HVAC Integration NLC Profile

Bluetooth® Profile Specification

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Abstract:

The HVAC Integration NLC Profile specifies the requirements for a product acting as a wall thermostat subscribing to occupancy sensors in a Bluetooth® mesh system.

Version History

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v1.0	2025-06-30	Adopted by the Bluetooth SIG Board of Directors.

Acknowledgments

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1 Introduction

Bluetooth® Networked Lighting Control (NLC) systems implement dense grids of occupancy sensors, very often using a sensor in every luminaire, known as luminaire-level lighting control (LLLC). Performance of heating, ventilation, and air conditioning (HVAC) systems controlled by wall thermostats can be improved when the thermostats are aware of occupancy status reported by the occupancy sensors used by lighting systems to save energy when rooms are unoccupied.

The HVAC Integration NLC Profile is the top-layer specification in the mesh networking stack (see Section 2.1 in Mesh Protocol [2]). The profile specifies the requirements for a product acting as a thermostat with an integrated Sensor Client model (see Section 4.4.1 in Mesh Model [3]) that can subscribe to occupancy sensors in a Bluetooth mesh system. The HVAC Integration NLC Profile sets up a methodology for building a thermostat with an integrated occupancy observer feature.

A common use case for the HVAC Integration NLC Profile is a device with a Sensor Client model subscribing to sensors reporting occupancy in a space.

The HVAC Integration NLC Profile supports three methods of occupancy detection and reporting:

- Sensing motion: This is the most common method, usually based on passive infrared (PIR) sensing to detect motion. When motion is detected, the space monitored by the sensor is considered occupied for an amount of time. The amount of time is specified by an application using the Sensor Client model, not the Sensor Client model.
- Sensing presence: This method requires that the sensor can detect both presence (occupancy) and absence (vacancy).
- People-counting: This method requires that the sensor can count and report the number of occupants in the space monitored by the sensor.

Terms, acronyms, and abbreviations that have a specific meaning in the context of this Bluetooth Document or the Bluetooth environment in general are either defined or cross-referenced on their first use in this Bluetooth Document. Bluetooth-specific terms that are not defined in this specification are defined in other Bluetooth specifications, such as the Bluetooth Core Specification [1].

1.1 Language

1.1.1 Language conventions

In the development of a specification, the Bluetooth SIG has established the following conventions for use of the terms “*shall*”, “*mandatory*”, “*shall not*”, “*should*”, “*should not*”, “*may*”, “*optional*”, “*must*”, and “*can*”. In this Bluetooth specification, the terms in Table 1.1 have the specific meanings given in that table, irrespective of other meanings that exist.

Term	Definition
shall *or* mandatory	—used to express what is required by the specification and is to be implemented exactly as written without deviation
shall not	—used to express what is forbidden by the specification
should *or* may *or* optional	— not mandatory. Used to express either: 1. what is recommended by the specification without forbidding anything (“should”) 2. what is permissible within the limits of the specification (“may” or “optional”)
should not	—used to indicate that something is discouraged but not forbidden by the specification
must	—used to indicate either: 1. an indisputable statement of fact that is always true regardless of the circumstances 2. an implication or natural consequence if a separately-stated requirement is followed
can	—used to express a statement of possibility or capability

Table 1.1: Language conventions terms and definitions

Where more than one item is permitted but not required, the choices to include or support those items are independent from one another unless the specification explicitly states otherwise. Each item that is implemented shall be implemented exactly as written without deviation.

1.1.1.1 Implementation alternatives

When specification content indicates that there are multiple alternatives to satisfy specification requirements, if one alternative is explained or illustrated in an example it is not intended to limit other alternatives that the specification requirements permit.

1.1.1.2 Discrepancies

It is the goal of Bluetooth SIG that specifications are clear, unambiguous, and do not contain discrepancies. However, members can report any perceived discrepancy by filing an erratum and can request a test case waiver as appropriate.

1.1.2 Reserved for Future Use

Where a field in a packet, Protocol Data Unit (PDU), or other data structure is described as "Reserved for Future Use" (irrespective of whether in uppercase or lowercase), the device creating the structure shall set its value to zero unless otherwise specified. Any device receiving or interpreting the structure shall ignore that field; in particular, it shall not reject the structure because of the value of the field.

Where a field, parameter, or other variable object can take a range of values, and some values are described as "Reserved for Future Use," a device sending the object shall not set the object to those values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous; however, this does not apply in a context where the object is described as being ignored or it is specified to ignore unrecognized values.

