Effect of the Generation of MPEG-Frames within a GOP on Queueing Performance

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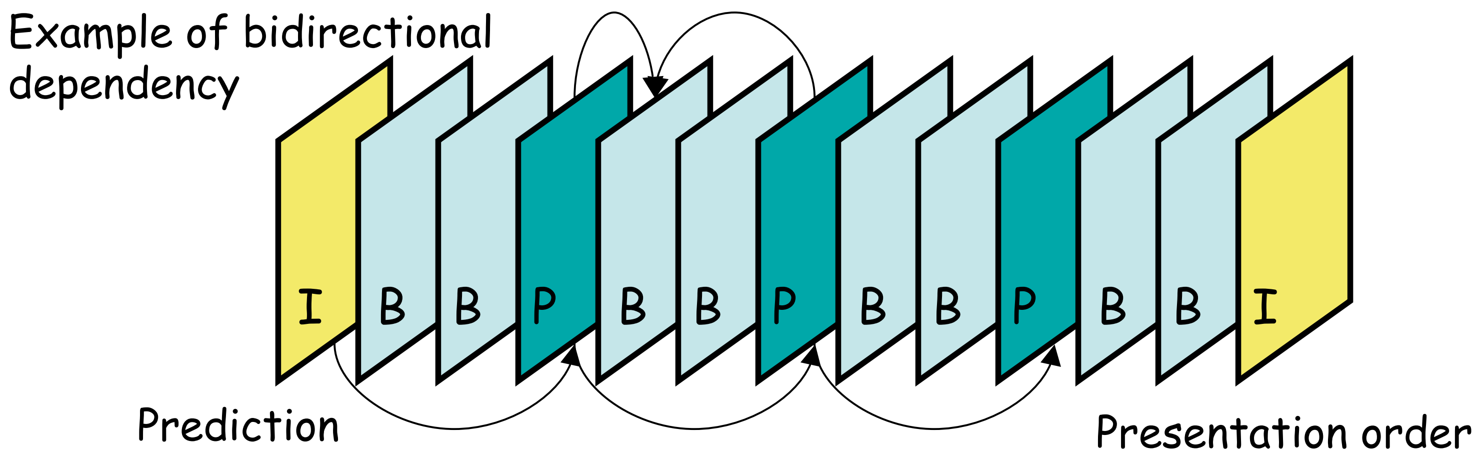
LNCS 2869/2003

