H23年度宇宙科学情報解析シンポジウム
H24 (2012)年2月15日、ISAS/JAXA、新A棟二階会議室

クラウド環境での磁気圏シミュレーションの3次元多重画像解析

Multiple 3D Visualization of Magnetosphere Simulation under Science Clouds

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Solar-Terrestrial Environment Laboratory,
Nagoya University

CSI Project（e-Science Program）Basic Study for Geospace Virtual Observatory/Virtual Organization

NAREGI Grid Middleware Version 1

Functions of NAREGI Grid System

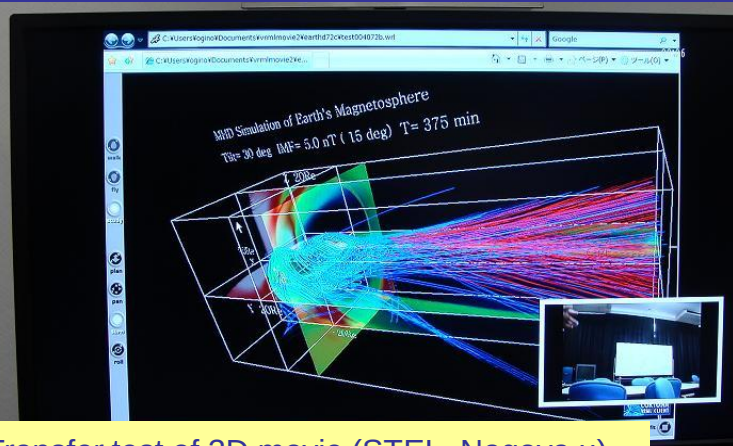
- Information Service
- Grid PSE
- Grid Workflow Tool
- GVS (Grid Visualization System)
- Data Grid

VO (Virtual Organization)

Basic Study for Geospace Virtual Observatory/Virtual Organization

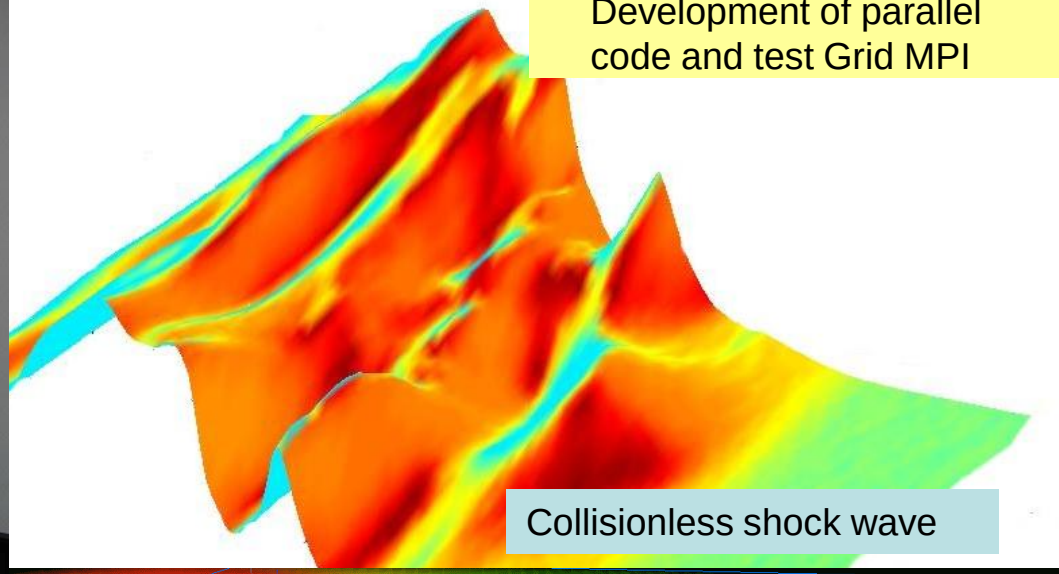
STEL and ITC of Nagoya University

1. Visualization Grid and Virtual Reality (VR)
   Remote 3D movie common usage



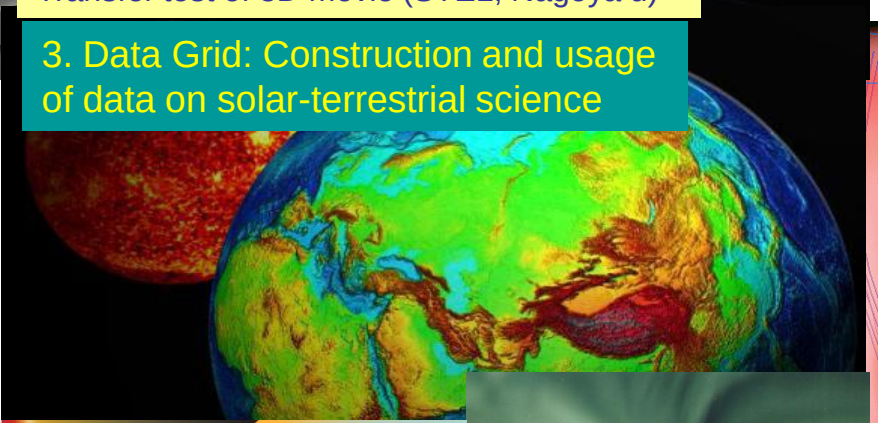
Transfer test of 3D movie (STEL, Nagoya u)

2. Grid Supercomputing and geospace simulator: Development of parallel code and test Grid MPI

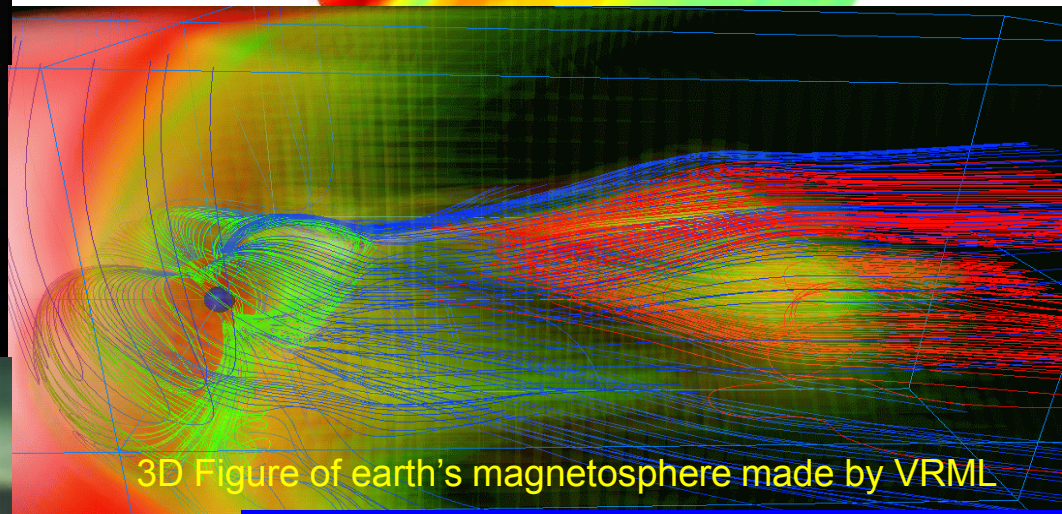


Collisionless shock wave

3. Data Grid: Construction and usage of data on solar-terrestrial science



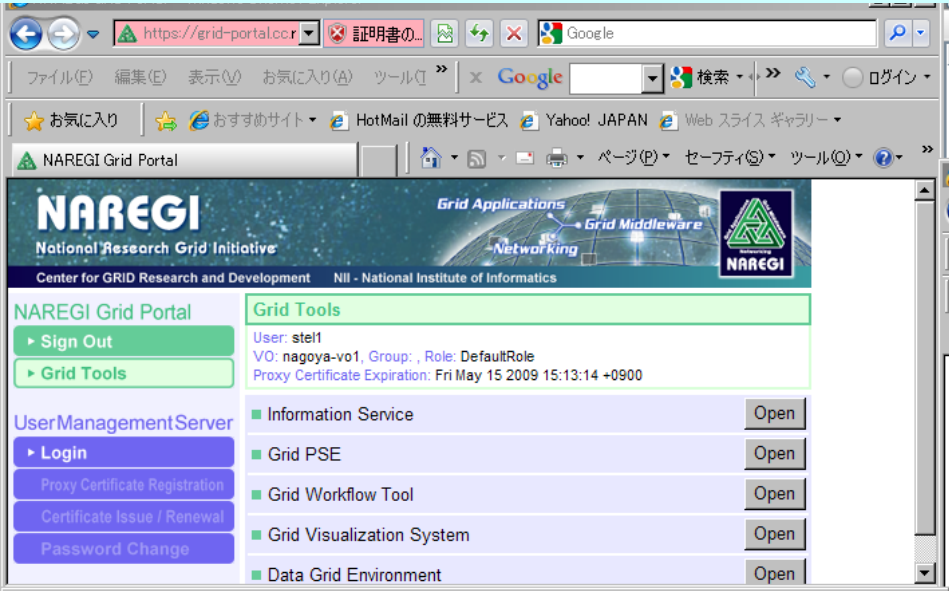
CAWSES and CAWSES-II Database in Japan (2007-2013)

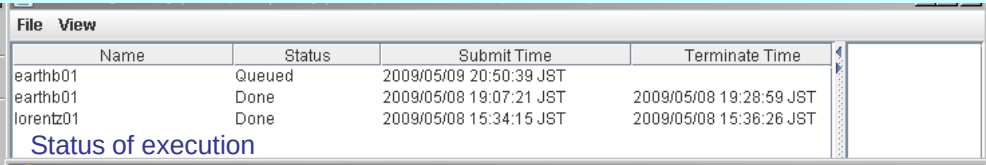


3D Figure of earth's magnetosphere made by VRML

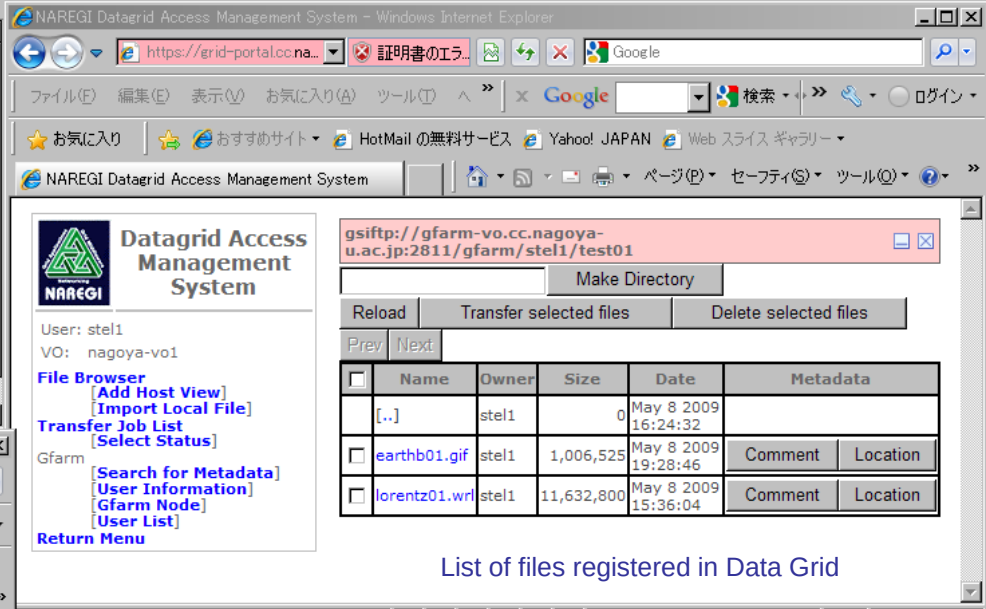
4. Test of Grid 3 functions and integration by NAREGI Middleware Version 1 of ITC, Nagoya U

