Workfolw-based Application Grid on Optical Network (WAGON): Architecture and Demonstration in 3TNET Testbed

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Outline

- Motivation
- WAGON and its Architecture
- 3TNet Testbed
- WAGON Demonstration
- Summary

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Workflow-based Applications

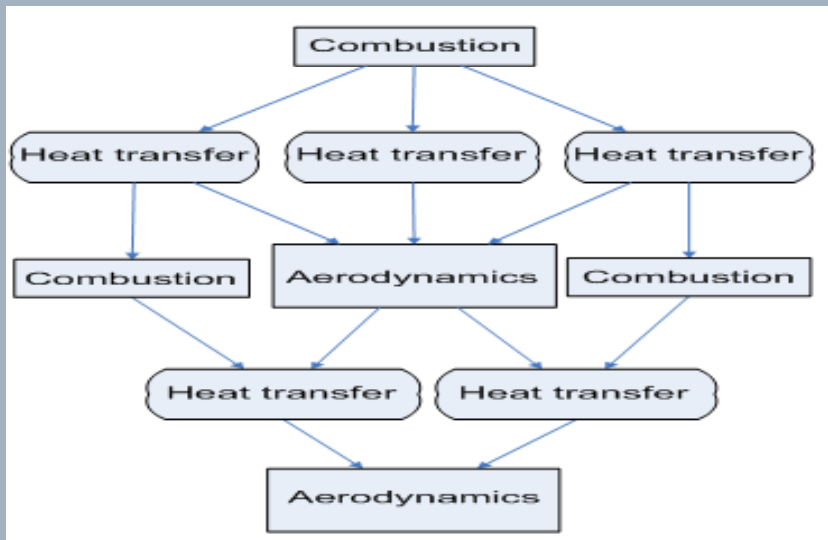
- Workflow: a set of tasks with dependent relationship
- Example: Aerocraft Design

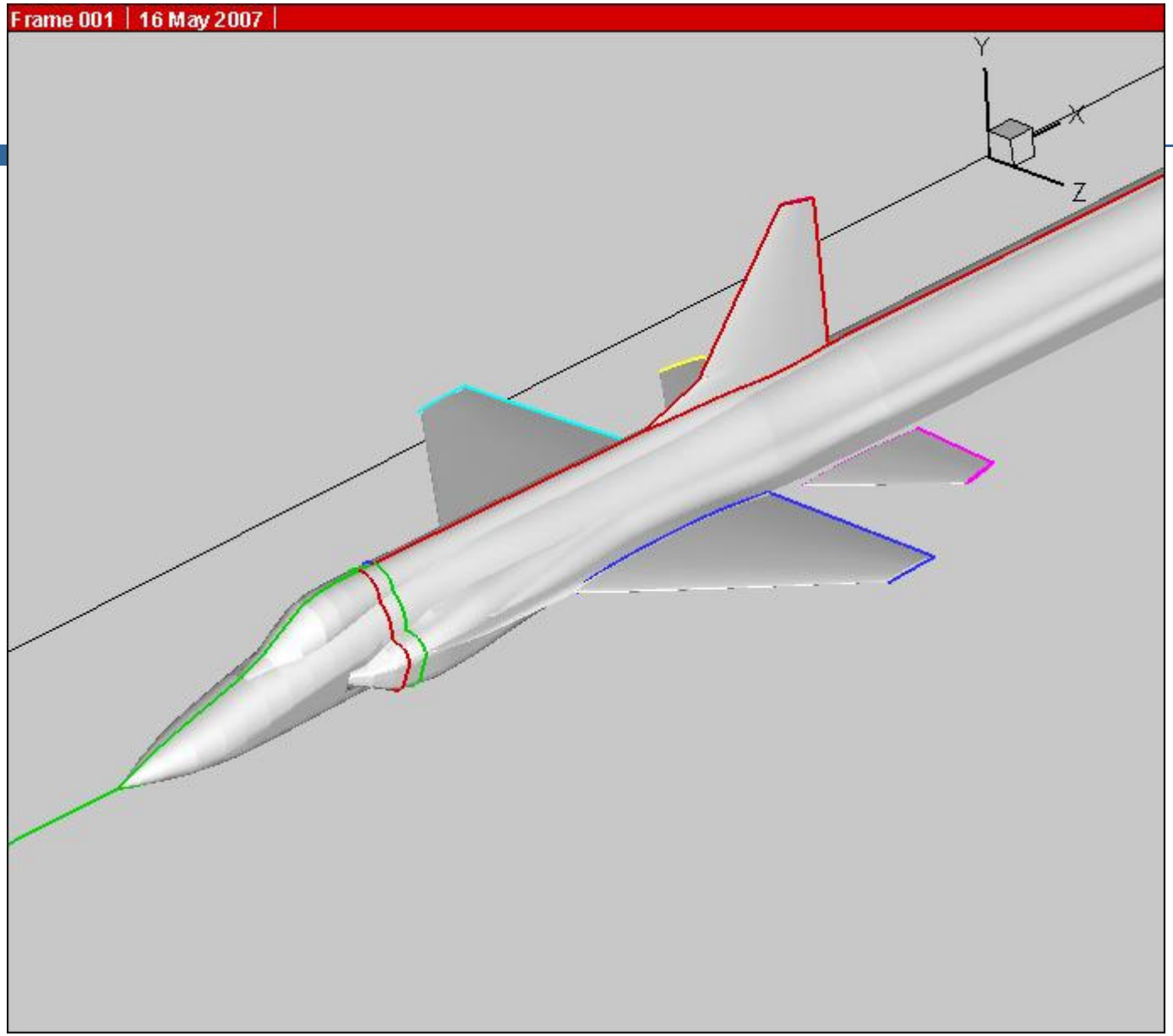
Modeling (Mesh)

High Performance Computing (HPC)

