



# Inter-domain Routing with Shared Risk/Resource Groups (SRG)

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## Outline

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- + Background
- + Shared Risk Group (SRG)
- + SRG applications
- + SRG example
- + Conclusions
- + References
- + Question and answers

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## Background - What is the problem?

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Problem: Need a concept of a **domain** (control domain - I TU) in transport networks.

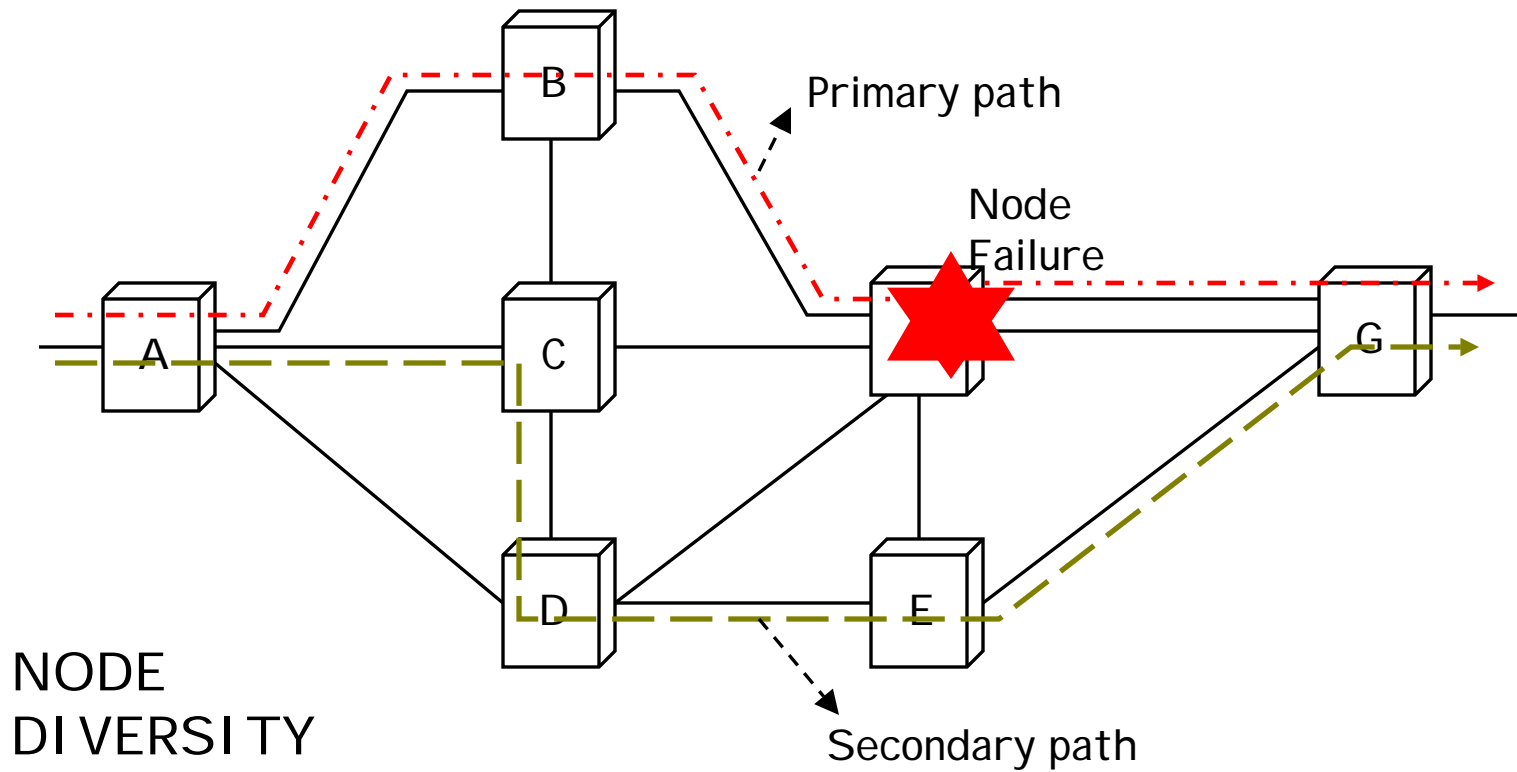
### Why?

