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A Snapshot on MPLS Reliability Features

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Outline

- ***Introduction***
- Fast Reroute
- Graceful Restart
- Summary

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MPLS in a Nutshell

- *Tunnels*
  - Drop a packet in, and out it comes at the other end
- *Explicit (aka source) routing*
- *Label stack*
  - e.g., 2-label stack: "outer" label defines the tunnel; "inner" label demultiplexes
- *Layer 2 independence*
  - Just like IP

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Why tunnels…

- ***Transfer Non-IP (or private addressed IP) packets over the backbones e.g.:***
  - **Layer 3 VPN (BGP/MPLS VPN)**
  - **Layer 2 VPN (draft-kompella-ppvpn-vpn)**
  - **Virtual Private LAN Service (VPLS)**
  - ***This is potentially a huge market!***
- ***Map user traffic according to your plan.***
  - **Guarantee bandwidth to user "flows"**
  - **More efficient use of network resources**

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Challenges

- ***What if my MPLS tunnels break…***
- ***Hold on…***
  - ***Let's first take a look at router's internal structure.***

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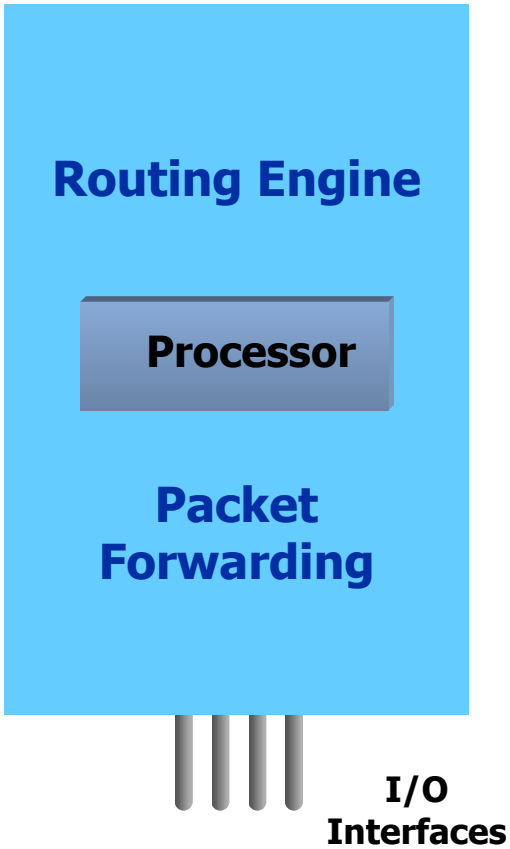
Legacy Router Architecture

- *Data plane and control plane are **together**.*
- *If either data or control plane fails, the entire router will get effected, which, in turn, can disrupt the data traffic.*



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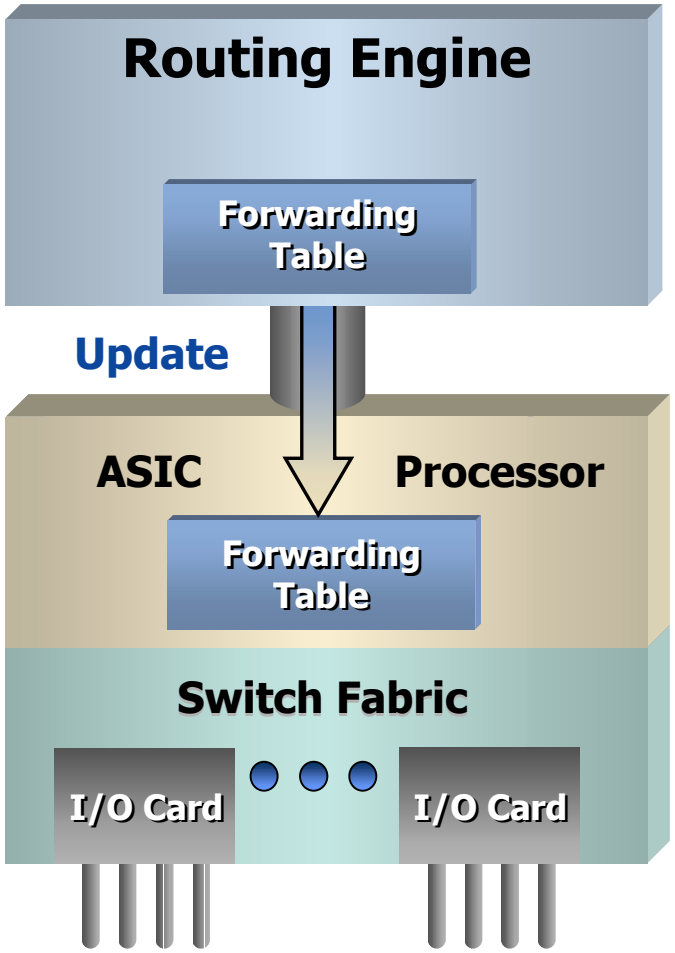
New-generation Router Architecture

