USERS' DISSATISFACTION PERFORMANCE FOR MOBILE COMMUNICATION NETWORK
An AHP Approach

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Keywords: AHP (Analytic Hierarchy Process), Teletraffic analysis, Traffic control, User lead.

Abstract: In this paper, we deal with a mobile communication network via an AHP (Analytic Hierarchy Process) approach. To apply the AHP approach, we first consider three hierarchies; goal, dissatisfaction, and traffic control schemes (spatial distribution, time distribution, and traffic reduction). We then assume practical situations where network congestions occur; a terrible earthquake, a large firework, and a popular ticket reservation. Based on these situations we propose an internet AHP questionnaire. Analyzing the AHP questionnaire results, we finally evaluate users' dissatisfaction regarding these traffic control schemes. Namely, we show how badly traffic control schemes perform for mobile communication network from users' point of views.

1 INTRODUCTION

In a terrible earthquake and a large firework, and for a popular ticket reservation, mobile communication traffic may exceed the system capacity to deteriorate the network performance. Several important traffic control schemes have previously proposed to avoid this network performance deterioration. Above all, Akinaga and Kaneda have proposed traffic control schemes (Akinaga, 1999); *spatial distribution*, *time distribution*, and *traffic reduction*. By *spatial distribution*, we mean that users are recommended to move in an area where communication channels are not so busy. Traffic can be spatially distributed. By *time distribution* we mean that users are recommended to wait for a while so that users can access the network with a higher probability. Traffic can be distributed over a period of time. By *traffic reduction* we mean that users are recommended to change from voice service into data (e-mail or web) service. Traffic can be reduced since data service channel holding time is known to be much shorter than voice service time. However, there are very few literatures on studying the relationship between user satisfaction (dissatisfaction) and the effect of traffic control scheme. The main purpose of this paper is to provide this relationship by using an AHP (Analytic Hierarchy Process) approach.

To apply the AHP approach, we consider THREE levels; 1) *goal*, 2) *dissatisfaction* and 3) *traffic control schemes* (see Figure 2 for details). The top level corresponds to our problem *goal*. At the second level *dissatisfaction* is evaluated from three view points (usability, preference, and reliability). At the bottom level we consider three *traffic control schemes* proposed in (Akinaga, 1999): spatial distribution, time distribution, and traffic reduction. The rest of this paper is organized as follows. Section 2 illustrates how network congestions occur and traffic control is of practical importance. Section 3 describes three traffic control schemes at the above-mentioned bottom level for more details.

Oguchi K., Takahashi Y., Hoshi K., Kaneda S. and Akinaga Y. (2006).
USERS' DISSATISFACTION PERFORMANCE FOR MOBILE COMMUNICATION NETWORK - An AHP Approach.
In *Proceedings of the International Conference on Wireless Information Networks and Systems*, pages 143-146

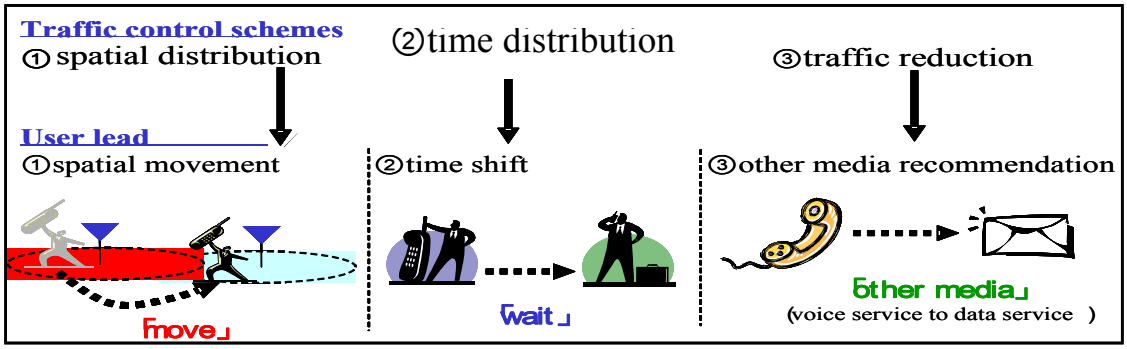

Figure 1: Traffic control schemes.

Section 4 is devoted to consider practical situations where network congestions occur. Based on these situations we propose an AHP questionnaire. Section 5 finally analyzes the AHP questionnaire results to evaluate users' dissatisfaction performance for mobile communication networks. Section 6 summarizes our results and describes our future research topics.

2 CONGESTION

Congestion is the situation that something concentrates on one place. When the telephone communication traffic increases and the communication demand to exceed the network accommodation is generated, congestion is caused. When customers begin to reserve various tickets and when the disaster occurs, congestion causes. For the congestion avoidance, the network side manages to restrict the traffic. Previously congestion research focus on restricting the traffic on the network side and maintaining the system in congestion. When user wants to use mobile phone, the user cannot use it because the network side limits the demand temporarily and compulsorily. In congestion, the user cannot use the service and dissatisfaction remains. The new method is needed.

