TI Designs: TIDC-01002 低于 1GHz 嵌入式传感器到云工业物联网 (IoT) 网关参考设计

TEXAS INSTRUMENTS

说明

TIDC-01002 设计展示了如何通过低于 1GHz 的远距离 无线网络将传感器连接到云,适合工业环境,例如楼宇 控制和资产跟踪。此 TI 设计搭载了 TI SimpleLink™CC3220 处理器和 SimpleLink 超低功耗 (ULP) 低于 1GHz CC13x0 和 CC13x2 器件。此参考设 计预集成了 SimpleLink CC13xx 软件开发套件 (SDK) 和 SimpleLink CC3220 SDK (两者均为 TI SimpleLink MCU 平台的组成部分)组成部分中的 TI 15.4-Stack 软 件,从而在 TI 低功耗有线和无线 MCU 中实现了一致的 软件体验。

咨询我们的 E2E 专家

资源

TIDC-01002	设计文件夹
TIDC-01002	示例库页面
CC1352	产品文件夹
CC1310	产品文件夹
CC1350	产品文件夹
CC3220	产品文件夹

TI E2E[™] Community

特性

- 大型网络到云连接可实现远距离应用,支持长达 1km 的视线
- 使用 TI 15.4-Stack,有助于设计人员实现符合 IEEE 802.15.4e/g 规范的系统
- 基于经 TI 测试的硬件设计,具有开箱即用的现成演 示软件,可缩短上市时间
- 基于可移植操作系统接口 (POSIX) 进行实施,可在
 TI 互联网连接的微控制器 (MCU) 之间实现轻松移植
- 支持星形网络
- ULP 传感器节点

应用

- 楼宇安全网关
- 门窗传感器网络
- HVAC 网关
- 资产管理和跟踪



岙

该 TI 参考设计末尾的重要声明表述了授权使用、知识产权问题和其他重要的免责声明和信息。



1 System Description

The TIDC-01002 provides a reference for creating an industrial, Internet of things (IoT) gateway that is capable of connecting a network of wireless sensors to an enterprise cloud provider. In this reference design, a long-range, low-power wireless network, made up of Sub-1 GHz CC13x0 or CC13x2 devices (both are supported) that run the TI 15.4-Stack-based application, can be connected to multiple *cloud service* providers, such as IBM Watson IoT®, AWS IoT, and so on. An online dashboard is provided, which allows users visualize the real-time sensor data as well as send actuation commands from anywhere in the world using an Internet-connected device with a web browser.

This reference design provides a list of suggested hardware, schematics, and foundational software to quickly begin IoT product development. The design also provides the ability to visualize the data inside a local network without connecting to a *cloud service*. The software design is created to be flexible, to enable other *cloud service* providers of choice.

This reference design enables IoT in numerous applications, such as building security gateways, door and window sensor networks, asset management and tracking, and other IoT-enabled home and industrial automation applications.

The connection between the wireless sensor network and the cloud is made possible by the TI SimpleLink CC3220 device on the CC3220SF LaunchPad[™] development platform. On one side, the CC3220 is connected to a Sub-1 GHz device acting as the central node in the wireless network, and on the other side, the device is connected to a cloud service such as IBM Watson IoT or AWS IoT using Wi-Fi®. These two connections allow the CC3220 device to act as a gateway to get the sensor messages from the Sub-1 GHz wireless network to the cloud and to get the actuation requests from the cloud dashboard sent back to the Sub-1 GHz wireless network.

Due to the long-range and low-power capabilities of the Sub-1 GHz sensors, this reference design may be useful for any application that would benefit from distributed sensing. This reference design provides an example that gives the ability to visualize or actuate tens or hundreds of sensors while only needing one gateway device, the SimpleLink CC3220, to be connected to the Internet.



2 System Overview

System Overview

2.1 Block Diagram



图 1. Block Diagram of IoT Gateway Reference Design



2.1.1 Software Block Diagram



图 2. Software Block Diagram of TI 15.4-Stack Sensor-to-Cloud Reference Design

The following is a high-level description of each module in the software block diagram:

- User interface application: This application presents the network information and device information and provides ability to control network behavior to the end user.
- IoT cloud application: This application runs on the cloud server, which communicates with the IoT gateway application. The interface of the *cloud service* task with the cloud server is described in ^{††} 2.3.1.
- IoT gateway application: This application runs on the SimpleLink CC3220. The application interfaces on one side with the *cloud service* task to enable cloud connectivity and on the other side to the *collector* task to interface with the TI 15.4-Stack based network. The interface between the IoT gateway and the *cloud service* is described in 节 2.3.1.
 - Cloud service task: This task provides the cloud service provider specific functionality. Users can
 take the current interface, which is designed as an extensible framework, and quickly modify the
 interface to add their own functionality for their end product development.
 - Gateway: This application component interfaces with the *collector* task through a POSIX message queue interface to enable connection with the TI-15.4 Stack network.
- *TI 15.4-Stack collector* task: This task implements the functionality that starts the network, allows new devices to join the network, configures the joining devices on how often to report the sensor data, configures how often to poll for buffered messages in case of non-beacon and frequency-hopping mode of network operation for sleepy network devices, and tracks connected devices to determine if they are active or inactive on the network. This determination is achieved by the collector periodically sending tracking request messages and awaiting corresponding tracking response messages. The *collector* task also implements components that talk to the *gateway* module. The communication is

implemented through POSIX-based message queues.

- *MAC CoP* application: The MAC coprocessor application runs on the CC13x0 or CC13x2 LaunchPad, which provides a UART-based interface from TI 15.4-Stack to the IoT gateway application.
- CC13x0 or CC13x2 LaunchPad Sensor End Node: The sensor example application from TI 15.4-Stack and runs on the CC13x0 or CC13x2 LaunchPad.

2.2 Highlighted Products

This section highlights key hardware devices and software components used in the reference design.

2.2.1 SimpleLink[™] CC13x0 and CC13x2

The CC13xx is a member of the SimpleLink family of cost-effective, ULP, 2.4-GHz and Sub-1 GHz RF devices. In addition to flexible low-power modes, very-low active RF and MCU current consumption provide excellent battery lifetime and allow long-range operation on small, coin-cell batteries and in energy-harvesting applications.

The CC13x2R devices combine a flexible, very low-power RF transceiver with a powerful 48-MHz Arm® Cortex®-M4F CPU in a platform supporting multiple physical layers and RF standards. A dedicated Radio Controller (Arm® Cortex®-M0) handles low-level RF protocol commands that are stored in ROM or RAM, thus ensuring ultra-low power and great flexibility. The low power consumption of the CC1352R device does not come at the expense of RF performance; the CC1352R device has excellent sensitivity and robustness (selectivity and blocking) performance.

The CC1350 is the first device in the CC13xx and CC26xx family of cost-effective, ULP wireless MCUs capable of handling both Sub-1 GHz and 2.4-GHz RF frequencies. The CC1350 device combines a flexible, very-low-power RF transceiver with a powerful, 48-MHz, Cortex®-M3 MCU in a platform supporting multiple physical layers and RF standards. A dedicated radio controller (Cortex-M0) handles low-level RF protocol commands that are stored in ROM or RAM, thus, ensuring ULP and flexibility to handle both Sub-1 GHz protocols and 2.4-GHz protocols (for example, *Bluetooth*® low energy). This enables the combination of a Sub-1 GHz communication stack that offers the best possible RF range together with a connection to a Bluetooth low energy smartphone that enables a great user experience through a phone application. The Sub-1 GHz-only devices in this family are the CC1310 and the CC1312.

2.2.2 SimpleLink[™] CC3220

The CC3220x device is part of the SimpleLink MCU platform, which consists of Wi-Fi, low energy, Sub-1 GHz and host MCUs, which all share a common, easy-to-use development environment with a single core SDK and rich tool set. A one-time integration of the SimpleLink platform enables the user to add any combination of the portfolio's devices into their design, which allows 100% code reuse when the design requirements change. For more information, visit *SimpleLink Solutions* overview.

Created for the IoT, the SimpleLink CC3220x device family from Texas Instruments is a single-chip solution that integrates two physically separated, on-chip MCUs. One of the MCUs is an application processor— an ARM® Cortex®-M4 with a user-dedicated 256KB of RAM and an optional 1MB of XIP flash. The other MCU is a network processor in charge of running all Wi-Fi and Internet logical layers. This ROM-based subsystem includes an 802.11b/g/n radio, baseband, and MAC with a powerful crypto engine for fast, secure Internet connections with 256-bit encryption.



System Overview

The CC3220x wireless MCU family is part of the second generation of TI's Internet-on-a-chip[™] family. This generation introduces new features and capabilities that further simplify the connectivity of things to the Internet. The new capabilities including the following:

- IPv6
- Enhanced Wi-Fi provisioning
- Enhanced power consumption
- Enhanced file system security (supported only by the CC3220S and CC3220SF devices)
- · Wi-Fi AP connection with up to four stations
- More concurrently opened BSD sockets; up to 16 BSD sockets, of which six are secure
- HTTPS support
- RESTful API support
- Asymmetric keys crypto library

The CC3220x wireless MCU family supports the following modes: station, AP, and Wi-Fi Direct[®]. The device also supports both WPA2-Personal and WPA2-Enterprise security modes. This subsystem includes embedded TCP/IP and TLS/SSL stacks, HTTP server, and multiple Internet protocols. The device supports a variety of Wi-Fi provisioning methods including HTTP based on AP mode, SmartConfig[™] technology, and WPS2.0.



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图 3. CC3220 Block Diagram

2.2.3 TI 15.4-Stack

TI 15.4-Stack is an IEEE802.15.4e/g-based software stack part of the SimpleLink CC13x0 SDK supporting a star network topology for Sub-1 GHz applications. TI 15.4-Stack software runs on the SimpleLink Sub-1 GHz CC13x0 or CC13x2 wireless MCU from TI. The TI 15-4 Stack offers several key benefits, such as longer range in FCC band and better protection against in-band interference by implementing frequency hopping. The SDK also offers customers an accelerated time to market by providing a complete end-to-end, node-to-gateway reference design. TI 15.4-Stack is supported on the industry's lowest-power SimpleLink Sub-1 GHz wireless MCU platform.



This release is available royalty-free to customers using TI's CC13x0 or CC13x2 wireless MCU and also runs on TI's SimpleLink Sub-1 GHz CC13x0 or CC13x2 wireless MCU LaunchPad development kit. This release is available royalty-free to customers using TI's CC13x0 or CC13x2 wireless MCU and also runs on the SimpleLink Sub-1 GHz CC13x0 or CC13x2 wireless MCU LaunchPad development kit from TI.

Features:

- IEEE 802.15.4e/g standards-based software stack
- Frequency hopping
- Medium access with CSMA/CA
- Built-in acknowledgment and retry
- Network and device management (joining, commissioning, service discovery)
- Security feature through AES 128-bit encryption and integrity check
- Supported on SimpleLink Sub-1 GHz CC1310 wireless MCU
- Star topology: point-to-point, one-to-many, and data concentrator
- Synchronous (beacon) and asynchronous (non-beacon) modes
- Designed for 915-MHz FCC, 863-MHz ETSI, and 433-MHz China bands
- · SimpleLink long range mode for all supported frequency bands
- Support for SimpleLink CC1190
- Bluetooth low energy beacon advertisement support
- Sensor-to-web example application
- Easy application development guided through sample applications showcasing the stack configuration and APIs
- Coprocessor mode for adding connectivity to any MCU or MPU with Linux[®] host middleware and console application

For more details and to get the TI 15.4-Stack software, download the SimpleLink CC13x0 SDK, which includes the TI 15.4-Stack.

