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**GSA / SEMATECH
Memory+ Conference
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Nothing on the Extrapolation In the Chip Industry

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Dr. T. Makimoto (TechnoVision)

Outline

★ **Impact of Chip Innovation**

★ **Nothing is on the Extrapolation**

★ **Longtime Dreams Coming True**

Mobile Phone in 1970's

* 3 sets of mobile phones during Vietnamese War

* Picture in Ho Chi Minh City (2006)

Current Model



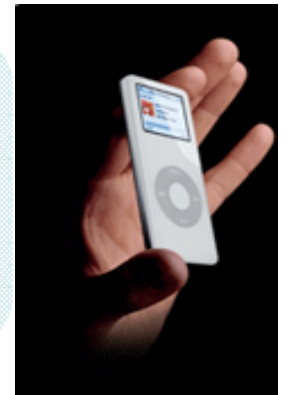
Supercomputer vs iPod

★ Cray-1A Introduced in 1976

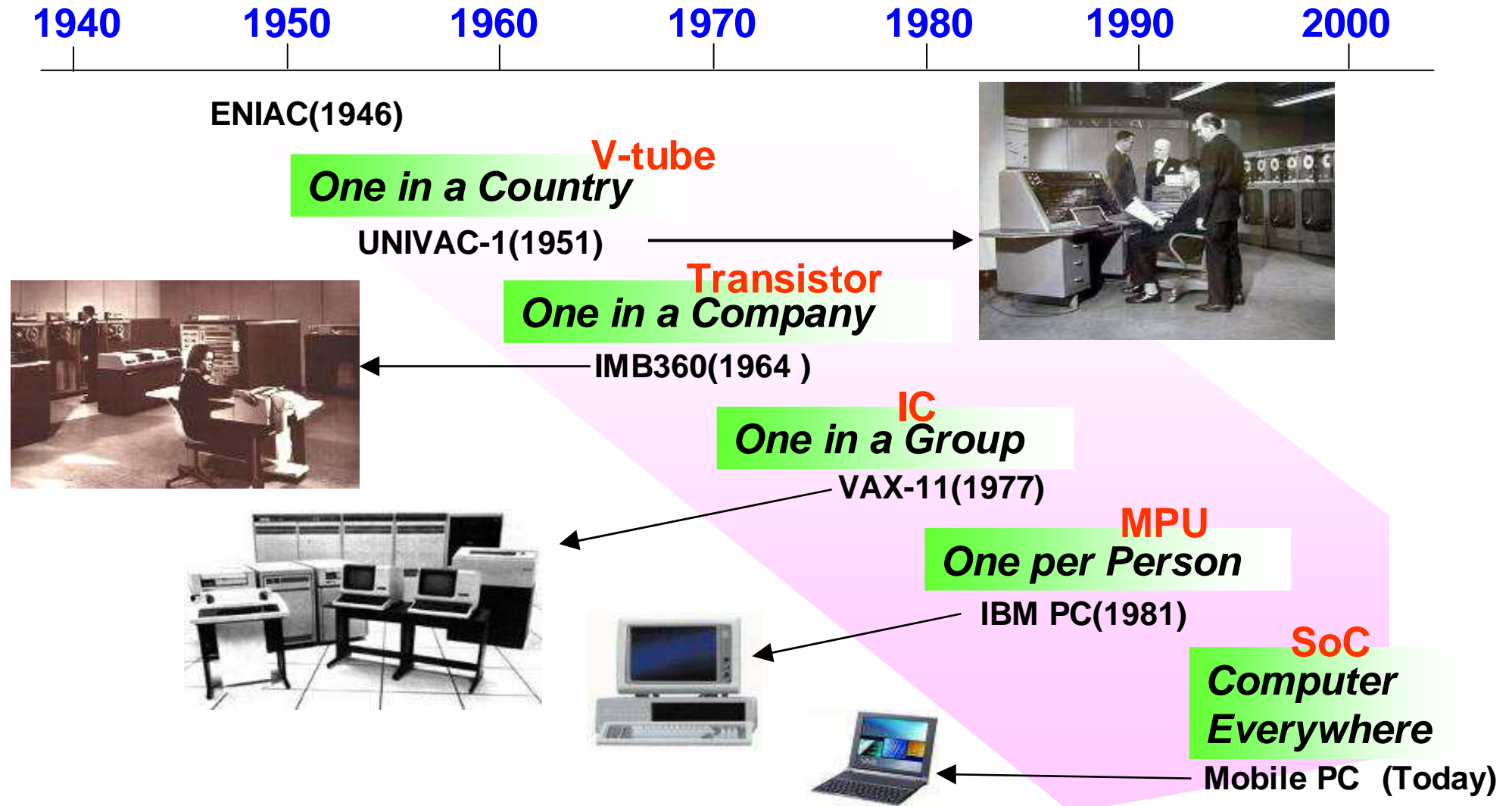
- Speed: 160MFLOPS
- Weight: 5.5tons
- Price: \$6M
- 5u Bipolar Technology

