Programmatic Internet

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SDN boiled way down

- Enables applications not resident in embedded OS' to extract and program state into a networking node and across nodes
- Three major religious assumptions to overcome
  - State of the node or network not distributed out to configuration files
  - State/Objects not programmed with assumptions of persistency (i.e. not via a transaction that writes to the configuration file)
  - Centralized view of the topology in addition to distributed routing

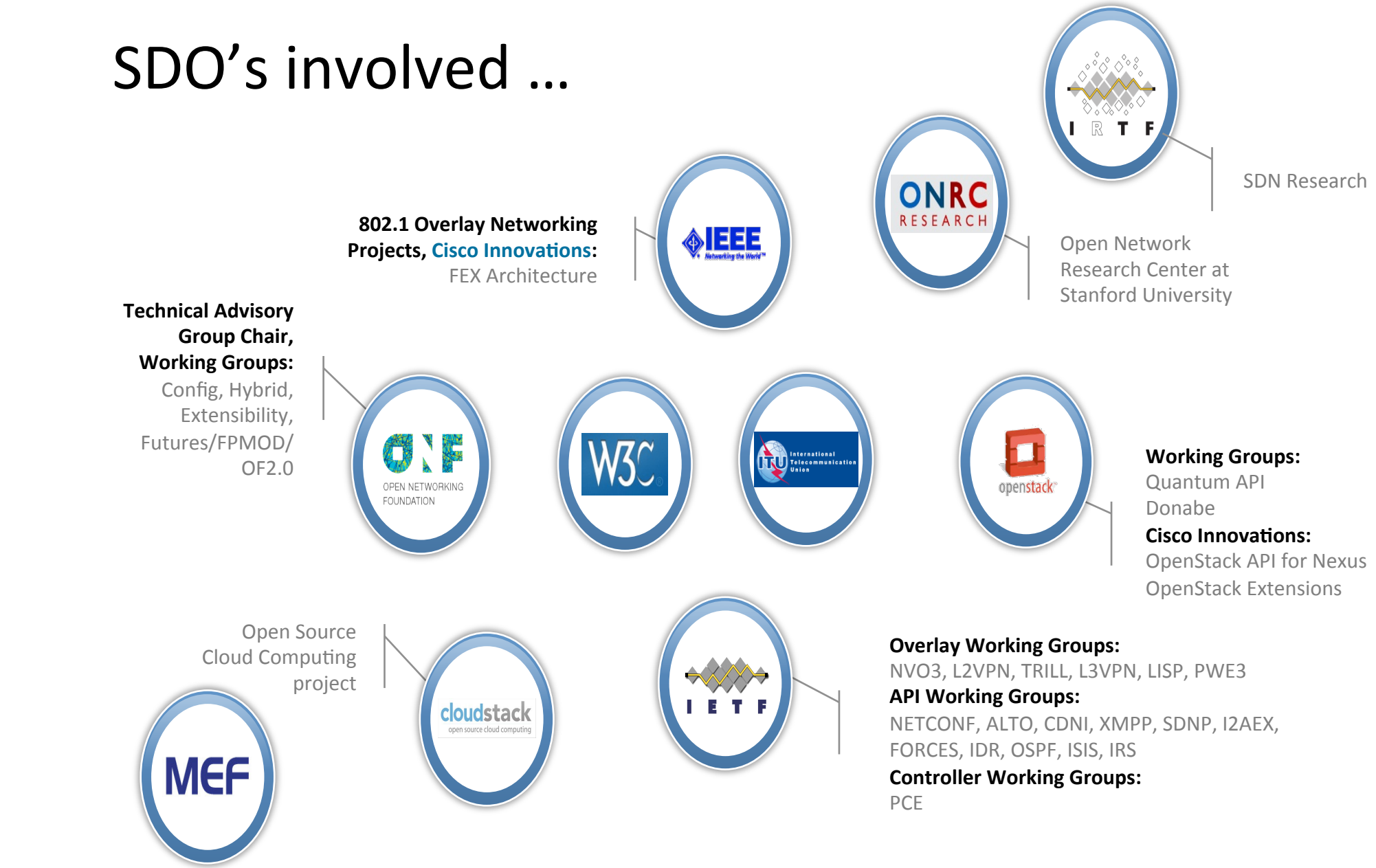
What problem is trying to be solved?

