Scheduling of Control Information Synchronization via Optical Multicasting

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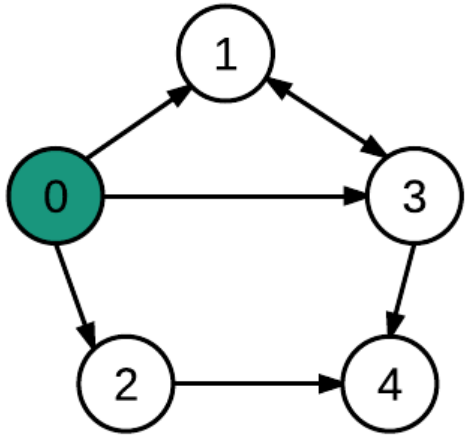
UCDAVIS

Outline

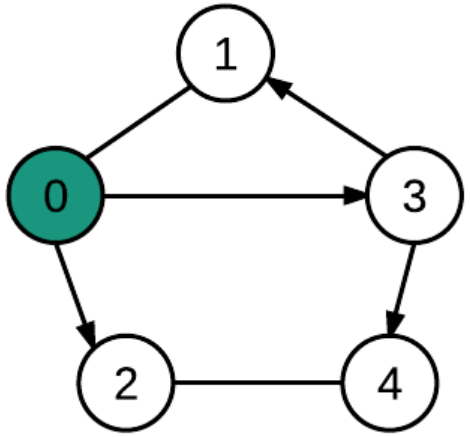
1. Motivation
2. Control Information Synchronization via Optical Multicasting
3. Problem Statement
4. MILP
5. A Possible Scheme
6. Conclusions

Motivation

- Low-latency requirement: cloud services, VR [1]
- Fast control information synchronization (CIS) is desirable
- CIS by flooding in IP networks
  - Hop by hop, queueing, …
- Optical multicasting
  - Single hop, low latency, …
- Focus – periodic update of control information



