

Blood Pressure

Bluetooth® Profile Specification

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Abstract:

This profile enables a device to connect and interact with a Blood Pressure Sensor device for use in consumer and professional health care applications.



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1 Introduction

The Blood Pressure Profile is used to enable a device to obtain blood pressure measurement and other data from a non-invasive blood pressure sensor that exposes the Blood Pressure Service [1].

1.1 Profile Dependencies

This profile requires the Generic Attribute Profile (GATT).

1.2 Conformance

If conformance to this profile is claimed, all capabilities indicated as mandatory for this profile shall be supported in the specified manner (process-mandatory). This also applies for all optional and conditional capabilities for which support is indicated. All mandatory capabilities, and optional and conditional capabilities for which support is indicated, are subject to verification as part of the Bluetooth qualification program.

1.3 Bluetooth Specification Release Compatibility

This specification is compatible with any Bluetooth core specification [2] that includes the Generic Attribute Profile (GATT) and the Bluetooth Low Energy Controller portion of the core specification.

1.4 Language

1.4.1 Language conventions

The Bluetooth SIG has established the following conventions for use of the words **shall**, **must**, **will**, **should**, **may**, **can**, **is**, and **note** in the development of specifications:

shall	<u>is required to</u> – used to define requirements.
must	is used to express: a natural consequence of a previously stated mandatory requirement. OR an indisputable statement of fact (one that is always true regardless of the circumstances).
will	<u>it is true that</u> – only used in statements of fact.
should	<u>is recommended that</u> – used to indicate that among several possibilities one is recommended as particularly suitable, but not required.
may	<u>is permitted to</u> – used to allow options.
can	<u>is able to</u> – used to relate statements in a causal manner.
is	<u>is defined as</u> – used to further explain elements that are previously required or allowed.
note	Used to indicate text that is included for informational purposes only and is not required in order to implement the specification. Each note is clearly designated as a “Note” and set off in a separate paragraph.

For clarity of the definition of those terms, see Core Specification Volume 1, Part E, Section 1.



1.4.2 Reserved for Future Use

Where a field in a packet, Protocol Data Unit (PDU), or other data structure is described as "Reserved for Future Use" (irrespective of whether in uppercase or lowercase), the device creating the structure shall set its value to zero unless otherwise specified. Any device receiving or interpreting the structure shall ignore that field; in particular, it shall not reject the structure because of the value of the field.

Where a field, parameter, or other variable object can take a range of values, and some values are described as "Reserved for Future Use," a device sending the object shall not set the object to those values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous; however, this does not apply in a context where the object is described as being ignored or it is specified to ignore unrecognized values.

When a field value is a bit field, unassigned bits can be marked as Reserved for Future Use and shall be set to 0. Implementations that receive a message that contains a Reserved for Future Use bit that is set to 1 shall process the message as if that bit was set to 0, except where specified otherwise.

The acronym RFU is equivalent to Reserved for Future Use.

1.4.3 Prohibited

When a field value is an enumeration, unassigned values can be marked as "Prohibited." These values shall never be used by an implementation, and any message received that includes a Prohibited value shall be ignored and shall not be processed and shall not be responded to.

Where a field, parameter, or other variable object can take a range of values, and some values are described as "Prohibited," devices shall not set the object to any of those Prohibited values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous.

"Prohibited" is never abbreviated.

2 Configuration

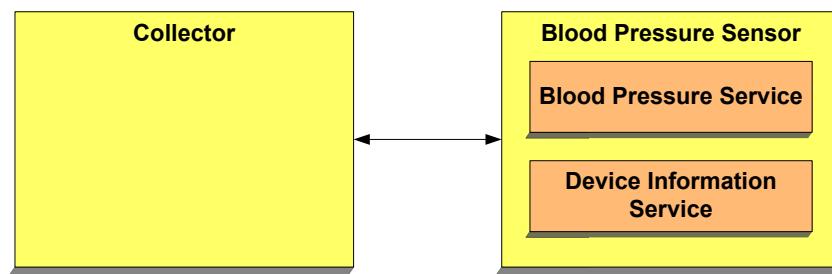
2.1 Roles

The profile defines two roles: Blood Pressure Sensor and Collector. The Blood Pressure Sensor is the device that measures the blood pressure and the Collector is the device that receives blood pressure measurement and other data from a Blood Pressure Sensor.