2.2.4 SimpleLink™ Wi-Fi CC3220 SDK

The SimpleLink Wi-Fi CC3220 SDK contains drivers for the CC3220 programmable MCU, over 30 sample applications, and related documentation. The SDK also contains the flash programmer, a command line tool for flashing software, configuring network and software parameters (SSID, access point channel, network profile, and so on), system files, and user files (certificates, web pages, and so on). This SDK can be used with TI's SimpleLink Wi-Fi CC3220 LaunchPad development kits.

Features:

- Internet-on-a-chip sample applications:
 - Email from SimpleLink Wi-Fi
 - Information center: Get time and weather from the Internet
 - https server: Host a secure web page on SimpleLink Wi-Fi
 - XMPP: IM chat client
 - Serial interface
- Wi-Fi sample applications:



- Easy Wi-Fi configuration
- Station, AP modes
- TCP/UDP
- Security—Enterprise and personal, TLS/SSL
- Power management—Deep sleep, hibernate
- MCU peripheral sample applications:
 - Including parallel camera, I2S audio, ADC, I²C, PWMs, JTAG Flashing, and more

2.3 System Design Theory

2.3.1 TI IoT Gateway-to-Cloud Service Interface

The purpose of this section is to provide a description of the message types and expected data flows that will be shared between the TI IoT gateway and an IoT cloud server. The interface is designed to be flexible to support multiple cloud vendors. For this purpose, the Sub-1 GHz wireless network and node information will be exchanged between the gateway and the cloud using the long-established JavaScript object notation (JSON) format. Additionally, IPSO alliance smart object definitions will be used to define sensors (and their data) that are connected to each node in the wireless networks.

2.3.1.1 Message Types

To fully specify the Sub-1 GHz wireless network information, as well as the Sub-1 GHz sensors and their data, two distinct message types have been defined for the IoT gateway to update the cloud. In order to allow the cloud to send messages back to the TI IoT gateway, two additional message types are defined that allow the cloud to update the wireless network state and send actuation messages to specific devices in the network.

2.3.1.1.1 Network Information Message Type (From TI IoT Gateway to the Cloud)

This message type presents information about the wireless network, its current state, and a list of devices that are connected to the network. As described later in this design guide, this will be the first message type sent after the network is initialized. This message type contains all the information necessary to prepare for receiving sensor data from devices. This message type contains the following fields:

- name: begins as the short address of the network but allows for the cloud to provide a more specific name
- channels: list of channels that the wireless network is operating on
- pan_id: the 16-bit PAN identifier of the network
- short_addr: the 16-bit short address of the PAN-coordinator
- ext_addr: the 64-bit IEEE extended address of the PAN-coordinator device
- security_enabled: yes, if security enabled; no, otherwise
- mode: network operation mode (beacon, non-beacon, frequency hopping)
- state: PAN-coordinator state values (waiting, starting, restoring, started, open, closed)
- · devices: list of wireless nodes in the network
 - name: begins as the short address of the device but allows cloud to update

- short_addr: the 16-bit short address of the PAN-coordinator
- ext_addr: the 64-bit IEEE extended address of the PAN-coordinator device
- topic: the topic that the device will send its sensor data updates to
- object_list: list of IPSO alliance smart objects (sensors) attached to this device
 - oid: object ID which specifies the sensor type in the IPSO standard
 - iid: list of instance IDs for the current object (can be multiple same type sensors)

2.3.1.1.2 Device Information Message Type (From TI IoT Gateway to the Cloud)

This message type provides information about the wireless device as well as the latest data for all of the sensors connected to the device. This message type will be sent when a device reports sensor data or switches between an active or inactive state. The following fields are contained in this message type:

- active: whether or not the wireless node is active
- ext_addr: the 64-bit IEEE extended address of the PAN-coordinator device
- · rssi: received signal strength indicator of the last message received
- smart_objects: list of the IPSO alliance smart objects connected to this wireless device
 - object ID description: type of sensor (as defined in the IPSO standard); can be multiple types of sensors connected to each device
 - instance ID: the instance ID for the parent object type; can be multiple sensors of the same type
 - resource ID description list: sensor data name value pairs (for example, sensorValue: 32.5, units: Celsius, and so forth); these resources match what is specified for the given object ID in the IPSO standard

2.3.1.1.3 Update Network State Message Type (From Cloud to TI IoT Gateway)

In the current implementation of the TI IoT gateway, this message type is intended to be able to open or close the wireless network to new devices joining. The cloud's front end user interface can allow a user to click a button to open or close the network and then generate this message type and send it to the TI IoT gateway. The gateway will then notify the network on whether it needs to open or close to new device joins. This message type only includes the desired state of the network and should be sent to the same topic that the cloud is receiving the network information messages from. The following field is all that is required:

• state: should be set to either open or closed

2.3.1.1.4 Device Actuation Message Type (From Cloud to TI IoT Gateway)

This message type is added to allow the cloud to send actuation messages to specific devices in the wireless network. The current implementation only supports toggling an LED on the wireless device's board. The device actuation message should be sent to the topic of the device as given in the devices list of the network information message. The following field is the only requirement for this message:

• toggleLED: should be set to true



2.3.1.2 Data Flows

2.3.1.2.1 Network Information Sent to the Cloud

The following bulleted items are the list of events that can occur on the TI IoT gateway that will cause a network information message type to be sent to the cloud. A description is given with each event and the end of this section describes the expected behavior from the cloud upon receipt of this type of message.

Network Startup

This is the initial event in the TI IoT gateway. The TI IoT gateway will aggregate the information about the wireless network as well as the list of connected devices and their sensor types. The TI IoT gateway will then make a connection to the cloud and send the aggregated data contained in the network information message type.

Network Information Update

This event can occur if any of the information about the wireless network changes. For example, if the network operation mode of the wireless network was changed, the TI IoT gateway would once again aggregate all the information needed (network information and device list) and send the network information message type to the cloud.

Network State Change

This event occurs if the state of the wireless network changes. For example, if the network state changes from open to closed the TI IoT gateway will send a network information message type to the cloud.

Device Joins the Wireless Network

When a new device joins the network, after the network is up and running, this event will occur. In this case, the TI IoT gateway will add the new device and its information to the devices list within the network information message type and then send the updated information to the cloud.

Expected Cloud Behavior

It is expected that the cloud will be prepared for the network startup event and will be able to receive the network information message type (using a wildcard and then filtering or by having prior knowledge about the destination or topic of the message). Once the cloud receives the network information message, the wireless network information (PANID, security, mode, and so on) can be displayed to users and the device list information (topic, object list, and so on) can be used to prepare itself to receive and display device and sensor data.

2.3.1.2.2 Device Information Sent to the Cloud

The following bulleted items are the list of events that will cause the TI IoT gateway to send a device information message type to the cloud. A description is given with each event and the end of this section describes the expected behavior from the cloud upon receipt of this type of message.

Device Becomes Inactive

This event occurs when the TI IoT gateway detects that one of the devices in the connected devices list has stopped sending sensor data updates. The TI IoT gateway will update the *active* field and send a Device Information Message Type to the cloud for the inactive device.

Device Reports Sensor Data

Each time a sensor on a connected device reports sensor data this event occurs. The TI IoT gateway updates the IPSO Alliance Smart Object list in the device for each sensor and then sends a device

information message type to the cloud.

• Expected Cloud Behavior

It is expected that the cloud will be listening on each topic given in the connected devices list from the network information message. When one of the two events occur in this section, the TI IoT gateway will send the device information message to the topic (corresponding to the device being update) that the cloud should be listening on or subscribed to. When the device information message arrives at the cloud, the cloud should display the latest device information and sensor data to users.

2.3.1.2.3 Update Network State Message Sent to the TI IoT Gateway

This message is used to open or close the wireless network to new devices joining. This message should be an option provided to users in the front end user interface that the cloud presents. When the user decides to update the network state, the cloud should send an update network state message type to the TI IoT gateway on the same topic that the network information messages are arriving on.

Expected TI IoT Gateway Behavior

The TI IoT gateway will receive the Update Network State message and will generate the correct command (either open or close) to the wireless network. This message should in turn cause a network state change event (from 7.2.1 above) that will send a network information message back to the cloud which can confirm the successful completion of the Update Network State command.

2.3.1.2.4 Device Actuation Message Sent to the TI IoT Gateway

This method is used to toggle the LED on the board of the connected devices. This message is meant to be a proof-of-concept on the current device setup and will change for customer use-case specific actuations. A toggle LED button for each device will be provided to users of the cloud's front end interface. When the toggle LED button is clicked the cloud should send a device actuation message to the TI IoT gateway on the same topic that the device information messages are arriving on.

• Expected TI IoT Gateway Behavior

The TI IoT gateway will generate a toggle LED command and send it to the device corresponding to the topic that the device actuation message was received on. This will cause the LED to toggle. Because the state of the LED is not captured in the device information message type, there will be no feedback to the cloud that the LED actually toggled.



3 Hardware, Software, Testing Requirements, and Test Results

3.1 Required Hardware and Software

The CC3220SF plus CC13x0/CC13x2 sensor-to-cloud reference design helps developers create ULP, long-range, star-topology network solutions. The sensor-to-cloud reference design includes the Gateway example application running on the CC3220SF, MAC CoProcessor (CoP) application running on the CC13x0 or CC13x2, in addition to sensor node applications. The CC3220SF Gateway example application interfaces over UART with a CC13x0 or CC13x2 LaunchPad, which acts as a MAC CoP. The Gateway example application implements a IEEE 802.15.4 full-function device, which performs the functions of a network PAN coordinator (starting a network and permitting devices to join this network) and also provides an interface for monitoring and collecting sensor data from one or more sensor devices.

The Gateway example application provides an IEEE 802.15.4 network to IP bridge and is a great starting point to create IoT applications based on TI 15.4-Stack.

3.1.1 Hardware

- 2x CC13x0 or 2x CC13x2 LaunchPad development kits
- 1x CC3220SF LaunchPad development kit
- USB cables
- Wi-Fi access point with Internet access

3.1.2 Software

- CC3220-SensorToCloud SW
- CC3220 SDK v1.50.00.06
- SimpleLink CC13x0 SDKor SimpleLink CC13x2 SDK
- UniFlash v4.1.1.1250 or later
- Tera Term or any other equivalent terminal program
- Cloud Foundry CLI (for IBM Cloud only)
- (Optional) SimpleLink Starter Pro IOS[®] app or SimpleLink Wi-Fi Starter Pro Android[™] app (downloaded from the app store on smartphones or tablets)

3.2 Testing and Results

This section describes the hardware and software used for running the tests and the results obtained.

3.2.1 Test Setup

During the development process of this reference design, the full hardware and software portions described in earlier sections were used for testing. Multiple CC13x0 and CC13x2 sensor nodes and a CC3220SF LaunchPad (connected to a CC1310 coprocessor) were used to verify the IoT gateway functionality with the IBM cloud and AWS IoT cloud services. The test results of this reference design can be visualized by the IoT dashboard shown in \ddagger 3.2.2.

3.2.1.1 Running the Out-of-Box Examples

This section provides detailed instructions to assist developers set up and understand the principles behind the out-of-box examples.

Some of the topics covered in this section are:

- 1. Programming the CC13xx LaunchPad development kits
- 2. Programming the gateway example application on the CC3220SF LaunchPad
- 3. Connecting the CC13x0 MAC-CoP LaunchPad with the CC3220SF LaunchPad
- 4. Setting up and configuring the cloud service
- 5. Running and using the example

For steps on how to setup and run the *IBM gateway example* please follow the instructions in \ddagger 3.2.1.1.1 and to setup and run the *AWS IoT gateway example* please follow the instructions in \ddagger 3.2.1.1.2.

