Julius-Maximilians-
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WÜRZBURG

Institute of Computer Science
Chair of Communication Networks
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DBM: Decentralized Burst Mitigation for Self-Organizing LoRa Deployments

Simon Raffeck, Stefan Geißler, Tobias Hoßfeld

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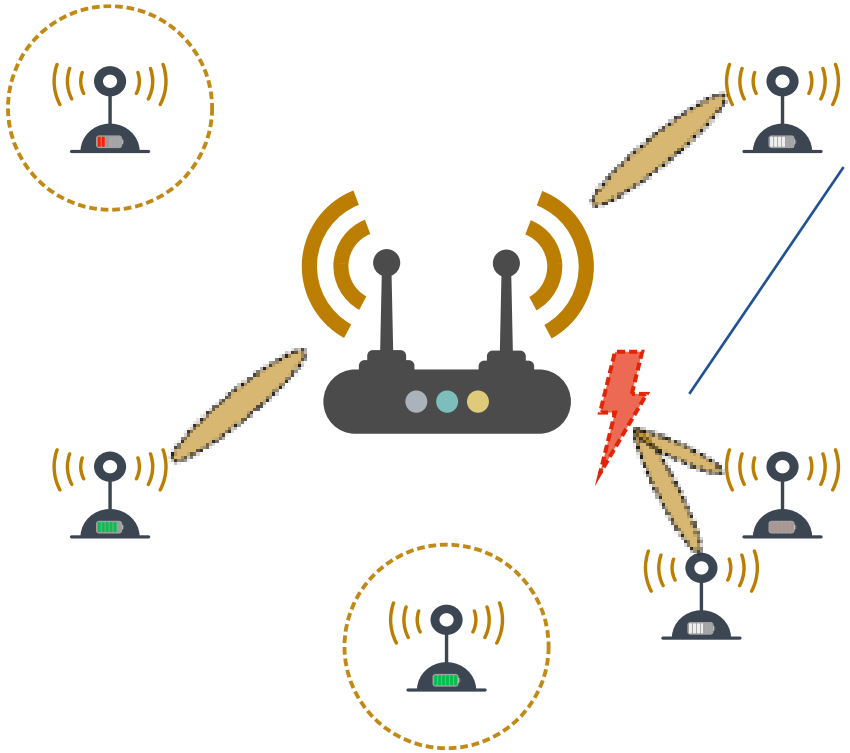
IoT Networks