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

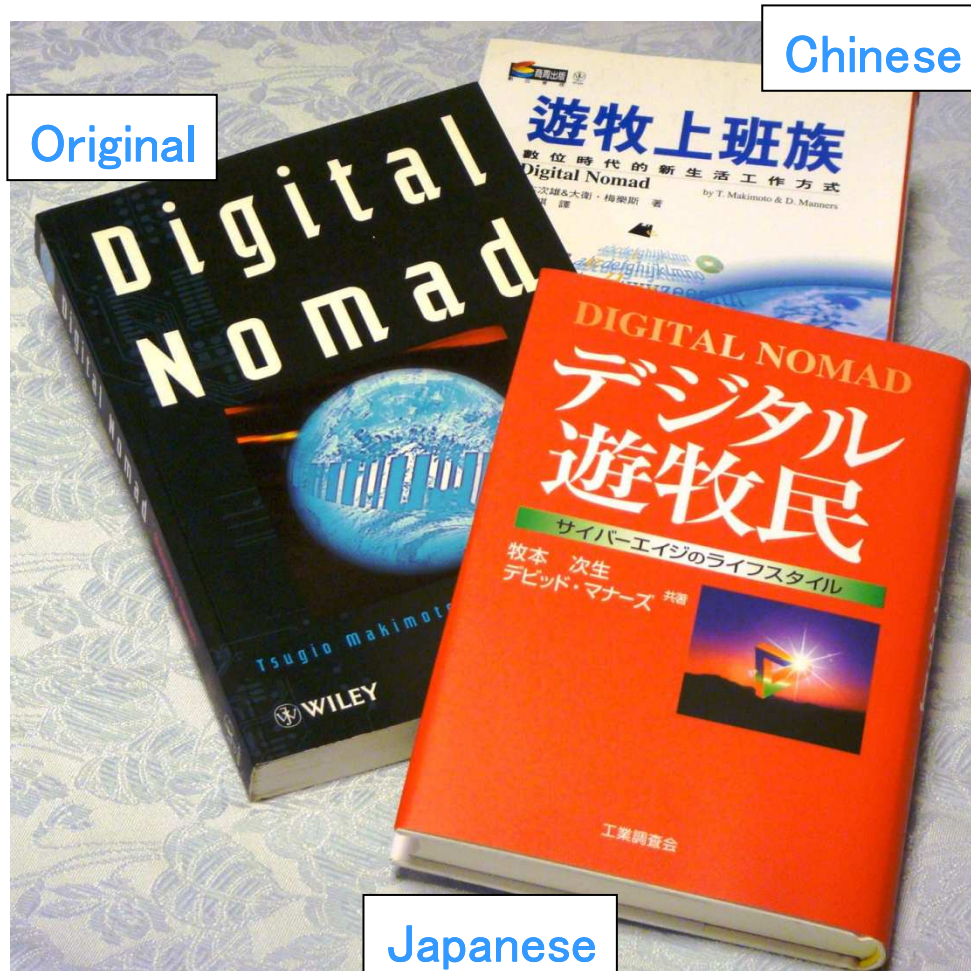
- 90nm CMOS Technology



Computer Revolution Driven by Chip Innovation



“Digital Nomad” Published in 1997

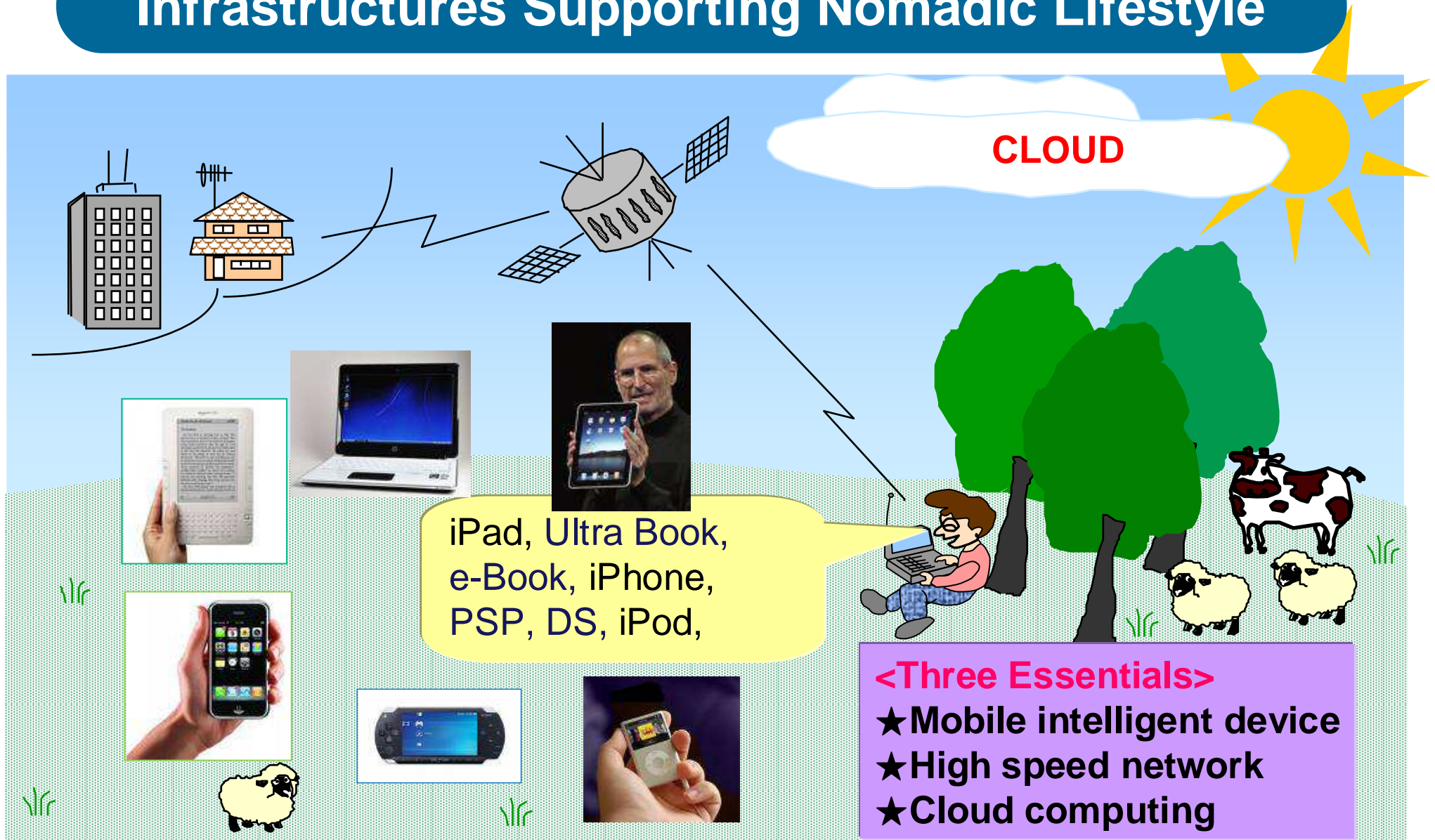


Co-authors

David Manners (left)

Tsugio Makimoto (right)

Infrastructures Supporting Nomadic Lifestyle



