Impact of Grid Computing on Network Operators and HW Vendors

Hot Interconnect @ Stanford

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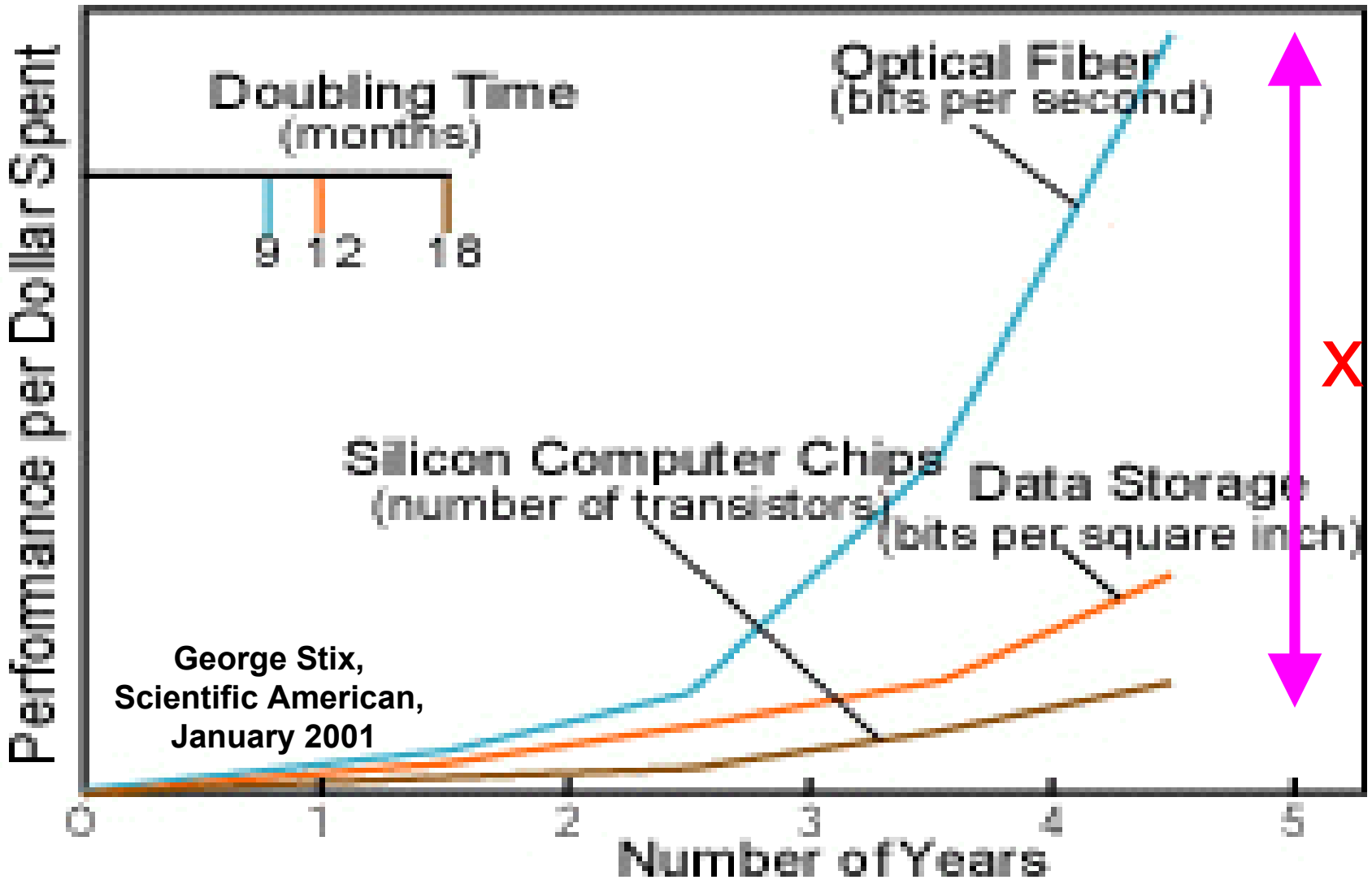
Optical Networks Change the Current Pyramid



