

Topology Issues in Inter-Domain Connection Services

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The Cynic's Perspective

&

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The "Topology Spring" Perspective

To Topology or Not To Topology

- **What is the proper strategy for making detailed internal network topology information publicly available to a global user community?**
- This talk will discuss the issue from two perspectives:
 - A default open, detailed topology, vs
 - Default limited service specific topology only.

Why do we need topology?

- Service provisioning (routing, connection path planning, traffic engineering, ...)
- Service debugging/fault localization
- Resiliency and robustness
- Network reach and capacity planning

What constitutes “Topology”?

- Topology is any information that is necessary to understand the structure and operation of the network in order to move user data from one point to another.
 - Resources – elements of a graph
 - Adjacencies and Groupings
 - State
 - Functional components

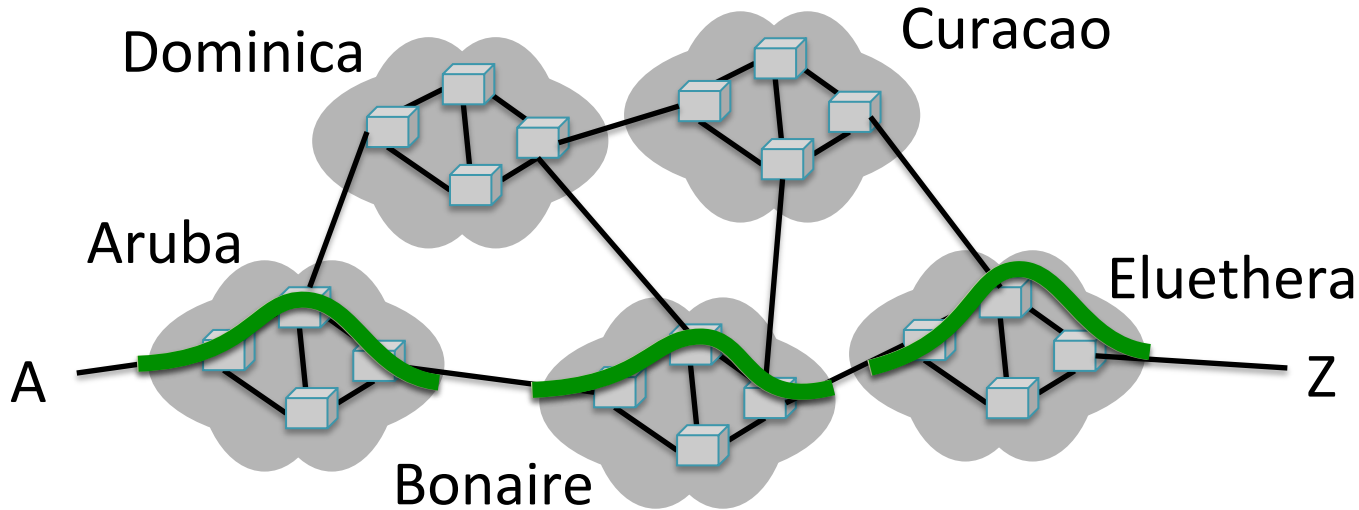
How Big is “Topology”?

- Topology information in today’s networks is *substantial, complex, and highly dynamic*
 - Globally, R&E networks comprise $\sim 10^6$ physical network elements, $\sim 10^8$ ports
 - Virtual resources
 - “Multi-layer” architectures add still more complexity
 - “State” associated with these elements is constantly changing

