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Performance Evaluation of Multimedia Traffic in IP-based ITS Network

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1. Abstract
This paper presents a study of uplink scheduling in Internet Protocol (IP) based network for real-time service in Intelligent Transport System (ITS) project. Two kinds of ITS user profiles are devised and each ITS user is assumed to perform a combination of simultaneous high-speed packet data transmission and low-rate voice connections. The ITS access network is cellular orientated and based on IP transmission. The uplink traffic is queued by different scheduling methods, e.g., First In First Out (FIFO), priority based queuing (PQ) and Weighted Fair Queuing (WFQ). Voice packet transmission delay, Web page response time and scheduling efficiency are evaluated by simulation, thus we verify the feasibility of providing multiple parallel services in IP based ITS access network.

2. ITS User Modeling & Profile Design

Based on service scenario in ITS system, an ITS user's traffic is assumed to be a mixture of real-time (VoIP) & best-effort (WWW). The voice traffic is modeled by an "ON-OFF" two-state model (Table 1), and the WWW traffic is modeled by two types of Web sample pages, i.e., *TestType* and *RealType*. The *TestType* sample page is composed of one object with size of 2kbytes [1], and the *RealType* sample page is modeled based on the measurements and statistics of the Web traffic in the real world (Table 2).

Corresponding to these two types of WWW traffic models, two kinds of ITS user profiles are designed, i.e., *TestType* & *RealType* (Table 3). For voice application, the statistical calling rate during a busy hour is 0.1erl/user. This can be referenced also in the Web browsing application. When the *TestType* sample page is used for Web traffic model, two types of Web traffic intensities of 0.1erl/user and 0.5erl/user, which refers to *light* and *heavy* Web utilization respectively, are introduced to verify the system feasibility. Corresponding to these two different Web traffic intensities, *light* & *heavy* profiles are designed. In contrast to the *TestType* user, when an ITS user's voice traffic intensity is the same 0.1erl and the Web sample page is modeled by the *RealType* page, this user is defined as *RealType* ITS user.

3. System Configuration

The IP-based ITS network is cellular-orientated based on 3GPP network by locating a Node B & a RNC (Radio Network Controller) at the center of the cell, and is arrayed in star topology. All the ITS users are supposed to move inside the cell without any handover. This assures that all the traffic flows have the same channel acquisition time. The voice destination and the HTTP server are located in another cell linked to another RNC, and all the Web pages to be downloaded are supposed to be stored in this server. The core network is IP-based. The uplink traffic is queued in the RNC, and when prioritized scheduling methods, i.e., PQ & WFQ are introduced, the priority is based on type of service (TOS).

Table 1: Voice traffic source parameters

Speech coder bit rate	8kbps
Packetization period	10ms
Voice packet size	50bytes
Average silence length	650ms
Average talk spurt length	352ms

Table 2: WWW traffic and sample page parameters

	TestType	*RealType*
Request interval time (s)	Lognormal [2] (E(x)=43.036, σ^2=4.58)	Lognormal [3] (E(x)=43.816, σ=131.26)
Object size (bytes)	2000 [1]	Lognormal [3] (E(x)=3429, σ=7613)
Number of objects per page	1	Geometric [3] (E(x)=3.63)

4. Simulation & Results

An OPNET simulation model is constructed to model the above framework. When E1 link is adopted as the bottleneck, voice packet transmission delay and HTTP page response time against the number of simultaneous *TestType* ITS users are shown in Figure 1 & Figure 2. For *RealType* ITS users, similar results were achieved and omitted in this paper. If the scheduling efficiency over FIFO is defined as:

$$efficiency = 1-(voice\ delay\_PQ / voice\ delay\_FIFO) \quad (1)$$

It is clear that the prioritized queuing methods are effective to voice traffic than to WWW traffic (Figure 3), and this efficiency depends on the Bottleneck Full Utilization Percentage (BFUP).

