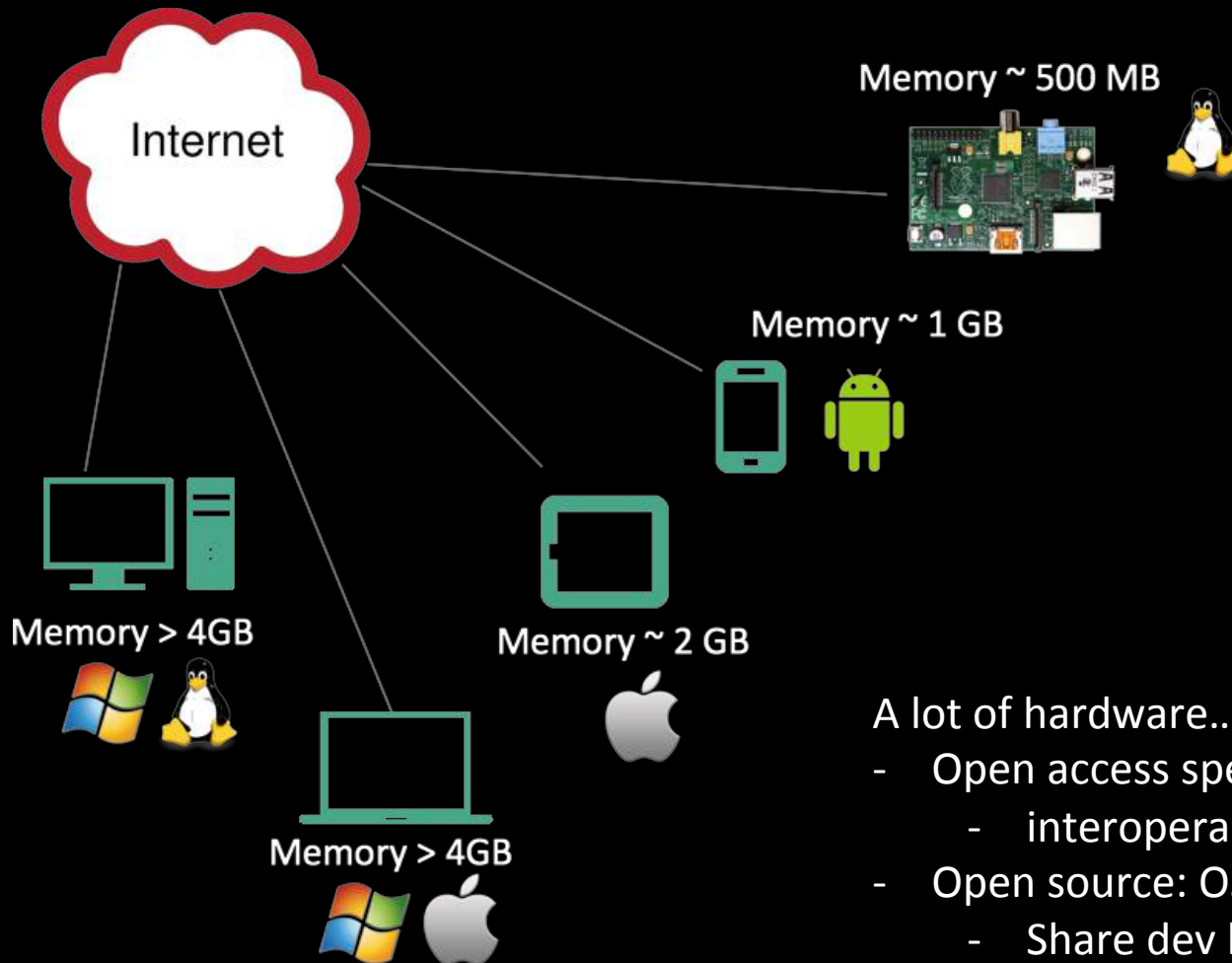




www.riot-os.org

Emmanuel Baccelli, on behalf of
the RIOT community

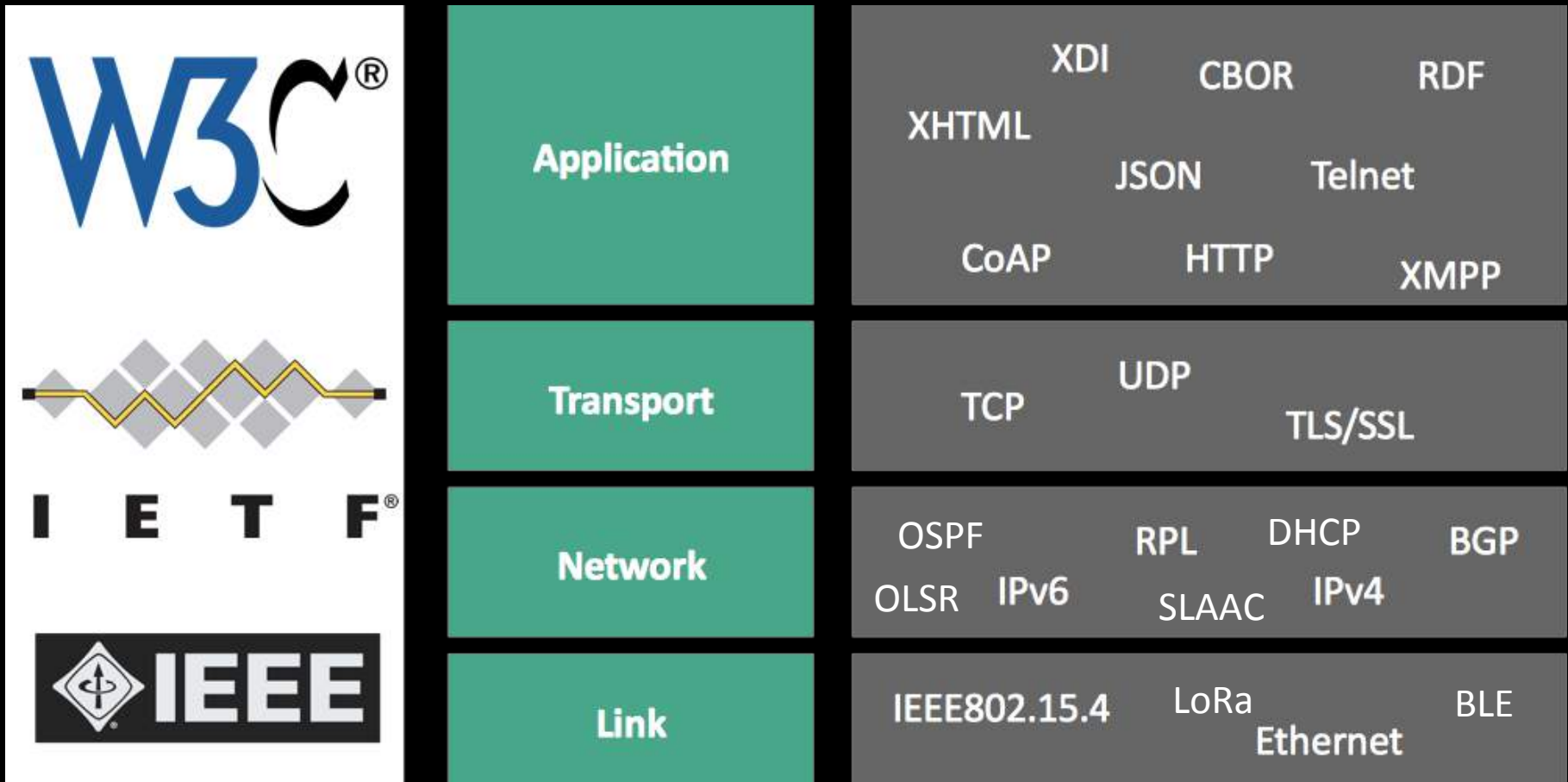
The Internet (as we know it)



