Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [NICT's MAC Proposal For IEEE802.15.8 Peer Aware Communications]
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Re: [Response to call for proposal of 15.8 PAC

Abstract: [MAC proposal for IEEE802.15.8 Peer Aware Communications]

Purpose: [This document is to provide a MAC mechanism for PAC]

NICT's MAC Proposal For IEEE802.15.8 Peer Aware Communications

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Purpose of This Document

- MAC proposal as a response to the call for proposal.

  15-13-0069-05

- Preliminary proposal with basic ideas and procedure design.

- Evaluation of performance will be presented at July meeting.

Common Mode vs. Operation Mode

- A PD can operate at one common mode and several operation modes that are allocated in a PAC frequency band listed in PAR and are supported by PAC PHY.
- A common mode shall be assigned with a fixed RF channel at a PAC frequency band, and shall be defined by fixed PHY parameters including modulation, FEC, and data rate.
- An operation mode should operate at one of the RF channels at a PAC frequency band. PHY parameters, including modulation, FEC, and data rate, can be selected from PHY specifications.

Characteristics of Common Mode

- A common mode defined in a given PAC frequency band will ensure global discovery/connection for all PDs operating in that frequency band.
  - Meet the request of interoperability.
- A common mode enables quick and efficient discovery for PDs through proper management.
  - Meet various requirements on discovery.
- A common mode provides smooth and quick delivery of emergency message.
  - Meet the requirement of priority for emergency services.

Usage of Common Mode

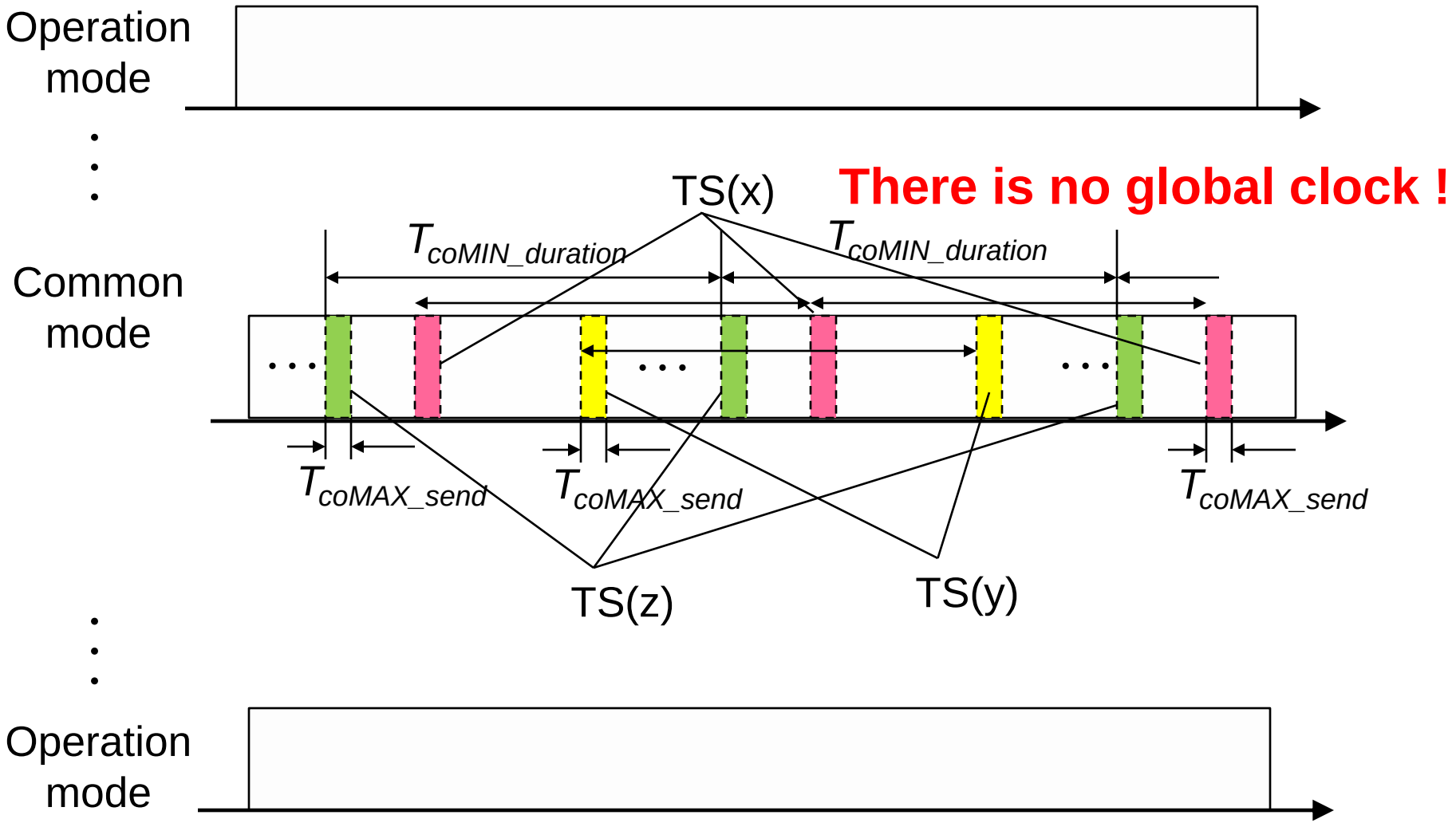
- To decrease scanning latency, common mode with a specified RF channel shall be used only for starting discovery, or for initiating a PAC group through broadcasting short signal/message.
- Common mode shall not be used in operations or communications for an established PAC group.
- Emergency message shall be broadcasted at the common mode to guarantee efficient delivery.

