



Economic and On-Demand Brain Activity Analysis on the Grid



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[An initiative of the GridBus Project]

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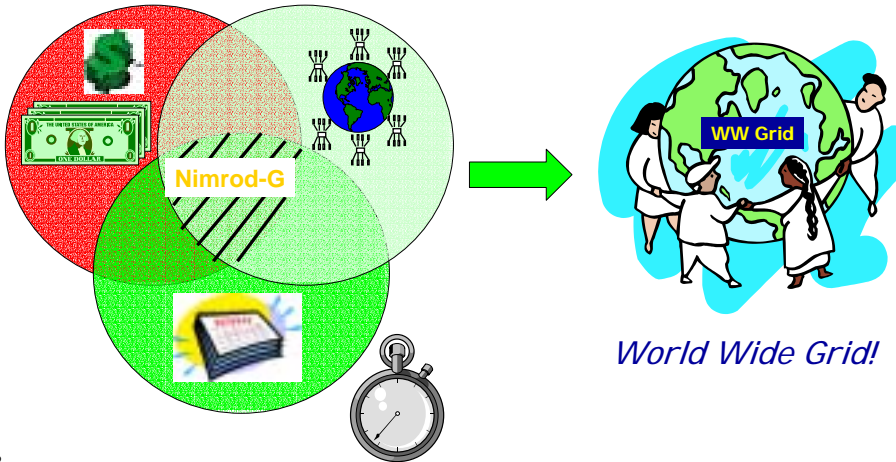
Susumu Date

David Abramson

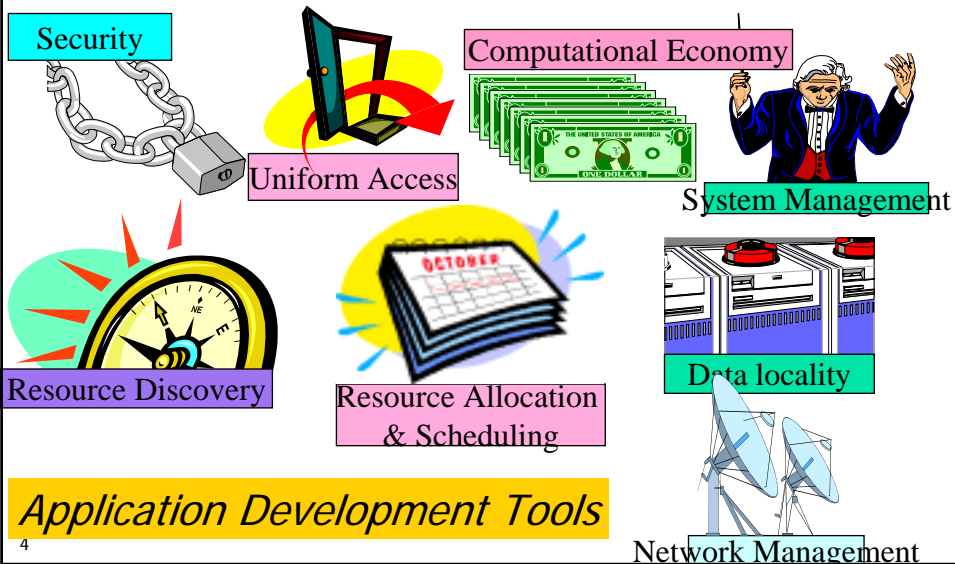
Yuko Mizuno-Matsumoto

OSAKA UNIVERSITY

The Gridbus Vision: To Enable Service Oriented Grid Computing & Business!



Need Grid tools for managing



GRIDS Lab @ the U. of Melbourne, The Gridbus Project: www.gridbus.org

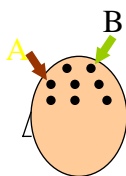
- Grid Economy & Distributed Scheduling (via Nimrod-G Broker)
 - <http://www.buyya.com/ecogrid>
- GridSim Toolkit: Grid Modeling and Simulation (Java based):
 - <http://www.buyya.com/gridsim/>
- Libra: Economic Cluster Scheduler
 - <http://www.buyya.com/libra/>
- Grid Bank: Accounting, Payment, Enforcement Mechanisms
- World Wide Grid (WWG) testbed:
 - <http://www.buyya.com/ecogrid/wwg/>
- Application Enabler Projects:
 - Virtual Laboratory Toolset for Drug Design
 - High-Energy Physics and the Grid Network (HEPGrid)
 - Brain Activity Analysis on the Grid
- Cluster and Grid Info Centres:
 - www.buyya.com/cluster/
 - www.gridcomputing.com



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MEG Data/Brain Activity Analysis

- MEG (Magnetoencephalography)
 - Achieve both **non-invasiveness** and **high degree of measurement accuracy**
cf. EEG (Electroencephalography), ECoG (Electrocorticography)
 - Measure functional data on multiple points around the head
 - Promising among medical doctors and brain scientists.



