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PROXIMITY PROFILE

Abstract

The Proximity profile enables proximity monitoring between two devices.

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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*).

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1 Introduction

The Proximity profile defines the behavior when a device moves away from a peer device so that the connection is dropped or the path loss increases above a preset level, causing an immediate alert. This alert can be used to notify the user that the devices have become separated. As a consequence of this alert, a device may take further action, for example to lock one of the devices so that it is no longer usable.

The Proximity profile can also be used to define the behavior when the two devices come closer together such that a connection is made or the path loss decreases below a preset level.

1.1 Profile Dependency

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 can be used with any version of the *Bluetooth* Core Specification that allows Generic Attribute Profile.

2 Configuration

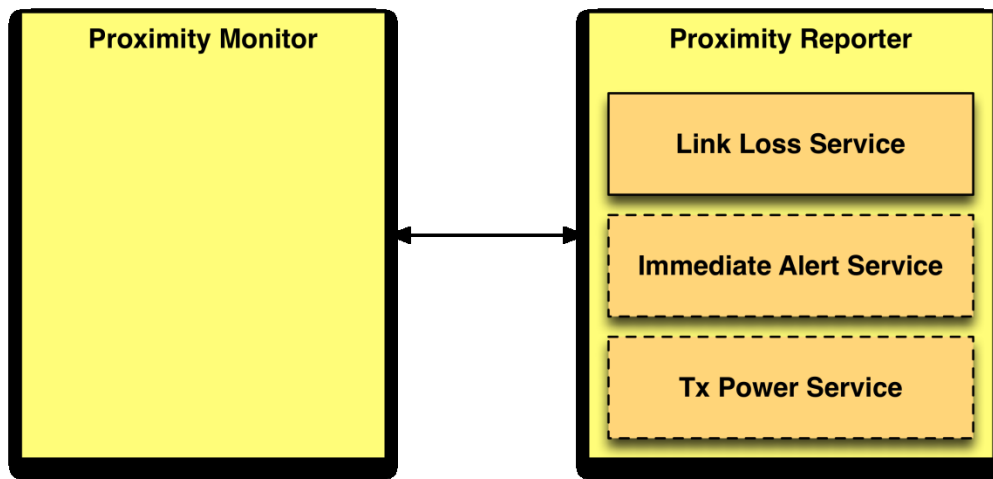
2.1 Roles

The profile defines two roles: Proximity Monitor and Proximity Reporter.

- The Proximity Reporter shall be a GATT server.
- The Proximity Monitor shall be a GATT client.

2.2 Role / Service Relationships

Figure 2.1 shows the relationship between services and the two profile roles.



Note: The dotted line indicates a service within this line is optional.

Figure 2.1: Relationship between services and roles

The Proximity Reporter has an instance of the Link Loss service, and optionally both the Immediate Alert and the Tx Power service.

2.3 Concurrency

A device may implement a Proximity Monitor or a Proximity Reporter together with other profiles at the same time.

The connection can be dropped according to the link supervision timeout as defined by the Bluetooth Core Specification [1] devices supporting multiple profiles including Proximity profile should set the link supervision timeout in accordance with the requirements of the Proximity Monitor.

A device may also implement both a Proximity Monitor and Proximity Reporter at the same time.

2.4 Topology

A Proximity Reporter is likely to be an LE-only device, and therefore it should be in the GAP Peripheral role and the Proximity Monitor should be in the GAP Central role.

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- If the Proximity Reporter is a device that implements the GAP Peripheral role, it shall be set to connectable mode. The device can also be discoverable and advertise that it supports the Link Loss service.
- If the Proximity Reporter is a device that implements the GAP Central role, it shall perform the connection procedures as defined by GAP to establish a connection.
- If the Proximity Monitor is a device that implements the Central role, it shall perform the connection procedures as defined by GAP to establish a connection.
- If the Proximity Monitor is a device that implements the Peripheral role, it shall be set to connectable mode. The device can also be discoverable and advertise with a service solicitation for Link Loss service as defined in GAP Section 11.1.9.
- If the Proximity Monitor implements both the Central role and Peripheral role, it can be set to connectable mode or perform the connection establishment procedures.

3 Proximity Reporter Requirements

The Proximity Reporter shall have only one instance of the Link Loss service and may have one instance of both the Immediate Alert service and the Tx Power service.

