
ARM Microcontrollers for Space Applications

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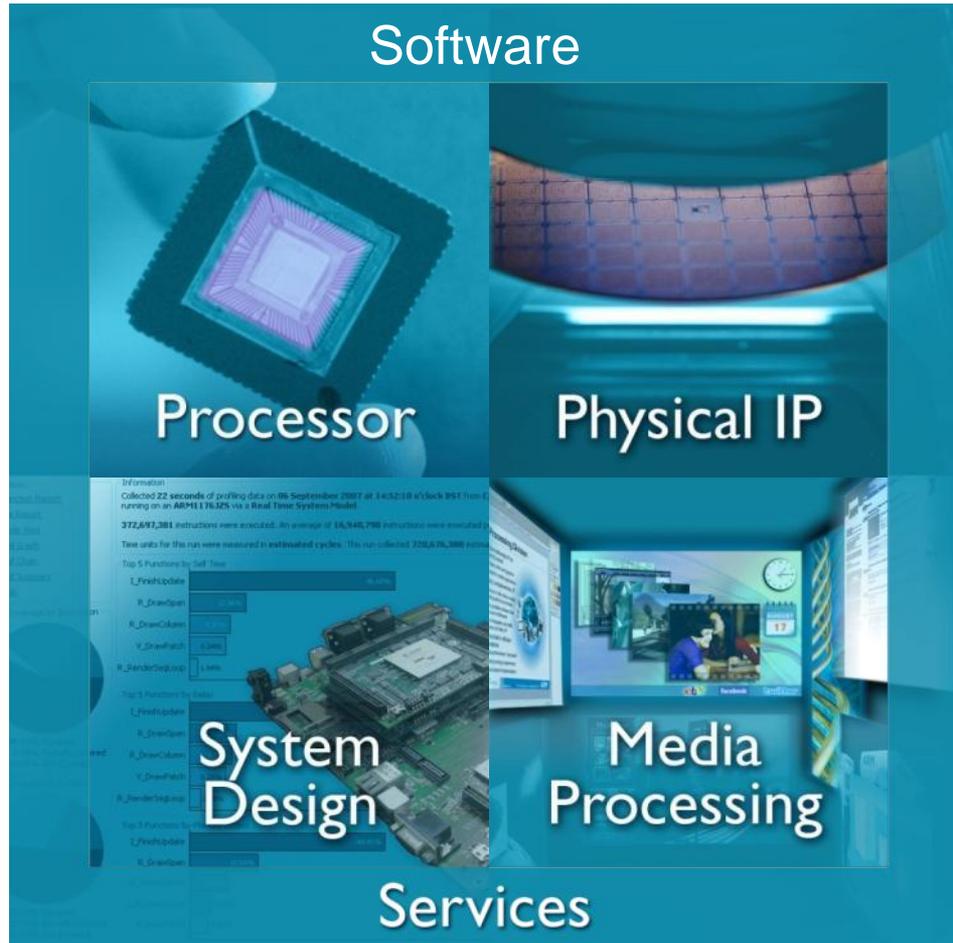
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Outline

- What does ARM do?
- ARM CPU Portfolio
- ARM Embedded CPUs and Microcontrollers
- ARM in Space/Aerospace

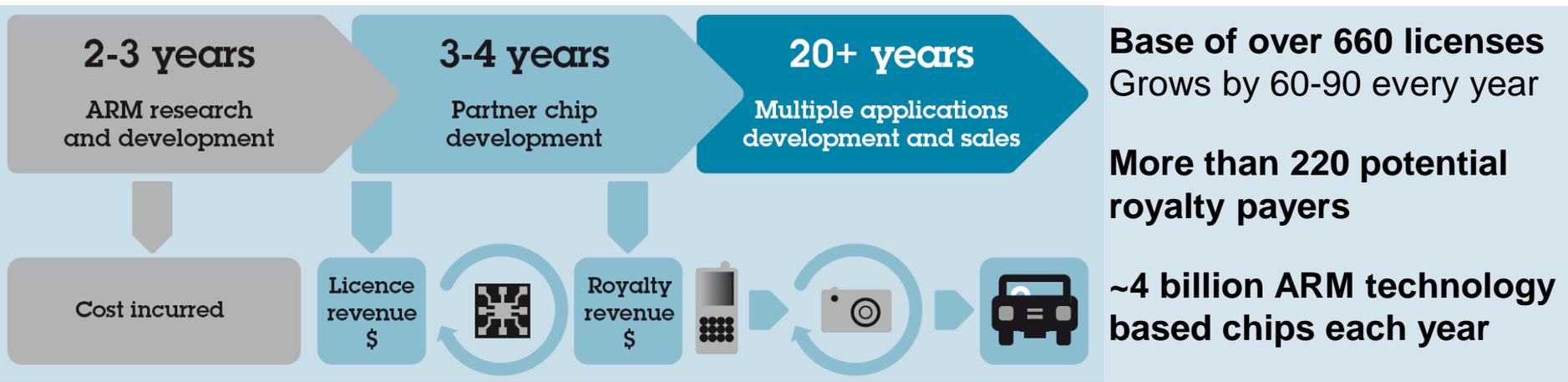
What does ARM do?

