Chip Innovations Opening
The Age of the Digital Nomad

Semico Research, March 2, 2010
Keynote Speech

Commentary

This keynote speech was an invitation from Semico Research, a semiconductor research company. It was like a follow-up version of my previous speech at Semico Summit sponsored by the company in 2004. In the previous speech, I predicted the end of PC era and the arrival of new mobile era, and it was to be verified this time. Various devices such as mobile PCs, smartphones, and tablets, etc. were released by 2010, and the “Age of Digital Nomad” was just emerging. The timing was just perfect for this speech.
Let me introduce some memories about this speech. Right after the speech, a young lady came up to me. She said she was from Vietnam and now working in Silicon Valley. "Today's speech was very impressive, especially the picture of mobile phones in the Vietnam War era (P. 11). Actually my father was fighting as a communication soldier, running around fields and mountains, carrying a heavy telephone machine with him. I saw the picture for the first time today and I remembered my deceased father."
An elderly gentleman also came to me and praised my “Little Bird” in the last slide (P.25). “Your Bird is extremely clever. With this Bird, there is nothing to worry about. I want to buy it at any price."
President Jim Feldhan was also in an expression of satisfaction. “Your Bird has a great memory, it remembered my last year's prediction and said that it was right. It is really a wise Bird!"

Semico Research
March 2, 2010

Chip Innovations Opening The Age of The Digital Nomad

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Chairman
Society of Semiconductor Industry Seniors

Dr. T. Makimoto(TechnoVision)

Semico Research used to hold conferences in Scottsdale, a suburb of Phoenix, but this time it was held in Silicon Valley. This is a keynote speech with the content that the time of digital nomad is finally opening thanks to the technical innovation of semiconductors.

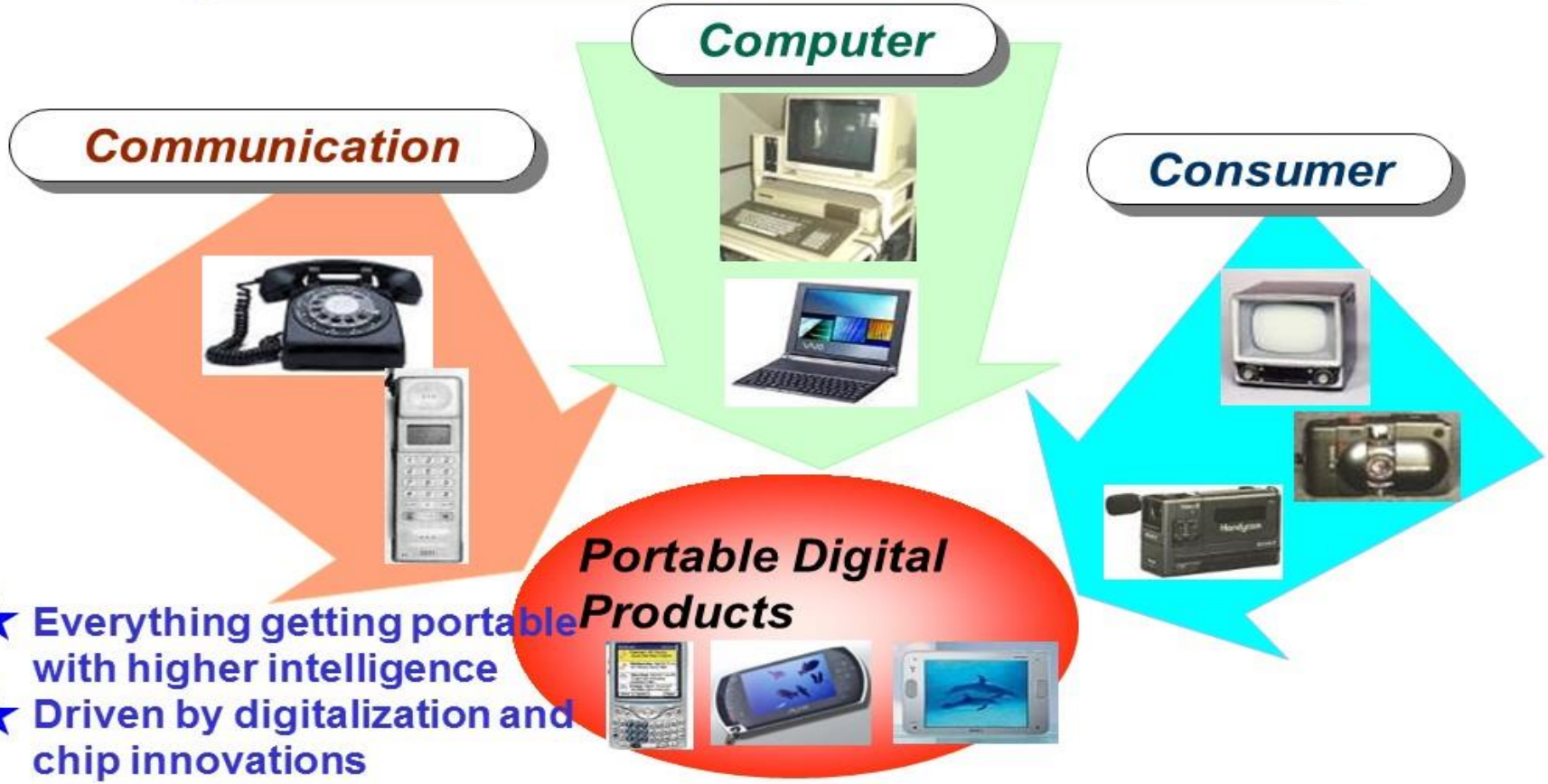
Outline

★ Paradigm Change in the Electronics

★ Impacts of Chip Innovations

★ The Age of "Digital Nomad"

