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TutoBAHN Developments

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8th Annual Global LambdaGrid Workshop

Seattle, 1st October 2008

AutoBAHN is…

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- … a research activity for engineering, automating and streamlining the inter-domain setup of guaranteed capacity (Gbps) end-to-end paths across multiple heterogeneous domains

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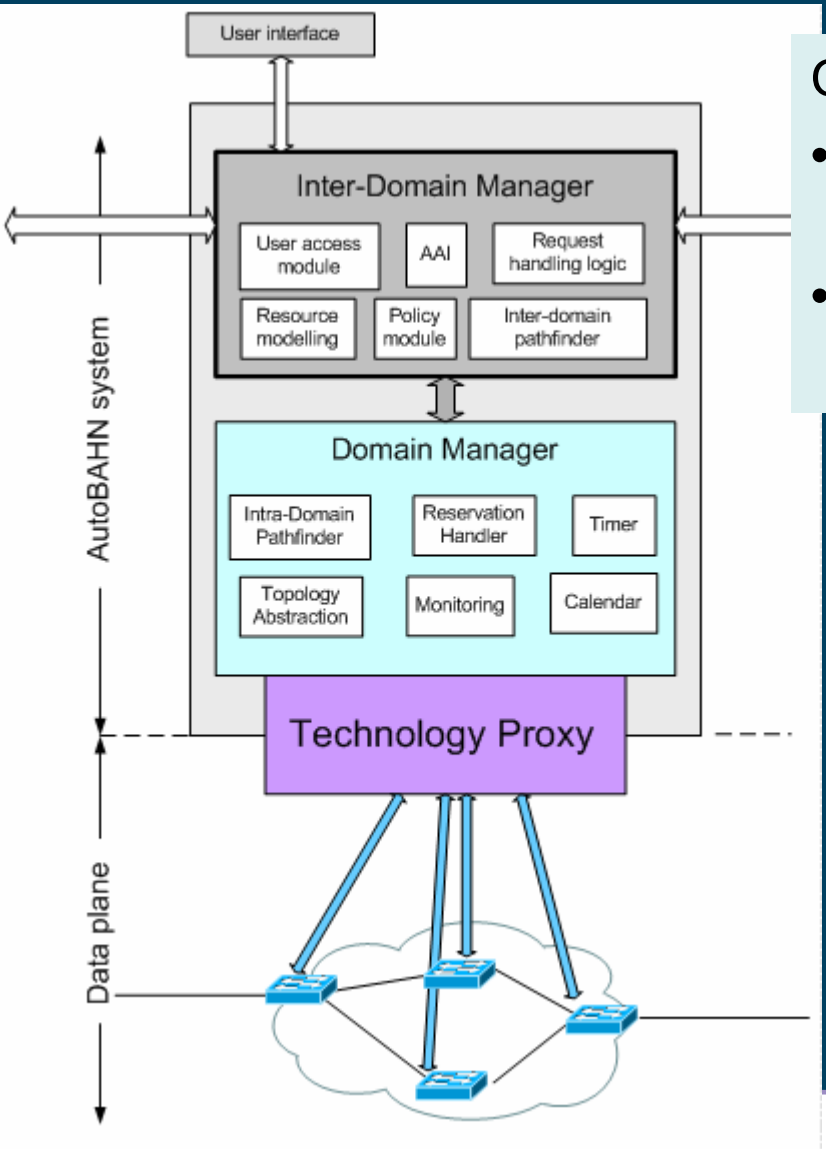
AutoBAHN approach



ONT4 workshop recommendations

- Uniform interfaces for management and control
- Exchange of useful information in a partially hidden environment

Collaborate

inter-

functionality, inter-domain interfaces for peering

  - Domain manager (DM): intra-domain functionality, topology information, resource availability information, signaling to the data plane
  - Interfaces
- Reference implementation including business layer and control plane functionality

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NREN BoD approaches

- Management plane solutions
  - The Alcatel NMS ISS interface used for EPL/EVPL provisioning over GEANT
- Control plane solutions
  - DRAC: Surfnet-NORTEL solution for the provisioning of lightpaths
- CLI-based tools
  - BLUEnet (HEAnet)
  - ANSTool (GRNET)
  - PIONIER L2 MPLS VLL configuration tool

Intra-domain solutions

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AutoBAHN is …

The multi-domain glue for local provisioning systems

- The AutoBAHN architecture requires each domain to:
  - Deploy the AutoBAHN system as a controller for inter-domain operations
  - Contribute with the development of a technology proxy between the AutoBAHN DM and the local provisioning system

