

The US Taiwan Business Council 2004

An Emerging Heterogeneous Integration Era

**— Global and Taiwan's IC Technology and
Business Development Trends**

Nicky C.C. Lu

CEO, President, and Chairman

Etron Technology, Inc.

Outline

- **Paradigm Shifts in Electronic System (ES) and Integrated Circuits (IC) Industries**
 - From 70s through 90s; Global versus Taiwan
- **Emerging Technology and Business Development Trends into 21st Century**
 - From monolithic integrated circuits to Heterogeneous Integrated system chips
 - From Fabless/Foundry to CVVI (Clustered Virtual Vertical Integration) business model
 - Taiwan outlook: Growth thrust towards innovation based on manufacturing, clustered with global partners
- **Conclusions**

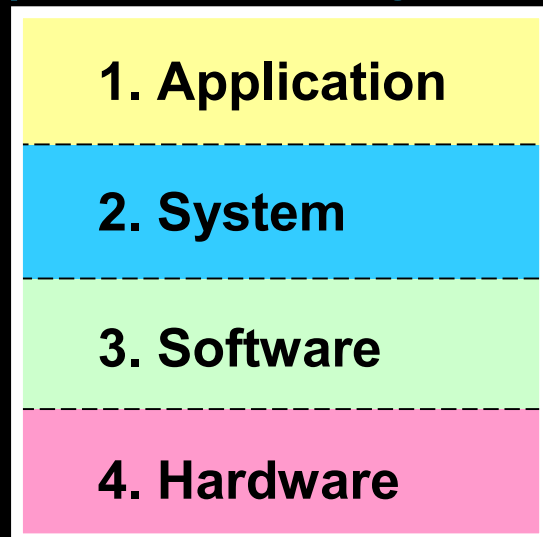
Paradigms in '70s to Mid-'80s

● Driving Forces and Keys for Success

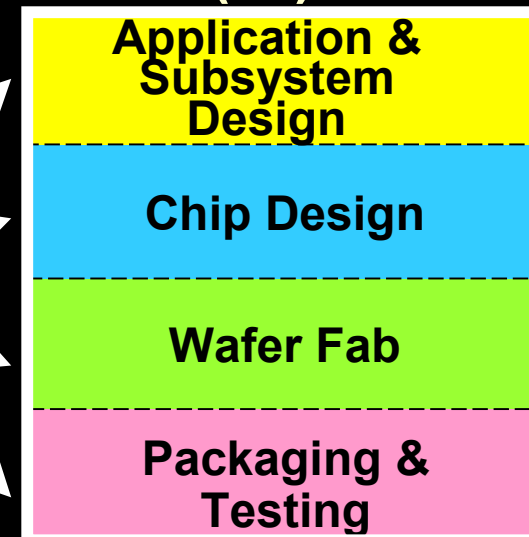
- Major Technology Innovations, e.g. Intel's CPU
- **Closed** Systems for **Single** Applications, e.g. Computer (IBM's Mainframes) or Telephone (AT&T's Switching Systems)

● Characteristics and Models

Vertical Integration (Electronic System)



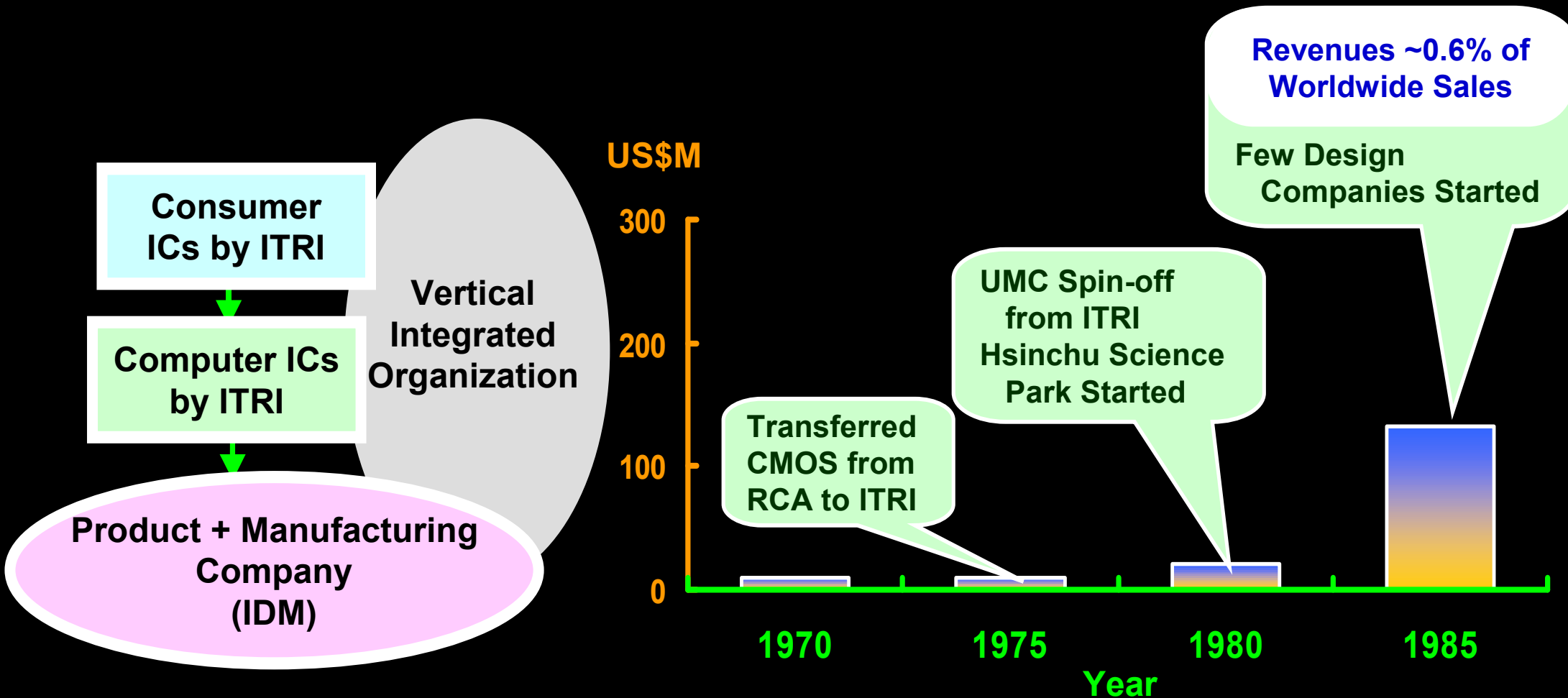
IDM (Integrated Device Manufacturer) (IC)



Specialty
Knowledge
Domains

Taiwan IC Industry in '70s to Mid-'80s

● A Small Player in the Worldwide IC Business



*ITRI: Industrial Technology Research Institute (A Mixed National and Industrial Laboratory)

