The Role and Prospect of ICT toward the Sustainable Society

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1. ICT Era in the Science History

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History of Science

Latin Origin: Scientia ➡ to know something

-mid of 14C Science = to know something
=Seven Liberal Arts

17C "the Scientific Revolution"
- Knowledge and wisdom by "the law of cause and effect"

19C Natural Science, Physical Science
- Specialization and systemization
- Birth of "scientists"

20C The Era of Big Science
- To link with industry and military affairs
- Birth of electronics

➡ ICT Revolution

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Three Digital Inventions for ICT Revolution

1947 **Transistor** (point-contact transistor)

- Shockley, Brattain and Bardeen at Bell Lab
- Solid-state amplification of electric signals

1948 **Theory of Communication by Shannon**

- Concept of “bit”
- All information can be resolved into “0” and “1”.

1945 **Von Neumann-type Computer**

- Built-in program computer

Three sacred treasures as the basis of ICT Revolution

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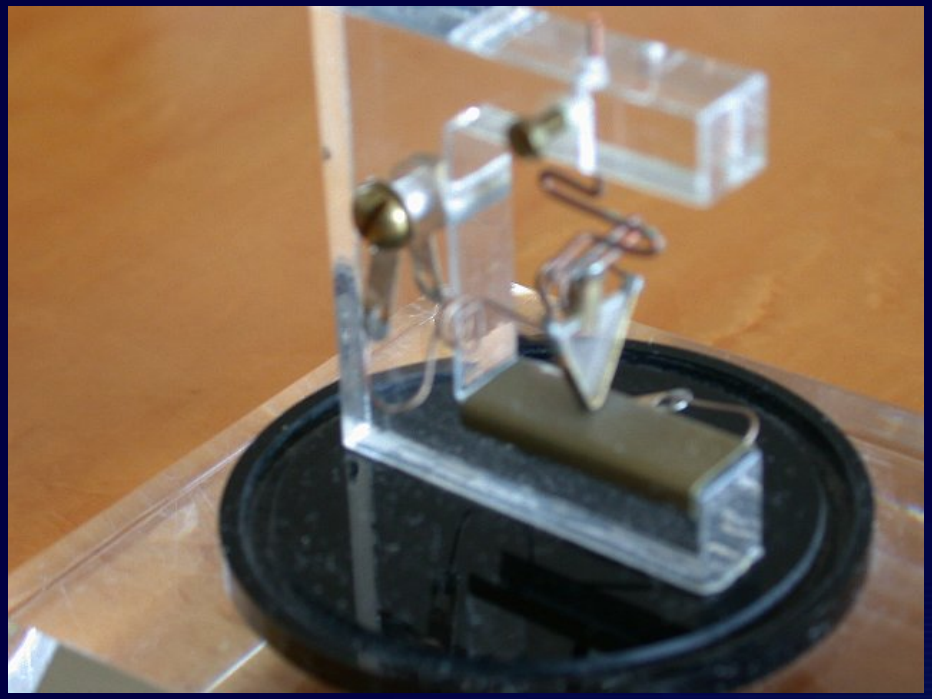
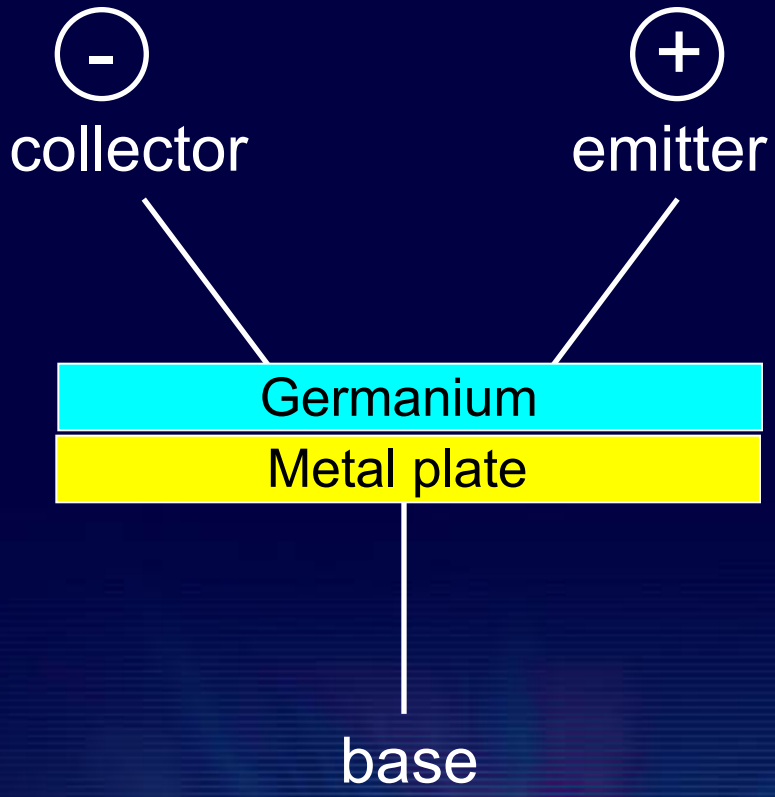
Point-contact Transistor





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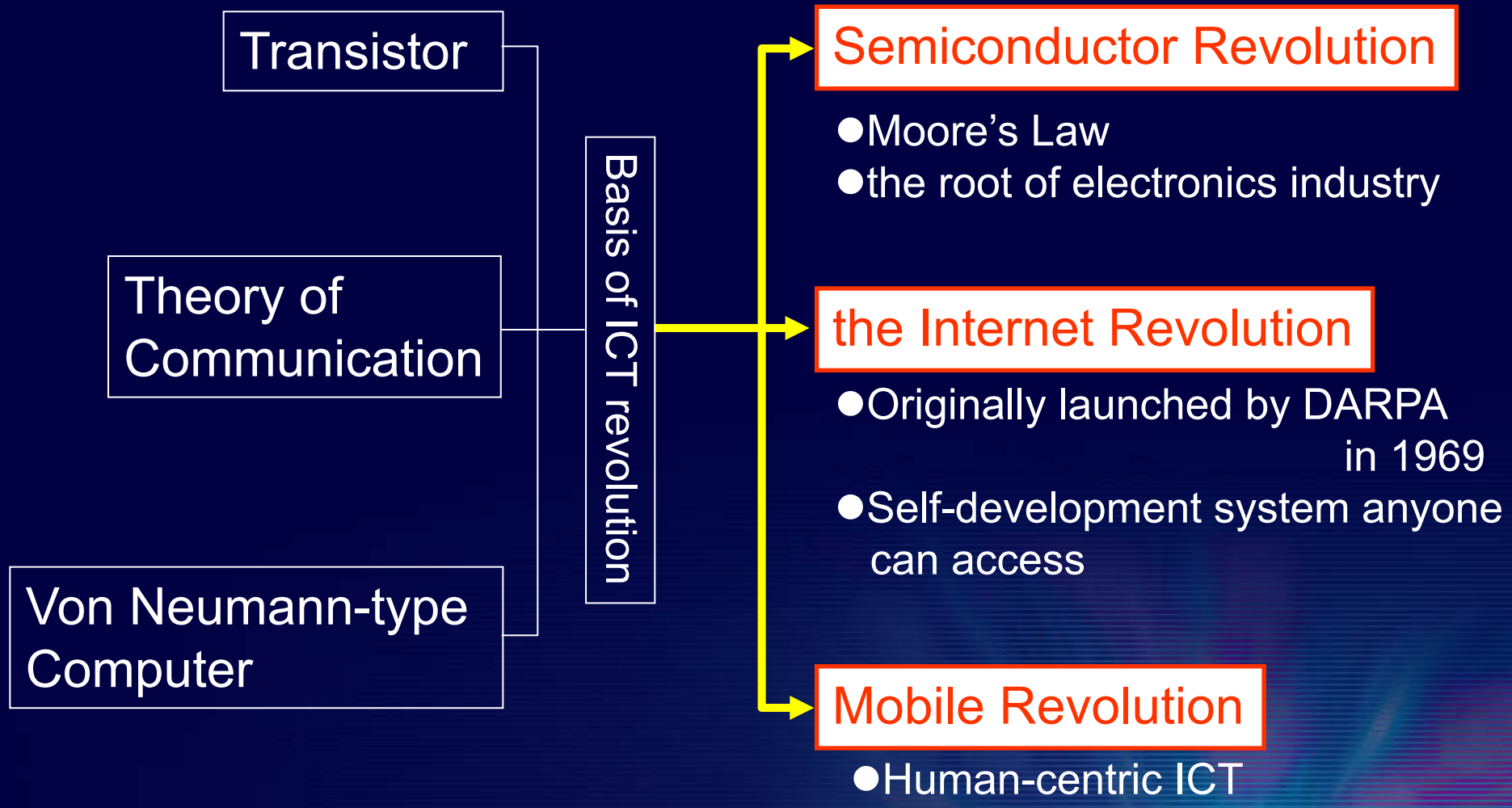
Completion of ICT Revolution