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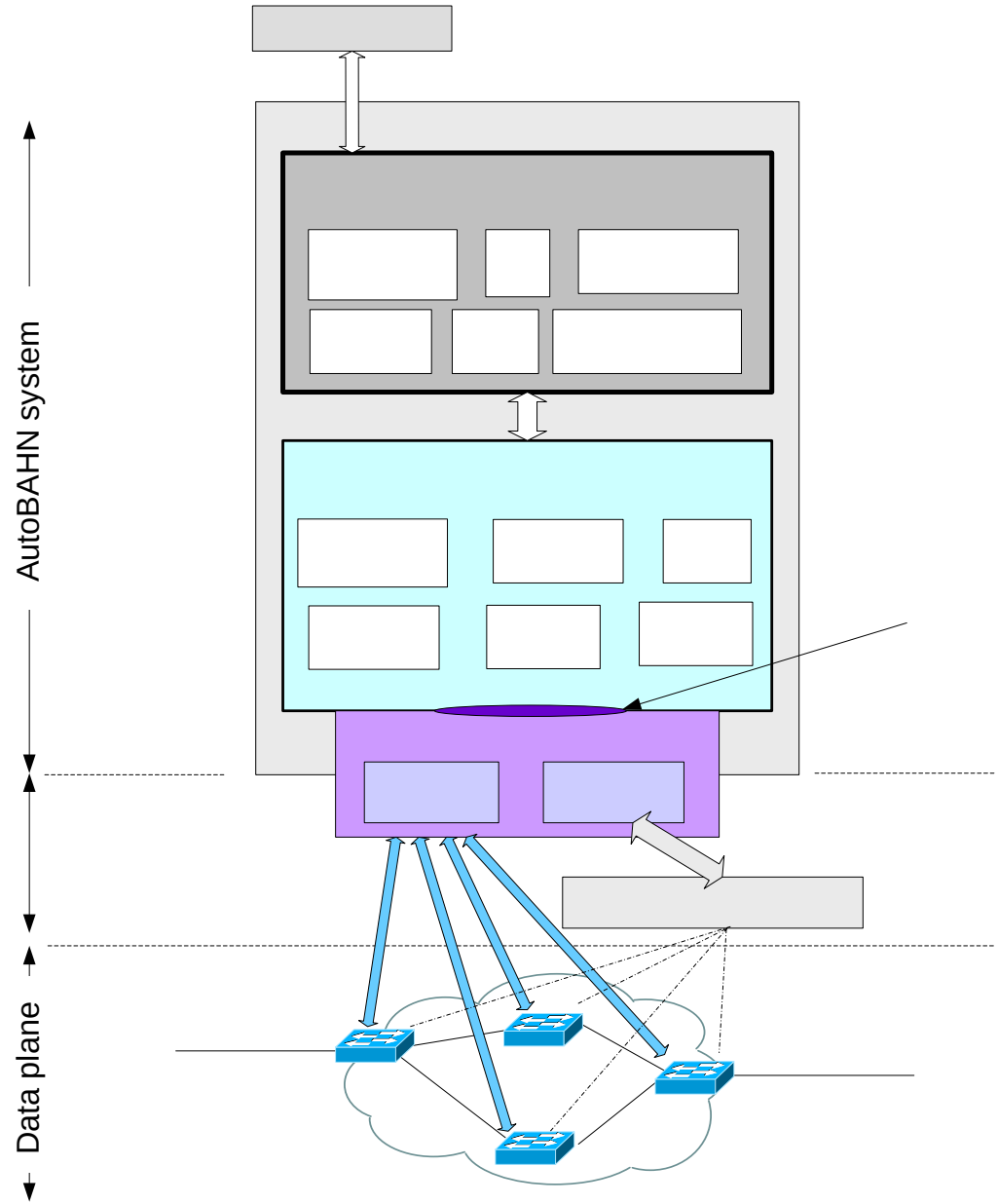

- Technology proxy between AutoBAHN and the data plane
  - WS-based interface
- Vendor proxies for:
  - NEs
  - Control/ Management plane
  - Provisioning system

User interface

Inter-Doma

User access module

A

Resource modelling

Policy modul

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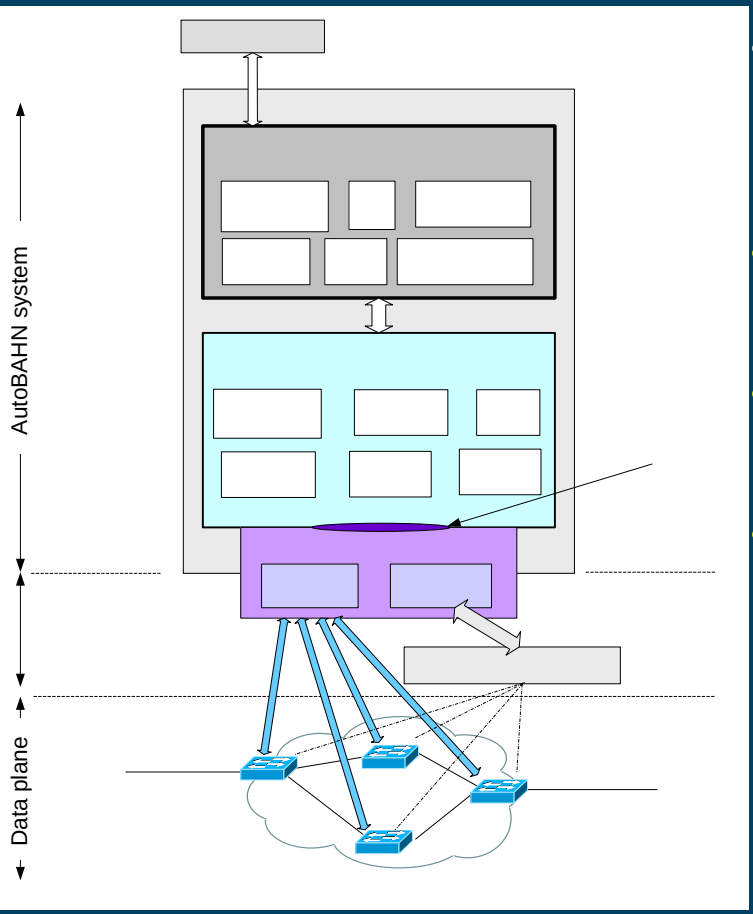
Technology proxy interface (1)



