CANARIE

Cyber-Infrastructure in Canada

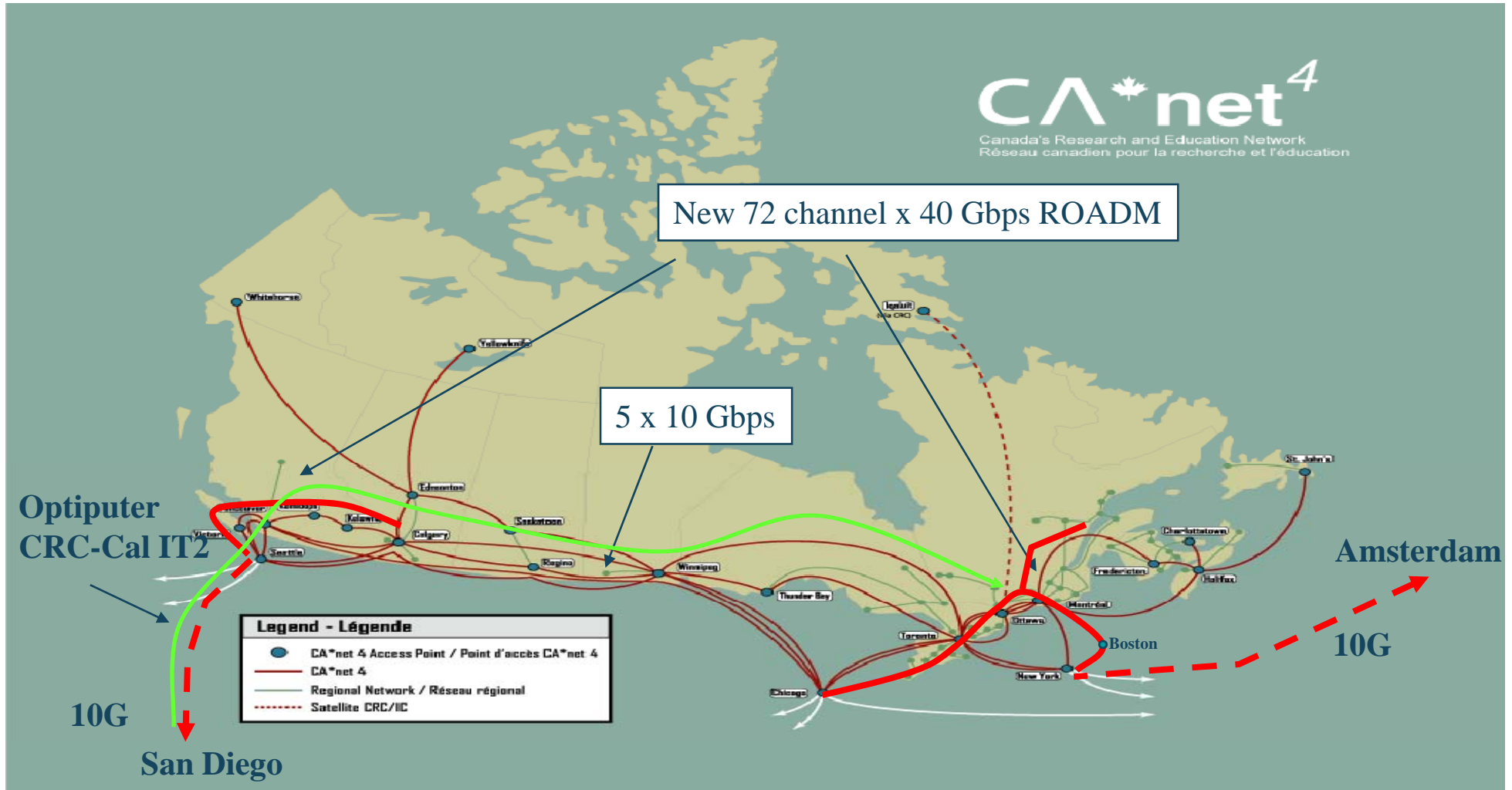**Bill St. Arnaud bill.st.arnaud@canarie.ca**

CANARIE Inc.- Overview

- *Federal leadership:* **Concept born in 1990 out of Industry Canada discussions**

