

Realisation of Ubiquity in Body Area Networks for Healthcare Systems

Thesis by
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Declaration of Authorship and Originality

I, Jan Szymanski, declare that I am the sole author of this thesis and that I have not used material in part or whole from other sources without proper acknowledgment. All theories, results, and designs of others that I have incorporated into my report have been properly referenced, and that sources of assistance have been acknowledged appropriately.

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Abstract

The world today is facing many health-related problems. Obesity-related health issues, often attributed to unhealthy lifestyle, represent one of the most serious global problems of the 21st century. Despite significant progress in the field of medicine, the level of chronic diseases is still on the rise.

These health issues are further exacerbated by a growing pressure on the healthcare system caused by a rapid growth of an aging population and a falling number of people of workforce age.

Physical and mental health is of prime importance to every individual and to society as a whole. There is a growing interest in new ways to support and maintain an overstressed healthcare system, and there is an expectation for solutions that come from the areas of science and technology. One of the main ideas offered is to move some of the traditional functions of clinicians, health centers and hospitals into the patient's home environment.

The Internet of Things (IoT) and Big Data domains are rapidly evolving. From the initial concepts of connecting things to the Internet for monitoring, control and collecting data, the technology extends into Big Data analytics in a ubiquitous and pervasive computing environment. The number of healthcare applications is becoming a core part of the IoT world, with all its benefits and challenges.

This research focuses on IoT solutions related to personal health monitoring and health-aware mobile devices, seen as an integrated system. The application of ubiquitous communication for plug-and-play, IP protocols, for interoperable low-power sensor networks are investigated together with research into effective resource management into Body Area Networks. The aim is to contribute to an area of health technology that can be available *"everywhere, anytime and to anyone"*.

Contents

Acknowledgements	iv
Abstract	v
Glossary	xx
I Principle Theory and Concepts	1
1 Introduction and Background	2
1.1 Background	2
1.1.1 Problems with existing Personal Monitoring Healthcare Systems . . .	3
1.1.2 Need for Proposed Solution	5
1.1.3 BAN Challenges	6
1.2 Formulation of the Hypothesis	8
1.2.1 Research Theme	8
1.2.1.1 Synthetic and Interdisciplinary Research Approach	8
1.2.2 Rationale and Goals	11
1.2.2.1 The Research Goal	11
1.2.3 Hypothetical Proposition	13
1.2.3.1 The Objectives, Research Approach and Validation of the Hypothesis	13
1.2.3.2 Impact and Required Work	14
1.2.3.3 Anticipated Results	14
1.3 Contribution and Accomplishments	15
1.4 Outline of the Thesis	15
2 Literature Review	20
2.1 Introduction. The Need for Ubiquitous and Pervasive Body Area Networks Healthcare Systems	20

2.1.1	History, Present and the Future of Technologies in Medicine	21
2.1.2	Body Area Networks	22
2.1.2.1	Body Area Network Challenges	25
2.1.3	History of Body Area Networks	26
2.1.4	Ubiquitous and Pervasive Computing	27
2.1.5	Internet of Things, Internet of Everything and Ubiquitous Body Area Networks	27
2.1.5.1	Building Blocks of IoT	30
2.2	Architecture for Pervasive Body Area Networks Healthcare Systems	31
2.2.1	Reference Architectures for Ubiquitous Computing	31
2.2.1.1	Connectivity Models for Body Area Networks	31
2.2.1.2	The Role of a Reference Architecture	32
2.2.1.3	Component Reference Architecture	33
2.3	Enabling Technologies for Pervasive Body Area Networks Healthcare Systems	36
2.3.1	Hardware	36
2.3.1.1	Communication Devices	36
2.3.1.2	Microcontrollers	37
2.3.1.3	Sensors and Actuators	40
2.3.1.4	Power Sources	42
2.3.2	Power Supply for BAN Motes	50
2.3.2.1	Supplying the System Directly from Battery	51
2.3.2.2	Using Linear Voltage Regulator or Switch-Mode DC-DC Converters	52
2.3.2.3	Supplying the System from Energy Harvesters	54
2.3.2.4	Supplying the System from a Combination of Power Sources	54
2.3.3	Software for BAN Motes	56
2.3.3.1	Operating Systems for BAN	56
2.3.3.2	Multithreaded versus Event Driven	56
2.3.3.3	Contiki Operating System	56
2.3.3.4	Signal Processing Software for BAN Motes	59
2.4	Communications for Pervasive Body Area Networks Healthcare Systems . . .	60
2.4.1	Physical Communication Standards	62
2.4.1.1	Interoperability	62
2.4.1.2	Communication Standards Used in BAN	63

