Tech Talks LIVE Schedule – Presentation will begin shortly

Topic	Date
Building a Proper Mesh Test Environment: How This Was Solved in Boston	Thursday, July 2
Secure Your Bluetooth Design with BG21/BG22	Thursday, July 23
New Bluetooth Mesh Light & Sensor Models	Thursday, July 30
Simplicity Studio v5 Introduction	Thursday, August 6
Long-Range Connectivity Using Proprietary RF Solution	Thursday, August 13
Wake Bluetooth from Deep Sleep Using an RF SIgnal	Thursday, August 20
Implementing a Bluetooth Network Co-Processor	**Thursday, August 27**

Fill out the survey for a chance to win a BG22 Thunderboard!

Find Past Recorded Sessions at:
https://www.silabs.com/support/training

Implementing a Bluetooth® Network Co-Processor

AUG 2020

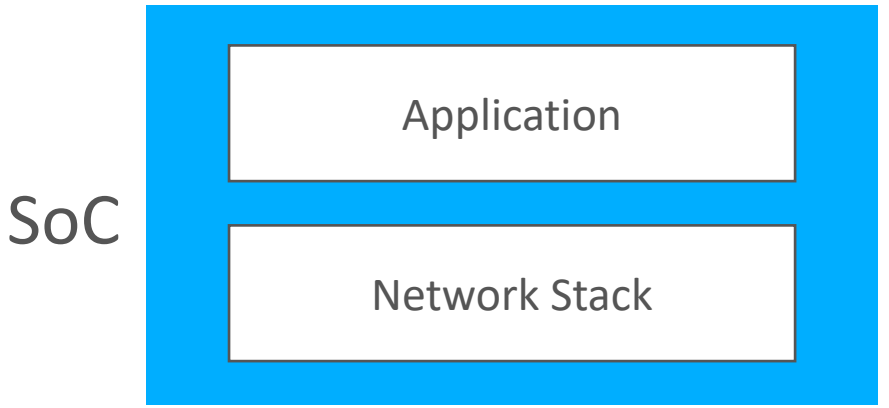
Agenda

- What is a Bluetooth Network Co-Processor?
- How does it work?
- How can you implement one?
- What all can you use it for?

Network Co-Processor (NCP): Definition

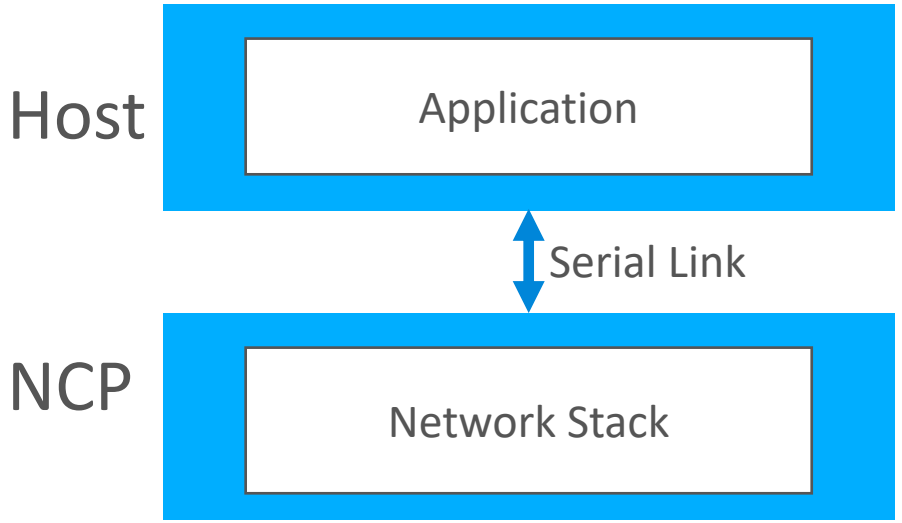
System on Chip (SoC)

- Application and Network Stack are both resident in the same device



Network Co-Processor (NCP)

- Network Stack is on the NCP device
- Application is on a separate host processor
- A serial link is used to communicate between the host processor and the NCP



NCP Use Cases

The NCP architecture is typically used when it’s easier or more efficient to manage the application on a separate processor than the processor on which the network stack resides.

- Gateways
- Test Fixtures
- Adding wireless interfaces to specialized SoCs
- High performance multi-protocol (SoC + NCP)

Blue Gecko NCP

Well Defined Serial API (BGAPI)