- To hide vendor clouds (unlike in router world)
- To make a transition from legacy equipment
- To have different cost centers in a carrier

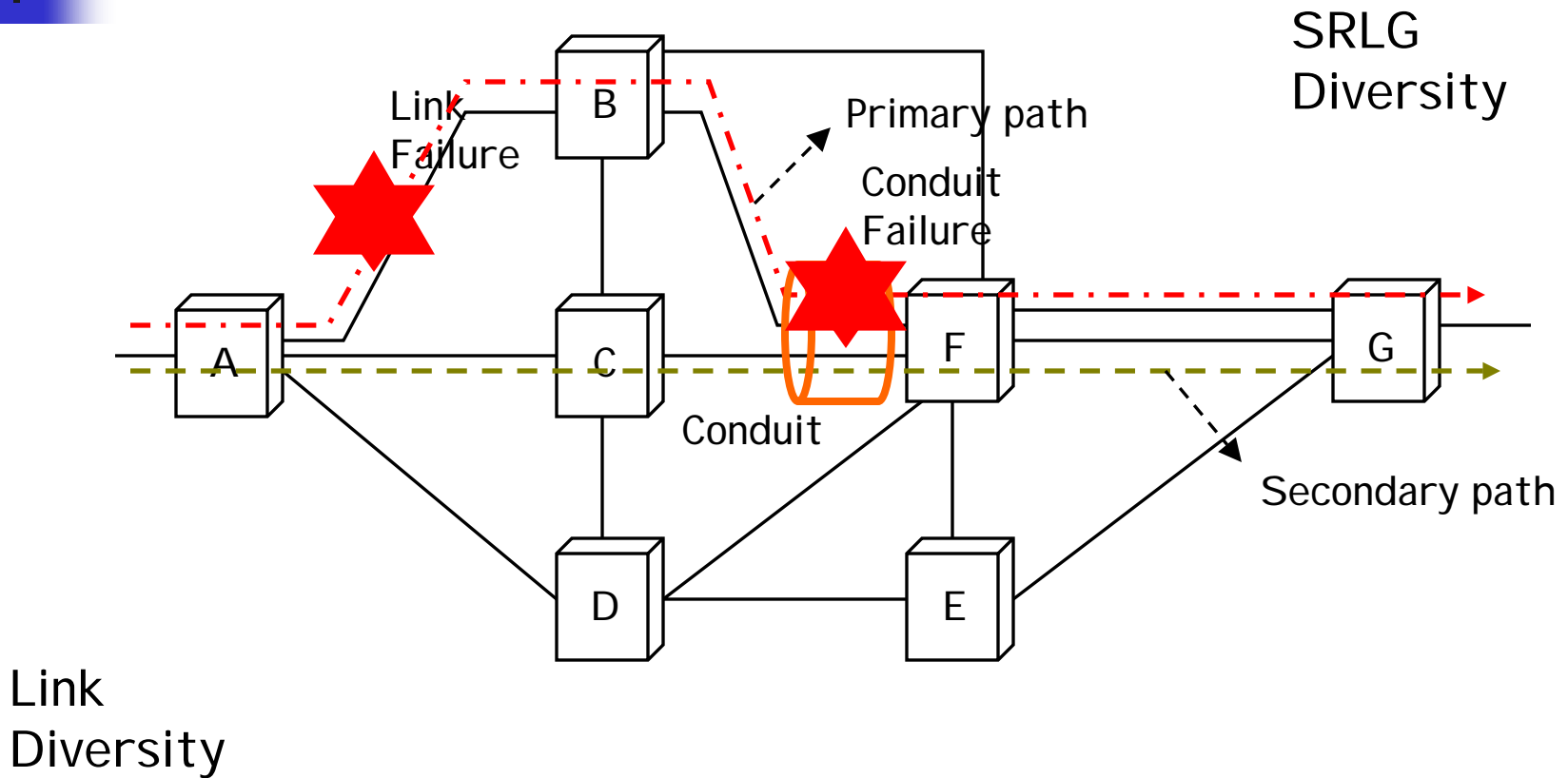
### So...

- We introduce the concept of a domain
- Make **incremental** changes to routing protocols
- We demonstrate its usage using P&R as a case study.

