Systems Approach to Computing Dependability In and Out of Hitachi

Concept, Applications and Perspective

IFIP-WCC2004 Topic 3

In honor of Emeritus Professor Algirdas Avizienis

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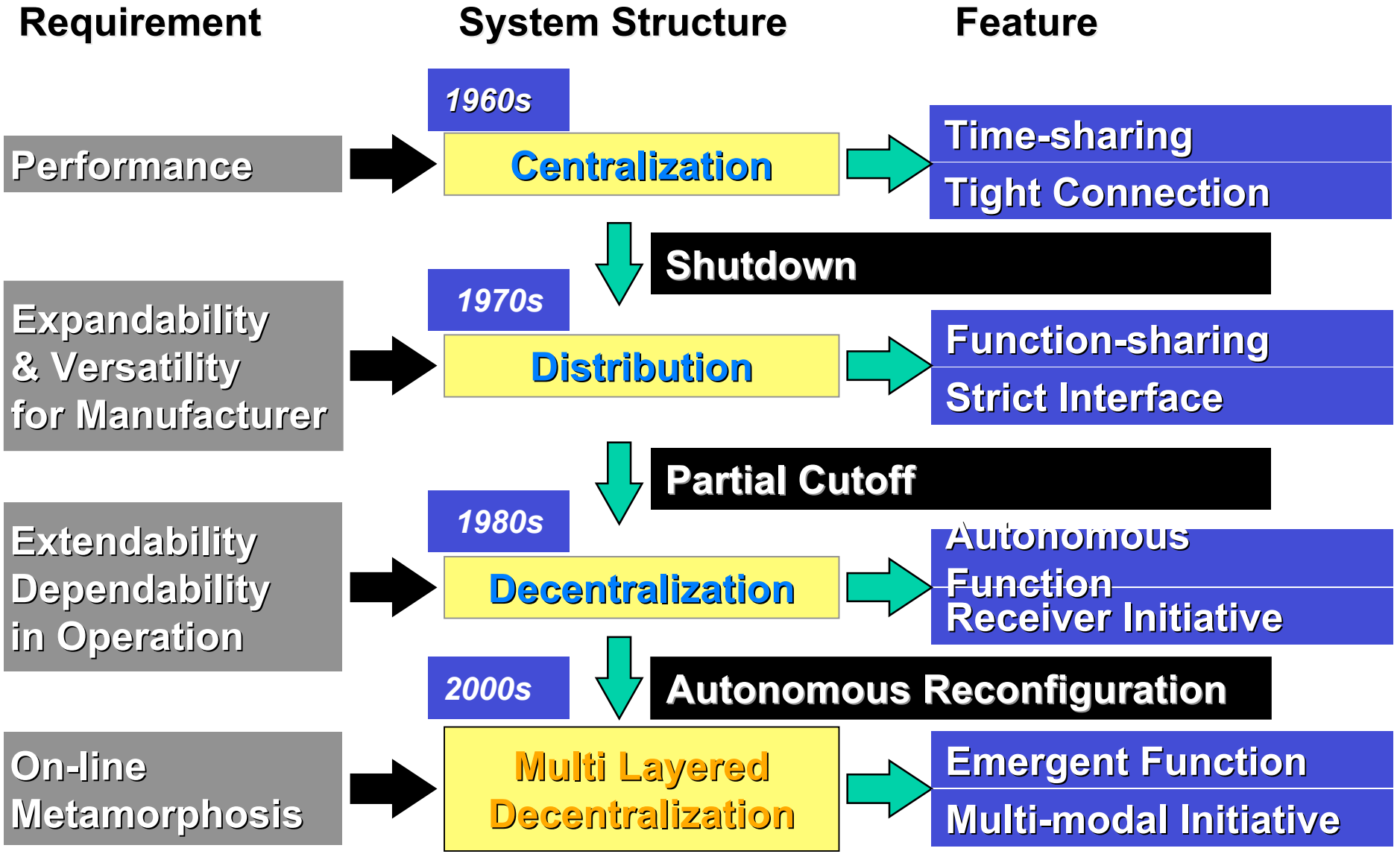
Sculpture by Ryoji Goto

Inherent Property of Control Computing Compared to Enterprise Computing

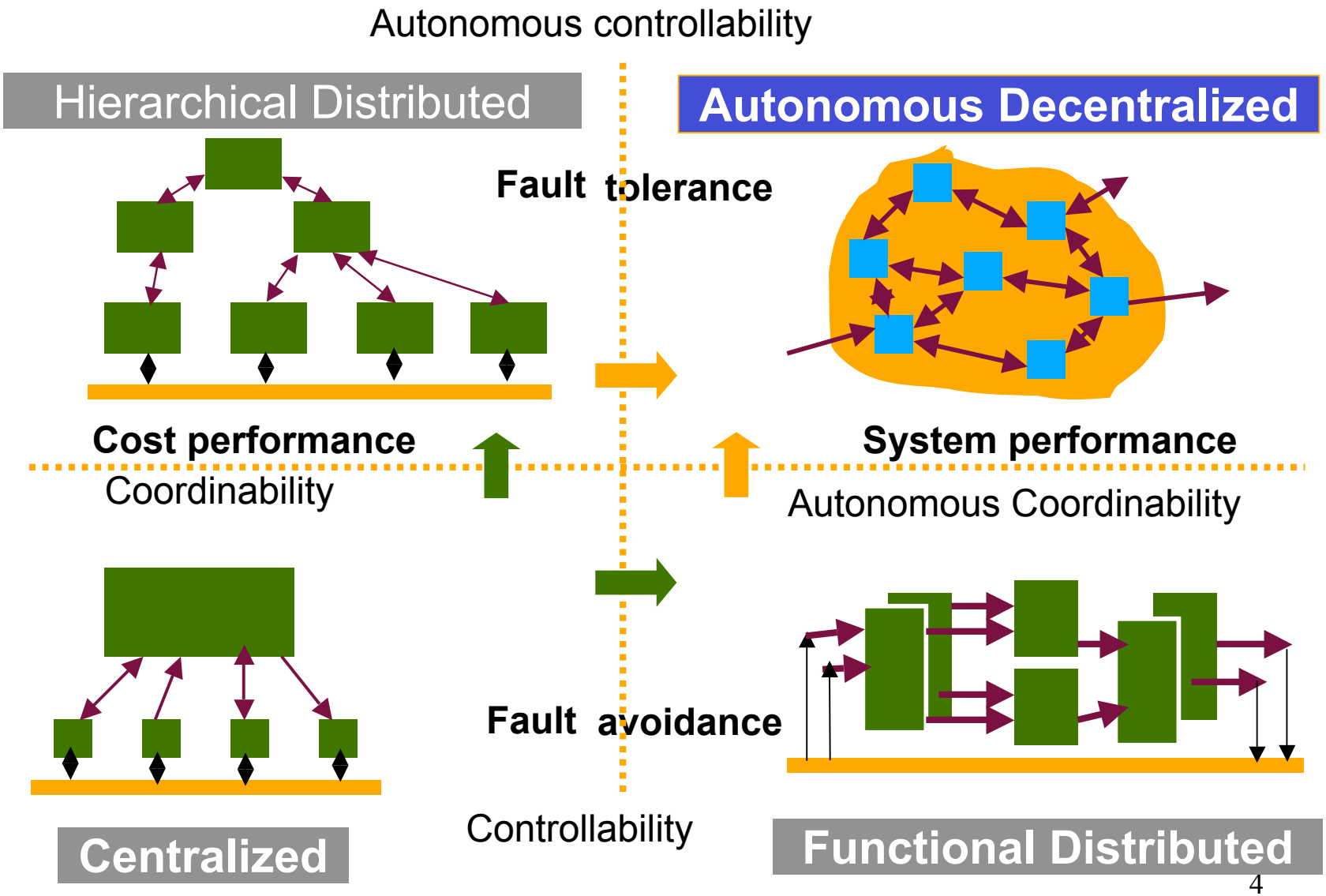
(a) Reliability is prior to its performance and cost.
(b) Environment conditions are very rigorous
(ambient temperature, humidity, vibration, dust, etc.)
(c)Event-driven or data-driven processing from the machines
(d) Time-critical
(e) The turnkey or the solution business
(f) Periodically to adapt their functions by changing demands

Two Business groups for Enterprise and Control Computing has been operated in Hitachi Ltd.

