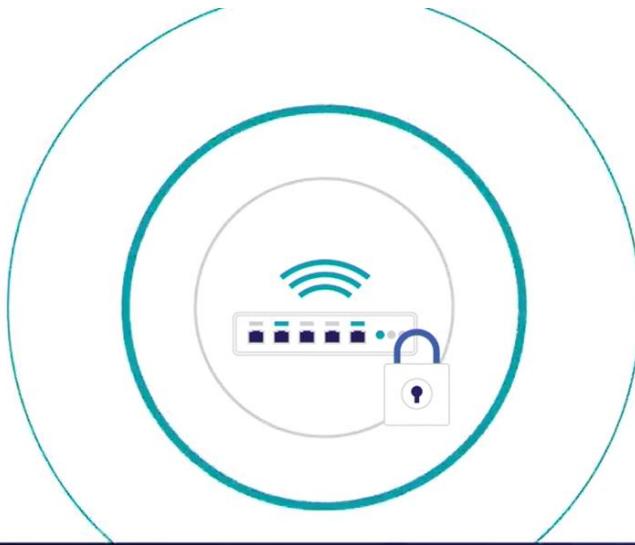


1 Robustness

▶ ⏪ ⏴ ⏵ 2:31 / 4:37

1x CC BY NC ND



2 Security

▶ ⏪ ⏴ ⏵ 3:26 / 4:37

1x CC ⏴ ⏵



Software • Data Communication

2 Security

▶ ⏪ ⏴ ⏵ 3:29 / 4:37

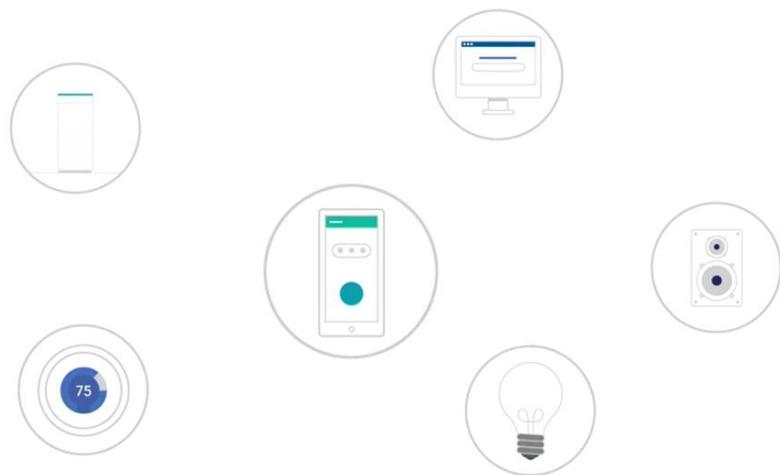
1x CC ⏴ ⏵

3 Modularity and Extensibility

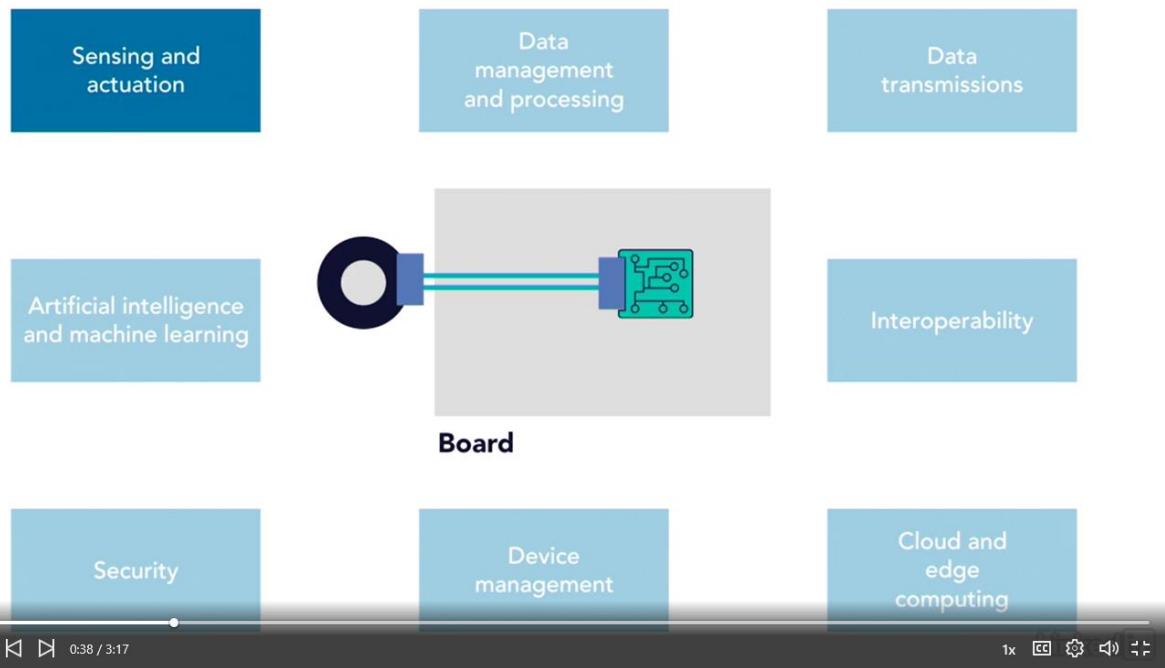
LinkedIn



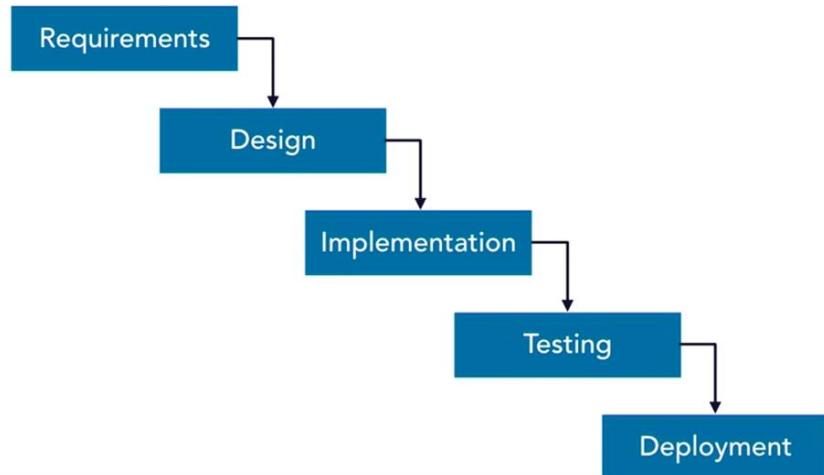
4 Manageability



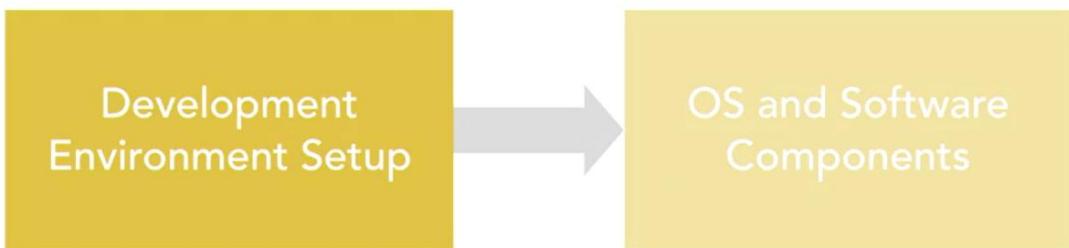
5 Connectivity and Interoperability



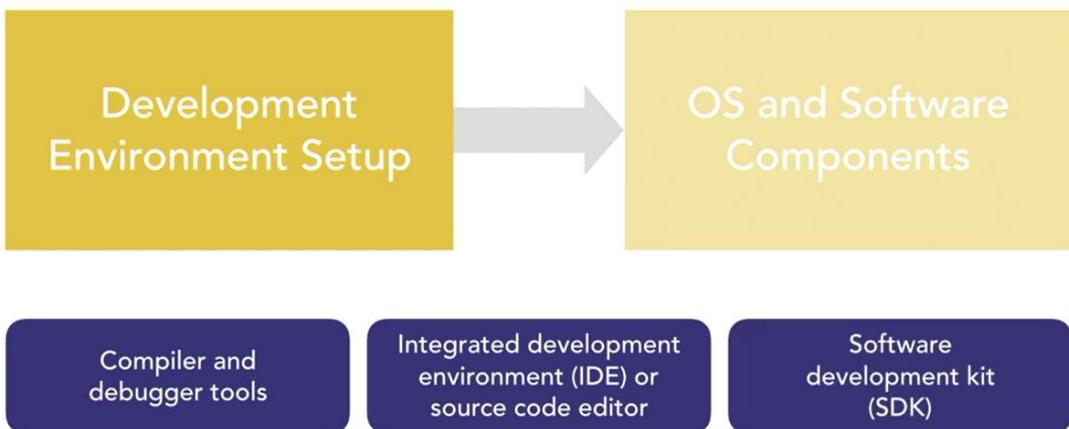
Waterfall Software Development



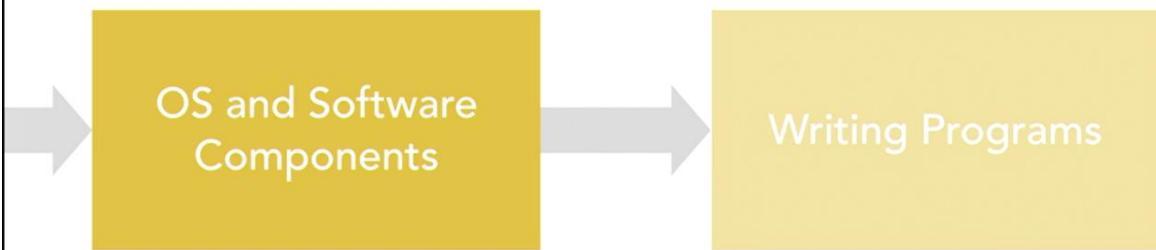
Workflow of Building an IoT Application



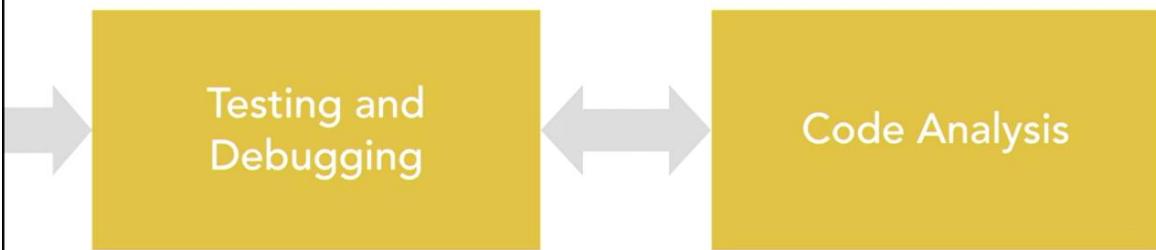
Workflow of Building an IoT Application



Workflow of Building an IoT Application



Workflow of Building an IoT Application



▶ ⏪ ⏴ ⏵ 3:22 / 4:10 1.5x CC ⏴ ⏵

Sensors and Actuators

- Bedrock of IoT
- Connected to an IoT board as peripherals
- Manipulation through software interfaces