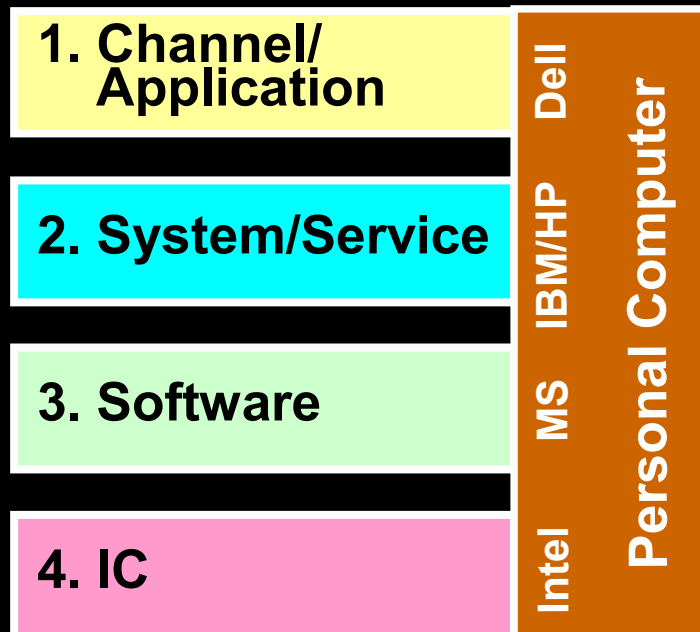
Paradigms in Mid-'80s through '90s

● Driving Forces and Keys for Success

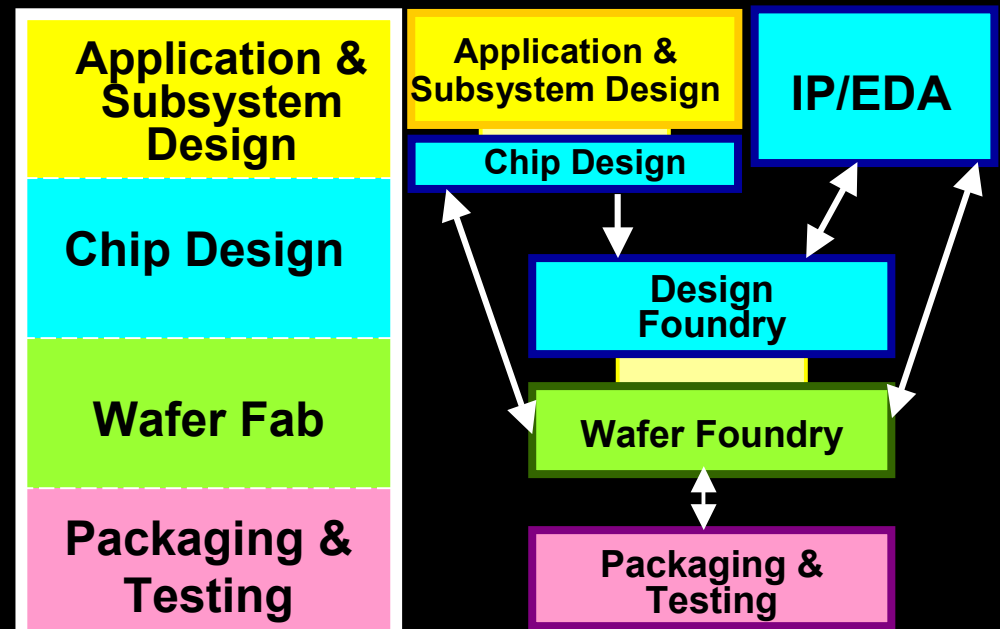
- Open Systems with Standards for ICs, e.g. PC/Notebook with CPUs and DRAMs
- Capital Intensive Manufacturing to Design/Foundry Synergy, e.g. Taiwan pioneered foundry model by TSMC

● Characteristics and Models

Horizontal Segmentation (Electronic System)

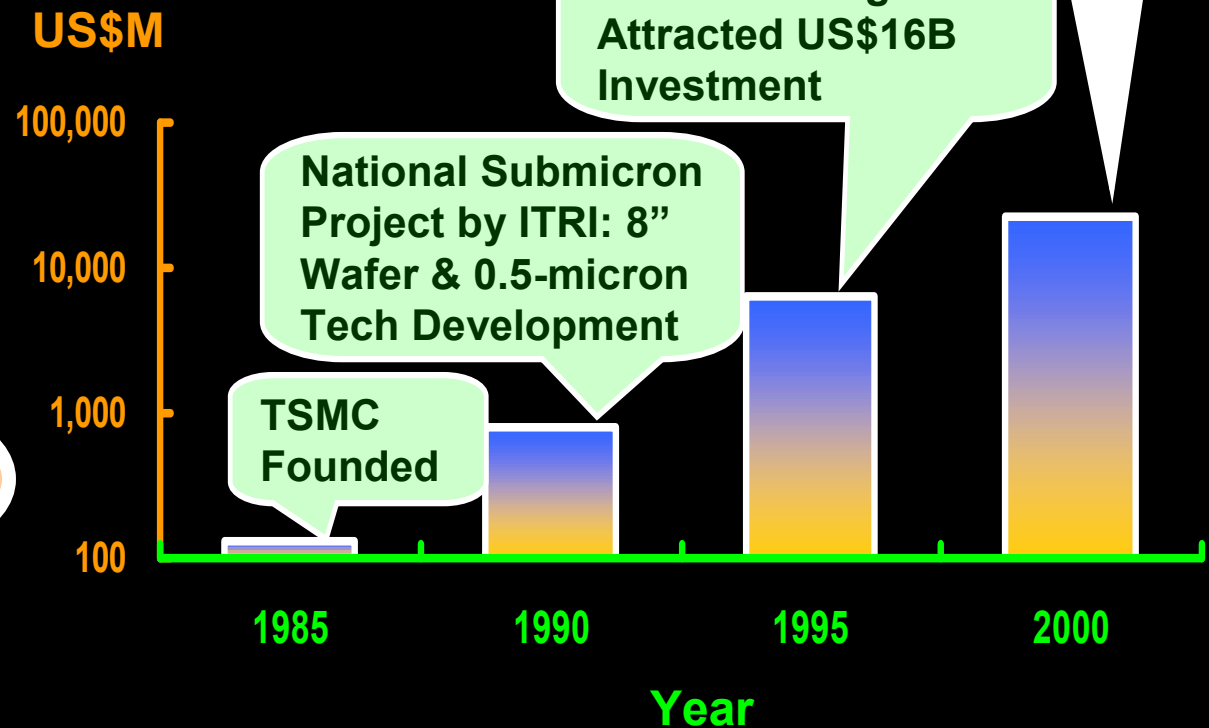
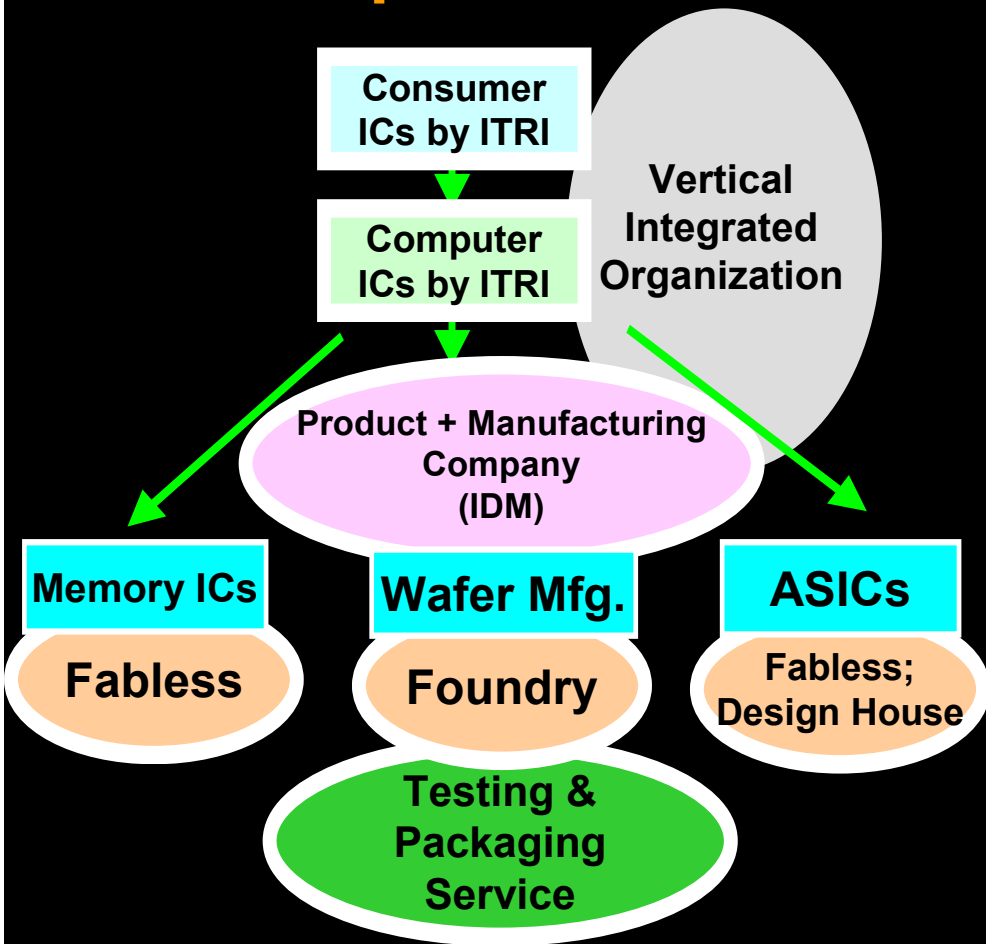