ALOHA

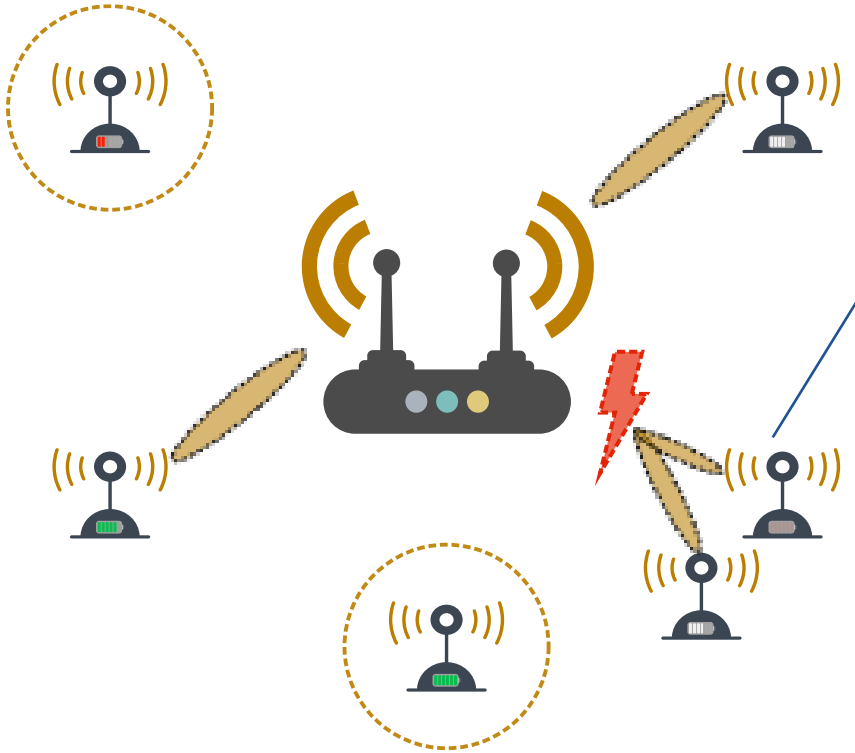


Collision caused by random access

➔ Random access with no further control

IoT Networks

LBT

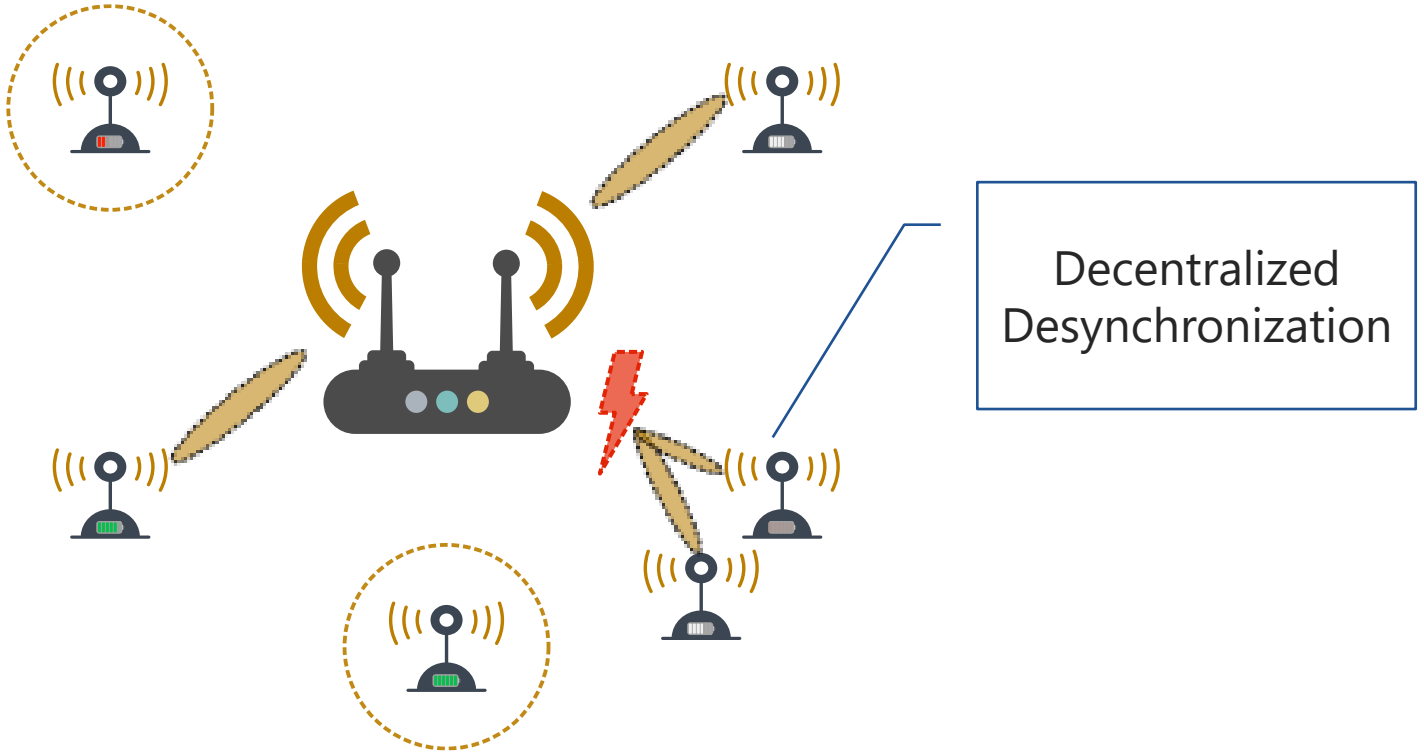


Sense channel to avoid collisions

➔ Avoiding collisions with central control

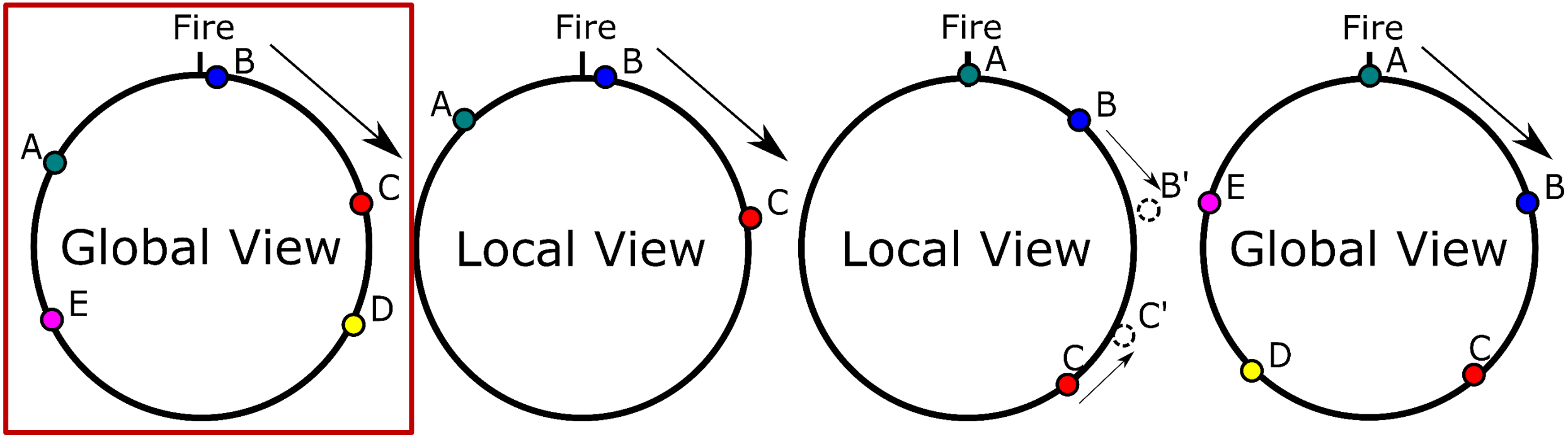
IoT Networks

DESYNC



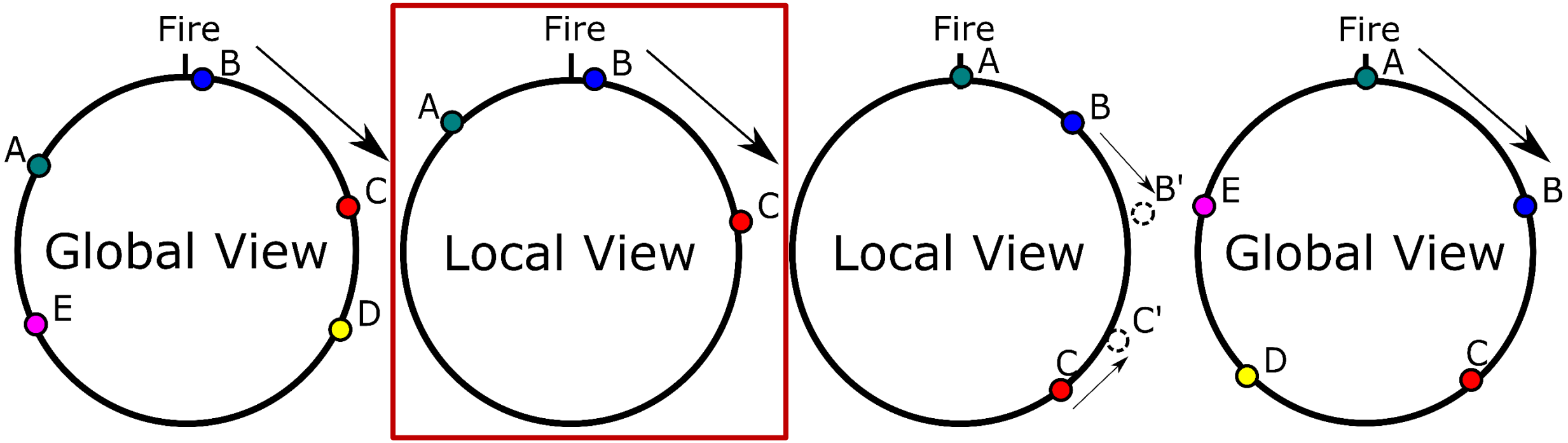
