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Azure Sphere, Azure IoT Edge e modelos de IA em microcontroladores: avanços tecnológicos da Microsoft em IoT.

Walter Silvestre Coan

Mestre em Sistemas Distribuídos, MCSA, MCP C#, MCP ASP.NET MVC Web App, AWS Certified Developer e SCP Java.

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- Microsoft Certified Solutions Associate – Web Applications
  - MCP em programação em C#
  - MCP em desenvolvendo aplicações Web ASP.NET MVC
- Participação com projeto finalista da etapa nacional do Microsoft Imagine Cup 2016 – Projeto Omni
- AWS Certified Developer Associate
- Sun Certified Programmer em Java 5.0
- Mestre em Ciência da Computação na área de Sistemas Distribuídos e Redes de Sensores sem Fio - PUCPR
- Pós-Graduado em Engenharia de Software - PUCPR
- Bacharel em Informática - UNIVILLE
- Professor no Bacharelado em Sistemas de Informação e do Bacharelado em Engenharia de Software da UNIVILLE
- Desenvolvedor de software na RDX – RDornel Data Experts

Microsoft CERTIFIED Professional

Microsoft CERTIFIED Solutions Associate Web Applications

aws certified Developer Associate

Agenda

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- Avanços tecnológicos da plataforma Azure IoT
- Azure Sphere
- Azure Iot Edge
- Modelos de IA em microcontroladores
  - Embedded Learning Library (ELL)

Agradecimento

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- Esta apresentação é um resumo das apresentações realizadas por:
  - **Olivier Bloch**
    - Principal Program Manager at Microsoft in the Azure IoT team
      - The Things Conference: LoRaWAN and the Intelligent Cloud Powerful solutions with Azure IoT - https://youtu.be/SivnPqqbWsc
  - **Ed Nightingale**
    - Partner Product Architect (Azure Sphere)
    - Introducing Azure Sphere - https://youtu.be/wJgCzaiRz9w
  - **Juliano Viana**
    - CTO da Kunumi
    - Redes Neurais Dinâmicas usando PyTorch - https://youtu.be/3fqWMhu32mM

Microsoft investe $5B em IoT

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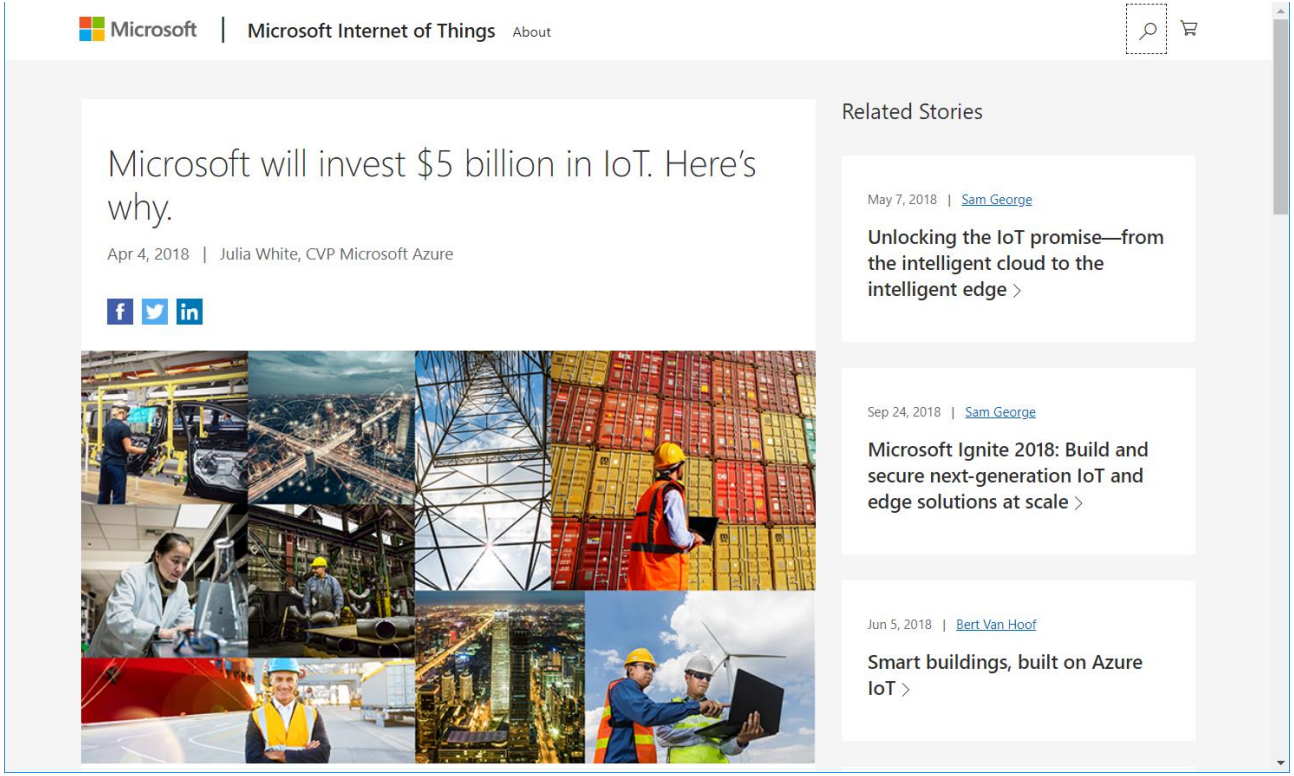
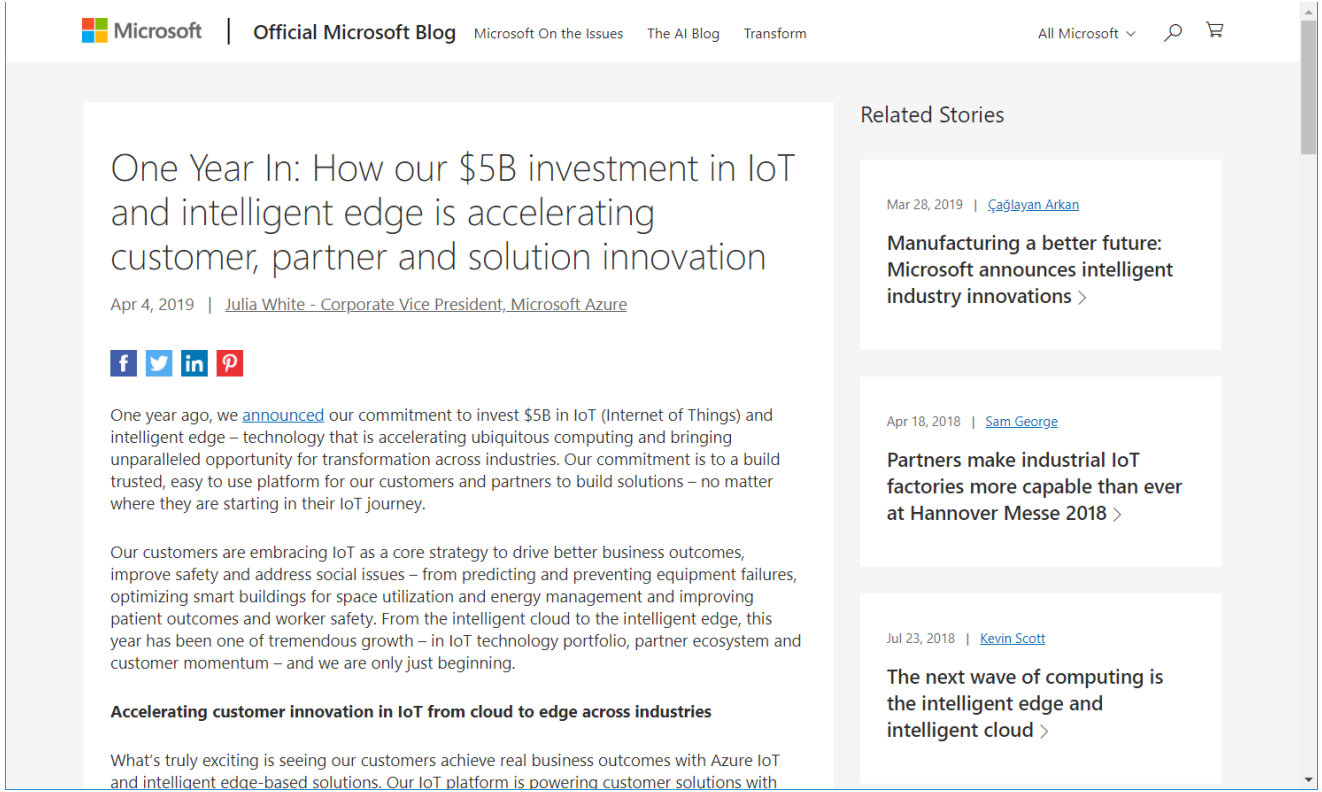


https://blogs.microsoft.com/iot/2018/04/04/microsoft-will-invest-5-billion-in-iot-heres-why/

Um ano depois...



https://blogs.microsoft.com/blog/2019/04/04/one-year-in-how-our-5b-investment-in-iot-and-intelligent-edge-is-accelerating-customer-partner-and-solution-innovation/

Um ano depois...

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- Azure Sphere
- Mais de 100 novos serviços e funcionalidades na plataforma Azure IoT
  - Azure IoT Central
  - Windows 10 IoT Core Services
  - Azure Security Center
  - Azure Digital Twins
  - Azure Maps
  - Azure Spatial Anchors
  - Azure Remote Rendering
  - Azure IoT Edge - Azure Cognitive Services
  - Windows Server IoT 2019
  - Azure IoT Edge VM on Azure Marketplace
  - Azure IoT Hub Device Streams
  - Embedded Learning Library (ELL)
  - Device Simulation Azure IoT
  - Time Series Insights
  - RBAC (Role Based Access Control) Azure IoT

Azure IoT

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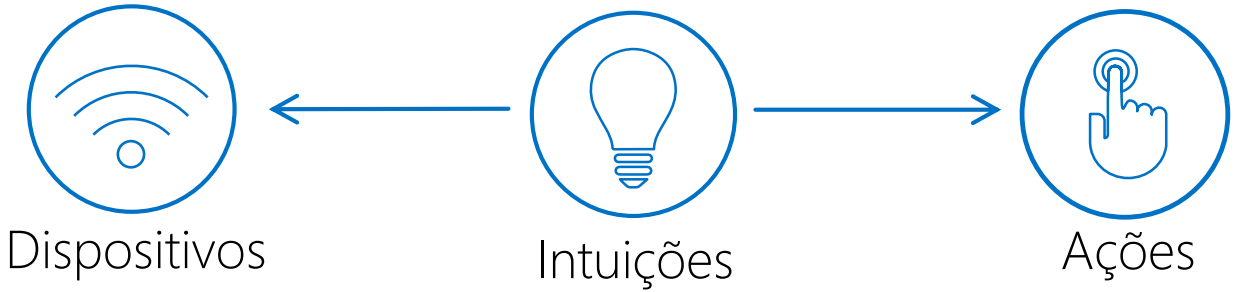

Azure IoT

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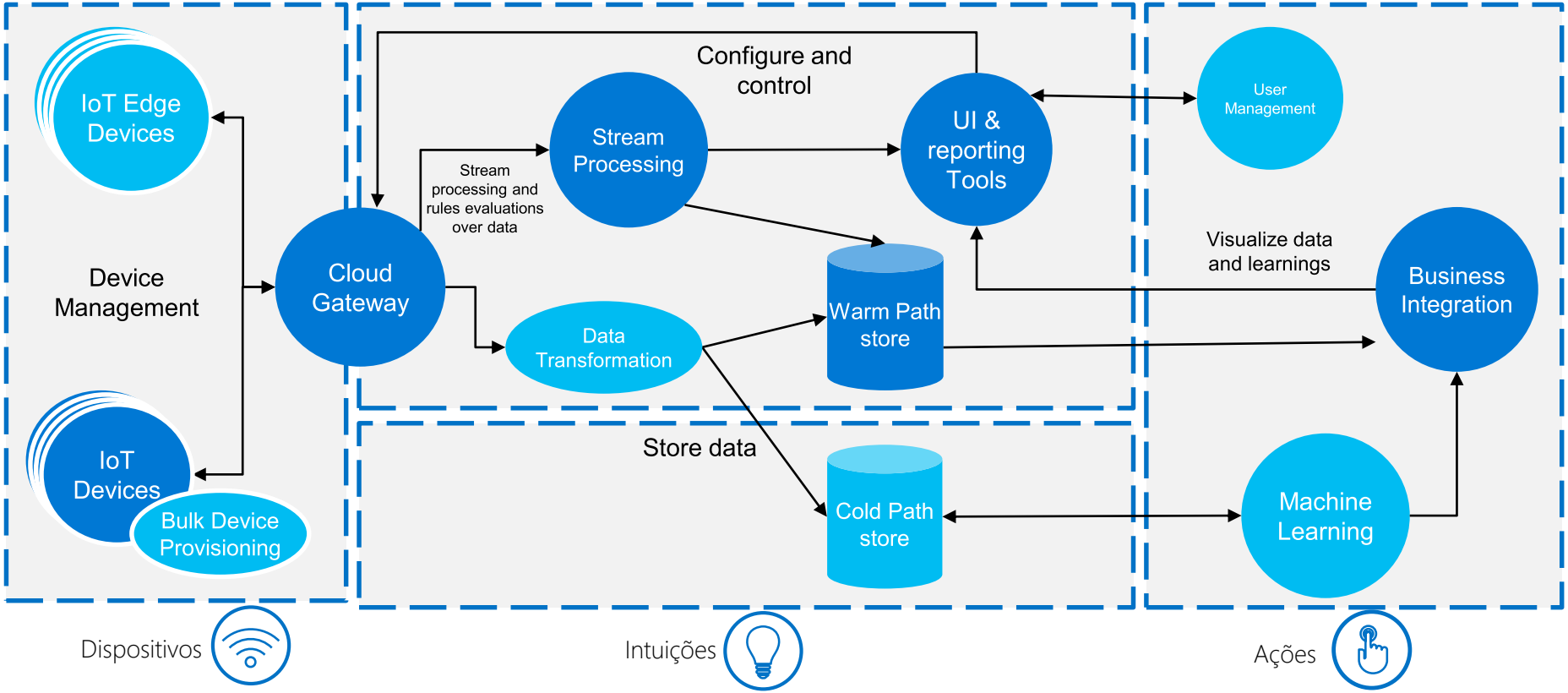

Azure IoT

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Use | Solutions

Build your own | Platform

SaaS

Managed Solutions

Azure IoT Central

Dynamics 365 Connected Field Service

PaaS

Solution Accelerators

Remote monitoring

Predictive maintenance

Connected factory

...

