Methods for Mitigating IP Network Packet Loss in Real Time Audio Streaming Applications

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Featuring GatesAir's

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Connecting What's Next

Methods for Mitigating IP Network Packet Loss in Real Time Audio Streaming Applications

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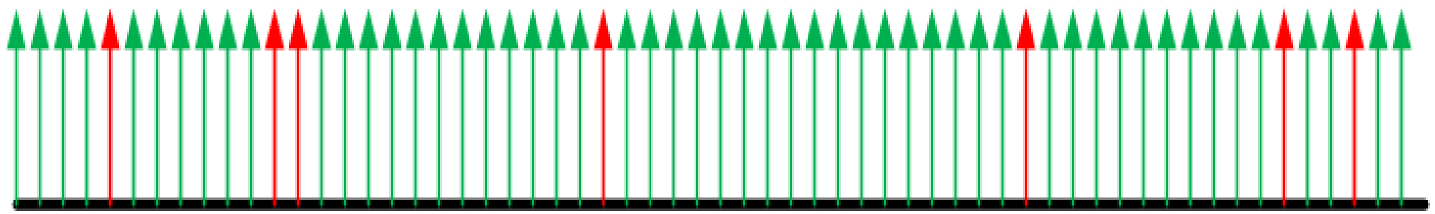
Overview

- Causes of IP packet loss: route flapping, transmission errors, congestion
- Unmanaged vs. managed network services
- Packet loss concealment methods: energy interpolation, noise substitution, replaying previous frame
- Concealment works well at very low packet losses
- Need to use correction techniques along with concealment for higher level packet losses
- Correction techniques are based on standard RTP over UDP protocol
- Bit error in packets

Understanding Packet Loss Model

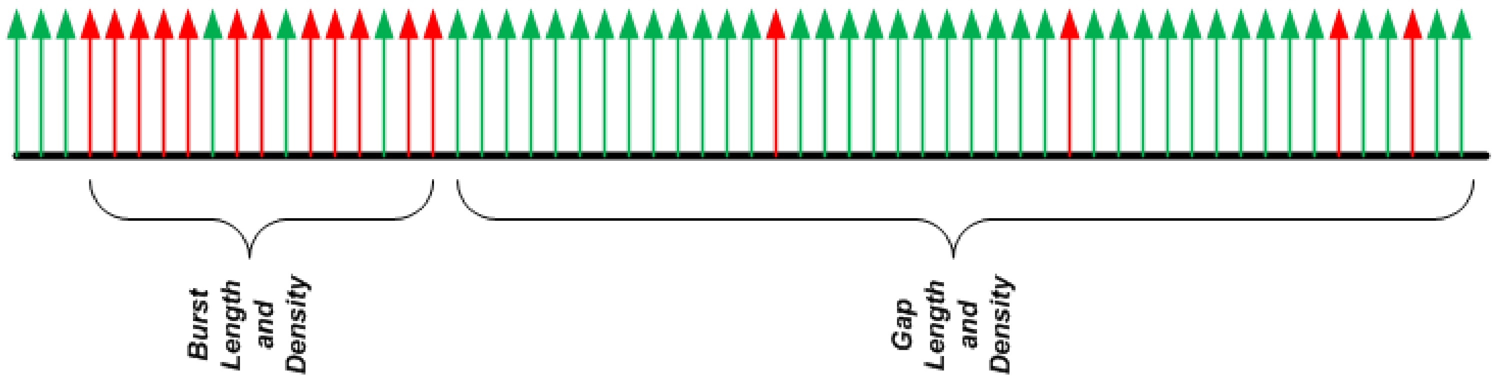
- Random vs. Burst Packet Loss
- Random Losses
  - Uncorrelated
  - Appear to be spread out



Burst Packet Loss Model

- Provides a more accurate view of network loss
- Two high level states: Burst State and Gap State
  - Burst State: correlated packet losses in burst
  - Gap State: isolated or random losses
- The burst packet loss of a network path can be characterized using:
  - Average Packet Loss
  - Burst and Gap Length
  - Burst and Gap Density

Burst Packet Loss Model (cont..)



