HTTP Servers – State-of-the-art and requirements for embedded hardware

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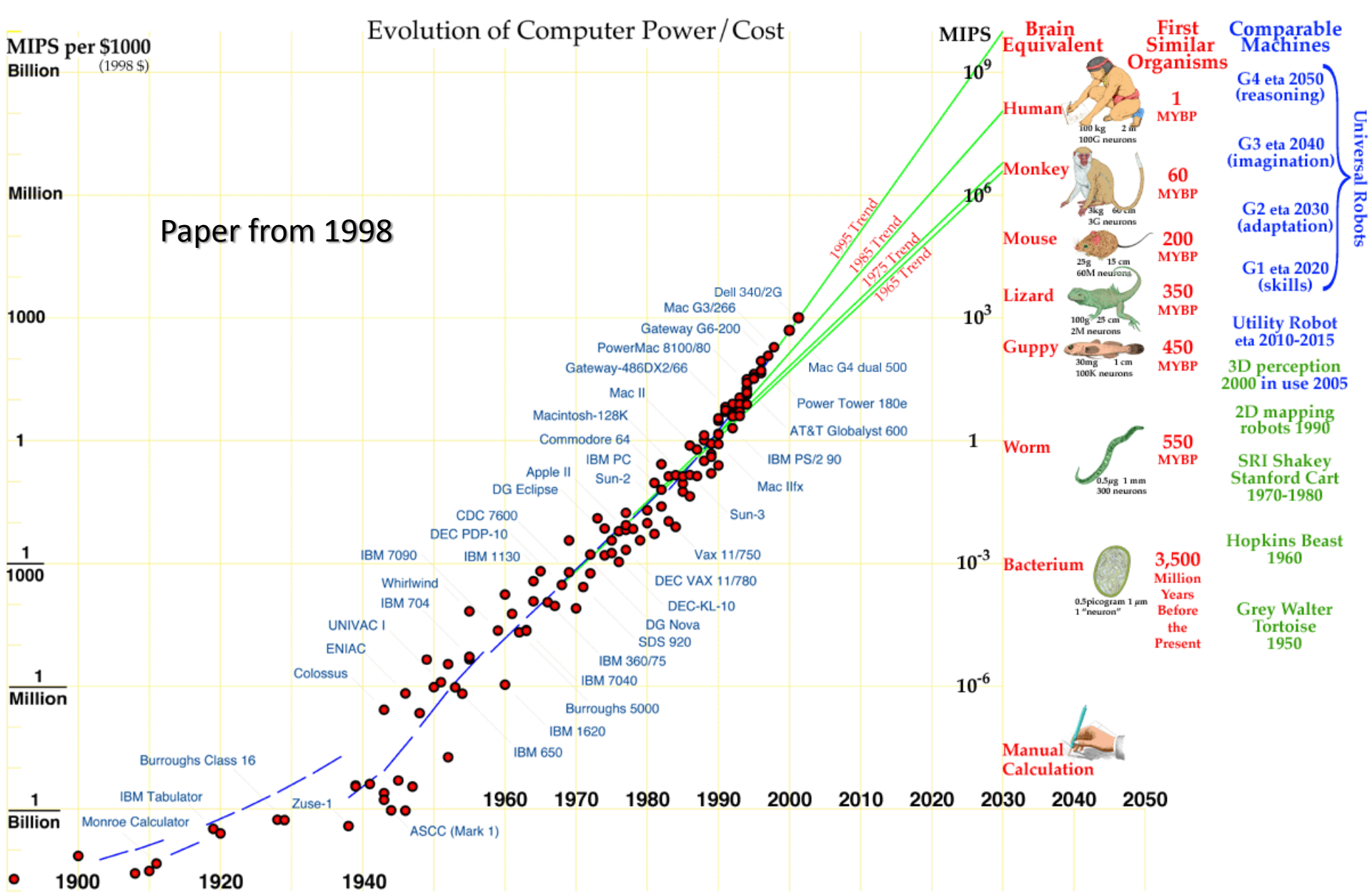
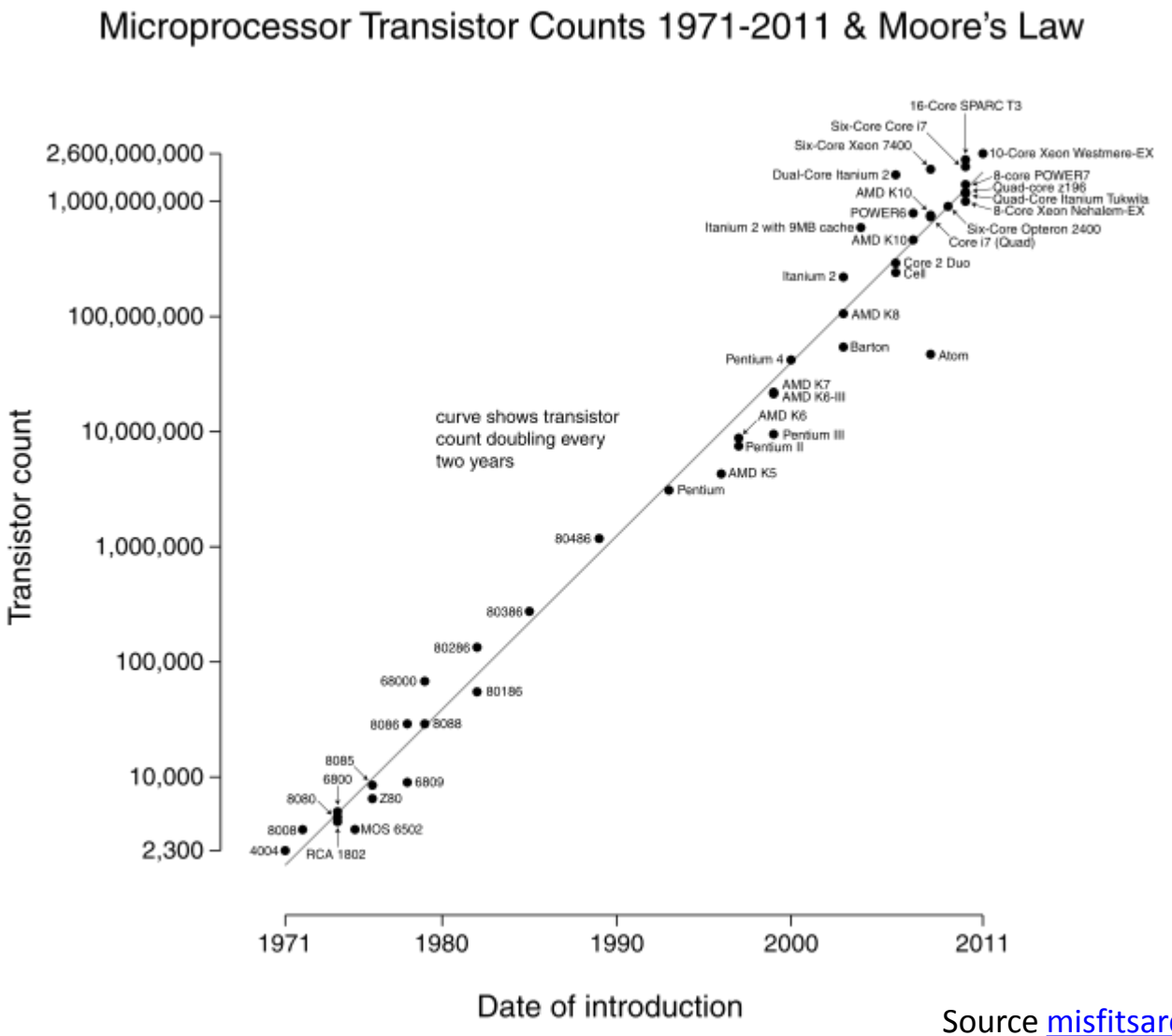