DWDM- fundamental miss-balance between computation and communication

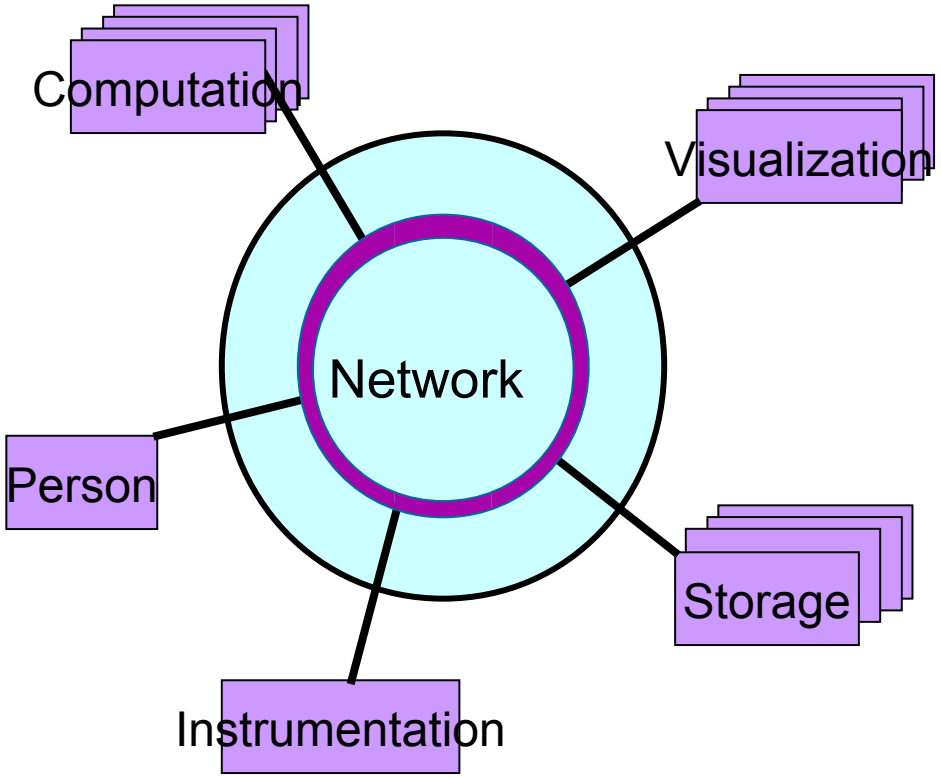
5 Years – x10 gap, 10 years- x100 gap

Waste Bandwidth

"A global economy designed to waste transistors, power, and silicon area -and conserve bandwidth above all- is breaking apart and reorganizing itself to waste bandwidth and conserve power, silicon area, and transistors."

George Gilder Telecosm

The "Network" is a Prime Resource for Large- Scale Distributed System



Integrated SW System Provide the "Glue"

Dynamic optical network as a fundamental Grid service in data-intensive Grid application, to be scheduled, to be managed and coordinated to support collaborative operations

From Super-computer to Super-network

> In the past, computer processors were the fastest part
  - peripheral bottlenecks

> In the future optical networks will be the fastest part
  - Computer, processor, storage, visualization, and instrumentation - slower "peripherals"

> eScience Cyber-infrastructure focuses on computation, storage, data, analysis, Work Flow.
  - The network is vital for better eScience

Grid Network Limitations in L3

- **Radical mismatch between the optical transmission world and the electrical forwarding/routing world.**
  - **Currently, a single strand of optical fiber can transmit more bandwidth than the entire Internet core.**
- **Transmit 1.5TB over 1.5KB packet size**
  - ✂→**1 Billion identical lookups**
- **Mismatch between L3 core capabilities and disk cost**
  - **With $2M disks (6PB) can fill the entire core internet for a year**
- L3 networks can't handle these amounts effectively, predictably, in a short time window
  - L3 network provides full connectivity -- major bottleneck
  - **Apps optimized to conserve bandwidth and waste storage**
  - Network does not fit the "e-Science Workflow" architecture

Prevents true Grid Virtual Organization (VO) research collaborations

Lambda Grid Service

Need for Lambda Grid Service architecture that interacts with Cyber-infrastructure, and overcome data limitations efficiently & effectively by:

- treating the "network" as a primary resource just like "storage" and "computation"
- treat the "network" as a "scheduled resource"
- rely upon a massive, dynamic transport infrastructure: Dynamic Optical Network

Generalization and Future Direction for Research

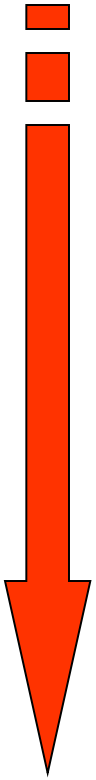
> Need to develop and build services on top of the base encapsulation