Flooding

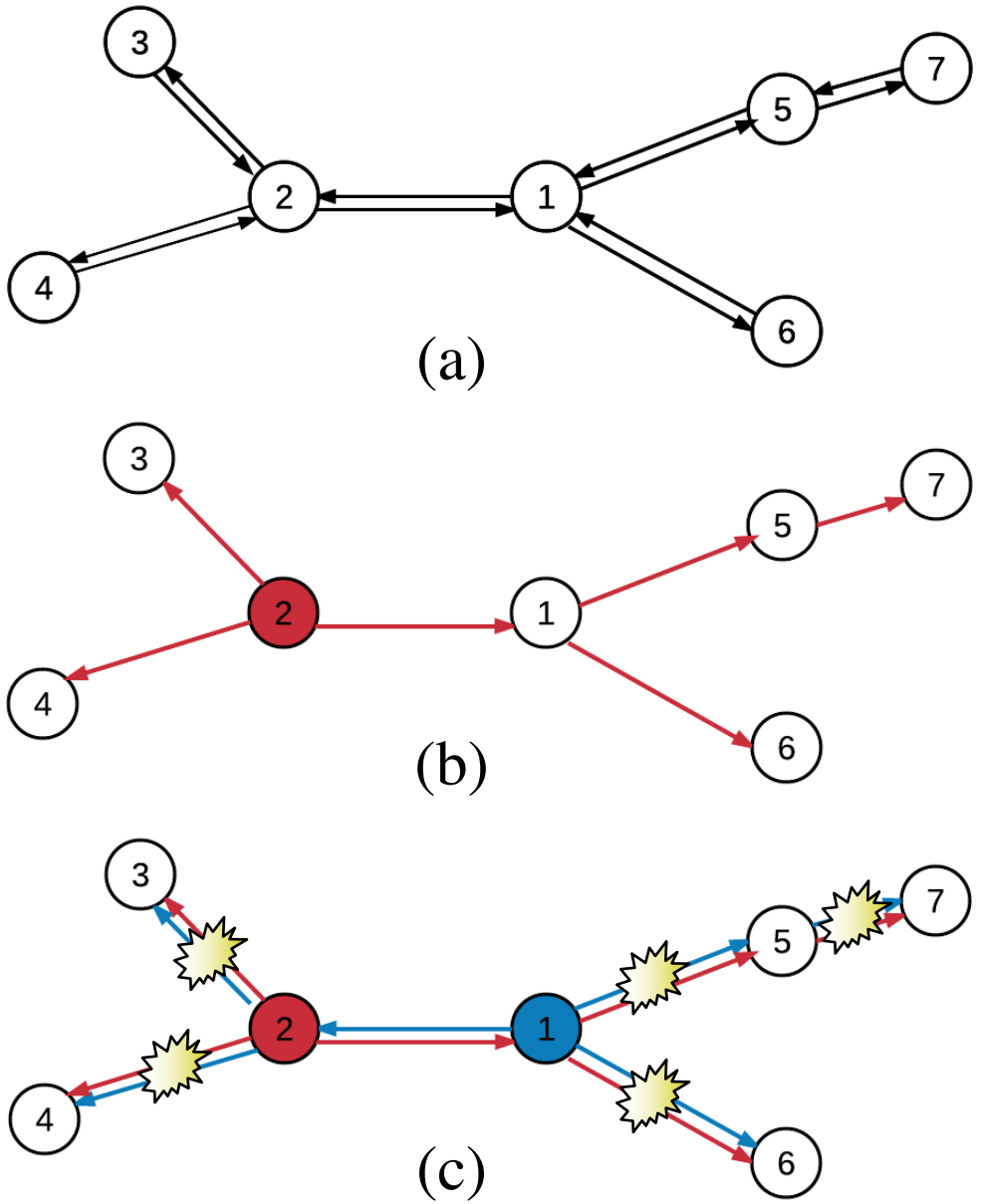


Optical multicasting

[1] T. Mastrangelo (June 29, 2016). Virtual Reality Check: Are Our Networks Ready for VR? Online: http://blog.advaoptical.com/virtual-reality-check-are-our-networks-ready-for-vr

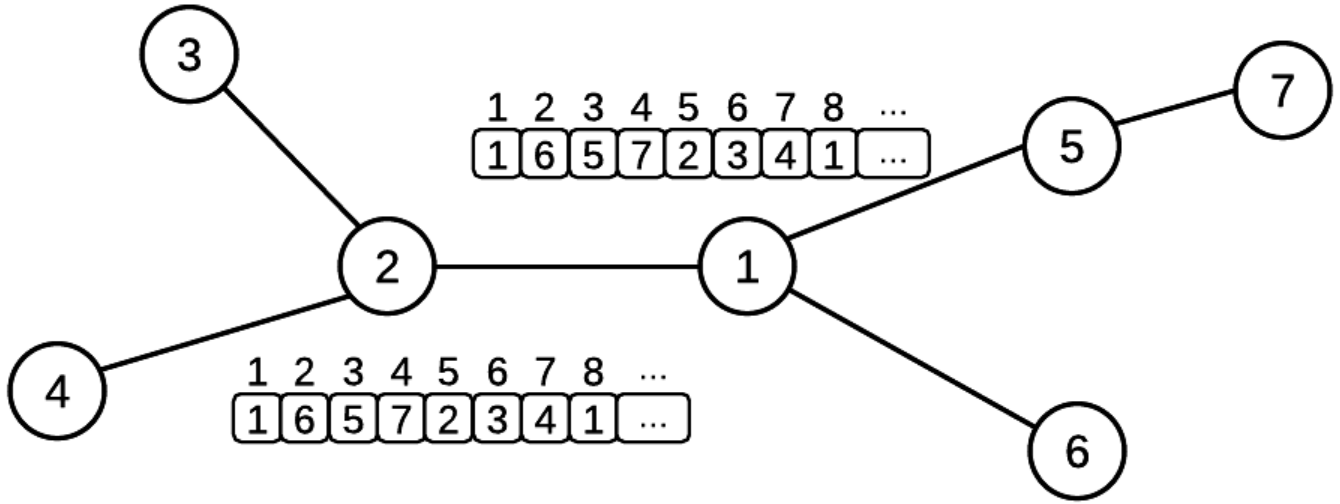
CIS via Optical Multicasting

- A group-shared tree: bidirectional
- Each node transmits its information to the other nodes via optical multicasting – no buffering
- Information from any two nodes cannot be switched to the same output of a node simultaneously
- Schedule the time when a node should start its transmission to avoid conflict



CIS via Optical Multicasting (Cont.)

