Design a Cloud Connected IoT Gateway with Security Protection

Prathap Srinivasan
Software Systems Engineer

Olivier Monnier
Wireless Connectivity and IoT Solutions Marketing Director

What is the IoT ?

Things, people and cloud services getting connected via the Internet to enable new use cases and business models

How is IoT different than M2M?

- M2M is focused on connecting machines – mainly proprietary closed systems
- IoT is about harmonizing the way humans and machines connect using common public services

Cloud Services

IoT

Things

People

2
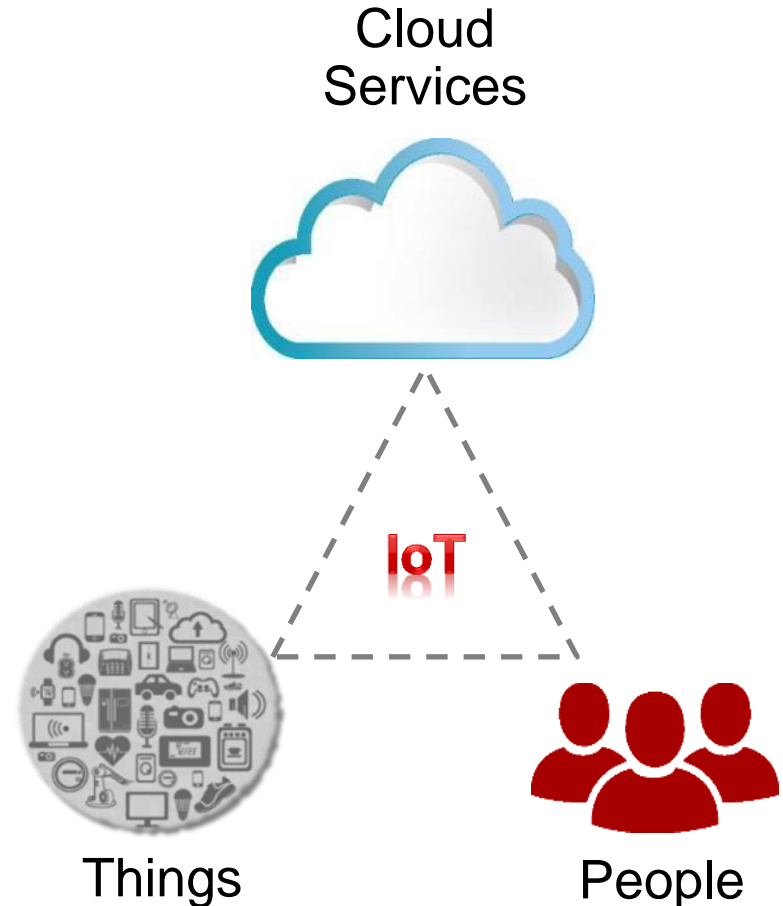
IoT is an enabling technology

Wearables
- Entertainment
- Fitness
- Smart watch
- Location and tracking

Building & Home Automation
- Access control
- Light and temp control
- Energy optimization
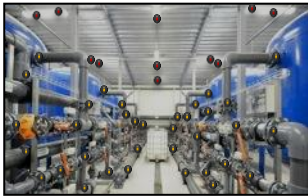- Predictive maintenance
- Connected appliances

Smart Cities
- Residential E-meters
- Smart street lights
- Pipeline leak detection
- Traffic control
- Surveillance cameras
- Centralized and integrated system control

Smart Manufacturing
- Flow optimization
- Real-time inventory
- Asset tracking
- Employee safety
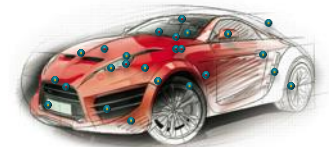- Predictive maintenance
- Firmware updates

Health Care
- Remote monitoring
- Ambulance telemetry
- Drugs tracking
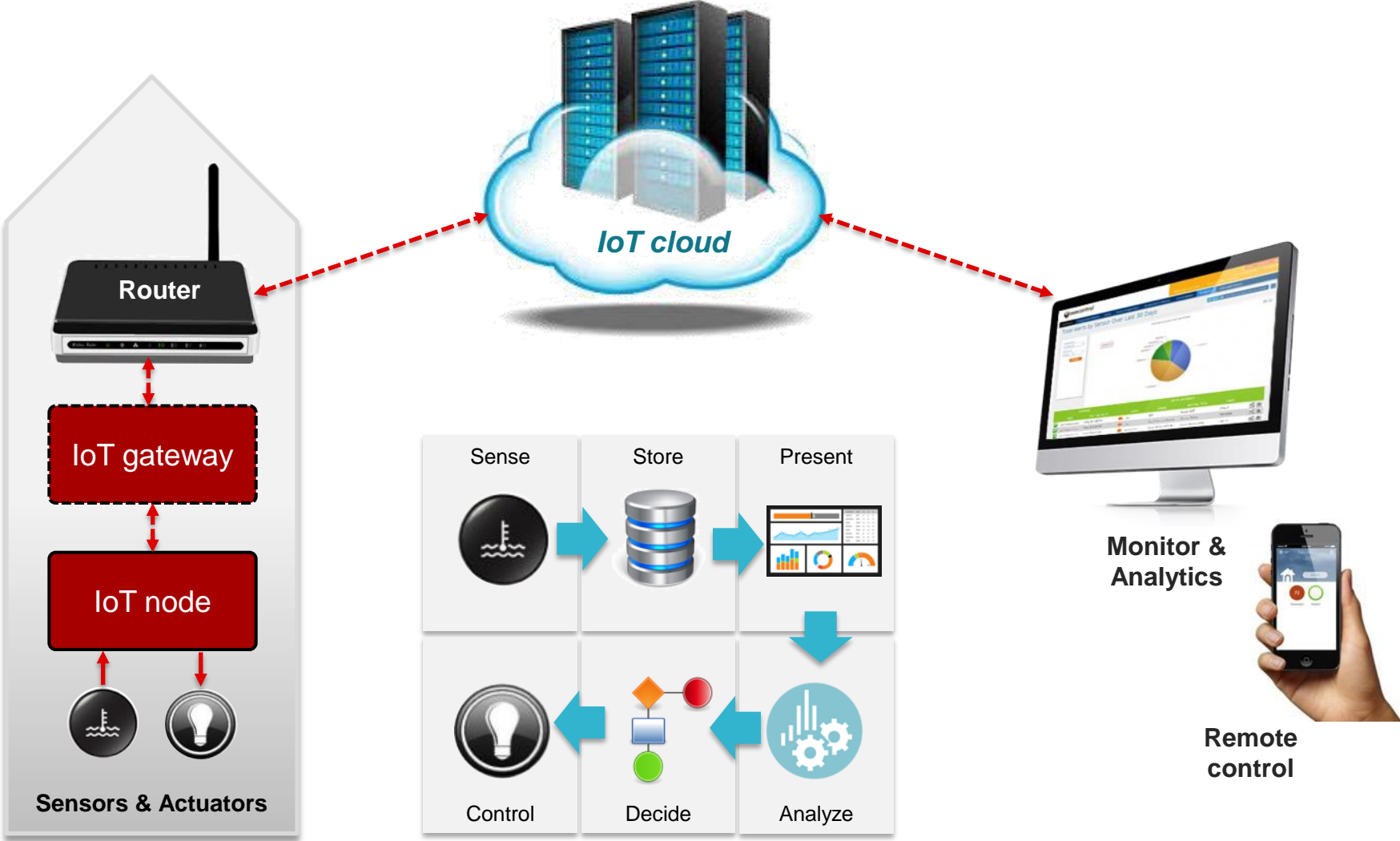- Hospital asset tracking
- Access control
- Predictive maintenance

