

The Second Wave of Digital Revolution

IEF Conference, Naples, Italy, 2000

Keynote Speech

Commentary

The IEF (International Electronics Forum) Conference is an international meeting of semiconductor management executives hosted by Future Horizons. It was held in Naples, Italy on October 9, 2000. The concept of "Second Digital Wave" was revealed for the first time in this conference.

The history of electronics up to this time was reviewed from the viewpoint of "analog centric" and "digital centric", and it was expressed by the transition of three waves. Analog consumer products such as TV, VCR, and Walkman etc. that grew strongly in the 1970s and 1980s were defined as the "Analog Wave". The wave of PCs which rose in the 1980s and 1990s was named as the "First Digital Wave". And the new wave of digital consumer products that have been rising since the 1990s is defined as the "Second Digital Wave".

It was predicted that the momentum of the second digital wave would surpass the first digital wave in the near future, and the prediction seems proved today by the emergence of smart phones and other consumer goods. The second digital wave has become the main wave of today.

Although I had come up with this concept in my Hitachi days, I moved to Sony in October 2000 before the opportunity of this speech. Since I got support from Hitachi staff to prepare this Exhibit, it is categorized as the last one in my Hitachi days.

This is the end of "Part 1 : Materials in my Hitachi days".

The Second Wave of Digital Revolution

Dr. Tsugio Makimoto

**Corporate Senior Executive Vice President
SONY Corporation**

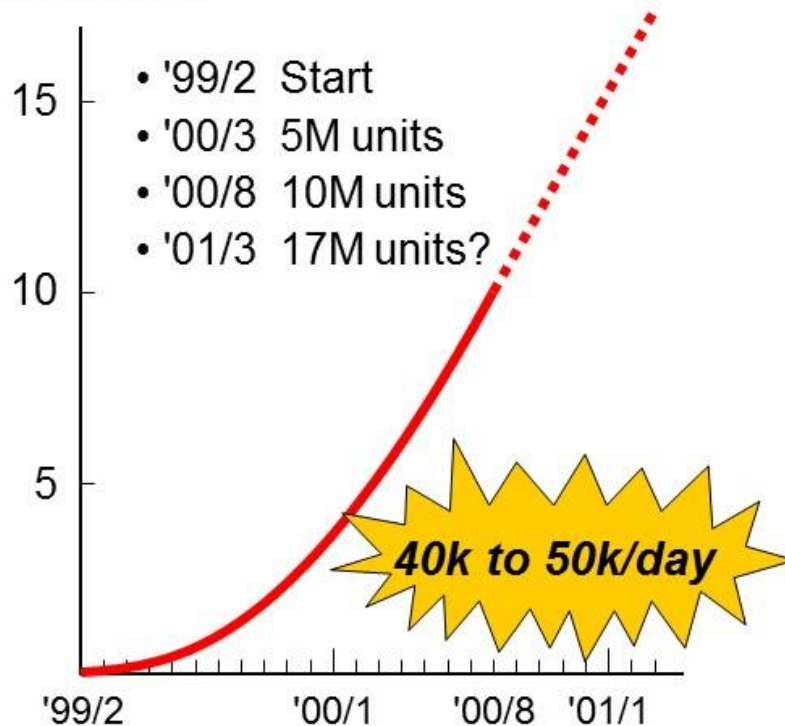
(Formerly Corporate Chief Technologist, Hitachi, Ltd)

I moved to Sony from Hitachi on Oct. 1, 2000, so I was with Sony at the time of this speech , Oct. 9. The official title of Sony is shown above together with the former title of Hitachi. At the beginning of the speech , Malcom Penn, Chairman and CEO of Future Horizons, touched on this issue and added that "this kind of move is extremely rare case in Japan".

- ◆
- **Emerging New Trends**
- **Second Wave of Digital Revolution**
- **New Directions of
Technology Development**
- **Regional Competitiveness**
- **Impact of the Second Wave**

Explosive Growth of i-mode

[M subscribers]



立川敬二社長

通しを眺らかにした。二十六日時点での加入者数は九百五十万。iモードは手軽にネット上閲覧やメール交換ができる点が受け、加入者が急増。増加ペースは昨年七月の一日当たり一万人程度から、現在では四万五万人に加速している。

NTTドコモの立川敬二社長は二十七日の記者会見で、同社の携帯電話を使ったインターネット接続サービス「iモード」の加入者数が八月上旬に一千万人に達するとの見

iモード、来月100万人突破

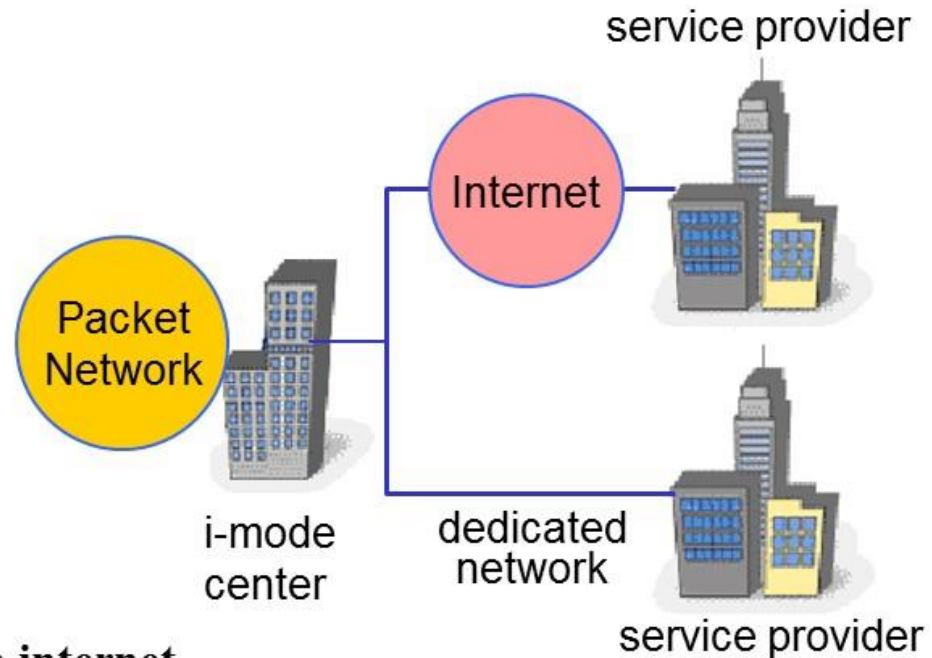
長は二十七日の記者会見で、同社の携帯電話を使ったインターネット接続サービス「iモード」の加入者数が八月上旬に一千万人に達するとの見

July 28, 2000 Nihon Keizai shinbun

There is a surge of a new trend in the electronics industry. One of the representative examples is the explosive spread of i-mode; a network connection service of mobile phones provided by DoCoMo. It is possible to browse contents on the Internet as well as sending and receiving e-mails. It started in February 1999, and the number of subscribers is expected to reach 10 million in August, 2000. It is spreading at a pace of 40,000 to 50,000 subscribers per day, and it is really explosive.

What is i-mode?

- ◆ **Cellular phone (voice)
+ Information Service**
- ◆ **Various services**
 - **Mobile Banking**
 - **Ticket Reservation**
 - **Flight Reservation**
 - **News, Weather,
Entertainment**
 - **Dictionary**
 - **e-mail**
 - **Browsing Webs on the internet**



In short, i-mode is one of information services besides the calling services of mobile phones. The service providers send information to the i-mode center via the Internet or dedicated lines, and it is delivered to the mobile phones from there. The services provided include mobile banking, ticket reservations, flight reservations, news/weather/entertainment, dictionaries, e-mails, browsing web on the internet and the like.

Thumb Tribe —The New Trend Setter



Source: Nikkei Business, June 5, 2000



Operating mobile tool
by a single thumb

“Thumb tribe” refers to young people who operate cell phone buttons with a single thumb. They are the new trend setters and will lead the future trend of consumption. It can be said that the “thumb tribe” represents another form of “Digital Nomad” which was described in the book published in 1997.

PC Age is Over?

? The PC era is over.

This is not to say that PCs are going to die off, any more than mainframes vanished when the IBM PC debuted in 1981. Indeed, IBM's own PC business was an important turnaround story in 1998. But the PC's reign as the driver of customer buying decisions and the primary platform for application development is over. In all those respects, it has been supplanted by the network. ----

Source: IBM Annual Report (1998)



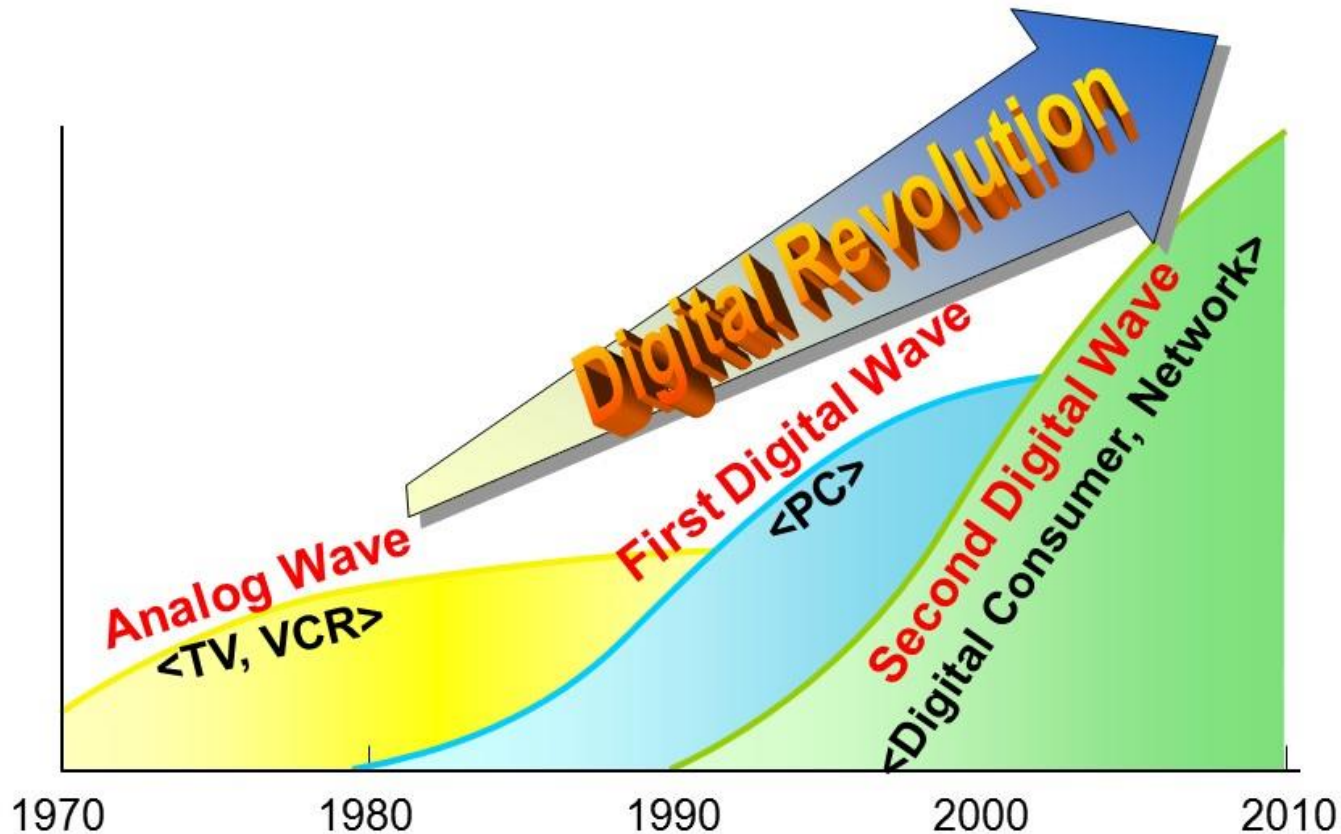
Nikkei shinbun
March 5, 2000



The sentence on the left is a quote from IBM's annual report in 1998. Picture in the center shows that "PlayStation2" was sold out. The right hand side figure is a special issue of "Goodbye, PC!" (Nikkei Multimedia). The picture was taken at the time of the release of Sega's Dreamcast. Both of them suggest the arrival of a new era of post PC.