IDM/Fabless/Foundry/Vendors (IC)



Taiwan IC Industry in Mid-'80s through '90s

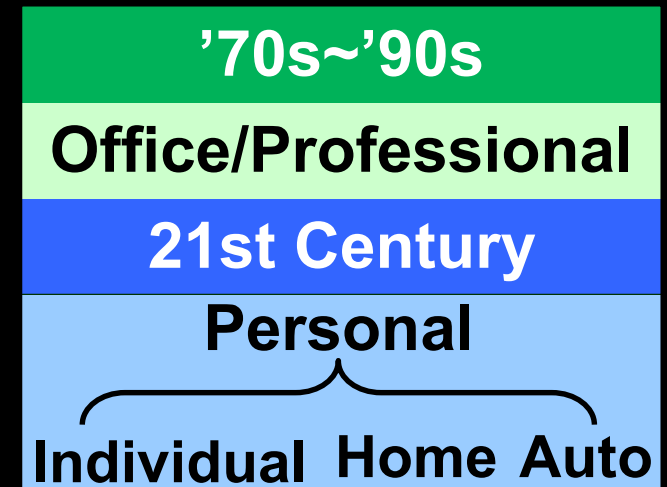
- Fast Growth Thanks to the Innovative Foundry & Fabless Model plus Advanced Technology Development Success



Paradigms into 21st Century – Personal Application Revolution

● Driving Force

- Application-Driven: **Consumer-Centric** with **4C** Integration (**C**omputer + **C**ommunication + **C**onsumer + **C**ontent)
- **Integrated** Systems with **Mixed** Closed and Open Standards



● Emergence of Mobile Intelligence Appliances (MIAs)

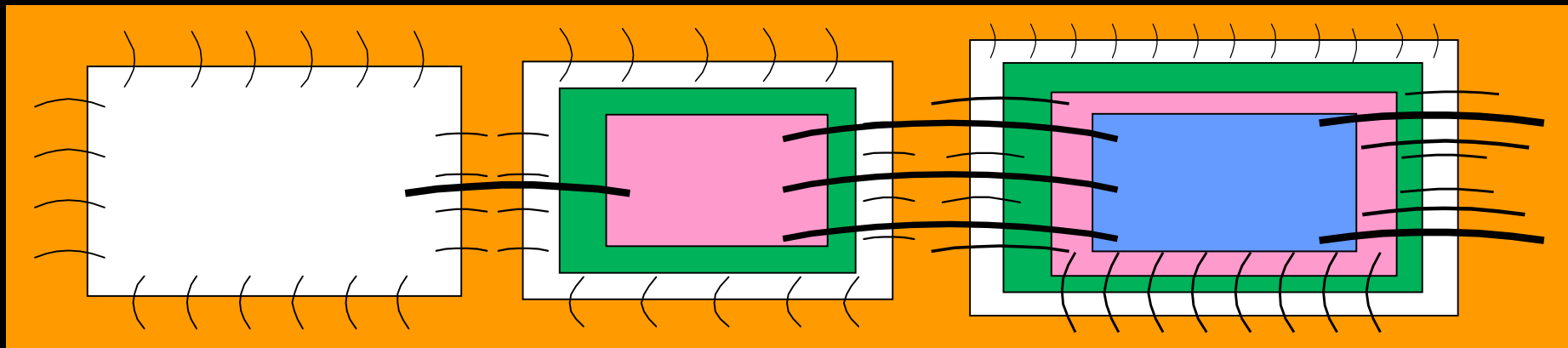
- Cell phones: 500M units in 2003 (3X of PCs),
- Digital Cameras,
- Digital Audio/Video Players,
- PDAs, iPods,
- Wireless/Bluetooth/Home Connectivity,
- Automobile Entertainment Units, etc

Personal Application Revolution Demands & Nourishes System Chips

- **4C Functionality in a Single MIA**
- **Small Formfactor, Limited Footprint, Low Cost, Reduced Power: Absolutely Required**
- **Various Circuit Families Integrated into One Single-Package/Module IC**
 - Digital, analog, memory, RF, power-related, etc.
 - **Single** Die or **Multiple** Dies: A Key Decision

New System Chip Architecture: MDSC

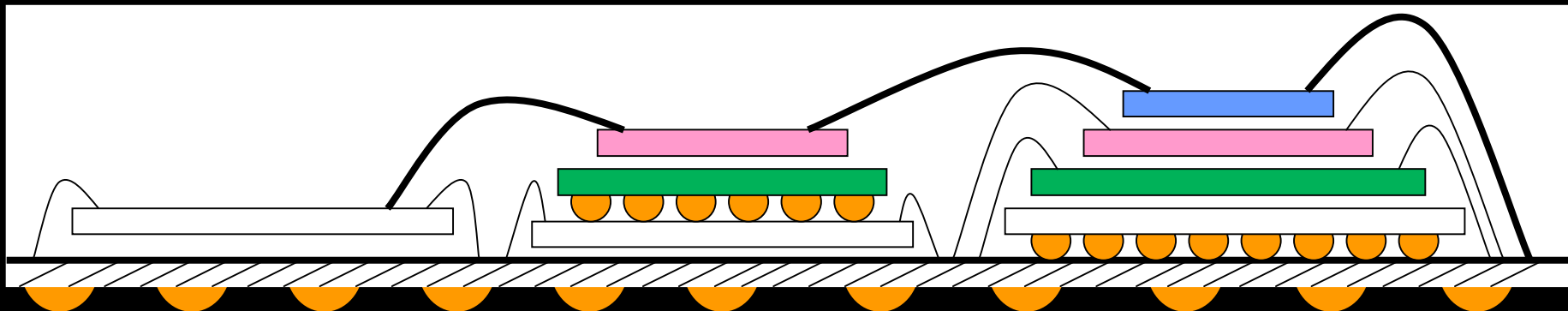
- Multi-dimensional Die integration System Chips



e.g. RF or
Power

Analog or
Cache over SoC

Memory
+ Logic



MDSC Analogy

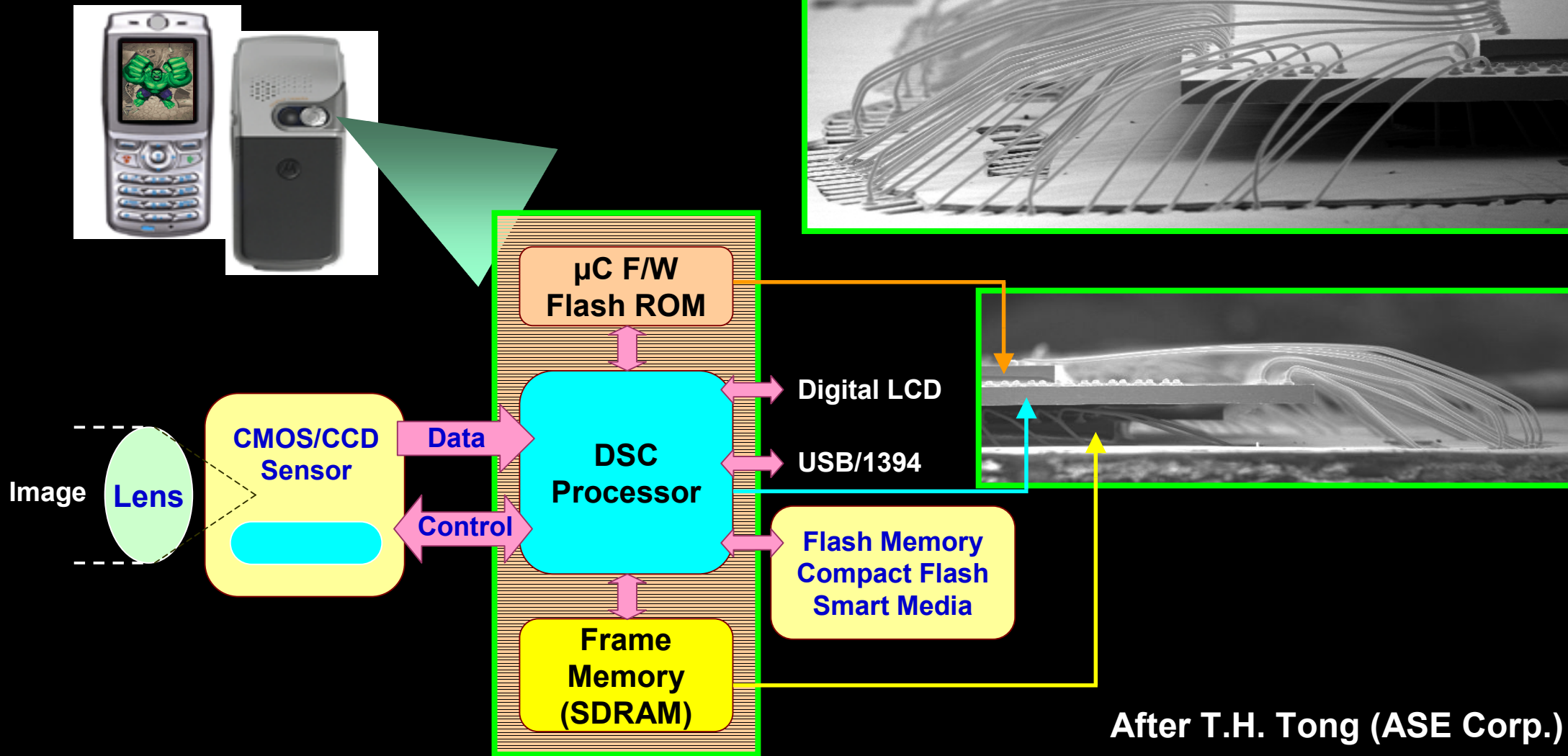
- **Metropolitan-like Die-Society Cluster**
 - Conceptualized as land development and building construction

