산학연계형 IoT교육지원사업 (KEA & 삼성전자)

강사양성과정 교육교재

본 교재는 산학연계형 IoT교육지원사업에 참여하는 대학교에 제공하는 표준교육교재로 교재본문과 부록으로 구성되어 있습니다. 사업 참여 대학교는 각 개설과정에 맞도록 교재를 편집, 가공하여 활용할 수 있습니다.

저작권 및 활용 안내문

본 교재는 산학형 **IoT**교육지원사업(이하 '지원사업')의 표준교육과정 운영을 목적으로 개발한 것으로 (사)한국전자정보통신산업진흥회와 삼성전자㈜가 공동으로 저작권으로 소유하고 있습니다. 동 교재는 지원사업 협약기관에 한하여 배포되므로, 해당 기관에 한하여 이를 가공, 인용하여 교육과정에 맞도록 활용할 수 있으며, 제**3**자의 가공, 인용 등 허락되지 않은 활용은 제한됩니다.

아틱을 활용한 사물인터넷과 임베디드 시스템 개발 과정

(IoT & Embedded System Development with ARTIK)

- 기획 : 한국전자정보통신산업진흥회 **IoT**융합지원센터

  삼성전자**(DS**부문**) IoT**사업화팀
- 개발 : 국중진 박사 **(IoT**융합지원센터 기술전문위원**,**

  상명대학교 정보보안공학과 교수**)**
- 감수 : 삼성전자**(DS**부문**) IoT**사업화팀

개정 이력

버전	작성일자	제, 개정 내용	작성기관
V 1.0	2017.08.18	최초 작성	KEA & 삼성전자

Table of Contents (1/5)

ARTIK Modules (1/2)

Category	Contents	# of Pages
Internet of Things	Definition, Platform & Ref. Model	8
IoT Platform ARTIK	ARTIK Module Types	4
	ARTIK Module Development Environment	1
	ARTIK Cloud Introductions	3
ARTIK 053 SPEC & Setup	ARTIK 053 Specification	4
	ARTIK 053 Power Configuration	1
	ARTIK 053 GPIO Header Map	2
	ARTIK 053 Arduino Shield & Sensor	2
	ARTIK 053 Setup, Driver Installations	18
	ARTIK 053 Demo (On-board Example)	
Tizen RT	NuttX	7
	Tizen RT Outlook	4
	Tizen RT Sub-systems	11
Command Line Interface	CLI Operation	2
	CLI Commands	1
	GPIO Commands (gpio)	4
	File System Command (smartfs)	1
	Ramdisk Command (mkrd)	1
	WiFi Configuration (wifi)	12
ARTIK IDE	ARTIK IDE Installation	7
	ARTIK IDE Project Setup	18
	Running ARTIK Application	9
ARTIK 053 Basic Example	Sensorbd LEDs & Resistors	3
	Sensorbd – circuit	2
	Sensorbd - Project Setup	3
	Sensorbd - source code	8
	Sensorbd – result	2

Category	Contents	# of Pages
File Operations	Linux File Operations	6
	Task Structure of Tizen RT	3
	Tizen RT File Operations	4
General Purpose I/O (GPIO)	Blink External LEDs - Circuit	5
	Blink External LEDs - Project Setup	1
	Blink External LEDs - Source Code	3
	Blink External LEDs - Result	1
	Digital Input with Push Button - Circuit	1
	Digital Input with Push Button - Project Setup	2
	Digital Input with Push Button - Source Code	4
	Digital Input with Push Button - Result	1
Blink LED WiFi	Blink LED WiFi - Circuit	1
	Blink LED WiFi - Project Setup	1
	Blink LED WiFi - Macros & APIs	1
	Blink LED WiFi - Result(only connection)	2
	Blink LED WiFi - Source Code	1
	Blink LED WiFi - Result(with IP allocation)	1
Analog Input	Analog Sensors	1
	Pulse Code Modulation (PCM)	4
	CdS Cell	2
	ARTIK 053 Analog Interfaces	1
	Analog Input - Circuit	2
	Analog Input - Project Setup	2
	ADC Data Structure of Tizen RT	1
	Analog Input - Source Code	2
	Analog Input - Result	1

Table of Contents (2/5)

ARTIK Modules (2/2)

Category	Contents	# of Pages
Pulse Width Modulation (PWM)	Pulse Width Modulation (PWM)	1
	LED Dimming - Circuit	1
	LED Dimming - Project Setup	2
	PWM Data Structure of Tizen RT	1
	LED Dimming - Source Code	2
	LED Dimming - Result	1
PIR Motion Sensor	HC-SR501 PIR Motion Sensor Module	7
	Tizen RT GPIO Header Map	1
	Motion Detector – Circuit	1
	Motion Detector - Project Setup	2
	Motion Detector - Source Code	4
	Motion Detector - Result	1
Ultrasonic	HC-SR04 Ultrasonic Sensor Module	3
	Ranging - Circuit	1
	Ranging - Project Setup	2
	Tizen RT GPIO Header Map	1
	Tizen RT GPIO Macros	1
	Tizen RT GPIO Low Level APIs	2
	Ranging - Source Code	3
	Ranging - Result	1
Digital Humidity & Temperature Sensor (DHT)	DHT11/DHT22 Digital Humidity & Temperature Sensor	10
	Thermo-hygrometer – Circuit	1
	Thermo-hygrometer – Project Setup	2
	Thermo-hygrometer - Source Code	6
	Thermo-hygrometer - Result	1