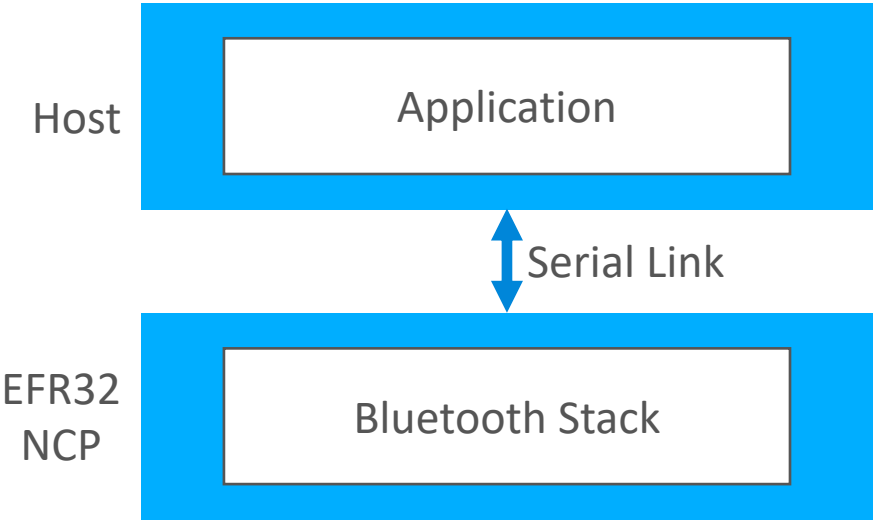
- Command
- Response
- Event

- Portable C BGAPI library code included in the SDK

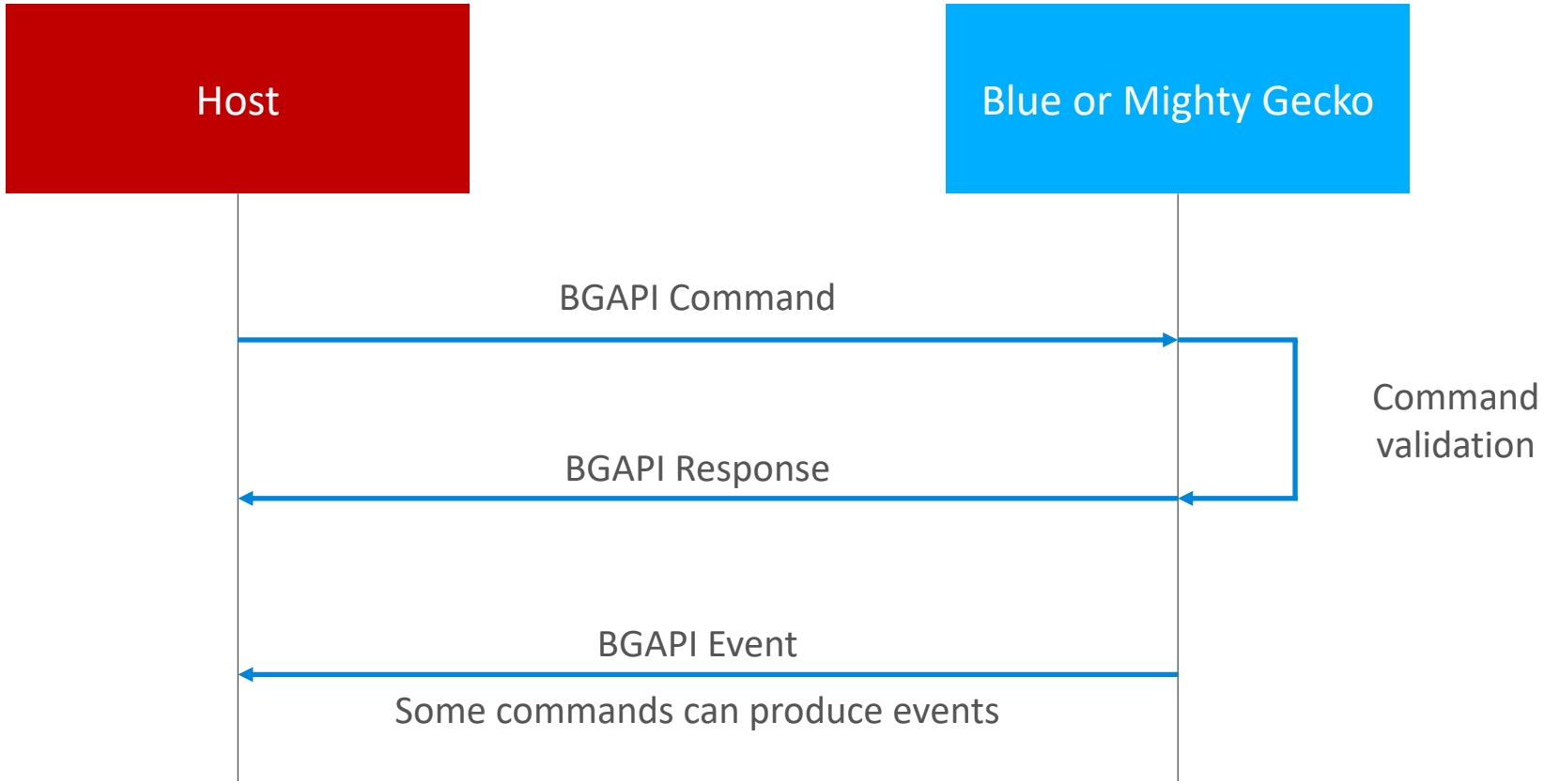
- XML API definition included for generating libraries for other programming languages

- Runs on any EFR32MG or EFR32BG device

- BGAPI NCP host code is identical to EFR32 SoC code!



BGAPI Serial Protocol Message Exchange



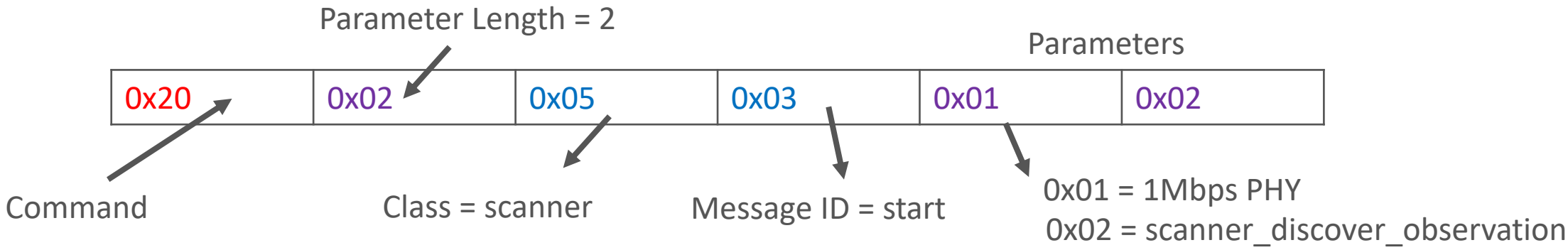
BGAPI Serial Protocol Packet Structure

Byte	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4-255
Explanation	Message type	Payload Length	Message Class	Message ID	Payload
Values	0x20: command 0x20: response 0xA0: event	0x00 – 0xFF	0x00 – 0xFF	0x00 – 0xFF	Specific to command, response, or event