- Designs and Licenses IP



The ARM Business Model

- Global leader in the development of semiconductor IP
 - R&D outsourcing for semiconductor companies
- Innovative business model yields high margins
 - Upfront license fee – flexible licensing models
 - Ongoing royalties – typically based on a percentage of chip price
 - Technology reused across multiple applications
- Long-term, scalable growth markets



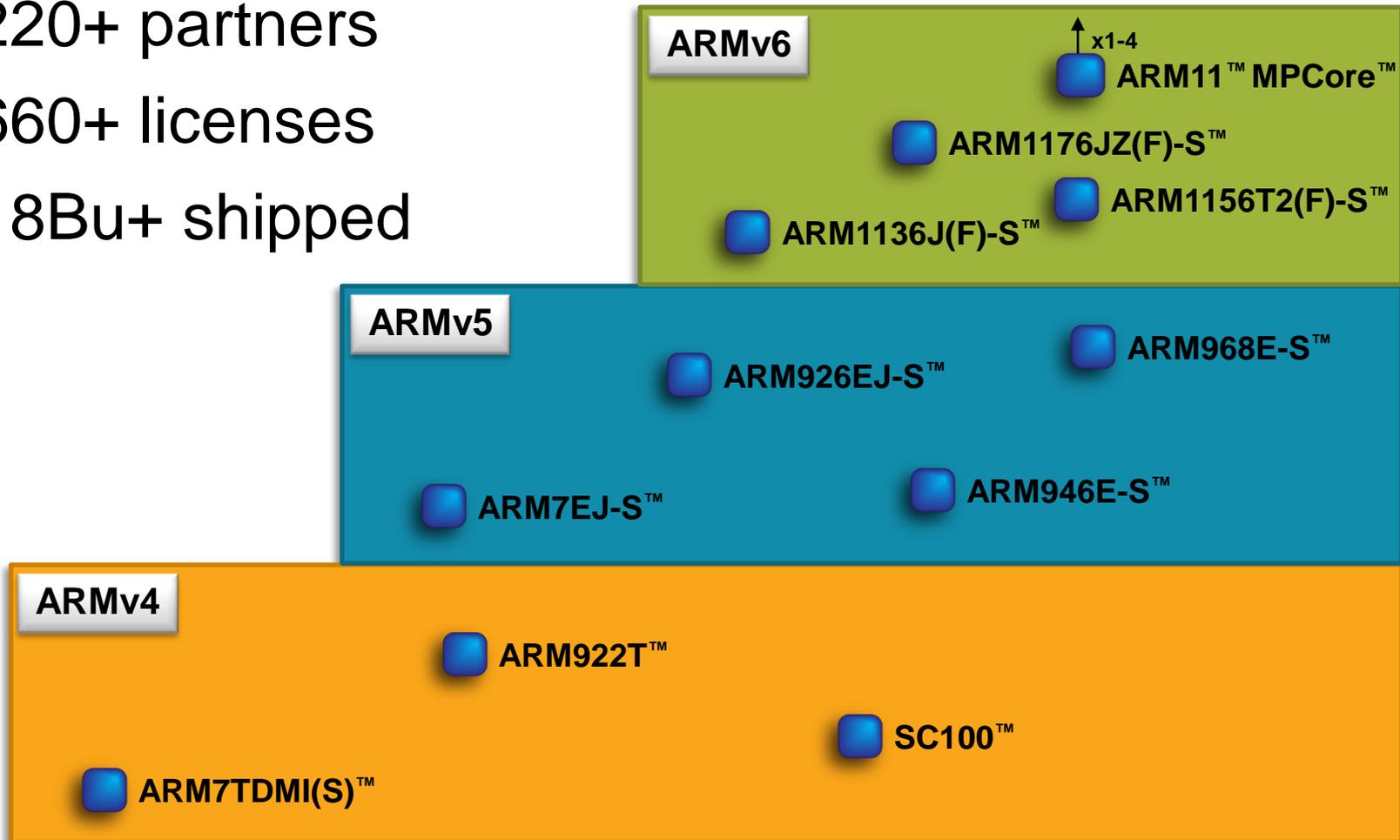
ARM Connected Community – 700+



Connect, Collaborate, Create – accelerating innovation

ARM Classic CPU Portfolio

- Classic, market-proven processor technology
- 220+ partners
- 660+ licenses
- 18Bu+ shipped



ARM Cortex Advanced Processors

Architectural innovation, compatibility across diverse application spectrum

- ARM Cortex-**A** family:

- Applications processors for smartphone, mobile computing, infrastructure, consumer electronics, netbooks and servers

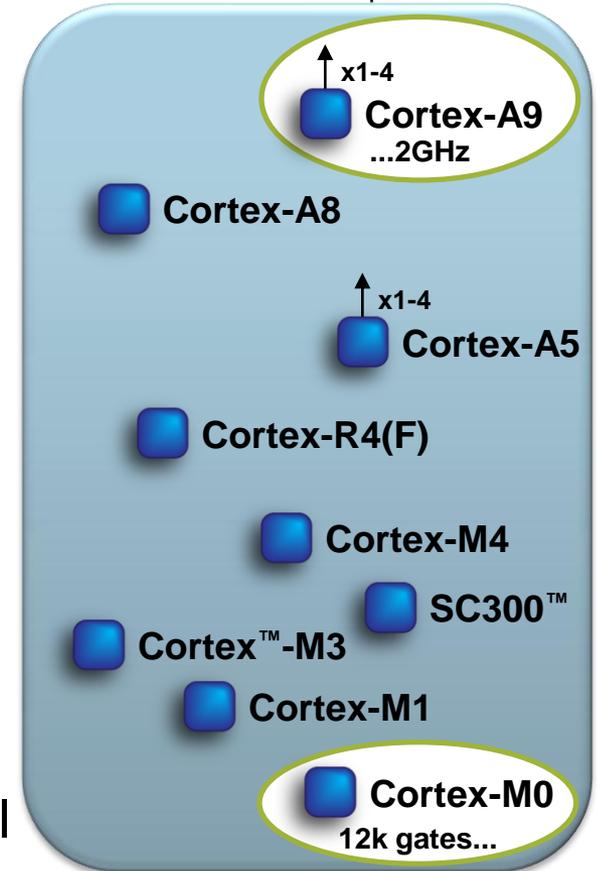
- ARM Cortex-**R** family:

- Embedded processors for real-time signal processing, hard drives and mission-critical systems

- ARM Cortex-**M** family:

- Microcontroller family for engine and industrial control, flash drives and smart cards

Cortex[™]
Low-Power Leadership from ARM[®]



ARM Cortex M and R

Features	Cortex M3	Cortex M4	Cortex R4
	32-bit Microcontroller	32-bit Microcontroller	32-bit embedded real-time CPU
Architecture	v7M	v7M	v7R
ISA	Thumb/Thumb2	Thumb/Thumb2	Thumb2 and ARM
Pipeline	3-stage single-issue	3-stage single-issue with branch prediction	8-stage dual-issue in-order with branch prediction
TCM	No	No	Yes
Cache	No	No	Yes
Memory Management	Memory Protection Unit (MPU)	Memory Protection Unit (MPU)	Memory Protection Unit (MPU)
Multi-core	No	No	Yes (redundant dual-core capability)
Floating-point Unit (FPU)	No	Single-precision	Single and double precision
SIMD/DSP support	No	8 and 16-bit SIMD and DSP instructions	Both SIMD and DSP instructions
Reliability Features	None	None	ECC/parity RAMs & Redundant core interface
Interrupt Controller	On-chip (up to 240 interrupts)	On-chip (up to 240 interrupts)	External Interrupt Controller Interface
Interrupt Latency	12 cycles	12 cycles	20 cycles
HW Divide	Yes	Yes	Yes
Software Compatibility	Thumb/Thumb2	Thumb/Thumb2	Binary compatible with M3 and M4

