Semiconductor Industry and It's R&D – Growth and Transformation

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President and CEO
Semiconductor Technology Academic Research Center (STARC)

STARC is a consortium on Design Technologies in Japan, supported by eleven major Japanese semiconductor companies.

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Survival of the Fittest

Semiconductor R&D Transformation

Industry Dynamics

Competition and Cooperation

Consortium

Semiconductor R&D Direction in the 21st century

An Age of Human Interface

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Transformation of Semiconductor R&D

Dr. Katsuhiro Shimohigashi
General Manager
Semiconductor Technology Development Division
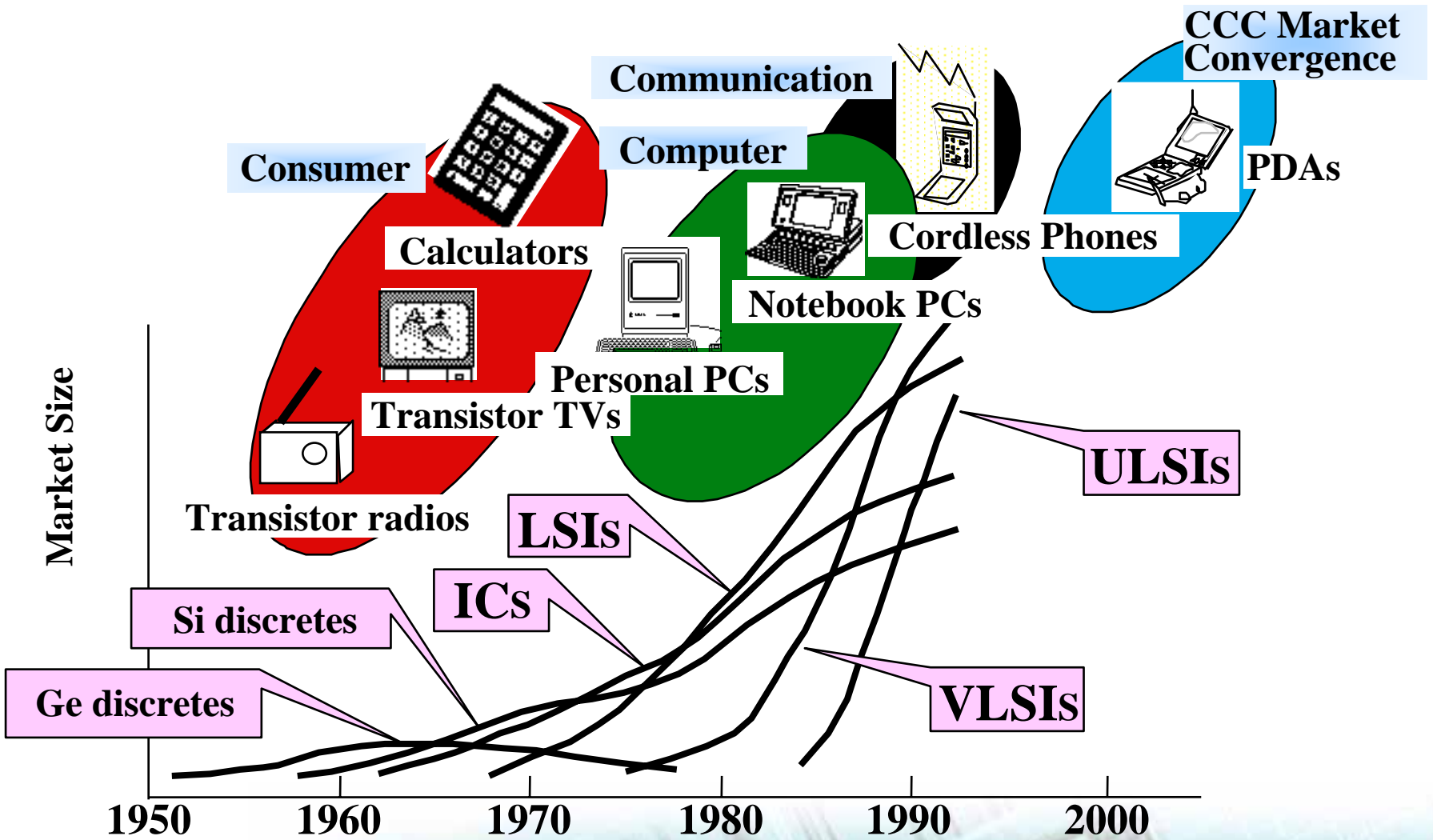**Semiconductor & Integrated Circuits**
Hitachi,Ltd.
STANFORD University 1999

The History

CCC Market Convergence

Communication

Computer

Consumer

PDAs

Calculators

Cordless Phones

Notebook PCs

Personal PCs

Transistor TVs

Market Size

Transistor radios

ULSIs

LSIs

ICs

Si discretes

VLSIs

Ge discretes

1950   1960   1970   1980   1990   2000

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Semiconductor Market Compared to Steel Production
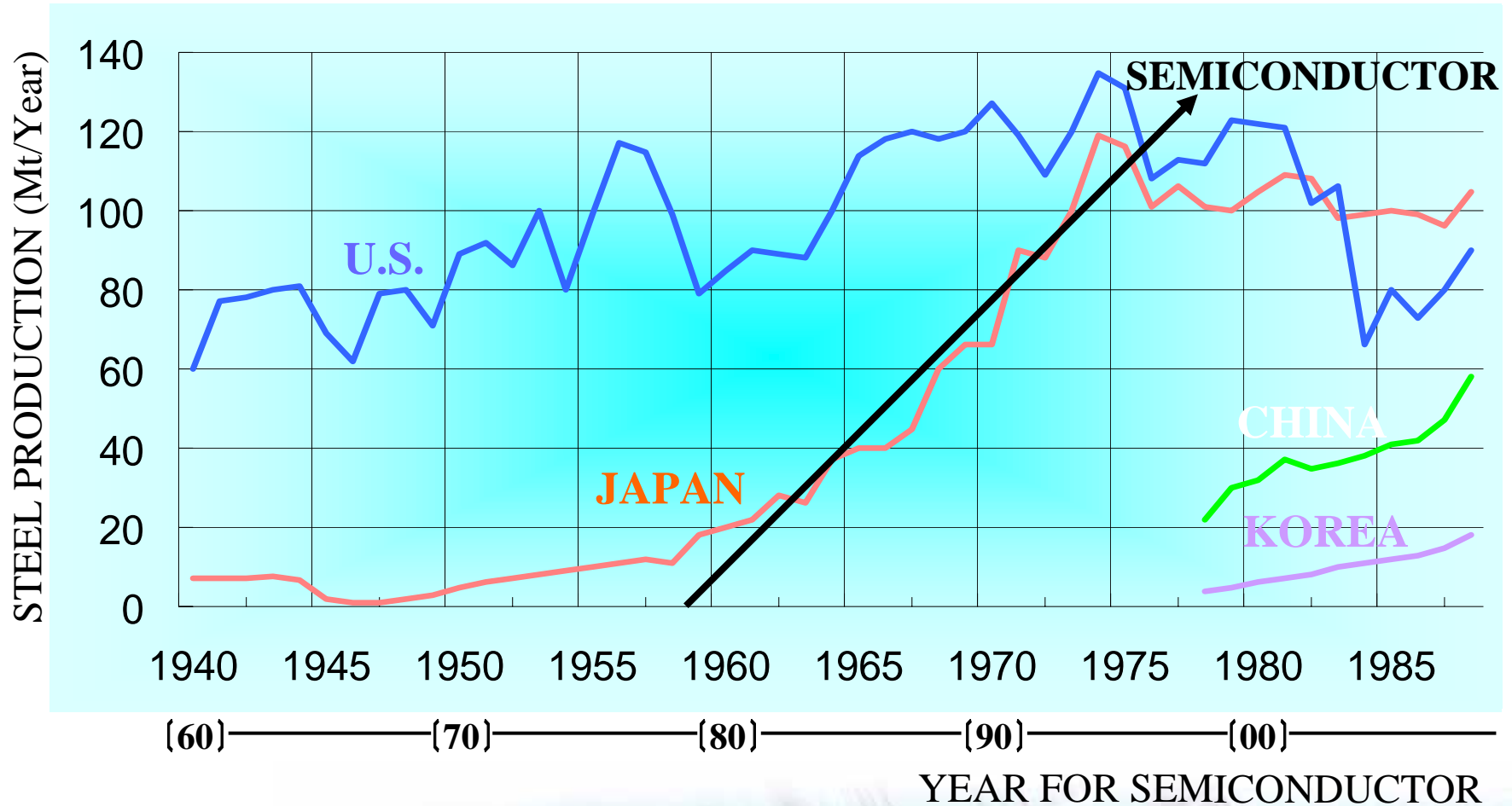
Semiconductor Industry Trend

	'70	'80	'90	'00
	10B$	40B$	150B$	
Market	**Develop**	Grow	**Mega Competition**	Oligopoly
Infra-Structure (Equipment)	**Scarce**	**Develop**	**Grow**	**Mega Competition**
Application	**Mainframe**	**PC**	**Wireless Communication**	**Digital Consumer**
ASP($)	10^6 10^5	10^4 10^3	10^3	10^2
Business Style	**IDM**	**IDM**	**IDM,Fabless,Foundry**	
R&D	**CRL**	**CRL**	**CRL**	

Government-University-Industry Partnership

To be discussed today!