➔ Decentralized collision avoidance

DESYNC



Degesys, Julius, et al. "DESYNC: Self-organizing desynchronization and TDMA on wireless sensor networks." Proceedings of the 6th international conference on Information processing in sensor networks. 2007.

DESYNC



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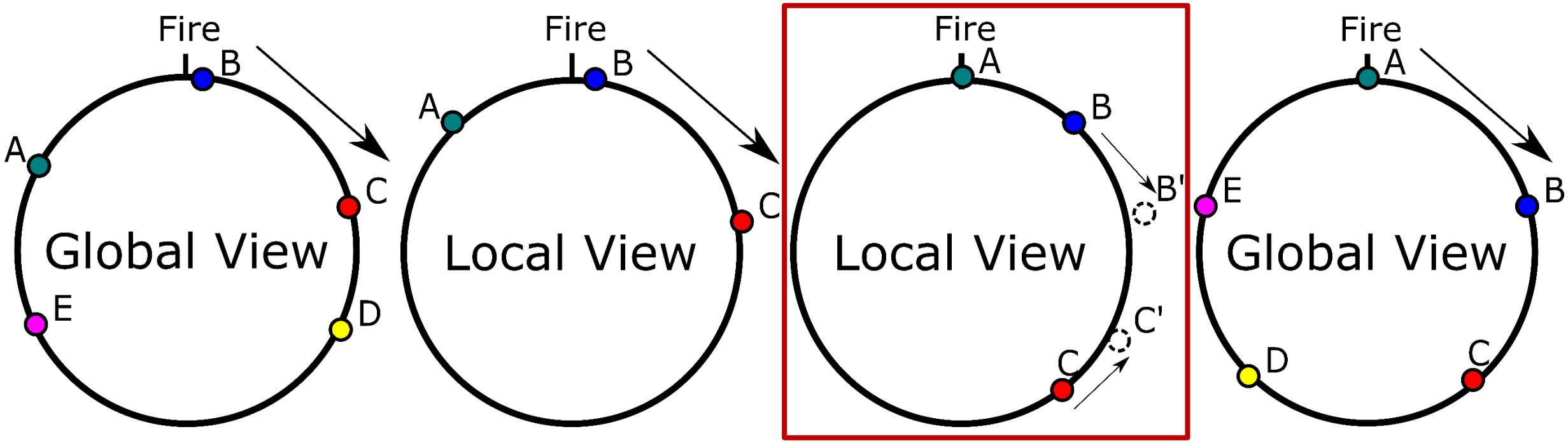

