Running Speed and Cadence Service

***Bluetooth*® Service Specification**

- **Revision:** v1.0.1
- **Revision Date:** 2024-10-01
- **Group Prepared By:** Sports & Fitness Working Group

Abstract:

This service exposes speed, cadence and other data from a Running Speed and Cadence sensor intended for fitness applications.

Revision History

Revision	Date (yyyy-mm-dd)	Comments
V10	2012-08-07	Adopted by the Bluetooth SIG Board of Directors.
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 16642, 16650, 18757, 22319, 23319.

Acknowledgments

Name	Company
Robert Hughes	Intel Corporation
Guillaume Schatz	Polar
Niclas Granqvist	Polar
Jari Miettinen	Polar
Leif-Alexandre Aschehoug	Nordic
Laurence Richardson	CSR
Jason Hillyard	Wicentric

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 Running Speed and Cadence (RSC) Service exposes speed, cadence and other data related to fitness applications such as the stride length and the total distance the user has traveled while using the Running Speed and Cadence sensor (Server).

1.1 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.

1.2 Service Dependency

This service is not dependent upon any other services.

1.3 Bluetooth Specification Release Compatibility

This specification is compatible with any *Bluetooth* Core Specification [1] that includes the Generic Attribute Profile (GATT) specification.

1.4 GATT Sub-Procedure Requirements

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

Table 1.1 summarizes additional GATT sub-procedure requirements beyond those required by all GATT Servers.

GATT Sub-Procedure	Requirements
Write Characteristic Value	C.1
Notifications	M
Indications	C.1
Read Characteristic Descriptors	M
Write Characteristic Descriptors	M

Table 1.1: GATT Sub-procedure Requirements

C.1: Mandatory if the SC Control Point characteristic is supported, otherwise excluded for this service.

1.5 Transport Dependencies

There are no transport restrictions imposed by this service specification.

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

1.6 Error Codes

This service defines the following Attribute Protocol Application Error codes listed in Table 1.2:

Name	Error Code	Description
Procedure Already in Progress	0x80	A SC Control Point request cannot be serviced because a previously triggered SC Control Point operation is still in progress.
Client Characteristic Configuration descriptor improperly configured	0x81	The Client Characteristic Configuration descriptor is not configured according to the requirements of the service.

Table 1.2: Attribute Protocol Application Error codes defined by this service

1.7 Byte Transmission Order

All characteristics used with this service shall be transmitted with the least significant octet first (i.e., little endian). The least significant octet is identified in the characteristic definitions in [2].

2 Service Declaration

The Running Speed and Cadence Service is recommended to be instantiated as a «Primary Service».

The service UUID shall be set to «Running Speed and Cadence Service» defined in [2].

3 Service Characteristics

The following characteristics are exposed in the Running Speed and Cadence Service. Only one instance of each characteristic is permitted within this service.

Characteristic Name	Requirement	Mandatory Properties	Optional Properties	Security Permissions
RSC Measurement	M	Notify		None.
RSC Measurement Client Characteristic Configuration descriptor	M	Read, Write		None.
RSC Feature	M	Read	Indicate C.3	None.
Sensor Location	C.1	Read		None.
SC Control Point	C.2	Write, Indicate		None.
SC Control Point Client Characteristic Configuration Descriptor	C.2	Read, Write		None.

Table 3.1: Running Speed and Cadence Service characteristics

C.1: Mandatory if the Multiple Sensor Location feature is supported, otherwise optional.

C.2: Mandatory if at least one SC Control Point procedure is supported, otherwise excluded.

C.3: The Indicate property shall be supported for the RSC Feature characteristic if the device supports bonding and the value of the RSC Feature characteristic can change over the lifetime of the device, otherwise excluded for this service

Notes:

- Security Permissions of “None” means that this service does not impose any requirements.
- Properties not listed as Mandatory or Optional are Excluded.

3.1 RSC Measurement

The RSC Measurement characteristic is used to send speed and cadence measurements. Included in the characteristic value are a Flags field (for showing the presence of optional fields and, if supported by the Server, whether the user is walking or running), an Instantaneous Speed field, an Instantaneous Cadence field, depending upon the contents of the Flags field, an Instantaneous Stride Length field and a Total Distance field.

