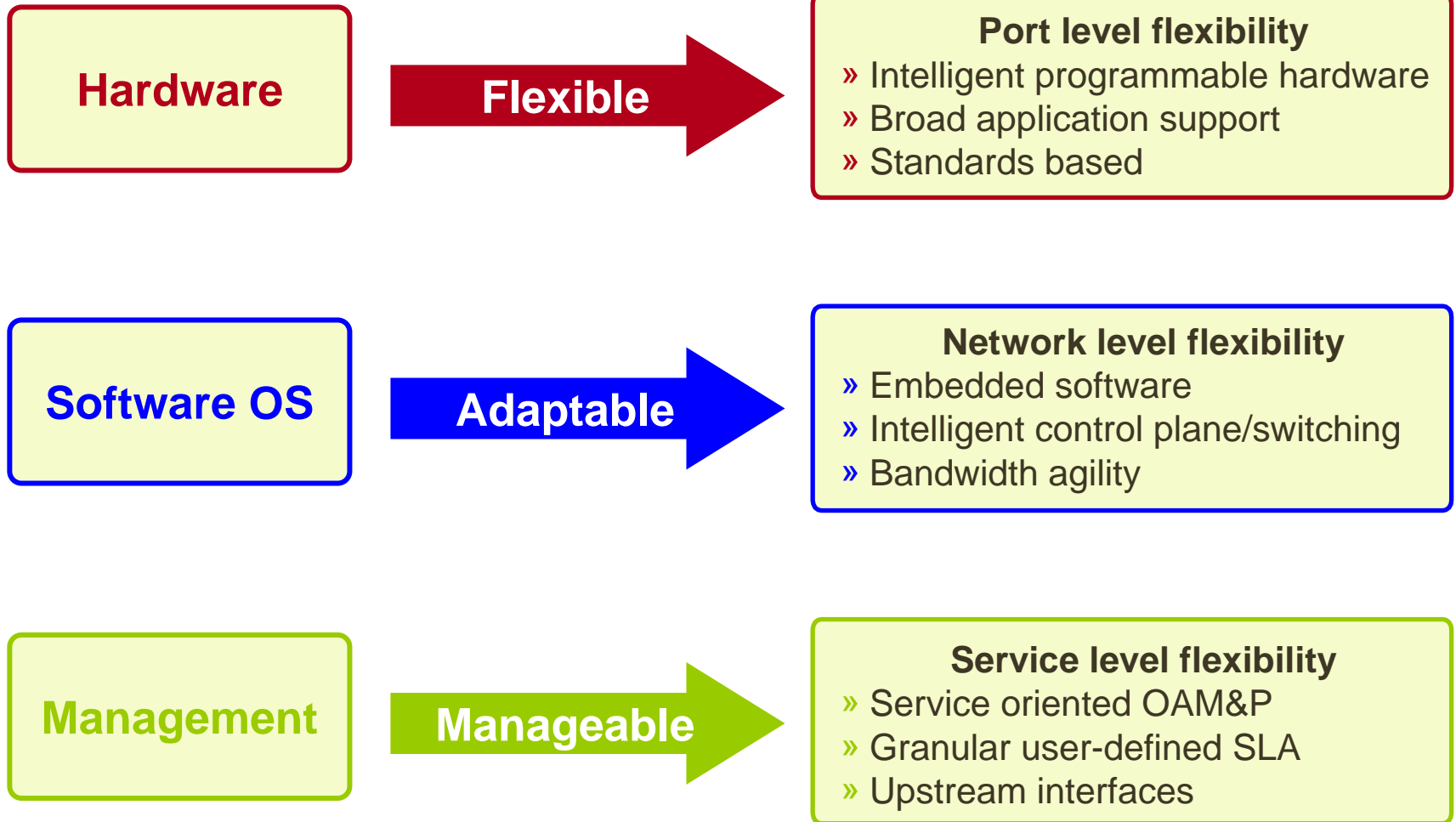# Advanced Optical Technologies Enabling Data Intensive iGRID Applications