Evolution of Computing Systems

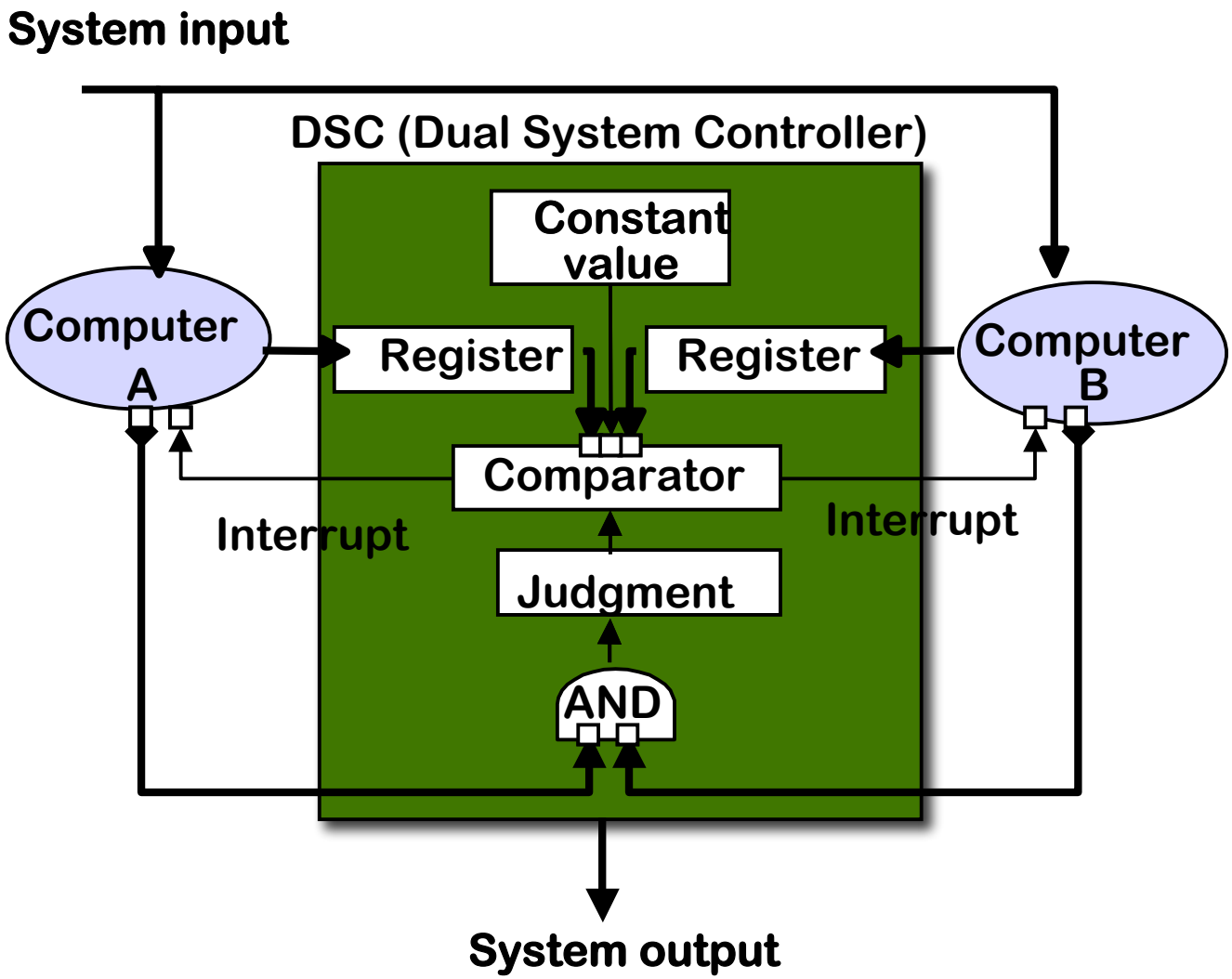


Our Target of System Concept

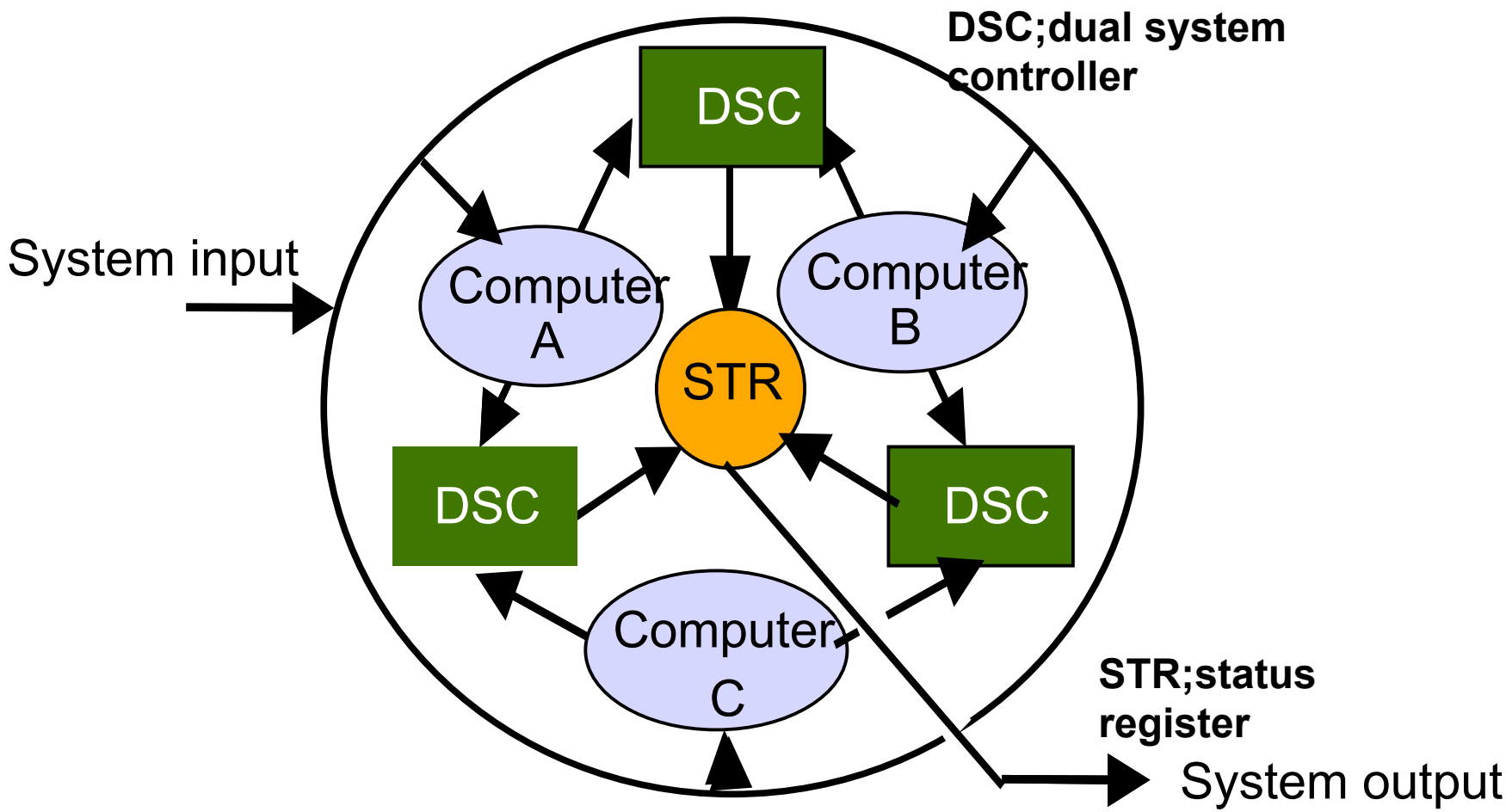


Dual Structure System of COMTRAC

COMputer aided TRAffic Control

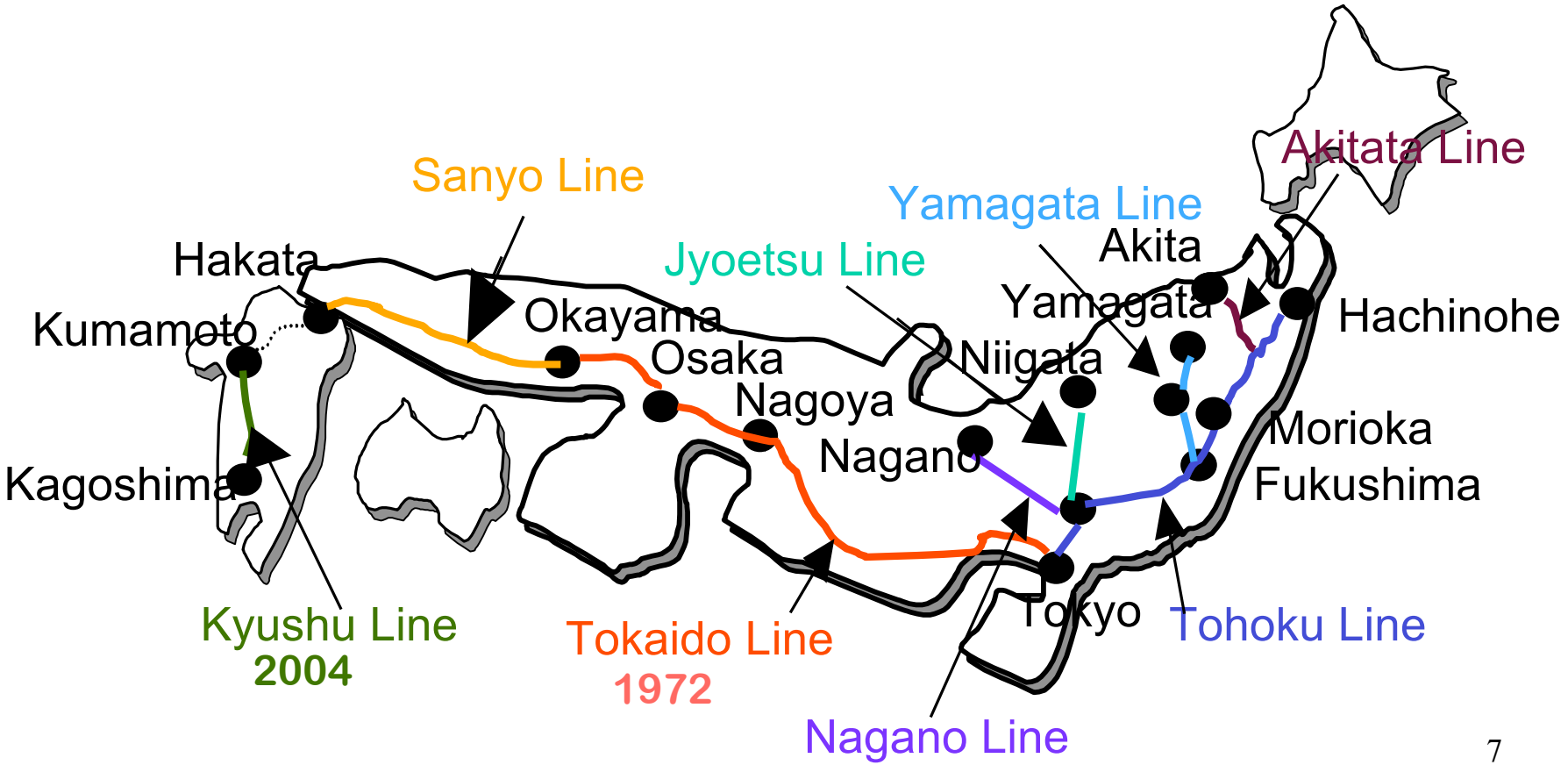


Symmetrical Structure of COMTRAC
Dual –Duplex System Structure



Present Dependable COMTRAC

Network of Shinkansen has been developed line by line since 1964 and operated by COMTRAC since 1972 without any system failure.



Principle Recognition of Autonomous Decentralization Concept (ADC)

(a) Always includes inactive (temporary faulty, complementary or spare) parts
(b) Always changes its conditions and states among operation, metabolism, generation and growth (plus or minus)
(c) Always changes its objectives to the goal by alternatives selection, optimization and daptation
(d) Always keeps accomplishing its objectives almost completely

