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Telehomecare: An ICT Use Case based on M2M Communication

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Abstract:
The advancement of communication device and internet has given us great platform for our day to day task. Use of mobile communication, wireless sensors, RFID tags, readers, computers, network, hardware, software and satellite systems gives multiple facilities like M2M communication which will be done by without human intervention. By using telecommunication technologies healthcare service to patients at their home becomes very easy. Patients can use ICT for communication to get service for heath from his own house. In this view, this paper presents different ICT applications followed by high level view of Telehomecare. This paper also explained mathematical expression of ICT convergence. This paper also gives overview of related projects which comes under ICT umbrella. At the end, this paper also discusses ICT challenges.

Keywords- Telehomecare, Network, Information technology

ICT OVERVIEW

The term 'information and communication technologies' (ICT) has been defined by Wiliams [1] in 1983.This term is an analogy for' systematic study or particular art. Williams defined ICT as relation between knowledge (science) and its practical application (technology) and now has been integrated into the composite term "Information Technology". Gunton [2] defined information technology as electronic technologies for collecting, storing, processing, and communicating information. They can be separated into two main categories: (1) those which process information, such as computer systems, and (2) those which disseminate information, such as telecommunications systems. ICT is technological convergence of multiple disciplines. Consider the example of FAX machine which is convergence of technologies like communications, optical scanning and printing. In similar way, ICT is also convergence of personal computers, telecommunication and television into user experience and the benefits can be extended to all the users. ICT convergence is always on-going process and can be mathematically expressed as:

$$\mathbf{ICT} = \sum_{i=1}^{5} C_i \quad (1)$$

Where:

C1: Communication- It includes communication between user-to-user (U2U), user-to-machine (U2M), machine-to-user (M2U) and machine-to-machine (M2M).

C2: Connectivity- It includes all network generations like 2G to 5G.

C3: Convergence - It includes integration of multiple technologies.

C4: Contents - It includes data from the audiovisual, publishing industries as well as data generated and captured from multiple sensors.

C5: Cooperation – It includes cooperative communication as well as cooperative delivery.

Communication is equivalence relation on set C = {U, M}

Where, U = User and M = Machine

Let R be a relation 'communicates with' on set C. Relation R can be defined as:

R = {(a, b) | a communicates with b, ∀a, b ∈ C} = {(U, U), (M, M), (U, M), (M, U)}

Note that, R is an equivalence relation because,

1) It is Reflexive as both (U, U) and (M, M) are present in R

2) It is Symmetric, since (U, M) ∈ R also (M, U) ∈ R

3) It is Transitive as well.

M2M communication is an integral part of da-to-day life without human intervention. The service technologies and enterprise systems of tomorrow will be able to make use of increased autonomous decision making capabilities, which will be strongly relying on the real world awareness provided by the ICT. Our economic and social interactions will be significantly enhanced with efficient information or intelligent and autonomous M2M interactions, enabling feedback and control loops which are currently based on human input and which are cumbersome, slow and fault ridden. Connectivity in ICT application includes features like virtual assistants, proactive services, email, and multimedia support. It should also support evolving Web n.0 which includes virtual world, disruptive business model, proactive services, service network, event fusion, multi-model interfaces and proactive context-aware services. Convergence covers integration of technologies like television, broadcasting, mobile and fixed telephone, broadband technologies and the game console. It also covers the convergence of services like computing, entertainment, information and communication. The current number of devices which amounts to billions and are connected to the internet in recent times will be seen to grow in number enormously and continually in the near future. All

ICT applications generate data which is big in size, varied in type and dimensions are generated by all the connected devices which are connected to the Internet. It obviously creates ample of new opportunities and business models to the communication industries and ICT players. Due to economics of scale in the ICT, Big data and its diffusion is increasing at higher rate in various industries. Industries including digital production and news, advertising, entertainment for online transmission have high degree of digitization and immense data intensity. For successful deployment of ICT applications, cooperation and collaboration between different communicating entities is essential including cooperation with media, m-banking, m-commerce partners, etc. Figure 1 summarise different ICT applications.

Figure 1: ICT Applications.