- Burst Length and Burst Density are the key parameters
- Burst Density dictates level of randomness
- E.g compare 1% Average Packet Loss (PL) with Burst Density (BD) 80% versus1% Avg PL with BD 40%
- RFC 3611 provides guidance on model calculations

Evaluation of Techniques

- Single RTP stream with different FEC schemes
- Stream Splicing
  - Streams are duplicated and grouped
  - Independent routing of streams for network diversity
  - Programmable time delay per stream
  - Programmable FEC per stream
  - Programmable interleaving

RTP Forward Error Correction (FEC)

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- FEC packets are generated from a matrix of RTP data packets
- Both data and FEC packets are sent to the receiver
- FEC attempts recovery of lost data packets at the receiver
- Unrecovered packets are considered lost and concealment is applied
- Effectiveness of recovery depends on the packet loss model

FEC Matrix

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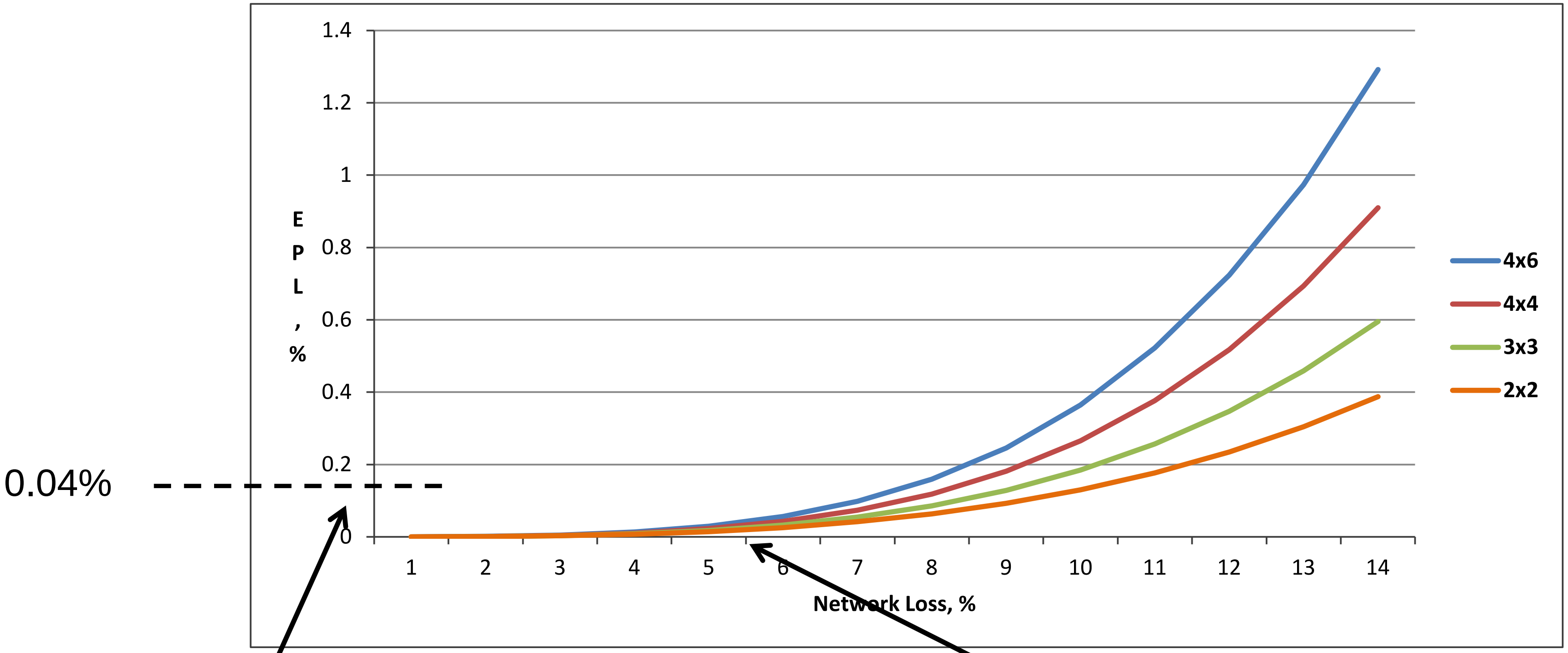
	Col 1	Col 2	Col 3	Col 4	FEC(x)
Row 1	1	2	3	4	XOR(1,2,3,4)
Row 2	5	6	7	8	XOR(5,6,7,8)
Row 3	9	10	11	12	XOR(9, 10,11,12)
Row 4	13	14	15	16	XOR(13, 14,15,16)
FEC(x)	XOR(1,5,9, 13)	XOR(2,6, 10,14)	XOR(3,7, 11,15)	XOR(4,8, 12,16)	

