
Assisted Living Innovation Platform - Interoperability Standards, Requirements & Activity Review



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Technology Strategy Board
Driving Innovation

Warning

This is not an approved Technology Strategy Board, Health KTN, ALIP or *dallas* document.

This document should be considered with the accompanying slideset:
'ALIP_InteropStdsRoadmap_Slideset_20130325.pdf'

Document Control

Revision History

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Known issues

Version	Owner	Issues
1.00	MR	Table 4 does not include smaller SDOs and EU NSBs except BSI.

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1 Background, Rationale and Scope

1.1 Background

It's axiomatic that standardisation and development of interoperability in the broadest sense will improve the large scale introduction of technology and services. This can be best evidenced by the development of the consumer market for mobile communications, and broadcast services. Standardisation in assisted living and lifestyle technology and services is however fractured. Previous standards work in assisted living was premised on better understanding of and dissemination of information about standardisation in order to improve the standardisation eco system, and has been useful, but without effecting a fundamental change, which is difficult to achieve in isolation given the large number of different organisations and companies involved in the whole ecosystem. Where it has been successful is connecting the interoperability requirements landscape with the need for standardisation.

Standardisation was seen as an important aspect of the Platform from its inception in 2007, but the actual practical requirements were difficult to pin down. The work programme that was ultimately devised for the period 2011/13 was wide ranging and premised around setting the scene for the then emergent TSB 'dallas' programme activity. As such it served a useful purpose, but lacked a convenient end point. Key elements included working more closely with the formal standardisation process with BSI and with the MHRA on the Medical Devices Directive. It is proposed to carry forward these important aspects into the next phase of work.

Work in the 2011/13 programme that didn't really move on to the next level included work with NOWIP and with the Continua Alliance, both of which had been anticipated to move forward significantly. Work that was successfully concluded included a contributions to the *dallas* Interoperability White Paper, a joint workshop with BSI, and contributions to the first *dallas* workshop on interoperability. The ALIP interoperability activity has, since 2011, had the ambition to set out a consensus interoperability standards roadmap for the Assisted Living sector and this paper attempts to provide a 'discussion starter' for that process. Attention is drawn to the other relevant standards resources described at 6.2.4.

1.2 Rationale

The push for scalability and interoperability in *dallas* and 3millionlives provides further impetus for standardisation, and the i3i component of the *dallas* i-focus community is building the infrastructure and membership to try to bring the various disparate strands together. The aims and objectives of i-focus i3i indicate that it intends to work in the standards area; is well placed to take on standards work, but is not yet in a position to do so. The requirement is therefore to facilitate transition, knowledge transfer and support for the development of i3i, providing specific expertise in standards in telecare and telehealth, wireless systems, electronic health and social care records, service standards and semantic standards and interoperability.

The purpose of this report is to assist understanding of existing and possible gaps in technology standards for Assisted Living (AL). This attention to the technical aspects is not intended to denigrate the necessary attention given to process and service standards, indeed to be successful both strands of work must be interwoven.

The intent of this report is therefore that ALIP stakeholders should be well placed to establish a firm consensus understanding of the AL technical landscape and with the possibility to determine market opportunities for the near- and longer-term.

This report does not of course stand alone in the topic area. The previous work undertaken within the ALIP programme of the TSB, and the longstanding European Commission sponsored activities under the AAL have, together with other initiatives, touched on various aspects of the content of this report in various technology and market roadmapping exercises. However, a major motivation for this report is to take stock of where we are, to enable examination of some of the options for specifically progressing interoperability – and to facilitate choices (perhaps educated guesses!) of the likely candidates for adoption. **Given the extensive proprietary nature of communications currently employed by products the road to interoperable AAL nirvana is likely to involve a lot of merging traffic** (some of it of terrifying size

and speed) , winding lanes, vehicle constraints and substantial diversions. Nevertheless, unless the first step is taken the destination can never be gained.

1.3 Scope

This document adopts, as a working definition for AL, the principles of the description of Ambient Assisted Living (AAL¹) used by the European Ambient Assisted Innovation Alliance (AALIANCE)ⁱ Ambient Assisted Living Roadmap (itself based on the AAL Joint Programme text)ⁱⁱ:

Ambient Assisted Living (AAL)

ICT-based products, services and systems for the process of aging well at home, in the community and at work, therefore improving the quality of life, autonomy, the participation in social life, skills and the employability of elder people and reducing the costs of health and social care

Note 1: this may be based e.g., on innovative applications of ICT, new methods of customer interaction or new types of value chains for independent living services.

Note 2: for purposes of this report the target consumers also include, in addition to older adults, those with disabilities — whether inherited or acquired later in life.

However, as the use of assistive technologies becomes the norm for increasing numbers of older people, as well as for the younger population who are enabled by improvements in medical science to live longer with disabilities (inherited or acquired), then it is our ambition that many of them will become embedded into 'mainstream' products. At a simple level this can be seen by the now-ubiquitous navigation nib on telephone keypads, or by voice guidance on moving walkways. For this reason it is somewhat difficult to provide a clean 'edge' to the scope of assisted living artefacts – particularly as they become truly ambient. This question is discussed further in Section 7 as this report seeks to arrive at conclusions.

It is important, in the global context of this report, to remember that the term Assisted Living as commonly used in the USA to describe what in the UK we might describe as sheltered housing is a small part of the wider spectrum of assisted living contexts.

1.4 The problem space

It is tempting to immediately examine the technical standards but examining the needs for technology within AAL is likely to provide a context that better stands the test of time and hence provides a more secure base for future work.

However this report is read it has to be recognized that there is a continuum which links each application area – and that not all of applications may be applicable to all persons – or in all geographical or cultural contexts. The sequence in which the groups of needs are examined is, necessarily somewhat arbitrary, so it is probably simplest to start from the most conventional application areas and move to the more futuristic.

It is the social well-being aspect of Ambient Assisted Living that is of mould-breaking importance because there is some evidence that a well-rounded lifestyle and being socially engaged helps to delay cognitive decline in older adults. There is related evidence that younger people suffering with degenerative diseases fare better physically if they are mentally, and physically, stimulated; and that in doing so they, like older adults, have less exacerbations in their condition and are less demanding on health and social care provision.

The main challenge of AAL is that it impinges on so many aspects of life – ambient living. It is this multi-faceted nature of AAL that causes very real challenges; not so much to care provision in isolation – but to the joins between self-provision, social care provision and health care provision. A recent graphic from the i-Focus activity in *dallas*^{iv} illustrates the problem with what has quickly become known as the infinity diagram (Figure 1).

¹ It is noteworthy that in telecoms AAL(2) is the common abbreviation for Asynchronous Transfer Mode (ATM) Adaptation Layer 2. As always, acronyms need to be used with care, particularly where, as here, the use contexts will overlap in some particulars.

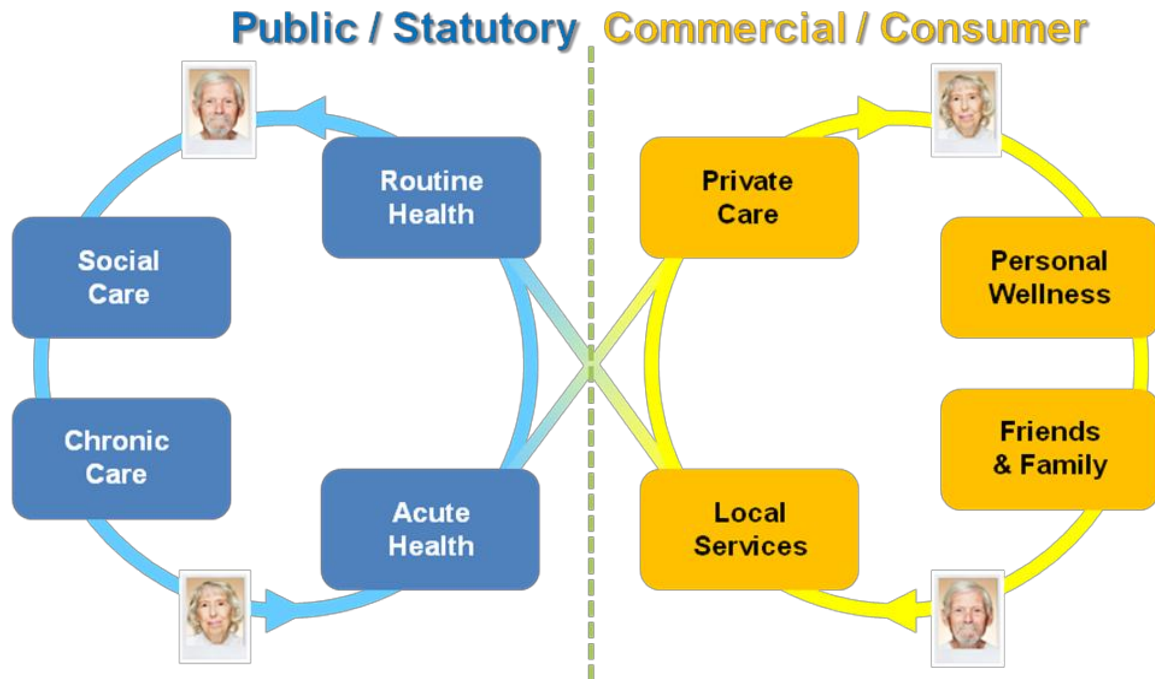


Figure 1: Integrated care – a connected journey (from the i-focus *dallas* activity)^{iv}

In practice this flow is much more complex when the recipient of services has multiple co-morbidities (Figure 2), but the issues raised by these interactions can be divided into two distinct groups:

- technical,
- organisational.

The technical issues are amenable to technical solutions, some of which can themselves be standardised in line with market need and forces.

The organisational issues are much more difficult to solve and globally are currently the main obstacle to adoption of coherent assisted living solutions – including consistent use of ‘standardised’ technical aspects. Where conservative professional practices are implicated the cultural barriers to changing practice are particularly deep-seated and can take years to change – even if new technology is adopted enthusiastically in order to replicate existing practices – or in the private lives of the same practitioners, to engage in entirely novel activities. However, there is scope here for guidance documents that might help lower barriers to embedding assisted living such that it can become ambient.

Currently much of the focus of Assisted Living is on ageing, the effect of which is to increase the likelihood of acquiring one or more disabilities. This may be as the effect of a long-standing health condition or lifestyle choice. In other instances new health problems which may not have had earlier expression become clear. Frequently, a combination of both causes is seen. It is in these situations where there are co-morbidities that the numbers of parties shown in Figure 2 is multiplied (think of the diagram having multiple layers but with each pinned to the same, single, client/user) and where the potential benefits of telecare and telehealth methodologies can quickly become lost — unless active co-ordination is imposed.

The purpose of this roadmap is, therefore, to investigate what standardised technological solutions exist to the interoperability challenges that impact various aspects of AAL from ‘current’ telecare provision through to truly ambient solutions. In attempting to grapple with this considerable challenge it is inevitable that the concentration will start from the base of what we know about the current situation, and then reach, with diminishing certainty, into the possible future.

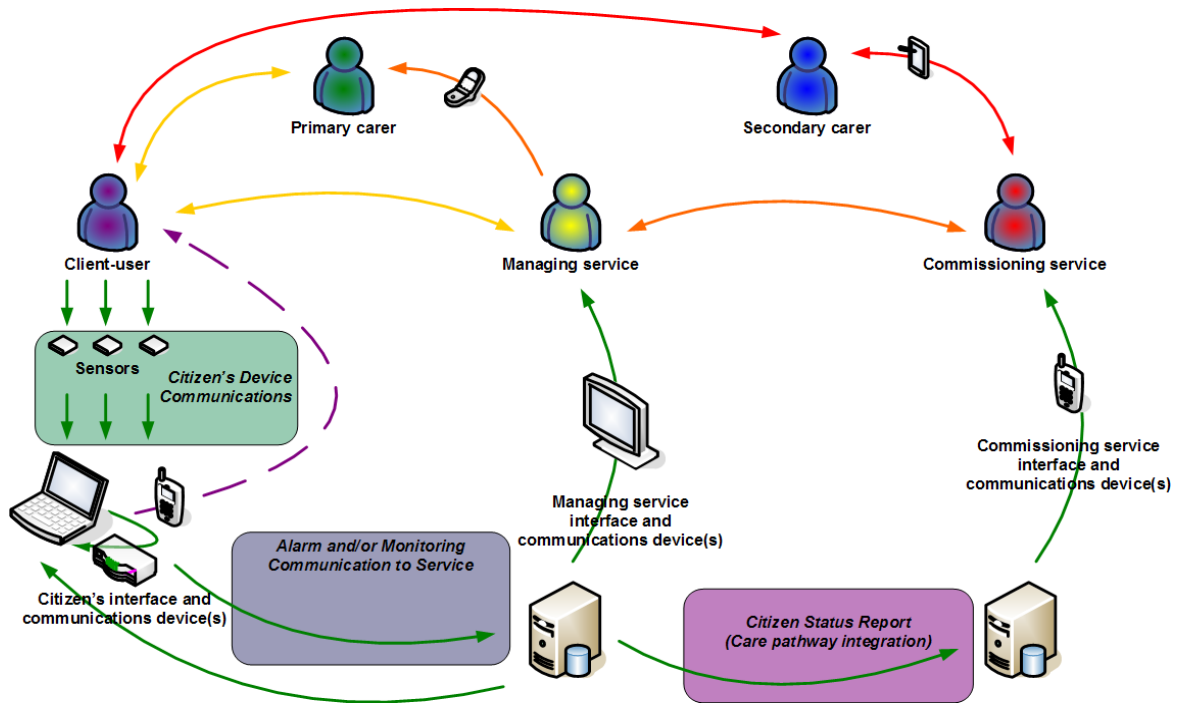


Figure 2: Typical communication flow in managed careⁱⁱⁱ

In order to attempt some consistency of approach this report attempts to use as a basis for analysis the top-level reference architecture that has been proposed by i-focus (Figure 3)^{iv}. In practice, at least as described in IT application terms, it is immediately necessary to postulate another group of components that are data components. Logically, these 'data components' could be shown linked to the *dallas* interoperability layer but in practice many may not be interoperable, so it is perhaps more accurate to represent the likely physical and logical configuration through the User and Service Components (in effect this is done by referring to these 'data components' as External Resources, though this is somewhat misleading because they are key components of the telehealth and telecare landscape).

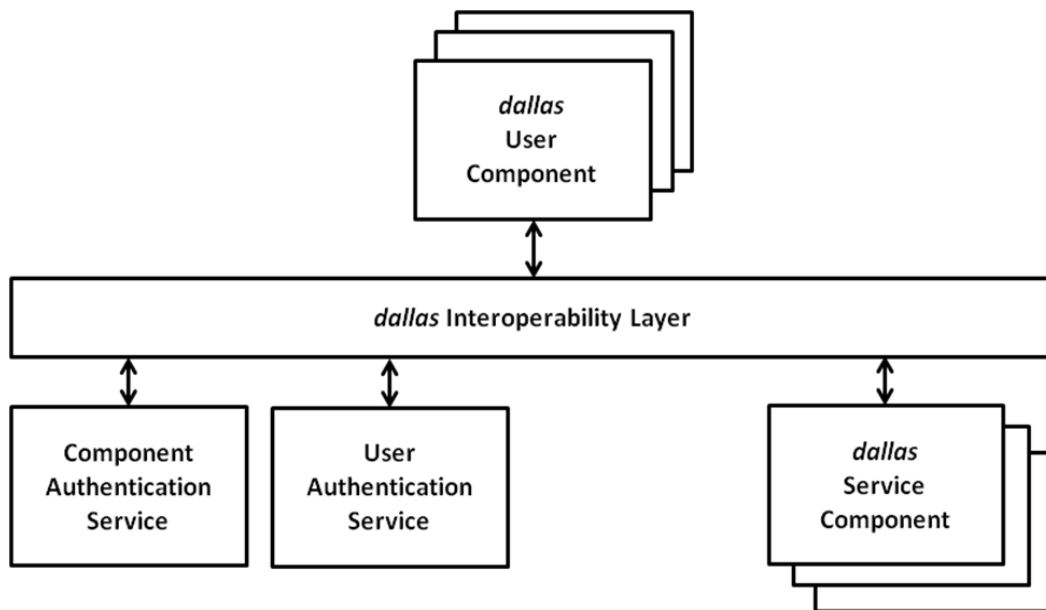


Figure 3: Top-level reference architecture proposed by i-focus^{iv}

2 Technology

Assisted Living is more than just Telecare and Telehealth. They have been the usual starting point for discussion of assisted living technology in the UK, although they are arguably not technologies in themselves, but are services that utilise a combination of different technologies. Telecare and Telehealth are discussed in more detail in Section 4.2 and 4.3.

In this section we review a range of technical artefacts in broad groups. Firstly we examine technologies that are in use today, though not necessarily in AAL ‘Candidate technologies’; next we look at some new technologies – which may not be very new but have not yet impacted significantly on ‘New technologies’, then lastly we examine a few new materials technologies which might be expected to impact AAL as they mature ‘New materials’.

2.1 Candidate technologies

2.1.1 Sensors

2.1.1.1 Single modality

Conventionally sensor technologies applied to assisted living have been based on electrical, electro-mechanical, electro-chemical or photo-electric principles. These have seldom been combined at the sensor level, although separate sensors have been combined into systems. With increasing miniaturization it is becoming possible (and common in other industries) to combine sensor technologies; such combinations are dealt with in 2.1.1.2 Smart sensors and 2.1.1.3 Nanotechnology below.

2.1.1.1.2 Sensors as actuators

At this point it is worth noting that some sensors can, when coupled with secondary systems, be used as actuators – for such applications as touch-sensitive elevator buttons (tactile sensor), lamps which dim or brighten by touching the base (inductive or capacitive sensors), and which are switched by stepping on a mat (pressure resistive).

2.1.1.1.3 Common assisted living sensors

Many different types of sensor exist^v, but sensors commonly used for current assisted living applications are listed in Table 1. Currently most sensors provide simple bi-state indications, i.e. the sensor as been triggered or remains un-triggered, though some (like the pill dispenser), perform counts of a sensor’s change of state.

The list in Table 1 deals primarily with simple sensors used for these state change functions though some (e.g. gaze and voice) are most commonly incorporated into systems that provide a self-contained function. Drawing this line is somewhat arbitrary, but the basis for exclusion has been the relatively complexity and cost of the sensor-based system – an example being text-to-speech, which though somewhat analogous to gaze and voice is dependent on obvious computing technology. These more advanced, and less used, technologies have been included in the next section, 2.1.1.1.4 Candidate assisted living sensors.

Table 1: Common assisted living sensor types

Sensor	Measurement principle	Typical applications
Accelerometer	Electromechanical	Fall alerting
Carbon monoxide	Electrochemical	Inadequate ventilation / fuel burning
Enuresis	Resistive / conductive	Involuntary urination

Sensor	Measurement principle	Typical applications
Flood	Resistive	Overflow of Bathtub, Wash-basin, Kitchen sink, etc.
Flow	Electromagnetic / Optical	Water faucet use, Gas use
Gas	Semiconductor, catalytic	Dangerous levels of gas
Gaze	Optoelectric	'Sip & puff' control of keypad or computer
Movement	Passive Infra Red (PIR) - heat	Activity/inactivity and intruder alarm
Open/close	Hall effect (Electromagnetic)	Door/window state (wander/intruder alarm)
Pill dispenser	Electromechanical switch	Medication reminder (when combined with clock) and dispense recording
Pressure pad	Resistive/Capacitive (Electromechanical)	Chair / bed / door use
Pressure	Resistive (Electromechanical)	'Sip & puff' control of computer
Smoke	Photoelectric	Fire/smoke alarm
Switch	Electromechanical switch	Panic / distress alarm, actuation
Temperature	Thermistor (resistive), bimetallic strip (switch)	Room temperature, outside temperature, water temperature, fire
Video camera	Photoelectric / CMOS	Entry systems, Wander monitoring
Voice	Microphone (Resistive / capacitive) / Laser / MEMS	Voice control of keypad or computer

2.1.1.1.4 Candidate assisted living sensors

Many additional types of sensor exist^y, which are not yet in common use (beyond research) for assisted living applications (either ambient or additive) and some of the more obvious of these are listed in Table 2. Many of these sensors are in industrial, consumer or research use but have yet to be applied in volume in assisted living use.

Table 2: Candidate assisted living sensor types

Sensor	Measurement principle	Potential applications
Accelerometer	Electromechanical	Wheelchair speed control, falls, eating aid
Digital Camera	Photoelectric	Proximity warning, blind-spot display
Curb feeler	Resistive / optical	Proximity warning
Inhaled/exhaled gas	Various electrochemical	Therapeutic, diagnostic and warning
Electronic nose / tongue	Various electrochemical	Odour / flavour indication
Body chemical	Optoelectronic, electrochemical	Therapeutic and diagnostic chemistry

Sensor	Measurement principle	Potential applications
Location	Triangulation (Mobile phone, RFID, etc)	Wander monitoring, Object finding
Text-to-voice	Speech synthesis	Overcome visual impairment or reading disability

2.1.1.2 Smart sensors

There is a technical and application continuum from nanotechnology to 'smart sensors'. As "Smart Sensors and Applications: Student Guide"^{vi} notes:

"Inside every smart sensor is one or more primitive sensors and support circuitry. The thing that makes a smart sensor "smart" is the additional, built-in electronics. The electronics make these sensors able to do one or more of the following:

- Pre-process their measured values into meaningful quantities
- Communicate their measurements with digital signals and communication protocols
- Orchestrate the actions of primitive circuits and sensors to "take" measurements
- Make decisions and initiate action based on sensed conditions, independent of a microcontroller
- Remember calibration or configuration settings"

This refreshingly honest description clearly identifies that smart sensors are in reality a miniaturized collection of components. That is all. The ability of such sensor systems to operate in the context of the Internet of Things is still dependent on mundane constraints such as processing capability, available power and communications range.

