SOCM

Service-Based
Optical Connection Management

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Packet & Optical Transport are still Ships in the Night

They are deployed independently.
They are often managed by different teams.
They have independent control infrastructure.

Optical Transport is still thought of as “wires”. We don’t think about wires as dynamic entities.

Today we view ROADMs as providing the ability to *move the wires around*.

But rarely are they used in a way that we “packet people” consider dynamic.

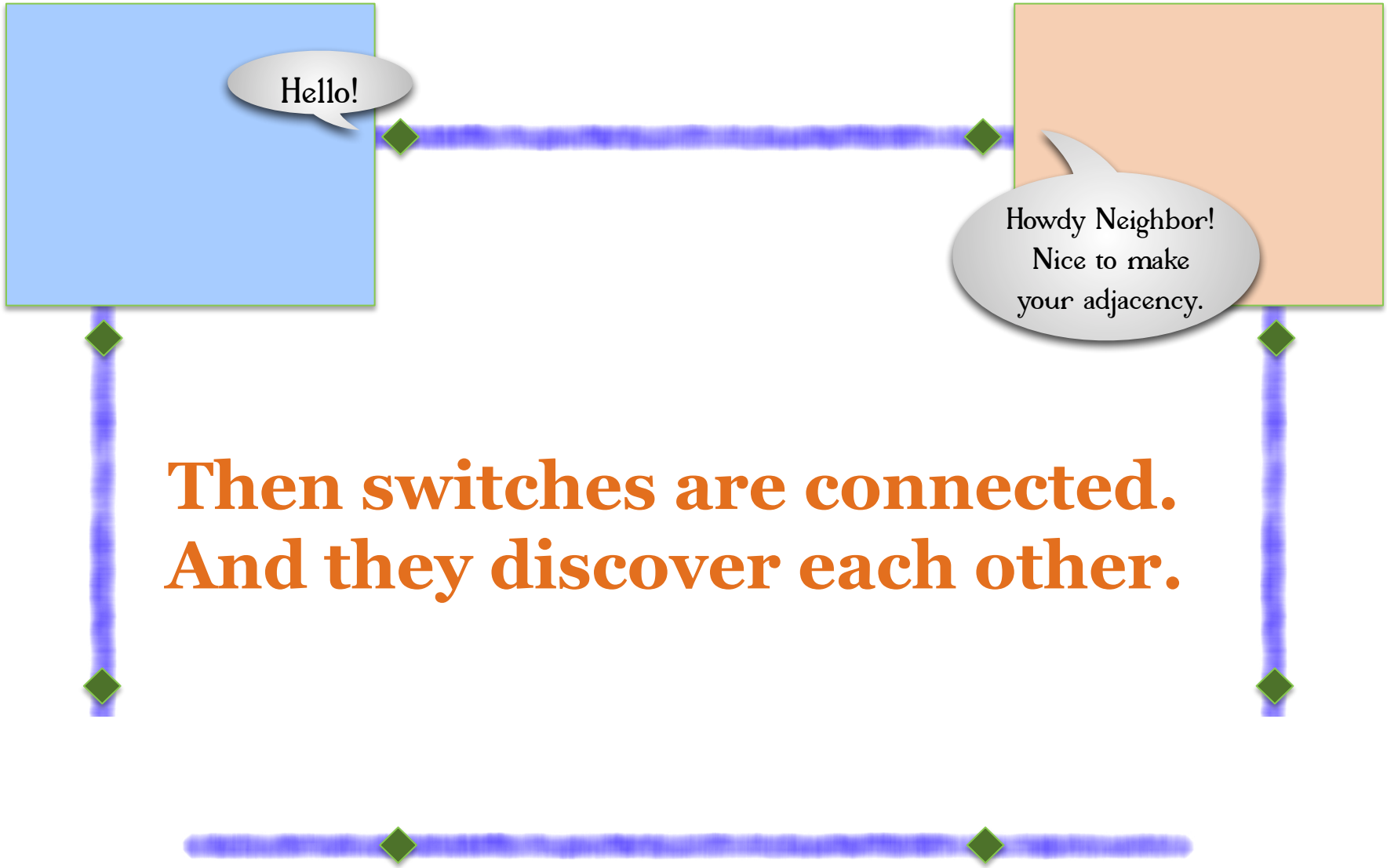
Infrastructure Dynamics	
Packet	µs, ms, sec
“Dynamic Optical” (ROADM)	days, months
Fixed Optical	months, years
Wires	years, decades

