Environmental Sensing Profile

Bluetooth® **Profile Specification**

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Abstract:

This profile enables a Collector device to connect and interact with an Environmental Sensor for use in outdoor activity applications.

Revision History

Revision Number	Date	Comments
V1.0	2014-11-18	Adopted by the Bluetooth SIG BoD
v1.0.1	2024-10-01	Adopted by the Bluetooth SIG Board of Directors.

Version History

Versions	Changes
v1.0 to v1.0.1	Incorporated errata 15786, 16272, 23324, 22593.

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Document Terminology

The Bluetooth SIG has adopted Section 13.1 of the IEEE Standards Style Manual, which dictates use of the words "shall", "should", "may", and "can" in the development of documentation, as follows:

The word *shall* is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).

The use of the word *must* is deprecated and shall not be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

The use of the word *will* is deprecated and shall not be used when stating mandatory requirements; *will* is only used in statements of fact.

The word *should* is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

The term *Reserved for Future Use (RFU)* is used to indicate Bluetooth SIG assigned values that are reserved by the Bluetooth SIG and are not otherwise available for use by implementations.

Contents

1 Introduction

The Environmental Sensing Profile is used to enable a data collection device to obtain data from an Environmental Sensor that exposes the Environmental Sensing Service [1].

1.1 Profile Dependencies

This profile requires the Generic Attribute Profile (GATT).

1.2 Conformance

Each capability of this specification shall be supported in the specified manner. This specification may provide options for design flexibility, because, for example, some products do not implement every portion of the specification. For each implementation option that is supported, it shall be supported as specified.

1.3 Bluetooth Specification Release Compatibility

This specification is compatible with Bluetooth Core Specification 4.2 or later [2].

2 Configuration

2.1 Roles

The profile defines two roles: Environmental Sensor and Collector.

The Environmental Sensor is the device that reports environmental data to a Collector. The Collector is the device that receives the data from an Environmental Sensor.

- The Environmental 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 service and profile roles.
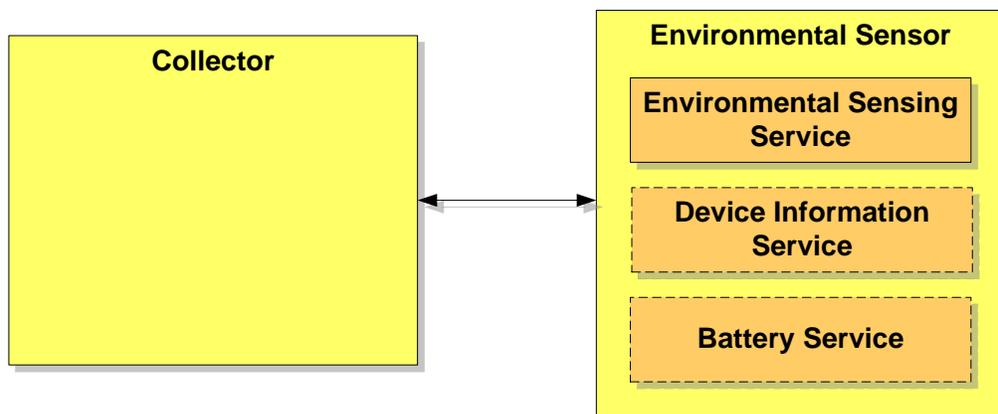
Notes: Profile roles (Collector, Environmental Sensor) are represented by yellow boxes and services (Environmental Sensing Service, Device Information Service, and Battery Service) are represented by orange boxes.

Items in dashed boxes are optional.

An Environmental Sensor instantiates the Environmental Sensing Service [1] and optionally the Device Information Service [4], as well as the Battery Service [5].

2.3 Concurrency Limitations and Restrictions

There are no concurrency limitations or restrictions for the Collector and Environmental Sensor imposed by this profile.

2.4 Topology Limitations and Restrictions

2.4.1 Topology Restrictions for Low Energy

This section describes topology limitations and restrictions when the profile is used over Low Energy transport.

The Environmental Sensor shall use the GAP Peripheral role (see Section 5).

The Collector shall use the GAP Central role (see Section 5).

2.4.2 Topology Limitations and Restrictions for BR/EDR

There are no topology limitations or restrictions when the profile is used over the BR/EDR transport.

2.5 Transport Dependencies

There are no transport restrictions imposed by this profile specification.

Where the term BR/EDR is used in this document, it also includes the optional use of AMP.

