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Cambodia Academy of Digital Technology

INP TOULOUSE ENSEEIHT

IRIT
Institut de Recherche en Informatique de Toulouse
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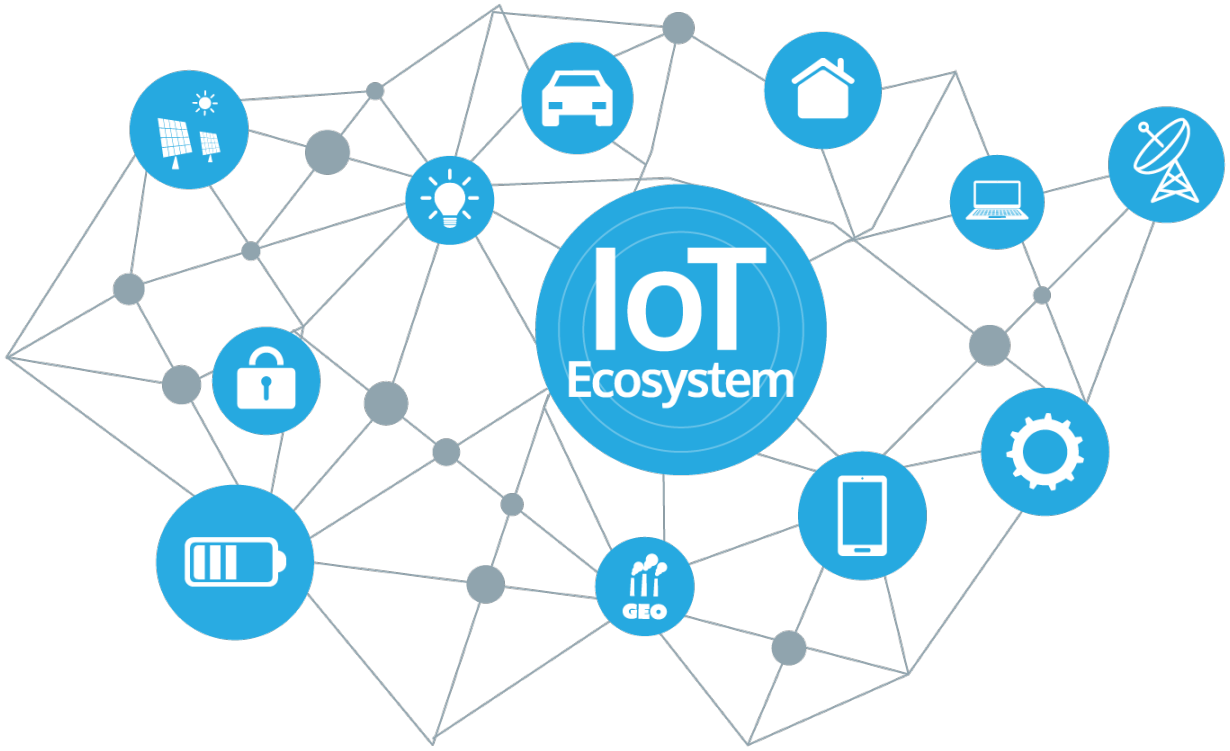
Design and Development of a Certifiable Real-Time IoT Solution

