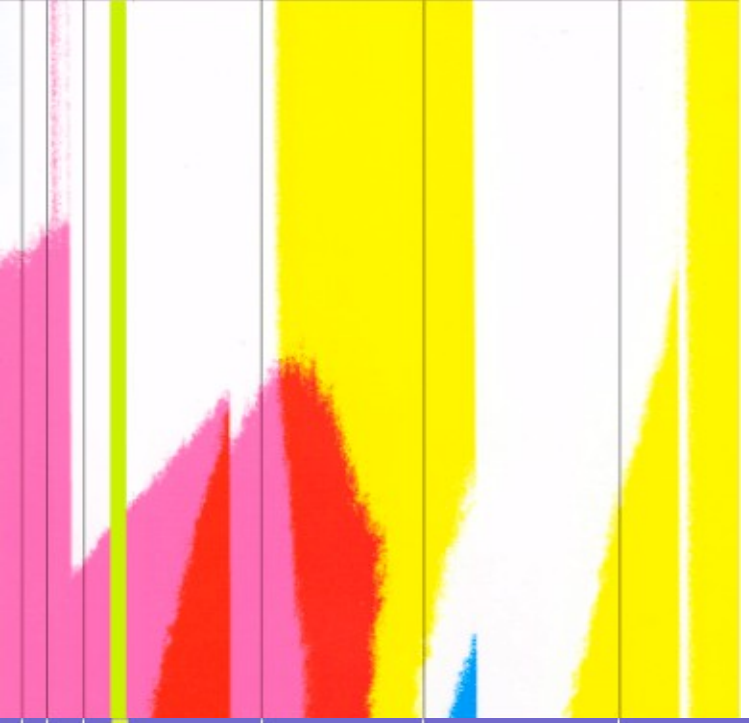

Towards Interplanetary Grids

SMC-IT 2006

July 17th, 2006

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

INRIA

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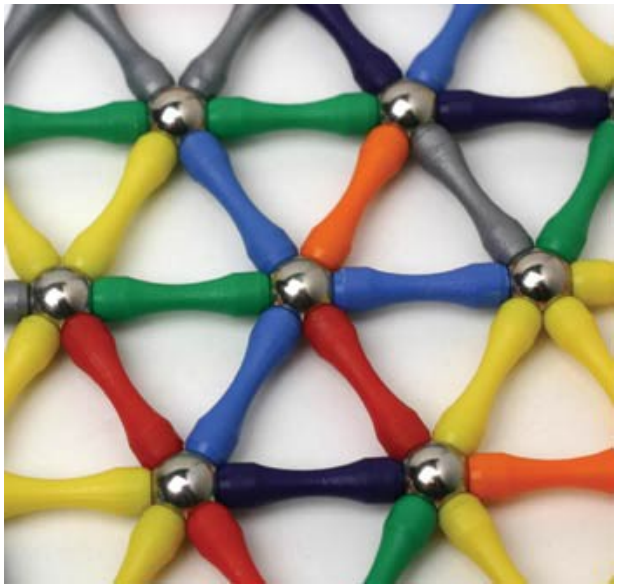


Space Mission Challenges for Information Technology 2006

July 17th, 2006

INRIA

Where do we come from?

INRIA RHÔNE-ALPES

160 M Euros
3600 persons
2800 scientists
1000 PhD students
(january 2006)

Lip

RESO
Réseaux haut debit, protocoles et services

ECOLE NORMALE SUPERIEURE DE LYON

Outline

Introduction to:

