



AutoBAHN: Automated Bandwidth Allocation across Heterogeneous Networks

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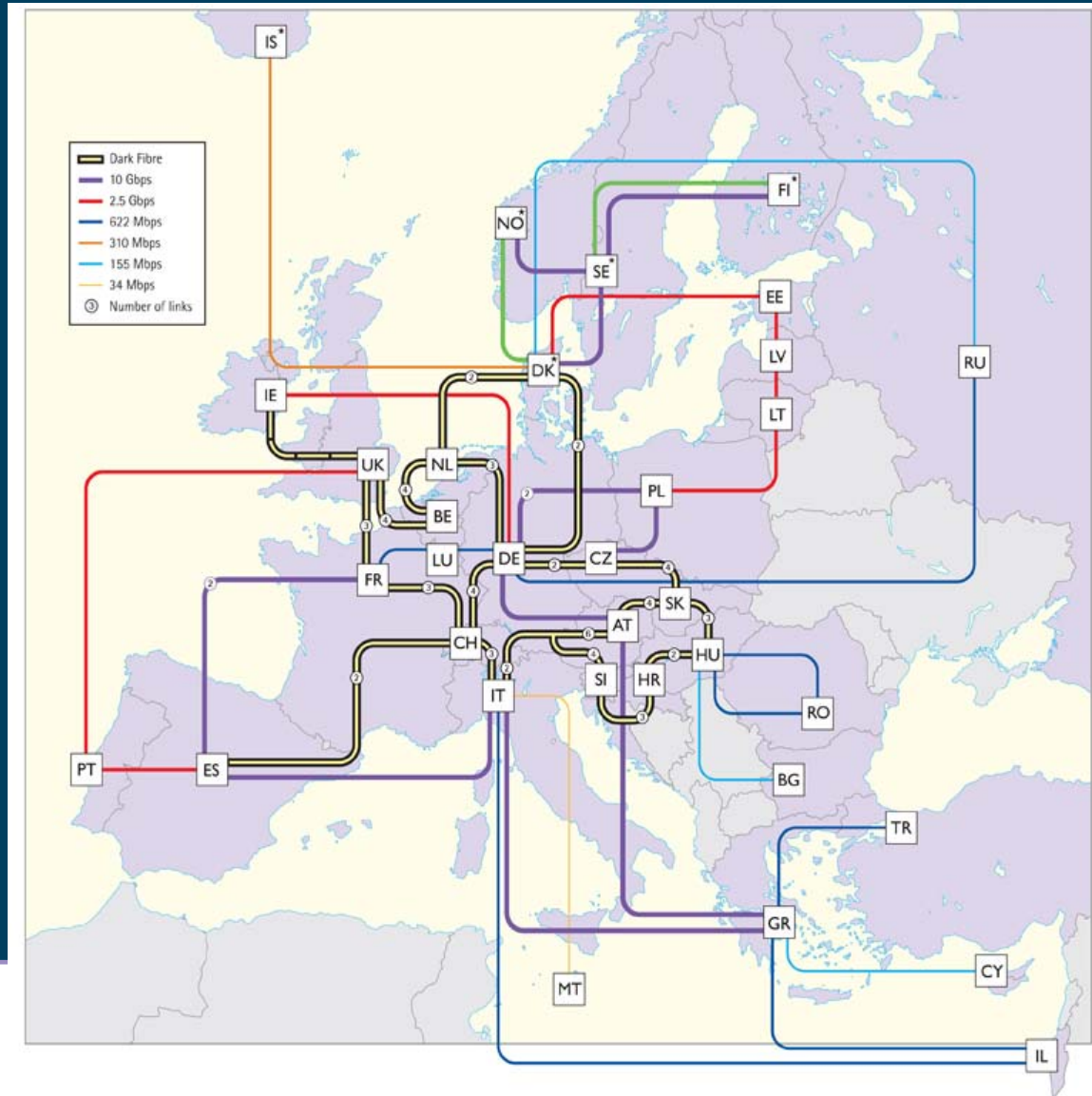
AutoBAHN is...

