SISO — Simulation Interoperability Standards Organization
"Simulation Interoperability & Reuse through Standards"

Workshop theme for Fall 2018: "Leveraging the Power of Simulation"

Lessons learnt from distributing video over an HLA backbone

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Distributing and capture video over an HLA backbone

- **Why capture video in a simulator?**

- **Why capture video digitally?**

- **Why distribute and capture video over HLA?**

- **Direct video streaming performance**

- **HLA video streaming performance**

- **HLA video recording performance**

- **Conclusions**

Why capture video in a simulator?

- **Easy way of making student stations screens, live cameras monitoring student performance and simulator out the window view available for live monitoring and After Action Review.**

- **If the simulator isn't designed for recording of all states and being able to replay those states.**

- **Add After Action Review capability to a system where no other software can be installed due to security restrictions. (capture on the HDMI/DVI display signal)**

- **No need for any simulator specific solution.**

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Why capture video digitally?

- **Easier to make sure everything is synchronized.**
    - Video
    - Simulation data
    - Radio communication
- **Easier to make backups and keep track on recordings.**
- **More reliable and less expensive hardware**
- **Todays computer hardware and storage is very capable in terms of both capacity and speed.**
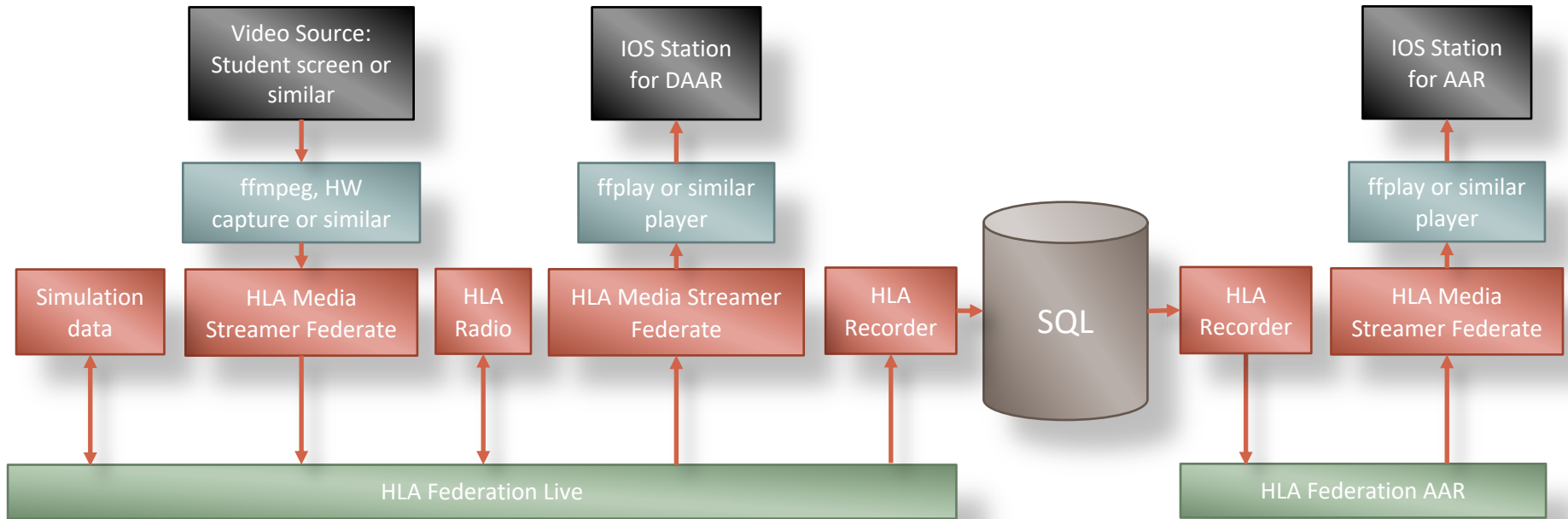
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Why distribute and capture video over HLA?