- Grid computing
- Active Networks and Active Grids
- Delay Tolerant Networking

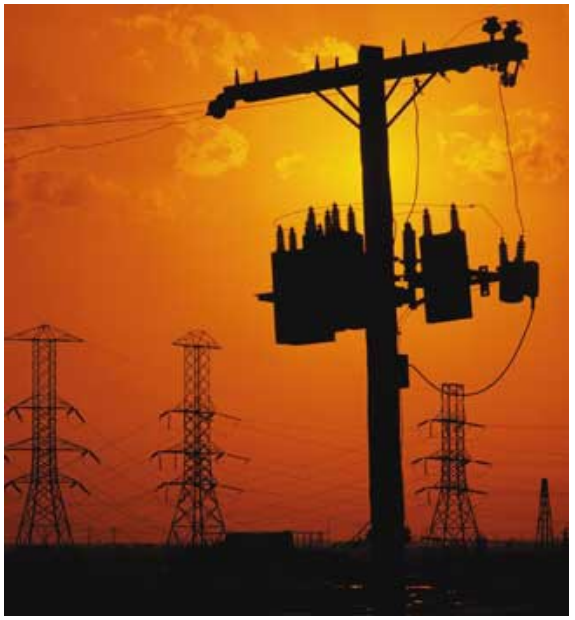
Objectives and constraints

Proposition to build an Interplanetary grid

Conclusion and future works

What is a (terrestrial) grid?

Early definition : « A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities. » [Foster, Kesselman, 1998]



•Grid computing facilities are generally composed of several high performance, permanently connected, clusters of computer.

•Standardisation effort : GGF id Forum)

Some Grids projects

Experimental Grids

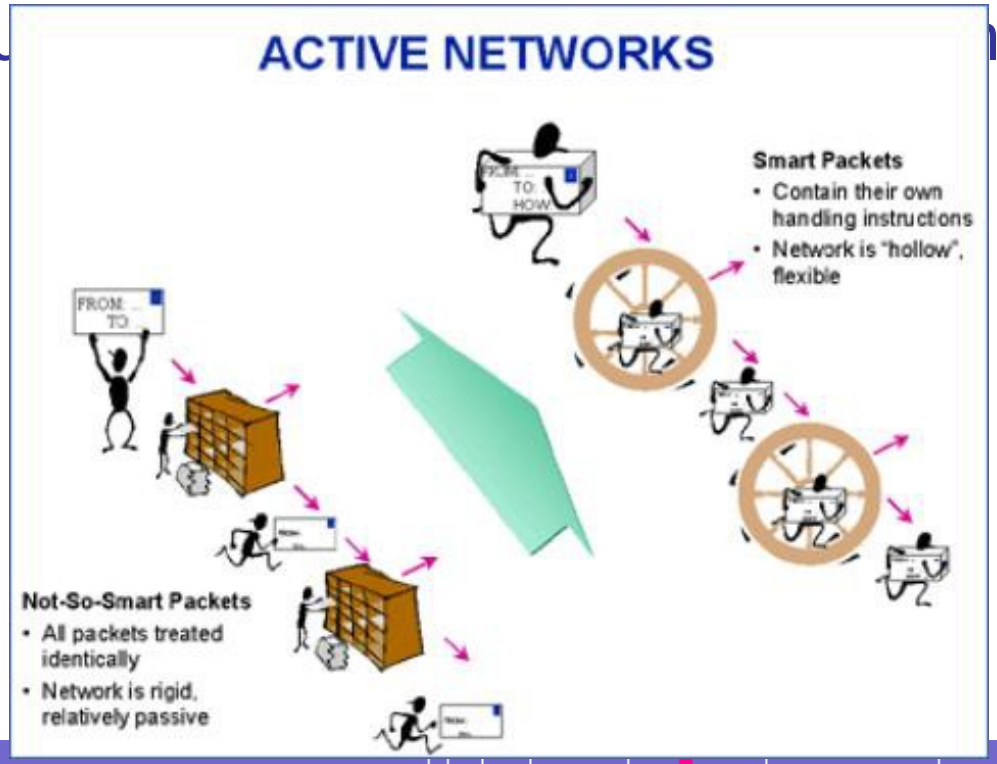
- Grid'5000
  Highly reconfigurable, controlable, monitorable,
  1 to 10 Gb/s dedicated network, 5000 CPUs