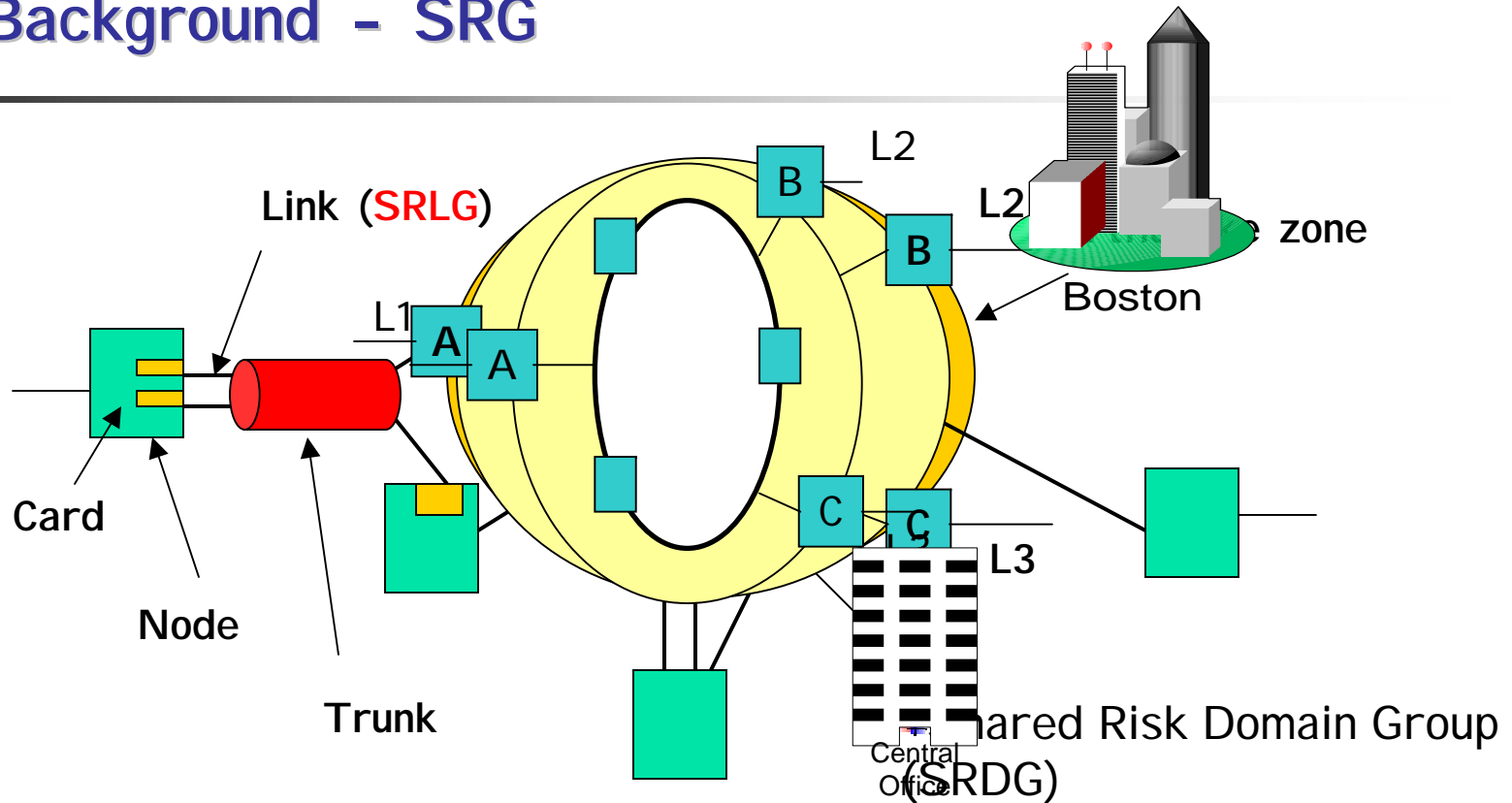
## Background - Node diversity



# Background - Link and SRLG diversity



## Background - SRG



- Group of links sharing the same risk

- A link may be member of many SRLGs

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- Shared Risk Node Group

- Risks are not limited to links
- Nodes also share risks
- A single node failure can bring down many links
- Users may want to avoid nodal risks