3 Environmental Sensor Role Requirements

The Environmental Sensor shall instantiate one and only one Environmental Sensing Service [1]. See specific recommendations in Section 3.1.

The Environmental Sensing Service shall be instantiated as a «Primary Service».

The Environmental Sensor should instantiate the Device Information Service [4]. See specific recommendations in Section 3.1.1.5.

The Environmental Sensor should instantiate the Battery Service [5].

Service	Environmental Sensor
Environmental Sensing Service	M
Device Information Service	O
Battery Service	O

Table 3.1: Environmental Sensing Service Requirements.

Other than the Environmental Sensor requirements in this section, refer to Sections 5.1 and 6.1 for additional Environmental Sensor requirements for the LE Transport and Sections 5.2.2 and 6.3 for the BR/EDR transport.

3.1 Incremental Environmental Sensing Service Requirements

3.1.1 Additional Requirements for Low Energy Transport

This section describes additional Environmental Sensor requirements beyond those defined in the Environmental Sensing Service [1] when using this profile over Low Energy transport.

3.1.1.1 Service UUIDs AD Type

While in a GAP Discoverable Mode for initial connection to a Collector, the Environmental Sensor should include the Environmental Sensing Service UUID defined in [3] in the Service UUIDs AD type field of the advertising data. This enhances the user experience as an Environmental Sensor may be identified by the Collector before initiating a connection.

3.1.1.2 Local Name AD Type

For enhanced user experience, an Environmental 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. For privacy reasons, Environmental Sensors with the Privacy Feature enabled should not include this field in the advertisement.

3.1.1.3 Writable GAP Device Name characteristic

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

3.1.1.4 Appearance AD Type

For enhanced user experience an Environmental Sensor should include the value of the Appearance characteristic defined in [3] in its Advertising data or Scan Response data.

3.1.1.5 Service Data AD Type

For reduced power consumption, an Environmental Sensor that supports notifications should support the Service Data AD Type.

When the Environmental Sensor is using Undirected Advertising, it should include the Service Data AD Type in its Advertising Data to reduce unwanted connection requests by unintended Collectors. The definition of the Service Data payload is shown in Table 3.2, and includes a Change Index field that contains a two-octet pseudo-random number value. Although the Collector will not specifically be able to determine whether the Server has notifications intended for it, it can read the Change Index value to determine if the Environmental Sensor has any pending notifications since the last time the Collector read the Change Index. See Sections 5.1.4 and 5.2.2 for additional requirements. In other words, this can be used by the Collector to determine if it should attempt to reconnect to the Environmental Sensor to receive notifications that may be pending.

Service UUID	Change Index
«Environmental Sensing»	two-octet pseudo-random number value

Table 3.2: Service Data AD Type for use with the Environmental Sensing Profile

3.2 Incremental Device Information Service Requirements

In order to allow the user to log the type of equipment used for sensor data collection, the Environmental Sensor should instantiate the Manufacturer Name String and the Model Number String in the Device Information Service [4].

4 Collector Role Requirements

The Collector shall use the Environmental Sensing Service [1].

The Collector should use the Device Information Service [4] as well as the Battery Service [5].

Service	Collector
Environmental Sensing Service	M
Device Information Service	O
Battery Service	O

Table 4.1: Collector Service Requirements

This section describes the profile requirements for a Collector.

Profile Requirement	Section	Support in Collector
Service Discovery	4.2	M
Environmental Sensing Service Discovery	4.2	M
Device Information Service Discovery	4.2	O
Battery Service Discovery	4.2	O
Characteristic Discovery	4.3	M
Environmental Sensing Service Characteristic Discovery	4.3.1	M
Device Information Service Characteristic Discovery	4.3.2	O
Battery Service Characteristic Discovery	4.3.3	O
ESS Characteristics	4.4	M
ES Measurement descriptor	4.4.1	M
ES Trigger Setting descriptor and ES Configuration descriptor	4.4.2	O
Characteristic User Description descriptor	4.4.3	O
Valid Range descriptor	4.4.4	O
Descriptor Value Changed Characteristic	4.5	O

Table 4.2: Profile Requirements for Collector

4.1 GATT Sub-Procedure Requirements

Requirements in this section represent a minimum set of requirements for a Collector. 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 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
Read Characteristic Value	M
Write Characteristic Value	C.3
Notification	C.4
Read Characteristic descriptors	M
Read Long Characteristic descriptors	C.5
Write Characteristic descriptors	C.6
Write Long Characteristic descriptors	C.7

Table 4.3: Additional GATT Sub-Procedure Requirements

C.1:   Mandatory to support at least one of these Service Discovery sub-procedures when using the LE transport. Excluded when using the BR/EDR transport since SDP must be used in this case.