- ... a **research** activity for engineering, automating and streamlining the **inter-domain setup** of **guaranteed** capacity end-to-end **paths**
- AutoBAHN = Joint Research Activity 3 of the GN2 project
 - **GN2** is an **EC-funded** Integrated Infrastructure Initiative (I3) project, with European R&E Networks (**NRENs**) as partners (DANTE: coordinator)
 - GN2 has implemented the GÉANT2 network, dark-fiber enabled infrastructure offering both IP and circuit-oriented services

GÉANT2



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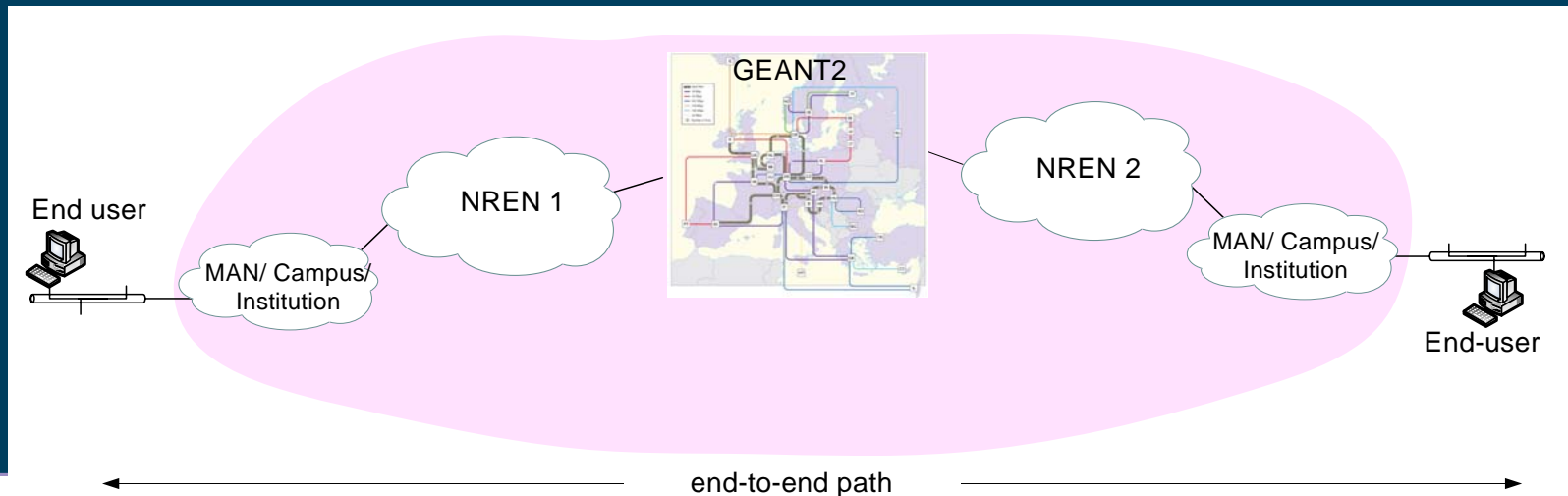




End-to-end services over GÉANT2

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- Up to now: Packet Switched IP (Layer 3) & L2 MPLS Managed Bandwidth Services – VPNs
- From now on the **hybrid** NREN - GÉANT2 service model also enables:
 - Layer 2 switched e2e circuits (e.g.1 GE) involving GÉANT2 & NREN - Campus circuits
 - 10 Gig Optical Private Networks (OPNs) configured for large *e-Science* projects using GÉANT2 DWDM & NREN - Campus lightpaths