- *The separation of data and control planes*
- *Either data or control processor failure will not effect the entire router.*



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Comparison

- **Legacy routers:**
  - ***Control and data plane live and die together!***
- **New-generation routers:**
  - ***Control and data plane can be managed separately.***
- ***Observation:***
  - ***For various reasons (e.g., software upgrade, control software crash), the control plane needs to be restarted more frequent than the data plane.***

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Ask me again…

- *What if my MPLS tunnels break…*
  - Link outage:
    - Solution: reroute at data plane
  - Control plane up/down, e.g.:
    - Solution: sustain the data plane, while recovering the control plane
- *The bottom line: we need to have high availability at data plane for MPLS tunnels!*

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A Snapshot on MPLS Redundancy

- ***Redundant Hardware and Software***
  - **… but what if it's the adjacent links and nodes are in trouble?**
- ***Backup Tunnels from ingress***
  - **… but this may not be fast enough.**
- ***Fast Reroute***
  - **At data forwarding level, redirect user traffic on the fly.**
- ***Graceful Restart***
  - **At control plane, recover the control information on the "down" nodes without disturbing data traffic.**

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Fast Reroute

- Reroute around link or node failure… *fast*
  - ~10s of msec reroute time
- Reroute paths immediately available
  - Make-Before-Break
- Crank back to the node closest to the failure, not ingress router
  - Local repair is the key.
- Short term solution for traffic protection
  - The ingress should re-compute alternative routes eventually.

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Fast Reroute (signaling protocol)

- **History:**
  - Juniper and Cisco both have working solutions.
  - Due to customer demand, we merged our ideas:
    - draft-ietf-mpls-rsvp-lsp-fastreroute-00.txt
- **RSVP Protocol Extensions:**
  - One-to-one backup
    - Backup each LSP separately.
    - More flexible
    - Simple to configure
  - Many-to-one backup
    - Backup a bunch of LSPs with one LSP
    - Less states with label stacking
    - Requires configuring backup LSPs
  - Use common set of RSVP mechanisms

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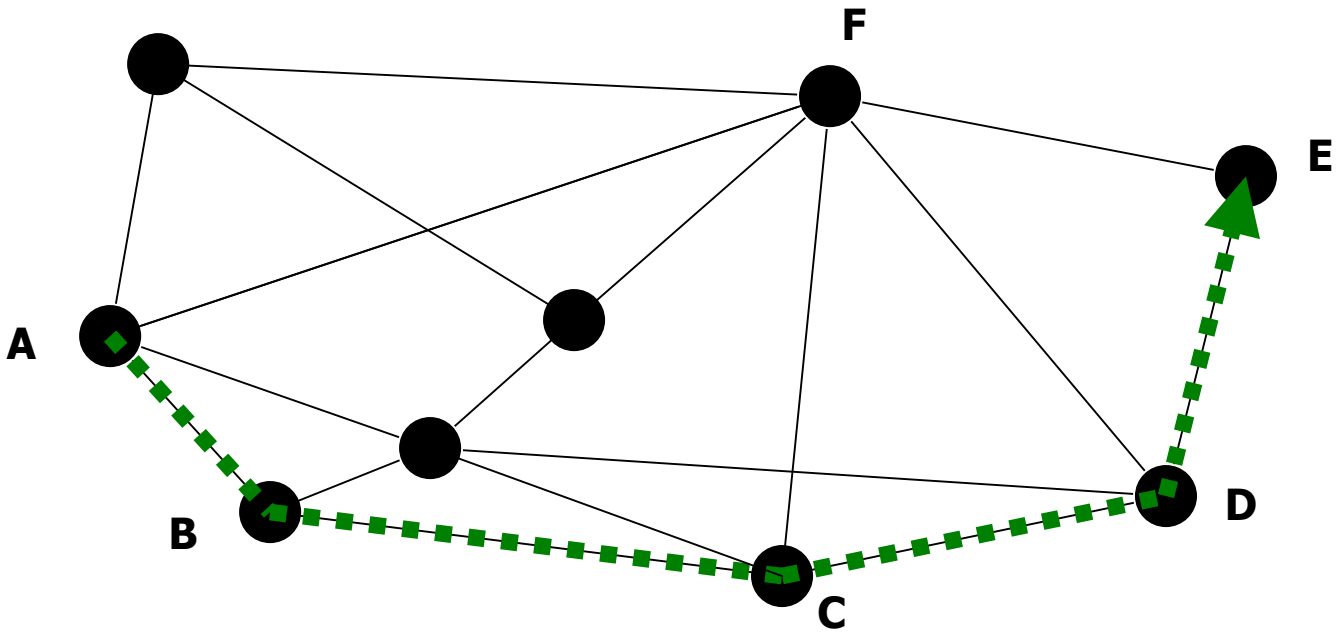
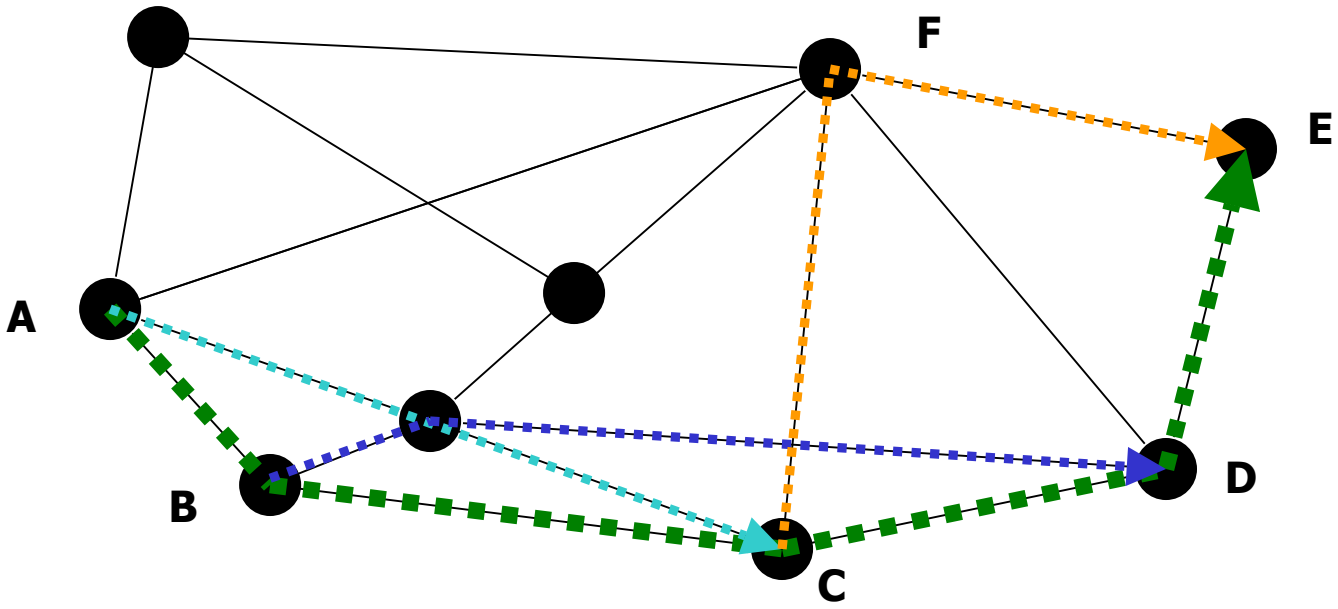
One-to-one backup: example