e.g. SFO Union Square or Taipei World Trade Center versus one-story house at Wyoming



Taipei World Trade Center

MDSC Realization in Cell-Phone Cameras – SEM



New Measurements into System-Chip Era

● Moore's Law

- More **transistors** in a 2D die **area**
- **Monolithic Integration (MI)** by using planar technologies in a single die
- 2X in 12 to 24 months
- Progress will continue for 4 decades (G. Moore, Electronics 1965 & ISSCC 2003)

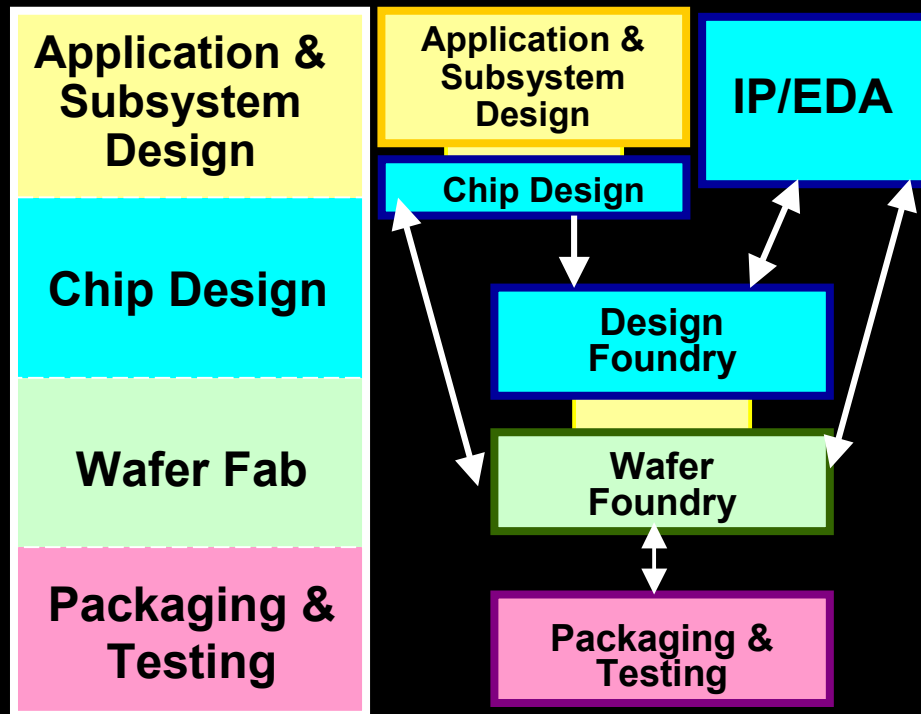
● MDSC – Lu's Metrics

- More **functions** per unit **volume** in a smaller **footprint**
- **Heterogeneous Integration (HI)** by using multi-dimensional stacked-die technologies
- ??X every year
- Emerging as Application-driven, starting in the 21st century (N. Lu, ISSCC 2004)

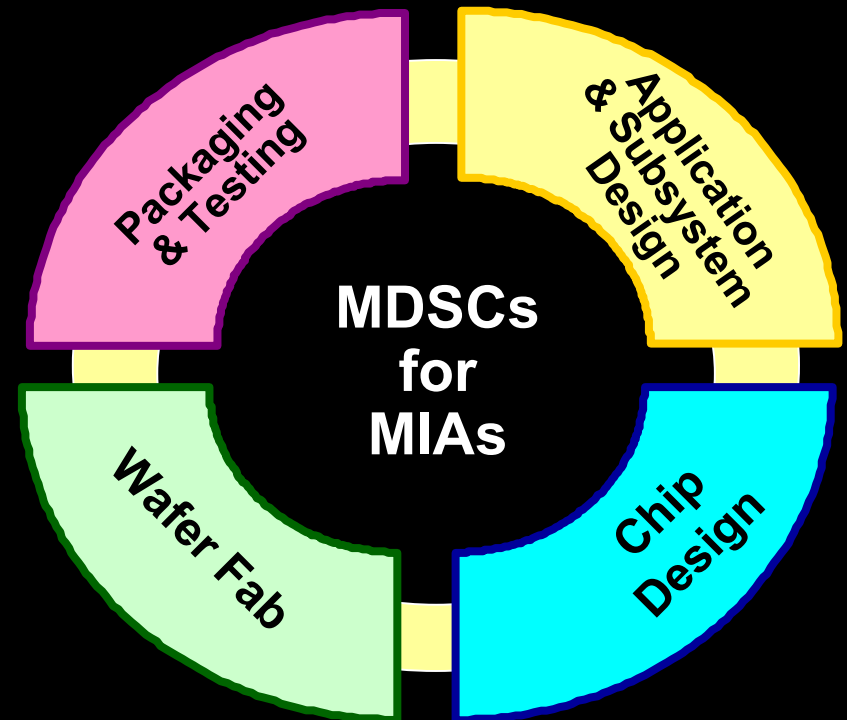
Emerging Business Models for System-Chip Companies

- **System Chips, Especially MDSCs, Need Clustered Virtual Vertical Integration (CVVI) Business Models**

Paradigm ('80s thru '90s)

