# The future society created nanotechnology
# <n-Plan21> Outline

March 27, 2001
Japan Federation of Economic Organizations (Keidanren)

## Basic Viewpoints in Promotion of Nanotechnology R&D

(1) Innovation of IT, biotechnology, energy & environment technology and materials by means of Nanotechnology
(2) Investment to the Fields, where Japan can be a winner and which has large impacts to Japanese Industry
(3) Proposal of flagship-type projects and challenge-type projects and appropriate distribution of fund including basic research.
(4) Sharing of vision on Nanotechnology and promotion of Nanotechnology strategy in national stage and dynamic promotion of Nanotechnology R&D under the construction of network between industry, Academia and government.

## Important Investment Fields Related to Nanotechnology R&D

### (1) Flagship Projects

○ R&D focused on practical application and industrialization in the next 5 to 10 years
○ Network-type Center of Excellence (COE) operation

◆ IT・Developing Low-Power, High-Performance Technology for Building a Ubiquitous Network Society

**① Next- generation semiconductor technology**
○Transcending design rule limits in semiconductor development
- *Nano-level semiconductor manufacturing/evaluation system*
- *New wiring technology*
- *Devices with new materials and structures*

**○ASUKA Project : From 100nm**
**MIRAI Project : From 70nm**

**② Terabit-level information storage technology**
○Terabit/inch$^2$ storage density (2010)
- *New materials for storage media and heads*
- *Precision actuators*
- *Magnetic heads with new structures*
- *Near-field optical memory*

**③ Network Devices**
○Optical : Petabit/second, Wireless: 10gigabit/second(2010)
- *Photonic waveguide devices*
- *Super broadband electronic devices*

### (2) Challenge to Future Projects

○ Targeted R&D revolving around developing innovative basic technology
○ Network-type COE operation
○ Well-timed practical application (including nurturing venture businesses)

**① Nano processes and materials**
○Creating innovate functionality through the control of extremely minute structures (nanocrystals, nanofilm, nanoparticles and nanotubes) across many fields
- Structural materials that are extremely light yet very strong
- Long-lasting materials
- Materials that support energy shifts
- Electronic materials with new functionality

**② Biological nanosystems**
○Creation of innovative diagnostic systems by fusing biotechnology with nanotechnology
- *μ TAS*
- *Measurement of single molecules*

**③ Nanodevices**
○Development of new devices for the "generation after next"
- *Photon control devices*
- *Single-electron control elements*
- *Spin electronics*
- *Superconducting devices*
- *Organic flexible devices*

**④ Nano-measurement**
○Implementation of the precision measurement required for nano-level fabrication and control
- Increased performance for electron beam/optical measurement
- Increased performance for probes measurement
- *Nanometer x-ray measurement*

**⑤ Nanofabrication**
○Implementation of mass-production nanofabrication technology
- *Top-down ultimate fabrication technology*
- *Bottom-up technology including self-assembly*
- *Integration of top-down and bottom-up technology*

**⑥ Nanosimulation**
○Development of simulation technology in the nanotechnology field
- *Device design, Computer Aided Design(CAD)*
- *Manufacturing equipment simulation*

### (3) Fundamental Research

○ Emphasis on researcher creativity
○ Clustering of research

**① Search for physical properties of nanostructures and elucidation of their functionality**
- *Structure and function of artificial lattices, quantum dots, single atoms/molecules, genomes and proteins*
- *Fundamental technology for intelligent computer systems (quantum computers, atomic/molecular computers and biocomputers)*
- *Fundamental technology for resource recycling and minimum energy systems*
- *Self-organization*

**② Measurement of Physical properties**
- *Precision measurement of electronic state, magnetic state, organization, structure and composition*
- *Temporal resolution measurement and extremely quiet environment*
- *Development of new probes*

**③ Theoretical calculation and analysis**

## Establish and enhancement of research and enforcement system

○Nanotechnology strategy made by Council for Science and Technology Policy, Cabinet Office, and unified enforcement under it
- Deciding the guideline of entire nanotechnology budget

○ Network type COE management
- Networking among potent universities, public research institutes, and companies
- Sharing information and promotion fir enterprising nanotechnology
- Concentrating competence and responsibility to program leaders

○Development and utilization of human resources
- Strengthening interdisciplinary and systemic education systems
- Increasing of the mobility of human resources among industries, universities, and public research institutions

○Strength of knowledge and intellectual base