The novel feature of 'smart sensors' is that, with miniaturization, cost and convenience factors may become more attractive, and deployment of such technologies therefore becomes more attractive. As sensors and actuators become more complex they provide support for various modes of operation and interfacing. Some applications require additionally fault-tolerance and distributed computing; this sort of high-level functionality can be achieved by adding an embedded microcontroller to the classical sensor/actuator, which increases the ability to cope with complexity.

Smart sensing systems can share characteristics with conventional sensor systems that make them "smart", for example self-calibrating, adaptive, remote sensing, or using by one sensor to serve multiple functions, e.g. an optical sensor might detect activity, lighting levels, water flow, intruders, perimeter security, smoke, steam, fire, spillage, etc.

2.1.1.3 Nanotechnology

Nanotechnology (Nanotech) is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometres.

Nanotechnology brings the potential to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

In an ICT context the most likely use for nanotech seems likely to be as a means of instantiating the smallest traceable elements in the Internet of Things (motes or 'smartdust') and it is not impossible that biosensors or bioactuators embedded in such motes could become viable in the future.

As with many relatively new fields of endeavour there is a large amount of 'talking up' of the potential for nanotechnology. Whilst it is true that at the cellular level nanotech has significant potential as a mediator and delivery mechanism for drugs and biological intermediates it is more difficult to assess the benefits at the macro level of AAL.

Certainly, if nanotechnology enables materials to be made more lightly and with improved strength then the applications are not difficult to see. However, given the experience with other 'advanced materials'

like carbon fibre, it could be many decades before the costs become compatible with production at scale – and hence with everyday use. However, it is notable that, since 2006 the rate of publication on such technologies has slowed to a trickle, and that the warning of Kissinger in 2004 has perhaps been heeded^{vii}:

“It is unfortunate that so many people working in this area do not present a balanced view of alternatives for making the same measurements, often more reliably and less expensively with proven, readily available tools. Glucose is a fine example and a great success commercially. This degree of success is unlikely to translate to analytes where the concentration is 10–10,000 times lower and the market is 10–10,000 times smaller.

Nanotechnology already plays a role in infection control, self cleaning, rapid diagnostic devices.

Likewise, the advantages of miniaturization and portable instrumentation are often overstated. Biosensors are by definition not versatile. This is their strength, but also their substantial weakness.”

Alongside ‘conventional’ nanotechnology, use of surface chemistry and physics can have an important role in human-machine interaction by improving grip or slip characteristics for people with motor and sensing limitations.

2.1.2 Telecoms and networking

As with following technology sections it is hard to draw a distinct line between this and, for example, the Internet of Things or Smart Grid and Smart Homes. The interdependencies are considerable. However, for practical purposes telecoms and networking technologies can be regarded as the technical underpinnings upon which application-oriented technologies for Internet of Things, Smart Grid and Smart Homes can be built.

In this section we’ll therefore consider briefly (and, broadly, radiating from the user):

- body area networks;
- personal area networks;
- local area networks;
- virtual private networks;
- metropolitan area networks
- wide area networks;
- internet;
- mobile telephony;
- telephone network;
- professional mobile radio networks.

Near-field communication (NFC) will be dealt with under the Internet of Things heading (2.1.2.12), but is the most (deliberately) constrained by the network range currently available.

2.1.2.1 Body area networks

As the name implies, Body area networks (BAN) (sometimes known as wireless body area network (WBAN) or body sensor network (BSN)) are terms used to describe the application of wearable computing devices. This enables wireless communication between several miniaturized body sensor units (see Smart Sensors (2.1.1.2) and a single central unit worn on the human body (BCU).

Initial applications of BANs appeared primarily in the healthcare research domain, especially for continuous monitoring and logging vital parameters of patients. Other applications of this technology now include sports, military, and security. Extending the communication from PAN into a higher level network enables exchange of information between individuals, or between individual and machines. Currently the level of information provided and energy resources capable of powering the sensors and BCUs are limiting. While the technology is still in its early stages it is being widely researched but awaits the breakthrough in power or computational means to become viable at scale.

Piconets are similarly reach-constrained networks, but although originally envisaged as working on a very small scale, are now widely associated with ad-hoc computer networks using PAN technologies.

In the AAL context BANs are the current research focus for forwarding person-related measurements to PANs (2.1.2.2) and/or LANs (2.1.2.3).

2.1.2.2 Personal area networks

A personal area network (PAN) is a computer network used for communication among computerized devices available to an individual, including smart phones and tablets, printers, etc. PANs can also be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network and the Internet (an uplink).

A PAN may be carried over wired computer buses such as USB and FireWire (which, in order to achieve high speed data transfers have limited allowable lengths), but most PAN attention is now on wireless personal area networks (WPAN) carried over wireless network technologies such as IrDA, Bluetooth, Wireless USB, Z-Wave, ZigBee, or even Body Area Network. The reach of WPAN technologies currently vary from a few centimetres to a few metres.

Many PAN technologies are designed to permit ad-hoc computer networks, but some require a master node within a network, while others are designed to be resilient peer-to-peer systems. For the most part PANs permit only point to point communication and are highly constrained in the services that they will support. Nor are they quick to reach sufficient maturity for everyday use; the Bluetooth development cycle has, for example, taken over 20 years to reach its current stage.

A near-me area network (NAN) is a logical communication network that focuses on communication among wireless devices in close proximity. Unlike a LAN (2.1.2.3) the devices in a NAN can belong to different proprietary network infrastructures (for example, different mobile telephony carriers). Thus, although two devices may be geographically close, the communication path between them might traverse many network segments and technologies. NAN applications therefore focus on two-way communications among people within a certain proximity to each other, but don't generally concern themselves with those people's exact locations.

In the AAL context PANs are the current focus for enabling remote access to person-related measurements.

2.1.2.3 Local area networks

A local area network (LAN) is a computer network that interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media. The defining characteristics of LANs, in contrast to wide area networks (WANs), include their usually higher data-transfer rates, smaller geographic area, and lack of a need for leased telecommunication lines.

ARCNET, Token Ring and other proprietary technologies have been used in the past, but cabled Ethernet and wireless Ethernet (WiFi) are the two most common technologies currently used to build LANs.

A residential LAN provides communication between digital devices deployed in the home. In this context an important function is ability to share Internet access, often a broadband service provisioned by fibre-to-the-home or via Cable Internet access, Digital Subscriber Line (DSL) or mobile broadband by Internet Service Providers (ISPs). If an ISP only provides one IP address, a router including network address translation (NAT), proxy server software and typically a network firewall, allows several computers to share the external IP address. The router function may be assumed by a PC with several network interfaces, but a dedicated router device is more common, often including a wireless (WiFi) access point.

A storage area network (SAN) is a dedicated network that provides access to network accessible data storage. A domestic SAN device is typically accessible through the local area network (strictly it might better be termed a networked storage device), whereas a business SAN has its own network of storage devices that are generally not accessible through the local area network by other devices.

Some 'local' area networks can be extremely large, covering an entire campus – but they do share unified management policies across the network (see 2.1.2.5).

In the AAL context residential LANs will be important for providing secure local access to remotely provided services.

2.1.2.4 Virtual private networks

A virtual private network (VPN) is a technology for using the Internet or telephony network to connect computing devices to distant computer networks that would otherwise be inaccessible. Typically a VPN provides varying levels of security so that traffic sent through the VPN connection stays isolated from other computers on the intermediate network, either through the use of a dedicated connection from one "end" of the VPN to the other, or through encryption. VPNs can connect individual users to a remote network or connect multiple networks together.

For example, users may use a VPN to connect to their work computer from home and access their email, files, images, etc., or to another work computer at a distant site. VPN users get the impression of being directly connected to the central network wherever they are working.

In the AAL context VPNs may be important for providing secure access to remotely provided services.

2.1.2.5 Metropolitan area networks

The IEEE 802-2002 standard describes a metropolitan area networks as follows:

A metropolitan area networks (MAN) is optimized for a larger geographical area than a LAN, ranging from several blocks of buildings to entire cities. MANs can also depend on communications channels of moderate-to-high data rates. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations. MANs might also be owned and operated as public utilities. They will often provide means for internetworking of local networks.

In the AAL context MANs may be important for providing contextually appropriate access to locally provided services.

2.1.2.6 Wide area networks

A wide area network (WAN) is a network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.

The Internet (2.1.2.7) can be considered a publicly accessible WAN using infrastructure with shared ownership, whereas a VPN (2.1.2.4) is a WAN used for privately agreed purposes only.

In the AAL context WANs can probably be regarded as a transparent enabler (but with some constraints to reliable quality of service) with respect to global access to services.

2.1.2.7 Internet

The Internet is a global system of interconnected computer networks that use the Internet Protocol to serve users globally. 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, wireless and optical networking technologies. The Internet backbone refers to the principal data routes between large, strategically interconnected networks and core routers on the Internet. These data routes are hosted by commercial, government, academic and other high-capacity network centres, the Internet exchange points and network access points, that interchange Internet traffic between the countries, continents and across oceans.

Internet Service Providers participate in Internet backbone exchange traffic by privately negotiated interconnection agreements, primarily governed by the principle of settlement-free peering. The Internet

has no centralised governance in either technological implementation or policies for access and usage; each constituent network sets its own standards.

The Internet carries an extensive range of information resources and services, such as the inter-linked hypertext documents of the World Wide Web (WWW) and the infrastructure to support email.

Most traditional communications media including telephone, music, film, and television are reshaped or redefined by the Internet, giving birth to new services such as Voice over Internet Protocol (VoIP) and Internet Protocol Television (IPTV). Newspaper, book and other print publishing are adapting to Web site technology, or are being reshaped into blogging and web feeds. The Internet has enabled and accelerated new forms of human interactions through instant messaging, Internet forums, and social networking.

In the AAL context the Internet can probably be regarded as a transparent enabler (but with some constraints to reliable quality of service) with respect to global access to services. However, Internet isolation is a characteristic of many disabled and older adults (3) and will require positive action if the Internet is to play a neutral role.

In spite of the challenges the Internet comes closest to providing a ubiquitous infrastructure for mainstreaming of AAL applications.

2.1.2.8 Mobile telephony

Mobile telephony is the provision of telephone services to phones which may move around freely rather than stay fixed in one location. Mobile phones connect to a terrestrial cellular network of base stations (cell sites), whereas satellite phones connect to orbiting satellites. Both networks are interconnected to the public switched telephone network (PSTN) to allow any phone in the world to be dialled.

In 2010 there were five billion mobile cellular subscriptions globally (more than half the global population), and by 2012 six billion mobile phone subscriptions, plus one billion smart phone subscribers,² which makes the mobile phone the most widespread technology and the most common electronic device in the world.

In the AAL context the mobile telephony can probably be regarded as an enabler (but with some constraints to nature and quality of service) with respect to access to services. However, non-mobile use is still common amongst disabled and older adults (3) and will require action if the mobile telephony is to play a neutral role.

Regulatory constraints on roaming arrangements for the licensed operators in the UK limit significantly its utility for AAL³.

2.1.2.9 Telephone network

The public switched telephone network (PSTN) is the network of the world's public circuit-switched telephone networks.

² Does not equate to users because some subscribers will have more than one device

³ When operator licences were issued in the UK roaming between operators was restricted together with sharing of infrastructure. The rationale behind this was to encourage both competition between operators and the build out of the UK network. As a consequence, the coverage of individual operators varies significantly from one to another, particularly in areas of low population density and when considering indoor coverage. This has two significant consequences:

1 If one network is blocked by demand or equipment failure calls will not failover to another network.

2 The limited information available outside of the operator on coverage means that providing the correct choice of network for a telecare user demands field surveys with some degree of skill and knowledge.

This is a time consuming, costly and rather big ask for a telecare operator.

Clearly there are devious ways around this (it is not a problem for SIMS sourced outside of the UK) but this introduces other issues for governance and politics.

Originally a network of fixed-line analog telephone systems, the PSTN is now almost entirely digital in its core and includes mobile as well as fixed telephones. It now consists of telephone lines, fibre optic cables, microwave transmission links, cellular networks, communications satellites, and undersea telephone cables, all inter-connected by switching centres, thus allowing any telephone in the world to communicate with any other.

In the AAL context public fixed analog telephony could probably be regarded as transparent with respect to access to services. However, with the introduction of digital PSTN, local policies (or sometimes their absence) in private and public service networks may introduce some constraints and limitations.

2.1.2.10 Professional mobile radio

Professional mobile radio (also known as private mobile radio (PMR) in the UK and land mobile radio (LMR) in North America) are field radio communications systems which use portable, mobile, base station, and dispatch console radios. PMR radio equipment is generally designed for dedicated use by specific organizations, but is also available for general commercial use. Typical examples are the TETRA radio systems used by police forces, fire brigades, and ambulance. Key features of professional mobile radio systems may include:

- Point to multi-point communications (as opposed to cell phones which are conventionally point to point communications);
- Push-to-talk, release to listen — a single button press opens communication on a radio frequency channel;
- Large coverage areas (unlike walkie-talkies);
- Closed user groups;
- Use of VHF or UHF frequency bands (TETRA primarily uses frequency at 380 – 390 MHz in the UK).

However PMR standards are analogue using shared channel whereas digital standards (TETRA, TETRAPOIL, ACPO25) are digital systems designed for emergency service use offering security and management facilities. All of these systems have limited capacity based upon design which did not envisage the current level of demand for non-voice information.

In the AAL context professional mobile radio may offer valuable features with respect to rapid and secure access to services, but accessing these features may carry a significant management overhead.

2.1.2.11 New technologies

The remainder of this section describes the technologies that could be regarded here as 'new'. New could be an applicable term here either because the technology is truly emergent or, more commonly, because an existing, perhaps relatively new, technology has not yet been adopted for the purposes of enabling Ambient Assisted Living.

The technology groupings used below are used more because of their linkage in public consciousness than because they represent related clusters of engineering.

2.1.2.12 Internet of Things

The Internet of Things (IoT) refers to uniquely identifiable objects (things) and their virtual representations in an Internet-like structure^{viii}. There has been a tendency, as with most new technologies, to overstate its capabilities by deliberately claiming some of the added value that can be achieved by using combining it with other, more established, technologies. In principle, such added value can be achieved whether IoT is used or not – though the new technology may bring benefits of cost, form-factor or ubiquity.

2.1.2.13 Automatic identification and data capture

Automatic identification and data capture (AIDC) refers to the methods of automatically identifying objects, collecting data about them, and entering that data directly into computer systems (i.e. without human involvement).

Technologies typically considered as part of AIDC include bar codes, Radio Frequency Identification (RFID), smart cards, magnetic stripes, Optical Character Recognition (OCR), biometrics (e.g. fingerprint, iris or facial recognition), and voice recognition. QR codes in particular have enjoyed widespread application and uptake since their development from linear bar codes in the 1990s.

AIDC is also commonly referred to as "Automatic Identification," "Auto-ID," and "Automatic Data Capture."

For convenience it is useful to discuss the overall Automatic Identification and Data Capture as to topics Automatic Identification and then Data Capture. Automatic Identification may be regarded as identification of imputed attributes, whereas Data Capture is dependent on recognizing inherent (e.g. a fingerprint) attributes and linking these to imputed attributes (e.g. an identification number).

2.1.2.13.1 Automatic Identification

2.1.2.13.1.1 Barcode

A barcode is an optical machine-readable representation of data relating to the object to which it is attached. The familiar strip barcodes represent data by varying the widths and spacing of parallel lines, and are generally referred to as linear or one-dimensional (1D). More recently, these have evolved into rectangles, dots, hexagons and other geometric patterns in two dimensions (2D). Although not strictly 'bar' codes, 2D symbologies are generally also referred to as barcodes and, most recently, as QR codes. Barcodes originally were scanned by dedicated optical scanners (barcode readers); much more recently scanners and interpretive software have become available on multi-purpose devices including desktop printers and smart phones.

2.1.2.13.1.2 Radio frequency identification

Radio frequency identification (RFID) is a relatively new AIDC technology although first developed in the 1980's. The technology uses tags (active or passive) as the means of identification, which then enable automated data collection and analysis systems. RFID has found application in a wide range of markets for high value items including livestock identification and vehicle identification, in part because of its capability to track moving objects. Whilst RFID is effective in some harsh environments where barcode labels could not survive, it is susceptible to interference in extreme thermal and electromagnetic conditions.

2.1.2.13.1.3 Smart cards

A smart card, chip card, or integrated circuit card (ICC) is any pocket-sized plastic card with an embedded integrated circuit. Smart cards can provide identification, authentication, data storage and application processing. Smart cards may provide strong security authentication for single sign-on (SSO) within large organizations – such the so-called Chip and PIN system used by credit cards globally.

Most such cards are read by insertion into machines with electrical contacts, newer contactless cards rely on short-range radio communication (near-field communication, NFC)

Smart cards are used as the subscriber identity module or subscriber identification module (SIM) in mobile telephones. A SIM card contains its unique serial number (ICCID), international mobile subscriber identity (IMSI), security authentication and ciphering information, temporary information related to the local network, a list of the services the user has access to and two passwords: a personal identification number (PIN) for ordinary use and a personal unblocking code (PUK) for PIN unlocking. Combined with some memory and microcontroller capability these smart cards contain the operating system of the card and might contain the so-called personalisation, which consists of security keys, phone book, SMS settings, etc., and operating system patches.

Developments of this SIM approach have led to cashless banking in sub-Saharan Africa, and contactless technologies are extensively used for payment and ticketing applications such as public transport and motorway tolls.

Standardisation and volume application has made this technology both robust and affordable.

2.1.2.13.1.4 Magnetic stripe

A magnetic stripe card is a type of card capable of storing data by modifying the magnetism of tiny iron-based magnetic particles on a band of magnetic material on the card. The magnetic stripe, sometimes called swipe card or magstripe, is read by swiping past a magnetic reading head.

It is a development, originally by IBM in 1960, of recording tape technology. Although lower cost than RFID or SIM technologies it does not have the data capacity of those newer technologies and although used widely, could now be regarded as of little significance for AAL purposes.

2.1.2.14 Automatic data capture

2.1.2.14.1 Optical character recognition

Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic conversion of scanned images of handwritten, typewritten or printed text into machine-encoded text. It is widely used for digitizing printed texts so that they can be electronically searched, stored more compactly, displayed on-line, and used in machine processes such as machine translation, text-to-speech and text mining.

Early approaches relied on programming with images of each character, and worked on only one font at a time; over time "Intelligent" systems with a high degree of recognition accuracy for most fonts have become common.

The technology is about one hundred years old and was originally developed for converting text into telegraph signals, and to create reading devices for the blind.

2.1.2.14.2 Biometrics (e.g. fingerprint, iris or facial recognition)

Strictly speaking, biometry is the application of statistical analysis to biological data, but the term biometrics is often used as shorthand for biometric signature – being the unique pattern of a bodily feature such as the retina, iris, or voice, encoded on (or, more commonly, linked to) an identity card and used for recognition and identification purposes^x.

Since biometric identifiers are unique to individuals, they are more reliable in verifying identity than token and knowledge-based methods; however, the collection of biometric identifiers raises privacy and consent concerns about the ultimate use of this information.

Many different aspects of human physiology, chemistry or behaviour can be used for biometric authentication but no single aspect will meet all the requirements of every possible application. Iris recognition, developed by Daugman in the UK, is widely recognised as very reliable. However, the selection of a particular biometric for use in a specific application involves a weighting of several factors. Jain et al. (1999)^x identified seven such factors:

- **Universality:** every person using a system should possess the trait;
- **Uniqueness:** the trait should be sufficiently different for individuals in the target population such that they can be distinguished one from another;
- **Permanence:** a trait with 'good' permanence will be reasonably invariant over time with respect to the specific matching algorithm;
- **Measurability** (collectability): the ease of acquisition or measurement of the trait, including the extent to which it permits subsequent processing and extraction of the relevant feature sets;
- **Performance:** accuracy, speed, and robustness of technology used;
- **Acceptability:** how well individuals in the relevant population accept the technology such that they are willing to have their biometric trait captured and assessed.
- **Circumvention:** the ease with which a trait might be imitated using an artefact or substitute.

As the name implies, Multimodal Biometrics use a combination of different biometric recognition traits to compare the identity of the person. So, in the case of a system using three technologies if one of the technologies is unable to achieve identification, the system can still use the other two to accurately

identify. By requiring matching to more than one trait, multimodal technologies can impose high levels of security.

The field of biometrics is developing fast, in part triggered by concerns about countering terrorism, and it is this aspect of its use that causes most concerns about privacy – especially when this data is combined with other involuntary tracking data such as attribution of IP addresses or SIM locations. Governments, and others, are not keen to discuss what are often termed ‘sources and methods’, which does little to the placate fears of some about covert surveillance. For this reason, most nations will need a reasoned debate about these issues if biometric identification is to be used widely in an AAL context.