- **Advanced filtering mechanisms in HLA can help reducing bandwidth problems.**
  - Publish/Subscribe
  - DDM
- **Can be distributed over WAN if needed.**
- **Possibilities to filter with already accredited Cross Domain Security (CDS) solutions.**
- **Capture video streams in sync with other simulation data and audio streams with a COTS HLA Recorder.**
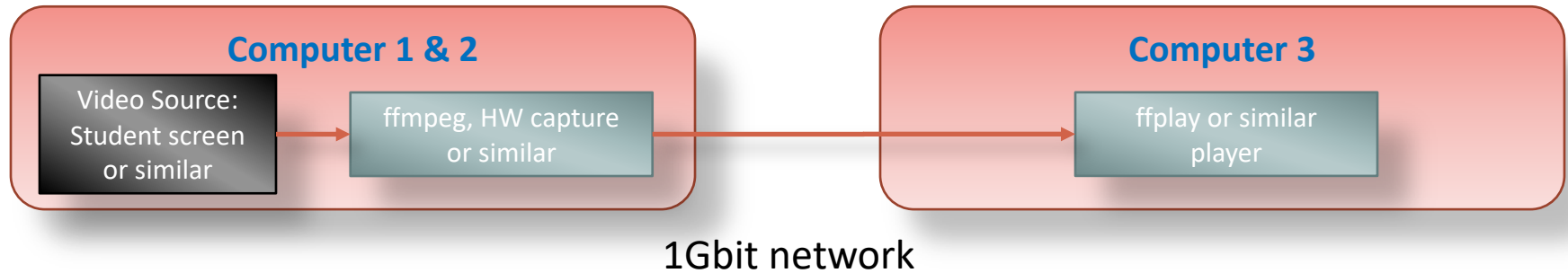
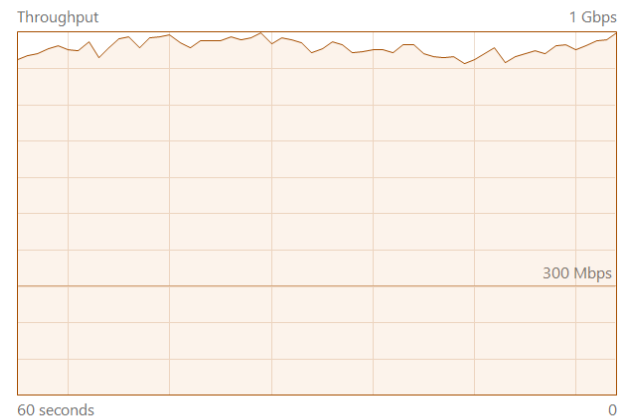# Example of HLA video and simulation architecture

- **Video streaming directly from ffmpeg to ffplay**

  - 1Gb network.

  - Two computers used for streaming data.

  - 4k 60Hz, 32Mbit/s per movie.

  - One computer receiving all data and displaying one of the 4k-videos.

  - Windows UDP buffers has been tweaked.

  - 30 movies @ 4k 60Hz 32Mbit/s could be streamed.

  - 960Mbit/s in total.

  - No artefacts in the videos.