▶ ⏪ ⏴ ⏵ 0:38 / 4:18 1.5x CC ⏴ ⏵

Polling through GPIOs

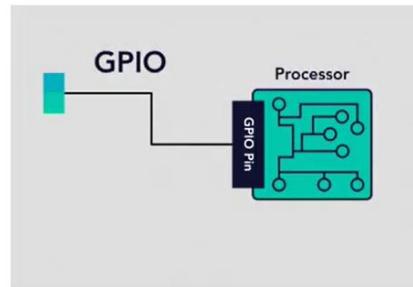
Example: LEDs

Set GPIO to 1 or 0

...

...

OS-based application



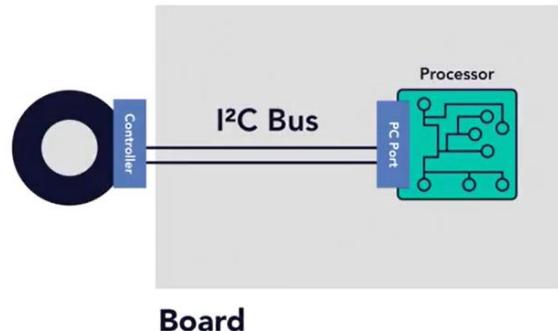
Board

Interrupts

Example: image sensor

Process image
sensor data through
ISR
...

OS-based application



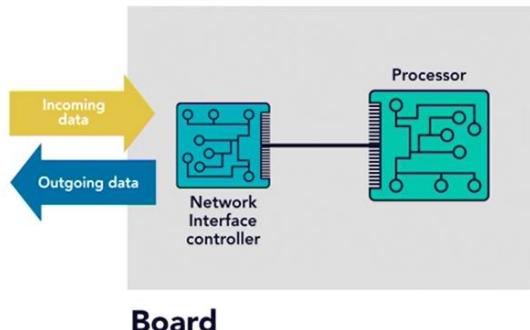
2:11 / 4:18 1.5x CC ⌂ ⌃ ⌄ ↻

Interrupts

Example: network interface controller

Access network
interfaces to handle
data packets
...

OS-based application



Play 2:50 / 4:18 1.5x CC ⌂ ⌃ ⌄ ↻

Temperature - SparkFun > nRF5-SDK-v12.zip / nRF > GNU Arm Embedded Tool

SparkFun Electronics [US] | https://www.sparkfun.com/categories/82

Environment - Temperature

SORT BY:

- Most Popular
- Highest Price
- Lowest Price
- Alphabetical
- Highest Reviewed
- Newest
- Oldest

REFINE BY:

- SparkFun Original
- On sale
- In stock

CUSTOMER REVIEWS:

- ★★★★★
- ★★★★★
- ★★★★★
- ★★★★★
- ★★★★★
- ★★★★★
- ★★★★★

PRICE:

- \$0 - \$10
- \$10 - \$20
- \$20 - \$30
- \$30 - \$40
- \$40 - \$50
- \$50 - \$75
- \$75 - \$100
- \$100+ -

Temperature Sensor - Waterproof (DS18B20)
SEN-11050
\$9.95
★★★★★ 20

Humidity and Temperature Sensor - RHT03
SEN-10167
\$9.95
★★★★★ 28

SparkFun Digital Temperature Sensor Breakout - TMP102
SEN-13314
\$4.95
★★★★★ 1

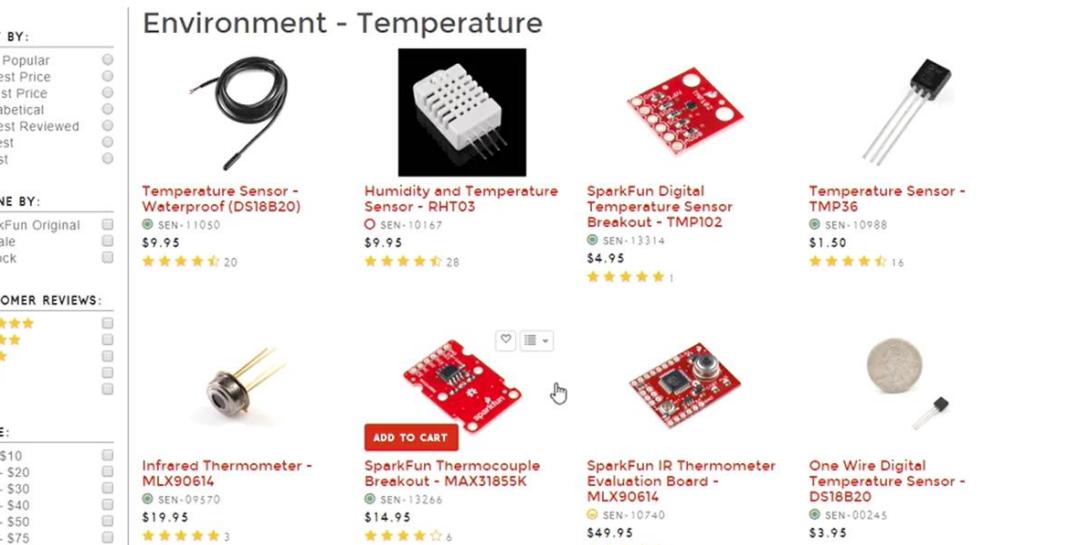
Temperature Sensor - TMP36
SEN-10988
\$1.50
★★★★★ 16

Infrared Thermometer - MLX90614
SEN-09570
\$19.95
★★★★★ 3

SparkFun Thermocouple Breakout - MAX31855K
SEN-13266
\$14.95
★★★★★ 6

SparkFun IR Thermometer Evaluation Board - MLX90614
SEN-10740
\$49.95
★★★★★ 1

One Wire Digital Temperature Sensor - DS18B20
SEN-00245
\$3.95



What's new in 7-2017-q4-major

In this release

- 1 gcc-arm-none-eabi-7-2017-q4-major-win32.exe
Windows 32-bit Installer
MD5: bb4def39ff1cb3ff5d2931597d9aea4e
- 2 gcc-arm-none-eabi-7-2017-q4-major-win32-sha1.exe
Windows 32-bit Installer (Signed for Windows XP and Vista)
MD5: 66c48495d7eb7239acad0290cb318c6a
- 3 gcc-arm-none-eabi-7-2017-q4-major-sha2.exe
Windows 32-bit Installer (Signed for Windows 7 and later)

Source Invariant
File: gcc-arm-none-eabi-7-2017-q4-major-mac.tar.bz2 (162.20 MB)

Windows 32-bit
File: gcc-arm-none-eabi-7-2017-q4-major-win32.exe (82.53 MB)
Download

Windows 32-bit
File: gcc-arm-none-eabi-7-2017-q4-major-win32-sha1.exe (82.53 MB)
Download

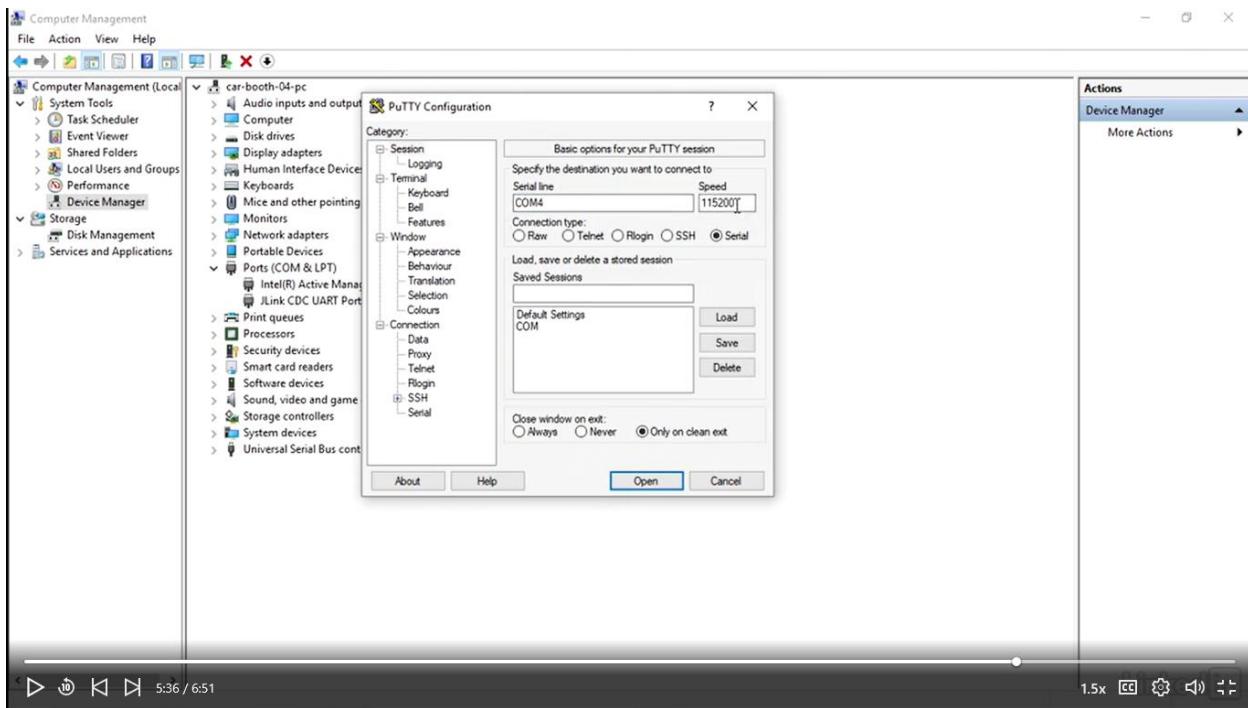
Windows 32-bit
File: gcc-arm-none-eabi-7-2017-q4-major-win32-sha2.exe (82.53 MB)
Download