This observations are opposite recognition against that system should be complete and stable.

Properties of ADC

Uniformity of structure	Equality among subsystems	Locality of information

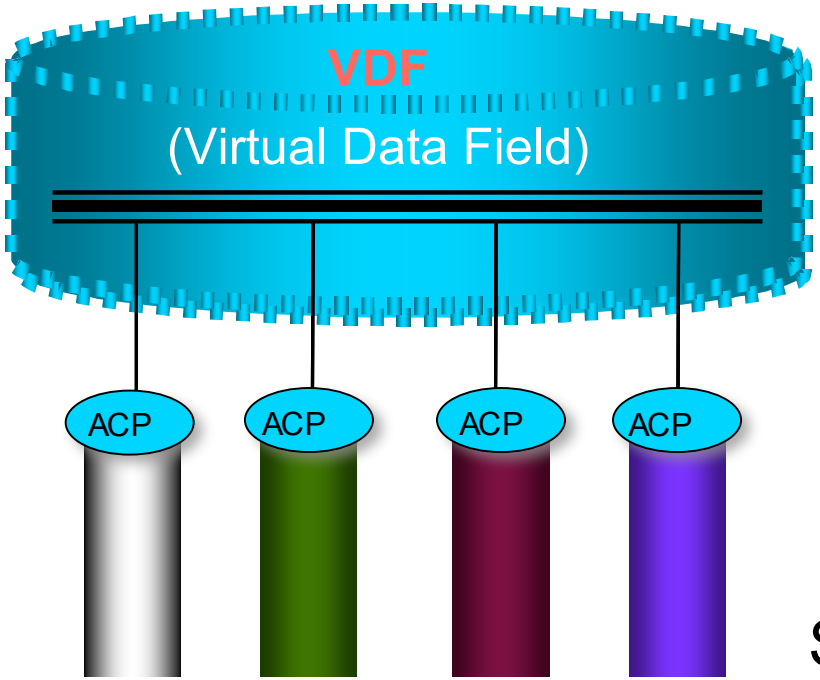
Definition of ADS

(a) **Autonomous controllability**:
if any subsystem fails,
the other survivors can manage themselves

(b) **Autonomous coordinability**:
if any subsystem fails,
the other survivors can coordinate
their individual objectives
among themselves.

Virtual Data Field by Broadcast

ACPs distinguish their necessary information by Content Codes



Broadcasting networks

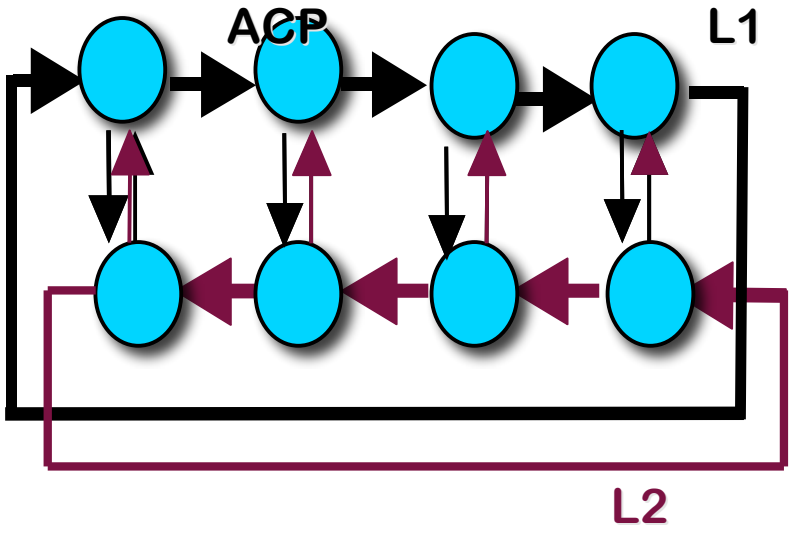
Autonomous control processor(ACP)

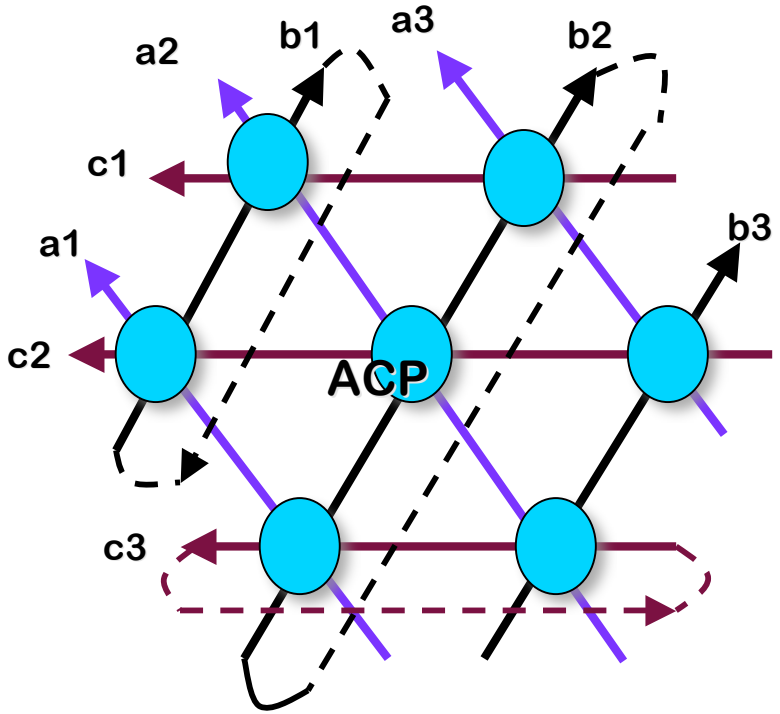
Subsystems

Elements of Typical Information Format

Flag	Content Code	Sender ID	Control Code	Data/ Command	RC	Flag

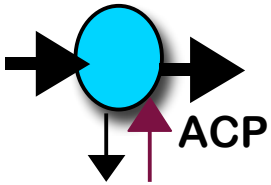
Connection of Autonomous Decentralized Systems





