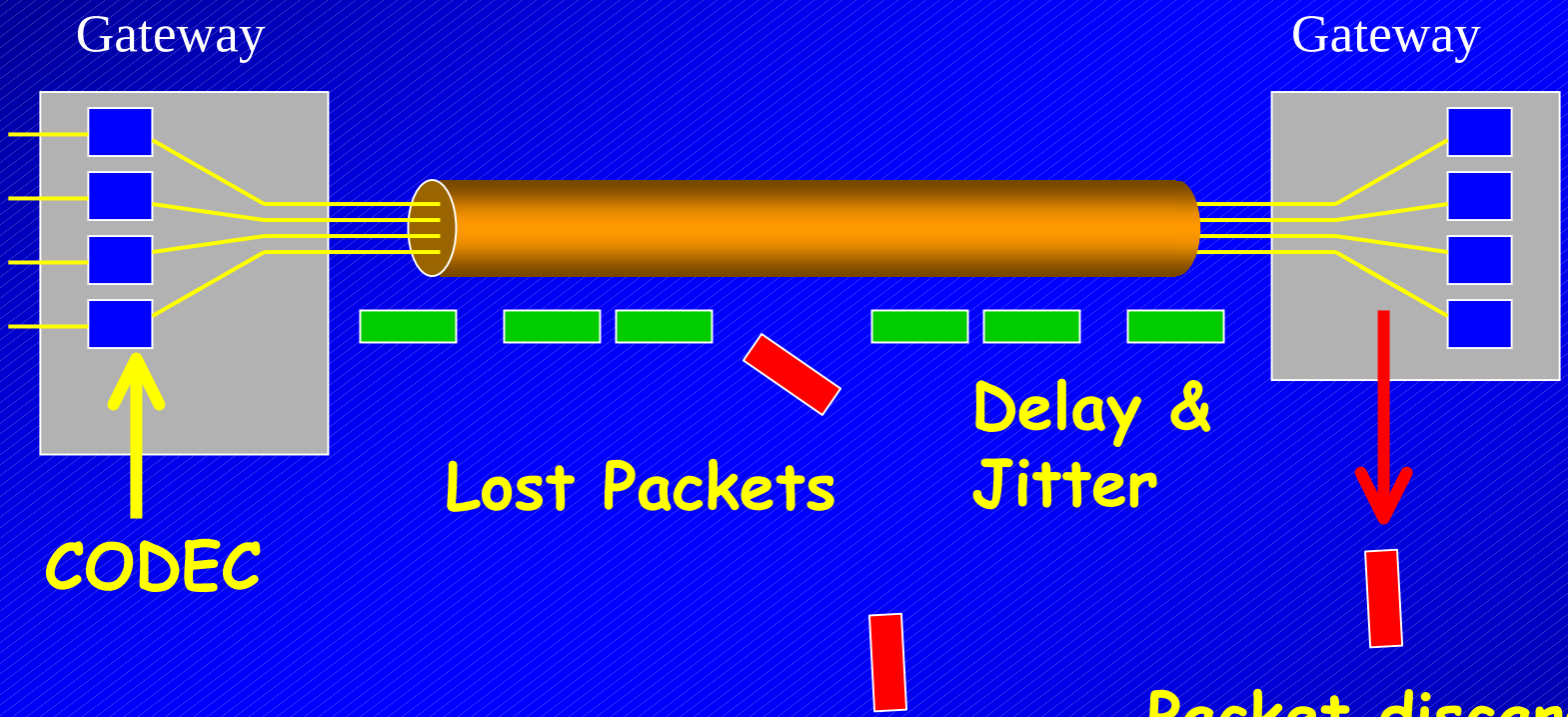
Example - IP Centrex



Example - IP Centrex

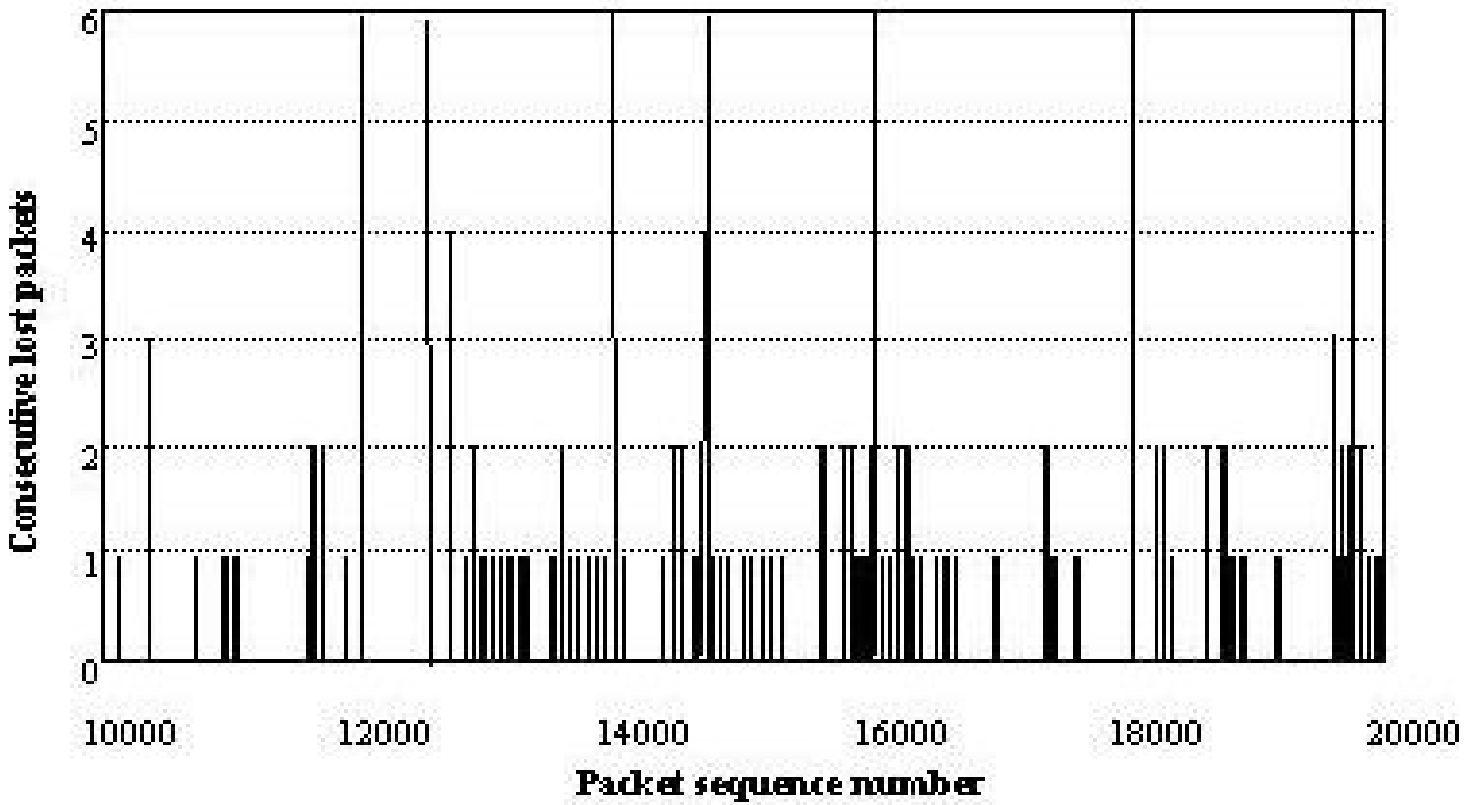


Factors impacting quality

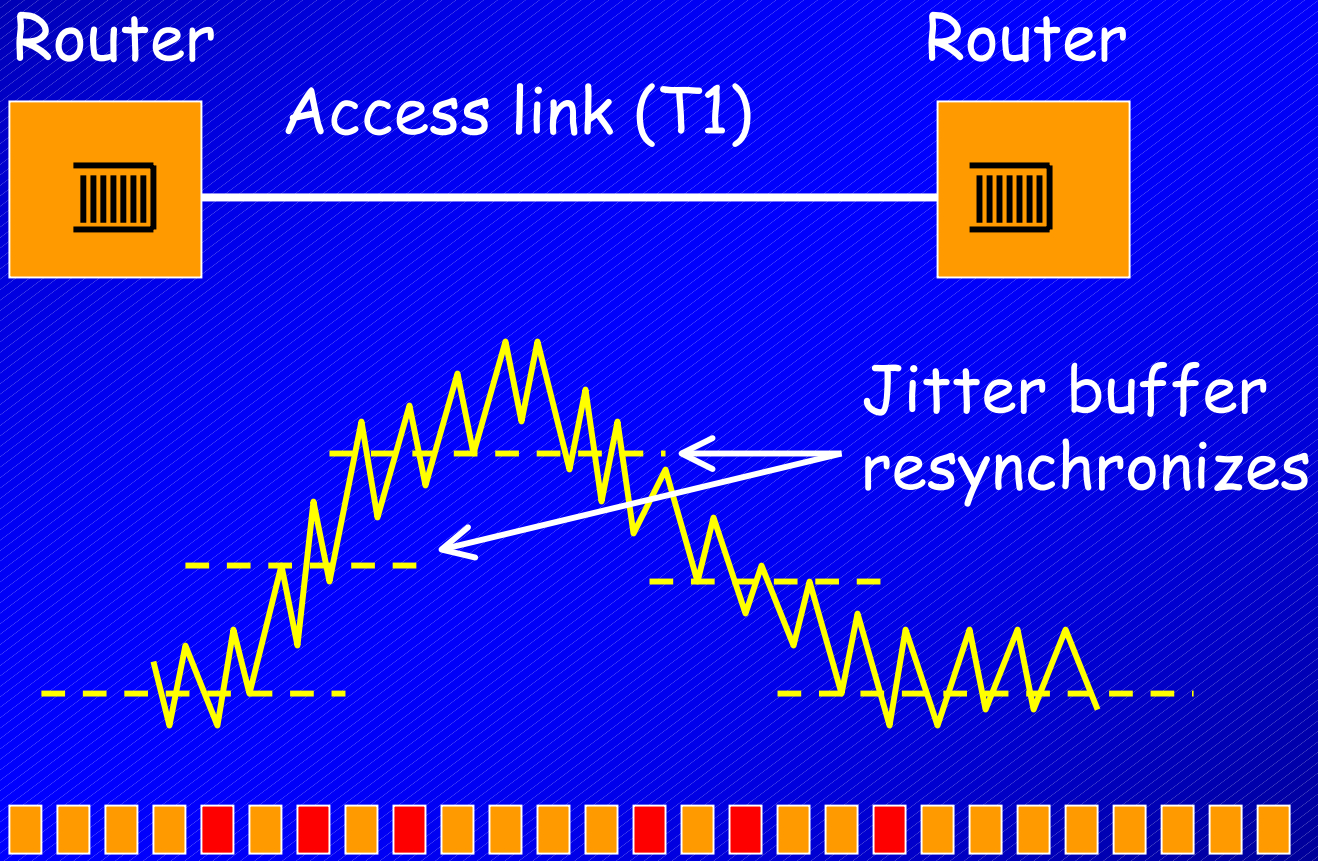


Jitter can cause more problems than packet loss