Outline

★ Impact of Chip Innovation

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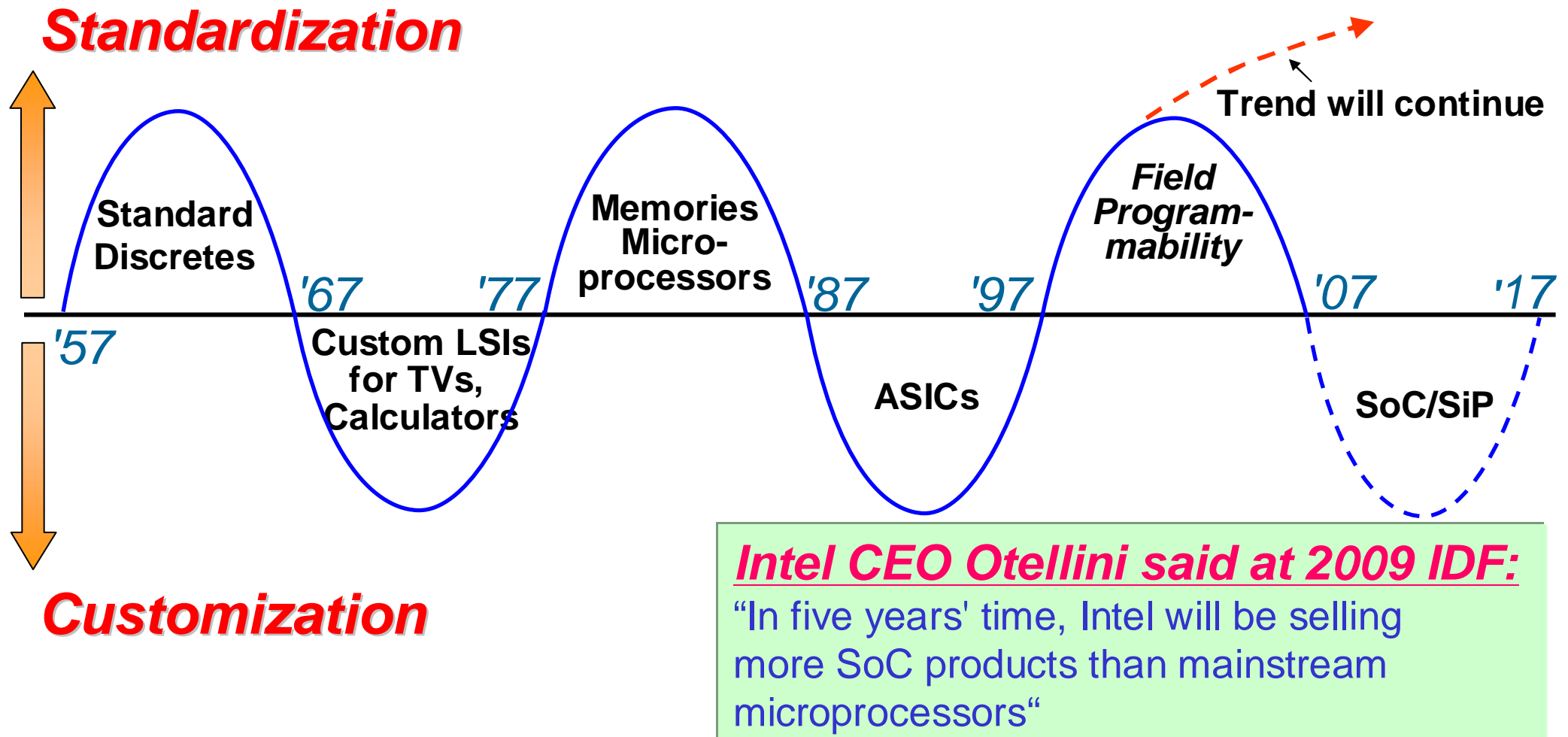
Customer is the King

The King Wants	Choice
Differentiation	Custom
Flexibility	Standard
Hi Performance/Lo Power	Custom
Time to Market	Standard
Low Initial Cost	Standard
Low Unit Cost	Custom

