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Smart Body Area Networks (SmartBAN);
Service and application standardized enablers and interfaces,
APIs and infrastructure for interoperability management

Reference

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Smart Body Area Network (SmartBAN).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document gives the high level description of infrastructure and mechanisms providing solutions for interoperability management in SmartBAN. The scope mainly covers the networking level up to the service and application level. The expected solutions will mainly concern the description and the specification of a standardized infrastructure for SmartBAN entities (e.g. sensors, actuators) interactions, data access and monitoring, irrespective of whatever lower layers and radio technologies are used underneath. On the service and application side, standardized APIs, in particular, for secure interaction and access to SmartBAN data/entities (data transfer and sharing mechanisms included) will be addressed.

1 Scope

The present document describes and specifies the high level infrastructure, its building blocks and associated APIs providing interoperability management solutions for SmartBAN. The architecture described in the present document also enables generic interaction and access to BAN data and entities, and thus paves the way to interoperability (networks and syntactic interoperability). Since the SmartBAN reference architecture specified and formatized in the present document fully relies on SmartBAN open semantic data model and corresponding ontologies as already standardized in [1], it therefore also addresses data and semantic interoperability.

The present document is applicable to a BAN and/or a SmartBAN comprising wearable sensors/actuators devices, a relay/coordinator device and a Hub. The relay/Coordinator and the Hub functionalities may be handled by a single device or by two distinct devices.

The present document is also addressing syntactic interoperability by defining unified data transfer and message formats.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 103 378 (V1.1.1) (12-2015): "Smart Body Area Networks (SmartBAN) Unified data representation formats, semantic and open data model".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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NOTE 2: SNOMED CT® is an example of an existing eHealth reference terminology. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of this reference terminology.

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3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

bpm	beats per minute
bps	bit per second
s	second

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACK	Acknowledgement (e.g. ACK message)
AE	Application Entity
AIOTI	Alliance for Internet of Things Innovation
API	Application Programming Interface
ASTM	American Standards for Testing and Materials
AT	ATtention (e.g. AT Command)
BAN	Body Area Network
BANID	Body Area Network IDentifier
BLE	Bluetooth Low Energy
BLES	Bluetooth LE Scanner agent
CCR	Continuity of Care Record
CCU	Central Control Unit
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CoAP	Constrained Application Protocol
CON	Confirmable (e.g. CON message)
Core	Constrained RESTful Environments
CPU	Central Processing Unit
CSE	Core Service Entity
DIM	Domain Information Model
DS	Data Scanner agents
DTLS	Datagram Transport Layer Security
E2E	End-to-End
ECG	Electrocardiogram
EDI	Electronic Document Interchanged
EEG	Electroencephalogram
EHR	Electronic Health Record
EHRS	Electronic Health Record Solution
EU	European Union
FHIR	Fast Healthcare Interoperability Resources
GATT	Generic Attribute Profile
GCM	Google Cloud Messaging
GUI	Graphical User Interface
GW	Gateway
HDF	HL7 Development Framework
HDP	Health Device Profile
HIAL	Health Information Access Layer
HL7	Health Level Seven International
HLA	High Level Architecture
HMI	Human-Machine Interface
HR	Heart Rate
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IHE	Integrating the Healthcare Enterprise
IoT	Internet of Things
IP	Internet Protocol
ISM	Industrial, Scientific and Medical
ISQ	Information Standards Quarterly
IT	Information Technology
JS	JSON Scanner
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation Linked Data
JW	JSON Writer
LAN	Local Area Network
LAN-IF	Local Area Network Interface
LD	Linked Data
LE	Low Energy

