

97-0858R1: Factors Affecting Multiplexing Gain for VBR Voice

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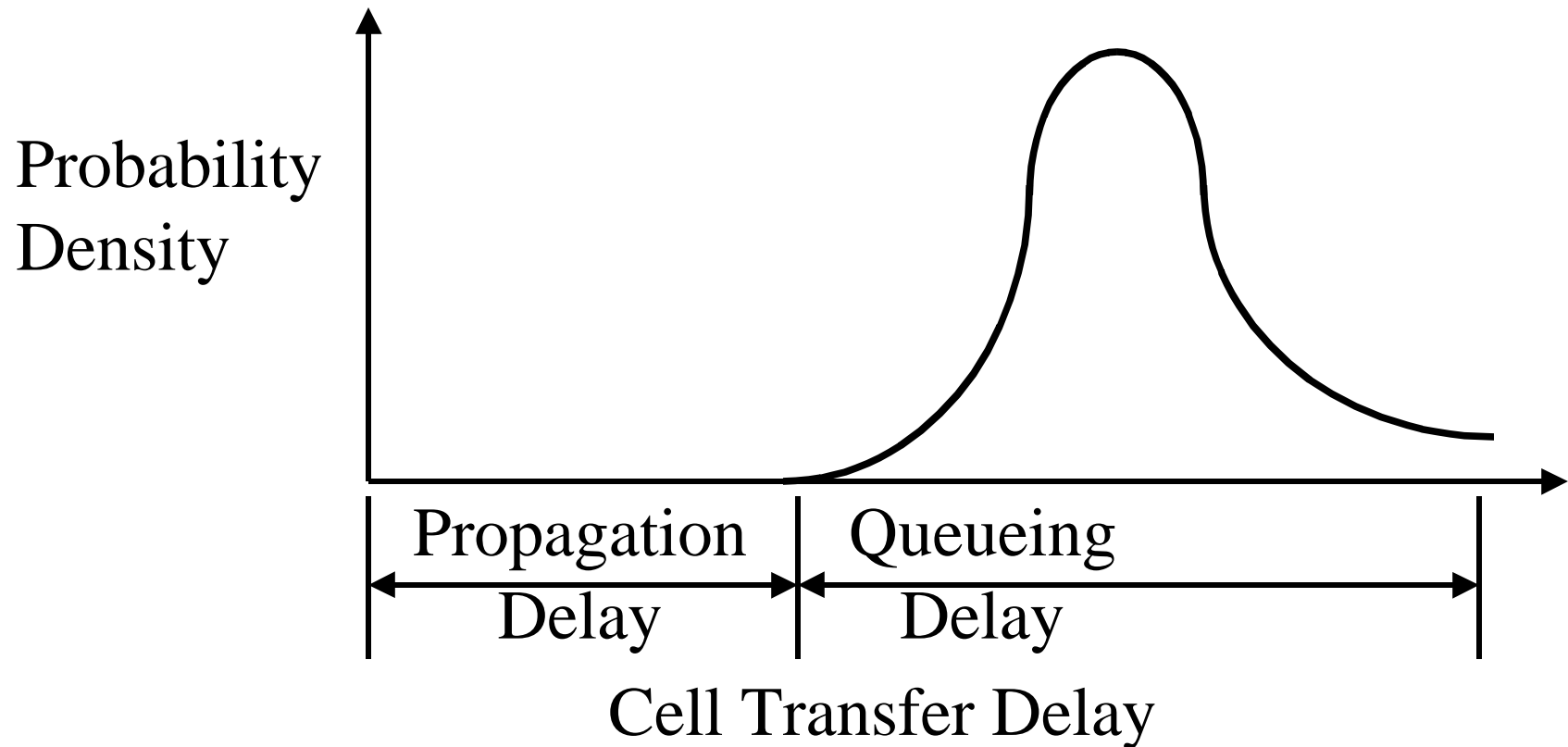


