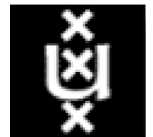# The Lambda Grid

www.science.uva.nl/~deλaat

Cees de Λaat

SURFnet
EU

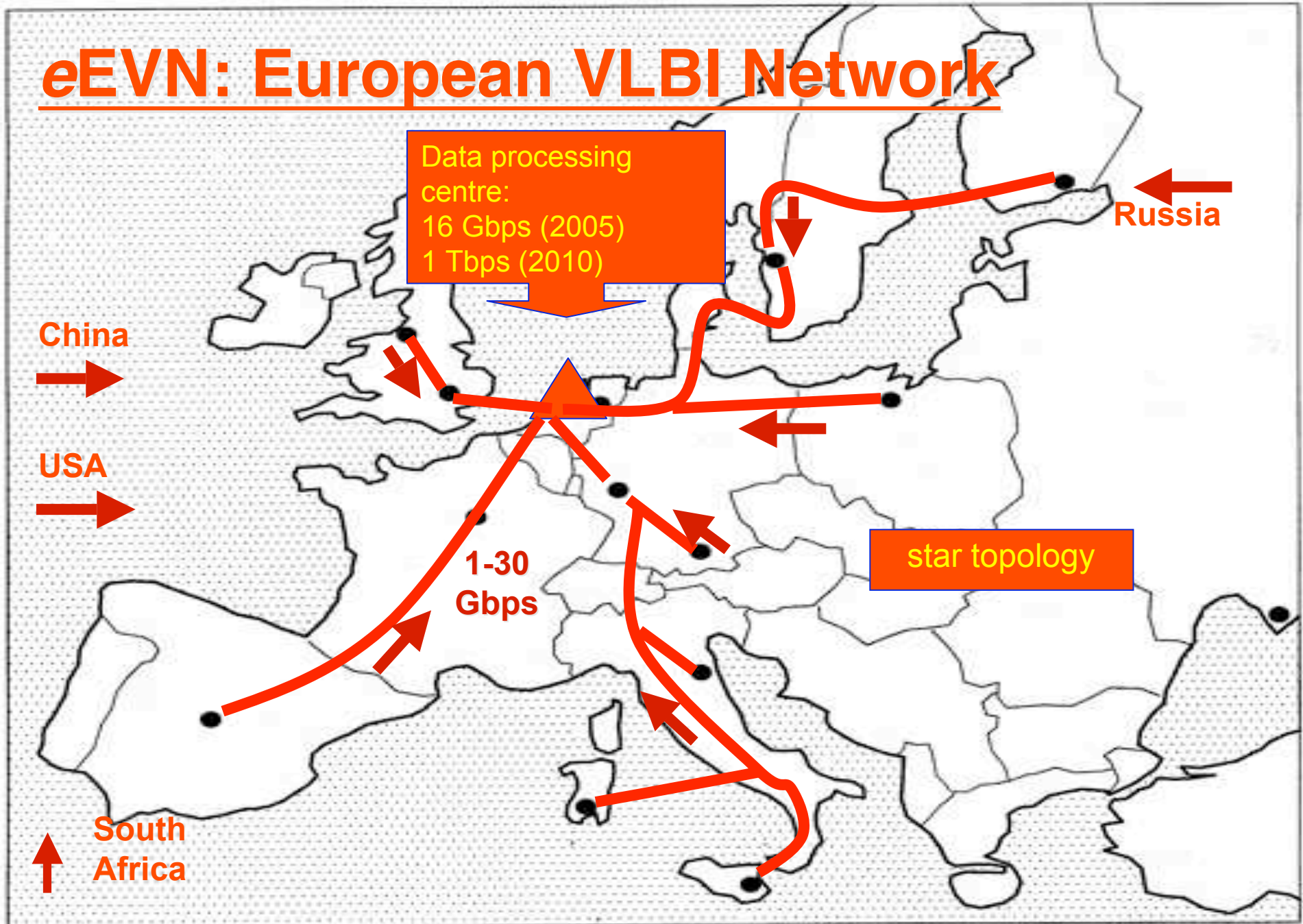## University of Amsterdam

SARA
NIKHEF
NCF

VLBI at JIVE in Dwingeloo today

*e*EVN: European VLBI Network

Data processing centre:
16 Gbps (2005)
1 Tbps (2010)

