Microsoft Azure

Azure RTOS

Simplify IoT and Empower Innovation

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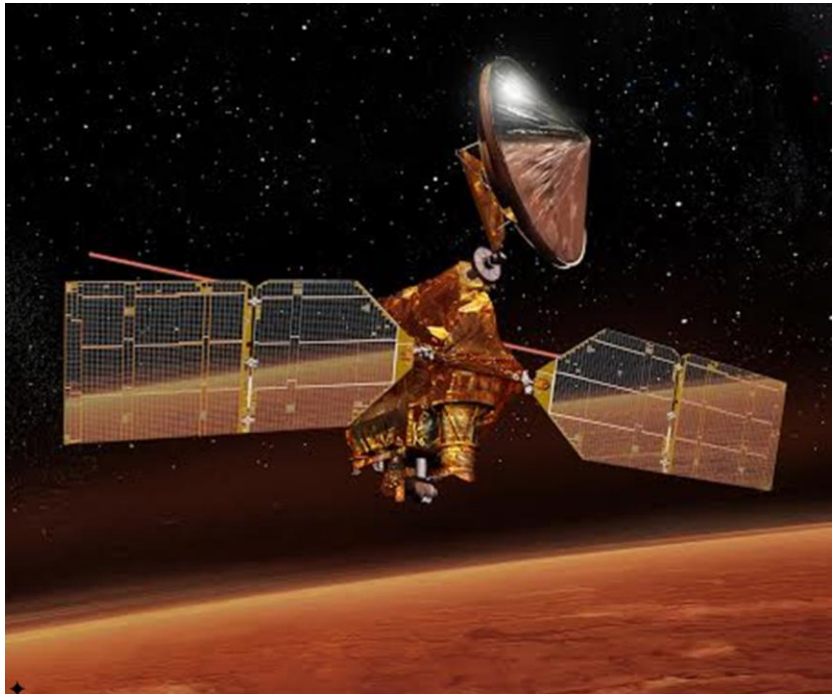
What is Real-Time of Embedded Systems?

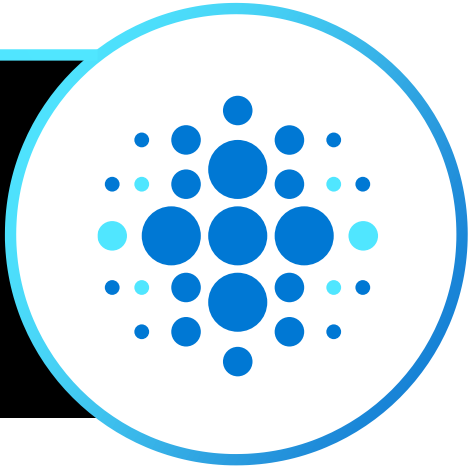
- Must respond to inputs or events within prescribed time limits
- Must operate within specified time constraints
- Important subclasses of Real-Time:
  - Hard Real-Time
    - Must meet deadlines 100% of the time
    - Generally true of safety-critical systems
  - Soft Real-Time
    - Must meet deadlines under normal conditions
    - Generally true of consumer electronics



NASA Mars Reconnaissance Orbiter

What is a RTOS?

A Real-Time Operating System(RTOS) is system software that provides services and manages processor resources for applications. These resources include processor cycles, memory, peripherals, and interrupts.

