Service Modeling for Situation-Aware Communication Method Decision

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Abstract. The expansion of wireless communication networks based on the development of diverse device technologies can promote an environment in which smart phones, tablet PCs, cars can be collaboratively communicated with each other anytime and anywhere. To meet such future expectations, communication is growing in order to enhance various possible interactions between smart devices. In the future, we may use truly immersive ways, which may be virtually indistinguishable from face-to-face meetings, to communicate with other people at a distance [1]. Whilst we develop communication technologies toward that vision, the interface between users and communication devices/systems needs to be advanced. In this paper, we discuss human-communication from the perspective of computers that can proactively learn and know about users. In other words, we want computers of communication system and devices that are well aware of users [2]. Therefore, we propose new models and systematic ways to design and implement the user- and situation-aware communication [3].

Keywords: Intelligent system · Context-aware · Situational-aware · Communication channel · Alternative communication

1 Introduction

Today, many computing devices around people are provided with interaction and behavior, which are very similar to human, and can be aware of environments around human. Advances in the technology help users to communicate with each other and share interactions anywhere and anytime.

In this paper, we discuss human-communication system interfaces from the perspective of a system that can anticipate and recognize the environment between users [4]. Most of all, we assert a service modeling, which maintains the effect of delivery for communications, even if different communication channels for different situations are alternatively used. First, we analyzed behavior based on situations and information of users. For example, whether a caller at the sending side has which goal-oriented communication, the other caller at the side is considered for relations between callers like business, family, friend, the situation of the receiver, or what the caller's purpose.

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Through this consideration, we structuralized situation information of a user based on 5W1H (Five W's and One H). Second, we designed the service modeling for communication with respective to user's communication activities. As a result, we assert the communication service which automatically knows the information and situation of a user, and suggests the good one. Namely, we propose the user-centric communication environment.

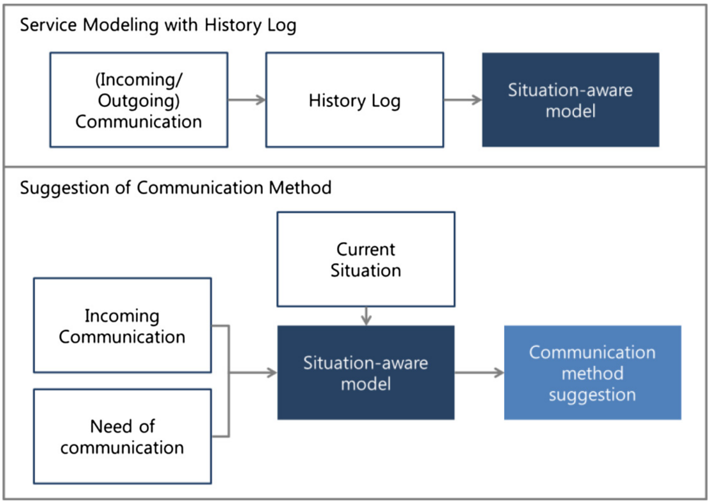


Fig. 1. The concept of the service modeling

Figure 1 describes the overall of our concept. When a caller at the sending side wants one activity for communication, he/she selects an appropriate one like voice/video-call, SNS, Text or e-mail based on situation modeling and history of the other caller at the receiving side.

2 Research Background

The increasing popularity of smart devices and new ways of communication unleash highly upgraded usability and values compared to traditional communication services. For example, Google HangoutTM includes instant messaging and video chat platform, and Skype provides video chat and voice call functions from computers, tablet PCs, and mobile devices to the similar devices, smartphones, and even to regular telephones. It enables users to send instant voice/video messages, exchange images and files, and make conference calls.

Most of these communication channels are provided directly by users' own devices. Especially, the usage of communication channels varies based on the relationship between users and the communication purpose. In order to identify usage behavior of communication channels in everyday life with respect to the type of relationships

Table 1. Communication channel usage behavior with respect to the type of relationships between users

	Communication	
Relationship	Preferred interaction (multiple answers)	Percentage of users using multiple interactions
Family (parents and siblings)	Voice call (95 %) Text (80 %) Video call (20 %)	80 %
Family (spouse and children)	Voice call (95 %) Text (75 %) Video call (25 %)	75 %
Close friends	Voice call (70 %) Text (95 %) Chat (40 %) Video call (15 %)	65 %
Colleagues	Voice call (20 %), Text (95 %), Chat (30 %), E-mail (50 %)	45 %
Others	Voice call (25 %), Text (55 %), Chat (10 %), E-mail (80 %)	35 %

between users, an experience sampling method (ESM) [5] was conducted with 20 participants who were aged between 27 and 45 during two days (Table 1).