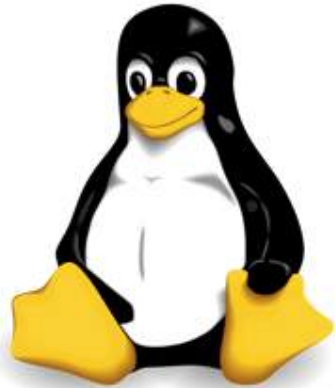
A lot of hardware... but more importantly:

- Open access specs
 - interoperability
- Open source: OS + protocol implementations
 - Share dev load, accelerate innovation

No Internet without Open Standards



No Internet without Open Source



WEINX



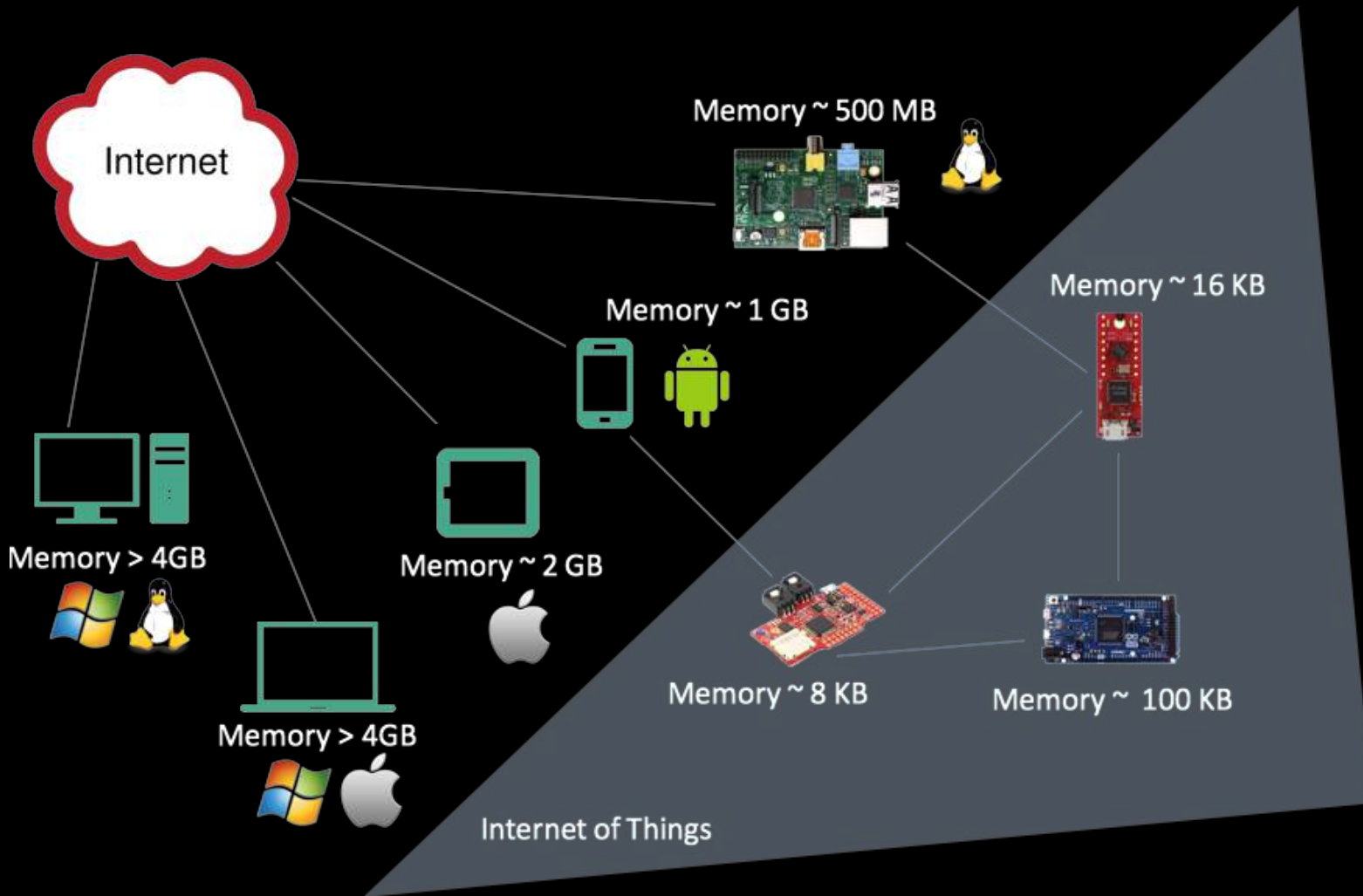
PostgreSQL

OpenWrt
Wireless Freedom

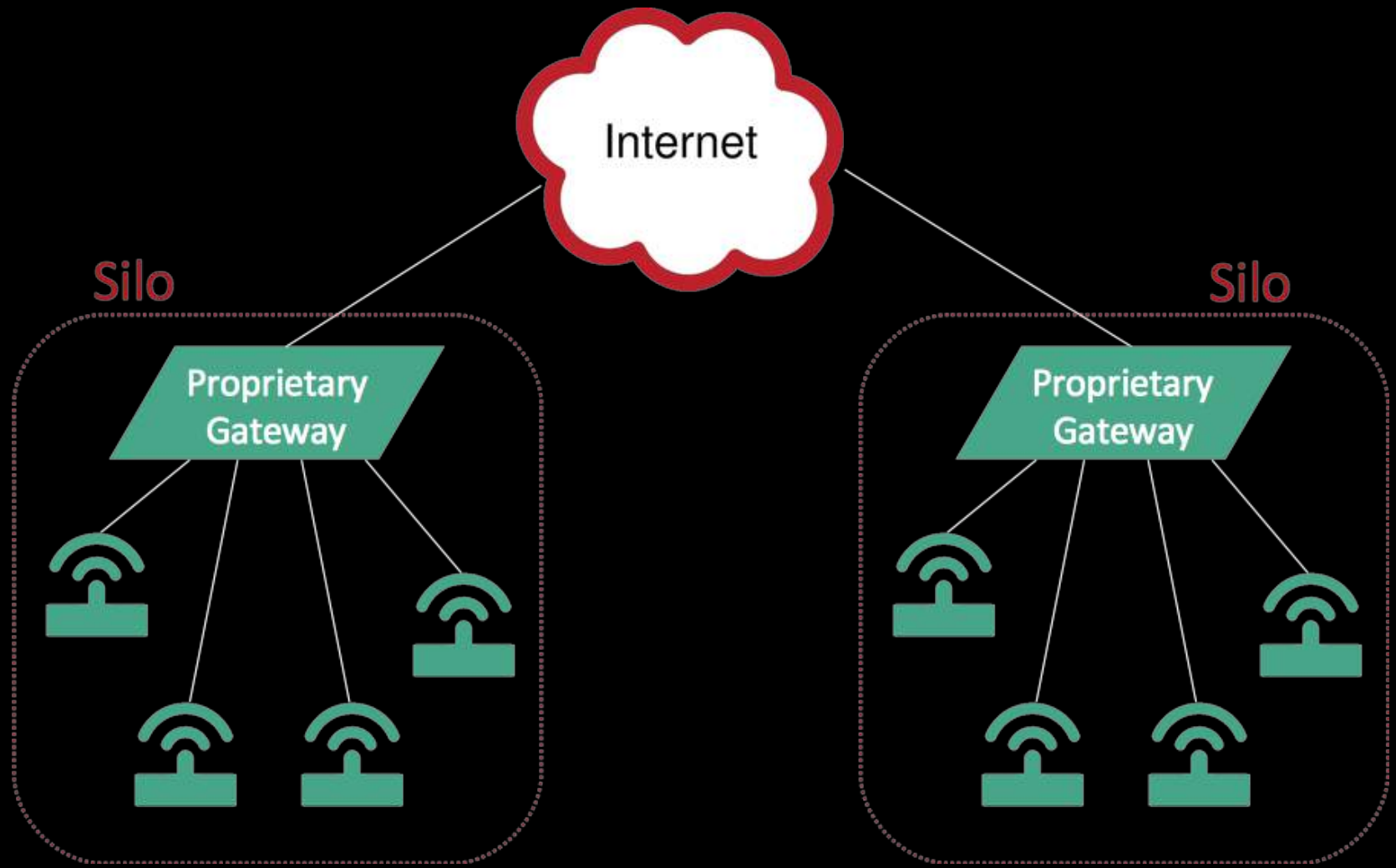


OpenSSL
Cryptography and SSL/TLS Toolkit

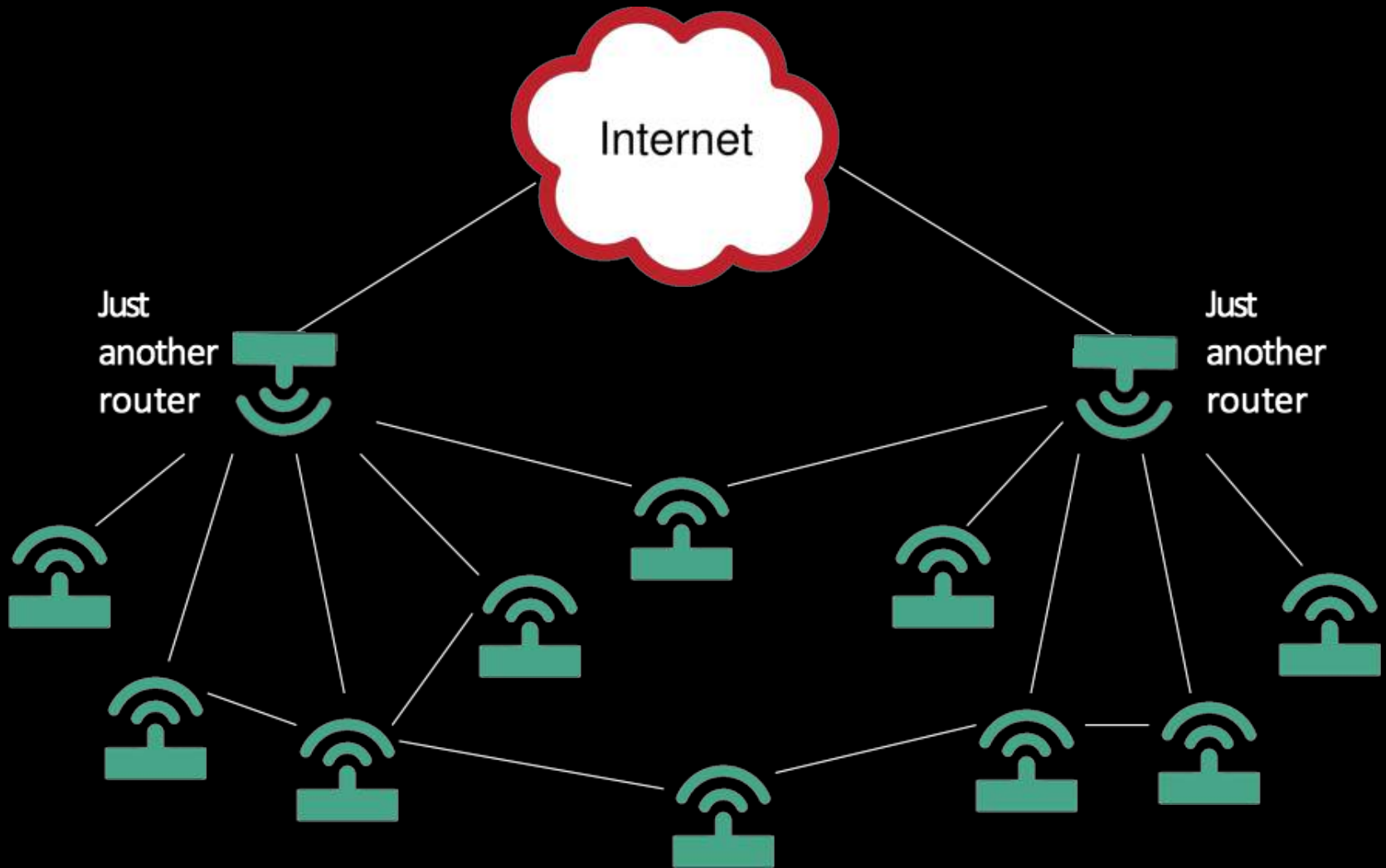
The Internet of Things (IoT)