Category	Contents	# of pages
UART	UART Introduction	1
	ARTIK 053 UART Interfaces	2
	Serial Communication - Circuit	1
	Serial Communication – Project Setup	2
	Tizen RT UART Data Structures & APIs	3
	ARTIK SDK for UART	2
	Tizen RT UART Node Files	1
	Serial Communication -Source Code	1
	Serial Communication -Result	1
I2C	I2C Introduction	5
	MPU9250 Specification	2
	ARTIK 053 I2C Interfaces	2
	MPU9250 - Circuit	1
	MPU9250 - Project Setup	3
	Tizen RT I2C Data Structures & APIs	3
	MPU9250 - Source Code	2
	MPU9250 - Result	1
SPI	SPI Introduction	4
	ARTIK 053 SPI Interfaces	2
	MCP3XXX ADC Modules	6
	MCP3XXX with CdS - Circuit	1
	MCP3XXX with CdS - Project Setup	2
	Tizen RT SPI Data Structures & APIs	4
	MCP3XXX with CdS - Source Code	5
	MCP3XXX with CdS – Result	1
Tizen RT Customization	Tizen RT Example Applications	1
	Linux Development Environment	16
	Customizing ARTIK 053	32
	Create New Device Type on ARTIK Cloud	11

Table of Contents (3/5)

ARTIK Cloud

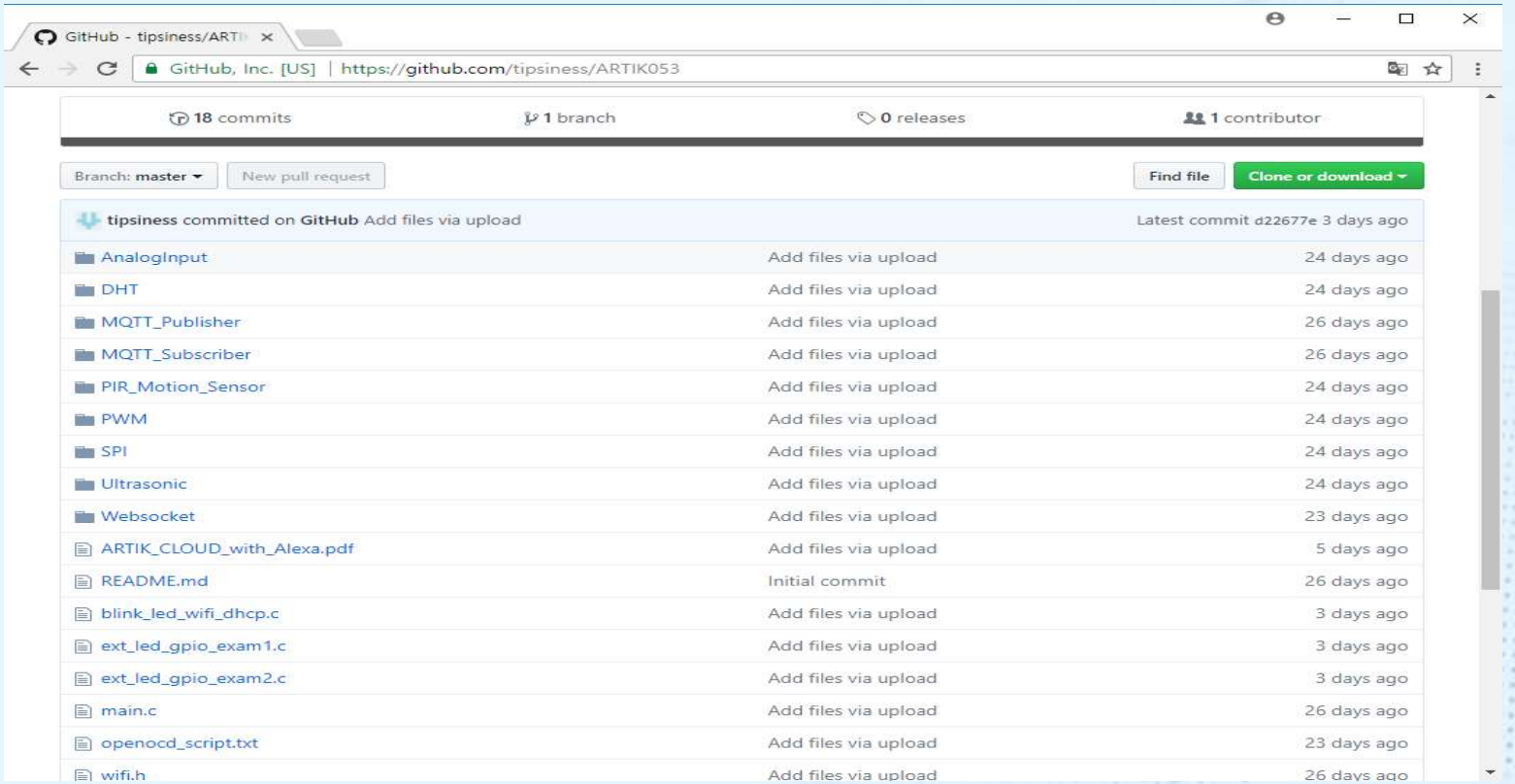
Category	Contents	# of Pages
Big Data & Cloud Computing	Big Data	1
	Cloud Computing	1
ARTIK Cloud Introduction	ARTIK Cloud Introduction	7
	ARTIK Cloud Terminologies	15
	ARTIK Cloud Basic Example	21
ARTIK Cloud APIs	IoT Federation with ARTIK Cloud	3
	Device to ARTIK Cloud Methods	6
	REST APIs	27
	Websocket	10
	ARTIK Cloud with Websocket	6
	MQTT	37
Device Management	Light Weight M2M	16
ARTIK Cloud Authentication	Authentication	6
	Three types of access tokens	9
	Obtain a Token	19
ARTIK Cloud Example	Temperature Monitoring System	1
	Device Registration on ARTIK Cloud	13
	Nodejs & Websocket Installation	4
	Temp Sensor Example	8
	Lamp Actuator Example	7
	Definition of Rules	5
	Cloud Connector for Naver Line	15
3rd Party Cloud Example : Amazon Alexa	ARTIK Cloud	1
	RPi-based Alexa	13
	Installation Alexa	2
	ARTIK 710 based Alexa	7
	Installation for Alexa	8
	Instruction for Alexa	14
	Cloud Connector Setup for Alexa	16

