International Telecommunication Union

QoS and security issues in Grids

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OGF - INRIA - RESO (France)

ITU-T/OGF Workshop on Next Generation Networks and Grids
Geneva, 23-24 October 2006

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Outline

- Grid challenges
- Security in grids
- QoS in grids
- Conclusion & Perspectives

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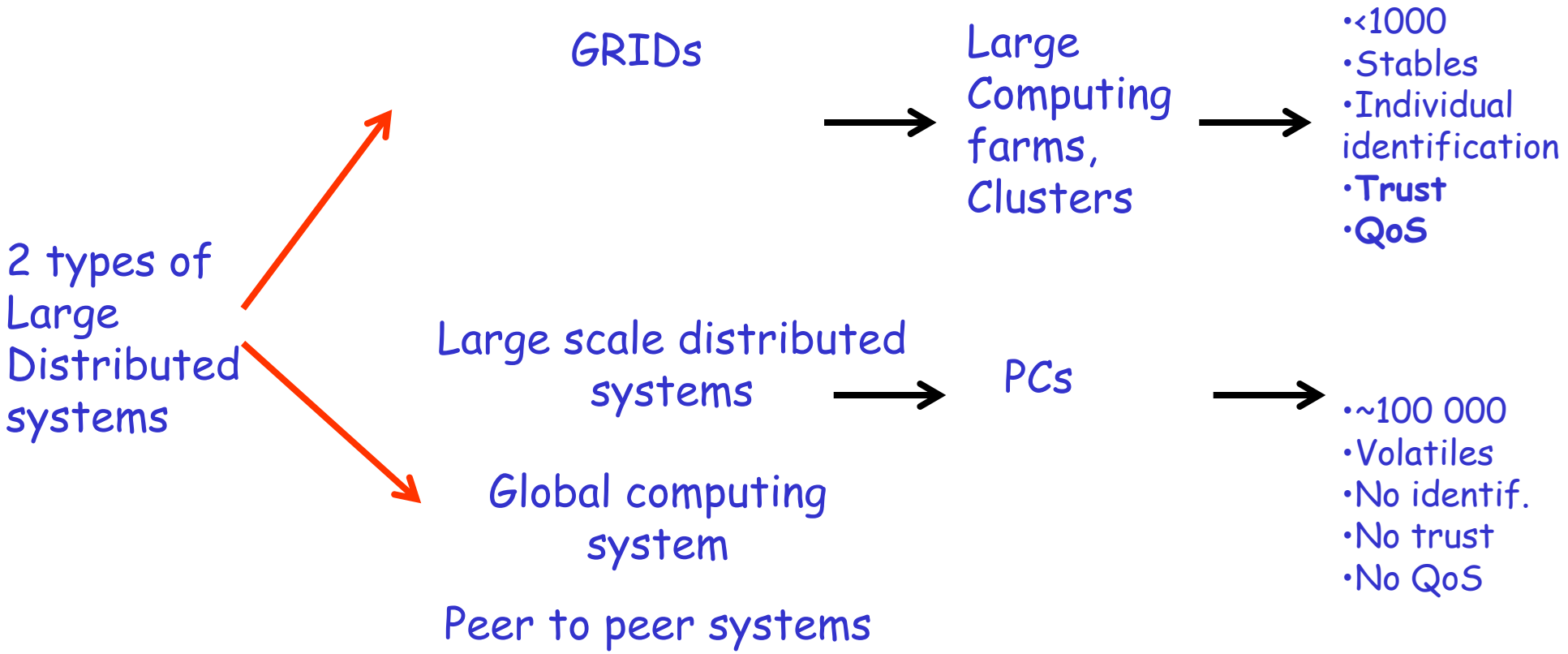
Context