- Exchange of topology/resource availability information between the data plane and the AutoBAHN DM
- Communication/signaling requests from the AutoBAHN DM to the data plane
- Notifications/errors from the data plane back to the AutoBAHN DM
- Modular design of DM:
  - Parts of the DM functionality can be substituted by management/control plane functions
    - e.g. Intra-domain pathfinder, Topology abstraction

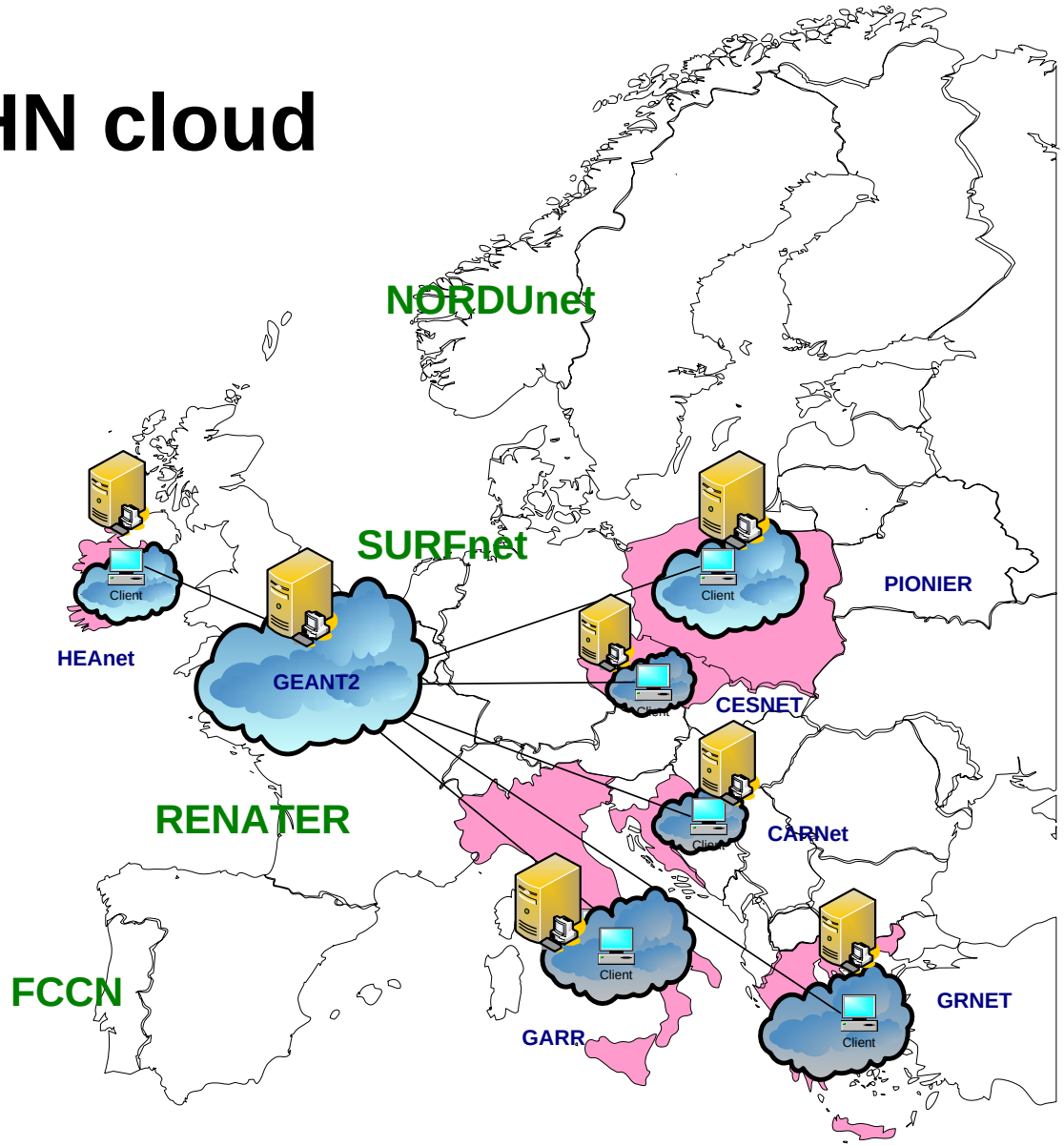
User interface

Technology proxy interface (2)

- Main methods:
  - addReservation(resID, links, params) –create new circuit reservation
    - resID – unique reservation identifier
    - links –list of links to be used for this reservation (intra-domain links, defined from ingress to egress port of a domain)
    - params –additional reservation parameters, including capacity to reserve
  - addReservationResponse() – confirms creation of circuit
  - removeReservation(resID) –remove circuit associated with given reservation ID
    - resID – unique reservation identifier
  - removeReservationResponse() – confirms removal of circuit and release of resources
- More methods related to failures and exceptions

