Proximity Profile (PXP)

Bluetooth® Test Suite

- ▪ **Revision:** PXP.TS.p9
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Contents

1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases to test the implementation of the Bluetooth Proximity Profile Specification with the objective to provide a high probability of air interface interoperability between the tested implementation and other manufacturers' Bluetooth devices.

2 References, definitions, and abbreviations

2.1 References

This document incorporates provisions from other publications by dated or undated reference. These references are cited at the appropriate places in the text, and the publications are listed hereinafter. Additional definitions and abbreviations can be found in [1] and [2].

[1]   Test Strategy and Terminology Overview

[2]   Bluetooth Core Specification, Version 4.0 or later

[3]   Proximity Profile Specification, Version 1.0 or later

[4]   ICS Proforma for Proximity Profile, PXP.ICS

[5]   GAP Test Suite, GAP.TS

[6]   GATT Test Suite, GATT.TS

[7]   Immediate Alert Service, Version 1.0 or later

[8]   Link Loss Service, Version 1.0 or later

[9]   Tx Power Service, Version 1.0 or later

[10] Immediate Alert Service Test Suite, IAS.TS

[11] Link Loss Service Test Suite, LLS.TS

[12] Tx Power Service Test Suite, TPS.TS

2.2 Definitions

In this Bluetooth document, the definitions from [1] and [2] apply.

2.3 Acronyms and abbreviations

In this Bluetooth document, the definitions, acronyms, and abbreviations from [1] and [2] apply.

3 Test Suite Structure (TSS)

3.1 Overview

The Proximity Profile is a client of GAP, SM (LE), and GATT. This is illustrated in Figure 3.1.
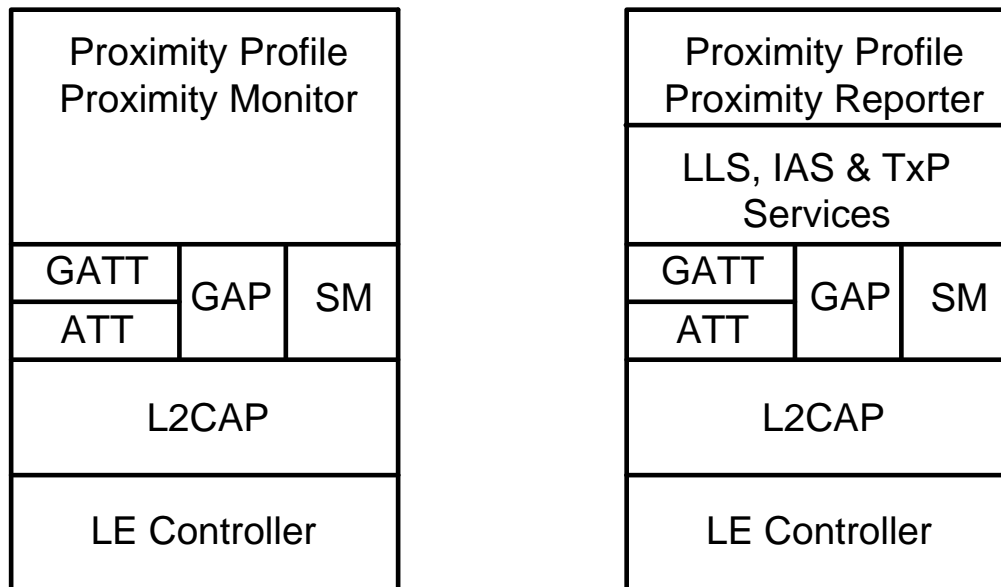
Figure 3.1: Proximity test model

3.2 Test Strategy

The test objectives are to verify the functionality of the Proximity Profile within a Bluetooth Host and enable interoperability between Bluetooth Hosts on different devices. The testing approach covers mandatory and optional requirements in the specification and matches these to the support of the IUT as described in the ICS. Any defined test herein is applicable to the IUT if the ICS logical expression defined in the Test Case Mapping Table (TCMT) evaluates to true.

The test equipment provides an implementation of the Radio Controller and the parts of the Host needed to perform the test cases defined in this Test Suite. A Lower Tester acts as the IUT's peer device and interacts with the IUT over-the-air interface. The configuration, including the IUT, needs to implement similar capabilities to communicate with the test equipment. For some test cases, it is necessary to stimulate the IUT from an Upper Tester. In practice, this could be implemented as a special test interface, a Man Machine Interface (MMI), or another interface supported by the IUT.