New approaches to biometric authentication, such as palm-vein reading or based on brain (electroencephalogram) and heart (electrocardiogram) signals are emerging as having potential to avoid the privacy problems associated with other types of marker (e.g. facial recognition) that are more easily collected covertly. However, more work is needed before they are used widely.

2.1.2.14.3 Voice recognition

In computer science, speech recognition (SR) is the translation of spoken words into text, whereas voice recognition refers to finding the identity of the speaker, rather than what is being said.

Recognising the speaker can simplify the task of translating speech in systems that have been trained on specific person's voices or it can be used to authenticate or verify the identity of a speaker as part of a security process.

Whilst voice recognition has wide potential application to AAL for security purposes, speech recognition has significant potential for some types of disability, e.g. where use of a mouse, keyboard and/or screen is difficult.

Most modern personal computing systems have some embedded speech recognition capability, and some include voice user interfaces such as voice dialling (e.g., "Call home"), call routing (e.g., "I would like to make a reverse-charge call"), domotic appliance control, search (e.g., find a podcast where particular words were spoken), simple data entry (e.g., entering a credit card number), and speech-to-text processing (e.g., word processors or emails).

Until quite recently techniques relied on segmenting speech into recognised sections and applying hidden Markov models and statistics to produce text conversions^{xi}. New approaches are emerging which further develop the process and hold out some prospect of better performance. Speaker recognition and speaker independent speech recognition present different challenges.

2.1.2.15 Internet of Things in Ambient Assisted Living

In the AAL context the Internet of Things offers scope for either enabling a person without direct manual intervention, to undertake activities of daily living. As with other internet based activity the accessibility of the participating systems to unintended users will have to be managed carefully.

Recent work published by the UK TSB^{xii} has usefully identified some of the major business, cultural, social and creative, as well as technical, challenges that remain to be overcome in making the IoT anything the performant ubiquitous infrastructure propounded by many technical interests. Many of the challenges are strikingly familiar within the more constrained AAL scope, see Figure 4 overleaf.

2.1.3 Domotics

Sometimes called ‘Home Automation’, domotics is automation of the home, housework or household activity. Domotics may include centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security. Domotics for older adults and the disabled can provide aids for persons who might otherwise require caregivers or institutional care.

The popularity of domotics technology has been increasing in recent years due to greater affordability and simplicity of control – in part through smart phone and tablet connectivity. The concept of the "Internet of

Things" is linked closely with the popularization of home automation, though this is something of an over simplification.

It takes little imagination to envisage the benefits to a person with mobility or dexterity problems of being able to control door opening, room temperature, lighting and window blinds from a bed or wheelchair. Similarly, for a person with dementia, the ability of a carer to remotely check the state of doors and domestic appliances could save time and cost, and alleviate stress.



Figure 4: TSB IoT_report topics

2.1.4 Smart homes

A Smart home is^{xiii} a dwelling that has highly advanced automatic systems for lighting, temperature control, multi-media, security, window and door operations, and many other functions.

A smart home appears "intelligent" because its computer systems can monitor so many aspects of daily living. For example, the refrigerator may be able to inventory its contents and order groceries. Although this example would, hopefully, be mediated by some human choice, smart home technology is a reality, and is becoming increasingly sophisticated. For most existing systems coded signals are sent through the home's electrical supply wiring to switches and outlets that are programmed to operate appliances and electronic devices in every part of the house. As the internet of things impinges on the established smart home technology it is probable that the control aspects of systems will become increasingly dependent on the internet at the level of the devices themselves – rather than at the control hub as at present.

Home automation technologies are viewed by some as integral additions to the Smart Grid (see 2.1.5). The ability to control lighting, appliances, heating, ventilation and air conditioning (HVAC) as well as Smart Grid applications (load shedding, demand response, real-time power usage and price reporting) will become vital as Smart Grid initiatives are rolled out. Green Automation is the term sometimes used to describe energy management strategies in home automation when data from smart grids is combined with home automation systems to use resources at either their lowest prices or highest availability, taking advantage, for instance, of high solar panel output in the middle of the day to automatically run washing machines.

2.1.5 Smart grid

Interpretation of what a Smart grid means or constitutes has still not reached solid consensus. For most purposes associated with governmental incentives to make better use of limited and expensive energy resources it is related to the ability to better manage the electrical power distribution network. To adopt the description used by NIST^{xiv}: "a modernized grid that enables bidirectional flows of energy and uses two-way communication and control capabilities that will lead to an array of new functionalities and applications." Unlike today's grid, which primarily delivers electricity in a one-way flow from generator to outlet, the Smart Grid will permit the two-way flow of both electricity and information.'

As hinted in 0 some would wish to include the in-home use of power under the smart grid umbrella, while others would widen the distribution network aspects to include other utilities such as gas and water. Some of this scope creep seems to be motivated by the availability of large sums of grant money to work on the 'smart grid'. It is perhaps safest to regard the scope, in the first phases of work, being as NIST describe it.

What is the relevance of Smart grid to AAL? There is no immediately obvious relationship, but the availability of information related to a person or equipment in some premises to those beyond those premises can be mediated by smart meters.

While most smart meters at present simply permit remote reading, in some instances data unrelated to equipment use (as well as that associated with energy consumption) can be conveyed as digital data over power lines to the utility company. In other instances the smart meter in a home may be equipped with a microcontroller with mobile phone technology for communication; a project funded under the Assisted Living Innovation Platform (Project Hydra) has demonstrated how assisted living data can be transmitted over Smart Meter infrastructure^{xv}. A new large-scale deployment in the UK is testing the value of this approach for embedding AAL^{xvi} technology into energy and care provision practice. .

2.1.6 Smart cities

Cities are vital to the future global economy. It has been estimated that in 2008, for the first time in human history, more people lived in urban areas than rural and that by 2050 more than 70% of the global population will live in cities.

Cities are more economically productive, and have a lower carbon footprint per capita than their sub-urban average, but are also struggling with climate change, changes in population and demographics, congestion, healthcare and pressure on key resources. To succeed in the future, city governments have to deliver economic activity and quality of life with a lower environmental footprint.

2.1.6.1 Smart city theory

Smart cities can, according to Giffinger et al^{xvii}, be identified (and ranked) along six main axes, being: a smart economy; smart mobility; a smart environment; smart people; smart living; and, finally, smart governance. These six axes are said to connect with traditional regional and neoclassical theories of urban growth and development, the axes are apparently based - respectively - on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

High-quality city infrastructure is essential to meeting this future need, but it is becoming increasingly clear that fast enough progress cannot be made by optimizing the individual components and systems of

the city. Integrated and city-wide solutions are required that maximize the benefits of big cities, whilst managing the downsides to deliver efficient, attractive and resilient cities.

City-wide integration is a complex challenge with many risks, so it is unlikely that any one city will, in isolation, be able to implement a fully comprehensive metastructure in an economically viable manner. Wide take-up of new solutions will require extensive evidence of performance in use to validate techniques and to build confidence.

For the purposes of this report we can probably put to one side most of the constructs; which should allow concentration on the ICT and quality of life aspects, although these clearly relate back to the other, notably sociological and economic, axes.

The concept of a city where technology is ubiquitous and fully ambient (in that it is an assumed part of life, and not an addition) is to some a seductive and liberating vision, while to others it is a constraining and stultifying nightmare. The difference is in people's ability to use the technology in order to benefit from it (a concept termed 'absorptive capacity' 3.2). When social and relational issues are not properly taken into account, social polarization may result; and the possible class (ability and age) inequality effect of policies aimed at creating smart cities is not resolved^{xviii}.

Godschalk presents a comprehensive and cogent argument for more effort to be invested in creating resilient communities – both at the 'hard infrastructure' level as well as at the societal level^{xix}. He went on to cite the work of Bolin and Stanford^{xx} in saying 'the most vulnerable are those whose lives are the most constrained, such as the poor, who have the least access to coping resources. [...] In effect, the poorest and most vulnerable communities within a city are the weakest links in its mitigation capacity. Here is an important opportunity to integrate hazard mitigation with economic development and social justice, achieving the multiple objectives needed for a resilient system.'

In applying this advice to AAL it is important not to forget the lessons that should be learned from the later section, Use of technology by older adults and disabled (3) — especially 3.2 Absorptive capacity, as applied to all of Table 3. In terms of most planning and infrastructure deployment, it translates to strategically clustering facilities designed to support the disabled and aged in areas where highest residence and resilience can be expected; almost exactly the opposite of the current situation. Strategically, there is little resilience that AAL can be expected to deliver unless it is implemented within an integrated locality strategy.

2.1.6.2 Smart cities in the AAL context

A truly smart city consists of more than good ICT infrastructure. However, recognizing that the possible influence of the assistive living technology sector is limited it is possible to hope that the evolution discussed later in '5, The future?', and particularly those related to Transgenerational design (5.3) will be influential within the context of focused societal expectations. This probably means that, for example, public transportation will become more accessible. Imagining buses (and bus stops) with sidewalk and stop position sensing, textural, audible and visual signalling of easy access doors and so on is not too difficult. Nor is it difficult to envisage analogous developments to public, then corporate and private built environments.

In the economic climate prevailing at the time at which this report is compiled it is possible to see these developments as either costly luxuries that a market economy cannot afford, or to see them as a means of providing incentives to technological investment in the future of society.

2.1.7 Robotics

According to Webster's dictionary^{xxi} robotics is technology dealing with the design, construction, and operation of machines (robots) in automation to perform tasks done traditionally by human beings. Robots are widely used in such industries as automobile manufacture to perform simple repetitive tasks, and in industries where work must be performed in environments hazardous to humans. Many aspects of robotics involve artificial intelligence; robots may be equipped with the equivalent of human senses such as vision, touch, and the ability to sense temperature. Some are now capable of simple decision making, and current robotics research is geared toward devising robots with a degree of self-sufficiency that will permit mobility and decision-making in an unstructured environment.

In the AAL context, the robotics has long been seen as offering scope for enabling a disabled person to undertake activities of daily living – or to have them undertaken on their behalf; much recent research has also been directed towards the development of social or companion robots. Some use has already been made in post-traumatic injury of robotic prosthetics with a degree of neurological control of the prosthetic being possible. As with other computer-based activity the accessibility of robots control systems to unintended users will have to be managed carefully.

2.1.8 Cloud computing

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet). The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams indicating the sharing of resources to achieve coherence and economies of scale similar to a utility (like the electricity grid) over a network.

Cloud computing users entrust remote service providers with their data, as well as with their software and computation provision.

In the AAL context cloud computing may offer valuable access to services not available locally – but users will need to be aware of who owns their ‘private’ data, and what rights they have to control of that (see Social networks, 2.1.9).

2.1.9 Social networking services

A social networking service is an online service, platform, or site that facilitates the building or consolidation of individual networks or social relations among people who, for example, share interests, activities, backgrounds, or other connections.

A social network service consists of a representation of each user (often a profile), his/her social links, and a variety of additional services. Most social network services are web-based and provide means for users to interact over the Internet, such as e-mail and instant messaging.

Online community services are sometimes considered as a social network service, though in a broader sense, social network service usually means an individual-centred service whereas online community services are group-centred.

A 2011 survey by Bloomberg found that 47% of American adults use a social network. However, almost all social networking services use the activity of ‘members’ as the basis for financing their service provision. In some cases this is by advertising, in others it is by selling access to personal data contributed by members.

In the AAL context social networking service may offer valuable social interaction – but, again, users will need to be aware of who owns their ‘private’ data, and what rights they have to control of that (see Cloud computing, 2.1.8).

2.1.10 Augmented reality

Augmented Reality On^{xxii} defines augmented reality as a demonstration of computer generated virtual characters/object on a live view of the real world.

As the author there points out, “we already know what augmented reality is, we just might not know it is called augmented reality.” An example is the score board displayed on television screen when we watch sports and games. In live sports broadcasts we can see the replay, which usually uses a graphical line that demonstrates the path of the ball. It is a composite view that is the combination of real world view and a virtual graphical line generated by a computer.

By addition of specialist hardware and software it is possible to augment a screen image with a user-related image (maybe from a body-worn camera) – or vice versa.

In the AAL context augmented reality offers scope for either enhancing a person's activities^{xxiii} or for prompting to undertake activities that may have been overlooked, see 2.1.11 Gaming.

2.1.11 Gaming

Electronic (including video) gaming, whether using local equipment or online, has become a huge consumer leisure industry in recent years and appeals to a wide range of ages with a spectrum of physical and mental ability states. Much of this equipment already brings together an array of different sensor types in order to produce a more immersive experience or to enable more intuitive control of the game elements.

There is a growing body of work^{xxivxxvxxvi} that indicates that engagement in mental activity such as game playing may be beneficial in ensuring that cognitive abilities can be maintained or improved by exercising the brain, in the same way that physical fitness is improved by exercising the body^{xxvii}.

An alternative approach is to use the activities involved in game playing to establish the achievement levels within the context of the game. This approach has been used with some success to provide personally-managed physiotherapy, for example for cystic fibrosis^{xxviiixxix}.

In early 2012, the White House Office of the National Coordinator for Health Information Technology and the White House Office of Science and Technology Policy hosted a group of game designers, researchers, and government officials to explore the potential for games to improve health and health care. Their discussion focused on three areas:

- Understanding the current landscape of games and health;
- Identifying areas where game dynamics and health needs could intersect to improve health outcomes in the future;
- Identifying areas where the federal government could play a role in promoting innovations in health games.

The report "Innovations in Games: Better Health and Health Care Report"^{xxx} summarizes the key discussion points from the day.

In the AAL context, game-playing and its associated console and display equipment perhaps represents the most attractive technical means to achieve longer active life, both directly and as a locus for other AAL functions and equipment^{xxxi}, see 0.

2.1.12 Location awareness

Location awareness refers to devices that can passively or actively determine their location. Navigational instruments provide location coordinates for vessels and vehicles. Surveying equipment identifies location with respect to the known location of a wireless communications device. Network location awareness (NLA) describes the location of a node in a network.

Location awareness is supported by navigation systems, positioning systems and/or locating services. Most location-aware systems use coordinates in a grid (for example using distance metrics and lateration algorithms) to determine and track relative positions. Most location aware systems are currently focused on the horizontal plane, but as wireless network nodes become more closely located then resolution of terrestrial vertical positioning has become more common.

While location awareness began as a matter of static user location, the notion was extended to reflect movement. Context models are emerging to support location-aware applications which use location to tailor interfaces, refine application-relevant data, increase the precision of information retrieval, discover services, make user interaction implicit and build smart environments.

Outdoor location awareness is achievable by more than just GPS (satellite); other outdoor location systems are also available that utilise the mobile phone networks and use algorithms based on propagation characteristics. Indoor location systems can be based on infra red sensor systems or e.g. on ultra sound; see the ALIP Personal and Social Communication Services for Health and Lifestyle Monitoring (PAL) project^{xxxii}.

In the AAL context location-aware offer scope for tracking materials and people to ensure that they are in safe or intended environments. It has a role in the context of urban interfaces such as road crossings, public transport use and access to retail services. As with other internet based activity the accessibility of the participating systems to unintended users will have to be managed carefully

2.1.13 Ambient intelligence

Ambient intelligence (AmI) enables and facilitates participation by the individual in society, in a multiplicity of social and business communities, and in the administration and management of all aspects of their lives, from entertainment to governance.^{xxxiii}

Ambient intelligence is closely related to the long term vision of an intelligent service system in which technologies are able to automate a platform embedding the required devices for powering context-aware, personalized, adaptive and anticipatory services.

In the AAL context Ambient intelligence offers potential for enabling a person to undertake activities of daily living in a context-aware manner. As with other internet based activity the accessibility of the participating systems to unintended users will have to be managed carefully.

2.1.14 Collective intelligence

Collective intelligence is a shared or group intelligence that emerges from the collaboration and competition of many individuals and appears in consensus decision making. The ability of new media to easily store and retrieve information, predominantly through databases and the Internet, allows it to be shared easily. Thus, through interaction with new media, knowledge easily passes between sources^{xxxiv} resulting in a form of collective intelligence. The use of interactive new media, particularly the internet, promotes online interaction and this distribution of knowledge between users.

In the AAL context collective intelligence offers potential for enabling a person to participate in consensus formation on matters that might directly affect them - <http://www.patientslikeme.com> is a good example. As with other internet based activity, users will need to be aware of who owns their 'private' data, and what rights they have to control of that (see Cloud computing, 2.1.8).

2.1.15 Security

There are two distinct aspects of Security that we should consider.

Firstly, the personal, physical, security of individuals and those that may have a role in caring for them; and secondly, the security of data owned by individuals and those that may have a role in caring for them.

2.1.15.1 Physical security

Many existing Home Automation systems are centred on or include property intrusion components. These usually consist of proximity sensors on building components such as doors and windows, and of infra-red movement sensors located so that intruders can be detected. With the advent of closed circuit TV at modest cost, and more recently, of IP-based cameras, triggered (by sensors) recordings of movement events have become commonplace.

Some of these systems are already integrated with telecare infrastructure (see 4.1), and some of these integrated systems are further integrated with telehealth provision (see 4.2). The expansion of capability based on these established technologies has further potential in the context of AAL.

2.1.15.2 Data security

The term data security means ensuring that collective processes and mechanisms protect sensitive and valuable information and services from publication, tampering or collapse by, respectively, unauthorized activities, untrustworthy individuals and unplanned events.

In a number of preceding sections we have mentioned the security of personal data in the AAL context. Many countries have privacy legislation that relates to access to and use of personally attributable data. Most such legislation is not coordinated (e.g. requirements of EU law are not provided for in the USA). For health-related data there is often additional sensitivity, and for data related to vulnerable persons there is the practical need to protect them from opportunistic use of public data to perpetrate fraud.

The Caldicott² review of information governance in the NHS, 'Information: to share or not to share'^{xxxv}, recommends a new duty to share information when it is in the interest of the patient. Dame Fiona Caldicott has said that some organisations were trying to share patient information, but that management sometimes acted as a barrier; "We certainly heard about agreements between health and social care organisations which laid the basis for information sharing, but then it didn't happen because someone at managerial level said 'no you can't do that, it's too dangerous', " she said.

2.1.15.3 Summary

AAL potentially brings together a diverse range of different technologies. It picks up developments from different sectors and applies them in a new context.

Although the mobile industry are investing in "mhealth", in the AAL context game-playing (2.1.11), and its associated console and display equipment, is perhaps the least explored technical means to achieve longer independent active life both directly and as a locus for other AAL equipment. Much game-playing equipment already brings together an array of different sensor types in order to produce a more immersive experience or to enable more intuitive control of the game elements. Its huge consumer market volumes mean that prices are low (for the amount of technology packaged) and they are presented in form factors that appear to be acceptable to many households. This area is explored in more detail in 5.

2.2 New materials

It is worth investigating this topic briefly because it has potential to enable dramatic changes to the way in which assistive equipment is constructed, or behaves; indeed in some areas such as wheelchairs and orthotics it is already doing so. The potential, though, is much greater.

2.2.1 Composite materials

Composite materials are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct within the finished structure^{xxxvi}.

Wattle and daub is one of the oldest man-made composite materials, and concrete is also a long-used composite material. Modern examples of a composite would be disc brake pads, which consist of hard ceramic particles embedded in soft metal matrix, shower stalls and bathtubs made of fibreglass (glass fibre matting and a plastic resin), or in semiconductors where, for example, phosphorus or arsenic (N-type) or boron or gallium (P-type) is added to the silicon crystal lattice.

2.2.2 3D printing

3D printing, commonly known as 'Additive Manufacture,' is a form of rapid manufacture or prototyping where items are made layer by layer without the use of moulds. 3D printing is distinct from traditional machining techniques (subtractive processes) which rely on the removal of material by methods such as cutting and drilling.

There are many forms of additive manufacture which all work in slightly different ways, but essentially they all follow the same principles. Each different method has its advantages and drawbacks, whether it be better surface finish, better strength for working prototypes or full colour product for display models. 3D printing is usually performed by a materials printer using digital technology.

All 3D printers work from the bottom of the item up. The first layer is placed down on the build tray. Rather like an inkjet printer, the machine 'draws' a cross section of the item across the X and Y axis in

one plane. Once this plane has been completed, the build tray is lowered (i.e. the model moves down the Z axis) by a fraction of a millimetre and the process of drawing out another layer on the X and Y axis is repeated. This is performed repeatedly until the entire item has been built.

For any part of the model where there is an overhang or gap between moving parts, a support material is laid down. Once the print has finished the support material is then removed to reveal the completed item.

The technology is now used routinely in the jewellery, footwear, industrial design, architecture, automotive, aerospace, dental and medical industries.

2.2.3 Summary

In 2012 research groups were examining 3D printing technology for possible use in tissue engineering applications where organs and body parts. 3D printing can now produce a personalized hip replacement in one pass, with the ball permanently inside the socket; at available printing resolutions the unit does not require polishing.

A proof-of-principle project at the University of Glasgow, UK, in 2012 has shown that it is possible to use 3D printing techniques to create chemical compounds, including new ones and Cornell Creative Machines Lab reported that with 3-D Hydrocolloid Printing method customized food production is possible.