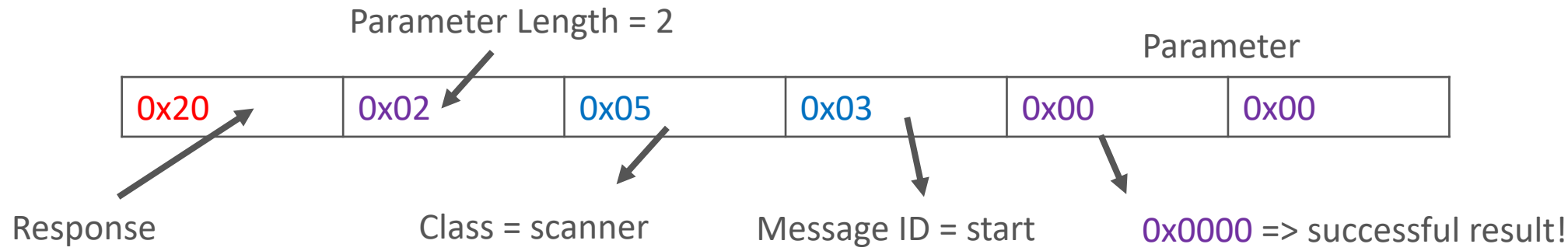
Blue Gecko NCP: Example

Command: sl_bt_scanner_start

- Begin scanning for advertising with previously configured parameters along with command parameters



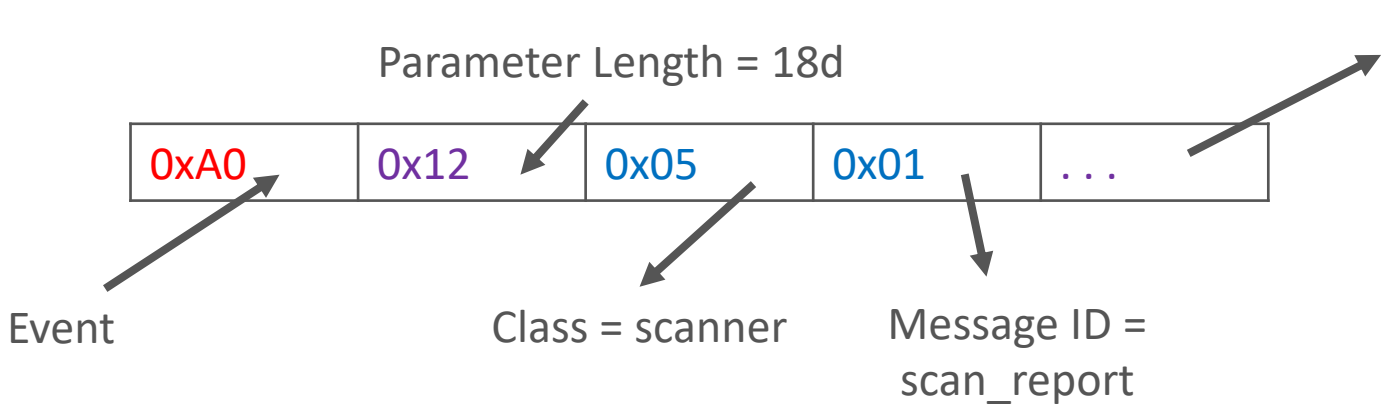
Response: sl_bt_scanner_start



Blue Gecko NCP: Example

Event: sl_bt_evt_scanner_scan_report

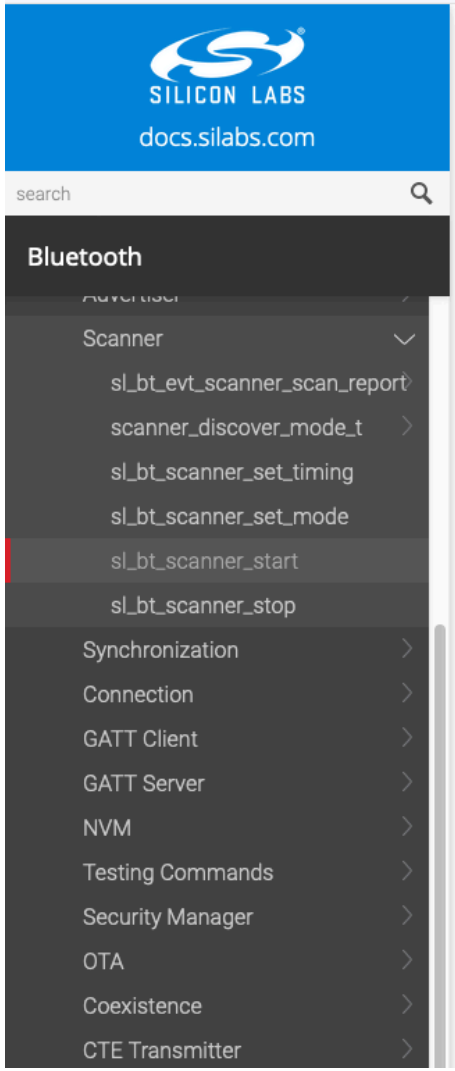
- Event triggered each time an advertising packet is received in scanning mode. Contains all the data for each received advertising (address, payload, etc.)



Parameters

uint8_t packet_type
bd_addr address
uint8_t address_type
uint8_t bonding
uint8_t primary_phy
uint8_t secondary_phy
uint8_t adv_sid
int8_t tx_power
int8_t rssi
uint8_t channel
uint16_t periodic_interval
uint8array data

Blue Gecko NCP: Documentation



◆ sl_bt_scanner_start()

```
sl_status_t sl_bt_scanner_start                    ( uint8_t    scanning_phy,
                                                     uint8_t    discover_mode
                                                   )
```

Start the GAP discovery procedure to scan for advertising devices on the specified scanning PHY or to perform a device discovery. To cancel an ongoing discovery process use the `sl_bt_scanner_stop` command.

The invalid parameter error will be returned if the scanning PHY value is invalid or the device does not support the PHY.

Parameters

[in]	`scanning_phy`	Enum `gap_phy_type_t`. The scanning PHY. Values: • **gap_1m_phy (0x1):** 1M PHY • **gap_coded_phy (0x4):** Coded PHY
[in]	`discover_mode`	Enum `scanner_discover_mode_t`. Bluetooth discovery Mode. Values: • **scanner_discover_limited (0x0):** Discover only limited discoverable devices. • **scanner_discover_generic (0x1):** Discover limited and generic discoverable devices. • **scanner_discover_observation (0x2):** Discover all devices.