Device Support

Data & Analytics

Visualization & Integration

Azure IoT Hub

Azure Time Series Insights

Azure Logic Apps

Edge

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Azure Sphere

Azure Sphere

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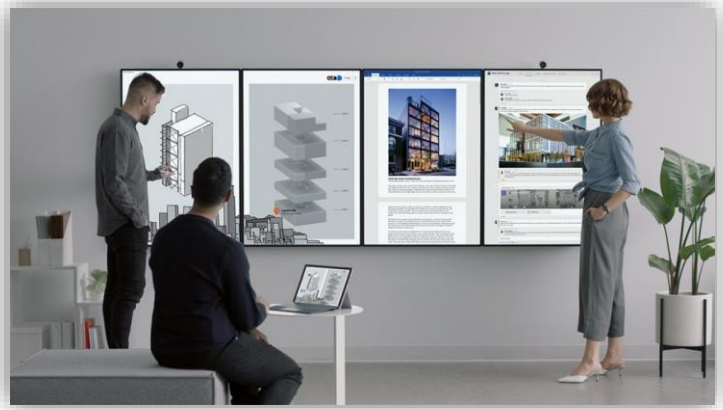
- Segunda transformação digital
  - Primeira onda 1970
    - Primeiros Microcontroladores MCU
  - Segunda onda 2010 – 2020
    - Conectividade pela Internet dos MCU

- Consequências
  - Mudança drástica nas experiências de uso dos dispositivos.
  - Maior preocupação com a segurança.



Microsoft Surface Hub 2

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Nenhuma empresa lançaria um produto com problemas de segurança

HACKADAY

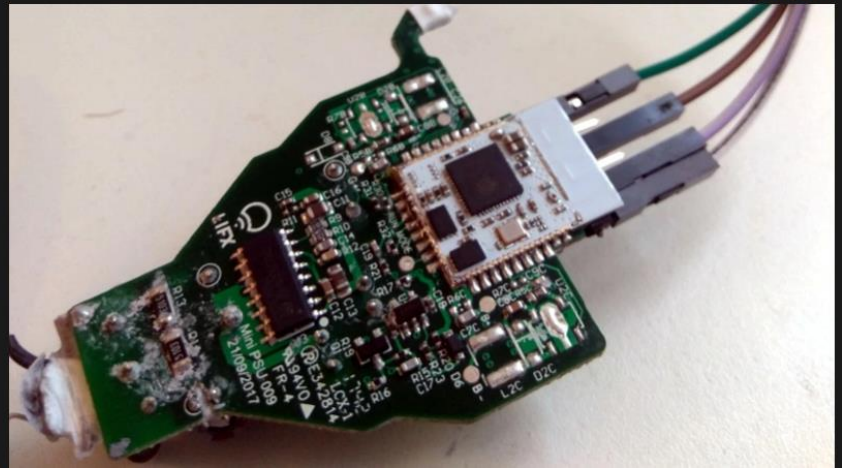
HOME BLOG HACKADAY.IO TINDIE HACKADAY PRIZE SUBMIT ABOUT March 23, 2019

DON'T TOSS THAT BULB, IT KNOWS YOUR PASSWORD

by: Tom Nardi

68 Comments

January 29, 2019



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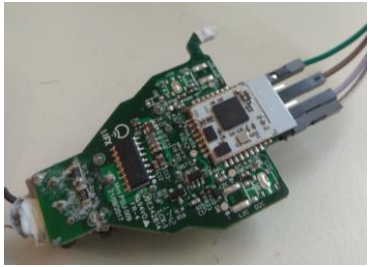

https://limitedresults.com/2019/01/pwn-the-lifx-mini-white/

```
xisco@E7440:~/esp/LIFX$ espefuse.py --port /dev/ttyUSB0 summary
espefuse.py v2.4.0-dev
Connecting.....
Security fuses:
FLASH_CRYPT_CNT         Flash encryption mode counter                    = 0 R/W (0x0)
FLASH_CRYPT_CONFIG      Flash encryption config (key tweak bits)         = 0 R/W (0x0)
CONSOLE_DEBUG_DISABLE   Disable ROM BASIC interpreter fallback           = 1 R/W (0x1)
ABS_DONE_0              secure boot enabled for bootloader               = 0 R/W (0x0)
ABS_DONE_1              secure boot abstract 1 locked                    = 0 R/W (0x0)
JTAG_DISABLE            Disable JTAG                                     = 0 R/W (0x0)
DISABLE_DL_ENCRYPT      Disable flash encryption in UART bootloader      = 0 R/W (0x0)
DISABLE_DL_DECRYPT      Disable flash decryption in UART bootloader      = 0 R/W (0x0)
DISABLE_DL_CACHE        Disable flash cache in UART bootloader           = 0 R/W (0x0)
BLK1                    Flash encryption key
  = 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 R/W
BLK2                    Secure boot key
  = 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 R/W
BLK3                    Variable Block 3
  = 00 00 00 00 00 00 00 00 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 d1 bc 30 d5 73 d0 ff R/W

Efuse fuses:
WR_DIS                  Efuse write disable mask                         = 0 R/W (0x0)
RD_DIS                  Efuse read disablemask                           = 0 R/W (0x0)
CODING_SCHEME           Efuse variable block length scheme               = 1 R/W (0x1)
KEY_STATUS              Usage of efuse block 3 (reserved)                = 0 R/W (0x0)

Config fuses:
XPD_SDIO_FORCE          Ignore MTDI pin (GPIO12) for VDD_SDIO on reset   = 1 R/W (0x1)
XPD_SDIO_REG            If XPD_SDIO_FORCE, enable VDD_SDIO reg on reset  = 1 R/W (0x1)
XPD_SDIO_TIEH           If XPD_SDIO_FORCE & XPD_SDIO_REG, 1=3.3V 0=1.8V  = 0 R/W (0x0)
SPI_PAD_CONFIG_CLK      Override SD_CLK pad (GPIO6/SPICLK)               = 0 R/W (0x0)
SPI_PAD_CONFIG_Q        Override SD_DATA_0 pad (GPIO7/SPIQ)              = 0 R/W (0x0)
SPI_PAD_CONFIG_D        Override SD_DATA_1 pad (GPIO8/SPID)              = 0 R/W (0x0)
SPI_PAD_CONFIG_HD       Override SD_DATA_2 pad (GPIO9/SPIHD)             = 0 R/W (0x0)
SPI_PAD_CONFIG_CS0      Override SD_CMD pad (GPIO11/SPICS0)              = 0 R/W (0x0)
DISABLE_SDIO_HOST       Disable SDIO host                                = 0 R/W (0x0)

Identity fuses:
MAC                     MAC Address
  = 30:ae:a4:3e:6c:20 (CRC c5 OK) R/W
CHIP_VER_REV1           Silicon Revision 1                               = 1 R/W (0x1)
CHIP_VERSION            Reserved for future chip versions                = 0 R/W (0x0)
CHIP_PACKAGE            Chip package identifier                          = 0 R/W (0x0)

Calibration fuses:
BLK3_PART_RESERVE       BLOCK3 partially served for ADC calibration data = 0 R/W (0x0)
ADC_VREF                Voltage reference calibration                    = 1100 R/W (0x0)

Flash voltage (VDD_SDIO) set to 1.8V by efuse.
```

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esptool.py -p /dev/ttyUSB0 -b 460800 read_flash 0 0x200000 flash.bin

```
001f0000  fe ff ff ff 0b 00 00 00-ff ff ff ff ff ff ff ff-ff ff ff ff ff ff ff ff-ff ff ff ff 54 83 ce 56  ............................T..V
001f0020  aa aa aa aa aa aa aa aa-aa aa aa aa aa aa aa aa-aa aa aa aa aa aa aa aa-aa aa fa ff ff ff ff ff  ................................
001f0040  02 41 21 ff da fb 6a 15-72 77 5f 64 61 74 61 00-00 00 00 00 00 00 00 00-fc 03 ff ff 15 3a a4 44  .A!...j.rw_data.............:.D
001f0060  02 80 44 00 61 64 36 63-35 35 30 62 34 34 36 34-38 30 38 30 62 63 65 38-32 35 65 30 34 39 33 63  ..D.ad6c550b44648080bce825e0493c
001f0080  37 39 63 37 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  79c7............................
001f00a0  00 00 00 00 00 ff ff ff-01 80 14 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 01 00 00 00 00  ................................
001f00c0  00 00 a4 00 4b 61 62 65-6c 42 6f 78 2d 30 35 37-30 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  ....KabelBox-0570................
001f00e0  00 00 00 00 00 33 32 33-32 33 36 33 38 33 34 33-33 33 31 33 39 33 36 33-38 33 38 33 32 33 34 33  .....32323638343331393638383234 3
001f0100  31 33 37 33 35 33 34 33-38 33 32 33 34 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  1373534383234....................
001f0120  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  ................................
001f0140  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  ................................
001f0160  00 00 00 00 00 00 fd ff-00 00 04 00 01 ff ff ff-e8 13 a4 00 4b 61 62 65-6c 42 6f 78 2d 30 35 37  ....................KabelBox-057
001f0180  30 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-33 32 33 32 33 36 33 38  0...............32323638343
001f01a0  33 33 31 33 39 33 36 33-38 33 38 33 32 33 34 33-31 33 37 33 35 33 34 33-38 33 32 33 34 00 00 00  331393638383234313735343834...
001f01c0  00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  ................................
```

Root certificate and RSA private key extracted

```
xisco@E7440:~/esp/LIFX/certs$ openssl rsa -in privkey.key -check
RSA key ok
writing RSA key
-----BEGIN RSA PRIVATE KEY-----
MIICXQIBAAKBgQChDW+ZctP1bAcB6WBW3d+bMwgDe/U1BtCRk+DIVFrdvXkFjUej
yrzkW0IHN/s4NFLrnEZD9jMimU3/6uGFeqM5vU+09q302dwW12IRDJMZhBOyqLK1
GyKZC1y1rw7vnOeyUNP3Nfk6C4Jcve3eX80D4iiV3uybVUq11HSPXNL/IQIDAQAB
AoGBAJ8nxPqStI5bVE16UP9nQfuAodG3pSni8yh6R/ARFL7+6GMpK/vcdXECEi1K
EFSJuMwn4nR1EDGH6MIYXwfmmvf6ClRrEt0hLdal6sXazo6SDkkWiZi8C4GkYIk2
dPNKlRhRSdKmD0JGPgTKIgKeYiJN3gVRIt/UYRanDgP2cfXBAkEAz0BGwMeutPi0
gJ/nICUK5TP3gKWF0ew3cdsc2yiUVKjBelBTq4JkuF/Ayoqh31lFdwMqt+TpySsb
9aK13lqsOQJBAMbvSfNKYnIU5qR2xRYoUTTMZ8817781g0wcUzxQqbLhtihnH7mW
2mz/NEoJZi+ZfGZQithSdL7AKGPoADCMuikCQEzEHzD7BcBsutdF42NptR5u4Edb
iDTYjTT0Fz0qS78L/xZiOIu3sb0FYrDjJtBHDc7mcmVJOjtUZ3fVvA3PgikCQQCc
rmDfJons8jtJ82V88xoqbIeicwe14I7dxj1kdt+BTTasEbSx9ndoe4QSf96kxM1u
xCbnA+KBTlVBgruLgXspAkA5l1RXzQF5K9wgUoQy6wA4GUunn+Vq8lR/8h5xDmjY
rWjmd109t1Pe9JthpydqYBhF2mGmhcZe8W0+kJFtNpIV
-----END RSA PRIVATE KEY-----
```

https://github.com/espressif/esptool/wiki/espefuse

The Seven Properties of Highly Secure Devices: the new standard for securing MCU powered IoT experiences

https://www.microsoft.com/en-us/research/wp-content/uploads/2017/03/SevenPropertiesofHighlySecureDevices.pdf

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Hardware Root of Trust

Seu dispositivo é Identificável e a integridade do software é confirmada por hardware?

Defense In Depth

Seu dispositivo se mantém seguro se um mecanismo de segurança for destruído?

Small Trusted Computing Base

O seu dispositivo esta protegido de erros em outros códigos fonte?

Dynamic Compartments

As proteções de segurança do seu dispositivo podem melhorar após a implantação?

Certificate-Based Authentication

Seu dispositivo utiliza certificados digitais ao invés de senhas para autenticação?

Failure Reporting

Seu dispositivo reporta falhas e anomalias?

Renewable Security

Seu dispositivo atualiza o software de forma automática?

Suporte do Hardware

Suporte do Sistema Operacional

Suporte do Serviço de Nuvem

Algumas necessidades dependem do suporte do hardware

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Hardware Root of Trust

Chave criptográfica que não pode ser excluída e protegida pelo hardware. Dispositivos contadores físicos impedem ataques do tipo *side-channel.*

A identidade do dispositivo e o software seguro dentro do hardware

- Hardware protege a **Identidade do Dispositivo**
- Hardware protege a **Inicialização com Segurança**
- Hardware atesta a **Integridade do Sistema**

Algumas necessidades dependem do suporte do hardware e do software

Dynamic Compartments

Barreiras internas limitam o alcance de qualquer falha

Hardware cria **Barreiras de Segurança**

Hardware firewall ou unidades de memória gerenciadas

Software **cria Compartimentos**

Isolamento de processos

Algumas necessidades dependem do suporte do hardware e do software

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Small Trusted Computing Base

Chave criptográfica são armazenadas em uma carteira protegida pelo hardware, inacessível pelo software.

Hardware protege as **chaves criptográficas de acesso**

A arquitetura de software é **concebida no formato de camadas** impedindo o acesso direto.

Algumas necessidades dependem do suporte do hardware, do software e da nuvem

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Renewable Security

A segurança do dispositivo é renovada para superar as ameaças em evolução e as violações de segurança.