- A LSP from A to E



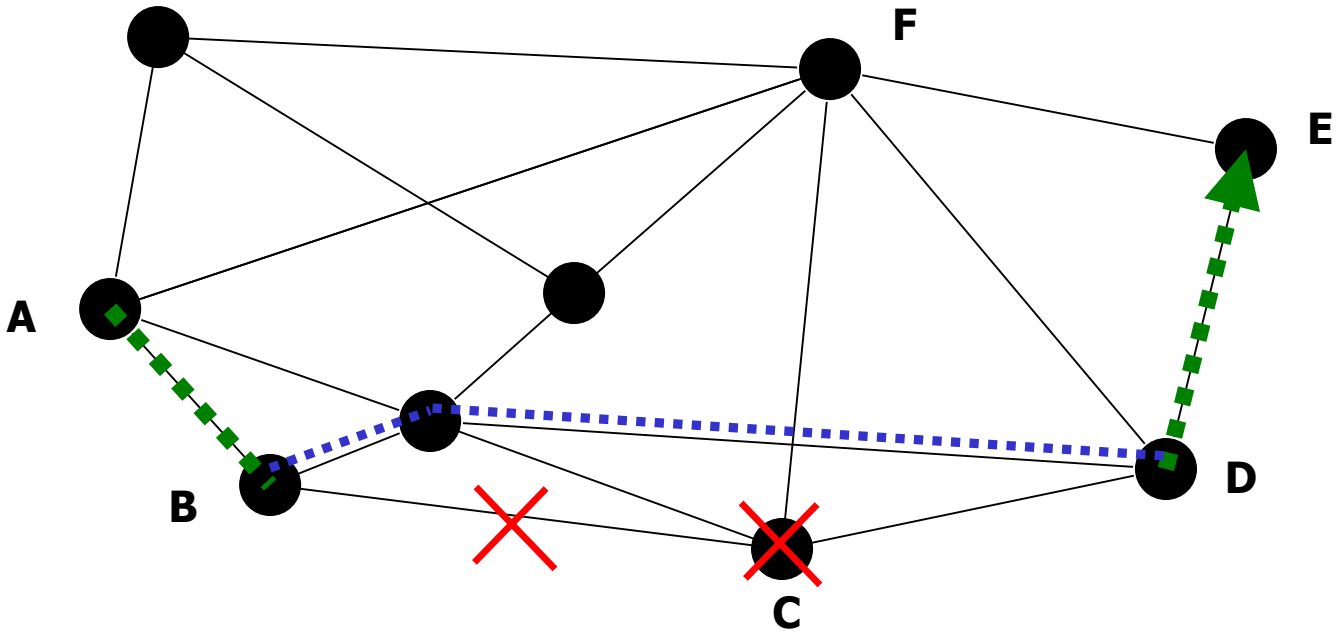
One-to-one backup: example

- **Enable fast reroute on ingress**
  - **A creates detour around B**
  - **B creates detour around C**
  - **C creates detour around D**
  - **No additional configuration required on B, C, D, etc…**



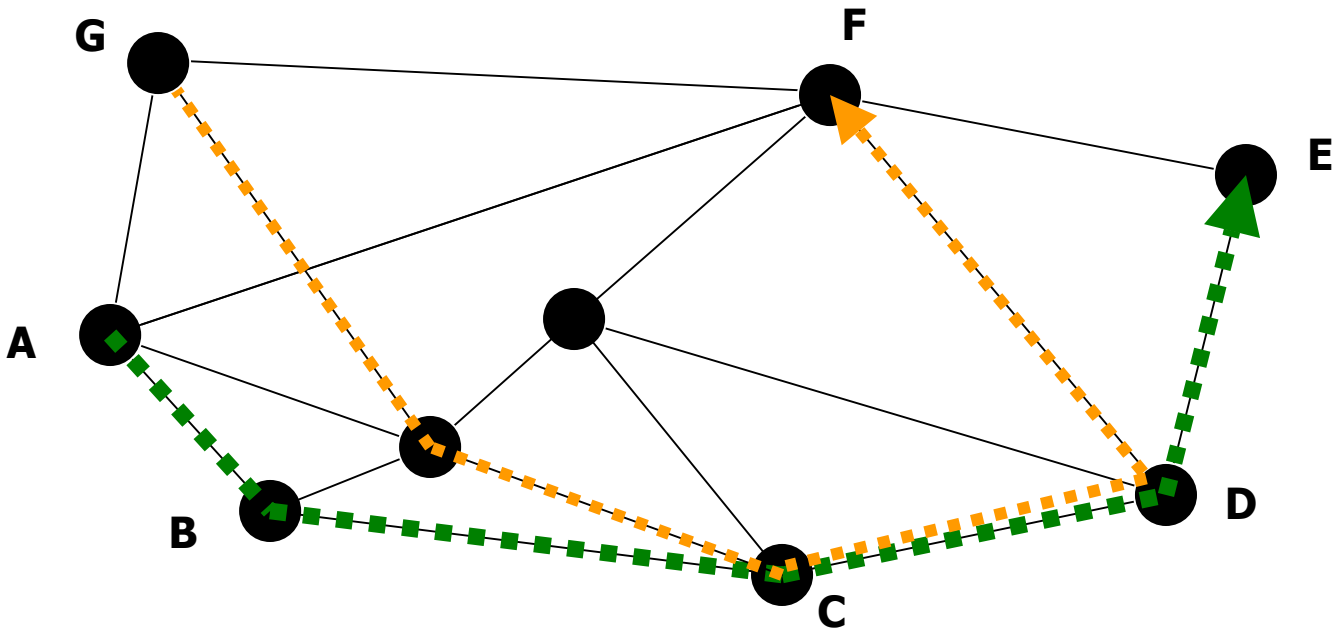
One-to-one backup: example

- **Node C or/and link B-C fail:**
  - **B immediately detours around C**
  - **B signals to A that failure occurred**