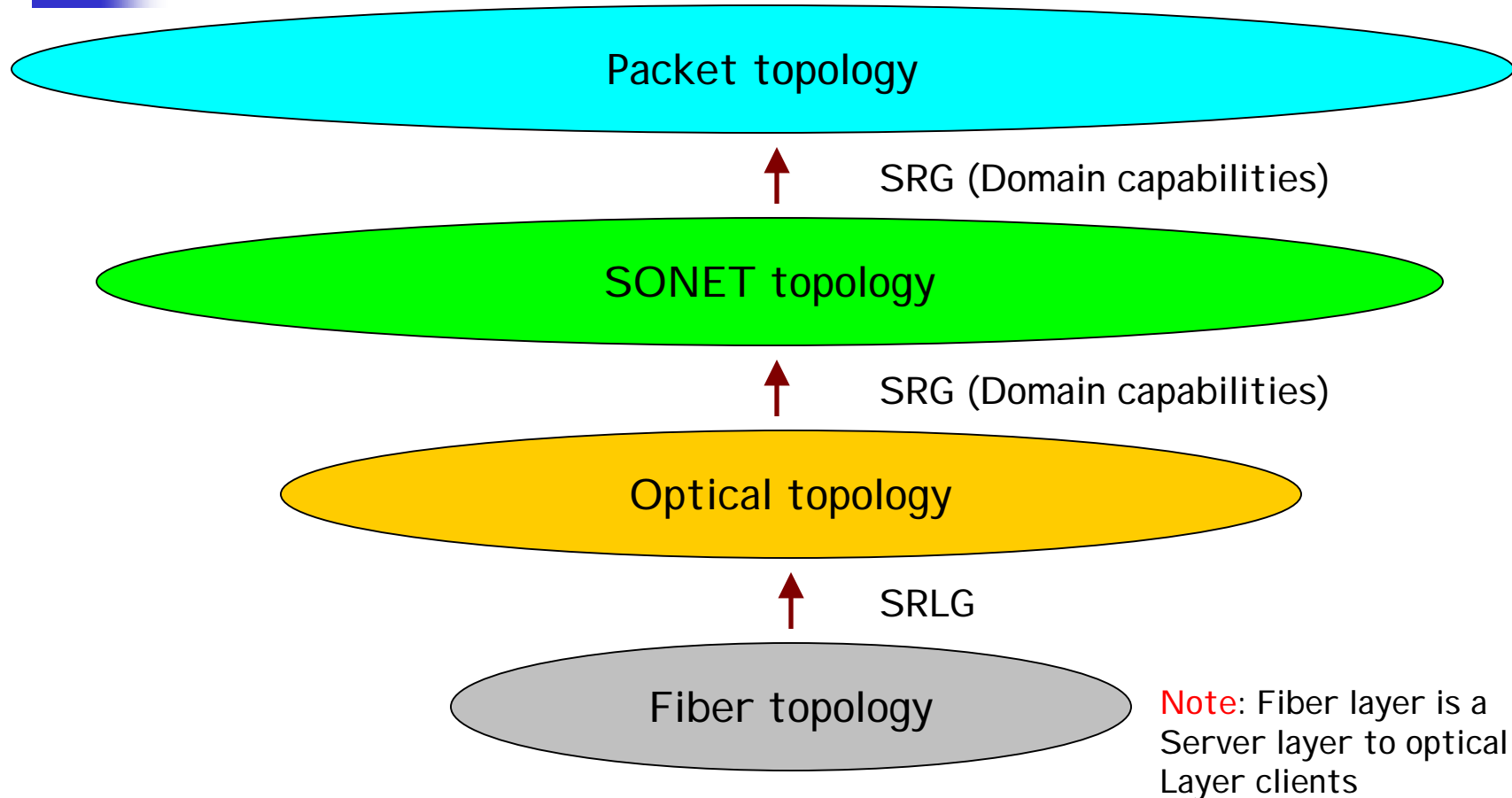
- Domain = A group of arbitrarily connected nodes and links possible with some common characteristics (Same administration, same technology, same risk)

## Background - SRG (Contd.)

- ✦ SRG = {SRLG, SRNG, SRDG, ...}
- ✦ SRLG's are a subset of SRG's
- ✦ Helps reduce computational complexity
- ✦ Users may want to have diverse paths not sharing (**Exclusive constraints**) the same SRGs