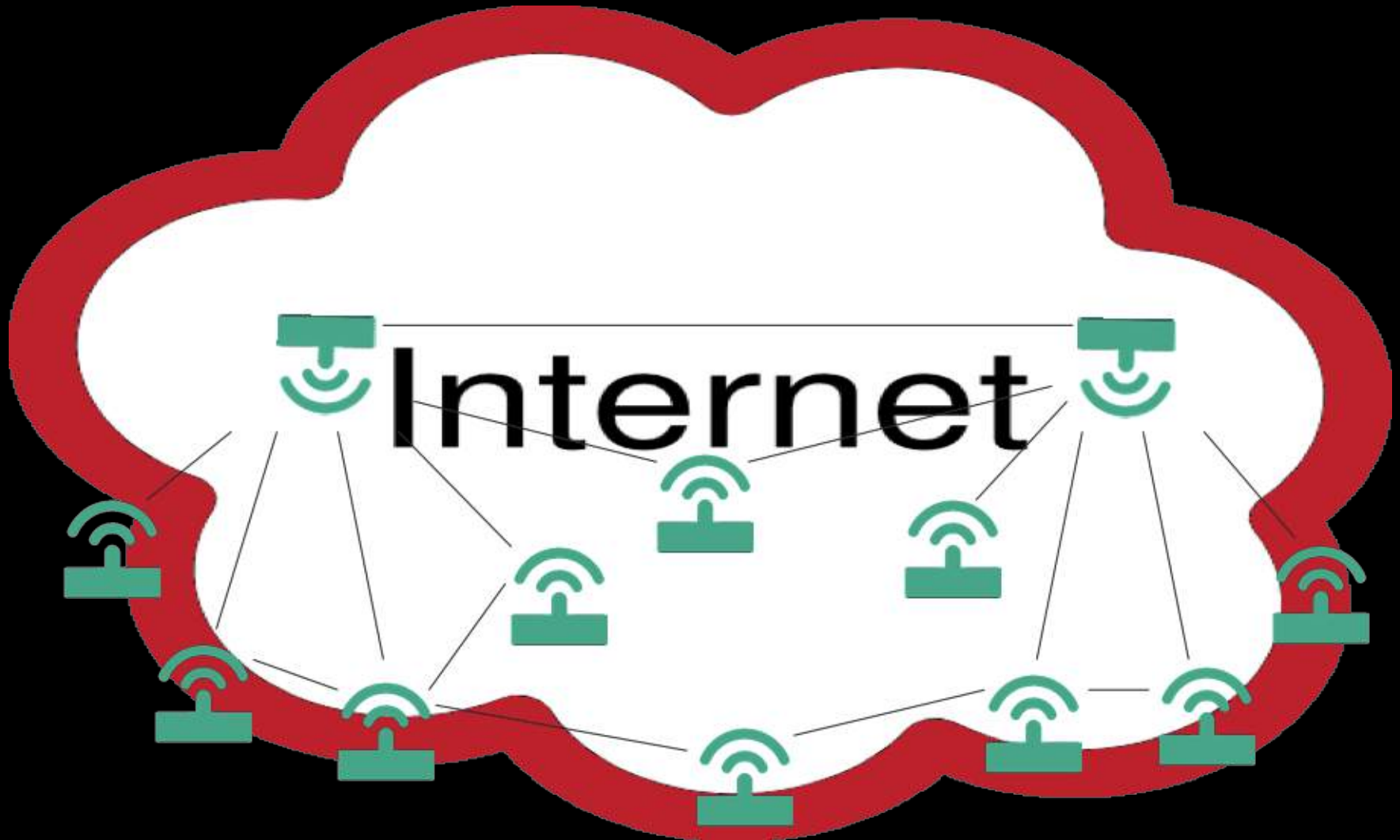
The IoT today looks mostly like this



The IoT we want looks more like that



The IoT we want is... the Internet!



The difference

- Network level interoperability
 - End-to-end connectivity per default
 - Device-to-device connectivity
 - => No more walls!

- System level interoperability
 - Efficient hardware-independent software
 - No device lock-down
 - => No more waste!

IoT Innovation Today?

- **Hindered by proliferation of closed platforms**
 - incompatible silos
 - locked-down hardware
- **Need standard open access network protocol specs**
 - Enable network level interoperability
- **Need de facto standard open-source platform**
 - Enable system-level interoperability
 - an OS equivalent of Linux for IoT devices
 - community-driven, open-source
 - independent from vendors, hardware architectures...

IoT network protocols? On the way.

New specs for radio technologies and link layers

- Low-power
- IEEE 802.15.4, Z-Wave, BLE, LoRa (and IEEE 802.11)
- More to come...

New specs for network layer protocols

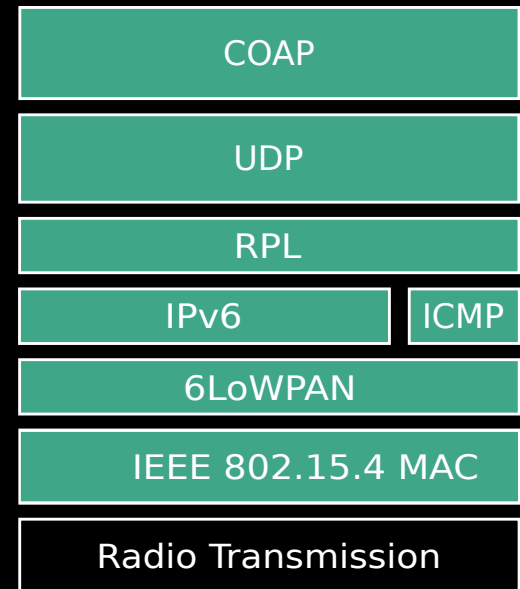
- Fitting IoT requirements and interoperable with IP
- 6TiSCH, 6LoWPAN, RPL, OLSRv2, AODVv2
- More to come...

New specs for application layer protocols

- Fitting IoT requirements and interoperable with web
- CoAP, LwM2M, CBOR
- More to come...

New network paradigms

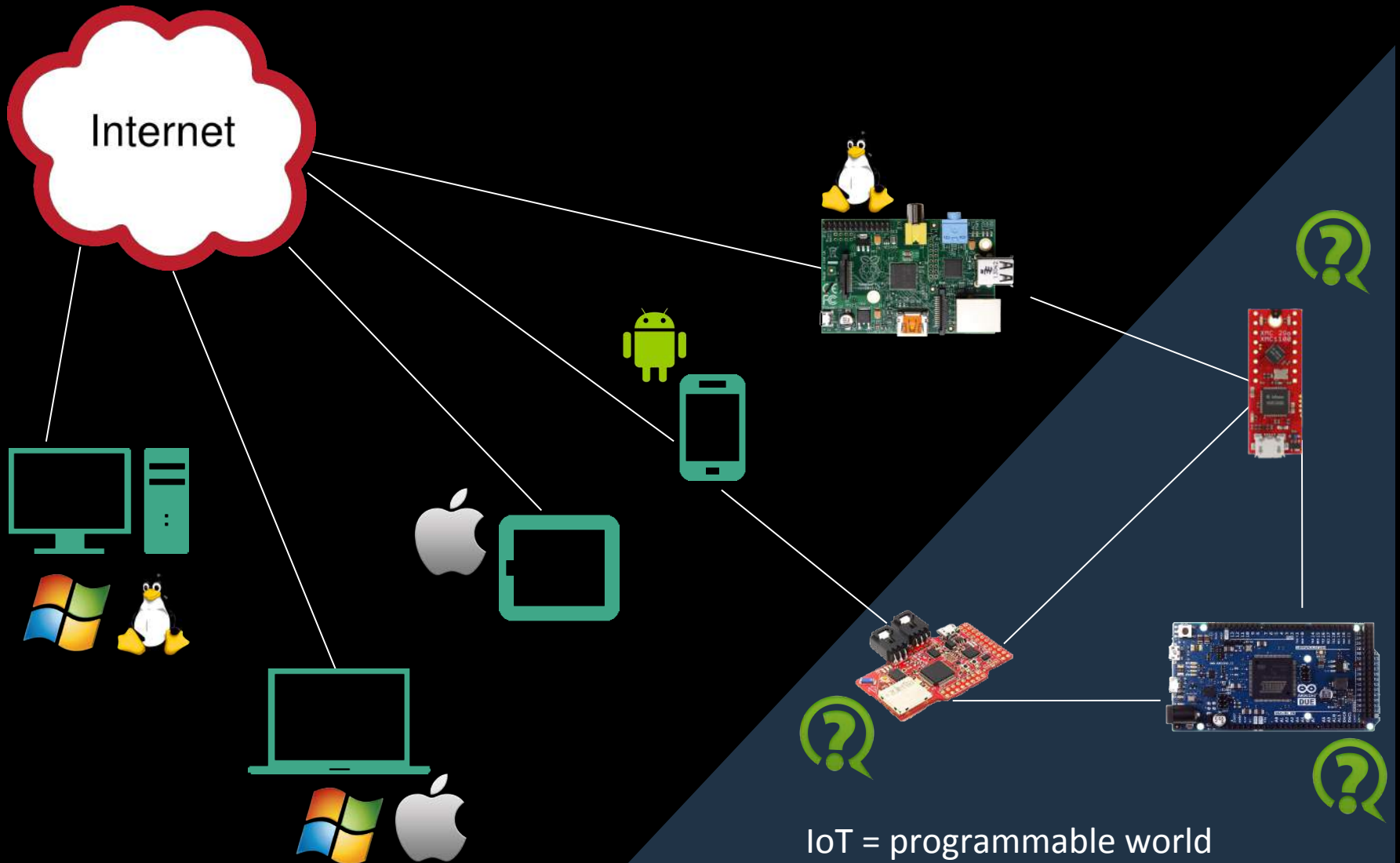
- Content-centric networking for IoT
- More to come...