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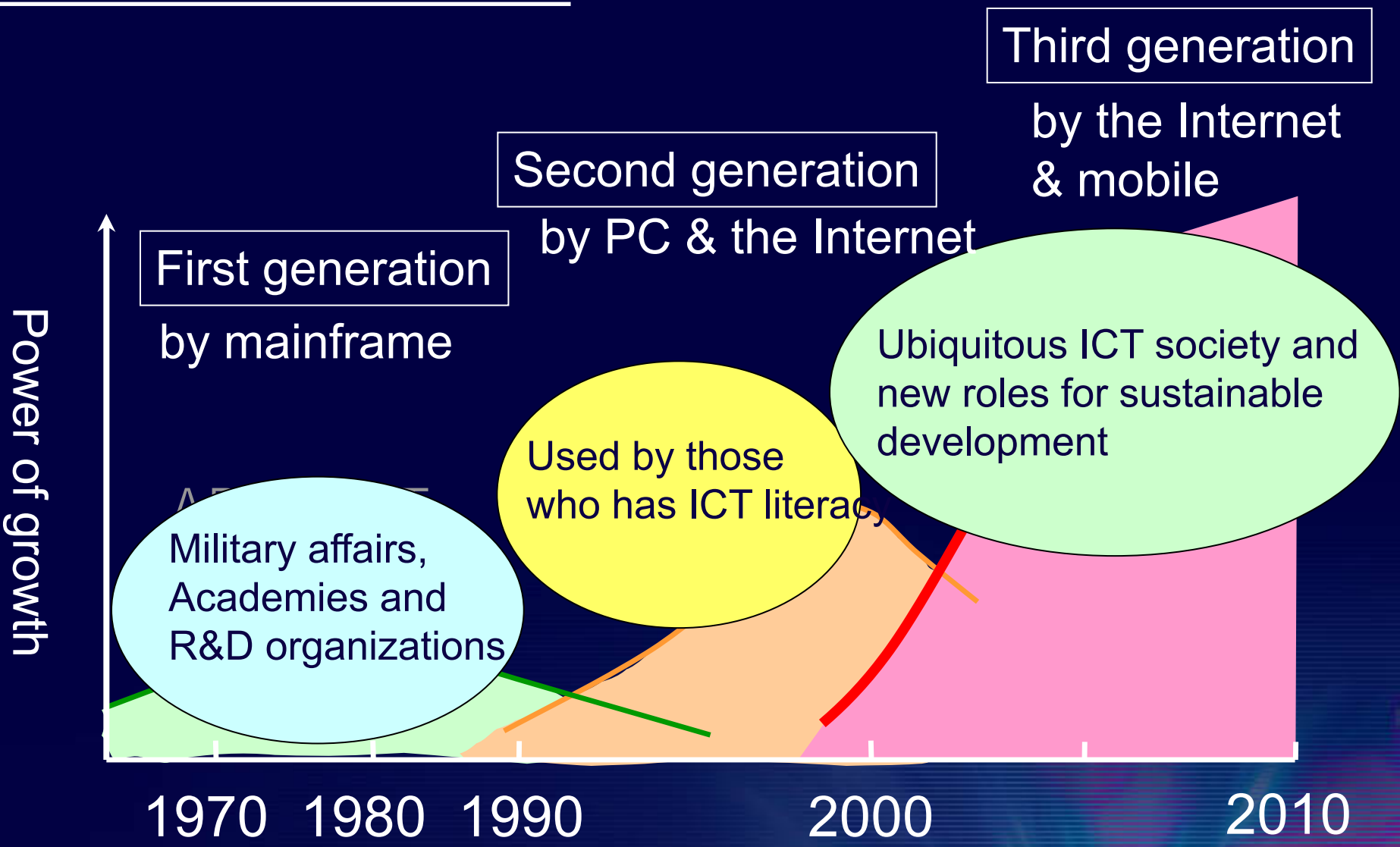
Three Waves of ICT



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Impact of Semiconductor on Computer Evolution

element	Vacuum Tube	Tr/IC	LSI	
model	ENIAC	N2200/ M500	PC-98NX (MA10T/C)	ENIAC vs PC
year	1946	1966	2001	
MIPS	0.005	0.2	2691	x540,000
volume (m^3)	900 $450m^2$ x2m	3	0.0087	$\frac{1}{100000}$
power consumption	140KW	17KW	max66W (18W)	1/2120 (1/7800)

():saving mode

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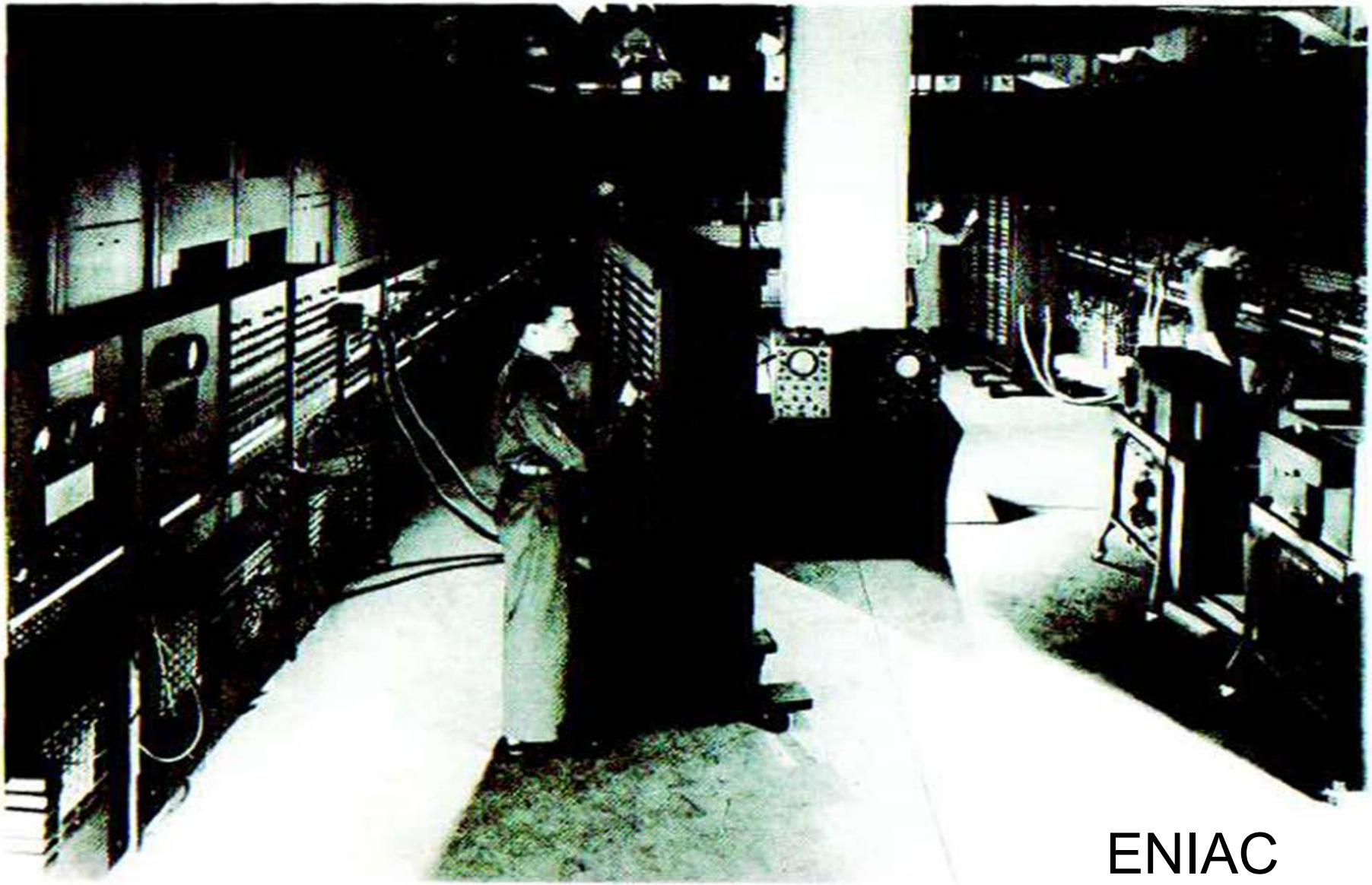

ENIAC

Operators instructed the ENIAC by plugging in wires and setting switches; in effect, they had to reconfigure the computer's wiring every time the ENIAC had a new problem to solve. Reprogramming thus went at the slow speed of human hands.

2. ICT Impact on Society

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Change of the Role of ICT for Business

	-1980s	1990s-
Substitute for	●Blue colors ●Office work ➢Office Automation	●White colors ●Sales process ➢SFA (Sales force automation)
Aiming at	●Production efficiency ●Volume-oriented efficiency	●Management efficiency ●Speed-oriented efficiency
Attitude to information	●Monopolization	●Sharing

Information sharing was one of the typical features of Japanese style management based on invisible human network.

