"USER CONTROLLED LIGHTPATH" ENABLED PARTICIPATORY DESIGN STUDIO: FIRST STEPS

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Abstract

The technical scheme and creative scenario of a new media-based "User Controlled Lightpath Provisioning" (UCLP) enabled "Participatory Design Studio" will be elaborated. This practical collaborative work environment model represents a technologically robust and sophisticated means of communication and sharing of resources that stands to radically transform design processes. UCLP technology is a fibre based software solution designed to enable end-users to create their own discipline or application-specific IP network whose topology and architecture is optimized for their particular applications needs and requirements. A distinction between "task-based collaboration" found in conventional "Virtual Design Studios" and the heterogeneous nature of the "participatory" work environment will be made. UCLP technology provides a secure, large bandwidth, low latency network that can accommodate up to 10Gbps. This capability creates an environment which is not dependent upon traditional low bandwidth requirements for communication, visualization, and production therefore allowing a greater range of desired tools for creative activity.

1. Introduction

The notion of the digitally mediated and e-centric "Virtual Design Studio" has been around since the mid 1990's and has been employed in various forms in a number of disciplines since its inception (Bradford et.al. 1994; Donath et.al. 1999; Kolarevic et.al. 1998; Vásquez de Velasco 2003; Wojtowicz 1995). Generally speaking and due to available technologies, the primary focus of VDS is on communicative and web-based modes of productive activity and databases. It is essentially a distributed task-based mode of "collaboration" and, arguably, embodies questionable notions of specialization and building practices.

The majority of VDS required relatively low bandwidth solutions and an agreed upon "lowest common denominator" set of collaborative and communicative tools and modes of creation. The technological limitations of networks and visualization tools restricts the effective deployment of sophisticated visualizations, multipoint video, real-time access to large data sets, synchronous immersive environments, and subsequently well crafted imagery and digitally mediated experiences. VDS projects typically require homogeneity within a restricted palette of tools compared to those available in conventional design studio situations.

With the advent and coming of age of fibre-based broadband networks, the ever growing network-based set of production and visualization tools, immersive technologies, and various other aspects of convergence in the realm of new media, it is becoming possible to more fervently incorporate the richness and heterogeneity of the creative process (tools, languages, spontaneity) into a more enabling, "participatory", and augmented (rather than "virtual") environment.

2. User Controlled Lightpath Provisioning technology (UCLP)

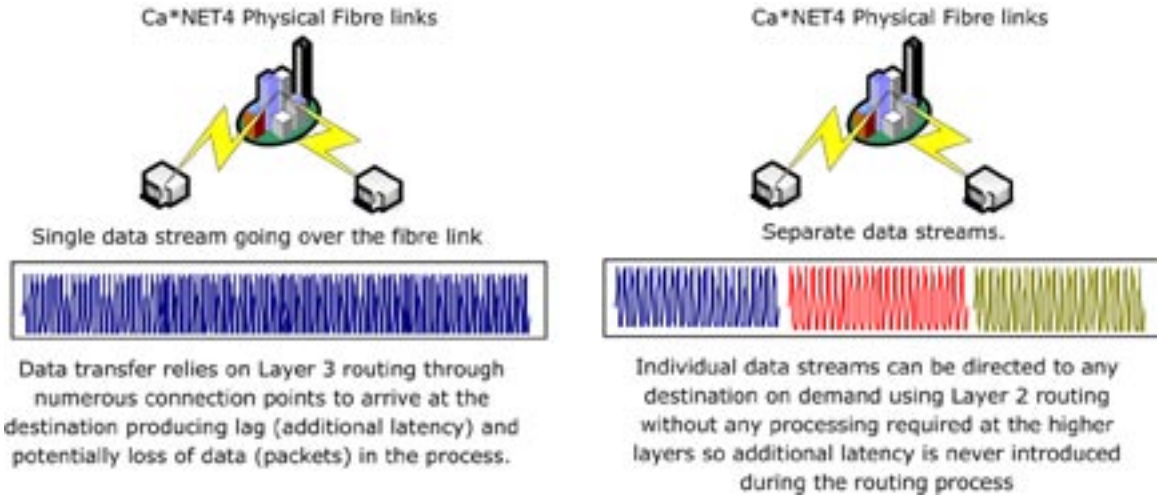
The following "Participatory Design Studio" (PDS) project is in its initial configuration and proof-of-concept phase. The work-in-progress is located within the Carleton Immersive Media Studio (CIMS), an organized research unit within the Carleton University School of Architecture. Partners include: the Communications Research Centre of Canada - Broadband Applications

Development lab (CRC); the National Research Council, Institute of Information Technology - Broadband Visual Communication Research Program (NRC), IBM-Deep Computing, and Alias Systems.

