

# Glossary

of

terms and expressions used  
in connection with

# The Internet of Things

with a final section of related 'Standards'

**Version 8 ACTIVE DRAFT**

*with acknowledgements to the many sources*

Whilst every reasonable effort has been made to make the content of this Glossary as accurate and complete as possible, no responsibility will be accepted for errors and omissions therein.

We are happy to update this Glossary, and to correct inaccurate definitions in later editions.

If you notice errors or omissions, please email these to Richard Poynder [richard@smartex.com](mailto:richard@smartex.com)

## Smartex: IoT Glossary of Terms and Standards

|     |  | Explanation  |
|-----|--|--|
| 0-9 | <b>3G<br/>(Third Generation)</b>                   | Mobile communications technology which among others includes the UMTS standard.  |
|     | <b>4G<br/>(Fourth Generation)</b>                  | Mobile communications that goes beyond 3G and is chiefly meant for ultra-broadband Internet connection with speeds of 100 megabit per second to mobile users.  |
|     | <b>6LoWPAN</b>                                     | A communication protocol which compresses Ipv6 packages for small, low power-devices to enable them to communicate within the IoT.   |
|     | <b>6LoWPAN header compression</b>                  | Stands for IPv6 over low-power wireless personal area networks. It is a compression mechanism that makes it possible to send and receive IPv6 packets via low-power radio using the standard IEEE 802.15.4, which works with very low bandwidth and power consumption.   |
| A   | <b>Active digital entity</b>                       | Any type of active code or software program, usually acting according to a Business Logic.   |
|     | <b>Actuator</b>                                    | Actuators transform electrical signals (energy, usually transported by air, electric current, or liquid) into different forms of energy such as motion or pressure. This is the opposite of what sensors do, which is to capture physical characteristics and transform them in to electrical signals.                                   |
|     | <b>Address of Device</b>                           | An address is used for locating and accessing – “talking to” – a device, a resource or a service. In some cases, the ID and the Address can be the same, but conceptually they are different.  |
|     | <b>AAL<br/>(Ambient Assisted Living)</b>           | AAL concerns itself with the development of intelligent systems to assist especially the elderly. This is mostly done through smart technology. Application fields are security (e.g. observation), functionality (e.g. automated light switches) as well as entertainment.  |
|     | <b>Alljoyn</b>                                     | A group backed by the Allseen Alliance, based on messages passed between apps and firmware-based routers. In the AllJoyn scheme, app-to-app messaging is accomplished through routers.   |
|     | <b>AMI<br/>(Ambient Intelligence)</b>              | Electronic environments that are sensitive and responsive to the presence of people. A vision developed in the 1990s.  |
|     | <b>API<br/>(Application Programming Interface)</b> | One way for an application to present itself to other, typically remote, applications so that they can interact with it (for example, to read or write data to it). Often now used as another term for a Web Service.  |
|     | <b>Application software</b>                        | ...are programs which enable specific, end user applications. This means that the software uses the given potential provided by computers to form an application. Examples include Microsoft Word (text editing), Adobe Photoshop (image editing) and many other programs.   |
|     | <b>Architectural reference model in IoT</b>        | The IoT-A architectural reference model follows the definition of the IoT reference model and combines it with the related IoT reference architecture. It also describes the methodology with which the reference model and the reference architecture are derived, including the use of internal and external stakeholder requirements. |
|     | <b>Architecture</b>                                | The fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution.  |
|     | <b>Architecture vision</b>                         | A high-level, aspirational view of the target architecture.  |
|     | <b>Arduino</b>                                     | An open-source physical computing platform which serves to create interactive objects, that's based on a simple microcontroller board. In the IoT, Arduino is used by beginners and experts alike to develop interactive objects for a variety of purposes.  |

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| <b>ARP<br/>(Address Resolution Protocol)</b>      | A communication protocol that is used to convert an IP-address into a physical address. By this means computers can communicate with each other, despite only knowing each other's IP addresses, by sending an ARP request which informs them about the other computer's MAC address.  |
| <b>Augmented entity<br/>(a.k.a. Digital Twin)</b> | A physical entity is represented by a virtual entity on the digital level. An Augmented entity combines the two and stands for any combination of the two entities.<br>OR<br>The composition of a Physical Entity together with its Virtual Entity.  |
| <b>Autoid and mobility technologies</b>           | Automatic Identification and Mobility (AIM) technologies are a diverse family of technologies that share the common purpose of identifying, tracking, recording, storing and communicating essential business, personal, or product data. In most cases, AIM technologies serve as the front end of enterprise software systems, providing fast and accurate collection and entry of data. AIM technologies include a wide range of solutions, each with different data capacities, form factors, capabilities, and "best practice" uses. AIM technologies also include mobile computing devices that facilitate the collection, manipulation, or communication of data from data carriers as well as through operator entry of data via voice, touch screens or key pads. Each member of the AIM technology family has its own specific benefits and limitations -- meaning there is no 'best' technology. Rather, applications may be best served by one or more AIM technologies. Multiple AIM technologies are often used in combination to provide enterprise-wide solutions to business issues. Most AIM technologies are defined by international and national technical standards. International, national or industry application standards also exist to define the use of AIM technologies. |
| <b>B<br/>Big data</b>                             | ...describes the always-growing sums of data, as well as the problems that come with processing this massive flood of information.   |
| <b>BLE<br/>(Bluetooth Low Energy)</b>             | BLE (Bluetooth 4.0) is a lower-energy-consumption version of the Bluetooth wireless communications standard, which runs constantly, announcing a device's presence to local sensors and optimizing battery life for the device in question. In the IoT, BLE allows for precise location and feature tracking without reduced battery life.   |
| <b>Brillo</b>                                     | Announced at Google's I/O 2015, Brillo is a lightweight, rather basic backbone for the IoT that will both integrate with Android devices and support Wi-Fi and Bluetooth Low Energy.   |
| <b>Brownfield</b>                                 | An IT environment in which there are existing systems to be considered when implementing any new solutions.  |
| <b>BTS<br/>(Base Transceiver Station)</b>         | A machine that enables two-way wireless communication between user equipment, for example a mobile phone or a computer, and networks like the GSM network. The data is received through an antenna and is then processed and transmitted by the BTS to create a wireless connection.   |
| <b>Business logic</b>                             | The code in an application that processes and executes the functional requirements of the application. Typically sits between any data stores and the end-user experience. In IoT the end user may be another system.  |