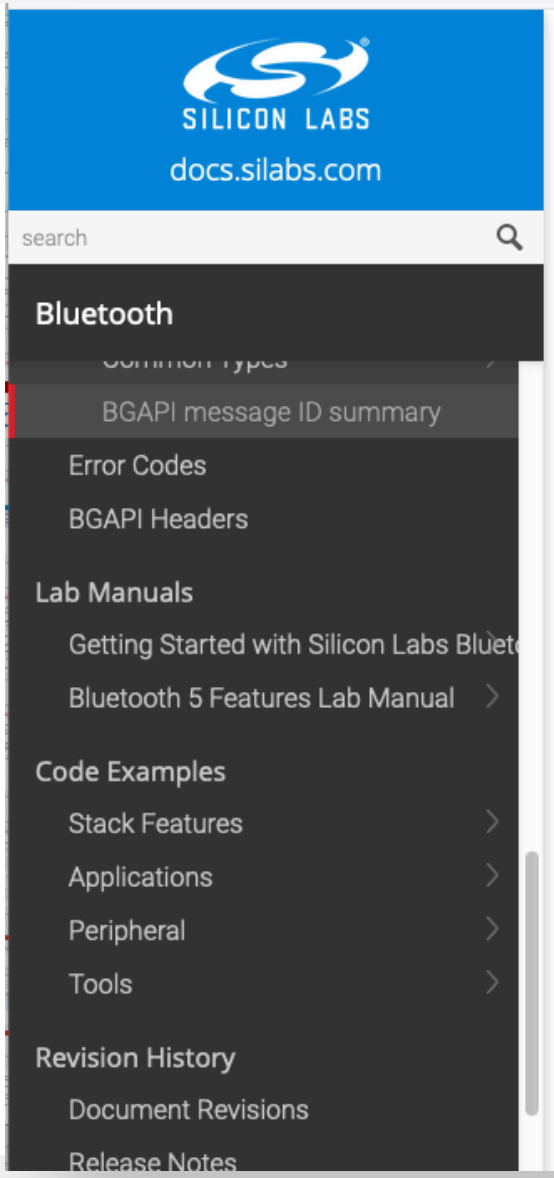
Returns

SL_STATUS_OK if successful. Error code otherwise.

Events

- `sl_bt_evt_scanner_scan_report` - This event is triggered each time an advertising packet is received. Packets are not filtered in any way, so multiple events will be received for every advertising device in range.

Blue Gecko NCP: Documentation



You are viewing documentation for version: **3.0** (latest) | 2.13 | Version History

BGAPI message ID summary

Summary of BGAPI command, response, and event IDs.

The following table summarizes the command, response, and event IDs used in the BGAPI protocol. The table shows the minimum payload length for each message. Messages that have an array parameter can have longer payload length depending on the length of the array.

BGAPI message ID summary

Name	Type	Minimum Payload Length	Class	Message ID
Scanner				
cmd_scanner_set_timing	0x20	0x05	0x05	0x01
rsp_scanner_set_timing	0x20	0x05	0x05	0x01
cmd_scanner_set_mode	0x20	0x02	0x05	0x02
rsp_scanner_set_mode	0x20	0x02	0x05	0x02
cmd_scanner_start	0x20	0x02	0x05	0x03
rsp_scanner_start	0x20	0x02	0x05	0x03
cmd_scanner_stop	0x20	0x00	0x05	0x05
rsp_scanner_stop	0x20	0x00	0x05	0x05
evt_scanner_scan_report	0xa0	0x12	0x05	0x01
Synchronization				

BGAPI 3.x vs. 2.x

- BGAPI has been revised with the Bluetooth SDK 3.0
- The new API commands and events use a new naming convention to comply with Silicon Labs standards
- New BGAPI classes and commands have been introduced and some removed to make the API more transparent and consistent
- API changes are described in section 5 of AN1255: Transitioning from the v2.x to the v3.x Bluetooth® SDK
- **BGAPI 2.x is not compatible with BGAPI 3.x!**

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AN1255: Transitioning from the v2.x to the v3.x *Bluetooth*® SDK

Bluetooth Software Development Kit (SDK) v3.0 contains a number of changes compared to Bluetooth SDK v2.x. Many of these changes are due to an underlying framework redesign that results in an improved developer experience within the new Simplicity Studio 5. Projects are now built on a component architecture. Simplicity Studio 5 includes project configuration tools that provide an enhanced level of software component discoverability, configurability, and dependency management. These include a Component Editor, and a redesigned GATT configurator.

KEY POINTS

Reviews differences in:

- Software architecture
- The API

Producing Blue Gecko NCP Target Firmware: Demo

Pre-built example NCP firmware images are available within Simplicity Studio for most Silicon Labs boards