Automotive
- Infotainment
- Wire replacement
- Telemetry
- Predictive maintenance
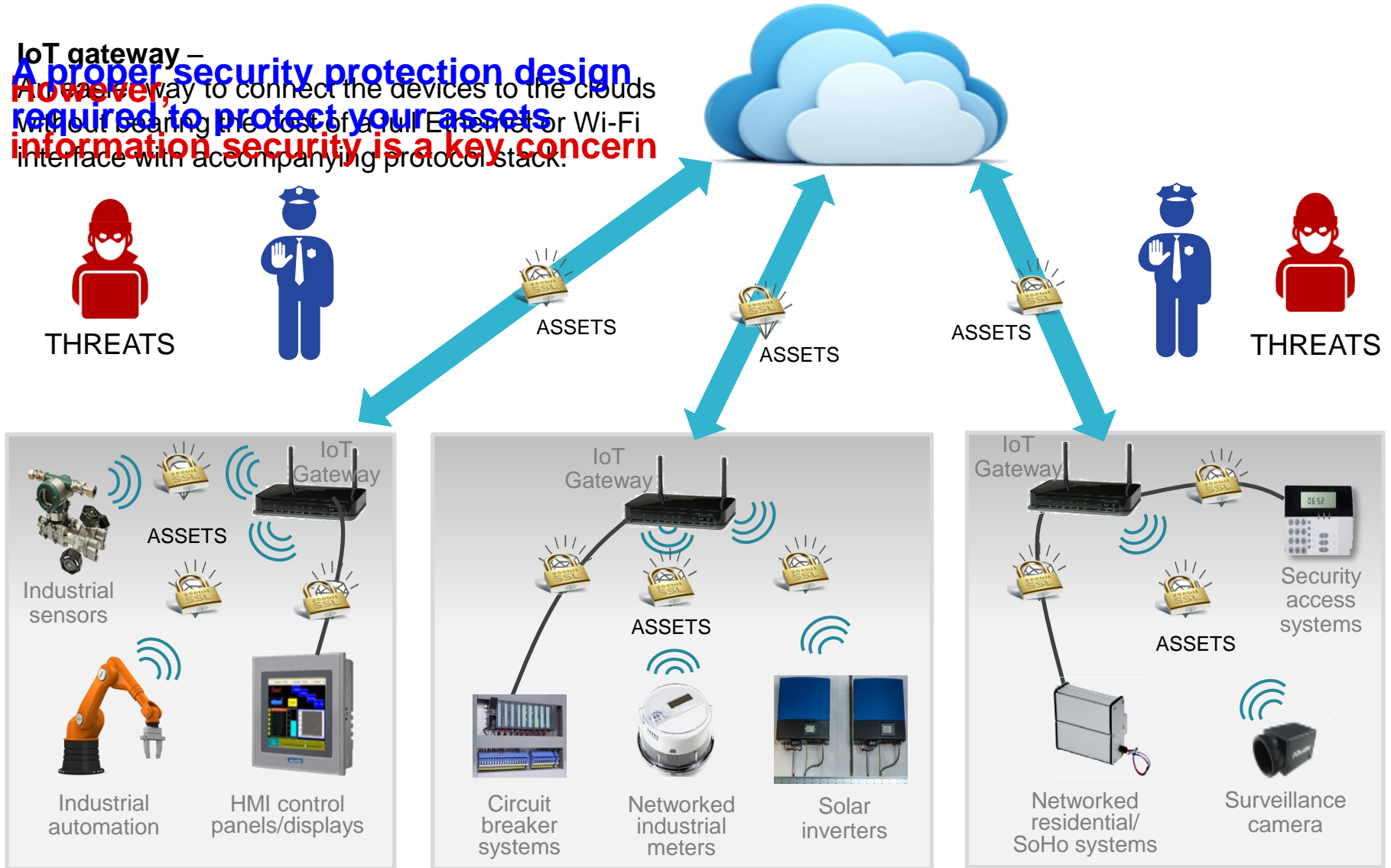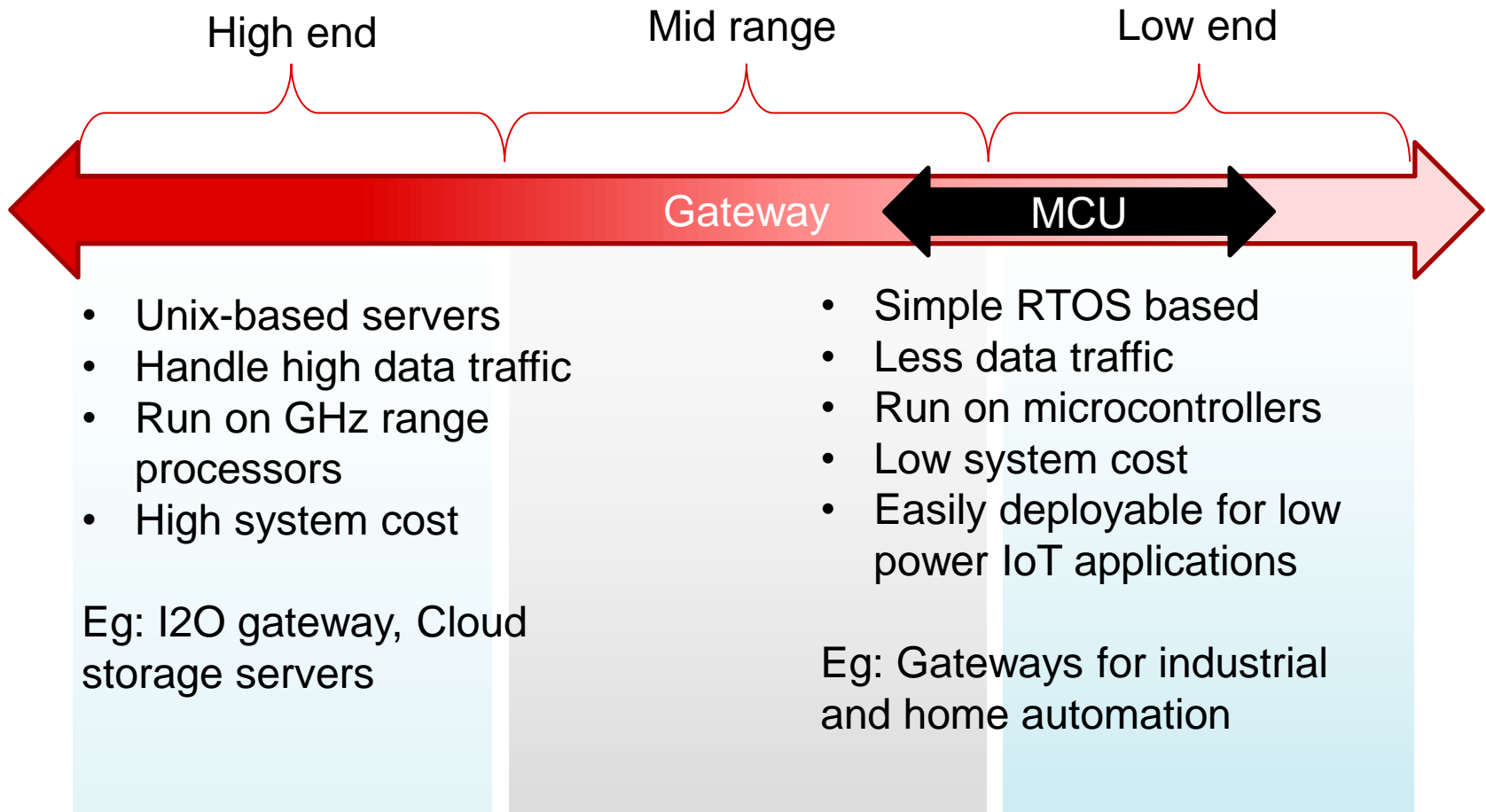- C2C and C2I