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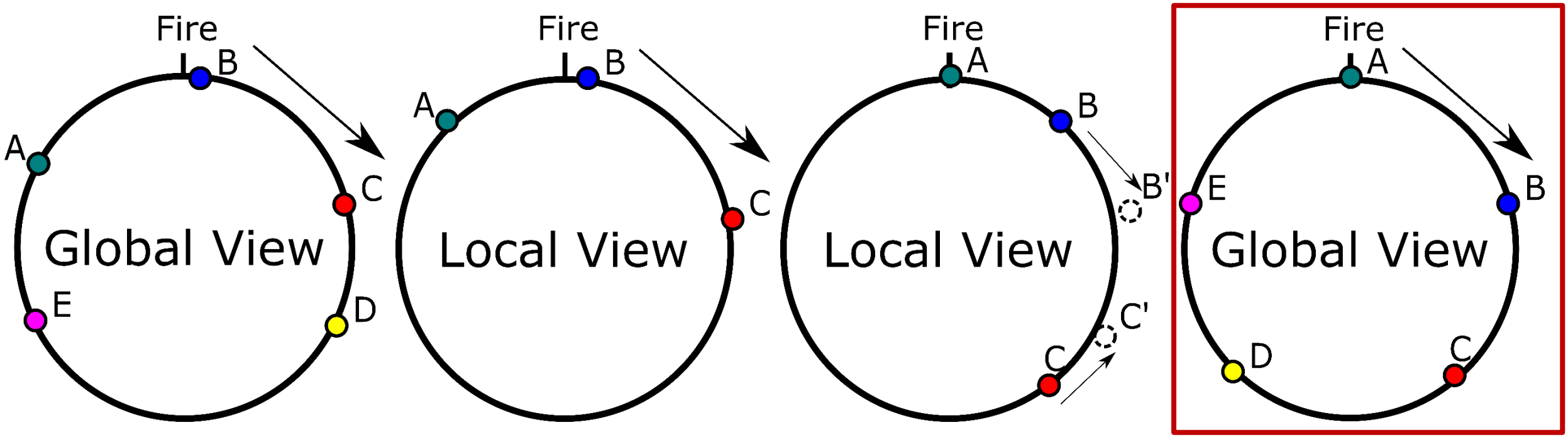

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