注: This guide can be performed using either CC13x0 or CC13x2 LaunchPad development kits for the MAC CoP. The training material is based on CC1350, and the same procedures apply when using either a CC1310 or CC13x2 devices.

3.2.1.1.1 Running IBM Gateway Example

- 1. Label one CC1350 LaunchPad as *Sensor* and the other as *MAC-CoP*. These labels will be referred to throughout this guide. It is recommended to use non-permanent marking for this (for example, sticky notes) as these labels may only be relevant for this specific example.
- 2. Program the *MAC-CoP* and the *Sensor* LaunchPad by following the steps in \ddagger 3.2.1.1.3.
- 3. Program the CC3220SF LaunchPad by following the steps in \ddagger 3.2.1.1.4.
- 4. Connect the MAC-CoP LaunchPad with the CC3220SF LaunchPad by following the steps in 节 3.2.1.1.5.
- 5. Set up an account for IBM Cloud by following the instructions in \ddagger 3.2.1.1.6.
- 6. Set up the Watson IoT platform service as in \ddagger 3.2.1.1.7.
- 7. Follow \ddagger 3.2.1.1.8 to set up Node.js and cloud foundry app.
- 8. After all of these steps have been completed, go to \ddagger 3.2.1.1.9, and follow the steps to connect the gateway to the Internet and run the example.



3.2.1.1.2 Running AWS IoT Example

Before getting started with the AWS IoT example please request the AWS IoT demo configuration from StackArmor by filling out the following form.

- 1. Label one CC1350 LaunchPad as Sensor and the other as MAC-CoP. These labels will be referred to throughout this guide. It is recommended to use non-permanent marking for this (for example, sticky notes), as these labels may only be relevant for this specific example.
- 2. Program the MAC-CoP and the Sensor LaunchPadTM by following the steps in \ddagger 3.2.1.1.3.
- 3. Import and build the AWS IoT example by following the steps in \ddagger 3.2.1.1.4.2.
- 4. Program the CC3220SF LaunchPad by following the steps in \ddagger 3.2.1.1.4.4.
- 5. Connect the MAC-CoP LaunchPad with the CC3220SF LaunchPad by following the steps in 节 3.2.1.1.5.
- 6. After all of these steps have been completed, go to \ddagger 3.2.1.1.9, and follow the steps on how to connect the gateway to the Internet and run the example.

3.2.1.1.3 Programming CC13x0 LaunchPad™

- 1. It is assumed that all the required software has already been installed. If not, install the required software 节 3.1.2 now.
- 2. Connect the CC13x0 LaunchPad to the PC.
- 3. Open UniFlash.
- 4. Select LAUNCHXL-CC1350 as show in 图 4, and click on the Start button.

Unit	lash		
New Configuration			
Chaose V	our Device		
Unouse 1	our Device		
Category: All C2000 mmWave MSP	PGA Safety T	va UCD	Wireless
Q Enter Device Name (915 Ava	ilable)	20	×
CC3220SF-LAUNCHXL	LaunchPad	On-Chip	*
CC3220SF-LAUNCHXL	LaunchPad	Serial	
TK-TM4C123GXL	LaunchPad	On-Chip	
EK-TM4C1294XL	LaunchPad	On-Chip	
A EK-TM4C129EXL	LaunchPad	On-Chip	
LAUNCHXL-CC1310	LaunchPad	On-Chip	
AUNCHXL-CC1350	LaunchPad	On-Chip	
LAUNCHXL-CC2650	LaunchPad	On-Chip	
LAUNCHXL-F28027	LaunchPad	On-Chip	
LAUNCHXL-F28069M	LaunchPad	On-Chip	
AUNCHXL-F28377S	LaunchPad	On-Chip	
LAUNCHXL-F28379D	LaunchPad	On-Chip	-
	r Connection		

图 4. Choose Device: UniFlash



5. Make sure the *Program* tab is selected on the left, and click the *Browse* button to select the desired image for the CC13xx LaunchPad located in <S2C_Repo_Directory>\tidc01002\prebuilt\.

9 UniFlash				X
UniFlash Session - Abo	but			٠
Configured Device : Texas Instruments X	DS110 USB Debug Probe > CC1350F128 [more info]		Cortex_N	VI3_0
Program	Select and Load Images			
Settings & Utilities	Flash Image(s)			1
Memory			Browse	
Standalone Command Line	Available Action(s)			
	Load Image Verify Image			
	▼ Quick Settings			
	Create your personalize settings view. Click to add settings.			
🗖 Console		•	=	×

图 5. Browse for Firmware Image

6. After selecting the desired image, click on the Load Image button to flash the CC1350 LaunchPad.

4 UniFlash	
	UniFlash 🛛 🗮
Configured Device : Texas Instrumen	ts XDS110 USB Debug Probe > CC1350F128 [more info]
Program	Select and Load Images
Settings & Utilities	Flash Image(s)
Memory	CC1350 Launcpad CoProcessor.hexSize: 281.14 KB Binary:
Standalone Command Line	
	Available Action(s) Load Image Verify Image
Console	↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

图 6. Load Image

7. If loading the image was successful, a success message should show in the console as shown in 图 7.

Console	- Mp	=	×
[4/13/2017, 2:35:02 PM] GEL: Cortex_M3_0: GEL Output: Memory Map Initialization C	omplete.		
[4/13/2017, 2:35:04 PM] GEL: Cortex_M3_0: GEL Output: Memory Map Initialization C	omplete.		
[4/13/2017, 2:35:08 PM] GEL: Cortex_M3_0: GEL Output: Board Reset Complete.			
[4/12/2017 2:25:42 PM] Status: Program Load completed successfully			

图 7. Successful Load

3.2.1.1.4 Programming the CC3220SF LaunchPad[™]

This section describes two ways of programming the CC3220SF LaunchPad. ^{††} 3.2.1.1.4.1 explains the process of programming the CC3220SF LaunchPad by importing a preconfigured Image Creator project to UniFlash. ^{††} 3.2.1.1.4.4 shows how to create an Image Creator project from scratch to program the CC3220SF with a binary generated from Code Composer Studio[™] (CCS).

3.2.1.1.4.1 Programming a Preconfigured Image Creator Project

Note that only the IBM cloud service is provided in the preconfigured Image Creator project since the AWS IoT example needs extra configuration that need to be added and compiled in the source code.

- 1. Open UniFlash.
- 2. On the *Choose your Device* section select *CC3220SF-LAUNCHXL*, and make sure to select the *Serial* option and not *On-Chip* as shown in 8 8. Click on the *Start Image Creator* button.

Unif	lash		
 New Configuration 			
1 Choose Y	our Device		
Category: All C2000 mmWave MSP	PGA Safety T	iva UCD 1	Wireless
Q Enter Device Name (915 Ava	iilable)	00	×
CC3220SF-LAUNCHXL	LaunchPad	On-Chip	-
SCC3220SF-LAUNCHXL	LaunchPad	Serial	
EK-TM4C123GXL	LaunchPad	On-Chip	
A EK-TM4C1294XL	LaunchPad	On-Chip	
IK-TM4C129EXL	LaunchPad	On-Chip	
LAUNCHXL-CC1310	LaunchPad	On-Chip	
LAUNCHXL-CC1350	LaunchPad	On-Chip	
LAUNCHXL-CC2650	LaunchPad	On-Chip	
LAUNCHXL-F28027	LaunchPad	On-Chip	
AUNCHXL-F28069M	LaunchPad	On-Chip	
LAUNCHXL-F28377S	LaunchPad	On-Chip	
LAUNCHXL-F28379D	LaunchPad	On-Chip	-
 LAUNCHXL-CC1350 LAUNCHXL-CC2650 LAUNCHXL-F28027 LAUNCHXL-F28069M LAUNCHXL-F28377S LAUNCHXL-F28379D 	LaunchPad LaunchPad LaunchPad LaunchPad LaunchPad LaunchPad	On-Chip On-Chip On-Chip On-Chip On-Chip On-Chip	•
	r Connection		

图 8. Choose Device: CC3220SF



Hardware, Software, Testing Requirements, and Test Results

3. After starting Image Creator, click on the Manage Projects button as shown in 图 9.

SimpleLink™ Image Creator		
UniFlash		
Texas Instruments	Welcome to SimpleLink™ Wi-Fi® Image Creator Create & program Images to your CC31xx/CC32xx devices easily	
	Manage Projects Open/Import/Export/Rename/Delete Recent Projects PAE Summi	
	New Project Start a blank project with new settings	
	Version: 1.0.17.5 All rights reserved to Texas Instruments inc (c) - For more information go to our Help Pages	
<u>L</u>		

图 9. Manage Project



 Click on the Import Project from ZIP file button, and select the zip folder C:\<S2C_Repo_Directory>\tidc01002\prebuilt\CC3220SF_LaunchXL\Uniflash_CC3220ImageCreatorPr oject.zip.

SimpleLink™ Image Creator		
UniFlash		
🗤 Texas Instruments	Project Management	Service Pack Certificate Help
General - Settings System Setting Device Radio Settings Constraints General Settings General Settings STA/WI-File Direct Device Network Settings Network Settings Network Settings Network Settings Network Settings Network Settings Network Settings Metwork Settings Service Pack Trusted Root-Certificate Catalog	Available Projects	Oevice status Onnected: Off Connect Connect Connect Connect Connect Connect Connect Connect Connect Connect Connect Connect

图 10. Import Project



Hardware, Software, Testing Requirements, and Test Results

5. Open the CC3220SF_154StackGtway project.

SimpleLink™ Image Creator		
UniFlash		
🐺 Texas Instruments	Project Management	Service Pack Certificate Help
General - Settings System Setting Device Radio Settings Ceneral Settings Ceneral Settings Ceneral Settings Ceneral Settings Ceneral Settings Ceneral Settings Ceneral Settings Ceneral Settings Network Settings Network Settings Network Settings Setvice Pack Trusted Root-Certificate Catalog	Available Projects	Device status
	Version: 1.0.17.5 All rights reserved to Texas Instruments inc (c) - For more information go to our Help Pages	

图 11. Open Project

Hardware, Software, Testing Requirements, and Test Results

6. Connect the device to the PC through a USB cable, and press the *Connect* button found on the bottom-right corner. Once the device is connected, select the *Generate Image* button underneath the *Disconnect* button, and select *Program Image (Create & Program)*.

SimpleLink™ Image Creator		
UniFlash		
🔱 Texas Instruments	Development Mode - Generate Image	Service Pack Certificate O Help
General - FAE Summit ☐ Settings System Setting	Create Image Program Image (Create & Program) Create OTA	Device status ▼▲ % Connected: On ★ Device Type: CC3220SF, Secure Ø MAC Address: 04:3316:45:80:f8
 Device Radio Settings Role Settings General Settings 	SLI, TI format, for ImageCreator programming.	HW Version: 48 <
STA/Wi-Fi® Direct Device Network Settings AP/Wi-Fi® Direct GO WLAN Settings	UCF, TI format, for host programming.	 Storage Capacity: 4096KB Formatted Capacity: N/A Available for User Files: 0KB
Network Settings □ Network Applications Files User Files	Bin, standard binary image file for Gang programming.	 SFLASH codes: 0xc2,0x28,0x16 Security Alerts: 0 / 0
Service Pack Trusted Root-Certificate Catalog	Hex, standard intel-hex format file for Gang programming.	Disconnect
	Version: 1.0.17.5	

图 12. Generate Image



3.2.1.1.4.2 Importing Examples to Code Composer Studio (CCS)

- 1. Open CCS version 7.3.
- 2. It is assumed that the CC3220 SDK has already been installed in a directory referred to as CC32XX_SDK_INSTALL_DIR. If not, install the CC3220 SDK now as this example requires it.
- 3. Import the Gateway project by going to $File \rightarrow Import \rightarrow C/C++ \rightarrow CCS$ Projects, and click on Next.