Management of Common Mode

1. There is no global clock for common mode. An initiating PD broadcasts a short signal/message on its own clock. Hereafter, we refer to the short signal/message broadcasted over common mode as a trigger signal (TS).

2. Length of a TS that is broadcasted via the common mode shall be within the maximum length T_{coMAX_send}. Re-broadcasting of a TS shall be after a minimum duration $T_{coMIN\_duration}$.

Illustration of Constraint 2



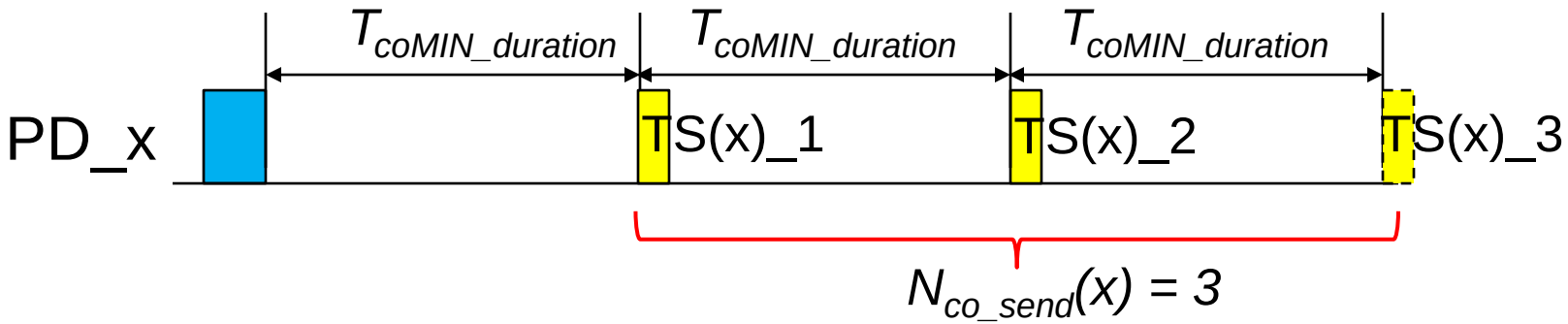
Management of Common Mode (continue)

3. An initiating PD shall perform CCA before broadcasting a TS. The minimum CCA time is T_{coMIN_cca}.

   A) When CCA reports a clear channel at time t_k, the initiating PD shall start broadcast of a TS at $t_k + T_{coMIN\_duration}$ and stop broadcast after broadcasting the last TS at $t_k + N_{co\_send} \times T_{coMIN\_duration}$.

   where, N_{co_send} is an integer randomly selected within [1, N_{coMAX_send}], and N_{coMAX_send} is the maximum number that a TS can be repeatedly broadcasted in an iteration. After an iteration, N_{co_send} is reset for the next iteration.