Visualization

CFD:Computational Fluid Dynamics

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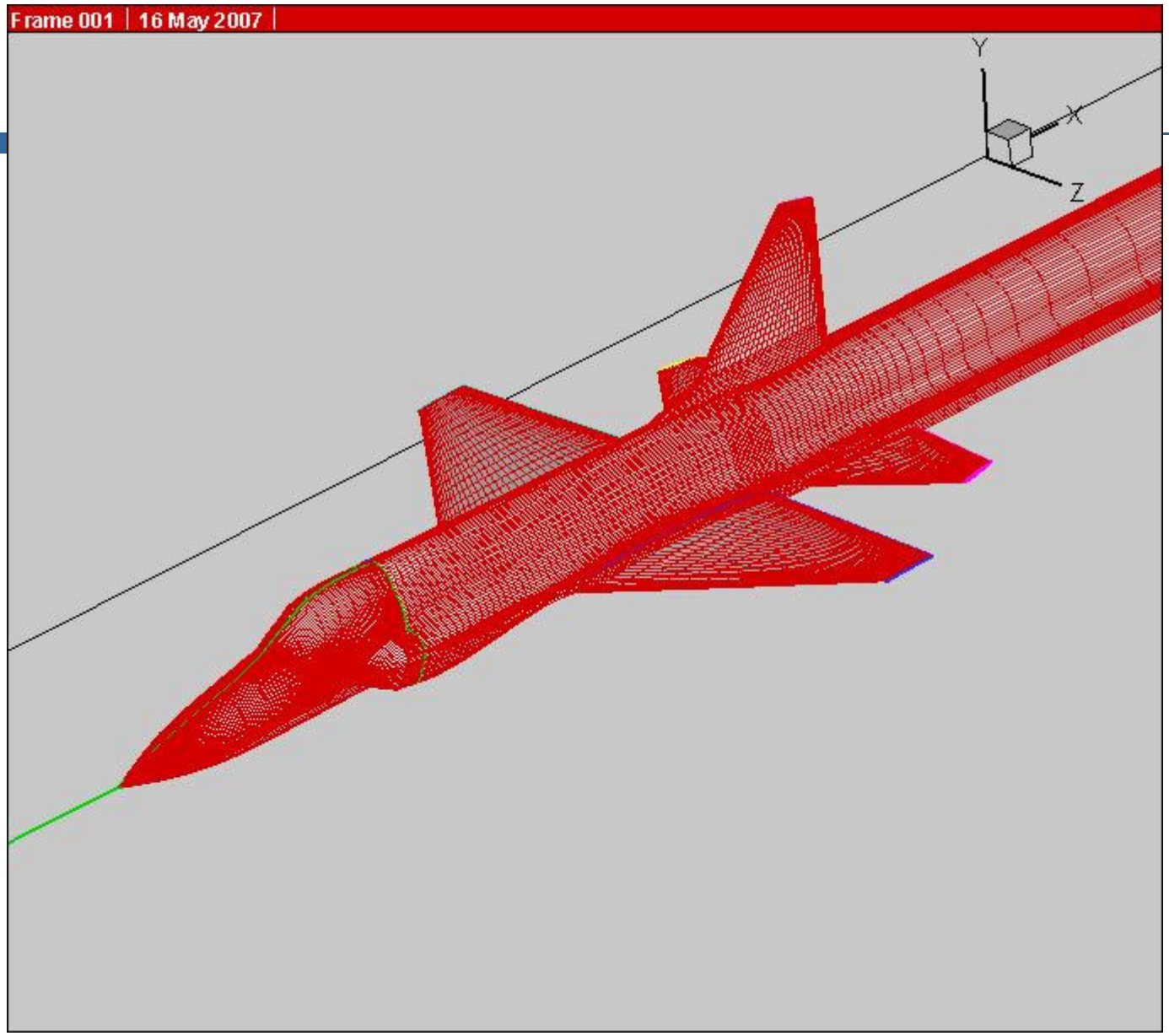
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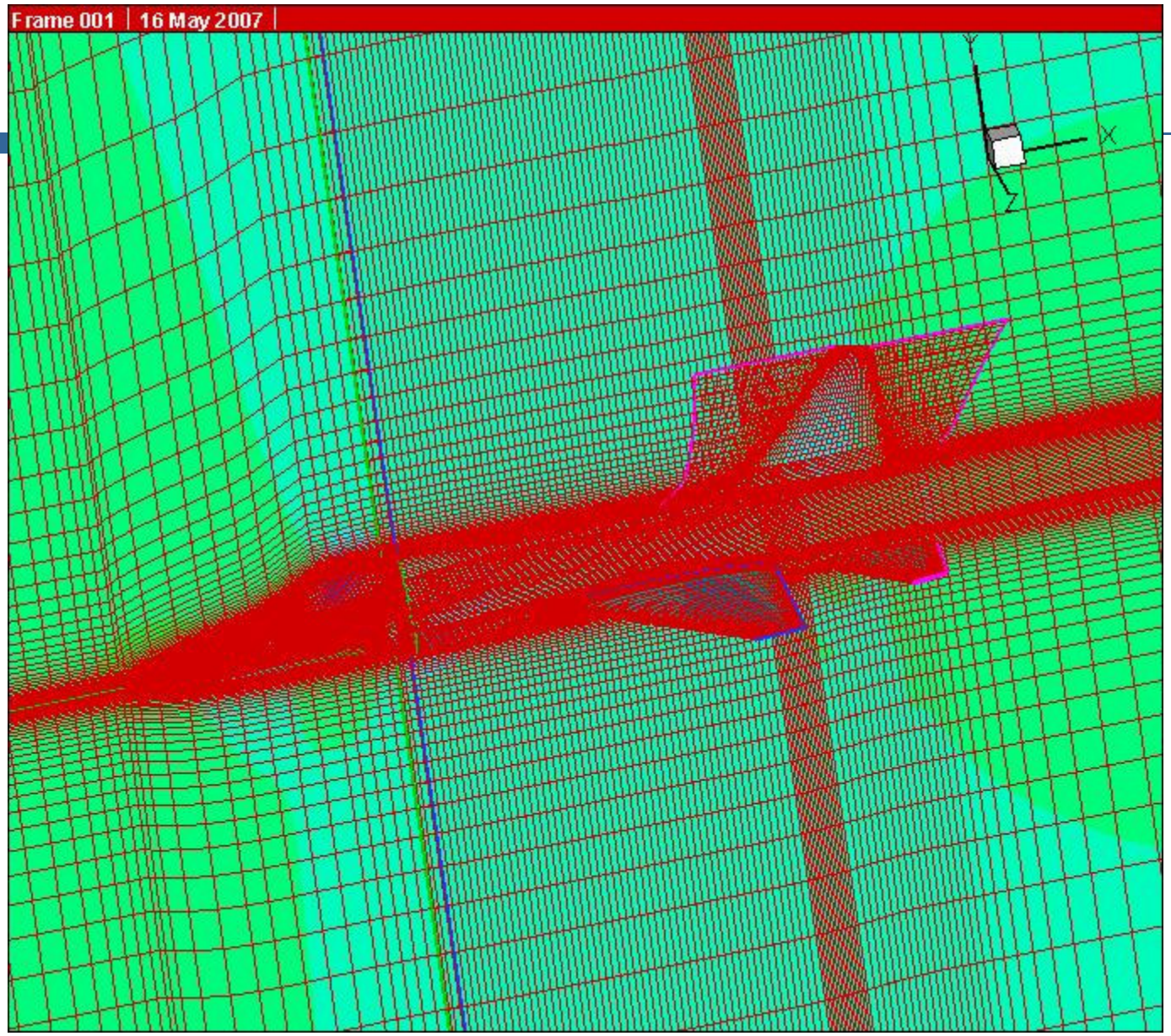
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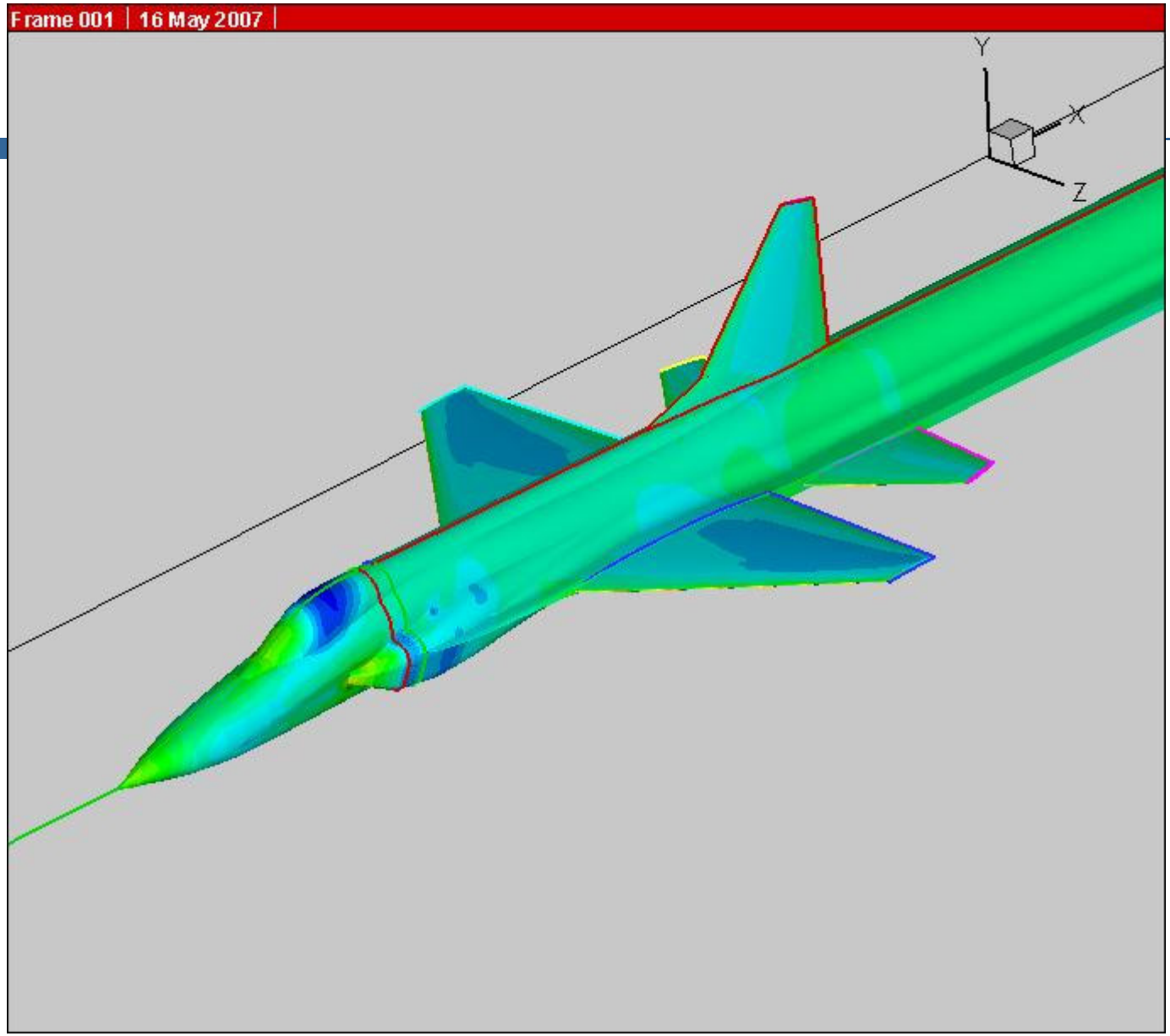
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Requirements of Applications