> Lambda Grid concept can be generalized to other eScience apps which will enable new way of doing scientific research where bandwidth is “infinite”

> The new concept of network as a scheduled grid service presents new and exciting problems for investigation:

- New software systems that is optimized to waste bandwidth
  - Network, protocols, algorithms, software, architectures, systems
- Lambda Distributed File System
- The network as a Large Scale Distributed Computing
- Resource co/allocation and optimization with storage and computation
- Grid system architecture
- enables new horizon for network optimization and lambda scheduling
- The network as a white box, Optimal scheduling and algorithms

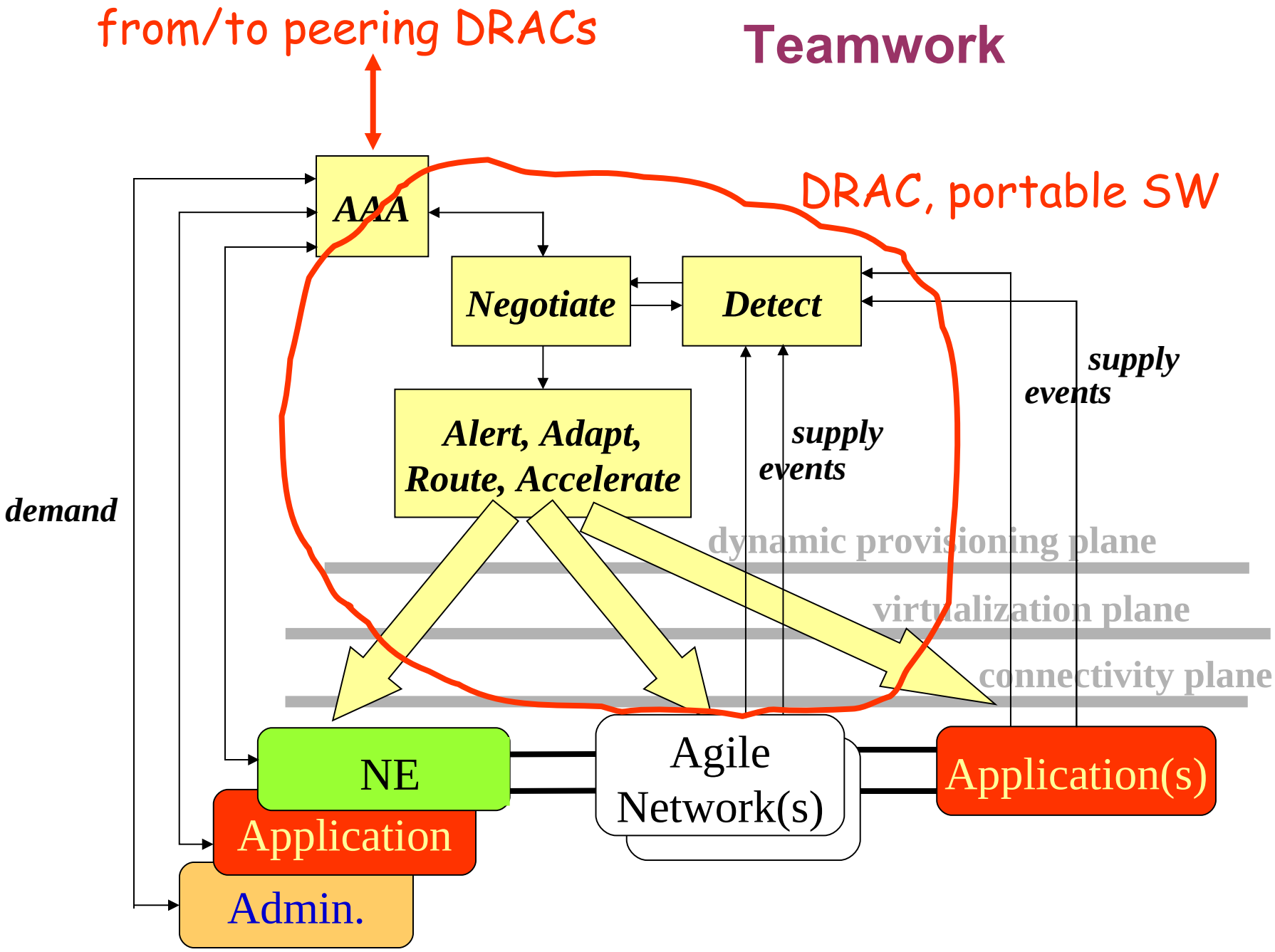
Enabling new degrees of App/Net coupling