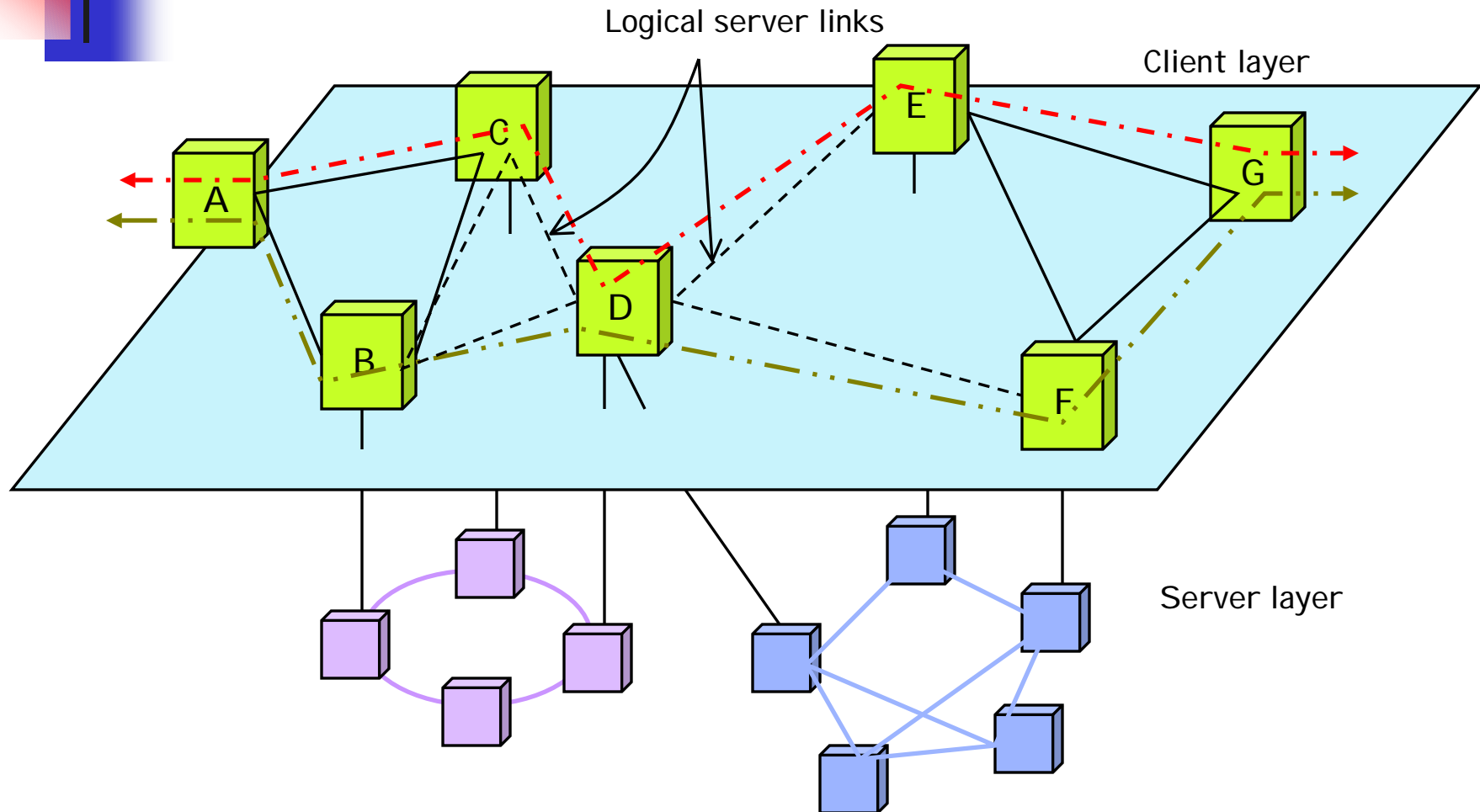


## Background - Multi-layer TE



**Observation:** SRLG makes sense only at the interface of the lowest two layers.

## Background - Multi-layer TE



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## SRG – Domain capabilities

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- ✚ Observation 1: Failure is restricted to a local scope (**Risk Domain**) by proper network planning
  - For example risks such as
    - ✖ Card failures are addressed by 1+1, 1:1 or M:N card redundancy
    - ✖ Node failures are addressed by restartable code, redundancy or by node diversity
    - ✖ CO failures are averted by redundant equipment (power supplies etc.)
    - ✖ Link/Span failure is addressed by 1+1, 1:1 or M:N link protection
    - ✖ Set of links/nodes are averted by rings, planned mesh network
  
- ➔ For proper use of planned resources use "**capability**" of the Risk Domain
  - Reachability information
  - Links have capabilities: 10 Mbps/100 Mbps, Encoding etc.
  - Domain's have capabilities:
    - ✖ Topology: Mesh, Ring (Bi-directional, Uni-Directional)
    - ✖ Protection: 1+1, 1:1, 1:N
    - ✖ Others: All optical ...

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## SRG - Inclusive constraints

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- ✦ Observation 2: Use a risk domain because of its capability (**Inclusive constraints**)
  - SRLG only provides exclusion constraints
  - SRG provides both **Inclusive** and Exclusive constraints
  
- ✦ For example following types of constraint specifications are possible
  - Use the same ring for both the primary and secondary paths
  - Do not establish a secondary path through a protected domain
  - Provide only domains that have certain level of risk protection

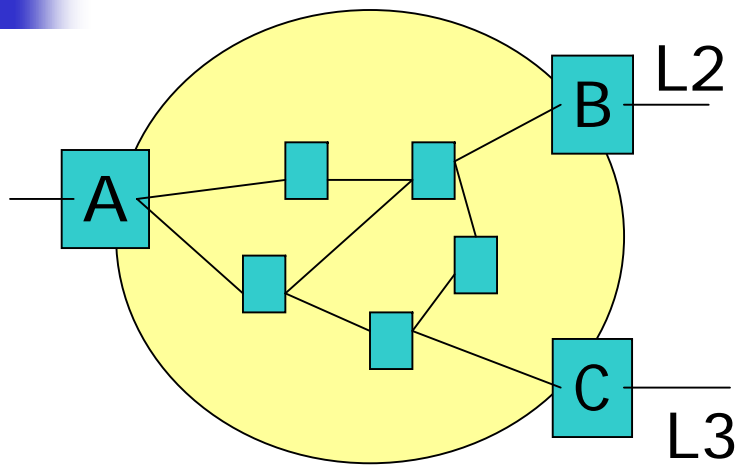
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## SRG - Scalability

