Touch to Communicate Using NGN Open Interfaces

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Abstract

This paper presents an award winning solution, allowing end users to communicate by touching a tangible user interface with RFID/NFC enabled mobile phone. The pilot prototype is implemented using NGN open interfaces, used for setting up communication actions such as sending SMS, setting up calls or call forwarding, etc. The proposed solution is especially suitable for people with special needs such as elderly and people with disabilities. First, the concept of open NGN interfaces is presented, followed by an outline of RFID/NFC technologies. Later on, the concept of tangible user interfaces is described together with our proposed solution and some usage scenarios. Open research issues and possible extensions are discussed at the end.

1. Introduction

When asked about current social and technology trends, one cannot help to think about growing multimedia consumption, extending social networks and convergence of devices. Functionality originally reserved for personal computers is being offered on TV devices and modern mobile phones. In addition, a number of technologies have matured in the past years, such as RFID (Radio Frequency Identification), NFC (Near Field Communication), numerous sensor technologies and many more, which are finding their way into modern mobile devices. These technologies, combined with high-level open interfaces provided by operators and service providers, are offering rich opportunities for development of new and innovative applications. They can provide entertainment, relevant and context aware information, increase work efficiency and facilitate daily communication activities. In particular, the latter is important when we want to satisfy some specific groups of end users. Here we are referring to older people or individuals with special needs who are not only unfamiliar with the latest technology but also unable use basic functions on mobile devices (sending SMS making a simple phone, etc.). In addition there are many people with visual impairment, hand-eye coordination problems or other physical impairments. Current demographic trends imply that the number of elderly users and consequently those with special needs will keep growing in the future. Taking into account the above mentioned trends and technical possibilities it is evident that usage of communication services should and can be made simpler.

A possible solution can be provided through implementation of tangible user interfaces (TUI), which bridge the gap between physical and digital worlds. Using this approach, the access to the existing service environment is brought to the place where people feel more at home - the world of objects.

2. Motivation

It seems that despite their alleged diversity, current user interfaces are based on the legacy WIMP (Windows, Icons, Menus, Pointer) model [1]. Users need to browse through menus, click or press icons and insert required information in order to send an SMS, setup a phone call, forward a phone call, etc. We have noticed that usability of existing systems varies significantly, and some manufacturers have truly improved usability of their devices. However, even the simplest and the most intuitive user interface may be too complicated to use for many users, especially elderly and people with certain disabilities. Some of these people often cannot grasp the concept of a menu or an icon or are afraid of technology per se. On the other hand, some people are unable to pinpoint the location of an icon or a letter on the keyboard due to disabilities they may have. Typing an SMS or setting up a phone call can be practically impossible for these people. Therefore alternative usability approaches are needed.

Moving the interaction into the world of physical objects seems like a natural approach. It replaces the need of selecting services on the (mobile) device, with a simple touch interaction with real life objects and concepts (touching pictures of people, things and events, time periods, etc. with a mobile device). In this way we not only remove the need to actively click and select services on the device itself, but also increase the functional space needed by people with disabilities.

Taking into account these needs, we decided to make a suite of services available through a tangible user interface (TUI), represented in the form of a blackboard with
images representing people, events, time periods, etc. In this way users are able to send SMSs, establish phone calls, setup phone conferences, forward phone calls and use a number of other mobile services without the need to use the original mobile device’s interface. Described functionality is enabled by the use of RFID and NFC technology providing detection of images touched by mobile device, and through implementation of NGN open interfaces, which take care of setting up calls and message sending. Both technologies are integrated using a Java based application running on the mobile device.