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| <b>C</b> | <b>Cloud</b>                                   | Highly scalable compute, storage and memory capabilities located in a data centre that enables flexible and rapid scale-up and scale-down of application resources.  |
|          | <b>Cloud communication</b>                     | Communication services being provided by third parties which can be accessed and used through the internet. The program Skype is the best-known cloud communication software.  |
|          | <b>Cloud orchestration</b>                     | The automated management of a cloud. This includes all services and systems that are part of the cloud as well as the flow of information.   |
|          | <b>CoAP (Constrained Application protocol)</b> | A software protocol that is used in small electronics devices. It serves the interactive communication between those devices.  |
|          | <b>Communication model</b>                     | This aims at defining the main communication paradigms for connecting elements as, in the IoT-A case, defined in the domain model. This model provides a set of communication rules to build interoperable stacks, together with insights about the main interactions among the elements of the domain model.  |
|          | <b>Connected home</b>                          | Where capabilities within the home such as utilities are connected to the internet in order to derive greater value and benefit for the home owner(s) or product/service providers   |
|          | <b>Constrained Application Protocol (CoAP)</b> | A application layer protocol intended for use in very simple electronic devices allowing them to communicate interactively over the internet. The IETF has done the major standardisation work for this protocol.  |
|          | <b>Constrained network</b>                     | A constrained network is a network of devices with restricted capabilities regarding storage, computing power, and/or transfer rate.   |
|          | <b>Controller</b>                              | Anything that has the capability to affect a physical entity, like changing its state or moving it.  |
|          | <b>Cooperating objects</b>                     | Coined in 2006, these are modular systems of autonomous, heterogeneous devices pursuing a common goal by cooperation in computations and in sensing and/or actuating with the environment.   |
|          | <b>Cortex-A</b>                                | ...refers to a series of processors from ARM that are equipped with ARMv7 and ARMv8 command sets. They are used for applications that require a lot of processing power, mainly in the areas of mobile handsets (smartphones), computing (tablets), digital home, automotive, enterprise and wireless infrastructure.  |
|          | <b>Cortex-M</b>                                | A family of microprocessors developed by ARM which is mainly used in micro-controllers. They range from the cheapest M0 processor up to the Cortex-M4, which is used for effective digital signal control. Applications are found in automotive, gaming and intelligent consumer products.   |
|          | <b>Credential</b>                              | A record that contains the authentication information (credentials) required to connect to a resource. Most credentials contain a user name and password.  |
|          | <b>Cyber-physical systems (CPS)</b>            | Systems that combine computer related and mechanical aspects. A smartphone for example combines software, hardware, etc. with a physical device. Overall, many mobile or embedded technologies or devices can be called Cyber-Physical Systems, thus applications are manifold. The systems often include some form of sensor which can transfer attributes from the real world to the digital sphere. |
| <b>D</b> | <b>Data centre</b>                             | A data centre is a location where most of the computer systems and the computing power of companies, or other large entities, are bundled.   |

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| <b>DDS (Digital Data Storage)</b>                   | ...is a format that is used to store computer data on audio tape. It was developed by HP and Sony in 1989, is based on the DAT (Digital Audio Tape) format and was a widely used technology in the 1990s.   |
| <b>Device</b>                                       | Technical physical component (hardware) with communication capabilities to other IT systems. A device can be either attached to or embedded inside a physical entity, or monitor a physical entity in its vicinity.   |
| <b>Device Discovery</b>                             | The process of discovering devices within a network, from the seed devices.   |
| <b>DGW [Should be DWG – from Drawing?]</b>          | A format for different CAD (computer-aided design) programs, including AutoCAD. It is used to store two and three-dimensional design data and meta data.  |
| <b>Digital entity</b>                               | Any computational or data element of an IT-based system.  |
| <b>Discovery</b>                                    | Discovery is a service to find unknown resources/entities/services based on a rough specification of the desired result. It may be utilized by a human or another service. Credentials for authorization are considered when executing the discovery.   |
| <b>Domain model</b>                                 | A domain model describes objects belonging to a particular area of interest. The domain model also defines attributes of those objects, such as name and identifier. The domain model defines relationships between objects such as 'instruments produce data sets'. Besides describing a domain, domain models also help to facilitate correlative use and exchange of data between domains. |
| <b>Domotics</b>                                     | ...indicates the confluences of 'domestic' and 'robotics' and forms the basis of many IoT innovations. These include home automation systems, autonomous service robots like the Roomba vacuum, and networked security systems. In the IoT, these devices often have machine-to-machine communication capabilities.   |
| <b>DSP (Digital Signal Processing)</b>              | The numerical manipulation of analogue signals. Such signals are represented in the form of number sequences that permit their digital processing.  |
| <b>E EAN (European Article Number)</b>              | ...stands for and is used to mark and identify products. Since 2009 it is called GTIN (Global Trade Item Number). The number is usually found beneath barcodes and consists of up to 13 digits (EAN 13 barcode).  |
| <b>EDGE (Enhanced Data Rates for GSM Evolution)</b> | ...increases the bandwidth of GSM networks. It builds on available GSM or GPRS standards and is thus easily integrated into the existing network. Since it has a lower data transfer rate than UMTS, it is seen as an intermediate step towards that standard.  |
| <b>eDiscovery</b>                                   | The collection, identification, archiving, and delivery of Electronically Stored Information (ESI) requested by legal teams and courts as part of an investigation, litigation, audit, industry compliance or other activity.   |
| <b>E-Health</b>                                     | Refers to the support of medical processes and applications through information and computer technologies. This includes the gathering and communication of data as well as automated responses of certain devices and processes.   |
| <b>Embedded computing / systems</b>                 | A term for computing that is dedicated to a single purpose, as opposed to general-purpose computing. Embedded computer systems are special-purpose and contain only the software and hardware needed to achieve those ends. In the IoT, many systems are developed for specific purposes and made to work in concert with other systems.  |