Nuvem provê as **atualizações**

Software **aplica as atualizações**

Hardware **previne rollback attacks**

Três pilares de segurança do Azure Sphere

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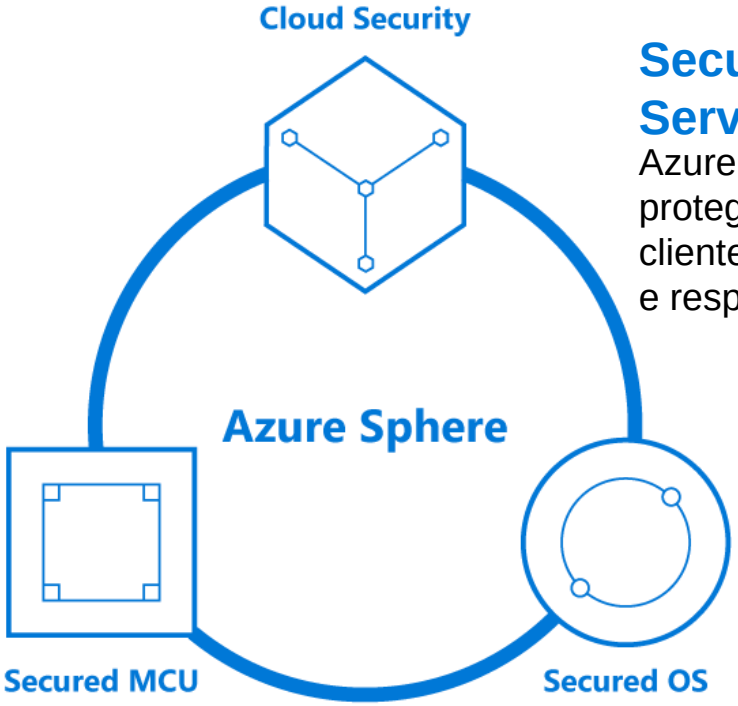

Secured by our Cloud Service

Azure Sphere Security Service protege cada dispositivo e os clientes, detecta falhas de segurança e responde de forma proativa.

Secured MCUs

Uma nova categoria de MCU's chamado Azure Sphere, produzidos por empresas parceiras, com tecnologia de segurança da Microsoft, que fornece conectividade, alto desempenho e características de segurança no hardware.

Secured Operating System

Sistema operacional seguro Azure Sphere OS que combina as melhores práticas da Microsoft e da comunidade Open Source, criando uma plataforma confiável para uma nova experiência em IoT.

Arquitetura do Azure Sphere MCU

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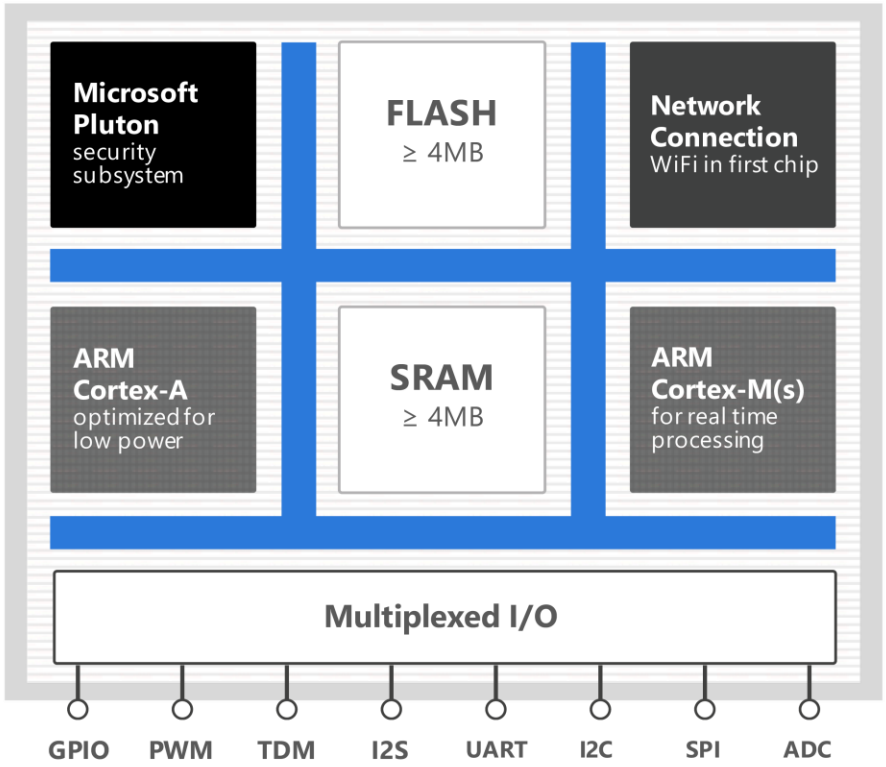
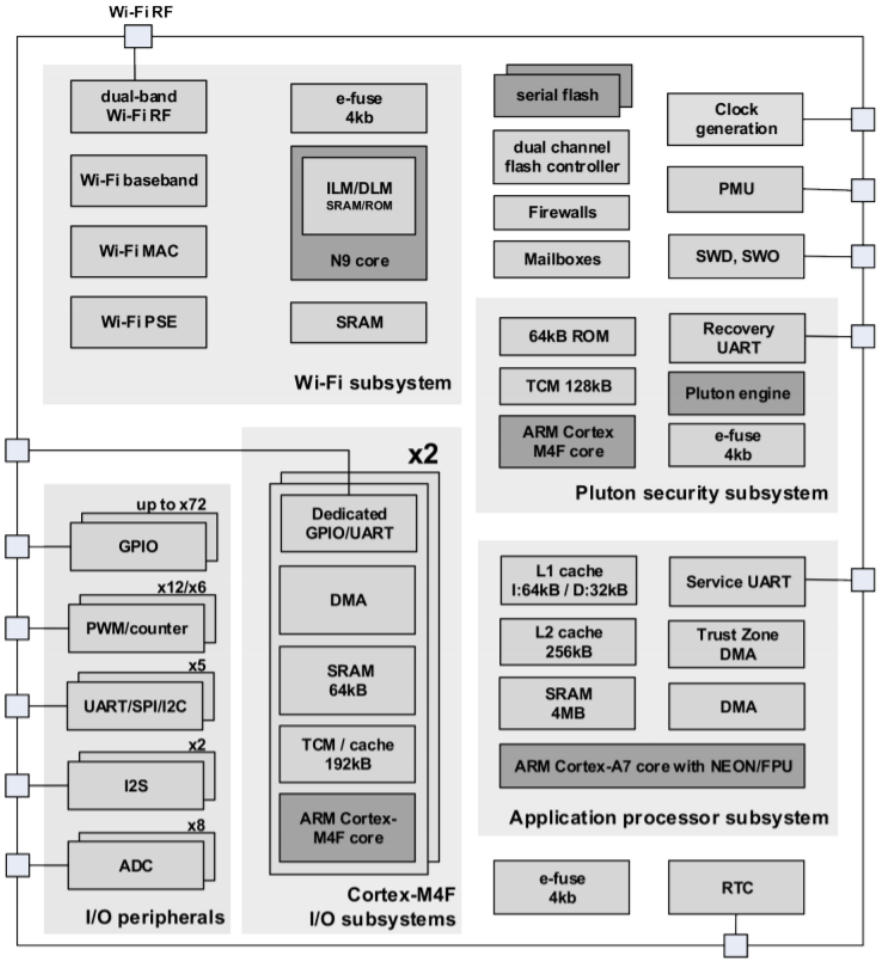
Microsoft Pluton Security Subsistem – Root of Trust

ARM Cortex-A provê isolamento de processos através do gerenciamento de unidades de memória. Azure Sphere OS cria containers para as aplicações que utilizam espaços de memória reservados.

2x ARM Cortex-M é o MCU, que executa o processamento em real time.





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- **ARM Cortex A7 NEON FPU**
  - 64kB L1 instruction cache
  - 32kB L1 data cache
  - 256kB L2 cache,
  - 4MB system memory for the Azure Sphere operating system and user applications
- **2x ARM Cortex M4 cores**
  - 192kB TCM (Tightly-Coupled Memory)
  - 64kB SRAM
  - FPU Floating Point Unit
- **Pluton Security Subsystem**
  - ARM Cortex-M4F security processor
  - 128kB secured TCM
  - 64kB secured mask ROM bootloader
- **Wi-Fi**
  - Processador dedicado N9 32-bit RISC core
  - IEEE 802.11 a/b/g/n
  - Bandas de 2.4GHz e 5GHz

https://d86o2zu8ugzlg.cloudfront.net/mediatek-craft/documents/mt3620/MediaTek-MT3620-Product-Brief-Nov2018.pdf

Geração do Device ID no Azure Sphere

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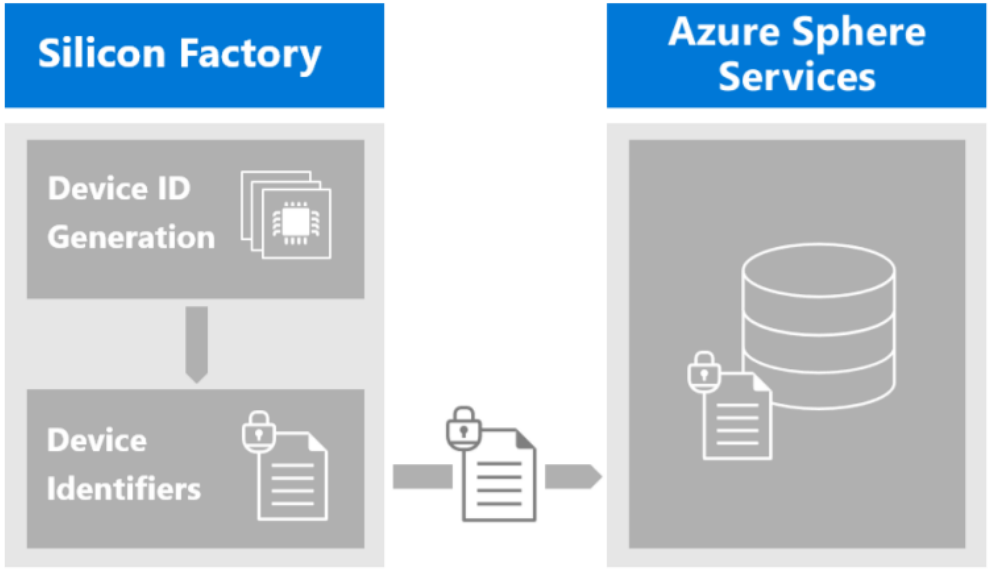
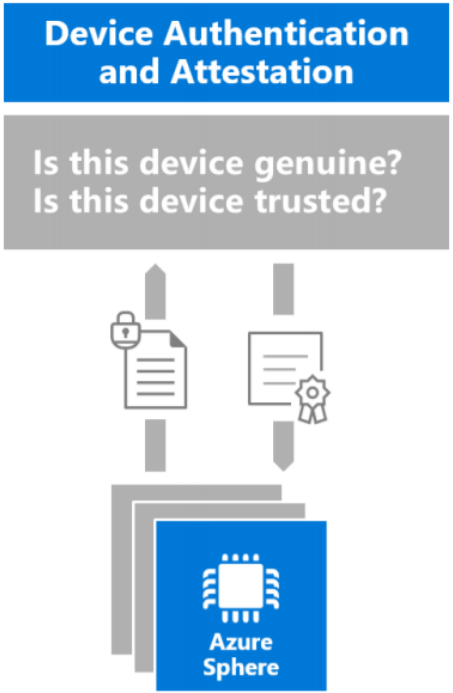
- Cada dispositivo possui um identificador único;
- O ID é gerado no processo de fabricação do MCU;
- Microsoft possui o controle de todos os IDs dos dispositivos produzidos.



https://azure.microsoft.com/mediahandler/files/resourcefiles/azure-sphere-device-authentication-and-attestation-service/Device_Authentication_and_Attestation_Service.pdf?v=cba244cabba1e2c8d7ceb8f3389d4c7eb8a97d1eacae2cdce17d73dc686a476b

Comprovação remota

- Ocorre durante o processo de autenticação
- Azure Sphere assina digitalmente um conjunto de informações para provar que o dispositivo é original;
- Dados são enviados para o Device Authentication and Attestation no Azure;
- Retorna um certificado de curta duração atestando que é um dispositivo original.



Status de Suporte MT3620

https://docs.microsoft.com/pt-br/azure-sphere/hardware/mt3620-product-status

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- **Suportado**
  - 76 GPIO mapeados apenas para o ARM Cortex-A7
  - Serial UART 1.200 a 2.000.000 bauds + 32 bytes de buffer
  - SPI 40 MHz – 2 dispositivos subordinados
  - I2C 100kHz a 1 MHz
  - Subsistema Wi-Fi
  - 5MB RAM – 4MB flash para o ARM Cortex-A7 (pode ser solicitado com 16MB flash SPI)
- **Não suportado** (por enquanto)
  - PWM e contadores de pulso
  - I2S (Inter-IC Sound)
  - ADC – 8 pinos
  - 2x ARM Cortex-M4F
  - Controle de energia
  - Detecção de Brownout