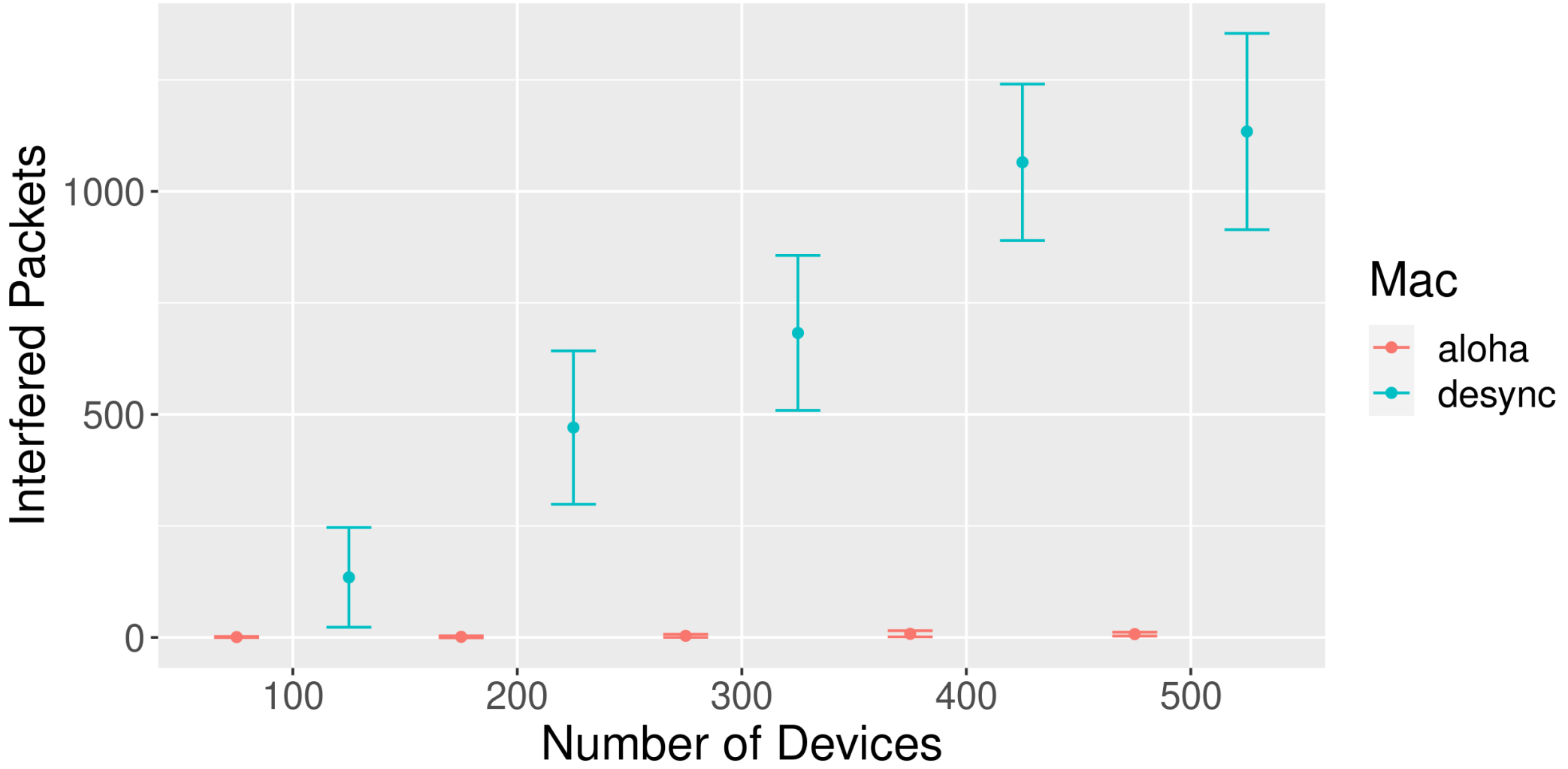
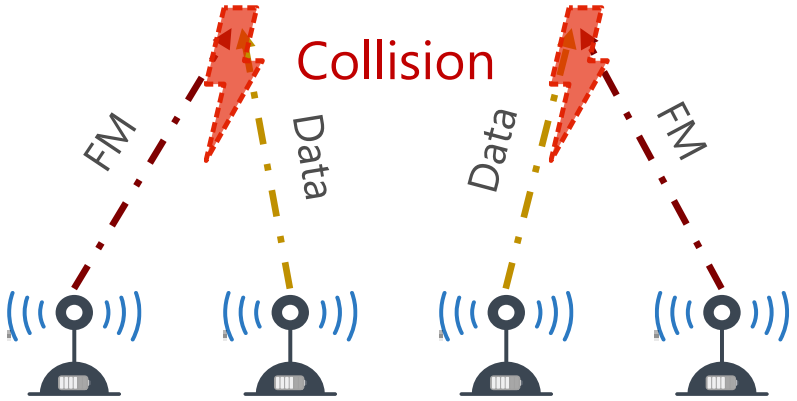
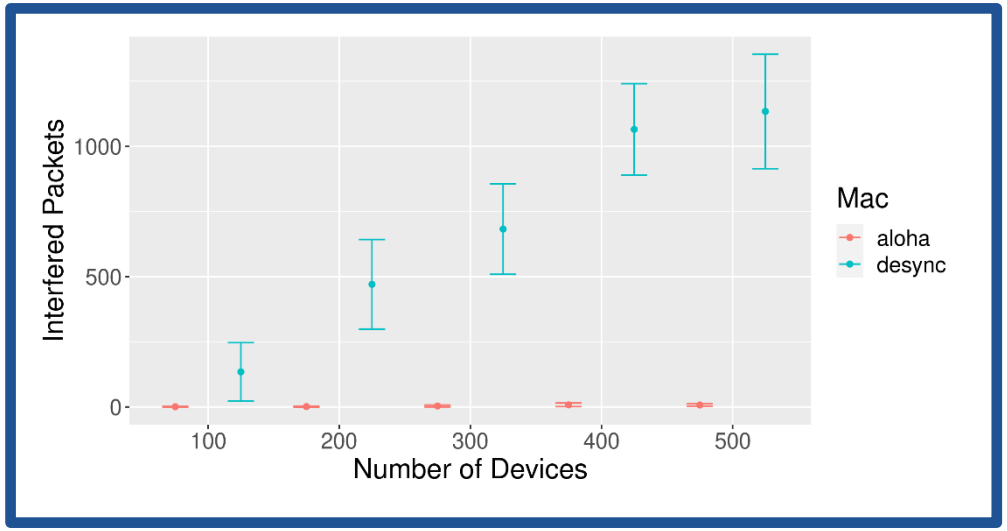
DESYNC for IoT – Limitations and Challenges