This Test Suite contains Valid Behavior (BV) tests complemented with Invalid Behavior (BI) tests where required. The test coverage mirrored in the Test Suite Structure is the result of a process that started with catalogued specification requirements that were logically grouped and assessed for testability enabling coverage in defined test purposes.
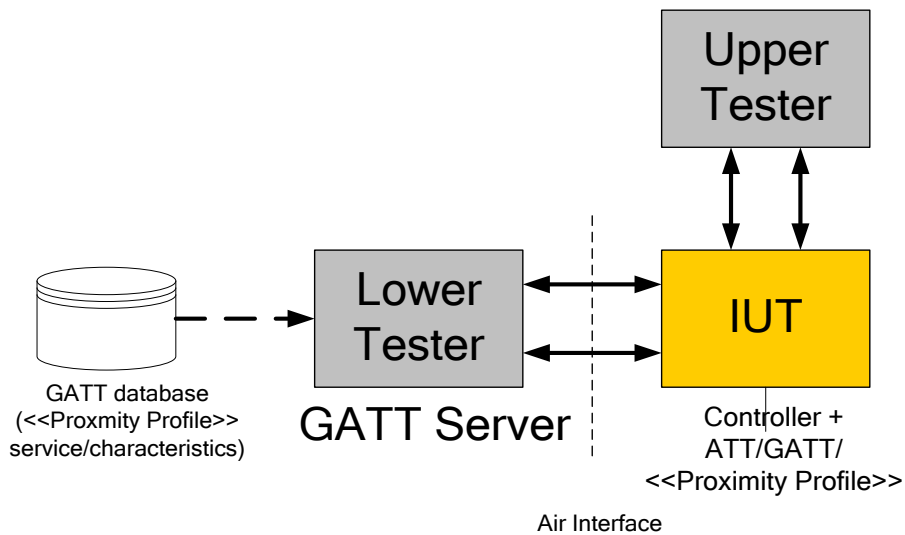
Figure 3.2: Proximity Profile Client test configuration

3.3 Test groups

The following test groups have been defined:

- Generic GATT Integrated Tests

- Features

4 Test cases

4.1 Introduction

4.1.1 Test case naming conventions

Test cases are assigned unique identifiers per the conventions in [1]. The convention used here is:
<spec abbreviation>/<IUT role>/<class>/**<feat>**/<func>/<subfunc>/<cap>/**<xx>-<nn>-<y>**.

Additionally, testing of this specification includes tests from the GATT Test Suite [6] referred to as Generic GATT Integrated Tests (GGIT); when used, the GGIT tests are referred to through a TCID string using the following convention:
<spec abbreviation>/<IUT role>/<GGIT test group>/< GGIT class >/<xx>-<nn>-<y>.

Identifier Abbreviation	Spec Identifier <spec abbreviation>
PXP	Proximity Profile
Identifier Abbreviation	**Role Identifier <IUT role>**
PM	Proximity Monitor Role
PR	Proximity Reporter Role
Identifier Abbreviation	**Reference Identifier <GGIT test group>**
CGGIT	Client Generic GATT Integrated Tests
Identifier Abbreviation	**Reference Identifier <GGIT class>**
CHA	Characteristic
DES	Descriptor
SER	Service
Identifier Abbreviation	**Class Identifier <class>**
PXF	Features

Table 4.1: PXP TC feature naming conventions

4.1.2 Conformance

When conformance is claimed for a particular specification, all capabilities are to be supported in the specified manner. The mandated tests from this Test Suite depend on the capabilities to which conformance is claimed.

The Bluetooth Qualification Program may employ tests to verify implementation robustness. The level of implementation robustness that is verified varies from one specification to another and may be revised for cause based on interoperability issues found in the market.

Such tests may verify:

• That claimed capabilities may be used in any order and any number of repetitions not excluded by the specification

• That capabilities enabled by the implementations are sustained over durations expected by the use case

• That the implementation gracefully handles any quantity of data expected by the use case

- That in cases where more than one valid interpretation of the specification exists, the implementation complies with at least one interpretation and gracefully handles other interpretations

- That the implementation is immune to attempted security exploits

A single execution of each of the required tests is required to constitute a Pass verdict. However, it is noted that to provide a foundation for interoperability, it is necessary that a qualified implementation consistently and repeatedly pass any of the applicable tests.

In any case, where a member finds an issue with the test plan generated by Launch Studio, with the test case as described in the Test Suite, or with the test system utilized, the member is required to notify the responsible party via an erratum request such that the issue may be addressed.