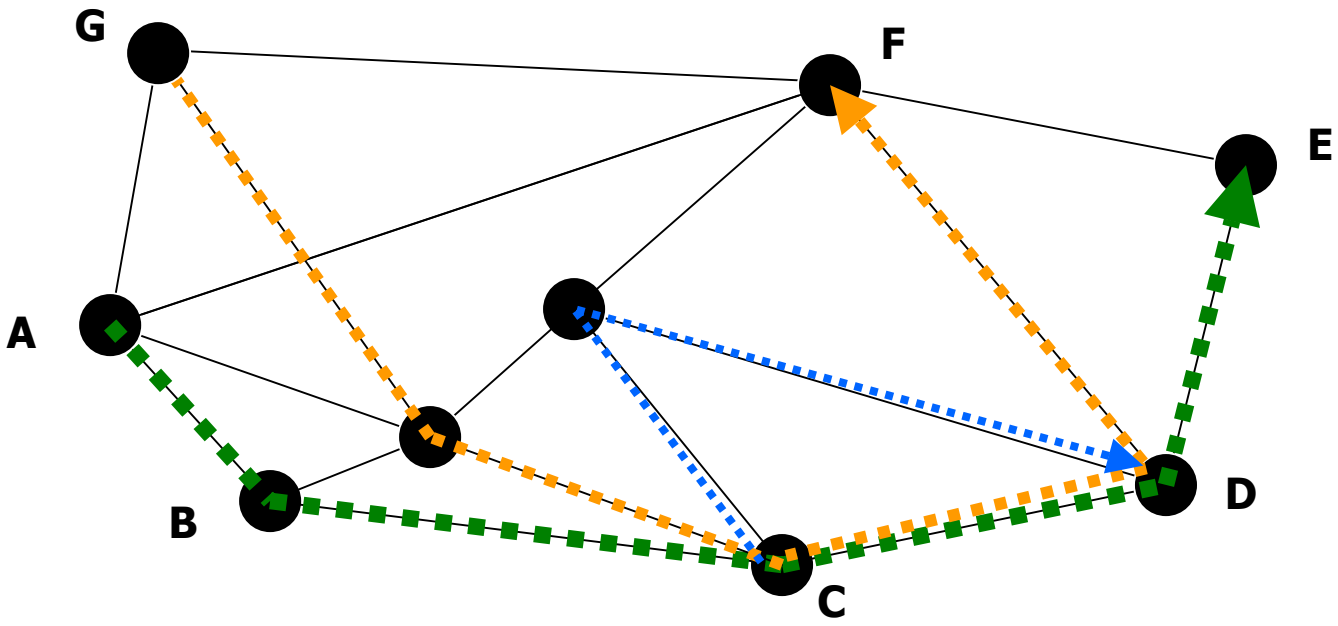
Many-to-one backup: example

- Two User LSPs going over link C-D.



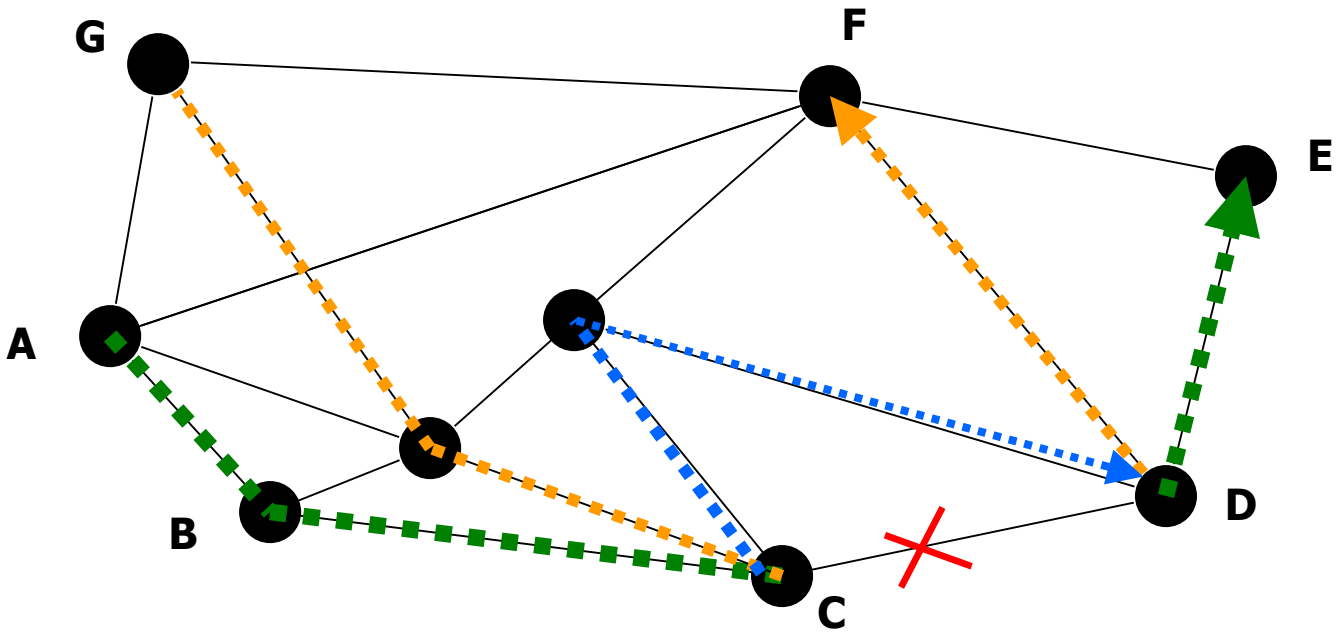
Many-to-one backup: example

- Enable link-protection
  - Each LSP that uses link protection has to be identified as such at the ingress (via configuration)
  - Requires configuration for every link that has to be protected
  - C creates a LSP that will bypass C-D.