ASEAN IVO Forum 2021

ASEAN IVO

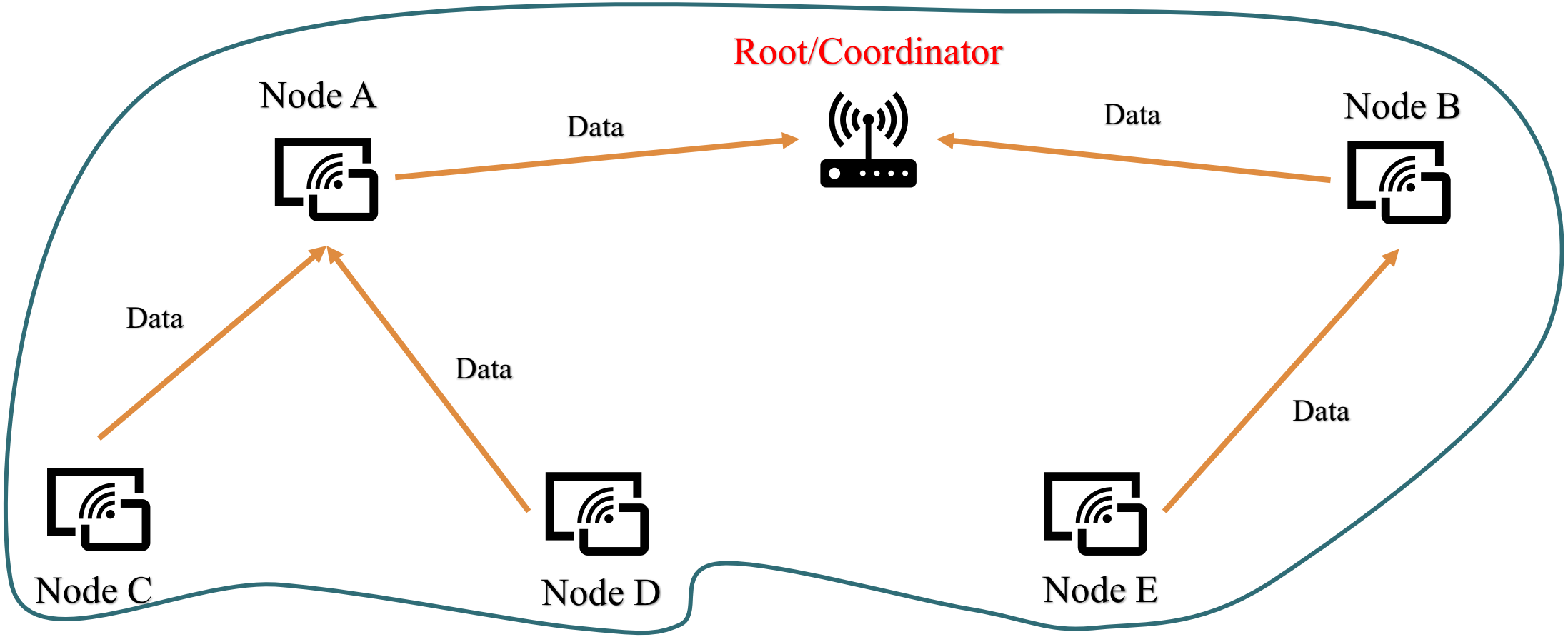
18/11/2021

CONTENT



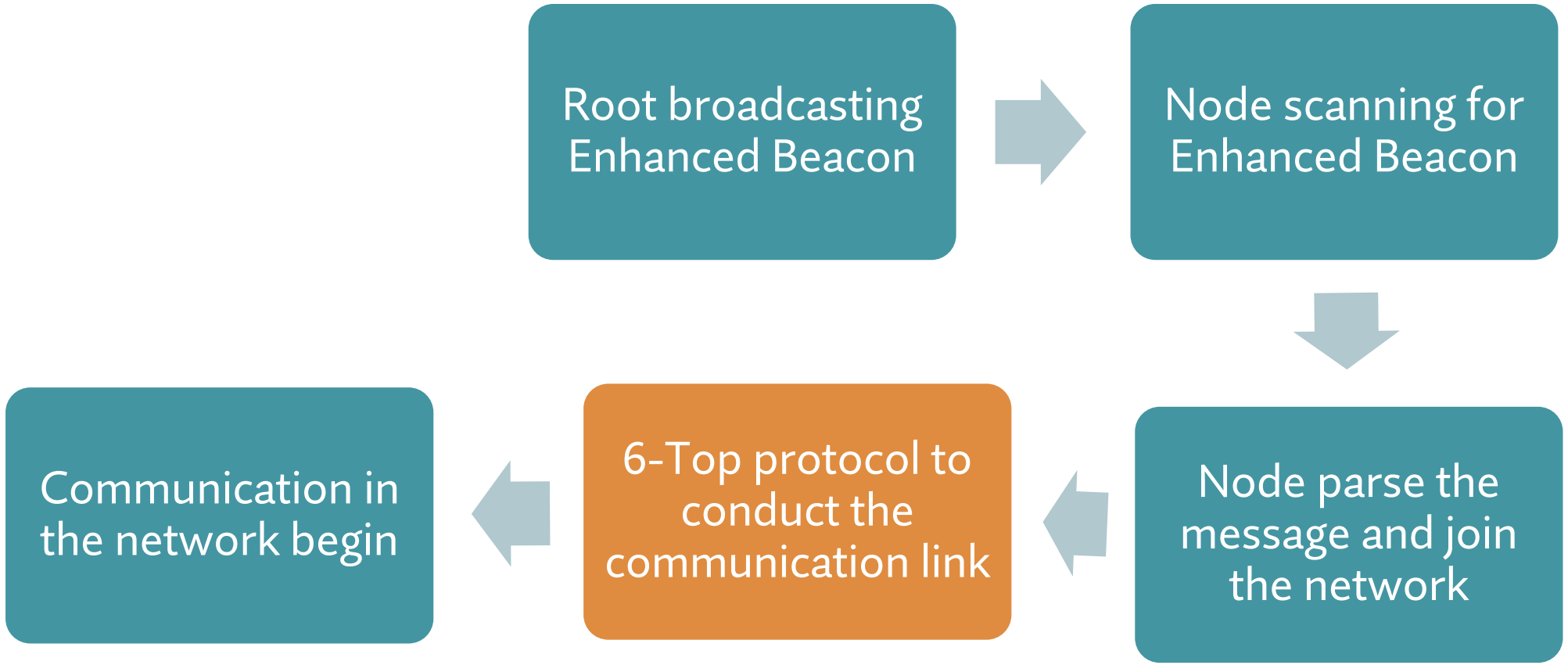
PROBLEM

Current Solution with 6TiSCH protocol stack does not allow **direct communication** within the network and it is **not deterministic** with 6-top