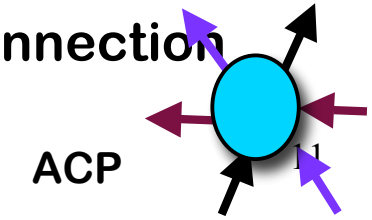
Analogy of Nerve

Loosely coupled Double loop network



Analogy of Brain

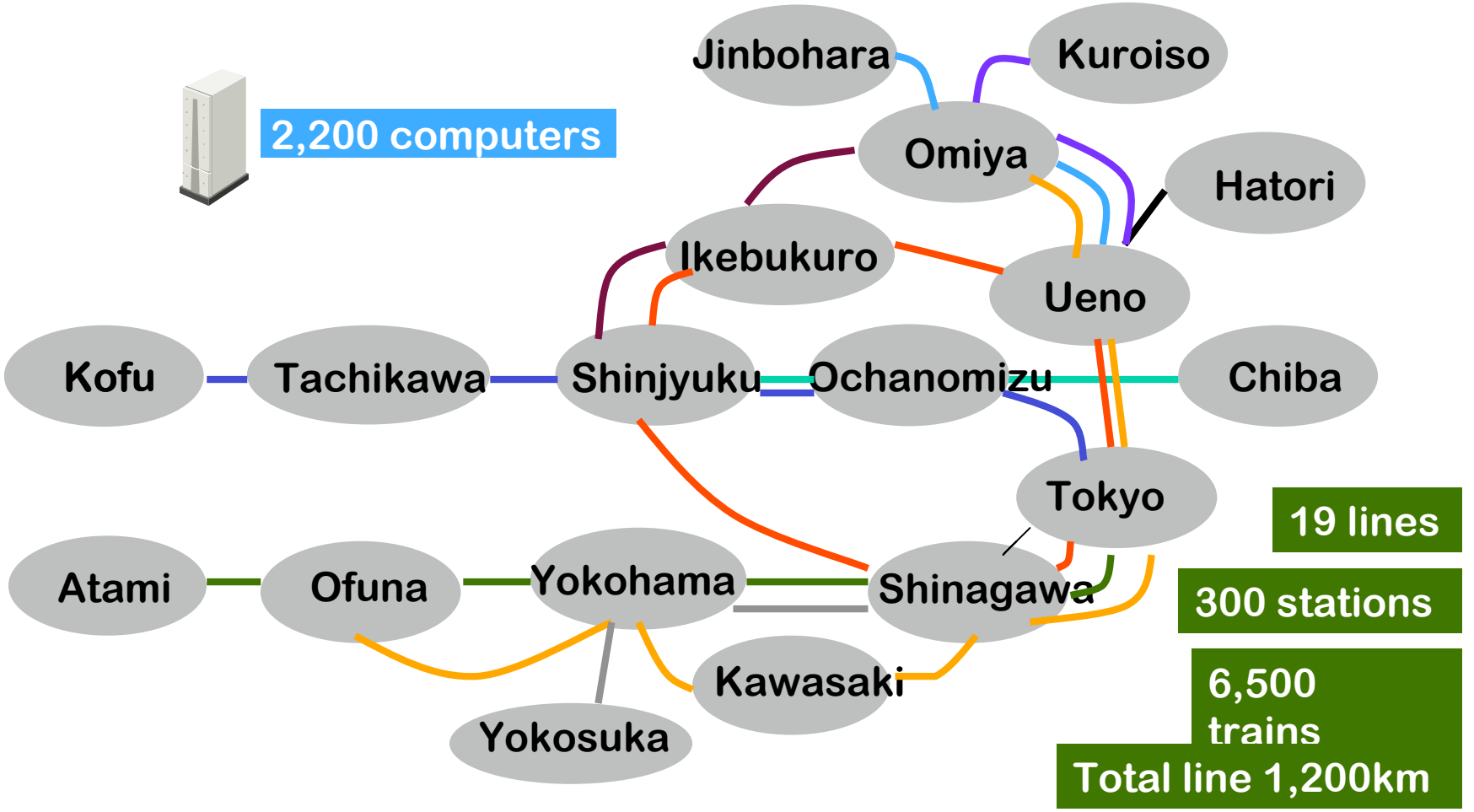
Tightly coupled Hexagonal connection



Autonomous decentralized Transport Operation control and information System (ATOS)

introduced since 1996 in Tokyo Metropolitan Wide Area

2,200 computers



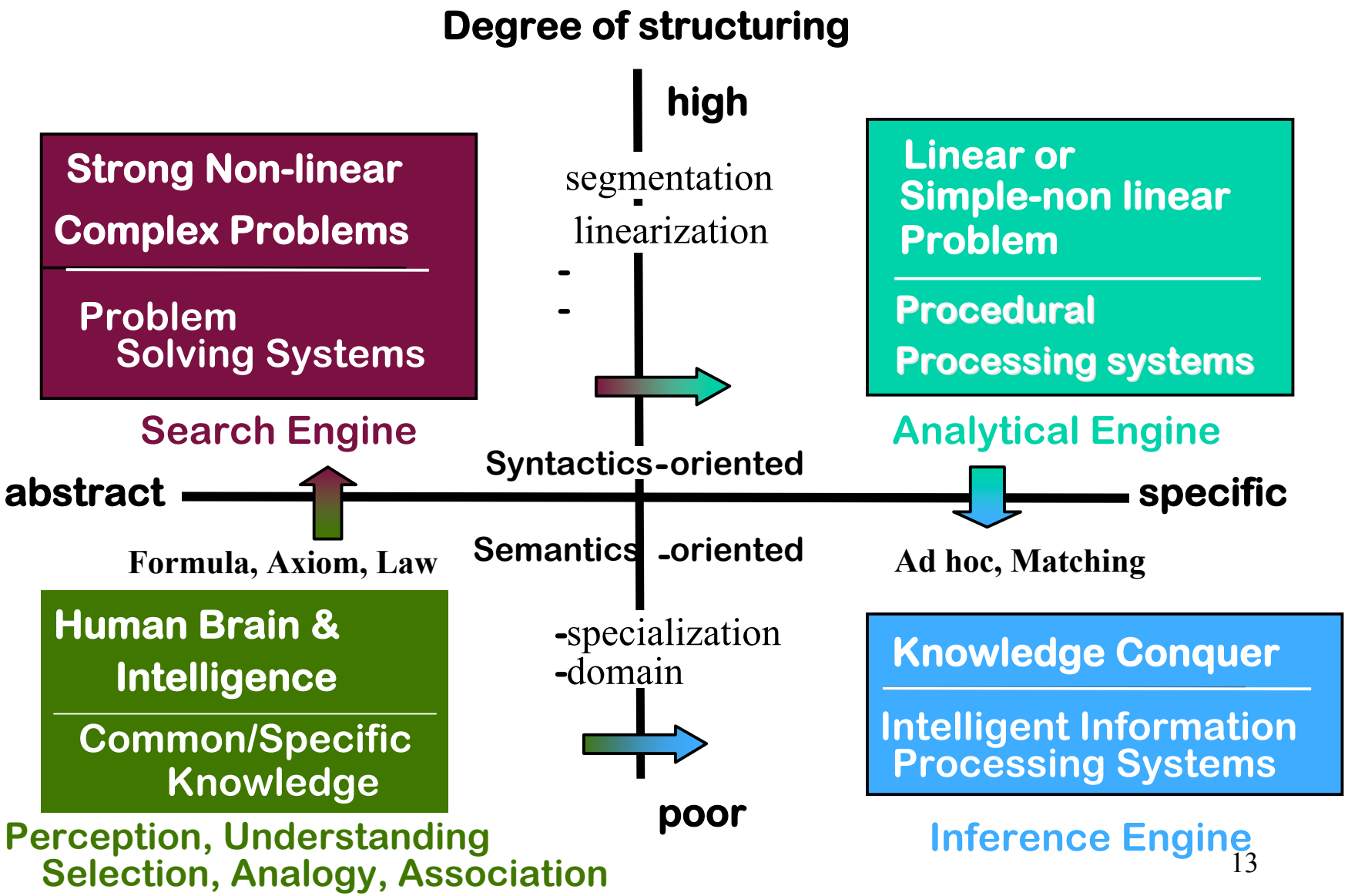
19 lines

300 stations

6,500 trains

Total line 1,200km

Our Target of Remained Area of Computing



Evolutional Practice of AI Technology

Attempts in early 1980s

- ✓Diagnosis of Nuclear Power Plant
- ✓Quality Control of Semiconductor Manufacturing
- ✓Project Management of Oversea Construction of Fossil Power Plant

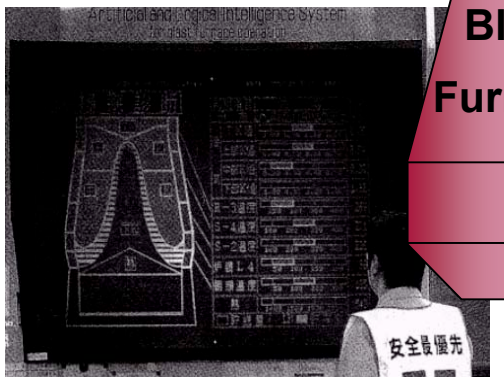
EUREKA (Real-time Inference Engine)

Real Applications Developed in 1980s

- ✓Operation Guidance of Blast Furnace and Public Utility Plants
- ✓Generation Assistance of Train Operation Diagrams
- ✓Construction Planning and Project Management Support
- ✓Assessment Support of Financial Investment