Windows ZIP
File: gcc-arm-none-eabi-7-2017-q4-major-win32.zip (123.71 MB)
Download

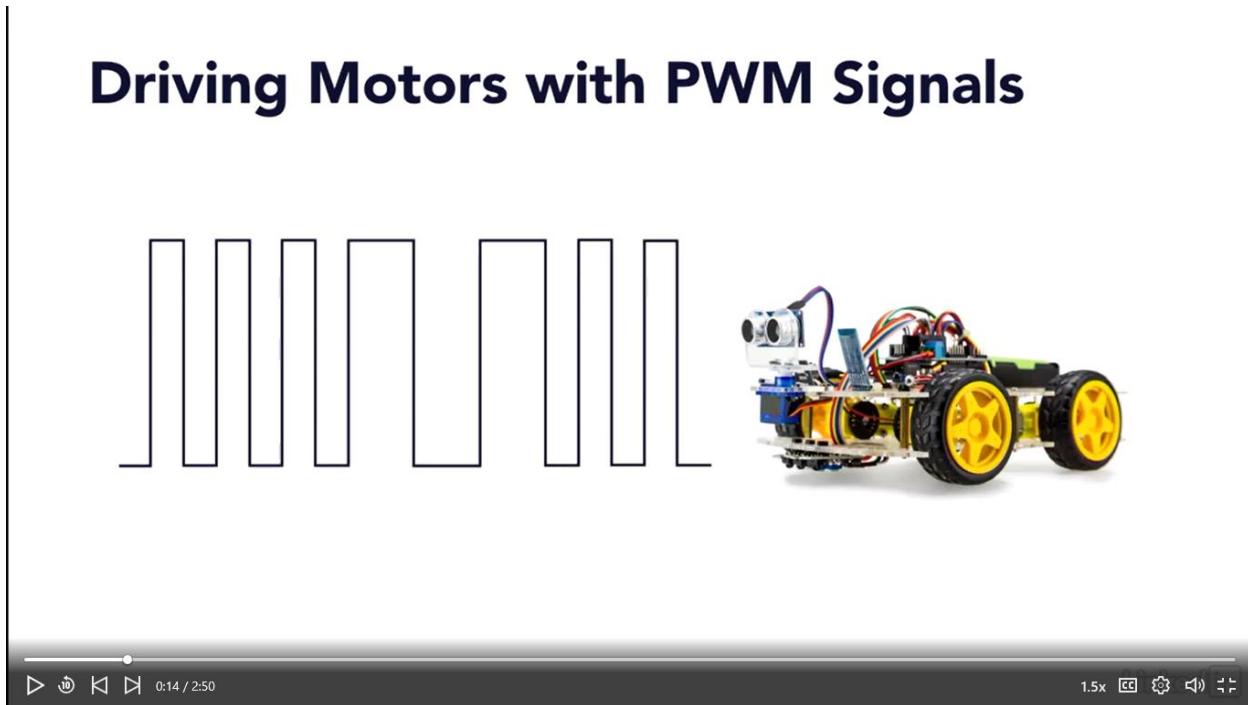
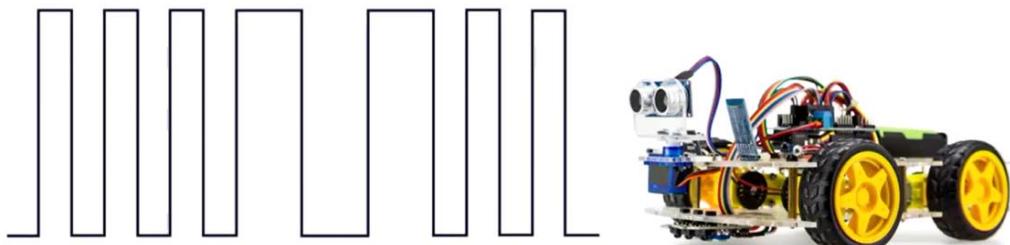
Linux 64-bit
File: gcc-arm-none-eabi-7-2017-q4-major-linux.tar.bz2 (95.23 MB)
Download

Mac OS X 64-bit
File: gcc-arm-none-eabi-7-2017-q4-major-mac.tar.bz2 (99.71 MB)
Download

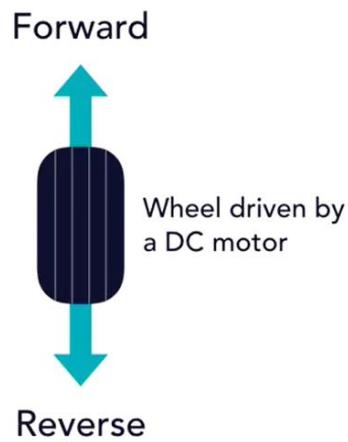
Feedback



Driving Motors with PWM Signals

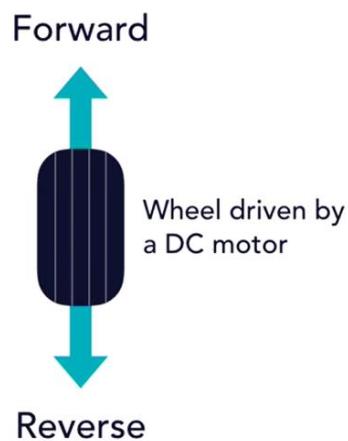


Driving Robots with PWM Signals



▶ ⏴ ⏵ ⏶ 0:45 / 2:50 1.5x 🎧 🔍 ⚙️ 🔊 ⌂

Driving Robots with PWM Signals



1:03 / 2:50 1.5x ▶

Driving Drones with PWM Signals



▷ ⏴ ▶ 2:09 / 2:50

1.5x

Data-Centric IoT



▷ ⏪ ▷ 0:23 /

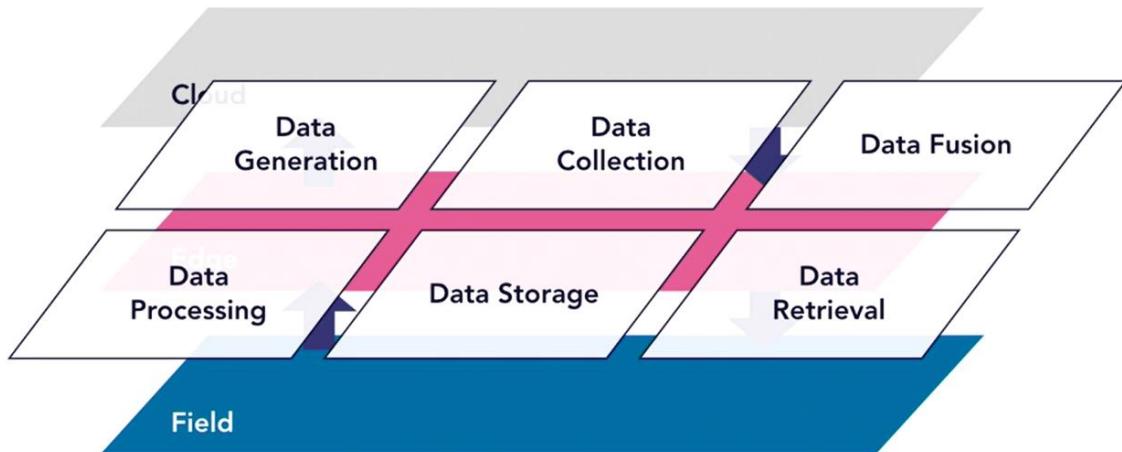
linkedin.com switched to full screen (Esc to exit).