Operationnal Grids

- EGEE (Enabling Grids for E-science)
- DataGrid
- DataTag
- TeraGrid

Introduction to Active Networks

- Programmable or active networks allow specified classes of users to deploy dynamic network services.
- « Compu … nput e-Forward



Courtesy of Darpa

Autonomic Networks

Dynamic service deployment

Self-*

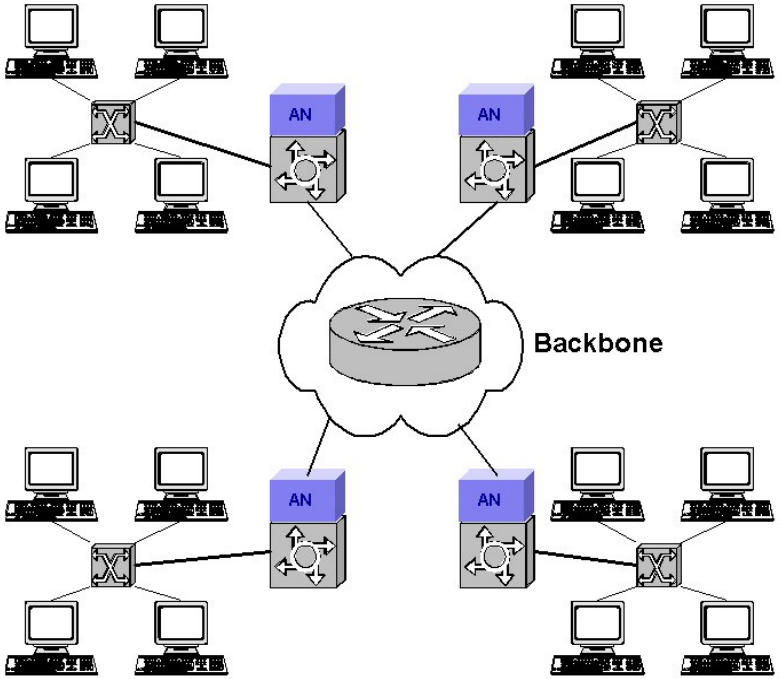
- self-management
- self-configuring
- self-optimizing
- self-repairing
- self-healing
- self-protection
- ...

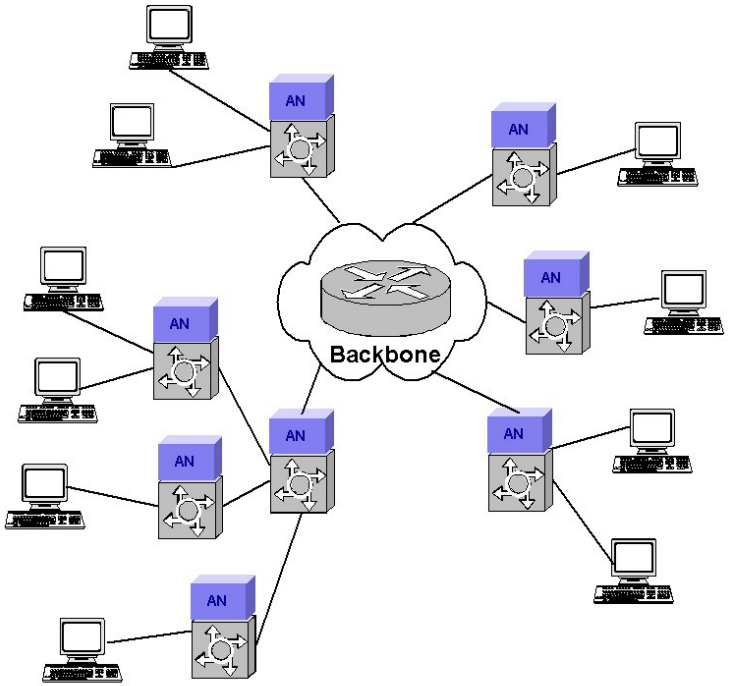
Active Grids

Blah...