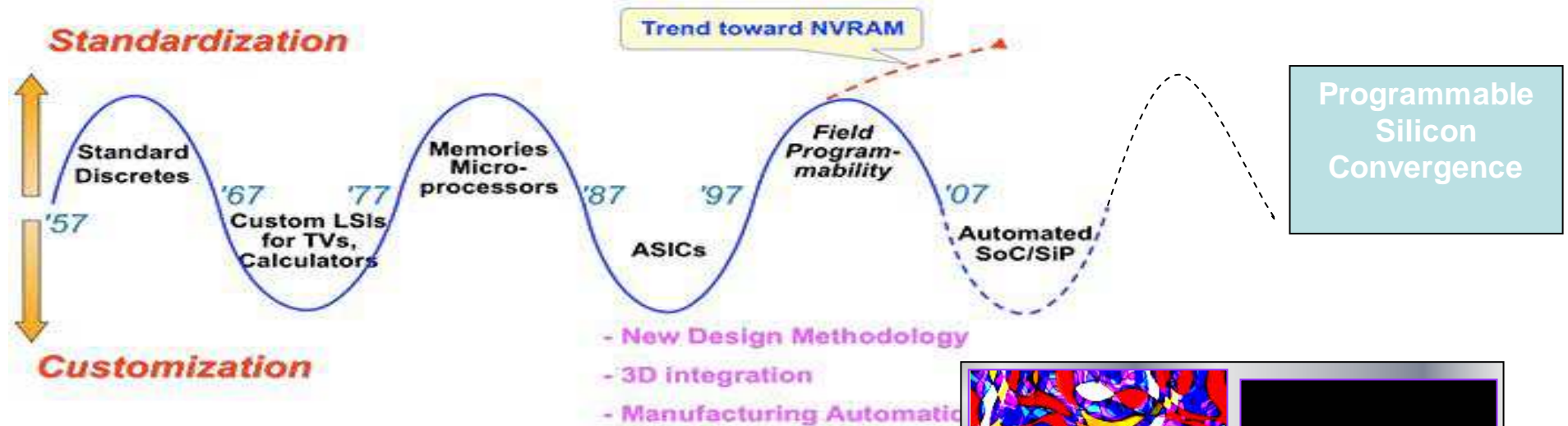
Standard	Discrete, MCU, MPU, DSP, Memory, FPGA, etc.
Custom	Pure Custom, ASIC(ASCP & ASSP), SoC & SiP, etc.

Makimoto's Wave

(Named by David Manners in 1991)



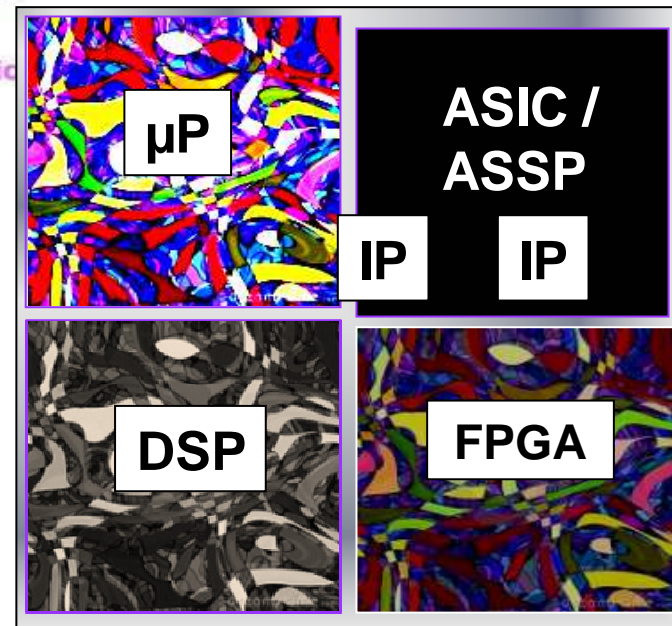
Extension of the Wave Beyond 2017 (Altera's Vision)



Source: Electronics Weekly, Jan. 1991/Dr. T. Makimoto TechnoVision

Programmable Silicon Convergence

Microprocessor and DSP: Standard
Application specific IP: Custom
FPGA fabric: Programmable
contains every component for flexibility and differentiation



Evolution of Application Market



Tesla born in Si valley

Bio/Medical

Auto/Robot

Digital Consumer
(Soc/Sip)

PC
(MPU/Memory)

Calculator
(MOSLSI)

Consumer AV
(Bipolar/MCU)

Computer
(Transistor/IC)

Military
(Transistor/IC)