A typical IoT application

Router

IoT gateway

IoT node

Sensors & Actuators

IoT cloud

Sense   Store   Present

Control   Decide   Analyze

Monitor & Analytics

Remote control

TEXAS INSTRUMENTS

4

IoT Gateway

TEXAS INSTRUMENTS

IoT enables a new class of highly connected products

IoT gateway – the gateway to connect the devices to the clouds without bearing the cost of a full Ethernet or Wi-Fi interface with accompanying protocol stack.

A proper security protection design required to protect your assets

However, information security is a key concern

THREATS

ASSETS

ASSETS

ASSETS

ASSETS

THREATS

IoT Gateway

Industrial sensors

ASSETS

Industrial automation

HMI control panels/displays

IoT Gateway

ASSETS

Circuit breaker systems

Networked industrial meters

Solar inverters

IoT Gateway

ASSETS

Security access systems

Networked residential/ SoHo systems

Surveillance camera

TEXAS INSTRUMENTS

Gateway spectrum

High end   Mid range   Low end

Gateway   MCU

- Unix-based servers
- Handle high data traffic
- Run on GHz range processors
- High system cost

Eg: I2O gateway, Cloud storage servers

- Simple RTOS based
- Less data traffic
- Run on microcontrollers
- Low system cost
- Easily deployable for low power IoT applications

Eg: Gateways for industrial and home automation

TEXAS INSTRUMENTS

Gateway design challenges

- **Complexity**
- **Connectivity**
- **Security**

IoT solutions for everyone, not just experts

TI DELIVERS

Offering all the building blocks to simplify the design process

TI and our ecosystem

- High performance MCU with comprehensive peripheral set for connectivity, hardware cryptographic accelerator, memory
- Modules and reference designs eliminating need for RF expertise
- On-chip internet connectivity SW stack and comprehensive development environment
- Example designs and all the building blocks

Our customers get seamless set-up and ease-of-use

Make things cloud connected in minutes

TEXAS INSTRUMENTS

IoT Gateway Use Case

Personal Devices, Activity trackers

WiFi

Gateway

WiFi

Surveillance Camera

Bluetooth

Bluetooth

WiFi

Smart Plugs

Sub-1GHz

Sub-1GHz

Access control panel

Ethernet

Sub-1GHz Nodes

Smart meter

Storage server

TEXAS INSTRUMENTS
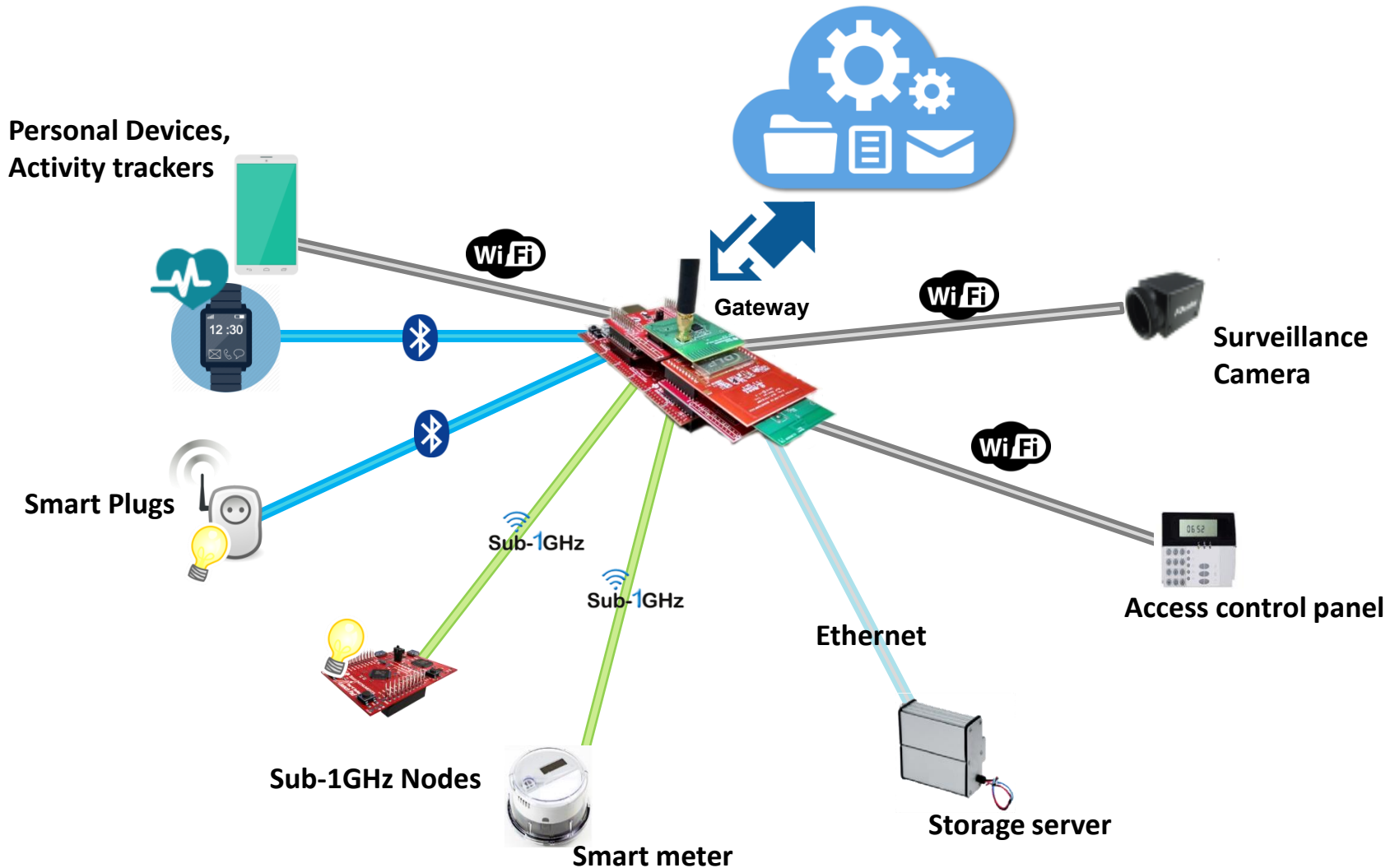
Embedded security framework