- Operational ease of configuring network
  - Moving the industry from CLI
  - Standardized interface that allows for Applications/services to customize network policy, topology, and feature state
- Ephemeral state programmed into the network
  - Enables feedback loop and events between different subsystems (e.g. identity, routing, policy, state of the topology)
  - Faster deployment of compute, storage, services
  - New services not possible with existing technology/protocols
- Visibility to multiple layers of hierarchical topology
  - Otherwise invisible to any single node
  - Virtual networks across multivendor/multifunction equipment
  - Manage state across layers of: optical, transport, trunks, virtual networks, services

Issues with current SDN architecture

- Interfaces to HW drivers are enough (e.g. IPC or RPC-esque)
- No topology, BW, utilization, delay, loss, jitter attributes or discovery
- No node capability or resource discovery
- No assumptions of RIB, loop detection, errors in state, duplication checking
- No “horizontal communication” between controllers or between networking nodes
- External events from OAM, triggers, forwarding state chages missing
- Limited L2, encapsulation

SDO's involved …



Some Interfaces to Internet required

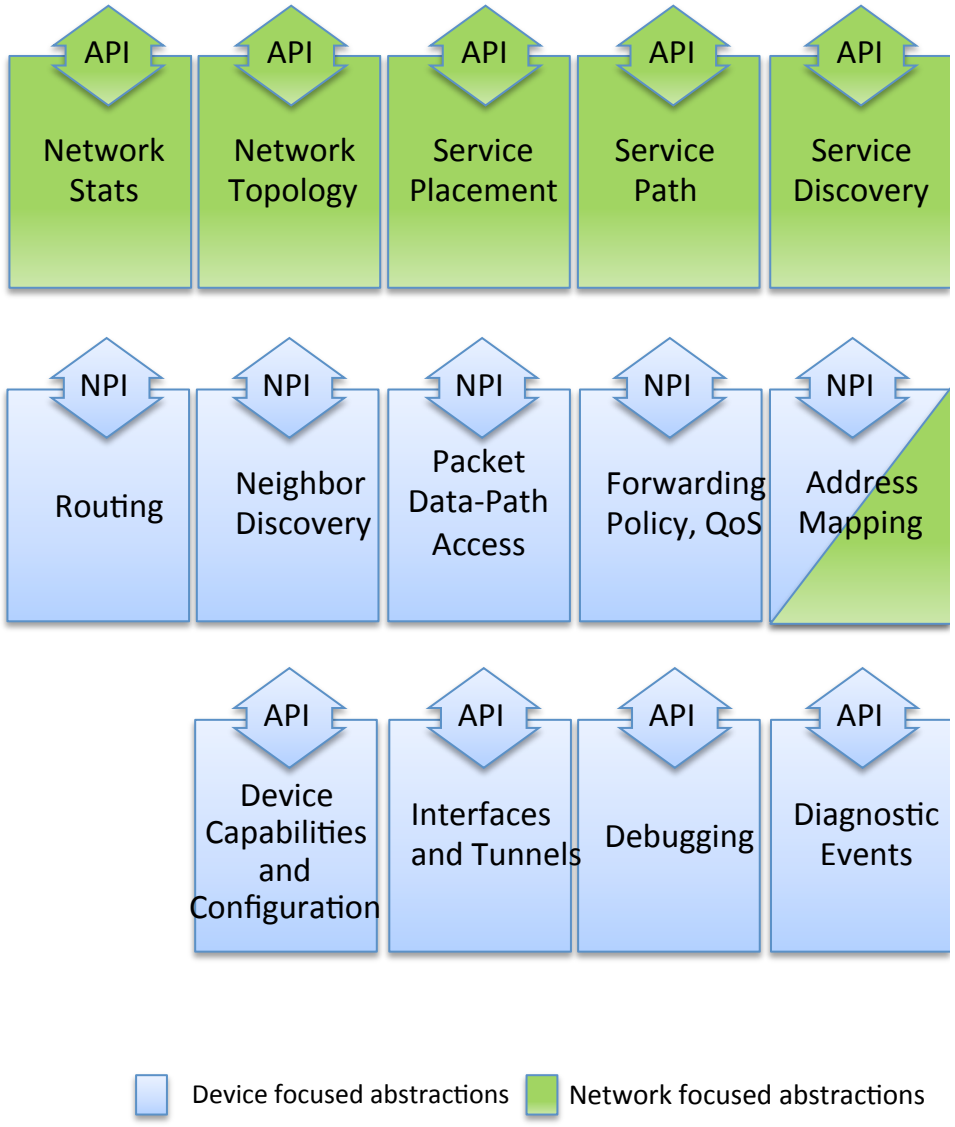
Lack of standards for many of these features

