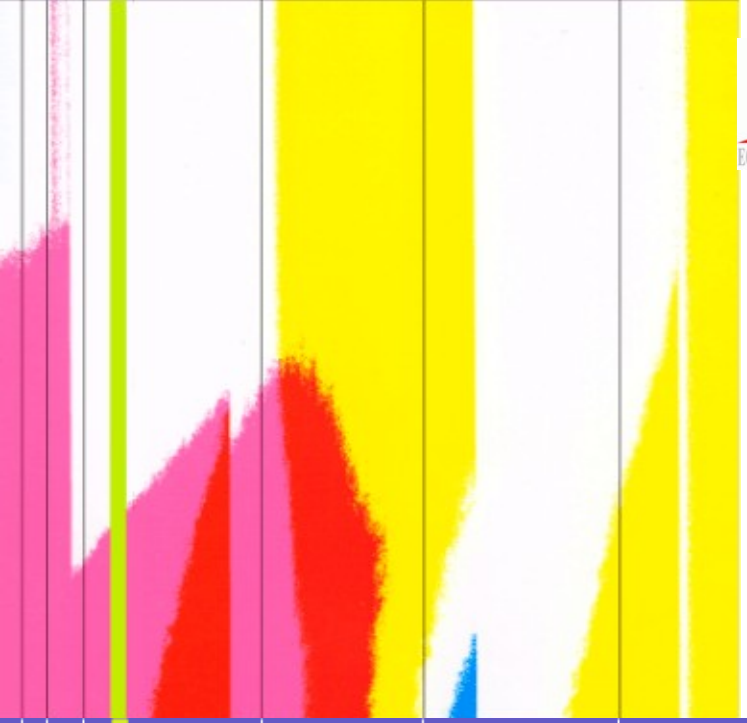


MoonGrid:

Bring processing power to the Moon

11th ISU Annual International Symposium

21-23 February, 2007, Strasbourg, France

Laurent Lefèvre, Jean-Patrick Gelas

INRIA/RESO/LIP (UMR 5668), France

École Normale Supérieure de Lyon
Université Claude Bernard – Lyon 1

jean-patrick.gelas@ens-lyon.fr, laurent.lefevre@inria.fr

Challenges

- Space missions already require computing/storage ressources to process collected data (from robots, cameras, sensors...)
- Sending large computing equipments on moon : too expensive!
- Need for a computing Interplanetary Grid which can support space and moon challenges and provide an unified framework for computing collected data.

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]

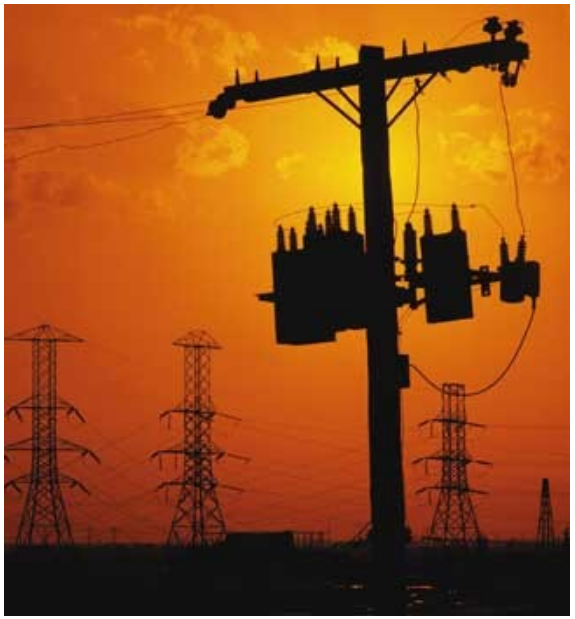
- Grid computing facilities are generally composed of several high performance, permanently connected, clusters of computer.