China

USA

Russia

1-30 Gbps

star topology

South Africa

Lambdas as part of instruments

GigaPort

LOFAR

www.lofar.org

20 Tbit/s
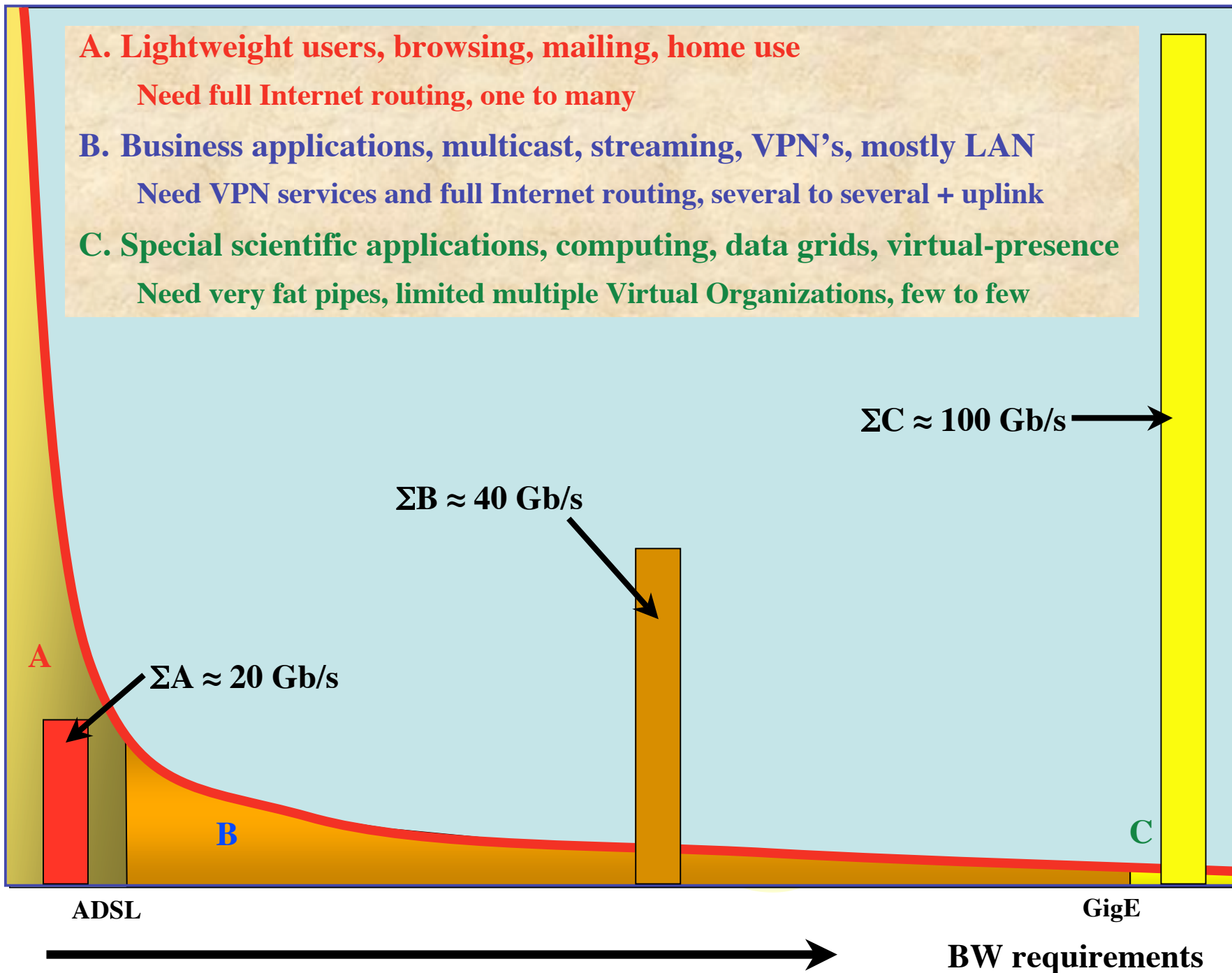
SURFnet

The Dutch Situation

- **Estimate A**
  - 17 M people, 6.4 M households, 25 % penetration of 0.5 Mb/s ADSL, 40 times under-provisioning ==> 20 Gb/s