protocol thus getting **real time response is not possible**. (TSCH, 6-top, RPL)



PROBLEM

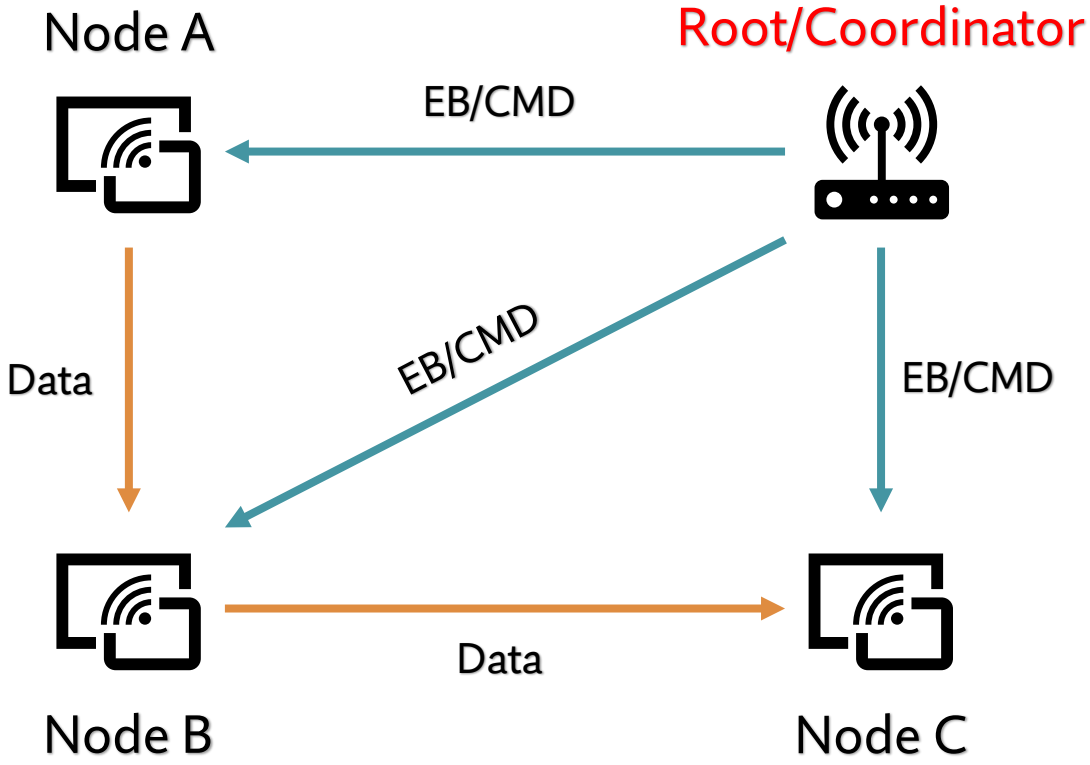
6-TiSCH Protocol Stack



OBJECTIVE

Contiki-FullMesh

Freely configured to **send to any node** in the network including the root node in a **timely manner**