<http://www.cif.com>

Why is brain targeted?

- Aging society
 - Brain diseases caused from functional disorders e.g. Alzheimer's diseases
 - Early detection and therapy is effective for these disease.
- Challenge to unknown region in our body
 - Most parts of brain are still unknown in terms of brain function.

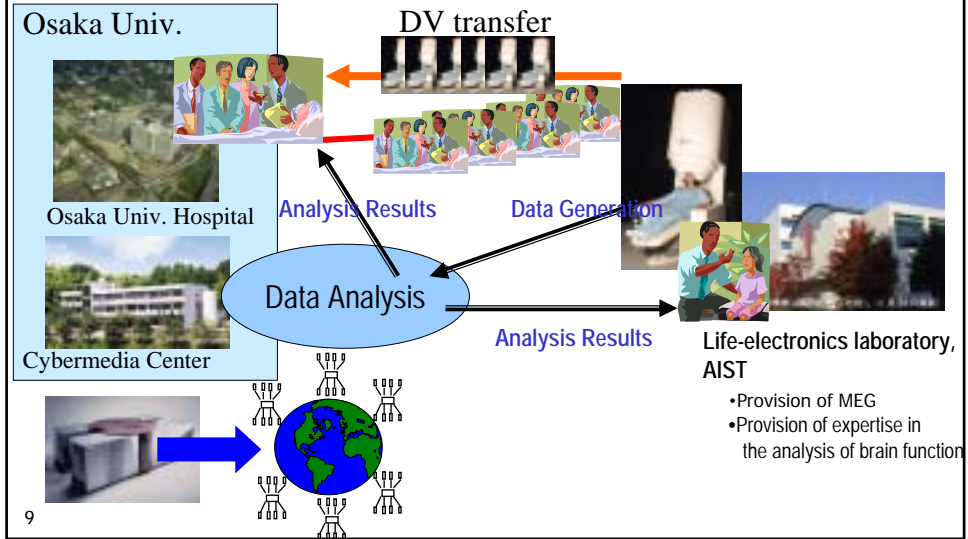
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Difficulties and Problems

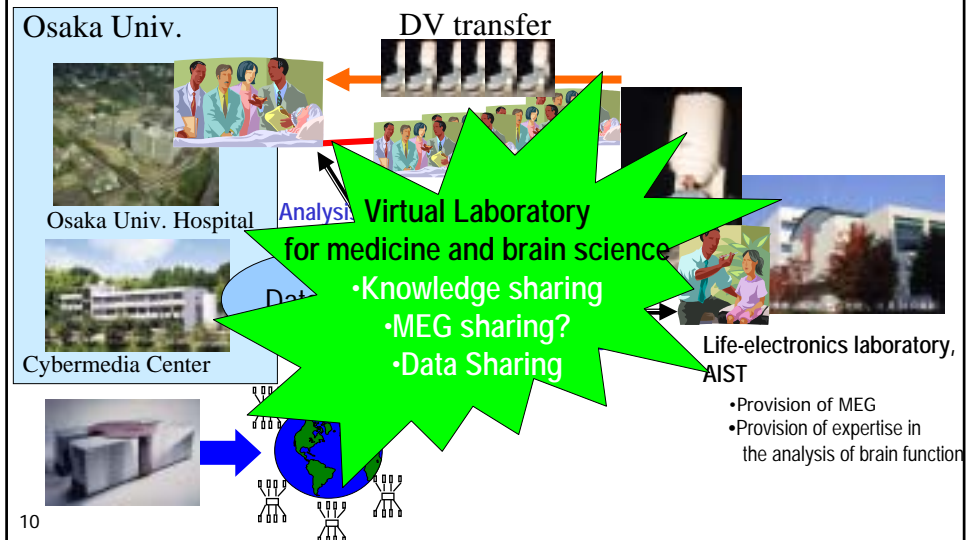
- The number of MEG instruments available is small.
- Knowledge of scientists is distributed.
 - No database?
 - Different group uses different analysis methods for different data..
- Many medical institutions and hospitals have no computers and that can satisfy doctors' analysis demand.

