Bringing it all together:
Multi-layer software-defined networks and automated operations intelligence

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Understanding the SDN value equation

SDN is now accepted by network operators as key to:
- Opex and capex constraint
- New service & revenue creation

The pain point doublet

How does SDN deliver these impacts?
- **Centralized control systems**: enable “autonomic operations intelligence” in software to attack opex, capex and revenue
- **Open architecture control systems**: allow customer business differentiation through customization and innovation of functions
The control layer and autonomic operations intelligence

Control Layer:
- Global control of network state ("supply")
- Global view of service demands ("demand")

Global Demand Synthesis

Real-Time Analytics

Supply & demand matching
- Revenue, capex

Automation
- Opex
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Operator differentiation through “Lego block” openness

Business Application Layer

Control Layer

Ciena Software

Other Software

Open Source

Infrastructure Layer

Operator 1

Operator 2

Operator 3
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Centralized control allows & drives “simplification” of the controlled networks:

→ Standardized control – “programming” – interfaces (e.g., OpenFlow)
→ Removal of “point” service functions from network equipment to servers (NFV)
→ Layer convergence - in network equipment, and in control plane/controllers
Multi-layer: the “inverted pyramid” of network layer economics

Yesterday: plan optical network given static routed packet traffic map

Today: re-configure transport network to adapt to evolving traffic map

Future: automate transport network adaptation to dynamic service loads

SDN: more centralized control, autonomous operations intelligence

Add flexibility  Improve granularity

→ Maximize inverted pyramid economics in dynamic service environments
One flexible way to make it work – “cascaded virtualization”

V = Virtualized resource view/control
P = “Physical” resource view/control

Logically-converged packet-optical transport network controller
E.g., multi-layer optimization “app”

Physically-converged packet-optical transport network
Showing it in action: Ciena’s OPₙ test-bed

Ciena
Internet2
CANARIE
Starlight

Multi-layer optimization
Dynamic pricing

Ottawa
Chicago
Baltimore
Evolving carrier networks with SDN: Expanding revenues, constraining costs