- **Estimate B**
  - SURFnet has 10 Gb/s to about 12 institutes and 0.1 to 1 Gb/s to 180 customers, estimate same for industry (overestimation) ==> 20-40 Gb/s
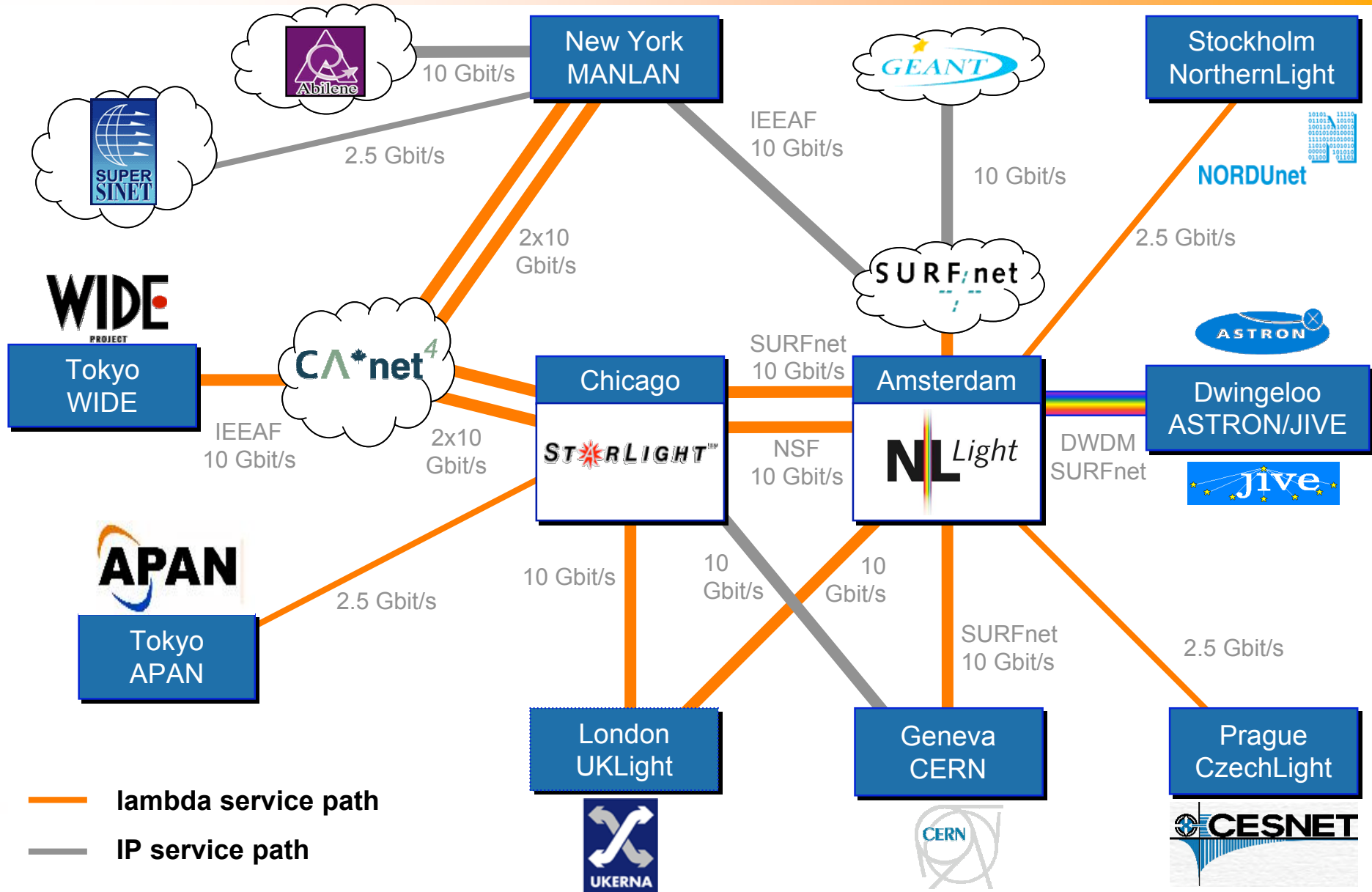
- **Estimate C**
  - Leading HEF and ASTRO + rest ==> 80-120 Gb/s
  - LOFAR ==> 20 TBit/s

GigaPort

- **Optical Internet exchange point in Amsterdam**

- **Built and operated by SURFnet**

- **Experiments with light path provisioning in a multi domain environment**

- **http://www.netherlight.net/**

SURFnet

International light path network 1Q2004

GigaPort

- **Realization of a next generation hybrid network with seamless end-to-end communication:**
  - Based on dark fiber
  - Native IPv4, IPv6 and Lambda Services over a single transmission infrastructure managed via a single control plane
  - Multi-domain networking
  - Ethernet services as part of the WANs (IP over GE over lambda)
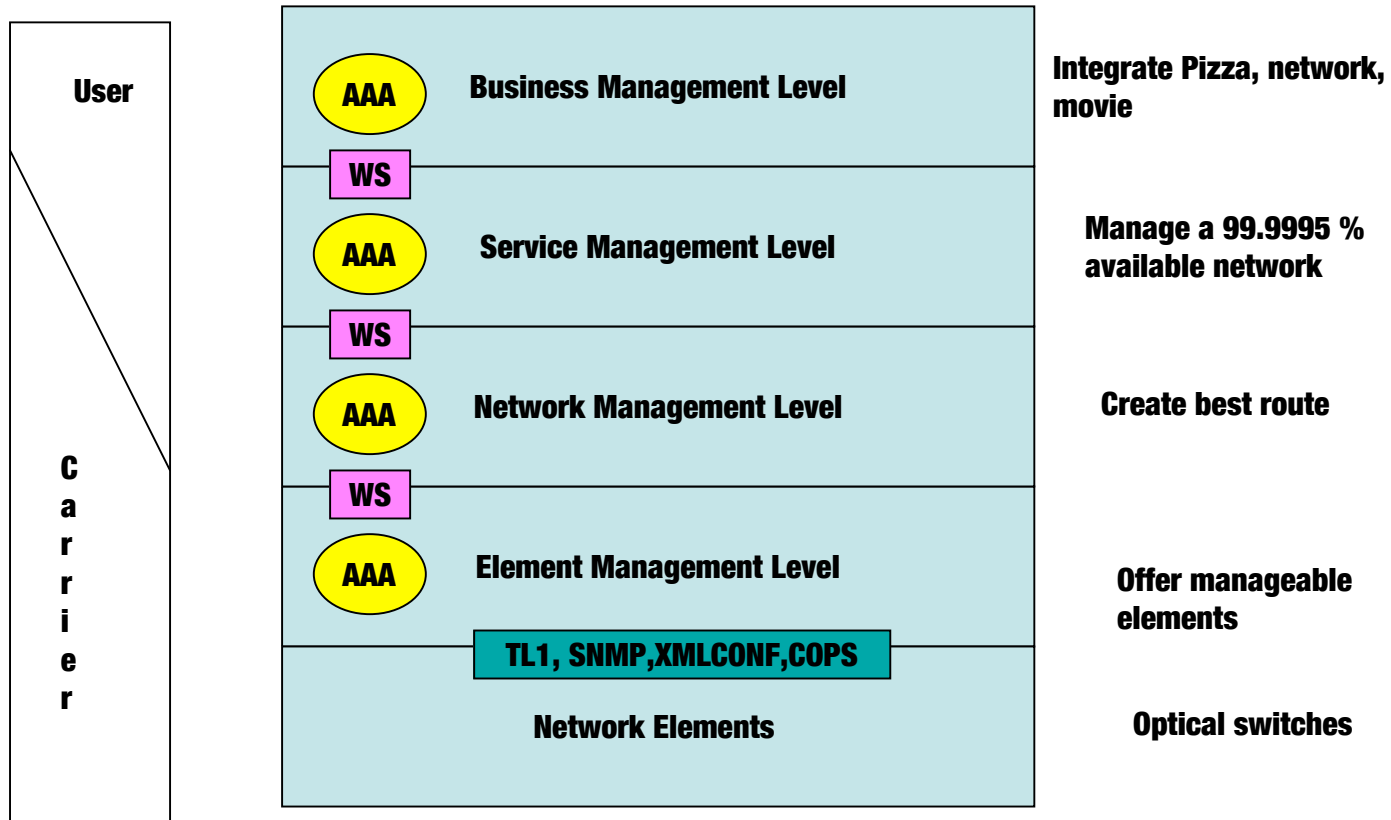 - Intelligence of networks and the associated responsibilities at the edges