Table of Contents (4/5)

- APPENDIX
  - **A.** **MQTT (PPT)**
  - **B.** **CoAP (PPT)**
  - C. NuttX Overview (PDF)
  - D. Tizen RT Introduction (PDF)
  - E. Product Brief – ARTIK 053 (PDF)
  - F. ARTIK-053 Starter Kit HW Guide (PDF)
  - G. ARTIK-053 HW Datasheet (PDF)
  - H. ARTIK-053 PCB Design Guide (PDF)
  - I. ARTIK-053 Interposer board (ZIP : netlist, pbc, bom, layout)

Table of Contents (5/5)

- Example Source Codes
  - https://github.com/tipsiness/ARTIK053
  - Download:
    $ git clone https://github.com/tipsiness/ARTIK053.git



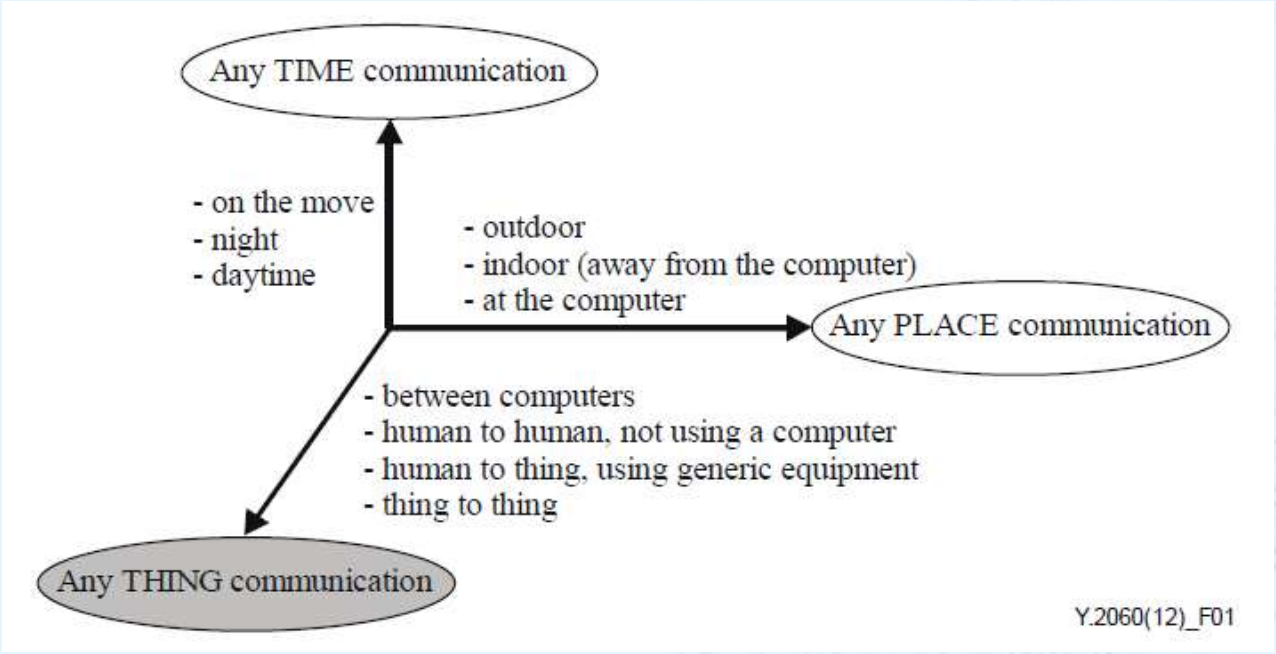
PART 1 : ARTIK Module

Internet of Things (IoT)