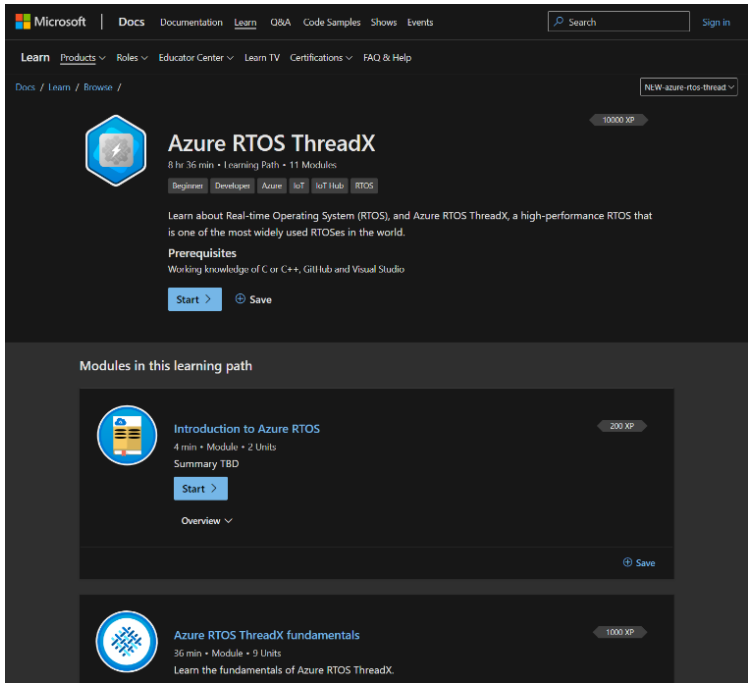


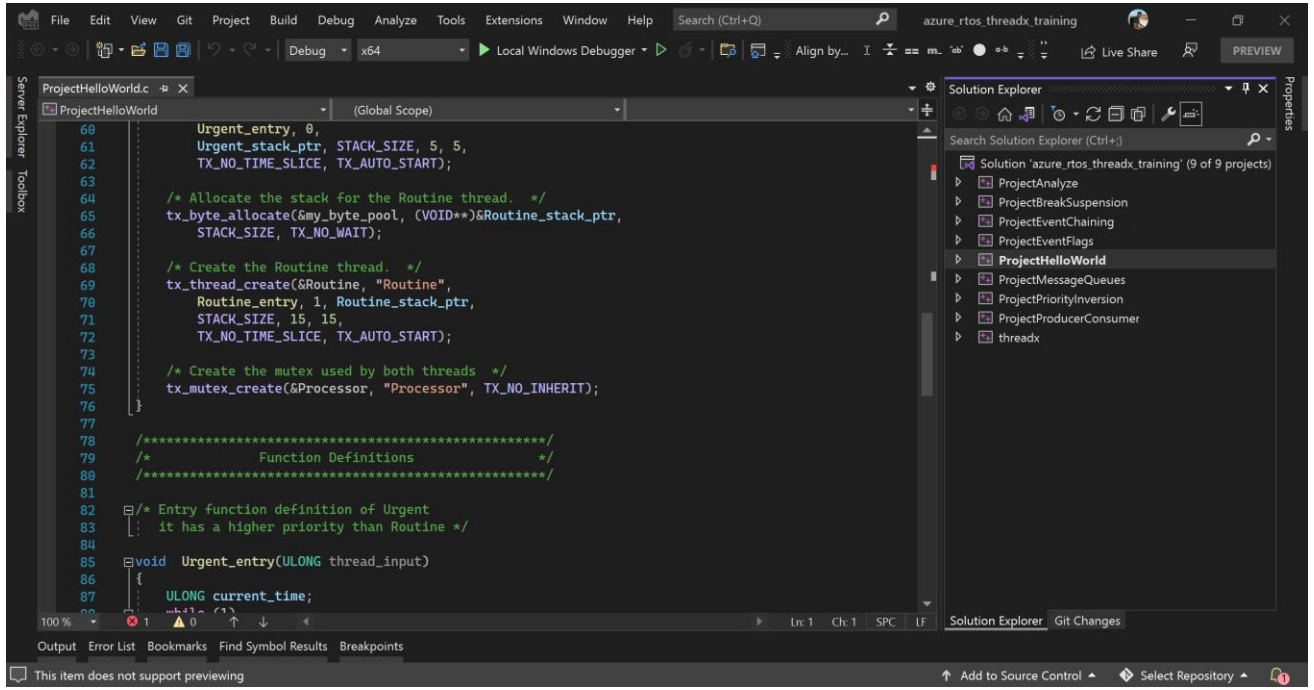
The main purpose of a RTOS is to allocate processing time among various duties the embedded software must perform.

Think:

- Small and fast
- A dedicated purpose
- Require real-time, deterministic processing
- Typical MCU (<512KB memory, <200MHz, 32-bit, MMU not req.)