Packet Switches are Topology Driven

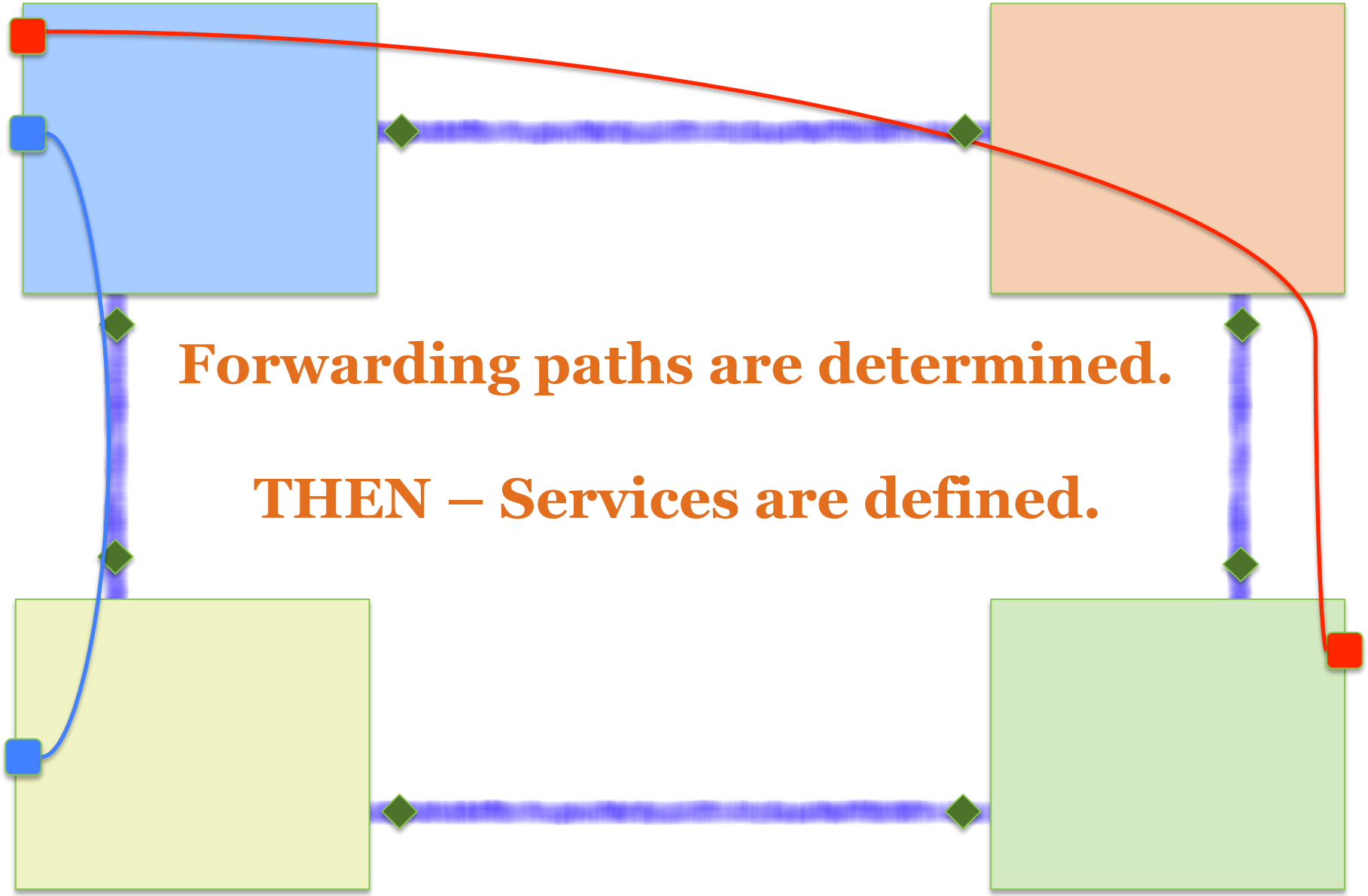
First the transport network is put in place.

Fiber is run, wavelengths are lit.

Packet Switches are Topology Driven



Packet Switches are Topology Driven



All Packet Switches (MSTP, OSPF, BGP, etc.) draw spanning trees across the set of ACCESSIBLE switches

The operative word here is *accessible*. The protocols operate by exchanging information between connected switches. If a switch is not connected, or a path doesn't exist, a priori, then it doesn't become part of the forwarding tree.

Of course, if new paths appear, they are detected and integrated. But from the point of view of the packet switch that is just *deus ex machina*.

A Vision of the Future

- Today, Ethernet Services are:
  - Static
  - Monolithic
  - Long Lasting
- We envision a future where Ethernet Services are:
  - Dynamic
  - Granular
  - Ephemeral (and Long Lasting)

Applications will create and destroy Ethernet services the way they do with files, streams, ports, etc. today. They are just another resource.

a=create_eservice(“epline”, uni1, uni2, service_template);

This provides an environment where VM migration, cloud bursting, etc. are accommodated naturally.

To achieve this vision we need to turn the current approach on its head!

In a dynamic world, we can't pre-determine where bandwidth will be needed.

We can't insist that the services go where the bandwidth has been allocated.

We need to put the bandwidth where the services are.

What if connections didn't exist, initially?

