
Report Brief on the Results of Telepresence Testing on the R/V Western Flyer

To: MBARI Management Team

We are happy to report that recently approved preliminary testing of the satellite system on the Western Flyer for use in telepresence was successful. We were able to build a simple proxy system for the ROV control room and streaming equipment, deploy it onboard the ship, and broadcast to a wide variety of shore targets with expected qualities set under the scoping study. We had 6 test users that were able to view all streams at encoded resolutions matching the source video of the ROV's main camera. The system is proven to handle the load of telepresence, with enough overhead to continue to offer normal internet connectivity as it operates onboard the vessels today.

Connecting through teleconferencing services like Zoom and Google Meet, we were pleased to observe no more than a 3-second delay maximum. This was not the best possible quality, but other solutions could stream at high-definition resolutions (720p30, 1080p30), albeit with 30-second delay. We believe that enough room exists to start designing a concept system that addresses current shortfalls in the test design system. However, there is sufficient proof that, with minimal work, this system could be functional for remote science use in time for the Flyer's return from the shipyard.

The immediate system could be deployed with these additional resources:

- Funds for increased VSAT service, estimated at an \$1100 per sea day (or \$800/day if used for a week) incremental cost increase above the normal VSAT service charges. Details can be found in the [requirements document](#).
- Cloud restreaming services through Wowza, our current best CDN performer at \$200 per month when used.
- A dedicated computer installed in the control room ~\$3,000.
- Support from the IS department and Dan Chamberlain for network and service configuration needs.
- Support from ROV pilots to specify connection endpoints for video and audio.

We want to thank you for your support. We are also grateful for the support of team members that came together over the last two days to make this test a success, including Dan Chamberlain, George Matsumoto, Andrew McKee, Todd Ruston, Adrianna Sisfontes and Mark Talkovic. Special thanks should also be extended to Dr. Dwight Coleman and his team at the Innerspace Center at URI for helping us by providing a stable streaming target and initial help in our scoping efforts. James Boden at Isotropic Systems has also been

an excellent partner, by donating the upgraded service at no cost to the institute for this testing.

There is clearly more knowledge to convey from the test, and more interest in pursuing the development of a richer system than what was put together over the last week. To that end, we expect to submit an abstract for 2021 to continue this development and capture costs. We will likely report more detail on our findings aboard the flyer through the abstract presentations.

Finally, an initial survey of potential users has indicated interest in using the Rachel Carson for telepresence within microwave range. When possible, we would like to work with the Ventana/Carson team to perform a similar series of tests using the Rachel Carson through the microwave system, to determine capability in the same way we have on the Western Flyer.

Here is a brief catalog of successful tests and latencies:

Stream Target	Video Quality	Average Latency (s)
uri innerspace center	720p30	35.5
wowza cloud	1080p30	23.7
microsoft streams	720p30	27.7
facebook	1080p30	22.5
youtube	720p30	26.3
zoom	480p30	1.5
google meet	720p30	1.5

Please find some additional screen captures on the next few pages of select test results. Thank you again for your support, and we look forward to your questions.

