Interoperability in AAL

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2 Introduction: What is Interoperability?

- Many definitions of the term “Interoperability” exist
- There are multiple “layers” of Interoperability:
  - **Protocol Interoperability**: the ability to exchange bits & bytes over a network
  - **Syntactic/Functional Interoperability**: the ability to exchange messages/data in a well-known format
  - **Semantic Interoperability**: the ability to provide a common understanding (semantics) of the data exchanged
  - **User Perceived Interoperability**: Components of a system communicate with one another effectively, correctly and provide the expected services to the user.
- User perceived interoperability is what we need, but all other layers are necessary preconditions!
3 Why is Interoperability Important for AAL?

- The ability to connect and exchange information is one of the distinguishing marks of AAL systems.
  - This makes interoperability indispensable for AAL.

- A survey among participants of the 2008 German AAL Congress asked for the most important factors that could prevent a successful introduction of AAL.
  - The two issues that received the highest rating were “interoperability problems” and “missing standards”.

- Much research is going into AAL currently, but with regards to standards, interfaces and interoperability the developments so far are fragmented, uncoordinated and often proprietary.
  - Very similar to state of medical IT 10-15 years ago
  - Consolidation towards a few interface standards for AAL quite desirable
4 Things that can go wrong…
when connecting devices

► Connectors don’t fit
  ► How many different USB connectors are there?
► Different network protocol
  ► Bluetooth, ZigBee, and WLAN all use the same frequency
► Different transport protocol
  ► HTTP, SOAP, RTP, WebDAV, HL7 MLLP, …
► Different application level protocol
  ► ECG transmitted in DICOM, HL7 aECG, SCP-ECG, or ISO/IEEE 11073-10306 format?
► Different interpretation (semantics) of data transmitted
  ► Everyone using SI units here?
  ► ECG leads clearly labeled?
  ► Character set: ASCII, UTF-8, UCS-2 or Latin-1?
  ► HL7 “veterans military status” vs. “patient’s profession”

5 The Interoperability Working Group
of the German BMBF/VDE Innovation Partnership on AAL

- A non-profit working group addressing issues of Interoperability in AAL
- Comprised of 17 experts from different domains
  - Home/building automation, medical IT, household appliances, consumer electronics, network technology, AAL middleware platforms, sensor networks, robotics, cognitive systems, standardization and certification.
- Mission:
  - To document the state of the art
    - standards with relevance for AAL
    - approaches to ensuring interoperability
  - To identify challenges and “missing links”
  - To provide recommendations to policy makers, industry, standardization and users
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► The main artifact of the Interoperability WG will be a „whitepaper“ in German language
  ► To be published as a two-volume book

► Interoperability of AAL System Components
  ► Part 1: State of the Art (Autumn 2009)
  ► Part 2: Roadmap (Spring 2010)

► The “AAL interoperability challenges” presented on the following slides are (preliminary) results of this work.
## Introduction: Interoperability

### Software Platforms
- Terminologies
- Runtime environments
- AAL Infrastructures
- Health Card & Telematics Infrastructure
- Personal Health Records
- Integration Profiles

### Data Formats
- in IT / Consumer Electronics
- in Medical Technology
- in Home/Building Automation
- Character Sets

### Communication Protocols
- in IT / Consumer Electronics
- in Medical Technology
- for Household Appliances
- Interfaces for Smart Metering

### Networks and Buses
- Cables
- Connectors
- Ethernet
- Powerline
- Field Buses & Building Automation
- Wireless Networks

### Devices and Sensors

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**Part 1: State of the Art**
8 Interoperability Challenges:
AAL brings together different Market Segments

- AAL brings together components, products and vendors from different market segments:
  - Building automation
  - Household appliances
  - Medical devices
  - Consumer electronics
  - Microsystem technologies
  - Telecommunications

- These all have different standards, different terminology, different products, and address very different markets in terms of price sensitivity, distribution channels, market “players” etc.

