Two proposals for priority based PLCA

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INTRODUCTION

1. Priority issues have been discussed for comment #573, but in OSI layer 2
2. However, IEEE P802.3cg 10SPE is defined in OSI layer 1, not in the upper layers
3. Two new priority methods are proposed in OSI layer 1 :
    1) Single critical node priority
    2) Multiple priorities method
4. Using the above two methods, we can have higher priority nodes in the OSI layer 1
5. Those two methods can be optional functions as a supplement of priority mechanism for PLCA

1. Objectives

   1) Provide only one node with high priority and the others with an equal priority.
   2) All nodes may have a certain time of IDLE when they are given a transmission opportunity.
   3) The critical node generates a ALARM signal to inform the master node the transmission request. The special signal can be an unassigned code in Table 147-1 such as 11101.
   4) If the node having the transmission opportunity detects the ALARM signal in the IDLE slot, the node waits for a certain time until the transmission of the high priority node is completed and resumes transmission.

1) Single critical node priority method

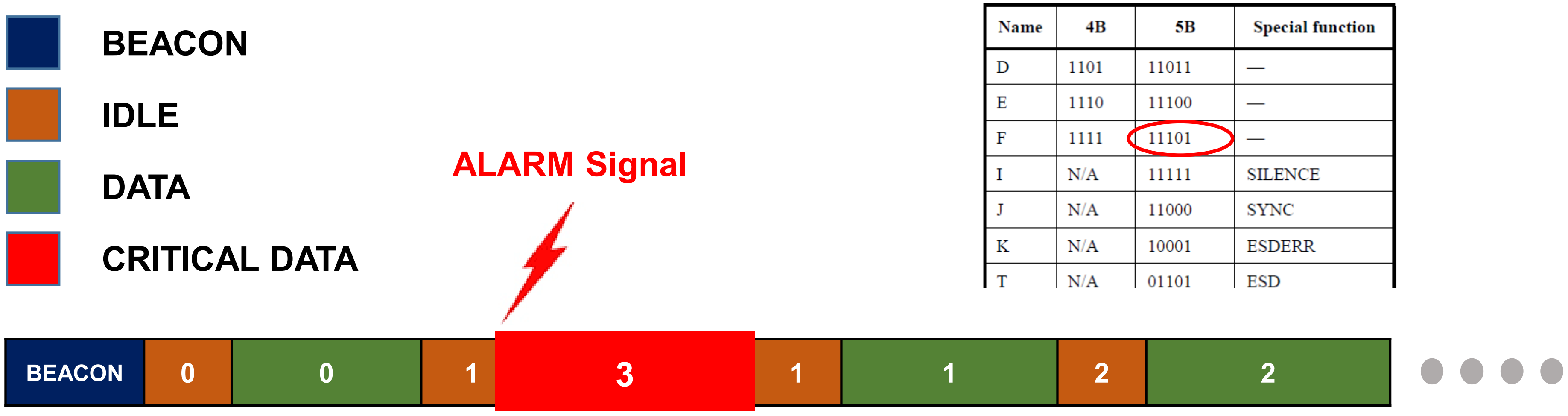


Table 147–1—4B/5B Encoding *(continued)*

Name	4B	5B	Special function
D	1101	11011	—
E	1110	11100	—
F	1111	11101	—
I	N/A	11111	SILENCE
J	N/A	11000	SYNC
K	N/A	10001	ESDERR
T	N/A	01101	ESD

2. Approaches

   1) All nodes are sequentially given transmission opportunities like the operation of the existing PLCA.