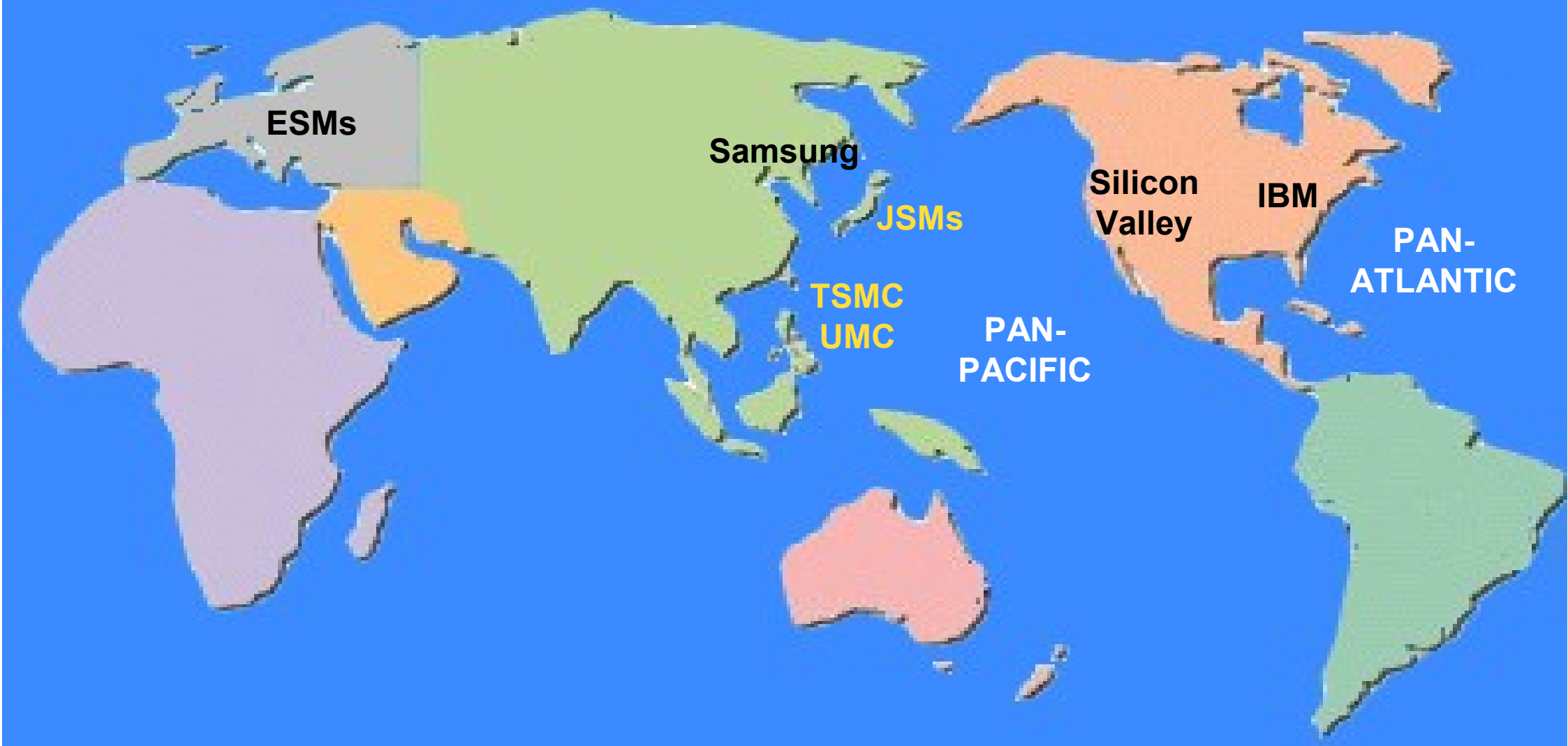


Emerging **CVVI**



- **Keys:** Co-Development and Profit-Sharing

System-Chip Olympics – Global Business CVVIs and Flagships



Business CIVI Example I: IBM

- **IDM from '70s to mid-'90s**
- **Diversified in mid-'90s: Contract Manufacturing**
 - Providing standard cells, IPs, foundry service to selected partners
 - Co-developing technologies in multiple alliances
- **In 2002: Technology and Engineering Service**
 - Providing skills in various specialty segments to customers with valuable application channels
 - Allowing partners to use IBM knowledge and resources to co-develop products for win-win results

*Communication with J. Kelly and T.C. Chen (IBM)

Business CVVI Example II: TSMC

- **Developed a New Foundry Model since 1986**
 - No product but manufacturing only in order to avoid conflicts of interest with customers
 - Provided best in-house technology – not most advanced at beginning but well-positioned business model made it successful
- **More Co-Development of Technologies and Business with Customers and Suppliers**
 - e.g. Co-developing flip-chip packaging technology with assembly vendors, but complete assembly production business will belong to those vendors
 - Invested in a sensor assembly company to support CMOS sensor customers

*Communication with G. Hu and M. Chang (TSMC)

Business CIVI Example III: JSMs

- **Japanese Semiconductor Manufacturers Changed into Two Major Business Structures**
 - One **DRAM-focused** manufacturer, clustered with emerging fabs in Taiwan and China
 - **IDMs** focused on SoC, SiP, flash memory, Combo, IP, etc.
- **Entering MDSC Era by Open IDM Model**
 - e.g. Toshiba's **SoC-centric Open IDM** model provides a technology/automation platform to facilitate partners' product development and foundry integration
 - e.g. NEC forming **cooperative** relationships with fabless companies by providing strong technology platforms

*Silicon Sea Belt Summit, Fukuoka, 2003; Communication with Kohyama (Toshiba) and Tosaka (NEC)

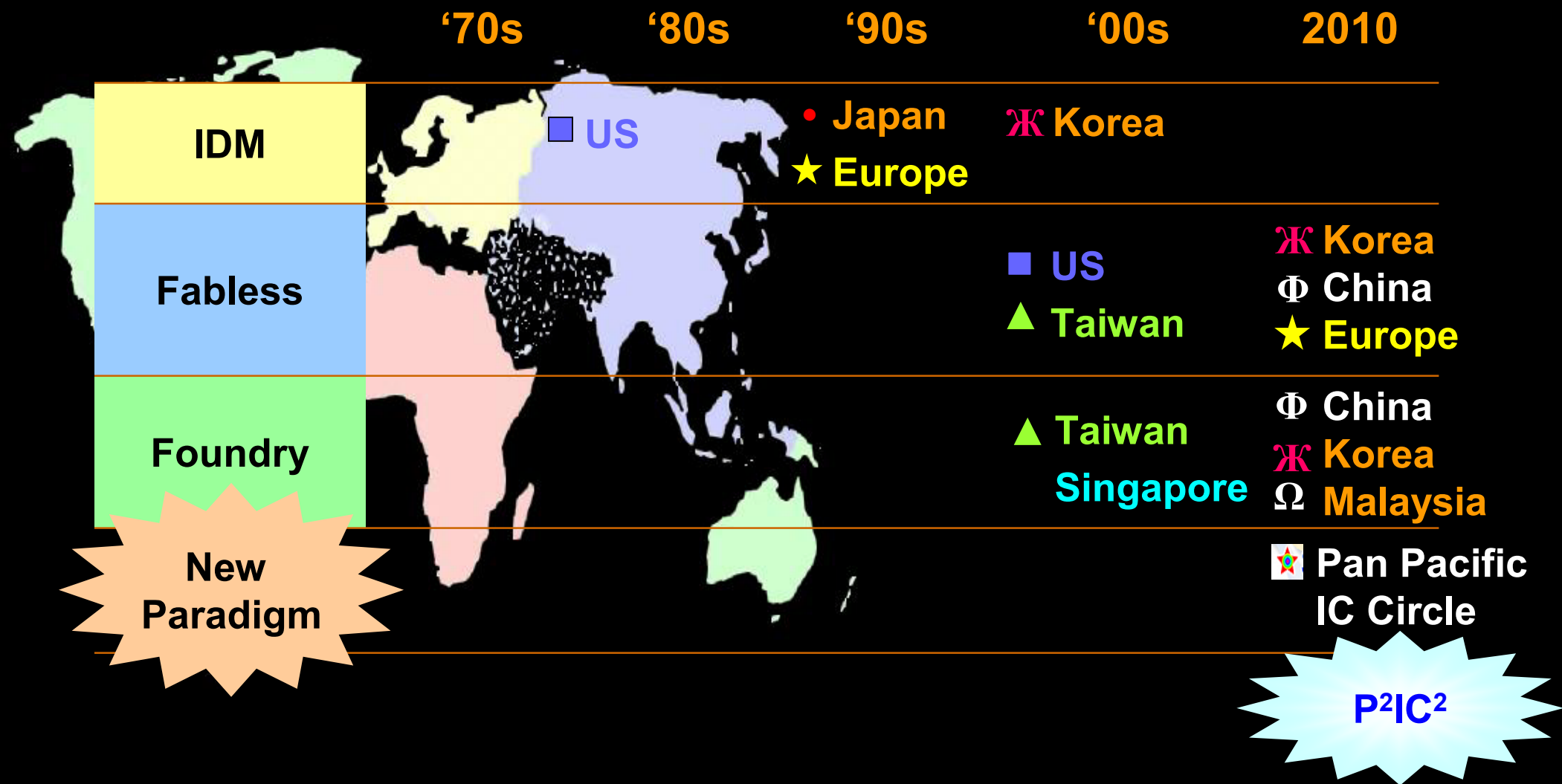
Business CVVI Example IV: Samsung

- **An Electronic System House with IDM Semiconductor Division**
 - Recent successes with ICs, displays, cellular phones, home appliances, games, etc.
- **Migrating Towards Vertical Integration**
 - Developing knowledge in all four system segments, especially for MIA products
 - Smartly mixing “owned and closed” technologies with “the best imported from the outside”
 - Promoting a vision of Collaborative Alliances, thus actually implementing CVVI strategies