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| <b>EMI (External Machine Interface)</b>                                | This protocol is an extension to the UCP (Universal Computer Protocol). It is used to connect to Short Message Service Centres which store, transform and send short messages.   |
| <b>Energy-harvesting technologies</b>                                  | This (also known as power harvesting or energy scavenging) is the process by which energy is derived from external sources (e.g., solar power, thermal energy, wind energy, salinity gradients, and kinetic energy), captured, and stored. Frequently, this term is applied when speaking about small, wireless autonomous devices, like those used in wearable electronics and wireless sensor networks. Traditionally, electrical power has been generated in large, centralized plants powered by fossil fuels, nuclear fission or flowing water. Large-scale ambient energy, such as sun, wind and tides, is widely available but technologies do not exist to capture it with great efficiency. Energy harvesters currently do not produce sufficient energy to perform mechanical work, but instead provide very small amount of power for powering low-energy electronics. While the input fuel to large scale generation costs money (oil, coal, etc.), the 'fuel' for energy harvesters is naturally present and is therefore considered free. For example, temperature gradients exist from the operation of a combustion engine and in urban areas, there is also a large amount of electromagnetic energy in the environment because of radio and television broadcasting. |
| <b>EPCglobal</b>   | A non-profit organization founded by GS1 (former EAN International) and GS1 US (former UCC). It serves to spread, improve and standardise RFDI (Radio Frequency Identification) technology and to support communication of gathered data through the internet.   |
| <b>EPCIS repository (Electronic Product Code Information Services)</b> | A standard for accessing and sharing data connected to the electronic product codes that are stored in, for example, RFID tags. An EPCIS repository is a kind of database for storing and providing access to this information.  |
| <b>ESD (Electrostatic discharge)</b>                                   | A discharge that can occur if two electrical objects with different electrical charge get in contact with each other. The difference in charge is often due to friction. The short process is often accompanied by sparks, as can be seen with lightning. ESD can lead to severe damage to electrical devices (for example, generators).   |
| <b>EtherCAT (Ethernet + Controller and Automation Technology)</b>      | A fieldbus system developed by Beckhoff, which allows for real-time-Ethernet. It wants to achieve short data update times, accurate synchronisation and low hardware costs, so it can be used specifically for automated or control systems.   |
| <b>F FOTA (Firmware Over-The-Air)</b>                                  | These capabilities allow mobile phones and other devices to be updated over a network rather than in a brick-and-mortar store. In the IoT, this functionality means that wired homes and other embedded systems can be installed on site and updated after the fact.   |
| <b>Fog computing</b>   | Describes an approach where, compared with Cloud Computing, IT performances are performed at the edge of the network, thus creating user proximity. This leads to lower service latency and denser geographical distribution. This is a CISCO term equivalent to Edge computing.   |
| <b>G Gateway</b>   | A network device or software run on a computer in the network that can communicate with other networks, even if these use a different protocol. This way they can share information with each other.   |

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| <b>GIS (Geographic Information System)</b>           | Such systems capture, manage, analyse, and present geographic data via hardware and software. In the IoT, GIS often forms the basis for location-enabled services and related apps.  |
| <b>Geotagging</b>                                    | The process of tagging a photo, video or other types of media with coordinates, thus marking it with a location.   |
| <b>Global Storage</b>                                | Storage that contains global information about many entities of interest. Access to the global storage is available over the Internet.   |
| <b>GPRS (General Packet Radio Service)</b>           | A platform for mobile data services in GSM mobile telephony networks OR (General Packet Radio Service) is a data service which provides a higher transfer speed of data as well as a more efficient use of channels in the GSM network.  |
| <b>Greenfield</b>                                    | A project (as opposed to Brownfield – see above) where no consideration of previous systems is needed  |
| <b>GSM (Global System for Mobile Communications)</b> | The most widely used digital cellular network and the basis for mobile communication such as 'phone calls and the short message service (SMS).   |
| <b>GTIN (Global Trade Item Number)</b>               | Since 2009 GTIN has replaced EAN (European Article Number). The number is usually found beneath barcodes.  |
| <b>H Haptic technology</b>                           | A form of touch feedback that imbues human/machine interactions with tactile responses. Sensors may detect pressure and direct feedback like vibrations and noises. In the IoT, haptic technology serves to facilitate human interaction with machines.  |
| <b>Home automation</b>                               | The automation of certain activities within a household. This can for example include automated control of lights, doors and air conditioning.   |
| <b>Hosts</b>   | Hosts are computers that provide (host) certain services or resources within a network, which other participants within the network can then access and use.   |
| <b>Hybrid cloud</b>                                  | A mix of public and private cloud. The distribution of services through private or public channels is decided upon by the users.   |
| <b>I IAAS (Infrastructure as a Service)</b>          | Refers to an on-demand business model for IT capacities. Instead of owning IT infrastructure or server space you rent it and pay for it on a per-use basis. Those capacities are usually owned, maintained and provided by a cloud service. These are specific services that are essential for any IoT implementation to work properly. Such services provide support for essential features of the IoT. |
| <b>iBeacon</b>                                       | A technology introduced by Apple. It uses sensors to locate iOS7 or Android devices and can send them notifications via Bluetooth Low Energy (BLE). This can be used in stores or museums to give further information about the painting or item a person is close to.   |
| <b>Identifier</b>                                    | Artificially generated or natural feature used to disambiguate things from each other. There can be several IDs for the same physical entity. The set of IDs is an attribute of a physical entity.   |
| <b>Identity</b>                                      | ...consists of recognizable properties that are linked to an object, a person, etc. Those attributes expose the entity and allow for clear identification. If two things have the exact same attributes, they usually have the same identity as they can't be distinguished from each other.   |