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R&D Direction
Technology -Process and Device

1. Process Technology Commoditization

Pre-competitive /Infrastructure

(Cooperation)

New Materials

Differentiation

Phase-Shift,OPC

2. Post Optical Lithography

NGL
(Worldwide Cooperation)

3. Low Cost Manufacturing

Large Diameter Wafer
(Worldwide Cooperation)

R&D Direction-Continued

4. Technology Maturity

Acceleration of Miniaturization
Multi-Value Storage and Logic
Module Level Integration

5. Nanometer Processing

Atomic Layer Manipulation
Selective Growth

(Oxide Thickness　3nm,Now!)

6. Invisible Defects

Molecular / Atomic Level
Physics and Chemistry

7. Wiring Material Limit (Cu)

Optoelectronics

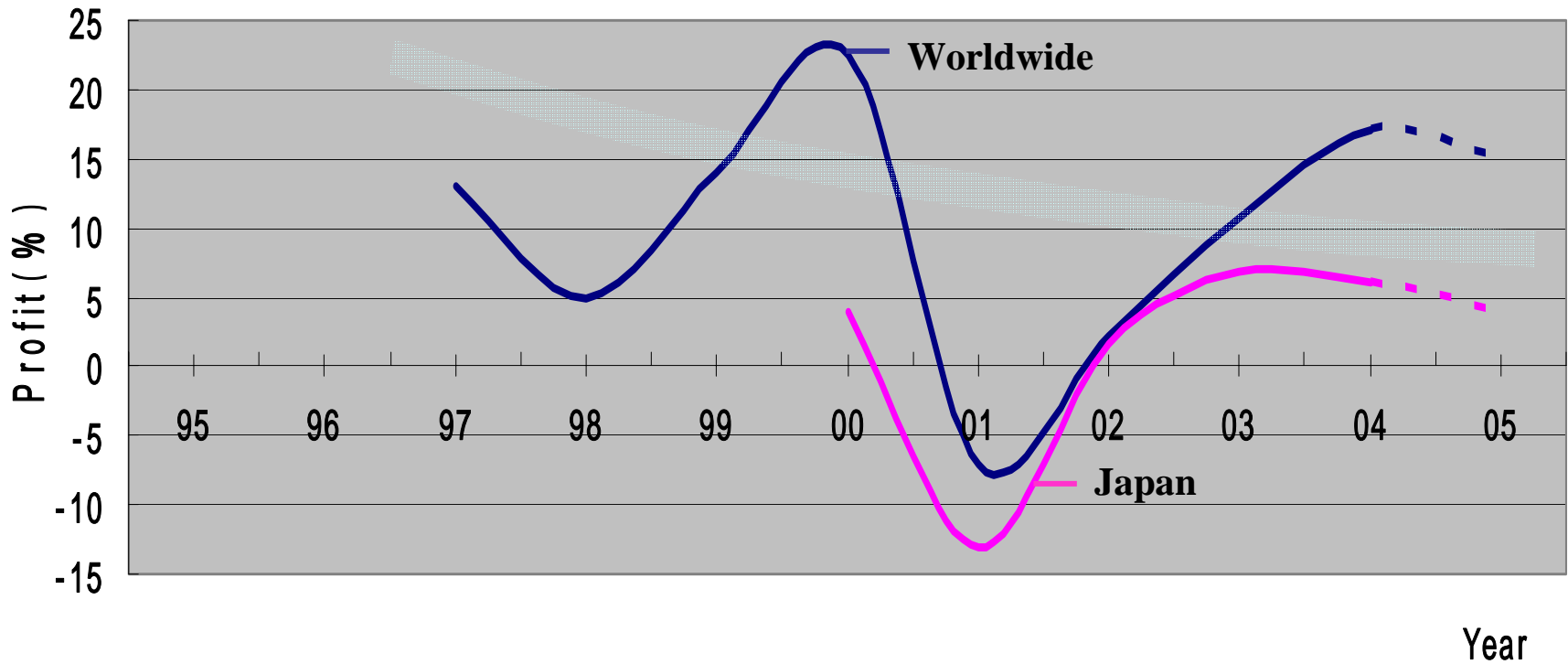**Cooperation, Back To The Science**

Trend of Semiconductor Market (WW)
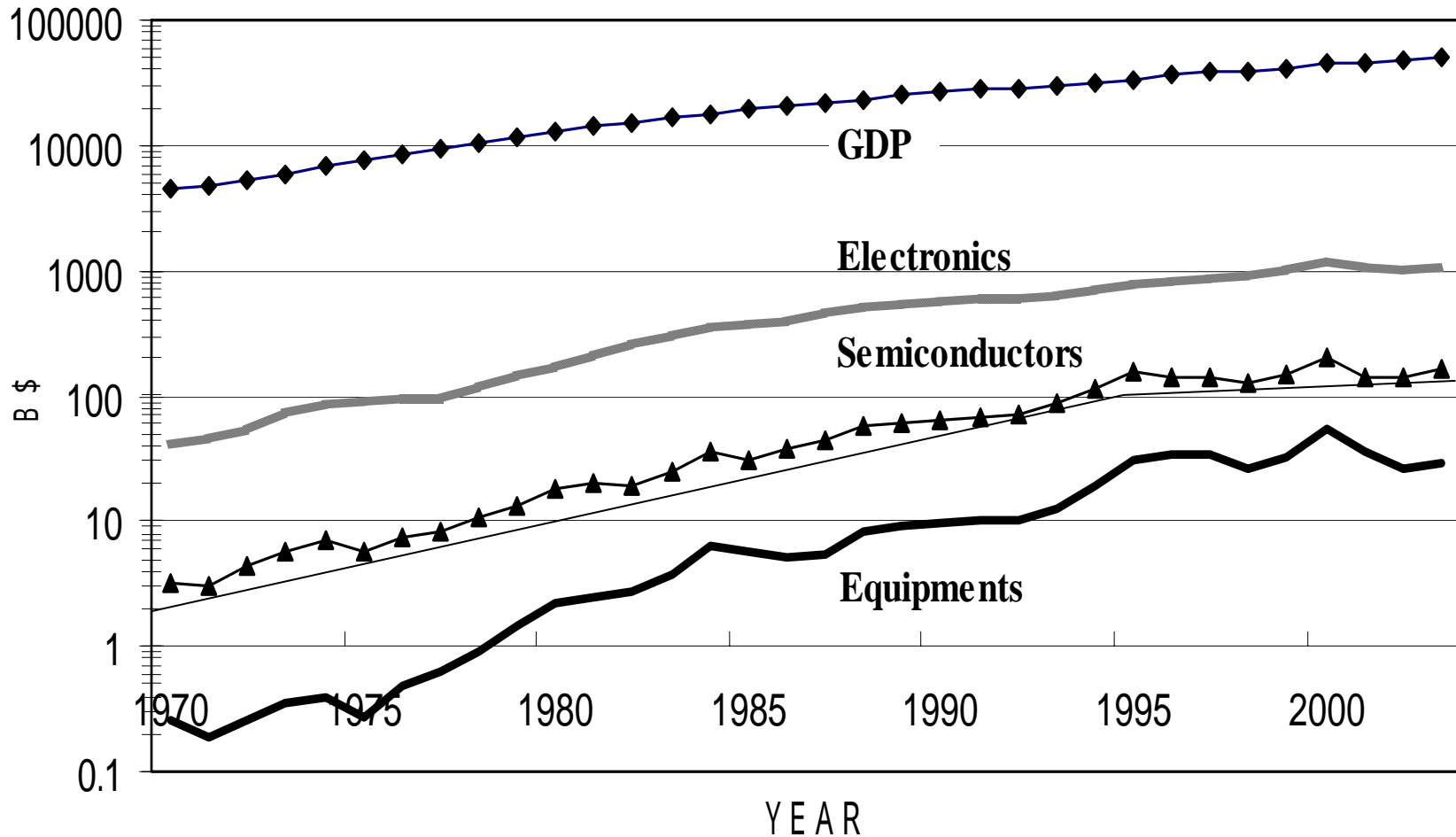
Semiconductor Company Profit Trend