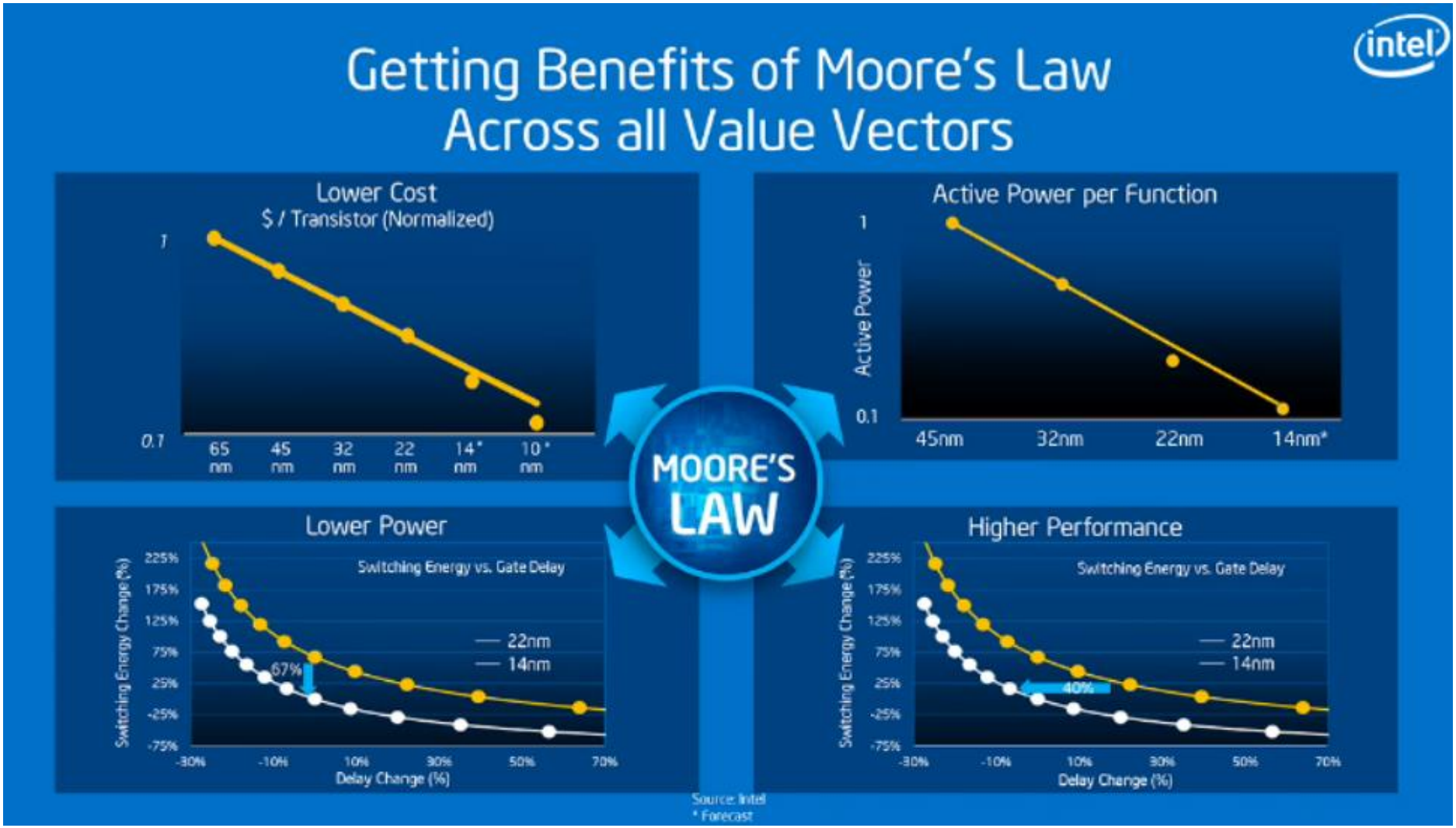
Hans Moravec http://www.frc.ri.cmu.edu/~hpm/