- **Paving the way to a ubiquitous and scalable Services Grid**

SURF/net

The Lambda Grid software

AAA and ISO Telecommunications Management Networks (TMN) reference model

User	
Carrier	

AAA Business Management Level — Integrate Pizza, network, movie

WS

AAA Service Management Level — Manage a 99.9995 % available network

WS

AAA Network Management Level — Create best route

WS

AAA Element Management Level — Offer manageable elements

TL1, SNMP,XMLCONF,COPS

Network Elements — Optical switches

TMN is based on the OSI management framework and uses an object–oriented approach, with managed information in network resources modeled as attributes in managed objects. TMN is defined in ITU–T M.3000 series recommendations
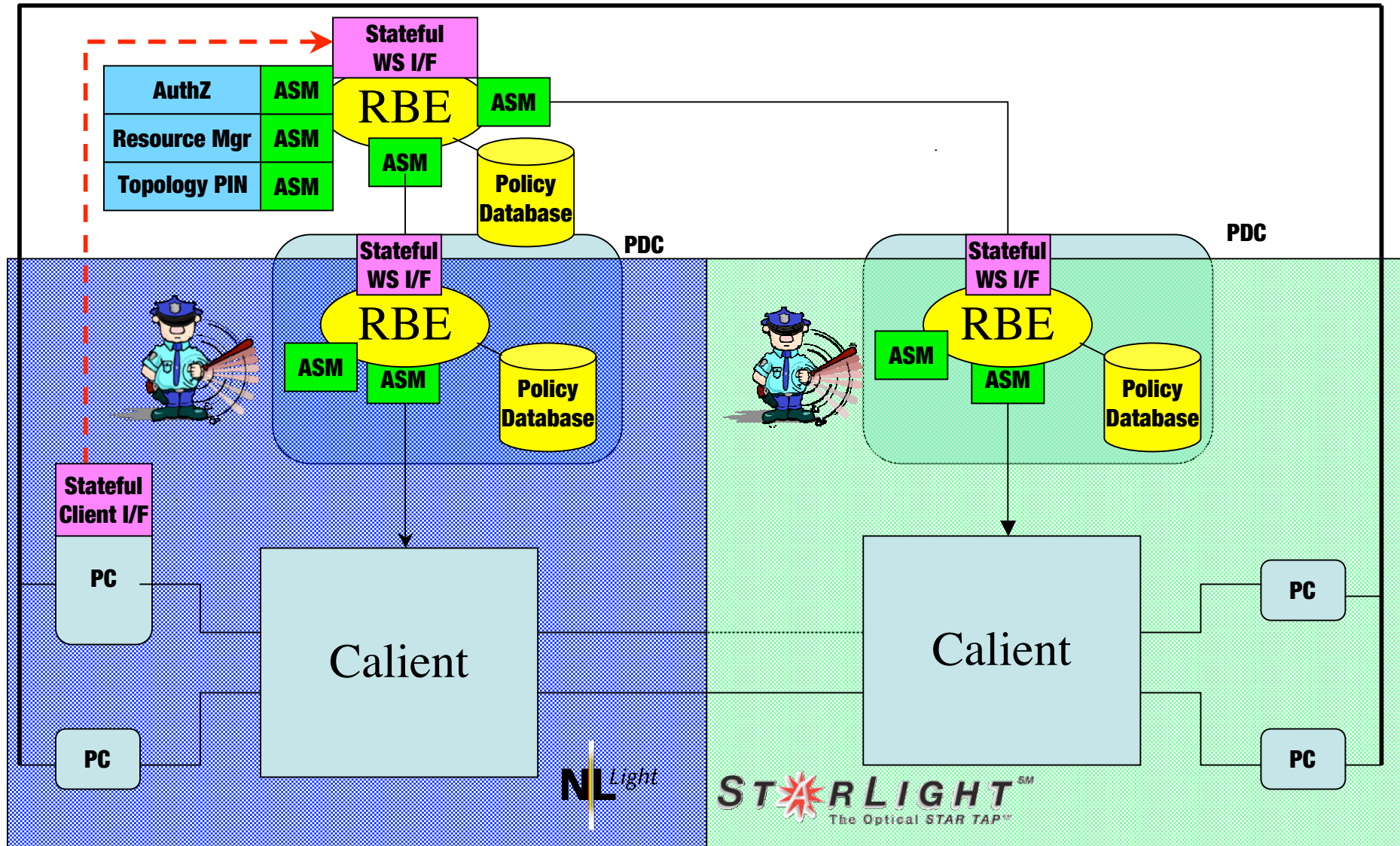
PIN Architecture
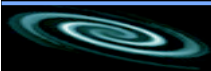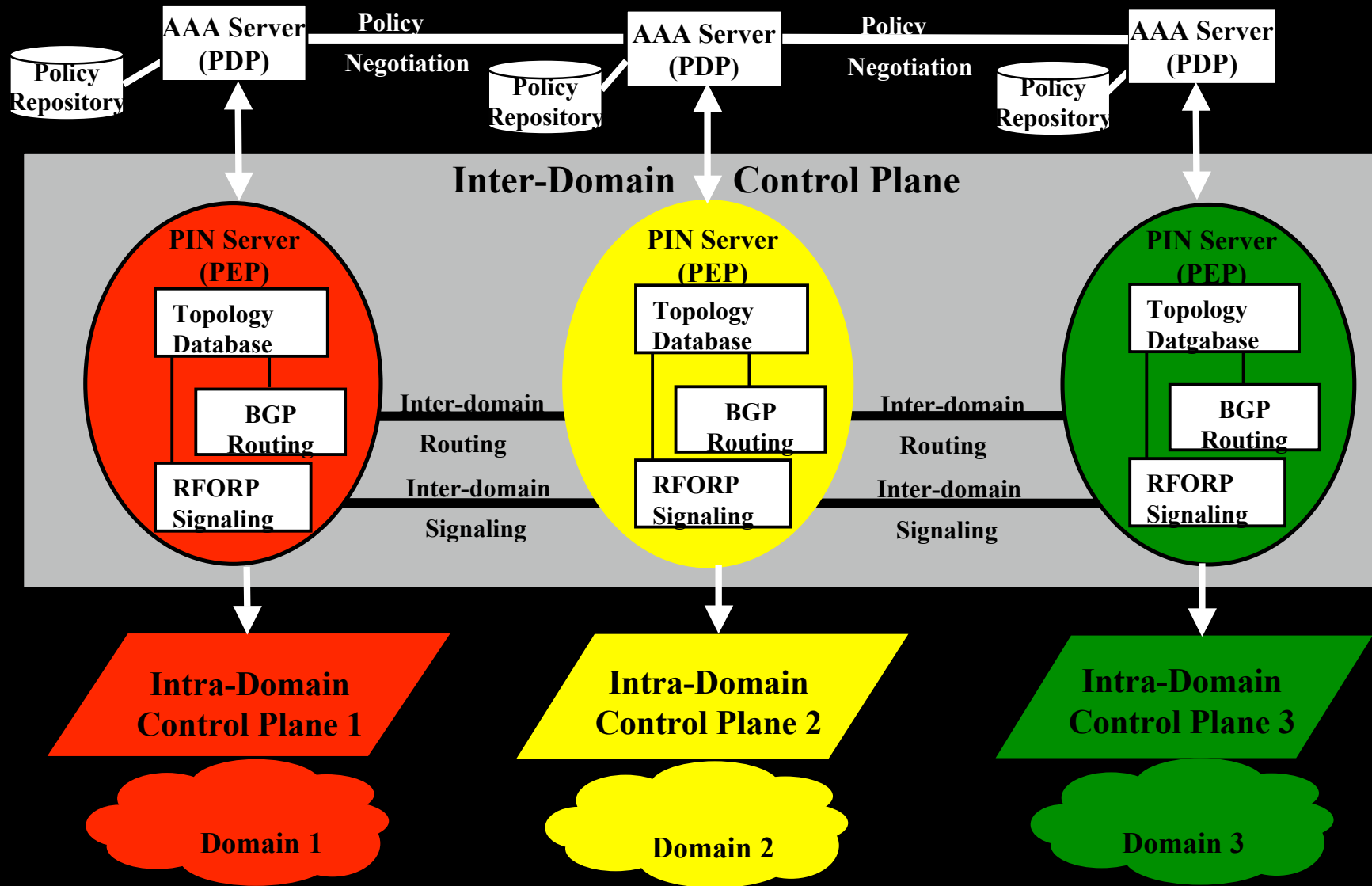
DARPA DWDM-RAM Large Scale Data+Dynamic Lambdas – Demonstrated at GGF9 & SC2003

