Core network protocols and architectures

MPLS-based Traffic Engineering

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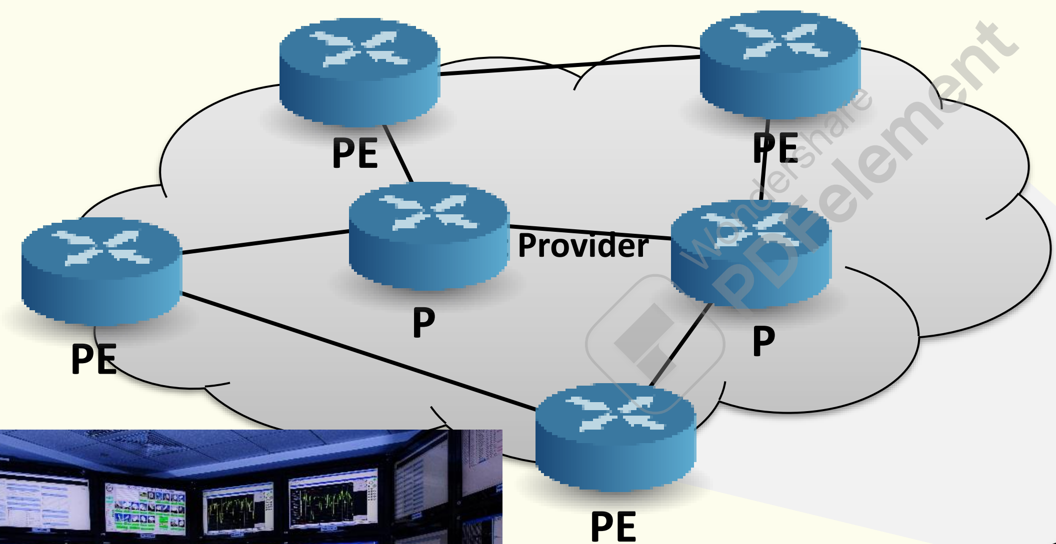
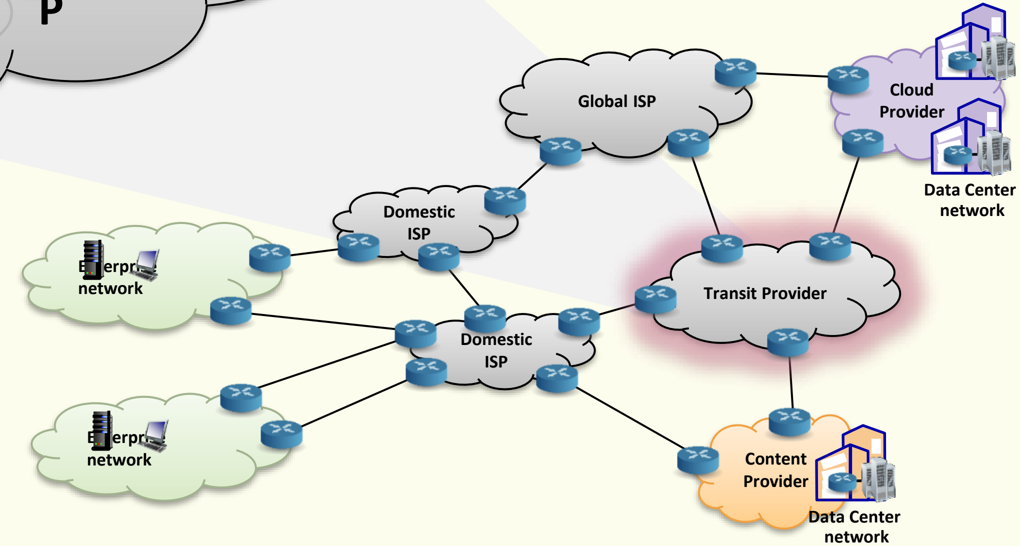
Routing flexibility

- Traffic Engineering

MPLS enables the decoupling of the CONTROL plane from the DATA plane





Traffic Engineering

In IP, Traffic Control can not be managed. IP Tables are configured, then each node runs a function based on the contents of the table.
If MPLS uses IP Routing to calculate the routes, it encounters the same fate

- **Controlling** the **path** taken by traffic **through a network**
- What is the purpose of influencing paths?
  - **Improve utilization** of network resources
    - Avoid congestion (and/or load unbalancing across the network)
  - Ensure the path has **certain characteristics**
    - E.g., not using high-latency links
  - Determine which traffic gets **priority** at a time of resource **crunch**

Traffic Engineering

- Why is that **relevant** for a network operator?