Okay

[Exit now](#)

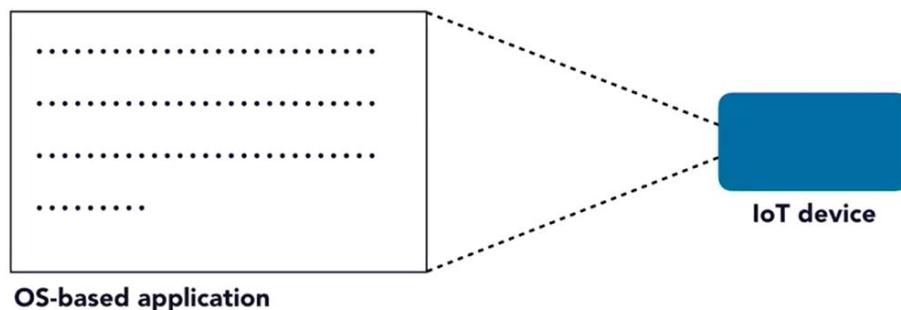
1.5x

Data-Centric IoT



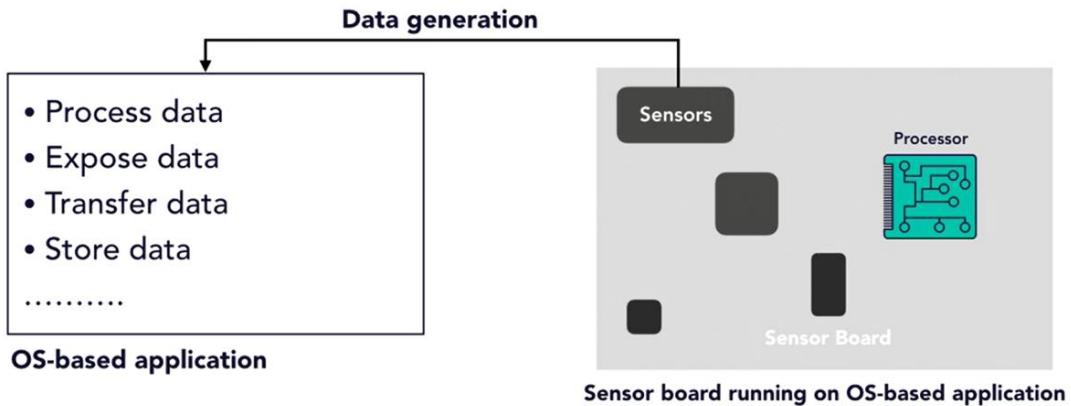
Data Management

From the OS application perspective



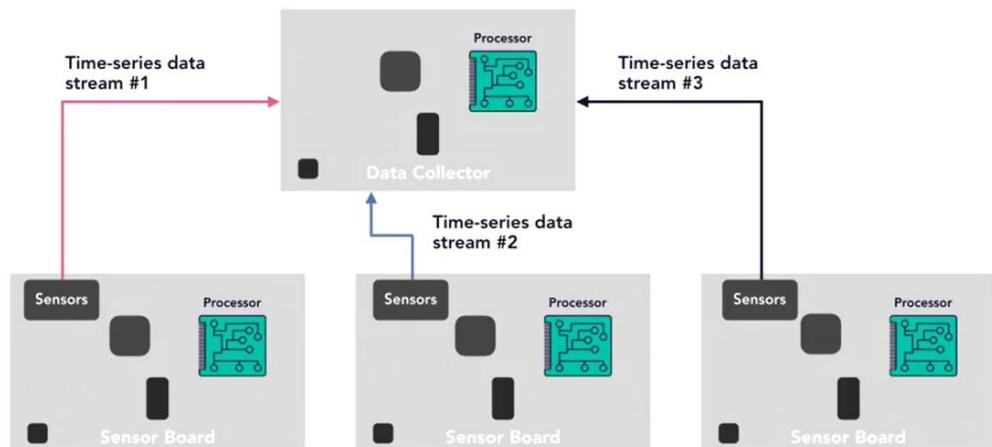
Data Management

From the OS application perspective



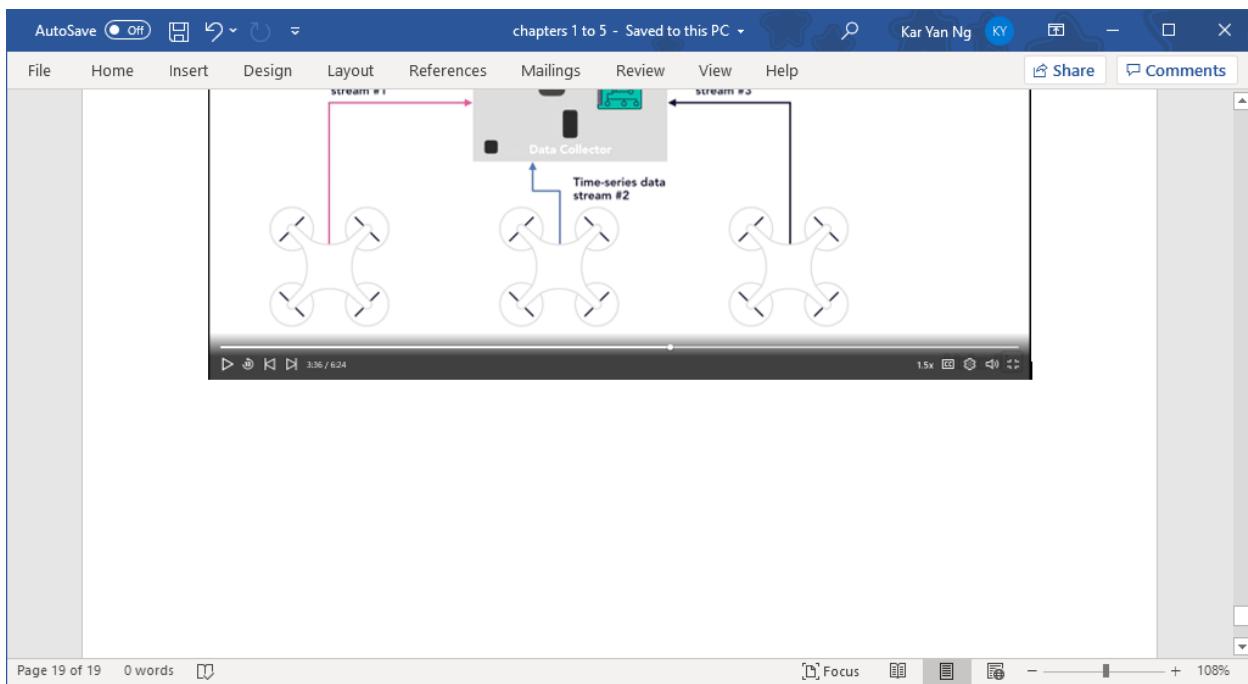
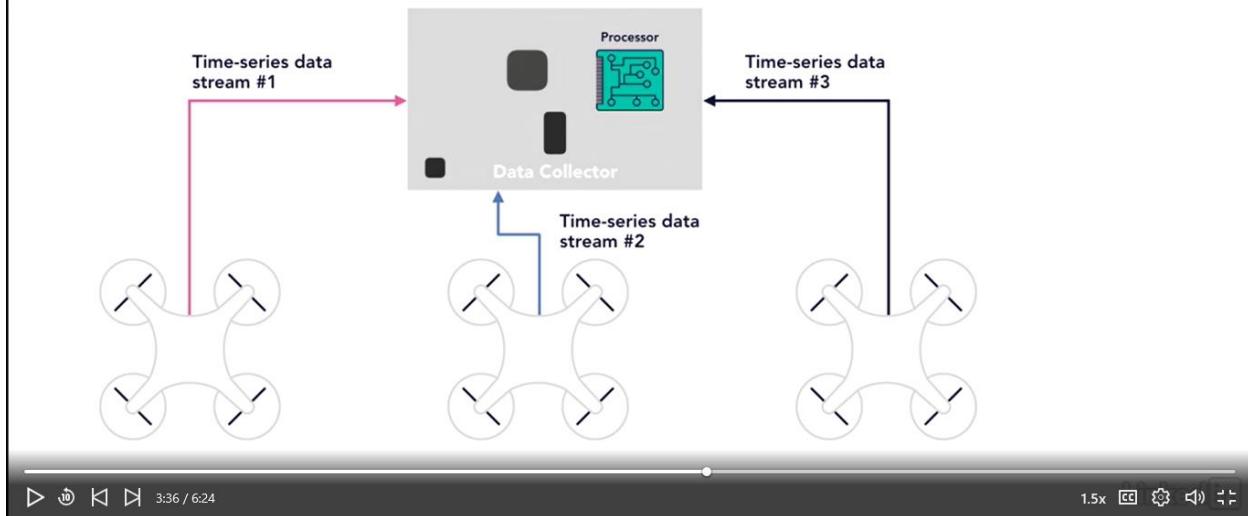
Data Management

