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# Possibilities of implementing Ambient Assisted Living concept in traffic environment

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## ABSTRACT

Demographic trends at national levels, caused by the aging of the population, raise the barriers to the possibilities of higher quality of living of the people when their working part of life comes to an end. The contribution to increasing the quality of life can be mostly realized by using customized information-communication solutions and services within the concept of “Ambient Assisted Living” (AAL). The AAL concept uses the advanced available technology to enable new products, services and processes that help ensure higher quality of living for the elderly, the disabled and persons of slow mobility. It also supports enhanced social connectivity, access to the outside world and it should provide inclusion and mobility (autonomy) to all persons. By applying the AAL concept in everyday movements and lives of the users allows the creation of the user base of all relevant information. With synergic action of several technologies the AAL concept becomes even more complex. In order to present this complexity, the paper describes the capabilities of individual technologies depending on the users’ needs, and the models of establishing the possible solutions. The application of the AAL concept in the traffic environment can contribute to significant increase in the quality of life also outside the basic environment (flat, house...). It is necessary to explore also the challenges of the interoperability and the area of coverage of services based in this way because of the sensitivity of the target users to the reliability of the system operation.

**Keywords: assistive technologies, mobility, elderly persons, persons with reduced mobility, ICT**

## 1. Introduction

According to the data provided by the World Health Organization (WHO) by the year 2025 twenty-five percent of the population in the European Union will be older than 65. The EU defines this phenomenon as “Active Aging”, which means aging with good health and active participation in the society, greater fulfilment at the workplace, greater independency in everyday life and greater civic involvement. Regardless of their age the persons may continue to be part of the society and enjoy in better quality of living. The challenge is to make more of the already existing potential owned by the elderly, even in more advanced age.

Today’s development of information and communication technologies (ICT) can contribute to better quality of life of the

elderly and persons of slow mobility (users). The concept that is based on the application of advanced ICT solutions and services for the mentioned purpose is called Ambient Assisted Living (AAL). The goals of such a concept are:

- Prolongation of lives of people in places which prefer upgrading of their independence, self-control and mobility;
- Maintenance of users’ health and functionality;
- Promotion of better and healthier life for the risk group of users;
- Enhancement of the level of safety, prevention of social isolation and maintenance of multifunctional networks around the individuals;
- Support by the caregivers, family, and care agencies, and
- Increase of efficiency and productivity of resources used in an aging society.

AAL concept includes the adaptability of products, services, solutions, systems and other environments using advanced ICT technologies for the users in special situations.

The research in this area shows the increasing application of the AAL concept in the systems of medical health for the clients, during which the service is personalized according to the user's needs [1], [2]. The application is visible also in the field of identification and monitoring of the habits and needs of the users and their synchronisation with caregivers. Therefore, the application is visible in the area of applying GPS modules and application solutions [3]. In the role of monitoring the user's activities the application of the AAL concept shows remarkable results, providing the user with adequate set of services with minimal energy consumption [4]. The solutions in the field of AAL concept application do not as a rule use the standards for communication between sensor technology and the device located in the architecture of the system. In an attempt to standardize the interfaces of the sensors and the devices and to introduce the advanced ICT solutions and technology, for this purpose a number of solutions have already been made [5], [6], [7], [8].

This paper provides a presentation of wireless communication technologies with their advantages and drawbacks and the possibilities of applying the AAL concept in the traffic environment.

## 2. Ambient Assisted Living concept

According to the definition, AAL concept represents a new paradigm which is based on the application of advanced ICT solutions for the elderly population of users. It represents a shift in the society with the emphasis on the upgrading of the quality of living, understanding, and distribution of services of support according to the defined users' requirements [9].

The AAL system components on an example of increasing the level of mobility of the blind and visually impaired persons and also the elderly users are composed of the following components [10]:

- navigation (GPS, compass, gyroscope);
- sensor technologies;
- speed controls;
- image controls;
- sound controls, and
- light control.

The aim of the ALICE system is the development of the computer vision which combines the technologies for locating, navigation and identification of barriers/facilities while the user is moving. It can be used both indoors and outdoors.

Indoors with Smart House solutions AAL concept can be based on the application of ZigBee and Bluetooth technology and RfID and NFC technology for the identification and information of the user.

The standards and protocols in wireless sensor network (WSN) allow the AAL concept the collection, processing and distribution of data according to the users' needs. The aim of the standards is to insure standardized interface for the sensors and devices that provide certain services to the users. In literature we can usually find

two standards: IEEE 11.073 defined for medical devices and IEEE 21451 defined for networks (not limited to the area of medicine).