- Need grid technology to utilize geographical distributed and heterogeneous resources, such as software, supercomputer, cluster, Virtual Reality(VR) devices, etc.) to improve the applications' efficiency and accuracy.
- Need high bandwidth connections with very low network latency to support large data exchange between grid resources every iteration.
- Need dynamically to establish and delete connections to utilize bandwidth only when necessary so as to optimize the costs.
- Need integrated resources managing and optimization task scheduling to improve the execution time of workflow which is usually a time-critical or real-time application.

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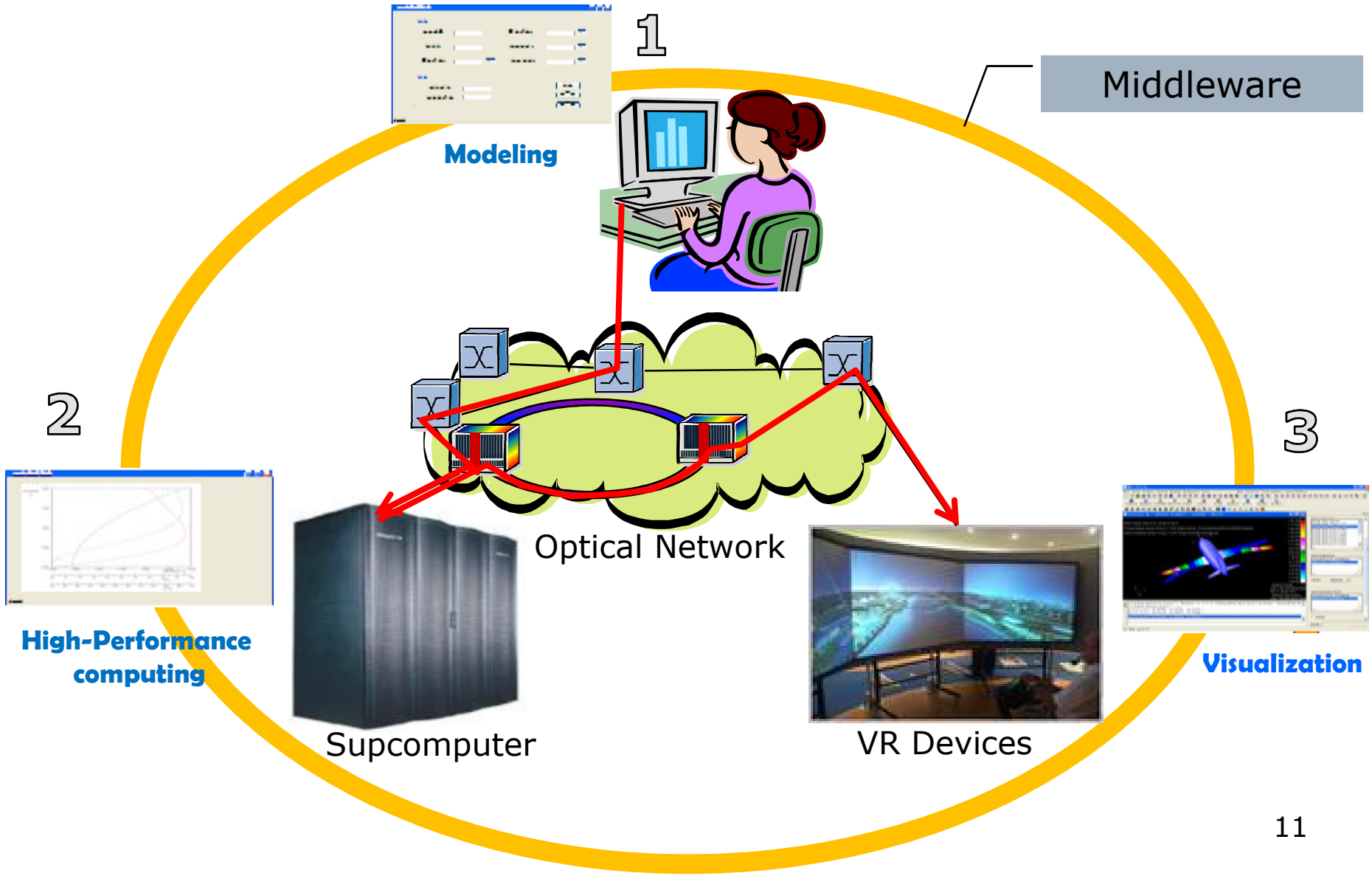
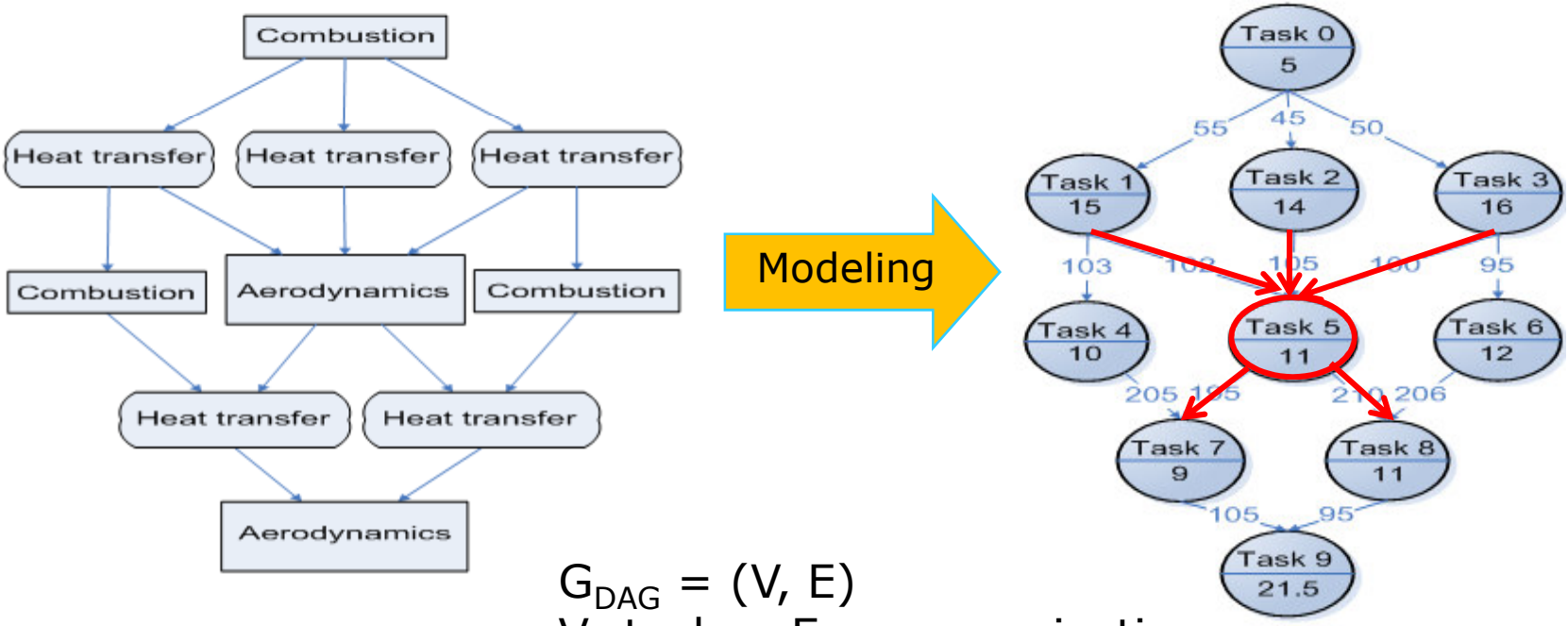
WAGON: **W**orkfolw-based **A**pplication **G**rid on **O**ptical **N**etwork