Microsoft Learning Path for Azure RTOS ThreadX





- 11 Modules, 8 step-by-step sample projects on GitHub
- Run sample projects without needing actual dev boards, or even toolchain
- Digital certification badges
- It's all free! More learning path will come online soon.

https://aka.ms/azrtos-threadx-learning

Best book to learn RTOS from fundamental

Microsoft

Real-Time Embedded Multithreading With Azure RTOS ThreadX

Fourth Edition

Edward L. Lamie

Published: *March 23, 2022*

Chapter 4

RTOS Building Blocks

for System Development

Introduction

An RTOS must provide a variety of services to the developer of real-time embedded systems. These services allow the developer to create, manipulate, and manage system resources and entities in order to facilitate application development. The major goal of this chapter is to review the services and components that are available with Azure RTOS ThreadX. Figure 19 contains a summary of these services and components.

Threads	Message Queues	Counting Semaphores
Mutexes	Event Flags	Memory Block Pools
Memory Byte Pools	Application Timers	Time Counter & Interrupt Control

Figure 19. Azure RTOS ThreadX components

https://docs.microsoft.com/en-us/learn/modules/threadx-next-steps/4-threadx-online-book

Introducing Azure RTOS

A comprehensive suite of multithreading facilities, middleware, and Windows tools for developing embedded IoT applications.

Small, fast, & safe real-time performance

for resource-constrained devices

- Remarkably small footprint
  (min 2KB, min 50KB cloud connect)
- Ultra fast (sub 1µs APIs/context switches)
- Deterministic
- Safe, field proven over 24 years with **10 billion** devices deployed.

A comprehensive, and easy-to-use solution

for fast get-to-market

- Comprehensive solution of middleware (File, GUI, Networking, and USB)
- Simple to use
- Supports the most popular architecture and embedded development tools

Access to the power of Azure IoT

with multiple paths to connect IoT devices to the benefits of Azure

- Out-of-the-box connectivity to Azure IoT
- Azure Defender integration helps protect devices from attack
- Azure Device Update for IoT Hub

Where is Azure RTOS being used?

Already used in more than 10 billion devices worldwide

Azure RTOS system components

Every Azure RTOS component is fully connected, easy to use—and helps developers get to market faster.

Azure RTOS ThreadX

A high-performance real-time operating system
(SIL 4, ASIL D, Med. Class C)

Azure RTOS NetX and NetX Duo

A TCP/IP IPv4/IPv6 embedded network stack that includes cloud connectivity and IPsec and TLS/DTLS security protocols
(SIL 4, ASIL D, Med. Class C, EAL 4+, FIPS 140-2)

Azure RTOS FileX

An embedded FAT file system that offers optional fault tolerant features
(SIL 4, ASIL D, Med. Class C)

Azure RTOS GUIX Studio and GUIX

A complete design environment and run-time to create and maintain 2D graphical user interfaces
(SIL 4, ASIL D, Med. Class C)

Azure RTOS USBX

A USB stack that provides host, device, and on-the-go support
(SIL 4, ASIL D, Med. Class C)

Azure RTOS TraceX

A graphical view of real-time events to help you analyze system-level behavior for problem solving and tuning

Pre-certified by Safety and Security Standards

Pre-certified by TÜV and UL to reduce time-to-market for safety critical IoT devices

- IEC 61508 SIL4 – functional safety standard applicable to all industries
- IEC 62304 SW Class C – Medical devices
- ISO 26262 ASIL D – Automotive applications
- EN 50128 – Railway applications
- UL/IEC 60730-1 Class B – Automatic Electrical controls
- UL/IEC 60335-1 Class B – Home Appliance
- Azure RTOS ThreadX and middleware pre-certified include FileX, NetX Duo, GUIX and USBX
- Artifacts (Certificate, Safety Manual, Test Report, etc.) are available to license.