Power, Performance and Area

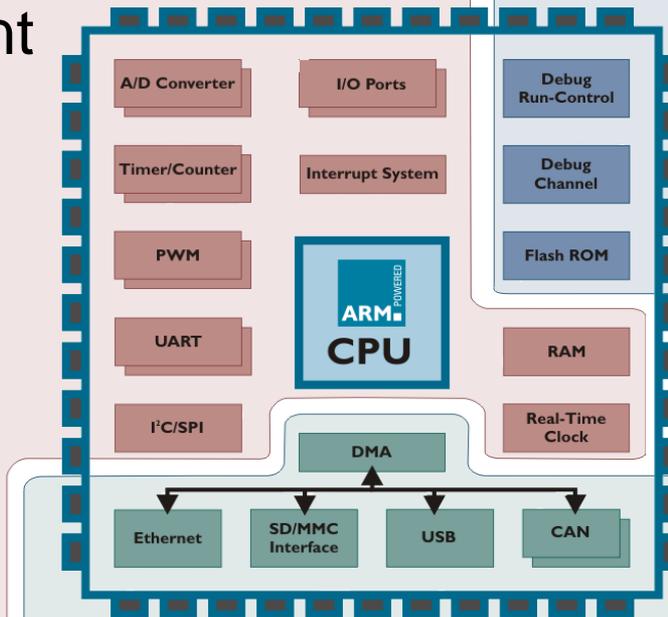
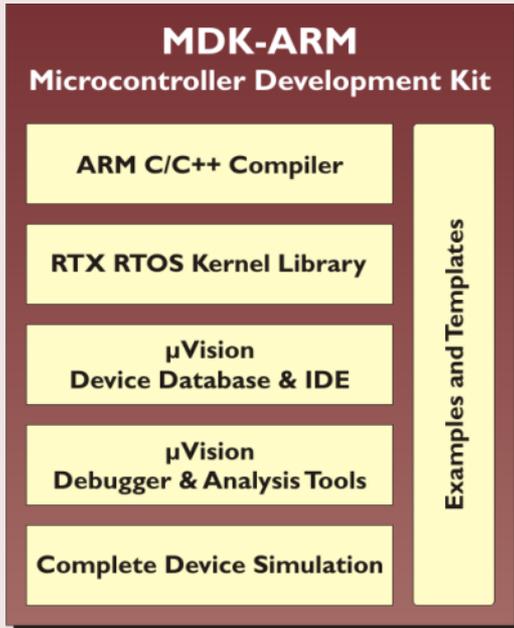
65 nm TSMC Low Power process, Advantage 10T library

	Cortex-M3	Cortex-M4	Cortex-R4
Max DMIPS	330	320	650
Max Frequency, MHz	264	256	392
Energy-efficiency , DMIPS/mW	13	12	10
Approx # of Gates in K	50	65	180
DMIPS/MHz	1.25	1.25	1.66