Packet Loss is *Bursty*



Jitter causes bursty "discards"



Effects of Burstiness

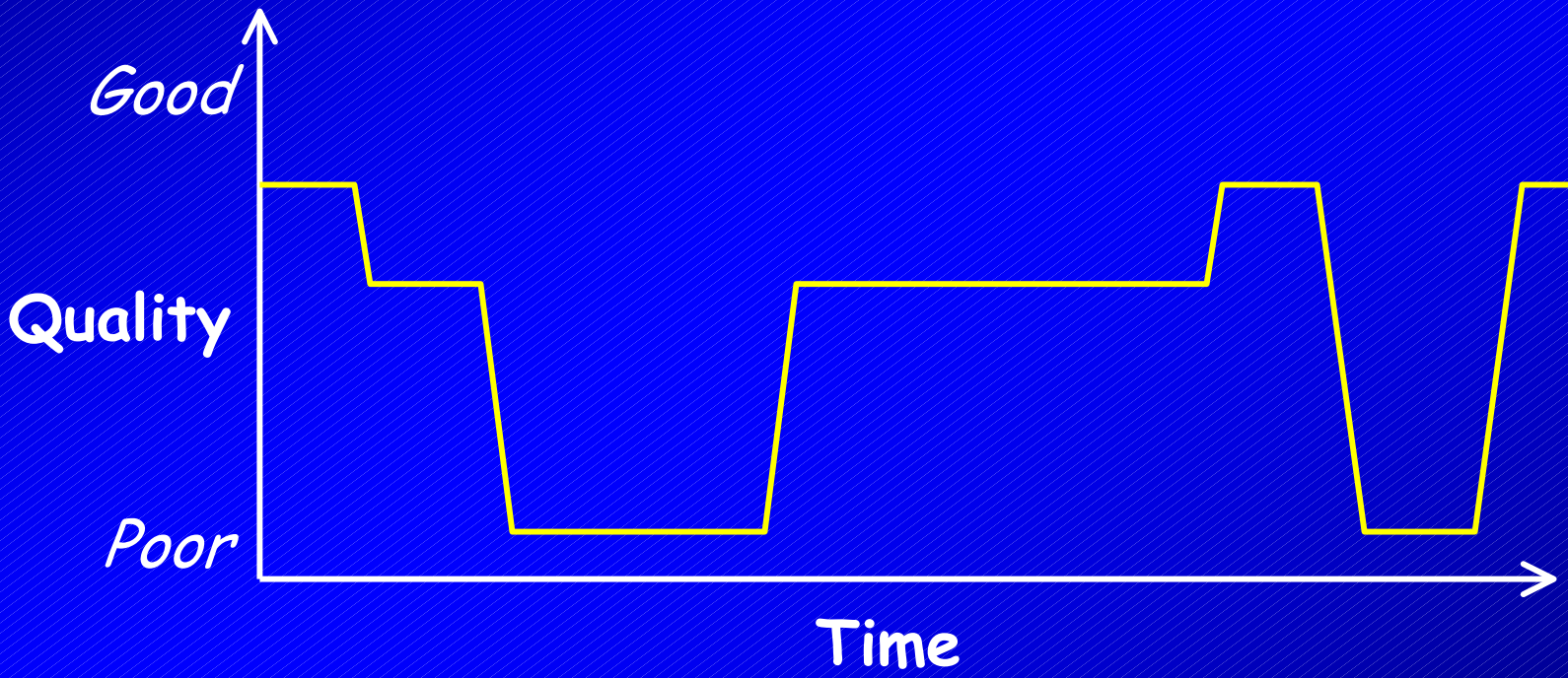
Packet loss concealment is effective for isolated lost packets but can't hide periods of high packet loss