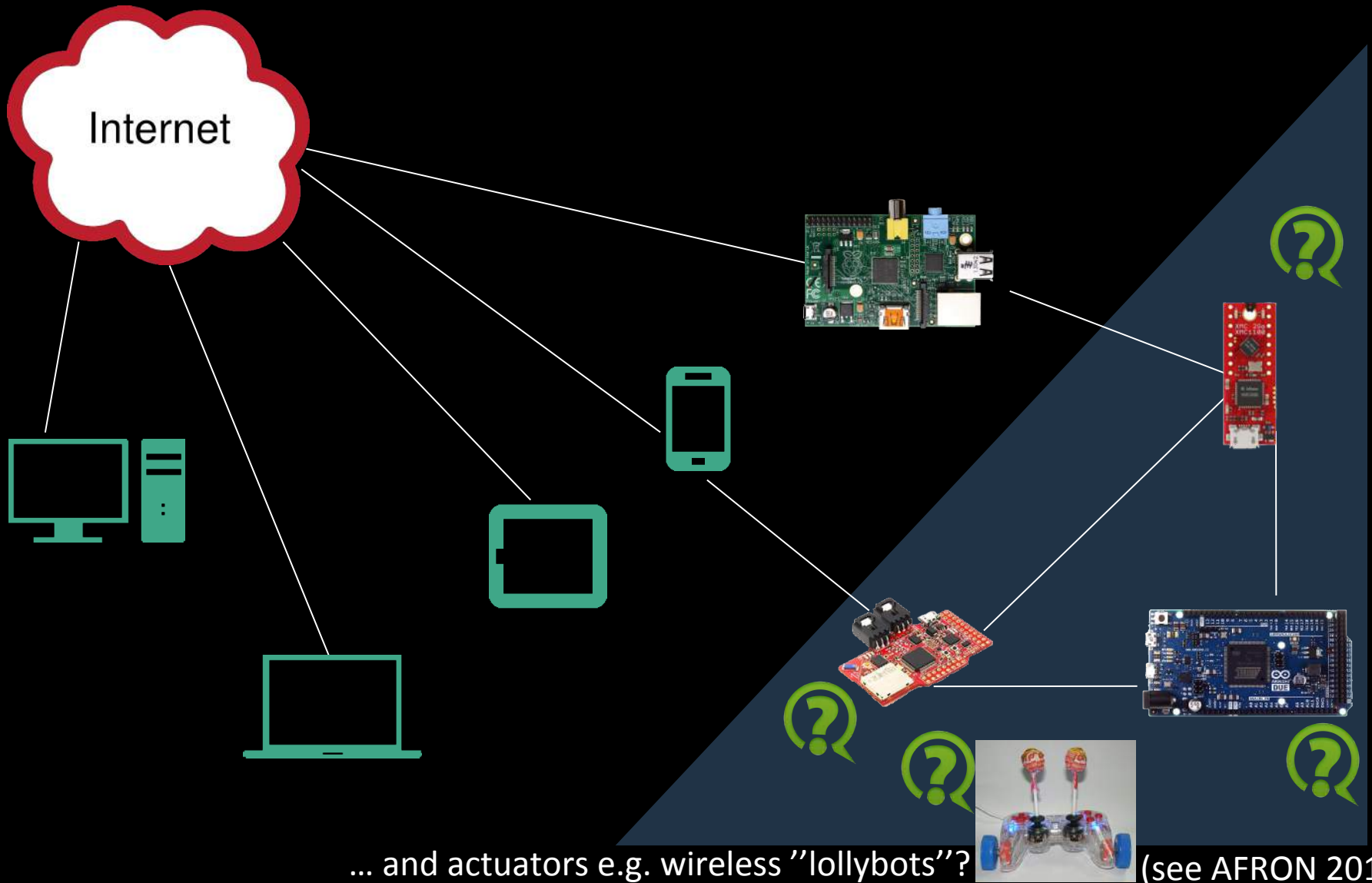
IoT Software platform? No great fit yet.

- Some “cloud” solution? *OK, but not sufficient.*
- Arduino? *Hardware specific, not an OS.*
- mbed? *Hardware- and ARM-centric, server-centric.*
- Android? *Big memory needs, Google-centric.*
- Contiki? *Fits memory, but old & exotic API.*

So... which platform for IoT devices?