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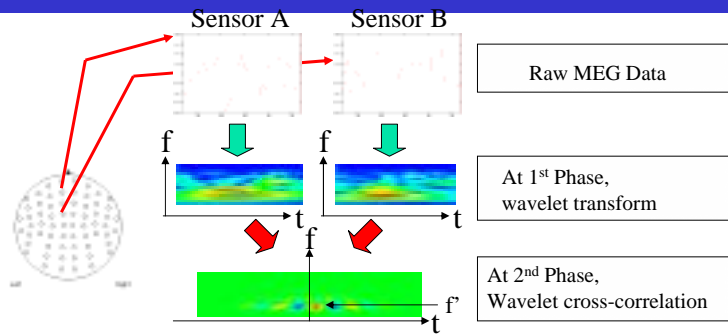
MEG data analysis on Grid



MEG data analysis on Grid



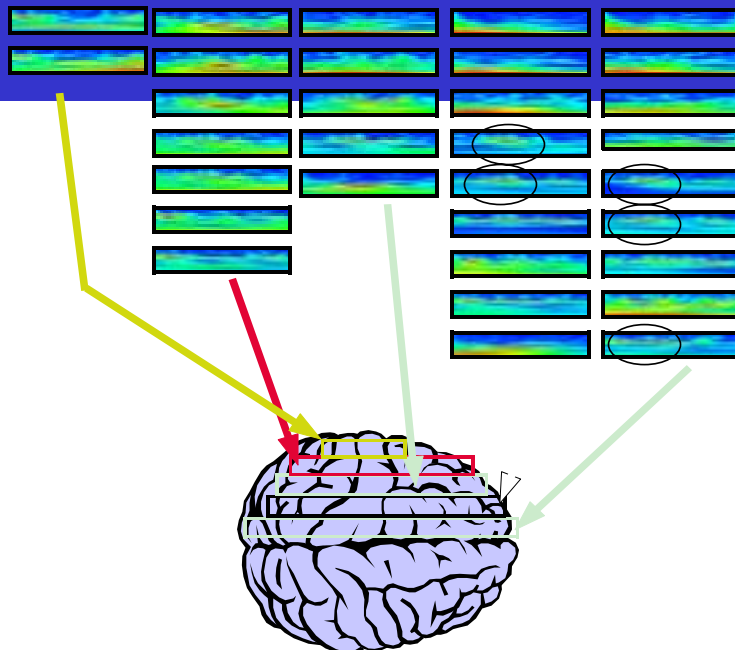
Wavelet cross-correlation analysis



This image indicates that a brain signal with frequency f' was detected earlier in Sensor B than in Sensor A.

- This analysis procedure needs to be performed for each pair of MEG sensors. E.g. 64ch -> 2016

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Computing requirements

■ Wavelet analysis

- Doctors want to know frequency components contained in MEG data because doctors determine if an interesting signal appears in the MEG data.



Doctors want to perform wavelet analysis for MEG data **in an interactive manner.**

■ Cross-correlation analysis

- Cross-correlation analysis quantifies the result of wavelet analysis.
- Cross-correlation analysis must be performed for all pairs of MEG sensors.
- Doctors want to obtain the result of cross-correlation analysis as fast as possible.



Doctors want to perform cross-correlation analysis **in a batch-processing manner.**

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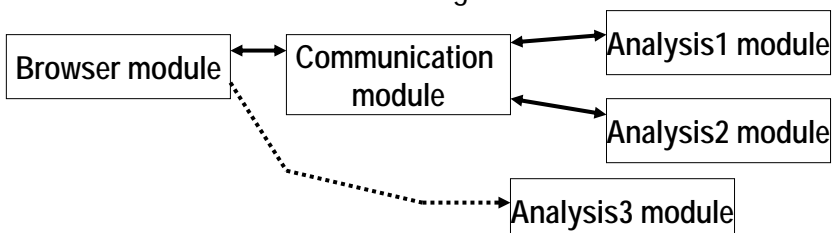
MPI based Parallelization