TECHNOLOGY

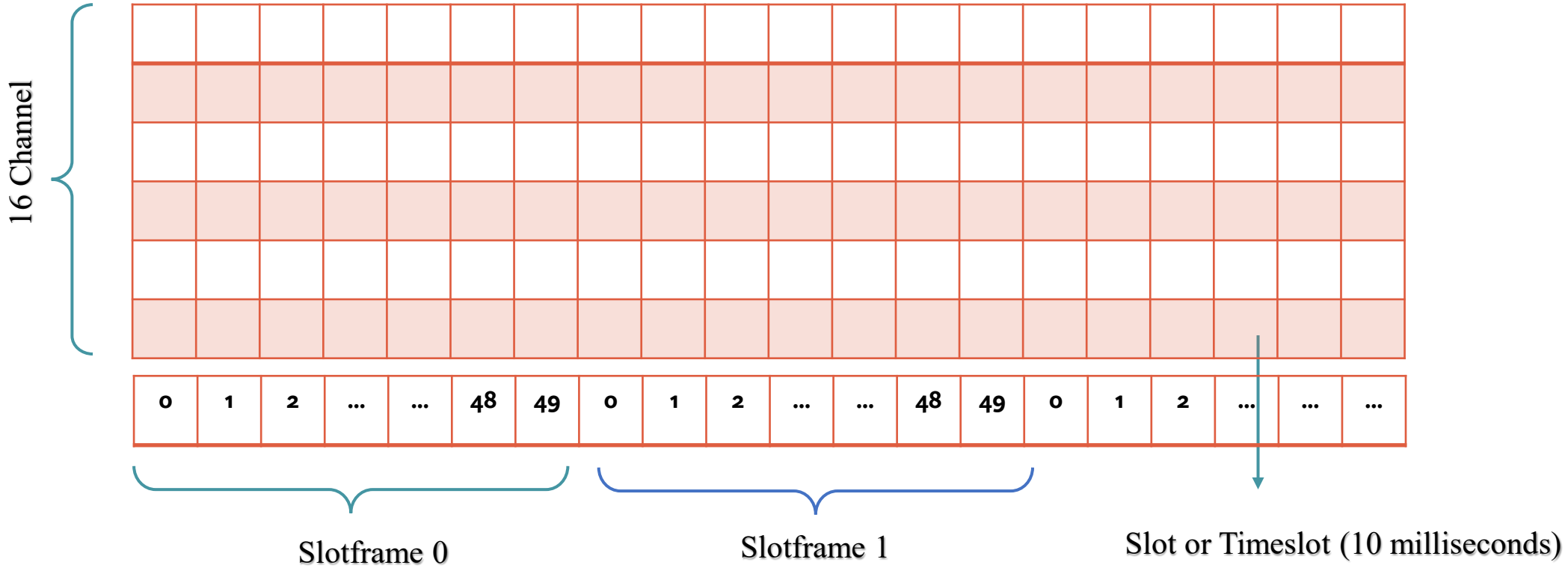
Contiki-NG

- **Embedded operating system** that is built to concentrate to be secure and reliable,
- Built-in with **wireless communication** protocols such as **TSCH** and more.

So we justifies TSCH in Contiki-NG.

