Japanese Semiconductor Industry Conference

April 12-13, 1990
Takanawa Prince Hotel
Tokyo, Japan

Dataquest

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1990 JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE

ULSI Era: Challenges and Opportunities

April 12-13, 1990
Takanawa Prince Hotel
Tokyo, Japan

THURSDAY, April 12

8:00 p.m.	**Registration**	
9:00 p.m.	**Welcome** Manny Fernandez President Dataquest Incorporated	*Prince Room*
9:30 p.m.	**Worldwide Semiconductor Industry Trends** Hal Feeney Group Vice President and Director, Components Group Dataquest Incorporated	*Prince Room*
10:00 a.m.	**Japanese Semiconductor Industry Trends** Kazunori Hayashi Associate Director, Japan Components Group Dataquest Japan Limited	*Prince Room*
10:30 a.m.	**Coffee Break**	*Crown Room*
11:00 a.m.	**The Electronics Industry in the '90s and the Role of ULSIs** Dr. Tadahiro Sekimoto President NEC Corporation	*Prince Room*
11:30 a.m.	**Semiconductor Industry in the '90s and the Role of ULSI in Korea** Jin Ku Kang Chairman Samsung Electronics Co., Ltd.	*Prince Room*
12:00 Noon	**Lunch**	*Crown Room and Zuisho-no-ma*
1:15 p.m.	**Semiconductor Industry in the '90s and the Role of ULSI in Europe** Speaker to Be Announced JESSI	*Prince Room*
1:45 p.m.	**The U.S. Semiconductor Industry: A Perspective for the '90s** Dr. Daniel L. Klesken Vice President, Senior Semiconductor Analyst Prudential-Bache Capital Funding	*Prince Room*
2:15 p.m.	**Prospects of the Semiconductor Business in the 1990s: A Spotlight on ASIC Business** Tsuyoshi Kawanishi Executive Vice President Toshiba Corporation	*Prince Room*
2:45 p.m.	**MOS Memory Trends in the '90s** Takeshi Sasaki Board Director and General Manager Semiconductor & Integrated Circuits Division Hitachi, Ltd.	*Prince Room*
3:15 p.m.	**Coffee Break**	*Crown Room*
3:45 p.m.	**The Trend of New Concept Devices** Dr. Hiroyoshi Komiya General Manager LSI Research and Development Laboratory Mitsubishi Electric Corporation	*Prince Room*
4:15 p.m.	**Ramping Up of the LSI Business** Nobutsune Hirai Managing Director Kawasaki Steel Corporation	*Prince Room*

(Over)

4:45 p.m.	**Half-Micron Lithography** .... *Prince Room* Shoichiro Yoshida Senior Managing Director Nikon Corporation
5:15 p.m.	**The Role of Thin-Film Technology in ULSI** .... *Prince Room* Wiliam W.R. Elder President and Chief Executive Officer Genus, Inc.
5:45 p.m.	**Cocktails** .... *Crown Room*

FRIDAY, April 13

9:00 a.m.	**Artificial Intelligence and Hyper Media: The Semiconductor Impact on Hyper Media** .... *Prince Room* Koji Yada President Hyper Media Corporation
9:30 a.m.	**Superconductor and Josephson Computer: The Roles and Impact of the 1990s** .... *Prince Room* Dr. Hiroshi Kashiwagi Director-General, Electrotechnical Laboratory Ministry of International Trade and Industry
10:00 a.m.	**Neural Net Application in the ULSI Era** .... *Prince Room* Masaka Ogi President Fujitsu Laboratories Ltd.
10:30 a.m.	**Coffee Break** .... *Crown Room*
11:00 a.m.	**HDTV—Its Present Status and Future Prospects** .... *Prince Room* Kenji Aoki Managing Director, Planning & Administration Headquarters for Affiliated Corporations Japan Broadcasting Corporation (NHK)
11:30 a.m.	**Evolution of Telecommunications Networks and LSI Technology** .... *Prince Room* Dr. Iwao Toda Executive Vice President and Senior Executive Manager NTT Research and Development Headquarters Nippon Telegraph and Telephone Corporation
12:00 Noon	**Lunch** .... *Crown Room & Zuisho-no-ma*
1:15 p.m.	**The Evolving Role of RISC Technology in ULSI** .... *Prince Room* Robert C. Miller Chairman, President, and Chief Executive Officer MIPS Computer Systems
1:45 p.m.	**Automotive Electronics—Today and Tomorrow** .... *Prince Room* Shoji Jimbo Director, Member of the Board Toyota Motor Corporation
2:15 p.m.	**Multimedia in the 1990s** .... *Prince Room* Richard A. Stauffer Marketing Manager Princeton Operation Intel Corporation
2:45 p.m.	**Closing Remarks** .... *Prince Room* Masahiro Miyagawa President Dataquest Japan Limited
3:00 p.m.	Adjournment

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Japanese Semiconductor Industry Conference

ULSI Era: CHALLENGE AND OPPORTUNITIES

Attendees' List

April 12. 13, 1990

Tokyo Takanawa Prince Hotel

Tokyo, Japan

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Mitsuo Otsuka

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ANELVA Corporation

Hideo Mito

ASCII Corporation

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Kazuhiko Nishi

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Dean Duffy

Analog Devices K.K.

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Yoshito Koriyama

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Hitoshi Mizorogi

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David Lammers

Electronic World News

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Embassy of The United States of America

Sam Kidder

Far Eastern Economic Review

Bob Johnstone

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Toshio Hoshino

Fuji Electronic Components, Ltd.

Peter Maly

Fuji Photo Film Co., Ltd.

Hirozo Ueda

Yuzo Mizobuchi

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Akira Honma

Fujitsu Laboratories Ltd.

Masaaki Ogi

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Matsushita Electronics Corporation

Toshimasa Asaka

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Junko Yairi

Masumi Sakoda

First Day

WORLDWIDE SEMICONDUCTOR TRENDS

Harold V. Feeney
Group Vice President and Director
Components Group
Dataquest Incorporated

Hal Feeney is Group Vice Prsident and Director of Dataquest's Components Group. In this capacity, he has direct responsibility for all U.S. semiconductor and component research and coordinates European and Japan-based research. Previously, he was Vice President and Director of Dataquest's Technical Computer Systems Industry Service. Before joining Dataquest, Mr. Feeney was Manager of International Customer Marketing at Intel Corporation, where he was responsible for international marketing/sales support of microcomputer components and development systems. During his 14 years with Intel, Mr. Feeney held various positions in marketing management, product marketing management, and LSI design engineering. He designed the Intel 8008, the first 8-bit microprocessor. Prior to joining Intel, Mr. Feeney was a Component Design Engineer with General Instrument Corporation. Mr. Feeney received a B.S.E.E. degree from the University of Notre Dame and an M.S.E.E. degree from Stanford University. He completed additional graduate studies in Electrical Engineering at the University of Notre Dame.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

B8887001.IMG 03/05/00 JSI

ULSI Era:
Challenges and
Opportunities

Worldwide Semiconductor Industry Trends

Hal Feeney
Vice President and Director
Components Group
Dataquest Incorporated

9042001.IMG 03/20/90:FEE

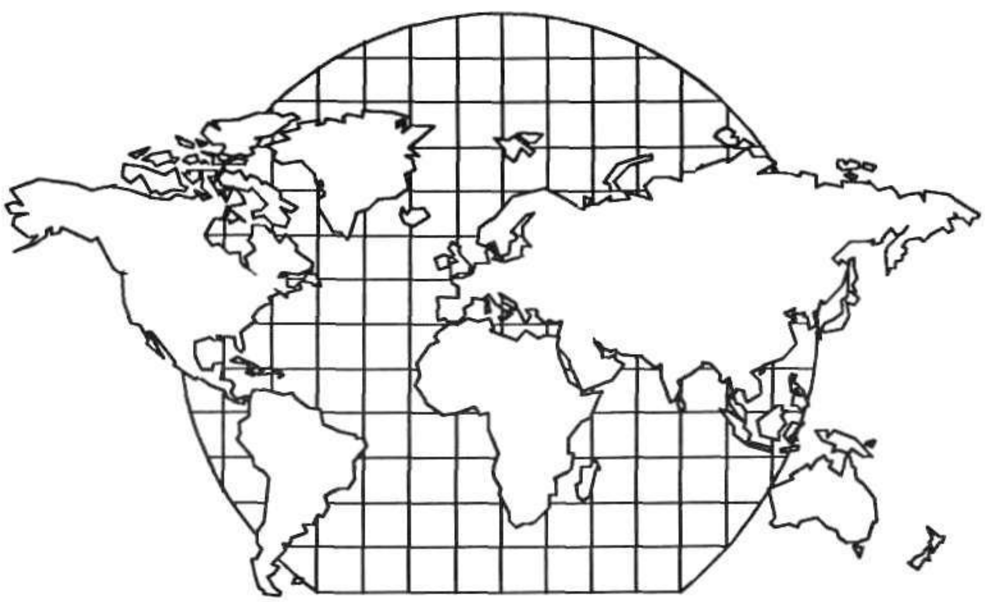
SUMMARY

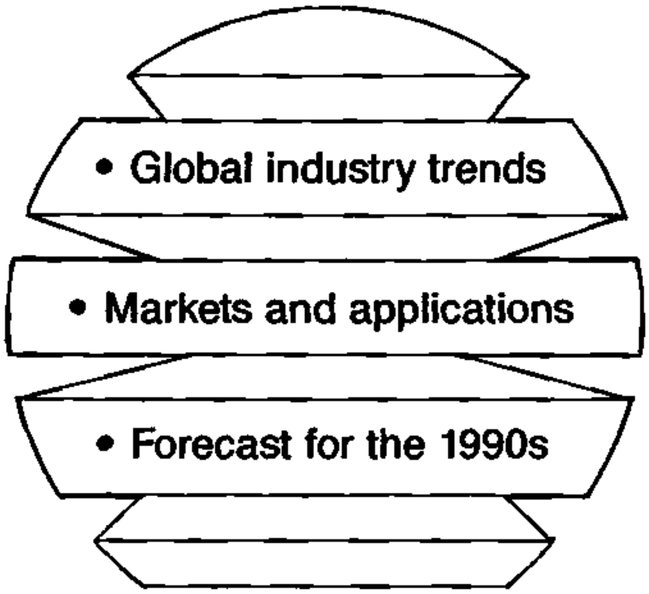
REVISITED

- Expect a slower industry in 1989
  - Strong first half
  - Then three negative growth quarters
- Capital spending slowing

Source: Dataquest
JSIS Conference
April 1989

B9042002.IMG 03/20/90:FEE



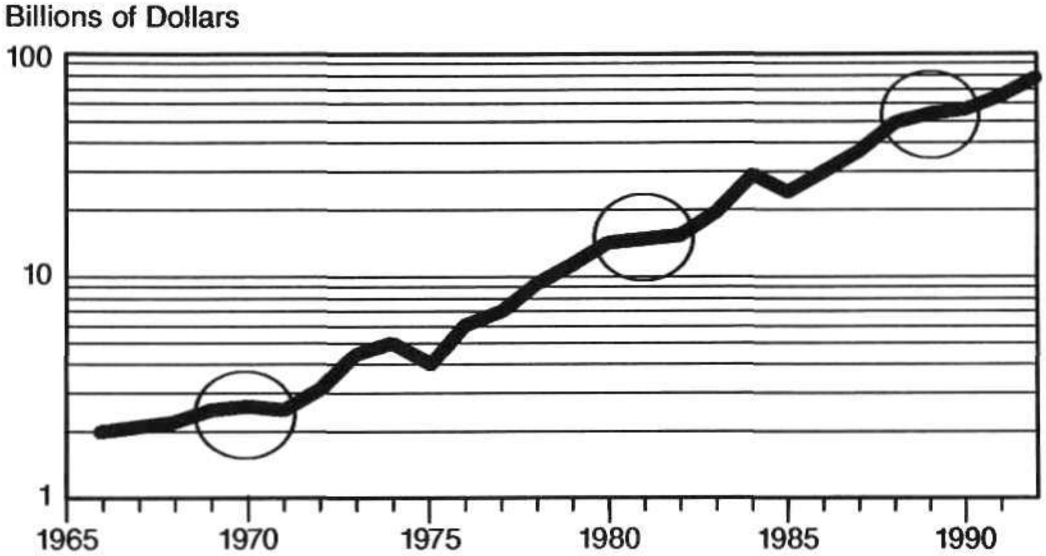


GLOBAL TRENDS FOR THE 1990s

- Regional manufacturing
- Electronic equipment standards become pervasive
- NICs become a greater force
- Wafer fabrication equipment -- worldwide sourcing

9042005.IMG 03/20/90:FEE

ESTIMATED WORLDWIDE SEMICONDUCTOR INDUSTRY REVENUE



Source: Dataquest

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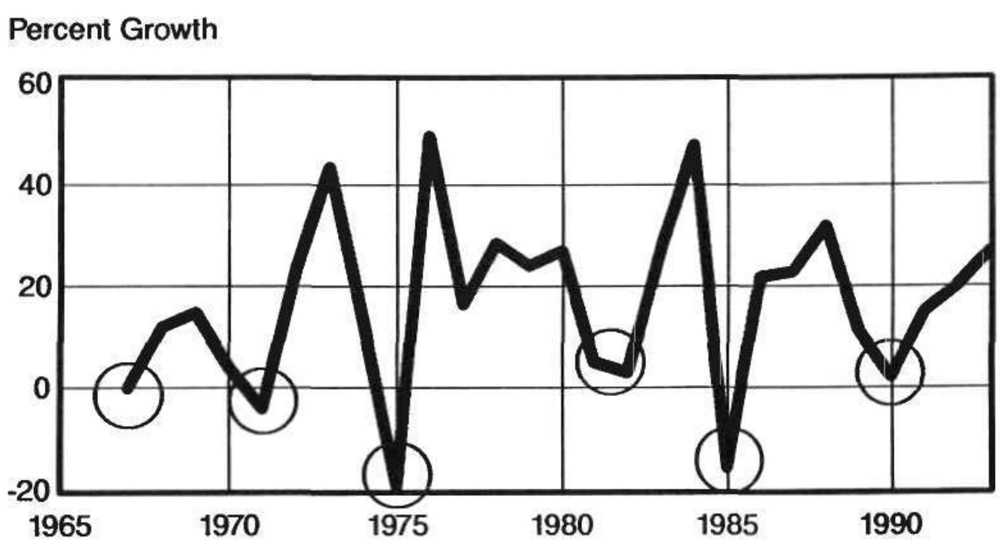
ESTIMATED WORLDWIDE SEMICONDUCTOR INDUSTRY REVENUE



Source: Dataquest

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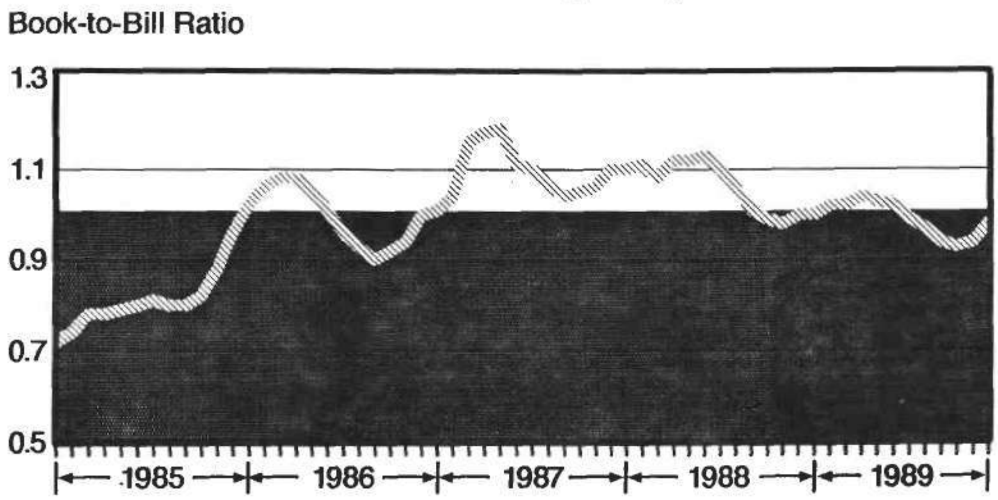
WORLDWIDE SEMICONDUCTOR BOOK-TO-BILL RATIO

Three-Month Moving Average



Source: WSTS

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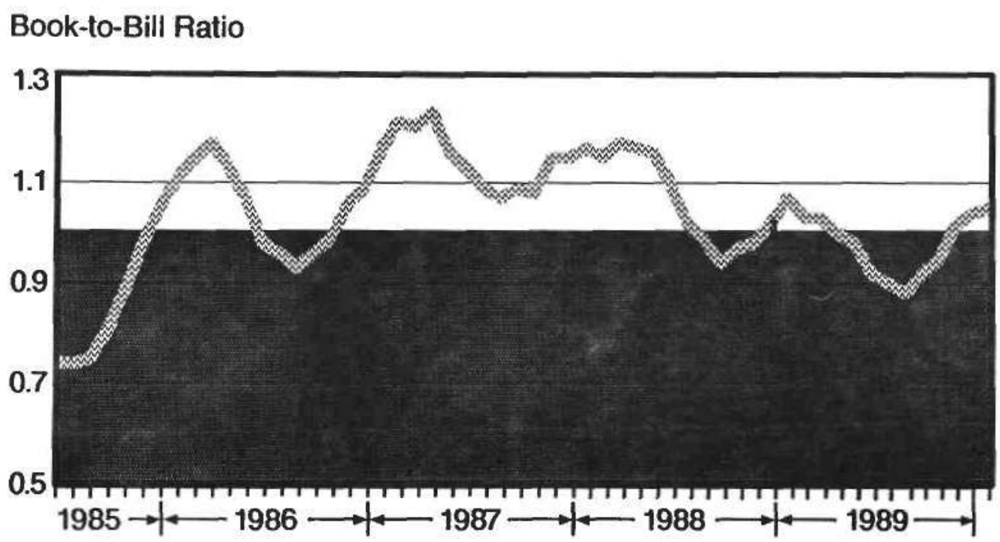
U.S. SEMICONDUCTOR BOOK-TO-BILL RATIO

Three-Month Moving Average



Source: WSTS

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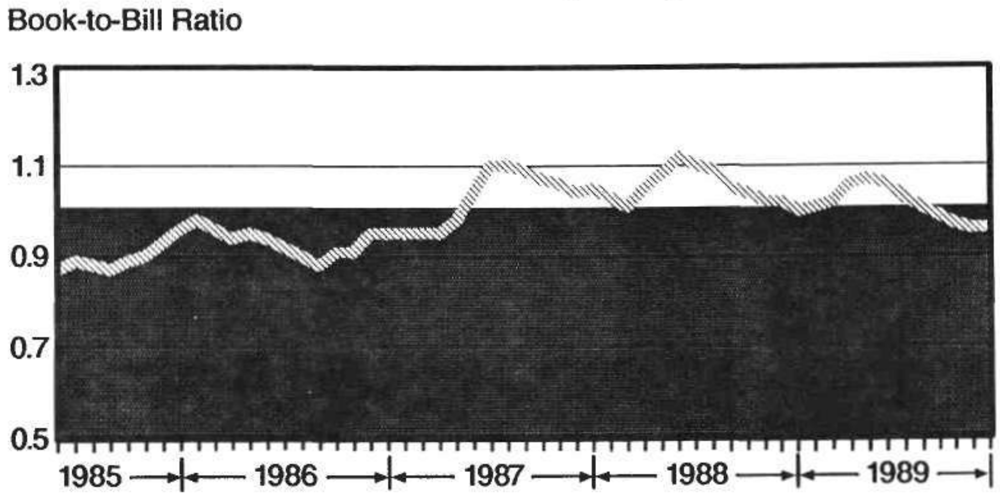
JAPANESE SEMICONDUCTOR BOOK-TO-BILL RATIO

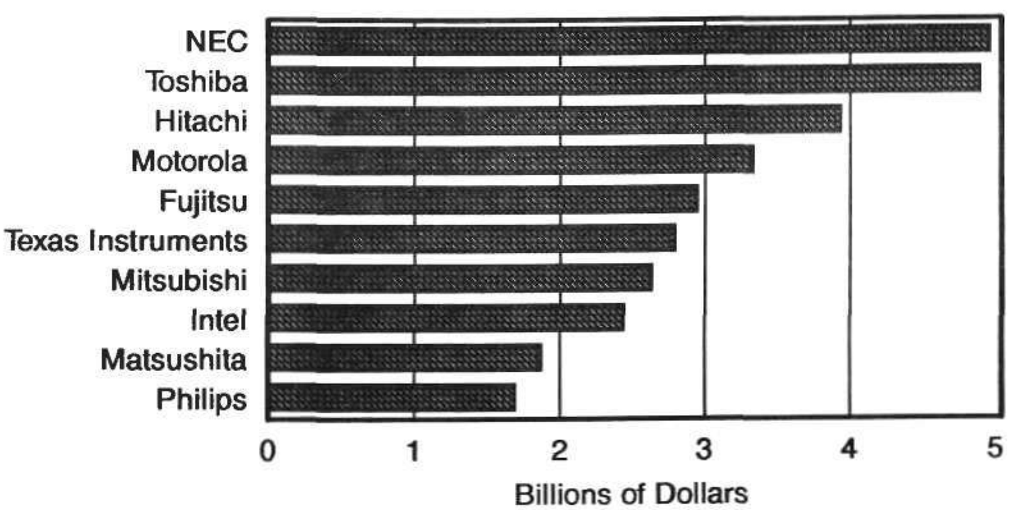
Three-Month Moving Average



Source: WSTS

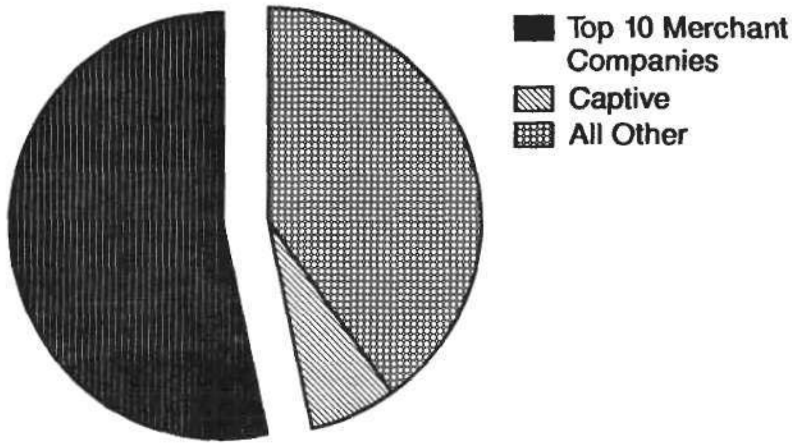
B9042006.IMG 03/20/90:FEE

TOP 10 MERCHANT SEMICONDUCTOR COMPANIES' WORLDWIDE REVENUE IN 1989



Source: Dataquest

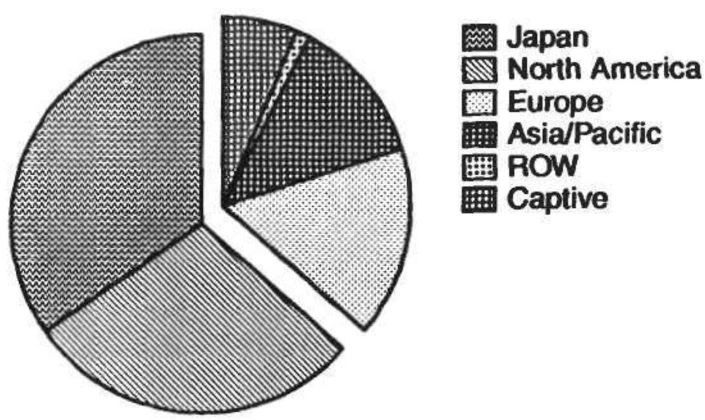
WORLDWIDE SEMICONDUCTOR PRODUCTION IN 1989



Total = $59.1 Billion
($55.8 Billion without Captive)

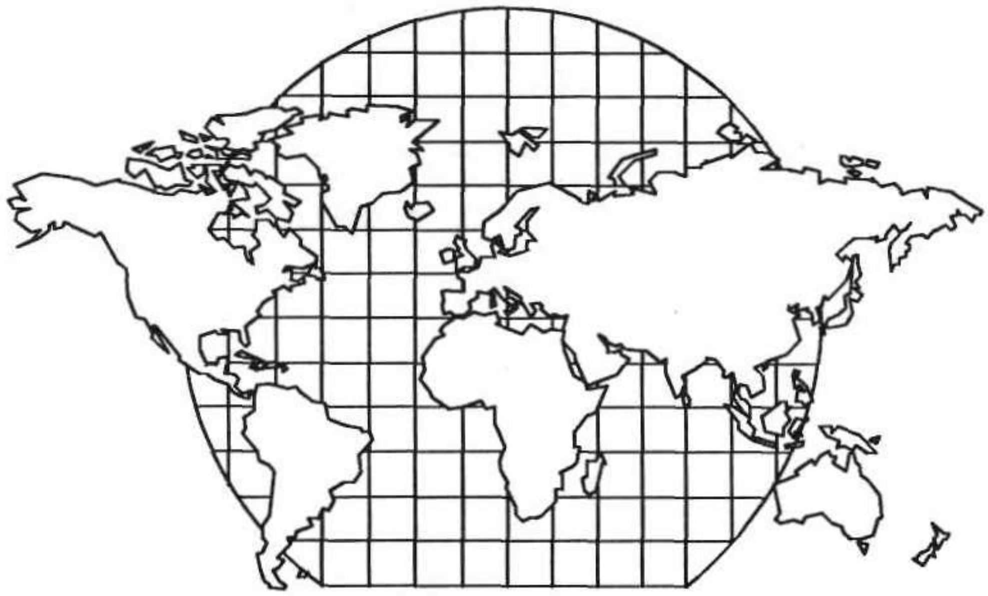
Source: Dataquest

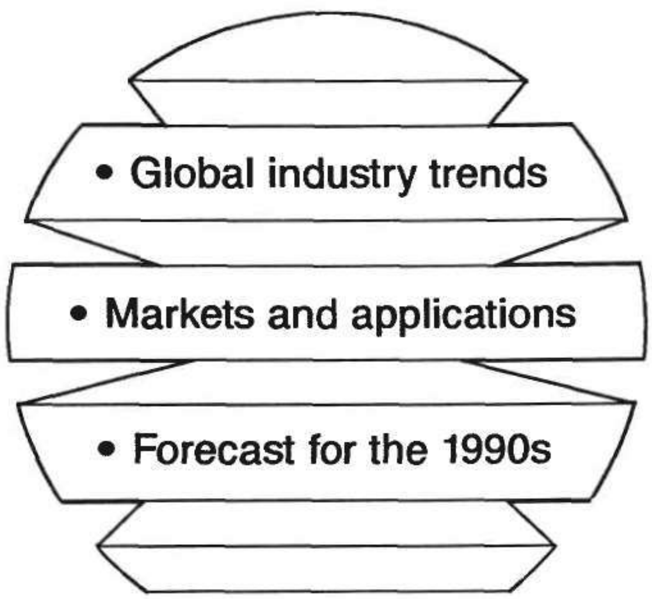
ESTIMATED 1994 WORLDWIDE SEMICONDUCTOR INDUSTRY CONSUMPTION BY GEOGRAPHY



Total = $121.1 Billion
($113.3 Billion without Captive)

Source: Dataquest





• Global industry trends
• Markets and applications
• Forecast for the 1990s

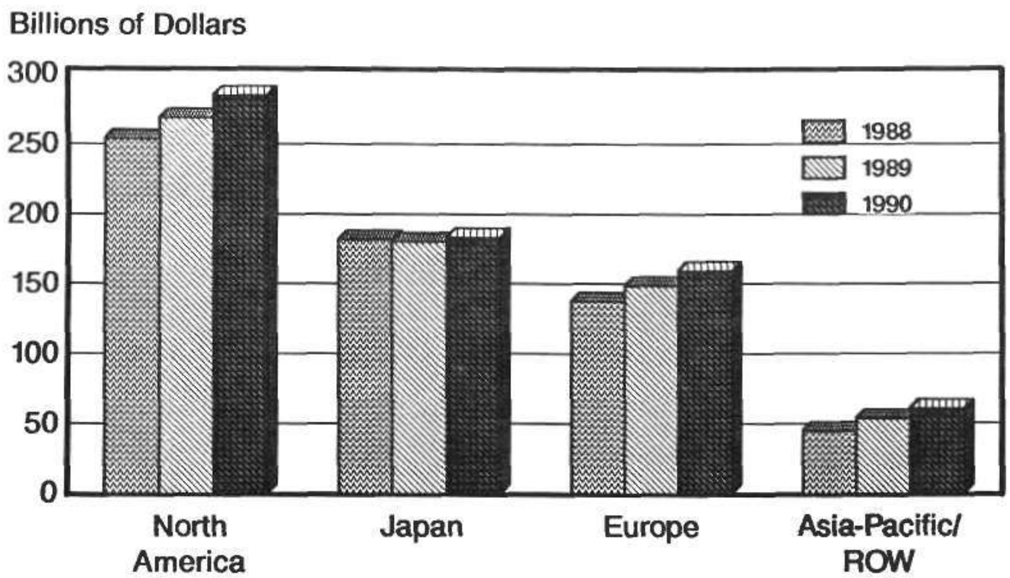
9042012.IMG 03/20/90:FEE

TRENDS IN SEMICONDUCTOR MARKETS

- Stronger order rates in all geographies
- Firming prices -- DRAMs
- Production adjustments
- Falling prices and consolidation in ASICs
- Selective personnel adjustments
- Concentration of vendor strength

89042014.IMG 03/20/90:FEE

WORLDWIDE ELECTRONICS PRODUCTION

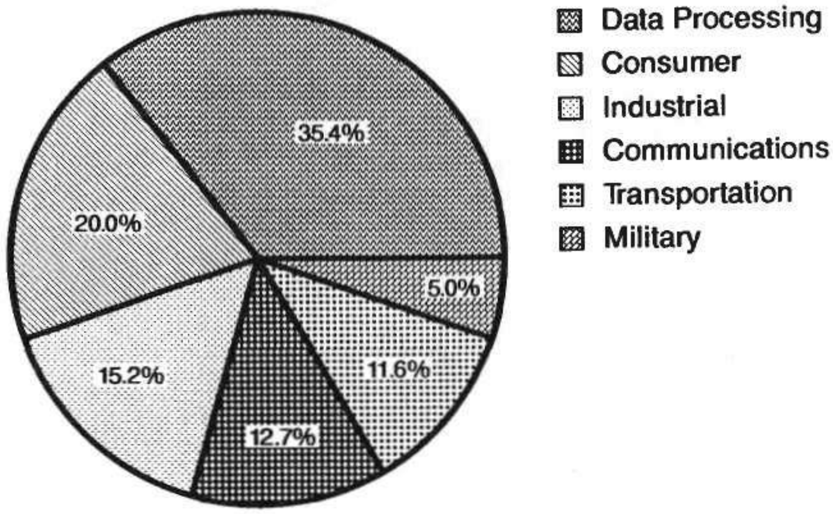


Source: Dataquest

B9042015.IMG 03/20/90:FEE

WORLDWIDE ELECTRONICS MARKETS

1989 Shipments



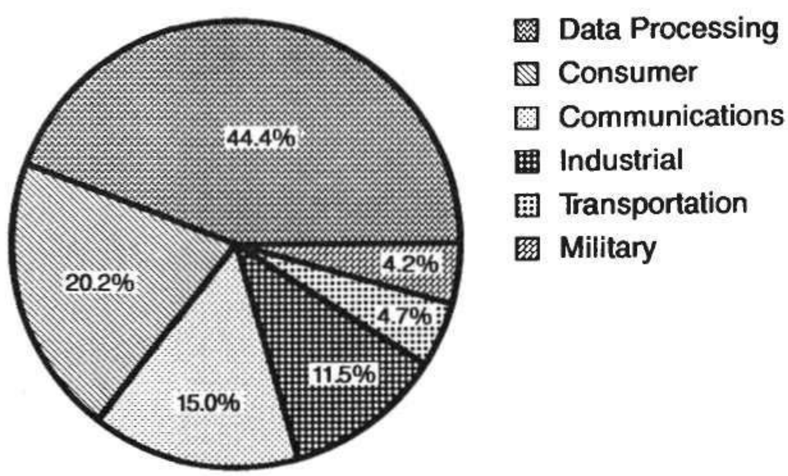
Total = $653 Billion

Source: Dataquest

B9042016.IMG 03/20/90:FEE

WORLDWIDE SEMICONDUCTOR SHIPMENTS BY APPLICATION MARKET

1989

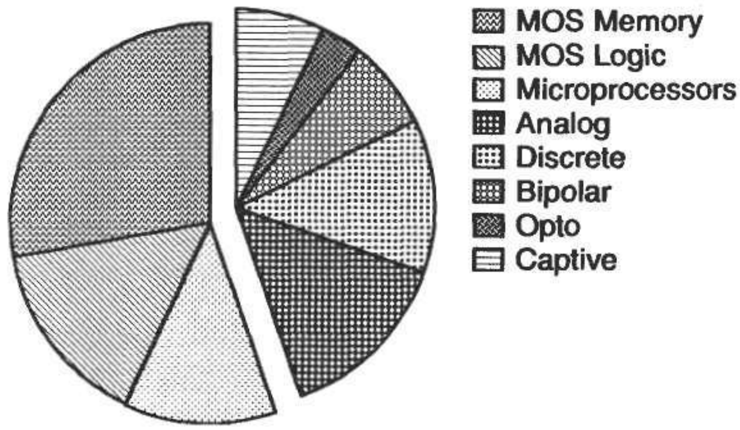


Total = $55.8 Billion

Source: Dataquest

B0042013.IMG 03/20/90:FEE

ESTIMATED 1989 WORLDWIDE SEMICONDUCTOR INDUSTRY CONSUMPTION BY PRODUCT

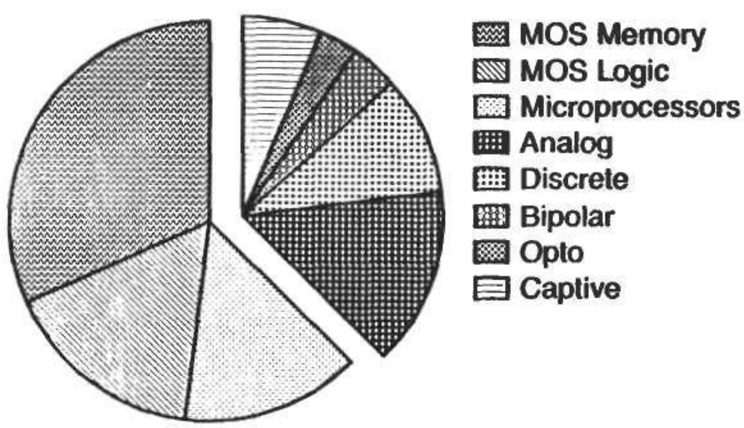


Total = $60.3 Billion
($55.8 Billion without Captive)

Source: Dataquest

[illegible].IMG 01/05/90:FEE

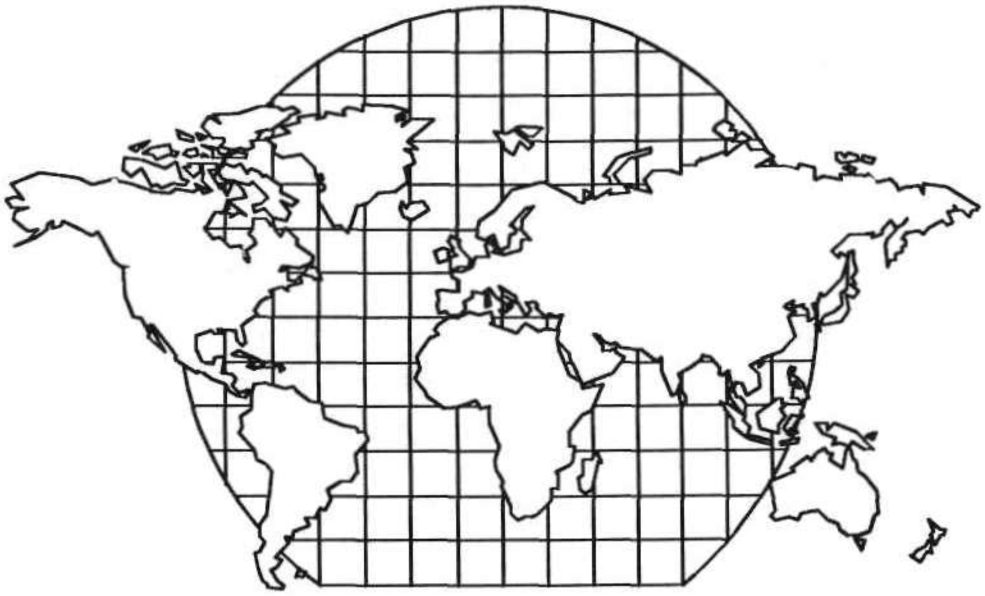
ESTIMATED 1994 WORLDWIDE SEMICONDUCTOR INDUSTRY CONSUMPTION BY PRODUCT



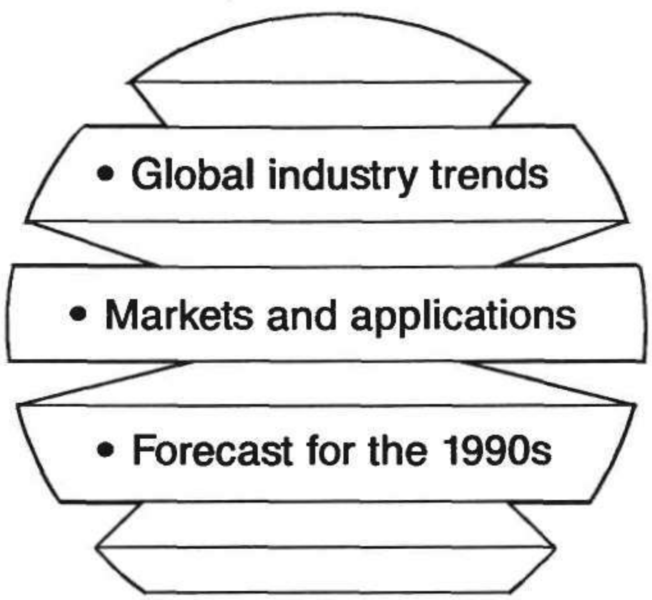
Total = $121.1 Billion
($113.3 Billion without Captive)

Source: Dataquest

B90042017.IMG 03/20/90:FEE



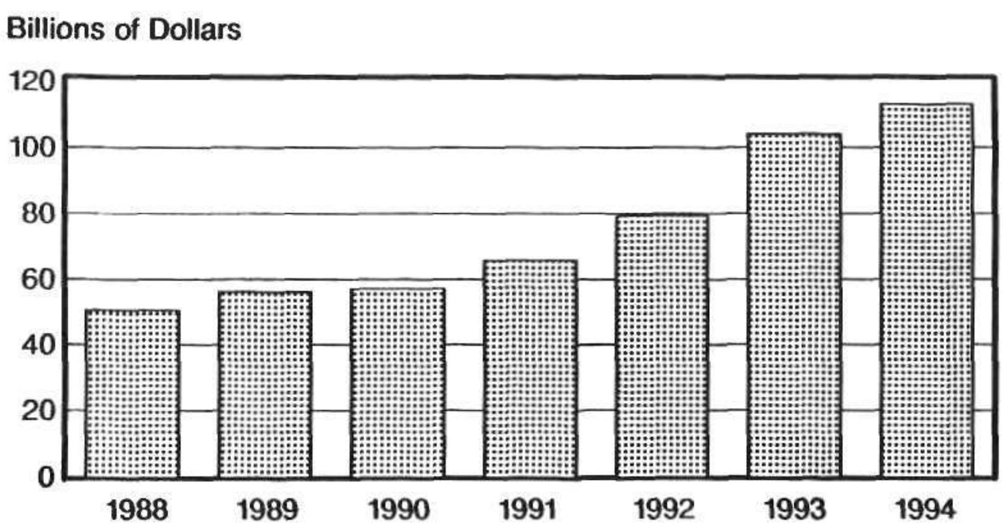
B90042018.IMG 03/20/90:FEE



FORECAST TRENDS IN THE 1990s

- A slow start as inventories are balanced and DRAM prices stabilize
- Promise of Europe 1992 becomes reality
- Peak year of forecast growth in 1993 is paced by 4Mb DRAM shipments
- Globalization continues as Japanese electronic equipment manufacturers move production to North America and Europe
- Asia/Pacific provides the fastest growth opportunity

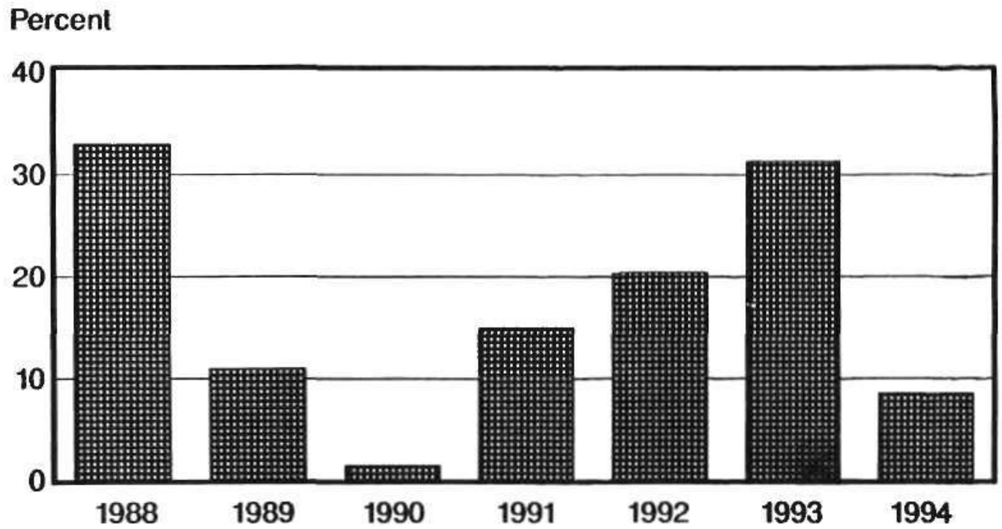
WORLDWIDE SEMICONDUCTOR INDUSTRY REVENUE FORECAST*



*Excludes captive

Source: Dataquest

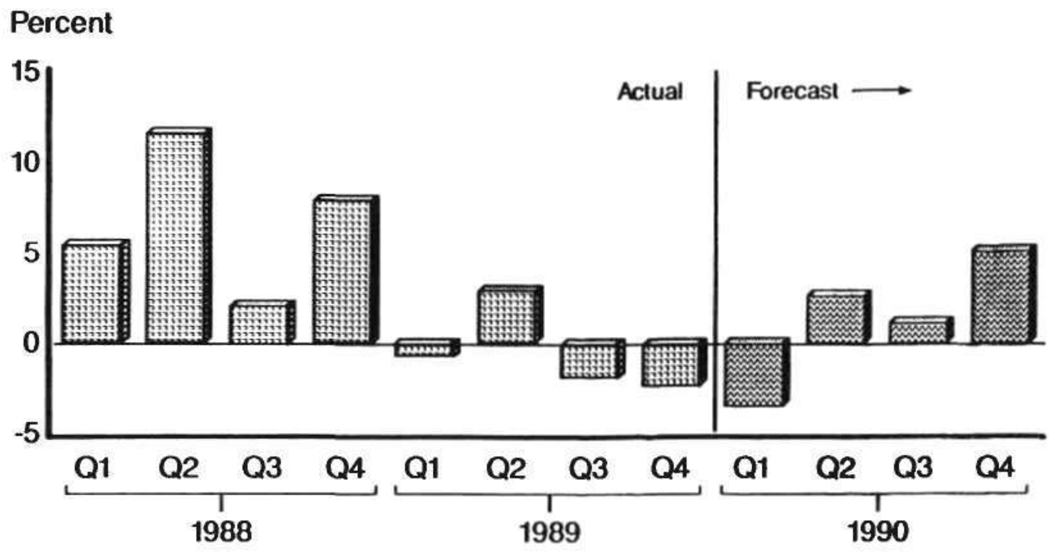
WORLDWIDE SEMICONDUCTOR INDUSTRY REVENUE GROWTH FORECAST



Source: Dataquest

WORLD SEMICONDUCTOR INDUSTRY FORECAST

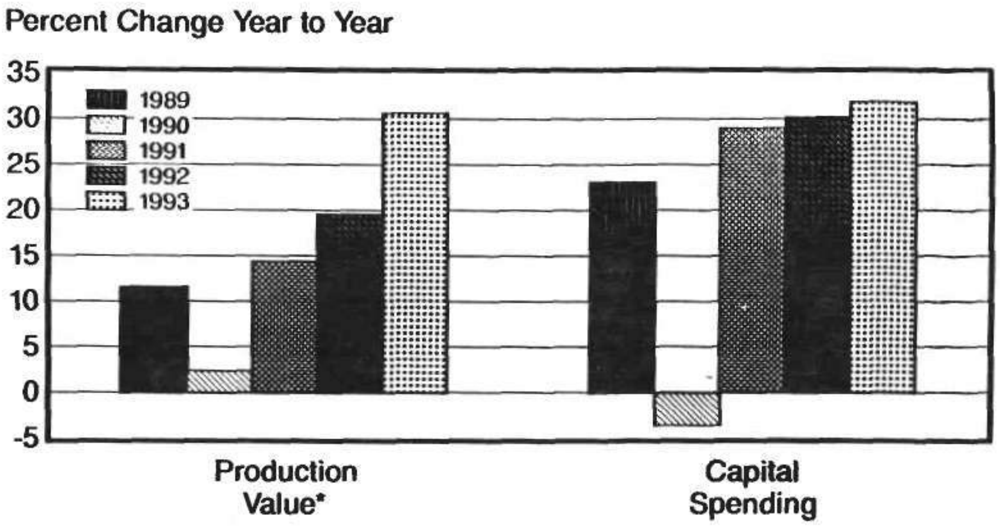
Quarter-to-Quarter Percentage Revenue Growth



Source: Dataquest

B8206020.IMG 01/05/90:FEE

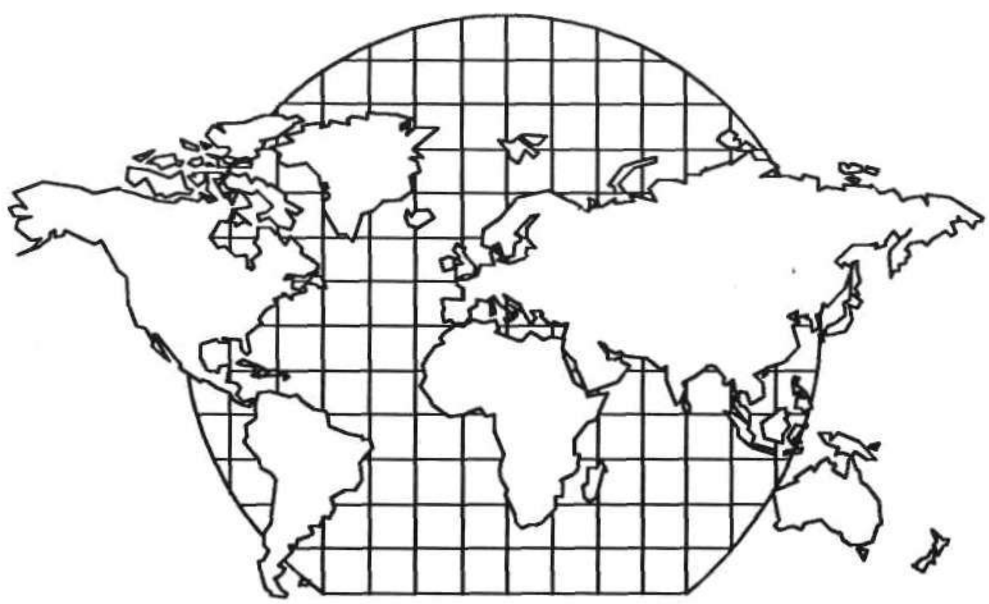
ESTIMATED SEMICONDUCTOR INDUSTRY PRODUCTION AND CAPITAL SPENDING



*Includes captive production

Source: Dataquest

B0042020.IMG 03/20/90:FEE

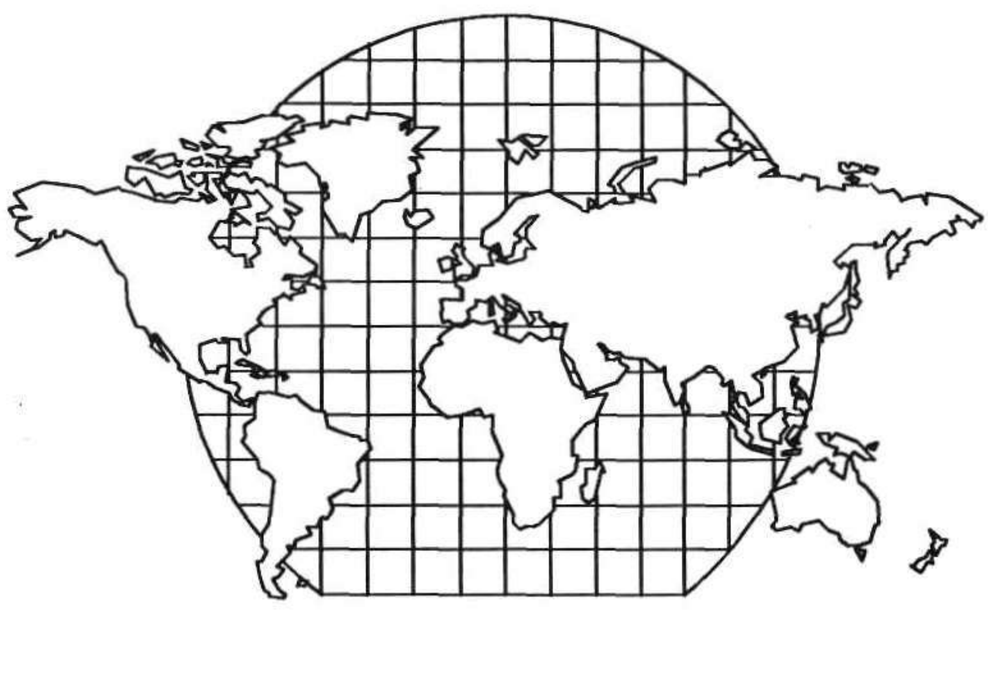


9042021.IMG 02/04/90:FEE

SUMMARY

- Today, life is flat
- Capital requirements outpace industry growth
- Expect DRAM price stability and perhaps a mild shortage
- Production capacity is under better control than in 1984-1985
- DRAM market still paces the industry, but the battle is no longer for market share
- Industry consolidation began in the 1980s; it will intensify in the 1990s

B9042022.IMG 03/20/90:FEE

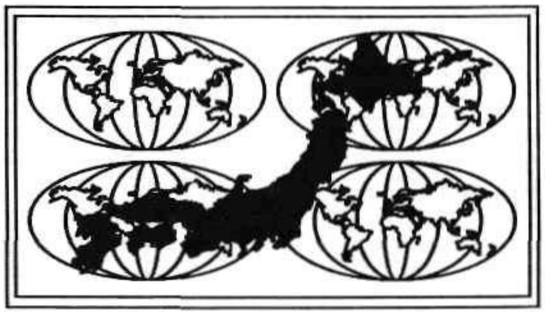


JAPANESE SEMICONDUCTOR INDUSTRY TRENDS

Kazunori Hayashi
Associate Director
Japanese Semiconductor Industry Service
Japanese Components Group
Dataquest Incorporated

Kazunori Hayashi is Associate Director of Dataquest's Japanese Semiconductor Industry Service (JSIS) and Japanese Components Group (JCG) and is based in Tokyo. Among his responsibilities are researching and compiling the Japanese fabrication plant data and the Japanese semiconductor company capital spending forecast and updating the Japanese equipment and materials data base. Prior to joining Dataquest, Mr. Hayashi was founder of Innov Japan and Techno Systems Research Corporation. He has had 12 years experience in the industry. During this time, he has also authored publications and performed research and consulting on the Japanese semiconductor equipment industry. Mr. Hayashi is a graduate of Meiji University with a degree in Commercial Sciences.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan



ULSI Era:
Challenges and
Opportunities

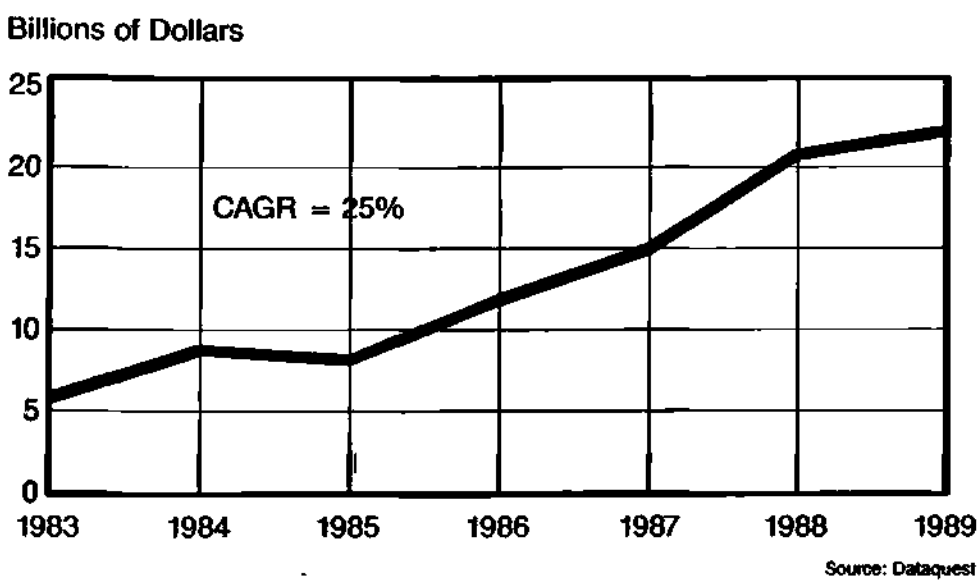
Japanese Semiconductor Industry Trends

Kazunori Hayashi
Associate Director
Japan Components Group
Dataquest Japan Limited

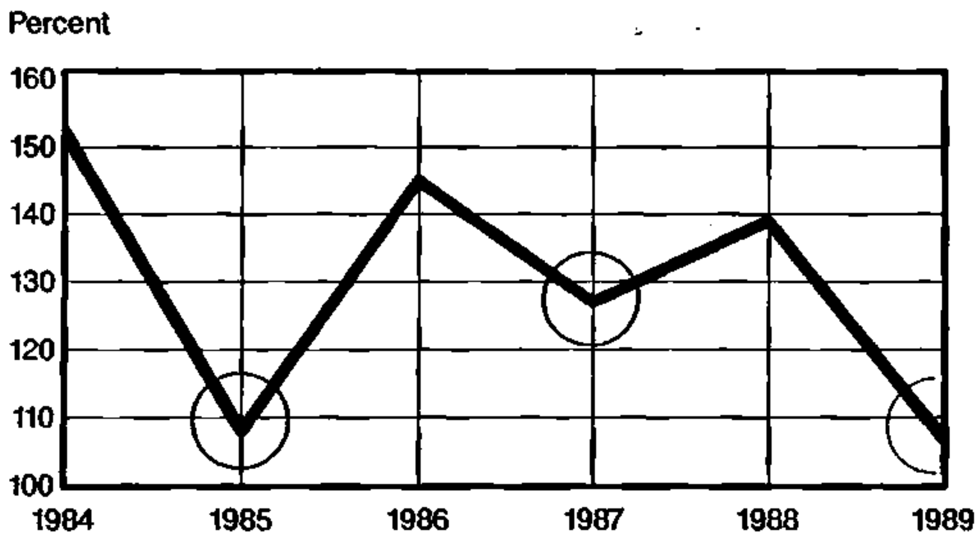
AGENDA

- Japanese semiconductor history
- Semiconductor consumption and forecast
- Semiconductor production and capital spending
- Future wafer fab plants
- Summary

JAPANESE SEMICONDUCTOR CONSUMPTION -- 1983-1989



JAPANESE SEMICONDUCTOR GROWTH RATE -- 1984-1989



Source: Dataquest

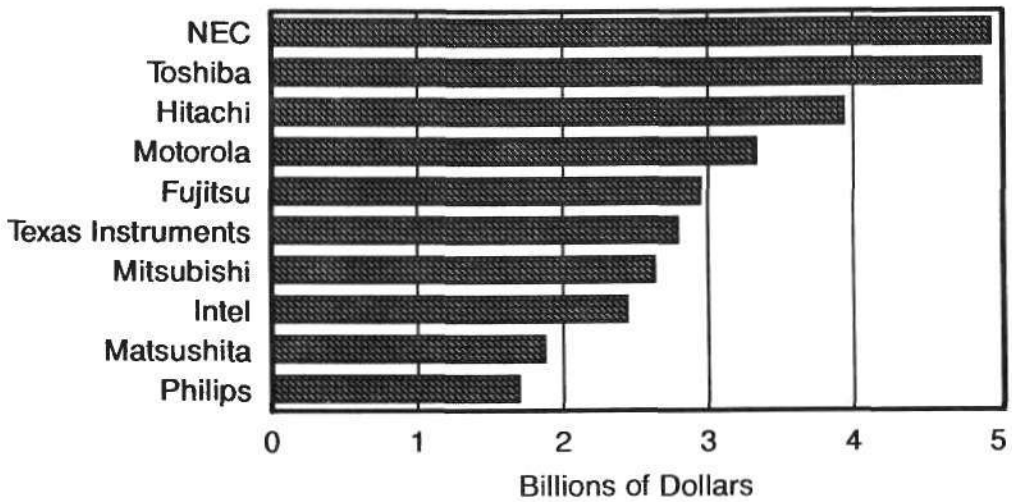
WHAT WE LEARN FROM HISTORY

Previous Worldwide Recessions	Millions of Dollars	Annual Growth/Decline
1967	1,926	(1.3%)
1971	2,487	(3.5%)
1975	4,496	(13.7%)
1981	14,828	5.0%
1982	15,261	2.9%
1985	24,823	(14.7%)

Source: Dataquest

B8971005.IMG 03/13/90:HAY

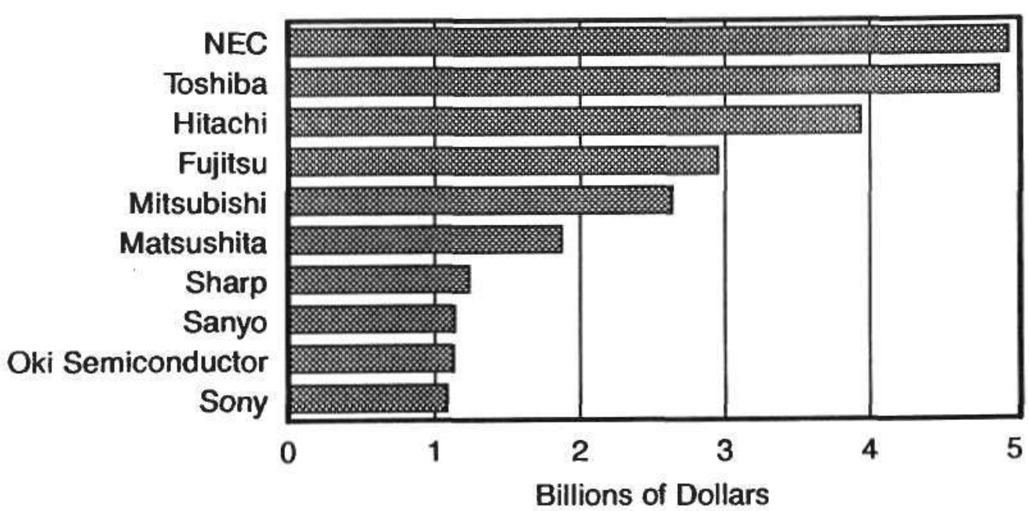
TOP 10 MERCHANT SEMICONDUCTOR COMPANIES' WORLDWIDE REVENUE IN 1989



Source: Dataquest

B8971006.IMG 03/13/90:HAY

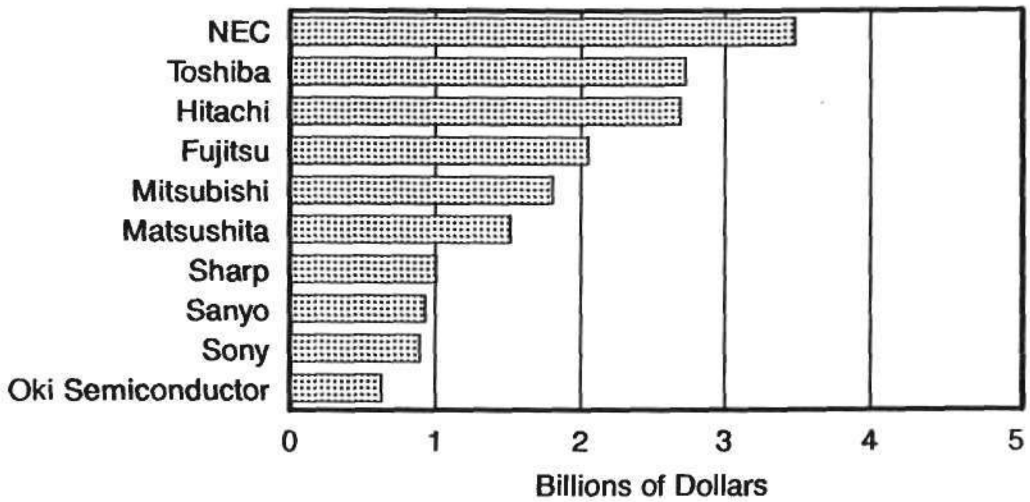
TOP 10 JAPANESE SEMICONDUCTOR COMPANIES' WORLDWIDE REVENUE IN 1989



Source: Dataquest

B8971007.IMG 03/13/90:HAY

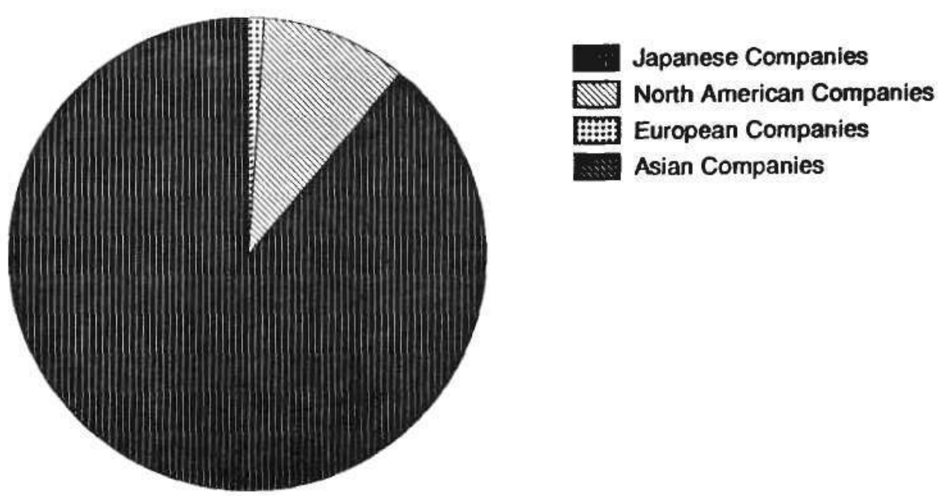
TOP 10 MERCHANT SEMICONDUCTOR COMPANIES' JAPANESE REVENUE IN 1989



Source: Dataquest

B8971008.IMG 03/13/90:HAY

SEMICONDUCTOR SHIPMENTS INTO THE JAPANESE MARKET IN 1989

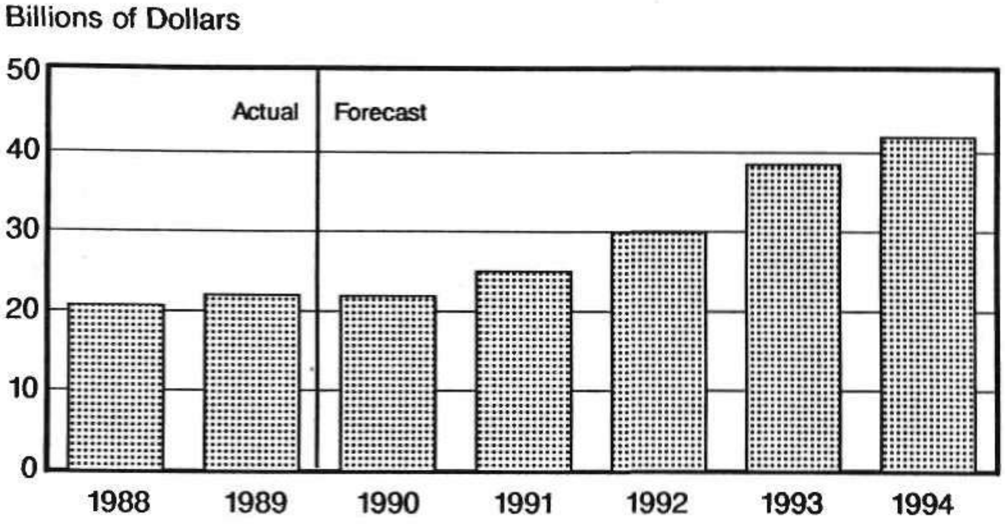


Total = $22.2 Billion

Source: Dataquest

B8071009.IMG 03/13/90.HAY

JAPANESE SEMICONDUCTOR INDUSTRY REVENUE FORECAST*

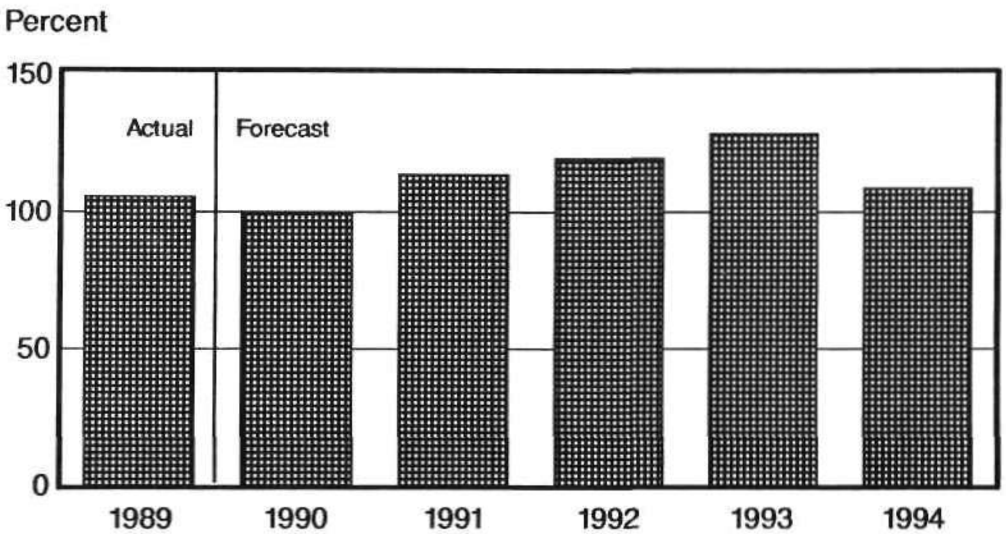


*Excludes captive

Source: Dataquest

B8071010.IMG 03/13/90.HAY

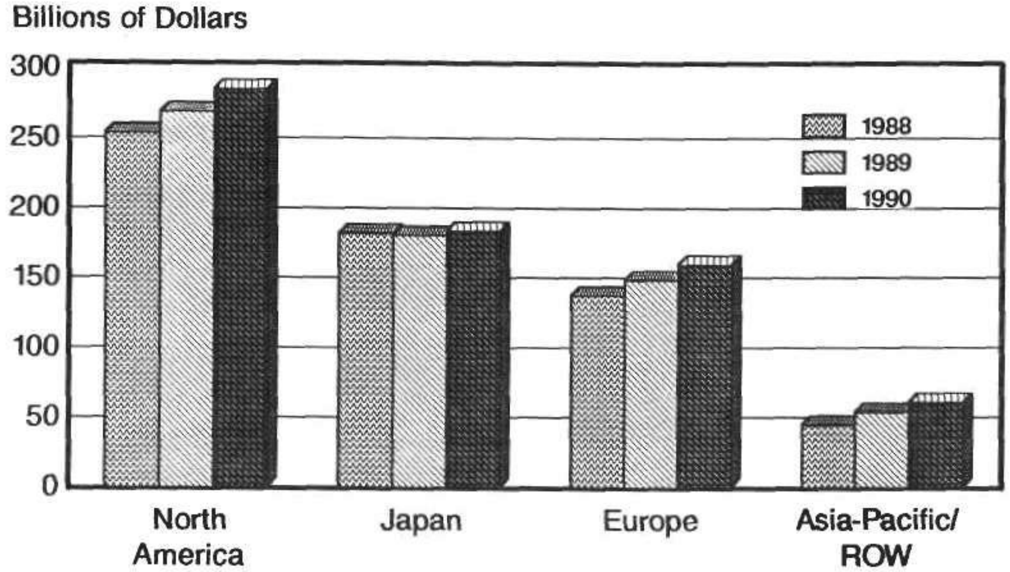
JAPANESE SEMICONDUCTOR INDUSTRY REVENUE GROWTH FORECAST



Source: Dataquest

88071012.IMG 03/19/90:HAY

WORLDWIDE ELECTRONICS PRODUCTION



Source: Dataquest

8071011.IMG 02/03/90:HAY

ESTIMATED JAPANESE SEMICONDUCTOR INDUSTRY CONSUMPTION BY PRODUCT

(Millions of Dollars)

	Actual	Forecast					
	1989	1990	1991	1992	1993	1994	CAGR
Bipolar	1,529	1,451	1,488	1,554	1,644	1,558	0%
MOS Memory	6,233	6,125	6,773	8,270	11,817	12,834	16%
Microprocessors	2,588	2,681	3,193	3,927	5,263	5,789	17%
MOS Logic	3,677	3,785	4,550	5,688	7,309	7,638	16%
Analog	3,626	3,632	4,251	5,096	6,190	7,118	14%
Discrete	3,192	3,047	3,404	3,853	4,462	4,962	9%
Opto	1,237	1,277	1,455	1,673	1,957	2,212	12%
Total	22,082	21,998	25,114	30,061	38,642	42,111	14%

Source: Dataquest

JAPANESE ELECTRONIC EQUIPMENT FORECAST

(Billions of Yen)

	Actual	Forecast					
	1989	1990	1991	1992	1993	1994	CAGR
Data Processing	6,608	7,080	7,588	8,299	9,069	9,455	7%
Communications	2,752	2,934	3,116	3,321	3,570	3,832	7%
Industrial	2,998	3,205	3,373	3,783	4,018	4,111	7%
Consumer	6,742	6,627	6,733	7,157	7,211	7,269	2%
Transportation	2,123	2,178	2,323	2,578	2,727	2,851	6%
Total	21,223	22,024	23,133	25,138	26,595	27,518	5%

Source: Dataquest

ESTIMATED SEMICONDUCTOR INDUSTRY PRODUCTION AND CAPITAL SPENDING

(Millions of Dollars)

	Actual	Forecast					
	1989	1990	1991	1992	1993	1994	CAGR
Production	30,074	29,556	32,294	37,596	48,706	52,154	12%
Capital Spending	5,368	5,089	6,635	8,802	11,090	11,234	16%

Source: Dataquest

ESTIMATED SEMICONDUCTOR CAPITAL SPENDING BY REGION

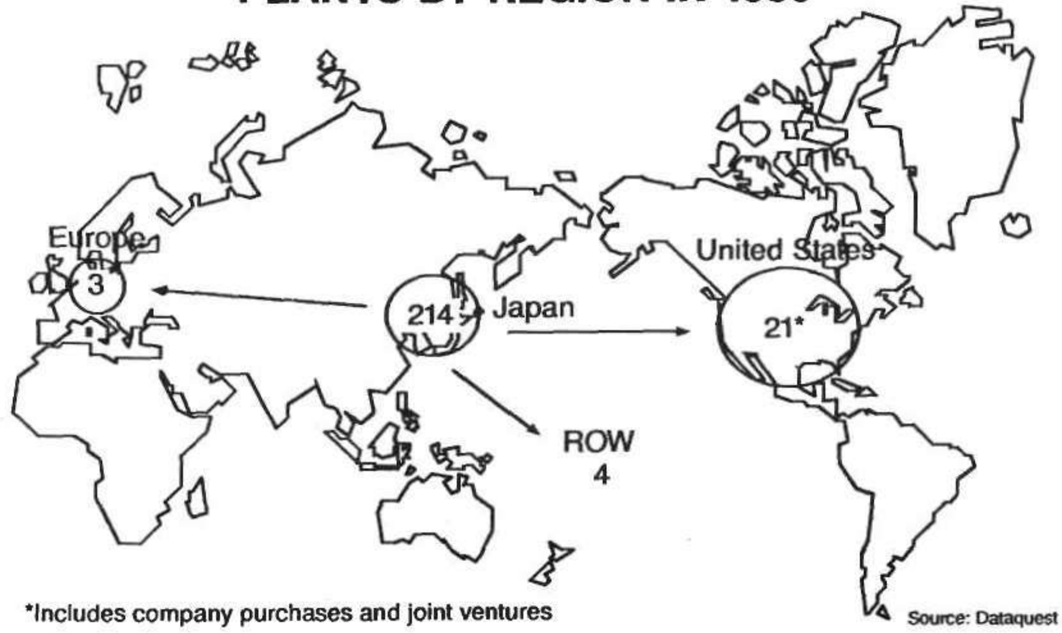
ESTIMATED SEMICONDUCTOR CAPITAL SPENDING BY REGION

(Millions of Dollars)

	Actual	Forecast					
	1989	1990	1991	1992	1993	1994	CAGR
North America	3,822	3,759	4,465	5,835	7,409	7,805	15%
Japan	5,368	5,089	6,635	8,802	11,090	11,234	16%
Europe	1,201	1,273	1,686	2,330	2,943	3,262	22%
ROW	1,854	1,877	2,333	2,985	3,433	3,983	17%
Total	12,245	11,998	15,119	19,952	24,875	26,284	17%

Source: Dataquest

JAPANESE WAFER FAB PLANTS BY REGION IN 1989



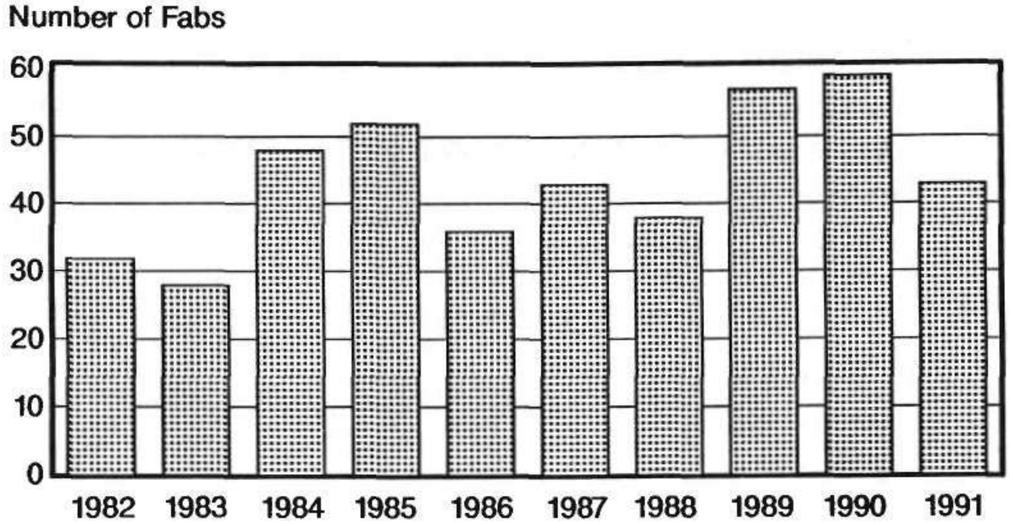
*Includes company purchases and joint ventures

Source: Dataquest

B8971016.IMG 03/14/90 HAY

NEW FAB LINES WORLDWIDE

R&D and GaAs Not Included



Source: Dataquest

8971017.IMG 03/14/90 HAY

ESTIMATED JAPANESE SEMICONDUCTOR EQUIPMENT REVENUE

(Millions of Dollars)

	1985	1986	1987	1988	1989	CAGR
Lithography	379.1	240.3	325.7	562.1	665.0	15%
Automatic Photoresist Processing Equipment	54.3	51.5	61.8	119.7	140.0	27%
Etch and Clean	184.3	172.0	211.3	391.0	450.0	25%
Deposition	259.8	228.1	245.7	407.0	475.0	16%
Diffusion and RTP	95.7	78.7	91.4	127.4	215.0	22%
Implantation	140.6	40.3	81.8	212.5	225.0	12%
Total Fab Equipment	1,113.8	810.9	1,017.7	1,819.7	2,170.0	13%

Source: Dataquest

SUMMARY

- ULSI era
  - Advanced products
  - Progress in high technology using 8-inch wafers
  - Various applications
- Competition and cooperation
  - Alliances
  - Investments

THE ELECTRONICS INDUSTRY IN THE '90s AND THE ROLE OF ULSIs

Dr. Tadahiro Sekimoto
President
NEC Corporation

Dr. Tadahiro Sekimoto is President of NEC Corporation. Dr. Sekimoto has been associated with NEC since 1948 except for a two-year period that he was on loan to COMSAT. Among his various managerial positions with NEC, Dr. Sekimoto has served as Executive Vice President; Senior Vice President; Board Director; General Manager, Transmission Division; Manager, Communication Research Laboratory, Central Research Laboratories; and Chief, Basic Research Department, Communication Research Laboratory. Dr. Sekimoto graduated from the Physics Department, Faculty of Science, Tokyo University. He also received his Doctor of Engineering from Tokyo University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

ULSI Era:
Challenges and
Opportunities

The Electronics Industry in the '90s and the Role of ULSIs

Dr. Tadahiro Sekimoto

President

NEC Corporation

AT OUR GUEST SPEAKERS REQUEST,

PRESENTATION MATERIAL

WAS NOT PROVIDED

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a company of The Dun & Bradstreet Corporation

SEMICONDUCTOR INDUSTRY IN THE '90s AND THE ROLE OF ULSI IN KOREA

Jin Ku Kang
Chief Executive Officer and Chairman
Samsung Electronics Company, Ltd.