- *Founding***: Incorporated in 1993 by industry and academia**

- *Funding:* **From Industry Canada: For networks and research applications from Canadian Heritage, HRDC, Health Canada**

- *Mission***: To facilitate development and use of Canada's advanced communications infrastructure**

- *Primary stakeholders:* **Government Departments, universities, provincial research networks, broader research community, colleges, carriers, IT sector, SMEs, broader education sector, broader health sector, provinces**

CA*net 4 Network

New 72 channel x 40 Gbps ROADM

5 x 10 Gbps

Optiputer
CRC-Cal IT2

Amsterdam

10G

10G

San Diego

Legend - Légende
- CA*net 4 Access Point / Point d'accès CA*net 4
- CA*net 4
- Regional Network / Réseau régional
- Satellite CRC/IIC

CA*net 4 Network details

> **CA*net 4 is NOT a single homogenous network**

> **CA*net 4 is made up of many virtual networks (APNs) or "platforms" dedicated to different communities and applications on a common substrate**

– High energy physics network

– Network for government research labs

– Network for distributed computer backplane

– Virtual networks for network research

> **One of the parallel networks is a general purpose IP network**

– This is the only network that carries IPv6

– All other networks only carry IPv4

> **New ROADM will allow us offer 10G wavelengths for $25k per year**
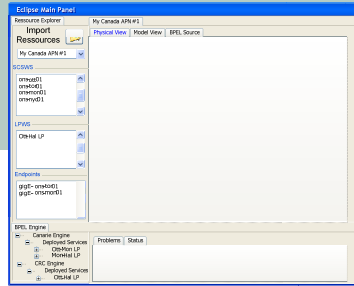
Driver for user controlled networks

> **Increasingly more and more organizations are acquiring their own fiber networks**
  - Universities, schools, hospitals, business

> **Acquiring fiber in the long haul is very expensive to light and obtain**
  - Alternative is to use "dim fiber" –point to point wavelengths
  - But want flexibility to do configuration and change management as with dark fiber

> **Increasingly science needs dedicated networks for specific applications and disciplines for high data volume grids**
  - Want to be able to manipulate the network in the same way they can manipulate the application

What is UCLP?

> **User Controlled LightPaths – a configuration and provisioning tool built around grid technology using web services**

> **Third party can concatenate cross connects together from various networks to produce a wide are network that is under their control**

– Articulated Private Network (APN)

> **Uses Service Oriented Architecture (SOA) and so network can be integrated with other web service applications**

> **APN can also do routing or switching with logical routers or switches represented as web services**

High Level "Architecture"

User Access Layer

Service Orchestration Layer

(BPEL)

LP-WS   ITF-WS   APN-WS   LPO-WS
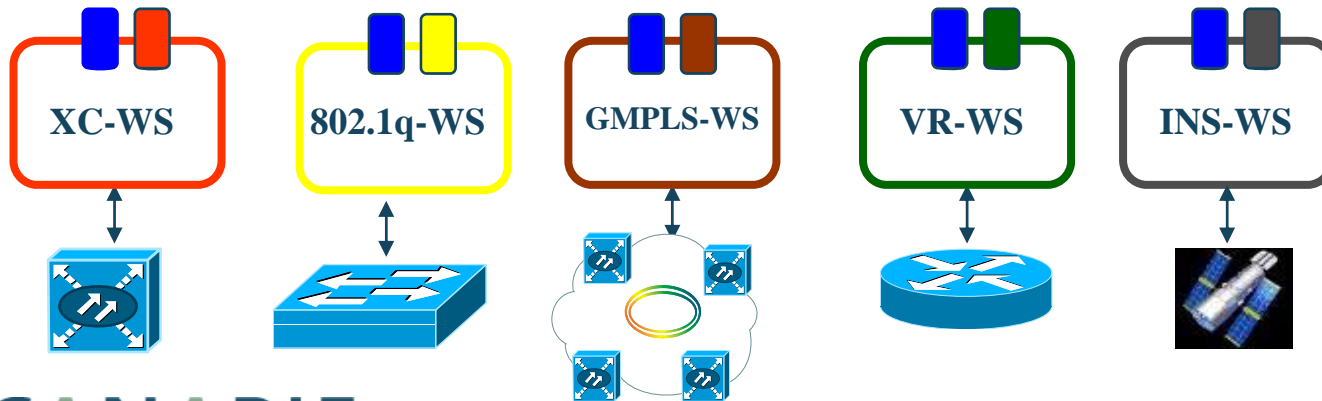
Resource Management Layer