2.4.1.3	IEEE 802.15.4	63
2.4.1.4	IEEE 802.15.6	64
2.4.1.5	ISO/IEEE 11073 Standards	67
2.4.1.6	Gateways Protocol Translation vs End-to-End IP	68
2.4.2	Communication Protocols	68
2.4.2.1	IP Protocols	71
2.4.2.2	Application Layer Protocol Example - CoAP	72
2.4.2.3	Routing Protocol Example - RPL	73
2.5	Resources in BAN	76
2.5.1	Monitoring and Managing Resources	76
2.5.1.1	Power Monitoring for BAN Motes (and WSN Motes in General)	76
2.5.1.2	Power Management for BAN Motes (and WSN Motes in General)	77
2.5.2	Application Power Management	78
2.5.2.1	Application Energy Monitoring Sample Implementation	79
2.5.2.2	Application Power Management Software	82
2.5.2.3	Energy Monitoring for WSN Motes	83
2.5.2.4	Memory Management	83
2.6	Close Related Works	85
2.6.1	Similar Works in Applying Ubiquitous and Pervasive Computing Paradigm to Body Area Networks	85
2.6.2	Similar Works Related to End-to-End IP BAN	86
2.6.3	Similar Works Related to Energy Monitoring in BAN	86
2.7	Review of Publications Supporting this Research	87
2.7.1	Applications of Cooperative WSN in Homecare Systems	88
2.7.2	Body Area Networks and Smart Spaces in Pervasive Health Monitoring	88
2.7.3	Towards Ubiquitous and Pervasive Healthcare	89
2.7.4	Teaching Multidisciplinary Engineering using Concepts and Technology of WSN	89
2.7.5	Enabling Design and Development of Wireless BANs Using 802.15.x Standards	90
2.7.6	Modeling of Triaxial Accelerometers in a Self-designed Wearable Inertial Measurement Unit	90

2.7.7	Dynamical Estimation of Key Cardiac-Respiratory Variables by Using Commercialized Wearable Sensors	90
2.8	Summary of the Chapter	91
3	Research Methodology	92
3.1	Literature Study	93
3.2	Case Study	94
3.3	Experimentation	95
3.4	Thesis Validation Criteria	96
3.5	Summary of the Chapter	96
II	Research Contribution	97
4	Experimental Environment	98
4.1	Concept of Experiments Implementation	98
4.1.1	End to End IP Communication for Resource Constrained Systems	99
4.1.2	BAN Motes Interfaces for ubiquity	99
4.1.3	Device Discovery using 6LoWPAN	100
4.1.4	CoAP based Service Discovery in BAN environment	101
4.1.5	Energy Monitoring of Motes in BAN	102
4.2	Selection of the Experimental Hardware	103
4.3	Experimental Platform Hardware Adaptation	104
4.3.1	Interfacing Additional Sensors to Experimental Board	104
4.3.2	Interfacing Battery Monitoring Sensor (Fuel Gauge)	104
4.3.3	Interfacing UV Radiation Sensor in BAN System	105
4.3.3.1	An Overview of UV Radiation	105
4.3.3.2	Interfacing UV Radiation Sensor in BAN System	108
4.4	Experimental Motes Operating System and 6LoWPAN Implementation Selection	111
4.4.1	Choice of 6LoWPAN Implementation	112
4.5	Experimental Platform Motes Software Development	113
4.5.1	BAN Software Development System	113
4.5.2	Sensors Firmware Development	113
4.5.3	Custom Sensors Software (Firmware) for Contiki OS	120