Illustration of Constraint 3 A)



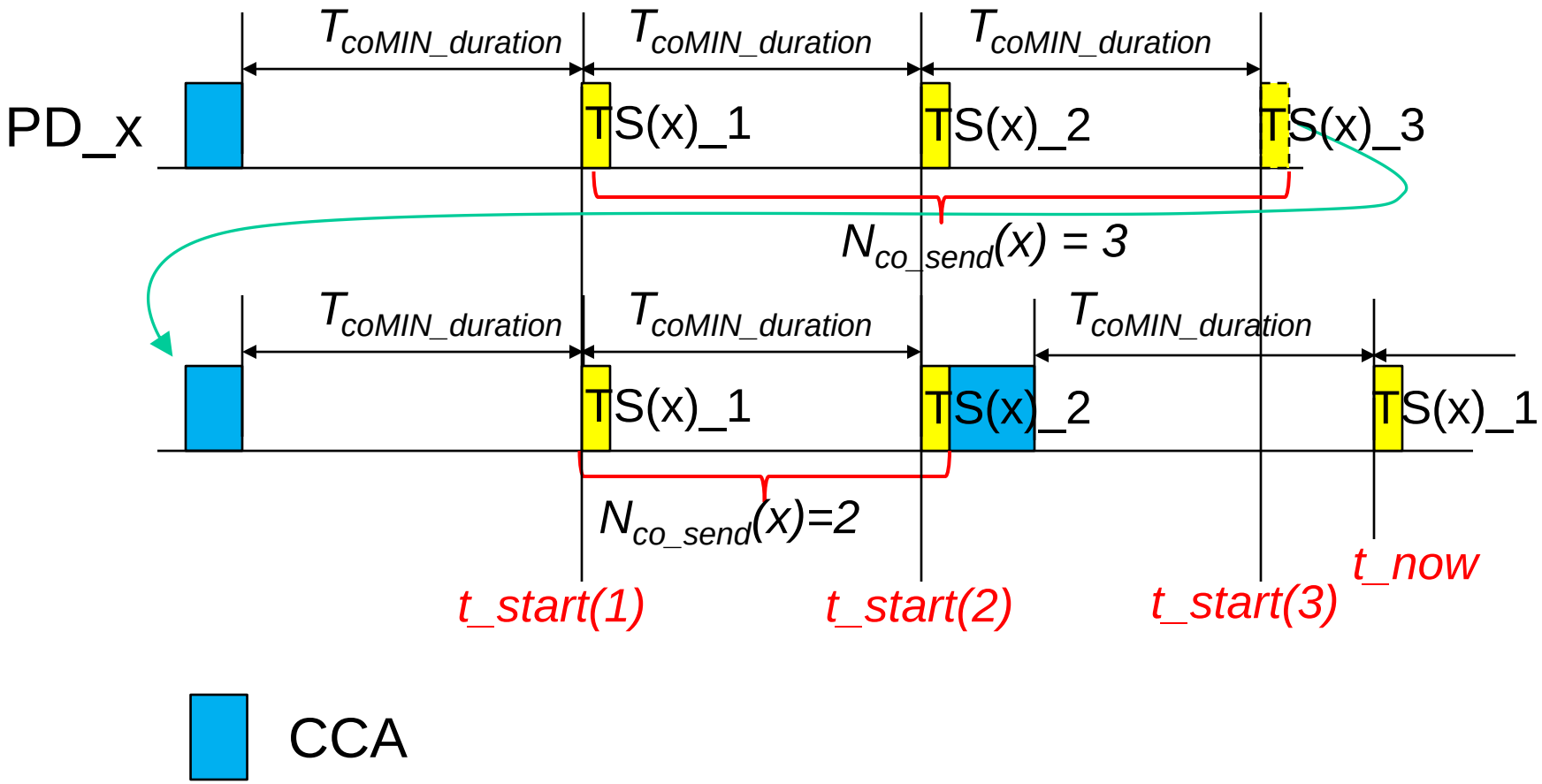
Management of Common Mode (continue)

B) After 3A), the initiating PD shall perform CCA again before further broadcasting. When CCA reports a clear channel, the initiating PD repeats (iteration) procedure 3A) again.

C) Procedure of 3B) will be iterated until the upper layers stop the iteration.

D) In each iteration, the group clock provides the information of start time, t_start, of TS which is synchronized to the first broadcasted TS, as well as the information of the current TS time, t_now. The latter is the start time of TS in the current iteration.