Technology in the Palm



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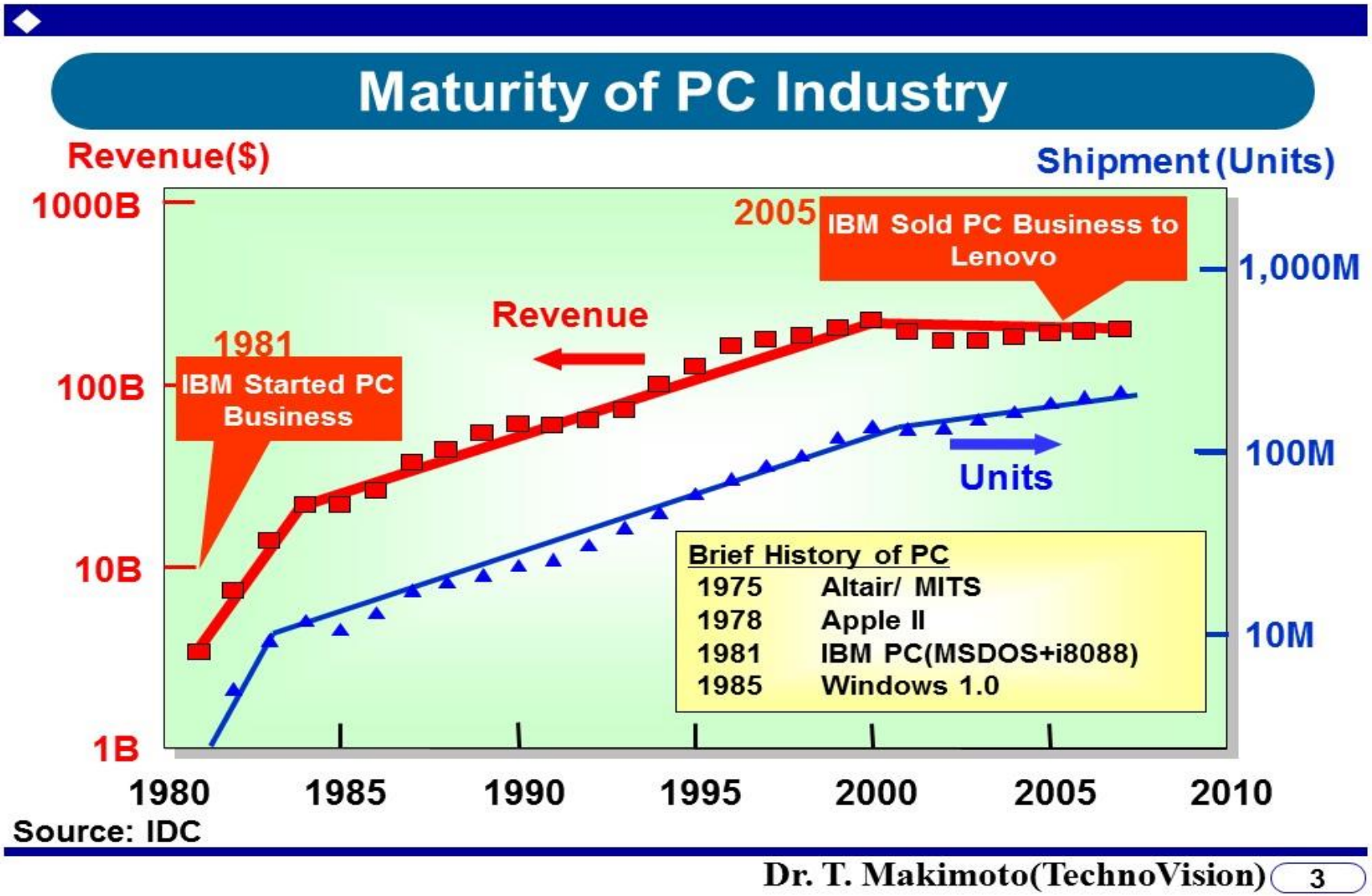
Technology development that puts everything on the palm is progressing. The boundaries of consumer, computer, and communication are gone, and they are being consolidated as "portable digital products".
Digitalization of information and semiconductor innovation are in the background of the movement of all products to higher performance and portable.



Since introduction of IBM PC in 1981, the PC industry got into full swing. Windows 1.0 was introduced in 1985, and PCs have been growing with high growth rate. However, after 2000, although they have been growing quantity wise, the sales amount has become almost flat. IBM sold the PC division to Lenovo in China. PC market has matured at the point of 2000.