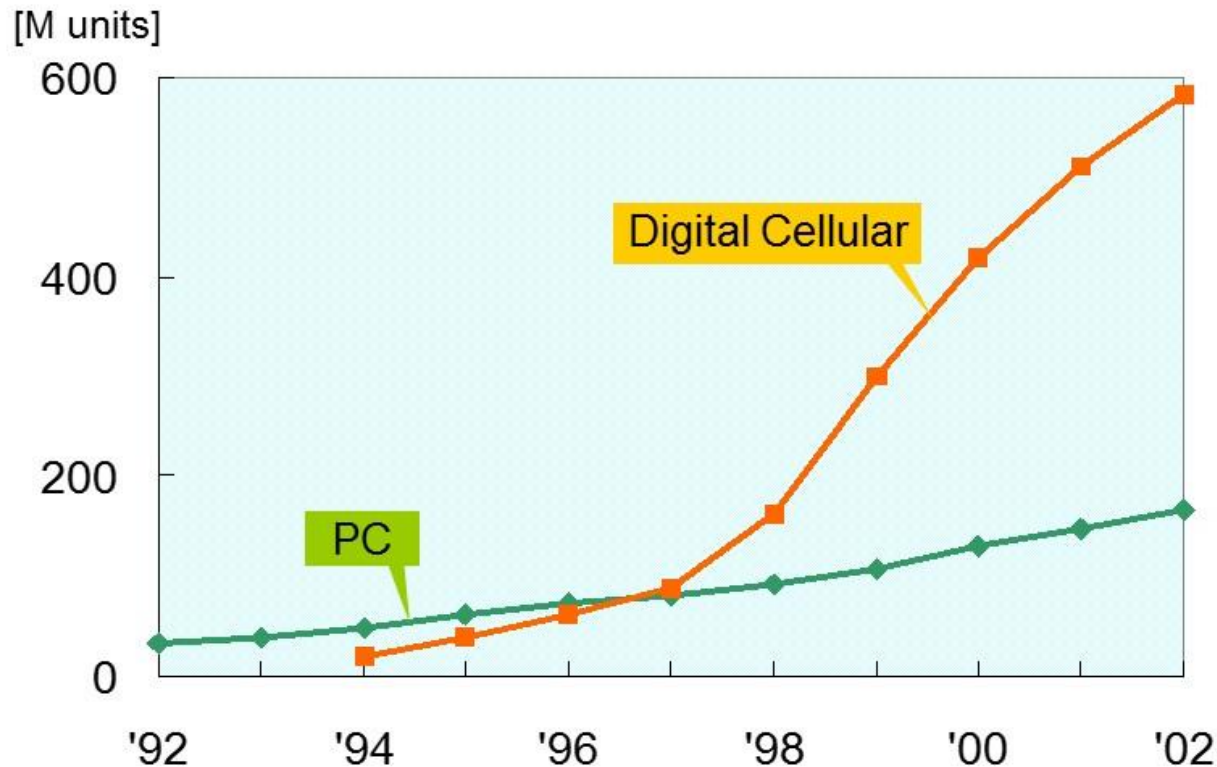
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The Rising Second Wave



Analog products such as TV and VCR occupied the core of electronics industry in the 1970s and 1980s. PC was the main player in the 80s and 90s. Meanwhile, Digital Consumer products that emerged in the 1990s are connected to networks and have been spreading rapidly, and they will surpass PC in the near future. This is the rise of "Digital Second Wave".

Shipment of PC and Cellular Phone

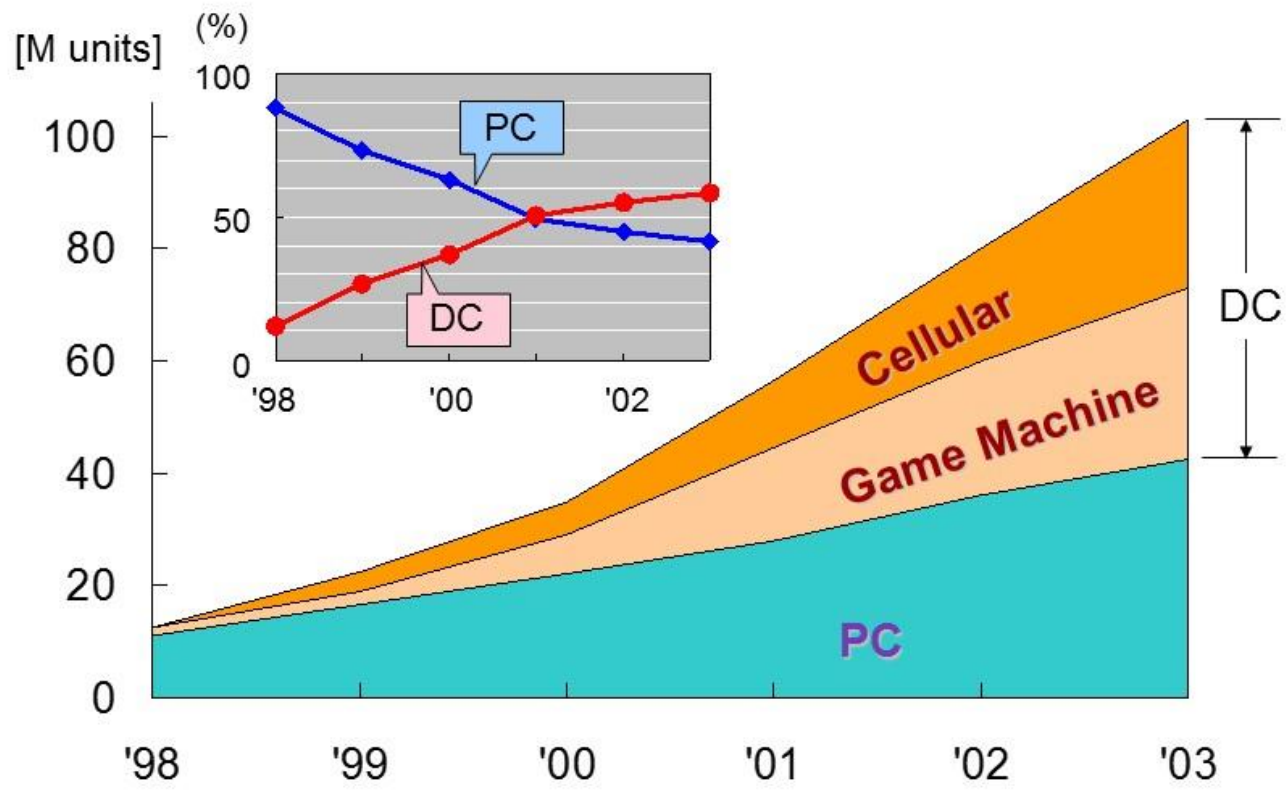


Source: EIAJ/IDC Japan

The figure shows the rapid growth of Digital Cellular phone shipment, which is the representative product in the second digital wave, outperforming PC shipment. It shows the real surging move of this wave.



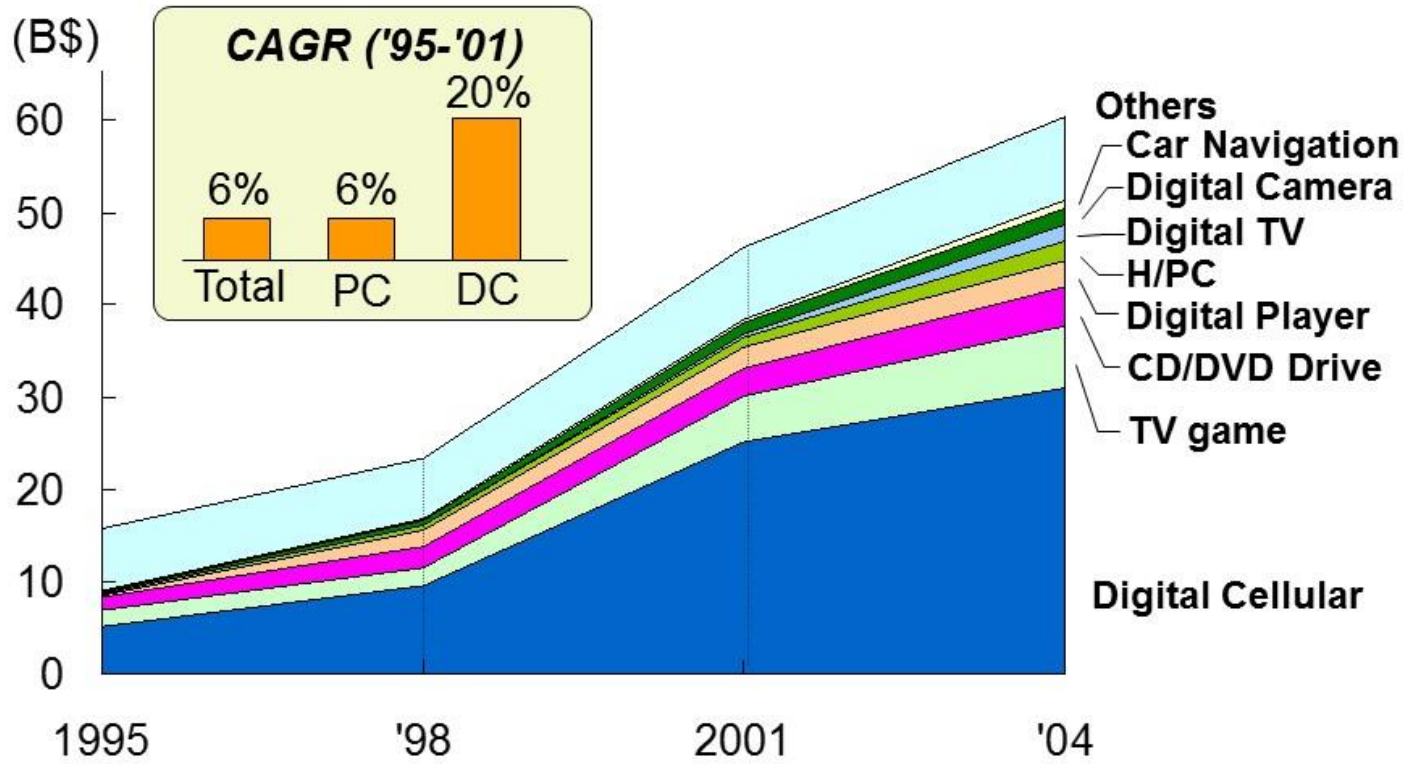
Evolution of Personal Internet Terminals



Source: Hitachi

The figure shows the number of units of PCs, game machines, and mobile phones as personal internet terminals. Game machines and mobile phones belong to digital consumer products. The figure on the upper left shows the ratio of PC vs. DC (Digital Consumer products). The figure indicates that the ratio will be almost equal in 2001, and thereafter the proportion of DC will become higher.