- The Blood Pressure Sensor shall be a GATT Server.
- The Collector shall be a GATT Client.

2.2 Role/Service Relationships

The following diagram shows the relationships between services and the two profile roles.



Note: Profile roles are represented by yellow boxes and services are represented by orange boxes.

A Blood Pressure Sensor instantiates the Blood Pressure Service [1] and the Device Information Service [3].

2.3 Concurrency Limitations and Restrictions

There are no concurrency limitations or restrictions for the Collector or Blood Pressure Sensor roles imposed by this profile.

2.4 Topology Limitations and Restrictions

The Blood Pressure Sensor shall use the GAP Peripheral role.

The Collector shall use the GAP Central role.

2.5 Transport Dependencies

This profile shall operate over an LE transport only. For BR/EDR (and HS) the Health Device Profile [4] is to be used. This is to avoid having two ways to send Blood Pressure data over a BR/EDR transport.

3 Blood Pressure Sensor Role Requirements

The Blood Pressure Sensor shall instantiate one and only one Blood Pressure Service [1] including devices that support multiple users and multiple bonds.

The Blood Pressure Service shall be instantiated as a «Primary Service».

The Blood Pressure Sensor shall have one instance of the Device Information Service [3].

Service	Blood Pressure Sensor
Blood Pressure Service	M
Device Information Service	M

Table 3.1: Blood Pressure Sensor Service Requirements

See Section 5.1 and Section 6.1 for additional requirements for the Blood Pressure Sensor role.

3.1 Incremental Blood Pressure Service Requirements

This section describes additional Blood Pressure Sensor requirements beyond those defined in the Blood Pressure Service.

3.1.1 Service UUIDs AD Type

While in a GAP Discoverable Mode for initial connection to a Collector, the Blood Pressure Sensor should include the Blood Pressure Service UUID defined in [5] in the Service UUIDs AD type field of the Advertising Data. This enhances the user experience as a Blood Pressure Sensor may be identified by the Collector before initiating a connection.

3.1.2 Local Name AD Type

For enhanced user experience a Blood Pressure Sensor should include the Local Name (containing either the complete or shortened value of the Device Name characteristic as defined in [2]) in its Advertising Data or Scan Response Data.

3.1.3 Writable GAP Device Name characteristic

The Blood Pressure Sensor may support the write property for the Device Name characteristic in order to allow a Collector to write a device name to the Blood Pressure Sensor.

3.1.4 Target Address AD Types

For enhanced user experience a Blood Pressure Sensor that supports multiple bonds may include either the Public Target Address AD Type or Random Target Address AD Type (see Section 5.1.5) in its Advertising Data or Scan Response Data. If a Blood Pressure Sensor does not support multiple bonds, the Blood Pressure Sensor shall not use a Target Address AD Type. As defined in the Blood Pressure Service, the value of the Multiple Bond Support bit of the Blood Pressure Feature characteristic is to be set according to the Blood Pressure Sensor's functionality. By doing so, a Collector can determine if the Blood Pressure Sensor does not support a Target Address AD Type (i.e., if the Multiple Bond Support bit is 0) or potentially supports a Target Address AD Type (i.e., if the Multiple Bond Support bit is 1). In the following sections the words “a Target Address AD Type” is intended to refer to either of the defined Target Address AD Types.

3.2 Incremental Device Information Service Requirements

Table 3.2 shows additional requirements beyond those defined in the Device Information Service.



Device Information Service Characteristic	Requirement
Manufacturer Name String	M
Model Number String	M
System ID	O (Note 1)

Table 3.2: Device Information Service Requirements

Note 1: System ID is required for implementations requiring compliance with IEEE 11073-20601.

Characteristics in this service may be transcoded for use in an ISO/IEEE 11073 ecosystem. See the Personal Health Devices Transcoding White Paper [6] for more information. Since strings in this service are encoded as UTF-8, and ISO/IEEE 11073-20601a [7] specifies that strings are encoded as ASCII printable characters (a subset of UTF-8), characters used in string characteristics that are to be transcoded for use in an ISO/IEEE 11073 ecosystem must be restricted to the printable ASCII character set in order to ensure that the strings can be correctly displayed.

If the ISO/IEEE 11073-20601 specification is updated in the future to include UTF-8 support, implementers should consider the impact of using non-ASCII characters on backward compatibility.