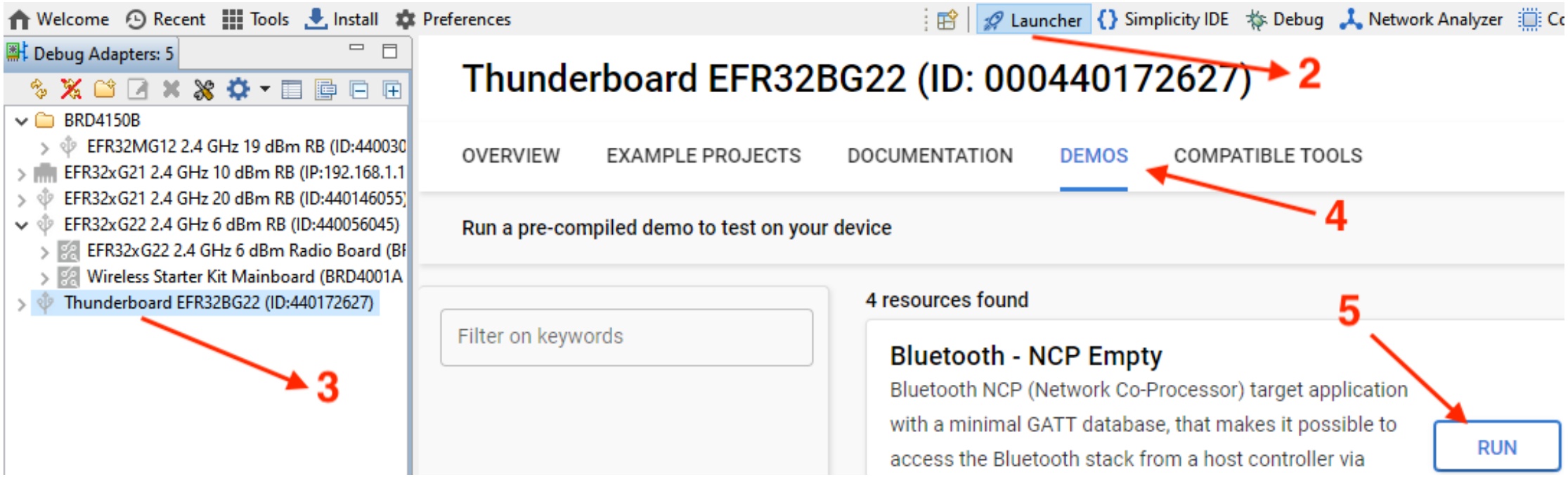
1. Plug board into USB port
2. Go to the Simplicity Studio ”Launcher” perspective
3. Select target board under ”Debug Adapters”
4. Select “Demo”.
5. Click ”Run” next to ”Bluetooth – NCP Empty”

Thunderboard Sense 2

BG22 Thunderboard

Wireless Starter Kit (WSTK) with Radio Board

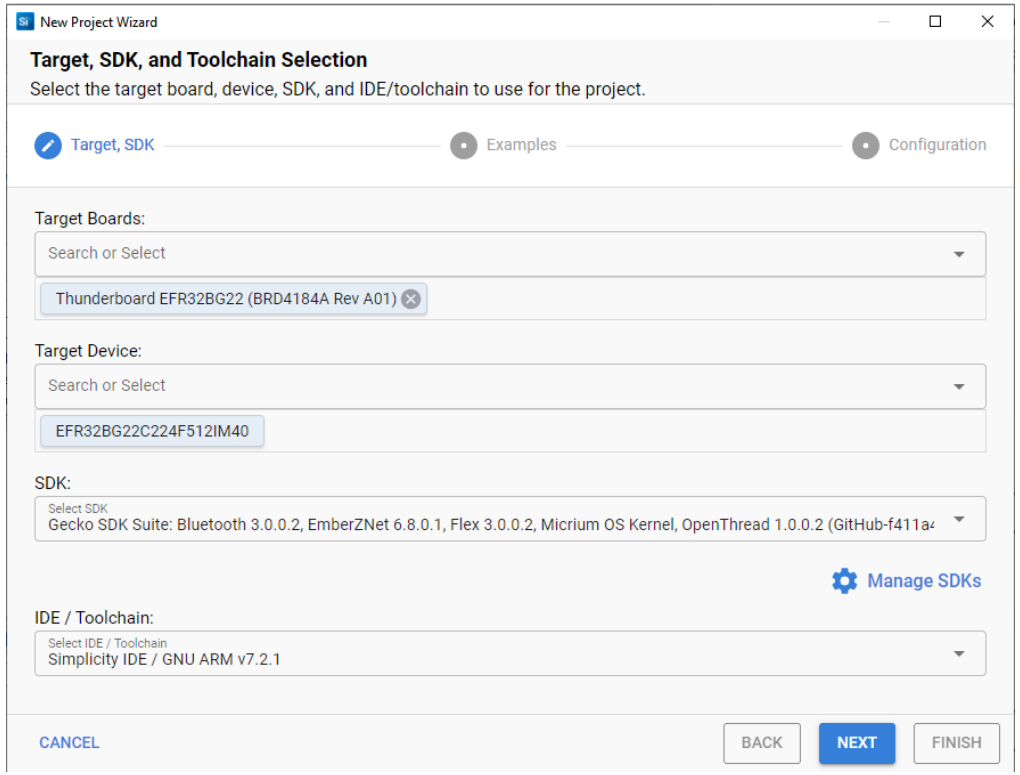
Producing Blue Gecko NCP Target Firmware: Demo



Producing Blue Gecko NCP Target Firmware

For boards on which the pre-built demo firmware is not available (including your own custom hardware), you can create and build your own NCP firmware project

1. Select File->Silicon Labs Project Wizard
2. Select target board or target device (if custom board).
3. Select ”Bluetooth – NCP Empty”



Other Useful NCP Features

Custom BGAPI

- Implement custom BGAPI NCP commands for custom functionality in the NCP firmware
- Examples:
  - System temperature sensing
  - UI handling (LEDs, buttons, etc.)

Local Event Handling

- Implementing local handlers in the NCP firmware reduces the amount of messages that the host has to service
- Example: advertisement filtering – only send advertisement events to the host that meet specific criteria

Other Useful NCP Features

Low Power Support

- Implemented with wake-lock pins
- Wake-lock input: when asserted by external host, wakes and then sends event sl_bt_evt_system_awake to indicate to the host that it has woken up.
- Wake-lock output: NCP can assert prior to sending an event (allows host to sleep too)

Angle of Arrival / Angle of Departure NCP Support

- EFR32BG22 supports CTE transmit and receive commands over NCP for Angle of Arrival / Angle of Departure implementations