- What if the network started as a blank slate?
  - Just supervisory channels

- What if the Packet Network and Optical Transport Network could conspire to create paths as needed?

Then, we could configure the network – both Optical and Packet – dynamically, to optimize for the current load.

SOCM

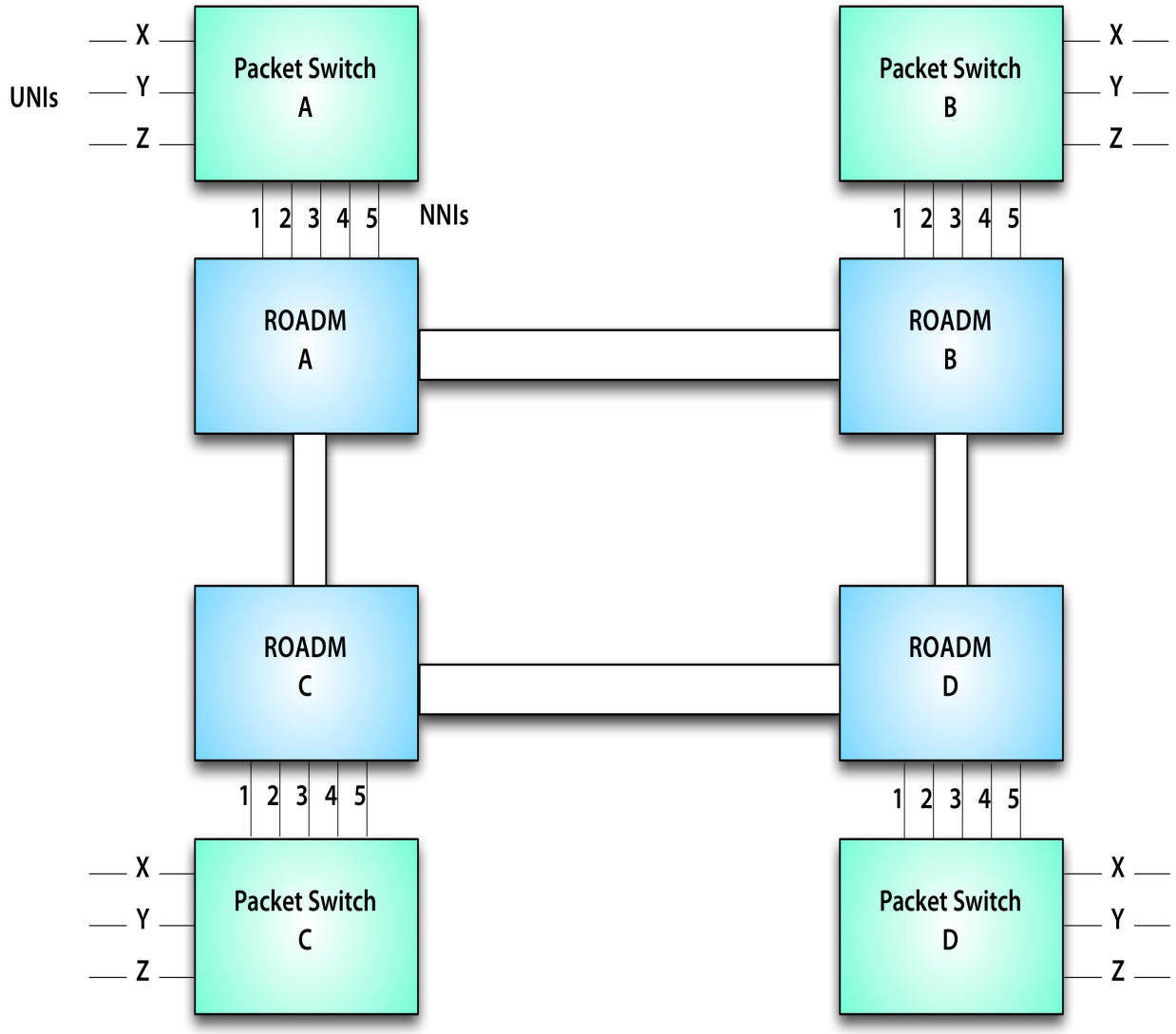
SOCM is a network control system that uses external control entities to provide packet services (E-Line, E-LAN, etc.) ***by dynamically allocating both an optical transport path and a packet path at service initiation***.