Azure Sphere MT3620 Dev Kit

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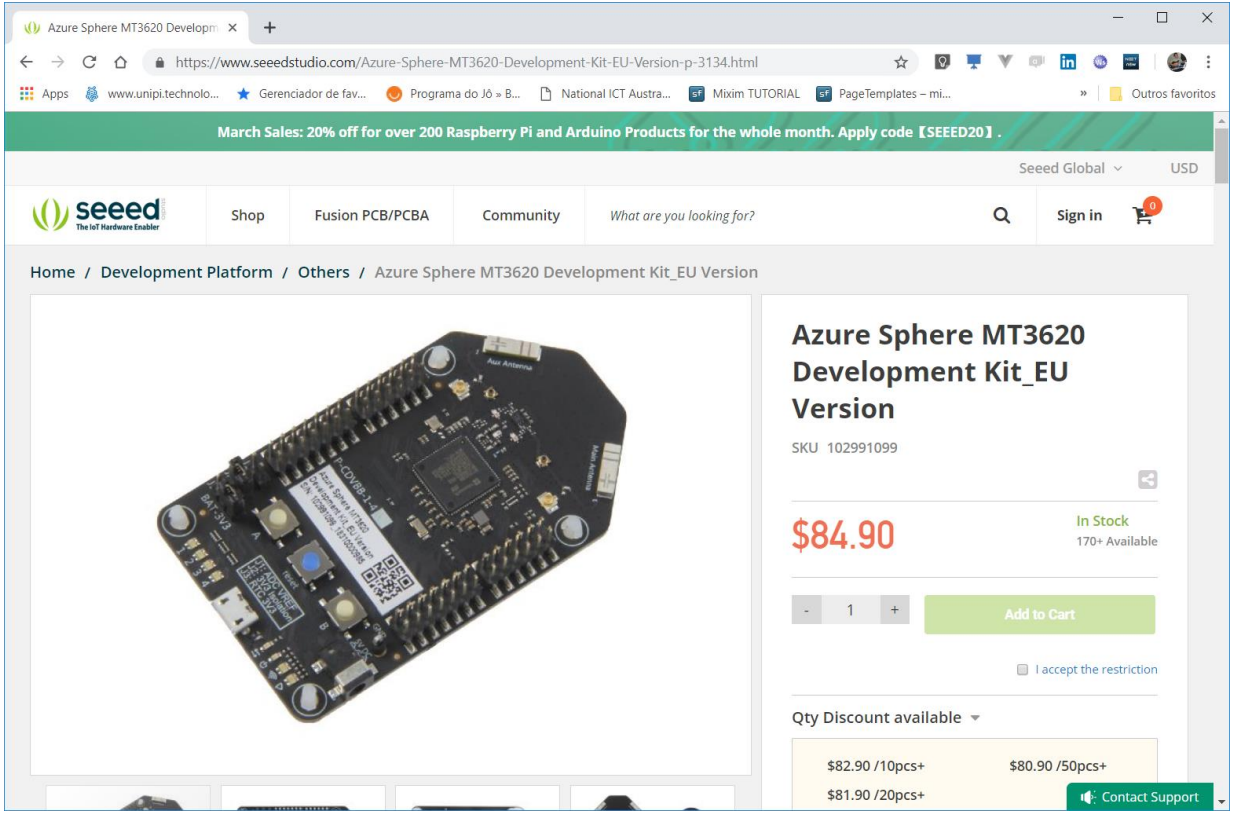
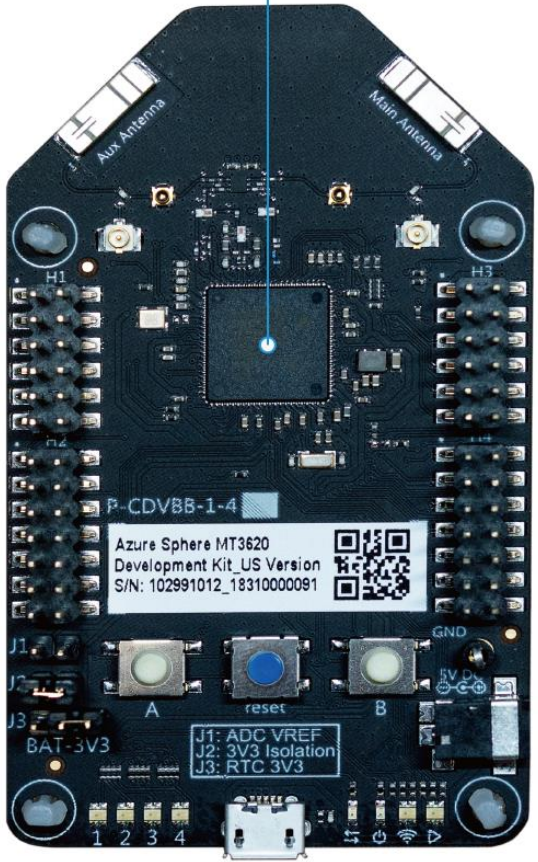


Extention Header Pinmap

				H1			
			SYS_RST_B	1	2	GND	
		I2S0_RX	GPIO 59	3	4	GPIO0	
		I2S0_TX	GPIO 56	5	6	GPIO1	
		I2S0_FS	GPIO 58	7	8	GPIO2	
		I2S0_MCLK	GPIO 57	9	10	GPIO3	
		I2S0_BCLK	GPIO 60	11	12	GPIO4	
				H2			
DATA0	RXD0	MISO0	GPIO 28	1	2	GND	
	TXD0	SCLK0	GPIO 26	3	4	GPIO 5	
	CTS0	CSA0	GPIO 29	5	6	GPIO 6	
CLK0	RTS0	MOSI0	GPIO 27	7	8	GPIO 7	
		CSB0	GPIO 30	9	10	ADC_VREF	
		ADC0	GPIO 41	11	12	GPIO 43	ADC2
		ADC1	GPIO 42	13	14	GPIO 44	ADC3



Extention Header Pinmap

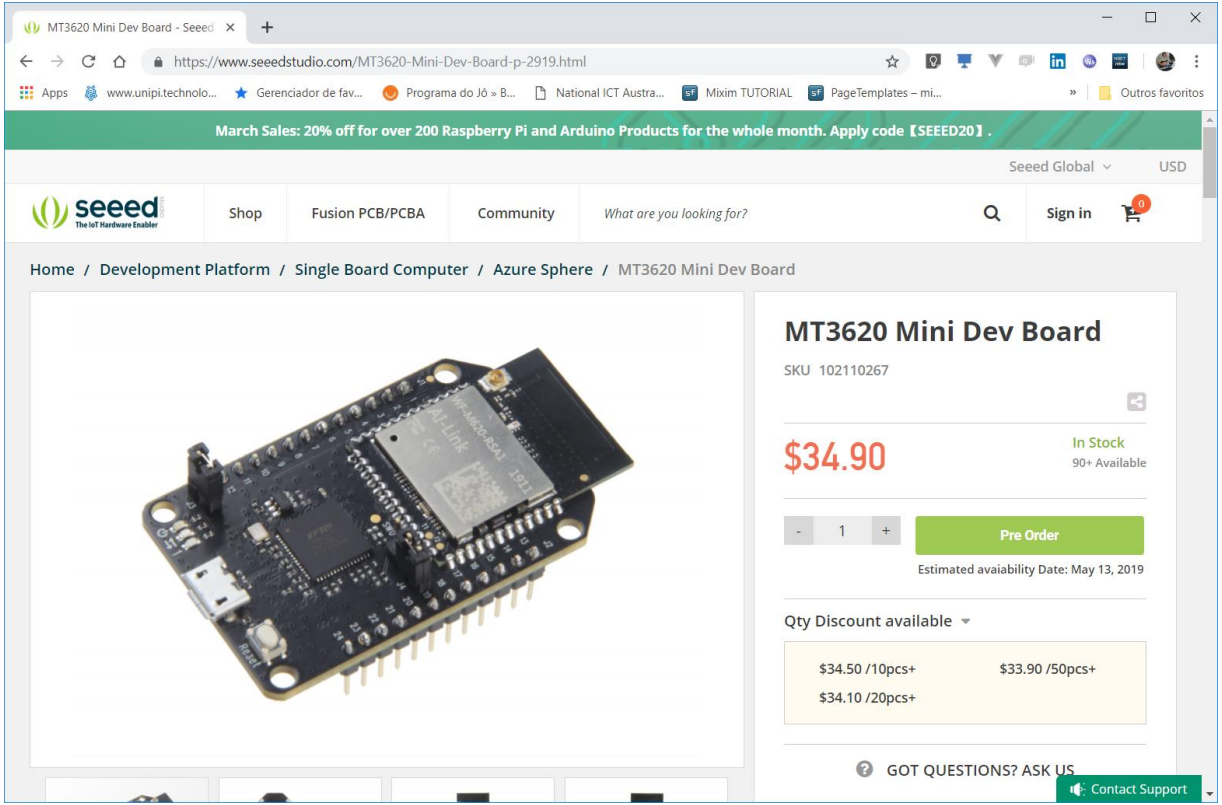
				H3					
			5V_OUT	1	2	GND			
			3.3V	3	4	WAKEUP			
	TXD3	SCLK3	GPIO 66	5	6	IO0_TXD			
CLK3	RTS3	MOSI3	GPIO 67	7	8	IO1_TXD			
DATA3	RXD3	MISO3	GPIO 68	9	10	PMU_EN			
	CTS3	CSA3	GPIO 69	11	12	GPIO 70	CSB3		
				H4					
			SWDIO	1	2	GND			
			SWCLK	3	4	SWO			
DATA1	RXD1	MISO1	GPIO 33	5	6	GPIO 38	MISO2	RXD2	DATA2
	TXD1	SCLK1	GPIO 31	7	8	GPIO 36	SCLK2	TXD2	
	CTS1	CSA1	GPIO 34	9	10	GPIO 39	CSA2	CTS2	
CLK1	RTS1	MOSI1	GPIO 32	11	12	GPIO 37	MOSI2	RTS2	CLK2
		CSB1	GPIO 35	13	14	GPIO 40	CSB2		

Note:
[2018/09/10]

The current Azure Sphere software release does not support all features of the MT3620 hardware.
The following are not yet supported in software:

- 2 x ARM Cortex-M4 with FPU
- ADC, I2C, I2S, PWM and SPI peripheral interfaces (GPIO and UART are supported)
- Wi-Fi 802.11a (b/g/n are supported)
- RTC with clock selection and battery backup

Azure Sphere MT3620 Mini Dev Board



Azure Sphere MT3620 Module

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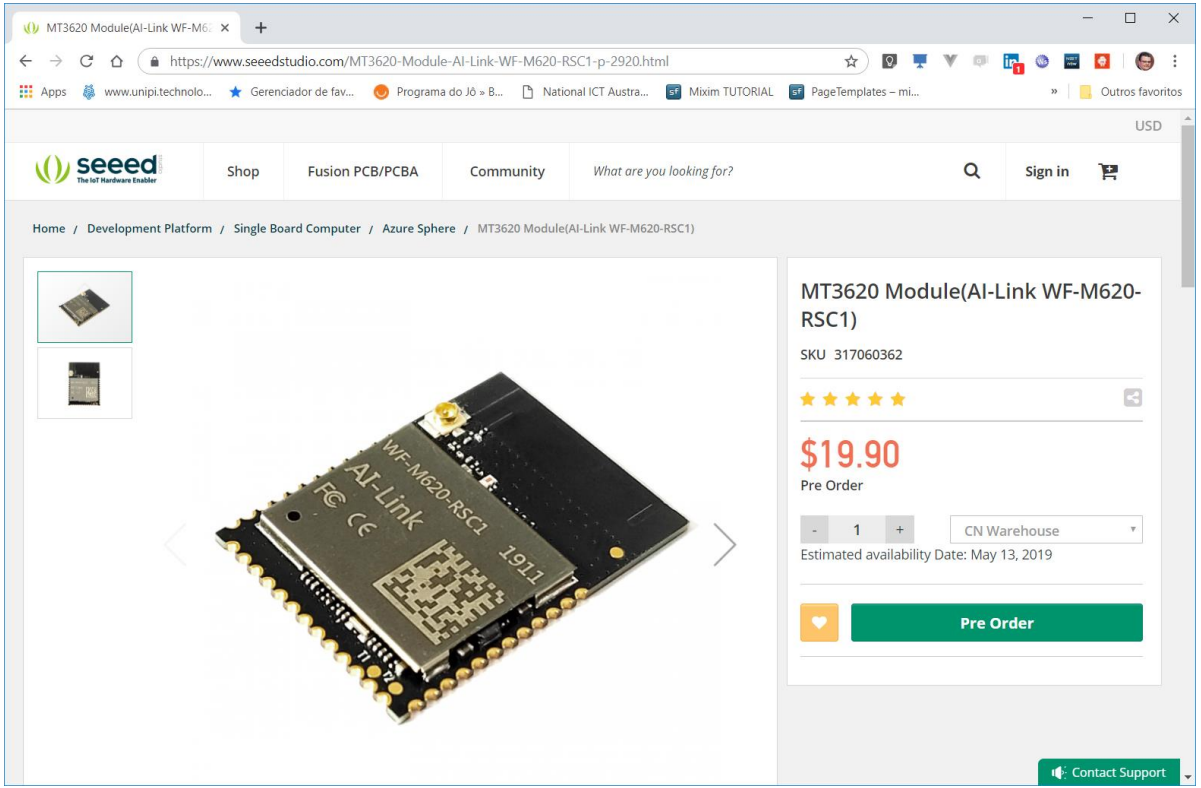

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Azure IoT Edge

Azure IoT Edge

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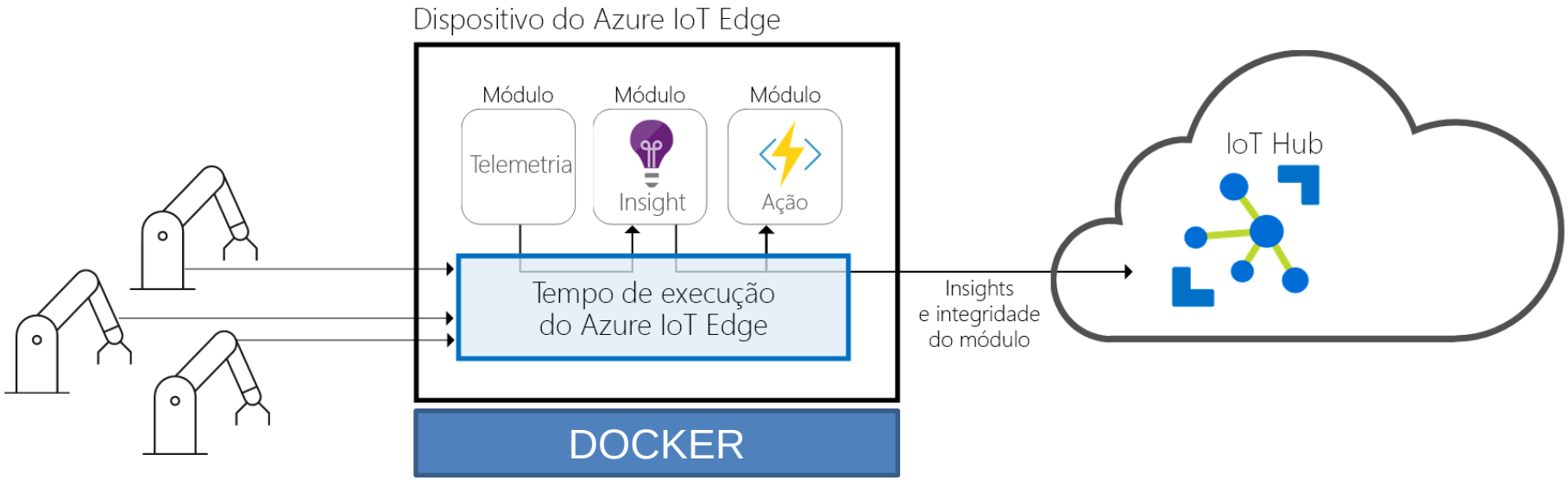
- O Azure IoT Edge move análises de nuvem e lógica de negócios personalizada para dispositivos, de modo que sua organização pode se concentrar em ideias de negócios em vez de gerenciamento de dados.