1% random loss may be ok but

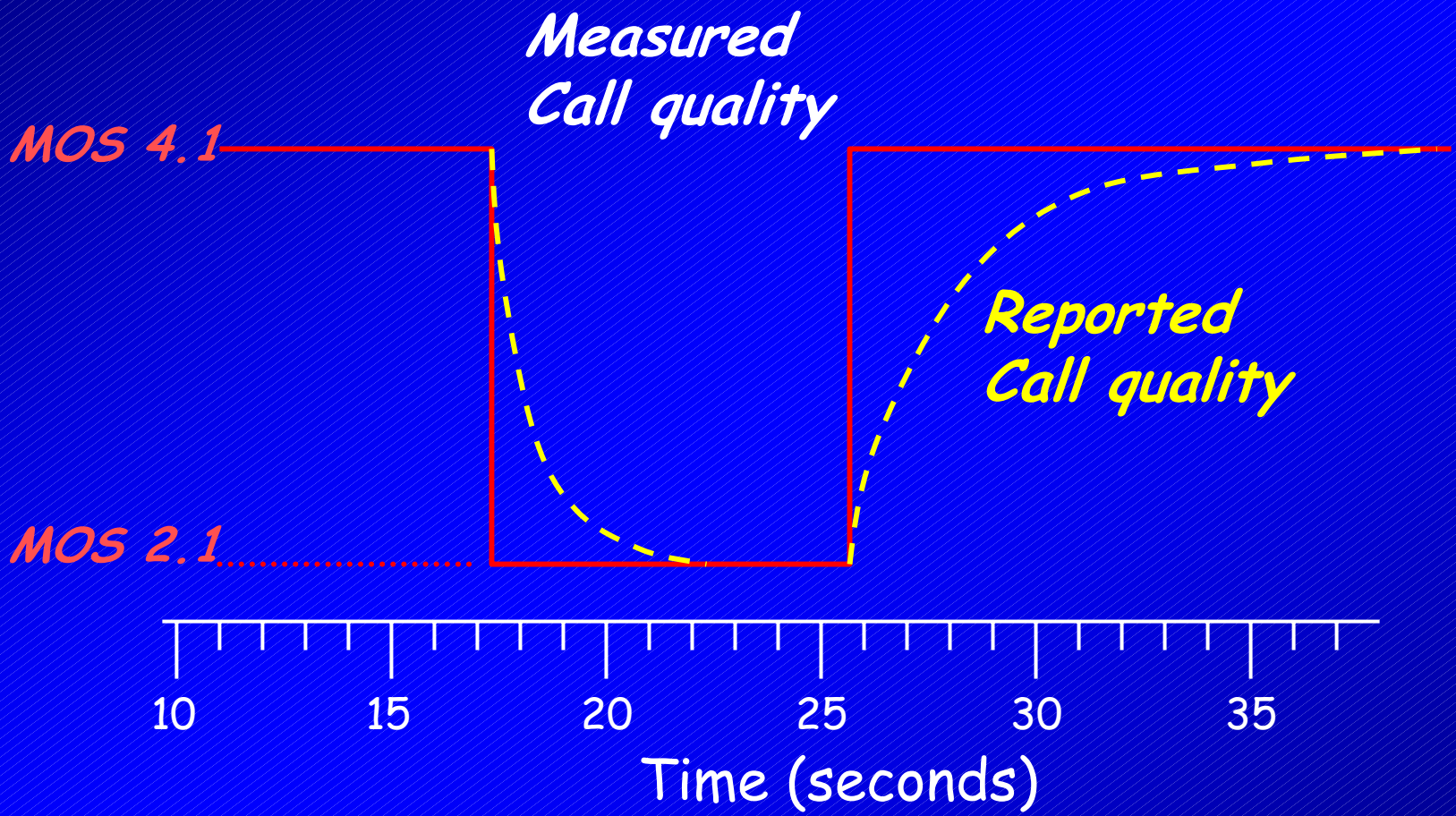
1% bursty loss may **not**

Result - time varying quality

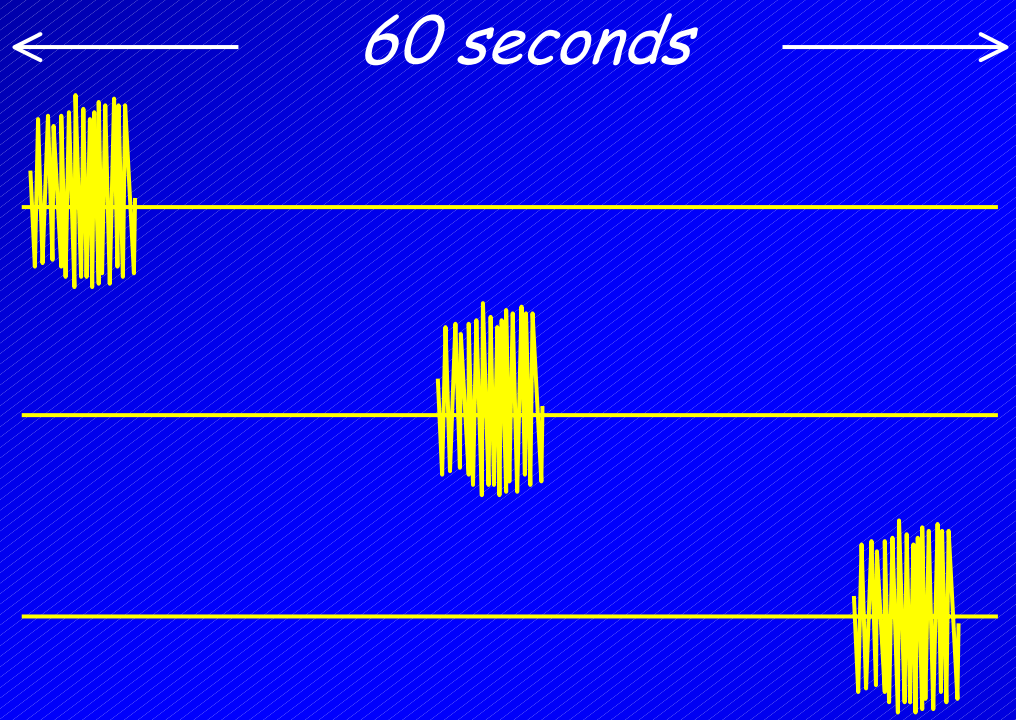
Problem – how to rate the call?