Changing Aspects of PC Companies

- ★Apple introduced iPod in 2001 to enter the consumer business
- ★Microsoft introduced Xbox in 2001 to enter the consumer business
- ★Dell and HP started flat panel TV business
- ★IBM supplying game chips to three majors
- ★IBM sold PC business to Lenevo in 2005

(Source: Apple's web site)

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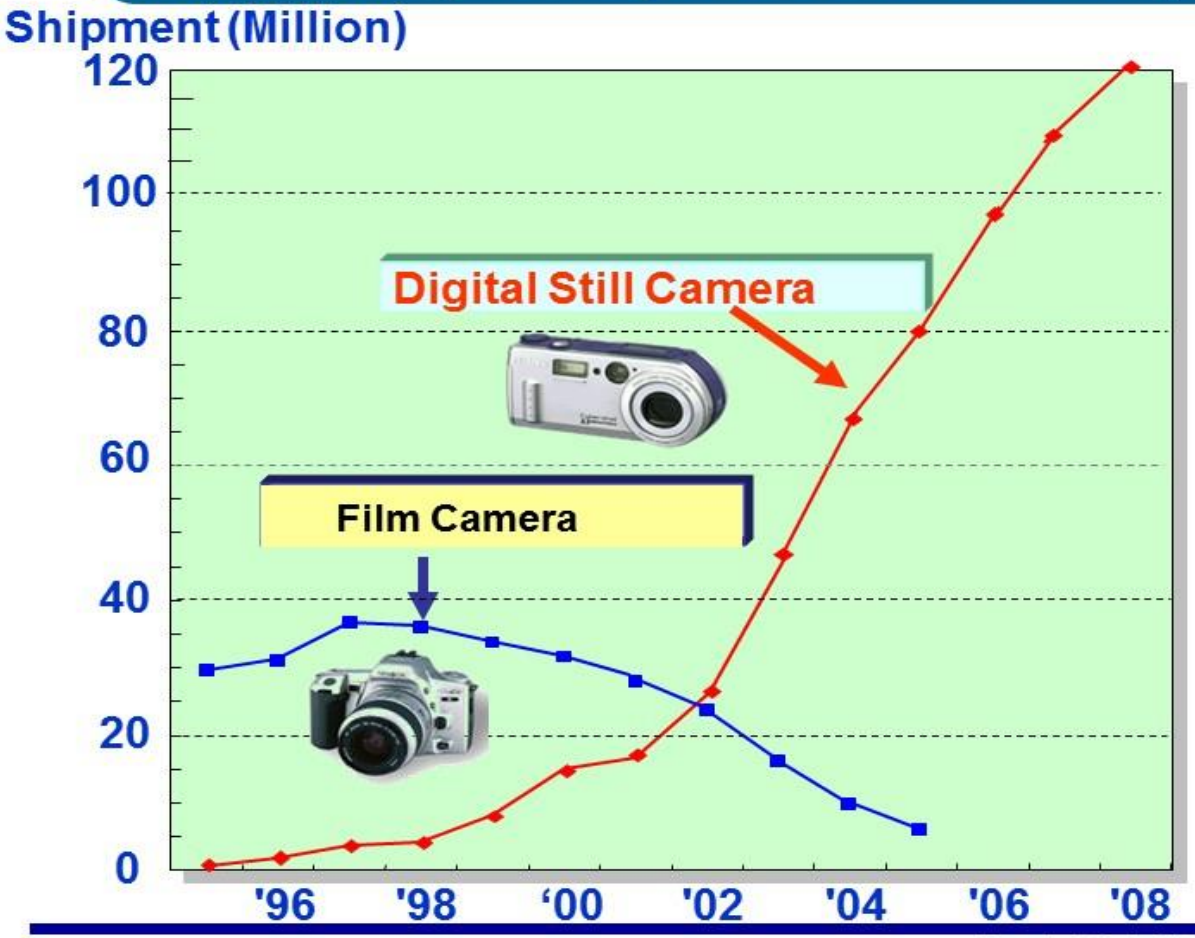
Relevant to the maturation of PC industry, computer companies started to depart from PC dependence.
Here are some concrete examples regarding how computer companies are responding to maturing of PC industry after 2000.

Analog to Digital Conversion (Camera)



QV-10 from Casio introduced in 1995

(250K pixel CCD)

