A Direct Manipulation User Interface for the Control of Communication Processes  
- Making Call Handling Manageable -

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Abstract
PC- or screen-based telephony applications should offer a new quality of usability to their users due to new interaction possibilities which are unavailable for the design for standard telephone interfaces. Most telephony applications on PCs are, however, not easier to use or to understand than conventional telephones. We argue that this is due to the fact that designers use these alternative interaction technologies only in a very rudimentary fashion. Making use of direct manipulation techniques seems to be a far more promising approach over modelling a telephone and its behaviour on a PC. Adding functionality in an aesthetically pleasing way cannot be achieved by straightforward use of the standard telephone metaphor.

With the advent of a multitude of devices integrating information and communication technology, the support of communication functionality with screen-based devices becomes more and more important [1]. Scalable user interfaces that are applicable on a large variety of these devices, from the PC to small handheld personal digital assistants, make communication transparent to the users of these devices. Instead of having to learn the basics of telecommunication over and over for each device the users can transfer their knowledge between these devices.

We developed a user interface for screen-based telephony applications (the Communication Circle) which combines the advantages of direct manipulation with an intuitive metaphor for setting up and controlling synchronous communication processes. In the Communication Circle environment, tasks like call swapping, transfer, or the control of conference calls can be done in an almost self-explanatory manner. This report describes the basic concepts of our approach and the state of the development, and discusses results of usability studies and future developments of the system.

The Basic Communication Concept of the Communication Circle
The rationale of the Communication Circle user interface is based on a concept that focuses on the communication between interlocutors. This should enable the user to use different modes of communications (e.g. to accept a waiting call, to swap between calls, or to set up a conference) without having to understand the underlying technology.

The central element of the user interface is the so-called Communication Circle which visualizes all communication partners of a synchronous communication process. Additionally, the state of different connections (Call on hold, conference, ...) is represented inside this circle. The symbolism of a circle seems particularly well suited
for this purpose given that it can be expected to be understood by people from different cultures as well as by children.

The user of the system is represented by an icon/picture in the centre of the circle. This icon may be replaced upon identification of the user if more than one person uses the system. To call a partner, the user drags an icon representing this partner into the circle. Selection of communication partners is done from a structured directory by dragging either icons or phone-numbers. Access to redial lists and missed-calls lists is done in a similar way.

If the partner can be reached by different means (Mobile, video, analogue phone network, or ISDN), the user can prioritise these means, choose a default connection for each partner or explicitly choose one of these possibilities. Incoming calls are indicated by an icon / number appearing on the outline of the circle. The call can then be accepted by dragging the icon / number into the circle.

In a conference situation, all interlocutors are visible inside the circle, each one positioned on a dedicated segment of the circle. Members of the conference using the same user interface on their device see the same group in the circle on their PC with the convenor of the conference clearly marked. It is worth noting that the system works with remote parties using the same interface as well as with parties using standard telephone equipment.

In a communication situation with active partners and partners on hold, the different segments are distinguished by different background colours. It is therefore very easy to interpret the state of the communication with each partner. Clicking on the icon of a partner toggles the state of the communication with this partner. Dragging partner icons from one segment to another allows for conference set-up with multiple users.
Switching between different states (incoming call, outgoing call, call waiting, call on hold, active) is visualised through animation to make it easier for the user to understand how a communication situation changes.

**The Interaction Concept of Communication Circle**

The basic interaction concept is based on moving communication partners into or out of the communication circle by direct manipulation. Moving the icon of a partner into the circle initiates a call set-up, incoming calls are visualised on the line of the circle. Moving the icon into the circle means call acceptance, moving it to the outside results in call rejection. Moving the icon to the answering device icon results in the expected activity. All these activities can be done by simple drag&drop actions.
Fig. 2: Schematic representation showing the "interaction concept":
1. Initiate consultation by pressing a key (softkey); then entry of destination
2. Initiate consultation by touching or clicking with the mouse, then entry of destination
3. Direct party selection by touching or clicking with the mouse (implicit holding of first partner)
4. Direct party selection by drag and drop (implicit holding of first partner)
5. Direct party selection by pressing a key (softkey; implicit holding of first partner)

Toggling between parties is carried out by clicking on partners or their circle segments ("see and show" principle: "I want to talk to that person"). Clicking on empty areas in the circle results in seizure of a free line - in an active call situation this action can be used to initiate consultation.

The outstanding advantage of direct manipulation in a telephony application is that the relevant function is initiated by the user action without the user having to explicitly select it or even know the function’s precise designation.