Install Azure IoT Edge runtime on Linux (ARM32v7/armhf)

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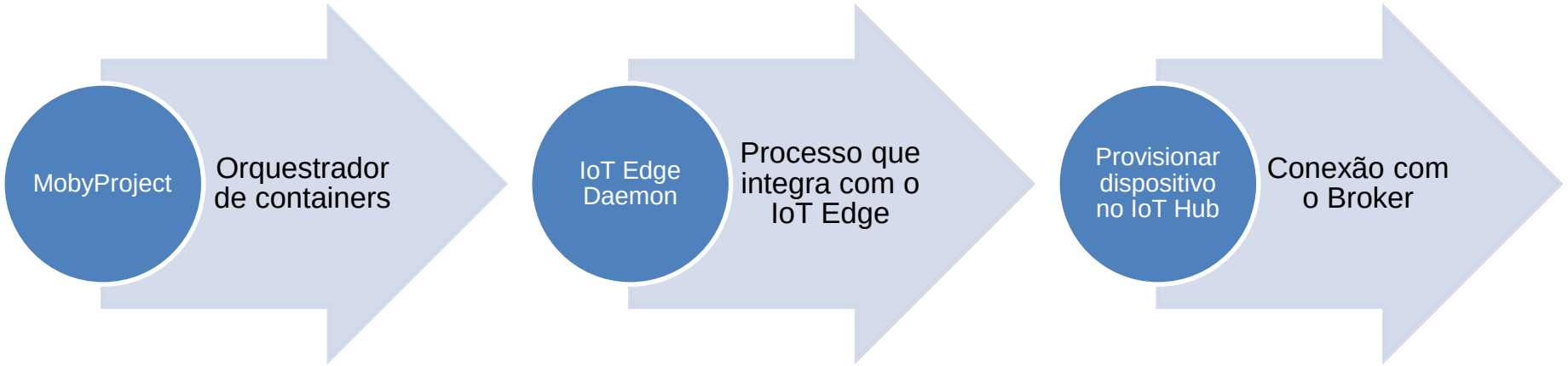
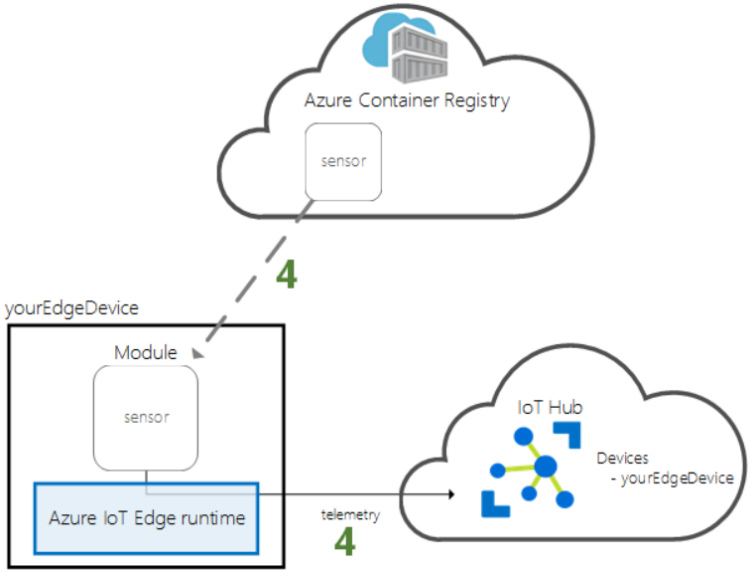
https://docs.microsoft.com/en-us/azure/iot-edge/how-to-install-iot-edge-linux-arm



Publicar módulo nos dispositivos



Codificação
- Desenvolvimento do módulo do IoT Edge

Container
- Compilação
- Geração da imagem do container Docker

Publicação da Imagem
- Imagem copiada para um Container Registry

Deploy
- Azure Iot Edge aciona publicação nos dispositivos.

https://docs.microsoft.com/en-us/azure/iot-edge/quickstart-linux#deploy-a-module

Monitoramento real de um CLP

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CLP (Controlador lógico programável)

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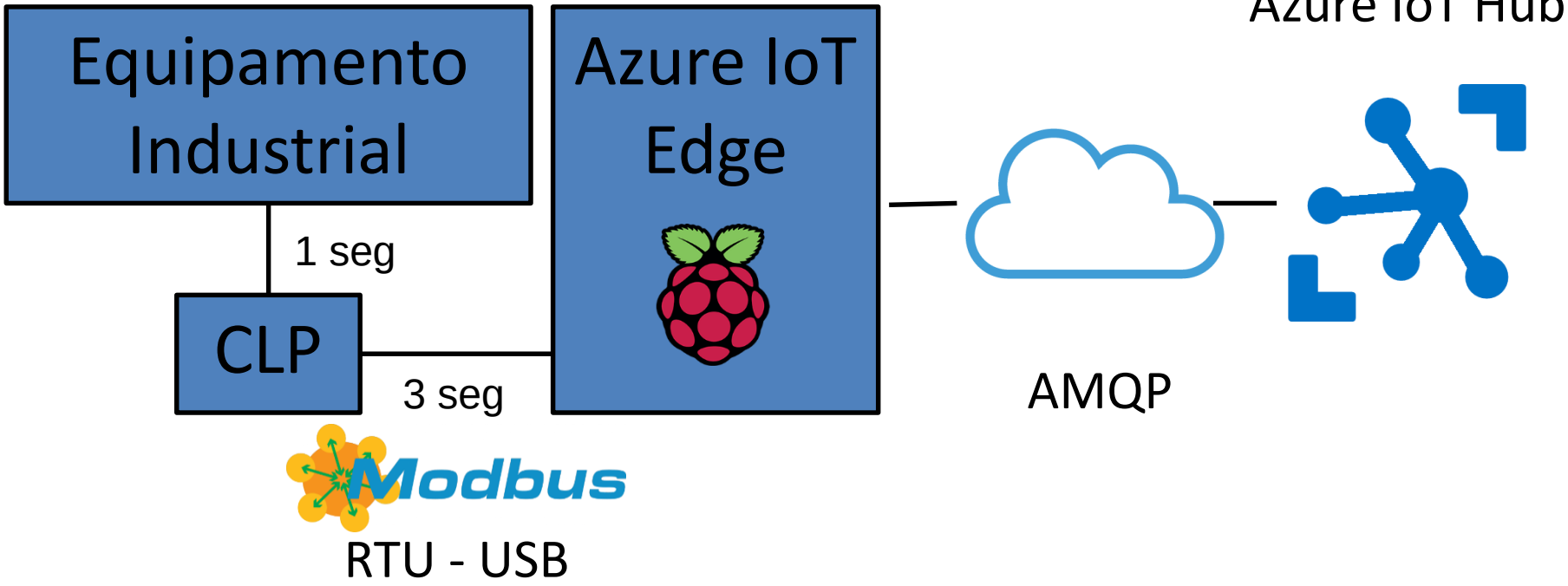
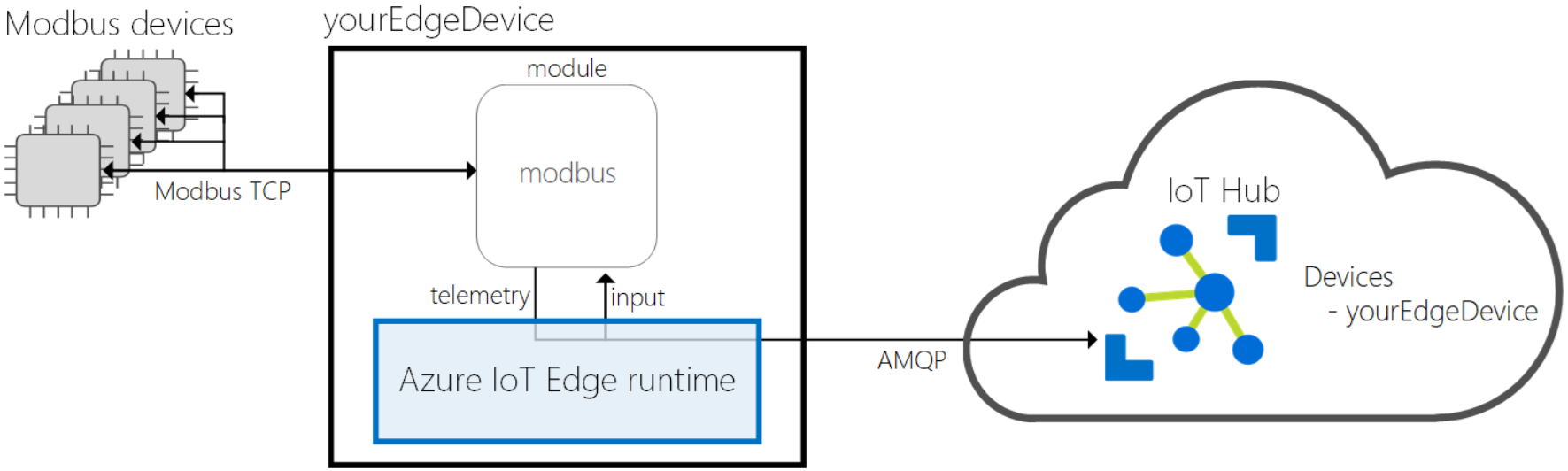
- Empresa ProXSys
  - CP-WS11/4DO4DI USB RS485
  - Alimentação em 24Vcc ou 12Vcc
  - Duas (02) saídas digitais para RELE
  - Quatro (04) entradas digitais a transistor tipo PNP
  - Porta de comunicação RS 485
  - Porta de comunicação/gravação USB
  - Protocolo MODBUS RTU

Monitoramento real de um CLP



Monitoramento real de um CLP



https://github.com/Azure/iot-edge-modbus

Monitoramento real de um CLP

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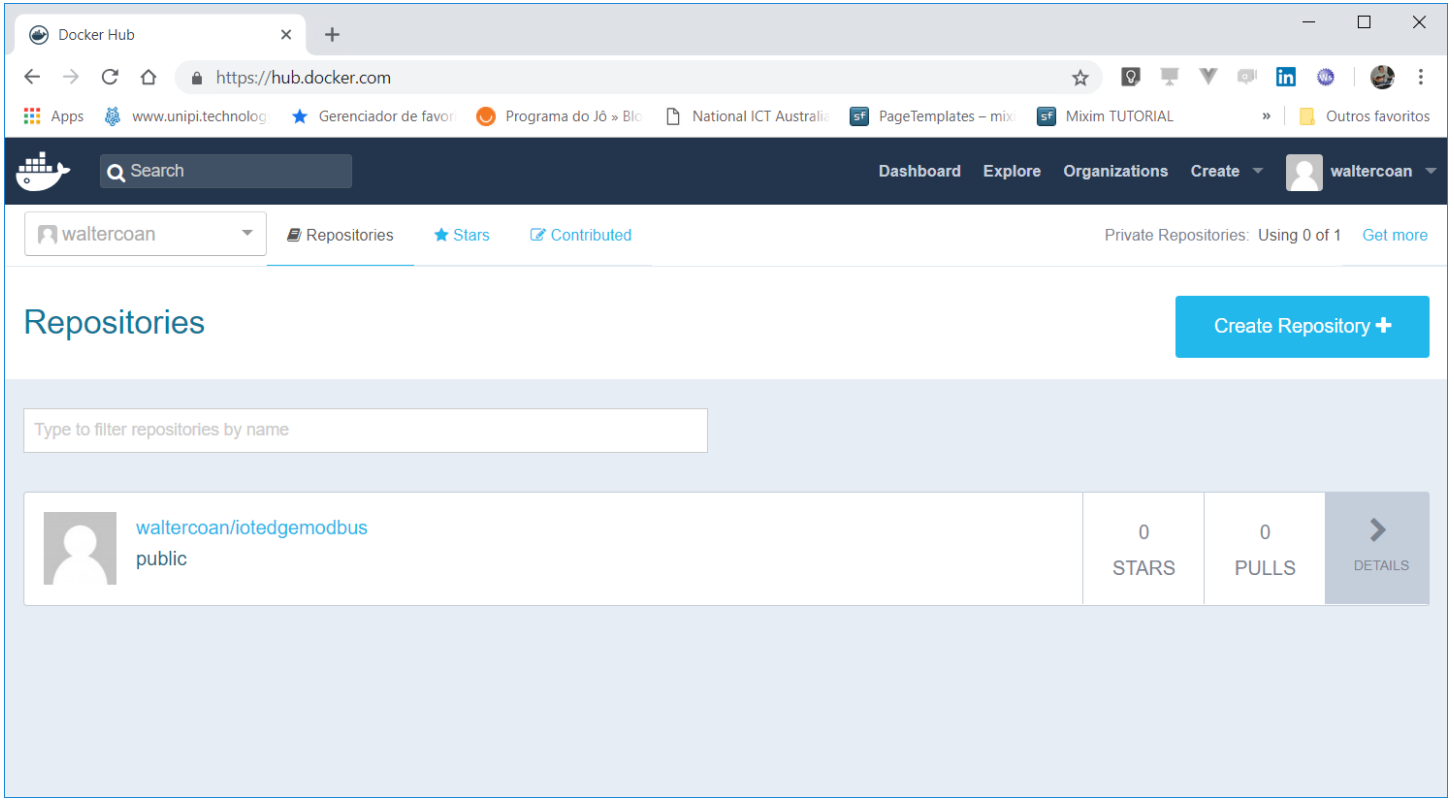

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Monitoramento real de um CLP

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Antes de habilitar o módulo

pi@raspberrypi: ~

```
root@raspberrypi:/home/pi# docker ps
CONTAINER ID        IMAGE                                         COMMAND
         CREATED             STATUS              PORTS
                        NAMES
b0ce650a90a2        mcr.microsoft.com/azureiotedge-hub:1.0      "/bin/sh -c 'echo
 \"$…"   27 hours ago        Up 2 hours          0.0.0.0:443->443/tcp, 0.0.0.0:8
883->8883/tcp, 5671/tcp   edgeHub
eb40d7f5caad        mcr.microsoft.com/azureiotedge-agent:1.0    "/bin/sh -c 'echo
 \"$…"   28 hours ago        Up 2 hours
                        edgeAgent
root@raspberrypi:/home/pi#
```