Measured vs Reported Quality

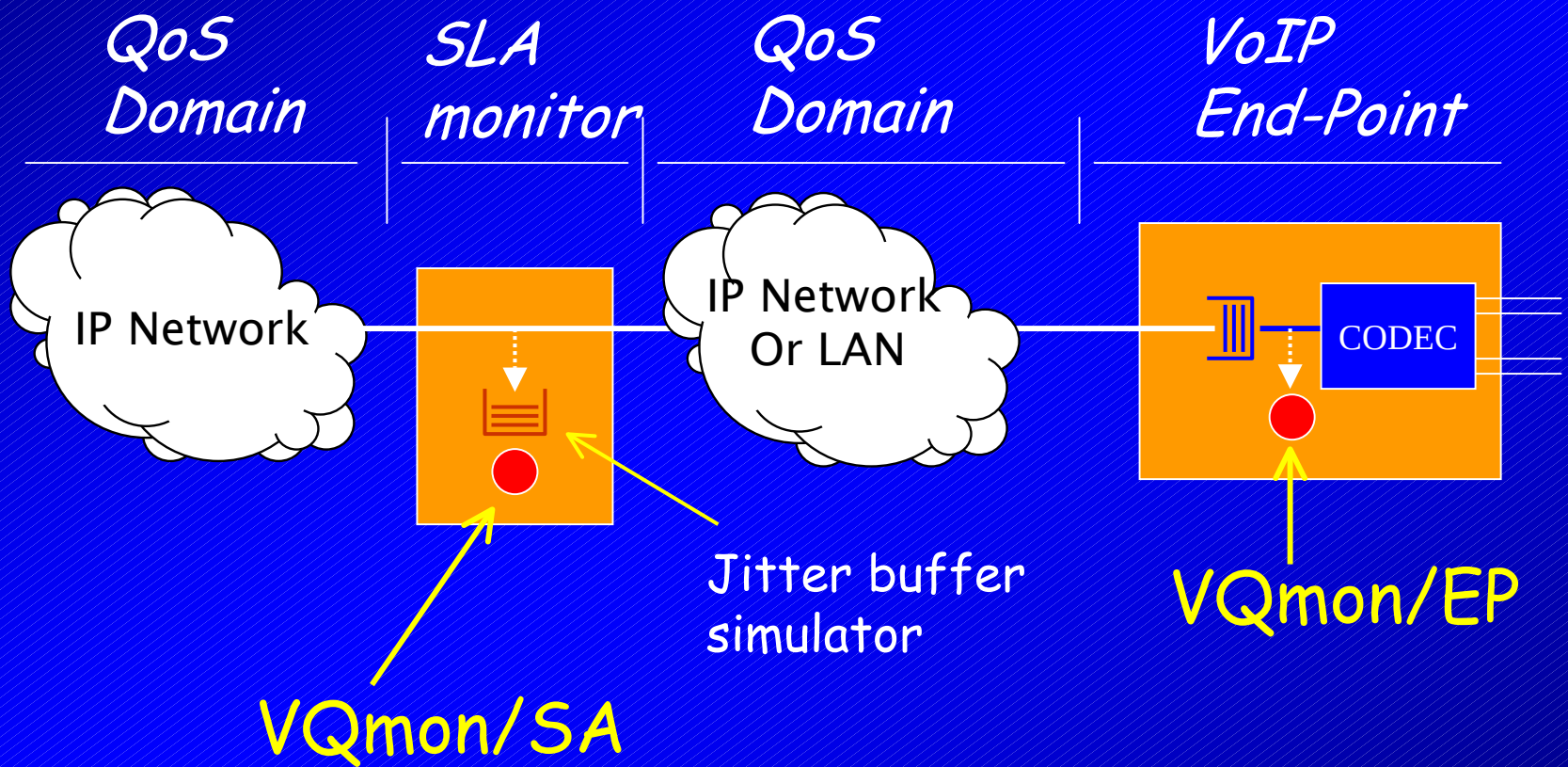


"Recency" effect

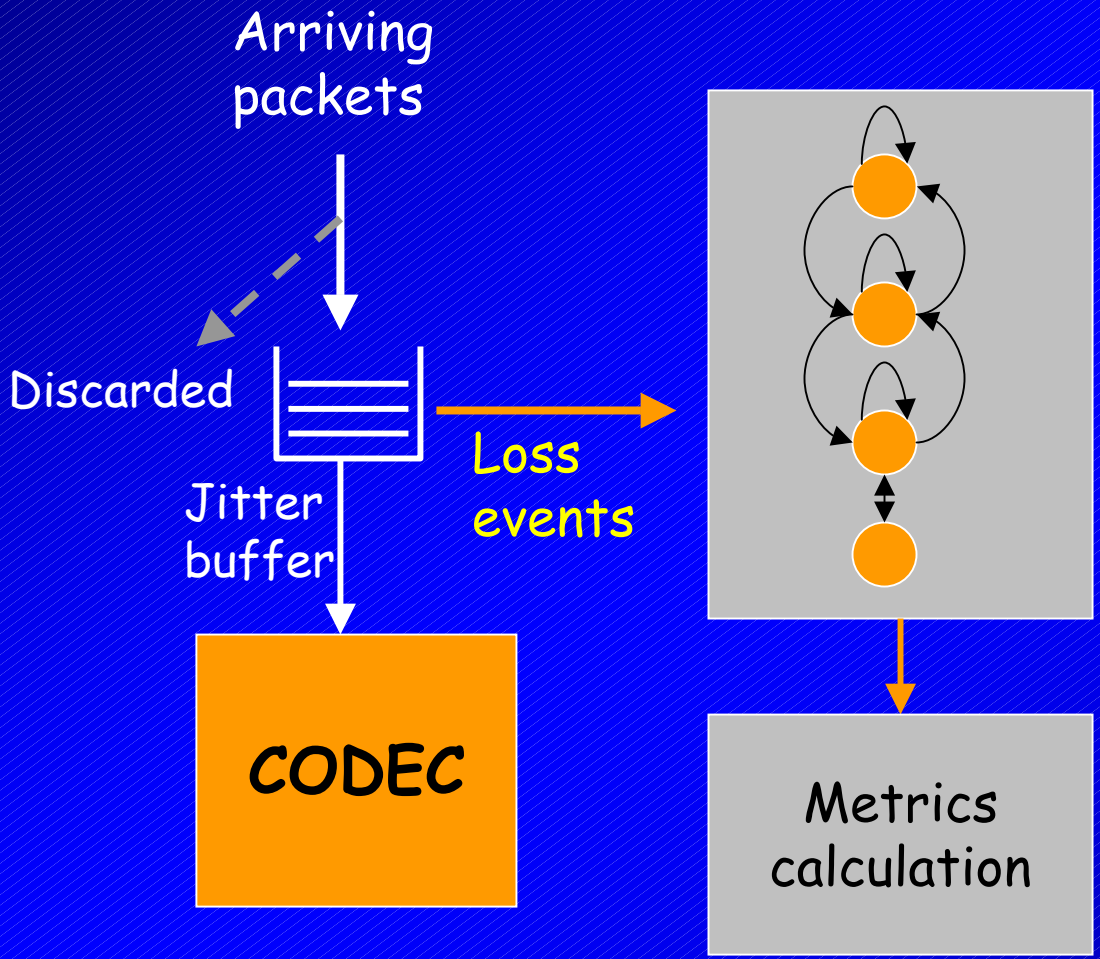


Source AT&T
T1A1.7/98-031

Approach


QoS Domain
SLA monitor
QoS Domain
VoIP End-Point
IP Network
IP Network Or LAN
CODEC
Jitter buffer simulator
VQmon/SA
VQmon/EP

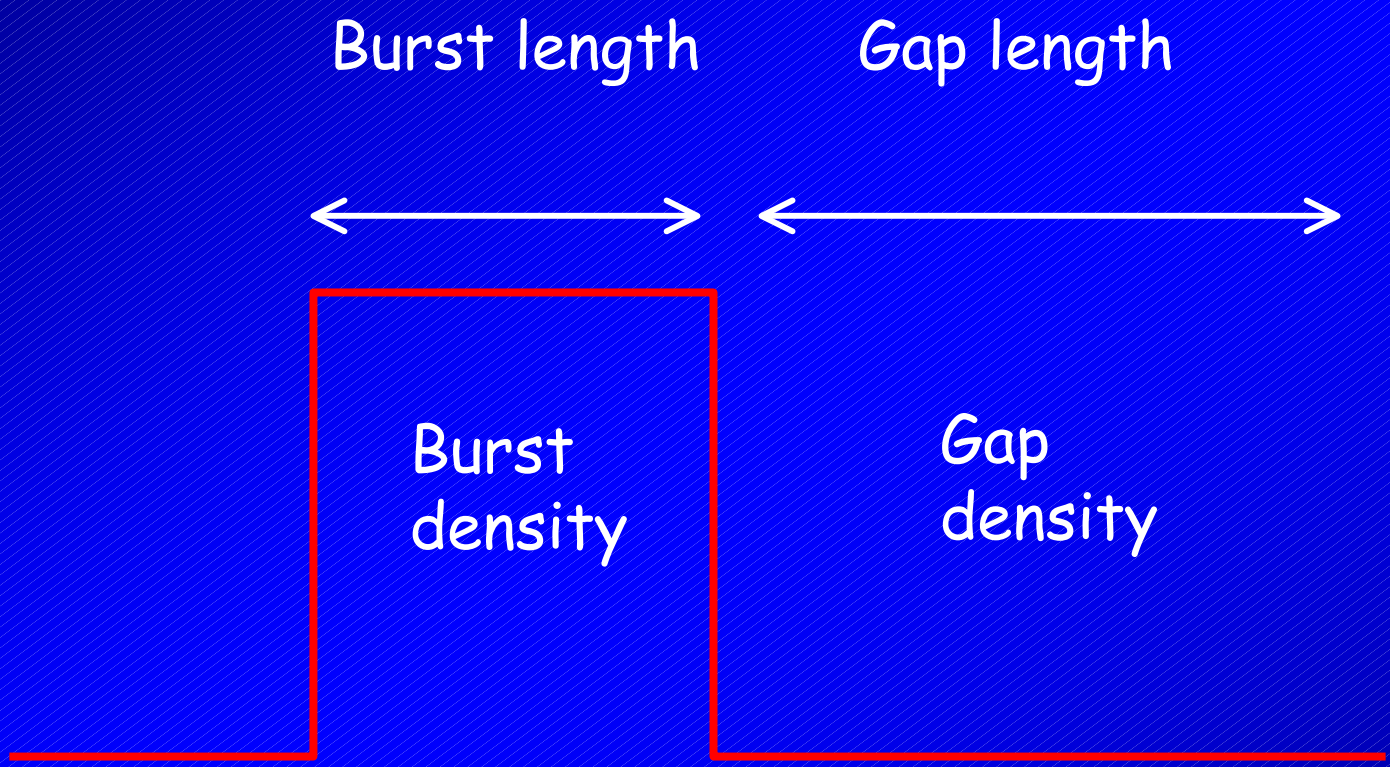
Efficient calculation



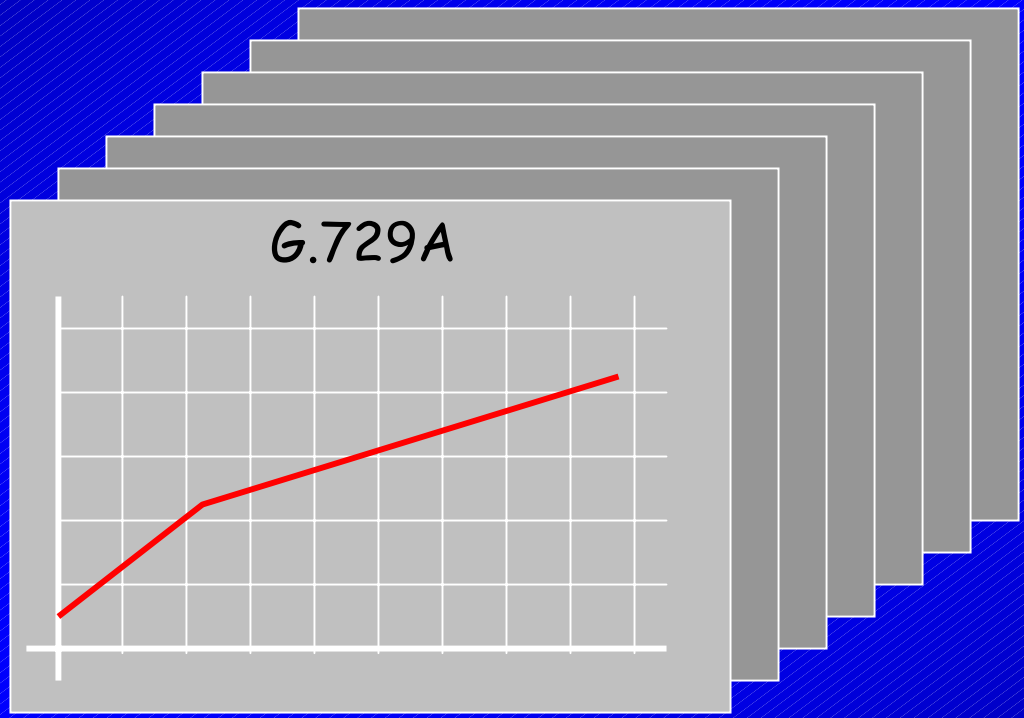
Gather detailed packet loss info in real time