Jin Ku Kang is Chief Executive Officer and Chairman of both Samsung Electronics Company, Ltd. and Samsung Electro-mechanics Company, Ltd. He has direct responsibility for consumer electronics, semiconductor, information systems, and computer business within SEC. Mr. Kang joined Samsung in 1965. He became President of Samsung Electronics Company, Ltd. in 1973. Mr. Kang has served as Chairman of the Korean Electronics Industry Association. Since 1979, he has held a variety of executive-level positions in Korea and at present serves as Vice Chairman the of Korea Chamber of Commerce and Industry, having once been its Chief Director. He has also been a Committee Member of Policy Advisors to the Ministry of Science and Technology, and Chairman of the Korea-Belgium Economy Cooperation Committee. Mr. Kang received a B.S. degree in Electrical Engineering from Seoul National University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
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ULSI Era:
Challenges and
Opportunities

Semiconductor Industry in the '90s and the Role of ULSI in Korea

Jin Ku Kang
Chairman
Samsung Electronics Co., Ltd.

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PRESENTATION MATERIAL

WAS NOT PROVIDED

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**SEMICONDUCTOR INDUSTRY IN THE '90S IN EUROPE--
EXAMPLE OF THE IMPACT OF ULSI ON THE NONVOLATILE MEMORIES EVOLUTION**

Igor Dorochevsky
Corporate Vice President
President, Japan
SGS-THOMSON Microelectronics K.K.

Mr. Igor Dorochevsky is a Corporate Vice President and President of SGS-THOMSON Microelectronics Japan. His main task is to develop the presence of SGS-THOMSON in Japan. Mr. Dorochevsky has worked for SGS-THOMSON for more than 28 years. Before coming to Japan, he was Vice President Marketing in Asia Pacific based in Hong Kong. Mr. Dorochevsky has spent most of his career in West Germany. Before being assigned to Hong Kong he was Managing Director of the components operation of the THOMSON Group in Central Europe, including West Germany, Austria and Switzerland. Mr. Dorochevsky has graduated as an Electronic Engineer at the French Ecole Superieure d'Electricite in Paris.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR AND ELECTRONICS TECHNOLOGY CONFERENCE
April 12-13, 1990
Tokyo, Japan

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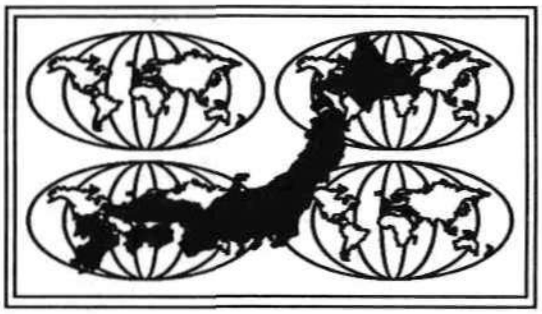


ULSI Era: Challenges and Opportunities

Semiconductor Industry in the '90s in Europe -- Example of the Impact of ULSI on the Nonvolatile Memories Evolution

Igor Dorochevsky
Corporate Vice President
President, Japan
SGS-Thomson Microelectronics K.K.

Semiconductor Industry in the '90s in Europe
Example of the impact of ULSI
on the NV Memories Evolution

ID490 - Dataquest conference 4/90

SC Industry evolution in Europe

* Europe has still a large proportion of older technologies

Example: Capacity by Line Geometry

	EUROPE	USA
above 3.0 um	54%	20%
1.0 to 3.0 um	46%	80%
	100%	100%

* However, the future looks much brighter...

ID490 - Source : Dataquest Dec.89

Wafer start capacity by line geometry

	EUROPE	USA	JAPAN
over 1 um	81%	91%	78%
below 1 um	19%	9%	22%
	100%	100%	100%

ID490 - Source: Dataquest Dec.89

Evolution of ULSI in Europe in the '90s

* Europe is state of the art in submicron technology
* Around 20 advanced fabs will be built in Europe in the next 3 years
* The environment is very favorable
  - Cooperation programs (JESSI)
  - Government policies (EUREKA)
  - Europe 92 - largest consumer market
* European companies show an aggressive process technology roadmap

ID490

PROCESS - PRODUCT STRATEGY OF NEW MICRON-SUBMICRON PROCESSES

Min.features µm	Processes	Products
- 1.0 0.8 0.5	N.V. Memories	EPROMs 1Mb-4Mb-16Mb FLASH EEPROM
1.5 1.2 0.8 0.5	Logic Multiapplication	MCU-CC-PLD-ASICs
- 1.2 0.7 0.5	Static RAMs	256K - 1Mb - 4Mb High Complex - High Perf.
- 1.2/1.0 0.8 0.5	Logic High Performance	Transputer - SOG - ASICs Cell Library - SRAM
- 1.2 0.8 0.5	Logic BICMOS	ASICs - Telecom - Video

Source : SGS-THOMSON -ID490

EPROM Technology in Europe

EPROM are one of the key technology drivers in Europe...

ID490

EPROM TECHNOLOGY TREND

		1MB ----- CMOS-E4	4MB ----- CMOS-E5	16MB ----- CMOS-E6	64MB ----- CMOS-E7
mini.feature	(um)	1.0	0.8	0.5	0.3
act. area	w/s(um)	1.0/2.0	0.8/1.6	0.6/1.5	0.4/1.0
gate pitch	w/s(um)	1.2/1.6	0.8/1.4	0.5/0.8	0.3/0.5
mtl. pitch	w/s(um)	2.8/1.6	2.0/1.0	1.2/0.8	0.8/0.5
contact size	(um)	1.4x1.6	1.0x1.0	0.6x0.6	0.3x0.3
gate oxide	(A)	280	200	160	130
cell area	(um2)	19	9	4	1.6
die size	(mm2)	46	90	130	200
access time	(nsec)	100	100	<100	<100
masks n.		15	16	18	20
waf.diameter	(inch)	6	8	6 - 8	8

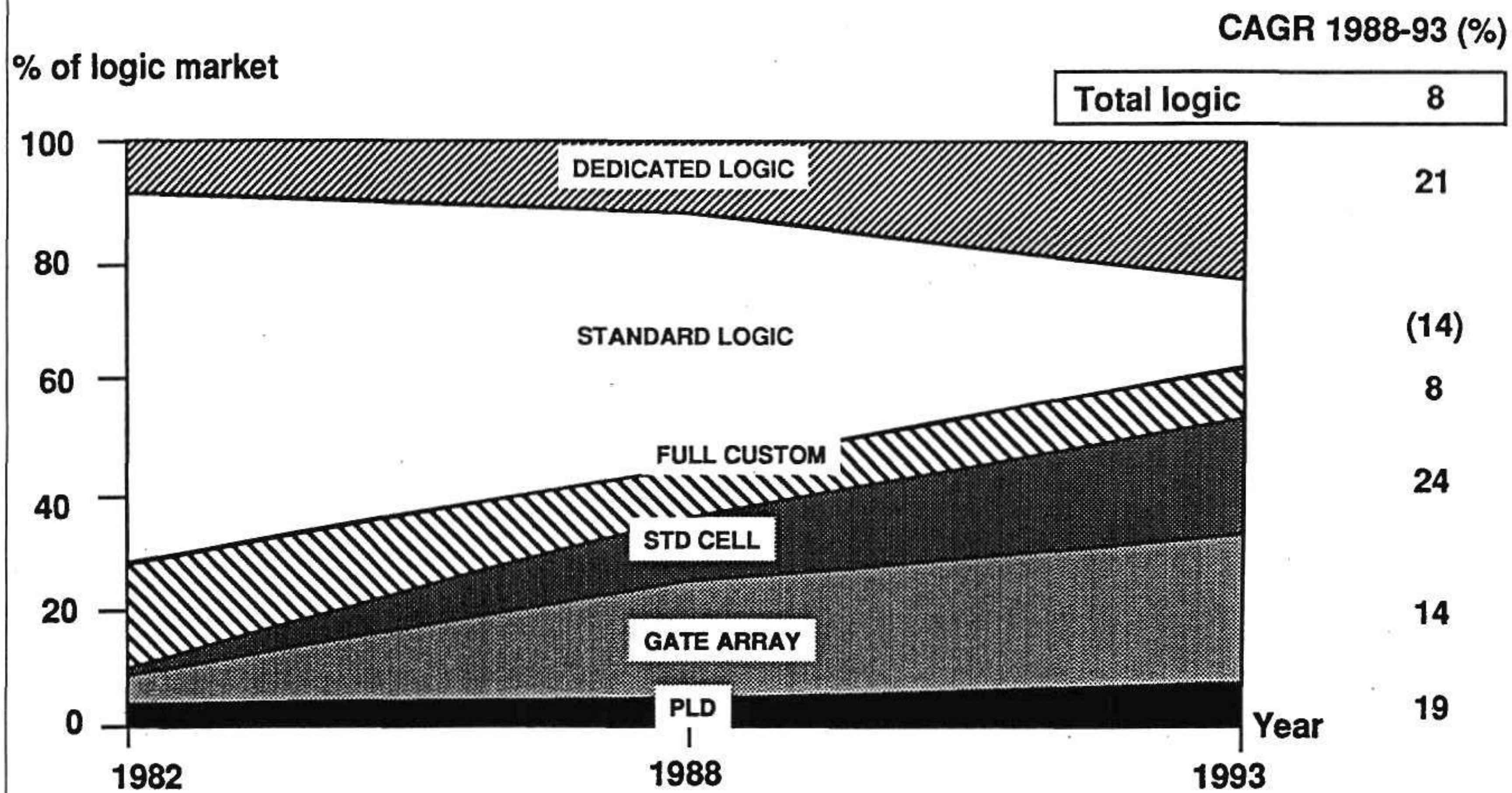
Source : SGS-THOMSON -ID490

NV Memories in advanced system architectures

The market is going towards more customisation

ID490

ULSI - Trend to customisation



ID490- Source: BCG 1989

NV Memories in advanced system architectures

NV MEMORY + RAM + LOGIC

in a multiapplication process open the way to

powerfull system architectures

Example...

ID490

Example : Multiapplication process

* 0.8 um CMOS double metal - 13 to 22 masks
* Allows combination of logics with NV Memories & features implanted capacitors for analog applications
* Tunel oxide for EEPROM/FLASH EEPROM
* Memory size : up to

EPROM	1 MB
ROM	1 MB
EEPROM	64 KB
FLASH	1 MB
SRAM	64 to 128 KB

ID490 - Source : SGS-THOMSON

Example : Multiapplication process

* Combination possibilities:

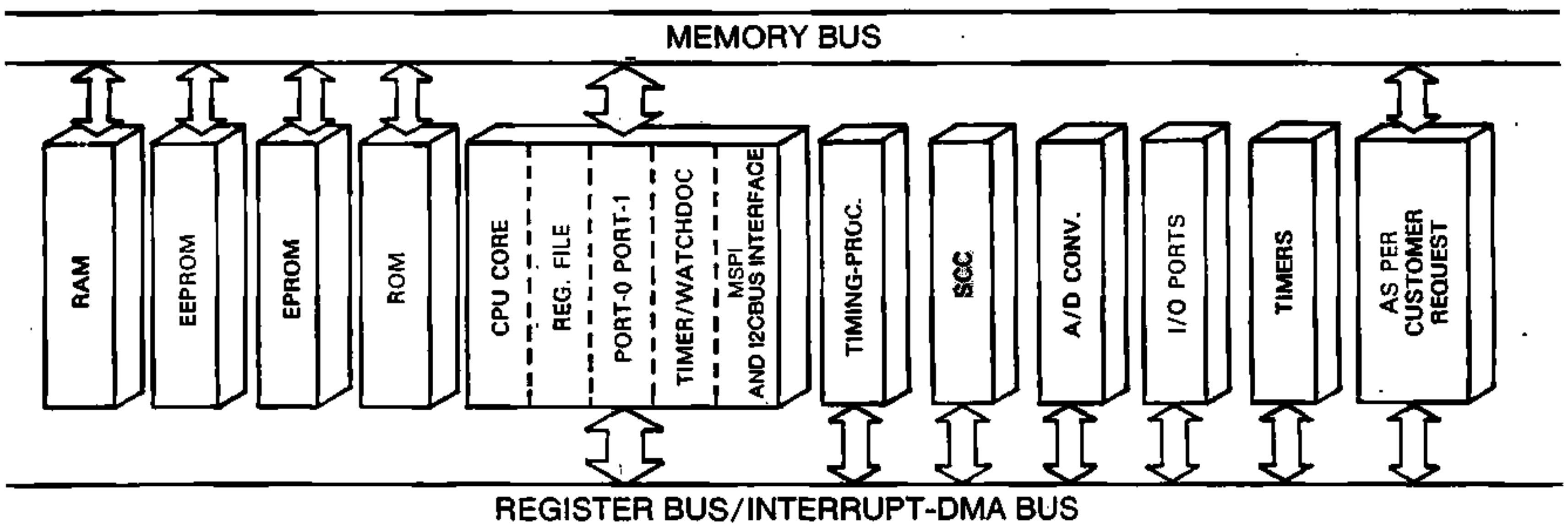
LOGIC	LOGIC
RAM	RAM
ROM	FLASH EEPROM
EPROM	ANALOG
EEPROM	
ANALOG	

* Key products:

  - Sea of gates and standard cells
  - Microcontrollers and smart card chips
  - Programmable logic

ID490 - Source : SGS-THOMSON

Example: Multiapplication process
Microcontroller with modular architecture ST9



ID490 - Source : SGS-THOMSON

SC Industry in Europe in the '90s

* A battle is never definitively won...
* A battle is never definitively lost....
* ULSI will be the chance of Europe to win again the battle.

ID490

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THE U.S. SEMICONDUCTOR INDUSTRY:
A PERSPECTIVE ON THE NINETIES

Dr. Daniel L. Klesken
Vice President
Senior Semiconductor Analyst
Prudential-Bache Capital Funding

Dr. Daniel Klesken is a Vice President and Senior Semiconductor Analyst for Prudential-Bache Capital Funding, the investment banking, institutional, and capital markets arm of Prudential-Bache Securities Inc. Prior to joining Prudential-Bache, Dr. Klesken was a General Partner and Senior Semiconductor Analyst at Montgomery Securities. Previously, he was a Vice President and General Manager of Dataquest's Semiconductor Group. He was with Dataquest for seven years and was one of three individuals largely responsible for launching Dataquest's Semiconductor Industry Service. Earlier, Dr. Klesken was associated with Texas Instruments for nine years where he was a Member of Technical Staff working on NASA and DOD-related programs. He also supported their corporate staff with market research and long range planning. Dr. Klesken also worked at IBM and Bell Telephone Laboratories. Dr. Klesken received both his B.S. and M.S. degrees in Electrical Engineering from Lehigh University, and his Ph.D. in Electrical Engineering from Carnegie-Mellon University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

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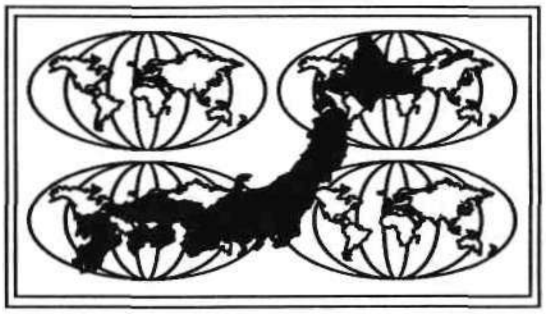


ULSI Era:
Challenges and
Opportunities

The U.S. Semiconductor Industry: A Perspective for the '90s

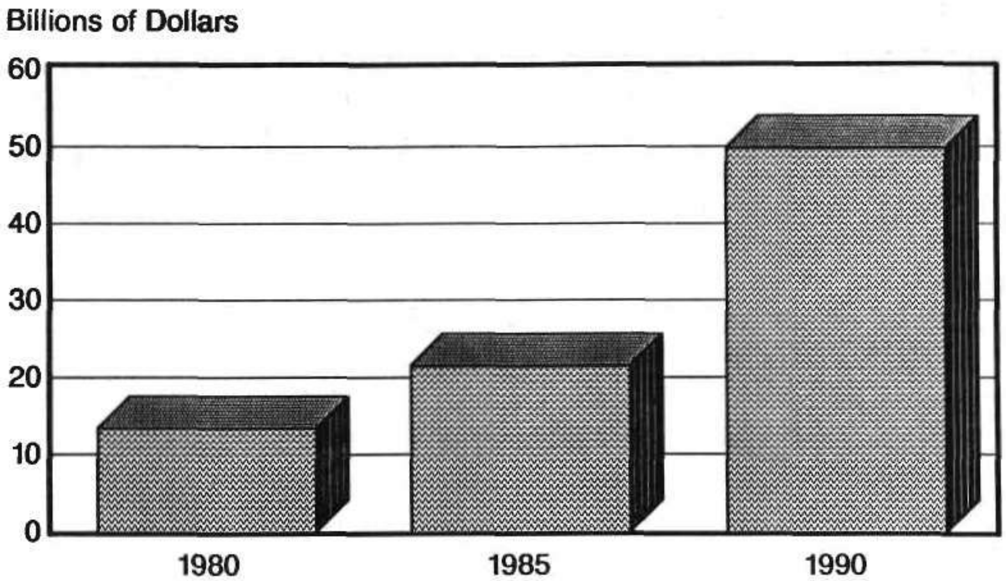
Dr. Daniel L. Klesken
Vice President
Senior Semiconductor Analyst
Prudential-Bache Capital Funding

OVERVIEW

- Review of the eighties
- Current status
- Issues for the nineties
- Perspective

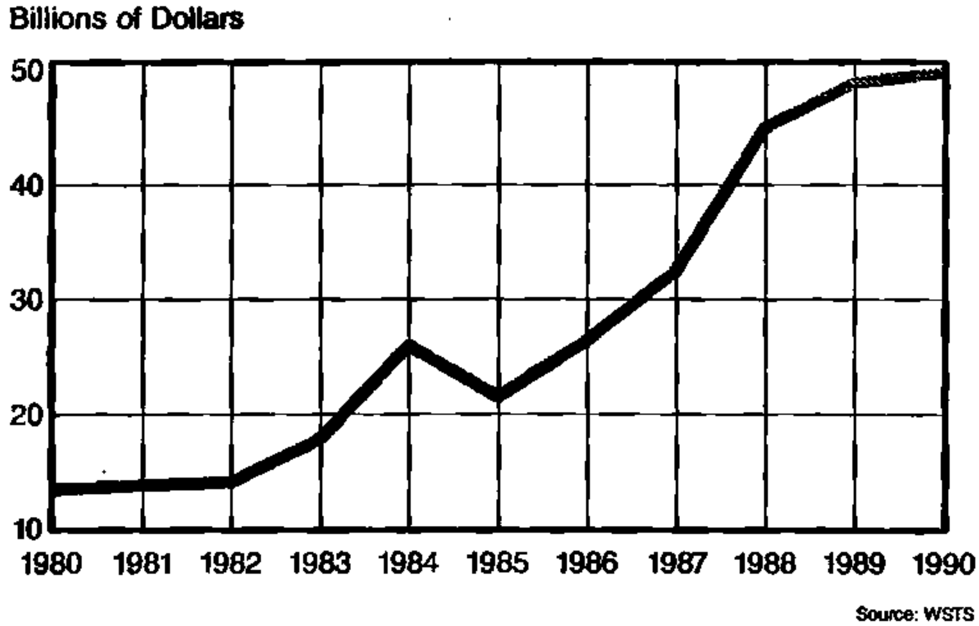
THE EIGHTIES

WORLDWIDE SEMICONDUCTOR MARKET



Source: WSTS

WORLDWIDE SEMICONDUCTOR MARKET



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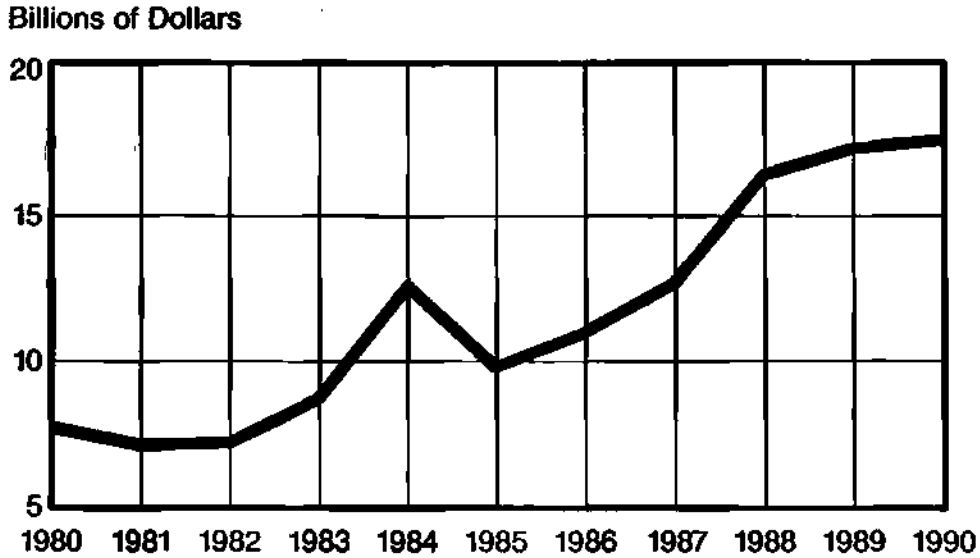
REVENUES OF U.S.-BASED COMPANIES



Source: Dataquest
WSTS

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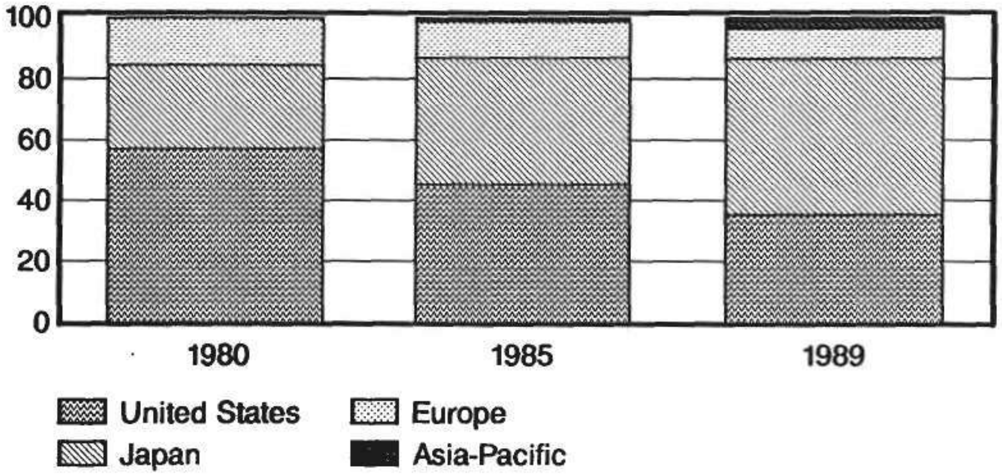
REGIONAL SHARES OF SEMICONDUCTOR MARKET

(Percentage of Worldwide Market)



Source: Dataquest

1985 INDUSTRY RECESSION

- Industry's worst nightmare
- Participants lost $6 billion
- Five U.S. DRAM producers drop out
- Japanese market share jumps

KEY EVENTS IN THE EIGHTIES

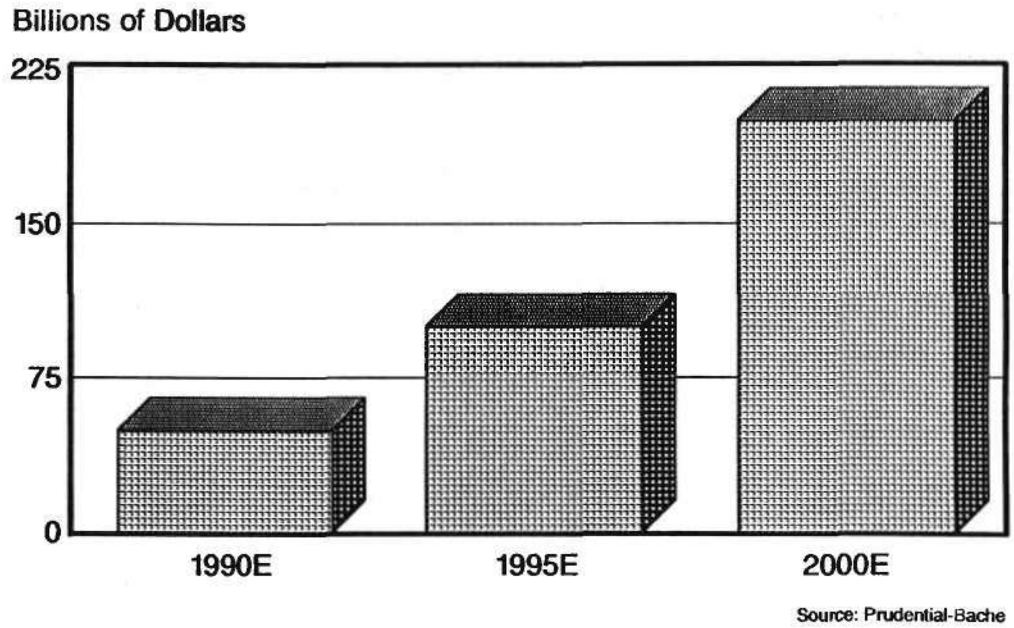
- Microprocessor revolution
- Growth of ASICs
- Insatiable demand for memory
- Extraordinary competition
- Increasing customer requirements
- Shifting consumption patterns

CURRENT STATUS

- 1990: a year of no growth
- User inventories low
- Realistic capital spending
- Greatly improved manufacturing capability
- Strong balance sheets

THE NINETIES

WORLDWIDE SEMICONDUCTOR MARKET



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EXPECTATIONS FOR THE NINETIES

- DRAM memory
  - 1990: $50 per megabyte
  - 2000: $3 per megabyte
- Microprocessors
  - 1990: 25-50 mips
  - 2000: 2,000 mips

EXPECTATIONS FOR THE NINETIES

- Linewidths
  - 1990: 1 micron
  - 2000: 0.3 micron
- Chip density
  - 1990: 4 million transistors
  - 2000: 100 million transistors

ISSUES FOR THE NINETIES

- Cost of capital
- Market shares
- Lack of critical mass
- Lack of consistent profits
- Shifting geographic markets

COST OF CAPITAL

- The number one issue
- Americans pay significantly more
- Low cost capital a must for DRAMs and SRAMs

WAYS TO CLOSE THE GAP

- Advance payments
- Long-term contracts
- Partnerships
- Use of foundries
- U.S. government policy
- Shifting capital markets

DECLINING U.S. MARKET SHARES

- The number two problem
- Greatest changes occurred in eighties
- Market share key to economies of scale

MARKET SHARE SOLUTIONS

- Leading-edge products & technology
- World-class manufacturing
- World-class customer service
- Global scope
- Government trade policy

LACK OF CRITICAL MASS

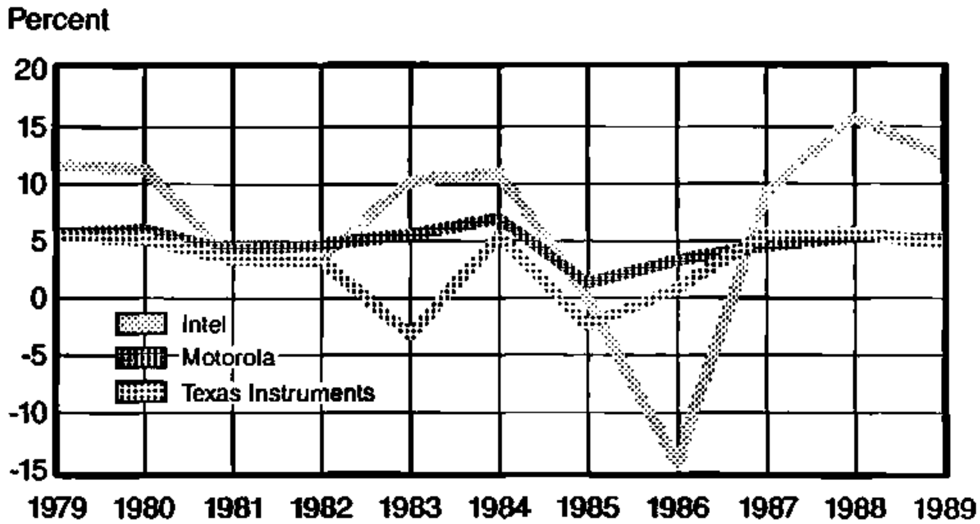
- Top 10 Japanese suppliers
  = 90% of Japanese production
- 20-25 Japanese suppliers
- Top 10 American suppliers
  = 72% of American production
- >100 American suppliers

CONSOLIDATION

- '70s and '80s: era of startups
- '90s: era of consolidation
- Marriage of convenience

LACK OF CONSISTENT PROFITS

(Net Profit Margin)



ROAD TO MORE CONSISTENT PROFITS

- Proprietary products
- Intellectual property
- High R&D investment
- Enforce anti-dumping laws

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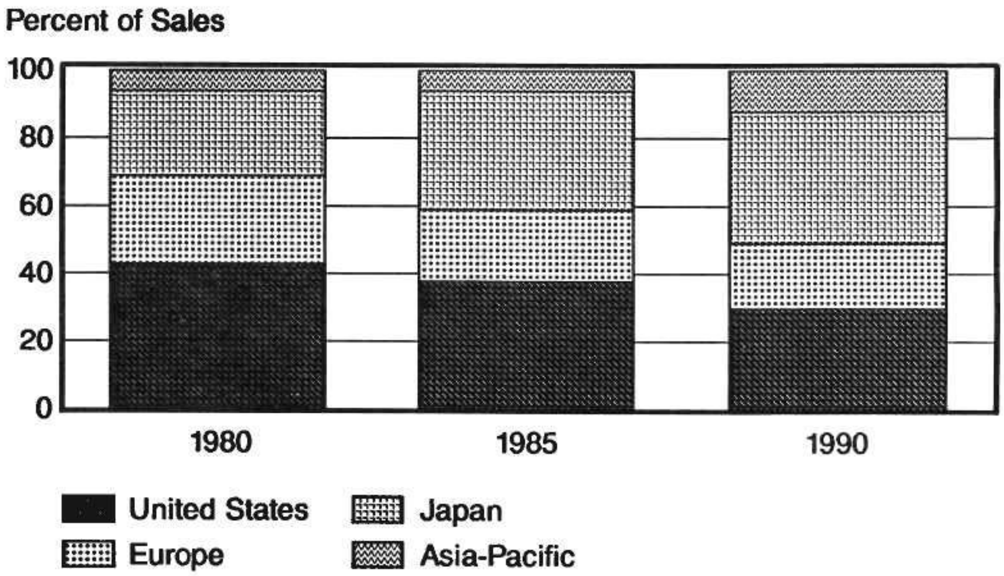
SHIFTING GEOGRAPHICAL MARKETS



Source: WSTS

SERVING ASIA-PACIFIC REGION

- Provide local sales & FAE support
- Establish local manufacturing
- Involve top management in Asia-Pacific
- Make worldwide customer support a priority

U.S. COMPANIES IN 2000

PERSPECTIVE

- Cost of capital narrows
- Market share declines
  - Americans
  - Japanese
- Significant consolidation in U.S.
- More consistent profits
- Market share gains in Asia

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PROSPECTS OF THE SEMICONDUCTOR BUSINESS IN THE 1990s: A SPOTLIGHT ON ASIC BUSINESS

Tsuyoshi Kawanishi
Executive Vice President
Toshiba Corporation

Tsuyoshi Kawanishi is Executive Vice President for Electronic Components and Materials at Toshiba Corporation. He joined Toshiba in 1952 and has held various manufacturing and management positions including General Manager of their MOS LSI plant, Vice President and Group Executive of the Semiconductor Group, and Senior Vice President. Mr. Kawanishi graduated from the Department of Electrical Engineering at Tokyo Institute of Technology.

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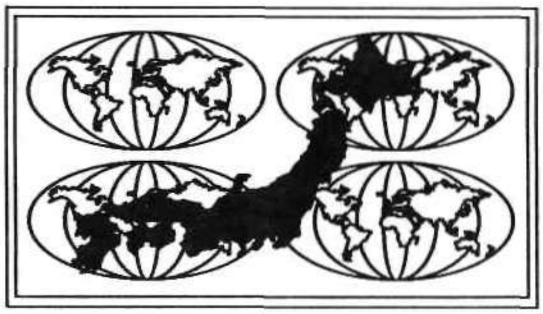

ULSI Era:
Challenges and
Opportunities

Prospects of the Semiconductor Business in the 1990s: A Spotlight on ASIC Business

Tsuyoshi Kawanishi
Executive Vice President
Toshiba Corporation

SPEECH CONTENT

1. SEMICONDUCTOR BUSINESS IN THE 1990s.

① A New Era Has Come — Mega-bit, ASIC, International —
② What is the Mega-bit Age ?
③ What is the ASIC Age ?
④ What is the International Age ?
⑤ 21 century — peering into a crystal ball —

2. ASIC BUSINESS IN THE 1990s.

① Why ASICs ?
② Trends in the ASIC Market
③ Trends in ASIC Technology
④ Key factors of ASIC Business

3. TOSHIBA'S STRATEGY FOR THE 1990s.

① Strategy for the 1990s
② Keys to the Mega-bit Age
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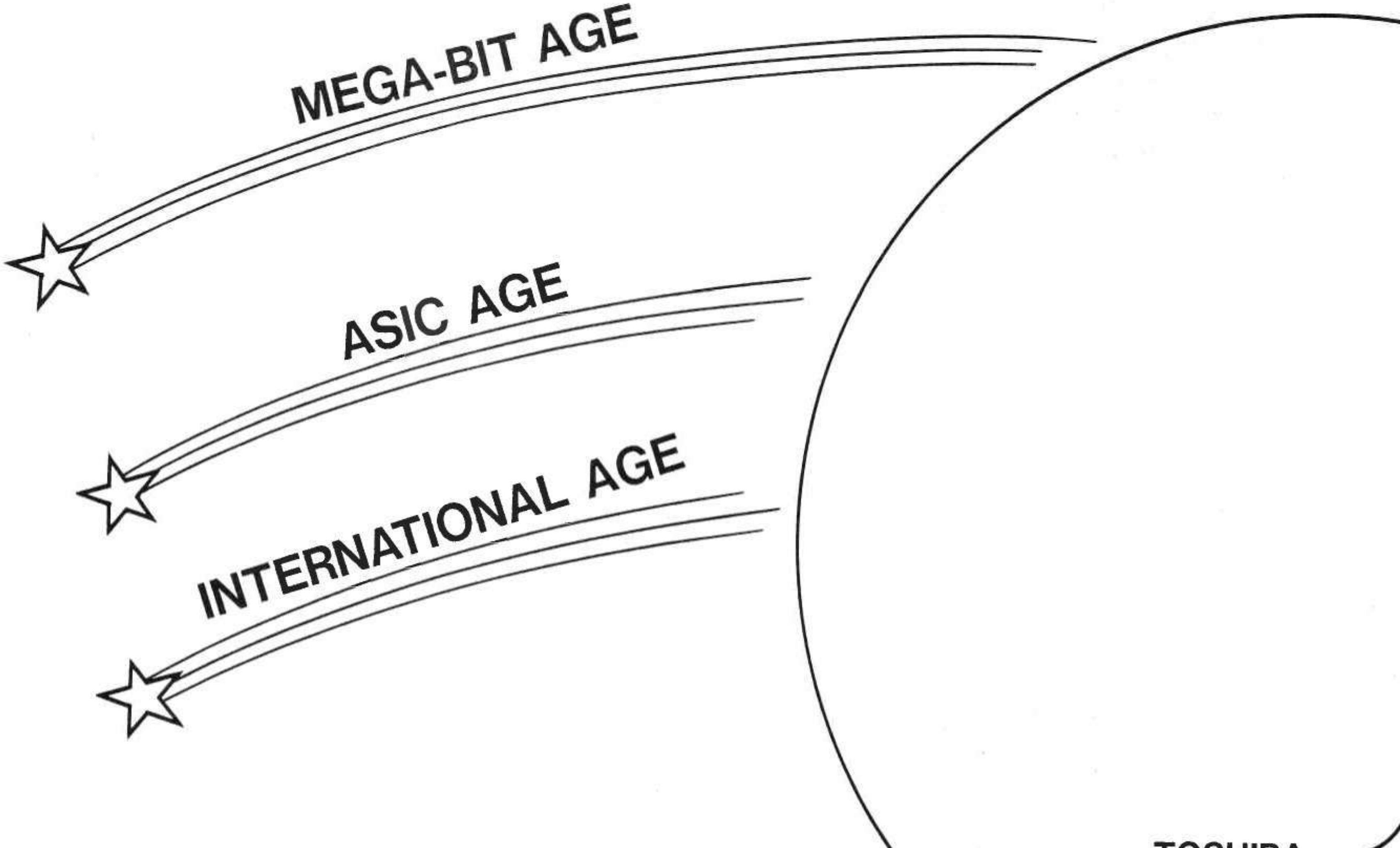
A NEW ERA HAS COME



TRANSITION OF AGE
KILO-BIT, MEGA-BIT, AND GIGA-BIT

Age		KILO-BIT	MEGA-BIT	GIGA-BIT
Year		1980～	1990～	2000～
DRAM		64K, 256K, 1M	4M, 16M, 64M	256M, 1G
Total data (Japan)	Total bits	1.5×10^{14} byte	6.0×10^{15} byte	1.5×10^{17} byte
	Per capita	1.2M byte	50M byte	1.25G byte
	Equivalent units of 1M DRAMs	150 Mp	48,000 Mp	1,200,000 Mp
Application of memory		DATA RECORDING Data of Computer, PC, WS, WP, etc.	+INFORMATION RECORDING Character and still picture of PC, WS, WP, TV, etc.	+AMORPHOUS INFORMATION RECORDING Moving pictures and music of TV, Audio, Video, etc.

(Source : NRI)

KILO-BIT AGE VS MEGA-BIT AGE

	Kilo-bit Age	Mega-bit Age
Business Style	Share oriented	Profit cautious
Key Strategy	Capacity Expansion	Advanced Products Development
Demand & Supply	Easy to oversupply (Requirement Era)	In short supply (Adjustment Era)
New Entry	Possible and Faster (Top ranker isn't far ahead)	Difficult (Technical barriers exist)
International Trade	Days of Friction	Days of Complementarity & Cooperation

TOSHIBA

3 ATTRACTIVE MARKETS FOR SEMICONDUCTORS IN THE MEGA-BIT AGE

1. Portable OA equipment

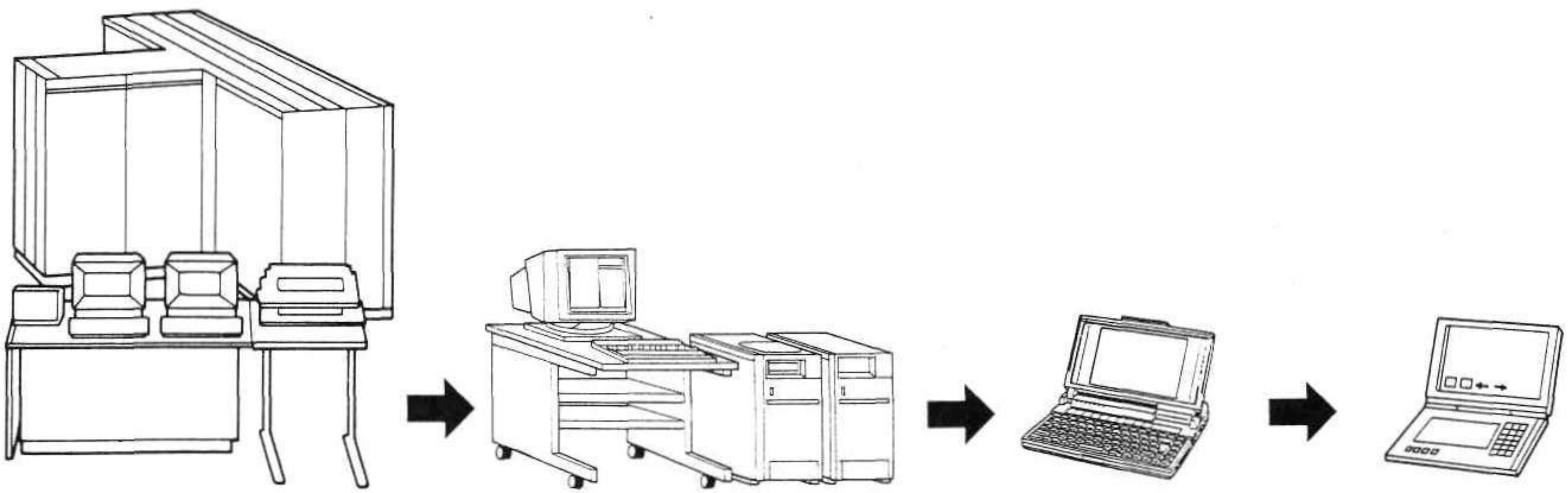
2. High performance AV equipment

3. Replacement of other recording media

COMPUTER EVOLUTION AND REVOLUTION

Mainframe to Personal

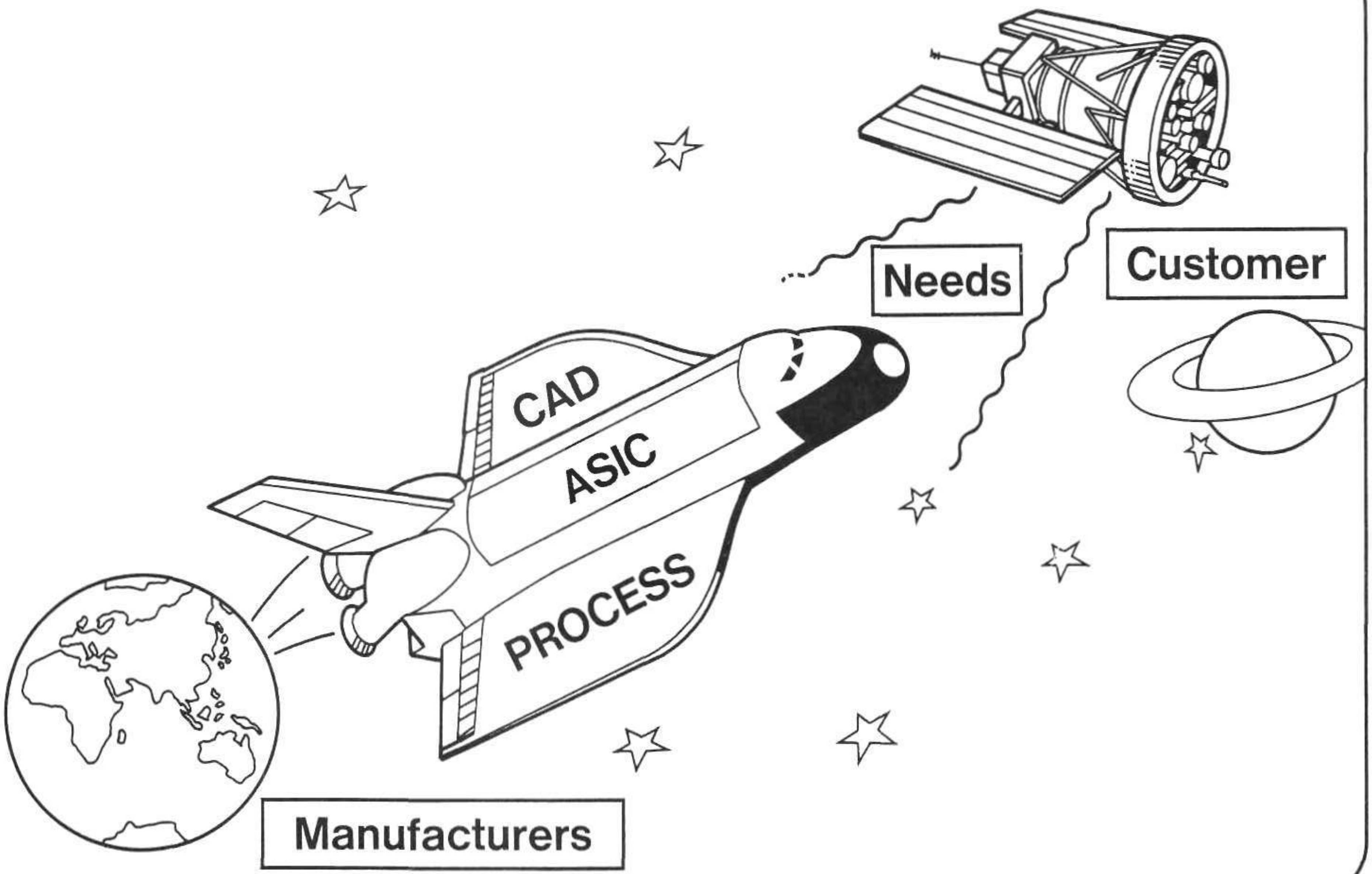
Speed : 10 MIPS ~
Memory Capacity : 128 MB ~



Mainframe 1980s → EWS 1990 → Personal WS 1992 ~ 1995 → Book Size 2000

CUSTOMERS' NEED

1. to aim at originality
2. to respond to changing requirements (short life cycle)
3. to pursue cost reduction



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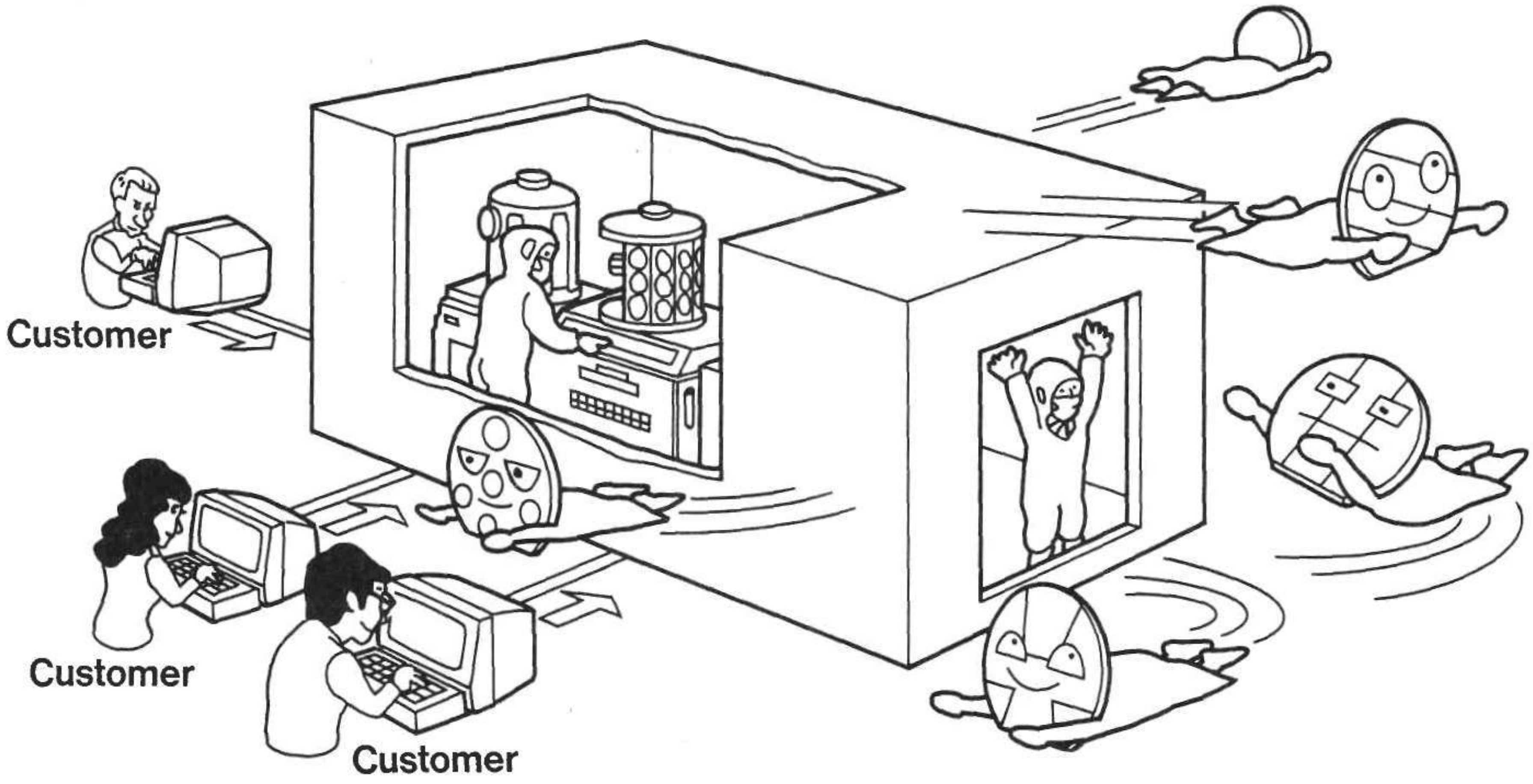
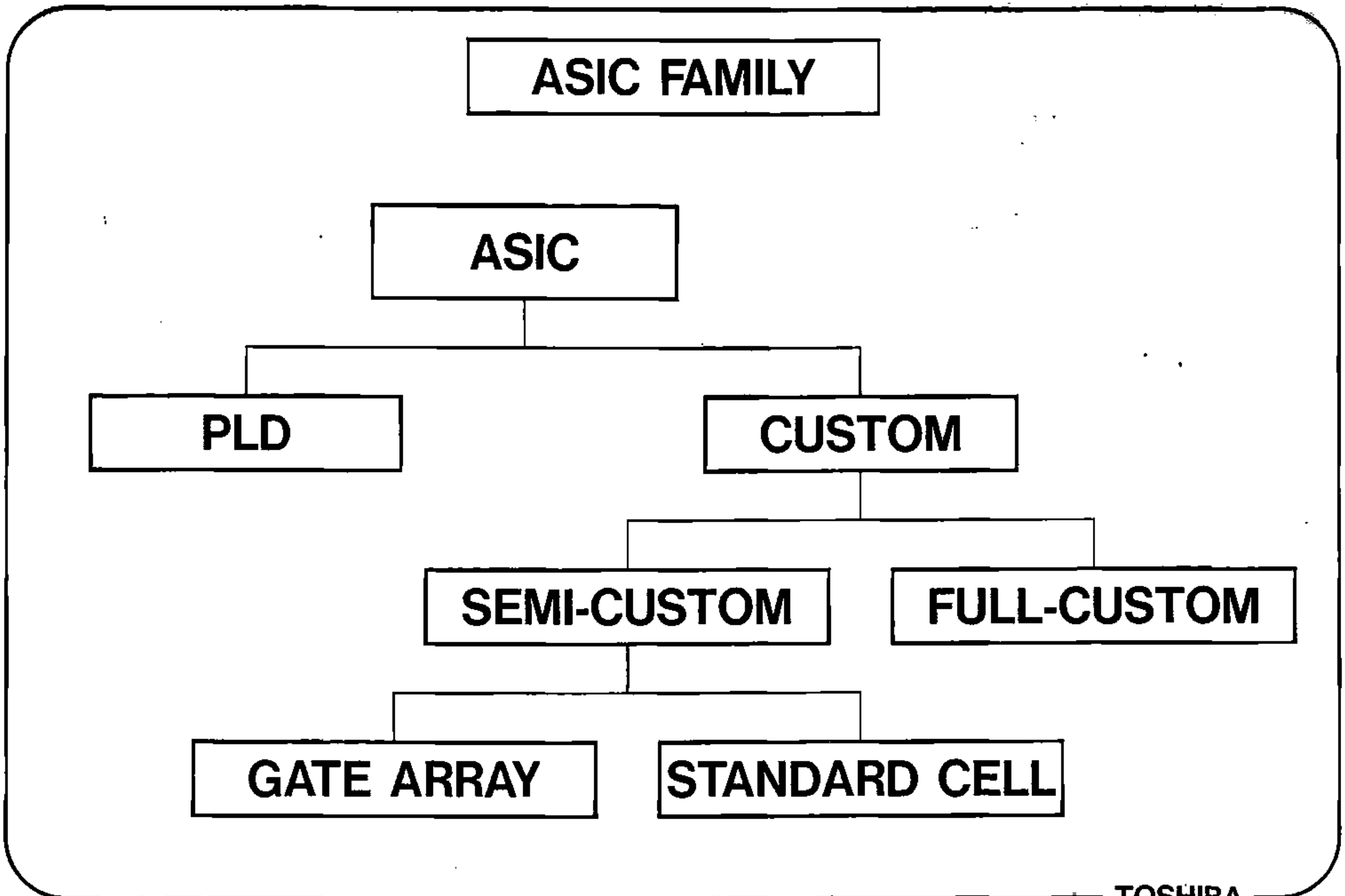
ASIC AGE means Diversification and Characterization

— ASIC is Tailor-made merchandise supported by advanced wafer fabrication facilities and excellent CAD. —



TOSHIBA

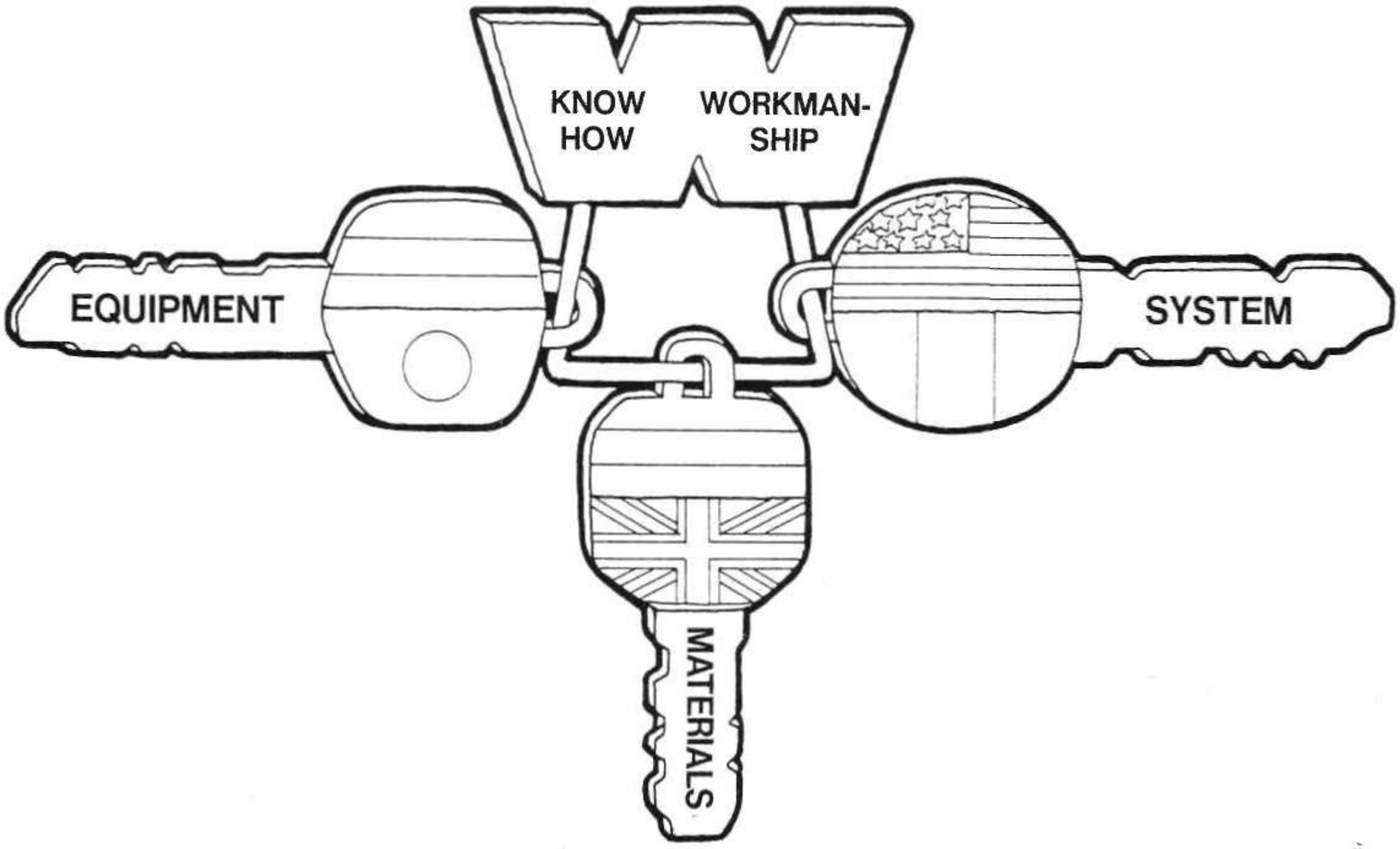

ASIC FAMILY
ASIC
PLD
CUSTOM
SEMI-CUSTOM
FULL-CUSTOM
GATE ARRAY
STANDARD CELL
TOSHIBA

GLOBALIZATION OF SEMICONDUCTORS

1. Technology without borders
   - frequent exchange, within established rules.
2. Customers without borders
   - economic principles work.
3. Logistics without borders
   - in consideration both of customer requests and political issues.
4. Prices without borders
   - merchandize and related information circulate worldwide in real-time.
5. A "crude oil industry" for all countries' economies
   - how to survive tough world class competition.
6. No single company can control and cover all
   - Multinational alliances and collaboration required.

RIGHT KEYS IN THE 1990s
– GLOBAL INTEGRATION OF THE VERY BEST OF THE BEST –

- Teamwork will be superior to One (Super) man performance.



21 CENTURY

— Peering into a crystal ball —

	<CLEAR VIEW>	<POSSIBLE ?>
Component	Giga-bit memory	Biological memory
Equipment	Multi media Palm-top computer	Humanoid computer
Transportation	Linear motor car	Flying carpet
System	Perfect weather forecasting	Environmental control

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WHY ASICs ?

ASICs

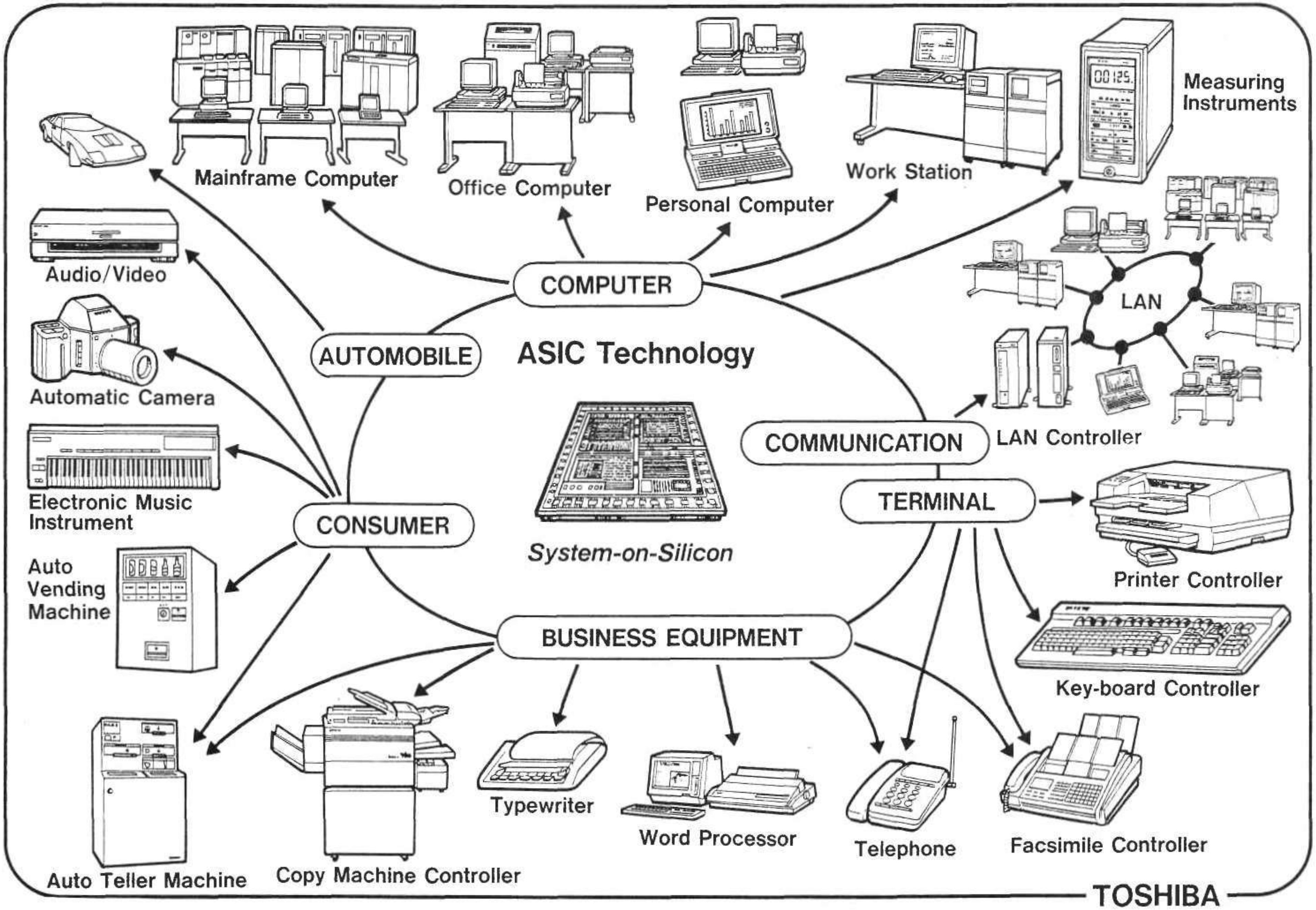
1. fit the era of differentiation and individuality.

2. expedite system integration.

3. enjoy the fruits of micro-lithography.

4. are key components of all kind of electronic equipment.

5. are a super hero of the information era.



Mainframe Computer
Office Computer
Personal Computer
Work Station
Measuring Instruments
Audio/Video
Automatic Camera
Electronic Music Instrument
Auto Vending Machine
COMPUTER
AUTOMOBILE
ASIC Technology
System-on-Silicon
CONSUMER
COMMUNICATION
TERMINAL
BUSINESS EQUIPMENT
LAN
LAN Controller
Printer Controller
Key-board Controller
Auto Teller Machine
Copy Machine Controller
Typewriter
Word Processor
Telephone
Facsimile Controller
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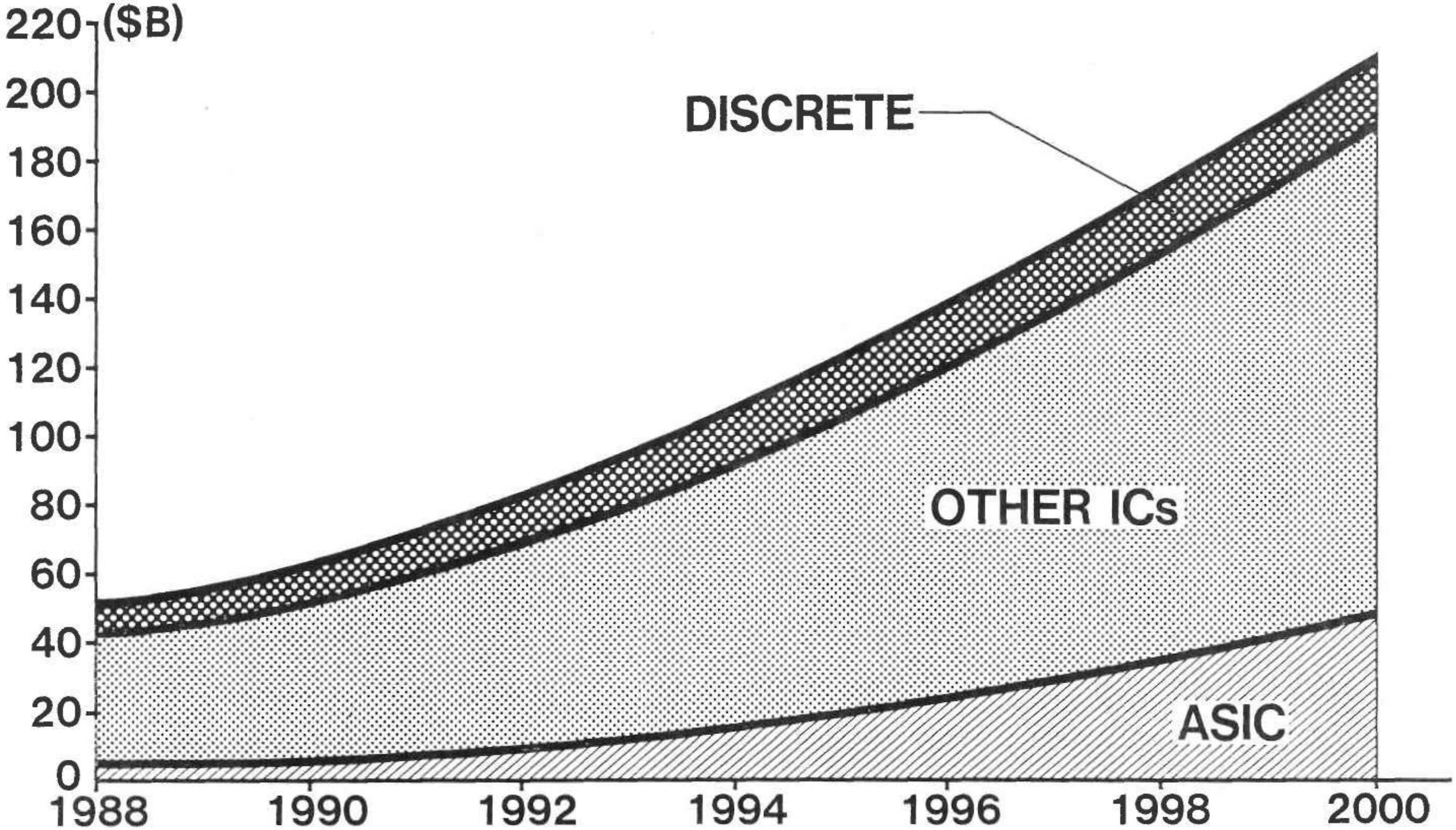
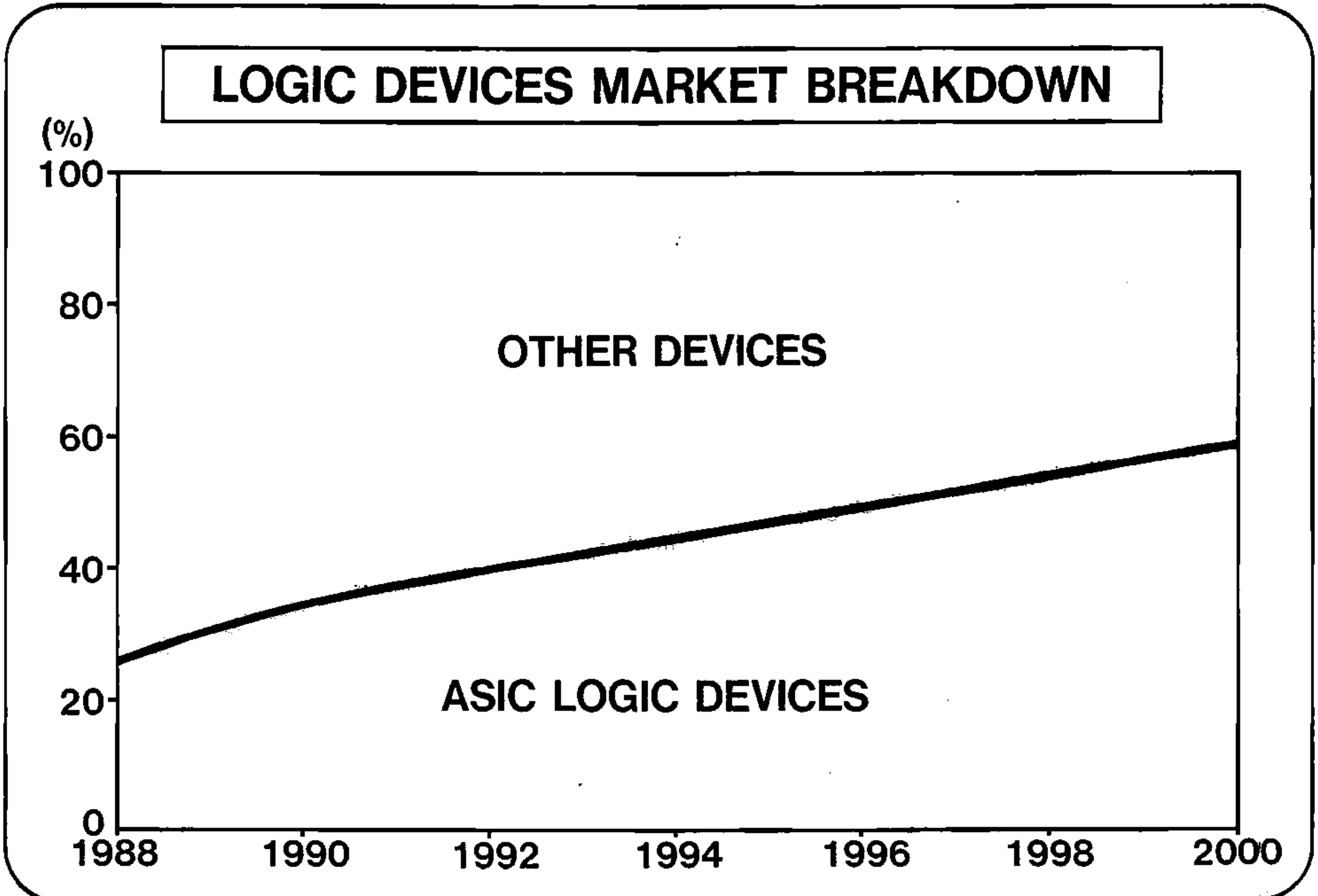
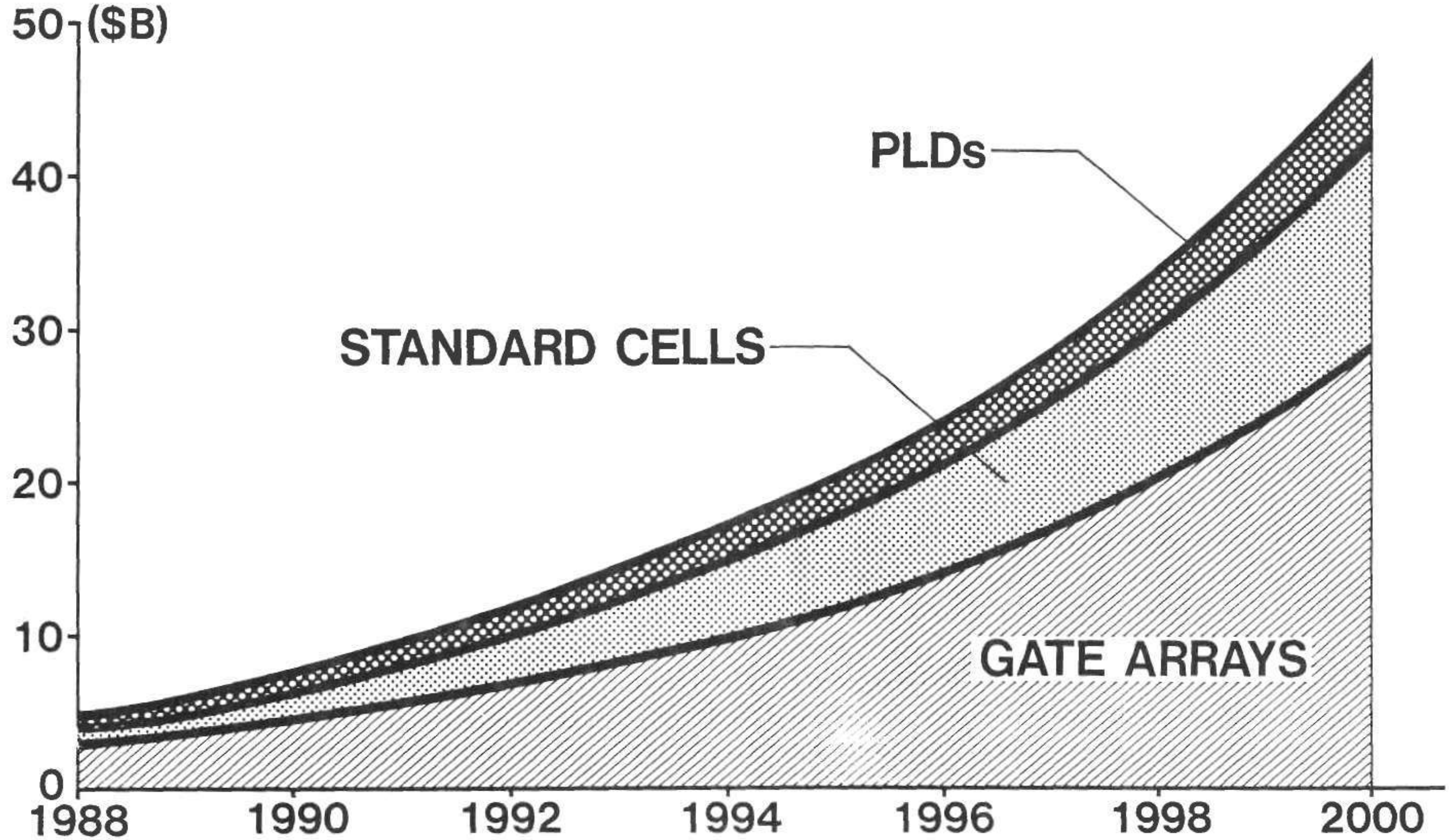
ESTIMATED SEMICONDUCTOR CONSUMPTION




LOGIC DEVICES MARKET BREAKDOWN
(%)
100
80
60
40
20
0
OTHER DEVICES
ASIC LOGIC DEVICES
1988
1990
1992
1994
1996
1998
2000

ESTIMATED ASIC CONSUMPTION BY PRODUCT



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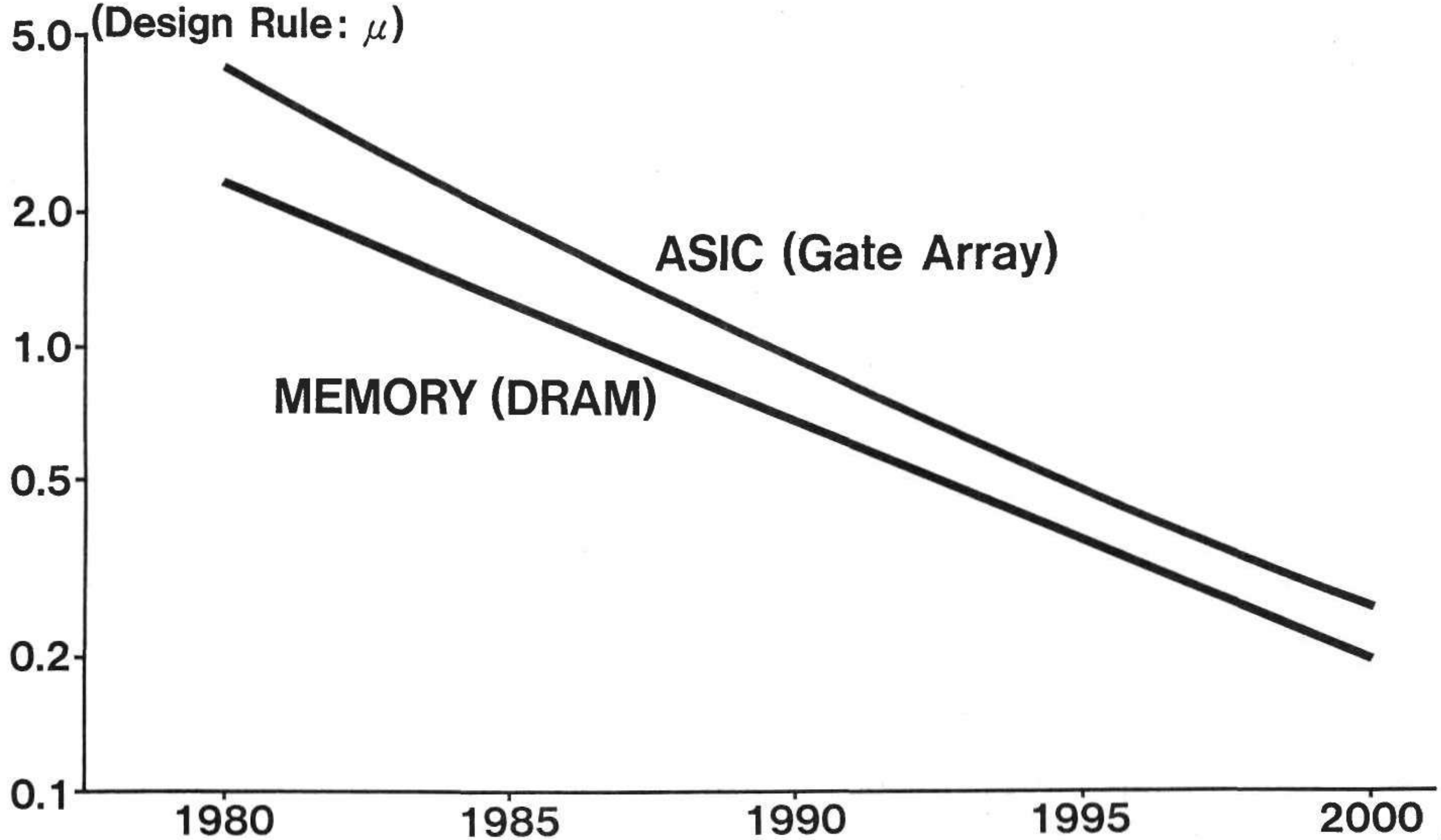
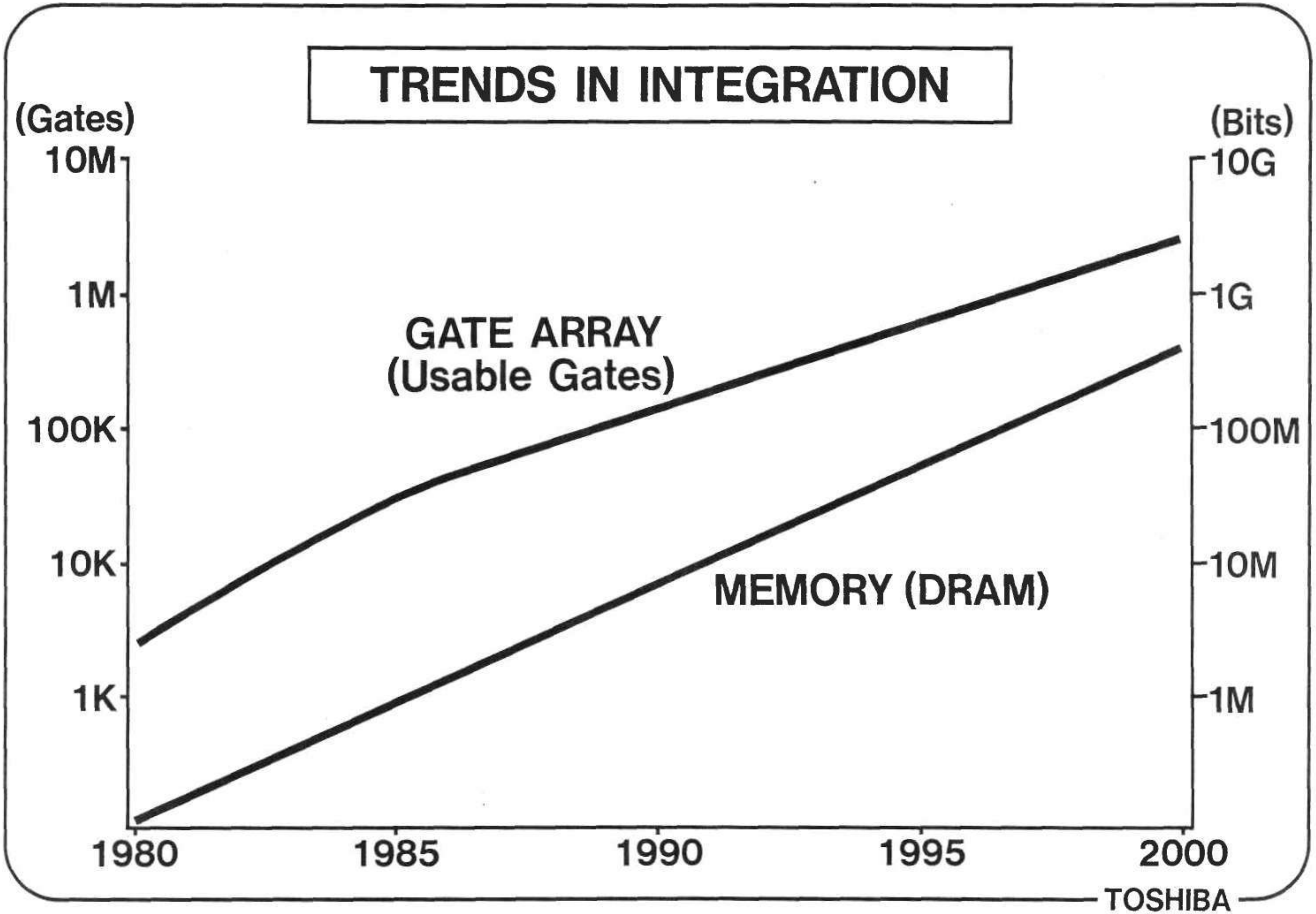
TRENDS IN PROCESS TECHNOLOGY