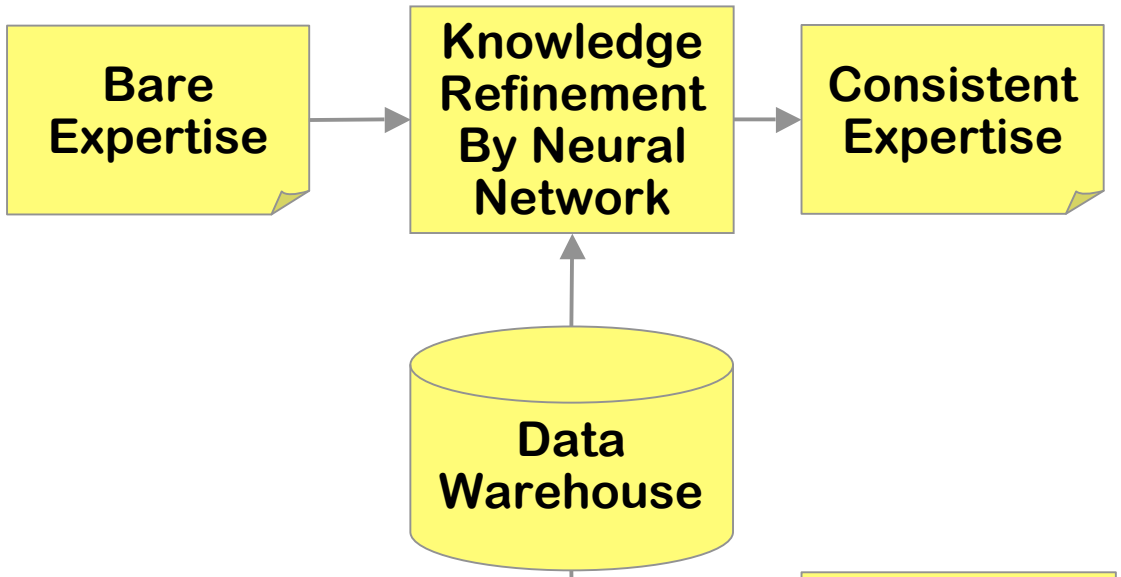
Fuzzy Expert System for Subway Operation (1987)

Management Methodology for Uncertainty

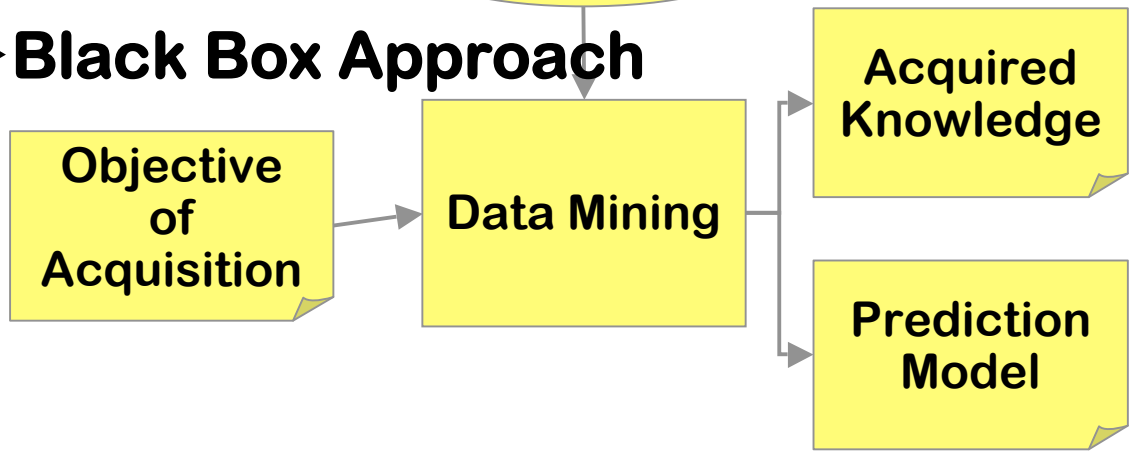


Knowledge Acquisition Technology for AI Systems

➤Gray Box Approach

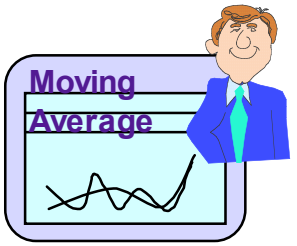


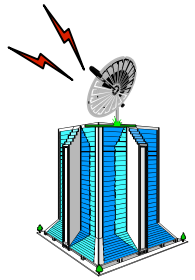
➤Black Box Approach



Applications for instance

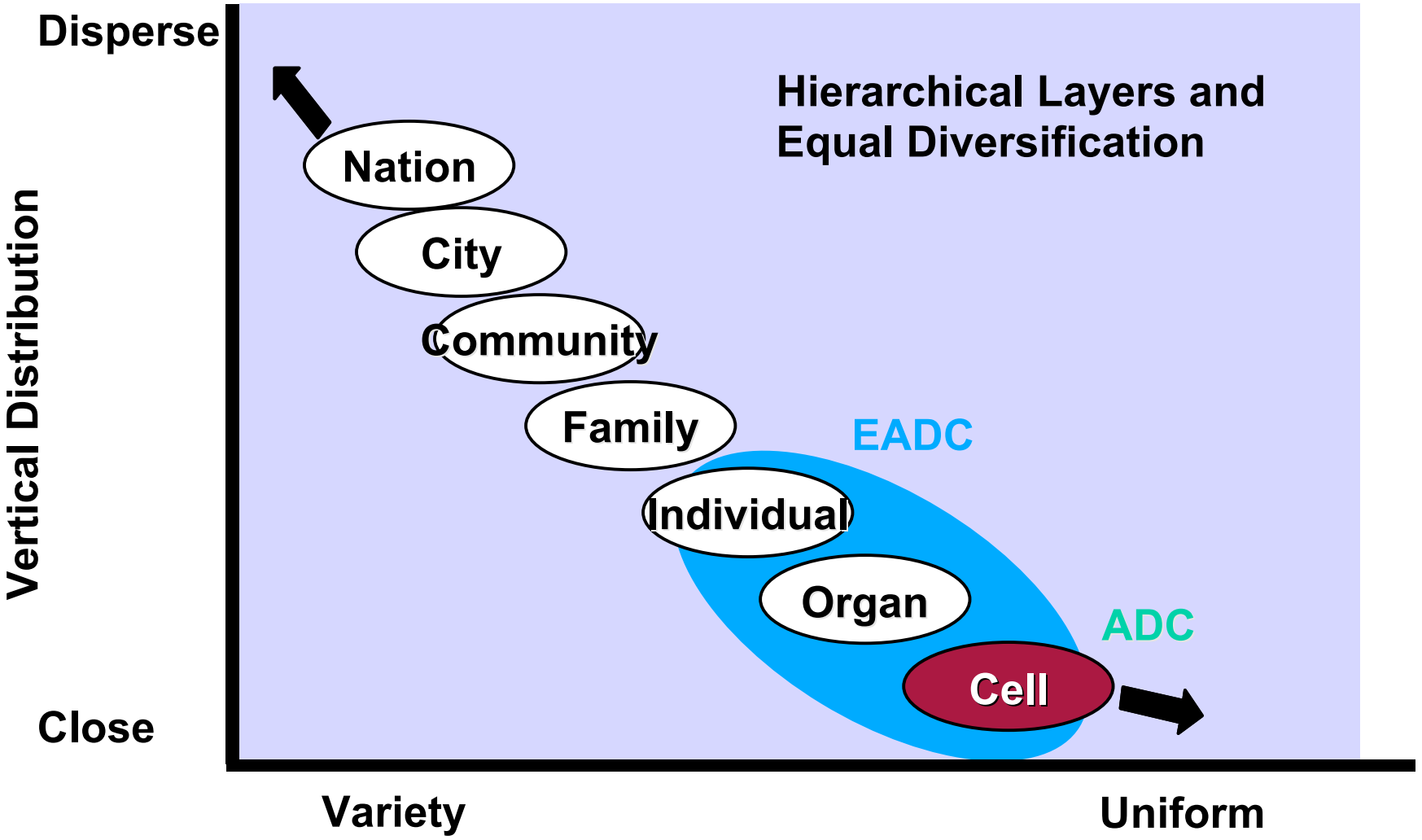
- ✓Control Systems for Public Utility Plants
- ✓Financial Trading Systems





- ✓ CRM (Customer Relationship Management) Systems in Telecommunication Operators
- ✓ Quality Control Systems in LSI Manufacturing

Hierarchical Systems of Human-beings



Definition of Autonomous Observability for EADC

Autonomous Observability:

if any change occurs
in the surrounding of the subsystem,
subsystems can observe it immediately