The Server measures the instantaneous speed at which the user is moving. The cadence represents the number of times per minute the foot with the sensor hits the ground. The stride length represents the distance between two successive contacts of the same foot to the ground and the total distance represents the distance the user has travelled with the sensor since the last reset of the total distance.

3.1.1 Characteristic Behavior

When the RSC Measurement characteristic is configured for notification via the *Client Characteristic Configuration* descriptor and a speed and cadence measurement is available, this characteristic shall be notified while in a connection.

The RSC Measurement characteristic contains time-sensitive data, thus the requirements for time-sensitive data and data storage defined in Section 3.5 apply.

3.1.1.1 Flags Field

The Flags field shall be included in the RSC Measurement characteristic.

Reserved for Future Use (RFU) bits in the Flags fields shall be set to 0.

The bits of the Flags field are defined in the following subsections.

3.1.1.1.1 Instantaneous Stride Length Present bit

The Instantaneous Stride Length Present bit (bit 0 of the Flags field) indicates whether or not the Instantaneous Stride Length field is present.

When the Instantaneous Stride Length field is not present, the Instantaneous Stride Length Present bit shall be set to 0. When the Instantaneous Stride Length field is present, the Instantaneous Stride Length Present bit shall be set to 1.

The value of the Instantaneous Stride Length Present bit may change during a connection.

3.1.1.1.2 Total Distance Present bits

The Total Distance Present bit (bit 1 of the Flags field) indicates whether or not the Total Distance field is present.

When the Total Distance field is not present, the Total Distance Present bit shall be set to 0. When the Total Distance field is present, the Total Distance Present bit shall be set to 1.

The value of the Total Distance Present bit may change during a connection.

3.1.1.1.3 Walking or Running Status bit

If the Server supports the Walking or Running feature, the Server shall set bit 2 of the Flags field according to whether the user is walking or running.

If the user is walking, the Server shall set the Walking or Running Status bit to 0 and if the user is running, the Server shall set the Walking or Running Status bit to 1.

If the Server supports the Walking or Running feature, the value of the Walking or Running Status bit may change during a connection. Otherwise, the Server shall set this bit to 0.

3.1.1.2 Instantaneous Speed Field

The Instantaneous Speed field shall be included in the RSC Measurement characteristic.

3.1.1.3 Instantaneous Cadence Field

The Instantaneous Cadence field shall be included in the RSC Measurement characteristic. The Instantaneous Cadence represents the number of times per minute a foot fall occurs.

3.1.1.4 Instantaneous Stride Length Field

The Instantaneous Stride Length field may be included in the RSC Measurement characteristic if the device supports the Instantaneous Stride Length feature.

If the Instantaneous Stride Length value is present in the RSC Measurement characteristic, the Server shall set bit 0 of the Flags field (Instantaneous Stride Length Present bit) to 1. Otherwise, the Server shall set bit 0 of the Flags field to 0.

3.1.1.5 Total Distance Field

The Total Distance field may be included in the RSC Measurement characteristic if the device supports the Total Distance feature.

If the Total Distance value is present in the RSC Measurement characteristic, the Server shall set bit 1 of the Flags field (Total Distance Present bit) to 1. Otherwise, the Server shall set bit 1 of the Flags field to 0.

The Total Distance value is expected to be set to 0 (or another desired value in case of e.g. a sensor upgrade) at initial installation on a shoe as described in Section 3.4.2.1.

Since Total Distance value is a UINT32, the highest value that can be represented is 4,294,967,296 decimeters (429,496.7296 kilometers). Since the product life expectancy of an RSC Sensor is about 5 years and given that top level runners may reach 2,000 kilometer a year (10,000 km in 5 years), this value significantly exceeds the expectation. This value is not permitted to roll over. If a reset or other specific setting of the Total Distance value is required, see Section 3.4.2.1 for requirements related to setting the value of this field.