3. NGN open interfaces

Next Generation Networks (NGN) concept is a response to the tremendous increase of digital traffic due to the growing Internet use, the user's interest in more advanced multimedia services and the deregulation of the telecommunications market. Essential guideline of the development is the convergence of telecommunication networks and services. Applications and services can access some of the services offered by the next-generation network, through special gateways which define abstract interfaces for the control of the key elements of the network (e.g. call server) [2]. These services typically include triggering, terminating and redirecting calls, creating conferences, setting call forwarding, accessing call logs, sending text and multimedia messages, etc. Usually they are accessed through high-level interfaces based on the Hypertext Transfer Protocol (HTTP). Technically speaking these are Remote Procedure Calls (RPC) in which the procedures are located within the server side Web Services (WS). Web services provide a simple but powerful means for one software component to invoke action of another via the use of message interactions [3]. There are many various options to provide access to such services. In the context of HTTP protocol the Simple Object Access Protocol (SOAP) or the Representational State Transfer (REST) are the main representatives. While SOAP is standardized (the specification for SOAP is a world-wide standard, administered by the World Wide Web Consortium (W3C) [4]), that does not apply to REST which is more loosely defined, but very widespread within the web developer communities.

3.1. SOAP open interfaces

SOAP usually relies on eXtensible Markup Language (XML) as its message format, which defines message form for requests and their corresponding responses. Consequently such messages and their responses can easily be parsed. There are also many development tools available for various programming languages, which further facilitate this process. Using fore mentioned tools to build WS client one normally needs only a service description file written in Web Service Description Language (WSDL). Consequently appropriate programming objects are created whose methods could be used within the local development environment. All of the major software platform vendors have agreed to implement this specification which means that a software component installed on one type of platform can communicate with another component on any other type of platform. Parlay X (standardized by the European Telecommunications Standards Institute (ETSI) [5]) represents a set of abstract Application Programming Interfaces (APIs) that expose communication capabilities to the applications via SOAP web services. The Parlay X gateway provides application developers with Parlay X APIs for managing call related features on switches and soft switches. Using these APIs, developers can enrich the applications with call related features.

3.2. REST open interfaces implementation

An important concept within REST is the existence of sources of specific information (resources), which are referenced with a global identifier. In case of HTTP it is a unique resource identifier (URI). Remote method’s parameters could be given as key – value pairs, usually inside of HTTP GET or POST request. Due to the additionally simplified data form, development of client-side services and applications is even faster. It is also easy to use such interfaces within some scripting programming languages (e.g. JavaScript). Unlike SOAP based web services, there is no official standard for RESTful services.

NGN architecture provides the implementation of open interfaces in the context of a service gateway, which enables external programmers to develop third party applications. Gateways may support various communication protocols [6], for example Network Application Part (INAP), Computer Supported Telecommunications Applications (CSTA) [7], Camel Application Part (CAP), Mobile Application Part (MAP) and others. The implemented interfaces are shortly described in the table below (Table 1).

<table>
<thead>
<tr>
<th>Interface</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ThirdPartyCall</td>
<td>Call management.</td>
</tr>
<tr>
<td>AudioCall</td>
<td>Audio call management (e.g. through voice XML service).</td>
</tr>
<tr>
<td>CallHandling</td>
<td>Forwarding management.</td>
</tr>
<tr>
<td>CallRedirection</td>
<td>Redirecting existing call in real time.</td>
</tr>
<tr>
<td>SMS</td>
<td>Sending short text messages using Short Message Service (SMS).</td>
</tr>
</tbody>
</table>
REST gateway is comprised of two logical entities. The first entity is represented by REST web service interfaces that are implemented inside the HTTP container (HTTP Servlet). It accepts HTTP requests and takes care of user authentication and authorization by using a predefined API key (a user name and a secret combination). Each user is authorized based on his or her permissions to control selected telephone number(s). During system initialization various Gateway modules are started, including internal client modules (INAPClient and CSTAClient) providing communication with traditional or mobile telecommunications networks (Figure 1).

NGN infrastructure allows developers to offer new advanced telecommunications services which can be used by users independently of the type of their communication device (convergence). As such they can be brought to stationary or mobile phones, Personal Digital Assistant (PDA) devices, (tablet) Personal Computers (PC) or even to television (TV) devices using built-in or external NetTopBox (NTB) device. Accordingly those services can be accessed independently of current time and location.