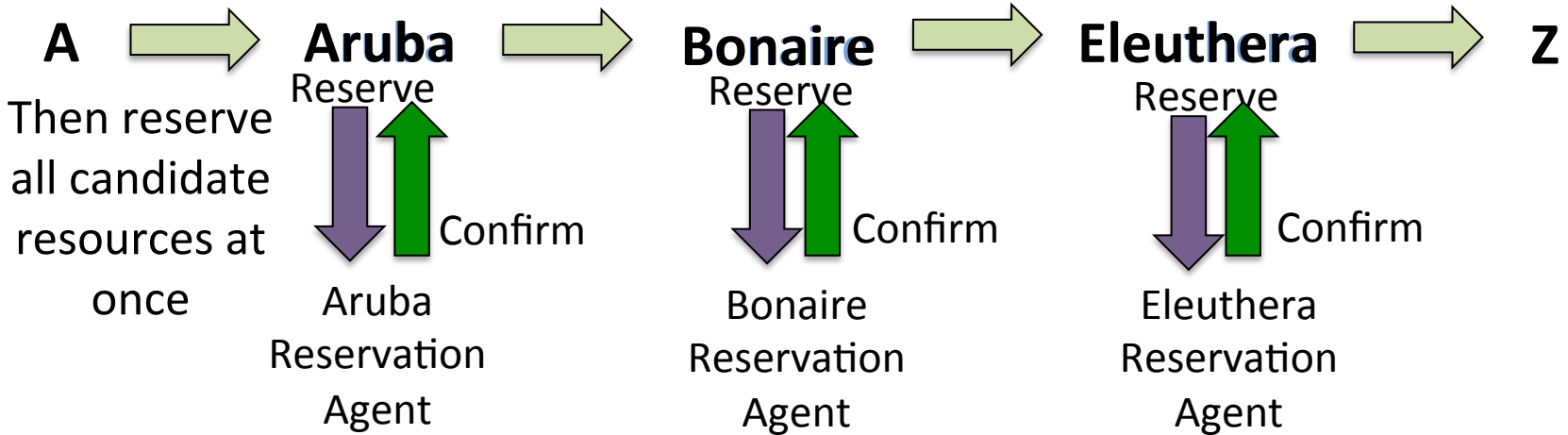
Scheduling and Policy

- **Scheduling of resources** add another dimension to each topological resource:
- **Policy**, i.e. each resource has a set of rules governing “authorized use” of the resource – and each request must pass muster according to these rules in order for the resource to be “available” to that request
- For PF purposes, a topological resource’s “availability” means that it has:
 - The characteristics required of the request (Performance)
 - It is available *when* it is needed (Scheduling)
 - It is available to the user/purpose requesting it (Policy)

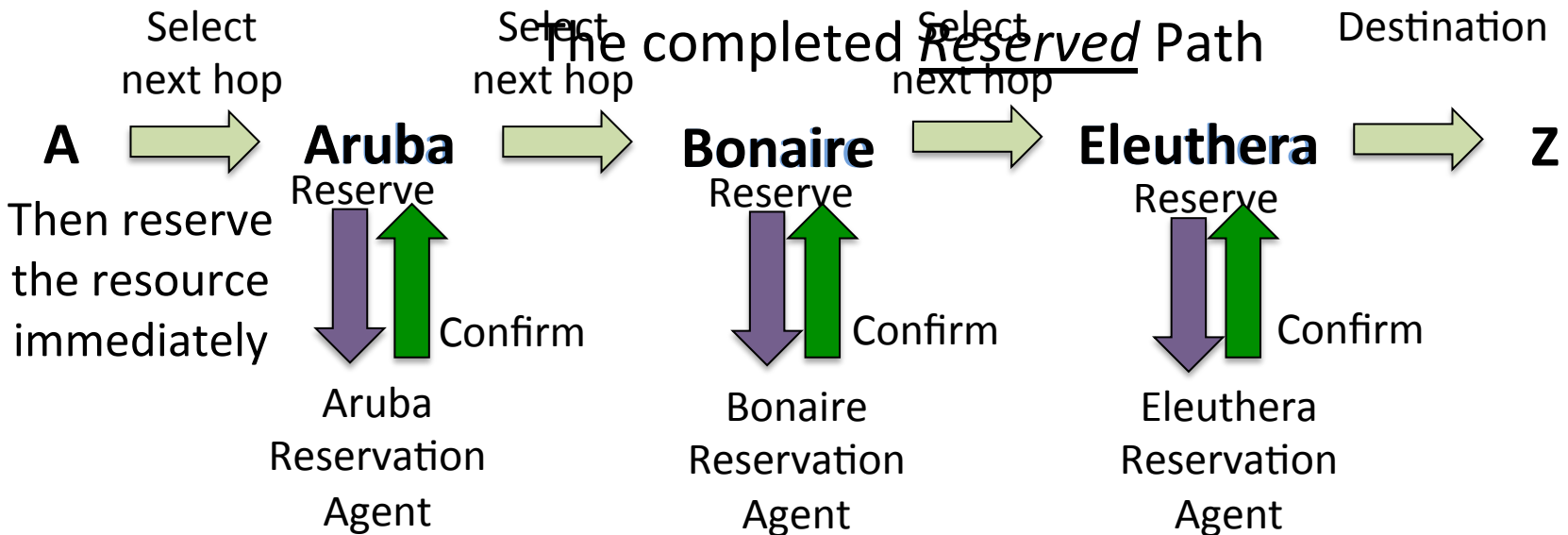
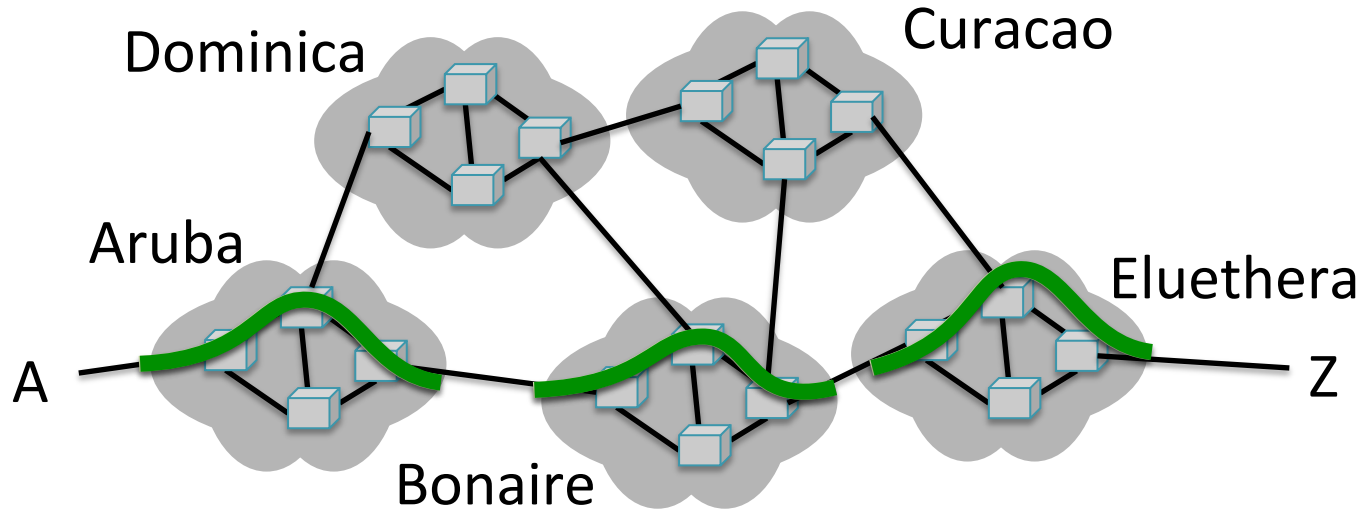
End to End Select, then Reserve



