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TECHNIQUES FOR THE USE OF VIDEO OVER DELAY TOLERANT NETWORKS AS A TOOL FOR SAFETY AND SITUATIONAL AWARENESS

Abstract

As human spaceflight is poised to head beyond low-earth orbit, the use of point-to-point communication (as was done for Apollo) or single-point data relay satellites (as is done for the International Space Station) will cease to remain cost-effective. In addition, there is an increase in the amount of data required for transmission. Interplanetary Networking seeks to solve these issues. IPN envisions a mesh network which interconnects ground stations, rovers, relay satellites, and human spacecraft utilizing Delay-Tolerant Networking (DTN) technologies.

This paper will outline the technical challenges and solutions which surround the use of delay-tolerant networking as a transfer medium for situational awareness video and particularly for Human Spaceflight. The problem of multimedia transmission is approached as a high-level issue suited for protocols running above a delay-tolerant network. Initial testing of video-over-DTN was precluded by the lack of suitable tools for transmission and reception. As a solution, an UDP-to-Bundle Protocol gateway was developed. This gateway allows DTN applications to seamlessly interoperate with existing video systems, and has been tested with great success by DLR/GSOC and RosCosmos. Additionally, a novel technique for the transmission of 3D point cloud data will be shown. This technique utilizes octree data structures in order to perform spatial filtering and reduction of the data set, before encoding it for DTN transmission. This method optionally removes the requirement for prediction frames, as such allowing an "intra-frame" 3D compression. Notably, the ability to define a "free form" viewpoint of the image allows for an increase in situational awareness.

Finally, various combinations of these techniques will be shown. The combination of DTN and video transmission technologies allows for an increase in the video capabilities of future missions and consequently in situational awareness. A future rover may use a DTN relay network to transmit video to an orbiting crew via an international system of DTN-compatible relay satellites, allowing the crew and ground teams to rapidly evaluate a potential landing site. Once landed, the rover may seamlessly switch to utilizing the landers connectivity and continue to transmit video back to earth. Additionally, the lander may transmit a 3D map of the descent area generated from a LIDAR, providing a full image of the environment for the ground. Finally, while returning to an orbiting space station, the arriving spacecraft may transmit its docking camera (either directly or via a relay satellite), allowing the space station teams to confirm a successful docking profile