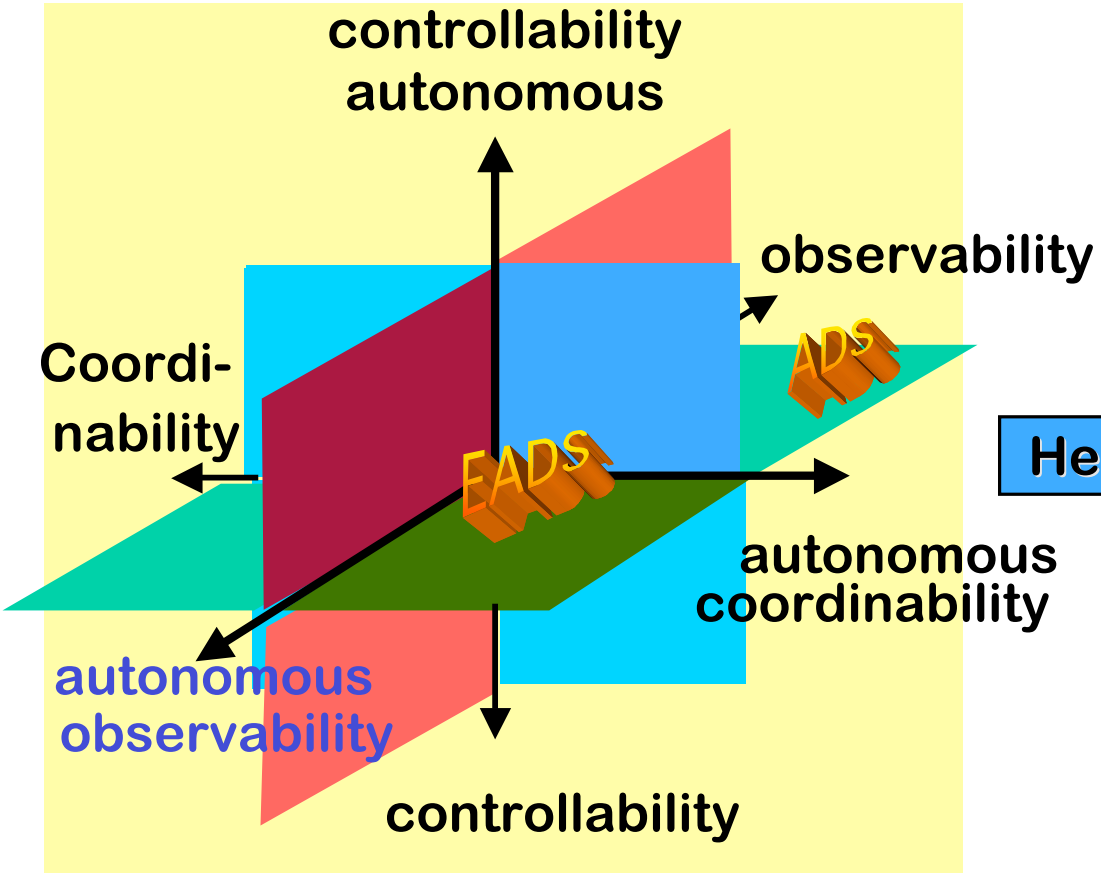
EADC is characterized by

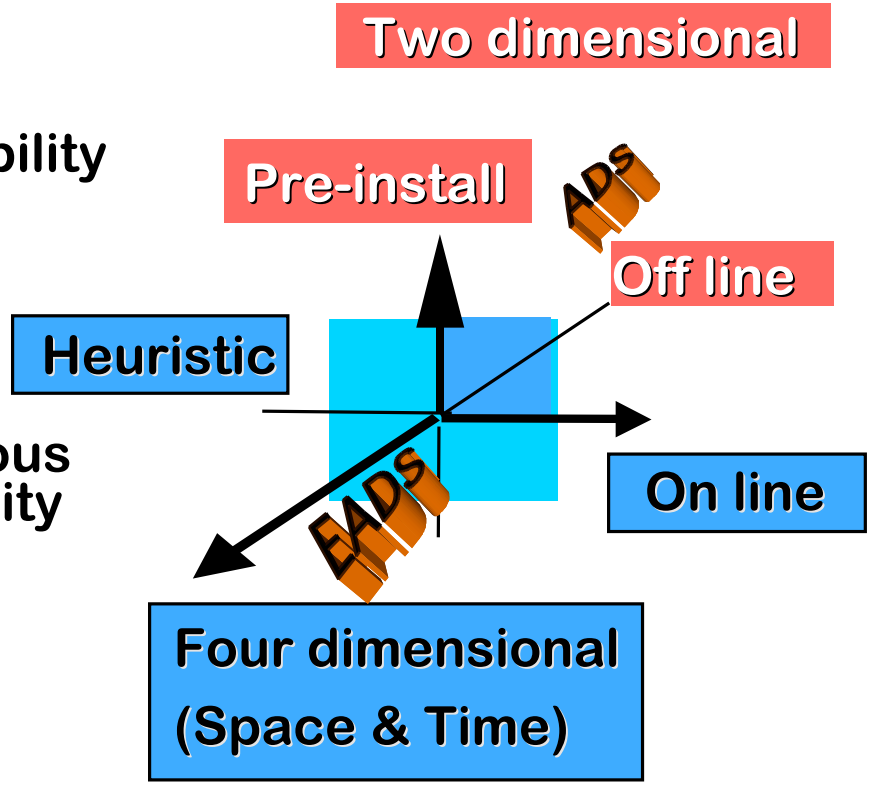
Autonomous controlability

Autonomous coordinability

Autonomous observability

Extended ADS Attached Autonomous Observability to ADS

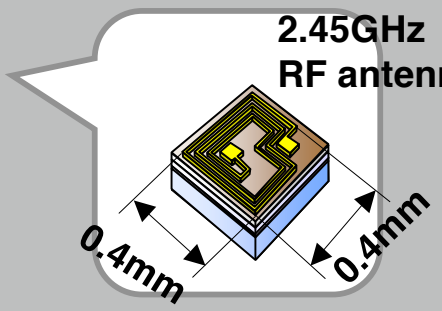




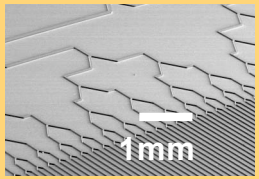
Emerging Players for Autonomous Observability

➤Antenna Built-in Type RFID

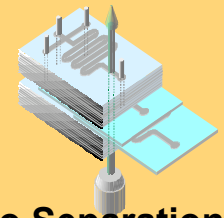
μ-chip



➤μ-TAS (Micro Total Analysis System) for Health Monitoring



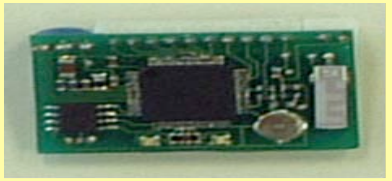
Micro Channel



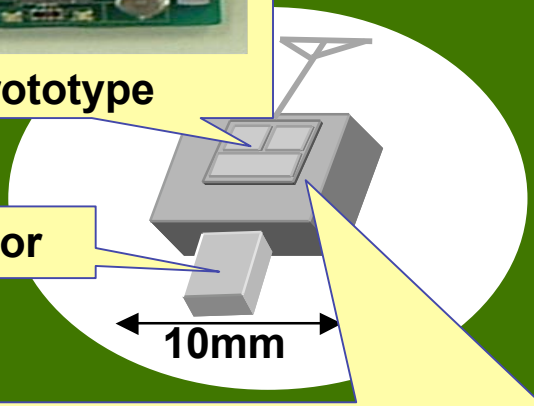
Micro Separation Devices

➤Sensor Network Devices

LSI(Wireless + Controller)