Monitoramento real de um CLP

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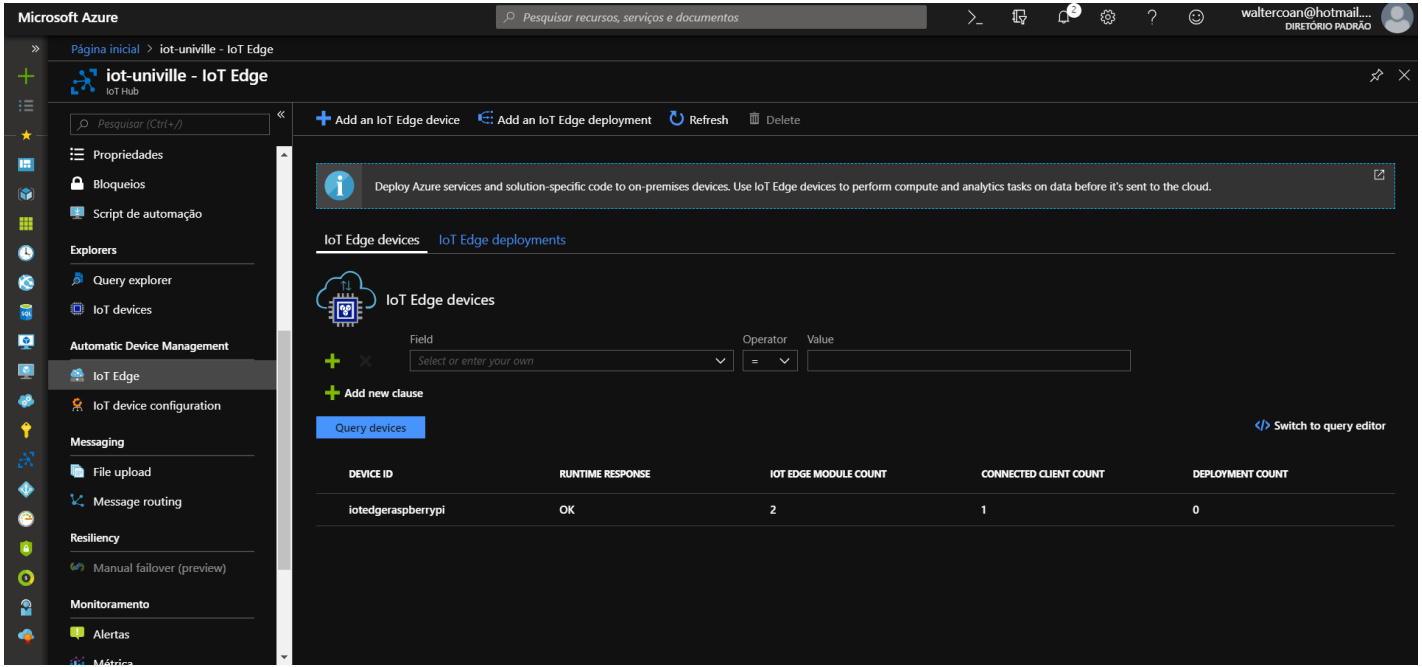

Monitoramento real de um CLP

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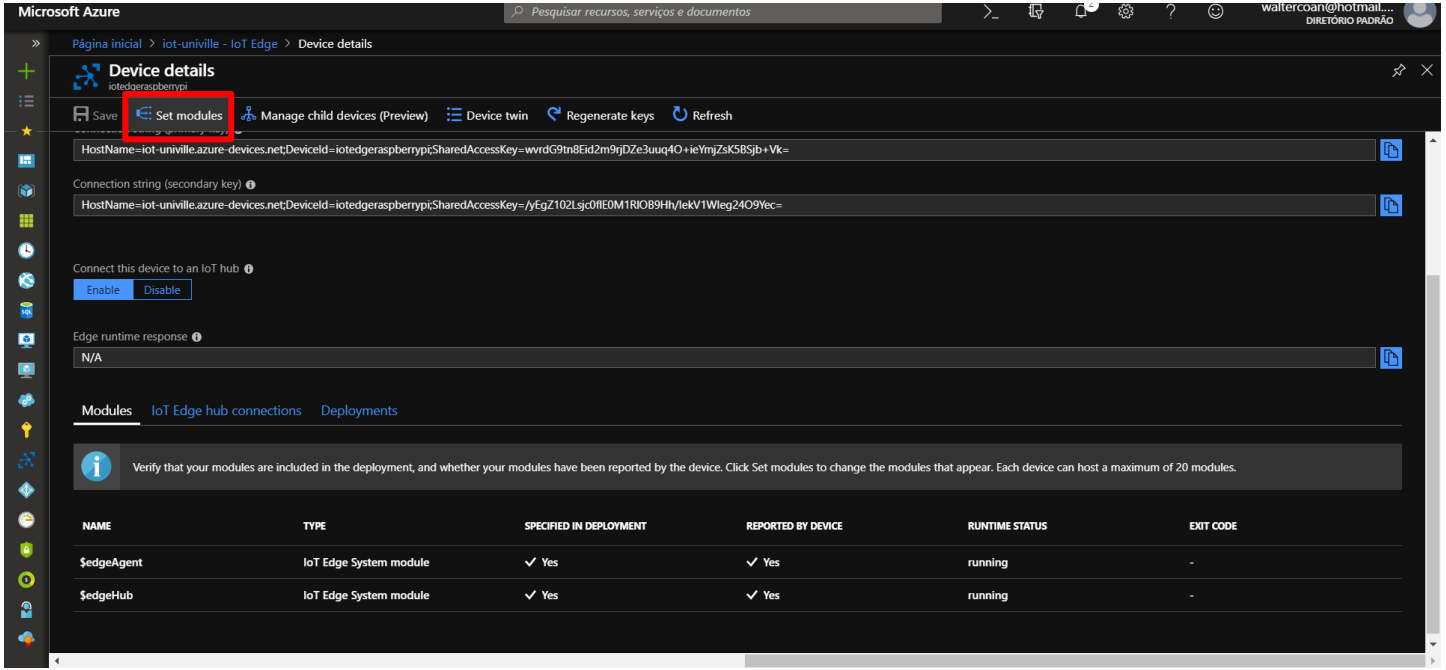

Monitoramento real de um CLP

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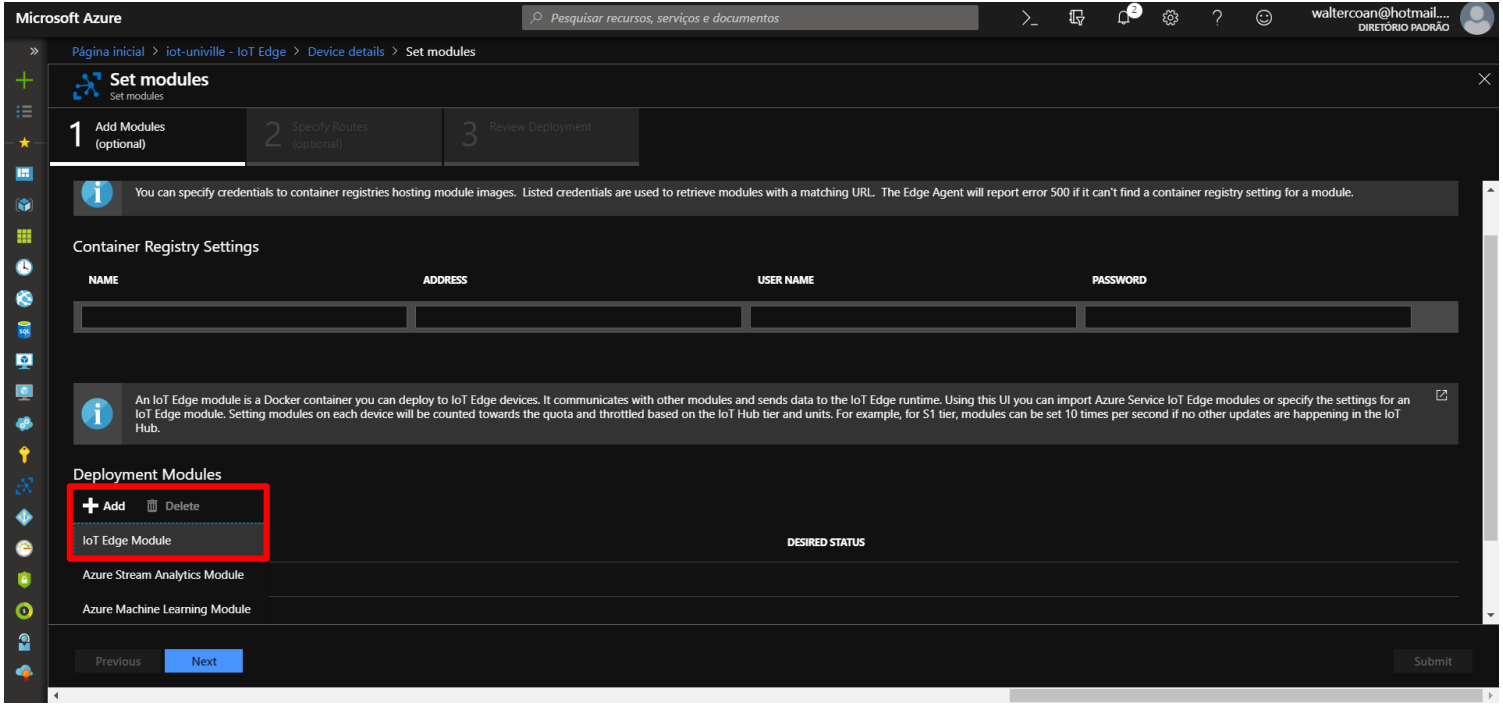

Monitoramento real de um CLP

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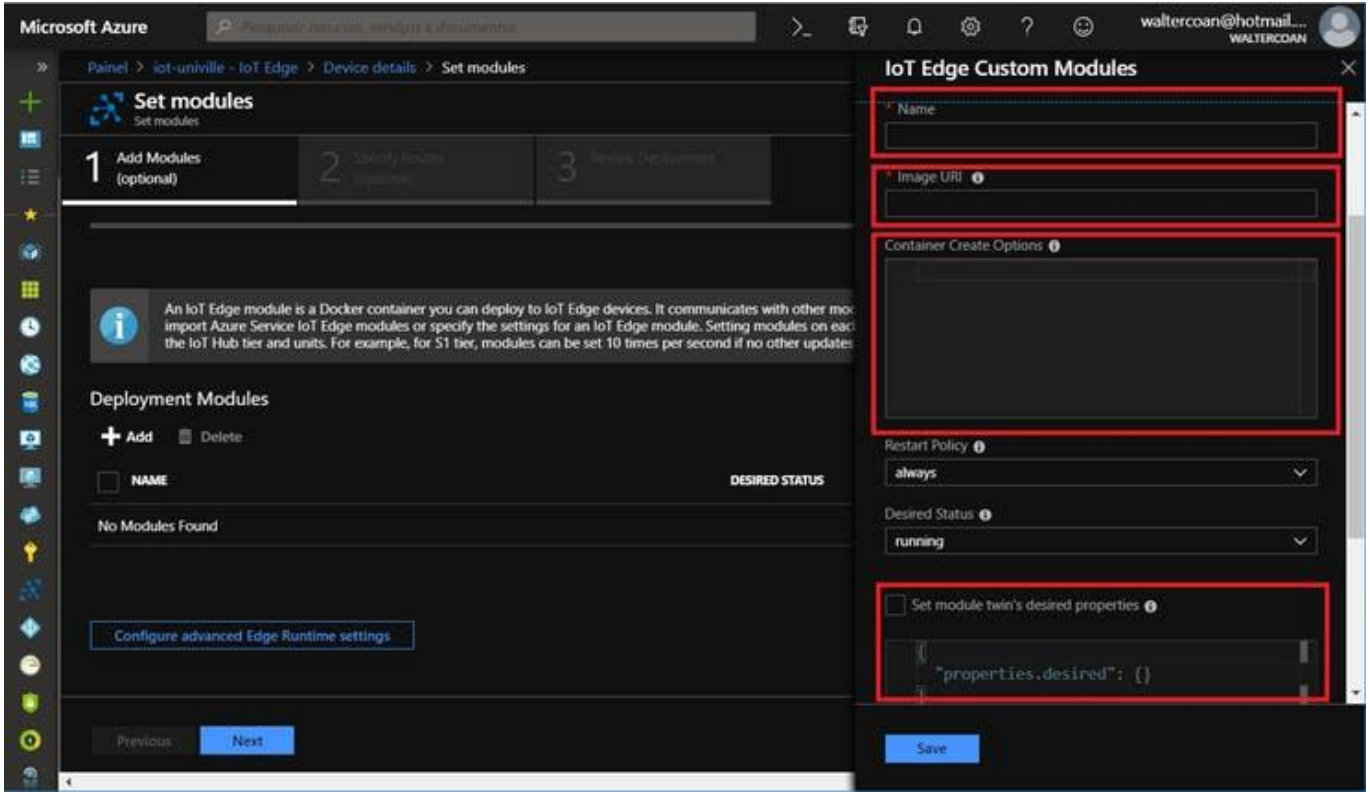

Monitoramento real de um CLP

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```
Name: iotedgemodbus
Image URI: waltercoan/iotedgemodbus
Container Create Options:
{
 "HostConfig": {
   "User": "root",
   "Privileged": true,
   "Devices": [
     {
       "PathOnHost": "/dev/ttyACM0",
       "PathInContainer": "/dev/ttyACM0",
       "CgroupPermissions": "mrw"
     }
   ]
 }
}
```

Monitoramento real de um CLP

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```
Module Twin's desired properties:
{
 "properties.desired":{
 "PublishInterval": "3000",
 "SlaveConfigs": {
   "Slave01": {
     "SlaveConnection": "/dev/ttyACM0",
            "TcpPort": "0",
     "RetryCount": "10",
     "RetryInterval": "50",
     "HwId": "CLP",
     "BaudRate": "9600",
     "DataBits": "8",
     "StopBits": "1",
     "Parity": "ODD",
     "FlowControl": "NONE",
     CONTINUA NO PRÓXIMO SLIDE!!!
```

Monitoramento real de um CLP

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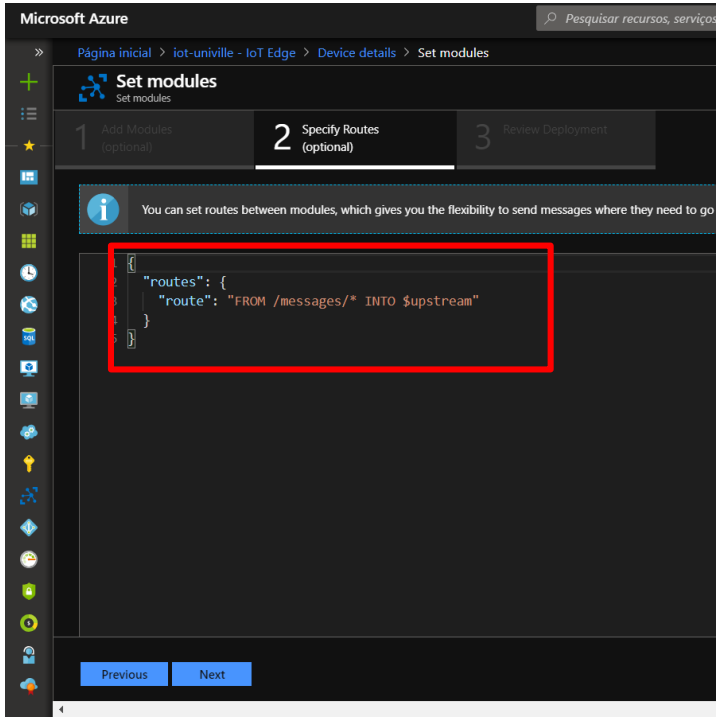
```
"Operations": {
       "Op01": {
         "PollingInterval": "1000",
         "UnitId": "1",
         "StartAddress": "100002",
         "Count": "1",
         "DisplayName": "disjuntor1"
       },
                     "Op02": {
         "PollingInterval": "1000",
         "UnitId": "1",
         "StartAddress": "100003",
         "Count": "1",
         "DisplayName": "disjuntor2"
       }
     }
   }
 }
}
}
```