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| <b>IGES (Initial Graphics Exchange Specification)</b> | A vendor-neutral, standardized file format that is used to transfer information between CAD (computer-aided design) programs. The standard was developed to create a uniform method for exchanging graphical data between the programs.   |
| <b>IGMP (Internet Group Management Protocol)</b>      | ...is a communication protocol based on the IP protocol. It is used to support group communication and allows for IP-multicasting. IP-multicasting enables the transmission of IP packages to many receivers with one transmission, which is a requirement for technologies such as internet television.  |
| <b>Industrial Internet</b>                            | A term introduced by General Electric (GE) and stands for the convergence of machinery and smart data. It allows for constant and real time adjustments.  |
| <b>Information model</b>                              | An information model is a representation of concepts, relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. The advantage of using an information model is that it can provide sharable, stable, and organized structure of information requirements for the domain context. The information model is an abstract representation of entities which can be real objects such as devices in a network or logical such as the entities used in a billing system. Typically, the information model provides formalism to the description of a specific domain without constraining how that description is mapped to an actual implementation., Different mappings can thus be derived from the same information model. Such mappings are called data models. |
| <b>Interface</b>                                      | How a software application or system, or physical device or component appears to other software or hardware so that it can be interacted with.  |
| <b>Internet</b>                                       | The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks of local to global scope that are linked by a broad array of electronic and optical networking technologies. The Internet carries a vast array of information resources and services, most notably the inter-linked hypertext documents of the World Wide Web (WWW) and the infrastructure to support electronic mail.   |
| <b>Internet of Everything</b>                         | A term defined by Cisco Systems and basically means applying the IoT to everything, thus creating new capacities and smart processes in virtually every field we can think of. Cisco calls it the connection of "people, process, data and things".   |
| <b>Interoperability</b>                               | The term describes a system's ability to share information and services with another system ideally based upon common standards. Much of the success of the IoT relies on the ability of connected devices to operate seamlessly and effectively together.  |
| <b>IoT (Internet of Things)</b>                       | A development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data. A state in which physical objects (things) having embedded technology to sense and communicate, being connected via an identifier such as a micro-chip/SIM. This will serve the communication among those things, closing the gap between the real and the virtual world and creating smarter processes and structures that can support us without needing our attention. It can be compared with the digital connection on the internet.  |



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| <b>IoT service</b>                                 | Software component enabling interaction with resources through a well-defined interface. Can be orchestrated together with non-IoT services (e.g. enterprise services). Interaction with the service is done via the network.   |
| <b>IoTivity</b>                                    | Middleware that sits between the physical radio hardware and the application (per OIC)  |
| <b>IP (Internet Protocol)</b>                      | One of the most fundamental protocols used for data communication on the Internet.  |
| <b>IP devices</b>                                  | Refers to all devices within a network which are labelled with an IP address.   |
| <b>IPv6 (Internet Protocol version 6)</b>          | ... is a new version of IP, where the addresses are made up of 128 bits and the number of addresses possible is huge.   |
| <b>L Local storage</b>                             | Special type of electronic data storage that contains information about one or only a few entities in the vicinity of a device.   |
| <b>Location technologies</b>                       | All location technologies like Global Positioning Systems (GPS) work to establish and communicate the location of a device to sensors around it. In the IoT, this capability serves to position a device or user within a system.   |
| <b>Look-up (IP Look-up)</b>                        | In contrast to discovery, look-up is a service that addresses existing known resources using a key or identifier.   |
| <b>Low-power radio network</b>                     | This is also referred to as WPAN (Wireless Personal Area Network) and is a network with limited range that enables smart objects to communicate with each other wirelessly. Besides the standard IEEE 802.15.4, Bluetooth is another example of a low-power radio standard. |
| <b>LTE (Long Term Evolution)</b>                   | ...is a mobile cellular standard that provides faster Down- and Upload speeds. Despite being marketed as a fourth generation standard it does not fulfil all of the technical requirements.   |
| <b>M M2M (Machine to Machine)</b>                  | A typically closed network of devices in which they can communicate with one another and/or other control systems located on the same network.  |
| <b>MEMS (Micro-Electro-Mechanical Systems)</b>     | Miniaturised mechanical and electro-mechanical elements (i.e. devices and structures) that are made using the techniques of microfabrication.   |
| <b>Message broker</b>                              | A message broker is a middleware program that translates a message from the messaging protocol of the sender into the messaging protocol of the receiver. This way a message broker makes it easier for two applications to communicate.                                    |
| <b>Message Queueing Telemetry Transport (MQTT)</b> | A lightweight messaging protocol for small sensors and mobile devices. Useful for connections with remote locations where a small code footprint is required.   |