Several visualization and collaborative tools are being developed but the key enabling component to deploy the PDS is the lightpath infrastructure. "User Controlled LightPath" (UCLP) is a fibre based software solution developed in Canada and available on the national research and education network (CA*net4). UCLP software is designed to enable end-users to create their own discipline or application-specific IP network, particularly in support for high-end e-science and grid applications whose topology and architecture is optimized for their particular applications needs and requirements. The key advantages of UCLP are a secure, high bandwidth with low latency peer-to-peer (P2P) channel.

Wave Division Multiplexing is the recently evolved technology that will transform the way existing networks are used. It promises to dramatically increase the number of organizations able to establish P2P connections over optical networks that are already in place. WDM devices (multiplexers/de-multiplexers) allow the full bandwidth of the fibre link to be partitioned into several logical channels. Although there is only one physical fibre link available to a particular institution, several organizations at the institution can establish dedicated high bandwidth and low latency connections to remote organizations. In order to take full advantage of this technology a software solution had to be developed that allows end users to route these individual data streams on demand from the originating data source to the destination and add intelligence and control to the network.

UCLP is a software application co-funded by Cisco Canada and CANARIE (Canada's advanced Internet development organization) under CANARIE's Directed Research program for User Controlled LightPath (UCLP) Software. The application takes advantage of WDM technology to allow users to create an Articulated Private Network (APN) that is application specific. Groups can "self provision and dynamically reconfigure optical (layer one) networks within a single domain or across multiple independent management domains." This allows the creation of a broadband network whose topology and architecture is optimized for particular disciplinary grid application needs and requirements. "The idea is to make one logical path from the originating site to the destination site virtualizing many connections that must be traversed by the traveling data set. UCLP provides a Layer 2 tunnel (low level switching with passive optical switches that require no power and perform no processing). It is also possible to send one data set over several LightPaths making this solution



Comparison of a single and multiple streams utilizing WDM.

highly customizable and tremendously improving the efficiency of the existing optical networks" (http://www.canarie.ca/canet4/uclp/uclp_software.html).

UCLP and WDM technology stands to significantly impact the collaborative work processes and environments. By creating high bandwidth and low latency connections between several distant sites on demand and making these connections transparent to the end users new possibilities for collaboration are presented. This P2P network which is created is a secure network with low level switching and unparalleled efficiency. Users can configure an APN that is secure with high bandwidth and low latency performance critical to real-time visualization and synchronous digitally mediated experiences. It is effective in linking resources and infrastructure across distinct geographical locations thus collapsing the spatial and temporal distances in a production environment. This technological advancement removes the presently applicable boundaries and increases the amount of data that can be shared between parties by an extraordinary amount (1Gbps as opposed to currently available 100Mbps Local and Wide Area Networks that are saturated with network traffic). This opens opportunities for developing innovative paradigms for collaboration as well as developing and utilizing new software packages and collaborative processes.

3. iGrid-PDS

(Note: At the time of writing this paper the following project was in its final testing and preparation stages. The demonstration will occur from September 26-28. Preparation will take place two days prior to the live demonstration. The results will be presented at SIGRADI in November. The remaining text will focus on the technical schema to date.)

The following research and development proposes to seize upon the unprecedented opportunity UCLP technologies offer in enabling a PDS for pedagogical and professional practices. The opportunity primarily lies in little to no restriction in terms of the bandwidth used and latency concerns. Due to the available bandwidth with UCLP, compression and decompression techniques used in low bandwidth solutions responsible for latency issues is not a factor. The challenges lie in the fact that currently few applications are capable of taking advantage of this capability.

The inaugural demonstration will occur at the iGrid 2005 meeting in San Diego (http://www.igrid2005.org/). For the purposes of the demonstration the model of the PDS is taken from heritage reconstruction work done by CIMS (http://www.cims.carleton/darp). The network technology to be demonstrated effectively collapses the space and time distances between the remote lab in San Diego and the primary facilities in Ottawa thus rendering the work environment transparent to the team. As such it does not restrict the tools to be used which are brought to the project from a proven 3D modeling and imaging protocol (CIMSp) and not determined in advance by conventional network restrictions. (Jemtrud 2005; El-Hakim et al. 2005).