TRENDS IN INTEGRATION
(Gates)
10M
1M
100K
10K
1K
(Bits)
10G
1G
100M
10M
1M
GATE ARRAY
(Usable Gates)
MEMORY (DRAM)
1980
1985
1990
1995
2000
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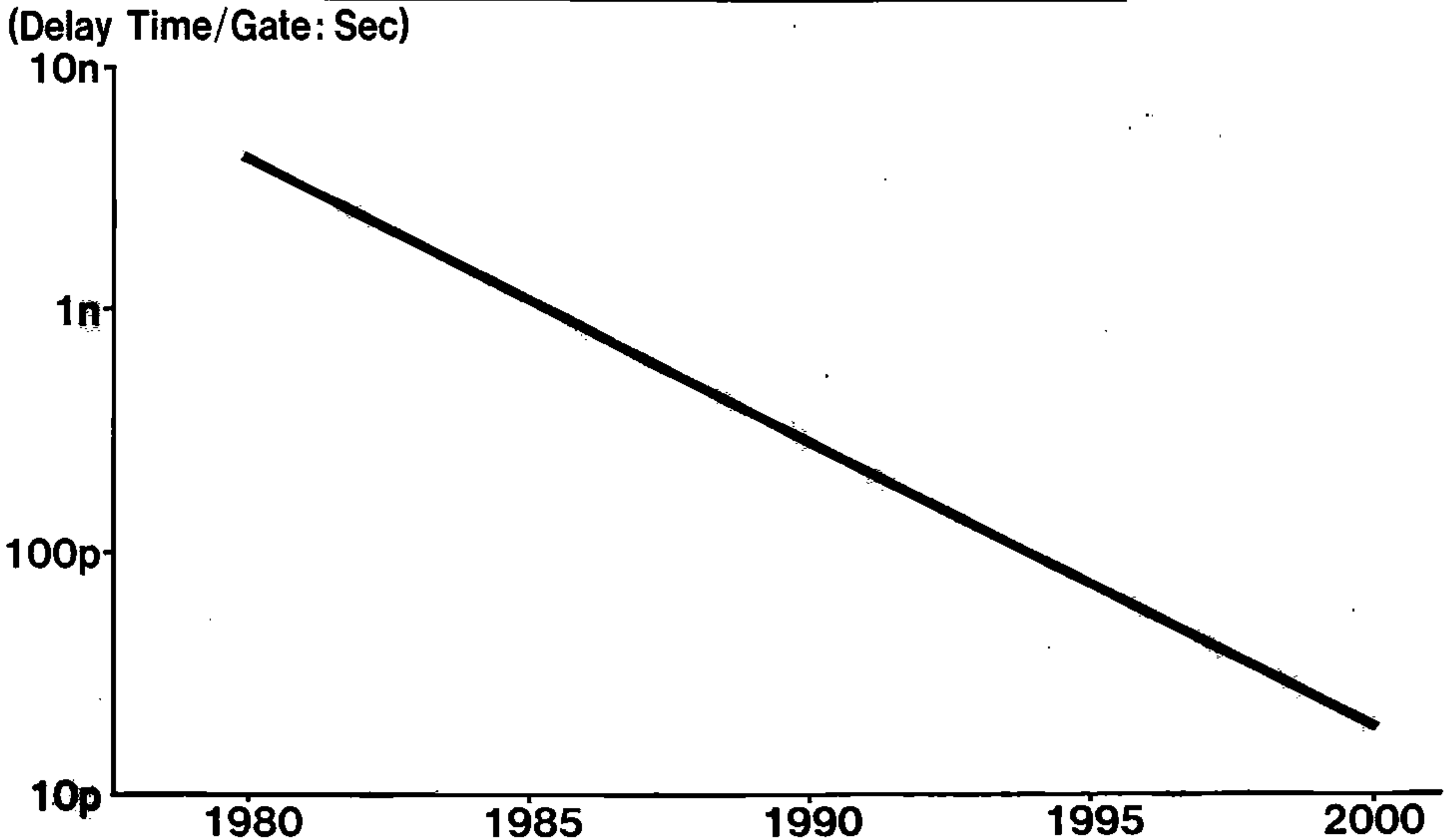
TRENDS IN GATE SPEED



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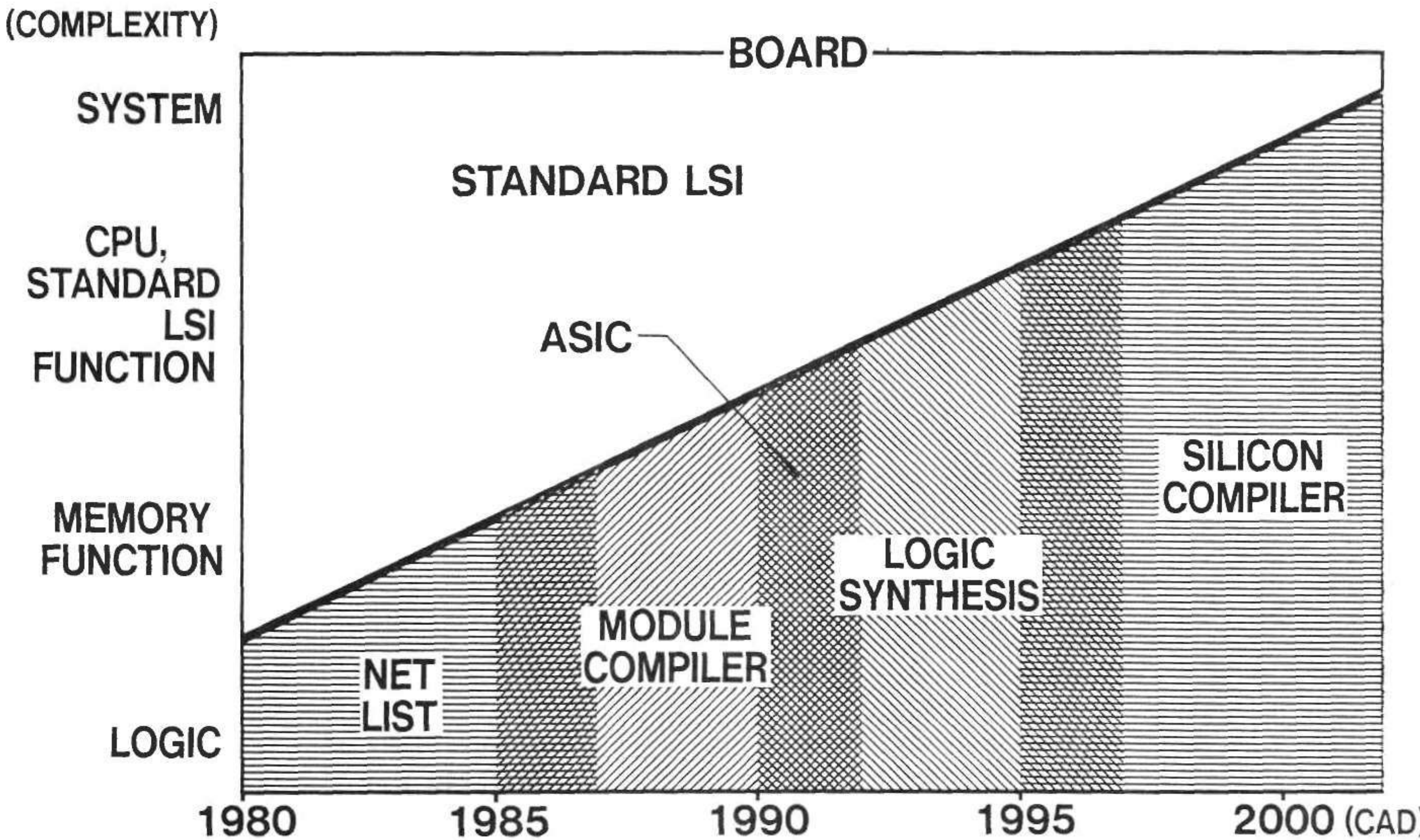
TRENDS IN ASICIZATION



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ASICs FOR

A … Advanced Process
S … Short Turn-Around Time
I …Interface between Customer & Vendor
C …CAD

A … Alteration
S … Speciality
I …Individuality
C …Change & Chance

A … Active & Able
S … Service & Sensitivity
I …Innovate & Improve
C …Characteristic & Conspicuous

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TOSHIBA'S STRATEGY FOR THE 1990s

1. 3 BASIC CONCEPTS OF SEMICONDUCTOR BUSINESS

① Foresight

② Consistency

③ Balance

2. 3 BASIC STRATEGY OF SEMICONDUCTOR BUSINESS

① Simultaneous 3-generation R & D

② International shareing based on CC & C policy

③ Management fitted to ASIC Age

KEYS TO THE MEGA-BIT AGE

1. Key processes for the Mega-bit Age

① Micro-lithography

- Stepper (4MDRAM : g Line / 16MDRAM : i Line)

② Three dimensional structure

- Trench/Stacked capacitor
- Multilayer metalization

③ Mixed device technology

- Bi-CMOS
- Memory-Logic (ASM)
- Discrete-Logic (Intelligent Power Device)

KEYS TO THE MEGA-BIT AGE

2. Key Materials for the Mega-bit Age

① Low Cost — High Grade Epitaxial Wafer
- Price < 1.5 × Mirror Polished Wafer

② Super-Flat 8" Mirror Polished Wafer
- LTV < 0.5 μm

③ Low Cost Multilead Package

④ Low-Stress Molding Compounds

⑤ High-Resolution/Sensitivity Photo Resist

⑥ High-Reliability Metalization Materials

3. Key Equipment for the Mega-bit Age

① Super High-Resolution Photo Stepper

② High Throughput Reactive Ion Etching Machine for Trench Capacitor

③ Low-Damage CVD Machine for Stacked Capacitor

④ High Throughput Epitaxial Reactor

⑤ Vertical Diffusion/CVD Furnace

KEYS TO THE ASIC AGE

Implementaion of

1. the most advanced process technology
2. highly advanced CAD
3. a powerful central engineering center
4. the best in customer service in convenient design centers
5. ASICs oriented plant
6. alliances with partners worldwide

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KEYS TO THE INTERNATIONAL AGE

1. G.H.S. Philosophy

- G Global View
- H Excellent Hardware
- S Software & Service

2. Philosophy of Globalization

Positioning Internationally

↓

Sharing Internationally

- Sharing of products & technologies
- Restructuring based upon each country's strengths
- Many kinds of alliances

MOS MEMORY TRENDS IN THE '90s

Takeshi Sasaki
Board Director and General Manager
Semiconductor and Integrated Circuits Division
Hitachi, Ltd.

Takeshi Sasaki is Board Director and General Manager of the Semiconductor and Integrated Circuits Division at Hitachi, Ltd. He has been with Hitachi for over thirty years and has held several managerial positions including, General Manager, Musashi Works; and General Manager and Deputy General Manager, Takasaki Works. Mr. Sasaki graduated from Hiroshima University.

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MOS Memory Trends in the '90s

Takeshi Sasaki
Board Director and General Manager
Semiconductor & Integrated Circuits Division
Hitachi, Ltd.

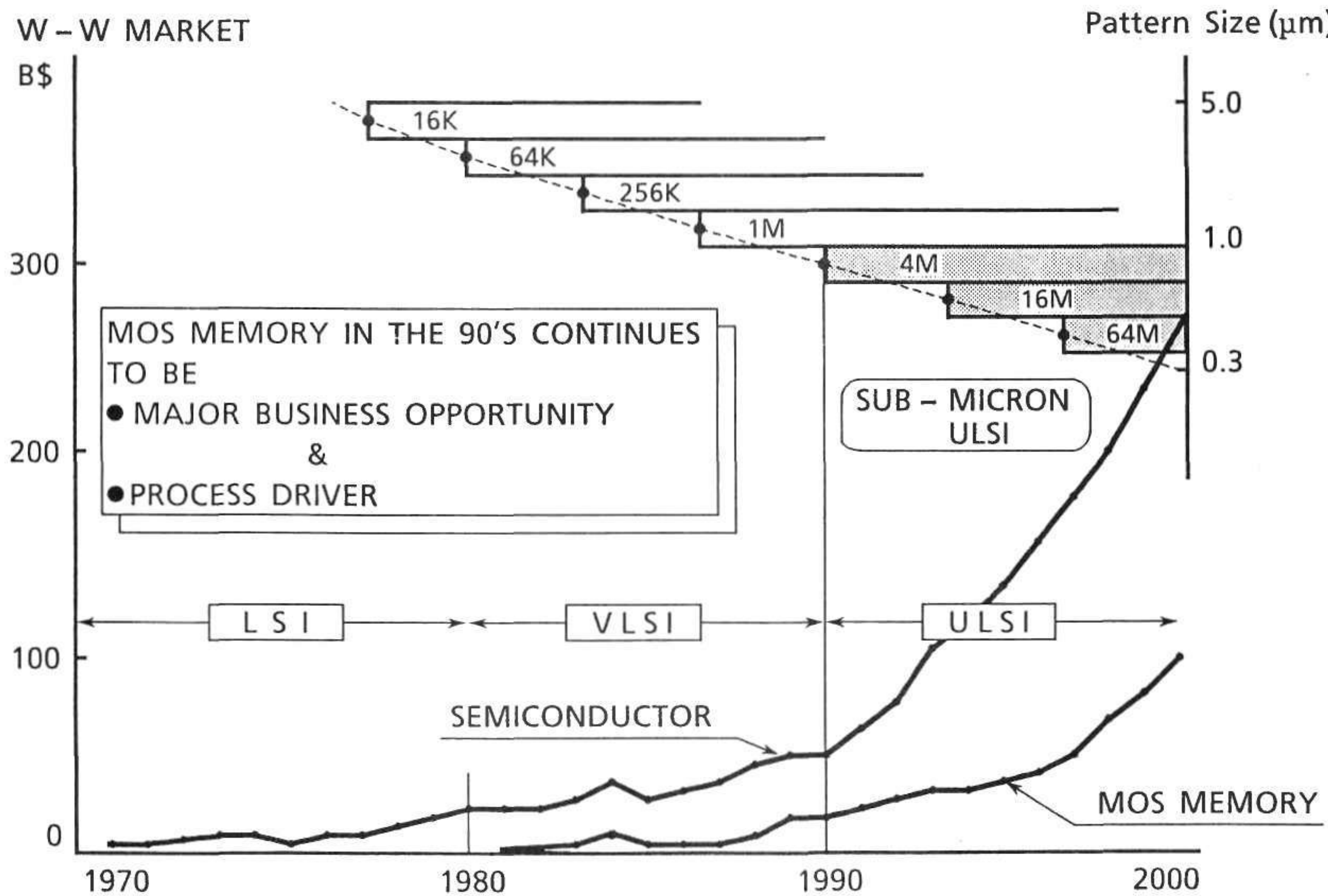
MOS MEMORY TRENDS IN THE 90'S

APRIL 12, 1990

TAKESHI SASAKI

HITACHI LTD.

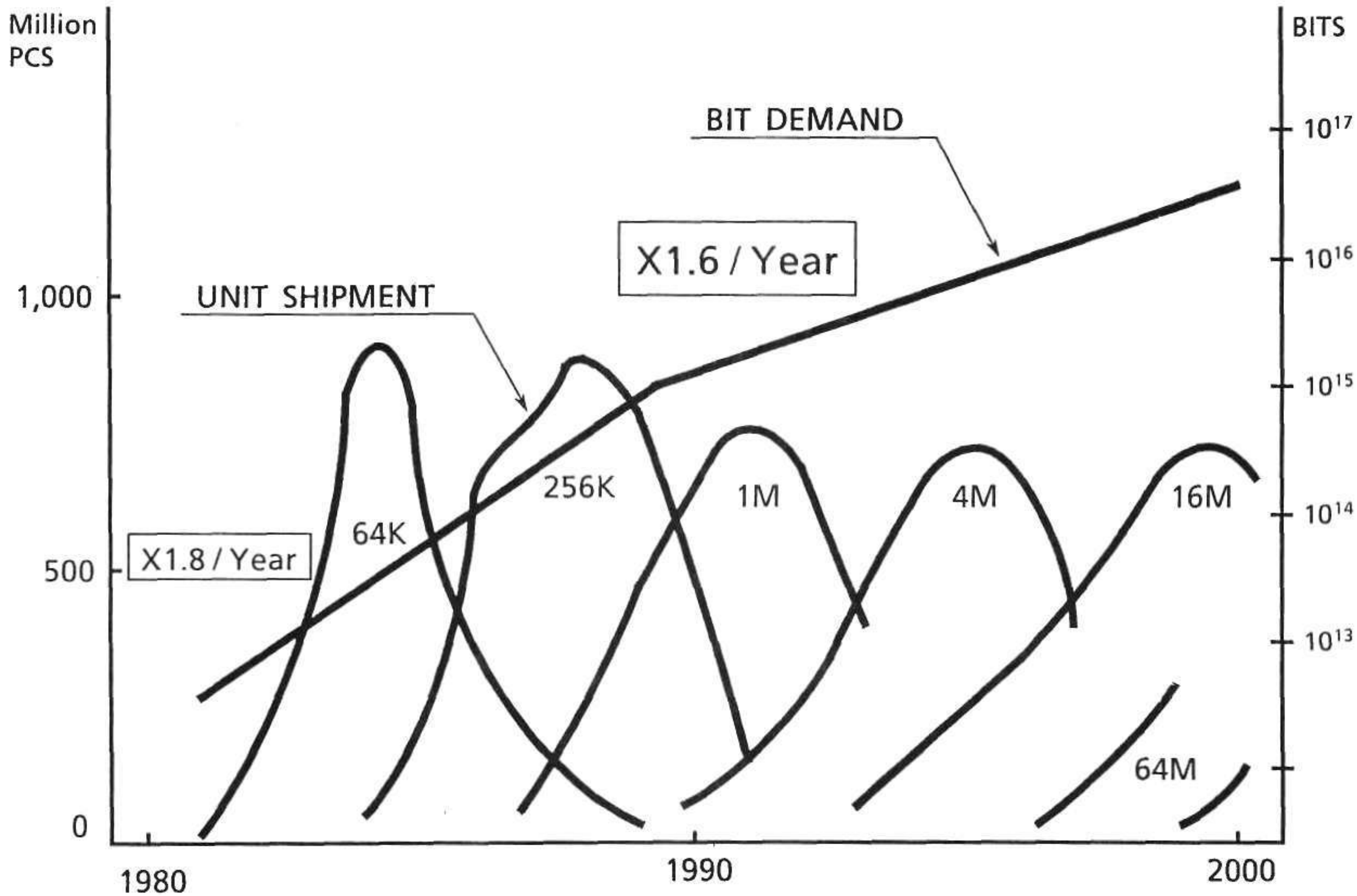
THE AGE OF ULSI



SOURCE : DATAQUEST, HITACHI

HITACHI

BIT DEMAND AND LIFE CYCLE OF DRAM



SOURCE : HITACHI

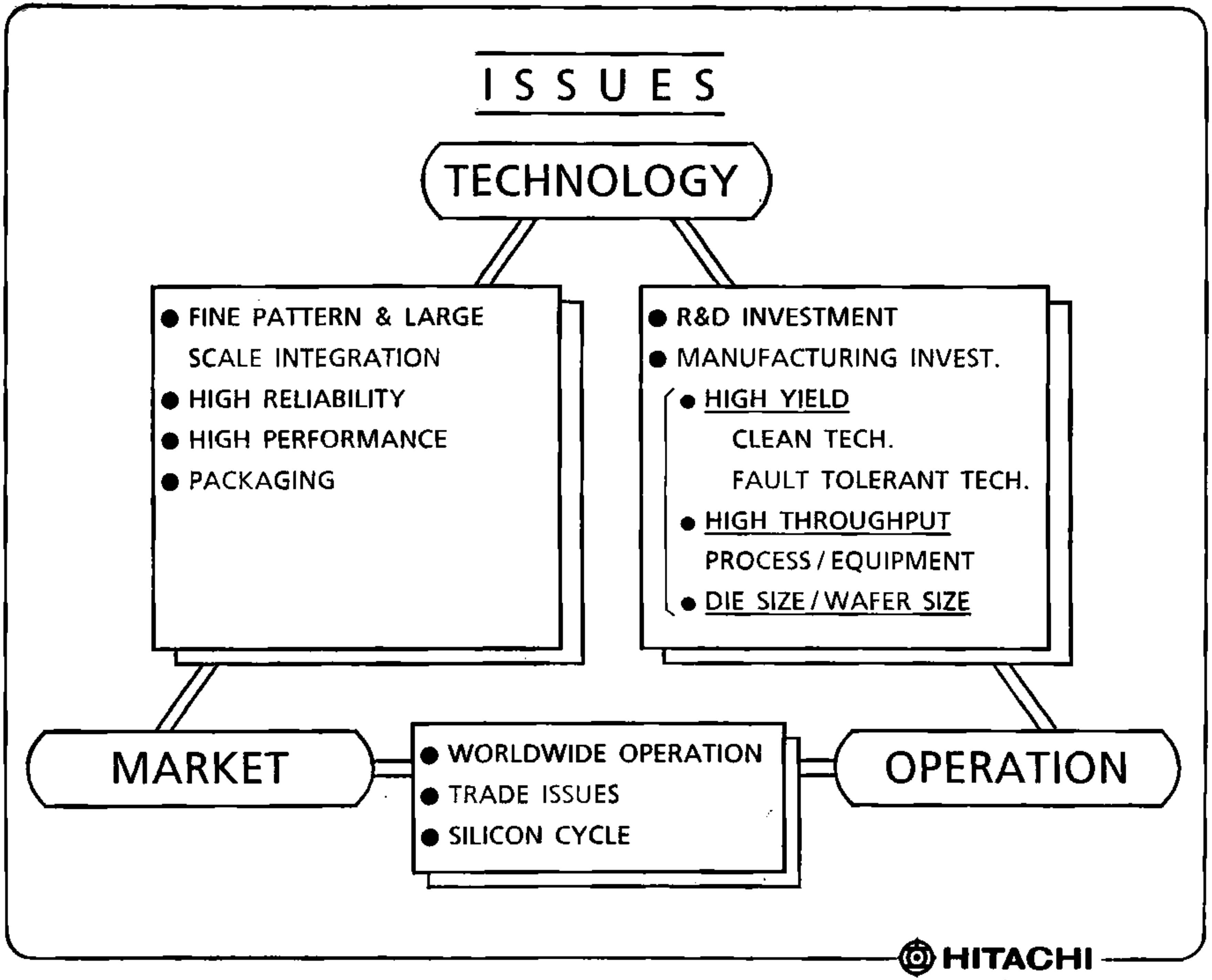
HITACHI

MOS MEMORY WILL LEAD ULSI AGE

1987 :	1Mbit DRAM	1.2μm
1990 :	4Mbit DRAM	0.8μm
1993 :	16Mbit DRAM	0.5μm
1996 :	64Mbit DRAM	0.3μm
1999 :	256Mbit DRAM	0.2μm

- 1990 IS THE YEAR OF SUB–MICRON MEMORY
- ANOTHER 1/10 AREA SCALE DOWN BY THE END OF THE CENTURY
- ULTRA HIGH–DENSITY, HIGH PERFORMANCE MICRO/ASICS WILL FOLLOW.

HITACHI

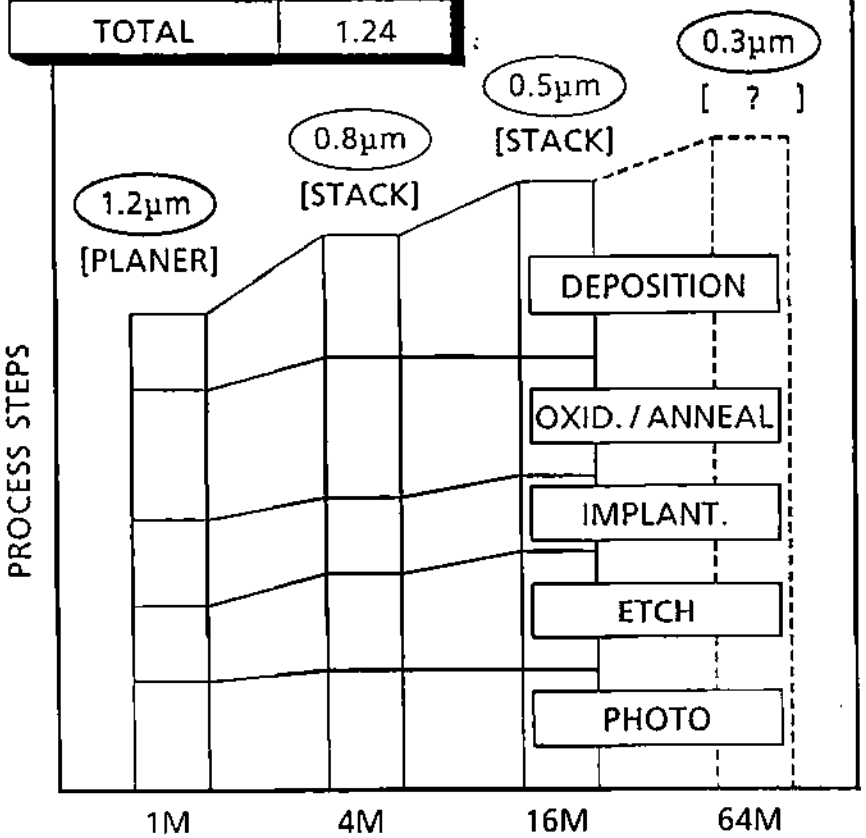

ISSUES
TECHNOLOGY
● FINE PATTERN & LARGE SCALE INTEGRATION
● HIGH RELIABILITY
● HIGH PERFORMANCE
● PACKAGING
● R&D INVESTMENT
● MANUFACTURING INVEST.
● HIGH YIELD
CLEAN TECH.
FAULT TOLERANT TECH.
● HIGH THROUGHPUT
PROCESS / EQUIPMENT
● DIE SIZE / WAFER SIZE
MARKET
● WORLDWIDE OPERATION
● TRADE ISSUES
● SILICON CYCLE
OPERATION
HITACHI

MEMORY AS A TECHNOLOGY DRIVER

- EVOLUTION OF DRAM PROCESS TECHNOLOGY
- ULTRA – CLEAN TECHNOLOGY
- REDUNDANCY
- INCREASING WAFER SIZE

EVOLUTION OF DRAM PROCESS TECHNOLOGY

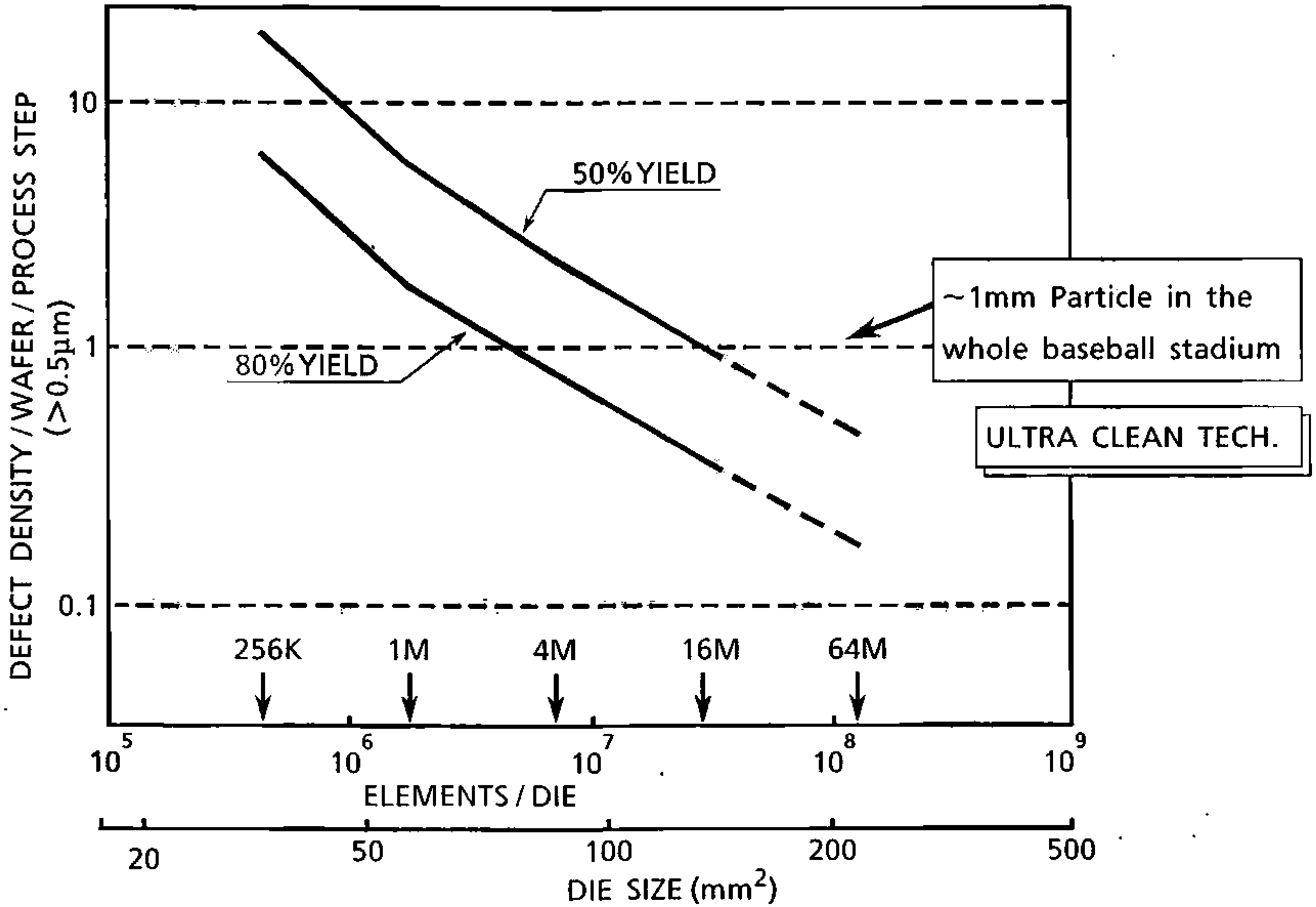
PROCESS STEPS : 16M / 1M	
DEPOSITION	1.95
OXID. / IMPLANT	1.06
ETCH	1.11
PHOTO	1.11
TOTAL	1.24



KEY TECHNOLOGIES IN THE '90'S	
DEPO.	① WIDER VARIETY OF MATERIALS ② HIGH THROUGHPUT / SINGLE WAFER PROCESSING – MULTI – CHAMBER SYSTEM – ③ LOW TEMP. LARGE WAFER EPI.
OXID. IMPL.	① RAPID THERMAL ANNEALING ② DEFECT CONTROL
ETCH	① LOW TEMPERATURE MAGNETRON (μ – WAVE) ETCH ② LOW DAMAGE / DAMAGE FREE ③ HIGH THROUGHPUT / SINGLE WAFER PROCESSING
PHOTO	① HIGH NA, i – LINE / EXCIMER ② WIDE FIELD STEPPER ③ PHASE SHIFT LITHOGRAPHY

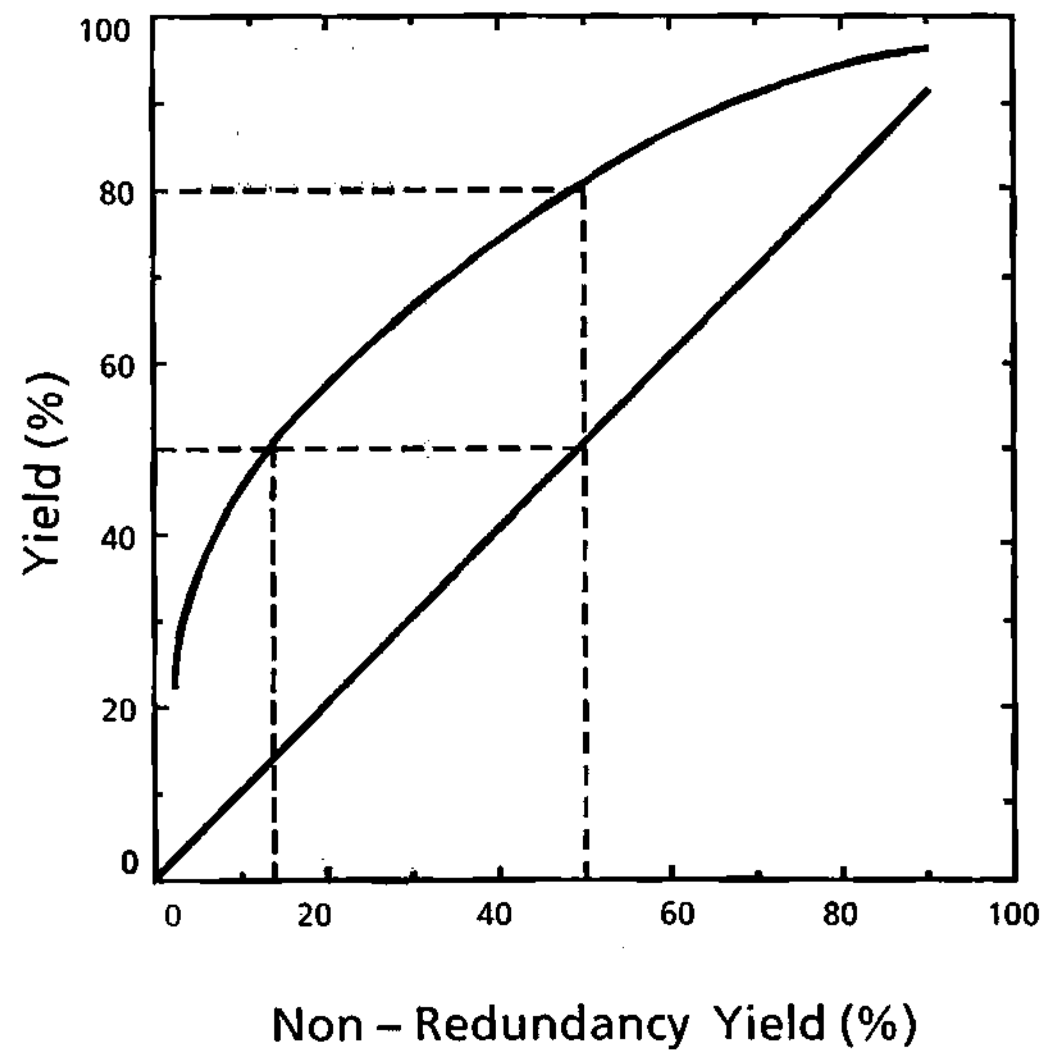
HITACHI

CLEAN TECHNOLOGY

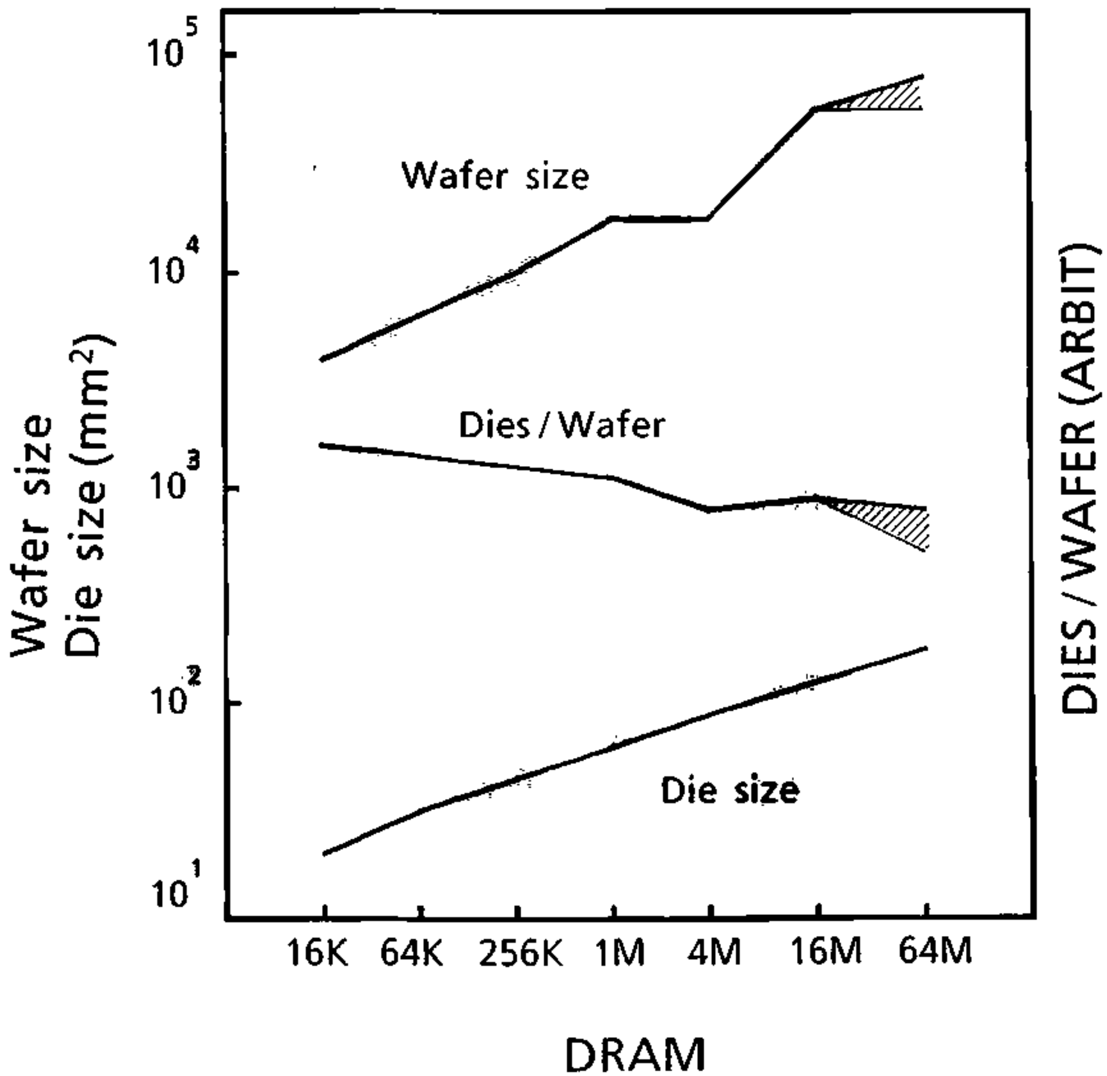


HITACHI

REDUNDANCY IS A KEY TECHNOLOGY FOR ULSI



WAFER SIZE AND DIE SIZE



- WAFER SIZE INCREASE IS NEEDED ALONG WITH DIE SIZE INCREASE
- 8 INCH MAY BE A KEY IN 16M
- WHAT ABOUT 10 INCH IN 64M?

HITACHI

MOS MEMORY MARKET TRENDS IN 90'S

- DIVERSIFICATION OF APPLICATION
- REQUIREMENT FOR HIGH PERFORMANCE
- PACKAGING FOR HIGH DENSITY ASSEMBLY

MARKET TRENDS IN 1990'S

KEY TRENDS

- PERSONALIZATION
- SOLID STATE MASS STORAGE
- HIGH QUALITY VIDEO / AUDIO
- HIGH PERFORMANCE

→

MAIN APPLICATIONS

- NOTE PC
- PERSONAL EWS
- MEMORY CARD
- SOLID STATE DISK
- FLAT DISPLAY
- HDTV
- RISC EWS

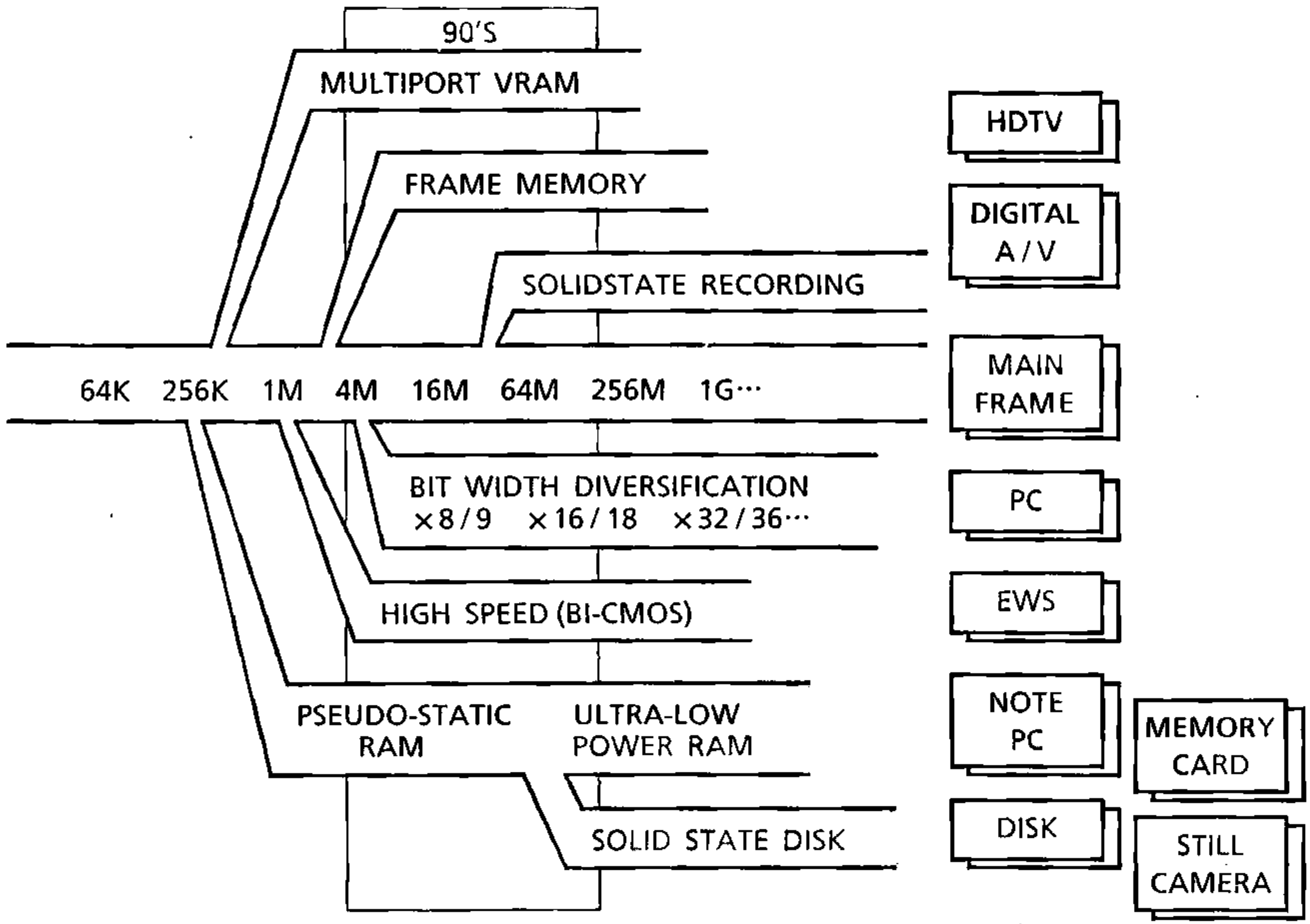
→

MEMORY REQUIREMENTS

- HIGH DENSITY INCL. PACKAGING
- ULTRA LOW POWER / NON VOLATILITY
- DIVERSFICATION / ASIC MEMORY
- HIGH SPEED
- LOW BIT COST

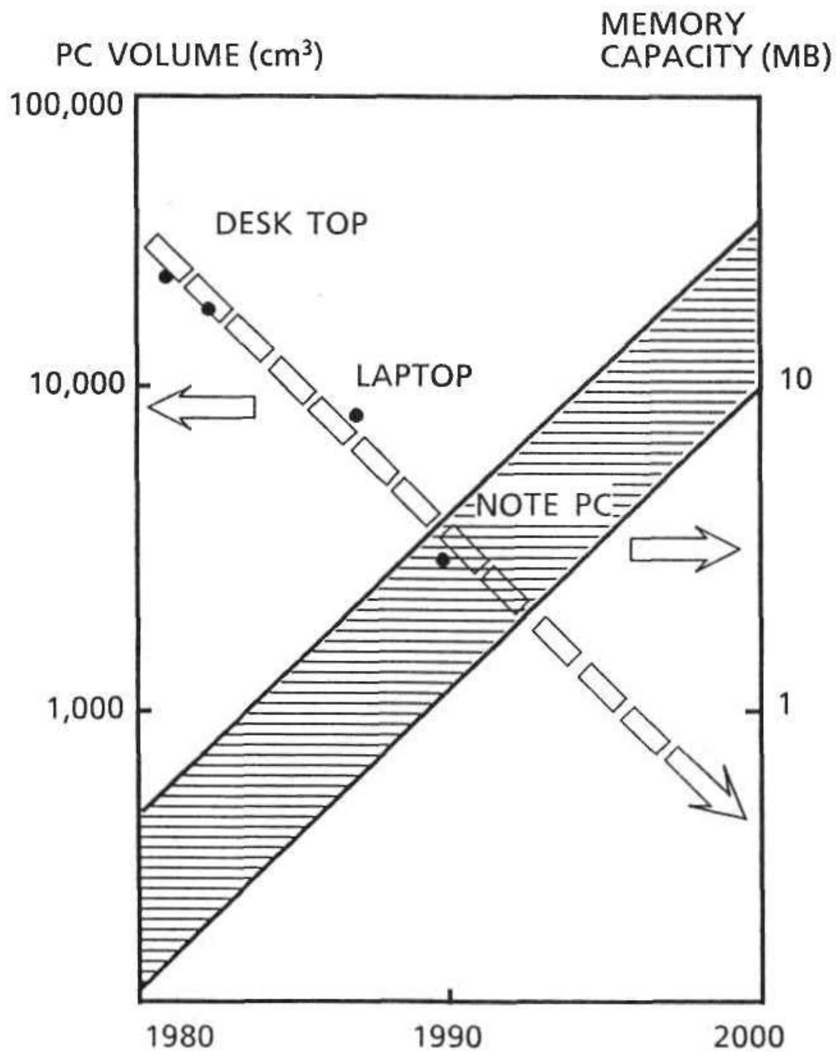
HITACHI

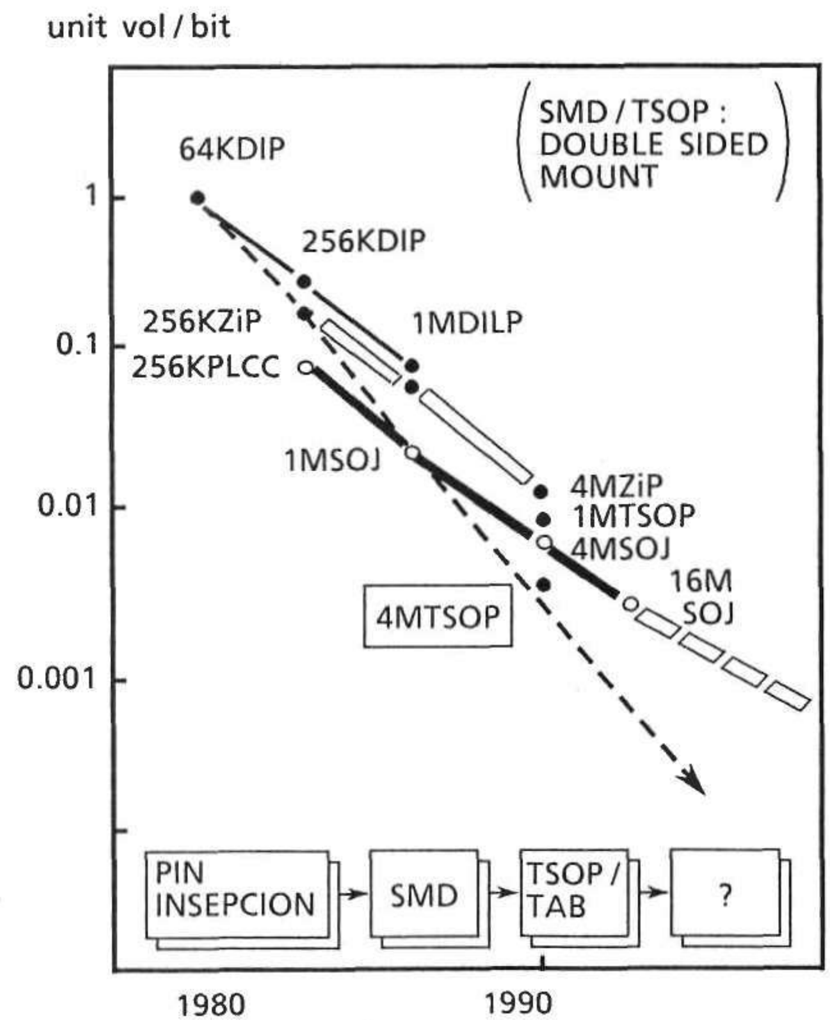
DIVERSIFICATION OF DRAM



HITACHI

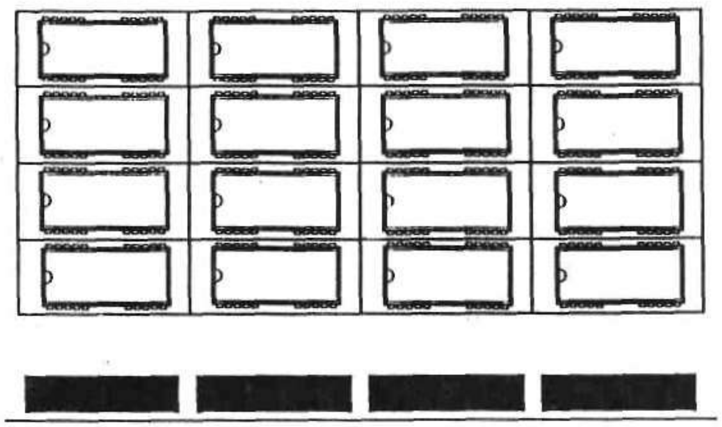
HIGH DENSITY PACKAGING IN SMALL SYSTEMS





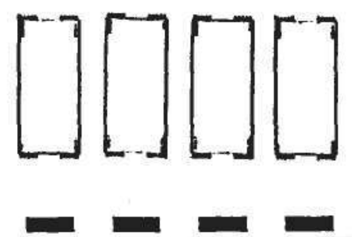
HITACHI

DRAM / PSRAM FOR SMALL SYSTEM



1MDRAM / SOJ

[256K × 4] × 16 : 2MB



4MDRAM / TSOP / LOW POWER.

[256K × 16] × 4 : 2MB

- MIGRATION

  FROM STANDARD 1MDRAM / SOJ

  TO 4MDRAM / TSOP / LOW POWER

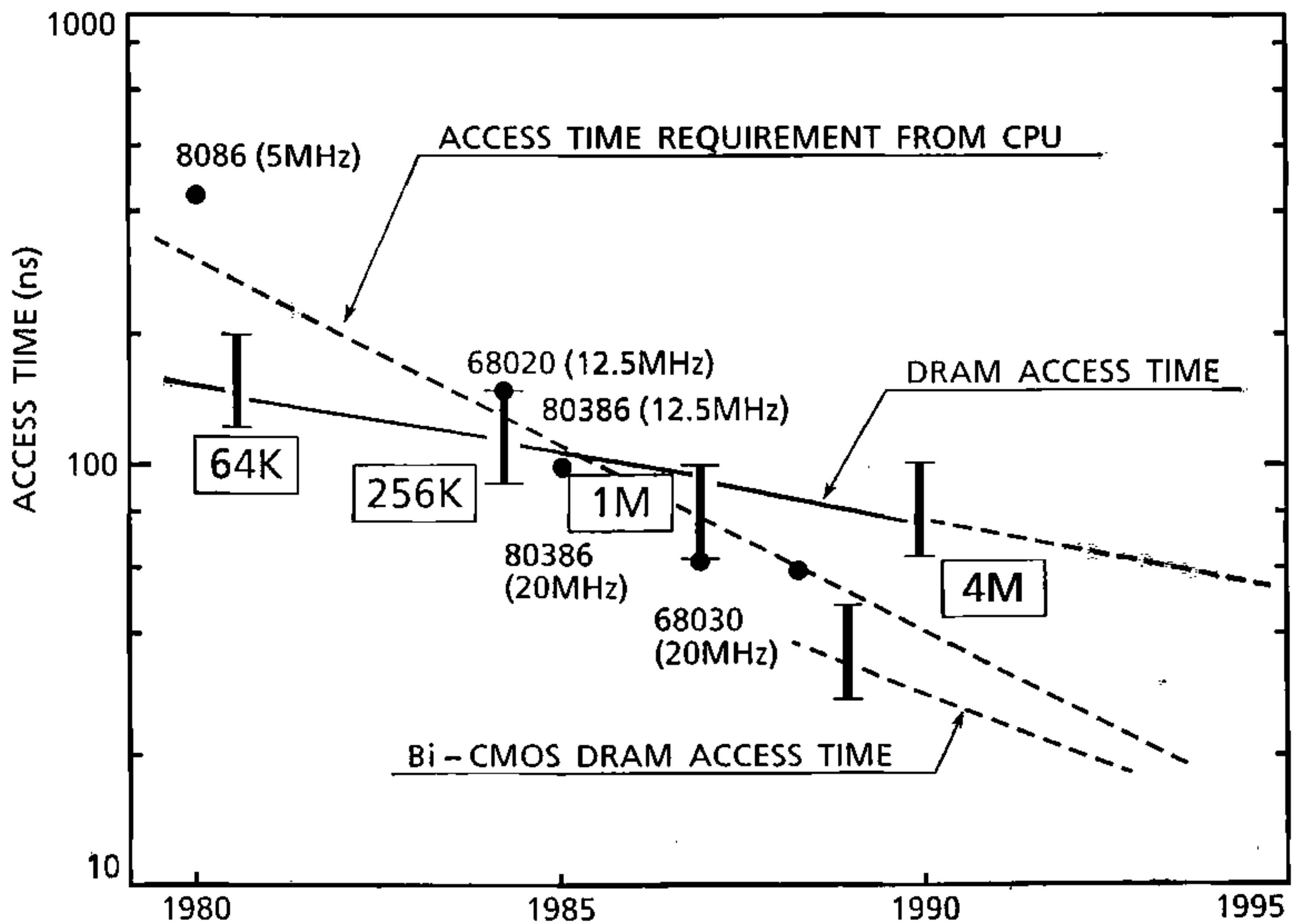
  GIVES 10 TIMES IMPROVEMENT

  IN VOLUME &

  DATA RETENTION CURRENT

- WIDE BIT, HIGH DENSITY DRAM / PSRAM IN HIGH DENSITY PACKAGE AND WITH LOW POWER SPEC IS A KEY TO FUTURE SMALL SYSTEM APPLICATIONS.

HIGHER SPEED IS EVER INCREASING REQUIREMENT



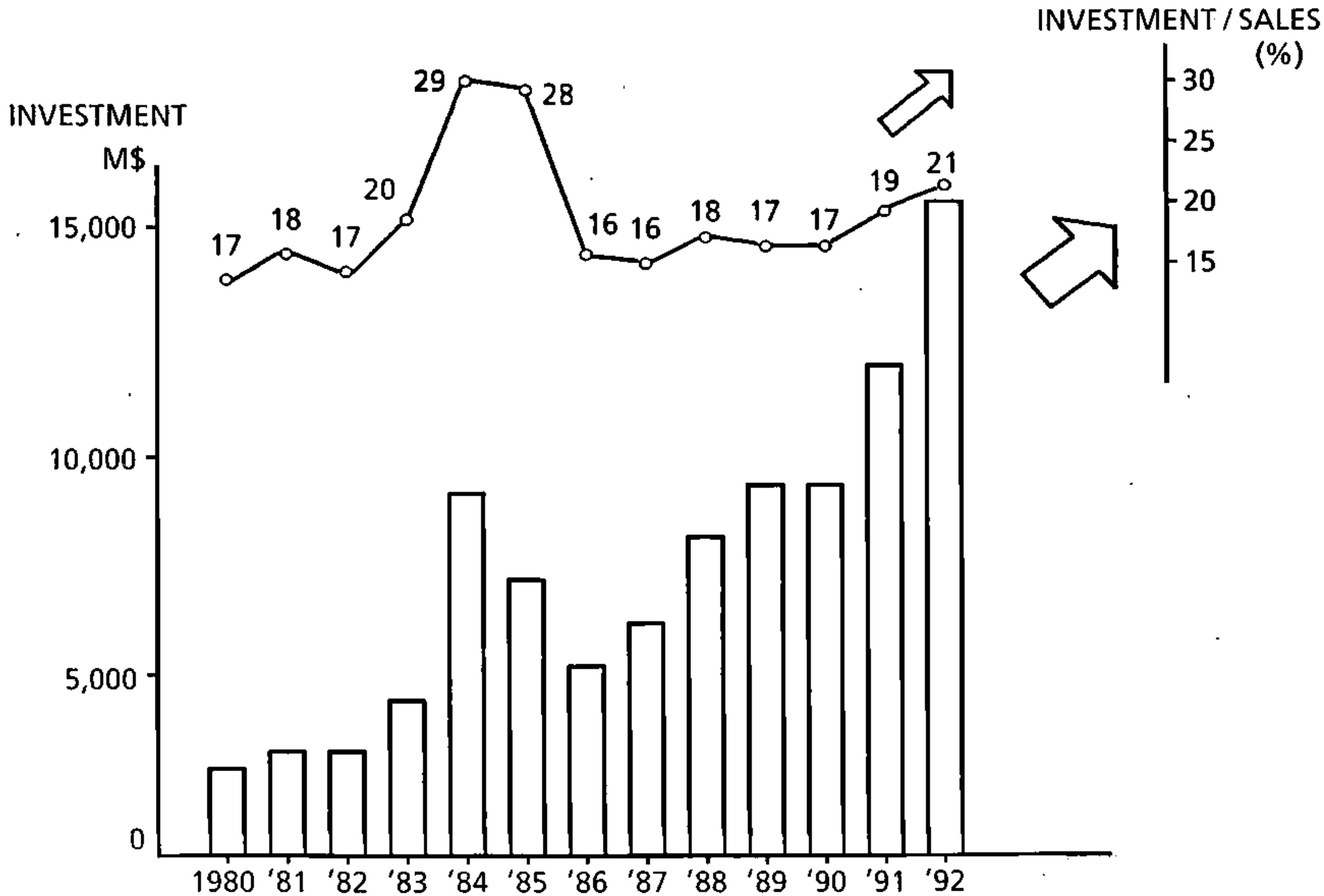
HITACHI

MEMORY AS BUSINESS OPERATION

- R&D INVESTMENT
- MANUFACTURING INVESTMENT
- TRADE ISSUES

HITACHI

HUGE INVESTMENT



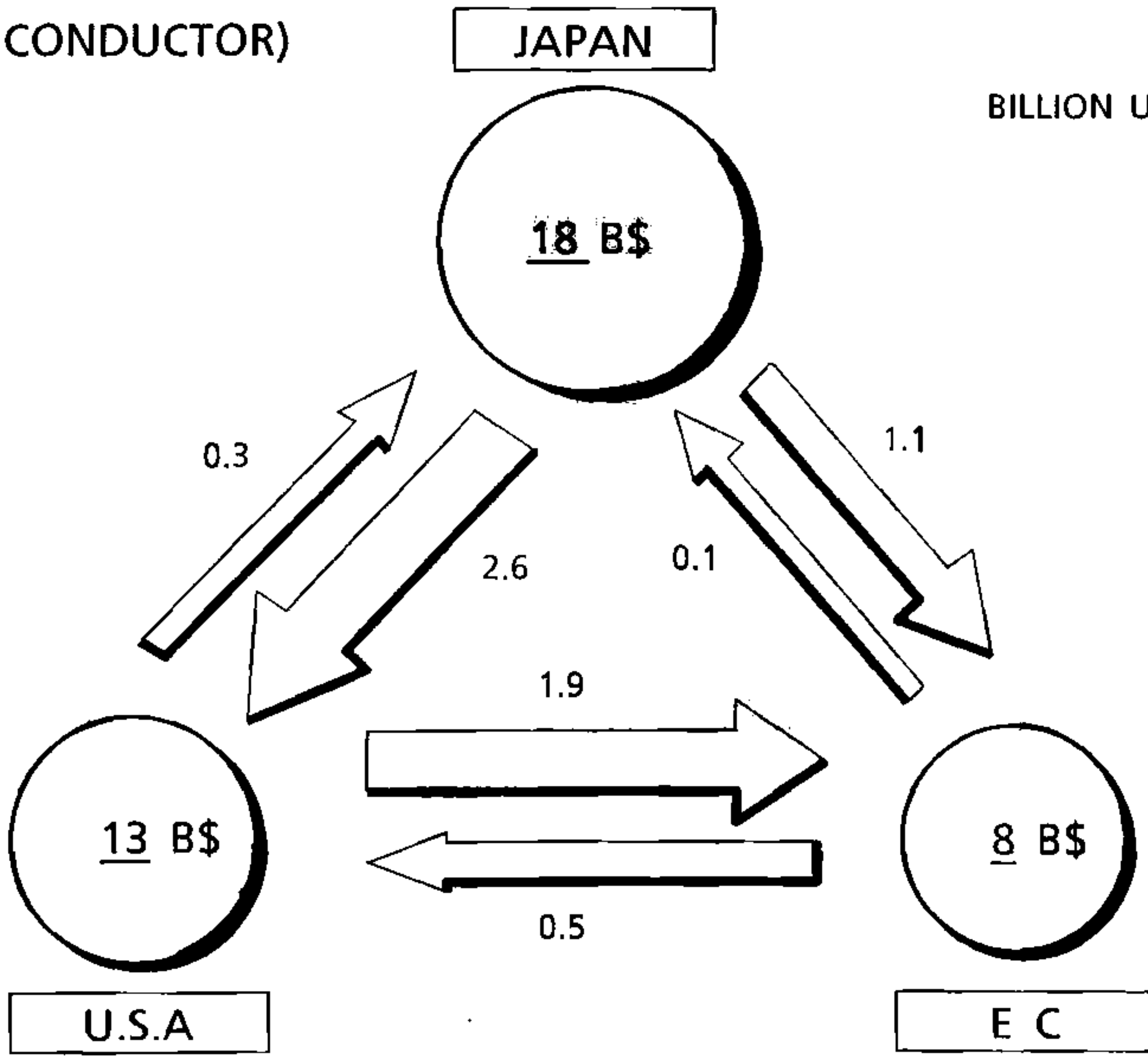
SOURCE: DATAQUEST

HITACHI

TRADE BALANCE BETWEEN USA, EC & JAPAN ('88)

(SEMICONDUCTOR)

BILLION US $



HITACHI

COMPETITON & COOPERATION

- 1990'S IS THE AGE OF **INTERNATIONAL BUSINESS INTERDEPENDENCE**

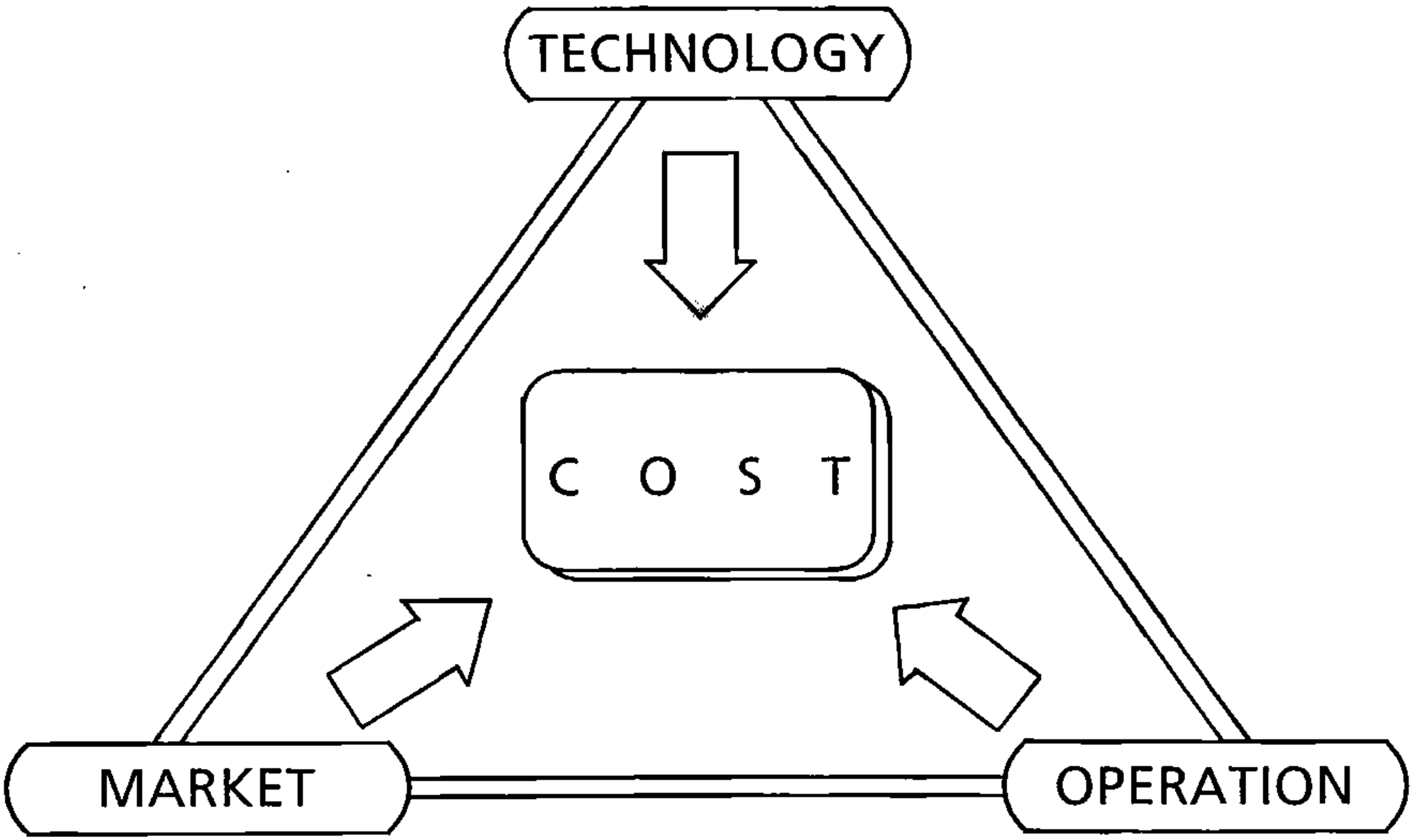
  – NO SINGLE MANUFACTURER CAN SATISFY EVERY SEGMENT OF FAST GROWING SEMICONDUCTOR DEMAND –

  - ALLIANCE
  - COOPERATION
  - JOINT INVESTMENT

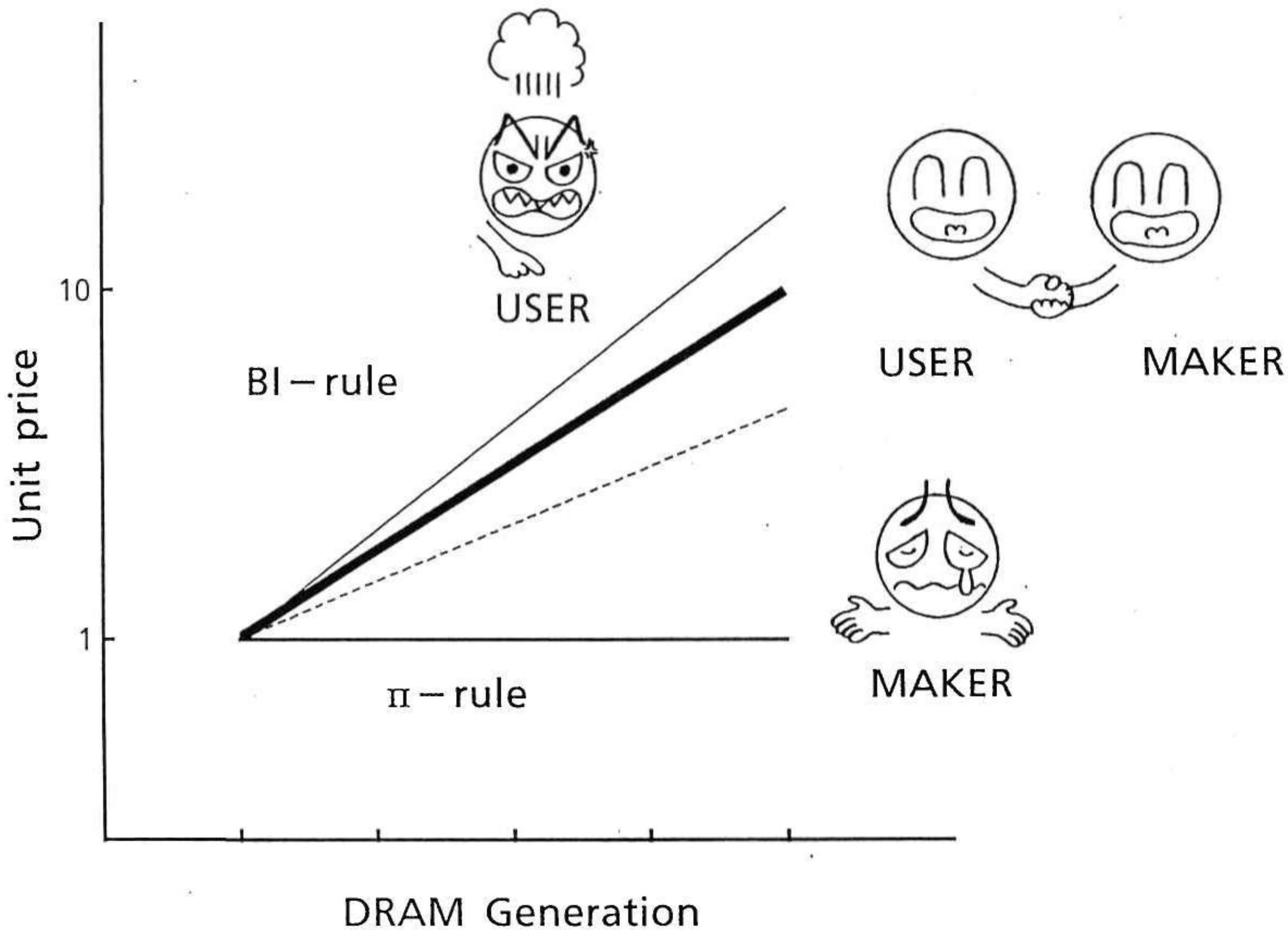
- ACTIVE PURSUIT OF " COMPETITION AND COOPERATION " IS REQUIRED BY OVERALL MARKET ENVIRONMENT THROUGH 1990'S.

HITACHI

ISSUES



INCREASING COST : BI or π



THE TREND OF NEW CONCEPT DEVICES

Dr. Hiroyoshi Komiya
General Manager
LSI Research and Development Laboratory
Mitsubishi Electric Corporation

Dr. Hiroyoshi Komiya is a General Manager of the LSI Research and Development Laboratory at Mitsubishi Electric Corporation. Prior to this position, he was General Manager of their Saijo Factory, which mass produces VLSI memories. Previously, at Mitsubishi's Kitaitami Works, Dr. Komiya managed the development of memories, microprocessors, and wafer processing technology. He also managed the design, development, and construction of fully automated manufacturing lines for the Saijo factory. Before that, he worked for Research and Development of LSI processing technology and of II - VI compounds as a senior researcher at Mitsubishi's Central Research Laboratories. Dr. Komiya received a B.S. Degree in Physics and a Ph.D. in Science from Kyushu University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

B8887000.IMG 03/05/90 JSI

ULSI Era:
Challenges and
Opportunities

The Trend of New Concept Devices

Dr. Hiroyoshi Komiya
General Manager
LSI Research and Development Laboratory
Mitsubishi Electric Corporation

TREND OF NEW CONCEPT DEVICES

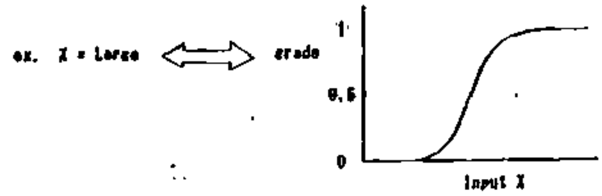
Hiroyoshi KOMIYA
LSI R&D Laboratory
Mitsubishi Electric Corporation

CONTENTS

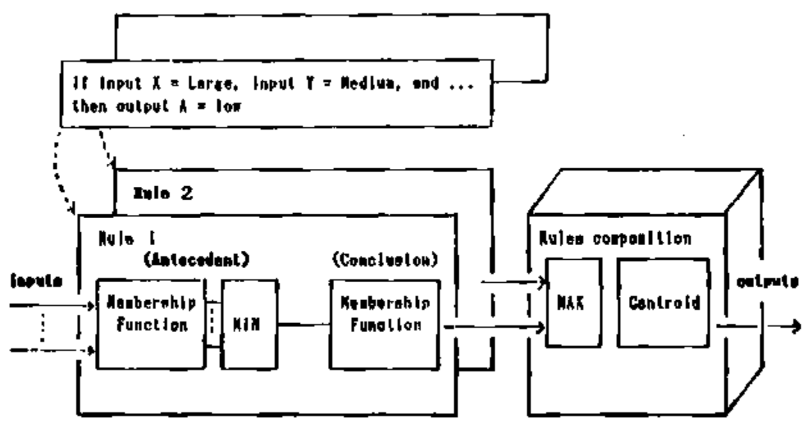
FUZZY CHIP (I)

□CONCEPT

Fuzzy Theory: Numerical Representation of Uncertainties using Membership Function



□STRUCTURE



FUZZY CHIP (II)

□FEATURES

- Fast Inference
- Incorporates Knowledge of Human Expertise in Systems
- Tolerates Discrepancies in Rules or External Noise

□APPLICATION

- Feedback Control
- Feeling-based Control
- Classification Control

FUZZY CHIP (III)

□PRESENT STATUS

- Digital Method

Example of Fuzzy Chip

Number of Rules	Unlimited
Membership Function	Arbitarary Configurable
Performance	58KFLIPS(=Fuzzy Logical Inference Per Second)
Inference Time	17μs (7 Rules,2 Inputs/1 Output)
	276μs (75 Rules,3 Inputs/2 Outputs)
Integration Scale	~60KTr
Clock Frequency	20MHz (1 Instruction/2 Clock Cycles)

- Analog Method
- Table Look-up

□PROBLEM

- Improving Fuzzy Chip Performance and Programmability
- Developing Suitable Application Area and Constructing Fuzzy Systems
- Providing System Development Tools

□FUTURE

- Growing Fuzzy Market
- Still need Fundamental Research on Fuzzy
- Combination of Fuzzy System with Neuro-Computer

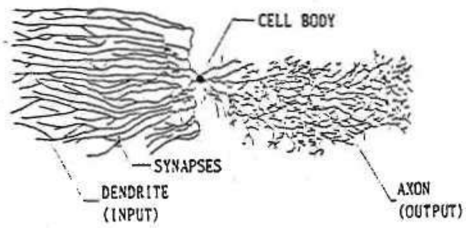
NEURO CHIP (I)

□CONCEPT

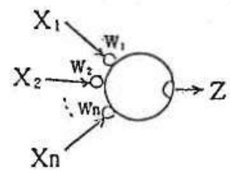
- Emulate the Human Brain and Nervous System
- Execute High Speed Operation
  by Learning without Programming or Algorithm

□STRUCTURE

- Neuron Model



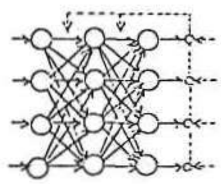
Biological Neuron



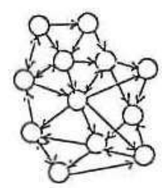
$$Z = f\left(\sum_i W_i X_i - h\right)$$

Xi : Input
(=Output from Other Neuron)
Wi : Synaptic Interconnection Strength
h : Threshold
f : Transfer Function
ex. Sigmoid Function
Z : Output

- Neural Networks Model



Back Propagation Model



Hopfield Model

NEURO CHIP (II)

□FEATURE

- Parallel Processing
- Self-Learning, Self-Organization
- Fault Tolerant
- Fuzzy Control Processing, Pattern Processing

□APPLICATION

- Pattern Matching
  - Recognition…Speech, Character, Image etc.
  - Synthesis………Speech
- Optimization Problem
  - Traveling Salesman Problem
  - Portfolio
  - Automatic Pattern Layout for ULSI Design

NEURO CHIP (Ⅲ)

□PRESENT STATUS

- ·Neuro—like Computor (Parallel Processing)
- ·Neuro Chip……R&D Phase

  Digital Neuro Chip (ATT, Hitachi etc.)

