BUILDING FEDERATED RESEARCH NETWORKS IN EUROPE

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TERENA Networking Conference

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connect • communicate • collaborate

“Federated Network Architectures” study

- GN3 JRA1 Task 3 – Federated Network Architectures
  - Part of the Future Networks (JRA1) activity of GN3
- Objectives
  - Optimise the use of network resources and to find practical ways to stitch together services from equipment originating in multiple domains, while maintaining a high quality of service.
  - Study alternative network architectures and investigate how effectively they can support the various multi-domain network and services that are planned to be ubiquitously supported by the GN3 community, thereby arriving at a set of recommendations for the architectural design optimum of both single- and multi-domain network infrastructures and services
  - Not limited to technical aspects
- Participants
  - SURFnet, PSNC, RedIRIS, CARNet, DFN, NORDUnet

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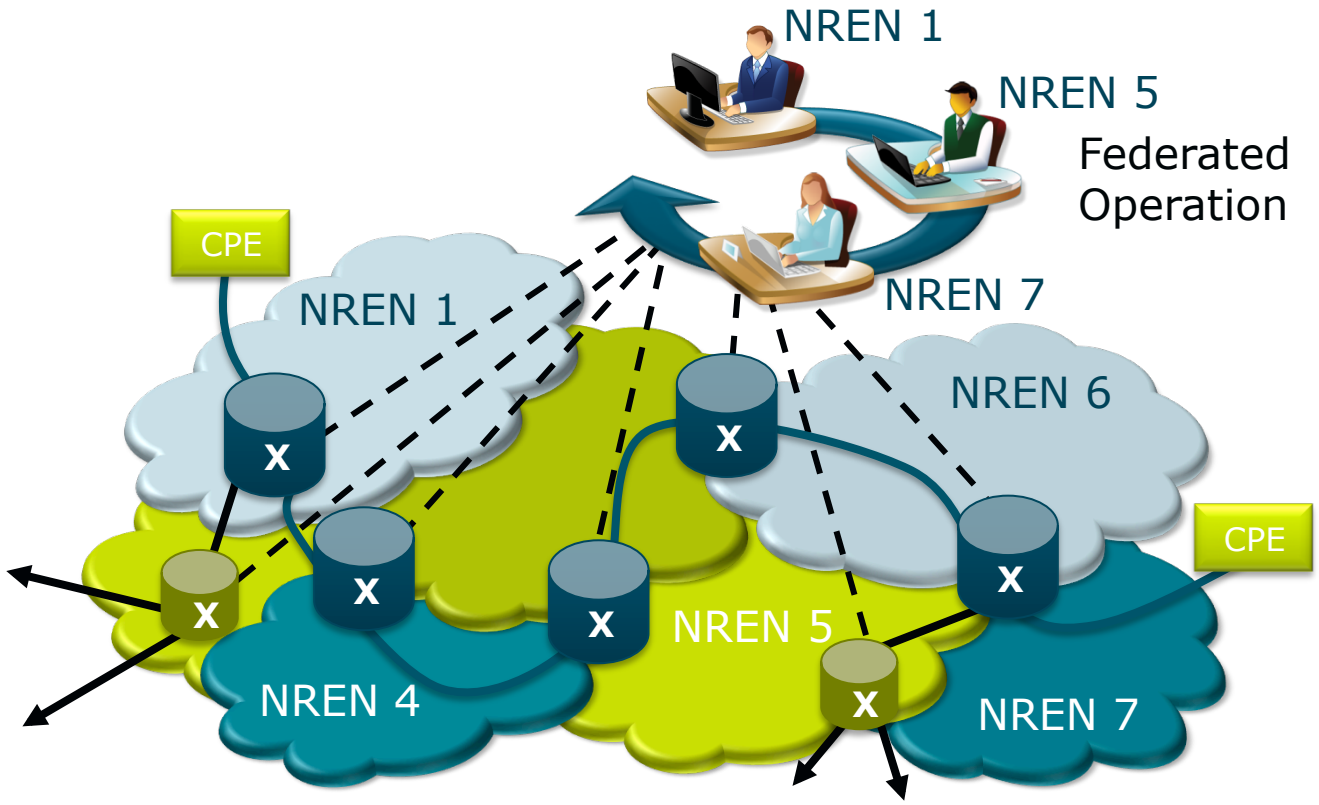
Federated?