4.1.3 Pass/Fail verdict conventions

Each test case has an Expected Outcome section. The IUT is granted the Pass verdict when all the detailed pass criteria conditions within the Expected Outcome section are met.

The convention in this Test Suite is that, unless there is a specific set of fail conditions outlined in the test case, the IUT fails the test case as soon as one of the pass criteria conditions cannot be met. If this occurs, then the outcome of the test is a Fail verdict.

4.2 Setup preambles

The procedures defined in this section are provided for information, as they are used by test equipment in achieving the initial conditions in certain tests.

4.2.1 ATT Bearer on BR/EDR Transport

Follow the preamble procedure described in [6] Section 4.2.1.1.

4.2.2 ATT Bearer on LE Transport

Follow the preamble procedure described in [6] Section 4.2.1.2.

4.3 Generic GATT Integrated Tests

Execute the Generic GATT Integrated Tests defined in [6] in Section 6.4, Client test procedures (CGGIT), using Table 4.2 below as input:

TCID	Service / Characteristic / Descriptor	Reference	Properties	Value Length (Octets)	Service Type
PXP/PM/CGGIT/SER/BV-01-C [Service GGIT – Link Loss]	Link Loss Service	[3] 4.1	-	-	Primary Service
PXP/PM/CGGIT/SER/BV-02-C [Service GGIT – Immediate Alert]	Immediate Alert Service	[3] 4.1	-	-	Primary Service
PXP/PM/CGGIT/SER/BV-03-C [Service GGIT – Tx Power]	Tx Power Service	[3] 4.1	-	-	Primary Service
PXP/PM/CGGIT/CHA/BV-01-C [Characteristic GGIT – Alert Level (Link Loss)]	Alert Level Characteristic (Link Loss)	[3] 4.2	0x08 (Write)	Skip	-
PXP/PM/CGGIT/CHA/BV-02-C [Characteristic GGIT – Alert Level (Immediate Alert)]	Alert Level Characteristic (Immediate Alert)	[3] 4.2	0x04 (Write Without Response)	Skip	-
PXP/PM/CGGIT/CHA/BV-03-C [Characteristic GGIT – Tx Power Level]	Tx Power Level Characteristic	[3] 4.2	0x02 (Read)	Skip	-
PXP/PM/CGGIT/DES/BV-01-C [Descriptor GGIT – Characteristic Presentation Format]	Characteristic Presentation Format Descriptor	[3] 4.2	0x02 (Read)	Skip	-

Table 4.2: Input for the GGIT Client test procedure

4.4   Proximity Profile Features

Verify Proximity Monitor IUT implementation of the Features defined in the Proximity Profile Specification [3] by a Proximity Monitor IUT, and usage of the same features by a Proximity Reporter IUT.

PXP/PM/PXF/BV-01-I [Configuration of Alert Level]

- Test Purpose

  Verify that the Proximity Monitor can write the Alert Level characteristic value of the Link Loss Service to a Proximity Reporter.

- Reference

  [3] 4.3

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT, see Section 4.2.

- Test Procedure

  The Upper Tester sends a command to the IUT to write a valid Alert Level value to the Alert Level characteristic in the Lower Tester.

- Expected Outcome

  Pass verdict

  The IUT sends a correctly formatted ATT_Write_Request to the Lower Tester, containing the handle of the alert level characteristic of the Link Loss Service, and with the Alert Level value specified by the Upper Tester.

PXP/PM/PXF/BV-02-I [Alert on Link Loss]

- Test Purpose

  Verify that when the monitored link is disconnected, the Proximity Monitor alerts.

- Reference

  [3] 4.4

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT, see Section 4.2.

- Test Procedure

  The link is disconnected by interrupting the radio communication between the two devices, without sending a disconnection command.

- Expected Outcome

  Pass verdict

  The IUT starts alerting when the physical link is disconnected. Note that the level of alerting is implementation specific and that some implementations may use No Alert as a valid alert level.

PXP/PM/PXF/BV-03-I [Read Tx Power]

- Test Purpose

  Verify that the Proximity Monitor can read the Tx Power Level characteristic after establishment of connection.

- Reference

  [3] 4.4

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT, see Section 4.2.

  - The Upper Tester knows the handle of a Tx Power Level characteristic contained in the Lower Tester.

- Test Procedure

  1. Send a command from the Upper Tester to request that the IUT read a Tx Power Level Characteristic from the Lower Tester using either the Read Characteristic Value or Read Using Characteristic GATT procedure.
  2. After receipt of the expected result by the Lower Tester, send an ATT_Read_Response from the Lower Tester to the IUT.

