
C335

Computer Structures

Computer Abstractions and Technology (Part #2)

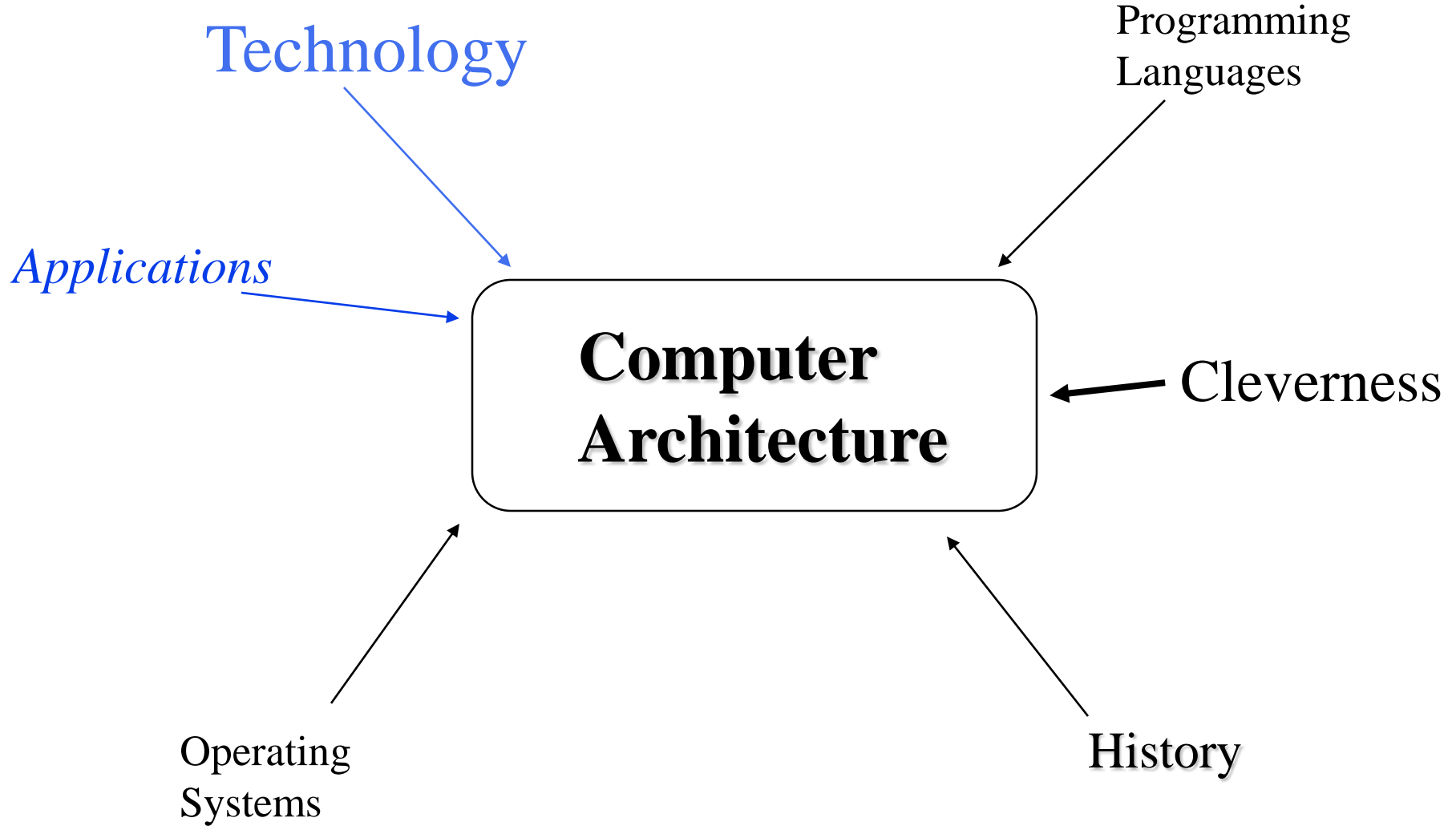
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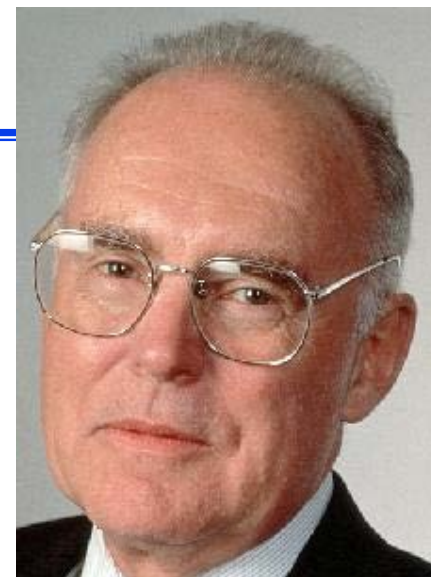
Computer Abstractions and Technology