Joe Berthold
Office of the CTO

Platform for High Performance Applications Needs
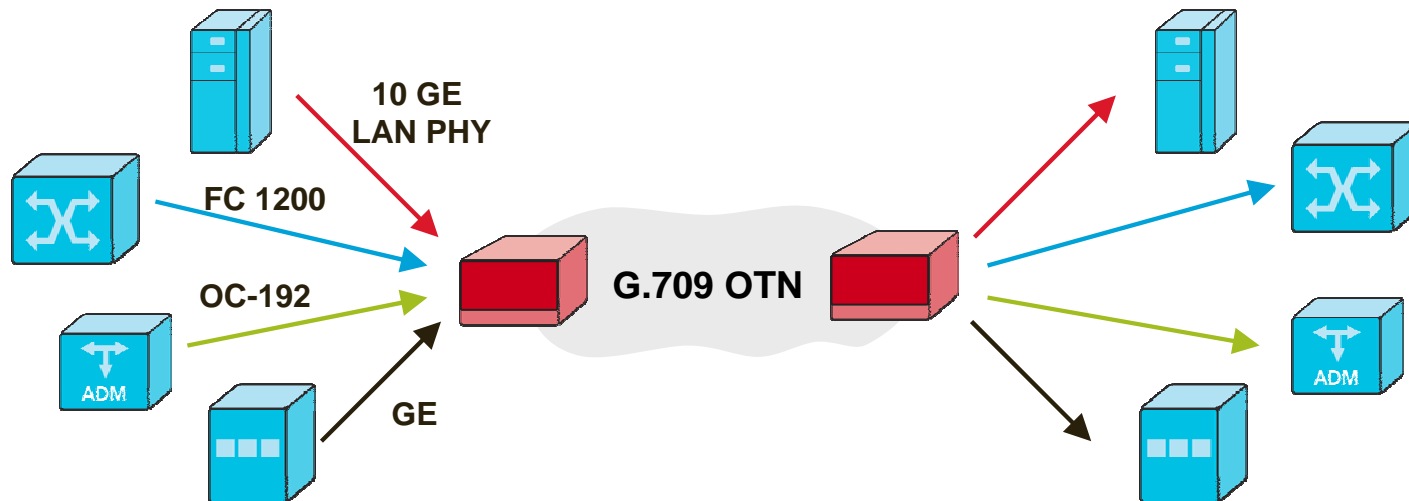
Hardware → **Flexible** →

Port level flexibility
» Intelligent programmable hardware
» Broad application support
» Standards based

Software OS → **Adaptable** →

Network level flexibility
» Embedded software
» Intelligent control plane/switching
» Bandwidth agility

Management → **Manageable** →

Service level flexibility
» Service oriented OAM&P
» Granular user-defined SLA
» Upstream interfaces

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Hardware – Port Level Flexibility
Using G.709/Digital Wrapper

The Challenge

» **Client Transport Protocol Uncertainty**

» **Fiber Channel Monday, Ethernet Tuesday?**

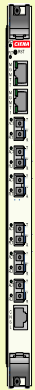» **Strong OAM (alarm, diagnostics, test, etc)**

The Solution

» **Complete network and service transparency**

» **All service management is passed through**

» **Complete end to end management capability**

10 GE LAN PHY

FC 1200

OC-192

GE

G.709 OTN

OTN Solutions Resolve Optical Interoperability Issues

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Hardware – Port Level Flexibility

Programmable Transport Line Module

STM-1 / OC-3
STM-4 / OC-12
STM-16 / OC-48
Fiber Channel
Gigabit Ethernet
Fast Ethernet
ESCON
Video

Any Service
Any Speed
Any Port
Any Time

Network or Client

» Broader application support

» Efficient use of wavelengths

» Faster network reconfiguration

» Less planning and engineering

» Fewer spares

» Download upgrades for future services

» Lower costs

More Flexible Support for iGRID Applications

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Automated Connection Provisioning