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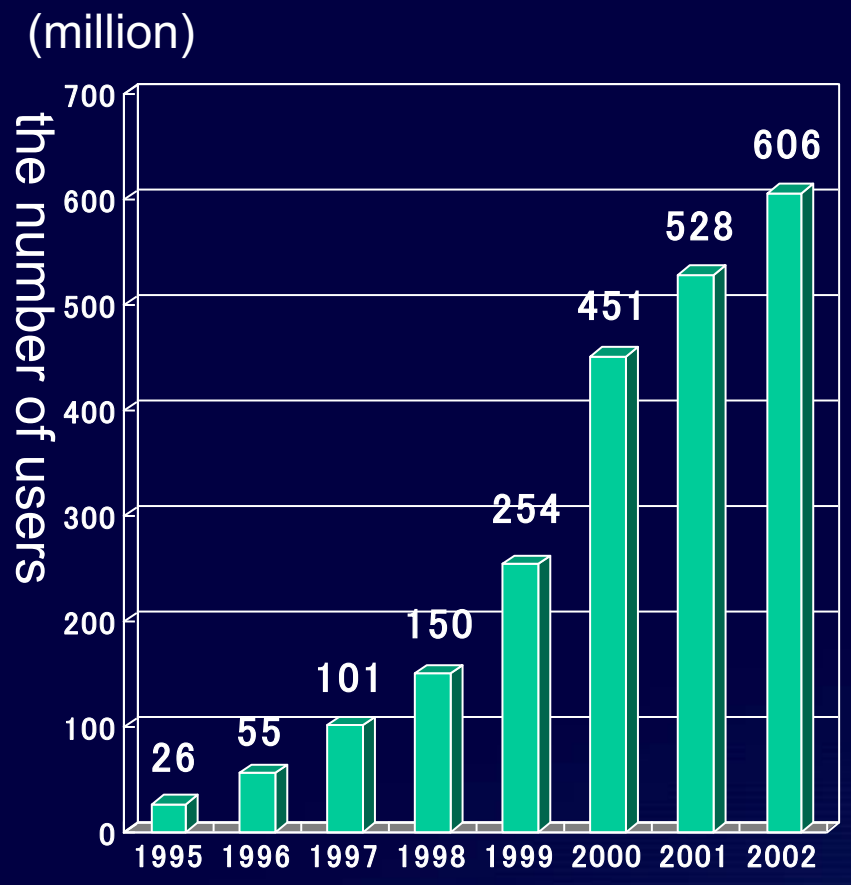
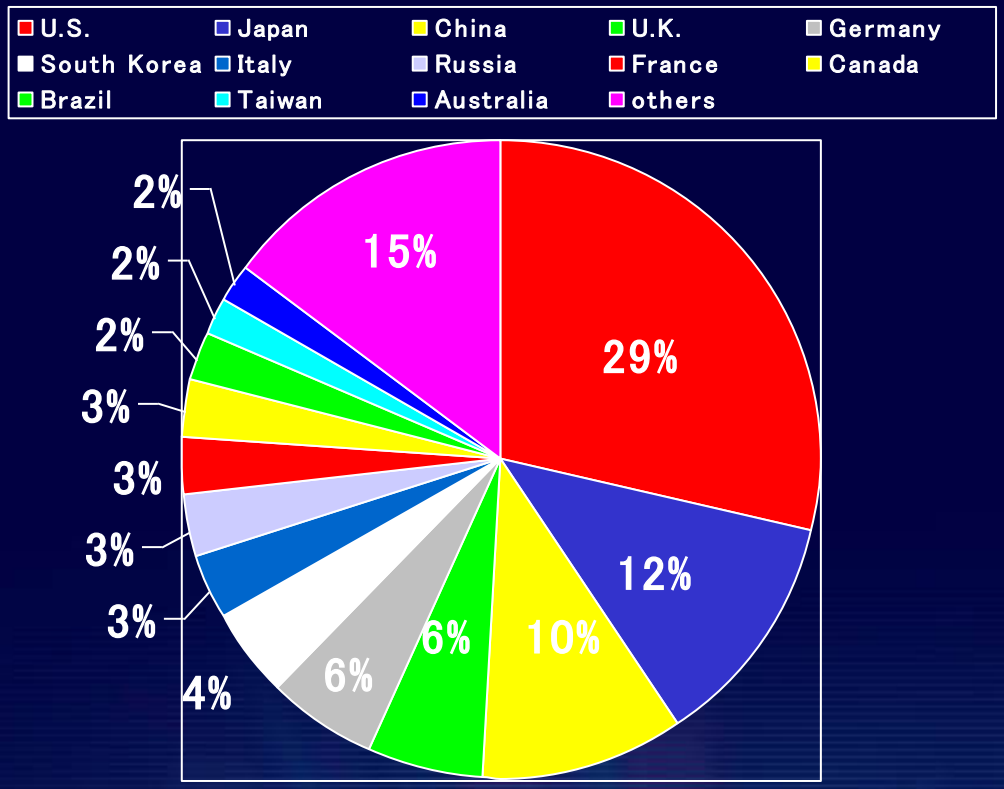
Worldwide Propagation of the Internet



Breakdown of users by regions(2002)



source :NUA, Ministry of Public Management, Home Affairs, Posts and Telecommunications

- More than 600 million people use the Internet worldwide.
  - The share of top three countries exceeds 50%.

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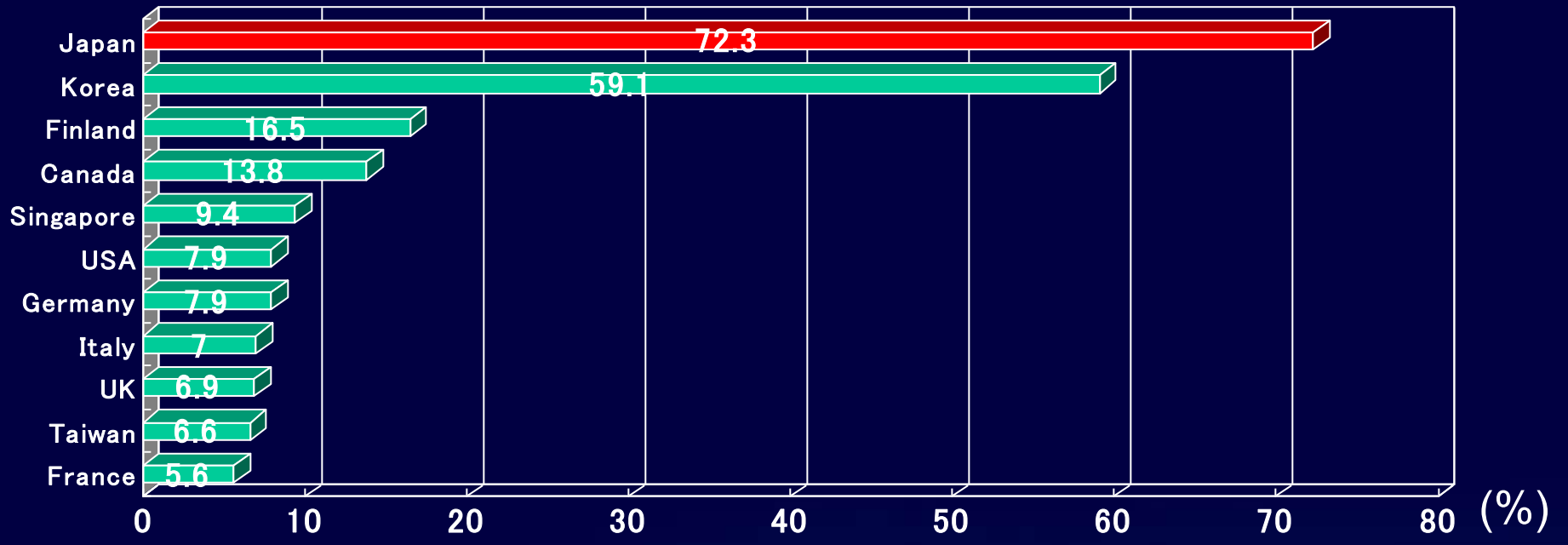
Japan's Advantage on the Mobile Internet

Comparison of propagation of the Mobile Internet by cellular phones(2001)



Source: White Paper on Information and Communication,2002

- In Japan, Mobile Internet service was started in Feb, 1999 by NTT Docomo.

As of Jan, 2003, the ratio of mobile Internet users was 82% including the users of all the providers.