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

C.3:   Mandatory if the writable GAP Device Name characteristic is supported (see Section 3.1.1.3).

C.4:   Mandatory if writing to ES Trigger Setting descriptors is supported, otherwise excluded.

C.5:   Mandatory if reading of the Characteristic User Description descriptor is supported; optional otherwise.

C.6:   Mandatory if notifications or indications or writing to Characteristic User Description descriptors are supported, otherwise excluded.

C.7:   Mandatory if writing to the Characteristic User Description descriptor is supported; optional otherwise.

4.2 Service Discovery

When using the Low Energy transport, the Collector 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.

When using the BR/EDR transport, the Collector shall perform service discovery by retrieving the SDP record of the Environmental Sensing Service as defined in [1].

The Collector shall discover the Environmental Sensing Service and may discover the Device Information Service and the Battery 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 Environmental Sensing Service Characteristic Discovery

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

The Collector shall use the GATT *Discover All Characteristic Descriptors* sub-procedure to discover the characteristic descriptors.

The discovery requirements for the Collector are shown in Table 4.4.

Characteristic	Discovery Requirements for Collector
ESS Characteristic	M
Descriptor Value Changed	O

Table 4.4: Discovery Requirements for Collector

Where a characteristic is discovered that can be notified, the Collector shall also discover the associated Client Characteristic Configuration descriptor.

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 this service.

4.3.3 Battery Service Characteristic Discovery

The Collector may discover the characteristics of the Battery Service.

In order for the Collector to discover the characteristics of the Battery 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 this service.

4.4 Environmental Sensing Service Characteristics

Environmental Sensing Service (ESS) characteristics are a set of characteristics listed in the Environmental Sensing Service Characteristics table in the Bluetooth SIG Assigned Numbers [3]. The design is such that the set of characteristics can be expanded in the future with no impact to the service or profile specifications.

The Collector shall be tolerant of the Environmental Sensor exposing multiple ESS characteristics. If the Environmental Sensor exposes multiple ESS characteristics using the same UUID (e.g., if multiple Temperature characteristics were exposed to support a device that included multiple Thermometers), the Collector can use their respective ES Measurement descriptors to differentiate between them.

If notifications are to be used by the Collector, it shall control the configuration of notifications (i.e., via the Client Characteristic Configuration descriptor) of any ESS characteristic that supports the notify property. If there is at least one writable ES Trigger Setting descriptor associated with the ESS characteristic, the Collector may also control the conditions under which the notifications occur by writing trigger settings within the Environmental Sensor.

The Collector may read the value of any ESS characteristic or the associated descriptors.

4.4.1 ES Measurement Descriptor

If present, the Collector may read the ES Measurement descriptor to obtain additional information about the ESS characteristic. For example, the Collector may read the value of the Internal Update Interval field to check the maximum age of the measurement (i.e., measurement provided cannot be any older than this value).

If the Collector reads a value with Reserved for Future Use (RFU) bits of the Flags field that are non-zero, it shall ignore those bits and any additional unassigned octets that may be present in the packet and continue to process the ES Measurement characteristic in the same way as if all the RFU bits had been zero.

The Collector shall ignore RFU values in the Sampling Function field and the Application field.

4.4.2 ES Trigger Setting Descriptor and ES Configuration Descriptor

If present, the Collector may read the value of the ES Trigger Setting descriptor(s) and the ES Configuration descriptor to understand the condition(s) upon which the associated ESS characteristic value will be notified by the Environmental Sensor.

If one or more ES Trigger Setting descriptors with the Write property are present, the Collector may write to the descriptor(s) to specify the condition(s) under which the associated ESS characteristic will be notified by the Environmental Sensor. If configuring more than one ES Trigger Setting descriptor, the Collector shall also configure the associated ES Configuration descriptor to the desired Boolean condition (i.e., AND or OR). To avoid the transmission of unintended notifications, the Collector shall disable notifications via the Client Characteristic Configuration descriptor before new Trigger Settings are being written and subsequently re-enable them after all the desired changes have been successfully written.

If the Collector supports reading an ES Trigger Setting descriptor, it shall be able to evaluate the logic of up to three ES Trigger Setting descriptors per ESS Characteristic together with the ES Configuration descriptor.