- What is a *federation*
  - an organisation composed of several autonomous members or partners, working towards a joint goal.
- What is *federating*
  - Creating a (complex) system from a resources contributed from autonomous entities
- What is a *federated network*
  - A network built from resources owned and operated by partners
- GÉANT
  - … consortium is a federation of NRENs
  - … network is not a federated network, but rather an entity separate from the networks of the consortium members
  - … multi-domain services are (sometimes) created by federating
  - … network operations is not federated (but some services are)

A Federated Network

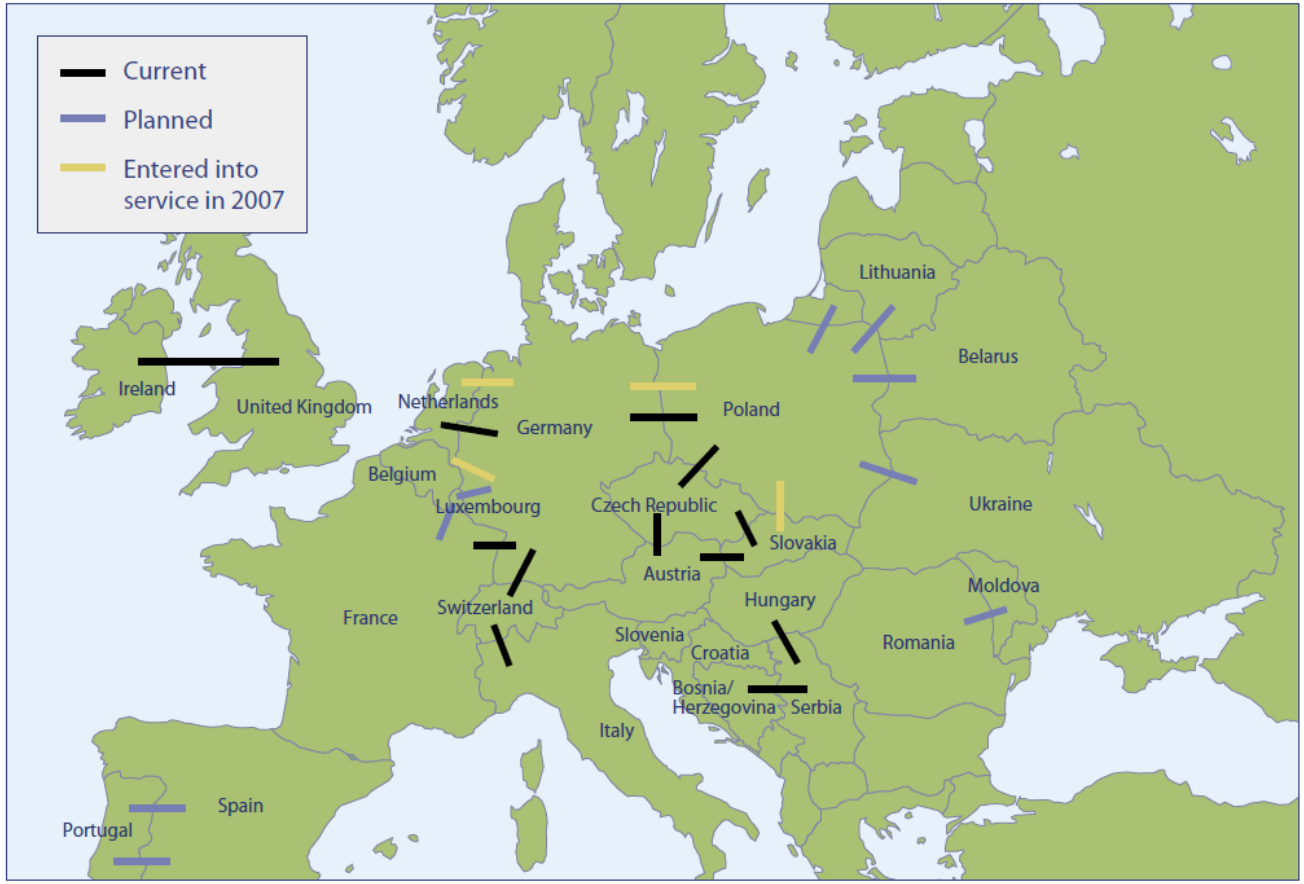


Examples and Demand

- Survey of projects and use cases that requires federated network services and network services across multiple domains
  - Large European e-Science projects and area-specific networks
  - Implications for network services, network requirements
- Survey of NREN owned and operated resources
  - Building blocks for federated networks
  - National Networks – dark fibre, DWDM
  - Cross-border Fibre Resources
- Survey of Federated Network Experience
  - LHCOPN Network and operations model

