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Reliable Sensor Data Transmission Method for Optical Home Network

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Abstract This paper proposes a delivery control method that can ensure reliable sensor data transmission in the next generation optical home network. The proposed method is verified by simulations. The results show the effectiveness of the proposed method.

1. Introduction

The advance in broadband technology in Japan is remarkable. The number of FTTH (Fiber-To-The-Home) users is rapidly increasing and will exceeded 30 million by the end of 2010. Along with the spread of broadband access networks, a Gigabit-class network environment is spreading in the home through the use of optical fiber. Devices previously not connected to any network are now IP-capable. It is expected that the home network (HN) will support various appliances. Since so many applications will be communicating at the same time, the transmission of important data such as medical and security data may be degraded. This paper proposes a delivery control method for reliable sensor data transmission. It ensures packet-loss free transmission of key sensor data.

2. Optical Home Network

Some of the services in the optical HN are shown in Fig.1. The HN will host various sevices with different requirements. All devices are connected to the home gateway by optical fiber. The HN will use optical fibers that enable data transmission via WDM (Wavelength Division Multiplexing), but the number of wavelengths available is limited.

Two types of services in the HN are considered: One requires high communication quality without any packet loss and the other permits some level of degradation in communication quality. The former includes important data such as medical and security data, which may impact people's life. The latter includes data transmission between PCs.

3. Traffic Classification based on Packet Sending Interval

It might be not effective to classify all applications in detail and satisfy communication quality simultaneously in HN. The most effective approach is to give adequate priority to

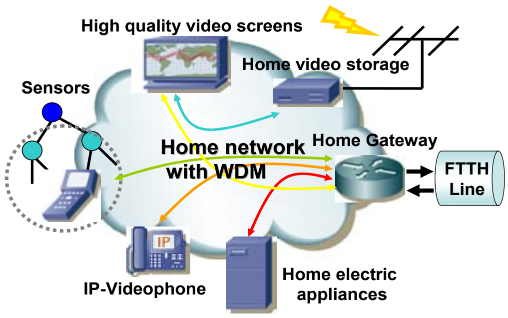
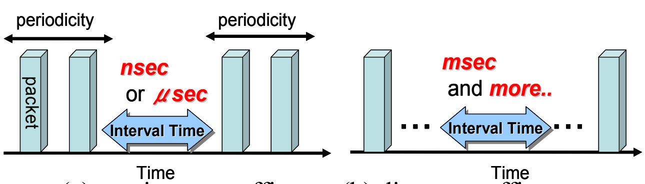


Fig.1 Services in the optical home network

the transmission of important data. This paper proposes traffic classification based on packet sending interval with high resolution. Figure 2 shows two traffic classes according to packet sending interval: "continuous traffic" and "discrete traffic." As shown in Fig.2(a), the feature of continuous traffic is that it has periodicity; the packet transmitting interval is relatively short (nanosecond to microsecond). This traffic is mainly output by audio/video streaming devices [2]. A discrete traffic source has a longer packet interval (millisecond or more). This traffic is mainly output by various health and security sensors. The HN should prevent degradation of the communication quality of discrete traffic.

4. Effective Bandwidth Control Scheme

To realize the reliable transmission of discrete traffic, we propose a token-based delivery control scheme for the IP layer. In proposed method, only the device that acquires the "transmitting right", the token, can transmit its data. Token-based control allows traffic release from any equipment to be controlled, while past control methods were active only when traffic passes through specific equipment in the network. Therefore, token-based control is superior in terms of scalability to other bandwidth control approaches.