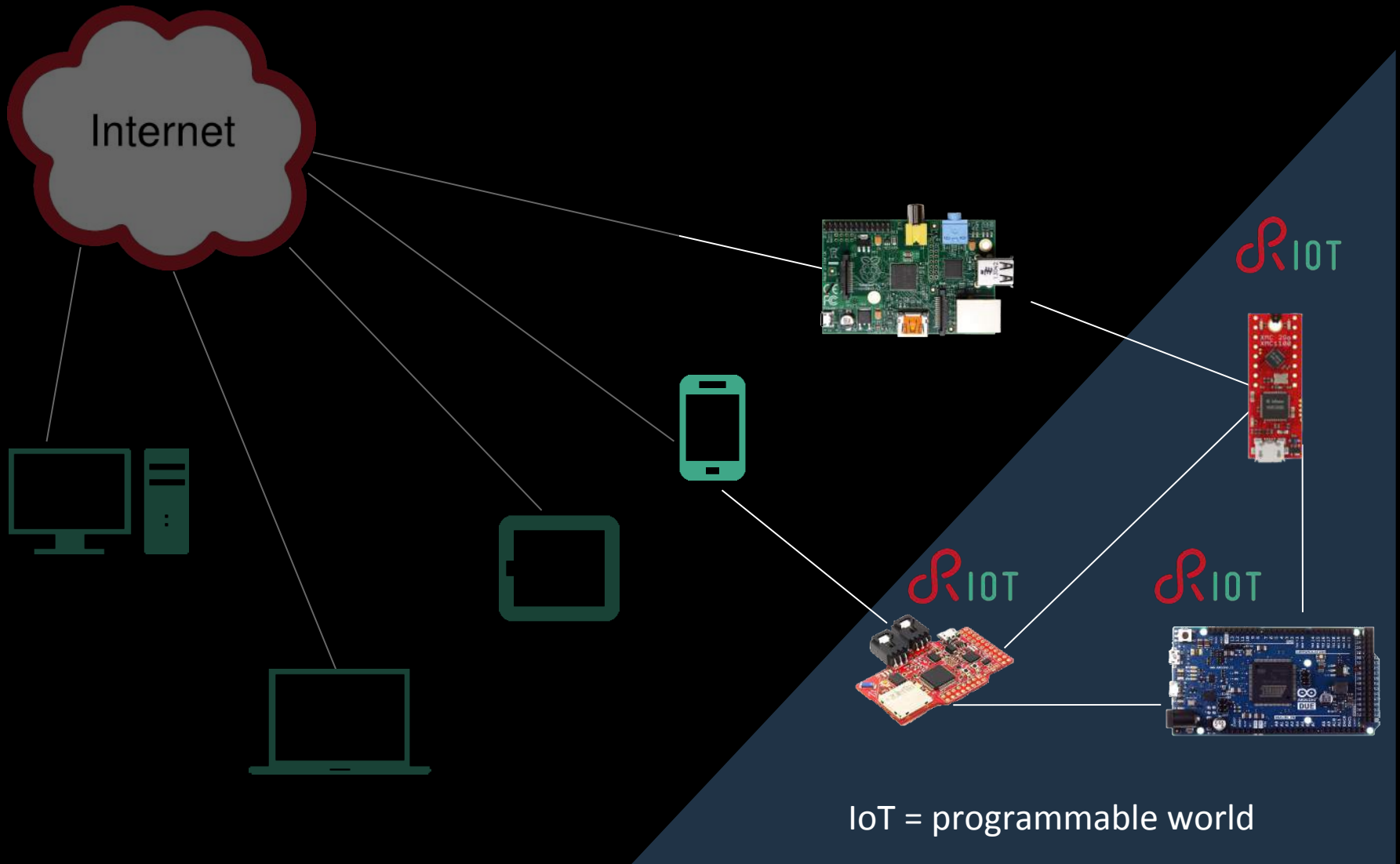


So... which platform for IoT devices?



... and actuators e.g. wireless "lollybots"? (see AFRON 2012)

Can't run Linux? Run RIOT!



Building blocks for an OS on IoT devices

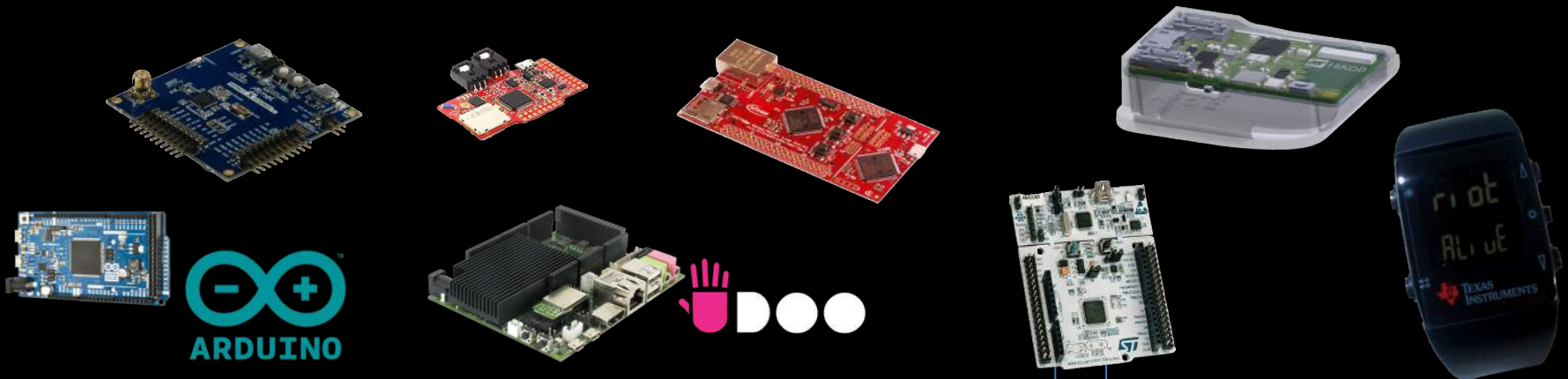
- Low memory footprint kernel
- Efficient hardware abstraction
- Low-power modes (LPM) management
- Real-time capability
- Future-proof (modular/extensible) network stack
- Appealing API

Meet RIOT: Micro-kernel & Energy efficiency

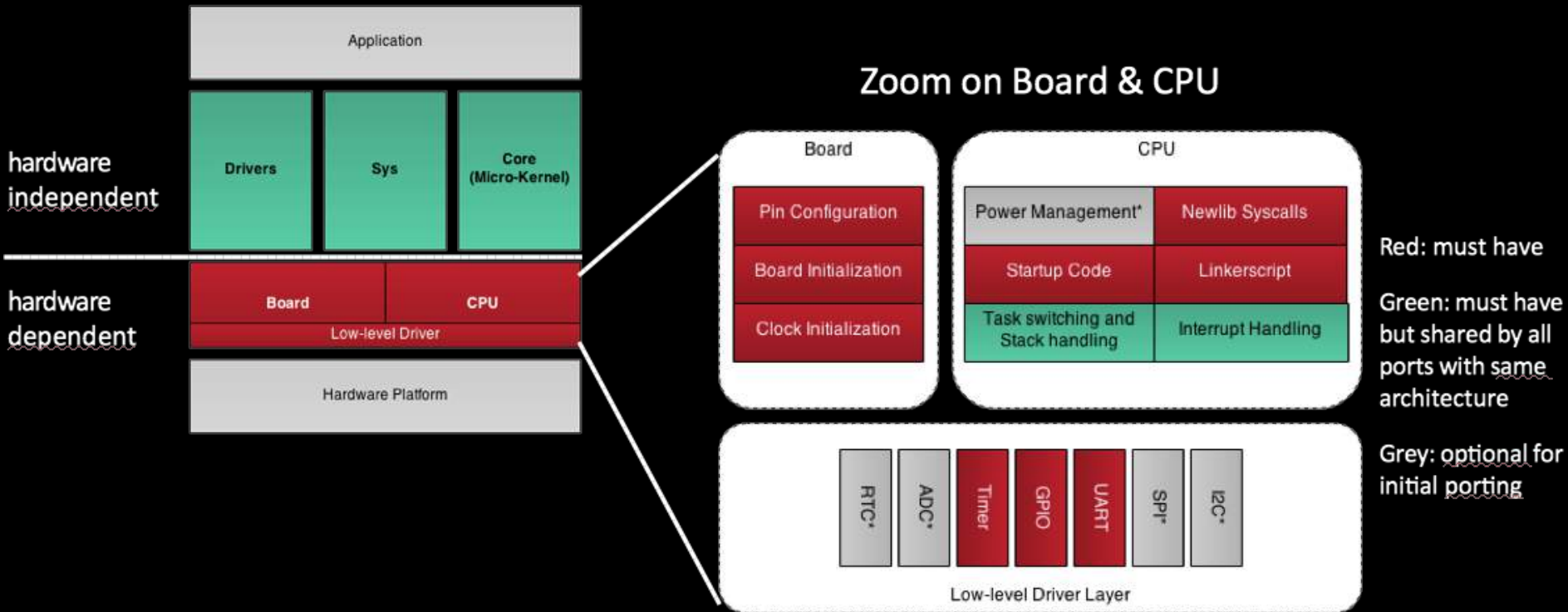
- Micro-kernel architecture (robustness)
 - minimal requirements below 1,5kB RAM @ 32-bit
- Tickless scheduler (energy efficiency)
- Deterministic $O(1)$ scheduler (real-time)
- Low latency interrupt handler (reactivity)