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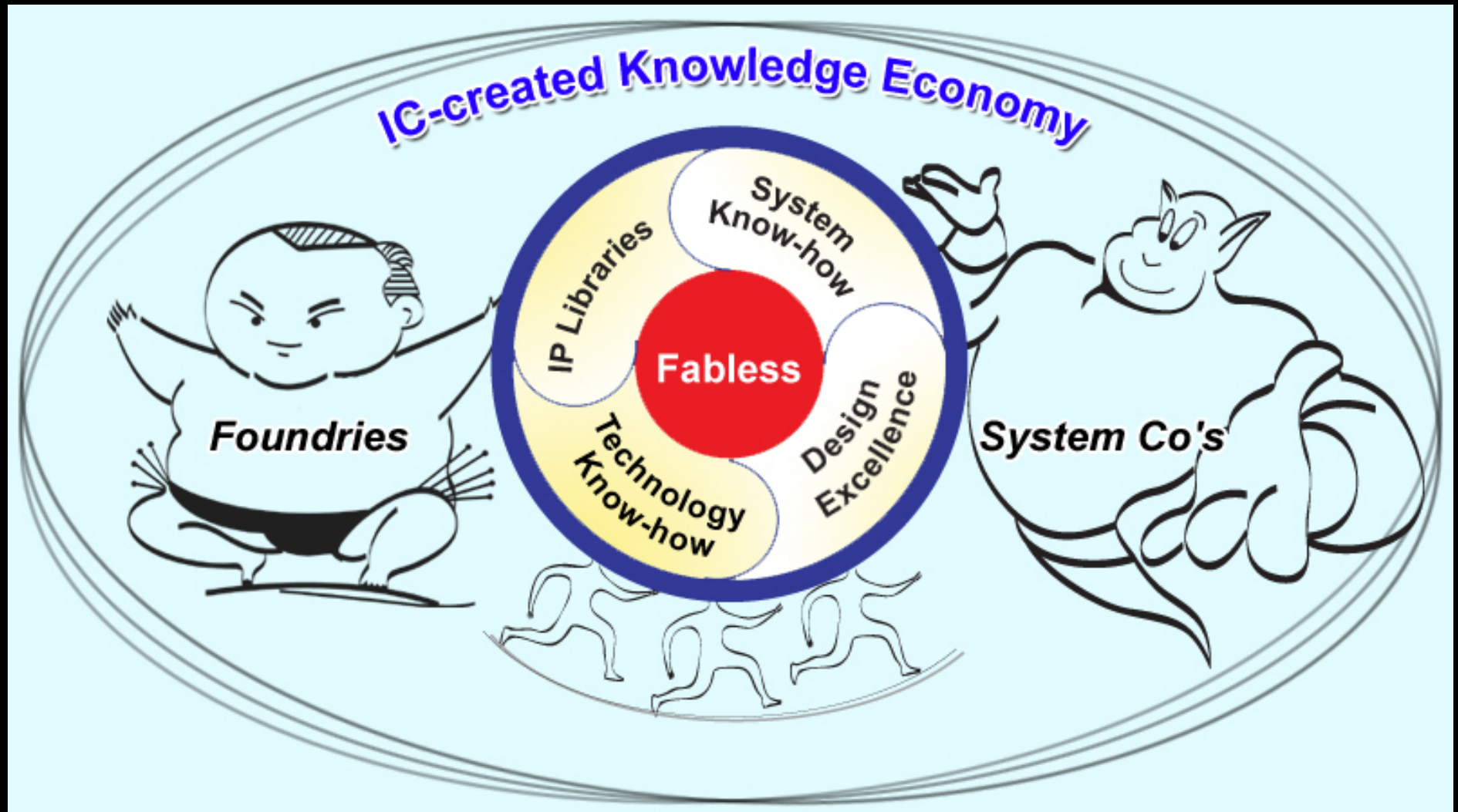
Paradigm Shift: Regional Force Change



Taiwan's New Directions for IC Growth

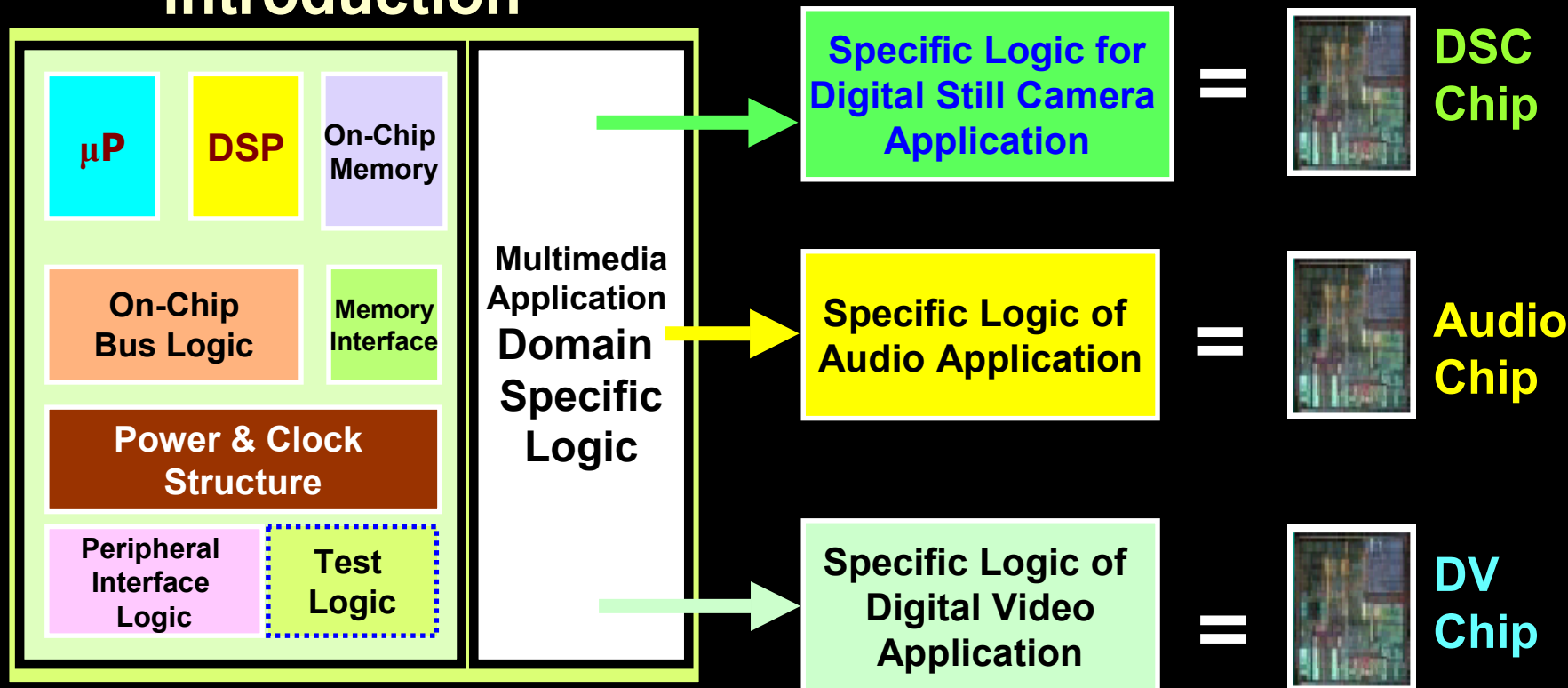
- **Leader in IT System and Display Manufacturing**
 - Fulfilling customer demands and setting product directions
 - Headquarters in Taiwan, cost-effective manufacturing in China, efficient global logistics for worldwide customers
- **Leader in Foundry Technology and DRAM Manufacturing**
 - Heavyweights supporting R&D; Best practice in global alliances
- **#2 in IC Design Industry Scale, Next to Silicon Valley**
 - Best CVVI Infrastructure to enhance product variations in the heterogeneous integration era, with partners coming worldwide
- **More Emphasis on Value-added Growth than Revenue Growth – An Industry Consensus**
 - Pushing for **innovation** and **competitiveness**
 - Respect IP; value intellectual power; focus on quality

