

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

**Submission Title:** [NICT's MAC Proposal In Response to Call For Contribution]

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**Re:** [Response to call for contribution of 15.8 PAC]

**Abstract:** [MAC proposal for IEEE802.15.8]

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

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# NICT's MAC Proposal In Response to Call For Contribution

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# Common Mode Proposal

# Common Mode in TGD

As described per TGD:

- *Common mode (e.g., for discovery and communication) shall be supported for interoperability.*
- *Common mode used in different frequency bands needs not necessarily be the same.*

# Proposed Common Mode (1)

- There shall be one and only one common mode at each frequency band that is dedicated to PAC.
- A common mode shall use a assigned fixed RF channel, and have fixed PHY parameters including modulation, channel coding, and data rate.
- All PDs shall be able to operate at the common mode.

***Reason: Fixed RF channel and PHY parameters guarantee interoperability among PDs.***

## Proposed Common Mode (2)

Common mode shall give the highest priorities for the following operation.

- Broadcasting/sending emergency message.
  - *IEEE 802.15.8 shall support prioritized services including emergency services with highest priority.*
- Initiating a PAC group through sending short signal/message.
  - *Energy-efficient discovery(e.g. low duty cycle)*
  - *Support high PD density and high discovery traffic*
  - *Prioritized access to discovery*

## Proposed Common Mode (3)

- Any PD is allowed to send emergency message through common mode.
- Any PD is allowed to send short signal/message (TS: triggering signal) to initiate a PAC group.
  - *To support a fully distributed, decentralized, and self-organized system.*
  - *To provide a fully distributed scheduling mechanism.*