Modeling of Workflow-based Applications

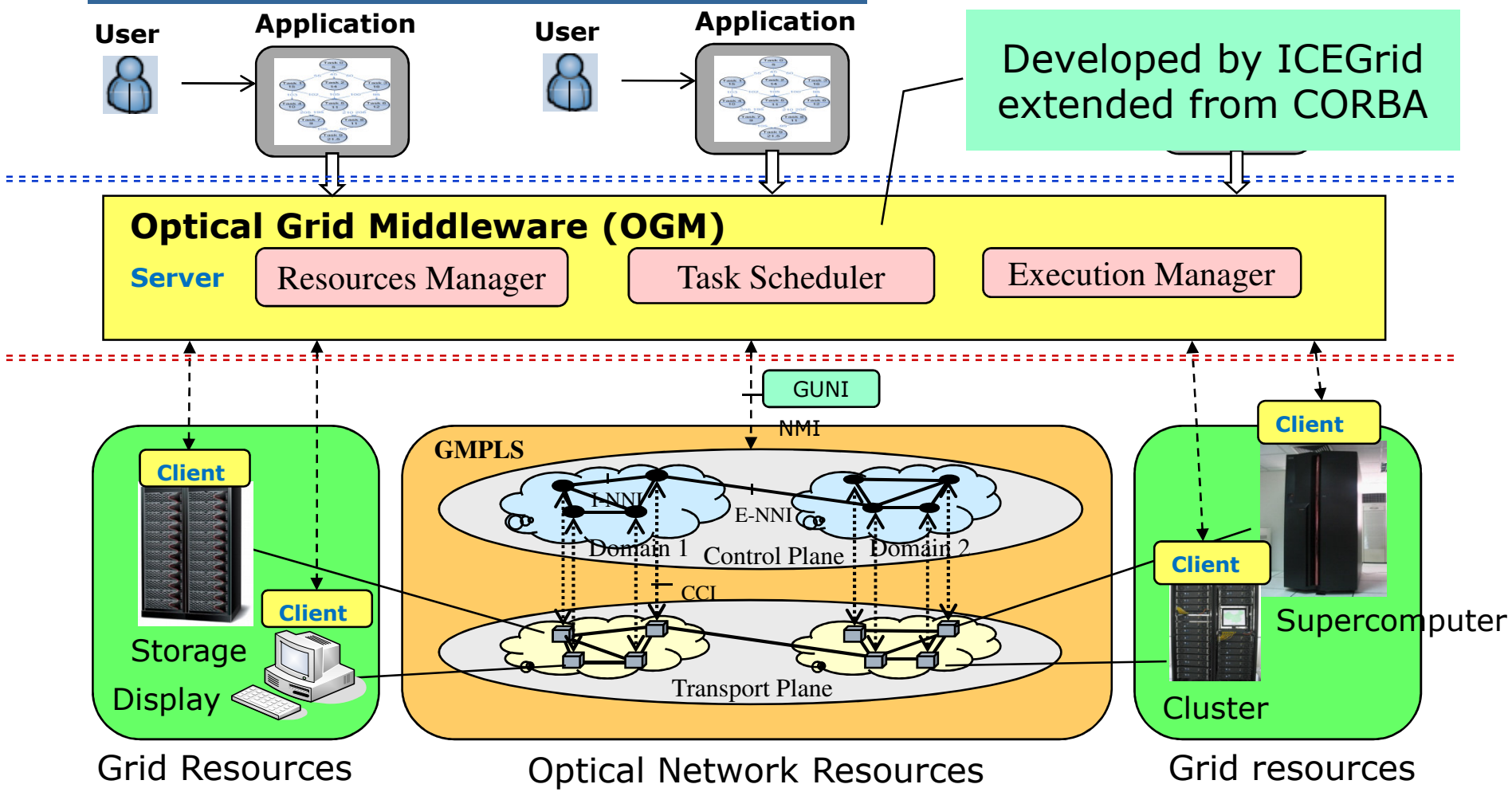
- In our work, a workflow-based application is modeled as Directed Acyclic Graph (DAG).
- A task cannot begin execution until all the data from its predecessors have arrived. After the task has finished the outputs then are available for communication.