Calculate call quality metrics at end of call Using extended E Model

Measured packet loss distribution

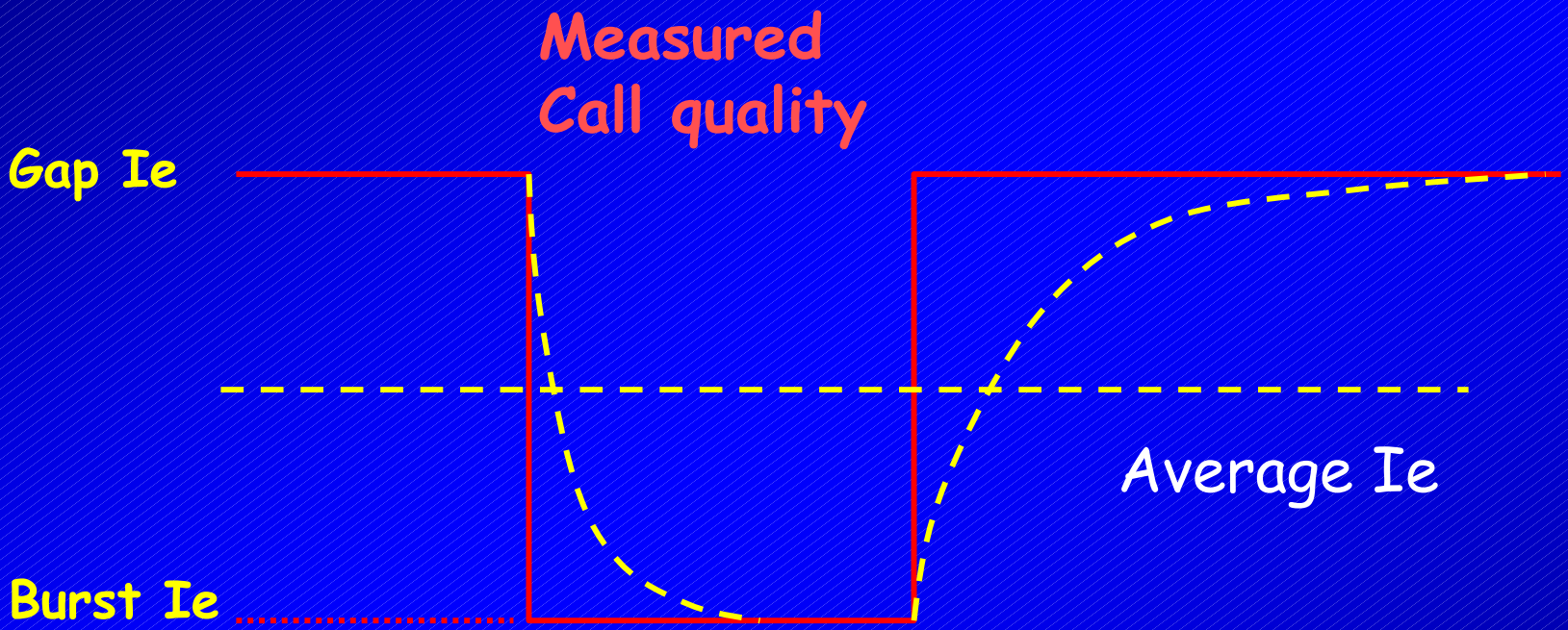


Packet Loss Model for each CODEC



Packet Loss Rate ->
Equipment Impairment factor (Ie)