If the Collector supports writing to an ES Trigger Setting descriptor, it should be able to write to up to three ES Trigger Setting descriptors per ESS Characteristic. Collectors that support writing of logic involving only one or two ES Trigger Setting descriptors shall be able to disable any unused ES Trigger Setting descriptors by writing to them. Collectors that support writing to two or three ES Trigger Setting descriptors shall be able to write to the ES Configuration descriptor.

The Collector may set one or more ES Trigger Setting descriptor to "Trigger Inactive" to effectively disable the trigger and make it inactive.

If only one ES Trigger Setting descriptor is active, the value of the ES Configuration descriptor, if present, shall be ignored. Similarly, if no ES Trigger Setting descriptors are active, the value of the ES Configuration descriptor, if present, shall be ignored.

The Collector shall be tolerant of reading a value of the ES Trigger Setting descriptor that is RFU. Similarly, the Collector shall be tolerant of reading a value of the ES Configuration descriptor that is RFU. This is to enable compatibility with future updates. If the Collector is unable to resolve the logic of the combination of the ES Trigger Setting descriptor(s) and the ES Configuration descriptor due to the presence of one or more RFU values, it may treat the trigger setting information as unavailable or handle it in an implementation specific manner.

4.4.3 Characteristic User Description Descriptor

If present, the Collector may read the value of the Characteristic User Description descriptor to obtain a human-readable label associated with the measurement.

If the Characteristic User Description descriptor is writable and the Collector is authenticated, the Collector may write a new value associated with a given ESS characteristic. The value is global and will be accessible by any other Collectors.

Note that per the Bluetooth Core Specification, the Collector may read Writable Auxiliaries bit of the Characteristic Extended Properties descriptor to find out if the Characteristic User Description descriptor is writable.

4.4.4 Valid Range Descriptor

If present, the Collector may read the value of the Valid Range descriptor to obtain the upper and lower bounds (inclusive) of an associated ESS characteristic.

4.5 Descriptor Value Changed Characteristic

The Descriptor Value Changed characteristic should be supported to enable a Collector to be alerted if the value of descriptors is changed either at the Environmental Sensor or by another Collector.

If supported, the Collector may configure the Descriptor Value Changed characteristic for indications if it requires alerts by the Environmental Sensor whenever ESS-related descriptors (i.e., descriptors other than the Client Characteristic Configuration descriptor) are changed by a device other than itself.

The Collector may control the configuration of indications (i.e., via the Client Characteristic Configuration descriptor) of the Descriptor Value Changed characteristic.

If the Collector supports this characteristic, the Collector shall be able to receive multiple indications of the Descriptor Value Changed characteristic from an Environmental Sensor for the case where descriptor values for multiple ESS Characteristics have changed.

If the Collector supports this characteristic, the Collector shall determine the associated ESS Characteristic for the changed descriptor(s) by the contents of the Characteristic UUID field of the Descriptor Value Changed characteristic.

If the Environmental Sensor exposes multiple ESS Characteristics using the same UUID (e.g., if multiple Temperature characteristics were exposed to support a device that included multiple Thermometers), the Environmental Sensor has no way to distinguish which had the changed descriptor(s) so the Collector should re-read descriptor values that potentially changed.

In some rare cases, an indication might be sent to a Collector relating to an ESS Characteristic for which the Collector has no interest (e.g., if the Characteristic User Description descriptor of that ESS Characteristic is changed). If this occurs, the Collector may ignore the remaining contents of the characteristic.

The Collector shall use the Source of Change bit of the Flags field (bit 0) to determine if a change to a descriptor value was made by the Environmental Sensor (e.g., via the Environmental Sensor UI) or by another Collector.

The Collector shall use bits 1 to 5 of the Flags field to determine which descriptor(s) were affected by the change.

If the Collector receives a Descriptor Value Changed characteristic with Reserved for Future Use (RFU) bits of the Flags field that are non-zero, it shall ignore those bits and any additional data that may be present in the packet and continue to process the Descriptor Value Changed characteristic in the same way as if all the RFU bits had been zero.

If the Collector receives a Descriptor Value Changed characteristic with additional unrecognized octets, the Collector behavior shall be identical to the Collector behavior when only recognized octets are received. This is to enable compatibility with future service updates for the case where available octets in the characteristic are specified for optional use. What the Collector does with the additional, unrecognized, octets is left to the implementation.

4.6 General Error Handling

The Collector shall be tolerant and behave appropriately when receiving the following error codes:

- Write Request Rejected

- Condition not supported

- Out of Range

- Insufficient Authentication

If a Descriptor Value Changed indication is received from an Environmental Sensor, this indicates that the cached values of specific ESS-related descriptors may no longer be valid and the Collector shall re-read the affected descriptors.