Number of transistors on a computer chip doubles approx. every two years

Moore's law

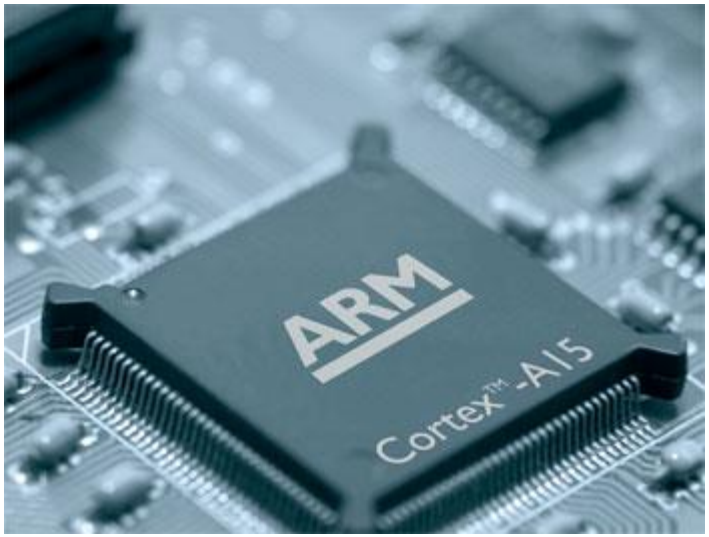


Source misfitsarchitecture.com



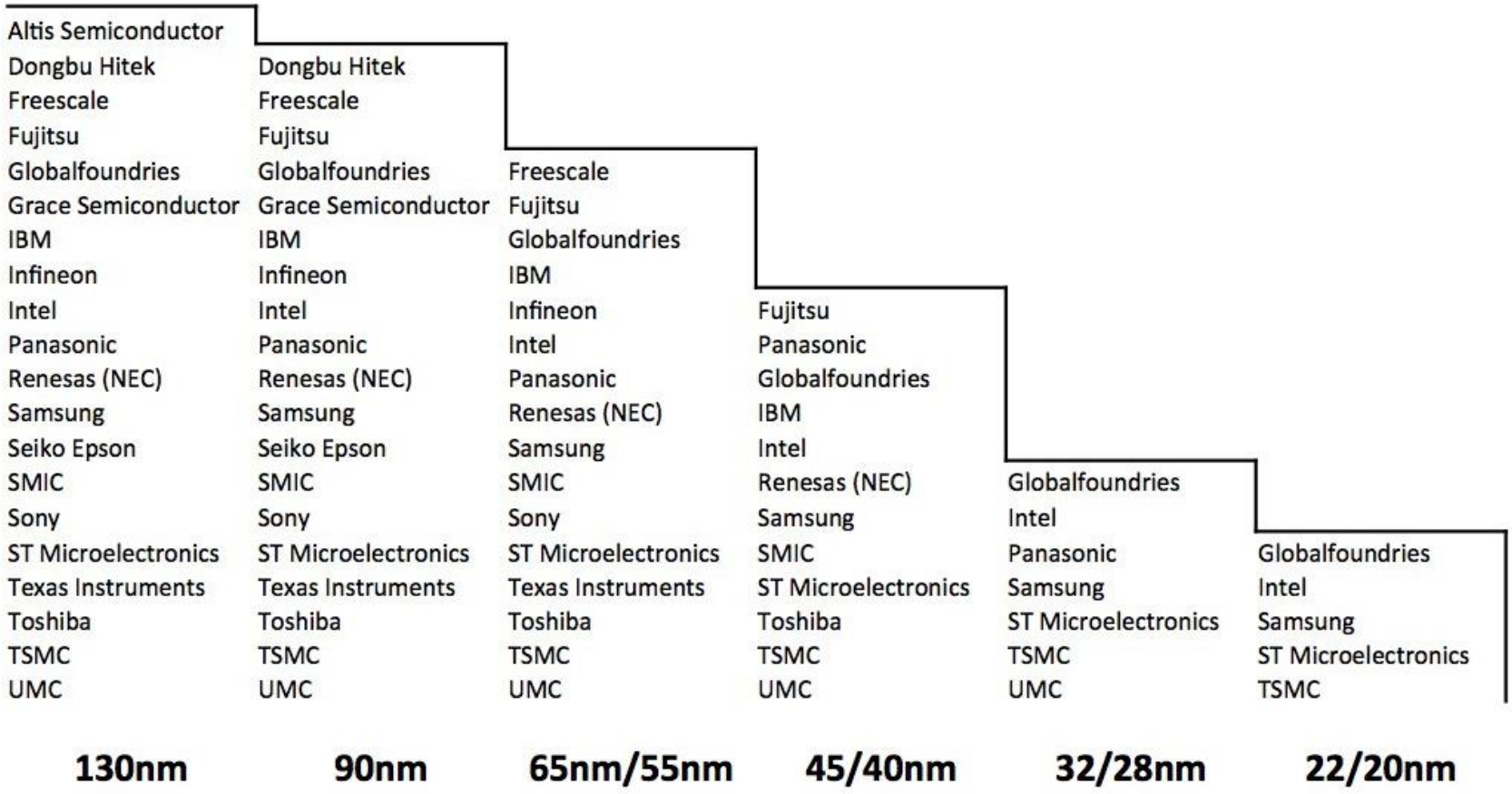
Source Intel

Development over last decade

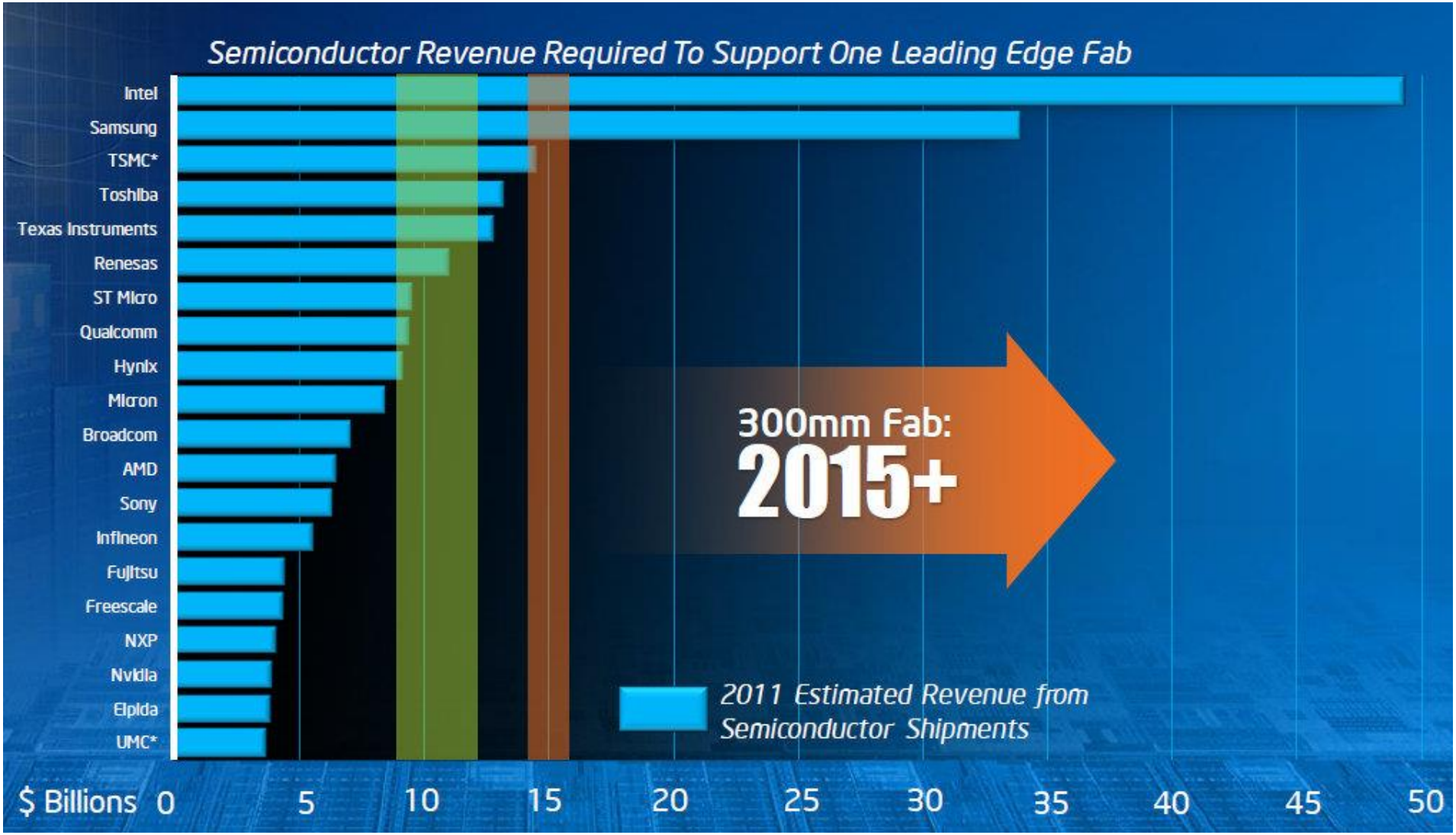


Source ARM

Fabs: not as popular as they used to be



Source: http://www.theregister.co.uk