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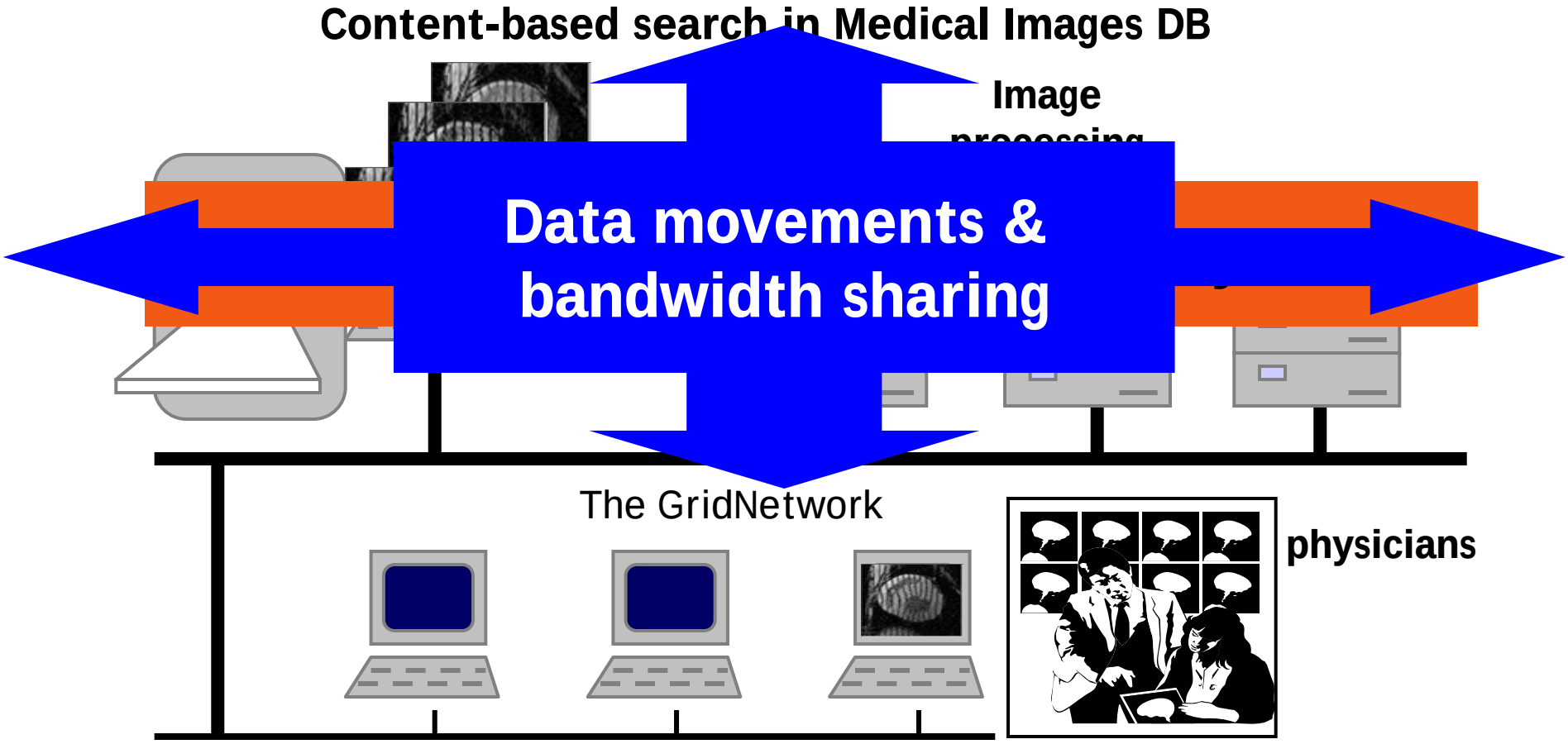
Definition

- a Grid is an aggregation of a large number of shared resources that creates an integrated & cost effective high performance computing environment

An example of grid application



An example of grid infrastructure

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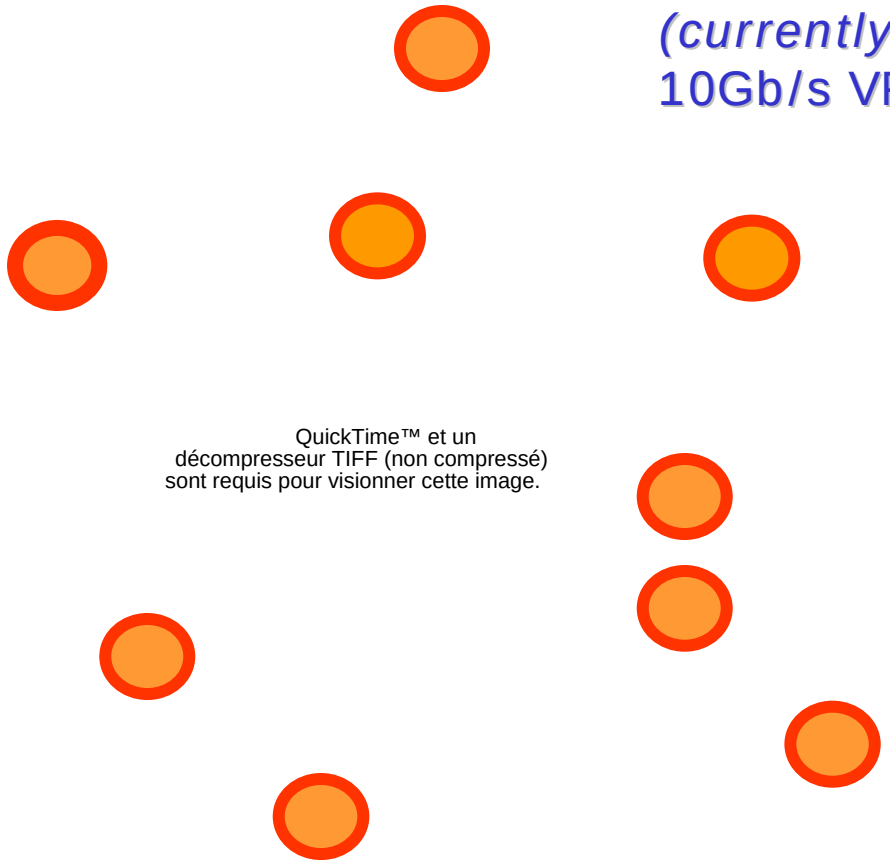
RENATER