Illustration of Constraint 3B, 3D

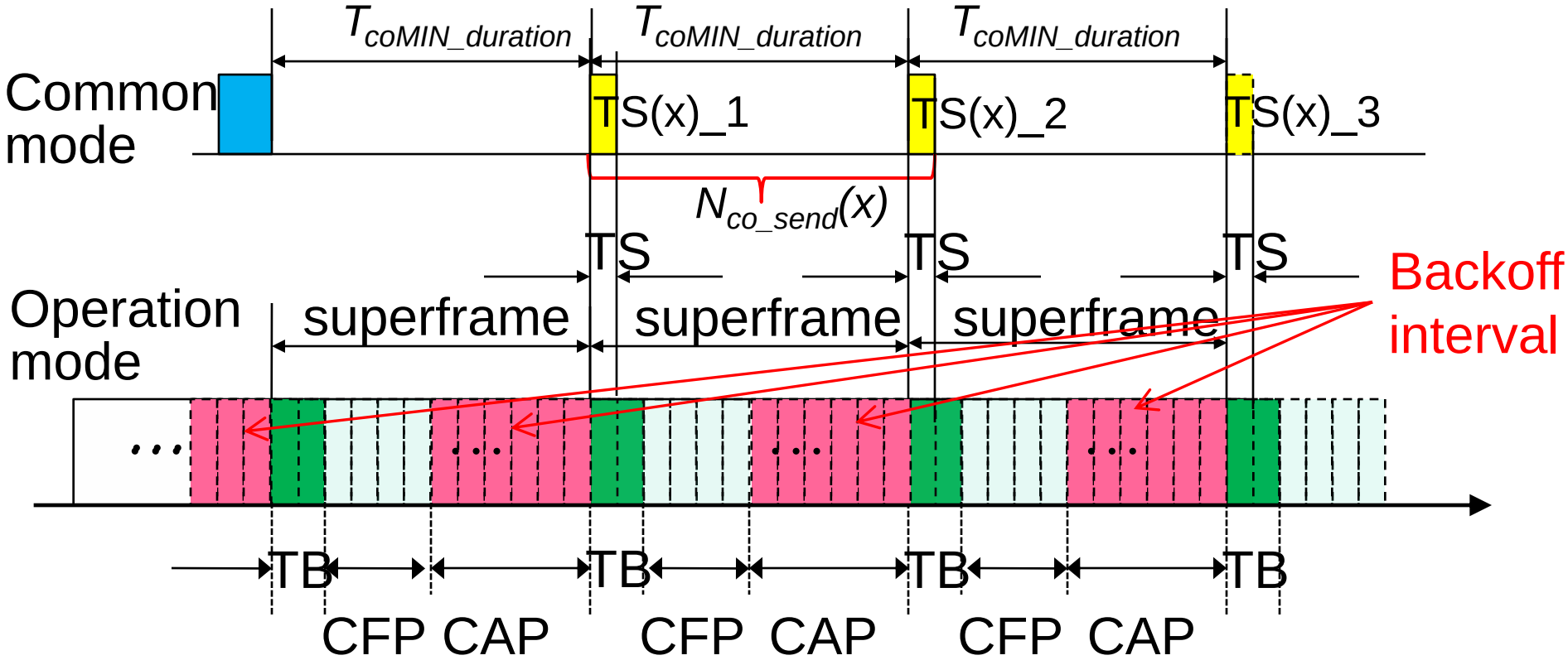


Group Forming

i. Initiating PD broadcasts group forming invitation (active scanning) within a TS including information of necessary IDs, selected operation mode (including channel), and group clock, under constraints 2 and 3.

ii. When a joining PD scans the invitation (passive scanning) at common mode, it moves to the selected operation mode announced in (i). Accounting from the start of TS, the joining PD waits for a duration of TB+CFP. Then, it sends joining request including its ID information with a random backoff within a duration of CAP.