1960

1970

1980

1990

2000

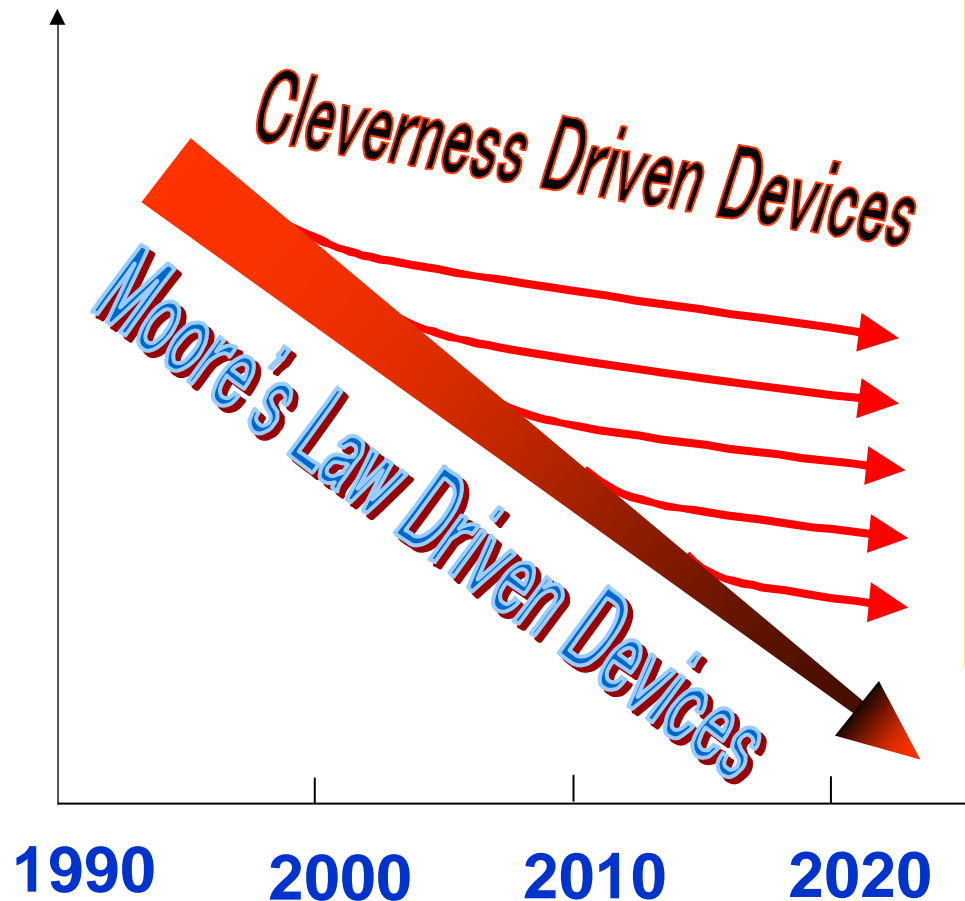
2010

2020

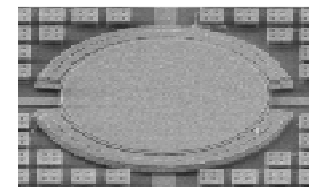
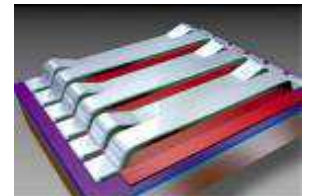
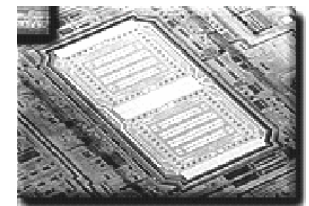
Diversifying Directions of Chip Technologies

Presented at 2002 IEDM

Geometry of Devices



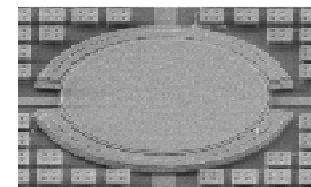
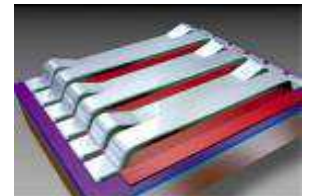
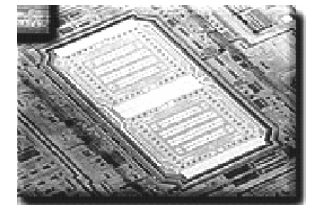
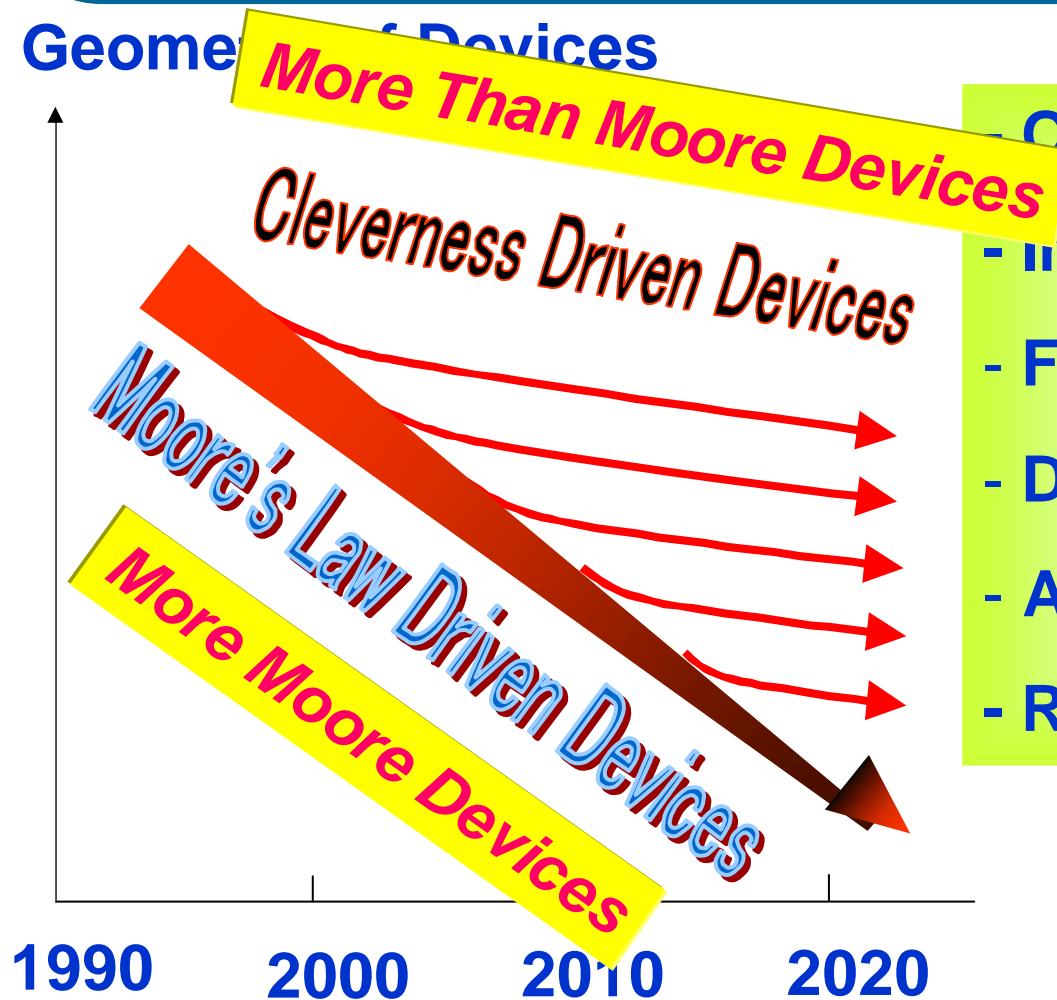
- Optical Sensors
- Inertial Sensors
- Force Sensors
- Display Devices
- Actuators
- RF Devices etc.