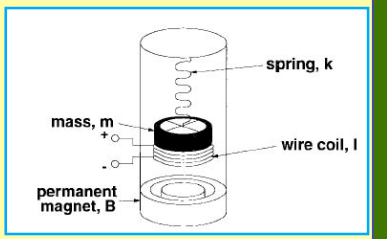


Prototype



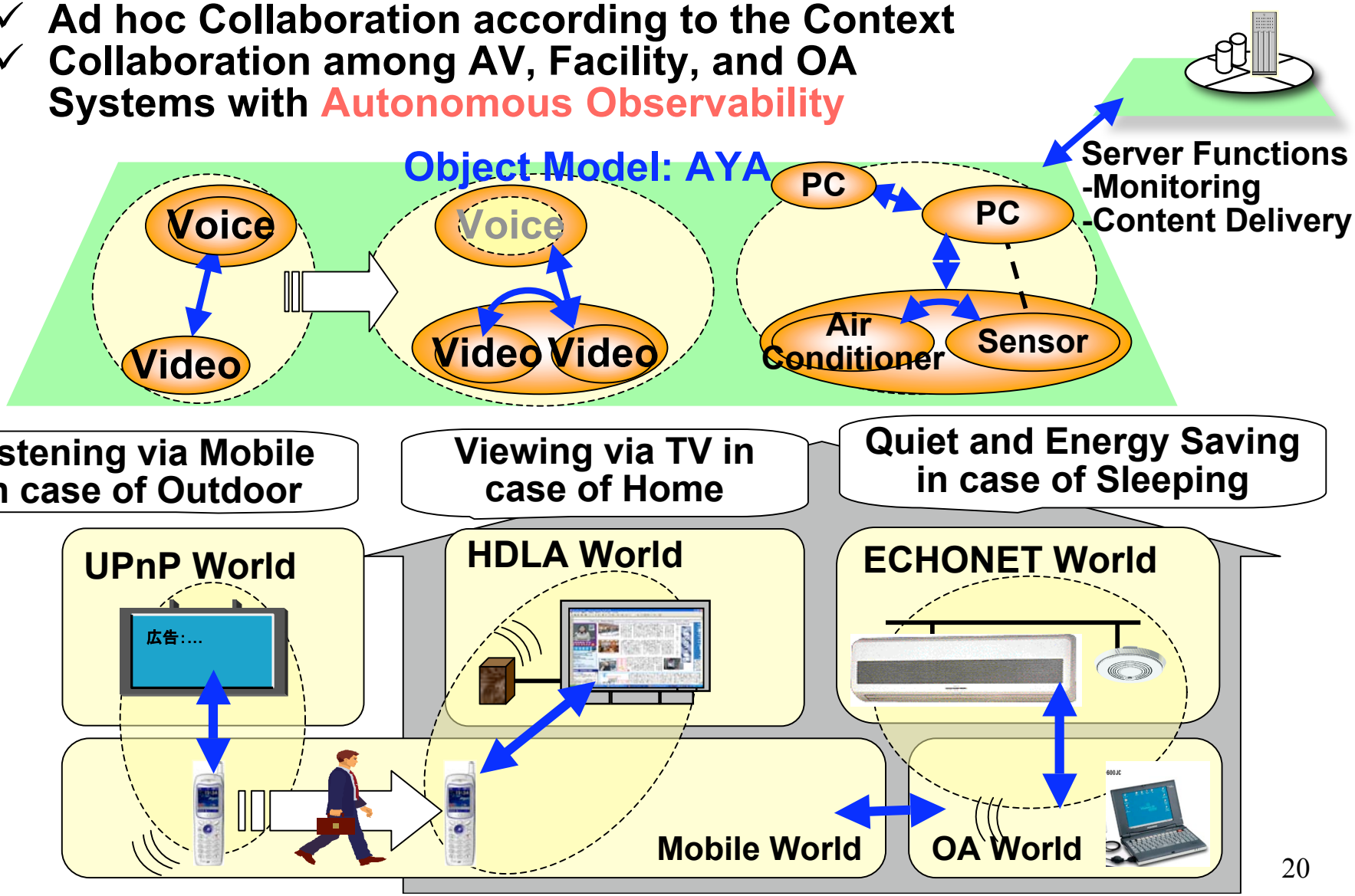
Vibration based Generator

R. Amirtharajah et al. of MIT (1999)



Super Distributed Objects:
AYA(context Aware & Yet Another service)

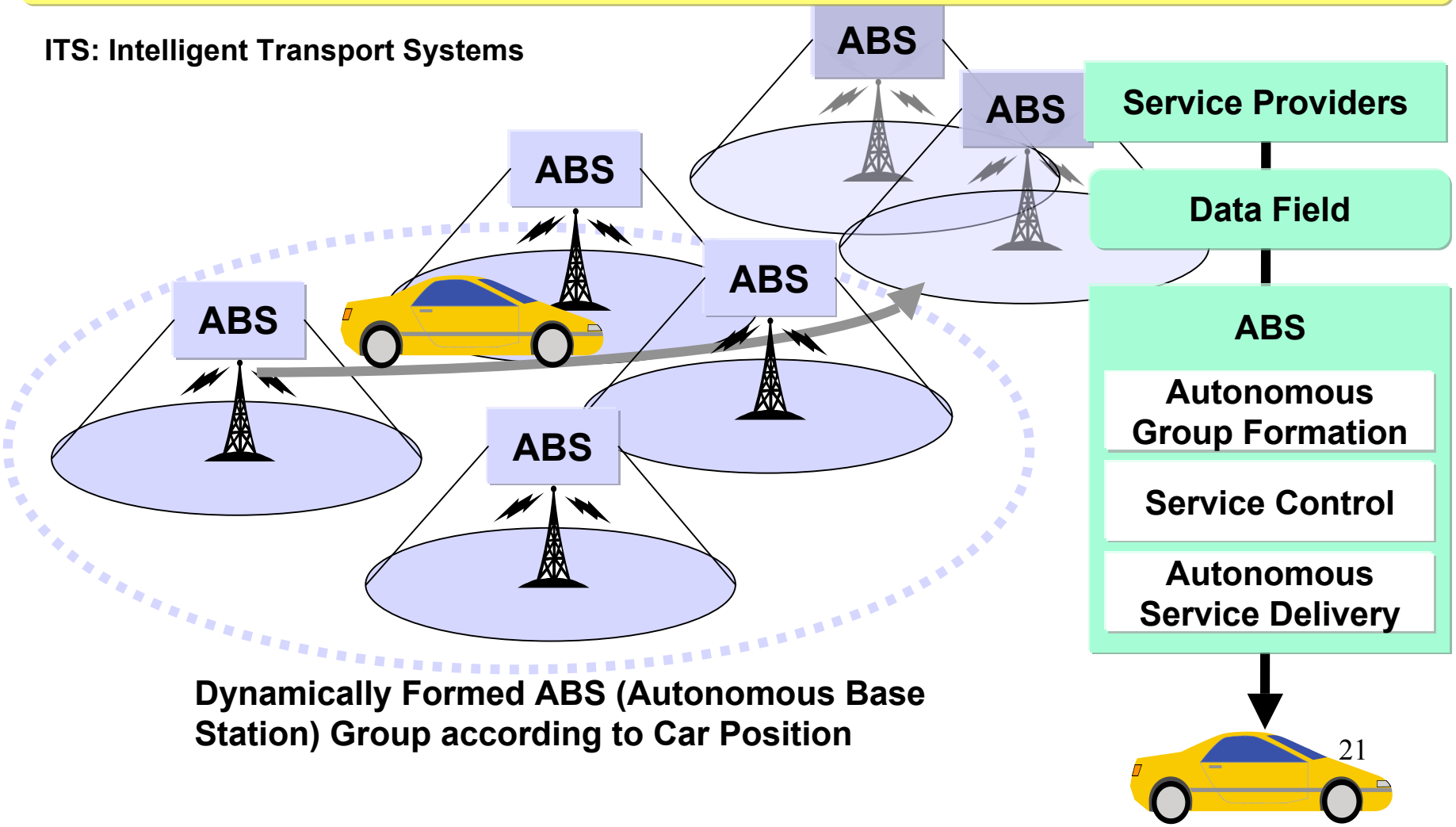
- ✓ Ad hoc Collaboration according to the Context
- ✓ Collaboration among AV, Facility, and OA Systems with Autonomous Observability



Autonomous Group Management for ITS based on Autonomous Observability

Reliable Data Transmission for High Speed Cars through DSRC (Dedicated Short Range Communications) by Autonomous Group Formation of Base Stations

ITS: Intelligent Transport Systems



Dynamically Formed ABS (Autonomous Base Station) Group according to Car Position

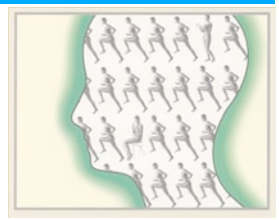
Open Development and Operation Infrastructure (ODOI)

requirement

development

Domain engineers

operation



Intelligent engineering system

Life Cycle system

Dynamic management system

Simulation

Simulator

System knowledge

Intelligent collaboration

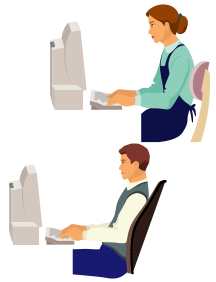
tools

Integration,Analysis,Optimization

Life cycle system model

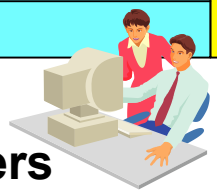
Model view

Information Base



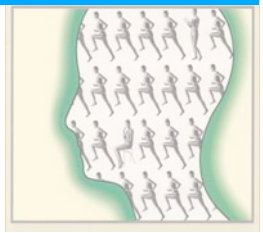
Outside expert/

Citizen



Systems engineers

Aims of Open Development & Operation Infrastructure (ODOI)



For project members

to retrieve, accumulate, suggest, simulate, validate and synthesize comprehensive information and knowledge for the phases of plan, design, validation and operation