GoP

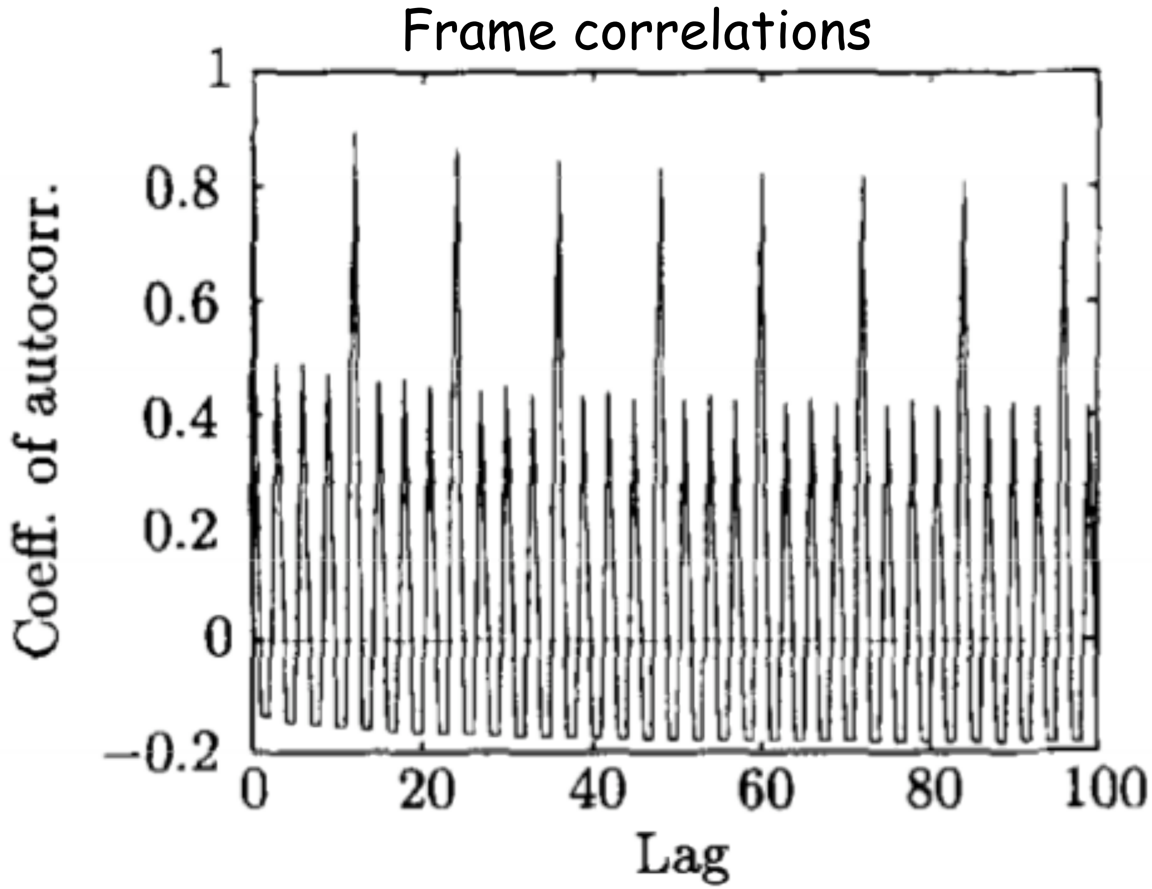
- *Group of Pictures*
- Around 1/2 sec each GoP
- Order
  - Presentation
    IBBPBBPBBPBB ibbpbb…
  - Codification
    Ej.: I bb PBBPBBPBB i BB pbb…
- Closed or Open GoP
- Broken GoP: lack of previous GoP

	I frame	P frame	B frame
Compression Ratio	Low	Good	Best
Random Access	Best	Hard	Hardest
Complexity	Normal	High	Highest