Semiconductor Market for Digital Consumer

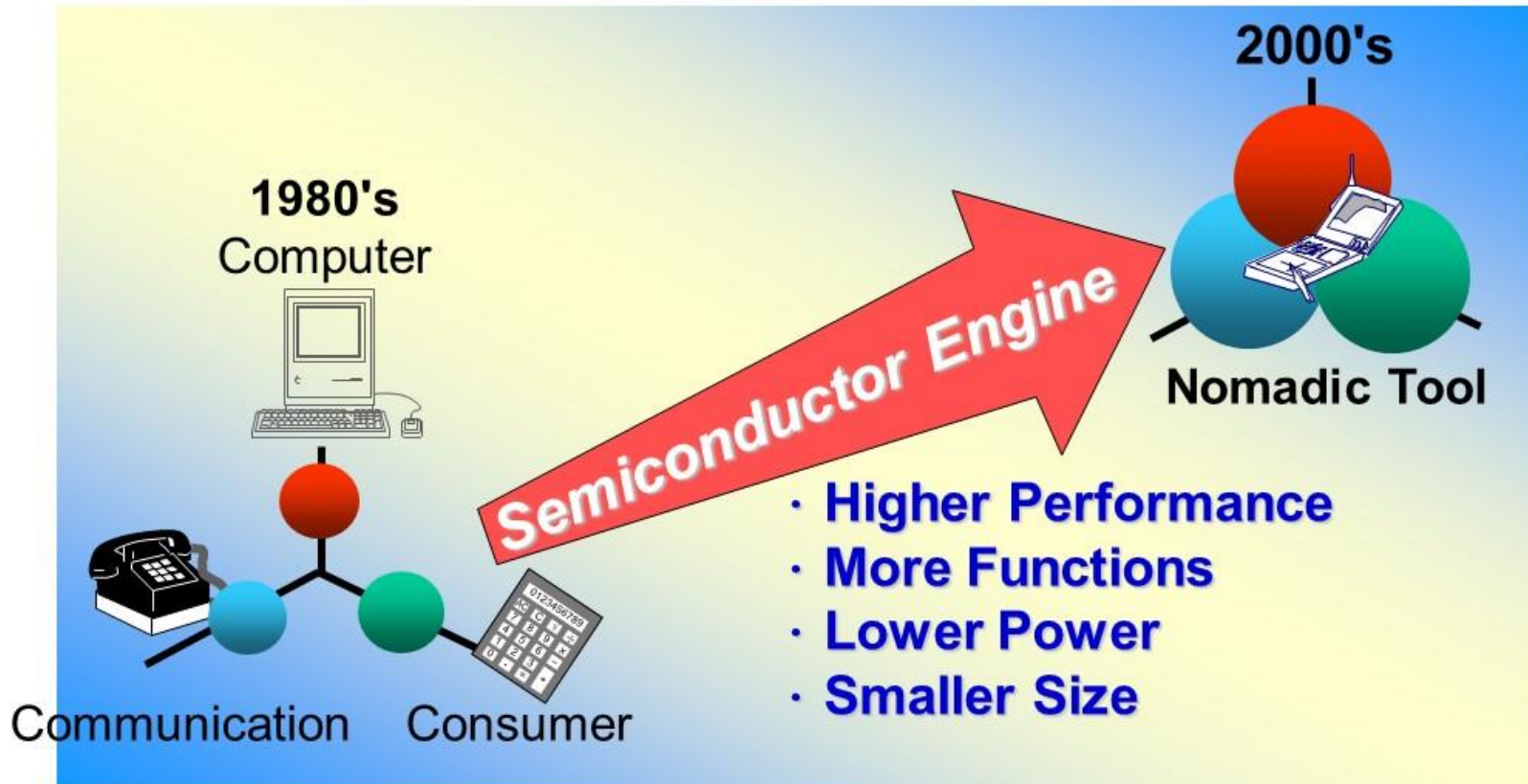


Source: EIAJ/IDC Japan, May 2000

The trend of semiconductor market for digital consumer products is shown. As of 2004, it is expected that mobile phones account for almost half, and the rest are occupied by various products such as TV games, CD/DVD drives, music players, H/PC, digital TV, car navigation systems and so on. The attached figure shows the annual average growth rate. While it is about 6% for the total semiconductor and PC, it is 20% for Digital Consumer. This indicates that the momentum of DC is overwhelmingly stronger than PC.

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Nomadic Tool



From the 1980s to the 2000s, the market of electronics has been greatly changing. Due to semiconductor innovation, the market boundaries of computer, consumer, and communication disappears and they converge on nomadic tools. This is because the powerful semiconductor engine promotes higher performance, higher functionality, lower power, and smaller size and weight of equipment.

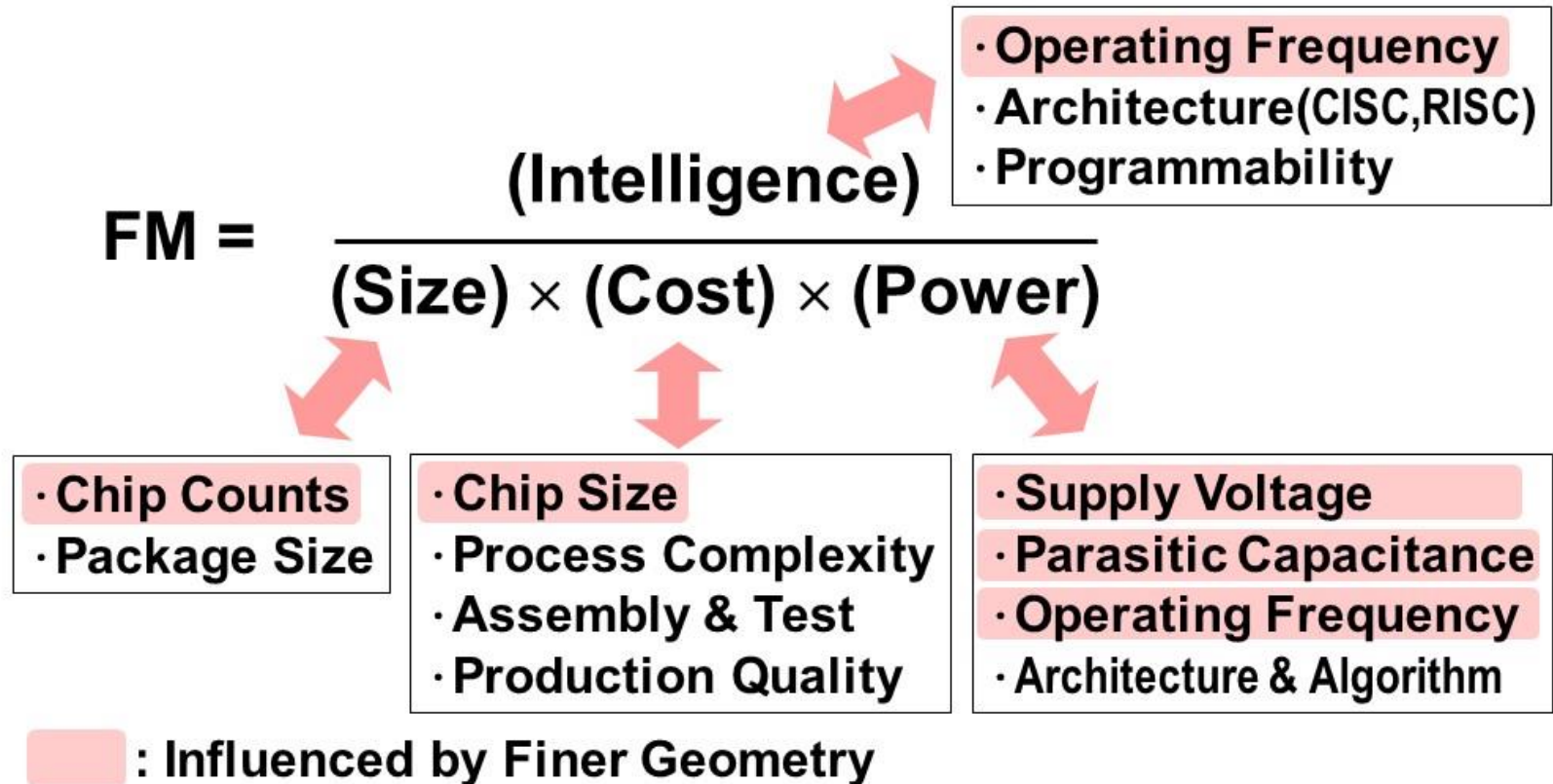
Figure of Merit in the Nomadic Age

$$\text{Figure of Merit} = \frac{\text{(Intelligence)}}{\text{(Size)} \times \text{(Cost)} \times \text{(Power)}}$$

Cooler the Better!