For project members and experts outside

to communicate, exchange, discuss and interact recursively

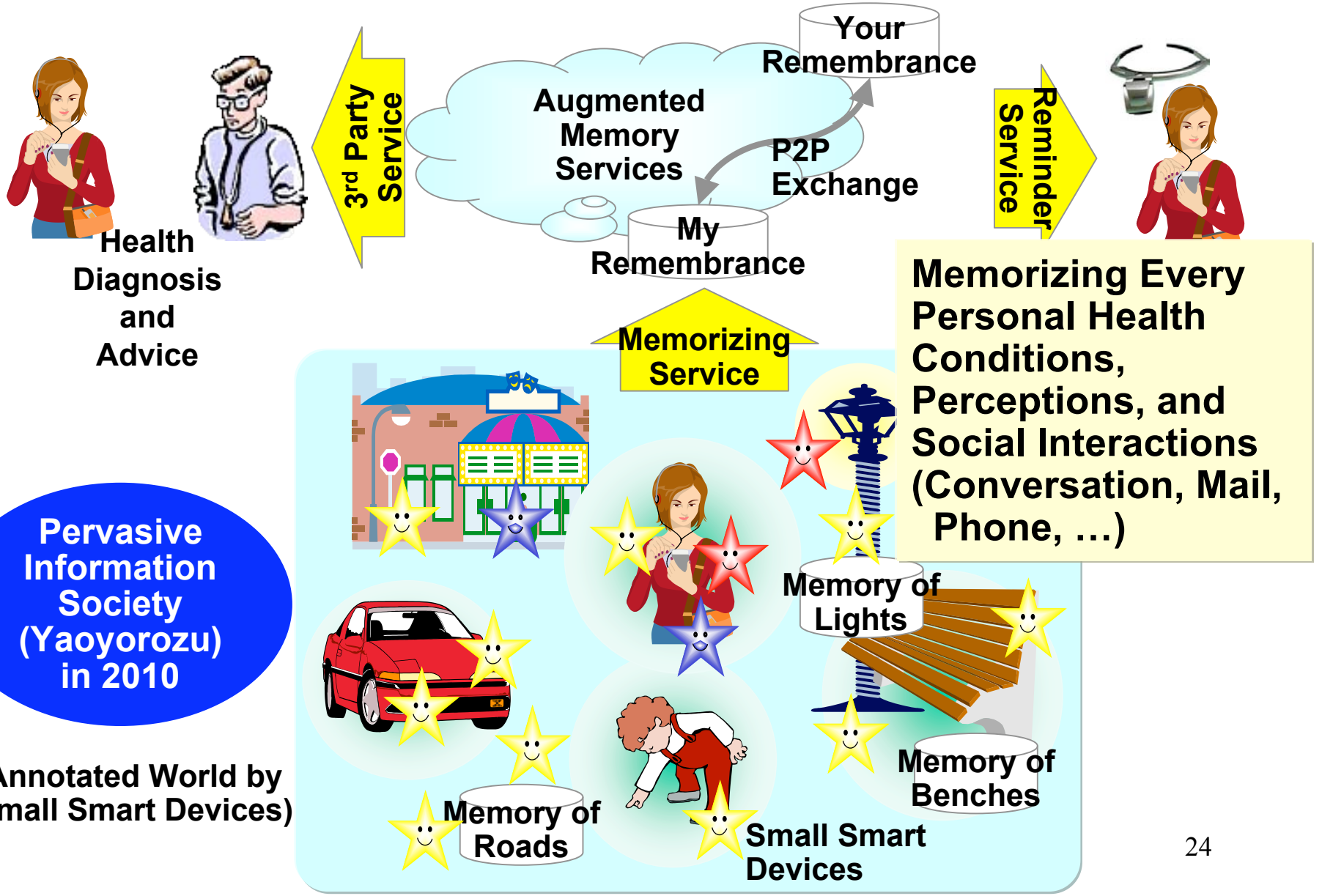
For people interested in including citizens

to watch recursively the on-going process and proposed new idea or suggestion

For developed systems

to have autonomous operation supported by **ODOE**

Sample Scenario for Yaoyorozu Society in 2010



Yaoyorozu in Japanese Myth

"Yaoyorozu" (= eight million) means countless in number, particularly in the phrase "Yaoyorozu no Kami-gami, or "eight million gods", indicating that gods live not only in the many shrines, but in trees and stones, in the sky and water, constantly surrounding and protecting us.

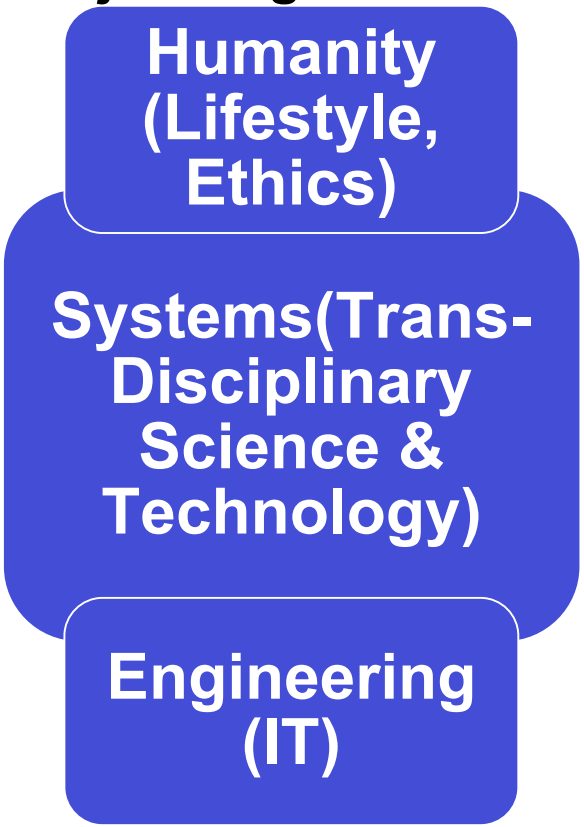
Eight Million Gods in Japanese Myth

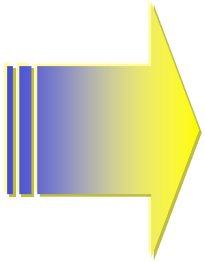
For our project, we use "Yaoyorozu" in place of Ubiquitous for the heterogenious intelligent devices surrounding and protecting us.

Secure and Affluent Society by Convergence of IT, Bio, and Nano

The Yaoyorozu Project

Project Organization





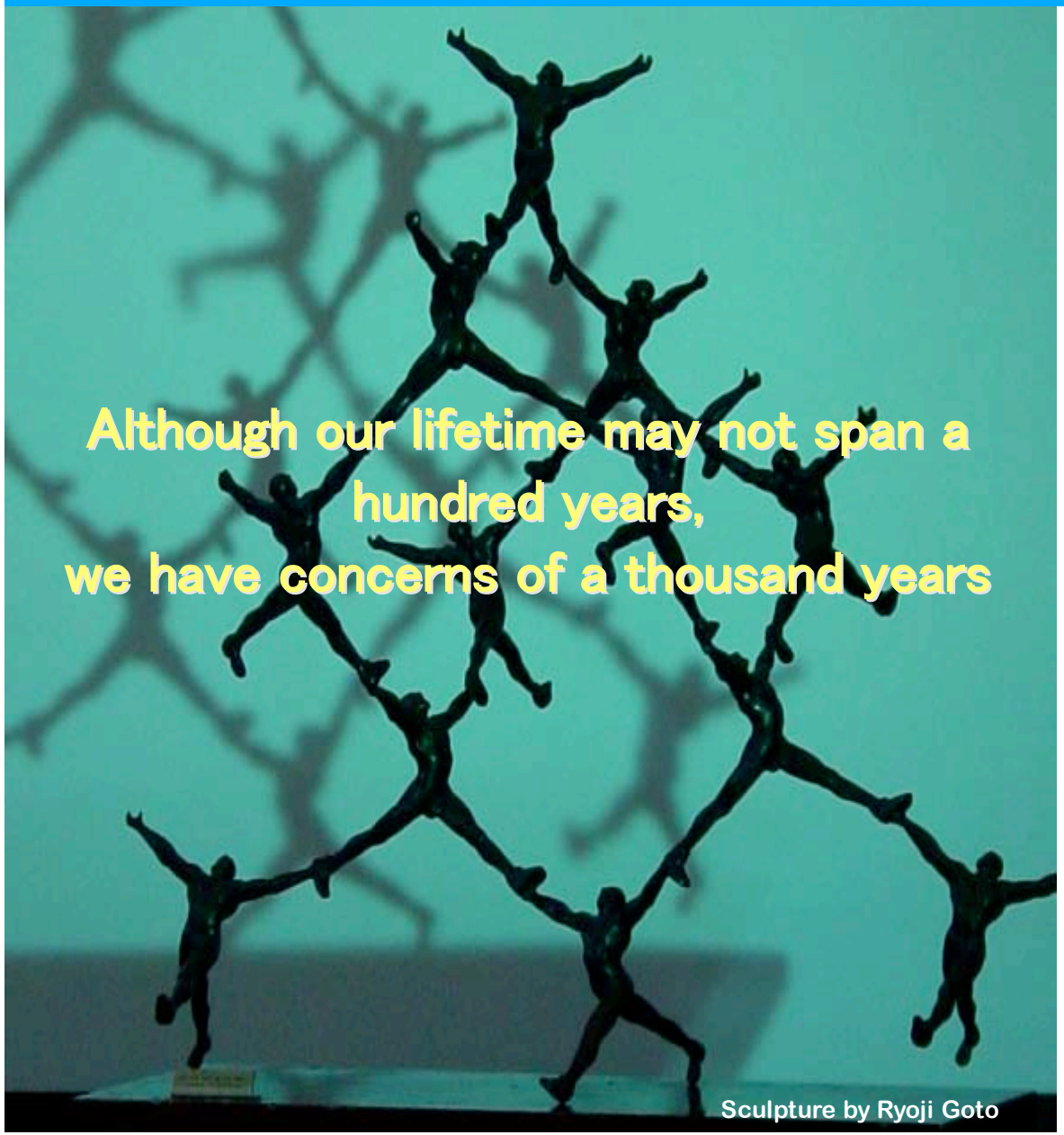
➢**Research Goal**

- **Desirable Institutional Systems & Core Technology for Ubiquitous (Yaoyorozu) Information Society in 2010**
- **Research Methodology for Multi-disciplines**

(August 2002-March 2005)

Supported by Special Coordination Funds for Promoting Science and Technology by MEXT (Ministry of Education, Culture, Sports, Science and Technology, Japan)

Our Research Attitude



Calligraphy by Mr. ODAIRA Namihei
(Founder of Hitachi, Ltd.)