4.7 Device Information Service Characteristics

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

4.8 Battery Service Characteristics

The Collector may read the value of the Battery Level characteristic. If the Environmental Sensor supports the notification of the Battery Level characteristic, the Collector may also configure this characteristic for notification (e.g., via the Client Characteristic Configuration descriptor).

5 Connection Establishment Procedures

This section describes the connection establishment and connection termination procedures used by an Environmental Sensor and Collector in certain scenarios.

The profile can support scenarios where measurements are frequently transferred, as well as scenarios where the time between measurements is much longer, with intervals measured in hours. Different connection strategies and different timeout settings can be chosen to optimize performance for the specific application. The procedures in the following sections enable a variety of scenarios.

5.1 Environmental Sensor Connection Establishment for Low Energy Transport

This section describes connection procedures that an Environmental Sensor should follow to initiate a connection with a Collector using an LE transport.

- Section 5.1.1 describes the connection procedure when the Environmental Sensor does not support bonding or if the Environmental Sensor supports bonding, but is not bonded with any Collectors.

- Section 5.1.2 describes the connection procedure when the Environmental Sensor is bonded with one or more Collectors.

- Section 5.1.3 is used when the established connection is broken after a link loss and a reconnection is required.

5.1.1 Connection Procedure for Unbonded Devices

This procedure is used for connection establishment when the Environmental Sensor is not bonded with any Collectors and ready for connection (e.g., when the Environmental Sensor has data to send or when commanded by the user).

If a connection is not established within 30 seconds, the Environmental Sensor may either continue sending background advertising to reduce power consumption as long as it chooses or stop advertising. The advertising interval and time to perform advertising should be configured with consideration for user expectations of connection establishment time using the GAP timers defined in Volume 3, Part C, Section 9.3.11 [2].

If a connection is not established within a time limit defined by the Environmental Sensor, the Environmental Sensor may exit the GAP Connectable Mode.

Table 5.1 summarizes the recommended procedure if the Environmental Sensor is not bonded to any Collectors.

Recommended GAP Modes	Recommended Filter Policy	Remarks
General Discoverable Mode Undirected Connectable Mode Bondable Mode	Attempt to connect to any Collectors.	

Table 5.1: Recommended Connection Procedure for Unbonded Devices

If a bond is created, refer to recommendations in Section 5.1.2.

When the Environmental Sensor no longer requires a connection, it should perform the GAP *Terminate Connection* procedure.

If the Environmental Sensor has no data to transfer (or no further data to transfer) and the connection is idle, the Environmental Sensor should wait at least longer than the maximum connection interval (e.g., 5 seconds) before performing the GAP Terminate Connection procedure. This allows the Collector to perform any additional required actions (e.g., read and configure descriptors). For devices that support Man in the Middle (MITM) protection, this duration may need to be longer to allow completion of the pairing sequence.

5.1.2 Connection Procedure for Bonded Devices

Table 5.2 summarizes the recommended procedure if the Environmental Sensor is bonded with one or more Collectors.

Recommended Time	Recommended GAP Modes	Recommended Filter Policy	Remarks
First 10 seconds	Non-Discoverable Mode Undirected Connectable Mode	Attempt to connect to only bonded Collectors in Filter Accept List.	The Filter Accept List should be used in conjunction with the ES Trigger Setting descriptor feature in order to accept connection requests only from the relevant bonded Collector.
After 10 seconds	General Discoverable Mode Undirected Connectable Mode Bondable Mode	Attempt to connect to any Collectors.	This allows bonding with a new Collector. Unbonded procedure is described in Section 5.1.1.

Table 5.2: Recommended Connection Procedure for Bonded Devices

If an Environmental Sensor requires a connection to a Collector that did not use a resolvable private address during bonding, it may use Low Duty Cycle Directed Advertisements in order to advertise to only the Collector for which it has data. However, it is usually not possible in practice to use Directed Advertising to connect to Collectors because many require the use of resolvable private addresses. Therefore, when a Collector uses a resolvable private address during bonding and the Environmental Sensor requires a connection to that Collector, Environmental Sensors should use the Undirected Connectable Mode along with the Service Data AD Type described in Section 3.1.1.5 to reduce unwanted connection requests.

If a connection is not established within 30 seconds, the Environmental Sensor may either continue sending background advertising to reduce power consumption as long as it chooses, or stop advertising.