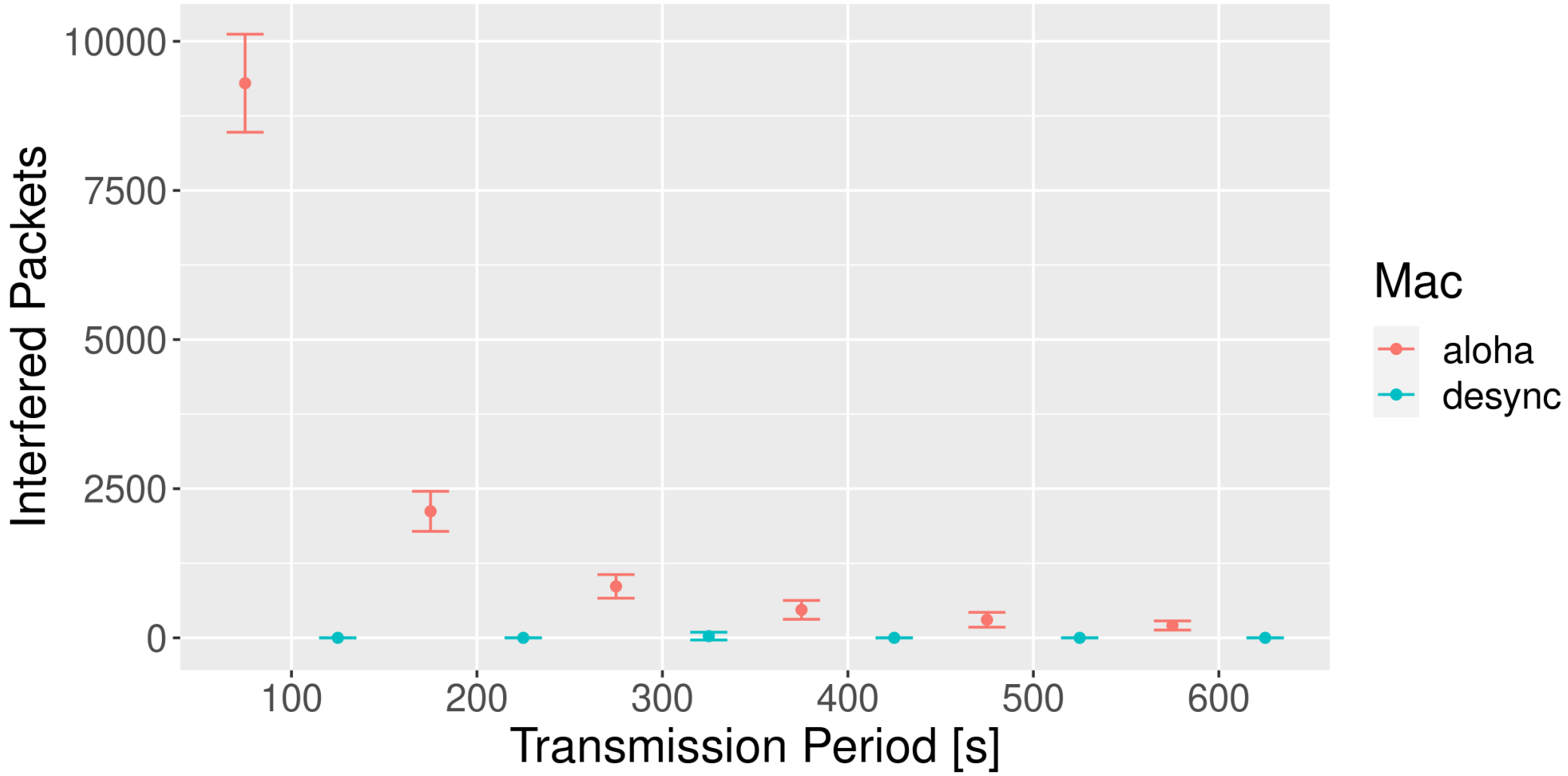
➔ Excessive amount of overhead messages and interference