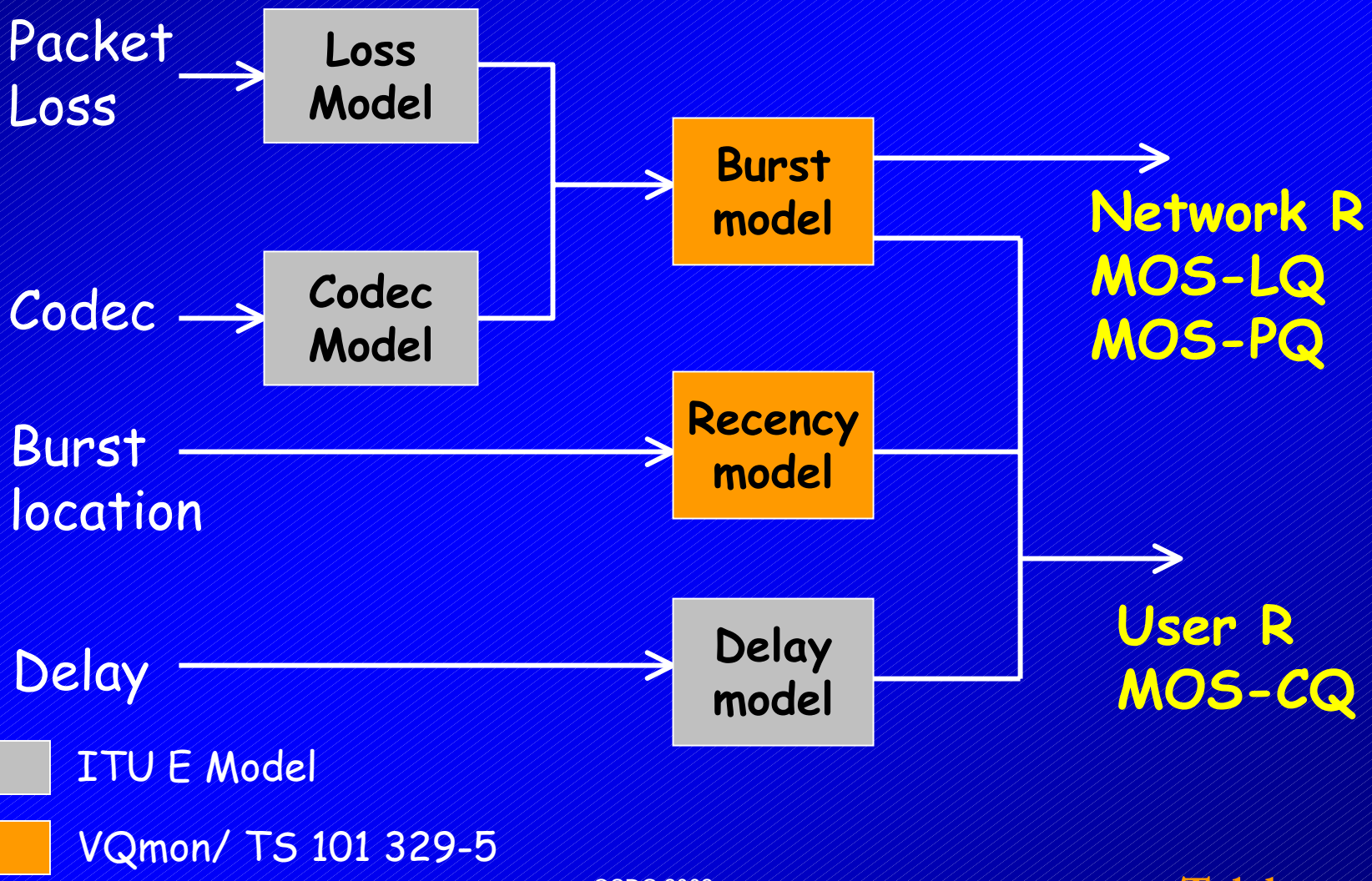
Applying Burst Model



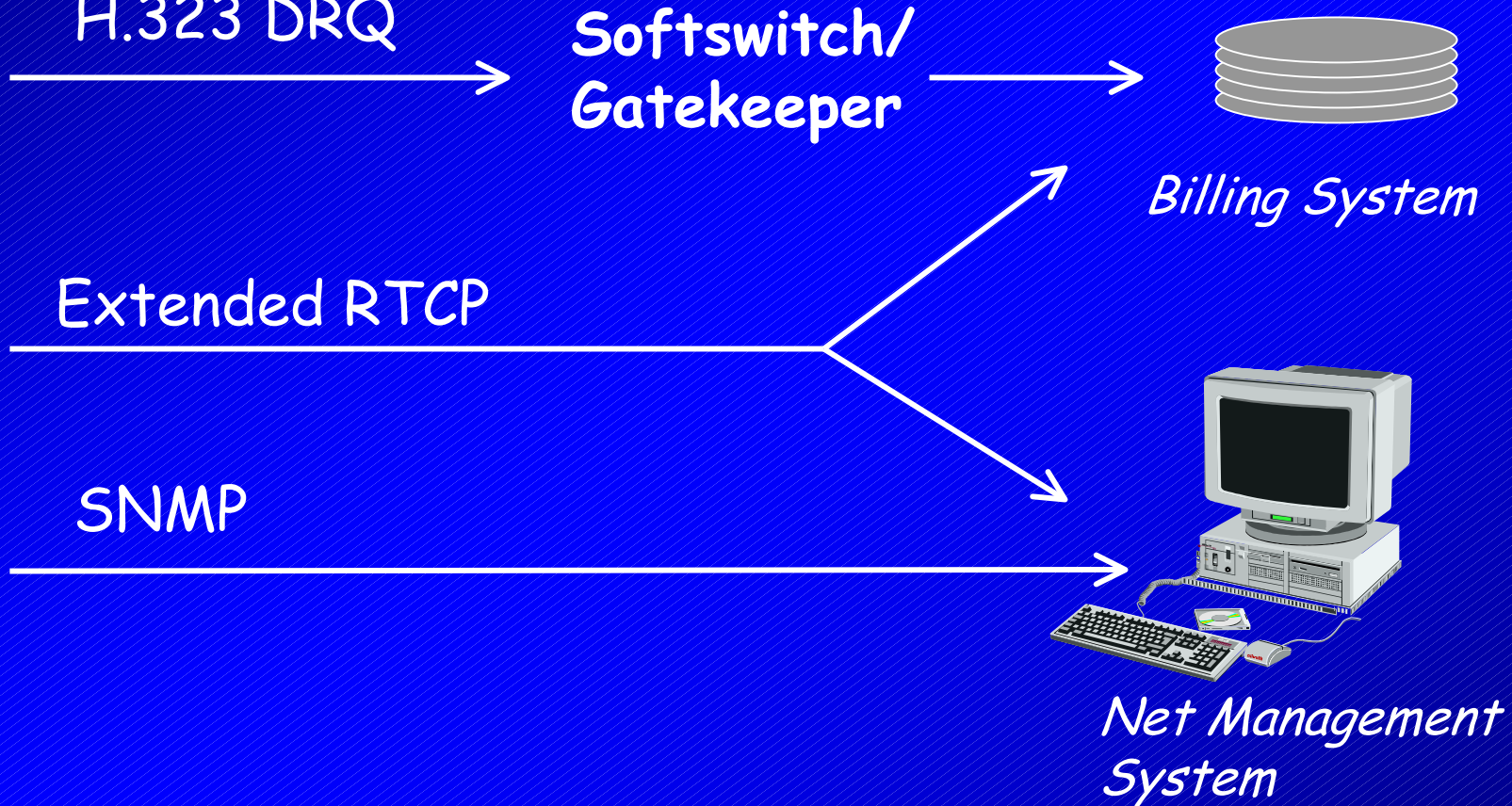
R = 94 – Ie - Id

MOS = f(R)

Extended E Model



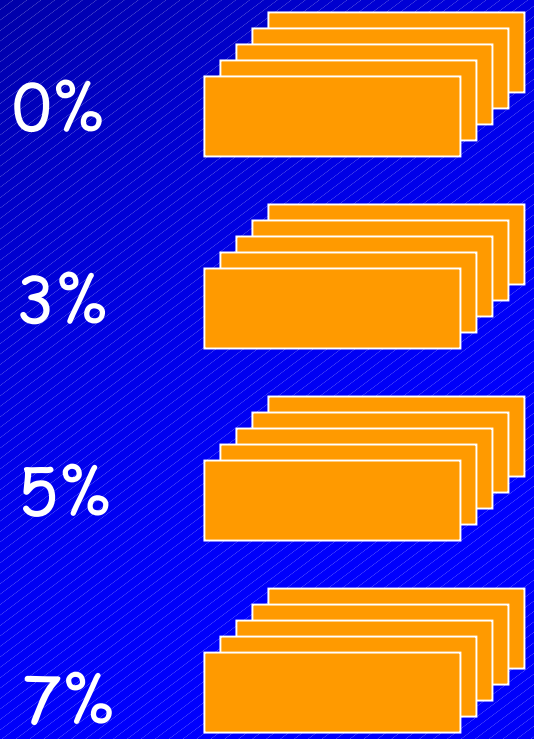
Extracting Metrics



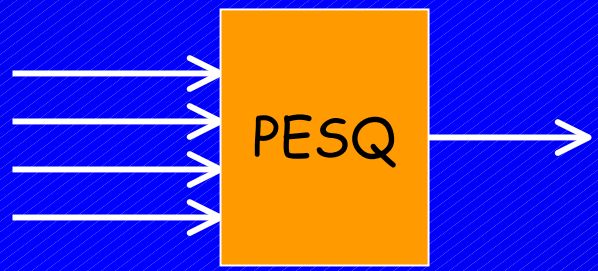
Implementation

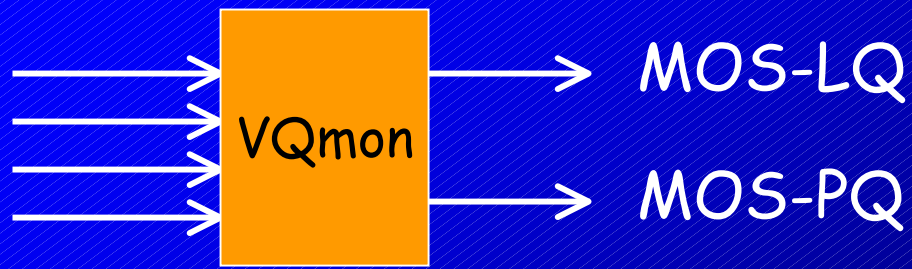
- Embedded agent
  - Software that can be integrated directly into IP Gateway/ IP Phone
  - Approx 0.000075 MIPS per VoIP call
- Stream monitor
  - Software that can be integrated into network analyzers, SLA monitors…..
  - Approx 0.005 MIPS per VoIP call
  - Potential to monitor a Gigabit Ethernet using a 2GHz Pentium PC