💱 Import	
Select Imports existing CCS Eclipse projects into workspace.	Ľ
<u>S</u> elect an import wizard:	
type filter text	
 CCS Projects Existing Code as Makefile Project Code Composer Studio Energia Git Finstall Remote Systems Run/Debug Team 	
Image: Second	Cancel

图 13. Select Project to Import



Hardware, Software, Testing Requirements, and Test Results

4. Click on Browse... and navigate to <S2C_Repo_Dir>\tidc01002\examples\cc3220sf_gateway_app.

V Import CCS Eclipse Projects				
Select CCS Projects to Import Select a directory to search for existing CCS Eclipse projects.				
Select <u>search-directory</u> : \tidc01002\examples\cc3220sf_gateway_app Select <u>a</u> rchive file:	B <u>r</u> owse B <u>r</u> owse			
Scovered projects. Iscovered projects.	<u>S</u> elect All <u>D</u> eselect All <u>Re</u> fresh			
 Automatically import referenced projects found in same search-directory Copy projects into workspace Open Resource Explorer to browse a wide selection of example projects 				
Image: Second system Mext > Finish	Cancel			

图 14. Select Projects to Import

- 5. Select the desired examples to be imported and click on Finish.
- 6. (AWS Example Only) Request AWS IoT demo configuration from StackArmor by filling out the following form.
- 7. (AWS Example Only) Update the AWS configuration file:
 - 1. After receiving the certificates and configuration information from StackArmos open the aws_iot_config.h file, found in CloudService/AWS.
 - 2. Set the value of AWS_IOT_MQTT_HOST to the URL provided by StackArmor, it should look something like this "https://<random-string>.iot.us-east-1.amazonaws.com "



Hardware, Software, Testing Requirements, and Test Results

- 3. Modify AWS_IOT_MQTT_CLIENT_ID to a unique name for the device.
- Replace the value of AWS_IOT_MY_THING_NAME with the extended address of the MAC-Cop LaunchPad.
- 5. Open the file certs.h, found in the CloudService/AWS directory.
- 6. Search for "USER STEP" and update the CA root certificate string, the client certificate string, and the client (private) key string.

📩 🗕 🖫 📑 🍕 🗕 💋

- 8. Compile the example by clicking on the Build button (
- 9. If the CC3220SF LaunchPad is already in developer mode, the example can be run and debugged

directly from CCS by clicking on the debug button

10. If the CC3220SF Launchpad is not in developer mode, follow 节 3.2.1.1.4.4 to flash and run the example.

3.2.1.1.4.3 Compiling the Mac-CoP from Source

These are optional steps if there is a need to re-compile the Mac-CoP firmware for the gateway as opposed to using the prebuilt CoP firmware.

When re-compiling the Mac CoP firmware, the pin configuration for the UART needs to be modified since the default Mac CoP example in the CC13xx SDK uses IOID 3 and IOID 2 pins for UART and the gateway uses IOID 11 and IOID 9. See steps below to modify the pin configuration.

- 1. Import the coprocessor example from the CC13xx SDK to CCS
- 2. Open the file CC13X0_LAUNCHXL.h and modify the two lines shown below.

/* UART Board */			
#define Board_UART_RX	IOID_9	/* RXD	*/
#define Board_UART_TX	IOID_11	/* TXD	*/

3. Now rebuild the example and flash it into the CC13xx LaunchPad

3.2.1.1.4.4 Creating an Image Creator Project in UniFlash

The following steps will allow the user to customize the example and use the new, updated files instead of the pre-build ones.

- 1. Open UniFlash.
- 2. On the *Choose your Device* section, select *CC3220SF-LAUNCHXL*. Make sure the *Serial* option is selected and not *On-Chip* as shown in **15**. Click on the *Start Image Creator* button.



 New Configuration 			
1 Choose	Your Device		
Category: All C2000 mmWave M	SP PGA Safety T	iva UCD	Wireless
Q Enter Device Name (915 A	vailable)	25	×
SCC3220SF-LAUNCHXL	LaunchPad	On-Chip	-
ICC3220SF-LAUNCHXL	LaunchPad	Serial	
EK-TM4C123GXL	LaunchPad	On-Chip	
W EK-TM4C1294XL	LaunchPad	On-Chip	
FK-TM4C129EXL	LaunchPad	On-Chip	
LAUNCHXL-CC1310	LaunchPad	On-Chip	
TAUNCHXL-CC1350	LaunchPad	On-Chip	
LAUNCHXL-CC2650	LaunchPad	On-Chip	
AUNCHXL-F28027	LaunchPad	On-Chip	
AUNCHXL-F28069M	LaunchPad	On-Chip	
LAUNCHXL-F28377S	LaunchPad	On-Chip	
LAUNCHXL-F28379D	LaunchPad	On-Chip	-
	our Connection		

图 15. Select CC3220 Device



Hardware, Software, Testing Requirements, and Test Results

3. After starting Image Creator, click on the New Project button as in 图 16.



图 16. New Project

4. Enter a project name, select CC3220SF in the Device Type drop-down menu, make sure device mode is in Develop, and click on the Create Project button.

SimpleLink™ Image Creator	ACCESSION OF A DESCRIPTION OF A	
UniFlash		
V TEXAS INSTRUMENTS	Start new project	Scivice Pack Certificate
General	Project Name	Device status
B Settings System Setting	<project name=""></project>	Connected: Off
Device Radio Settings Role Settings General Settings STA/Wi-File Direct Device Network Settings AP/Wi-File Direct G0	Project Description	Connect
WLAN Settings Network Settings B. Network Applications Files User Files Service Pack	Device Type CC3220SF Device Mode Develop III	
Trüsted Poot Certificate Catalog	<< Back	a ,





 Select Trusted Root-Certificate Catalog in the bottom-left corner and uncheck the Use default Trusted Root-Certificate Catalog box. Include the Source File (certcatalogPlayGround20160911.lst) and Signature Source File (certcatalogPlayGround20160911.lst.signed.bin) found in C:\ti\simplelink_cc32xx_sdk_1_50_00_06\tools\cc32xx_tools\certificate-catalog.

Flash		
🐺 Texas Instruments	Development Mode - Files > Trusted Root- Certificate Catalog	Service Pack Certificate Help
General - FAE Summit		St. Connected: Off
Settings	Trusted Root-Certificate Catalog	
System Setting		
Device	Use detault Trusted Root-Certificate Catalog	
🖂 Radio Settings	Source File	
⊟ Role Settings	<u>↓</u>	Connect
⊟ General Settings	ertcatalogPlayGround20160911.lst Browse	
STA/Wi-Fi® Direct Device		
Network Settings		
AP/Wi-Fi® Direct G0	Signature Source File	3
WLAN Settings	×	
Network Settings	ayGround20160911.lst.signed.bin Browse	
Network Applications		
Files		
User Files		
Service Pack		
Trusted Root-Certificate Catalog	Version: 1.0.17.5	
	All rights reserved to Texas Instruments inc (c) - For more information go to our Help Pages	

图 18. Trusted Root Certificates



6. Select Service Pack in the bottom-left corner and include the service pack bin (sp_3.3.0.0_2.0.0.0_2.2.0.4.bin) found in C:\ti\simplelink_cc32xx_sdk_1_50_00_06\tools\cc32xx_tools\servicepack-cc3x20.

		Service Pack Certificate V Help
General - FAE Summit	Service Pack File Name	Device status Connected: Off
Settings	sp 3.3.0.0 2.0.0.0 2.2.0.4.bin Browse Clear	
System Setting		
Device		
Radio Settings		Connect
Role Settings		
General Settings		
STA/Wi-Fi® Direct Device		
Network Settings		
AP/Wi-Fi® Direct GO		J.C.
WLAN Settings		
Network Settings		
Network Applications		
Files		
User Files		
Service Pack		
Trusted Root-Certificate Catalog	Version: 1.0.17.5	

图 19. Service Pack



- Select User Files and include the dummy-root-ca-cert and dummy-root-ca-cert-key files by clicking on the Add File icon. These files can be found in C:\ti\simplelink_cc32xx_sdk_1_50_00_06\tools\cc32xx_tools\certificate-playground.Create a folder named www by clicking on the New Folder icon. This folder will contain all the web server required files.
 - 注: When adding the files do not select any of the options in the pop-up window—just click the *Write* button.

P IEXAS INSTRUMENTS	Development Mode - Files > User	Files	Service Pack Certificate Help
General - EAE Summit	Check All Uncheck All Action Select Action	Execute	Device status
	Check All J Uncheck All		S Connected: Off
Settings	File	Properties	
Dovice		*	
Device Radia Sattinga	🗆 🖻 www		
Radio Settings	dummy-root-ca-cert-key	1.2KB	Connect
	u dummy-root-ca-cert	1.UKB	
STA (Wi Si@ Direct Davies			
Notwork Sottings			
WI AN Settings			pe.
Network Settings			
Network Applications			
Files		*	
Liser Files	4	•	
Service Pack			
Trusted Root-Certificate Catalon			
Haster hast service serving	10175		
	Version: 1.0.17.5	on go to our Help Pages	

图 20. User Files

8. Go to the following directory: C:\<S2C Repo Directory>\tidc01002\src\www, and recreate the same folder structure in the www folder in the devices User Files.



Hardware, Software, Testing Requirements, and Test Results

www.ti.com.cn

9. After creating all the folders in the www folder, transfer all the files in C:\<S2C Repo Directory>\tidc01002\src\www to the www folder of the device.

oleLink™ Image Creator				
iFlash				
🜵 Texas Instruments	Development Mode - Files > User File	S	Service Pack Certificate Help	1
General - FAE Summit	Check All Uncheck All Action: Select Action	Execute	S Connected: Off	2
E Settings				2
System Setting	File	Properties		
Device				
Radio Settings	🗆 陆 js			
Role Settings	🗆 🖿 jquery.min.js	95.1KB	Connect	
General Settings	🗆 🖿 bootstrap.min.js	36.0KB		
STA/Wi-Fi® Direct Device	🗆 🏷 css			
Network Settings	bootstrap.min.css	118.4KB		
AP/Wi-Fi® Direct GO	Dootstrap.min.css.map	53.1KB		
WI AN Settings	index.css	2.7KB	J.C.	
Network Settings	C cloud info.html	4.9KB		
	C connectioninfo.txt	0.0KB		
	🗆 🖿 network_info.html	6.4KB 🖕		
riles	4	÷.		
User Files				
Service Pack				
Trusted Root-Certificate Catalog				
	Version: 1.0.17.5			
	All rights reserved to Texas Instruments inc (c) - For more information go to	our Help Pages		

图 21. www Folder



Hardware, Software, Testing Requirements, and Test Results

10. On the drop-down box in the top-right corner, select Select MCU Image, and press Browse.



图 22. Select MCU Image



Hardware, Software, Testing Requirements, and Test Results

11. Navigate to the examples directory (<S2C Repo

Directory>\tidc01002\examples\cc3220sf_gateway_app). Go into the directory of the example to be programmed in the CC3220sf and then go to the Debug folder. If the example has been successfully compiled in CCS then the Debug folder should have the files shown in 🛽 23. Select the *.bin* file.