$G_{DAG} = (V, E)$

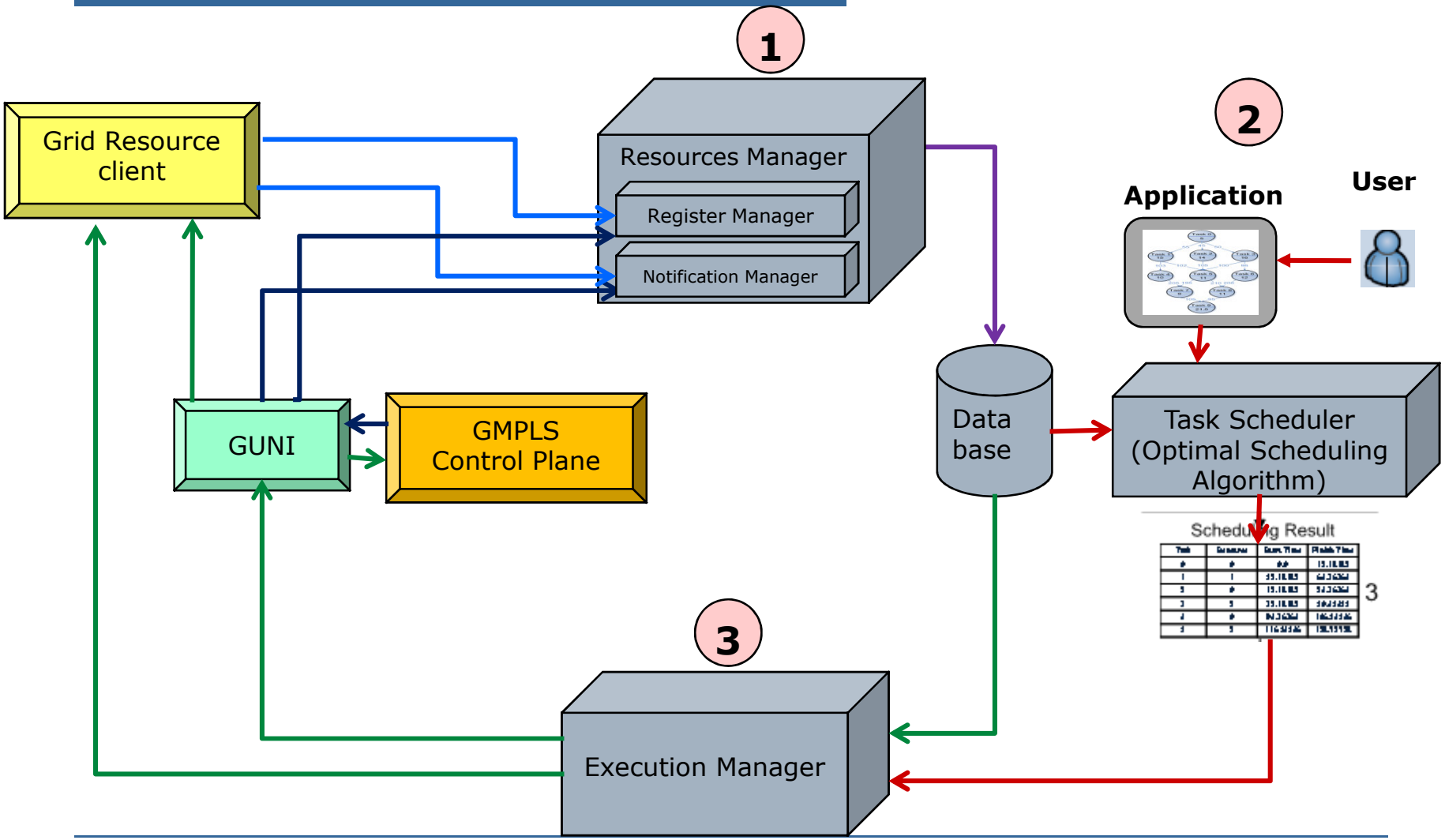
V: tasks E: communications

Architecture of WAGON



GUNIA: Grid UNI Agent

Execution Process



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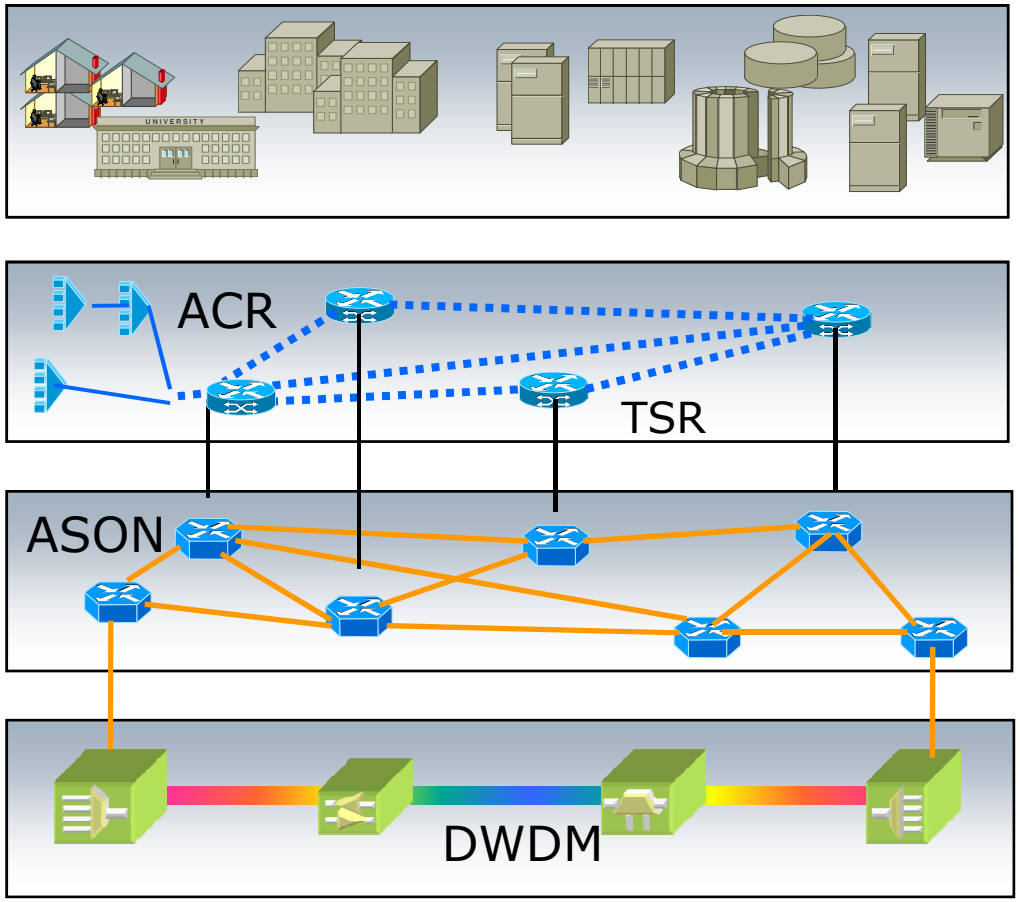
3TNET Testbed

- **3TNET** - China High Performance Broadband Information Network
- funded by Hi-Tech Research and Development Program of China



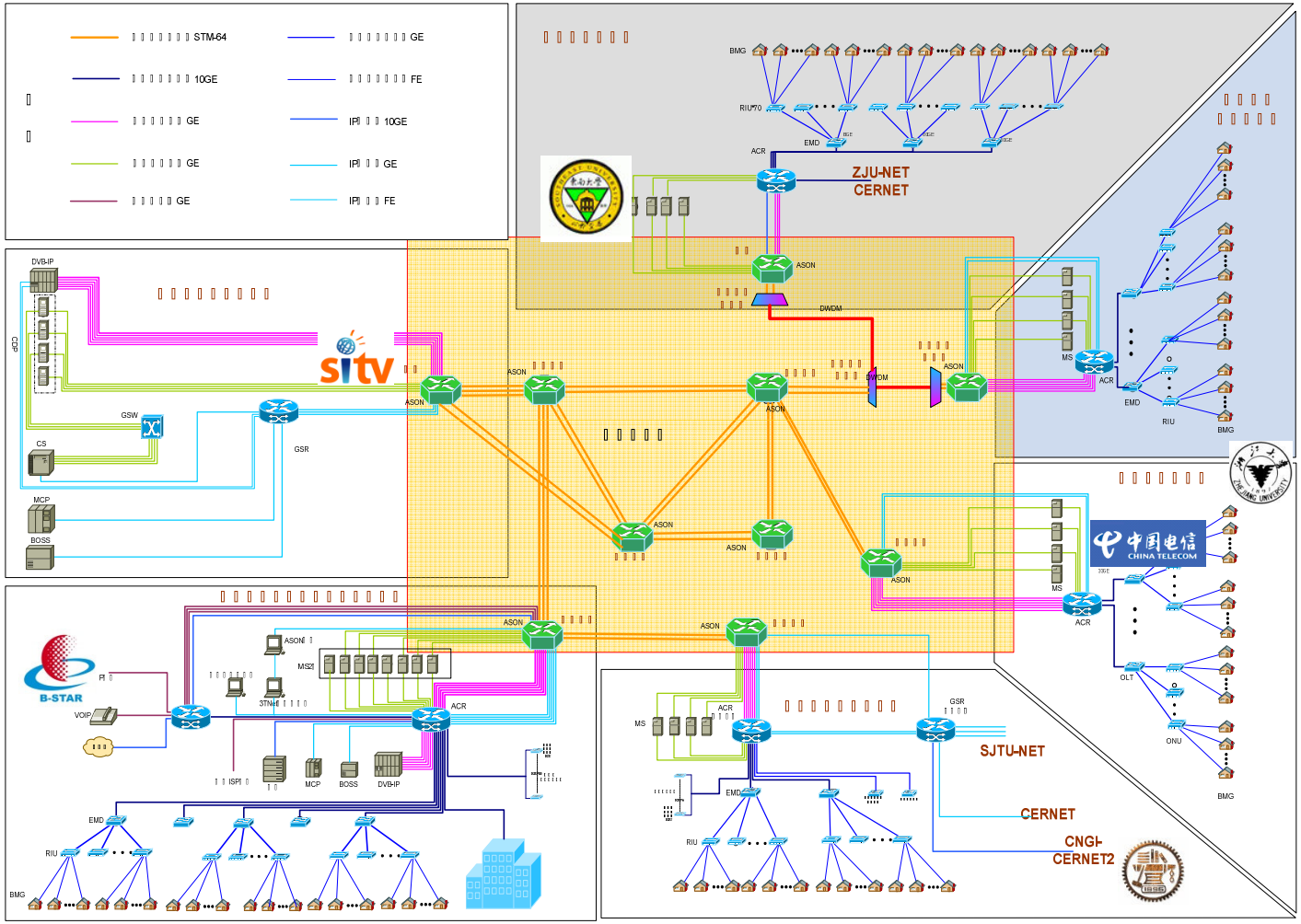
IP TV/HDTV
e-Science
e-Learning, e-Health
e-entertainment, e-show