Turning Point of Semiconductor Industry (1995)

New Technologies and Products Time To Market

Business Efficiency High-Cost Corporate Culture Cancellation

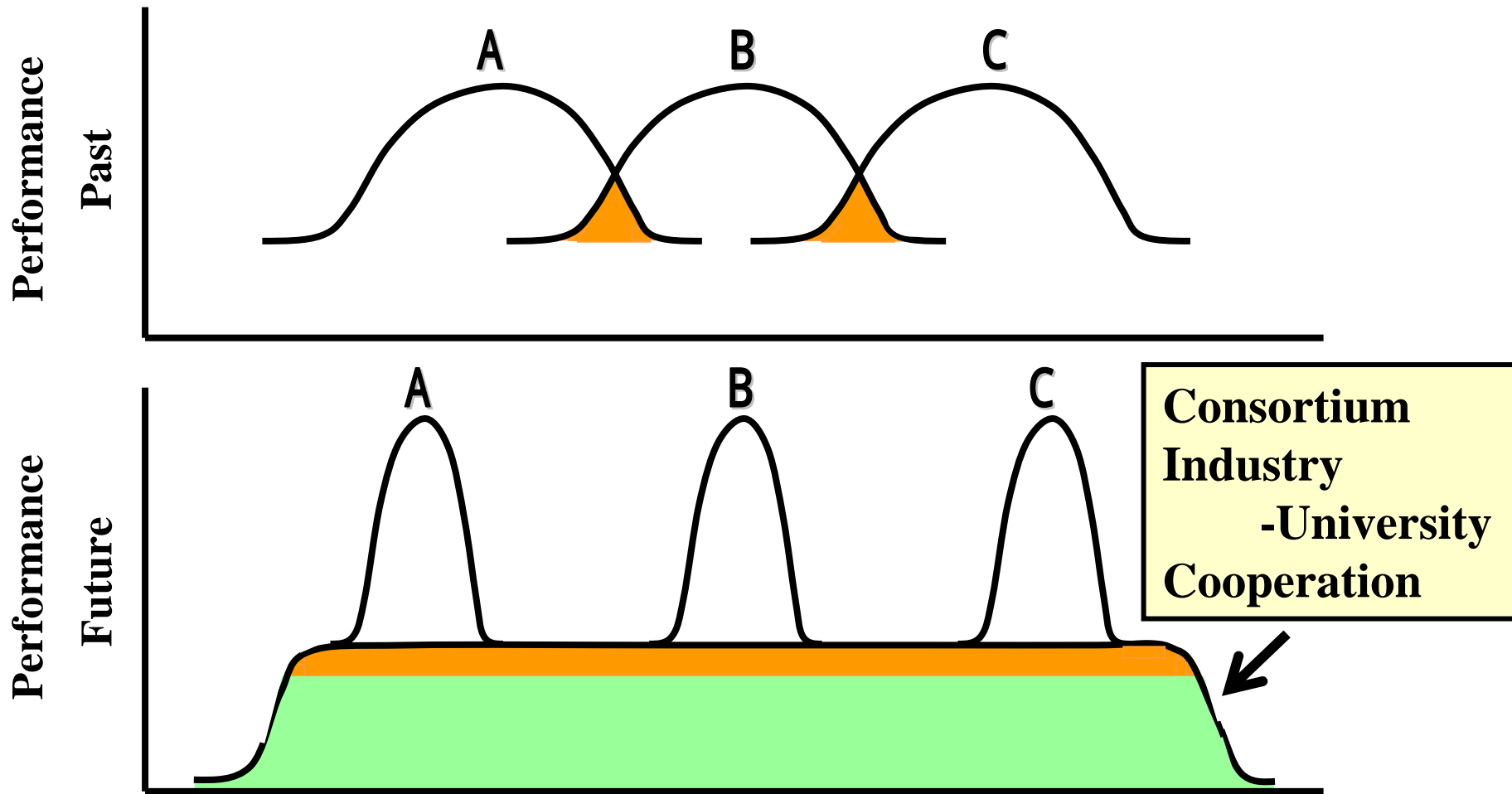**Expenditure**

Expenditure

Measures to Reconcile Together ?

STRJ WS: March 3, 2003

STAR C

Consortium As a Leverage

Performance Past

Performance Future

Consortium Industry -University Cooperation

STRJ WS: March 3, 2003

Transformation of Semiconductor R&D
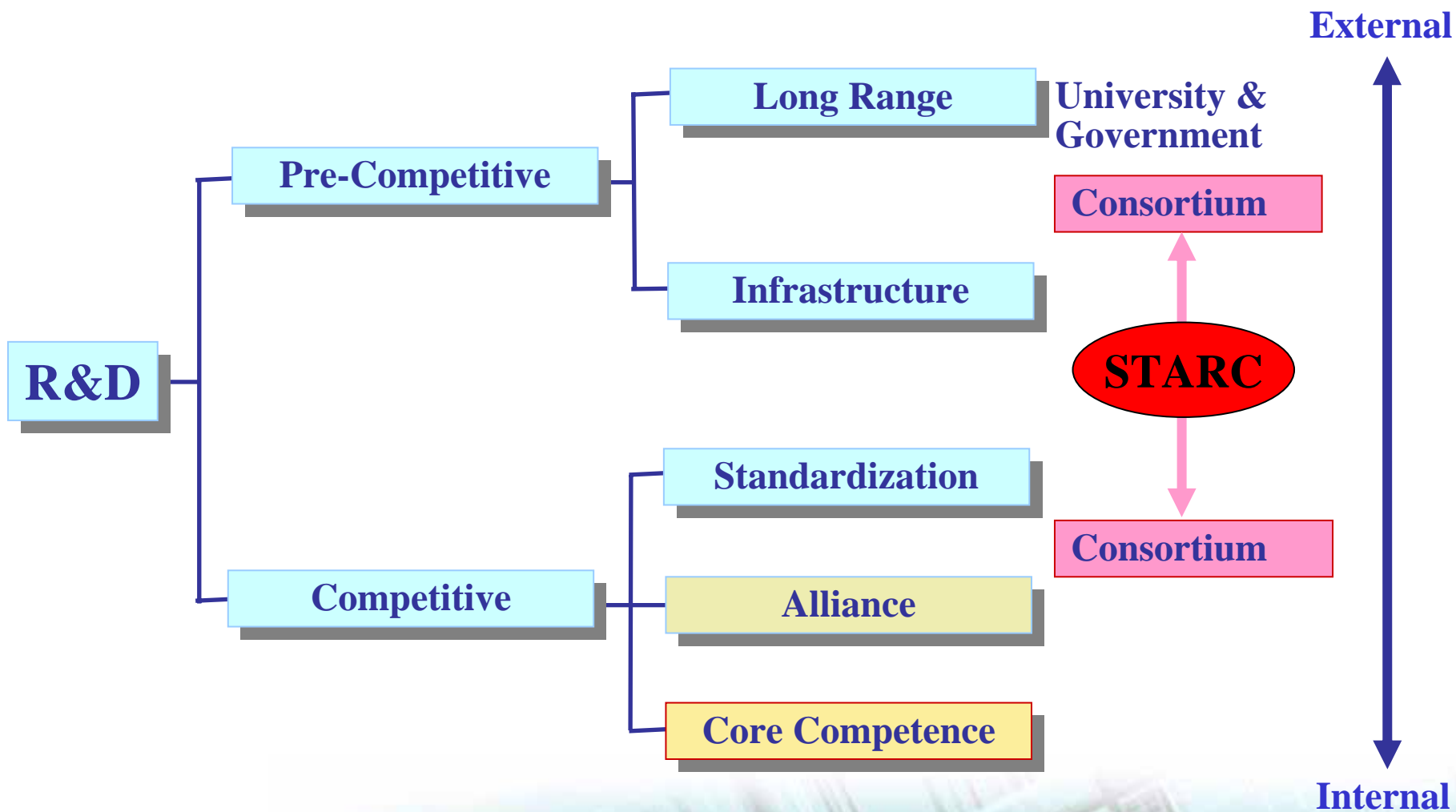
External