- Details in conference paper, GN3 report DJ1.3.1

Cross-border network resources in Europe



(2008 TERENA compendium)

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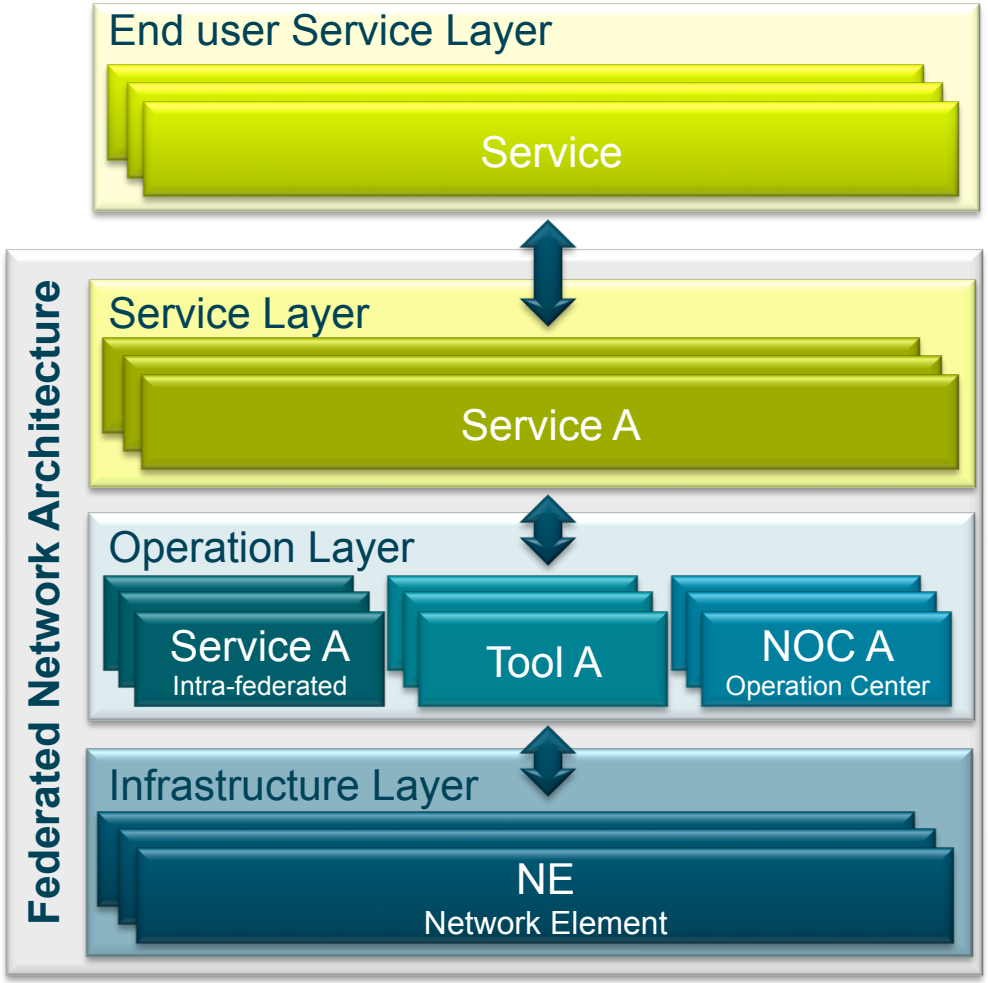
Benefits and Challenges

- Benefits
  - Improved multi-domain services as resources are integrated across the federated network
  - Increased options for further collaboration, i.e., operations
  - Reduced capital expenditure
- Challenges
  - Management challenges: provisioning, fault handling, quality of service, security must be handled across multiple domains of control
  - Technology: Interconnecting and sharing resources complicated by unlike technologies, vendor differences, etc. across resource owners
  - Ensuring a unified view: the federated nature of the network should be transparent to users
  - Cost sharing: establishing a cost sharing model is not straightforward