Superframe and Group Forming



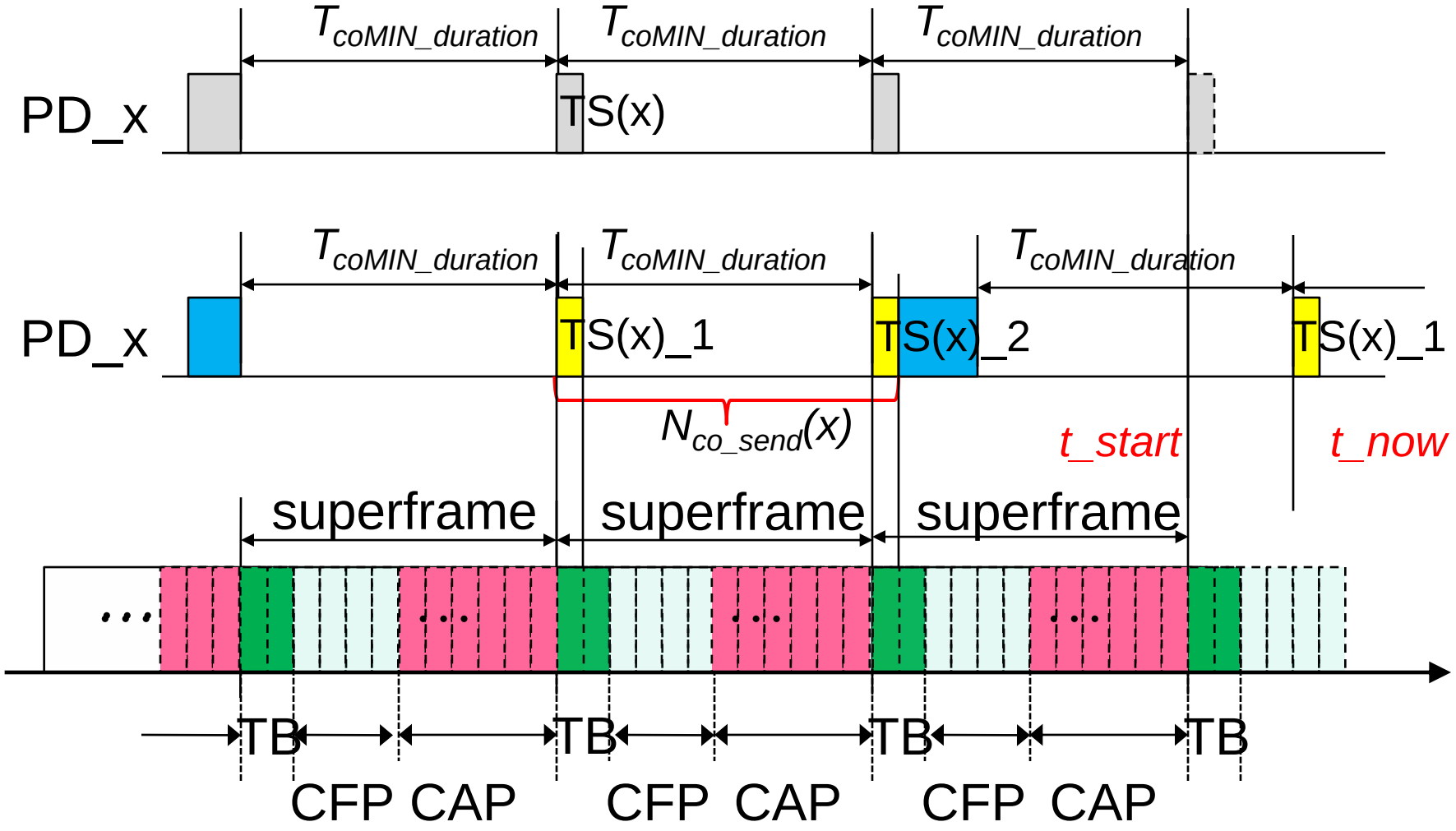
Operation within an operation mode is based on a superframe structure, which includes a temporary beacon (TB), CFP, and CAP. The clock of TB is synchronized to the first TS.

Group Forming (continual)

iii. When a joining PD scans the TS in an iteration, it will calculate the difference between t_now and t_start. If t_start is within a CAP, the joining PD takes random backoff between t_start and the end of CAP and sends joining request. If t_start is out of a CAP, it waits until the next CAP before sending request.

iv. Initiating PD scans the selected operation mode (passive scanning), registers the joining PDs and distributes a list of the registered PDs within the temporary beacon (TB) at the selected operation mode.

Illustration of Constraint (iii)