[J.P. Gelas, L.Lefèvre et al. « Designing and evaluating an active grid architecture », FGCS, Feb. 2005]

Example of services : Reliables Multicast, QoS, service deployment, compression,...



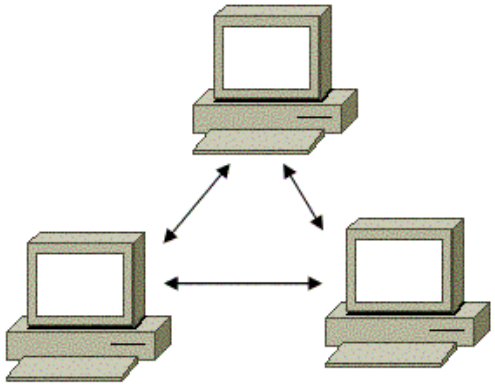


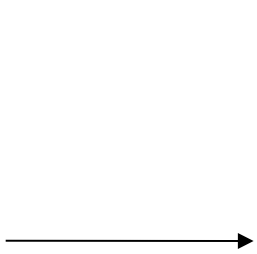
Other kind of Grid...

Access Grid (ex: Group-to-group communication)

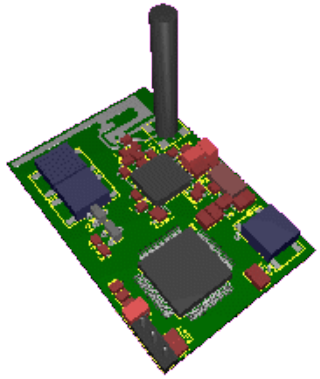
Sensor Grid (ex: Air polluting monitoring)

P2P networks (ex: Boinc)





less reliable
volatility
no guaranties
lously connected



DTN: Delay Tolerant Networking

An approach to interplanetary internet

DTN community works on networks which must deal with:

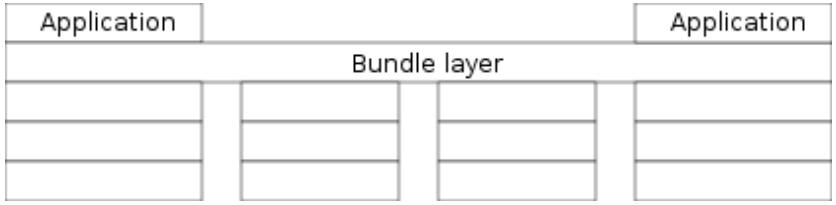
- high latencies
- frequent disconnections
- no end-to-end path
- power saving constraints
- ...

Bundle layer	
TCP	Transport
IP	Network
Ethernet	Link

DTN RESEARCH GROUP
Open architecture
Open specifications
Open software

Based on a additional protocol layer. The *bundle layer*, which provides:

- intermediate storage
- **adapatation** to all kind of networks
- high latencies and long disconnections support



[S.Burleigh, A.Hooke, L.Torgerson, K.Fall, V.Cerf, B.Durst, K.Scott and H.Weiss, IEEE Communications, June 2003]

Some DTN projects

- UMassDieselNet http://prisms.cs.umass.edu/diese
- ZebraNet http://www.princeton.edu/~mrm/zebranet.html
- DakNet http://firstmilesolutions.com
- SaamiNetworks
- DTN train demo
- ...

New service required

- If the network is out of reach equivalent to a very large network congestion
- Needs to introduce equipments with new services
- In a large scale context, man can not really intervene
- Autonomic services are required...