# Management of Common Mode



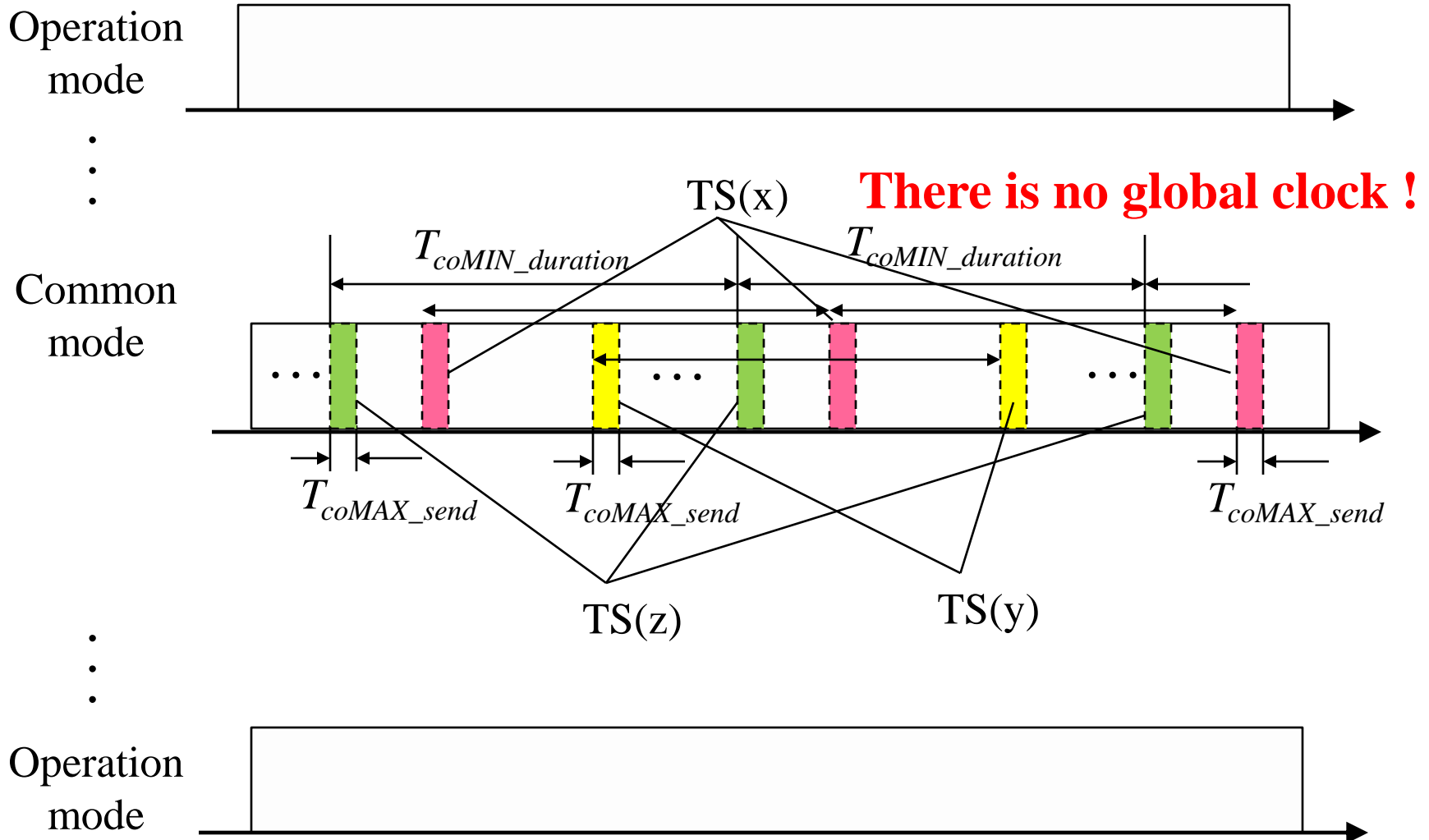
# Policy of Using Common Mode

- Besides emergency message transmission, to decrease scanning latency, it is desired to use common mode only for starting discovery, or for initiating a PAC group.
- Common mode should not be used in operations or communications for an established PAC group.

# Management of Common Mode (Discovery signal)

1. There is no global clock for common mode. An initiator PD (I-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



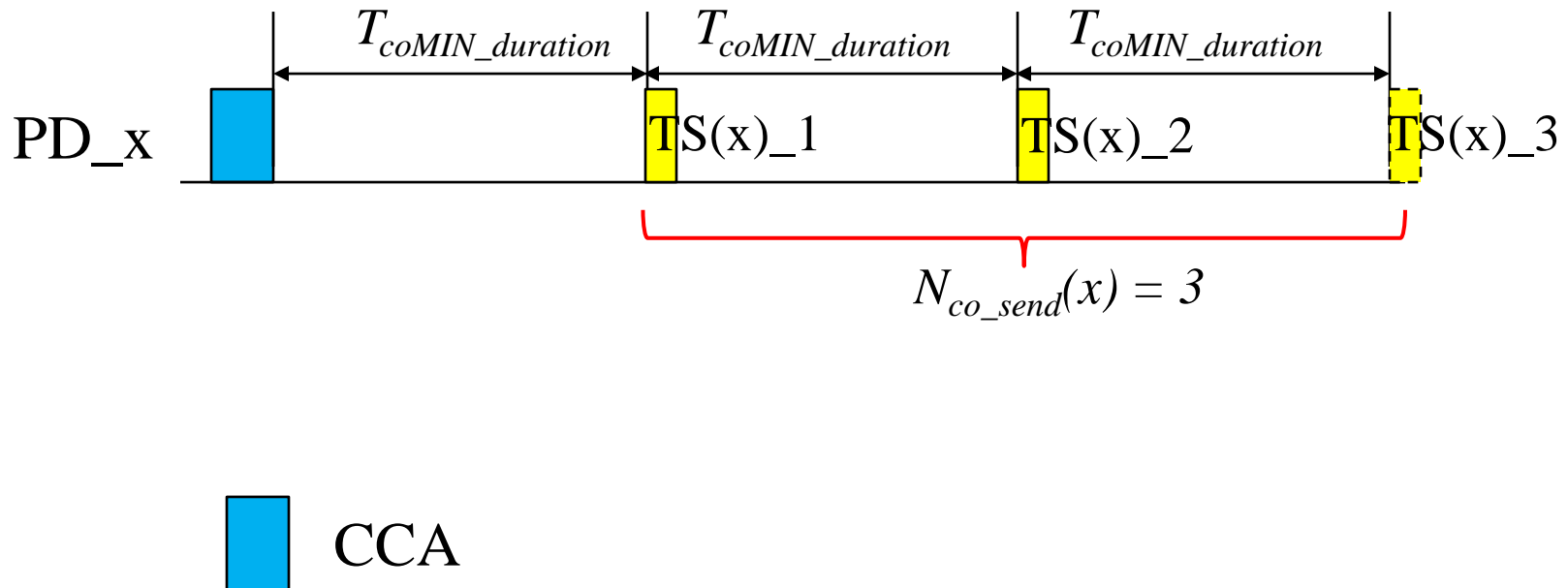
# Management of Common Mode (continue)

