Global Navigation Satellite System Profile (GNSS)

Bluetooth® Test Suite

- **Revision:** GNSS.TS.p2
- **Revision Date:** 2024-07-01
- **Prepared By:** BTI
- **Published during TCRL:** TCRL.2024-1

Contents

1 Scope

This Bluetooth document contains the Test Suite Structure (TSS) and test cases to test the implementation of the Bluetooth Global Navigation Satellite System Profile 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], [2], and [3].

[1]   Bluetooth Core Specification - revision 2.1 + EDR or later

[2]   Test Strategy and Terminology Overview

[3]   Global Navigation Satellite System Profile

[4]   ICS Proforma for Global Navigation Satellite System Profile (GNSS)

[5]   Specification of the Bluetooth System; Serial Port Profile

[6]   SDP Test Suite, SDP.TS

2.2   Definitions

In this Bluetooth document, the definitions from [1], [2], and [3] apply.

2.3   Acronyms and abbreviations

In this Bluetooth document, the abbreviations from [1], [2], and [3] apply.

3   Test Suite Structure (TSS)

3.1   Overview

The GNSS profile exists primarily to provide an SDP record to identify the RFCOMM port of a GNSS server device. Interoperability and conformance to the NMEA-0183 specification is outside the scope of Bluetooth Qualification since GNSS profile does not specify which NMEA-0183 sentences will be transmitted by the server device, nor the interval at which those sentences are transmitted. Since all of the over-the-air GPS protocol is defined by the NMEA-0183, profile specification testing will focus on connection setup and release.

3.2   Test Strategy

The test objectives are to verify the functionality of the Global Navigation Satellite System 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.

3.3   Test groups

The following test groups have been defined:

- Generic SDP Integrated Tests

- Connection Establishment

- NMEA Data Transfer

- Connection Release

4 Test cases (TC)

4.1 Introduction

4.1.1 Test case identification conventions

Test cases are assigned unique identifiers per the conventions in [2]. 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 SDP Test Suite [6] referred to as Generic SDP Integrated Tests (GSIT); when used, the test cases in GSIT are referred to through a TCID string using the following convention:
<spec abbreviation>/<IUT role>/<GSIT test group>/< GSIT class >/<xx>-<nn>-<y>.

Identifier Abbreviation	Spec Identifier <spec abbreviation>
GNSS	Global Navigation Satellite System Profile
Identifier Abbreviation	**Role Identifier <IUT role>**
CL	Client role
SR	Server role
Identifier Abbreviation	**Reference Identifier <GSIT test group>**
CGSIT	Client Generic SDP Integrated Tests
SGSIT	Server Generic SDP Integrated Tests
Identifier Abbreviation	**Reference Identifier <GSIT class>**
ATTR	Attribute
OFFS	Attribute ID Offset String
SERR	Service Record
SFC	SDP Future Compatibility
Identifier Abbreviation	**Feature Identifier <feat>**
GCE	GNSS Connection Establishment
GCR	GNSS Connection Release
GDT	GNSS Data Transfer

Table 4.1: GNSS 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 the Bluetooth SIG qualification tool, 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 Generic SDP Integrated Tests

4.2.1 Server Generic SDP Integrated Tests

4.2.1.1 Global Navigation Satellite System Profile – Server

Execute the Generic SDP Integrated Tests defined in Section 6.3, Server test procedures (SGSIT), in [6] using Table 4.2 below as input:

TCID	Reference	Attribute ID name	Attribute ID definition source (Universal, Profile)	Value/secondary value	Attribute presence (Present/Present for [role], Optionally present, TCMT defined)
GNSS/SR/SGSIT/SERR/BV-01-C [Service record GSIT – GNSS Server]	[3] 4.4	ServiceClassIDList	Universal	"GNSS_Server" (UUID), "SerialPort" (UUID)	Present for Server
GNSS/SR/SGSIT/ATTR/BV-01-C [Attribute GSIT – Protocol Descriptor List]	[3] 4.4	ProtocolDescriptorList	Universal	"L2CAP" (UUID, "RFCOMM" (UUID): Server Channel – skip (Uint8)	Present for Server
GNSS/SR/SGSIT/ATTR/BV-02-C [Attribute GSIT – Bluetooth Profile Descriptor List, GNSS 1.0]	[3] 4.4	BluetoothProfileDescriptorList	Universal	"GNSS" (UUID): Version – "0x0100" (Uint16)	Present for Server
GNSS/SR/SGSIT/ATTR/BV-03-C [Attribute GSIT – Supported Features]	[3] 4.4	SupportedFeatures	Profile	skip (Uint16)	Present for Server

Table 4.2: Input for the GNSS Server SGSIT SDP test procedure

4.2.1.2 Global Navigation Satellite System Profile – Attribute ID Offset String tests

Execute the Generic SDP Integrated Tests defined in Section 6.3, Server test procedures (SGSIT), in [6] using Table 4.3 below as input:

TCID	Reference	ServiceSearchPattern	Attribute ID name	Attribute ID Offset	Attribute presence (Present/Present for [role], Optionally present, TCMT defined)
GNSS/SR/SGSIT/OFFS/BV-01-C [Attribute ID Offset String GSIT – Service Name]	[3] 4.4	GNSS_Server	ServiceName	0x0000	Optionally present

Table 4.3: Input for the Global Navigation Satellite System Profile SGSIT Attribute ID Offset String tests

4.2.2   Client Generic SDP Integrated Tests

Execute the Generic SDP Future Compatibility Tests defined in Section 6.4, Client test procedures (CGSIT), in [6] using Table 4.4 below as input:

TCID	Reference	Service Record Service Class UUID description	Lower Tester SDP record initial conditions
GNSS/CL/CGSIT/SFC/BV-01-C [SDP Future Compatibility – IUT is GNSS Client]	[3] 4.4	GNSS_Server, SerialPort	The Lower Tester exposes a GNSS Server SDP record. The version in the Bluetooth Profile Descriptor List is greater than the most recently adopted version. All bits are set in the supported features attribute, including Reserved bits.

Table 4.4: Input for the Client CGSIT SDP future compatibility tests

4.3   GNSS Connection Establishment

Verify the correct establishment of a service level connection (SLC) in the Bluetooth Global Navigation Satellite System Profile.

4.3.1   Connection Establishment

- Test Purpose

  Verify that a GNSS profile SLC is successfully established to the Server from the Client.

- Reference

  [3] 3.2

  [5] 3

- Initial Condition

  - The GNSS server is discoverable and connectable.

  - An ACL link is established between the Client and the Server.

- Test Case Configuration

Test Case
GNSS/SR/GCE/BV-01-C [Connection Establishment]
GNSS/CL/GCE/BV-01-C [Connection Establishment]

  Table 4.5: Connection Establishment test cases

- Test Procedure

  1. From the Client device, initiate a GNSS connection with the Server. This can be initiated by the power-up sequence, or by user interaction.
  2. The Server accepts the GNSS connection requested by the Client. User input may be required to accept the connection and for security procedures.
  3. Follow the procedure to establish link and set up virtual serial connection, in Section 3 of Serial Port Profile [5].

- Expected Outcome

  <u>Pass verdict</u>

  Upon completion of the GNSS SLC connection between the client or server device, there is an indication to the MMI in case a virtual serial connection is ready to be used for communication.

4.4   NMEA Data Transfer

Verify that the NMEA data is transferred from the Server to the Client.

4.4.1   NMEA Data Transfer

- Test Purpose

  Verify that streaming NMEA data is sent from the Server to the Client following setup of a GNSS profile SLC.

- Reference

  [3] 3.4.1

  [5] 3

- Initial Condition

  - Devices are in range and connectable.

- Test Case Configuration

Test Case
GNSS/SR/GDT/BV-01-C [NMEA Data Transfer]
GNSS/CL/GDT/BV-01-C [NMEA Data Transfer]

Table 4.6: NMEA Data Transfer test cases

- Test Procedure

  1. A Service Level Connection between the Client and the Server is established. There is an indication to the MMI in case a virtual serial connection is ready to be used for communication.
  2. Following GNSS connection establishment, the Server starts streaming NMEA-0183 data to the Client.