Towards a Model for Federated Network Architecture

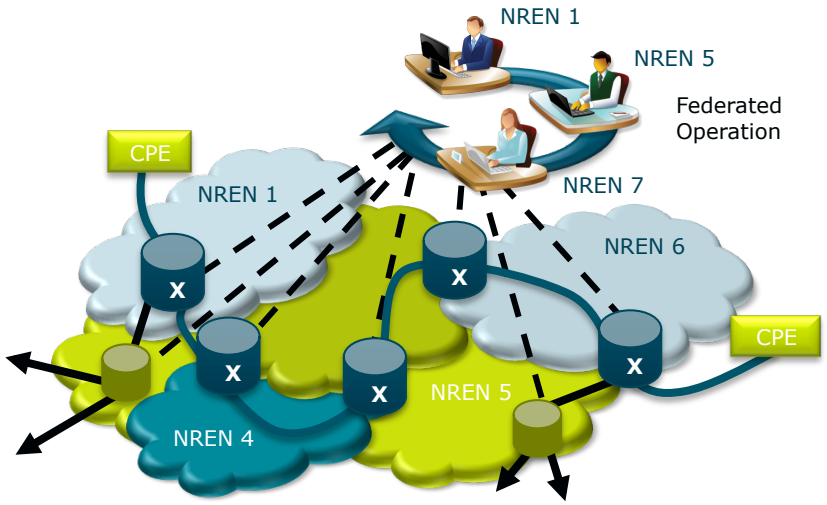
GÉANT

Base Model – The building blocks



Model A: Simple architecture

Model B: Complex architecture



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Federated Network Service Delivery

- Federated Network Services
  - End-to-end network services – L1, L2, L2.5 lightpaths
  - Shared IP transport services
  - Network virtualization services
- Service delivery
  - Direct aggregation
  - Service network built from partner resources

- Dual role of network services
  - Building blocks for the federated network
  - End-user network services

Federated Network Building Blocks

- Services
  - Single-domain circuit services
  - E2E network services
  - IP network services
  - Network virtualization
- Operations
  - NOC's
  - Network operations and management tools
  - Procedures, workflows
- Network and infrastructure elements
  - Individual network elements
  - Federation partner network resources (NREN networks)
  - Inter-partner network elements ("cross-border fibre")

Composition strategies & Federation models

- Service Aggregation
  - IP peering
  - Stitching lightpath services
- Service composition
  - Building federated core networks from partner transport services

- Loosely coupled federations
  - Best-effort based
  - IP Peering community
  - GLIF collaboration for end-to-end services
- Tightly coupled federations
  - SLA based
  - Shared service process basis
  - GN3 AutoBAHN
  - LHCOPN

Federated Networks Operations Challenges

- Not having central control requires new ways of performing network operations
  - Must deal with multiple domains of control
  - Requires additional tools and processes to handle inter-domain issues
- Challenges
  - Configuration. Federated services must be appropriately configured with respect to their use of NREN resources.
  - The fault and performance management processes and tools being used in the domains have to be integrated to resolve issues in federated services
  - Quality-of-Service
  - Accounting. Depending on the cost-sharing and service models used, charging may be required. The charging can be used for federation-internal cost-sharing or for user accounting.
  - Commons security standards and policies must be agreed
  - Management systems today are built for single-domain purposes and are therefore not suitable for a federated enviroment.