In general, families and couples frequently used voice, video calls and texts with each other over e-mail, whereas co-workers more often used e-mails instead. Especially, the participants told that they used more than two different communication channels when communicating with other people. Moreover, we found that people with a more intimate relationship tended to prefer communication channels with quicker feedback like voice or chat. Even though a user uses more than two communication channels with others, the natural flow of communication must be considered. According to the condition for a good communication, an effective communication environment and minimizing the communication preparation time are essential.

In the future, smart devices communication systems and interfaces must proactively understand user's preference and situation rather than a user has to learn some interactions interfaces to manipulate them.

2.1 User Behavior Analysis

In order to achieve the future communication, as mentioned above, we have to analyze user's behavior for communication purposes. However, even though a user focuses on a specific task, it is difficult to examine user's accurate behavior because situation-aware service modeling is not built yet. In order to resolve this problem, we made "user behavior structuring" under environments with smart devices. Through it, we can design the communication service modeling based on situations. These ways are required to consider the preference of communication channels and communication history between people.

Table 2 shows the preference of communications based on user's activities. In addition, this preference can be structured by 5W1H like Table 3.

Table 2. User behavior structuring

Main action (constants)	Situation model (constants)	User behavior (preference)	System action (available candidates)
Meeting	Speak X, Listen O	Send texts back (I'm in a meeting)	Switch SMS/SNS message
Jogging	Read X	Switch to voice call	Switch to voice call
Calling	–	Send texts back (I will call you later)	Automatic sending message
Walking	Read X	Switch to voice call	Switch to voice call
Sleeping	–	Not to disturb	Automatic block
Driving	Speak O, Listen O	Redirect to voice call	Switch to voice call

Table 3. 5W1H factors

WHEN	Date & time	Time, date (weekend, holiday..), celebration day
WHERE	Location	User location info by GPS, Beacon and Wi-Fi
WHAT	Activity & state	Place & activity mapping (ex) Working in the office Guessing the user activity by place, motion and sensors (ex) 100 km/h speed in the highway location → Driving
WHO	Personal information	Communication partner (ex) Friends, Family, Business partners and etc.
WHY	Schedule & event	User activity & status by schedule info. (ex) 10:00 AM, Meeting schedule → Not available call
HOW	Method	Available communication channels

2.2 The Decision Modeling of Communication Channel

In order to provide users with appropriate communication services, the service modeling requires numerical history data. We designed 5W1H graph that is a requisite for the service model to decide which communication channel would be suggested. The most important factors to decide a proper communication channel are how much interaction is concentrated and immediacy of feedback is required. We created the Flow Indicator of Communication (FIC) to evaluate qualitative levels that are difficult to be obtained by the amount of interaction. For instance, since e-mail does not usually require immediate response, it is considered to lead to the lowest FIC, while video chat exposes all users' actions and has therefore the highest FIC.

FIC of non-real time interaction such as e-mail or text message is calculated by the average response period. Real-time chat may have a similar FIC level as with voice call and the FIC of late reply texts may be lower than the FIC of fast reply e-mail (Table 4).

Table 4. Checklist for flow indicator

Factors	e-mail	Text	Chat	Voice	Video call
Immediate take	1	2	2	3	3
Immediate response	1	1	2	3	3
Visual exposure	0	0	0	0	3
Audial exposure	0	0	0	3	0
Requires real time device/service control	0	1	2	1	1

[0 (Not associated) ~ 3 (Highly required)]

Several factors including immediacy of feedback, exposures, and operations are taken into account to evaluate FIC.

FIC is used on five W variables defined as Wn (When), Wr (Where), Wy (Why), Wt (What) and Wo (Who). These variables represent how immediate communication is required in each W. All events from a user activity have their own numerical W values. Situations with higher FIC value require voice or video calls more. As all factors are relative value, we set the minimum and maximum value of those with 0 to 10.