GRID5000: the largest Computer Science Grid:

Goal: 5000 CPUs
(currently 3000)
10Gb/s VPN



10 Gbps

Dark fiber
Dedicated Lambda
Fully isolated traffic!

Grid'5000

Special features

4 main features:

- A high security for Grid'5000 and the Internet, despite the deep reconfiguration feature

  --> Grid'5000 is confined: communications between sites are isolated from the Internet and Vice versa (level2 MPLS, Dedicated lambda).

- A software infrastructure allowing users to access Grid'5000 from any Grid'5000 site and have simple view of the system

  --> A user has a single account on Grid'5000, Grid'5000 is seen as a cluster of clusters, 9 (1 per site) unsynchronized home directories

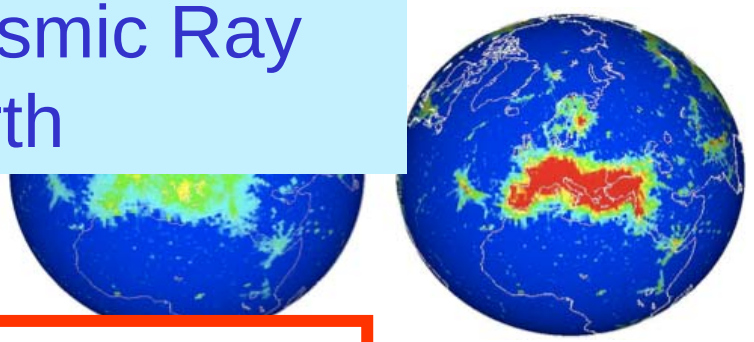
- A reservation/scheduling tools allowing users to select nodes and schedule experiments

  → QuickTime™ et un décompresseur TIFF (non compressé) sont requis pour visionner cette image. a reservation engine + batch scheduler (1 per site) + OAR Grid (a co-reservation scheduling system)

- A user toolkit to reconfigure the nodes

  -> QuickTime™ et un décompresseur TIFF (non compressé) sont requis pour visionner cette image. oftware image deployment and node reconfiguration tool

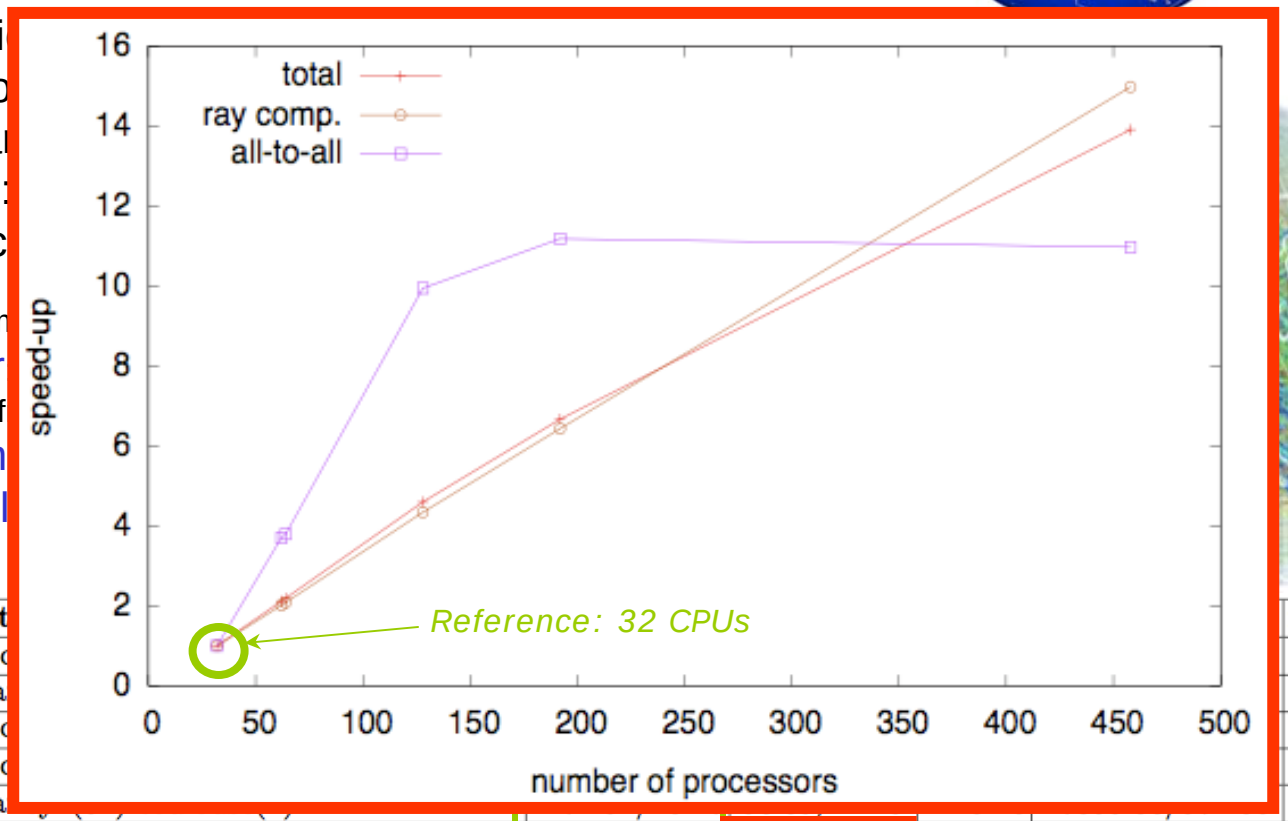
•Experiment: Geophysics: Seismic Ray Tracing in 3D mesh of the Earth