3 TRAFFIC CONTROL SCHEMES

There is a method of user interactive control. The idea can control users before they flow in the network so that the user can be appropriately induced. Users' service chance can be improved by combining with the traffic control. The inflow traffic to the network can be controlled by dynamically inducing the users' behaviour. When the network communication demand increases, this method shows that the traffic is distributed by three methods (spatial distribution, time distribution, and traffic reduction). In this paper, spatial distribution is defined as the spatial movement, time distribution is defined as the time shift, and traffic reduction is defined as other media recommendation (see Figure 1). This method also assumes reducing the traffic by using other media such as mail, the web use, and the push talk instead of the user's using the telephone. We assume three situations, and induce the user. Three situations are a terrible earthquake, a large firework, and ticket reservation for events. When taking it as an example of a terrible earthquake, when the user tries the call out, and not connecting, the voice guide said "The telephone is not connected due to a terrible earthquake." The announcement must tie according to three movement patterns after this guide.

"It becomes easy to connect the telephone in several-meter previous Tokyo Station area." (spatial movement)

"It becomes easy to connect the telephone after several minutes." (time shift)

"It becomes easy to connect the telephone in case of the use for E-mail etc." (other media recommendation)

The guides add after the announcement each situation, and lead the user. We work for the congestion avoidance.

4 AN AHP QUESTIONNAIRE

AHP (Analytic Hierarchy Process) is a hierarchy decision making method. This method is a technique for challenging the possession of a scientific approach for various trade-offs and the opinion collisions encountered by the scene of the

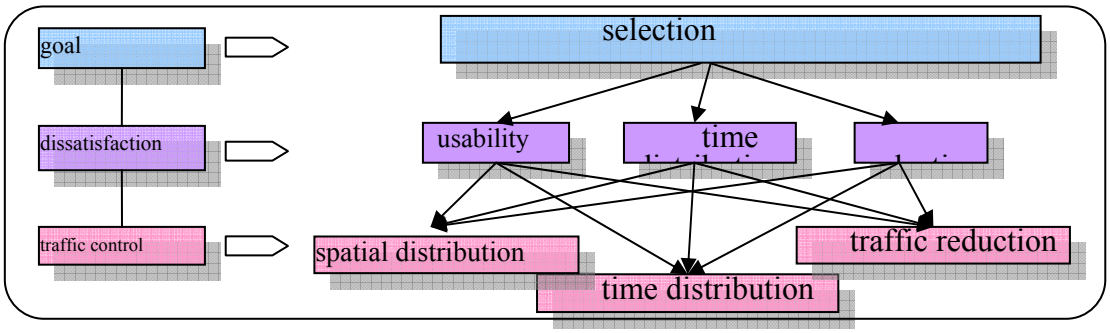

Figure 2: Hierarchal questionnaire concept.

decision making and the solutions. AHP enables people to make a decision containing many kinds of considerations. While general statistics are objectivities, AHP makes the analytical result objectivity by expressing people's subjectivity and intuitions numerically. There are a lot of things to which AHP is actually applied. The effect in the place of the decision making is clear and is remarkable. The problem when the questionnaire is executed has the inclusion of a point to need a big sample and non-logical answer in the questionnaire total result. In the setting of the questionnaire item by using AHP, a big sample like a statistical analysis is not necessary. Non-logical answer can be excluded according to CI (Consistency Index) requested by AHP (Saaty, 1980). The points are the reasons to introduce AHP that the comparative assessment in the mind can be correctly shown and non-logical answer can be deleted. This paper has aimed to measure users' dissatisfaction, and to understand the characteristic of the action. The opinion like the vote is not good when thinking about the communication quality of service. We can show the plan of which everyone can compromise convincing considering all psychological priority levels by the result of AHP. The AHP questionnaire has a pair-wise comparison. A pair-wise comparison makes the priority level of each user and the action based on the priority. We made a questionnaire with three evaluation items (usability, preference, and reliability) for users' dissatisfaction. We can quantitatively understand the priority of the user. As in Figure 2, the hierarchy diagram that uses AHP hierarchically constructs goal, dissatisfaction (usability, preference, and reliability), and traffic control schemes (spatial distribution, time distribution, and traffic reduction). We made the questionnaire for the respondent to execute directly the pair-wise comparison. There are three situations; A terrible earthquake: Situation in which user calls terrible earthquake to know safety of important person in the emergency. A large firework: Situation in which user who gets lost and cannot contact the other party to friend in a large firework calls. Ticket reservation: Situation in which user calls for early ticket's reservation of event and tries redial until the ticket reservation can be taken.

5 RESULTS AND ANALYSIS

We made Waseda university students as well as Fukagawa high school students reply to the questionnaire from December, 2005 to February, 2006 through the Internet. We totaled result of the questionnaire, and analyzed it by AHP. The data of CI 0.1 or more was deleted (Hoshi 2006). The AHP data of the group can be requested by using individual AHP data. From questionnaire result, we formulate a pair-wise comparison matrix (p.c.m.). We then calculate the maximum eigenvalue of the matrix (p.c.m.). Though this process, we obtain a user's dissatisfaction for an individual questionnaire respondent. Taking the geometric average over individual pair-wise matrices enables us to finally get the total users' dissatisfaction (Hoshi, 2006).