Grid'5000

eGee Enabling Grids for E-sciencE

TeraGrid

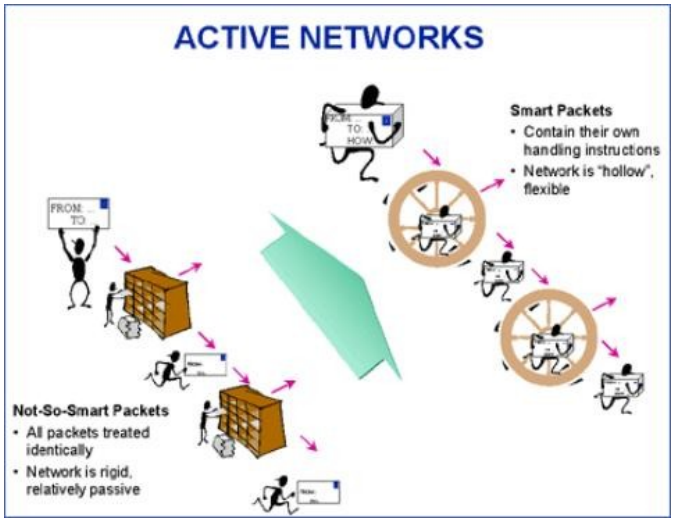
OpenGridForum OPEN FORUM | OPEN STANDARDS



INRIA

Active Networks : “How to dynamically personnalize network equipments...”

- Programmable or active networks allow specified classes of users to deploy dynamic network services.
- « Compute while travel » or « Store-Compute-Forward »
- Require design of new kinds of network equipments.
- Design of autonomic services.



Courtesy of Darpa

Autonomic Networking : “When human intervention is not possible...”

Derived from “Autonomic Computing” (IBM)

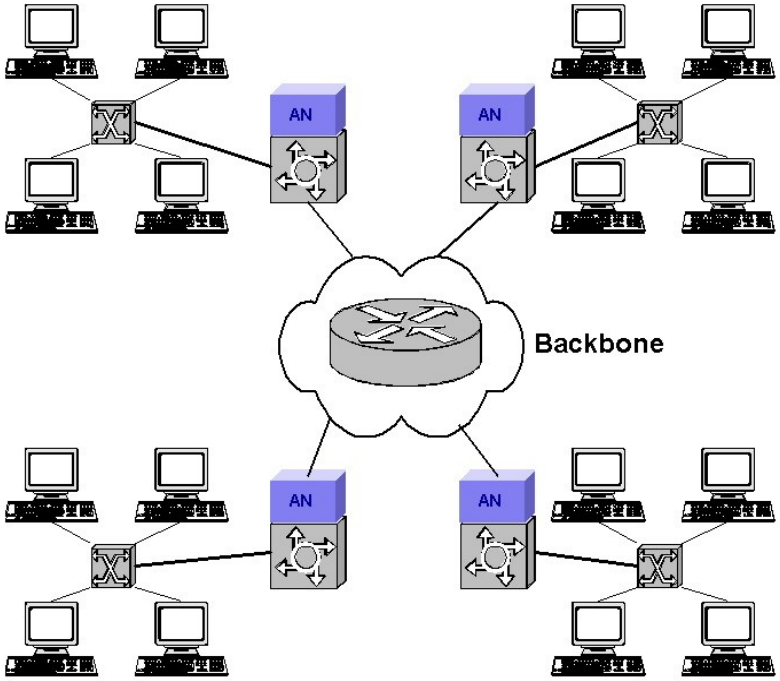
Dynamic service deployment

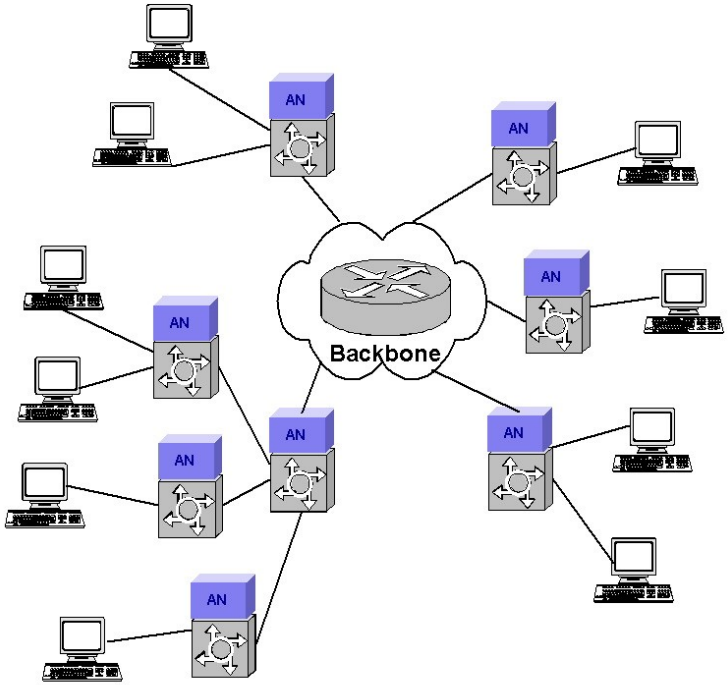
Self-*

- self-managing
- self-configuring
- self-optimizing
- self-protecting
- self-healing/repairing
- ...