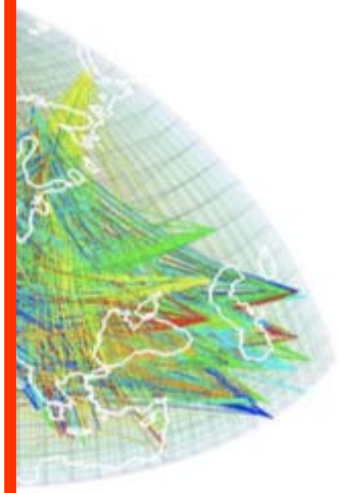


IPGS: "Institut de Physique du Globe de Strasbourg"

Building a seismi
seismic wave pro
Seismic waves a
tracing algorithm:
between the epic

A MPI parallel progran
1) Master-worker
successively fetched f
2) all-to all comm
3) merging of cell





sites	procs	sit					in transit
1	32	nic					7.29 GB
	62	na					9.02 GB
	62	nic					8.88 GB
	138	nic					15.47 GB
2	64	na					9.26 GB
	128	nancy*(62) toulouse(66)	610.91/20.40	34.68/3.08	688.28	8629.14/573.01	15.29 GB
3	128	rennes(42) nancy*(44) toulouse(42)	620.27/21.21	33.56/2.98	699.57	8629.14/648.83	15.47 GB
	192	rennes(64) nancy*(64) toulouse(64)	412.16/13.70	30.84/2.23	474.65	5737.70/410.90	16.77 GB
5	458	rennes(152) nancy*(32) orsay(184 nice(58) toulouse(32)	177.07/5.69	31.43/1.47	227.53	2398.03/221.91	20.82 GB

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OpenGridForum

Security in Grids

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- Key issues

- **Access to shared resources**

  ->Make an **authorization decision** when a shared resource is accessed:

  who can do what (and how)

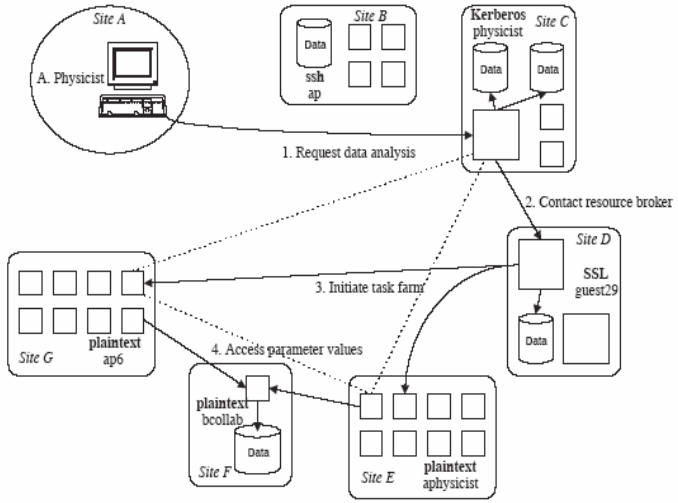
- **Secure Communication Channels**

  ->**protection of data and flows** during exchanges:

  - Data : integrity, authentication, confidentiality…
  - Flow : authentication, confidentiality, …

  ->**protection of resources** during Grid life:

  - Channel and grid : isolation, Deny of Service prevention, intrusion prevention…



Secured communication channels

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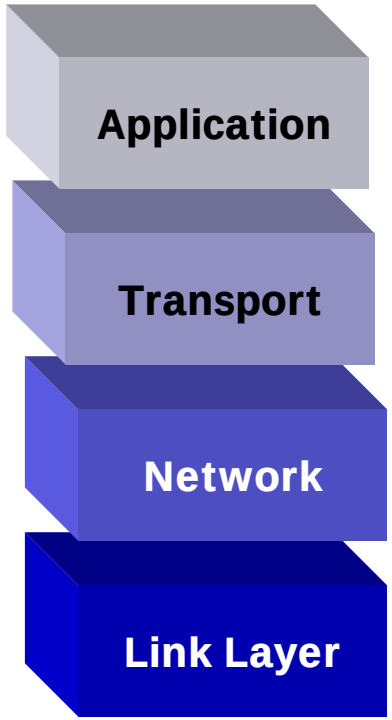

Encrypted E-mail, DNSsec

TLS (RFC 2246), SSL: GSI/ Globus) , SSH

IPsec

MPLS VPN's

VLANs

Optical VPN's

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Why Grid security is hard

- Resources being used may be valuable & the problems being solved sensitive
  - Both users and resources need to be careful
- Dynamic formation and management of virtual organizations (VOs)
  - Large, dynamic, unpredictable…
- VO Resources and users are often located in distinct administrative domains
  - Can't assume cross-organizational trust agreements
  - Different mechanisms & credentials
    - X.509 vs Kerberos, SSL vs GSSAPI, X.509 vs. X.509 (different domains),
    - X.509 attribute certs vs SAML assertions

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Grid Internetwork

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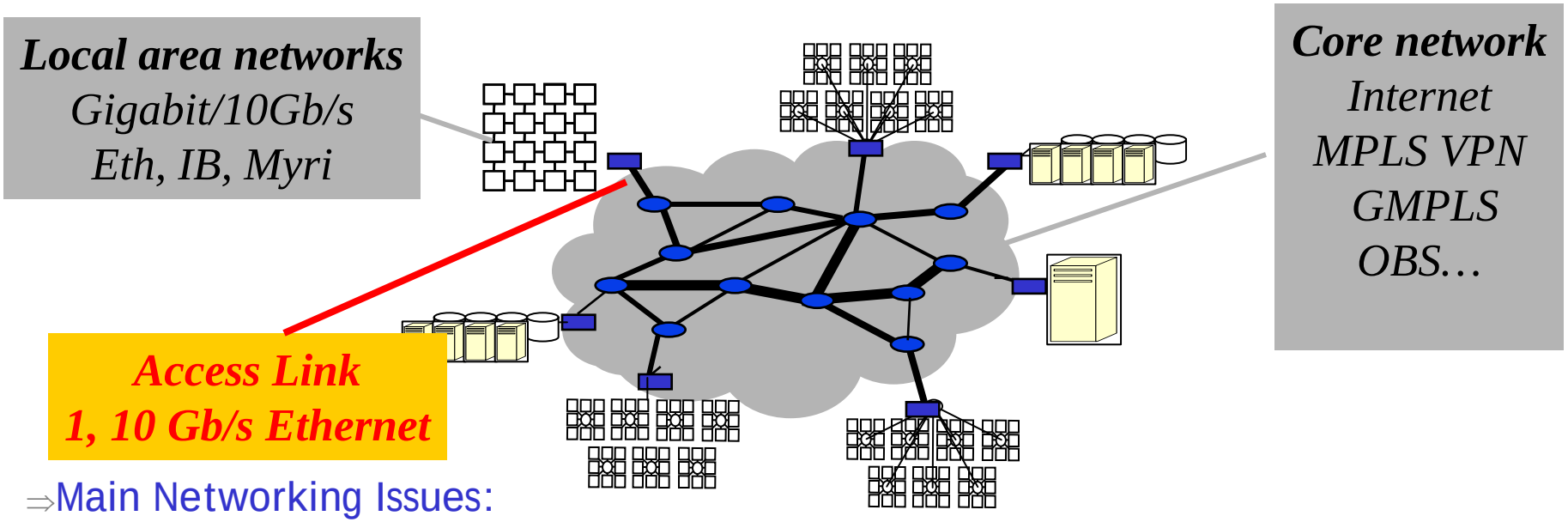
- The shared resources are interconnected by a complex internetwork
- Applications use Internet protocols: TCP/IP



⇒Main Networking Issues:

⇒1 : Security

⇒2 : E2E performance prediction and control

Grid Flows characteristics

- Heregeneous but Predictable traffic pattern !