Used in combination with 3D scanning techniques^{xxxvii} to produce 3D design files prosthetics are already being produced. However, bearing in mind the possibility of creating composite prints from materials with different characteristics, it is not difficult to envisage prosthetics capable of acting as smart objects containing the neuromuscular sensors that would facilitate actuation of their host prosthetic. Similarly, the ability to dope 3D prints could enable all manner of new user interfaces that may begin to address some of the conventional problems of users with functional disabilities

3 Use of technology by older adults and disabled

Much existing technology aimed at enabling Ambient Assisted Living has been focused on alerting carers to falls by those already identified as being at risk. Unfortunately many first falls are severe, but are the first indication of significant frailty and risk.

More recent technologies have been aimed at warning of risky behaviour and have some application in dementia.

The significant, but tractable, challenge is to ensure that as these technologies improve and become less obtrusive such that they are acceptable in a normal 'ambient living' context, and are not seen as signals of disability. This shift in perception could make it easier for relatives, friends, carers and statutory bodies to propose use of assistive technologies preventatively.

Table 3 below shows user groups that have problems using ICT as a percentage of the European population^{xxxviii}. This emphasizes that much impairment is expressed as shared problems; in this instance with ICT.

Table 3: User groups that have problems using ICT

User group with problems using ICT	Percentage of population in Europe
Hard of hearing	6
Cannot walk without aid	5
Intellectually impaired	3

User group with problems using ICT	Percentage of population in Europe
Reduced strength	2.8
Low vision	1.5
Reduced coordination	1.4
Dyslexic	1
Language impaired	0.6
Blind	0.4
Wheelchair user	0.4
Speech impaired	0.25
Cannot use fingers	0.1
Cannot use one arm	0.1
Deaf	0.1

In addition to the above groups there are groups for which it is difficult to obtain reliable statistics such as people with allergies. Also, there are many people who simply dislike or distrust technological systems.

"Consumers and the communications market report - Focus on consumers aged 65 and over"^{xxxix} looked at how consumers with a disability under 65 compare with consumers in the UK overall. Findings include:

- Consumers under 65 with a disability have higher levels of ownership than other groups, but more likely to have difficulties using technology;
- Less likely to have a landline or internet access at home;
- More likely to live in a 'mobile only' household;
- More likely to have visual, hearing or mobility difficulties using TVs, PCs, landline or mobile phones (TVs cause biggest difficulties, with main problems relating to hearing);
- The gap between those with a disability under 65 and UK consumers overall in respect to home internet access is widening;
- Broadband ownership has increased, but still a gap with the rest of the UK;
- Those aged under 65 and with a disability are less likely to use the internet for purchasing goods, finding information for work and banking;
- Around one in five consumers under 65 with a disability have or say they would be likely to have difficulties with mobiles, TVs and landlines;
- Ownership of digital TV has increased and remains in line with the UK average.

Although the numbers associated with these factors may have changed since it was undertaken in 2007, they indicate, taken with those in the table, that there are a number of assumptions often made about the likely access of those needing 'ambient living' technology that are not, in reality, valid:

- All households have (or will soon have) access to a landline or high speed internet at home;
- Use of common technologies such as telephones, televisions computers and remote controls is becoming more difficult as they become more compact and increasingly rely on touch (rather than press button or rotary) controls;
- The impact of global economic recession since 2007 has made it less likely that the costs of assistive technologies will be seen as priorities by users and carers — although the benefits are potentially life-enhancing and cost-saving.

These simple lessons will need to be learned, and that learning embedded in products, before technology will actually start to have the impact that its proponents have envisaged.

3.1 Isolation

It is known that older adults may see a change in social networks brought about by physical disabilities and illness or the loss of personal means of transport^{xi}. Research in the United States has also shown that as many as two-thirds of older persons there are isolated from the much of society, with those who live alone, and those who have health problems, more likely to be isolated^{xii}. Other studies have shown that isolation and lack of connectedness to others are predictors of morbidity and mortality^{xiii}.

However, other research has shown a positive relationship between the quality and frequency of interaction that older adults have with others, and their life satisfaction^{xiiii}, and others have shown that the effects of isolation and loneliness may be reversible through re-socialization and communication^{xiv}.

A danger with Domotics and AAL facilities that are tied to the home is that the user may also be effectively, but unintentionally, restricted to their home. It is therefore important that AAL provision should exist outside the home so that those who might lapse into isolation are enabled to remain engaged with extra-mural activity to the maximum extent possible. In an ideal world such extra-mural AAL provision would be available before a person becomes isolated. In practice the challenges are such that we have not yet seen this happen to a great extent in the ICT-enabled space – though changes in societal expectations^{xlv} about physical access and assistance have brought about very significant changes in those areas in the last 20 years or so.

3.2 Absorptive capacity

Absorptive capacity is a term used in business administration and defined as "... ability to recognize the value of new information, assimilate it, and apply it ...". Typically it is applied at individual, group [social unit?], firm [city?], and national levels. It assumes prior knowledge and communication. It has been said that innovation, aspiration, and learning capability improve absorptive capacity^{xlvi}.

Zahra and George propose four^{xlvii} indicators for each element of absorptive capacity:

- Knowledge acquisition capability
- Assimilation capability
- Transformation capability
- Exploitation capability

Sadly, therefore, we see that when the bold aspirations of those proposing new assistive technologies are compared to the abilities of those who might benefit most from ambient assistive technologies there is a stark mismatch.

This situation could be the cause for despair about our ability to cope well with those citizens whose abilities are declining. There seems to be little reason for hope that dramatic improvement in the capabilities listed above can be brought about for those in whom they are already diminishing.

An alternative, more optimistic, view would be to see the opportunity to embed assistive technologies in an ambient manner into all aspects of our environment, so that the necessary skills can be acquired whilst knowledge acquisition, assimilation, transformation and exploitation capabilities are at their highest.

This approach might be seen as relegating those currently suffering from disability and the effects of aging to a second class status. That is one possible consequence.

Another, more interventionist - and expensive, response would be to explicitly add more human care and assistance to the lives of those who are affected by disability and the effects of aging until the new cohort of technically savvy disabled and aged take their place.

4 Existing provision

Because any development of Ambient Assisted Living will be impacted by the legacy of existing provision for some or all of the at risk groups it is worth examining the current state of the market. Broadly, this can be divided into 4 groups – although there is some technology cross-over between groups and some users do or will consume services from all four:

- Telecare provision;
- Telehealth provision;
- Disability provision;
- Lifestyle assistance.

4.1 Telecare provision

The meaning and usage of the term 'telecare' has not yet settled into consistent international use⁴, but generally refers to the idea of enabling people to remain independent in their own homes by providing person-centred technologies to support the individual or their carers, and is different from telemedicine and telehealth. In the UK Telecare can be defined as a service that uses 'a combination of alarms, sensors and other equipment to help people live independently. This is done by monitoring activity changes over time and will raise a call for help in emergency situations, such as a fall, fire or a flood' (Department of Health 2009)

In the UK Telecare is grounded in the social care framework and focuses on the meaning described above. In other countries 'telecare' may be applied to the practice of healthcare at a distance.

Most telecare is intended to mitigate harm by enabling timely reaction to untoward events and by raising a help response quickly. The use of sensors may be part of a package which can provide support for people with illnesses such as dementia, or people at risk of falling.

Some telecare, such as safety confirmation and lifestyle monitoring can have a preventive function if some deterioration in the telecare user's wellbeing can be identified at an early stage, although use in this way is relatively rare. More normal practice in countries where telecare is in widespread use is to respond only to alarm conditions from the person's home – so it is almost always reactive.

The technologies are not generally very modern, and are poorly integrated with the normal life and style of most people's lives. In its most basic form, it uses a fixed telephone with a connection to a monitoring centre through which the user can raise an alarm from a body-worn pendant or risk area (e.g. shower cubicle) mounted pull cord. More advanced systems use 'activities of daily living' (ADL) sensors, by which actual events (such as falls, or environmental changes in the home such as floods, fire and gas leaks) or potential risks (such as door opening, or external climate changes) can be monitored.

Typically, when a sensor is activated it sends a radio (or cabled) signal to a central unit in the user's home, which then automatically calls a 24-hour monitoring centre where trained operators can take appropriate action, such as contacting a local key holder or the emergency services. Although many telephony systems are now IP-based, there remains a challenge in ensuring that existing and legacy equipment is fully IP compatible in a manner that retains or improves the quality of service.

In the AAL context, most telecare, as for disabled aids (see below), would benefit from better alignment to style-conscious modern life. Although in most delivery models there is enormous scope for improvement in the service delivery model itself, more embedded use of ambient ADL sensors could enable users to be reminded of overdue actions and potential hazards. For example smart stoves that could message a TV or radio with a reminder that food is now ready would prevent spoiling of food (and improve nutrition) as well as reducing the risk of fire.

⁴ We understand that in the USA this provision is known as Personal Emergency Response Systems (PERS).

4.2 Telehealth provision

If telecare is a problematic term, then telehealth is more so. It is perhaps worth putting it into a context, although within that context there are different regional preferences.

According to the WHO, **eHealth** is the combined use in the health sector of electronic communication and information technology (digital data transmitted, stored and retrieved electronically) for clinical, education and administrative purposes, both at the local site and at a distance^{xiviii}.

Within that broad eHealth category of functions then is **telemedicine** which WHO defines as the delivery of health care services, where distance is a critical factor, by health care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities. Telehealth accordingly falls within the WHO definition of Telemedicine.

In the UK **Telehealth** has can be defined as a service that ‘uses equipment to monitor people’s health in their own home... [monitoring] vital signs such as blood pressure, blood oxygen levels or weight ’ (Department of Health 2009).

Given the issues considered in 3 and the growth in mobile computing use, the above definition might be usefully updated to something like: “a service to monitor people’s health outside of a formal care institution, primarily but not exclusively at home” – but the purpose of such monitoring needs to be clear.

Telehealth has been described by the US Veterans Health Administration (VHA) Office of Telehealth Services as helping ensure that patients get the right care in the right place at the right time and aims to make the home into the preferred place of care, whenever possible^{xix}. The VHA then goes on to describe 3 groups of telehealth provision as follows:

- Home telehealth;
- Store-&-forward telehealth;
- Clinical video telehealth.

Whatever the shortcomings of their description and grouping their vision of Telehealth does have a clearly explained purpose.

4.2.1 Home Telehealth

For patients who have a health problem like diabetes, chronic heart failure, chronic obstructive pulmonary disease (COPD), depression or post-traumatic stress disorder, getting treatment can be complex and inconvenient.

For some, especially older, patients conditions like these can make it difficult for them to remain living independently in their own home and make it necessary for them to go into a nursing home where their symptoms and vital signs (pulse, weight, temperature etc) can be checked frequently. Having this information means physicians and nurses can change medications or other treatments and prevent serious health problems from developing.

Telehealth technologies that make it possible to check on symptoms and measure vital signs in the home using regular telephone lines. A care coordinator usually works with the patient to help them learn ways to self-manage their care needs and not to be dependent on frequent interaction with professional service provision. Some of the home telehealth devices that connect patients with their care coordination service can also provide information about health, the conditions and the various treatments that may be offered. Such home telehealth services and devices can make it possible to become more actively involved in self-managed care.

4.2.2 Store-&-forward Telehealth

In reality this is related to clinical video telehealth, except that, instead of an interactive consultation, data from a test is sent for remote asynchronous consultation. In the case of the VA this data is for clinical images such as for retinopathy, dermatology or radiology. Because most home telehealth data is actually

stored and then forwarded from the home to the care coordinator this grouping is a somewhat unhelpful distinction.

Unless a home is equipped with imaging equipment it is unlikely that this category of telehealth is relevant to AAL.

4.2.3 Clinical video telehealth

Clinical video telehealth (CVT) uses these telehealth technologies to make diagnoses, manage care, perform check-ups, and actually provide care.

These video technologies make it possible for patients to either stay in their own homes or to attend community-based outpatient clinics and connect to a specialist physician or other practitioner who may many miles away.

Clinical video telehealth means that instead of having the cost and inconvenience of travelling by to see a physician in a hospital or clinic the physician becomes 'telepresent' using technology similar to Skype. All conventional aspects of a consultation and the actions from it (prescription change, referral, etc.) can even be arranged through Clinical Video Telehealth. In most areas of the world these interactions would be thought of as telemedicine because they directly involve a medical professional.

4.3 Disability provision

There are many areas of disability provision and, in general, the unifying feature is their extremely utilitarian and unattractive presentation. This is often said to be because relatively small production volumes of each device need to be individually customized to the disability of the user. Some modern aids (e.g. mobility scooters) are more aesthetically pleasing, but this is often because the production volumes are large and individual adaptability is relatively limited.

At present, with the exception of the aids for those with sight, hearing and speech difficulties, and environmental controls most aids for disabled people have a very low ICT content; though as is noted in the sensors section (2.1.1) there is scope for considerable improvement by ICT in many mobility aids.

In the AAL context, most disabled aids would benefit from better alignment to style-conscious modern life. This alone would help grow markets and improve adoption. Addition of ICT capability to aids themselves would make the lives of disabled users simpler and less embarrassing (touch sensors on wheelchairs to prevent, or slow, collisions for example). However, there is considerable potential for adaptation at concept of many designs used by all the population. For example, rotating, and even extending, automobile seats could ease transfers for some physically people – but would also make dealing with infants in transferrable buggy seats easier for families. Similarly, kitchens or bathrooms designed with integrated grab ledges on worktops, or knee-holes for close working with chairs would be discreet but effective ambient adaptations, see 4.4.

4.4 Lifestyle assistance

Lastly, there is the emergent area of lifestyle assistance provision, the aim of which is to encourage healthy lifestyles such that problems associated with chronic, acquired illnesses and consequent disability do not arise.

This is mostly associated with self provision using 'apps' on mobile devices. Whilst attracting significant numbers of downloads from app repositories on the internet it is somewhat too early to have any data about the value and longer term effects of these tools. Nevertheless, the appetite apparently exists, if only transiently, amongst sections of the public to achieve some self-improvement in lifestyle choices.

4.5 Summary

We have seen that, in the AAL context, most disabled aids would benefit from better alignment to style-conscious modern life, and that integration with some ICT would ease the activity of daily living for users.

Similarly, if telecare were better integrated with mainstream devices, such as gaming, computers and TVs, it could be less dependent on old PSTN telephony and more able to adopt sensor technologies to help users.

On a market numbers basis telehealth is a subset of telecare – with more dependent users. For that reason the adoption of near-ubiquitous consumer technologies will be a requirement for market growth and user uptake. The difficulty in doing so is the need to accommodate the challenges which we noted in 3.

5 The future?

Predicting the development trajectory of new and emerging technologies is notoriously prone to error.

However, better healthcare has enabled people with innate or acquired disabilities to survive for longer, and for the rest of the population to live for longer without infectious diseases or accident curtailing life. This trend has created and ever-growing market in aids for disability; which is now a large, if sub-mature, business.

The rapid expansion in telephony through the second half of the 20th century enabled the slow development of home telecare services, and this has provided some of the basis for subsequent home telehealth development. The problem is that both markets have been slower to grow than anticipated by the small companies that have invested in product development. The reason for this is somewhat circular, but is primarily impacted by external factors.

5.1 Business models

Many companies innovating and developing in the AAL space are small. Most have a single idea and product, and a limited understanding of the wider market in which their product must fit. The EU AAL joint program has found that because of their size and commitment to their own niche product they tend to have problems in formulating an integrated offering, and building business models for sets of separate solutions is challenging¹. Large companies tend to have small divisions within their overall portfolio of activities, and these may well be cross subsidised by other aspects of the business, and may be seen as an extension of an ICT, pharma, health technology or consumer electronics based business. [Microsoft, Philips, GE, O₂, Pfizer, etc.]

In particular validation of value proposition has been difficult. The capability to create value for all players is a cornerstone of a sustainable AAL business model. Projects analysed faced problems in validation of value proposition; limitations in value proposition validation were identified in both the coverage and depth.

Validation coverage problems were identified in cases where value proposition was evaluated only from a limited point of view, for example from the viewpoint of an older adult. In such cases, important value network actors, such as family members or a service provider, were neglected in the validation process. Validation depth was an issue, if the development did not advance far enough in the validation process, i.e. concentrated on technical testing instead of an iterative value definition-validation-redefinition cycle. This re-validation mantra has generally been ignored because the technologies being used have been too immature and unstable to permit re-validation before a product has had to be launched in order to recoup development costs. Once launched, most small companies have not had sufficient capital to make investment in refining the product into a timely 'version 2' – and have had to concentrate on selling the immature 'version 1.'

The pressure to premature release has also made it difficult to fit consumer and industrial design phases into development.

5.2 Design

The products developed as aids for the disabled and to address home telecare and telehealth have lacked attractive design aesthetic and have been a poor fit to user desires. In general they have been

perceived as a stigmatising label instead of being a desirable, possibly fashionable, accessory. This has limited consumer acceptance, such that even those citizens that need assistance have rejected it because 'I'm not having one of those in my home!' The producers have underestimated the personal pride of the individuals that constitute their potential market.

This poor design ethic has been reinforced by the professional health and care sectors demanding low-cost equipment if they have to supply at low, or no, cost to the user; 'why should we pay for something fancy?'

T. Kleinberger et al^{li} have reported that 'elderly people are the most demanding stakeholders for IT-development – even highly sophisticated systems will not be accepted when they do not address the real needs of elderly and are not very easily accessible and usable.'

5.3 Transgenerational design

Alongside the disabilities to which technical assistance to living must attend if it is to be successful, it is worth spending a short while looking at the 'ambient' aspect of assisted living.

Webster's online English Learners Dictionary provides the following definition:

ambient
surrounding on all sides

It is this immersive ubiquity that is the important concept underlying the European-originated phrase 'Ambient Assisted Living.' The implication being that the assistance is available to anyone at any time. This in itself implies that the technologies involved are explicitly designed from conception to blend into the activities of everyday living of the entire population — including all types of disability. The term applied to this concept was 'Transgenerational design'^{liii} — although this did not explicitly include early life disability; hence the 'Ambient Assisted Living' term emerged.

It should be pointed out at this stage that either 'Ambient Assisted Living' or 'Transgenerational design' is a 'big ask' for society as a whole and would, for the foreseeable future, require substantial cost, performance and intrusiveness compromises^{liii}. However, the principle that "people, including those who are aged or impaired, have an equal right to live in a unified society"^{liv} is laudable and guidance from PirkI's Transgenerational.org website provides some valuable first principles for physical design characteristics^{lv}.

What is notable though, despite ambitious claims, is the extent of the gap between ICT and ambient (or transgenerational) designs. Given the numbers of new technologies emerging with touch-screen interfaces it is clear that scant attention is, in reality, being paid to the needs of users with some of the needs and constraints outlined in section 3.

5.4 Future interfaces

Kleinberger et al^{li} listed requirements for interfaces of AAL Systems (AALS):

- Adaptivity: The systems need to adapt themselves to the context at runtime^{lvi};
- Natural, anticipatory, human-computer interaction: AALS have to provide human accessible interfaces for different target user groups;
- Homogeneity masking Heterogeneity: Full-fledged AALS will integrate several subsystems provided by different manufacturers with a homogeneous interface;
- Formalization of domain knowledge: Developing AALS requires domain knowledge to be transformed for machine processing;
- Users as the most important stakeholders: Some of the currently available solutions put a strong focus on the technological solution and neglect usability issues;
- Late learning: Many of today's older adults (esp. in Europe) are not used to modern IT systems and are afraid of using them^{lvii}.

In addition they cite low acceptance of health-assistance solutions because they are stigmatising, have poor integration of technologies (lack of interoperability) and the immaturity of the market sector.

5.5 Future characteristics

Oppermann et al^{lix}; indicate that AAL Systems (AALS) should exhibit the following characteristics:

- invisible, i.e., embedded in clothes, watches, glasses, etc.;
- mobile, i.e., being carried around;
- spontaneous (ad hoc) communication among the nodes;
- heterogeneous and hierarchical, i.e., they comprise different kinds of system nodes regarding their computational power and rendered functionality;
- context-aware, i.e., they are aware of their local environment and spontaneously exchange information with similar nodes in their neighbourhood;
- anticipatory, i.e., acting on their own behalf without explicit extrinsic requests;
- natural communication with users by voice and gestures instead of keyboard, mouse, or text on screens,
- natural interaction with users by means of devices they are used to, e.g., clothing, watches, TV, telephone, household appliances (implying some kind of intelligence);
- adaptive, i.e., capable of reacting to all abnormal and exceptional situations in a flexible way.

The state of the market is in some areas a long way from achieving these desiderata. Others on the list perhaps indicate a particular bias from the authors – for example users with neuromuscular control problems would struggle with gesture interfaces. Nevertheless, the general requirements remain broadly correct – and largely unmet since the work was published in 1997.

In more recent observations by Sun et al^{lx} they observe that there are still many fundamental issues in AAL that remain open. Most of the current efforts still do not fully express the power of human being, and the importance of social connections and social activities is less noticed. They conjecture that such features are fundamental prerequisites towards truly effective AAL services, and that they pose challenges we must meet in order to develop practical and efficient AAL systems for older adults.

5.6 Future strategy

Given the fractured nature of the AAL 'market' it might be thought that the challenge is impossible. It is indeed clear that unless some of issues of business models, including value chains and benefit realization, are addressed assisted living technology will never become ambient. However, there are clues to the ways forward.