LRS	Longitude Record Services
M2M	Machine to Machine
MAC	Medium Access Control
MAS	Management Abstraction and Semantics
MBAN	Medical Body Area Network
MQTT	Message Queue Telemetry Transport
MVTU	Ministry of Science Technology and Innovation
MW	Measurement Wrapper
NICTA	National ICT Australia
NISO	National Information Standards Organization
NON	Non-confirmable (e.g. NON message)
NSE	Network Service Entity
NW	Node semantic Wrappers
OGC	Open Geospatial Consortium
OMA	Open Mobile Alliance
OSWA	Open Sensor Web Architecture
OWL	Web Ontology Language
OWL-S	Web Ontology Language for Services
PAN	Personal Area Network
PAN-IF	Peripheral Area Network Interface
PDA	Personal Digital Assistant
PER	Packet Error Rate
PHY	Physical
PoS	Point of Services
PW	Process semantic Wrappers
QoI	Quality of Information
QoS	Quality of Service
RAM	Random Access Memory
RDF	Resource Description Framework
REST	REpresentational State Transfer
RFID	Radio Frequency Identification
RSSI	Received Signal Strength Indication
RST	Reset (e.g. RST message)
RTLS	Real Time Location Services
SAS	Sensor Alert Service
SCS	Sensor Collection Service
SDO	Standards Development Organizations
SensorML	Sensor Model Language
SIG	Special Interest Group
SMS	Short Message Service
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOS	Sensor Observation Service
SPARQL	Simple Protocol and RDF Query Language
SPS	Sensor Planning Service
SW	Semantic Wrapper
SWE	Sensor Web Enablement
SWRL	Semantic Web Rule Language
TAN	Touchable Area Network
TAN-IF	Touchable Area Network Interface
TBD	To Be Defined
TC	Technical Committee
TCP	Transmission Control Protocol
TML	TransducerML
TransducerML	Transducer Model Language
TS	Technical Specification
UDDI	Universal Description, Discovery and Integration
UDI	Universal Device Identifier
UDP	User Datagram Protocol
UI	User Interface
UML	Unified Model Language
URI	Uniform Resource Identifier

URL	Uniform Resource Locator
US	United States
UUID	Universally Unique IDentifier
W3C	World Wide Web Consortium
WAN	Wide Area Network
WAN-IF	Wide Area Network Interface
WBAN	Wireless Body Area Network
WNS	Web Notification Service
WoT	Web of Things
WRS	Web Registry Service
WSDL	Web Services Description Language
WSN	Wireless Sensor Network
WW	WSN Writer
XaaS	Everything as a Service
xHRN-IF	Electronic/Personal Health Records Network Interface
XML	eXtensible Markup Language

4 Ambit and induced constraints

The scope of the present clause is to briefly investigate the initial TC SmartBAN use case requirements in order to point out their impact on High level specifications and designs of the present document. The initial additional requirements induced by scenario addressed within the present document are also listed.

Wireless Body Area Networks (WBANs) are made of a collection of low-power embedded devices, mainly sensors or actuators that are used for monitoring vital data of a human and its environment (but not limited to human). Those embedded devices are located in the vicinity or on or inside the body, and are mainly provided with short range communication technologies. BANs are short distance networks of maximum 6 m^3 that contain maximum 6 networks per m^2 and maximum 256 nodes per network [i.1]. These nodes may be mobile and the network topology may change frequently. The data rate of sensed data can actually vary from 75,9 kbps to 15,6 Mbps [i.1]. WBANs are not expected to be operated in licensed frequency bands. Hence, the frequency spectrum of operation will be in the unregulated frequency bands for industrial, scientific and medical (ISM) applications. If ISM and MBAN bands (US and European) with frequency between 2,3 GHz and 2,5 GHz are initially considered within TC SmartBAN, higher frequency bands (from 3,2 to 10,2 GHz) will also be considered for allowing the support of Real Time Location Services (RTLS). Finally, WBANs are characterized by strong constraints in terms of low power, low latency, low Packet Error Rate (PER), reliability, QoS, coexistence and security. The initial technical requirements retained by TC SmartBAN for WBAN parameters are listed in table 1.

Table 1: Initial technical requirements retained by TC SmartBAN for WBAN parameters

Parameter	SmartBAN Requirements
Coexistence/robustness	Good (low interference to other systems, high tolerance to interference)
Data rates (Sensor)	Nominally < 100 kbps/node (vital sign monitoring)
Transmission rate (PHY)	Up to 1 Mbps
Network topology	Star network
Power consumption (node)	TBD
QoS control	Priority based control and cross layer optimization. Emergency signal transmission supported.
Reliability	Robust to shadowing and multipath interference
Max. node capacity	up to 16 nodes (typically 8)
Range	< 1,5 m
Latency	< 125 ms (high sampling applications e.g. ECG, EEG.)
Security / privacy	TBD

The initial ambit envisioned by TC SmartBAN is a BAN network organized around a Hub and mainly following a star topology. The Hub play the role of the BAN cluster head and also serves as an intermediary Gateway (GW) node allowing the interconnection of the BAN cluster with an healthcare local/remote monitoring and control centre. This node, with extended memory and processing capacity (e.g. a smartphone), should be responsible for all the heavy processing data collection and management/control operations of the SmartBAN. In case of a multi hope routing strategy, the BAN shall be provided with at least a bridge/relay functionality that could be handle by the SmartBAN's Hub or within a dedicated SmartBAN device. This relay/bridge device offers enhanced performance and robustness (e.g. relay around hidden devices), as well as optimized SmartBAN solutions with enhanced connectivity (multi-radio) routing (multi-hop) and data forwarding capabilities. In some global healthcare architectures, the BAN's Hub role may sometimes be handled by a cluster-external intermediary node called Central Control Unit (CCU) [i.2]. Figure 1 gives a simple example of the considered SmartBAN end-to-end architecture.