From the OS application perspective

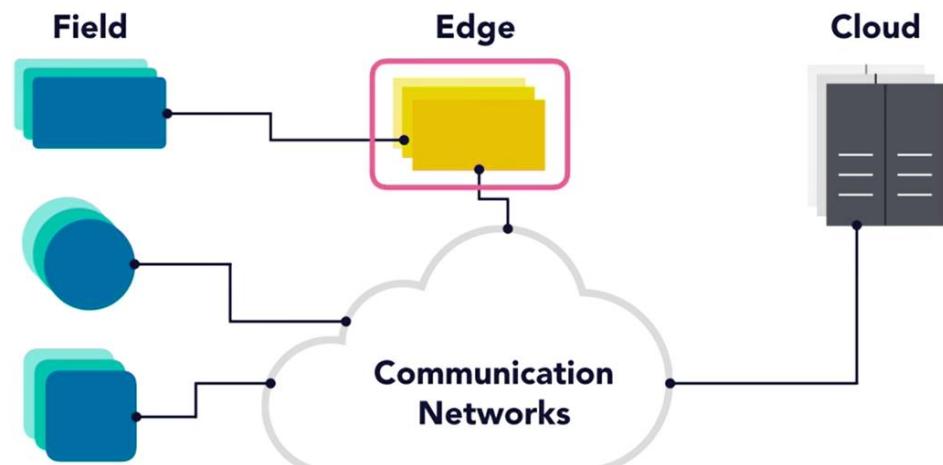


Data Management

From the OS application perspective

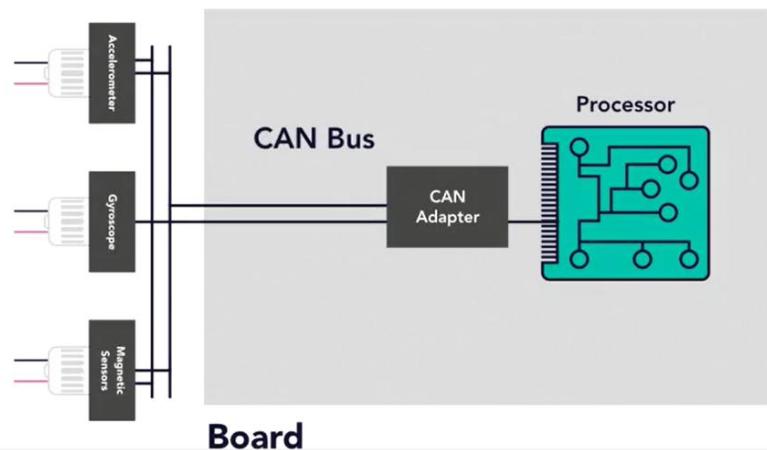


Data Fusion



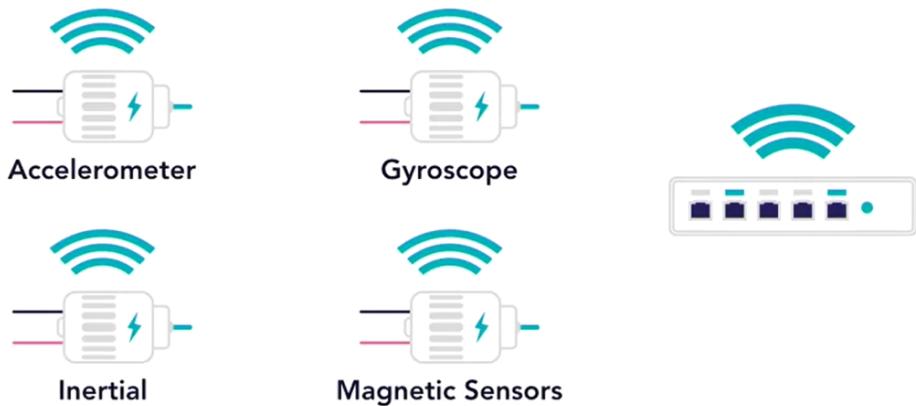
Data Fusion

Example: single device

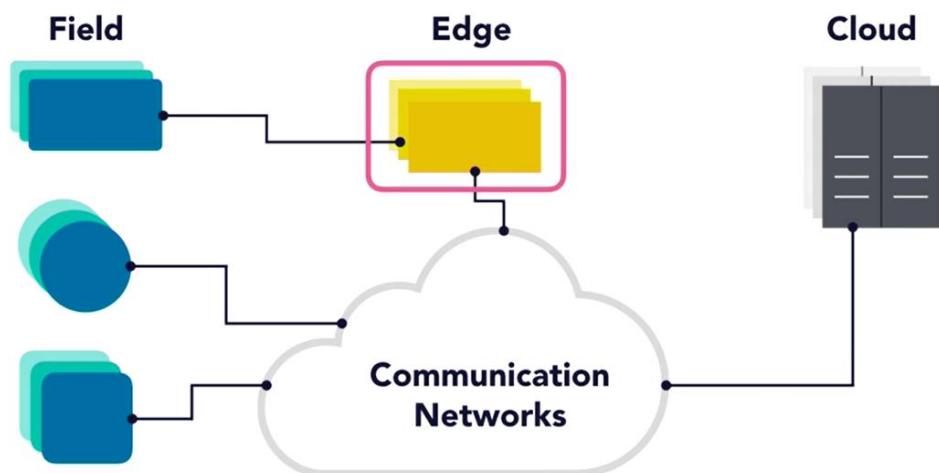


Data Fusion

Example: industrial machine health monitoring

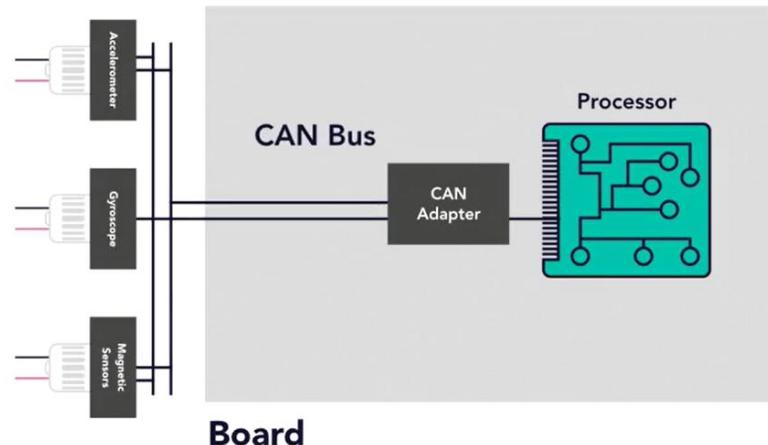


Data Management at the Edge



Data Fusion

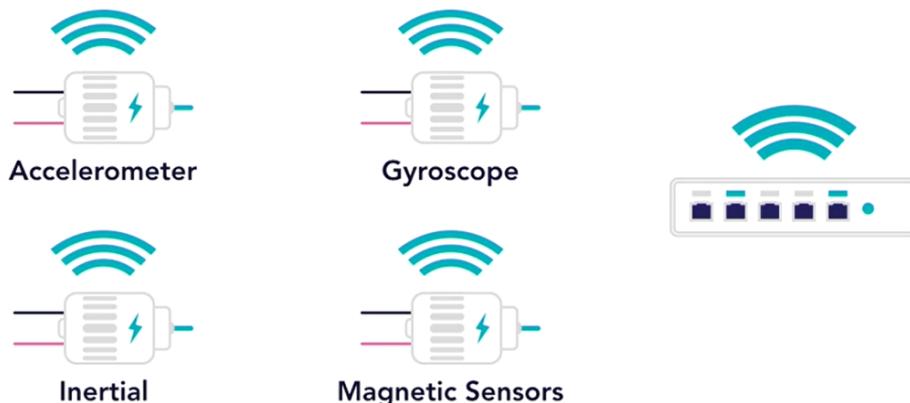
Example: single device



◀ ▶ ⏪ ⏩ 4:19 / 6:24 1.5x CC BY-SA

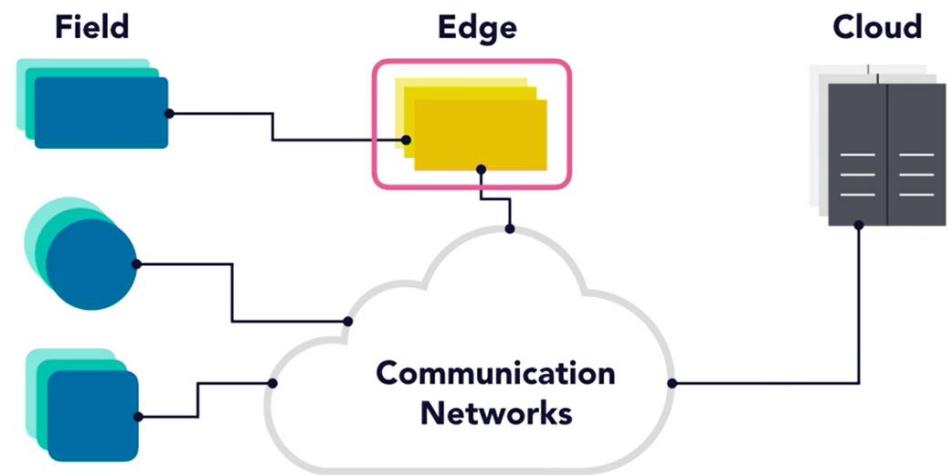
Data Fusion

Example: industrial machine health monitoring



◀ ▶ ⏪ ⏩ 4:59 / 6:24 1.5x CC BY-SA

Data Management at the Edge



▶ ⏪ ⏴ ⏵ 5:17 / 6:24 1.5x CC ⏴ ⏵

Data Management at the Edge



▶ ⏪ ⏴ ⏵ 6:13 / 6:24 1.5x CC ⏴ ⏵

TN FAT File System SQLite Home Page

Secure | https://technet.microsoft.com/en-us/library/cc938438.aspx

FAT File System

FAT File System

The FAT file system has the file allocation table located at the beginning of a logical volume. FAT was designed for small disks and simple folder structures. Two copies of the file allocation table are stored on the volume. In the event that one copy of the file allocation table is corrupted, the other file allocation table is used.

Compact Disc File System

Using Long File Names

FAT16 File System

FAT16 is included in Windows 2000 for the following reasons:

- It provides backward compatibility in the form of an upgrade path for earlier versions of Windows-compatible products.
- It is compatible with most other operating systems.

For Windows 2000 and Windows NT, the maximum size for a FAT16 volume is 4,095 megabytes (MB).

A volume formatted with FAT16 is allocated in clusters. The default cluster size is determined by the volume size, and can be as large as 64 kilobytes (KB). The cluster size must be a power of 2 between 512 and 65,536 bytes. Table 3.2 shows the default cluster sizes for FAT16 volumes. You can specify a different cluster size if you format the volume with the **format** command from the command prompt. However, the size you specify must be listed in Table 3.2.

Table 3.2 FAT16 Cluster Sizes

| Volume Size | Sectors Per Cluster | Cluster Size |
|---------------|---------------------|--------------|
| 0 MB–32 MB | 1 | 512 bytes |
| 33 MB–64 MB | 2 | 1 KB |
| 65 MB–128 MB | 4 | 2 KB |
| 129 MB–255 MB | 8 | 4 KB |
| 256 MB–511 MB | 16 | 8 KB |

TN FAT File System SQLite Home Page

www.sqlite.org/index.html



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Choose any three.*

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SQLite is a self-contained, high-reliability, embedded, full-featured, public-domain, SQL database engine. SQLite is the most used database engine in the world. [More Info](#)

Latest Release: Version 3.23.1 (2018-04-10). [Download](#) [Prior Releases](#)

Sponsors

Ongoing development and support of SQLite is made possible in part by [SQLite Consortium](#) members, including:


Common Links

- Features
- When to use SQLite
- Frequently Asked Questions
- Getting Started
- Prior Releases
- SQL Syntax
 - Pragmas
 - SQL functions
 - Date & time functions
 - Aggregate functions
 - JSON functions
- C/C++ Interface Spec
 - Introduction
 - List of C-language APIs
- The TCL Interface Spec
- Commit History
- Report a Bug
- News

The screenshot shows a web browser window displaying the FFTW Home Page. The title bar reads "FFTW Home Page". The address bar shows the URL "www.fftw.org". The main content features a large, stylized logo where the letters "FFTW" are rendered in black and red. Below the logo is a navigation menu with links: Download, GitHub, Mailing List, Benchmark, Features, Documentation, FAQ, Links, and Feedback. A section titled "Introduction" follows, containing text about FFTW's purpose and history. Another section, "Features", lists various performance and functionality highlights. The bottom of the page includes a video player interface showing a video thumbnail and playback controls.