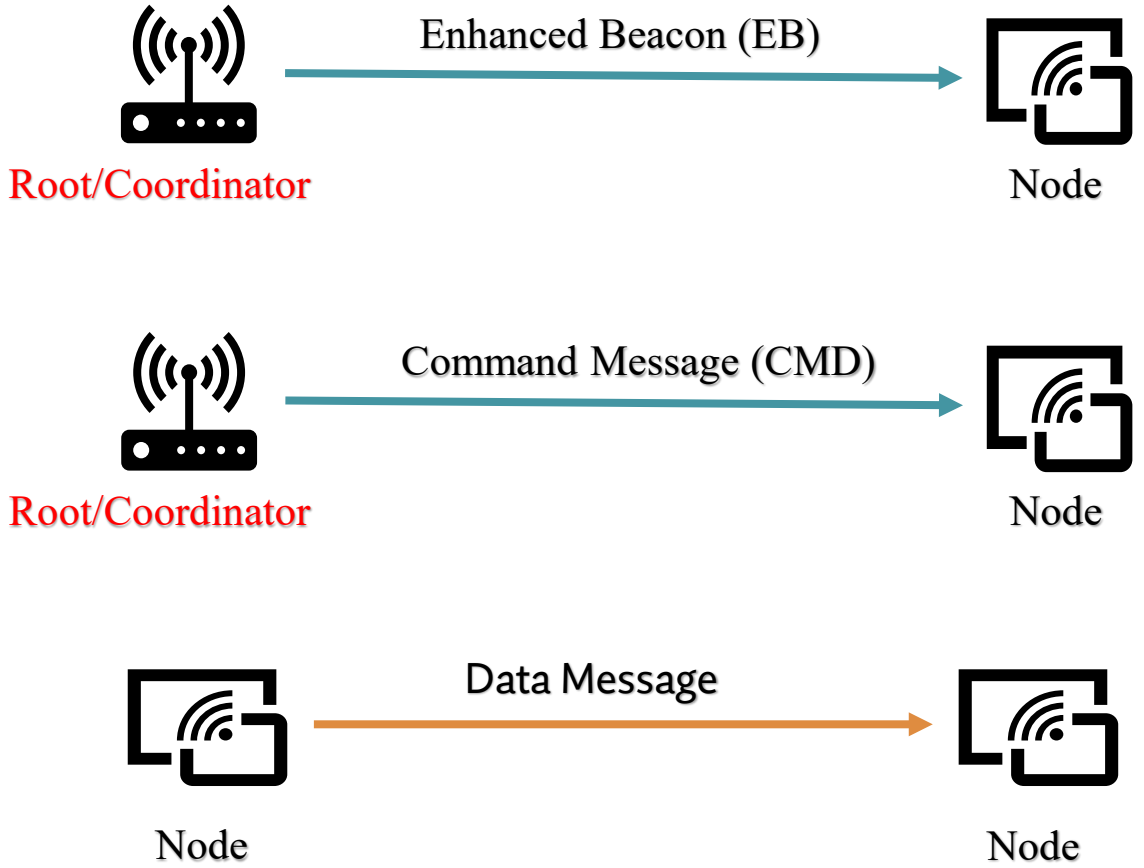
TSCH Communication Protocol

- TSCH is part of **6TiSCH** protocol stack
- Time is divided into small slots of normally 10 milliseconds



DEVELOPED FUNCTIONS

- Eliminate using 6-Top and RPL protocol
- Create Command Message
- Nodes listen and handle command message
- Nodes handle data message



DEPLOYMENT SETTING

Root	EB	CMD	CMD							
A		Rec	Rec			Send				
B		Rec	Rec			Rec			Send	
C		Rec	Rec						Rec	
	0	1	2	....	....	10	....	....	20	....

The four node that is used in this experiment is mentioned below:

- Node A address is 00:12:4b:00:19:35:55:4f
- Node B address is 00:12:4b:00:19:35:55:8f
- Node C address is 00:12:4b:00:19:35:55:ab
- Root node address is 00:12:4b:00:19:35:56:40