■ MPI CH-G2 –based structure

- Modular structure
 - Analysis module
 - Browser module
 - Communication module

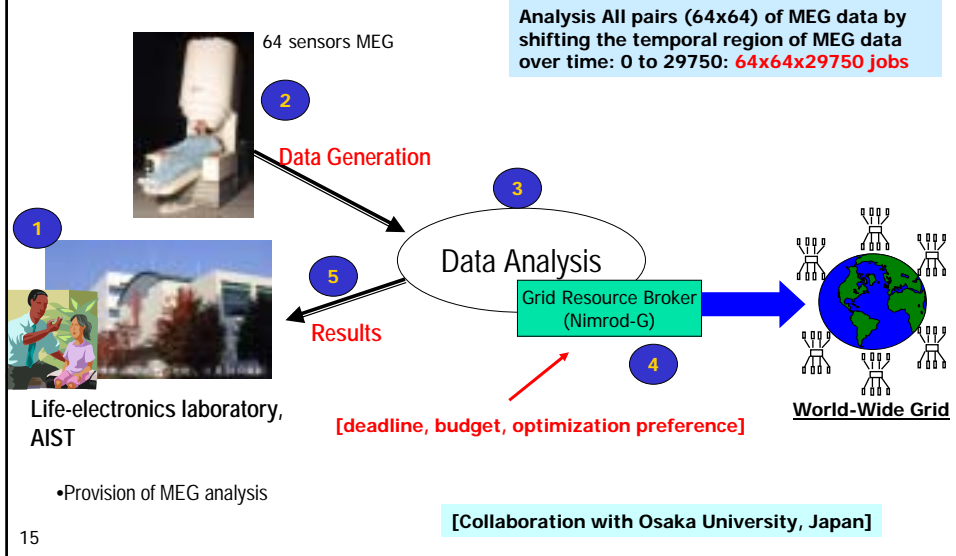


- Large Development effort (**Neuro scientific need to learn parallel program?**) + Limited Scalability + No QoS based Processing + Maintenance.



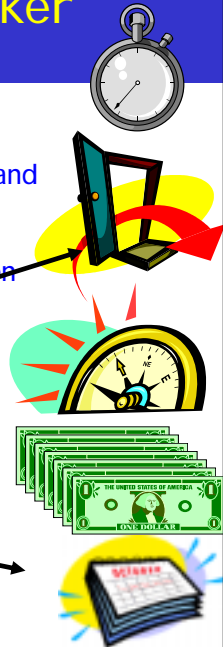
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Users QoS Requirements driven MEG Data Analysis on the Grid



Nimrod/G : A Grid Resource Broker

- A resource broker for managing, steering, and executing task farming (parameter sweep/SPMD model) applications on the Grid based on deadline and computational economy.
- Based on users' QoS requirements, our Broker dynamically leases services at runtime depending on their quality, cost, and availability.
- Key Features
 - A single window to manage & control experiment
 - Persistent and Programmable Task Farming Engine
 - Resource Discovery
 - Resource Trading
 - Scheduling & Predications
 - Generic Dispatcher & Grid Agents
 - Transportation of data & results
 - Steering & data management
 - Accounting



Nimrod-G based Parameterization

```

# PARAMETERS
parameter time_offset label "MEG Data Temporal Region Shift" integer range from 0 to 29750 step 50;
parameter MetaJobSize label "Meta Job Size, same as time_offset parameter step size" integer default 50;
parameter meg_sensors_count label "number of MEG sensors" integer default 2;

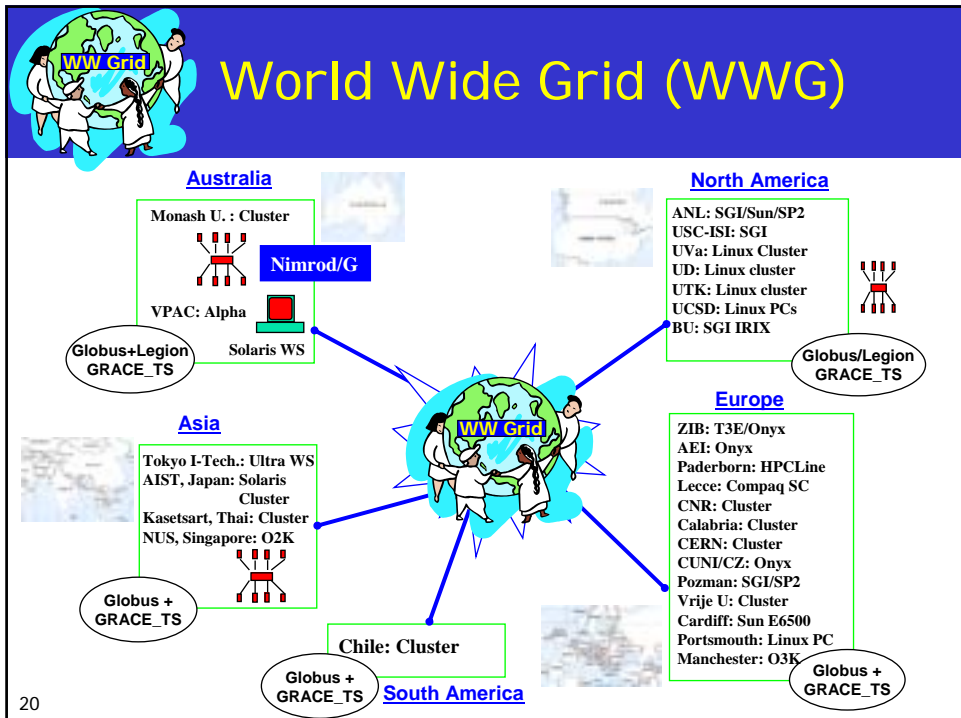
# DATA+PROGRAM STAGING
task nodestart
  copy meg_data.tar node:
  copy raw2wavelet.$OS node:raw2wavelet
  copy wavelet2cross.$OS node:wavelet2cross }
  copy metameg.$OS node:metameg
endtask

int time_offset; /* the paramter that shifts temporal region of MEG data over time */ int time_offset_step; /* this
indicates number of waveletcross processing jobs packaged */ int meg_sensors; /* number of sensors in Magneto-
encephalo-graphy (MEG) */

# Execution: Wavelet + Cross correlation [pair wise cross correlation for each offset value]
task main
  node:execute /bin/tar xvf meg_data.tar
  node:execute ./metameg $time_offset $MetaJobSize $meg_sensors_count
  node:execute /bin/tar cvf output.tar *.asc *.ppm
  copy node:output.tar output.tar.$jobname
endtask