A "Candidate" Path selected for reservation (A path) ^{Select next hop} ^{Select next hop} ^{Select next hop} ^{Destination} topology



Hop by Hop Select-Reserve



Considerations for Pathfinding

- Crank-Back
- Recursive Pathfinding

Select-Reserve Recursion

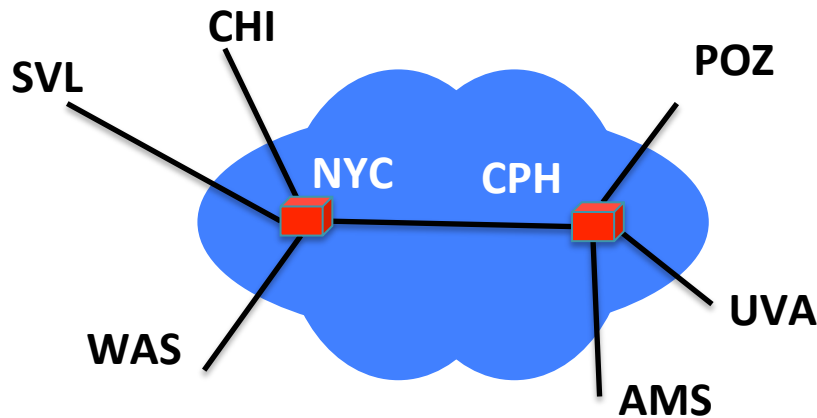
- The selection of a resource/path segment is based upon user constraints..
- Passing the appropriate path constraints to the Reservation agent (rather than a specific path) allows the recursive PF process to Select and Reserve a conforming path locally – thus averting the slow exhaustive search otherwise required.