SGS TÜV SAAR FUNKTIONALE SICHERHEIT GEPRÜFT FUNCTIONAL SAFETY APPROVED

c UL us

Design with high security standard and pre-certified

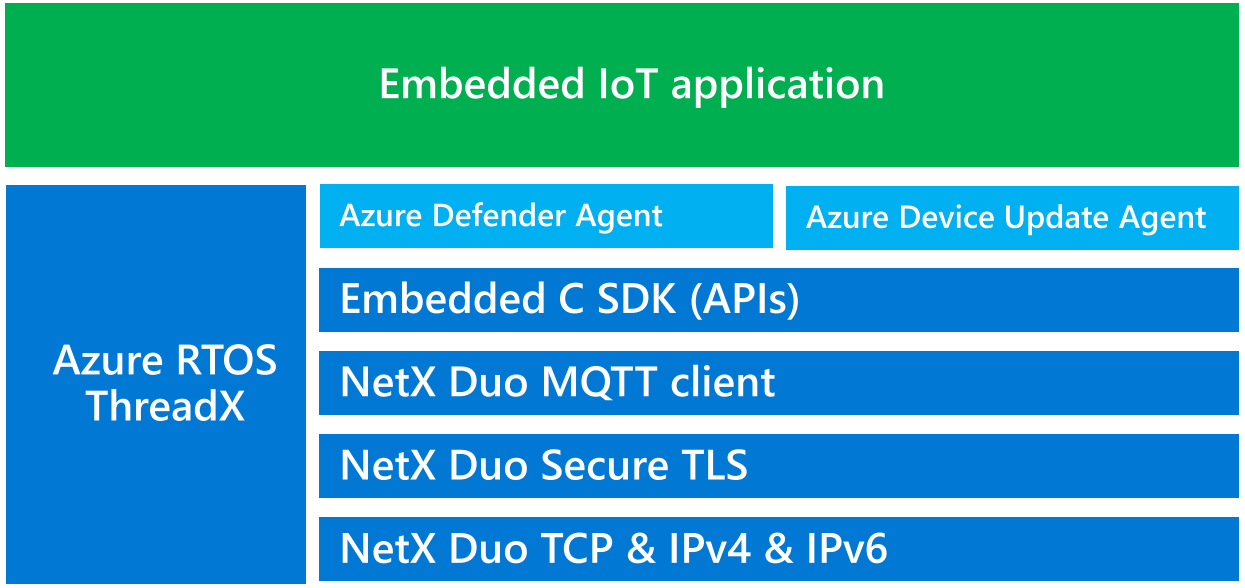
- Security features: TLS1.3, DTLS1.2 and software crypto library.
- Hardware security integration:
  - Secure Element and general hardware security integration
  - ARMv8-M TrustZone and TF-M integration
  - PSA and PKCS#11 API support
- Pre-certified PSA Certified Level 1 and SESIP Level 3(ongoing)