4 Collector Role Requirements

The Collector shall support the Blood Pressure Service [1].

The Collector may support the Device Information Service [3].

Service	Collector
Blood Pressure Service	M
Device Information Service	O

Table 4.1: Collector Service Requirements

This section describes the profile procedure requirements for a Collector.

Profile Requirement	Section	Support in Collector
Service Discovery	4.2	M
- Blood Pressure Service Discovery	4.2.1	M
- Device Information Service Discovery	4.2.2	O
Characteristic Discovery	4.3	M
- Blood Pressure Service Characteristic Discovery	4.3.1	M
- Device Information Service Characteristic Discovery	4.3.2	O
Blood Pressure Measurement	4.4	M
Intermediate Cuff Pressure	4.5	O
Blood Pressure Feature	4.6	M

Table 4.2: Collector Requirements

4.1 GATT Sub-Procedure Requirements

Requirements in this section represent a minimum set of requirements for a Collector (Client). Other GATT sub-procedures may be used if supported by both Client and Server.

Table 4.3 summarizes *additional* GATT sub-procedure requirements beyond those required by all GATT Clients.

GATT Sub-Procedure	Collector (Client) Requirements
Discover All Primary Services	C.1
Discover Primary Services by Service UUID	C.1
Discover All Characteristics of a Service	C.2
Discover Characteristics by UUID	C.2
Discover All Characteristic Descriptors	M
Notifications	C.3
Read Characteristic Descriptors	M
Write Characteristic Descriptors	M

Table 4.3: Additional GATT Sub-Procedure Requirements

C.1: Mandatory to support at least one of these sub-procedures.

C.2: Mandatory to support at least one of these sub-procedures.

C.3: Mandatory if the Intermediate Cuff Pressure characteristic is supported.



4.2 Service Discovery

In order for the Collector to discover the characteristics of the Blood Pressure Service, it shall perform primary service discovery using either the GATT *Discover All Primary Services* sub-procedure or the GATT *Discover Primary Services by Service UUID* sub-procedure. Recommended fast connection parameters and procedures for connection establishment are defined in Section 5.2.4.

4.2.1 Blood Pressure Service Discovery

The Collector shall discover the Blood Pressure Service.

4.2.2 Device Information Service Discovery

The Collector may discover the Device Information Service.

4.3 Characteristic Discovery

As required by GATT, the Collector must be tolerant of additional optional characteristics in the service records of services used with this profile.

4.3.1 Blood Pressure Service Characteristic Discovery

The Collector shall perform either the GATT *Discover All Characteristics of a Service* sub-procedure or the GATT *Discover Characteristics by UUID* sub-procedure in order to discover the characteristics of the service.

The Collector shall perform the GATT *Discover All Characteristic Descriptors* sub-procedure in order to discover the characteristic descriptors described in the following sections.

4.3.1.1 Blood Pressure Measurement Characteristic

The Collector shall discover the Blood Pressure Measurement characteristic.

The Collector shall discover the *Client Characteristic Configuration* descriptor of the Blood Pressure Measurement characteristic.

4.3.1.2 Intermediate Cuff Pressure Characteristic

The Collector may discover the Intermediate Cuff Pressure characteristic.

The Collector may discover the *Client Characteristic Configuration* descriptor of the Intermediate Cuff Pressure characteristic.

4.3.1.3 Blood Pressure Feature Characteristic

The Collector shall discover the Blood Pressure Feature characteristic.

4.3.2 Device Information Service Characteristic Discovery

The Collector may discover the characteristics of the Device Information Service.

In order for the Collector to discover the characteristics of the Device Information Service, it shall use either the GATT *Discover All Characteristics of a Service* sub-procedure or the GATT *Discover Characteristics by UUID* sub-procedure to discover all characteristics of the service.

4.4 Blood Pressure Measurement

The Collector shall control the configuration of indications (i.e. via the *Client Characteristic Configuration* descriptor) of the Blood Pressure Measurement characteristic.

The Collector shall be able to receive multiple indications of the Blood Pressure Measurement characteristic from a Blood Pressure Sensor for the case where the Blood Pressure Sensor has stored measurements to send. Even if the Collector does not store, forward or otherwise process these indications, the Collector shall accept valid indications without error.