Monitoramento real de um CLP




```
{
    "routes": {
        "route": "FROM /messages/* INTO $upstream"
    }
}
```

Monitoramento real de um CLP

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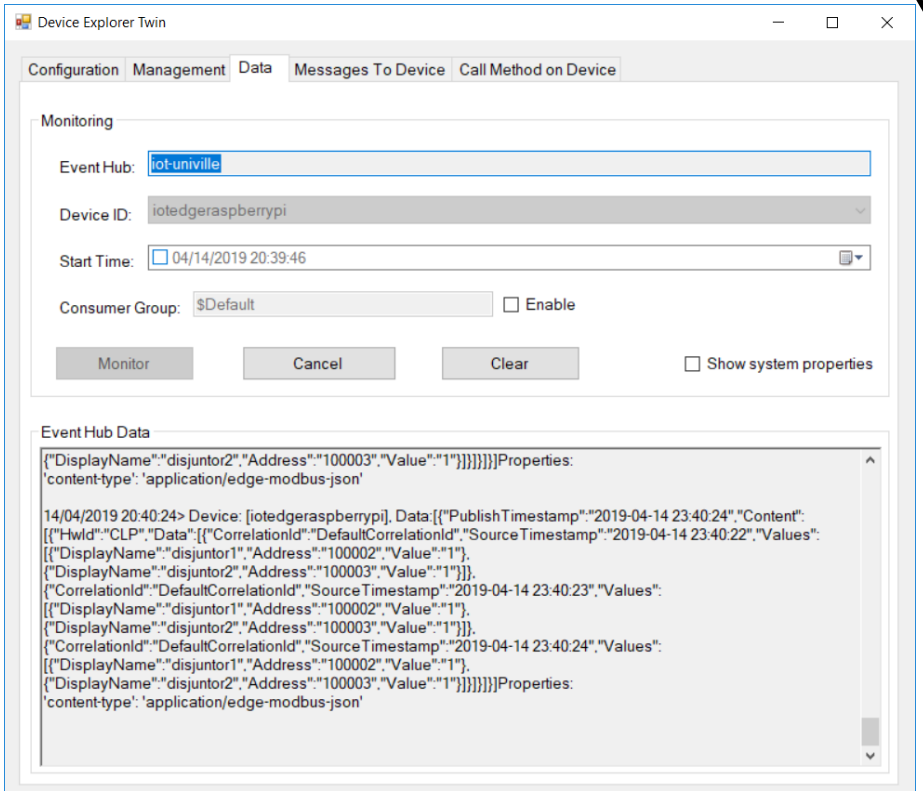
pi@raspberrypi: ~

```
root@raspberrypi:/home/pi# docker ps
CONTAINER ID        IMAGE                                       COMMAND
         CREATED              STATUS              PORTS
                        NAMES
5e9c263fe2cf        waltercoan/iotedgemodbus                    "dotnet iotedgeMo
dbu…"    About a minute ago   Up About a minute
                        iotedgemodbus30
b0ce650a90a2        mcr.microsoft.com/azureiotedge-hub:1.0      "/bin/sh -c 'echo
 \"$…"   8 days ago           Up 21 minutes       0.0.0.0:443->443/tcp, 0.0.0.0:
8883->8883/tcp, 5671/tcp   edgeHub
eb40d7f5caad        mcr.microsoft.com/azureiotedge-agent:1.0    "/bin/sh -c 'echo
 \"$…"   8 days ago           Up 3 hours
                        edgeAgent
root@raspberrypi:/home/pi#
```

Monitoramento real de um CLP



Monitoramento real de um CLP

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Tutorial completo

https://www.hackster.io/waltercoan/azure-iot-edge-reading-data-from-plc-industrial-iot-ef8214

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Modelos de Inteligência Artificial em microcontroladores

Azure IoT Starter Kit (AZ3166)

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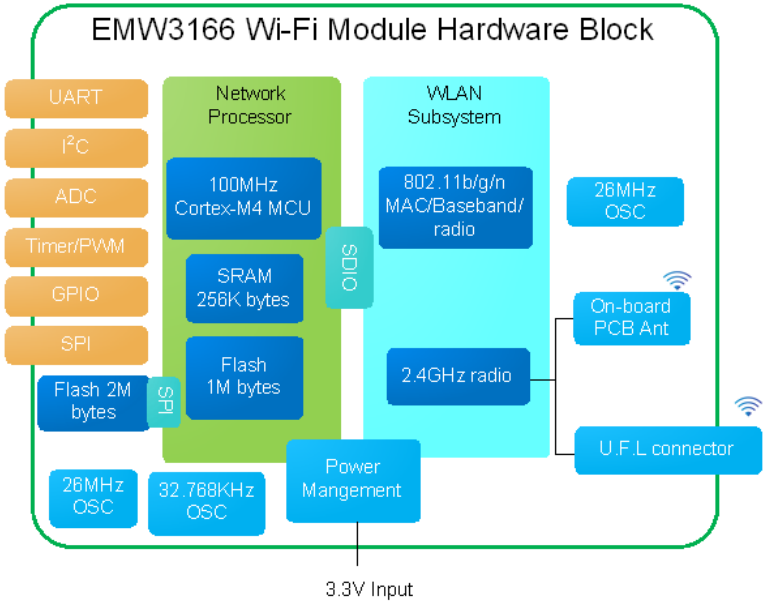
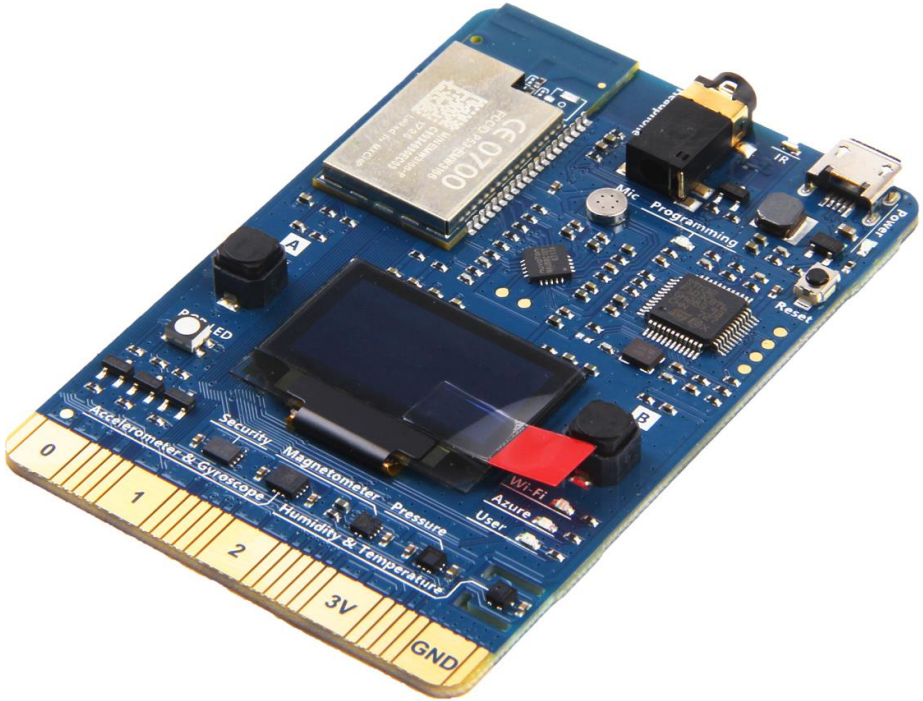
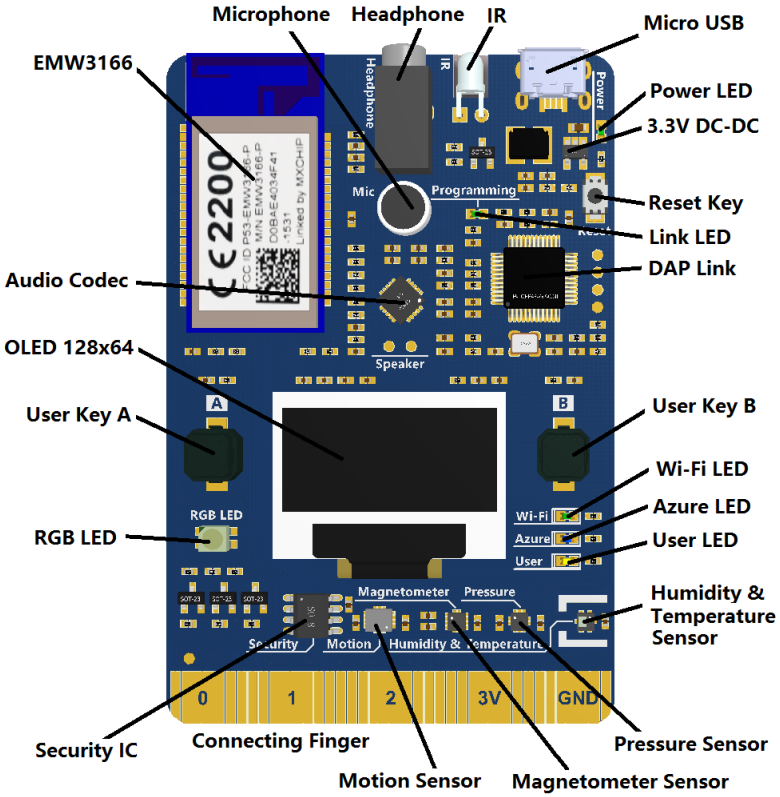
- MXCHIP
- ARM Cortex-M4 100Mhz
- EMW3166 Wifi
- STSAFE-A100





Azure IoT Starter Kit (AZ3166)

https://microsoft.github.io/azure-iot-developer-kit/



Azure IoT Starter Kit (AZ3166)

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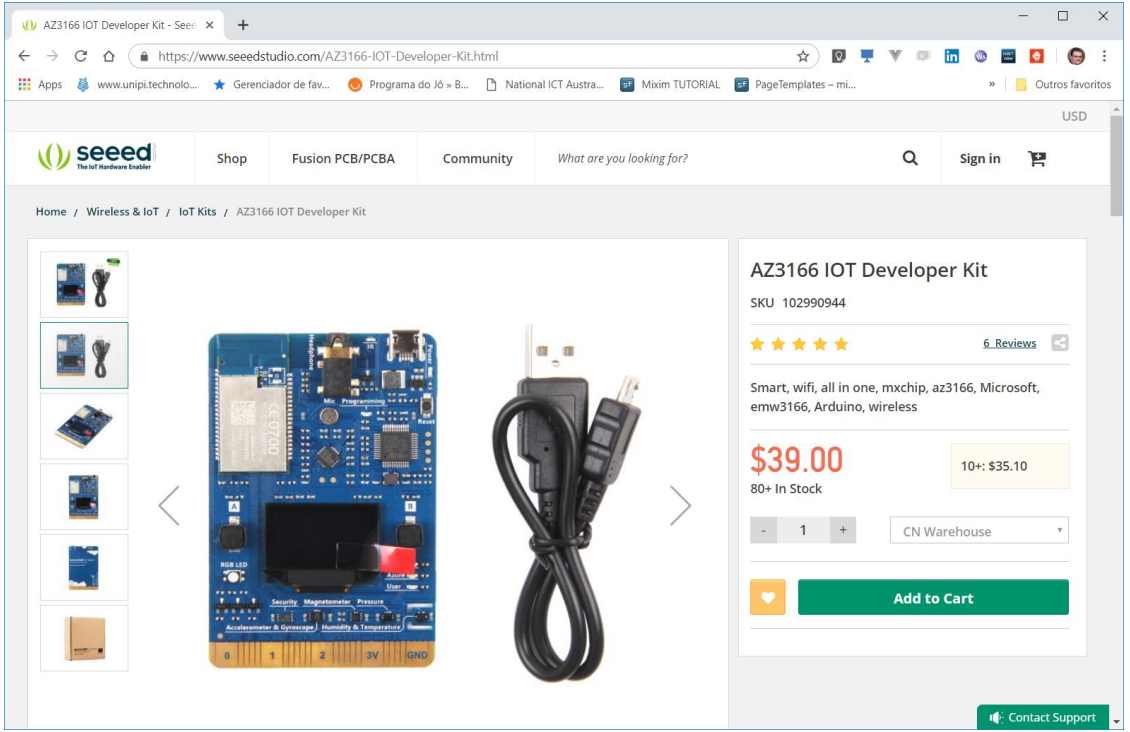
https://www.seeedstudio.com/AZ3166-IOT-Developer-Kit.html



Azure IoT Starter Kit (AZ3166)