Effective Fabless Plays a Pivotal Role



Technology C-VI Example I: A Common Platform for System Chips

- Design Foundry + Wafer Foundry + System Houses
- A Reconfigurable DAV Platform to Derive SoCs
 - Rapid implementation with pre-defined technologies
 - Accumulated learning and reuse for faster product introduction

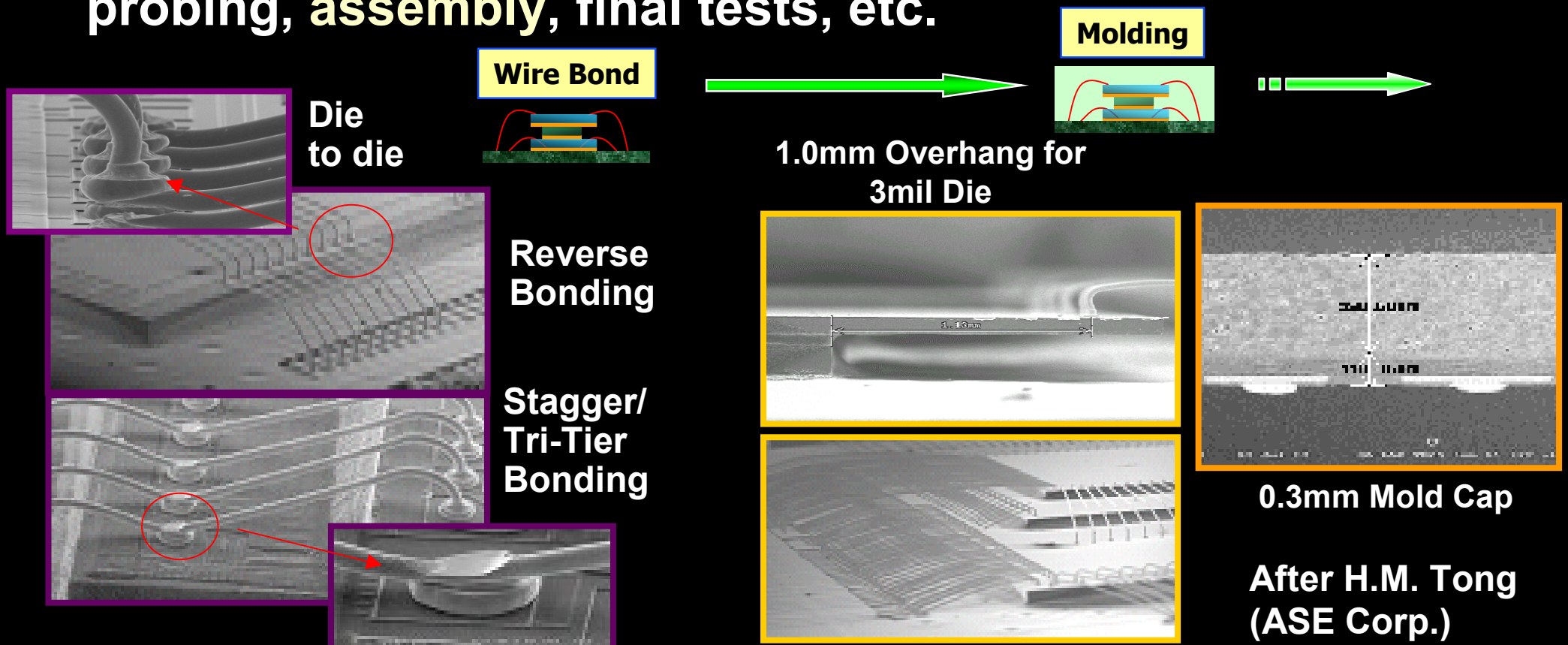


After Y.R. Lin, K.C. Shih, J. Lai, and N. C.C. Lu (Global Unichip Corp.)

Tech-CVVI Example II:

MDSC Packaging Technologies

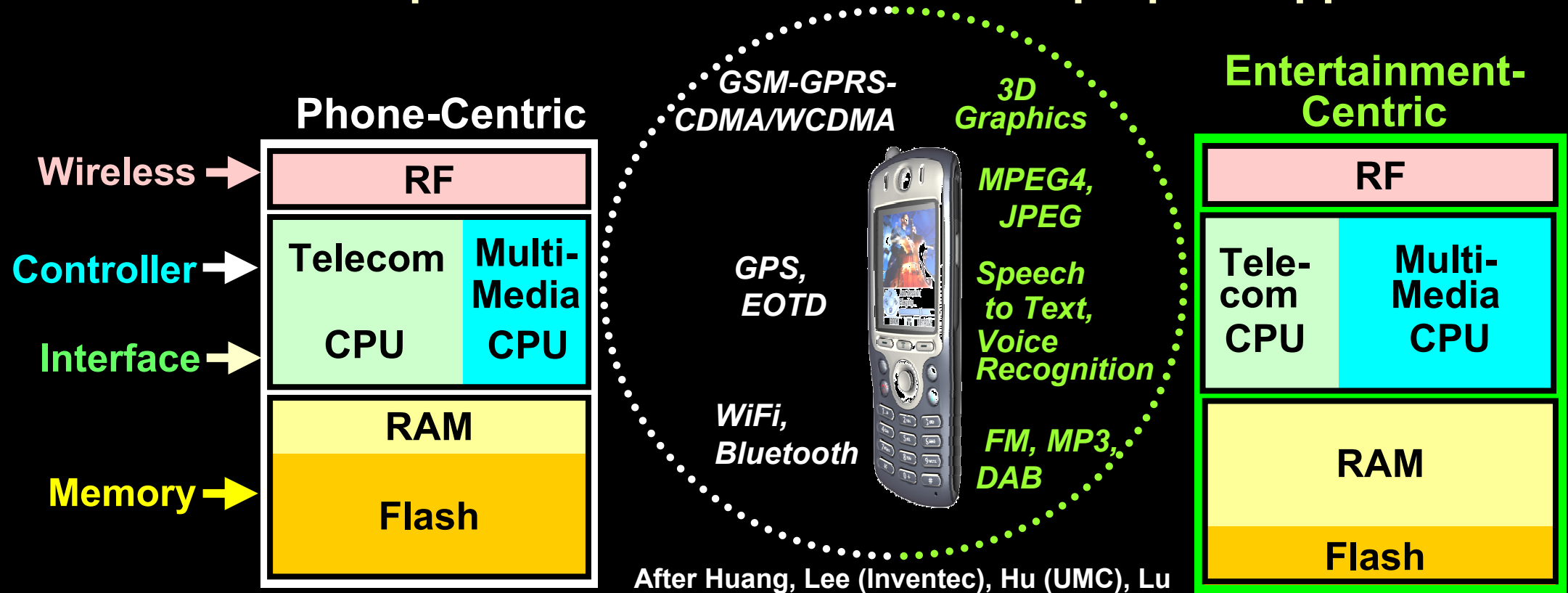
- Packaging Houses + Design Houses + Wafer Foundries
- **Stacked-die** and **Flip-chip** Turnkey Capabilities
 - Wafer thinning, bonding or bumping, bumped-wafer probing, assembly, final tests, etc.