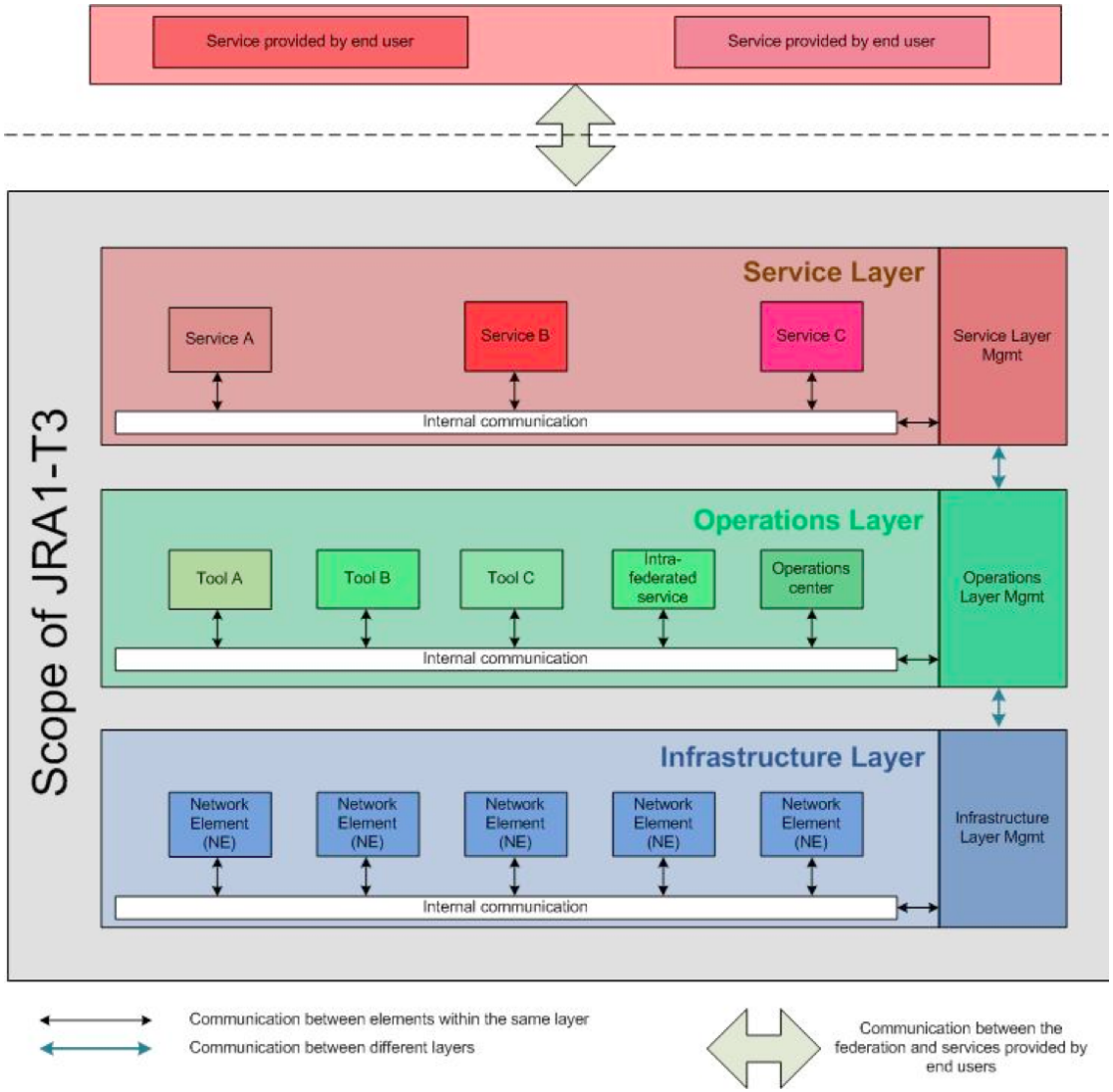
Meeting the operations challenge

- Federated Fault and Performance Management
  - GN3 tools: eduPERT, perfSONAR, I-SHARe, E2EMon
- Process- and workflow management
  - LHCOPN Workflow descriptions
  - E2Emon process management component
- Multi-domain Service Operations Experiences
  - eduPERT
  - eduroam
  - E2ECU
  - LHCOPN
- Federated NOC experiences
  - EGEE, NDGF
- Multi-domain information systems
  - .