DESYNC for IoT – Limitations and Challenges



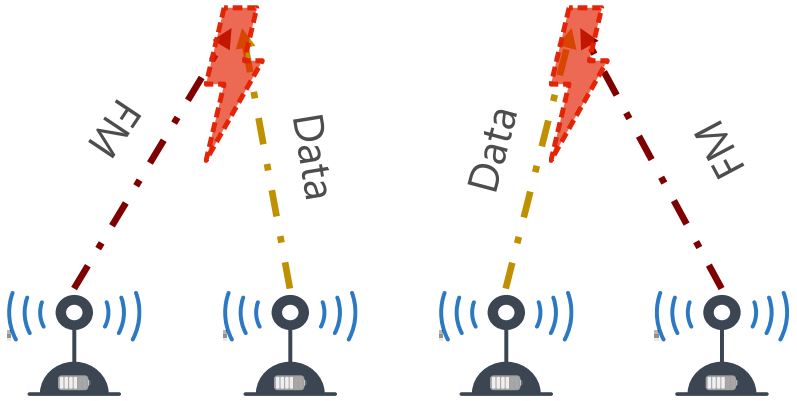


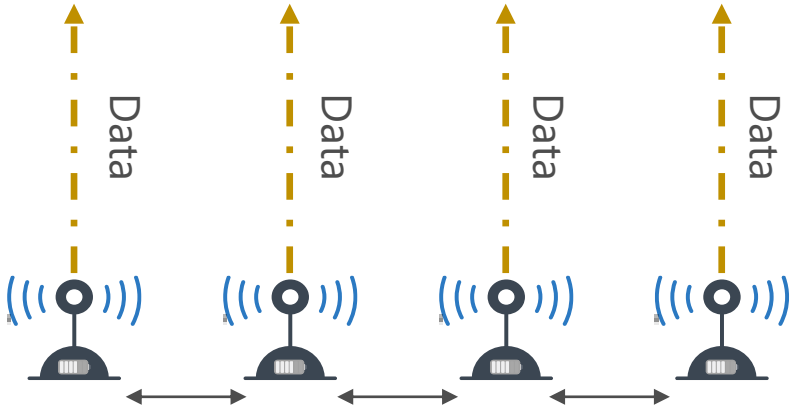
DESYNC in LoRa – Previous Results



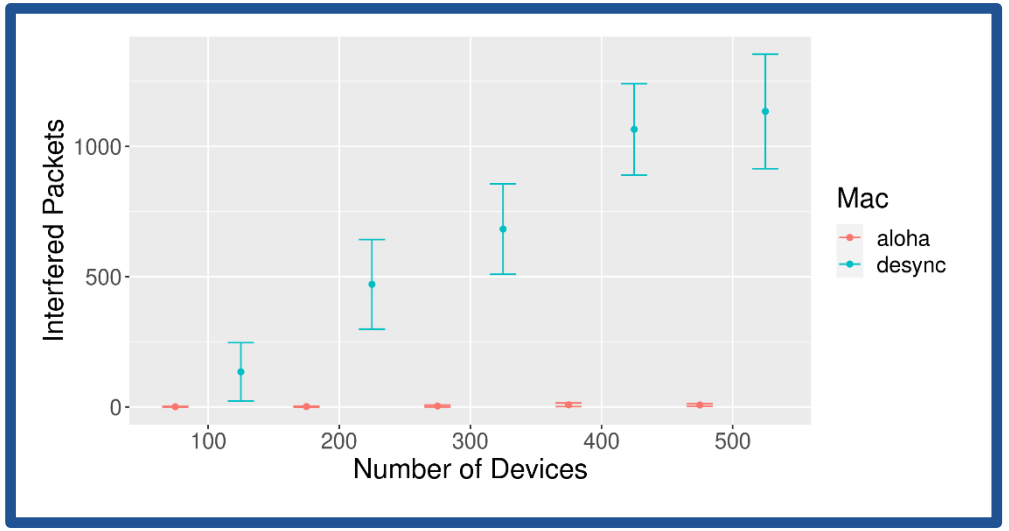
➔ Collisions from simultanous transmissions avoided with DESYNC

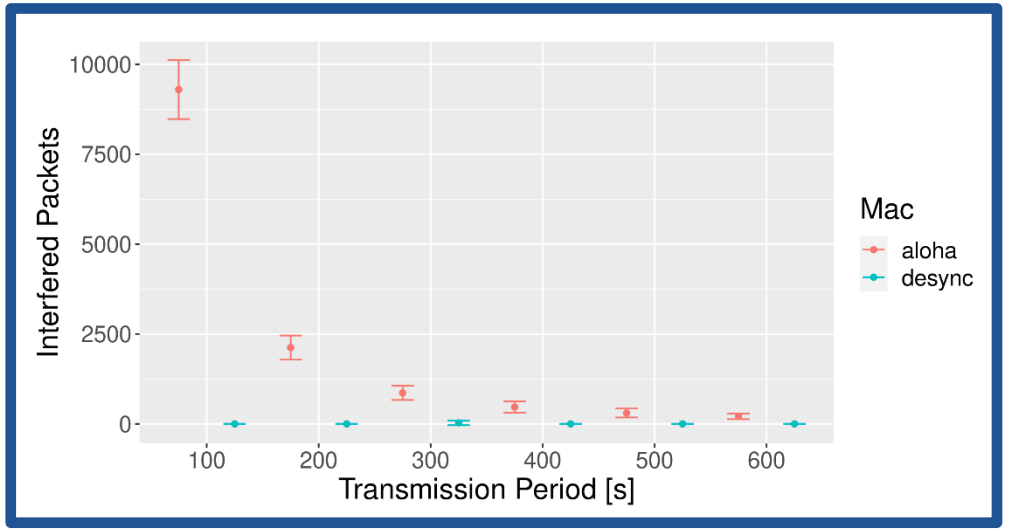
DESYNC for IoT – Limitations and Challenges