- IoT Definition
- Technical Overview
- Evolution of IoT Platform
- IoT Reference Model
- IoT Challenges

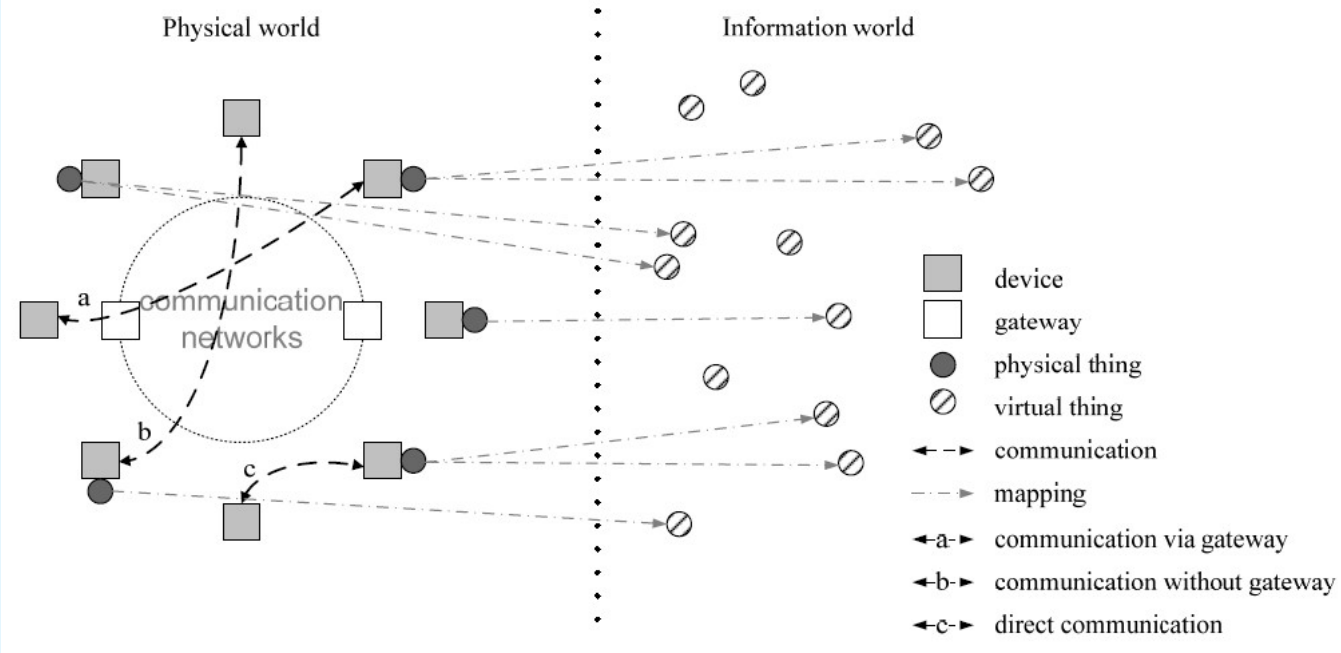
IoT Definition

- Global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT) [ITU-T Y.2060, June, 2012]



Technical Overview

- A physical thing may be represented in the information world via one or more virtual things (mapping)
- A device is a piece of equipment with the mandatory capabilities of communication and optional capabilities of sensing, actuation, data capture, data storage and data processing



[ITU-T Y.2060, June, 2012]

Technical Overview

- The devices collect various kinds of information and provide it to the information and communication networks for further processing
- Some devices also execute operations based on information received from the information and communication networks
- Devices communicate with other devices
  - Case a: communicate through the communication network via a gateway
  - Case b: communicate through the communication network without a gateway
  - Case c: communicate without using the communication network

Evolution of IoT Platform

Traditional Embedded System	*Ubicomp System*	*IoT System*
		M2M, IoTivity
UART, Ethernet	IEEE 802.15.4 LR-WPAN, ZigBee, 6LowPAN	Ad-hoc, BLE 4.X Mesh, ZigBee, XMPP, MQTT, CoAP
Wired Communication	Wireless Communication (ZigBee, RF)	Wireless Communication (WiFi, Bluetooth, ZigBee)
Sensors & Actuators	Sensors & Actuators	Sensors & Actuators
MCU / Firmware	MCU / Small OS	CPU / Operating System