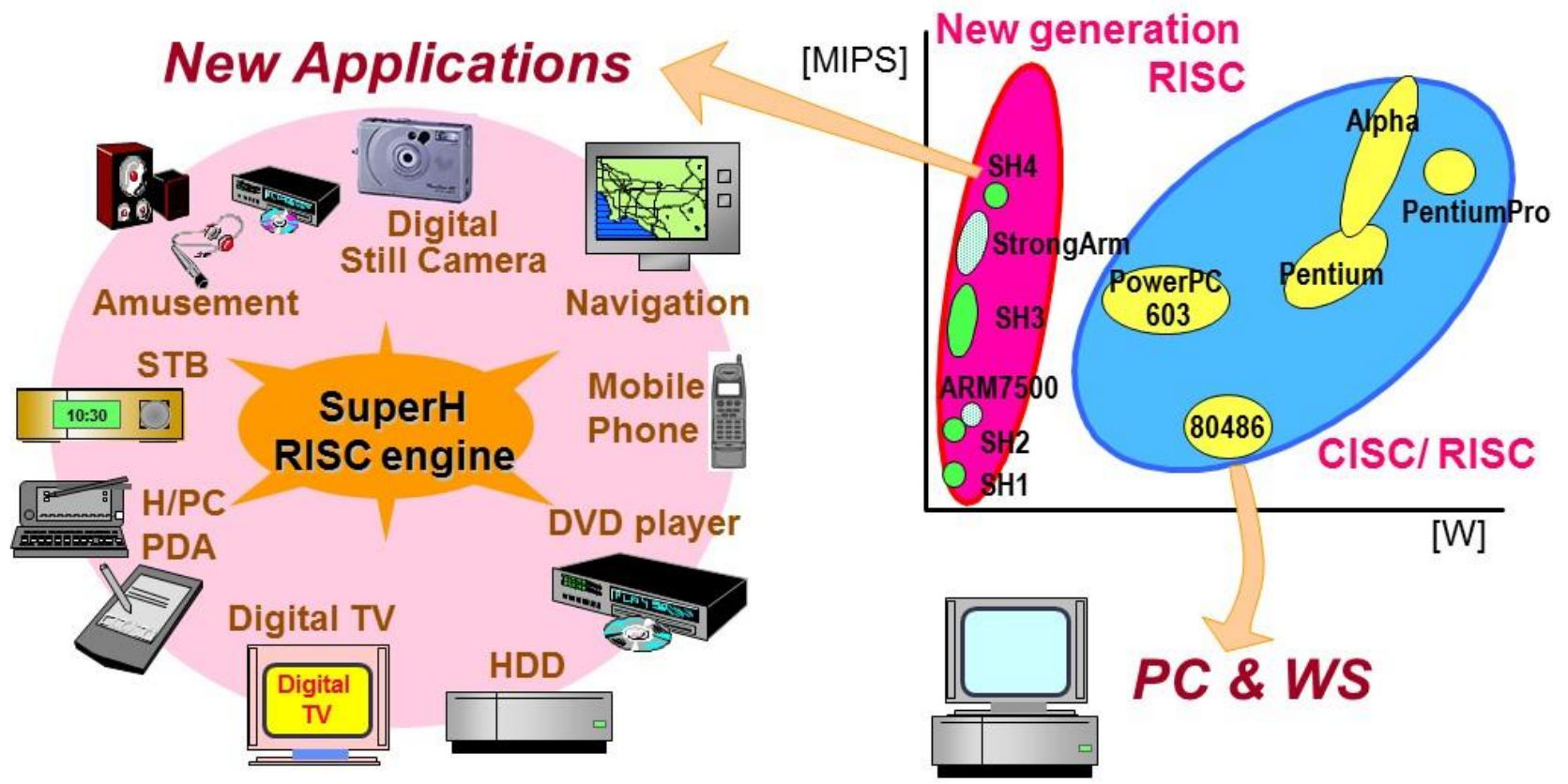
This equation is proposed as the Figure of Merit in the nomadic age. Low power is a prerequisite in the nomadic tools, and the Figure of Merit becomes higher with lower power. The biggest factor to raise the Figure of Merit is semiconductor innovation.

Major Factors Affecting the FM Value



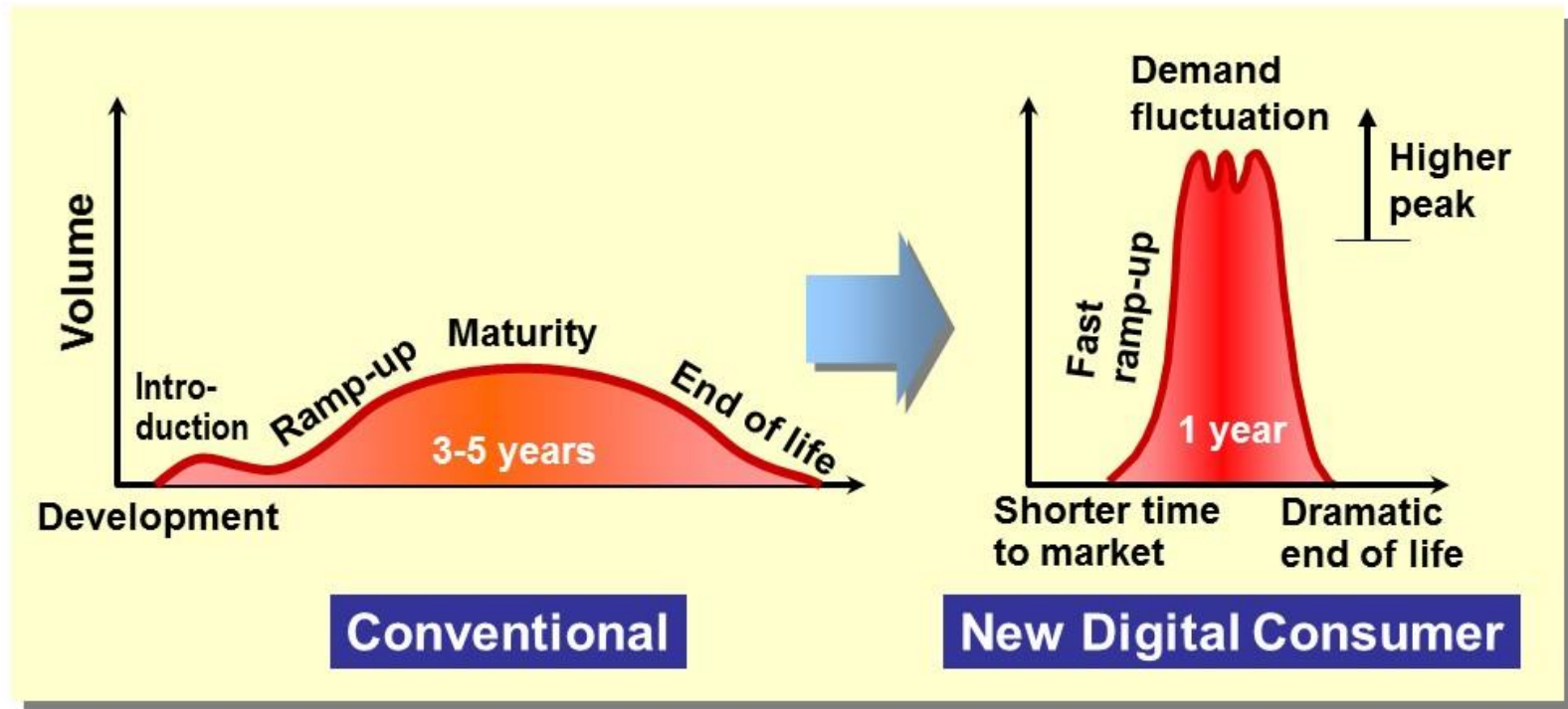
Major factors affecting "Figure of Merit" value are shown here. Factors shadowed in the cherry color are influenced by finer geometry of devices. It is expected that the Figure of Merit value is greatly improved by shrinking the device.

New Architecture and New Market



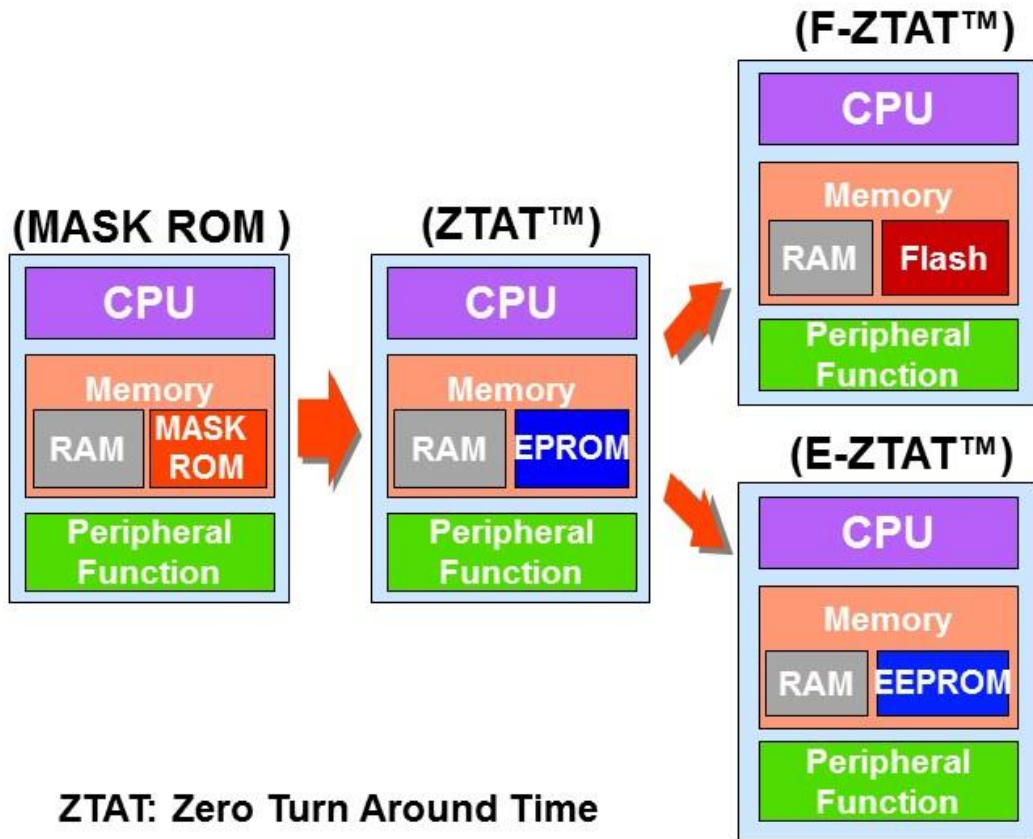
The figure on the right shows the distribution of performance (MIPS) and power (W) for the conventional architecture for PC/WS and the new generation RISC architecture. The value of MIPS/W is overwhelmingly high in the case of new RISC devices compared with the conventional devices. With this characteristic, the new machine, such as Hitachi's SuperH RISC Engine, opened a new field as shown on the left: digital camera, car navigation, mobile phone, DVD player, digital TV, HDD, PDA, H/PC, STB, music players and so on. These applications would not have been achieved with conventional devices.