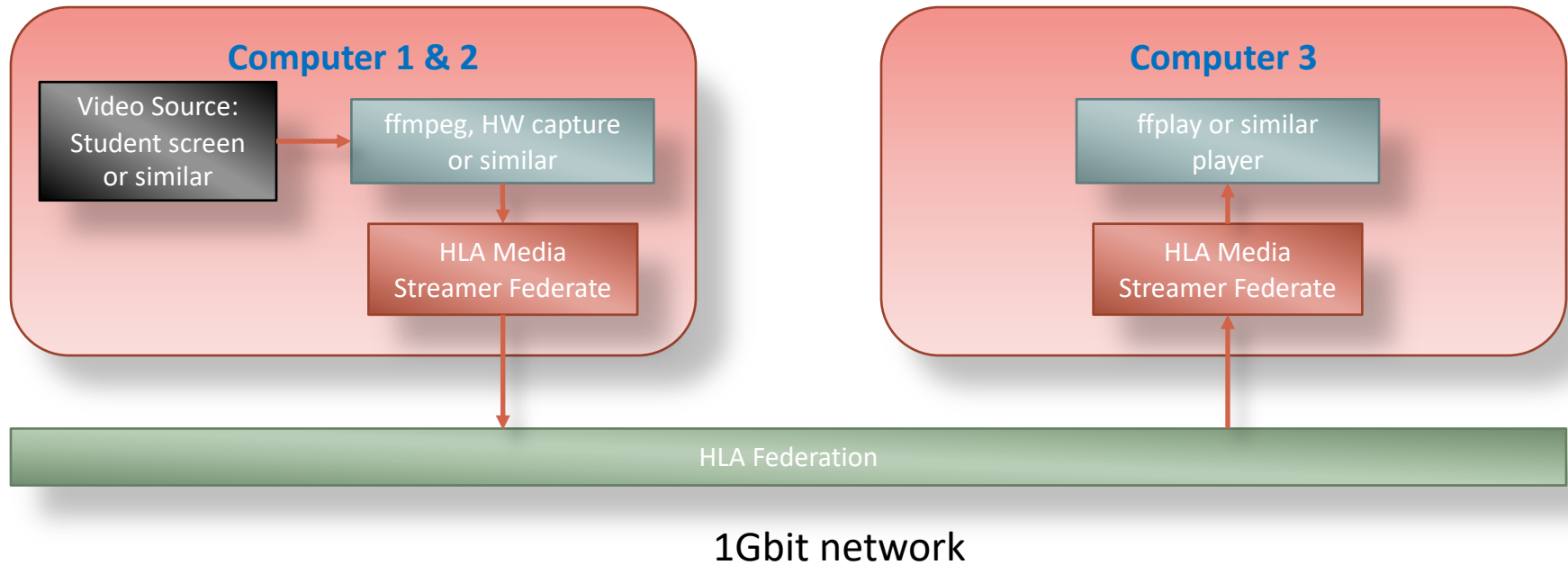 - Streaming can be done until the network gets saturated.

Ethernet — Intel(R) 82579LM Gigabit Network Co...

Throughput	1 Gbps
	300 Mbps
60 seconds	0

Send		
0 Kbps	Adapter name:	Ethernet
	Connection type:	Ethernet
	IPv4 address:	10.46.99.3
Receive	IPv6 address:	fe80::c585:4483:f4ae:2c12%5
997 Mbps		

HLA video streaming setup

Computer 1 & 2

Video Source: Student screen or similar

ffmpeg, HW capture or similar

HLA Media Streamer Federate

Computer 3

ffplay or similar player

HLA Media Streamer Federate

HLA Federation

1Gbit network

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- **HLA video streaming performance - Unoptimized**
  - Same setup as before, 4k 60Hz, 32Mbit/s per movie.
  - Streaming ffmpeg → HLA federate → HLA federate → ffplay.
  - Default packet-size for ffmpeg (1360bytes/packet)
  - One HLA interaction per ffmpeg UDP packet.
  - Video can be streamed up to 20 movies and a total of 640 Mbit/s.
  - After that, the computer receiving the HLA interactions starts to get overloaded, especially when it needs to show one of the 4k-movies at the same time.
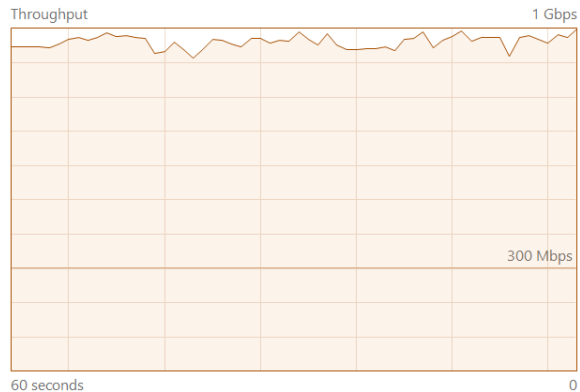 - Without showing the 4k-movie, up to 28 movies and a total of 896Mbit/s can be streamed.