The ISO/IEEE 11073 standards enable communication between medical, health care and wellness devices and with external computer systems. They provide automatic and detailed electronic data capture of client-related and vital signs information, and device operational data. This standard has been used for systems with low memory requirements and low consumption and requires high amounts of available RAM, large packet length and it does not provide plug-and-play support. This standard was updated in 2010 with a new profile added to deal with these specific needs. ISO/IEEE 11073—part 20601 resolves all the previously mentioned issues [11], [12].

The IEEE 21451 standard has been designed to standardize the definition of Transducer Electronic Data Sheets (TEDS) for each transducer and the data sending and reception and transducers description in instrumentation systems and control/field networks such as WSNs; it is not restricted to a single transmission technology and can operate with the most popular ones (ZigBee, Bluetooth, RfID, NFC, etc.).

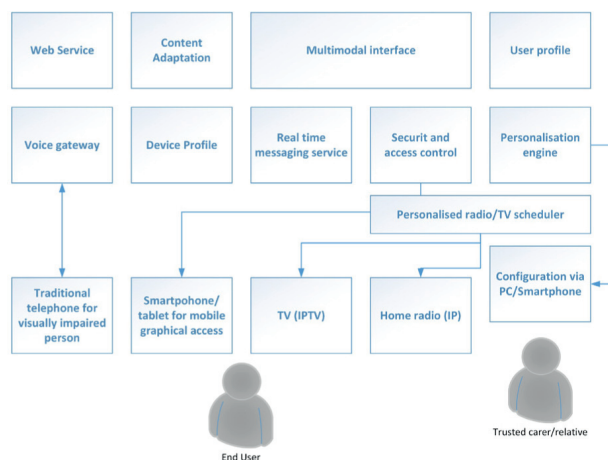


Fig. 1. Architecture of the GoldUI system based on AAL concept [13]

Figure 1 shows an example of the architecture of a system for assistance to the users based on the AAL concept [13]. The concept of GoldUI is focused on empowering the older individual, enabling them to access online "self serve" services and therefore to benefit from the digital world by using the familiar home technologies of domestic radio, TV and telephone augmented by a mobile smartphone interface when away from home. By using content adaptation and personalisation techniques GoldUI will provide the elderly with access to a wide range of online services considering the individual's abilities and needs.

The analysis of the presented can determine that the application of the AAL concept in everyday needs of the users is inevitable for a better life. Wireless technologies in the described solutions, apart from the application such as in hospitals or smart homes, can find possible application also in the traffic environment.

### 3. Analysis of the possibilities of the wireless technology in providing precise information

Today's movement of the users in the traffic environment such as a pedestrian zone, traffic intersection or any part of the traffic network may be better accessible. This means an increased level of mobility and information of the users about their needs during movement. The solutions based on advanced ICT technologies today are mainly based on the GNSS navigation technology which allows usage of LBS services.

The errors occurring in the location can be substituted by other technologies:

- RfID;
- Bluetooth;
- NFC - (Near field communication);
- Wireless LAN,
- RTLS.

As network architecture indoors ZigBee or RTLS are included, whereas outdoors their combination can be used, integrated into a unique system resistant to all the meteorological conditions. Therefore, Figure 2 shows the advantages and drawbacks of individual technologies.

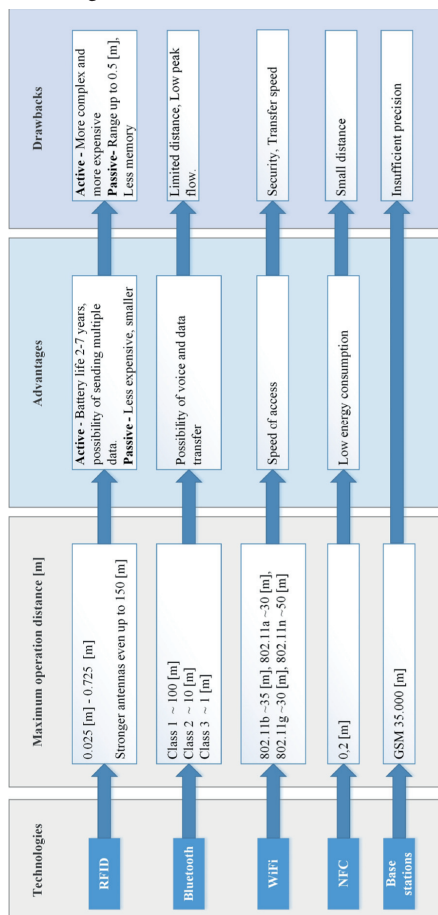


Fig 2. Characteristics of other technologies in locating the user [14]

