e-R&D, Grid and e-Science

May 2005

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Changing R&D environment

- ✓ **High-speed Internet based Integrated R&D environment**
  - **IT is recognized as today's major creative basis for knowledge**
  - **Fast advancement of the R&D productivity through integration of traditional S&T and IT**

- ✓ **Changing characteristics of modern Science & Technology**
  - **Expansion •Integration •Complication • Intellectualization • Acceleration of technology innovation • Reduction of the technology development cycle, and pursuit of challenging technology**

e-R&D, Grid and e-Science

- ✓ **e-R&D**
  - R&D activities on electronic platform such as digital instrument, software and internet
- ✓ **Grid**
  - Integrated R&D activities and research resources for effective use of increased and expanded R&D resources
- ✓ **e-Science**
  - e-R&D activities specialized in the field of Science & Technology

Contents

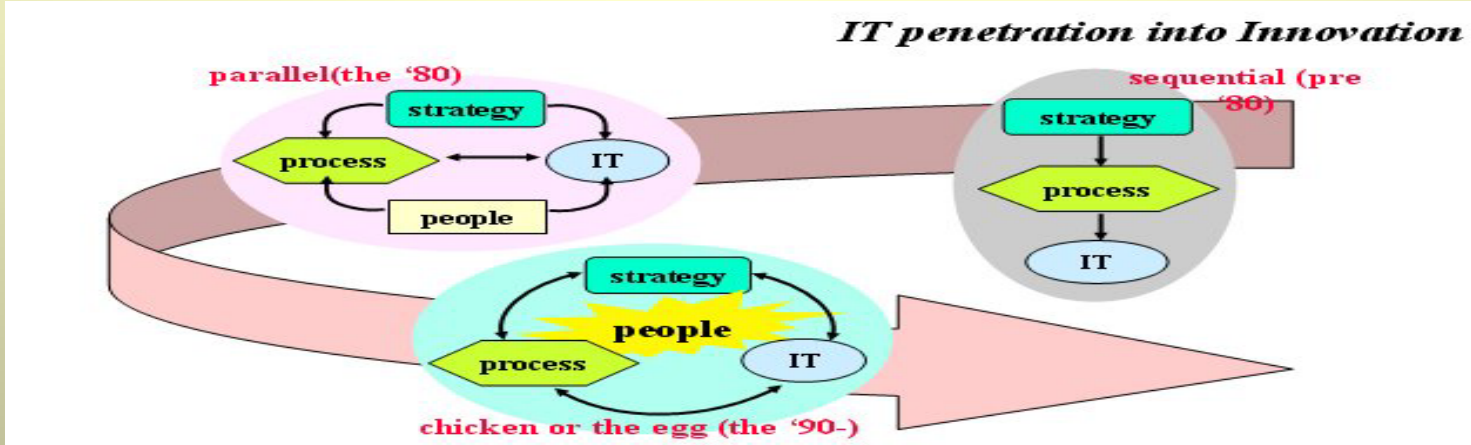
- **e-R&D**
  - ✓ Background of e-R&D
  - ✓ Core subject of e-R&D
  - ✓ Examples of e-R&D
- **Grid Technology**
  - ✓ Concept and necessity of Grid
  - ✓ Classification of Grid
  - ✓ Major Grid Projects
  - ✓ Market outlook on Grid technology
- **e-Science**
  - ✓ Collaboration & Research Productivity
  - ✓ Necessity & Possibility of Building Collaborative Environment
  - ✓ e-Science Research Environment
  - ✓ Expectations from e-Science Research Environment
  - ✓ Domestic Status
  - ✓ National e-Science Project
  - ✓ Future Plans & Expected Outcome

e-R&D

- Background of Advent of e-R&D
- Core Subject of e-R&D
- e-R&D examples

Necessity for Innovative System

- ✓ **Acceleration of Internet Use in R&D activities**
  - → **Requires R&D process models adequate for new environment**
- ✓ **Need for technology innovation management due to distribution of Internet**
  - → **New structure for organizing and analyzing the essence of innovation**

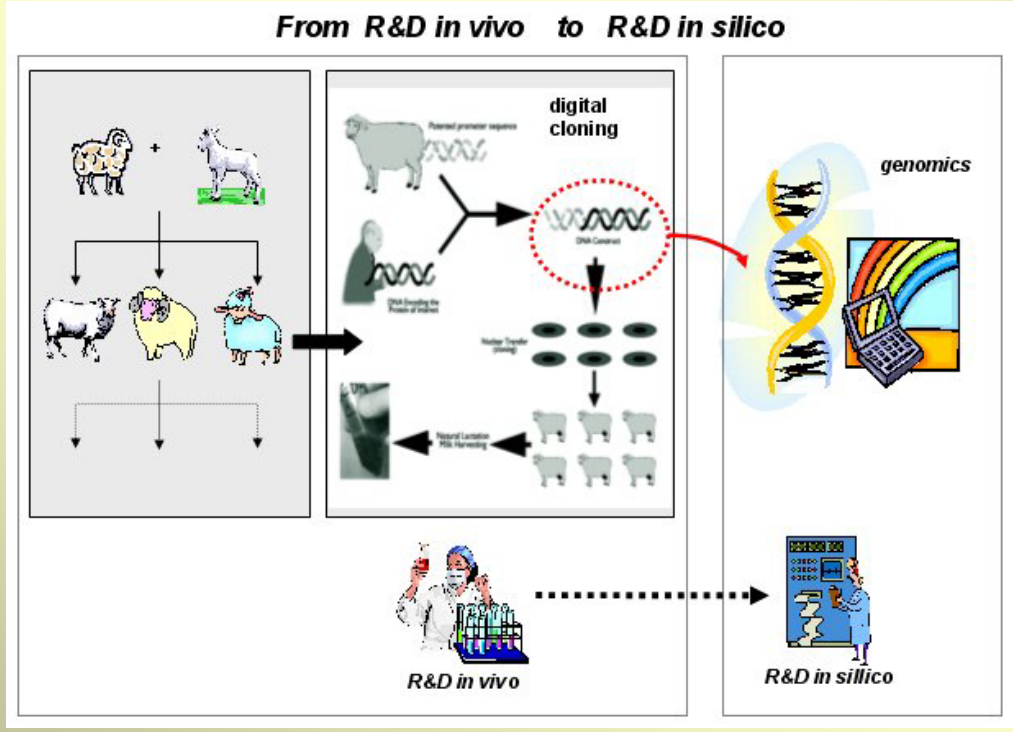


	1980 →		2005
focus	automation	consolidation	Innovation
role of IT	To do things better	to do better things	to do new things
Impact	improved Efficiency	improved effectiveness	Improved Innovativeness
	cost down	performance	dynamic capability

Changes in use of IT (Dong-Hyun Park 2002)

Changing features of R&D

- **Recent advances in performance of computers and development of various softwares**
  - ✓ Fast adoption of computational application in the area of material development



Example : Bioinformatics, *in Silico* R&D

Changing characteristics of e-R&D

- **Large scale data**
  - ✓ **Automated research equipments**
  - ✓ **Advances in size of Data storage capacity and data production**
- **Large number of computation**
  - ✓ **The number increases by twice every year**
- **High-Speed Network**
  - ✓ **10~100Giga of Network Capacity**
- **Increased number of mutual processes and collaborative researches**
  - ✓ **Active collaboration of scientists and computer technicians**
  - ✓ **Interaction between numerical computation and data**

