An Introduction to the Operating Systems of the IoT

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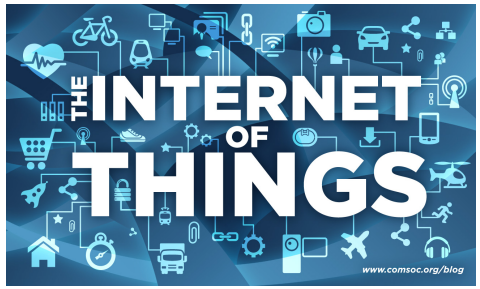
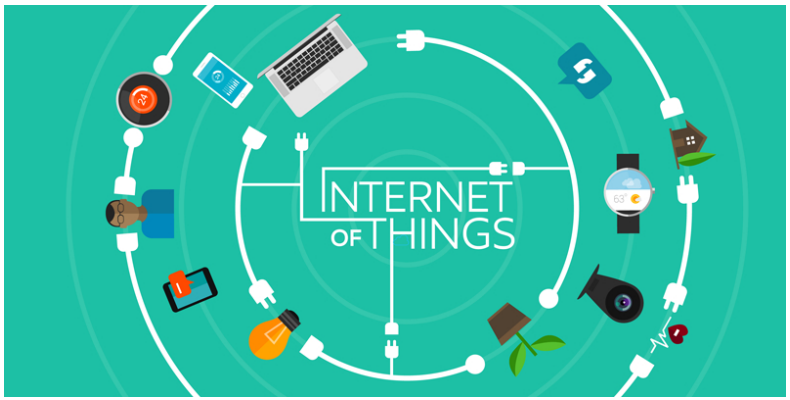
What is IoT...

The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.



Open Source Operating Systems for the IoT

- FreeRTOS
- RIOT
- Contiki
- TinyOS
- Embedded Linux
- OpenWSN



FreeRTOS

- FreeRTOS is designed to be small and simple.
- The kernel itself consists of only three or four C files.
- It provides methods for multiple threads or tasks, mutexes, semaphores and software timers.
- Key features are very small memory footprint, low overhead, and very fast execution.

RIOT

- RIOT is a real-time multi-threading operating system.
- RIOT is based on design objectives including:
  - Energy-Efficiency
  - Reliability
  - Real-Time Capabilities
  - Small Memory Footprint
  - Modularity
  - Uniform API Access
    independent of the underlying hardware
    (this API offers partial POSIX compliance)

Contiki

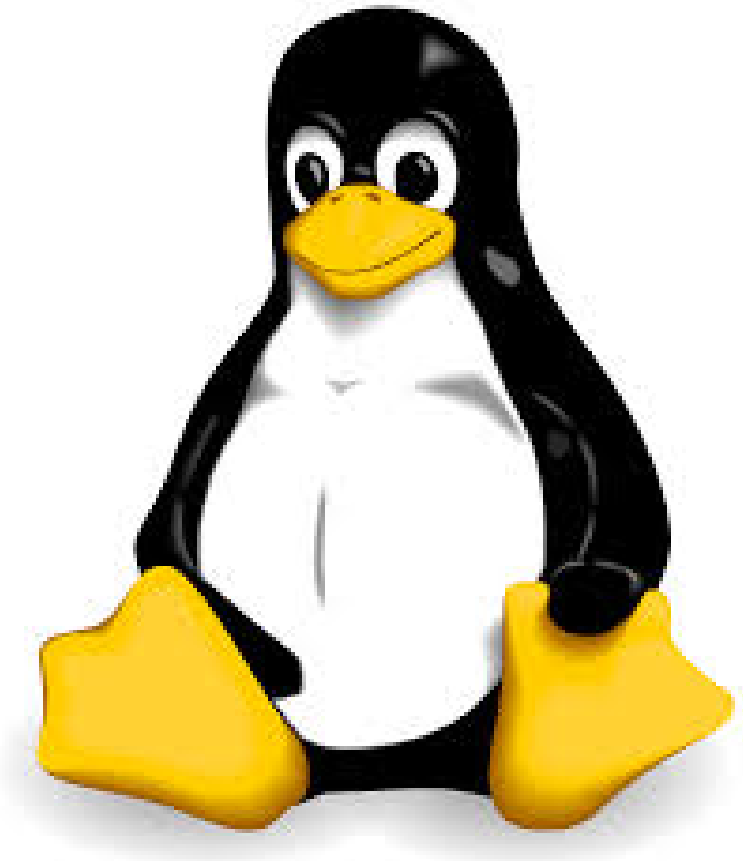
- Contiki is an open source operating system for networked, memory-constrained systems
- Contiki provides three network mechanisms:
  - The uIP stack, which provides IPv4 networking,
  - The uIPv6 stack, which provides IPv6 networking,
  - The Rime stack, which is a set of custom lightweight networking protocols designed specifically for low-power wireless networks.

TinyOS

- TinyOS is a component-based operating system and platform targeting wireless sensor networks.
- TinyOS is an embedded operating system written in the nesC programming language as a set of cooperating tasks and processes.

Embedded Linux

- Embedded Linux is created using OpenEmbedded, the build framework for embedded Linux.
- OpenEmbedded offers a best-in-class cross-compile environment.

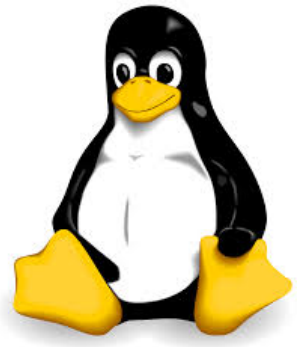


OpenWSN

- The goal of the OpenWSN project is to provide open-source implementations of a complete protocol stack based on Internet of Things standards, on a variety of software and hardware platforms.