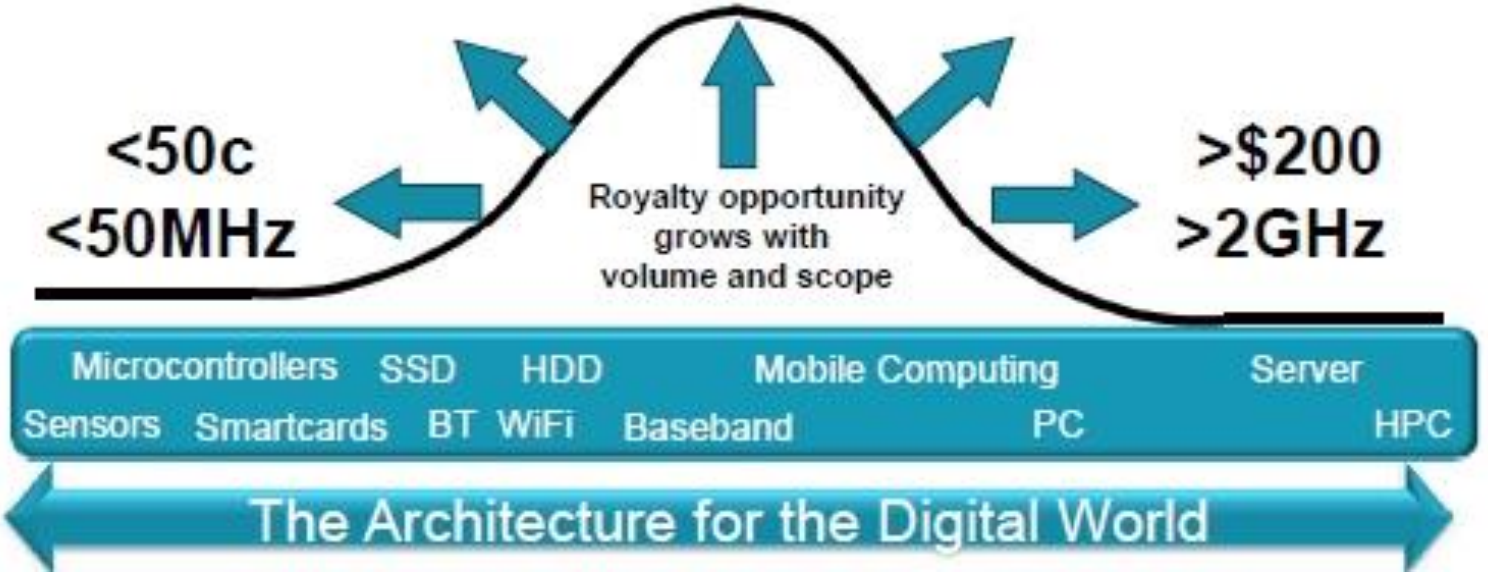


www.cnx-software.com

Embedded technology

ARM's 2020 Vision

- ARM is growing into new markets and product categories
  - From sensors to servers, from 50c to $200, from <50MHz to >2GHz
- Today's processor licenses drive shipments beyond 2015
- Expect over 100 billion cumulative ARM based chips by 2020

