The friendly operating system for the IoT!

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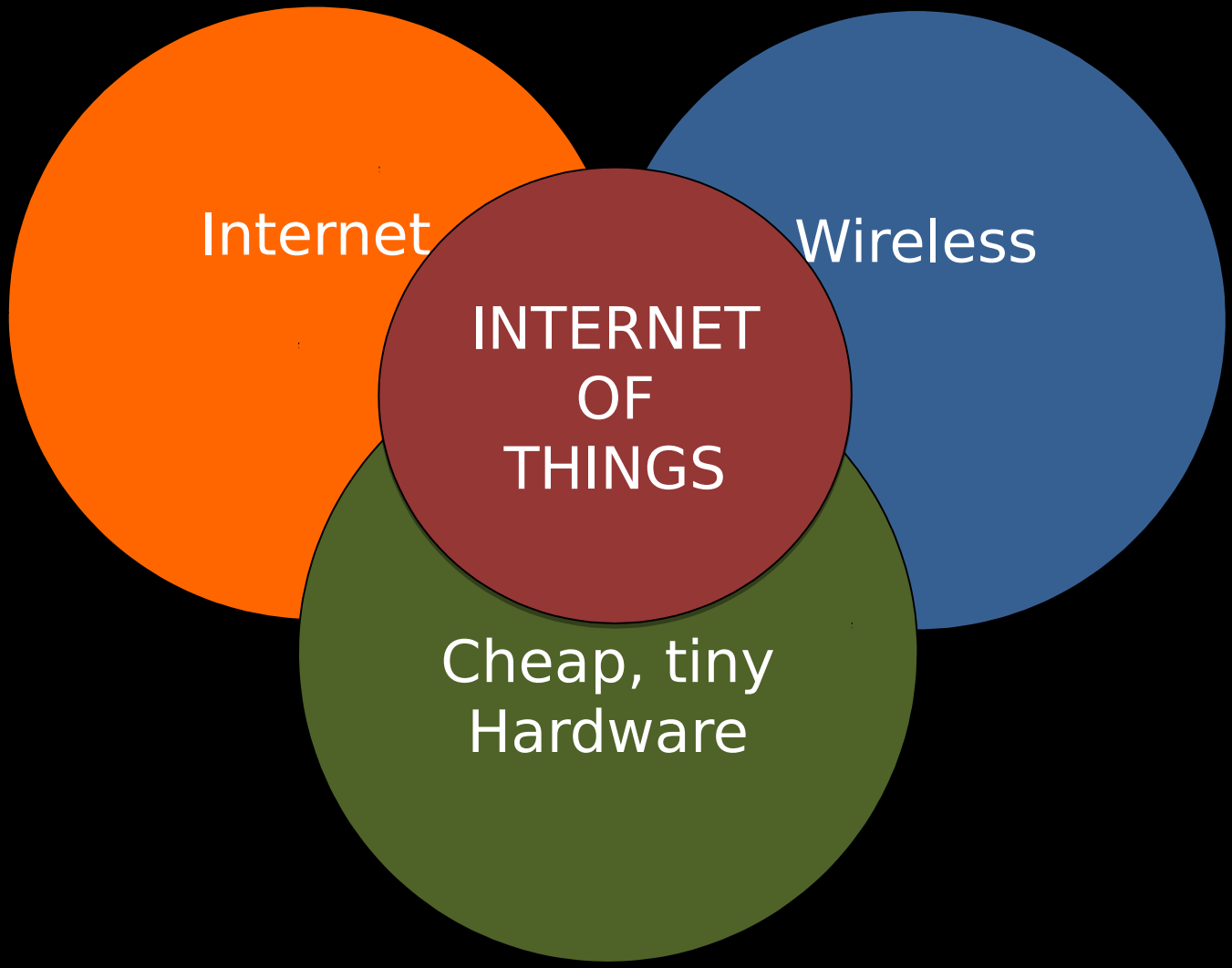
AGENDA

- Our vision of the IoT
- Wishlist for an IoT operating system
- RIOT specs
- Zoom on connectivity
- Zoom on portability
- RIOT as a platform for experiments
- Join the RIOT