Increase revenues

- – **Offering new services** with extra guarantees
  - Extra guarantee -> extra money charged
  - Example: *Guaranteed Bandwidth service*

Capital Expenditures, the money used

- – **Lowering capex** in new resources **by improving utilization** of existing ones
  - Cost savings by delaying link upgrades, e.g., by increasing average % of link utilization

Traffic Engineering

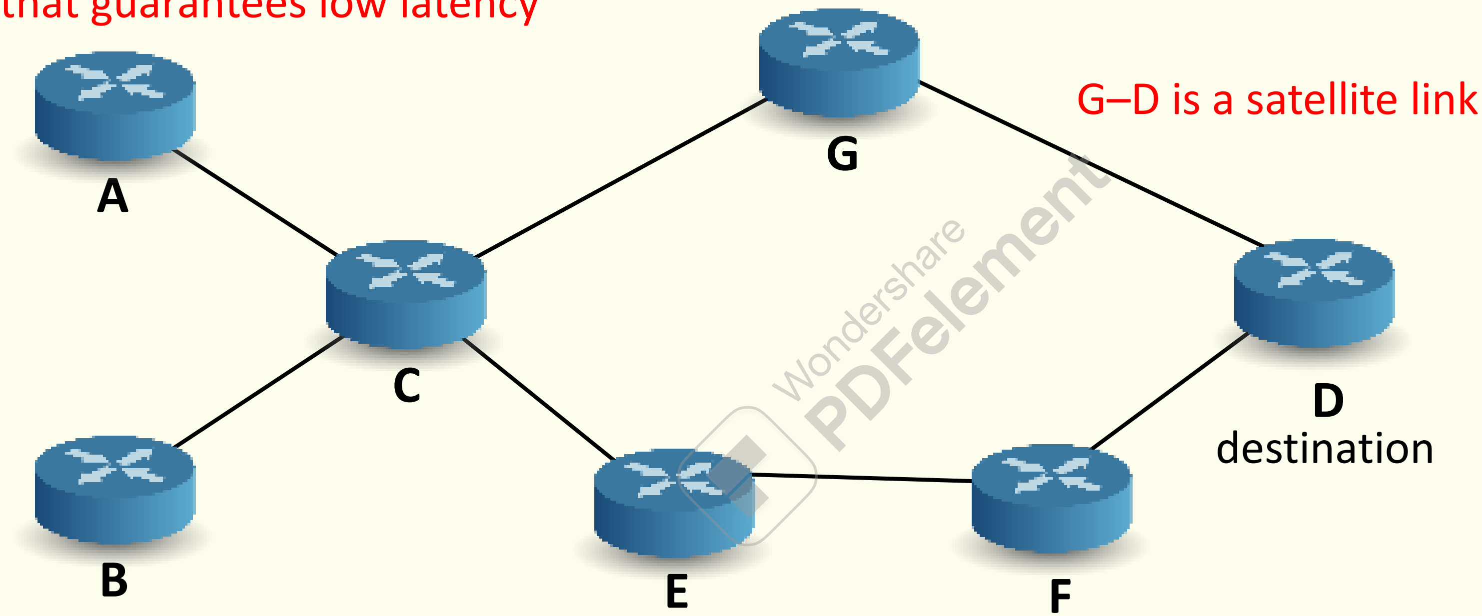
Further protocols and such are needed to use TE with with MPLS

- TE is **not always required**
  - Not all MPLS deployments are used for TE
  - Not all MPLS networks can indeed provide TE
- TE entails operating a more complex network (i.e., **additional cost**)
  - The means by which TE is implemented must be simple enough to deploy and maintain
  - **MPLS** provides **operational simplicity** along with **flexibility** to support complex TE policies

Application scenario [1]

The aim is to get rid of DESTINATION-based Routing

Customer A buys a service
that guarantees low latency



Not possible with IP Routing → **traffic originating at A should avoid the high-latency link G–D**