Processing and graphics of simulation data with NAREGI Grid Portal

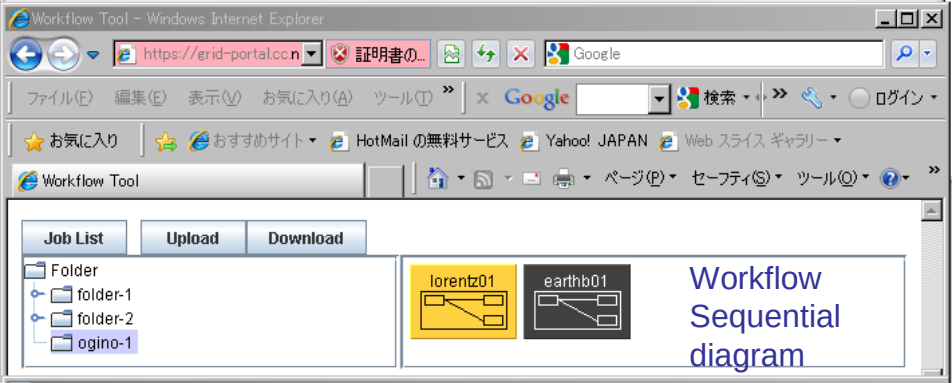




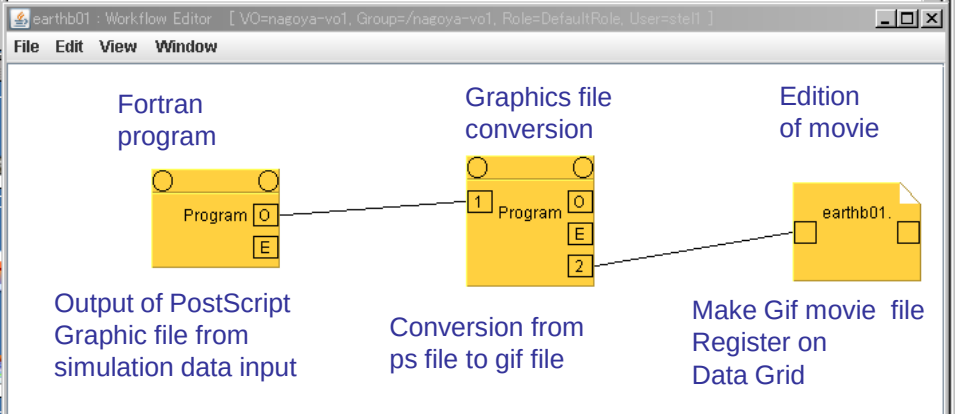
Status of execution



List of files registered in Data Grid



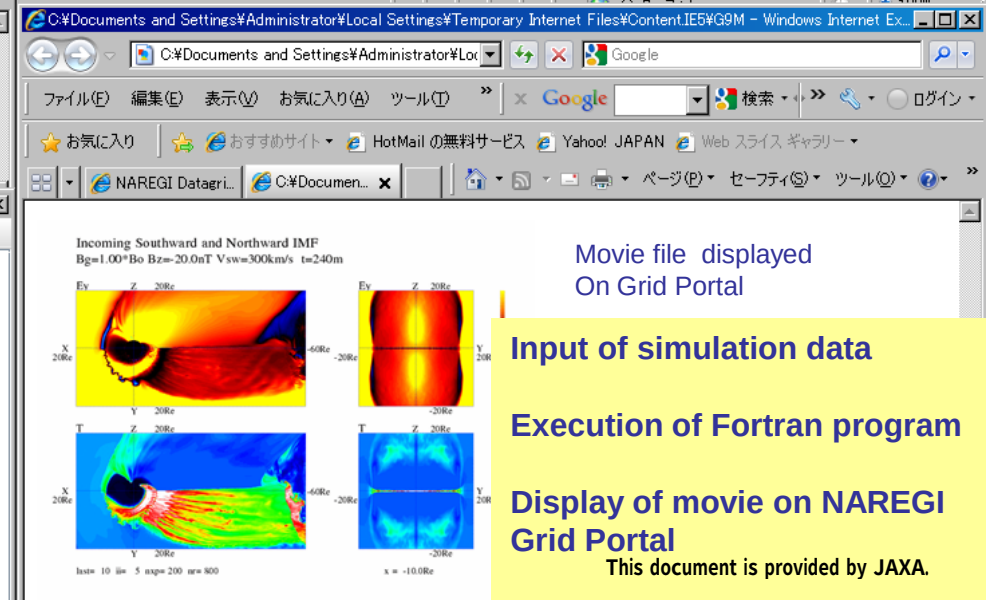
Workflow Sequential diagram



Output of PostScript Graphic file from simulation data input

Conversion from ps file to gif file

Make Gif movie file Register on Data Grid



Movie file displayed On Grid Portal

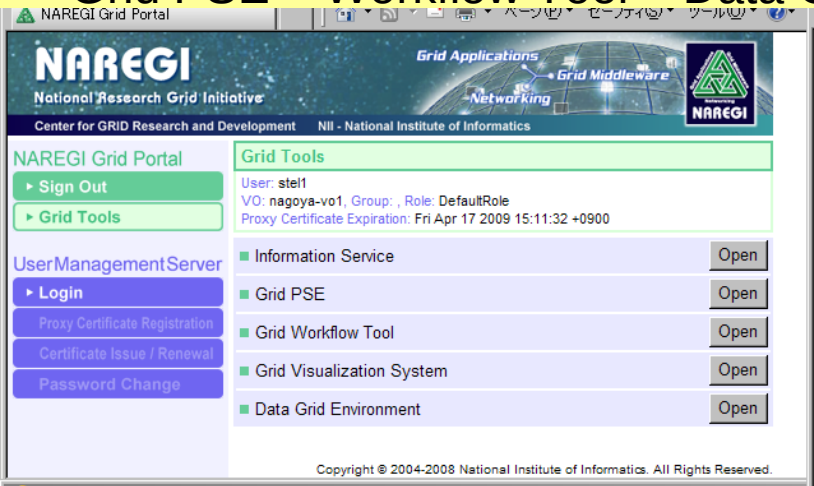
Input of simulation data

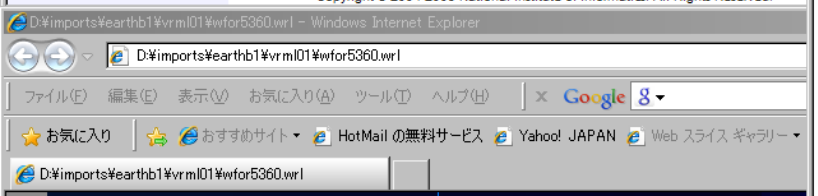
Execution of Fortran program

Display of movie on NAREGI Grid Portal

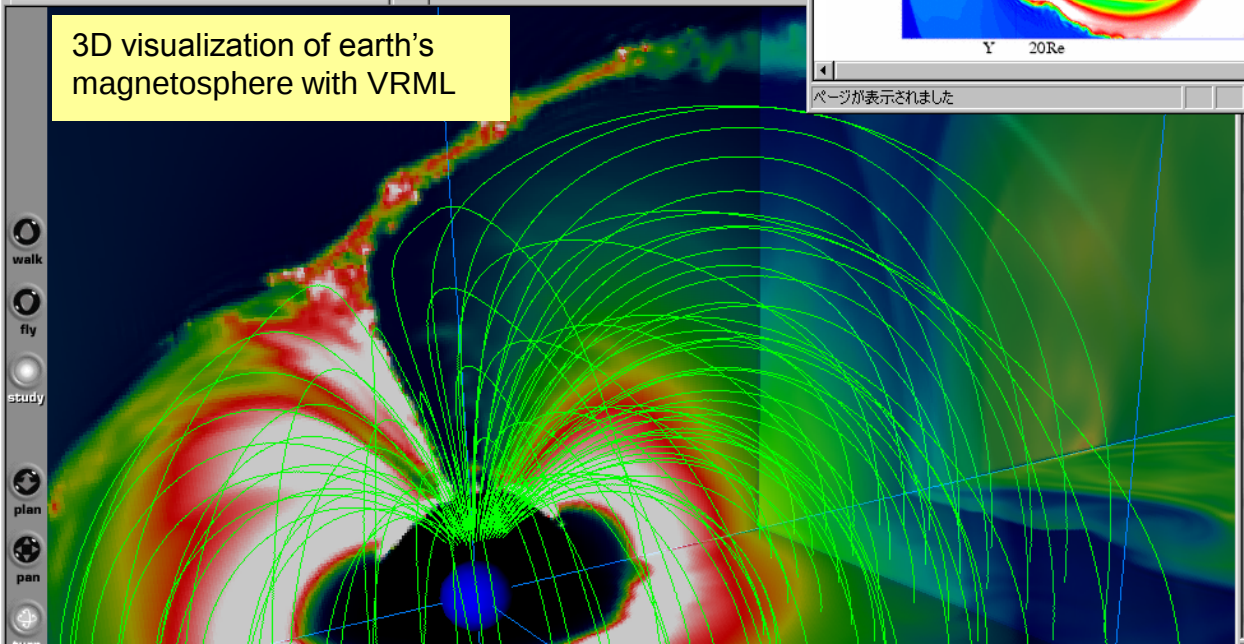
Execution with NAREGI Grid Portal and Graphics with Data Grid

Grid PSE + Workflow Tool + Data Grid → Graphics and 3D Visualization with VRML

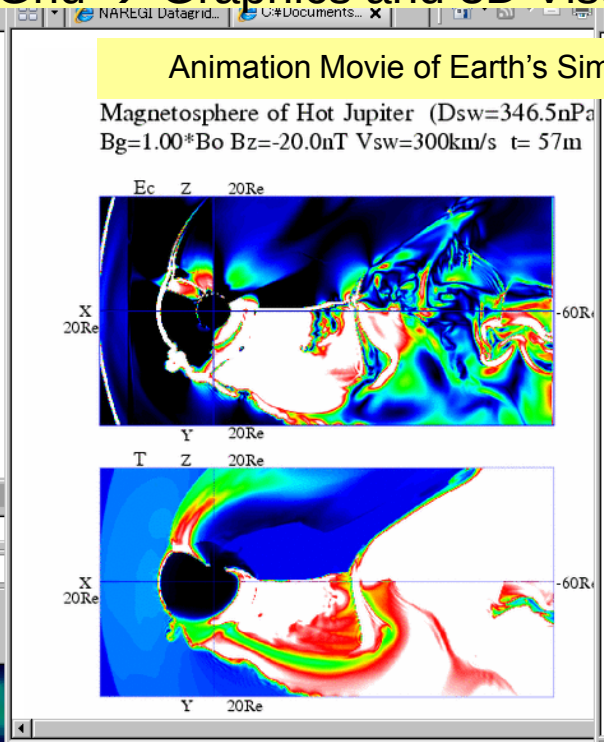


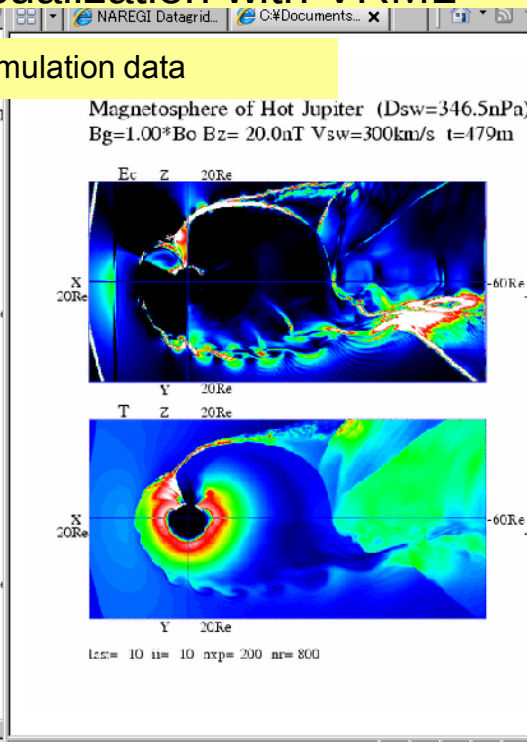


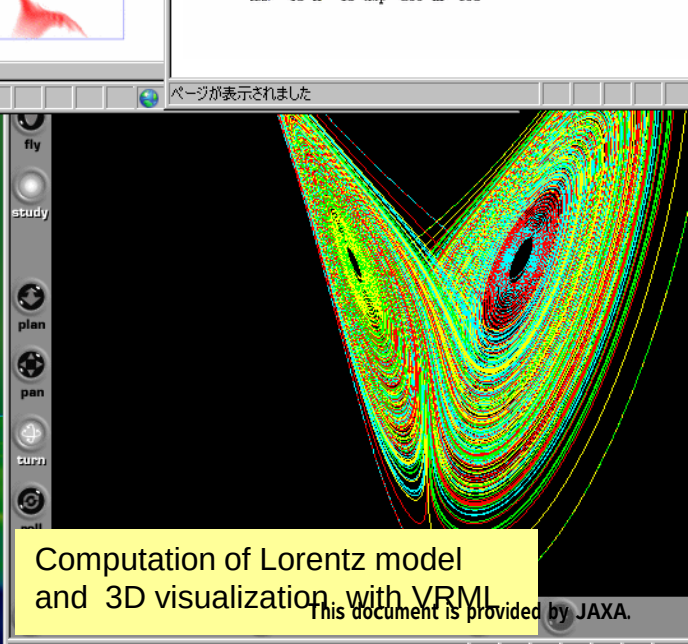
3D visualization of earth's magnetosphere with VRML