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| <b>Microcontroller</b>                   | A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on-chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared with a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to control digitally even more devices and processes. Mixed signal microcontrollers are common, integrating analogue components needed to control non-digital electronic systems. |
| <b>Modbus</b>                            | A communication protocol that is mainly used to connect electronic devices. The Modbus Master (for example a computer) requests information from the Modbus Slaves (for example electronic thermometers). Up to 247 Slaves can transmit their information to one Master.   |
| <b>MOM (Message Oriented Middleware)</b> | MOM is middleware that allows for synchronous as well as asynchronous (queue) messaging between distributed systems.   |
| <b>N</b> <b>Nagios</b>                   | Software which monitors IT infrastructures. It includes for example immediate problem detection.   |
| <b>NAT (Network Address Translation)</b> | ... is a technology that enables the connection of several computers to an Internet connection with one or a few common IP addresses.  |
| <b>Nest</b>                              | The Nest Learning Thermostat represents Google's first foray into the automated home market. Through regular use, the Nest learns your schedule, programs itself, and can be controlled from your phone, lowering heating and cooling bills by up to 20 percent.   |
| <b>Network – body area (BAN)</b>         | A body area network, also referred to as a wireless body area network (WBAN) or a body sensor network (BSN), is a wireless network of wearable computing devices. BAN devices may be embedded inside the body, implants, or may be surface-mounted on the body in a fixed position, wearable technology, or may be accompanied devices which humans can carry in different positions, in clothes pockets, by hand or in various bags.  |
| <b>Network – cellular</b>                | A cellular network is a radio network distributed over land through cells where each cell includes a fixed-location transceiver known as a base station. These cells together provide radio coverage over larger geographical areas. User equipment (UE), such as mobile phones, is therefore able to communicate even if the equipment is moving across cells during transmission.  |

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|                                       | Explanation   |
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| <b>Network – low power wireless</b>   | Or 6LoWPAN. The 6LoWPAN concept originated from the idea that 'the Internet Protocol could and should be applied even to the smallest devices, and that low-power devices with limited processing capabilities should be able to participate in the IoT'.<br>The 6LoWPAN group has defined encapsulation and header compression mechanisms that allow IPv6 packets to be sent and received over IEEE 802.15.4 networks. IPv4 and IPv6 are the work-horses for data delivery for local-area networks, metropolitan-area networks, and wide-area networks such as the Internet. Likewise, IEEE 802.15.4 devices provide sensing communication-ability in the wireless domain. The inherent natures of the two networks are, however, different. |
| <b>Network – personal</b>             | A personal-area network (PAN) is the interconnection of information technology devices within the range of an individual person, typically within a range of 10 meters. For example, a person travelling with a laptop, a personal digital assistant (PDA), and a portable printer could interconnect them without having to plug anything in, using some form of wireless technology. Typically, this kind of personal area network could also be interconnected without wires to the Internet or other networks.  |
| <b>Network – satellite</b>            | A satellite system or a part of a satellite system, consisting of only one satellite and the cooperating earth stations.  |
| <b>Network – fixed</b>                | A group of computers, printers, phones, and other equipment that are connected by wires, rather than by radio signals.  |
| <b>Network resource</b>               | A resource hosted somewhere in the network, e.g. in the cloud.  |
| <b>Next-generation networks (NGN)</b> | Packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies.   |
| <b>NFC (Near Field Communication)</b> | ... is a set of wireless technologies which allows for simple and contactless exchange of data within very close distance (a few inches).   |
| <b>Node</b>                           | A connection point, a redistribution point or a communication endpoint. The definition depends on the network and the protocol layer referred to. A network node is an active electronic device that is attached to a network and is capable of creating, receiving or transmitting information over a communications channel.  |
| <b>O Object</b>                       | ... means a 'thing' in IoT (in contrast to the digital and network connection shared between these systems). This could be household appliances, wearable technology, security systems or other connected devices. See <b>Thing</b> .   |
| <b>Observer</b>                       | Anything that has the capability to monitor a physical entity, like its state or location.  |
| <b>On-device resource</b>             | Resource hosted inside a device and enabling access to the device and thus to the related physical entity.  |
| <b>Open Manufacturing Language</b>    |   |
| <b>Open source</b>                    | Open Source software makes its source code freely available for anyone to modify and redistribute. This stands in contrast to a proprietary system. Readily available Open Source software is fuelling a great deal of advancement in the IoT, as developers from all walks of life try their hand at innovation.   |