- Expected Outcome

  Pass verdict

  Server: Sends the NMEA data after the GNSS profile SLC is established without prompt from Client.

  Client: Receives the NMEA data[1] from Server as soon as the GNSS profile SLC is established without any prompt from Client.

- Notes

  [1] Valid NMEA-0183 data can be verified by two methods. When using a pair of GNSS-capable devices, the client device should display the correct location data. When testing a server against a protocol tester, such as PTS, the NMEA-0183 sentences can be identified and verified by their checksum data. When testing a client, a protocol tester sends known position data. See Appendix A for sample code to verify NMEA-0183 sentences.

  The GNSS profile does not specify the exact NMEA sentences that will be sent by the Server. Testing of specific sentence sets or interval between transmissions is not within scope of this test.

GNSS/SR/GDT/BI-01-C [Unsupported Command]

- Test Purpose

  Verify that the Server IUT ignores an unsupported command sent by the Client.

- Reference

  [3] 3.4.3

  [5] 3

- Initial Condition

    - The IUT and the Lower Tester are in a GNSS profile SLC.

    - Following GNSS connection establishment, the IUT starts streaming NMEA-0183 data to the Lower Tester.

- Test Procedure

    1. The Lower Tester receives the NMEA-0183 data sent by the Server IUT.
    2. During this streaming of position data, the Lower Tester will generate a simulated unsupported data stream. If proprietary extensions are supported, this data is not one of the extensions supported by this Client-Server pair.
    3. The Lower Tester sends this data to the IUT.
    4. The Lower Tester does not receive a response to this data from the IUT.
    5. The Lower Tester continues to receive NMEA-0183 data from the IUT.

- Expected Outcome

    Pass verdict

    The IUT correctly detects the unsupported message sent from the Lower Tester and ignores it.

    The IUT continues to send the NMEA data after ignoring the unsupported command.

- Notes

    The GNSS profile does not specify the exact NMEA or non-NMEA sentences that will be sent by the client. Testing of specific sentence sets or interval between transmissions is not within scope of this test.

GNSS/CL/GDT/BI-02-C [Unsupported Command]

- Test Purpose

    Verify that the Client IUT ignores an unsupported data stream from the Lower Tester.

- Reference

    [3] 3.4.3

    [5] 3

- Initial Condition

    - The IUT and the Lower Tester are in a GNSS profile SLC.

    - Following GNSS connection establishment, the Lower Tester starts streaming NMEA-0183 data to the IUT. During this streaming of position data, the Lower Tester will insert data that is not supported.

- Test Procedure

    1. The IUT receives the NMEA-0183 data sent by the Lower Tester.
    2. During this streaming of position data, the Lower Tester will generate a simulated unsupported data stream. If proprietary extensions are supported, this data is not one of the extensions supported by this Client-Server pair.
    3. The Lower Tester sends this data to the IUT.
    4. The IUT does not send a response to this data from the Lower Tester.
    5. The IUT continues to receive NMEA-0183 data from the Lower Tester.

- Expected Outcome

    <u>Pass verdict</u>

    The IUT correctly detects the unsupported message sent from the Lower Tester and ignores it.

    The IUT continues to receive the NMEA data, after ignoring the unsupported command.

- Notes

    The GNSS profile does not specify the exact NMEA or non-NMEA sentences that will be sent by the server. Testing of specific sentence sets or interval between transmissions is not within scope of this test.

4.5   GNSS Connection Release

Verify the shutdown procedure of the GNSS RFCOMM session (service level connection).

GNSS/CL/GCR/BV-01-C [Client initiated connection release]

- Test Purpose

    Verify that the Client IUT can close the GNSS session.

- Reference

    [3] 3.5

- Initial Condition

    - The IUT and the Lower Tester are in a GNSS profile SLC.