FEC Correction Capability for Random Loss

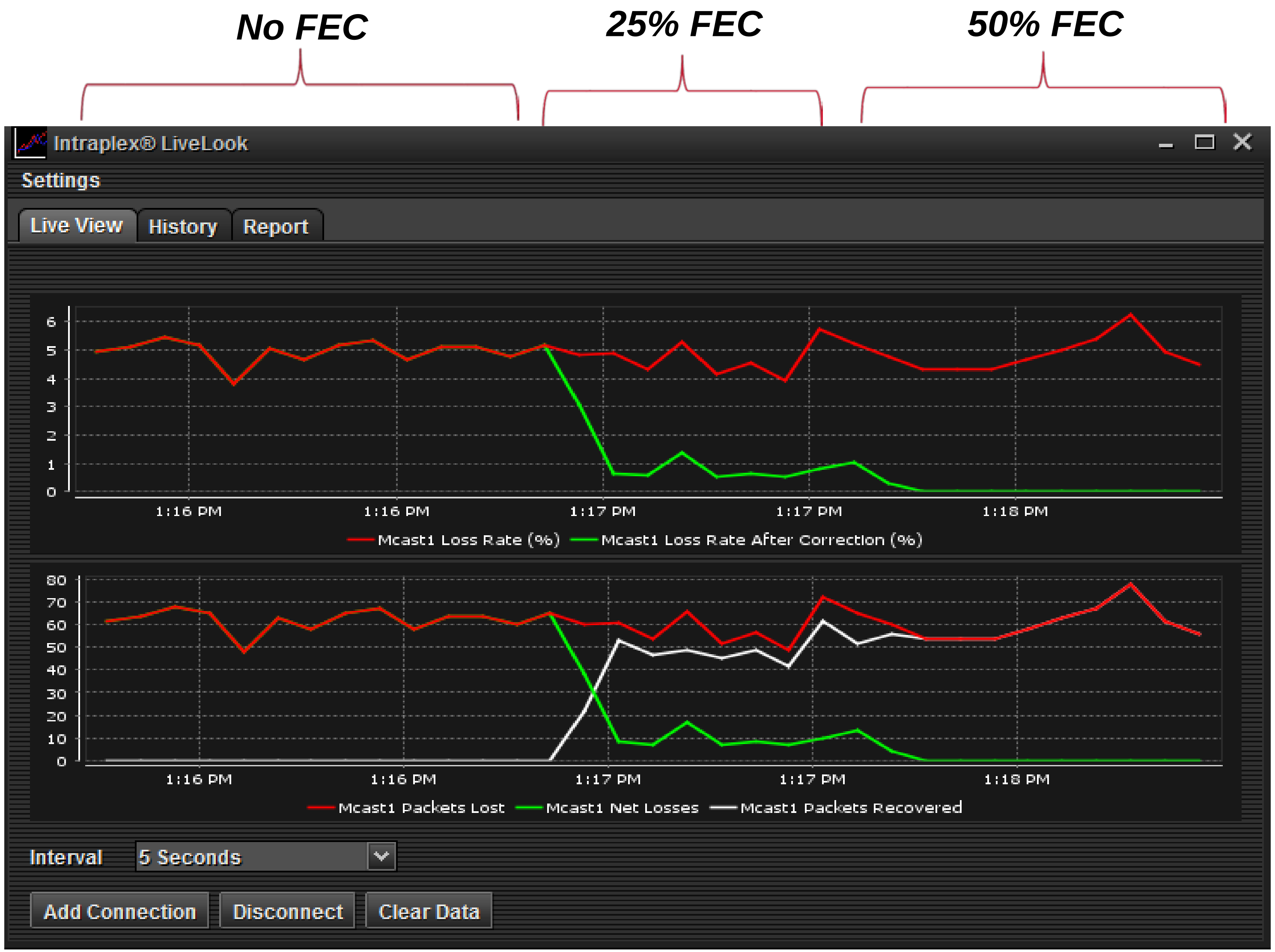


After 4x4 or 50% FEC

5% Network Loss

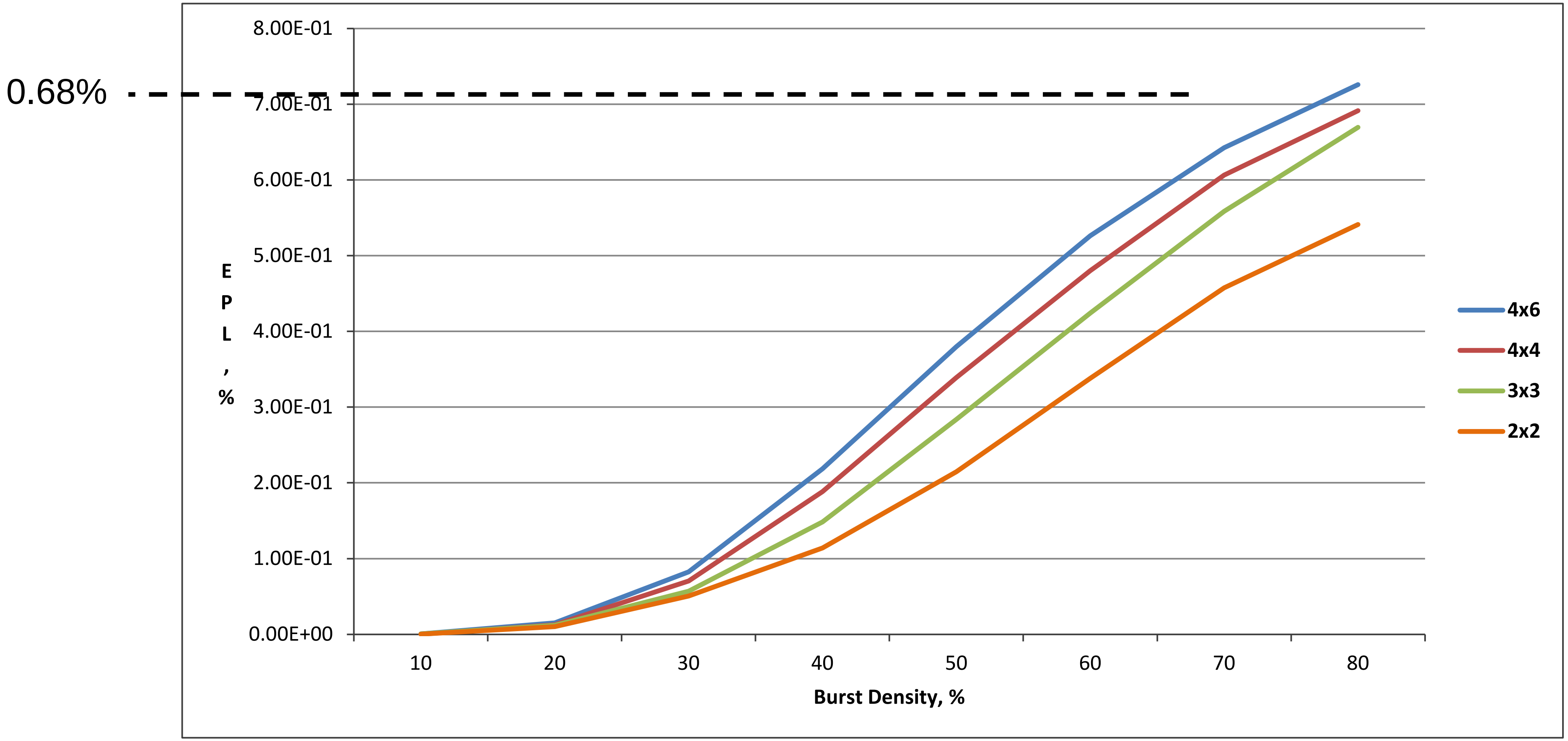
FEC Performance for 5% Random Loss

Router Configuration:
5% Random Loss

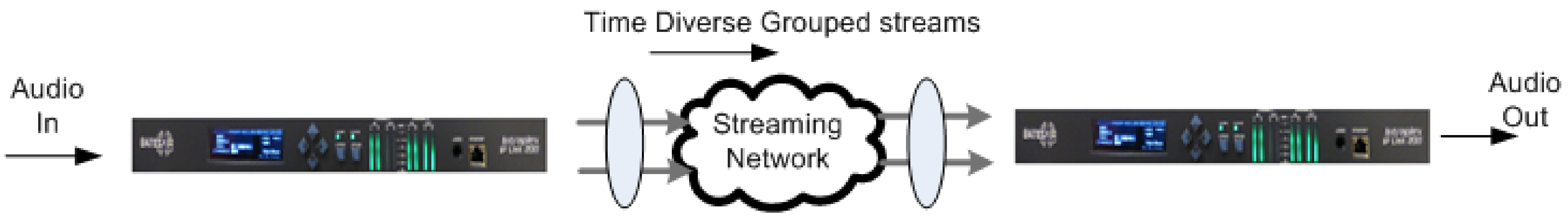


FEC Correction Capability vs. Burst Density