- Programmatic configuration – Yang data model via NetConf/ReST-HTTP, OMI
- Tunnels/Encapsulation: MPLS, IPnIP, GRE, L2TP, UDP, OTV, VXLAN
- Topology and “weather report” export
- Transport: Lambdas
- Cross Connect
- Routes, VPN
- Classifiers
- QoS
- Analytics

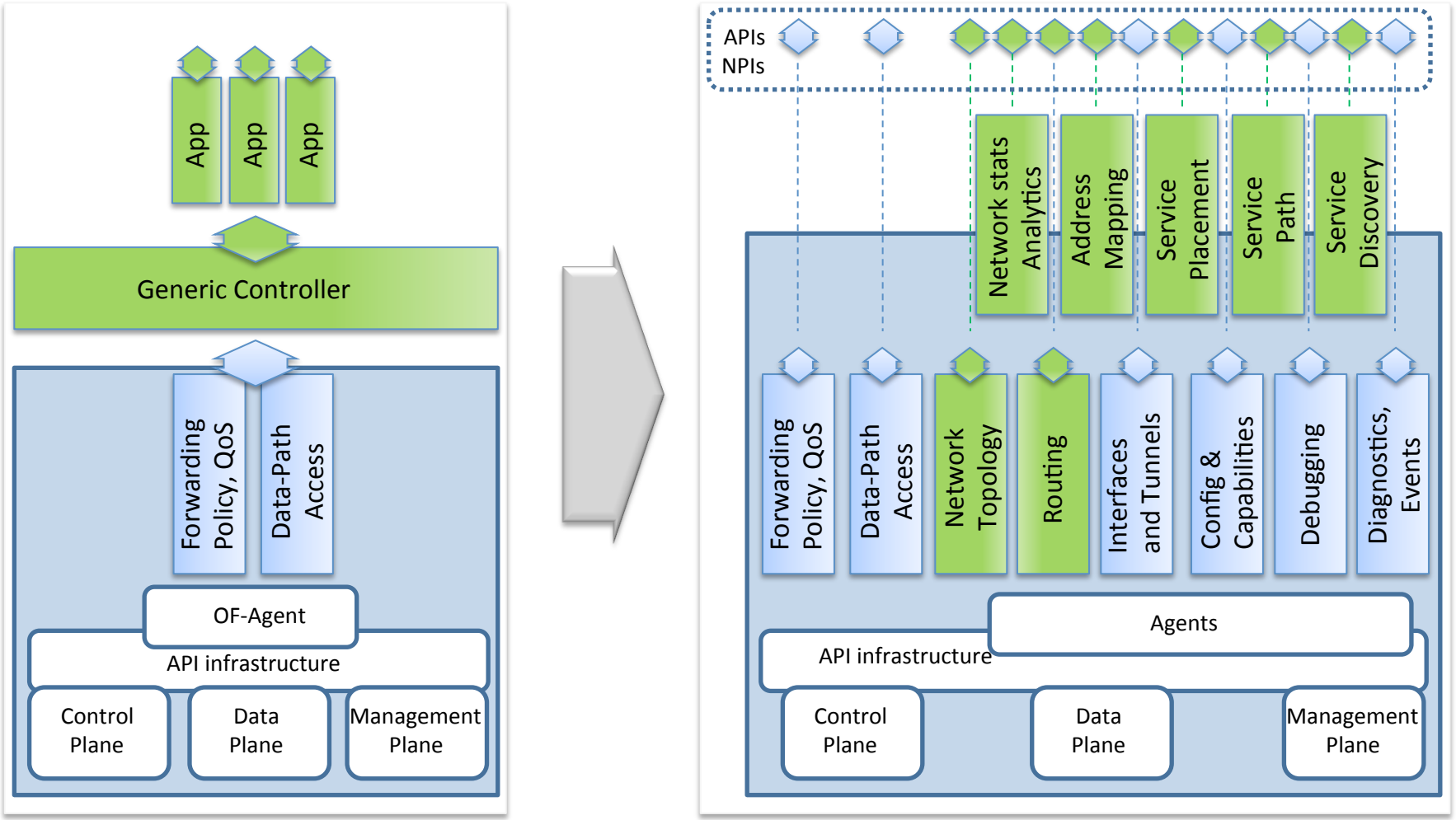
Future: Security, DPI, NAT, Gateways

Approaching Service Abstractions

- Abstractions allow the definition of layered APIs and NPIs
  - Enable multi-layer APIs across all elements, to integrate with operator development environments
  - Accelerate development of network applications: Integrated stack from device to network
  - Multiple deployment modes , local and remote APIs
  - Multiple Language and Virtualization options



