A New Control Scheme for Token Ring LANs

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This paper presents a new token ring local area network for multimedia traffic stream. A station (source), which is continuously transmitting data to other station (destination), will insert a new pattern called *Insertion pattern* to the data stream, when the token or a frame arrives at the source station. The destination station, which is receiving the data, will detect this pattern and will release a new token to the ring simultaneously. Thereby, concurrent transmissions between multi-stations can be performed at a time. As a result, high network throughput and low messages waiting in the system can be achieved.

1. INTRODUCTION

The multimedia terminals for LAN networks, which handle various traffic rates such as video Image, voice, and data applications, require a high-speed communication network to transfer large data rates from source to destination. Therefore, the massages in the other stations have to wait unlimited period of time in order to seize a free token at the station.

Many researches have devoted to solve these problems and focused on a high-speed token ring with concurrent transmission for stations in LAN, such as transmission delay distribution [1], and message destination removal [2]. The current IEEE 802.5 standard token ring protocol [3] makes no significant performance in view of throughput and latency [4]. Therefore, significant research has been dedicated to enhance LAN performance by modifying the protocol of data link layer (medium access control and logical link control). Therefore, it is necessary to design a new protocol that offers high throughput and gives a capability to handle bursty traffic arrival in multimedia.

In this paper, we propose a new control scheme for token ring local area network where a message destination removal scheme is employed to achieve concurrent multiple transmission, same as in [2]. The station, which is continuously transmitting data to another station, will insert a new pattern called *Insertion pattern* to the data stream, when the token arrives at the source station. So the buffered token in a station will be substituted by an insertion pattern which will be sent to down-stream with data frame. By detection of insertion pattern, a stations can start its transmission of a frame or release a new

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トークンリングにおける高多重伝送のための制御手法
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token to the loop, thereby, concurrent transmission for multi-station can be performed at a time.

2. SYSTEM MODEL

We consider a token ring with N stations as shown in Fig. 1. The ring consists of single-mode fiber ring of FDDI (fiber distributed data interface) as the transmission medium [5], and permits to operate up to 100 km in distance. The protocol among the stations that we have used is the insertion pattern strategy which employ a message destination removal scheme to realize the concurrent multiple transmission in a time and to reduce the network delay.

The standard 802.5 token ring networks, when a station transmits its own frame to a destination station, must remove what is been sent. It means that the data stream gets back to the source after a round trip and removed by source station.

In Parallelring [2] which has used a message destination removal scheme, where the destination station will release a new free token as soon as the valid packet header [2] has been translated. Therefore, the free token will pass through either a station that has a message to send or a busy station that is sending a message, and in the latter, the token will be buffered until the station completes its sending. Therefore, the other stations will wait unknown period to receive a free token to send its message. Such kind of unlimited waiting time for a station will influence on the network performance in view of network throughput and network delay.
Our solution to these problems that we propose in this paper is a new control scheme for token ring network. Our approach is based on a message destination removal scheme[2]. When a valid packet header reaches the station that is sending message to another station, the station will insert a small packet information (pattern) into the data frame that has been sending a message without buffering a token. The insertion pattern can be detected and removed by the destination station, and the destination station will release a new free token to the ring. Therefore, the new token will circulate around the ring to enable the other stations to transmit its data concurrently.

2-1. FRAME FORMATS

In the insertion pattern scheme, there are four kinds of packet formats circulating around the ring, insertion pattern Fig. 2(a), token frame Fig. 2(b), and data frame Fig. 2(c) - 2(d)). Figures 2(c) and 2(d) show the data frame formats with and without insertion pattern data respectively.