R&D

Pre-Competitive

Long Range

University & Government

Consortium

Infrastructure

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Competitive

Standardization

Consortium

Alliance

Core Competence

Internal

STAR(

STARC, Company Overview

- Name: STARC,
  Semiconductor Technology Academic Research Center
- Head Office: 17-2, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama 222-0033 Japan
- Chairman: Toshio Nakajima,
  President and CEO,NEC electronics Corporation
- President and CEO: Katsuhiro Shimohigashi
- Capital: JPY 440 million (~USD 4 million)
- Established: December 28,1995
- Shareholders: Fujitsu Limited
  Matsushita Electric Industrial Co.Ltd.
  NEC Electronics Corporation
  Oki Electric Industry Co.Ltd.
  Renesas Technology Corporation
  Rohm Co.Ltd.
  Sanyo Semiconductor Co.Ltd.
  Seiko Epson Corporation
  Sharp Corporation
  Sony Corporation
  Toshiba Corporation

STARC, Bridge between Industry and Academia
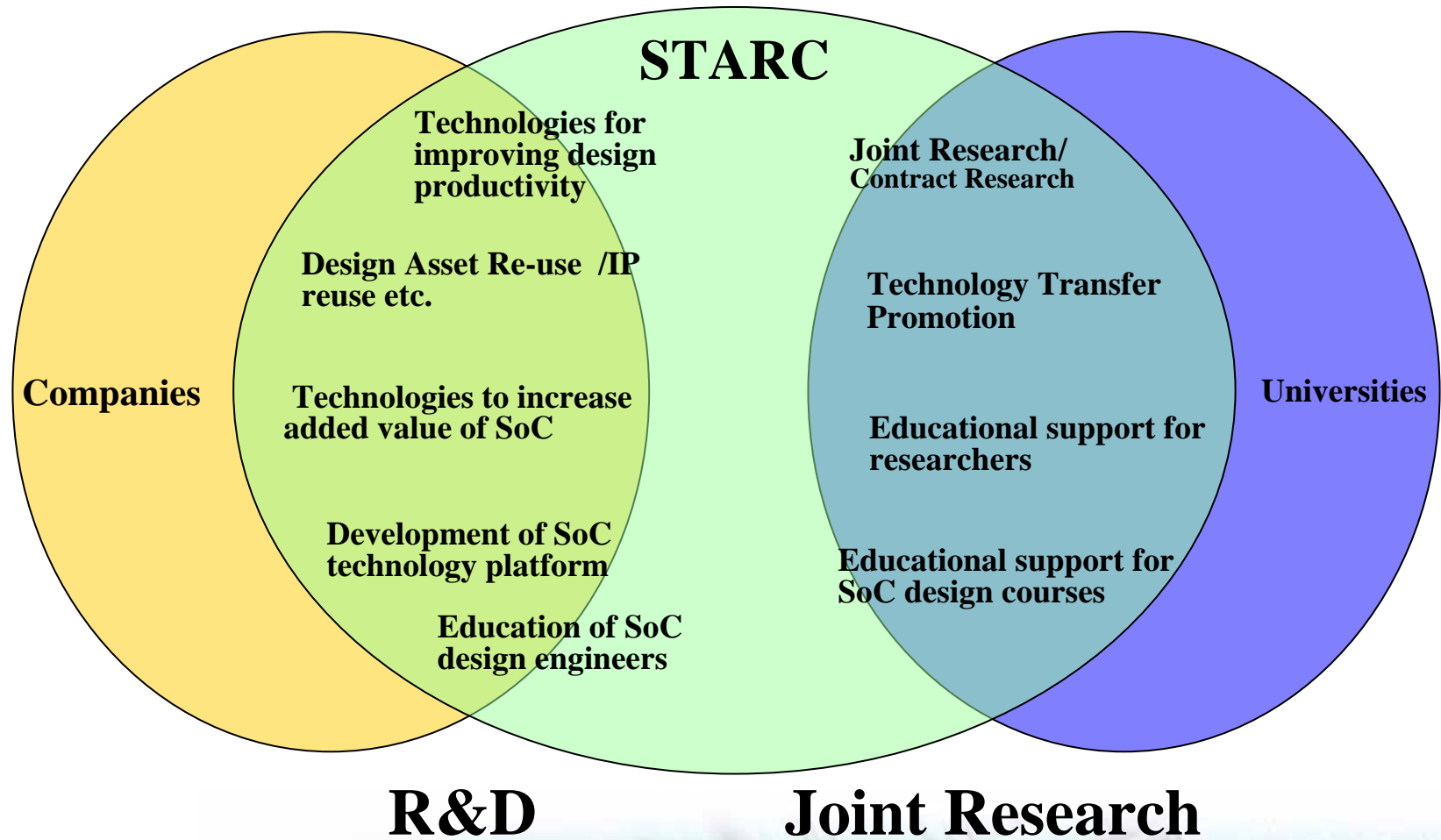
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Companies

Universities

Technologies for improving design productivity

Design Asset Re-use /IP reuse etc.

Technologies to increase added value of SoC

Development of SoC technology platform

Education of SoC design engineers

Joint Research/ Contract Research

Technology Transfer Promotion

Educational support for researchers

Educational support for SoC design courses

R&D

Joint Research
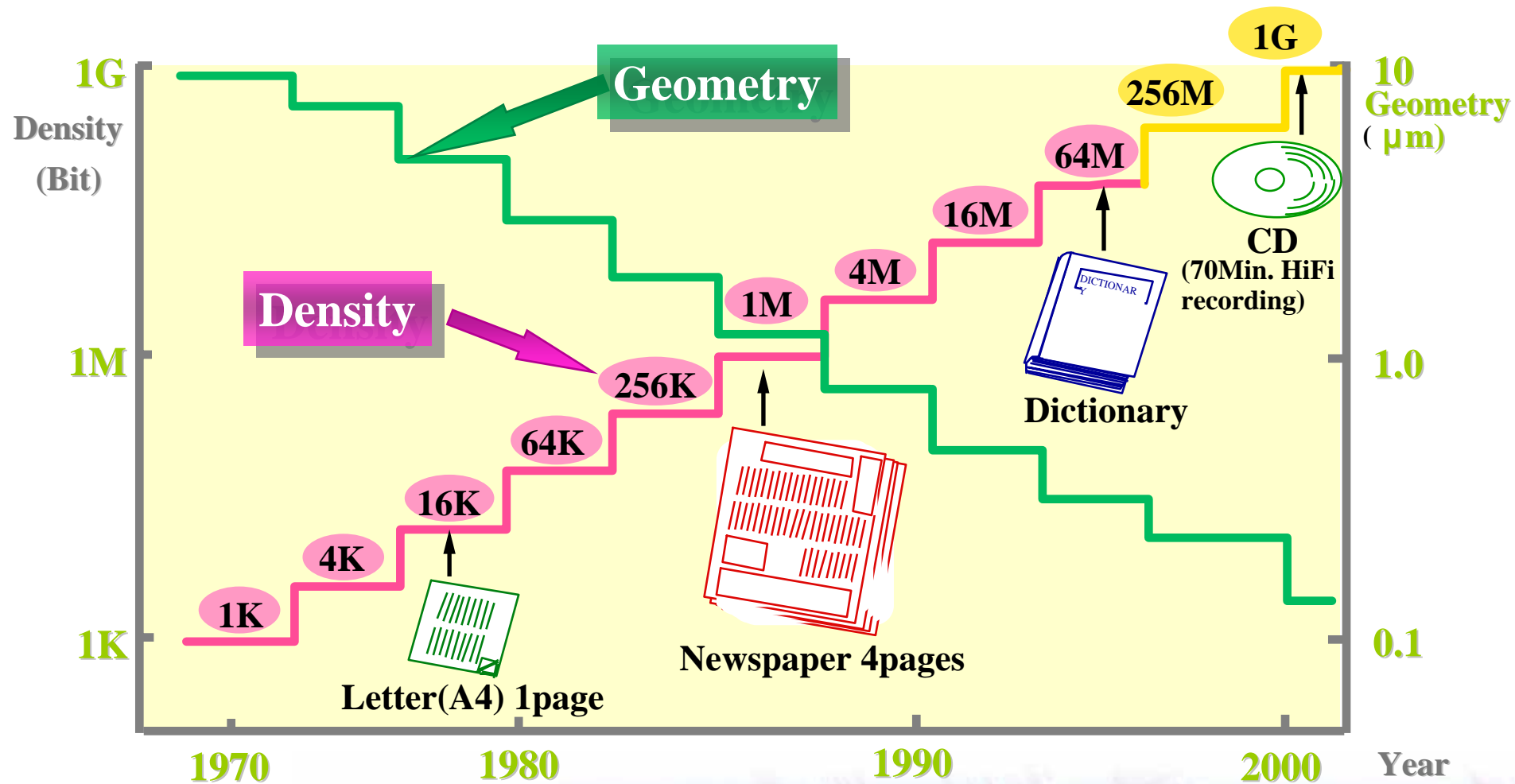
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Semiconductor R&D Direction in the 21st century