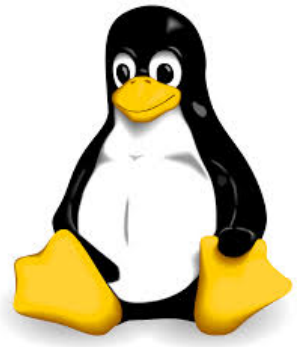
Comparison

OS	Min RAW	Min ROM	C Support	C++ Support
Contiki	$< 2kB$	$< 30kB$	Partial support	No support
Tiny OS	$< 1kB$	$< 4kB$	No support	No support
Linux	$\sim 1MB$	$\sim 1MB$	Full support	Full support
RIOT	$\sim 1.5kB$	$\sim 5kB$	Full support	Full support



Comparison

OS	Multi-Threading	Modularity	Real-Time
Contiki	Partial support	Partial support	Partial support
Tiny OS	Partial support	No support	No support
Linux	Full support	Partial support	Partial support
RIOT	Full support	Full support	Full support



Why Not Linux?

Real-Time Linux

Controlling a laser with Linux is crazy, but everyone in this room is crazy in his own way. So if you want to use Linux to control an industrial welding laser, I have no problem with your using PREEMPT_RT.

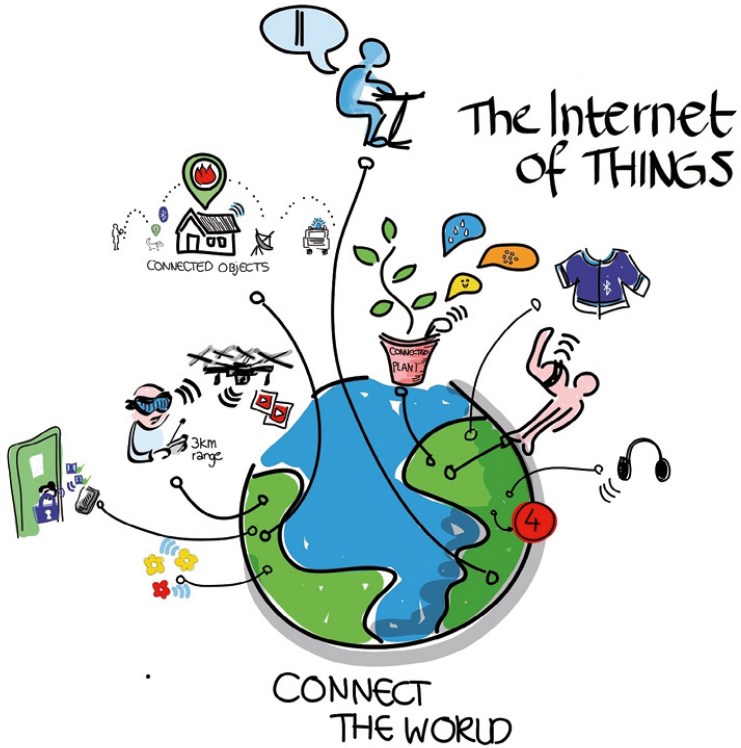
- Linus Torvalds

Why Not Linux?

- Linux certainly is a robust, developer-friendly OS
- Linux has a disadvantage when compared to a real-time operating system:
  - Memory footprint
  - It simply will not run on 8 or 16-bit MCUs

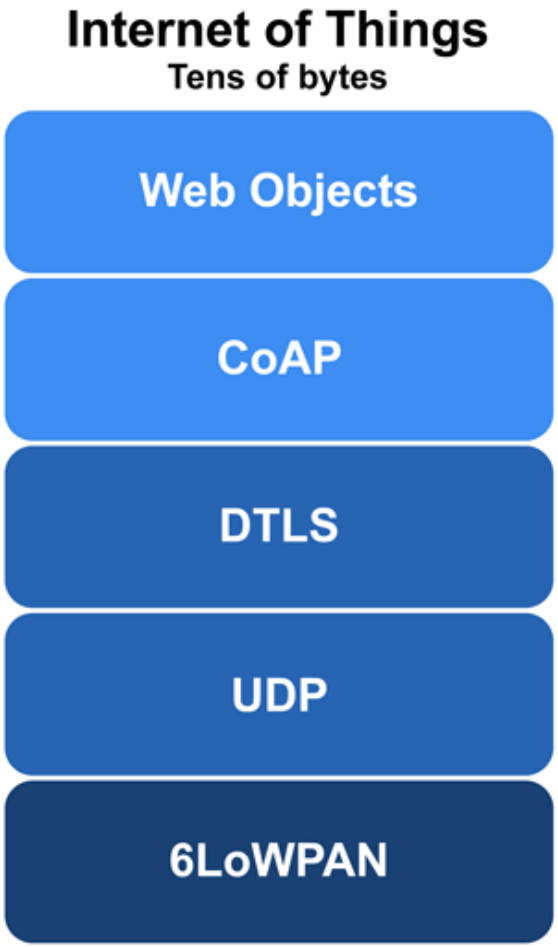
Requirements for IoT

- Scalability
- Modularity
- Connectivity
- Reliability



Internet Usage and Protocols for the IoT

- Inefficient content encoding
- Huge overhead, difficult parsing
- Requires full Internet devices



- Efficient objects
- Efficient Web
- Optimized IP access

Questions?