## Smartex: IoT Glossary of Terms and Standards

| Explanation  |  |
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| <b>Operator</b>  | The operator owns administration rights on the services it provides and/or on the entities it owns, is able to negotiate partnerships with equivalent counterparts and define policies specifying how a service may be accessed by users.  |
| <b>OT/IT Convergence (Operational Technology/IT)</b>               | The process or aspiration of bringing together Information Technologies and Operation Technologies (which provide operational control of assets in a network in real time). Higher efficiency and reliability may be attained with such a smart grid platform combining the physical infrastructure and human interface.   |
| <b>P</b>   | <b>Passive digital entities</b> A digital representation of something stored in an IT-based system.  |
| <b>Perspective (also referred to as architectural perspective)</b> | ... is a collection of activities, checklists, tactics and guidelines to guide the process of ensuring that a system exhibits a particular set of closely-related quality properties that require consideration across a number of the system's architectural views.   |
| <b>Pervasive computing</b>   | Pervasive computing (also called ubiquitous computing) is the growing trend towards embedding microprocessors in everyday objects so they can communicate information. Such computing devices are completely connected and constantly available.   |
| <b>Pervasive sensing</b>   | The ubiquitous capabilities in sensing device activity or condition changes: regarded as essential in IoT, often applied to the sensing of human activity by a system.   |
| <b>Physical entity</b>   | Any physical object that is relevant from a user or application perspective.   |
| <b>Platform as a service (PAAS)</b>                                | A cloud service: a platform which provides web developers with all the infrastructure they need to develop and run an application.   |
| <b>Power over WiFi (PoWiFi)</b>                                    | A technology that can convert signals sent by wireless routers into direct current. A continuous stream of low power signals can be harvested from inactive WiFi hotspots.   |
| <b>Private cloud</b>   | ... provides services with cloud characteristics but only within a single organization, for example a company.   |
| <b>Public cloud</b>  | ... services are public and made available for everyone.   |
| <b>Pulse oximeter</b>  | As the IoT branches into healthcare, wearable tracking devices like the Owlet enable parents to be connected to their infants at all times by using portable pulse oximetry to measure heart rate and oxygen levels, but without being invasive.   |
| <b>Q</b>   | <b>Quantified self</b> A movement that started in 2007 which uses modern technical advances to gain more insight into one's own life, by collecting data relating to, amongst other things, health and emotions. This data is then used to improve a person's lifestyle and state of mind.   |
| <b>R</b>   | <b>Raspberry Pi</b> A credit-card sized personal computer that plugs into a TV and a keyboard. The device helps to democratise programming, since it's inexpensive, available to the masses, and can do many of the things that desktop PCs can do.  |
| <b>Reference architecture</b>                                      | ... is an architectural design pattern that indicates how an abstract set of mechanisms and relationships realises a predetermined set of requirements. It captures the essence of the architecture of a collection of systems. The main purpose of a reference architecture is to provide guidance for the development of architectures. One or more reference architectures may be derived from a common reference model, to address different purposes/usages to which the reference model may be targeted. |

## Smartex: IoT Glossary of Terms and Standards

| Explanation   |  |
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| <b>Reference model</b>                                    | A reference model is an abstract framework for understanding significant relationships among the entities of some environment. It enables the development of specific reference or concrete architectures using consistent standards or specifications supporting that environment. A reference model consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details. A reference model may be used as a basis for education and explaining standards to non-specialists.                           |
| <b>Remote monitoring and control</b>                      | ... describes the more and more automated monitoring and control of devices, technologies or processes. Wireless devices which send information gathered directly to control centres are often used to achieve this.   |
| <b>Resolution</b>   | Service by which a given ID is associated with a set of addresses of information and interaction services. Information services allow querying, changing and adding information about the thing in question, while interaction services enable direct interaction with the thing by accessing the resources of the associated devices, based on <i>a priori</i> knowledge.   |
| <b>REST (Representational State Transfer)</b>             | ... is an architecture for web standards, especially for the HTTP protocol. It is supposed to simplify the design of network applications compared with, for example, SOAP. An architecture for representing entities exposed by a Web Service in order to interact with them (Create, Read, Write, Delete). Has become very popular as a more efficient alternative to traditional SOAP Web Services.   |
| <b>RFID (Radio Frequency Identification)</b>              | The use of electromagnetic or inductive coupling in the radio frequency portion of the spectrum to communicate to or from a tag through a variety of modulation and encoding schemes uniquely to read the identity of an RFQ Tag. A method to identify objects (including humans) through electromagnetic waves without actual physical contact. This way, data can be gathered more easily. An object or creature is equipped with a transponder which transmits data to an electronic reader. Other than, for example, barcodes, the information can be read without a line of sight and in some cases operating distance can be over a kilometre. |
| <b>S SCADA (Supervisory Control And Data Acquisition)</b> | ... is a computer system which gathers real-time data to monitor and control systems or processes.   |
| <b>SDN (Software-defined networking)</b>                  | Enables network infrastructure can be defined through software code. Typically in an environment where a virtual network is layered on top of the physical.  |

## Smartex: IoT Glossary of Terms and Standards

|                               | Explanation  |
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| <b>Security (Information)</b> | <p>The correct term is 'information security' and typically information security comprises three component parts:</p> <p><u>Confidentiality</u>: assurance that information is shared only among authorised persons or organisations. Breaches of confidentiality can occur when data is not handled in a manner appropriate to safeguard the confidentiality of the information concerned. Such disclosure can take place by word of mouth, by printing, copying, e-mailing or creating documents and other data, etc.;</p> <p><u>Integrity</u>: assurance that the information is authentic and complete. Ensuring that information can be relied upon to be sufficiently accurate for its purpose. The term 'integrity' is used frequently when considering information security as it represents one of the primary indicators of information security (or lack of it). The integrity of data is not only whether the data is 'correct', but whether it can be trusted and relied upon.;</p> <p><u>Availability</u>: assurance that the systems responsible for delivering, storing and processing information are accessible when needed, by those who need them.</p> |
| <b>Sensor</b>                 | A sensor is used to determine certain physical or chemical characteristics and transform them into an electrical signal to make them digitally processable. Sensors form the backbone of the IoT, helping to bridge the gap between digital and physical.  |
| <b>Sensor hub</b>             | A technology which connects sensor data and processes it. This way the hub does part of a processor's data-processing job.   |
| <b>Single sign-on</b>         | Ability to enter a name and password only once in order to get to several password protected systems in one working period. Once the user has logged in, a central network application grants access to all the resources to which the user is entitled.   |
| <b>Smart buildings</b>        | Buildings which are designed and equipped to try to minimize costs and environmental impact. This is achieved by connected systems and efficient use of energy through new, automated technology that intelligently responds to certain circumstances (available solar energy, temperature inside the building, etc.).   |
| <b>Smart cars</b>             | Cars which use new technologies to support the driver and create a safer traffic environment. Different systems (inside and outside of the car) are connected and communicate with each other to allow intelligent intervention in dangerous situations, and thus more fluent traffic flows.   |
| <b>Smart cities</b>           | A concept that tries to create a more intelligent city infrastructure by using modern information and communication technologies. Smart cities are about a more flexible adaptation to certain circumstances, more efficient use of resources, improved quality of life, fluent transportation and more. This will be achieved through networking and integrated information exchange between humans and things.   |
| <b>Smart grids</b>            | Grids which coordinate energy use and distribution. This enhances efficiency and becomes more and more important because of renewable energies which are not always as reliable as other forms of energy.  |
| <b>Smart home</b>             | Refers to the networking of household devices and systems through information and communication technology. This way, processes within a household can be monitored and controlled automatically to optimize quality of life, costs, security and environmental impact.  |