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Memory Density Reaches Giga-Bit

Density (Bit)

1G
1M
1K

Geometry

Density

1G
256M
64M
16M
4M
1M
256K
64K
16K
4K
1K

Geometry (μ m)
10
1.0
0.1

Letter(A4) 1page

Newspaper 4pages

Dictionary

CD (70Min. HiFi recording)

1970   1980   1990   2000   Year

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Processor Performance Reaches GIPS
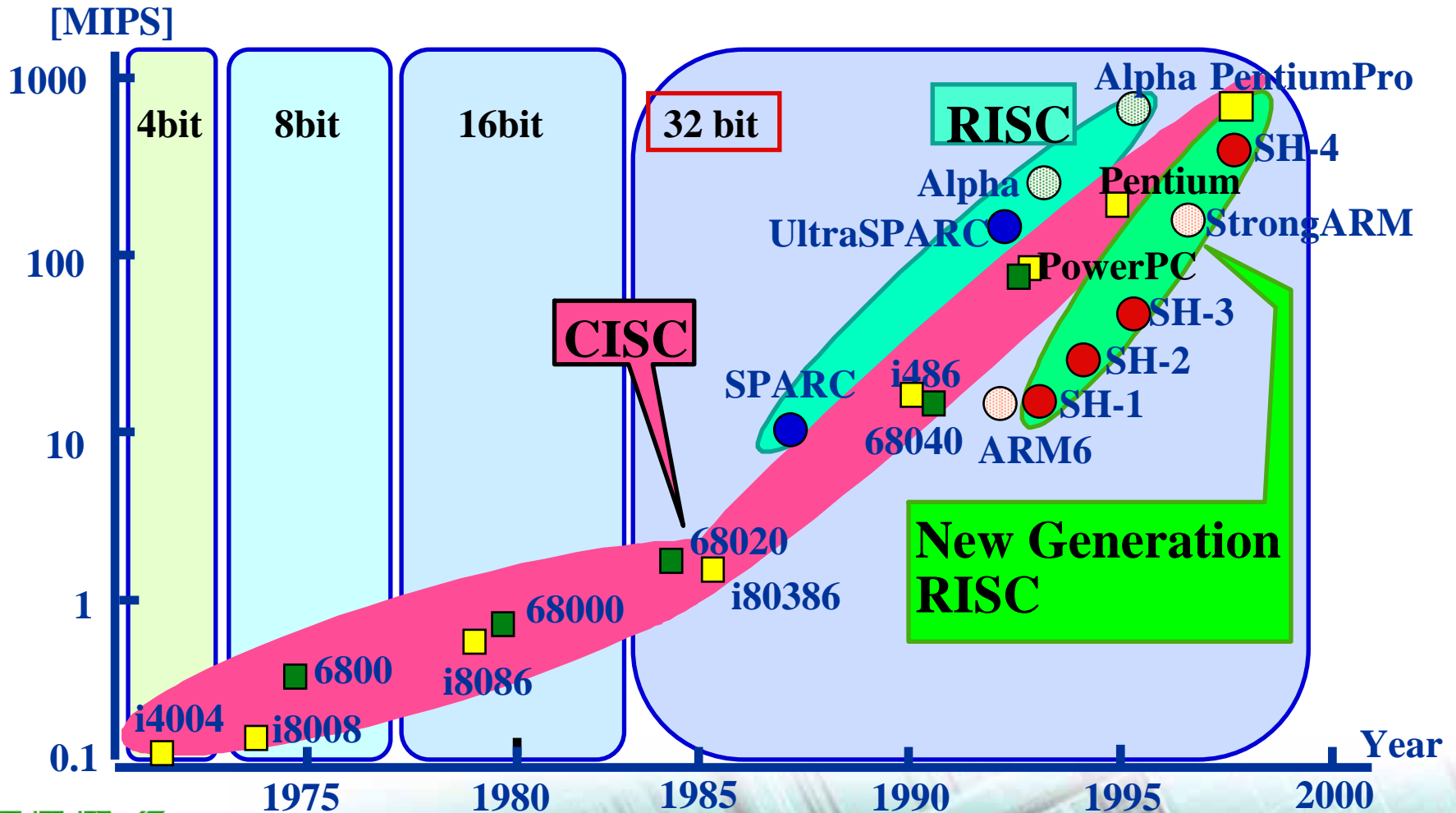
Frequency Reaches Giga-Herz in Mixed Signal LSI
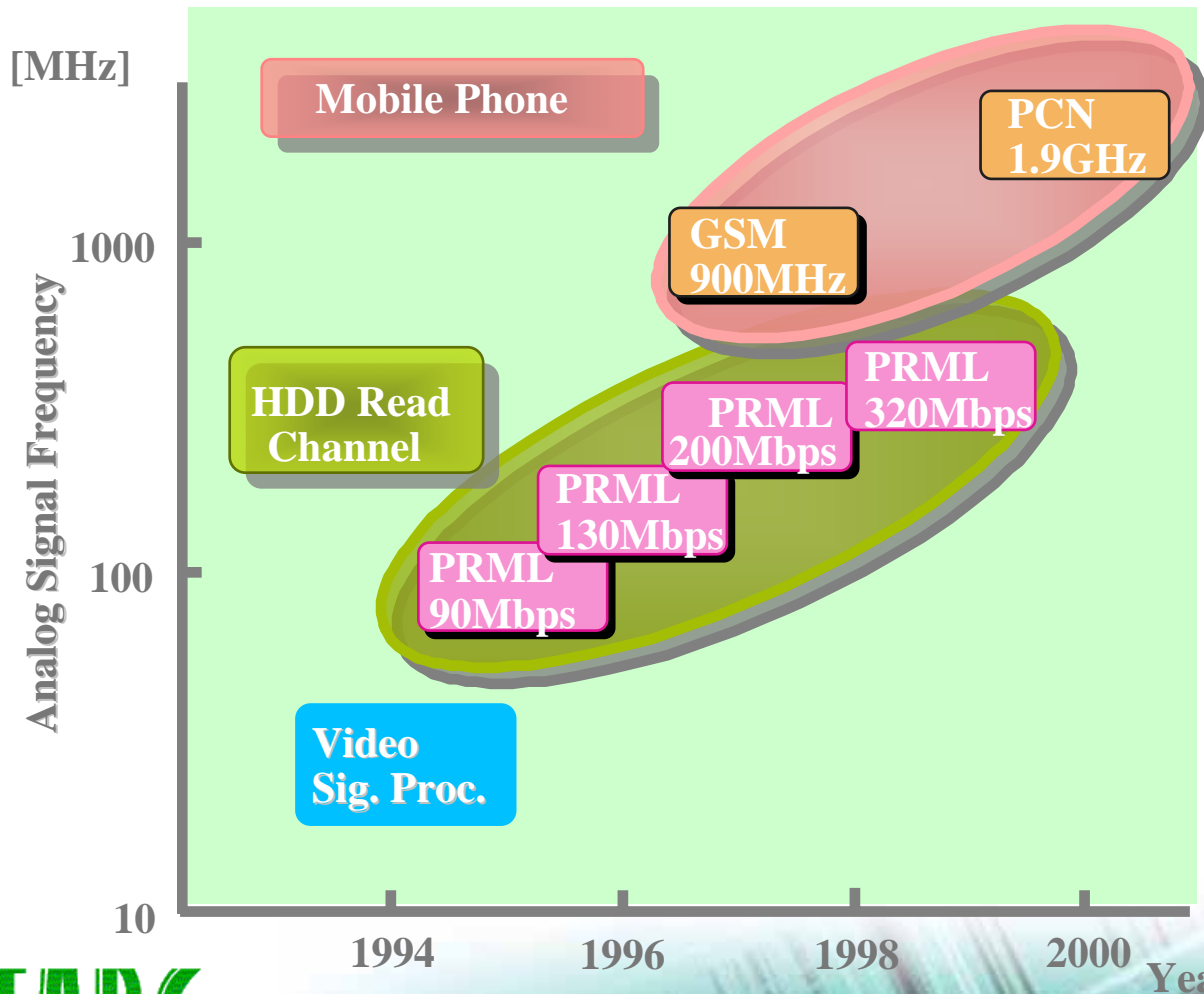
GSM RF Transceiver IC
(0.6μ Bi-CMOS)
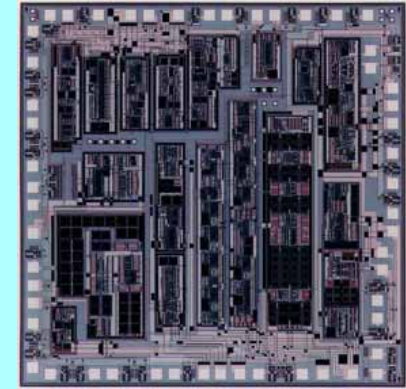
PRML Read Channel LSI
(200Mbps 0.35μ CMOS)

