3.4 Bluetooth Smart software

Bluegiga's *Bluetooth* Smart stack suite provides a complete development framework for *Bluetooth* Smart application implementers.

The *Bluetooth* Smart software supports two architectural modes:

- **Standalone operation:** All software including *Bluetooth* 4.0 stack, profiles and end user application all run on the Bluegiga's *Bluetooth* 4.0 hardware
- **Host assisted operation:** The *Bluetooth* 4.0 single mode stack and profiles run on the Bluegiga 4.0 single mode hardware but the end user application runs on a separate host (a micro controller for example)

The benefits of the development suite in either of the use cases is that it provides a complete *Bluetooth* 4.0 single mode stack so that no *Bluetooth* development is required, a well-defined transport protocol exists between the host and the *Bluetooth* hardware and also simple development tools are available for embedding the end user applications on the *Bluetooth* 4.0 single mode hardware.

The *Bluetooth* 4.0 single mode development suite consists of several components:

- A *Bluetooth* 4.0 single mode stack
- Binary based BGAPI protocol between the host (MCU) and the *Bluetooth* stack
- A C library (called BGLib) for the host that implements the BGAPI protocol
- BGScript scripting language and interpreter for implementing stand-alone applications on the *Bluetooth* 4.0 single mode hardware
- A Profile Toolkit for quick and easy development of GATT based *Bluetooth* services and profiles

3.4.1 *Bluetooth* Smart software

The *Bluetooth* Smart software is a full, embedded implementation of *Bluetooth* v.4.0 single mode stack software and it's dedicated for Bluegiga's *Bluetooth* Smart modules. The stack implements all mandatory functionality for a single mode device.

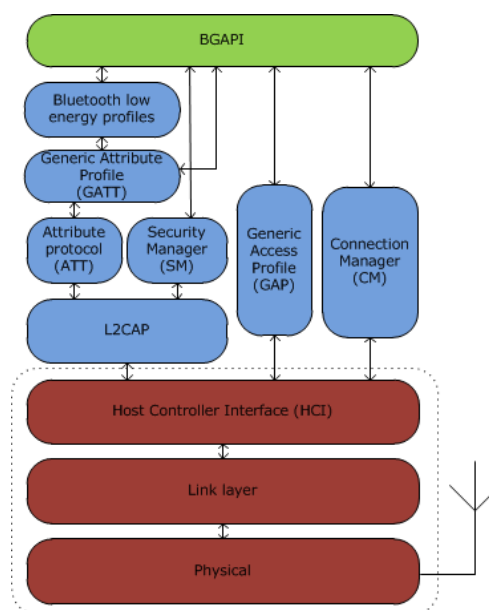The structure and layers of the stack are illustrated in the figure below.

Figure 1: Bluetooth 4.0 single mode stack

3.4.2 BGAPI protocol

For applications where a separate host is used to implement the end user application, a transport protocol is needed between the host and the *Bluetooth* Smart stack. The transport protocol is used to communicate with the *Bluetooth* stack as well to transmit and receive data packets. his protocol is called BGAPI and it's a binary based communication protocol designed specifically for ease of implementation within host devices with limited resources.

The BGAPI provides access to the following layers:

- **Generic Access Profile** - GAP allows the management of discoverability and connetability modes and open connections
- **Security manager** - Provides access the *Bluetooth* low energy security functions
- **Attribute database** - An class to access the local attribute database
- **Attribute client** - Provides an interface to discover, read and write remote attributes
- **Connection** - Provides an interface to manage *Bluetooth* low energy connections
- **Hardware** - An interface to access the various hardware layers such as timers, ADC and other hardware interfaces
- **Persistent Store** - User to access the parameters of the radio hardware and read/write data to non-volatile memory
- **System** - Various system functions, such as querying the hardware status or reset it

The BGAPI protocol is intended to be used with:

- a serial UART link or
- a USB connection

3.4.3 BGLib library

For easy implementation of BGAPI protocol a host library written with ANSI C is available. The library is easily portable ANSI C code delivered within the _Bluetooth Smart _software development kit. The purpose is to simplify the application development to various host environments.
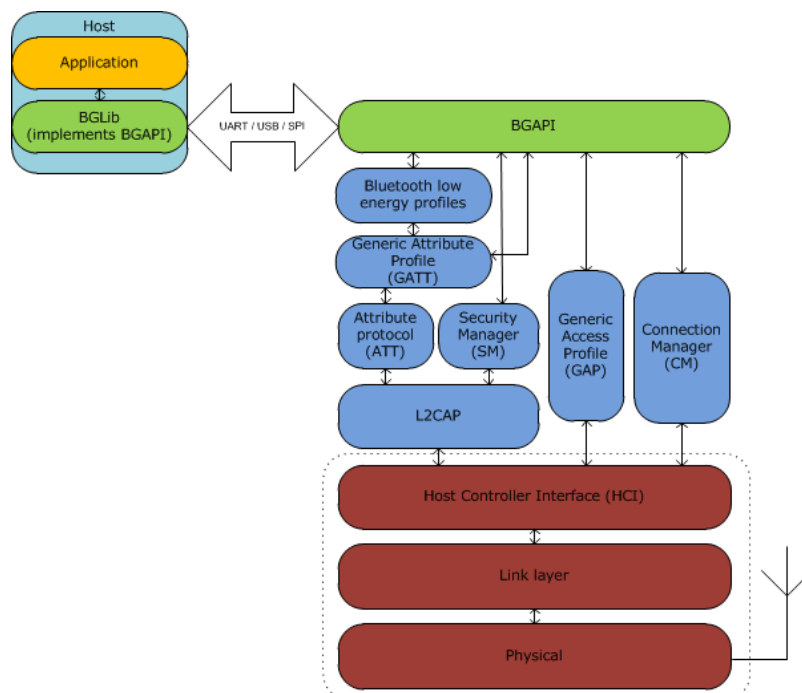

Figure 2: Host using BGLib

3.4.4 BGScript scripting language

Bluegiga's *Bluetooth* Smart products allow application developers to create standalone devices without the need of a separate host processor. The *Bluetooth* Smart modules can run simple applications along the *Bluetooth* stack and this provides a benefit when one needs to minimize the end product size, cost and current consumption. For developing standalone *Bluetooth* Smart applications the development suite provides a simple BGScript scripting language. With BGScript provides access to the same software and hardware interfaces as the BGAPI protocol. The BGScript code can be developed and compiled with free tools provided by Bluegiga.

When the BGScript approach is used the BGAPI host interface is not needed nor is it available.
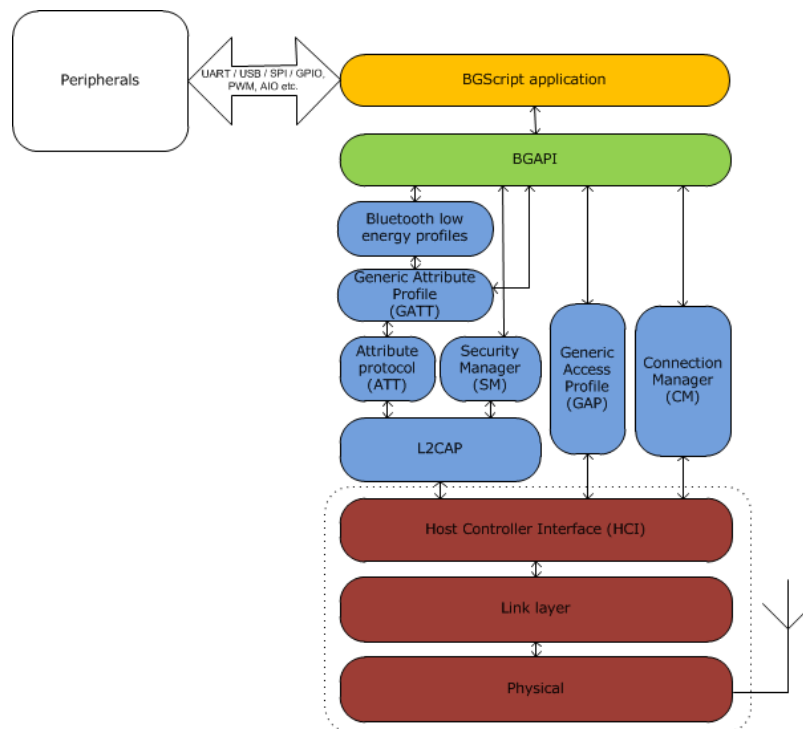
Figure 3: Standalone application model

A BGScript code example:

```
# System Started
event system_boot(major, minor, patch, build, ll_version, protocol_version,
hw)

  #Enable advertising mode
  call gap_set_mode(gap_general_discoverable,gap_undirected_connectable)

  #Enable bondable mode
  call sm_set_bondable_mode(1)

  #Start timer at 1 second interval (32768 = crystal frequency)
  call hardware_set_soft_timer(32768)
end
```

3.4.5 Profile Toolkit

The *Bluetooth* low energy profile toolkit a simple set of tools, which can used to create GATT based *Bluetooth* services and profiles. The profile toolkit consists of a simple XML based description language , which is used to describe the devices local GATT database as a set of services. The profile toolkit also contains a compiler, which converts the XML to binary format and generates API to access the characteristic values.