3.1.1.6 Transmission Interval

In typical applications, the RSC Measurement characteristic is notified approximately once per second. The Total Distance field, if supported, is typically included in the RSC Measurement characteristic for transmission approximately once every 2 or 3 seconds. These intervals may vary and are determined by the Server and are not required to be configurable by the Client.

3.1.2 Characteristic Descriptors

3.1.2.1 Client Characteristic Configuration Descriptor

The *Client Characteristic Configuration* descriptor shall be included in the RSC Measurement characteristic.

3.2 RSC Feature

The RSC Feature characteristic shall be used to describe the supported features of the Server.

Reserved for Future Use (RFU) bits in the RSC Feature characteristic value shall be set to 0.

3.2.1 Characteristic Behavior

When read or indicated, the RSC Feature characteristic returns a value that is used by a Client to determine the supported features of the Server.

The bits of the RSC Feature characteristic may either be static for the lifetime of the device or guaranteed to be static only during a connection. This requirement is defined in the table below on a bit-by-bit basis. Although all defined bits as of this printing are required to be static during the lifetime of a device, it is possible that some future bits will be defined as being static only during a connection.

When the Client Characteristic Configuration descriptor is configured for indications and the supported features of the Server have changed, the RSC Feature characteristic shall be indicated to any bonded Collectors after reconnection.

Bit	RSC Feature Bit	Static Requirement
0	Instantaneous Stride Length Measurement Supported	Lifetime
1	Total Distance Measurement Supported	Lifetime
2	Walking or Running Status Supported	Lifetime
3	Sensor Calibration Procedure Supported	Lifetime
4	Multiple Sensor Location Supported	Lifetime
5-15	Reserved for Future Use	Not defined.

Table 3.2: Static Requirements for RSC Feature Bits

If the Instantaneous Stride Length Measurement feature is not supported, the Instantaneous Stride Length Measurement Supported bit shall be set to 0 and the Instantaneous Stride Length Present bit (from the Flags field of the RSC Measurement characteristic) shall also be set to 0. Otherwise the Instantaneous Stride Length Measurement Supported bit shall be set to 1 (Instantaneous Stride Length Measurement feature supported) and the Instantaneous Stride Length Present bit shall be used to show whether or not Instantaneous Stride Length field is present in the RSC Measurement characteristic.

If the Total Distance Measurement feature is not supported, the Total Distance Measurement Supported bit shall be set to 0 and the Total Distance Present bit (from the Flags field of the RSC Measurement characteristic) shall also be set to 0. Otherwise the Total Distance Measurement Supported bit shall be set to 1 (Total Distance Measurement feature supported) and the Total Distance Present bit shall be used to show whether or not Total Distance field is present in the RSC Measurement characteristic.

If the Walking or Running Status feature is not supported, the Walking or Running Status Supported bit shall be set to 0 and the Walking or Running Status bit (from the Flags field of the RSC Measurement characteristic) shall also be set to 0. Otherwise the Walking or Running Status Supported bit shall be set to 1 (Walking or Running Status feature supported) and the Walking or Running Status Flag shall be used to show whether the user is walking or running.

If the Calibration Procedure feature is not supported, the Calibration Procedure Supported bit shall be set to 0. Otherwise the Calibration Procedure Supported bit shall be set to 1 (Calibration Procedure feature supported).

If the Multiple Sensor Locations feature is not supported, the Multiple Sensor Locations Supported bit shall be set to 0. Otherwise the Multiple Sensor Locations Supported bit shall be set to 1 (Multiple Sensor Locations feature supported).

3.3 Sensor Location

The Sensor Location characteristic of the device is used to describe the physical location of the Server when correctly fitted.

If the Server supports the Multiple Sensor Locations feature, the value of the Sensor Location characteristic may be updated while in a connection as described in Section 3.4.2.3.

If the Server supports the Multiple Sensor Locations feature, the Client should not assume that the value of the Sensor Location characteristic of the Server is set to the same value as at the end of a previous connection.

3.3.1 Characteristic Behavior

The Sensor Location characteristic returns the sensor location value when read.

3.4 SC Control Point

If the SC Control Point is supported, profiles utilizing this service are required to ensure that the Client configures the SC Control Point characteristic for indications (i.e. via the *Client Characteristic Configuration* descriptor) at the first connection.