[MHz]

Mobile Phone

PCN 1.9GHz

GSM 900MHz

Analog Signal Frequency

1000

HDD Read Channel

PRML 320Mbps

PRML 200Mbps

PRML 130Mbps

100

PRML 90Mbps

Video Sig. Proc.

10

1994   1996   1998   2000

Year

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Mega Trends

Nomadic

Portability
Multimedia
Network

Down Sizing

PDA   **H/PC**

EWS

Digital Cellular

DVB

Electronic Money

Notebook PC

Sub-note PC

PC/Apple

PC/IBM

Lap Top PC

1980   1990   2000   **Year**

October.23.2007   125   -   -

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Future Look at Multimedia

Automatic Tour Guide

Safety Car

Digital Camera

IMAGE

MULTIMEDIA

CHARACTER

VOICE

OCR

Digitalization

Navigation

Machine Translator

Recognition

Nomadic Assistant
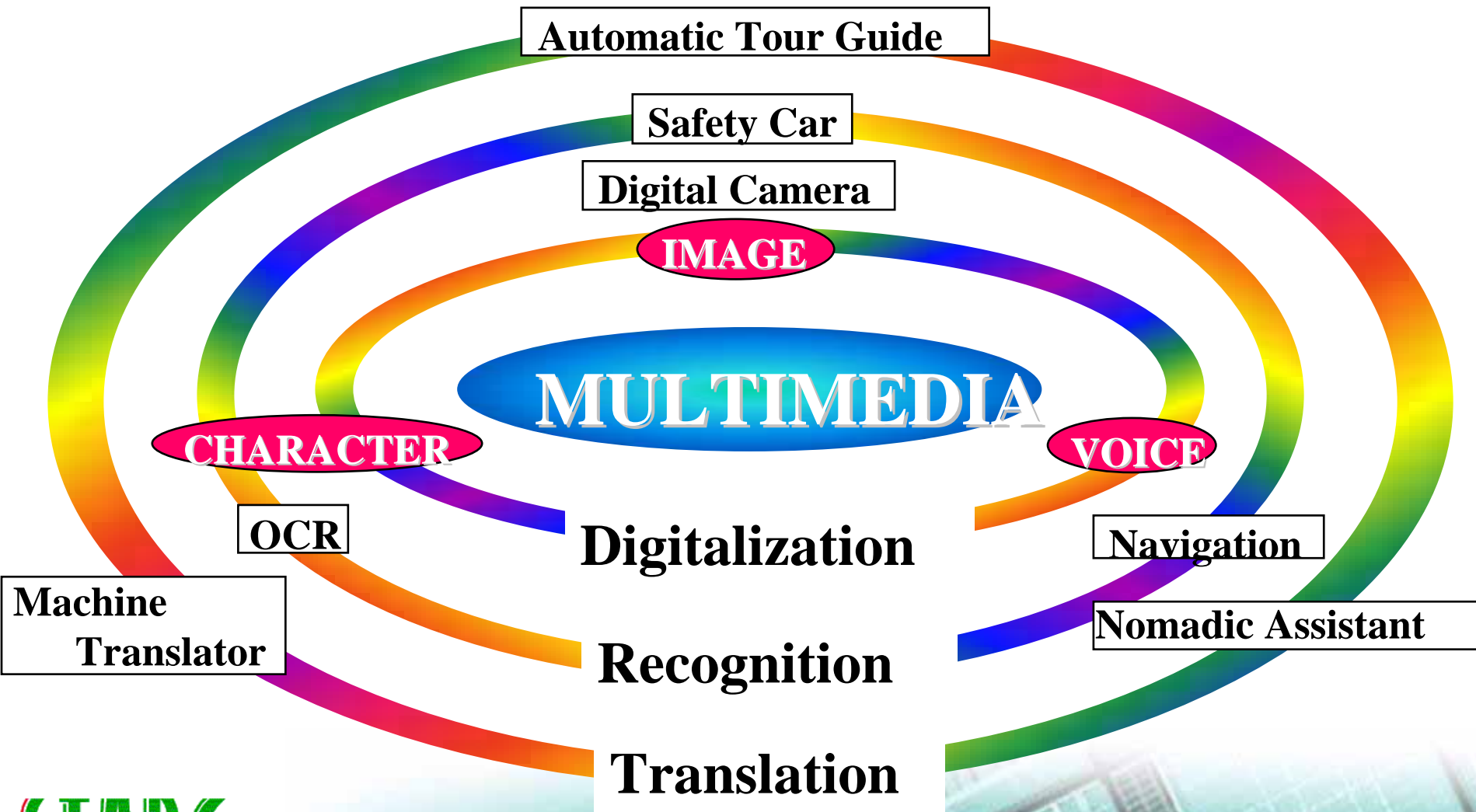
Translation

Processor Performance
for Real Time Voice Processing

Speaker Independent

Controlled

Dictation

Car Naviga-tion

Ticket Reserva-tion

SH3 **SH4** **SH5**

Vocabulary (Words)

100K

10K

1K

100

50   100   1000   10000

Processor Performance (MIPS)

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Controlled Sentence Speech Translation

Trend

E-to-J & J-to-E Dictionary (50,000 words x 2)

Controlled Sentence Translation

Rule based MT 10,000 words 500sentences

E-to-J Dictionary (50,000 words)

Rule based MT 1,000 words 500sentences

Memory(ROM) Size (MB)

CPU (MIPS)

An Example of Speech Translation System
(Controlled Sentence,1999)