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<configuration>

    <service uuid="1800">
      <description>Generic Access Profile</description>

      <characteristic uuid="2a00">
        <properties read="true" const="true" />
        <value>BGDemo sensor</value>
      </characteristic>

      <characteristic uuid="2a01">
        <properties read="true" const="true" />
        <value type="hex">4142</value>
      </characteristic>
    </service>

</configuration>
```

Figure 4: A profile toolkit example of GAP service

3.5 More information

More information about the products can be found from:

- Bluegiga web pages
- Bluegiga Tech Forum

4 Getting started with Bluetooth 4.0 development

If you have not implemented a Bluetooth Smart application with Bluegiga's products before. This section briefly describes the recommended path to stat the implementation and describes the available documents, tools and examples, which help you to get started.
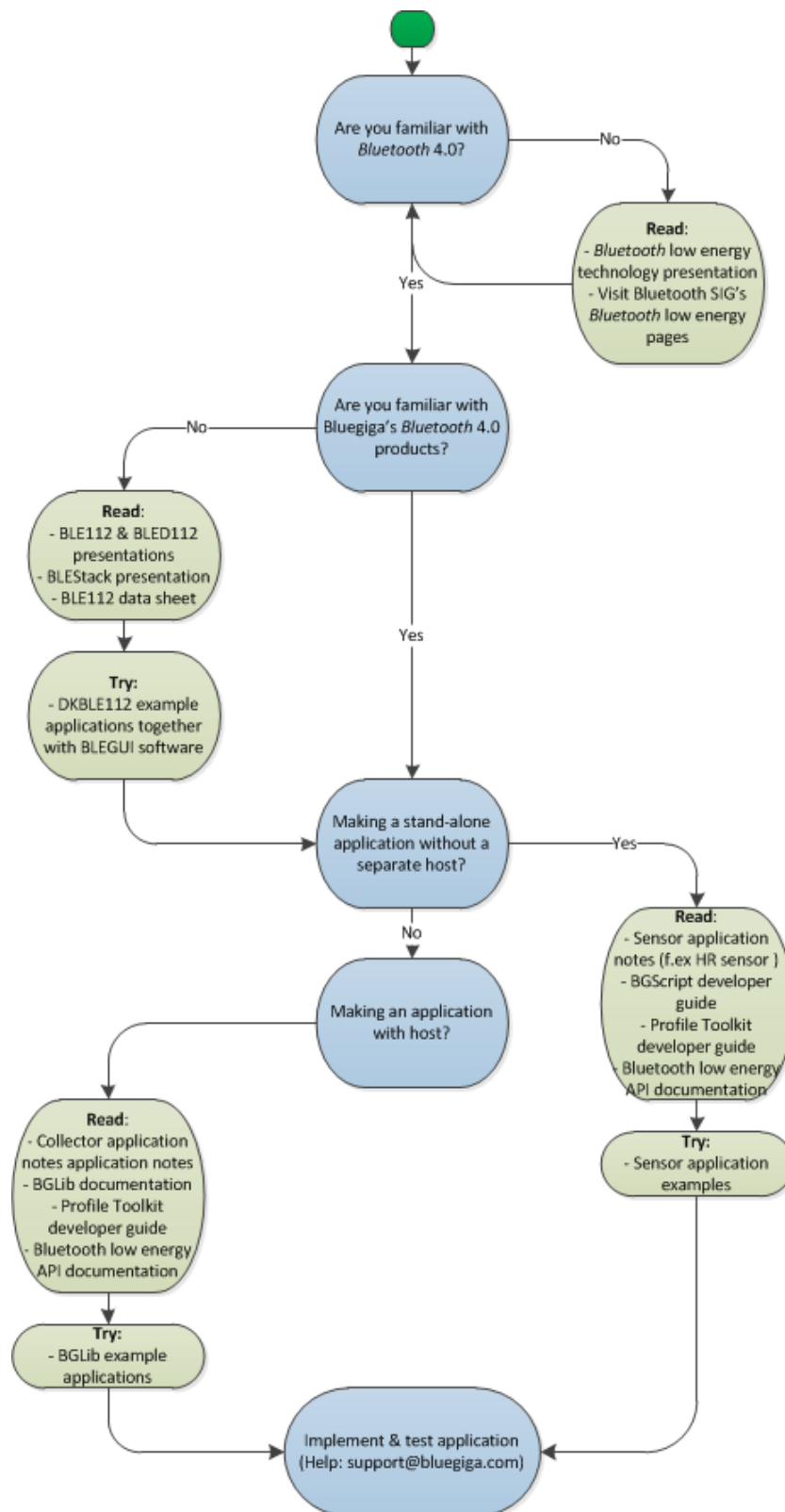
Figure 5: Recommended development path

4.1 Documentation and Tools

This section briefly summarizes the available *Bluetooth* low energy tools and documentation supporting the application development.

Tools:

- **BLEGUI** : This application can be used to control BLE112 or BLED112 over UART or USB. BLEGUI sends the BGAPI command to the hardware and parses the responses. It's a useful tool to get familiar with the products and try out Bluetooth low energy applications.

- **BGBuild** : BGBuild application compiles the hardware configuration file, GATT database, BGScript and the Bluetooth 4.0 single mode stack into a single binary image (.hex), which can be installed into BLE112 or BLED112 hardware.

- **DFUTool** : DFUTool can be used to update the firmware of BLE112 or BLED112 using USB DFU protocol.

- **Thermometer-demo:** Thermometer demo is a Windows command line application, which implements Thermometer collector using BGLib. It can scan Bluetooth 4.0 single-mode devices, and read temperature values from them.

- **Collector demo:** Collector demo implements a simple Windows HR collector application, which scans, connects and reads HR and Battery status values from a HR sensor

- **TI Flash programmer :** TI's flash programmer application can be used to update the firmware of BLE112 over the debug/programming interface.