Video Traffic - Frame based

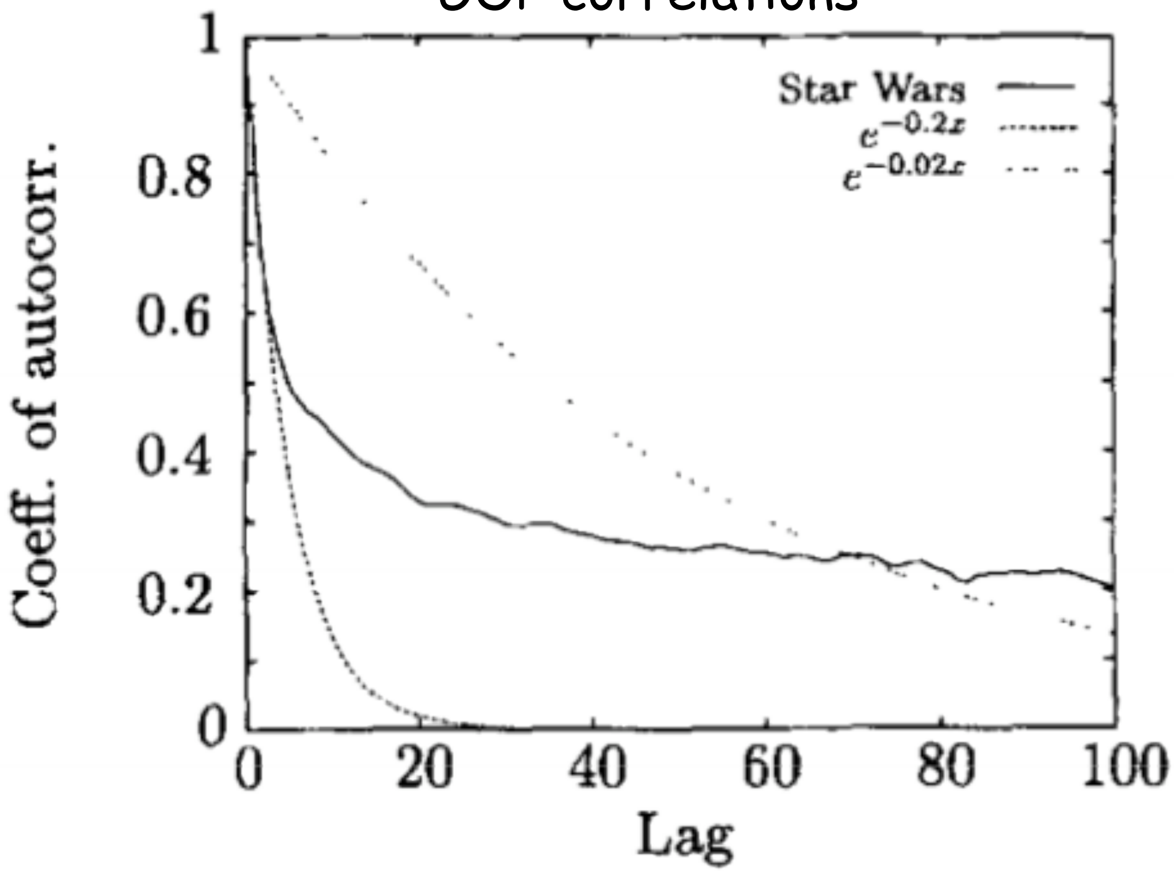
- Autocorrelation of frame-size process
- Periodic coding due to the GOP structure
- Complex to model



Video Traffic - GOP based

- Non exponential decay ACF
- Long-range dependence
- Loss of detail in lower scales (below GOP)

GOP correlations



Objective

- This paper compares the frame-level models and their impact on queueing performance
- Most video models do not generate below the GOP-level

Models in the literature

- Hierarchical
  - Scene/activity level
    - Time-scale of minutes
    - Change of the mean bit-rate (camera cuts)
  - GOP/frame level
    - Time-scale of milliseconds/seconds
  - Scene layer adds complexity
  - Subjective component in scene detection
- Non-hierarchical
  - Only GOP/frame level
  - Must incorporate a wide range of time-scales
  - Markovian, AR, Self-similar

Generating Frames within GOP

Solution HUA (1995)

- Background LRD process
- Matches the ACF of I-frames (inter-GOP correlation)
- Distribution transformation for each frame type (I, P and B)

HUA: LRD, h_I h_B h_P

Generating Frames within GOP

Solution KRU (1997)

- Hierarchical
- Inter-GOP correlation only for the I-frames process generation
- P- and B- frames as i.i.d. with Lognormal distribution

HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B

Generating Frames within GOP

Solution ROS (1997)

- GOP-size process
- Frame sizes by multiplying GOP size by a scaling factor
- Scaling factor = mean frame size / mean GOP size

HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor

Generating Frames within GOP

Solution ANS (2002)