Sincerely,

Kakani Katija, Eric Martin, Ben Erwin, and David Caress

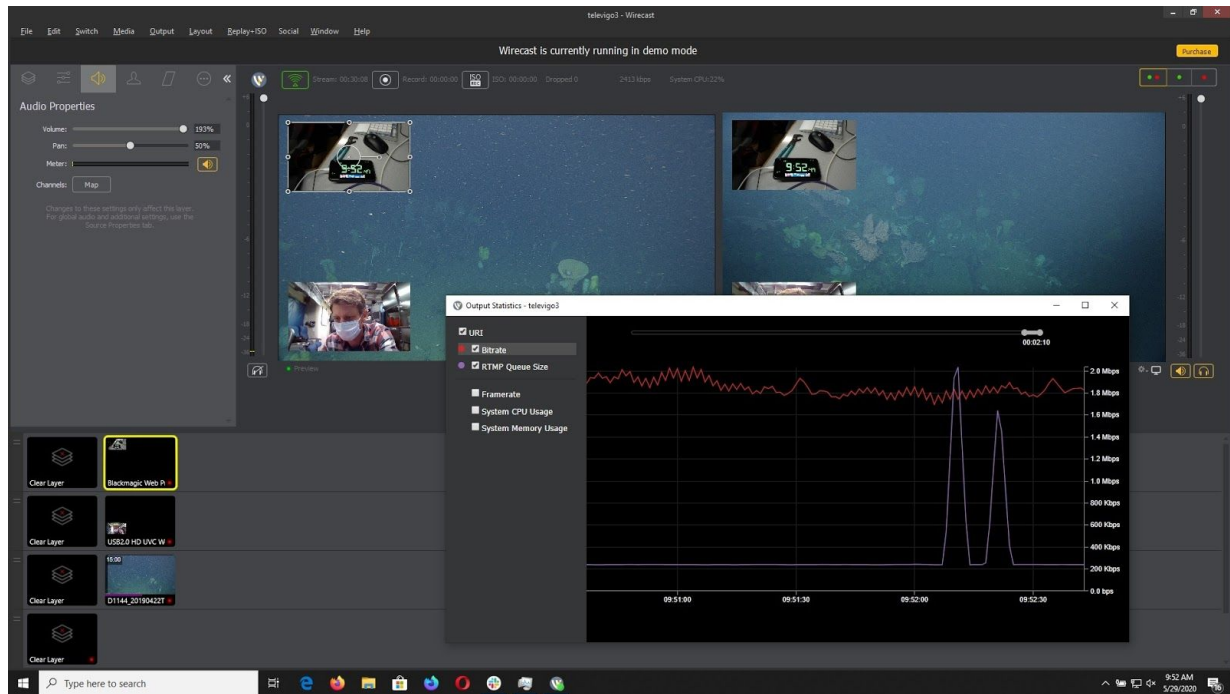


Figure 1: The broadcaster software and metrics for a stream that had no interruptions for 30 minutes with intentional ending over the satellite.

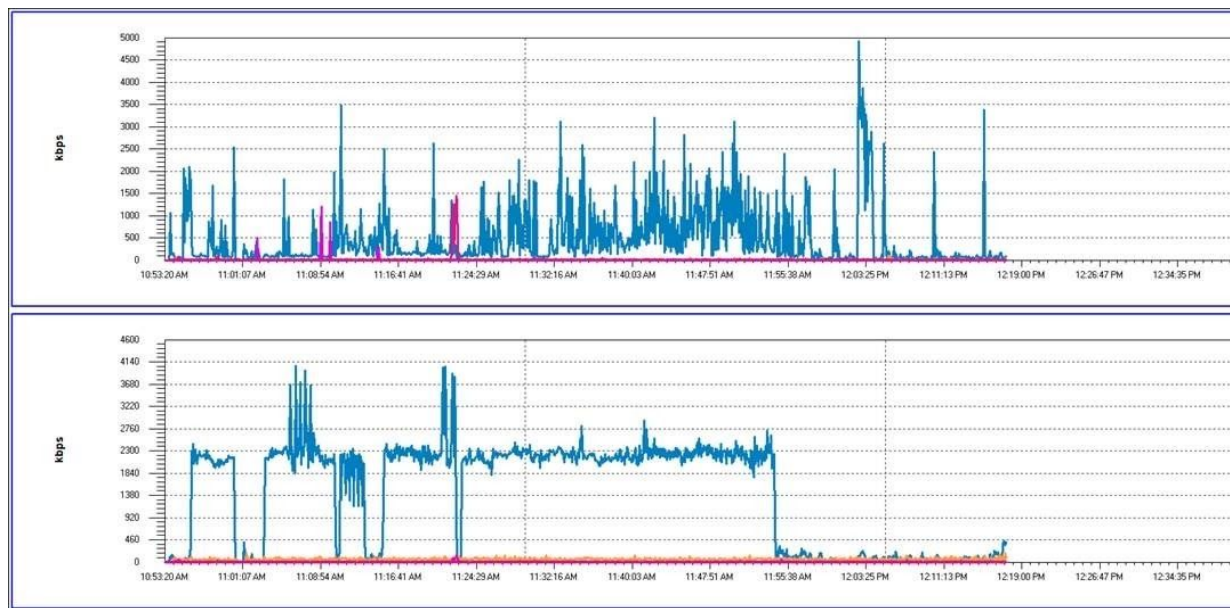


Figure 2: Satellite traffic confirming nearly constant satellite traffic was stable for the same 30 minute test shown in Figure 1.