Basic Operation of SOCM

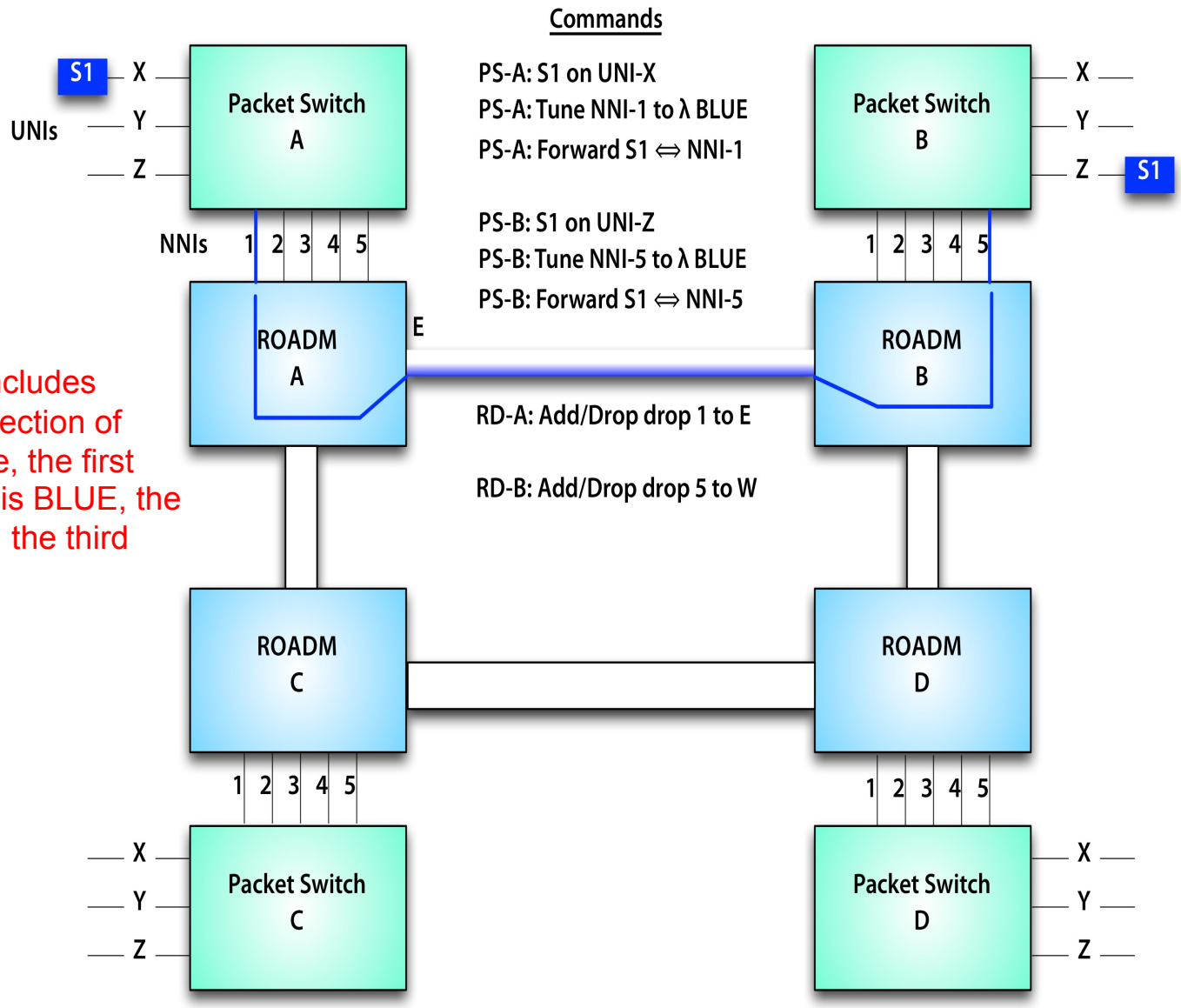
- Service requests come from a management entity or an application to create an Ethernet service:
  - SOCM allocates an optical path by using space in existing wavelengths, lighting new wavelengths, and/or concatenating wavelengths through packet forwarding.
  - Then it binds a packet service to the optical path.
- The transport path can be a direct single hop, or it can be multi-hop. The selection of the path can be based on several parameters:
  - Available ports and wavelengths
  - Currently instantiated paths
  - Bandwidth requirements of the service
  - QoS (e.g. delay) requirements of the service
  - Protection/availability requirements of the service
  - Other relevant variables

The initial network

In the beginning there are no services and no paths.