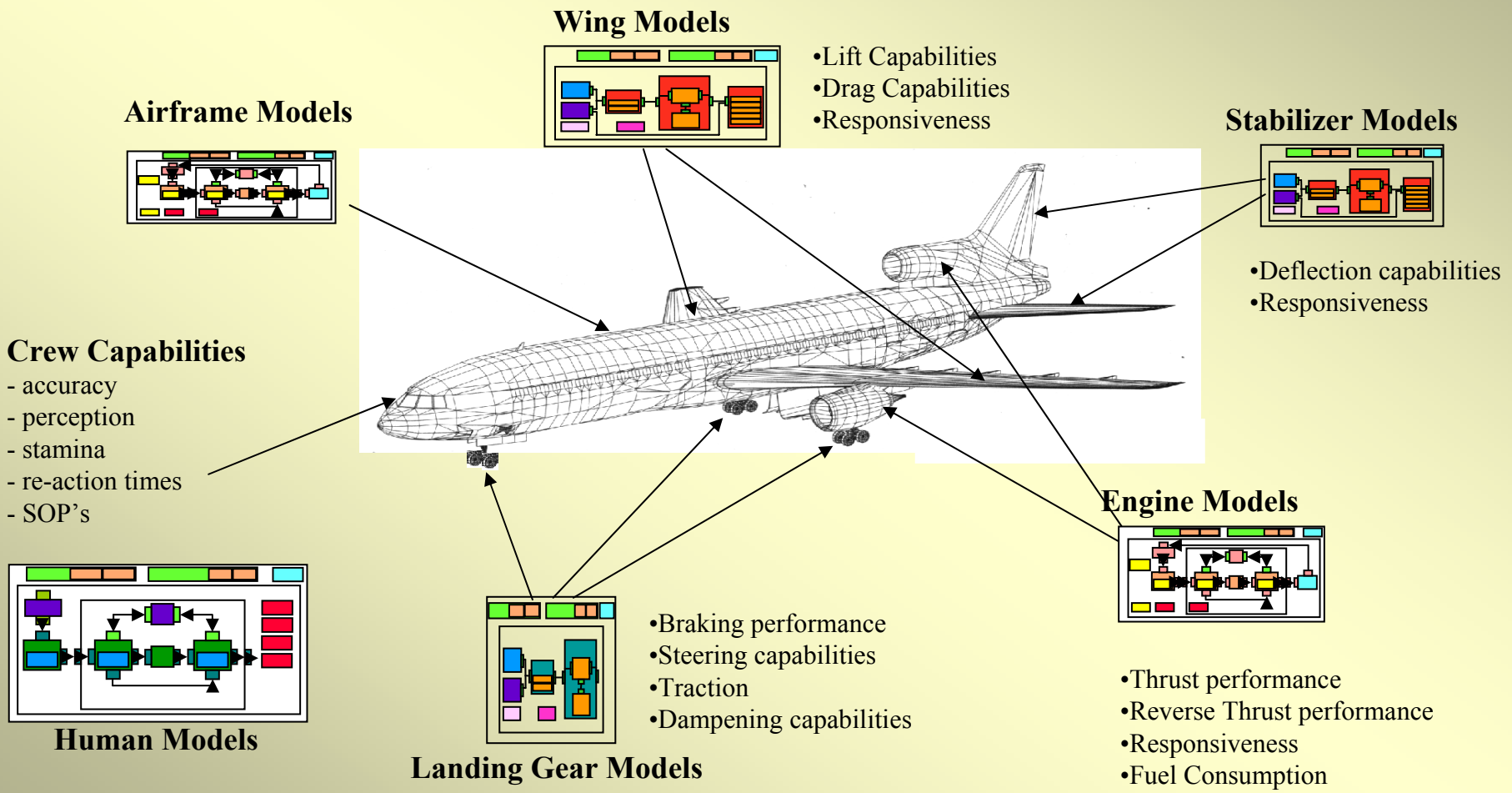
- **Develop Data and models**
  - ✓ **Produce data from researches using computer**

- **Deluge of data for everybody**
  - ✓ **example) The number of genetic information increases by twice the number every 9 months**

Summary:

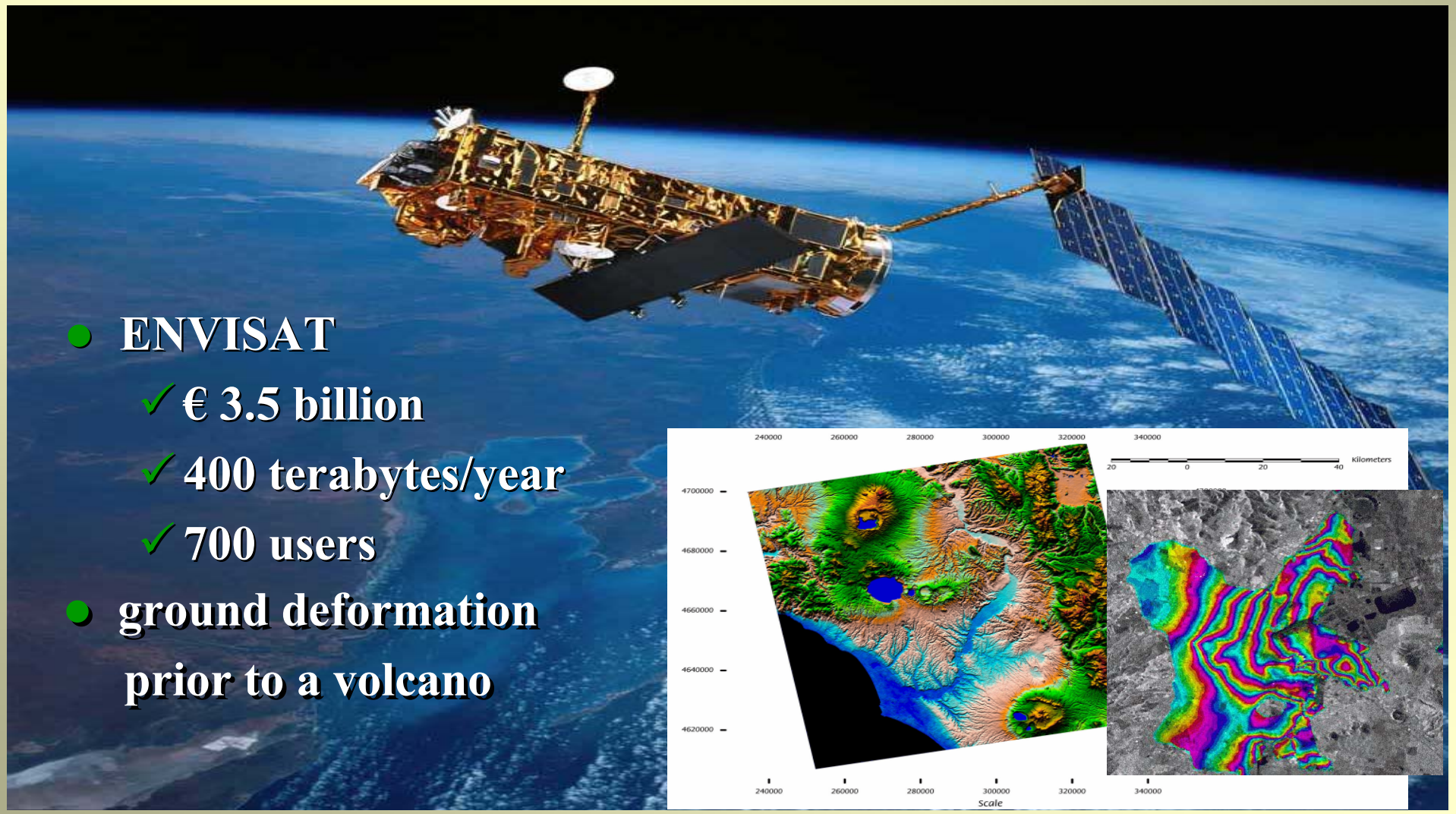
Share geographically dispersed data, information and computation among scientists throughout the world

Numerical analysis of various areas (Boeing)



Whole system simulations are produced by coupling all of the sub-system simulations

- *Earth Investigation* **(Disaster forecast)**



- **ENVISAT**
  - ✓ **€ 3.5 billion**
  - ✓ **400 terabytes/year**
  - ✓ **700 users**
- **ground deformation prior to a volcano**

- **Bioinformatics**
- **Collaborative Engineering**
- **Medical/Healthcare informatics**
- **TeleMicroscopy**
- **Virtual Observatories**
- **Robotic Telescopes**
- **High Energy Physics**