An important characteristic of single technologies is the capacity of data stored in the tags (RfID, NFC), which is important from the aspect of providing information to the user. In case of RfID technology, the given data depends on the method of design. Therefore, in case of passive tag the data capacity ranges from 48 bytes to 736 bytes. Active tag has a capacity of 64 bytes to 32 KB, and Read-only which has a capacity of 20 bits.

Bluetooth technology depends on the version on the mobile terminal device and is exclusively used for information transmission to the user. The transmission speed depends on the versions; the latest version of Bluetooth SIG (V 4.0LE) allows the speed of 25Mbps. NFC technology allows data transmission speed of up to 424 kbit/s, parallel with RfID technology it represents Point-to-Point communication, and a scope less than 0.2 m. Wireless technology allows transmission speeds depending on the protocols; standard protocols operate at frequencies of 2.4 GHz (802.11b and 802.11g) and 5 GHz (802.11a) and allow transmission speeds of up to 54 Mbit/s.

Cloud Computing (CC) concept at the level of archiving and distribution of data in the example of AAL environment with the presented technologies has the possibility of providing more efficient data management. The usage of CC concept enables the user to access data via Web interface or by using the mobile terminal device (application solution). For the purpose of more efficient provision of services of real-time information it is possible to use also the Internet of Things (IoT) platform which can provide through its characteristics faster integration of data between the sensor and the device. When designing the system an important parameter is interoperability which according to the EU Directives is defined as "Interoperability is capability with which two programs (client and server, for instance) can exchange and interpret their data correctly".

Interoperability is a mechanism which is used to overcome heterogeneity, and this can be solved at several different levels as presented in Table 1.

Table 1. Interoperability levels [15]

Interoperability level	Relevant to:
Technical	Communication infrastructures
Syntactic	Standards and format specifications
Semantic	Specifications schemas for exchange of information and meaning
Pragmatic	Application/service interfaces
Dynamic	Behavioral adaptation and response
Conceptual	Knowledge presentation and processing
Organizational	Knowledge sharing

Agreeing on transport protocols and new traffic patterns that derive from new ways of interaction and scenarios of use is not at all a trivial task. Many solutions deal with different aspects. Together with increased popularity of cloud-based computing some new (cloud-based) solutions also appeared on the market.



**Table 2. Presentation of technologies depending on the type of application [16]**

	Emergency Treatment	Autonomy Enhancement	Comfort	Technology
Indoor	Prediction Detection Prevention	Drinking Eating Cleaning Cooking Dressing Medication	Logistic services services for finding things infotainment services	NFC Bluetooth WiFi RTLS
Outdoor	Prediction Detection Prevention	Shopping Travelling Banking Public transport Movement through the traffic network	Transportation services  Navigation services	RfID Base station (GSM) NFC Bluetooth WiFi RTLS

According to the presented possibilities and characteristics of single technologies, their implementation may be divided into two levels: external and internal implementation. At the users the mentioned implementation refers to everyday activities, and it is therefore important to insure that the users have a reliable system. Table 2 shows some of the activities divided according to the type of implementation and possible technology that may be used.

Emergency treatment services aim at the early prediction of and recovery from critical conditions that might result in an emergency situation and the safe detection and alert propagation of emergency situations.

Autonomy enhancement services enable an independent living of the assisted persons, in case of lacking capabilities of the assisted persons.

Comfort services cover all areas that do not fall into the categories. These services ease the daily life but are not required necessarily. Technology presentation of wireless technologies that can be used depending on the designed purpose and service.

## 4. Recommendations for the design of AAL concept in traffic environment

When designing the system or service in the traffic environment which is based on the AAL concept the following has to be met: identification of relevant possibilities of the technologies, defining of the user's requirements, analysis of the environment and purpose. Therefore, the architecture of the system has to contain elements for:

- Identification of the users within the technology coverage zone;
- Information of users about the location;
- Information of users about the facilities in the surroundings;
- Management of real-time information of the user;
- Provision of information according to a larger number of criteria and special points of interest;
- Generation of logical structure of information, more accessible to most frequently used information;
- Two-way communication of information, data and voice communication with the user;
- Information of users, location precision of the user, and
- Automatic management of specific system elements.

