

# Chapter 12

## Parallel Data Transfer Protocol

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### ABSTRACT

*Transferring very high quality digital objects over the optical network is critical in many scientific applications, including video streaming/conferencing, remote rendering on tiled display walls, 3D virtual reality, and so on. Current data transfer protocols rely on the User Datagram Protocol (UDP) as well as a variety of compression techniques. However, none of the protocols scale well to the parallel model of transferring large scale graphical data. The existing parallel streaming protocols have limited synchronization mechanisms to synchronize the streams efficiently, and therefore, are prone to slowdowns caused by significant packet loss of just one stream. In this chapter, the authors propose a new parallel streaming protocol that can stream synchronized multiple flows of media content over optical networks through Cross-Stream packet coding, which not only can tolerate random UDP packet losses but can also aim to tolerate unevenly distributed packet loss patterns across multiple streams to achieve a synchronized throughput with reasonable coding overhead. They have simulated the approach, and the results show that the approach can generate steady throughput with fluctuating data streams of different data loss patterns and can transfer data in parallel at a higher speed than multiple independent UDP streams.*

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## INTRODUCTION

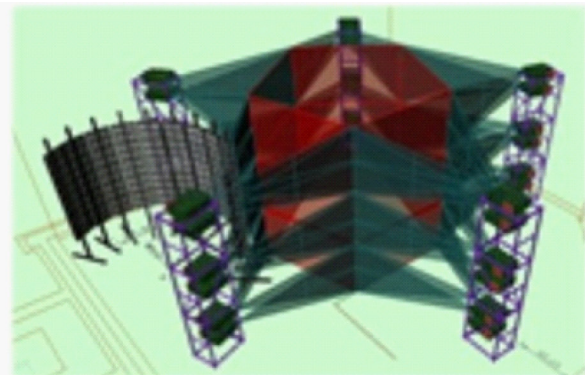
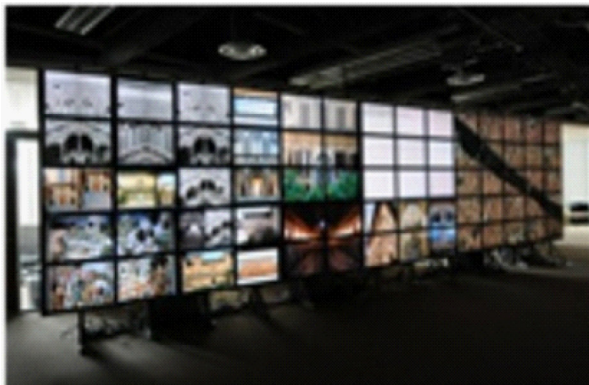
In the recent years, CineGrid (CineGrid) has led the new trend of using high bandwidth networks, to transfer very high quality digital content, for real-time show and for digital preservation. Although CineGrid has performed many successful demonstrations of 4K video (Shirai & et. Al., 2009) (Herr, 2005), we also foresee the challenges of designing new protocols, which can scale the current solution to applications demanding higher bandwidth and higher resolution digital content. Now a days, ultra-high resolution displays have become a standard infrastructure in scientific research. These displays are typically achieved by tiling together an array of standard LCD displays into a display wall, using a PC cluster to drive it. (DeFanti & et. Al., 2009). Figure 1 a) and b) show different settings of display walls: the HiPerSpace uses fifty five 30' LCD displays to form a display wall with more than two million effective pixels; the StarCAVE (DeFanti & et. Al., 2009) uses 16 high-definition projectors to construct a 3D virtual room, where people can navigate 3D virtual reality objects.

Meanwhile, high-speed research in optical networks (GLIF) makes it possible for scientists to use these ultra-high resolution displays over

long distances, in their scientific applications like very-high-definition video streaming/conferencing (OPIPUTER), real-time data visualization generated by remote scientific instruments and etc. As a perfect example of the combination of display walls and high-speed network, the OpTi-puter (OPIPUTER) (Smarr, 2009) research project, funded by the American National Science Foundation, constructed a 1Gbps-10Gbps optical network infrastructure and middleware, aiming to achieve interactive access of remote gigabyte to terabyte visualization data objects, and bring them to its visual interface, the OptIPortals (DeFanti & et. Al., 2009).

However, the scaling up of display devices, from a single PC with a single display to a cluster of PCs with a cluster of displays, has brought up challenges on how to feed data into these display devices. These challenges make the traditional single data source communication model obsolete, and bring forth the creation of a new multiple-to-multiple communication model, which needs very-high-bandwidth parallel data streaming communications, between terminal display devices, while still appearing as a point-to-point communication between them. This put challenges on the traditional transport protocols. The widely adopted Transport Control Protocol (TCP) is slow

Figure 1. a) HiPerSpace, one of the world's largest display wall in Calit2, UC San Diego, has 286,720,000 effective pixels. b) The STARCAVE, a third-generation CAVE and virtual reality OptiPortal in Calit2, UC San Diego, ~68,000,000 pixels.



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