Many-to-one backup: example

- **Link C-D fails**
  - **C reroutes user traffic with label-stacking ("outer" label + "inner-1" or "inner-2" labels)**
  - **C signals to A and G that failure occurred**



Fast Reroute Issues

- **Network Operation:**
  - **Having too many configuration parameters complicates the usage**
    - **One-to-one backup: only ingress routers initiate fast reroute.**
    - **Many-to-one backup: both ingress and transit routers need to configure.**
- **Performance:**
  - **On Juniper routers, for both one-to-one and many-to-one backups, the data-plane reroute time after the detection of a failure:**
    - **An OC12 link is protected via an OC48 link.**
    - **100 packet sources, 20,000 pps, load balancing.**
    - **~0 for 1 LSP**
    - **~40 msec for 10 LSP's**

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- ***Graceful Restart***
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Graceful Restart

- A generic solution to
  - BGP
  - ISIS
  - OSPF
  - LDP
  - RSVP-TE
  - Various MPLS VPN solutions
- RSVP-TE graceful restart:
  - draft-ietf-mpls-generalized-rsvp-te

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Graceful Restart…

- Currently, while data forwarding is OK,
  - *IF….*
    - the router control plane restarts (due to crash or s/w upgrade)
    - the control channel between a pair of routers restarts
  - *Then…*
    - All LSP's traversing the router are terminated.
    - Major traffic disruption inside the network
- *With Graceful Restart,*
  - the control plane can be recovered,
  - … without disturbing the data plane
    - no disruption to data/user traffic

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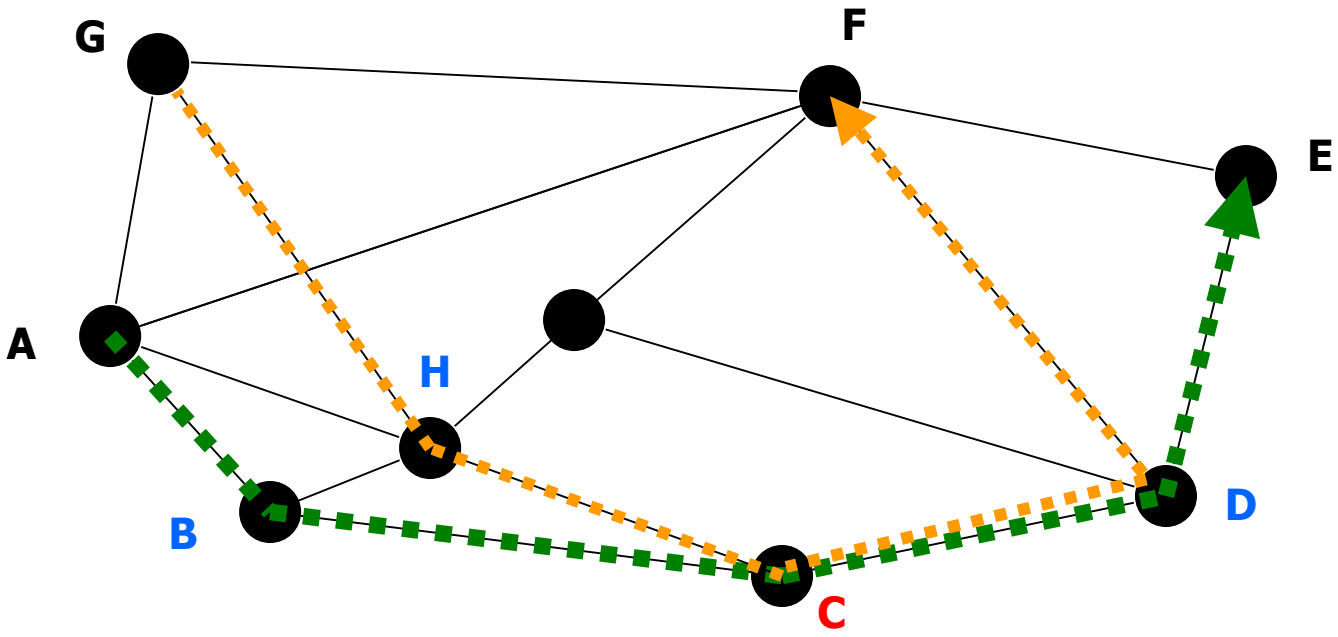
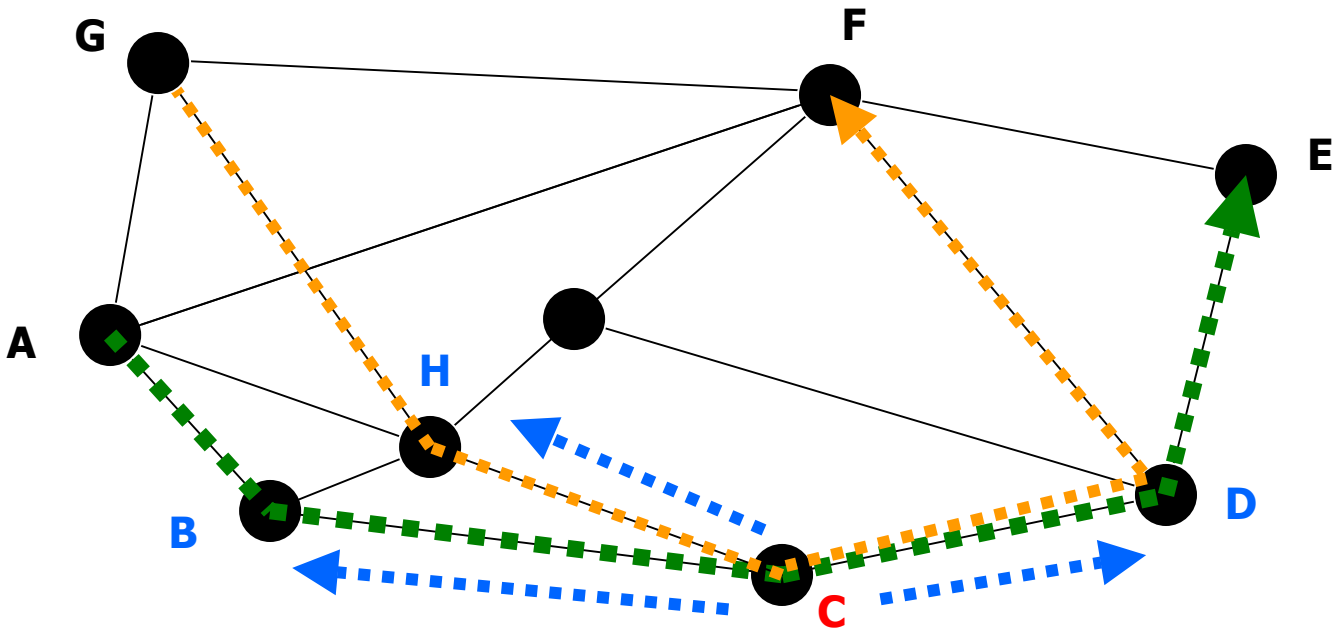
Graceful Restart (example)