Semiconductor Content	
Film	Digital
$4	$50

Source: Nikkei Market Access

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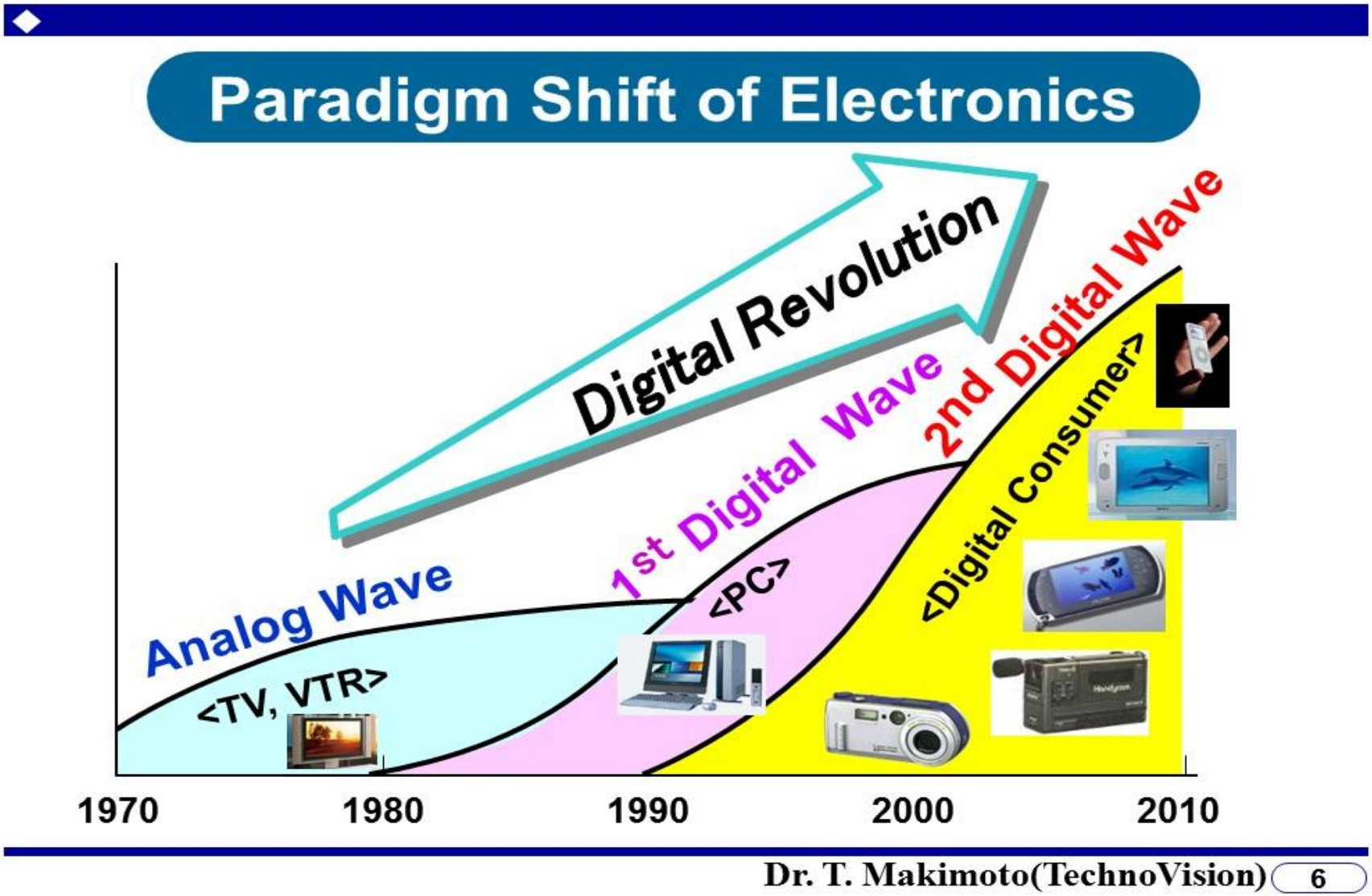
Analog to digital conversion has been proceeding in various kinds of equipment. Digitalization of cameras began after Casio introduced digital camera QV - 10 in 1995. Many manufacturers subsequently entered the market, and it grew rapidly. Film cameras peaked out in 1997 and were surpassed by digital in 2002. Good news for chip manufacturers is that semiconductor content increases from $ 4 to $ 50.



The figure shows a representation of paradigm shift in electronics in the form of waves. The wave from 1970s was analog wave; mainly TV and VTR. The first digital wave was driven by PCs from 1980s, and the second digital wave was driven by digital consumer products, which began in the 1990s. Many mobile products were launched, leading to today's smartphone.

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Basic Mechanisms of Chip Innovations

1) Discontinuous Innovation

- Transistor (Bell Lab./1947)
- IC (Kilby/1958, Noyce/ 1959)
- Microprocessor (Intel/1971)

2) Exponential Innovation

- Moore's Law (1965)

3) Cyclical Innovation

- Makimoto's Wave(1991)

Shockley, Bardeen and Brattain

Typical types of semiconductor innovation are shown. The first type is discontinuous innovation which includes invention of the transistors in Bell Labs (1947), invention of IC by Kilby and Noyce (1958/1959), and development of MPU by Intel (1971). The second type is exponential innovation, and Moore's Law (1965) corresponds to this type. The third type is innovation with periodical cycles as explained by Makimoto's Wave.

Mobile Phone in 1970's

A remarkable example realized by semiconductor innovation is miniaturization of mobile phones. This picture was taken when I visited Vietnam. Three set of mobile phones are shown that soldiers used in the battle fields during the Vietnam War. Each set weighs about 10 kilograms, 100 times heavier than the current mobile phone (about 100 grams). This kind of miniaturization was made possible by semiconductor innovations.