Comparison with PESQ and Subjective Score

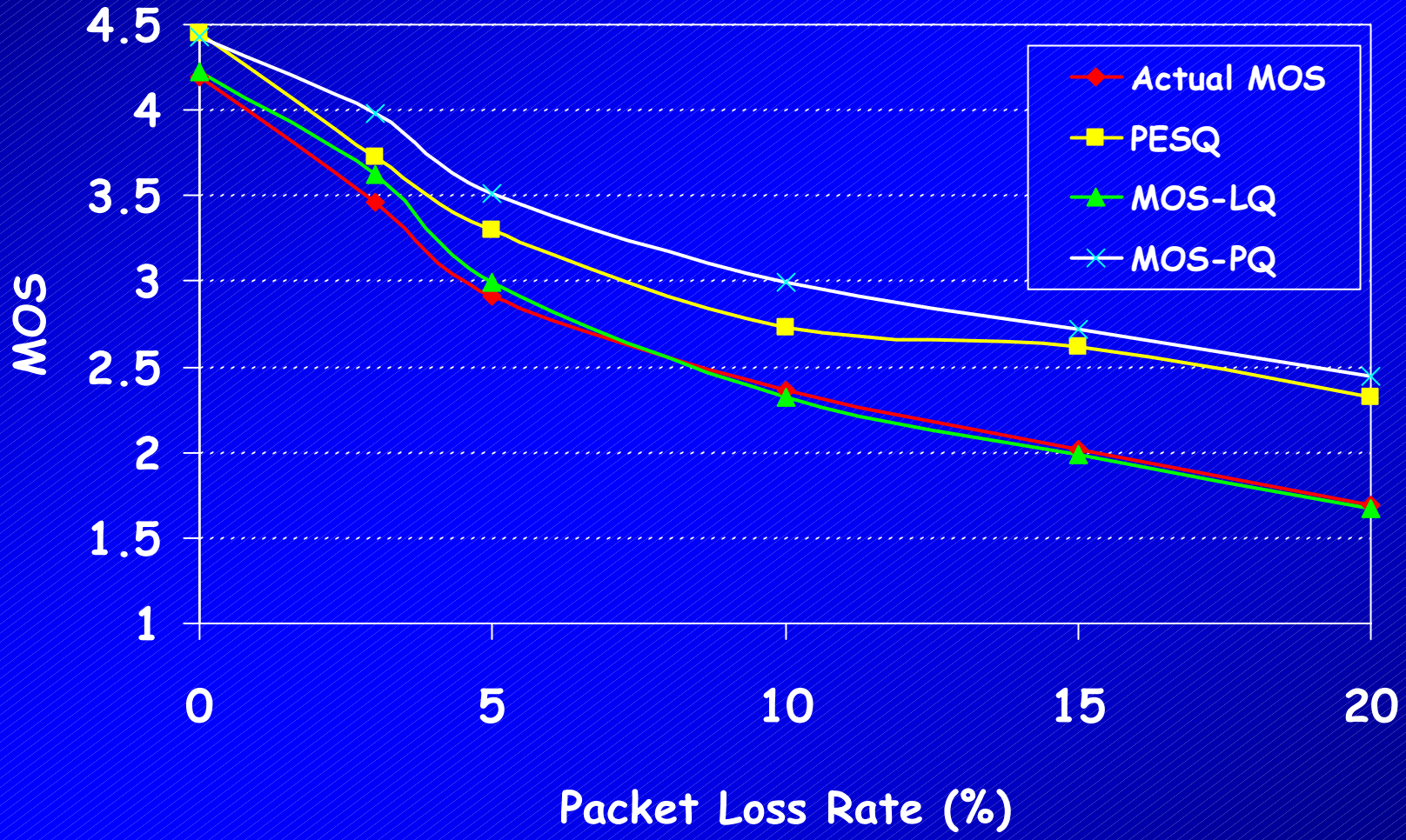


Subjective test data

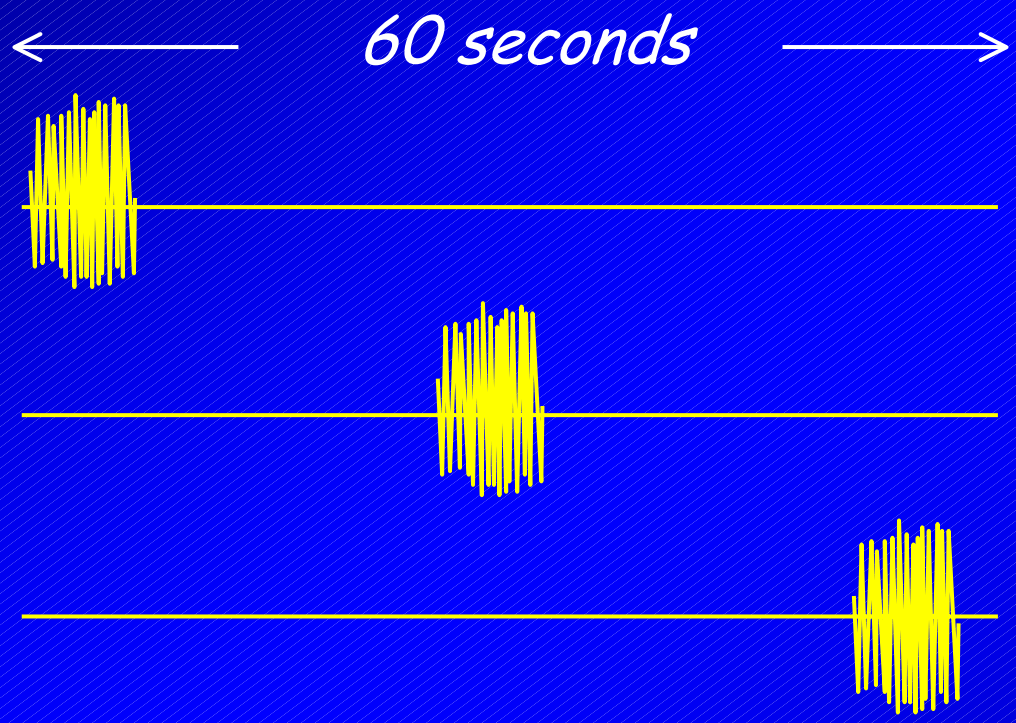




VQmon MOS-LQ and MOS-PQ

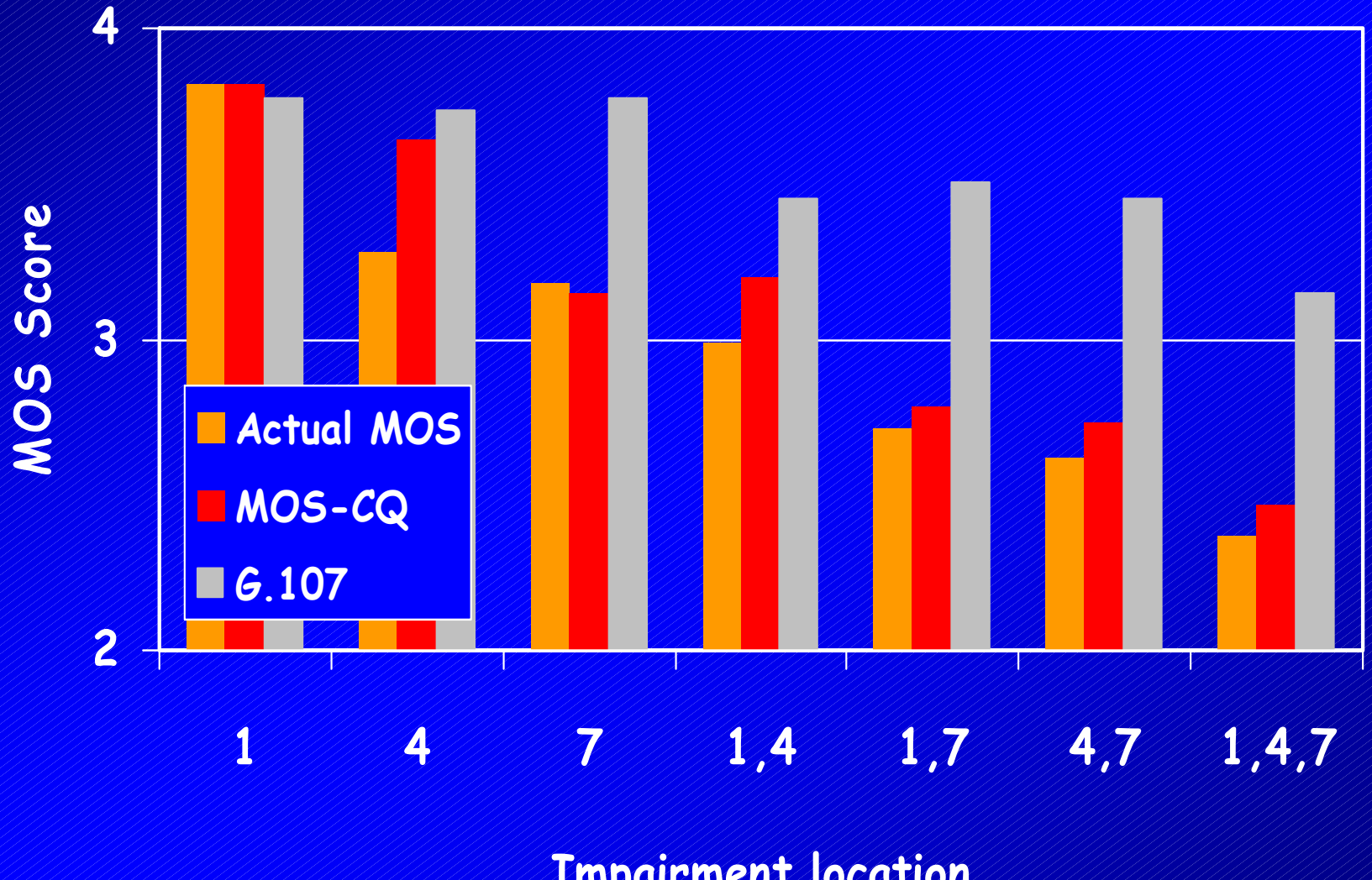


VQmon MOS-CQ vs G.107



Source AT&T
T1A1.7/98-031

VQmon MOS-CQ vs G.107



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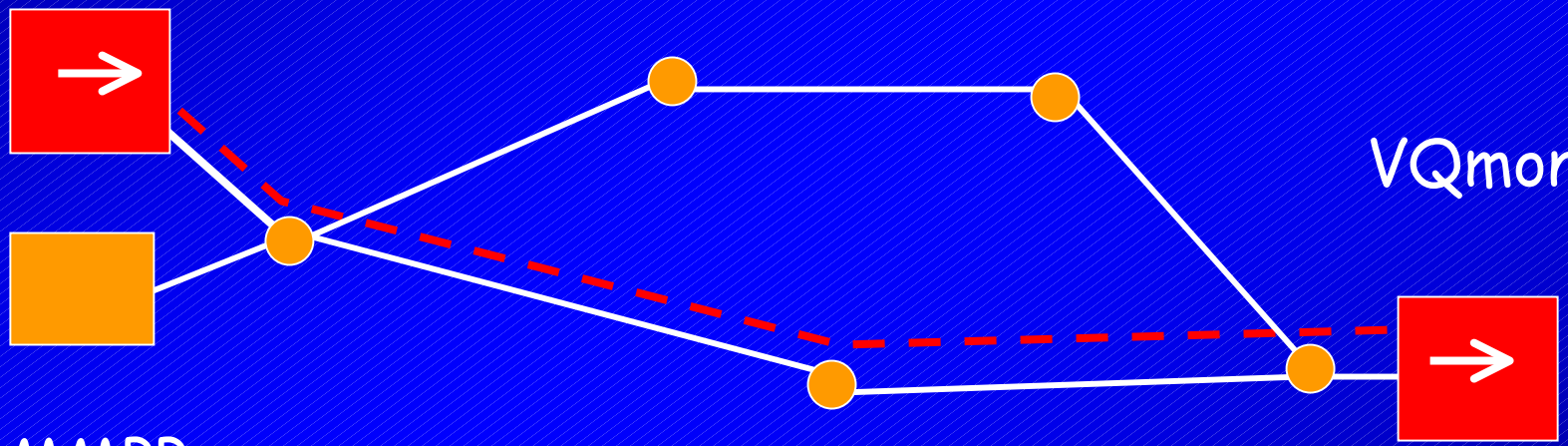
Other applications

- Modeling VoIP Service Quality
- Identifying network problem type and location

VoIP Service Modeling

Test call

Predict service quality with varying voice/data traffic levels