Board labels: ROM, SH3, RAM, Controller, ADC, output, input
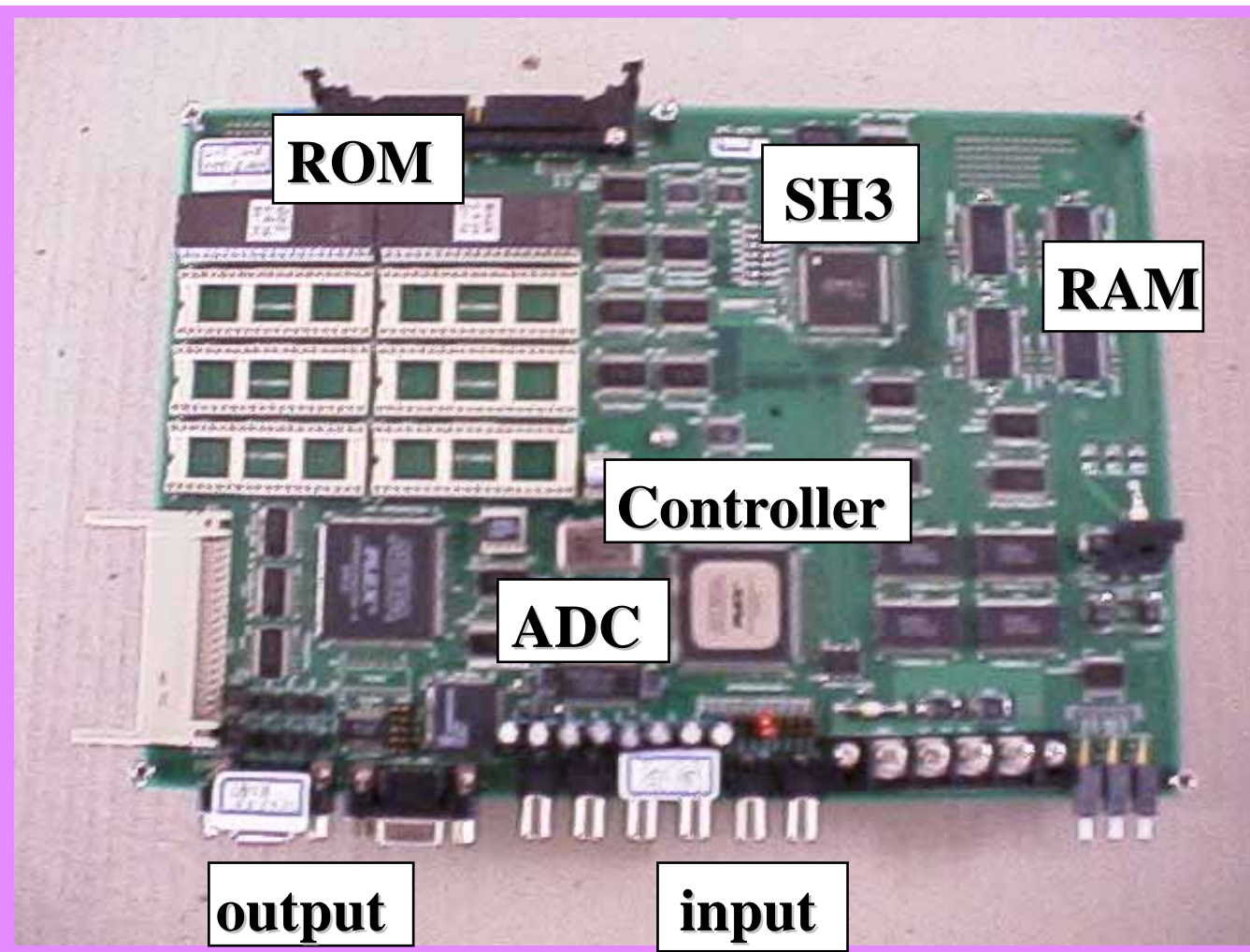
spec

SH3(60MHz)

sampling
  11/12/16kHz

response
  around 0.6sec

memory size

SR
  ROM 256kB
  RAM 500kB

TTS
  ROM 1.5MB
  RAM 500kB

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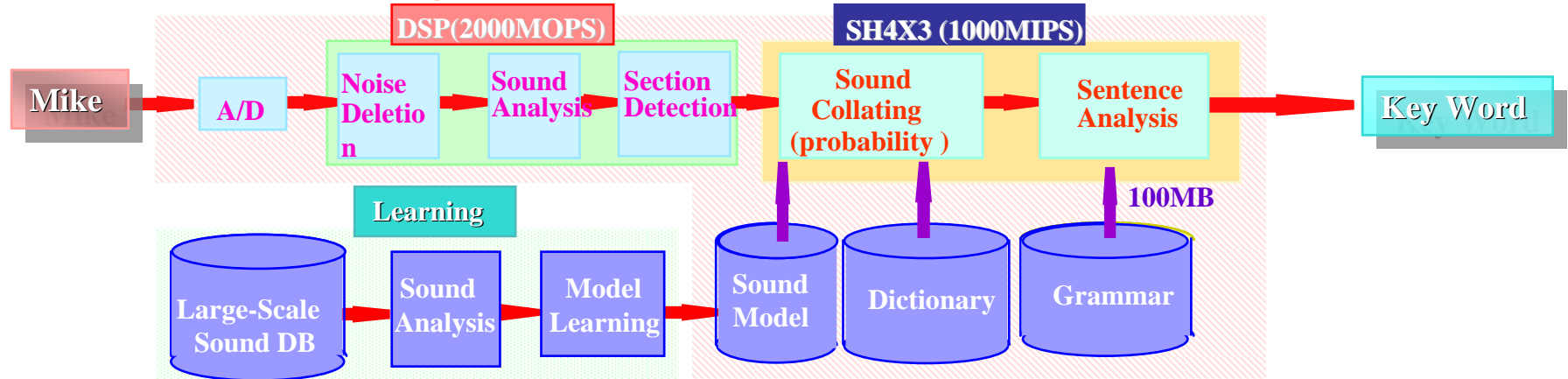
Free Speech Translation

Trend

Chart — Memory(ROM) Size (MByte) vs CPU (MIPS):

- E-to-J & J-to-E Dictionary (50,000 words x 2)
- E-to-J Dictionary (50,000 words)
- Rule based MT 1,000 words 500sentences
- Rule based MT (10,000 words)
- Free Conversation Speech Translation

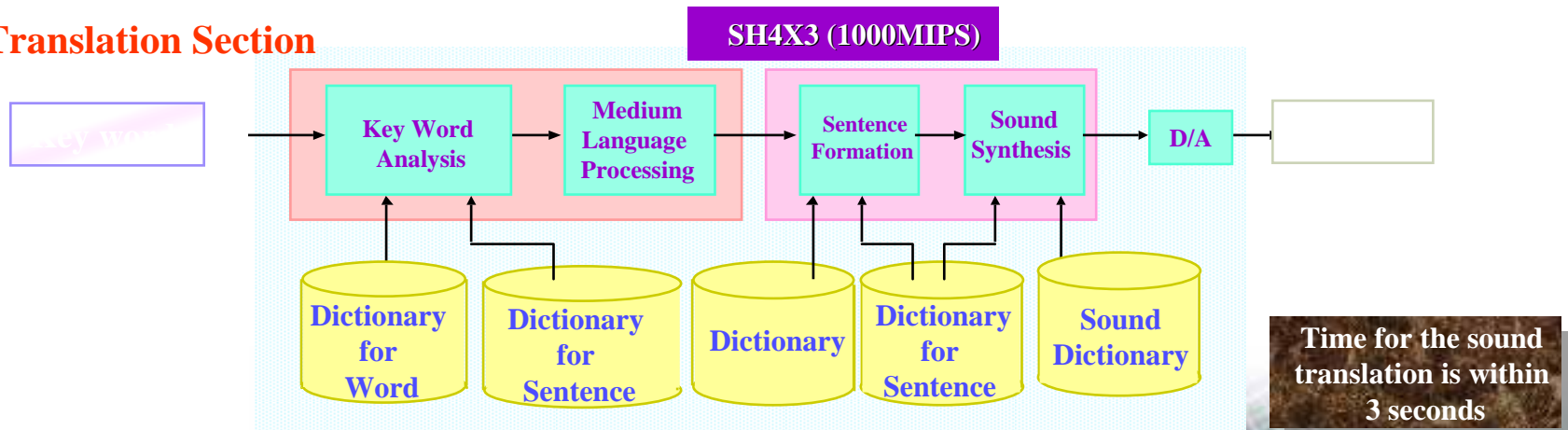Y-axis: Memory(ROM) Size (MByte) — 1000, 100, 10, 1, 0.1