Dramatic Change in Life Cycle

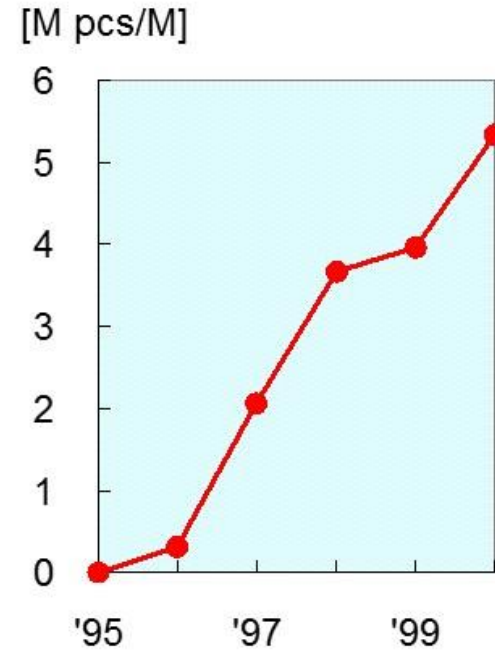


The figure shows a dramatic change in product life cycle. The figure on the left is a conventional pattern, and it slowly rises and disappears slowly with product life of 3 to 5 years. The figure on the right is a pattern of new digital consumer products. It rises rapidly with the demand fluctuation at the peak, and it has dramatic end of life. Lifespan is one year. In order to cope with such a sudden change in the market, new technology is required.

Hitachi's F-ZTAT™ Micro's



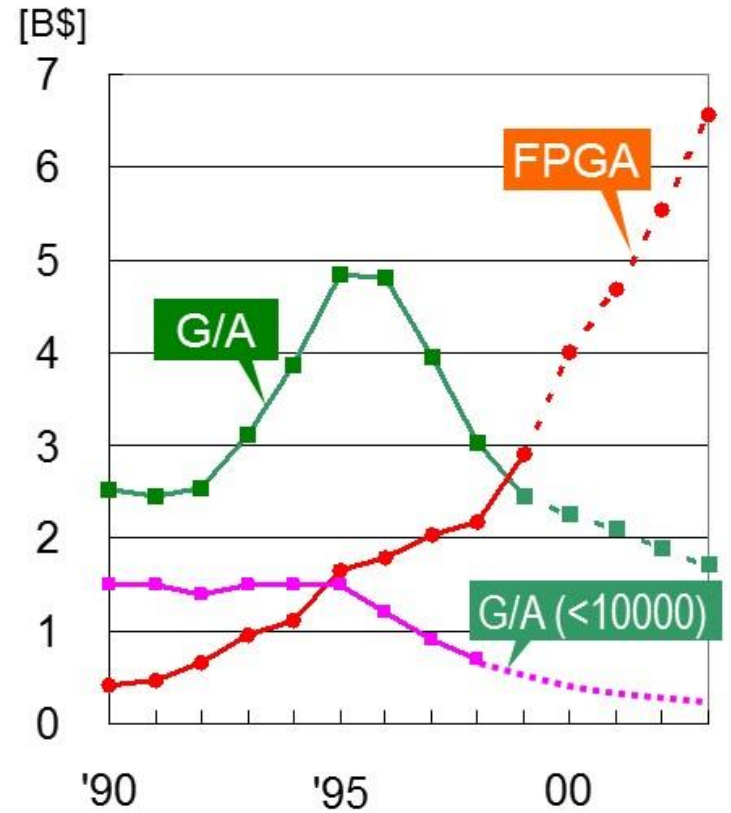
ZTAT: Zero Turn Around Time



Hitachi F-ZTAT Sales Volume

Hitachi's Z-TAT MCU is shown as an example of technology to cope with rapid market changes. The MCU has been evolving from the mask ROM version into EPROM version (Z-TAT). It then expanded into flash memory version (F-ZTAT), and to EEPROM version (E-ZTAT). The figure on the right shows that the F-ZTAT version has been rapidly rising from around 1997.

FPGA beats Conventional GA



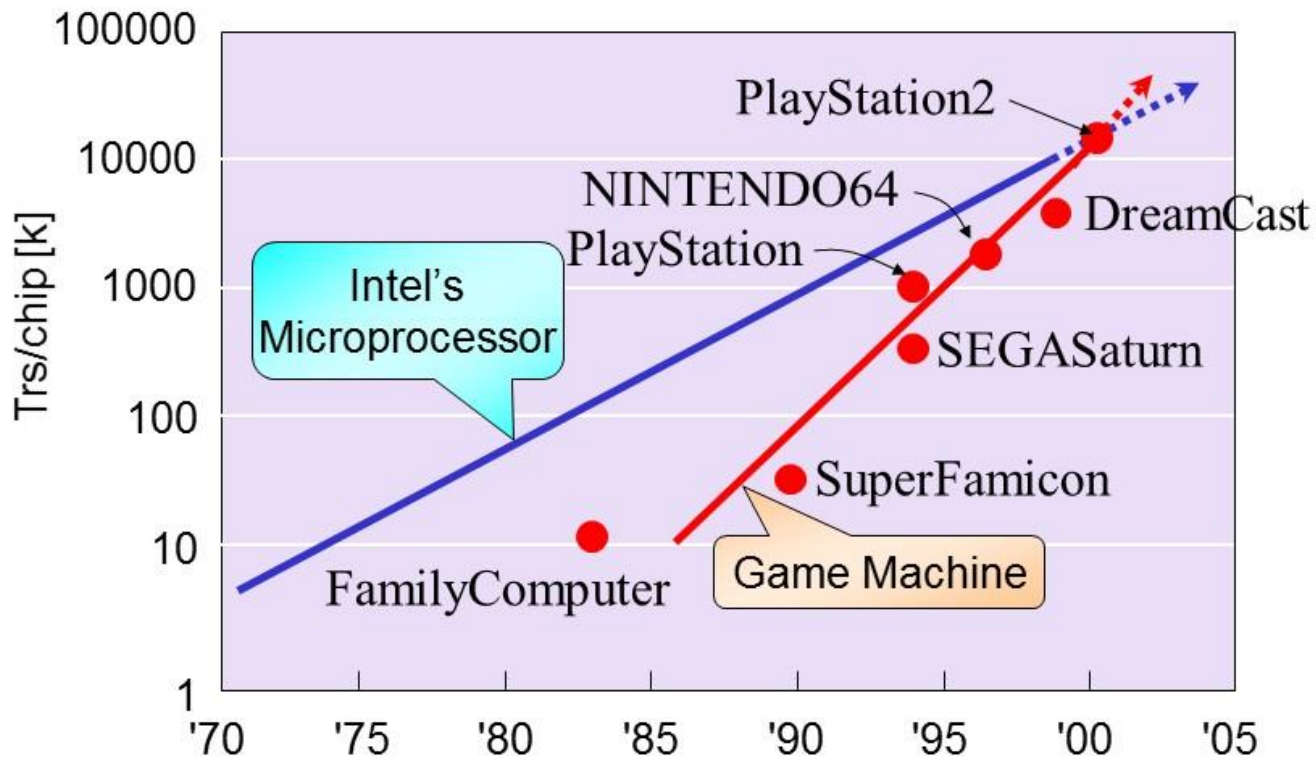
Changing threshold

Now	Future
50-M Hz	100-M Hz
50-k Gate	100-k Gate
50-k pcs	100-k pcs

Source: WSTS, DataQuest

FPGA, a typical field programmable device, surpassed the sales of gate arrays of less than 10,000 gates in 1995, and then the entire gate array in 1999. In the future, the range covered by the FPGA will expand drastically as shown on the right; from the current 50 MHz to 100 MHz in frequency, and from the present 50 thousand gates to 100 thousand gates in the integration level. The lot size will also expand from the current 50 thousand per lot to 100 thousand.

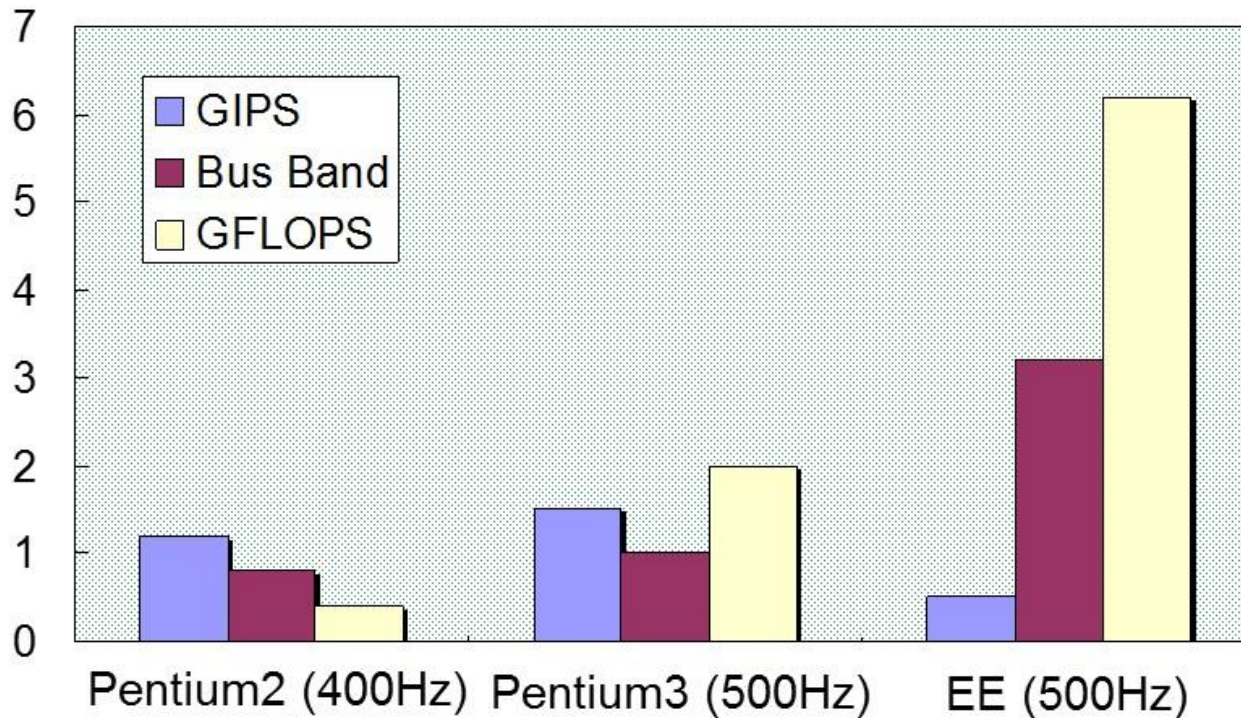
Game Machine as Technology Driver



Source: Nikkei Electronics, October 14, 1999

The figure shows the trend of integration levels of Intel's microprocessors and the chips for game machines. Intel MPU overwhelmed the Family-Computer chip in the 1980s and Super-Famicon chip in the early 1990s in terms of density. However, the difference has gradually decreased since the introduction of Sega Saturn. In the case of Sony's PlayStation2 released in March 2000, there is no difference any more. Game machines will play a role of the technology driver in the future.