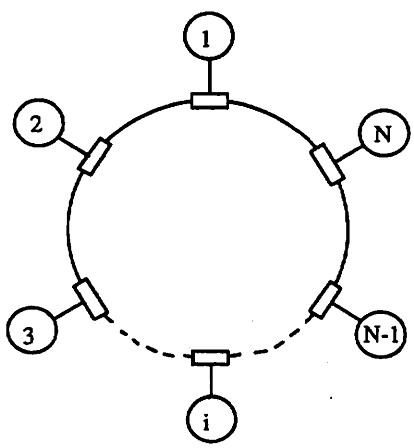


Fig. 1. Configuration of Token Ring

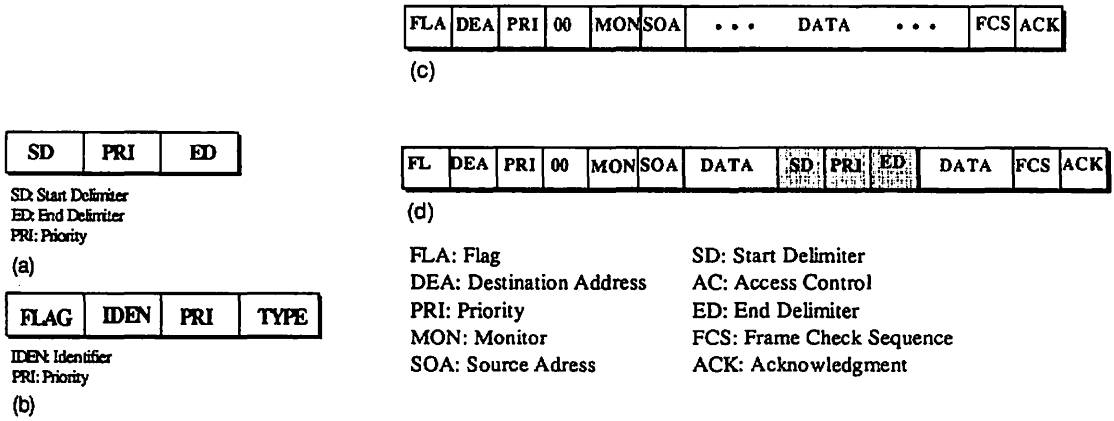


Fig. 2 Frame Format (a) Insertion Pattern Format (b) Token Format
(c) Data Format without Insertion Pattern(d) Data Format with Insertion Pattern

2-2 Protocol

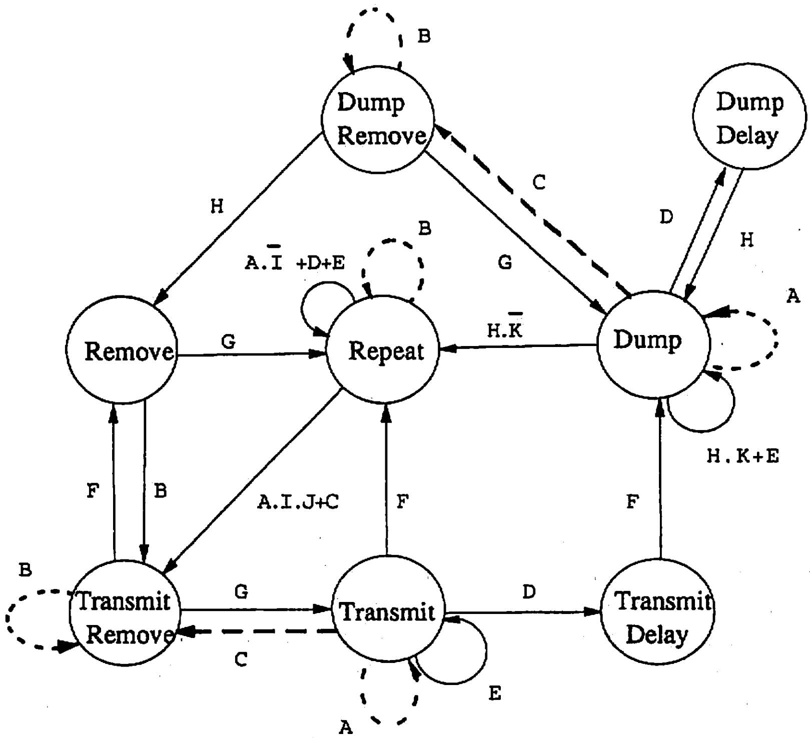
This section describes the protocol of the insertion pattern model in which each station has different states at every instant of time. However, the operation of the protocol can be best understood by using a state diagram through state, event and the condition of the station. A symmetric token network with N stations is considered. The main characteristics of our model's protocol are described as the following states:

1. A station is idle if it has no message to send or no message has to receive. The station's ring interface may pass three kinds of frames: token frame, data frame, and data with insertion pattern frame. The token circulates around the ring passing through the stations until seized by a station which has a send request.
2. The source station is transmitting its own message and at the same time it can remove a token or a message addressed to it, After the valid packet header or insertion pattern is checked, the source station will insert insertion pattern into the sending data stream. If the source station finds the message is not addressed to it,the station simply delay this frame until end of its own message transmission.
3. The frame or the insertion pattern is removed by destination station and at the same time the destination station can transmit its own message or send a free token to the ring when the destination station has no message to send.
4. When the token arrives at a station that is dumping the delayed frame, the station also inserts insertion pattern into the dumping stream.
5. When a dumping station receives a frame addressed to it, it will remove the arrived frame and inserts insertion pattern into the dumping stream. When it received a frame that does not addressed to it, the station will delay this frame.