Server/Client

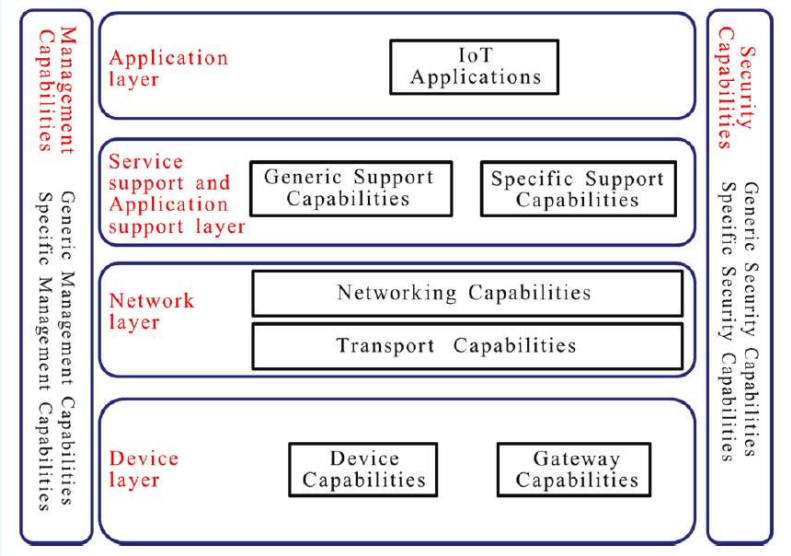
Cloud

BigData

Deep Learning

IoT Reference Model

- Application Layer: contains IoT applications
- Service support and application support layer:
  - Generic Support Capabilities: The generic support capabilities are common capabilities which can be used by different IoT applications, such as data processing or data storage
  - Specific Support Capabilities: The specific support capabilities are particular capabilities which cater for the requirements of diversified applications



[ITU-T Y.2060, June, 2012]

IoT Reference Model

- Network Layer:
  - Networking capabilities: provide relevant control functions of network connectivity, such as access and transport resource control functions, mobility management or authentication, authorization and accounting (AAA)
  - Transport capabilities: focus on providing connectivity for the transport of IoT service and application specific data information, as well as the transport of IoT-related control and management information

IoT Reference Model

- Device Layer:
  - Device Capabilities:
    - Direct interaction with the communication network
    - Indirect interaction with the communication network
    - Ad-hoc networking
    - Sleeping and Waking-up
  - Gateway Capabilities:
    - Multiple interfaces support
    - Protocol conversion

IoT Challenges

- IoT H/W Platforms
- IoT S/W Platforms (OS, Middleware)
- Connectivity
- Network, Protocols
- Interoperability
- Big Data, Cloud, Deep Learning
- Security

IoT Platform ARTIK

- ARTIK Module Types
- ARTIK Module Development Environment
- ARTIK Cloud Introduction