Grid Technology

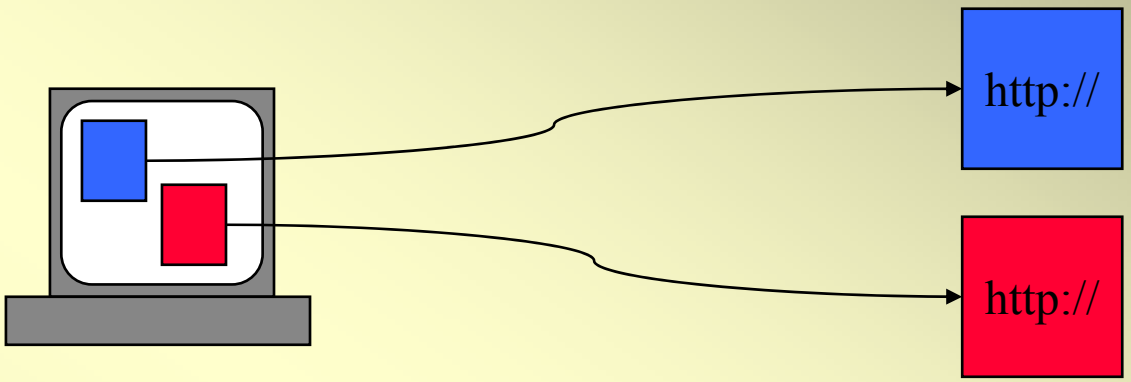
(e-R&D IT Infrastructure)

- Concept of Grid and its Necessity
- Classification of Grid
- Major Grid Projects
- Market Outlook for Grid technology

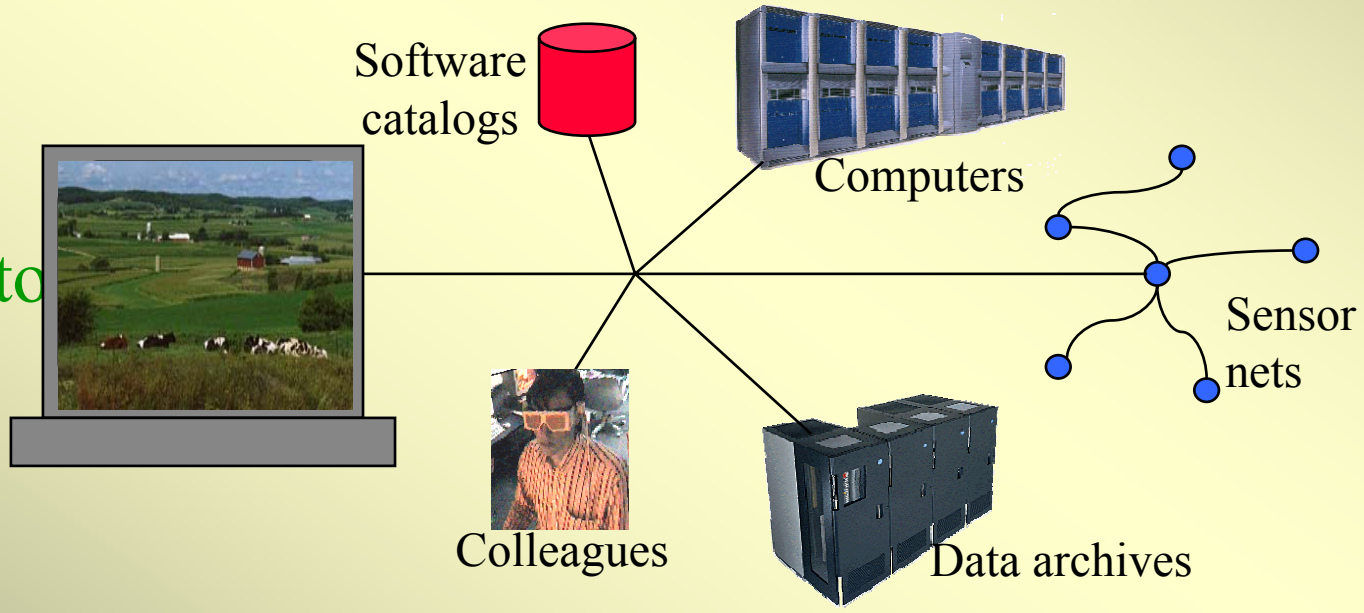
The Concept of Grid(1/2)

- The term comes from the electricity grid: **Anyone can use the electricity anytime and anywhere**

Web: Uniform access to HTML documents



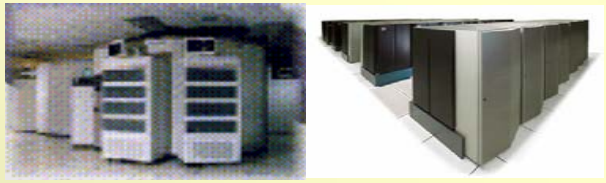
Grid: Flexible, high-perf access to all significant resources



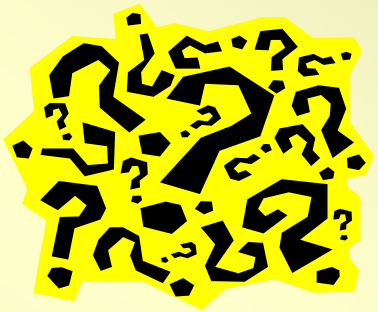
On-demand creation of powerful virtual computing systems

The Concept of Grid(2/2)

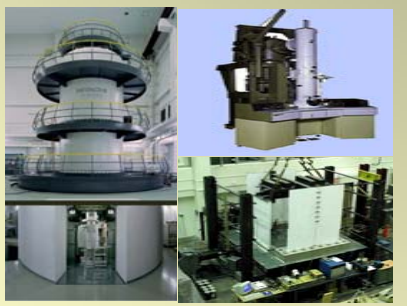
- Core technology and management system for sharing high-performance computers, large scale database, various high-end IT facilities connected through network



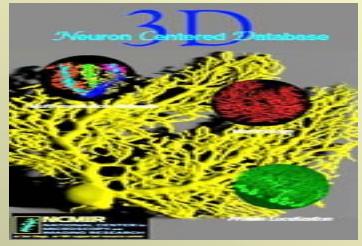
Computing Resources



Challenging problems



Experimental equipments



Database

GRID

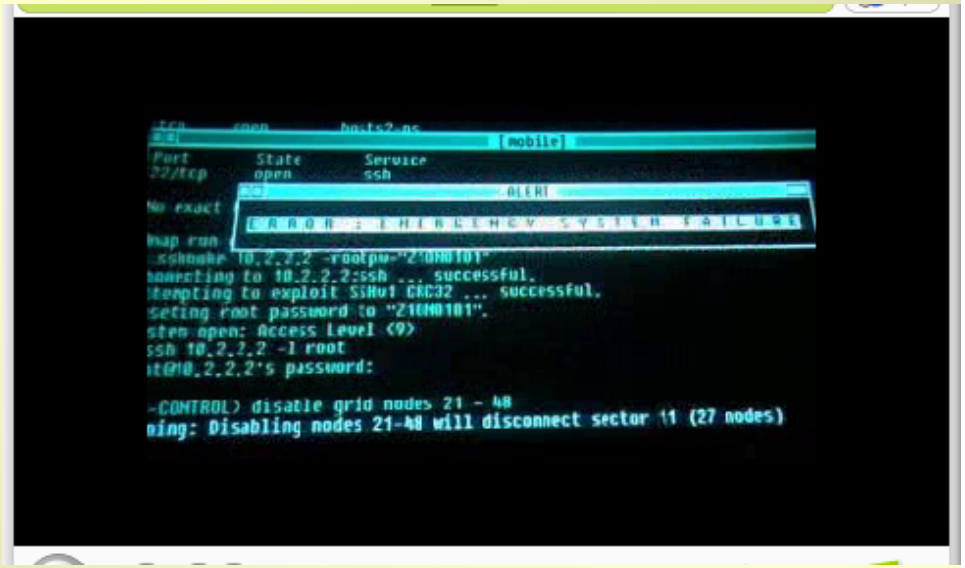
Knowledge

Solve problems

Human resources

- **MATRIX2**

Directed by : Larry Wachowski, Andy Wachowski
Starring : Keanu Reeves, Carrie Ann-Moss, Hugo Weaving, Joe Pantoliano, Gloria Foster_
Genre : Action, SF
Run time : 138min
Year : 2003
Country : USA