The Big Picture: a Giant Collision



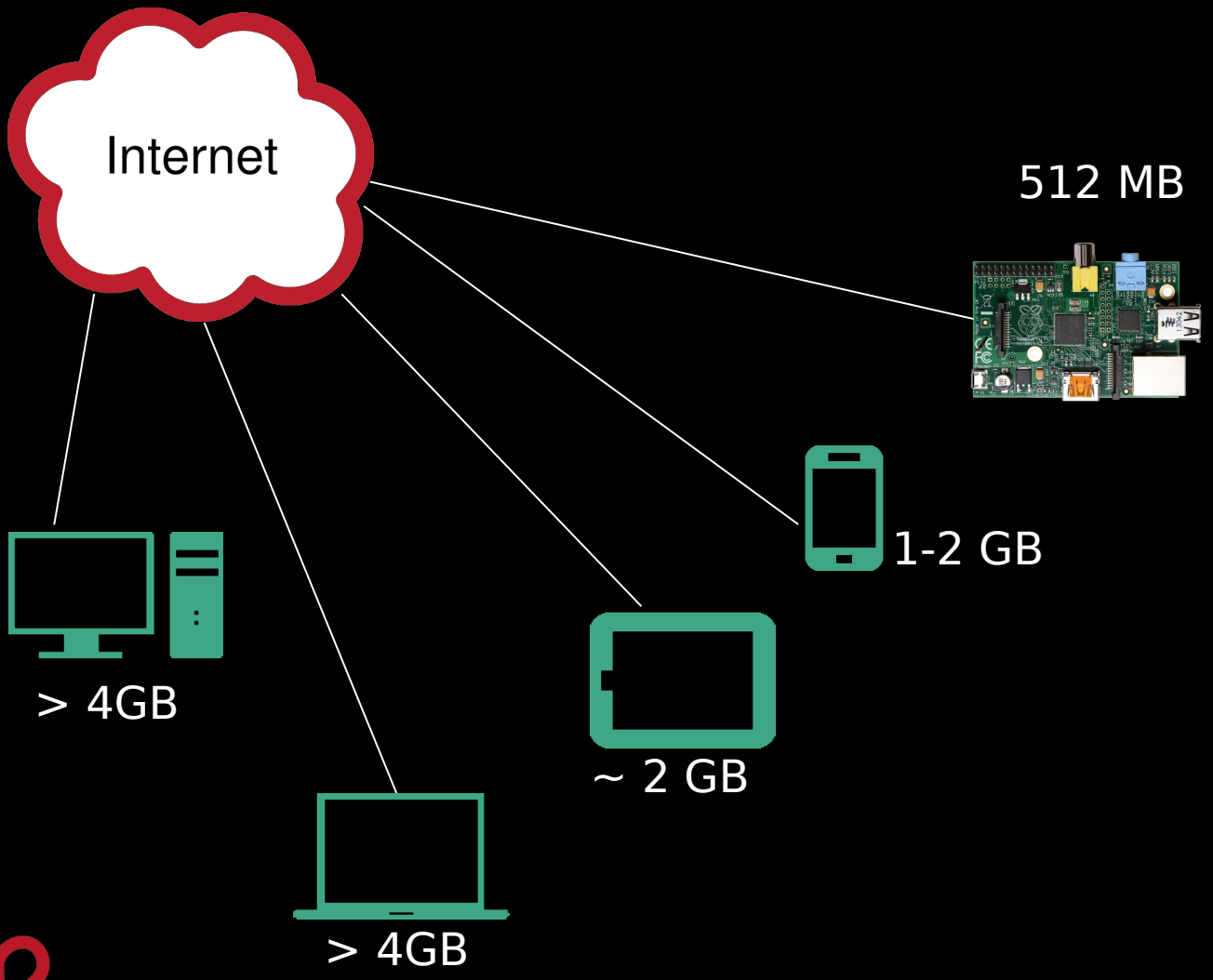
RIOT

Our Vision of the IoT

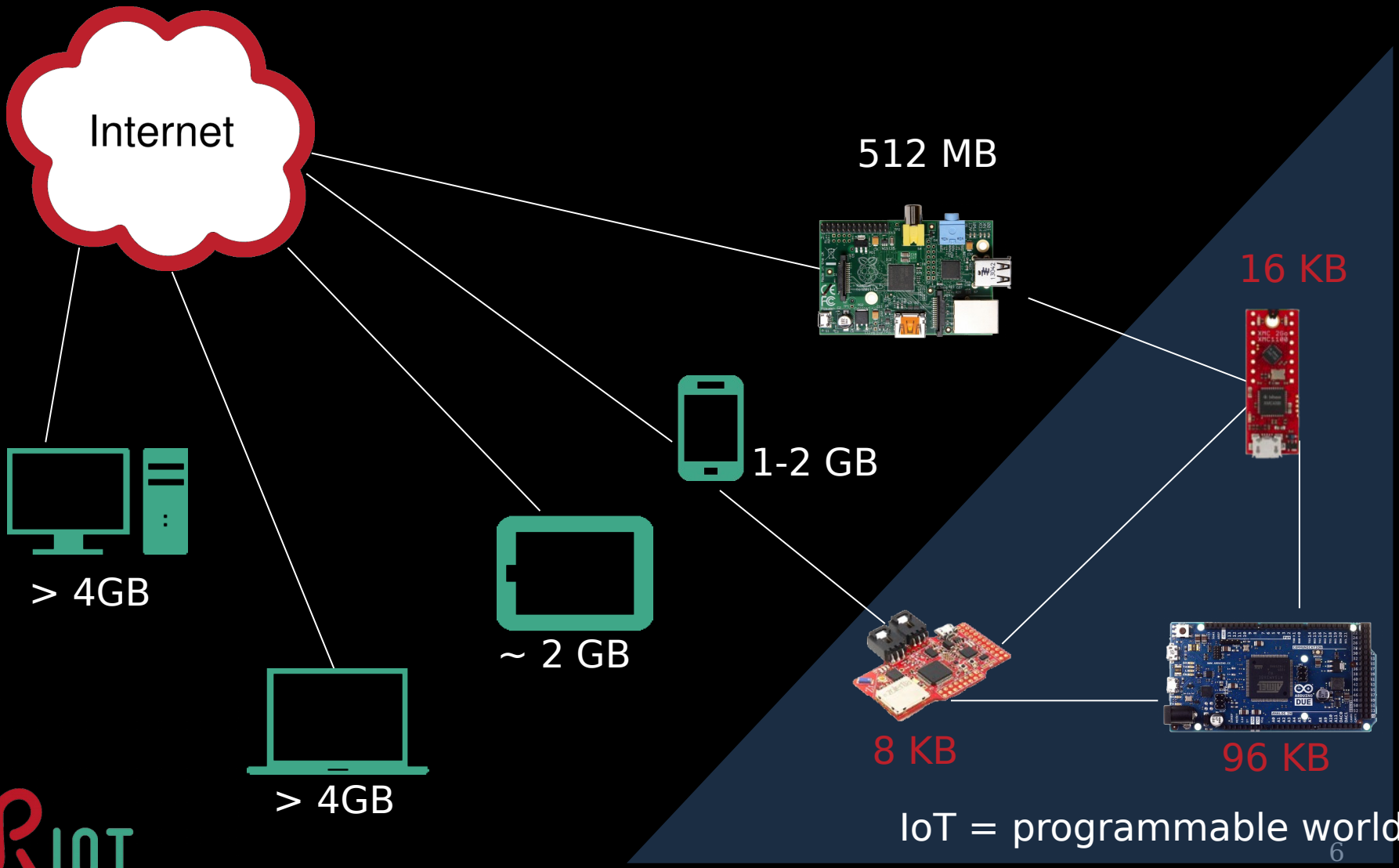
- A new world of interconnected hardware
- A new world at the application layer
- A new world in terms of user experience

➔ Physical Computing
i.e. our interface to the Internet will no longer be predominantly a screen, a keyboard and/or a mouse

The Internet



The Internet of Things



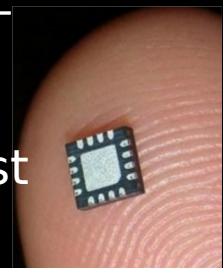
IoT: From the Hardware Perspective

- The IoT is already here
  - Tiny, cheap & exciting new devices pop up daily
  - Mostly equipped with Atmel AVR, TI MSP430, or increasing numbers of ARM Cortex-M MCUs
  - Typically running with a CPU frequency < 100MHz and less than 100 kB RAM