4.6	Experimental Platform Edge Router (Gateway)	121
4.7	Backend Server	123
4.7.1	Landing Page	124
4.7.2	Implementation of Neighbour Discovery	125
4.7.3	Implementation of Service Discovery	128
4.7.3.1	Service Discovery with Existing Tools	129
4.7.3.2	Service Discovery Using Our Solution	129
4.7.4	Node Registering (Joining) Process in 6LoWPAN - ND, RPL	132
5	Experiments and Results	133
5.1	Experiment 1 - Design-Time Power Monitoring for BAN	133
5.1.1	Formulation of Experiment 1	133
5.1.2	Performing Power Monitoring and Optimization at Design and Test Time	135
5.2	Experiment 2 - Ubiquitous and Pervasive BAN with Run-time Power Monitoring	140
5.2.1	Formulation of Experiment 2	141
5.2.2	Performing Run-time Power monitoring experiment	141
5.2.2.1	Performing Experiments	142
5.2.2.2	Collecting Results	143
5.2.3	Experimental Results	143
6	Analysis and Assessment of Experiments	150
6.1	Research Studies into BAN	151
6.2	Experimental Review and Evaluation	152
7	Conclusion	155
7.1	Thesis Summary	155
7.1.1	Meeting the Research Goals	155
7.1.2	Thesis Contribution and Discussion of Findings	156
7.1.3	Journal and Book Chapter Authorship	156
7.1.4	Thesis Limitations	157
7.2	Future Directions	158
7.3	Final Conclusions	161

III Bibliography and Publications	162
8 Bibliography	163
9 Appendix	181
9.1 Software Environment Setup	181
9.1.1 Adaptation of Contiki OS for BAN System	181
9.1.2 Installation of Build Tools	183
9.2 Source Code for Experiments	187
9.3 Other Publications	187

List of Figures

1.1	Three stages of modern computing, adapted from [191]	2
1.2	IoT economic value predictions showing Healthcare impact, source McKinsey	3
1.3	The Knowledge Pyramid	5
1.4	The ubiquitous systems are available “everywhere”	11
1.5	Communication Tiers in a Wireless Body Area Network, modified from [121]	12
1.6	Body Area Network using 6LoWPAN	14
1.7	Thesis Development	17
2.1	Evolution of stethoscopes, a - one of the original stethoscopes belonging to Rene Theophile Laennec made of wood and brass and b - a modern stethoscope, source Wikipedia	21
2.2	Evolution of ECG devices, a - an early commercial ECG device (1911) and b - a modern portable ECG, source Wikipedia	22
2.3	General Architecture of Wireless Sensors and Actuators Networks source [81]	23
2.4	The concept of Body Area Networks showing human being in the center with many implantable, wearable, portable and ambient sensors/actuators, source [81]	24
2.5	Star (left) and mesh (right) topologies	24
2.6	Possible BANs interference with other BANs	25
2.7	Real entities and their digital entity counterparts adapted from [106]	29
2.8	Waves of Internet growth, source - [34]	29
2.9	Building blocks of the Internet of Things	31
2.10	Autonomous Body Area Networks, source - [81]	32
2.11	Body Area Networks as part of The Internet of Things, source - [81]	32
2.12	Types of Body Area Networks motes interfaces	34
2.13	Interfaces of Body Area Networks motes, source - [169]	34
2.14	Basic architecture of BAN mote	36
2.15	CC520 IEEE802.15.4 transceiver block diagram (left) and application circuit (right), source - [40]	37