Connection Confirmed

Click Source

Click Destination
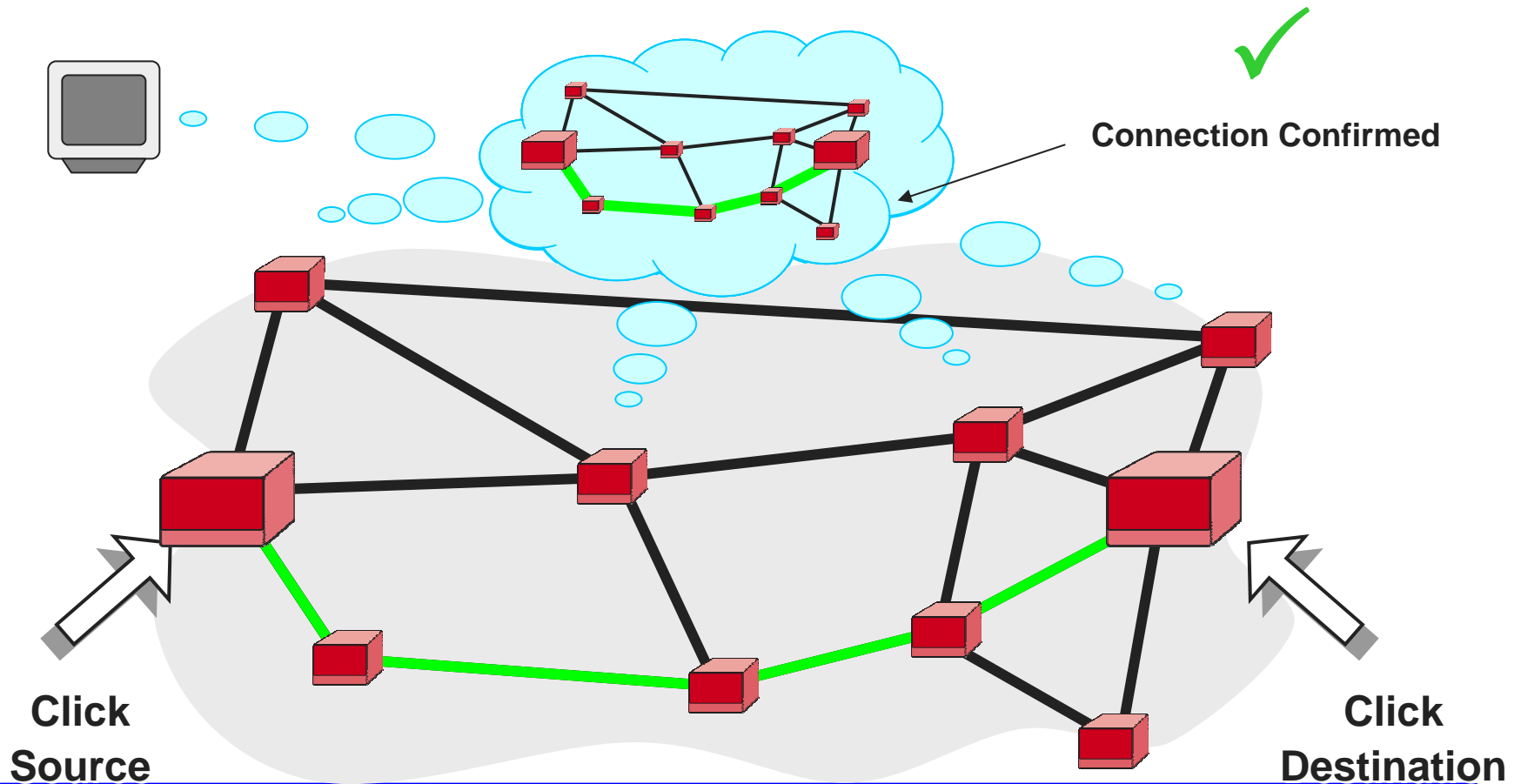
Discovery   **Routing**   **Signaling**

ITU-T G.ASON, IETF GMPLS, OIF O-UNI & NNI

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Department of Energy UltraScience Net

Transparent Photonic Domain

Dynamic Control Domain

Seattle
Sunnyvale
Chicago
Indianapolis
Louisville
Oakridge
Nashville
Chattanooga
Atlanta

CoreDirector CI

CoreStream Terminal

CoreStream ROADM

Reconfigurable Photonic links
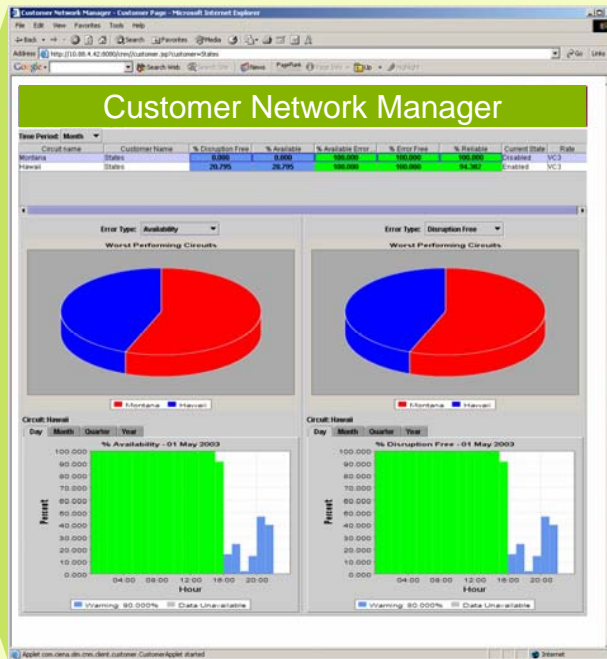
Static optical links - NLR