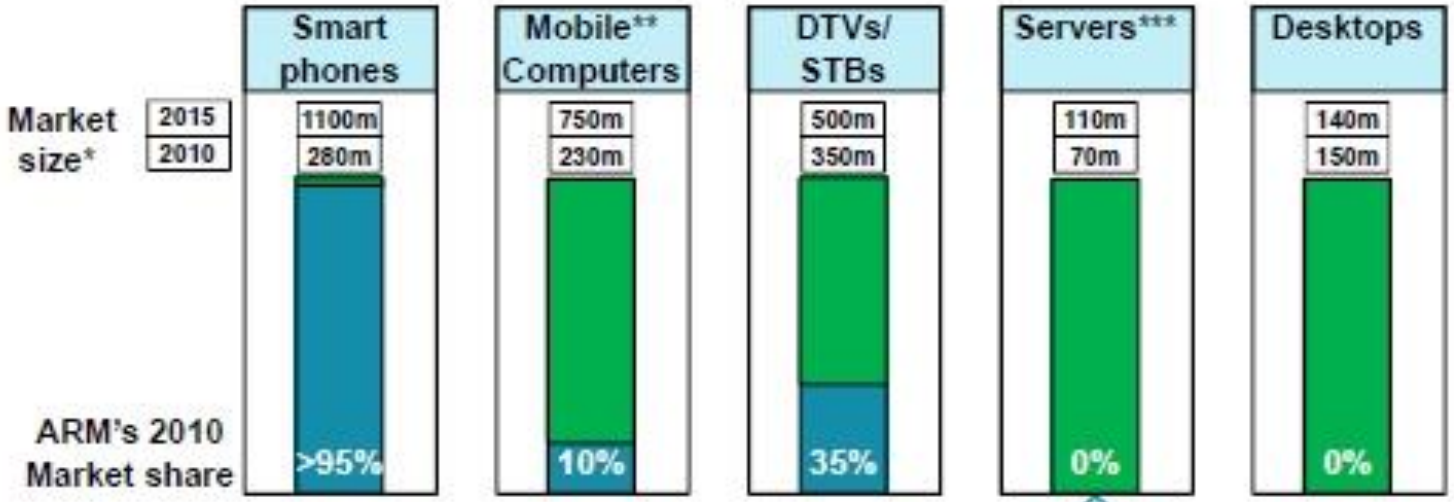


Source: http://www.theregister.co.uk

Embedded technology

ARM's High Performance Computing

- ARM Cortex-A family are used as applications processors in a wide range of computing products



Source: http://www.theregister.co.uk

ARM Roadmap

Launch of Multicore Mali-T658 GPU

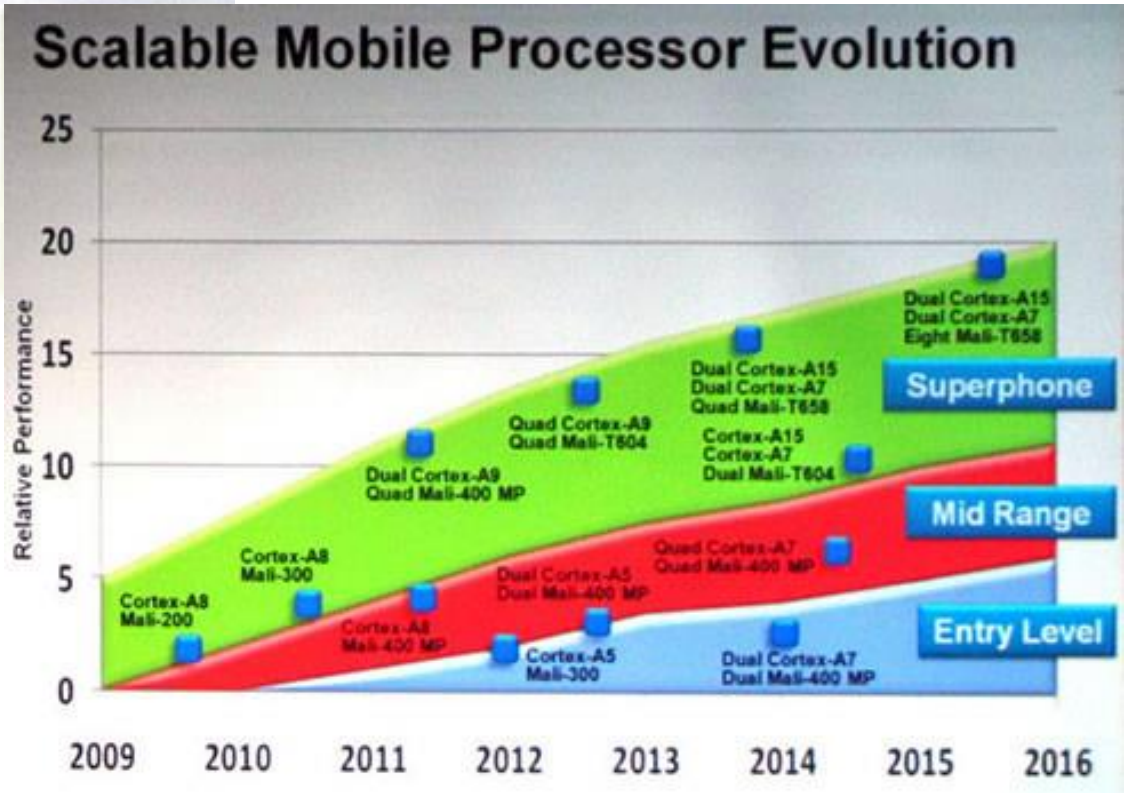
- **Up to 10x graphics performance** compared to mainstream Mali-400 MP implementations
- **4x GPU compute performance** compared to Mali-T604 implementations
- Scalable to **8 cores**
- Next **Midgard** GPU: building on the **technology leadership** of Mali-T604
  - Perfect embedded high-end GPU for 4K mass markets
  - Highest performance GPU for immediate design start
- Common set of drivers enables **faster time-to-market** and **minimizes** software upgrade **costs**
- **ARM system–level approach** to GPU Compute now in place
- Compatible with **ARMv8**