Why? (1)

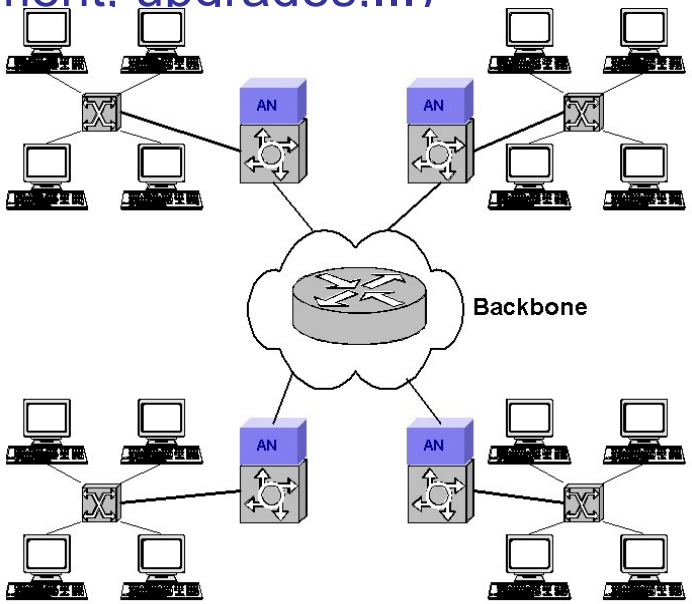
- Today, applications must be adapted to support very high latency.
- Can not use end-to-end protocols. Store-and-forward technics required.
- Can not use negociation protocols. Protocols must take decisions locally and autonomously.

Why? (2)

- Grids' clusters connections can be through unreliable public links (like Internet), providing absolutely no guaranty.
- Clusters owner may decide to disconnect their cluster from public access (own usage, management, upgrades....)

Other clusters running the application **should not stop**

because a cluster disappear for maybe just few hours.



Constraints

- *Transport protocols*, *routing*, *name space*... must be changed to fit new requirements.
- To build our architecture we need to take into account :

Classical Grid constraints

- Processing power
- Bandwidth
- Latency

DTN constraints

- Power consumption
- Volume (size)
- Ultra high latency
- Fault tolerance (no human intervention)

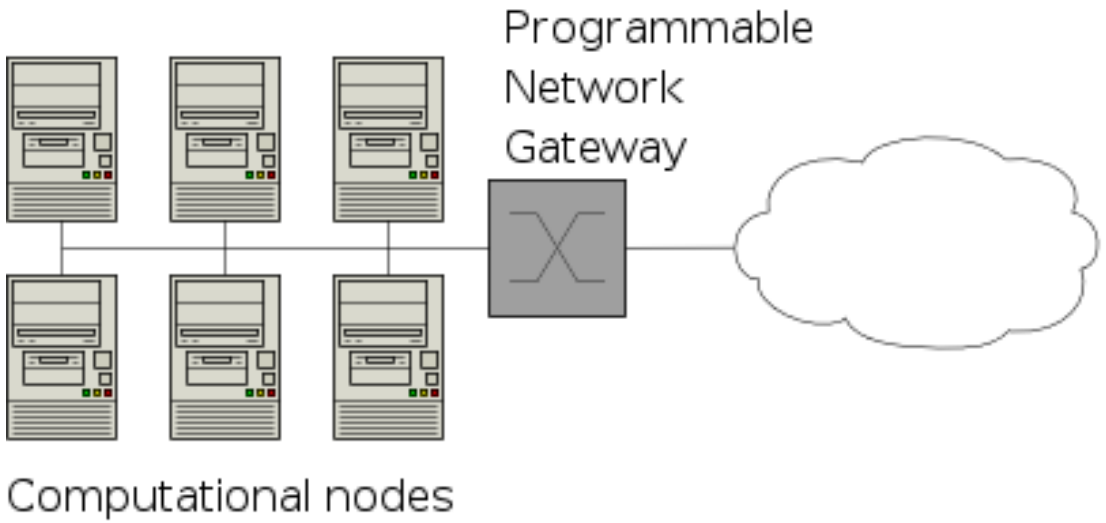
Our approach

- High latency can be generalized to disrupted infrastructure
- As transparent as possible for *users*, *applications* and *Grid middleware*
- Modify only the system used as a *Programmable Network Gateway (PNG)*
- PNG are located beween clusters and the external networks

Disruption tolerant protocol:
Programmable Network Gateway (PNG)