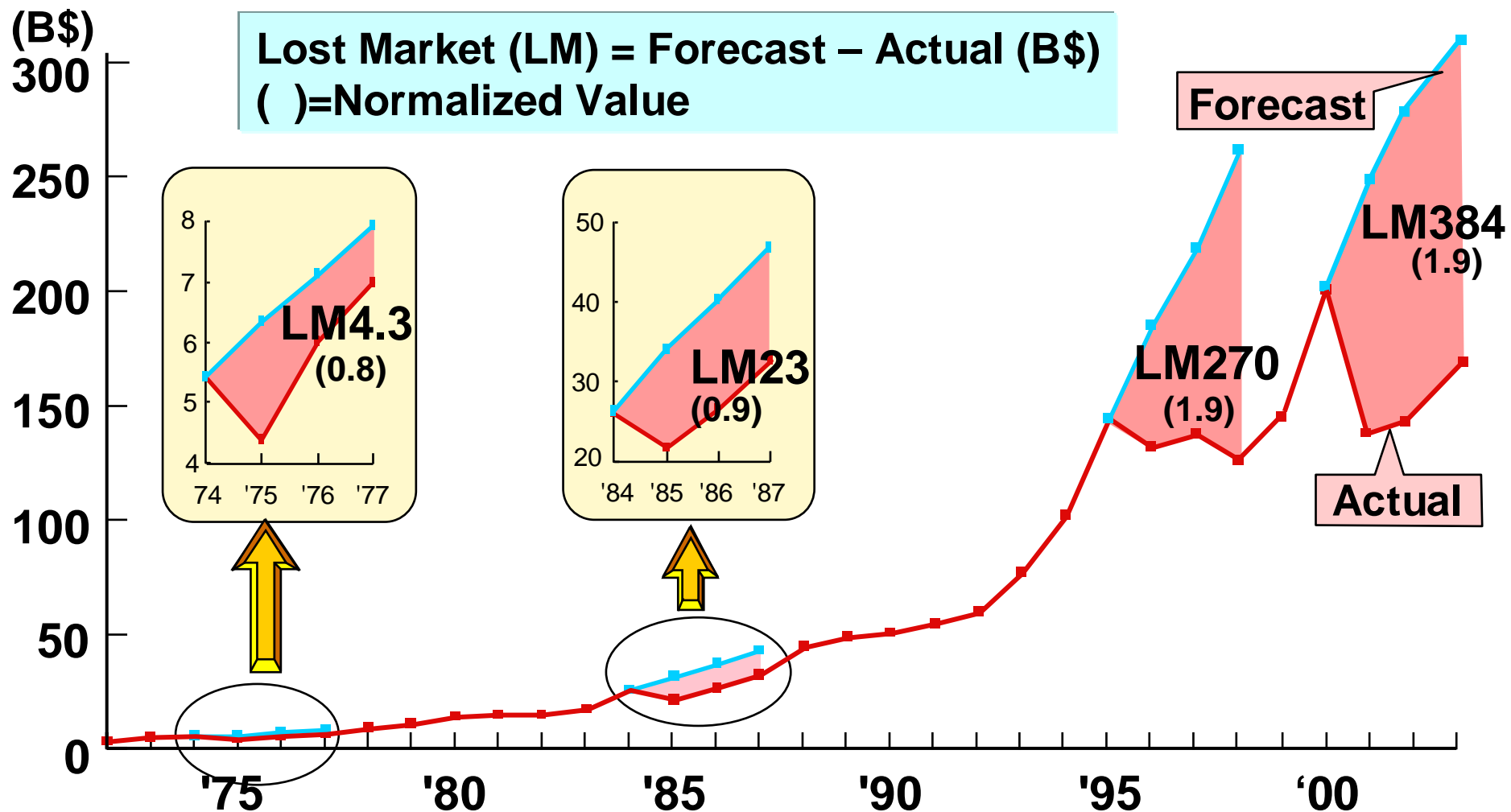
Diversifying Directions of Chip Technologies