Copen				
	cc3220sf_gate	way_app\15_4_Stack_Gtway_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs\Deb	oug 🔻 🍫 🛛 Search De	ebug 🔎
Organize 🔻 New folder				• 🔟 🔞
☆ Favorites	^	Name	Date modified	Туре
E Desktop		🚴 ThirdParty	10/19/2017 2:06 PM	File folder
🐌 Downloads		🔄 .gitignore	6/16/2017 10:22 A	Text Document
laces 😓 Recent Places	=	15_4_Stack_Gtway_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs.bin	8/15/2017 3:25 PM	BIN File
		15_4_Stack_Gtway_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs.map	8/15/2017 3:25 PM	Linker Address
[Libraries		15_4_Stack_Gtway_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs.out	8/15/2017 3:25 PM	Wireshark captı
Documents		15_4_Stack_Gtway_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs_linkInf	8/15/2017 3:25 PM	XML File ≡
😹 Git		ccsObjs.opt	8/15/2017 3:25 PM	OPT File
🕹 Music		main_tirtos.d	7/18/2017 10:44 A	D File
le Pictures		🖄 main_tirtos.obj	7/18/2017 10:44 A	Object File
lacktrian Subversion		a makefile	8/15/2017 3:25 PM	File 👻
Nideos		III		•
File <u>n</u> ame: 1	5_4_Stack_Gtw	vay_awsIoT_CC3220SF_LAUNCHXL_tirtos_ccs.bin	✓ All Files	-
			Open	Cancel
			Open •	cancer
-	-			-11

图 23. Select Desired Example Binary



12. On the next menu select *Private Key Name:* and include the dummy-root-ca-cert-key. On the *Certification File Name:* select *dummy-root-ca-cert* from the list.

🚱 SimpleLink™ Image Creator				
UniFlash				
🐺 Texas Instrum	JENTS Dovo	lanmant Mada - Eilas - Lisar Eil	ée an	Certificate 🛛 🛛 Help
	File Name:		Max File Size: (actual size: 122160)	
General - FAE Sun	mcuflashimg.bin		524288	
Settings System Setting Device Role Settings General STAWH Neth	 Failsafe Secure No Signature Test Static File Token:	 Vendor Public Write Public Read 		5 2
C AP/WLF WL/ Net D Network Appl Files User Files	Private Key File Name: dummy-root-ca-cert-key	Browse Clear		
Service Pack Trusted Root-	Certification File Name: dummy-root-ca-cert Write Cancel	T		

图 24. Select MCU Image



Hardware, Software, Testing Requirements, and Test Results

13. Connect the device to the PC through a USB cable, and press the *Connect* button found on the bottom-right corner. Once the device is connected, select the *Generate Image* button underneath the *Disconnect* button. Select *Program Image (Create & Program)*.

SimpleLink™ Image Creator		
UniFlash		
🜵 Texas Instruments	Development Mode - Generate Image	Service Pack Certificate Help
		Device status
General - FAE Summit	Create Image Program Image (Create & Program) Create OTA	% Connected: On
 Settings 		★ Device Type: CC3220SF, Secure
Radio Settings	SLL TI format for ImageCreator	HW Version: 48
Role Settings	Sava Imago	Programming Status: On
General Settings	Save mage	(). Current Mode: No file system
STA/Wi-Fi® Direct Device		viz current wode. No nie system
Network Settings	UCF, TI format, for host programming.	Storage Capacity: 4096KB
□ AP/Wi-Fi® Direct GO	Save UCF	Formatted Capacity: N/A
WLAN Settings		Available for User Files: UKB
Network Settings	Bin, standard binary image file for Gang	SFLASH codes: 0xc2,0x28,0x16
Network Applications	programming.	! Security Alerts: 0 / 0
Files		
User Files	Hey standard into hey format file for	
Service Pack	Gang programming.	
Trusted Note Certificate Catalog	Save HEX	Disconnect
	Version: 1.0.17.5	2
	All rights reserved to Texas Instruments inc (c) - For more information go to our Help Pages	

图 25. Generate Image



3.2.1.1.5 Connecting the MAC-CoP and the CC3220SF LaunchPad™

The following procedure applies for both CC13x0 and CC13x2.

1. Remove all jumpers at the center of the *MAC-Cop LaunchPad* except the *Reset* jumper highlighted in *green*. Also move the *VSENSE* jumperhighlighted in *blue* in <u>8</u> 26 to the Extern Pwr position.



图 26. CC1350 LaunchPad™



2. Stack both LaunchPad development kits on top of each other as shown in 图 27.



图 27. Stacked CC1350 and CC3220SF LaunchPad[™] Development Kits

- 3. Connect a USB cable only to the CC3220 LaunchPad, and plug it in the PC.
- 4. Open a serial console (such as, PuTTy or Tera Term), select the COM port associated to the CC3220SF LaunchPad, and use the configuration below:
 - Baud Rate: 115200 Data: 8bit Parity: none Stop: 1bit Flow Control: none
- 5. Press the Reset button on the CC13x0 or CC13x2 LaunchPad attached to the CC3220SF, if the setup was successful, some debug logs should be displayed on the terminal..


Hardware, Software, Testing Requirements, and Test Results

3.2.1.1.6 Open and Configure an IBM Cloud[™] Account

- 1. It is assumed that all the required software has already been installed. If not, install the required software now.
- 2. Go to IBM Cloud, click sign up if to create an account or log in if you already have an account.
- 3. Once logged in, click on the *Catalog* tab located on the top-right corner.

≡	资 IBM Cloud	Catalog	Docs	Support	Manage	0				
	Dashboard REGION CLOUD FOUNDRY ORG CLOUD FOUNDRY SPACE All Resources * United Kingdom * * * Filter by resource name			Create re	esource					
	③ You don't have access to any organizations or spaces in this region. Check that you have the appropriate access with your account owner or administrations or spaces in this region.	ator.			×					
	Dashboard									
	Your dashboard is empty. Either you haven't created any resources yet or you've filtered everything out. Check out some of our popular offerings we've highlighted below, or go to the catalog to create a new application or service. Explore our Offerings									
	图 28. IBM [®] Cloud									



Hardware, Software, Testing Requirements, and Test Results

4. After selecting Catalog, click on Cloud Foundry Apps on the left menu.

☰ 🍐 IBM Cloud			Cata	log Docs	Support	Manage	0
All Categories >	C, Search					Filter	
Infrastructure	Infrastructure						
Compute							
Storage	Compute						
Network	Build your virtual environments.						
Security							
Containers	Bare Metal Server	Virtual Server					
VMware	Bare metal servers provide the raw horsepower you demand for your	Our virtual servers deliver a higher degree of transparency, predictability, and					
Platform	IBM	IBM					
Boilerplates							
APIs							
Application Services	Storage						
Blockchain	Otorage						
Cloud Foundry Apps	Order storage.						
Data & Analytics	Block Storage	File Storage		Object Stor	ade		
DevOps	Persistent iSCSI based storage with high-	Fast and flexible NES-based file storage	(🕥)	Provides flexi	ble cost-effective	and	
Finance	powered performance and capacity up 1	with capacity options from 20GB to 12TB.		scalable cloud	d storage for unst	ructured	
Functions	IBM	IBM		Lite IBM			
Integrate				_			
Internet of Things							
Mobile	N						
Network	Network						

图 29. IBM Cloud™ Catalog

5. Choose SDK for Node.js from the options provided.



图 30. Create Node.js Application



6. Enter a name for the new Node.js application under the *App name* text box, and press the *Create* button on the bottom-right corner.

≡	්ර IBM Cloud			c	Catalog Do	cs Support	Manage	Q
÷	View all Create a Cloud Foundry App							
	SDK for Node.js TM Develop, deploy, and scale server-side JavaScript®	App name: CC3220sampleName]
	apps with ease. The IBM SDK for Node,js™ provides enhanced performance, security, and serviceability.	Host name: CC3220sampleName		Domain: mybluemix.net			•	
	Lite IBM	Choose a region/location to deploy in:	Choose an organiza	ation:	Choose a s	pace:		
	View Docs	US South 🗸	LPC-IoT		dev			
	VERSION 3.x TYPE Application REGION United Kingdom, Germany, Sydney, US East, US South	Pricing Plans		Monthly price	es shown are for	country or region: <mark>U</mark>	nited States	
		PLAN	FEATURES			PRICING		
		✓ Default	Run one or more apps	free for 30 days (375 GB-hours	s free).	\$0.07 USD/GB-Hou	r	
	Need Help? Estimate Monthly Co Contact IBM Cloud Sales 7 Cost Calculator	ost		\$0.07	USD/GB-Hou	r Creat	te]

图 31. Name and Create Application

7. Once the app has been created, click on the Catalogtab located on the top-right corner.

目 ざ IBM Cloud		Catalog	Docs	Support	Manage	0
Getting started Overview Runtime	Cloud Foundry apps / CC3220sampleName C Starting <u>Visit App URL</u> Org: LPC-IoT Location: US South Space: dev			R	outes 🔻	
Connections Logs Monitoring API Management	<section-header> Download, modify, and redeploy your Cloud Foundry app with the command line interface. Lat Updated: 2017-06-31 Edit in GitHub Use IBM Cloud command line interface to download, modify, and redeploy your Cloud Foundry applications and service instances. Deveload Bluemix Command Line Interface Image: Command Line Interface Deveload Bluemix Command Line Interface Image: Command Line Interface Marcinetion: The command line interface, you can get started: Image: Command Line Interface Image: Command Line Interface I</section-header>	1				
	图 32. Go to Catalog					



Hardware, Software, Testing Requirements, and Test Results

8. After selecting the Catalog, click on Internet of Things under Services on the left menu

三 🍐 IBM Cloud				Catal	log Docs	Support	Manage	Q
All Categories >	◯, Search						Filter	,
Infrastructure	Infrastructure							
Compute								
Storage	Compute							
Network	Build your virtual environments.							
Security								
Containers	Bare Metal Server		Virtual Server					
VMware	Bare metal servers provide the raw horsepower you demand for your		Our virtual servers deliver a higher degree of transparency, predictability, and					
Platform	IBM		IBM					
Boilerplates								
APIs								
Application Services	Storogo							
Blockchain	Storage							
Cloud Foundry Apps	Order storage.							
Data & Analytics	Plack Stavage		Eile Stevens		Ohioat Stano			
DevOps	Burstatert (2001) have distance with high		File Storage		Object Storag	je		
Finance	powered performance and capacity up i	~	with capacity options from 20GB to 12TB.		scalable cloud	e, cost-effective, storage for unstr	uctured	
Functions	IBM		IBM		Lite IBM			
Integrate								
Internet of Things								
Mobile								
Network	Network							

图 33. IBM Cloud™ Catalog

9. Choose Internet of Things Platform from the options provided.







10. Give the new platform a service name. Click the Create button on the bottom-right corner.

≡	尚 IBM Cloud				Catalog	Docs	Support	Manage	0
÷	Viewall Internet of Things Platform								
	This service is the hub for IBM Watson IoT and lets you communicate with and consume data from connected devices and gateways. Use the built-in	Service name: myS2C_loTservice]
	web console dashboards to monitor your IoT data and analyze it in real time. Then, enhance and	Choose a region/location to deploy in:	Choose an orga	anization:	Choose	e a space:			
	customize your IBM Watson IoT Platform experience by building and connecting your own	US South 🗸	LPC-IoT		dev				
	apps by using messaging and REST APIs.								
	Lite IBM	Features							
	View Docs	Connect		Information Managemen	ıt				
	AUTHOR IBM	Quickly and securely register and connect y and gateways. You can find simple step-by- instructions for connecting popular devices	your devices -step 5. sensors, and	Control what happens to t connected devices. Manage transformation actions, an	he data that i ge data stora d integrate w	s received ge, configu ith other da	from your ire data ata services		
	TYPE Service	gateways in our recipes site.		and device platforms.	9				
	LOCATION	Analyze in real time		Risk and Security management	gement				
	Germany, United Kingdom, US South	Monitor your real-time device data through	rules, analytics,	Our secure-by-design cor	trol capabiliti	es protect	the integrity of	f	
	Need Help? Estimate Monthly Co Contact IBM Cloud Sales 7 Cost Calculator	st					Creat	e	





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11. Click on the Launch button as shown below.