Current AutoBAHN cloud

- FCCN is just about to join
- More NRENs are interested



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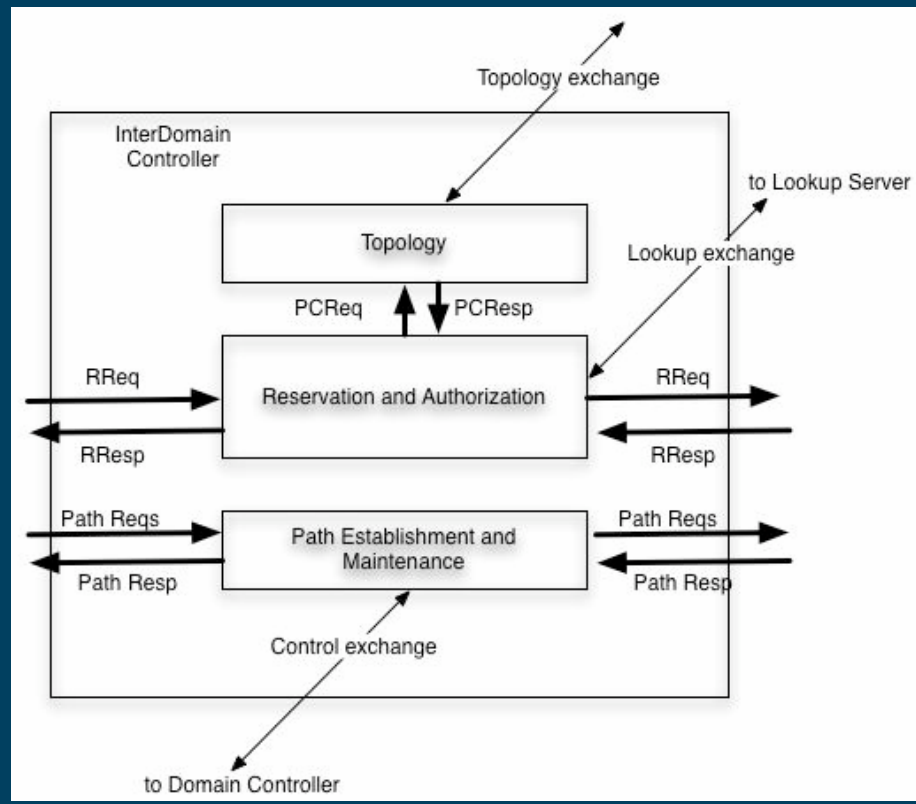
IDC protocol

- A Web-Services based protocol for inter-domain negotiations between different BoD systems
  - Topology exchange
  - Resource scheduling
  - Signaling
- Different implementations from
  - GN2, Internet2, ESnet, Nortel …



AutoBAHN is IDC-compatible

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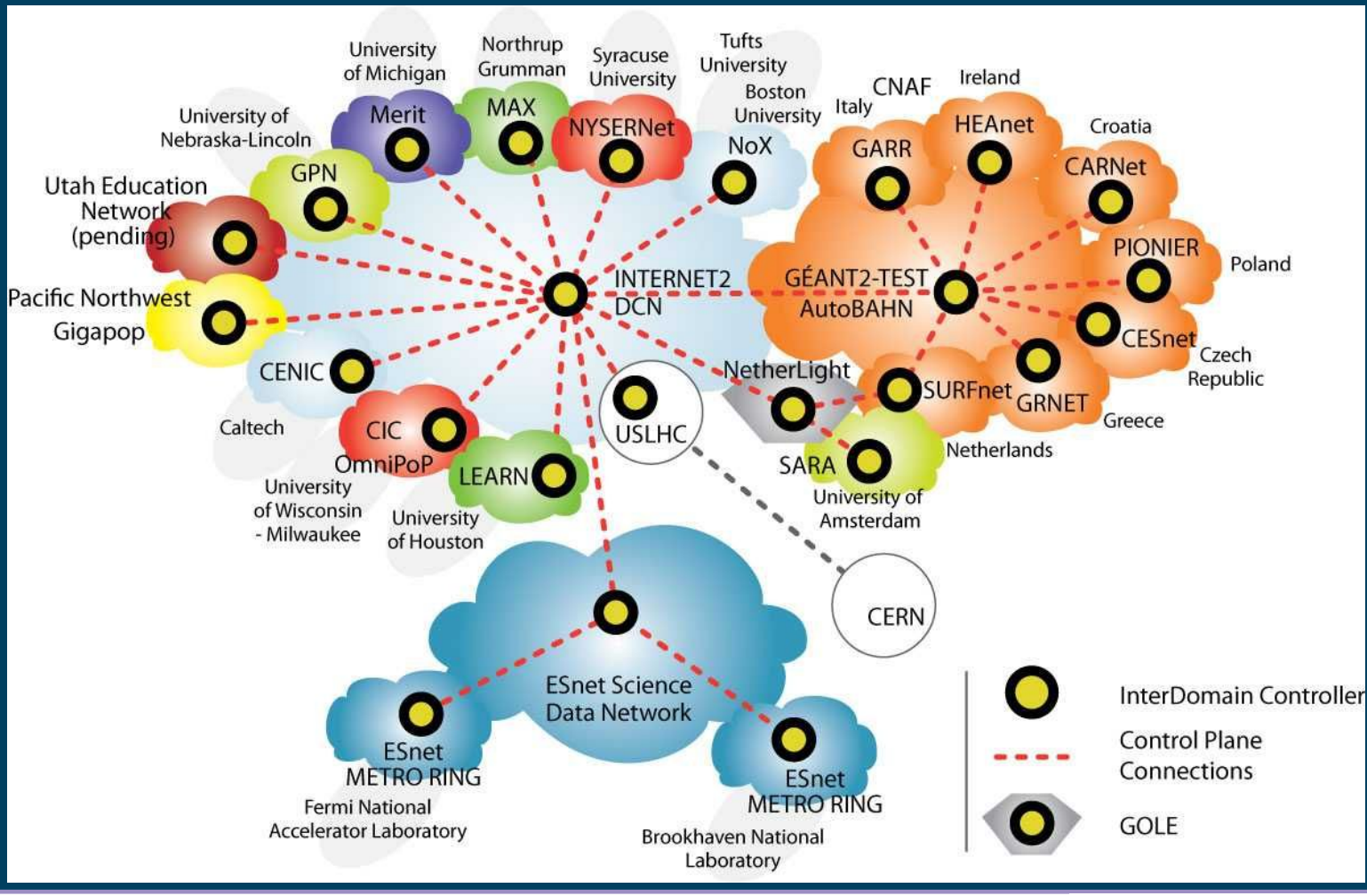