ARTIK Module Types

*ARTIK Modules - https://www.artik.io/modules/

ARTIK 020 Module

Size: 15.0 X 12.9

Bluebooth 4.2

ARTIK 030 Module

Size: 15.0 X 12.9

ZigBee/Thread

ARTIK 053 Module

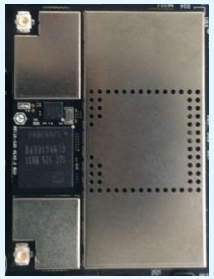
Size: 15.0 X 40.0

WiFi

IoT End Device

ARTIK 710 Module

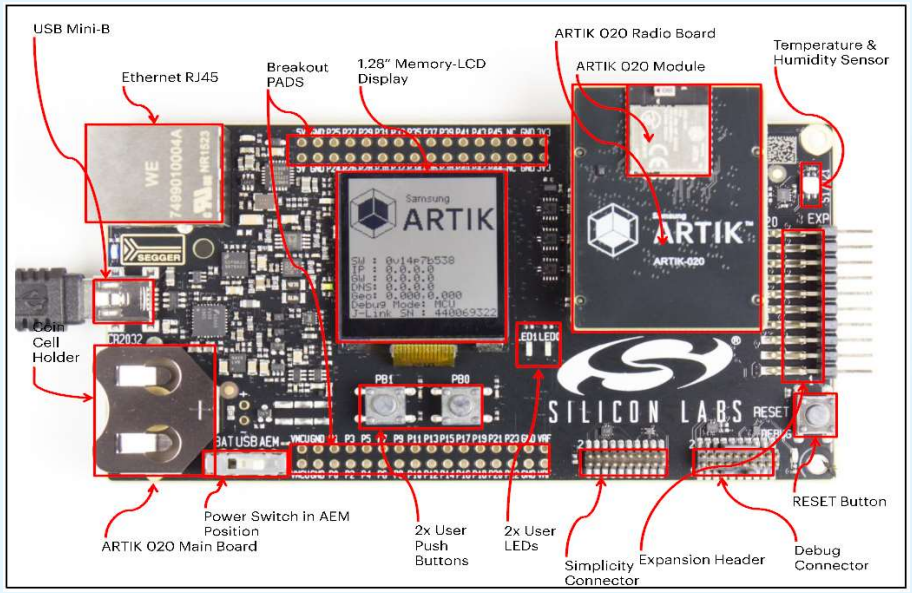
Size: 36.0 X 49.0

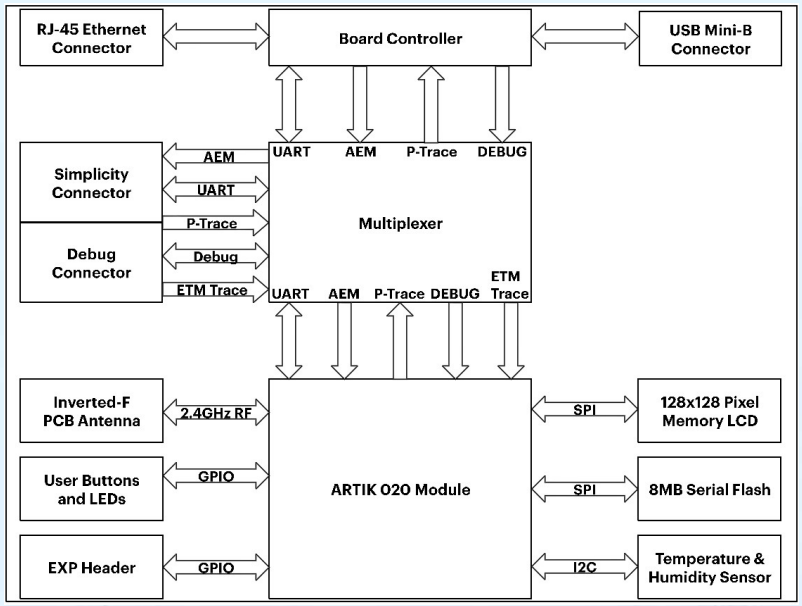


Ethernet/WiFi, Bluetooth, ZigBee/Thread

IoT Hub/Gateway Device

ARTIK Module Types (ARTIK 020)





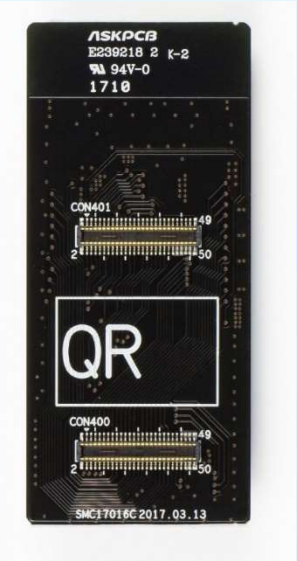
Key Features

- Bluetooth 4.2 Compliant
- Integrated antenna
- TX power: up to +8 dBm
- RX sensitivity: down to -92 dBm
- Range: up to 200 meters
- 32-bit ARM® Cortex®-M4 core at 40 MHz
- Flash memory: 256 kB
- RAM: 32 kB
- Autonomous Hardware Crypto Accelerator and Random Number Generator
- Integrated DC-DC Converter
- Onboard Bluetooth stack

ARTIK Module Types (ARTIK 053)