HP-PPFS

Data Intensive App2

Data Intensive App3

Data Intensive App4

Grid Data Management Services

Data Web Services

Data Grid Services

Grid L3-L7 OGSA Compliant

Dynamic Path Services (ODIN, THOR, etc),OGSA Compliant, Soon WSRF

Dynamic vLANs

Dynamic Lightpaths

Physical Processing Monitoring and Adjustment

New Control Plane And Management Plane Processes

Optical Layer Control Plane

Client Controller

Client Layer Control Plane

Optical Layer Control Plane

UNI

Controller

Controller

Controller

I-UNI

Controller

Controller

CI

CI

CI

Client Device

Client Layer Traffic Plane

Optical Layer – Switched Traffic Plane
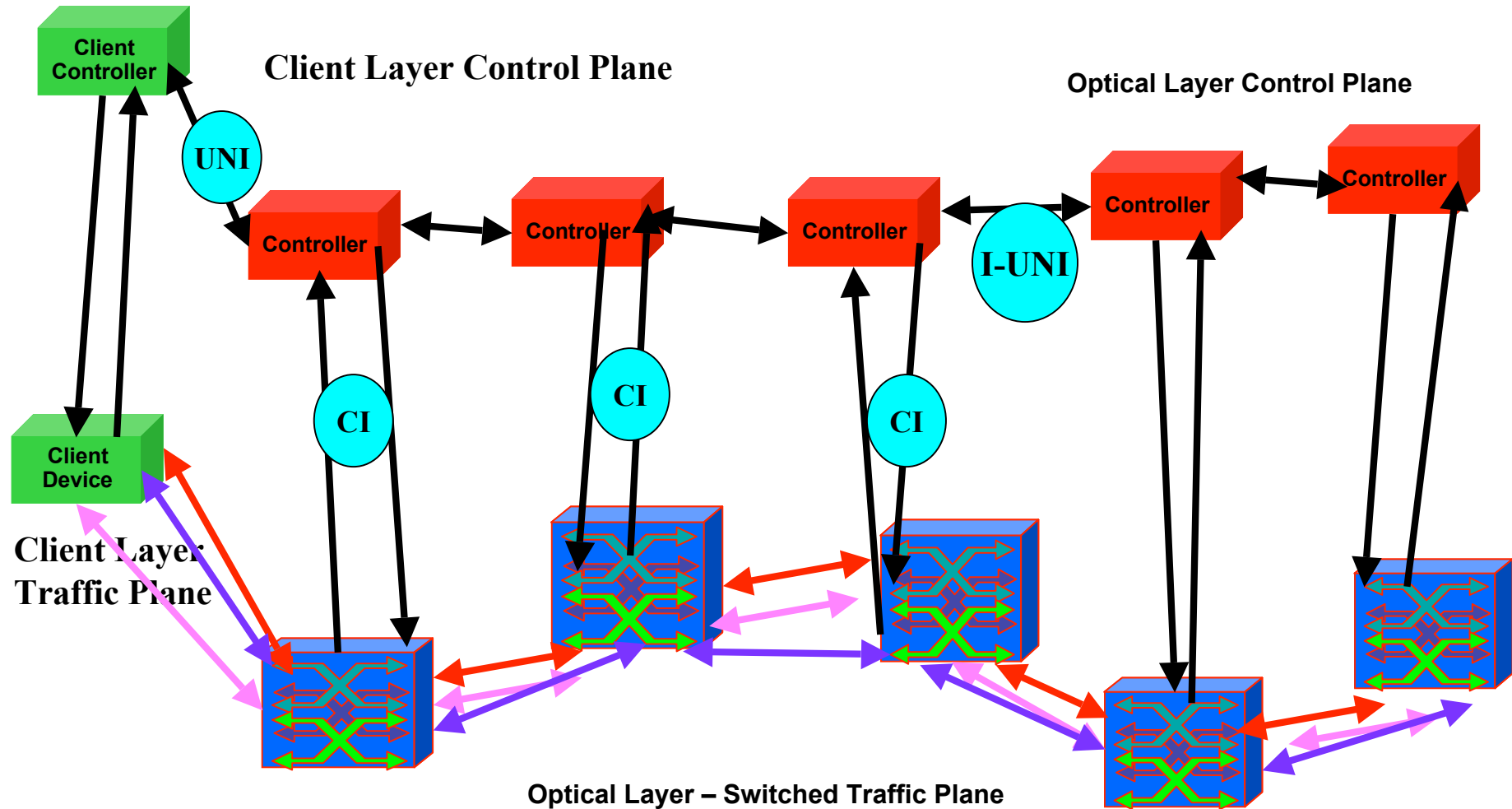
+ Optical Dynamic Intelligent Network (ODIN) for Dynamic Provisioning