  Analog Neuro Chip (MIT, Matsushita etc.)

  Optical Neuro Chip (Mitsubishi etc.)

□PROBLEM

- ·Model
- ·Architecture of Massive Parallel Operation
- ·Device Technologies

□FUTURE

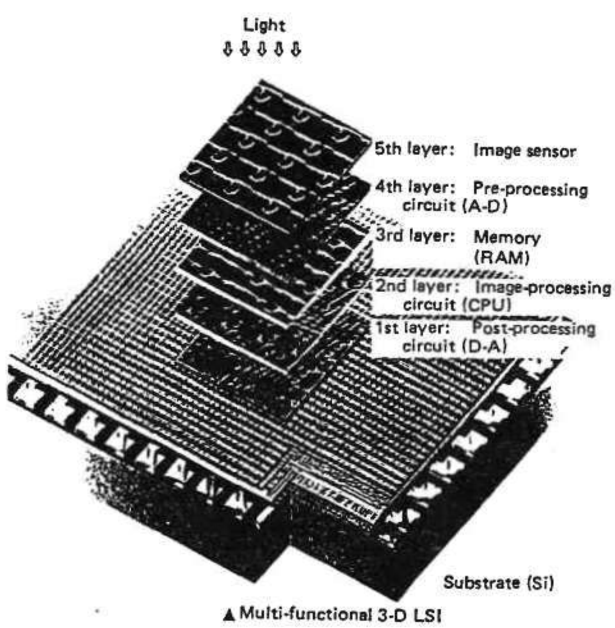
- ·Still need Fundamental Research Theory and Hardware
- ·Development Phase Applications
- ·Combination of Neuro and Fuzzy

THREE DIMENSIONAL IC (I)

□CONCEPT

Vertical Stacking of Active IC Layers

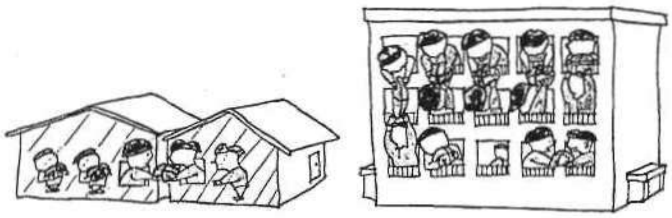
□STRUCTURE



▲Multi-functional 3-D LSI

THREE DIMENSIONAL IC (II)

□FEATURES



Conventional 2-D LSI   3-D LSI

- High Density by Multilayers
- High Speed Operation by Shorter Wiring and Small Capacitance
- Parallel Processing by Numerous Wiring Arranged Vertically
- Multi Functions by Assigned Each Active Layer

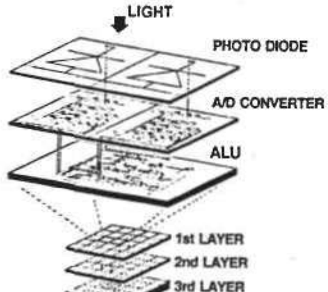
□APPLICATION

- High Density Logic & Memory
- Super Compact High Performance Signal Processing Equipment
- Intelligent Image Information Processor

THREE DIMENSIONAL IC (III)

□PRESENT STATUS

- High Density Devices
  - 64K-Bit SRAM…(TI)
    Pch/Nch Stacked CMOS
  - 8K-Bit SRAM……(Matsushita)
    4K-Bit CMOS Cell/4K-Bit CMOS Cell
  - 256-Bit SRAM…(Mitsubishi)
    CMOS Peripheral/NMOS Memory Cell
  - SRAM Cell…………(Mitsubishi)
    (0.6 μm Design Rule)
    Inter CMOS
- New Functional Devicees
  Image Signal Processor TEG (Mitsubishi)



□PROBLEM

- Still SOI and Other Basic Technologies under Development
- Long Processing Term for Production

□FUTURE

- Application to Simple Structured Device
- High Density Logic & Memory
- Intelligent Devices
  One Chip Image Processing with Super 3-D Chip Consisting of Monolothic Multilayer and Chip Bonding Structure

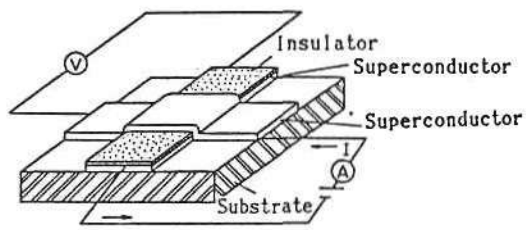
SUPERCONDUCTING DEVICE (I)

□CONCEPT

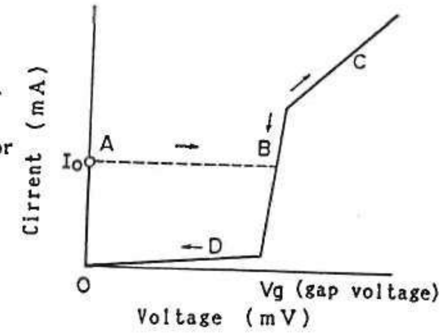
·Superconducting Effects in Cryogenic or Cooled Operation

□STRUCTURE

Josephson Device



Basic Structure



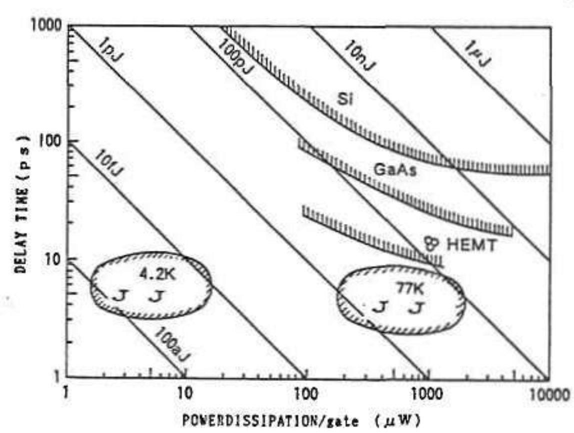
I—V Characteristics

SUPERCONDUCTING DEVICE (II)

□FEATURES

·High Speed Switching

·Low Power Dissipation



□APPLICATION

·High Speed/Low Power Consumption Logic

·Huge Scale Memory

·Wiring for Wafer Scale Integration

SUPERCONDUCTING DEVICE (Ⅲ)

□PRESENT STATUS

Josephson Device
- ·4Kbit RAM
- ·2K Gate Array
- ·4bit CPU (Hitachi, Fujitsu)
- ·8bit DSP (Fujitsu)

Superconducting Transistor

Quantum Flux Parametron

□PROBLEM

- ·Liq. He Temperature Operation
- ·Incompatibility with Semiconductor

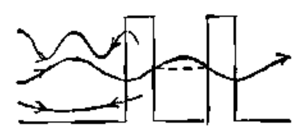
□FUTURE

- ·High Temperature Operation ex. Liq. N_2
- ·Hybrid of Semiconductor with Superconductor

QUANTUM DEVICE (Ⅰ)

□CONCEPT

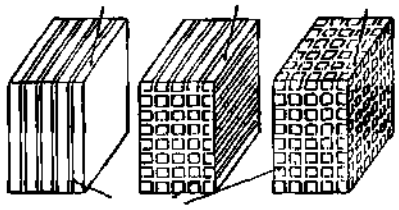
·Functional Device Using Wave Nature of Electrons Confined in a Quantum Sized Area



Resonant Tunneling Effect

□STRUCTURE

·Quantum Well, Quantum Wire, Quantum Box, by Super Lattice Structure
Lattice Period Longer than That of Semiconductor Crystal
Very Thin Film with Only One Hetero Interface



(a) Quantum Well Structure

(b) State Density vs Energy ($P(\varepsilon)$ vs ε)

QUANTUM DEVICE (Ⅱ)

□FEATURE

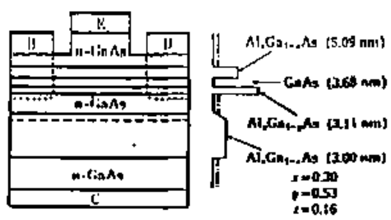
- Ultra High Speed
- Low Power Dissipation
- Very Small Size

□APPLICATION

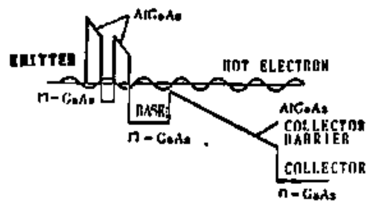
- Opto—Device
- High Speed, High Density Logic Circuit
- Ultra High Capacity Memory

□PRESENT STATUS

- Development Phase…Super Lattice HEMT
- Research Phase
  …Incoherent Elecrtron Waves (Tunneling, Resonance)
  Hot Electron Transistor
  Resonant Tunneling Hot Electron Transistor (RHET)
- Exploratory Research Phase
  ……Coherent Electron Waves (Interference, Diffraction)
  Quantum Interference Transistor



Layer Structure



Energy Band Structure

Resonant Tunneling Hot Electron Transistor (RHET)

QUANTUM DEVICE (Ⅲ)

□PROBLEM

- Fabrication Technology
- Si Based Material System
  Instead of Ⅲ—V Compound Semiconductors
- High Operating Temperature
  ex. Liq. N_2
- Circuit Disign Technology/CAD

□FUTURE

- New IC Technology for 0.1~0.01μm
- Brain Scale Integration & Intelligent System on Chip

Research and Development Schedule of Future Electron Device Project

<table>
<tr><th>Fiscal year</th><th>'81</th><th>'82</th><th>'83</th><th>'84</th><th>'85</th><th>'86</th><th>'87</th><th>'88</th><th>'89</th><th>'90</th><th>'91 ~ '95</th><th>'96~</th></tr>
<tr><td>Superlattice Devices</td><td colspan="4">Phase 1
Develope heteroepitaxial growth of atomic layer</td><td colspan="3">Phase 2
Propose novel devices using superlattices</td><td colspan="3">Phase 3
Demonstrate the performance of device</td><td colspan="2"></td></tr>
<tr><td>Three-Dimensional IC's</td><td colspan="4">Phase 1
Develope SOI technology and 3D-IC process technologies</td><td colspan="3">Phase 2
Progress process tech. & fabricate 3D-IC TEG</td><td colspan="3">Phase 3
Fabricate prototype 3D-IC's</td><td colspan="2"></td></tr>
<tr><td>Bio-Electronic Devices</td><td colspan="4"></td><td colspan="6">Phase 1
Model biological information process
Develope molecular assembly technique</td><td>Demonstrate & fabricate prototype bioelectronic devices</td><td></td></tr>
<tr><td>HiTc-Superconducting Devices</td><td colspan="7"></td><td colspan="3">Phase 1
Construct device concept
Develope high quality film preparation and control technologies</td><td>Phase 2
Fabricate device test elements
Develope microfabrication & processing technologies</td><td>Phase 3
Fabricate prototype HiTc-superconducting devices</td></tr>
</table>

CONCLUSION

Item＼Phase	Present	Future
Fuzzy	Fuzzy Inference Software	Fast Inference ➡ Fuzzy Chip
Neuro	Neural Network (General Purpose CPU) (Special Purpose CPU) Pseudo–Neuro Chip	Step by Step
3–D	Development Phase (Device Technologies)	Application to Simple Structured Device
Super–conducting	R&D Phase	Development Phase High Speed Computer High Tc Operation
Quantum Device	Research Phase (Transistor Level)	R&D Phase (IC Level)

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a company of
The Dun & Bradstreet Corporation

RAMPING UP OF THE LSI BUSINESS

Nobutsune Hirai
Managing Director
Kawasaki Steel Corporation

Nobutsune Hirai is Managing Director of Kawasaki Steel Corporation. He is also Assistant General Manager of their New Business Division, and General Manager of its LSI Works Construction Team. Mr. Hirai has served as General Manager of various departments and divisions including the Planning and Development Department, New Business Division; LSI Department; the New Materials Department; the Planning Department, Mizushima Works; the Plate Rolling and Shape and Bar Rolling Departments, Mizushima Works. He was also Staff Assistant General Manager of the Systems Planning Section of the Systems Planning and Data Processing Department at Mizushima Works. Mr. Hirai received a Bachelor of Engineering in Metallurgy from Kyushu University, Fukuoka, Japan.

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ULSI Era:
Challenges and
Opportunities

Ramping Up of the LSI Business

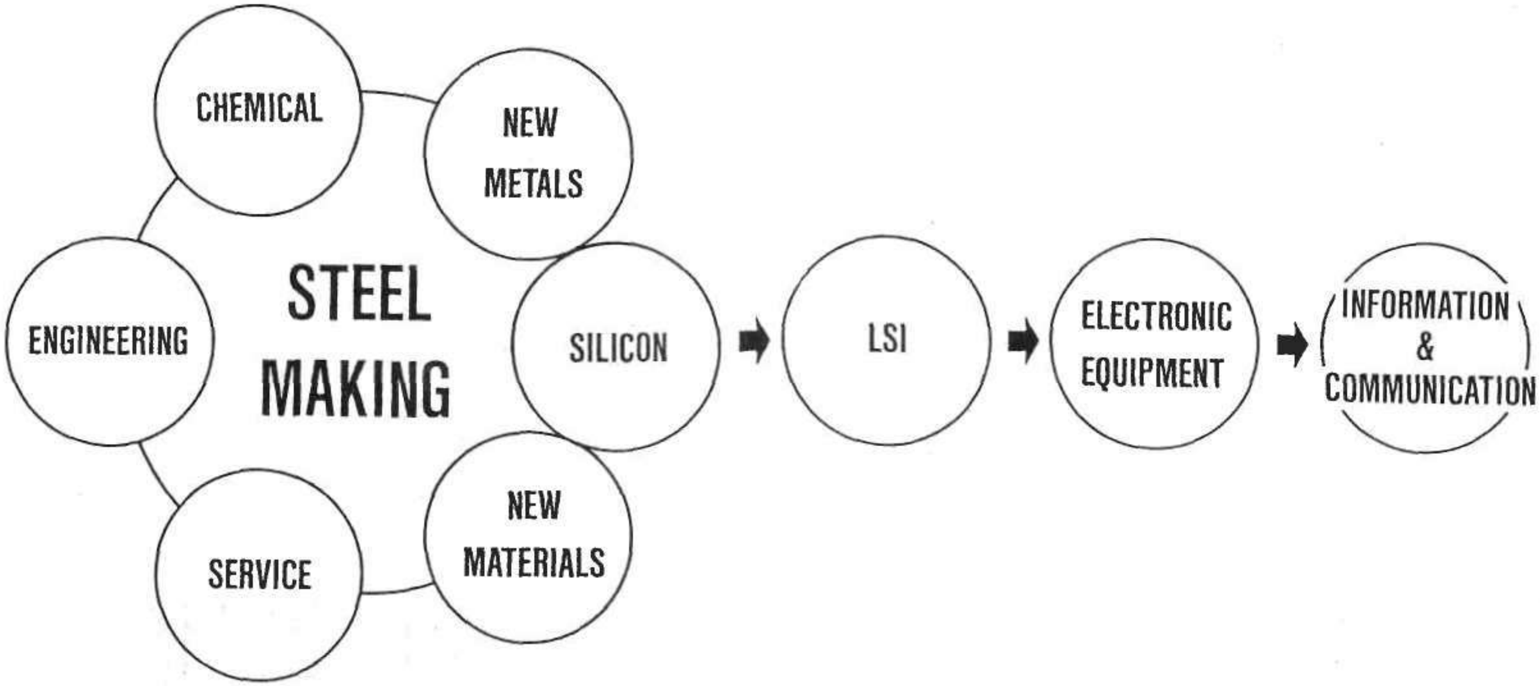
Nobutsune Hirai
Managing Director
Kawasaki Steel Corporation

ACCELERATING DEVELOPMENT OF LSI BUSINESS

NOBUTSUNE HIRAI
MANAGING DIRECTOR
NEW BUSINESS DIVISION
KAWASAKI STEEL CORPORATION

KAWASAKI STEEL

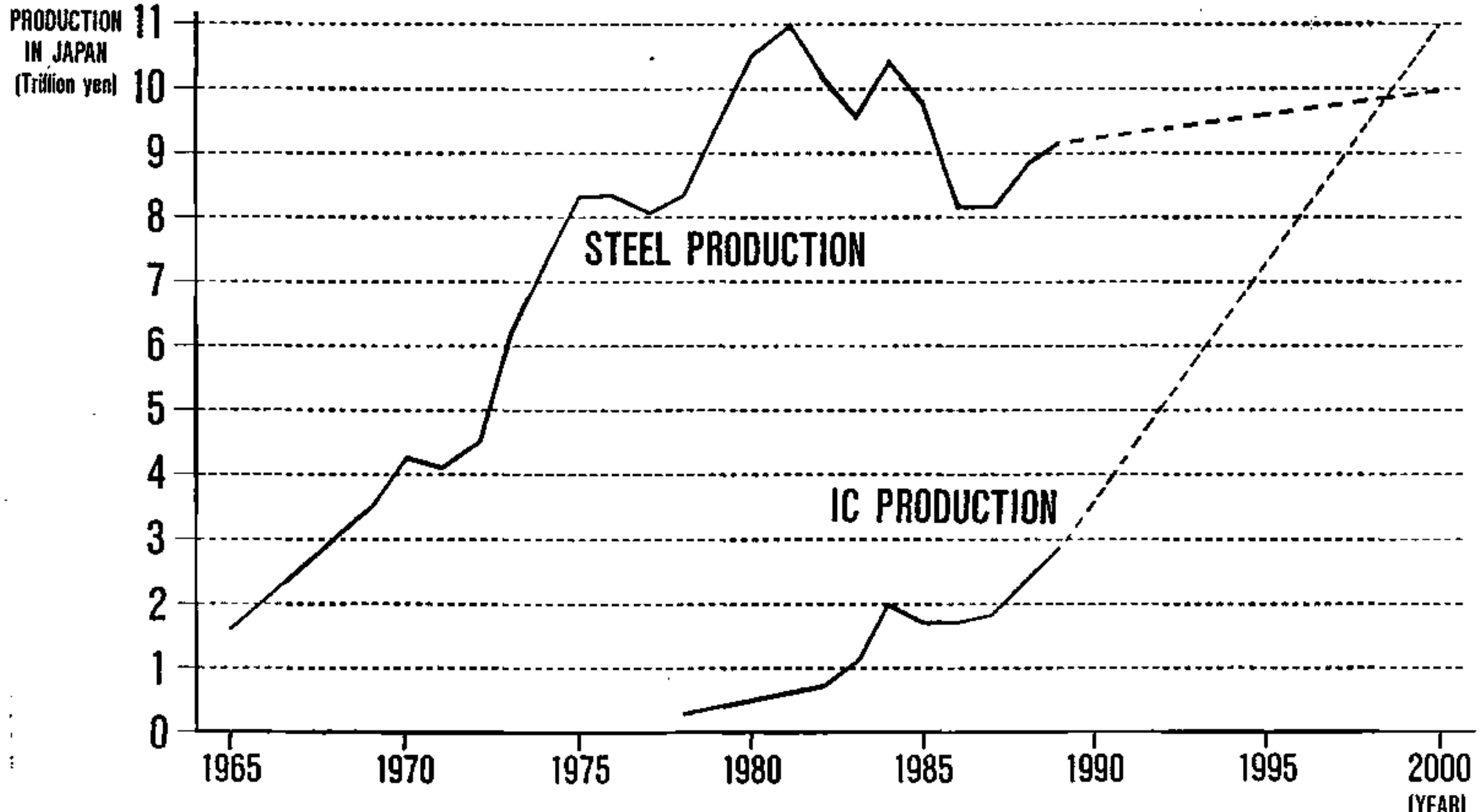
BUSINESS DIVERSIFICATION AT KAWASAKI STEEL



KAWASAKI STEEL

WHY KAWASAKI STEEL DECIDED TO GO INTO LSI INDUSTRY (1)

—MARKET VOLUME & GROWTH RATE OF LSI INDUSTRY



(Data Source: MITI, The Bank of Japan)

KAWASAKI STEEL

WHY KAWASAKI STEEL DECIDED TO GO INTO LSI INDUSTRY (2)

—— FAMILIARITY WITH MANUFACTURING

—— SIMILARITY FROM INDUSTRIAL VIEWPOINT

"RICE" OF INDUSTRY	"NEW RICE" OF INDUSTRY
STEEL	LSI

ENTRY STRATEGY

"TARGET ASICs"

- Niche Market in Japan in 1985
- To Avoid Competition with Major Players

↓

ESTABLISHED "NIHON SEMICONDUCTOR, INC." AS JOINT VENTURE WITH LSI LOGIC CORPORATION

- In View of Benefit to U.S.-Japan Industrial Cooperation
- Parachute to the Front of "LSI MANUFACTURING"

NIHON SEMICONDUCTOR, INC.

8/1985: Established as J/V of LSI LOGIC (55%) and KAWASAKI STEEL (45%)

10/1987: Started Commercial Production of Masterslices

8/1988: Started Commercial Production of Metalized Wafers

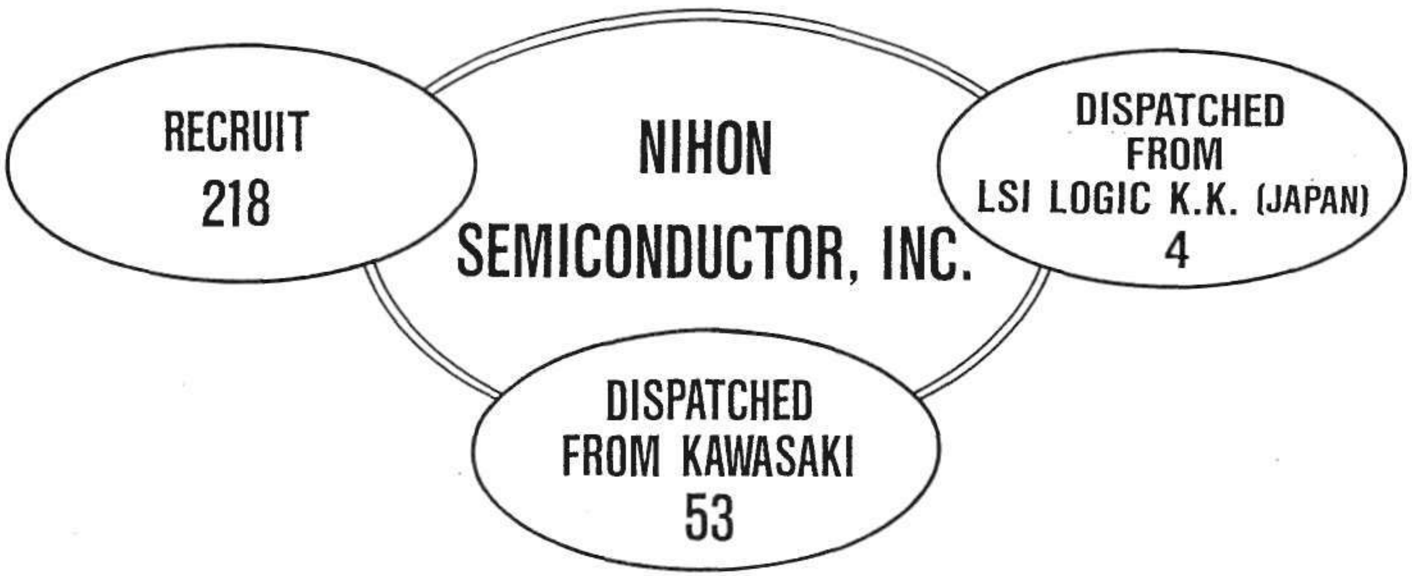
1989: Generated Operating Income

1990: Expected to clear off Accumulated Losses

KAWASAKI STEEL

NIHON SEMICONDUCTOR, INC.

HUMAN RESOURCES—"MANAGEMENT BY JAPANESE"



KAWASAKI STEEL

MEANING OF NIHON SEMICONDUCTOR, INC. TO KAWASAKI STEEL

- LSI MANUFACTURING KNOW-HOW
- PRODUCTION CONTROL TECHNOLOGY OF STEEL MAKING

↓

KAWASAKI OBTAINED CONFIDENCE TO DEVELOP ITS OWN LSI BUSINESS

KAWASAKI STEEL

LSI RESEARCH CENTER

10/1986: Established LSI RESEARCH CENTER in TECHNICAL RESEARCH DIVISION

7/1987: LSI Pilot Line in LSI RESEARCH CENTER started operation

— Number of Researchers: 124 (3/1990)

— Plan to create a new facility for Fundamental Research & Next Generation Technology Research

TOCHIGI FACTORY

1985
NIHON SEMICONDUCTOR, INC.
—PARACHUTE INTO LSI MANUFACTURING

1986
LSI RESEARCH CENTER
—TYPICAL LSI R & D

1990
TOCHIGI FACTORY
—DEVELOPMENT OF KAWASAKI'S OWN LSI BUSINESS

TOCHIGI FACTORY

START OF OPERATIONS : July 1990

CONSTRUCTION COST : ¥28 billion ($200 million)

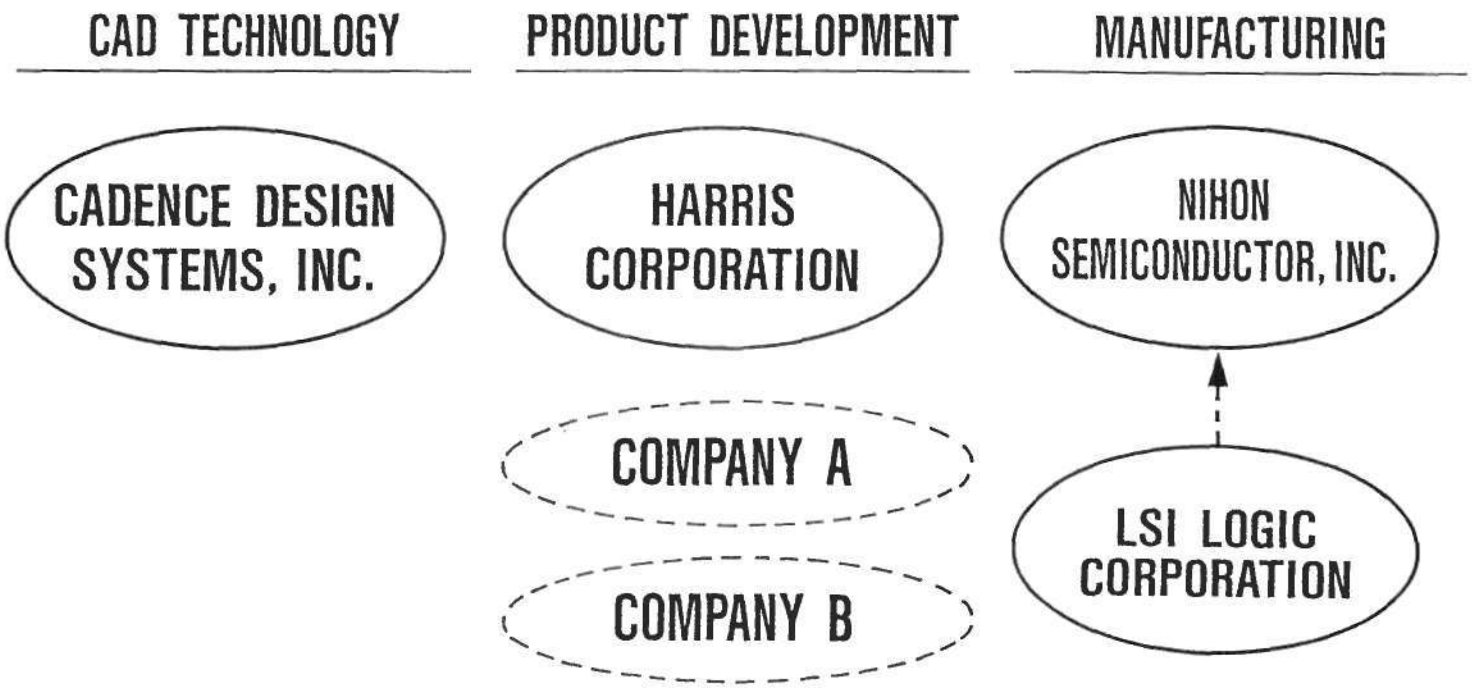
PRODUCTION CAPACITY : 10,000 wafers/month (6 inch wafers)

NUMBER OF EMPLOYEES : 200 (in 1994)

PRODUCTS : Especially ASICs (ASSPs, ASCPs)

KAWASAKI STEEL

ALLIANCES



KAWASAKI AGGRESSIVELY SEEKS ALLIANCES WITH LEADING COMPANIES

KAWASAKI STEEL

KEY TASKS FOR KAWASAKI STEEL

- ENHANCEMENT OF PRODUCT DEVELOPMENT CAPABILITIES

- ESTABLISHMENT OF DISTRIBUTION CHANNELS & DESIGN CENTERS

ENHANCEMENT OF PRODUCT DEVELOPMENT CAPABILITIES

—TARGET AREAS FOR ASIC PRODUCTS

- Digital Signal Processing
- Image Processing

—ASIC PRODUCT DEVELOPMENT

- Self-Development
- Joint Development with other Semiconductor Manufacturers
- Joint Development with LSI Design Companies
- Joint Development with Customers

—FEEDBACK FROM KAWASAKI INTERNAL CONSUMPTION

- Electronic Equipment Business
- Information & Communication Business

ESTABLISHMENT OF DISTRIBUTION CHANNELS & DESIGN CENTERS

- Establishment of Distribution Channels

- First Design Center is established at Makuhari Techno Garden (Chiba)

- Other Design Center Locations scheduled

KAWASAKI STEEL

HALF-MICRON LITHOGRAPHY

Shoichiro Yoshida
Senior Managing Director
Nikon Corporation

Shoichiro Yoshida is Senior Managing Director at Nikon Corporation. Prior to this he was Managing Director. Mr. Yoshida joined Nippon Kogaku K.K. (Nikon Corporation after April 1988) in 1956 and has held several managerial positions including, President, Nikon Precision, Inc.; Member of the Board and Director of their Industrial Supplies & Equipment Division; General Manager, Designing Department, Industrial Supplies & Equipment Division; Mr. Yoshida was elected Director of the Semiconductor Equipment Association of Japan in May 1989. He was appointed Project Director, YOSHIDA Nano-Mechanism Project Research Development Corporation of Japan in October 1985. Mr. Yoshida graduated in Precision Engineering from the Department of Technology at Tokyo University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

ULSI Era:
Challenges and
Opportunities

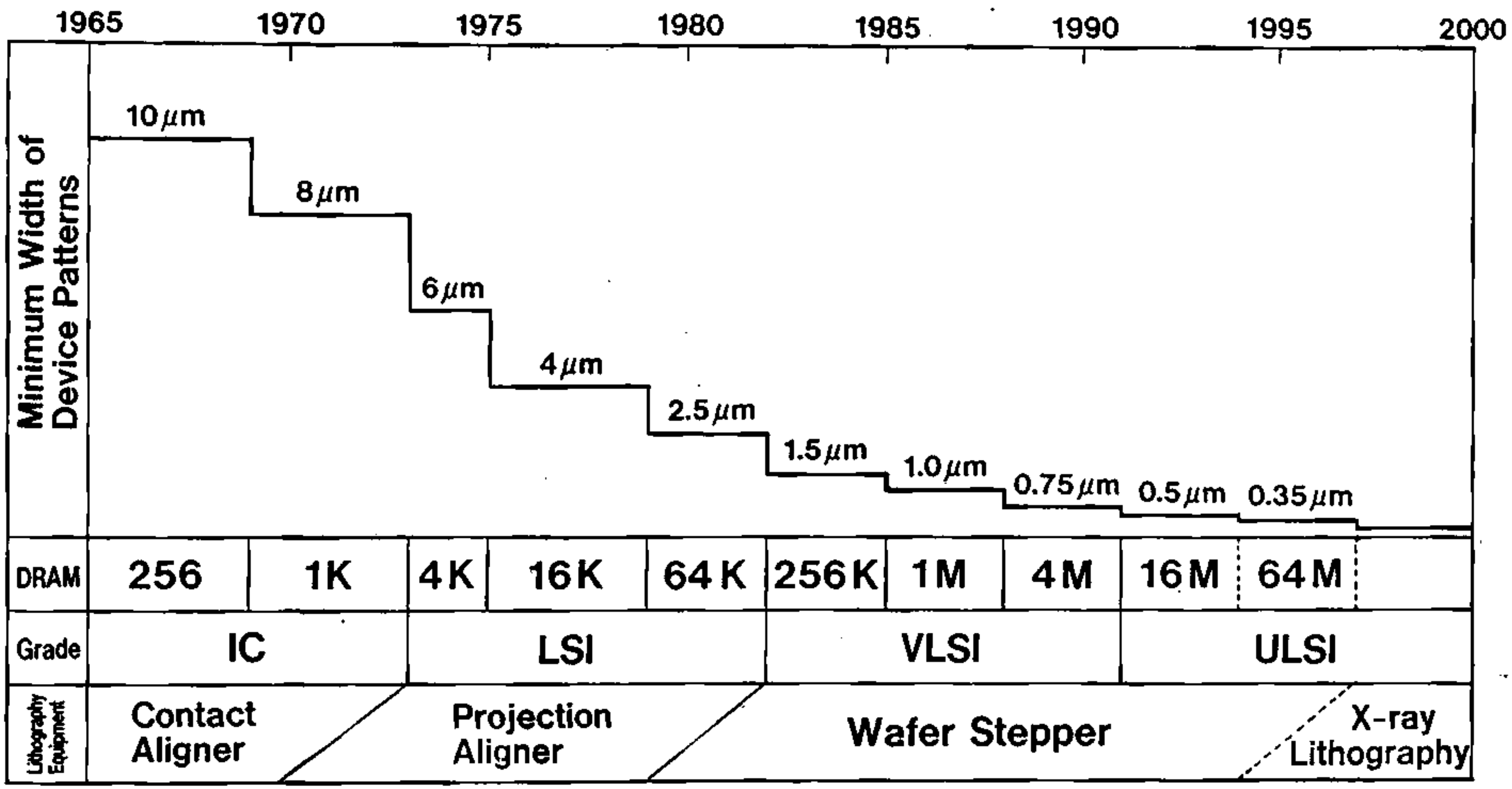
Half-Micron Lithography

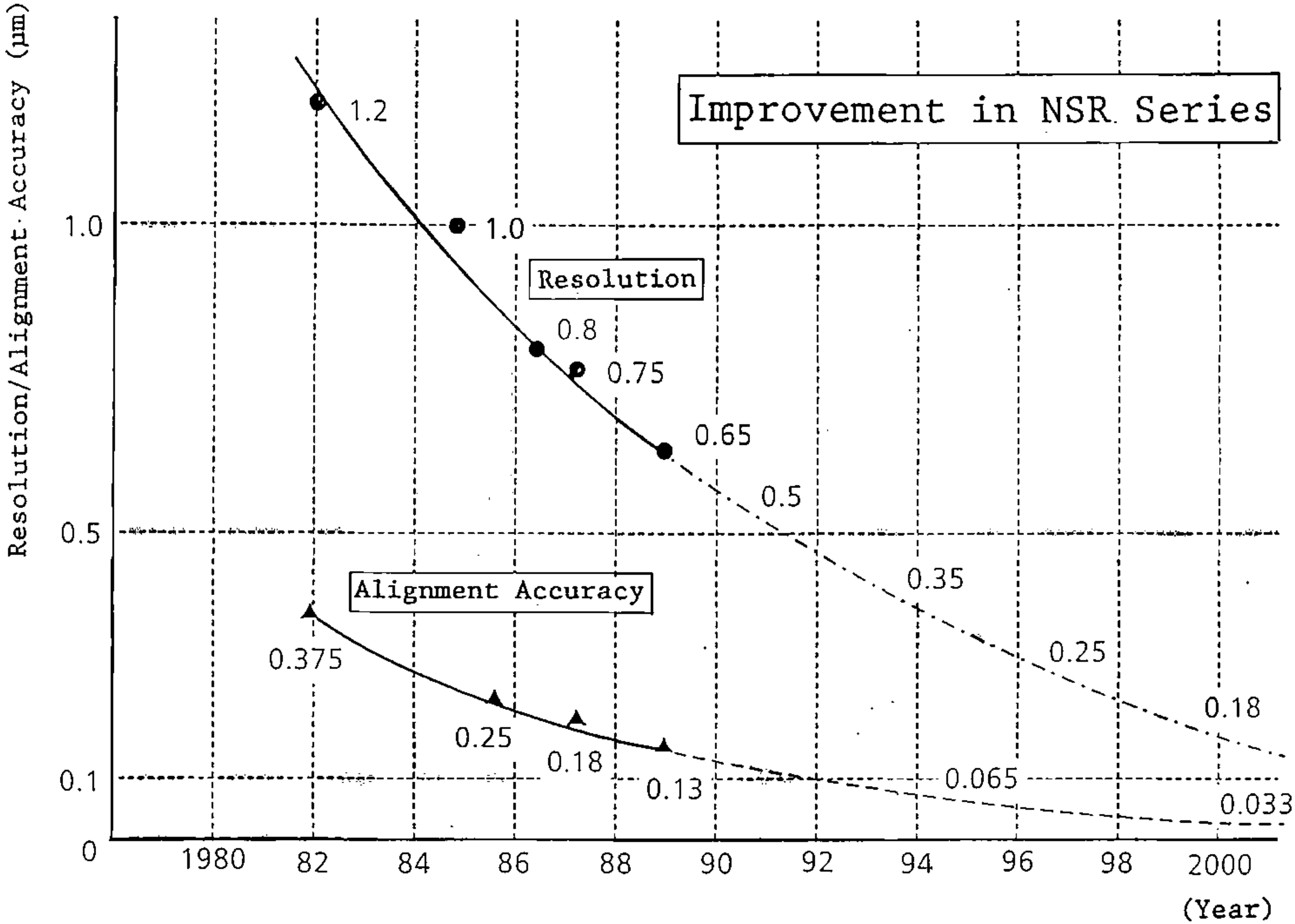
Shoichiro Yoshida
Senior Managing Director
Nikon Corporation

Lithography in 0.5 μm Era

Shoichiro Yoshida
Nikon Corporation
Senior Managing Director

Tendensy of Micronization of VLSI Patterns

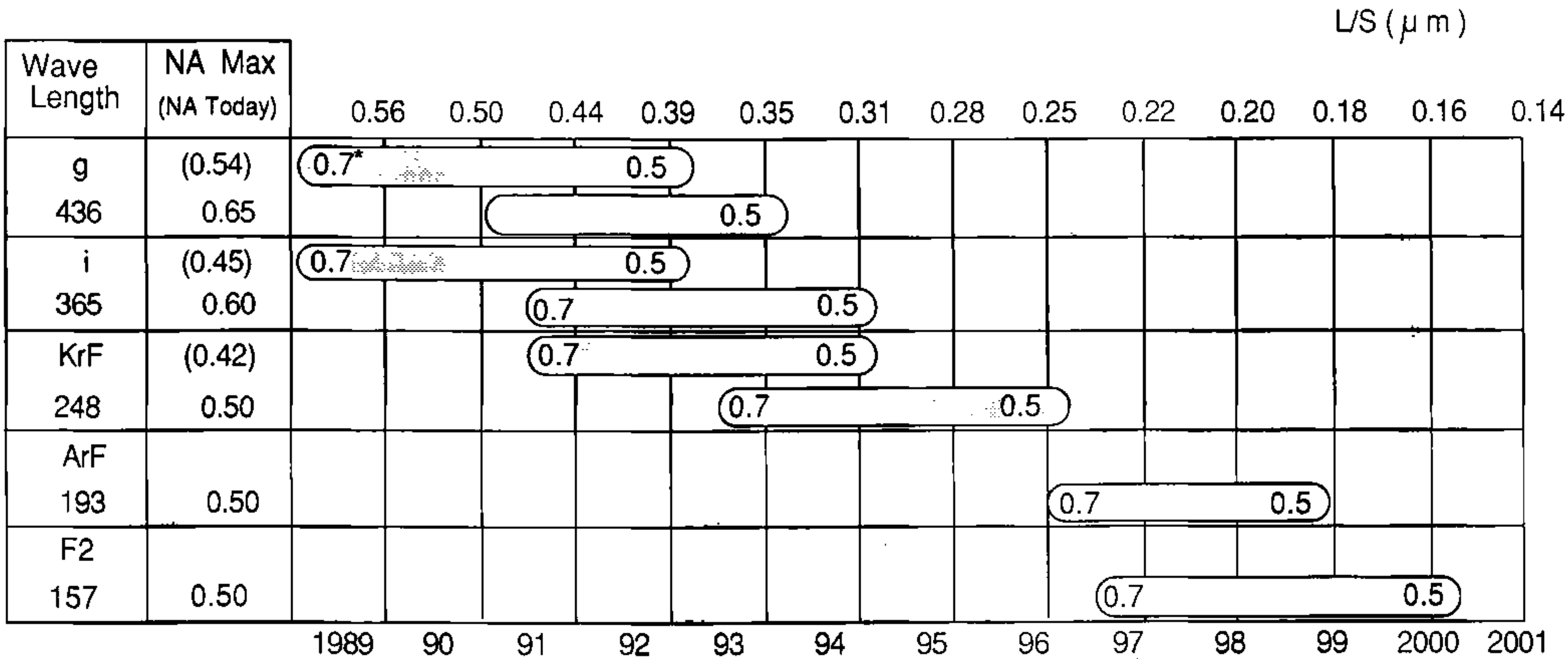



Improvement in NSR Series
Resolution/Alignment Accuracy (μm)
Resolution
Alignment Accuracy
1.2
1.0
0.8
0.75
0.65
0.5
0.35
0.25
0.18
0.375
0.25
0.18
0.13
0.065
0.033
1.0
0.5
0.1
0
1980
82
84
86
88
90
92
94
96
98
2000
(Year)

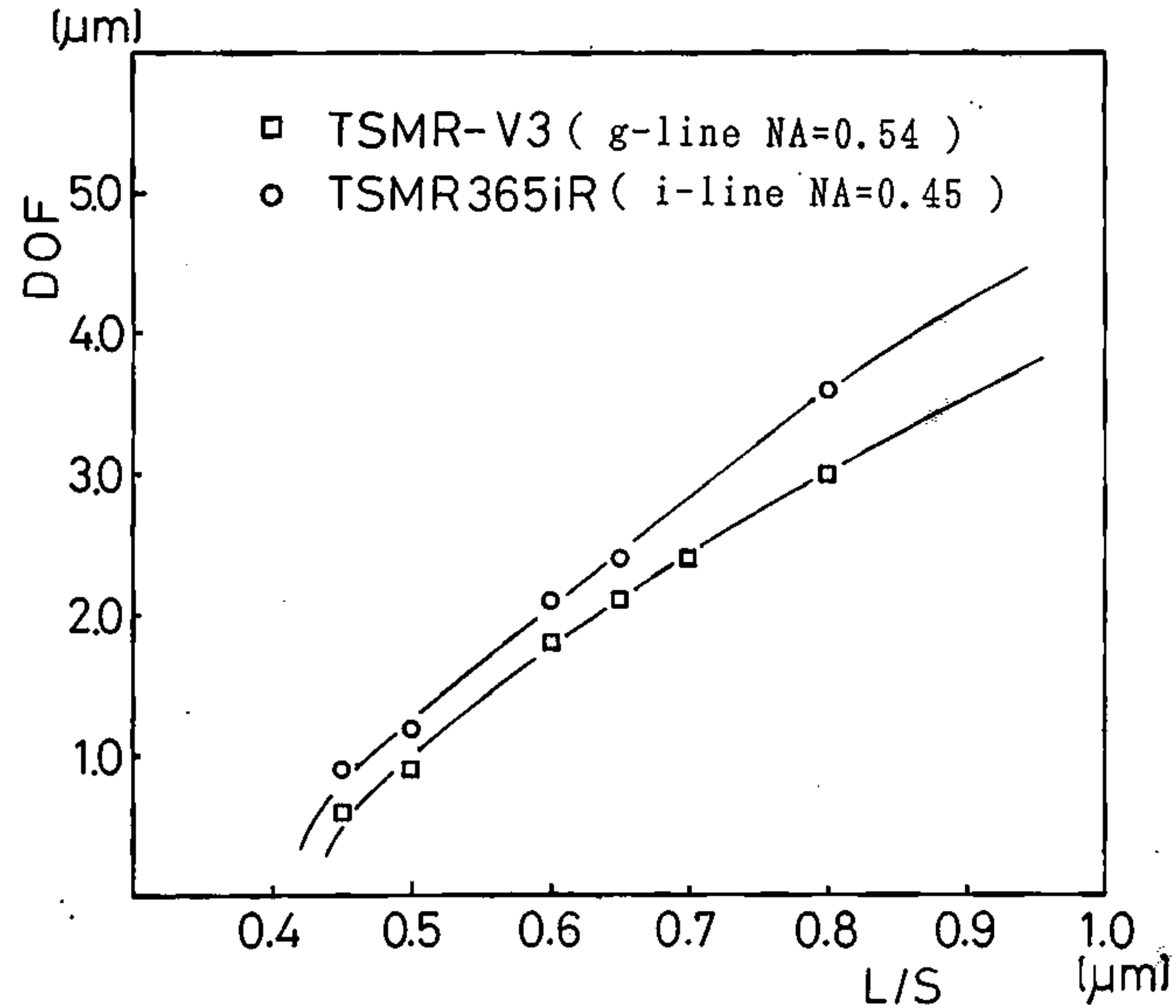
Resolution and Focus Depth

$$R = K_1 \lambda / NA \quad \text{.........} (1)$$

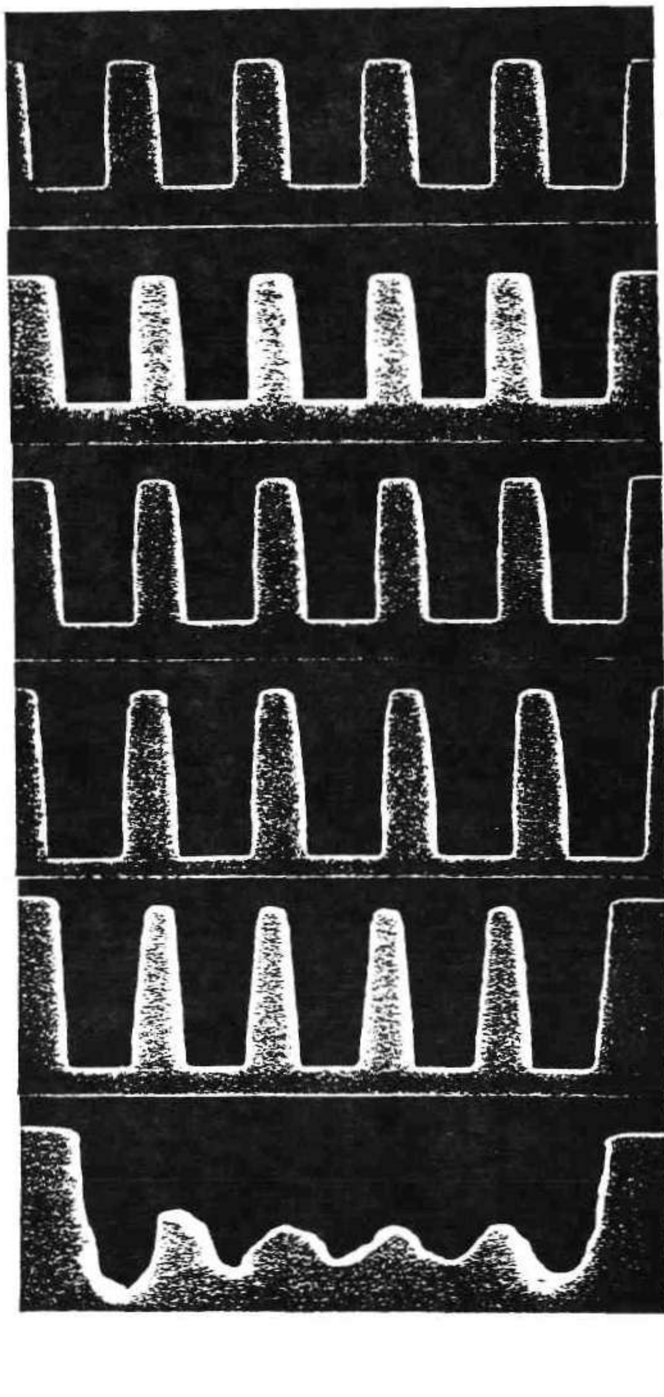
$$D = K_2 \lambda / (NA)^2 \quad \text{......} (2)$$



* Process Coef. K1



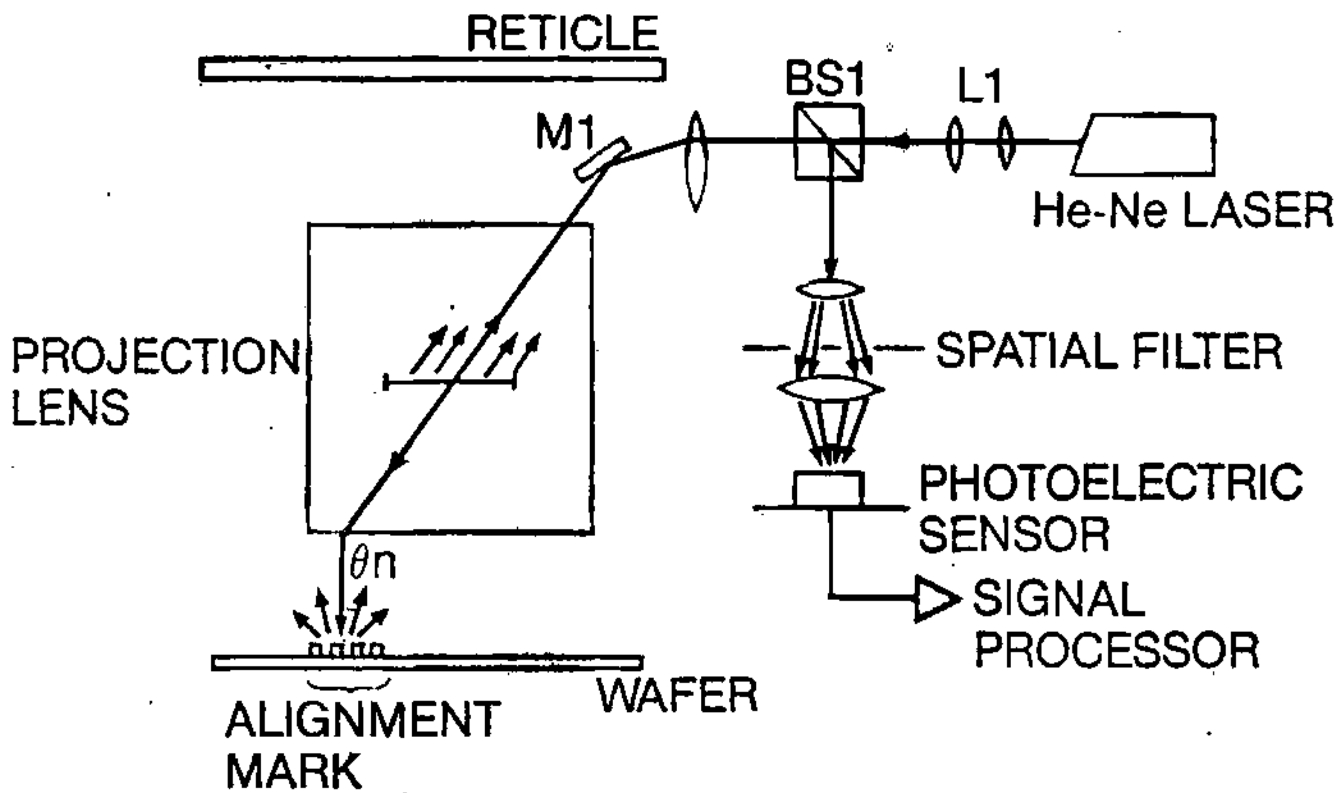
The Depth of Focus for Various L/S Patterns



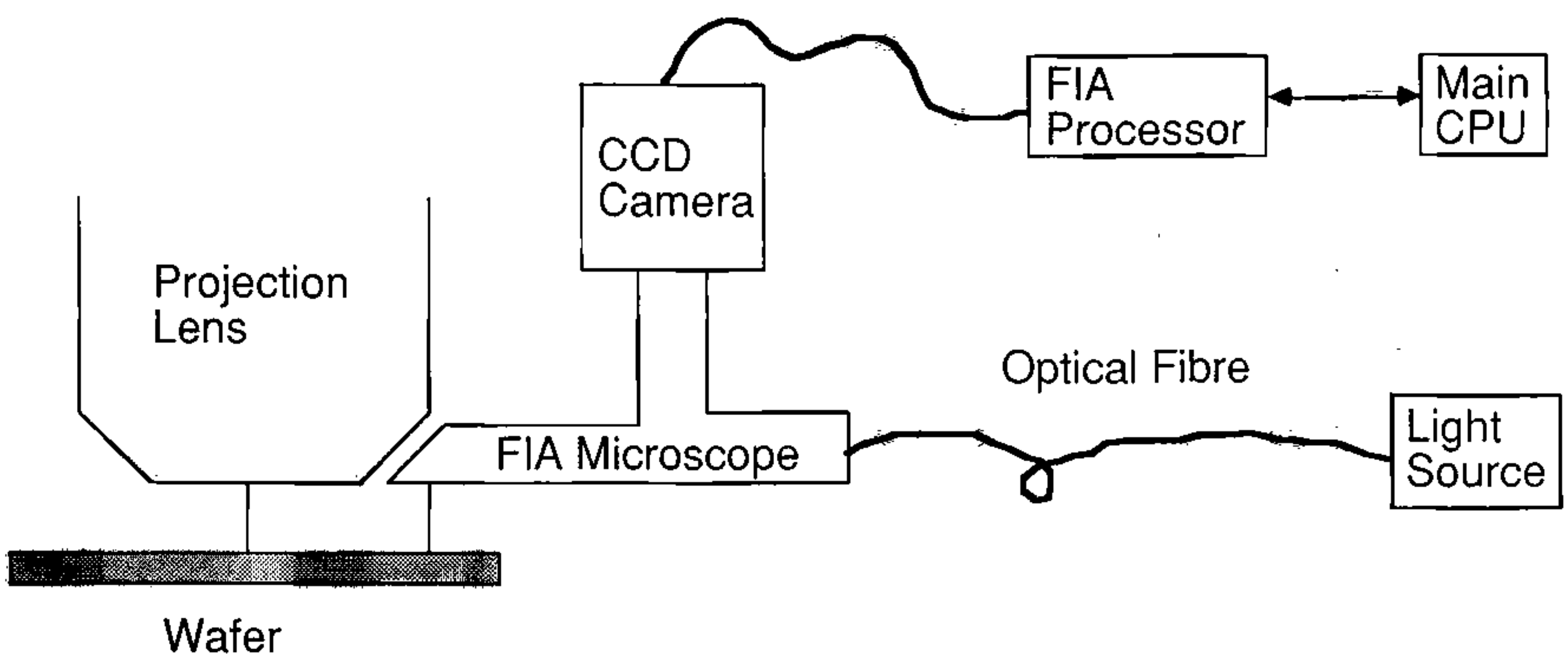
Resist Profiles of Various Line Width

TSMR 365-1.2µmt (Center)

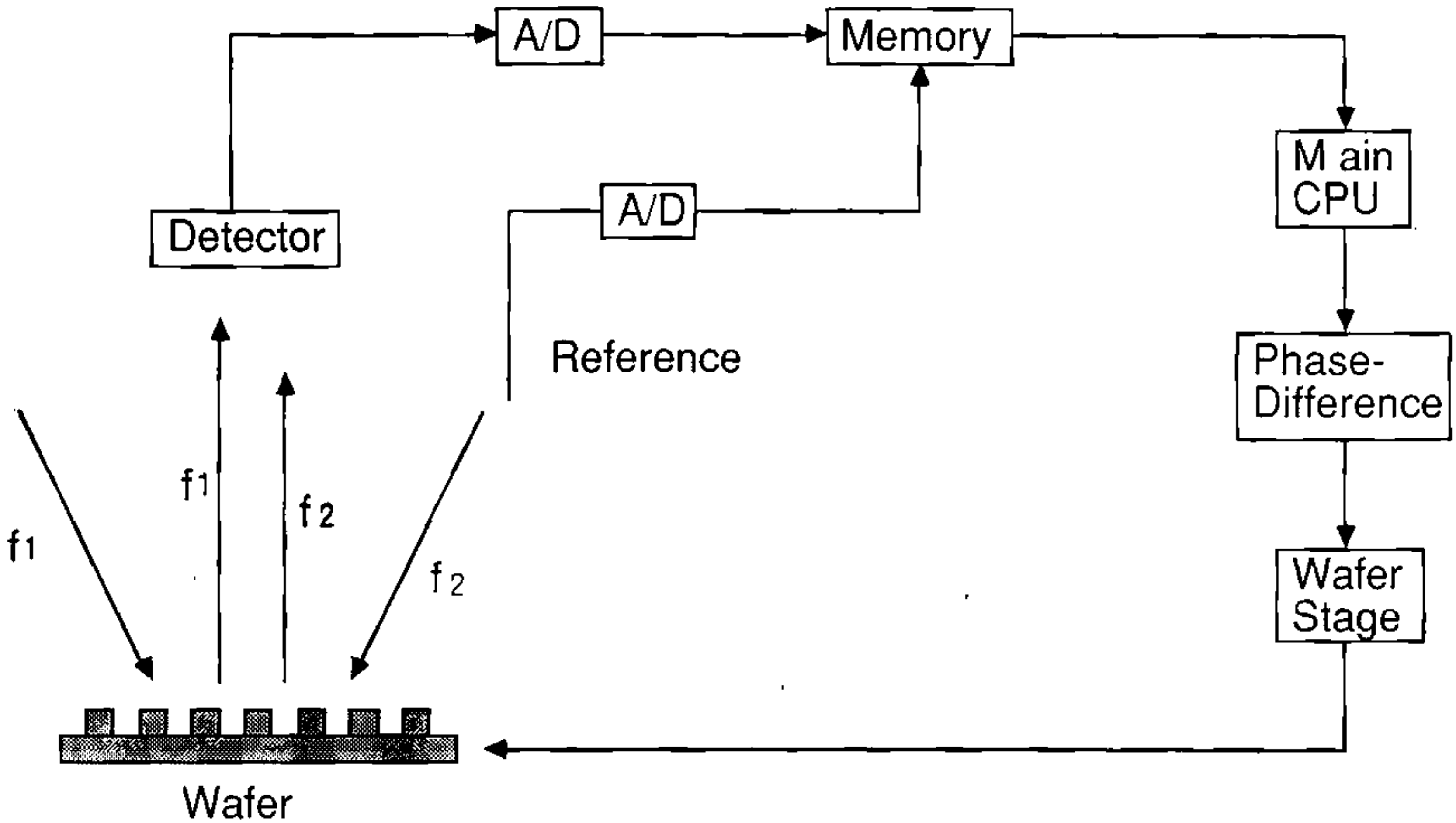
OPTICAL SYSTEM OF LSA

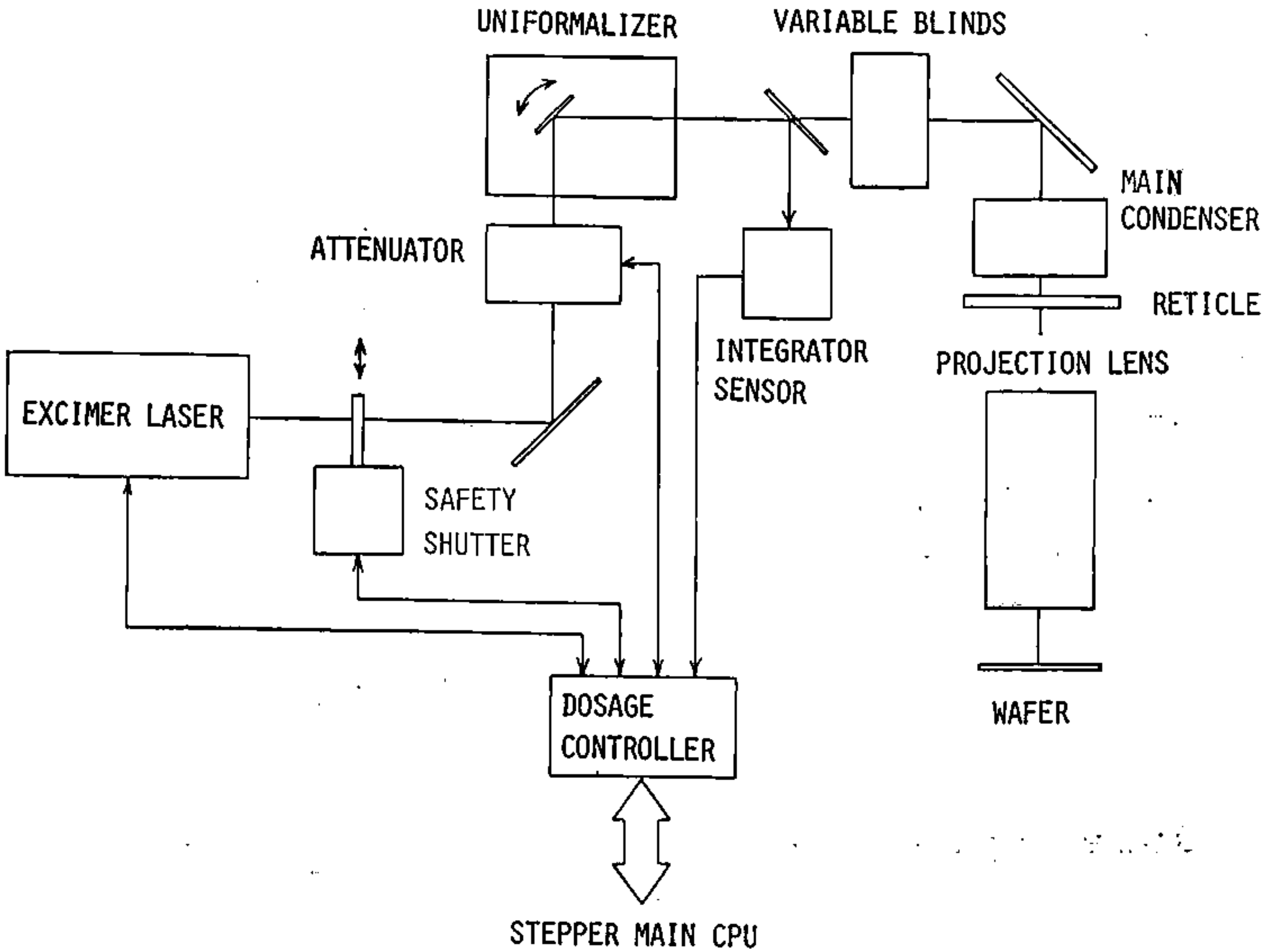


Field Image Alignment



Laser Interferometric Alignment




UNIFORMALIZER
VARIABLE BLINDS
MAIN
CONDENSER
ATTENUATOR
RETICLE
INTEGRATOR
SENSOR
PROJECTION LENS
EXCIMER LASER
SAFETY
SHUTTER
WAFER
DOSAGE
CONTROLLER
STEPPER MAIN CPU

Basic specifications for the excimer laser

Spectrum width (FWHM)	$\lesssim$3 pm
Wavelength stability	$\pm$1 pm
Average output power	2~3 W
Pulse energy	10~20 mJ
Repetition rate	100 or 200 Hz
Gas life time	10^6~10^7 pulses
Window cleaning interval	10^7~10^9 pulses
Main components life time	10^8~10^9 pulses ?

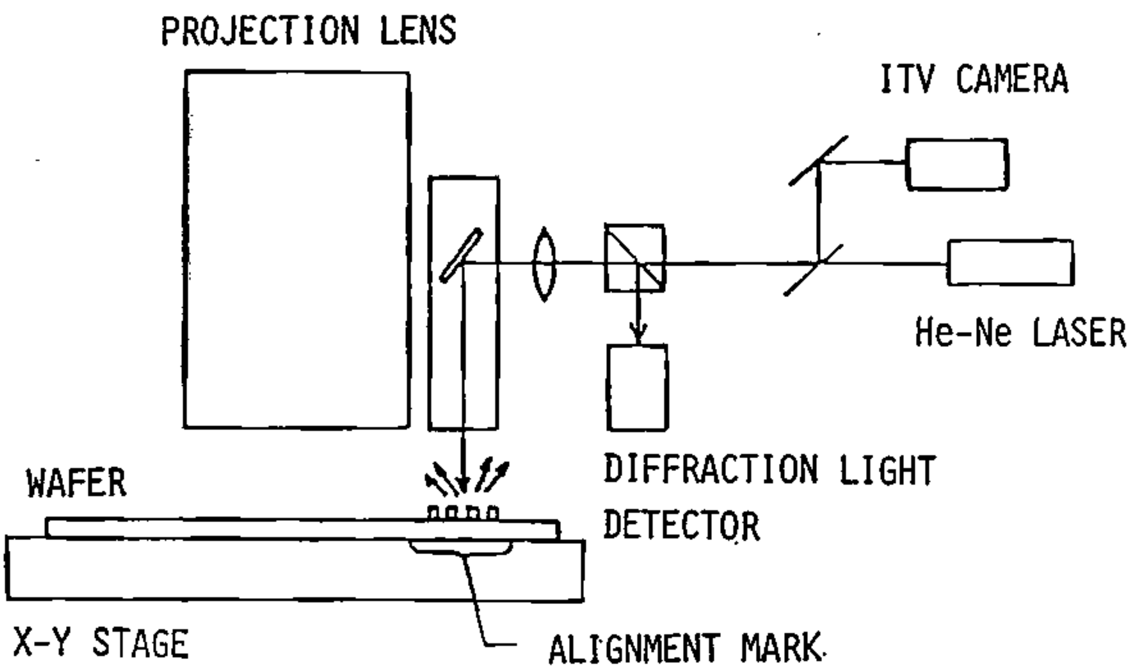


DIAGRAM OF WAFER ALIGNMENT SENSING SYSTEM

Dataquest

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THE ROLE OF THIN-FILM TECHNOLOGY IN ULSI

William W. R. Elder
President and Chief Executive Officer
Genus, Inc.

William Elder is President and Chief Executive Officer of Genus, Inc., a semiconductor equipment manufacturing company. He is one of the founders of Genus and has served as a director of the company since its organization in 1981. Prior to Genus, Mr. Elder was President of the Wafer Processing Division of Eaton Corporation. He was affiliated with Fairchild Semiconductor in various senior management positions before he entered the semiconductor equipment industry. Mr. Elder has an extensive background in the semiconductor industry with over nineteen years of senior level management experience in semiconductor equipment manufacturing and semiconductor manufacturing and is currently a member of the Board of Directors of SEMI/SEMATECH.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

ULSI Era:
Challenges and
Opportunities

The Role of Thin-Film Technology in ULSI

William W. R. Elder
President and Chief Executive Officer
Genus, Inc.

Slide 1

Genus Presentation

The Role of Thin Film Technology in the ULSI Era

by

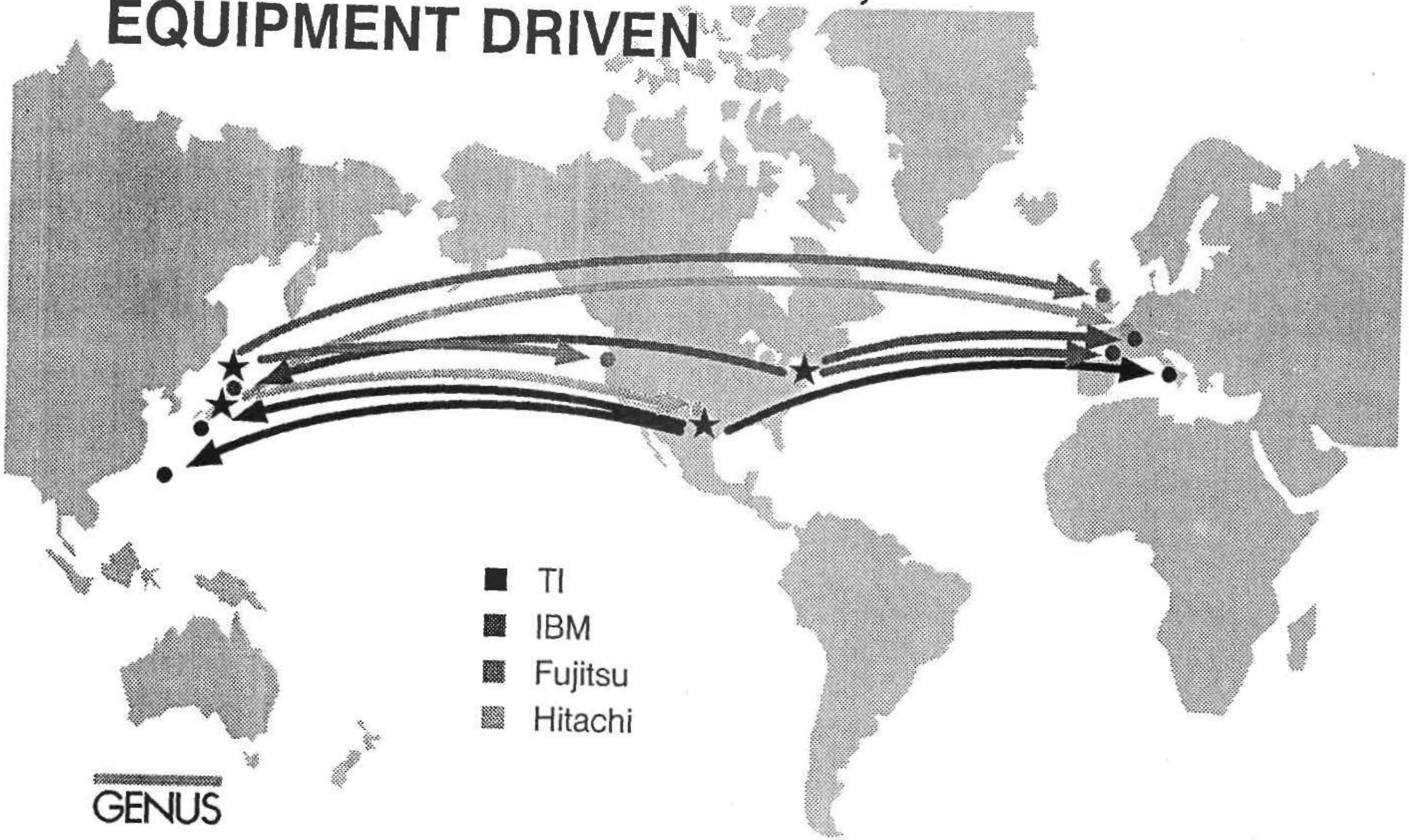
William W. R. Elder
Chairman and CEO

Dataquest Conference, Japan
April 12,13, 1990

GENUS

SLIDE 2.