- Optical Packet Hybrid
  - Steer the herd of elephants to ephemeral optical circuits (few to few)
  - Mice or individual elephants go through packet technologies (many to many)
  - Either application-driven or network-sensed; hands-free in either case
  - Other impedance mismatches being explored (e.g., wireless)
- Application-engaged networks
  - The application makes itself known to the network
  - The network recognizes its footprints (via tokens, deep packet inspection)
  - E.g., storage management applications
- Workflow-engaged networks
  - Through workflow languages, the network is privy to the overall “flight-plan”
  - Failure-handling is cognizant of the same
  - Network services can anticipate the next step, or what-if’s
  - E.g., healthcare workflows over a distributed hospital enterprise

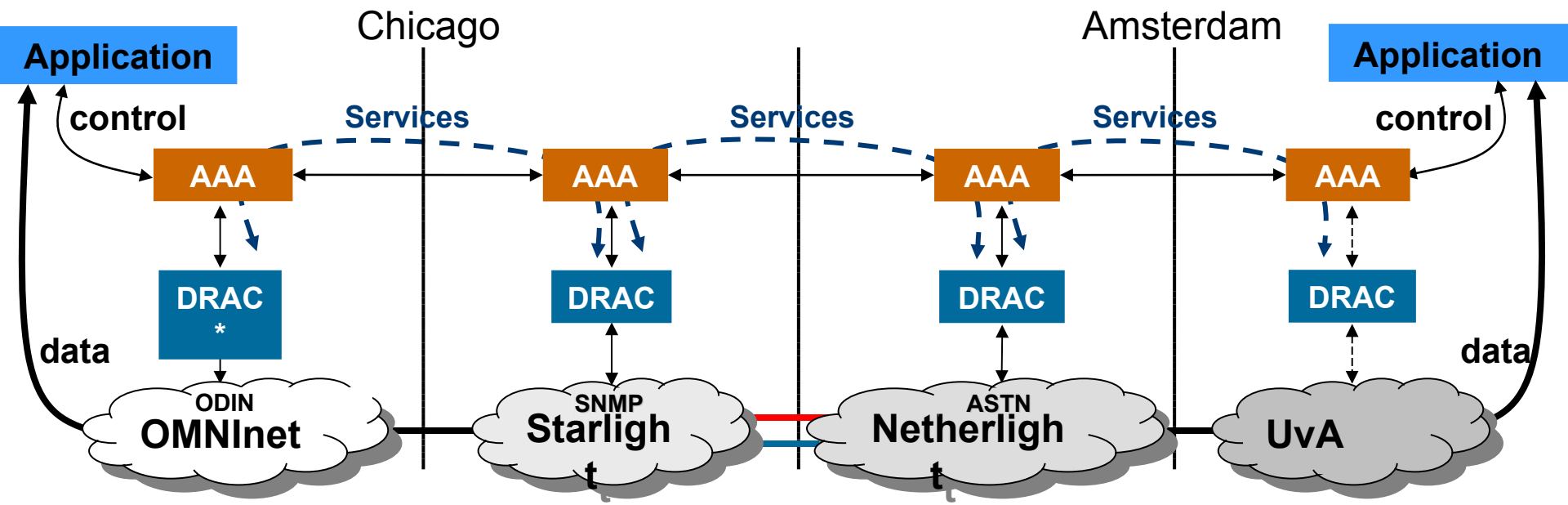
DRAC - Dynamic Resource Allocation Controller

Teamwork


from/to peering DRACs
DRAC, portable SW
AAA
Negotiate
Detect
Alert, Adapt,
Route, Accelerate
supply
events
supply
events
demand
dynamic provisioning plane
virtualization plane
connectivity plane
NE
Application
Admin.
Agile
Network(s)
Application(s)

SC2004 CONTROL CHALLENGE

NORTEL NETWORKS
BUSINESS WITHOUT BOUNDARIES



* Dynamic Resource Allocation Controller

- finesse the control of bandwidth across multiple domains
- while exploiting scalability and intra- , inter-domain fault recovery
- thru layering of a novel SOA upon legacy control planes and NEs