- ❑ Summarize previous study
- ❑ Analyze effect of:
 - ❑ End to end delay threshold
 - ❑ Activity Factor
 - ❑ On and Off time duration
 - ❑ Link Capacity
 - ❑ Acceptable CLR
 - ❑ Compression

Conclusion of the Previous Study [97-0608]

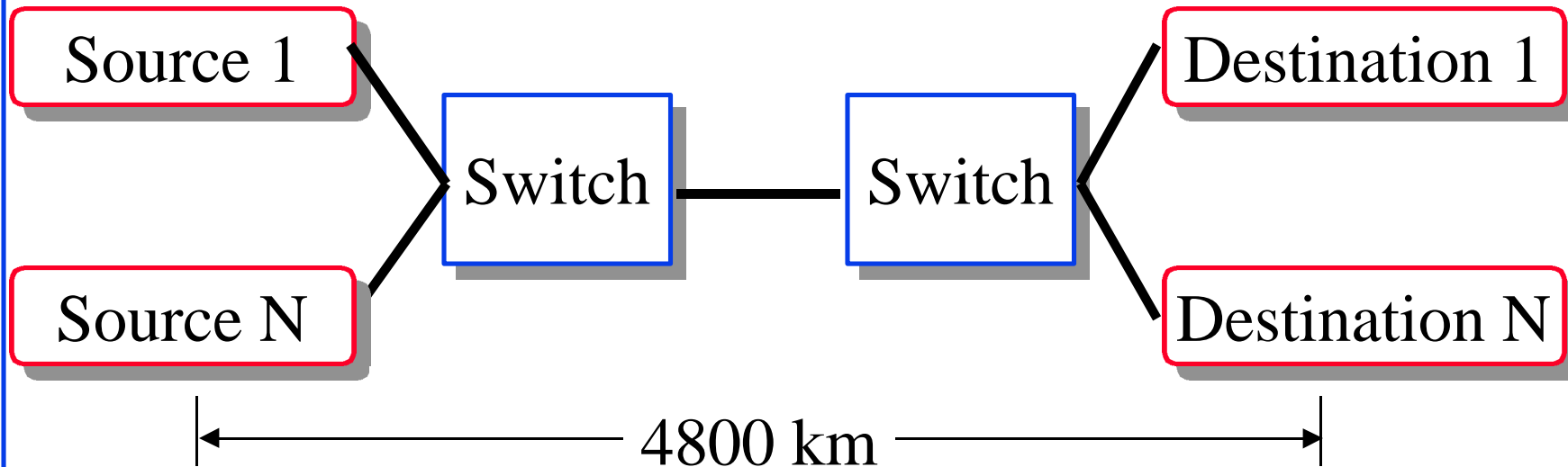
- ❑ Overbooking VBR voice causes queueing and performance becomes unacceptable.
- ❑ Instead of overbooking, it is better to fill the left-over bandwidth by ABR or UBR.
- ❑ Small buffering (1 or 2 cells per connection) is ok. Larger buffering makes delay unacceptable.
- ❑ Its really the maxCTD that determines the buffering at the destination. CDV is not important.

CDV



- For VBR voice, we need to specify Max CTD

N-Source Configuration



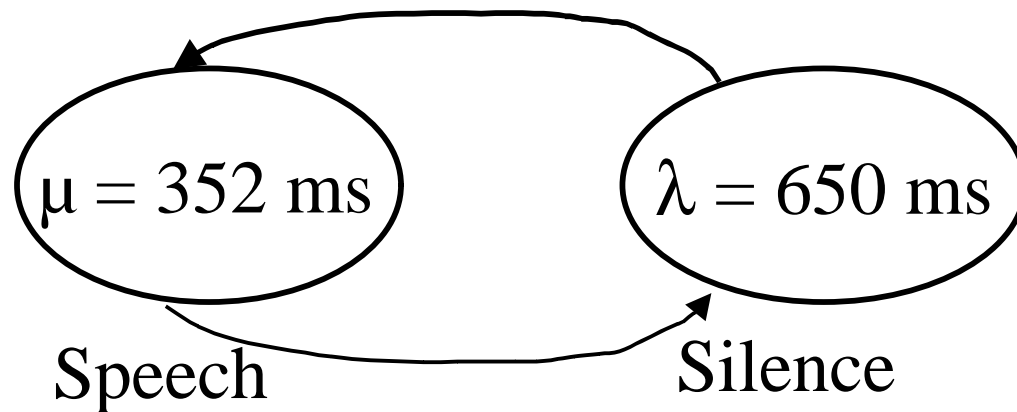
- ❑ Links between Switches = 1.544 Mbps (T1).
- ❑ *N* multiplexed 64-kbps VBR voice sources
Silence suppression \Rightarrow VBR
- ❑ Per-VC Queuing at the Switch