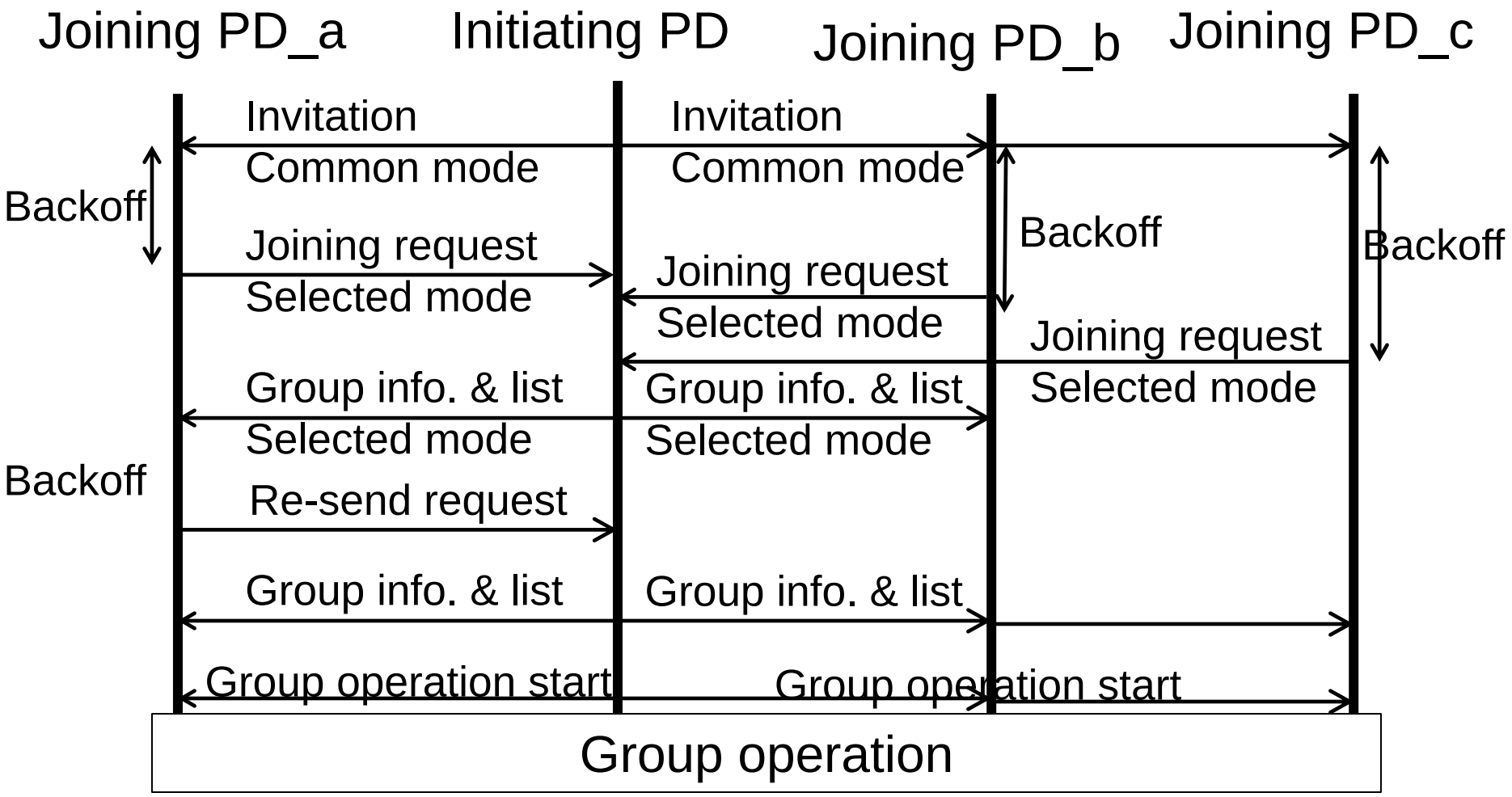
Group Forming (continue)

v. Joining PDs that had sent joining requests but are not included in the distributed PDs list should repeat the process of (ii) and (iii).

vi. The initiating PD decides when to move to the group operation stage.

vii. Communications within the formed group are undertaken using the selected operation mode and managed by the initiating PD.

Illustration of Group Forming



Group Operation Example

- With the selected operation mode, the initiating PD should act as a temporary coordinator. It broadcasts temporary beacon (TB) to coordinate group operation.
  - The clock of TB is synchronized to the first TS.
  - TB should have similarity with TS and the length of TB is larger than TS.
  - The temporary coordinator updates the group list and broadcast within the TB.