DEPLOYMENT RESULT

Proof of developed functions

50_1.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

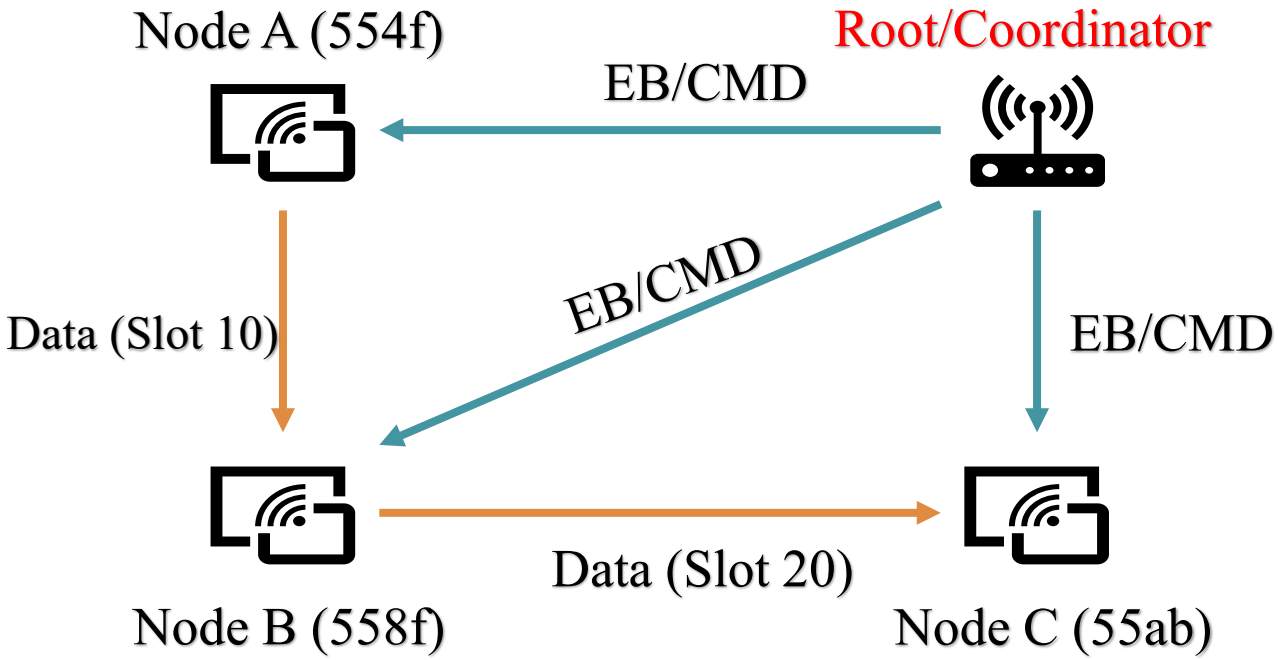
Apply a display filter ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
24	50.093467	00:12:4b:00:19:35:55:4f	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:4f, Bad FCS
25	50.093841	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:4f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:4f, Src: TexasIns_00:19:35:55:8f, Bad FCS
26	50.189648	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:ab	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:ab, Src: TexasIns_00:19:35:55:8f, Bad FCS
27	50.589618	00:12:4b:00:19:35:55:4f	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:4f, Bad FCS
28	50.590000	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:4f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:4f, Src: TexasIns_00:19:35:55:8f, Bad FCS
29	50.685376	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:ab	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:ab, Src: TexasIns_00:19:35:55:8f, Bad FCS
30	50.685718	00:12:4b:00:19:35:55:ab	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:ab, Bad FCS
31	51.085341	00:12:4b:00:19:35:55:4f	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:4f, Bad FCS
32	51.085670	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:4f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:4f, Src: TexasIns_00:19:35:55:8f, Bad FCS
33	51.197316	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:ab	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:ab, Src: TexasIns_00:19:35:55:8f, Bad FCS
34	51.197640	00:12:4b:00:19:35:55:ab	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:ab, Bad FCS
35	51.597330	00:12:4b:00:19:35:55:4f	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:4f, Bad FCS
36	51.597663	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:4f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:4f, Src: TexasIns_00:19:35:55:8f, Bad FCS
37	51.693373	00:12:4b:00:19:35:55:8f	00:12:4b:00:19:35:55:ab	IEEE 802.15.4	28	Data, Dst: TexasIns_00:19:35:55:ab, Src: TexasIns_00:19:35:55:8f, Bad FCS
38	51.693710	00:12:4b:00:19:35:55:ab	00:12:4b:00:19:35:55:8f	IEEE 802.15.4	27	Ack, Dst: TexasIns_00:19:35:55:8f, Src: TexasIns_00:19:35:55:ab, Bad FCS