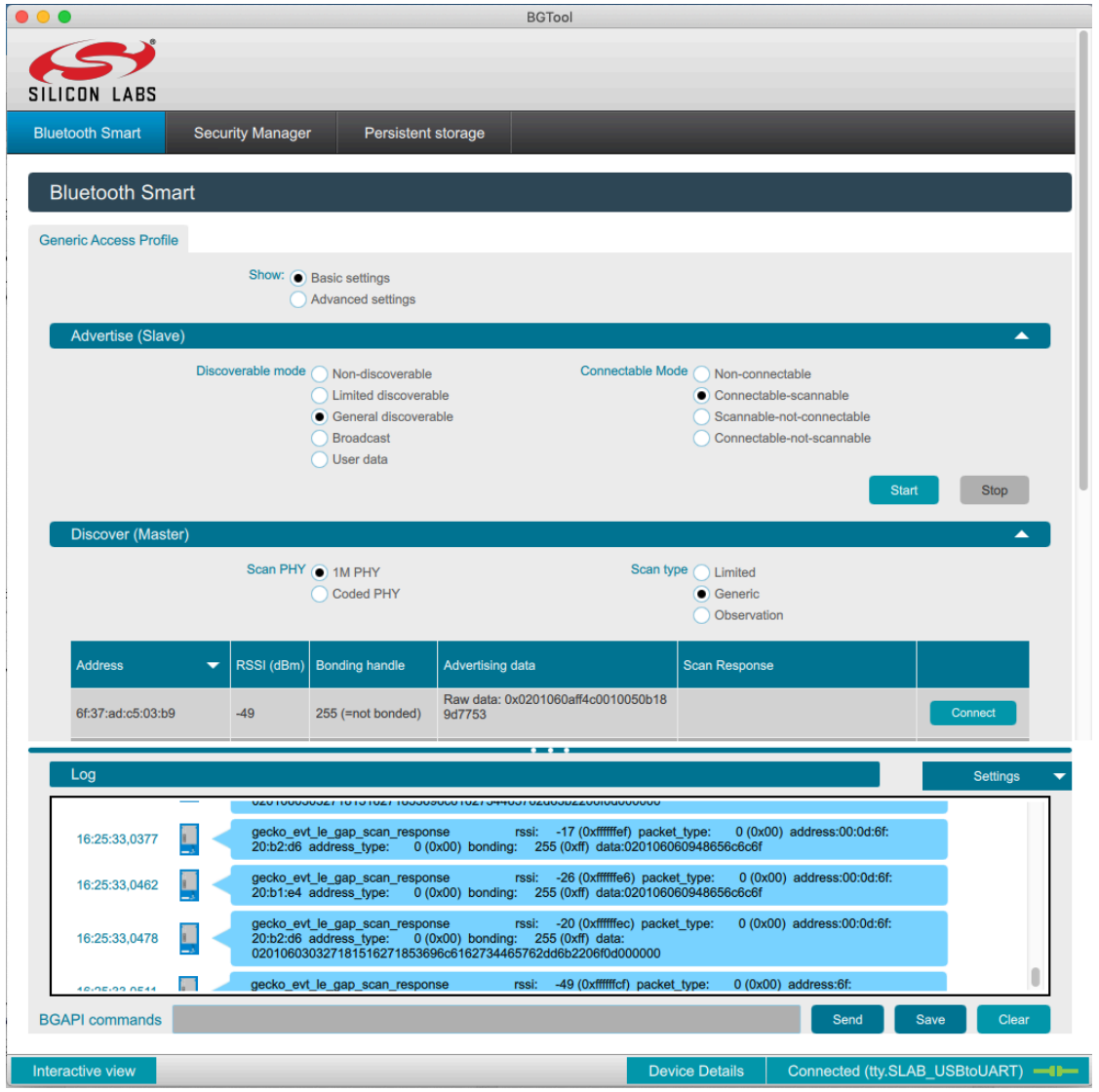
- **Wi-Fi Coexistence**

Blue Gecko NCP Host Software: BGTool

Simplicity Studio includes an NCP host GUI utility called BGTool

Provides the ability to command the NCP to:

- Transmit advertising
- Receive advertising
- Establish a connection with a connectable device and browse the remote GATT database
- Perform DTM transmit and receive tests
- Execute arbitrary API commands

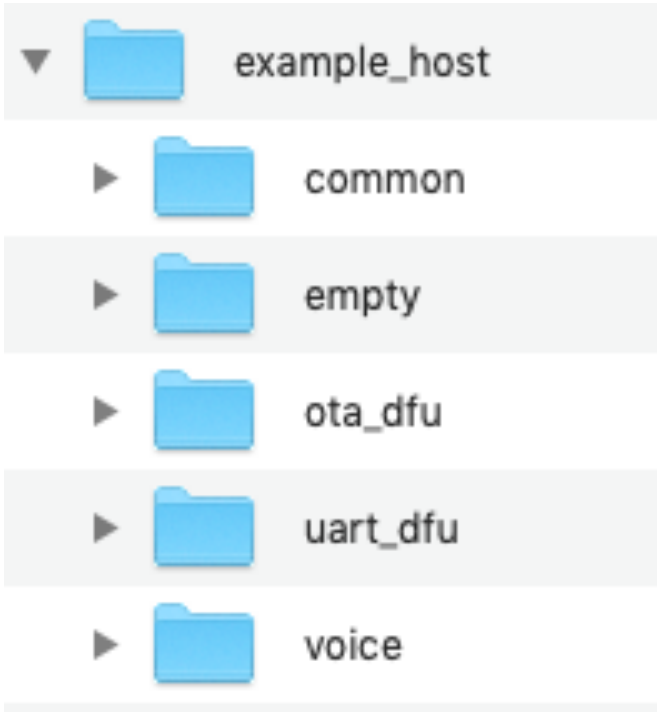


Blue Gecko NCP Host Software

The Silicon Labs Bluetooth SDK includes several example host applications as portable GCC C language projects with makefile:

Studio v5 (Gecko SDK 3.x): app\bluetooth\example_host\

Studio v4 (Gecko SDK 2.x): app\bluetooth\examples_NCP_host\



- **empty** – An empty ”shell” project to use to implement your own application
- **ota_dfu** – Used to perform an OTA firmware update to a device running the Silicon Labs Apploader
- **uart_dfu** – Used to perform a serial firmware update to the NCP device
- **voice** – Example using BLE to collect ADPCM compressed voice data