4. RFID & NFC technology

The technology of Radio Frequency Identification (RFID) has its roots in the time of World War II. Therefore today it does not represent a major innovation but despite its long existence, it gained more public recognition just in the past few years. The main reason is that it is becoming associated with activities such as logistics and trade. There are also many libraries around the globe that started using RFID for identification of books instead of legacy technologies such as barcode. The main breakthrough of technology is mainly related with the fact that today’s industry is able to produce RFID tags cheaper than ever before due to optimized manufacturing processes of RFID circuits, antennas, and the final packaging into a tag product. As a result we have many new applications today where RFID can be used.

RFID systems comprise of two main hardware units – RFID reader and RFID tag [8]. The latter can be completely passive, which means that its operation does not require its own source of energy (e.g. battery). Passive RFID tags operate by harvesting energy through electromagnetic induction (inductive coupling) or electromagnetic waves (backscatter) provided by the RFID reader powering up the integrated circuit in the tag which then transmits and receives data [9]. Inductive coupling works when a tag and reader transfer energy through a shared magnetic field. Such RFID tags have a relatively short reading range (< 1m), depending mainly on tag and reader antenna size and environmental conditions. Backscatter principle works by reflecting electromagnetic waves back in the direction from which they originally came. In this case reading distance can be much larger (< 10m) and depends on tag size and environmental conditions.

RFID technology also operates at various frequency ranges from kHz to GHz frequencies. For our TUI implementation we have chosen range of high frequencies (with central frequency 13.56 MHz), where RFID works on the basis of inductive coupling (Figure 2).
are marked with NFC tags) and the existing digital systems. Such principles are met under the term “Internet of Things” (IoT). The idea behind is very simple - if all objects of daily life, from bread to car parts, are equipped with RFID tags, they can be identified and managed by computers in the same way as by humans.

5. Touch to Communicate solution

The prime target user group for our solution are people with cognitive and motor disabilities, whether due to age, illness or traumatic events. They require a simple user interface which enables them to make or redirect calls, create conferences, send simple SMS messages, set reminders and access different voice XML services (e.g. e-Weather, e-News) without the complexity of keyboards or menus with tree structures. The motivators behind are: simplicity, accessibility, usability and efficiency – all in the scope of target user groups and usage scenarios. Presented solution is comprised of three main parts:

- REST open interfaces gateway,
- Tangible User Interface,
- NFC probe device.

Last two parts are described in following sections.

5.1. Tangible User Interface (TUI)

In the past, computer applications were designed with little regard for the user, most of the effort being oriented towards functional requirements. Fortunately, this trend has changed towards designing user adapted interaction, which lets users build confidence in themselves while using modern devices and applications. This is especially important for elderly and people with special needs, who are additionally hindered due to their age or disabilities, making them even more reluctant to use high tech devices and services.

In order to overcome these obstacles, an interaction designer needs to understand and be aware of the user’s mental model and the physical, physiological and psychological abilities of users and follow the principles of user interface design [10]. In case of our target users the most important principles undoubtedly are allowing users to directly manipulate interface objects, providing visual clues, using real world metaphors and emphasizing recognition not recall thus minimizing needed memorization of users and allowing users to customize the user interface.

Once these requirements are taken into account it becomes evident that interaction required in our system can be greatly simplified using tangible user interfaces. Using physical representations of people, actions, time periods, etc. in the form of images on the wall allows us to move the interaction from the device to a more familiar and thus comfortable space. There, user can customize the interface by spreading the photos in her/his own way, select the sizes according to her/his needs, etc. As physical representations are computationally coupled to underlying digital information, the application on the device can collect these data in the background and set up the appropriate action (send message, setup a phone call, etc.). On the other hand, user needs to know nothing about it except about the result of the ongoing activity (phone ringing, message successfully sent).