- ❑ What is computer architecture?
- ❑ What forces drive computer architecture?
- ❑ Performance

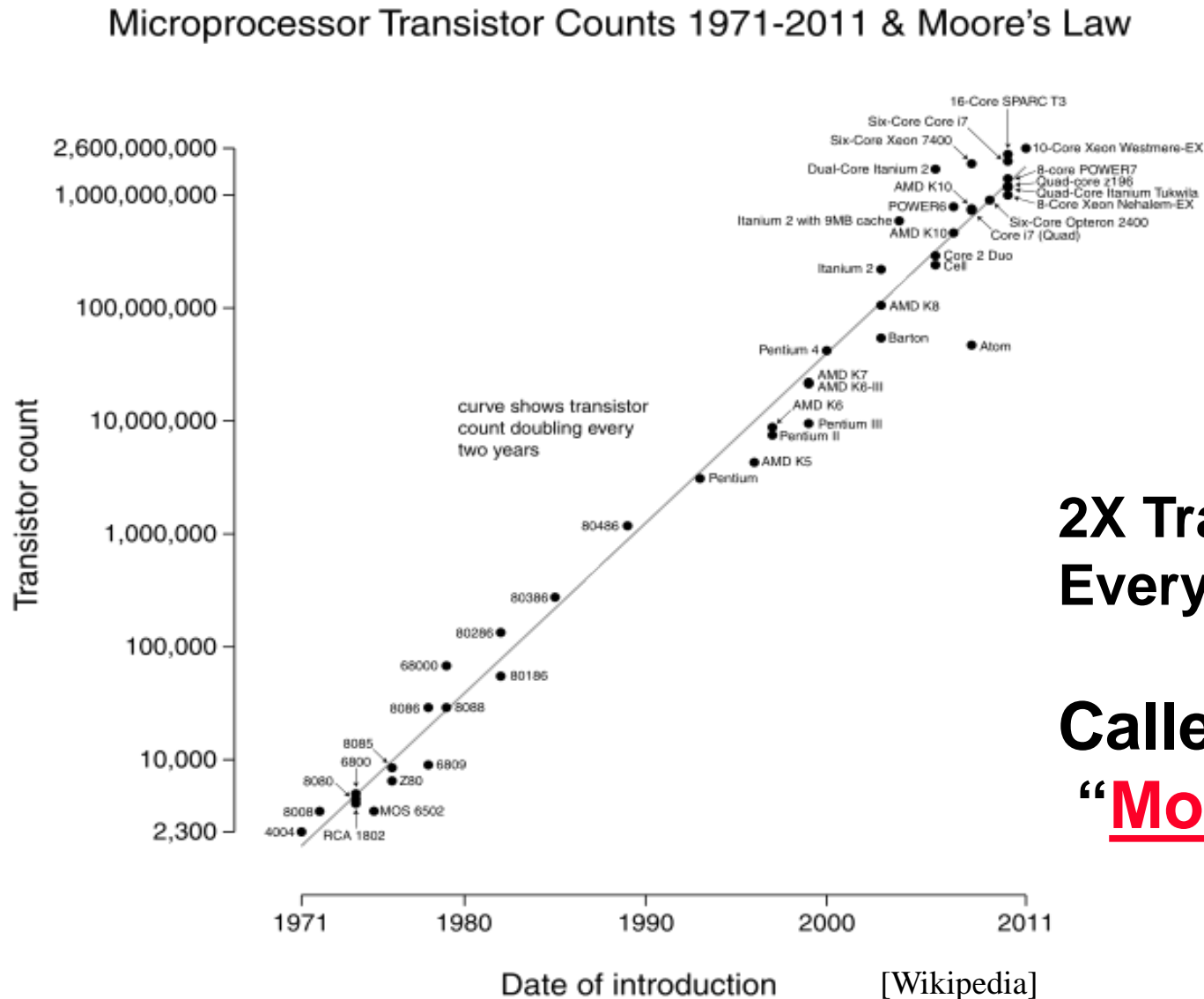
Forces on Computer Architecture



Example: Technology => Dramatic Changes



Gordon Moore
Intel Cofounder



**2X Transistors / Chip
Every 2 years**

Called
"Moore's Law"

The Underlying Technologies



Year	Technology	Relative Perf/Unit Cost
1951	Vacuum Tube	1
1965	Transistor	35
1975	Integrated Circuit (IC)	900
1995	Very Large Scale IC (VLSI)	2,400,000
2013	Ultra VLSI	250,000,000,000

What if technology in the automobile industry advanced at the same rate?