Arduino Uno board
8 bit Atmel AVR

TI eZ430 Chronos watch
16 bit MSP 430
sub-GHz radio

SAM R21 Xplained Pro
32 bit ARM Cortex-M0+
2.4 GHz radio



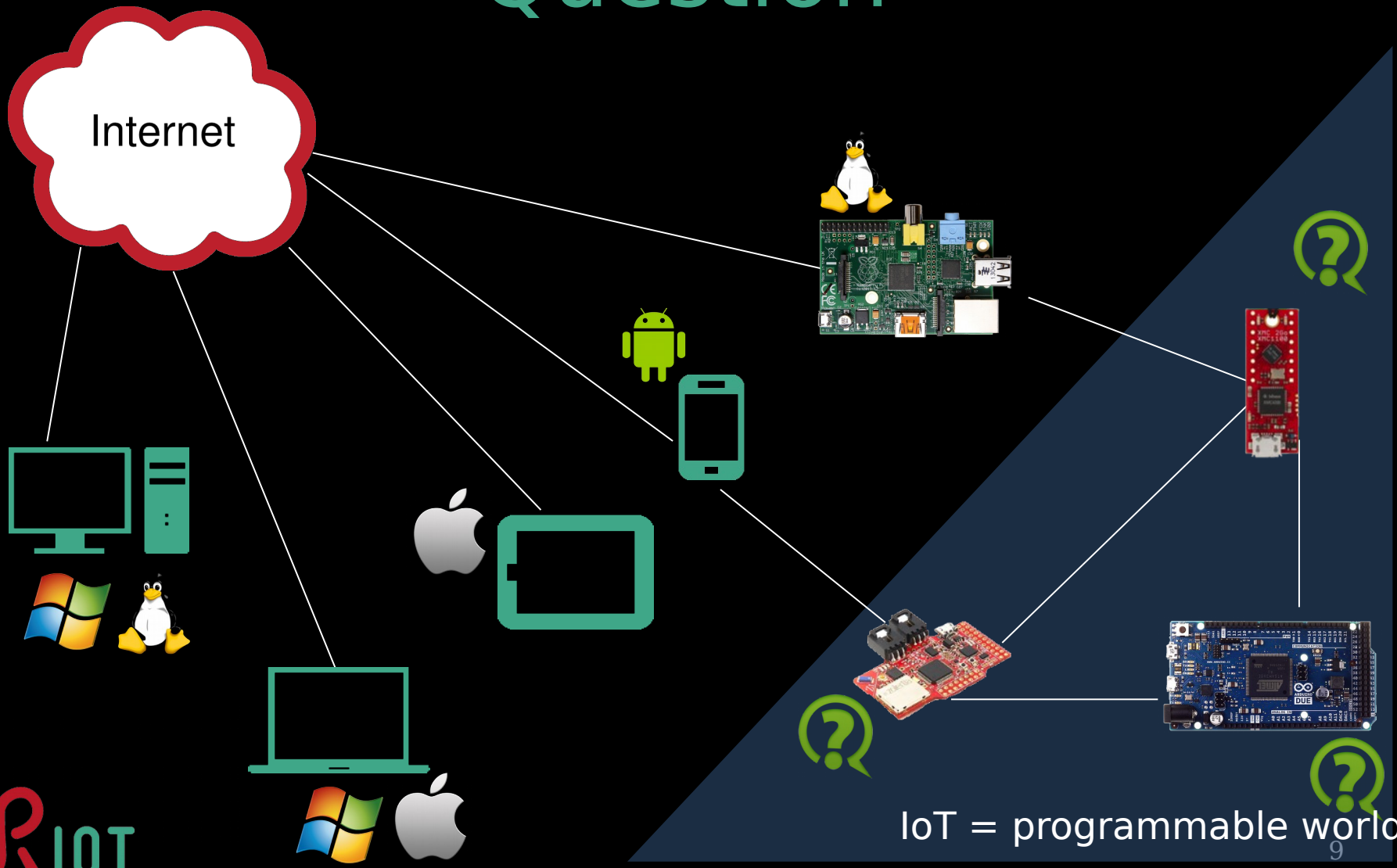
Smart Dust

But: No IoT Until...

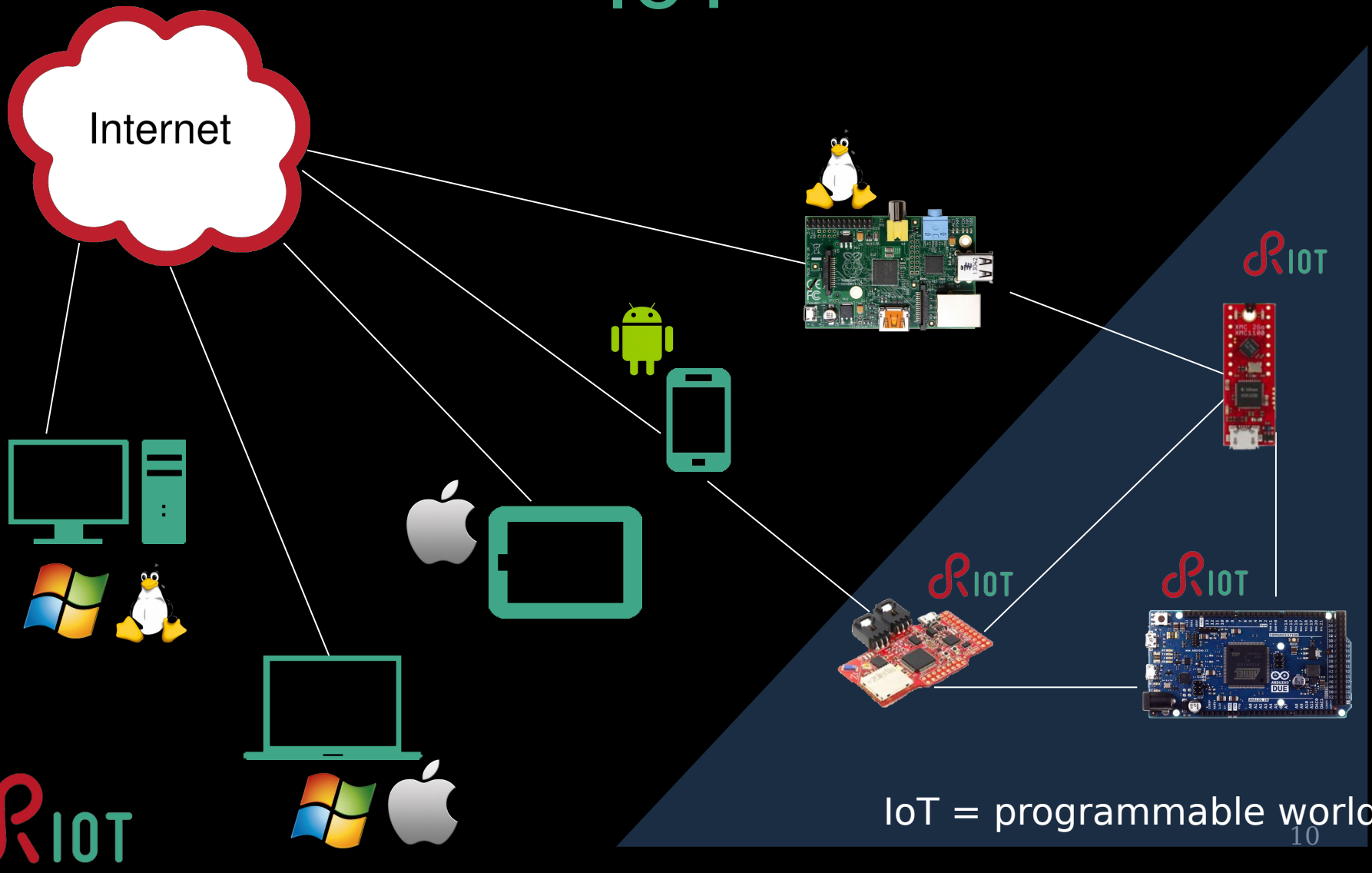
- ... a software big-bang happens
  - Similar to mobile phone industry since 2007 with iOS and Android dominance
  - Must have: de facto standard OS, providing consistent API & SDK across-hardware platforms