Average Packet Loss = 1%, Burst State Length= 16 packets



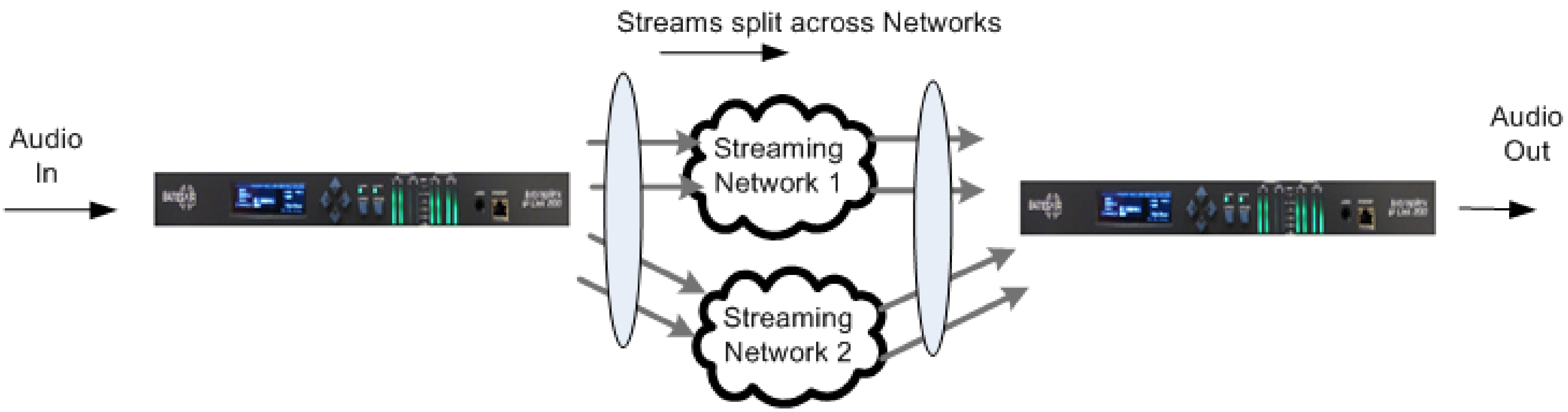
Stream Splicing – Single WAN



- Two time diverse streams
- Time diversity value is set based on receiver's calculation of burst parameter, in this case it is 400 mSec