When a field value is a bit field, unassigned bits can be marked as Reserved for Future Use and shall be set to 0. Implementations that receive a message that contains a Reserved for Future Use bit that is set to 1 shall process the message as if that bit was set to 0, except where specified otherwise.

The acronym RFU is equivalent to Reserved for Future Use.

1.1.3 Prohibited

When a field value is an enumeration, unassigned values can be marked as “Prohibited.” These values shall never be used by an implementation, and any message received that includes a Prohibited value shall be ignored and shall not be processed and shall not be responded to.

Where a field, parameter, or other variable object can take a range of values, and some values are described as “Prohibited,” devices shall not set the object to any of those Prohibited values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous.

“Prohibited” is never abbreviated.

1.2 Requirements in Tables

Requirements in this specification are defined as "Mandatory" (M), "Optional" (O), "Excluded" (E), “Not Applicable” (N/A), or "Conditional" (C.#). Conditional statements (C.#) are listed directly below the table in which they appear.

- "M” for mandatory. See Table 1.1: Language conventions terms and definitions.
- "O” for optional. See Table 1.1: Language conventions terms and definitions.

- “E” for excluded. “Excluded” means not permitted in this context; cannot be supported or included for this purpose. The item can still be supported or included if allowed for some other purpose (e.g., a feature can be mandatory for one role and excluded for another; a device that supports both roles must support this feature).
- “C.#” for conditional. “Conditional” means that an item is required, optional, or prohibited based on whether one or more other items are supported or included (# represents any number). Within the definition of the condition, if those other items mean that “not permitted” applies, it has the same meaning as “E”.

1.2.1 Table requirements for unused cells

An unused cell is a table cell without a value or content, which is indicated with either the word “none” (without quotation marks) or a hyphen (i.e., a “minus” sign).

To use an additional form of notation in this specification’s tables—such as an ellipsis (...) to indicate a gap in a series of values—add an explanation of that notation in the specification’s section on table conventions for requirements and unused cells. If a particular table uses a notation that differs from the initially expressed table conventions for unused cells, explain this additional notation in the introduction of the table to which it applies.

1.3 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.

2 Configuration

2.1 Identification

The HVAC Integration NLC Profile shall be identified by the «HVAC Integration» mesh profile UUID (see [5]) in the Composition Data Page 2 (see Mesh Protocol [2]).

2.2 NLC profile relationships

A device implementing the HVAC Integration NLC Profile interacts with a device implementing the Occupancy Sensor NLC Profile [6] as outlined in Mesh Model [3] Section 4.4.1.2.12, “Receiving a Sensor Status message”, and shown in Figure 2.1.

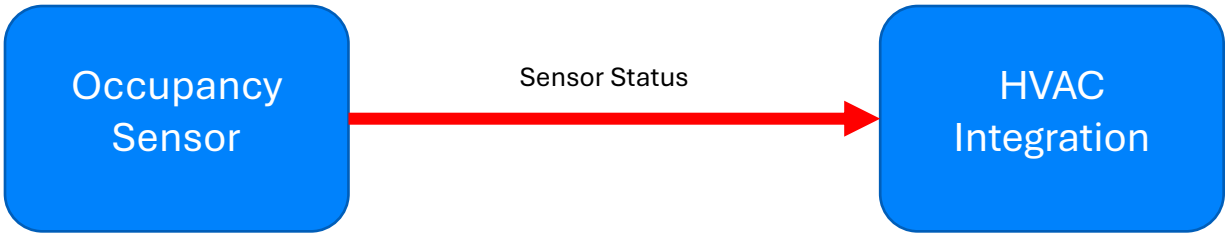

Figure 2.1: Interaction of an HVAC Integration with an Occupancy Sensor

2.3 Concurrency limitations and restrictions

There are no concurrency limitations or restrictions imposed by this specification.

2.4 GAP: Topology limitations and/or restrictions defined by GAP

There are no topology limitations or restrictions imposed by this specification.

2.5 Core Configuration dependencies

There are no Core Configuration dependences imposed by this specification.

2.6 Dependencies on other specifications external to the Core

This specification is compatible with Mesh Protocol, Version 1.1 [2], and Mesh Model, Version 1.1 [3].

This specification requires implementation of all mandatory requirements for an unprovisioned device, and a node described in the Mesh Protocol [2].

3 Requirements and recommendations

The HVAC Integration NLC Profile specifies the following requirements and recommendations.

3.1 Provisioning

The following requirements are related to provisioning:

- The PB-GATT provisioning bearer shall be supported. See Section 5.2.2 in Mesh Protocol [2].
- Either the device «Complete Local Name» advertising data (AD) type or the device «Shortened Local Name» AD type shall be included in scan response data when advertising the Mesh Provisioning Service. See Section 7.1.2.2.1 in Mesh Protocol [2].
- Visual attention indication for all instances of the Attention Timer shall be supported. The visual attention indication may be shared among multiple instances of the Attention Timer. See Section 4.2.10 in Mesh Protocol [2].