The requirements of Oppermann's group^{lix} for spontaneous communication between heterogeneous systems in a context-aware manner are almost certainly the minimum technical provisions that will enable acceptance. Their requirement for natural interaction with users by means of devices they are used to would seem to tally with our previously expressed opinion (4.2.3).

To meet these acceptability requirements on a technical basis calls for the achievement of **interoperability**^{lxi} "ability of two or more systems or components to exchange information and to use the information that has been exchanged" with the richness of the ETSI^{lxii} extended understanding of technical, syntactical, semantic and organizational interoperability.

To meet the requirement for natural interaction with users calls for assistive functions to be embedded in familiar objects, as well as for new assistive technologies to embody 'natural' interfaces within familiar environments is a challenge to retain on our agenda.

6 Specifications or formal standards to enable the infrastructure

6.1 Standards inventory

6.1.1 General considerations

The terms of reference of this Report require an inventory of standards to be prepared. Such inventory exercises are commonly undertaken but usually prove to be a time-constrained study of perpetual motion because they are very difficult to scope; are inevitably out of date even before publication - and are of rapidly diminishing value thereafter. Without dedicated ongoing resource, such inventories are of little value to would-be standards users. The role of this short section is therefore simply to explain how we started to deal with inventory issues – and then, when the task became too onerous, what we now present in 6.2 instead.

6.1.2 Structured inventory method

We attempted to analyse existing standards with reference to three orthogonal axes to which they are related: *Process (design, manufacture, deployment and maintenance)*, *Technical infrastructure* and *Use domain*. These axes are largely independent of demand- or supply-side role and are, at different stages in the life cycle, applicable to each role. Additionally, any one standard may have aspects applicable on more than one, and sometimes all three, axes.

6.1.2.1 Process-related standards

Process-related standards have to be evaluated for their applicability in specific product-oriented applications from a management, governance or regulatory perspective.

6.1.2.2 Technical infrastructure standards

Technical infrastructure standards may be considered explicitly in implementing AAL applications but in many instances the technical infrastructure is assumed to be in place by the specific content domain for a particular type of user. Criteria for selecting such infrastructure elements depend on the requirements of the respective application, but also on availability of implementations of such standards and their acceptance in the field; standards in this group cover technical and, to some extent, semantic content.

6.1.2.3 Use domain related standards

Use domain related standards are related to particular aspects of functionality with which a user will interact in their work; standards in this group cover the business, semantic and application content.

6.1.2.4 Alternative methods of analysis

Whilst it would have been in some ways attractive to have used the 'viewpoints of the Reference Model for Open distributed processing, Viewpoint specifications (ISO/IEC 10746-1)^{lxiii} it would have been difficult to manage the presentation of these views in the limited time available. However, these viewpoints are described below for reference.

A viewpoint (on a system) is an abstraction that yields a specification of the whole system related to a particular set of concerns. Five viewpoints are said to cover all the domains of architectural design. These five viewpoints are:

- the enterprise viewpoint, which is concerned with the purpose, scope and policies governing the activities of the specified system within the organization of which it is a part;
- the information viewpoint, which is concerned with the kinds of information handled by the system and constraints on the use and interpretation of that information;
- the computational viewpoint, which is concerned with the functional decomposition of the system into a set of objects that interact at interfaces – enabling system distribution;

- the engineering viewpoint, which is concerned with the infrastructure required to support system distribution;
- the technology viewpoint, which is concerned with the choice of technology to support system distribution.

For each viewpoint there is an associated viewpoint language, which can be used to express a specification of the system from that viewpoint.

6.1.3 Outcome

We started work on the basis of the tri-axial categorization and allocation of keywords aligned on our chosen axes and by analyzing the title and scope statements. The tri-axial organization was relatively easy but the use of keywords to provide the basis for grouping the published and in-progress standards regrettably, and somewhat surprisingly, it proved difficult - to the point of near-impossibility.

Attempts to access any modern or representative set of keywords applicable to AAL when searching the resources of the International Medical Informatics Association, or its American or European counterparts were fruitless. The U.S. National Library of Medicine Medical Subject Headings (MeSH) proved to be outdated; by far the best found were those for the by the Association for Computing Machinery (ACM) Computing Classification System (2012 Version)^{lxiv}. However, these are more generally applicable to pure ICT than AAL and thus address only the process and technology keyword areas. The Health Management Information Consortium (HMIC) database^{lxv} is a newish compilation of data from two sources, the Department of Health's Library and Information Services and King's Fund Information and Library Service and could prove to be a more useful basis for work if time permits.

So, although we had intended to provide an analysis based on commonly available keywords related to healthcare, health informatics, computer technology and telecommunications this was not possible in the time and resource available. Because such a list is not readily available – only the computer technology area is partially covered – we have not proceeded further with this work.

Any structured inventory of AAL-relevant standards would therefore need to be resourced adequately so that it can be constructed appropriately, have broad and deep international coverage, and be maintained in a timely manner for the foreseeable future.

6.2 Assisted Living related standards & activities

6.2.1 General introduction

The following three sections attempt a review of current Assisted Living related standards activities structured as follows:

- International Assisted Living related committees, 6.2.2;
- BSI Assisted Living related committees, 6.2.3;
- Collections of Assisted Living related standards, 6.2.4.

6.2.2 International Assisted Living related committees

This section attempts a review of the current 'standards' activities internationally, of relevance to AAL. However, because of the wide-ranging nature of the activity at the level of industry consortia and national initiatives such a review cannot be exhaustive^{lxvi}.

With the exception of internationally influential IEEE and HL7, nationally affiliated standards organizations have been omitted simply because of the sheer numbers involved, though in any future version of this document this listing needs to be expanded to consider at least BS, NEN and DIN standards directly relevant to AAL. The focus has been on international committees ISO, IEC and ITU and the consortia from which many of their ICT standards are derived. The European formal standards bodies CEN, CENELEC (CLC) and ETSI have also been considered because of their use in support of EU regulation.

In addition there are a considerable number of de-facto standard which are maintained outside of formal SDO organisations in the field of the Internet, Computing and Telecare. Of the many which exist, the USB Implementers forum is probably the largest and most influential example.

These are followed by: a brief comparison of the deliverables from the most widely cited standards developers (6.2.3) and then the current standards development process (6.4).

This section is presented in tabular form as related to the topics in sections 2, 4 and 5, so the order of presentation there has been reproduced here. In each case the organization has been hyperlinked from the document text.

Table 4: Standards developers by topic area

Subject title	Subject Section	Organisation & Activity Non-US national SDOs not included – see 6.2.3 for BSI.
Technology	2	IEEE SA Technical Committees ISO Technical Committees IEC Technical Committees ISO/IEC JTC 001 "Information technology" ITU Telecommunication Standardization Sector (ITU-T) European Committee for Standardization (CEN) CEN/TC 304 Information and communications technologies - European localization requirements European Committee for Electrotechnical Standardization (CENELEC) CEN/CLC/BTWG 6 ICT standardisation policy European Telecommunications Standards Institute (ETSI)
Candidate technologies, Sensors	2.1.1	IEEE Accelerometer Panel Working Group IEC/TC 65 Industrial-process measurement, control and automation
Candidate technologies, Sensors, Single modality	2.1.1.1.1	IEEE 1451.0 Smart Transducer Interface for Sensors and Actuators - Common Functions, Communications Protocols and Transducer Electronic Data Sheets (TEDS) Formats IEEE 1451.1 - Common Functionality and TEDS Working Group IEEE 1451.2 - Transducer to Microprocessor Communication Working Group IEEE 1451.4 - Mixed-mode Communication Working Group IEEE 1451.5 Wireless Sensor Working Group IEEE 1451.6 High-speed CANopen-based Transducer Network Interface IEEE 1451.7 Sensor and RFID Integration Working Group ISO/IEC JTC 1/SC 29 Coding of audio, picture, multimedia and hypermedia information IEC/TC 100 Audio, video and multimedia systems and equipment
Candidate technologies, Sensors, Smart sensors	2.1.1.2	IEEE 11073 Health Device Communication Standards Committee IEEE 11073 Health Device Communication Upper Layer WG IEEE 11073 Health Device Communication Lower Layer WG IEEE 11073 Health Device Communication Personal Health Device WG IEEE 2010 Neurofeedback (EEG Biofeedback) Systems WG ISO/TC 215/WG 07 "Devices" Joint IEEE/11073 Health Device Communication CEN/TC 248 Textiles and textile products OMG: CORBA Smart transducers
Candidate technologies, Sensors, Nanotechnology	2.1.1.3	IEEE Nanotechnology Standards IEC/TC 113 Nanotechnology standardization for electrical and electronic products and systems ISO/TC 229 "Nanotechnologies" CEN/TC 352 Nanotechnologies CLC/SR 113 Nanotechnology standardization for electrical and electronics products and systems

Subject title	Subject Section	Organisation & Activity Non-US national SDOs not included – see 6.2.3 for BSI.
Telecoms and networking	2.1.2	IEEE 802 LAN/MAN Standards Committee IEEE 802.3 Ethernet Working Group IEEE 802.18 Radio Regulatory TAG IEEE 802.19 Wireless Coexistence Working Group IEEE 802.21 Media Independent Handover Services Working Group IEEE 1901 Broadband Over Power Lines PHY/MAC Working Group (BPLPHMAC) IEEE 1902.1 RuBee Working Group ISO/IEC JTC 1/SC 6 Telecommunications and information exchange between systems ISO/IEC JTC 1/SC 25 Interconnection of information technology equipment ITU Telecommunication Standardization Sector (ITU-T) CLC/TC 215 Electrotechnical aspects of telecommunication equipment European Telecommunications Standards Institute (ETSI) The Internet Society The Internet Engineering Task Force (IETF) Thousands Of Specifications (RFCs) For Internet Use – WGs are here Internet Architecture Board (IAB)
Body area networks	2.1.2.1	IEEE 802.15.6 Local and metropolitan area networks, Wireless Body Area Networks WPAN WG IEEE 802.15 WPAN WG, Task Group 4j Medical Body Area Networks
Personal area networks	2.1.2.2	IEEE 802.15 Wireless Personal Area Network (WPAN) Working Group
Local area networks	2.1.2.3	IEEE 802 LAN/MAN Standards Committee IEEE 802.3 Ethernet Working Group 802.1 Higher Layer LAN Protocols Working Group 802.11 Wireless LAN Working Group
Virtual private networks	2.1.2.4	IEEE 802 LAN/MAN Standards Committee 802.1 Higher Layer LAN Protocols Working Group The Internet Engineering Task Force (IETF): WGs are here
Metropolitan area networks	2.1.2.5	IEEE 802 LAN/MAN Standards Committee IEEE 802.3 Ethernet Working Group IEEE 802.16 Broadband Wireless Access Working Group IEEE 802.22 Wireless Regional Area Networks
Wide area networks	2.1.2.6	IEEE 802.16 Broadband Wireless Access Working Group IEEE 802.22 Wireless Regional Area Networks ITU Telecommunication Standardization Sector (ITU-T) European Telecommunications Standards Institute (ETSI)
Internet	2.1.2.7	IEEE SA Technical Committees IEEE P1903 Next Generation Service Overlay Network (NGSON) ISO/IEC JTC 001 "Information technology" ITU Telecommunication Standardization Sector (ITU-T) The Internet Society The Internet Engineering Task Force (IETF) Thousands Of Specifications (RFCs) For Internet Use – WGs are here Internet Architecture Board (IAB) The World Wide Web Consortium (W3C) OASIS OMG The Open Group CEN/TC 365 Internet Filtering

Subject title	Subject Section	Organisation & Activity Non-US national SDOs not included – see 6.2.3 for BSI.
Mobile telephony	2.1.2.8	ITU Telecommunication Standardization Sector (ITU-T) European Telecommunications Standards Institute (ETSI) Open Mobile Alliance (OMA)
Telephone network	2.1.2.9	ITU Telecommunication Standardization Sector (ITU-T) European Telecommunications Standards Institute (ETSI)
Professional mobile radio	2.1.2.10	IEEE 802.16 Broadband Wireless Access Working Group (WMAN) Telecommunications Standards Institute (ETSI) Trans-European Trunked Radio (TETRA)
New technologies, Internet of things	2.1.2.12	OMG: CORBA Super distributed objects
New technologies, Internet of things, Automatic identification and data capture	2.1.2.13	IEEE 1902.1 RuBee Working Group ISO/IEC JTC 001/SC 17 "Cards and personal identification" ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques ISO/IEC JTC 1/SC 37 Biometrics CEN/TC 224 Personal identification, electronic signature and cards and their related systems and operations CEN/TC 225 AIDC technologies (inc. IoT) GS1 OASIS: Biometric Identity Assurance
New technologies, Internet of things, Automatic data capture	2.1.2.14	ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques GS1
New technologies, Domotics	2.1.3	IEC/TC 100 Audio, video and multimedia systems and equipment (IEC/TA 1 – 14) CLC/SR 110 Flat panel display devices
New technologies, Domotics, Smart homes	0	IEEE 1905 Convergent Digital Home Network IEEE 1377 End Device - End Device/Telemetry Interface Unit Subcommittee ISO/TC 205 "Building environment design" CLC/TC 205 Home and Building Electronic Systems (HBES) IEC/TC 34 Lamps and related equipment IEC/TC 59 Performance of household and similar electrical appliances IEC/TC 72 Automatic electrical controls IEC/TC 79 Alarm and electronic security systems CEN/TC 72 Fire detection and fire alarm systems CLC/TC 72 Automatic controls for household use CLC/TC 79 Alarm systems ISO/TC 274 "Light and lighting" CEN/CLC/ETSI SMCG Smart Meters Co-ordination Group CEN/CLC/JWG RRM CEN/CENELEC Joint Working Group Remote Reading of Meters CLC/WS 04 Interoperability framework requirements specification for services to the home (IFRS) CWA 50560:2010 Interoperability framework requirements specification for service to the home (IFRS) KNX Association, KNX specification approved as: European Standard (CENELEC EN 50090 and CEN EN 13321-1, EN 13321-2:2012); International Standard (ISO/IEC 14543-3)

Subject title	Subject Section	Organisation & Activity Non-US national SDOs not included – see 6.2.3 for BSI.
New technologies, Domotics, Smart grid	2.1.5	IEEE 802 LAN/MAN Standards Committee IEEE 802.15 Wireless Personal Area Network (WPAN) Working Group IEEE 802.24 Smart Grid TAG IEEE 1377 End Devic - End Device/Telemetry Interface Unit Subcommittee IEEE 1901-2 Narrow Band Power Line Communications for Smart Grid Applications WG IEC/TC 8 Systems aspects for electrical energy supply IEC PC 118 Smart grid user interface CLC/SR 118 Smart grid user interface
New technologies, Smart cities	2.1.6	IEEE P1888 Ubiquitous Green Community Control Network Working Group ISO/TC 204 "Intelligent transport systems" CEN/TC 278 Road transport and traffic telematics CEN/TC 320 Transport - Logistics and services ITU-T SG 16 Q21/16 (Multimedia Architecture) and Q29/16 (Mobility for Multimedia Systems and Services) ISO/TC 207 "Environmental management" ISO/TC 211 "Geographic information / Geomatics" CEN/TC 287, Geographic Information Open Geospatial Consortium, Inc. (OGC) Open Mobile Alliance (OMA) Location Interoperability Forum (LIF) CEN/TC 217 "Surfaces for sports areas" ISO/TC 268 "Sustainable development in communities" ISO/TC 268/SC 01 "Smart community infrastructures"
New technologies, Smart cities, Urban resilience	Error! Reference source not found.	ISO/TC 146 "Air quality" ISO/TC 147 "Water quality" ISO/TC 223 "Societal security" CEN/TC 325 Crime prevention through building, facility and area design CEN/TC 391 Societal and Citizen Security
New technologies, Robotics	2.1.7	IEEE 1872 Ontologies for Robotics and Automation (ORA) ISO/TC 184 "Automation systems and integration" ISO/TC 184/SC 02 "Robots and robotic devices" ISO/TC 184/SC 02/JWG 09 "Joint ISO/TC 184/SC 2 - IEC/SC 62A; Safety for medical devices using robotic technology" ISO/TC 184/SC 02/WG 07 "Personal care safety" ISO/TC 184/SC 02/WG 08 "Service robots" ISO/TC 184/SC 05 "Interoperability, integration, and architectures for enterprise systems and automation applications" CEN/TC 310 Advanced automation technologies and their applications
New technologies, Cloud computing	2.1.8	IEEE P2301 Working Group (Cloud Profiles) IEEE P2302 Working Group (Intercloud) OASIS: Cloud Open: Cloud
New technologies, Social networking services	2.1.9	ISO/TC 232 "Learning services for non-formal education and training"
New technologies, Augmented reality	2.1.10	
New technologies, Gaming	2.1.11	IEEE Working Group for Distributed Interactive Simulation IEEE P1817 Standard for Consumer-ownable Digital Personal Property
New technologies, Location awareness	2.1.12	OASIS: Identity Metasystem Interoperability (IMI)
New technologies, Ambient intelligence	2.1.13	OMG CORBA Embedded intelligence specifications Open: Boundaryless Information Flow

Subject title	Subject Section	<p style="text-align: center;">Organisation & Activity</p> <p style="text-align: center;">Non-US national SDOs not included – see 6.2.3 for BSI.</p>
New technologies, Collective intelligence	2.1.14	IEEE Learning Technology Standards Committee ISO/IEC JTC 1/SC 36 Information technology for learning, education and training
Security, Physical security	2.1.15.1	ISO/TC 223 "Societal security" IEC/TC79 Alarm and electronic security systems CEN/TC 391 Societal and Citizen Security CEN/CLC/TC4 Services for fire safety and security systems
Security, Data security	2.1.15.2	IEEE Industry Connections Security Group IEEE P1363 Standard Specifications For Public-Key Cryptography CEN/TC 224 Personal identification, electronic signature and cards and their related systems and operations CEN/TC 365 Internet Filtering CORBA: Security OASIS: Biometric Identity Assurance Services (BIAS) OASIS: Identity in the Cloud Open: Security ISO 2700 series
New materials	2.2	ISO VAMAS "Versailles Project on Advanced Materials and Standards"
New materials, Composite materials	2.2.1	ISO/TC 150 "Implants for surgery" ISO/TC 168 "Prosthetics and orthotics"
New materials, 3D printing	2.2.2	ASTM F42 "Additive Manufacturing Technologies" ASTM F42.04 "Design" ASTM F2915, Specification for Additive Manufacturing File Format (AMF) ASTM F2915 files, documentation and forums Guidelines for 3D Printing ISO/TC 261 "Additive manufacturing"
Existing provision	4	ISO/PC 273 "Project Committee: Customer contact centres" ISO/TC 145 "Graphical symbols" IEC/TC 100 Audio, video and multimedia systems and equipment (IEC/TA 1 – 14) IEC/TC 110 Electronic display devices
Existing provision, Disability provision	Error! Reference source not found.	ISO/TC 059 "Buildings and civil engineering works" ISO/TC 059/SC 16 "Accessibility and usability of the built environment" ISO/TC 059/SC 16/WG 01 "Accessibility and usability of the built environment" ISO/TC 159 "Ergonomics" ISO/TC 159/SC 05 "Ergonomics of the physical environment" ISO/TC 159/SC 05/WG 05 "Physical environments for people with special requirements" ISO/TC 173 "Assistive products for persons with disability" CEN/TC 293 Assistive products for persons with disability CEN/SS S99 Health, environment and medical equipment CEN/CLC Guide 6:2002 Guidelines for standards developers to address the needs of older persons and persons with disabilities CLC/BTWG 101-5 Usability and safety of electrical products with reference to people with special needs ISO/TC 199 "Safety of machinery" ISO/IEC JTC 1/SC 35 User interfaces CEN/TC 122 Ergonomics
Existing provision, Telecare provision	4.1	IEC/TC79 Alarm and electronic security systems CENELEC CLC/TC 79, "Alarm systems"

Subject title	Subject Section	Organisation & Activity Non-US national SDOs not included – see 6.2.3 for BSI.
Existing provision, Telehealth provision	4.2	<u>CEN/TC 362 Healthcare services</u> <u>ISO/TC 121 "Anaesthetic and respiratory equipment"</u> <u>ISO/TC 121/SC 03/JWG 06 "Joint TC/SC62A-ISO TC121/SC3/JWG 6; Medical electrical equipment and medical electrical systems used in home care applications"</u> <u>ISO/TC 121/SC 03/JWG 12 "Joint ISO/TC 121/SC 3-IEC/SC 62D WG; Home respiratory equipment"</u> <u>CEN/TC 215 Respiratory and anaesthetic equipment</u> <u>IEC/TC 62 Electrical equipment in medical practice</u>
Existing provision, Telehealth provision, Clinical video telehealth	4.2.3	<u>ITU Telecommunication Standardization Sector (ITU-T)</u> <u>European Telecommunications Standards Institute (ETSI)</u>
Existing provision, Telehealth provision, Home telehealth	4.2.1	<u>ISO/TC 215 "Health informatics"</u> <u>ISO/TC 215/JWG 07 "Joint ISO/TC 215 - IEC/SC 62A WG; Application of risk management to information technology (IT) networks incorporating medical devices"</u> <u>ISO/TC 215/WG 01 "Data structure"</u> <u>ISO/TC 215/WG 02 "Data interchange"</u> <u>ISO/TC 215/WG 04 "Security"</u> <u>ISO/TC 215/WG 07 "Devices" Joint IEEE/11073 medical device Communication</u> <u>CEN/TC 251 Health informatics</u> <u>HL7</u>
Existing provision, Telehealth provision, Store-&-forward telehealth	4.2.2	<u>CEN/TC 251 Health informatics</u> <u>HL7</u>
The future?	5	<u>IEC Standardization Management Board SG5 Ambient Assisted Living</u>
The future? Business models	5.1	<u>ISO/COPOLCO "Committee on consumer policy"</u> <u>ISO/TC 176 "Quality management and quality assurance"</u> <u>ISO/TC 176/SC 03 "Supporting technologies"</u> <u>ISO/TC 176/SC 03/WG 17 "Guidelines for business-to-consumer electronic commerce transactions"</u>
The future? Transgenerational design	5.3	<u>ISO/TC 136 "Furniture"</u> <u>ISO/TC 159 "Ergonomics"</u> <u>ISO/TC 159/WG 02 "Ergonomics for people with special requirements"</u> <u>ISO/TC 159/SC 03 "Anthropometry and biomechanics"</u> <u>ISO/TC 159/SC 03/WG 04 "Human physical strength; manual handling and force limits"</u> <u>ISO/TC 159/SC 04 "Ergonomics of human-system interaction"</u> <u>ISO/TC 159/SC 04/WG 03 "Controls, workplace and environmental requirements"</u> <u>ISO/TC 159/SC 04/WG 06 "Human-centred design processes for interactive systems"</u> <u>ISO/TC 159/SC 04/WG 09 "Tactile and haptic interaction"</u> <u>ISO/TC 159/SC 04/WG 10 "Accessible Design for Consumer Products"</u> <u>ISO/TC 159/SC 04/WG 11 "Ease of operation of everyday products"</u> <u>CEN/TC 122 Ergonomics</u>

6.2.3 BSI Assisted Living related committees

Although BSI (formally, The British Standards Institution) claims to be “the business standards company that helps organizations make excellence a habit – all over the world” it falls rather short of that claim because it makes it almost impossible to find who does what (unless you are already involved) in standards development. Worse, it makes it almost impossible to look for a standard that might be relevant to the work one is trying to undertake. This is not so much of a problem for standards published by the international WTO recognised standards bodies (just look elsewhere), but searching in hopeful ignorance for national standards is unlikely to bear fruit.