When a Collector requires a connection to a Blood Pressure Sensor to receive Blood Pressure Measurements it shall follow the connection procedures described in Section 5.2.

The Collector shall determine the contents of the Blood Pressure Measurement characteristic structure based on the contents of the Flags field. This allows the Collector to determine the unit of the measurement and whether or not a time stamp, Pulse Rate, User ID and Measurement Status are included.

If the Collector receives a Blood Pressure Measurement characteristic with bits of the Flags field set that are designated as Reserved for Future Use (RFU), it shall ignore those bits and continue to process the Blood Pressure Measurement characteristic normally. Since there are many types of Collectors, what a Collector does with the received RFU information is left to the implementation.

If the Collector receives a Blood Pressure Measurement characteristic with bits of the Measurement Status field set that are designated as RFU, it shall ignore those bits and continue to process the Blood Pressure Measurement characteristic normally. What a Collector does with the received RFU information is left to the implementation.

If the Collector receives a Blood Pressure Measurement characteristic with additional octets that are not recognized by the implementation, it shall ignore these extra octets. What a Collector does with the received RFU information is left to the implementation.

4.5 Intermediate Cuff Pressure

This section is applicable when the Intermediate Cuff Pressure characteristic is supported.

The Intermediate Cuff Pressure characteristic enables a Collector to receive notifications of the Intermediate Cuff Pressure characteristic from a Blood Pressure Sensor supporting this feature to show the progress of a measurement for display purposes.

The Collector shall control the configuration of notifications (i.e. via the *Client Characteristic Configuration* descriptor) of the Intermediate Cuff Pressure characteristic.

The Collector shall be able to receive multiple notifications of the Intermediate Cuff Pressure characteristic from the Blood Pressure Sensor. Even if the Collector does not store, forward or otherwise process these notifications, the Collector shall accept valid notifications without error.

When a Collector requires a connection to a Blood Pressure Sensor to enable Intermediate Cuff Pressure notifications, it shall follow the connection procedures described in Section 5.2.

The Collector shall determine the contents of the Intermediate Cuff Pressure characteristic structure based on the contents of the Flags field. This allows the Collector to determine the unit of the measurement and whether or not additional information such as time stamp, Pulse Rate, User ID and Measurement Status are included.

If the Collector receives a Intermediate Cuff Pressure characteristic with bits of the Flags field value that are designated as Reserved for Future Use (RFU), it shall ignore those bits and continue to process the Intermediate Cuff Pressure characteristic normally. Since there are many types of Collectors, what a Collector does with the received RFU information is left to the implementation.

If the Collector receives an Intermediate Cuff Pressure characteristic with bits of the Measurement Status field set that are designated as RFU, it shall ignore those bits and continue to process the Intermediate Cuff Pressure characteristic normally. What a Collector does with the received RFU information is left to the implementation.

If the Collector receives an Intermediate Cuff Pressure characteristic with additional octets that are not recognized by the implementation, it shall ignore these extra octets. What a Collector does with the received RFU information is left to the implementation.

4.6 Blood Pressure Feature

The Collector shall read the Blood Pressure Feature characteristic in order to determine the supported features of the Blood Pressure Sensor and to interpret the bits in the Measurement Status field of the Blood Pressure Measurement characteristic. For example if the Cuff Fit Detection feature is not supported, then the Cuff Fit Detection Flag in the Measurement Status field has no meaning. On the other hand, if the Cuff Fit Detection feature is supported, then the Cuff Fit Detection Flag will indicate that the cuff either fits properly or is too loose.

If the Body Movement Detection Support bit is set to 0 (Body Movement Detection feature not supported), the Collector shall ignore bit 0 of the Measurement Status field of the Blood Pressure Measurement characteristic (Body Movement Detection Flag).

If the Cuff Fit Detection Support bit is set to 0 (Cuff Fit Detection feature not supported), the Collector shall ignore bit 1 of the Measurement Status field of the Blood Pressure Measurement characteristic (Cuff Fit Detection Flag).

If the Irregular Pulse Detection Support bit is set to 0 (Irregular Pulse Detection feature not supported), the Collector shall ignore bit 2 of the Measurement Status field of the Blood Pressure Measurement characteristic (Irregular Pulse Detection Flag).