EXPOSURE POINTS

THREATS

MEASURES

TI SECURITY FEATURES

ASSETS
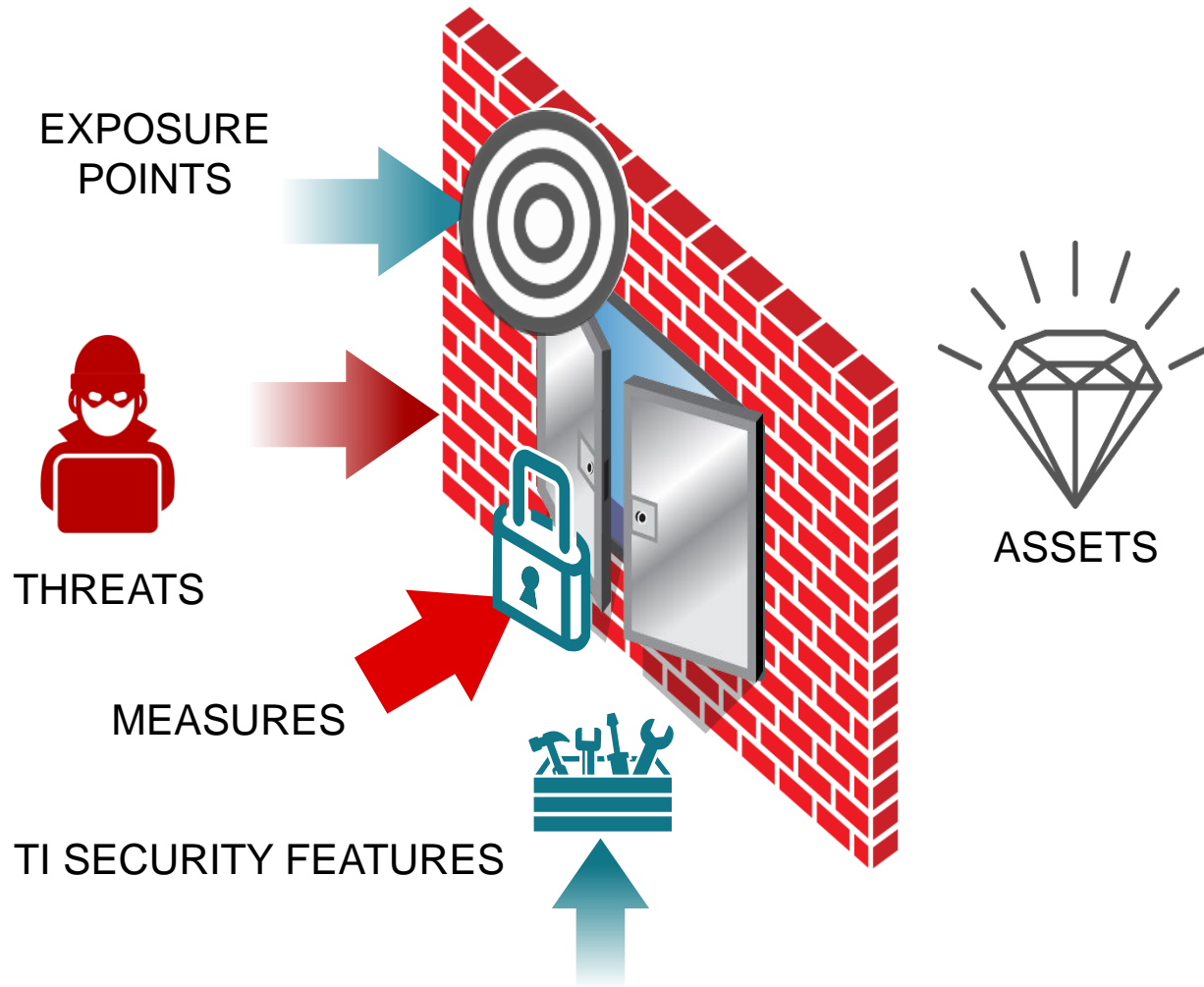
"TI is your security partner by delivering you a tool box of *security features* for you to implement your security measure"

Secure Cloud Connected IoT Gateway Reference Design

# TM4C IoT gateway design architecture
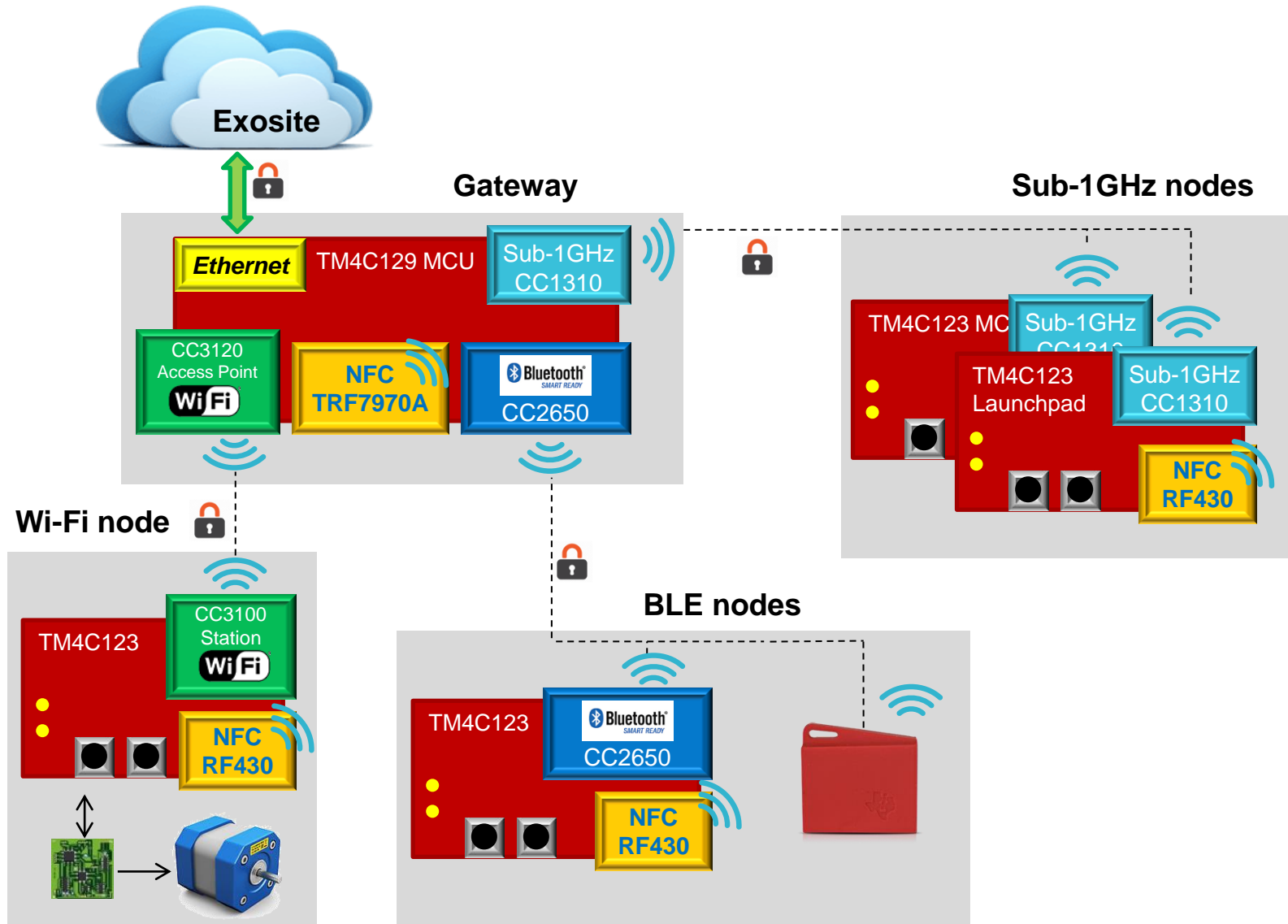
Why TM4C MCUs for IoT Gateway?
Ideal and widely used MCU for IoT Gateway