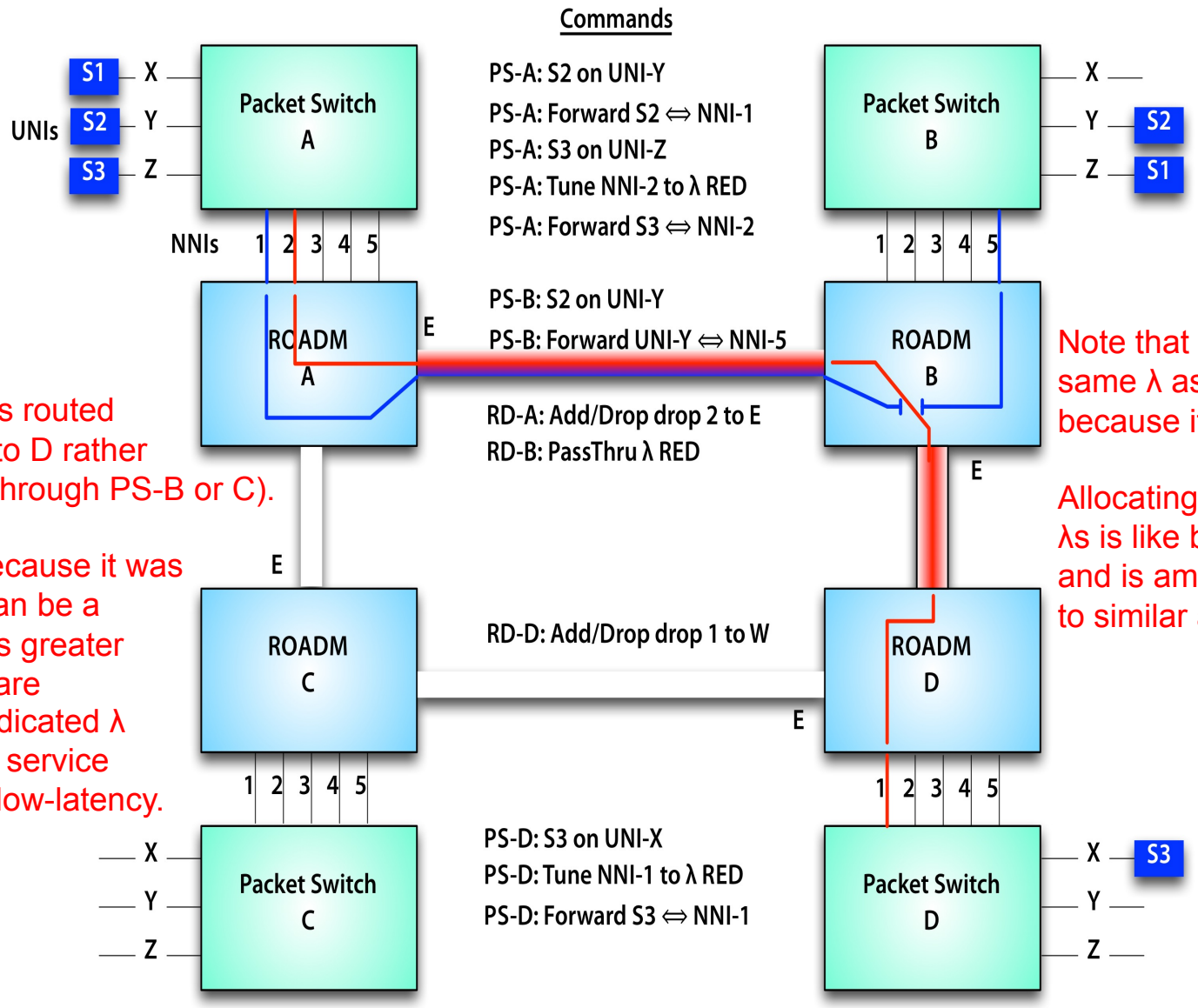


Add the first service



The rules DB includes rules on the selection of λs. For example, the first λ on each path is BLUE, the second is RED, the third Is GREEN, etc.

Add a couple of more services



Note that S3 was routed optically from A to D rather than in 2 hops (through PS-B or C).