Building Blue Gecko NCP Host Examples

Builds natively on Mac or Linux – just go to the folder using a terminal and type “make”

For Windows, there are two options (both also use gcc make):

1. **MinGW**
   - Minimalist GNU development environment for Windows
   - Builds native MS-Windows command-line applications
   - https://mingw.org/

2. **Cygwin**
   - POSIX Emulator for Windows
   - Build executables that run within the Cygwin environment
   - http://cygwin.com/

3rd Party Blue Gecko NCP Host Software

There are several Blue Gecko NCP host implementations that are not official Silicon Labs releases, but are quite useful:

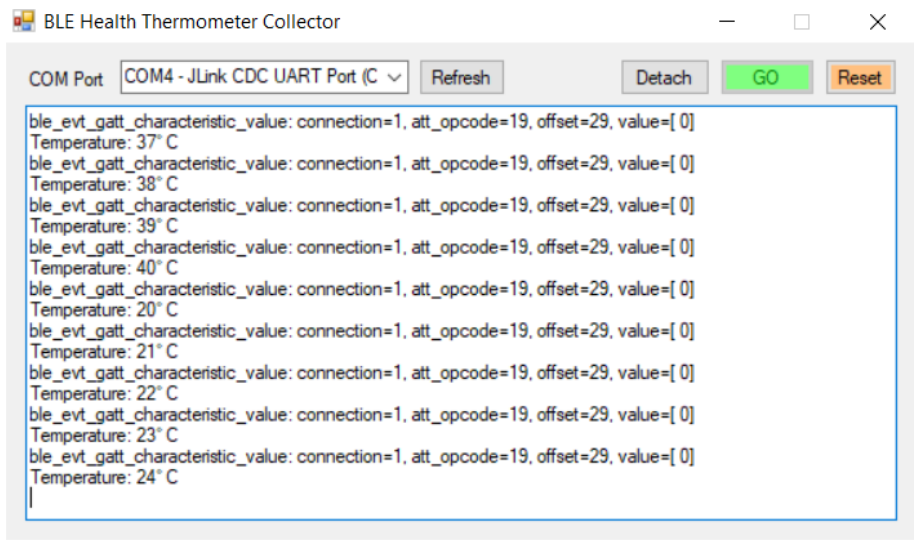
- https://github.com/jrowberg/bglib/tree/master/BlueGecko

  This repo includes API 2.x Blue Gecko NCP host libraries and example projects for both MS Visual C# and Python 3

- https://github.com/kryoung-silabs/

  This repo includes a few additional API 2.x BGLIB C library example projects

  - **soc-thermometer-client**: Connects to multiple health thermometer server devices and displays the temperature readings
  - **BLETest**: A general purpose NCP host RF test utility




```
$ ./exe/thermometer-client /dev/ttyACM0 115200 1
Starting up...
Resetting NCP target...

BLE Central started

ADDR  TEMP   RSSI |ADDR  TEMP   RSSI |ADDR  TEMP
2a9b 29.90C -28dBm|0000  0.00C   0dBm|0000  0.00C
```

Silicon Labs' Bluetooth Module Families

						
	BGM13P	**BGM13S**	**BGM210P**	**BGM210L**	**BGM220P (Q3'20)**	**BGM220S (Q3'20)**
Protocols	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)
EFR32 SoC	BG13	BG13	BG21	BG21	BG22	BG22
Antenna	Built-in or U.FL	Built-in or RF pin	Built-in or RF pin	Built-in	Built-in	Built-in or RF pin
Max TX power	+8 / +19 dBm	+8 / +18 dBm	+10 / +20 dBm	+12.5 dBm	+8 dBm	+6 dBm
Sensitivity (1M)	-94.8 dBm	-94.1 dBm	-97 dBm	-97 dBm	-98 dBm	-98 dbm
Flash (kB)	512	512	1024	1024	512	512
RAM (kB)	64	64	96	96	32	32
GPIO	25	30	20	12	24,25	25
Operating Voltage	1.8V – 3.6V	1.8V – 3.6V	1.8 – 3.8V	1.8 – 3.8V	1.71V – 3.8V	1.71V – 3.8V
Operating Temp.	-40 to +85C	-40 to +85C	-40 to +125C	-40 to +125C	-40 to +105C	-40 to +105C
Dimensions W x L x H (mm)	13.0 x 15.0 x 2.2	6.5 x 6.5 x 1.4	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	6 x 6 x 1.3
Certifications	BT, CE, FCC, ISED, Japan, S-Korea and Taiwan	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea

3rd Party Hardware – Darwin Tech Bluetooth 5.0 Dongle

- Agency Certifications
  - US
  - Canada
  - Australia and New Zealand
  - Europe
- +7 dBm
- Bluetooth v5.0 including long range PHY support
- Based on EFR32BG13
- Available through Symmetry Electronics

Blue Gecko NCP Summary

- Highly flexible solution for implementing Bluetooth in a variety of different applications and architectures
- It’s easy to get started on Silicon Labs development boards and available software examples
- It’s easy to deploy with agency certified modules from both Silicon Labs and third parties