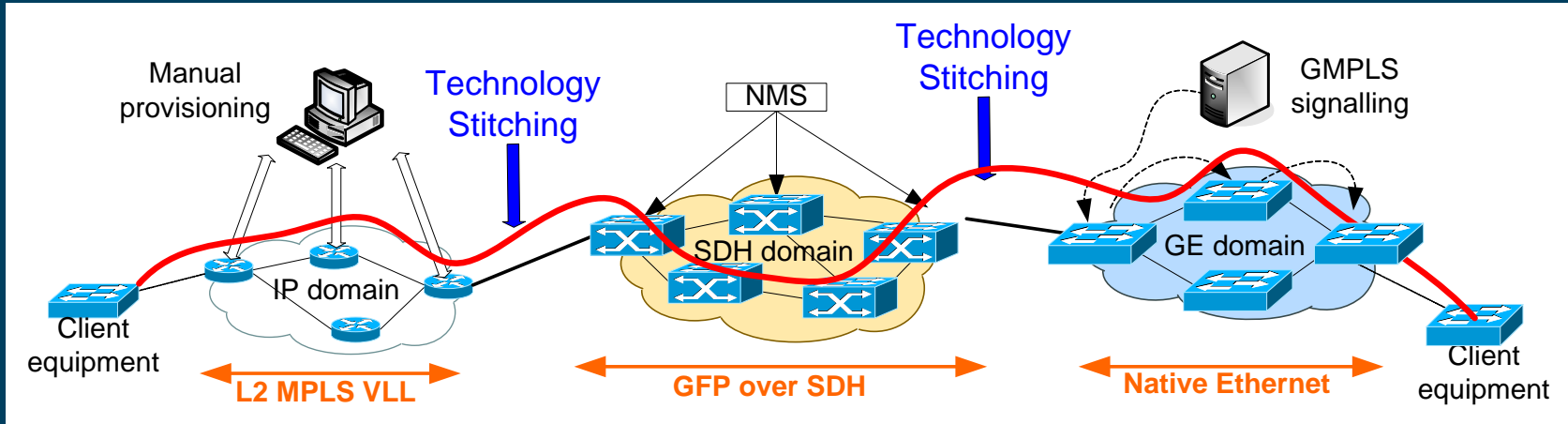




A multi-domain ...

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- ...multi-technology, multi-disciplinary environment
- Control and provisioning has to be distributed
- Technology stitching between domains
- Business-layer related interactions include AAI, policies, advance reservations, etc.
- Privacy and control of intra-domain resources must be safeguarded





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Approach

- The effort to provision end-to-end Bandwidth on Demand services in the European scenario requires specific developments in **inter-domain collaboration**
- **Splitting intra-domain** management functionalities from **inter-domain** ones in separate modules, allows multi-domain R&D to proceed autonomously and focus on this less standardized area
- At the same time, it allows to **leverage existing inter-domain** managers through wrappers/proxies and interfaces, exploiting a **modular approach**
- This effort can provide solid experience for **brokering services** other than Bandwidth on Demand