TM4C123x

- **80 MHz ARM Cortex-M4F CPU**
- **Up to 256KB Flash, 32KB SRAM, 2KB EEPROM**
- **High-performance analog integration**
- **Extensive timer offering to include options with add'l Motion Control / PWM timer module**
- **USB 2.0 Host/Device/OTG + PHY**
- **8 UART, 6 I²C, 4 SPI, & Dual CAN**
- *TivaWare* **loaded in internal ROM**

TM4C129x

- **120 MHz ARM Cortex-M4F CPU**
- **Up to 1MB Flash, 256KB SRAM, 6KB EEPROM**
- **Integrated 10/100 ENET MAC & PHY**
- **Integrated LCD controller**
- **Integrated HW security features**
- **High-performance analog integration**
- **USB Host/Device/OTG & Dual CAN**
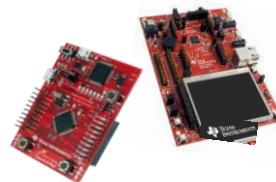- *TivaWare* **loaded in internal ROM**

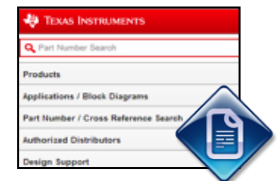| Vast Ecosystem of IDE & Tools	State of Art Software Libraries	Scalable Evaluation Platform & Kits	Supports & Training	Web Resources & Documentation

TI E2E™ Community

TEXAS INSTRUMENTS

13

TM4C IoT Gateway – Key Features

- Multiple wireless protocol support:
  Wi-Fi, BLE and Sub-1GHz

- Cloud connected stepper motor control through Wi-Fi

- Pushing sensor data and button press count from BLE and Sub1-GHz nodes to the Cloud

- Controlling LED toggles from remote application terminal

- Connectivity to different wireless modules through UART, SPI and I2C

- Developed using readily available LaunchPad™ development kits and BoosterPack™ Plug-in Modules

- Modular software architecture for easy customer reuse

- Low cost wireless node implementation using TM4C123 MCUs

- Easy credential exchange between Gateway and Nodes (Tap to connect)