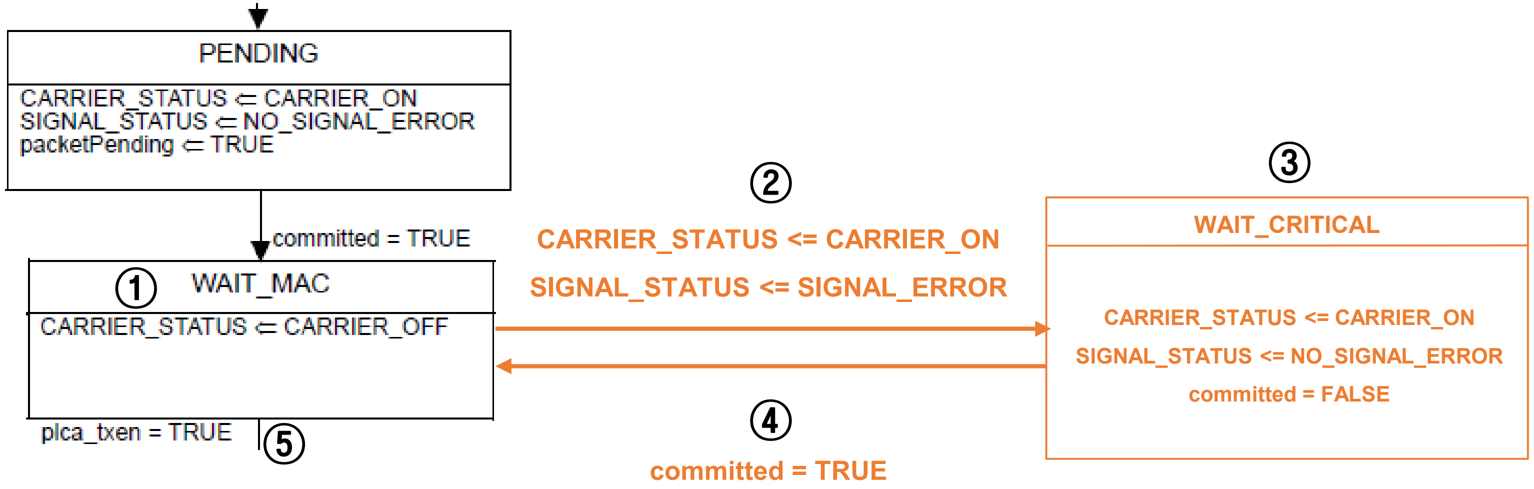
   2) Suppose that node 3 is the only node with the high priority in this scenario.

2. Approaches (Contiuned)

3) As shown in the figure above, node 1 has an IDLE time before transmission, but CRITICAL DATA transmission request from node 3 occurs at the corresponding IDLE time.
4) Node 3 receives the transmission opportunity and transmits CRITICAL DATA.
5) Node 1 waits until the transmission of CRITICAL DATA is completed, and then starts transmission with a certain time of IDLE.
6) If there is no CRITICAL DATA transmission request, the PLCA transmission scheme is maintained.

1) Single critical node priority method

Figure 148-5 PLCA DATA state Diagram



3. Changes to PLCA DATA state Diagram

- Figure 148-5 shows the state diagram of the operation of the node with the transmission opportunity.

1) WAIT_MAC = IDLE time

3. Changes to (continued) PLCA DATA state Diagram

2) When an ALARM signal is received, the CARRIER_STATUS is in the CARRIER_ON state to transmit CRITICAL DATA and the SIGNAL_STATUS becomes the SIGNAL_ERROR state to enter WAIT_CRITICAL.