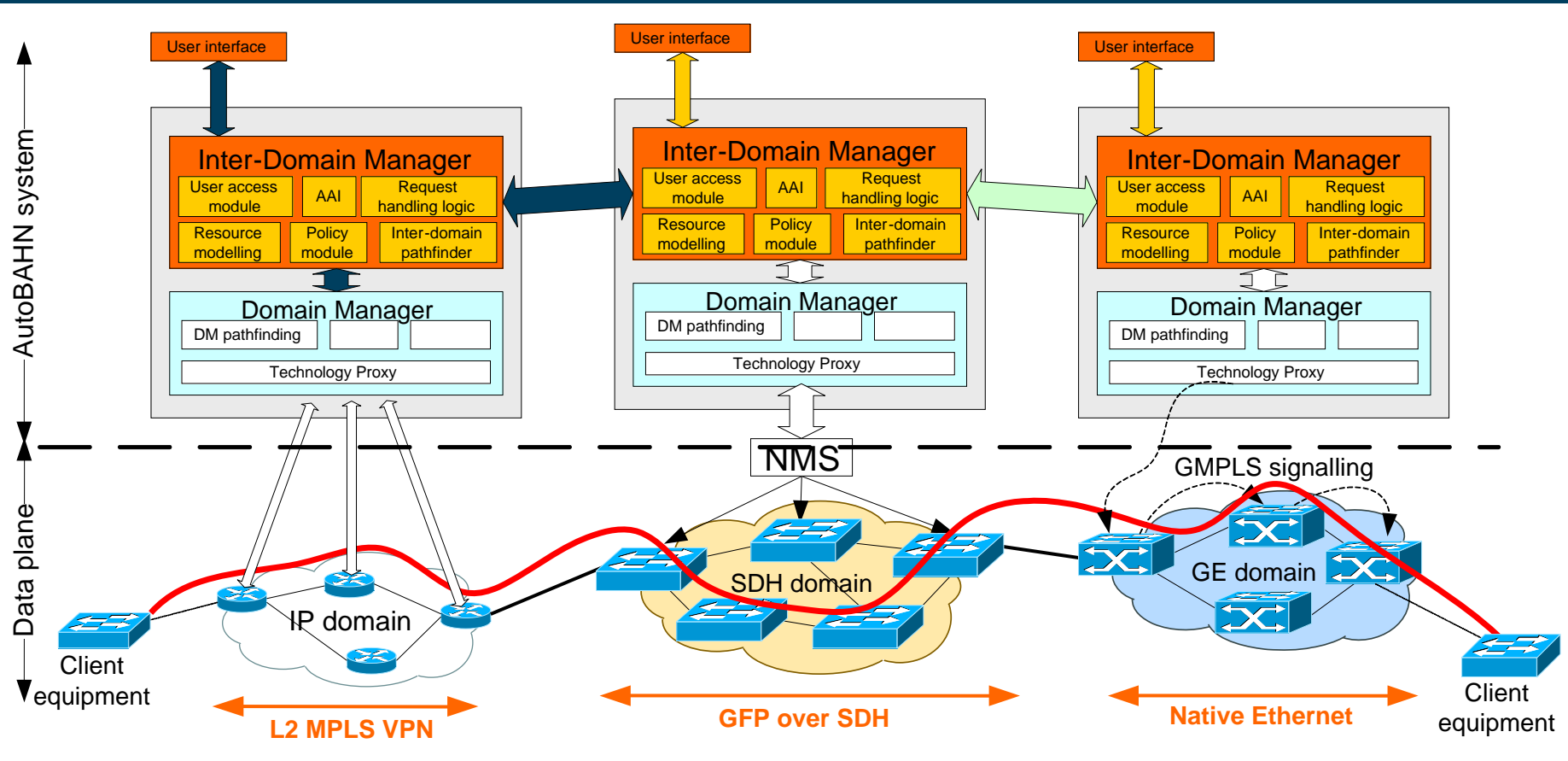
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AutoBAHN key elements

- Components:
 - Inter-Domain manager (IDM)
 - Domain manager (DM)
- Topology abstraction
- Path finder
- Technology proxies
- Standardized interfaces
- Each domain participating in the BoD service provisioning needs to operate an IDM and honor the IDM-DM and IDM-IDM interfaces.
- The local DM can be any technology, a proxy is needed towards the IDM