Alongside this there is the possibility - intended especially for users with knowledge of classical enhanced-convenience telephony - of controlling communication connections using conventional function keys whose labelling (plain text and/or symbol) tells users something about the type of function. This approach is supplemented by a special preview function. When the preview function is activated, the selection of a function key will display an image in a small circle below the communication circle symbolically showing the effect of the selected function. The user now has the opportunity to carry out this function or to select another function key if the preview does not show the image she expected.

The interaction concept shown in Fig. 2 is not limited to corded communication. Provision is also made for interactions from a mobile phone or cordless handset/headset.
using a navigator. The widest variety of manipulation techniques can be used on the display depending on the level of equipping:

- **TAB mode** (strictly linear chaining of selectable elements, forward/backward navigation)
- **Zap mode** (horizontal/vertical branches to nearest selectable elements)
- **Mouse mode** (free positioning of entry/selection mark).

**Usage Scenario**
The following scenario describes a standard telephony application with the following flow of operations:

- Direct station selection with "direct station selection key" to the 2-party call
- 2-party call
- Direct station selection to the second call (consultation)
- Second call
- Conference preview
- Conference

The scenario focuses on the use of buttons in order to elucidate the simplicity of the UI in combination with the preview function.

**Starting point: idle condition**
The telephony application is opened and is in the idle condition. The user has activated the preview function in "Settings". The preview circle is indicated but is empty because no function has been selected.

In this example the address field (left-hand side of the display field) is predominantly occupied by direct station selection keys. One of the keys signals that the party is currently busy. All other parties are currently free. The idle condition, represented by the time of day/date and terminal "owner’s" directory number, is displayed in the status and entry bar above the communication circle. The communication circle also signals the idle condition.

If the user presses the direct station selection "O. Müller" the system initiates a call to the respective party. After Müller accepts the call, the system represents the call condition by changing the colour of the respective segment of the circle (Fig. 4).
To establish a consultation call to a second part, “Heller”, the user only has to select the direct station key labelled with the respective name. The same effect could be achieved by dragging the labelled area “Heller” into the “Idle” section of the circle. The system puts the active first call on hold and initiates a second call to “Heller”. After this call is accepted the display looks as in Fig. 5.

In this situation the user may initiate a conference call. To achieve this she simply has to press the button labelled “Konferenz einleiten (Initiate conference)”. If she is not sure about the outcome of this interaction she may click on this button once to get a preview of the respective outcome. Fig. 6 shows the system response to a preview request submitted by the user. A little circle on the bottom of the window shows what the result of selecting this button will be. If she is satisfied the action can be executed by pressing the button a second time. An alternative to choosing the “Konferenz einleiten (Initiate conference)” button would be to drag the inactive party into the active segment of the circle. Fig. 7 shows the display after the conference is initiated by the user. After this user action the set of available command has changed. This is visible by the modification of the button row in the upper right corner of the window.
Fig 6: Preview window showing a conference situation

Fig. 7: Conference call situation after the user pressed the “Konferenz einleiten (Initiate conference)” button a second time.

The conference can be ended by replacing the handset or directly moving the conversation partners out of the Communication Circle. The display will then return to idle condition (Fig. 3).

User Testing
The prototype of the communication circle UI was evaluated by 20 users in a usability test. Although the functionality of this prototype is far from being complete, the results of the usability test are very satisfactory. In particular, the subjective evaluation of the interface was extremely positive. The concept seems to be fairly easy to understand and users had no problems to control their communication processes after a short introduction by the evaluator. The screenshots shown in this article already show the improved version of the Communication Circle UI

Discussion
We have implemented a prototype of the Communication Circle user interface for a system for Internet telephony. In this prototype we use the concept of the communication circle also for co-operative work (application sharing) and for asynchronous communication processes (email, file transfer, fax transfer).
An important topic for the future development of the communication circle concept is the question of scalability of the interface. It is our goal to offer the same UI on a wide range of different communications devices (smartphones, mobiles, screen phones, PCs). To achieve this goal, we plan to integrate alternative interaction methods into the concept which will allow a smooth transition to devices with very small displays.

The current development of the UI leads in two directions based in part on the results of the user tests mentioned above. First, we are going to compare drag&drop operations to select&click. We will build a new prototype using both concepts and run a comparative usability test with both interaction methods. The results of this study will be important for the implementation of the Communication Circle on touch-screen devices. The interaction with the system must be adapted to the characteristics of different devices, e.g. the use of pointer movement without selection is not possible on a touch screen.

The second approach uses the communication circle concept for the realisation of redial lists and missed-calls lists. Instead of simple caller or callee information, we will be able to store more complex communications situations. These situations can be replayed manually or automatically with a scheduling mechanism ("Get the same 4 people together on a conference call next Tuesday"). The question of when to store a communications situation in the recall list remains to be answered since communications situations may be modified over time (new members will be added to a conference, people on hold disconnect, etc.)

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