If the hopeful searcher happens to know, then there is a 'hidden, but accessible' website at: <http://standardsdevelopment.bsigroup.com/> which can, with patience, be searched by topic or by committee number.



Figure 5: Top-level mind map of Assisted Living related committees at BSI
see too the associated interactive document <<BSI_AL_006-20120417.pdf>>

For that reason the following transcript from the associated MindMap document (see Figure 5) has just one hyperlink to IST/035 and its associated standards, but not yet to other BSI Committees or the Standards they produce or input to from a British standpoint. If time permits, a subsequent version of this document which includes hyperlinks to each committee or subcommittee may be produced.

CH/062 Electrical Equipment in Medical Practice

CH/062 is responsible for UK input into CENELEC TC62 and IEC TC62 and its SCs.

See also: CH/173 Assistive products for persons with disability.

CH/062/01 Common aspects of Electrical Equipment used in Medical Practice

Under the direction of CH/062/01 is responsible for UK input into IEC/SC 62A, the preparation, revision and amendment of British Standards in the field of electrical equipment used in medical practice and the provision of advice to BEC on such work.

CH/062/04 Electromedical equipment

Under the direction of CH/062/04 is responsible for UK input into IEC/SC 62D, the preparation, revision and amendment of British Standards in the field of electromedical equipment and the provision of advice to British Electrotechnical Committee on such work.

CH/173 Assistive products for persons with disability

Under the direction of the Standards Policy and Strategy Committee is responsible for UK input into ISO/TC 173 and CEN/TC 293 standardization in the field of Technical systems and aids for disabled or handicapped persons.

See also: CH/101 Healthcare and medical equipment (National), CH/062 Electrical Equipment in Medical Practice.

7+ subcommittees, of which four are particularly relevant:

CH/173/0-02 Classification and Terminology of Assistive Products

Under the direction of CH/173 is responsible for UK input into ISO/TC173/SC2 and CEN/TC293 standardization in the field of classification and terminology for technical aids for people with disabilities.

CH/173/0-03 Aids for ostomy and incontinence

Under the direction of CH/173 is responsible for the UK input into ISO/TC 173/SC 3 and CEN/TC 293 - standardization in the field of aids for ostomy and incontinence.

CH/173/0-06 Hoists for the transfer of persons

Under the direction of CH/173 is responsible for UK input into ISO/TC173/SC6 and CEN/TC293 standardization in the field of hoists for the transfer of persons.

CH/173/01 Wheelchairs

Under the direction of CH/173, is responsible for the UK input into ISO/TC173/SC1 and CEN/TC 293 for standards relating to wheelchairs.

CH/101 Healthcare and medical equipment (National)

Under the direction of the Standards Policy and Strategy Committee is responsible for Healthcare standardization in new topical areas not originating in Europe and Internationally.

See also: CH/173 Assistive products for persons with disability, CH/210 Quality management and corresponding general aspects for medical devices.

CH/210 Quality management and corresponding general aspects for medical devices

Under the direction of the Standards Policy and Strategy Committee is responsible for UK input into CEN/CLC TC 3, ISO/TC 210 and ISO/TC 210/WG 2 and the preparation, revision and amendment of British Standards in the field of quality for medical devices.

See also: CH/101 Healthcare and medical equipment (National), CH/212 In Vitro testing Devices (IVDs).

4 subcommittees, of which the following 3 are particularly relevant:

CH/210/01 Quality systems for medical devices

Under the direction of CH/210 is responsible for UK input into CEN/CLC TC 3 and ISO/TC 210/WG 1 and the preparation, revision and amendment of British Standards in the field of quality systems for medical devices.

CH/210/03 General terminology and symbols for medical devices

Under the direction of CH/210 is responsible for UK input into CEN/CLC TC 3/WG 1 and ISO/TC 210/WG 3 and the preparation, revision and amendment of British Standards in the field of general terminology and symbols for medical devices.

CH/210/04 Risk analysis for Medical Devices

Under the direction of CH/210 is responsible for UK input into CEN/CLC TC 3 and ISO/TC 210 - IEC/SC 62A/ JWG 1 and the preparation, revision and amendment of British Standards in the field of risk management for medical devices.

CH/212 In Vitro testing Devices (IVDs)

CH/212 is responsible for standardization in the field of in vitro diagnostics (IVDs). It is the UK mirror committee for:

ISO/TC 76 Transfusion, infusion and injection equipment for medical and pharmaceutical use;

ISO/TC 212 Clinical laboratory testing and in vitro diagnostic test systems;

CEN/TC 140 In vitro diagnostic medical devices;

Parts of the work of CEN/TC 205 Non-active medical devices; The areas covered are specifications, general requirements, and terminology.

See also: CH/210 Quality management and corresponding general aspects for medical devices.

NTI/001 Nanotechnologies

Under the direction of the Standards Policy and Strategy Committee, is responsible for the UK input to ISO/TC 229 Nanotechnologies, IEC/TC 113 Nanotechnology Standardization for electrical and electronic products and systems and CEN/TC 352 Nanotechnologies as well as formulating a UK strategy for standardization in nanotechnologies through a broad consultation with relevant stakeholders

5 cross-sector subcommittees.

EPL/100 Audio, video and multimedia systems and equipment

Under the direction of the British Electro-technical Committee (BEC) and the Standards Policy and Strategy Committee, is responsible for the UK input to IEC/TC 100 for standards relating to the specification of the performance, methods of measurement for consumer and professional equipment and their application in systems and its interoperability with other systems or equipment

7+ subcommittees, of which one is particularly relevant:

EPL/100/0-/01 Audio frequency induction loop systems

Under the direction of EPL/100, is responsible for the preparation, revision and amendment of British Standards relating to Audio frequency induction loop systems.

CPL/072 Electrical control devices for household equipment and appliances

Under the direction of the British Electro-technical Committee and the Standards Policy and Strategy Committee, provides UK input to IEC/TC 72 and CENELEC/TC72 for the preparation of harmonized standards for rules related to inherent safety, to the operating characteristics where such are associated with applicational safety and to the testing of automatic electrical control devices used in appliances and other apparatus, electrical and non-electrical for household and similar purposes such as those for central heating, air-conditioning.

FSH/012 Fire detection and alarm systems

Under the direction of the Standards Policy and Strategy Committee, is responsible for producing and developing standards, harmonised where necessary, to meet the essential requirements.

B/559 Access to buildings for disabled people

Under the direction of the Standards Policy and Strategy Committee, is responsible for formulating the UK strategy for standardisation in the area of Access for Disabled People through a broad consultation with relevant stakeholders.

SSM/001 Societal security management

Under the direction of the Standards Policy and Strategy Committee, is responsible for being the focal point for the development of standards for societal security in the UK and to monitor and mirror the work of ISO TC 223 - Societal Security, and CEN/BT WG 161- Protection and Security of the Citizen, and other appropriate relevant national and international bodies.

8 subcommittees, including: SSM/001/0-/04 Societal Technologies and SSM/001/06 Resilience.

ICT/00- Information and communications technology co-ordination and strategy committee

Under the direction of the Standards Policy and Strategy Committee, is responsible to advise BSI on all matters relating to national, European and International Standardization in the area of Information and Communications Technology and to co-ordinate such activities of all BSI committees working in this area

6 subcommittees, of which 2 are particularly relevant:

ICT/00-/05 European ICT co ordination committee for CEN, CENELEC, ETSI and ICTSB

Under the direction of ICT/-, is responsible for coordination of UK positions and representation to the European Standards bodies (CEN, CENELEC, ETSI and the ICTSB) in matters related to ICT and co-ordination of the activities of BSI technical committees working in these bodies

ICT/00-/06 ICT Accessibility Co-ordination

Under the direction of ICT/-, is responsible for the UK input to ISO/IEC JTC 1/SC 35 and ISO/IEC JTC 1/SWG-A and the preparation, revision and amendment of British Standards for ICT Accessibility

IST/00-/99 Participating IST members

This is not a committee but is a group set up to facilitate the distribution of papers of interest to all committee members on committees with the starting reference IST/

IST/006 Data communications

Under the direction of the British Electrotechnical Committee and the Standards Policy and Strategy Committee, is responsible for UK participation in ISO/IEC JTC1/SC 6, ISO/IEC JTC 1/SC 25/WG 1 and CENELEC TC 205.

6 subcommittees, of which 2 are particularly relevant:

IST/006/0-11 Local area networks

Under the direction of IST/6, is responsible for providing a forum for all UK interests on the standardization of all matters relating to Local and Metropolitan Area Networks that reside in the OSI Data Link Layer. To review and recommend in a timely fashion to IST/6 UK positions during the development of International and European Standards that relate to Local Area Networks. To liaise with appropriate committees etc to ensure consistent, well-informed positions are developed on cross-layer issues.

IST/006/0-12 Home Electronic Systems

Under the direction of IST/6, is responsible for the UK input to ISO/IEC JTC 1/SC 25/WG 1 and CLC TC/205, providing an accessible framework for the development of Home and Building Electronic Systems, the industries based upon them and the delivery of the resulting benefits to the UK.

Strong current focus on Smart Grid technology.

IST/035 Health informatics

Scope: Under the direction of the British Electrotechnical Committee and the Standards Policy and Strategy Committee, is responsible for UK participation in standardisation relating to health informatics. It provides a forum for representatives of organisations with an interest in developing standards in health informatics to help in achieving common standards in this field throughout Europe and internationally.

Formally, BSI mirror to CEN TC251 and ISO TC215.

Informally, through UK membership representation, it tracks the activity of Joint Initiative Council (JIC) members (CDISC, GS1, HL7, IHE, IHTSDO, ...) and IEEE 11073 (ISO PSDO).

The BSI standards development website link is:

<http://standardsdevelopment.bsigroup.com/Home/Committee/50001782>

6 subcommittees, of which 5 are particularly relevant:

IST/035/01 Information models

Input to the development of ISO and European standards to facilitate communication between independent information systems within and between organisations, for health related purposes. The standards are based on information models - generic models of aspects of health care or health care information. Panel I will therefore develop domain model based reference architectures for evolvable information systems.

This group is the UK entry point for the following:

- ISO/CEN HL7v2,
- ISO/CEN HL7v3,
- ISO/CEN HL7 CDA
- ISO/CEN IHE.

IST/035/02 Terminology and knowledge representation

The semantic organisation of information and knowledge, so as to make it of practical use in the domains of health informatics and telematics, and the provision of information and criteria to support

harmonisation. This encompasses clinical, managerial and operational aspects of the medical record and enabling access to other knowledge.

The actual work items focus on :-

1. Terms, Concepts and the interrelationship of concepts;
2. Structures for concepts systems including those for multi-axial coding schemes;
3. Guidelines for the production of coding systems and knowledge representation.

This group is the UK entry point for the following:

- ISO/CEN GS1,
- ISO/CEN Consys,
- [HTSDO SNOMED]

IST/035/03 Security, safety and quality

The current European and national legislation emphasise the importance of quality, safety and security. It provides a statutory framework to ensure that information systems used in healthcare have appropriate levels of quality, safety and security.

IST/035/04 Technology and interoperability

Develop and promote standards that enable the interoperability of devices and information systems in health informatics.

The scope covers 3 main areas:

1. Intercommunication of data between devices and information systems
2. Integration of data for multimedia representation
3. Communication of such data between source departments and other legitimate users elsewhere in the healthcare sector, in order to facilitate electronic healthcare record provision.

This group is the UK entry point for the following:

- IEEE/ISO/CEN 11073,
- ISO/CEN DICOM,
- ISO/CEN IHE.

IST/035/06 Safety of Software and networks

Scope: to work with CH/62 and CH/210 to coordinate input to CEN/CLC JTF SAMD, and to (ISO/)IEC SC62A JWG 3 (software) and 7 (networks).

This group is the UK informatics entry point for the following:

- ISO/CEN 14971,
- ISO/CEN 62304,
- ISO/CEN IEC/CLC 80000,
- ISO/CEN 82304,
- ISO/CEN IEC/CLC 80001.

AMT/00-/02 Robots and robotic devices

Under the direction of the Standards Policy and Strategy Committee, is responsible for the UK input to ISO/TC 184/SC 2, ISO/TC 266 and some elements of CEN/TC 310 for standards in the field of robots and

robotic devices including vocabulary for robots and robotic devices, medical care robots and personal care robot safety.

GW/001 Electronic security systems

Under the direction of the British Electrotechnical Committee and the Standards Policy and Strategy Committee, GW/1 is responsible for the UK input into CLC/TC79 and standards for electronic security systems.

There are 8 sub-committees, of which the following are most relevant. They work under the direction of GW/001, and are responsible for producing British Standards and relevant UK input into CLC/TC79.

GW/001/01 Alarm components

GW/001/02 Installed alarm systems

GW/001/05 Transmission equipment and networks

GW/001/08 Access control

GW/001/10 Closed circuit television (CCTV)

GW/001/11 Remote centres

GW/001/12 Social alarms

GW/003 Manned security services

Under the direction of the British Electrotechnical Committee and the Standards Policy and Strategy Committee, is responsible for the preparation of standards in the area of manned security services.

There are 10 sub-committees, of which the following 4 are most relevant:

GW/003/0-09 Security screening

Under the direction of GW/003 produces standards for the security screening of personnel.

GW/003/0-12 Protection of lone workers

Under the direction of GW/003 produces standards for the security and protection of lone workers.

GW/003/0-18 Warden Schemes

Under the direction of GW/003 produces 8523 – Operation and management of warden's scheme – Code of Practice. This code of practice gives recommendations for the management, control, staffing, operation, training and organisation of a warden scheme, functioning in a community environment.

GW/003/0-21 Revision of BS 7984

Under the direction of GW/003 produces BS 7984, which gives the recommendations for the management, staffing and operation of an organization providing keyholding and response services on a contracted basis.

SVS/000 Customer service - Fundamental principles

Under the direction of SVS/00- Service standardization strategy group, is responsible for the development and maintenance of standards for customer service in all Business-to-customer relationships (formerly SVS/8). Subjects include complaints handling systems, external dispute resolution, customer-focussed codes of conduct, and the measurement of customer satisfaction. RMS/1/1 provides the UK input to ISO/TC 176/SC 3 Working Groups 10, 12, 13 and 14. There is no corresponding European work as yet.

There are a number of sub-committees, of which the following are most relevant:

SVS/000/01 Customer contact services

Under the direction of SVS/000 is responsible for the development and maintenance of standards for Customer Contact Centres in all Business-to-customer relationships. SVS/0/1 (formerly SVS/7/-/5) provides the UK input to CEN BT TF 182. There is no corresponding International work as yet.

SVS/000/02 Vulnerable consumers

Under the direction of SVS/000, is responsible for the investigation into and any resulting development of standards for venerable consumers

SVS/001 Business Services

Under the direction of SVS/00- Service standardization strategy group, provides the UK input to CEN TC 374 Business Support Services.

There are a number of sub-committees, of which the following is most relevant:

SVS/001/02 Collaborative business relationships

Under the direction of SVS/001, is responsible for the development of a standard specifies methods of establishing and maintaining long-term business relationships and contractual B2B partnerships to assist in the delivery of services and products in both the private and public sectors. It will be developed into a full British Standard using PAS 11000.

SVS/008 Community Services

Under the direction of SVS/00- Service standardization strategy group, is responsible for the UK input to CEN/ PC 385 for standards in the field of community services.

There just one sub-committee:

SVS/008/01 Sheltered housing services

Under the direction of SVS/008 is responsible for the development and maintenance of standards for sheltered housing in all Business-to-customer relationships. SVS/008/1 provides the UK input to CEN PC 385. There is no corresponding International work as yet.

SVS/015 E-services

Under the direction of SVS/00 is responsible for the standardization of e-services, both B2B and B2C. Responsible for the preparation of British Standards and for the nomination and briefing of uK delegates to ISO/TC 176/SC 3/WG 17 'Guidelines for business-to- consumer electronic commerce transactions'.

CAS/001 Conformity assessment

Under the direction of the Standards Policy & Strategy Committee, is responsible for the UK input to ISO/CASCO and CEN/CLC/TC 1 and their working groups. It is also responsible for the preparation, publication, review and revision of British Standards or other products in conformity assessment and related fields in coordination with similar CASCO and CEN activities and product developments.

There are 7 sub-committees, none of which are currently active.

6.2.4 Collections of Assisted Living related standards

In the same way as this document will be incomplete, and outdated, before it is read so are the two other major recent works on the AAL / M2M topic of which we have become aware.

The first is the "E-health Standards and Interoperability" ITU-T Technology Watch report prepared by Dr. Laura DeNardis of American University in Washington, DC and published in April 2012^{lxvii}. Its object was to survey the ICT landscape to capture new topics for standardisation activities, assess new technologies with regard to existing standards inside and outside ITU-T and their likely impact on future standardisation.

It a rather high level analysis (the ITU-T M2M group have published a more detailed gap analysis consultation to SDOs this year) but is, as might be expected, more comprehensive on Internet and telcoms than our report is likely to be.

It is perhaps worth observing that as part of its M2M eHealth work the ITU is working with the Continua Healthcare Alliance to adopt the Continua Design Guidelines.

At the time of completing our report the second source of reasonably up-to-date information is the AALIANCE^{2lxviii} Deliverable D4.1, which provides an overview of current standards in technology related to AAL in a Wiki-based online repository in which this information is maintained. A snapshot copy dated 2013-01-14 of the live resource was used as a basis for the 1st workshop on standards and certification in AAL in early 2013 and the wiki is expected to become publicly accessible later in the year.

6.3 Standards activities

6.3.1 General observations

We have not attempted to differentiate in the listing below, between formally recognized standards organizations – see 6.4 for that. The list therefore shows a wide variety from health and care specific industry consortia (some of which do not regard themselves as standards organizations) through to those formally recognized internationally (though it is notable that this formal recognition is not recognized in practice in some markets).

Moreover, the list is not exhaustive and omits important organizations undertaking valuable work in particular market niches. Instead we have taken a pragmatic view of the organizations that have to date had most impact across the range of health and care standardisation, with an eye to those whose activity may also provide some relationship to AAL in the future.

6.3.2 WTO/GATT standards

The General Agreement on Tariffs and Trade "Agreement on Technical Barriers to Trade" (the so-called GATT Standards Code) introduced in 1979 aims at ensuring that regulations, standards, testing and certification procedures do not create unnecessary obstacles to trade. The Agreement also sets out a code of good practice for both governments and non-governmental or industry bodies to prepare, adopt and apply voluntary standards.

6.3.2.1 EU Standards SDOs

6.3.2.1.1 Shared practice and deliverables

The member states of the EU and EFTA believe that standardisation diminishes trade barriers, promotes safety, allows interoperability of products, systems and services, and promotes common technical understanding. Standards therefore help to build the 'soft infrastructure' of modern, innovative economies by providing certainty, references, and benchmarks for designers, engineers and service providers – an optimum degree of order.