Presented at 2002 IEDM

Geometric Devices

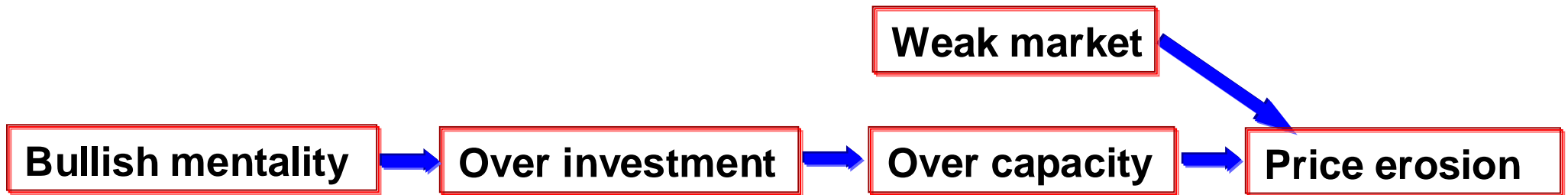


Semiconductor Market is Unpredictable



Remember the '95 Mentality

- Market will reach **200B\$** in '97, exceeding **300B\$** by the year **2000**
- **No more Silicon Cycle** because of solid state pervasiveness
- **400 new fabs** required by 2000
- Severe shortage of resources



Outline

★ **Impact of Chip Innovation**

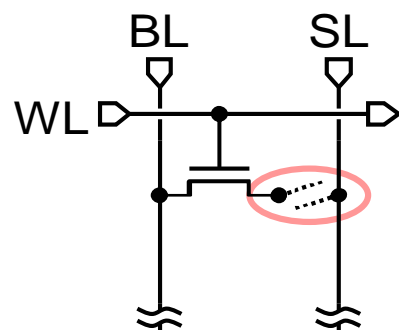
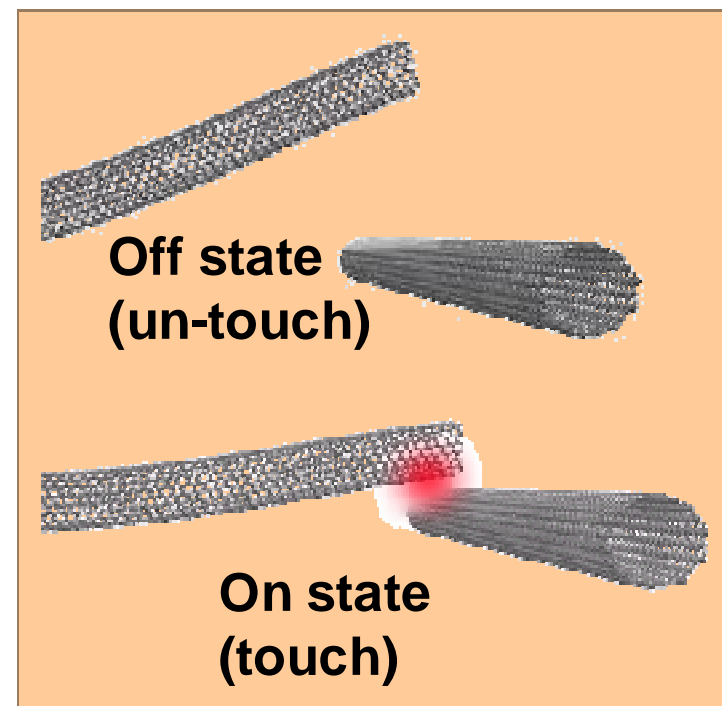
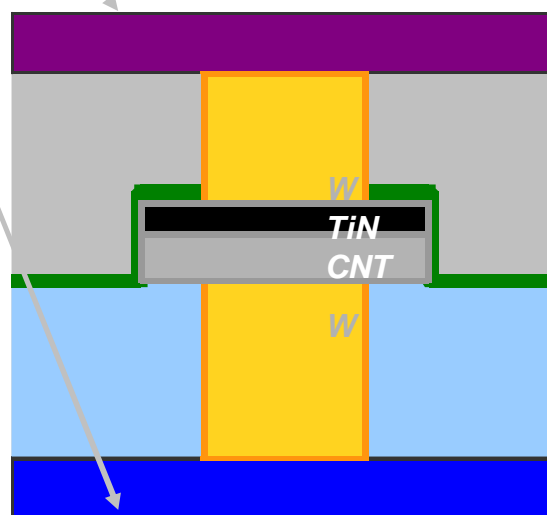
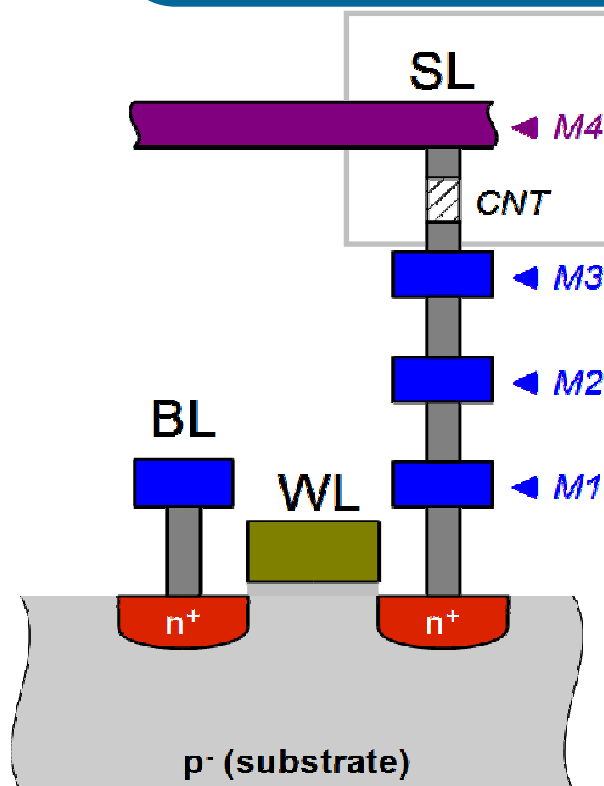
★ **Nothing is on the Extrapolation**