2.16	Integrated radio module example, source - Anaren [10]	37
2.17	Power consumption for MSP430FR5969 microcontroller, source - TI[38]	38
2.18	Experimental hardware setup for benchmarking.	39
2.19	Theoretical ULPBench Scores, source [51]	40
2.20	Practical ULPBench Scores obtained by measurement process	40
2.21	Block diagram of data acquisition and actuation, source [81]	41
2.22	Block diagram of the power supply of the mote, source - [132]	43
2.23	Typical discharge profile of AA alkaline cell, source - [185]	43
2.24	Characteristic of lithium batteries, source - [109]	44
2.25	The discharge profile of lithium batteries, source - [109]	44
2.26	Summary Comparison of some primary types of batteries, source - [54]	45
2.27	Typical Discharge Profile / NiMH Battery, source - [185]	45
2.28	Energy Density for Rechargeable Batteries, source [185]	46
2.29	Discharge and Temperature Profile for example LiPo Battery, source [185]	46
2.30	Working principle of Ultracapacitor, source [126]	47
2.31	Comparison of energy transducers suitable for BAN - Grady and Corporation [69]	48
2.32	The Ultra Low Power (ULP) technology with different levels of power consumption used in medical and health applications, source [64]	48
2.33	Harvesting table - source [64]	48
2.34	Block diagram of sensor node powered by battery (a) and HEAP (b), source [147]	50
2.35	WSN Generic Block Diagram, source - WSN Generic Block Diagram	50
2.36	CC2530ZNPmini from TI source - TI	51
2.37	Schematic of supplying CC2530ZNPmini directly from batteries source - TI CC2530ZDK-ZNP-MINI Datasheet	51
2.38	Simple battery sensing	52
2.39	Simple battery sensing code created using TI Code Composer Studio IDE	52
2.40	Basic features of linear voltage regulator source - [114]	52
2.41	Using Dynamic Voltage Scaling, source [114]	53
2.42	Comparison of direct battery and LDO supply method, source [114]	53
2.43	Efficiency of high-end dc-dc converters for use in micro-power systems, sources (a) - TI TPS63002 Datasheet , (b) - LT LT1316 Datasheet	54
2.44	WSN power supply block diagram, source - Digikey	55

2.45	Openmote supply based on TI reference design, source a - TI , b - Openmote .	55
2.46	BAN mote block diagram, source http://www.digikey.com	55
2.47	Comparison of different programming models, source [186]	56
2.48	6LoWPAN Protocol Stack Model, source [137]	57
2.49	6LoWPAN Frame Formats, source [146]	58
2.50	Fragmentation Example, source [146]	58
2.51	Partitioning into core and loaded programs, adapted from [43]	59
2.52	Contiki OS Architecture, adapted from [58]	59
2.53	Low Power Signal Processing for BAN motes - adapted from [1]	60
2.54	Examples of Wireless modules used during experimentation.	60
2.55	Summary of wireless technology parameters, source [141]	61
2.56	A brief characteristic of IEEE 802.15.6 , modified from [203]	67
2.57	The concept of layering in the TCP/IP and OSI architecture, source Dunkels et al. [44]	69
2.58	Simplified OSI model (left) and an example of a TCP/IP protocol stack (right)- source Reiter [141]	69
2.59	TCP/IP Protocol Stack and 6LoWPAN Protocol Stack, source Vasseur and Dunkels [186]	69
2.60	Screenshot of Internet of Things browser extension 'Copper.'	72
2.61	Screenshot of Copper Observing node sensor resources	73
2.62	RPL DIO, adopted from Thingsquare	74
2.63	Setting up the routes, adopted from Thingsquare	74
2.64	RPL upwards routing, adopted from Thingsquare	75
2.65	RPL downwards routing, adopted from Thingsquare	75
2.66	Graphical visualization of battery capacity	78
2.67	Measurement of current using shunt resistor, source TI	81
2.68	Energy Trace technology, source http://www.ti.com/tool/energytrace	81
2.69	Simple Contiki OS thread code	82
2.70	Checking memory sections with GNU size	84
2.71	Checking detailed memory sections with GNU size	84
2.72	Available memory for CC2650 MCU source TI CC2650 Datasheet	84
2.73	The operation of energy estimation method, source [44]	87
2.74	The energy map of cooperating sensors in the homecare system displayed by UC, source [207]	88