FUJITSU

LG

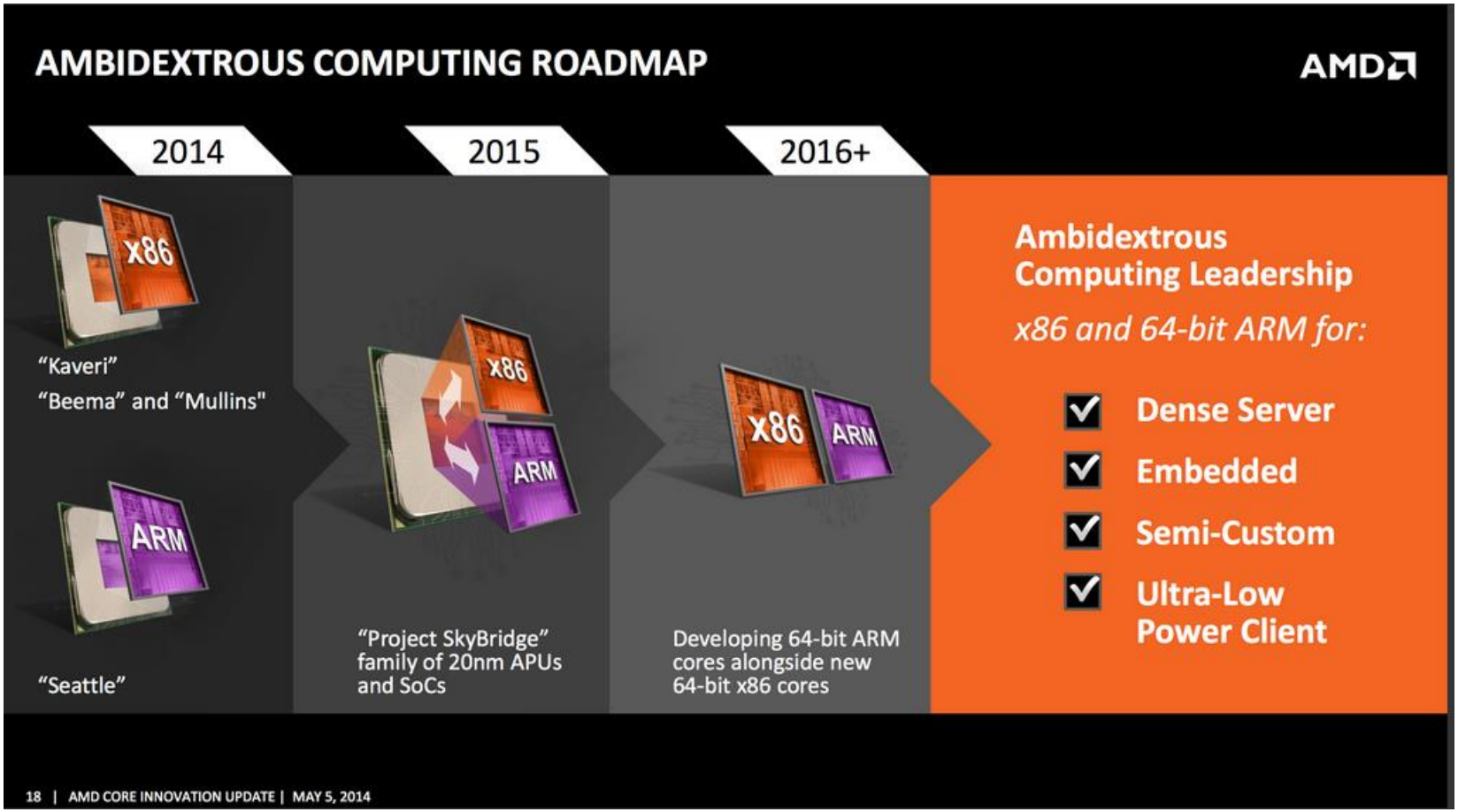
NUFRON

SAMSUNG



http://www.cdrinfo.com/

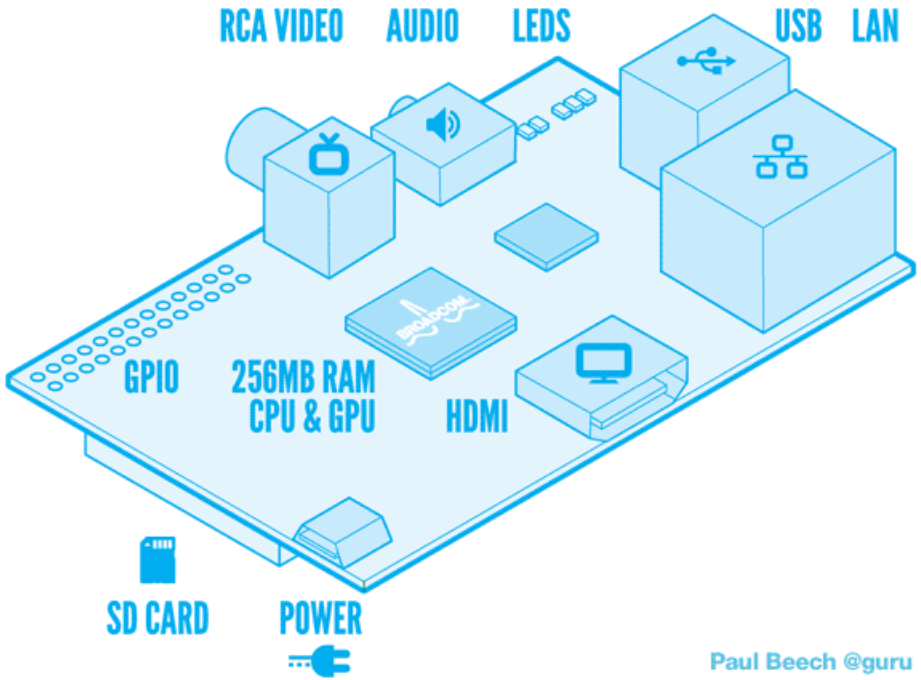
AMD Roadmap



http://wccftech.com/

Raspberrypi.org

- Credit card-sized computer released 2012
- Charity foundation founded in 2009
  to promote the study
  of basic computer science
- Keyboard, TV connector, HD Video
- Price tag $25 to $35
- Various OSs



Raspberrypi.org

	Model A	Model B
Target price:[7]	US$ 25	US$ 35[73]
SoC:[7]	Broadcom BCM2835 (CPU, GPU, DSP, SDRAM, and single USB port)[3]	
CPU:	700 MHz ARM1176JZF-S core (ARM11 family, ARMv6 instruction set)[3]	
GPU:	Broadcom VideoCore IV @ 250 MHz[74][75] OpenGL ES 2.0 (24 GFLOPS) MPEG-2 and VC-1 (with license[71]), 1080p30 h.264/MPEG-4 AVC high-profile decoder and encoder[3]	
Memory (SDRAM):	256 MB (shared with GPU)	512 MB (shared with GPU) as of 15 October 2012
USB 2.0 ports:[14]	1 (direct from BCM2835 chip)	2 (via the built in integrated 3-port USB hub)[66]
Video input:	A CSI input connector allows for the connection of a RPF designed camera module[76]	
Video outputs:[7]	Composite RCA (PAL and NTSC), HDMI (rev 1.3 & 1.4),[77] raw LCD Panels via DSI[78][79] 14 HDMI resolutions from 640×350 to 1920×1200 plus various PAL and NTSC standards.[80]	
Audio outputs:[7]	3.5 mm jack, HDMI, and, as of revision 2 boards, I²S audio[81] (also potentially for audio input)	
Onboard storage:[14]	SD / MMC / SDIO card slot (3,3V card power support only)	
Onboard network:[7][14]	None	10/100 Ethernet (8P8C) USB adapter on the third port of the USB hub[66]
Low-level peripherals:	8 × GPIO,[82] UART, I²C bus, SPI bus with two chip selects, I²S audio[83] +3.3 V, +5 V, ground[74][84]	
Power ratings:	300 mA (1.5 W)[85]	700 mA (3.5 W)
Power source:[7]	5 volt via MicroUSB or GPIO header	
Size:	85.60 mm × 53.98 mm (3.370 in × 2.125 in)[86]	
Weight:	45 g (1.6 oz)[87]	
Operating systems:	Arch Linux ARM,[2] Debian GNU/Linux, Fedora, FreeBSD, NetBSD, Plan 9, Raspbian OS, RISC OS,[30] Slackware Linux[88]	