What if...

“If the automobile had followed the same development cycle as the computer,

– *Robert X. Cringely, InfoWorld magazine*

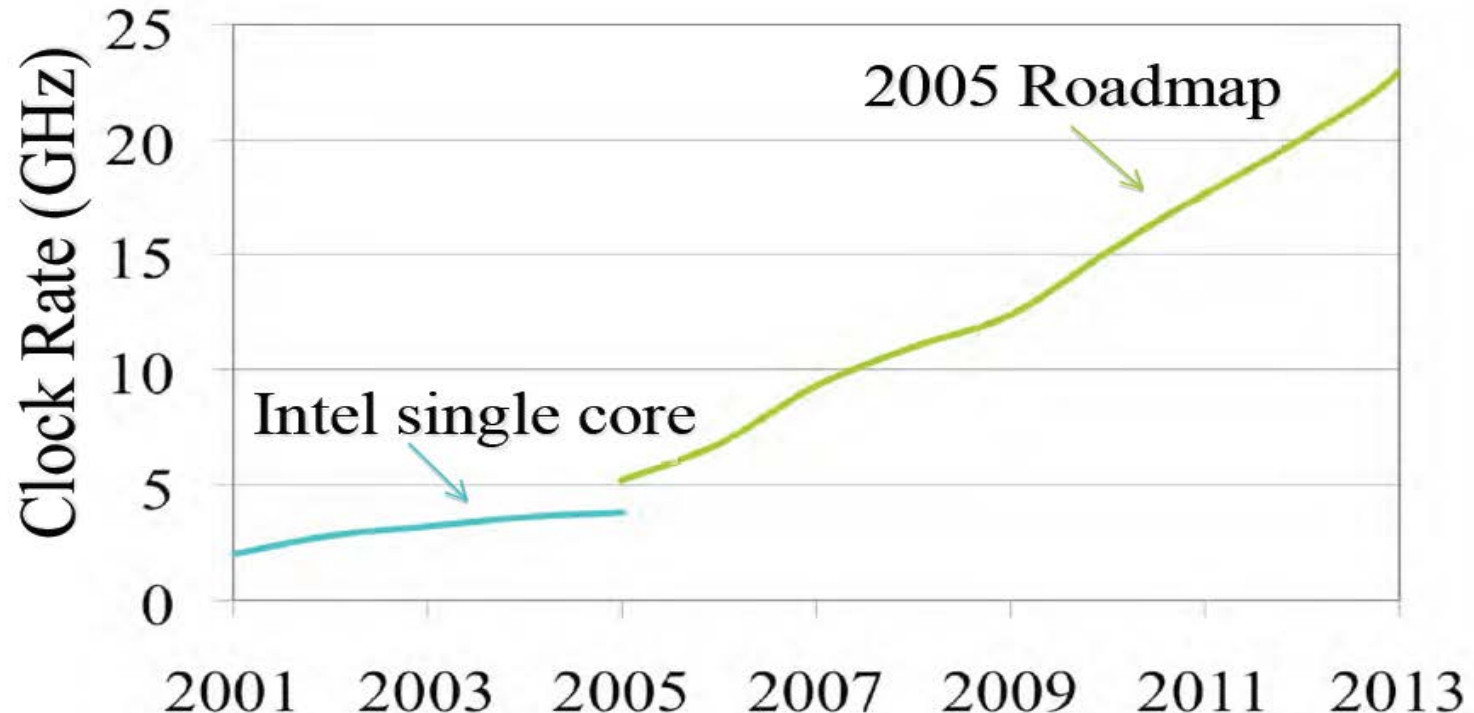


Technology Scaling Road Map (ITRS)

Year	2004	2006	2008	2010	2012	2014	2016
Feature size (nm)	90	65	45	32	22	14	10
Intg. Capacity (BT)	2	4	6	16	32	?	?

But What Happened to Clock Rates and Why?