- Expected Outcome

  Pass verdict

  The IUT sends a correctly formatted and valid Tx Power Level to the Upper Tester.

PXP/PM/PXF/BV-05-I [Alert on Exceeding Path Loss]

- Test Purpose

  Upon exceeding a path loss determined by the Proximity Monitor, verify that the Proximity Monitor writes the Alert Level characteristic of the Immediate Alert Service.

- Reference

  [3] 4.6

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT, see Section 4.2.

  - The Lower Tester has set its Alert Level characteristic to No Alert.

- Test Procedure

  Send a command from the Upper Tester to request the IUT to trigger an immediate alert.

- Expected Outcome

  Pass verdict

  The IUT uses the Characteristic Write command to write the Alert Level characteristic of the Immediate Alert Service in the Lower Tester with the value of Mild Alert or High Alert.

PXP/PM/PXF/BV-06-I [Cancel Alert on Reducing Path Loss]

- Test Purpose

  After an alert due to exceeding a path loss determined by the Proximity Monitor, as the path loss falls below a threshold determined by the Proximity Monitor, verify that the Proximity Monitor writes the Alert Level characteristic of the Immediate Alert Service with No Alert.

- Reference

  [3] 4.6

- Initial Condition

  - Establish an ATT Bearer connection between the Lower Tester and the IUT, see Section 4.2.

  - An Alert level value of Mild Alert or High Alert has previously been written to the Alert Level characteristic of the Immediate Alert Service in the Lower Tester.

- Test Procedure

  Send a command from the Upper Tester to request the IUT to stop the immediate alert.

- Expected Outcome

  <u>Pass verdict</u>

  The IUT uses the Characteristic Write command to write the Alert Level characteristic of the Immediate Alert Service in the Lower Tester with the value No Alert.

PXP/PM/PXF/BV-07-I [Verify Bond Status on Reconnection]

- Test Purpose

  Verify that the Proximity Monitor starts encryption with a previously bonded Proximity Reporter on reconnection.

- Reference

  [3] 5.2.3

- Initial Condition

  - The IUT and the Lower Tester are bonded.

  - No connection is established between the IUT and the Lower Tester.

- Test Procedure

  The Lower Tester begins advertising using GAP undirected connectable mode.

  The IUT establishes a connection to the Lower Tester.

  The IUT starts encryption when the connection is established.

- Expected Outcome

  <u>Pass verdict</u>

  The IUT starts encryption when the connection is established.

5 Test case mapping

The Test Case Mapping Table (TCMT) maps test cases to specific requirements in the ICS. The IUT is tested in all roles for which support is declared in the ICS document.

The columns for the TCMT are defined as follows:

Item: Contains a logical expression based on specific entries from the associated ICS document. Contains a logical expression (using the operators AND, OR, NOT as needed) based on specific entries from the applicable ICS document(s). The entries are in the form of y/x references, where y corresponds to the table number and x corresponds to the feature number as defined in the ICS document for the Proximity Profile (PXP) [4].

Feature: A brief, informal description of the feature being tested.

Test Case(s): The applicable test case identifiers are required for Bluetooth Qualification if the corresponding y/x references defined in the Item column are supported. Further details about the function of the TCMT are elaborated in [1].

For the purpose and structure of the ICS/IXIT, refer to [1].

Item	Feature	Test Case(s)
PXP 6/1 AND PXP 6/2	Set Alert Level	PXP/PM/PXF/BV-01-I
PXP 6/3	Alert on link loss	PXP/PM/PXF/BV-02-I
PXP 6/4	Read Tx Power level	PXP/PM/PXF/BV-03-I
PXP 6/7	Write Alert Level when path loss exceeds threshold	PXP/PM/PXF/BV-05-I
PXP 6/8	Write Alert Level when path loss falls below threshold	PXP/PM/PXF/BV-06-I
PXP 7/1	Discover Link Loss Service	PXP/PM/CGGIT/SER/BV-01-C
PXP 7/2	Discover Immediate Alert Service	PXP/PM/CGGIT/SER/BV-02-C
PXP 7/3	Discover Tx Power Service	PXP/PM/CGGIT/SER/BV-03-C
PXP 7/4	Alert Level for Link Loss	PXP/PM/CGGIT/CHA/BV-01-C
PXP 7/5	Alert Level characteristic for Immediate Alert	PXP/PM/CGGIT/CHA/BV-02-C
PXP 7/6	Tx Power Level	PXP/PM/CGGIT/CHA/BV-03-C
PXP 7/7	Tx Power Level Characteristic Presentation Format Descriptor	PXP/PM/CGGIT/DES/BV-01-C
PXP 6/9	Verify Bond Status on Reconnection	PXP/PM/PXF/BV-07-I