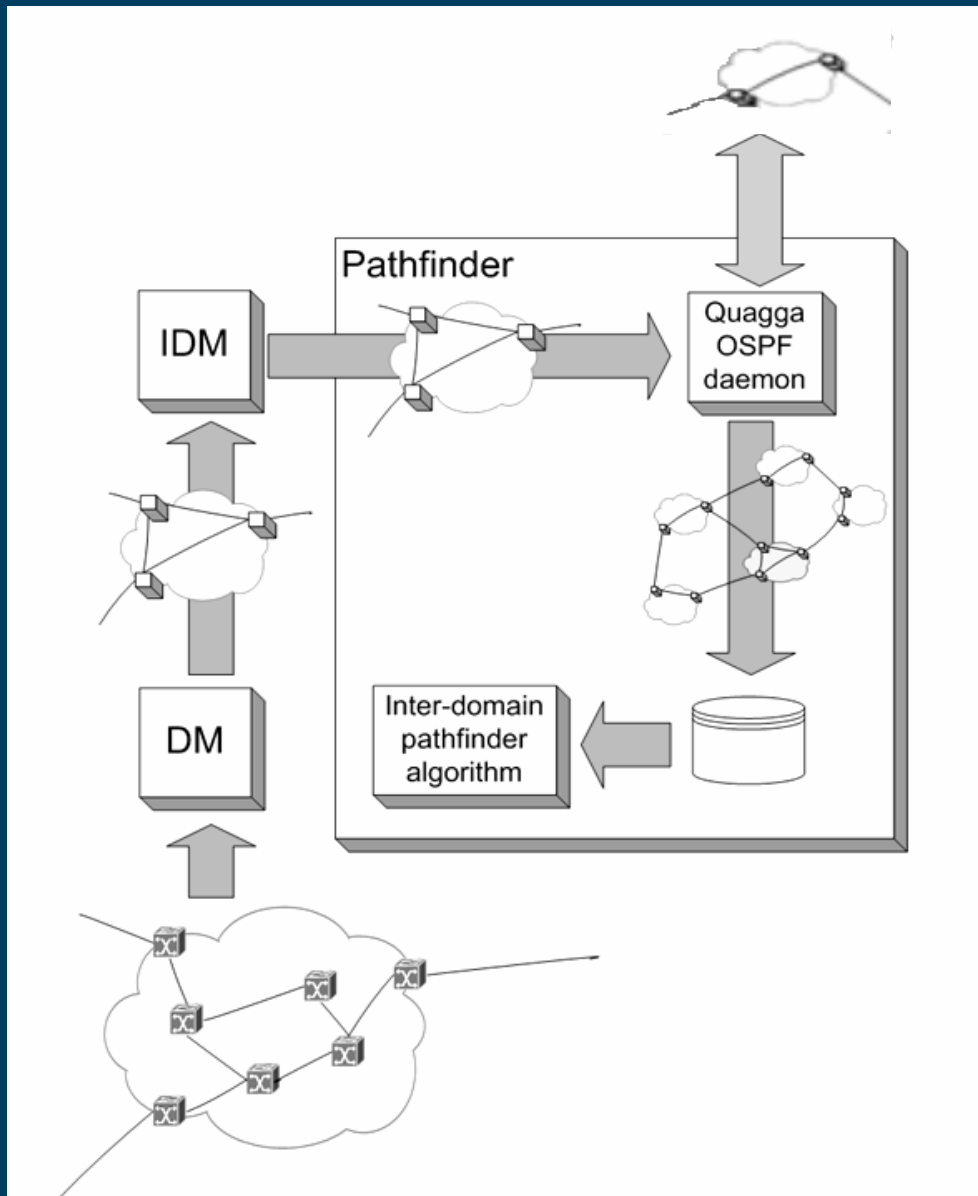
AutoBAHN overview

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Topology abstraction and pathfinding

InterDomain Manager



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- Implements the IDM-IDM interface for **negotiations** with neighbouring domains
- **No centralised** management
 - Better resilience possibilities
- Implements south-bound **(IDM-DM) interface** towards the local domain for topology updates, reservation handling, provisioning
- Exports **interface to end-users/applications**
- Use of an **abstract topology representation** at the inter-domain level
 - Domain independence for resource usage policies and technological choices
 - Possibility (not mandatory) to hide domain internals
 - A common naming and addressing schema for the abstract topology based on IPv4/6 addresses
- Implements **federated AAI** (inter-working with eduGAIN: the federated AAI framework developed by GN2)