目 ざ IBM Cloud	Catale	g Docs	Support	Manage (Ĉ
Manage Plan Connections	Internet of Things /			:	
	data from the physical world.				
<	Learn about Watson IoT Platform A Expand using step-by-step recipes A				

图 36. Launch Service Screen

3.2.1.1.7 Set Up Watson IoT[™] Platform Service

1. Once on the IBM Watson IoT Platform, go to Devices on the navigation bar on the left as shown in 37.



图 37. Go to Dashboard

2. Go to *Device Types* and Select *Add Device Type* on the top-right corner.





图 38. Add Device Type



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3. Select Gateway under Type and enter "gateway" for the name and click on Next .

IBM W	atson loT Platform		QUICKSTART	SERVICE STATUS	DOCUMENTATION	BLOG	•
G	Browse Diagnose Action De	vice Types Manage Schemas	s				
#	Add Type Identity	Device Information					×
Å	Select Type Devic versi	e types group devices that have to on, or location. Give the device type acteristics that are shared by devi	similar characteristics, such as model nu be a unique name and a description that ces of this twne	nber, firmware dentifies			
~~~	Туре	Device	Or Gateway				
	Name	gateway					
ی چ		The device and uses a use.	type name is used to identify the device restricted set of characters to make it su	type uniquely itable for API			
2	Desc	iption					
						Cancel	Next

## 图 39. Create Gateway Type

4. Click on Done.

IBM <b>Wa</b>	tson IoT Platform		QUICKSTART	SERVICE STATUS	DOCUMENTATION	BLOG	Ŧ
Q	Browse Diagnose Action	Device Types Manage Schemas					
₽	Add Type Identity	Device Information					×
00	Device Information	You can enter more information about purposes.	the device type for identification				
Å		Serial Number	Manufacturer				
~~		Enter Serial Number	Enter Manufacturer				
		Model	Device Class				
		Enter Model	Enter Device Class				
		Description	Firmware Version				
0		Enter Description	Enter Firmware Version				
~		Hardware Version	Descriptive Location				
ý <b>ô</b> r		Enter Hardware Version	Enter Descriptive Location				
8		+ Add Metadata					
						•	Done





5. Go to the Browse tab and click on Add Device.

IBM <b>V</b>	Natson IoT Platform	QUICKSTART	SERVICE STATUS	DOCUMENTATION	BLOG	▼
Q	Browse Diagnose Action Device Types Manage Schemas					+ Add Device
٠						
000	Browse Devices This table shows a summary of all devices that have been added. It can be filtered, organized, an	id searched on using c	different criteria. To get star	ted, you can		
Å	add devices by using the Add Device button, or by using API.					
$\mathcal{N}$	Device ID 🗘 Device Type 🗘	Class ID	Date	Added	亩	☞ 《 🚻 እ
		0 results				
]						
0						
	C	∕≣∪				
ŵ	-					
	You don't	have any devices.				
2	Cre	eate a device.				

## 图 41. Browsing Devices

6. Select gateway as the device type and enter a device ID.

IBM <b>V</b>	Vatson IoT Platform		QUICKSTAF	T SERVICE STATUS	DOCUMENTATION	BLOG	•
ā	Browse Diagnose Actio	ion Device Types Mar	nage Schemas				
٠	Add Device Ide	entity Device Informati	on Security Summary				×
್ಲಿ							
Å	Identity	Select a device type for unique ID.	the device that you are adding and give the device	1			
Ň		Select Existing Device Type	gateway 👻				
		Device ID	mys2cloTgateway				
0							
ŵ						Cancel	Next
2							
	Browse Dev	vices					
	This table shows a summary of add devices by using the Add [	of all devices that have been a Device button, or by using AP	dded. It can be filtered, organized, and searched or ગ.	using different criteria. To get	started, you can		

## 图 42. Add Device Identity



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#### 7. Skip the Device Information and click next.

IBM W	atson IoT Platform		QUICKS	START SERVICE STAT	US DOCUMENTATION	BLOG	•
Ģ	Browse Diagnose Action	Device Types Manage Sc	chemas				
۵	Add Device Identity	Device Information	Security Summary				×
<u>°°</u>							
Å	Device Information	You can modify the defa purposes.	ult device information and enter more i	nformation about the device	or identification		
~~		Serial Number	Enter Serial Number	Manufacturer	Enter Manufacturer		
		Model	Enter Model	Device Class	Enter Device Class		
6		Description	Enter Description	Firmware Version	Enter Firmware Version		
ŝ		Hardware Version	Enter Hardware Version	Descriptive Location	Enter Descriptive Location		
2		+ Add Metadata					
						<	Next

# 图 43. Device ID

8. On the Security tab, fill out the token field. Make note of this token, as this will be used for authenticating the device to the cloud. Click Next.

IBM W	atson IoT Platform	QUIC	KSTART SERVICE STATUS	DOCUMENTATION	BLOG
ত	Browse Diagnose Action	Device Types Manage Schemas			
۰	Device Security	There are two options for selecting a device authentication token	ι.		
000 000		Auto-generated authentication token (default)	Self-provided authenti Provide your own authentication to	cation token ken for this device. The	
Å		Allow the service to generate an authentication token for you. Tokens are 18 characters and contain a mix of alphnumeric characters and symbols. The token is returned	token must be between 8 and 36 c mix lowercase and uppercase lette symbols, which can include hypher	haracters and contain a rs, numbers, and 1s, underscores, and	
۳.		to you at the end of the device registration process.	periods. Do not use repeated chara user names, or other predefined se	acters, dictionary words, quences.	
		Authentication Token	(1)		
0		Make a note of the generated token. Lost authentication tokens cannot be recovered. Tokens are encryped before			
\$ 2		being stored. Authentication token are encrypted before we store them.			
2					
					< Next





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9. Keep clicking *Next* until a summary of the device credentials and information shows. Take a screenshot of this page, as this will be the last time the *Authentication Token* is visible. Click on Done.



**Browse Devices** 

# 图 45. Adding Device Summary



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10. After adding the new device, go to security on the menu on the left as shown below.

IBM	Watson IoT Platform			QUICKSTART	SERVICE STATUS	DOCUMENTATION	BLOG		▼
Q	BOARDS	•	pards					+ Create New Board	
¢	DEVICES	•				Sort By		Recently changed	Ŧ
000	MEMBERS	•							
Å	APPS	►	DEVICE-CENTRIC     ANALYTICS						
~ ^{1"}	USAGE	•	5 Cards						
	RULES	•							
0	SECURITY	►	d with you						
ŝ	SETTINGS	٨							
89 9	EXTENSIONS	•							

# 图 46. Security Menu



11. Click on the edit button for Connection Security.

IBM V	Vatson IoT Platform	QUICKSTART	SERVICE STATUS	DOCUMENTATION	BLOG	•
Q	Policies					
۵						
000	Policies					
Å	You can configure policies to enhance connection security and control access to the server from					
Ň	Connection Security					<i>.</i>
	Configure the security level for before connection.					
0	Blacklist Block access from specific IP addresses and countries. Activating a blacklist disables an active whitelist.				Disable	ed 💉
ŝ						
8	Whitelist Allow access from specific IP addresses and countries. Activating a whitelist disables an active blacklist.				Disable	ed 💉

图 47. Modifying Connection Security



12. Click on the drop down menu under security level and select TLS Optional, and then save the new configuration.

IBM V	atson IoT Platform QUICKSTART SERVICE STATUS DOCUMENTATION BLOG
Q	← Back Save
•	Use the Connection Security policy to set the default security level that is applied to all devices. You can then add custom rules for specific devices. When the default rule and custom rules are defined, you can view the compliance levels for your organization.
Å	Default Rule
~~~	Define the default connection security level to use for all device types that do not have custom rules defined. You can view the number of devices that are affected and then predicted level of compliance.
	Note: The device number and predicted compliance values are estimates based on a report that runs at varying intervals.
0	Scope Security Level Predicted Compliance () # of Devices
ŵ	Default TLS with Token Authentication 0 Pass 0 Fail 1 Unknown 1 device
2	TLS Optional
	Custom Rules TLS with Client Certificate Authentication You can define custom connection rules for sompliance value is updated to reflect the determinant of the certificate AND Token Image: Custom Connection rules for sompliance value is updated to reflect the determinant of the certificate OR Token

图 48. Save New Security Rule

3.2.1.1.8 Set Up Node.js Cloud Foundry App

- 1. Locate C:\<S2C Repo Directory>\tidc01002\examples .
- 2. Open the *ibm_cloud_application* folder, and open the *Manifest.yml* with a text editor. Replace the name and *services* fields with the *name* of the cloud foundry app and Watson IoT platform.

4 Þ	manifest.yml
1	applications:
2	- path: .
3	memory: 256M
4	instances: 1
5	domain: mybluemix.net
6	name: APP_NAME
7	host: APP_NAME
8	disk_quota: 1024M
9	services:
10	- SERVICE_NAME

图 49. Manifest



- 3. Open a command console and navigate to the IBM-Cloud-Dashboard folder (*cd C:*\<*S2C Repo Directory*>*tidc01002**examples**ibm_cloud_application*).
- 4. Type in cf api https://api.ng.bluemix.net
- 5. Log in to the created account: cf login
- 6. Push the code to the IBM cloud foundry app: cf push



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7. Go back to the IBM Cloud Dashboard by clicking IBM Cloud on the top left.

≡	ど IBM Cloud				Cata	log Docs	Support	Manage	0
		0						5 11	
A	Il Categories	V, S	earch					Filter	
In	frastructure	Infrastru	icture						
C	ompute								
St	torage	Comp	ute						
Ne	etwork	Build you	ır virtual environments.						
Se	ecurity								
C	ontainers		Bare Metal Server	Virtual Server					
VI	Vware .		Bare metal servers provide the raw horsepower you demand for your	Our virtual servers deliver a higher degree of transparency, predictability, and					
Ρ	latform		IBM	IBM					
В	pilerplates								
AF	Pis								
Ap	oplication Services	Storac	10						
BI	ockchain	Siorag	Je						
CI	loud Foundry Apps	Order sto	orage.						
Da	ata & Analytics		Block Storage	File Storage		Object Stor	000		
De	evOps	(🞎)	Pereistent iSCSI based storage with high-	Fast and flexible NFS-based file storage	(🕥)	Provides flexil	ale cost-effective	and	
Fi	nance		powered performance and capacity up to	with capacity options from 20GB to 12TB.	\smile	scalable cloud	d storage for unst	ructured	
Fu	unctions		IBM	IBM		Lite IBM			
Int	tegrate								
Int	ternet of Things								
M	obile								
N	etwork	Netwo	ork						

图 50. Dashboard

8. The cloud foundry apps and IoT services created on the previous on the dashboard will be visible. Click on the cloud foundry app.