CA*net 4 Architecture

This AS is connected via 2 switches to AS6509

AS15296

AS803

Edmonton

Saskatoon

AS10965

AS376 Montreal

St. John's

AS271

AS818 AS10786

AS7860

AS10972

Vancouver

Winnipeg

Victoria

Regina

AS549

Ottawa

AS8111

Calgary

Toronto

AS611

Seattle

Fredericton

Halifax

Chicago

New York

AS101

AS683

AS145

AS8933

AS513

AS7170

AS293

UCLP general operation

Subtended Lightpaths to User

DWDM Westbound

DWDM Eastbound

OXC

Standard CLI or TL1 interface

Customer A and
sub- partition

MonFox TL1 Proxy

Grooming agents

Customer A
UCLP Server

Customer A signaling plane

Customer B signaling plane

Customer B

Customer C signaling plane

Customer C

Signal Control Plane Agents

Switch Agents

CA*net 4 UCLP

CANARIE
NETWORKS > COLLABORATION > RESULTS > RÉSEAUX > COLLABORATION > RÉSULTATS

High-Level Architecture
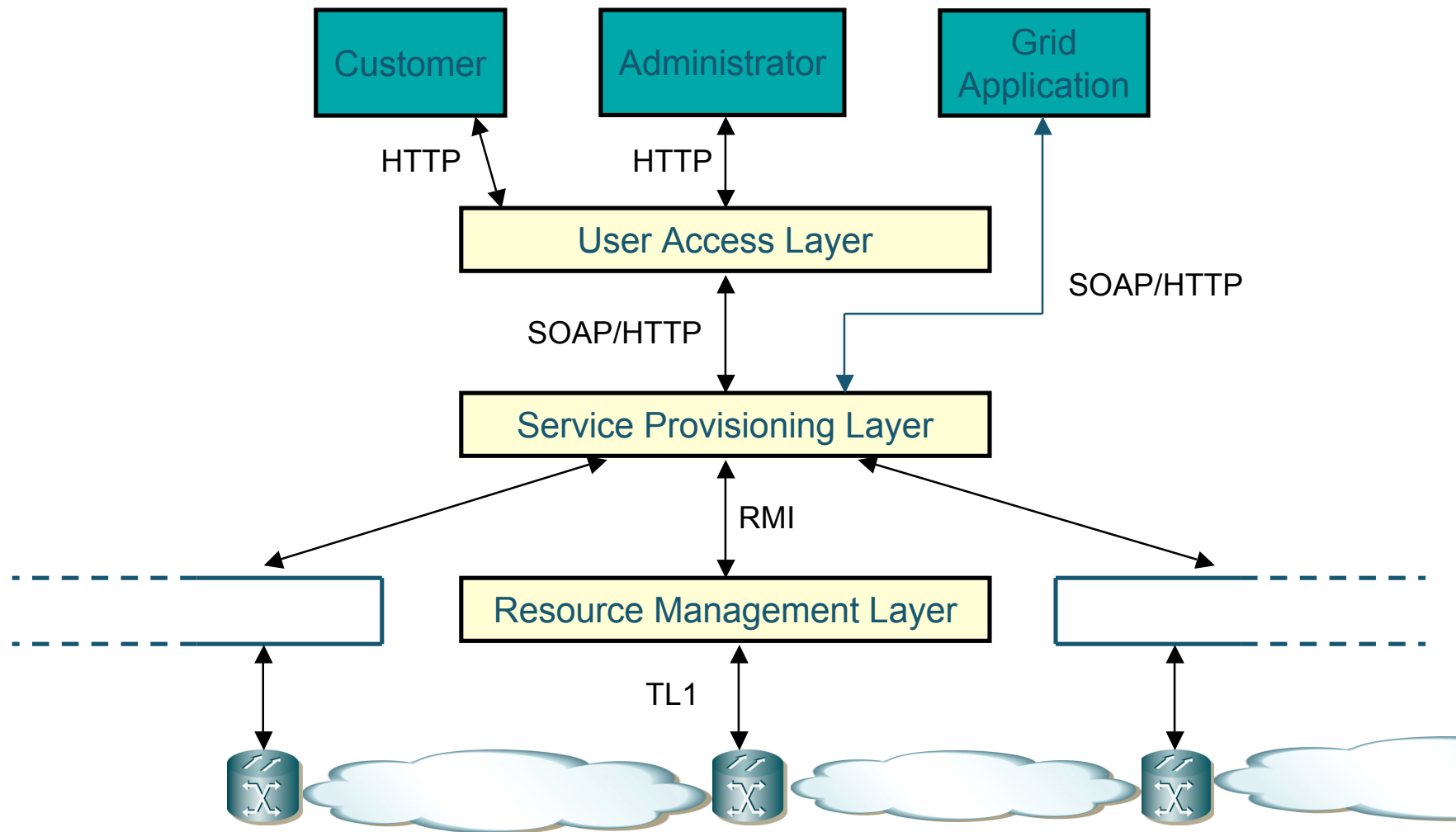
Example – Server to server