2.75	Monitoring sensor data in CC2530ZNP using Putty, source [26]	89
2.76	The screenshots of the web page served from a local server prototype outputting weekly history of blood pressure measurement, source [172]	90
4.1	Algorithm for implementing ubiquitous motes interfaces	100
4.2	Algorithm for implementing device discovery using 6LoWPAN	101
4.3	Algorithm for implementing CoAP based service discovery	102
4.4	The architecture of the proposed Ubiquitous and Pervasive Body Area Networks Healthcare System	102
4.5	CC2650 Sensortag block diagram and pcb view, source TI User Guide [177] CC2650 Sensortag	103
4.6	MAX17043 battery fuel gauge block diagram and application circuit, source [77] MAX17043	105
4.7	MAX17043 test board, source [77] MAX17043 board	105
4.8	The relationship between ultraviolet radiation (UVR) exposure and the burden of disease, source [136]	106
4.9	The light spectrum, source UVsensor	107
4.10	Radiation that reaches the earth's surface, source UVsensor	107
4.11	Strength of irradiance and the UV-Index, source UVsensor	108
4.12	VEML6070 UV sensor, source [189] VEML6070	108
4.13	VEML6070 Test Board, source [189] VEML6070 board	109
4.14	Photo of experimental setup	109
4.15	Block diagram of experimental setup	110
4.16	Comparison of available OSes for IoT- source [48]	111
4.17	Energy needed to send a UDP packet per amount of data, source [137]	112
4.18	Example makefile screenshot	114
4.19	Updating sensors objects table with new sensors.	115
4.20	The hardware definitions for MAX1043 sensor,.	116
4.21	Functions required by Contiki OS to interface sensor..	117
4.22	Sensor test function for MAX17043 (part 1).	118
4.23	Sensor test function for MAX17043 (part 2)..	119
4.24	Serial terminal output when running a sensor test program	119
4.25	Sensors structure in Contiki OS.	120
4.26	SENSORS macro for our (sensortag) platform.	120
4.27	Photo of edge router	122

4.28	Photo of packet sniffer setup 1	122
4.29	MVC components interactions	123
4.30	Screenshot of landing page on various devices	124
4.31	Screen Backend server code to read network sensors and routes.	126
4.32	Socket io example code used on server side.	127
4.33	Socket I/O example code used on client side.	128
4.34	Example resource response in Copper for Firefox	129
4.35	Core Link format of CoAP response showing well-known/core resource (a) and corresponding javascript object as seen in debugger (b)	130
4.36	Menu system is created dynamically showing CoAP observe (a) and GET (b) methods	131
4.37	Theory of discovery process in ubiquitous computing (A), source [169] and A complete flow of node joining process in 6LoWPAN (B), source AD FAQ	131
4.38	Typical CoAP message exchanges. Top, a successful confirmable (CON) message is acknowledged (ACK). Bottom, a retransmission is performed before a successful ACK is received, source Shelby et al. [205]	132
4.39	Normal (A) and Conditional (B) CoAP observation, source [175]	132
5.1	Zero Gecko kit from EnergyMicro used to obtain an example energy profile	134
5.2	The screenshot showing example energy measurement using EnergyMicro tools	135
5.3	Block diagram of power monitor	135
5.4	Photo of energy monitoring setup using EEMBC ULPBench Energy Monitor	136
5.5	Block diagram of energy monitoring setup using EEMBC ULPBench Energy Monitor	136
5.6	Photo of energy monitoring setup using Silicon Labs Advanced Energy Monitor	137
5.7	Block diagram of energy monitoring setup using Silicon Labs Advanced Energy Monitor	137
5.8	Photo of energy monitoring setup using TI Energy Trace	138
5.9	Block diagram of energy monitoring setup using TI Energy Trace	138
5.10	Screenshot of energy monitoring results using EEMBC ULPBench Energy Monitor	139
5.11	Screenshot of energy monitoring results using Silicon Labs Advanced Energy Monitor	139
5.12	Screenshot of energy monitoring results using TI Energy Trace	140
5.13	Standard (non-IoT) a) and IoT solution b) (pictures inspired by Sensortag and Thingsquare)	141