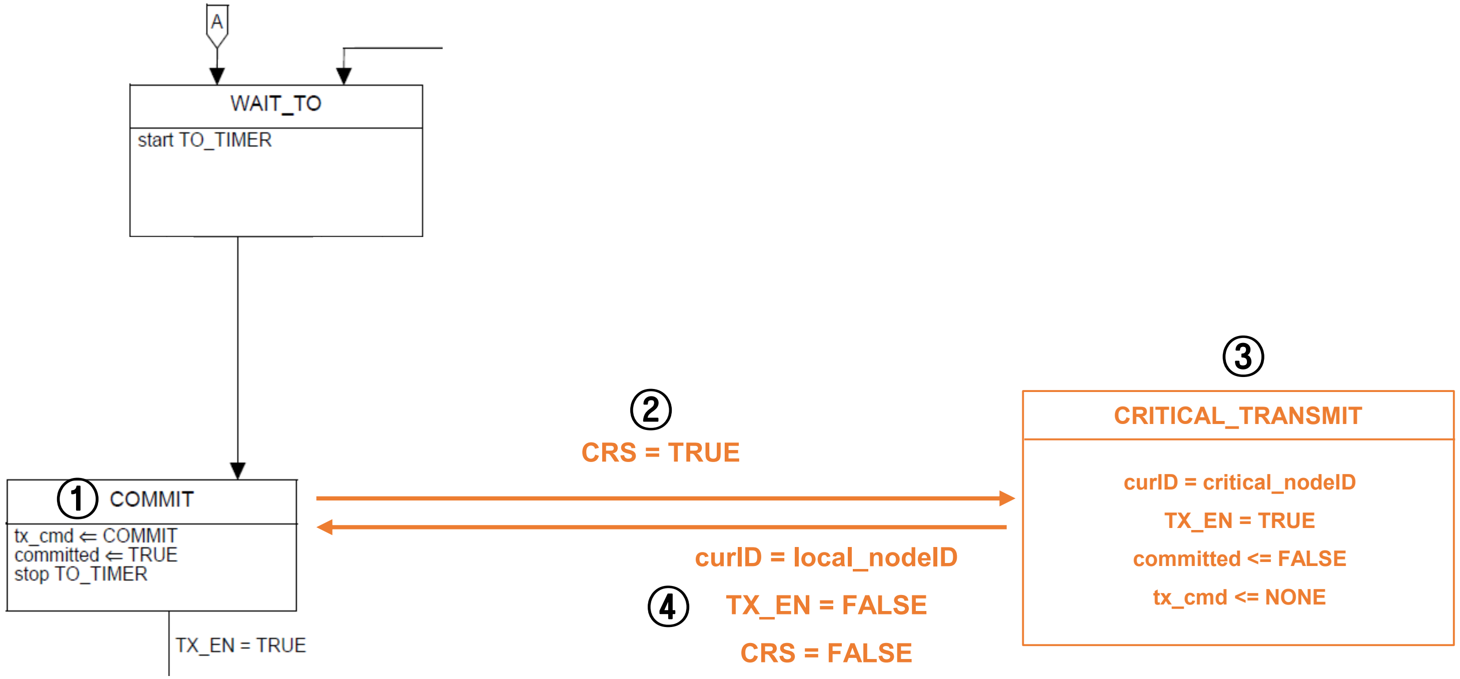
3) After entering the WAIT_CRITICAL state (CRITICAL DATA transmission), the state of the node having the transmission opportunity recognizes the transmission of the CRITICAL DATA through CARRIER_STATUS <= CARRIER_ON and waits (committed = FALSE).

4) After CRITICAL DATA transmission is completed, the waiting node acquires the transmission opportunity again (committed = TRUE).

5) The waiting node have an IDLE time and start to transmit DATA.

1) Single critical node priority method

Figure 148-4 PLCA CONTROL state Diagram



3. Changes to PLCA CONTROL state Diagram

   1) It is IDLE time of a low priority node.

   2) An ALARM signal has been detected (CRS = TRUE).

3. Changes to PLCA CONTROL state Diagram

3) The transmission opportunity is passed to the node that generated the ALARM signal (curID = critical_nodeID). The node with the previous transmission opportunity stores th e transmission sequence number using the local_nodeID variable.

4) When the transmission of the critical data is completed, the transmission opportunity is returned to the original node (curID = local_nodeID) and the regular PLCA transmission cycle is continued.

1) Single critical node priority method

3. Make the following changes to Table 147-1: (p.170)

E	1110	11100	—
F	1111	11101	ALARM
I	N/A	11111	SILENCE
J	N/A	11000	SYNC

3. Changes to texts : Add the following Clause: (p.206, line 17)

148.4.3.8 Mapping of PLS_CRITICAL_DATA.indication

Map of the primitive PLS_CRITICAL_DATA.indication (CARRIER_ON and SIGNAL_ERROR) following with 148.4.3.3 and 148.4.3.4 shall comply with 147.3.2.3.

3. Changes to texts : Add the following text: (p.214, line 2)

Clause148.4.5.1 PLCA Data State Diagram

But when an ALARM signal is received, the CARRIER_STATUS is in the CARRIER_ON state to transmit CRITICAL DATA and the signal status becomes the SIGNAL_ERROR state to enter WAIT_CRITICAL. After entering the WAIT_CRITICAL state (CRITICAL DATA transmission), the state of the node having the transmission opportunity recognizes the transmission of the CRITICAL DATA through CARRIER_STATUS <= CARRIER_ON and waits (committed = FALSE). After CRITICAL DATA transmission is completed, the waiting node acquires the transmission opportunity again (committed = TRUE). The waiting node have an IDLE time and start to transmit DATA.