psacertified™ level one

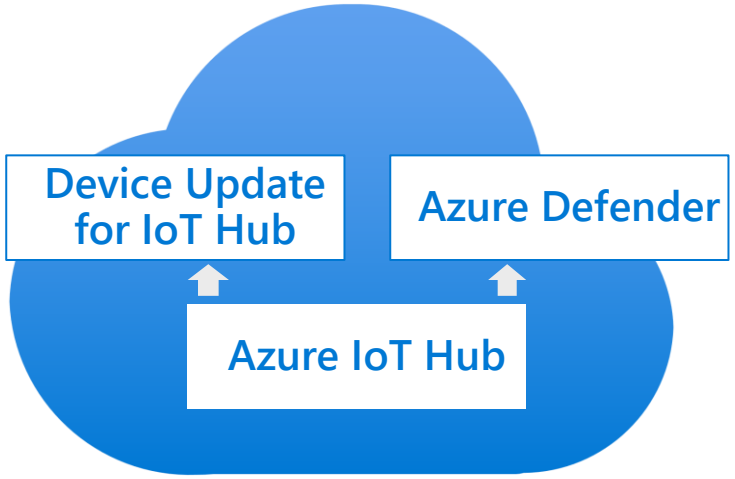
SESIP™

Azure RTOS: Industrial-grade connectivity to the cloud

IoT sensors, devices, edge routers, gateways

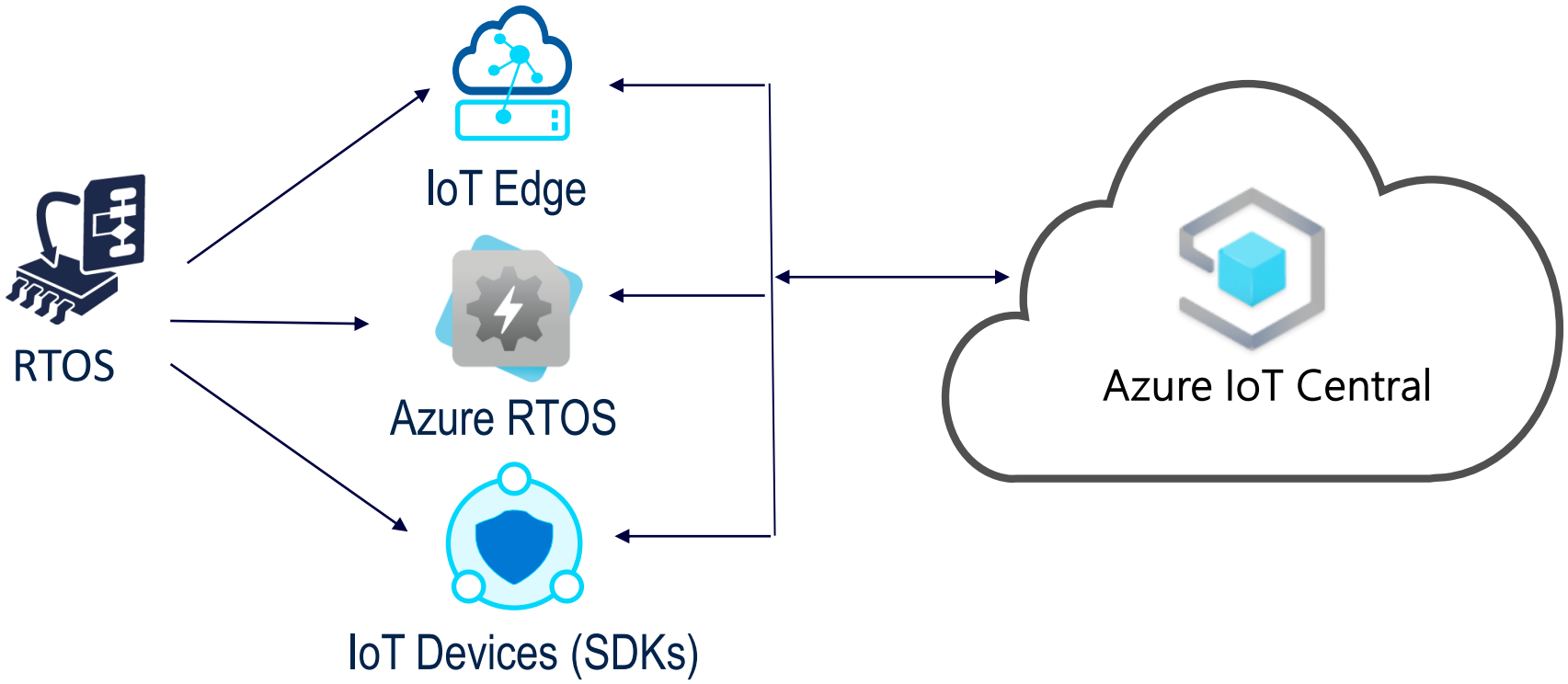


Cloud services, analytics, etc.