FFTW is a C subroutine library for computing the discrete Fourier transform (DFT) in one or more dimensions, of arbitrary input size, and of both real and complex data (as well as of even/odd data, i.e. the discrete cosine/sine transforms or DCT/DST). We believe that FFTW, which is [free software](#), should become the [FFT](#) library of choice for most applications.

The latest official release of FFTW is version [3.3.7](#), available from [our download page](#). Version 3.3 introduced support for the AVX x86 extensions, a distributed-memory implementation on top of MPI, and a Fortran 2003 API. Version 3.3.1 introduced support for the ARM Neon extensions. See the [release notes](#) for more information.

The FFTW package was developed at [MIT](#) by [Matteo Frigo](#) and [Steven G. Johnson](#).

Our [benchmarks](#), performed on a variety of platforms, show that FFTW's performance is typically superior to that of other publicly available FFT software, and is even competitive with vendor-tuned codes. In contrast to vendor-tuned codes, however, FFTW's performance is *portable*: the same program will perform well on most architectures without modification. Hence the name, "FFTW," which stands for the somewhat whimsical title of "Fastest Fourier Transform in the West."

Subscribe to the [fftw-announce mailing list](#) to receive release announcements (or use the web feed [RSS](#)).

Features

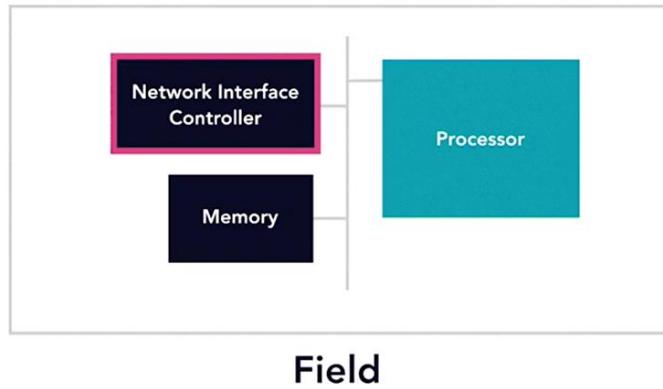
FFTW 3.3.7 is the latest official version of FFTW (refer to the [release notes](#) to find out what is new). Here is a list of some of FFTW's more interesting features:

- [Speed](#) (Supports SSE/SSE2/AltiVec, since version 3.0. Version 3.3.1 supports AVX and ARM Neon.)
- Both one-dimensional and multi-dimensional transforms.
 - (All one-dimensional transforms (except with small prime factors) are best; but FFTW uses $O(N \log N)$ algorithms even for prime sizes.)
 - (All transforms of purely real input or output data.)

▷ ⏪ ⏴ 1:16 / 4:45
Translates even/odd data: the [discrete cosine transform](#) (DCT) and the [discrete sine transform](#) (DST), types I-IV. (Version 3.0 or later.)

1.5x CC ⏴ ⏵ ⏴ ⏵

Data Transmissions with Your Applications



Field

Data Transmissions with Your Applications

Software

OS Kernel

Hardware Interface



Data Transmissions with Your Applications

Software

OS-Based Applications

Communication/Network Stacks

Other Libs

OS Kernel

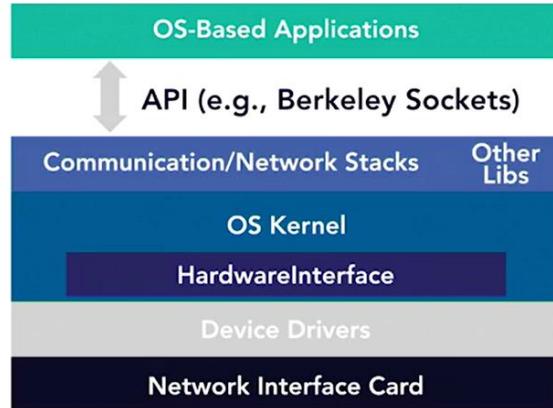
Hardware Interface

Device Drivers

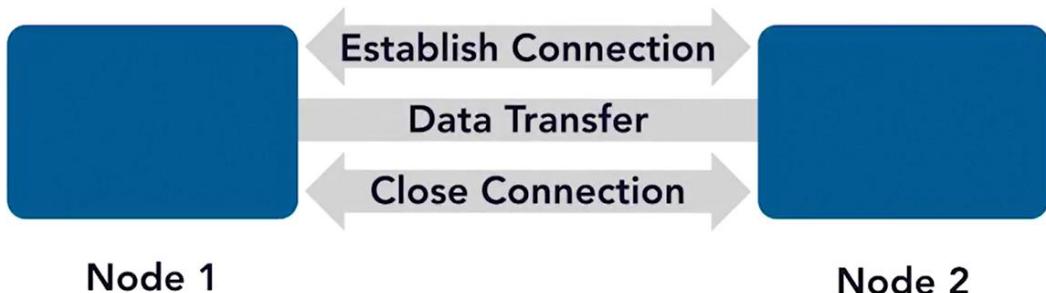
Network Interface Card

Data Transmissions with Your Applications

Software



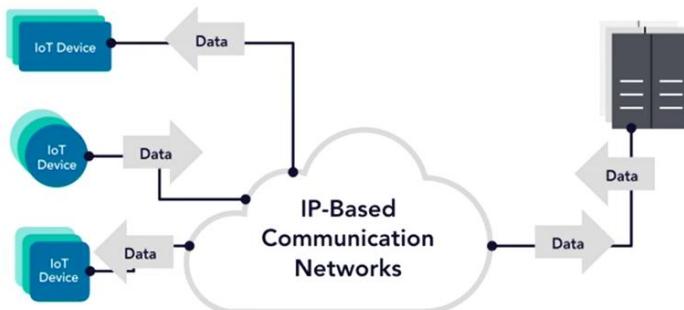
Data Transmissions with Your Applications



▶ ⏪ ⏴ ⏵ 1:38 / 2:03 1.5x CC BY NC SA 🔍

TCP/IP Stack

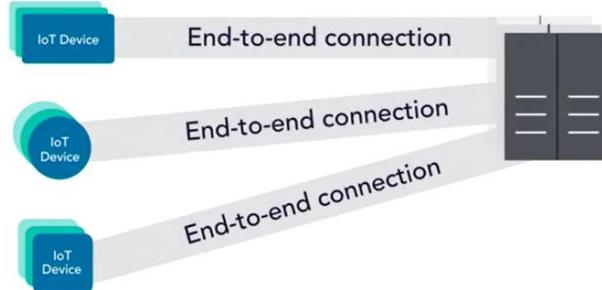
- Essential network protocol stack for data transmission over internet



▶ ⏪ ⏴ ⏵ 0:10 / 1:20 1.5x CC BY NC NC 🔍

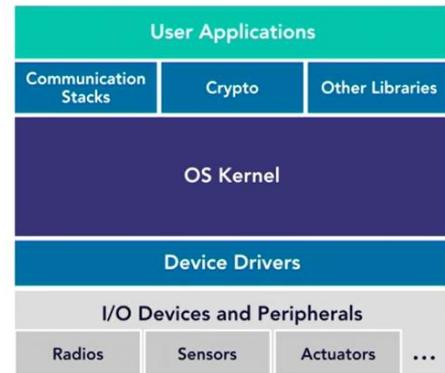
TCP/IP Stack

- Let OS-based applications establish end-to-end connections



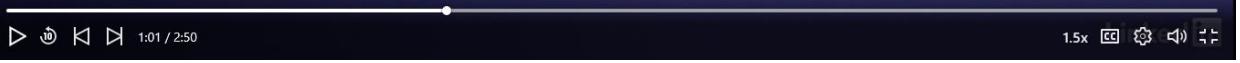
TCP/IP Stack

- May need to be added to an OS



Bluetooth Connectivity for IoT

- Commonly seen on consumer electronic devices
- Hardware network interface + software
- Bluetooth 5 with extended range and speed
- Bluetooth low energy (BLE) provides a popular low-power connectivity option for energy-constraint IoT devices

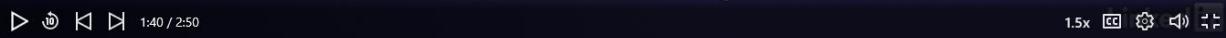


▶ ⏪ ⏴ ⏵ 1:01 / 2:50

1.5x CC ⌂ ⌂ ⌂ ⌂

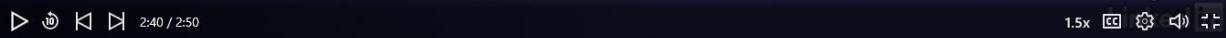
Transfer Bluetooth Packets over

- Bluetooth packets can be transmitted via internet
- Simplify programming and integration efforts



Example: Nordic nRF52 DK

- nRF52 DK provides support for 6LoWPAN over BLE and FreeRTOS port
- Data transmission and reception are handled by OS tasks



Cellular Connectivity for IoT

- Another popular wireless connectivity option
- Low-power cellular vs. regular cellular
- Infrastructure based vs. infrastructure-less



1.5x CC ⏪ ⏴ ⏵ ⏹

Example: Bus Tracking System

- The bus trajectory is tracked with a GPS module on the bus
- Each bus uses cellular connectivity for wide communication coverage