- Two LSPs going through C.
- B, D and H have the knowledge about the labels that are used for data forwarding on C.



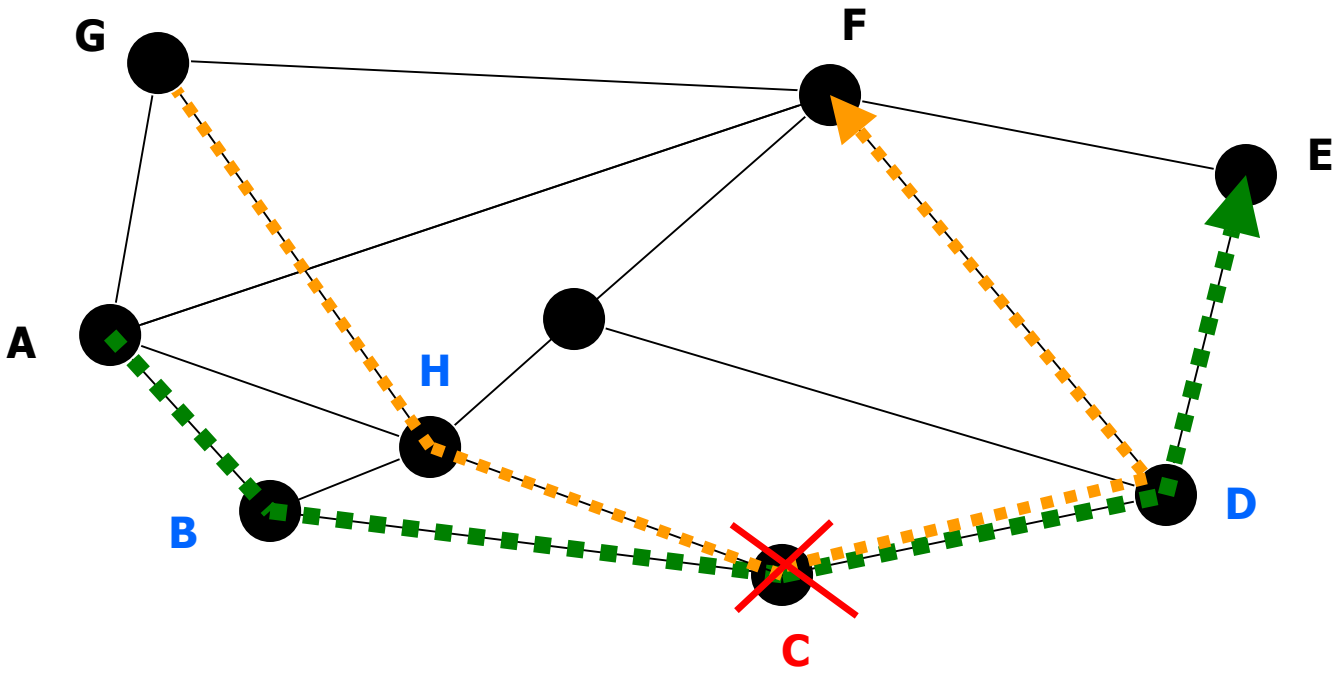
Graceful Restart (example)

- C advertises the Graceful Restart capability to neighbors, B, H, D.