Domain Manager

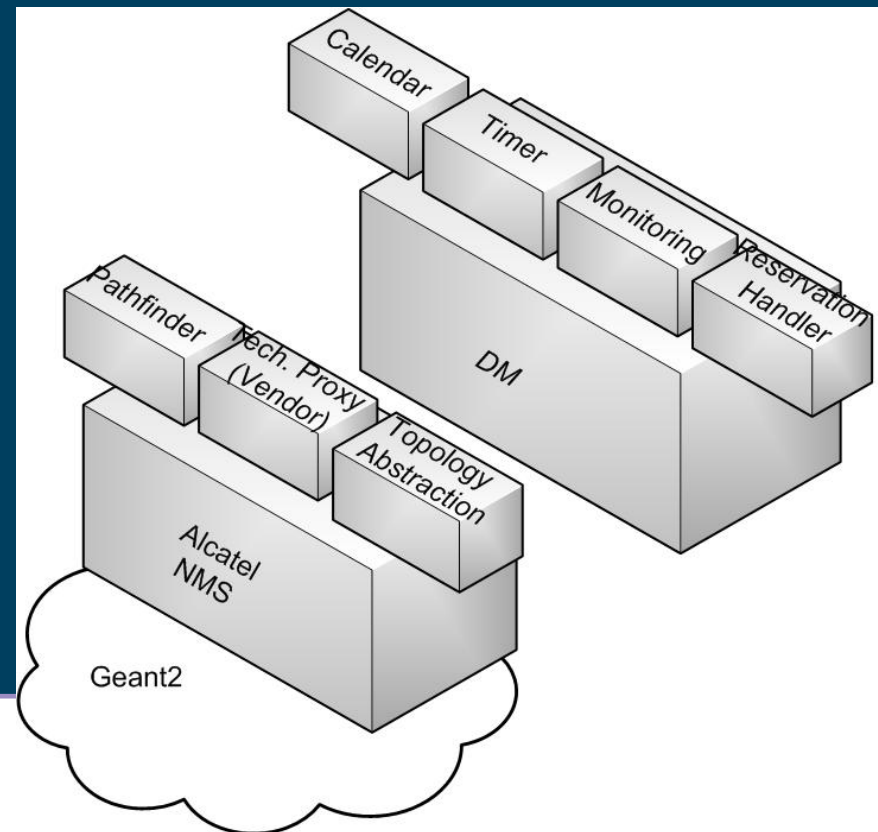
- A **reference** implementation (WebServices based) for **intra-domain** operations:
 - **Data plane topology handling and abstraction**
 - **Reservations handling**
 - **Intra-domain pathfinding**
 - **Technology proxy**
 - Technology-specific parameters for end-to-end technology stitching
 - Intra-domain signaling and provisioning
 - **Intra-domain monitoring**

The implementation of the technology proxy is heavily dependent upon the underlying technology



Domain Manager modularity

- The Domain Manager is designed to **support modularity**
- **Complements the missing functionality** of the underlying management plane for the operations of AutoBAHN
- In the case of GÉANT2, DM functionality is distributed between the AutoBAHN DM and the NMS