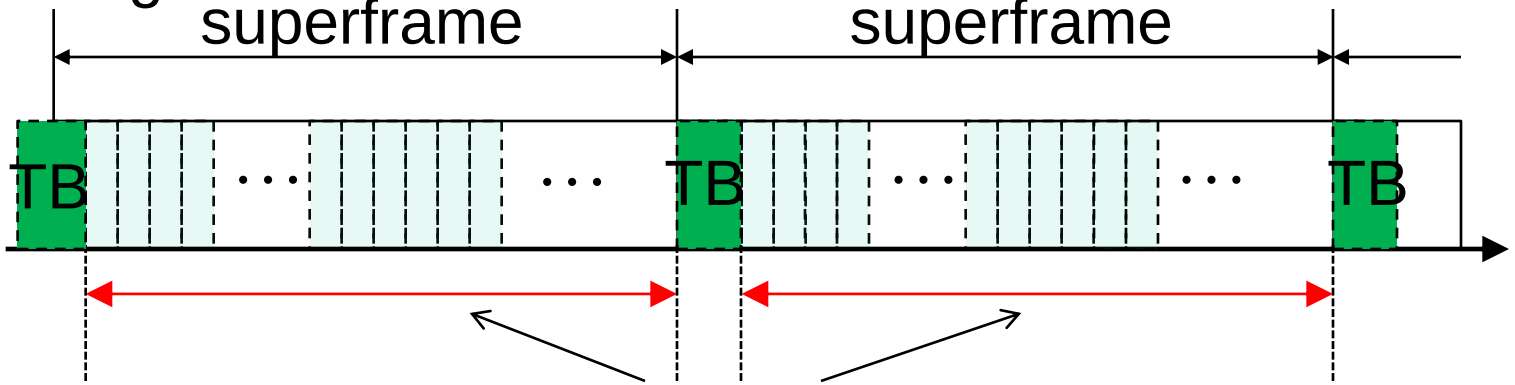
Group Operation Example (continue)

- Temporary coordinator can be changed from one device to another device.
  - When the temporary coordinator can not operate further because of some reasons, it can pass the role to another PD in the group.

- The operation within the group can be based on a superframe structure, e.g., similar as that in 15.4 MAC. Detailed parameter should be refined to PAC.

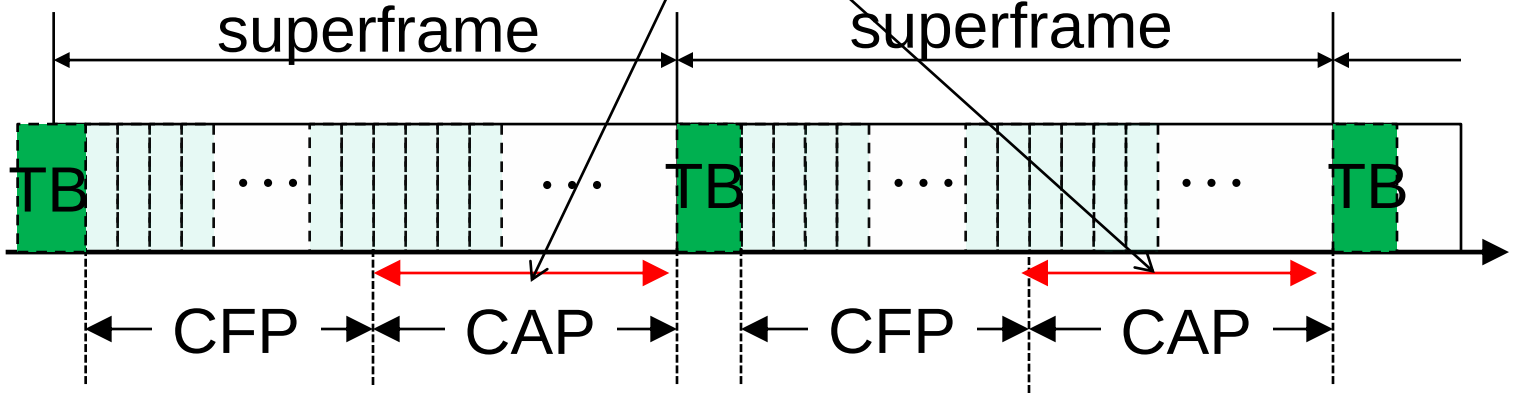
Superframe Structure Example

Group forming:



Joining requests backoff interval

Group operation:



Advertisement Procedure

a. Advertising PD broadcasts information of operation mode, clock, category of advertisement, etc. within TS via common mode under constraints 2-3.