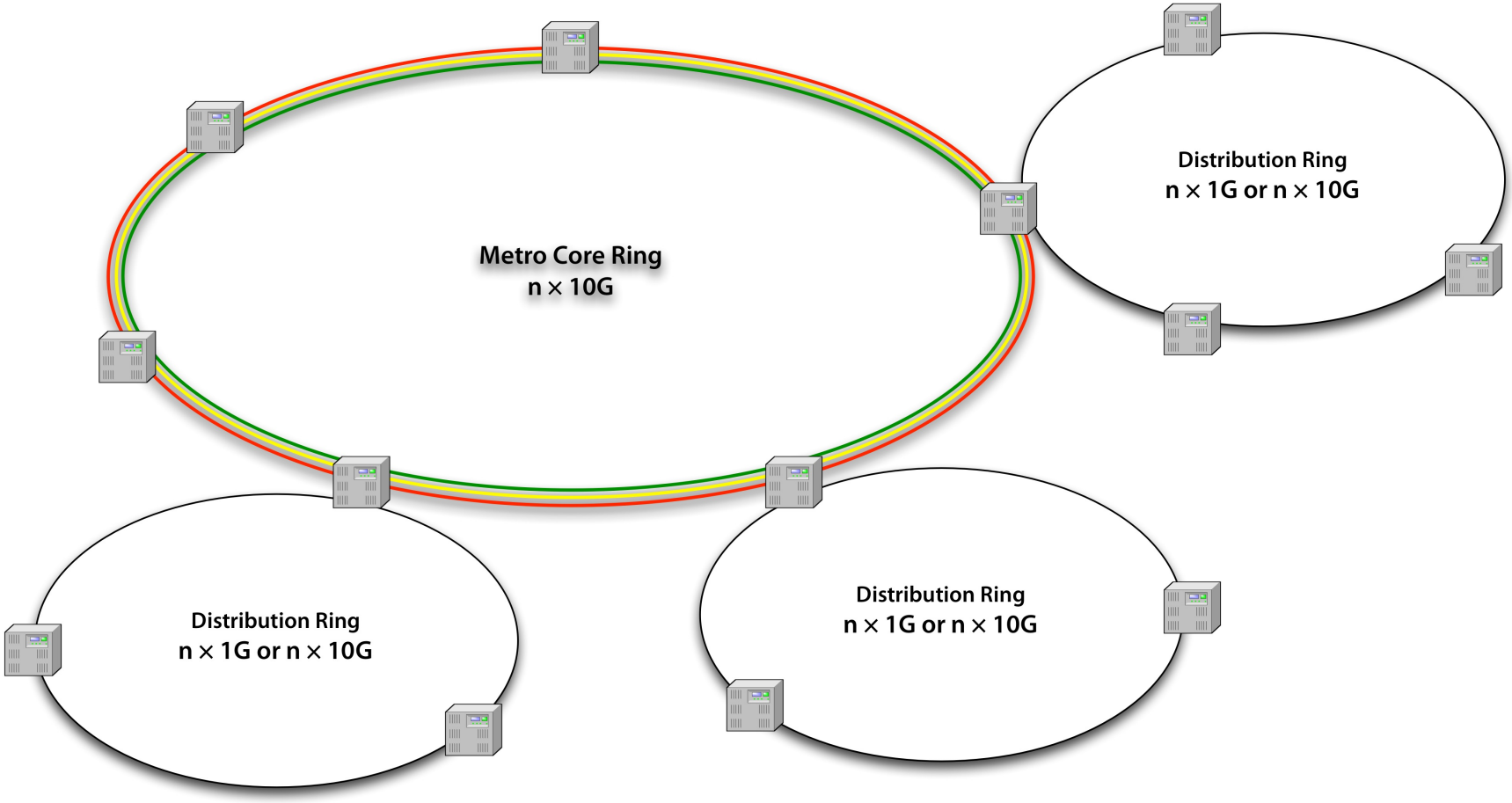
This could be because it was big (e.g. there can be a rule that services greater than (say) 7GB are initiated on a dedicated λ … or maybe the service was defined for low-latency.

Note that S2 is on the same λ as S1. This is because it fit.

Allocating services to λs is like bin packing and is amenable to similar algorithms.