TECHNOLOGY TRANSFER, EQUIPMENT DRIVEN



GENUS

TOP TEN MERCHANT SEMICONDUCTOR SUPPLIERS

1975	1983	1989
Texas Instruments	Motorola	NEC
Motorola	Texas Instruments	Toshiba
Fairchild	NEC	Hitachi
National Semiconductor	Hitachi	Motorola
Philips/Signetics	Toshiba	Fujitsu
NEC	Philips/Signetics	Texas Instruments
Hitachi	National Semiconductor	Mitsubishi
Siemens	Intel	Intel
RCA	Fujitsu	Matsushita
Toshiba	Matsushita	Philips/Signetics

GENUS

Source: Dataquest

SLIDE 4

TOP TEN SEMICONDUCTOR EQUIPMENT MANUFACTURERS

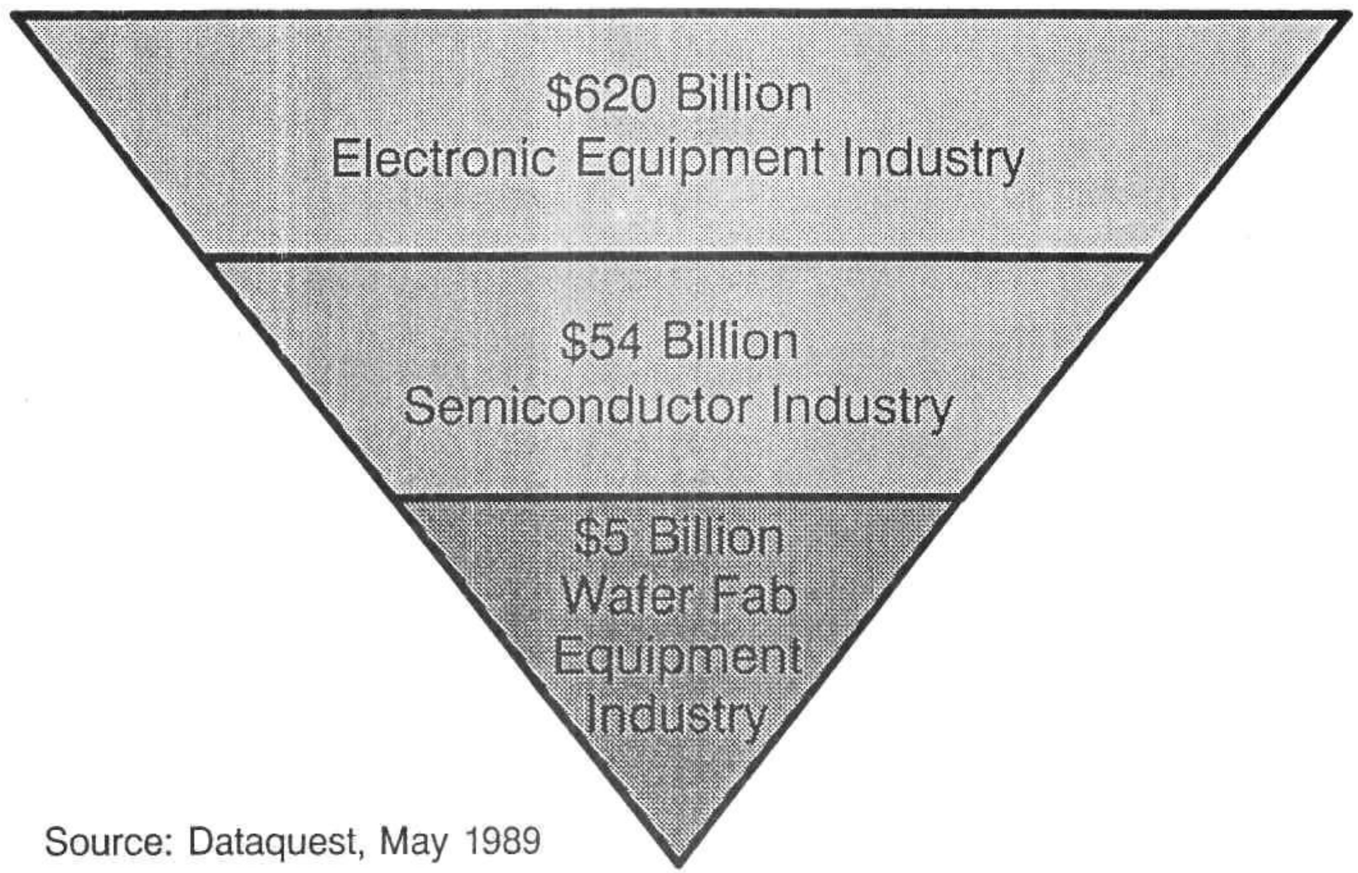
1980	1984	1989
Perkin-Elmer	Perkin-Elmer	Tokyo Electron Ltd
GCA	General Signal	Nikon
Applied Materials	Tokyo Electron	Applied Materials
Fairchild TSG	Eaton	Advantest
Varian	GCA	Canon
Teradyne	Teradyne	General Signal
Eaton	Nikon	Varian
General Signal	Sentry Schlumberger	Hitachi
Kulicke & Soffa	Varian	Teradyne
Takeda Riken	Canon	ASM International

GENUS

Source: VLSI Research, 1990

Slide 5

WORLDWIDE ELECTRONIC INDUSTRY FOOD CHAIN



Source: Dataquest, May 1989

GENUS

300-10A

Slide 6

SEMICONDUCTOR EQUIPMENT INDUSTRY

- Worldwide Sales: $9.2 Billion in 1989
- Highly Fragmented Industry ≈ 500 Equipment Companies
  - U.S. 68%, Japan 21%, Europe 11%
- Most Companies Are Single Product Suppliers
- Top 10 Companies Have 41% of Market, Top 50 Have 70%
- Largest Supplier: $634M, 7% Total Market

Slide 7

MAJOR TRENDS - SEMICONDUCTOR EQUIPMENT INDUSTRY

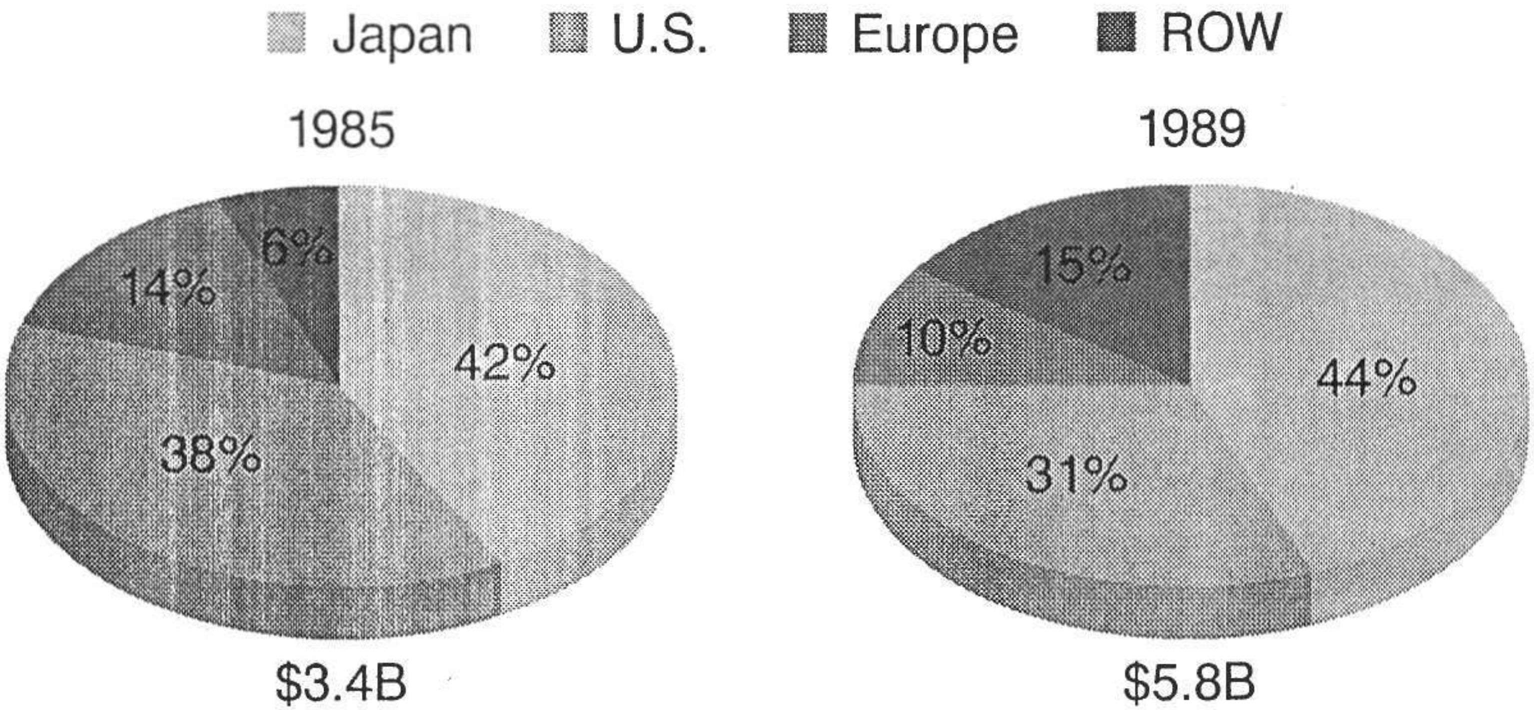
- Submicron ICs Drive New Production-Worthy Equipment Solutions
- Equipment Makes IC Technology Transferable
- Japan Assumes Leadership in Several Equipment Technologies and Surpasses U.S. Overall
- IC Mfrs Want Stable, Multi-Product, Technology Suppliers
- Customer/Equip. Vendor Joint Development Efforts
- Business Shakeout, Consolidation Increases

SVG - Thermco
LAM - Gemini
Genus - Gen. Ion.
Gen. Signal - GCA

GENUS

WORLDWIDE SEMICONDUCTOR EQUIPMENT MARKET

Wafer Fabrication - Geographic

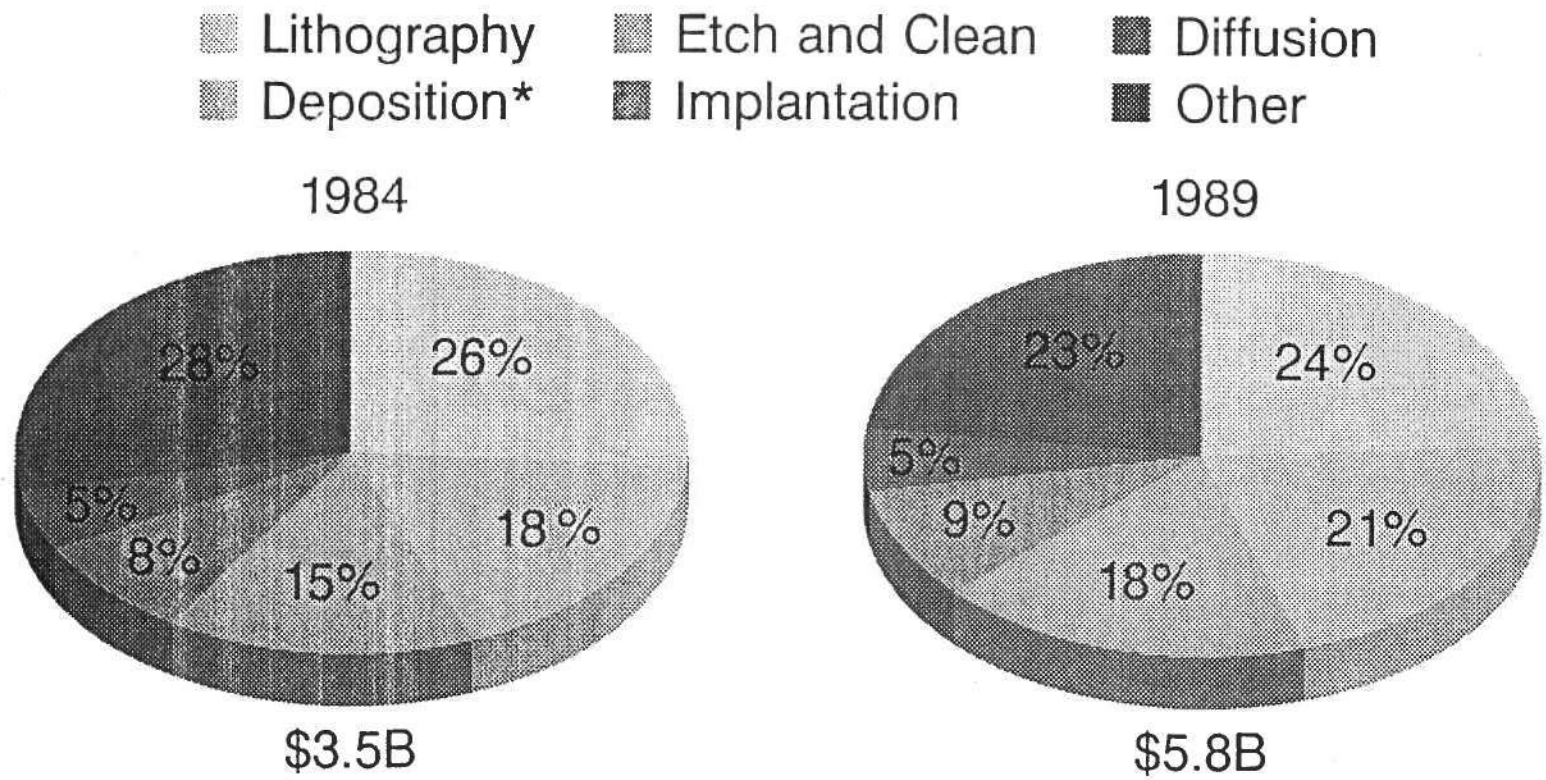


Source: Dataquest, March 1990

GENUS

SEMICONDUCTOR EQUIPMENT MARKET

Wafer Fabrication - Technology Function



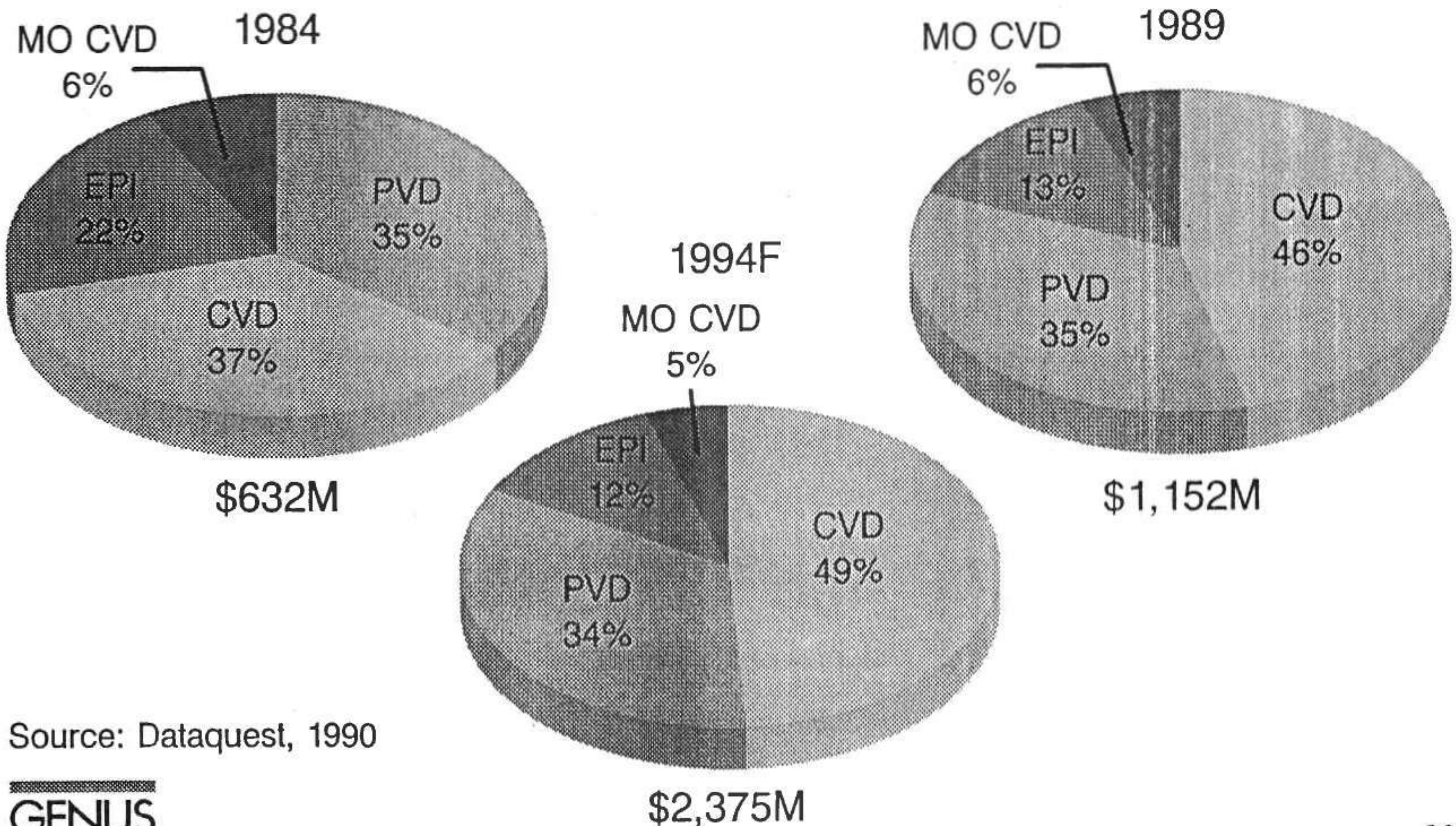
Source: Dataquest, March 1990

*CVD, PVD, EPI

GENUS

WAFER FAB EQUIPMENT MARKET

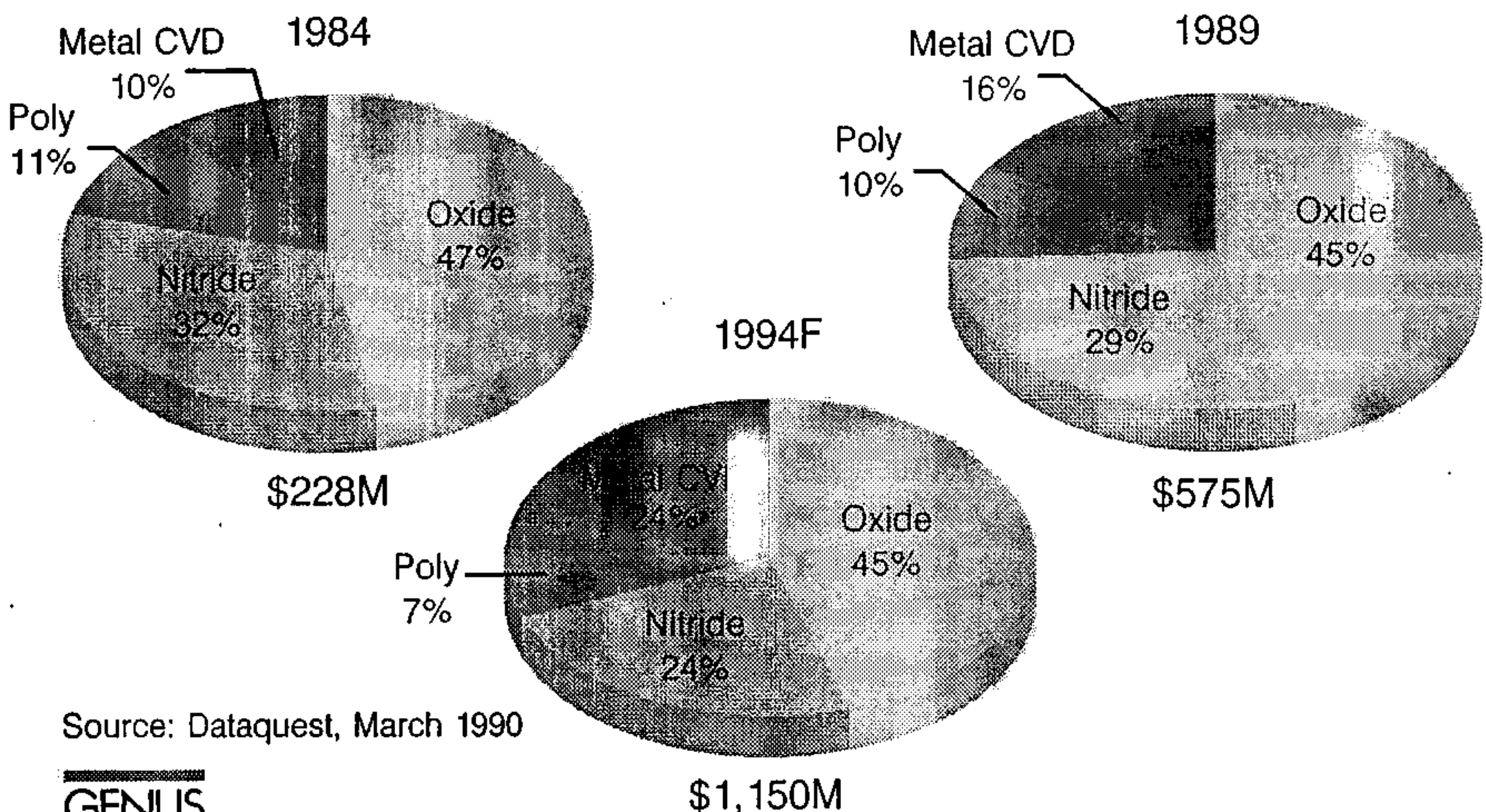
Thin Film Deposition



Source: Dataquest, 1990

GENUS

CVD THIN FILM - WORLDWIDE MARKET

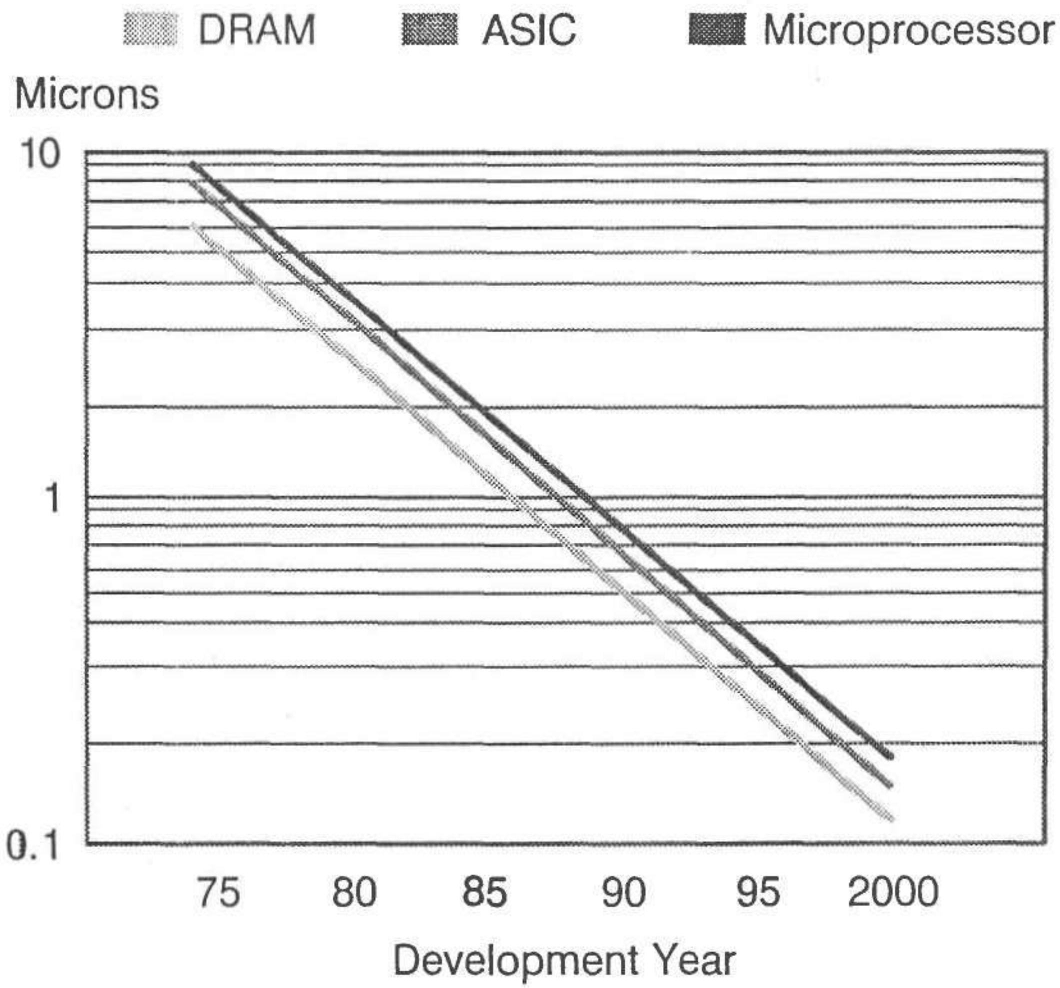


Source: Dataquest, March 1990

GENUS

Slide 12

SHRINKING DESIGN RULES

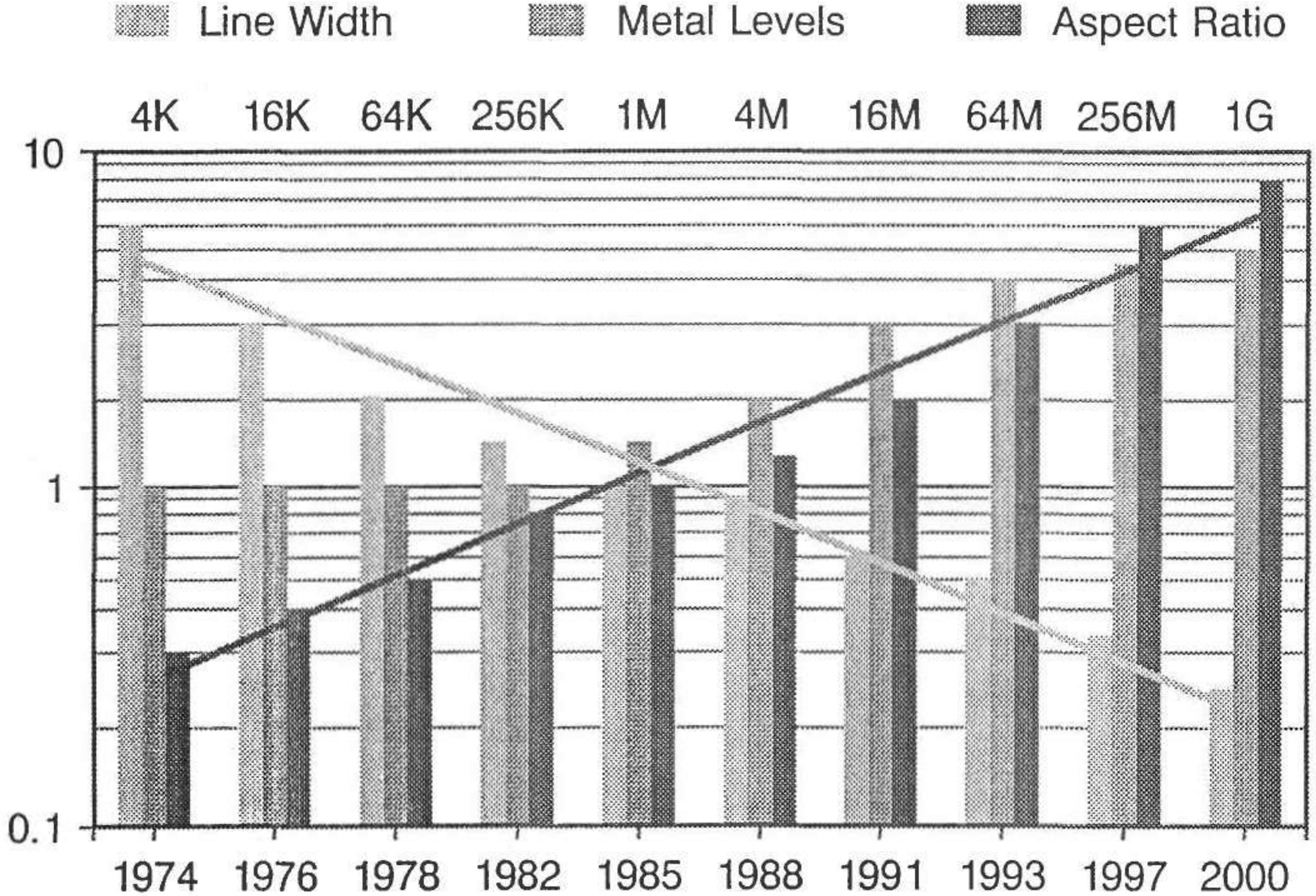


GENUS

390-10

SLIDE 13

DRAM COMPLEXITY FACTORS



Source: Dataquest, Genus

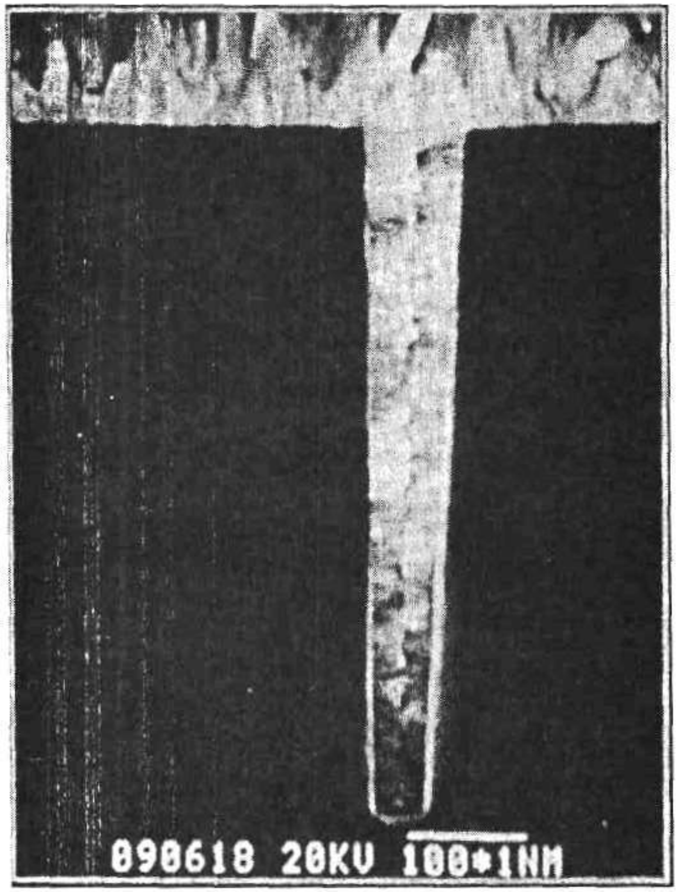
GENUS

SLIDE 14

GENUS TUNGSTEN TECHNOLOGY - BEYOND 1G TODAY

9:1

Aspect Ratio



Optimized High Pressure/High Deposition
Blanket W Process

GENUS

INTERCONNECT TECHNOLOGY - A NEW FRONTIER

- Scaling of Devices Has Outpaced Interconnect Capability
- Search for Low Resistivity, Ease of Deposition, Etchability Drives Selection of Material for M1 Interconnects
- PVD Aluminum Displays Step Coverage and Reliability Problems at 1M DRAM
- Tungsten Silicide Choice for Gate Interconnect Beginning at 256K
- CVD Blanket Tungsten Now in Production for 1-4M DRAMs
- Selective Tungsten Not Yet Production-Worthy
- CVD Aluminum, High Dielectric Films and Copper Metallization in Research

GENUS

CVD EXPANSION

- CVD Market Grew 126% from $254M in 1987 to $575 in 1989
- IM DRAM Capacity Increase Doubled Japanese CVD Market in 1988
- Japan Is Largest Market for CVD Fabrication Equipment
- U.S. Equipment Companies Hold Largest Share of Worldwide CVD Market
- Vertical Tubes Replacing Horizonal Tubes
- Non-Tube Reactors Take Over Market for Submicron Applications and Large Wafer Diameters

ROLE OF THIN FILMS IN ULSI TECHNOLOGY

Equipment Driven

- Sputtering no Longer Technology Driver
- CVD Becoming Dominant Deposition Technology Due to:
  - Planarization Issues
  - Increasing Aspect Ratios
  - Particle Control
- Metal Deposition (W) CVD Will Be Process Standard
- Non-Tube CVD Increasing
- CVD Driving Integrated Process Tool Development
- Multilevel Interconnect Is Technology Bottleneck for ULSI Technology (0.35 um)

ROLE OF THIN FILMS IN ULSI TECHNOLOGY

Film/Process Driven

- Interlayer Dielectrics
  - Between Poly and Metal 1: BPSG, Oxy-Nitride, Oxide, PSG, SOG
  - Between Metal 1 and Metal 2: Al-Si-Cu, Ti/Al-Cu, Blanket Tungsten, Selective Tungsten, Gold
  - Between Metal 2 and Metal 3: PETEOS Oxide, PSG/SOG
- Barrier Metals - Ti/TiN, TiW
- Contact Plugs - Blanket Tungsten, Selective Tungsten
- First Via Plugs - Blanket Tungsten/Etchback, Selective Tungsten

Source: Dataquest 1990, Genus

INTEGRATED PROCESSING

- Wave of the Future for Sub-0.5 um
- Crowded Market
  - 14 U.S. Companies
  - 5 Japanese Companies
  - 5 European Companies
- Only a Few Players Will Survive
- Partnering Is a Must for "Best of Breed" Technology

THE CHALLENGE

Can 3 Global Equipment Companies
Cooperate and Partner to Bring
a World Class Integrated System
Successfully to Market?

GENUS

Slide 21

MULTI-LEVEL INTERCONNECTS - YEAR 2000

- 64M DRAM with 0.3 Micron Lines Is a Mature Product
- X-Ray Lithography in Production
- DRAM and ASIC Factories Require Different Equipment
- In situ Multi-Processing Equipment with "Best of Breed" Modules
- ASIC/High Density Logic Use 8-10 Levels of Metal
- Copper CVD Interconnects with Low Dielectric Constant, ILD
- Tungsten Gate Structures with New Gate Dielectric Material
- 20-30 Large, Multi-National Equipment Companies Dominate

GENUS

Second Day

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ARTIFICIAL INTELLIGENCE AND HYPER MEDIA: THE SEMICONDUCTOR IMPACT ON HYPER MEDIA

Koji Yada
President
Hyper Media Corporation

Koji Yada is President of Hyper Media Corporation and President of CSK Research Institute. Prior to this, Mr. Yada was Director of Linguaphone Japan Ltd. He established the Knowledge Information Research Institute. From 1960 to 1983, Mr. Yada was with Electrotechnical Laboratory, Ministry of International Trade and Industry. His development activities included conversational adding machine systems, computer control systems, robot for ocean research, research information processing systems, optical communication systems, CAD system for LSI design, expert systems, and security systems. Mr. Yada has received awards from the Japan Information Center of Science and Technology, and the Information Processing Society of Japan. He has been published many times including Understanding Software, Dictionary of Microcomputers, The First Step in Electronics, AI Will Change the Future, A Micro Computer Handbook, The Story of AI, An AI Primer, and AI Handbook. Mr. Yada graduated from the University of Electric Communication, Tokyo, Japan.

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April 12-13, 1990
Tokyo, Japan

ULSI Era:
Challenges and
Opportunities

Artificial Intelligence and Hyper Media: The Semiconductor Impact on Hyper Media

Koji Yada
President
Hyper Media Corporation

AI&HYPER MEDIA

HYPER MEDIA Corp
KOJI YADA

Ⅰ Trend of AI Business

Ⅱ A View of Hyper Media Business

Ⅲ Expect to Semiconductor Technology

The Trend of A I Business.

1. Platform for AI

- LISP Machine
- Work Station
- Mainframe
- Personal Computer
- Game Machine
- Embeded Machine

2. AI Integration

- Various Platform
- Fusion to Data Processing
- System Integration using Pattern Pecognition

3. AI Application User

- AI Development Division
- Data Processing Division
- End User

4. Expert System Tool

- Shell
- DST (Domain Specific Tool)
- Embeded Expert System

5. Hyper Media Technology

- Audio Visual
- CD-ROM
- High Vision (HDTV)

A View of Hyper Media Business

1. Computer Software and Hyper Software

Computer Software	Hyper Software
Text Media	Image Media
Logic Base	Sensitivity Base
Computer Culture	Traditional Culture
Business Sense	Maniac Sense

2. Technology of Hyper Software

(1) Reasoning System

- Expert System.
- Object Oriented Programming
- Actor Oriented Programming

(2) Human Interface

- Image Understanding
- Speech Understanding

(3) Display

- Clear Vision
- High Vision

(4) Mechatronics

- Robotics
- Intelligent Sensor

(5) Multi Media

- CD-ROM
- CD-ROM XA

3. Hyper Media Dedicated System

- FM TOWNS
- CD-I
- DVI

4. Market for Hyper Media

- Vertical Market
- PC Market
- Home Use Market

5. Application for Hyper Media

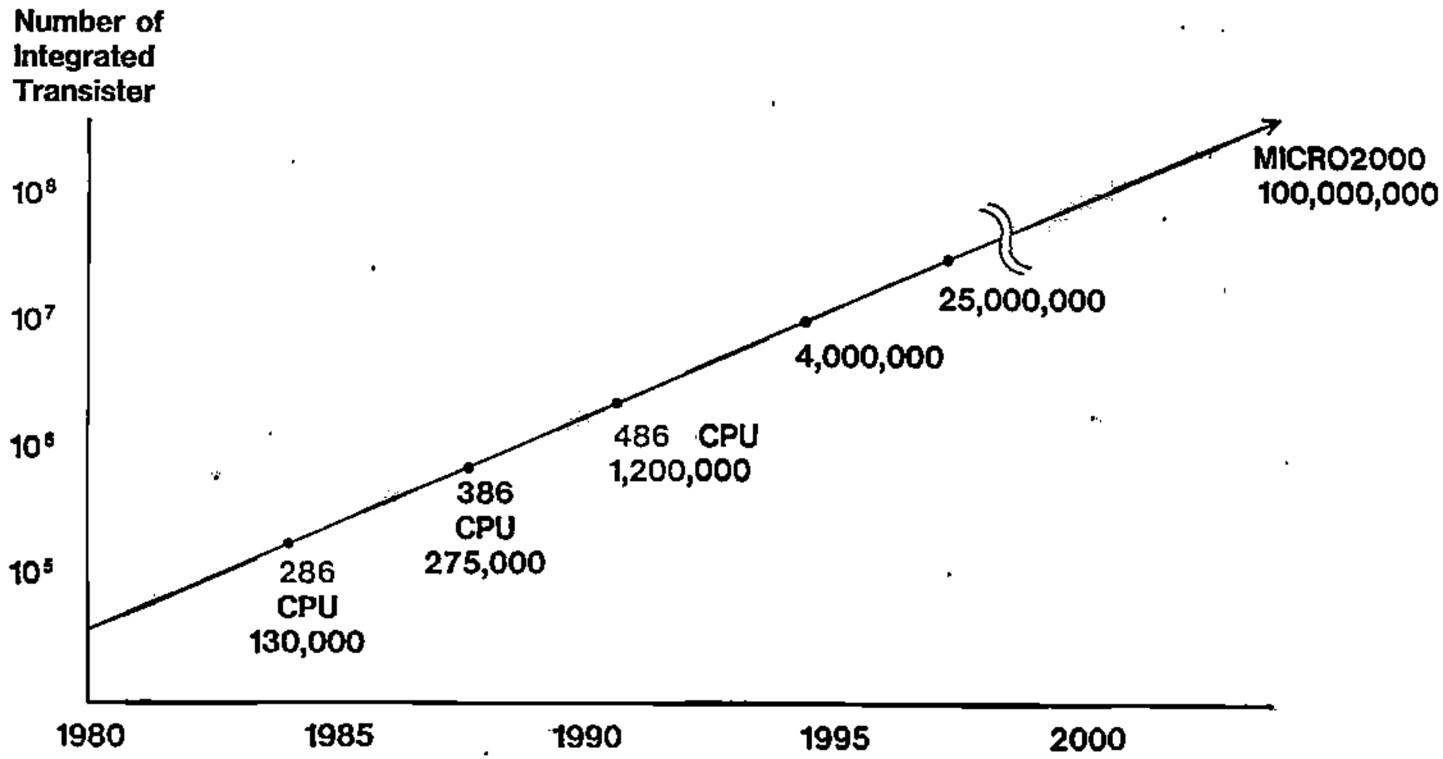
- Business
- Industrial
- Entertainment
- Education

Expect to Semiconductor Technology

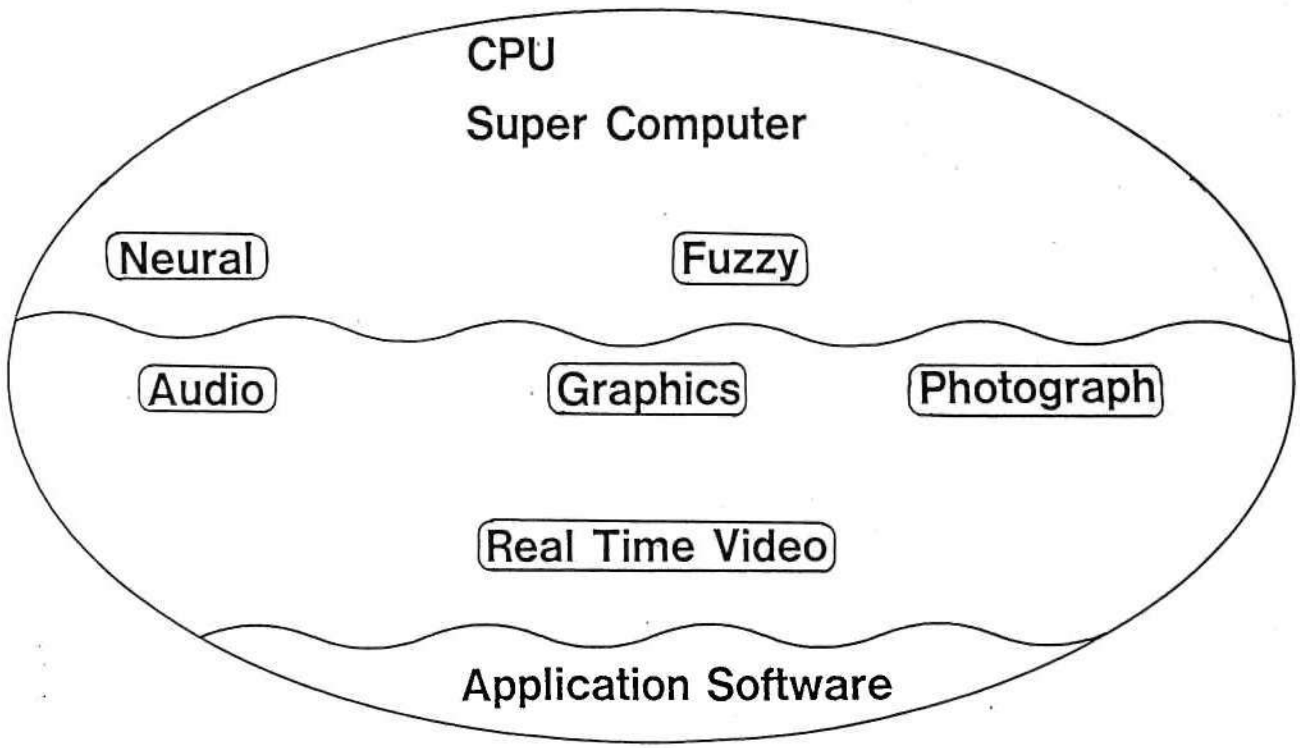
1. State of Arts

	386 Micro Processor	IBM 370/168
Operation Speed	4～5 MIPS	4 MIPS
Memory Capacity	4 Gbyte (4×10^9 byte)	4 Gbyte (2×10^9 byte)
Price	¥1,000,000	¥500,000,000
User	For One Person	For a Many People

2. The Growth of Micro Processor



3. Future Micro Proseccor



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SUPERCONDUCTOR AND JOSEPHSON COMPUTER: THE ROLES AND IMPACT OF THE 1990s

Dr. Hiroshi Kashiwagi
Director-General
Electrotechnical Laboratory
Ministry of International Trade and Industry

Dr. Hiroshi Kashiwagi is Director-General of Electrotechnical Laboratory and also serves as Expert Member of the Science and Technology Commission. Dr. Kashiwagi joined Electrotechnical Laboratory in 1963 and has been engaged in research related to laser technology. He pioneered in optical fiber and optical integrated circuit fields in Japan and started an experiment on optical LAN, the first in the world, which is partly used in the Research Information Processing System (RIPS) network at the Agency of Industrial Science and Technology in Tsukuba. As Director of the Computer Department, Dr. Kashiwagi led the research on supercomputers, including data flow, non "Von Neumann" type parallel processing machine "SIGMA-1" and Josephson devices. Dr. Kashiwagi received his Ph.D. from Keio University.

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ULSI Era:
Challenges and
Opportunities

Superconductor and Josephson Computer: The Roles and Impact of the 1990s

Dr. Hiroshi Kashiwagi
Director-General
Electrotechnical Laboratory
Ministry of International Trade and Industry

THIS PRESENTATION WAS NOT AVAILABLE AT

TIME OF PUBLICATION

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NEURAL NET APPLICATION IN ULSI ERA

Masaka Ogi
President
Fujitsu Laboratories Ltd.

Masaka Ogi is President of Fujitsu Laboratories Ltd. Mr. Ogi joined Fujitsu Limited in 1952 and has held several managerial positions including Executive Director, Fujitsu Limited; President, Fujitsu America, Inc.; Managing Director and Board Member, Fujitsu Limited; Deputy General Manager, International Operations Group; Deputy General Manager and Vice General Manager, Communications Systems Group; General Manager, Radio Communications Division; and Manager, Satellite Communications Laboratory, Fujitsu Laboratories, Ltd. Mr. Ogi received a Bachelor of Electrical Engineering degree from the University of Tokyo.

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B8887015.IMG 03/07/90:JSI

ULSI Era: Challenges and Opportunities

Neural Net Application in ULSI Era

Masaka Ogi
President
Fujitsu Laboratories Ltd.

THIS PRESENTATION WAS NOT AVAILABLE AT

TIME OF PUBLICATION

HDTV--ITS PRESENT STATUS AND FUTURE PROSPECTS

Kenji Aoki
Managing Director
Planning & Administration Headquarters
for Affiliated Corporations
Japan Broadcasting Corporation (NHK)

Kenji Aoki is Managing Director, Planning and Administration Headquarters for Affiliated Corporations, Japan Broadcasting Corporation (NHK). Mr. Aoki joined Nippon Hoso Kyokai (Japan Broadcasting Corporation), originally assigned to their Kushiro Broadcasting station. He was then assigned to their Current Affairs Program Division, News Department, General Broadcasting Administration. He has since held various managerial positions, including Senior Director and Manager of the Current Affairs Program Division, News Department; Deputy Director, News Department; Senior Executive Vice President, NHK Enterprises, Inc. Mr. Aoki graduated from the Department of Literature, Tokyo University.

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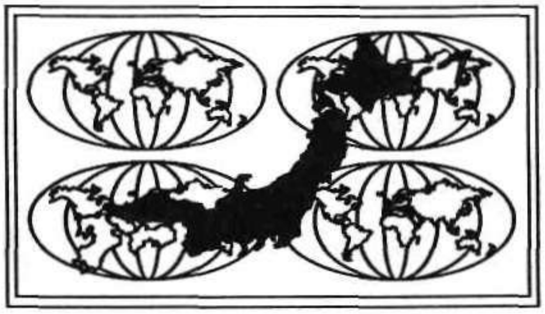

ULSI Era:
Challenges and
Opportunities

HDTV -- Its Present Status and Future Prospects

Kenji Aoki
Managing Director
Planning & Administration Headquarters
for Affiliated Corporations
Japan Broadcasting Corporation (NHK)

PRESENT AND FUTURE PROSPECTS OF HDTV IN JAPAN

KENJI AOKI

NHK, JAPAN BROADCASITNG CORPORATION

1. Introduction

The number of television units in Japan at present totals an estimated70 million units, and the figure climbs to some 140 million for the United States. About 200 million units are in use in China, although the majority of these are of the black and white variety. On a world- wide scale, the number of TV receivers in current use is believed to total approximately 700 million units.

These figures indicate the potential for a gigantic new industry. If all of the 700 million TV sets were replaced today by HDTV sets, the economic impact would be enormous---and beyond the calculation skills of industry analysts.

While it is important to discuss the HDTV issue from a macro-economic point of view, it is also essential at this time to carry out a thorough discussion of the potential of HDTV as a medium. HDTV boasts picture quality comparable to that of 35mm film, its sound quality is CD-comparable, its pictures are easily convertible to those of other media and, above else, it has diversified application potentials for transmission and record-keeping. All these attributes point to the fact that this technology can occupy top place as a medium in an increasingly information-oriented society. HDTV represents not merely an advanced television format for the next generation of broadcasting;it opens up the door to a wide range of applications in areas other than broadcasting.

Following is a list of industries that have attempted to apply HDTV technology to date: motion film, CATV, printing, publishing, education, medicine, art-museum, museum, HDTV theater, video programm-ing, video game, event, fashion, commercial film, airport information system, TV conference, computer graphics, CAD/CAM, etc. And the development of HDTV for different applications has just begun.

2. Attempts at HDTV Software Production

In June 1989, a daily one-hour Hi-Vision broadcast (aired 2:00-3:00 p.m.) on an experimental basis got underway. In addition to live sports, the primary components of software packages, HDTV programs produced both in Japan and overseas are also shown. These programs are also displayed to the public at Hi-Vision exhibits set up at about100 sites around the country, including train stations, department stores, post offices, broadcast stations, manufacturers' commercial exhibit sites and city halls. A full-scale Hi-Vision broadcast service, to be offered jointly by NHK and commercial broadcasters, is scheduled for the fall of 1991. A spare channel of the BS-3b, a back-up satellite for BS-3a, will be secured exclusively for Hi-Vision broadcasting.

There have been positive signs from the general public. In September 1989, NHK broadcast the Seoul Summer Olympics Games in the HDTV format for a total of 73 hours. Hi-Vision receivers were set up at 81 public exhibit sites all over Japan, attracting a total of 3.72 million people to the world's first Hi-Vision broadcast.

A survey conducted at this time revealed that 93% of the people watching the Hi-Vision broadcast were interested in Hi-Vision, and 75% replied that they want to buy Hi-Vision receivers. Forty-eight percent of those polled said they would buy a Hi-Vision set if the price was within the range of two to three times the retail price of current TV sets.

The impact of HDTV will be substantial, resulting in high quality video pictures and a cinema-scopic screen. But it will also result in a considerable diversification of applications creating a new video/ image system for the 21st century. It is expected that it will have a substantial influence on people's life, culture and business as a whole.

Naturally, the production of software will not be limited solely to TV programs, but will include a wide variety of software. In addition to simply broadcasting HDTV productions on TV, a series of activities that would never have been possible in the realm of the conventional TV, have become realistic --- all because of the fine quality of the HDTV picture. Examples include organizing an exposition or a trade show utilizing HDTV software, publishing a book using high definition pictures and converting them to a 35-mm film, and commercializing the home video. The present situation regarding software production is evidence that "broadcasting is only one of the many applications of HDTV."

A major focus of NHK at present is the organization of large international co-productions in HDTV. "The Ginger Tree," which NHK co-produced with BBC and WGBH in 1989 is a typical example. After its completion, the program was converted to PAL and broadcast in Britain first. It was also converted to NTSC and shown to the viewers in Japan where later it will be shown in HDTV as well. American public will also be able to see the program in NTSC.

Another joint work already completed is the production of a record-marking fifteen-hour-long HDTV video of "Nibelung Ring," an opera in four parts written by Wagner, which was performed in November 1989. In collaboration with the Bayer National Opera Theater of West Germany, NHK recorded all of the four opera performances in HDTV, which would then be later broadcast in Japan. The plan under current discussion calls for screening the opera video in a HDTV theater where a limited number of viewers will be able to savor the art of opera in an elegant and relaxed setting.

Another possibility is the sale of HDTV-disc recordings of the opera series and/or video cassettes converted into NTSC. Such artistic records in HDTV will prove to be priceless human assets in the future.

NHK plans to broadcast about 400 hours of HDTV programs in 1989. And the number of HDTV broadcasting hours will dramatically increase during the next decade. Opinions differ regarding the type of programs most appropriate for HDTV broadcasts, but the primary ones will be sports such as baseball and football. In my personal opinion, however, I believe HDTV will also enhance news broadcasting with its full scope of features. Already at NHK, research has been conducted to determine the most effective size of video or film images, as well as the most effective display position of these pictures on the screen for news broadcasting.

Conventionally two types of cameras, NTSC and HDTV, are used for sports events coverage when broadcasting in both NTSC and the HDTV; but recently only HDTV cameras have been used for shooting with the video pictures simultaneously down-converted for broadcasting in NTSC. A plan is gradually being implemented to replace all the NTSC cameras with HDTV cameras in large studios to tape entertainment programs and down-convert for the conventional broadcast.

3. Industrial Applications of HDTV

In Japan HDTV has been applied to many industrial areas other than broadcasting. Medical application is one such area that is attracting a high level of attention. A microscopic brain surgery operation was recorded with a HDTV camera for the first time at the Shinshu University Hospital in December 1987. By plugging a HDTV camera into a microscope and projecting finely detailed pictures of the surgical process on a large screen, it was possible for a number of the hospital's doctors and medical students to view the surgery which would otherwise be available only to the physicians involved.

Furthermore, another brain surgery operation was videotaped again at the same hospital in February 1989, but it was taken with a 3-D camerathis time. By linking two HDTV cameras to both the microscope's right and left eye pieces, pictures were then recorded simultaneously. The educational effect far exceeded expectations; witnessing the wonder of a human body that is offered through a vivid high definition picture of a brain was an emotional experience.

The application of HDTV in the world of art is also making progress. The Gifu Art Museum in Gifu Prefecture recently celebrated the opening of its HDTV Art Gallery in April 1989. The HDTV system there is designed to allow guests and professional researchers free access to all of the art pieces on hand at the museum; still pictures of all the museum's paintings were taken using an HDTV camera and then stored in a CD-ROM data base. In addition to descriptions and commentaries on paintings, provided both in caption and oral narration, the viewers can also magnify any portion of the picture which is projected on a large screen. All these service functions had never been possible before at any conventional museum.

As a result of the introduction of the new system, art lovers and other interested people have swarmed to the art museum. Attendance hit a record in the first month of the operation of the HDTV Art Gallery. The number of visitors reached the same level as that of the entire year of 1988. The new system is attracting a great deal of attention among art museum officials, both domestic and international.The same system has been introduced at the Saison Art Museum in Tokyo,and a new museum in the suburb of Tokyo (Machida-city) recently decided to adopt the system.

HDTV has another great potential in the application of generating tour guide information and ecological video pictures. The dynamic scenery of the Grand Canyon, caught through an HDTV camera attached to the front of a small jet plane, has no comparison whatsoever to any video images produced until now.

An attempt has been made to use closed circuit television in combination with a communication satellite. In November 1989, scenes of a Japan Cup Race, held at the Fuchu Horse Race Track in Tokyo, were taken with seven HDTV cameras, and the satellite was used to transmit the images to three different race tracks in Japan, where the viewers were able to see the Japan Cup Race on huge screens. The following December was also another successful month. A lively concert scene of one of the most popular Japanese rock music groups, filmed with HDTV cameras, was transmitted via communication satellite, and shown at a charge at five live houses around Japan. The plan proved to be a big success.

A gas company in Osaka recently installed two HDTV screens at a gas processing plant. One display is for showing sharp and detailed pictures of actual work on the operation line at the plant, while the other one displays computer graphics of the work process. Operators can supervise the entire operation by keeping their eyes on these two screens. An entirely new use for HDTV linked to a computer network was thus invented.

In the publishing area, attempts have been made to produce animal and plant encyclopedias, art encyclopedias, and general encyclopedias using CD-ROM or CD-1. HDTV image signals are being converted into digital numbers, then processed by computers to create photoengraving for printing. Several HDTV photography books made with this process are already on sale in book stores.

However, the area with the greatest potential for HDTV apart from broadcasting is probably the movie picture industry. In film-making, HDTV will greatly reduce filming costs and allow for the creation of special effects with ease. This was not possible with conventional film methods. Currently, thousands of copies of a movie are made for commercial distribution, but HDTV will definitely save on the costs of copying films. More importantly, however, it will make possible the simultaneous transmission of movies through satellite and fiber optics, and bring about a revolution in the movie distribution system. HDTV technology has already been used, although partially, in at least seven movie productions in Japan, including those of Akira Kurosawa.

The plan for mini-movie theaters incorporating the HDTV system is already within the reach. While they are now seriously being studied from various angles in Japan, a plan to link 14 HDTV theaters is being realized in Florida, U.S.A.

4. Conclusion

We do not need to go through all the classic stories about historic innovations and discoveries to be convinced that the history of man's advancement would not have been possible without intellectual inspiration, supported by the good will and cooperation of a number of people.

In past years, there have been a number of discussions held repeatedly to determine an HDTV world standard. It appears, however, that these have only led to an escalation in hostile debate, thwarting joint efforts to develop an advanced medium. HDTV, which is not a movie or a simple TV but a new medium, requires a pooling of different experiences and technical creativity in order to develop in the future.

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EVOLUTION OF TELECOMMUNICATIONS NETWORKS AND LSI TECHNOLOGY

Dr. Iwao Toda
Executive Vice President and Senior Executive Manager
NTT Research and Development Headquarters
Nippon Telegraph and Telephone Corporation

Iwao Toda is an Executive Vice President of Nippon Telegraph and Telephone Corporation (NTT). Since 1958, has has been with NTT, where he participated in and managed many of software and hardware development projects, including DIPS and DCNA computer-communication system projects. He is currently the Senior Executive Manager of NTT Research and Development Headquarters. He is currently Senior Executive Manager of their Research and Development Headquarters. Dr. Toda received his B.S., M.S., and Ph.D. degrees in electrical engineering from the University of Tokyo in 1956, 1958, and 1964, respectively. He was a vice president of the Artificial Intelligence Society of Japan. In 1987, he chaired the Information and System group of the Institute of Electronics, Information and Communication Engineers of Japan (IEICJ). Dr. Toda is an editor-in-chief of the Japanese translation of IEEE Software Magazine and is a Vice President of the Information Processing Society of Japan. He is a Fellow of IEEE.

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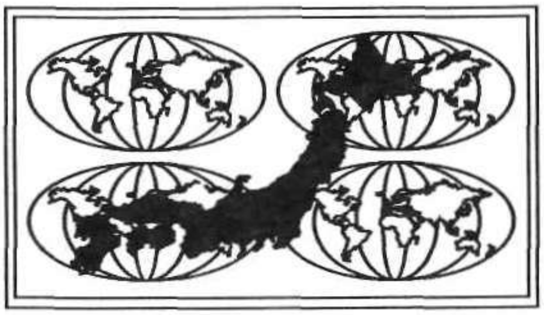
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan



ULSI Era:
Challenges and
Opportunities

Evolution of Telecommunications Networks and LSI Technology

Dr. Iwao Toda

Executive Vice President and Senior Executive Manager
NTT Research and Development Headquarters
Nippon Telegraph and Telephone Corporation

Evolution in Telecommunications Network and LSI Technologies

April 13, 1990

Iwao TODA
Executive Vice President
Senior Executive Manager
Research and Development Headquarters
NTT

NTT

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-LSI's in Telecommunications Network

-Technical Trends in Telecommunications Services

-Trends in Telecommunications Systems Technology

-LSI's for Telecommunications Network Evolution

-Summary

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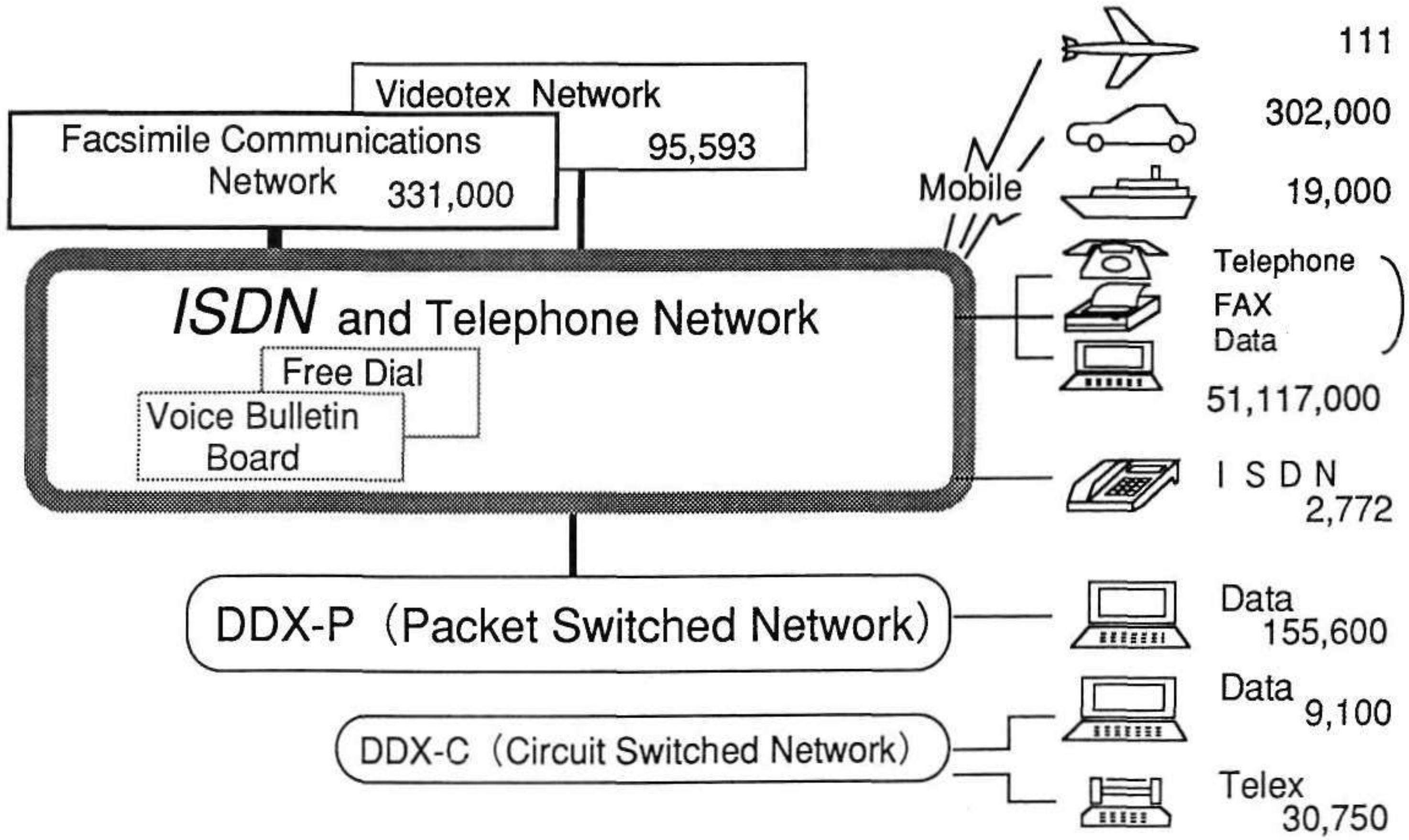
NTT's Telecommunications Networks



(As in September, 1989)

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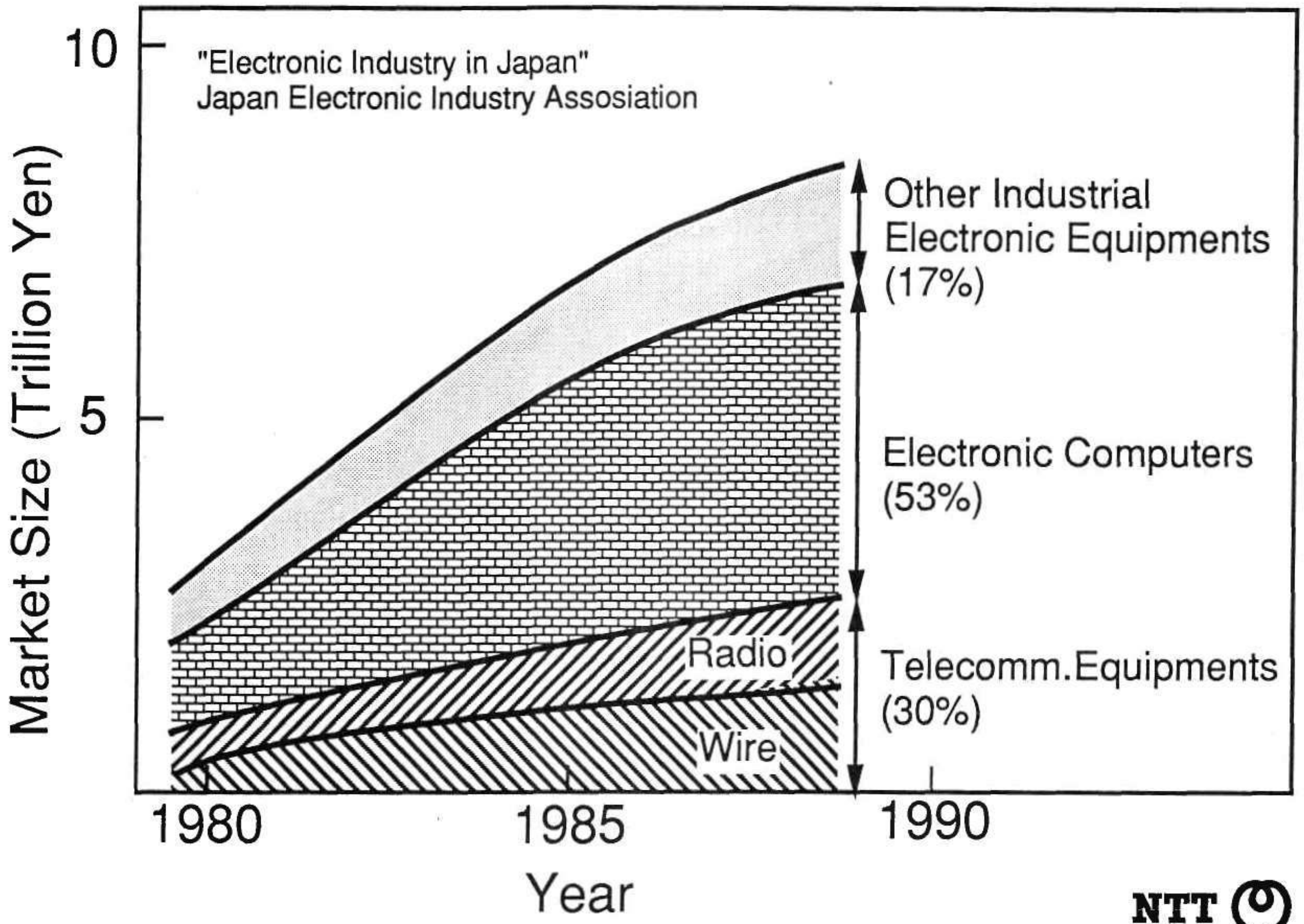
Telecommunication Equipments Market in Japan



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LSI's in Current Telecommunications Network

Terminal Systems

- -Telephone
- -FAX
- -Data
- -Image
- -Mobile

<LSI's>

- -Frequency Synthesizer
- -AD/DA Converter(Voice)
- -AD/DA Converter(Video)
- -CODEC(Voice)
- -CODEC(Video)

Control & Managanent Systems

- -Computers

<LSI's>

- -Processors
- -Memories

Transport Systems

- -Circuit Switching
- -Packet Switching
- -Wire Transmission
- -Radio Transmission

<LSI's>

- -Time Switch
- -Packet Control
- -MUX/DEMUX
- -MMIC
- -Viterbi

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Technical Trends in Telecommunications Sevices

-Multimedia Transportability :

Voice, Character, Image, Video

Super Digital, INS-NET 64/1500, B-ISDN(150Mb/s)

-Portability : Pager, Mobile Telephone

-User-friendliness :

Intelligent services controlled by

NSP (Network Service Control Point),
NSSP (Network Service Support Point)

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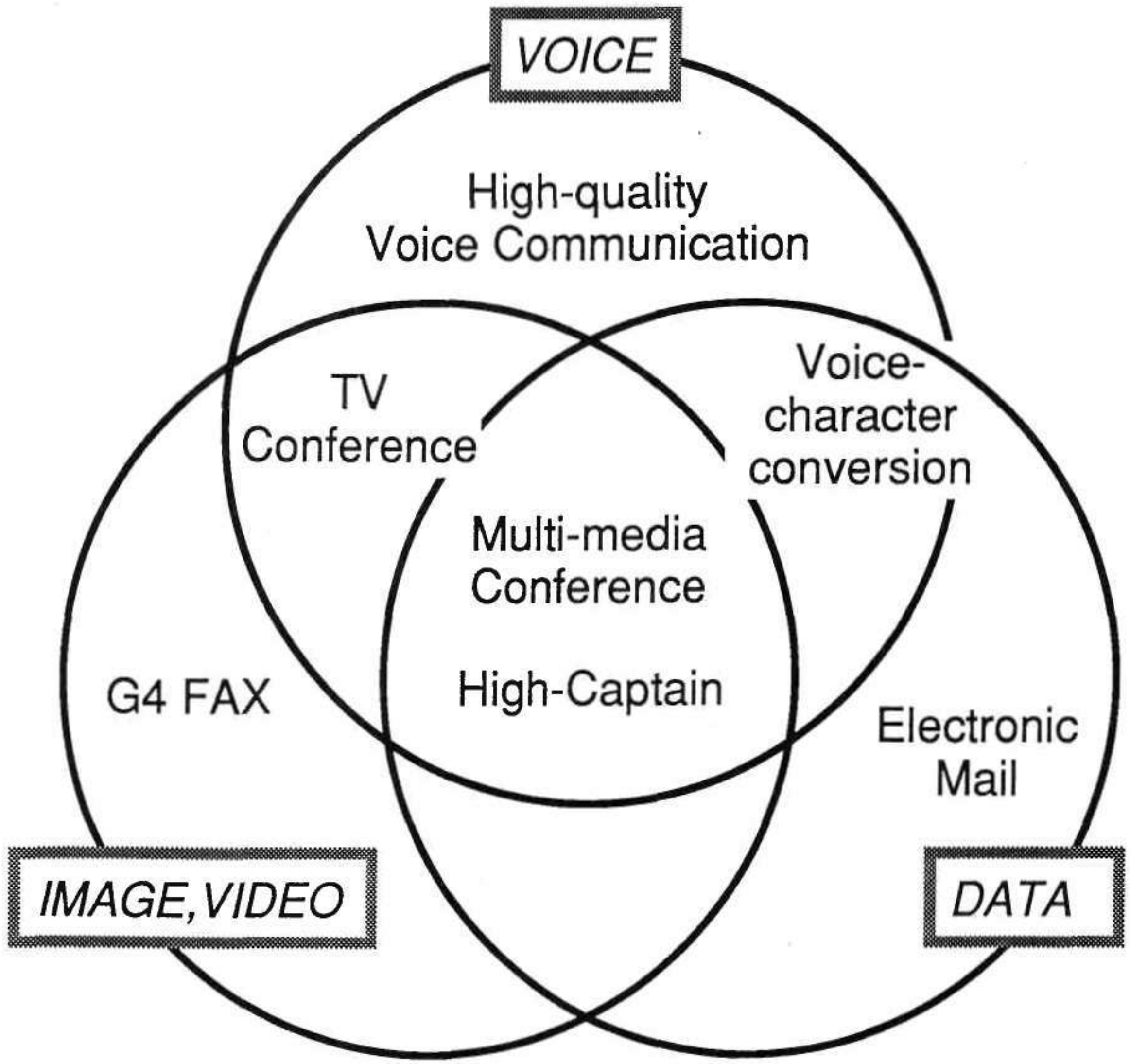
Multi-Media Communication Sevices



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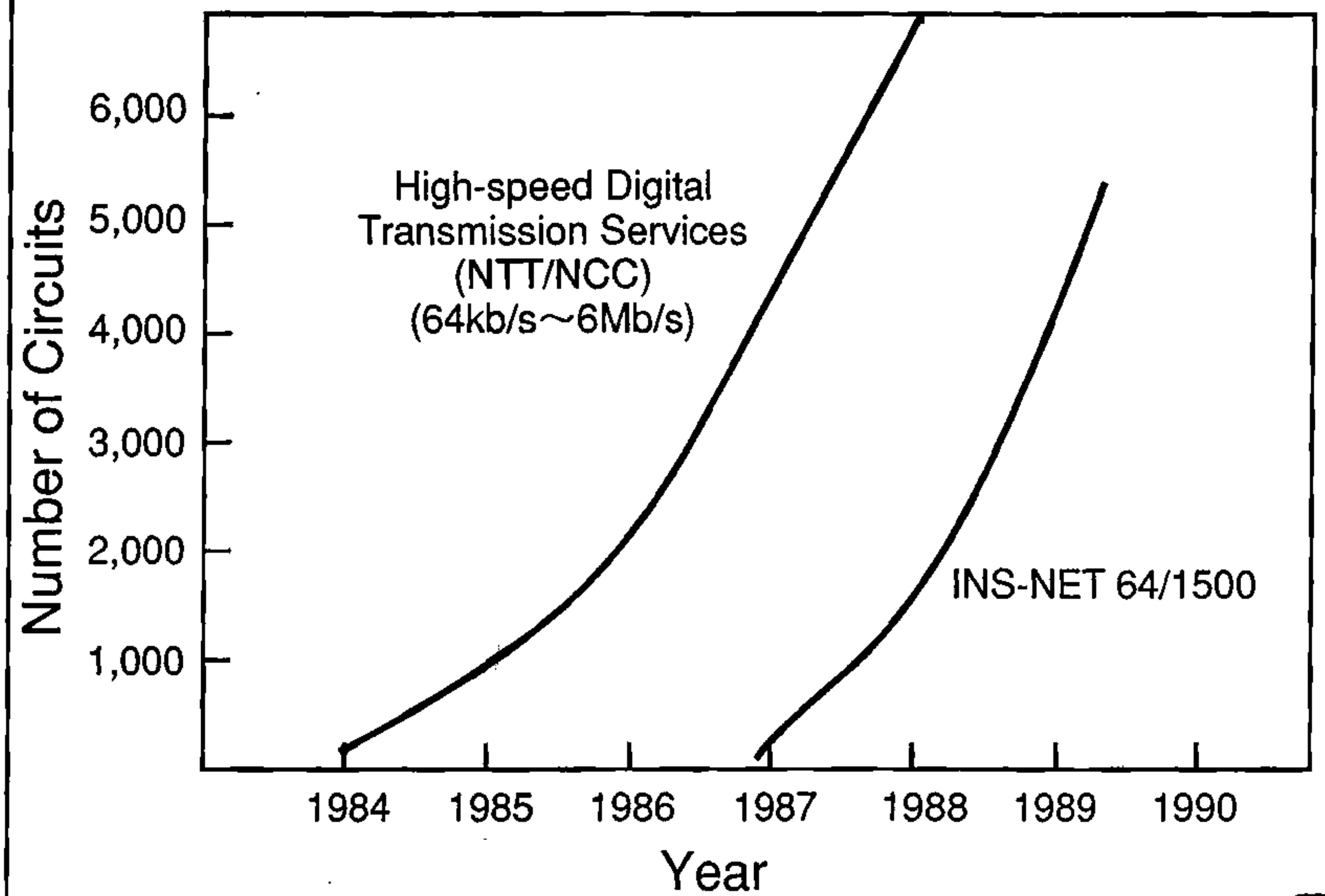
High-speed Digital Services



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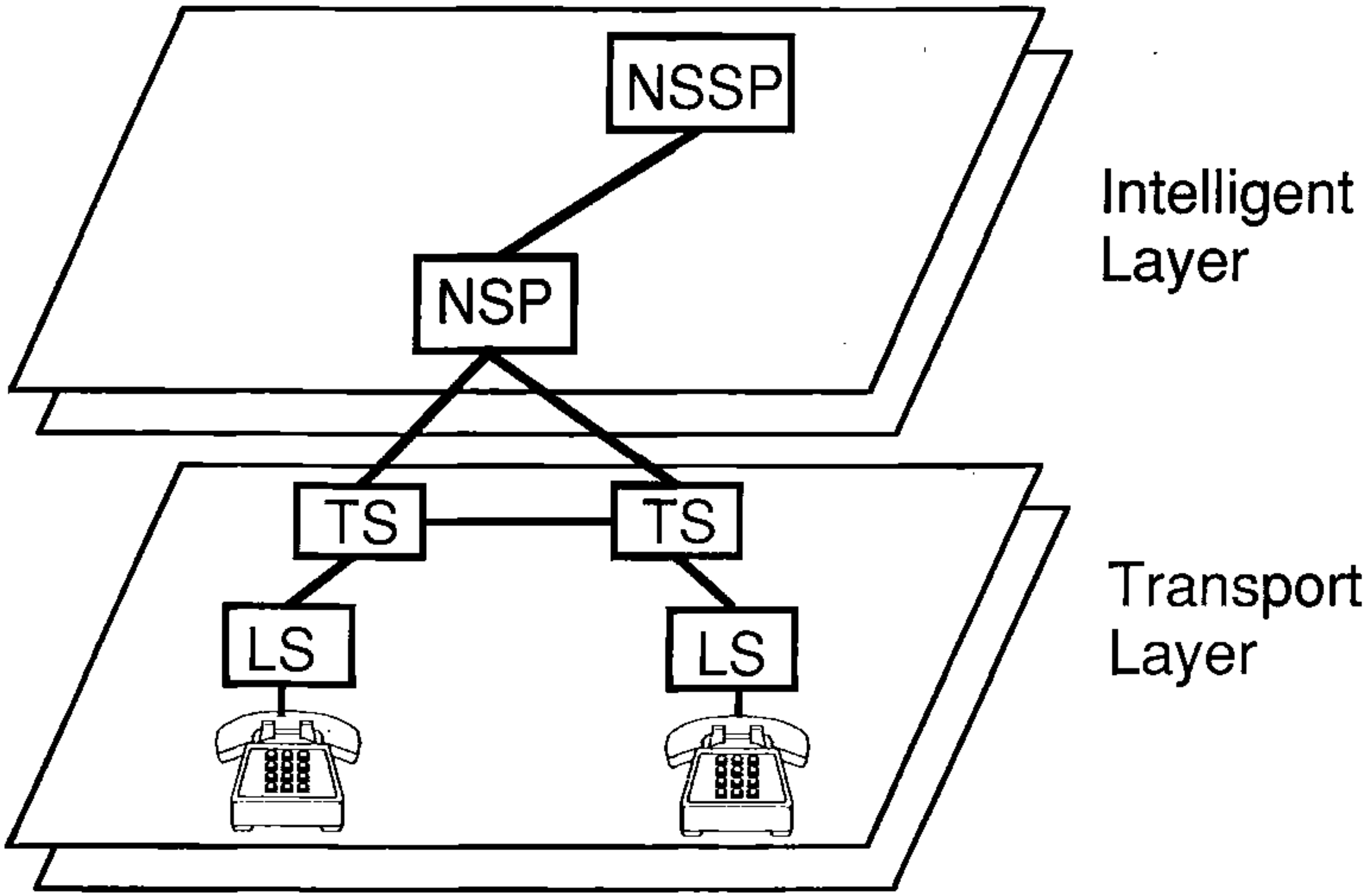
Intelligent Network



NSSP : Network Service Support Point
NSP : Network Service Control Point

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Personal Communication Services

Indoor

Home

Restaurant

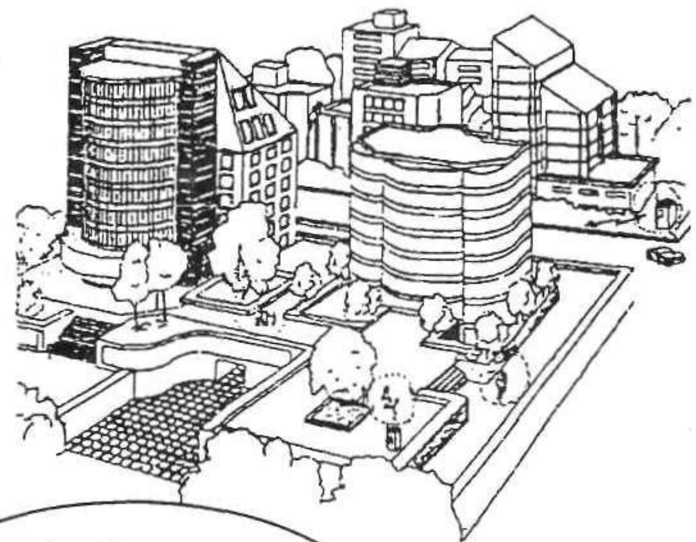
Office

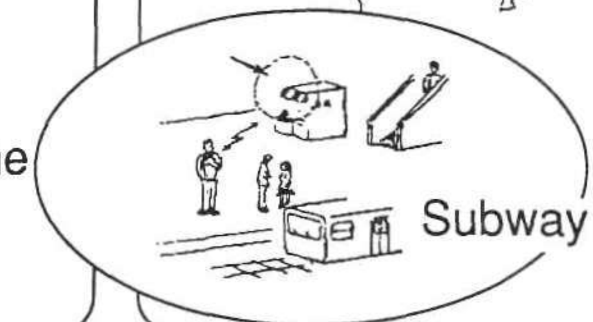
Shop/Store

- Portable Telephone
- IC Cardphone
- Personal ID Service
- Portable Telephone
- Pager