XC-WS   802.1q-WS   GMPLS-WS   VR-WS   INS-WS

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Lighpaths as BPEL Orchestrations

> **Lightpaths should be orchestrations because they are logical representations of a flow of operations made on two WS-Enabled nodes**

> **It will allow internal invocation of instruments or application when the link is created or setup**

> **Different layers of services (Switching, VLANs) can be set up at usage time**

> **The Lightpath workflow can be changed at any time without effecting the WSDL**

Workflow Screen Shot

Integrated Grid-Lightpath Workflow

Lightpaths + SOA = UCLP

Grid initiatives in Canada

- > **Grids slow to take off in Canada**
  - – Grid X1 – Globus v2 linking systems at various sites for processing CERN Tier 2 data and astronomy
- > **Various HPC consortia dedicated to a variety of tasks**
- > **Westgrid – Consortium of High Performance computers in western Canada with various applications**
  - – CA*net 4 provides lightpaths for backplane integration of various HPC machines
- > **SHARCnet/HPCVL – High Performance Computing Consortia in Ontario with various applications**
  - – 10 GbE lightpath interconnecting facilities
  - – CA*net 4 provide 1 Gbe lightpath linking SHARCnet and Westgrid
- > **ACEnet – new consortia of HPC machines under development in Eastern Canada**

The Vision: Cabled Ocean Laboratories

> **Research areas include:**

 – Plate tectonic processes and earthquake dynamics

 – Dynamic processes of fluid fluxes and gas hydrates in the sea bed

 – Regional oceanic/climate dynamics and effects on the marine biota

 – Deep-sea ecosystem dynamics

 – Engineering and computational research

> **Delivering power and communications to instruments on and in the seafloor and through the water column**
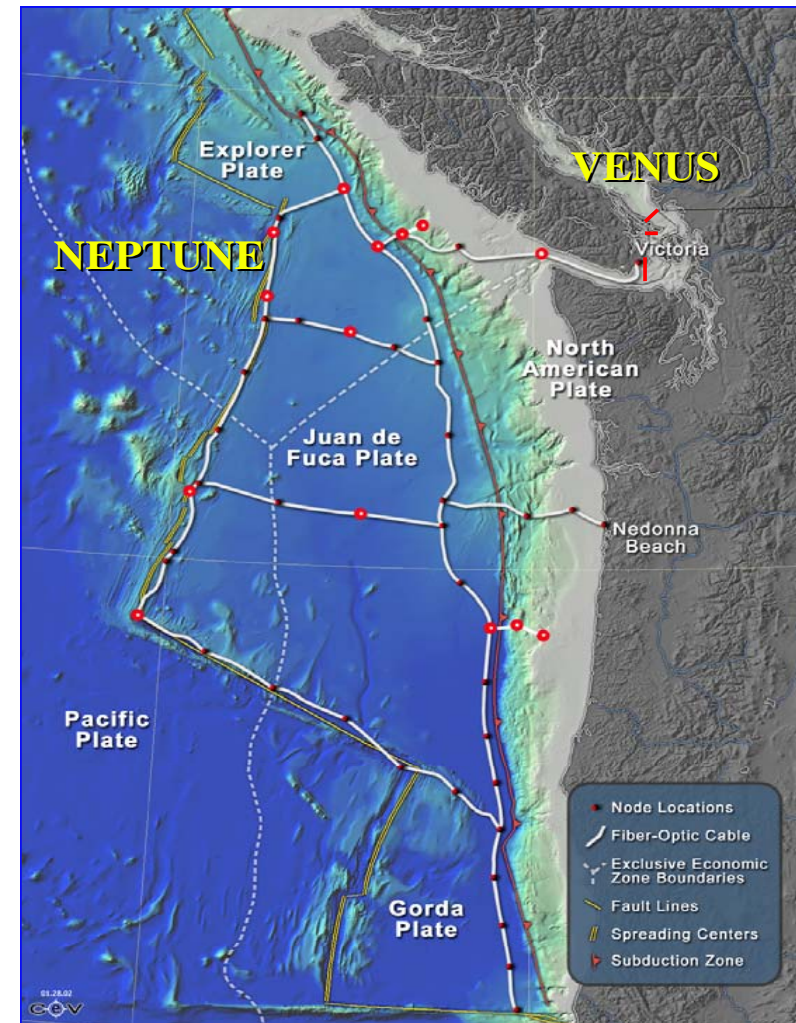
The Enabler: VENUS & NEPTUNE System Design
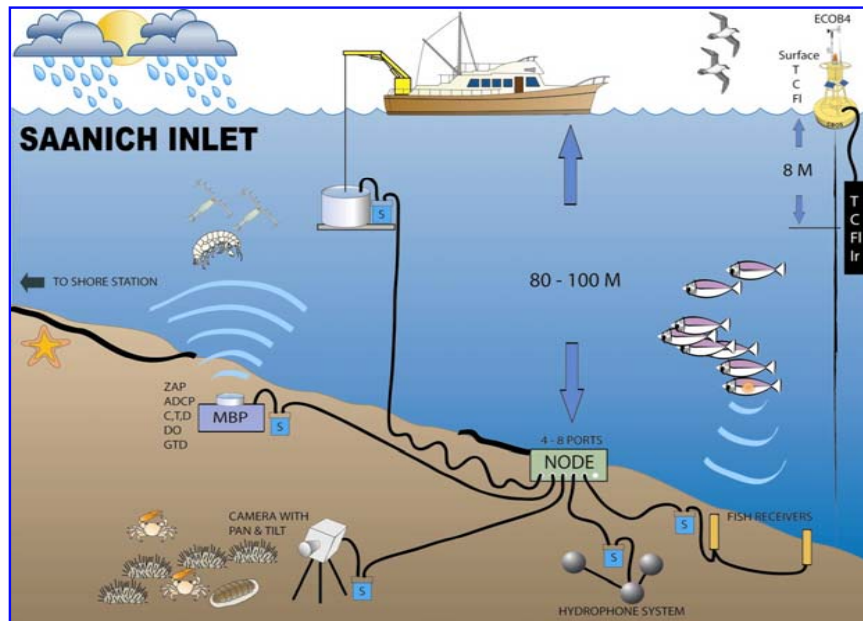
> **Power & Communications Cables**
> **Seafloor nodes/arrays for Instruments**
> **Shore station**
> **Operation Centre**