## (Active discovery Scan)

3. An I-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 I-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)

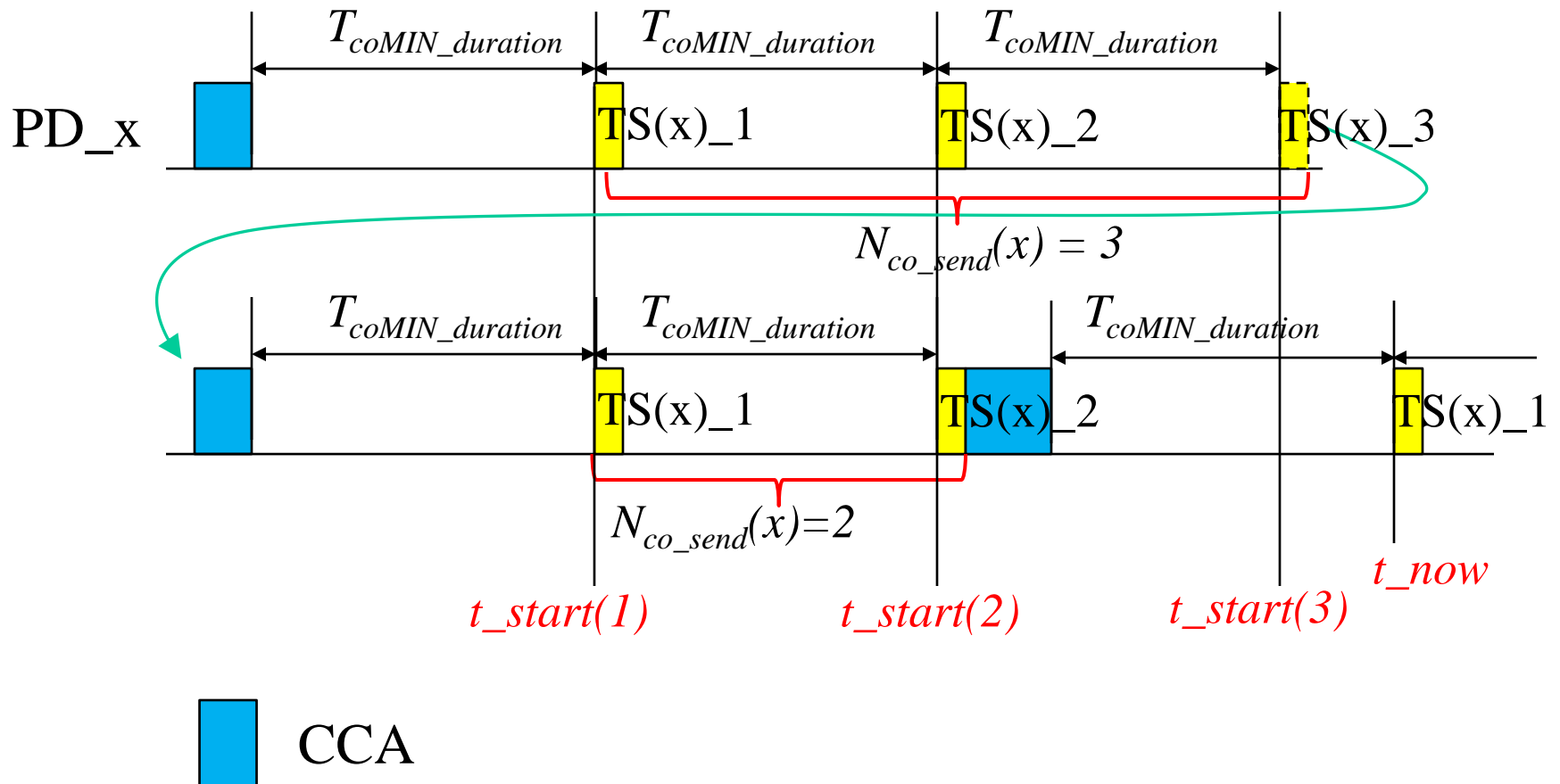


# Management of Common Mode (continue)

## (Active discovery scan - continue)

- B) After 3A), the I-PD shall perform CCA again before further broadcasting. When CCA reports a clear channel, the I-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,  $t_{\text{start}}$ , of TS which is synchronized to the first broadcasted TS, as well as the information of the current TS time,  $t_{\text{now}}$ . The latter is the start time of TS in the current iteration.