A convenient way to support:

- network disruptions or
- no access to the recipient nodes

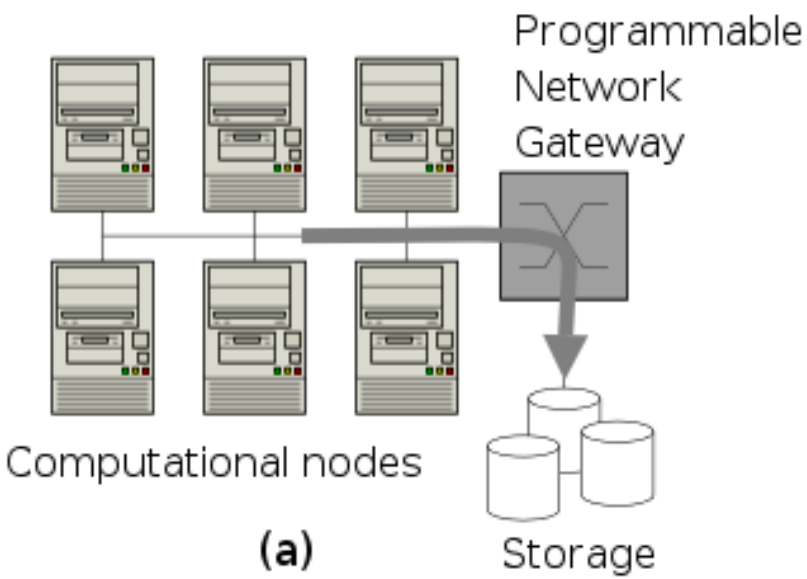


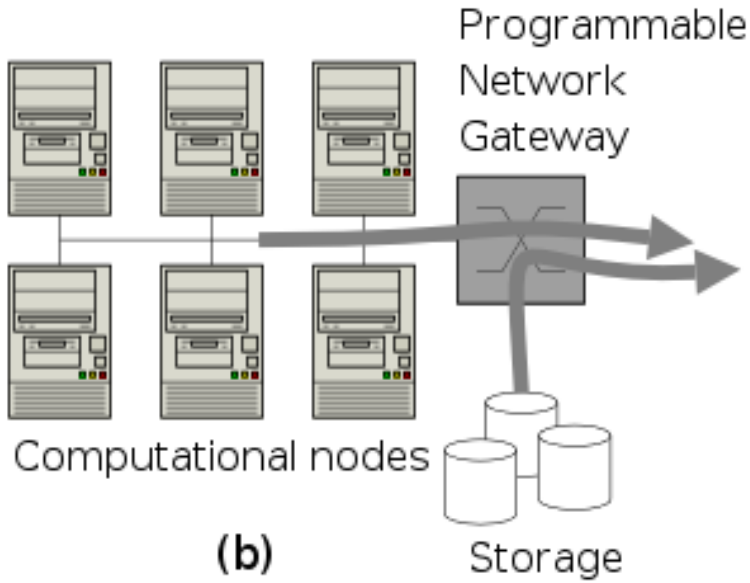
Disruption tolerant protocol

More about the Programmable Network Gateway (PNG)