TEXAS INSTRUMENTS

TM4C IoT Gateway – Key Features

Security features

- **Cloud security**
  - Exosite based secure cloud connectivity and control using SSL
  - Exosite secure login to access data ports and control
- **Access and pairing**
  - Secure OOB pairing using NFC
  - Unique client identification key based data exchange to Exosite
- **Data security between Gateway and Nodes**
  - **Wi-Fi** → WPA2
  - **BLE** → Paired communication (AES-CCM).
  - **Sub 1GHz** → AES-CCM using hardware crypto accelerators
- **Key storage in EEPROM**
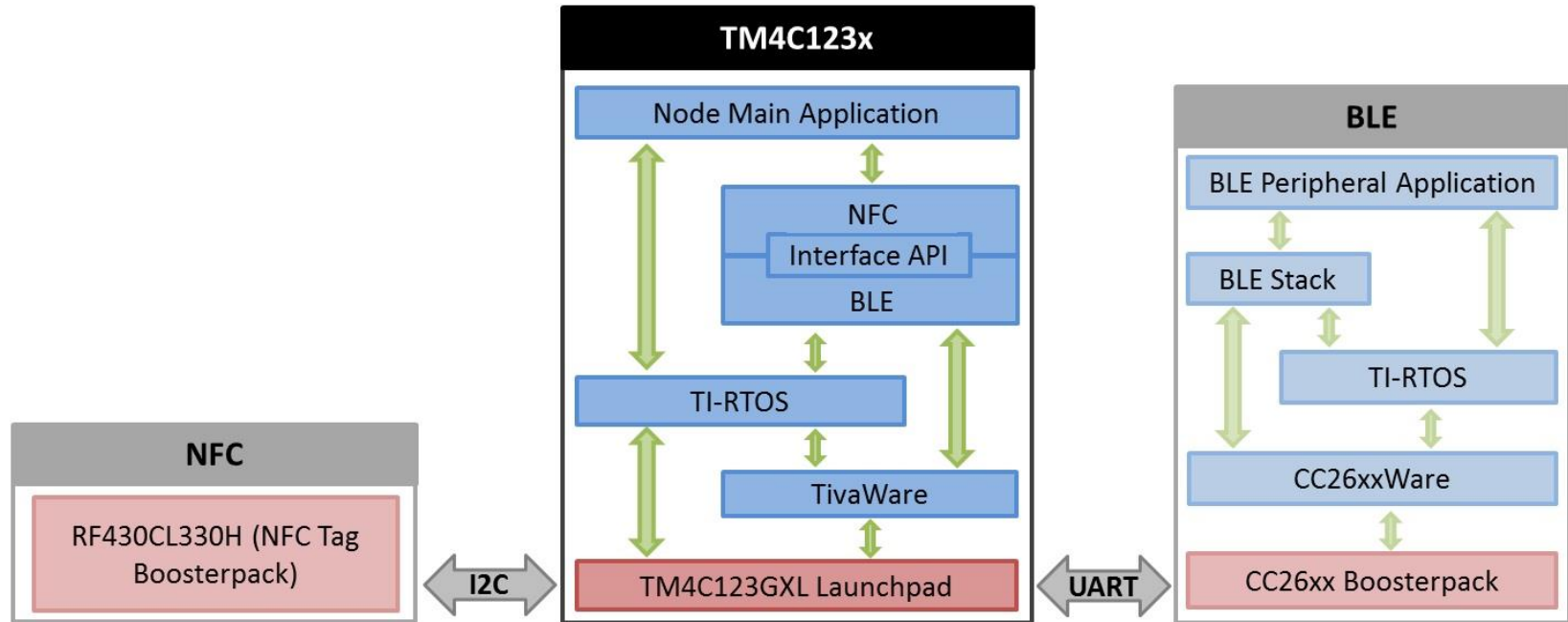- **MPU for memory protection**
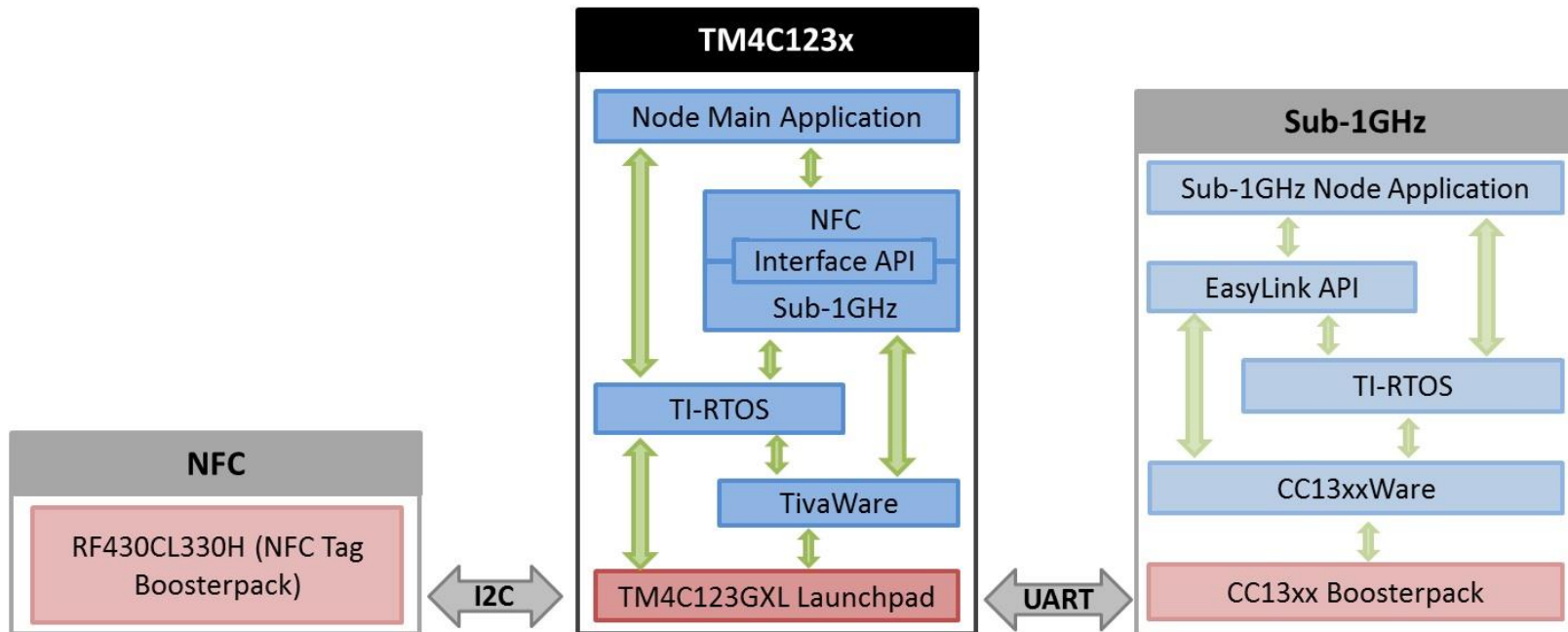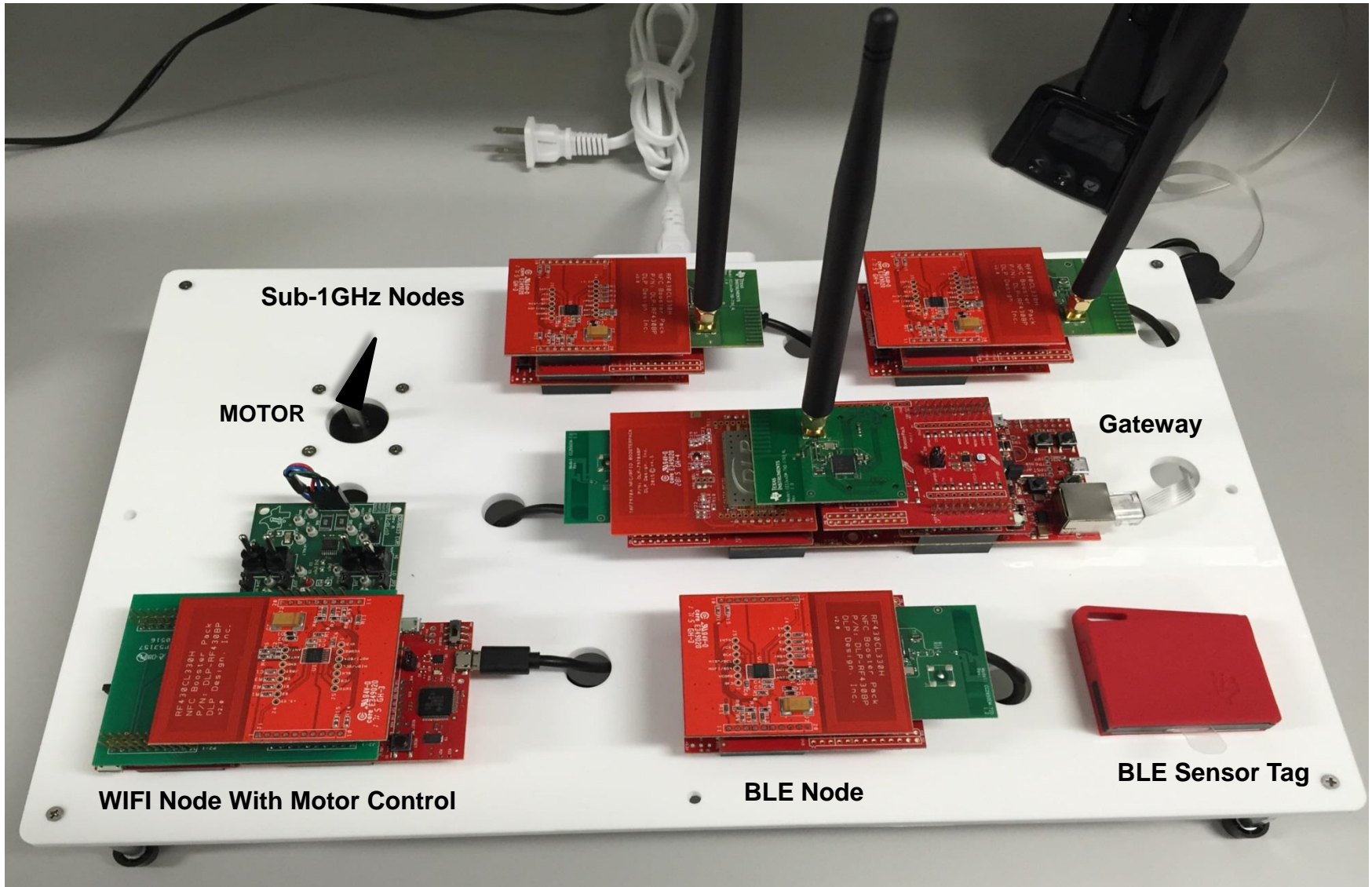
Gateway – Software Blocks
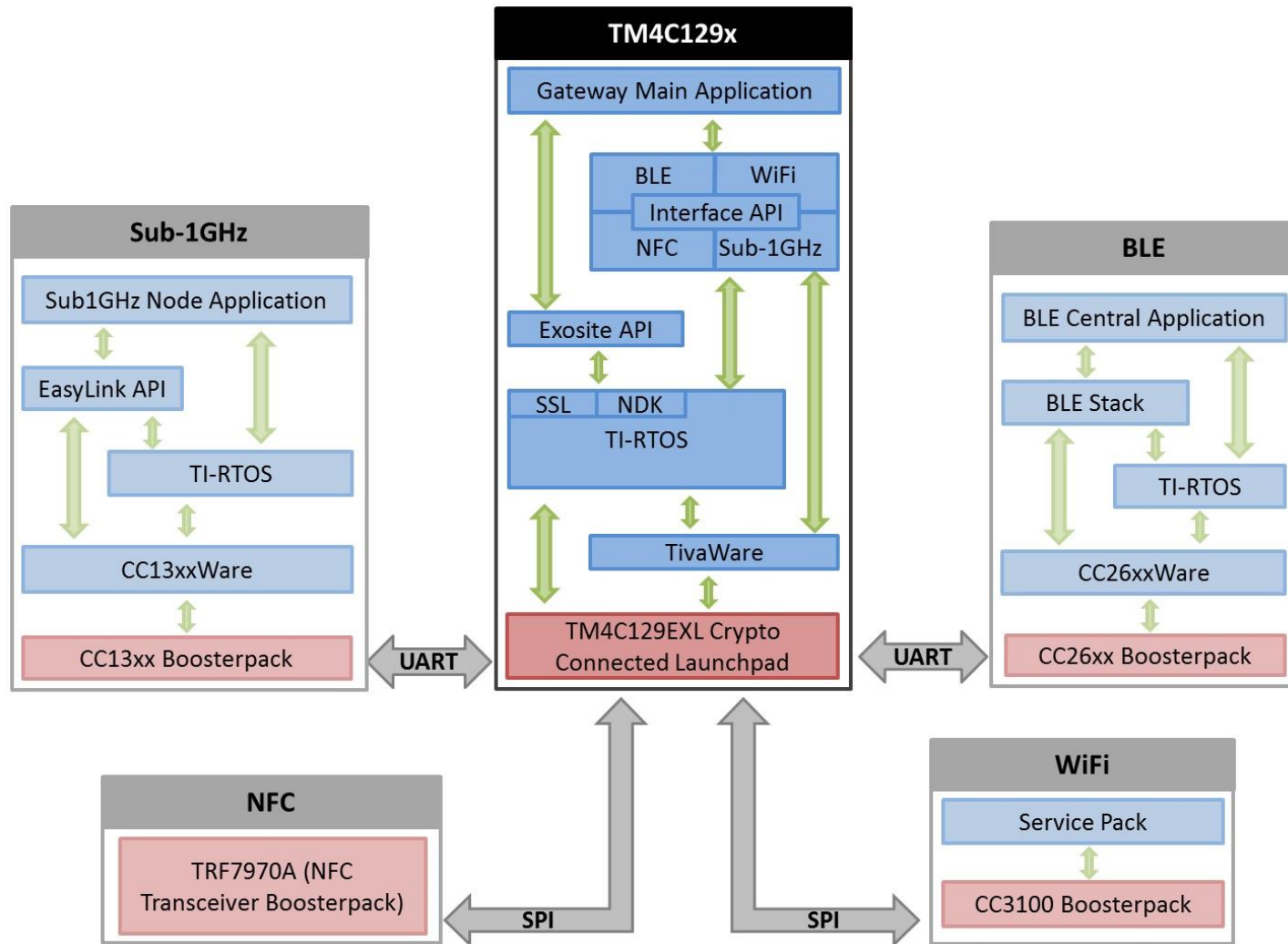
Wi-Fi Node – Software Blocks
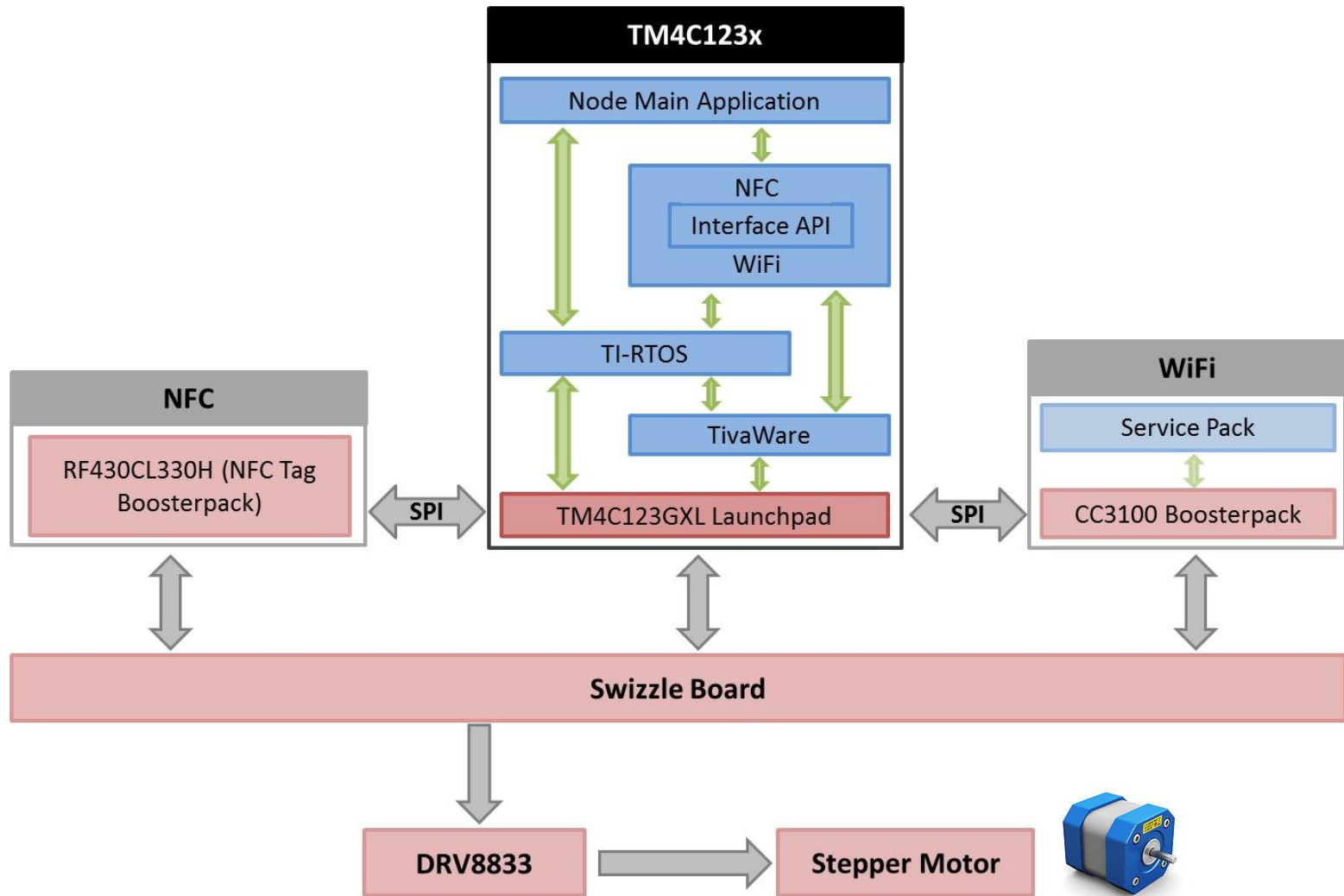
BLE Node – Software Blocks