The presented solution is based on the use of existing physical objects (e.g. photos, images, pictograms) for the purpose of building tangible user interface. The main focus is on the interaction between user and selected objects, which we named Touch.

5.2. NFC probe device

NFC probe device is an essential element that allows us to exploit proposed TUI by interacting with the photos, images and pictograms within a pin board. It is a handy battery assisted stand-alone device, with a low power consumption and NFC module inside. To write to or read from the tag NFC Data Exchange Format (NDEF) [11] is used. All data inside the tags are in the form of Uniform Resource Identifier (URI) strings as it is defined in “NFC URI Record Type Definition (RTD) Technical Specification” [12] by NFC Forum organization. Probe connects to a data network via available wireless technologies, like Wireless Local Area Network (WLAN). When user touches a tag using NFC probe device and data is read, device vibrates and also emits sound notification confirming successful interaction. Local application inside the NFC probe device sends HTTP request to REST gateway which triggers new communication event (e.g. make call, send SMS, add participant to the conference, redirect call etc.). Telephone switch can control any communication terminal that supports one of many standardized signaling protocols. It could be legacy communication equipment as also new modern Voice over Internet Protocol (VoIP) clients, that in future will be implemented also within Internet Protocol Television (IPTV) client platforms.

6. TUI implementation

To implement TUI, three elementary requirements should be met by selected end-user technology - robustness (e.g. independence of the environmental lighting, voices), high availability and user friendliness. To accomplish last requirement TUI should comply following interaction requirements:
- **Touch** should be natural, instinctive;
- Implementation of **Touch** is independent of object size and form, however emphasis is on photos, images and selected pictograms which are semantically associated;
- User’s communication devices (e.g. mobile, fixed phone) remain unchanged. Therefore user does not need to learn using new communication terminal;
- TUI can be used by users who have coordination and shivering problems;

TUI maps the selected tagged objects to the digital world using REST open interfaces. To define various manipulation scenarios, logical pairs physical vs. digital should be defined as a relation between tangible and legacy digital user interface (Table 2).

<table>
<thead>
<tr>
<th>Physical UI</th>
<th>Digital UI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid set of photos of individuals and e-contents symbols.</td>
<td>Digital phonebook with selectable contacts and functional keys.</td>
</tr>
<tr>
<td>Grid set of symbols and sentences.</td>
<td>SMS input forms and letter (A-Z) keys.</td>
</tr>
<tr>
<td>Grid set of symbols.</td>
<td>Functional keys, menu structures.</td>
</tr>
</tbody>
</table>

Table 2. Logical pairs physical vs. digital

Physical board can be logically divided into three areas, as placed in the table above. Each area consists of a grid of photos and symbols, that are semantically associated (Figure 3). In order to fulfill selected communication task users combine between objects inside grids. More details about each of the three areas are discussed below.

### 6.1. Contacts grid

Contacts grid (Figure 4) enables a user to select the person with whom he/she would like to connect with. User can also select e-content (e.g. e-News, e-Weather) located on external web server and delivered on request using voice XML server. Some actions are performed with a single touch of NFC probe device with an object inside contacts grid. These actions are triggering a call to a person or audio call to a voice XML machine, adding another user to a conference and putting current user on hold.

![Figure 4. Contacts grid](image)

### 6.2. SMS composition grid

Language studies have shown [13] that most people are using a small number of words and phrases while speaking – the corpus is referred to as our "core vocabulary". If we put these high frequency words and phrases on the main grid inside the board, they are readily available in a single selection. There are already many grid sets available at the market with various language levels and numbers of unique words (some of them provide more than a thousand unique words). Grids can support users with sentence creation. Different users can cope with varying levels of complexity in their symbol systems. The grid can take the user from very simple arrangements to the more advanced ones.