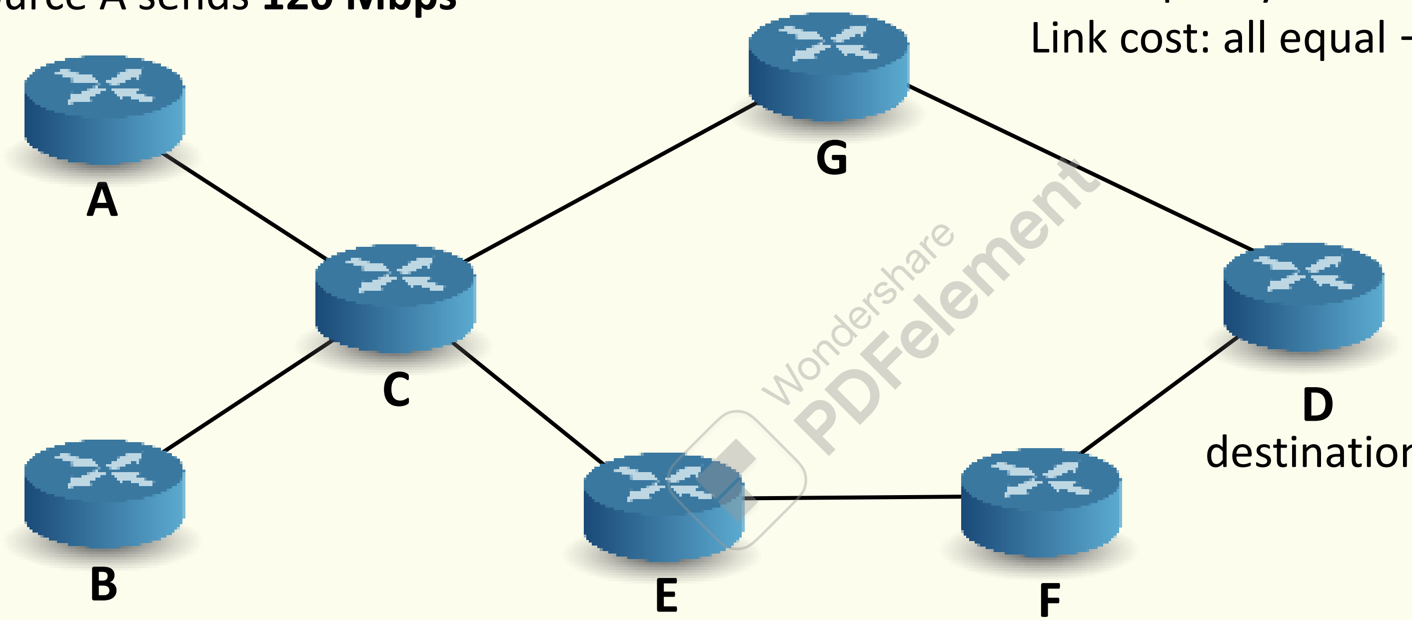
Ability to forward traffic along a path specified by the source, i.e., **explicit routing**

Application scenario [2]

source A sends **120 Mbps**

Link capacity: all **150 Mbps**

Link cost: all equal → Path cost = #hops



source B sends **40 Mbps**

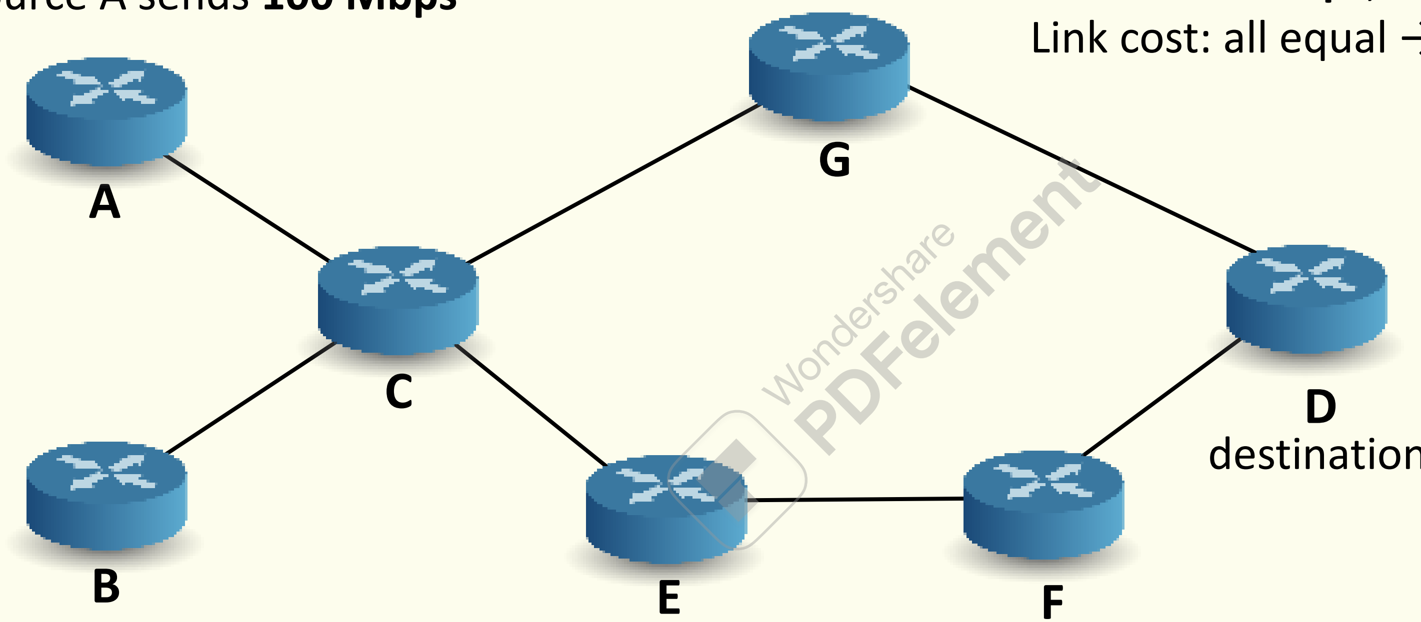
1. **Shortest path → C-G-D is congested**
2. **ECMP → ok, needs manipulating link costs**
3. **What if link E-F has capacity of 50 Mbps?**

