Design a Cloud Connected IoT Gateway with Security Protection

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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
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
IoT Gateway
IoT enables a new class of highly connected products

A proper security protection design required to protect your assets, information security is a key concern.

However, information security is a key concern.

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

High end

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

Eg: I2O gateway, Cloud storage servers

Mid range

Low end

- 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

Gateway

MCU
Gateway design challenges

**CHALLENGE**
- Complexity
- Connectivity
- Security

**WHAT IS NEEDED**
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
“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

Exosite

Gateway

Ethernet

Sub-1GHz nodes

TM4C123 MCU

Sub-1GHz
CC1310

CC3120
Access Point

NFC
TRF7970A

CC2650

Wi-Fi

BLE nodes

TM4C123

Sub-1GHz
CC1310

NFC
RF430

Sub-1GHz
nodes

CC3100
Station

WiFi

BLE nodes

TM4C123

CC2650

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Wi-Fi node

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NFC
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Wi-Fi node
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 I^2^C, 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

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

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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)
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 $\rightarrow$ WPA2
  - BLE $\rightarrow$ Paired communication (AES-CCM).
  - Sub 1GHz $\rightarrow$ 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

- NFC
  - RF430CL330H (NFC Tag Boosterpack)
  - I2C

- TM4C123x
  - Node Main Application
  - NFC Interface API
  - BLE
  - TI-RTOS
  - TivaWare
  - TM4C123GXL Launchpad

- BLE
  - BLE Peripheral Application
  - BLE Stack
  - TI-RTOS
  - CC26xxWare
  - CC26xx Boosterpack

- UART
Sub-1GHz Node – Software Blocks

NFC
RF430CL330H (NFC Tag Boosterpack)

TM4C123x
Node Main Application
NFC Interface API
Sub-1GHz
TI-RTOS
TivaWare
TM4C123GXL Launchpad

Sub-1GHz
Sub-1GHz Node Application
EasyLink API
TI-RTOS
CC13xxWare
CC13xx Boosterpack

I2C
UART

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TM4C IoT Gateway – Demo Setup
Exosite Demo Snapshot – IoT Gateway

TM4C Based Secure Cloud Connected IoT Gateway

- WiFi
- Bluetooth
- SSL

Status: ONLINE
- On Time: 12 m 29 s

It is advised to reset the dataports and GUI panel here once before proceeding with another session of the application.
- RESET DATAPORTS & GUI

LED Toggle
- Button 1 Presses: 3
- Button 2 Presses: 3

Stepper Motor Control
- Full Step
- Half Step
- Micro Step: 100

- Anti-Clockwise
- Clockwise

Rotation Speed: 30
- Select from [0 - 100%]

- Stop
- Start

- Rotate Fixed Steps
- Rotate Fixed Steps and Reverse

Rotation Steps: 100
- Select from [1 - 999]

LED Blink Speed: 78%

- Average temp: 44°C
- Button 1 presses: 0
- Button 2 presses: 0

Luxometer: 1

- Ambient Temperature: 30°C

- IR Temperature: 24°C

- Barometer: 909

- Average temp: 47°C
- Button 1 presses: 0
- Button 2 presses: 0

- Average temp: 45°C
- Button 1 presses: 0
- Button 2 presses: 0

Texas Instruments
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

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Connect More with TI

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## Wireless Connectivity Portfolio

<table>
<thead>
<tr>
<th>Proximity</th>
<th>Personal area networks</th>
<th>Local area networks</th>
<th>Neighborhood area networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFC RFID</td>
<td>Bluetooth* Bluetooth LE</td>
<td>Proprietary 2.4GHz</td>
<td>6LoWPAN</td>
</tr>
<tr>
<td>Identification</td>
<td>Personal Connection</td>
<td>Customizable</td>
<td>Mesh/ P2P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Key Differences

<table>
<thead>
<tr>
<th>Data or Voice</th>
<th>Data</th>
<th>Data</th>
<th>Data or video</th>
<th>Data</th>
<th>Data</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 848 Kbps</td>
<td>Up to 3 Mbps</td>
<td>Up to 1 Mbps</td>
<td>Up to 256 Kbps</td>
<td>Up to 100 Mbps</td>
<td>Up to 256 Kbps</td>
<td>Up to 1 Mbps</td>
</tr>
<tr>
<td>No battery to coin cell</td>
<td>Coin cell to AAA</td>
<td>Coin cell</td>
<td>Energy harvesting to AAA</td>
<td>AA battery</td>
<td>Energy harvesting to AAA</td>
<td>Coin cell</td>
</tr>
</tbody>
</table>

### Key Attributes

- Passive operation & data storage
- 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

<table>
<thead>
<tr>
<th>cm</th>
<th>Up to 100m</th>
<th>km</th>
</tr>
</thead>
</table>

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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

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

ARM® Cortex®-M3

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

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

Memory
- Flash
- cache
- SRAM

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...

TI Designs
TI reference designs online

TI IoT cloud ecosystem

TI store 24/7
Silicon & kit sales & samples on TI Store
## 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, SN65HVD48 5E
Humidity & Temp Sensor Node for Sub-1GHz Star Networks Enabling 10+ Year Coin Cell Battery Life | CC1310, HDC1000
TI SimpleLink Wireless connectivity portfolio

www.ti.com/simplelink
Easily develop Secure IoT applications with TM4C Crypto Connected LaunchPad

- Downloadable code examples and hardware design files available.
- Open source projects
- Online support at [www.e2e.ti.com](http://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

$24.99

EK-TM4C129EXL
[www.ti.com/launchpad](http://www.ti.com/launchpad)

More than 60 BoosterPacks in the LaunchPad ecosystem!
Additional information

Jump start your IoT development with the TM4C1294 MCU and the CC3100 network processor.

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

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