

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





- 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.





- 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.



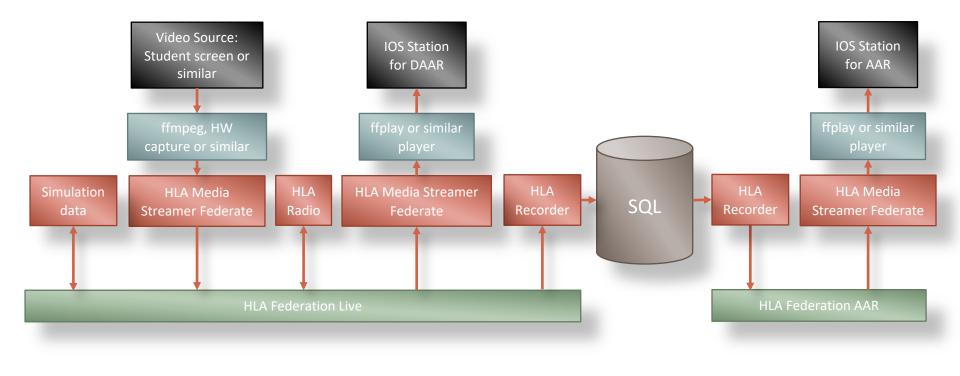


- Advanced filtering mechanisms in HLA can help reducing bandwidth problems.
 - Publish/Subscribe
 - DDM
- Can be distributed over WAN if needed.
- Possibilities to filter with already accredited Cross Domain Security (CDS) solutions.
- Capture video streams in sync with other simulation data and audio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





Example of HLA video and simulation architecture

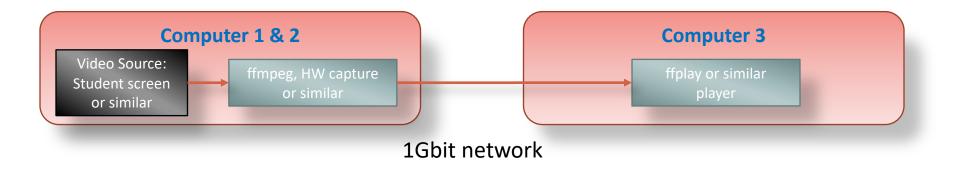


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Direct video streaming setup

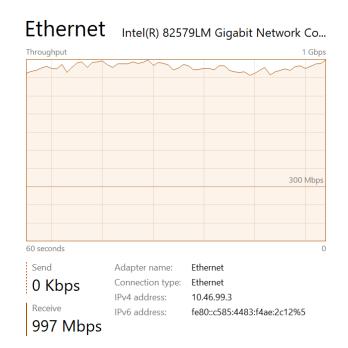






• Video streaming directly from ffmpeg to ffplay

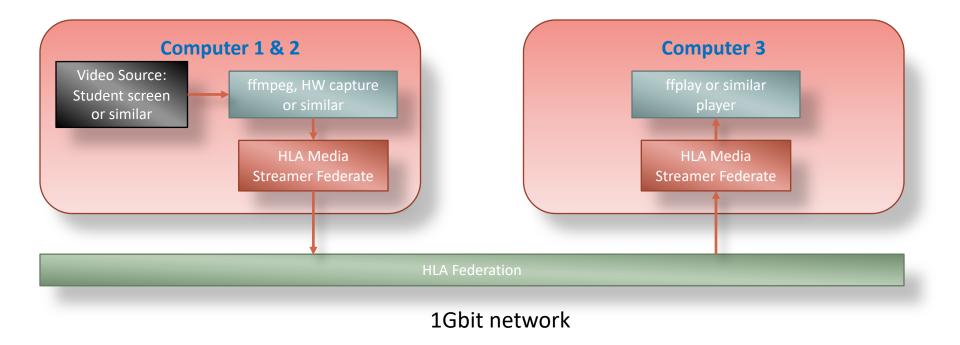
- 1Gb network.
- Two computers used for streaming data.
- 4k 60Hz, 32Mbit/s per movie.
- One computer receiving all data and displaying one of the 4k-videos.
- Windows UDP buffers has been tweaked.
- 30 movies @ 4k 60Hz 32Mbit/s could be streamed.
- 960Mbit/s in total.
- No artefacts in the videos.
- Streaming can be done until the network gets saturated.







HLA video streaming setup







- HLA video streaming performance Unoptimized
 - Same setup as before, 4k 60Hz, 32Mbit/s per movie.
 - Streaming ffmpeg \rightarrow HLA federate \rightarrow HLA federate \rightarrow 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.

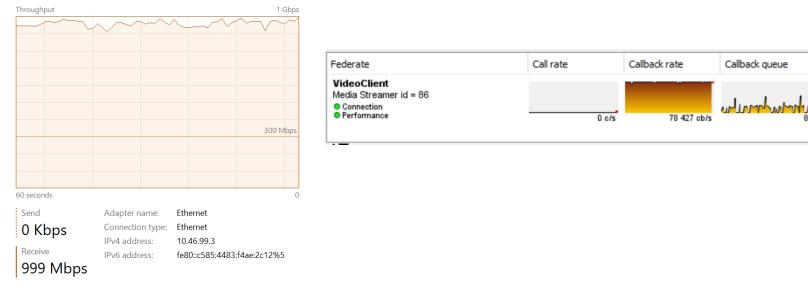




• HLA video streaming performance - Unoptimized

Bitrates and callback-rates for 28 movies and 1360 bytes per packet:

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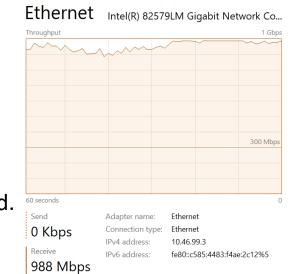






- HLA video streaming performance Optimized
 - Changes to ffmpeg to use larger packet size of 52kB gave less callbacks and much higher performance.
 - 30 movies @ 4k 60Hz 32Mbit/s could be streamed.
 - 960Mbit/s in total.
 - CPU-usage was low for the receiving federate.
 - Callback queue was empty.
 - Streaming can be done until the network gets saturated.

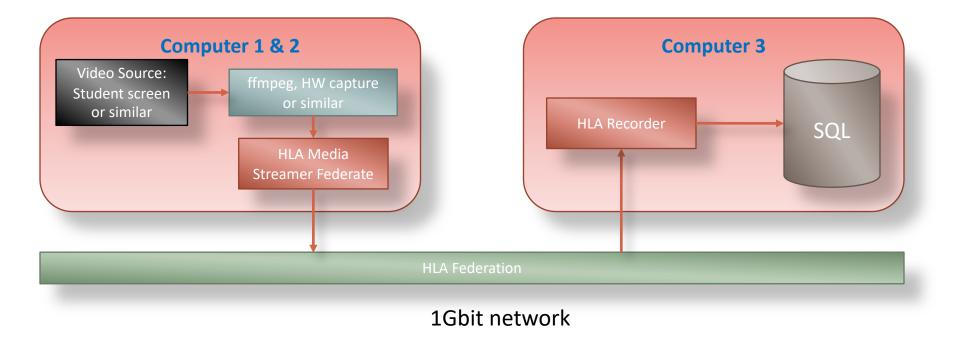
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HLA video recording setup







- 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.

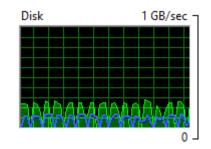


Video recording performance

• Up to 1Gbit/s of video data have been recorded to a single SQLserver using 4 Recorders.

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Disk recording with up to 270MB/s







- 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 radiodata 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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