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- **Computational Grid**
  - ✓ **Distributed collaborative computation resources (metacomputing resources)**
  - **Enables ultra large scale, high-speed computation and remote control**
- **Data Grid**
  - **Analysis and management of geographically distributed large-scale data**
  - **International collaboration using high-speed Internet**
  - **Examples of areas) High-energe physics, Bioinformatics, Earth observation**
- **Access Grid**
  - ✓ **Human interface for supporting collaborative activities**
  - **Real-time remote conference and collaborative researches on Grid infrastructure**

- **Major Grid Projects in IT Advanced Countries**

  - ✓ **Tera Grid Project(US)**
    - Connecting supercomputing resources in major 4 sites in US
    - 153 M USD (2000~2007)

  - ✓ **Data Grid Project(EU)**
    - Building Grid for data processing in the areas of High-energy, environmental science, bioinformatics
    - 183 M EURO (1998~2007)

  - ✓ **NAREGI Project(Japan)**
    - Building Grid infrastructure for national R&D activities
    - 360 M USD (2003~2007)

National Grid Project in Korea

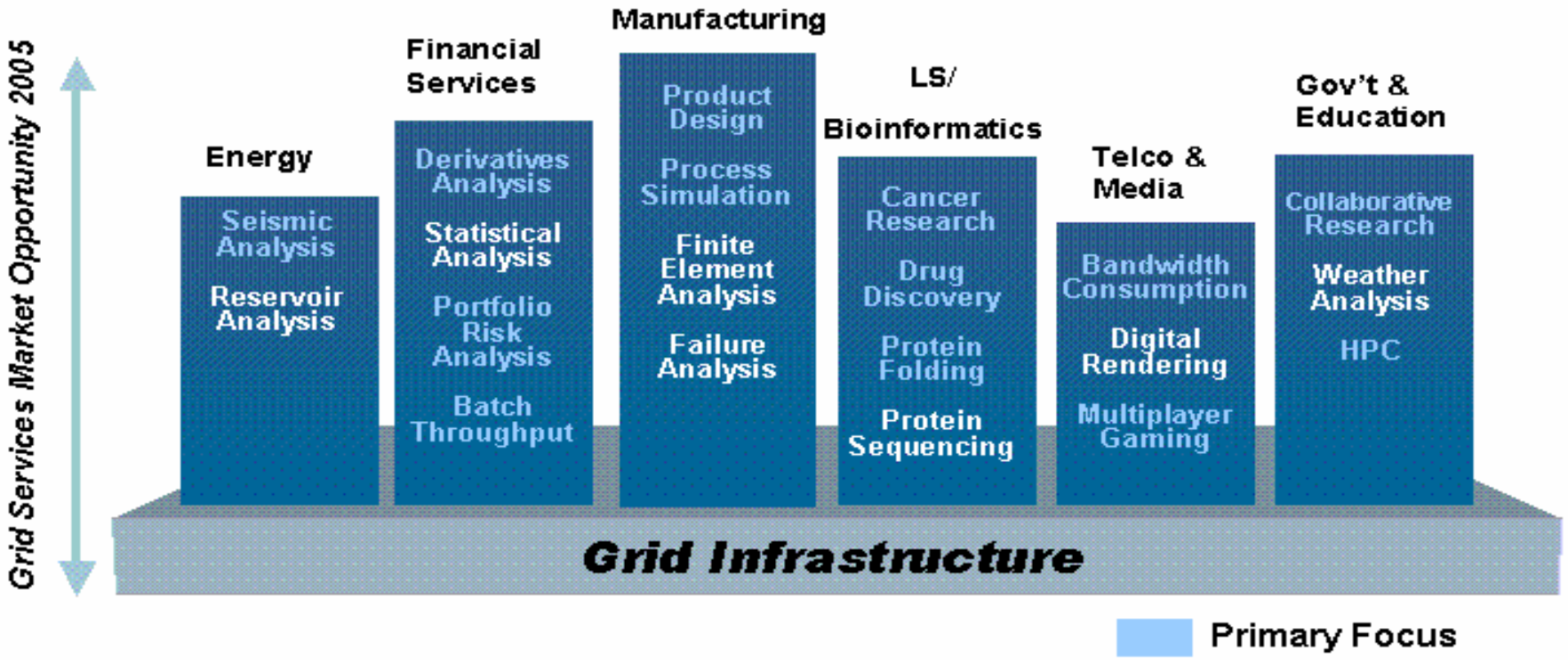
✓ Under the 'National Basic Plan for Grid'

- Supervised by: Ministry of Information & Communication
- Managed by: Korea Institute of Science & Technology Information
- Budget: 43.5Billion(2002~2006)
- Activities: Construction of Grid infrastructure, Grid middleware development, Grid standardization, Grid Forum Korea(GFK)

✓ International Grid Activities

- Invited the 13th Global Grid Forum (GGF13) in Seoul, March 2005

Unique by Industry with Common Characteristics

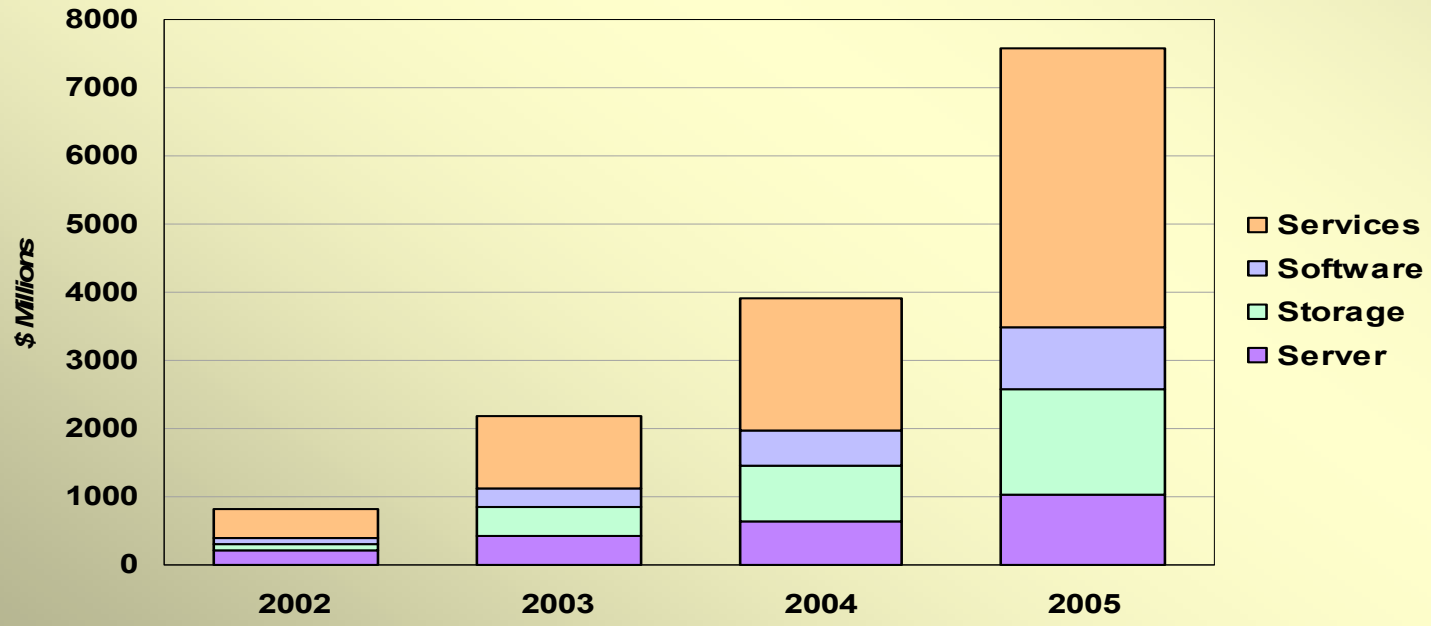


Sources: IDC, 2000 and Bear Stearns- Internet 3.0 - 5/01 Analysis by SAI

Market Outlook

Market Size

- **Grid is the next generation computing resources for enterprises: The global population will be connected to Grid and the large population will become their customers. Therefore, industry sees the potential of Grid and is devoting full efforts on researches, standardization of Grid and its business.**
  - **Report on Grid Computing Technology and Market Investigation (2002)--**