Sub-1GHz Node – Software Blocks

TM4C IoT Gateway – Demo Setup

Sub-1GHz Nodes

MOTOR

Gateway

WIFI Node With Motor Control

BLE Node

BLE Sensor Tag

TEXAS INSTRUMENTS

Exosite Demo Snapshot – IoT Gateway

TI Wireless Connectivity Portfolio

Largest wireless selection

Support for all key technologies and standards for industrial, automotive and consumer

A solution for any application.
Future proof.
Leverage your investment

Lowest power consumption

Use a coin cell or for multi-year, always-on operation or go battery-less with energy harvesting

Ultra-low power by design

Easiest to design with

Quickest learning-curve and development time with full broad market ecosystem

Software, tools, E2E, certified TI modules, TI Designs, SensorTag, online trainings, Cloud

Connect More with TI

TEXAS INSTRUMENTS

Wireless Connectivity Portfolio

Proximity	Personal area networks		Local area networks			Neighborhood area networks
NFC RFID	***Bluetooth*®** ***Bluetooth* LE**	**Proprietary 2.4GHz**	**ZigBee & RF4CE**	**Wi-Fi®**	**6LoWPAN**	**Sub-1GHz** (standards or proprietary)
Identification	*Personal Connection*	*Customizable*	*Mesh/ P2P*	*Existing Infrastructure*	*IP Mesh*	*Customizable*

Key Differences

Data Up to 848 Kbps	Data or Voice Up to 3 Mbps	Data Up to 1 Mbps	Data Up to 256 Kbps	Voice or video Up to 100 Mbps	Data Up to 256 Kbps	Data Up to 1 Mbps
No battery to coin cell	Coin cell to AAA	Coin cell	Energy harvesting to AAA	AA battery	Energy harvesting to AAA	Coin cell

Key Attributes

• Passive operation & data storage • Dedicated multi-tag read zone • In Portable devices	• Interoperable with other Bluetooth devices • Large install base • In mobile devices	• Customizable to application • Robust RF	• Standards based • Self-healing mesh • Low power • Large area coverage • Remote control	• Existing infrastructure • High throughput	• IPv6 stack • Ultra low power • IoT platform	• Longest range • Customizable to application • Robust RF

Range — cm → Up to 100m → km

Go Battery Less

The First Multi-standard
Wireless MCU Platform for the IoT

- **Code and pin compatibility**

- **Common architecture**

- **Maximum design reuse with software change**

CC26xx/CC13xx
One architecture, several technologies

Application MCU
- Application
- Profiles / services
- TI RTOS
- Peripheral drivers and libraries
- Royalty free protocol stacks

Peripherals / modules
- DC/DC converter
- Temp/battery monitor
- AES
- GPIO
- Timers
- UART / SPI
- I2C / I2S
- DMA

ARM® Cortex®-M3

Radio

SCE

Memory

Peripherals / modules

QFN package options:
4x4mm (10 IOs), 5x5mm (15 IOs), 7x7mm (31 IOs)

Radio
- Flexible, SW defined radio
- Multi-protocoll support
- LinkLayer in ROM

Sensor controller engine
- ADC and comparators
- Digital sensor readings
- Capacitive sensing

Memory
- Flash
- cache
- SRAM

Sub-1GHz   RF4CE   Bluetooth® SMART   ZigBee   6LoWPAN   M-Bus wireless   SIGFOX One network A billion dreams   802.15.4g

Easy-to-use: Software, support and more

Software

Common software
Across all SimpleLink ULP products:
- TI-RTOS operating system
- Code Composer Studio™ integrated development environment
- IAR Embedded Workbench for ARM

Royalty-free network stacks
Robust, certified and proven stacks:
- BLE-Stack with OTA support
- Z-Stack supporting various ZigBee applications

Support

Comprehensive
Development documentation, guides and wikis available online

Design support
Online community – answers at your fingertips from engineers

Training
Online videos and other resources to learn more about the parts and tools

And more...

TIDesigns
TI reference designs online

TI IoT cloud ecosystem

TI store 24/7
Silicon & kit sales & samples on TI Store

TEXAS INSTRUMENTS

TIDesigns for IoT (www.ti.com/tidesign)

Solution	TI Devices	
BLE to Wi-Fi IoT gateway	CC3200 CC2650	
Wi-Fi Enabled NFC Card Reader	CC3200 TRF7964A TRF7970A	
Bluetooth Low Energy (Bluetooth Smart) to RS-485 Gateway	CC2540T SN65HVD485E	
Humidity & Temp Sensor Node for Sub-1GHz Star Networks Enabling 10+ Year Coin Cell Battery Life	CC1310 HDC1000	

TEXAS INSTRUMENTS

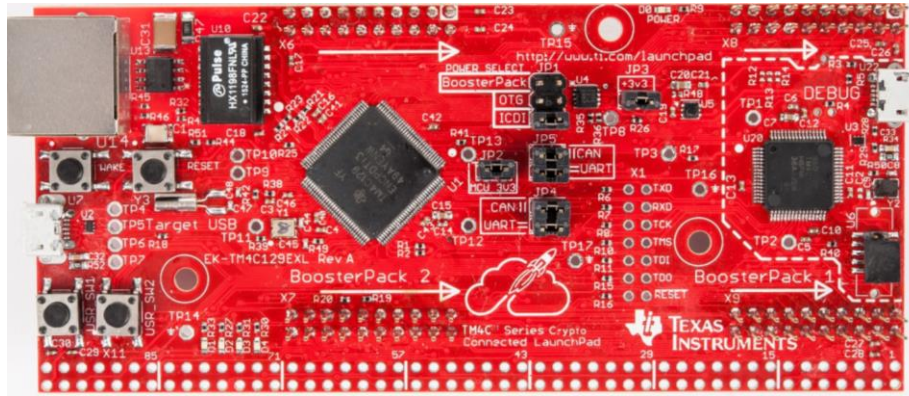# TI SimpleLink Wireless connectivity portfolio
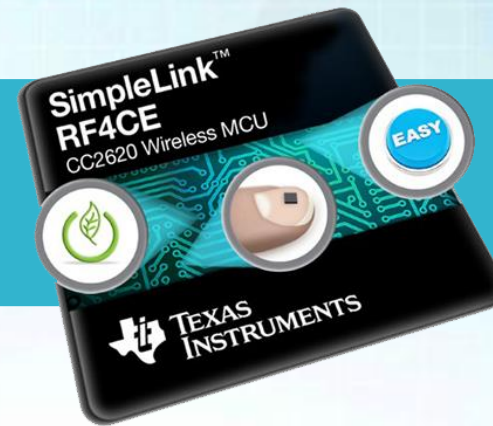
www.ti.com/simplelink

Easily develop Secure IoT applications with TM4C Crypto Connected LaunchPad

TM4C Crypto Connected LaunchPad

$24.⁹⁹

EK-TM4C129EXL

www.ti.com/launchpad

More than 60 BoosterPacks in the LaunchPad ecosystem!

- Downloadable code examples and hardware design files available.

- Open source projects

- Online support at www.e2e.ti.com

- Free downloadable unrestricted Code Composer Studio IDE

- Comprehensive quick start and user guides

- Secured cloud connection out-of-box demonstration with TI RTOS, WolfSSL and Exosite

Additional information

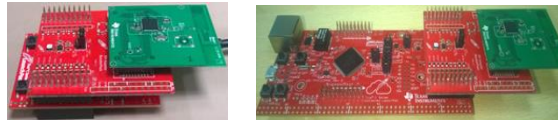| Jump start your IoT development with	**TIDesigns**
How to build a WI-Fi Node by integrating the TM4C1294 MCU and the CC3100 network processor. (Board bundle discount available at TI eStore)	
Configuring Wi-Fi network connection parameters using NFC technology (Board bundle discount available at TI eStore)	
BLE enabled IoT Node (TM4C129, CC2650) (Board bundle discount available at TI eStore)	
Sub-1GHz enabled IoT Node (TM4C129, TM4C123, CC1310)	
Portable ZigBee Plug-In SW Framework for any OS (TM4C129, CC2538)	

www.ti.com/iot

www.ti.com/tm4c

Training Series:
www.ti.com/iot-cloud-training

TI E2E™ Community

Community Forum:
www.ti.com/tm4c-e2e

TEXAS INSTRUMENTS