TELEHOMECARE

Several works or projects have been done or still going on in ICT areas. Basic building blocks of ICT can be used to build applications which can benefit society. Telehomecare is ICT-based platform and make use of telecommunication technology to provide assisted living, including health services across geographic, time, social and cultural barriers.

Description

Telehomecare aims to make it possible for people to remain at home rather than use residential, long-term, or institutional-based nursing care. Home Care providers render services in the client's own home. These services may include some combination of professional health care services and life assistance services. Professional Home Health services could include medical or psychological assessment, wound care, medication teaching, pain management, disease education and management, physical therapy, speech therapy, occupational therapy. ICT expert's role in Telehomecare is to provide the network architecture, which consists of WSN technologies for medical or health monitoring, communication protocols between different entities, and alarm system. We are also developing a system based on RFID which especially targeting the people with dementia problem and elderly person in order to increase their quality of life. Moreover, security and privacy issues especially in Telehomecare scenario are addressed by our group, for example security analysis, threat analysis, data protection mechanism with authentication and secure communication channel, etc.

Application Scenario

A system can be implemented which will involve involving readers, sensors, wireless transmissions, data receivers and their interfaces for a radio enabled assisted living platform.

Figure 1 shows the high level view of Telehomecare. The main component of this system is RFID and some features of this system are as follows:

Tracking/localization of the primary user (i.e. patient, elderly person, etc) even the movement monitoring by means of vibration sensor attached to a RFID tag

1. Localization of important assets, eg. wallet, medicine box, hand bag, etc.

2. Provide monitoring information to caregivers

Alarm or notification to primary user as well as caregivers, e.g. by means of sms, email, sound, etc.

High level view of Telehomecare is depicted (Figure 2).

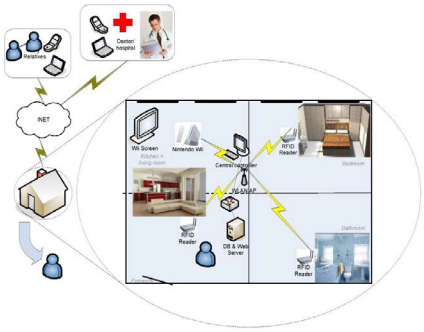

Figure 2: High Level View of Telehomecare.

Implementation of the system consists of interface between RFID readers with the PC, design and implementation of web application as well as database.

Business Targets

ICT application like Telehomecare offers wide range of applications in the market. It has potential to create a lot of business opportunities and attract customers, partners, and other type of organizations, which are summed up as follow:

1. Application developers (including SME's) to develop added-value services over this infrastructure.

2. Service providers to deploy those services and accordingly charge for them based on a tariff schemes.

3. Organizations that support the elderly, including hospitals, caretakers, insurance organizations as well as public institutes and organizations.

4. Subsidize from public authorities in order to lower/reduce the cost entry barrier for end user wishing to exploit the Telehomecare services.

5. Structure of service bundles targeting different user types and user problems. Hence various cost choices will be offered to the customers.

6. Establish a strong relationship with devices manufacturers and hardware vendors doing business in the home networking.

RELATED PROJECTS

eWall

eWall [3] provides services to those adults those who wants to live independently and suffering from physical disability due to

their old age. Independent living of senior citizens is one of the main challenges linked to the ageing population. Senior citizens may suffer from a decline of memory function, less ability to orientate and a declined ability to cope with complex situations, a number of diseases, including the decline in cardiopulmonary conditions, weaker muscle functions and a declined neuromuscular control of the movements, which result in a higher risk of fall and a higher vulnerability for cardiovascular and pulmonary diseases. For all these disease affecting this population, which requires either the institutionalization or the constant support from care-givers. eWALL will be an affordable, easy to deploy assembled wall that can be mounted on an existing wall and includes, into the background, all the ICT technology needed to enable a number of services for the senior citizen to cover the major ontologies of Active and Healthy Ageing.

In this project there are two kinds of users,

1. Primary users

2. Secondary users

Primary users are Elderly with age related Impairments (ARI), Chronic obstructive pulmonary disease patient (COPD), Elderly suffering from mild dementia. Secondary users are hospital nurse, visiting nurse friends, relatives and caregivers. The main objective of E-wall project is independent living of adults and provide communication framework for primary and secondary users.