Supercomputer vs iPod

★ Cray-1A Introduced in 1976

- Speed: 160MFLOPS
- Weight: 5.5tons
- Price: $6M
- 5u Bipolar Technology

"Cray-1A specs are comparable to those of 2006 iPod shuffle" (Wikipedia)

- 90nm CMOS Technology

Courtesy of Computer History Museum

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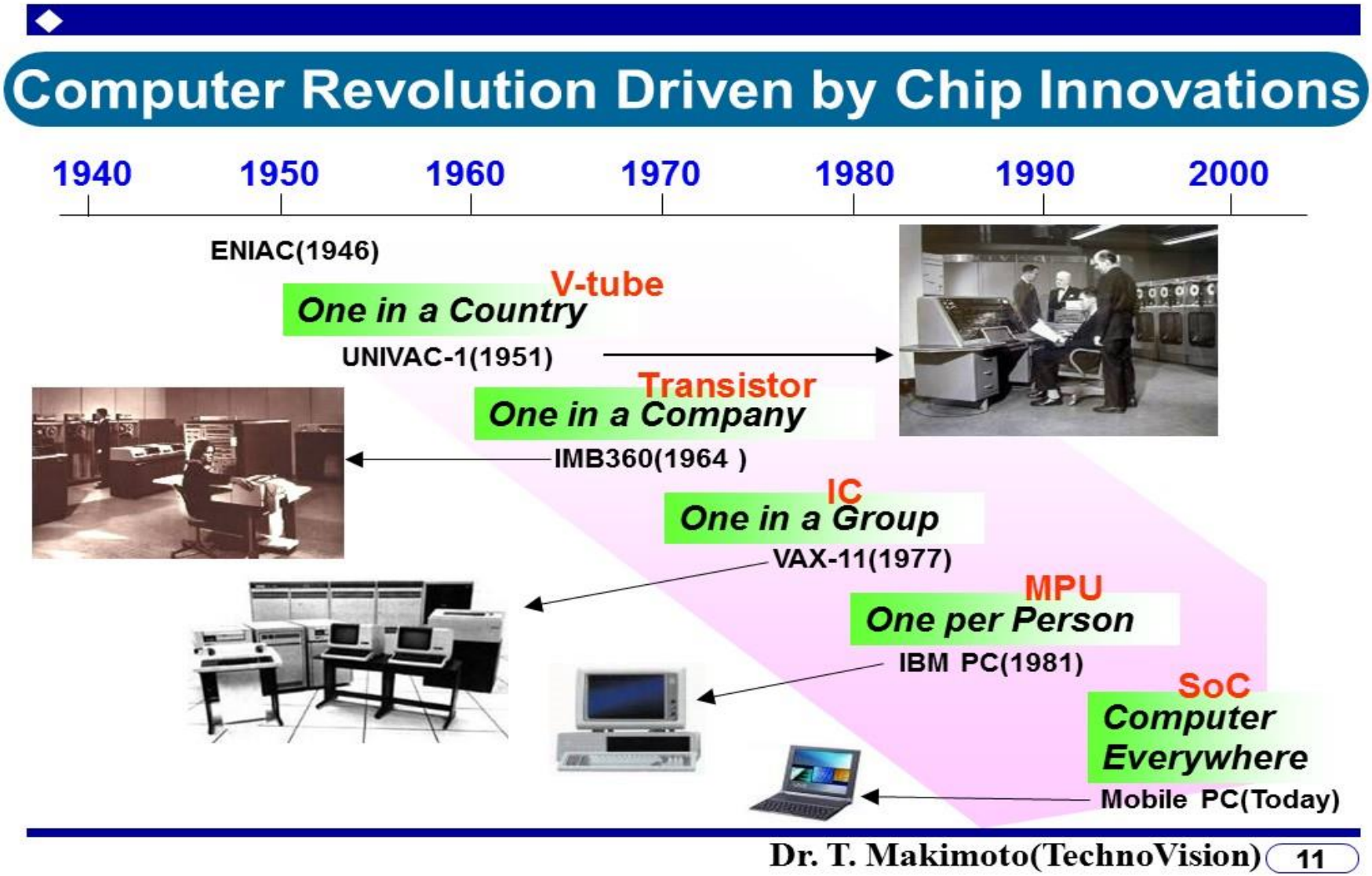
The above is a comparison of supercomputer and iPod. This picture was taken when I visited the Computer History Museum (US). The performance of Cray 's supercomputer released in 1976 was 160 MFLOPS which is comparable to the performance of today's iPod. The change in the chip technology from "5 μm bipolar" to "90 nm CMOS" enabled such a magical change.



The progress of computers and semiconductors has been made in a one-to-one relationship. Computers in the age of vacuum tubes were as precious as "one in a country". As the semiconductor innovation proceeded the computer became more readily available At the present time of SoC, computers are everywhere. Computers and semiconductors have evolved in inseparable relationship with each other.