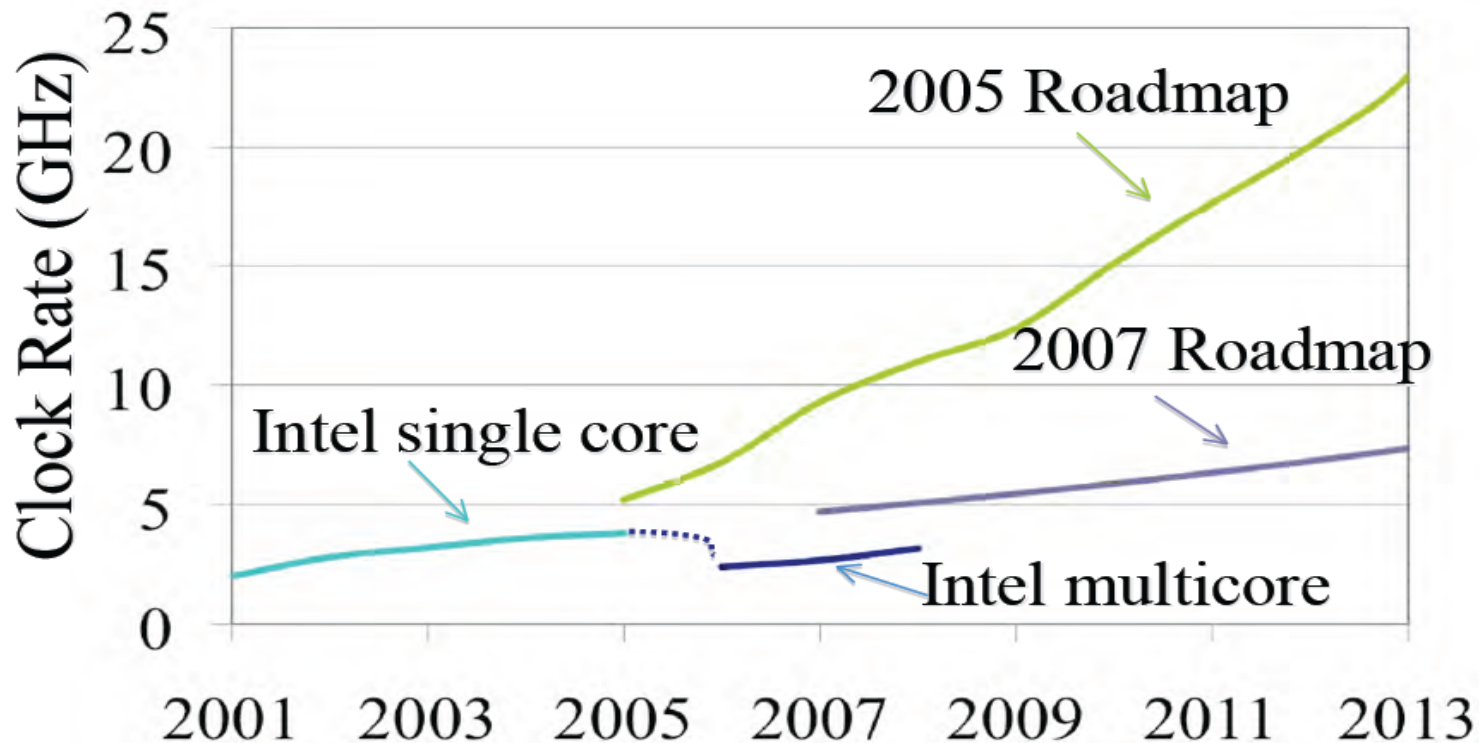
2005 IT Roadmap Semiconductors



--David Patterson, Keynote Address in USENIX'08, "The Parallel Revolution Has Started"

But What Happened to Clock Rates and Why?