- Who can design a system that combines vital signs with data from building automation, detects an emergency, establishes contact via a TV set, switches off a cooker, and calls for an ambulance?
9 Interoperability Challenges:
A Multitude of Relevant Standards and Norms

► Which of these are relevant for your AAL system?
  ► Cabled Networks: Ethernet (32 variants!), HomePlug, HomePlugAV
  ► Point-to-Point: DisplayPort, DVI, FireWire, HDMI, SCART, USB
  ► Field Buses: BACnet, BatiBUS, EHS, KNX/EIB, LON
  ► Wireless Networks: WLAN, ZigBee, Z-Wave, EnOcean, Bluetooth, DECT, HomeRF
  ► Network Protocols: AFP, BitTorrent, Bonjour/Zeroconf, CalDAV, CUPS, DHCP, DNS, DPWS, DynDNS, FTP, HTTP, IMAP, IPP, IRC, JetDirect, LDAP, LPR, NAT-PMP, NFS, OMA DM, POP3, RTP, RTSP, SIP, SMB, SMTP, SNMP, SSDP, SSH, TFTP, TR-069, UPnP, WebDAV, CHAIN/AIS, SML,
  ► Medical: aECG, CCD, CCR, CDA, DICOM, EDF, EDIFACT, HL7, IHE, ISO/EN 13606, ISO/IEEE 11073, PHMR, SCP-ECG, xDT, XPHR, ICD-10, ICHI, ICPM, LOINC, OPS, SNOMED, UCUM, UMLS
  ► Runtime: OSGi, .NET, Linux, MIDP
  ► Middleware: Agent System, SOA, Event Based, URC
  ► A real challenge for product designers, developers, integrators
10 Interoperability Challenges: Rivaling Standards

- In an ideal world, we would have exactly one standard for each task or interface.
- In reality, there are often overlapping or rivaling standards, driven by different vendor “camps”:
  - Building automation: KNX/EIB, LON, BACnet
  - Wireless networks: Bluetooth, ZigBee, WLAN, EnOcean, Z-Wave
  - ECG file formats: DICOM, HL7 aECG, SCP-ECG…
- So what can an AAL developer do?
  - Support all standards? Too expensive.
  - Wait for one standard to replace all others? May not happen.
  - Implement a software abstraction layer that permits certain interfaces/standards to be replaced? Good if possible.
  - Choose one standard and accept incompatibility with all others? Bad, but sometimes the only choice.

“The beauty of standards is that there so many to choose from!”
[Andrew S. Tanenbaum, 1990]
11 Interoperability Challenges:
Missing Standards

- For many topics relevant for AAL, there simply are no standards (with market acceptance) yet
  - Remote Maintenance of AAL Systems
  - Connecting to Medical Sensors
  - AAL Terminology
  - AAL Middleware / Service Execution Environment
  - Emergency Calls and Connection to Call Centers

- This forces everybody to “re-invent the wheel” with every new product/project.
12 Interoperability Challenges: 
Integration with Healthcare IT

► AAL technology enables us to permanently monitor relevant health parameters at home:
  ▶ Detection of adverse events / emergencies
  ▶ Better information for follow-up
  ▶ Better patient involvement & better compliance
► How to ensure that the AAL system at home „knows“ which values are critical for this user?
► How to ensure that the data measured at home is available to the family doctor or specialist for follow-up?
► This requires connectivity between „professional“ healthcare IT and AAL systems at home
  ▶ IT infrastructure in hospitals and practices is not prepared for this at all!
  ▶ The fact that health insurance (at least in Germany) will not pay for such services does not help either…
13 **Interoperability Challenges:**

**Product Labeling**

► **Product Component Classification**
  ► When purchasing a device such as a scale, the product's classification with regard to reliability and precision is not obvious: consumer product (fitness, wellness) or medical device. Both carry a CE mark.

► **Interoperability of AAL Components**
  ► When purchasing a component, it is not easily possible to determine whether or not that component can be integrated into an existing AAL system.

► **Capabilities of AAL Products**
  ► The capabilities of an AAL product should be described through a harmonized terminology (compare DVD players: plays MP3, plays VCD, supports 5.1 audio…)

► This all calls for a harmonized approach towards product labeling (and possibly certification) in AAL.
14 Conclusion

- Interoperability is one of the topics AAL research needs to address
- Interoperability Challenges:
  - Complex topic (many domains involved, many standards, no harmonized product labels);
  - Rivaling standards here, missing standards there;
  - Integration with healthcare IT not clear.
- However, Interoperability is just one out of many challenges AAL research needs to address:
  - Robustness (systems that work in “real life”)
  - Sustainable business models (hybrid products etc.)
  - Usability
  - Training for planners, plumbers & technicians