

An Introduction to UCLP

(User Controlled Lightpath Provisioning)

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Overview of this talk

- Context
 - Network management
 - User-owned fibres, switches, wavelengths
- Possible UCLP services
 - Type of resources: nodes, links, devices
 - Lightpath operations
 - APNs: collection of resources; can be subleased
 - End-to-end lightpath management and routing
 - Other aspects
- Canarie's UCLP development projects
- Our UCLP systems
 - UCLP v1
 - UCLP v2

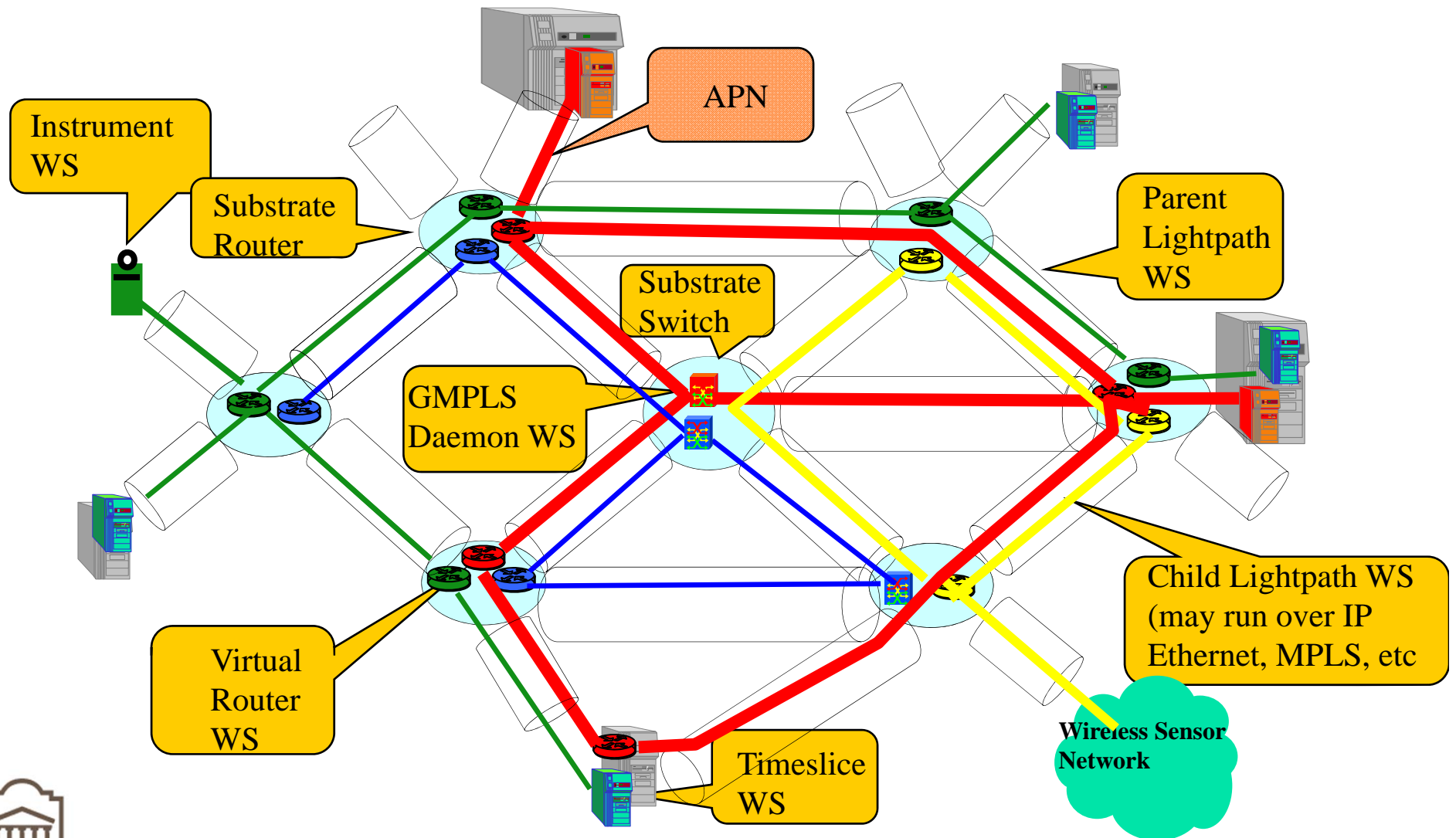


Network management

- Traditional view
 - User interface (signalling) for establishing **end-to-end connections**
 - Network management (the owner's perspective) for **configuration control, fault management, accounting, etc.**
- Trend for making networks more "open"
 - Open Network Architecture (OpenArch - <http://comet.columbia.edu/openarch/>)
 - Making interfaces to internal components accessible (switches, routers)
 - Ideally providing some open standards for interfaces to networks
 - Open Signalling (OpenSig - <http://comet.columbia.edu/opensig/activities/activities.html>)
- Customer-owned fibres / networks
 - a trend for university networks, hospitals
 - in relation with condominium fibre builds
 - may involve condo switches (different ports belonging to different owners). – At Ethernet and Internet level, one talks about "virtual switches/routers".