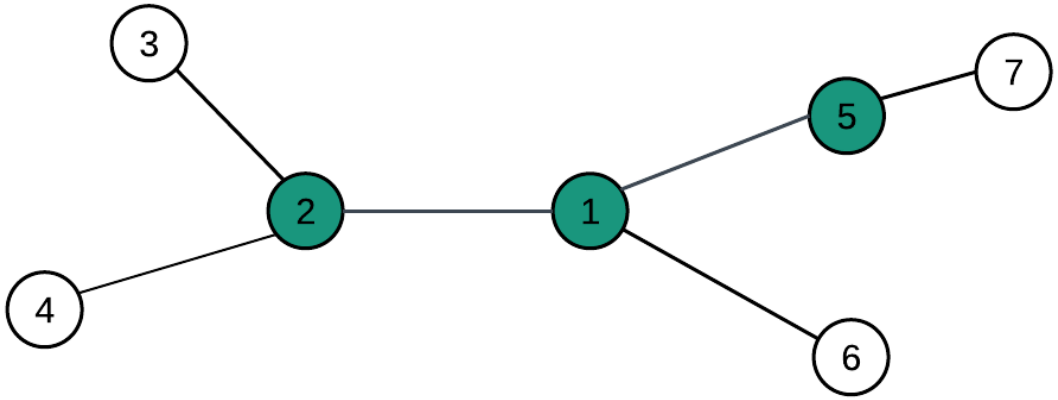
- For a conflict-free design, nodes whose information arrives at a node can be ordered in a sequence based on their arrival time
- Cycle time – period between two consecutive transmissions of each node



Problem Statement

- Input
  - A group-shared tree
  - Transmission time and link delay
- Output
  - Transmission start time table of nodes that ensures no conflict
- Objective
  - Minimize cycle time: period between two consecutive transmissions of each node