- Test Procedure

    A user action on the IUT initiates the GNSS connection release.

- Expected Outcome

    <u>Pass verdict</u>

    After release is initiated, the device may give an indication that the connection has been released.

    After release is initiated, the GNSS application response to incoming NMEA-0183 data cannot be observed.

GNSS/SR/GCR/BV-02-C [Server initiated connection release]

- Test Purpose

    Verify that the Server IUT can close the GNSS session.

- Reference

    [3] 3.5

- Initial Condition

    - The IUT and the Lower Tester are in a GNSS profile SLC.

- Test Procedure

    A user action on the IUT initiates the GNSS connection release.

- Expected Outcome

Pass verdict

After release is initiated, the device or host may give an indication that the connection has been released.

After release is initiated, the GNSS application response to incoming NMEA-0183 data cannot be observed.

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 Global Navigation Satellite System Profile (GNSS) [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 [2].

For the purpose and structure of the ICS/IXIT, refer to [2].

Item	Feature	Test Case(s)
GNSS 1/1	GNSS Server SDP Service	GNSS/SR/SGSIT/SERR/BV-01-C GNSS/SR/SGSIT/ATTR/BV-01-C GNSS/SR/SGSIT/ATTR/BV-02-C GNSS/SR/SGSIT/ATTR/BV-03-C GNSS/SR/SGSIT/OFFS/BV-01-C
GNSS 1/2	Successful Connection with future SDP Record value – GNSS Client	GNSS/CL/CGSIT/SFC/BV-01-C
GNSS 1/2 AND GNSS 3/1	Client Initiated Connection Establishment	GNSS/CL/GCE/BV-01-C
GNSS 1/1 AND GNSS 2/1	Client Initiated Connection Establishment	GNSS/SR/GCE/BV-01-C
GNSS 1/1 AND GNSS 2/3	Data Transfer	GNSS/SR/GDT/BV-01-C
GNSS 1/2 AND GNSS 3/3	Data Transfer	GNSS/CL/GDT/BV-01-C
GNSS 1/1 AND GNSS 2/3	Unsupported Command	GNSS/SR/GDT/BI-01-C
GNSS 1/2 AND GNSS 3/3	Unsupported Command	GNSS/CL/GDT/BI-02-C
GNSS 1/2 AND GNSS 3/2	Start Streaming by SRC	GNSS/CL/GCR/BV-01-C
GNSS 1/1 AND GNSS 2/2	Start Streaming by SRC	GNSS/SR/GCR/BV-02-C

Table 5.1: Test case mapping

6 Appendix A – NMEA-0183 Verification and Checksum Calculations

The following is an example of how one might identify and verify NMEA-0183 sentences. This code is meant as an example only and is not guaranteed to be complete, optimal, or robust.

Data in:

```
"$GPGGA,021502.728,4207.8508,N,08800.6293,W,1,06,2.2,183.3,M,-
34.1,M,0.0,0000*47",
"$GPGSA,A,3,15,18,21,22,09,03,,,,,,,3.2,2.2,2.2*37",
"$GXRMC,021502.728,A,4207.8508,N,08800.6293,W,0.15,184.15,230106,,*19",
"$GPGSV,3,1,10,15,79,237,43,18,73,014,33,21,58,161,36,22,47,295,42*7F",
"$GXRMC,021502.728,A,4207.8508,N,08800.6293,W,0.15,184.15,230106,,"
```

Output from sample code

```
*** 0: $GPGGA: Valid Sentence type
*** 0: $GPGGA: Checksum valid: 47
*** 1: $GPGSA: Valid Sentence type
*** 1: $GPGSA: Checksum valid: 37
*** 2: $GXRMC: Invalid Sentence type
*** 2: $GXRMC: Checksum invalid: Expected: 19 Calculated: 11
*** 3: $GPGSV: Valid Sentence type
*** 3: $GPGSV: Checksum valid: 7f
*** 4: $GXRMC: Invalid Sentence type
*** 4: $GXRMC: No checksum present
```