DEPLOYMENT RESULT

Study of Determinism

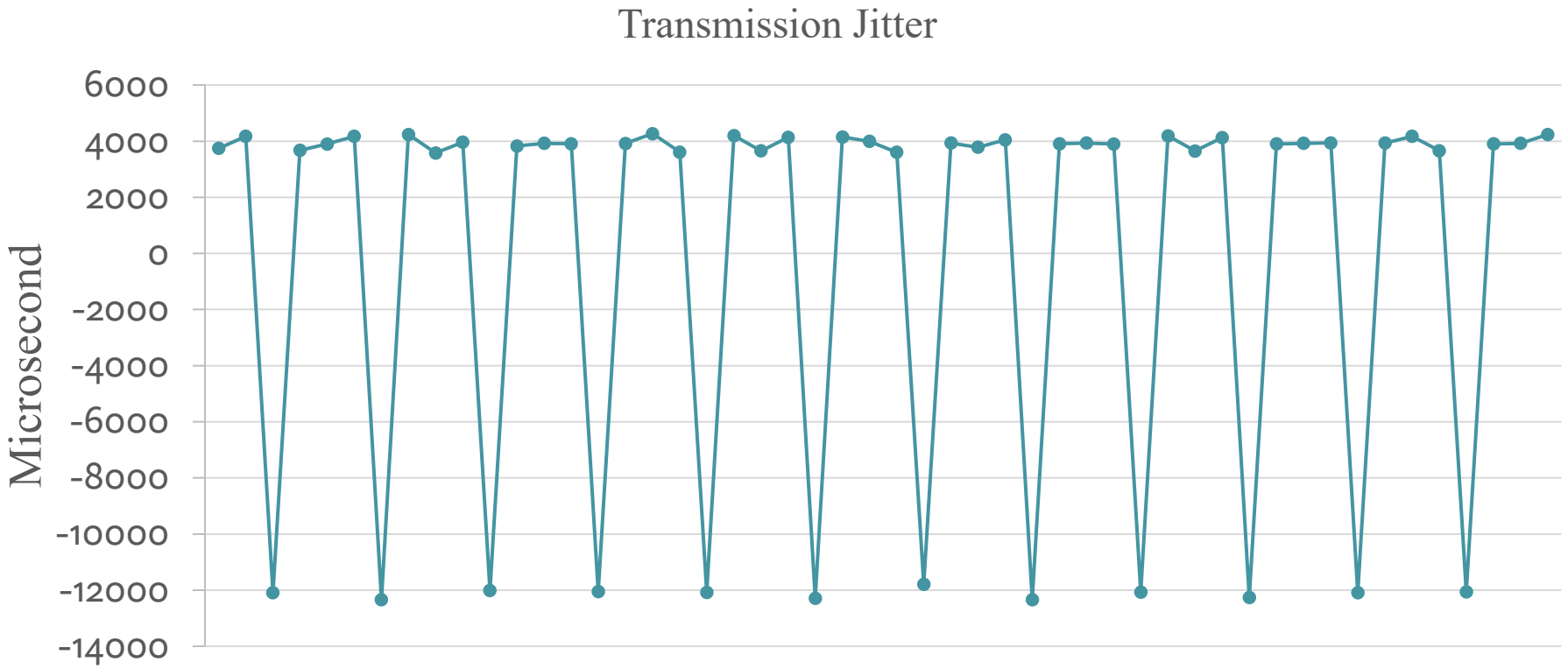
Jitter = Average transmission delay – Max Transmission delay.
The solution is deterministic only if
Deadline >= Jitter + Average transmission delay



- Slotframe Length equal to 50 slots equal to 500 millisecond that have 2 transmissions

DEPLOYMENT RESULT

First 50 Transmissions/Super frames (Node A -> Node B)