X-axis: CPU (MIPS) — 10, 100, 1000

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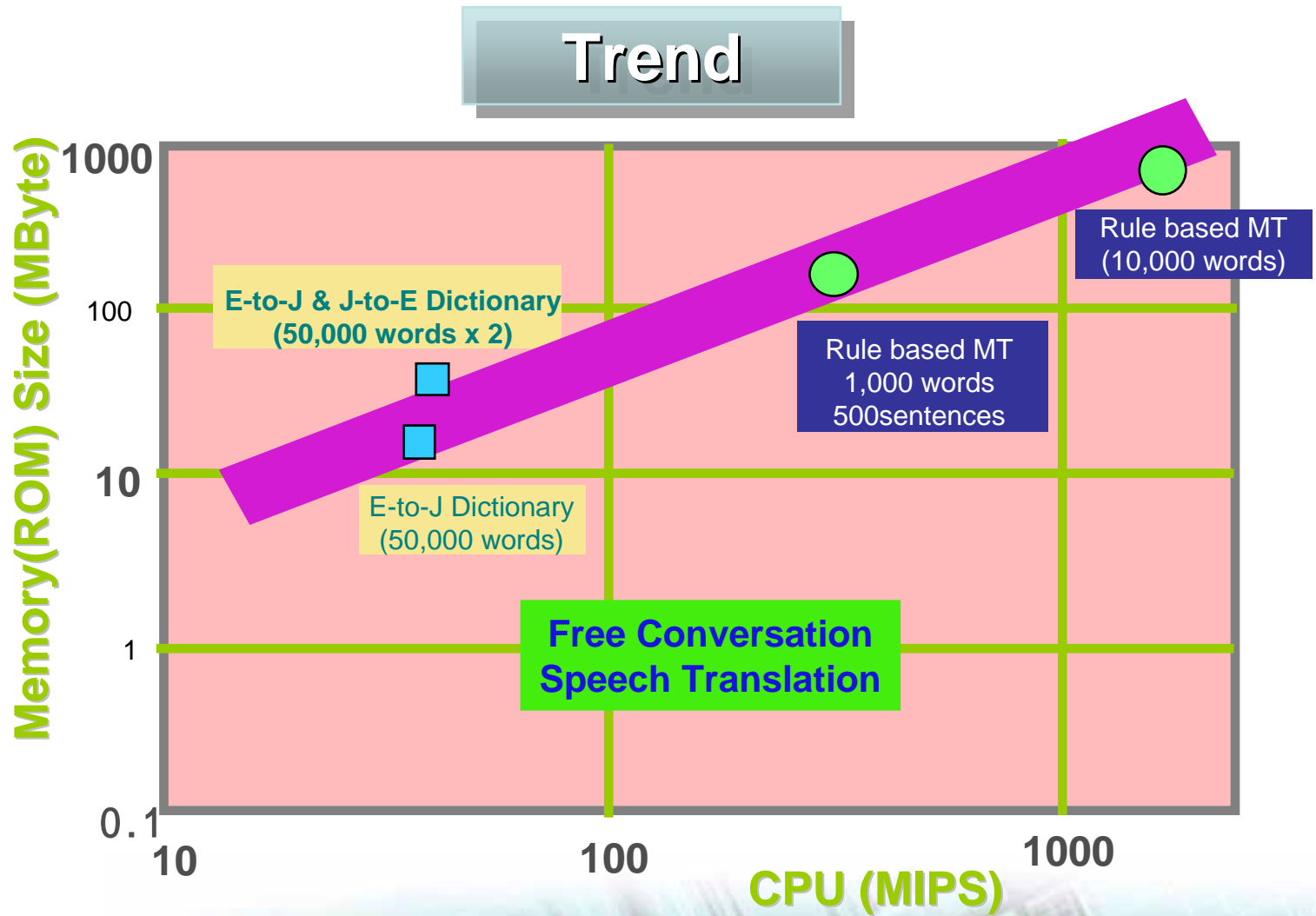
Normadic Language Assistance
- ULSIs will make this happen! -

Recognition Section
(Successive word sound recognition)

DSP(2000MOPS)

SH4X3 (1000MIPS)

Mike → A/D → Noise Deletion → Sound Analysis → Section Detection → Sound Collating (probability) → Sentence Analysis → Key Word

Learning

100MB

Large-Scale Sound DB → Sound Analysis → Model Learning → Sound Model | Dictionary | Grammar

Translation Section

SH4X3 (1000MIPS)

Key Word Analysis → Medium Language Processing → Sentence Formation → Sound Synthesis → D/A

Dictionary for Word | Dictionary for Sentence | Dictionary | Dictionary for Sentence | Sound Dictionary

Time for the sound translation is within 3 seconds

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Japanese Language Translation Challenges

Both Polite and Normal Expressions
　　　　/Normal,　　　　　　/Polite=" I will go."

Same Expression, But Multiple Meanings
　　　　　　=" I'm sorry/Excuse me/I see."

No Articles, No Expressions for The Singular and The Plural

No Entries of Conversational/Colloquial Expressions in Dictionary
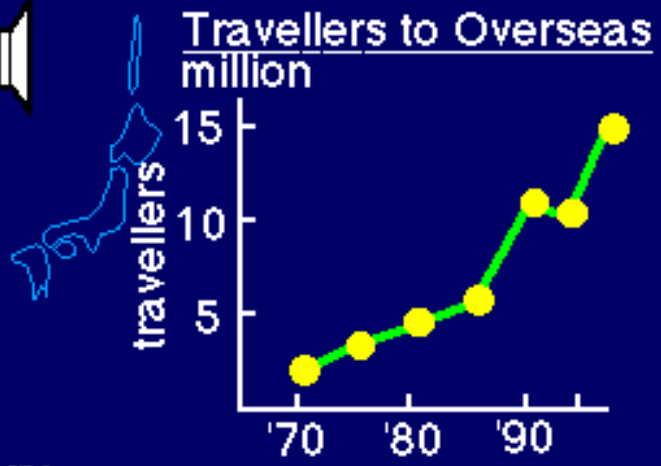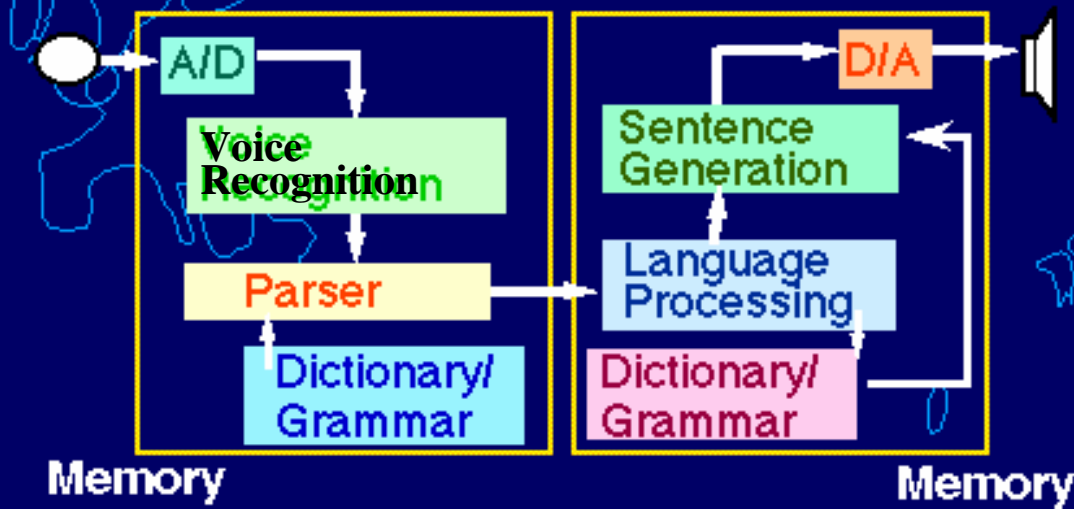　　　　etc=A sosrt of "is it? / isn't it?" at the last part of
the sentence

Challenging Language Barrier

Semiconductor R&D Direction
- An Age of Human Interface-

1. *Giga-era has been coming in the semiconductor industry; Gb memories, GIPS microprocessors, GHz ASICs,*

2. *I have shown that these massive performance increase would best be suited to improve man-machine interface by using multimedia processing,*

3. *Examples of multimedia processing have been shown with a special emphasis placed on voice recognition and translation,*

4. *With the advent of portable language translator, I hope that the 21st century will be known*

as " True Communication Age".

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