≡	ඊ IBM Cloud							Catalog	Docs	Support	Manage	0
	Dashboard Resource group All Resources ~	REGION US South Y	cloud foundry org	CLOUD FOUNDRY SPACE	Filter by reso	ource name				Create re	esource	
	Cloud Foundry Apps	512 MB/2 GB Use	ed									
	Name 🔺			Route		Memory (MB)	Sta	ate				
	CC3220sampleName			CC3220sampleNa	me.myblu	256	•	Running (1/1)				
	Cloud Foundry Servic	es 3/10 Used		Service Offering		Plan						
	availability-monitoring-a	iuto		Availability Monitorin	ng	Lite					:	
	myS2C_loTservice			Internet of Things PI	latform	Lite					:	





9. Click on the Connections tab to the left.

三 ざ IBM Cloud		Catalog	Docs	Support	Manage	0
Getting started Overview Runtime	Cloud Foundry apps / is CC3220sampleName Running Visit App URL Org: IoT Location: US South Space: dev		Routes	• Ċ	•	
Connections Logs	Runtime					
Monitoring API Management	js BUILDPACK SDK for Node Ja™ NSTANCES All instances are running Health is 100% MB MEMORY PER INSTANCE	E	TOTAL M 1.5 GB e	256) BE ALLOCATION Still available @	N	
	Connections Runtime cost					
<	No services are connected to this app You can bind a service:		\$0.00)		

图 52. Connections

10. Click on the *View credentials* button. This page shows the information required to establish a connection between the cloud front end and the back end server. Screenshot or save the information for later.



图 53. View Credentials



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11. Select the service previously created in this guide and click the connect button.

目 ざ IBM Cloud					Catalog D	ocs Support	Manage	0
Getting started Overview Runtime	Connect Existin	ng Compatible Service	e		O _s Search	compatible services	×	
Connections	10 V Items per page 1-	1 of 1 items				1 of 1 pages <	1 >	
Logs	SERVICES	RESOURCE GROUP	PLAN	SERVICE OFFERING				
Monitoring	myS2C_loTservice		Lite	Internet of Things Platform		Co	onnect	
API Management								
<								

图 54. Connect Service



12. Restage the app.

三 ざ IBM Cloud		Catalog	Docs	Support	Manage	0
Getting started Overview Runtime	Cloud Foundry apps / js CC3220sampleName Running Visit App URL Org: LPC-loT Location: US South Space: dev		Routes	- Č	۲	
Connections Logs Monitoring API Management	IO THE Restage app Your 'CC3220sampleName' app must be restaged to use the new 'myS2C_loTservice' service. Restaging makes this service available for use. Do you want to restage it now?		1of1;	Create conne Mages K	ection ↔	
	myS24 Cancel Restage				:	
<						

图 55. Restage the App



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13. Click on the right side of the service and select View Credentials.

三 ざ IBM Cloud				Catalog	Docs	Support	Manage	0
Getting started Overview Runtime	Cloud Foundry apps / js CC3220sampleName Running Org: LPC-IoT Location: US South Space: dev	Visit App URL			Routes	- ¢	•	
Connections Logs			O _s Filter items		¢	reate conne	ection 🕀	
Monitoring	10 Vitems per page 1-1 of 1 items				1 of 1 p	ages <	1 >	
API Management	CONNECTION NAME	ТҮРЕ						
	myS2C_loTservice	Internet of Things Platform					:	
	-					View crede	entials	
						Unbind ser	vice	
						Rename se	vice	
						Boloto Bol		
<								

图 56. View Service Credentials



14. Take note of the Service credentials by clicking on the copy button and paste them into a notepad since they will be used in the next steps.

三 ば IBM Cloud				X ^{Data}	log	Docs	Support	Manage	0
Getting started Overview Runtime Connections Logs Monitoring	Cloud Foundry : js C(Org: LPC-IoT	myS2C_IoTservice Service credentials { "iotf-service": [{ "credentials": { "ordcredentialsdentifier": "a6g6636686r6", "mqtt_host": "6.messaging.internetofthings.ibmcloud.com", "mqtt_up.port": 1883, "mott_sport": 8883	Сору			Routes	 ↓ Ĉ ireate conne 	©	
API Management	10 The CONNECT	<pre>mqit_s_port::eses, "http://ost::6.messaging.internetofthings.ibmcloud.com",</pre>				1of1p	ages <	1 >	
<			Close						

图 57. Copy Service credentials



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15. Now go back to the Dashboard and open the webpagefor the Cloud Foundry App.The link can be found next to the cloud foundry app name.

送 IBM Cloud			Catalog	Docs Support	Manage	0
Dashboard resource aroup region cloud foundry org All Resources US South IoT	CLOUD FOUNDRY SPACE dev ~	Filter by resource name		Creat	e resource	
Cloud Foundry Apps 512 MB/2 GB Used						
Name 🔺	Route	Memory (MB)	State			
CC3220sampleName	CC3220sampleNar	ne.myblu 256	 Running (1/1) 		:	
Cloud Foundry Services 3/10 Used						
Name 🔺	Service Offering	Plan				
availability-monitoring-auto	Availability Monitorin	g Lite			:	
myS2C_loTservice	Internet of Things Pla	atform Lite			:	

图 58. IBM[®] Web Page Link

16. If everything setup correctly, the dashboard will be visible. At this point, open the configuration menu located at the top.

TI 15.4-Stack Sensor-To-Cloud IBM Gateway TI 15.4-Stack Gateway Example Application

Network Information	on
PanID	
Coord Addr	
Network Mode	Not Started
Security	
Network	
•	

图 59. Sensor2Cloud Front End



17. A form will pop up. Use the information saved in step 15 to fill out the form. For the *Device Type* and *Device ID*, use the information entered in 🖄 60. Save the changes, and close when done.

APP_NAME	IBM IoT Credentials
Service credentials	Service Name
"iotf-service": [{ "credentials": {	Enter iot Credentials Identifier
"iotCredentialsIdentifier": "a2g6k39sl6r5", "mqtt_host": "qlq2p4.messaging.internetofthings.ibmcloud.com", "mqtt_u_port": 1883,	Org Enter org
"mqtt_s_port": 8883, "http_host": "qlq2p4.internetofthings.ibmcloud.com", "org"; <mark>"qlq2p4",</mark>	API Key Enter api Key
"apiKey": <mark>[a-qlq2p4-idhr0gsq3s]</mark> "apiToken": <mark>"YKzll8RFvmRAgJp2TU"</mark>	API Token Enter api Token
"syslog_drain_url": null, "label": "iotf-service", "provider": null,	Device Type Enter Device Type
"plan": "iotf-service-free", "name": "APP_NAME" "tags": [Device ID Enter Device Id
"internet_of_things", "Internet of Things",	Close Save changes

图 60. IBM[®] IoT Credentials



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3.2.1.1.9 Run and Use the Gateway

Before getting started with the instructions on how to run the gateway, make sure that the CC3220SF is plugged into the PC and that a serial console has been oppened on the serial port assigned to the CC3220SF LaunchPad.

There are two ways to get the S2C Gateway up an running. The first method is described in \ddagger 3.2.1.1.9.1, which explains how to provision the CC3220SF LaunchPad to a WiFi Network from the Simple Link Starter Pro App. The second method is explained in \ddagger 3.2.1.1.9.2; this method uses the built-in, local provisioning web page.

3.2.1.1.9.1 Using the SimpleLink™ Starter Pro App

This section assumes that either the IOS or the Android app is already installed on the user's mobile phone. If not, install the app now.

- 1. Launch the SimpleLink Starter Pro App from the phone.
- 2. If the device is not found automatically by the app, go to *Device to configure*, and tap on *search for your device*.

Configuration Page
Device to configure 👔 Search for your device 🔻
Name your device ? Dev-142
START CONFIGURATION
Connected to : mysimplelink-459730
Provisioning Devices Settings

图 61. Configuration Page

3. Wait for the app to find the device to connect. The name should be something like mysimplelink-XXXX.



4. Select the device to connect, and tap OK.



图 62. Select Device to Configure



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5. Select the desired Wi-Fi network to connect with the CC3220SF LaunchPad. Enter the password, tap *OK*, and then tap *Start Configuration*.

	Select your Wi-Fi router from the list]
Devi	🕋 NETGEAR 🛛 🗸	~
Nan	稖 6mesh	
VVIII	💏 cpn84	
	🕋 externalhotspot84	
	🕋 net4guest	
	Security Key	
	Сок	

图 63. Select Wi-Fi Router

6. After the configuration is done, make sure the phone is connected to the same Wi-Fi network that the CC3220SF is connected.



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7. Once connected, select the device from the device list.



图 64. Devices



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8. This will open a web page hosted by the device. If the device has already been provisioned to a Wi-Fi network then click on Sensor Dashboard, otherwise click on Configure WiFi Network and enter the WiFi access point credentials.



图 65. Local Web Server Start Page

注: If the browser gives a warning about security certificates, ignore it, and continue to the web page.



 (AWS IoT Example Only) If running the AWS Example and the gateway is connected to the Internet then got to the front end website provided by StackArmor, it should look something like this http://iotdash.stackbuilder.us/#/dashboard/home?net=AWS_IOT_MY_THING_NAME where AWS_IOT_MY_THING_NAME should match the thing name in aws_iot_config.h

NOTE: if running the IBM Example then continue with the steps below.

stackArmor				🔱 Texas Instrum	1ENTS
IOT Dashbo	pard				
Network Information		Network Chart			
PanID	0x0001				
Coord Addr	Oxaabb				
Network Mode	beacon				
Security	yes				
Network	On				
Sensor Nodes				(5	2
Device Info	Device Data	Last Received	Device Status	Toggle-Req	

图 66. AWS IoT Dashboard

10. (*IBM Example Only*)On the start page click on the Sensor Dashboard button. Once on the dashboard click on the settings button to enter the IBM Cloud configuration information.



nsor-To-Cloud Local [×			
C A Not secu	ure https://192.168.1.2	22/dashboard.html		\$
Address:192.168.1 Fi: • ud: •				
1 15.4-51	tack IOT Ga	ateway Dashboard		
		A second back of a		
Network In	formation	Sensor Nodes		
name	Oxaabb	Sensor	Value	RSSI
Short Address	0xAABB	© 2016-17 Texas Instruments Incorporat	ed.	
Extendded Address	0x124b000e07d5db			
Channels	0			
Mode	beacon			
State	started open			

图 67. Local Dashboard



11. *(IBM Example Only)* A form will pop up, fill out the form with the IBM Cloud account information. When complete, click *Save Changes* and then *Close*. If the Gateway was successful on connecting to the IBM Cloud then the Red dot next to "Cloud" on the dashboard should turn green.

Sensor-To-Cloud L	Local D X					X
\leftrightarrow \rightarrow C A Not	t secure https://192.168.1.2	22/dashboard.html				☆ :
IP Address:192. WiFi: • Cloud: •	-Stack IoT Ga	Cloud Credentials	×			
11 10.1		Org Id				
		Enter IBM Org Id				
		Device Type				
Network	k Information	Enter IoT Watson Registered Device Type				
		Device Id			RSSI	
name	Oxaabb	Enter IoT Watson Registered Device Id				
Short Addre	ess 0xAABB	Password				
Extendded Address	0x124b000e07d5db	Enter IoT Watson Registered Password for the Device				
Channels	0		Close Save changes			
Mode	beacon					
State	open close			-		

图 68. Cloud Credentials Form

- 12. (*IBM Example Only*) Go to the IBM Cloud Foundry App URL provided on the IBM Cloud account, which looks something like *APP_NAME.mybluemix.net*.
- 13. Click the open button on the dashboard to allow sensors to join the network.