CANARIE
NETWORKS > COLLABORATION > RESULTS
RÉSEAUX > COLLABORATION > RÉSULTATS

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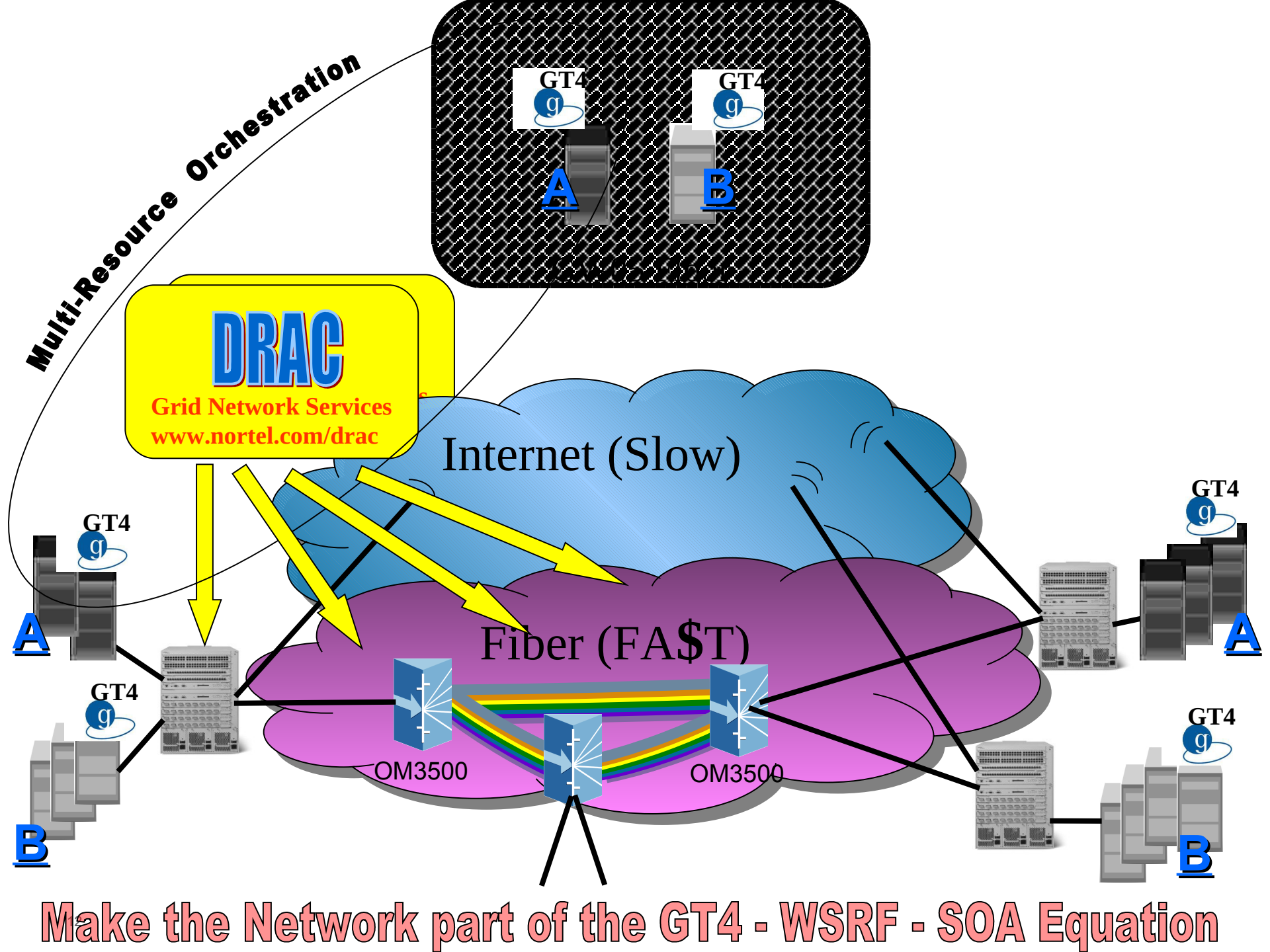
NL Light

STARLIGHT

SURFnet

UvA Universiteit van Amsterdam



Make the Network part of the GT4 - WSRF - SOA Equation

Some key folks checking us out at our booth, GlobusWORLD ‘04, Jan ‘04