> **Instruments**
- Seismometer
- Hydrophone
- Acoustic Transponders
- GPS
- HDTV & Still Cameras
- Crawler

> **Data Management and Archive System (DMAS)**
- Data Capture and Retention
- Instrument Control and Programming
- Scheduling and Execution of crawlers and instruments
- Resource scheduling and assignment (crawlers, cameras)

The Means: NEPTUNE CIIP Project

To adopt and further refine CANARIE to realize a generic web-service enabled telemetry and control system for VENUS and NEPTUNE

> Embrace open standards **to further innovation, collaboration and knowledge sharing** (Open Source, Linux, OASIS)

> Migration from proprietary or legacy instrument control schemes (RS-232, RS-485, LECIS, SCADA)
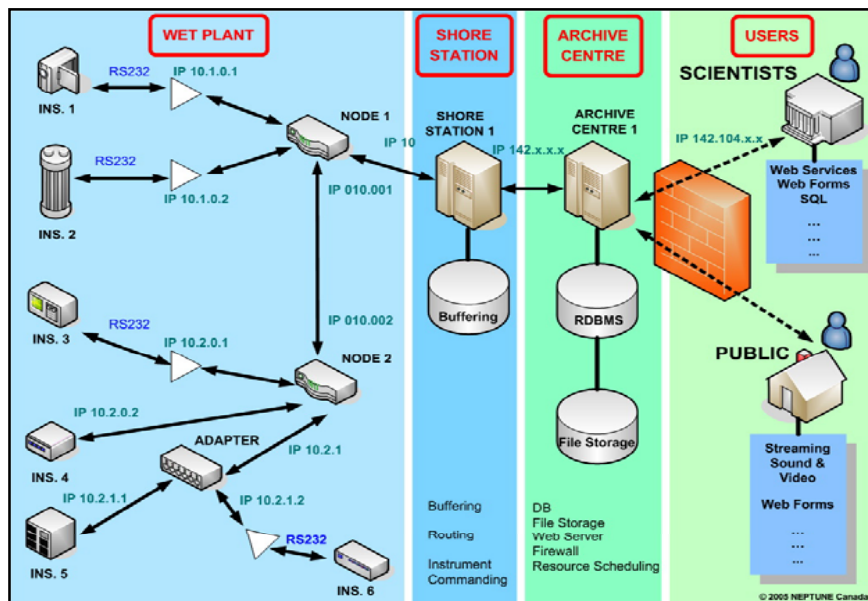
> Abstract and service-enable system end-points (instruments, PC control stations, compute clusters, data management or analytical applications)