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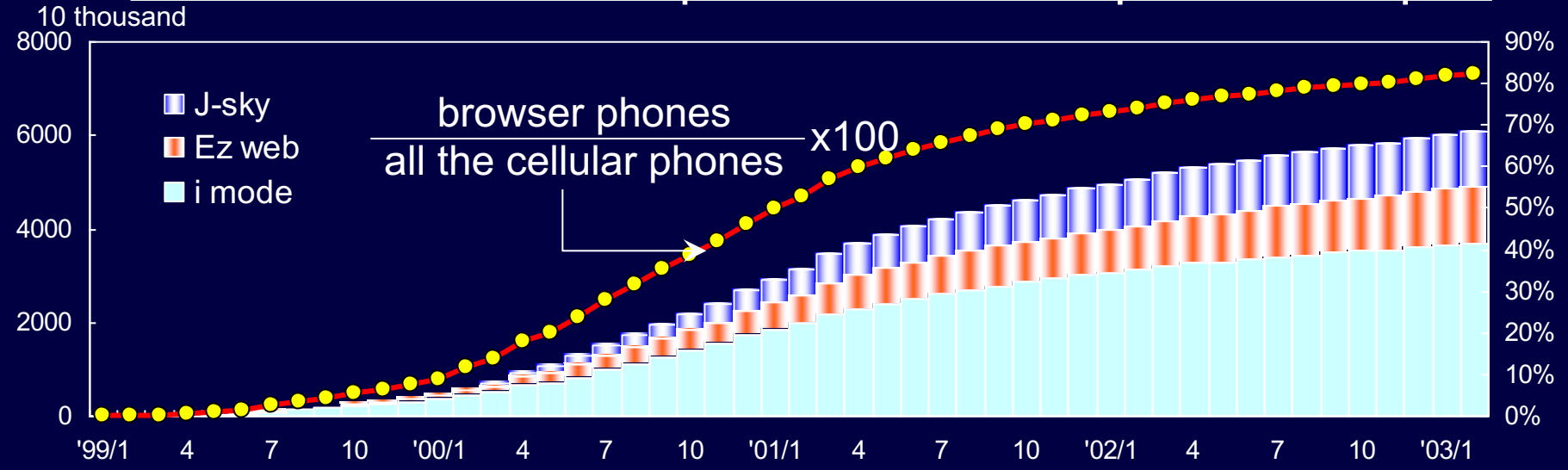
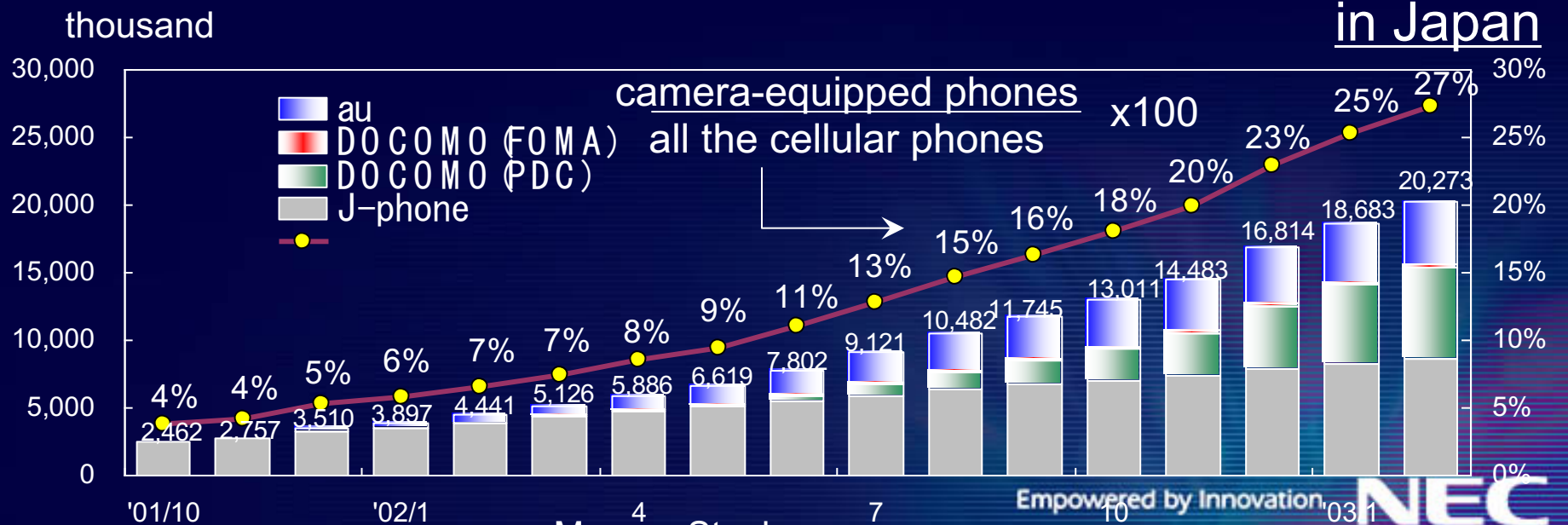
The number of subscriptions of browser phone in Japan



The number of subscriptions of camera-equipped cellular phone in Japan



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source: Morgan Stanley

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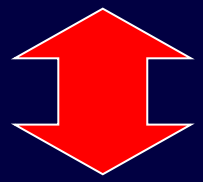
Two types ICT Based on Social Cultures

- ICT for individual



- ICT for members
- ICT for the shared space

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Comparison of Two types ICT

	ICT for individual	ICT for members ICT for the shared space
Culture analogy	Hunting society	Agrarian society
Characteristics	To get or send exclusive information	To share optimal information for the members
Examples	●PC+ the Internet ●Corporate information system	●Mobile + the Internet ●Networked household appliances
Concept	●Winner takes all ●To maximize the performance	●The greatest happiness of the greatest number ●To ensure Mission Critical

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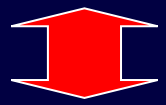
New Role of ICT for a Sustainable Society

- ICT for individual



- ICT for members
- ICT for the shared space

ICT for a sustainable society

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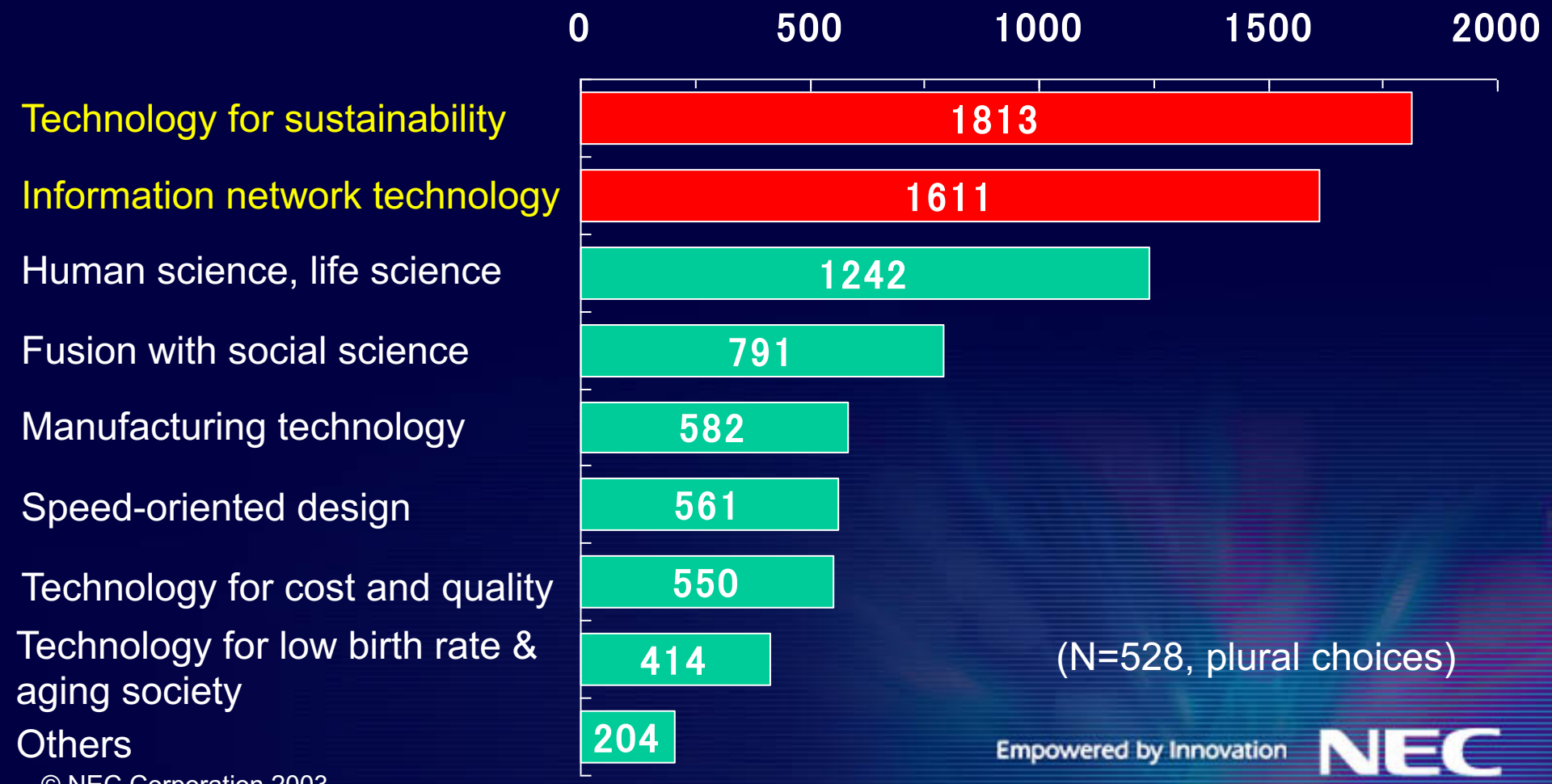
Technological Trend for the Next Decade

Q: What kind of technological changes do you expect for next ten years?

source: NEDO, 2001



(N=528, plural choices)

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3. ICT Contribution to Sustainability

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Concept of “Sustainability”

- 1987 UN Brundtland Commission
  - Report: “Our Common Future”
  - Definition of “sustainable development”

“development which meets the needs of the present without compromising the ability of future generations to meet their own”

Tradeoff with worldwide economic development aiming at conquering hunger and poverty

- 2000.5 InterAcademy Tokyo
  (Conference of the World’s Scientific Academies)
  - Statement: “Transition to Sustainability”
  - To underscore the importance of science and technology for the sustainability

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(InterAcademy Statement: Transition to Sustainability)

Fundamental research in environment and earth sciences, including ecology, biodiversity, climatology, seismology, and new interdisciplinary fields, will help our capability to predict or lessen the consequences of natural disasters and ecological change.

