Details of the ARM Architecture

Sommerakademie in Leysin
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Studienstiftung
des deutschen Volkes

Outline

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- As of 2014 50 billion ARM chips produced thus far, 15 bn in 2015
  Share of about 90 % at smartphones

In General

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Summary

RISC reduces amount of hardware, CISC focuses performance

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4. **Load/Store architecture:** Processor operates only on registers. Load and Store instructions access external memory

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- Additionally "Current Program Status Register" (CPSR)

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Supported instruction set modes:

- Jazelle provides direct support of Java bytecode
- Thumb instructions

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- Lack of performance due to less functionality

Basic Pipeline Scheme

- Up to ARM7 : Fetch - Decode - Execute
- With ARM9 : Fetch - Decode - Execute - Memory - Write
- With ARM10 : Fetch - Issue - Decode - Execute - Memory - Write
- Newer generations up to 14 stage pipeline (e.g. ARM Cortex-A8)
- ARM Cortex-A8 first to incorporate superscalar elements

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Classical distinction between RISC and CISC blurs the more it has been developing

Power Consumption: RISC Architecture

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	0.5 - 1.9 W	130 W (TDP)

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- ARM design allows purpose-oriented optimization
- **System-on-a-Chip** (SoC): Suitable additional components melted together with ARM core
- Only required components ⇒ Only required power

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- Liquid cooling/heat pipe technique in smartphones

Heat Dissipation

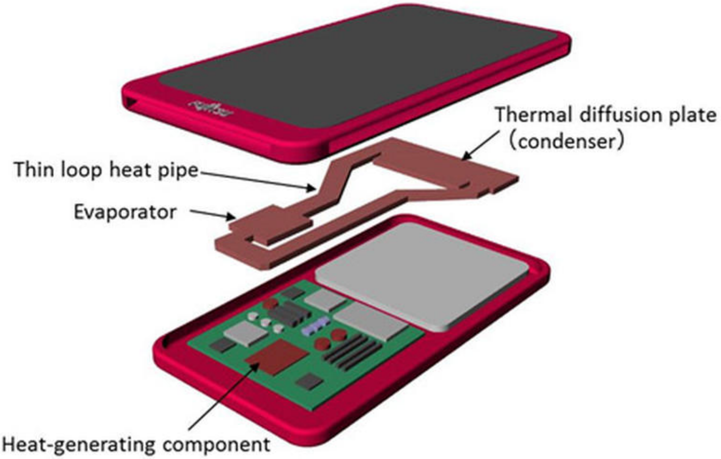
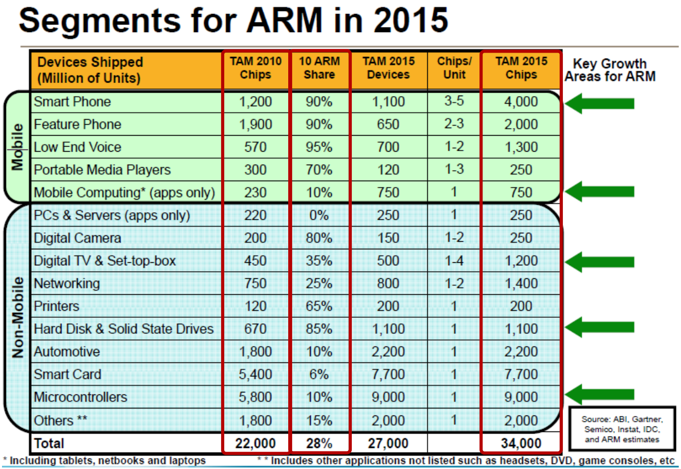


Figure: `http://www.zdnet.com/article/fujitsu-has-a-cool-liquid-answer-to-hot-spots-in-smartphones/`

The ARM Ecosystem

- Licensing model allows various companies to implement technology
- SoCs for every conceivable purpose powered by ARM cores
- Creating versatile, specialized market based on a common architecture
- ARM instruction set already dominant on smartphone market (Android and iOS)

Applications of ARM



Segments for ARM in 2015

	Devices Shipped (Million of Units)	TAM 2010 Chips	10 ARM Share	TAM 2015 Devices	Chips/ Unit	TAM 2015 Chips	Key Growth Areas for ARM
Mobile	Smart Phone	1,200	90%	1,100	3-5	4,000	←
	Feature Phone	1,900	90%	650	2-3	2,000	
	Low End Voice	570	95%	700	1-2	1,300	
	Portable Media Players	300	70%	120	1-3	250	
	Mobile Computing* (apps only)	230	10%	750	1	750	←
Non-Mobile	PCs & Servers (apps only)	220	0%	250	1	250	
	Digital Camera	200	80%	150	1-2	250	
	Digital TV & Set-top-box	450	35%	500	1-4	1,200	←
	Networking	750	25%	800	1-2	1,400	
	Printers	120	65%	200	1	200	
	Hard Disk & Solid State Drives	670	85%	1,100	1	1,100	←
	Automotive	1,800	10%	2,200	1	2,200	
	Smart Card	5,400	6%	7,700	1	7,700	
	Microcontrollers	5,800	10%	9,000	1	9,000	←
	Others **	1,800	15%	2,000	1	2,000	
	Total	**22,000**	**28%**	**27,000**		**34,000**	