	Proximity Reporter
Link Loss service	M
Immediate Alert service	C1
Tx Power service	C1

C1: If a device exposes only one of the Immediate Alert or Tx Power services, then neither the Immediate Alert service nor the Tx Power service shall be used in this profile.

3.1 Link Loss Service

This profile does not impose any additional requirements beyond those defined by the Link Loss Service Specification [2].

3.2 Immediate Alert Service

This profile does not impose any additional requirements beyond those defined by the Immediate Alert Service Specification [3].

3.3 Tx Power Service

This profile does not impose any additional requirements beyond those defined by the Tx Power Service Specification [4].

4 Proximity Monitor Requirements

The Proximity Monitor shall support the Link Loss service [2].

The Proximity Monitor may support the Immediate Alert service [3] and the Tx Power service [4].

Service	Proximity Monitor
Link Loss service	M
Immediate Alert service	C1
Tx Power service	C1

Table 4.1: Proximity Monitor Service Requirements

C1: If a device only supports one of the Immediate Alert or Tx Power services, then neither the Immediate Alert service nor the Tx Power service shall be used.

The Proximity Monitor defines requirements for observing, connecting, reading and configuring a Proximity Reporter.

This section describes the procedure requirements for a Proximity Monitor.

	Procedure	Ref.	Support in Proximity Monitor
1.	Service Discovery	4.1	M
2.	Characteristic Discovery	4.2	M
3.	Configuration of Alert on Link Loss	4.3	M
4.	Alert on Link Loss	4.4	M
5.	Reading Tx Power	4.5	O
6.	Alert on Path Loss	4.6	O

Table 4.2: Proximity Monitor Requirements

4.1 Service Discovery

The Proximity Monitor shall perform service discovery using the GATT *Discover All Primary Services* sub-procedure or the GATT *Discover Primary Services by Service UUID* sub-procedure as follows:

- To discover the Link Loss service with «Link Loss» for the service UUID.
- To discover the Immediate Alert service with «Immediate Alert» for the service UUID.
- To discover the Tx Power service, with «Tx Power» for the service UUID.

The Immediate Alert and Tx Power services are optional and a Proximity Monitor must not assume that these services are exposed by all devices. If a device only exposes one of the Immediate Alert or Tx Power services, neither the Immediate Alert nor the Tx Power services shall be used in this profile.

Recommended fast connection interval parameters for LE connection establishment are defined in Section 5.2.5.

4.2 Characteristic Discovery

The GATT *Discover All Characteristic of a Service* sub-procedure shall be used to discover the characteristics of the following services:

- Link Loss service
- Immediate Alert service
- Tx Power service

For the Tx Power Level characteristic, the GATT Discover All Characteristic Descriptors sub-procedure shall be used to discover the *Characteristic Presentation Format* descriptor.

4.3 Configuration of Alert on Link Loss

After the Link Loss service and its Alert Level characteristic are discovered by the Proximity Monitor, the Proximity Monitor shall write the Alert Level characteristic in the Link Loss service to the required link loss alert level, after the Proximity Monitor and the Proximity Reporter have established the connection. The required level may be set by the user of the Proximity Monitor.

4.4 Alert on Link Loss

The Proximity Monitor shall maintain a connection with the Proximity Reporter and monitor the RSSI of this connection.

When the connection is disconnected the Proximity Reporter will alert to the level specified in the Alert Level characteristic, as defined by the Link Loss service specification. The Proximity Monitor may also alert when the connection is disconnected. The duration of the alert is implementation specific.

It is recommended that the Link Supervision Timeout (LSTO) is set to 6x the connection interval.

When the connection is re-established the Proximity Monitor should stop link loss alerting.

4.5 Reading Tx Power

After the Immediate Alert and the Tx Power services are discovered by the Proximity Monitor, the Proximity Monitor shall read the Tx Power Level characteristic of the Tx Power service, using the GATT Characteristic Value Read procedure, when the Proximity Monitor and the Proximity Reporter have established the connection.

Note: The Tx Power Level will never change during a connection and the Proximity Monitor should thus only read the Tx Power Level characteristic once as described above to conserve energy.