PS-2/EE vs. Pentium



Source: DataQuest/Sony Computer Entertainment Inc. 1999

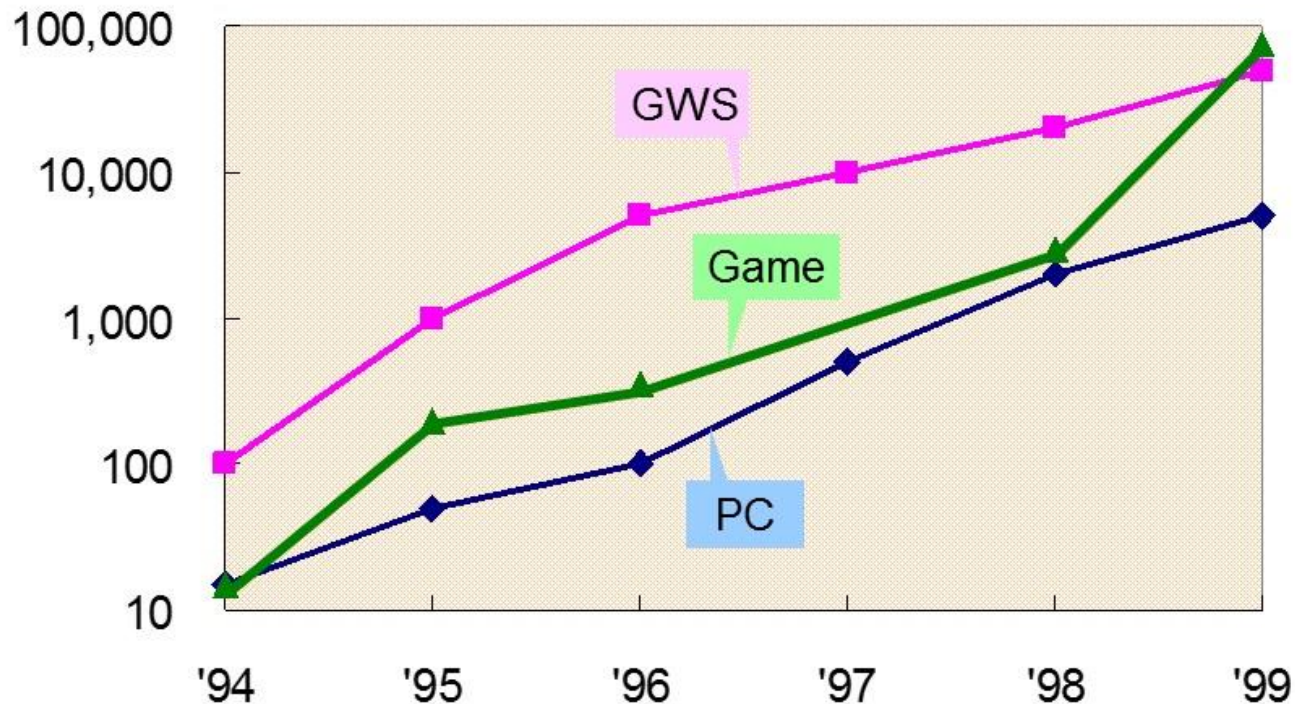
EE: Emotion Engine

20

The figure compares GIPS value, bus bandwidth, and GFLOPS value for Intel's Pentium 2 (400 MHz), Pentium 3 (500 MHz) and Sony's PS-2 processor (Emotion Engine: EE). Although Pentium surpasses in GIPS value, EE overwhelmingly prevails in bus bandwidth and GFLOPS value. That is, there are advantages and disadvantages, not that Pentium is winning all.

Performance Comparison: Game/PC/GWS

[k polygon/sec]

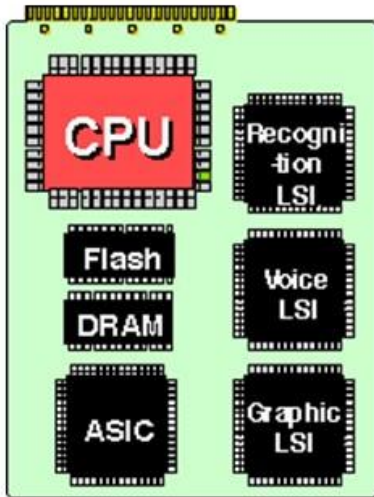


Source: Sony Computer Entertainment Inc. 1999

This is a comparison of rendering performance (K polygon/second) for PC, game machine, and GWS (graphic work station). Since 1994, game machines had already exceeded the performance of PCs, and in 1999 they surpassed the performance of GWS. At that time, game machines tended to be seen below PC and GWS, but this figure shows they were already superior to both in the field of their specialty.

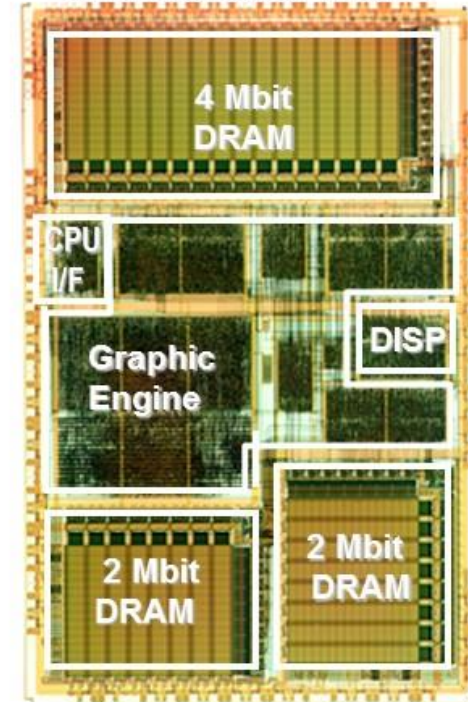
SoC: The Driver of the Second Wave

Board



Chip

ex. 3-D Graphic Engine



SoC: System on Chip



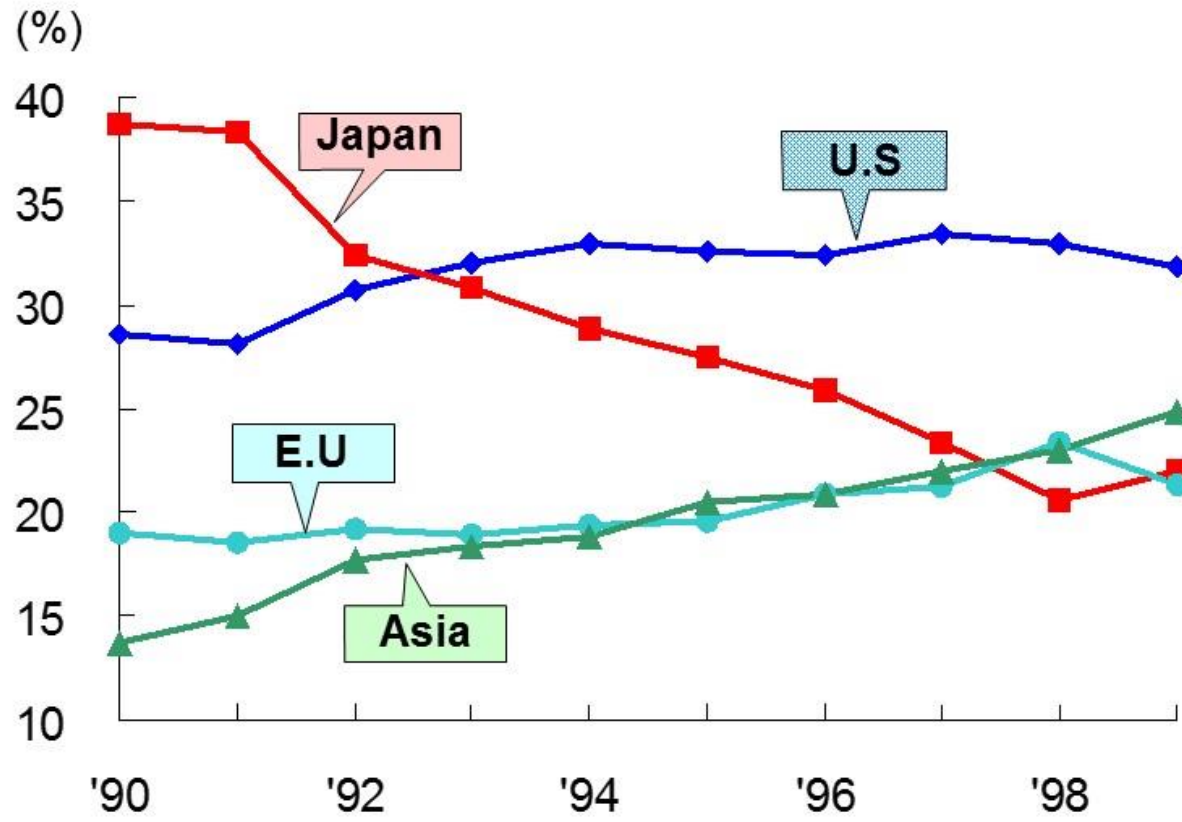
- Performance: $\times 4$
- Power : $1/5$
- Chip Counts : $1/4$
- Pin Counts : $1/3$

SoC is the driver of the second digital wave. As shown in the figure on the right, CPU, flash memory, DRAM, graphic LSI and the like which were all separate chips are now integrated on one chip. By this, the performance is improved by 4 times, the power is 1/5, the number of chips is 1/4, and the number of pins is reduced to 1/3. SoC greatly contributes to the high performance, low power, low cost, and miniaturization of equipment.