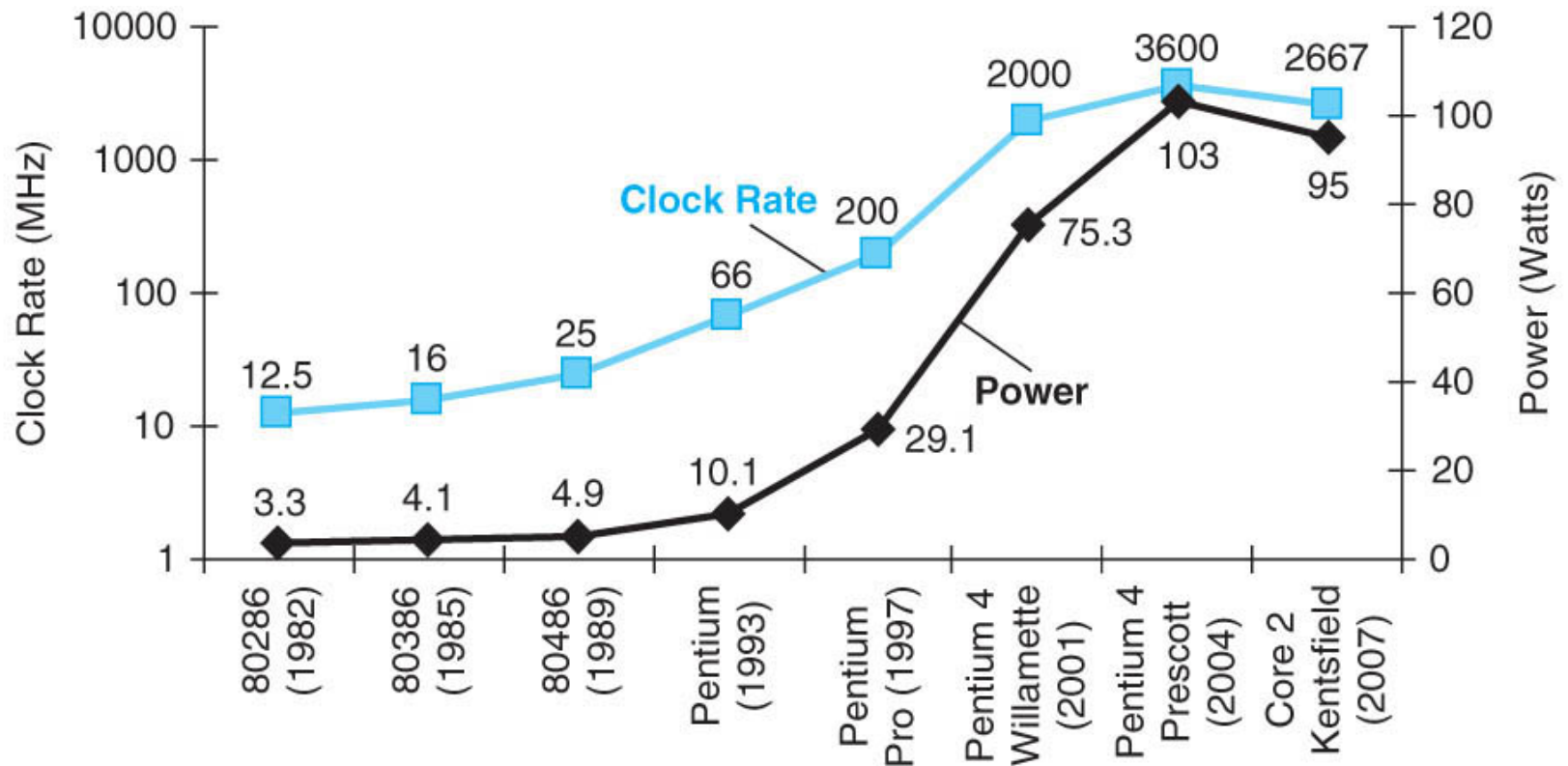
Change in ITS Roadmap in 2 yrs



--David Patterson, Keynote Address in USENIX'08, "The Parallel Revolution Has Started"

But What Happened to Clock Rates and Why?

- ❑ Clock rates hit a “power wall”



A Sea Change is at Hand!

- ❑ The power challenge has forced a change in the design of microprocessors
 - Since 2002 the rate of improvement in the response time of programs on desktop computers has slowed from a factor of 1.5 per year to less than a factor of 1.2 per year
- ❑ Since 2006 all desktop and server companies are shipping microprocessors with multiple processors – cores – per chip

Product	AMD Barcelona	Intel Nehalem	IBM Power 6	Sun Niagara 2
Cores per chip	4	4	2	8
Clock rate	2.5 GHz	~2.5 GHz?	4.7 GHz	1.4 GHz
Power	120 W	~100 W?	~100 W?	94 W

- ❑ Plan of record is to double the number of cores per chip per generation



Example: Impact of Applications

❑ Desktop Applications

- Emphasizes performance of integer and Floating Point (FP) data types
- Little regard for program (code) size and power consumption

❑ Server Applications

- Database, file system, web applications, time-sharing
- FP performance is much less important than integer and character strings
- Little regard for program (code) size and power consumption*