If the Pulse Rate Range Detection Support bit is set to 0 (Pulse Rate Range Detection feature not supported), the Collector shall ignore bits 3 and 4 of the Measurement Status field of the Blood Pressure Measurement characteristic (Pulse Rate Range Detection Flags).

If the Measurement Position Detection Support bit is set to 0 (Measurement Position Detection not supported), the Collector shall ignore bit 5 of the Measurement Status field of the Blood Pressure Measurement characteristic (Measurement Position Detection Flag).

If the Multiple Bond Support bit is set to 0 (Multiple Bonds not supported), the Collector can determine that the Blood Pressure Sensor supports only a single bond. Otherwise the Collector can determine that the Blood Pressure Sensor supports multiple bonds.

Whether a bit is defined as static during the lifetime of the device (i.e., static permanently or until Service Changed is indicated) or static during a connection, is defined on a bit-by-bit basis in Table 3.2 of [\[1\]](#) (Static Requirements for Blood Pressure Feature Bits).

If the Collector reads Blood Pressure Feature characteristic bits that are set and designated as Reserved for Future Use (RFU), it shall ignore those bits and continue to operate normally. What a Collector does with the received RFU information is left to the implementation.

4.7 Device Information Service Characteristics

The Collector may read the value of Device Information Service characteristics.

5 Connection Establishment

This section describes the connection establishment and connection termination procedures used by a Blood Pressure Sensor and Collector in certain scenarios.

The following scenario description is informative:

Once configured by the Collector, a Blood Pressure Sensor will typically remain powered off between uses and will only advertise and allow a Collector to connect when it has data to send. In this scenario, the Blood Pressure Sensor will enter a GAP Connectable Mode and start advertising when it has data to send to the Collector. The Collector will typically execute a GAP connection establishment procedure such that it is scanning for the Blood Pressure Sensor using a white list. When a connection is established, the Blood Pressure Sensor sends one or more indications or notifications to the Collector. When the data transfer is complete the Blood Pressure Sensor typically terminates the connection.

5.1 Blood Pressure Sensor Connection Establishment

5.1.1 Connection Procedure for Unbonded Devices

This procedure is applicable when the Blood Pressure Sensor connects to a Collector to which it is not bonded. This is typically initiated through user interaction when a user intends to bond the Blood Pressure Sensor with a Collector.

The Blood Pressure Sensor should use the *GAP Limited Discoverable Mode* with connectable undirected advertising events when establishing an initial connection. The $T_{\text{GAP}}(\text{lim_adv_timeout})$ used during *GAP Limited Discoverable Mode* may be larger than the value specified in the Section 16, Appendix A in the GAP specification [2], but the value shall be less than or equal to 180 seconds.

It is recommended to use the advertising interval parameters in Table 5.1 during the *GAP Limited Discoverable Mode*. The interval values in the first row are designed to attempt fast connection during the first 30 seconds; however, if a connection is not established within that time, the interval values in the second row are designed to reduce power consumption for devices that continue to advertise.

Advertising Duration	Parameter	Value
First 30 seconds (fast connection)	Advertising Interval	20 ms to 30 ms
After 30 seconds (reduced power)	Advertising Interval	1 s to 2.5 s

Table 5.1: Recommended Advertising Interval Values

Notwithstanding the above, the advertising interval and time to perform advertising should be configured with consideration for user expectations of connection establishment time.

The Blood Pressure Sensor shall accept any valid values for connection interval and connection latency set by the Collector until service discovery and encryption is complete. Only after this has been completed should the Blood Pressure Sensor request to change to the preferred connection parameters that best suits its use case.

If a connection is not established within a time limit defined by the Blood Pressure Sensor, the Blood Pressure Sensor may exit the GAP discoverable mode.

The Blood Pressure Sensor should be in a bondable mode during this procedure to optimize connecting to the Collector again using the procedure described in Section 5.1.2.

If the Client Characteristic Configuration descriptor has been configured to enable indications or notifications and the Blood Pressure Sensor has no data to transfer (or no further data to transfer), then after waiting for an idle connection timeout (see Section 5.1.4), the Blood Pressure Sensor should perform the *GAP Terminate Connection* procedure. This allows the Collector to perform any additional required actions (e.g. read Blood Pressure Feature characteristic).

5.1.2 Connection Procedure for Bonded Devices

This procedure is applicable after the Blood Pressure Sensor has bonded with the Collector using the connection procedure in Section 5.1.1 and either when the user initiates a connection or autonomously when a notification or indication is pending.