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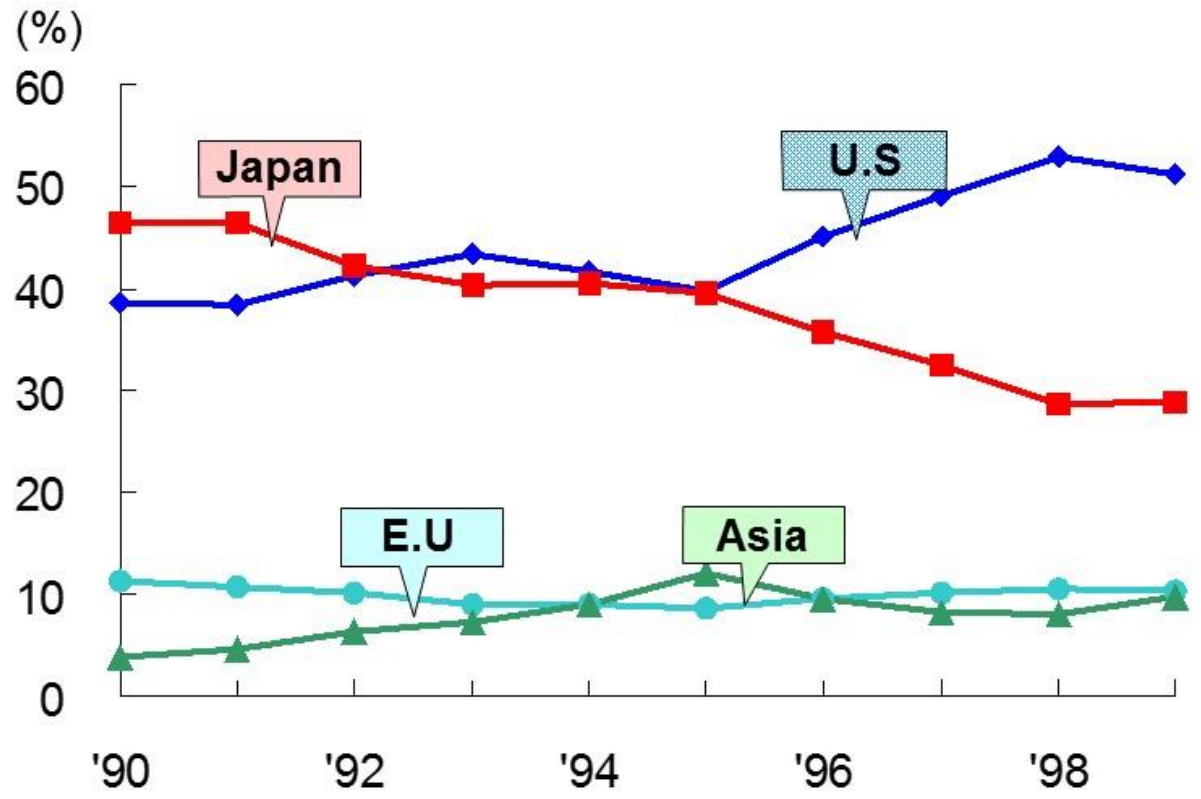
Regional Semiconductor Consumption



Source: WSTS, June 2000

Along with the progress of digitalization, major changes are occurring in the market size by region. As shown in the figure, it is noteworthy that the Japanese market is rapidly declining, while the Asian market is rapidly increasing. Japan's share in 1990 was slightly less than 40% and Asia's was less than 15%, but in 1999 the shares were reversed with Asian share of 25% against a little more than 20% of Japan. The share of US and Europe slightly increased in this same period.

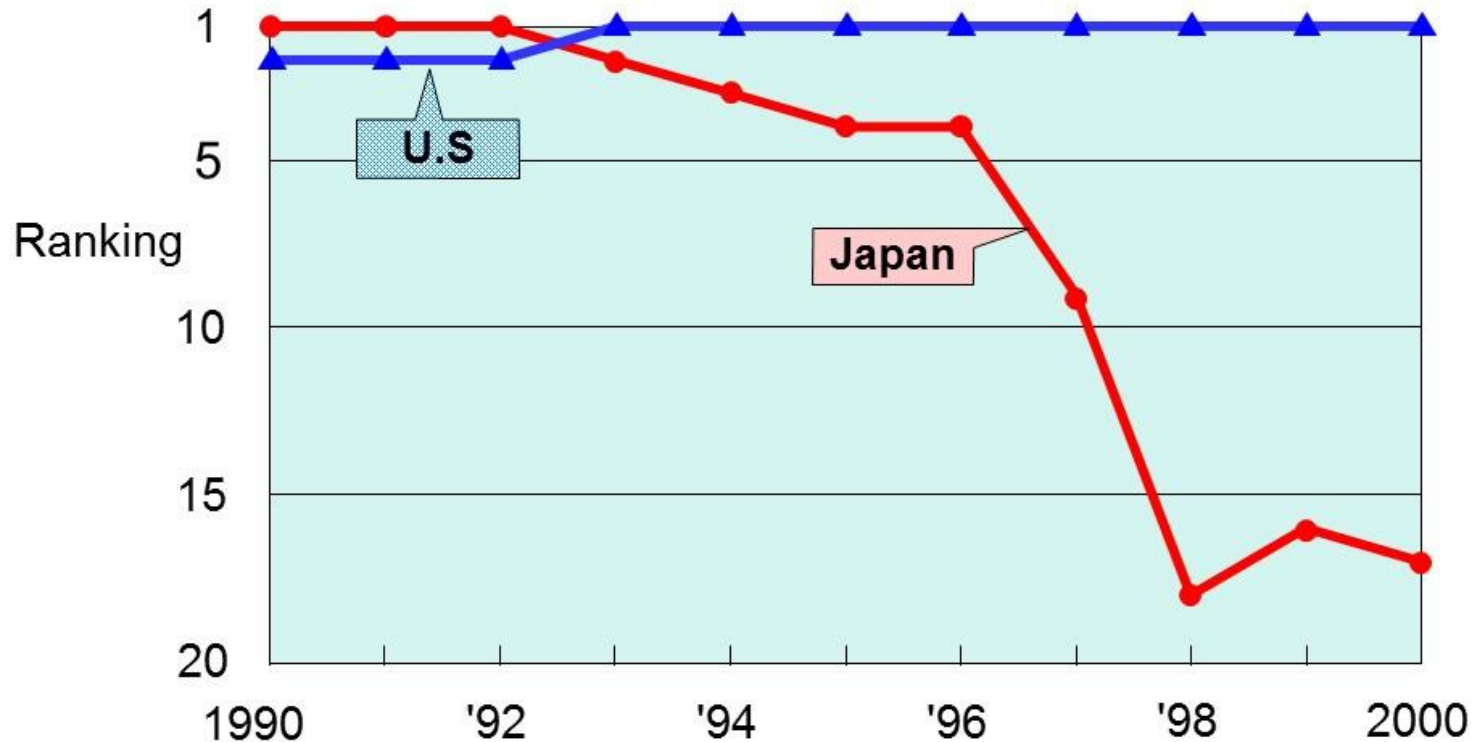
Semiconductor Shipment



Source: Dataquest, May 2000 (GG2000-HIT-006)

This figure shows the semiconductor shipment share by regions. The share of Japan and the US reversed in 1993, and the share of Japan thereafter has been consistently decreasing. Europe is flat and Asia shows a trend of gradual increase. The decline in Japan's share reflects the impact of the decline in consumption share shown in the previous page. With the spread of digitalization, it can be said that Japan has weakened both in electronic equipment and semiconductors in a linked manner.

IMD Scoreboard of Competitiveness

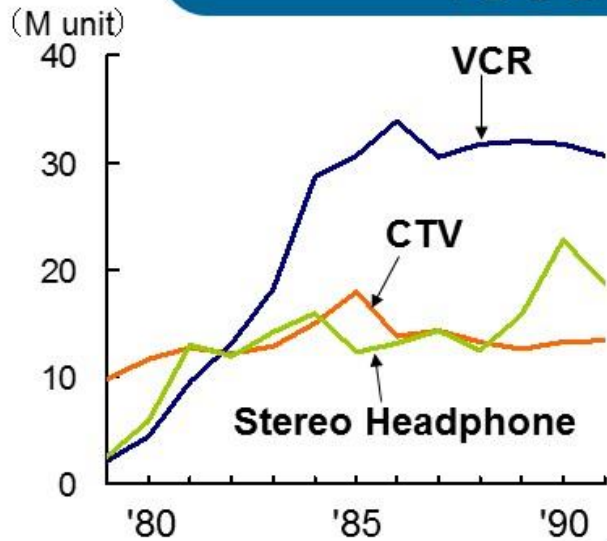


Source: The World Competitiveness Yearbook 1999 (IMD)

This figure shows the transition of world competitiveness ranking (IMD). Since 1990 when the survey began, Japan was in the top position for three consecutive years, but it fell to second place in 1993. After that it quickly dropped, and in 2000 it fell to 17th place.

The US kept its lead since 1993. The year of reversal in 1993 coincide with the year of semiconductor share reversal, suggesting that "the rise and fall of a nation depends on the semiconductor".

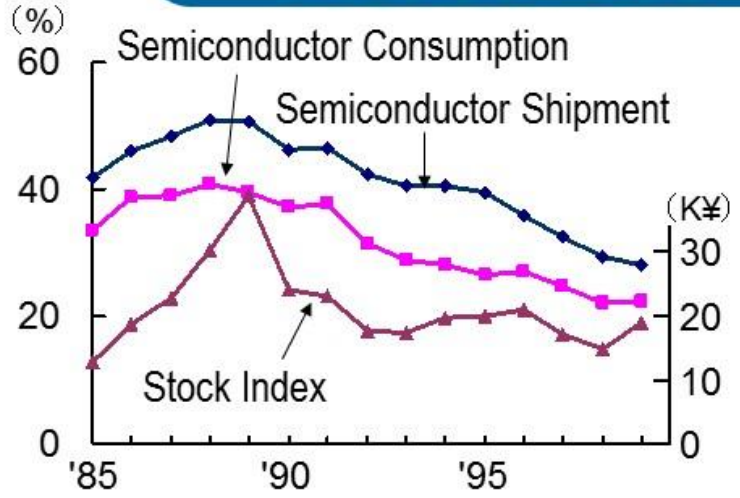
1980's: Japan as No.1



"Japan as No. 1"
Ezra Vogel (1979)

The 1980s was the era when it was said "Japan As No.1". As shown in the figure, analog equipment such as VCR, color TV, and Walkman etc. were in prime season, and Japan was in sweeping victory by its "winning run on analog street". The US, Europe and Asia were chasing from behind.