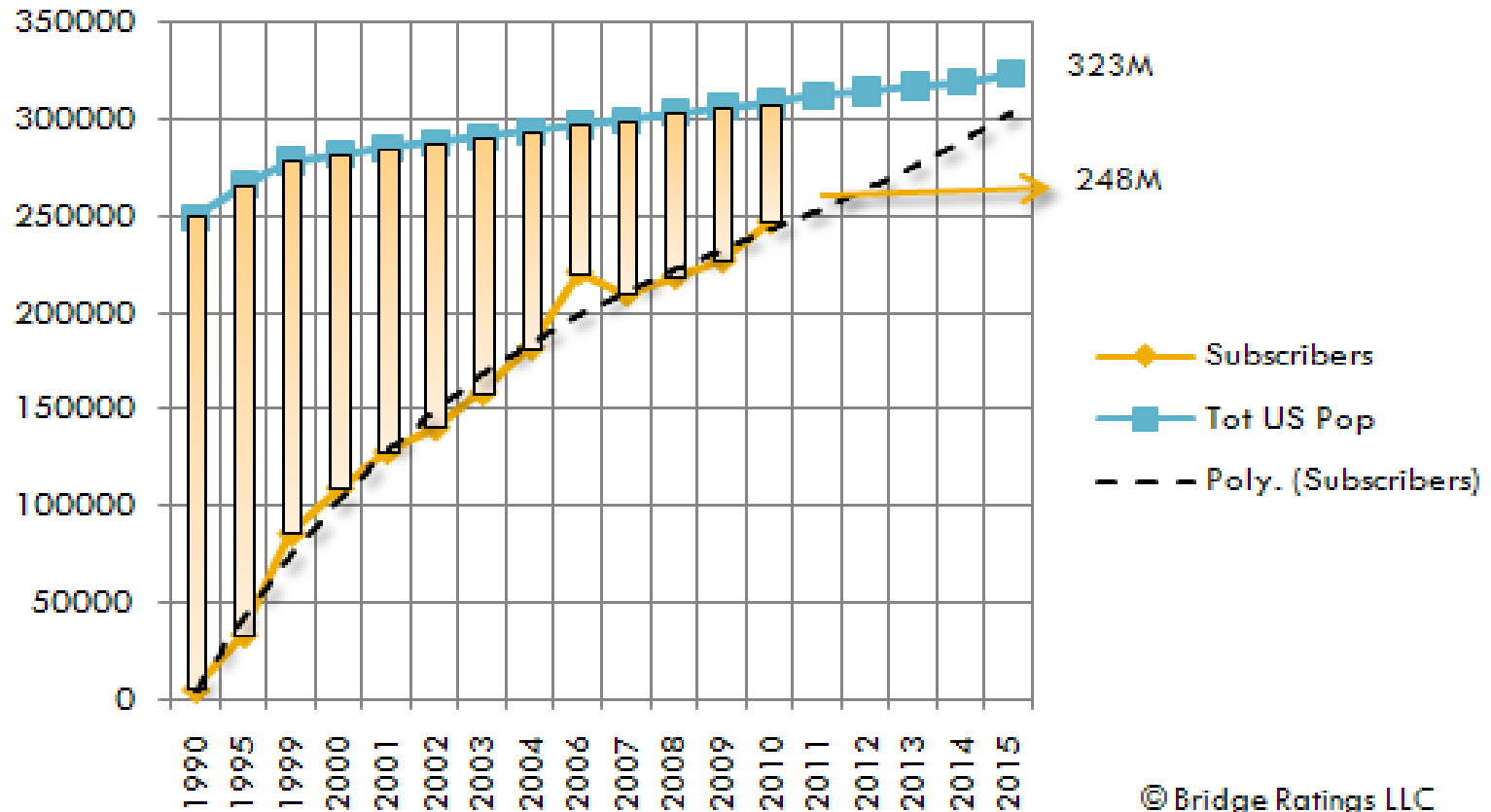
❑ Embedded Applications

- Digital Signal Processors (DSPs), media processors, control
- High value placed on program size and power consumption
 - Less memory, is cheaper and lower power
 - Reduce chip costs: FP instructions may be optional

Growth in Cell Phone Sales (Embedded)