3. Changes to texts : Add the following text (p.208, line 31)

Clause148.4.5.1 PLCA Control State Diagram

When an ALARM signal has been detected (CRS = TRUE), the transmission opportunity is passed to the node that generated the alram signal (curID = critical_nodeID). The node with the previous transmission opportunity stores the transmission sequence number using the local_nodeID variable. When the transmission of the critical data is completed, the transmission opportunity is returned to the original node (curID = local_nodeID) and the regular PLCA transmission cycle continues.

2) Multiple priorities method

1. Objectives
   1) Assign various priority levels to different nodes not just a single node.

2. Approaches
   1) A node with a higher priority is given more transmission opportunities than a node with a lower priority.
   2) Nodes with a lower number have higher priorities (e.g. priority of node #0 > #1 > #2…).

3. Proposed Method

1) Suppose that there exist N nodes in a LAN.
2) Two kinds of cycles are used.
3) They are Main-Cycles and Sub-Cycles depicted in big bracelet and Sub-Cycles are depicted in small parentheses as shown in the following three examples.

    (e.g) N = 3, { (012) (010) } (except BEACON).

    (e.g) N = 4, { (0123) (0120) (0101) } (except BEACON).

    (e.g) N = 5, { (01234) (01230) (01201) (01010) } (except BEACON).

- Each number in the cycles represents a node number and its time slot. Other time slots such as BEACON, IDLE, and SILENCE slots are shown.

3. Proposed Method (Continued)

- In the first Sub-Cycle all nodes are included in the priority descenting order. In the second Sub-Cycle, the last node is dropped and is replaced with the node 0. In the third Sub-Cycle, the last two nodes are dropped and are replaced with the nodes 0 and 1. In the fourth Sub-Cycle, the last three nodes are dropped and are replaced with the nodes 0, 1, and 2. In the N-1 Sub-Cycle, N-2 nodes are dropped and are replaced with either 0, 1, 0, 1…0 when N is odd and 0, 1, 0, 1…1 when N is even.
- Notice that in the three examples, nodes with lower numbers have always more opportunities to transmit than nodes with higher numbers. Cases for higher Ns are shown in the appendix (1).

2) Multiple priorities method

- If there are three or more nodes on the LAN, use multiple nodes priority method.

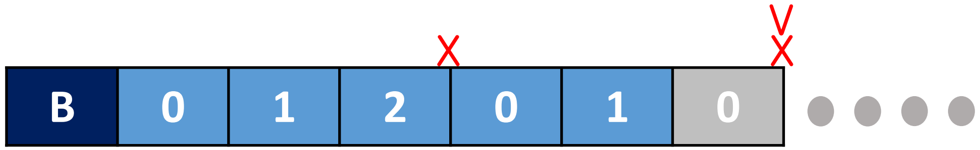
Example :

Number of nodes = N

N = 3

V : The point at which one Main-Cycle ends

X : The point at which one Sub-Cycle ends



BEACON

Time slot

Replaced slot

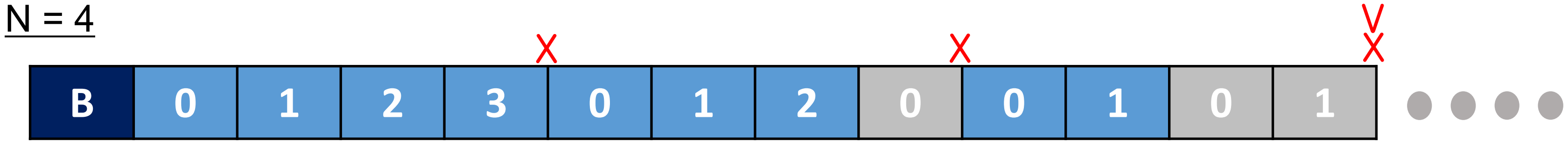
- First, BEACON is transmitted and a cycle of N * (N – 1) time slots is started.
  - One such cycle is called a Main-Cycle.
- Since the node #2 has the lowest priority, transmission opportunity node #2 is replaced in next Sub-Cycle, and node #0 replaces that transmission opportunity.
- In the last Sub-Cycle, only the node #0 and node #1 have been granted the transmission opportunity, so the Main-Cycle ends and the BEACON is transmitted again to restart the Main-Cycle.