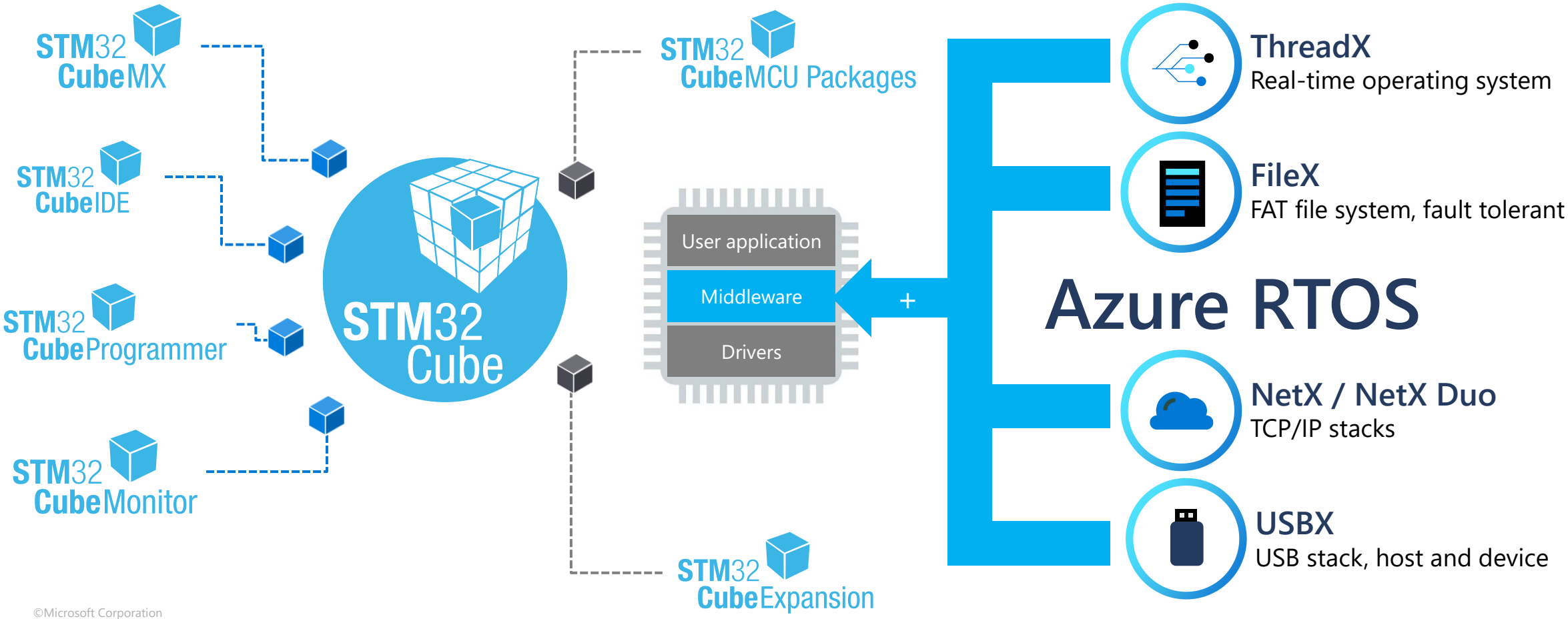
Ethernet, Wi-Fi, Cellular, 802.15.4 radio, etc.

Microsoft and ST Partnership – IoT Solutions



Azure RTOS Native Integration in STM32Cube Ecosystem

Software Tools | Embedded Software | **Complemented with Microsoft Azure RTOS**



Free Production License for any STM32

Azure IoT Development Kits

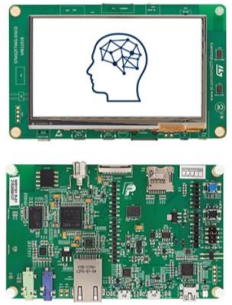
B-U585I-IOT02A
ARM® Cortex®-M33
TODAY – Available

Azure IoT Hub/ IoT Central
Ultra-low-power STM32U585AII6Q microcontroller based on the Arm® Cortex®-M33 core with Arm® TrustZone®
2 Mbytes of Flash memory and 786 Kbytes of SRAM, and SMPS in UFBGA169 package 512-Mbit Quad-SPI Flash memory, 64-Mbit Octo-SPI PSRAM, 256-Kbit I2C EEPROM
802.11 b/g/n compliant Wi-Fi® MXCHIP module, Bluetooth Low Energy from STMicro
Wide range of MEMS sensors from STMicro
Azure Certified **Azure IoT Plug and Play**

B-L4S5I-IOT01A
ARM® Cortex®-M4
TODAY – Available

Azure IoT Hub/ IoT Central
Ultra-low-power STM32L4+ Series STM32L4S5VIT6 microcontroller based on the Arm® Cortex®-M4 core
2 Mbytes of Flash memory and 640 Kbytes of RAM in LQFP100 package 64-Mbit Quad-SPI Flash memory from Macronix™
802.11 b/g/n compliant Wi-Fi® Inventek module, Dynamic NFC tag
Wide range of MEMS sensors from STMicro
Azure Certified