> **Introduce a** loosely-coupled integration fabric **which places the burden on the "service bus" rather than the end-points** (SOA, ESB, SOAP/XML)

> **Exploit** reliable asynchronous messaging or synchronous messaging **as a means for instrument control or data interchange**

> Research driven process and service choreography (BPEL, BPEL4WS)

> **Adopt** self describing data packets **that can be inspected or transformed in transit** (XML)

> **Provide** dynamic and ever-evolving experimental design **or conditional handling support via content based routing for alerting, workflow, and event management**

Many Industries Share NEPTUNE's Objectives

> The "Extended Internet" will connect information systems to physical assets, products, and devices
> Complex business processes often need to connect to resources and systems beyond the world of IT and computer users. They link network endpoints like RFID, telematics, sensor networks, along with the necessary network protocols - bandwidth
> It also involves the sorting, sifting, and analysis of data gathered by networks of intelligent devices. Data analysis and business intelligence software, linked with device or sensor networks, helps organizations deal with the onslaught of data that such networks will create.

- Partners Healthcare equips discharged wound patients with digital cameras, allowing nurses to view after-care problems (like gangrene) via pictures downloaded over the Internet, avoiding costly home visits
- Delta Air Lines plans to use RFID luggage tracking to handle the 0.7% of bags that are misdirected each year, hoping to cut some of the nearly $100 million it spends to find those 800,000 lost bags.
- Norwich Union uses vehicle telematics to adjust insurance premiums based on where customers actually drive their cars, rather than just on where they live
- Temperature sensors in Union Pacific rail cars automatically alert repair crews when refrigeration goes on the blink, improving the quality of its produce delivery.

"The Seeds Of The Next Big Thing: Sketching The Fourth Wave Of Growth For The Technology Economy"
Forester Research Inc, June 2005

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Similar initiatives at Cal-IT(2) & UCSD

LOOKING

A real-time data grid system
>> Multi-disciplinary data being integrated
>> Multiple Sensor types being adapted
>> Real-time data virtualization enabled
>> Discovery & access through metadata supported

> (Laboratory for the Ocean Observatory
> Knowledge Integration Grid)
> Integrate Instruments & Sensors
> (Real Time Data Sources)
> Into a LambdaGrid
> Computing Environment
> With Web Services Interfaces

> New OptIPuter Application Driver:
> Gigabit Fibers on the Ocean Floor
> • Goal: Prototype Cyberinfrastructure for NSF ORION
> www.neptune.washington.edu

ROADNet

OptIPuter

Eucalyptus Participatory Design Studio Grid – using UCLP and SOA

> **Carleton Immersive Media Studio (CIMS), Carleton University, Canada**

The Participatory Design Studio will allow architects and industrial designers at multiple locations to collaborate in real time by sharing computational resources, geometry datasets, and multimedia content.
The expected result is the development and field testing of a Service Oriented Architecture utilizing User Controlled Light Paths (UCLPv2) on CA*net 4 that provides university architecture staff and students in Ottawa and Montreal with on-demand simultaneous shared access to visualization, modeling, and visual communication tools. The project is innovative because commercially available architectural tools not originally intended for long-distance use will become easy-to-use powerful enablers of long-distance design participation.