(a) continuous-traffic (b) discrete-traffic

Fig.2 Traffic class according to packet sending interval

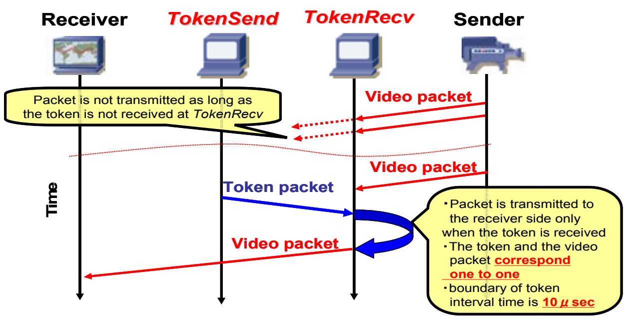


Fig.3 Flow of the token control in the simulation

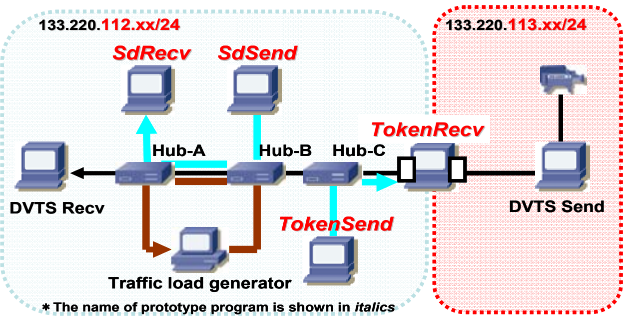


Fig.4 Simulation network configuration

5. Verification of effectiveness of proposed method

5.1. Simulation Scenario

To verify the functions and performance of the proposed token control method, we wrote a packet delivery control program that operates on the application level. The proposed method measures the packet loss rate of the discrete traffic and continuous traffic. Token sending interval for continuous traffic sources is taken as a variable. Figure 3 shows the flow of the token control program in the simulation. Hereafter, the prototype programs are shown in *italics*. *TokenRecv* serves to repeat data transmission. The packet in the *TokenRecv* buffer is transmitted to the receiver side only when the token is received. *TokenSend* has enough performance to be used as the token controller.

Figure 4 shows the simulation network configuration. All network links offered 100 Mbps. DVTS [3] was used as the continuous traffic source. The token is transmitted at constant time intervals with order of microseconds. In order to simulate congestion, a sufficient amount of background traffic was applied.

5.2. Results and discussions

Simulation results are shown in Fig.5. The horizontal dotted line (around 5 x 10^{-1}) in Fig.5 shows the packet loss rate of discrete traffic when the proposed method is not used. It is understood that using the proposed method decreases the packet loss rate of the discrete traffic for interval times longer than about 100 microseconds. This result shows that the proposed method is effective in guaranteeing the quality of discrete traffic. Figure 6 shows the variation of average continuous traffic rate limited with token control active. It shows that the continuous traffic rate was well controlled. Figure 5 also shows that the packet loss rate of discrete traffic was very small, less than 10^{-3} or so, while that of continuous traffic was small at the value of 175 micro seconds, which represents the optimal setting with respect to maximizing the communication quality of both traffic streams. The optimal value increases with the load. This implies that it is necessary to change the token interval dynamically according to the load in the HN to realize effective control.

6. Conclusion

This paper proposed a delivery control method for reliable sensor data transmission which generally consists of important information related to health and security services. Specifically, the method uses token control; we evaluated its validity by simulations. The results confirmed that the method could decrease the packet loss rate of discrete traffic (health etc.). We should examine dynamic control of the optimal token interval to increase HN efficiency.

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[3] DVTS Consortium http://www.dvts.jp/en/

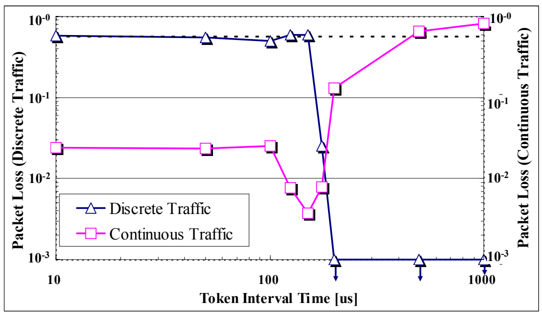

Fig.5 Packet loss rate vs. token interval time

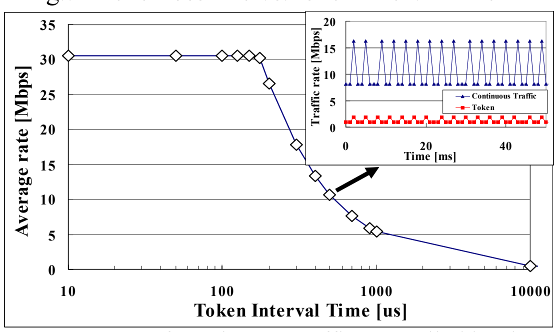

Fig.6 Average rate of continuous traffic controlled by the token