C Code:

```c
{
      /* Sample data for testing */
 char *GPS_Sent[5] = {
"$GPGGA,021502.728,4207.8508,N,08800.6293,W,1,06,2.2,183.3,M,-
34.1,M,0.0,0000*47",
"$GPGSA,A,3,15,18,21,22,09,03,,,,,,,3.2,2.2,2.2*37",
"$GXRMC,021502.728,A,4207.8508,N,08800.6293,W,0.15,184.15,230106,,*19",
"$GPGSV,3,1,10,15,79,237,43,18,73,014,33,21,58,161,36,22,47,295,42*7F",
"$GXRMC,021502.728,A,4207.8508,N,08800.6293,W,0.15,184.15,230106,,"
};

        char *WrkPtr, *Junk;
        unsigned char X, SentLen,Sum, ExpectedSum, SumX;

        for (X=0; X < 5; X++)
        {
            WrkPtr = GPS_Sent[X];
            if (strncmp(WrkPtr,"$GP",3) == 0 )
                fprintf(fout,"\t *** %d: %6.6s: Valid Sentence type\r\n",
X, WrkPtr);
            else
                fprintf(fout,"\t *** %d: %6.6s: Invalid Sentence type\r\n",
X, WrkPtr);

            SentLen = strlen(WrkPtr);
            Sum = 0;
```

```
            if (WrkPtr[SentLen-3] == '*')
            {
                Junk = decode_byte((WrkPtr + (SentLen-2)), &ExpectedSum);

                for (SumX = 1; SumX < (SentLen-3); SumX++)
Sum = Sum ^ WrkPtr[SumX];

                if (ExpectedSum == Sum)
                    fprintf(fout,"\t *** %d: %6.6s: Checksum valid:
%2.2x\r\n",X, WrkPtr,ExpectedSum);
                else
                    fprintf(fout,"\t *** %d: %6.6s: Checksum invalid:
Expected: %2.2x Calculated: %2.2x\r\n",
X, WrkPtr,ExpectedSum, Sum);
            }
            else
                fprintf(fout,"\t *** %d: %6.6s: No checksum present\r\n",
X, WrkPtr);
        }
    }
```

7   Revision history and acknowledgments

Revision History

Publication Number	Revision Number	Date	Comments
0	1.0.0	2012-03-14	Prepare for publication.
	1.0.1r00	2016-10-05	Converted to new Test Case ID conventions as defined in TSTO v4.1.
	1.0.1r01	2016-11-06	Converted test specification template.
1	1.0.1	2016-12-13	Approved by BTI. Prepared for TCRL 2016-2 publication.
	p2r00–r04	2023-10-20 – 2024-03-26	TSE 23916 (rating 1): Converted -I tests to -C tests as appropriate; updated the TCMT and TCRL accordingly. TSE 24914 (rating 4): Added a new GSIT section with new TCs GNSS/CL/CGSIT/SFC/BV-01-C, GNSS/SR/SGSIT/ATTR/BV-01-C – -03-C, GNSS/SR/SGSIT/OFFS/BV-01-C, and GNSS/SR/SGSIT/SERR/BV-01-C. Deleted SDP tests GNSS/SR/GSD/BV-01-I. Updated the TCMT accordingly. Added a reference to the SDP.TS, deleted the figure in the TSS Overview, completely revised the Test Groups list, and updated the TCID Conventions section. Modernized Client/Server language to IUT/Lower Tester. Editorial updates, including setting previous v1.0.1 to p1 and removing draft rev history entries. Updated the disclaimer text and footers to align with the latest DNMD and logo. Simplified the test groups section and replaced all boilerplate text per the latest TS template. Moved TCIDs into TC Config tables or reformatted as H8.
2	p2	2024-07-01	Approved by BTI on 2024-05-22. Prepared for TCRL 2024-1 publication.

Acknowledgments

Name	Company
Sowmya Ramjee	Bluetooth SIG, Inc.
Alicia Courtney	Broadcom
Burch Seymour	Continental Automotive Systems