Evaluation Kit

Interposer Board

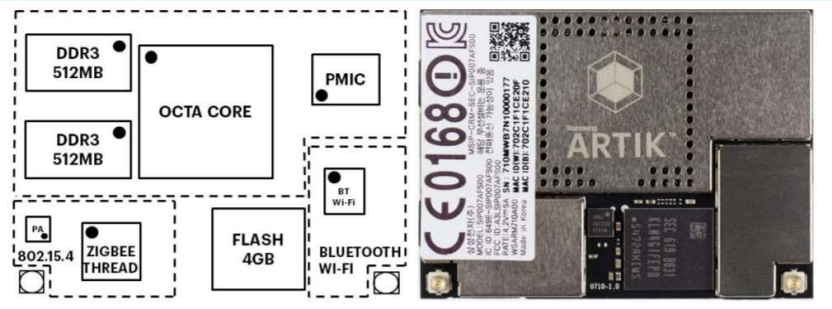


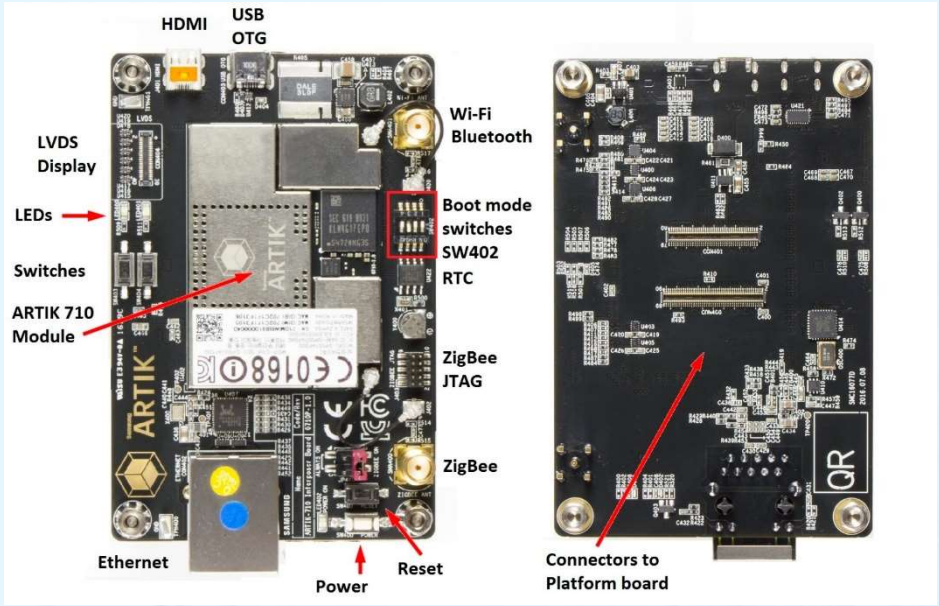
ARTIK 053 Module

Key Features

- CPU: 32bit ARM Cortex R4 (@320MHz), I-Cache/D-Cache 32KB
- RAM: 1280 KB (General Use), 128 KB (Global IPC data)
- Flash: 8 MB
- Secure System: AES/DES/TDES, SHA-1/SHA-2, PKA, PRNG/DTRNG, Secure key storage
- PUF: Physical Unclonable Function
- WiFi: Certified IEEE 802.11 b/g/n, 2.4 GHz radio
- Regulatory: FCC(U.S), IC(Canada), CE(EU), KC(Korea), SRRC(China)
- Power Supply: 5~12V
- I/O: UART, I2C, SPI, PWM, ADC, GPIO
- Dimension: 15mm(W) x 40mm(H) x 3mm (D)

ARTIK Module Types (ARTIK 710)





Key Features

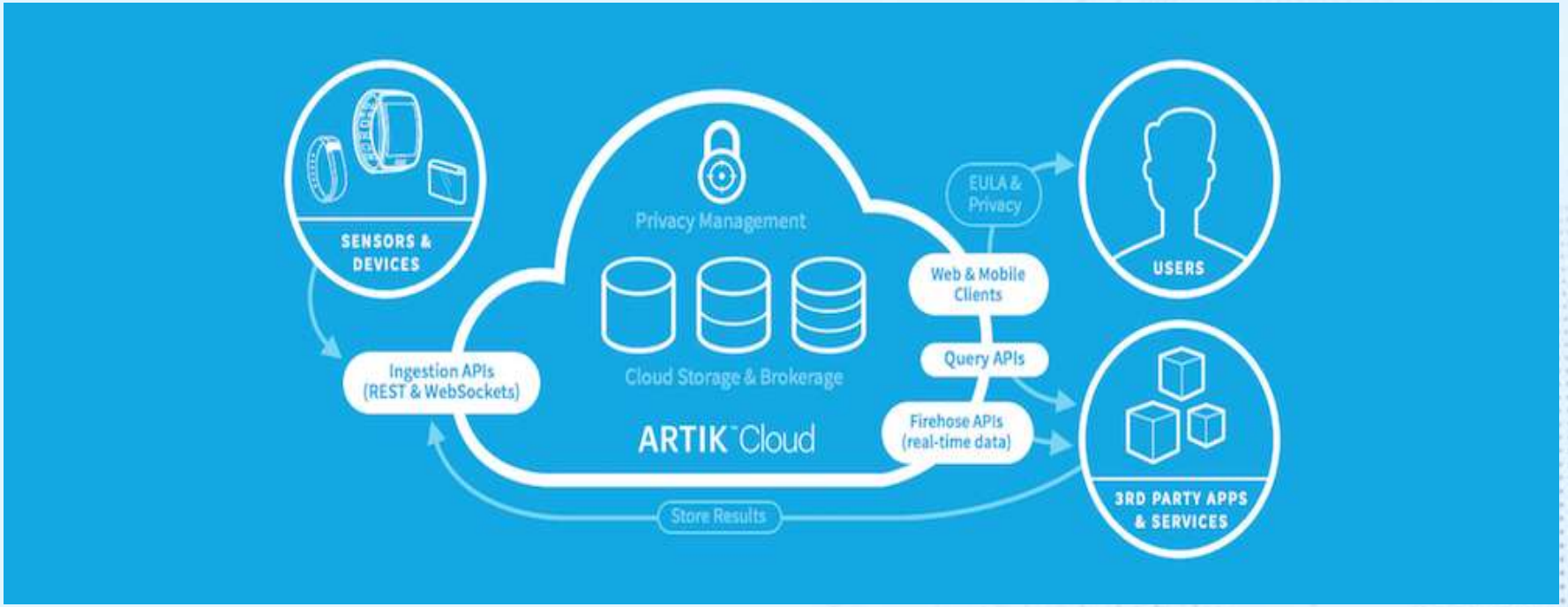
- High performance, 8-core, 64-bit Cortex® A-53 processor with Wi-Fi®, Bluetooth®, ZigBee®, Thread
- ARM MALI™ GPU for multimedia, graphics applications
- 1GB RAM, 4GB flash (eMMC)
- Enterprise-class security with hardware secure element and Secure OS
- Fedora Linux package with multimedia, connectivity, graphics, power management and security libraries