Evolve the SDN Model … the need for diverse information and interfaces



Not all Networking Interfaces are the same

- WAN NPIs follow their Scope
  - Defined by their *scope*

    API Scopes:
    Location independent; Area; Particular place; Specific device

    Approaches like device/network/ service APIs not mapped to topology

    Location where an API is hosted can differ from the scope of the API

  - Different network planes require different programmatic interfaces, based on proper layer interaction

Utility

Example: Get Auth, Publish Log,..
Scope: Location independent

Area/Set

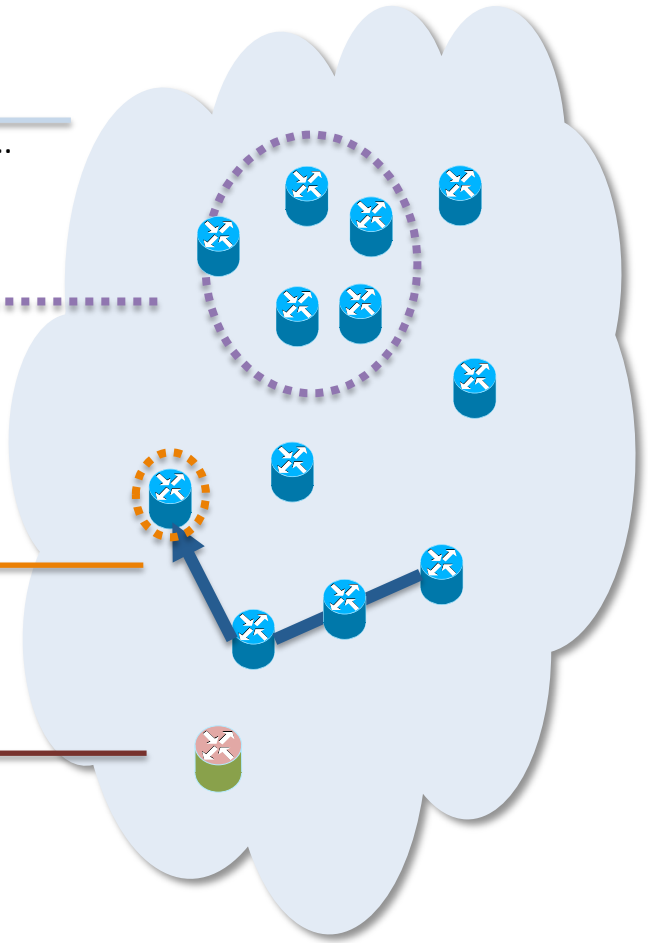
Example: Domain, OSPF-area,..
Scope: Group/Set/Area