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New features for AutoBAHN

- Inter-domain monitoring: SDH
- Updates to the AutoBAHN system messaging took place
- The AutoBAHN system's DM module blocks split into packages so that respective vendor proxies can use or replace DM blocks' functionality on a case-by-case basis
- Improved GUI
- IDC protocol implementation is evolving (additional functionality like 'modify reservation', topology exchange protocol, lookup service etc.)

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Demonstrations-Events

- Internet2 Spring Member meeting (20-22 April, Arligton, VA)
  - Dynamic circuits signaled from Internet2/ESnet end-points and configured all the way to end-hosts in Europe (in GARR, CARNet, PIONIER, HEAnet)
  - Positively accepted by the I2 SMM audience
  - The importance of such efforts important was highlighted from the USLHC group, especially for transfers among T1 sites and T1-T2 sites, as part of the LHC operations.
- TERENA Networking conference ’08 (19-22 May, Brugges, Belgium)
  - Multiple dynamic circuits established among end-points in Europe and dynamically signaled from Europe to the US for the first time
  - Attended by a number of NRENs and user groups with increased interest

Demonstration at the 8th GLIF workshop

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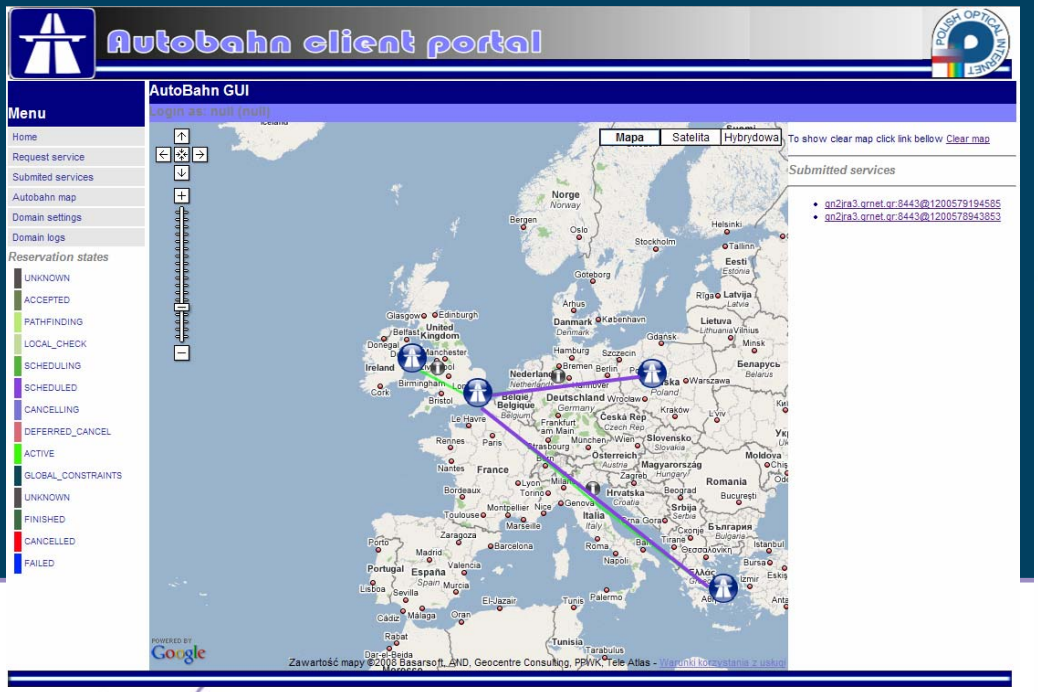
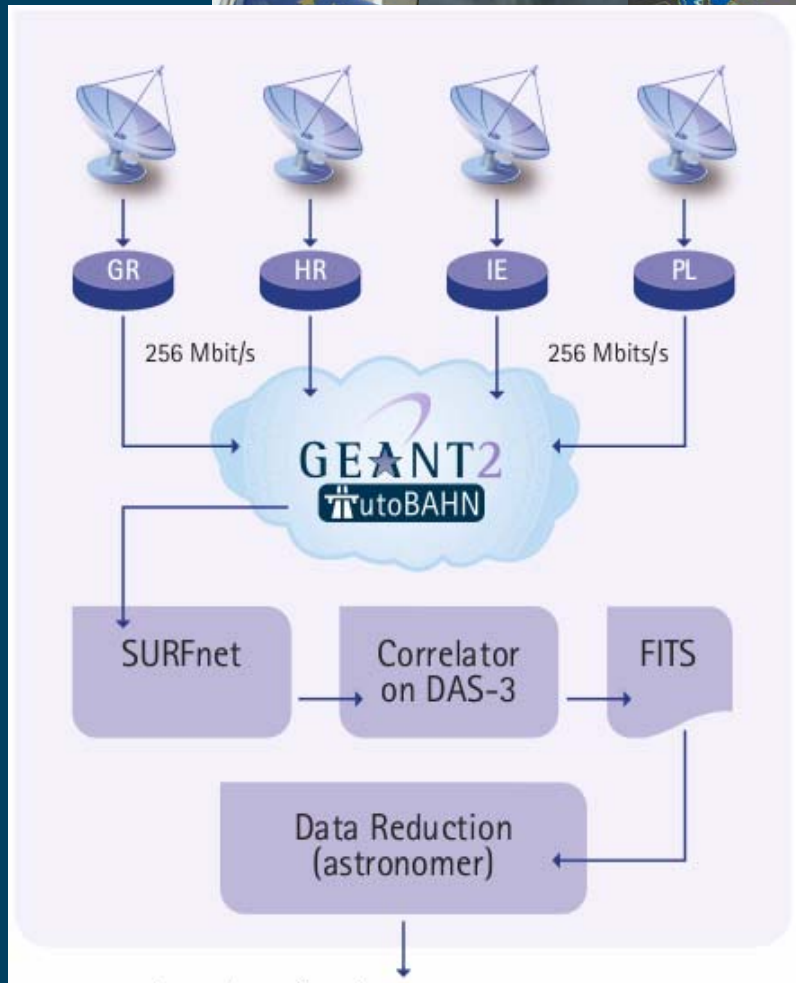
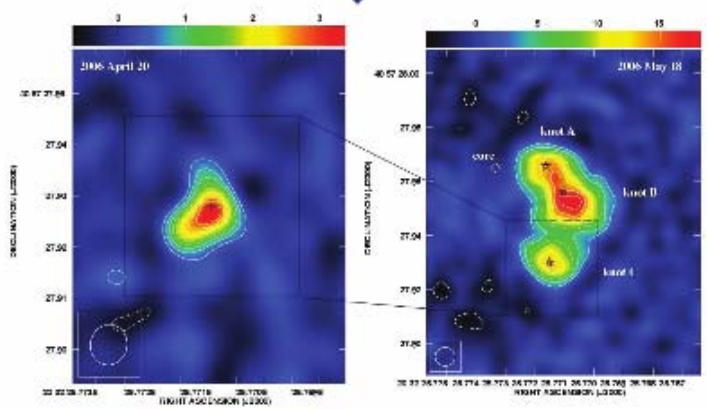
- In collaboration with the SCARIe project
  - Software Correlator Architecture Research and Implementation for e-VLBI
- Reproduction of an e-VLBI observation where data from radio telescopes across Europe (or across the globe) is sent to a compute cluster running the SFXC VLBI software correlator in order to be correlated in real-time.
- Why is AutoBAHN needed?
  - AutoBAHN functionality is needed to ensure integrity of data transfers from the telescopes to the correlator.
  - The European VLBI Network (EVN) only operates as a VLBI network during a few weeks a year. Outside these so-called VLBI sessions, most telescopes have their own observation programs, although it is possible to arrange VLBI observation outside the regular sessions for observing so-called transients (Gamma Ray Bursts, flares).
