Open-source ULL-DASH-PC for multi-party real-time communication

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Background

The future of communication is **immersive**: XR (Extended Reality) offers realism, interactivity, and natural remote presence.

- Current systems rely on WebRTC / WebSocket → centralized, limited scalability.
- Lack of Standardized Benchmarking
- Limited data on performance in real-world networks (e.g., 5G).

We propose **ULL-DASH-PC**: an open-source implementation of ultra-low-latency DASH for point cloud contents, enabling real-time, multi-user, multi-quality immersive telecommunication.

We integrate our solution in VR2Gather [1] and cwipc [2] and benchmark it against real-time transport protocols.

Evaluation

Fig. 1: Example frame from interactive dataset created for the evaluation

Two testbeds: Local (CWI) and 5G (Surrey)

Three scenarios:

- Unidirectional: single sender, single receiver, pre-recorded point cloud.
- Bidirectional: each node acts as sender and receiver, pre-recorded point cloud.
- Interactive: each node ingests RGBD feed from 4 cameras, converts them into point clouds, and plays them back with head camera traces for movement. Simulates live capturing (Fig. 1).

Results

Protocol	Octree	Target fps	Latency	Achieved fps
webRTC	7	15	**54.70 ± 24.14**	13.90 ± 4.26
	7	30	**58.92 ± 11.74**	27.79 ± 4.58
	9	15	**215.99 ± 139.71**	8.14 ± 4.82
	9	30	**223.10 ± 148.48**	8.06 ± 5.04
ULL-DASH-PC	7	15	108.70 ± 15.74	**15.30 ± 3.65**
	7	30	76.22 ± 14.57	**30.91 ± 7.61**
	9	15	239.18 ± 49.08	**15.34 ± 3.46**
	9	30	255.35 ± 31.99	**16.00 ± 3.52**

Tab. 1: Results for unidirectional @ Surrey testbed (4 tiles of 150K points)

Protocol	Octree	Target fps	Latency	Achieved fps
webRTC	7	15	**76.12 ± 25.43**	13.98 ± 4.62
	7	30	**117.12 ± 17.79**	22.75 ± 6.12
	9	15	**363.47 ± 151.43**	5.54 ± 3.97
	9	30	**328.04 ± 153.65**	5.51 ± 3.93
ULL-DASH-PC	7	15	160.26 ± 18.74	**15.14 ± 3.10**
	7	30	171.10 ± 20.52	**24.06 ± 4.52**
	9	15	438.74 ± 59.37	**9.33 ± 2.49**
	9	30	408.13 ± 83.76	**8.85 ± 2.23**

Tab. 2: Results for bidirectional @ CWI testbed (4 tiles of 150K points)

Protocol	Octree	Target fps	Latency	Achieved fps
webRTC	7	15	**176.96 ± 57.31**	14.25 ± 3.11
	7	30	**123.71 ± 37.03**	22.85 ± 4.99
	9	15	514.10 ± 215.07	11.92 ± 5.48
	9	30	488.41 ± 206.92	14.85 ± 8.38
ULL-DASH-PC	7	15	298.27 ± 63.23	**15.22 ± 2.11**
	7	30	265.33 ± 59.36	**24.08 ± 3.56**
	9	15	**372.63 ± 74.18**	**15.15 ± 2.13**
	9	30	**387.08 ± 72.15**	**19.75 ± 4.78**

Tab. 3: Results for interactive @ CWI testbed (15 tiles, various point count)

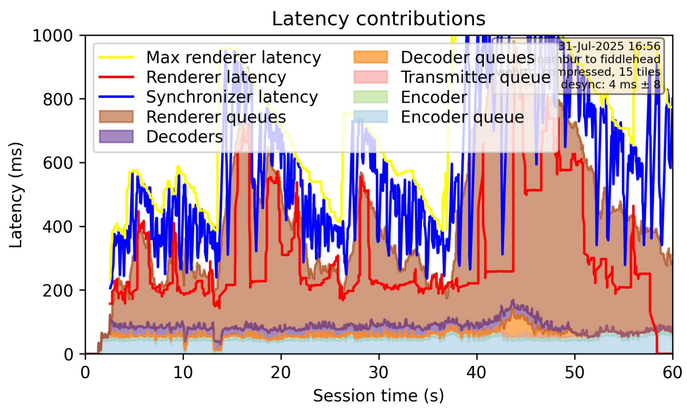

Fig. 2: Example latency for webRTC in interactive session

- Comparable performance in the two testbeds
- Target fps is achieved only for lowest quality in unidirectional setup

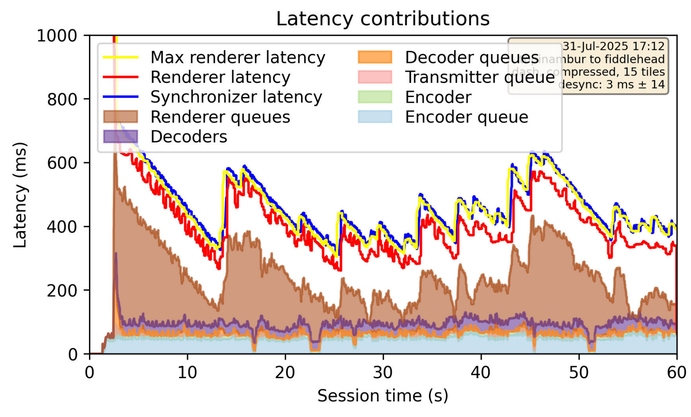

Fig. 2: Example latency for ULL-DASH-PC in interactive session

- WebRTC achieves better latency, with lower frame throughput
- ULL-DASH-PC has higher latency, but better framerate

References

[1] Viola, I., Jansen, J., Subramanyam, S., Reimat, I., & Cesar, P. (2023). VR2Gather: A collaborative social VR system for adaptive multi-party real-time communication. IEEE MultiMedia, 30(2), 48-59.
[2] Reimat, I., Alexiou, E., Jansen, J., Viola, I., Subramanyam, S., & Cesar, P. (2021, June). CWIPC-SXR: Point cloud dynamic human dataset for social XR. In Proceedings of the 12th ACM Multimedia Systems Conference (pp. 300-306).

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https://github.com/MotionSpell/lldash