Active / Autonomic Grids : « How to support next generation Grids... »

- Improving exposition of network capabilities to Grid middleware
- Support of multi-clusters / P2P Grids
- Example of services : Reliable Multicast, QoS, service deployment, compression, video adaptation,...
  [J.P. Gelas, L.Lefèvre et al. « Designing and evaluating an active grid architecture », FGCS, Feb. 2005]





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

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

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

Application			Application
Bundle layer			

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

Definition : what is a *MoonGrid* ?

- Infrastructure definition :
  - Derived from Interplanetary networks
  - Heavy computing resources on Earth
  - Light computing remote resources
- Services definition :
  - Remote intervention without human
  - Ultra long latencies networks
  - Disruptive connections
- Applications definitions :
  - Supporting space missions applications with local and remote ressources

- MoonGrid = Grid + Autonomic Networks + DTN

New services required but problems already exist...

- If the network is out of reach it is 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?

- 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.
- 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

MoonGrid constraints

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

Our approach : designing a gateway for MoonGrid

- Considering disrupted infrastructure as ultra high latencies (or null bandwidth)
- Remaining as transparent as possible for *users*, *applications* and *Grid middleware*
- Designing an Autonomic *Programmable Network Gateway (APNG)*
- Deploying APNG on strategic locations (between clusters and the external networks)

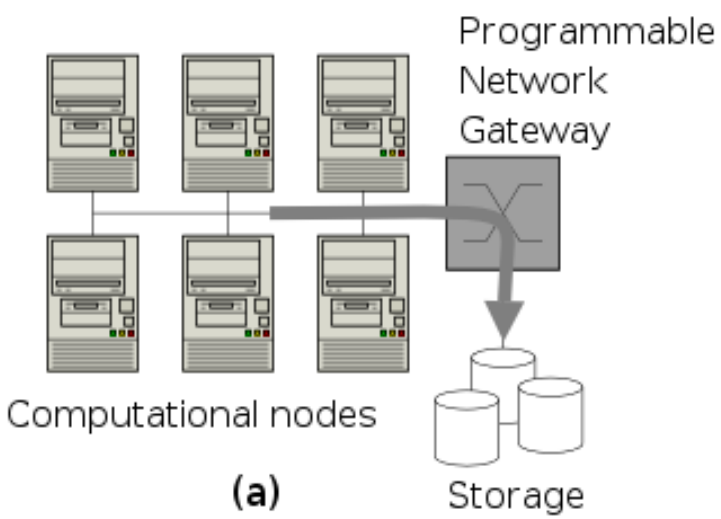
Autonomic Programmable Network Gateway (APNG)

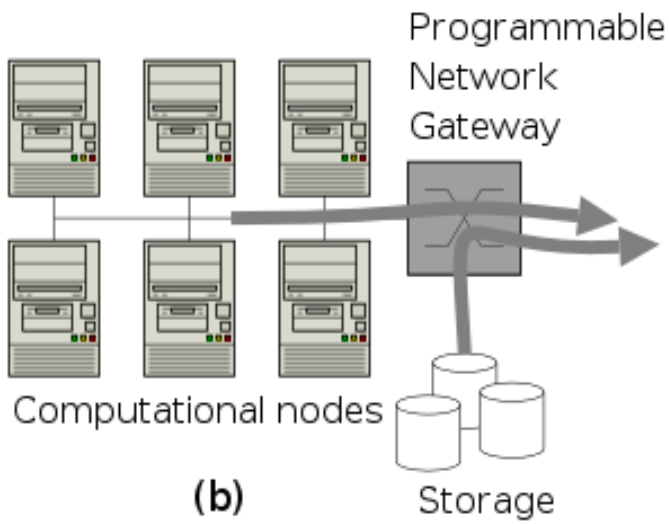
A convenient way to support:

- network disruptions
- no access to the recipient nodes
- Processing/adaptation on the fly of data streams