Tb/s Router

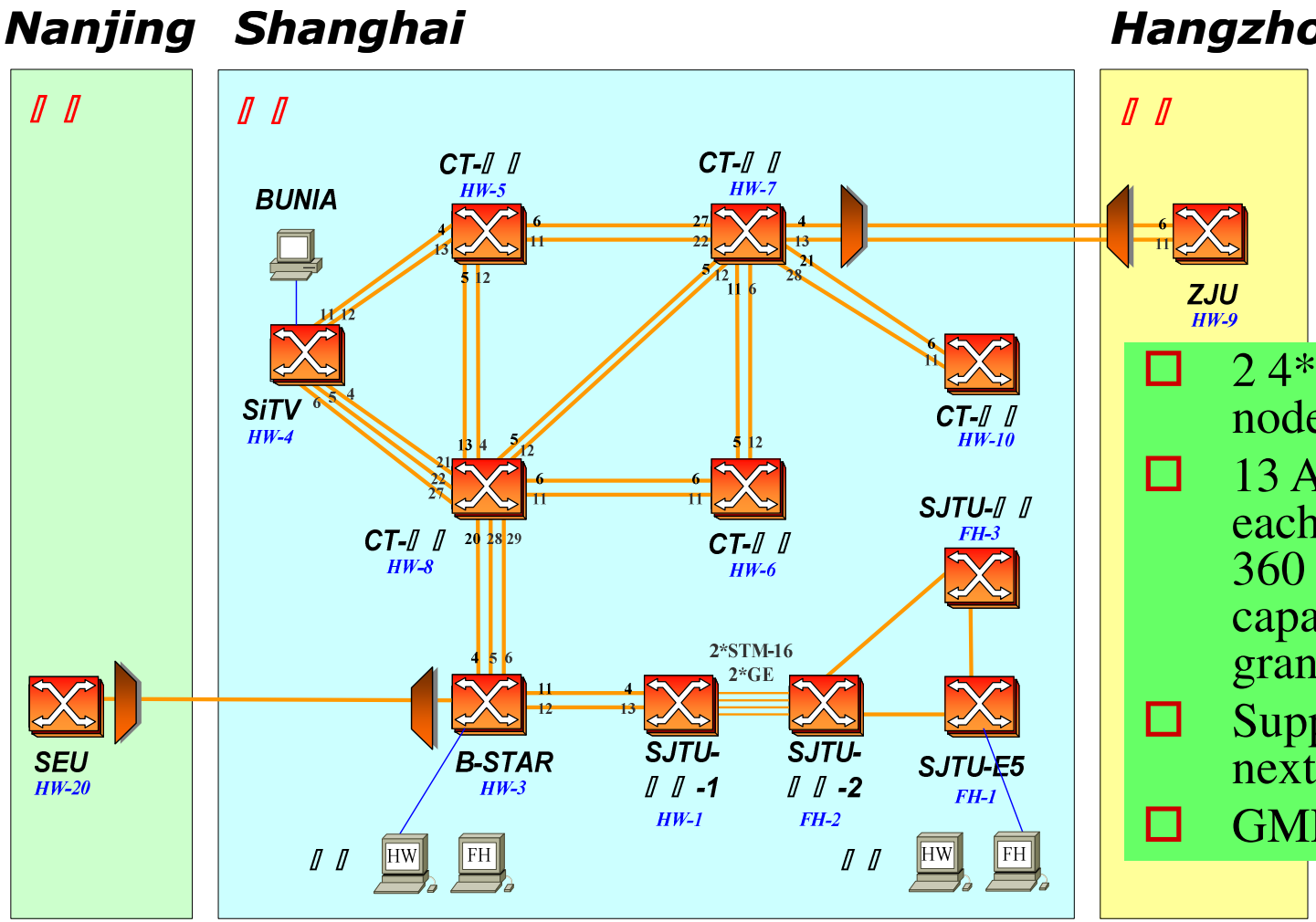
Tb/s ASON

Tb/s DWDM

3TNet Topology



3TNET optical network



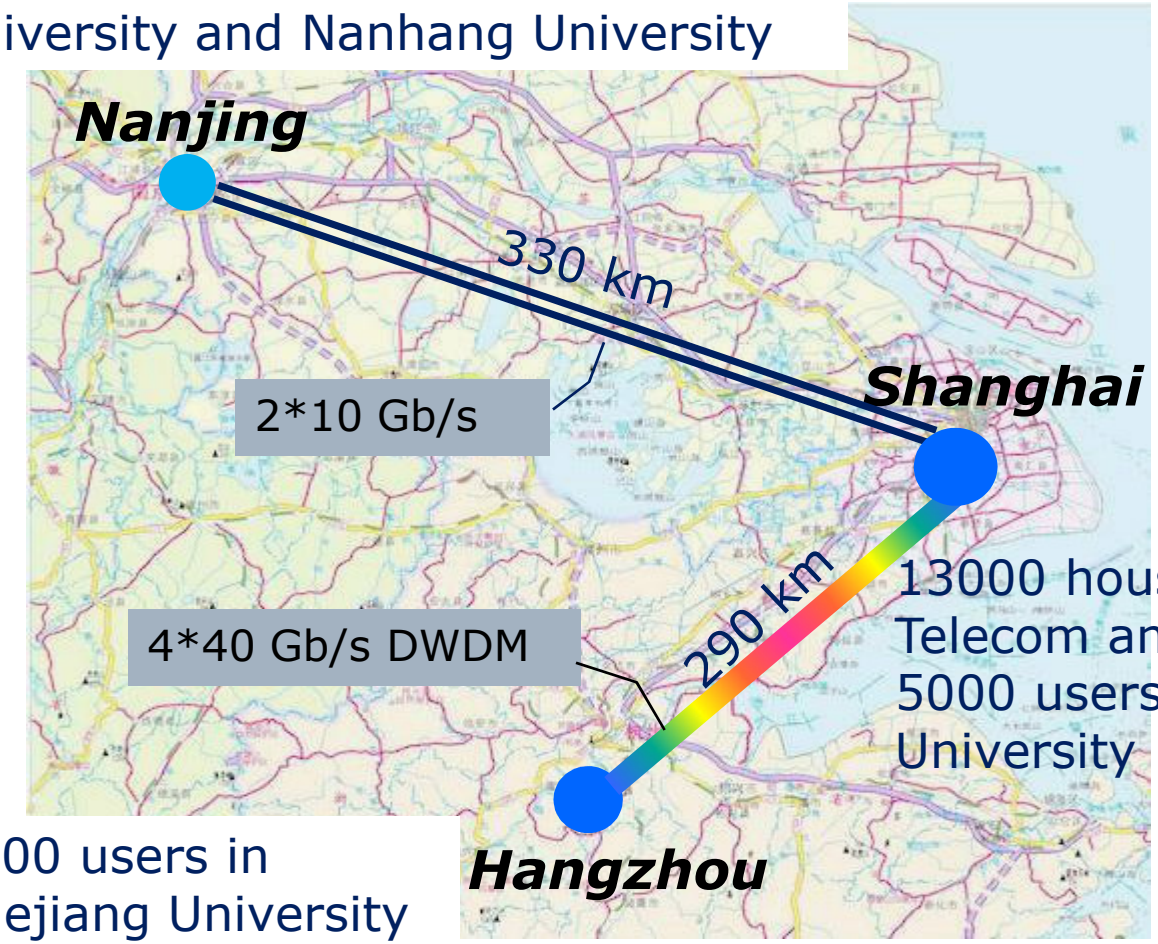
- 2 4*40 Gb/s DWDM nodes
- 13 ASON nodes and each node has at least 360 Gb/s switching capability with VC-4 granularity.
- Support GE interface by next generation SDH.
- GMPLS control plane

Field Trial in Yangtze River Delta

Yangtze River Delta is a region including Shanghai, Jiangsu, and Zhejiang.