Documentation:

- *Bluetooth* **low energy - getting started** : This document, describes the very basics of *Bluetooth* low energy and related Bluegiga products

- **BGScript developer guide** : Describes the BGScript scripting language, it's features and limitations. Contains also practical BGScript examples.

- **Profile developer toolkit developer guide** : Describes the basics of *Bluetooth* LE profile development, as well the features and syntax of hardware and GATT XML files. Contains also practical examples.

- *Bluetooth* **4.0 single mode stack API reference** : This document contains the BGAPI, BGLib and BGScript API. Describes the available commands, responses, events and their parameters. API reference document also explains the basics of *Bluetooth* low energy technology.

- **BLEGUI User Guide** : The document describes how the BLEGUI application works and how to use it

- **Application notes:** Various application notes describe specific use cases like for example Heart Rate Sensor or Health Thermometer collector and walk through the necessary development steps required to implement those.

Presentations:

- *Bluetooth* **low energy technology presentation :** A more in-depth presentation about *Bluetooth* low energy technology, how it works and what applications it's target for.

- **BLE112 Product presentation :** A short introduction to BLE112 *Bluetooth* 4.0 single mode module

- **BLED112 Product presentation** : A short introduction to BLED112 *Bluetooth* 4.0 single mode USB dongle

- **Low energy design :** Practical considerations and tips for implementing low energy applications

5 Contact information

Sales: sales@bluegiga.com

Technical support: support@bluegiga.com

http://techforum.bluegiga.com

Orders: orders@bluegiga.com

WWW: http://www.bluegiga.com

http://www.bluegiga.hk

Head Office / Finland: Phone: +358-9-4355 060

Fax: +358-9-4355 0660

Sinikalliontie 5 A

02630 ESPOO

FINLAND

Head address / Finland: P.O. Box 120

02631 ESPOO

FINLAND

Sales Office / USA: Phone: +1 770 291 2181

Fax: +1 770 291 2183

Bluegiga Technologies, Inc.

3235 Satellite Boulevard, Building 400, Suite 300

Duluth, GA, 30096, USA

Sales Office / Hong-Kong: Phone: +852 3182 7321

Fax: +852 3972 5777

Bluegiga Technologies, Inc.

19/F Silver Fortune Plaza, 1 Wellington Street,

Central Hong Kong