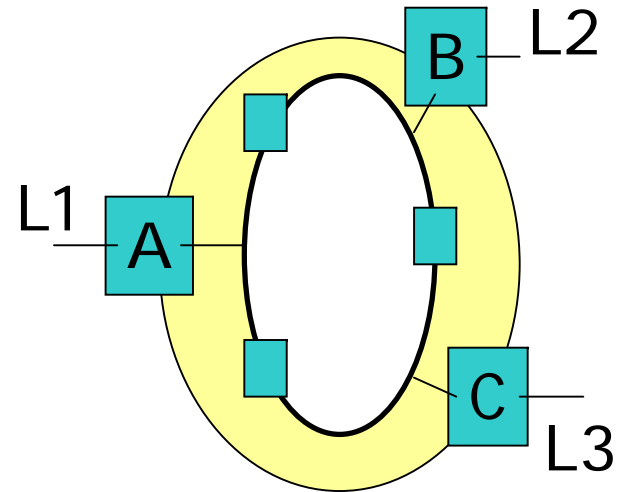
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- ✚ Observation 3: SRG notion provides scalability
  - SRLG on trans-continental link ( $N \gg 1$ )
  - SRG set of SRLG (or a sequence)
  - Link, Fibers, Ducts, Transport equipment, Nodes, COs
  - # of TLVs, Diverse path computation - NOT scalable
  - ➔ "Summarize" capability per risk domain

# SRG - Topology representation




Mesh Topology

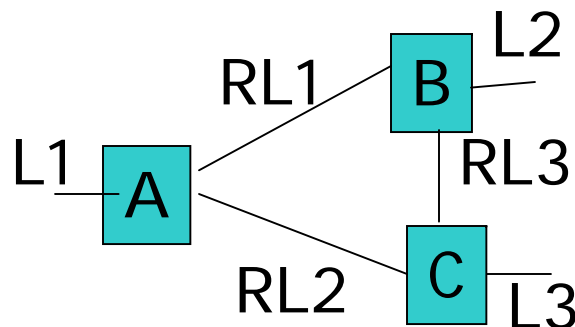


Ring Topology

## Legend:

-  Node B
- L1 Link 1
- RL2 Risk Link 2

**Note:** A, B, C may be client layers to the intermediate nodes which constitute RLs.



## Diversion – Packet vs Transport networks

Category	Packet networks	Transport networks
Inherent protection	Not supported	Supported (using rings etc.)
Topology	Only mesh	Mesh, ring, and mesh-ring interconnects
Sub-layers of connections	Single layer	Multiple layers
Capability assignment	Only to link	Link, node and domain
Inclusive constraints	None	Link, node, SRLG, and SRG diversity
Exclusive Constraints	Link, node, SRLG	Link, node and SRG
Path computation	Only strict explicit paths	Strict and loose explicit paths

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## SRG applications

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- ✚ Business applications
  - Preferred quality circuit provisioning
  - Preferably routed circuit provisioning
  - Protected path provisioning
- ✚ Mechanisms applicable to
  - Multi-layer networks
    - ✖ server layer topology capability
  - Tiered networks
    - ✖ Single or multiple administrative domains
    - ✖ Peer-to-peer or overlay control planes
- ✚ With the following in mind
  - Reduce the TE information
  - distributed path computation
  - Others

## What changed in applications?

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- ✚ Before: Failure safe path provisioning
  - This is what we are doing now.
    - ✖ Link, Node, SRLG/SRG diverse paths
  
- ✚ Now: Preferred quality circuit provisioning
  - Need to know and hence should propagate (routing)
    - ✖ Inclusive resource list
    - ✖ Exclusive resource list
    - ✖ Path quality list

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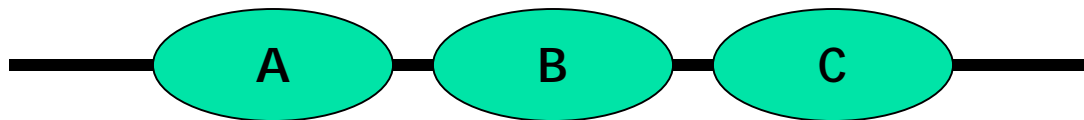
## Business applications

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- ✦ Protected circuit provisioning
  - Diversity specification
  
- ✦ Preferably routed circuit provisioning
  - Customers (or client layers) can specify the preferences
  - Customers (or client layers) will have abstract representation of the provider topology
  
- ✦ Preferred quality circuit provisioning
  - 5-9s or 6-9s availability

## SRG applications - Risk Assessment

- ✦ SRG's are helpful not only in finding diverse paths but also in quantifying the risks of a given path
- ✦ Risk  $\approx$  Availability
- ✦ E.g., A, B, C are 99% available
  - Risk (Path ABC) = Risk A  $\times$  Risk B  $\times$  Risk C = 97%