A Blood Pressure Sensor should enter the GAP *Undirected Connectable Mode* either when commanded by the user to initiate a connection to a Collector or when a Blood Pressure Sensor has one or more indications or notifications to send to a previously connected Collector.

The Blood Pressure Sensor should write the address of the target Collector in its White List and set its controller advertising filter policy to 'process scan and connection requests only from devices in the White List'.

The Blood Pressure Sensor should use the recommended advertising interval values shown in Table 5.1.

The advertising interval and time to perform advertising should be configured with consideration for user expectations of connection establishment time.

Once connected, the Blood Pressure Sensor may request to change to the preferred connection parameters that best suits its use case.

If a connection is not established within a time limit defined by the Blood Pressure Sensor, the Blood Pressure Sensor may exit the GAP connectable mode.

If the Client Characteristic Configuration descriptor has been configured to enable indications or notifications and the Blood Pressure Sensor has no data to transfer (or no further data to transfer), then after waiting for an idle connection timeout (see Section 5.1.4), the Blood Pressure Sensor should perform the GAP *Terminate Connection* procedure. This allows the Collector to perform any additional required actions (e.g. read Blood Pressure Feature characteristic).

See Section 5.1.5 for additional requirements related to support for multiple bonds.

5.1.3 Link Loss Reconnection Procedure

When a connection is terminated due to link loss, a Blood Pressure Sensor should attempt to reconnect to the Collector by entering the GAP *Undirected Connectable Mode* using the recommended advertising interval values shown in Table 5.1.

5.1.4 Idle Connection

The Blood Pressure Sensor should perform the GAP *Terminate Connection* procedure if the connection is idle for more than five (5) seconds.

5.1.5 Multi-Bond Considerations

This section is applicable when a Blood Pressure Sensor supports multiple bonds.

A Blood Pressure Sensor supporting multiple bonds may advertise with the address of the target Collector(s) in a Target Address AD Type to enable bonded Collectors to determine if they are the intended recipient of the data. This feature is designed to avoid a situation where a bonded Collector unnecessarily responds to the Blood Pressure Sensor advertisement intended for another bonded Collector. The applicable Public Target Address AD Type format or Random Target Address AD Type format (see Table 5.2) should be used when including the address corresponding to Collector's address type. As stated in Section 3.1.4, if the Blood Pressure Sensor does not support multiple bonds, a Target Address AD Type is not to be included in either the Advertising Data or the Scan Response Data.

If the Blood Pressure Sensor uses a Target Address AD Type and was given a random address by that Collector, the Blood Pressure Sensor shall use that address in the Random Target Address AD Type. A Blood Pressure Sensor may include multiple target addresses in its Advertising Data or Scan Response Data although the maximum number possible is four due to data size restrictions. As described in

Section 5.1.2, the Blood Pressure Sensor should also use a White List to avoid connection with an unwanted Collector.

Description	Information
Public Target Address	Multiples of 6 octets – 6 octets are required for each Device Address of the targeted Collector. This AD type is used when the target address is a public address.
Random Target Address	Multiples of 6 octets – 6 octets are required for each Device Address of the targeted Collector. This AD type is used when the target address is a random address.

Table 5.2: Target Address AD Types

5.2 Collector Connection Establishment

5.2.1 Connection Procedure for Unbonded Devices

This procedure is applicable for connection establishment when the Collector connects to a Blood Pressure Sensor to which it is not bonded. This is typically initiated through user interaction when a user intends to bond the Collector with the Blood Pressure Sensor.

A Collector should use the *GAP Limited Discovery* procedure to discover a Blood Pressure Sensor.

The Collector should use the recommended scan interval and scan window values shown in Table 5.3. For the first 30 seconds (or optionally continuously for mains powered devices), the Collector should use the first scan window / scan interval pair to attempt fast connection. However, if a connection is not established within that time, the Collector should switch to one of the other scan window / scan interval options as defined in Table 5.3 to reduce power consumption.

Once the Blood Pressure Sensor is discovered, the Collector should initiate connection using the *Direct Connection Establishment* procedure.