  - The telescopes that actually participate in a VLBI experiment are variable (depending on observation frequency, source brightness, source structure and availability of the telescopes).
  - Since the software correlator can in principle be run on many clusters, the location of the correlation center is no longer fixed

Demonstration overview

- Astronomic data over AutoBAHN circuits
  - Scheduled for: Oct 1st, 17:30 - 18:30, @Kane Hall, University of Washington
  - Demonstration presentation: Oct 2nd, 09:00-10:30, GLIF Workshop venue







Standardization efforts in OGF

- OGF 23
  - Similarities between the GNI BoF and the GNI and DMNR proposals led to an agreement to agree to form a single WG with input from both the BoFs: NSI (Network Services Interface) WG
- OGF 24 : Inaugural meeting for NSI WG
- NSI WG ad-hoc meeting on Friday, 3rd Oct
- AutoBAHN is participating and contributing to NSI WG

AutoBAHN media

AutoBAHN Technical Overview

The AutoBAHN system is based on the Inter-Domain Manager (IDM), a module responsible for inter-domain operations of circuit reservation on behalf of a domain. This includes inter-domain communication, resource negotiations with adjacent domains, resource scheduling, and topology advertisements.

To build a real end-to-end circuit, the Domain Manager (DM) module is also required to manage intra-domain resources. This module is the part of the AutoBAHN system that needs to be tailored to the domain-specific conditions and has an interface to the local IDM which sits immediately above it.

The local Network Management System (NMS) or service provisioning system, monitoring infrastructure, administration policies, and security, may need to be adjusted for each networking domain making each DM implementation unique. However, the design of the DM has been optimised to support modular deployment and leverage the management infrastructure already deployed in any domain.

In each domain, the data plane is controlled by the DM module using a range of techniques, including interfaces to the NMS, signalling protocols, or network elements. A dedicated Technology Proxy module, as part of the AutoBAHN DM, allows the AutoBAHN system to support a range of technologies and vendors according to domain and global requirements.