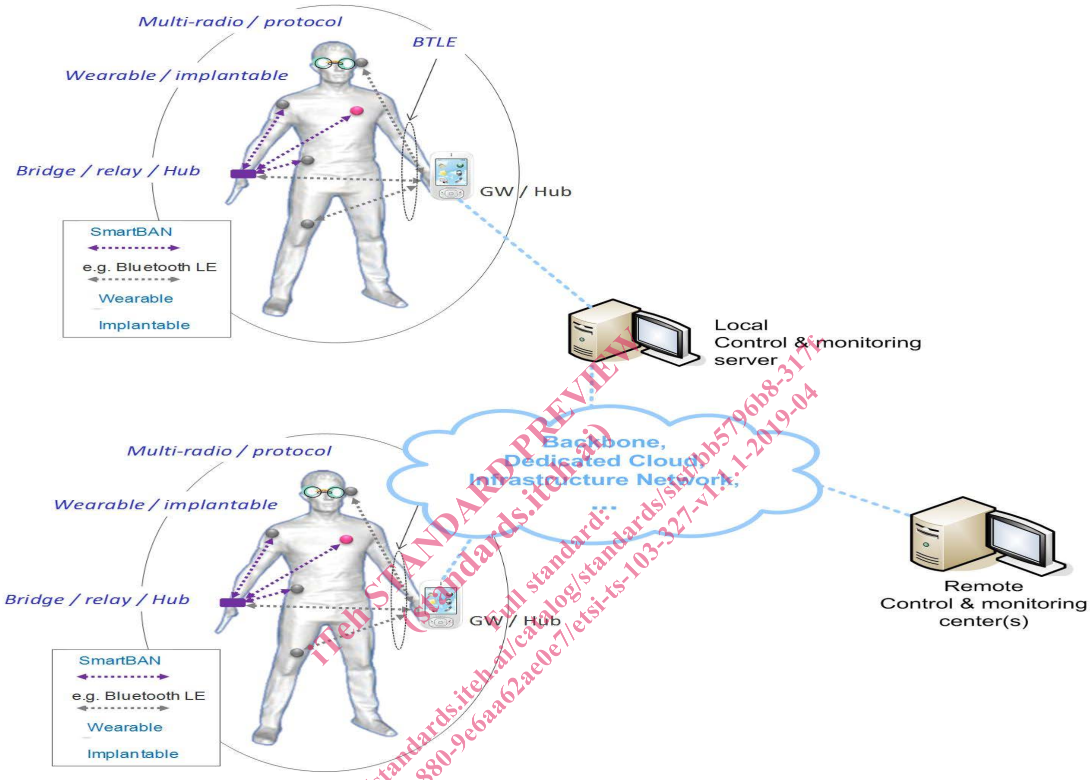

Figure 1: Example of considered SmartBAN end-to-end architecture

BANs are made of a growing number of small sensing devices and are used in multiple use cases for which data procurement, collection, monitoring and control are mandatory. Generally domain dedicated, those devices are provided by an increasing number of manufacturers, which leads to interoperability problems (e.g. heterogeneous interfaces and/or grounding, heterogeneous descriptions, profiles, models, etc.). Interoperability management is thus a SmartBAN key requirement and shall be handled.

Therefore, the main objective of the present document is the BAN interoperability management through the specification of an high level infrastructure, its building blocks and associated APIs providing generic interaction and access to BAN data and entities. This kind of open middleware/framework will not only enable vertical interoperability within a given application domain (such as e.g. well-being, m-health, tele-health, safety/emergency, entertainment) but will also ease the cross domain interworking of in particular devices. This represents a first step towards the horizontal management of BAN multiple vertical application domains. SmartBAN interoperability management also involves the design of interworking components (entities, APIs or gateways) for allowing non SmartBAN enabled environments to interoperate with SmartBAN.

Interoperability of multiple and new BAN technologies not only implies a generic interconnection between BANs components (sensors, actuators, relays, concentrators and hubs) but also a shared and mutual understanding of BAN devices and environment description, as well as of exchanged data format (syntactic and structural interoperability among frameworks). Syntactic and structural interoperability will thus be addressed in the present document.