Place in the Network

Example: Edge Session, NAT
Scope: Specific place/location

Element

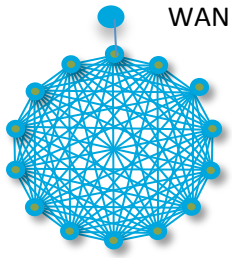
Example: interface statistics
Scope: Specific element

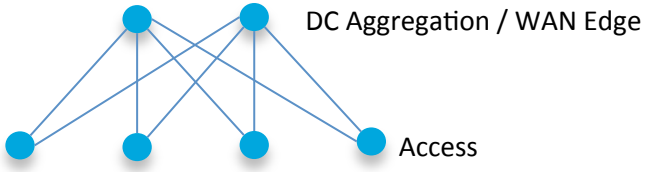


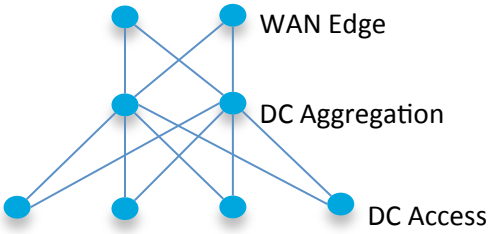
A Router positioned on the Edge of a WAN != TOR

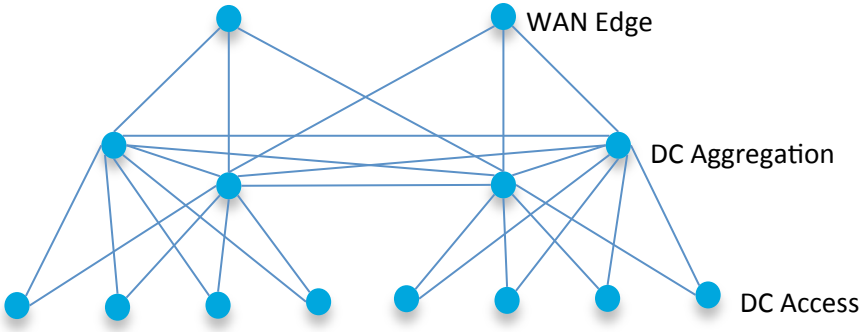
Multi-Tenant Data Center Design 101

- 1 Layer
  - full mesh, distinct WAN edge
- 2 layers
  - WAN edge and DC aggregation combined
- 3 layers hierarchical
  - WAN edge and DC aggregation separate
- 3 layers + folded clos
  - Meshed aggregation