Animation Movie of Earth's Simulation data

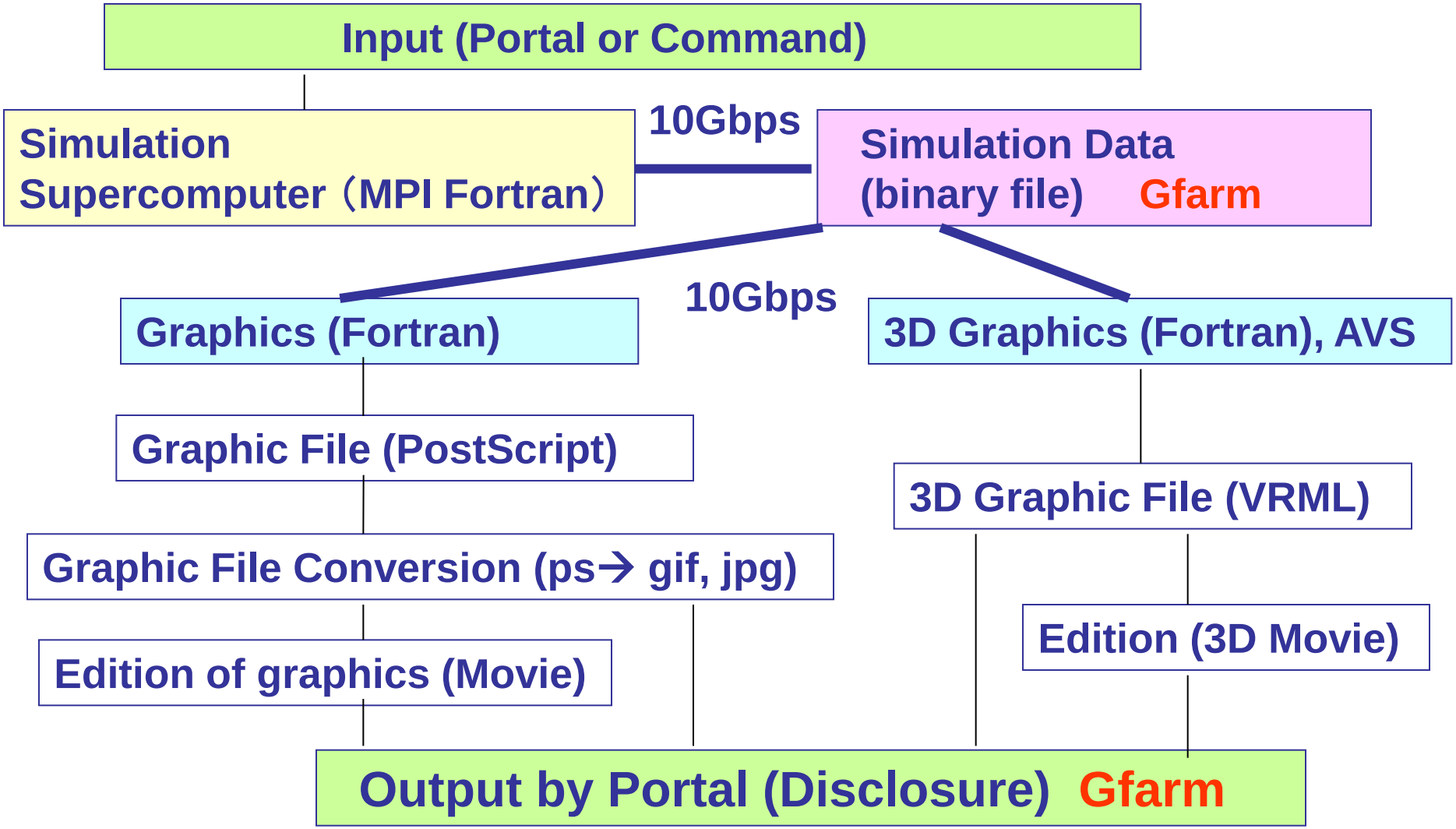




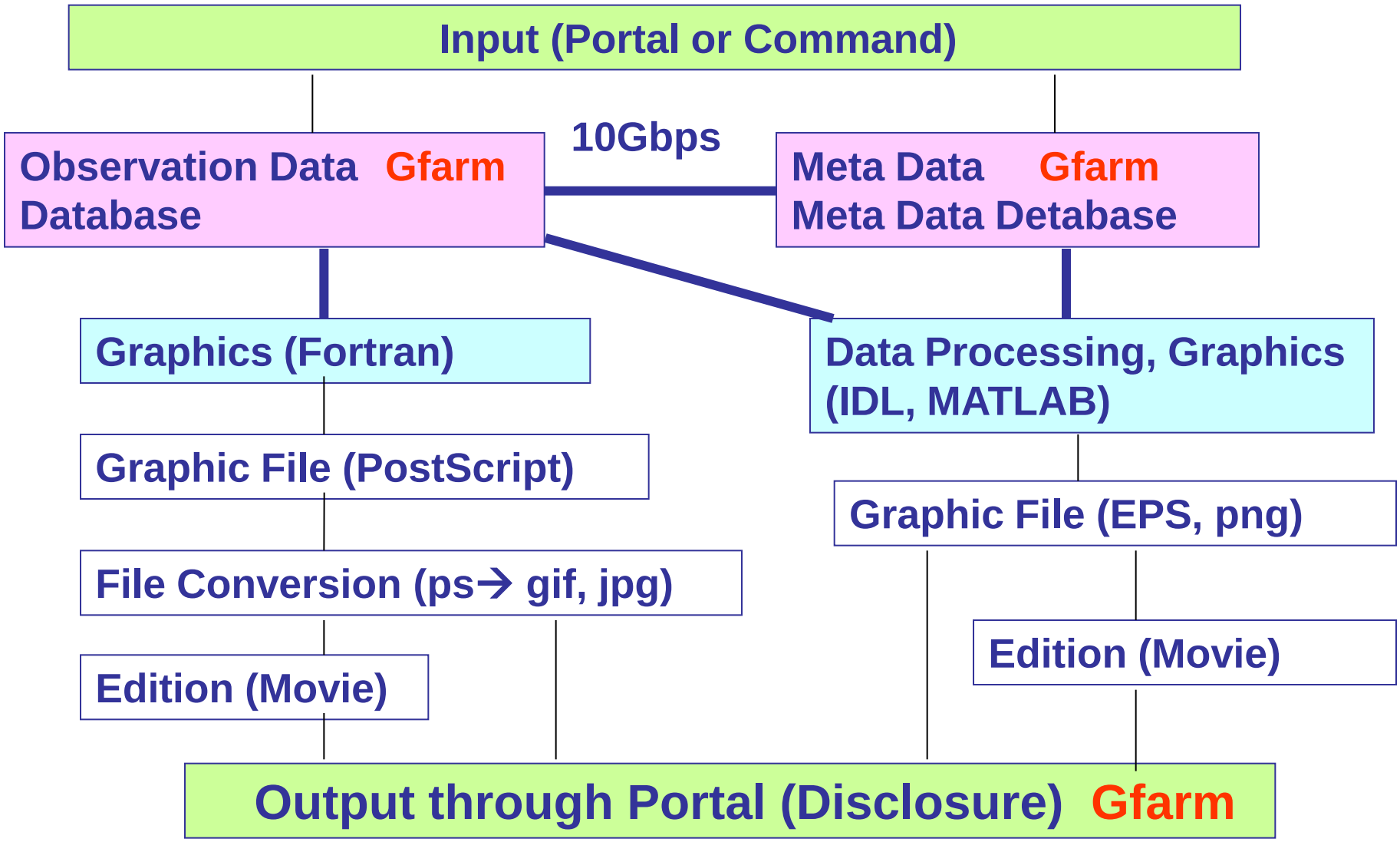


Computation of Lorentz model and 3D visualization with VRML

Integration of Simulation
Workflow (Network)

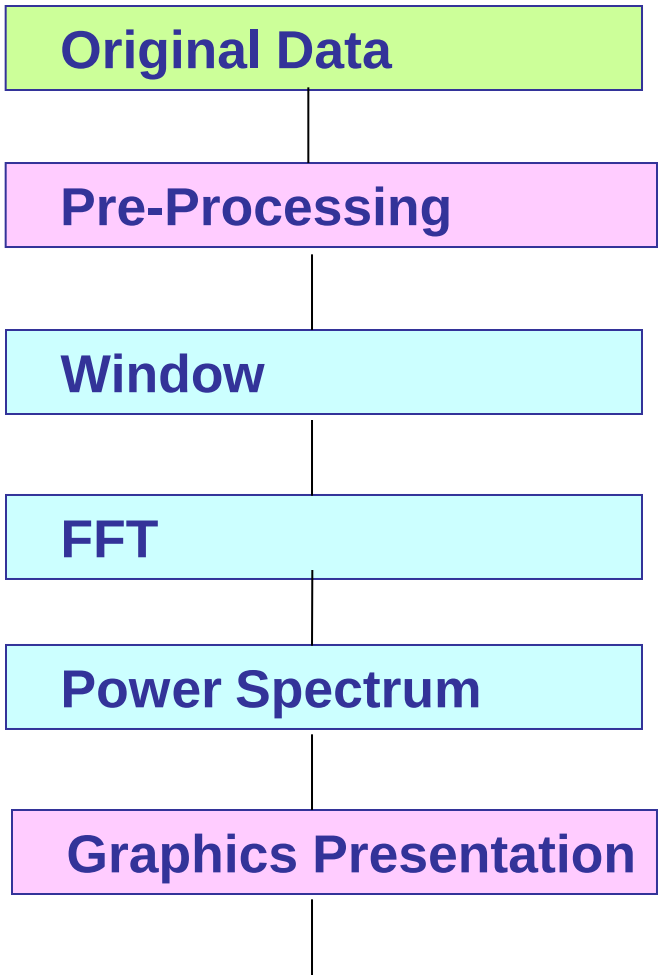


Observation Data
Workflow (Network)



Data/Graphics Processing

Network: Process and Data on Screen + Pick Up



Time sequential data

Data Pre-Processing

Haming, Haning windows

Real and Imaginary Parts

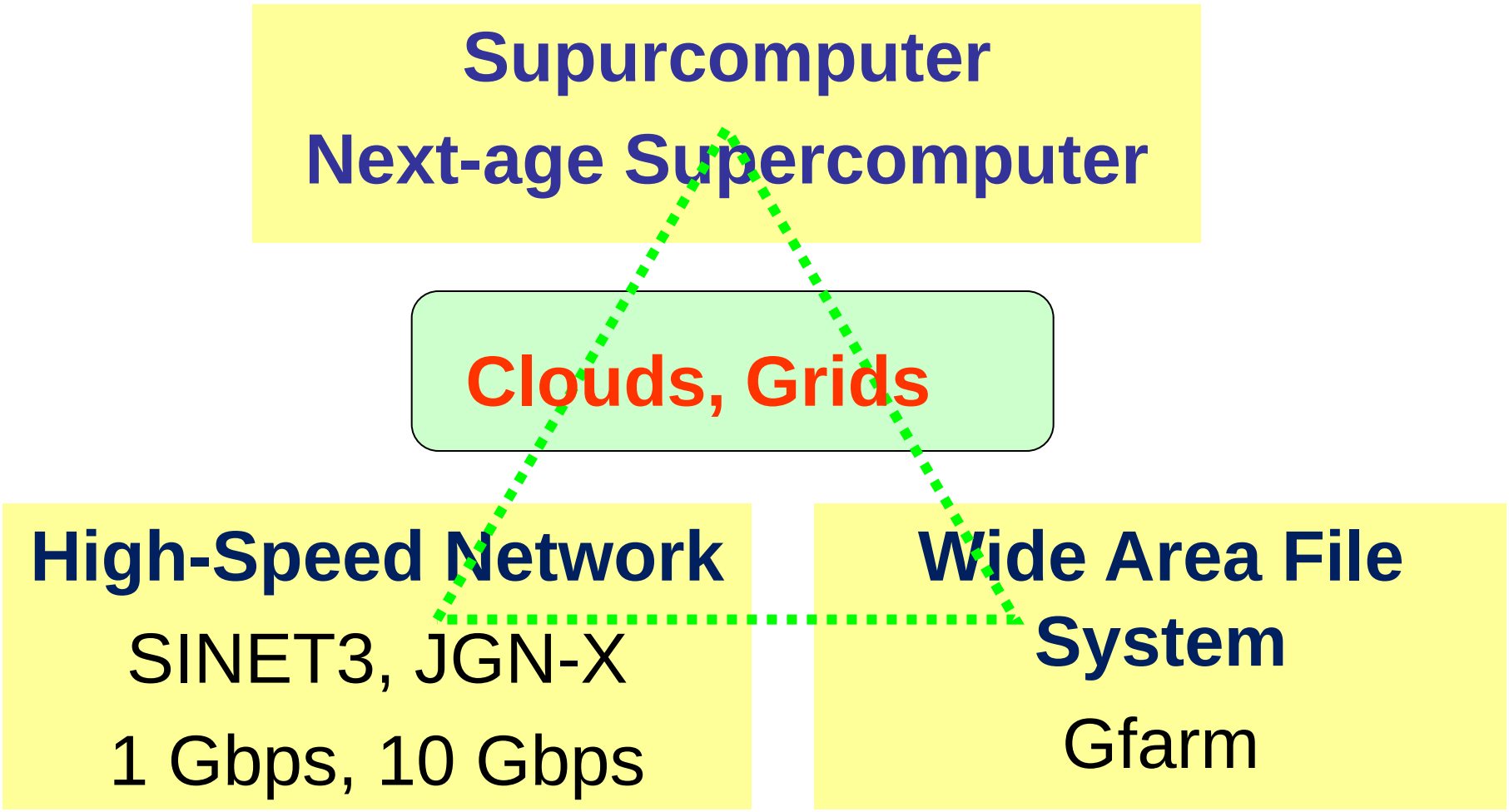
Amplitude, phase (phase velocity)

Linear, Logrizm

NASA
PDS

Screen Presentation of Process and Results and Pick Up One

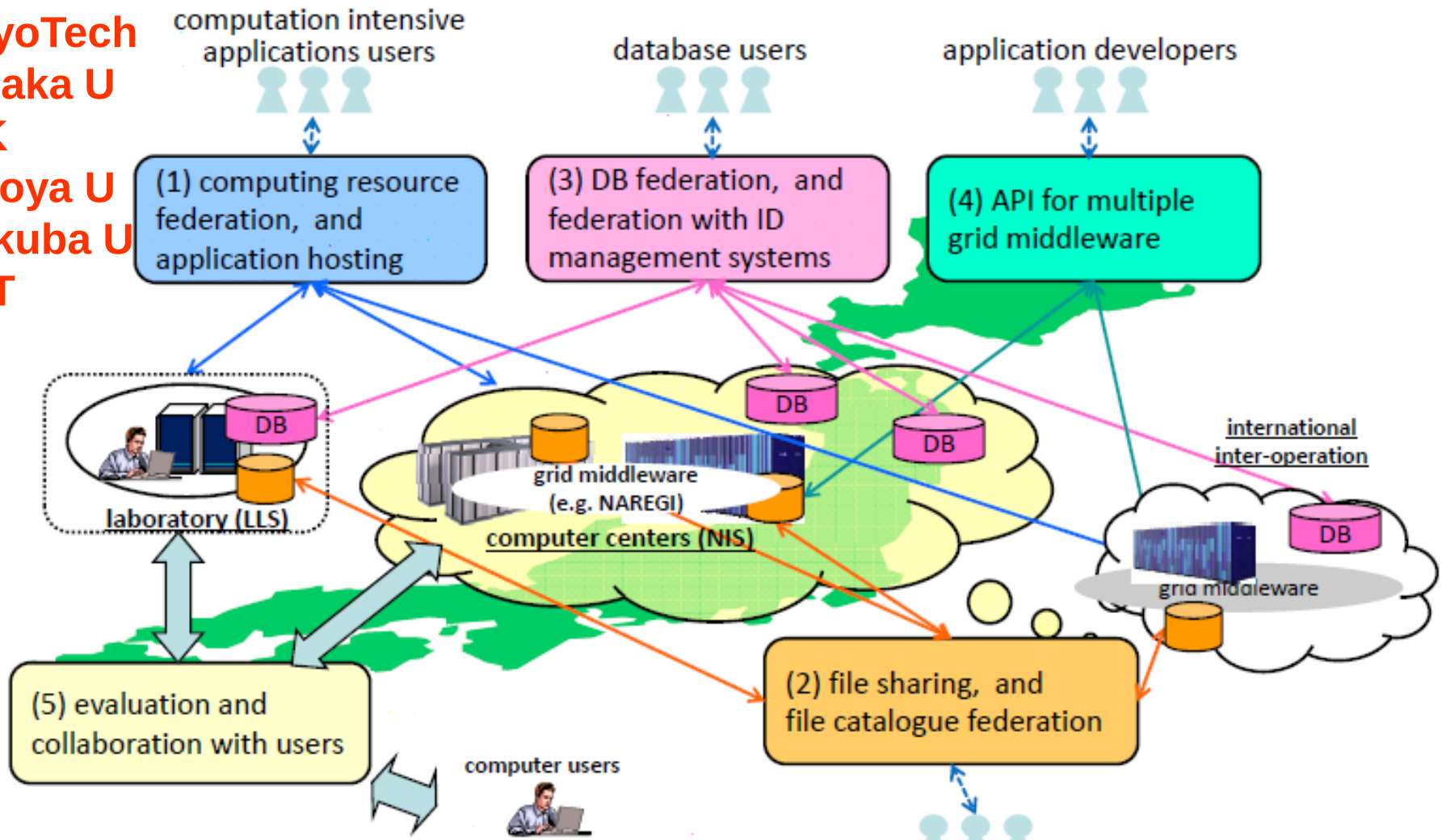
New Trends on Advanced IT Usage



How can we use the IT in simulation and data analyses?