32F746GDISCOVERY
ARM® Cortex®-M7
TODAY – Available



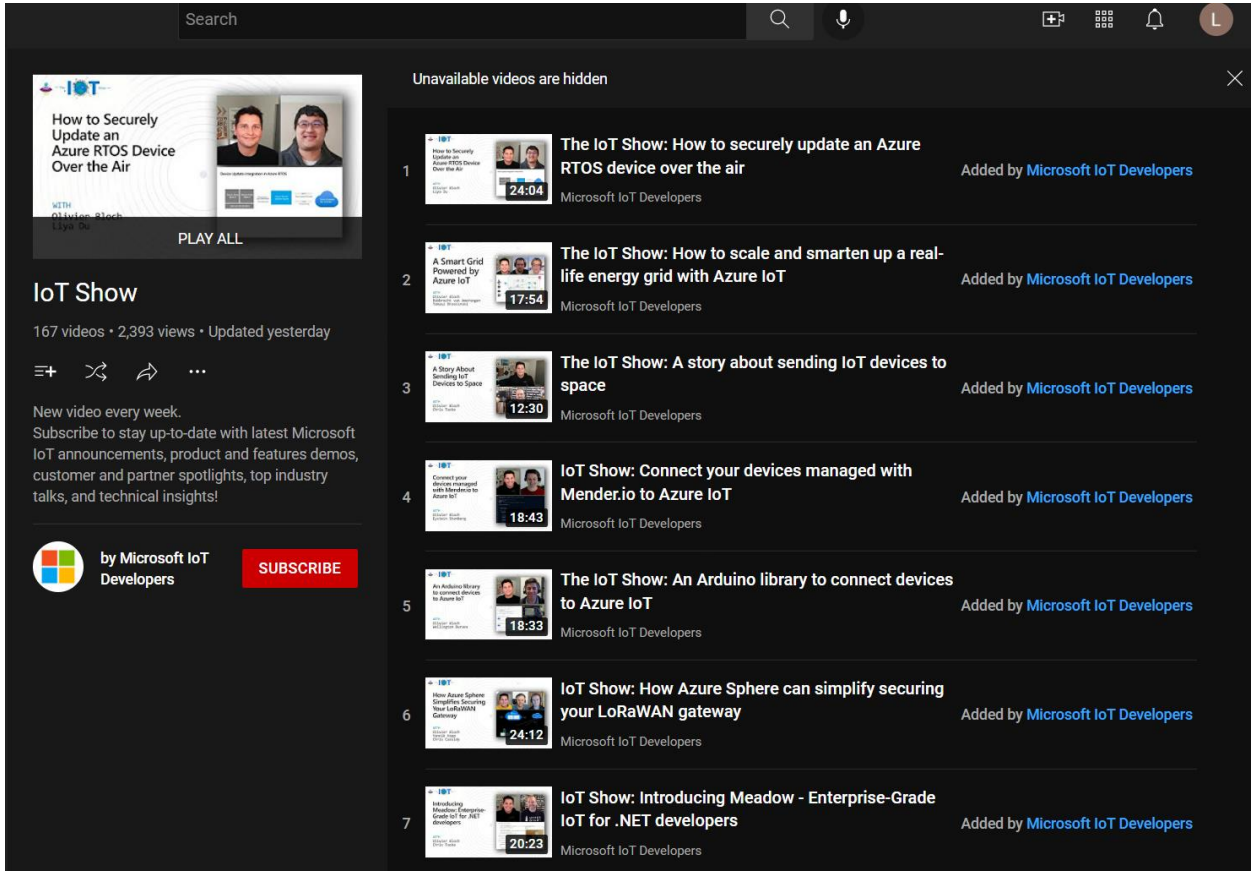
Azure IoT Hub/ IoT Central
STM32F746NGH6 Arm® Cortex® core-based microcontroller
1 Mbyte of Flash memory and 340 Kbytes of RAM, in BGA216 package
Ethernet compliant with IEEE-802.3-2002
Wide range of MEMS sensors from STMicro
Azure Certified

STM32MP157A/D
ARM® Cortex®-A7
TODAY – Available

Azure IoT Hub
STM32MP157 Arm®-based dual Cortex®-A7 800 MHz 32 bits + Cortex®-M4 32 bits MPU in TFBGA361 package
Linux Azure IoT Edge Runtime
Ethernet compliant with IEEE-802.3-2002
Azure Certified **Azure IoT Plug and Play**

Azure RTOS – More Learning Resources

- GitHub: https://github.com/azure-rtos
  - Source code for all products
  - Getting started samples
  - Samples for Semiconductor IDEs and IAR Workbench
- Docs: https://docs.microsoft.com/en-us/azure/rtos/
  - Detailed docs for each middleware
  - APIs
- IoT Show: https://aka.ms/iotshow



Call to Actions

- Join Azure IoT session in Day3
  - Azure IoT Product Portfolio
  - Fun demos of Azure Device Update, Azure IoT Central, etc.

- Join idea contest and prototype your ideas
  - Sample projects will be published for dev boards hardware

Microsoft Azure

Thank you