The proof-of-concept exercise and initial infrastructure configuration will include a total of three sites connected via a Lightpath providing a bidirectional link in excess of 1Gbps. The sites are iGrid (San Diego); CRC-BADlab (Ottawa); and CIMSlab (Ottawa). The three-day intensive demonstration is a 3D reconstruction exercise that involves multiple stakeholders at physically distinct sites who contribute a variety of digital assets. Immediate and effective communication, sharing of information and expertise between these reciprocally dependent partners in the process is paramount.

Researchers from CIMS and the CRC will be located at the sites and will digitally reconstruct the Salk Institute in La Jolla across from the conference site. The demonstration will involve a multitude of software packages and middleware that will combine to create a heterogeneous work environment. There will be two personnel in San Diego responsible for gathering basic data sets, CAD files, textures, photographic assets, etc. They will do direct analysis and confirmation during the 5-day process and are responsible for the photogrammetry modeling (ShapeCapture) with two laptop computers and an 8-megapixel digital camera. The primary modeling and animation software will be FormZ and Maya. The

results will be an accurate 3D model and high-resolution animation.

The scenario will utilize cluster-based high-performance visualization technologies, transfer of large data sets across the network, remote sharing of resources, and bidirectional communication between participants performed via multiple-party HDTV and NTSC video conferencing systems. Conference attendees will be able to observe and participate in the activity.

Access to resources located at the primary facility in Ottawa such as a rendering farm, archives, high-resolution screens, and workstations will be configured through the lightpath. Assets will be collected and archived on the central SAN depository. The animation will be set up with cameras and lights in San Diego and run on the rendering farm in Ottawa. Data will be transferred between the locations to be converted, manipulated, created, and deployed for visualization over the network.