Useful References

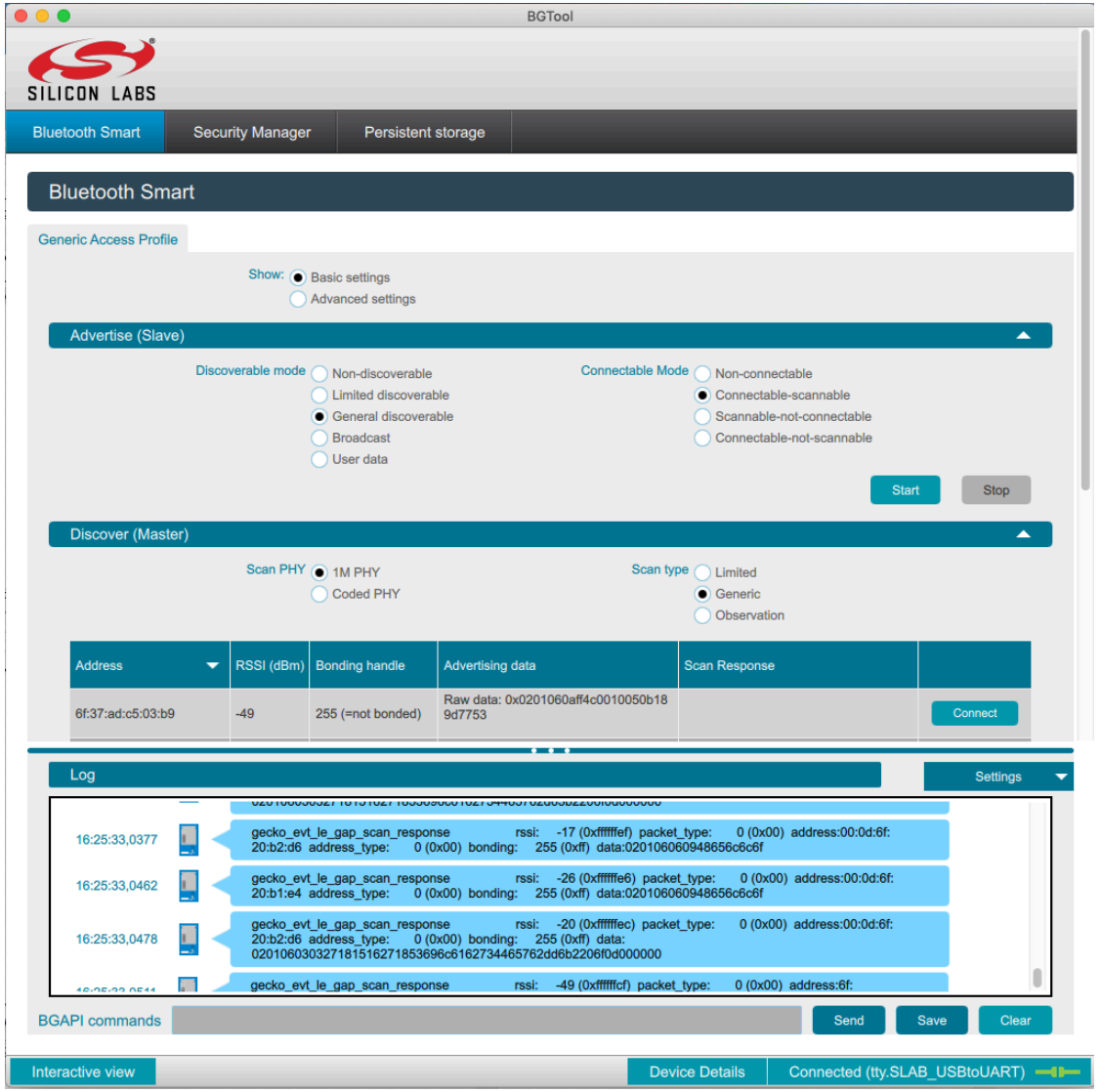
- AN1259: Using the v3.x Silicon Labs Bluetooth® Stack in Network Co-Processor Mode
- AN1042: Using the v2.x Silicon Labs Bluetooth® Stack in Network Co-Processor Mode

  These are general guides with details on getting started with using NCP mode. Also includes information on implementing custom BGAPI.
- AN1255: Transitioning from the v2.x to the v3.x Bluetooth® SDK
- KBA_BT_1602: NCP Host Implementation and Example

  This example implements an NCP host on an EFM32 device. This is a good guide for implementing NCP hosts on a generic embedded processor (specialized SoC, etc.).
- Local Event Handling on Bluetooth NCP

  docs.silabs.com link explaining how to implement event handling local to the NCP
- https://github.com/jrowberg/bglib/tree/master/BlueGecko
- https://github.com/kryoung-silabs/
- https://www.darwintechnologiesllc.com/products

BGTool Demo


BGTool
SILICON LABS
Bluetooth Smart
Security Manager
Persistent storage
Bluetooth Smart
Generic Access Profile
Show:
Basic settings
Advanced settings
Advertise (Slave)
Discoverable mode
Non-discoverable
Limited discoverable
General discoverable
Broadcast
User data
Connectable Mode
Non-connectable
Connectable-scannable
Scannable-not-connectable
Connectable-not-scannable
Start
Stop
Discover (Master)
Scan PHY
1M PHY
Coded PHY
Scan type
Limited
Generic
Observation
Address
RSSI (dBm)
Bonding handle
Advertising data
Scan Response
6f:37:ad:c5:03:b9
-49
255 (=not bonded)
Raw data: 0x0201060aff4c0010050b189d7753
Connect
Log
Settings
16:25:33,0377
gecko_evt_le_gap_scan_response rssi: -17 (0xffffffef) packet_type: 0 (0x00) address:00:0d:6f:20:b2:d6 address_type: 0 (0x00) bonding: 255 (0xff) data:0201060609486 56c6c6f
16:25:33,0462
gecko_evt_le_gap_scan_response rssi: -26 (0xffffffe6) packet_type: 0 (0x00) address:00:0d:6f:20:b1:e4 address_type: 0 (0x00) bonding: 255 (0xff) data:020106060948656c6c6f
16:25:33,0478
gecko_evt_le_gap_scan_response rssi: -20 (0xffffffec) packet_type: 0 (0x00) address:00:0d:6f:20:b2:d6 address_type: 0 (0x00) bonding: 255 (0xff) data:
020106030327181516271853696c6162734465762dd6b2206f0d000000
gecko_evt_le_gap_scan_response rssi: -49 (0xffffffcf) packet_type: 0 (0x00) address:6f:
BGAPI commands
Send
Save
Clear
Interactive view
Device Details
Connected (tty.SLAB_USBtoUART)

works with

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TWO DAYS OF TECHNICAL TRAINING
FROM BEGINNER TO ADVANCED