In addition, regional or European Standards are necessary for the Single Market and support the Union's policies for technical integration, protection of the consumer, and promotion of sustainable development.

The three ESOs are: CEN, the European Committee for Standardization; CENELEC, the European Committee for Electrotechnical Standardization; and ETSI, the European Telecommunications Standards Institute.

The ESOs contribute to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programs, and public procurement.

European Standards adopted by CEN, CENELEC or ETSI, have an obligation of implementation as an identical national standard and withdrawal of conflicting national standards

On behalf of governments, the European Commission or EFTA Secretariat may request the European Standards organizations to develop standards in support of their policies by issuing formal 'mandates'.

The decision by the European Union to formulate legislation in terms of very general essential requirements - the "New Approach to technical harmonization and standards" (resolution of the Council of the European Union, 7 May 1985), and to require that the so-called "New Approach Directives" be supported by a portfolio of European voluntary standards, was an extremely significant event in the history of modern standardisation

This 'new approach' policy decided that:

- legislative harmonization is limited to the 'essential requirements', these being obligatory and formulated in general terms;
- writing of the detailed technical specifications necessary for the implementation of directives is entrusted to the European, voluntary standards organizations like CEN;
- the standards are not mandatory, but products manufactured according to such 'harmonized' standards gives a 'presumption of conformity' to the essential legal requirements in the directives;
- compliance results in the right of the product to bear the CE marking of conformity and market release throughout Europe.

What follows are the principles that govern standards development amongst the ESOs:

- Standards are developed through a consensus process;
- Participants in standards development represent all interests concerned: industry, authorities and civil society — and, except in the case of ETSI, contributing mainly through their national standards bodies;
- Draft standards are made public for consultation at large;
- The final, formal vote is binding on all members;
- The European Standards (ENs) must be transposed into national standards and conflicting standards withdrawn.

Considerable valuable work has been done in the ESOs in partnership with other SDOs – though its connection to strategic Member States programs is less clear. At present there are, at best, perceptions of mismatch between the technical approach being taken in different SDOs, and Member States.

6.3.2.1.2 EU ICT co-ordination

The ICT Standards Board (ICTSB, <http://www.icts.org/>) is an initiative from the three recognized European standards organizations CEN, CENELEC, & ETSI with the participation of specification providers as partners to co-ordinate specification activities in the field of Information and Communications Technologies (ICT). [...] The ICTSB listens to requirements for standards and specifications that are based on concrete market needs and expressed by any competent source. The Board then considers what standards or specifications need to be created, and how the task will be carried out.

ICTSB is dealing with Design for All and Assistive Technologies (DATSCG)^{lxix}, Intelligent Transport Systems(ITSSG), Smart House Standards (SHSSG)^{lxx}, and Network & Information Security (NISSG). It

has completed its co-ordination work on Electronic Signature (EESSI) and has contributed to the discussion on ICT standardization (ICTSFG).

Radio Frequency Identification (RFID) is being dealt with by a number of standardisation organizations. The ICTSB is collecting information for the purpose of a harmonized standardisation approach.

Five ICTSB partners (CEN, CENELEC, ETSI, The Open Group and W3C) combined to launch a support action under FP6 to optimize the interface between standards and research. details of this project - the Cooperation Platform for Research and Standards (COPRAS) - are found at www.copras.org.

The ICTSB Board Members are drawn from Fora & Consortia (10), ESOs (3) and Observers (4): EC, EFTA, European Association for the Co-ordination of Consumer Representation in Standardization (ANEC) and The European Office of Crafts, Trades and SMEs for Standardization (Normapme).

The ICTSB has not been as active recently as it was a decade ago and has been largely superseded by the creation of a "Strategy Platform" of stakeholders to advise the Commission as well as proposals related to the future of the ICTSB, and hence affect future consideration of these policy issues.

6.3.2.1.3 CEN

The European Committee for Standardization, CEN, was founded in 1961 by the national standards bodies in the European Economic Community and EFTA countries and is a non-profit making technical organization set up under Belgian law. As will be seen when we review the other ESOs, the scope of CEN standards work is very broad; effectively it covers by default all areas not addressed by the more specific scopes of CENELEC and ETSI.

In addition to Standards mentioned above other principal products are (see 6.4):

- Technical Specification (CEN TS) – normative documents produced in Technical Committees with national delegations, and approved by them, but not undergoing the formal national enquiry process;
- Technical Report (CEN TR) – informative documents produced in Technical Committees with national delegations, and approved by them as informative publications;
- CEN Workshop Agreement (CWA) - normative or informative documents produced in open Workshops and agreed by consensus of those participating.

The Technical Board of CEN coordinates the standards program.

Most standards are drawn up in technical committees and their working groups, whereas CEN Workshop Agreements are drawn up in more short-lived arrangements – Workshops.

6.3.2.1.4 CENELEC

The European Committee for Electrotechnical Standardization, CENELEC, was created in 1973 as a result of the merger of two previous European organizations: CENELCOM and CENEL originating in the 1950s. CENELEC is a non-profit making technical organization set up under Belgian law and is composed of the National Electrotechnical Committees of 30 European countries. In addition, 8 National Committees from neighbouring countries participate in CENELEC work with an Affiliate status.

CENELEC's scope is to prepare electrotechnical standards for electrical and electronic goods and services.

Like CEN, in addition to the traditional European standard deliverables (see 6.1 and 6.4), the dynamic Workshop (CWA: CENELEC Workshop Agreement) has been included in its portfolio, offering an open platform to foster the development of pre-standards for short lifetime products where time-to-market is critical.

6.3.2.1.5 ETSI

The European Telecommunications Standards Institute (ETSI) defines electronic communication standards for products and processes, including protocols and testing, in information & communication technology (ICT).

Its members are drawn from ICT sectors worldwide and it is their technical experts who drive the content and creation of ETSI standards and deliverables. It is worth noting that the membership and participation basis for ETSI is somewhat different from that of CEN and CENELEC, being formed from individuals and organizations⁵ – with no mediating role for NSBs.

In an increasingly global and competitive business environment, standardisation provides a forum for consensus.

In addition to the traditional European standard deliverables ETSI has a suite of specifications, standards and reports that fulfil the various needs of the market (see 6.4). These are referred to as 'deliverables'. It is the ETSI members who determine the standards work program according to their needs.

The published work of ETSI already identified as relevant to eHealth is analyzed in Annex A – Inventory. However, it should be noted that ETSI Special Task Force 355 has produced a Technical Report: TR 102 764, "eHealth architecture; User service models and application classification into service models". This work was an initial step in developing user service models to address interoperable solutions for healthcare data collection, transmission, storage and interchange with the required security, privacy and reliability. The next step of this work was to be to develop requirements and service architecture to provide improved services involving the relevant stakeholders, including users, medical professionals etc. The belief being that such systems contribute to user ubiquitous access to more cost effective care services irrespective to location.^{lxxi} In the event, that work stream was disbanded.

6.3.2.2 International SDOs

6.3.2.2.1 IEC

The International Electrotechnical Commission (IEC), founded in 1906, prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardisation and as references when drafting international tenders and contracts. The IEC charter embraces all electrotechnologies including electronics, magnetics and electromagnetics, electroacoustics, multimedia, telecommunication, and energy production and distribution, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility, measurement and performance, dependability, design and development, safety and the environment.

The IEC produces two categories of publications:

- International consensus products – International Standards (full consensus), Technical Specifications (full consensus not (yet) reached), Technical Reports (information different from an IS or TS), Publicly Available Specifications, and Guides (non-normative publications).
- Limited consensus products – Industry Technical Agreements and Technology Trend Assessments.

In the ICT area the IEC has a joint committee with ISO, known as Joint Technical Committee 1 (JTC1). This is largely autonomous and is examined separately below. In the health area the most apparent linkage is with IEC TC62 – and its subcommittees (IEC SC62A, IEC SC 62B, IEC SC 62C and IEC SC62D); SC 62A produces a range of basic safety standards and SC62 B, C and D produce, among other standards, a set of modality-related safety standards called "particular standards". This work is adopted in CENELEC TC62 (using the Dresden Agreement between the SDOs) – in support of the EU medical devices directive.

The wider AAL agenda will require attention to many disparate IEC TCs and IEC established IEC Study Group 5 "Ambient Assisted Living", which reports directly to the Technical Board, in 2012. Until the date of drafting this section of this report it has only had a preliminary meeting.

6.3.2.2.2 JTC 1

Information technology standardisation has some unique requirements as a consequence of the pace of innovation. Therefore, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1,

⁵ Subject to fee paying membership of ETSI

Information Technology. ISO/IEC JTC 1 has accordingly developed and maintains its own procedures, as well as collaborating with the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) in the maintenance of a guide to collaboration between ISO/IEC JTC 1 and ITU-T and rules for the drafting and presentation of common ISO/IEC/ITU-T texts.

In view of the dynamic nature of IT standardisation, as part of the process of maintenance of its procedures, ISO/IEC JTC 1 develops Supplements to the Procedures for the technical work of ISO/IEC JTC 1 on Information Technology. Such Supplements are published by ISO/IEC and are available from the ISO/IEC Information Technology Task Force (ITTF <http://www.iso.org/ittf>). Such Supplements may be incorporated into subsequent editions of the Procedures for the technical work of ISO/IEC JTC 1 on Information Technology.

The ITTF is responsible for the day-to-day planning and coordination of the technical work of JTC 1 relative to IEC and ISO, and supervises the application of the ISO and IEC Statutes and rules of Procedure.

The scope of JTC 1 is "Standardization in the field of Information Technology" where "Information Technology" includes the specification, design and development of systems and tools dealing with the capture, representation, processing, security, transfer, interchange, presentation, management, organization, storage and retrieval of information.

Its members are National standards Organizations. There are 40 Participating (P) Members and 42 Observers (O) Members. Other organizations participate as Liaison Members. There are 14 Liaison members Internal to ISO and IEC, and 22 External Liaison members.

JTC 1 is composed of 18 Sub-Committees and 2 Special Working Groups and 3 Study Groups, comprising approximately 2100 technical experts from around the world

The final product of the work conducted within JTC 1 is the published international standard. In a typical year around 140 standards are published.

Associated with the development of JTC 1 standards are 40 Registration Authorities which are organizations approved by ISO/IEC for performing international registration in various technical areas.

6.3.2.2.3 ISO

Founded in 1946, the International Organization for Standardization (ISO) is the world largest standards developing organization. Between 1947 and the present day, ISO has published more than 17000 International Standards covering broadly the same wide range of topics as does CEN.

Since 1979, ISO has taken the commitment and implemented all the necessary measures to ensure that ISO's International Standards are fully compliant with the requirements set by the Agreement on Technical Barriers to Trade of the World Trade Organization (WTO). ISO promoted the value of its International Standards to be used worldwide as instruments facilitating the elimination of unnecessary barriers to trade, and, whenever needed, as a suitable basis for technical regulations.

Most early ISO's International Standards were highly specific to a particular product, material, or process. However, during the 1980s, ISO entered into new areas of work, dealing with quality issues, destined to have enormous impact on organizational practices and trade. This accomplishment marked the beginning of the ISO 9000 family of standards – now the most widely known standards ever. The tremendous impact of ISO 9001 and ISO 14001 on organizational practices and on trade has stimulated the development of other ISO standards and deliverables that adapt the generic management system to specific sectors or aspects including Information security, Supply chain security and Medical devices.

Following the decision by the European Union to formulate legislation in terms of very general essential requirements - the so-called "New Approach Directives" there was a widespread perception among European as well as international stakeholders that the single European market needed to be integrated into the wider, global market and that this could best be achieved by ensuring that the standards used to regulate the single European market were also those which regulated the global market. With this in mind, it seemed that what was needed was a set of procedural mechanisms to try to ensure that, to the

largest possible extent, International Standards and European Standards are compatible or, even better, identical. Thus the agreement (called the Vienna Agreement) on technical cooperation between ISO and CEN was approved by ISO Council resolution and CEN General Assembly resolution in 1990, and was published in June 1991. A major benefit is this is to make rational use of the resources available for standardisation by avoiding duplication of work - this meaning that there has to be agreement on work allocation between ISO and CEN. In the health informatics technical committees of ISO and CEN most standards have developed under the Vienna Agreement.

6.3.2.2.4 ITU

6.3.2.2.4.1 General

The International Telecommunications Union (ITU) is the United Nations agency for information and communication technologies.

ITU's mission is to enable the growth and sustained development of telecommunications and information networks, and to facilitate universal access so that people everywhere can participate in, and benefit from, the emerging information society and global economy.

ITU's biggest achievement is undoubtedly the pivotal role it has played in the creation of the international telecommunications network — the largest man-made artefact ever created.

The ITU role in global communications spans Radiocommunication, Standardization and Development. Founded in Paris in 1865 as the International Telegraph Union, ITU took its present name in 1934 and, in 1947, became a specialized agency of the United Nations; it is now based in Geneva, Switzerland. A public-private partnership organization since its inception, ITU now has a membership of 191 countries and over 700 public and private sector companies as well as international and regional telecommunication entities. The Union's consensus-based approach is designed to give a voice to all its members.

ITU is organized into four market-facing 'sectors':

Radiocommunication (ITU-R)

Manages the international radio-frequency spectrum and satellite orbit resources.

Standardization (ITU-T)

Consensus standards-making activity.

Development (ITU-D)

Provides an implementation guidance and task prioritization activity to enable access to ICT.

ITU TELECOM

Is a marketing activity with an annual exhibition, a high-level forum and other outreach.

The activity of the Standardization (ITU-T) and Development (ITU-D) Sectors are examined in more detail here – but the 'Radiocommunication regulatory' and 'Telecom marketing' activities of the other Sectors are of interest in within the holistic view taken by ITU.

Telecommunication Standardization Sector (ITU-T): <http://www.itu.int/net/about/itu-t.aspx>

The main products of ITU-T are the Recommendations. At present, more than 3,000 Recommendations (Standards) are in force. Recommendations are standards that define how telecommunication networks operate and interwork. ITU-T Recommendations are non-binding, however they are generally complied with because they guarantee the interconnectivity of networks and enable telecommunication services to be provided on a worldwide scale.

From 2007 *.pdf format versions of current, in-force, ITU-T Recommendations are freely available.

Individual ITU-T Recommendations are grouped by category which eases accessibility for users – see <http://www.itu.int/publications/sector.aspx?lang=en§or=2>

The ITU Telecommunication Development Sector (ITU-D): <http://www.itu.int/net/about/itu-d.aspx>

The ITU Telecommunication Development Sector (ITU-D) was established to help spread equitable, sustainable and affordable access to information and communication technologies (ICT) as a means of stimulating broader social and economic development and holds a conference to establish concrete priorities to help achieve these goals. Through a series of regional initiatives together with national programs, activities on the global level and multiple targeted projects, the Sector works with partners in government and industry to mobilize the technical, human and financial resources needed to develop ICT networks and services to connect the unconnected.

It promotes an enabling regulatory and business environment through a range of tools for policy-makers and regulators to support innovation and a more efficient marketplace. It supports the deployment of new technologies through projects to bring access to rural communities, and helps create an ICT-literate workforce through technical and policy training initiatives. Acting as a promoter and catalyst for ICT development, ITU-D engages with government leaders and the international donor community to find the right balance between public and private investment. Recognizing that there is no “one-size-fits-all” strategy to create digital opportunity ITU-D assists Member States in elaborating targeted national e-strategies, working to create a culture of security. In addition, ITU-D offers statistics on trends and developments in the ICT field and organizes study groups on issues facing governments and industry.

ITU-D provides opportunity for governments and private sector companies interested in forging new development partnerships, by identifying “win-win” opportunities for collaboration, and linking external partners with experienced ITU project specialists to ensure successful project implementation.

ITU-D’s activities, policies and strategic direction are determined by governments and shaped by the industry it serves. The Development Sector’s diverse membership includes telecommunication policy-makers and regulators, network operators, equipment manufacturers, hardware and software developers, regional standards development organizations and financing institutions.

The mission of the Telecommunication Development Sector (ITU-D) encompasses ITU’s dual responsibility as a United Nations specialized agency and an executing agency for implementing projects under the United Nations development system or other funding arrangements.

6.3.2.2.4.2 International SDO cooperation

The World Standards Cooperation (WSC <http://www.worldstandardscooperation.org/>) was established in 2001 by the International Telecommunication Union (ITU), the International Organization for Standardization (ISO), and the International Electrotechnical Commission (IEC) in order to strengthen and advance the voluntary consensus-based international standards systems of ITU, ISO, and IEC. The WSC also promotes the adoption and implementation of international consensus-based standards worldwide; and resolves any outstanding issues regarding cooperation in the technical work of the three organizations.

Several initiatives have been undertaken by the WSC since its constitution, including workshops, education and training, and the promotion of international standards system in several contexts.

ITU, ISO, and IEC believe that international standards are an instrument enabling the development of a harmonized, stable and globally recognized framework for the dissemination and use of technologies, best practices and agreements, which support the overall growth of the Information Society. Indeed, their transparent and consensual mechanisms, based on the possible contribution of all interested stakeholders, as well as their extensive network of national members, represent strong assets for market relevance and acceptance, as well as for more equitable development.

The three organizations are working together to implement the strategic role of international ICT standards for development and trade, as recognized and reflected in the declaration of principles and plan of action adopted by WSIS.

Many ITU-T Recommendations are jointly developed and/or published with IEC and ISO – usually through JTC 1. With free access to these only from ITU, and with the Dresden and Vienna Agreements

between IEC/CENELEC and ISO/CEN respectively this clearly creates an asymmetry in the business models.

6.3.2.2.5 WHO

In May 2008 the World Health Organization (WHO <http://www.who.org/>), as a long-established contributor of standard classifications for public health purposes, issued the following text on the subject of collaboration on health information standards.

The WHO openly recognizes the leading role of the International Organization for Standardization and its TC215, the European Committee for Standardization (CEN) and its TC251, Health Level 7 (HL7) and the International Health Terminology Standards Development Organisation (IHTSDO). It also acknowledges the work initiated by the eHealth Standardization Coordination Group (eHSCG), in which WHO participated and which brought together representatives from ISO/TC215, CEN/TC251, HL7, DICOM, IEEE, and ITU.

Within its 2009-2015 program of work, WHO has merged all its activities in the field of health informatics within the newly established department called Health Statistics and Informatics. As the name suggests, the department continues the traditional role of WHO compiling health statistics under a new web portal called the World Health Observatory.

A new stream of work on health informatics has been created merging WHO's previous lines of work on eHealth, knowledge communities, classifications and terminologies and GIS to have more coordination and coherence, and to benefit from the critical mass. A new health information strategy is being developed in consultation with multiple parties and stakeholders around the world.

Under that stream of work a new activity has been formally recognized in the line of Health Information Standards. To that end, a systematic review of standardisation and standards implementation in the health sector is currently taking place. Until recently, the main line of activities had been in the field of ICT standards for health. The Health Information Standards, however, i.e. those relating to content knowledge like indicators, diagnostic guidelines to guide the implementation of policies and the development of adequate tools, have received less attention. In view of the digitalization of health information services, proactive thinking is needed to establish a more comprehensive and action-oriented inventory of the current health information practices and standards, together with an analysis of their actual implementation. This activity has been placed under the Classifications, terminologies and Standards unit.

As a priority contribution to international work in that area, WHO considers that a Global Health Information Standards Repository could serve as an access and dissemination platform for health information standards and their implementation. Building on work already initiated elsewhere, and in partnership with leading standards development institutions, WHO would undertake to mobilize support and resources to build an international health information objects repository (International IOD repository) and to coordinate health information standards implementation aspects on a web-based platform. Registered users would be invited to browse, search and download standards for use in their health information systems.

As a semantic wiki with a contextual database accessible under an open access policy, due consideration being given to the administration of socio-economic and legal issues, such as liability, intellectual property and security, the proposed platform would facilitate access to existing health information standards. It would also assist in identifying needs, priority areas and gaps in content areas where health information standards are being contemplated, developed or tested, and assist in the harmonization and complementary aspects of the work of HIS developers. It would serve to communicate on, and promote the adoption and use of, endorsed health information standards. It could also be used to monitor the adequacy of health information standards, including with regard to their development, uptake and implementation.

WHO, in response to its Member States' request in numerous areas relevant to public health action, invites all interested parties to join in discussions to create a common roadmap for this activity, focusing on its form, functions, resources and sustainability. It should result in a joint international plan of action

that would involve other UN bodies and related organizations, EU partners, excellence centers around the world, foundations and industry partners.

6.3.2.3 ANSI affiliated SDOs

6.3.2.3.1 IEEE

A non-profit organization, IEEE is probably the world's largest professional association for the advancement of technology with in excess of 375,000 members in more than 160 countries.

The IEEE Standards Association (IEEE-SA) is a developer of industry standards in a broad-range of industries and has strategic relationships with the IEC, ISO, and the ITU and satisfies all SDO requirements set by the World Trade Organization.

The best-known ICT standards originating in IEEE are undoubtedly those for 'Ethernet' and its derivatives (the 802 series), though there are a number of activities of more specific relevance to AAL; of which the 11073 (formerly known informally as MIB) is 'sponsored' by the Engineering in Medicine and Biology Society (EMBS) and is concerned with medical and personal health device communications.