Observations

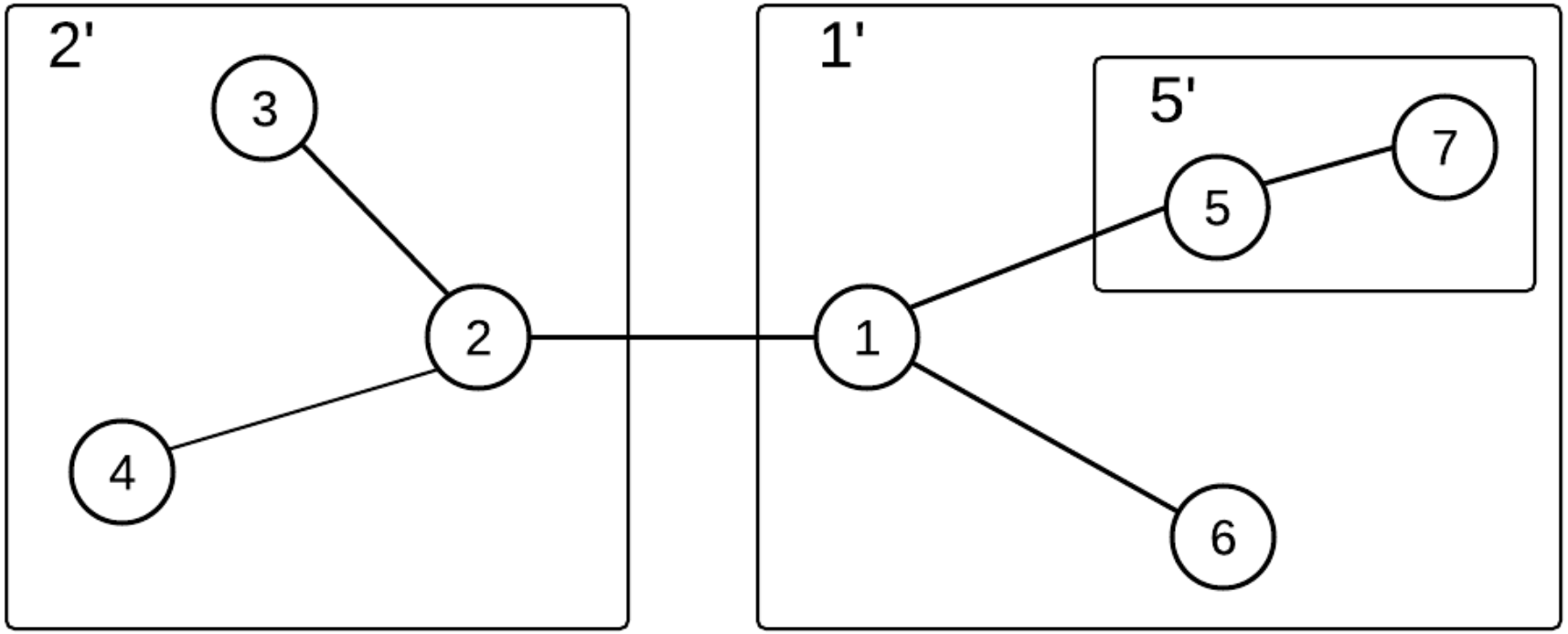


- Leaf node (nodes 3, 4, 6, and 7)
  - Connected to only one link
  - Information arrived will not be switched to other nodes but dropped locally
  - Information sourcing from a leaf node is independent from information arrived (no synchronization scheduling is required between them)
- Synchronization node (nodes 1, 2, and 5)
  - Connected to two or more links
  - Information arrived will be switched to other nodes and dropped locally
  - Information sourcing from a synchronization node share resources with information arrived (synchronization scheduling is required)

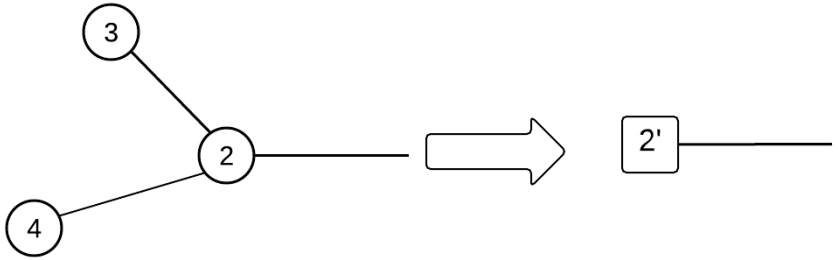
An Example

Assume that transmission time is longer than link delay

Three steps:
1. Cut
2. Grouping
3. Scheduling

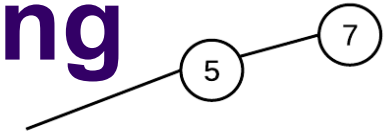


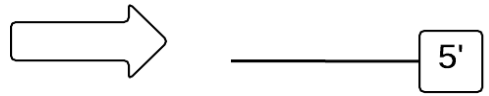
Intra-Group Scheduling

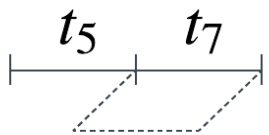


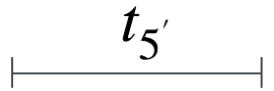
$$t_{2'} = t_2 + t_3 + t_4$$

(a)



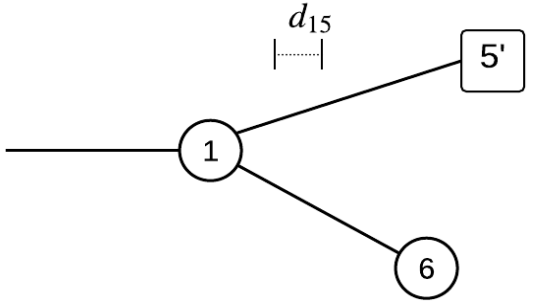


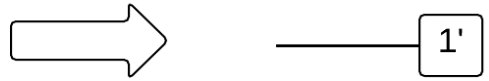


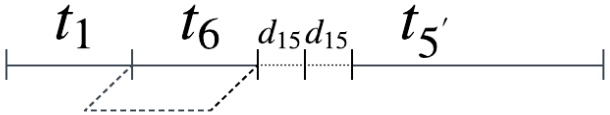


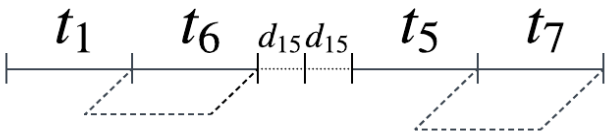
$$t_{5'} = t_5 + t_7$$

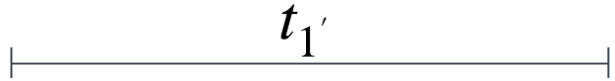
(b)