Topology and Path Finding

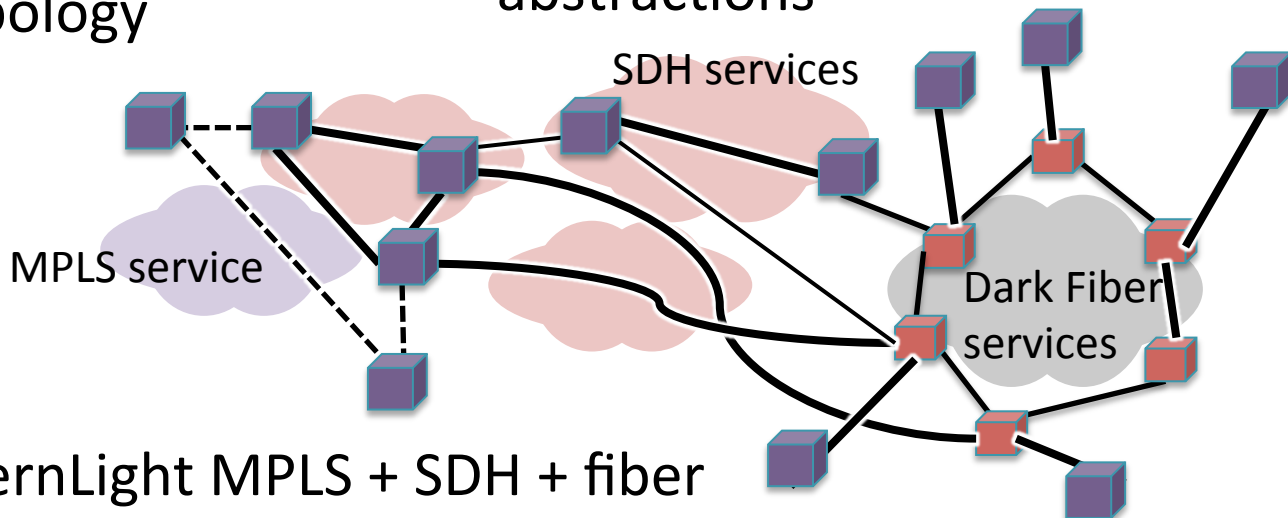
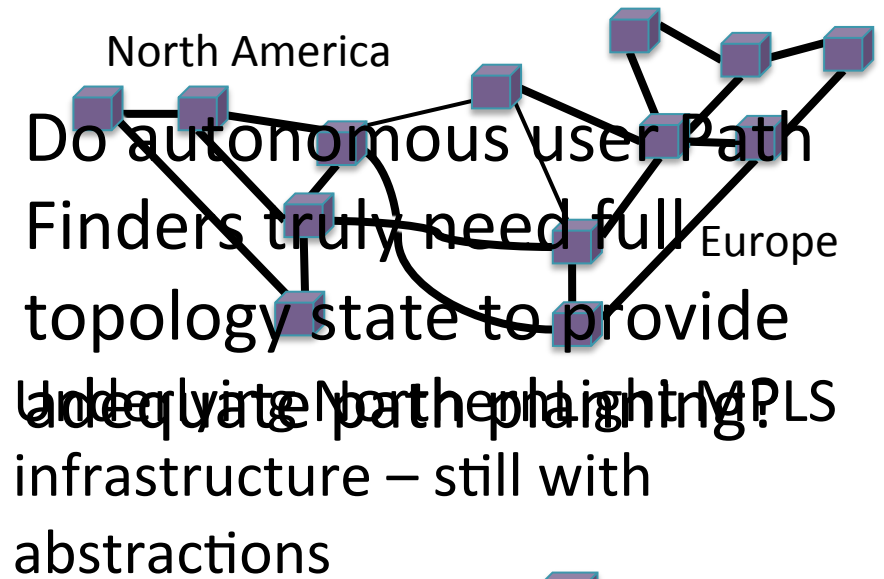
- We endorse strongly the notion of “requester based” path selection as a complement to traditional “provider based” path planning.
- But we also endorse strongly the notion that real networks must be able to manage their resources unilaterally as they see fit to meet their mission objectives.
- Thus a balance must be found –
 - A minimum topology announcement may include almost nothing – but it then falls to the provider to insure that the user constraints are met reliably – and verifiably.
 - But the status quo is probably overly paranoid – Providers should be encouraged to announce topology where it poses little or no threat to operational stability