Ref: Wiki

FLOPS

Date	Approximate cost per GFLOPS	Approximate cost per GFLOPS inflation adjusted to 2012 dollars[45]	Least expensive platform able to achieve 1 GFLOPS
1961	US $1,100,000,000,000 ($1.1 trillion)	US $8.3 trillion	About 17 million IBM 1620 units costing $64,000 each
1984	$15,000,000	$33,000,000	Cray X-MP
1997	$30,000	$42,000	Two 16-processor Beowulf clusters with Pentium Pro microprocessors[47]
April			
November 2013	$0.16	$0.16	AMD Sempron 145 GeForce GTX 760 System	Built using commercially available parts, a system using one AMD Sempron 145 and three GeForce GTX 760 reaches a total of 6.771 TFLOPS for a total cost of $1090.66.[53]
December 2013	$0.12	$0.12	Pentium G550 R9 290 System	Built using commercially available parts. Pentium G550 & AMD R9 290 tops out at 4.848 TFLOPS grand total of $681.84 USD.[54]
August 2007	$48	$52	Microwulf
March 2011	$1.80	$1.80	HPU4Science
August 2012	$0.75	$0.73	Quad AMD7970 GHz System
June 2013	$0.22	$0.22	Sony Playstation 4

@24GFLOPS=$3.48

@24GFLOPS=$2.88

@24GFLOPS=$43

@24GFLOPS=$17.50

@24GFLOPS=$5.30

http://en.wikipedia.org/wiki/FLOPS

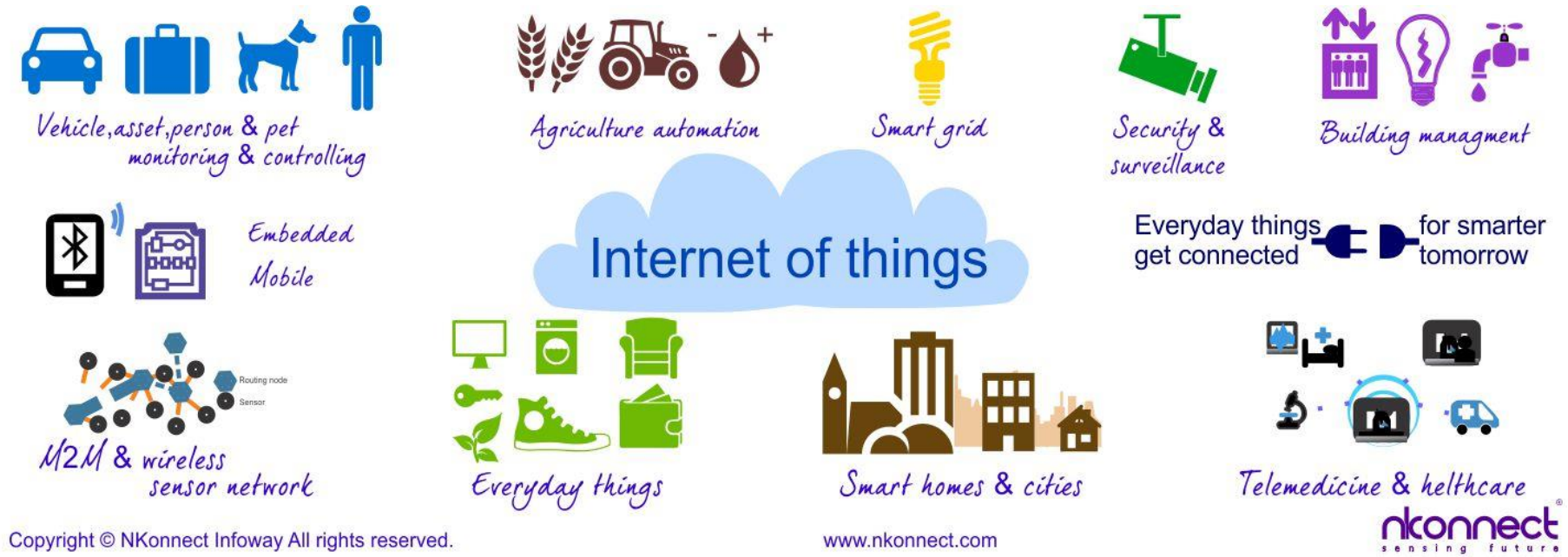
Raspberry Pi competitors

- Banana Pi (Dual Core)
- Cubieboard (Dual Core)
- Beagle Bone Black
- Intel Galilieo
- Intel Edison
- Arduino Tre
- Humming Board
- Minnow Board
- Odroid-U3
- Udoo
- Radxa Rock
- ……..