## Smartex: IoT Glossary of Terms and Standards

| Explanation   |  |
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| <b>Smart meters</b>   | Electronic devices which measure and display resource consumption (of water, gas, electricity, etc.) and communicate this information to third parties (mainly control systems). This allows for a more efficient distribution, usage and control of these resources.  |
| <b>SoC ((IoT) System On a Chip)</b>                                 | The bundling of all necessary parts of a system into a single chip. This saves space and reduces energy consumption, making it especially useful in small electronic devices.  |
| <b>Social web of things</b>   | ... is in a way the socialisation of the IoT. It is the integration of connected things into our social life. An example would be a TV that not only informs us that our favourite TV show is on in an hour, but also lets us know which of our friends like the show too, so that you can meet up and watch together.   |
| <b>Software as a service (SAAS)</b>                                 | Software is delivered to the user and updated via the internet. Typically enabled by a cloud service that hosts the software. Often there is no software installed on the user's device but it is accessed via a web browser. Although this is not a requirement of SaaS, for example, Adobe and Microsoft both deliver applications that are installed on the user's device through a SaaS model. |
| <b>Stakeholder (also referred to as system stakeholder)</b>         | An individual, team, or organisation (or classes thereof) with interests in, or concerns relative to, a system.  |
| <b>STOMP (Simple (or Streaming) Text Oriented Message Protocol)</b> | It is similar to HTTP and allows STOMP clients to communicate with most of the message brokers, making it language-agnostic.   |
|   |  |
| <b>T Tag</b>  | A label or other physical object used to identify the physical entity to which it is attached.   |
| <b>Thing</b>  | In the phrase 'IoT', the word 'thing' denotes a physical entity (in contrast to the digital and network connection shared between these systems). This could be household appliances, wearable technology, security systems, or other connected/connectable devices.   |
| <b>Thread</b>   | An organisation attempting to specify how to assemble and configure a range of standards into a complete software stack to create an IP-based, secure, reliable, interoperable mesh network.   |
| <b>U Ubiquitous computing</b>                                       | Systems that are integrated in their surroundings and easily and constantly accessible, without traditional interfaces like screens and keyboards: all forms of computers which are implemented in everyday objects and connected. Other names, which sometimes have a slightly different meaning, are pervasive computing, ambient intelligence and everywhere.                                   |
| <b>Unconstrained network</b>  | A network of devices with no restriction on capabilities such as storage, computing power, and/or transfer rate.   |
| <b>User</b>   | A human or any active digital entity that is interested in interacting with a particular physical object.  |
| <b>V Vehicle-to-vehicle (V2V)</b>                                   | Part of the future of self-driving cars, such systems allow passenger cars and other vehicles to communicate with each other and with various road and traffic sensors. This intercommunication may eventually allow for self-regulating traffic and transportation systems.   |
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## Smartex: IoT Glossary of Terms and Standards

| Explanation  |   |
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| <b>Viewpoint</b>                                     | A definition of the perspective from which a view is taken. It is a specification of the conventions for constructing and using a view (often by means of an appropriate schema or template). A view is what you see; a viewpoint is where you are looking from - the vantage point or perspective that determines what you see.  |
| <b>Virtual entity</b>                                | Computational or data element representing a physical entity. Virtual entities can be either active or passive digital entities.  |
| <b>Virtual power plant</b>                           | In a virtual power plant, different, decentralized power generating plants are connected and are monitored and controlled from a single control centre. This way, virtual power plants can integrate smaller energy providers – for example solar or wind parks – into the energy infrastructure. VPPs are also able to react flexibly to changes in demand.  |
| <b>Virtual sensors</b>                               | ... use data from sensors to gather information that would not be measurable by a single device. This way they can attain information that cannot be measured directly.   |
| <b>W Wearable technology</b>                         | Technologies or computers that, integrated into articles of clothing or accessories, can be worn. The most prominent example would be Apple Watch. Wearable technology, like the Jawbone Up and Fitbit activity trackers, is one of the main focus areas of the IoT at the moment. Devices like these often work by gamifying real-life tasks, bringing people into the device's ecosystem and generating data that can be analysed to improve products and lifestyles. |
| <b>Weightless-N standard</b>                         | An open standard based on a low power (with an extremely long battery life) wide area star network architecture, for signal propagation over several kilometres. V1 of the standard was announced on 5 <sup>th</sup> May 2015.  |
| <b>WiFi HaLow</b>                                    | A new technology that uses unlicensed 900 MHz spectrum and 802.11ah standard for lower power wifi. The principal significance of HaLow is expected to be its enablement of a new generation of smart home devices thanks to the lower power required to connect to it, compared to current wifi in the 2.4 and 5 GHz bands. The lower frequency also promises greater range.  |
| <b>Wireless communication technologies</b>           | Wireless communication is the transfer of information over a distance without the use of enhanced electrical conductors or 'wires'. The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometres for radio communications). When the context is clear, the term is often shortened to 'wireless'. Wireless communication is generally considered to be a branch of telecommunications.               |
| <b>Wireless sensors and actuators network (WSAN)</b> | ... are networks of nodes that sense and, potentially, control their environment. They communicate the information through wireless links enabling interaction between people or computers and the surrounding environment.   |
| <b>Wireline communication technologies</b>           | A term associated with a network or terminal that uses metallic wire conductors (and/or optical fibres) for telecommunications."  |
| <b>X XML (Extensible Markup Language)</b>            | ... is universally used to describe content on websites or other information that can be read by machines.  |