Outdoor

- Mobile Telephone





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Trends in Terminal Systems

-Transportability : Voice/Character/Image/Video

-Portability : Small Size, Light Weight

-User-friendliness : Recognition, Synthesis

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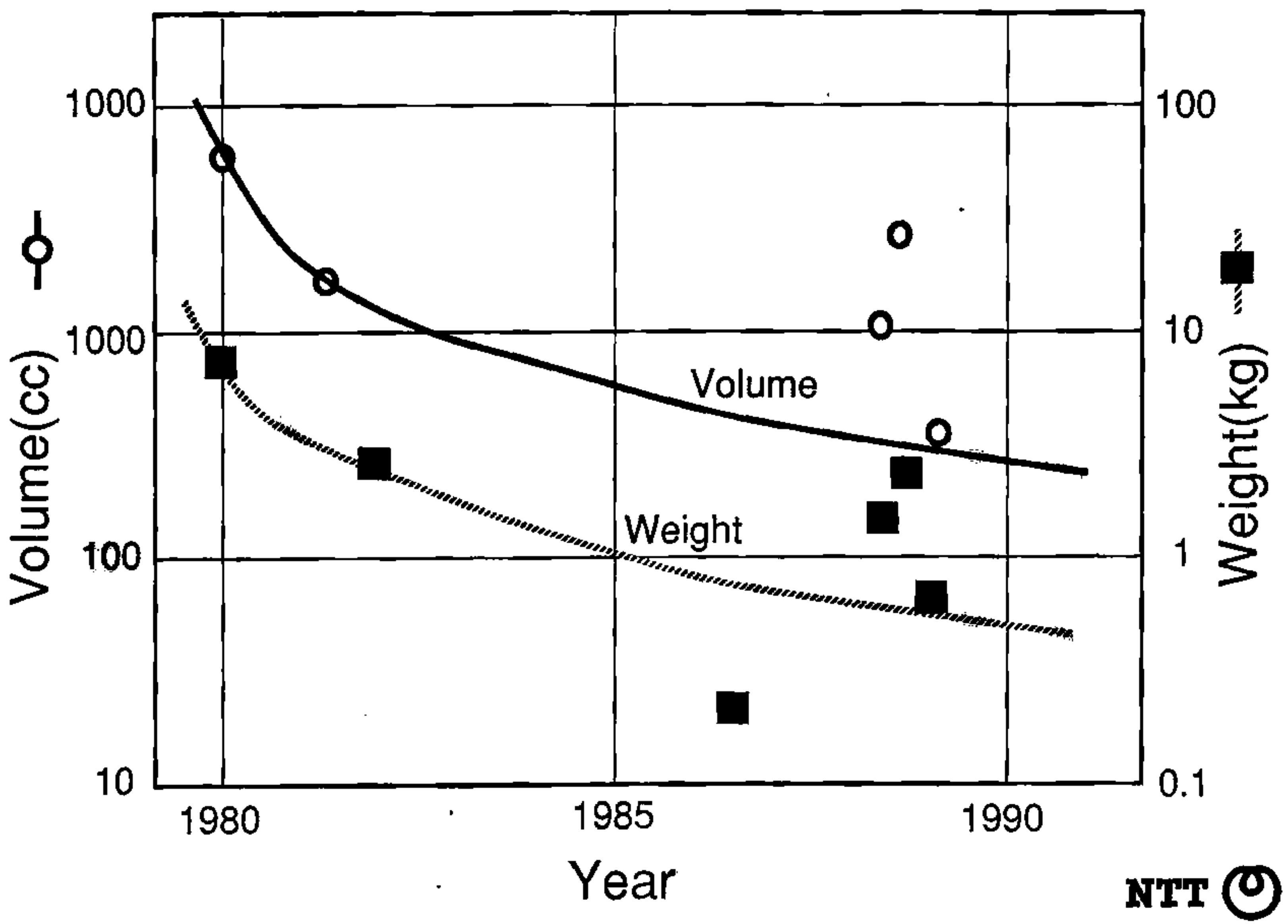
Trend of Mobile Telephone



Trends in Transport Systems

-Fiber to the Home

-Coherent Optical Transmission

-Asynchronous Transfer Mode(ATM)

-Digital Mobile Communications

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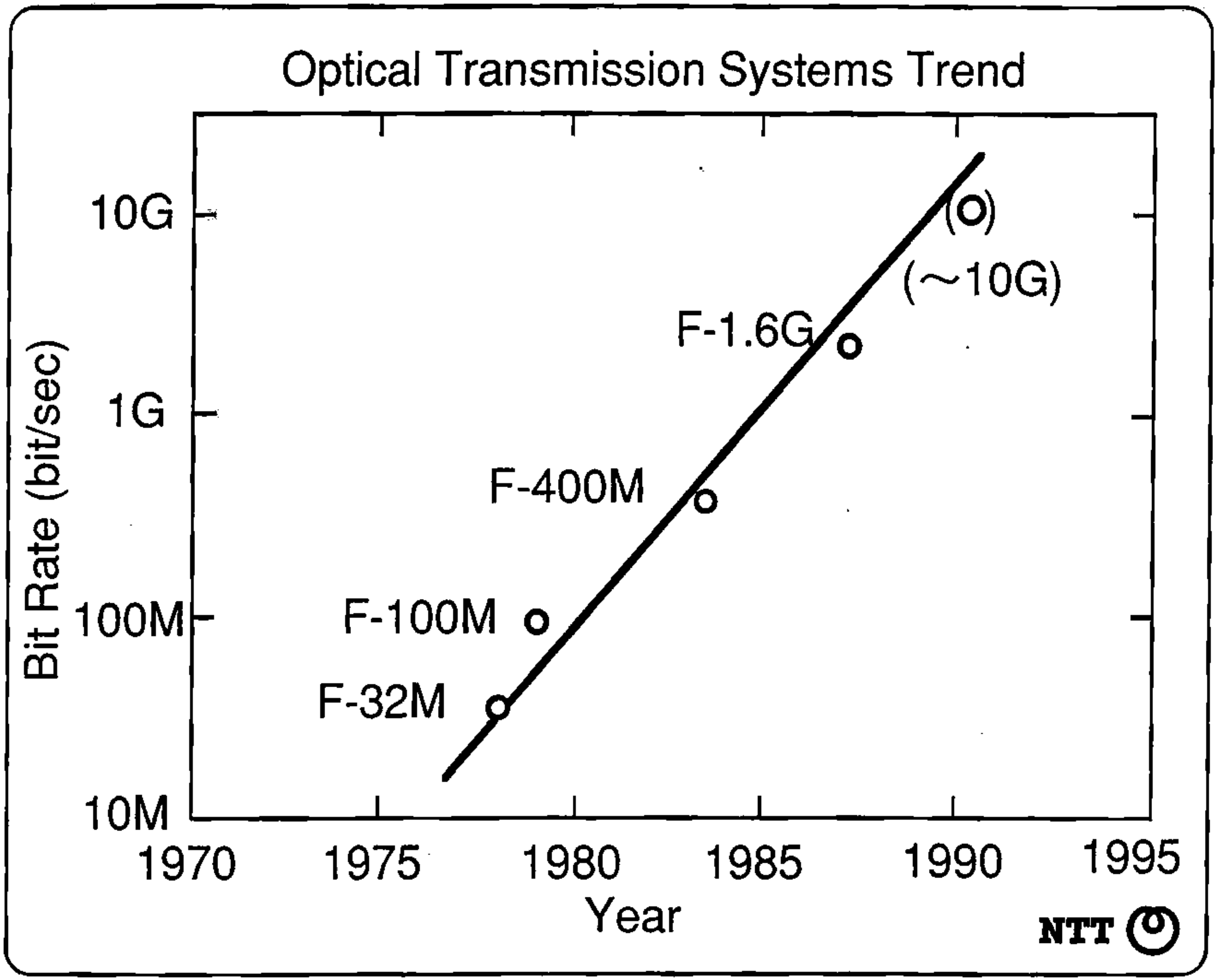
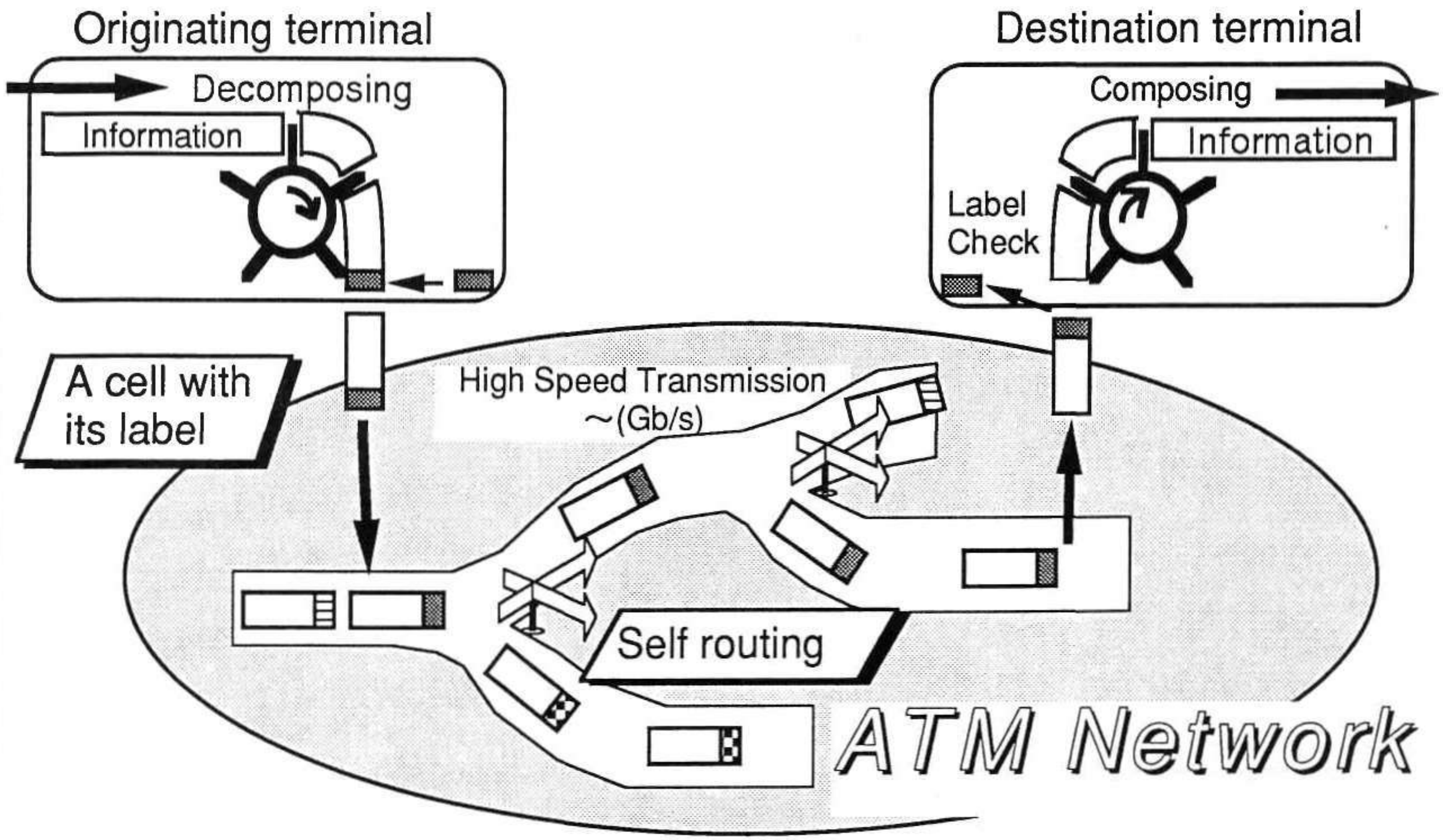


Optical Transmission Systems Trend
Bit Rate (bit/sec)
10G
1G
100M
10M
(~10G)
F-1.6G
F-400M
F-100M
F-32M
1970
1975
1980
1985
1990
1995
Year
NTT

Asynchronous Transfer Mode



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Control and Management Systems

(Functions of NSP/NSSP)

○Advanced Network Services

- -Free Dial
- -Voice Bulletin Board
- -Closed User Group
- -Personal Number Program

○Advanced Network Managements

- -End Customer Control
- -Software Defined Network

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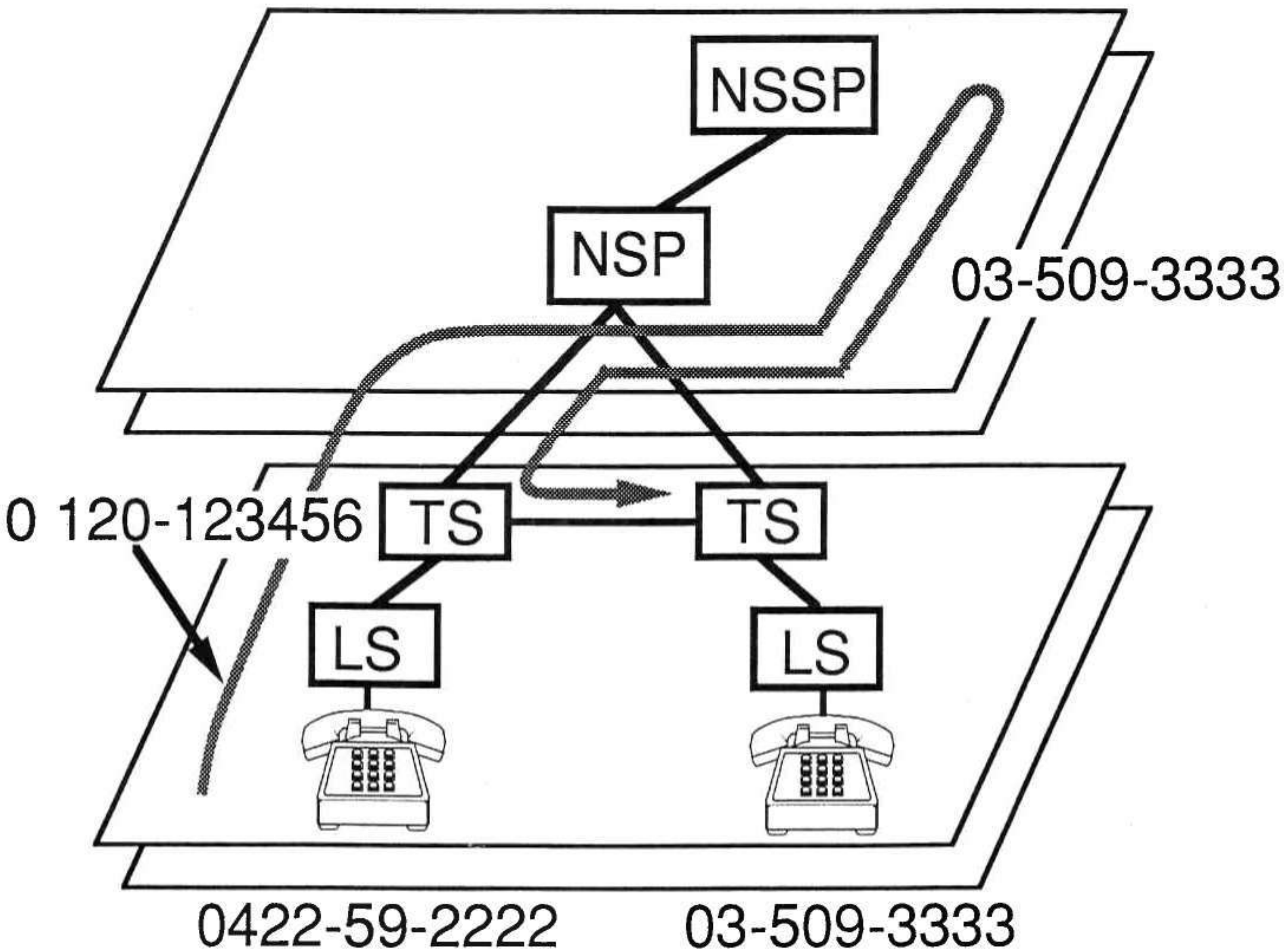
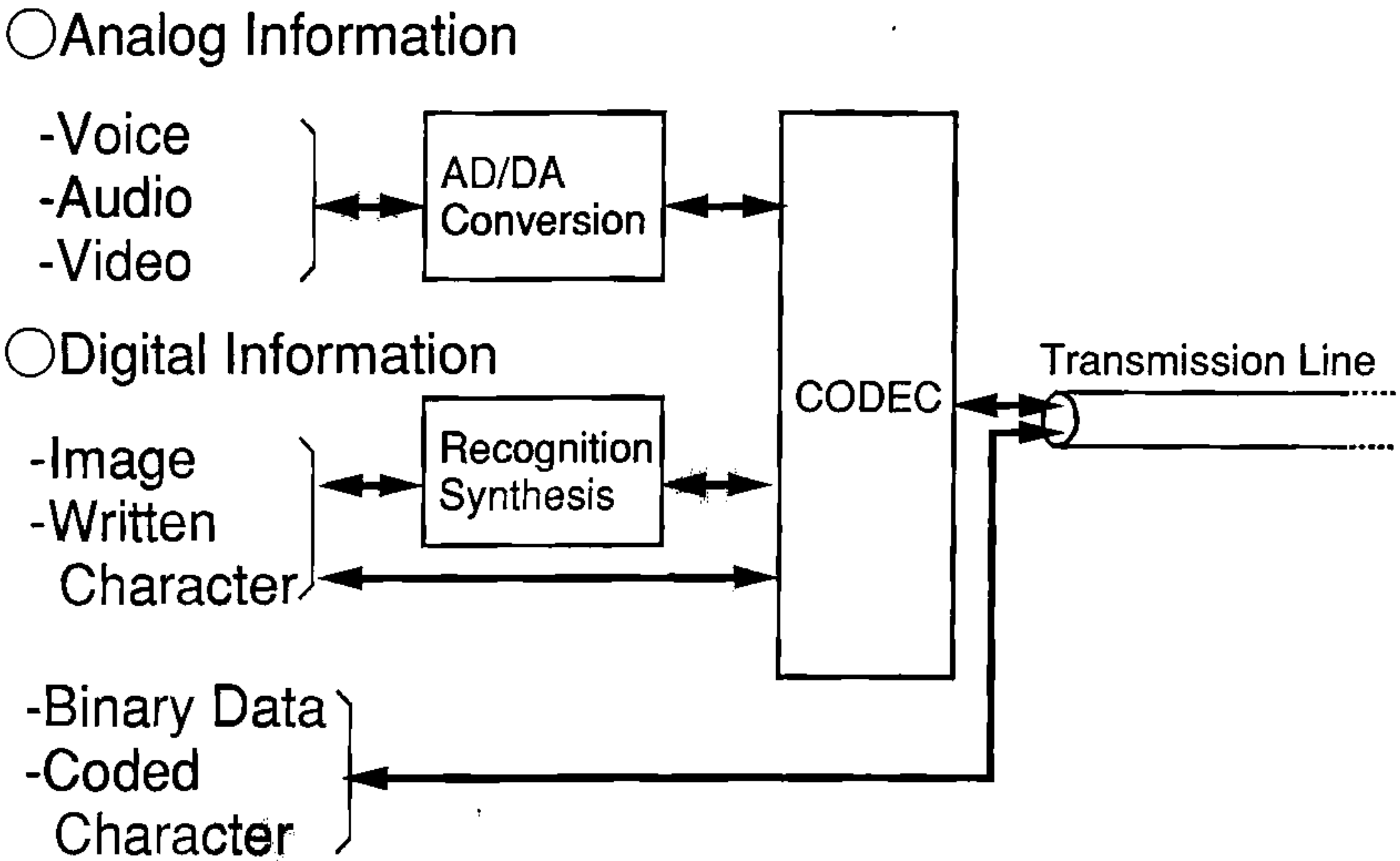
Free Dial Service



Typical LSI Functions in Telecommunications Networks



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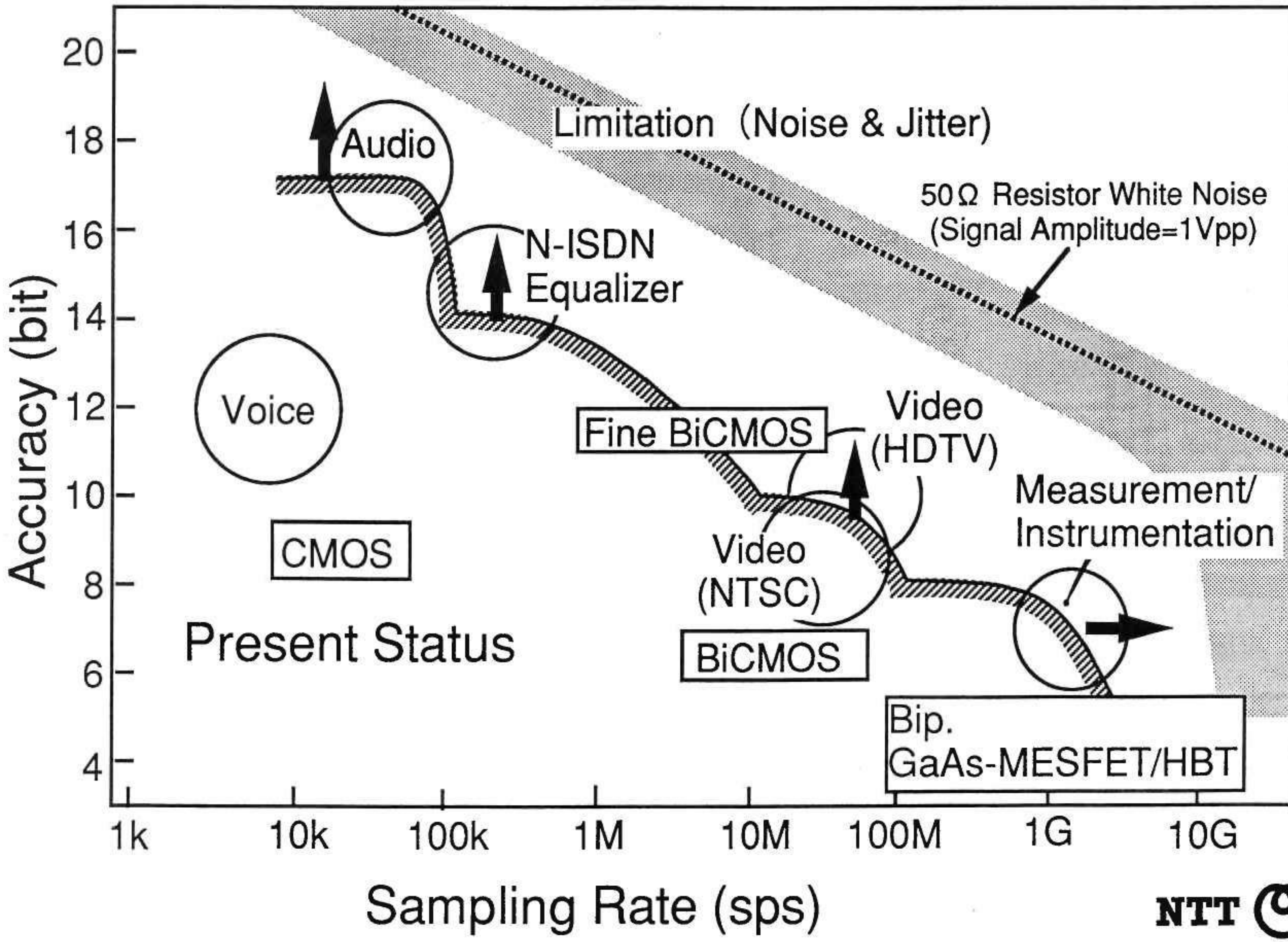
AD/DA Converter



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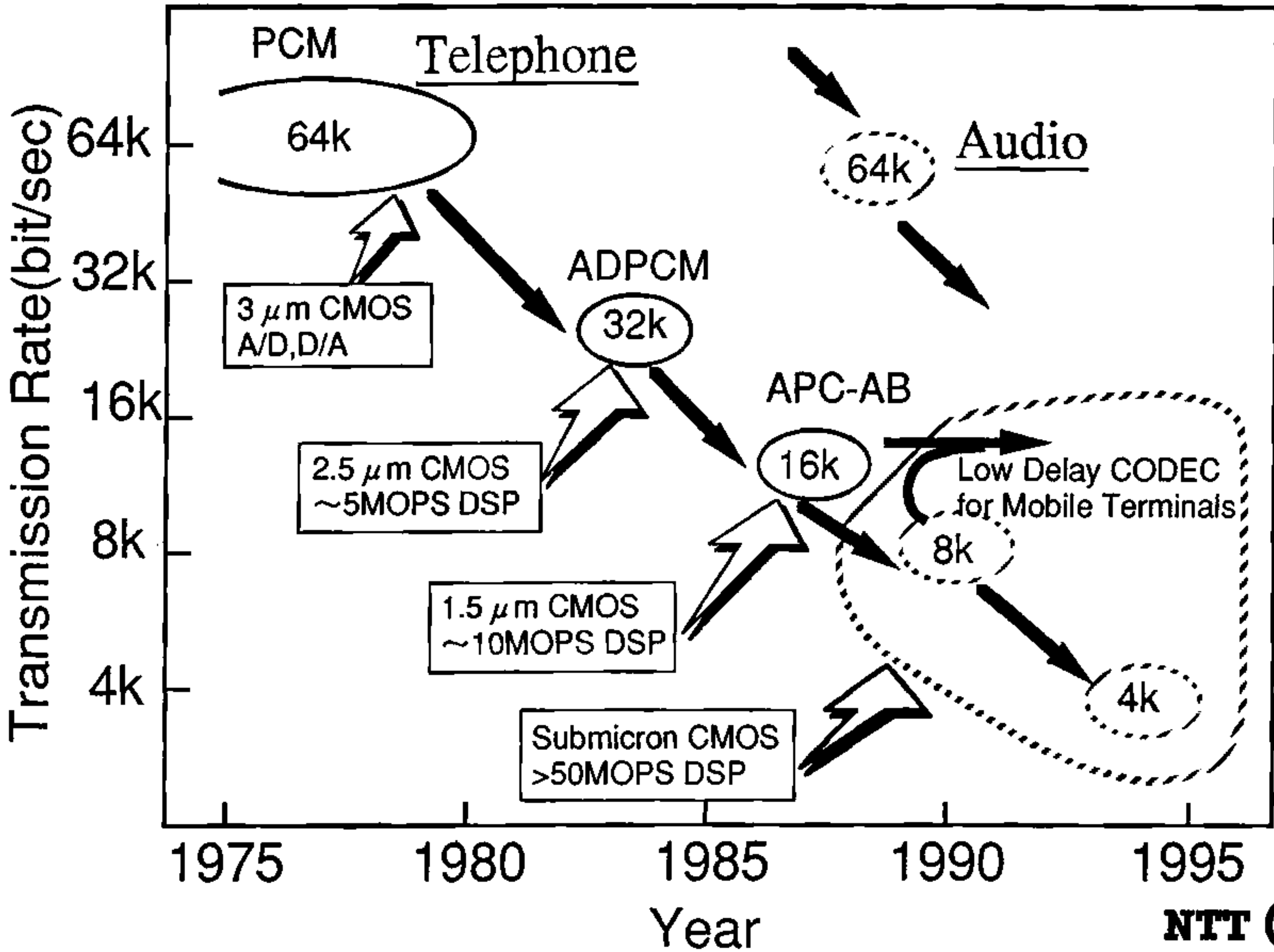
Voice CODEC and LSI Applications



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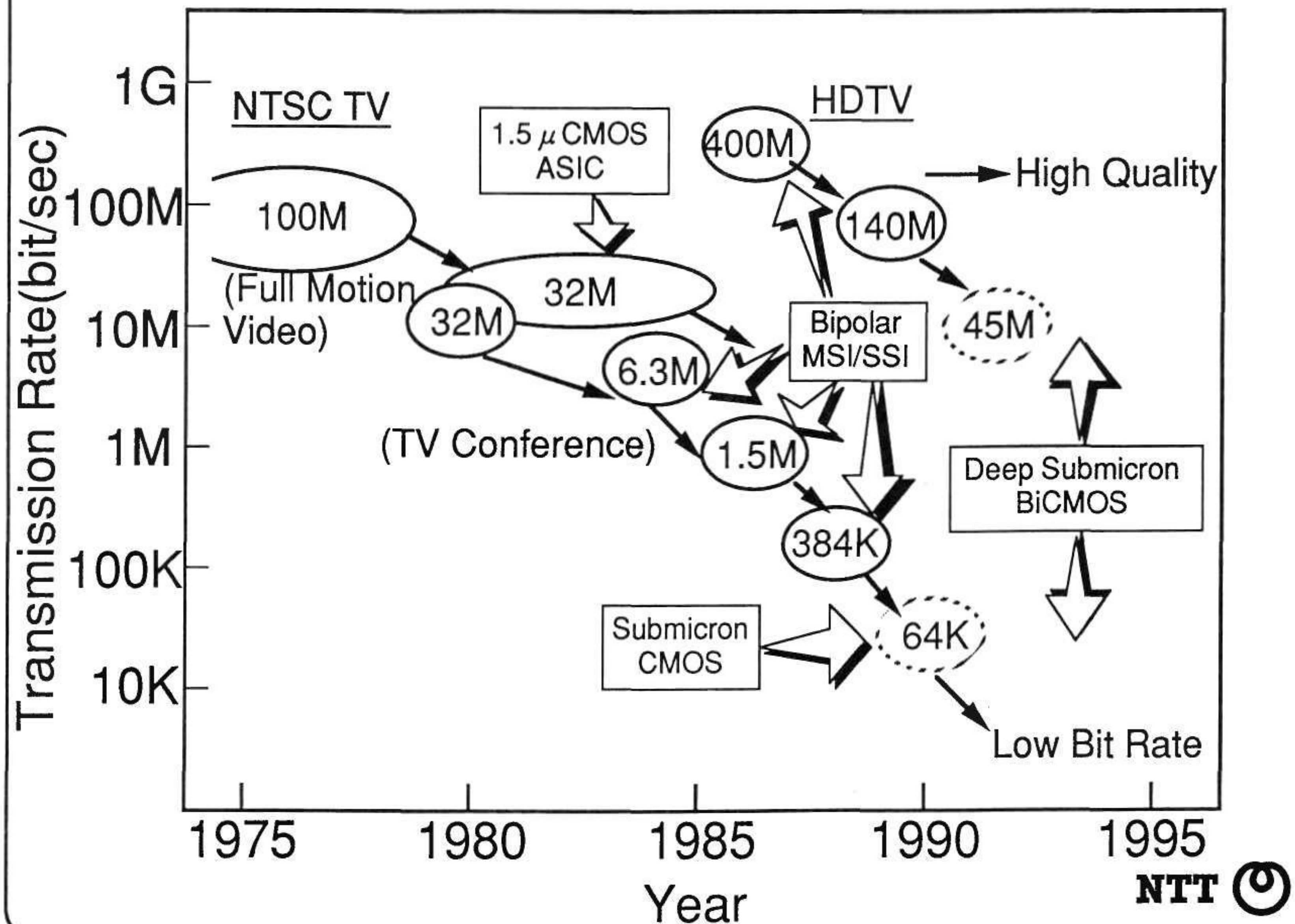
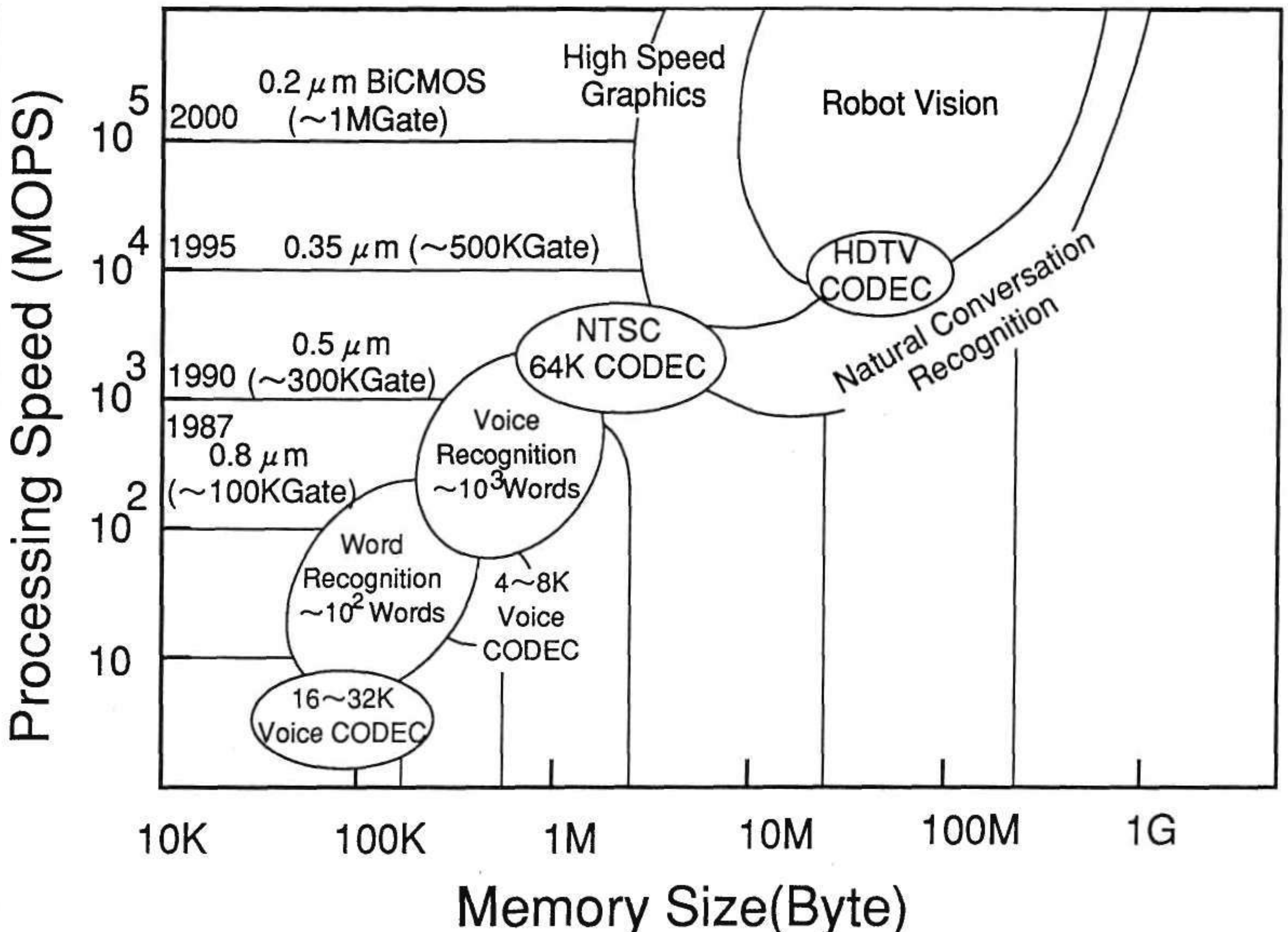
Video CODEC and LSI Applications



Voice/Video CODEC and Recognition



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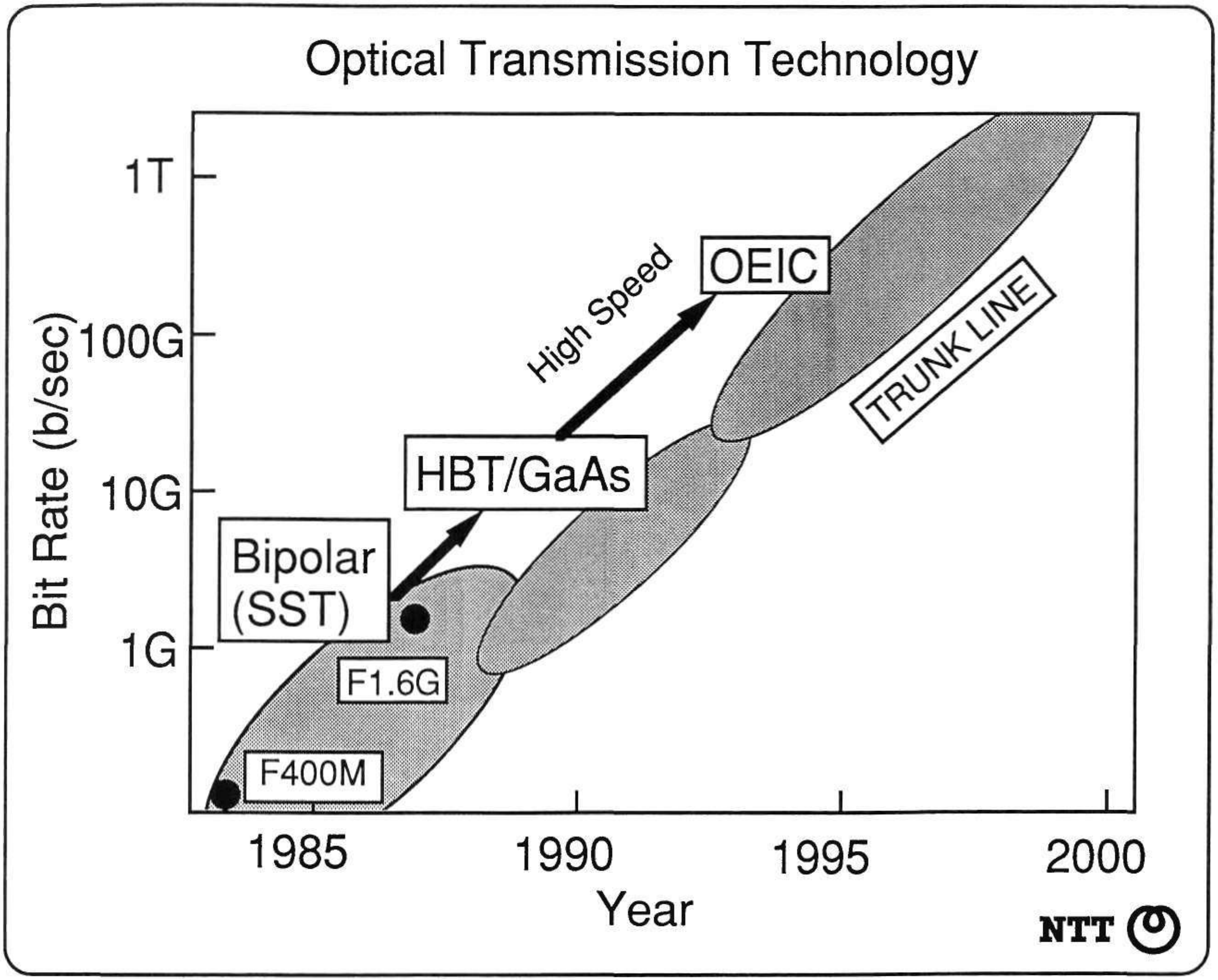
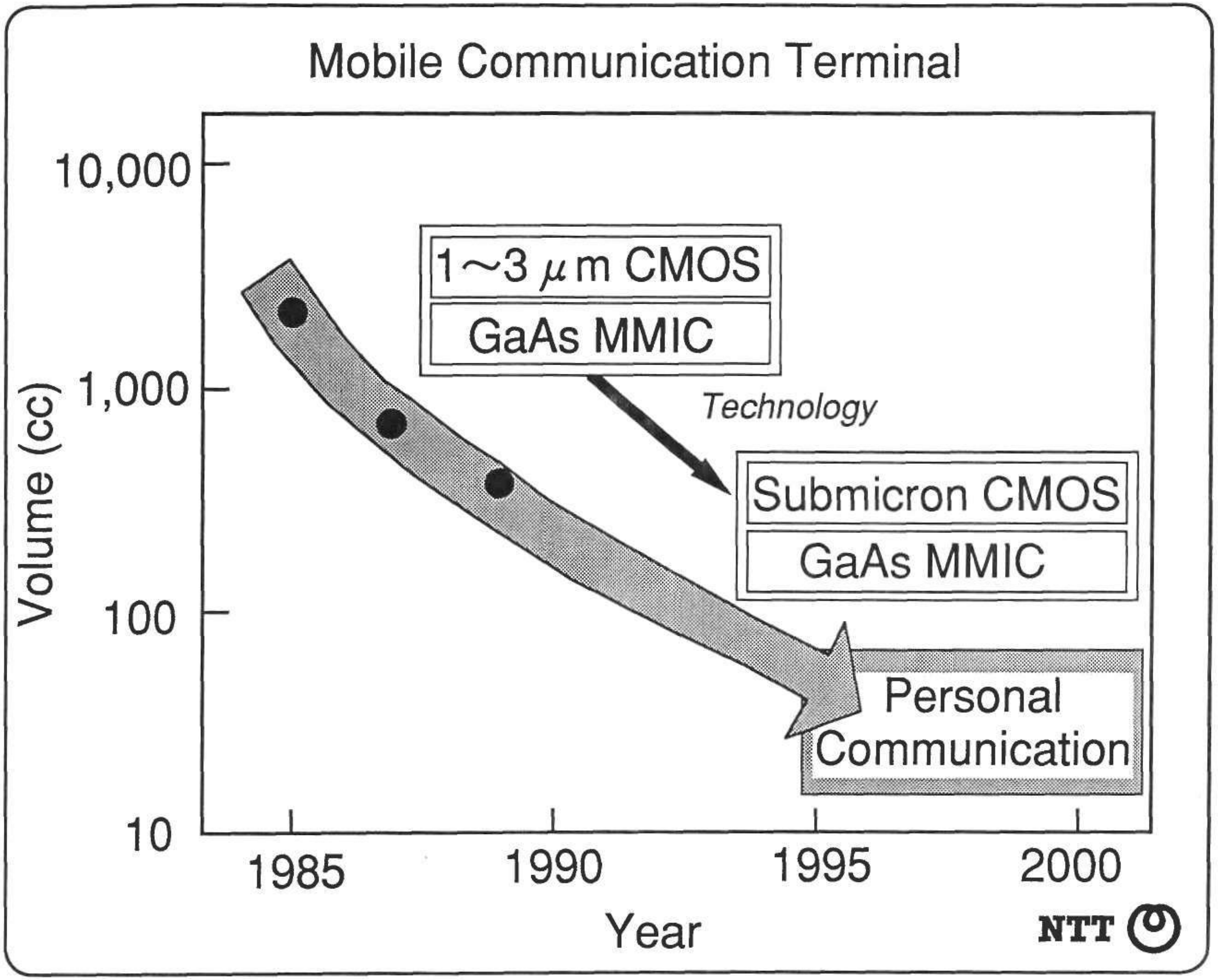


Optical Transmission Technology
1T
100G
10G
1G
Bit Rate (b/sec)
OEIC
High Speed
TRUNK LINE
HBT/GaAs
Bipolar
(SST)
F1.6G
F400M
1985
1990
1995
2000
Year
NTT



Mobile Communication Terminal
10,000
1,000
100
10
Volume (cc)
1〜3 μm CMOS
GaAs MMIC
Technology
Submicron CMOS
GaAs MMIC
Personal Communication
1985
1990
1995
2000
Year
NTT

Summary

Technical Trends in Telecommunications Services

-Multi-Media Transportability
-Portability
-User-friendliness

Trends in Telecommunications Systems Technology

-Transport Systems----Optical Transmission, ATM
-Control and Managament Systems---NSP,NSSP
-Terminal Systems-----Multi-media, Personal, Complex, Intelligent, High-speed

LSI Technology Evolution Toward 21st Century

-Ulta High Speed IC·LSI---Tera-Herz (10^{12}HZ) Operation
-Ultra Large Scale LSI------Mega Gate (10^{6}gate/chip) Integration
-Low Power ASIC------------Femto Joule Devices

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THE EVOLVING ROLE OF RISC TECHNOLOGY IN ULSI

Robert C. Miller
Chairman, President, and Chief Executive Officer
MIPS Computer Systems

Robert Miller is Chairman of the Board, President, and Chief Executive Officer of MIPS. Prior to joining MIPS, Mr. Miller was with Data General Corporation where he was Senior Vice President of the Information Systems Group. He had responsibility for all computer systems, as well as marketing and sales development for the federal marketplace. Previously, Mr. Miller was with IBM Corporation in a series of senior technology and product development assignments, culminating in Director of IBM's Boulder, Colorado laboratory. Mr. Miller holds six U.S. patents and has authored a number of publications related to computer architectures. He is a senior member of the IEEE Society, is a registered Professional Engineer, and on the board of directors of Bucknell University. Mr. Miller received a B. S. degree in Mechanical Engineering from Bucknell University and an M.S. degree in Thermodynamics from Stanford University.

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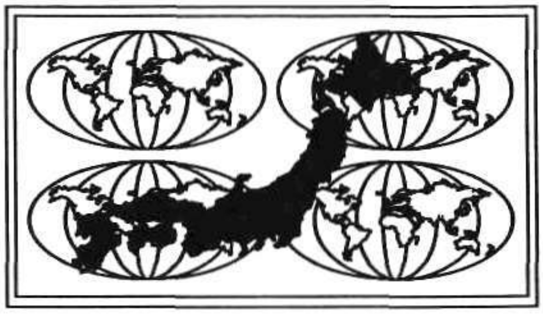
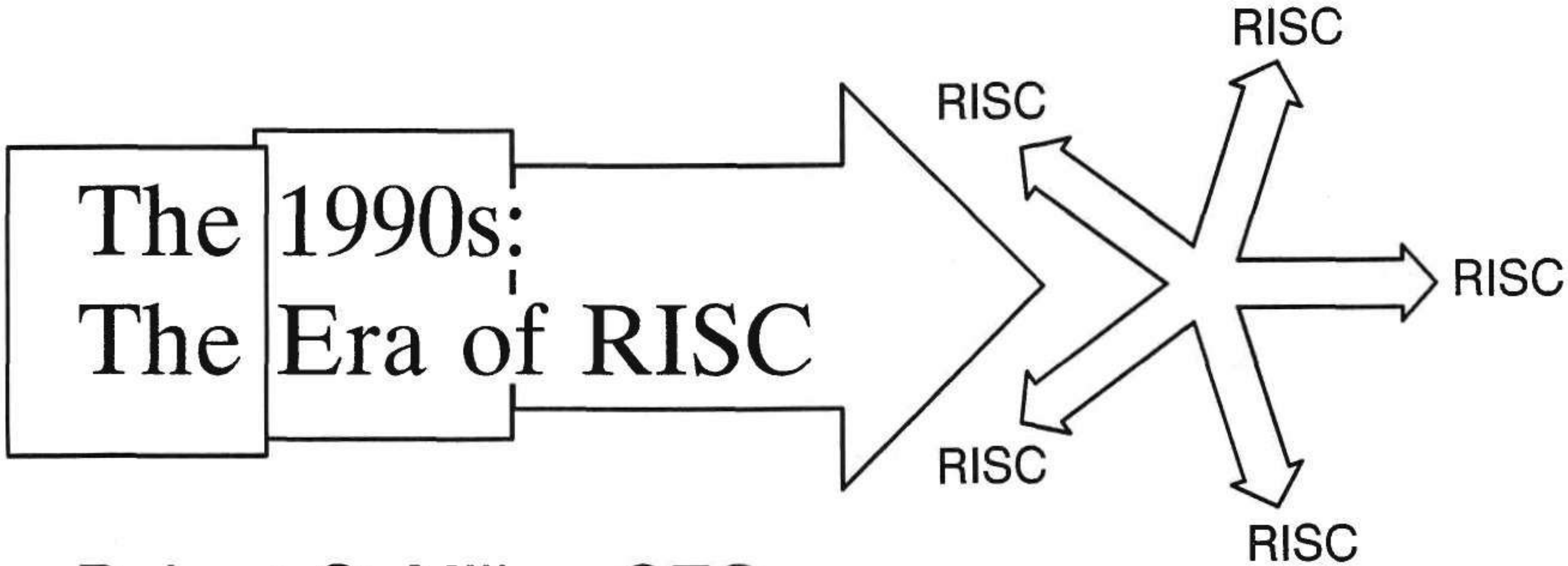


ULSI Era: Challenges and Opportunities

The Evolving Role of RISC Technology in ULSI

Robert C. Miller
Chairman, President, and Chief Executive Officer
MIPS Computer Systems

The 1990s: The Era of RISC



Robert C. Miller, CEO
MIPS Computer Systems

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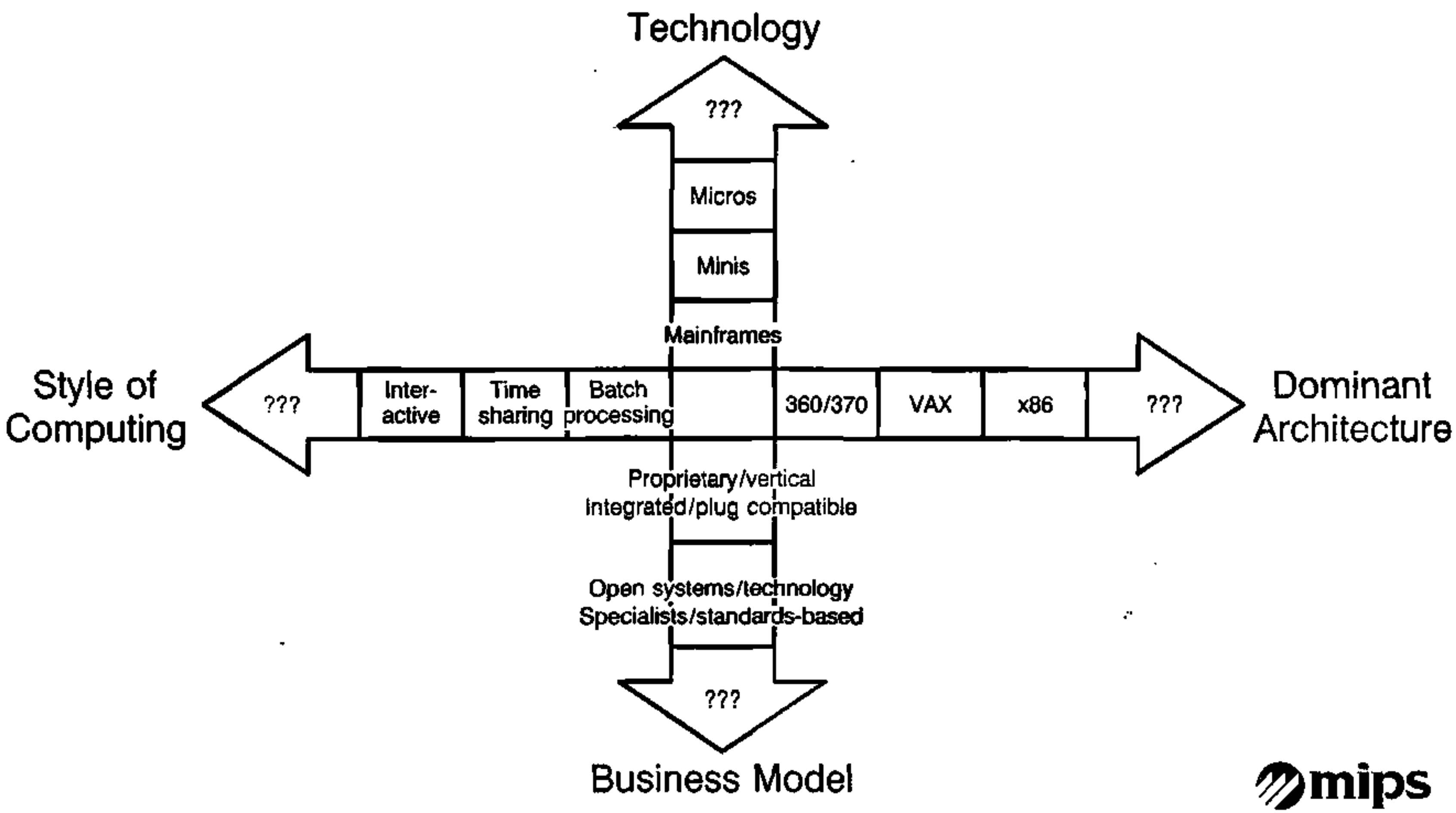
What Do You Mean by "Era"?



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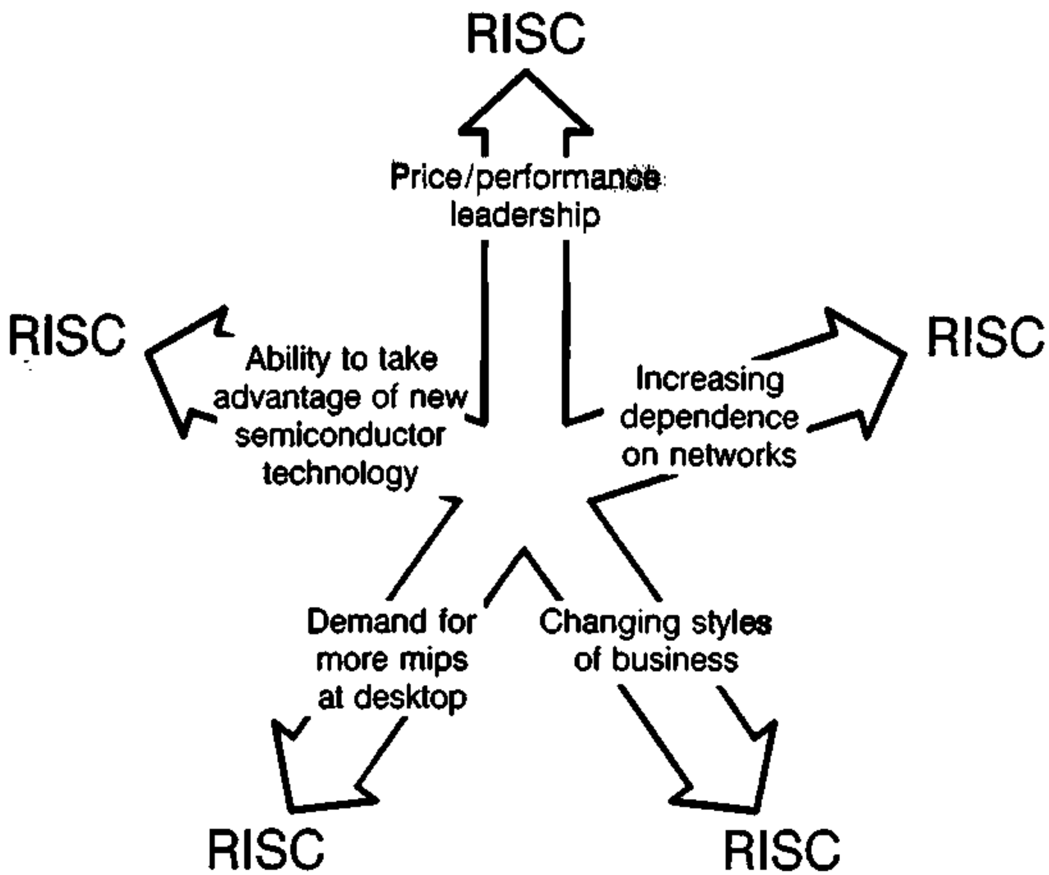
The Era of RISC: The Big Picture

- Microprocessor-based machines dominant across the entire breadth of the market
- Steady 50% to 100% annual increases in performance for the next five years
- Comparable reductions in cost per mips
- New generation applications which appeal to broader groups of end-users
- Order of magnitude increases in microprocessor volume
- The emergence of one or possibly two dominant CPU architectures

mips

The 1990s RISC Explosion



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The Era of RISC: Technology

or "The Beauty of a Low Transistor Count"

- Takes advantage of innovations in semiconductor technology sooner
- Incorporates computer architecture innovations easier
- Smooth transition path to 64-bit architecture
- Makes better use of chip area for purposes of integration
  - At high-end: on chip caches, floating point processing
  - At low-end: (embedded controllers) I/O and peripheral interfaces

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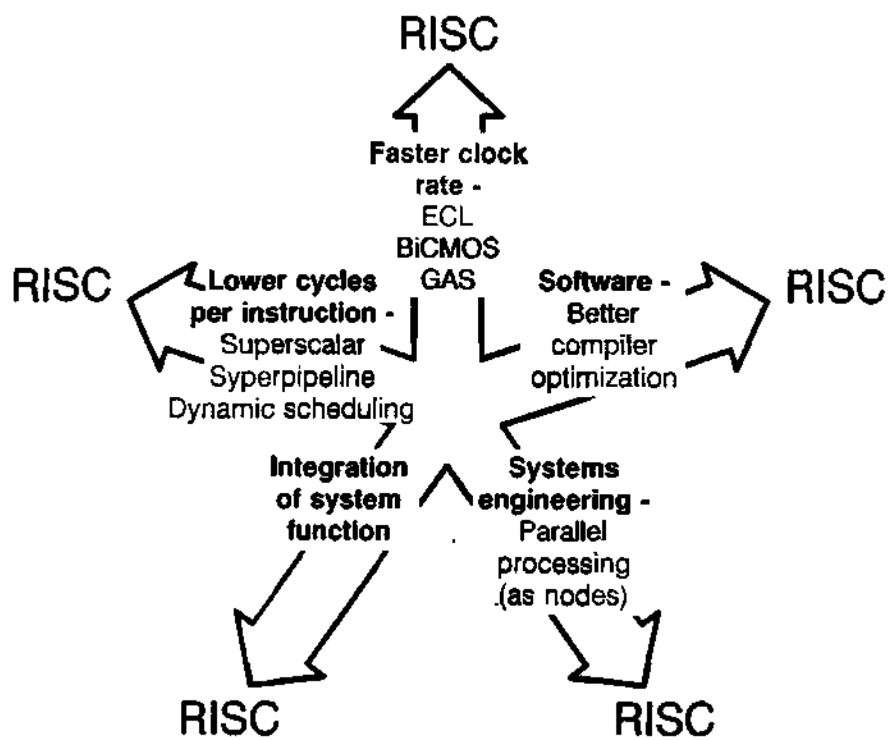
Riding the 1990s Performance Explosion*



* The key to a good RISC design is balancing these forces

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The Era of RISC: Business

or "The Revenge of the Marketplace"

- Open Systems: Customers always wanted freedom, but felt trapped. RISC offers enough performance to lure users away from proprietary systems
  - Trends are accelerated by macro changes in business climate, e.g. increased competitiveness, emergence of global markets
- Semiconductor houses become high-end CPU vendors. Value-added comes from process technology
- CPU design returns to systems houses

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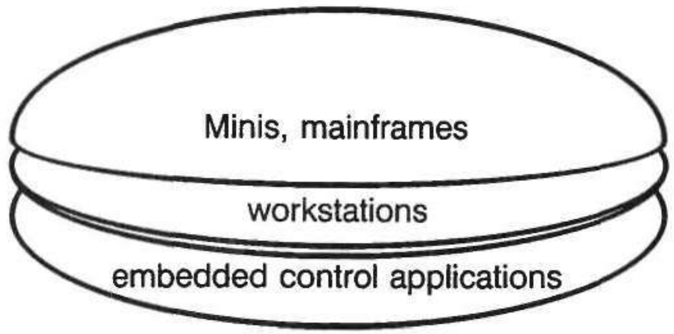
The Era of RISC: Applications

or "Who Will Eat All Those Mips?"

The "Mipsburger"



- At high-end: competes with minis, mainframes
- In middle: provides workstations with new functionality for networking, high-resolution graphics, and human responsive interfaces
- Underneath: innovative new embedded control applications

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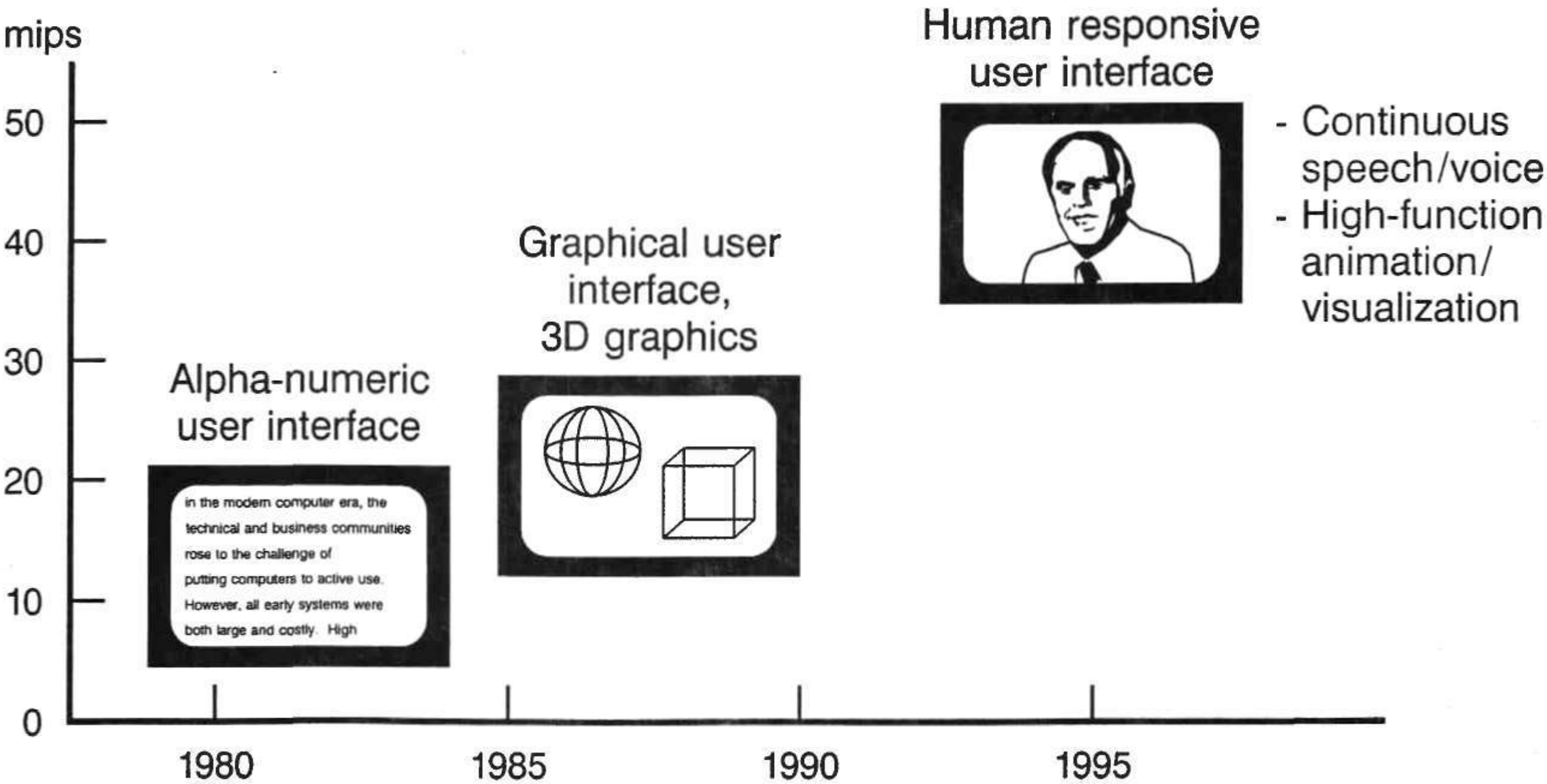
User Interface Consumption of Mips



RISCmyths versus the Well-Balanced RISC

- Aren't RISCs only good for technical workstations?
  No. Some are used in commercial applications
  50% of MIPS servers are sold into multi-user commercial applications, running databases, including Pick/UNIX
- Aren't RISCs only good for C and Fortran?
  No. RISCs support many other languages
  MIPS has supplied COBOL, ADA, PL1 since 1988
  At least 3 third-party COBOLs are available
  A MIPS M/2000 is about equal an Amdahl 5860
- Aren't MIPS RISC chips limited to UNIX?
  No. > 50% elsewhere. Laser printers, switching machines, avionics, automobiles, high-speed controllers, etc.

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MIPS Computer Systems: A Product of the RISC Era

- Designs and supports a CPU architecture
- Licenses manufacturing rights to five semiconductor partners worldwide
- Purchases CPUs for its own systems division
- Licenses system design to manufacturers worldwide

For Example ... MIPS Chips in

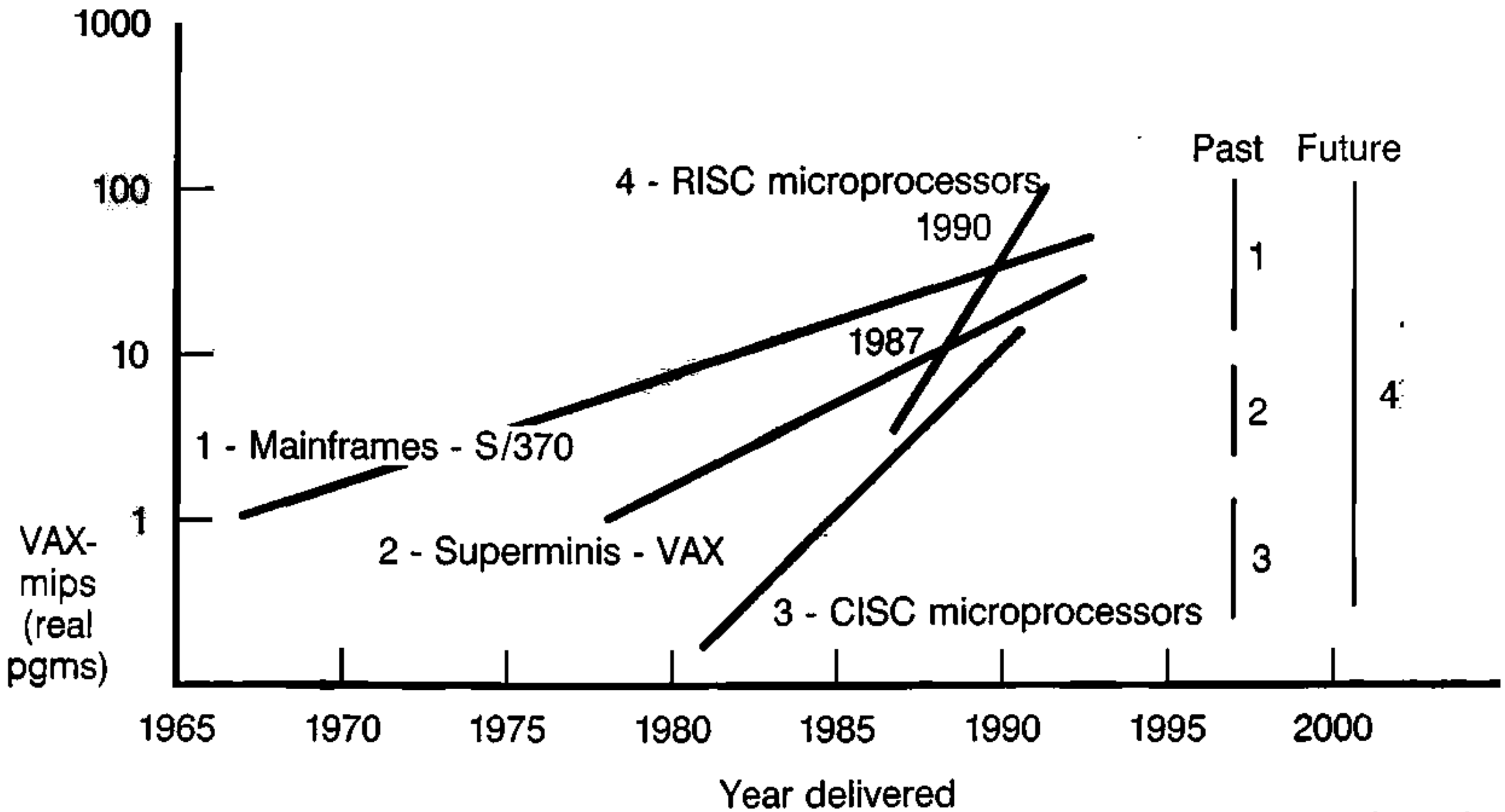
Workstations: MIPS, DEC, SGI, SONY, Sumitomo, NEC
Servers: MIPS, DEC, SGI, CDC, ERSO, HCL
Multi-user commercial: MIPS, Bull, Nixdorf, CDC, Pyramid
Multi-user commercial, fault-tolerant: Tandem, RC Computer
Real-time: Concurrent Computer

Laser Printers: Kodak and many others
Avionics: Westinghouse and many others
Switching: Northern Telecom and others
Controllers: Array Technologies and others
Automobiles: Several

A small sample ...

mips

Uniprocessor CPU Performance Trends*



*An approximation

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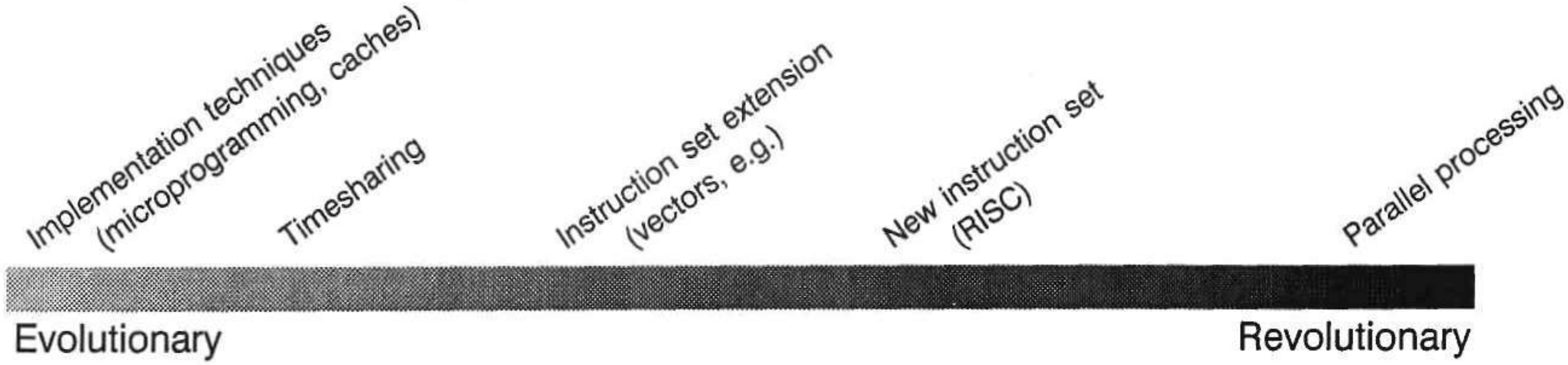
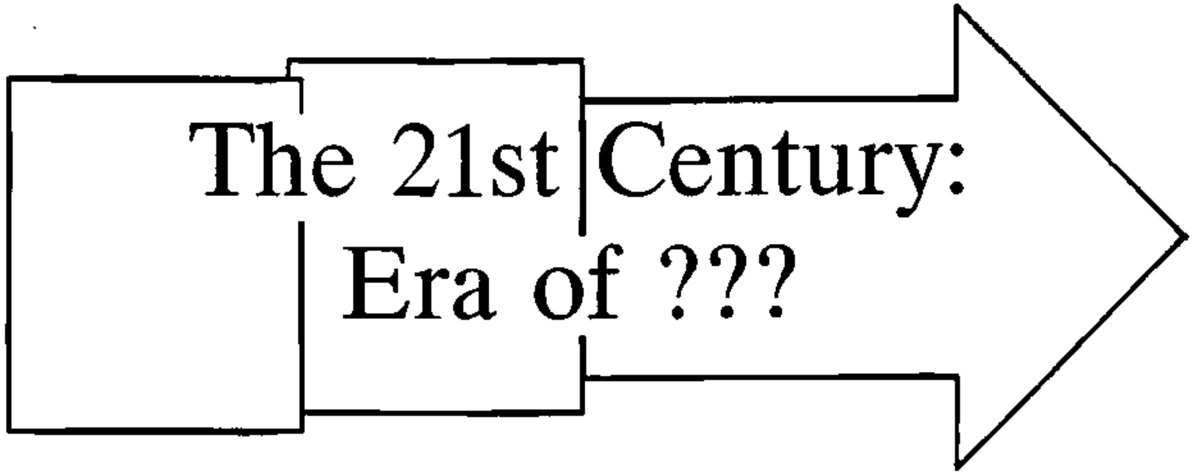
Final Thoughts:
Evolution vs. Revolution

- How long does it take for a new idea in architecture to catch on?
- Key metric is how it affects the user - transparent, superset, recompile, rewrite programs
- The more revolutionary the longer the time to transfer the idea from the lab to practice



What About Revolutionary Approaches?