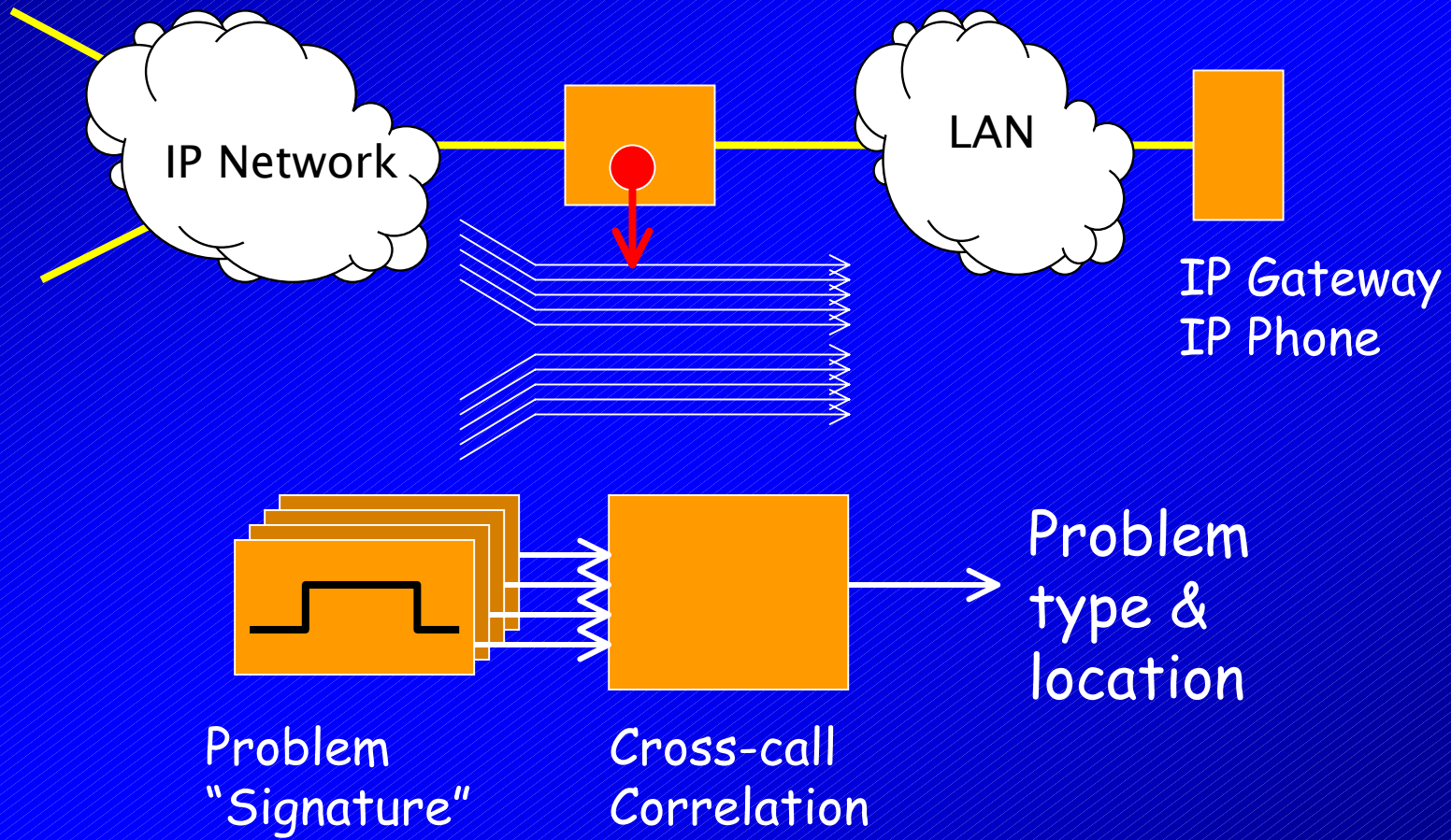


VQmon

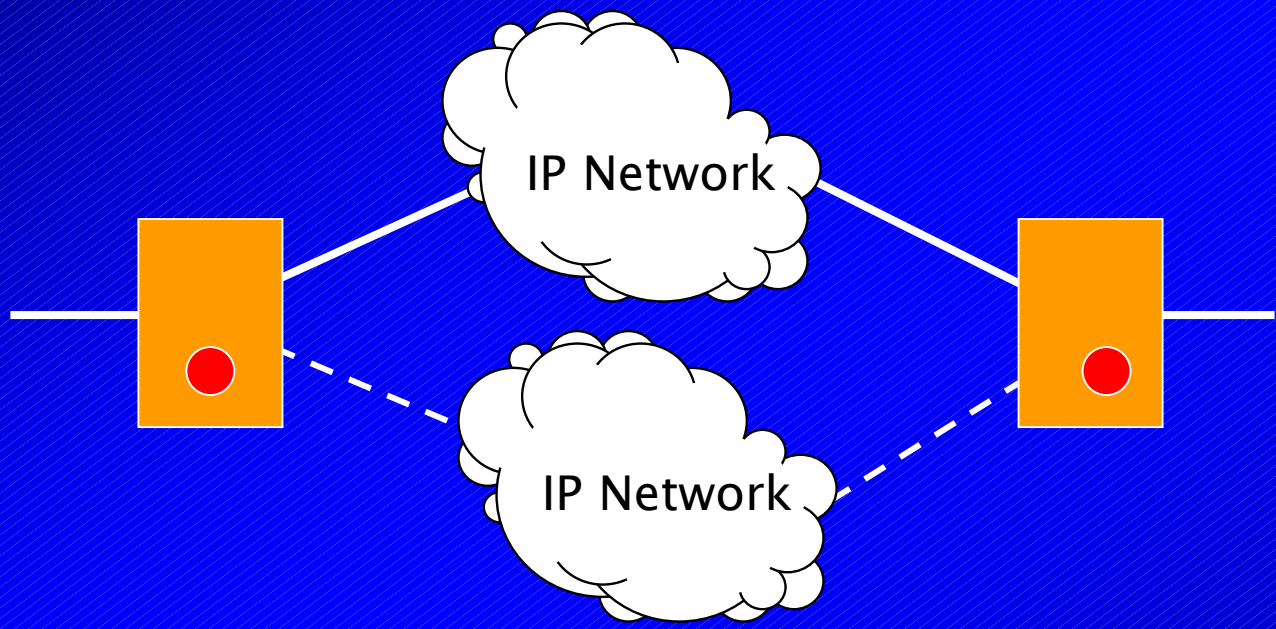
MMPP Traffic model

IP network model – CBQ, RED, WRR, MPLS etc.

Locating IP Network Problems



VoIP Route Selection



Select route based on estimate of subjective quality metric – not components
Monitor live calls on active route
Generate test calls on inactive route

Key Points

- Packet loss is Bursty
- Call Quality is Time Varying
- For accurate results on live calls must consider time varying impairments
- Need to use the same algorithm at different locations in the network to monitor SLAs, isolate problems