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Network Inform	ation	Sensor Node	25				
'anID	0X0001	Short Address	Ext Address	Sensors Data	RSSI	Toggle/Submit	Value
Coord Addr	0XAABB						
letwork Mode	Beacon Enabled						
Security	Disabled						
Vetwork close for Nev Devices	open 🚽	_					

图 69. IBM Cloud Dashboard Open Button

🖲 sta	ackArmor				texas li	NSTRUMENTS
IO	T Dashboar	d				
Ne	etwork Information		Network Chart			
P	anID	0x0001				
C	coord Addr	Oxaabb				
N	letwork Mode	beacon				
s	ecurity	yes				
N	letwork	On Con				
Se	ensor Nodes					ζ٥
	Device Info	Device Data	Last Received	Device Status	Toggle-Req	

图 70. AWS Cloud Dashboard Open Button

- 14. Apply power to the LaunchPad labeled Sensor.
- 15. Now the sensor should automatically start looking for a network. If paired with the network successfully, the *Sensor* board can be viewed and controlled from the web browser.
 - 注: If the device is not visible in the web browser, the device is most likely connected to another network. To solve this error, complete a factory reset on the sensor by pressing the reset button while holding the right button (BTN-2), and try again.

TEXAS INSTRUMENTS

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🖲 stackArmor

🚸 TEXAS INSTRUMENTS

IOT Dashboard

Network Information	on	Network Chart	
PanID	Oxacdc		
Coord Addr	0x1234		
Network Mode	Non Beacon		
Security	1		
Network	On		
Sensor Nodes Device Info		Device Data	Toggle-
Sensor Nodes Device Info Short Address R\$SI	0x1 0x124b0008fb14c9 -33	Device Data temperature 22 Cels	Toggie-I Toggie
Sensor Nodes Device Info Short Address Ext Address RSSI Short Address Ext Address RSSI	0x1 0x124b0008fb14c9 -33 0x2 0x124b000bcd7f83 -54	Device Data temperature 22 Cels	Toggle- Toggle Toggle

图 71. AWS Front End After Devices Joined



Sensor-To-Cloud Local C × C Sensor-To-Cloud IB → C Secure https://gtwayfrontend.myd I 15.4-Stack Sensor-To-Cloud IBM Gate TI 15.4-Stack Gate	MG ×	mple Application		¢.
Network Information		Sensor Nodes		
PanID	0x0001	Device Info	Sensors Data	Toggle-Req
Coord Addr	0xAABB		21.0% RH	A
Network Mode	Beacon Enabled			
Security	Enabled	SAddr: 0x0002	26.0°C	
Network open for New Devices	close	ExAddr: 0x124B000BCCDB01	g 1lux	DeduED
		RSSI: -51 dBm	2514 Pa	RedLED
Network			🣋 3320 m∨	
•			2017	
			26.0°C	
		SAddr: 0x0001		•
© 2016-17 Texas Instruments Incc	rporated.			

图 72. Sensor2Cloud Front End

3.2.1.1.9.2 Using the Local Provisioning Web Page

- 注: This is an alternate option if using the SimpleLink App is not desired.
- 1. Make sure the CC3220SF LaunchPad is powered on and that a serial console, like Tera Term, is opened to see the console output of the device.
- 2. On the PC search for Wi-Fi networks, and connect to the one broadcasted by the LaunchPad, which should look something like *mysimplelink-XXXX*.





图 73. Connect to LaunchPad™



3. Open a browser window, and navigate to *mysimplelink.net* this should open the start page shown below.



图 74. mysimplelink.net Local Home Page

 Press the Configure WiFi Network button to go to the Network Configuration page. Note: Before entering the network information make sure to have a serial terminal open for the CC3220 gateway so you can record the IP address given to the gateway.


Sub 1GHz to WiFi Gatewark		
← → C ▲ Not secure h	ttps://10.123.45.1/network_info.html	☆ :
TI 15.4 Stack - IoT Ga Connect your iot gate	ateway Setup (Network Configurator) eway to your Wi-Fi network, Please select your network from the List.	
SSID	Select Network	
Security Type Security Key Profile Priority	Open •	

图 75. Network Configuration Page



Hardware, Software, Testing Requirements, and Test Results

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5. Enter the required information for the desired Wi-Fi access point, and click on the *Add* button. A popup window with instructions like 🛛 76 will appear.

10.123.45.1 says:	×	
 Check command console and make sure device is connected and take note of the IP Address. 		
2.Connect to: NETGEAR		
3.Type the device IP in the browser address bar.		
**If Device provision failed, wait for the device network to show, and reconnect to it and try again.		
ок]	

图 76. Pop-up Message

6. Go to the serial terminal and make sure to save the new IP address assigned to the CC3220 gateway.

COM155:115200baud - Tera Term VT		_ 🗆 🗙
<u>File Edit Setup Control Window Help</u>		
[Provisioning] Profile Added: SSID: E03A8E [Provisioning] Profile confirmation: WLAN Connecte [Provisioning] Profile confirmation: IP Acquired! [NTP] Current time: Mon Dec 18 16:56:13 2017	d! [192.168.0.12]	
		T

图 77. IP Address displayed on Serial Terminal

7. Using a computer or a mobile device connect to the same WiFi access point as the CC3220 gateway, open an internet browser and go to the IP addess assigned to the gateway, in this case it would be https://192.168.0.12 this should open the start page shown below.





图 78. Start Page

8. Go to the section Using SimpleLink Starter Pro App at the beginning of \ddagger 3.2.1.1.9, and follow the instructions starting from step 8.



3.2.2 Test Results

3.2.2.1 IoT Dashboard

Sensor2Cloud	Sub 1G Sensor To Cloud							¢
	Sub 1G Sensor	To Cloud						
	Network Information		Sensor Nodes					
	PanID	0xACDC	Short Address	Ext Address	Sensors Data	RSSI Value	Action	
	Coord Addr	0x1234	0x2 0x1248000	E07E7D1	24.0°C	20 Togglol ed		
	Network Mode	Non Beacon	0.2 0.1246000	X124B000E07E7D1		-20 ToggieLed	Ŧ	
	Security	Enabled	0x1 0x124B000	00E07D00D	24.0°C			
	Network close for New Devices	open			۲	-22 ToggleLed	+	
	Network							
	© 2016-17 Texas Instruments Inco	rporated.						

图 79. IBM Sensor-to-Cloud Dashboard Results



4 Design Files

This reference design showcases the connectivity between CC3220SF and CC13x0 devices. The CC3220SF acts as a gateway processor and the CC13x0 as communication node. The CC3220SF LaunchPad is used as a platform for gateway processor, and the CC13x0-based LaunchPad acts as communication node. The recommended schematics for this reference design uses the schematics of the CC3220SF LaunchPad and CC13x0 LaunchPad and interface the two devices using the UART lines. This IoT gateway reference design only uses one UART port. In addition, bootloader backdoor pins are described in the CC2538/CC26xx Serial Bootloader Interface application report. These pins can be connected to upgrade the firmware on the CC13x0 using the serial ROM bootloader on the CC13x0 devices.

4.1 Schematics

To download the schematics for this reference design, see the following links:

- LAUNCHXL-CC1310
- LAUNCHXL-CC1350
- CC3220SF-LAUNCHXL

4.2 Bill of Materials

- LAUNCHXL-CC1310
- LAUNCHXL-CC1350
- CC3220SF-LAUNCHXL

4.3 PCB Layout Recommendations

For layout prints, Altium project files, Gerber files, and assembly drawings, see the following links:

- LAUNCHXL-CC1310
- LAUNCHXL-CC1350
- CC3220SF-LAUNCHXL

5 Software Files

To download the software files, see the link at https://git.ti.com/tidc01002/tidc01002.

6 Related Documentation

- 1. Texas Instruments, SimpleLink TI 15.4-Stack IEEE 802.15.4e/g Standard Based Star Networking Software Development Kit, Tools Folder
- 2. Texas Instruments, SimpleLink CC3220 SDK, Tools Folder
- 3. Texas Instruments, TI 15.4-Stack Wiki, Wiki Page
- 4. Texas Instruments, TI 15.4-Stack Embedded Developers Guide

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修订历史记录

注: 之前版本的页码可能与当前版本有所不同。

Changes from Original (July 2017) to A Revision

Page

•	已更改 all instances of <i>TI Design</i> to <i>reference design</i>	. 2
•	已更改 CC1310 to CC13x0 and CC1350 to CC13x02 throughout	. 2
•	已更改 cloud service provider to IBM Watson IoT	. 2
•	已更改 Software Block Diagram of TI 15.4-Stack Sensor-to-Cloud Reference Design image	. 4
•	已添加 System Design Theory section and moved TI IoT Gateway-to-Cloud Service Interface section	. 8
•	已添加 (for IBM Cloud only) to the Software section	12
•	已更改 CC3220 SDK v1.30.01.03 to CC3220 SDK v1.50.00.06 in the Software section	12
•	已添加 SimpleLink CC13x2 SDK and removed v1.30 from SimpleLink CC13x0 SDK	12
•	已添加 AWS IoT cloud services to Test Setup section	13
•	已更改 Running the Out-of-Box Examples section	13
•	已添加 Running IBM Gateway Example section and changed Bluemix to Cloud	13
•	已添加 Running the AWS IoT Example section	14
•	已更改 section title from Program the MAC CoP LaunchPad™ to Programming the CC13x0 LaunchPad™	14
•	已更改 MAC CoP to CC13x0 in the Programming the CC13x0 LaunchPad™ section	14
•	已更改 CC1350 LaunchPad CoProcessor.hex or sensor_cc1350lp_doorlock.hex to CoProcessor or Sensor hex files	
	provided in the prebuilt directory in the Programming the CC13x0 LaunchPad [™] section	15
•	已更改 out-of-the-box demonstration to CC3220SF LaunchPad in the Programming the CC3220SF LaunchPad™	40
	Section	16
•	C.\ <s2c_repo_directory>\CC3220_CC13x0Gateway\prebuilt\CC3220SF_LaunchXL\Uniflash_CC3220ImageCreatorPret.zip to C:\<s2c_repo_directory>\tidc01002\prebuilt\CC3220SF_LaunchXL\Uniflash_CC3220ImageCreatorProject.zip n Programming a Preconfigured Image Creator Project section</s2c_repo_directory></s2c_repo_directory>	roj :ip 19
•	已添加 Importing Examples to Code Composer Studio (CCS) section	22
•	已添加 Compiling the Mac-CoP from Source section	24
•	已更改 trusted root-certificate catalog directory path in the Creating an Image Creator Project in UniFlash section	27
•	已更改 service pack directory path in the Creating an Image Creator Project in UniFlash section	28
•	已更改 directory path from C:\ <s2c repo<br="">Directory>\\CC3220_CC13x0Gateway\\examples\\CC3220SF_LaunchXLcc3220sf_gateway_app/15_4_Stack_Gtway_C 220SF_LAUNCHXL_tirtos_ccs/ to C:\<s2c directory="" repo="">tidc01002\src\www in the Creating an Image Creator Projection in UniFlash section</s2c></s2c>	CC3 ct 29
•	已添加 instructions for the www folder in the Creating an Image Creator Project in UniFlash section	29
•	已更改 section title to Connecting the MAC-CoP and the CC3220SF LaunchPad™ and updated jumper/configuration	
	instructions	35
•	已更改 content in Open and Configure an IBM Cloud™ Account section	37
•	已更改 content in Set Up Watson IoT™ Platform Service section	42
•	己更改 content in Set Up Node.js Cloud Foundry App section	50
•	已更改 cd C:\ <s2c directory="" repo="">\CC3220_CC13x0Gateway\\examples/ibm_cloud_application to cd C:\<s2c directory="" repo="">\tidc01002\examples\ibm_cloud_application in Set Up Node.js Cloud Foundry App section</s2c></s2c>	51
•	已更改 content in Using the SimpleLink™ Starter Pro App section	60
•	已更改 content in Using the Local Provisioning Web Page section	70

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