Since the formation of ISO TC215, the IEEE 11073 has been the vehicle by which the global work on point-of-care medical device communication has been harmonized by merging CEN and IEEE work into a series now, for the most part, developed, owned and published jointly by all three bodies under the lead of IEEE.

The published and in-progress work of IEEE 11073, where it is not on the ISO and CEN work program is nevertheless directly relevant to health and care aspects of AAL.

6.3.2.3.2 HL7

HL7 (Health Level 7) is a US-headquartered standards organization with central offices, international country affiliates, and topic-oriented working groups. HL7 is, unlike the representational structures of CEN and ISO and their national counterparts, based on individual or corporate membership. The original process for defining HL7 messages was established in 1987. Today HL7 is ANSI accredited and an open dialogue platform (Joint Initiative Council – JIC) with ISO and CEN has been established.

HL7 products currently come in two main modes, namely HL7 v.3 and HL7 v.2.X (X=8 currently), but there are complementary standards covering other aspects of communication in healthcare. HL7 V3, like V2.x, is a standard for exchanging health information among information systems that support healthcare applications. HL7 V3 Specifications (e.g. HL7 V3 messages, structured documents, etc.) permit loosely coupled information systems to interoperate (i.e. exchange data) in a variety of healthcare delivery contexts including those found in disparate provider organizations, perspectives, and jurisdictions.

In V3 HL7 volunteers have sought to improve the V2 process and its outcomes. The development principles behind HL7 V3 are intended to lead to a more robust, fully specified standard. Not all areas covered by v2.X are as yet addressed by V3; and some inherently close-coupled processes may not benefit from the functions of V3 in the short term. For that reason, and because v2.X is still in more widespread use, content of both versions are presented in our inventory.

HL7 is pragmatic in its origin; it uses events as triggers and roles as central information flow entities. Although it started as a message exchange (a set of information assembled for the purpose a specific exchange) standard HL7 is no longer only a point-to-point messaging standard; in particular The Clinical Document Architecture (CDA) is designed to support standards for storing and retrieving persistent information, such as Medical Records, and in its current release 2.0 is tightly integrated with the HL7 V3 Reference Information Model (RIM). HL7 develops specifications, standards, and in some cases some tools related to the electronic documentation of its standards.

HL7 has other publications covering: The Clinical Context Object Workgroup (CCOW) Context Management Specifications, Arden Syntax for Medical Logic Systems, HL7 Security Service Framework, Continuity of Care Document (CCD), Functional Profiles for Personal and Medical Health Records, and GELLO: A Common Expression Language.

Although an application layer standard, thus the 7 in its name, from the number of the application layer in the ISO OSI reference model^{lxxii}, HL7 also produces infrastructure (transport) specifications for its messages, by building upon a selection of IT standards, such as ebXML^{lxxiii}.

6.3.3 Consortia

6.3.3.1 Continua Health Alliance

The Continua Health Alliance (<http://www.continuaalliance.org>) is a membership organization with around 200 members. Most members are product manufacturers, but there are a small number of both healthcare providers and research organizations.

The Continua Design Guidelines (now at Version 2012) combine healthcare informatics data standards with consumer electronic technologies. This integration provides the specifications necessary to enable connectivity across a wide variety of personal telehealth devices and services. The adopted standards for devices include the Zigbee Healthcare Profile, Bluetooth Health Device Profile (HDP) and Bluetooth LE Specifications from the Bluetooth SIG for wireless connectivity, the USB Personal Health Device Specification from the USB Forum for wired device connectivity, and Personal Health Device Specifications from ISO/IEEE for protocol and data definitions. The standards for integration with standards-based electronic care records consist of the CDA-based Personal Health Monitoring Report (PHMR) Specification from HL7 and the Cross-enterprise Report (XDR) Profile Specification from IHE. Guidelines are made publicly available after they are finalized and issued to members.

Continua uses a Use case driven process where all members have input to decisions on which integration capabilities are developed. Continua's goal is not to create new standards but to identify the best in class existing standards that satisfy the Use Case requirements and provide profiling to ensure tight interoperability. Continua will develop a set of design guidelines and will coordinate changes in existing standards to enable a set of personal telehealth use cases.

Continua collaborates with a number of government regulatory agencies to develop methods for safely and effectively regulating diverse multi-vendor personal telehealth solutions.

Continua participates with other industry organizations to help create the new business models needed to appropriately reimburse professional services for personal telehealth solutions.

Continua is currently proposing its guidelines to ITU-T for publication, and simultaneously seeking liaison with ISO (TC215) and IEC.

6.3.3.2 GS1

GS1 is a global standard organization, resulting from the merger of EAN International and the Uniform Code Council (UCC), headquartered in both Belgium and the USA. This organization has developed since the 1960's a suite of standards used by companies across the world to enhance the supply chain; including identification, traceability, cataloguing, and electronic communication. GS1 standards have a global scope and they are used by organizations in 20 different sectors including retail, food and beverage, transport, chemicals and healthcare.

GS1 is organized as a federation, with affiliate member organizations in more than 100 countries. The user' community is affiliated to the local member organizations. The organization works closely with ISO and UN/CEFACT to define, propose and refine standard sets which are implemented by its user community.

GS1 products are organized in four main groups, namely: BarCodes, eCom, GDSN and EPCglobal. All are based on common identification keys and semantics.

- BarCodes is the grouping of optical data carriers which are designed to carry information according to GS1's semantic that is based on "Application Identifiers". Different barcodes are defined to be used according to business needs, from logistics (GS1-128) to patient safety in the medication process (GS1 DataMatrix).

- eCom groups the set of electronic messages for supply chain partners, to implement business processes as ordering, transport, delivery, financial transactions, etc. GS1's users have defined EANCOM, a subset of UN/EDIFACT, and GS1-XML, largely aligned with UN/CEFACT ebXML.
- The Global Data Synchronization Network (GDSN) is an architecture allowing manufacturers to share detailed product descriptions with their existing and potential customers through a network of electronic product master data catalogues.
- EPCglobal develops and promotes a set of standards combining RFID (radio frequency identification) technology, communication networks and the Electronic Product Code (a number for uniquely identifying an item) to enable immediate and automatic identification and tracking of items through the whole supply chain globally, resulting in improved efficiency and visibility.

The Global Standards Management Process, or GSMP, is the worldwide collaborative forum where GS1 standards are built and maintained. The GSMP brings together users from all industries and from everywhere in the world to identify needs for standards, gather business requirements, document best practices, obtain consensus on solutions, and then develop and implement the resulting supply chain standards.

6.3.3.3 Integrating the Healthcare Enterprise (IHE)

Integrating the Healthcare Enterprise (IHE <http://www.ihe.net>) International is an organization established to help users and developers of information technology for healthcare to achieve interoperability of systems through the precise definition of healthcare tasks, the specification of standards-based communication between systems required to support those tasks and the testing of systems to determine that they conform to the specifications. IHE is an initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information. IHE promotes the coordinated use of established Base Standards such as ISO, DICOM, HL7, IEEE, IETF, OASIS, W3C, etc, to address specific clinical needs in support of optimal patient care.

Implementing integrated information systems can be complex, expensive and frustrating. Healthcare professionals seeking to acquire or upgrade systems do not have a convenient, reliable way of specifying a level of adherence to communication standards sufficient to achieve truly efficient interoperability. Great progress has been made in establishing such standards, but a gap persists between the Base Standards that make interoperability possible and the actual implementation of integrated systems. To fill in that gap has, until now, required expensive, site-specific interface development to integrate even Base Standards-compliant systems.

The IHE initiative is designed to bridge the gap. Within IHE healthcare professionals, including members of its sponsoring organizations, identify the integration capabilities they need to work efficiently in providing optimal patient care. Representatives of clinical modality and information systems companies then reach consensus on a specific implementation of established communication standards that provides those capabilities. Their selections are recorded in the IHE Technical Framework, a detailed resource for the implementation of Base Standards that is freely available to the whole industry. The Technical Framework is open to public comment and is proven via an industry-wide testing and implementation process. The process works by annual cycles, expanding the scope of integration capabilities each year.

6.3.3.4 Internet Engineering Task Force (IETF)

The mission of the IETF (<http://www.ietf.org>, itself part of The Internet Society) is stated to be “to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.”

IETF Working Groups (WGs) are the primary mechanism for development of IETF specifications and guidelines, many of which are intended to be standards or recommendations. These are published as Request for Comments (RFC) – which are never altered after initial publication – if necessary they are superseded.

Working Groups are typically created to address a specific problem or to produce one or more specific deliverables (a guideline, standards specification, etc.). Working Groups are generally expected to be short-lived in nature. Upon completion of its goals and achievement of its objectives, the Working Group

is terminated. Each Working Group has a charter. WG charters state the scope of work for group, and lay out goals and milestones that show how this work will be completed.

6.3.3.5 OASIS

OASIS (Organization for the Advancement of Structured Information Standards <https://www.oasis-open.org/>) was founded in 1993 under the name SGML Open as a consortium of vendors and users devoted to developing guidelines for interoperability among products that support the Standard Generalized Markup Language (SGML). OASIS changed its name in 1998 to reflect an expanded scope of technical work, including the Extensible Markup Language (XML) and other related standards.

OASIS is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society. The consortium produces more Web services standards than any other organization along with standards for security, e-business, and standardisation efforts in the public sector and for application-specific markets. OASIS has more than 5,000 participants representing over 600 organizations and individual members in 100 countries.

OASIS is distinguished by its transparent governance and operating procedures. Members themselves set the OASIS technical agenda, using a lightweight process expressly designed to promote industry consensus and unite disparate efforts. Completed work is ratified by open ballot. Governance is accountable and unrestricted. Officers of both the OASIS Board of Directors and Technical Advisory Board are chosen by democratic election to serve two-year terms. Consortium leadership is based on individual merit and is not tied to financial contribution, corporate standing, or special appointment.

A wide range of informal relationships means that a number of SDOs have used OASIS specifications in an eHealth context – as can be found by searching for "health" on the OASIS website.

6.3.3.6 OMG

OMG (Object Management Group <http://www.omg.org>) has been an international, open membership, not-for-profit computer industry consortium since 1989. Any organization may join OMG and participate in its standards-setting process. Its one-organization-one-vote policy ensures that every organization, large and small, has a voice in its process. Its membership includes hundreds of organizations, with half being software end-users in over two dozen vertical markets, and the other half representing large and small organizations in the computer industry.

OMG's modeling standards, including the Unified Modeling Language (UML) and Model Driven Architecture (MDA), enable visual design, execution and maintenance of software and other processes, including IT Systems Modeling and Business Process Management. OMG's middleware standards and profiles are based on the Common Object Request Broker Architecture (CORBA) and support a wide variety of industries.

The requirements document that initiates each OMG standard-setting activity (the Request for Proposal) and other key documents are available for viewing by anyone, member or not. Email discussion, meeting attendance, and voting are restricted to members; though prospective members are invited to attend a meeting or two as a guest observer.

Many SDOs and other consortia maintain liaison relationships with OMG. OMG is an ISO PAS submitter, able to submit specifications directly into ISO's fast-track adoption process. OMG's UML, MOF and Interface Definition Language (IDL) standards are already ISO standards and ITU-T recommendation.

6.3.3.7 Open Group

The Open Group (<http://www.opengroup.org>) is a global consortium that claims to enable the achievement of business objectives through IT standards. It has a diverse membership of more than 400 member organizations covering all sectors of the IT community.

The mission of The Open Group is "to drive the creation of *Boundaryless Information Flow*[™] achieved through global interoperability in a secure, reliable and timely manner."

Members participate in The Open Group through Forums and Work Groups that address a comprehensive range of technical, business, legal and regulatory issues. Each Open Group Forum and Work Group focuses on a specific area, and provides an objective and legal environment where members collaborate on developing standards, certifications and best practices in their areas of interest and expertise.

6.3.3.8 W3C

The World Wide Web Consortium (W3C <http://www.w3.org/>) develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding.

The World Wide Web Consortium (W3C) is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is "To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web."

W3C primarily pursues its mission through the creation of Web standards and guidelines. Since 1994, W3C has published more than 110 such standards, called W3C Recommendations. W3C also engages in education and outreach, develops software, and serves as an open forum for discussion about the Web. In order for the Web to reach its full potential, the most fundamental Web technologies must be compatible with one another and allow any hardware and software used to access the Web to work together. W3C refers to this goal as "Web interoperability." By publishing open (non-proprietary) standards for Web languages and protocols, W3C seeks to avoid market fragmentation and thus Web fragmentation.

W3C's global initiatives also include nurturing liaisons with national, regional and international organizations around the globe. These contacts help W3C maintain a culture of global participation in the development of the World Wide Web. W3C coordinates particularly closely with other organizations that are developing standards for the Web or Internet in order to enable clear progress.

W3C operations are supported by a combination of Member dues, research grants, and other sources of public and private funding, and the Supporters Program. [...] The W3C Offices work with their regional Web communities to promote W3C technologies in local languages, broaden W3C's geographical base, and encourage international participation in W3C Activities.

6.4 Standards deliverables

The various terminologies applied to the types and status of formal standards can be confusing to the uninitiated, so the following Table 5 attempts to clarify some of the more commonly occurring terms, and give a (simplified) indication as to equivalence with some of the other SDOs.

Being simplified and non-exhaustive, this cannot reflect the detail of equivalence between deliverables – and in practice it makes little difference to their acceptance. Nor can we readily establish the comparative real-world value of the outputs.

Sadly, it is common for some groups in many of the bodies listed in Table 5 to issue specifications and standards without any evidence that they have actually been tested in real working systems^{lxixv}.

As an example of good practice, the requirements of the **Information Standards Board for Health and Social Care (ISB HASC)** in the UK NHS (and perhaps analogous bodies in other nations) are explicit about their expectations of developmental stages:

There are three sequential stages of standard, each with a specific focus that ensures that the developer and sponsor of a standard ultimately has provided evidence through testing that a standard is needed, is fit for purpose, is implementable and integrates with other standards.

- At Requirement standard stage, ... assures that there is a defined need for the standard to be developed for use [within the UK care sector] and that there is a funded development and implementation plan;

- At Draft standard stage, ... assures that there is early evidence [through testing] of the standard being able to deliver the benefits which were described in the 'Requirement';
- At Full standard stage, ... assures that there is evidence that the standard is implementable, interoperable and safe and is supported by an ongoing maintenance and update process.

Table 5: Comparison of terms and equivalence between standards bodies

WTO* Stage / status →	Preliminary / preparation			Non-normative		Normative
Body ↓						
CEN Cenelec	New work item (NW)	Working draft (WD) then Committee draft (CD)	Public draft for Enquiry (prEN) Draft Workshop Agreement on web for comment (CWA)	Technical Report (TR)	Workshop Agreement (CWA)	European Standard (EN) Technical Specification (TS) Workshop Agreement (CWA)
ETSI	Proposal	Working draft (WD)	Committee draft (CD)	Group Specification (GS) / Special Report (SR) /	Technical Report (TR) / ETSI Guide (EG)	Technical Specification (TS) ETSI Standard (ES) European standard (EN)
ISO IEC	New work item (NW)	Working draft (WD) then Committee draft (CD)	Public draft for international ballot (DIS/FDIS)	Technical report (TR)	Technical specification (TS)	International Standard (IS)
ITU	Proposal	Working draft (WD) then Committee draft (CD)	Public draft for international ballot	Technical report		Recommendation
HL7	Proposal	Committee draft	Draft for Membership Ballot	Implementation guidance	Draft standard for trial use (DTSU)	Standard
IEEE	Project authorization request (PAR)	Committee draft	Draft for Membership Ballot	Guide	Technical specification (TS)	Standard
Continua	Use Case Capability Proposal	White Paper	Draft for Membership Ballot	Draft Design Guidelines	Design Guidelines	N/A
GS1	Proposal (Change Request)	Business Requirement Analysis Document	Business Solution Design	Technical Solution Design	Pilot	Standard (Posting)
IHE	Profile proposal	Draft Supplement for Public Comments	Trial Implementation Supplement	White Paper	Technical Framework	N/A
W3C	Proposal	Committee draft	Public draft - Membership ballot			Recommendation

*NOTE: The WTO stage/status, and solid background colour, indicates direct recognition at intergovernmental treaty (World Trade Organization) level.

The striped background indicates indirect WTO recognition through ANSI affiliation.

The deeper color assigned to the EN indicates that, at present, it has priority status over all other standards and requirements in public sector procurements inside the EU.

7 Finding a strategy

The range of standards-producing organizations is huge and baffling for most. Rather few of these organizations have an obvious and direct relationship with AAL; but many will probably have a number of areas of work that have some contribution that can be made – as demonstrated by the mindmap of relationships presented in. The breadth of the contribution area depends of course on the scope of interpretation of the term AAL.

For that reason we are building our recommendations from the base of where assistive technology is today, and then looking forward to the extent possible in the time available.

Rossi Mori, in a recent piece of EU policy research^{lxxv}, distinguishes two complementary technology domains:

- the artefacts that act on specific functions, e.g. a wheelchair, an aerosol therapy device, a hearing aid or a sensor of movement; and
- the tools to manage information and communication that can cope synergistically with multiple requirements and goals.

He identifies the first group as including all the assistive equipment and medical devices that directly deal with the impaired functions of an individual, as well all the clinical devices used by healthcare professionals and the equipment for surveillance and signalling alerts.

He then observes that an array of more and more complex equipment is being developed and adopted, which embed functions of information processing and communications capabilities. For example, common to both domains is all the modern equipment considered in the realm of activities of daily living domotics (for measurements, alarms, surveillance, comfort of daily activities), which are increasingly connected to networks for remote control and communication.

The second kind of technology includes all the services involving the management of information and knowledge. Their recording, storage, retrieval and communication is carried on by several participants (e.g. the individual, the informal carers, professionals, managers), together with the management of the data that are generated or used by an increasing number of the pieces of equipment from the first group.

Progress in the electronic management of information and communications and the increased performance of home equipment may facilitate the introduction of dramatic changes in the organization of health and social care. In particular, technological solutions could assist the move towards a more sustainable care system, to effectively transform the care provision towards the community, by supporting more independent living and reducing unnecessary hospitalizations.

He does not then move on to consider the bigger challenge of making some of these assisted living technologies 'ambient' as distinct from additive. This pragmatic omission provides a useful clue as to how we might address the roadmap strategy in an evolutionary manner – something that is also more likely to resonate with market forces. However we are going to propose a reversal and minor amendment of the first two groups of technology, and then add the third to address transgenerational design (5.3) in line with the future strategy outlined in 5.6:

- the tools to sense, manage and communicate information to assist, synergistically, with multiple requirements and goals;
- the physical artefacts that act on or support specific functions, e.g. a wheelchair, a cane, etc.;
- assistive functions to be embedded in familiar objects, as well as for new assistive technologies to embody 'natural' interfaces within familiar environments.

As with all pragmatic attempts to organize thought, there will be some difficulties with overlaps and boundaries – but it is at least a starting proposal.

Work to address any of these topic areas will be of no real world value unless it can connect with the user community and with the carer community at the functional and design level, at least as effectively as with engineering and professional interests. It is worth noting that the interoperability profiles emerging from the i-focus activity^{lxxvi} are addressing the immediate concerns of the other *dallas* communities. It is hoped that the roadmapping slideset^{lxxvii} to accompany this document will enable a wider exploration of the hot issues and that in doing so an evolutionary strategy can be developed to take the islands of provision that currently exist forward into a more coherent infrastructure that will enable assisted living to become truly ambient.

Rossi Mori^{lxxv} considers many of the details of needs and considerations affecting technological solutions potentially influencing the future of long-term care, and there is no benefit to repeating them here, and his report is certainly recommended reading on the topic.

8 Summary & conclusions

8.1 Summary

This report has attempted to review the scope of Ambient Assisted Living as standards (notably for interoperability) relate to it, and has implicitly anticipated a progression from the current islands of disconnected functionality toward integration of those islands (which themselves are likely to expand) such that technologies including ICT are embedded in many aspects of everyday life to the point where they are no longer noticeable.

Because one of the major factors in the success of the adoption of any technology is its fitness for purpose we also examined a wide range of ability impairments that have to be accommodated if AAL is to be fit for all. We have therefore reviewed a range of technologies and materials (but not all, and not in detail) to understand their likely impact on AAL development. This was followed by a brief review of current provision and what the interoperable technology aspirations for the future might be.

With that background in place the report then examined standards development activities within BSI and international SDOs and from some of the major consortia with a broad range of technology interests.

The associated slideset <<ALIP_InteropStdsRoadmap_Slideset_20130325.pdf>> is intended to build on this detailed, if incomplete, background to aid consensus formation on a strategic standards roadmap, at least as conceived in March 2013. Attention is again drawn to the other relevant standards resources described at 6.2.4.

8.2 Conclusions

AAL is not primarily about technologies, but is about the application of those technologies to a complex topic which embraces medical, social, business, personal and technical dimensions. To achieve success the standards-producing process has to engage those interests to work together to reach consensus; success in achieving that engagement and consensus is not inevitable.

Acting alone as TSB ALIP would be the most difficult way to take forward standardisation in an area that is not primarily technical. It is our view that TSB ALIP should not deliberately embark on a sole source activity that would probably also be competitive to other similar activities. The new i-focus *dallas* project with its i3i activity should be well-placed to broker the necessary consensus, and to represent UK views and interests into Europe and the rest of the world.

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