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

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





MoonGrid : constraints and heterogeneity

3 levels of disruptions :

- Local (on earth) disruptions : between cluster/sites
- Long distance network disruptions (between earth and moon)
- Remote disruptions : between remote sensors and remote APNG

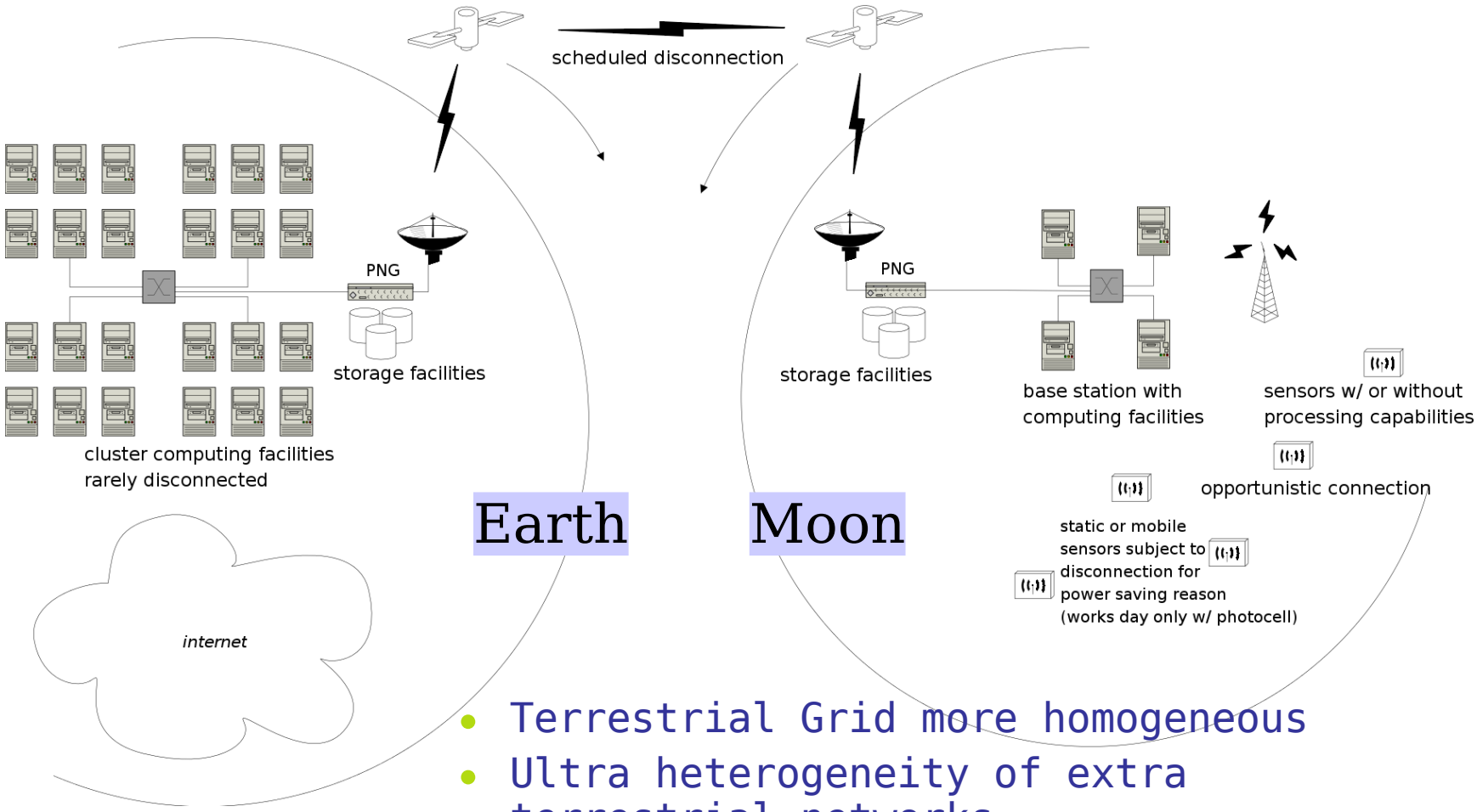
2 computing levels :

- Heavy computing on Earth
- Light computing / filtering / storage on moon/space station