Assumptions about State of the Network Missing

Meshed Symmetric Topologies

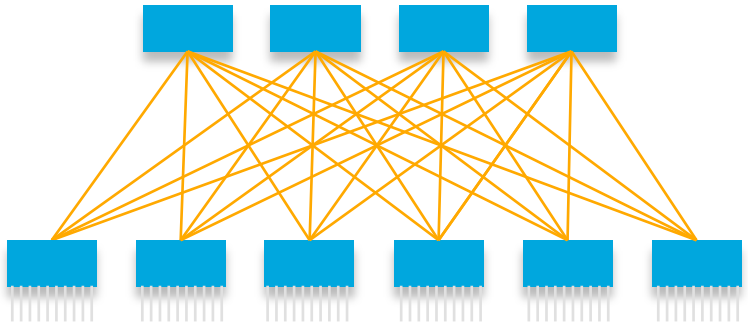
Unconstrained Bandwidth

Simplified Abstraction Models

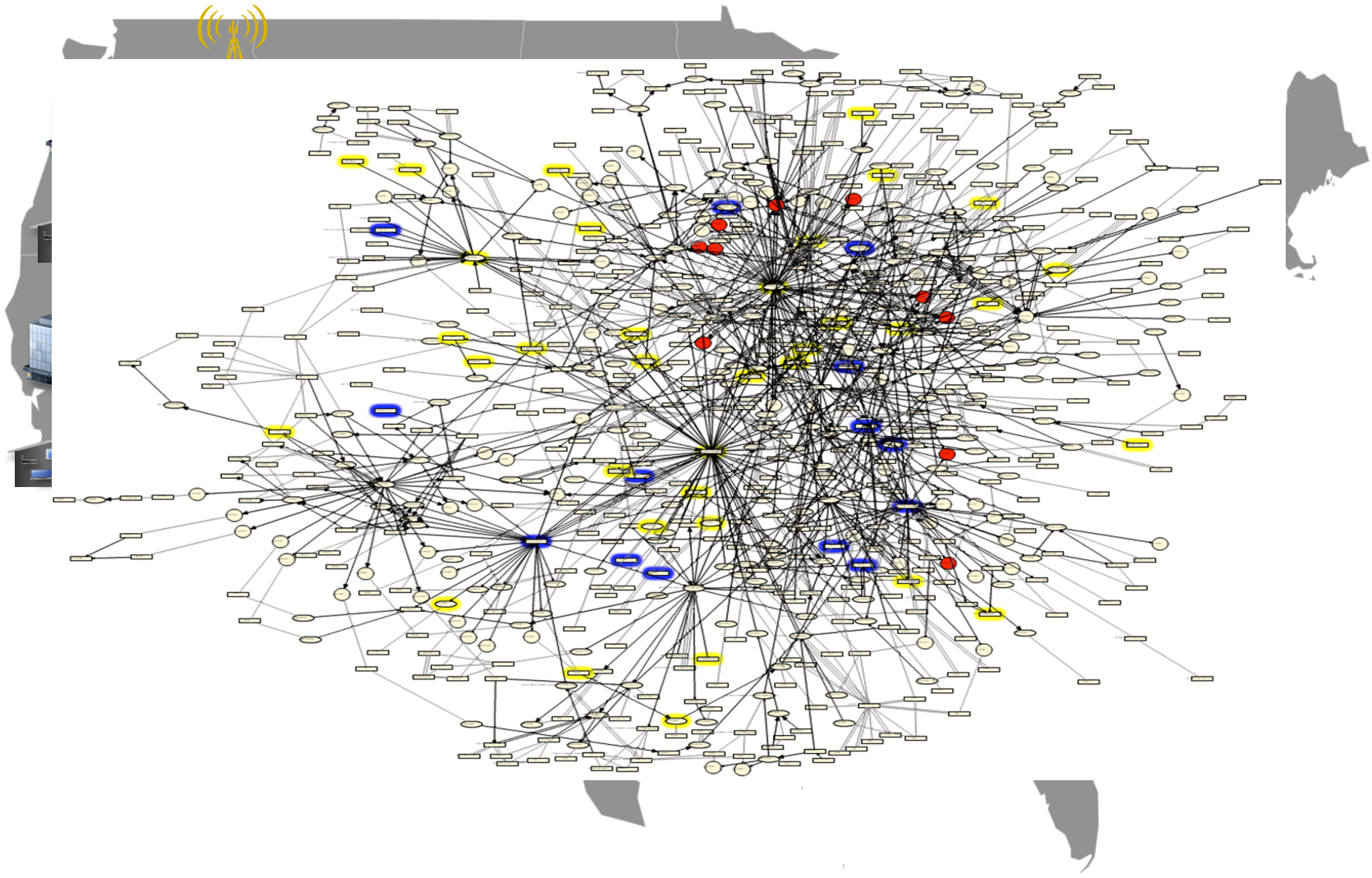
Workload Mobility Distributed Across L3 WAN