RIOT

IoT: The Operating System Question



RIOT : The Friendly OS for the IoT



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Wishlist for an IoT Operating System

An operating system for the IoT should:

- Support heterogeneous hardware
- Have a low memory footprint
- Provide interoperability with the Internet
- Make applications portable

Developing for the IoT

It should be easy to program, with support for:

- standard programming languages & techniques
- well known APIs (e.g. POSIX sockets)
- familiar debugging tools
- on-chip debugging capabilities
- comprehensive documentation

RIOT

Developing for the IoT

It should be secure & independent:

- open source
- vendor-independent
- cloud-independent
- architecture-independent (8-bit, 16-bit, 32-bit)

RIOT

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Meet RIOT

- Free, open source (LGPLv2.1) operating system for IoT
  - Write your code in ANSI-C or C++
  - Compliant with the most widely used POSIX features like pthreads and sockets
  - No IoT hardware needed for development
    - Run & debug RIOT as native process in Linux

RIOT Specs

- Microkernel architecture (for robustness)
  - The kernel itself uses ~1.5K RAM @ 32-bit
- Tickless scheduler (for energy efficiency)
- Deterministic O(1) scheduling (for real-time)
- Low latency interrupt handling (for reactivity)
- Modular structure (for adaptivity)
- Preemptive multi-threading & powerful IPC (for developer convenience)

E. Baccelli, O. Hahm, M. Günes, M. Wählisch, T. Schmidt. RIOT OS: Towards an OS for the Internet of Things. In *The 32nd IEEE International Conference on Computer Communications (INFOCOM 2013)*.

H. Will, K. Schleiser, J. Schiller. A Real-Time Kernel for Wireless Sensor Networks Employed in Rescue Scenarios. In *The 34th IEEE Conference on Local Computer Networks (LCN 2009).*