Much more, the global information network and its underlying technology can and certainly will rapidly evolve to provide new possibilities that cannot now foresee.

- The new role of ICT toward sustainability was recognized by the 66 scientific organizations from 52 countries of the world that signed the statement.

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Challenges in the Environmental Science Project

source: “New role of scientists” H. Yoshikawa, 2002

1. Grand design to integrate researches in each field
2. Initiative by the government to prevent sectionalism
3. Lack of fundamental study and knowledge infrastructure
4. Insufficient approach of social science
5. Short of talented people
6. Contribution to and leadership in international scheme

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ICT Contribution to Sustainability

Direct contribution to reduction of CO_2

- Positive effect of promoting ICT society is bigger than negative one of increasing CO_2 caused by increase of power consumption for ICT systems.

Simulation by NEC Environment Technology Laboratories

1995(act) vs. 2010	CO_2	(%)
Increase of power consumption	+4900 kt-C	+1.5
Change of industrial structure	-9300 kt-C	-2.9
Improvement of energy efficiency	-5500 kt-C	-1.7
total	-9900 kt-C	-3.1

Scientific contribution to assess global environment

- The Earth Simulator

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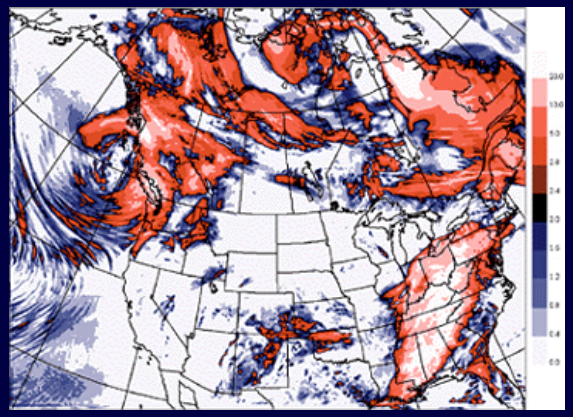
The Earth Simulator Project

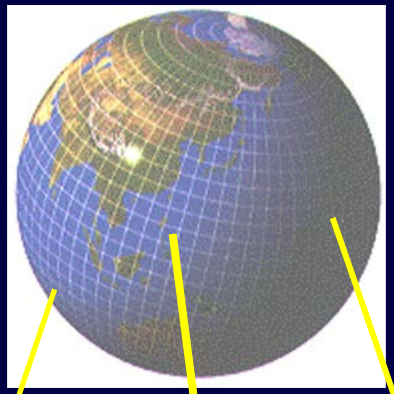
by the Ministry of Education, Culture, Sports, Science and Technology

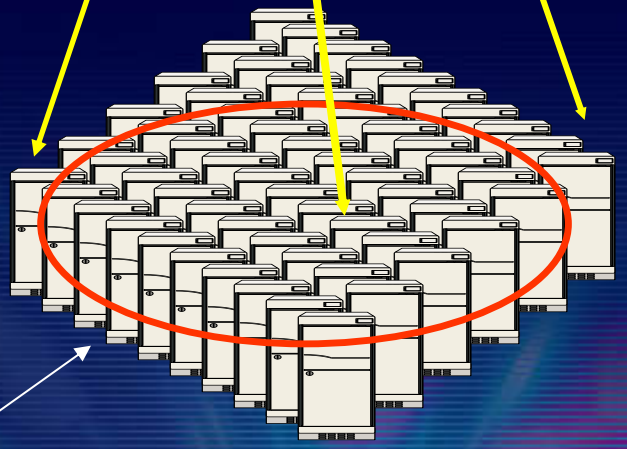
- Average performance of usual supercomputer cannot meet the needs for global environment analysis.



(North American 24hours Precipitation)

The Earth Simulator





Power
x 640

NEC SX-6/8A

Each CPU executes its share of computation.

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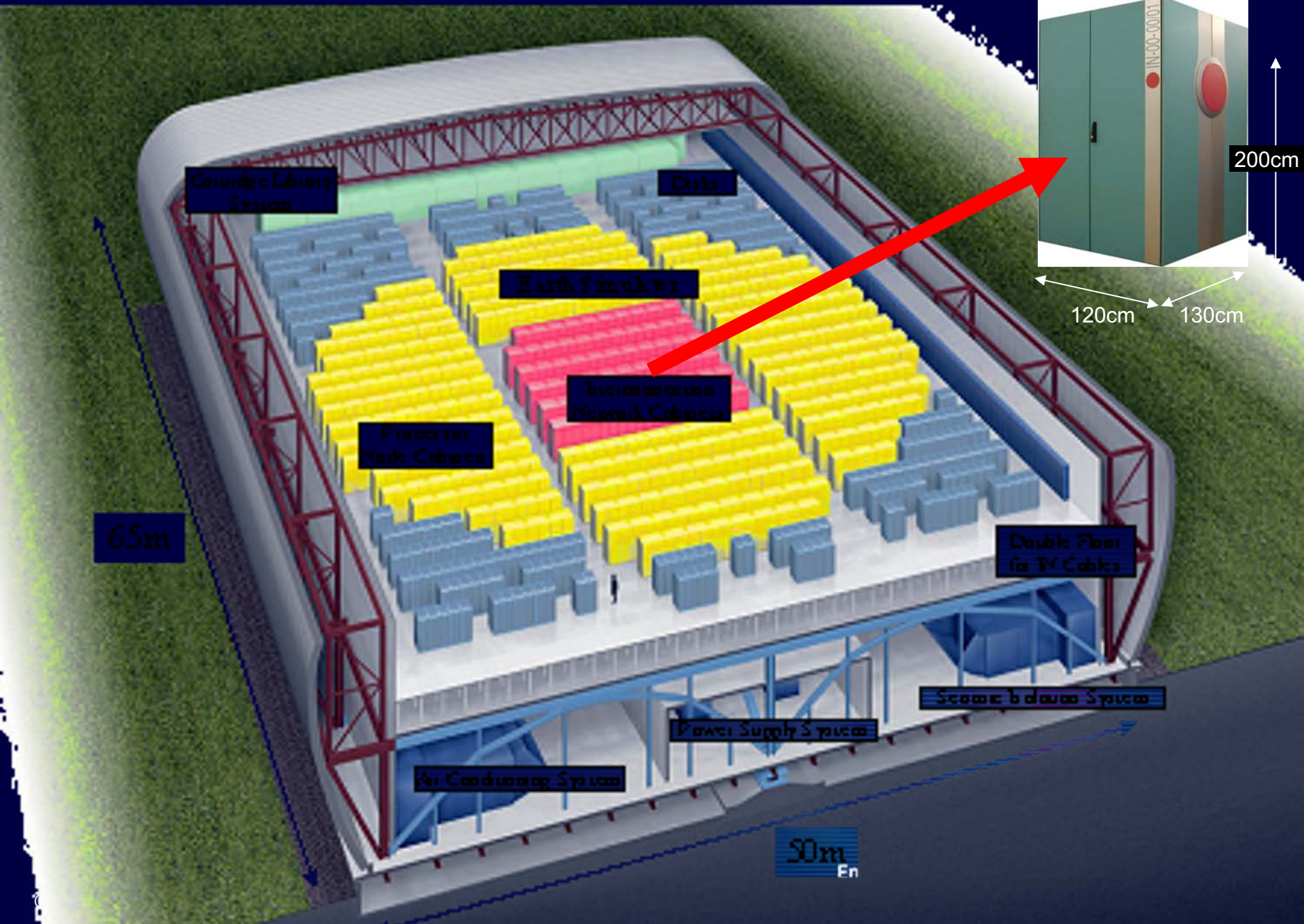
Bird's Eye View of the Earth Simulator Building