5.14	Screenshot of collecting sensors data with CoAP observe option	142
5.15	UV sensor integration time and scaling as used in experiments, source a table from Vishay appnote	142
5.16	Screenshots of SQLite Manager showing sensor tables for PowerMon sensor (a) and UVMon sensor (b)	143
5.17	Example battery voltage results obtained with CoAP request-response	144
5.18	Example battery State of Charge results obtained with CoAP request-response	144
5.19	Example UV index results obtained with CoAP request-response	144
5.20	Example UV risk results obtained with CoAP request-response	145
5.21	Example battery voltage results obtained with CoAP observe	145
5.22	Example battery state of charge results obtained with CoAP observe	145
5.23	Example UV index results obtained with CoAP observe	146
5.24	Example UV risk results obtained with CoAP observe	146
5.25	Example UV index and UV risk results obtained with CoAP observe (post-processed using Matlab®)	147
6.1	John Donne, No Man is An Island, adapted from [41]	150
6.2	Current consumption of MAX17043, source MAX17043 datasheet	153
6.3	Current consumption of BQ27441, source BQ27441 datasheet	153
6.4	Screenshot of updated GUI showing battery state of charge as progress bar	154
7.1	Energy monitoring as the first stage to develop and implement power management policies	160
9.1	Screenshot of the file explorer showing Contiki OS structure	181
9.2	Cloning Contiki OS from github.	182
9.3	Screenshot of the text editor showing development of Contiki OS custom additions	183
9.4	Obtaining GNU tools version under Cygwin terminal.	184
9.5	Basic syntax of makefiles, source make syntax	184
9.6	Invoking build tools from Cygwin terminal.	185
9.7	Flashing embedded target	186
9.8	Wireshark Screenshot	186

List of Tables

1.1	Outline of the Thesis.	16
1.2	The Research Process	16
2.1	Comparison of the features of various types of popular networks - WLAN, WSN, and BAN	25
2.2	Example SAR values	26
2.3	Power consumption for EFM32xxx microcontroller, source - SiliconLabs [156]	38
2.4	Vital signs and their parameters	41
2.5	Sensors used in BAN	42
2.6	Summary of some wireless technologies suitable for BAN	61
2.7	Comparison of different IEEE standards used in BAN	63
2.8	RFCs describing 6LoWPAN	71
3.1	Experimental System Development Methodology	95
4.1	Comparison of existing 6LoWPAN implementation, source [200]	112
5.1	Cumulative results of energy monitoring using various equipment	140
5.2	Sample results of real time energy monitoring using CoAP observe for various motes	147
5.3	Sample cumulative results of real time energy monitoring using different CoAP applications	148
5.4	Sample results of energy monitoring using computer instrumentation (TI Energy Trace) for 5 different motes	149
5.5	Comparison of sample results of energy monitoring using computer instrumentation vs online (real time) using power monitor sensor	149

Glossary

A

Actuator - An actuator is a device converting energy from electrical to another form.

Agent - An agent is a program construct that acts on behalf of a user or other program, designed with a binding agreement to operate within a set of pre-defined rules and outcomes.

AI - Artificial Intelligence is the branch of computer science that seeks to approximate intelligence exhibited in nature.

API - Application Programming Interface is a defined set of interface rulesets to allow extensible functionality of software code.

AR - Augmented reality (AR) is a live view of real-world in which a view of reality is modified by a computer.

Architecture - The Architecture of a system is the conceptual model defining the structure and behaviour and views of the system

B

BAN - formally defined by IEEE 802.15 is a communication standard optimized for low power devices and operation on, in or around the human body

Bluetooth - Bluetooth is a wireless technology standard also known as IEEE 802.15.1

C

Cloud - a set of scalable server infrastructure performing Cloud Computing by processing and storage of data from devices or other sources, and enabling the creation and integration of software systems and applications

Cloud Computing - A model of network computing performed on connected servers rather than on a local computers.

CoAP - Constrained Application Protocol (CoAP) is a software protocol for the Internet of Things able to run on devices with limited resources

Configuration - BAN mote interface enabling a set of configuration properties to be read and modified through it.

Contiki - Operating system including IP protocol stack for WSN.

D

Discovery - BAN motes interface enabling publishing of capabilities in the network/group and dynamical search for motes based on certain criteria.

Distributed Systems - A Distributed System is a software system consisting of multiple autonomous components communicating through a common network and interacting in order to achieve a common goal or objective.

E

Energest - a software module in Contiki OS used to estimate the energy consumption

F

Framework - A System Framework provides a reusable set of development libraries or classes for a software system or subsystem.

G

Github - Both Git and GitHub refer to this as a repository, or repo for short, a digital directory or storage space where the project, its files, and all the versions of its files are stored

H

I

IDE - An Integrated Development Environment is a software application that provides complete development tools including source code editor, build automation tools and code debugger.