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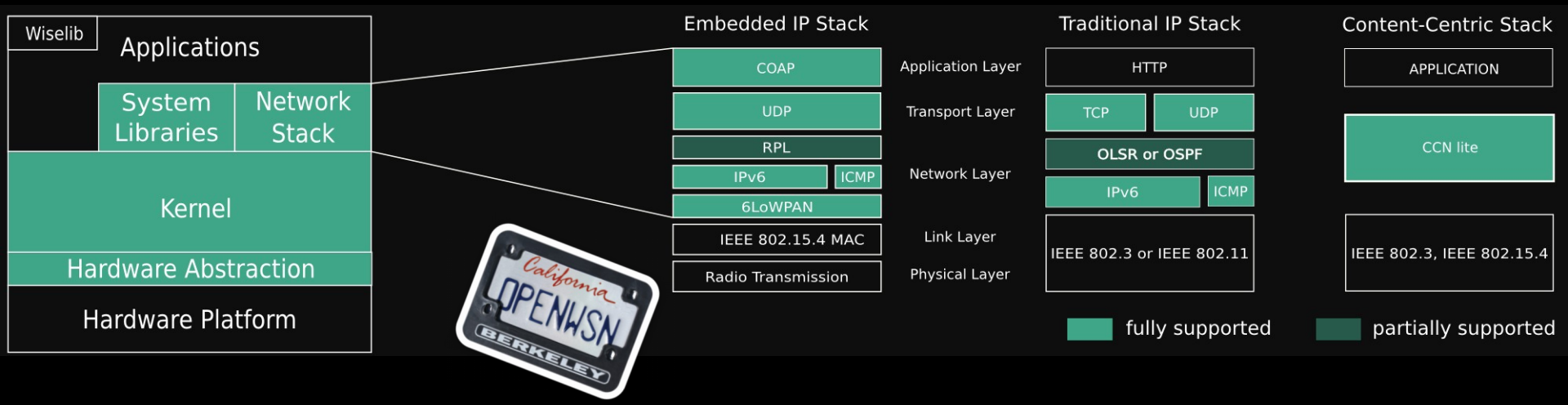
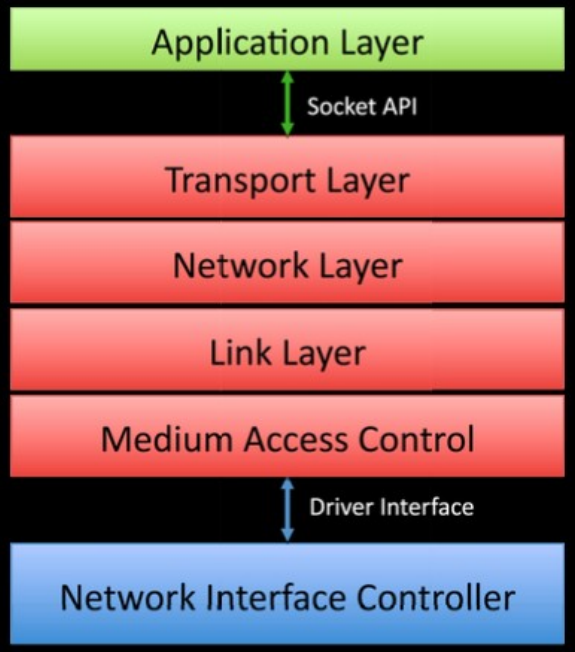
RIOT Supports Several Network Stacks

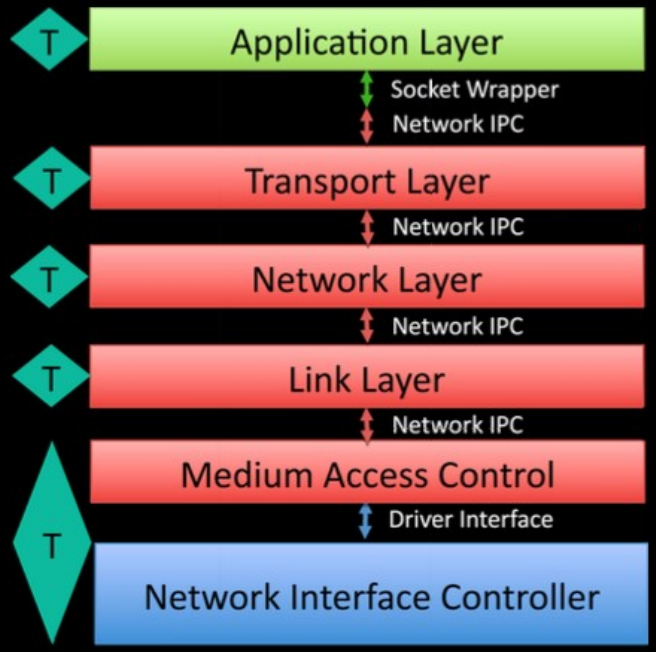


- BSD-like ports for: OpenWSN, LibCoAP, microcoap, relic, micro-ecc
- What's already there:
  - Application layer (CoAP, CBOR, UBJSON), Transport layer (UDP, TCP), Network layer (IPv6, 6LoWPAN, RPL, NHDP, AODVv2, CCN-lite), Link layer (IEEE 802.15.4 and 802.15.4e support)
  - Nativenet: network emulation & debugging
- On-going:
  - Bluetooth LE link layer support, Cooja and ns-3 simulator support, OLSRv2, & more...