ARTIK Module Development Environment

- ARTIK SW IDEs
  - ARTIK 020/030
    - Silicon Labs Simplicity Studio (IAR Embedded Workbench)
  - ARTIK 053
    - ARTIK IDE (ARTIK SDK), Linux(Ubuntu)
  - ARTIK 710
    - Eclipse Che or Linux with ARTIK SDKs(C/C++/node.js)

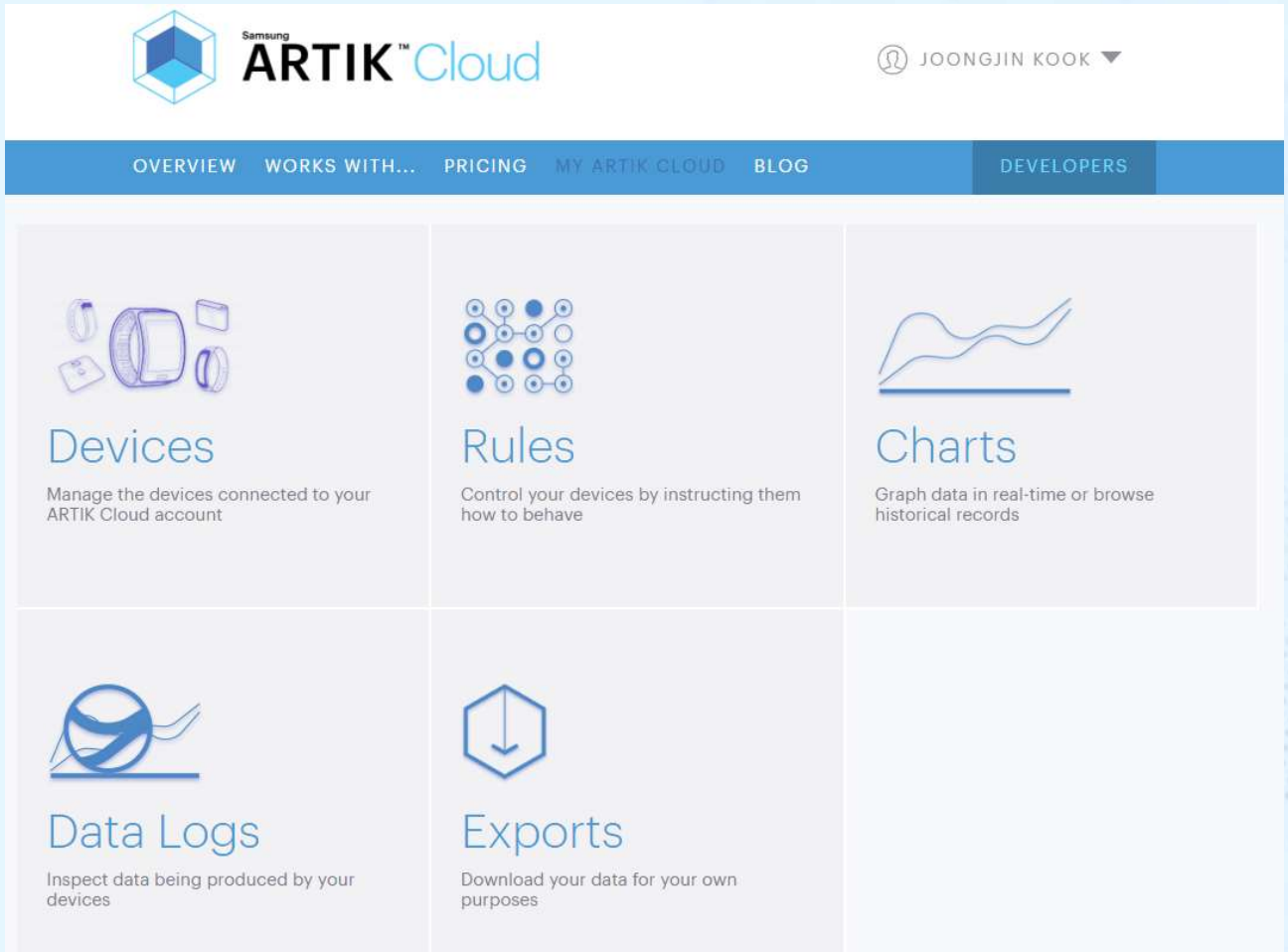
ARTIK Cloud Introduction

- ARTIK Cloud Platform
  - Data Exchange Platform
    - Enables any device or sensor to push its data to the cloud
    - Applications, services and devices can then use that data through simple APIs



ARTIK Cloud Introduction

- ARTIK Cloud Platform
  - Device Management, Logging/Monitoring, Interoperability(Rule base)



ARTIK Cloud Introduction

- ARTIK Cloud Platform
  - Device Management, Logging/Monitoring, Interoperability(Rule base)