5. References

[1] K. Sekiguchi, K. Tsurumaki, M. Kitaguchi, and O. Takahashi, "An Implementation of Request Pipelining Method on Mobile Internet Access Environment," IPSJ SIG Notes, Vol.2000, No.112, pp. 1-8, Nov. 2000

[2] M. Nabe, K. Baba, M. Murata, and H. Miyahara, "Analysis and Modeling of WWW Traffic for Designing Internet Access Networks," Vol. J80-B-I No. 6,1997, IEICE

[3] K. Ishibashi, T.Ozawa, "A Study on the Multiple Layered Modeling of WWW Traffic," IEICE General Conf. B-7-83, Mar. 1998

Table 3: ITS user profiles

Profile	*TestType*				*RealType*	
	Light		Heavy			
Application	VoIP	Web Browsing (TestType sample page)	VoIP	Web Browsing (TestType sample page)	VoIP	Web Browsing (RealType sample page)
Duration (s)	90	30	90	150	90	799
Repeatability	1	3	1	3	1	1
Request Interval (s)	-	Lognormal (E(x)=43.036, σ^2=4.58)	-	Lognormal (E(x)=43.036, σ^2=4.58)	-	Lognormal (E(x)=43.816, σ=131.26)

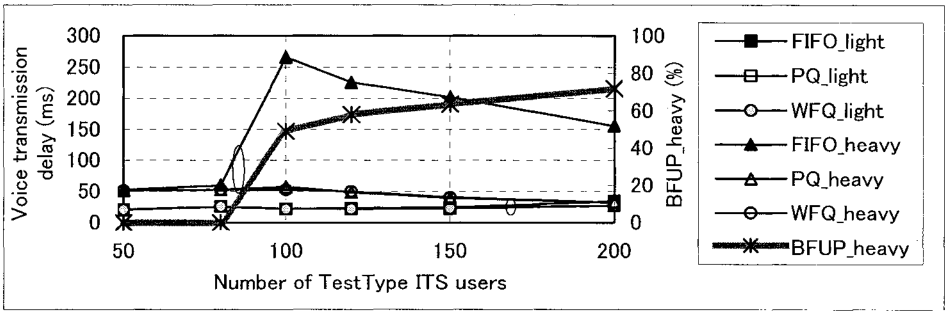

Figure 1: Voice transmission delay for TestType ITS users (95% cumulative)

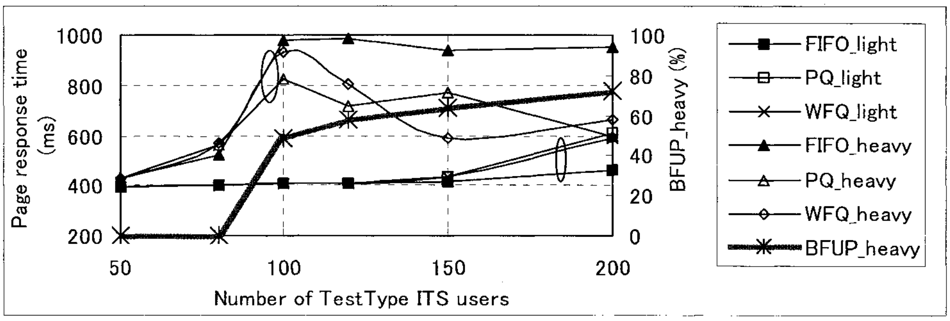

Figure 2: Web page response time for TestType ITS users (95% cumulative)

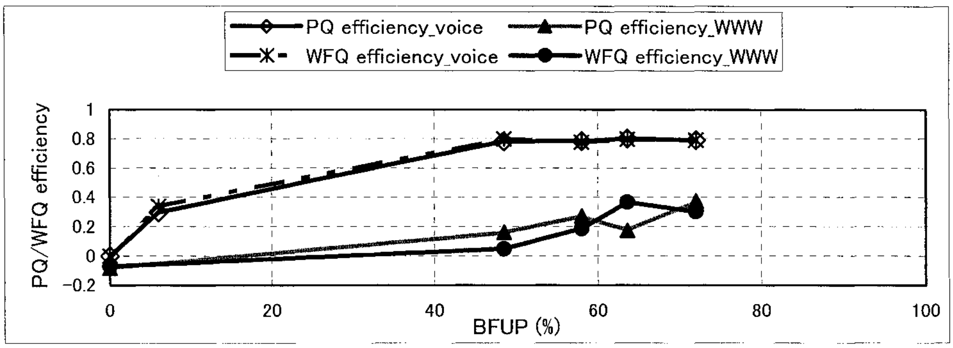

Figure 3: Scheduling efficiency over FIFO