Figure of Merit of Electronic Equipment

MIPS or FLOPS

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

Smaller the better within the limit of human interface

Lower the better

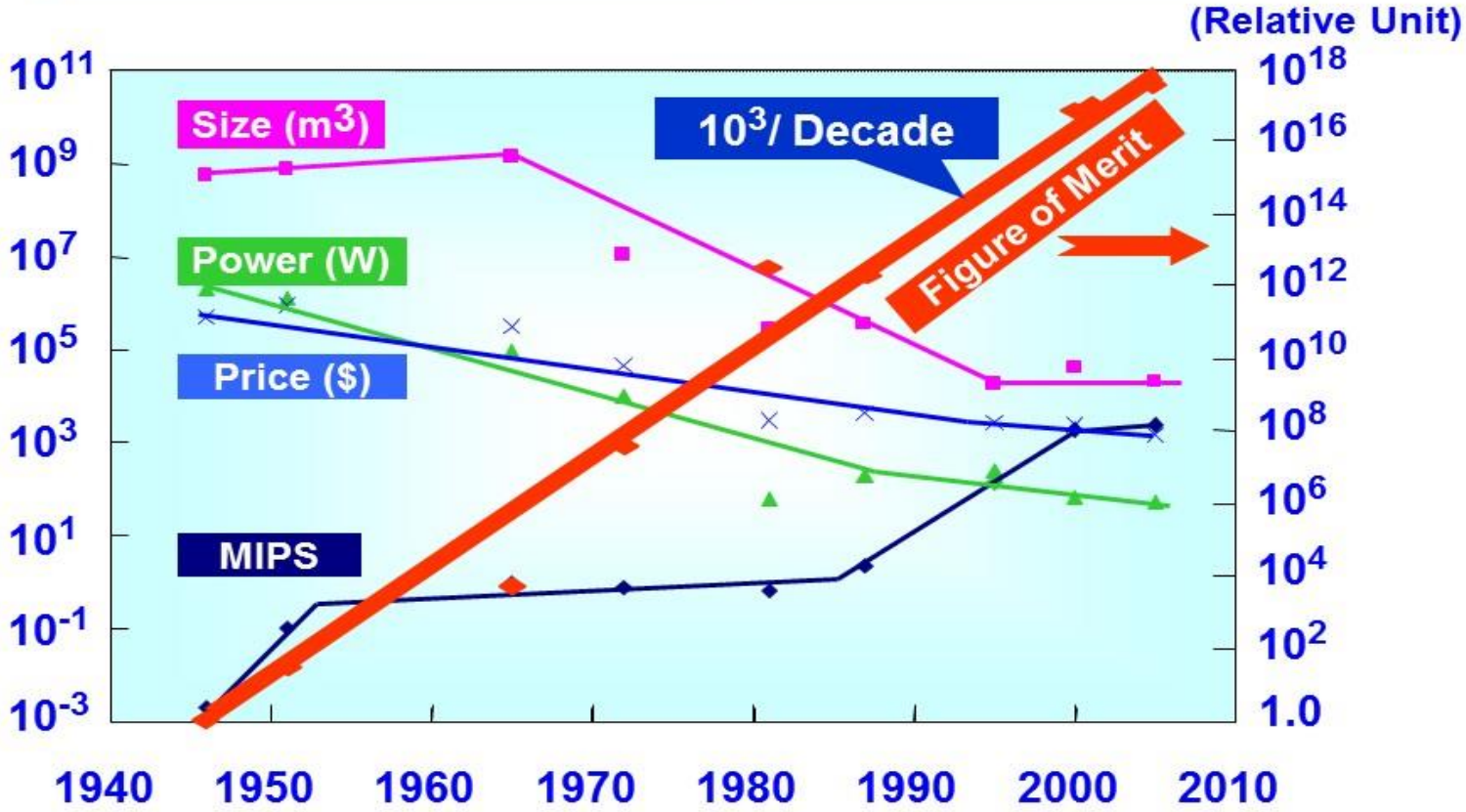
Cooler the better

★ Maximize the Figure of Merit value within the limit of human interface

★ Guiding principle for the future direction of development

As an attempt to quantify the evolution of electronic equipment, I proposed "Figure of Merit (FoM)". FoM is the intelligence (for ex., MIPS value) divided by size, cost and power consumption of the equipment. The larger the numerator, or the smaller the denominator, the higher is the FoM. This formula is a guideline indicating the future direction of development. We should aim to maximize FoM within the limit of human interface.

Evolutions of Figure of Merit



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This figure shows the trend of FoM over a long period of time for computers. Although the plot of each term in the numerator and denominator in FoM equation is somewhat varied, the resulting FoM is lined up on roughly one straight line. The gradient of this straight line tells that the speed of computer progress has been "1000 times in 10 years". This value is the measure in setting the future target.

Major Factors Affecting the FM Value

$$FM = \frac{(\text{Intelligence})}{(\text{Size}) \times (\text{Cost}) \times (\text{Power})}$$

- Operating Frequency
- Architecture
- Software

- Chip Counts
- Package Size

- Chip Size
- Process Complexity
- Assembly & Test
- Production Quality

- Supply Voltage
- Parasitic Capacitance
- Operating Frequency
- Architecture & Algorithm

: Influenced by Finer Geometry

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Major factors are shown that affect each term constituting FoM equation. Some terms, shadowed in pink , are influenced by finer geometry of the chip. It shows how big the impact of semiconductor is for improving “Figure of Merit” of electronic equipment.