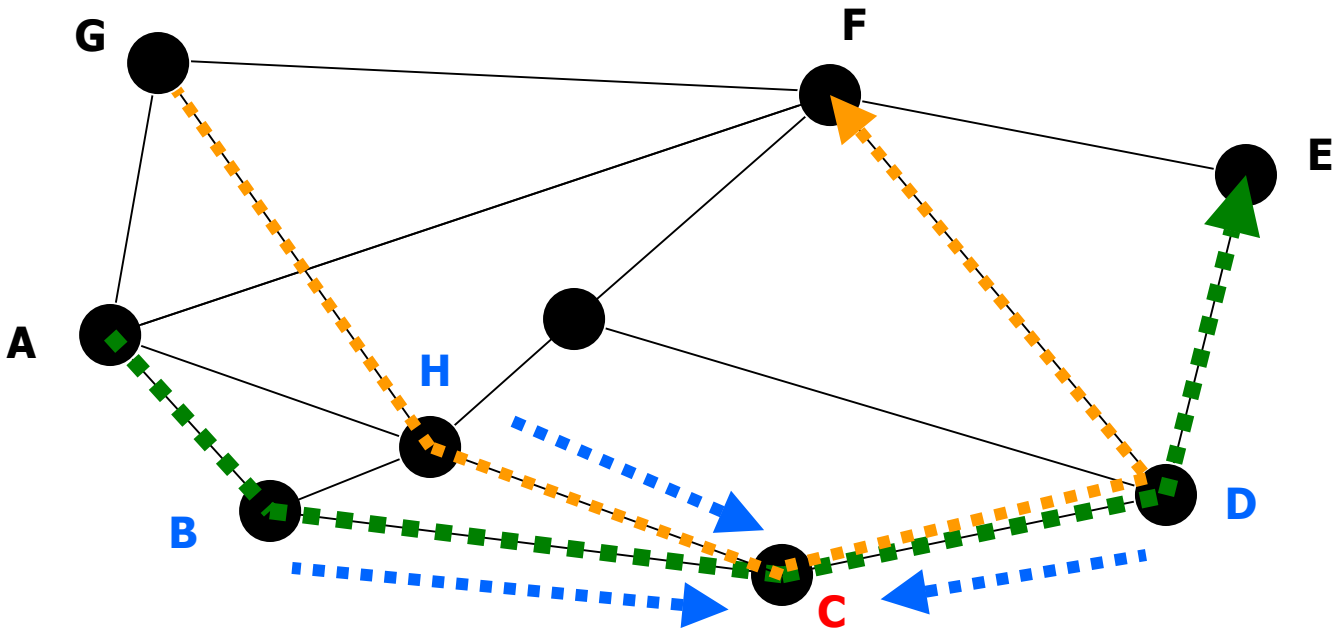
Graceful Restart (example)

- The control plane on C has crashed.
- If data forwarding is OK, B, H and D won't over-react, and keep the LSPs intact.



Graceful Restart (example)

- After detecting C is up again, B, D and H sends labels information to C to help its recovery.



Graceful Restart Issues

- Only applicable on new-generation routers:
  - Requires the separation of data & control plane
- This is perceived to be especially important in the context of GMPLS

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Summary

- Both Fast Reroute and Graceful Restart are designed to improve data plane availability in the face of network failures.
- From our measurement, the reroute timing on MPLS Fast Reroute is as good as SONET APS.
- MPLS Graceful Restart can help to prevent traffic disruption in today's network.
- Requires new-generation routers.

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Fast Reroute and Graceful Restart Comparison (1)

- **Fast Reroute:**
  - **Backup tunnels may consume network resources (e.g. bandwidth in case of SONET/SDH or OXCs).**
    - **Can become a serious constraint in optical networks**
  - **Many-to-one backups rely on label-stack**
    - **Not available in environments such as optical networks**
  - **Configuration can be a problem.**
  - **Cannot protection user traffic at ingress routers**
    - **Works very well on transit routers.**

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Fast Reroute and Graceful Restart Comparison (2)

- **Graceful Restart:**
  - **Does not consume any network resource**
    - **Very desirable for optical networks**
  - **Configuration is simple**
    - **Thanks to the capability advertisement**
  - **Can protect ingress routers**
    - **As well as transit and egress routers**
  - **Require new-generation routers**

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Thank you!

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