# Illustration of Constraint 3B, 3D



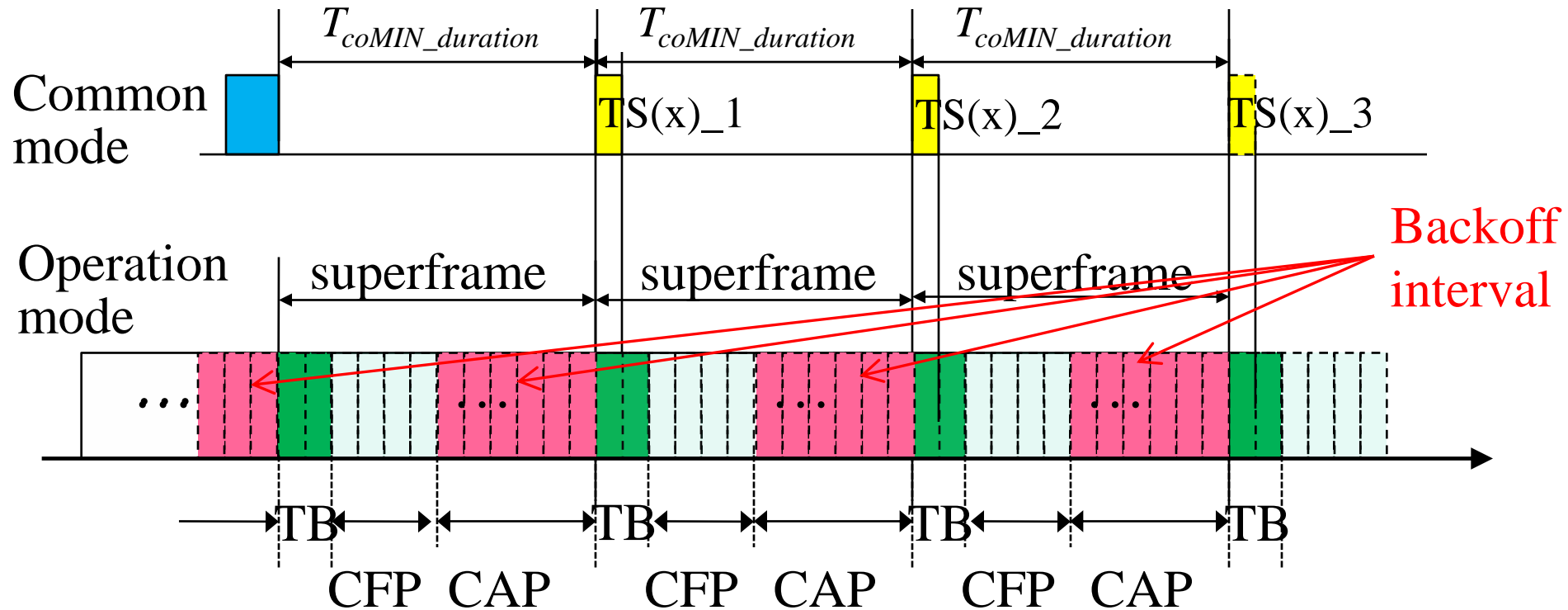
# Emergency Message

- 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  $2 \leq K \leq 4$ .