Integrated Service Virtualization

Secure Containers

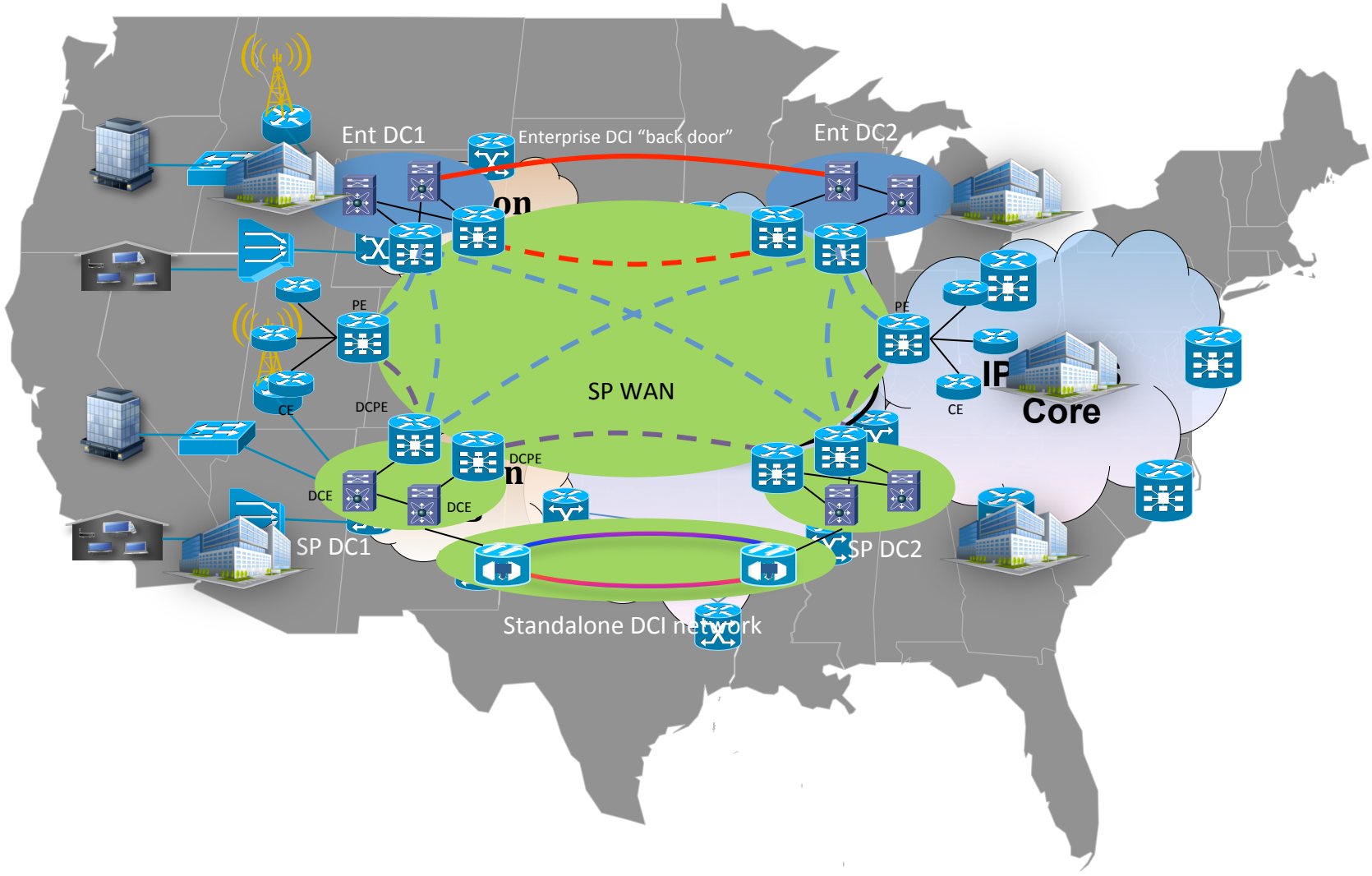


Service Provider WANs
Hierarchical Multi-Domain Topologies



Multi-tenant Cloud Interconnect

Just One WAN = At Service of Many



What does this mean for the IETF

- There is a desire for real-time, full duplex state transfer with the network and nodes
  - Enable an augmentation of the deployed internet's services
- Many of the critical features of networking nodes not standardized
- Required interfaces diminishing (e.g. SNMP configuration), not fully featured or nascent (netmod)
- Programmatic interfaces are the bridge between Ops, Apps, RT-Apps, Routing, Internet, Sec and Transport
- Architecture work will be required
- Given industry trends and desires, new WGs must be formed and older silos, processes, requirements modified