- Mice, Elephant…: I/O, IPC, grid control&management
  - **Throughput**:
    - Rates: more than 9 orders of magnitude
    - Few bytes for interactive traffic or control traffic
    - To terabytes for bulk data transfer.
  - **Delay:**
    - Very heterogeneous needs
    - Some applications are very sensitive to latency (MPI; visu)
    - File Transfer delays have to be **controlled (bounds)**
  - **Reliability** :
    - Generally reliable (=> TCP)
    - but some apps are loss tolerant (Astrophysics)
  - **Communication models:**
    - Point to point, point to multipoint, multipoint to point…

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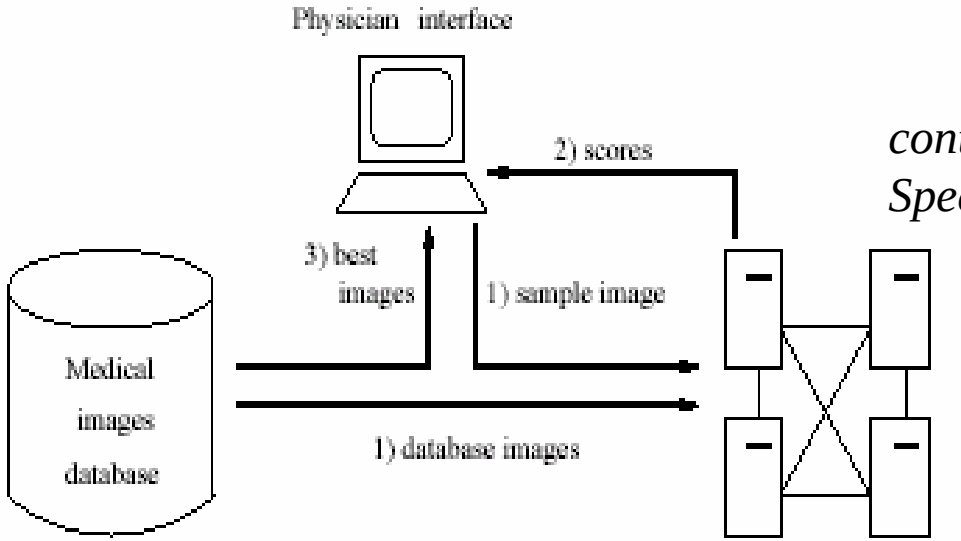
Bandwidth sharing problem

- A central issue in networking is how to allocate bandwidth to flows
  - efficiently and fairly => **optimization objective**
  - in a decentralized manner => **algorithm/protocol implem.**

Net. type	Internet: user2any	Gridnet: machine2machine
Traffic type	Elastic document transfer (95% TCP)	Infrast. & services mngt& control Application exchanges : I/O+IPC
User type	Final users	High End Computing Applications & Final users
Optimization goals	Global network throughput & fairness	Global **system** throughput Flow performance vs fairness -> Co-scheduling pb (CPU, disk, bandwidth)

Example



$$\text{SpeedUp} = \frac{S_1}{S_k} = \frac{nkC}{(nC) + (n + k^2)T}$$

controlled network
Speedup is good

	k		
C (s)	4	10	100
0.8	3.228213	7.003844	9.962241
15.37	3.950837	9.538926	67.766197
734.1	3.990896	9.990857	99.900540

	k		
C(s)	4	10	100
0.8	1.208275	2.210455	8.386187
15.37	3.570596	8.450010	63.790815
734.1	3.988906	9.906162	99.881129

Speedup depends on C/T
C: computing time / image
T: transfer time / image

congested network
Speedup is very low

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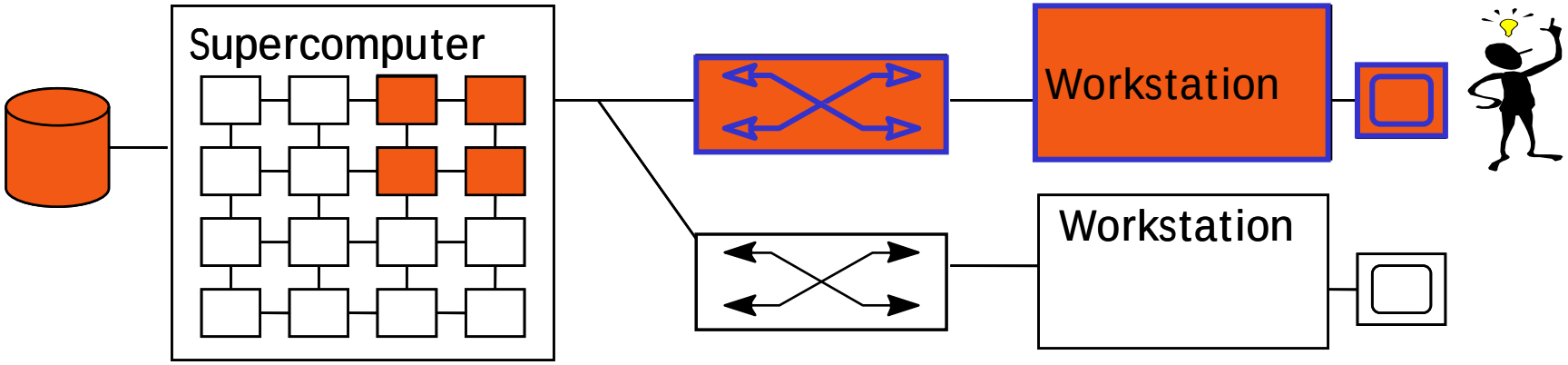
E2E performance control