4. Side Effects of ICT

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Another Side of ICT

- Opportunity divide
- Cyber crime
- System failure

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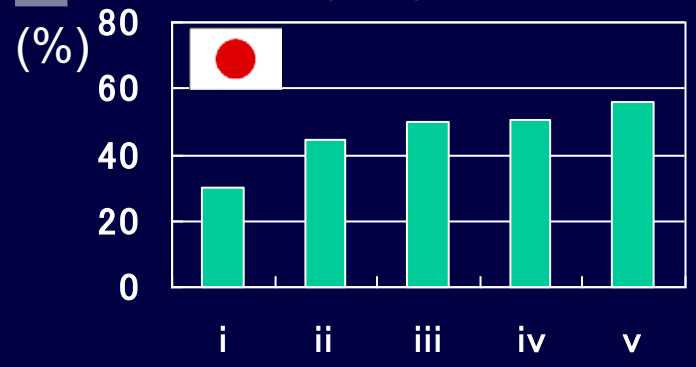
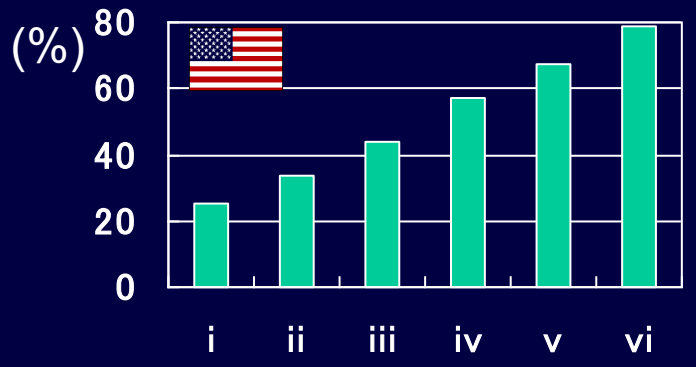
Comparison of ICT Disparity between Japan and U.S.

Popularization of the Internet in 2001

Disparity by income　U.S. > Japan





Disparity by region

Japan > U.S.

	Urban	Rural
Japan	49.9%	36.4%
U.S.	55.8%	52.9%

Disparity by gender

Japan > U.S.

	male	Female
Japan	49.8%	38.4%
U.S.	53.9%	53.8%

Source: White Paper on Information and Communication,2002

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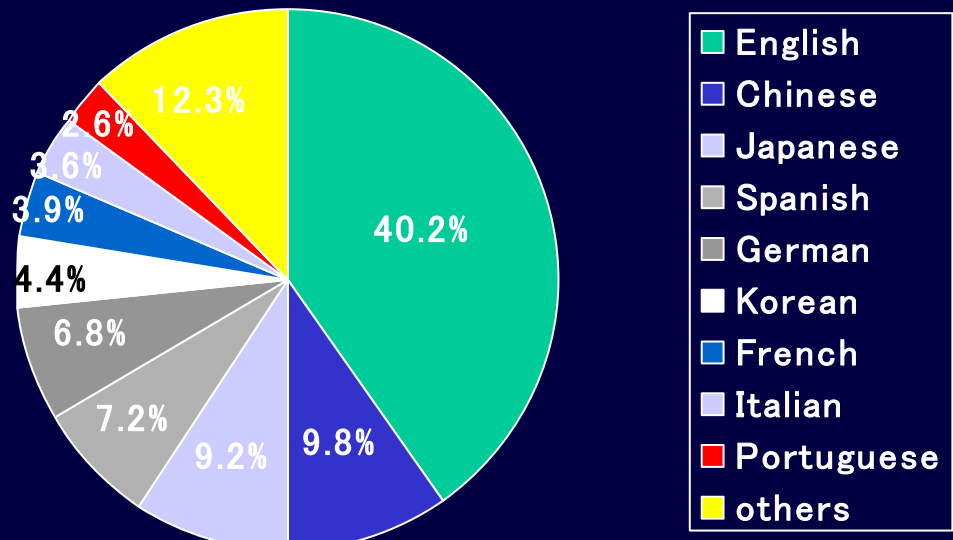
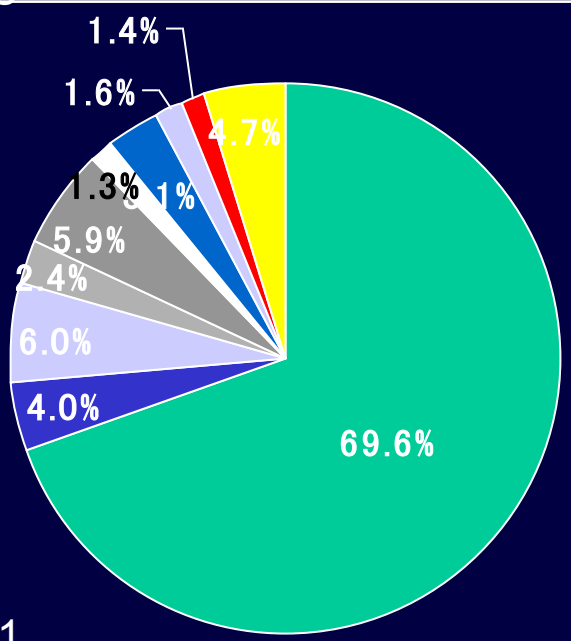
Native languages of the Internet users



Languages used in the Web contents



source: Global Research,2001

- Though English is the major language for the Internet, more than 25% of the Web contents is made in other ones.
- In each country, foreign language teaching in elementary education will be much more importance from the view point of “ICT literacy”.

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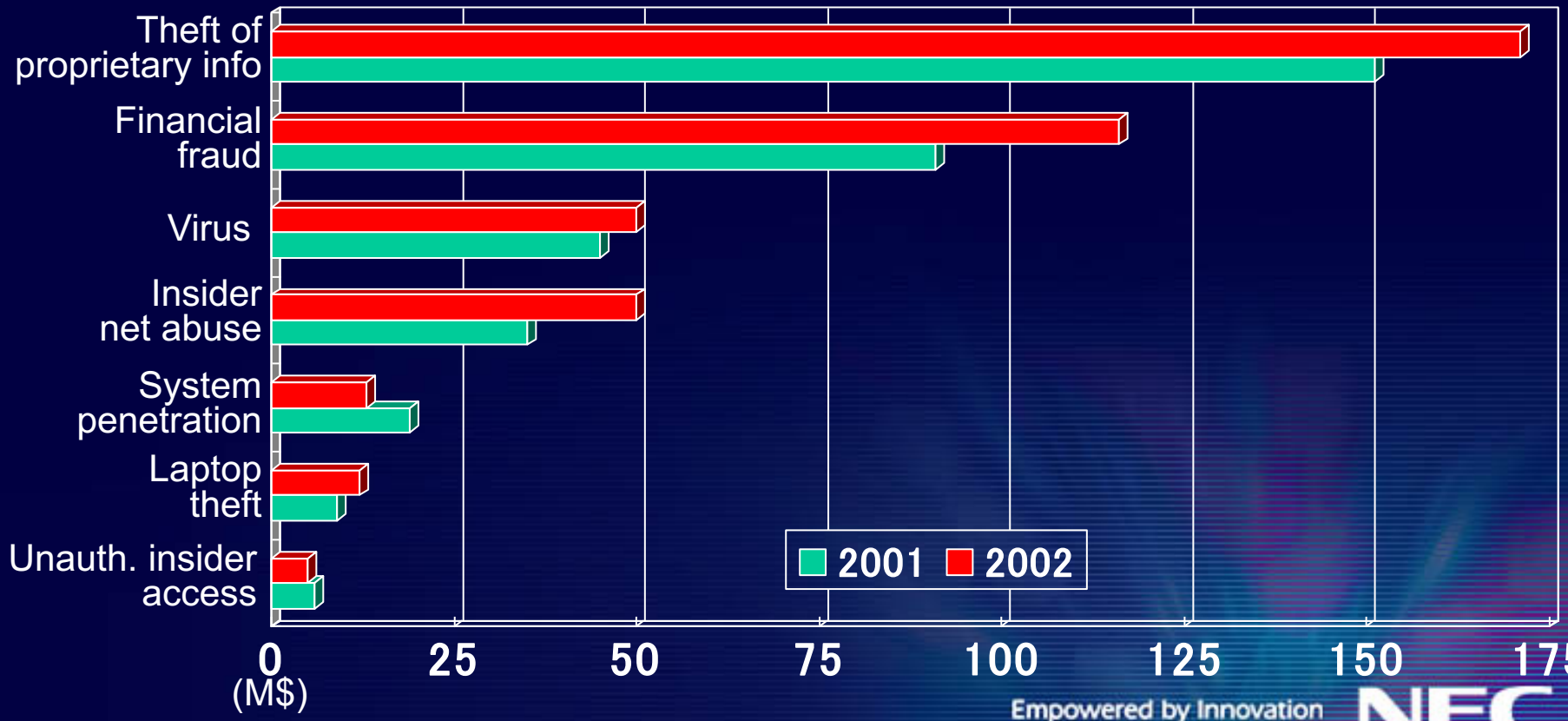
- The survey by CSI and FBI tells
  “90% of the respondents suffer damage by the cyber crime in 2002”.
- However, only 44% of them recognize the amount of damage.

Dollar amount of losses by type in U.S.