The advertising interval and time to perform advertising are implementation specific and should be configured with consideration for user expectations of connection establishment time using the GAP timers defined in Volume 3, Part C, Section 9.3.11 [2].

If a connection is not established within a time limit defined by the Environmental Sensor, the Environmental Sensor may exit the GAP Connectable Mode.

When the Environmental Sensor is disconnected and the Environmental Sensor is ready for reconnection (e.g., when the Environmental Sensor has new data to send or when commanded by the user), the Environmental Sensor should reinitiate the connection procedure (e.g., start advertising).

If the Environmental Sensor has no data to transfer (or no further data to transfer) and the connection is idle, the Environmental Sensor should wait at least longer than the maximum connection interval (e.g., 5 seconds) before performing the GAP Terminate Connection procedure. This allows the Collector to perform any additional required actions (e.g., read and configure descriptors). For devices that support Man in the Middle (MITM) protection, this duration may need to be longer to allow completion of the pairing sequence.

5.1.3   Link Loss Reconnection Procedure

When a connection is terminated due to link loss, the Environmental Sensor should attempt to reconnect to the Collector by entering a GAP Connectable Mode.

5.1.4   Use of Service Data AD Type

This section outlines an optional procedure that is applicable when an Environmental Sensor uses the Undirected Connectable Mode and the Service Data AD Type.

The Service Data AD Type described in Section 3.1.1.5 provides a mechanism to reduce unwanted connection requests by unintended Collectors when Undirected Connectable Mode is used and when an Environmental Sensor has new notifications of an ESS Characteristic to send. Refer also to Section 5.2.2 for the procedure from the Collector perspective.

When an Environmental Sensor uses undirected connectable advertisements, it should include the Service Data AD Type in its Advertising Data. The value of the Change Index field of the Service Data AD Type shall be changed to any two-octet pseudo-random value that has not been recently used each time a new notification is pending. This allows each Collector to determine if the Environmental Sensor has any new pending notifications since the last time the Collector read the Change Index value.

5.2   Collector Connection Establishment for Low Energy Transport

This section describes connection procedures a Collector should follow to initiate a connection with an Environmental Sensor using an LE transport.

The Collector should use the GAP General Discovery procedure to discover an Environmental Sensor.

A Collector may use one of the GAP connection procedures based on its connectivity requirements as described in Table 5.3:

GAP Connection Procedure	Unbonded Collector	Bonded Collector
General Connection Establishment	Allowed	Allowed
Direct Connection Establishment	Allowed	Allowed

GAP Connection Procedure	Unbonded Collector	Bonded Collector
Auto Connection Establishment	Not Allowed	Allowed
Selective Connection Establishment	Not Allowed	Allowed

Table 5.3: Allowed GAP Connection Procedure

If a connection is not established within 30 seconds, the Collector may either continue background scanning to reduce power consumption, or stop scanning.

The connection interval, scan interval, scan window, and time to perform scanning are implementation specific and should be configured with consideration for user expectations of connection establishment time using the GAP timers defined in Volume 3, Part C, Section 9.3.11 [2].

If a connection is not established within a time limit defined by the Collector, the Collector may exit the connection establishment procedure.

When the connection is established, the Collector may bond with the Environmental Sensor to optimize the future connections to the device depending on the use case.

The Collector should terminate the connection when the measurement session is terminated at the Collector by the user.

When the Collector is disconnected, the Collector may continue scanning for advertisements from Environmental Sensors and may initiate a new connection.

5.2.1   Link Loss Reconnection Procedure

When a connection is terminated due to link loss, the Collector should attempt to reconnect to the Environmental Sensor using any of the GAP connection procedures using the connection establishment timing parameters defined in Vol. 3, Part C (GAP) section 9.3.11 [2] and the connection interval timing parameters defined in Vol. 3, Part C (GAP) section 9.3.12 [2].

5.2.2   Use of Service Data AD Type

This section outlines an optional procedure that is applicable when a Collector supports the use of the Service Data AD Type for this service.

The Service Data AD Type described in Section 3.1.1.5 provides a mechanism to reduce unwanted connection requests by unintended Collectors when Undirected Connectable Mode is used and when an Environmental Sensor has new notifications to send. Refer to Section 5.1.4 for the procedure from the Environmental Sensor perspective.