Copras

COPRAS [4] is created by a consortium of the European Standards Organizations (CEN, CENELEC & ETSI) and two major international specification providers (The Open Group & W3C), put together with the aim to improve the research/ standards interface under FP6. The COPRAS consortium partners are all members of the ICT Standards Board, commonly known as ICTSB, the coordinating forum for European ICT standardization.

In the fast-moving world of ICT, research & standardization are closely interlinked:

1.Technologies need standardization, preferably global standards, in order to fully exploit all market opportunities.

2. Research results need to be brought into standards as quickly as possible in order to ensure interoperability & compatibility.

COPRAS intend to fulfil this gap and provide the necessary platform that will encourage and facilitate the interaction between research projects results and standardization. COPRAS will thus examine new standards-related technologies involving over 300 European Commission funded IST Research Projects under FP 6, spanning most of the key technology domains.

The overall strategic objective of COPRAS is to establish a supporting action to enable the FP6 IST projects (in all the three envisaged calls) to interface with standardization activities in Europe and elsewhere in a consistent and effective manner while increasing standards awareness within the research and technical development area.

Collaboration and Interoperability for networked enterprises (COIN)

"By 2020 enterprise collaboration and interoperability services will become an invisible, pervasive and self-adaptive knowledge and business utility at disposal of the European

networked enterprises from any industrial sector and domain in order to rapidly set-up, efficiently manage and effectively operate different forms of business collaborations, from the most traditional supply chains to the most advanced and dynamic business ecosystems."

The mission of the COIN IP [5] is to study, design, develop and prototype an open, self-adaptive, generic ICT integrated solution to support the above 2020 vision, starting from notable existing research results in the field of Enterprise Interoperability (made available by the Enterprise Interoperability DG INFSO D4 Cluster and specifically by the projects ATHENA, INTEROP, ABILITIES, SATINE, TRUSTCOM) and Enterprise Collaboration (made available by projects ECOLEAD, DBE, E4 and ECOSPACE).

In particular, a COIN business-pervasive open-source service platform will be able to expose, integrate, compose and mash-up in a secure and adaptive way existing and innovative to-be-developed Enterprise Interoperability and Enterprise Collaboration services, by applying intelligent maturity models, business rules and self-adaptive decision-support guidelines to guarantee the best combination of the needed services in dependence of the business context, as industrial sector and domain, size of the companies involved, openness and dynamics of collaboration.

This way, the Information Technology vision of Software as a Service (SaaS) will find its implementation in the field of interoperability among collaborative enterprises, supporting collaborative business forms, from supply chains to business ecosystems, like a utility, the Interoperability Service Utility (ISU).

The COIN project will finally develop an original business model based on the SaaS-U (Software as a Service-Utility) paradigm on the base of the open-source COIN service platform.

Cuteloop

The CuteLoop [6] project was funded by the European Commission in the scope of the Information and Communication Technologies (ICT) programme. As we know "Networked Devices" are providing their own computing capability, becoming more advanced as well as less expensive and can be combined with an increasing number of other devices. Examples are mobile phones, PDAs, notebooks, wearable, digital pens, displays, or even passive/ active RFID tags and many others. They are generally neither easily interconnected nor interoperable; often missing required ICT related environment and infrastructure. Key challenge is to facilitate an industrial uptake as well as to improve the required technology infrastructure and environment for development of business specific software, service and applications. Therefore, the CuteLoop project intended to explore how to radically improve the interaction of diverse actors in the integrated enterprise, targeting at an approach which would facilitate the inclusion

of customers as an integral part of complex relationships in such business networks. A special emphasis has been put on the elaboration of a new approach for employing a "Networked Devices Enabled Intelligence" for distributed and asynchronous control of business processes. Key issues to be taken into account for such an approach were:

1. Decoupling of decentralised message routing from subsequent processing.

2. Decentralised and multi-layer asynchronous optimisation of tasks in workflows of loosely coupled actors.

3. Decentralised approach for communities of interest and trust.

4. Innovative interactions among actors (especially with customers).

From technology point of view, the CuteLoop consortium has specifically addressed how to better exploit the potentials of enhanced RFID-based systems and Global Navigation Satellite Systems (GNSS), starting from the assumption that a combination of these two technologies is a promising way to support the integration of customers in the Integrated Enterprise. Cuteloop provide framework for interaction of various heterogeneous ICT applications.