Scan Duration	Parameter	Value
First 30 seconds (fast connection)	Scan Interval	30ms to 60ms*
	Scan Window	30ms
After 30 seconds (reduced power) - Option 1	Scan Interval	1.28s
	Scan Window	11.25ms
After 30 seconds (reduced power) - Option 2	Scan Interval	2.56s
	Scan Window	11.25ms

Table 5.3: Recommended Scan Interval and Scan Window Values

* A scan interval of 60ms is recommended when the Collector is supporting other operations to provide a 50% scan duty cycle versus 100% scan duty cycle.

Option 1 in Table 5.3 uses the same background-scanning interval used in BR/EDR so the power consumption for LE will be similar to the power consumption used for background scanning on BR/EDR. Option 2 uses a larger background-scanning interval (e.g. twice as long) than used in BR/EDR so the power consumption for LE will be less than the power consumption used for background scanning on BR/EDR. Connection times during background scanning will be longer with Option 2.

After the connection is established, the Collector should bond with the Blood Pressure Sensor during this procedure to optimize connecting to the Blood Pressure Sensor again using the procedure in Section 5.2.2. If a bond is created, the Collector should write the address of the Blood Pressure Sensor in the Collector controller's White List.

The Collector should configure the Client Characteristic Configuration descriptor to enable indications or notifications as needed.

The Blood Pressure Sensor typically terminates the connection if it has no data to transfer.



5.2.2 Connection Procedure for Bonded Devices

This procedure is applicable after the Collector has bonded with the Blood Pressure Sensor using the connection procedure in Section 5.2.1 and either when the user initiates a connection or autonomously when a Collector requires measurements from a Blood Pressure Sensor.

A Collector may use one of the following GAP connection procedures based on its connectivity requirements:

- *General Connection Establishment Procedure.* The Collector may use this procedure when it requires measurements from one or more Blood Pressure Sensors. This procedure allows a Collector to connect to a Blood Pressure Sensor discovered during a scan without using the White List. The Collector should decode the Target Address AD Type to attempt to get the target address as described in this section.
- *Selective Connection Establishment Procedure.* The Collector may use this procedure when it requires measurements from one or more Blood Pressure Sensors. This procedure allows a Collector to connect to a Blood Pressure Sensor discovered during a scan while using the White List. The Collector should decode the Target Address AD Type to attempt to get the target address as described in this section.
- *Direct Connection Establishment Procedure.* The Collector may use this procedure when it requires measurements from a single (or specific) Blood Pressure Sensor. The Collector may also use this procedure for link loss reconnection described in Section 5.2.3.
- *Auto Connection Establishment Procedure.* The Collector may use this procedure when it requires measurements from one or more Blood Pressure Sensors. This procedure will automatically initiate connection to a Blood Pressure Sensor in the White List. The Collector should not use this procedure if one of the Blood Pressure Sensors supports multiple bonds.

If the Collector receives an undirected connectable advertisement from a bonded Blood Pressure Sensor while performing the General or Selective Connection Establishment Procedure, and the Blood Pressure Sensor supports multiple bonds (i.e. the Multiple Bond Support bit of the Blood Pressure Feature characteristic is set to 1 meaning 'Multiple Bonds supported') see Section 5.2.5 for multi-bond considerations and the use of target addresses. Otherwise a Target Address AD Type will not be present in either the Advertising Data or Scan Response Data.

The Collector should use the recommended scan interval and scan window values shown in Table 5.3. When initiating connection, the Collector should use the first scan window / scan interval pair to attempt fast connection. However, if a connection is not established within 30 seconds, the Collector should switch to one of the other scan window / scan interval options as defined in Table 5.3 to reduce power consumption.

If the Collector is in background scanning, it may use the scan window / scan interval Option 1 or Option 2 to reduce power consumption.

Notwithstanding the above, the Collector should use a scan window and scan interval suitable to its power and connection time requirements. Increasing the scan window increases the power consumption, but decreases the connection time.

The scan interval and scan window should be configured with consideration for user expectations of connection establishment time.

The Collector shall start encryption after each connection creation to verify the status of the bond. If encryption fails upon connection establishment (i.e. the bond no longer exists), the Collector must, after user interaction, re-bond, perform service discovery (unless the Collector had previously determined that the Blood Pressure Sensor did not have the <<Service Changed>> characteristic), and set the Blood Pressure Sensor Client Characteristic Configuration descriptor again before using any of the services referenced by this profile in case the configuration was altered or lost.