Experimental Zones

5000 users in Southeastern University and Nanhang University



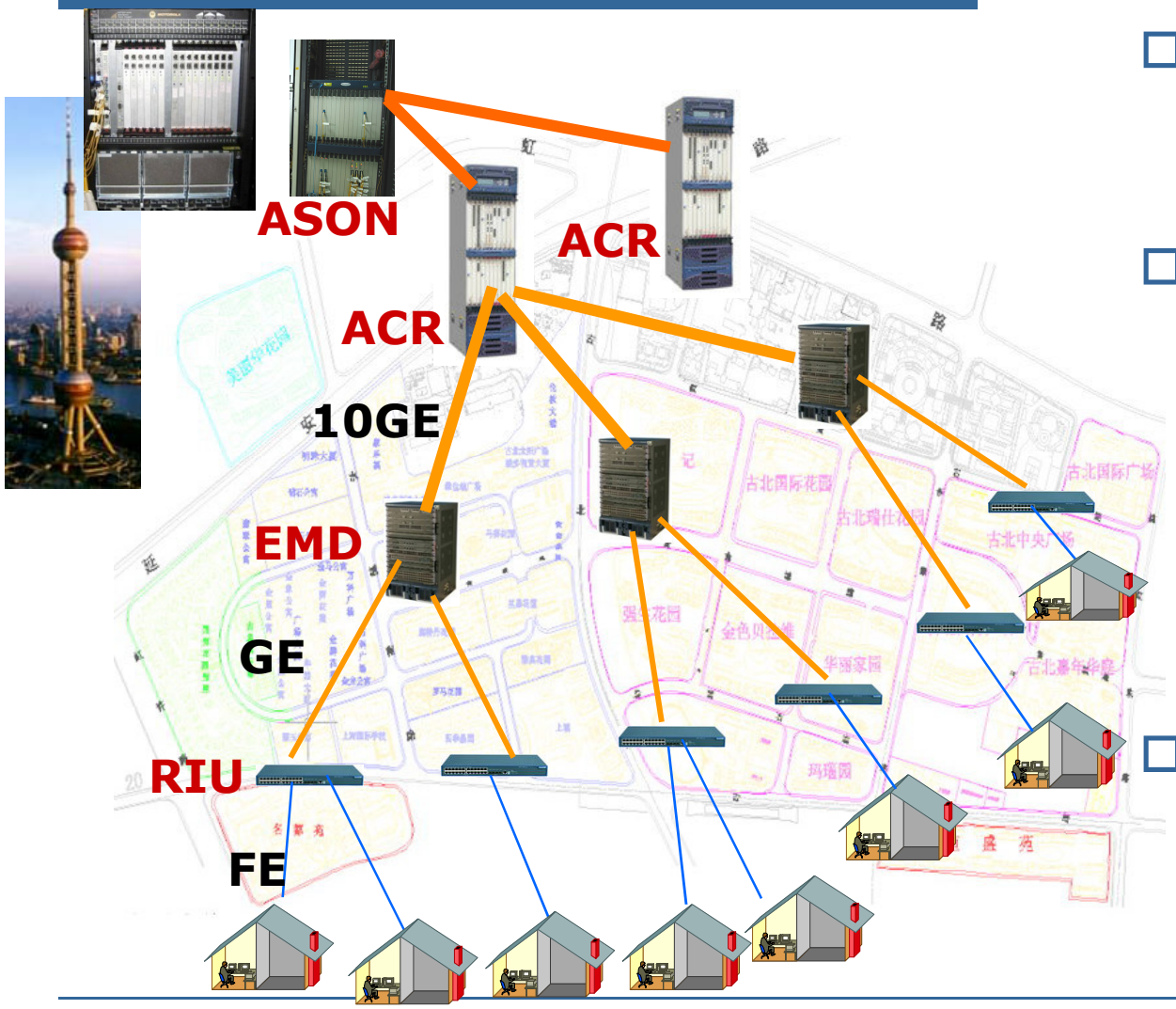
~28000 Users

13000 households in Shanghai Telecom and B-Star

5000 users in Shanghai Jiao Tong University

5000 users in Zhejiang University

User Access



- Each user can possess about ~50 Mb/s bandwidth.
- One user can enjoy 1 HDTV channel with 25 Mb/s, 2 SDTV channels with 14 Mb/s, and 9 Mb/s high speed Internet simultaneously.
- Users can enjoy 101 DTV/HDTV and 2000 interactive VODs

53 Participants

- Carriers and SPs:

  China Telecom, Shanghai TV, CETV, B-Star

- Venders:

  Huawei, Fiberhome, ZTE, Harbor, Amoi, …

- Universities:

  Shanghai Jiao Tong U., Tsinghua U., Beijing U., …

- Institutes:

  CAS (IoA), RITT, ABS

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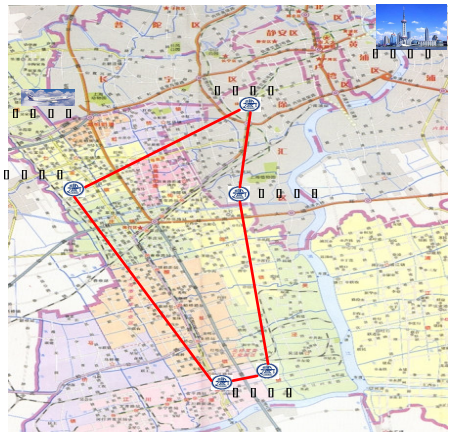
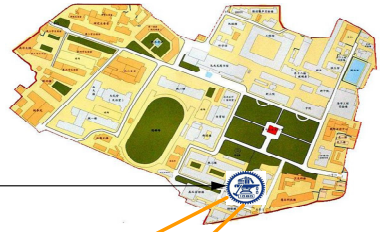
WAGON Demonstration



SJTU Xuhui Campus



SJTU Minhang Campus

25km

20km

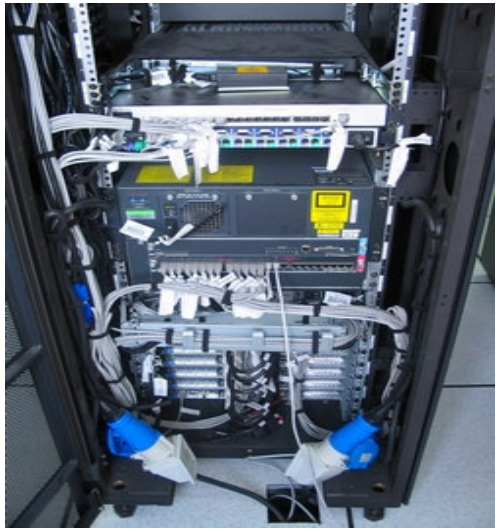
2km

Supercomputer – IBM P690

Performance

Hardware	CPU	Power 4 1.3GHZ，
	Node number	32
	Computational Capacity	32×1.3×4 = 166GFlops
	L3 Cache	128MB
	Memory	128GB
	Storage	4.4TB
	Network	1Gb Ethernet、1Gb optical、SMP
Software	OS	AIX 5.lL
	Grid	Globus Toolkit 4.0，CGSP 2，ICE Grid 3.0

Cluster– IBM E1350



Performance

hardware	CPU	Xeron 335 2.0GHZ，
	Node number	9
	Computational Capacity	(8+1)×2×2×2 = 72GFlops
	Memory	8×1 + 1×2 = 10GB
	Storage	8×146.8GB + 1×73.4GB=1.25TB
	Network	1Gb Ethernet、1Gb optical
software	OS	Linux Redhat 9.0
	Grid	Globus Toolkit 4.0，CGSP 2，ICE Grid 3.0

Windows Cluster– HP DL140

Performance

Hardware	CPU	6×Xeron 2.8GHZ，
	Node number	6
	Computational Capacity	68GFlops
	Memory	6×2 = 12GB
	Storage	6×80GB=0.48TB
	Network	1Gb Ethernet、1Gb optical, cluster
Software	OS	Windows Server 2003
	Grid	Globus Toolkit 4.0，ICE Grid 3.0