Source: “2001 &2002 CSI/FBI Computer Crime and Security Survey”

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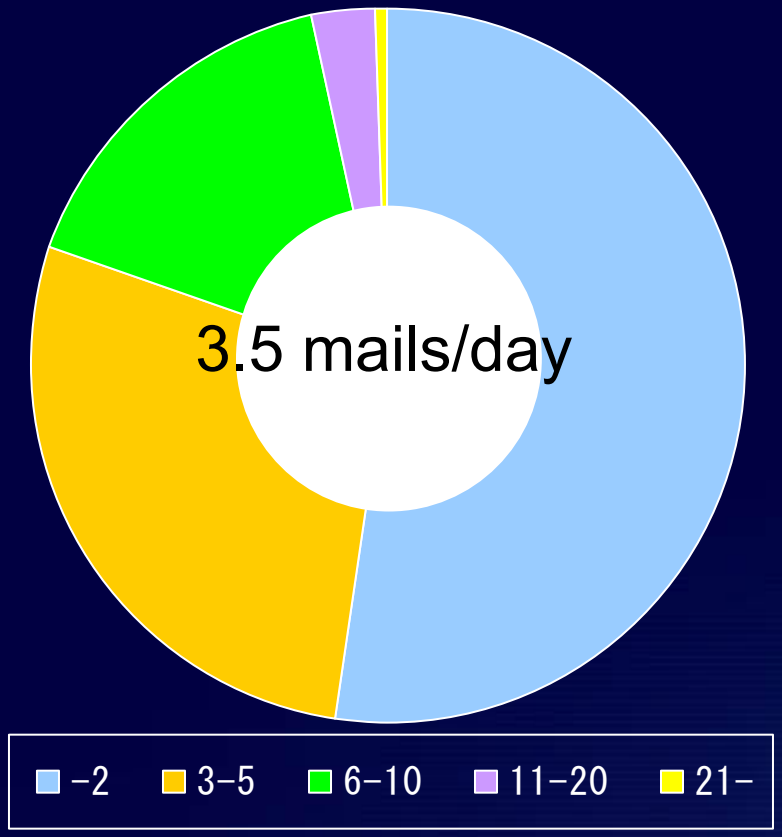
Damages from Spam Mails to Browser Phones

Q: How many spam mails do you receive per day ?

(Apr. 2002, N=607)



Source: Japan Management Association

Number of subscription
of browser phones in Japan
: 62,460,300

220 million spam mails/day !

@ \0.9 for 3 packets
(128byte X 3packets)

Annually 550 million Euros is
charged to honest citizens.

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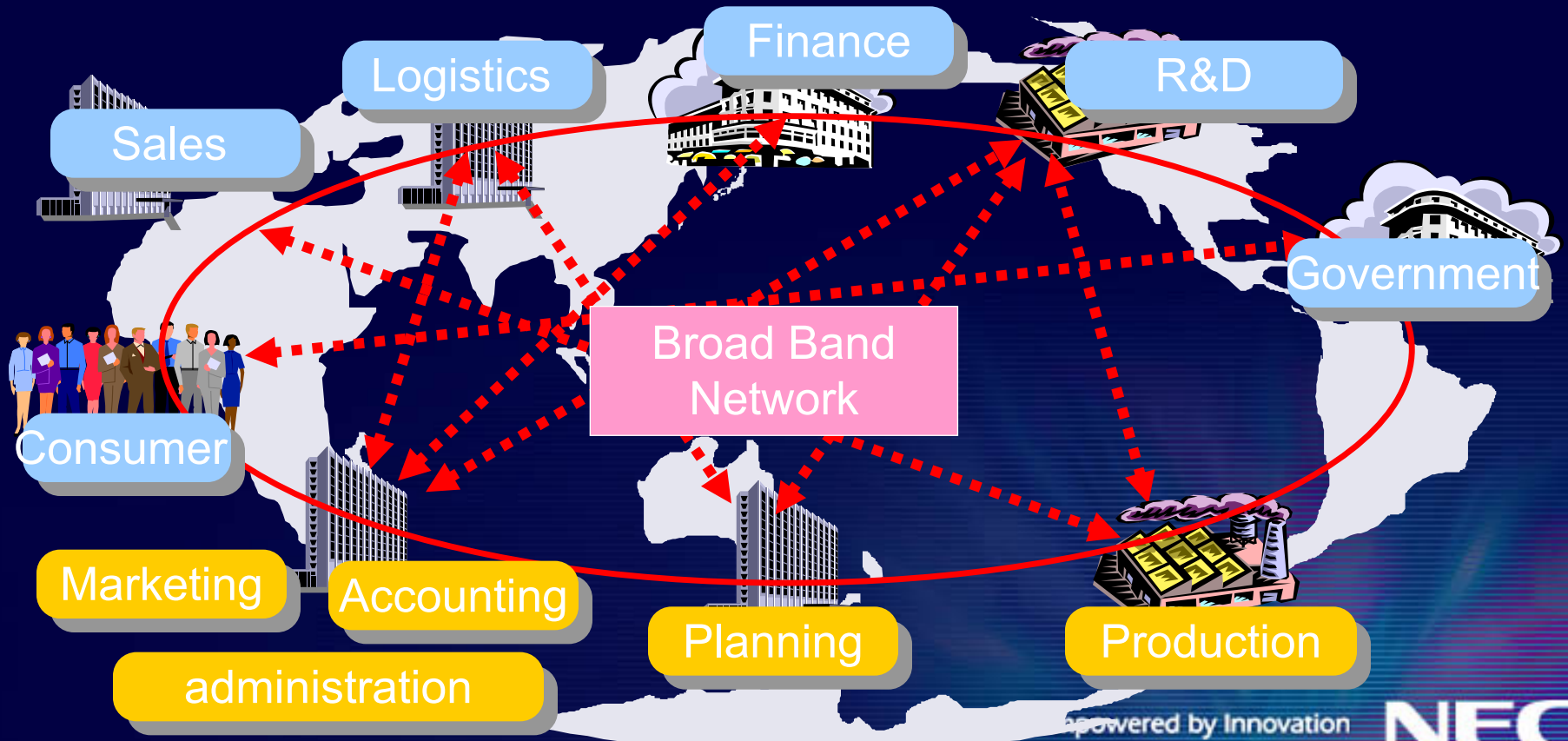
Need for Mission Critical Network

- The impact of system failure can be compared to “the Butterfly effect” of Complexities.
  - Nobody tells the whole influence beforehand.
  - Much more serious than the New York City Blackout in 1977



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Threats to Network Security

Caused by…

Network

- Unauthorized access, Lurker, Virus, Worm

Software

- Vulnerability of OS and applications, Bugs,

Human error

- Configuration mistakes, Operating mistakes

Physical factors

- Natural calamity, Theft, Accidents

In the survey on security incidents in Japan in 2002, among the 54 respondents, 63% suffered damages. 80% of the cases and 98% of the economic damages from them was caused by virus or worm.

source : ISEC

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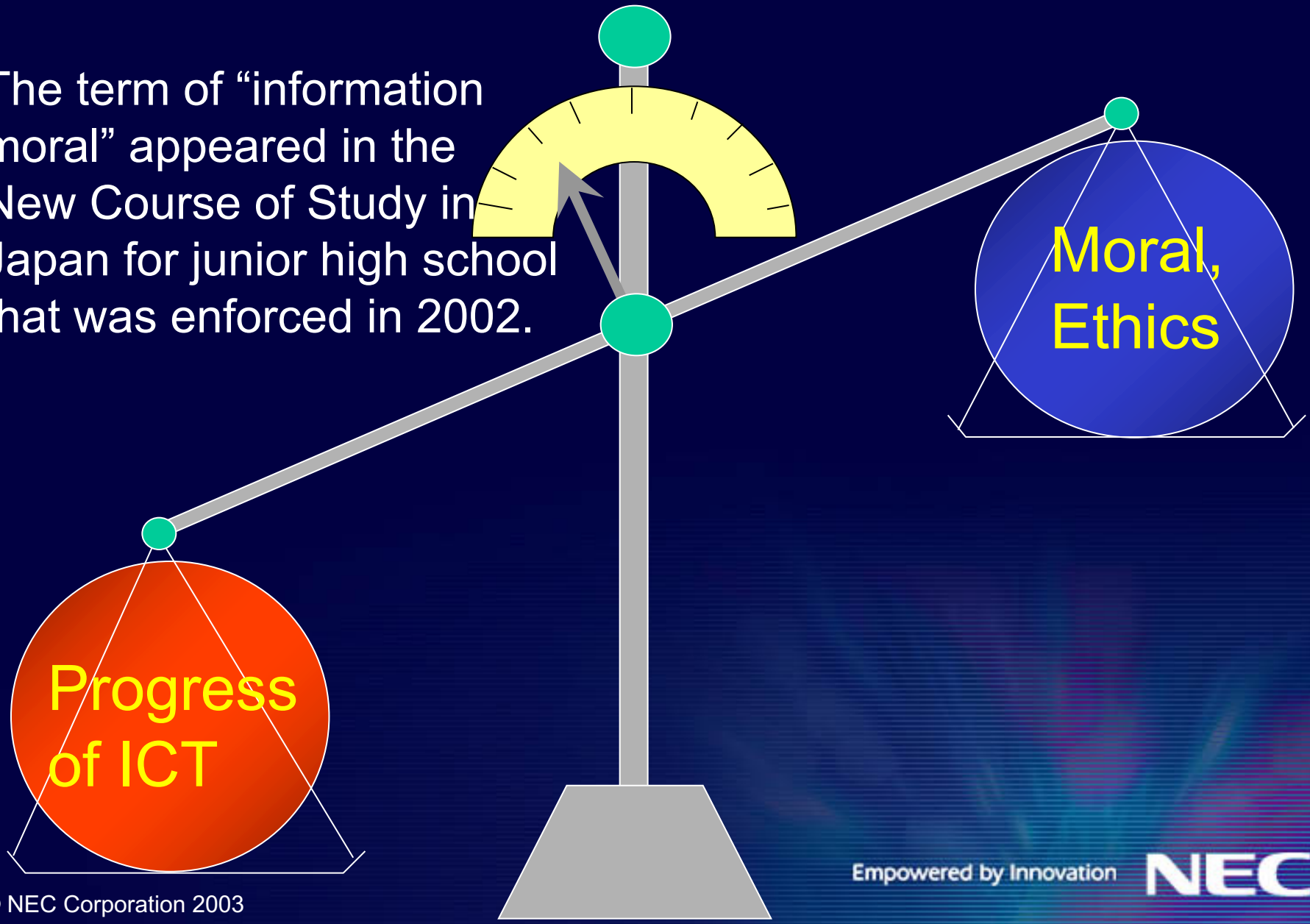
Imbalance between Technology and Ethics