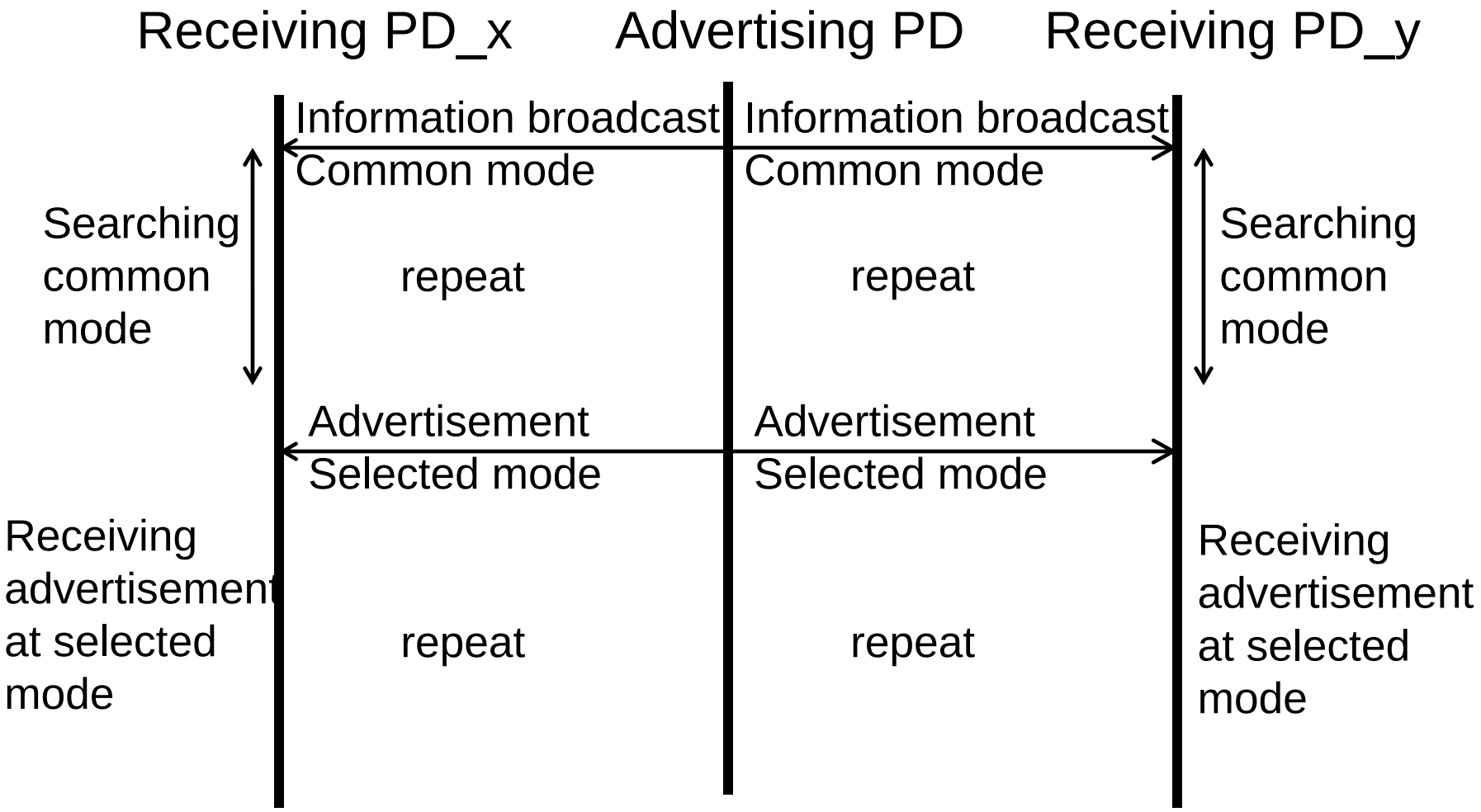
b. Receiving PDs scan the advertising information with own filters via the common mode.

c. Advertising PD broadcasts advertisement message via the selected operation mode.

d. Receiving PDs receive the advertisement message via the selected operation mode.

✓ How to decide selected operation mode is responsibility of the advertising PD.

Illustration of Advertisement Procedure



Emergency Message

- PD shall broadcast emergency message directly via common mode under constraints 2-3 when required (e.g., asked by upper layer).
- An emergency message could have a maximum length of T_{coMAX_send} multiplied by m (integer).
- The repetition interval of an emergency message could be $T_{coMIN\_duration}$ divided by k (integer).

✓ E.g., $1 \leq m \leq 3$ and $2 \leq K \leq 4$.

Conclusion Remarks

- Preliminary MAC proposals for 15.8.
- Efficient and fair usage of common mode.
  - Restrict to starting discovery only in order to increase throughput
  - Randomization to avoid collision.
- No global clock before discovery.
- Operation with superframe after discovery