Support for this characteristic is mandatory if the Server supports Calibration Procedure, Total Distance or Multiple Sensor Locations features, otherwise it is excluded in accordance with Table 3.1.

3.4.1 SC Control Point Procedure Requirements

Table 3.3 shows the requirements for the SC Control Point characteristic in the context of this service:

Procedure	Requirement	Properties	Parameter Description	Applicable Response Value(s)	Response Parameter
Set Cumulative Value	C.1	Write	Cumulative Value (UINT32)	Success, Operation Failed	None
Start Sensor Calibration	C.2	Write	None	Success, Operation Failed	None
Update Sensor Location	C.3	Write	Sensor Location (UINT8)	Success, Operation Failed Invalid Parameter	None
Request Supported Sensor Locations	C.3	Write	None	Success	Byte array
				Operation Failed	None
Response Code	M	Indicate	Request Op Code, Response Value, Response Parameter	N/A	N/A

Table 3.3: SC Control Point Procedure Requirements

C.1: Mandatory if Total Distance Measurement feature is supported, otherwise excluded from this Service.

C.2: Mandatory if Sensor Calibration Procedure feature is supported, otherwise excluded from this Service.

C.3: Mandatory if Multiple Sensor Locations feature is supported, otherwise excluded from this Service.

3.4.2 SC Control Point Behavioral Description

The SC Control Point is used to control certain behaviors of the Server. Procedures are triggered by a Write to this characteristic value that includes an Op Code specifying the operation (see Table 3.3) which may be followed by a Parameter that is valid within the context of that Op Code.

3.4.2.1 Set Cumulative Value Procedure

When the *Set Cumulative Value* Op Code is written to the SC Control Point and if the Total Distance Measurement feature is supported by the Server, the Server shall set the Total Distance Value to the same value as the UINT32 parameter which accompanies the op code. For example, a parameter of 0x00000000 will set the Total Distance value to 0. The response shall be indicated when the Total Distance value is applied using the *Response Code* Op Code, the *Request Op Code* along with "Success" or other appropriate *Response Value*.

If the operation results in an error condition or if the Total Distance Measurement feature is not supported by the Server, this shall be indicated using the *Response Code* Op Code, the *Request Op Code* and the appropriate *Response Value* for the error condition.

3.4.2.2 Start Sensor Calibration Procedure

When the *Start Sensor Calibration* Op Code is written to the SC Control Point and if the Sensor Calibration feature is supported by the Server, the Server shall initiate the sensor calibration procedure. The response shall be indicated upon completion of the calibration procedure using the *Response Code* Op Code, the *Request Op Code* along with "Success" or other appropriate *Response Value*.

If the operation results in an error condition or if the Sensor Calibration feature is not supported by the Server, this shall be indicated using the *Response Code* Op Code, the *Request Op Code* and the appropriate *Response Value* for the error condition.

3.4.2.3 Update Sensor Location Procedure

When the *Update Sensor Location* Op Code is written to the SC Control Point and if the Multiple Sensor Locations feature is supported by the Server, the Server shall update the value of the Sensor Location characteristic with the value of the desired sensor location transmitted as a Parameter of the SC Control Point. The response shall be indicated when the sensor location is updated in the Server using the *Response Code* Op Code, the *Request Op Code* along with "Success" or other appropriate *Response Value*.

The Server should cache the most recent value of the Sensor Location characteristic to avoid reconfiguration of this characteristic by the Client each time a connection is established.

If the operation results in an error condition or if the Multiple Sensor Locations feature is not supported by the Server, this shall be indicated using the *Response Code* Op Code, the *Request Op Code* and the appropriate *Response Value* for the error condition.

3.4.2.4 Request Supported Sensor Locations Procedure

When the *Request Supported Sensor Location* Op Code is written to the SC Control Point and if the Multiple Sensor Locations feature is supported by the Server, the Server shall send a list of the supported sensor location values (i.e. a byte array containing values of each supported sensor location). The response shall be indicated using the *Response Code* Op Code, the *Request Op Code*, the appropriate *Response Value* and, if the procedure succeeds, the *Response Value* shall be set to "Success" followed by a list of supported sensor location values in the Response Parameter as described in [2].