Source: Maxine Brown

Eucalyptus Network (APN)

UCLP for international science

- > **Hyugen's Cassinni probe landing on Titan**
- > **First time VBLI data ever transferred over networks**
- > **AARNet's was connected to a *CANARIE (CA)* switch and a User Controlled LightPath (UCLP) set up at 1GbE to the *Joint Institution for VLBI in Europe (JIVE, NL)***
- > ***More recently connecting VLBI dishes in China and Australia to Europe***
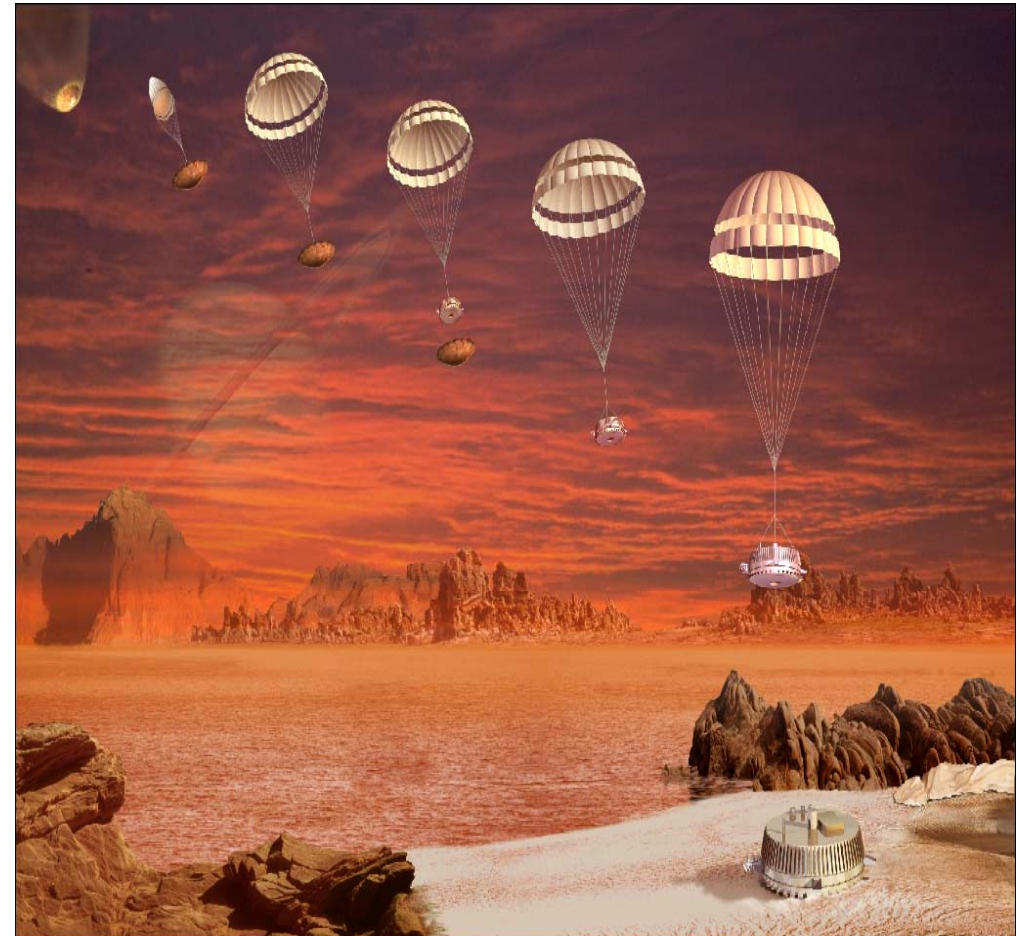
Data Reservoir Project

> Goal to create a global grid infrastructure to enable distributed data sharing and high-speed computing for data analysis and numerical simulations

> Online 2-PFLOPS system (part of the GRAPE-DR project), to be operational in 2008

Won April 26, 2006 Internet2 Land Speed Records (I2-LSR) in theIPv4 and IPv6 single and multi-stream categories. For IPv4, created a network path over 30,000 kilometers crossing eight international networks and exchange points, and transferred data at a rate of 8.80Gbps, or 264,147 terabit-meters per second(Tb-mps). For IPv6: created a path over 30,000 kilometers, crossing five international networks, and transferred data at a rate of 6.96 Gbps, or 208,800 Tb-mps.