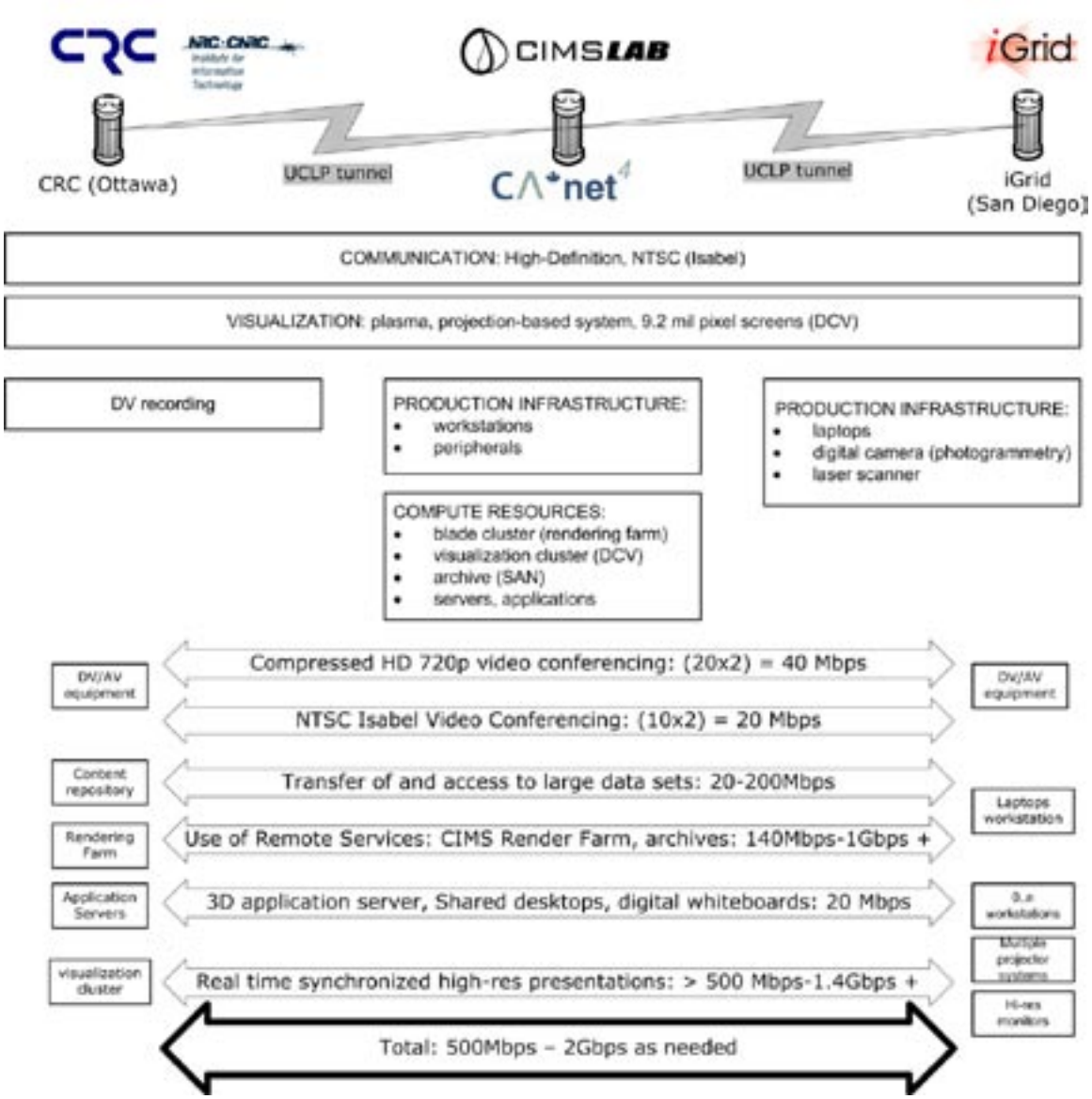


Diagram showing iGrid components and demands.

This will occur in real-time and asynchronously.

Basic web services are being developed by NRC to make the PDS environment a more user friendly and efficient setup. In particular the primary web services will concentrate on resource discovery and make the connection between end user and remote resource easier to implement on demand.

A key component in enabling the intensive visualizations of large data sets and the synchronous sharing of single instances of the modeling program is a high-performance visualization cluster. CIMS is researching and beta testing the "Deep Computing Visualization" cluster with IBM. It will be used to display digital content (high-resolution images, video, animations) to the various sites. DCV is a software solution running a cluster of commodity 64-bit workstations. It is OpenGL based and runs as an MPI (Message Passing Interface) application that requires a large amount of bandwidth and low latency.

Testing confirms that the expected network traffic will range from 100Mbps to 1Gbps depending upon the task and multiplicity of operations during the demonstration. For instance, when it is being used primarily for NTSC and HD communication the traffic will be no more than 100Mbps. When accessing the rendering farm remotely, depending upon the amount of render nodes used, it will approach 1Gbps. The DCV streaming of the animation will occupy 500Mbps.

4. Conclusion

With the development of UCLP the "time/space" collapse in a primarily digitally mediated, distributed work environment takes a significant step toward reality. Through the APN created by a UCLP enabled network the remote site is effectively "next door" from a technological perspective. As such, the necessity of low bandwidth technology no longer restricts the tools or modes of creation for the working group. The capability to access distributed resources and manipulate sophisticated content from rendering farms and compute clusters to simulation, fabrication equipment and immersive environments is immense. The number and type of resources and tools available is dramatically expanded which has extraordinary consequences for interdisciplinary activity. UCLP technology provides a secure peer-to-peer APN and with DWDM technology allows for a full 10Gbps bandwidth with no network related latency thus rendering itself transparent to the working group.

Future development primarily lies in the development of applications (3D modeling, analysis software, real-time interaction) to take advantage of such network capability. Network enabled applications such as the DCV visualization cluster will benefit greatly from UCLP and allow for effective synchronous production and deployment of experiences. This will range from multiple distributed players working simultaneously in a single instance of a 3D modeling program such as Maya to the simultaneous streaming of interactive content for multimedia, immersive events.

Over the next year web services and "intelligence" in the network will play an integral part in the PDS environment. Everything from resource discovery and resource monitoring to authentication and links between multiple remote resources will be handled by web services. These advanced and intelligent web services will serve as a user friendly wrapper of the actual resources. Web services will also make it simple for the end user of the PDS to customize some of the remote resources. This is the case with HPC clusters where raw processing power can be directed towards any particular workflow, setup and application.

The design and construction of our physical environment is a highly collaborative and participatory process that involves a plethora of contributors from the Architectural/Engineering/Construction industry (AEC) with varying degrees and types of expertise and communicative means. The demonstration is applicable to various CWE scenarios in the AEC, industrial design, automotive, entertainment industries and the like. The use of the UCLP and visualization technologies in such a collaborative environment stands to revolutionize large-scale, multiple stakeholder design activity. It engenders a real-time discursive work environment as well as asynchronous feedback that typify design activity

normally possible only in physically constrained, site specific situations. The utilization of UCLP and broadband technologies will enable an effective PDS that allows for the unparalleled real-time creative and discursive context for design activity.

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