REsources liNKage for E-sclence (RENKEI)

NII +
TokyoTech
Ohsaka U
KEK
Nagoya U
Tsukuba U
AIST



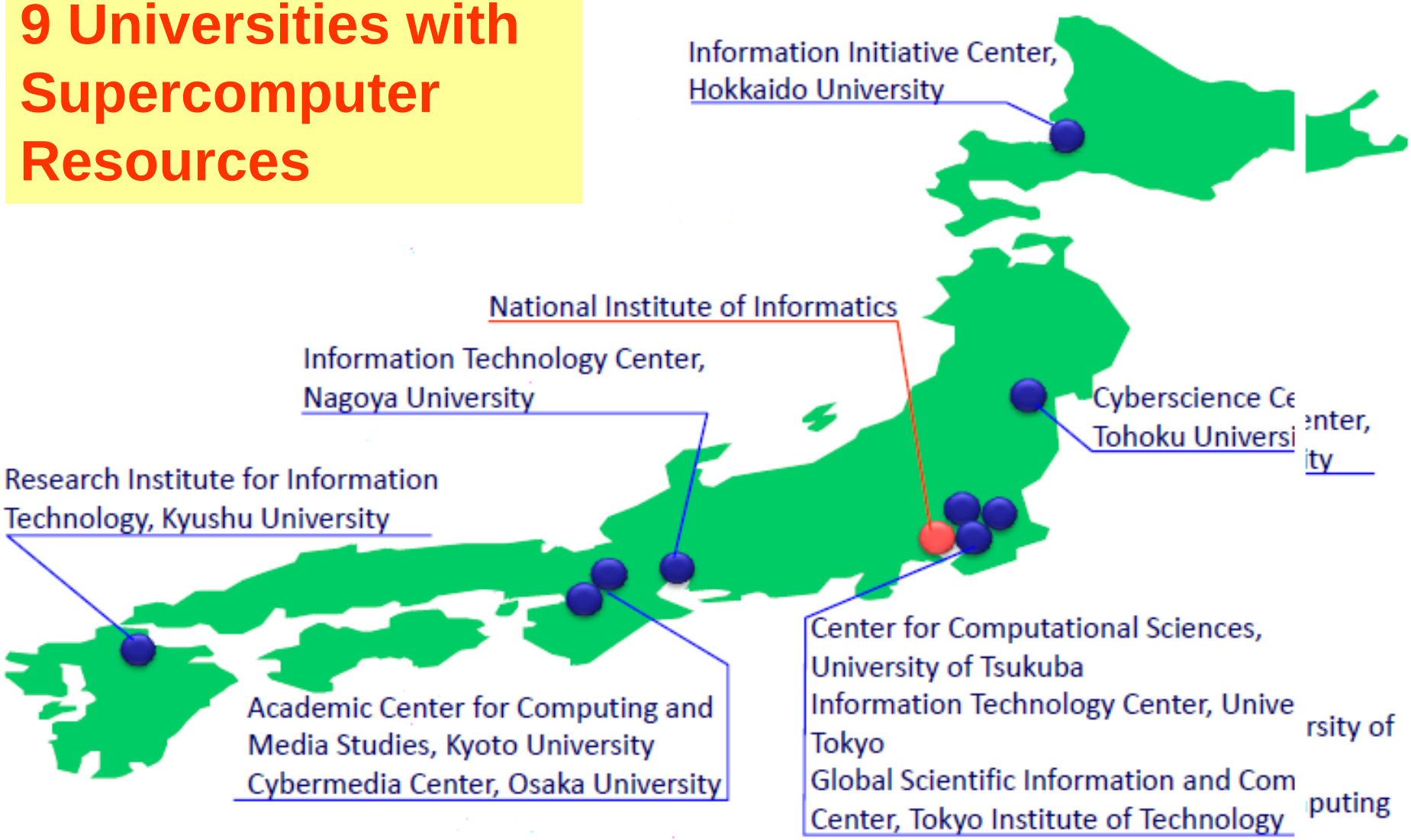
NII

Kento Aida, National Institute of Informatics

NII + 9 Universities with Supercomputer Resources

Sites

CSI GRID



Gfarm storage system

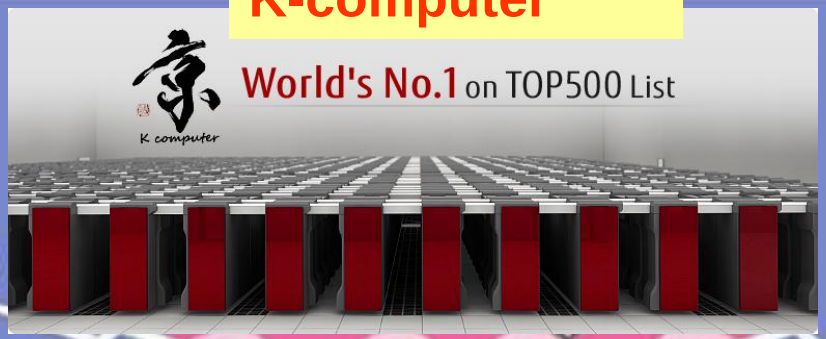
NII

Kento Aida, National Institute of Info
rmatics

Computing Systems in CSI →HPCI

CSI Grids

K-computer



Next Generation Supercomputer (K-computer)

Gfarm storage

NII + 9 Universities

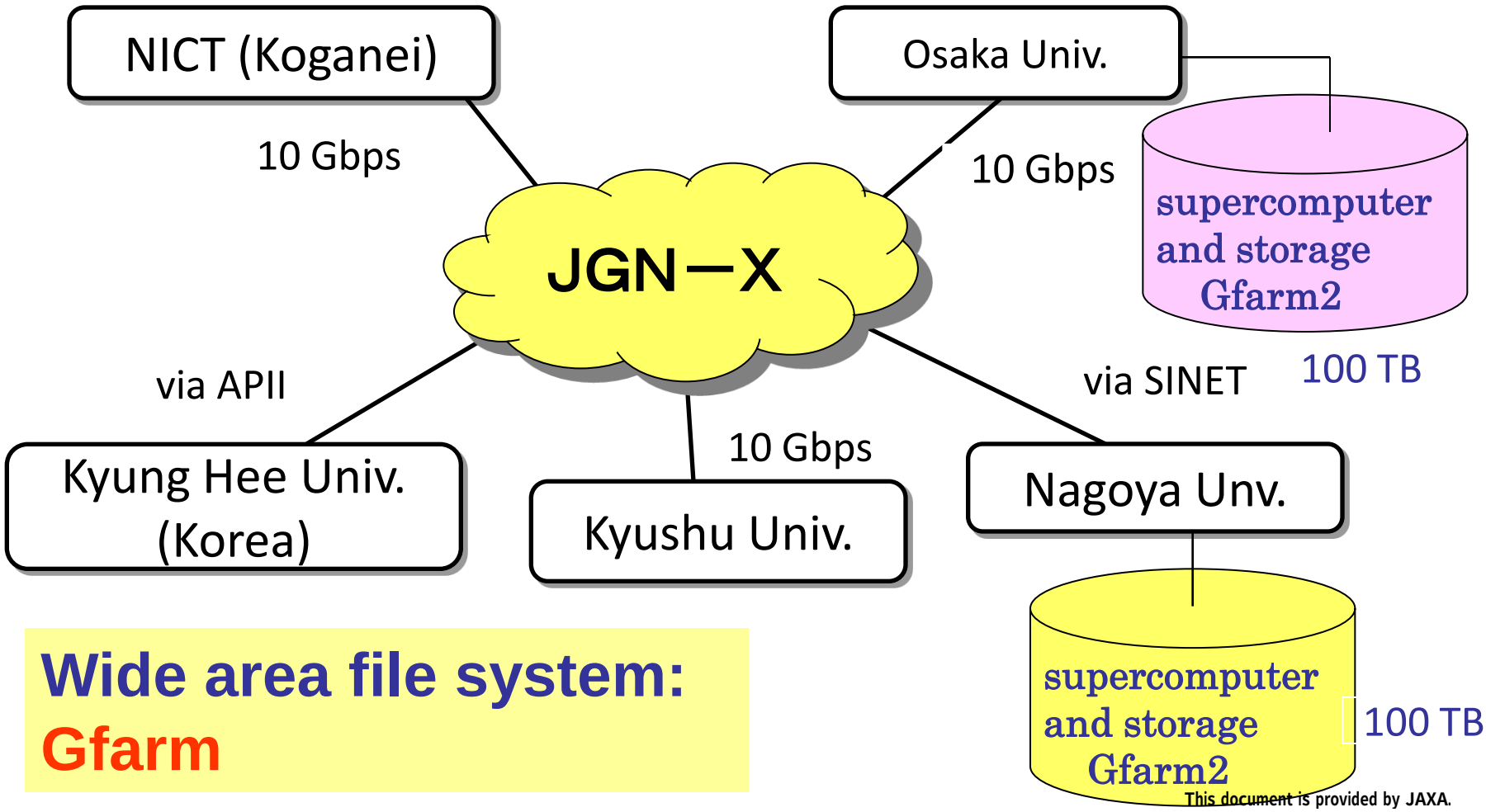
NII

Kento Aida, National Institute of Informatics

Network Topology of JGN-X

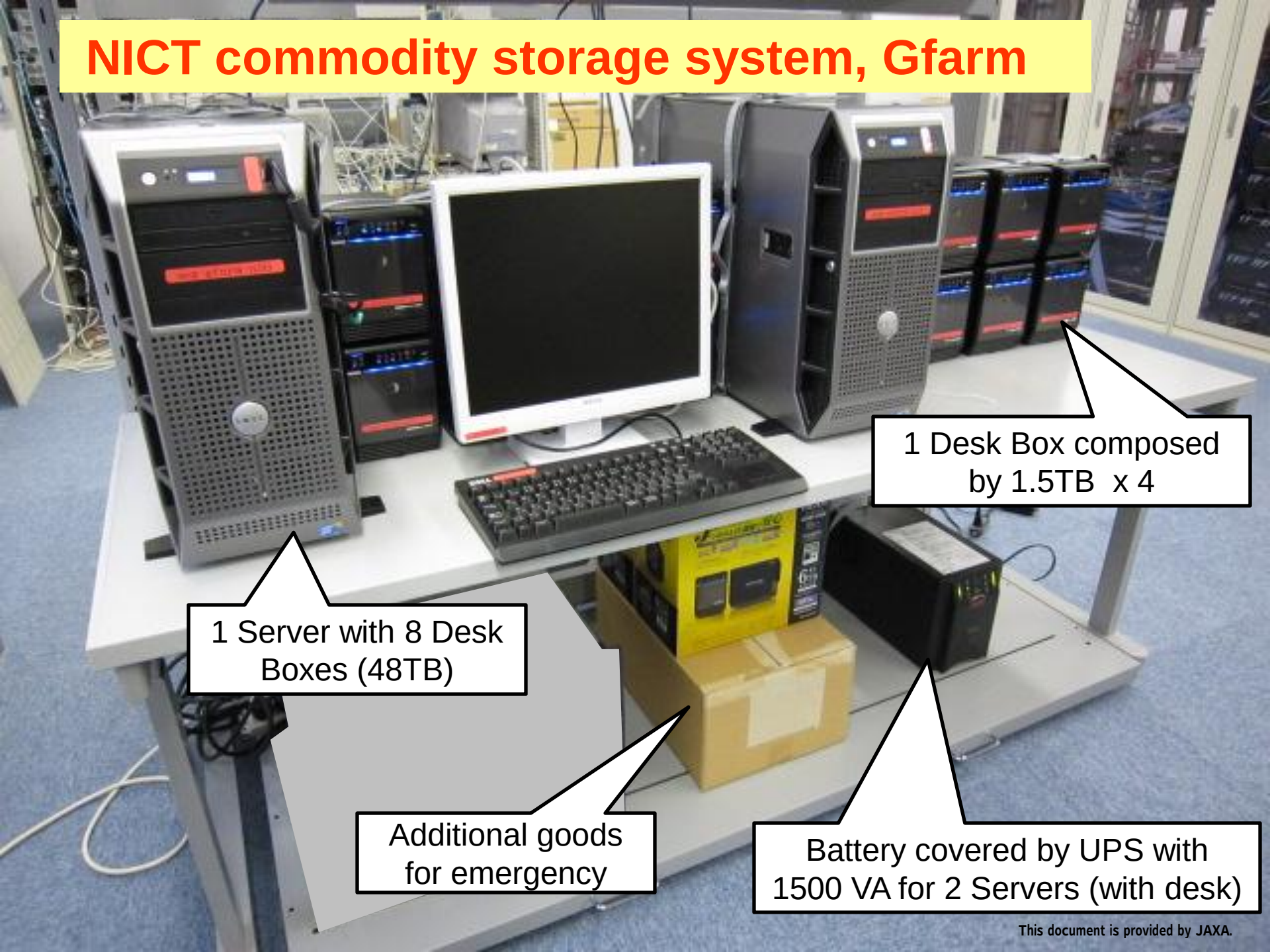
NICT OneSpaceNet (10 Gbps)