UCLP – an example



UCLP vs traditional network management

- With UCLP
 - Network user and owner are the same
 - Leasing network resources to other parties, including full control
- Traditional approach:
 - Signalling protocols (O-UNI, GMPLS, etc.) for establishing end-to-end connections for users
 - No access to underlying resources for the user



UCLP Services (overview)

- Resources to be shared
- Operations on lightpaths
- Articulated Private Networks (APN)
- End-to-end lightpath management
- Other service aspects
 - Access rights and security
 - Fault tolerance
 - Inter-domain operations



Resources

- Resources to be controlled / shared / leased
 - Nodes – “switches”
 - Optical cross-connect, e.g. SONET/SDH or ROADMs
 - Level-2 switch or level-3 router
 - Sub-area network (provides cross-connections between the external ports visible to UCLP)
 - Links – “lightpaths”
 - Fiber, wavelength, SONET channel, MPLS-flow, etc.
 - Devices – “applications”
 - Data sources or data sinks, e.g. e-science measurement devices or data processing computers
 - Could be routers in case of level-1 UCLP systems



Resources -- notes

- Each end-point of a link is usually connected to the port of a node or to a device. Thus, a network is formed.
- Among the physical resources owned by a given organization, only a subset may be made available to UCLP (i.e. could be leased to other parties).
 - A UCLP system may manage the whole set of resources or only those that could be leased (while the others are managed by another network management system).



UCLP Services: Lightpath (LP) operations

- Use – activate the resource for usage
 - When **use** is performed on a concatenated LP, the intermediate switches are configured to establish the required cross-connections
- Concatenate with another LP
- Partition into several lower-bandwidth LPs
- Lease to another party
- *Un-do each of the above operations*



UCLP Services:

Articulated Private Network (APN)

- APN: A concept proposed by Bill St-Arnaud, with a relatively vague meaning
- In our UCLP v2 project, we have implemented a notion of “APN” which is essentially a **set of resources**:
 - A resource list defines an APN
 - The operation **setConfig** may be performed on an APN (which means that the operation **use** is performed on all LPs contained in the APN)
 - An APN may be leased (exported) as a whole



UCLP Services:

End-to-end lightpath management

- Given two end-points (e.g. devices), establish a lightpath for transmission between these two end-points (one-way or both ways)
 - Note: this is the function of traditional signalling protocols. It is already provided by GMPLS, O-UNI, etc.
- This requires a routing function
 - Intra-domain: routing information available in local UCLP system
 - Inter-domain: some partial routing information must be exchanged between domains (similar to BGP; note: the BGP routing table concerns IP packet routing, but lightpath routing is at a lower level).
 - Inter-working between normal Internet transmission and lightpath shortcuts desirable at the end-points
 - O-BGP proposal by St-Arnaud
 - The company BigBangWidth has implemented end-point software that performs automatic end-to-end lightpath establishment and switch-over from normal Internet communication when a high-bandwidth data flow is detected



Additional function:

Future reservation of lightpaths

- Basic function: Immediate reservation
 - For an indeterminate period (e.g. telephone)
 - For a specified period (the normal case in UCLP)
- Additional function: reservation starting in the future, for a specified period
 - See for instance: A. Hafid, G. v. Bochmann and R. Dssouli, Quality of service negotiation with present and future reservations: A detailed study, *Computer Networks and ISDN Systems*, volume 30, issue 8, 1998, pp. 777-794.
 - Ongoing work:
 - a project in the USA
 - capability development under the UK ESLEA project



UCLP Services:

Other service aspects

- Access rights
 - Who can access which resources, and when ??
- Security
 - Reliable operations in the presence of “hackers”
 - Privacy of information about resources and operations performed
 - Authentication of users, servers, resources, etc.
- Fault tolerance
 - Graceful operations in the presence of user errors and system faults (e.g. link failures, node failures)
 - Monitoring the status of available resources
- Inter-domain operations – inter-operability standards
 - Different UCLP systems covering different domains must inter-operate in order to manage lightpaths that go through these different domains.
 - This requires common standards about LP operations, and basic conventions for access rights and authentication. (Note: detailed access right policies may vary from domain to domain)



Canarie's UCLP projects

- **Objective:** Ease the use of lightpath resources offered for experimental e-science projects within Canada and for international cooperation
- **First Canarie UCLP projects (2003-04)**
 - Three teams: CRC-UofO, UofWaterloo, UCarleton
- **Second Canarie UCLP projects (2005-06)**
 - Three teams: CRC-UofO-i2Cat-Inocybe, UQAM-UofO, Solana Networks
 - Requirement for inter-operability
- **Important requirements:**
 - General promotion of WS and GRID technologies
 - Providing WS interfaces for applications that use lightpaths
 - Interfacing with existing switches through various interfaces: TL1 and other conventions



Our UCLP systems

- UCLP system v1 (2003-04)
 - Originally developed by CRC and UofO, maintenance and extensions in collaboration with i2Cat and Inocybe
 - Initial exploration of UCLP concept
 - Emphasis on end-to-end lightpath provisioning
- UCLP system v2 (2005-06)
 - Developed by CRC-UofO-i2Cat-Inocybe
 - Service emphasis on APNs
 - Inter-operability requirements



UCLP v1: Some characteristics

- End-to-end lightpath provisioning service accessible through WS (OGSA) interface
 - to be used by Grid applications and our GUI application
- Distributed system implementation supporting several “federations”
- Use of Jini technology for service lookup, RMI for distributed operations, and Java Spaces for storage of UCLP system state



UCLP v2: Some characteristics

- Service WS interfaces to access LPs, End-Points (“Interfaces”), Devices, APNs
- Nice user interface (GUI) application accessing the above WS
- Internal WS interface to switches
- Resource list describes resources included in an APN
- Various functions are implemented using advanced technologies (in Java):
 - Within AXIS Web server
 - As BPEL processes providing WS interfaces
 - Within the GUI client application (using the Eclipse framework)



Overview of following presentations

- Today
 - UCLP tutorial and demonstration (Eduard Grasa)
 - HEAnet: practical experiences of deploying UCLP (Victor Reijs)
 - Discussion – Questions for tomorrow
- Tomorrow
 - The UKERNA perspective (David Salmon)
 - The user perspective (Marco Ruffini)
 - DISCUSSIONS and Conclusions ??