Specify **bandwidth requirements** between each source/destination pair, **find a path** that **satisfies** these requirements, **forward** the traffic **along this path**

Application scenario [3]

source A sends **100 Mbps**

All link **150 Mbps**, but **E-F** (**50 Mbps**)
Link cost: all equal → Path cost = #hops



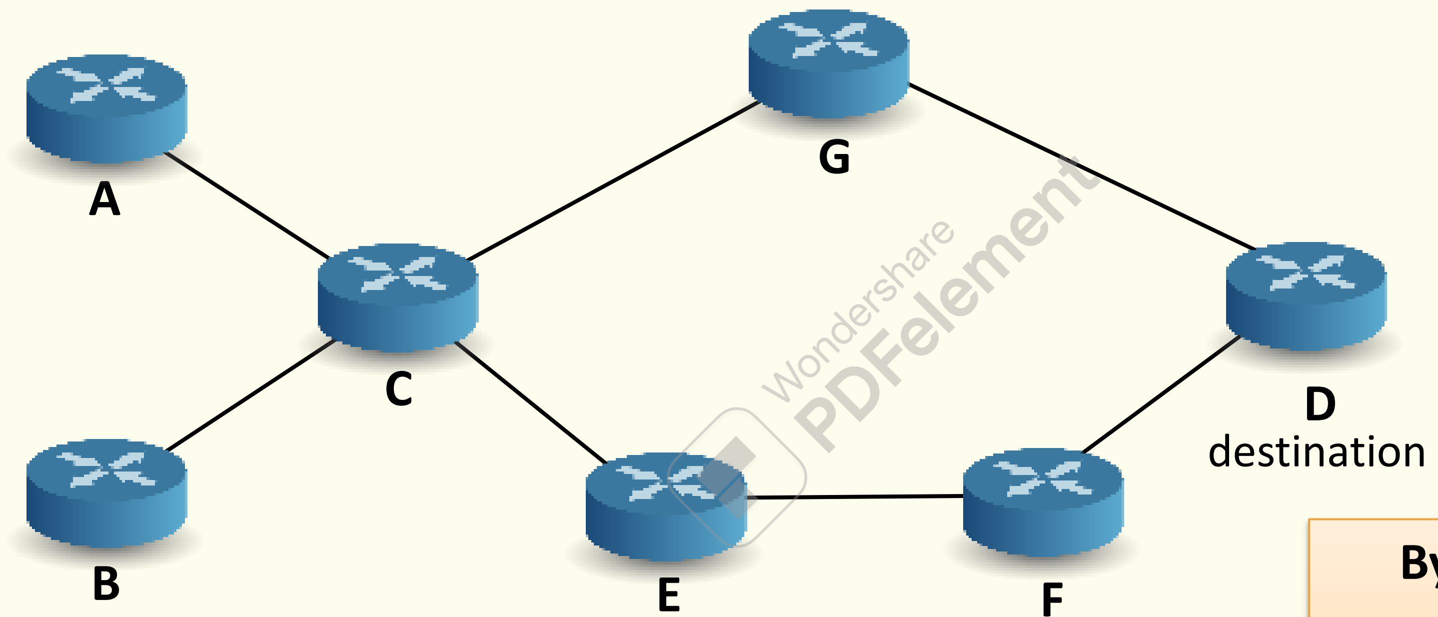
It's a matter of controlling packets in the Control plane, and not in the Data plane with things like Traffic Class header fields

source B sends **40 Mbps**
Customer B buys a service with strict guarantees

1. **Shortest path → ok in normal conditions**
2. **What if link G-D fails?**

find paths between source/destination pairs that **comply with bandwidth constraints**, enforce the **priority of the path** sourced at B over that sourced at A

Requirements for TE



Computing paths that comply with a set of constraints

Enforcing traffic to be forwarded along these paths

By decoupling service from transport, MPLS is fundamental to support TE requirements