★ **Longtime Dreams Coming True**

Emerging Non-Volatile RAM

	FeRAM	MRAM	PCRAM	RRAM
Basic mechanism	Polarization of ferroelectric crystal	Tunneling magneto-resistance effect	Resistance change by material's phase change	Mechanism depends on material used
Current status	Production	Early production	Limited production	R&D
Prospects	Embedded low power application	Embedded/stand-alone hi-speed application	8Gb chip was presented at ISSCC 2012	Promising candidate for SCM (storage class memory)

NRAM: The New Entrant of NV-RAM

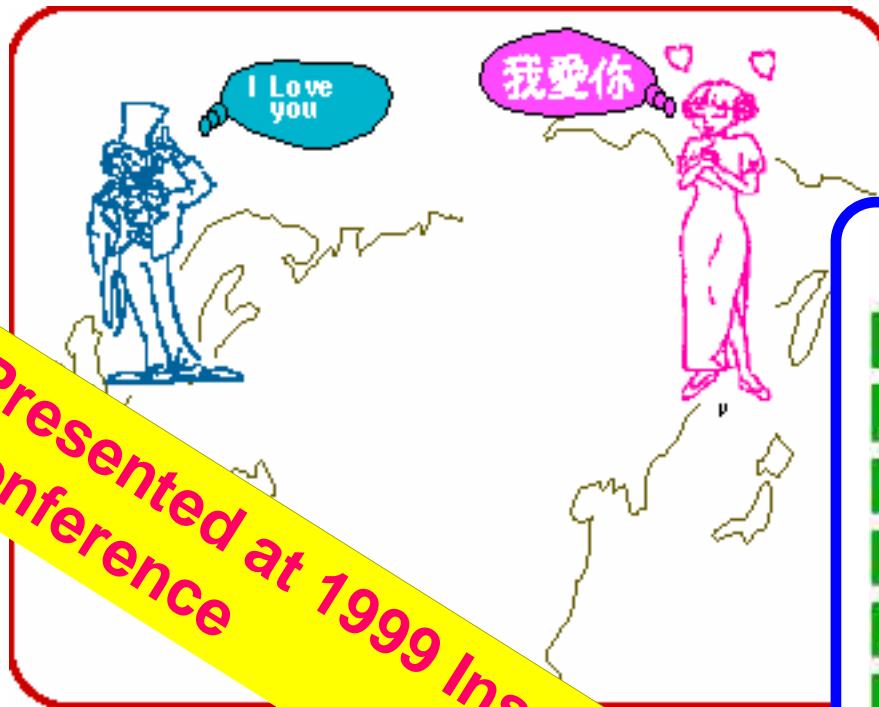


Main Features

- high speed (3ns write, 20ns for read)
- low power (less than 10 μ A for write)
- high endurance (>10E12 cycles)
- long retention (10 years at 300 DC)
- multi-Mbit devices developed

Challenging the Language Barrier

New business potential is opening



Presented at 1999 InStat Conference

A newspaper clipping with the headline "LET'S TALK!" in large, bold, orange letters. To the left of the headline is a green banner with white text that reads: "SPEECH TECHNOLOGY IS THE NEXT BIG THING IN COMPUTING WILL IT PUT A PC IN EVERY HOME?". Below the headline is a "Special Report" section with a red header. The text in the article discusses the challenges of speech technology, mentioning the need for a "natural language" understanding and the importance of context. It also mentions that computers have been listening to humans and transcribing what they say for years, and that the 1990s saw a boom in startups like Kurzweil Applied Intelligence and Dragon Systems Inc. The article concludes by stating that the next generation of speech technology will be able to understand context and meaning.

Special Report Business Week / Feb 23, 1998

Language Barrier Getting Lower

★ Language understanding has been the longtime dream and challenge for semiconductor technology

★ Why so difficult?

- Many languages in the world
- Many dialects for one language
- One word, different meanings
- Everyone talks differently
- Noise in the real environment

★ Siri as intelligent assistant

- Siri makes phone call, sends messages, sets reminders, and answers your question
- Siri supports English, French, and German



iPhone 4S

Summary

Nothing is on the extrapolation of the past

- ★ Custom or Standard
- ★ Unpredictable semiconductor market
- ★ Diversifying technology directions
- ★ Emergence of new market

Longtime dreams coming true

- ★ NV RAM and language technology

“Catch the turning point and ride the new wave! Bravely!!”



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Thank you for your attention!

Tsugio Makimoto, Ph. D