4.6 Alert on Path Loss

The Proximity Monitor shall maintain a connection with the Proximity Reporter and monitor the RSSI of this connection. The Proximity Monitor shall calculate the path loss

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by subtracting the RSSI from the transmit power level of the Proximity Reporter as discovered using the Reading Tx Power procedure. If the path loss exceeds a threshold set on the Proximity Monitor it shall write in the Alert Level characteristic of the Immediate Alert service, using the GATT Write Without Response sub-procedure, to cause the Proximity Reporter to alert. The Proximity Monitor may also alert when the path loss exceeds the threshold. The duration of the alert is implementation specific.

If the path loss falls below a threshold set on the Proximity Monitor it shall write in the Alert Level characteristic of the Immediate Alert service, using the GATT Write Without Response sub-procedure, to cause the Proximity Reporter to end the alert. When the path loss is below the threshold the Proximity Monitor should stop alerting.

If link loss occurs during this procedure, then the behavior defined in the Alert on Link Loss procedure shall be used, and this procedure shall stop.

The Proximity Monitor should implement some means of detecting changes in link conditions. The implementation should minimize false alerts.

5 Connection Establishment

This section describes the connection establishment procedures used by a Proximity Reporter and Proximity Monitor when using the recommended topology in Section 2.4.

5.1 Proximity Reporter

5.1.1 Device Discovery

The Proximity Reporter should use the GAP Limited Discoverable Mode when establishing an initial connection. The T_{GAP} (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 [1] but the value shall be less than or equal to 180 seconds.

5.1.2 Connection Procedure for Unbonded Devices

This procedure is used for device discovery and connection establishment when the Proximity Reporter connects to a Proximity Monitor to which it is not bonded and the user initiates a connection.

It is recommended that the Proximity Reporter advertises using the parameters in Table 5.1. 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

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

The Proximity Reporter shall accept any valid values for connection interval and connection latency set by the Proximity Monitor. Only after that should the Proximity Reporter 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 Proximity Reporter, the Proximity Reporter may exit the GAP connectable mode.

The Proximity Reporter should write the *Bluetooth* device address of the Proximity Monitor in the Proximity Reporter controller's white list and set the Proximity Reporter controller's advertising filter policy to 'process scan and connection requests only from devices in the White List'.

5.1.3 Connection Procedure for Bonded Devices

This procedure is used after the Proximity Reporter has bonded with the Proximity Monitor using the connection procedure in Section 5.1.2 when the user initiates a connection.

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A Proximity Reporter shall enter the GAP Undirected Connectable Mode when commanded by the user to initiate a connection to a Proximity Monitor.

The Proximity Reporter should use the advertising filter policy configured when bonded using the connection procedure in Section 5.1.2.

The Proximity Reporter 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.

The Proximity Reporter shall accept any valid values for connection interval and connection latency set by the Proximity Monitor until service discovery, bonding, and encryption are complete. Only after that should the Proximity Reporter change to the preferred connection parameters that best suits its use case.

The recommended value for the connection interval is 500 ms and the recommended value for the slave latency is 0.

If a connection is not established within a time limit defined by the Proximity Reporter, the Proximity Reporter may exit the GAP connectable mode.

5.1.4 Link Loss Reconnection

When a connection is terminated due to link loss a Proximity Reporter should attempt to reconnect to the Proximity Monitor by entering a GAP connectable mode using the recommended advertising interval values shown in Table 5.1.

5.2 Proximity Monitor

5.2.1 Device Discovery

The Proximity Monitor should use the GAP Limited Discovery Procedure to discover a Proximity Reporter.

5.2.2 Connection Procedure for Unbonded Devices

This procedure is used for device discovery and connection establishment when the Proximity Monitor is unbonded and the user initiates a connection.

A Proximity Monitor should use a GAP connection establishment procedure to initiate a connection to a Proximity Reporter when commanded by the user. The scan interval and scan window should be configured with consideration for user expectations of connection establishment time.

The Proximity Monitor should use the recommended scan interval and scan window values shown in Table 5.2. For the first 30 seconds (or optionally continuously for mains powered devices), the Proximity Monitor should use the first scan window / scan interval pair to attempt fast connection. However, if a connection is not established within that time, the Proximity Monitor should switch to one of the other scan window / scan interval options as defined below to reduce power consumption.

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

Table 5.2: Recommended Scan Interval and Scan Window Values

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

Option 1 in Table 5.2 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.

The Proximity Monitor should write the *Bluetooth* device address of the Proximity Reporter in the Proximity Monitor controller's white list and set the Proximity Monitor controller's initiator filter policy to 'process connectable advertisement packets.'