Promoting National Science & Technology Innovation

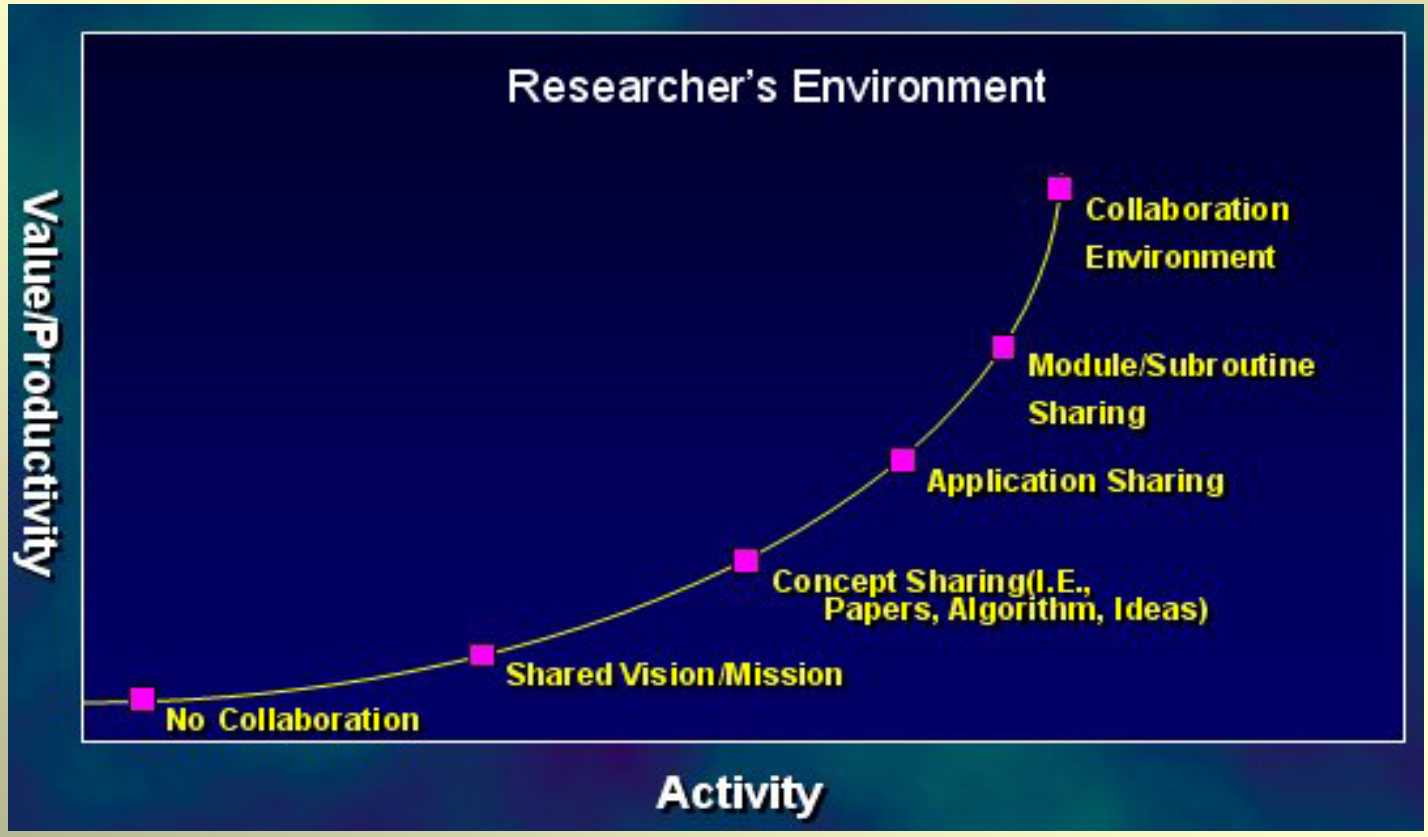
e-Science

- Collaboration & Research Productivity
- Necessity & Possibility of Building Collaborative Environment
- e-Science Research Environment
- Expectations from e-Science Research Environment
- Domestic Status
- National e-Science Project
- Future Plans & Expected

Collaboration & Research Productivity

- **In an era of digital economy, collaboration can decrease cost as well the complexity of an organization**

- *"Coase's Law"*



Source: 'Researcher's Productivity chart', Prototyping an Earth System Grid, DOE

Collaboration & Research Productivity

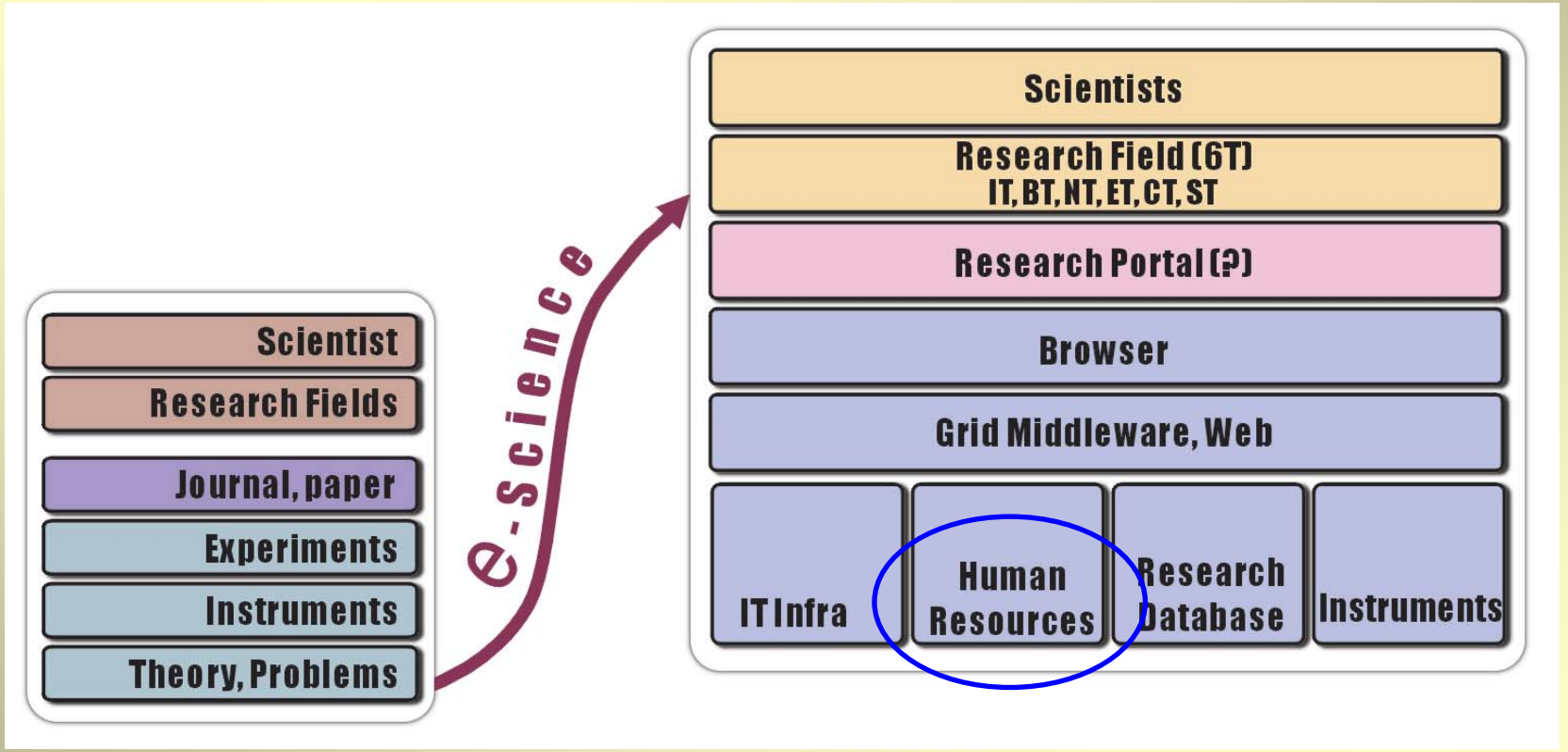
- **Current research environment**
  - ✓**Limited collaboration and resource sharing due to restricted research activities and information exchanges**
  - ✓ **Difficult to connect and use distributed S&T resources due to time and space limit**
  - ✓**Ineffective R&D, low productivity**