Simulation configuration

- Propagation delay : 24 ms
- Avg packetization delays: 6 ms + 6 ms (PCM)
- Assuming 5 switches on a typical path,
delay variation allowed at each switch
 $= (100 - 24 - 6 - 6)/5 = 12.8$ ms
- For single switch bottleneck case,
End-to-end delay $= 12.8 + 24 = 36.8$ ms
- We used end-to-end network delay bound of 30 ms
and 40 ms

Source Model

- ❑ 2-State Markov Model [Brady69]
- ❑ On-off times for silence and speech
- ❑ Exponential distribution for speech and silence state.
- ❑ Speech activity = 35.1%



Performance Metric

- ❑ Degradation in Voice Quality (DVQ) = Ratio of cells lost or delayed to total number of cells sent across.
- ❑ Cells lost or delayed = Cells dropped by switches + Cells arriving late

Parameters

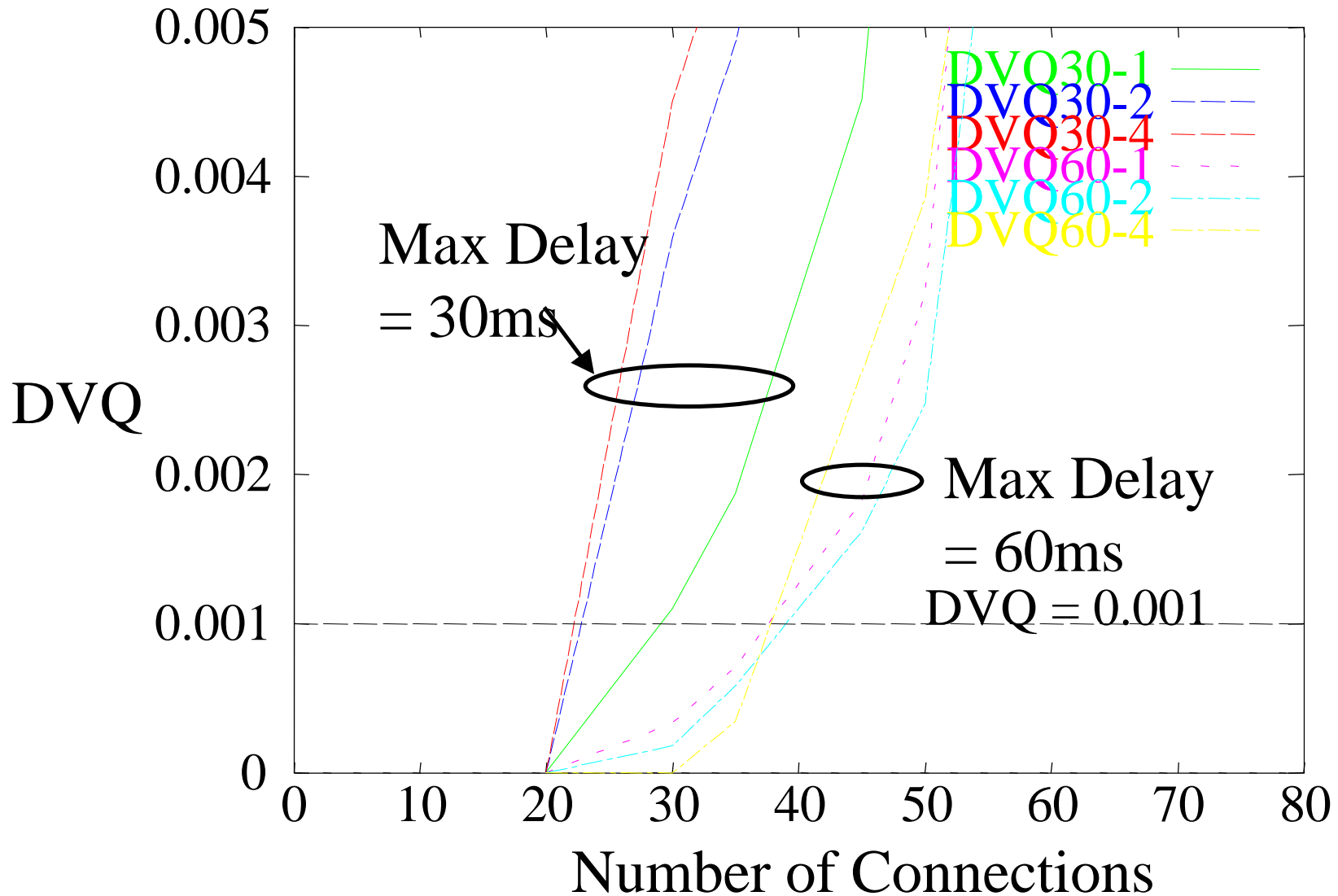
- ❑ Allowed end-to-end delay = 30 ms
- ❑ Allowed degradation = 10^{-3}
- ❑ Switch Buffers = 1 buffer/VC
- ❑ Average speech duration = 352 ms
- ❑ Average silence interval = 650 ms
⇒ Activity Factor = $352/(352+650) = 0.35$
- ❑ Link speed = 1.54 Mbps
- ❑ Voice rate = 64 kbps