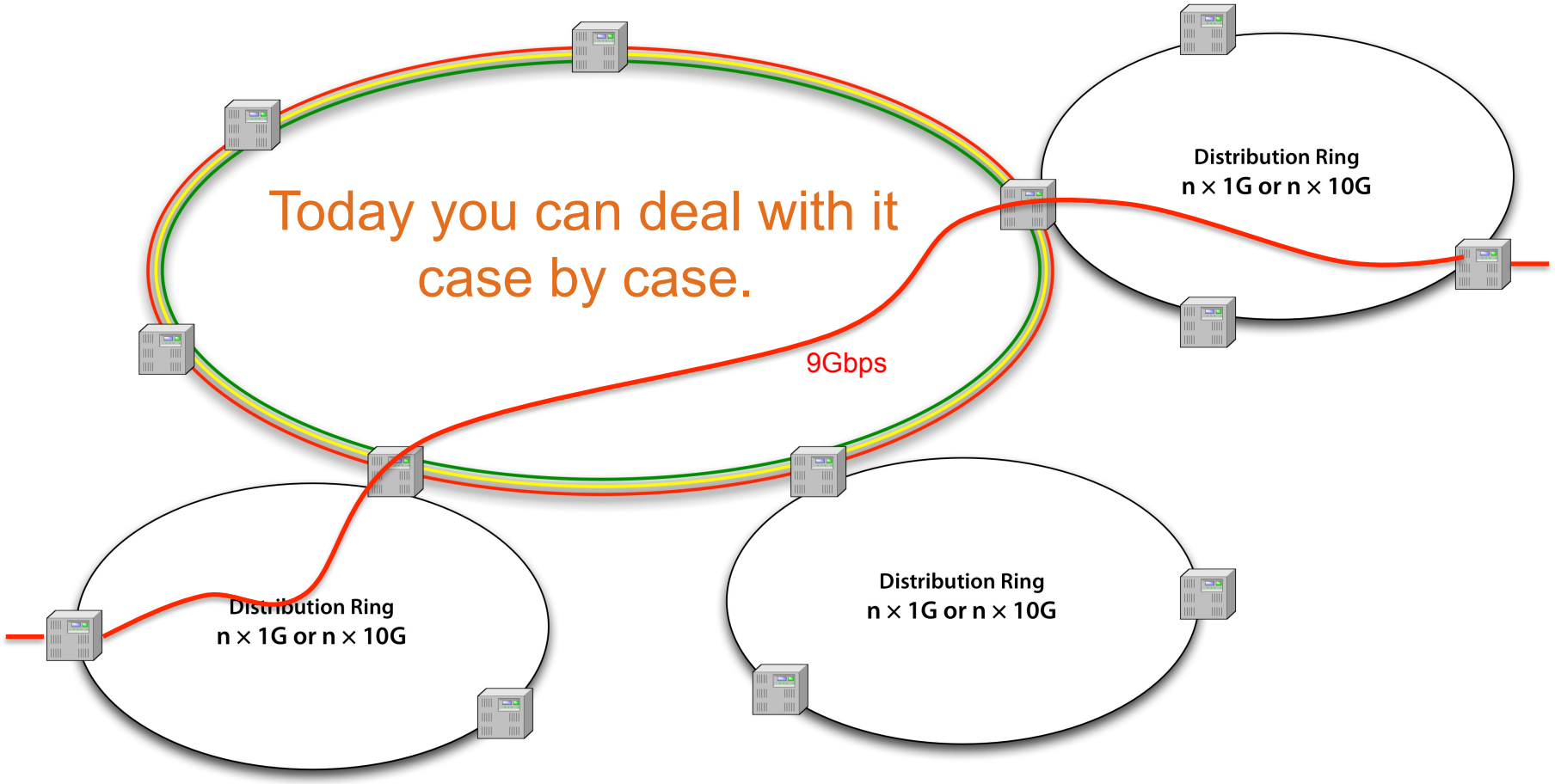
Customer Network

Customer has built the network with n×10G around the metro core (n=4 in some cities and n=2 in others).



Not *because* that much is needed on each hop,
but *in case* that much is needed on each hop.

That works for static, well-defined services although likely a lot of wasted bandwidth. But what if we need a lot of bandwidth (or low-latency) between distant destinations?



But in our vision there can be ***lots*** of cases.

Defragmenting / Reclaiming Wavelengths

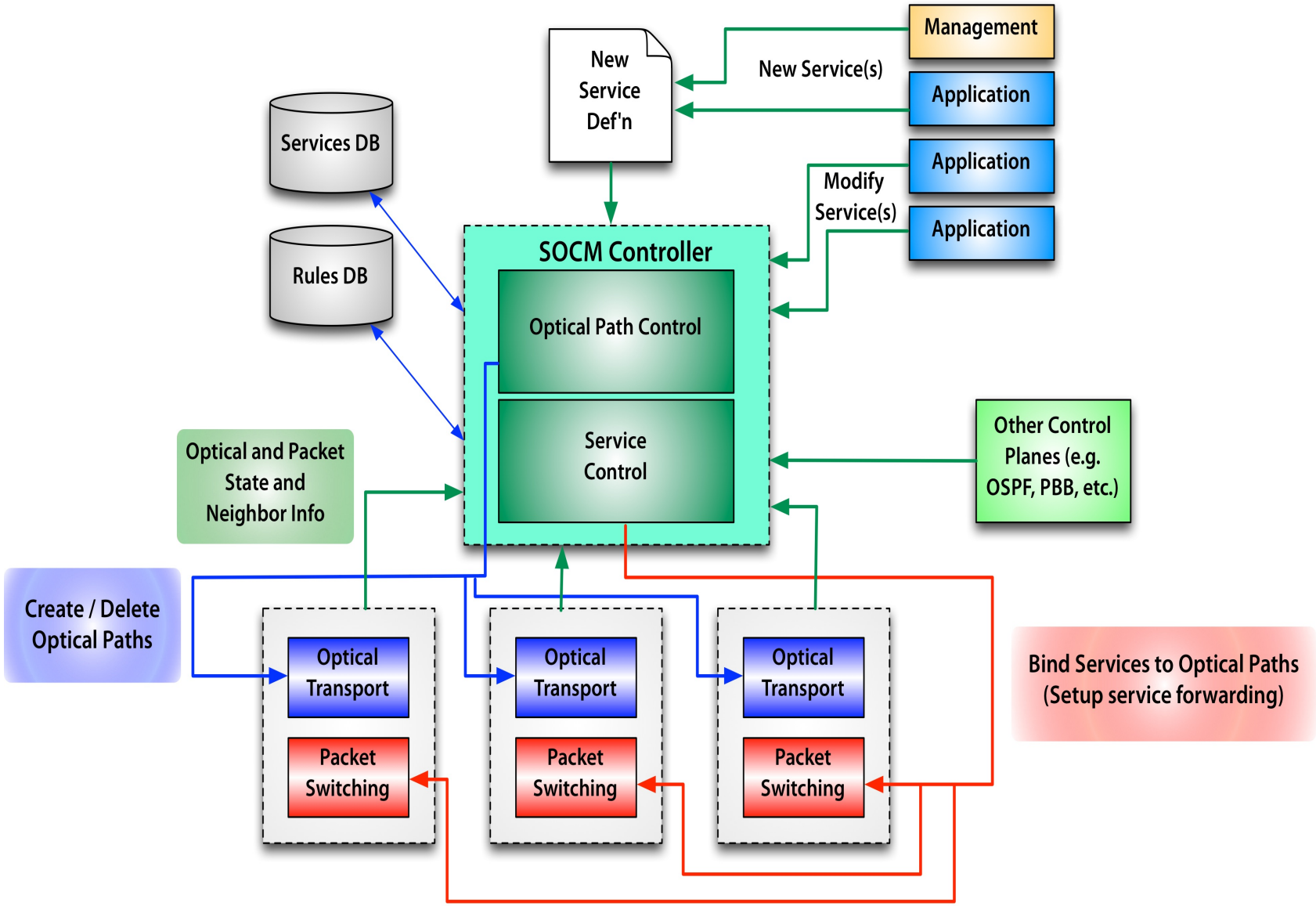
- Dynamic Optical Transport infrastructure means we get to optimize wavelength usage.
- As services are created and deleted wavelengths can get fragmented and underutilized.
  - Create three 4Gbps services between A and B. This requires two (10G) wavelengths.
  - Delete one service. Now there are two 4Gbps services and two wavelengths.
  - You might end up with an unused wavelength that can be reclaimed.