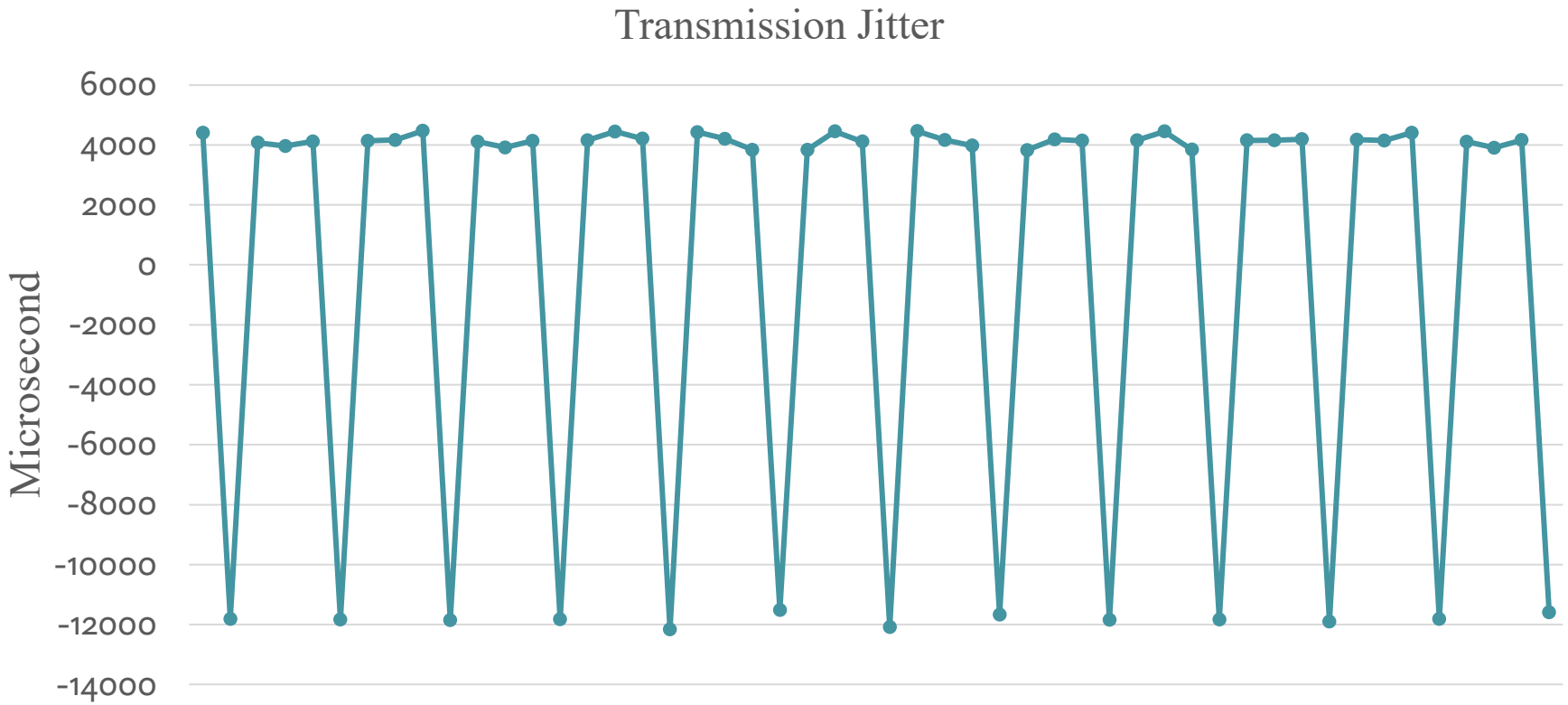


Duration between two consecutive transmissions

Minimum	Average	Maximum
495 ms	499 ms	512 ms

DEPLOYMENT RESULT

First 50 Transmissions /Super frames (Node B -> Node C)



Duration between two consecutive transmissions

Minimum	Average	Maximum
495 ms	500 ms	512 ms

CONCLUSION

After deployments of the experiment, it can be seen that there are some patterns emerge which is the fluctuation of the transmission jitter. With that pattern, it is possible to conclude that the **transmission jitter is being tempered with on the fourth transmission because the network time is updated every 2 seconds by the root node.** Because each Slotframe consists of 500 milliseconds and at the fourth transmission network time is being updated which can be seen by the pattern of the first experiment.

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Thank you for your attention !

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