```

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WWG Resources Used

```

globus hpc420.hpcc.jp timezone=+9 1
globus hpc420-1.hpcc.jp timezone=+9 3
globus hpc420-2.hpcc.jp timezone=+9 1
globus hpc220-1.hpcc.jp timezone=+9 2
globus hpc220-2.hpcc.jp timezone=+9 1
globus hpc220-3.hpcc.jp timezone=+9 2
globus onyx1.zib.de timezone=+1 1
globus onyx3.zib.de timezone=+1 2
globus origin.aei.mpg.de timezone=+1 1
globus mat.ruk.cuni.cz timezone=+1 3
globus prosecco.cnuce.cnr.it timezone=+1 1
globus barbera.cnuce.cnr.it timezone=+1 4
globus novello.cnuce.cnr.it timezone=+1 2
globus marge.csm.port.ac.uk timezone=0 1
globus pitcairn.mcs.anl.gov timezone=-6 1
    
```

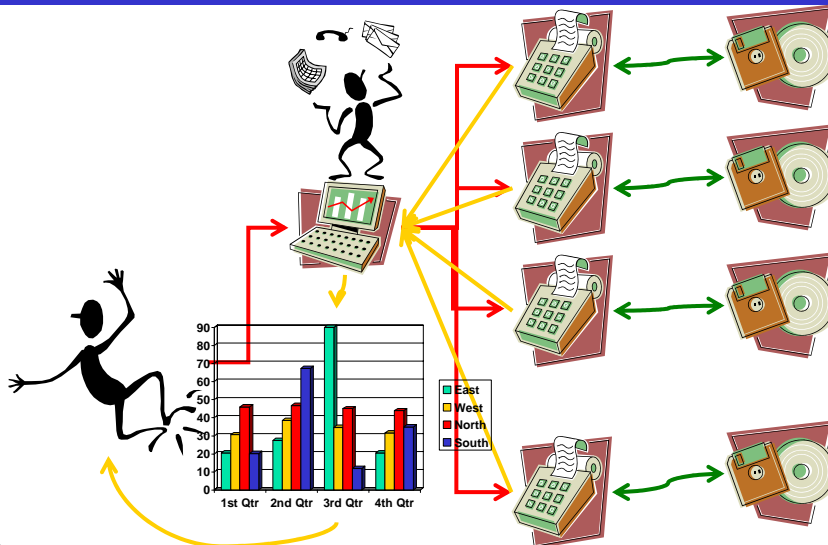
(Resource URL)

Cost: CPU/sec.



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Nimrod-G Broker Automating Distributed Processing



22 Compose, Submit, & Play!

Thank You.



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- Visit The GRID S Lab and The GridBus Project:
 - <http://www.gridbus.org>
- We welcome Collaborations: Talk to me now or email later.

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Download Software & Information



- Nimrod & Parameteric Computing:
 - <http://www.csse.monash.edu.au/~davida/nimrod/>
- Economy Grid & Nimrod/G:
 - <http://www.buyya.com/ecogrid/>
- Virtual Laboratory Toolset for Drug Design:
 - <http://www.buyya.com/vlab/>
- Grid Simulation (GridSim) Toolkit (Java based):
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