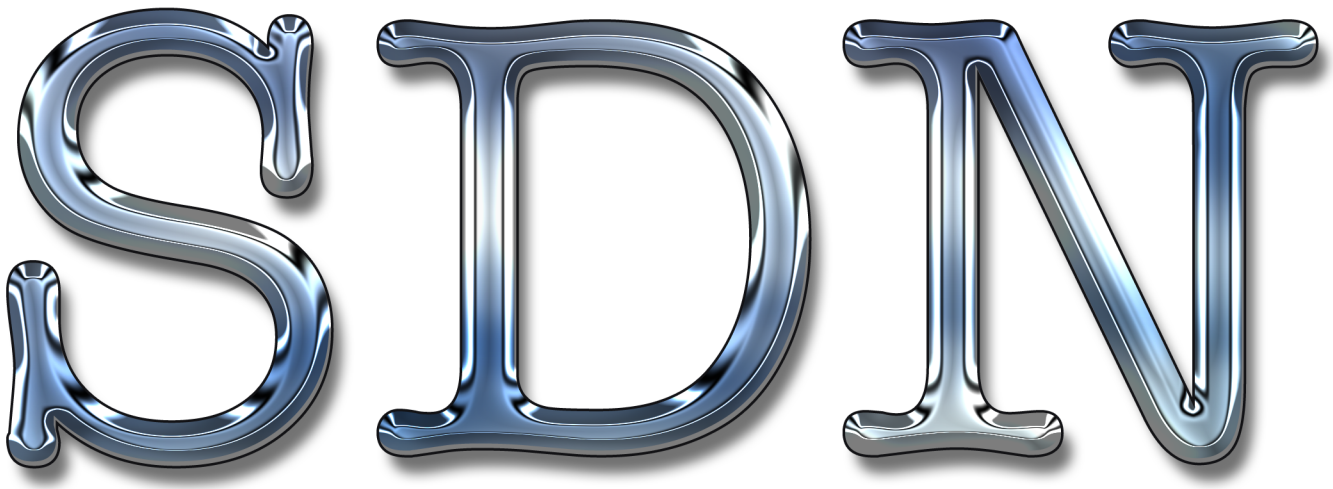
➠ More wavelengths are available for new services.

SOCM Components

1. ROADM-based transport infrastructure
   - Particularly a Colorless, Directionless, Contentionless (CDC) ROADM. Will be practical soon.
2. Packet switching infrastructure
   - The SOCM forwarder can be at L2, L2.5, or L3
3. Tunable optical transceivers in the packet switches
   - These have been available for a while
4. An external control infrastructure
   - This is the part that needs to be developed

SOCM control/network architecture




SDN

SOCM is a Software Defined Network

"What fundamentally differentiates SDN from traditional networks is the separation of control [plane] from forwarding plane."*

With SOCM, an external control entity provides a focal point for integrating multiple control planes which would be very hard to do if they were implemented in a traditional way – i.e., integrated into the Optical and Packet switches.

This is the power and promise of SDN!

IMHO

* On Scalability of Software-Defined Networking, Yeganeh, Tootoonchian, Ganjali, IEEE Communications Magazine, Feb 2013

SOCM puts the bandwidth where the services are

- **SOCM** manages the *optical topology* and the *packet topology* in a co-ordinated, dynamic way.
  - Using an external control entity to effect the network configuration.
  - Network configuration is based on services, flows, and applications.

Result:

Better utilization of network resources,
Better dynamic response to changes in load,
Less manual configuration and less guesswork.

Questions? Answers?

Thank You