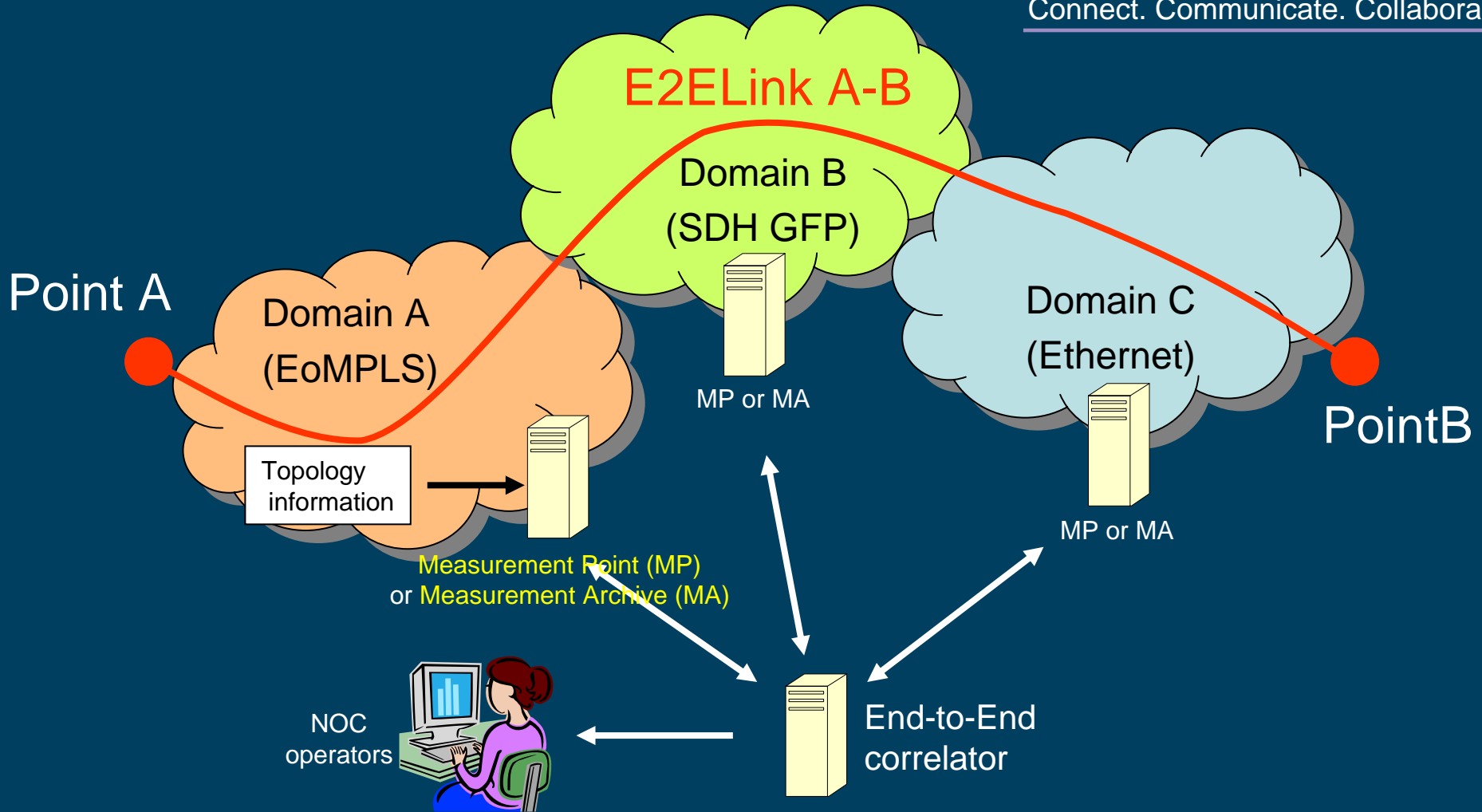
Multi-domain monitoring

- Technologies: BoD Ethernet circuits over
 - One **EoMPLS/switched Ethernet network** (SNMP-based)
 - One **SDH-based network** (Monitoring based on SDH metrics from the Alcatel IOO interface)
- **Metrics** to be monitored, in order of priority
 - **Up/down**
 - Degraded/not degraded
 - Level of usage (where possible)
- User GN2-PerfSONAR methodology
- Next, work on **concatenating** more complex metric across multiple technologies

Multi-Domain Monitoring



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AutoBAHN demo:

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- Signaling of a GE circuit from an end-point in Greece to another in Ireland over:
 - GRNET, using ANC_Tool (L2 MPLS VPN)
 - GÉANT2, using an EVC
 - HEAnet, using BLUEnet (L2 MPLS VPN and native ethernet)

The screenshot shows a web browser window titled "Reservation - Neostrada TP". The address bar contains the URL "http://150.254.160.188/autobahndemo/MapReservation.as". The page content includes a navigation bar with buttons: "Manage Map Request Cancel Reservation Map Add Admin Download". Below this is an "Advance" button and the text "from: srv2.lon.uk.geant2.net, to: gn2jra3.gnet.gr". The main area features a map of Europe with a black line indicating a path from Greece (Athens) to Ireland (Dublin). The map is labeled with various countries and cities. The browser's status bar at the bottom shows "Gotowe" and "Internet" with a 100% zoom level.



Technology stitching

- Technology stitching covers **change** and **configuration** management task
- Topology in most databases is the **actual topology**; used for configuration/performance/fault management
- For **change management** one needs to know the **extendibility of the topology** and the **allowable range/list** of parameter data (remotely configurable).
 - extendibilityability of the topology soemtimes *humans* also need to intervene if not *remotely or auto* configurable.
 - Main thing: topology (cNIS/NDL/etc.) also needs to know something about change/extendibility: metadata
 - allowable (dynamic) range/list of parameter data could solve this



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Future work

- Further develop DM
- Incorporate AAI
- Interworking (like definitions of interfaces and Topology Abstraction schema) with Internet2 and ESnet
- Demonstrations; possibly SC07 together with Internet2/ESnet
- Liase e.g. GLIF Control plane WG, etc.



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Thank you !