3. Transition Diagram of Insertion Pattern Protocol

The state diagram in the insertion pattern is presented by modifing and enhancing the state diagram of the protocol in [2]for the insertion pattern scheme.

The state diagram consists of eight states, eleven conditions, as shown in Fig. 3.



* Here, a dash line represents the state transition which means the station sends an insertion pattern into the ring

* Operators ".", "+", and "-" represent AND, OR, and NOT logical operations respectively.

Fig. 3 State Transition Diagram

State:

Repeat: A station is either idle or directly forwards a frame into the ring.

Trains: A station transmits its own data frame into the ring.

Remove: A station removes an arriving frame from the ring.

Dump: A station forwards a delayed frame into the ring.

Transmit.Remove: A station transmits its own frame into the ring and, at the same time, removes an arriving frame from the ring.

Transmit.Delay: A station transmits its own frame into the ring and, at the same time, delays a frame.

Dump.Remove: A station forwards a delayed frame and, at the same time, removes an arriving frame from the ring.

Dump.Delay: A station forwards a delayed frame and, at the same time, delays a frame.

Conditions of the State Diagram:

A: Arrival of the token

B: Arrival of the insertion pattern
C: Arrival of a data frame addressed to the station
D: Arrival of a data frame not addressed to the station
E: Arrival of an invalid frame
F: Completion of transmission of a frame
G: Completion of removal of an incoming frame
H: Completion of forwarding of a delayed frame
I: Station has a data frame ready to transmit
J: Station has a priority higher than an incoming frame
K: There is more delayed frame(s) in the station

We can summarize this diagram as follows:

- In the state diagram in Fig. 3., there are five state transitions for the station that can generate insertion pattern and represent by dash line.
- The station cannot generate insertion pattern if the station in one of three states: Remove, Dump-Delay, and Transmit Delay. The reason is to prevent generating more than two token in the ring.
- The station is idle when the station has neither data to transmit nor delayed data. This station may pass token , insertion pattern with frame, or frame with valid header through station's interface.

- In the transmission state, the station that has been transmitting message, two frames may arrive at the station either invalid fame or free token frame. In the case of invalid frame arrival the station has to delay the frame in the buffer until the station end sending its own message, the station will transit from the Transmit state to the Transmit-Delay state. When the station finishes sending its message the station's state will change to Dump state, the station starts transmitting delayed message. In the case of free token arrival, the station will insert the pattern to the transmitting data.
- The station that has been sending a message to another station receives valid frame destined for this station. The arrival frame will be removed and the station will insert the insertion pattern to the sending massage.
- If the station is in the transmitting state, then the arrival of data frame not addressed to the station will be delayed. Therefore, the station will transit to the Dump-Delay state. The dumping of the delayed data begins when the station's transmitting data has been completed.

4. EXAMPLE

In this section, we consider an example to illustrate the proposed scheme. Fig. 4 shows six stations connected to the ring.