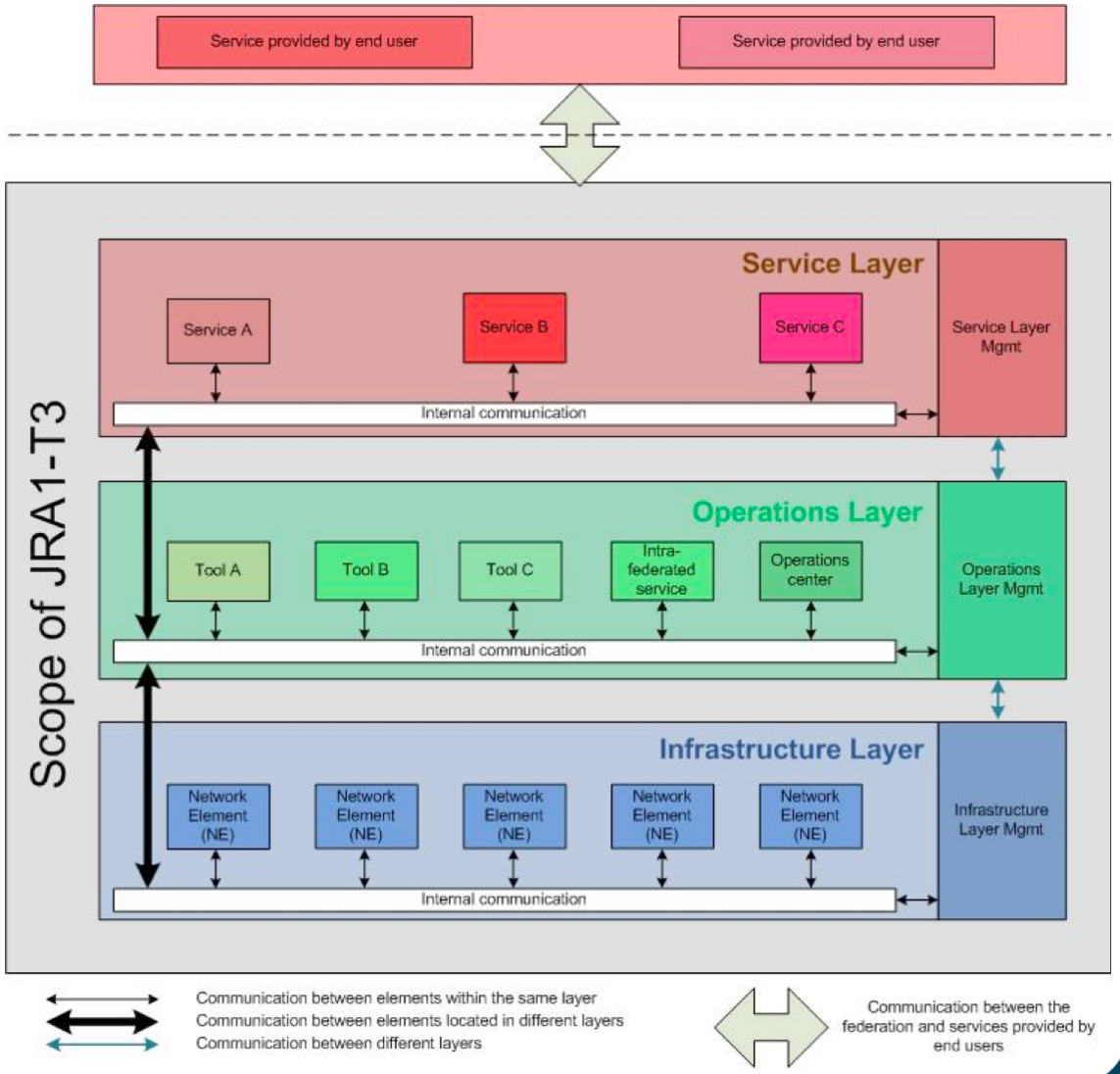
Federated Network Architecture models

- Three-layer architecture model
  - Infrastructure, Operations, and Services
  - Federate at all three layers
  - All communication between infrastructure and services layer managed by operations layers (procedures, tools, workflows)
- Simple and Complex model
  - Simple model with tightly managed inter-layer communication, and one-to-one relationships. Suitable for describing, say, application specific federated networks
  - Complex models with direct inter-component communication between layers and one-to-many relationships.

Architecture model A



Architecture model B



Future Work & Test Cases

- Analysis of Federated Network Architecture Models
- Apply Federated Network Designs to GÈANT Network
  - Possible impact on future GÉANT network architecture
  - Possible implementation of test cases
- Test cases
  - Use of NREN cross-border-fibre (network resources) for GÉANT POP-to-POP connection - Integrating NREN network resources in GÉANT long-haul connectivity
  - Design of a federated GÉANT POP, serving multiple NRENs connecting on NREN network resources
  - Using cross-border fibre for NREN IP connectivity to GÉANT
- Test cases must handle network design, operational impact and workflows, and tools required
  - … and consider cost sharing and procurement.