We converted various situations into 5W values. Graphs in Fig. 2 are initiated values that can be changed by new user histories. Whenever a history of situation and chosen communication channel is made, the area of each situation on W graph is adjusted (Fig. 3).

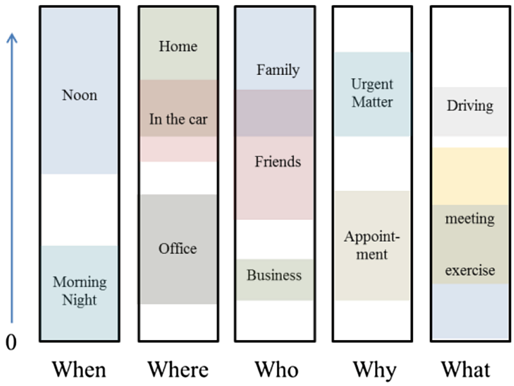


Fig. 2. The 5W graph

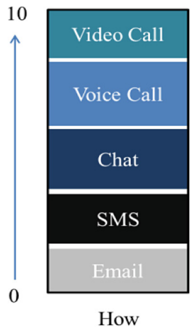


Fig. 3. The default H graph

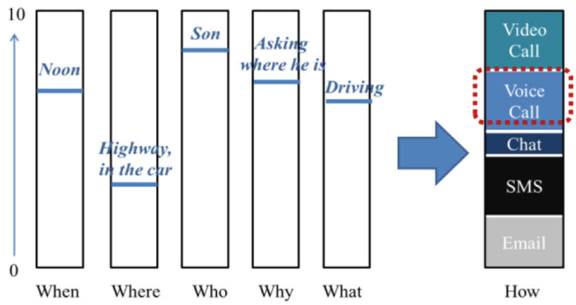
H is a weighted average of W values. All communication channels have their ranges on 5W graphs. Each W value is calculated by two variables, U and F. The variable U is user's weighted value of each W. Another variable F is FIC value of each situation. All situations have their own F value. U values differ from users.

We extracted the following formula.

$$\mathrm{H} = U_n F_n + U_r F_r + U_y F_y + U_t F_t + U_o F_o$$

Based on FIC, A history of user communication and communication channel with 5Ws led to the results described below.

By calculating the amount of interaction based on each W graph, 5W1H graph is created for each history, as shown in Fig. 4.



	Factors	FIC value	Weighted Value
When	Noon	7.4	0.2
Where	Highway	3.5	0.1
Who	Son	8.9	0.3
Why	Asking Where he is	7.6	0.1
What	Driving	7.3	0.3

Weighted Average	7.45
Voice call range	5.5~7.5

Fig. 4. An example of communication channel history based on 5W1H

Table 5. Factors defining communication channel area

C^x_{min}	The minimum H (How) value that a user would use the communication channel x
C^x_{MAX}	The maximum H (How) value that a user would use the communication channel x
S^z_{min}	The minimum W (5Ws) value that the communication channel is used in situation z
S^z_{min}	The maximum W (5Ws) value that the communication channel is used in situation z

In W and H graph, situations and communication channels have their own ranges. These ranges are customized for users. Every history of users affects the communication channel(C) and situation(S) ranges.

The greater (C^1_{min}-C^1_{MAX}) value means that the communication channel is used under various situation. If (C^1_{min}-C^1_{min}) value is small, it means that the communication channel is used only under very limited situation.

In the manipulation process of 5W1H graph, when user histories are not made enough, initial values are given. The modeling doesn't automatically provide any communication channels until a user creates sufficient history (Fig. 5).

As user history logs are accumulated on the decision modeling, the shape of each graph changes. When the history logs are collected enough, the decision modeling can recommend appropriate communication channels automatically (Fig. 6).

When a user prefers suggestion services, H graph is fully filled with communication channels. On the other hand, if a user doesn't want, H graph has a lot of blank area that doesn't provide any communication channels automatically. Whenever a user denies a proposed communication channel, the area of suggestion shrinks. This step prevents users from receiving unnecessary suggestions.