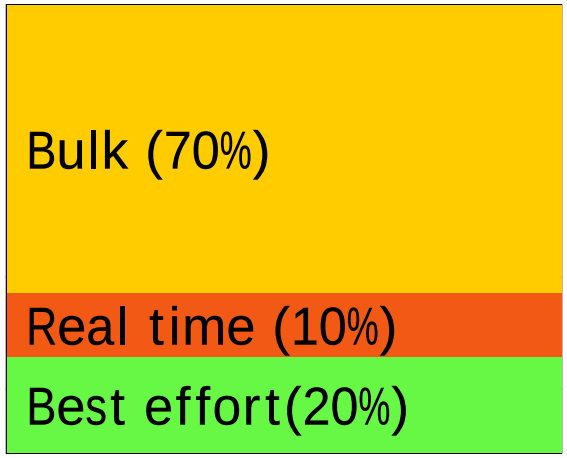
- Multidomain and heterogeneous transport (wdm, MPLS, IP…)
- Very large spectrum of rates (1Mb/s to 10Gb/s)
- Very large spectrum of requirements (delay, bdw, loss…)
- Last miles (heterogeneous networks: Geth, Myrinet…)
- But traffic patterns may be known in advance
- Scales (#flows) much lower than Internet

E2E resource reservation?

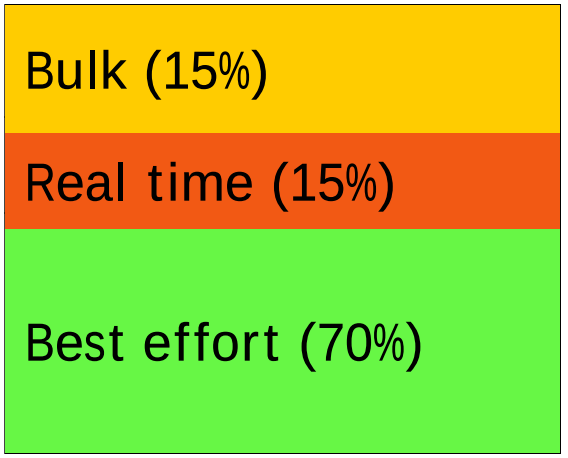
- Provide end-to-end Quality of Service to applications.
- This requires:
  - Discovery and selection of resources
  - Allocation of resources
  - Advance reservation of resources
  - Scalability, robustness issues…!



Sol 1: Traffic isolation
[Zeng 05]



Requested bandwidth

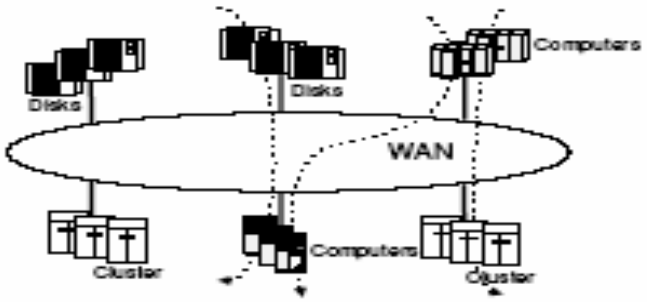


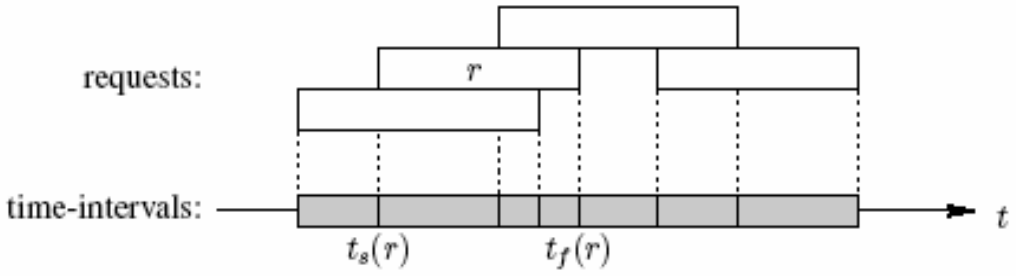
Requests Number

- Considering real time & MPI & best effort traffic volume is low :
  - differentiate and schedule RT & BE packets with traditionnal IP QoS solutions (DiffServ EF & BE…)
- Considering number of requests for bulk data transfer (I/O) is low and known in advance:
  - Globally schedule and control bulk requests
- Isolate different types of traffic in different « virtual networks »