➔ **Needs for geographically-dispersed collaborative research environment arises**

- **Present Research Environment**
  - ✓ **Faster advancement of networking technology (double in speed every 9 months) than that of computers (doubling every 18 months)**
  - ✓ **Development of Grid technology to integrate geographically distributed research equipments ➔ Overcome time & space limits for research**
  - ✓ **Advent of very large scale scientific problems in such areas as High-energy physics and Space Science requires ultra-large experimental equipment and sharing of data analysis**
    - ➔ **Requires distributed collaborative research environment**

- **What is e-Science R&D environment?**
  - ✓ **Virtual R&D environment for distributed collaborative researches by using Grid, the next-generation internet service, as a core infrastructure for integrating and coordinating geographically distributed high-performance computers, large-scale data storages, high-end database and high-end experimental equipments through high-speed network**

●Changes in Research Environment



Current & past R&D environment (Serial)

Next-generation R&D environment (Collaborative & integrated)

Expected results of e-Science R&D Environment

Maximize the use of S&T resources

- Collaboration of High-end R&D resources

- Build huge virtual resource by connecting geographically distributed high-end R&D resources
  - ✓ Able to run grand-challenge research projects
- Automatic connection to heterogeneous resources
  - ✓ Example) Remote science, Digital climate forecasting system
- Environment for sharing data from observation & experiment
  - ✓ Example) Protein data bank, Image information from climate satellites
- Environment for remote collaboration
  - ✓ Telecommunication & information sharing through Access Grid

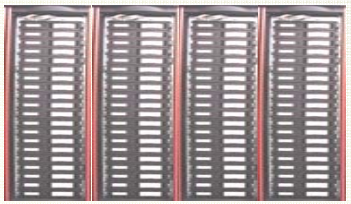
Domestic infrastructure & Role of KISTI

World-class IT & "S&T" Infrastructure

Top 7

Supercomputer(IBM p690)

Supercomputer(NEC SX-5/6)



Tera Cluster(Domestic technology)

World's Top Class

Large-scale Research Equipment
(UHV- TEM)

Large-scale Research Equipment
(Pohang Synchrotron
Lightsource Accelerator)

Large-scale Research Equipment
(Neutron Application Reactor-Hanaro)

Network Infrastructure
(Minimum 2.5GBps)

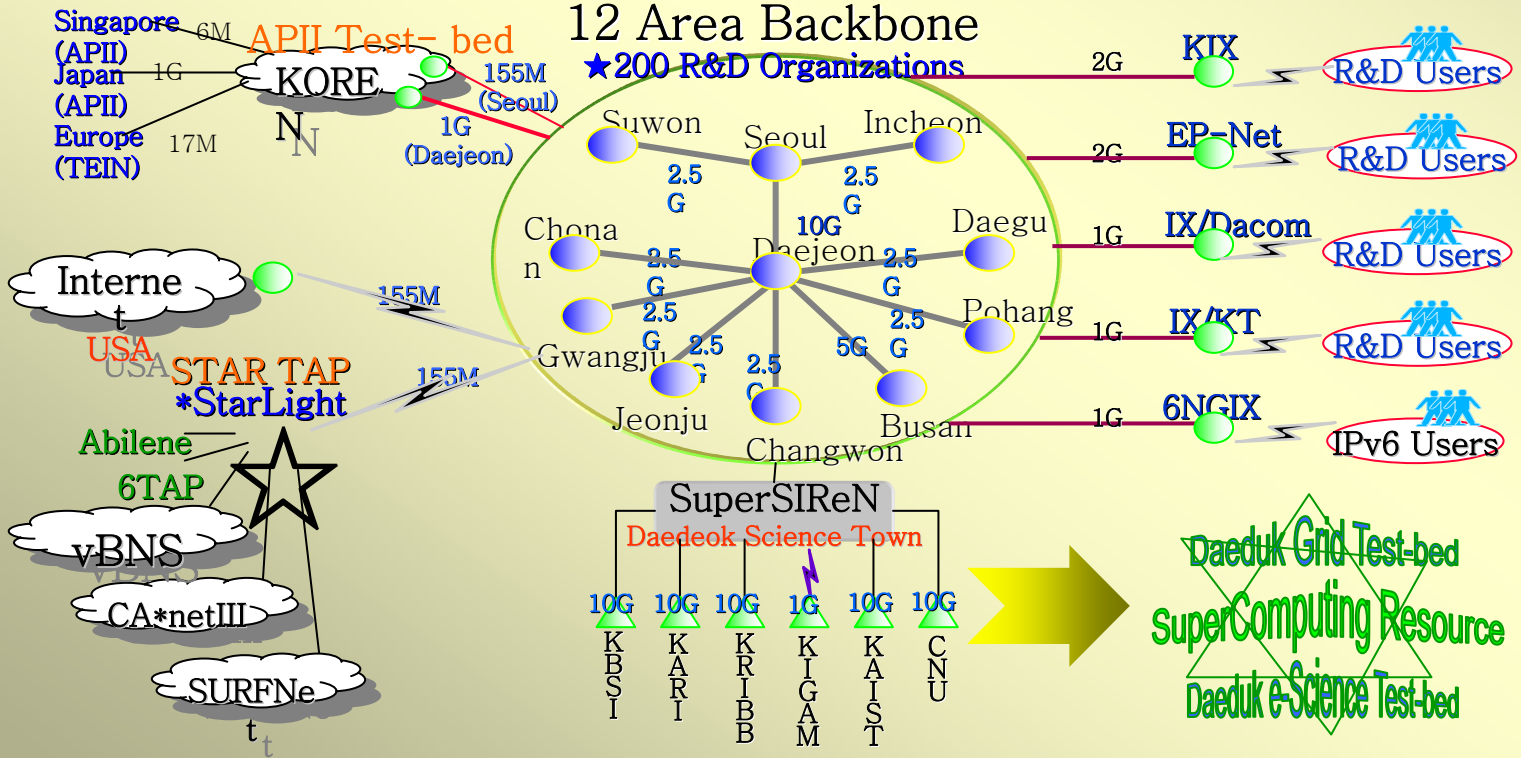
Currently carrying out the project "National Grid Infrastructure Development" for integrating and coordinating Supercomputers, Data Storage, Visualization System, Research Equipments