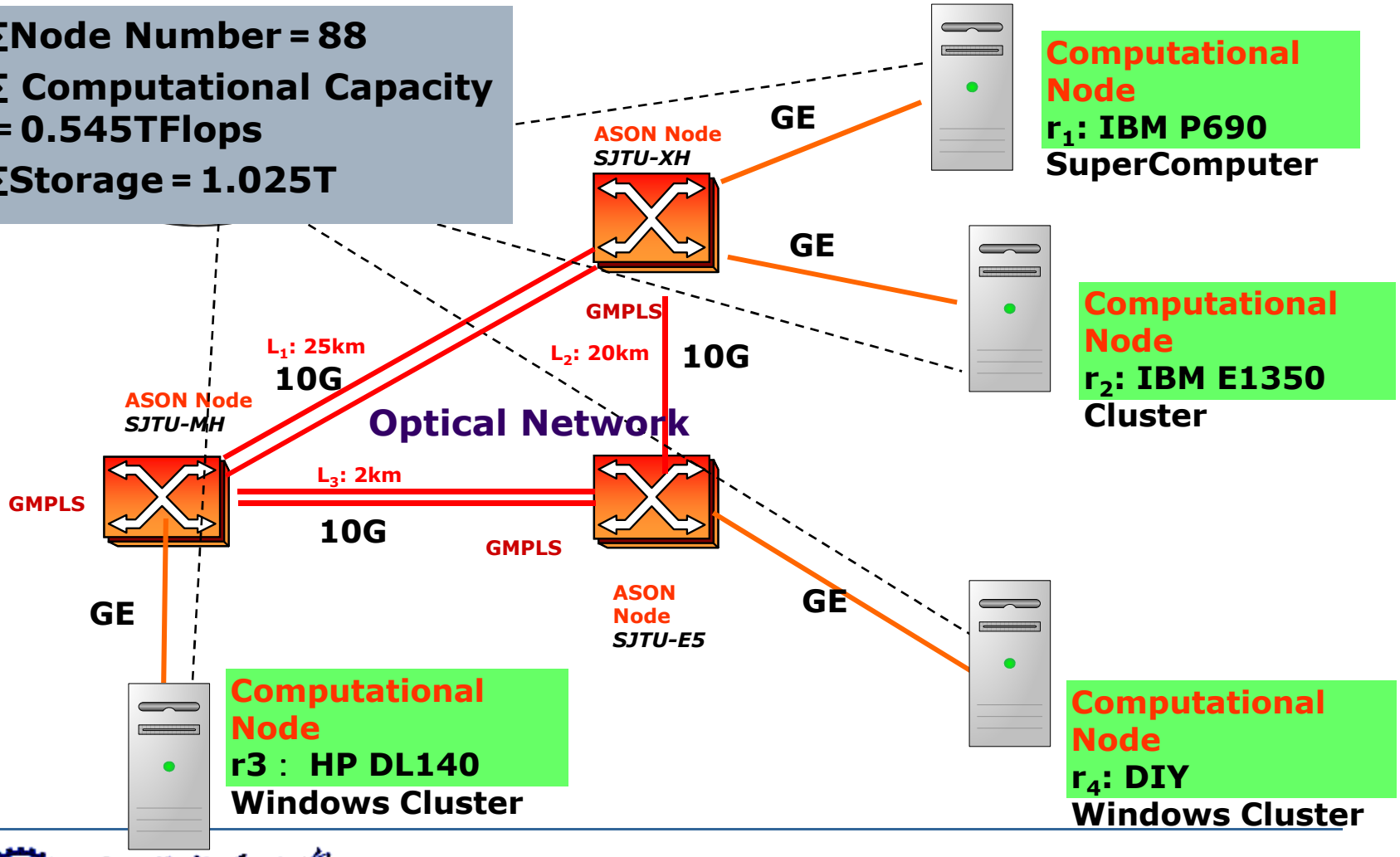
Windows Cluster - DIY

Performance

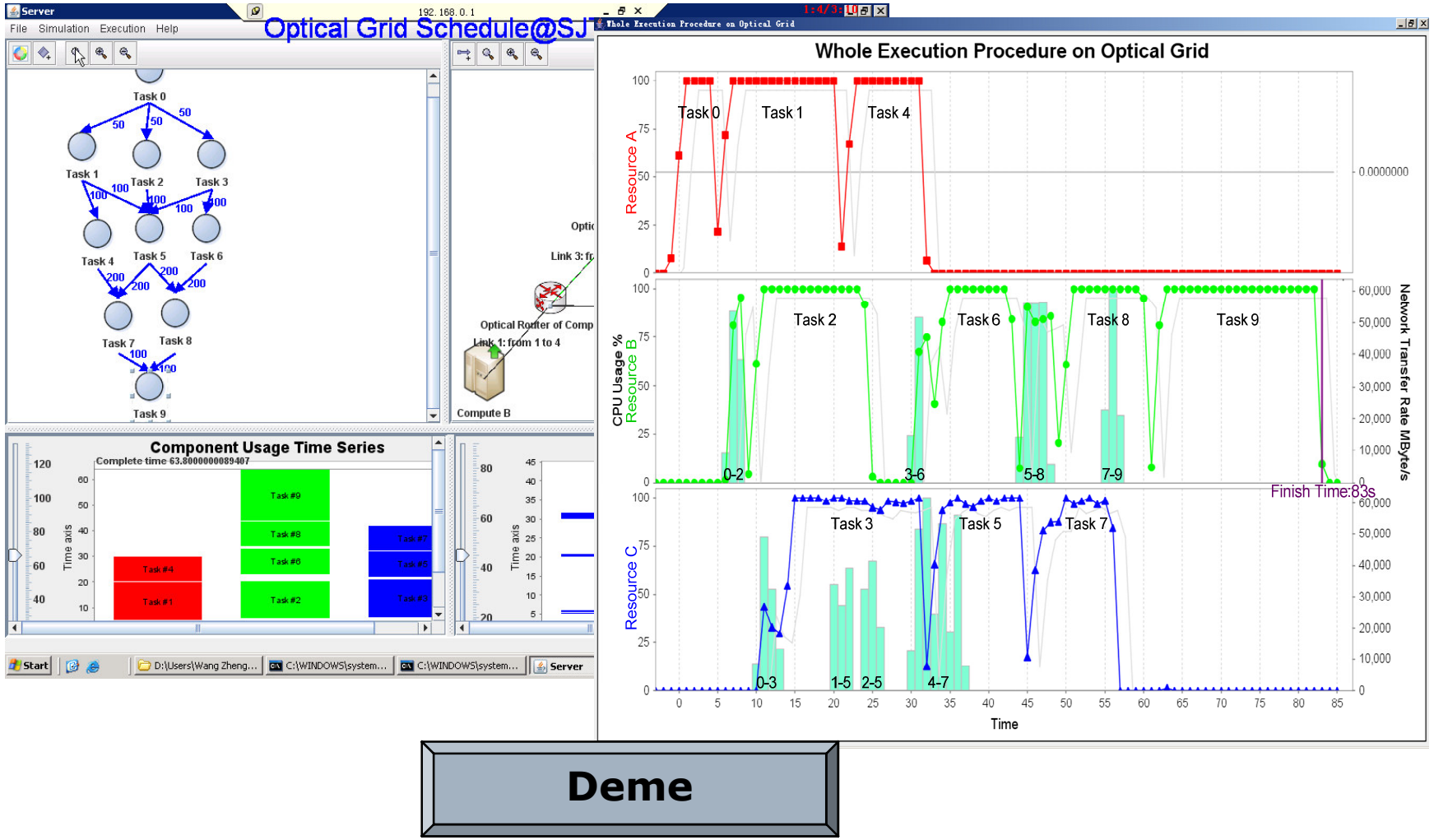
Hardware	CPU	2×Xeon 5110，1.6GHZ，
	Node number	41
	Computational Capacity	41×1.6×2×2×2 = 0.5TFlops
	Memory	41×1 = 42GB
	Storage	41×250GB=1.025TB
	Network	1Gb Ethernet、1Gb optical, cluster
Software	OS	Windows Server 2003
	Grid	Globus Toolkit 4.0，CGSP 2，ICE Grid 3.0

Network Topology

- ΣNode Number = 88
- Σ Computational Capacity = 0.545TFlops
- ΣStorage = 1.025T



Demo


Server
File Simulation Execution Help
Optical Grid Schedule@SJTU
Task 0
Task 1
Task 2
Task 3
Task 4
Task 5
Task 6
Task 7
Task 8
Task 9
Optical Router of Comp
Link 1: from 1 to 4
Compute B
Component Usage Time Series
Complete time 63.8000000089407
Time axis
Whole Execution Procedure on Optical Grid
Resource A
Resource B
Resource C
CPU Usage %
Network Transfer Rate MByte/s
Task 0
Task 1
Task 4
Task 2
Task 6
Task 8
Task 9
Task 3
Task 5
Task 7
0-2
3-6
5-8
7-9
0-3
1-5
2-5
4-7
Finish Time:83s
Time

Deme

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Summary

- Workflow-based applications need the support of optical-grid network.
- The WAGON and OGM have been developed to implement integrated Resource Managing, optimal Task Scheduling and Execution Managing.
- WAGON and OGM has been demonstrated in 3TNET testbed.
- WAGON and OGM can support the workflow-based applications efficiently.

Thank You!