PROPOSED ARCHITECTURE FOR SENSOR DATA PROCESSING

Data transmission requires significant amount of energy in IoT applications. Sensor is a device which detects or measures temperature, motion, etc. A physical platform which accommodates one or more sensors is called as sensor node. Sensor node can have the capability to communicate, sense, process data, etc. When two or more sensor nodes communicate between each other with wired or wireless means then they form a typical sensor network. Internet can be used to connect these type sensor networks. The emergence of IoT gives more importance to sensor network as a major technology used to realise the IoT vision.

Sensor data processing can be depicted as following Figure 3:

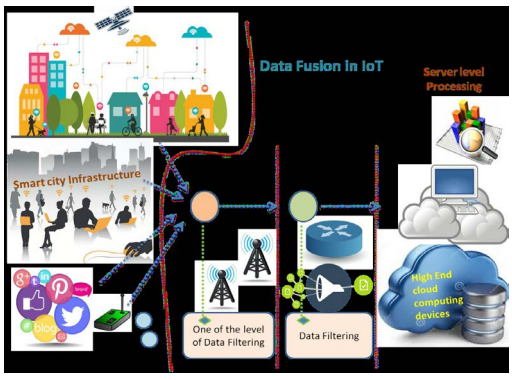

Figure 3: Architecture for Sensor Data Processing.

Redundant data fusion can help to reduce the overhead of data transmission. But low-level nodes may not able to understand full environment. In such cases data can be sent to the next level for processing. The following algorithm decides how data processing can be done.

CL = Current Level

CL+1 = Next Level

KR = Knowledge Required

KA = Knowledge Available

DTC = Data Transmission Cost

DFC = Data Fusion Cost

Consider two functions DataProcess (Level) and SendData (Level) which require Level as input.

```
If ((DTC > DFC) and (KR<KA)){
DataProcess(CL);
}
else{
SendData(CL+1) ;
}
```

To make IoT worthy, it should be able to capture and reason about data and events continuously. To detect the relevant events applying sensor data fusion techniques at different levels is very important. Sensor data fusion enables context awareness in IoT applications. A whole set of new services can be provided to the city and its citizen with the help of context awareness. IoT applications which have the ability of data fusion can enable context aware decision making and support. For example, a bridge which is experiencing a structural issue and will collapse in short time can alert all vehicles to stay away and seek alternative routes.

ICT CHALLENGES

Technological innovation is a need of today and it is very much essential for human development. ICT really helped to devise tool for facilitating learning and dissemination. Telecommunication and Internet plays fundamental function in ICT and act as a basic infrastructure which is necessary for the economic and social development of a country. ICT benefits can be extended to solve problems in areas like education, job training, health care, food security, environment management, government efficiency and specifically in science and technology. However, there are several issues that determine the viability of ICT and ICT applications [7]. These challenges are listed below:

1. Awareness: It is very important that the user must be aware that what can be done with ICT.

What are the benefits of ICT? User must also be open to using ICT.

2. Availability: ICT must be available with reasonable cost and also must be offered within reasonable proximity. Also appropriate hardware and software components must be available.

3. Accessibility: Ability must be created amongst users in order to use ICT. It includes efforts like offering literacy, e-literacy and language programs.

4. Affordability: It is recommended that the cost to use ICT and its application should not cross more than 10% of the user's income. This will make ICT affordable to the maximum users

CONCLUSIONS AND FUTURE WORK

Thus above discussion gives brief idea of ICT application, Challenges and high level view of Telehomecare. ICT is an integral part of daily life and its potential can be extended in wide range of application areas. However, human resources are essential infrastructure without which technology and ICT means nothing. In Indian context, education is important area where ICT is not yet mature and significant efforts are required to utilise ICT at its fullest. In addition to this, there are many social problems which can also be solved using ICT.

Future work is to perform threat analysis and attack modelling for Telehomecare use case to make ICT and its usage more matured. Another future outlook will be to extent ICT to solve societal problems by effective implementations.

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