Towards a Flexible Embedded Stack Design



Traditional Network Stack Architecture



RIOT Network Stack Redesign

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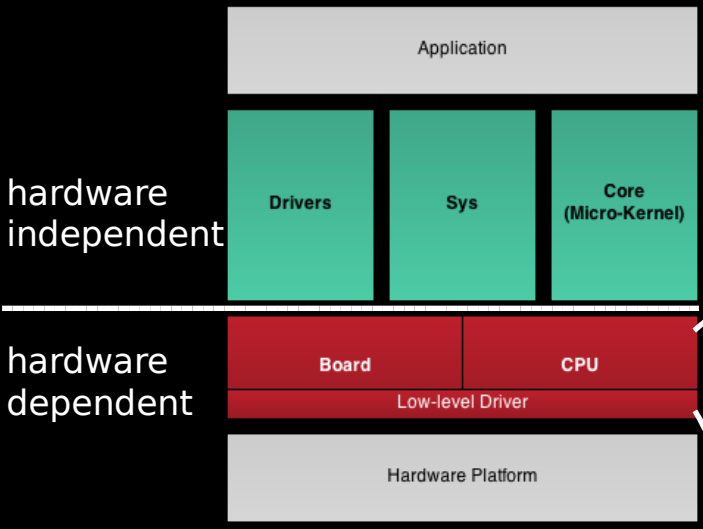
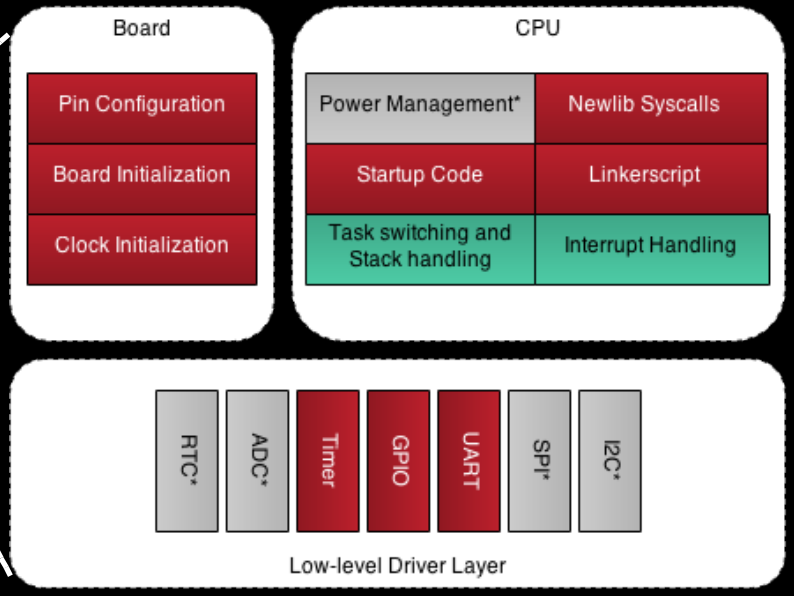
Code for RIOT is Portable

- Code your application once & run it everywhere
  - Mostly 32-bit platforms, but 8-bit and 16-bit platforms are supported, too
  - Independent from vendor-specific solutions
- Easy porting of RIOT to new hardware
  - Porting is a matter of hours, or days
  - e.g. support for new ARM Cortex-M boards is ‘trivial ’

Portable Architecture



Zoom on Board & CPU



Red: must have

Green: must have but shared by all ports with same architecture

Grey: optional for initial porting

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RIOT as a Platform for Experiments

- How to build the Internet of Plants with RIOT
  - Testing a distributed IoT application
  - Sensor monitoring & CoAP & 6LoWPAN

Attend our tutorial tomorrow!

- Other use cases:
  - Run RIOT on an open testbed like IoT-LAB (tutorial availale at https://www.iot-lab.info/tutorials/)
  - Emulation of virtual networks without changes to RIOT code
  - Connect real nodes to virtual topologies of RIOT instances
  - Experiments with new protocols & concepts for the IoT (e.g. content-centric networking)
    - E. Baccelli, C. Mehlis, O. Hahm, T. Schmidt, M. Wählisch. Information-Centric Networking in the IoT: Experiments with NDN in the Wild. In *1st ACM International Conference on Information Centric Networks (ICN 2014)*.
  - Low learning curve => RIOT as a teaching platform
    - O. Hahm, E. Baccelli, H. Petersen, M. Wählisch, T. Schmidt. Simply RIOT: Teaching and Experimental Research in the Internet of Things. In *13th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN 2014)*.

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In a Nutshell: RIOT is Accessible

- The goal is to be the fastest coding platform:
  - Code your IoT app or your IoT protocol in one afternoon
- Designed to be interoperable:
  - Standard APIs & standard network protocols
  - Contiki could run as a RIOT thread (but not the reverse ;)
  - RIOT can run as a Linux process
- Designed to be a modular solution:
  - From kernel-only to full stack including hardware support, network stacks, schedulers & your favorite API (POSIX, Arduino coming soon?)