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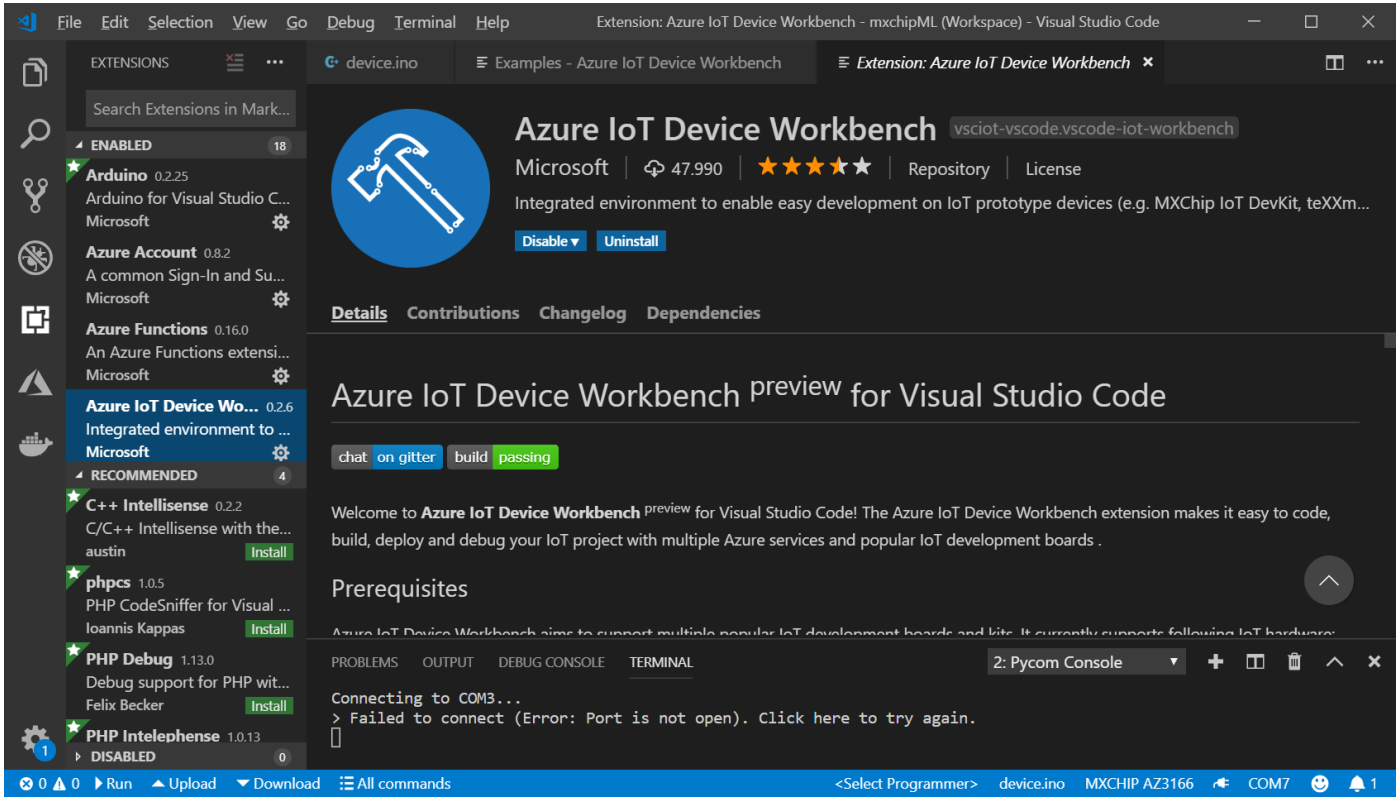

Azure IoT Starter Kit (AZ3166)

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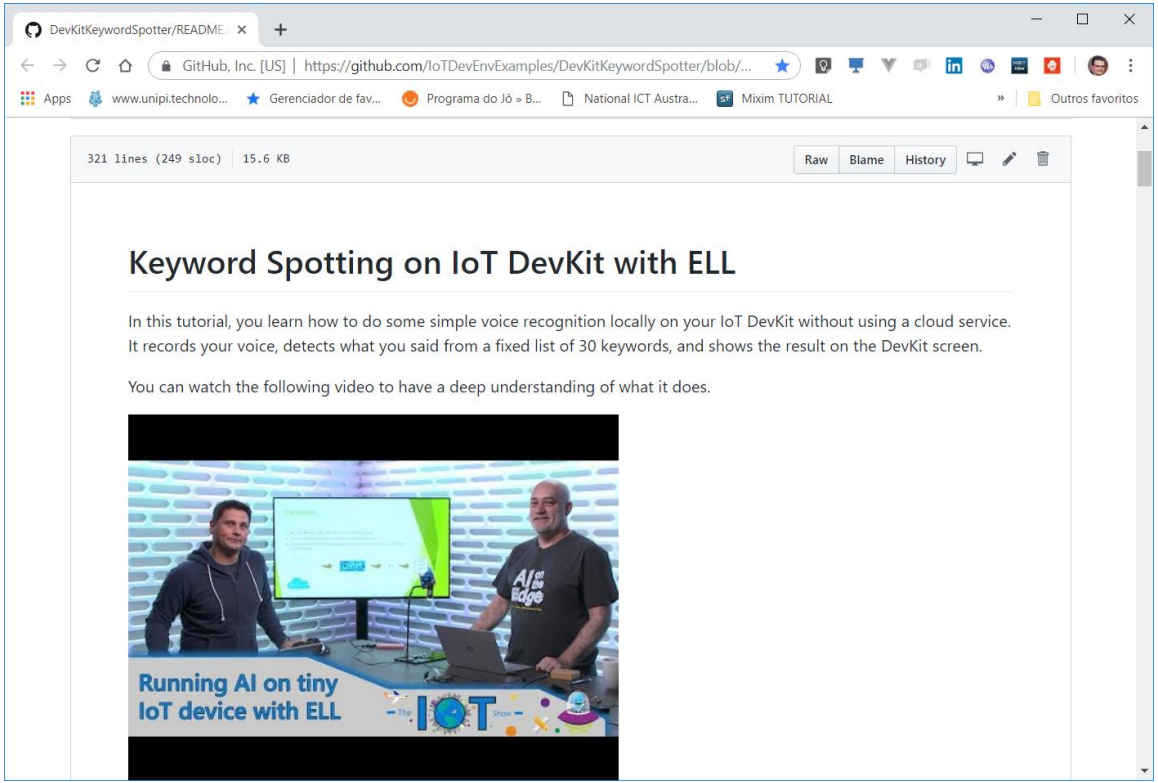
https://github.com/IoTDevEnvExamples/DevKitKeywordSpotter/blob/master/README.md



Embedded Learning Library

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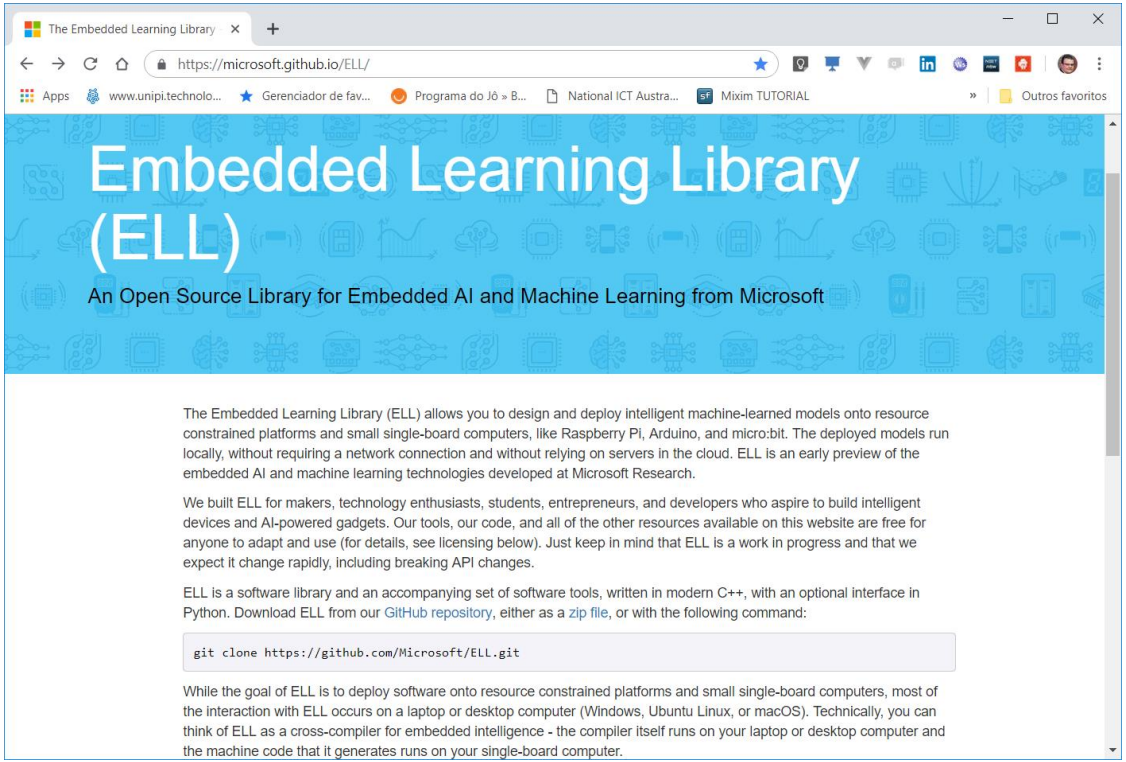
https://microsoft.github.io/ELL/



Embedded Learning Library

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Demonstração

Embedded Learning Library

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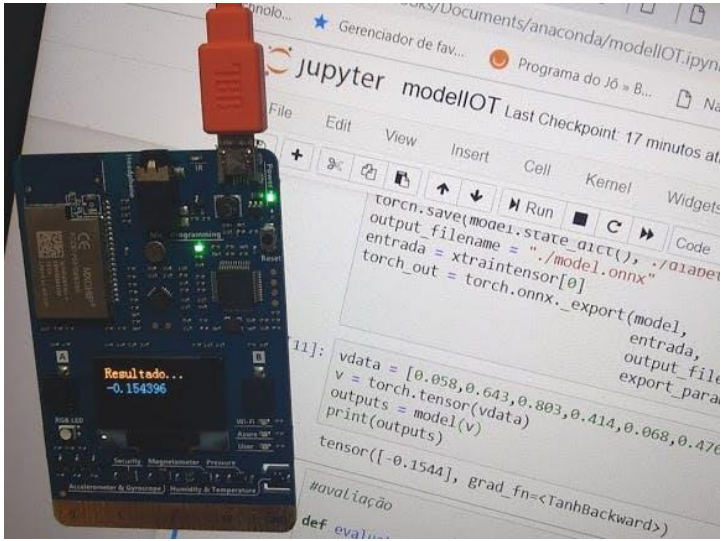
Tutorial completo

https://www.hackster.io/waltercoan/machine-learning-model-running-on-azure-iot-starter-kit-f9608b



Para aprender mais...

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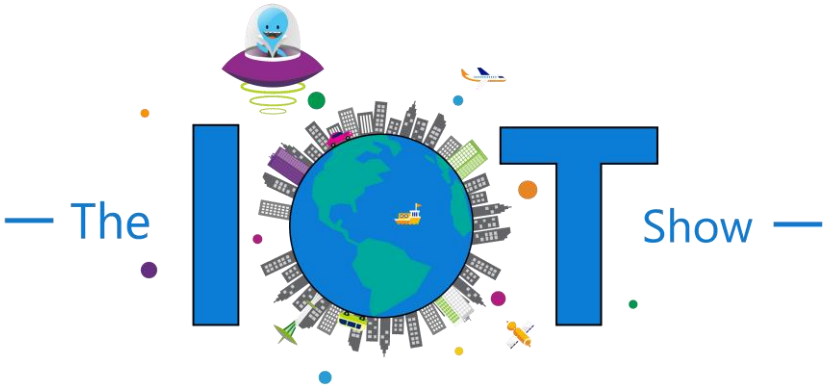

aka.ms/IoTShow

aka.ms/IoTSchool

Para aprender mais...

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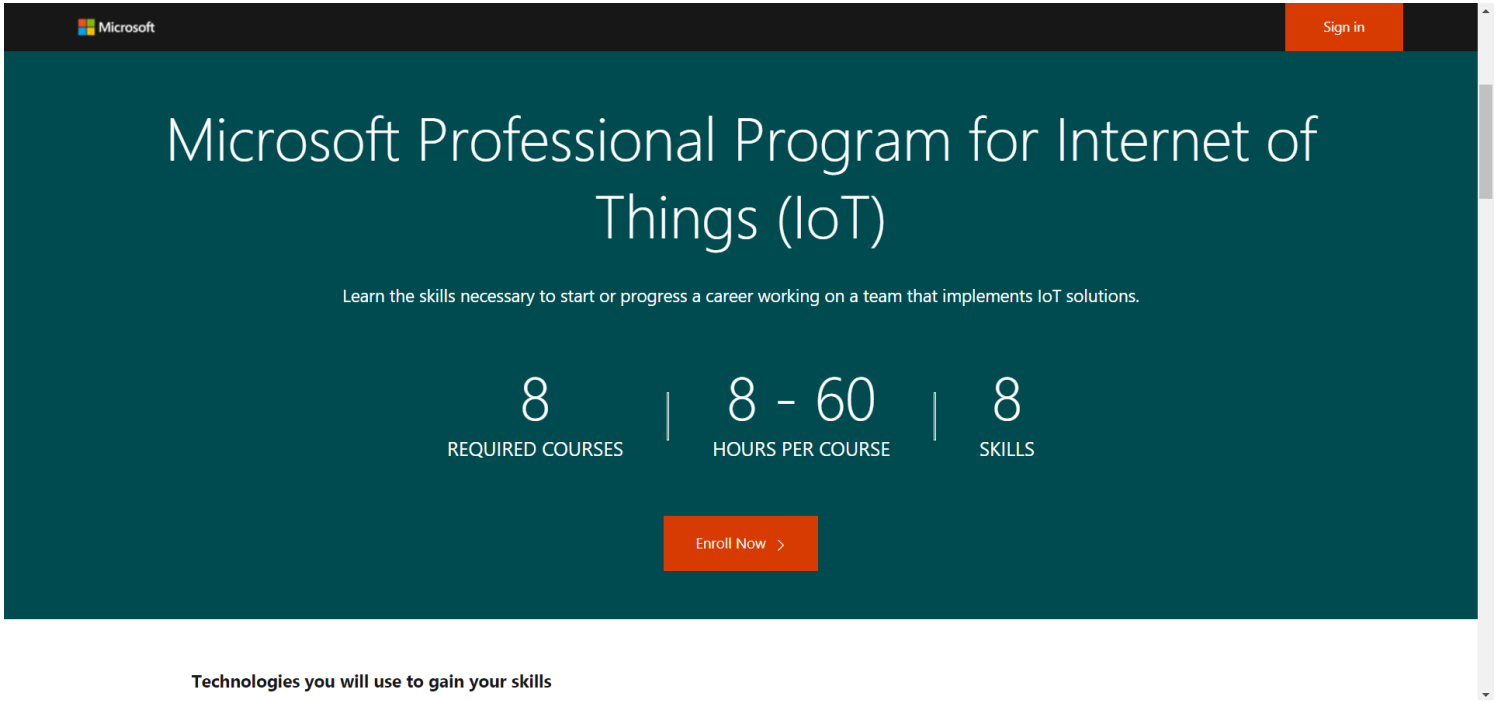

https://academy.microsoft.com/en-us/professional-program/tracks/internet-of-things/

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