In this contribution we study sensitivity to each of the above parameters.

Delay Thresholds and Buffers

- Given 1 buffer per VC, the delay cannot exceed a certain amount
⇒ Delay thresholds and buffering at switches are related (The factors interact)
- Conducted a 2×3 Full factorial experiment:
Max allowable network delay = 30 ms or 60 ms
Buffers per VC = 1, 2, or 4 cells
- **Conclusion:** Increasing the allowable delay or buffers increases the allowable multiplexing gain

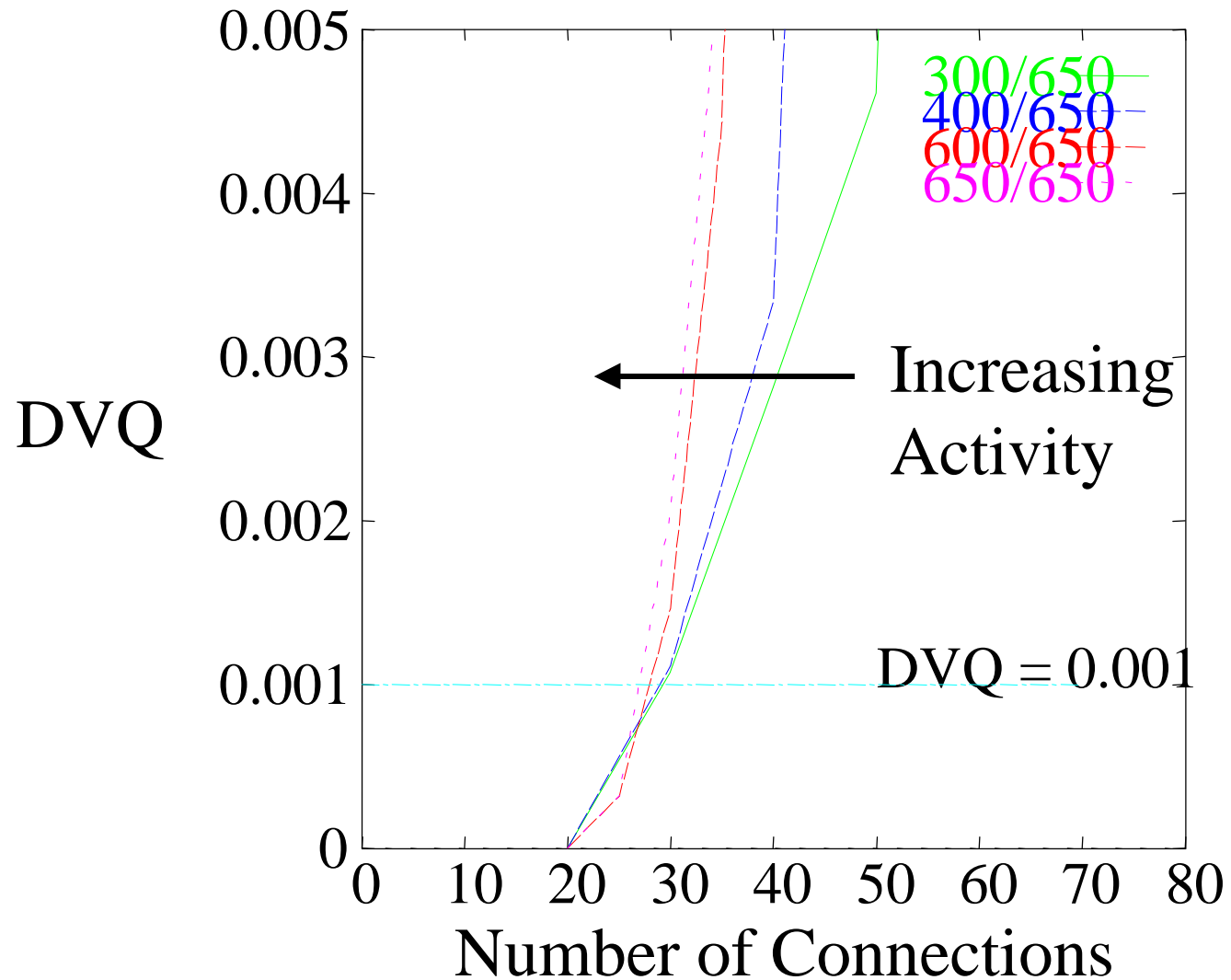
Delay Thresholds and Buffers



Activity Factor

- ❑ Activity Factor = $\text{Speech} / (\text{Speech} + \text{silence})$
- ❑ In the previous study:
Activity factor = $352 / (352 + 650) = 0.35$
- ❑ In this analysis:
 - ❑ Silence Interval = 650 ms
 - ❑ Speech duration = 300, 400, 600, 650 ms
- ❑ **Conclusion:**
 - Increase in the activity factor \Rightarrow Increase in load
 - \Rightarrow Increases the CLR and DVQ
 - \Rightarrow Decreases overall multiplexing gain