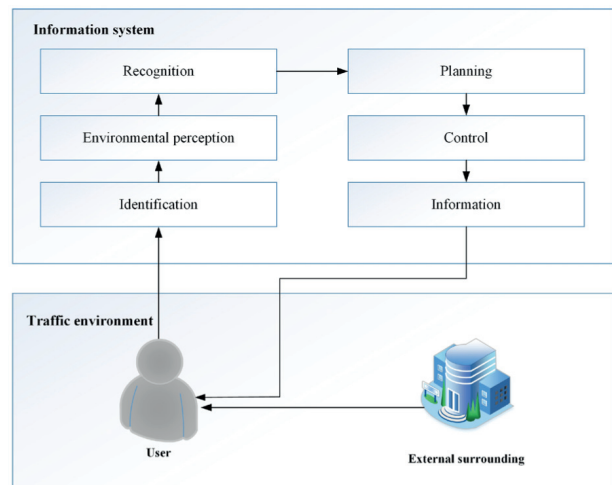
The identification of the user within the coverage zone of the technology (the user's location) means the size of the traffic environment in which the user is located, with the definition of the adequate network infrastructure and wireless sensor technology (example: ZigBee, RTLS).

Information of the user about the location (shape of the traffic environment and all its elements) – the user receives from the system accurate information about their location using the application solutions.

Information of the users about the facilities surrounding them – facilities that surround the user have to be within the coverage scope of the wireless technology. The facilities can be state institutions, banks, hospitals, cultural sites and other facilities that can be found in the user's environment.

Management of real-time information of the user – real-time information of passengers, service that informs the user by means of application solution in the mobile terminal device or some other form. An example: if there are works on the pedestrian crossing and it is impossible to cross it, the user receives the information about this, and gets the proposal for alternative routes for safe movement.

Providing information according to a larger number of criteria and special points of interest – if the user uses the application while moving, the system provides the information such as: selection of the shortest route, information that are input in the navigation map about the user's environment, pre-announcement when arriving to the input point of interest.



**Fig 3. User information system about the environment when moving along the traffic network [own study]**

The logic structural information, more accessible because of the most frequently used information – logic structure of the system facilitates easier access to the most frequently used information. The most frequently used information are defined according to single users' requirements.

Two-way information, data and voice communication with the user – before starting to move along the traffic network the users can determine their own route using navigation applications, and the information that are not entered the user can enter independently while moving. The information can be, due to safety reasons very

important, for instance: if there are works in the direction of the user's movement or the information found at an intersection are incorrect.

Informing the users, user's position precision – by applying other wireless technologies (RFID, Bluetooth or NFC) the user receives precise information about their location if their movement is based on GPS navigation. Automatic management of specific system elements, if this refers to specific user requirements (a blind or visually impaired person) the management elements need to be adapted and enable safe and accurate information.

Apart from this, it is important that the system can operate in any weather condition because of the user's safety. If the weather conditions allow some modifications in the operation of the system, the user has to be informed.

## 5. Conclusion

The implementation and development of the AAL concept in the society, especially in case of the elderly population can provide safer and more accessible contents surrounding the person. The services based on AAL concept today are exclusively oriented to the assistance in the field of medicine and at homes of the users. This research has made a presentation of the possibilities and analyses of ICT technology in the current solutions of the AAL concept and as a proposal the architecture in the traffic environment surrounding the user has been made.

The user located in the traffic environment is provided a more accessible contents that surround them while moving along the traffic network. The real-time information would provide the users with a higher level of feeling of safety while moving. The application of CC platform and the application solution the users can be provided with 24/7 system of assistance if there is need.

A drawback of the current application of AAL concept in the traffic environment is reflected in insufficient financial means, and this leads to the possibility of implementing the public-private form of financing of the possible solutions. For this purpose the action plan Joint Action Plan has been proposed. It has been developed in cooperation with SEE\_Innova Governance Innovation Team (GIT). The mentioned plan contains nine key fields (Active aging, Political support and legal frame, Education, training and employment, Inter-sector and international cooperation and networking, Financing and financial support, Raising awareness and information supply, Expansion and promotion, Developing of AAL solutions, Implementation and launching on the market) with the purpose of a more efficient distribution of AAL solutions on the market.

The described solution allows the users to upgrade the level of their quality of living both indoor and outdoor.

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