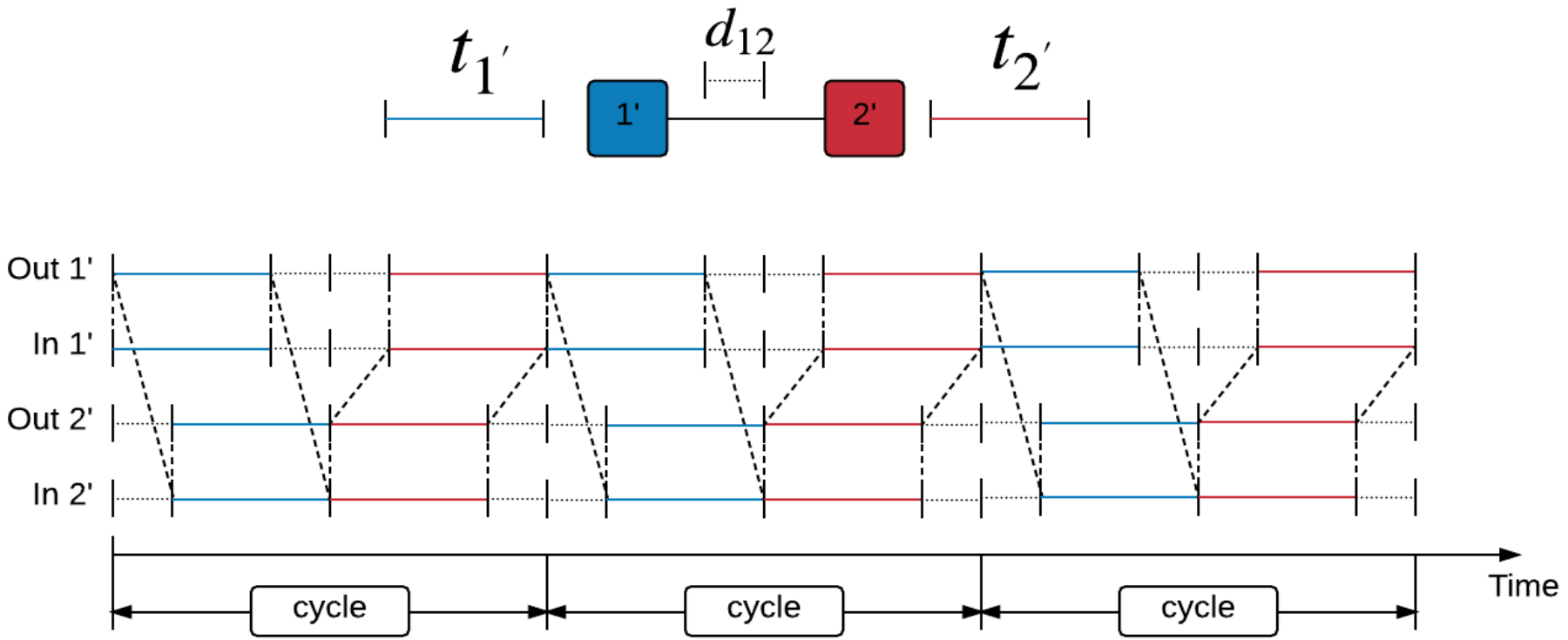




$$t_{1'} = t_1 + t_{5'} + d_{15} + t_6 + d_{15}$$
$$= t_1 + t_5 + t_6 + t_7 + 2d_{15}$$