AS 6509

AS10786

AS8111

Local Border Router

ons-ott01   1/15/1   ons-mon01   ons-fre01   4/15/1   ons-hal01

GbE/14/2

GbE/14/1   1/14/1   20/15/1   4/14/1   GbE/4/2

20/14/1   Destination

WS/SOAP   8/16/1   8/17/1

2   **3**

LPO I/F   LPO I/F   LPO I/F   LPO I/F

LPOS Factory   LPOS Factory   LPOS Factory   LPOS Factory

Lightpath Creation Agent

7

LPO I/F
LPO I/F
LPO I/F
LPO I/F
LPO I/F
LPO I/F
LPO I/F
LPO I/F
LPO I/F

AS 6509 factories

4

6

LPOS Server

Factory resolver

AAA

5

AS6509 LPOS

LightPath Object Registry

Channel/slot/port/

Advertises LPO service between AS10786 and AS8111

Coordination with Optiputer, OBS and others
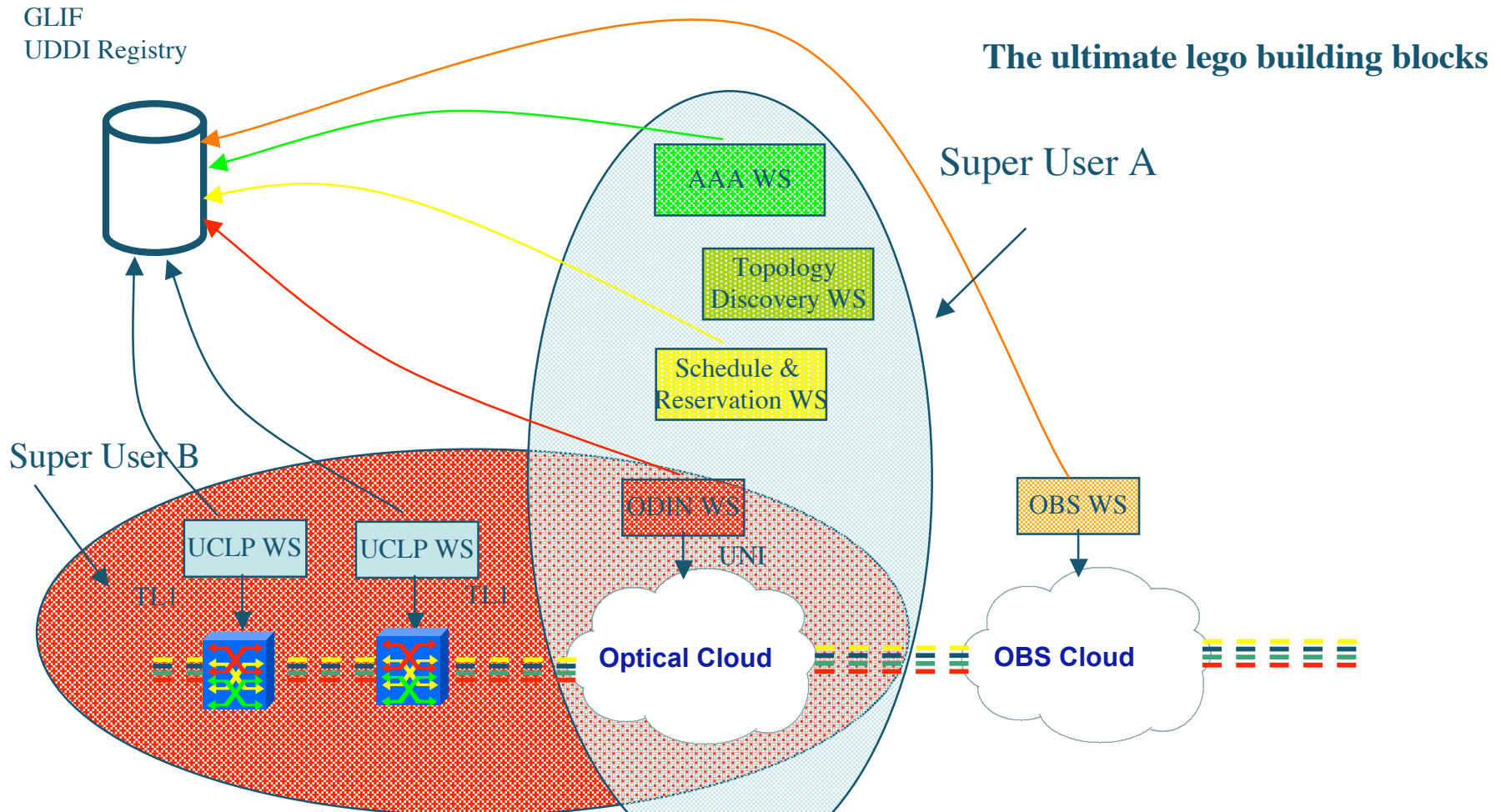
GLIF
UDDI Registry

The ultimate lego building blocks

AAA WS

Super User A

Topology Discovery WS

Schedule & Reservation WS

Super User B

UCLP WS   UCLP WS

TL1   TL1

ODIN WS

UNI

OBS WS

Optical Cloud

OBS Cloud

CANARIE

NETWORKS > COLLABORATION > RESULTS > RÉSEAUX > COLLABORATION > RÉSULTATS

The END

RESERVED

Case
Delaat

9/10/2003

9:00 AM - 3:00 PM
Wednesday

NWO/NCF

Partially complete list:
Caas
Chase
Cess
Kess
Case

SURF;net