Meet RIOT: Efficient HAL & Appealing API

- Minimized hardware-dependent code
- Same API on 8-bit, 16-bit, 32-bit
 - C, C++, preemptive multithreading, IPC... just like Linux!
- Modular structure (adapt to diverse hardware)
 - Current support for 50 different boards/devices

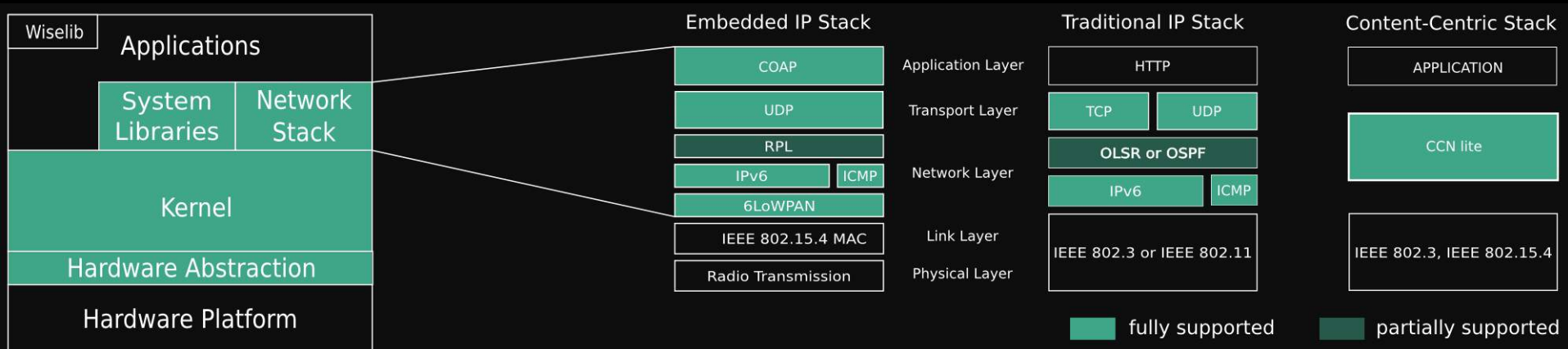


Minimized Hardware-Dependent Code



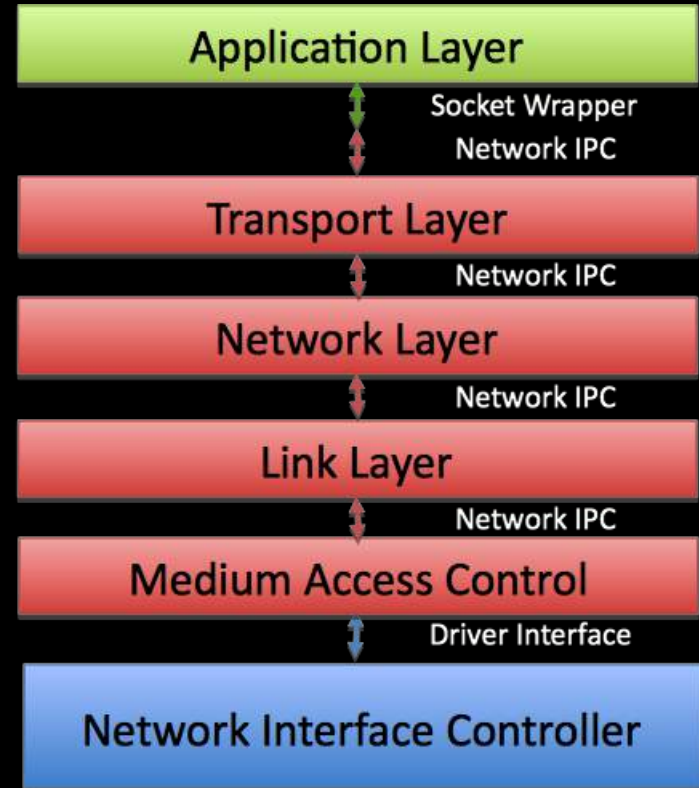
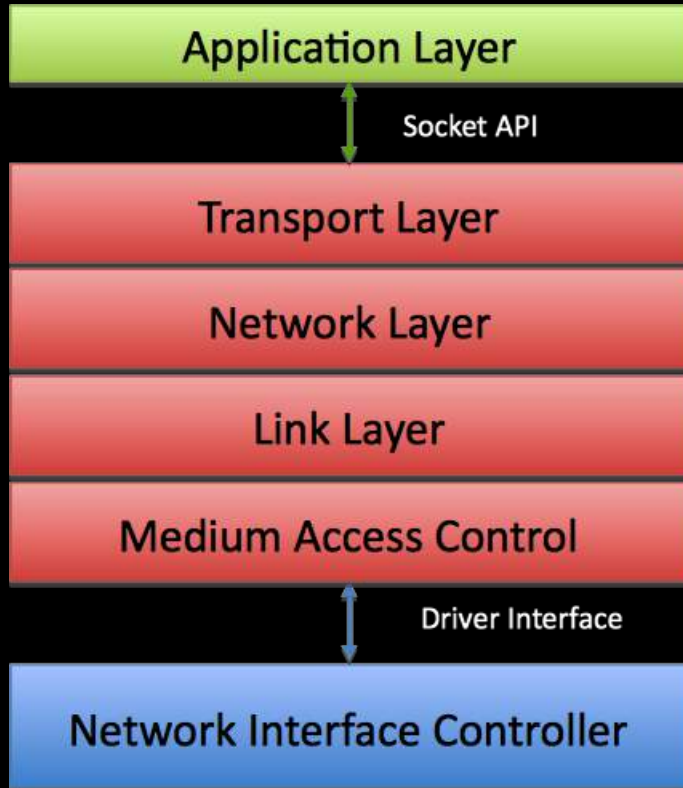
Meet RIOT:

Ultra-flexible network stack architecture



- BSD-like ports for: OpenWSN...
- Plain IPv6 stack
- 6LoWPAN stack
- NDN stack (CCN-lite)
- gnrc : IPC between layers, ultra-flexibility

gnrc: Embedded Network Stack Ultra-flexibility



Meet RIOT:

Use common development tools

- Compliance with the most common POSIX
 - POSIX sockets, pthreads
- No IoT hardware needed for debugging
 - Run & debug a native process in Linux

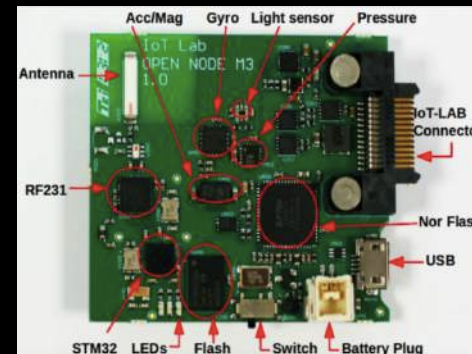


Open Testbed: RIOT on



IoT-LAB open testbed : <http://www.iot-lab.info>

- Hardware support:
 - IoT-lab M3 node is reference RIOT hardware
 - Continuous support of latest RIOT release (2015-09)
 - Full support for radio AT86RF231 & MCU STM32F1
 - Full support for all sensors



- Additional tools:
 - easy experimentation from the command line (integration of CLI tools into RIOT's build system)
 - sniffer application + python script to sniff IEEE.802.15.4 traffic + 6LoWPAN and upper layers

RIOT can do more, so RIOT can do less

- Arduino scripts can run as-is on top of RIOT
- mbed applications could run on top of RIOT
- Contiki could run in a single RIOT thread



mbed

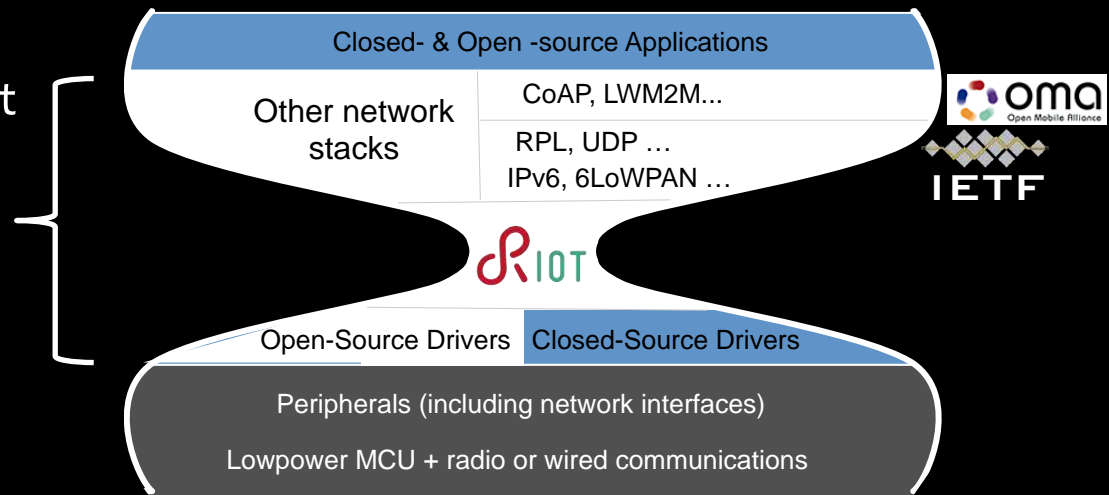


RIOT in a nutshell: a thin-waist for IoT

Open-source platform for embedded IoT software

Core functionally equivalent to Linux, based on:

- open-source,
- open-access protocol specs
- community-driven dev.



- RIOT
- Third-party software
- Hardware

RIOT Roots

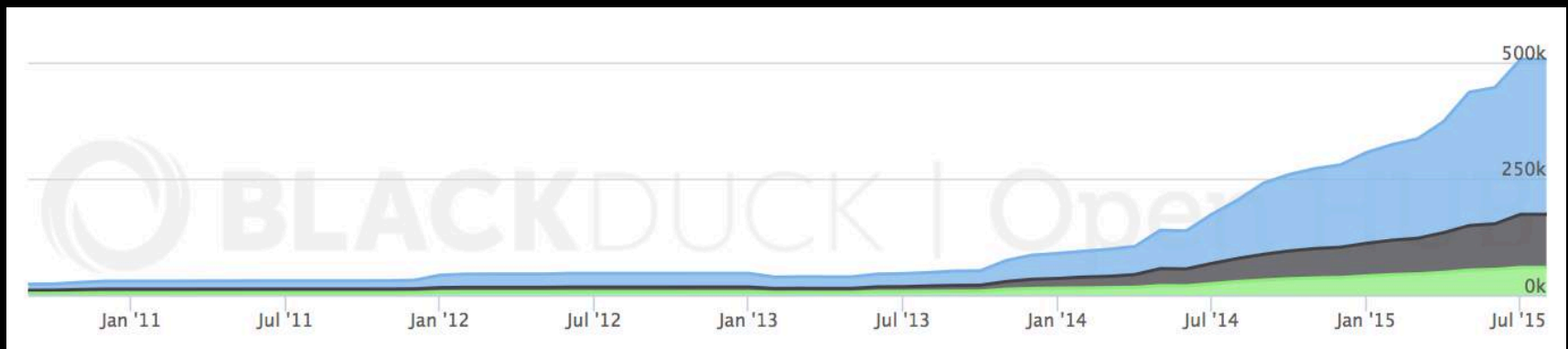
- **2008 - 2012**
Ancestors of RIOT kernel developed in research projects (FireKernel, uKleos).
- **2013 - 2015**
Branding of RIOT started, source code moved to Github, major development of the network stack & the OS as such.

Founding institutions



Growing RIOT Open Source Community

- LGPLv2.1 open source license
- 100+ contributors (Europe, North America, Asia)
 - <https://github.com/RIOT-OS/RIOT>




- Use & support from various
 - SMEs & major companies (e.g. Cisco)
 - Makers & tinkerers
 - Research community

[1] source: www.openhub.net/p/RIOT-OS estimate using the basic COCOMO Model

Technical next steps for RIOT

- System
 - Generic sensor/actuator interface
 - Over the air (OTA) binary updates
 - (Secure) storage
 - Distributed CI system
- Network stack
 - MAC : more link layer technologies support
 - More lightweight network security protocols
 - More application layer protocols
 - More integration or new ports of other stacks
 - ...

Bottom line

- The IoT will not fulfill its full potential until...
 - An IoT software « bigbang » happens
 - Similar to smartphone evolution with iOS / Android
- We need a (functional/social) equivalent of Linux for IoT devices that cannot run Linux!
- RIOT fills this gap: www.riot-os.org 

Thanks for your interest!

News: https://twitter.com/RIOT_OS

For cooperation questions: riot@riot-os.org

For developer questions: devel@riot-os.org

Support & discussions on IRC: [irc.freenode.org](irc:freenode.org) #riot-os

