Next Generation Optical Transport Networks, 100G and beyond

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Powerful market forces are teaching new lessons

The majority of traffic is now packet

Significant proliferation of mobile broadband

Workforce mobility & increased connectivity

Enterprise IT is shifting to the cloud

Video, video and more video

Real-time, low latency applications

First we Connected Places, Then People, Then Things
Ciena’s Earliest Public 100G Milestones

- **2008**
  - SC08 - Supercomputing
    - Nortel 100G in SCinet
    - Carried live traffic for the duration of the event
  - COMCAST
    - Carrying live Internet for IETF
    - Philadelphia - Washington
    - 335km, 4x 50GHz ROADM
    - 100G error-free 7 days
    - Foreign 40G live video traffic

- **2009**
  - NEOS Networks
    - Manchester – London
    - 705km, no regens
    - 10G/40G/100G over existing network
  - VERIZON
    - 890km, >30 x 10G λ
    - LIVE DEPLOYMENT!
  - JANET/Verizon Business
    - London, Reading 103km
    - 25ps mean DGD added
    - 10G/40G/100G over existing network
  - BANVERKET
    - Sundsvall - Stockholm
    - 810km, no regens
    - 10G/40G/100G over existing network
  - OFC/NFOEC
    - 10x10GE over 100G λ
    - 800km, 4 x 50GHz ROADM
    - Colorless OADM with coherent receiver
  - SURFNET
    - Amsterdam, Hamburg
    - 1244km, no regens
    - 10G/40G/100G over existing network

- **2010**
  - COMCAST
    - Carrying live Internet for IETF
    - Philadelphia - Washington
    - 335km, 4x 50GHz ROADM
    - 100G error-free 7 days
    - Foreign 40G live video traffic
  - VERIZON
    - 100G over fibre that could not carry 10G, 73km
    - Passed 107ps DGD PMD
  - BANVERKET
    - Sundsvall - Stockholm
    - 810km, no regens
    - 10G/40G/100G over existing network
  - OFC/NFOEC
    - 10x10GE over 100G λ
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- **100G Demo over Challenging Conditions**
- **100G over same challenges carrying live traffic**
- **100G over worst span in network**
- **100GE over 112Gbps λ**
- **10 x 10GE over 112Gbps λ**
- **Record Distance**
- **100G requiring No Network Re-Engineering**
Ciena Coherent 40/100G Deployments

Shipping since 2008
74 customers (and counting)
Verizon’s 100G Deployments

New York to Chicago

North American first 100G/100GbE over 1500 km of mixed and high PMD fiber

Terrestrial Demo Content & Applications – 100G

100G Connectivity from Ciena Ottawa to Starlight Gigapop in Chicago.

Ability to show simultaneous data-flows sourced from major collaborators.
Using 100G Network Technology in Support of Petascale Science
A Collaborative Initiative Among NASA, NLR, Northwestern/ICAIR, SCinet & UIC/NCDM

StarLight@Chicago

GSFC@Greenbelt

SC10@New Orleans

J. P. Gary 5/27/10
Route Plan for Terena demo May 16

Prove 40G over foreign waves CERN to Stockholm
Where are we today?

- Spectral Efficiency is limited by nonlinearities.
- A spectral efficiency of 8 bit/s/Hz is practicable at ~1000 km.
  - Requires compensation for nonlinearities.
  - Maximum C-band capacity ~29 Tbit/s (good for the next ~10 years).
- Ciena has successfully completed 200G, 400G, and 1Tbps lab demonstrations.
Three Dimensions of Capacity Evolution

- Symbol rate
- Constellational multiplicity
- Subcarrier multiplicity

Exploit all 3Ds in order to Optimize Spectral Efficiency, Performance, Cost & Reliability
Coherent receivers deployed today

> 7,000

Building the new global information infrastructure