- 2002-2006 /43.5Billion

Advancing High-speed Research Network

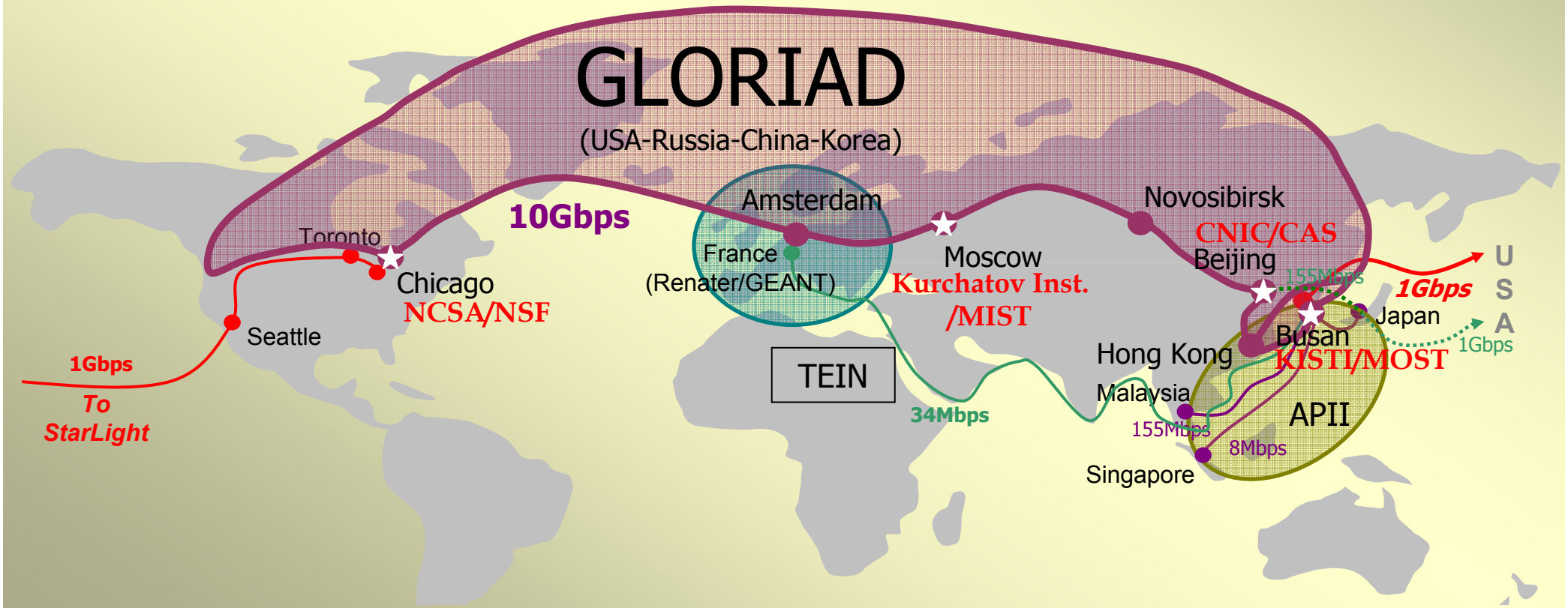
- **Area : High-speed Research Network (KREONET) Giga backbone deployment and services**
- **Characteristic: Seoul-Daejeon(10Gbps), 12 local network centers (2.5Gbps)**

  - Integrated monitoring system service (24 hours), Apply next-generation technology (IPv6, QoS, Multicast)
- **Results: High-end application (e-Science, Grid) needs based Infrastructure**



GLORIAD (GLObal RIng network for Advanced application Development)

- Definition : The world's first global science & technology network connecting the continents with 10Gbps ring-type lambda network (Funded by Korea, US, Russia, and China)
- Application : Serve as international collaborative network for high-end science and technology areas such as high-energy physics, bioscience and nuclear fusion that require real-time large scale data transfers



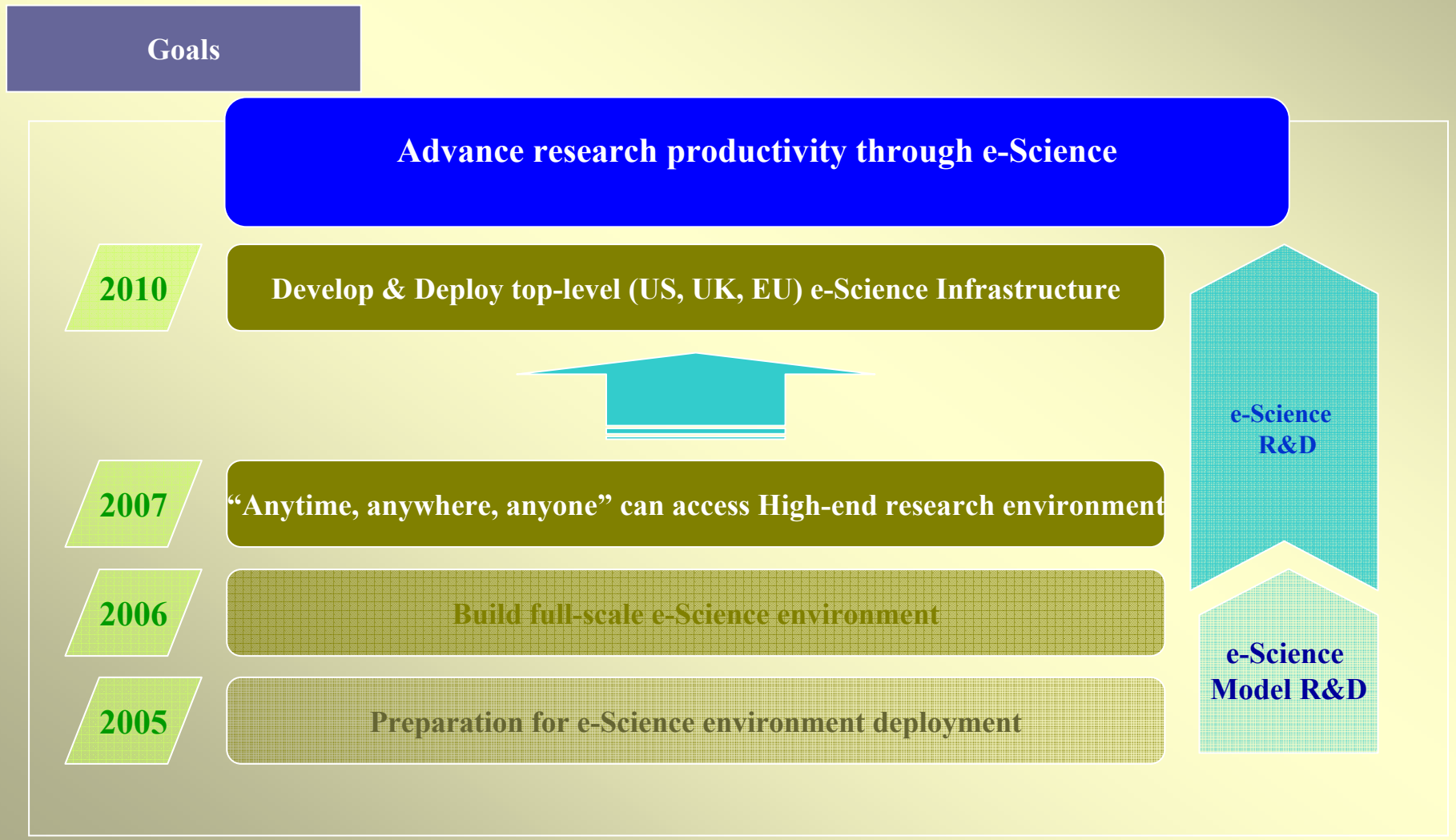
What is National e-Science Project ?

The National e-Science Project is a national R&D project for developing technologies to bring about e-Science environment and activities by coordinating and integrating geographically distributed researchers, research equipments and information.