AutoBAHN Use Cases

The benefits of BoD services are most obvious where advanced requirements for network connectivity exist, especially when multiple domains are involved, capacity reservation needs to be supported in advance and circuits must be realised and released in a dynamic manner. A number of user cases for AutoBAHN are under development, including scenarios involving the Large Hadron Collider (LHC) project – the latest and most powerful in a series of particle accelerators based at CERN in Geneva and the SCARIe project – aimed at building a distributed software correlator for real-time processing of astronomical electronically transmitted data. In these scenarios, reliable transfer of large amounts of critical data among multiple end-points will take place over AutoBAHN-enabled circuits. Dynamic allocation of BoD circuits will optimise the utilisation of the available network resources and will allow "on the fly" selection of the endpoints among which data is exchanged.

For more information please visit www.geant2.net/autobahn

GÉANT2 is an advanced pan-European backbone network that interconnects National Research and Education Networks (NRENs) across Europe. With an estimated 30 million research and education users in 34 countries across the continent connected via the NRENs, GÉANT2 offers unrivalled geographical coverage, high bandwidth, innovative hybrid networking technology and a range of user-focused services, making it the most advanced international network in the world. Together with the NRENs it connects, GÉANT2 has links totalling more than 50,000km in length and its extensive geographical reach interconnects networks in other world regions to enable global research collaboration. Europe's academics and researchers can exploit dedicated GÉANT2 point-to-point links, creating optical private networks that connect specific research centres.

GÉANT2 is co-funded by the European Commission under the EU's Sixth Research and Development Framework Programme. The project partners are 30 European NRENs, TERENA and DANTE. GÉANT2 is operated by DANTE on behalf of Europe's NRENs. For more information, visit **www.geant2.net**

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AutoBAHN

GÉANT2 AutoBAHN

AutoBAHN

Automated Bandwidth Allocation across Heterogenous Networks

Overview

Researchers today often need dedicated channels to transport data at higher bandwidth with guaranteed quality. Internet Protocol (IP) networks provide always-on services for data transfer but cannot guarantee this quality. Bandwidth on Demand (BoD) balances the use of the network by highly demanding applications, and prioritises traffic so that a faster and better level of service is received. The GÉANT2 network supplies the ability to transfer large amounts of information quickly and effectively, with capacity available whenever needed.

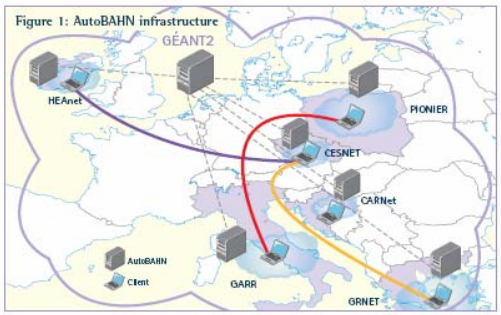
BoD activity is central to the efforts to develop the next generation GÉANT2 network, using transport technologies to offer new services in addition to IP-based services. The GÉANT2 Joint Research Activity 3 (JRA3) Automated Bandwidth Allocation across Heterogeneous Networks (AutoBAHN) system is working towards providing a BoD service by configuring on-demand circuits across various networks. These circuits will be reserved in advance.

AutoBAHN demonstrations

Automated provisioning of such circuits using AutoBAHN was first demonstrated in June 2007 during the 4th GÉANT2 Technical Workshop and in November during the SuperComputing 2007 conference. During 2008 it will be demonstrated at the Internet2 Member Meeting in April and the TERENA Networking Conference in May.

The forthcoming demonstrations will use the capabilities of AutoBAHN to demonstrate multiple BoD circuit instances among existing clients over an infrastructure similar to that shown in Figure 1.

Figure 1: AutoBAHN infrastructure



management domains, and incorporate features such as advance reservations and comprehensive performance monitoring. In particular, the AutoBAHN system has been designed to allocate network bandwidth to applications both immediately and in advance. Allocations will be restricted to authenticated users, acting within authorised

network. To provide guaranteed end-to-end service with resource reservation, service requests must be co-ordinated across domains. This role is undertaken by instances of the AutoBAHN system deployed in each involved domain.

The AutoBAHN system will not act as a replacement for existing control plane, signalling and provisioning capabilities. Instead it provides an integrated business layer for co-ordinated inter-domain provisioning, complementing existing control plane capabilities (where they exist) with AAI, inter-domain routing functionality, inter-domain monitoring, and so on. It also substitutes for the control plane functions where those are not available. AutoBAHN, acting as the intermediary between users (or applications) and the network, interprets user requests and translates them to requests to the network. The network itself must specify to the middleware what services are available and their corresponding quality parameters.

Each network domain defines policies for use of networking resources as well as quality parameters and is able to express them through AutoBAHN. Users authenticated by identity and role may receive authorisation against the respective policies. The originality of AutoBAHN lies in ensuring that new network services are introduced to meet the requirements of next generation network users, overcoming the borders of physically and technically disjointed networks.

Figure 2: Dynamic circuit provision: the concept

To engineer, automate and streamline the inter-domain setup of dedicated capacity end-to-end paths in a multi-technology environment

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AutoBAHN media (2)

Watch out for SC'08 demonstrations

Astronomic data over on-demand network circuits

AutoBAHN & SCARIe

Researchers today often need dedicated channels to transport data at high rates with guaranteed levels of service. Traditional Internet Protocol (IP) networks provide always-on services for data transfer but cannot guarantee the capacity or level of service required for certain research projects and use cases.