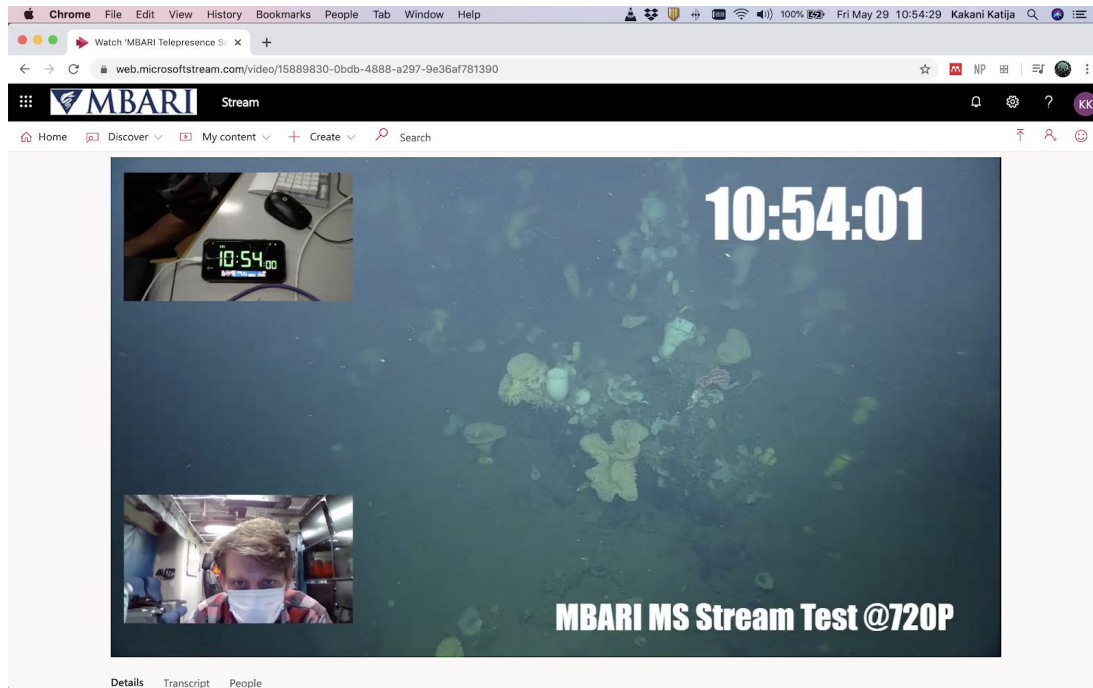


Figure 3: Streaming through Microsoft Stream to Kakani's computer in Carmel Valley, this is a CDN we have access to through our Microsoft licensing agreement.

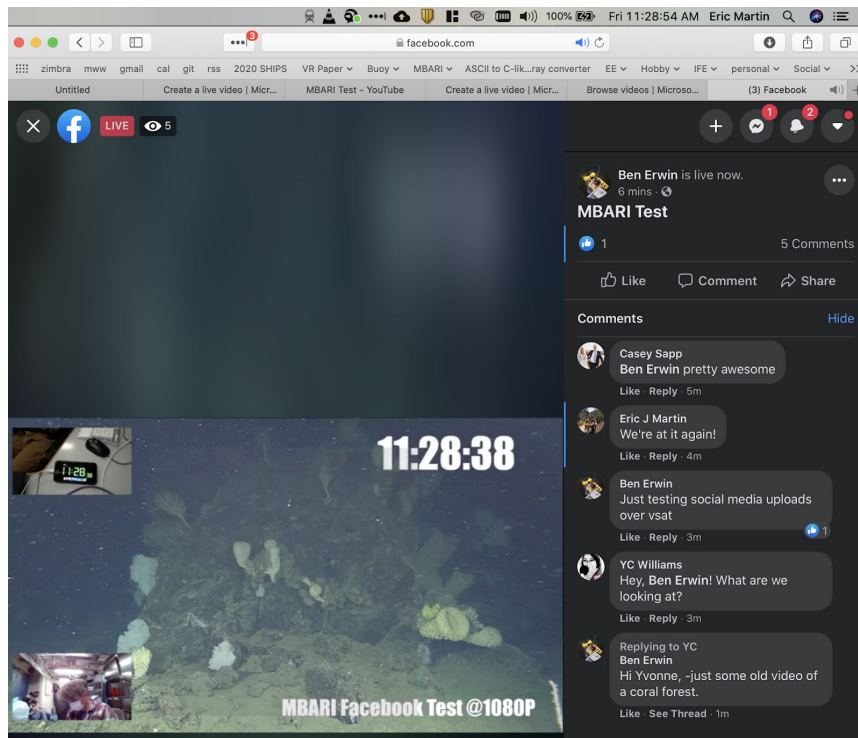


Figure 4: Facebook live direct from the boat at 1080p30. This stream was not as stable as others, as it was near the limits of the satellite service. Isotropic could support high rates that would improve reliability.