2) Multiple priorities method

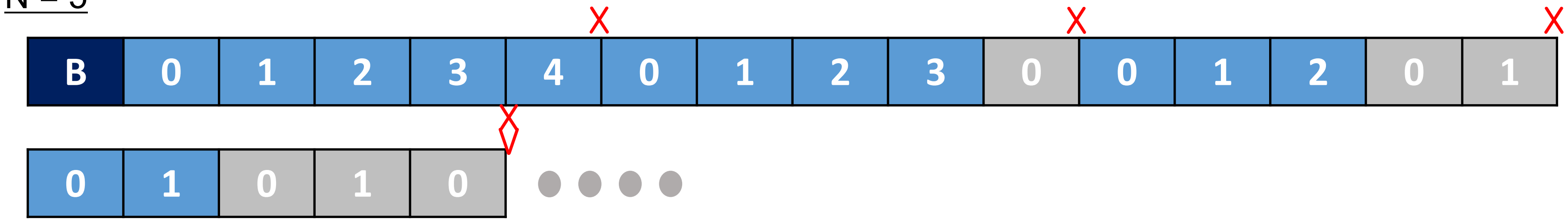
Example :

Number of nodes = N

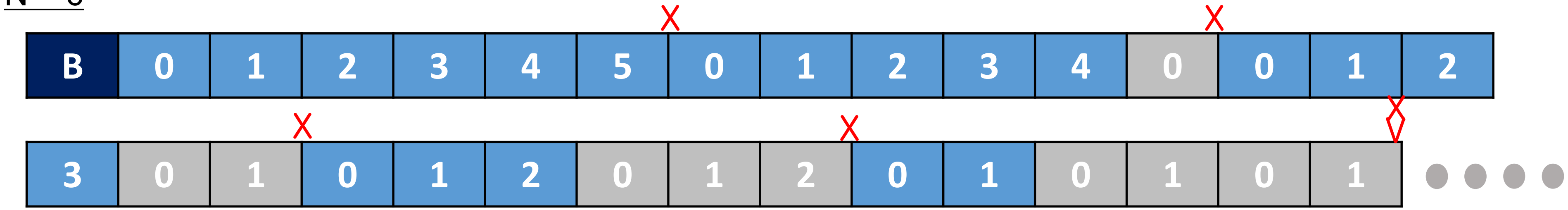
<u>N = 4</u>



<u>N = 5</u>



<u>N = 6</u>



CONCLUSION

- We recommend to put our first proposal (Single critical priority node method) as changes in state diagrams and tables into a standard document.

- Also, we recommend to put our second proposal (Multiple priorities method) as an option of PLCA operation into an annex part of a standard document.

Q & A

APPENDIX (1)

- Example (N = 10)

1. Existing PLCA :

{ (0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9)
(0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9)
(0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 9) }

2. Proposed method :

{ (0 1 2 3 4 5 6 7 8 9) (0 1 2 3 4 5 6 7 8 0) (0 1 2 3 4 5 6 7 0 1)
(0 1 2 3 4 5 6 0 1 2) (0 1 2 3 4 5 0 1 2 3) (0 1 2 3 4 0 1 2 3 4)
(0 1 2 3 0 1 2 3 4 5) (0 1 2 0 1 2 3 4 5 6) (0 1 0 1 0 1 0 1 0 1) }

APPENDIX (2)

Comparison of transmission opportunity efficiency with existing PLCA :

An example through the sum of the number of

transmission opportunities of node #0 and node #1 in comparison of those in the traditional PLCA.

- S1 = The sum of transmission opportunities of node #0 and node #1 in one cycle of the existing PLCA
  - If N > 2, S1 = 2 * (N – 1) slots

- S2 = The sum of transmission opportunities of node #0 and node #1 in the Main-Cycle of the proposal
  - If N = 3, S2 = 5 * N – 11 (+ 1) = 5 * N – 10 = 5 slots (An exception not covered by the formula below)
  - If N > 3, S2 = [(5 * N) – 11] slots

- The efficiency is calculated as follows :

$$\lim_{n \to \infty} \left(\frac{S2}{S1} \right) = \lim_{n \to \infty} \left(\frac{5\,N - 11}{2\,(\,N - 1\,)} \right) = 2.5$$

- Node #0 and node #1 have transmission opportunities of about 2.5 times as much as those of the existing PLCA.

THANK YOU !