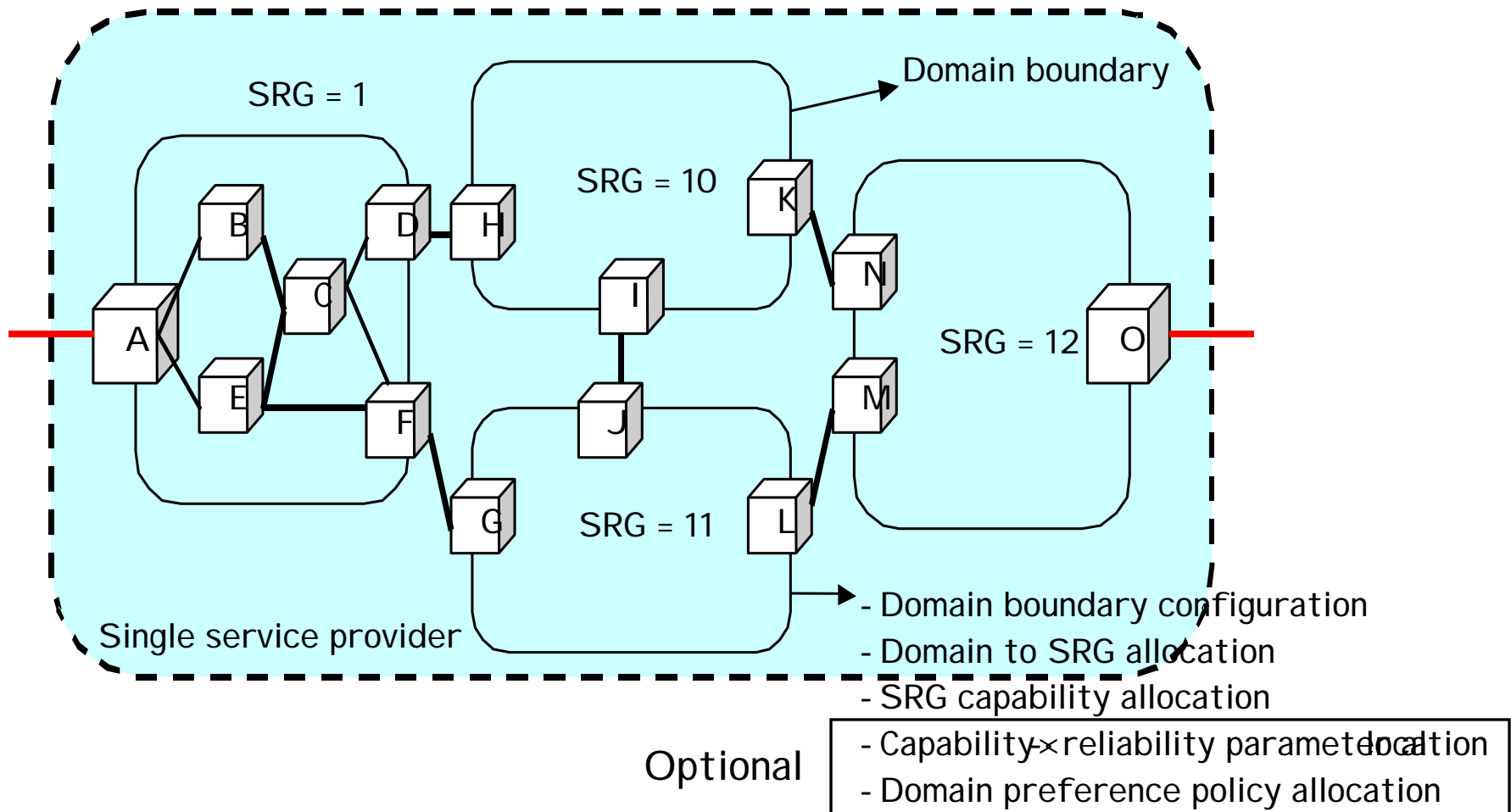
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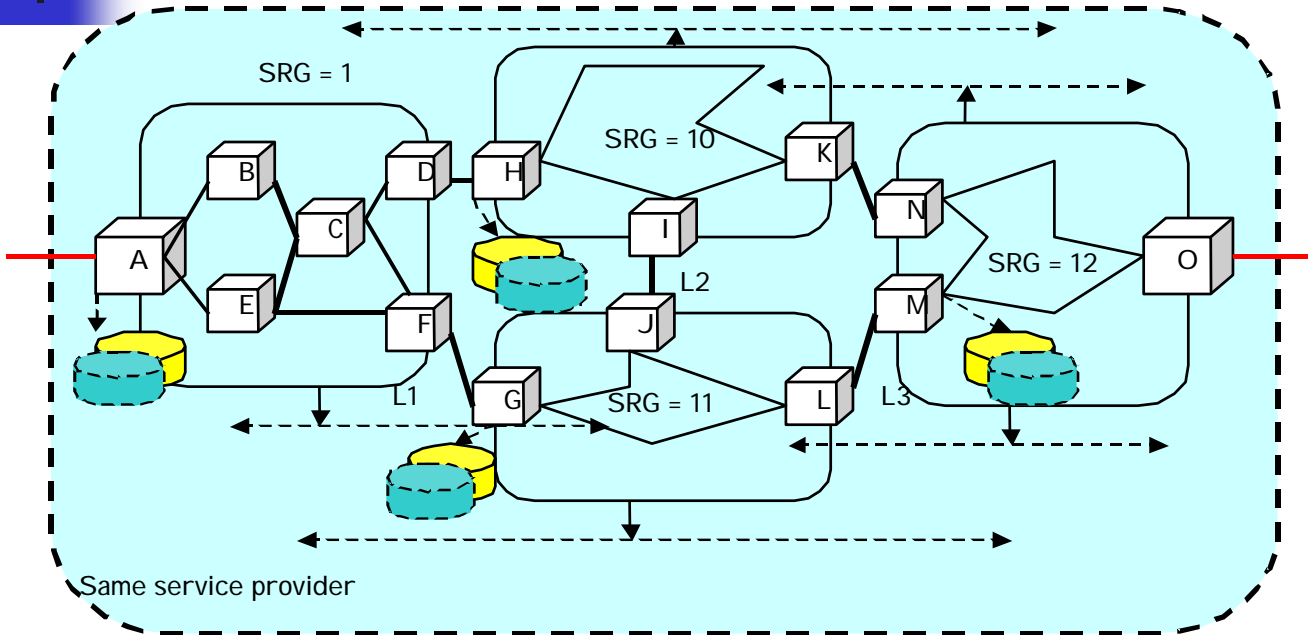
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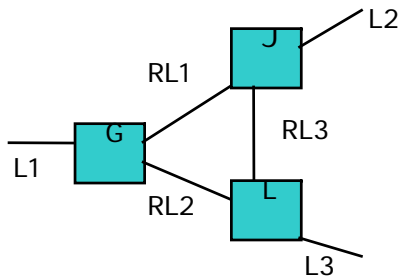
# SRG example - Configuration