1% Avg PL, 80% Burst Density Network Loss → **Two Time Diverse streams: 400 msec. EPL 0.07**

Stream Splicing – Multiple WANs



- Streams of the group are split across multiple diverse networks
- Provides "hitless" protection against failure of any single network
- Provides higher level of packet loss protection due to uncorrelated network paths

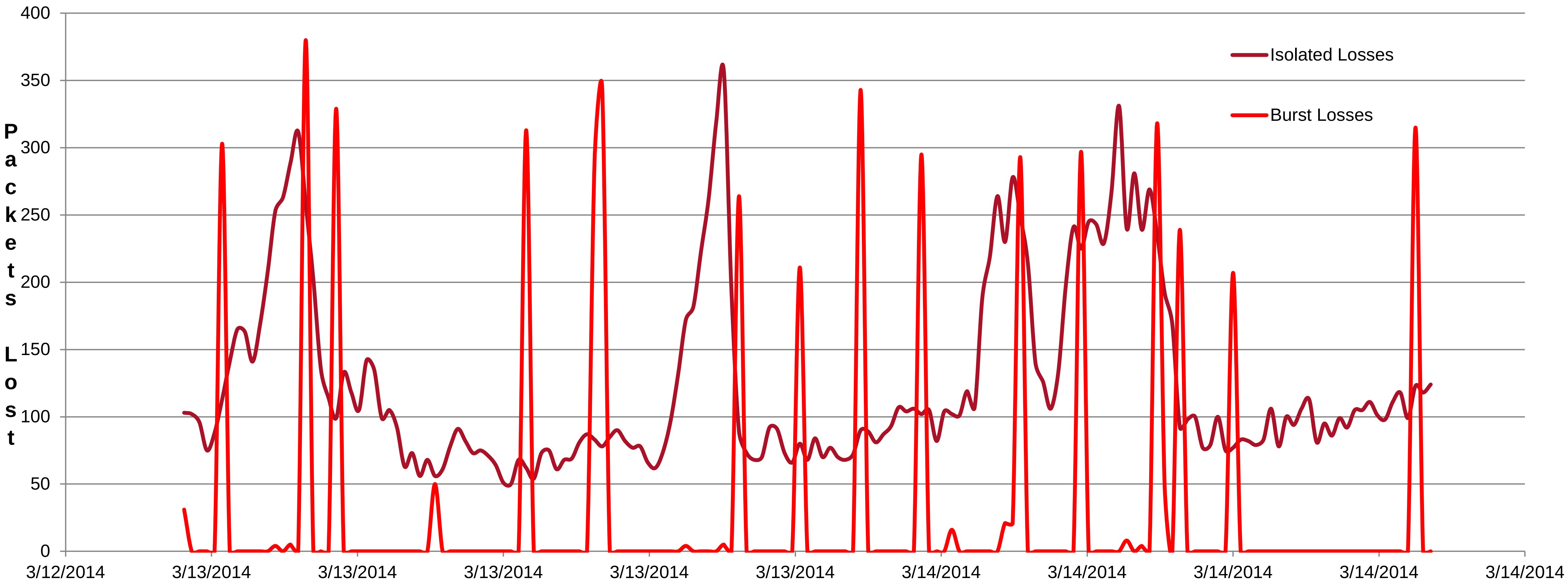
Time Diversity vs. Network Diversity

Avg Loss = 1%
Burst Length = 16 packets
Burst Density = 80%

Row	Group Configuration	EPL (%)	Additional BW (%)
1	One normal stream One stream with time diversity	0.07	100
2	One stream on WAN 1 One stream on WAN 2	0.009	100