Construction of geospace science clouds

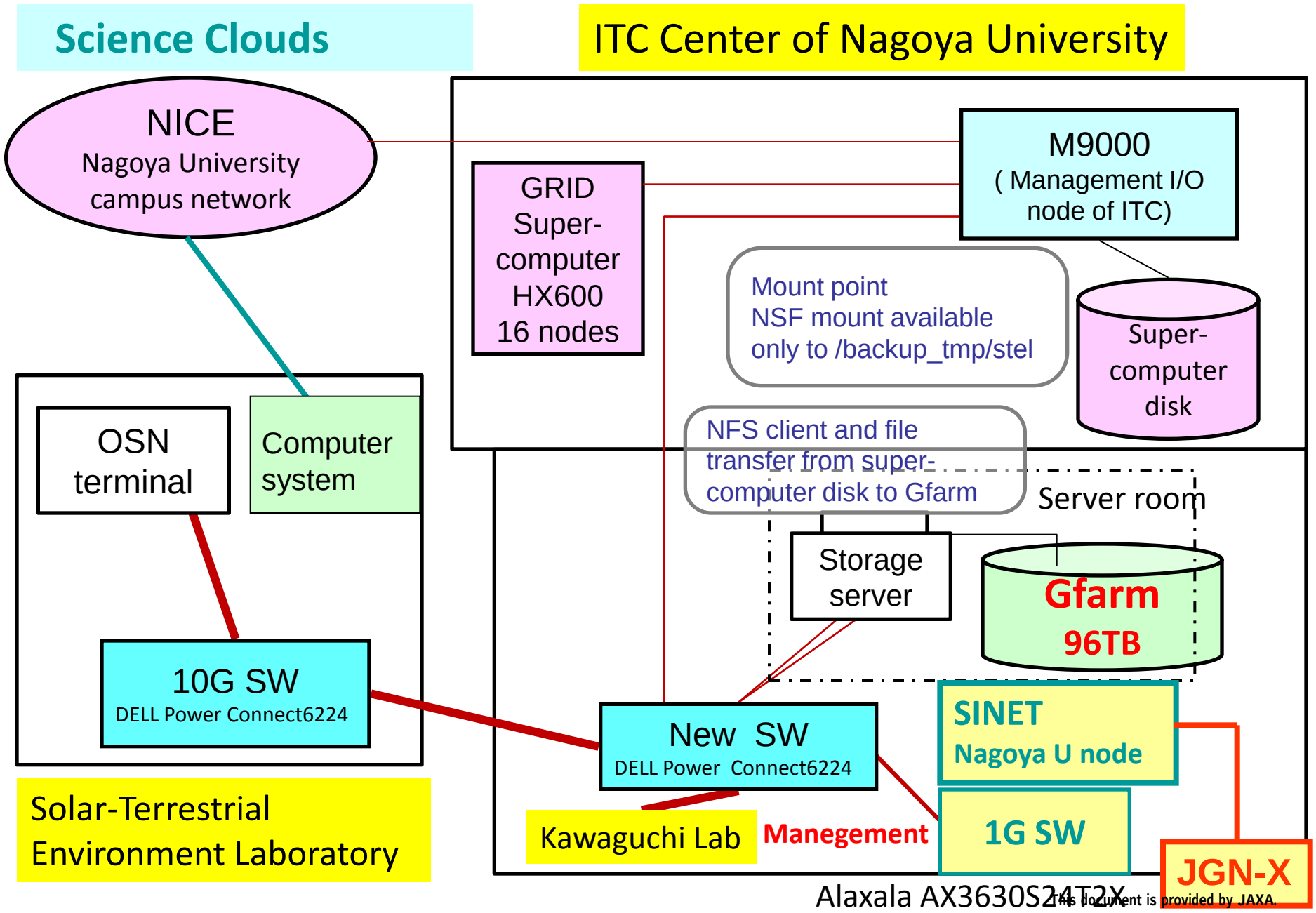


Wide area file system: Gfarm

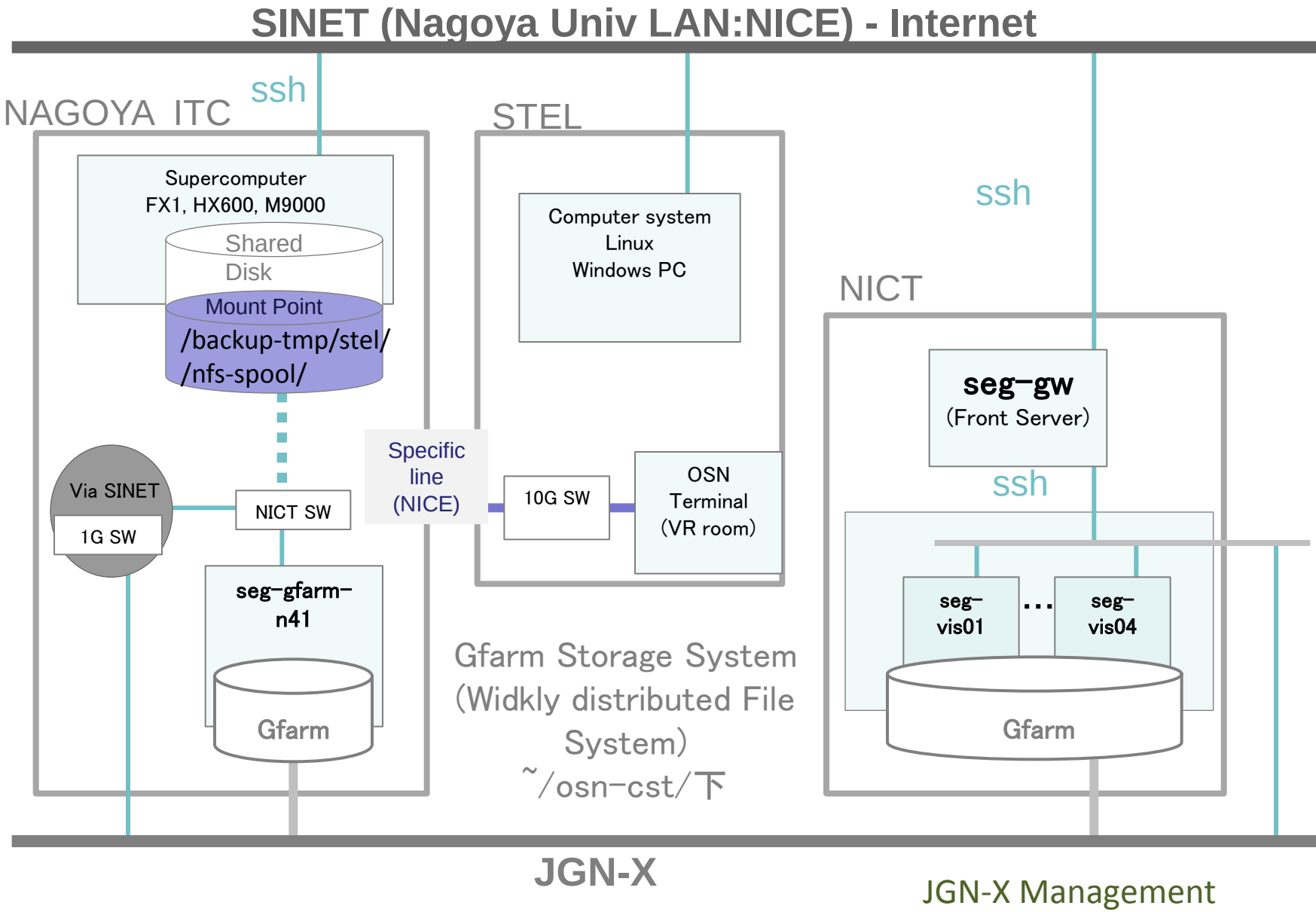
NICT commodity storage system, Gfarm



NICT OneSpaceNet – in Nagoya University（2011/08/26）



NICT OneSpaceNet – Nagoya University Connection (2011/11/08)



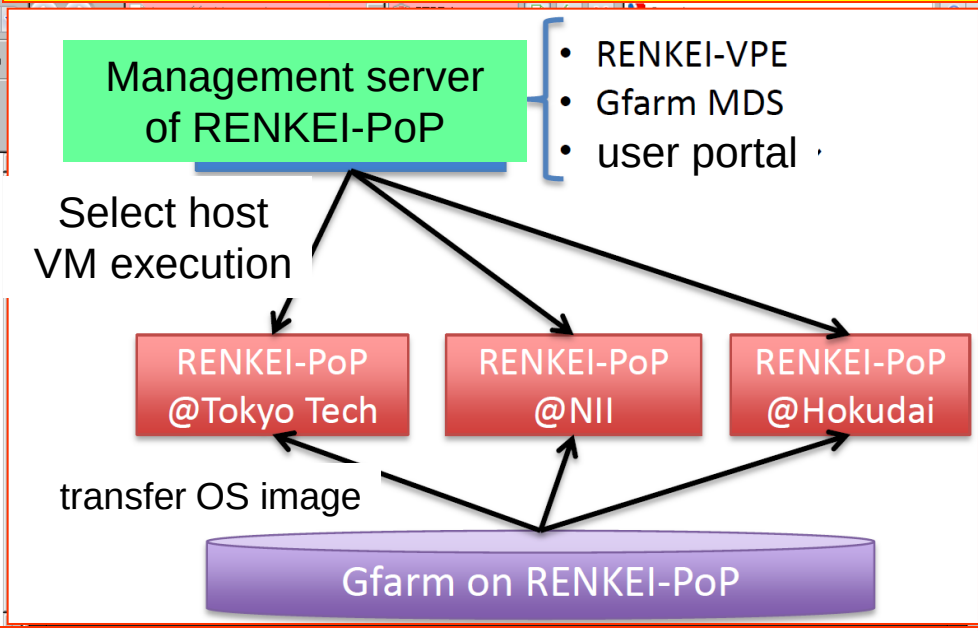
Use of NAREGI Computation GRID and RENKEI-PoP

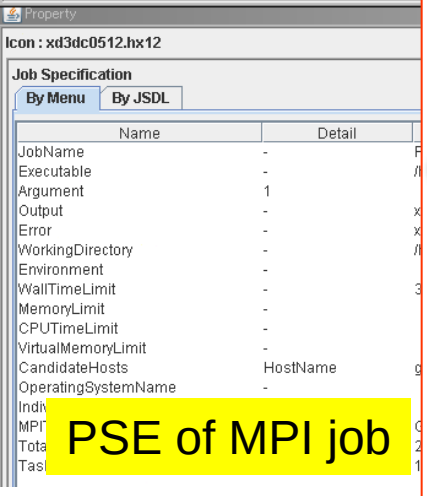
Execution of MHD simulation with MPI Fortran