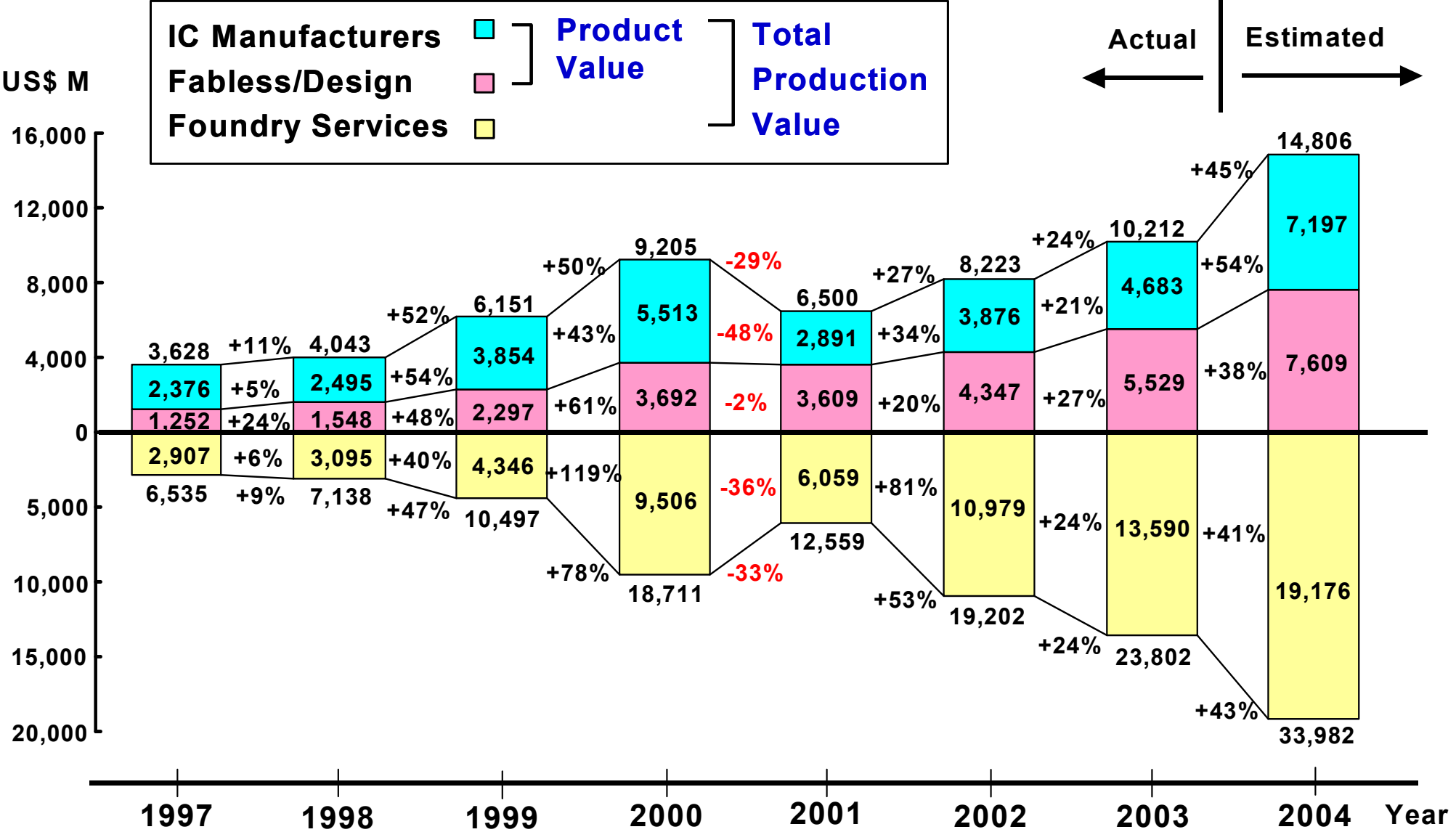
Technology CIVI Example III:

Handset Platform for Telecom & Multimedia

- System Houses + IC Companies + Package Vendors
- Multiple Processors + Variable Memories Architecture
 - IC contents determine functionality for different end-user needs
 - Identical footprints manufactured for multi-purpose applications

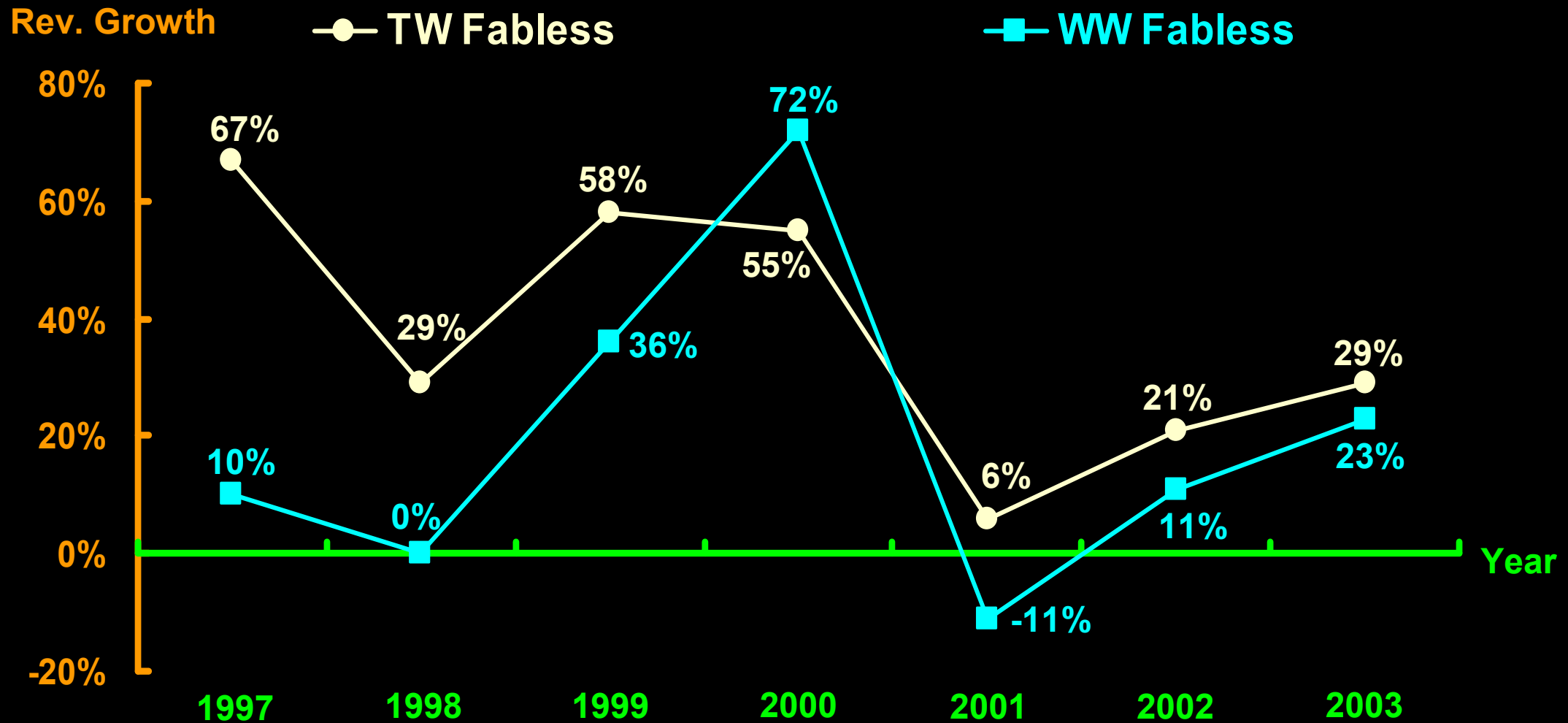


Revenue Trend of Taiwan's IC Industry



Source : IEK-ITIS (Oct.'04)

Fabless Revenue Growth: Taiwan vs. Worldwide



Source : IEK/ITRI-TSIA Project (Nov. 2004)

A Race with Obstacles

Rank		Economy	Description
2004	2003		
1	1	Finland	Strong planning
2	2	U.S.	Tech supremacy
3	3	Sweden	Squeaky clean
4	5	Taiwan	Strong innovator
7	6	Singapore	Superefficient
9	11	Japan	Top in R. and D.
21	24	Hong Kong	Good institutions
29	18	South Korea	Recession fear
31	29	Malaysia	Deficit problem
34	32	Thailand	Lagging in tech
46	44	China	Growing pains
55	56	India	Budget woes
69	72	Indonesia	Organized crime
73	68	Sri Lanka	High inflation
76	66	Philippines	Tax issues
77	60	Vietnam	Low Tech
91	73	Pakistan	Poor credit rating
102	98	Bangladesh	Worst corruption

***TIME Magazine,
Oct. 25, 2004***



Conclusions

- **Paradigm Shifts in Both ES and IC Industries:**
 - From closed Mainframe to open PC to integrated MIA
 - From Office computation to Personal 4C
 - From monolithic ICs to heterogeneous integrated chips
- **Heterogeneous Integration (HI) Transforming IC Industry on Four Aspects:**
 - Synergistic growth of technologies for smart products
 - Emerging CVVI business model
 - Knowledge consolidation from system, IC to manufacturing
 - Mix-and-Match in culture from West to East and B to C
- **Taiwan's New IC Thrust in the HI Era**
 - Add innovation value and continue manufacturing growth
 - Play a pivotal role in Pan-Pacific IC business and technology growth