When a Collector receives an undirected connectable advertisement from an Environmental Sensor that includes the Service Data AD Type in its Advertising Data, the Collector shall read the Change Index field of the Service Data AD Type to determine if a new notification is pending since the last time it read the value of the Change Index field. If the value of the Change Index field in the Service Data AD Type matches the last value that the Collector cached, the Collector may ignore the undirected advertisement. Otherwise, the advertisement may be intended for the Collector and it should attempt to connect to the Environmental Sensor to retrieve the notification.

5.3 Connection Establishment for BR/EDR

This section describes the connection establishment and connection termination procedures used by an Environmental Sensor and Collector using a BR/EDR transport. Unlike the LE Connection procedures, which describe specific connection parameters, BR/EDR connection establishment does not state requirements beyond those described in GAP based on potential interactions with other BR/EDR profiles operating concurrently on the Environmental Sensor and/or Collector.

When using BR/EDR, devices can utilize sniff mode and sniff subrating to reduce power consumption; however no particular parameters are recommended and the requirements of other profiles may need to be considered.

5.3.1 Connection Procedure

The procedures for establishing a connection between an Environmental Sensor and Collector that do not have an existing bond and for re-establishing a connection between bonded devices use the inquiry, discovery, paging, pairing and security procedures described in Generic Access Profile of the Core Specification [2] and any additional GAP requirements enumerated in Sections 5 and 7.

5.3.1.1 Connection Procedure for Unbonded Devices

The Environmental Sensor shall use the GAP General or Limited Discoverable Mode when it is not bonded with any Collectors and is ready for a connection (e.g., when the Environmental Sensor has data to send or when commanded by the user).

The Collector should use the GAP *General Discovery* procedure to discover an Environmental Sensor to establish a connection to an Environmental Sensor to which it is not bonded.

Either the Environmental Sensor or the Collector can establish a BR/EDR link to a remote peer device.

Once a link is established, the Collector shall discover the Environmental Sensing Service using SDP procedures prior to establishing a GATT connection.

Once the Environmental Sensing Service is discovered and a GATT connection is established, the Collector shall discover the Environmental Sensing Service characteristics exposed by this service using GATT Discovery procedures.

Once connected, the Collector shall configure any ESS characteristics for notification that have an ES Trigger Setting descriptor for all ESS characteristics for which it requires notifications.

The Collector should terminate the connection when the measurement session is terminated at the Collector by the user.

When the Environmental Sensor no longer has data to send, it may disconnect the link, depending on the use cases of the devices and other profiles connected on either device.

5.3.1.2 Connection Procedure for Bonded Devices

The Environmental Sensor shall use the GAP Link Establishment Procedure to connect to any bonded Collectors when it is ready for a connection (e.g., when the Environmental Sensor had data to send or when commanded by the user).

The Collector shall be Connectable to accept a connection from an Environmental Sensor to which it is bonded.

Either the Environmental Sensor or the Collector can establish a BR/EDR link to a remote peer device.

If a higher layer determines the bond no longer exists on the remote device, the local device must reconfigure the remote device after

- user interaction confirms that the user wants to re-pair with the remote device,

- re-bonding has been performed, and

- service discovery has been performed. (If the local device had previously determined that the remote device did not have the «Service Changed» characteristic then service discovery may be skipped because the service is not allowed to change per the Core specification.)

The Collector should terminate the connection when the measurement session is terminated at the Collector by the user. When the Environmental Sensor no longer has data to send, it may disconnect the link, depending on the use cases of the devices and other profiles connected on either device.

When the Environmental Sensor is disconnected and it is ready for reconnection (e.g., when the Environmental Sensor has new data to send when commanded by the user), the Environmental Sensor should initiate a connection with the Collector.

5.3.2 Link Loss Reconnection Procedure

When a connection is terminated due to link loss, an Environmental Sensor should reconnect to the Collector by attempting, for an implementation-specific time, to reestablish an ACL link between the two devices. The Collector should remain Connectable for an implementation-specific time so that an Environmental Sensor can reestablish an ACL link.

6 Security Considerations

This section describes the security considerations for an Environmental Sensor and Collector.

6.1 Environmental Sensor Security Considerations for Low Energy

This section describes the security requirements for the Environmental Sensor for an LE transport.

All supported characteristics specified by the Environmental Sensing Service shall be set to LE Security Mode 1 and Security Level 1 or higher.

The Environmental Sensor may bond with the Collector; however, if the Environmental Sensor supports the Write property for the ES Configuration descriptor or the ES Trigger Setting descriptor, then Bonding is Mandatory.

The Environmental Sensor should use the SM *Peripheral Security Request* procedure.