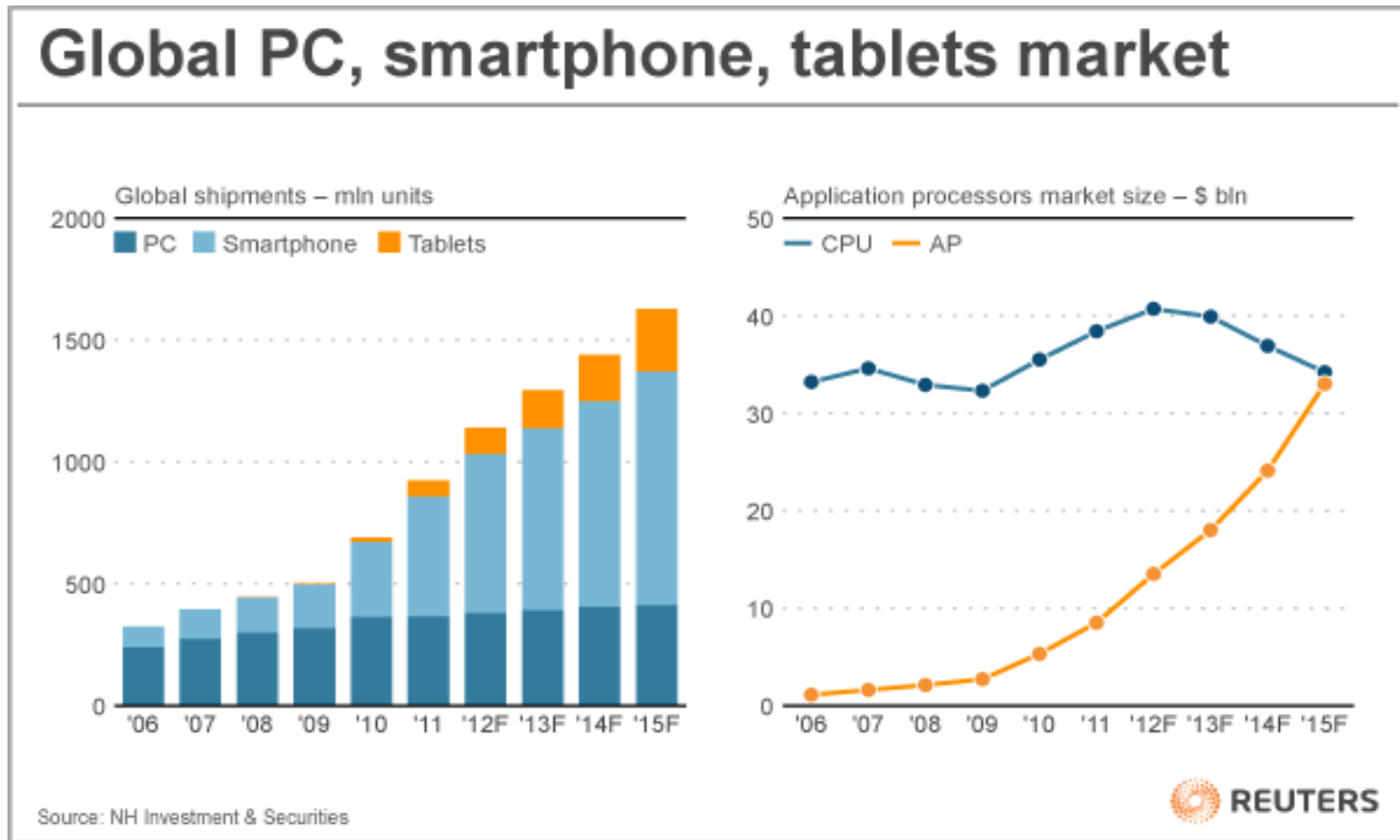
embedded growth >> desktop growth

U.S. Cell Phone Subscriber Growth 1990-2015



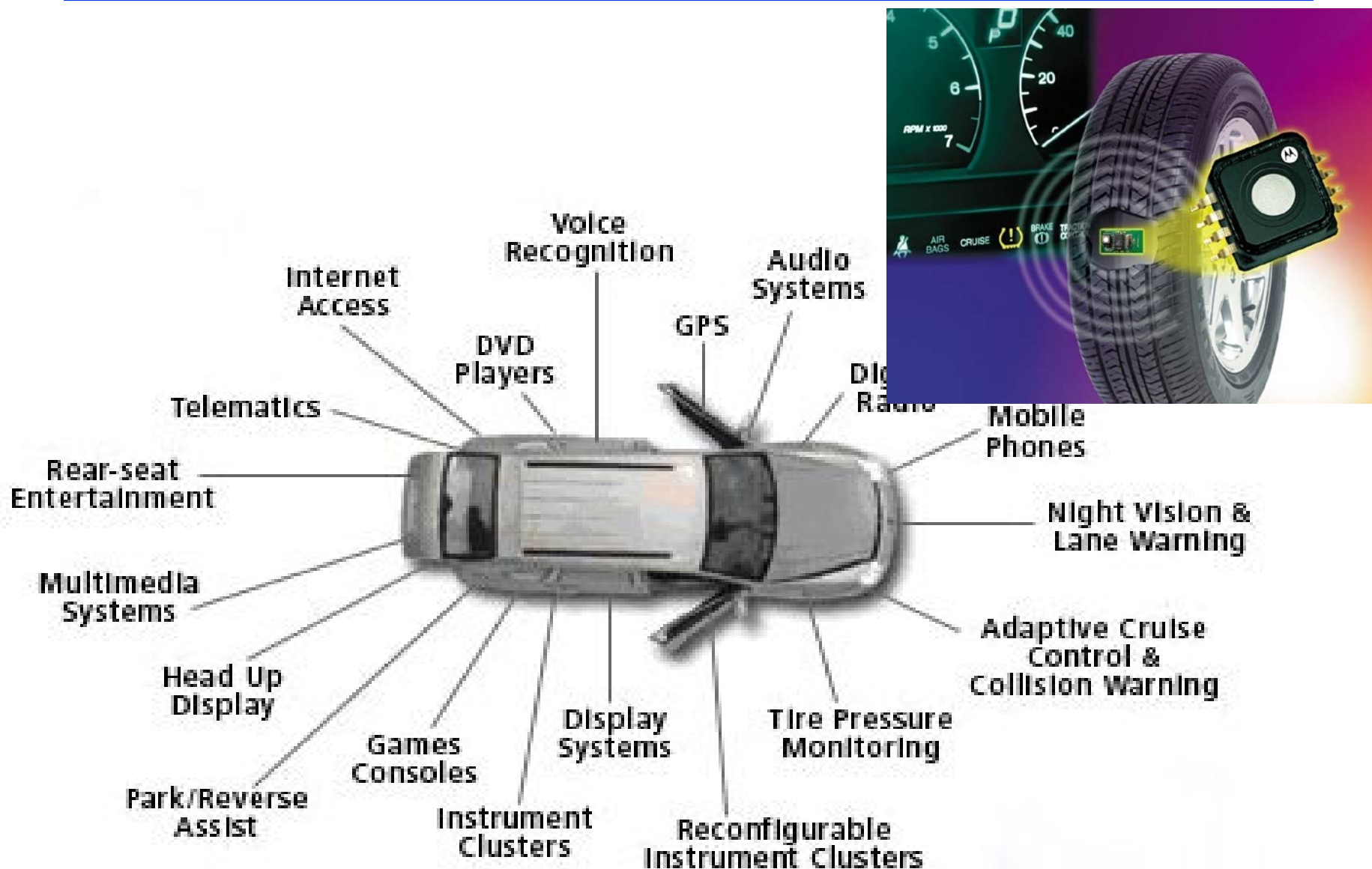
The PostPC Era

embedded growth >> desktop growth

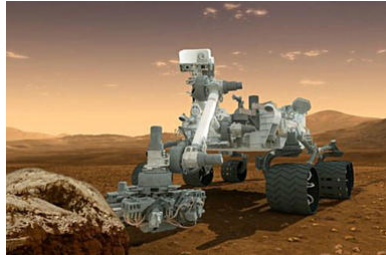


❑ Where else are embedded processors found?

Embedded Computers in You Car



Embedded Computers Everywhere



Anti-lock brakes
Auto-focus cameras
Automatic teller machines
Automatic toll systems
Automatic transmission
Avionic systems
Battery chargers
Camcorders
Cell phones
Cell-phone base stations
Cordless phones
Cruise control
Curbside check-in systems
Digital cameras
Disk drives
Electronic card readers
Electronic instruments
Electronic toys/games
Factory control
Fax machines
Fingerprint identifiers
Home security systems
Life-support systems
Medical testing systems



Modems
MPEG decoders
Network cards
Network switches/routers
On-board navigation
Pagers
Photocopiers
Point-of-sale systems
Portable video games
Printers
Satellite phones
Scanners
Smart ovens/dishwashers
Speech recognizers
Stereo systems
Teleconferencing systems
Televisions
Temperature controllers
Theft tracking systems
TV set-top boxes
VCR's, DVD players
Video game consoles
Video phones
Washers and dryers

■ UAV/Drone camera/camcorder/delivery

■ Amazon Primary Air: <http://www.amazon.com/b?node=8037720011>