- Three independent processes matching the ACFs of I-, P- and B- frames

HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes

Performance measures

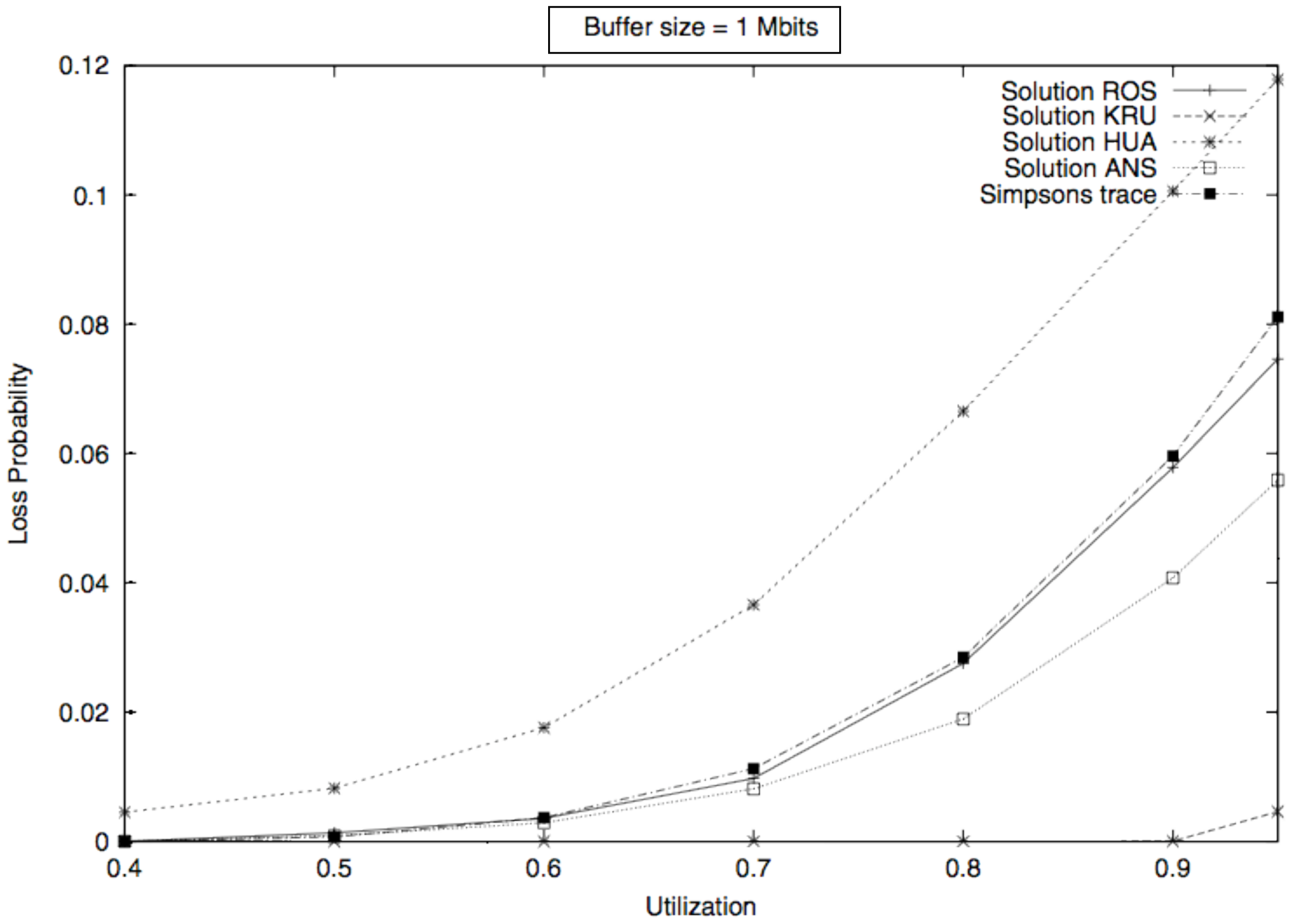
- Loss probability
- Mean delay
- Jitter

- They are supposed to have used several traces
- They only mention *The Simpsons* trace
- GOP G12B2, 40.000 frames

Loss Probability

- ROS the best one
- ANS underestimates
- HUA and KRU are terrible
- They don't say how do they change rho (change capacity?)