# SRG example - Info dissemination



A. Routing in a multi-domain transport network

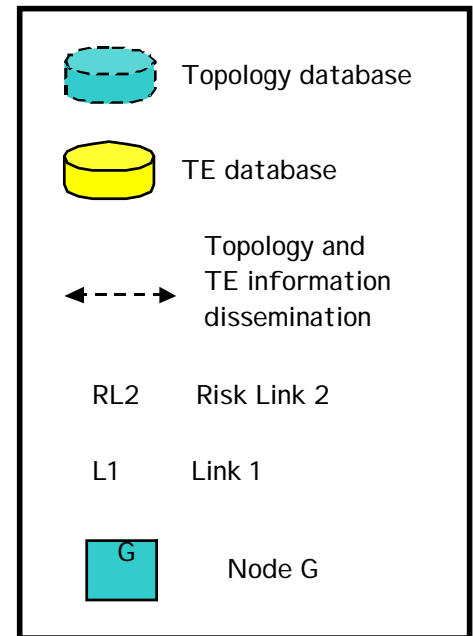


B. Node A's SRG 11 representation in topology database

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- SRG Capabilities:  
 - a, b, c
- RL1 Capabilities:  
 - a = n, b = m, c = o
- RL2 Capabilities:  
 - ...
- RL3 Capabilities:  
 - ...

C. Node A's SRG 11 representation in TE database





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## Conclusions

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- ✦ Introduced concepts of
  - Domain (or risk domain)
  - SRG and its capabilities
- ✦ Extend the current protocols to
  - Define per domain capabilities (protection etc.)
    - ✖ Link protection (present)
  - Define inclusive constraints
    - ✖ Exclusive constraints (present)
  - Provide risk assessment to a path
    - ✖ Not possible with present extensions
  - Summarize “some” capabilities across areas
    - ✖ No inter-area solution yet
    - ✖ Note: Not every TE parameter is summarizable
- ✦ Discussed realization of new services

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## References

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### TE

- Requirements for Traffic Engineering Over MPLS - RFC2702
- Network hierarchy and multi-layer survivability, draft-ietf-tewg-restore-hierarchy-01.txt
- Routing, Signaling, and Others for transport networks - <http://www.ietf.org/html.charters/ccamp-charter.html>

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### SRG References

- Inter domain routing with SRG, draft-many-ccamp-srg-01.txt
- "Achieving Diversity in Optical Networks Using Shared Risk Groups," <http://www.cs.odu.edu/~sudheer/technical/papers/journal/SRGPaper.pdf>

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### Updated/extended version -

<http://www.cs.odu.edu/~sudheer/technical/presentations/MPLSWorldCongress2002.SRG.pdf>



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# Questions and Answers