NAREGI Portal and MPI Fortran job run

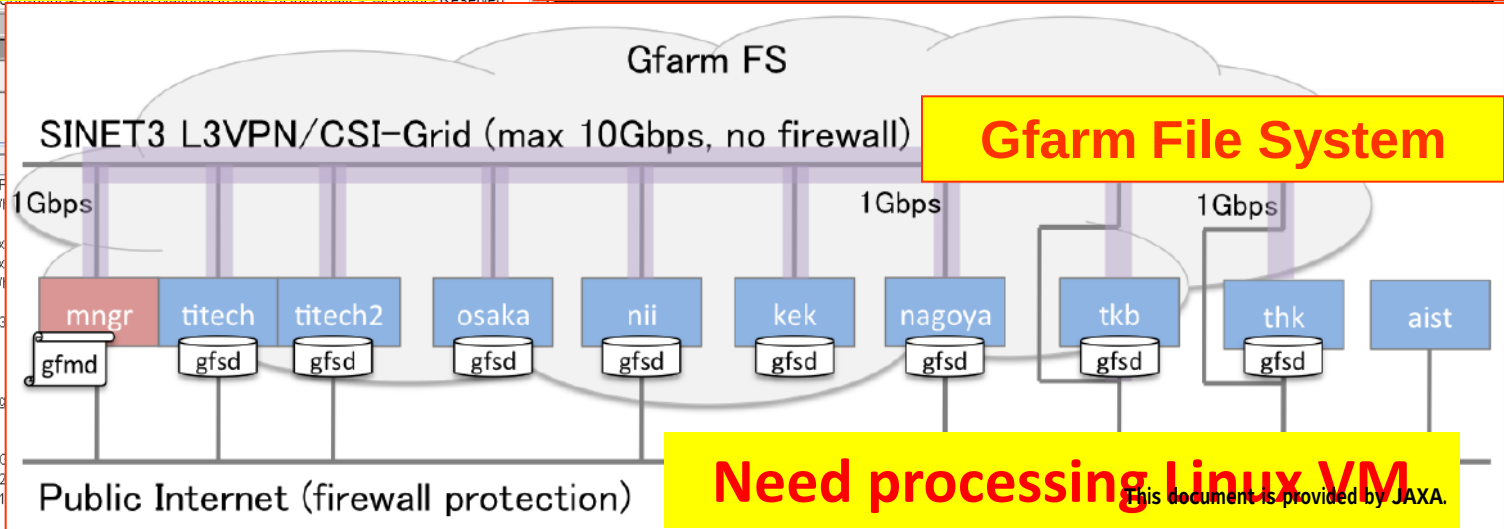
Parallel job by HX600 16node 256 cpu

RENKEI-PoP and wide area file（Gfarm2）



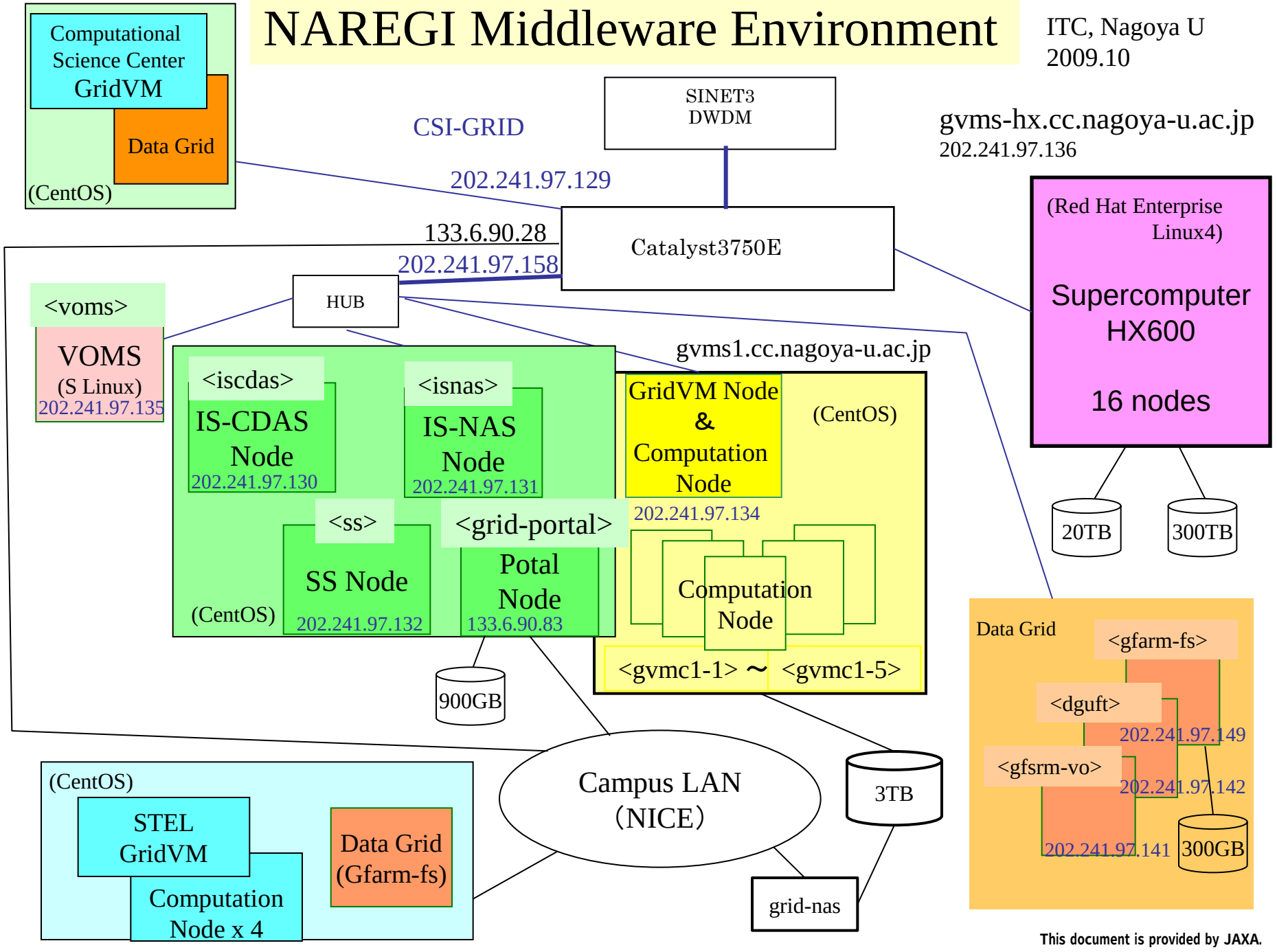


PSE of MPI job



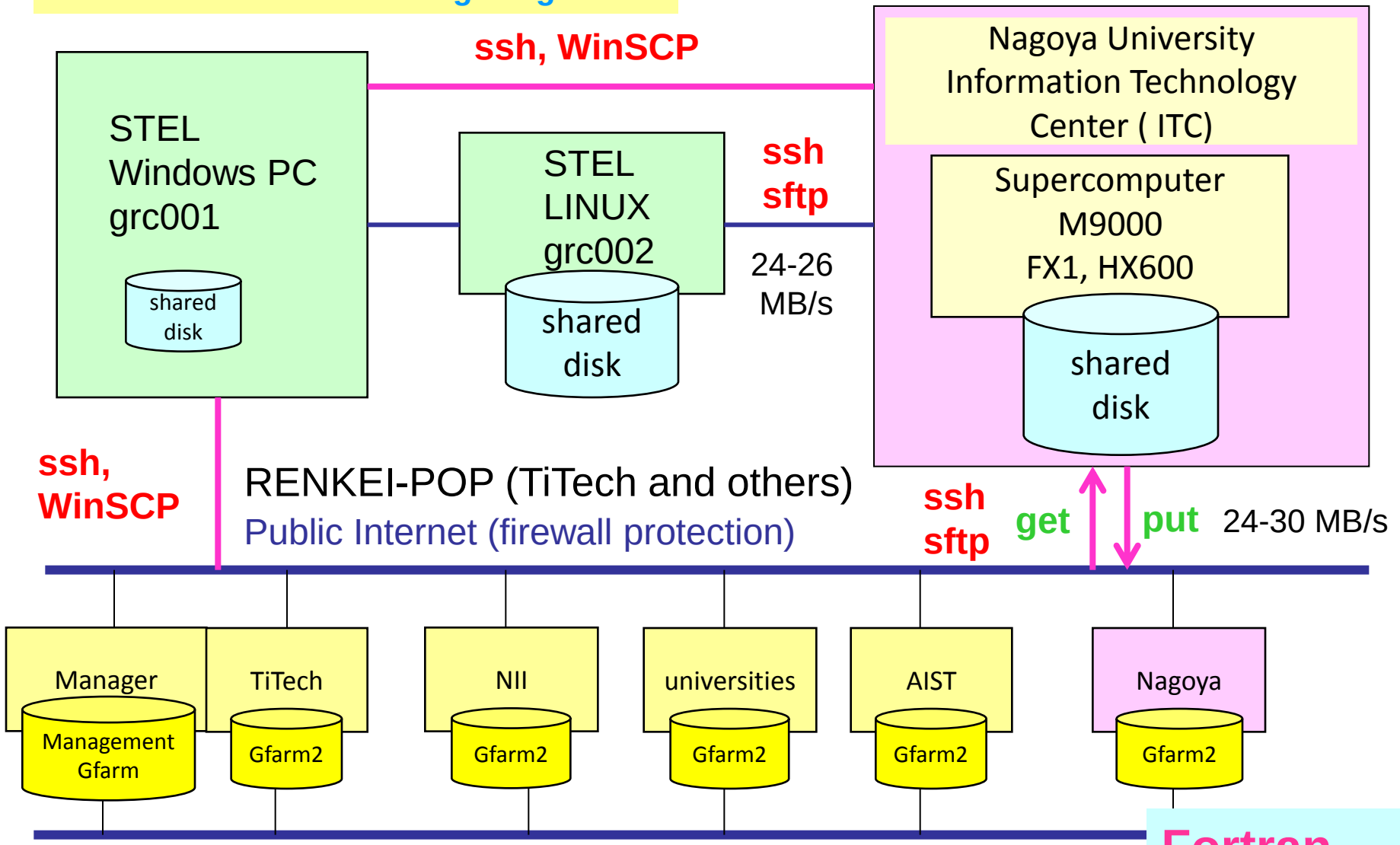
NAREGI Middleware Environment

ITC, Nagoya U
2009.10



Use of Supercomputer and Gfarm System

Install of Gfortran and ImageMagick



Fortran compiler

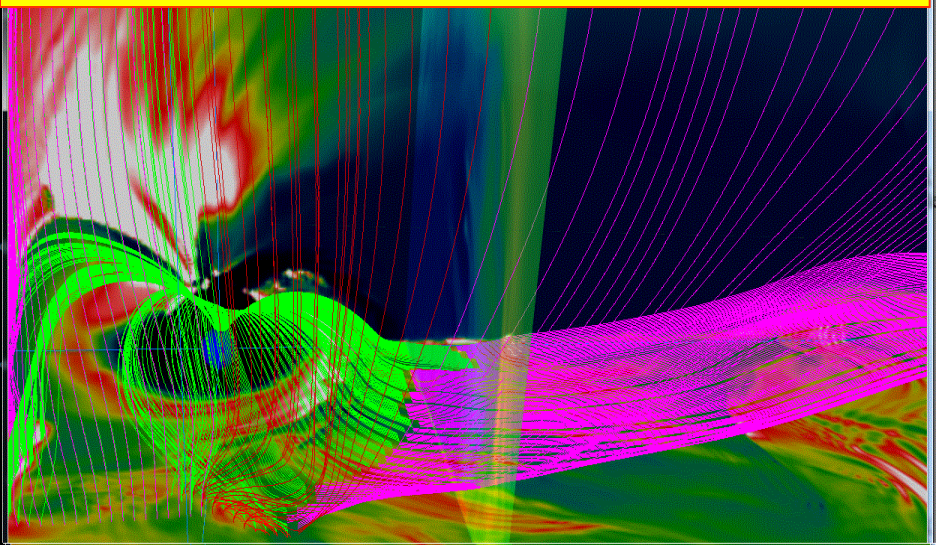
RENKEI-PoP (Nagoya)

Access to Nagoya U supercomputer

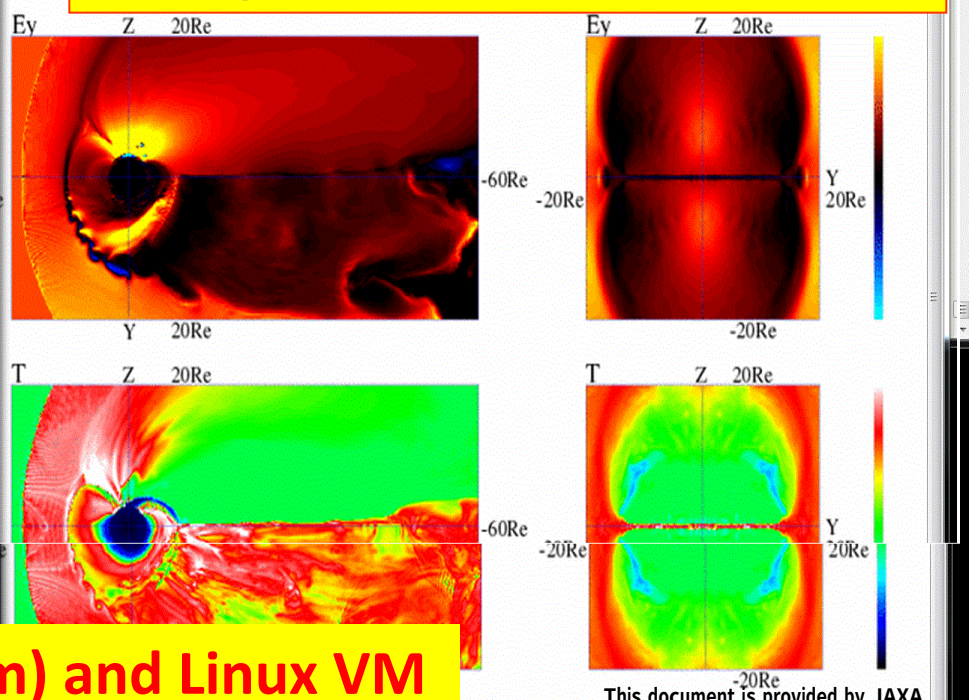
RENKEI-PoP (TiTech)

Shared disk for supercomputer

3D visualization by LINUX and graphic display by PC



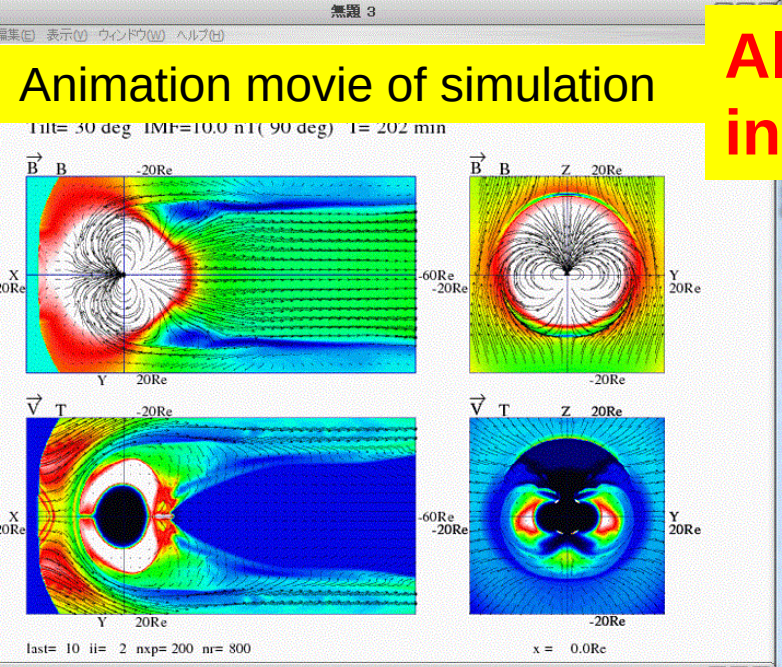
Making movie by Linux and graphic display by PC