3 Networking levels :

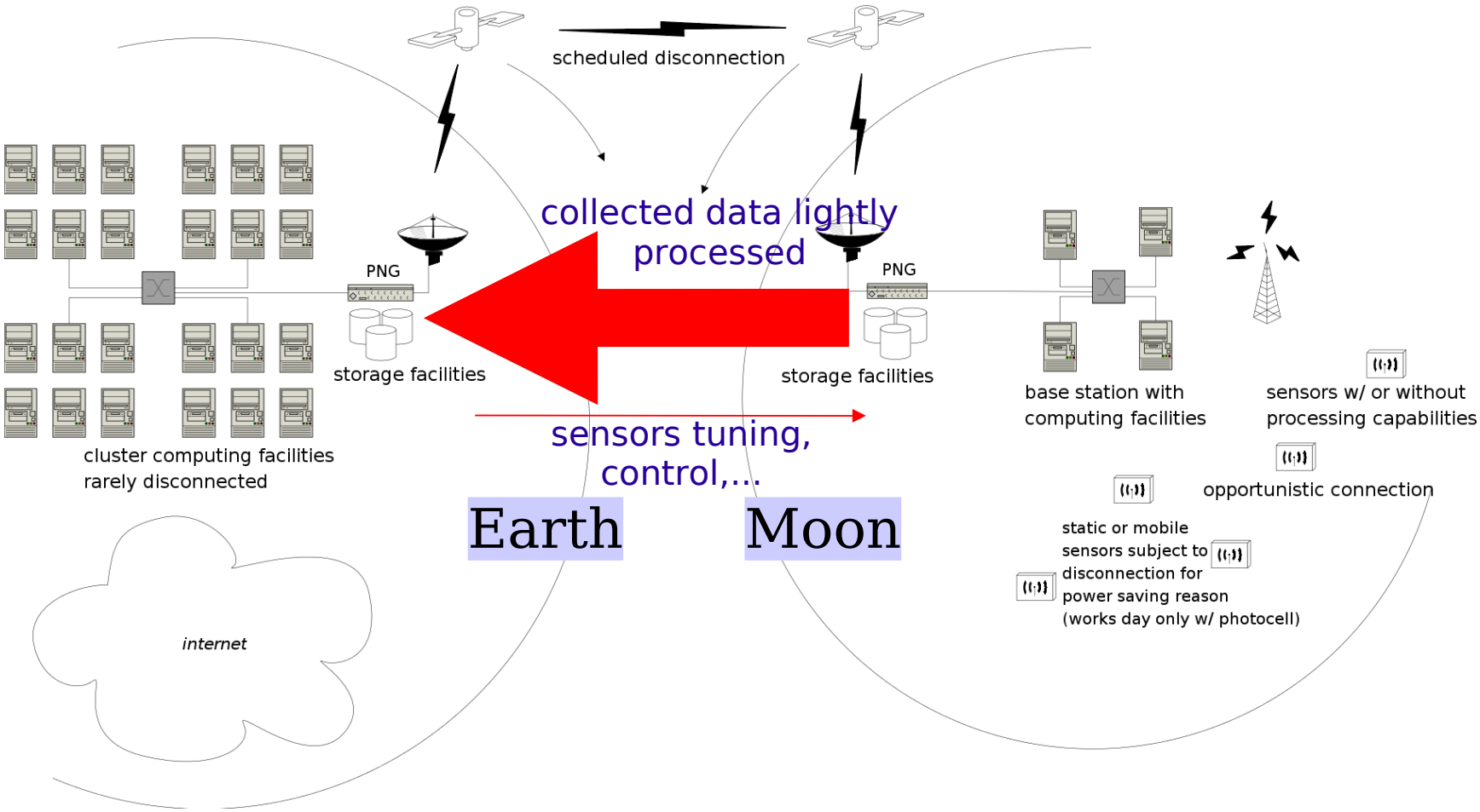
- High speed networking : between clusters on earth
- High latency networking : satellite link between earth and moon
- Low power networking : between sensors and light processing capabilities

A *MoonGrid* scenario: Grid between Earth and Moon



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

Heterogeneity in communications



Conclusions

- Given the available technologies, the concept of *MoonGrid* is far from Sci Fi
- The proposed architecture can also be applied to Grid infrastructure dealing with unreliable long distance network connections
- Our approach : first step to DTG *Disruption Tolerant Grids*
- We are looking for collaborations ! Contact us :-)