- Massively parallel: just coming into market
- Optical computing: in research labs
- Biological computing: on the way to the lab



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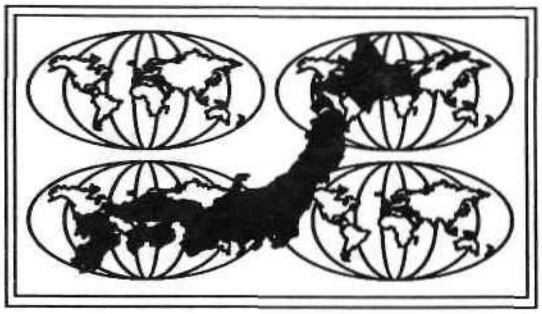
AUTOMOTIVE ELECTRONICS -- TODAY AND TOMORROW

Shoji Jimbo
Director and Member of the Board
Toyota Motor Corporation

Shoji Jimbo is Director and a Member of the Board of Toyota Motor Corporation. His current executive duties have focused on drive train engineering, electric and electronics engineering, chassis engineering, micro electronics development, and vehicle testing and research. Previously, Mr. Jimbo was General Manager of Product Planning. In that capacity, he oversaw the development of models in the Mark II line (marketed as the Cressida outside Japan), and also supervised the early development work on the Lexus. These responsibilities took him overseas a number of times on visits to Toyota's overseas marketing facilities. Prior to this, Mr. Jimbo supervised a technical division at Toyota. Mr. Jimbo received a degree in mechanical engineering from Hokkaido University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

B8687018.IMG 03/07/90 JSI



ULSI Era:
Challenges and
Opportunities

Automotive Electronics -- Today and Tomorrow

Shoji Jimbo
Director and Member of the Board
Toyota Motor Corporation

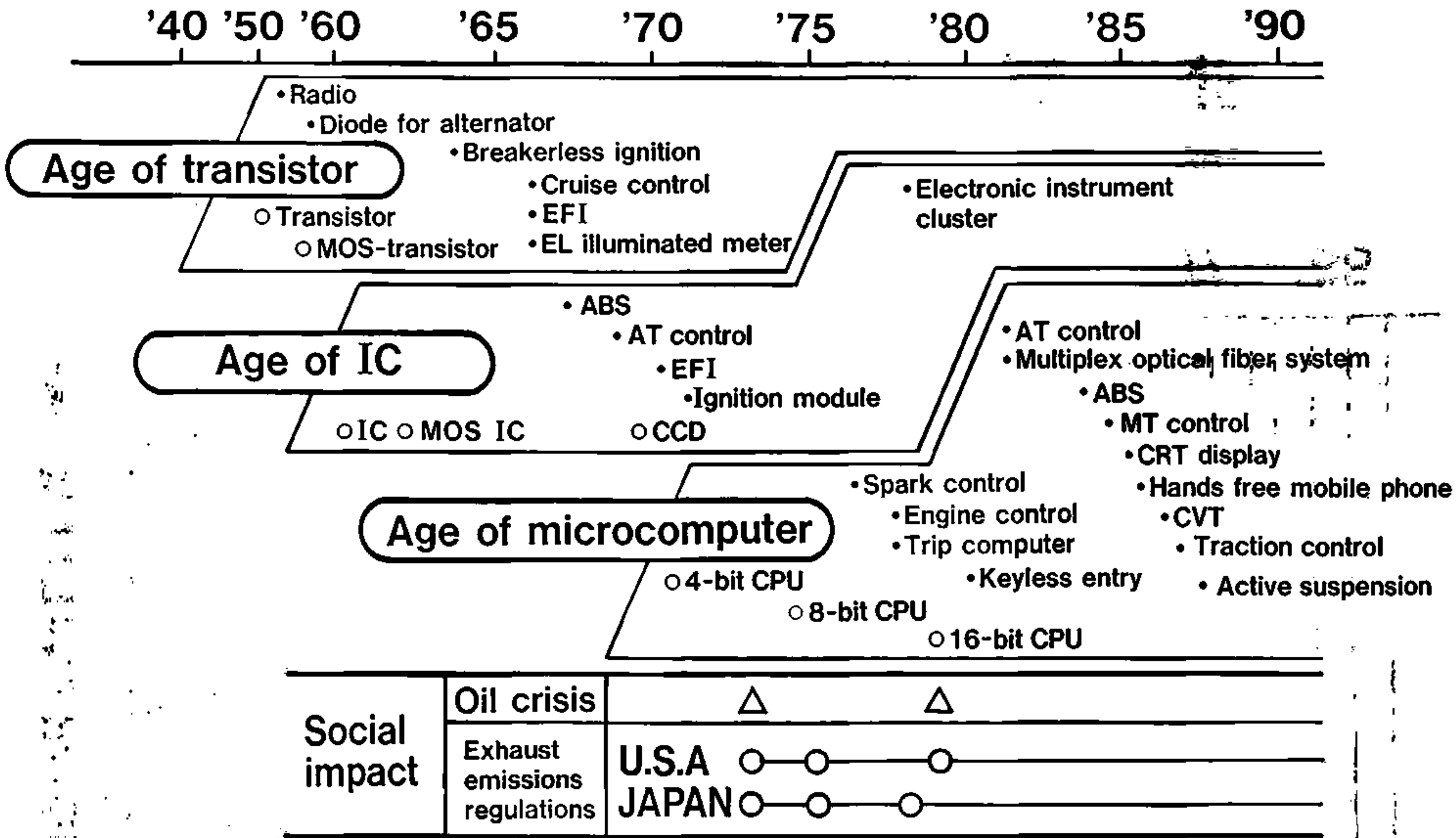
AUTOMOTIVE ELECTRONICS

—TODAY AND TOMORROW—

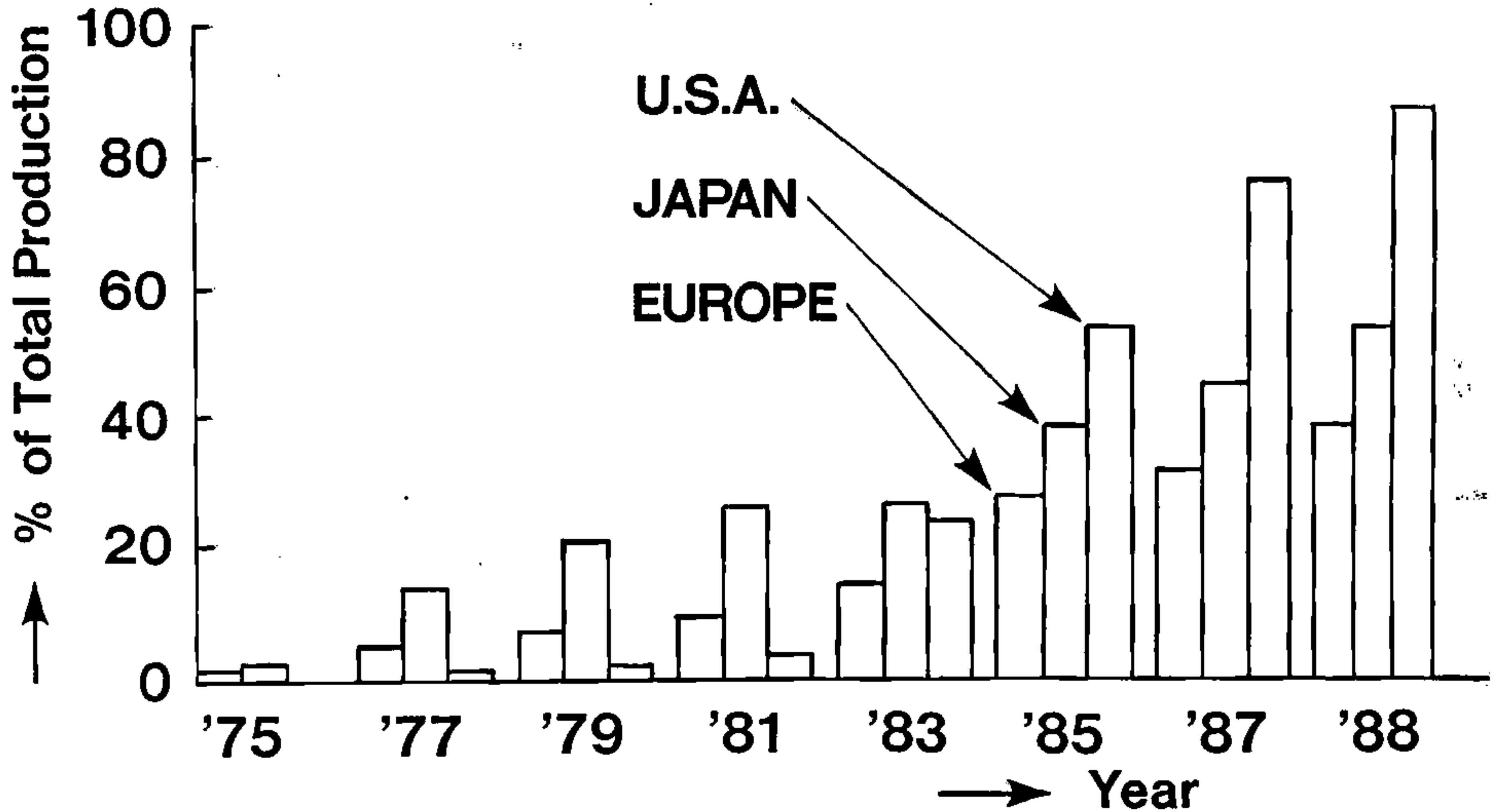
Shoji Jimbo

Director

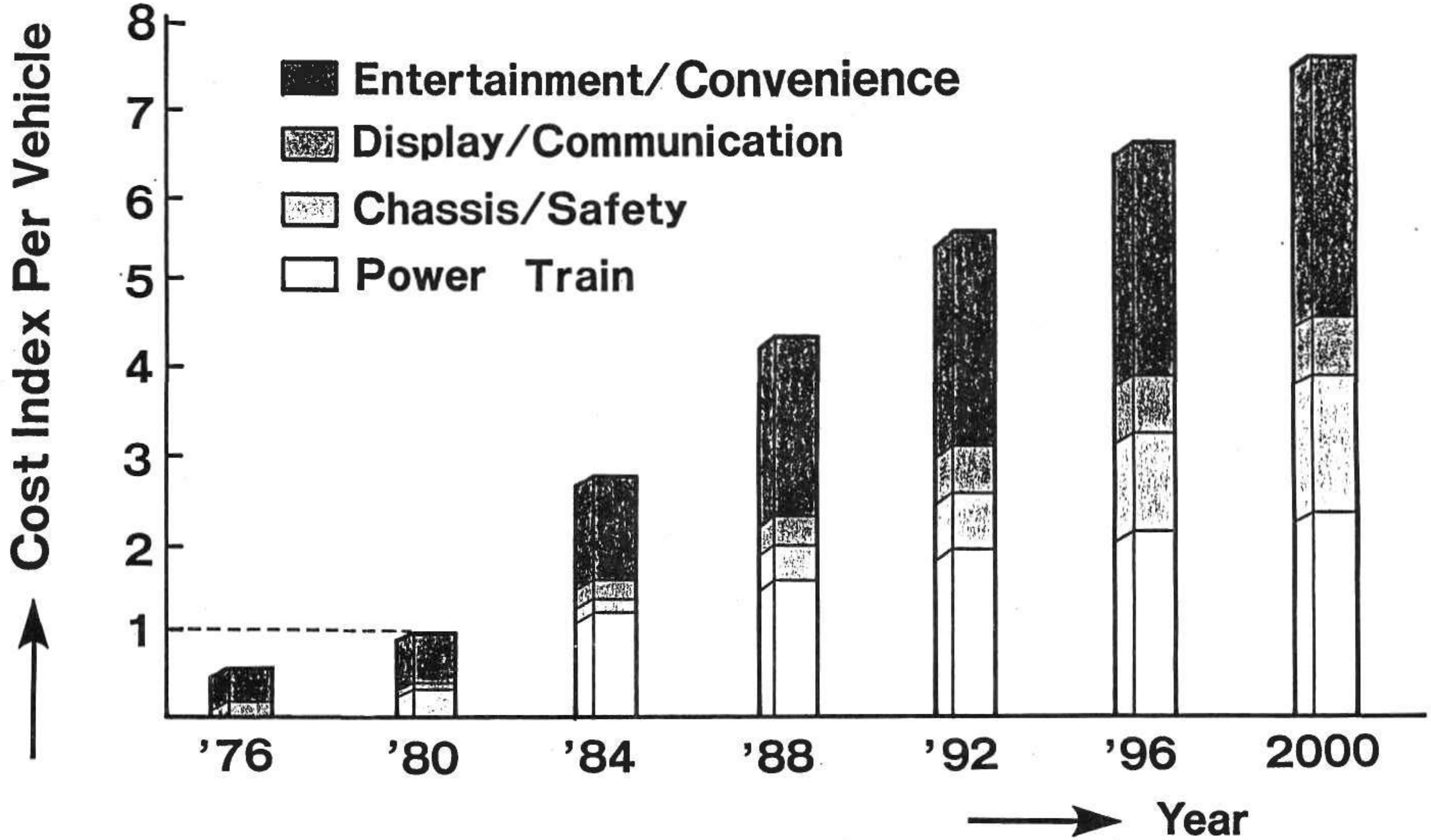
TOYOTA MOTOR CORPORATION



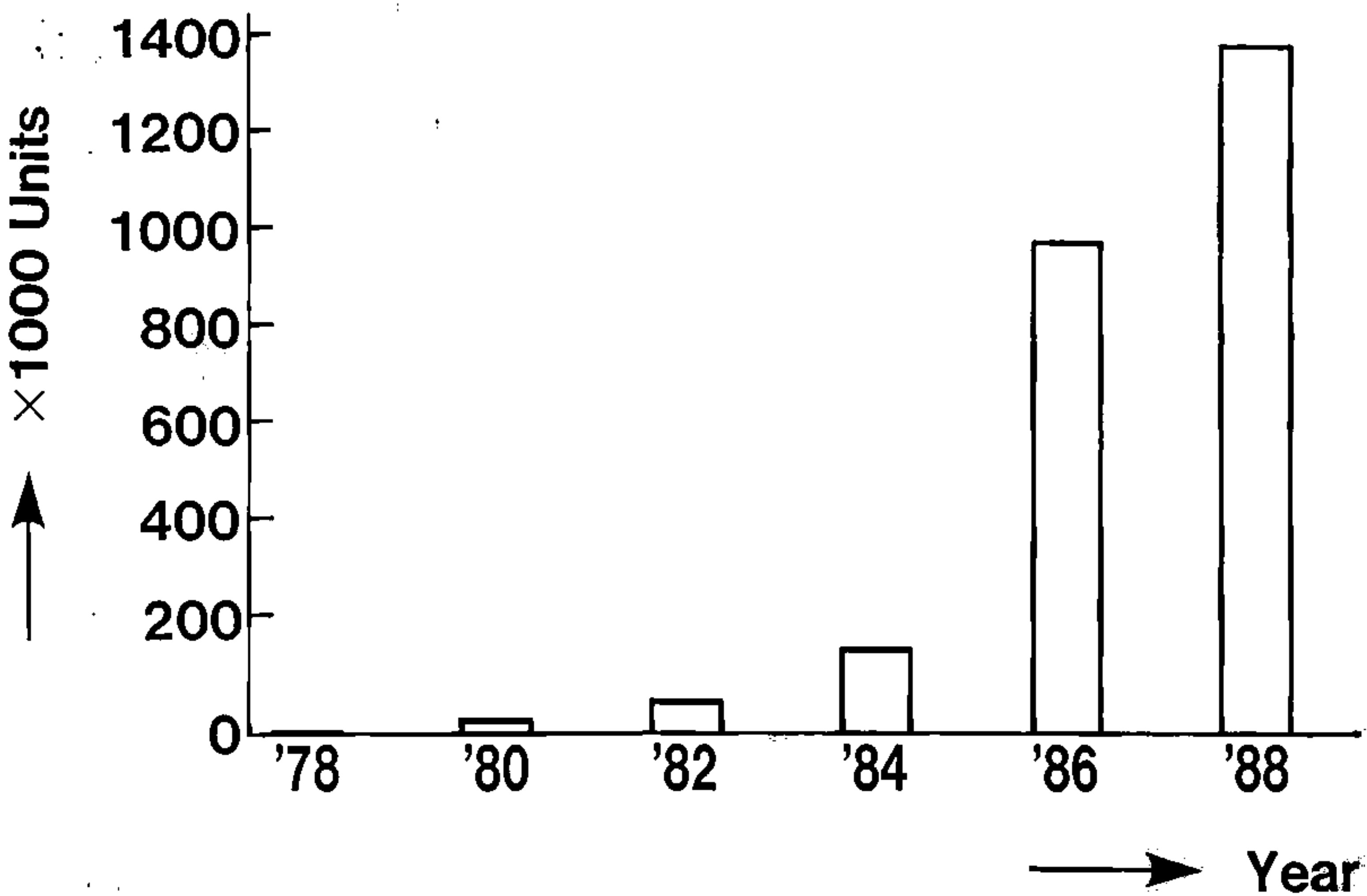
EVOLUTION IN AUTOMOTIVE ELECTRONICS



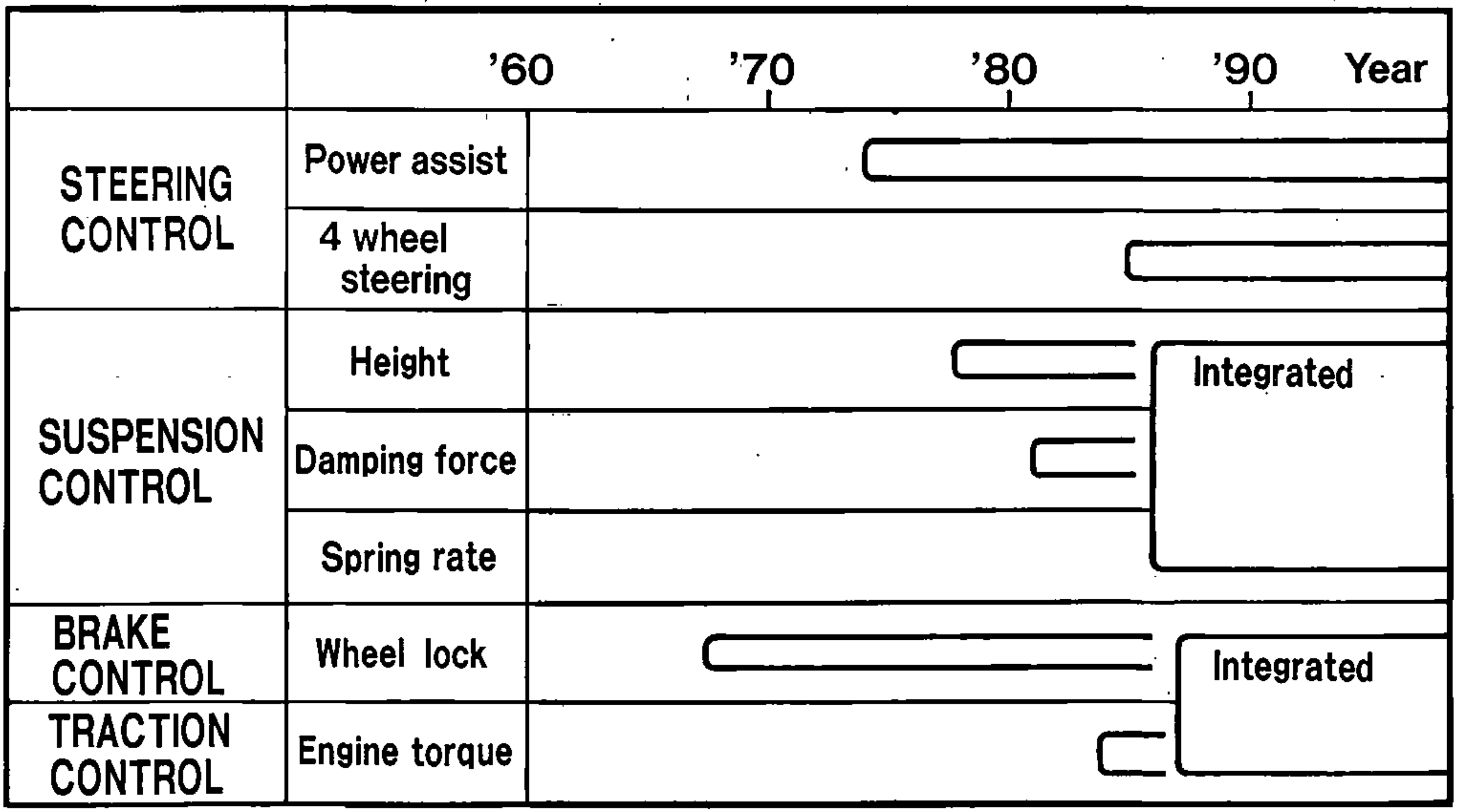
FUEL INJECTION INSTALLATIONS



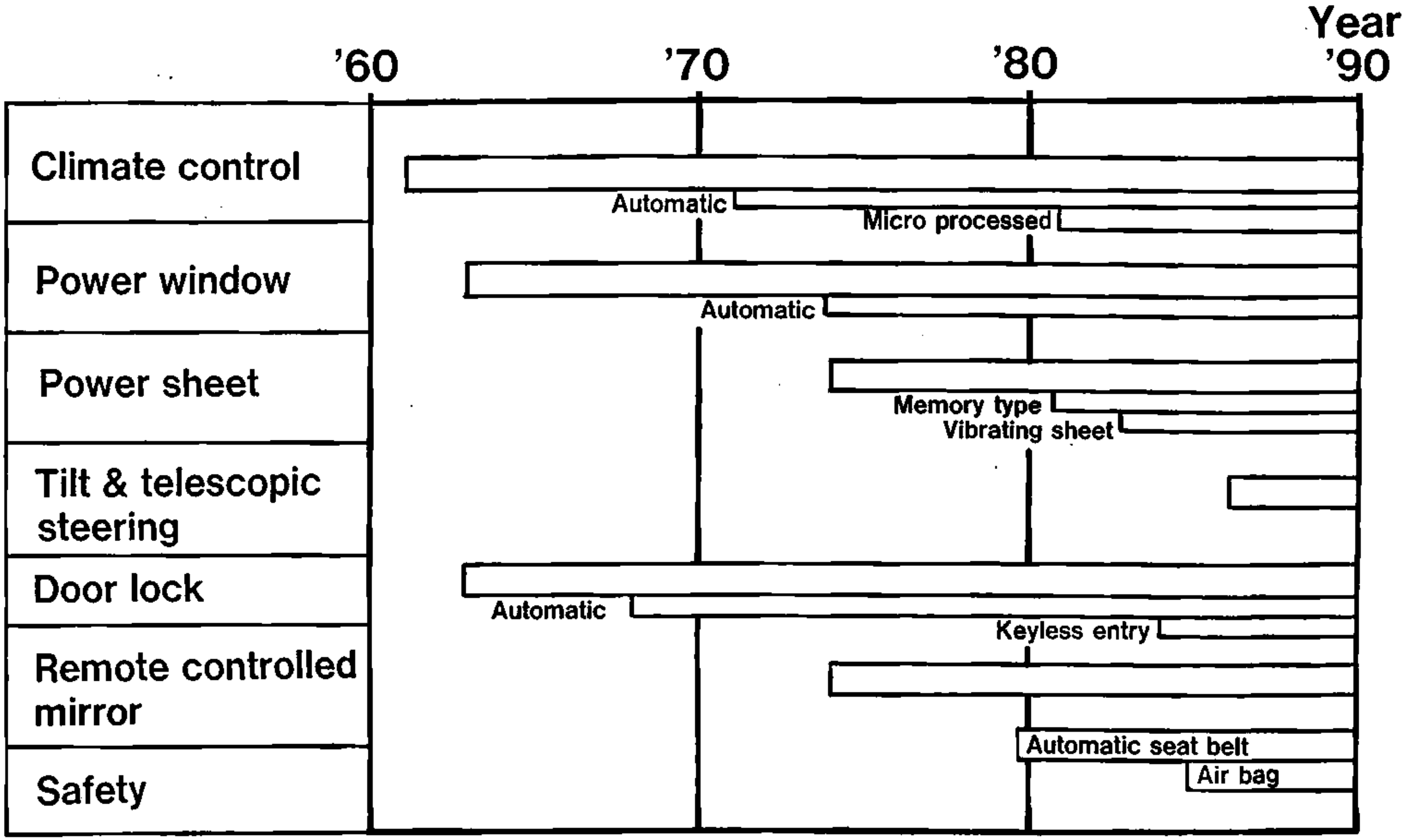
INCREMENT OF AUTOMOTIVE ELECTRONICS



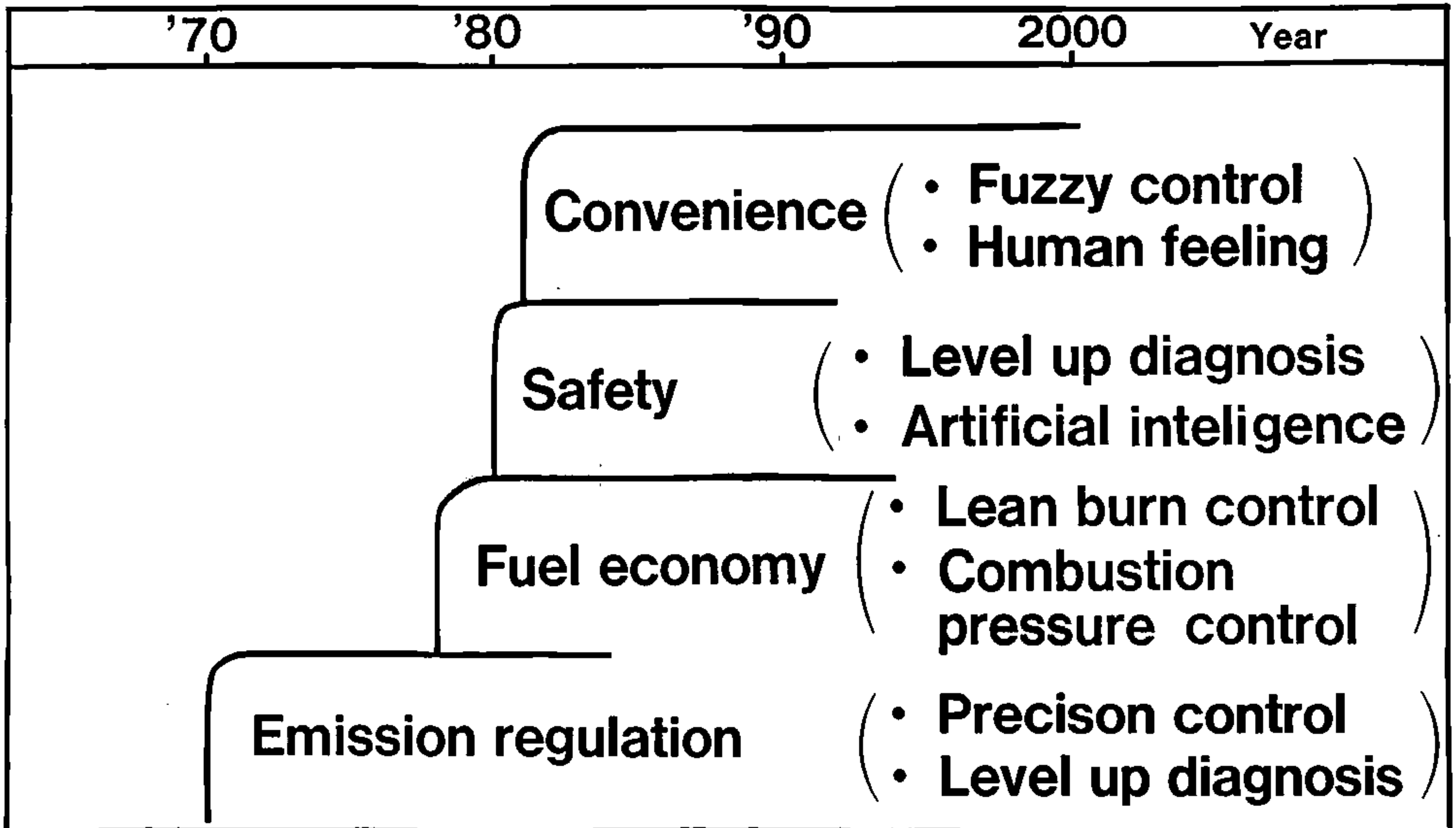
ABS INSTALLATIONS IN THE WORLD



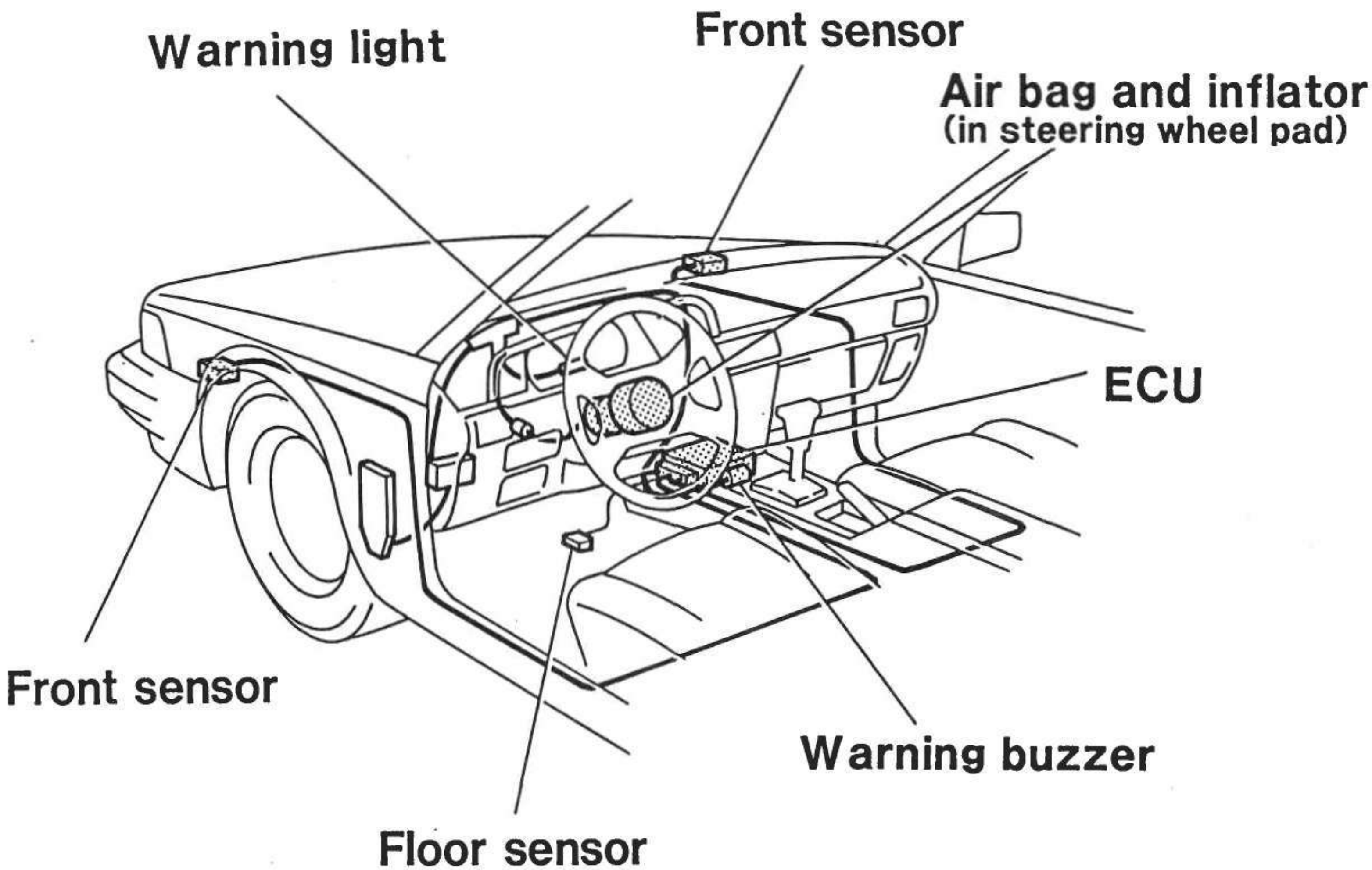
EVOLUTION OF CHASSIS ELECTRONICS



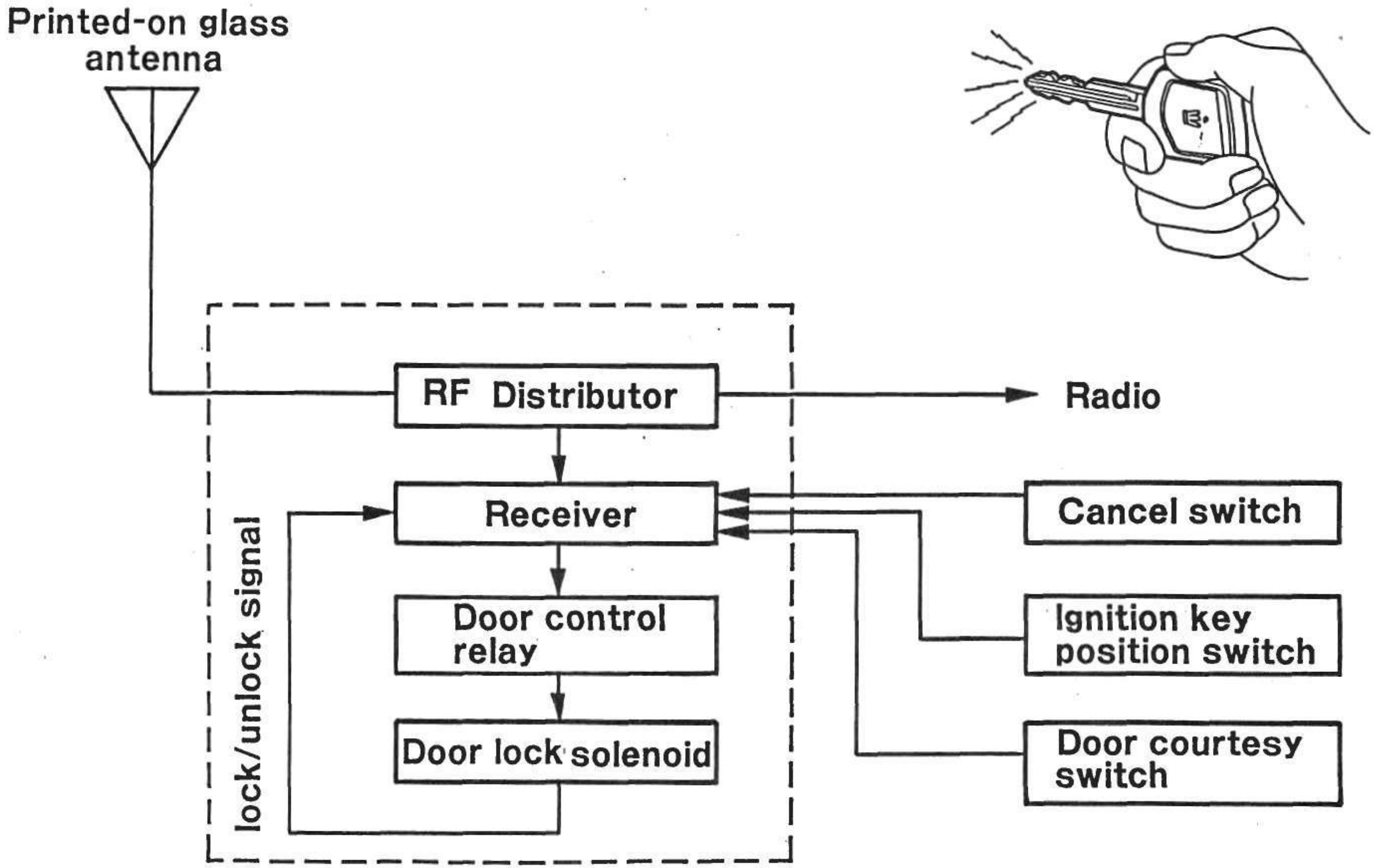
EVOLUTION IN CONVENIENCE & SAFETY



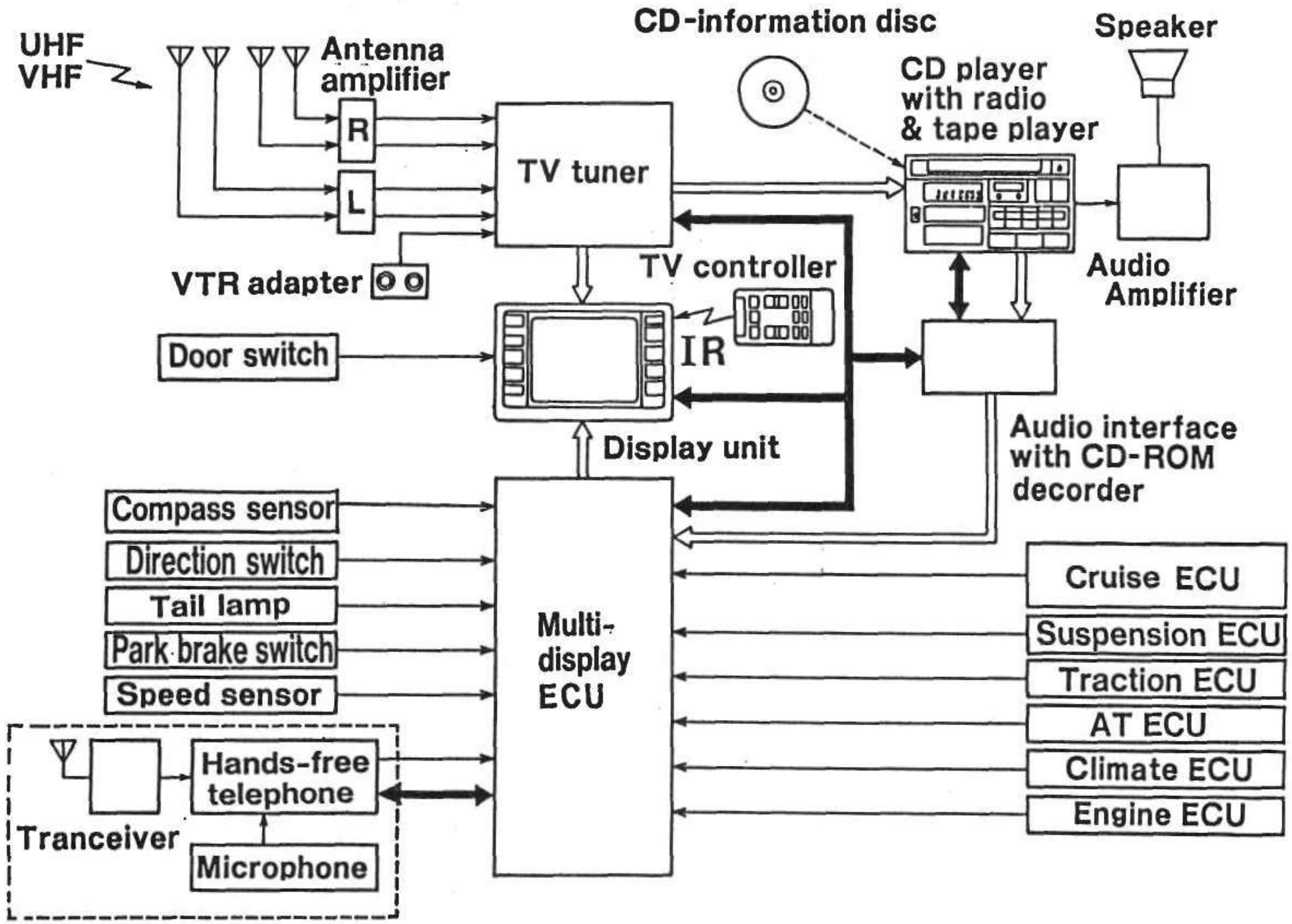
FUTURE AUTOMOTIVE ELECTRONICS



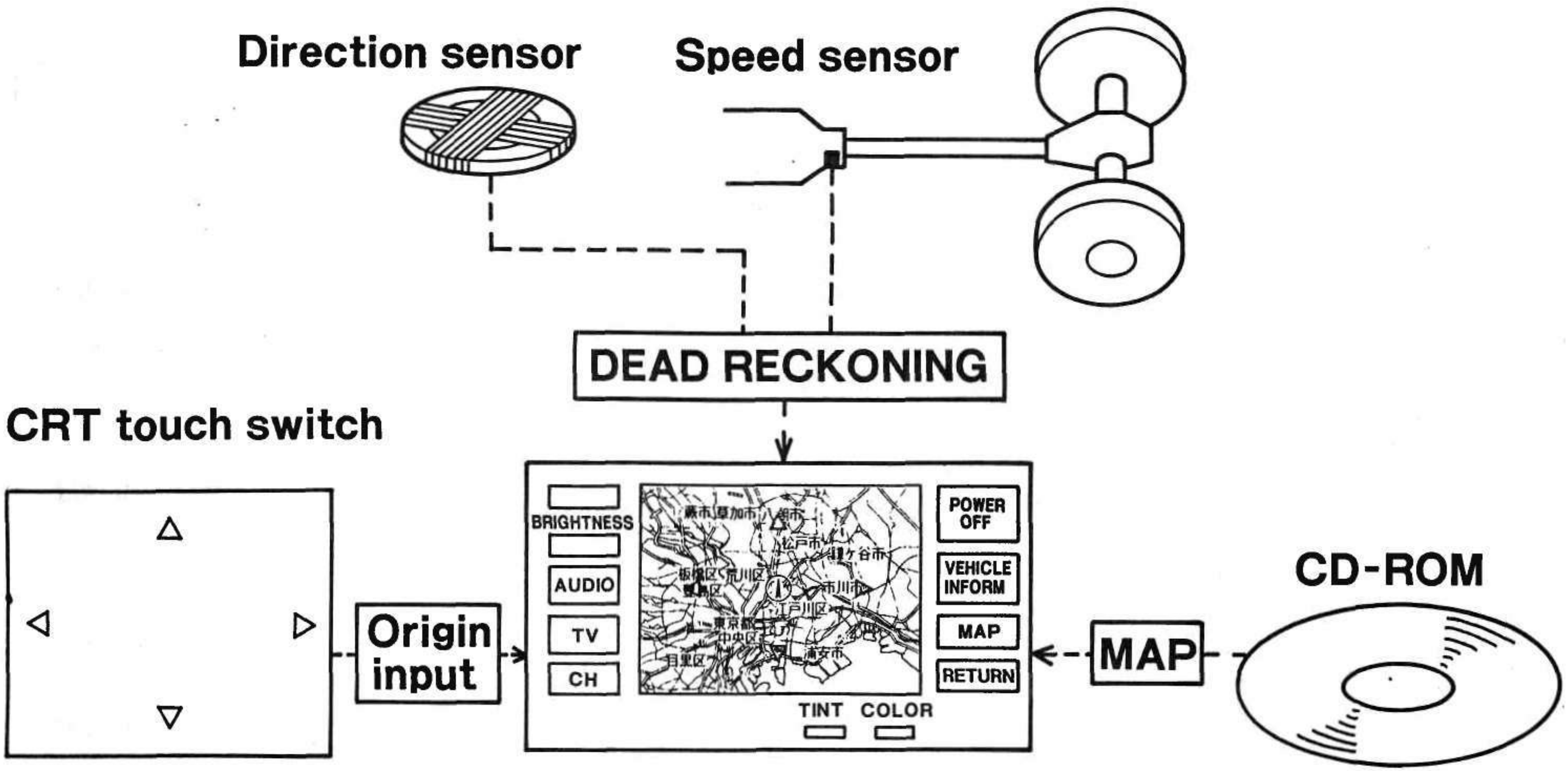
AIR BAG SYSTEM



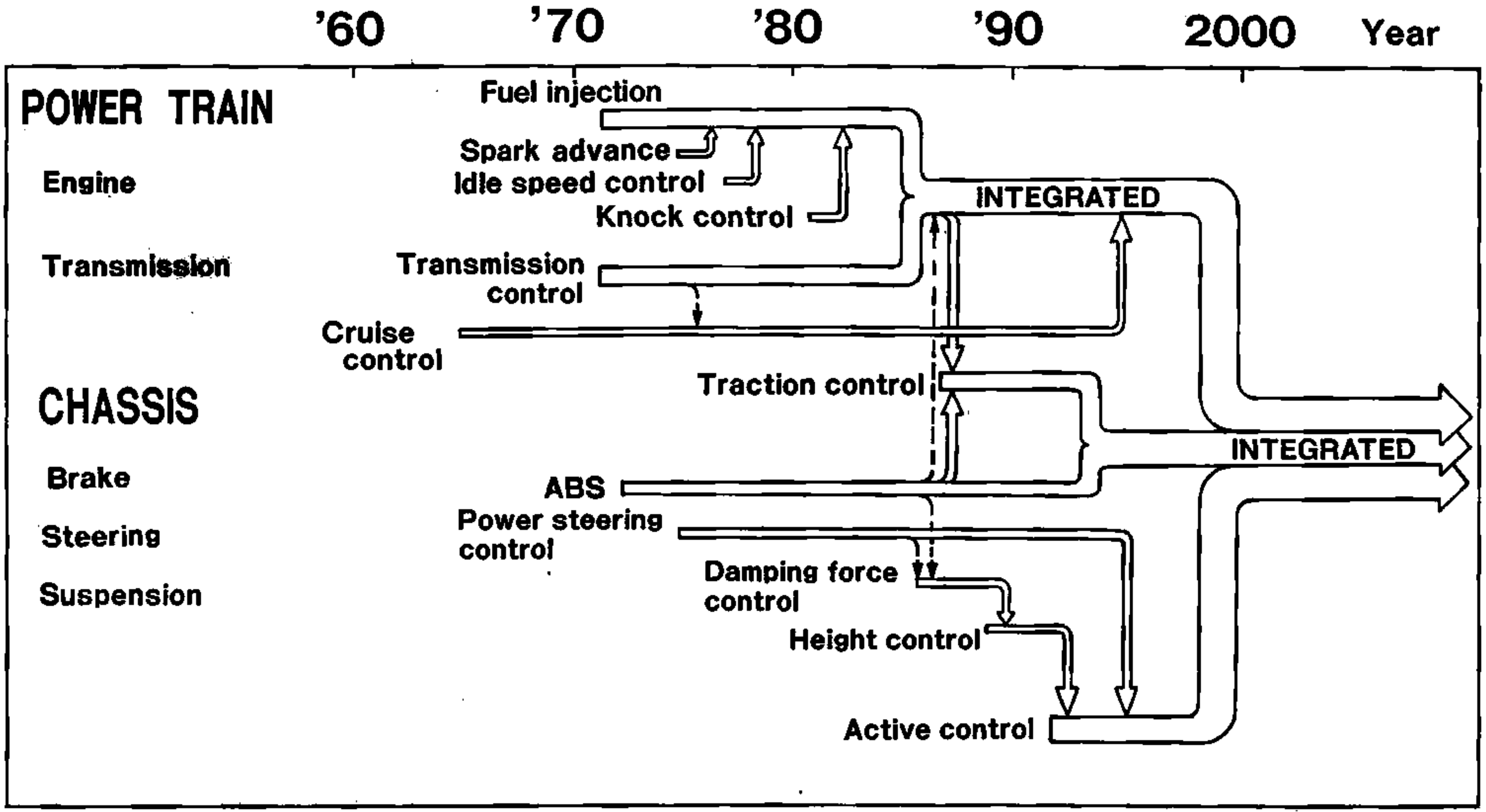
KEYLESS ENTRY



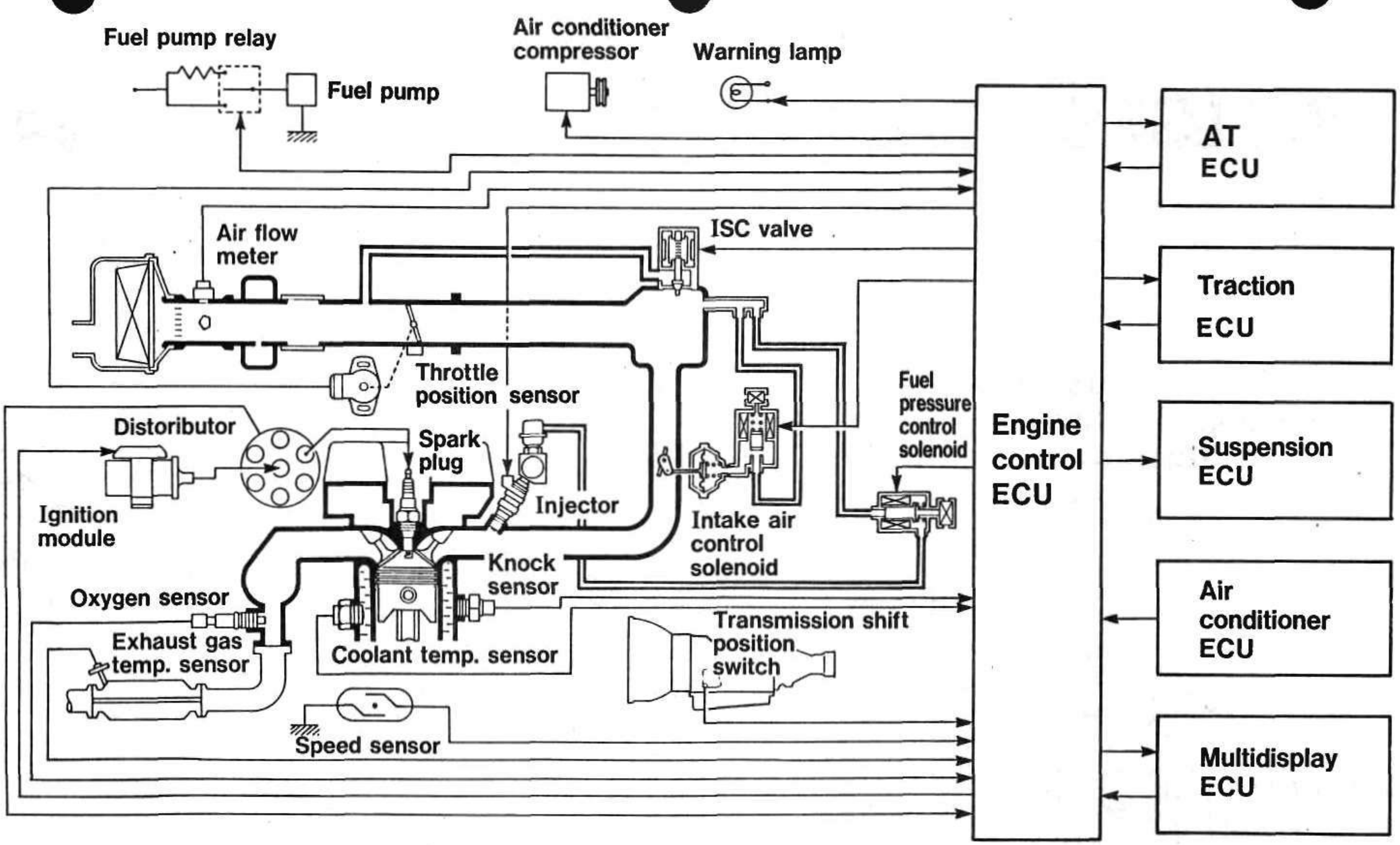
TOYOTA ELECTRO MULTIVISION



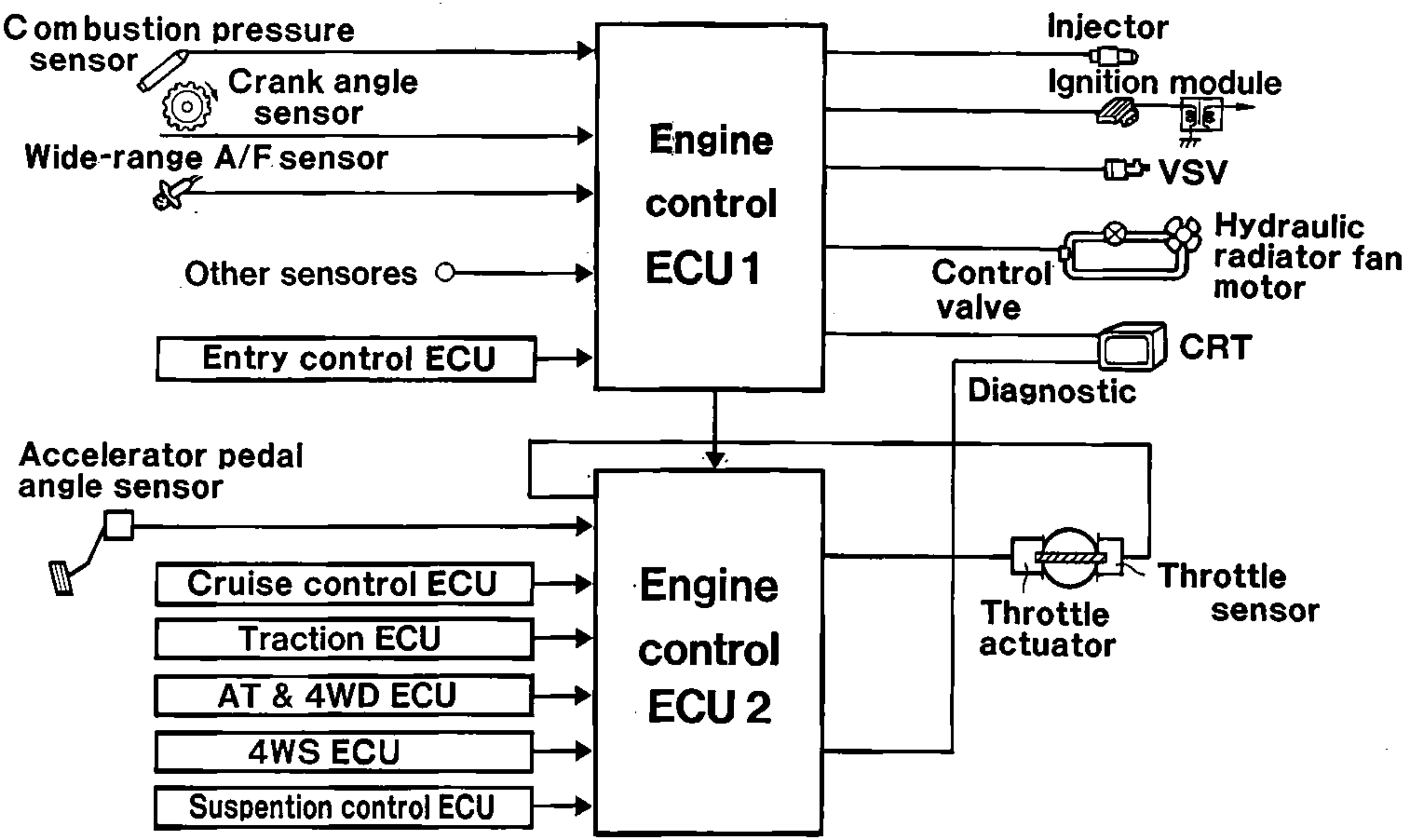
NAVIGATION SYSTEM



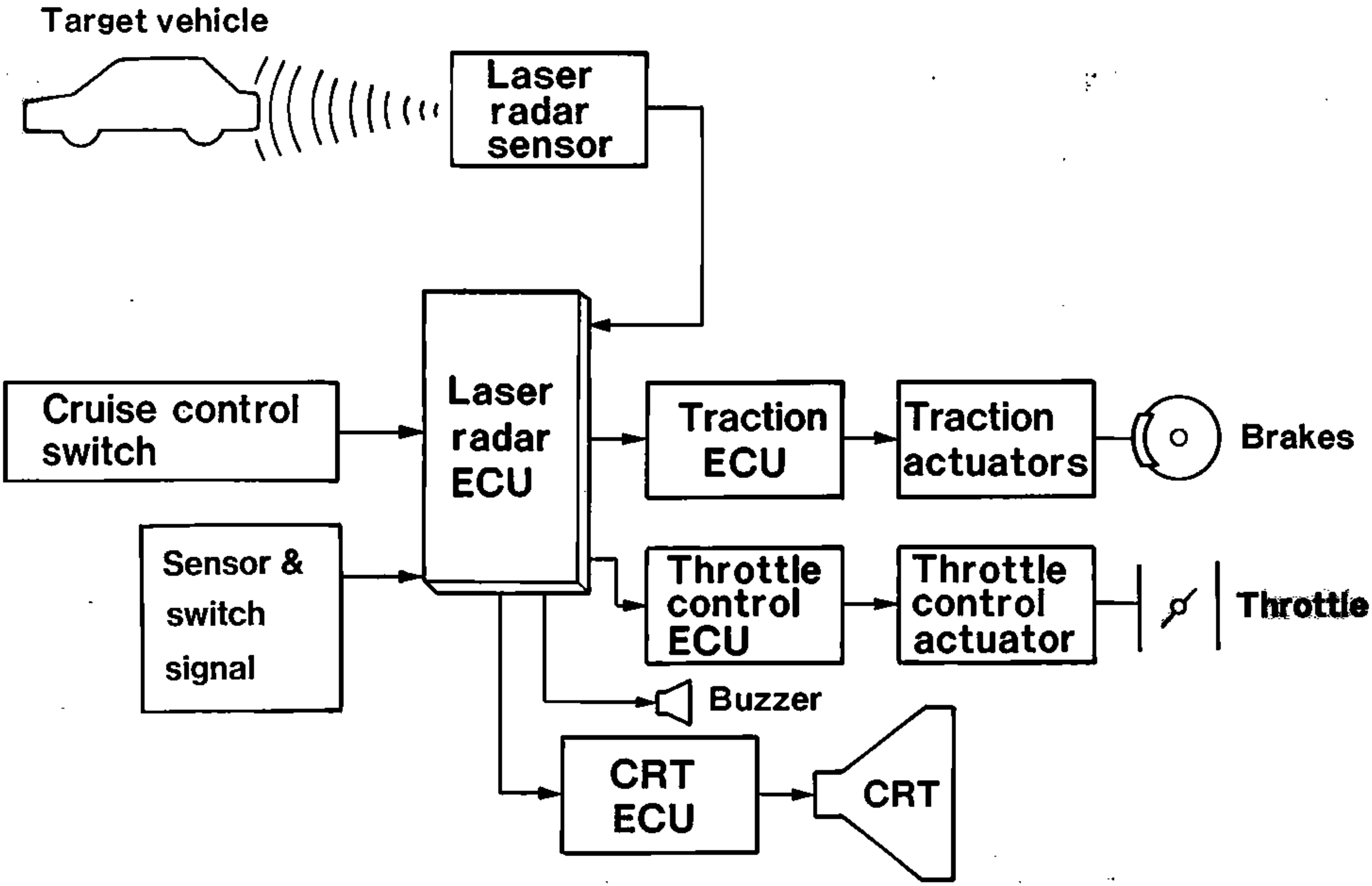
EVOLUTION OF SYSTEM INTEGRATION



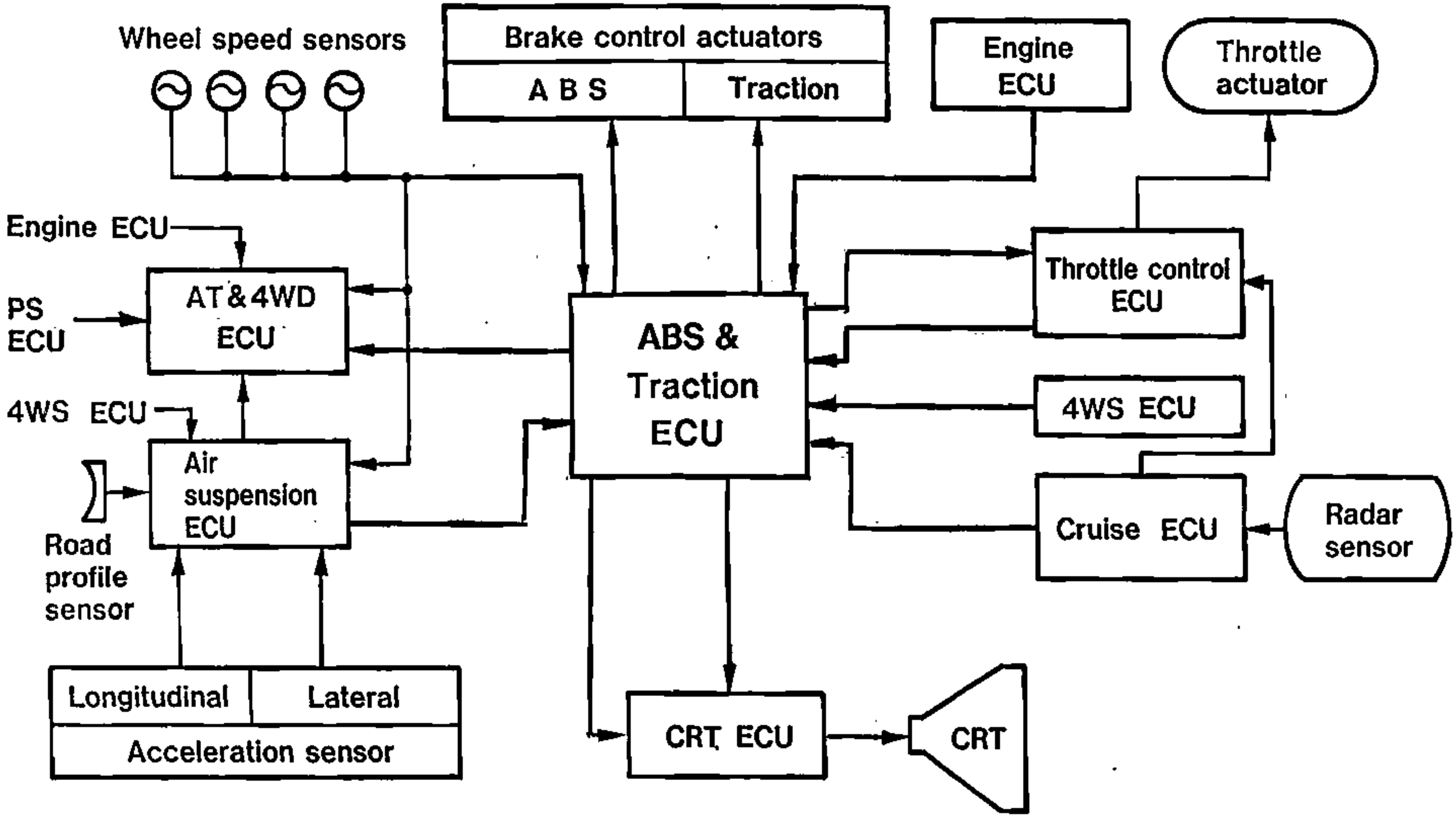
'89 TOYOTA COMPUTER CONTROLLED SYSTEM



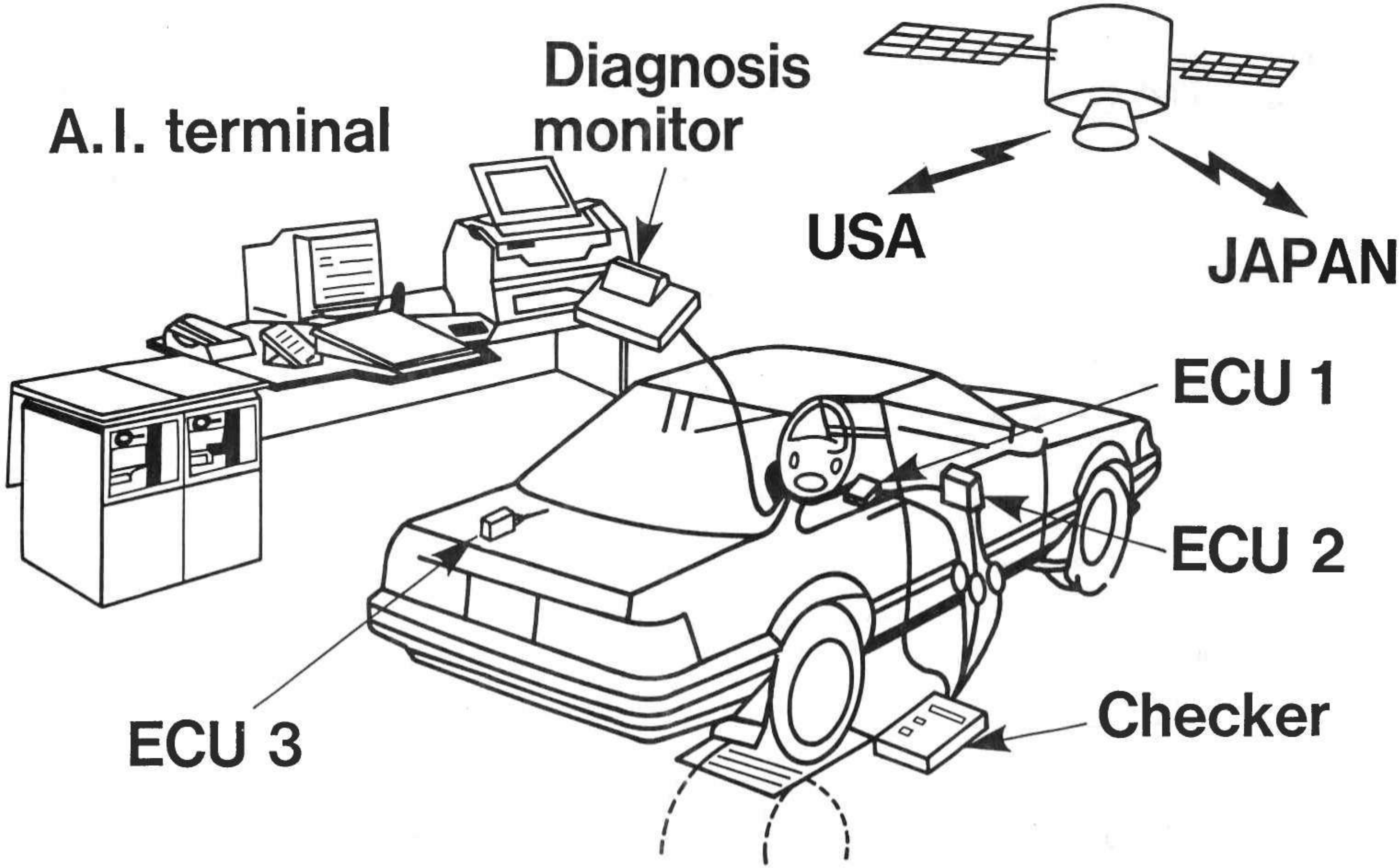
ENGINE THROTTLE CONTROL SYSTEM



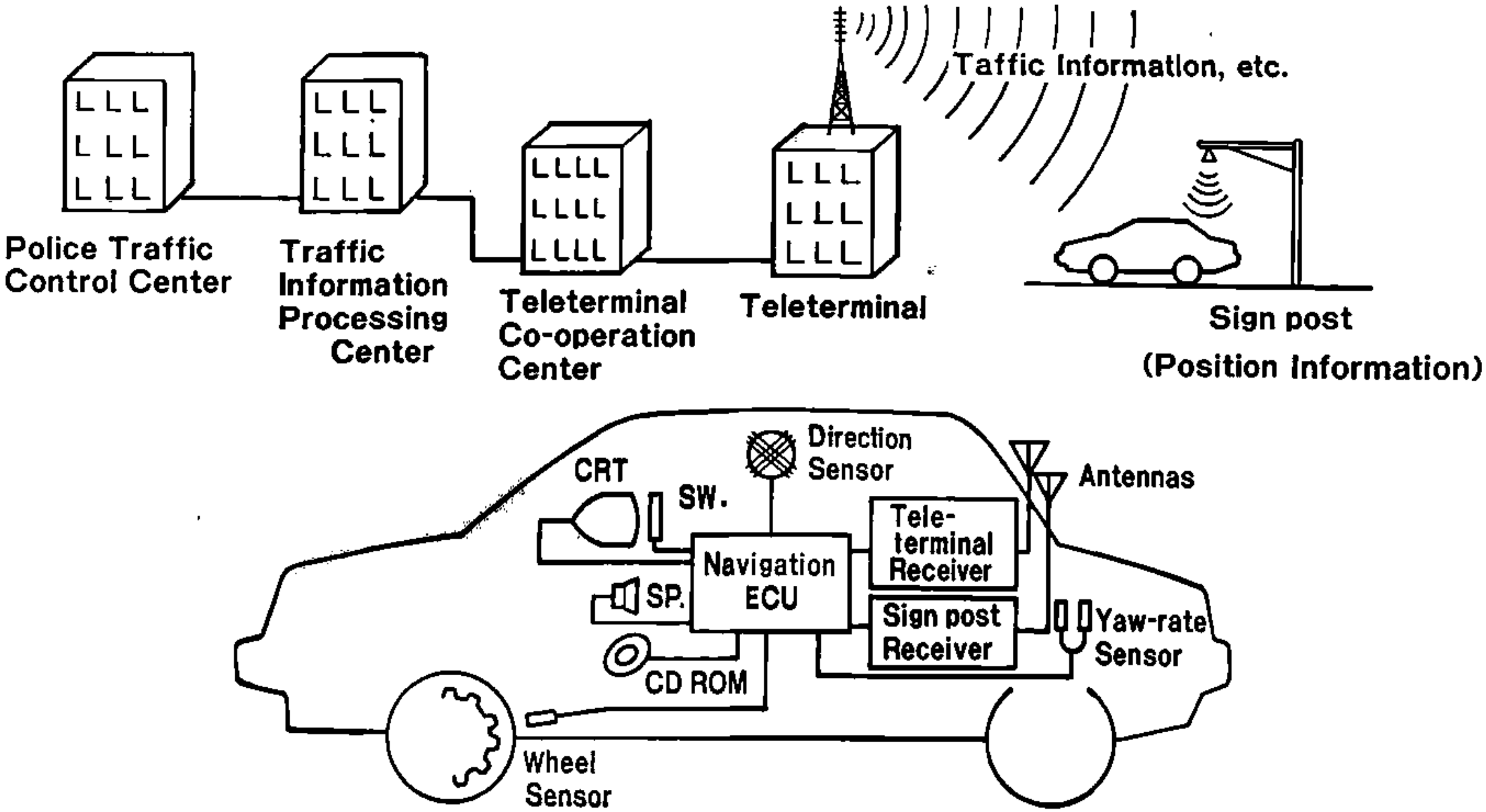
LASER RADAR CRUISE CONTROL SYSTEM



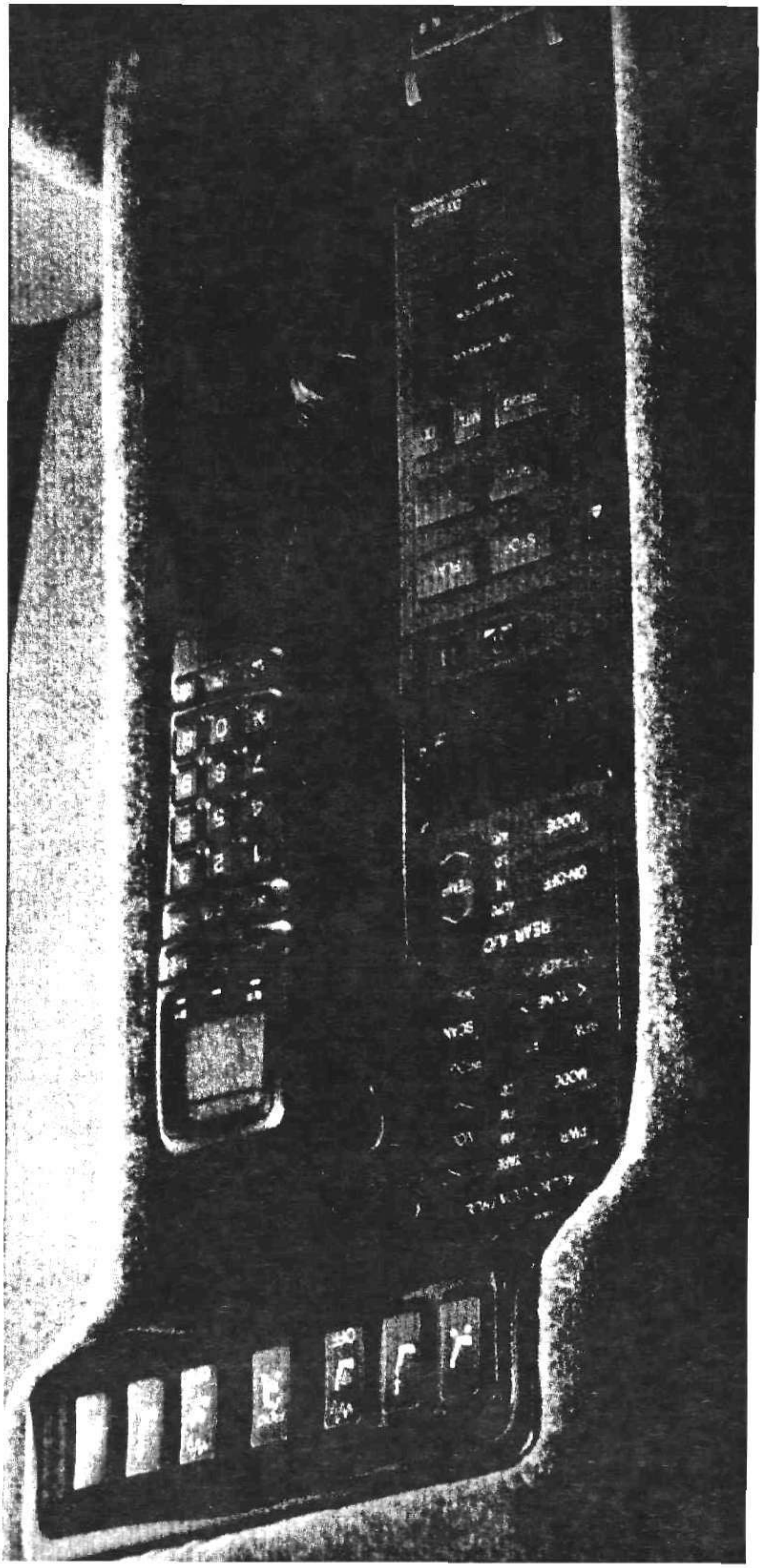
INTEGRATED VEHICLE MANAGEMENT SYSTEM

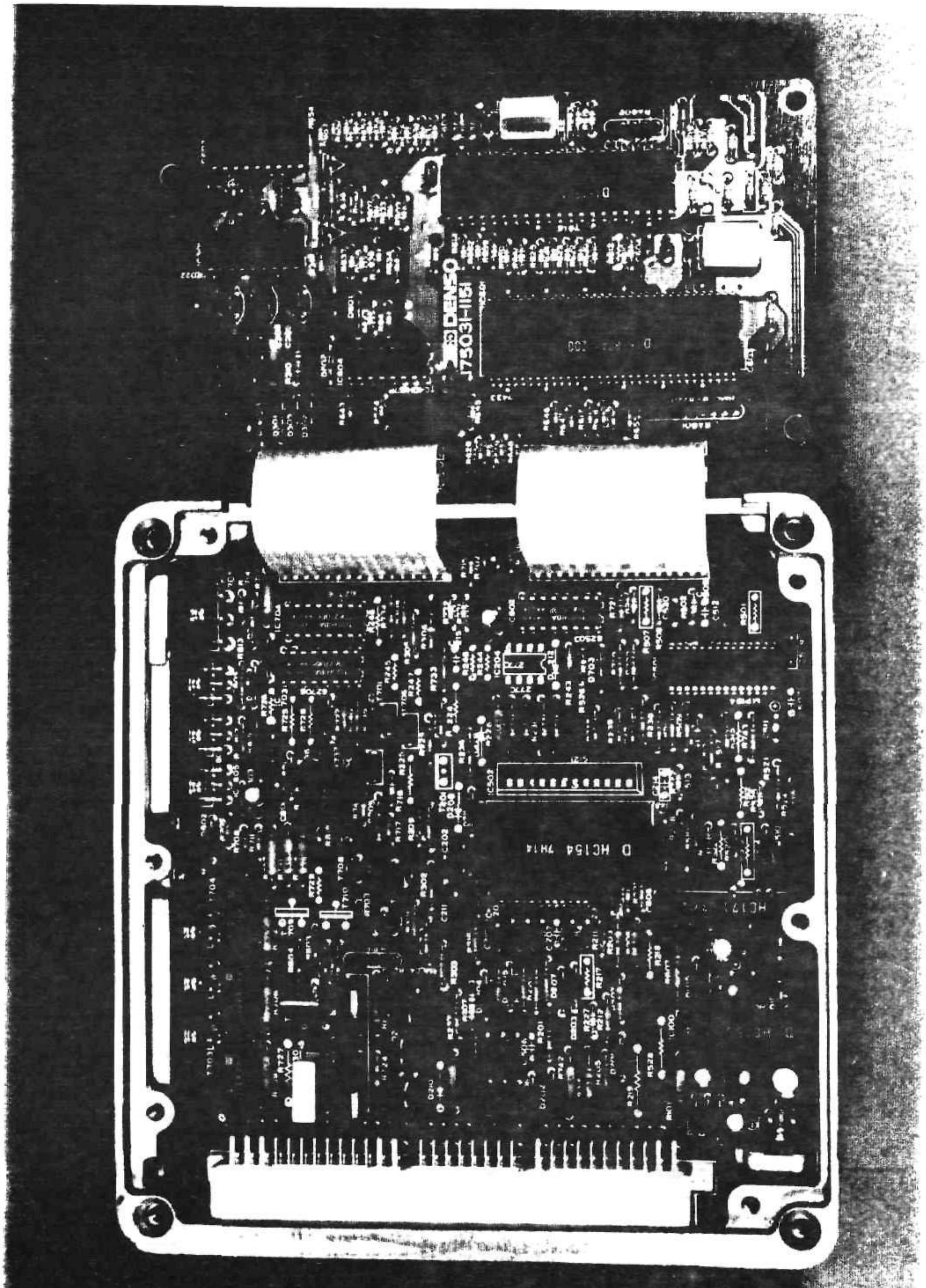


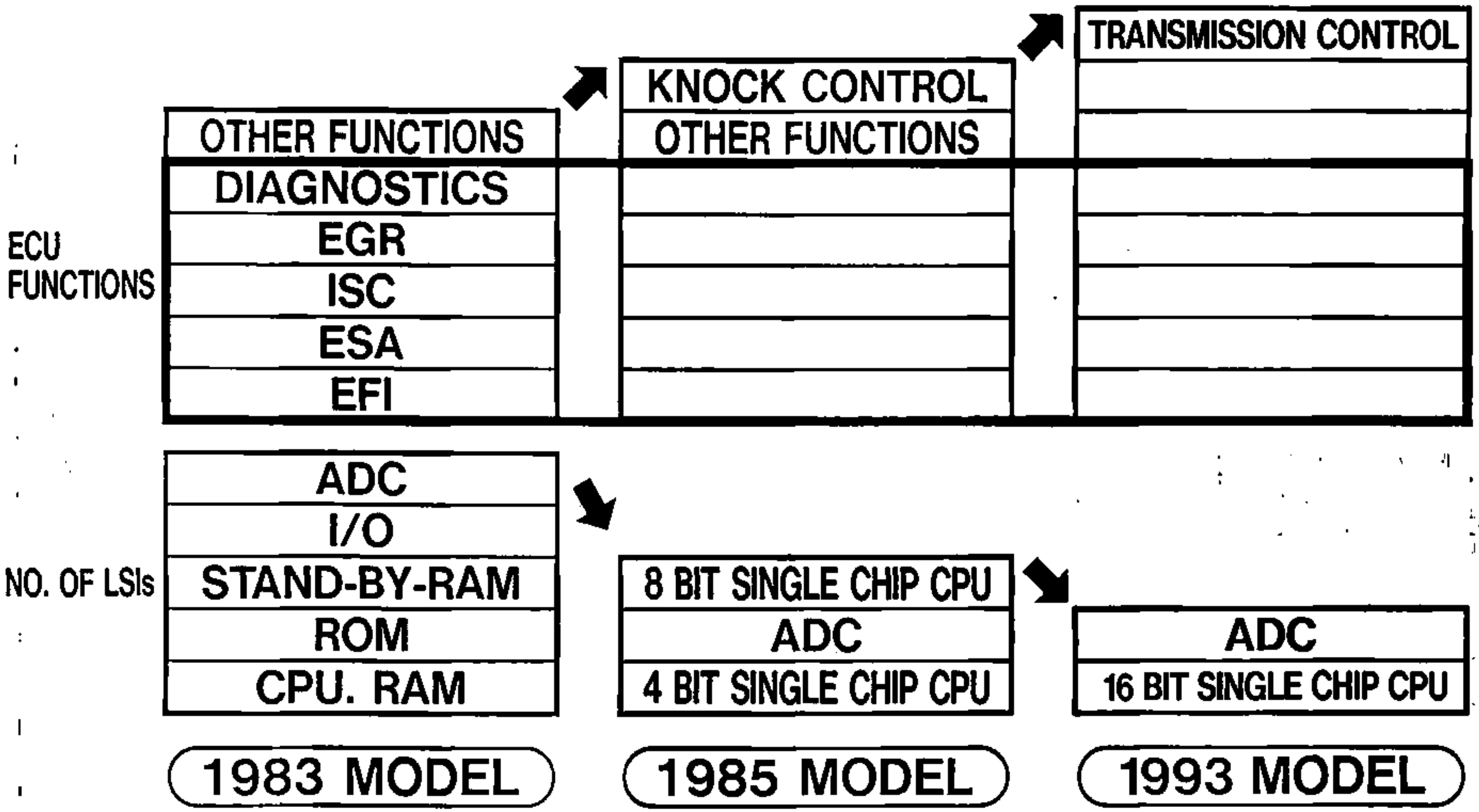
FUTURE DIAGNOSTIC CONCEPT



ADVANCED MOBILE TRAFFIC INFORMATION & COMMUNICATION SYSTEM



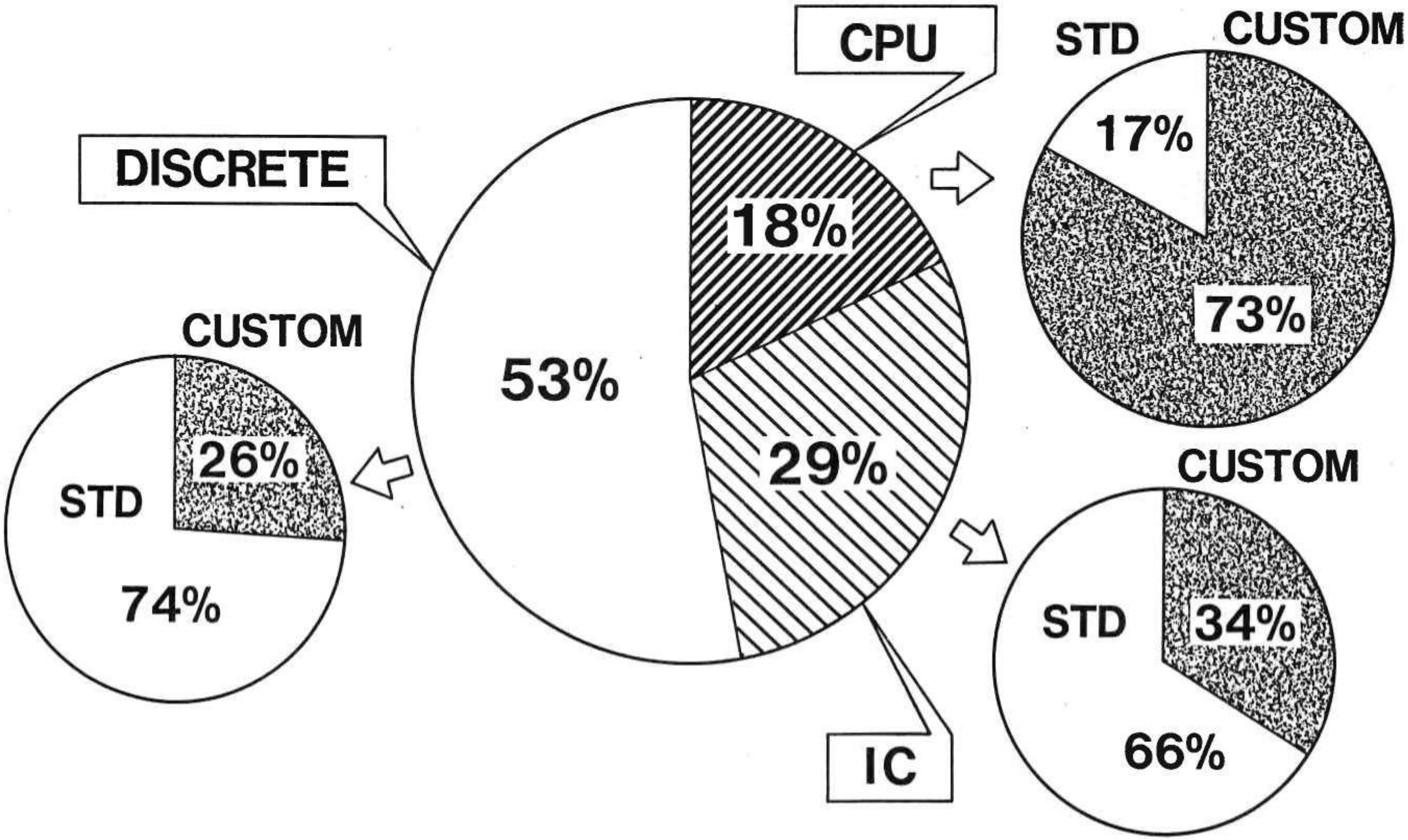




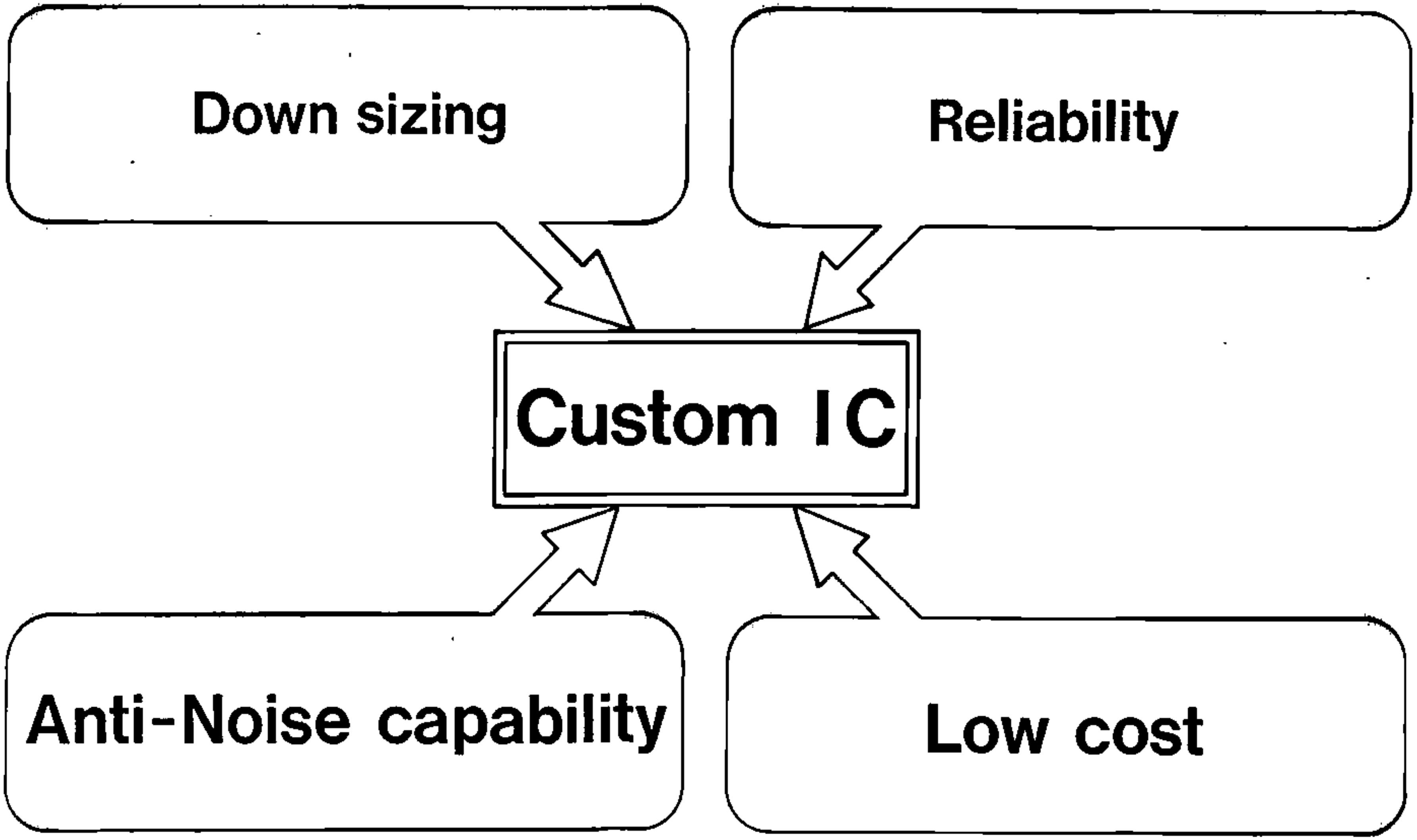
ECU TREND OF ENGINE CONTROL

CONTROL SYSTEM	Engine control	20	101
	Transmisson control	9	
	ABS	19	
	Traction control	24	
	Air suspension control	29	
ENTERTAINMENT	CRT display	123	251
	Electronic instrumental cluster	25	
	Car audio	51	
	Mobile telephone	33	
	Climate control	19	
OTHERS		37	37
TOTAL			389