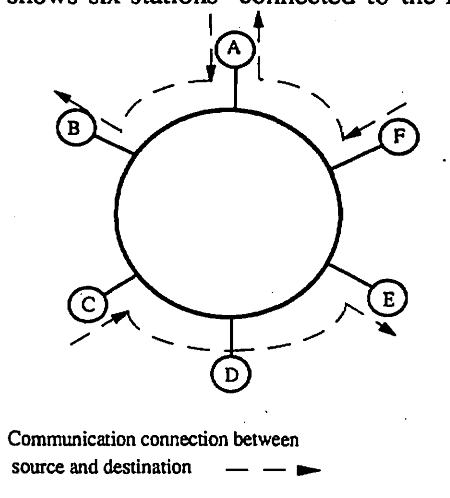


Fig. 4 An Example for a Ring Network

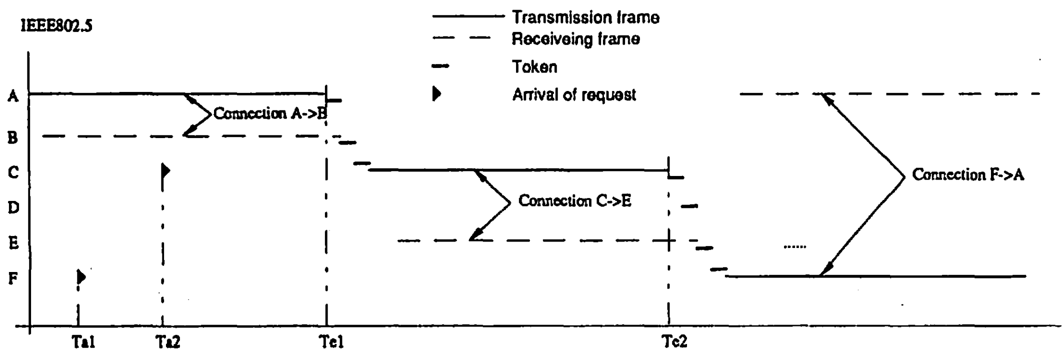


Fig.5 Time Schedule for IEEE802.5 Model

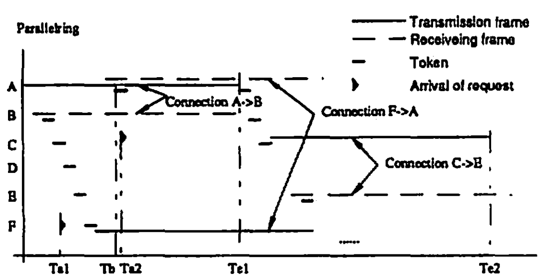


Fig. 6 Time Schedule for Parallelring Model

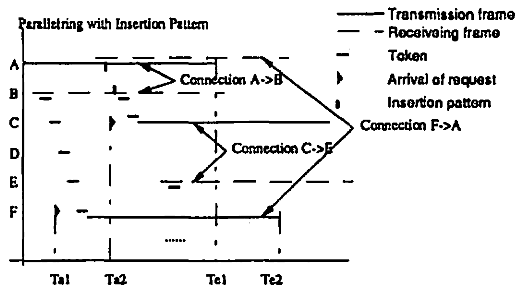


Fig. 7 Time Schedule for Insertion Pattern Model

We assume that average arrival rate to each station is identical with same average packet length. When the ring initiate, a free token is put into the ring and it will circulate around the ring until the token is seized by a station that has data to send. We suppose that the station *A* is the first station in the ring that seizes a free token and begins to send its message to station B. During transmission period, two transmission requests arrive at the stations F and C successively with destinations A and E respectively.

Figures 5, 6, and 7 show the operation process among three protocol models IEEE802.5, Parallelring, and Insertion pattern, respectively. While the token arrives at the station *A*, the station *A* will start transmitting its data to the destination *B*. During data transmission of A, we suppose that there are two requests arriving at time T_{a1} and T_{a2} at the stations *F* and *C* respectively. In the IEEE802.5 protocol scheme, the source station removes its data that has been sent. The station will release a token to the ring when the message has been transmitted. For token round trip, there is only one station that can transmit its data and the other stations might have to wait for an unlimited period of time for free token arrival. Therefore, there is no multiple concurrent transmission occurred in the network, as shown in Fig. 5. In the parallelring and the insertion pattern schemes, the data is removed by the destination station which will release a free

token as soon as the header of the data frame is interpreted.
In the parallelring scheme, when the free token is arrived at the station A, which has been sending data to the other station, the station will delay the token arrived in the buffer until the station ends sending its data, this delay that is indicated in Fig. 6 as T_b will affact on the network performance. Such a problem can be resolved by the insertion pattern scheme. The station A will remove the token or the frame received and inserts insertion pattern into the sending frame. The destination station will remove the pattern and release a free token to the ring. This a new token may utilize by the other stations that has message to be sent. Therefore, concurrent transmission can be performed as shown in Fig. 7. The insertion pattern scheme provides high network throughput because the station can substitutes the arrival of the token by inserting a pattern into the sending stream.

5. CONCLUSION

We proposed a new token ring local area network called insertion pattern. This new token ring is enabling multiple stations to transmit data frame simultaneously. Now we are working on the analysis of the performance of insertion pattern using simulation studies. We have got some results, which are not completed, using insertion pattern scheme, and by the comparison with other token ring schemes, it's show that we can get better performance(network's throughput) by using Insertion Pattern strategy.

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