The Blood Pressure Sensor typically terminates the connection after it has no additional data to transfer.



5.2.3 Link Loss Reconnection Procedure

When a connection is terminated due to link loss, a Collector should attempt to reconnect to the Blood Pressure Sensor using any of the GAP connection procedures with the parameters in [Table 5.3](#).

5.2.4 Fast Connection Interval

To avoid very long service discovery and encryption times, the Collector should use the connection intervals defined in [Table 5.4](#) in the connection request.

Parameter	Value
Minimum Connection Interval	50 ms
Maximum Connection Interval	70 ms

Table 5.4: Recommended Fast Connection Interval Values

At any time a lower latency is required, for example to perform key refresh or encryption setup, this should be preceded with a connection parameter update to the minimum and maximum connection interval values defined in [Table 5.4](#) and a connection latency of zero. This fast connection interval should be maintained as long as low latency is required. After that, it should switch to the preferred connection parameters as decided by the Blood Pressure Sensor using the *GAP Connection Parameter Update* procedure.

5.2.5 Multi-Bond Considerations

If the Collector receives an undirected connectable advertisement from a bonded Blood Pressure Sensor while performing the General or Selective Connection Establishment Procedure and the Blood Pressure Sensor supports multiple bonds (i.e. the Multiple Bond Support bit of the Blood Pressure Feature characteristic is set to 1 meaning 'Multiple Bonds supported') then the Collector should decode the Target Address AD Type to attempt to get the target address. If supported by the Blood Pressure Sensor, this will allow the Collector to determine the intended recipient of the advertisement.

If the Advertising Data or Scan Response Data contains a Target Address AD Type;

1. If the target address is the same as the Collector's address, the Collector should initiate a connection to the Blood Pressure Sensor using *Direct Connection Establishment* Procedure.
2. If the target address is not the same as the Collector's address, the Collector should not initiate a connection to the Blood Pressure Sensor.

If the Advertising Data and Scan Response Data do not contain a Target Address AD Type, the Collector may initiate Connection to the Sensor using *Direct Connection Establishment Procedure*.

For the case where a Collector is associated with a Blood Pressure Sensor for multiple users, the User ID field in the Blood Pressure Measurement characteristic shall be used by the Collector to associate measurements with the correct user.

6 Security Considerations

This section describes the security considerations for a Blood Pressure Sensor and Collector.

6.1 Blood Pressure Sensor Security Considerations

The Blood Pressure Sensor should bond with the Collector.

All supported characteristics specified by the Service shall be set to Security Mode 1 and Security Level 2 or 3.

The Blood Pressure Sensor should use the SM *Slave Security Request* procedure to inform the Collector of its security requirements. If the Blood Pressure Sensor uses bonding, it shall use the SM *Slave Security Request* procedure.

The Blood Pressure Sensor may also support LE Secure Connections.

All characteristics specified by the Device Information Service that are relevant to this profile should be set to the same security mode and level as the characteristics in the Blood Pressure Service.

6.2 Collector Security Considerations

The Collector should bond with the Blood Pressure Sensor.

The Collector shall support LE Security Mode 1 and Security Levels 2 and 3. The Collector shall accept any request by the sensor for a specific Security Mode and Security Level as defined by this profile for the Blood Pressure Sensor.

The Collector may support LE Secure Connections.

7 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
AD	Advertising Data
BR/EDR	Basic Rate / Enhanced Data Rate
GAP	Generic Access Profile
GATT	Generic Attribute Profile
HS	High Speed
LE	Low Energy
RFU	Reserved for Future Use
SM	Security Manager
UUID	Universally Unique Identifier

Table 7.1: Acronyms and Abbreviations

8 References

- [1] Blood Pressure Service
- [2] Bluetooth Core Specification v4.0
- [3] Device Information Service v1.0
- [4] Health Device Profile v1.0
- [5] Characteristic and Descriptor descriptions accessible via the [Bluetooth SIG Assigned Numbers](#)
- [6] Personal Health Devices Transcoding White Paper v1.2 and later
- [7] ISO/IEEE Std 11073-20601™- 2008 Health Informatics - Personal Health Device Communication - Application Profile - Optimized Exchange Protocol - version 1.0 or later. This also includes ISO/IEEE Std 11073-20601a™- 2010 – Amendment 1.