The term of “information moral” appeared in the New Course of Study in Japan for junior high school that was enforced in 2002.



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5. Challenges of Future Science

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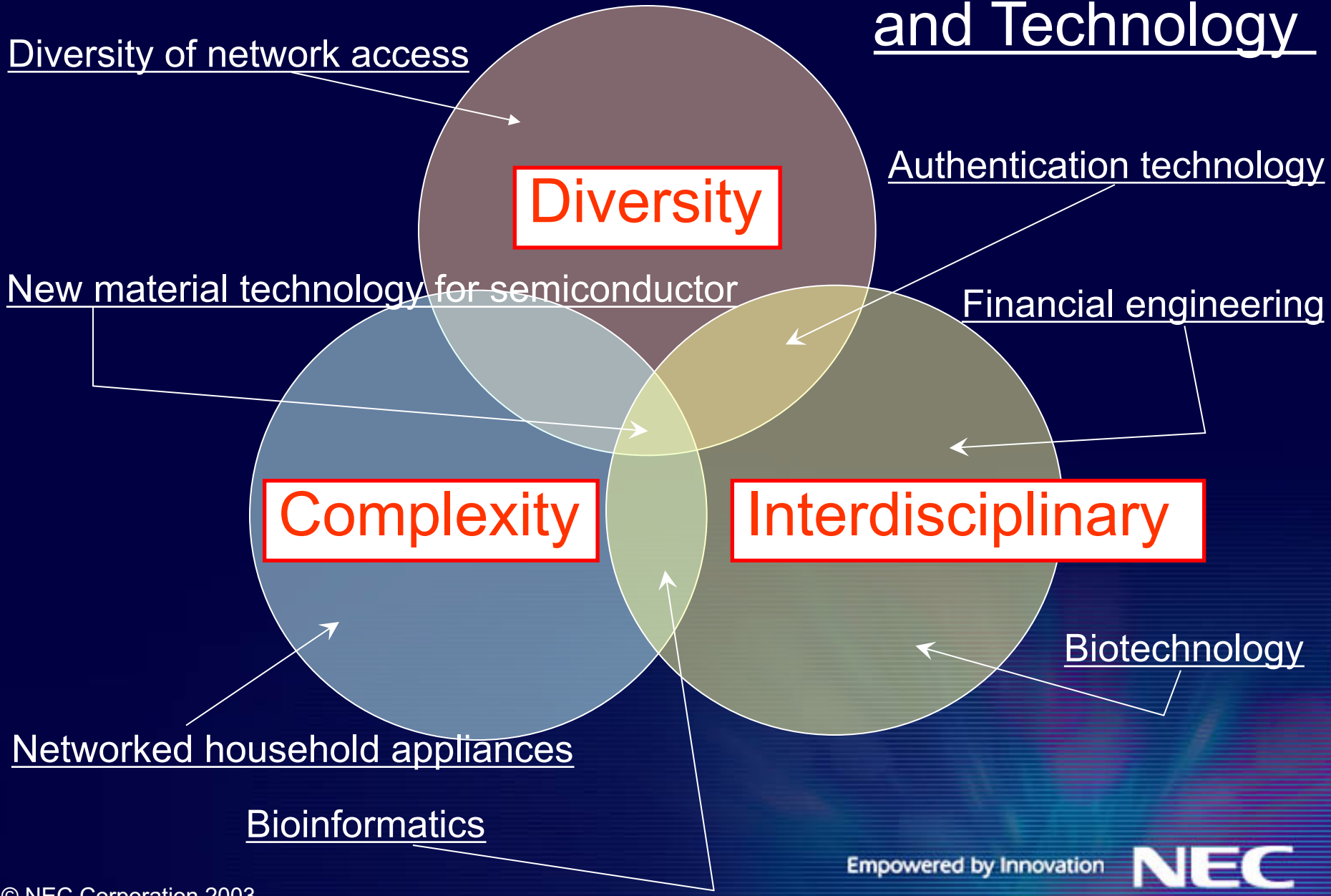
Three Characteristics of Future Science and Technology



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Three Key Concepts for Engineers' Competence

Objective Evaluation of Engineers' Competence

- Necessary to Establish Standard for Evaluation That Is Valid Globally

Global Liquidity of Human Talent

- Farewell to "Enclosure Movement" of Engineers

Lifelong Self-Development

- Change from "Engineers for Corporation" to "Corporation for Engineers"

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Accreditation System for Engineering Education in Japan

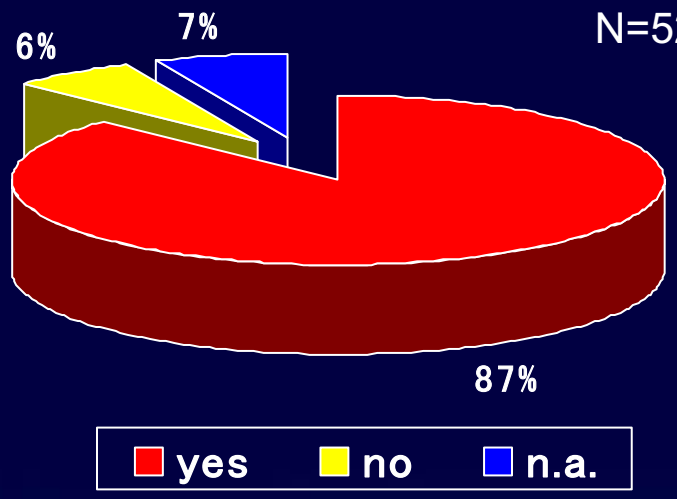
Japan Accreditation Board for Engineering Education (JABEE)

A professional accreditation system whereby an outside organization can

- fairly evaluate whether programs in engineering education reach the levels expected by society and
- accredit those programs that reach such levels.

Established in 1999, JABEE is a nongovernmental organization that examines and accredits programs in engineering education in close cooperation with engineering associations and societies.

On June 22, 2001, JABEE became a tentative member of Washington Accord.



Do you recognize the necessity to establish an objective evaluation system about engineering education that can be accepted globally ?

Source: survey by NEDO 2001

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Extracts from Criteria for Accrediting Japanese Engineering Education Programs

(2002 version approved by the JABEE Board of Directors on April 11, 2002)

(a) The ability and intellectual foundation for considering issues from a global and multilateral viewpoint.

.....

(b) Understanding of the effects and impact of technology on society and nature, and of engineers' social responsibilities (engineering ethics).

.....

(g) The ability to carry on learning on an independent and sustainable basis.

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The third Subject to Promote Future Science

Scientists and Engineers

Corporations or Industries

Promotion under the current paradigm

+

NGOs and NPOs

Break the current paradigm for new one based on speciality and freedom from conflicts of interests

- Shift in the value system
- Reform of institutional system
- Innovation of technology

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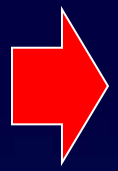
Necessity to Establish New Norm

- Technology reaching the realm of God
- Physical limit of the earth
- Expanding global disparity
- Fragmentation and diversity of science and technology and appearance of new studies
- Increase of dependence on industries



Science

Technology

Ethics

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The era when it is required to establish new norms accordance with or behind the results of scientific and technological progress

Establishment of norms by

History, Legend, Religion,…..

Contemporary citizen

- Uncertainty because of lack of dignity
- Time consuming from conflict of interest

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