5.2.3 Connection Procedure for Bonded Devices

This procedure is used after the Proximity Monitor has bonded with the Proximity Reporter using the connection procedure in Section 5.2.2 when the user initiates a connection.

A Proximity Monitor should use a GAP connection establishment procedure to initiate a connection to a Proximity Reporter when commanded by the user.

The Proximity Monitor should use the recommended scan interval and scan window values shown in Table 5.2. For the first 30 seconds (or optionally continuously for mains powered devices), the Proximity Monitor should use the first scan window / scan interval pair to attempt fast connection. However, if a connection is not established within that time, the Proximity Monitor should switch to one of the other scan window / scan interval options as defined below to reduce power consumption.

The Proximity Monitor 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 Proximity Monitor 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 Proximity Monitor must, after user interaction, re-bond, perform service discovery (unless the Proximity Monitor had previously determined that the Proximity Reporter did not have the «Service Changed» characteristic) and reconfigure

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the Proximity Reporter before using any of the services referenced by this profile in case the configuration was altered or lost.

5.2.4 Link Loss Reconnection

When a connection is terminated due to link loss a Proximity Monitor should attempt to reconnect to the Proximity Reporter using any of the GAP connection procedures, and using the recommended parameters shown in [Table 5.2](#).

5.2.5 Fast Connection Interval

To avoid very long service discovery and encryption times, the Proximity Monitor should use the connection intervals defined in [Table 5.3](#) in the connection request.

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

Table 5.3: Recommended Connection Interval Values

At any time a lower latency is required, for example to perform key refresh, this should be preceded with a connection parameter update to the minimum and maximum connection interval values defined in [Table 5.3](#) 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 Proximity Reporter using the GAP Connection Parameter Update procedure.

6 Security Considerations

6.1 Security Considerations

The Proximity Reporter shall support LE Security Mode 1 and Security Levels 2 or 3. The Proximity Reporter should use the SM Slave Security Request procedure only when bonded with the Proximity Monitor to inform the Proximity Monitor of its security requirements.

The Proximity Monitor shall support LE Security Mode 1 and Security Levels 2 and 3. The Proximity Monitor should accept the LE Security Mode and Security Level combination requested by the Proximity Reporter.

6.2 Distance Measurement Security

Note that for the Bluetooth Core Specification [1] v4.0 (and possibly later versions) even if the link between the Proximity Monitor and Proximity Reporter has security enabled, the two devices can be spoofed into assuming that the other device is close. So the Proximity Profile should not be used as the only protection of valuable assets.

One simple attack would utilize the fact that a MIC is not added to empty packets. For the Bluetooth Core Specification [1] v4.0 it's recommend that use cases that require a moderate security level ensure that there is some authenticated data traffic on the link between the Proximity Monitor and the Proximity Reporter. If no other profile is causing data to be exchanged, the Proximity Monitor might read the Alert Letvel characteristic of the Link Loss Service occasionally. The average frequency of the data traffic must be chosen as a trade-off between the security requirement of the use case and the added battery drain in the tiny device.

More advanced attacks might use some form of relay to extend the range of between the two devices. There is currently no known way to protect against such attacks using Bluetooth technology.

7 GATT Interoperability Requirements

The following GATT sub-procedures are required to be implemented for both the Proximity Monitor and Proximity Reporter roles.

GATT sub-procedure	Proximity Monitor	Proximity Reporter
Discover All Primary Services	C.1	M
Discover Primary Services by Service UUID	C.1	M
Discover All Characteristic of a Service	M	M
Discover Characteristic by UUID	N/A	M
Discover All Characteristic Descriptors	O	M
Read Characteristic Value	M	M
Write Characteristic Value	M	M
C.1: Either Discover All Primary Services or Discover Primary Services By Service UUID shall be supported by the Proximity Monitor.		

8 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
BR/EDR	Basic Rate / Enhanced Data Rate
GAP	Generic Access Profile
GATT	Generic Attribute Profile
LE	Low energy
RSSI	Received Signal Strength Indicator
SDP	Service Discovery Protocol
UUID	Universally Unique Identifier

9 References

- [1] *Bluetooth v4.0 Core Specification*
- [2] Link Loss Service
- [3] Immediate Alert Service
- [4] Tx Power Service
- [5] Characteristic and Descriptor descriptions are accessible via the [Bluetooth SIG Assigned Numbers](#) web page.