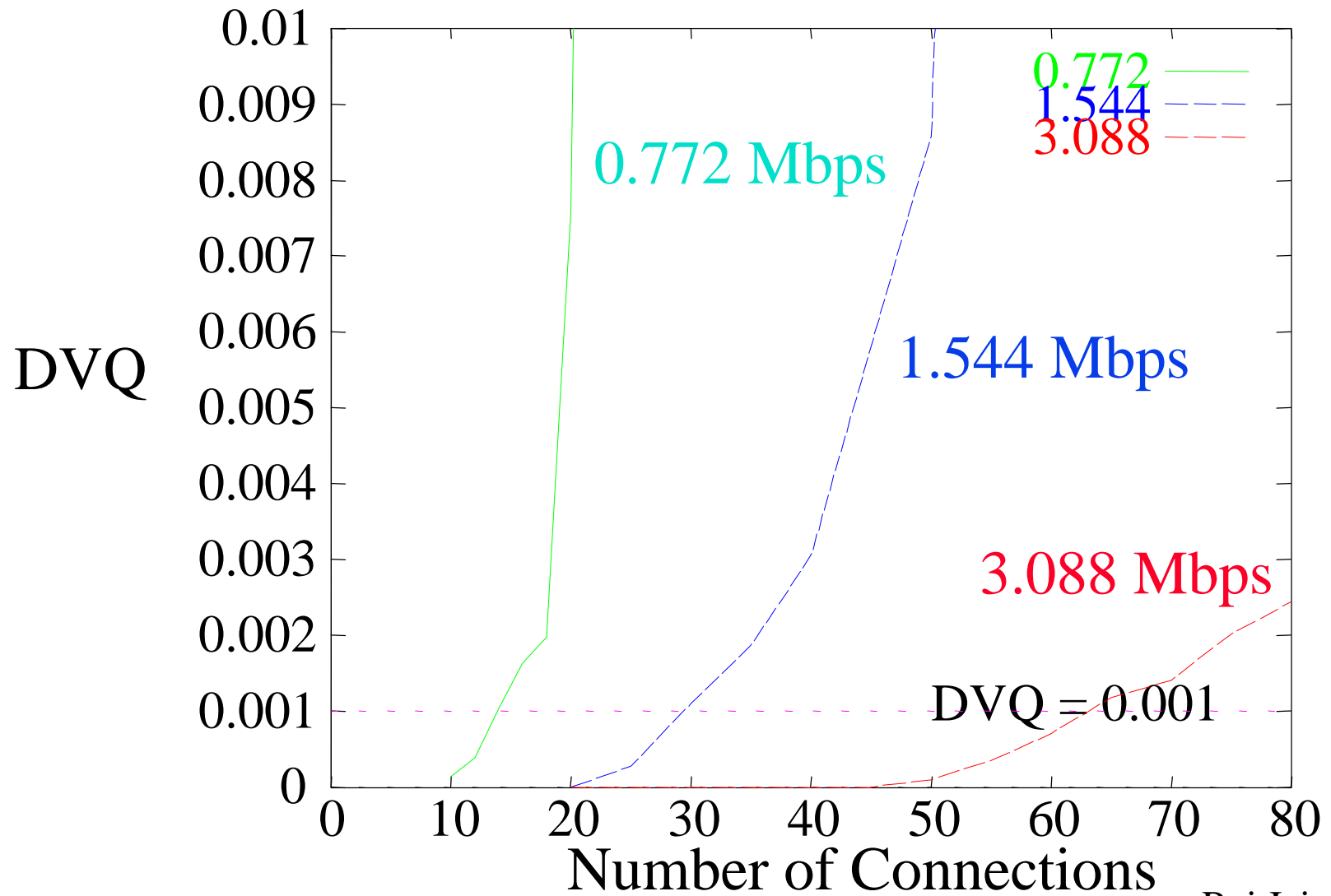
Activity Factor



Link Speed

- ❑ Parameter Values: 1.544 Mbps (default)
Tried 0.772, 1.544, and 3.088 Mbps
- ❑ Conclusion:
 - ❑ A larger pipe can buffer more source variations
 - ❑ The CLR and DVQ drop with a larger overall bandwidth
 - ⇒ Increases the overall multiplexing gain