# Superframe Proposal

# Proposed Superframe Structure



- 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.
- **The length of a superframe is equal to  $T_{coMIN\_duration}$**

# Association Procedure

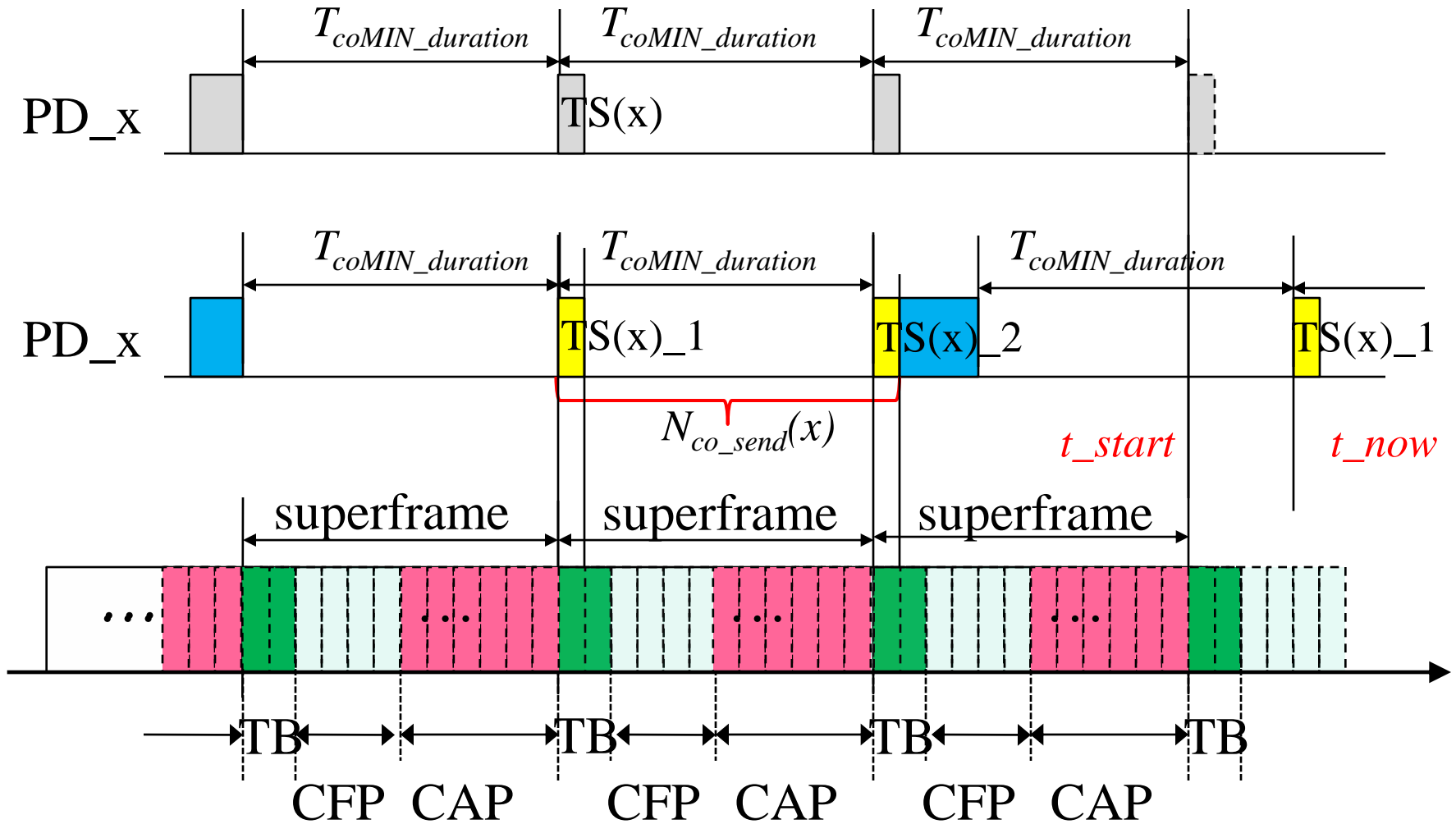
# Association Procedure

- i. The I-PD broadcasts an invitation (active scanning) with TS including information of necessary IDs, selected operation mode (including channel), and a group clock.
- ii. When a joiner PD (J-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.

## Association Procedure (continual)

- iii. When a J-PD scans the TS in an iteration, it should calculate the difference between  $t_{\text{now}}$  and  $t_{\text{start}}$ . If  $t_{\text{start}}$  is within a CAP, the J-PD takes random backoff between  $t_{\text{start}}$  and the end of CAP and sends joining request. If  $t_{\text{start}}$  is out of a CAP, it waits until the next CAP before sending request.
- iv. I-PD scans the selected operation mode (passive scanning), registers the J-PDs and distributes a list of the registered PDs within the temporary beacon (TB) at the selected operation mode.
- v. J-PDs that had sent joining requests but are not included in the distributed PDs list should repeat the process of (ii) and (iii).