The following example shows that a voice call is activated outside of the current suggestion area for voice call.

As a new history is created, each area of communication channel must be rearranged. In Fig. 7, after a voice call event occurs, it affects the voice call area of 5W1H graph. The smaller scope is allocated for the communication channels that are rarely used. The cases such as above help devices to provide alternative communication methods or proper feedbacks by understanding the context of user activity or constrains of user situation.

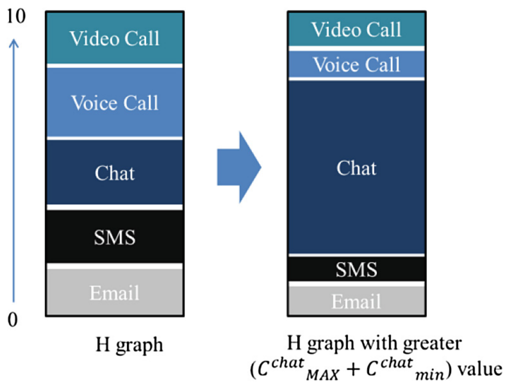


Fig. 5. The process of H graph adjustment

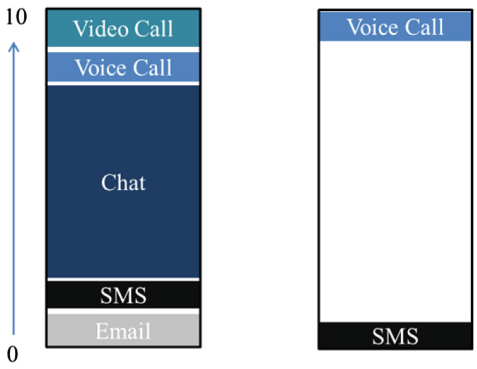


Fig. 6. Comparison of automation-preferred and customization-preferred

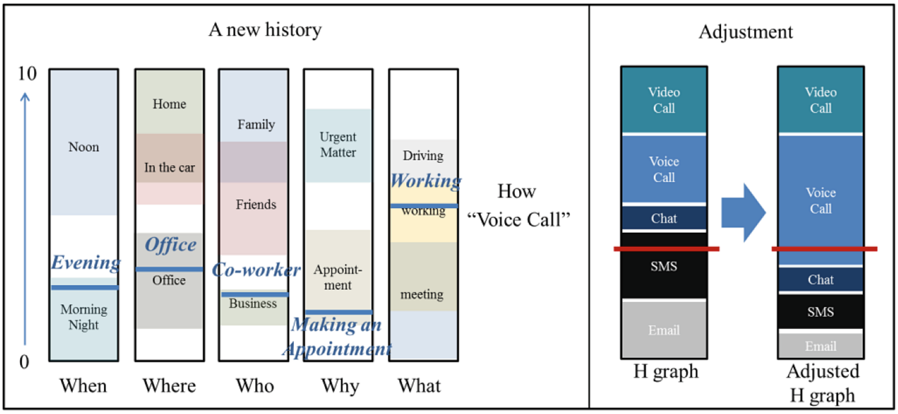


Fig. 7. Adjustment of decision matrix by user history

3 Conclusions

With the introduction of new IT technologies and the emergence of numerous smart devices, complexity of user experience has greatly increased and our everyday life is evolving at a rapid pace. This trend motivated many research institutions [6, 7] and companies [8, 9] to actively study new communication interfaces that can intuitively connect people and support various communication channels as needed based on traditional communication. In this paper, we introduced a new communication service model that can synthetically suggests whichever any communication channel to design and implement user-centric communication instead of the current device-centric communication.

The ultimate purpose of the model is that users can conveniently use an appropriate communication based on user situations. The previous ways of communication have the dependency of device functions and capabilities. For example, a caller in a receiving side has to accept the request from the caller channel in a sending side. Our proposed modeling can consider the caller context in the both receiving and sending side. Furthermore, we can provide useful functions and services to users by using analyzed life-log data from electric devices like smartphones, wearable devices and smart TV devices. It's the change of communication paradigm [10]. Therefore, this study can be immediately deployed in smart devices and can be directly applied to actual communication services. In other words, it will focus on developing user-centric communication services that can build mash-up service and new business models.

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