The GÉANT2 Automated Bandwidth Allocation across Heterogeneous Networks (AutoBAHN) system is providing a Bandwidth-On-Demand service by allowing demanding users/applications to reserve and schedule the usage of on-demand circuits across various research networks in Europe.

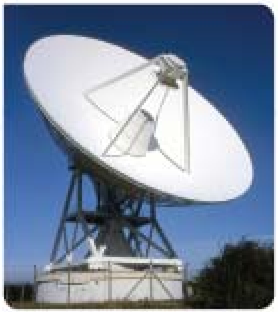

Figure 1. 32 m telescope dish in Cambridge, UK

Very Long Baseline Interferometry (VLBI) is a radio-astronomical technique used to make extremely high-resolution images of cosmic sources. To this end, signals from radio telescopes across the globe (Figure 1) need to be collated at a central facility, the correlator. In the past, data were recorded on magnetic tapes (more recently on disk packs) and shipped to the correlator. Over the last few years, the VLBI community has started employing networks as a transport medium transferring data over the public Internet or dedicated high-bandwidth end-to-end circuits. This method of doing VLBI (also known as e-VLBI) has some interesting benefits, like the significant reduction of the time between observation and final data product and the capability to react flexibly and rapidly to the occurrence of transient objects (such as Gamma Ray Bursts or Supernovae).

Also, VLBI correlators were traditionally built using special-purpose hardware (ASICs, FPGAs). Moore's law has made it feasible to implement correlators in software. While extremely powerful, hardware correlators lack the flexibility that software correlators provide.

The SCARIe project aims to develop a distributed software correlator that can be used for real-time e-VLBI, integrating it with advanced networking technologies. The project is a collaboration between JIVE, the University of Amsterdam and SARA, and is funded by the Netherlands Organisation for Scientific Research (NWO). The SCARIe software correlator is more flexible than a hardware correlator as it can be deployed in different locations. Also, the telescopes feeding the correlator with data are distributed around Europe (and beyond). The Internet could be used for the data transport between the telescopes and the correlator but as a publicly shared medium, it is often congested or unreliable. Alternatively, static circuits between the telescopes and the location of the correlator could be provided on a case-by-case basis but this option is not always possible and not flexible enough for a constantly changing set of locations.

Dynamic circuit provisioning by AutoBAHN presents a better solution for the SCARIe e-VLBI:

- The worldwide VLBI Network does not operate continuously, which means that the circuits are not needed permanently.
- The locations of the actual telescopes that participate in observations vary.
- In an advanced correlator setup, the software can be run on many distributed clusters, with more demanding and dynamic needs for connectivity.

GÉANT2 AutoBAHN · University of Amsterdam · JIVE Joint Institute for VLBI in Europe

Demonstrating e-VLBI over dynamic circuits

This demonstration uses pre-recorded data distributed across Europe, simulating telescopes sending data to the correlator, the DAS-3 cluster in University of Amsterdam. Signals from at least four telescopes, at a minimum data rate of 256 Mbit/s per telescope are correlated. Four data servers are accessible via the AutoBAHN-supported infrastructure in Europe (comprising of the GÉANT2 testbed backbone and several National Research & Education networks) or over the DCN of Internet2.

The four data servers mimic real telescopes streaming data and are currently based in Greece (connected through GRNET), Ireland (connected through HEAnet), Croatia (connected through CARnet) and Poland (connected through PIONIER). The servers are connected through the local NREN and GÉANT2 with dynamic 1 Gbps circuits provisioned by AutoBAHN. The circuits are delivered at the GÉANT2 point of presence (PoP) in Amsterdam and then transported by SURFnet (the Dutch NREN) over a 10-Gbit/s link to one of the bridge nodes of DAS-3 (Figure 2). The bridge node is configured to route data packets at the IP layer between DAS-3 and the servers using Ethernet VLANs.

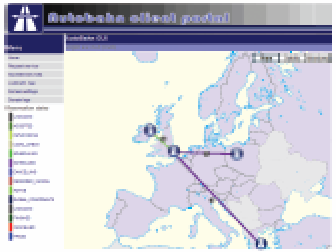

Figure 3. AutoBAHN client portal

The DAS-3 cluster is used in this scenario as the software correlator. In principle, other grid clusters could also be used; this is one of the advantages of using a system for provisioning of dynamic circuits like AutoBAHN. Shortly before the software correlation starts, the circuits to carry the telescope data to the correlator from four different locations are dynamically configured through the AutoBAHN portal (Figure 3), available at: http://srv-poznan.pionier.net.pl:8080/autobahn/portal/login.htm. While the correlation process is running, statistics about the correlation are presented. A fringe-display depicts the correlation function for one or more pairs of telescopes. This display shows a clearly identifiable peak when the telescopes move "on source", indicating that the observed source has been detected (Figure 2b).

> AutoBAHN is using Web Services and accepts requests for dynamic circuits over its currently supported topology, using symbolic names for the circuit end-points and other parameters, such as capacity, duration etc. Upon submission of a request, subject to availability of resources, dynamic circuits are instantiated across Europe in the order of minutes. The current implementation of AutoBAHN is a pilot, however circuit provisioning through AutoBAHN is delivering fully operational circuits.

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