Summarization of Topology

- An example of real vs abstract topology

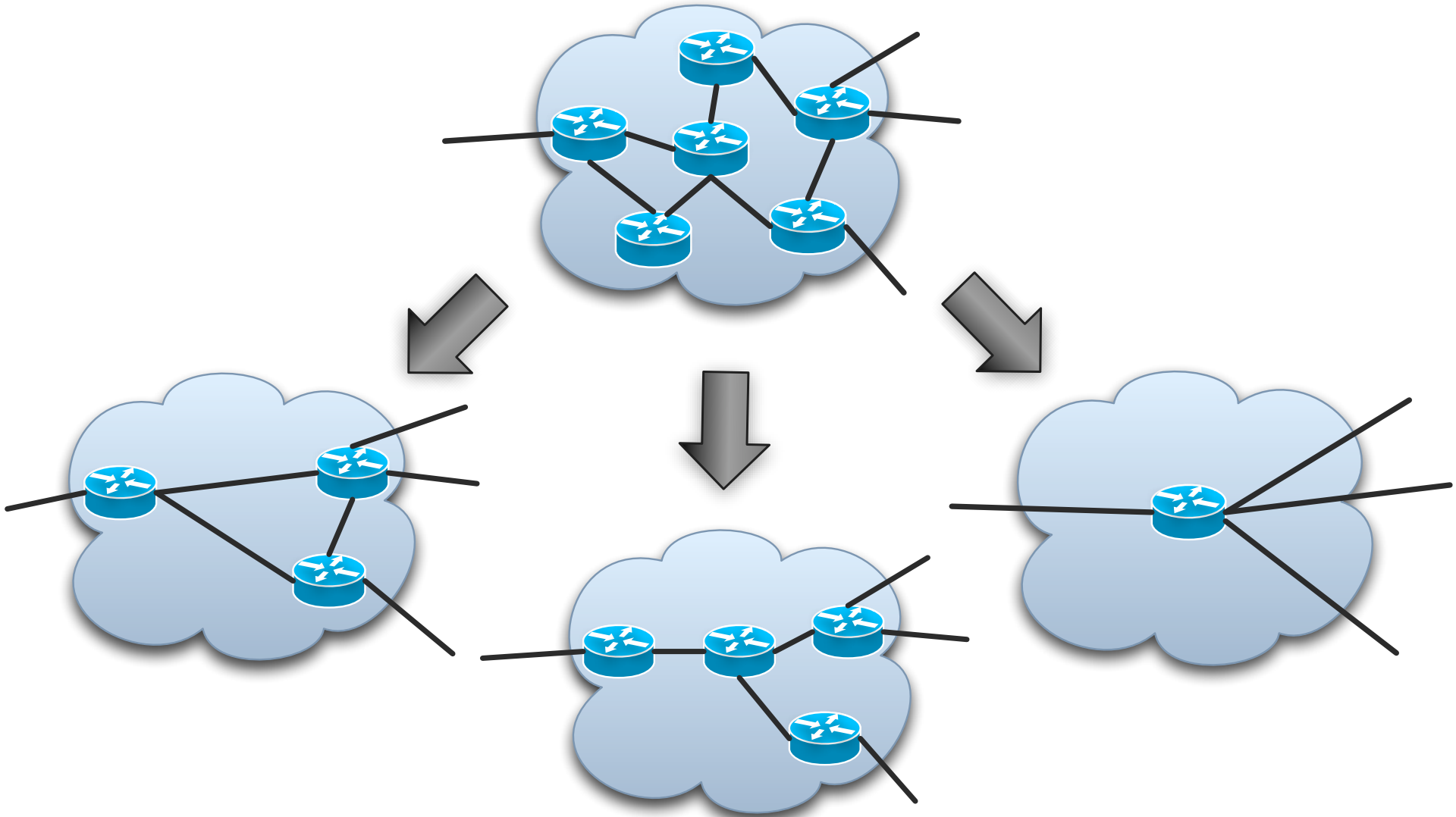


NorthernLight GOLE
Abstract topology



NorthernLight MPLS + SDH + fiber
Infrastructure – with still more commercial service abstractions

Topology Aggregation



Open Topology

- Advantages:
 - “optimal” path calculation in end to end multi-domain scenarios
 - Access to detail can be important to fault localization and mitigation processes
- Risks:
 - Security and Privacy
 - Reduced Flexibility and manageability

Open Topology for Users

- Downsides
 - Complex massive dynamic heap of information
 - Few “users” really care
 - Authorization Policy is especially tricky
- Upsides
 - Advanced applications can engineer sophisticated dynamic virtual networks inter-domain
 - More sophisticated end to end services

NSI Model Implications

- The NSI Framework is intended to be an inter-domain environment:
 - path selection is done at the inter-domain level selecting “domains” as hops rather than specific devices.
 - Path planing internal to a domain is delegated to the local NSA
- However – this domain level summarization hides substantial path planning options
 - The NSI topology assumes a monolithic service region – all NSI networks offer a consistent transport service capability
 - A more sophisticated topological architecture could expose multi-layer technologies and allow more sophisticated path planning end to end.