Overview of the Project

- **Objective: To deploy world's top-class e-Science environment by 2010**
- **Project period: 2005 ~ 2007 (Phase I: Build foundation for e-Science)**
  2008 ~ 2010 (Phase II: Completion of e-Science environment)
- **Total budget: 102.7 Billion KRW (Phase I&II, 6 years)**
- **Supervisor: Ministry of Science and Technology**
- **Manager: Korea Institute of Science & Technology Information**

Goals of the National e-Science Project



National e-Science Strategic Plan

Early Deployment

- ✓ Maximize use of domestic research results
- ✓ Focused development of founding technology, core technology

Success Model

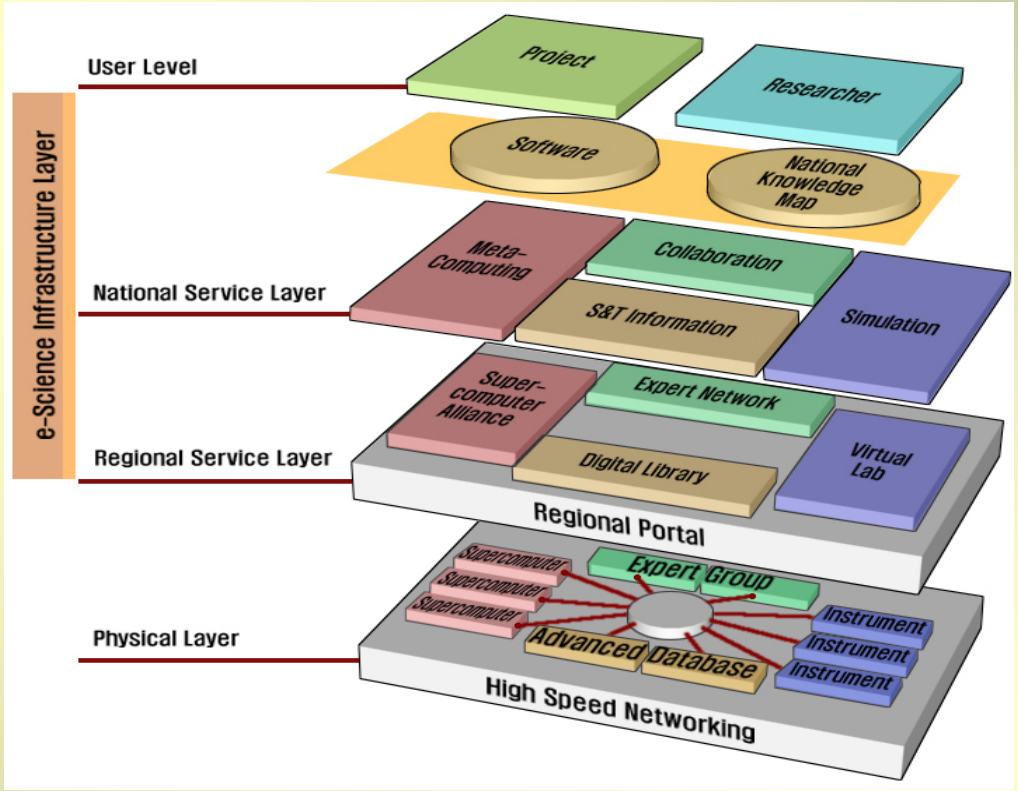
- ✓ Focused development of highly effective **Killer Application**(Core application)
- ✓ Collaboration of industry, university and institutes

Collaboration of Ministries

- ✓ MOST : "National **e-Science**"
- ✓ MIC : "National Grid"
- ✓ MOCIE: "National **e-Business**"
- ✓ MOHW : "National **e-Health**"
- ✓ NSTC : Mediation & evaluation of the roles of each Ministry

● Deploy national e-Science R&D environment by expanding the National Grid infrastructure

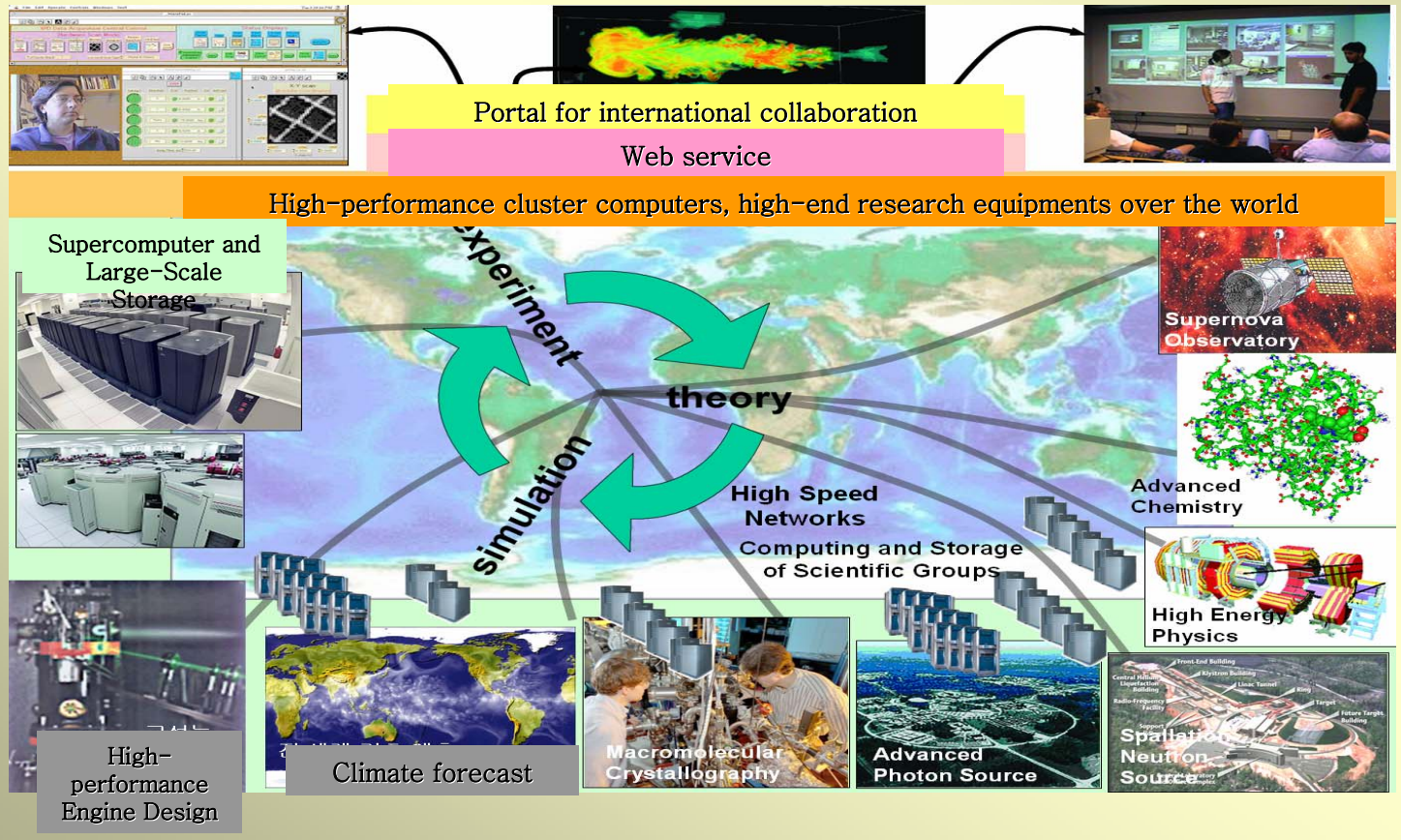
✓**e-Science R&D environment** will bring innovation to the national science and technology R&D by **integrating distributed high-end S&T infrastructure** (Computing resources, network resources, data resources, experimental equipment and human resources)



National e-Science R&D Environment

Future Outlook

- **High-end science and technology infrastructure will merge into e-Science environment, which will provide the vision for the 21st century with high-end application technology(6T) and open up a bright future with science and technology**



- **In the 21st century the value of knowledge and information will decide the future of individuals and nations**
- **Requires effort on the development of next-generation, promising new integrated technology based on information technology**
- **Requires Grid technology based e-Science environment applicable to the areas of welfare, industry, science, education, health**

Conclusion

- **The world is going through a rapid change into e- R&D based science and technology environment**

- **Requires active response to the changes from provider-centric to customer-centric environment, and from infrastructure to application**

- **We shall be the leader of the innovation and promote the national knowledge & information society of the 21st Century**

"e-Science is about global collaboration in key areas of science, and the next generation of infrastructure that will enable it."

John Taylor

Thank you!