1990's: Lost Decade of Japan

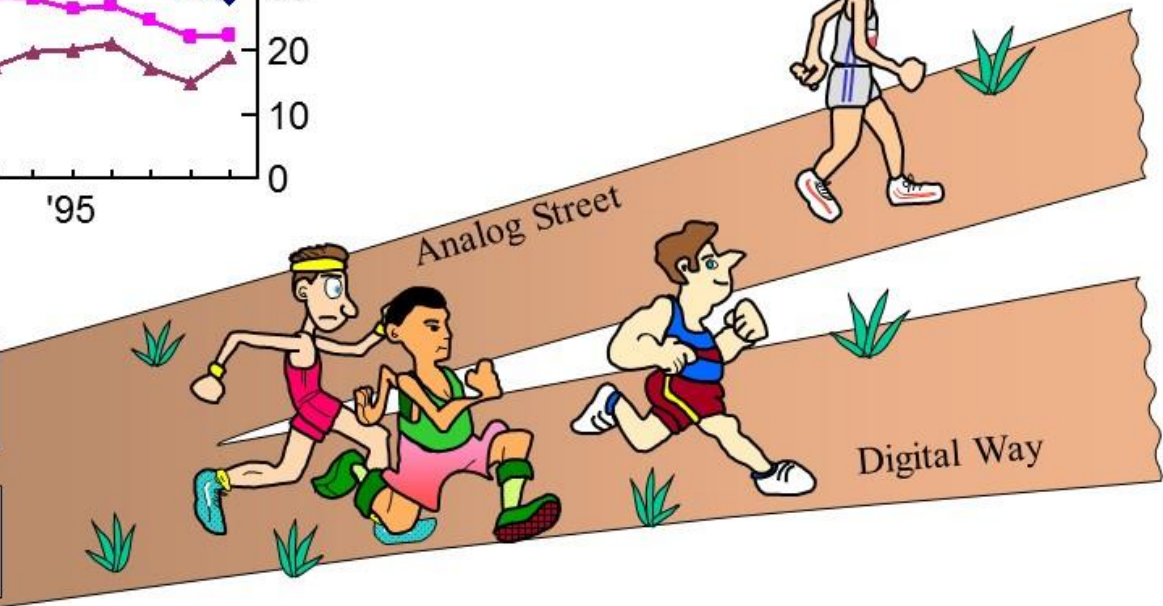


Wrong way?



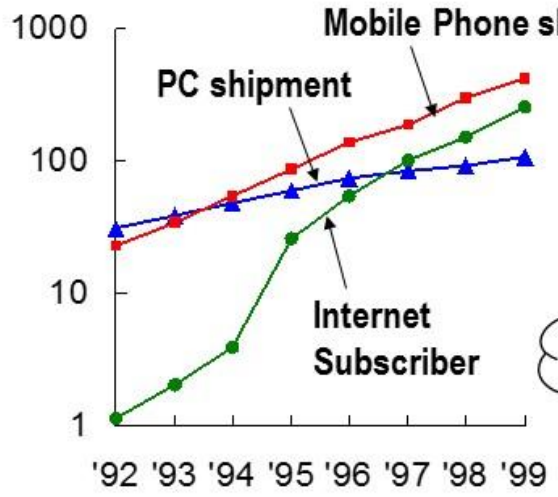
“The Sun also Sets”
Bill Emott (1989)

“Made in America”
M.L.Dertouzos (1989)



In the 1990s, both shipment share and consumption share of semiconductors of Japan sharply declined. Also, the stock market index that peaked in 1989 fell sharply in the following year, and continued to be sluggish after that. The center of electronics market shifted from analog equipment to PC, and Japan missed that wave. The US, Europe, and Asia have made revival and Japan has entered the "lost decade". "Did we take a wrong way?", and the stray began.

Who will Lead the Next Wave?



“The Long Boom”
P.Schwalz et al (1999)

In the latter half of the 1990s the "second digital wave" started to rise, and the situation is changing. The prime time of "digital consumer products" is approaching. Is the winner going to be US, Europe, or Asia with the strength in digital technology, or is there a chance again for Japan with its strength in consumer field? We must prepare for the new competitive environment. Form today's viewpoint, the US led the new way with Apple as the top runner.



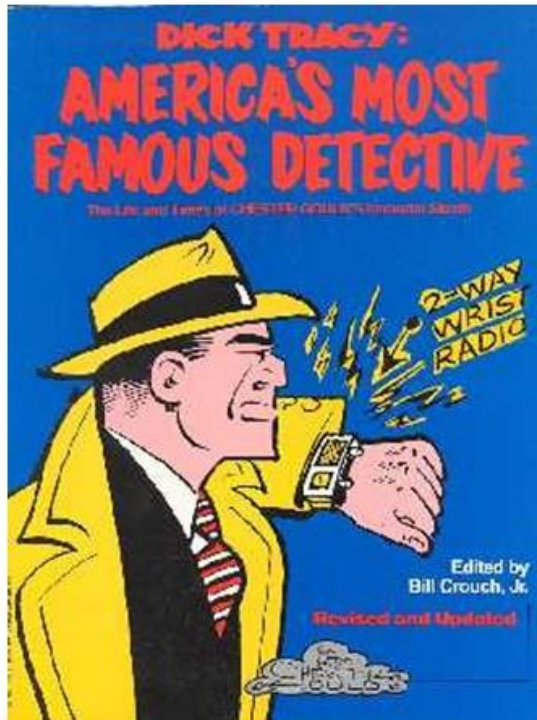
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Features of Three Waves

<i>Analog Wave</i>	<i>First Digital Wave</i>	<i>Second Digital Wave</i>
<ul style="list-style-type: none"> • Audio-Visual Equipment (TV, VCR) 	<ul style="list-style-type: none"> • PC 	<ul style="list-style-type: none"> • Digital Consumer & Network
<ul style="list-style-type: none"> • Microcontroller / Bipolar IC 	<ul style="list-style-type: none"> • Wintel (X86 & Windows) 	<ul style="list-style-type: none"> • New Generation MPU • System on Chip
<ul style="list-style-type: none"> • Simultaneous News Spread • Walkman Style 	<ul style="list-style-type: none"> • Down Sizing & Flat Organization 	<ul style="list-style-type: none"> • Nomadic Life Style & Clean Environment
<ul style="list-style-type: none"> • Japan Leads 	<ul style="list-style-type: none"> • US Leads 	<ul style="list-style-type: none"> • Who will Lead?

The table summarizes features of three waves. Comparisons are made for the core application, the semiconductor devices (including the OS), and the impact on society and lifestyle. The winner of each wave is indicated in the bottom line; Japan for analog wave and the US for first digital wave. In the case of second digital wave, the leader is not yet clear at the time of this speech.

When is Dick Tracy's Watch Available ?



MP3
player

Digital
camera



Dick Tracy is the most famous American detective. Wearing an excellent information device of the wristwatch type, any difficulty is solved by this. It is, so to speak, the ultimate nomadic tool. Currently, MP3 players and digital cameras of this style are out in the market, but they are still in an infant stage. In order to be a leader of the second digital wave, it is imperative to make a real Dick Tracy's watch.

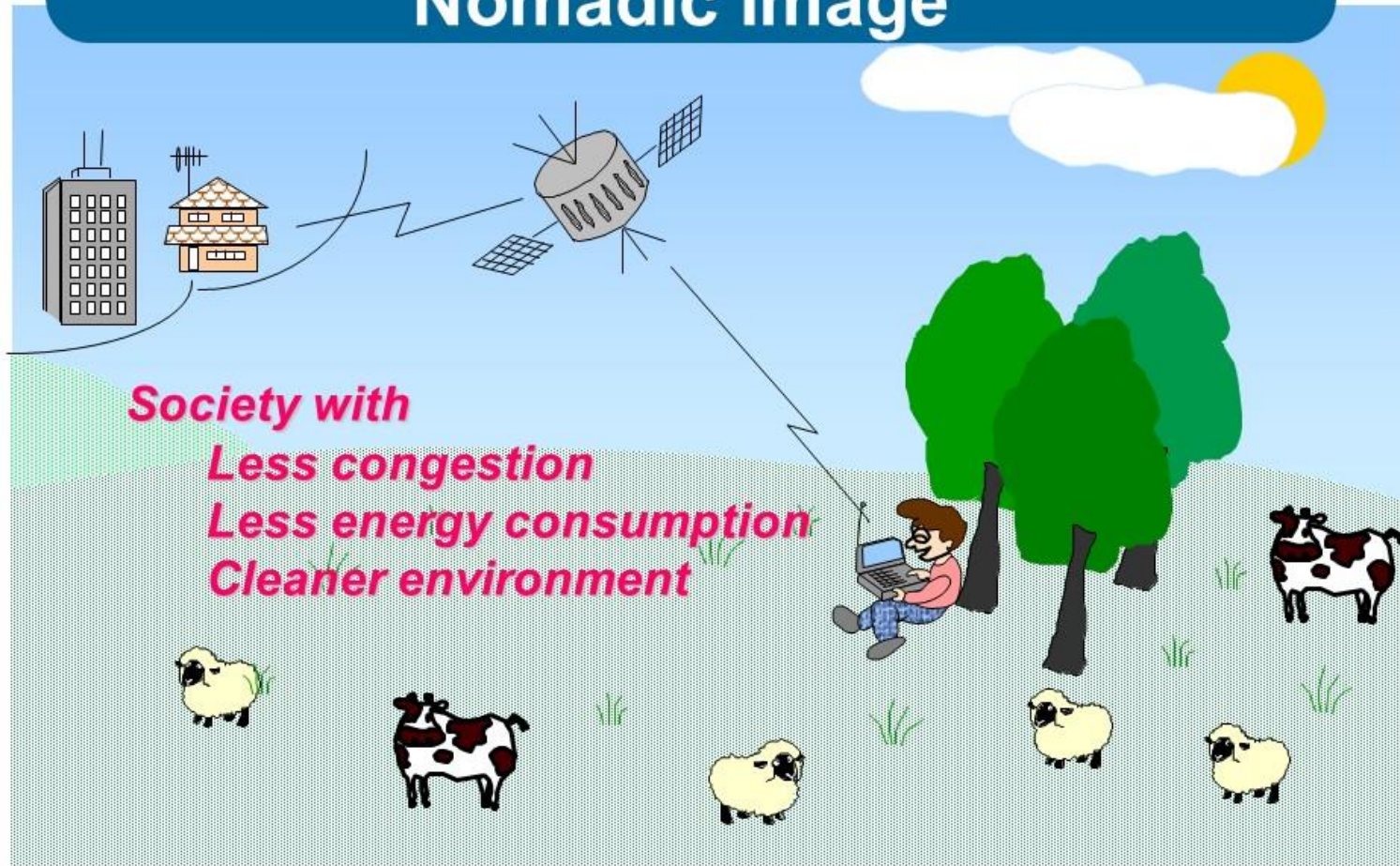
Looking Back from 2050



- **This picture was taken about 50 years ago in Tokyo.**
- **Passengers were pushed inside train by professional pushers.**
- **The second digital wave contributed for solving the problem through the nomadic tools.**

Looking back from 2050, you may not understand what people in this photo are doing. Passengers are being pushed into the car from the entrance by professional "pushers". It was awful, wasn't it? This problem was solved by nomadic tools which spread in the era of second digital wave.

Nomadic Image



How will the world change in the Nomadic era? There is no need to purposely commute and there will be no traffic congestion. Energy consumption will be reduced accordingly, and a cleaner environment will spread. Nomadic tools will be able to solve the problem of modern civilization and to regain the rich natural environment of the days before the industrial revolution.