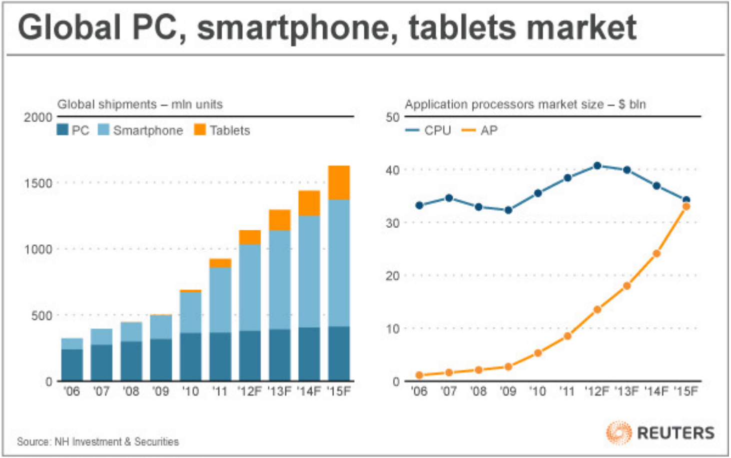
Source: ABI, Gartner, Semico, Instat, IDC, and ARM estimates

* Including tablets, netbooks and laptops

* * Includes other applications not listed such as headsets, DVD, game consoles, etc

Figure: http://www.cityindex.co.uk/market-analysis/market-news/40069092016/arm-shares-steady-on-firm-grip-of-smartphone-market/

Competition with PC Market



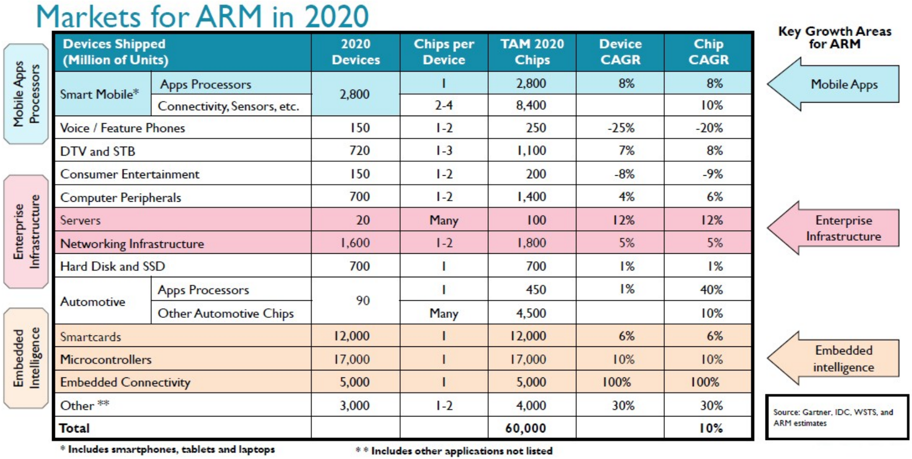
Reuters graphic/Christine Chan 20/06/12

Figure: http://gadgets.ndtv.com/mobiles/news/smart-logic-samsung-chips-away-at-intel-lead-234639

64-bit ARM Architecture

- ARM Cortex-A50 series released in 2013 with 64-bit architecture
- First consumer device: iPhone 5S with Apple A7 processor
- Improvements:
  - Using 64-bit adresses, no 3.5 GB memory limitation
  - 31 instead of 15 general purpose registers

Future Markets



Markets for ARM in 2020

Devices Shipped (Million of Units)		2020 Devices	Chips per Device	TAM 2020 Chips	Device CAGR	Chip CAGR
Smart Mobile*	Apps Processors	2,800	1	2,800	8%	8%
	Connectivity, Sensors, etc.		2-4	8,400		10%
Voice / Feature Phones		150	1-2	250	-25%	-20%
DTV and STB		720	1-3	1,100	7%	8%
Consumer Entertainment		150	1-2	200	-8%	-9%
Computer Peripherals		700	1-2	1,400	4%	6%
Servers		20	Many	100	12%	12%
Networking Infrastructure		1,600	1-2	1,800	5%	5%
Hard Disk and SSD		700	1	700	1%	1%
Automotive	Apps Processors	90	1	450	1%	40%
	Other Automotive Chips		Many	4,500		10%
Smartcards		12,000	1	12,000	6%	6%
Microcontrollers		17,000	1	17,000	10%	10%
Embedded Connectivity		5,000	1	5,000	100%	100%
Other **		3,000	1-2	4,000	30%	30%
Total				**60,000**		**10%**

* Includes smartphones, tablets and laptops

** Includes other applications not listed

Source: Gartner, IDC, WSTS, and ARM estimates

Figure: http://www.nextplatform.com/2015/10/06/why-are-we-still-waiting-for-arm-servers/

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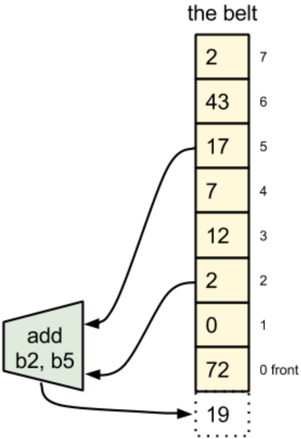

Figure: http://millcomputing.com/blog/wp-content/uploads/2014/02/intro_belt.png

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Problems:

- Very, very, complex programming

`<insert obligatory cookie/potato meme here>`

Sänk ju!