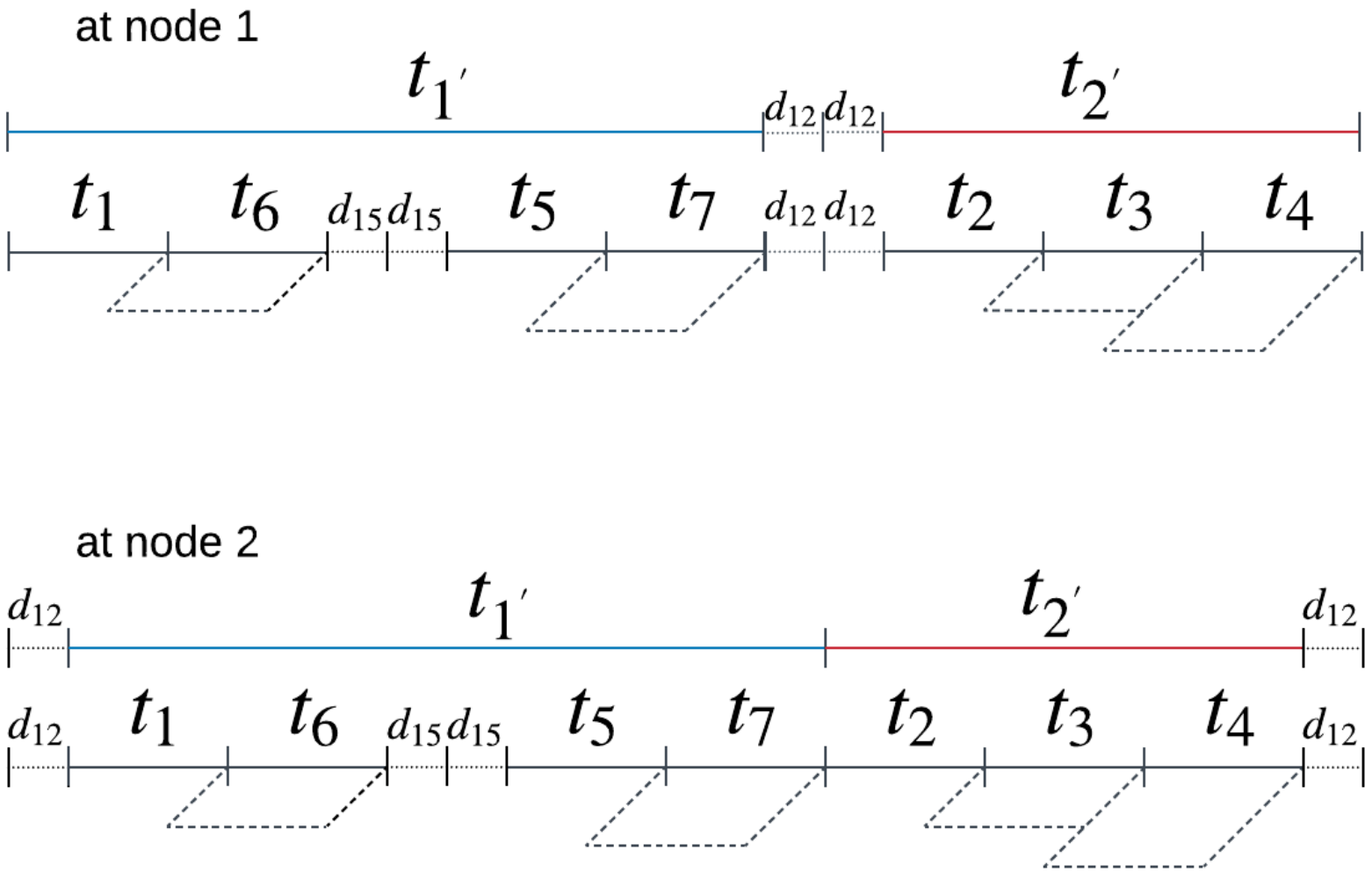
(c)

Inter-Group Scheduling



$$T_{\text{cycle}} = t_{1'} + t_{2'} + 2d_{12}$$
$$= t_1 + t_5 + t_6 + t_7 + 2d_{15} + t_2 + t_3 + t_4 + 2d_{12}$$

Scheduling (Cont.)



Conclusions

- We investigated a scheduling problem of control information synchronization via optical multicasting
- We provided a MILP formulation and proposed a scheme

Thank you!

Questions or comments?

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