THE NUMBER OF LSI AND IC ON A LUXURY CAR



SEMICONDUCTORS USED IN AUTOMOBILES



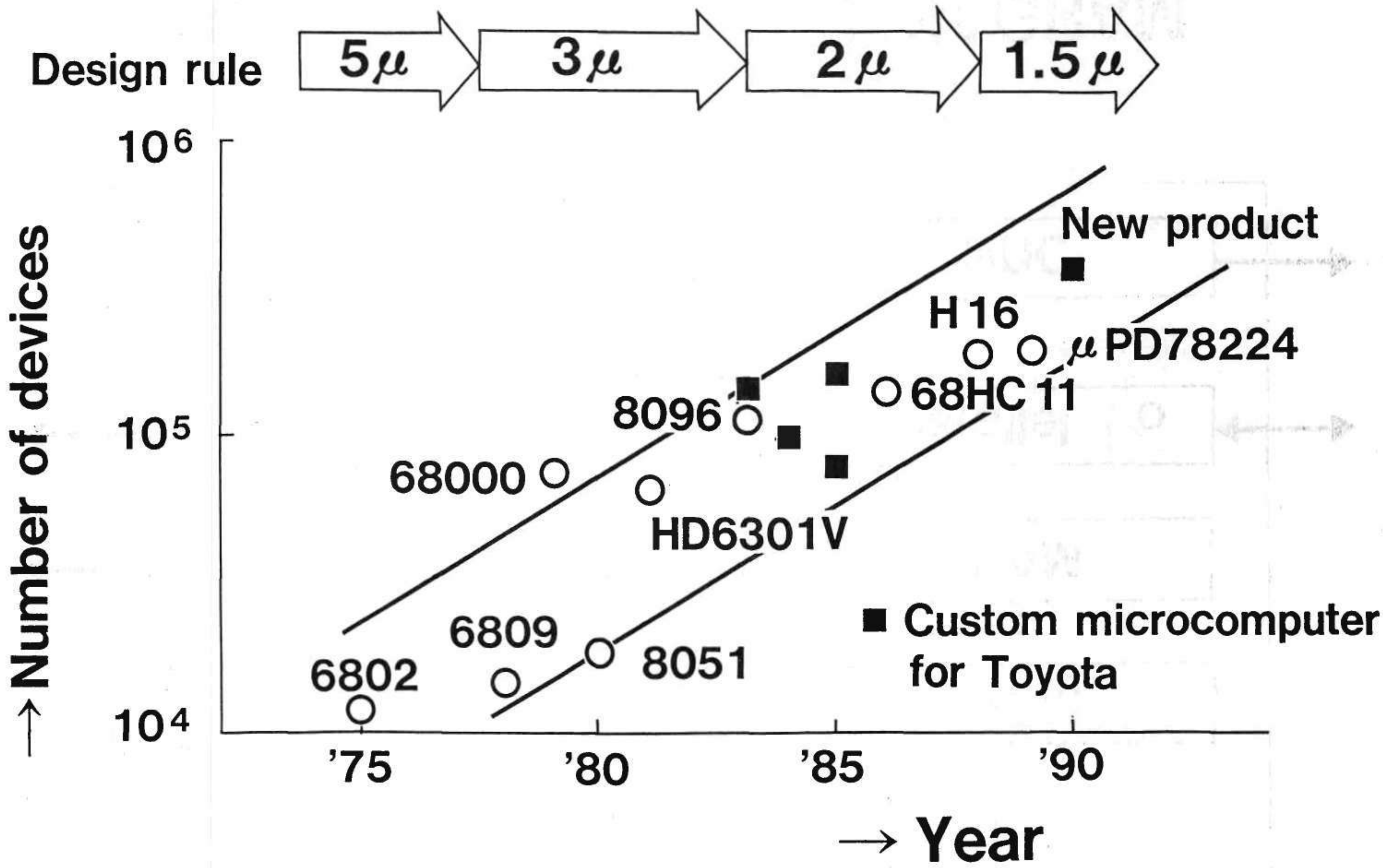
TREND OF AUTOMOTIVE SEMICONDUCTORS

1. High reliability
2. Low cost
3. High speed
4. Low power
5. Small size
6. Sufficient ROM/RAM
7. Multi function
8. Quick turn around time

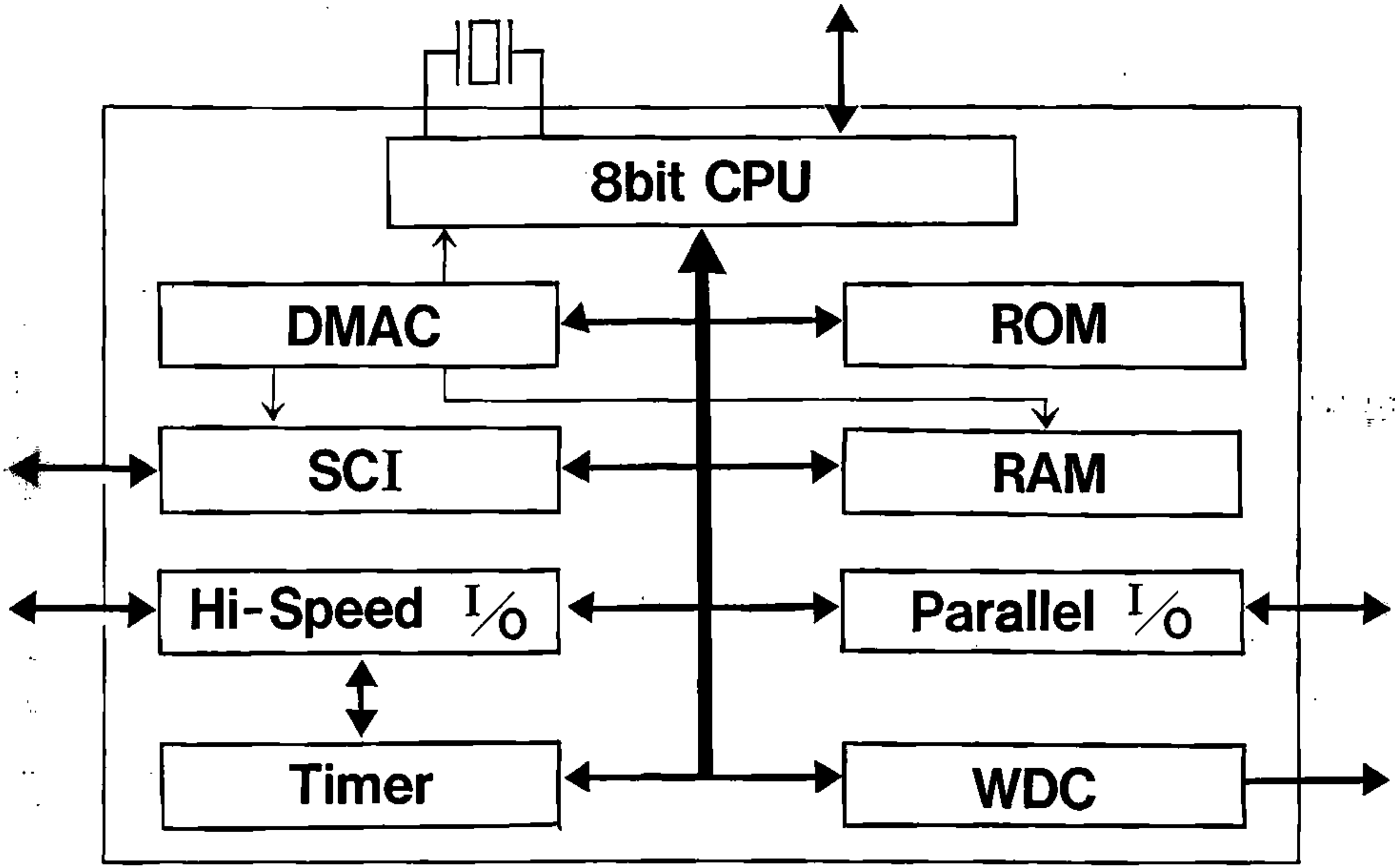
REQUIREMENTS FOR AUTOMOTIVE SEMICONDUCTORS

Manufacturer	Today	Future
TOYOTA (NIPPON DENSO) (FUJITU TEN)	8 Bit (Custom)	8 Bit, 16 Bit
NISSAN (JECS) (HITACHI)	8 Bit (6301) 16 Bit (8096)	8 Bit, 16 Bit
G M (DELCO)	8 Bit (GMP4, GMCM)	8 Bit, 32 Bit
FORD (EED)	16 Bit (8061)	16 Bit
BOSCH	8 Bit (8051)	8 Bit, 16 Bit

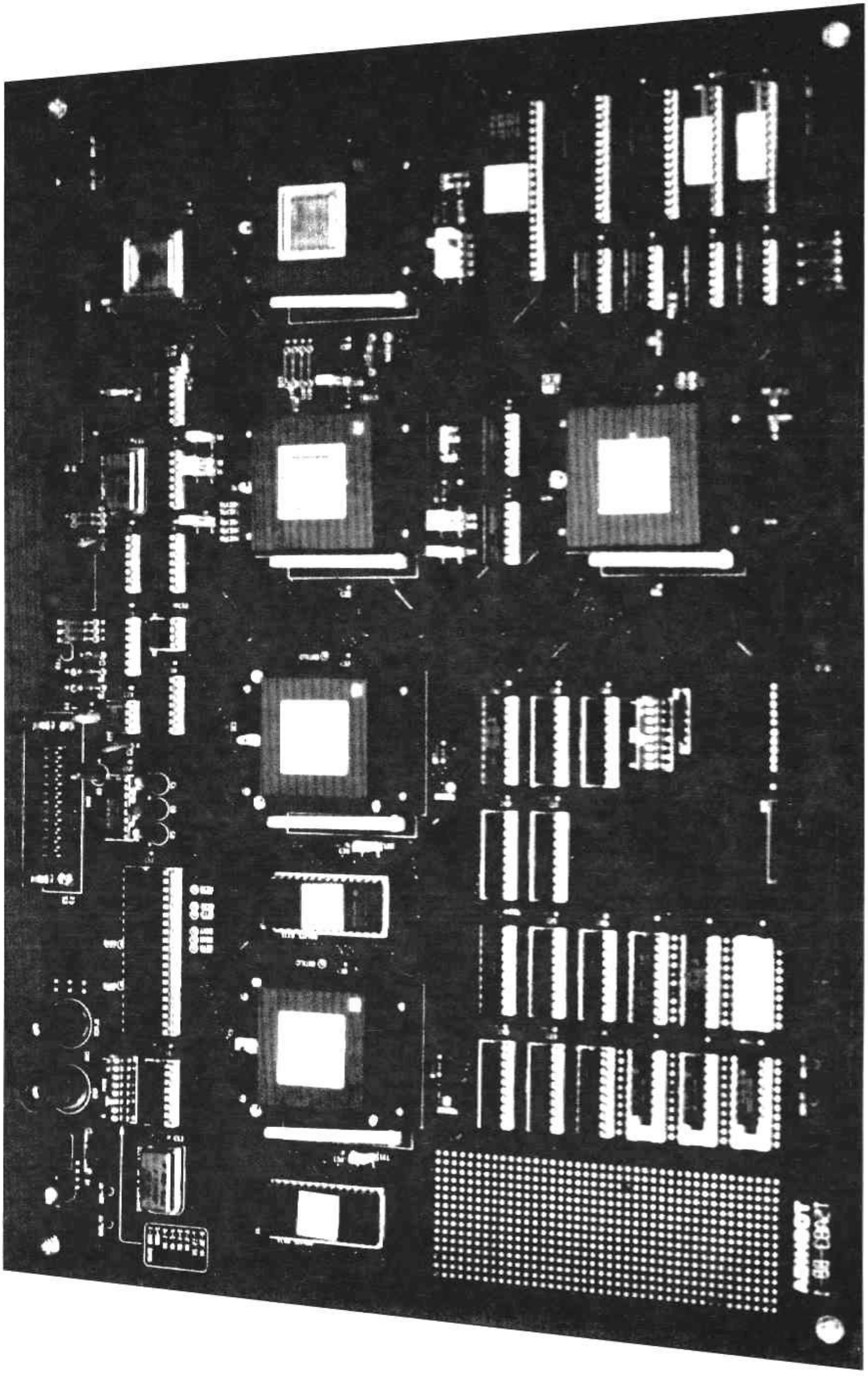
CPU TREND FOR AUTOMOTIVE USAGE

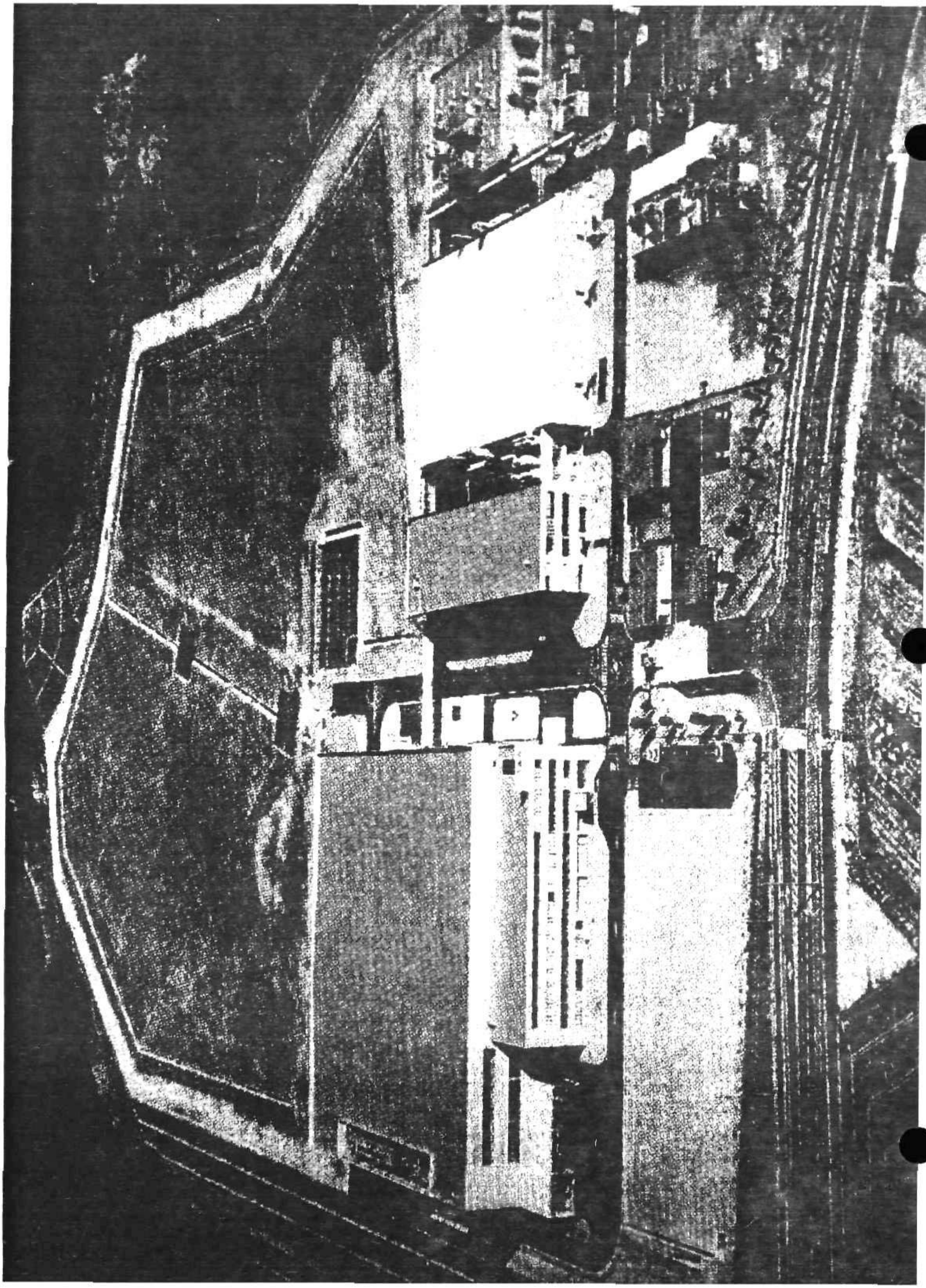


INTEGRATION TREND OF CPU



NEW PRODUCT CPU DIAGRAM



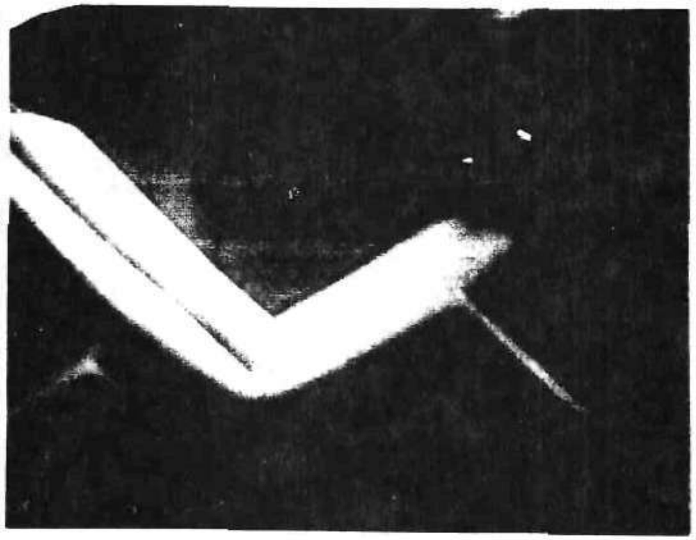


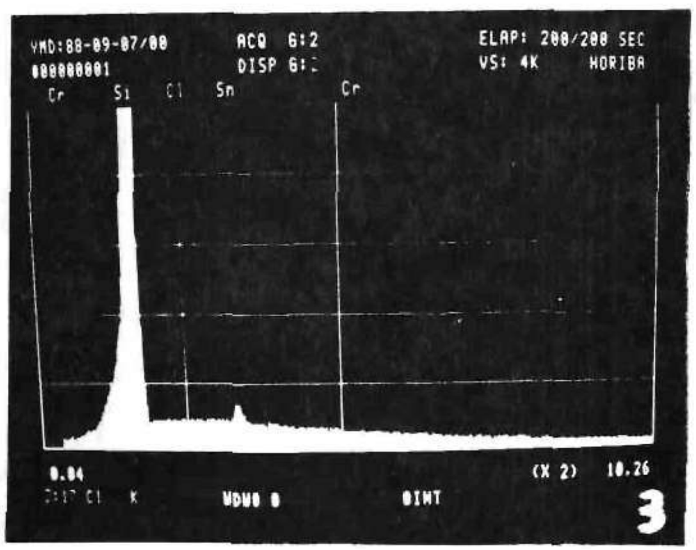
- Steady improvement with each defect analysis in the market

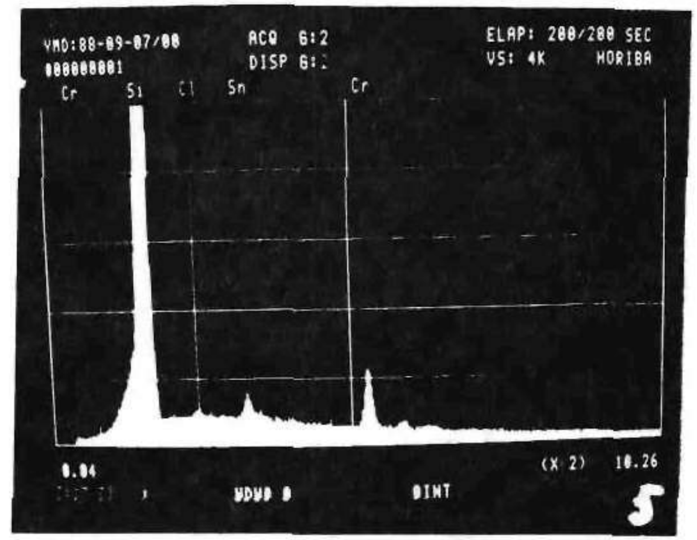
- Quality control in the upstream
  (more approarch to the source)

STEPS TO ESTABLISH RELIABILITY

● ● ●




YMD:88-09-07/00
000000001
ACQ 6:2
ELAP: 200/200 SEC
VS: 4K
HORIBA
Cr
Si
Cl
Sn
Cr
0.04
(X 2)
10.26
3


YMD:88-09-07/00
000000001
ACQ 6:2
ELAP: 200/200 SEC
VS: 4K
HORIBA
Cr
Si
Cl
Sn
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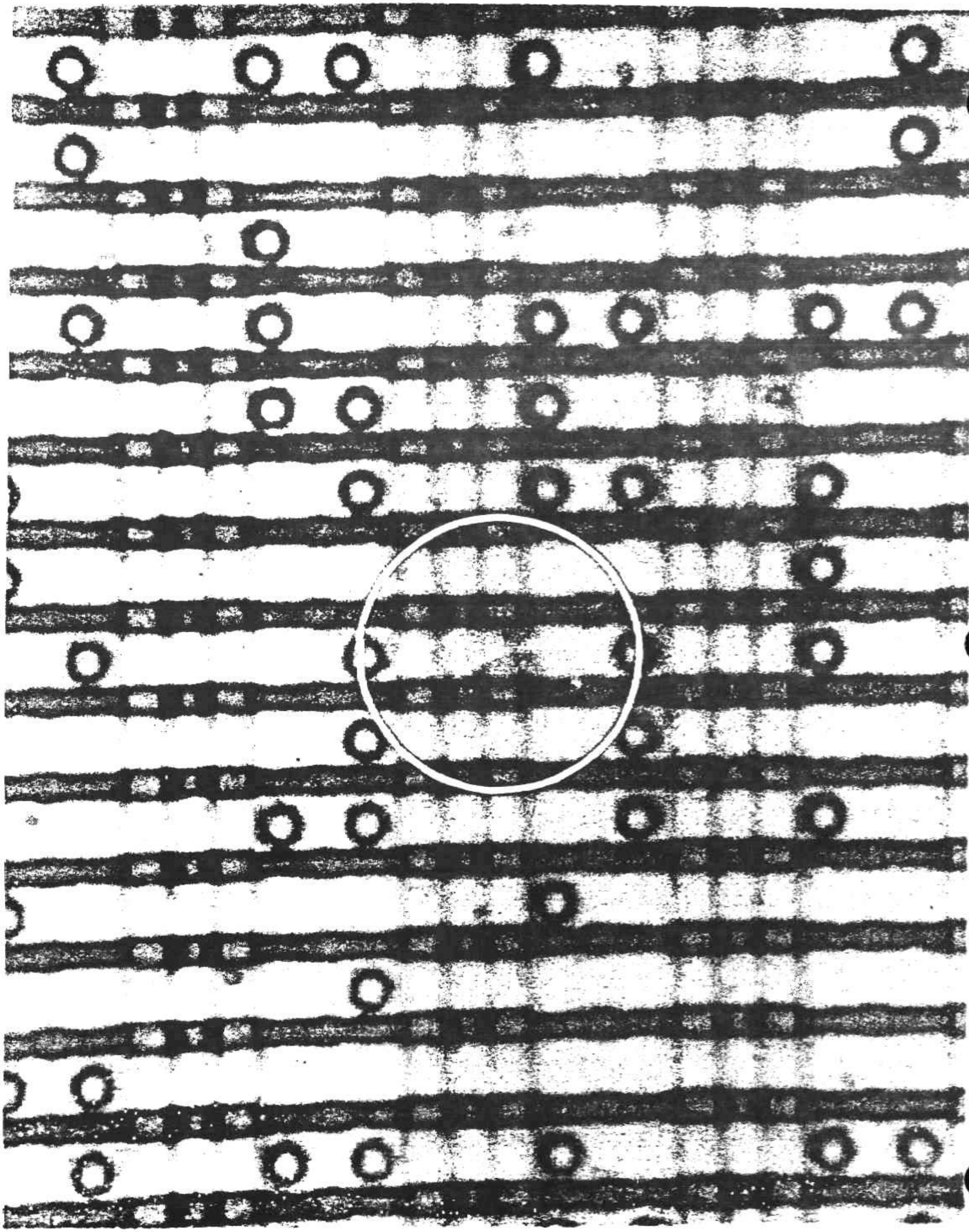
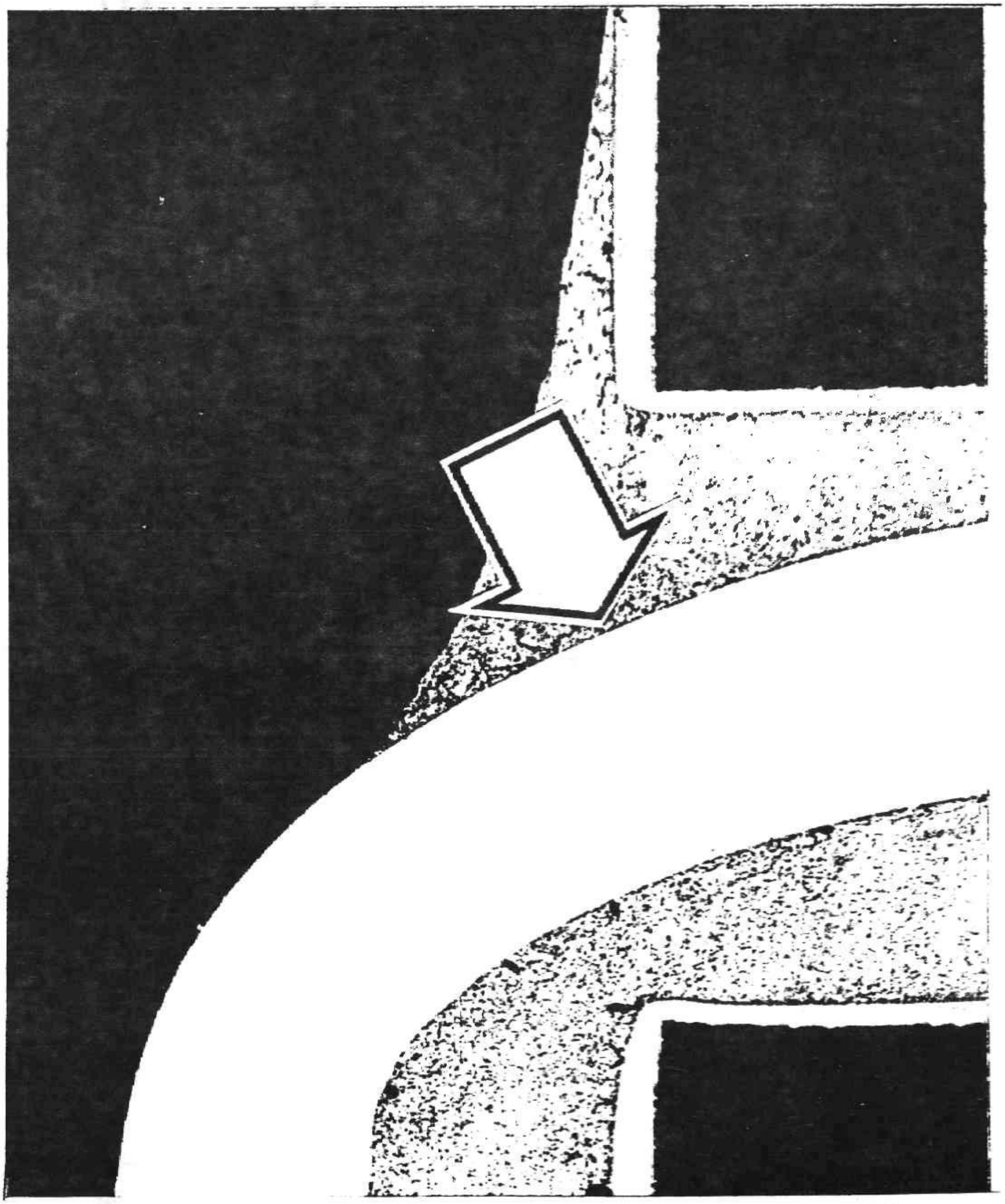
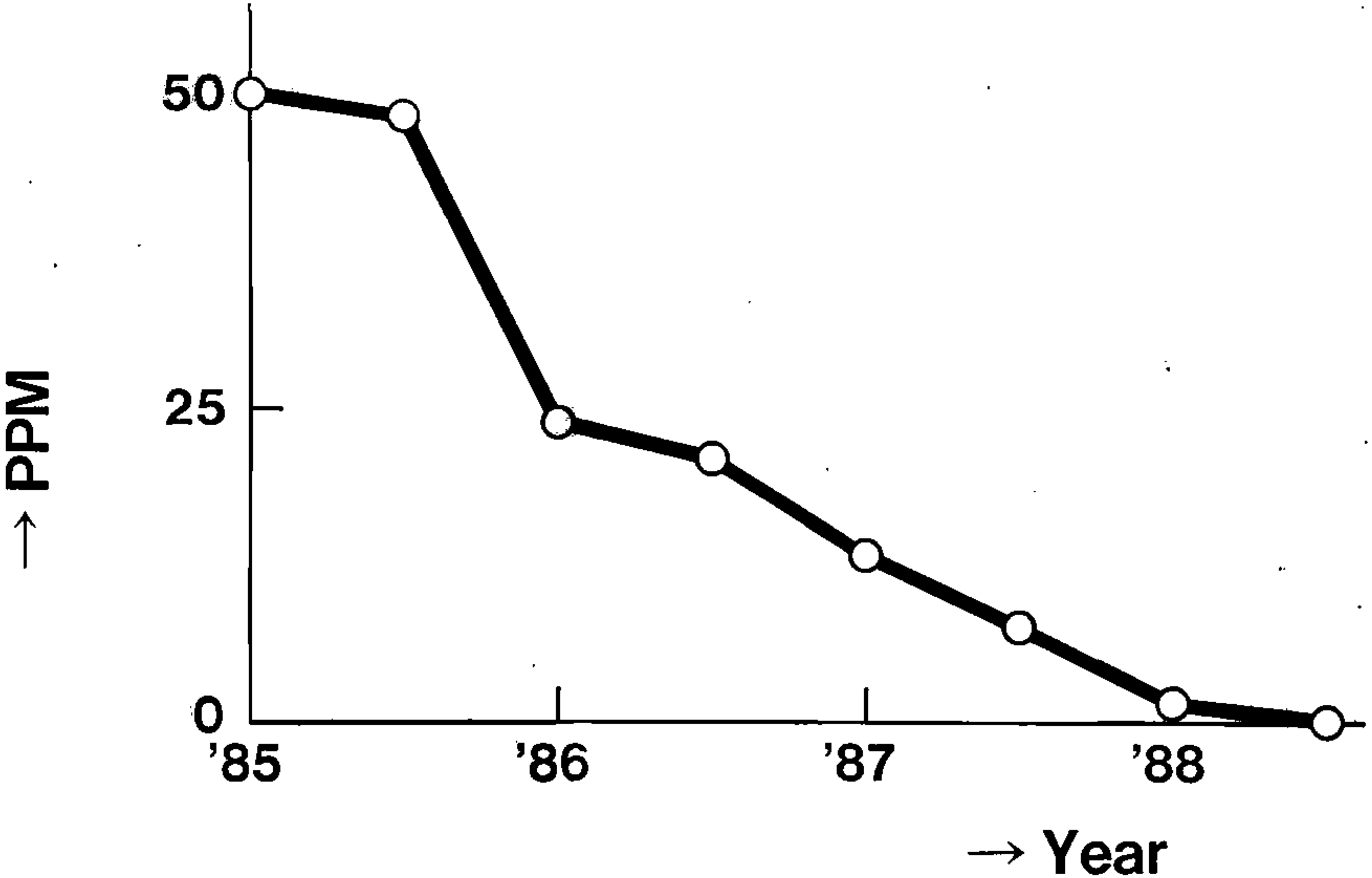
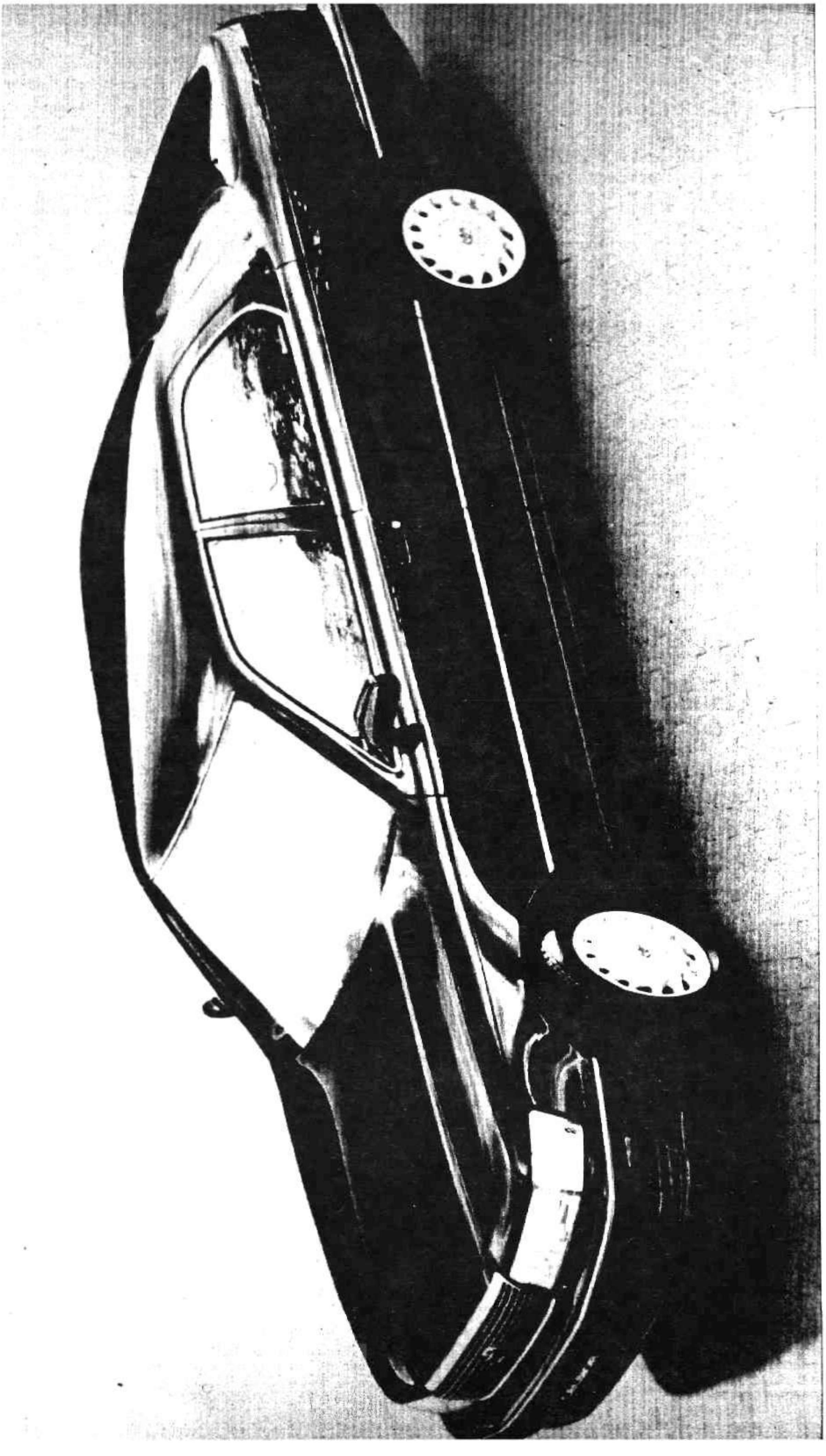
(X 2)
10.26
5







ZERO PPM RELIABILITY IN THE MARKET



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MULTIMEDIA IN THE 1990s

Richard A. Stauffer
Marketing Manager
Princeton Operation

Mr. Stauffer is the Marketing Manager for Intel's new Princeton Operation. He is responsible for marketing, application development, and customer support for Intel's evolving line of DVI Technology products. Mr. Stauffer joined intel with its acquisition of DVI Technology from GE where he had been managing GE's internal DVI Technology Venture. Mr. Stauffer was instrumental in developing the initial DVI Technology business plan and in negotiating the transfer of the technology from GE to Intel for its continued development. Prior to his work at GE, Mr. Stauffer worked with the international management consulting firm of Booz Allen & Hamilton. Mr. Stauffer received a BSE from Princeton University and an MBA from Stanford University.

Dataquest Incorporated
JAPANESE SEMICONDUCTOR INDUSTRY CONFERENCE
April 12-13, 1990
Tokyo, Japan

89116001.IMG 03/26/90:JSI

ULSI Era:
Challenges and
Opportunities

Multimedia in the 1990s

Richard A. Stauffer
Marketing Manager
Princeton Operation
Intel Corporation

Intel's Multimedia Roadmap

Presented by: Dave House
Intel Corp.

Presented at: Microsoft CD-ROM Conference
February 28, 1990

Contact: Karen Andring
(609) 936-7619

Paula Zimmerman
(609) 936-7615

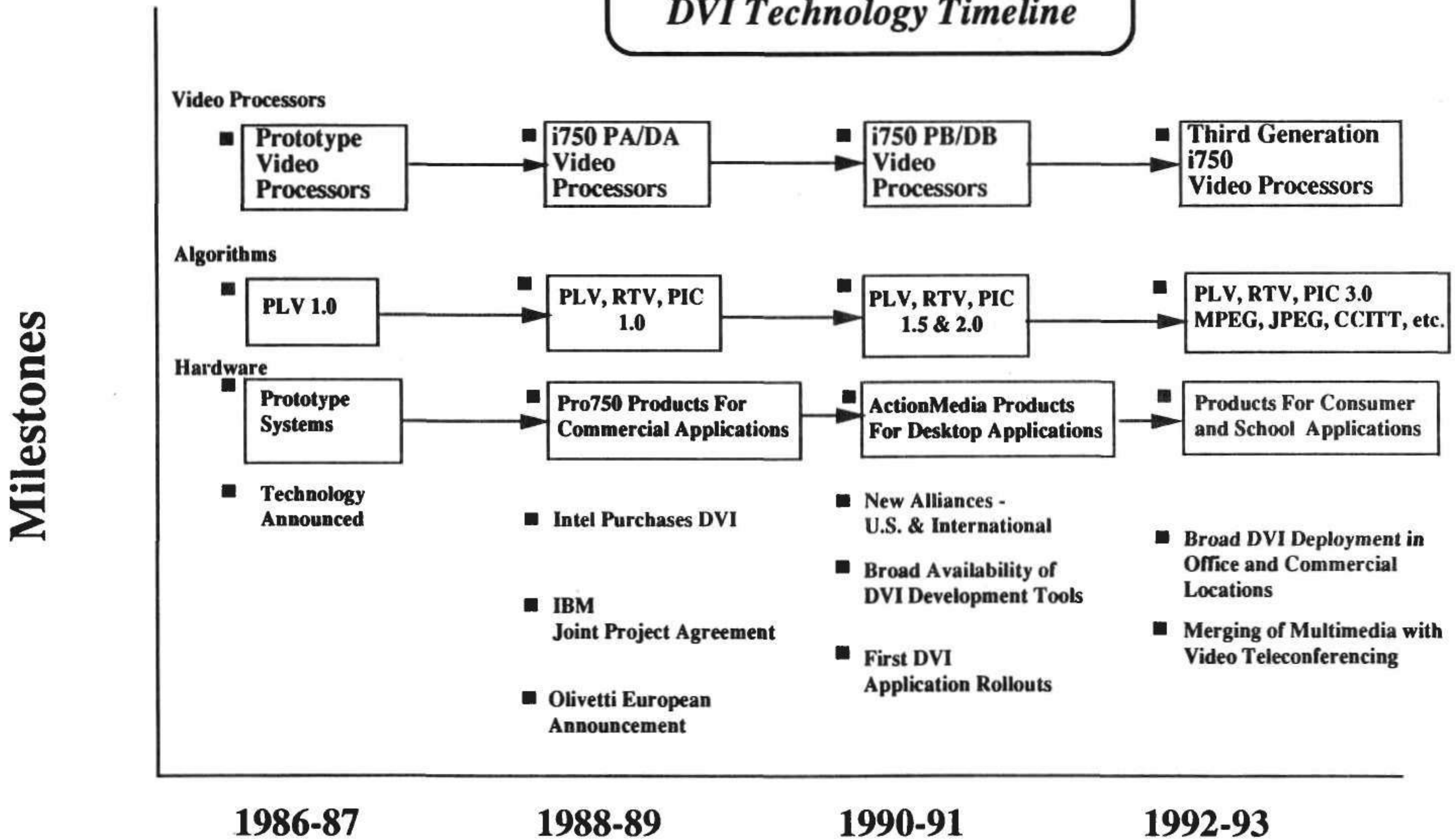
Intel's key multimedia strategies are to deliver...

- a clear, long-term vision of multimedia computing
- dramatic component performance growth
- state-of-the-art technical performance and video quality
- increasing integration and decreasing cost
- a flexible approach compatible with emerging industry standards
- a total product solution
- an array of authoring products
- targeted to a broad range of markets

We've included a glossary at the end for your reference.

DVI™ Technology

Long Term Vision
DVI Technology Timeline



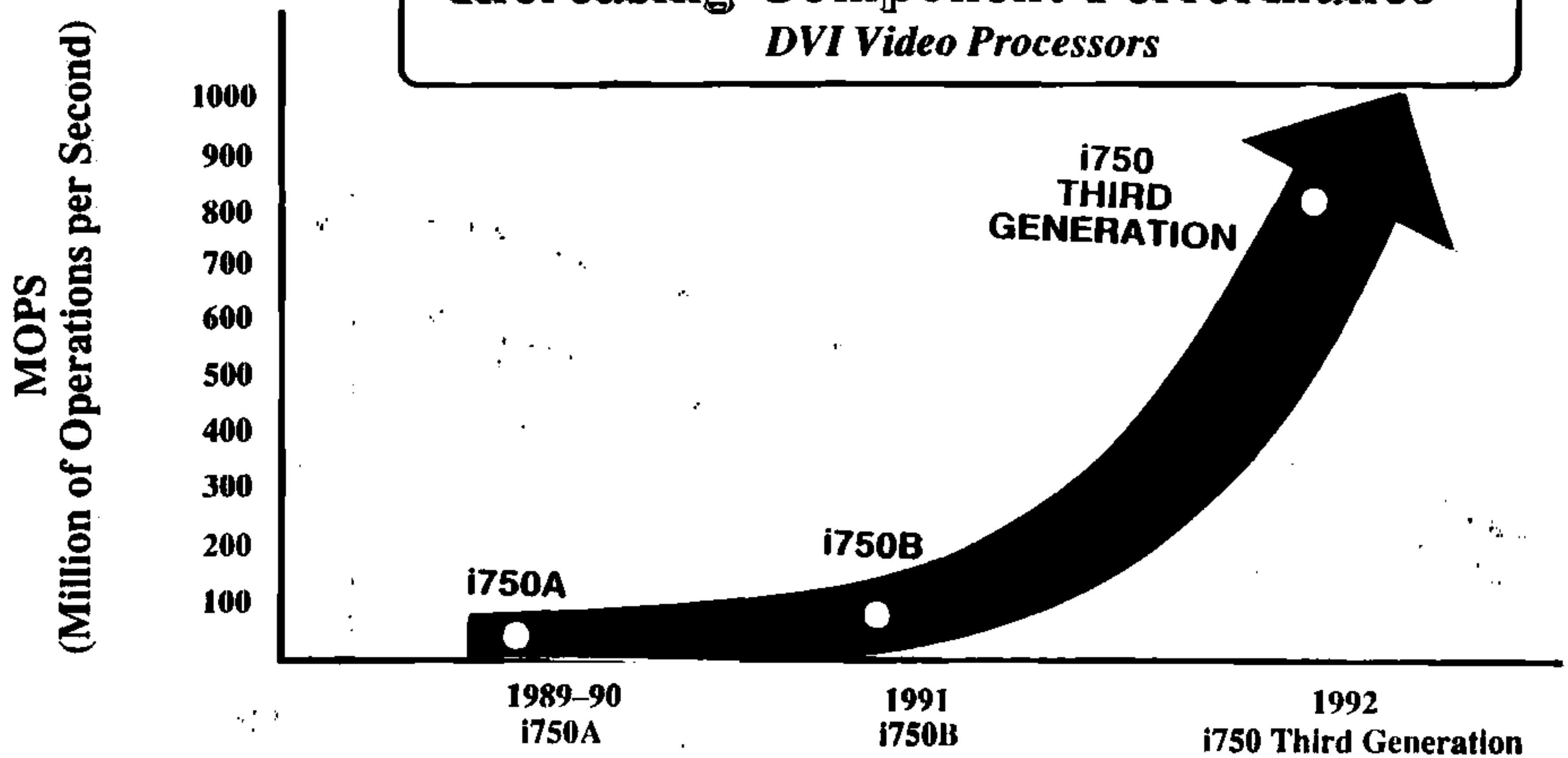
Intel's long term view of the future of multimedia computing - DVI Technology's on-going progression from an R&D project to commercial products.

2/27/90

DVI™ Technology

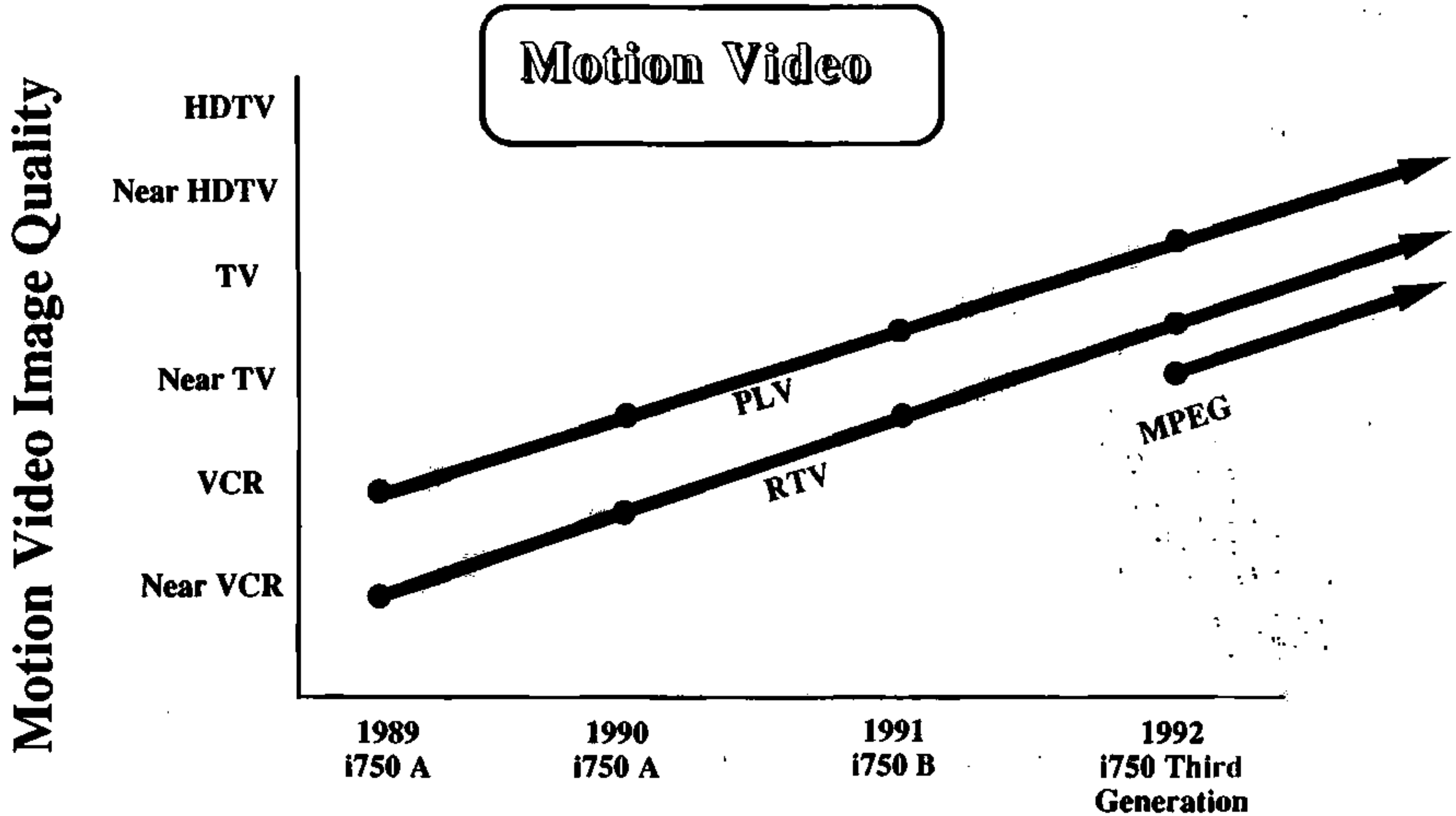
Increasing Component Performance

DVI Video Processors

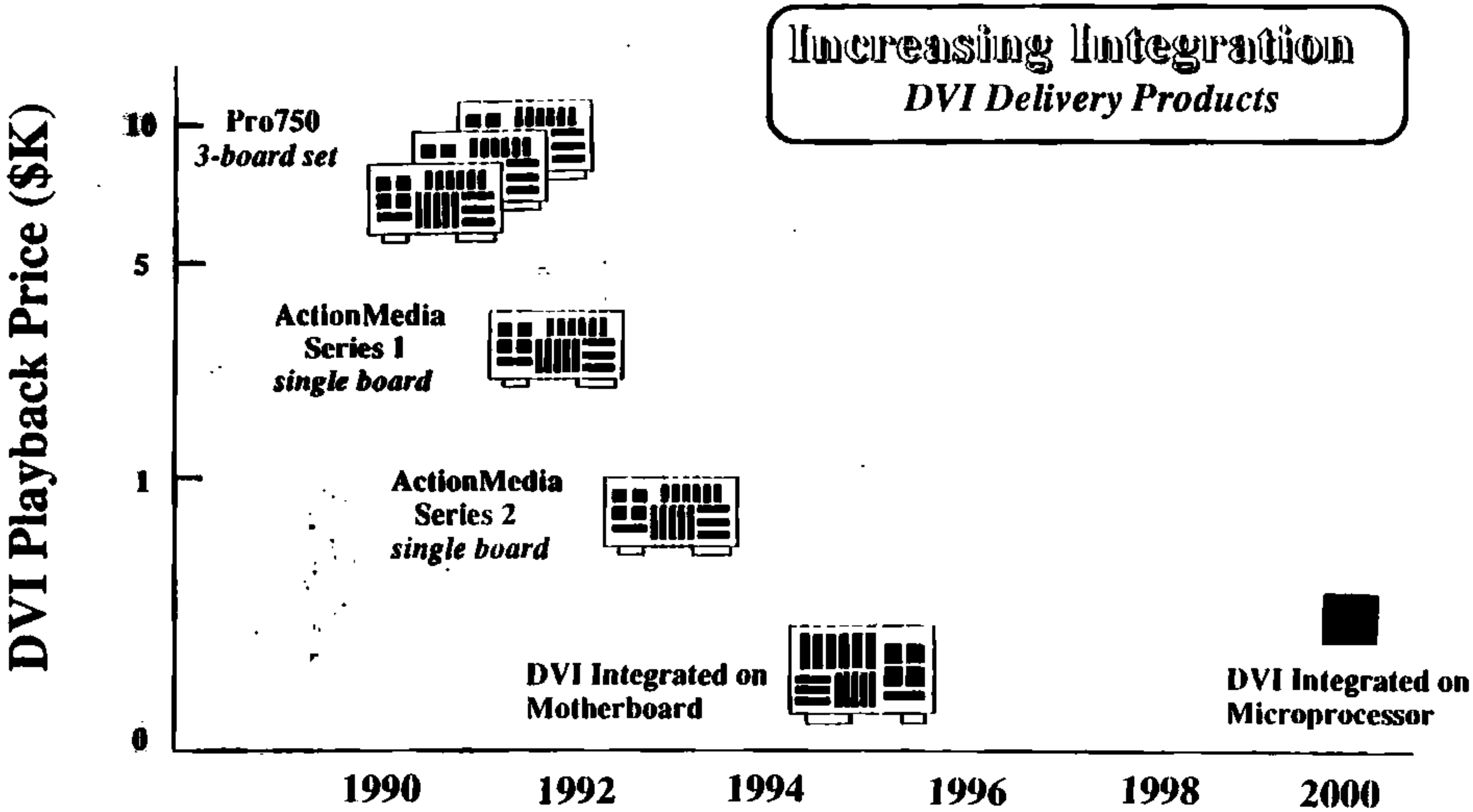


Multimedia computing requires tremendous amounts of processing power to meet the special needs of motion video, audio, stills, graphics and text manipulation and display. Intel's DVI processors will provide greater power over time to meet these needs. Their programmability offers full flexibility and backward compatibility.

DVI™ Technology

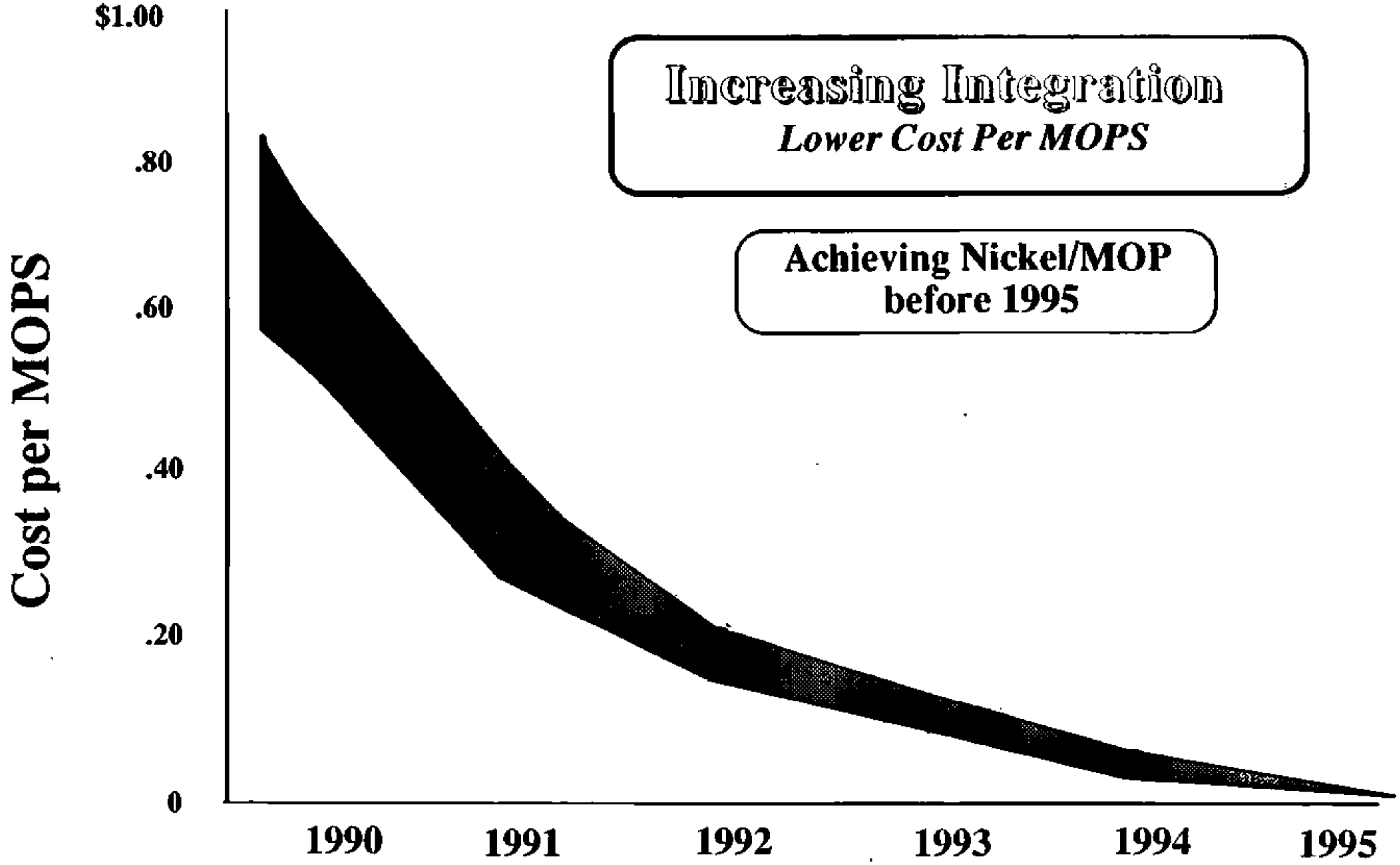


DVI Technology currently uses two motion video compression algorithms - PLV (Production Level Video) and RTV (Real Time Video). Advancements in silicon technology and algorithm software will move image quality toward HDTV resolutions over time.



Since its first product introduction in 1989, Intel has been working to reduce the price and footprint of DVI products, on-a-path from multiple boards to a fraction of a chip.

DVI™ Technology



The cost of MOPS (millions of operations per second) will continue to decrease over the next five years, making multimedia more powerful and more cost effective with each generation.

DVI™ Technology

1992 PC

Multimedia at Low Cost

Features		Estimated Price
– 386™ microprocessor – 40 Mb HD/floppy disk – CD-ROM drive – 2 Mb system RAM	– DOS/Windows – VGA + Monitor – Audio – Mouse/Keyboard	$2500

(Cost of adding DVI Technology to motherboard)

– i750B video processor – 1 Mb video memory	$ 500*

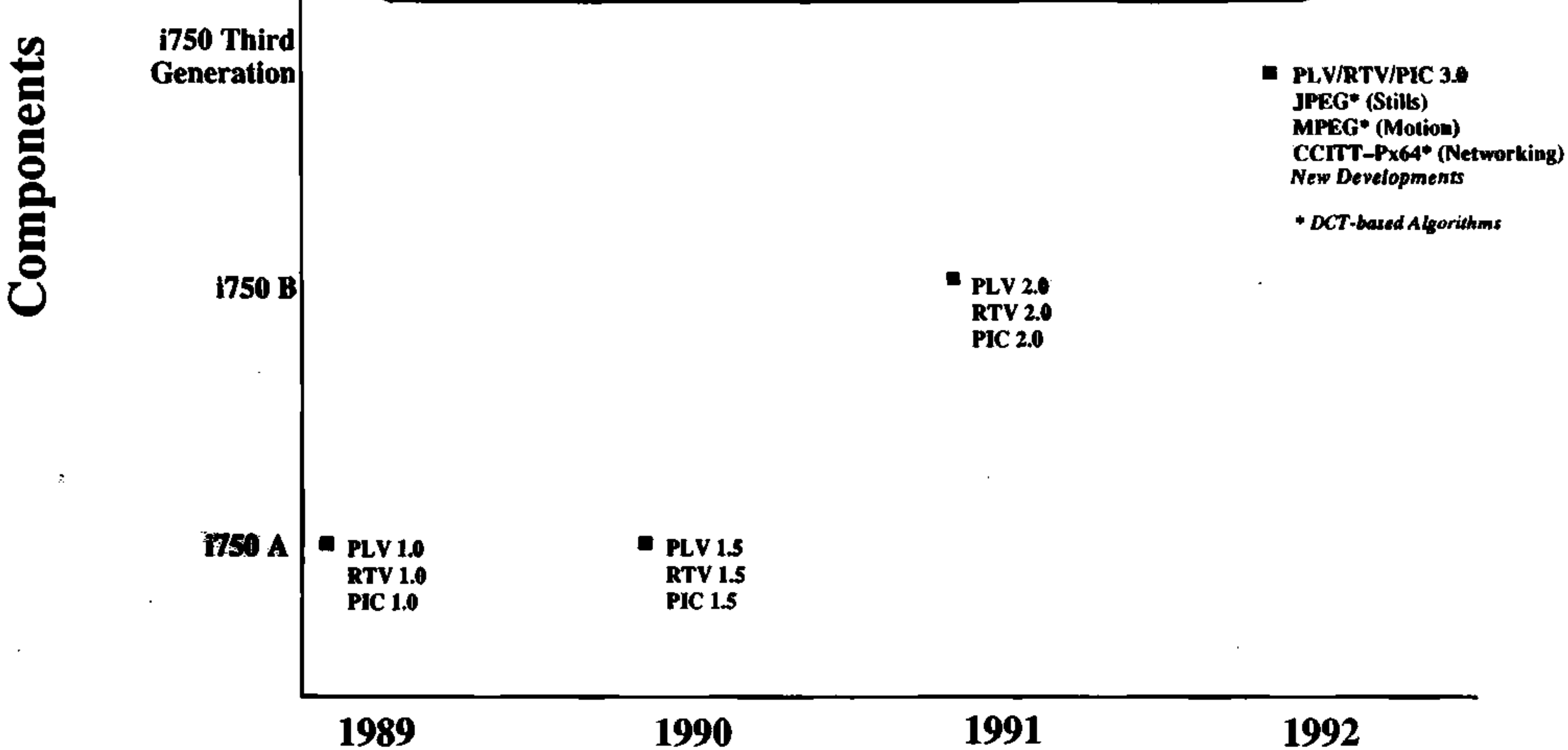
Multimedia PC of 1992 = $3000

At $500 or less we expext DVI Technology to become a standard feature of every PC by 1992.

** Sub $300 by 1995.*

Flexible Programmable Approach

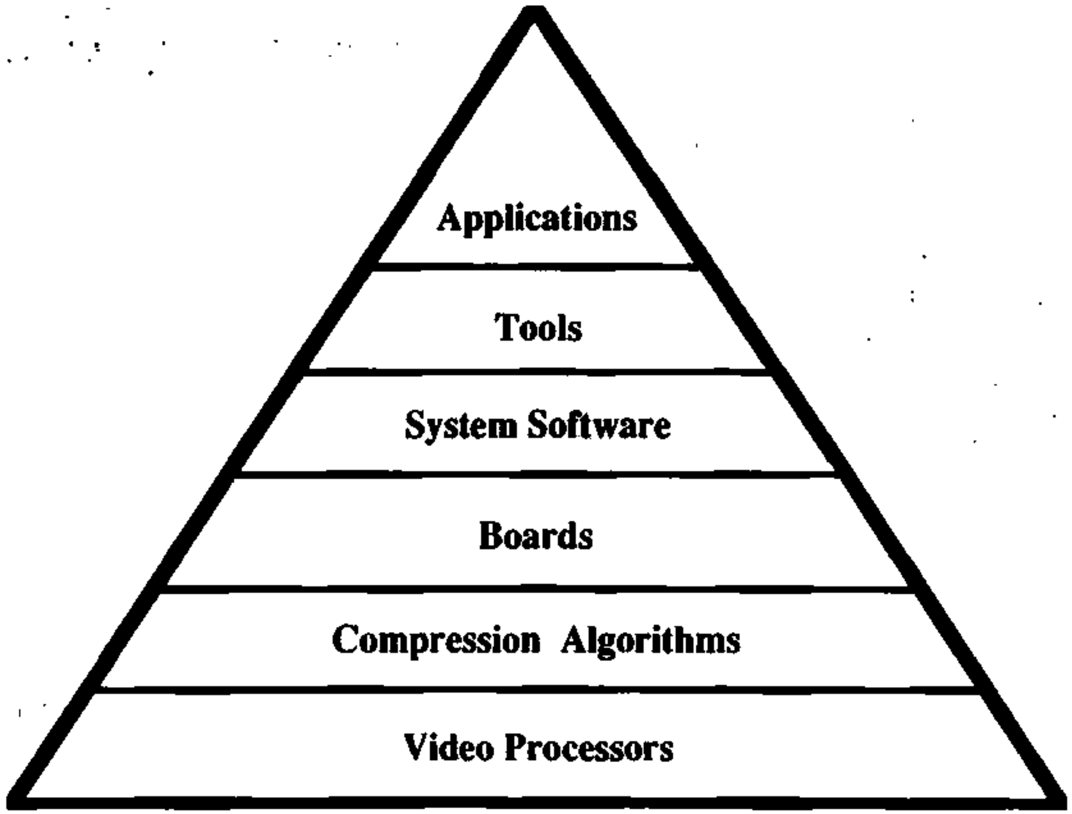
Evolving Algorithm Alternatives



Because DVI utilizes a programmable video processor, it runs a wide range of compression algorithms and allows compatibility with future standards as they evolve.

Total Product Solution

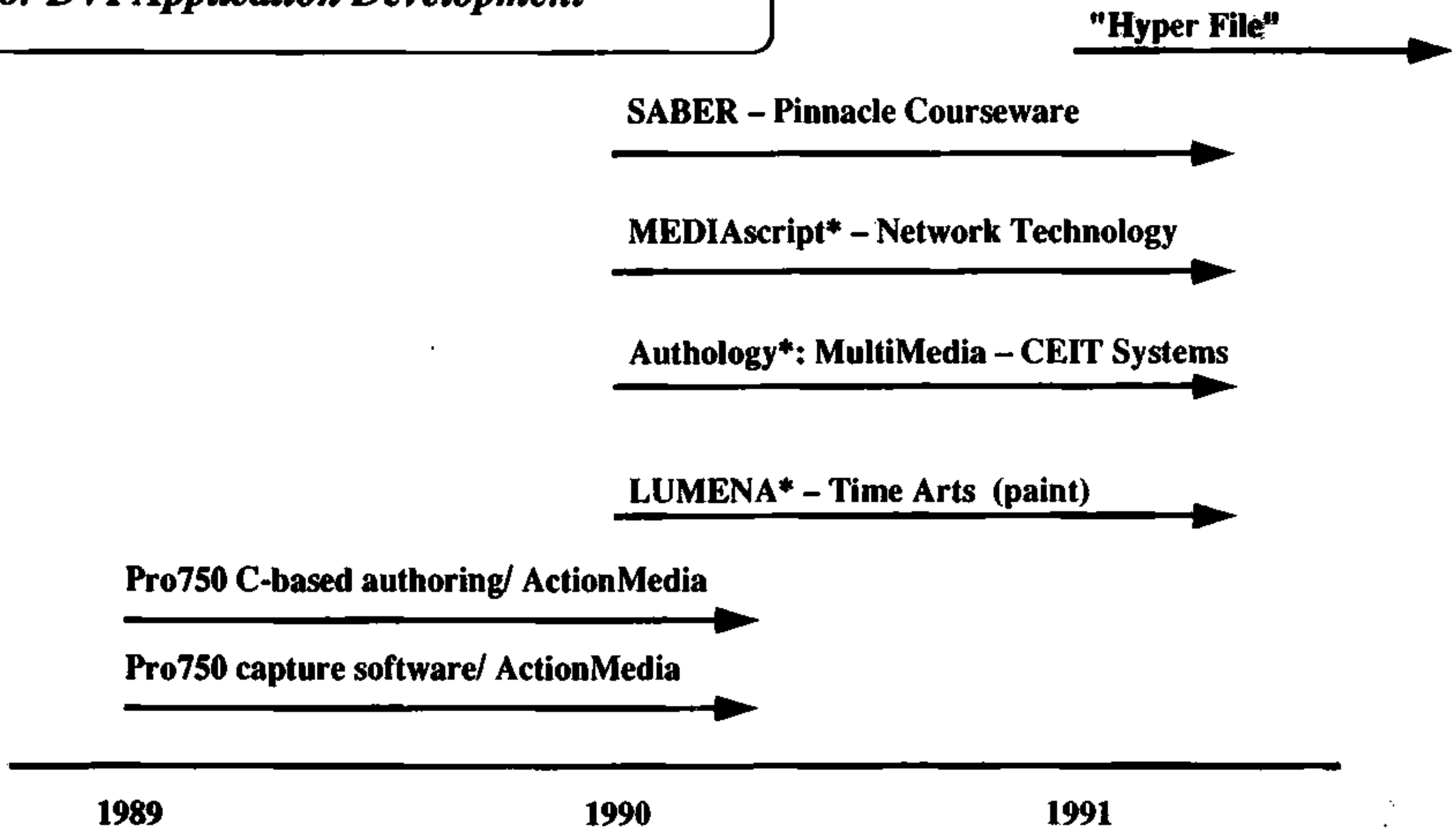
DVI Technology



Intel's is a *total* solution. DVI components, compression techniques, hardware and software evolve in parallel making a wide array of exciting applications possible.

An Array of Authoring Products

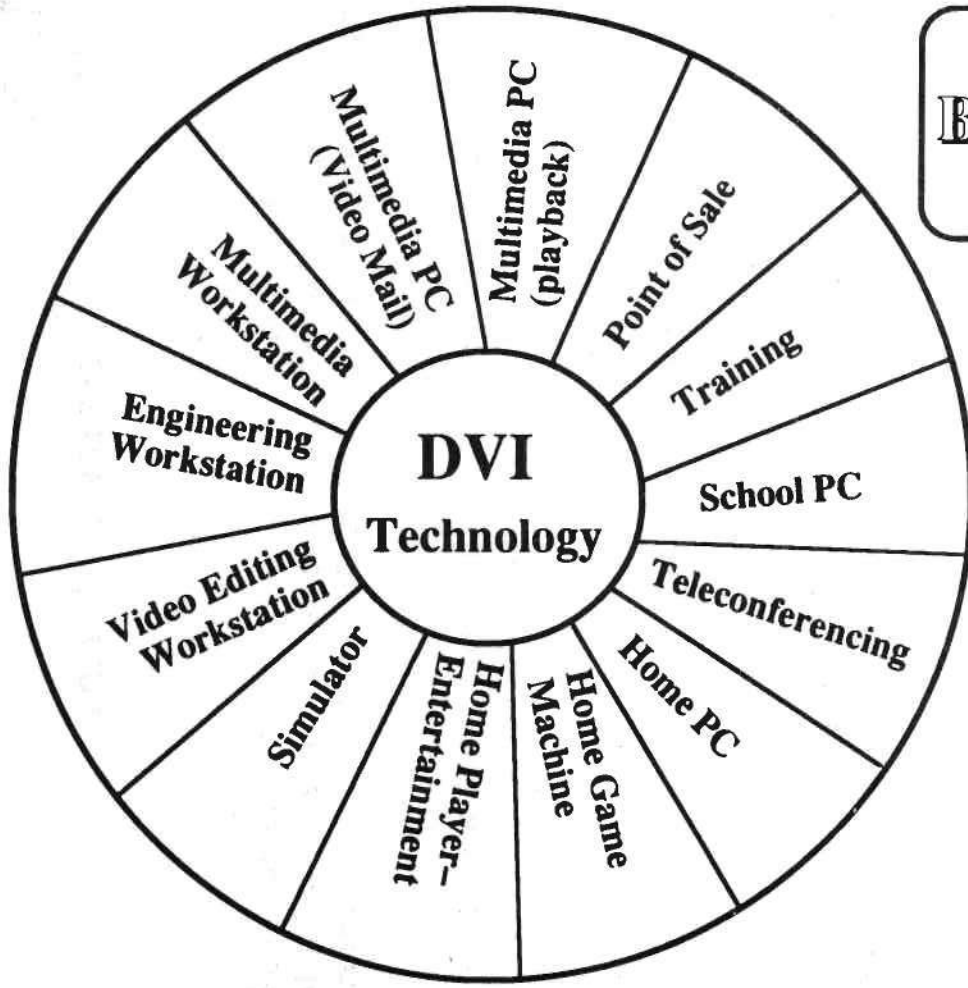
for DVI Application Development



Easy-to-use, advanced authoring tools are making their appearance and offer developers user-friendly, flexible options for creating applications.

DVI™ Technology

Multimedia for Broad OEM Markets
An Enabling Technology



DVI is an enabling technology which will allow broad market penetration over the coming months and years.

intel®

Glossary of Terms

ActionMedia ™ - DVI Technology's product family, introduced in 1990 and consisting of single-board delivery and single board capture capability for AT or Micro Channel™ architecture buses (introduced with IBM*), e.g. ActionMedia 750 ADP, etc.

CCITT - Consultative Committee of Telegraph and Telephone. International standards committee whose charter is to generate standards for networking and telephony.

DCT - Discrete Cosine Transform - algorithm or mathematical technique which can be used as part of a compression algorithm.

i750 ™ - DVI Technology programmable video processor family.

ISO - International Standards Organization. The worldwide group responsible for establishing and managing the standards committees and expert groups, including those working on international compression standards.

JPEG - Joint Photographic Experts Group. A group within ISO whose charter is to generate standards for full color still image compression.

MIPS - Millions of instructions per second. Refers to a processor's performance.

MOPS - Millions of operations per second. Refers to a processor's performance. In the case of DVI Technology, more MOPS translates to better video quality. Intel's video processor can perform multiple video operations per instruction, thus the MOPS rating is usually greater than the MIPS rating.

intel®

MPEG - Motion Picture Experts Group. A group within ISO whose charter is to generate standards for motion picture video compression from digital storage media.

Px64 - informal name for CCITT video algorithm (formal name is H.261) proposed by CCITT for teleconferencing applications. Targeted for ratification as a standard for telephony within the next year.

PIC - Picture Image Compression - DVI Techology's on-line still image compression algorithm.

PLV - Production Level Video - DVI Technology's highest quality motion video compression algorithm. Compression is "off-line", i.e. non-real time, and playback (decompression) is real time. Independent of the technology in use, off-line compression will produce a better image quality than real time since more time and processing power is used per frame.

Pro750 - A DVI product family introduced in 1989 consisting of Application Development Platform, boards and software.

RTV - Real Time Video - DVI Technology's on-line, symmetrical, 30 frames per second motion video compression algorithm.