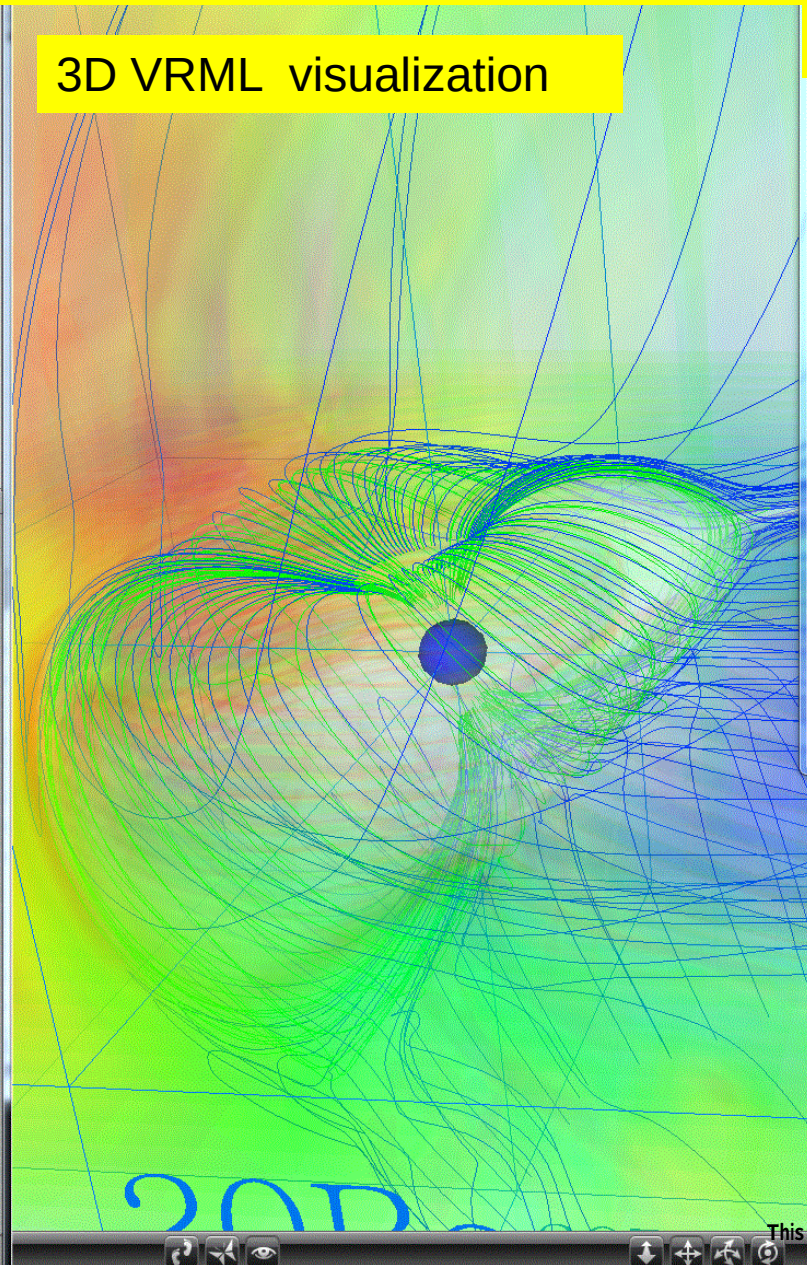
Need wide area file system (Gfarm) and Linux VM

All processes can be done in RENKEI-PoP Gfarm

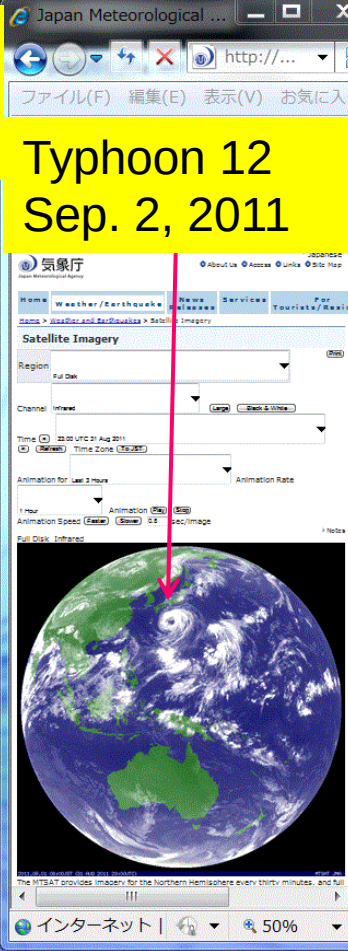
Animation movie of simulation



3D VRML visualization

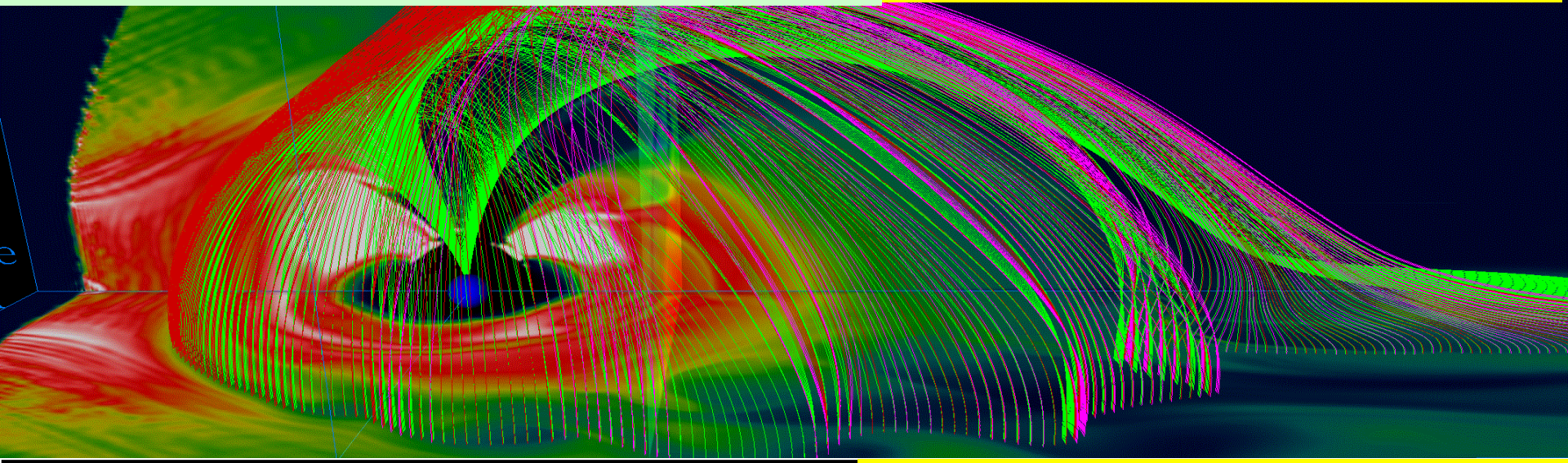


Typhoon 12
Sep. 2, 2011



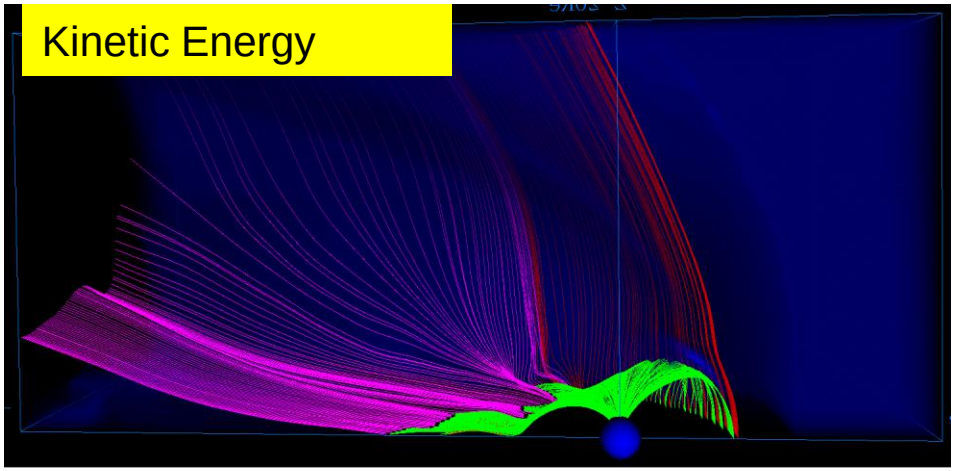
High Resolution MHD Simulation

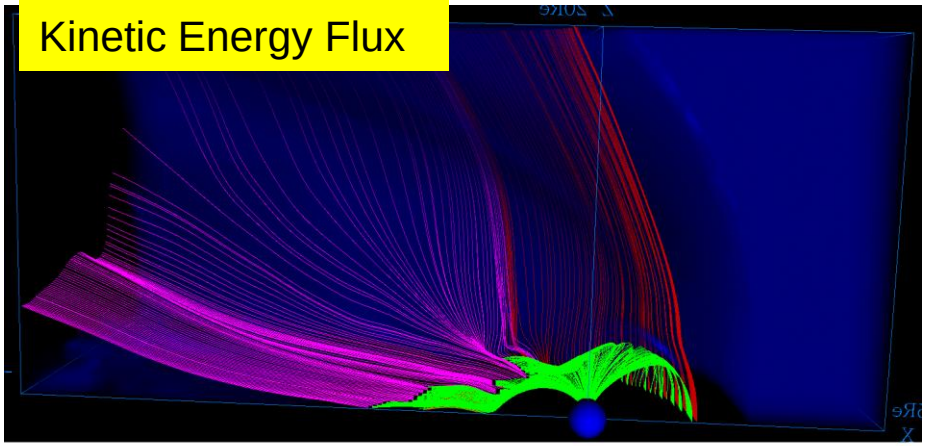
Structure of earth's magnetosphere by 3D visualization (VRML) for northward IMF

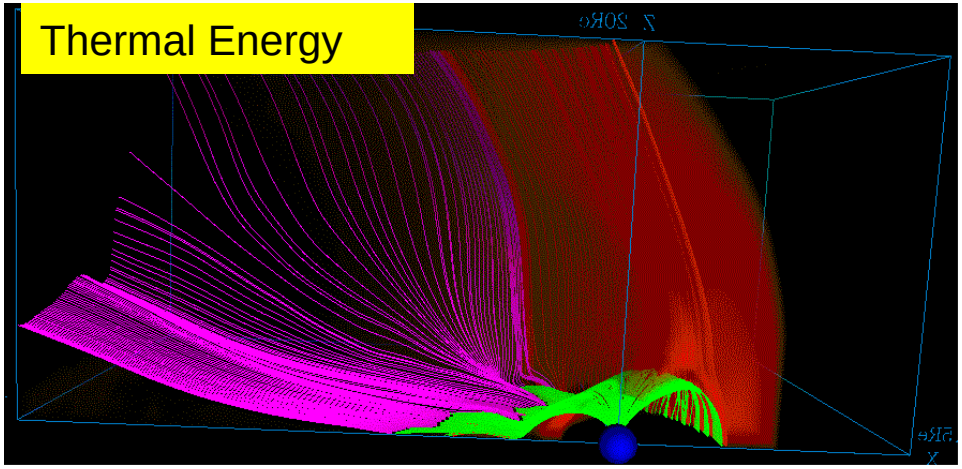


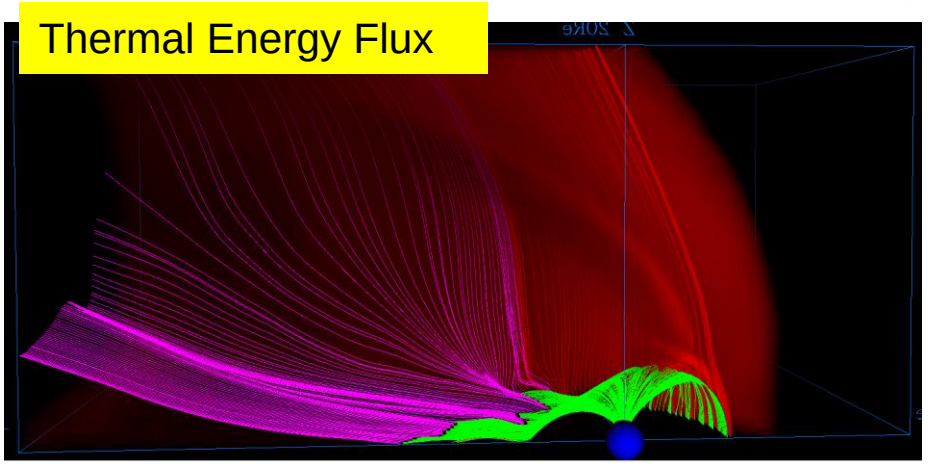
Structure of earth's magnetosphere by 3D visualization (VRML) for southward IMF

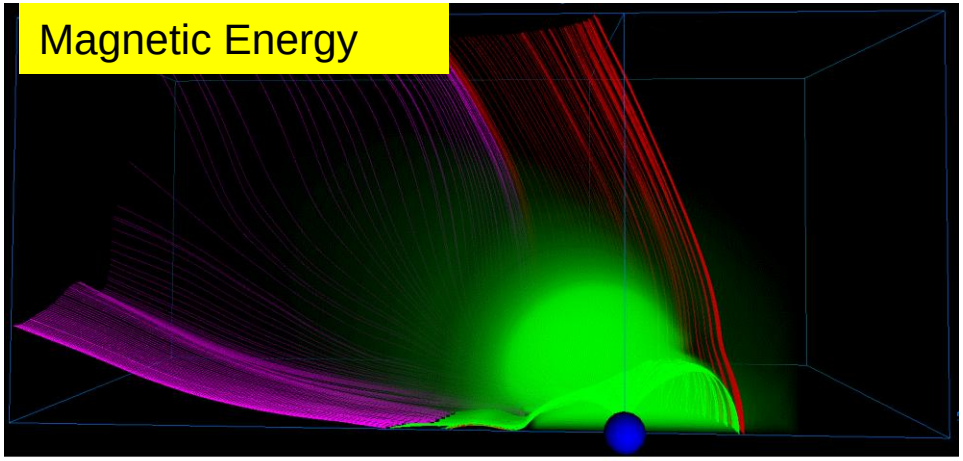
Make 3D VRML movie

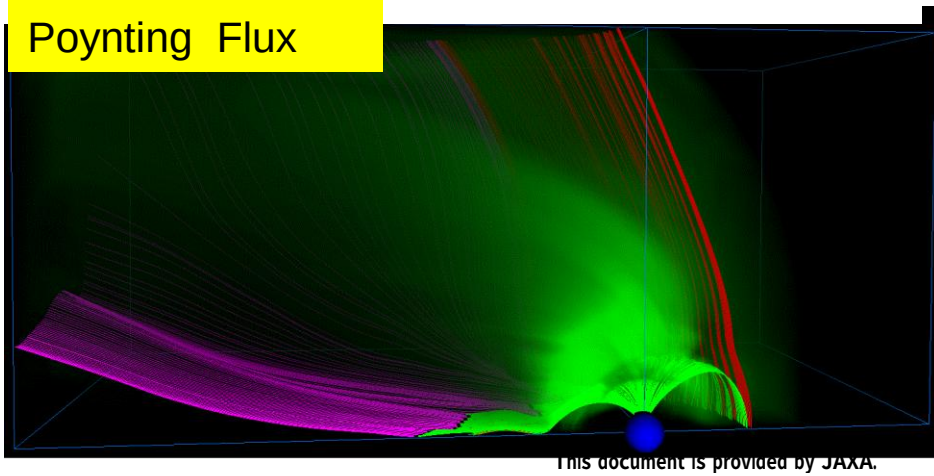












Procedure of Simulation and Processing

1. Execute computer simulation on earth's magnetosphere by Nagoya supercomputer (FX1, HX600, M9000).

2. File transfer of simulation data from supercomputer shared disk to RENKEI-PoP Gfarm (wide area storage system, Gfarm2) with sftp. (use secret/public key system, then carry out file transfer by "put file-name")