## Smartex: IoT Glossary of Terms and Standards

### Explanation

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| <b>Z</b> | <b>ZigBee</b> | A low-power radio protocol for small amounts of data, based on the IEEE 802.15.4 standard. It has low power consumption, a range of about a 100 metres and a bandwidth of 250 kbps. IoT staples like the Nest thermostat and Hue light bulb both use Zigbee chips. |
|----------|---------------|--|

## SUMMARY OF IoT 'STANDARDS' AND STANDARDS BODIES

| No.      | Name   | Scope  | Promoters   | URL   |
|----------|--|--|---|---|
| <b>1</b> | <b>Internet Protocol for Smart Objects (IPSO) Alliance</b> | Internet Protocol as the network for the connection of smart objects in energy, consumer, healthcare, and industrial applications  | Global, non-profit forum:<br>50+ members  | <a href="http://www.ipso-alliance.org">http://www.ipso-alliance.org</a>       |
| <b>2</b> | <b>Industrial Internet Consortium (IIC)</b>                | M2M standardisation  | AT&T, Cisco, GE, Intel, IBM, SAP, Siemens, Infineon<br>Non-profit consortium: 50+ members | <a href="http://www.iiconsortium.org">http://www.iiconsortium.org</a>         |
| <b>3</b> | <b>AllSeen Alliance (AllJoyn)</b>                          | Non-profit group dedicated to supporting the Internet of Everything  | Qualcomm<br>The 11th Linux Foundation Collaborative Project<br>Philips                    | <a href="http://www.allseenalliance.org">http://www.allseenalliance.org</a>   |
| <b>4</b> | <b>Thread Group</b>  | Product certification to ensure security and interoperability of products around the home  | Google NEST Labs<br>A marketing education group: 7 members                                | <a href="http://www.threadgroup.org">http://www.threadgroup.org</a>           |
| <b>5</b> | <b>Open Interconnect Consortium (OIC)</b>                  | Develop standards for discovery, connectivity and device authentication. <b>And see IoTivity</b>   | Consortium: GE, Cisco, Acer, Intel<br>27 members  | <a href="http://www.openinterconnect.org">http://www.openinterconnect.org</a> |
| <b>6</b> | <b>IEEE Standards Association P2413</b>                    | This draft standard defines an architectural framework for the Internet of Things (IoT), including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. | IEEE Board (BOG/CAG)  |   |
| <b>7</b> | <b>Deutsche Telekom + SAP</b>                              | Software standards for IoT devices that take German businesses' interests into account   | Deutsche Telekom + SAP  |   |

## Smartex: IoT Glossary of Terms and Standards

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| <b>8</b>  | <b>International Telecommunication Union (ITU)</b>        | Establishment of a new ITU-T Study Group to address the standardization requirements of the Internet-of-Things...   |  |   |
| <b>9</b>  | <b>Open Connectivity Foundation</b>                       | A cross-industry collaboration aimed at unlocking opportunities for consumers and business with IoT devices, and ultimately a way quickly to get everyone to adopt a single open standard.  | Arris, CableLabs, Cisco, Electrolux, GE Digital, Intel, Microsoft, Qualcomm and Samsung.   |   |
| <b>10</b> | <b>M2.COM</b>   | A physically interchangeable standard for wireless IoT sensor nodes to combine wireless technology, a microcontroller and networking capability, with a new industry body.  | Advantech, ARM, Bosch Sensortec, Sensirion, and Texas Instruments are to co-operate on this.   |   |
| <b>11</b> | <b>Wireless IoT Forum</b>                                 | IoT standards body. The Wireless IoT Forum said it is working on accelerating the adoption of wireless wide-area networking technologies dedicated to IoT. Other founding and board members include Accenture, Arkessa, BT Telensa and WSN. | Cisco  |   |
| <b>12</b> | <b>Open Source Application Development Portal (OSADP)</b> | The OSADP features Connected Vehicle and other ITS-related applications from the USDOT ITS Program and other sources to support the use and development of this technology.   | The United States Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO)                           | <a href="http://itsforge.net">http://itsforge.net</a>       |
| <b>13</b> | <b>oneM2M</b>   | oneM2M is the global standards initiative that covers requirements, architecture, API specifications, security solutions and interoperability for Machine-to-Machine  | ARIB (Japan), ATIS (North America), CCSA (China), ETSI (Europe), TTA (North America), TSDSI (India), TTA (Korea), and TTC (Japan), together with six | <a href="http://www.onem2m.org/">http://www.onem2m.org/</a> |

## Smartex: IoT Glossary of Terms and Standards

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|  |  | and IoT technologies.<br>oneM2M was formed in<br>2012 | industry fora or<br>consortia<br>(Broadband Forum,<br>Continua Alliance,<br>GlobalPlatform, HGI,<br>Next Generation<br>M2M Consortium,<br>OMA) and over 200<br>member<br>organizations. |  |
|--|--|---|---|--|