Typical configurations, excluding FPUs, excluding cache for R4

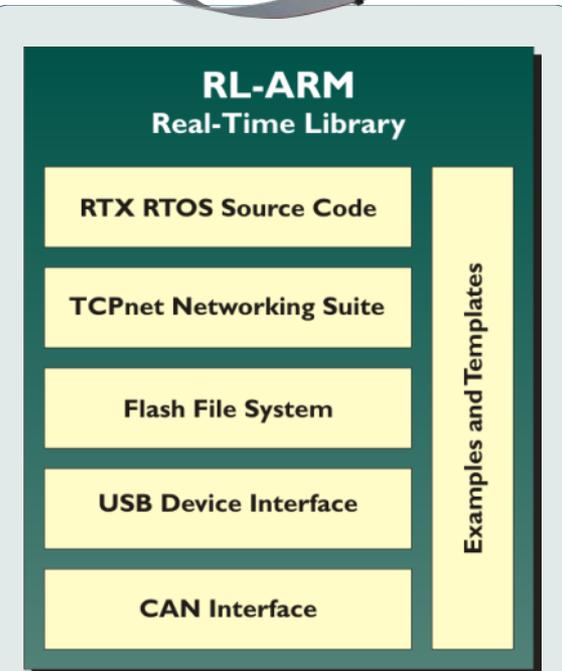
ARM Microcontroller System

■ C/C++ Development



■ Middleware

■ Debug & Trace



Growth in ARM Microcontrollers

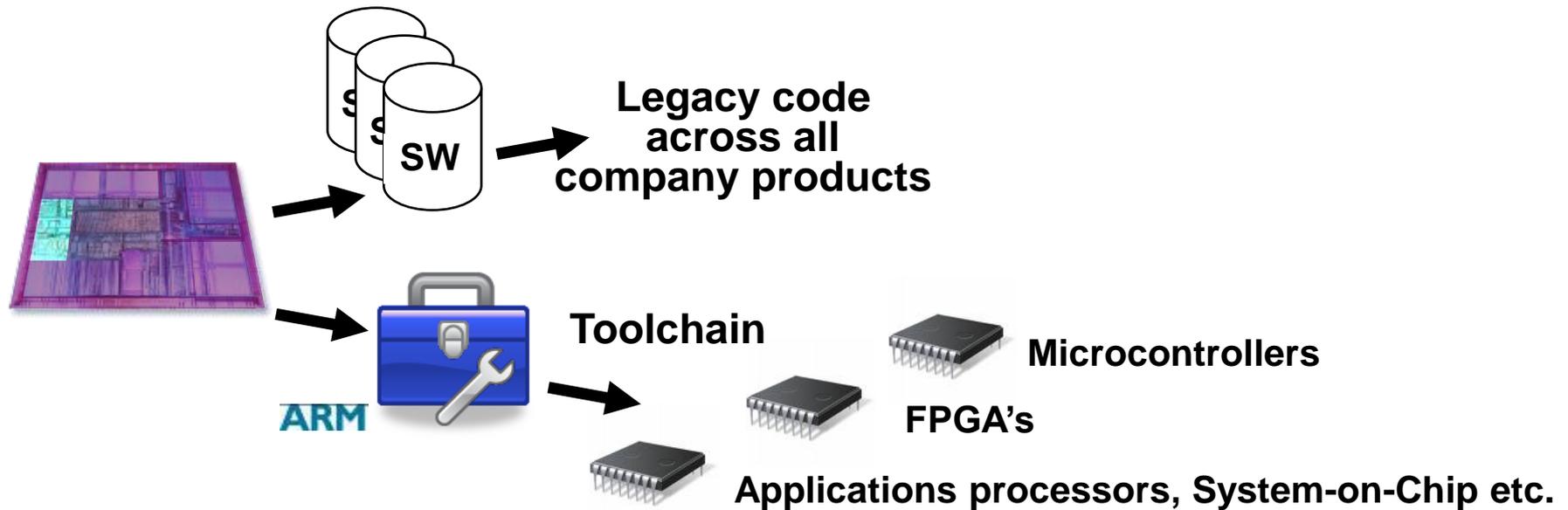


Companies with announced ARM MCU product lines

More partner announcements expected in next few months

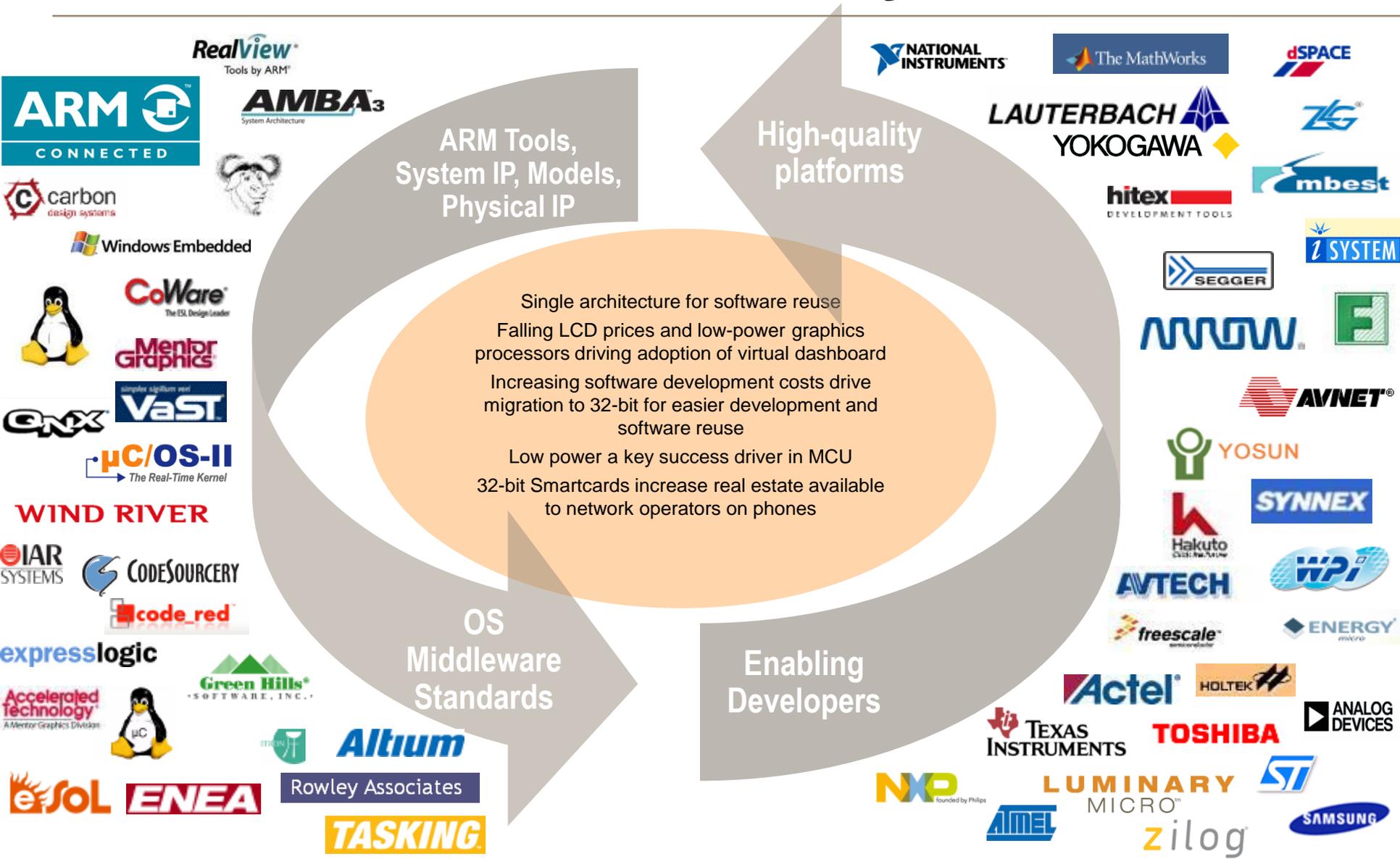
- ARM increasingly adopted as the standard 32-bit MCU architecture – recent announcements:
 - Atmel announces family of Cortex-M3 based MCUs
 - Cypress announces Cortex-M3 based pSOC
 - Fujitsu plans roadmap of Cortex-M3 based MCUs
 - ST announces STM32L family of low-power MCUs based on Cortex-M3
 - NXP demonstrates first Cortex-M0 in working silicon and announces family of low-power MCUs using M3
 - Toshiba announces ARM9 based MCU for touch-screens
 - Maxim acquires part of Zilog to gain access to ARM7/9 based MCUs
 - TI acquires Luminary to gain access to line card of over 140 products based on Cortex-M3