# Illustration of Constraint (iii)



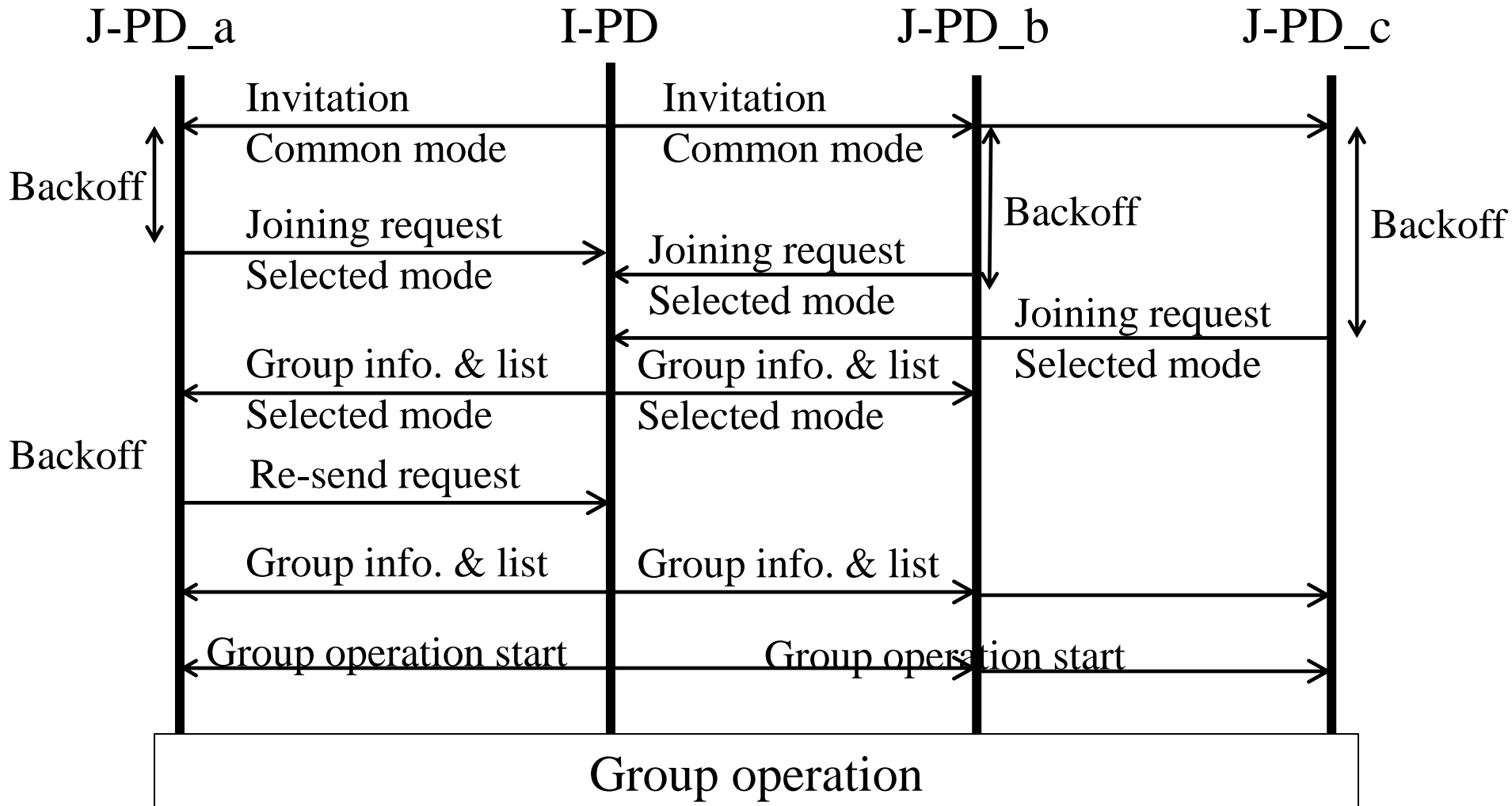
# Group Operation

# Group Operation

- ① Any I-PD that initiated a group will act as a temporary leader of the formed group (*distributed and self-organized control*). Moreover, the role of leader can be changed among PDs in the group.
- ② Communications within the formed group are undertaken using an selected mode and can move to the other selected modes.
- ③ Coordination may performed among neighbor groups for channel sharing or interference avoidance.