IEEE - The Institute of Electrical and Electronics Engineers is a non-profit professional association involved among others in a development of communication standards

IETF - Internet Engineering Task Force is the group of people producing technical documents and new ideas related to Internet

Internet of Things (IoT) - New Internet paradigm being the extension of the Internet into low power intelligent objects (Things) for the purpose of monitoring and control

IP for Smart Object or 6LowPAN - 6LowPAN (IPv6 over Low power Wireless Personal Area Networks) is a protocol defining IPv6 packets over IEEE802.15.4 wireless networks.

IPSO - IP for Smart Object Alliance is a global forum serving the goal to establish the Internet Protocol (IP) as the network for the connection of Smart Objects

J

Java (software platform) - The Java Platform is a software runtime environment developed by Sun Microsystems, providing a system for developing application software and deploying it in a cross-platform computing environment.

Java Script - High-level, dynamic, untyped, and interpreted programming language

jQuery - jQuery is a JavaScript library

jQuery UI - jQuery UI is a JavaScript library for user interfaces

K

L

Layer - An layer provides a way to abstract the implementation details of a functionality in a system architecture.

LLN - Low-Power and Lossy Networks (LLNs) described in RFC 6550 is a network of resource constrained devices

M

Monitoring - Supervising activities in progress to ensure they are on-course and on-schedule in meeting the objective and performance targets, in BAN mote interface providing a mechanism to monitor the various properties or parameters of a mote.

MQTT - MQTT (MQ Telemetry Transport or Message Queue Telemetry Transport) is an ISO standard (ISO/IEC PRF 20922) publish-subscribe-based lightweight messaging protocol for use on top of the TCP/IP protocol.

MTU - In computer networking, the maximum transmission unit (MTU) is the size of the largest network layer protocol data unit that can be communicated in a single network transaction

N

Neural Networks - Neural Networks are biologically inspired models of computations, capable of machine learning and pattern recognition.

Node.js - JavaScript framework using an event-driven, non-blocking I/O model for speed and efficiency.

O

OSI - The Open System Interconnection model is a model that characterizes and standardizes the internal functions of a communication systems.

P

Pervasive - Pervasive means permeated into environment.

Pervasive Healthcare - Pervasive Healthcare (or the European Union term: ambient assisted living) is a paradigm and a vision for the future of healthcare.

Q

Quality of Service - The Quality of Service (QoS) refers to the networking of components that enable the transport of traffic with specialized or prioritized requirements or service demands.

R

Replica - Replica is an exact reproduction of the object. In computing Replication is the use of redundant resources to improve reliability, fault-tolerance, performance or substitute original hardware components.

Repository - software repository is a place where software is found and organized, can be local or online

Responsive Web Design Responsive Web Design is a design method using CSS and HTML to resize, hide, shrink, enlarge, or move the content to make it look good on any screen.

RPL - IPv6 Routing Protocol for Low power and Lossy Networks

S

Sensor - A sensor is a transducer converting various physical types of energy into electrical energy

Service Discovery and Publishing - service discovery protocols used to discover services present in a network.

Sink - In WSN Sink is a special node where data collected (sometimes, already aggregated data) is sent

Smart Dust - Smart Dust was originally a concept for miniature wireless sensor networks and a project undertaken at University of California Berkeley.

Smart object - Smart object is an item equipped at least with a form of sensor and/or actuator, a microprocessor, a communication device (radio transceiver) and a power source. Additionally, smart object might contain other modules, for example data storage.

SOTA - State of the Art is the currently highest level of development of a device, scientific field or technique.

T

TinyOS - Operating system including IP protol stack for WSN

Transducer - A transducer is a device converting energy from one form into another

U

Ubiquitous - Ubiquitous is something that is available anywhere, anytime

Usability - Usability is the ease of use and learnability of anything a human interacts with. Typical example is the elegance and clarity with which the interaction with a computer program or an electronic hardware is designed

V

W

Web Server - A web server is a computer system processing requests and serving resources

WSN - Wireless Sensor Network (WSN) is a network made of number of small intelligent devices called motes having capabilities to sense, control and communicate wirelessly

WSN-HEAP Acronym for Wireless Sensor Networks Powered by Ambient Energy Harvesting

X

Y

Z

ZigBee - ZigBee is a standard using small, low-power digital radios based on the IEEE 802.15.4 standard for WSN