Table 5.1: Test case mapping

6 Revision history and acknowledgments

Revision History

Publication Number	Revision Number	Date	Comments
0	1.0.0	2011-06-27	Prepare for publication.
	1.0.1r0 -1r2	2011-11-11 – 2012-02-09	TSE 4446 TP/PXF/PM/BV-02-C, TP/PXS/PM/BV-09-C, TP/PXF/PM/BV-03-C, TP/PXF/PM/BV-11-C, TP/PXF/PM/BV-04-C, TP/PXF/PM/BV-05-C, TP/PXF/PM/BV-06-C TSE 4577: TP/PXS/PM/BV-08-C , TP/PXF/PM/BV-01-C, more changes to TCMT Prepare for publication. TSE 4652: TP/PXF/PM/BV-07-C remove statement from initial condition
1	1.0.1	2012-03-30	Prepare for publication.
	1.0.2r0	2012-05-21	TSE 4723: Changes to TCMT for TP/PXF/PM/BV-01-C, TP/PXS/PM/BV-07-C, TP/PXS/PM/BV-09-C, TP/PXS/PM/BV-11-C
2	1.0.2	2012-07-24	Prepare for publication.
	1.0.3r1	2012-09-05	TSE 4929: Change all Test Case IDs from –C to –I.
3	1.0.3	2012-10-30	Prepare for Publication
	1.0.4r1	2013-05-02	TSE 5150: Updated TCMT mapping for TP/PXF/PM/BV-07-I from "PXP 6/9 OR PXP 7/9" to "PXP 6/9"
	1.0.4r2	2013-05-05	Update version and references to align with ESR06. (Rejected in revision 3)
	1.0.4r3	2013-06-05	Removed ESR06 changes, updated change history and versioning.
4	1.0.4	2013-07-02	Prepare for Publication
	1.0.1.0r00	2015-05-20	ESR08: Incremented revision number to match spec (1.0.1) and added 4th digit for TS revision (1.0.1.0).
5	1.0.1.0	2015-07-14	Prepared for TCRL 2015-1 publication
	1.0.1.1r00	2016-05-26	Converted to new Test Case ID conventions as defined in TSTO v4.1.
	1.0.1.1r01	2016-06-03	Converted to current TS template.
	1.0.1.1r02	2016-06-08	Corrected Client role to Proximity Monitor.
6	1.0.1.1	2016-07-14	Prepared for TCRL 2016-1 publication.
	1.0.1.2r00	2017-04-25	TSE 7786: Removed PXP/PM/PXS/BV-01-I, PXP/PM/PXS/BV-02-I, PXP/PM/PXS/BV-03-I from TS and TCMT.
	1.0.1.2r01	2017-05-08	Additional cleanup and Removal of references to the test cases PXP/PM/PXS/BV-01-I, PXP/PM/PXS/BV-02-I, and PXP/PM/PXS/BV-03-I in sections PXP/PM/PXS/BV-07-I to BV-11-I as these tests were removed by TSE 7786.

Publication Number	Revision Number	Date	Comments
7	1.0.1.2	2017-06-26	Approved by BTI. Prepared for TCRL 2017-1 publication.
	1.0.1.3r00	2019-06-24	TSE 11378 (rating 2): Removed test case PXP/PM/PXF/BV-04-I from TS and TCMT.
8	1.0.1.3	2019-07-29	Approved by BTI. Prepared for TCRL 2019-1 publication.
	p9r00	2023-05-10	TSE 22810 (rating 2): Converted the following test cases to GGIT: PXP/PM/PXS/BV-04-I – -11-I. The new GGIT converted TCIDs are: PXP/PM/CGGIT/CHA/BV-01-C – -03-C, PXP/PM/CGGIT/DES/BV-01-C, and PXP/PM/CGGIT/SER/BV-01-C – -03-C. Updated the TCMT accordingly. Editorials to align the document with the latest TS template and DNMD, including setting the previous v1.0.1.3 as p8 and removing the draft entries from the revision history.
9	p9	2023-06-29	Approved by BTI on 2023-05-28. Prepared for TCRL 2023-1 publication.