3. Data processing and graphics (including 3D visualization) by a LINUX machine in RENKEI-PoP system with our **own Fortran program**. (make PostScript graphic files and change gif files by gfortran program and ImageMagick, make 3D VRML graphic files by gfortran program)

4. Get output graphic files from RENKEI-PoP Gfarm to Windows PC with WinSCP and display on PC.

Importance of Integration with Software to Use Advanced IT Infrastructure

Supercomputer

Next-Generation, K-computer

Geospace Science Clouds

Integration (PSE, Workflow, Network)

High Speed Network

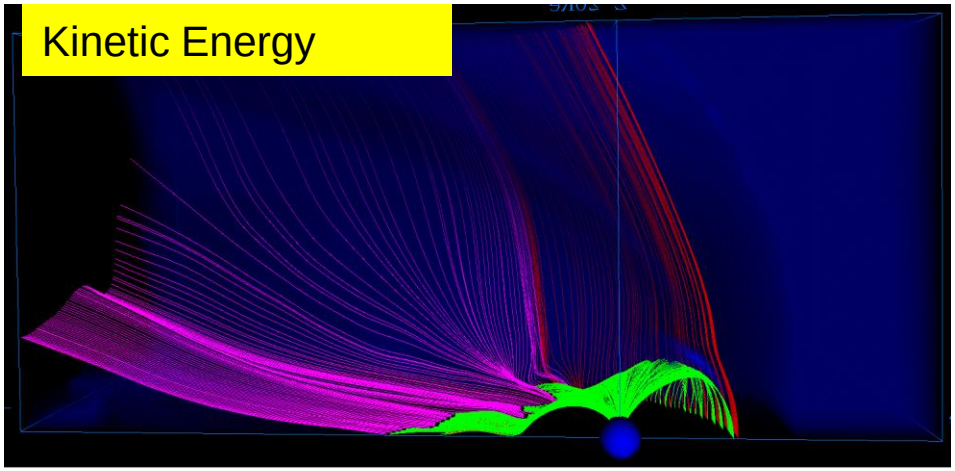
SINET3, JGN-X

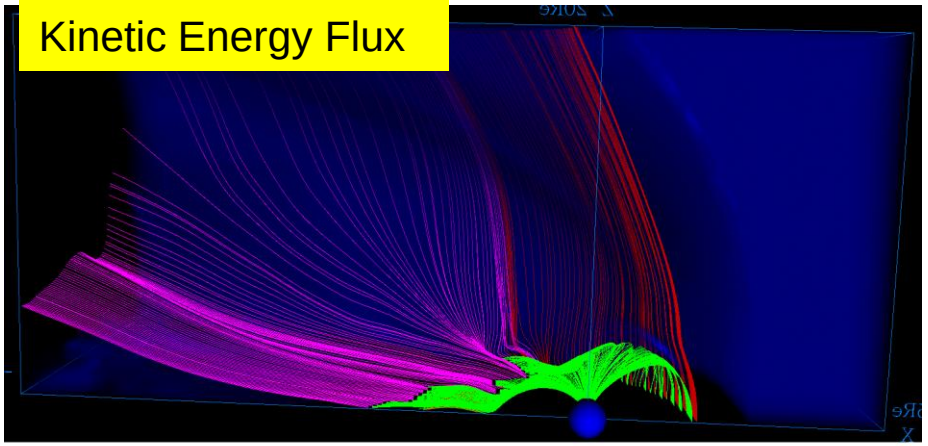
1 Gbps, 10 Gbps

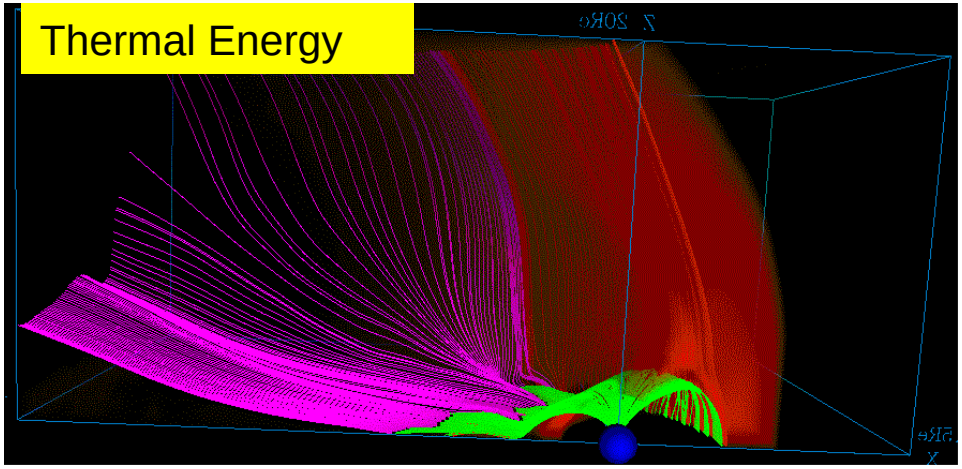
Wide Area File System

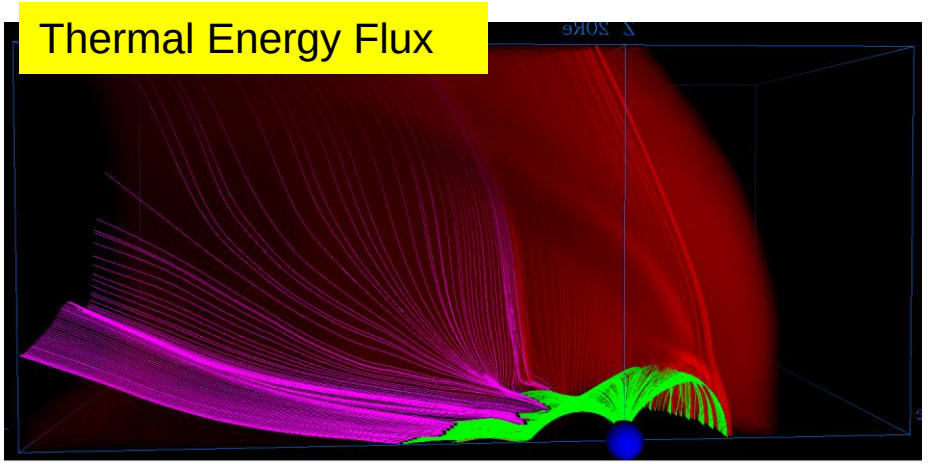
Gfarm

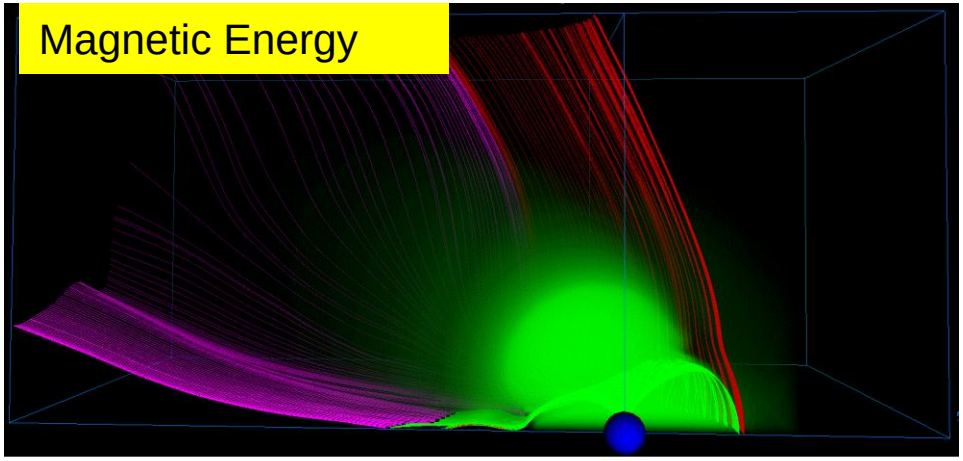
We can use it with Linux with Fortran compiler.

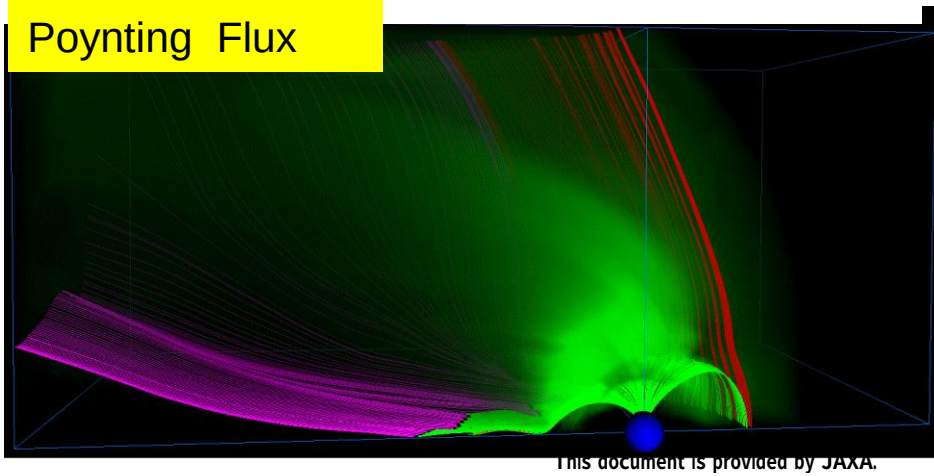






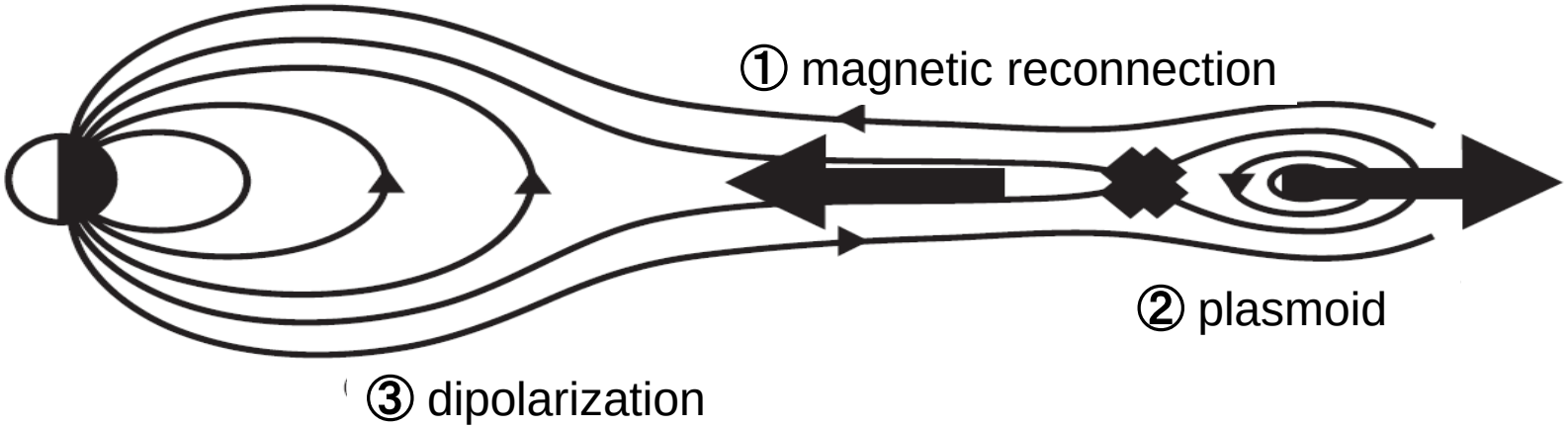






Dynamics in Plasma Sheet

Plasma sheet has high temperature and Mach number < 1.
Thermal flux (TF) is greater than kinetic flux (KF) in plasma sheet.



- Magnetic flux returns from tail to dayside by Poynting Flux (PF).
- As a position approaches from reconnection point to the earth, KF changes to TF, and then to PF, which carries energy from tail to dayside magnetosphere.

$$\mathrm{KF} + \mathrm{TF} + \mathrm{PF} = \frac{1}{2} v^2 \mathbf{v}\rho + \frac{\gamma}{\gamma - 1} p\mathbf{v} + \mathbf{E} \times \mathbf{B}$$

$$\frac{\partial}{\partial t}\left(\frac{1}{2} v^2 \rho + \frac{1}{\gamma - 1} p + \frac{1}{2} B^2\right) + \nabla \cdot \left(\frac{1}{2} v^2 \mathbf{v}\rho + \frac{\gamma}{\gamma - 1} p\mathbf{v} + \mathbf{E} \times \mathbf{B}\right) = 0$$