While short messaging service is already defined as short (limited by 160 characters) it is easier to specify an appropriate grid for composing messages. The content of grids differentiates between end users (e.g. elderly people or younger people with special needs). Each sentence could be divided into four parts which answers next questions: “What to do?” (message core), “When?” (time), “Where?” (place), “What?” (objects involved). Symbols or phrases inside the grid are equipped with NFC tags that enable user to compose messages by touching them, using NFC probe device (Figure 5).

![Figure 3. Pin board is divided into three semantically associated areas](image)
Figure 5. SMS composition grid

SMS composition process is simple and intuitive. In the first step, user selects message core (e.g., "Please bring me"), then time (e.g., "Today"), after that place is selected (e.g., "Pharmacy") and object at the end (e.g., "Medicines"). Result of selections is a string with value "Please bring me medicines from the pharmacy today." which is semantically organized by the application inside the NFC probe device.

6.3. Communication actions grid

Using communication actions grid, user can trigger some communication services, like redirecting call in real time, setting forwarding and sending messages using SMSs (Figure 6). For example, after the message is composed using SMS composition grid as described in previous section, the send SMS icon is touched and send SMS service is accessed through available REST open interfaces.

Figure 6. Communication actions grid

7. Usage scenarios

This section will present several usage scenarios, how to utilize some of the most typical communication services by exploiting proposed TUI. Basic usage scenario (Figure 7) represents the usage of three fundamental communication services – dialing, adding another participant to the conference and putting participant on hold. In the first step, user selects a contact within the contacts grid. The selected person or voice service is automatically dialed. When user selects the same contact during an existing call, B side of a call leg is put on hold.

After touching it again, participant is taken off-hold. If another contact is selected by user, new participant is added to existing call. Each selection (touch) is confirmed by (sound) notification.

Figure 7. Basic usage scenario

The second usage scenario (Figure 8) demonstrates how to use some additional communication services (e.g., setting forwarding or redirecting existing call). In this case, user selects communication action (e.g., set forwarding) from the communication actions grid in the first step. After that, the new contact is selected within contacts grid. Consequently, all incoming calls are now forwarded to selected person or voice service. If a user selects redirect action at the time of existing call, the call is automatically redirected to selected person or voice service.

Figure 8. Extended usage scenario

The third usage scenario is the most complex one, but also most valuable for many people who are now unable to create and send short messages via SMS by using existing mobile devices (Figure 9).
New short message can be composed by selecting various symbols within SMS composition grid. After composition process is accomplished user selects one or more message recipient(s) within contacts grid. The entire usage scenario ends with selecting send SMS action within communication actions grid.

8. Related work

The presented paper concerns three main areas of research. These are technologies that form an integral part of next generation networks (e.g. telco open interfaces), wireless identification technologies (NFC) and the field of tangible user interfaces. In recent years we have put a lot of our research efforts mainly in the first two areas. The results are reflected in the practical implementation of NGN gateway [14], various NGN and NFC applications, as well as in a multitude of paper contributions that were published in selected journals and presented at international conferences [15]. The area of tangible user interfaces has become interesting for our research work with the emergence of the term Internet of Things, which presents the integration of physical objects and digital systems through usage of RFID technologies. However, the development of such interfaces has already been going on for quite a long time, in the context of some other research institutions. The leading TUI research group is most likely the Tangible Media Group, Massachusetts Institute of Technology (MIT) with their vision of Human Computer Interaction (HCI) under the name of Tangible Bits [16, 17].

9. Conclusion

Increasing number of functionalities and services available to users demonstrates the possibilities of convergence in network infrastructure and devices. However, usability issues are often forgotten, even though they represent one of the main adoption factors. When functional solutions are intended to address older population and people with special needs, usability issues become of paramount importance. Innovative pilot concept presented in this paper is one of such examples and is focused on ease of use through simplification of device oriented interactions. Even though the current solution already satisfies the requirements of a wide audience, a look beyond it reveals a rich variety of possible improvements. Some of them include interaction enhancements such as voice or force feedback for blind

10. References