3.2 Bearers

The following requirements are related to bearers:

- The advertising bearer shall be supported. See Section 3.3.1 in Mesh Protocol [2].
- The Generic Attribute Profile (GATT) bearer shall be supported in the GATT Bearer Server role. See Section 3.3.2 in Mesh Protocol [2].

3.3 Features

The following requirements are related to features:

- The Relay feature shall be supported. See Section 3.4.6.1 in Mesh Protocol [2].
- The Proxy feature shall be supported. See Section 3.4.6.2 in Mesh Protocol [2].

3.4 Performance

The following requirements are related to performance:

- At least two network keys shall be supported. See Section 3.9.6.3 in Mesh Protocol [2].
- At least three application keys shall be supported. See Section 3.9.6.2 in Mesh Protocol [2].
- At least three application keys shall be supported by the Model to AppKey List state for each model instance that uses application keys. See Section 4.2.7 in Mesh Protocol [2].
- At least 255 entries in the replay protection list shall be supported. See Section 4.2.2.1 in Mesh Protocol [2].
- The Sensor Client model shall support a subscription list size of at least 32 items. See Section 4.2.3 in Mesh Protocol [2].

- At least 8 entries per connection in the proxy filter list shall be supported. See Section 6.4 in Mesh Protocol [2].
- At least 64 entries in the network message cache shall be supported. See Section 3.4.6.5 in Mesh Protocol [2].

3.5 Models

The following requirements are related to models:

- The Sensor Client model shall be supported. See Section 4.4.1 in Mesh Model [3].
- The Sensor Client model shall support receiving the Sensor Status message with any of the following:
  - A Sensor Property ID field value referencing the Motion Sensed device property (see [4]).
  - A Sensor Property ID field value referencing the Time Since Motion Sensed device property (see [4]).
  - A Sensor Property ID field value referencing the People Count device property (see [4]).
  - A Sensor Property ID field value referencing the Presence Detected device property (see [4]).

3.6 Combinations of NLC profiles

The following requirements are related to combinations of the HVAC Integration NLC Profile and combinations with other NLC profiles (see [5]):

- When multiple instances of the HVAC Integration NLC Profile are combined on a device, the number of entries in the replay protection list on the device shall be at least the number of entries in the replay protection list required by the HVAC Integration NLC Profile. See Section 4.2.2.1 in Mesh Protocol [2].
- When the HVAC Integration NLC Profile is combined with other NLC profiles on a device, the number of entries in the replay protection list on the device shall be at least the highest required minimum number of entries among the NLC profiles. See Section 4.2.2.1 in Mesh Protocol [2].
- When multiple instances of the HVAC Integration NLC Profile are combined on a device, the device shall support at least the minimum number of network keys identified for the HVAC Integration NLC Profile. See Section 3.9.6.3 in Mesh Protocol [2].
- When the HVAC Integration NLC Profile is combined with other NLC profiles on a device, the device shall support at least the highest minimum number of network keys identified among the NLC profiles. See Section 3.9.6.3 in Mesh Protocol [2].
- When multiple instances of the HVAC Integration NLC Profile are combined on a device, the device shall support at least the minimum number of application keys identified for the HVAC Integration NLC Profile. See Section 3.9.6.2 in Mesh Protocol [2].
- When the HVAC Integration NLC Profile is combined with other NLC profiles on a device, the device shall support at least the highest minimum number of application keys identified among the NLC profiles. See Section 3.9.6.2 in Mesh Protocol [2].

3.7 Recommendations

Implementers should consider the following recommendations:

- If a reset to factory default settings is supported, then a manual reset (i.e., physical interaction with the device) should be supported.

4 Acronyms and abbreviations

Acronym/Abbreviation	Meaning
AD	advertising data
GATT	Generic Attribute Profile
LLLC	luminaire-level lighting control
PDU	Protocol Data Unit
PIR	passive infrared
RFU	Reserved for Future Use

Table 4.1: Acronyms and abbreviations

5 References

It is recommended to use the latest version of the Core Specification.

[1] Bluetooth Core Specification

[2] Mesh Protocol, Version 1.1 or later

[3] Mesh Model, Version 1.1 or later

[4] Device Properties, https://www.bluetooth.com/specifications/specs/device-properties

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

[6] Occupancy Sensor NLC Profile, Version 1.0 or later