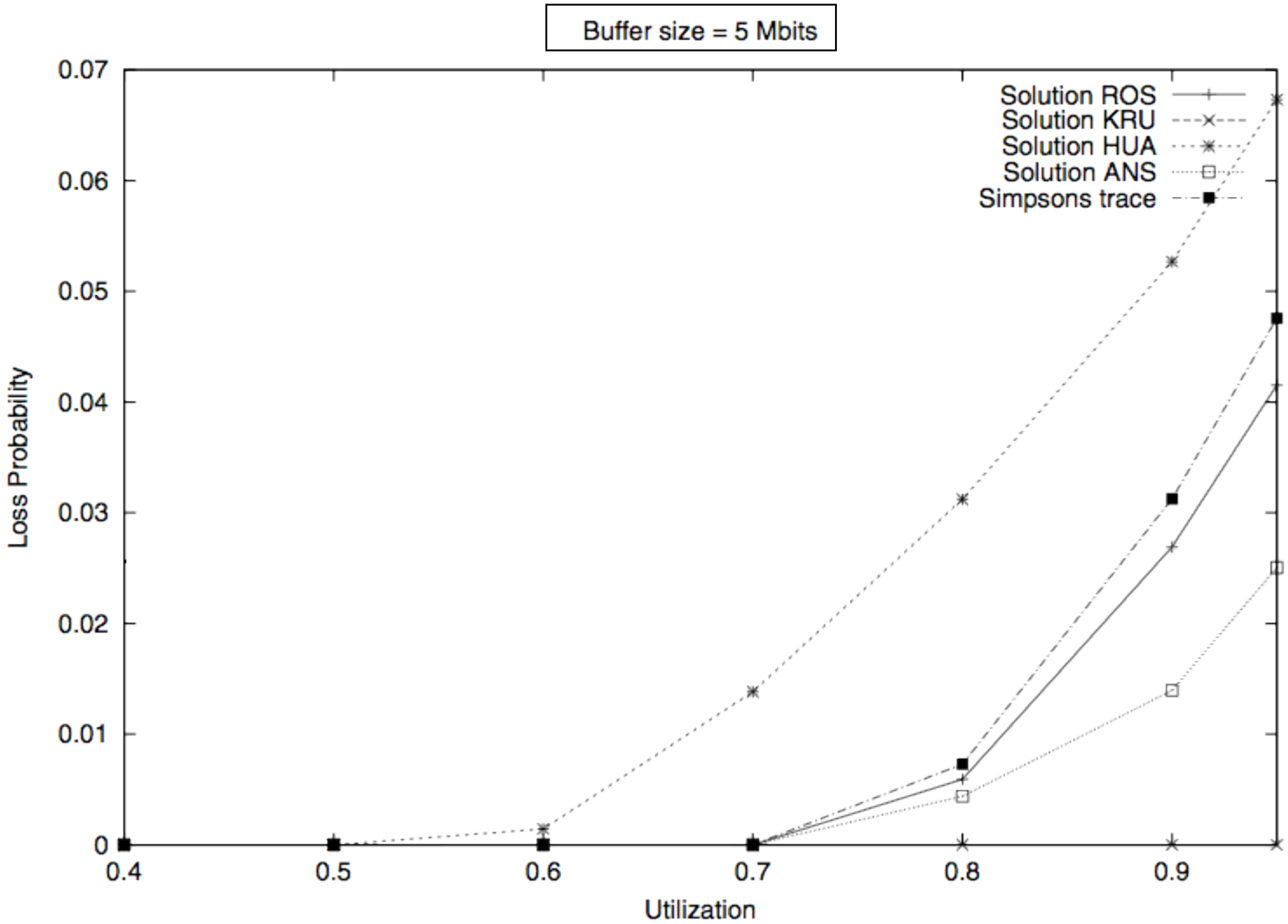
HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes



Loss Probability

- GOP-size process is dominant for loss performance

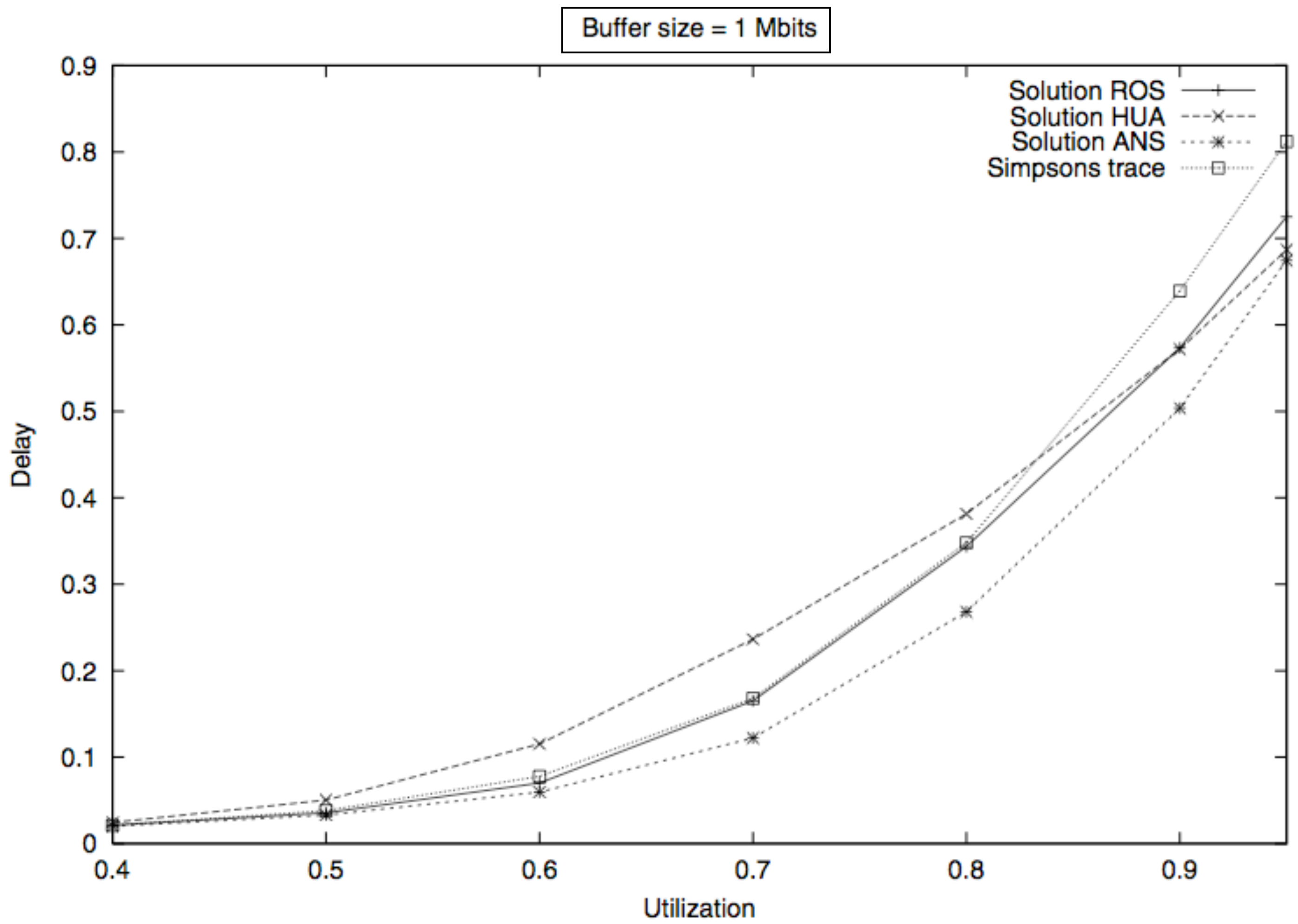
HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes



Mean Delay

- ROS the best, followed by ANS
- KRU out of range

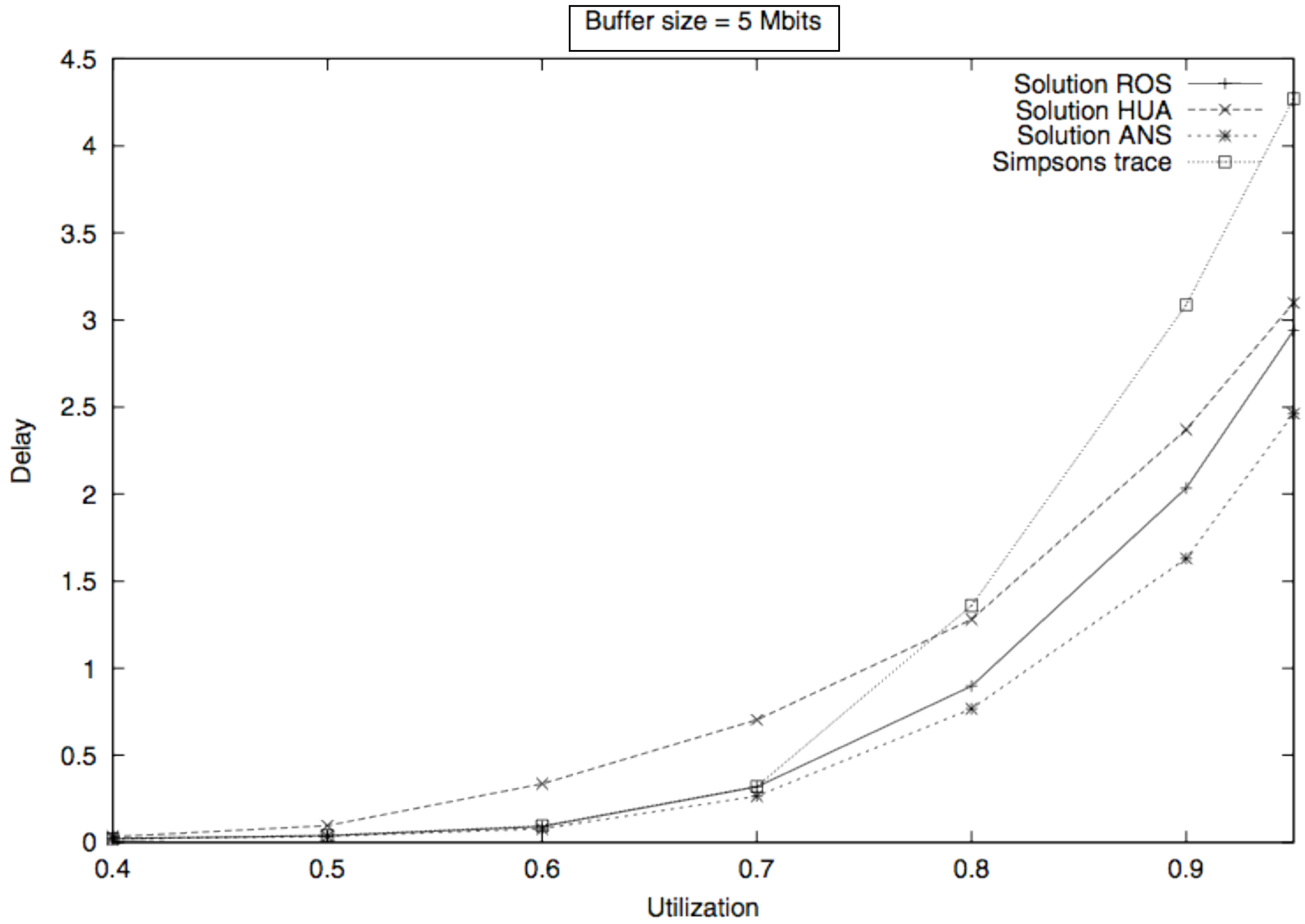
HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes



Mean Delay

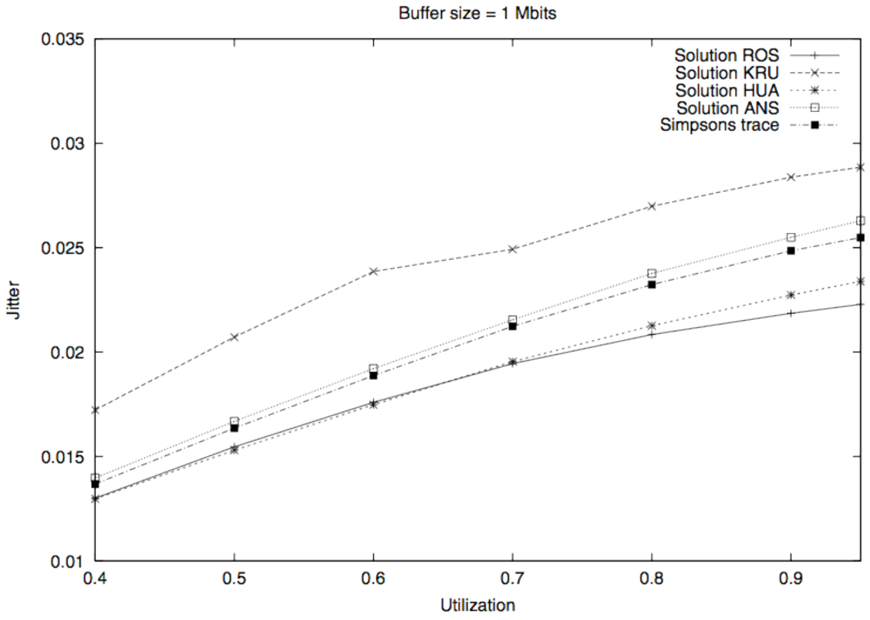
- ROS and ANS get worse as the buffer size increases
- HUA improves as buffer size increases

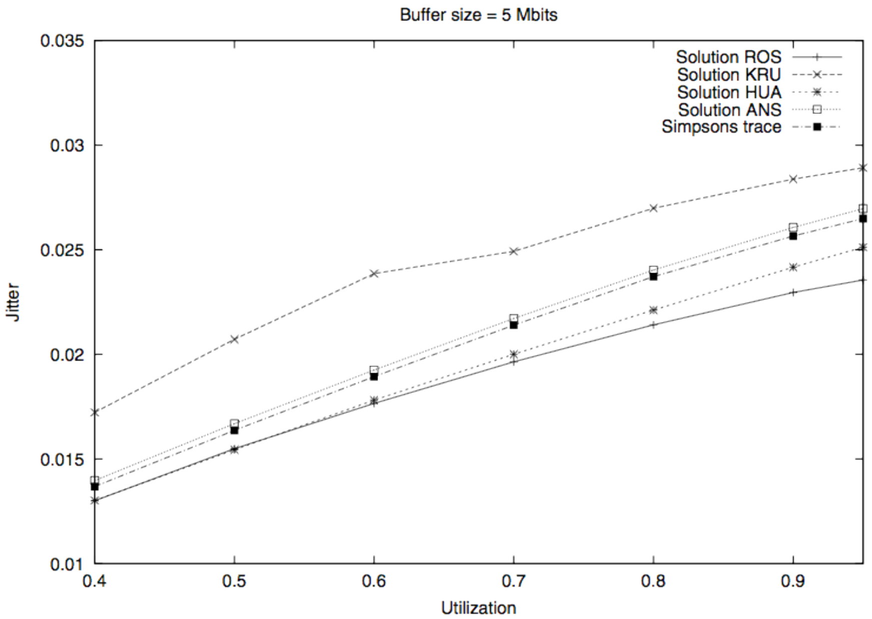
HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes



Jitter

- Most of the frames are P or B, hence their modeling is important for jitter
- ANS is the best
- ROS has no frame-by-frame correlation (hence it underestimates jitter)
- KRU removes intra-GOP correlation and autocorrelation of each frame-type
- HUA improves with larger buffer size





HUA: LRD, h_I h_B h_P
KRU: LRD, iid P and B
ROS: Markov in Markov + factor
ANS: 3 independent processes

Conclusions

- ROS best for loss rate and mean delay
  - Modeling GOP-size process
  - Simple modeling of intra-GOP structure
- For large buffers intra-GOP correlation dominates in mean delay
- For jitter adecuately characterizing ACF and PDF of B-frames is very important

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