Sol2: Grid bandwidth Sharing [Primet 06]

- Assumption:
  - Core and LANs are overprovisionned (cf. OBS),
  - access links are potential bottlenecks
- Isolate bulk traffic from other traffic
- Scalable & easy to deploy solution is required
- Optimal flow scheduling





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Conclusion and perspectives

The network is a key component of the Grid

- Lot of specific issues:
  - High performance in heterogeneous network environments
  - Network control and end to end transfer delay bounds
  - End to end security
  - Optimizing network resource utilization.

- Need a general view of performance control in grids.
- Need more knowledge on real requirements
- Hybrid QoS strategy that combines QoS differentiation and advance reservation
- Still a big research & development topic

EC-GIN: Grid Internetworking

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Original Internet technology

Enriched with customised network mechanisms

Bringing the Grid to its full potential !

Today's Grid applications

EC-GIN

EC-GIN enabled Grid applications

Driving a racing car on a public road

Applications with special network properties and requirements

Traditional Internet applications (web browser, ftp, ..)

Real-time multimedia applications (VoIP, video conference, ..)

⇒Faster Grid: network mechanisms based on Grid peculiarities

⇒Economic Grid traffic management and security

EC-GIN : Research Challenges

- How to model Grid traffic?
  - Much is known about web traffic (e.g. self-similarity) - but the Grid is different!
- How to simulate a Grid-network?
  - Necessary for checking various environment conditions
  - May require traffic model (above)
  - Currently, Grid-Sim / Net-Sim are two separate worlds (different goals, assumptions, tools, people)
- How to specify network requirements?
  - Explicit or implicit, guaranteed or "elastic", various possible levels of granularity
- How to align network and Grid economics?
  - Grid service model, charging model for grid services, and network model for such Grid services
  - Network Mgmt mechanisms in support of those three areas in an integrated fashion

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Links

- 1st GridNets conference => Lyon - 14-17 october 2007
  - http://www.gridnets.eu
  - Goal: Gather people interested in reqearch and development of network protocols, network resource management services, network monitoring tools ... for grids
  - Follow up of GridNets workshop serie of the IEEE Broadnet conference
- OGF GHPN http://www.ogf.org/
- Pascale Vicat-Blanc Primet : pascale.primet@inria.fr
  - Projet INRIA RESO - LIP - ENS -Lyon
  - http://www.ens-lyon.fr/LIP/RESO
- Grid5000 website:
  - https://www.grid5000.fr

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Publications

Optimal Bandwidth Sharing in Grid environment.

*Loris Marchal, P. Vicat-Blanc Primet, Yves Robert, and Jingdi Zeng - **IEEE HPDC,** Paris, France. June 2006*

Large Scale Gigabit Emulated Testbed forGrid Transport Evaluation

*P. Vicat-BlancPrimet, R. Takano, Y. Kodama, T. Kudoh, O.Gluck, C. Otal , **PFLDNET06** International workshop on Protocols for Fat Long Distance Networks. Nara, Feb. 2006*

Optimizing network resource sharing in grids.

*Loris Marchal, Vicat-BlancPrimet, Yves Robert, and Jingdi Zeng. **IEEE GLOBECOM'05**, USA. November 2005.*

Traffic Isolation and NetworkResource Sharing for Performance Control in Grids,

Vicat-BlancPrimet, J. Zeng , ICNS'05, USA, october2005.

HIPernet: fully distributed security for grid environments

*J. Laganier, Vicat-BlancPrimet **GRID2005** workshop of the International ConferenceIEEE SuperComputing 05 conference, Seattle, November 2005.*

Dynamic control and flexible management of quality of service in grids: the qosinus approach.

*Pascale Vicat-Blanc~Primet in proceeding of the 1st **IEEE Broadnet Conference, GridNets workshop**, San José, October 2004.*

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Some OGF key documents

GFD.23 "A Hierarchy of Network Performance Characteristics for Grid Applications and Services "

B. Lowekamp, B. Tierney, L. Cottrell, R. Hughes-Jones, T Kielmann, M. Swany (NM-WG)

GFD.37 "Networking Issues for Grid Infrastructure "
V. Sander and al. (GHPN-RG)

GFD.55 A Survey of Transport Protocols other than "Standard" TCP
E. He, P. Vicat-Blanc Primet, M. Welzl (DT-RG)

http://www.ogf.org/gf/docs/?final