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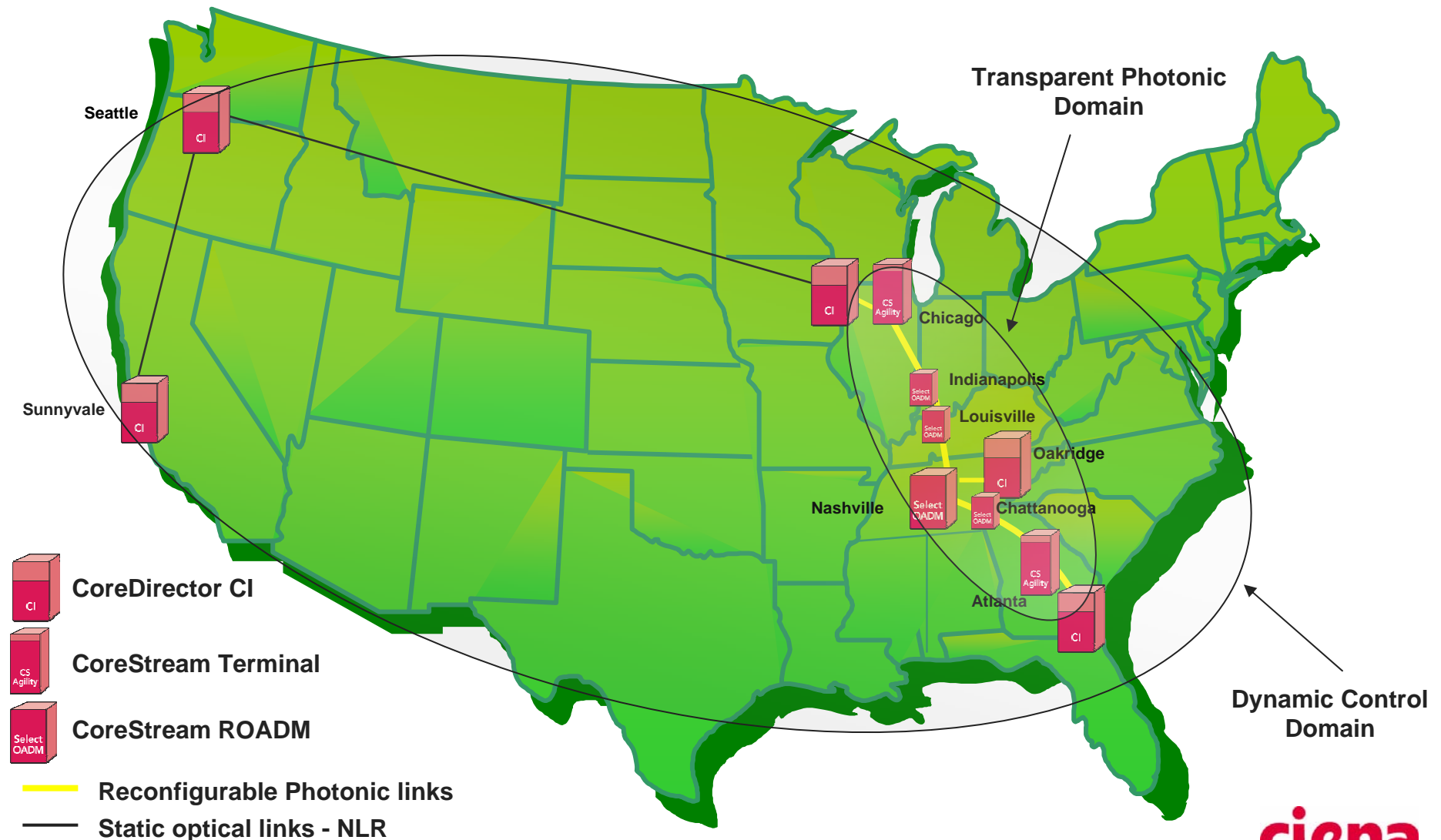
Management – Service Level Visibility
Supporting and debugging applications quickly and automatically!

Service Management

» Provide the application user:

  » End-end service visibility in a dynamic network environment

  » Performance statistics

  » Network state history

» Management integrated with hardware and software intelligence

» Dynamic fault isolation

» Failure identification & associated resource reconfiguration

» Service protection knowledge

» Proactive network planning

» Resource utilization tracking

Automatic Association of Network Events with Customer Service

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What's Coming?
Few Examples in a 3-5 Year Horizon

» Faster application interfaces to optical networks

  » N X 10G channel bonding

  » 100 GE channel technology

» Photonic Switching advances

  » Beyond ROADMs to Wavelength Selective Switches

  » Low cost switching via wavelength tuning

» Automated control of photonic networks

  » Accurate knowledge of maximal photonic reach in real network

  » G.ASON/GMPLS for the agile _photonic_ layer

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Thank You

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