# Illustration of Group Forming

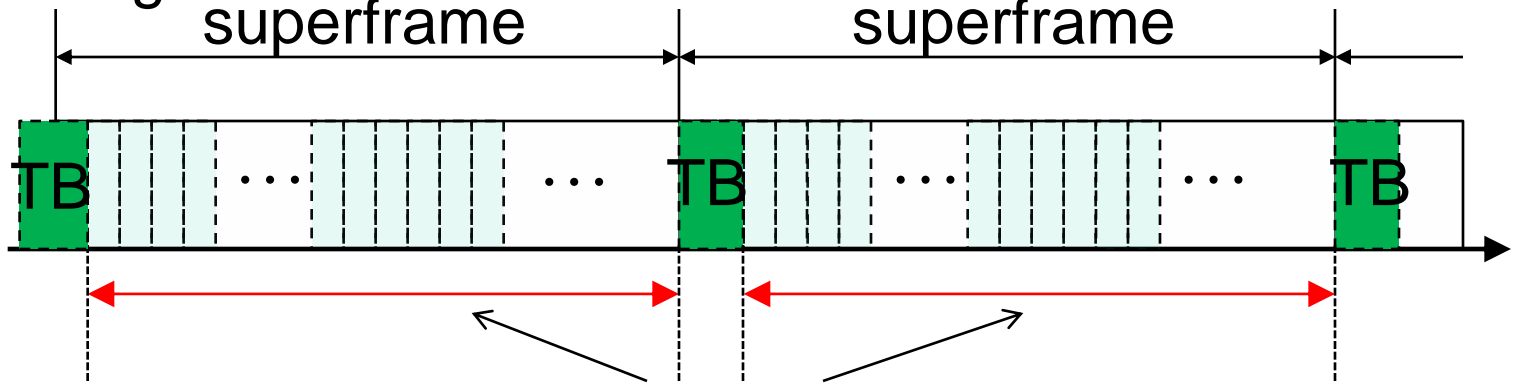


# Group Operation Example

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

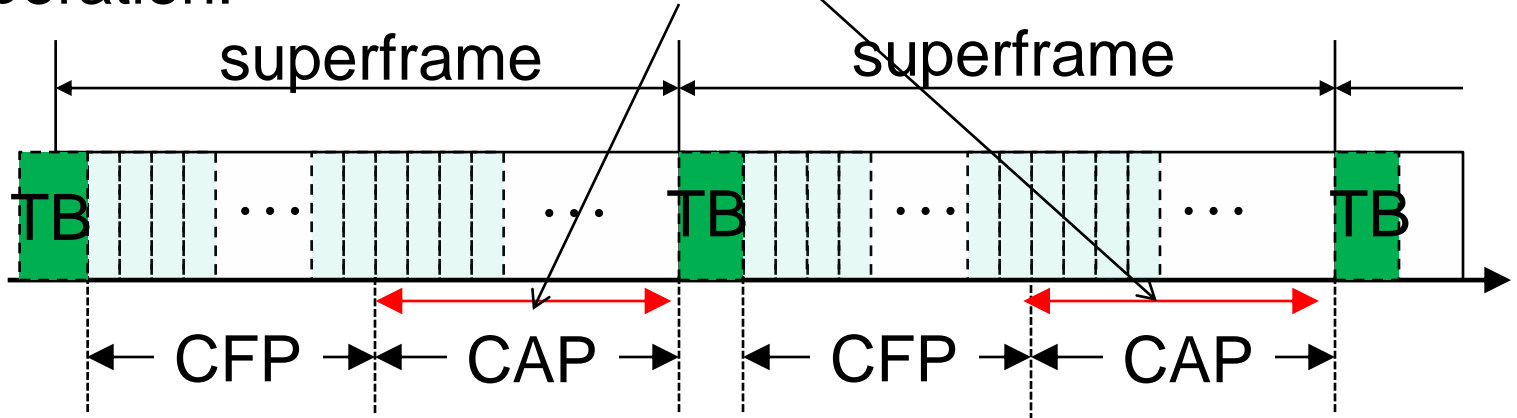
# Superframe Structure Example

Group forming:



Joining requests backoff interval

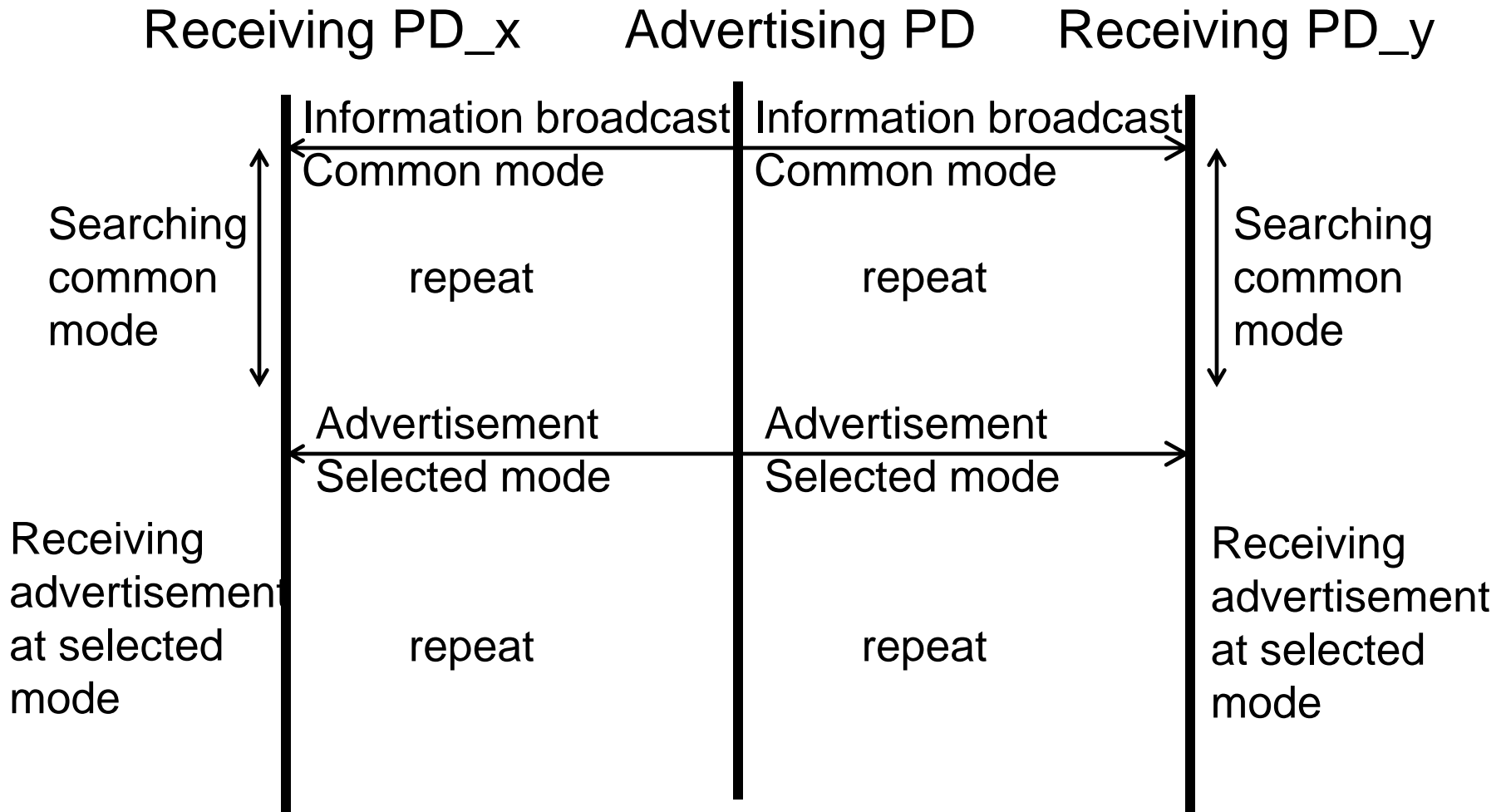
Group operation:



# 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.

# Illustration of Advertisement Procedure



# Conclusion Remarks

- Proposals are given for
  - Common mode
  - Common mode management
  - Superframe structure
  - Discovery
  - Association
  - Group operation