If the operation results in an error condition or if the Multiple Sensor Locations feature is not supported by the Server, this shall be indicated using the *Response Code* Op Code, the *Request Op Code* and the appropriate *Response Value* for the error condition.

3.4.3 General Error Handling procedures

Other than error handling procedures that are specific to certain Op Codes, the following apply:

If an Op Code is written to the SC Control Point characteristic that is unsupported by the Server, the Server, after sending a Write Response, shall indicate the SC Control Point with a *Response Code* Op Code, the *Request Op Code* and *Response Value* set to *Op Code Not Supported*.

If a Parameter is written to the SC Control Point characteristic that is invalid (e.g. the Client writes the *Update Sensor Location* Op Code with a sensor location that is not valid in the context of the Server), the Server, after sending a Write Response, shall indicate the SC Control Point with a *Response Code* Op Code, the *Request Op Code* and *Response Value* set to *Invalid Parameter*.

If an Op Code is written to the SC Control Point characteristic while the Server is performing a previously triggered SC Control Point operation (i.e. resulting from invalid Client behavior), the Server shall return an error response with the Attribute Protocol Application error code set to *Procedure Already In Progress* as defined in Section 1.6.

If an Op Code is written to the SC Control Point characteristic and the Client Characteristic Configuration descriptor of the SC Control Point is not configured for indications, the Server shall return an error response with the Attribute Protocol Application error code set to *Client Characteristic Configuration Descriptor Improperly Configured* as defined in Section 1.6.

3.4.4 Procedure Timeout

In the context of the SC Control Point characteristic, a procedure is started when a write to the SC Control Point characteristic is successfully completed. When a procedure is complete, the Server shall indicate the SC Control Point with the Op Code set to *Response Code*.

In the context of the SC Control Point characteristic, a procedure is not considered started and not queued in the Server when a write to the SC Control Point results in an error response with the Attribute Protocol Application error code defined in Section 1.6.

When the Server transmits an indication of a characteristic, the acknowledgement response shall be considered to have timed out if a handle/value confirmation is not received from the Client within the ATT transaction timeout, defined as 30 seconds in Volume 2 Part F Section 3.3.3 of [1]. If a timeout occurs, the Server shall stop sending any further indications and notifications related to the operation and consider the procedure to have failed and may disconnect.

3.4.5 Characteristic Descriptors

3.4.5.1 Client Characteristic Configuration Descriptor

The *Client Characteristic Configuration* descriptor shall be included with the SC Control Point characteristic.

3.5 Requirements for Time-Sensitive Data

The RSC Measurement characteristic contains time sensitive data and is considered a time-sensitive characteristic, thus the following requirements apply:

Since this service does not provide for a time stamp to identify the measurement time (and age) of the data, the value of the RSC Measurement characteristic shall be discarded if either the connection does not get established or if the notification is not successfully transmitted (e.g., due to link loss).

4 SDP Interoperability

If this service is exposed over BR/EDR then it shall have the following SDP record.

Item	Definition	Type	Value	Status
Service Class ID List				M
Service Class #0		UUID	«Running Speed and Cadence»	M
Protocol Descriptor List				M
Protocol #0		UUID	L2CAP	M
Parameter #0 for Protocol #0	PSM	Uint16	PSM = ATT	M
Protocol #1		UUID	ATT	M
BrowseGroupList			PublicBrowseRoot*	M

Table 4.1: SDP Record

* PublicBrowseRoot shall be present; however, other browse UUIDs may also be included in the list.

5 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
AMP	Alternate MAC PHY
BR/EDR	Basic Rate / Enhanced Data Rate
GAP	Generic Access Profile
GATT	Generic Attribute Profile
LE	Low Energy
RFU	Reserved for Future Use
RSC	Running Speed and Cadence
SC	Speed and Cadence
SDP	Service Discovery Protocol
UUID	Universally Unique Identifier

Table 5.1: Acronyms and Abbreviations

6 References

[1] Bluetooth Core Specification v4.2 or later

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