@$50 Sept 2014

Source Intel

Internet of Things (IoT)



Embedded HTTP Servers Requirements

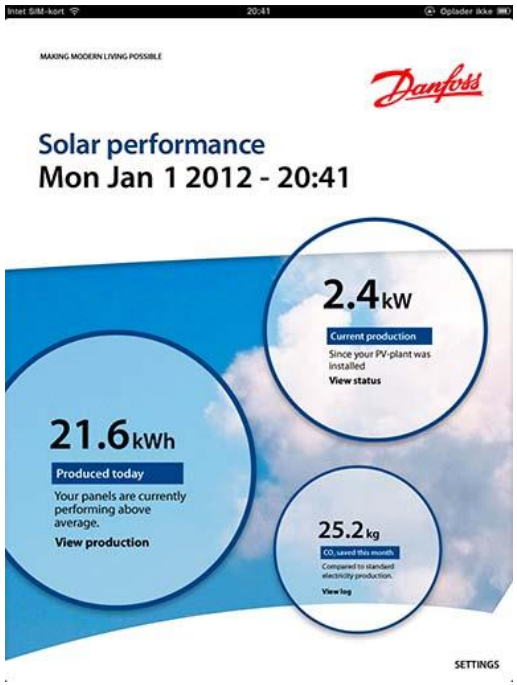
- Small resource footprint (RAM/CPU)
- Cross-platform, support multiple OS / no-OS
- Easy integration into controller / sensor apps
- Serving pages from memory if no file system
- Modular
- Single / multi-thread support

(Embedded) HTTP Servers

Name	Features
Mongoose	X-Platform, Lib + Stand-alone, Multi-threaded, GPL, C
Libmicrohttpd	X-Platform, LGPL2.1, Multi-threaded, C
TNTNet	Linux/Posix, LGPL2.1 (C++)
TinyWebServer	Small web server for Arduino, fits in 10KB ROM, less than 512 bytes RAM, C++
Contiki	Tiny embedded OS with http server support
Poco C++ Libs	X-Platform, Modular Lib, SSL, Single/Multi-threaded, In-Mem Boost License
Apache2	Heavy weight, ultra-comprehensive, OS required, Processes/Thread-based
NodeJS	Requires OS, JavaScript, Event-based→System resources manages by OS
Nginx	Handle C10k "get one web server to handle 10,000 connections", Event-based →System resources manages by OS
…	…

Embedded HTTP Servers

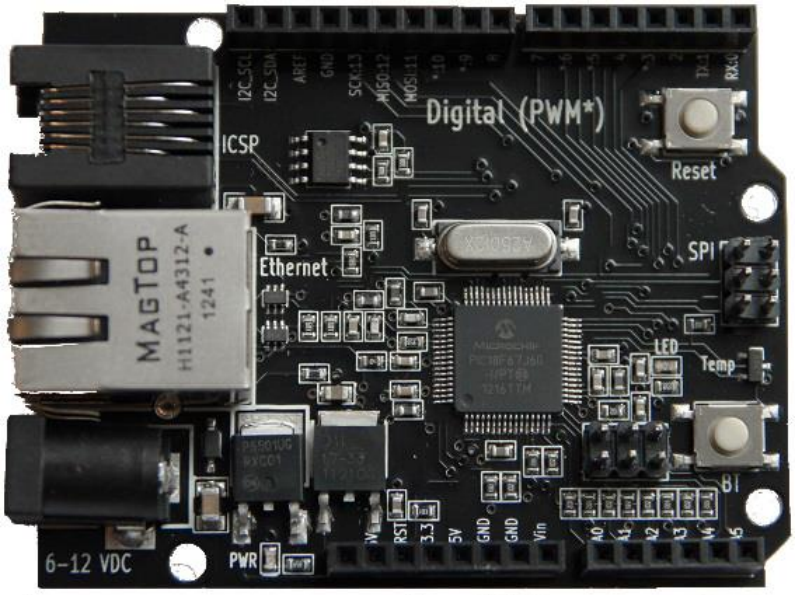
- Nabto SDK http://nabto.com/
- 20 kB Web Server Example: Web Enabled Embedded Device
- Enable users to access your product from a web browser or mobile / tablet device. Direct access, strong encryption, no intermediate cloud data storage - all taken care of by the Nabto framework.



Source: Danfoss

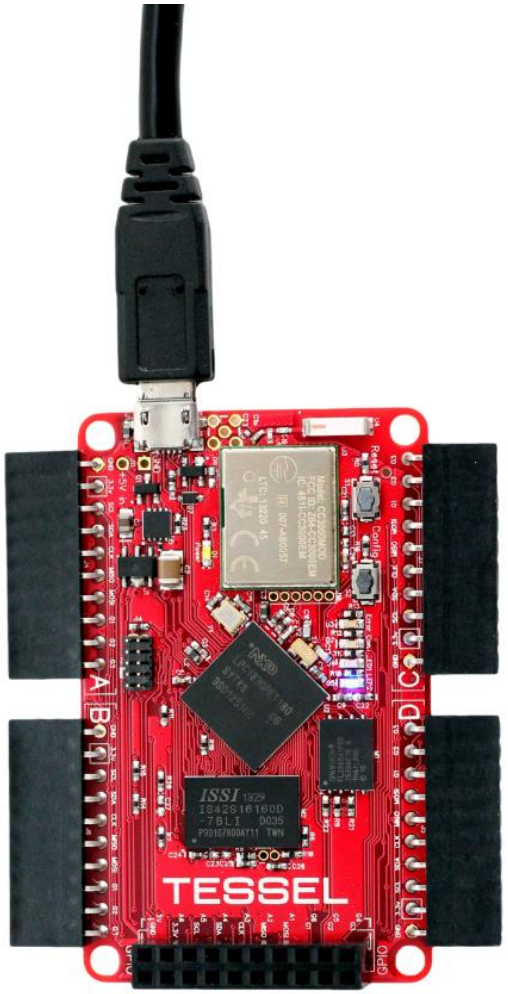
Embedded HTTP Servers

- The Nabduino board is an open source peer-to-peer remote access embedded board with a user modifiable web-interface developed by Nabto.
- 33€
- http://www.nabduino.com/



Embedded HTTP Servers

- Tessel, NodeJS Embedded System
- "Use it to easily make physical devices that connect to the web"
- $99 → Still expensive
- https://tessel.io/



Embedded HTTP Servers Experiment

- Test: 300 concurrent HTTP requests to Cubietruck Ubuntu HTTP Server from Laptop Node.js Client
- Apache2 → Best 4s, average 5s+/-2s, CPU Load <1%, many processes spawned
- Node.js -> Best 4s, average 4s+/-0.5s, CPU Load <3% continuously increasing after experiment repeat
- PocoNet -> Best <1s, average 2s +/-2s, CPU Load <3%

Embedded HTTP Servers Conclusions

- Lean C++ implementation seems to perform best as expected
- More and better defined testing on multiple platforms still needed