If used, all characteristics exposed by the Device Information Service for use by this profile should be set to the same security mode and level as the characteristics in the Environmental Sensing Service.

If present and writable, the Collector shall be authenticated in order to write to the Characteristic User Description descriptor.

If present and writable, the Device Name descriptor should support Authentication.

6.2 Collector Security Considerations for Low Energy

This section describes the security requirements for the Collector for an LE transport.

The Collector may bond with the Environmental Sensor; however, if the Environmental Sensor supports the Write property for the ES Configuration descriptor or the ES Trigger Setting descriptor, then Bonding is Mandatory.

The Collector shall accept any request by the Environmental Sensor for LE Security Mode 1 and Security Level 1 or higher.

6.3 Security Considerations for BR/EDR

As required by GAP, Security Mode 4 (service level enforced security) shall be used for connections by Environmental Sensor and Collector.

- Bonding shall be supported by Environmental Sensors that support the Write property on the ES Configuration descriptor or the ES Trigger Setting descriptor, otherwise bonding is optional for Environmental Sensors.

- Bonding shall be supported by Collectors that support writing to the ES Configuration descriptor or the ES Trigger Setting descriptor, otherwise bonding is optional for Collectors.

7 Generic Access Profile for BR/EDR

This section defines the support requirements for the capabilities as defined in the Generic Access Profile of the Core Specification [2] when BR/EDR is used.

7.1 Modes

The Mode Procedures as defined in GAP describe requirements for both Environmental Sensor and Collectors involved. This profile further refines the requirements.

- Discoverable Mode shall be supported by Environmental Sensors supporting BR/EDR.

- Bondable Mode should be supported by Environmental Sensors that support the Write property on the ES Configuration descriptor or the ES Trigger Setting descriptor. See Section 6.3 for bonding recommendations.

- Bondable Mode should be supported by Collectors that support writing to the ES Configuration descriptor or the ES Trigger Setting descriptor. See Section 6.3 for bonding recommendations.

Table 7.1 shows the support status for GAP modes in this profile.

Procedure	Support in Environmental Sensor	Support in Collector
Discoverable Mode	M	X
Bondable Mode	C.1	C.2

Table 7.1: Modes

C.1:   Mandatory if the Environmental Sensor supports the Write property on the ES Configuration descriptor or the ES Trigger Setting descriptor. Otherwise optional.

C.2:   Mandatory if Environmental Sensor supports writing to the ES Configuration descriptor or the ES Trigger Setting descriptor. Otherwise optional.

7.2 Idle Mode Procedures

The Idle Mode Procedures as defined in GAP, describe requirements for both Environmental Sensor and Collectors involved. This profile further refines the requirements.

- General inquiry shall be supported by all Collectors.

- General bonding should be supported by Environmental Sensors that support the Write property on the ES Configuration descriptor or the ES Trigger Setting descriptor.

- General bonding should be supported by Collectors that support writing to the ES Configuration descriptor or the ES Trigger Setting descriptor.

Table 7.2 shows the support status for Idle Mode procedures within this profile.

Procedure	Support in Environmental Sensor	Support in Collector
General Inquiry	X	M
General Bonding	C.1	C.2

Table 7.2: Idle mode procedures

C.1:   Mandatory if the Environmental Sensor supports the Write property on the ES Configuration Descriptor or the ES Trigger Setting descriptor. Otherwise optional.

C.2:   Mandatory if Environmental Sensor supports writing to the ES Configuration descriptor or the ES Trigger Setting descriptor. Otherwise optional.

8 Abbreviations and Acronyms

Abbreviation or Acronym	Meaning
ACL	Asynchronous Connection-oriented [logical transport]
AD	Advertising Data
AMP	Alternate MAC/PHY
BR/EDR	Basic Rate / Enhanced Data Rate
ES	Environmental Sensor
ESP	Environmental Sensing Profile
ESS	Environmental Sensing Service
GAP	Generic Access Profile
GATT	Generic Attribute Profile
LE	Low Energy
RFU	Reserved for Future Use
SDP	Service Discovery Protocol
SM	Security Manager
UI	User Interface
UUID	Universally Unique Identifier

Table 8.1: Abbreviations and Acronyms

9 References

[1]   Environmental Sensing Service

[2]   Bluetooth Core Specification v4.2 or later.

[3]   Bluetooth Assigned Numbers, https://www.bluetooth.com/specifications/assigned-numbers/

[4]   Device Information Service v1.1 or later

[5]   Battery Service v1.0 or later

[6]   Supplement to the Bluetooth Core Specification, Version 11 or later