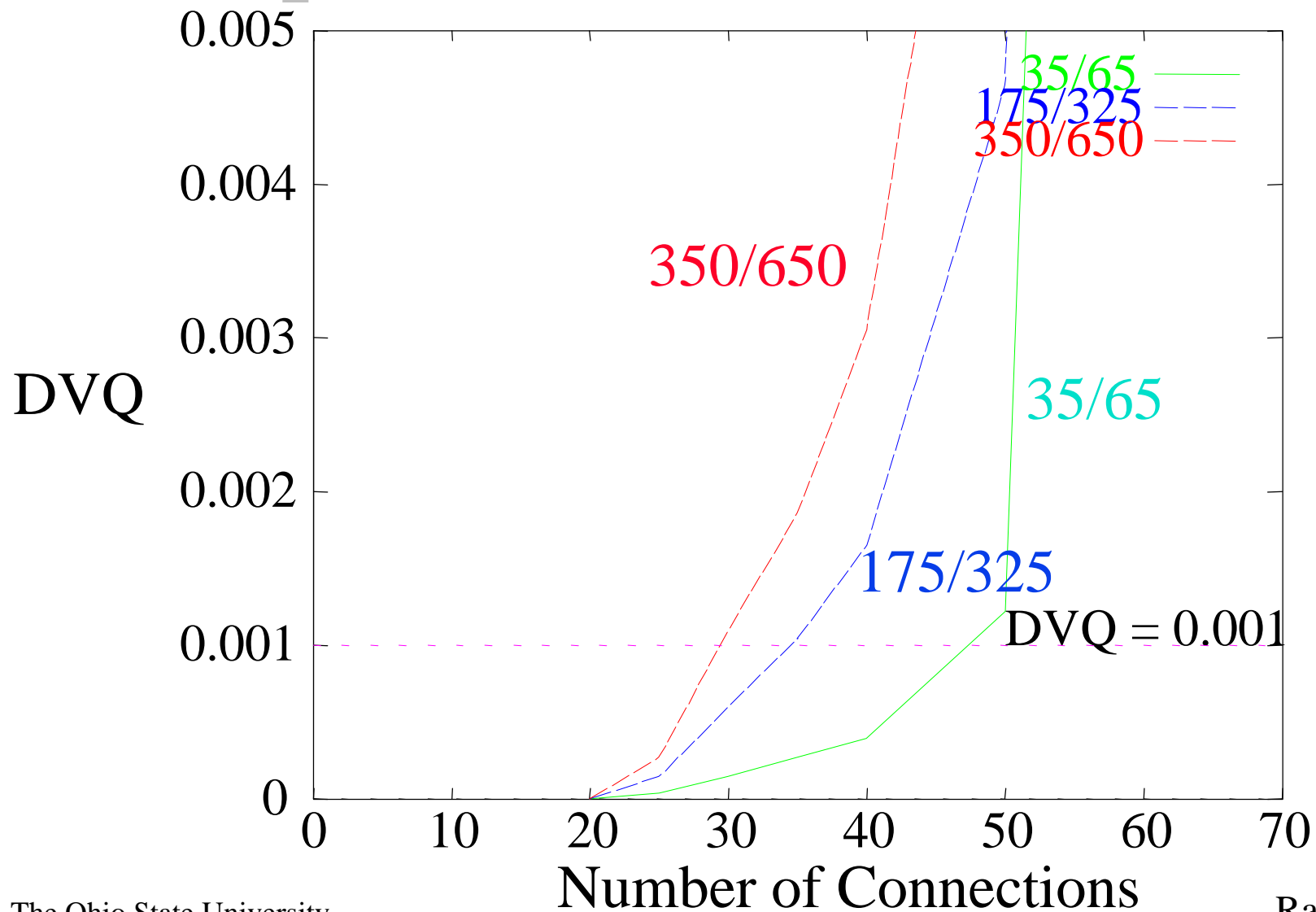
Link Speed



Speech/Silence Durations

- ❑ Goal: Increase speech bursts and silence intervals while keeping activity factor constant
- ❑ Parameter Values: 352/650 ms (default), Tried 35/65, 175/325, 350/650
- ❑ Conclusions: Longer speech burst
 - ⇒ More burstiness
 - ⇒ More cell loss
 - ⇒ Larger DVQ
 - ⇒ Lower multiplexing gain
- ❑ Fluid approximation gives incorrect results

Speech/Silence Durations



Compression

- ❑ Higher compression ratio
 - ⇒ Less bandwidth required per source
 - Also, more packetization delay
 - Also, acceptable cell loss ratio may be lower
- ❑ Parameter Values: 64 kbps (default)
 - Tried 16 kbps, 32 kbps
- ❑ Conclusion: Compression does increase the multiplexing gain (assuming that the same CLR is acceptable)

Summary



- ❑ Multiplexing gain improves with
 - ❑ Increasing the link speed
 - ❑ Decreasing voice rate (compression)
 - ❑ Decreasing speech interval
- ❑ For the same activity factor, the duration of speech has a significant impact on multiplexing gain.
⇒ Fluid approximation does not give correct results.