Table 1: Group dissatisfaction at a terrible earthquake.

	Importance	Spatial	Time	Other media
Usability	0.248	0.423	0.255	0.322
Preference	0.186	0.423	0.255	0.322
Reliability	0.567	0.365	0.277	0.358
Dissatisfaction		0.390	0.267	0.342

Table 2: Group dissatisfaction at a large firework.

	Importance	Spatial	Time	Other media
Usability	0.210	0.460	0.222	0.318
Preference	0.217	0.434	0.359	0.206
Reliability	0.574	0.496	0.296	0.208
Dissatisfaction		0.475	0.294	0.230

Table 3: Group dissatisfaction at ticket reservation.

	Importance	Spatial	Time	Other media
Handiness	0.267	0.421	0.208	0.370
Preference	0.221	0.417	0.340	0.243
Reliability	0.511	0.424	0.298	0.279
Dissatisfaction		0.422	0.283	0.295

Table 4: Group does not adopt when the user at time does an important report usually.

	Importance	Telephone	E-mail	Web
Handiness	0.255	0.146	0.251	0.603
Preference	0.261	0.247	0.240	0.512
Reliability	0.484	0.189	0.271	0.540
Dissatisfaction		0.193	0.258	0.549

As in Table 1, in congestion at a terrible earthquake, the group feels dissatisfied at a rate of 0.390: 0.267: 0.342 (spatial movement: time shift: other media movement). The priority level that the entire group adopts is time shift > other media recommendation > spatial movement. In congestion at a large firework (Table 2), the group priority level is other media recommendation > time shift > spatial movement. In congestion at ticket reserving (Table 3), the group priority level that the entire group adopts is time shift > other media recommendation > spatial movement.

It is clear from result of the questionnaire that the method of ***"It becomes easy to connect the telephone in several-meter previous Tokyo Station area. "*** (spatial movement) is not allowed by users and users' dissatisfaction is much. We understood that clear domination is not seen about time shift and other media recommendation, and the approximation might be shown, and some user allowance is admitted. As in Tables 1, 2, 3, and 4, we can understand a more detailed characteristic.

6 CONCLUSION

We have studied a mobile communication network user opinion by using the AHP approach. To apply the AHP approach, we have firstly assumed THREE hierarchies; goal, dissatisfaction, and traffic control schemes. We have subsequently assumed practical situations where network traffic exceeds the system capacity; a terrible earthquake, a large firework, and a popular ticket reservation. Using these situations we have presented the internet AHP questionnaire. We have made Waseda University students as well as Fukagawa High School students reply to the questionnaire. We have analyzed the AHP questionnaire results to finally evaluate users' dissatisfaction regarding these traffic control schemes. In other words, we have shown which traffic control scheme performs worst in the mobile communication network from users' dissatisfaction view point.

It is left for future research to make senior (old) people to reply to our internet questionnaire (because our questionnaire respondents were nothing but university and high school students belonging to a young generation). Our qualitative result may change to a questionnaire respondent generation.

NTT DoCoMo,Inc. started 'Push Talk' service in 2005. It is also left for future research to investigate that this 'Push Talk' can be an alternative media as a traffic control scheme at the bottom level in our AHP analysis.

REFERENCES

Akinaga, Y., Kaneda, S., Shinagawa, N., and Miura, A., 2005. A proposal of mobile communication traffic forecasting method using call characteristics and environmental information. *IEICE Technical Report*, vol. 105, no. 12, NS2005-6, pp. 21-24.

Ferguson, P., and Huston, G., 1998. *Quality of Service*. John Willy & Sons, New York.

Hoshi, K. Kano, S. Takahashi, Y. Kaneda, S., Shinagawa, N., 2006. Analytic hierarchy process and its application to grade of traffic service in cellular network. (To be presented at *ICETE*)

Kaneda, S., Akinaga, Y., Shinagawa, N., and Miura A., 2005. Traffic control by influencing users' behaviour in mobile networks. *Proc of the 19th International Teletraffic Congress*, 6A, pp. 583-592.

Saaty, T.L., 1980. *The Analytic Hierarchy Process.* McGraw-Hill, New York.

Takahashi, A., Takahashi, Y., Kaneda, S., Akinaga, Y., and Shinagawa, N., 2005. The robustness of blocking probability in a loss system with repeated customers. *Proc. of the 2nd ICETE 2005*, vol. II, pp. 60-65.

Oodan, A.P., Ward, K.E., and Mullee, A.W., 1997. *Quality of Service in Telecommunications*. IEE. London.

Ramarswami, V., and Wirth, P.E. Ed, 1997. *Teletraffic Contributions for the Information Age*. Elsevier. Amsterdam.