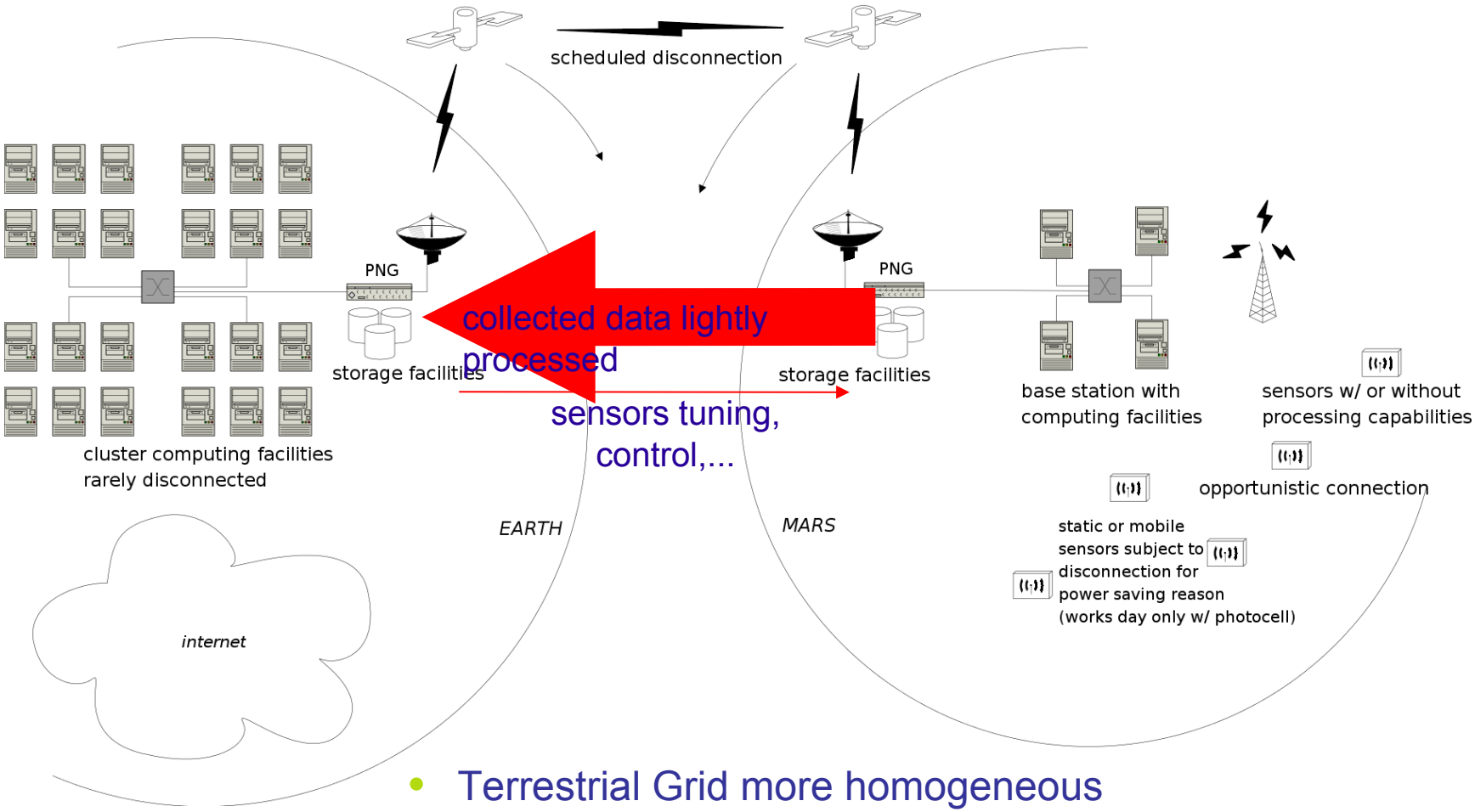
When a cluster is disconnected from the network the PNG should be able to:

- store data sent by the cluster's node in a local storage
- send a special acknowledgement (TACK) to the application





Interplanetary Grid between Earth an Mars



- Terrestrial Grid more homogeneous
- Ultra heterogeneity of extra terrestrial networks

Our experience

We gain a large experience from the TEMIC project (Industrial cooperative remote maintenance)

- Deployment of Indutrial Autonomic Network nodes

Conclusions

- Given the available technologies, the concept of InterPlanetary Grid (IPG!) is far from Sci Fi.
- The proposed architecture can also be applied to Grid infrastructure dealing with unreliable long distance network connections.

Future works

- First experimentation is on going work.
- Design on Network Processor card is difficult.
- Evaluation on a large scale with *Grid'5000* project.
- Open issue : Fault tolerance!

Questions?

Thank you for your attention!