- **University of Tokyo, WIDE Project, JGN2 network, APAN, Fujitsu Computer Technologies, NTT Communications, Japan**
- **Chelsio Communications**
- **StarLight, PNWGP, IEEAF, USA**
- **CANARIE, Canada**
- **SURFnet, SARA and University of Amsterdam, The Netherlands**

Source: Maxine Brown

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http://data-reservoir.adm.s.u-tokyo.ac.jp

GridJam: A Networked 3D Immersive Performance

> **Fine Arts Department, ARTSLab and Center for High Performance Computing, University of New Mexico**

> **Mills College, CA**

> **Calit2, UCSD, CA**

> **University of Alberta, Canada**

> **De Waag, NL (tentative)**

> **V2_, Institute for the Unstable Media, NL (tentative)**

Gridjam is an art and research project to study real-time, interactive, low-latency, partly improvised, 3D visualized, musical performances. The Virtual Color Organ (VCO) is a 3D immersive environment in which music is visually realized in colored and image-textured shapes as it is heard. The VCO visually illustrates information in a music's score, the composer's instructions to the musicians, and the musicians' contributions to the score as they improvise in reaction to one another's performances and to the immersive visual experiences. The VCO displays the emergent properties within the meaning of music, both as information and as art.
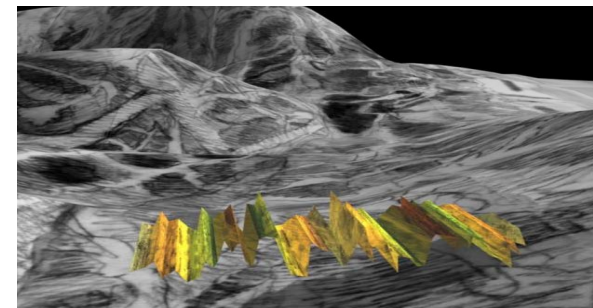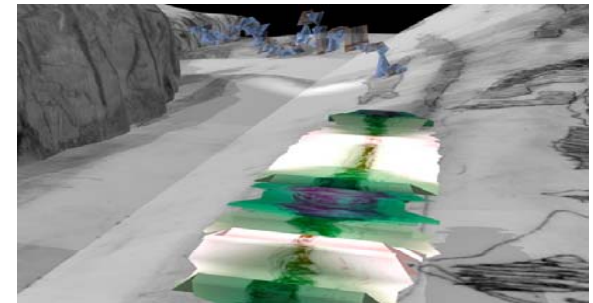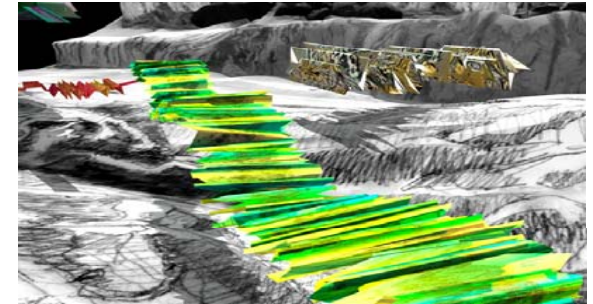
http://jackox.net/pages/gridjampages/Gridjam1.html

Source: Maxine Brown

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CANARIE Funding

> **Government of Canada has announced $120m funding for CANARIE**

> **A key aspect of new CANARIE funding will be deployment of "platforms" to support eScience and other applications**
>   – "**Network Enabled Platforms (NEP)**"

> **Next generation Internet architectures and cyber-infrastructure are converging on a similar architecture principles of "virtualization" of resources and services and creation of many concurrent facilities linking distributed computing, sensors, instruments, databases, etc**
>   – e.g. GENI is a platform to support network, computational and other types of research

> **Focus of NEP is on interconnection of "production" facilities of distributed computers, databases, instrument and sensor integrated with middleware technology such as grids, web services, Web 2.0, UCLP, Next Generation Internet, etc**

> **NEP is NOT a research program**

Network Enabled Platforms suggestions

> **Ideally proposal should be led by "community of interest" or "virtual organization" (VO) of domain scientists or users**
>> – Single PI, single institution proposals are likely to be less favoured
>> – VO may designate implemntation organization to manage VO, develop SOW with CANARIE, develop middleware etc
>> – Example NSF – Cyber Infrastructure Implementation Organizations
>> – JOI for Oceanography
>> – BBN for GENI
>> – etc

> **Consortium or VO establishes governance and set resource sharing policies for users and defines common architectures, etc**

> **Many such international consortia or VO already exist**
>> – **Therefore participation in international platforms strongly encouraged**