Outline

★ Paradigm Change in the Electronics

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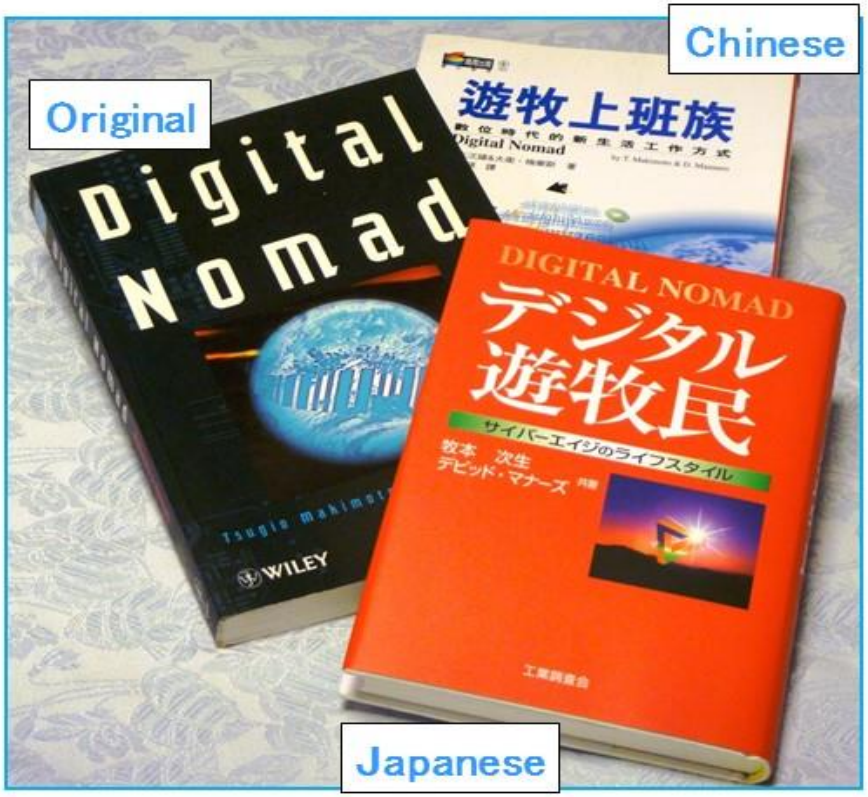
"Digital Nomad" Published in 1997



David Manners (left)
Tsugio Makimoto (right)

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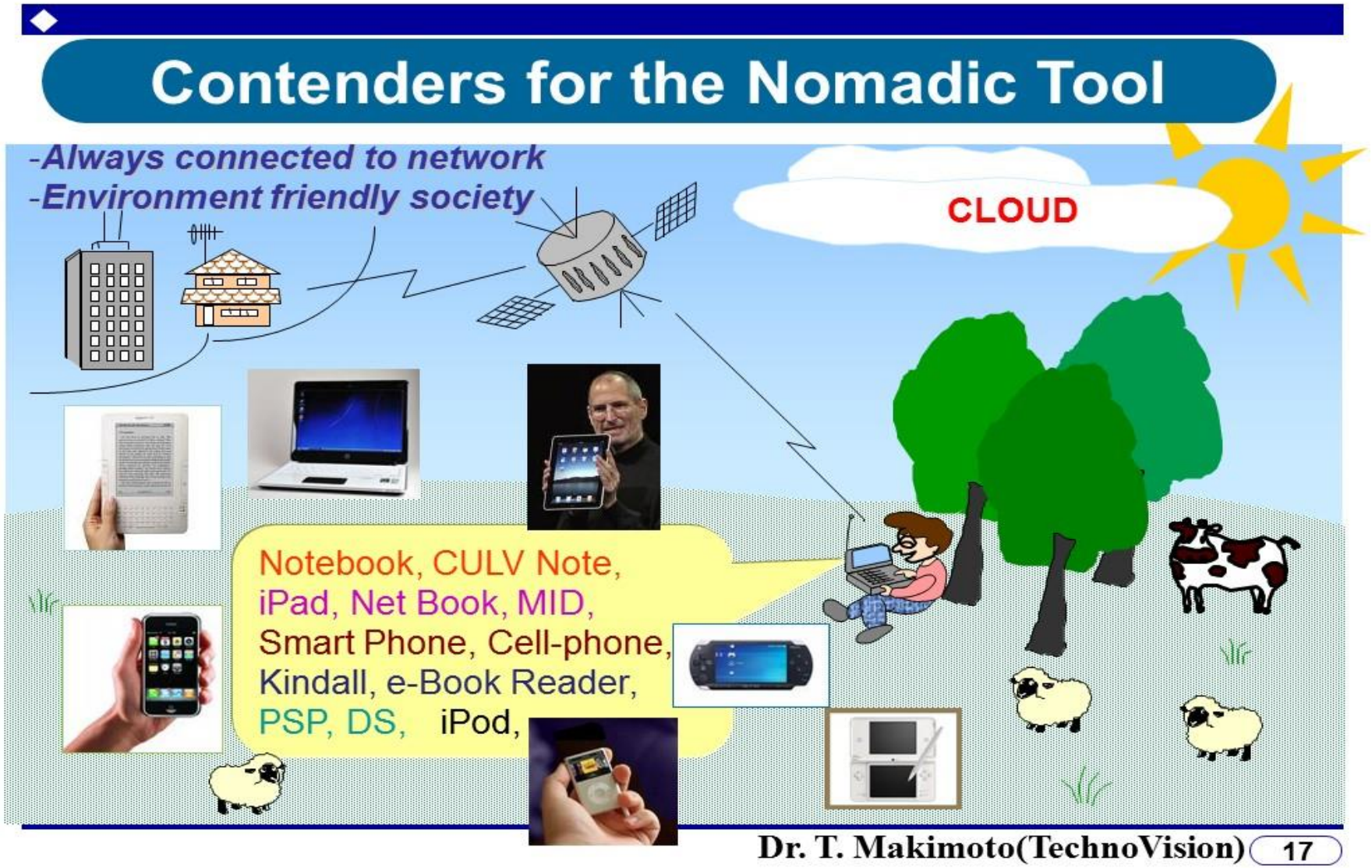
"Digital Nomad" (English version) was published in1997, followed by Chinese and Japanese versions in the following year. It is a prediction about the future lifestyle, which will be brought about by the progress of semiconductor technology. This is one of the examples that "the future can be seen well from the semiconductor window".