- ## HLA video streaming performance - Unoptimized
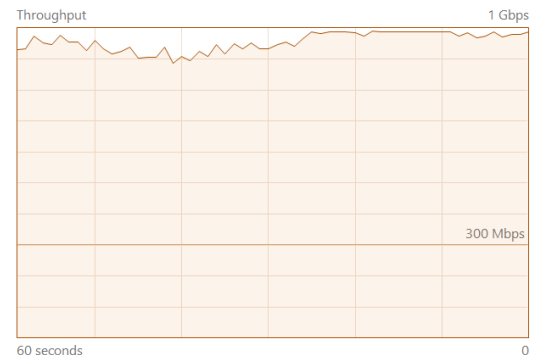
  - Bitrates and callback-rates for 28 movies and 1360 bytes per packet:

- **HLA video streaming performance - Optimized**

  - Changes to ffmpeg to use larger packet size of 52kB gave less callbacks and much higher performance.

  - 30 movies @ 4k 60Hz 32Mbit/s could be streamed.

  - 960Mbit/s in total.

  - CPU-usage was low for the receiving federate.

  - Callback queue was empty.

  - Streaming can be done until the network gets saturated.
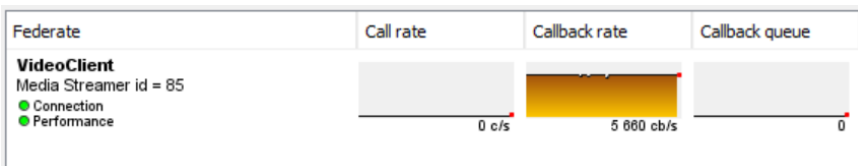
Ethernet — Intel(R) 82579LM Gigabit Network Co...

Throughput — 1 Gbps

300 Mbps

60 seconds — 0

Send		Adapter name:	Ethernet
0 Kbps		Connection type:	Ethernet
		IPv4 address:	10.46.99.3
Receive		IPv6 address:	fe80::c585:4483:f4ae:2c12%5
988 Mbps			

Federate	Call rate	Callback rate	Callback queue
VideoClient Media Streamer id = 85 ● Connection ● Performance	0 c/s	5 660 cb/s	0

HLA video recording setup

Computer 1 & 2

Video Source: Student screen or similar

ffmpeg, HW capture or similar

HLA Media Streamer Federate

Computer 3

HLA Recorder

SQL

HLA Federation

1Gbit network

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- **Recording of the HLA video and simulation data can be done to a SQL server for After Action Review.**

- **The SQL servers single session performance is what's currently limits the bitrate that can be recorded.**

- **Fast SSD-drives and CPU:s can help recording speed.**

- **Multiple Recorders can be used for increasing recording speed using multiple SQL sessions.**

Video recording performance

- **Up to 1Gbit/s of video data have been recorded to a single SQL-server using 4 Recorders.**

Disk recording with up to 270MB/s

Conclusions

- **Direct video streaming can be done over a 1Gb network up to the full capacity of the network.**

- **HLA video streaming can be done over 1Gb network up to the full capacity of the network.**

- **HLA has no negative effect on video streaming performance.**

- **In our tests we have recorded 1Gbit/s of HLA video data to a SQL server.**

- **Tuning of the various components is required in order to get high performance for both direct and HLA video streaming.**

- **We can distribute and record synchronized video-, simulation- and radio-data over HLA for After Action Review applications.**
  - Audio data and simulation data is not affected by video streaming when bandwidth is available

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