RIOT Origins

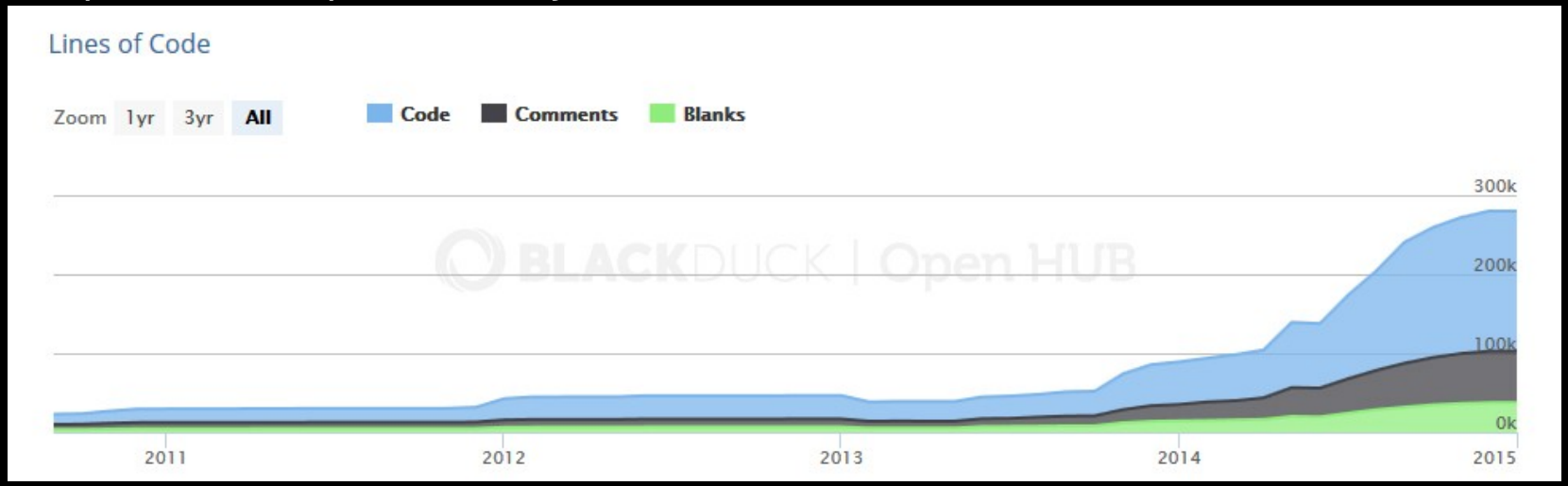
History

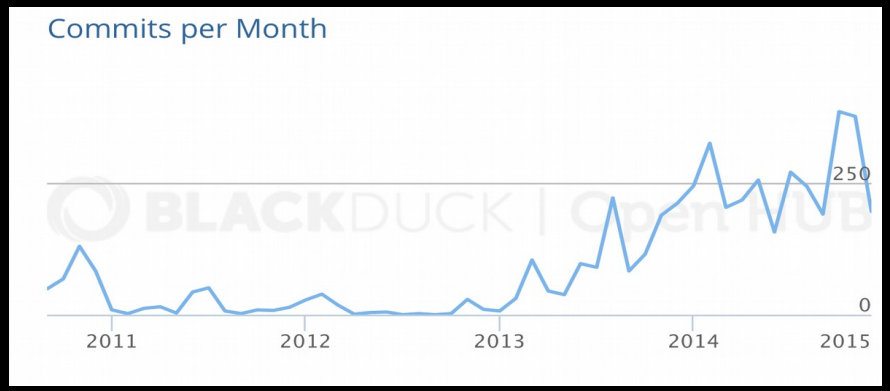
- 2008 – Project roots:
  The kernel was started
  as part of a research project
- 2010 – Towards the IoT:
  Implementation of 6LoWPAN
  and RPL was initiated
- 2013 – RIOT goes public:
  Branding of RIOT started,
  source code moved to Github

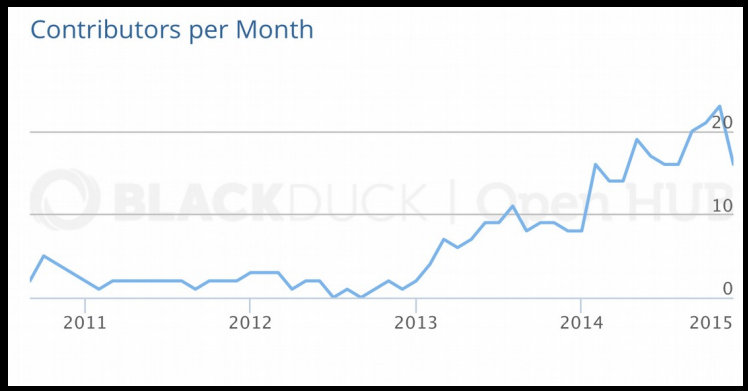
Founding institutions

RIOT: Code evolution

»RIOT is one of the largest open-source teams in the world«
www.openhub.net/p/RIOT-OS, Jan. 2015







Join the RIOT

- Open source community
- ~ 250 forks on GitHub https://github.com/RIOT-OS/RIOT
- ~ 260 people on the developer mailing list: devel@riot-os.org
- Developers from all around the world
- Mentoring organisation for Google Summer of Code 2015
- Support & discussions on IRC: irc.freenode.org #riot-os
- ~ 750 followers on Twitter
-

Join our tutorial tomorrow!

Please take a look at

http://watr.li/workshop.html


IOT