- Many other announcements on ARM-based products by licensees in enterprise and consumer electronics markets

Software Advantage with ARM



- **Enabling a standard platform for embedded development**
 - Protecting investment in software design
 - Enable reuse, not just from MCU to MCU but onto other digital solutions

The ARM Embedded Ecosystem

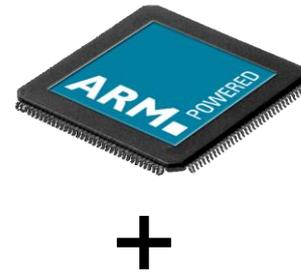


Why ARM in Space/Aerospace?

Market Segments Today



Space and Aerospace Tomorrow



Rad-hard ARM CPU Investigation

- **ARM R&D Investigates Rad-hard CPU**

- **Single Event Upset (SEU) Mitigation**

- Investigating the circuit/microarchitectural techniques for radiation hardening, e.g. Triple Modular Redundancy (TMR), and ECCs for SRAMs/buses

- **Potential Markets**

- Space
 - Aerospace
 - Terrestrial Radiation-sensitive (Nuclear Reactors, Particle Accelerators and X-Ray Cargo Scanning)
 - Medical (CT, Ultrasound, MRI and implantable devices)
 - Automotive (ABS, EBS, Cruise and Airbag control devices)

Questions?