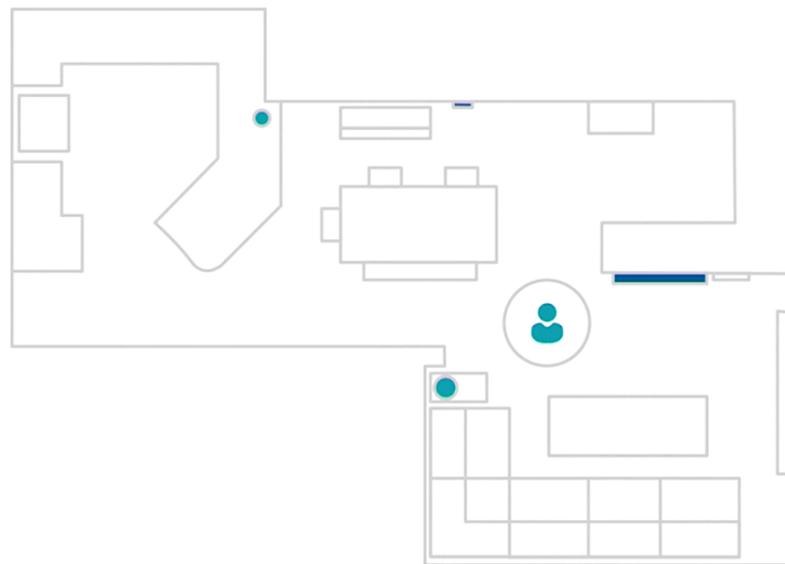


1.5x CC ⏪ ⏴ ⏵ ⏹

Use LTE Cellular Connectivity

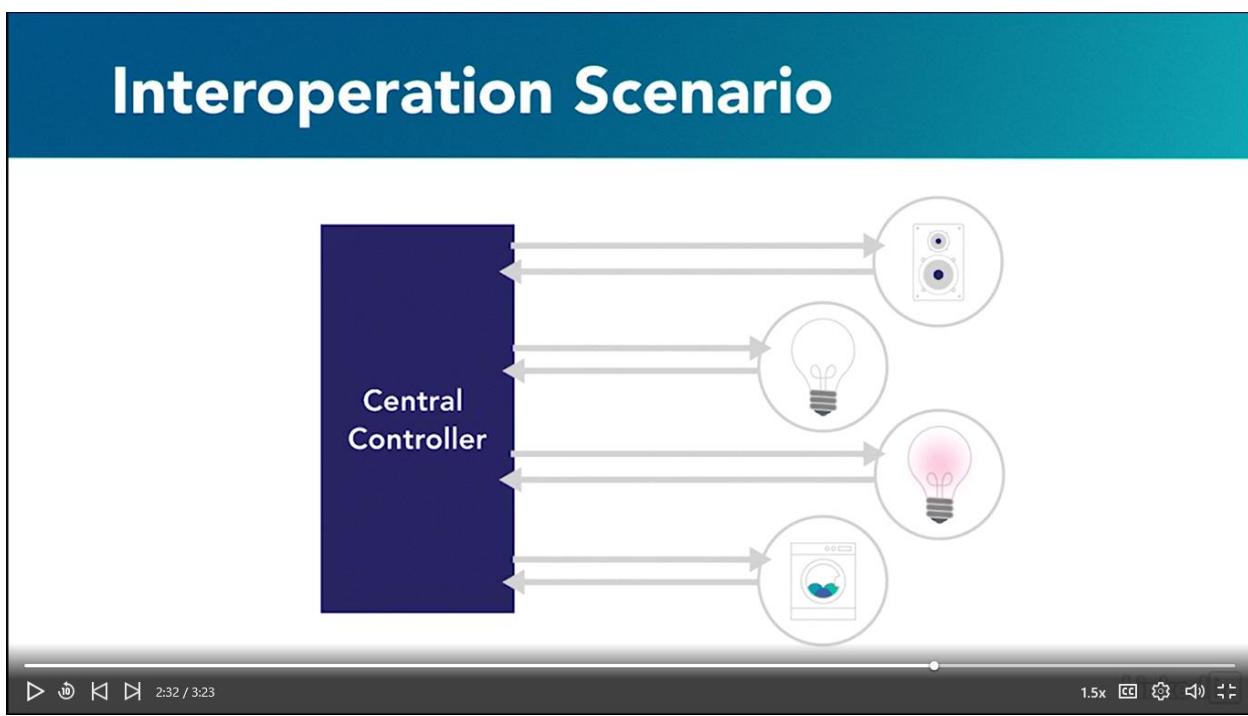
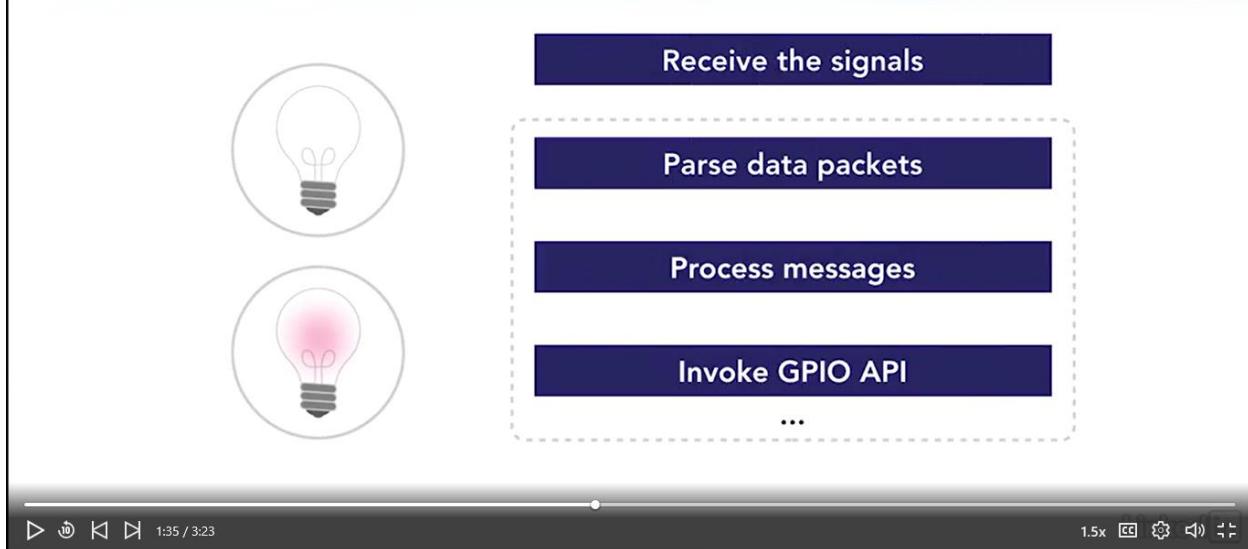
- LTE module as a modem that may be integrated into the hardware
- Send commands to the modem