Sown above are numerous information terminals that have appeared in the Nomadic age. Included are notebook PCs, tablets, smartphones, game machines, and music players, etc. These terminals are connected to the world through the network, and to the cloud.

Pushers in the Pre-Nomadic Age

★Pusher's job is to push passengers inside a train during rush hour.
The job started in 1955.
The picture was taken in the winter of 2000.

★A social phenomenon created by people going to same location at a same time.

★ The pusher will lose the job in the age of "Digital Nomad"

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The picture above shows a scene in a train station in Tokyo before the nomadic age. "Pushers" are pushing passengers into the car. Such a scene started around 1995. In this era, people would commute to the city central part at the same time, and it caused this kind of extreme congestion. In the era of digital nomads the "pushers" may lose job.

Some Aspects of Nomadic Society

★"Information" moves to people, rather than people move to "information"
Examples: TV conference, home office, moving professional, etc.

★From pyramid organization to flat and networked organization
As the result, "Fast eats Slow", rather than "Big eats Small"

★Globalization of business expanding, but localization cannot be ignored. Hence, "GLOCALIZATION"

★Rush hour in city area will disappear.
Rural life more convenient and enjoyable.
Example: Remote health care, remote education, etc.

★Beginning of "Low Carbon, Silicon Rich society"
Example: Solar energy, Electric car, LED etc.

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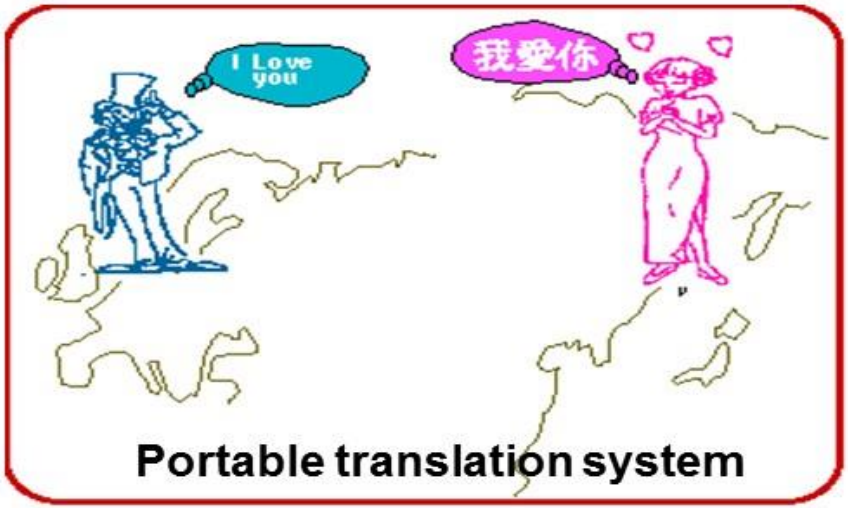
This is to summarize the characteristic features of Nomadic society. An underling mechanism of the Nomadic society is that "information gathers to people, rather than people move to information".

Next Big Thing

- Language understanding is the next big challenge of the chip technology
- Why so difficult?
  - Many languages in the world
  - One language, many dialects
  - One word, different meanings
  - Everyone talks differently
  - Noise in the real environment
- But, it is coming gradually
  - Car navigation system
  - PC input
  - Robots
  - Travel Guidance
  - Weather forecast, etc.

- Toshiba's translation system based on smart phone
  - Japanese-English, Japanese-Chinese
  - 30K words for each language
  - First version Intended for travelers



Language understanding is the next big challenge. I had touched on this subject as early as 1999 under the title of "New Scenery after the Storm" (Exhibit VI, No.7). However, even after the timespan of more than ten years, the challenge has not yet been achieved. There are many reasons why it is so difficult, but now it is finally coming true although gradually.

Introducing My Little Bird

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Finally, my cute Little Bird under development was introduced. It is very clever and has a great memory. Our conversation is about a person whom I met last year in Scottsdale. His name is Jim Feldhan, the President and CEO of Semico Research who organized the conference this time.

Good Memory and Intelligence

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We discussed the market situation of 2010. Jim was bullish about it and I was less optimistic. The result was that the chip industry grew nicely this year. This conversation was an indirect praise to Jim Feldhan through the mouth of a little bird.

Too Early for the Debut

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"Everyone, My Little Bird talks too much, and seems to be a bit too early for the sale. I will let you know when it is trained well and ready for the sale. Thank you for your attention".
A lot of laughter and applause spread in the venue.
A gentleman came to me after the speech, and said "I will buy your Little Bird at any price".