Loss Distribution

Two systems connected via Time Warner at home and Verizon in the lab



Network Loss/EPL

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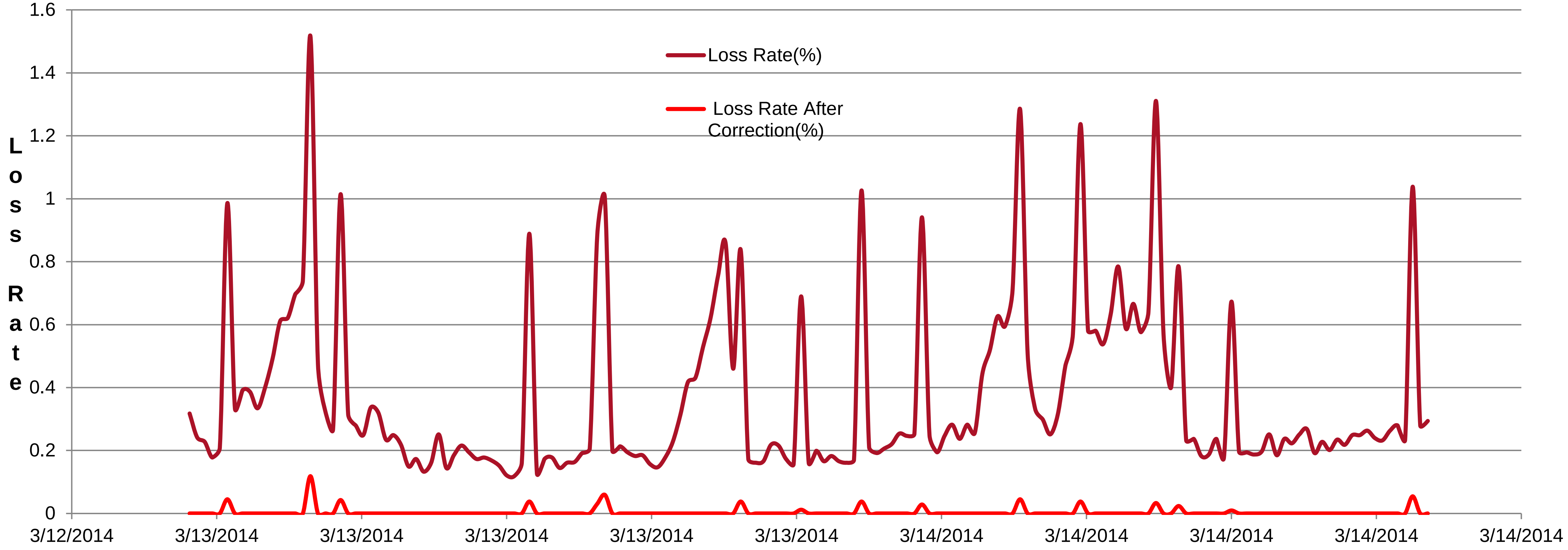
- Two streams with time diversity
  - Stream 1 time offset = 0, with 4x4 FEC
  - Stream 2 time offset = 1.25 secs



Summary

- Burst statistics model can provide insight of network's performance
- We can use this information to configure and/or adapt stream splicing configuration – i.e change codec rate, FEC level, or time diversity value
- Network diversity will provide the best overall packet loss protection
- For single networks, use time diversity for burst loss protection
- FEC schemes are effective for lower burst density and random losses
- FEC schemes can provide incremental benefit when used with diversity techniques
- Cost of IP network bandwidth is going down and the effectiveness of audio encoding algorithms is going up

Thank You