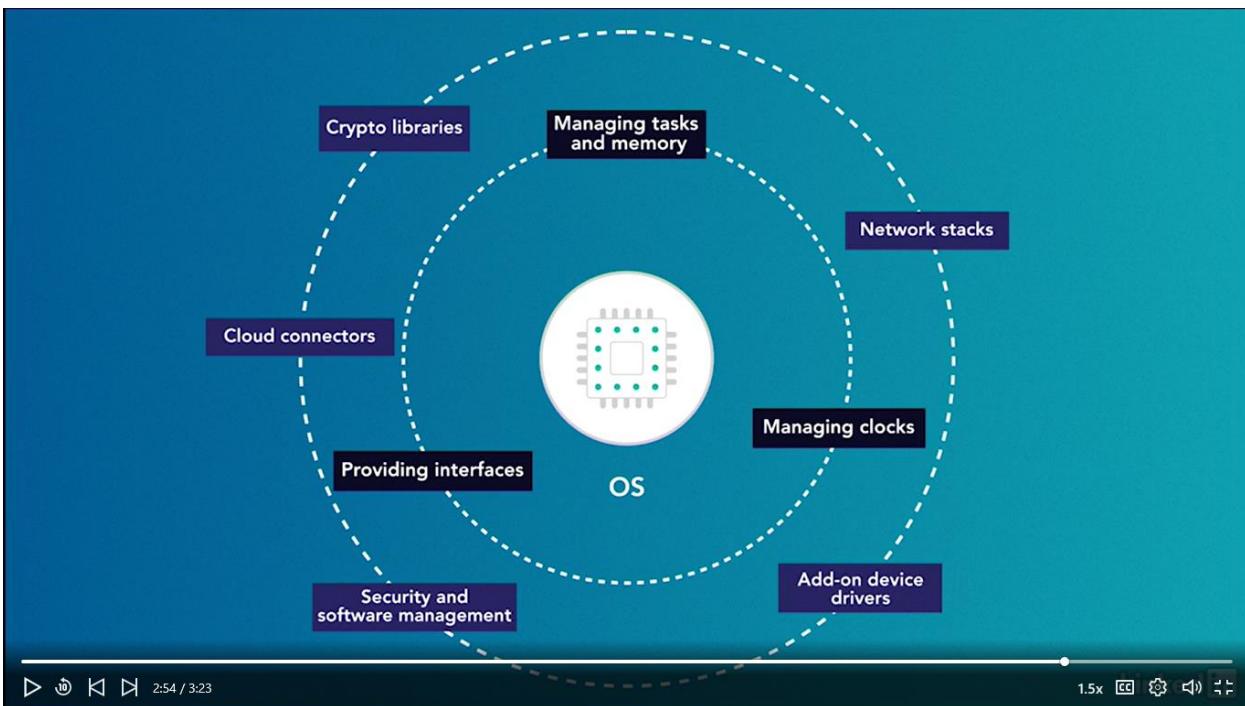
▶ ⏪ ⏴ ⏵ 2:39 / 2:43 1.5x CC ⏹ 🔍 🔍 🔍



▶ ⏪ ⏴ ⏵ 0:43 / 3:23 1.5x CC ⏹ 🔍 🔍 🔍

Example: Central Controller and Smart Lights

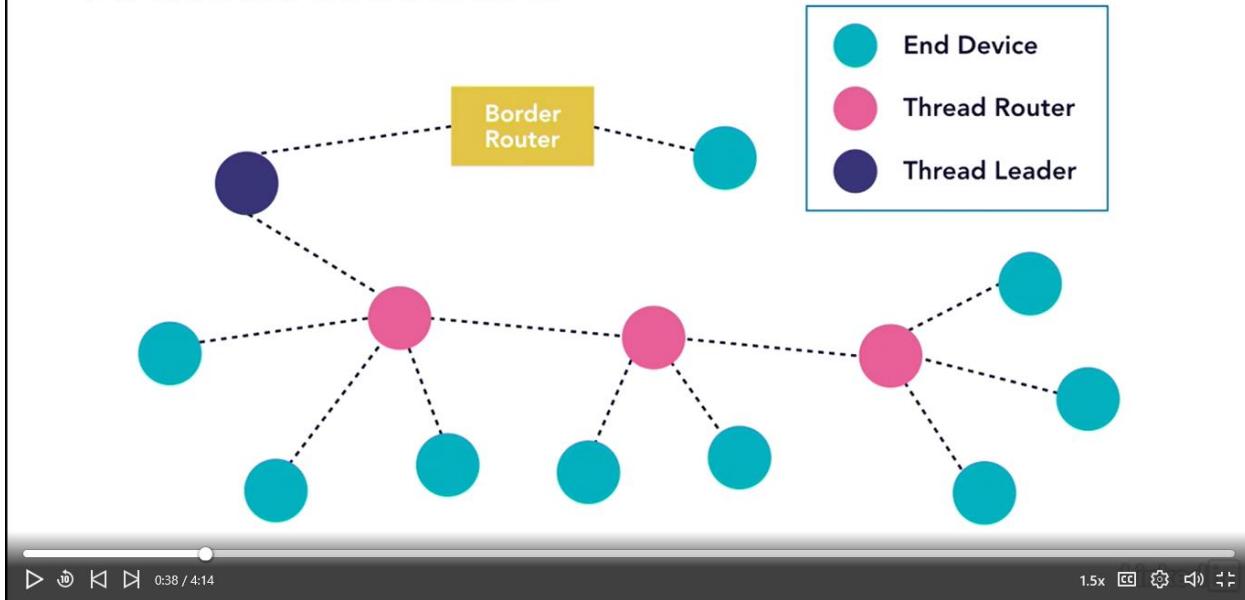




Thread Protocol

- IPv6-based network protocol based on the IEEE 802.15.4-2006 specs
- Help build networking applications with little worry about the underlying communication protocols or platforms

A Mesh Network



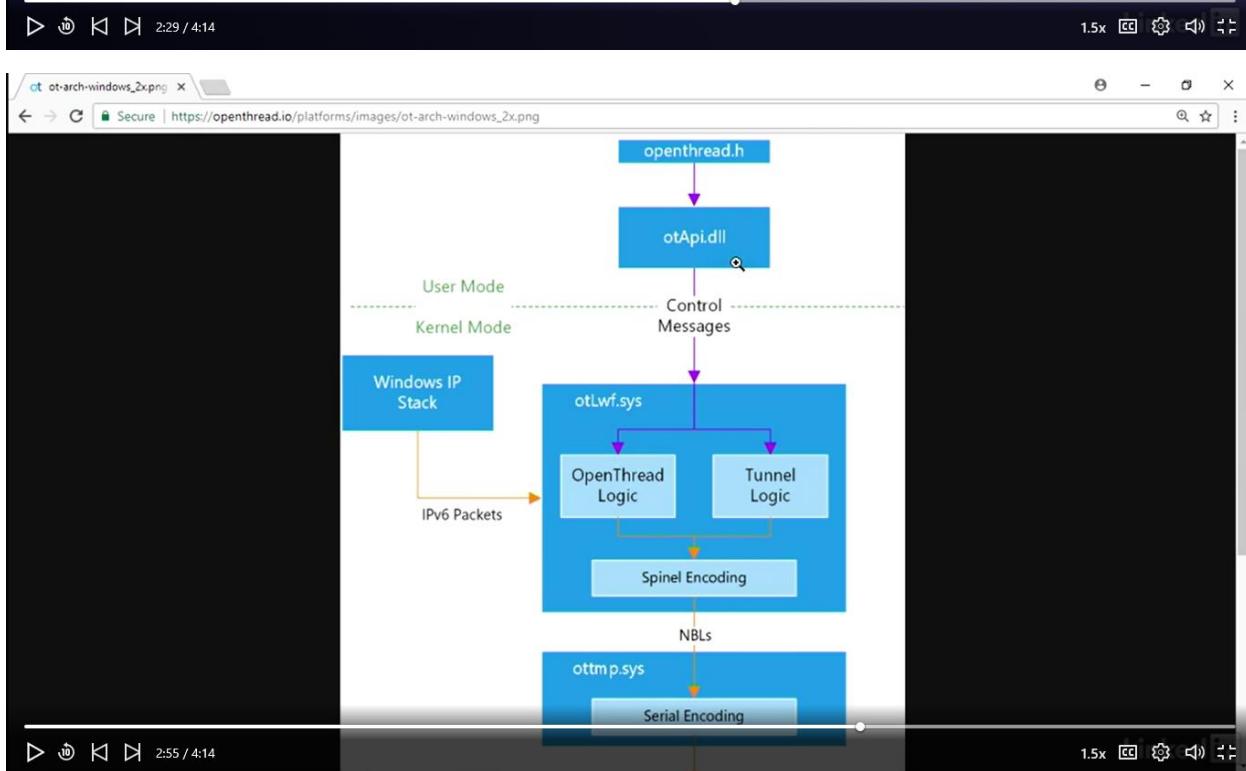
OpenThread

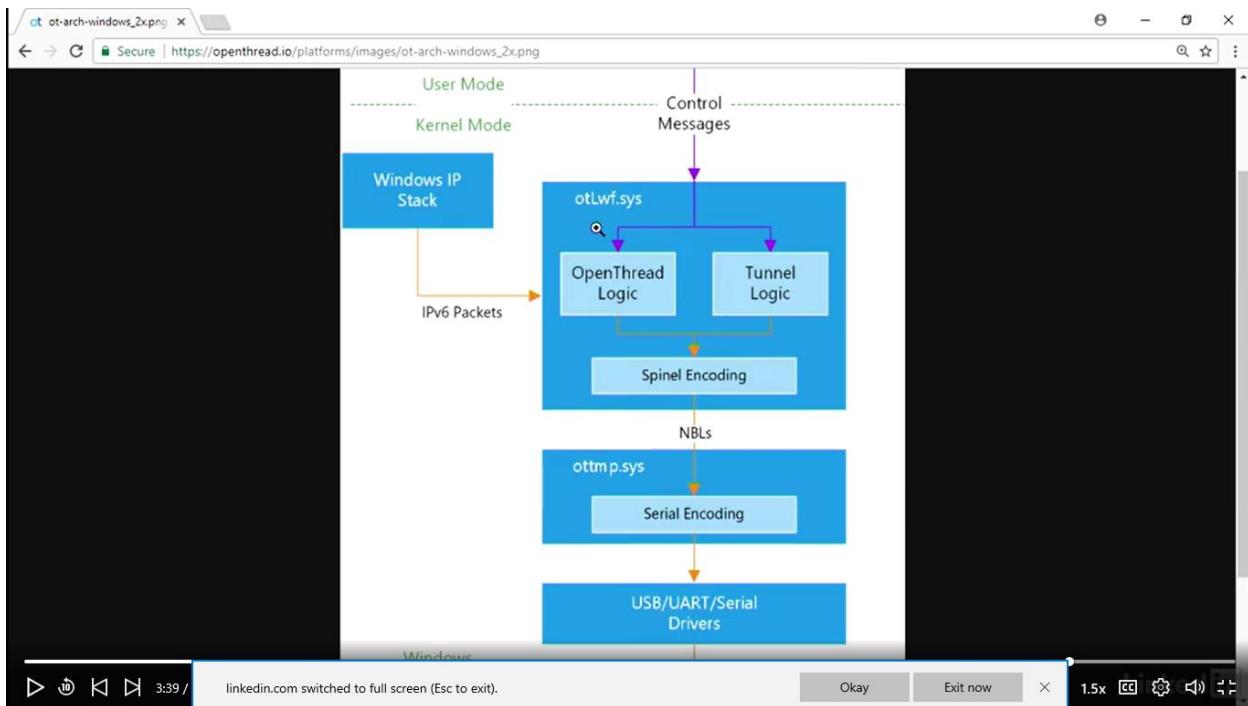
- Open-source implementation of the Thread protocol
 - Platform agnostic
 - OSs that run OpenThread include Linux, macOS, and Windows 10, as well as FreeRTOS and Riot



Support SoC and NCP

- System on a chip (SoC)
- Network coprocessor (NCP)





IoTivity

- Open-source application framework for device-to-device interconnectivity sponsored by Open Connectivity Foundation (OCF)
- Compliant with the OCF specifications
- Out-of-the box support for some platforms and OSs, such as Ubuntu, Raspbian, Windows, iOS, Android, macOS, Riot OS, Contiki OS, and Zephyr

IoTivity

- Middleware layer with interfaces for resource modeling, resource discovery, messaging, cloud, and security
- Released in two streams: IoTivity and Motivity-Constrained
- IoTivity is for regular devices with ample compute resources and power

▷ ⏪ ⏴ ⏵ 1:36 / 3:41 1.5x CC ⏷ ⏵ ⏶

IoTivity



▷ ⏪ ⏴ ⏵ 2:38 / 3:41 1.5x CC ⏷ ⏵ ⏶

IoTivity-Constrained



▶ ⏪ ⏴ ⏵ 2:43 / 3:41 1.5x CC ⏹ 🔍

Get Started with IoTivity

- Download the releases for your target OS:
<https://www.iotivity.org/downloads>
- Check the GitHub page: <https://github.com/iotivity>
- IoTivity wiki page: <https://wiki.iotivity.org>
- OCF specifications: <https://openconnectivity.org>

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