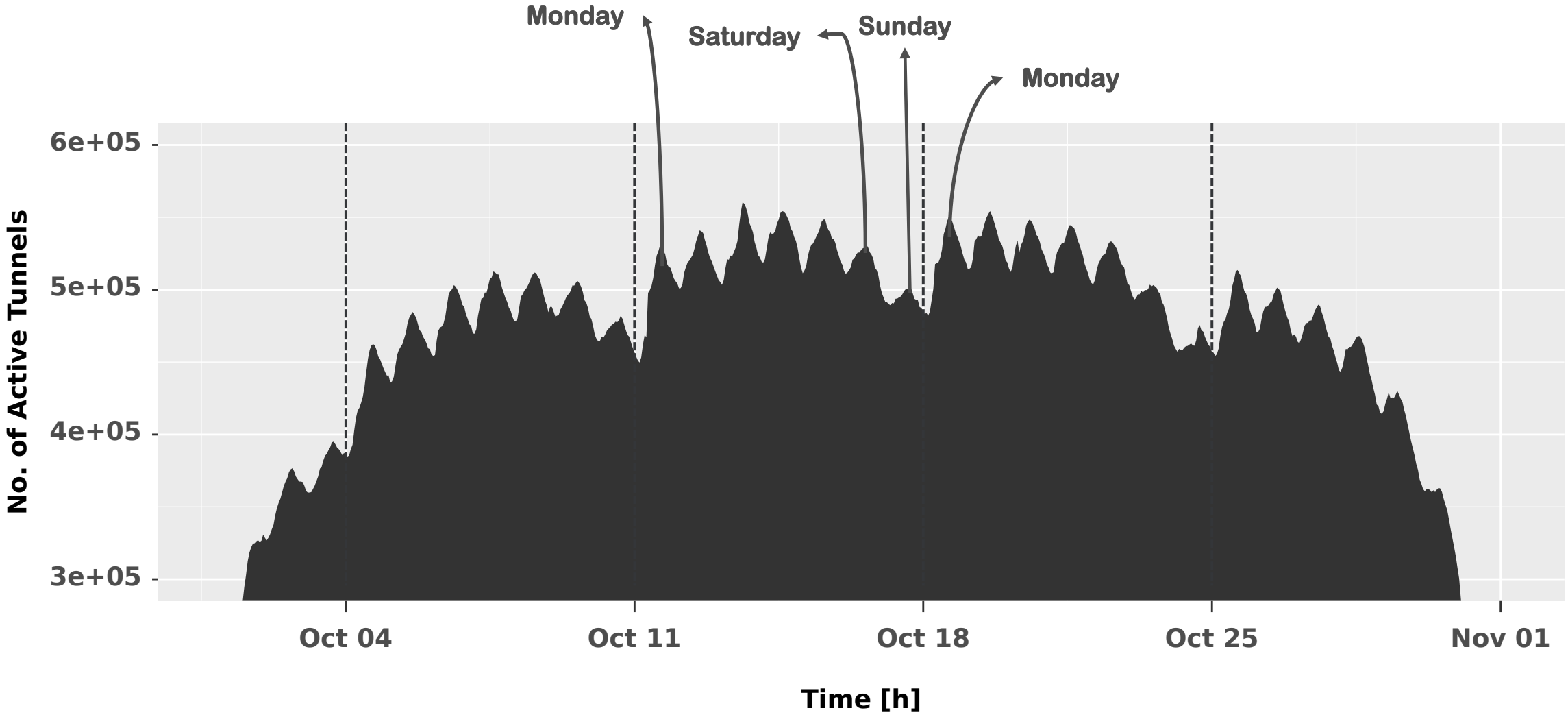


Spaced out by FMs





IoT Device Behaviour



S. Raffeck, S. Geissler, M. Krolikowski, S. Gebert and T. Hoßfeld, "Data Usage in IoT: A Characterization of GTP Tunnels in M2M Mobile Networks," NOMS 2022-2022 IEEE/IFIP Network Operations and Management Symposium, 2022, pp. 1-6, doi: 10.1109/NOMS54207.2022.9789901.

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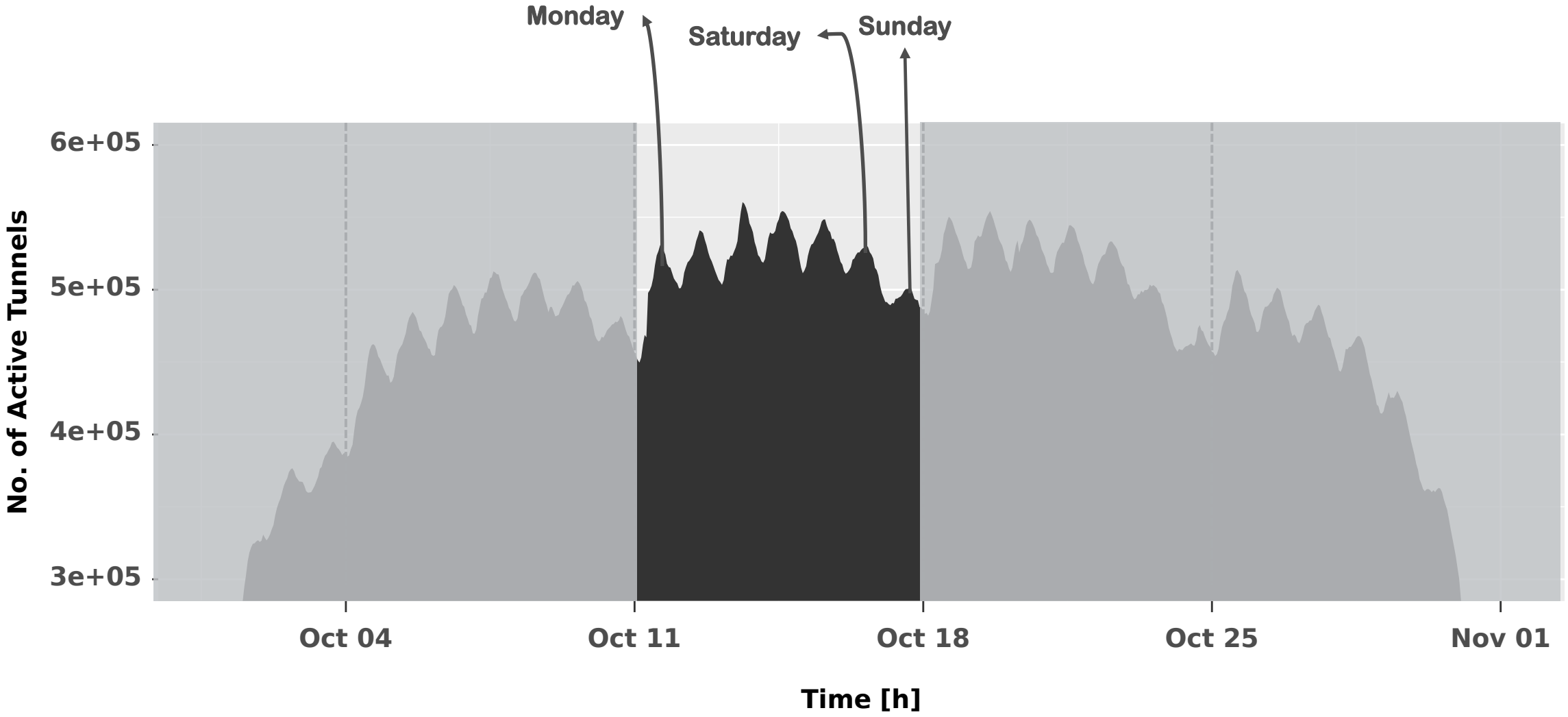
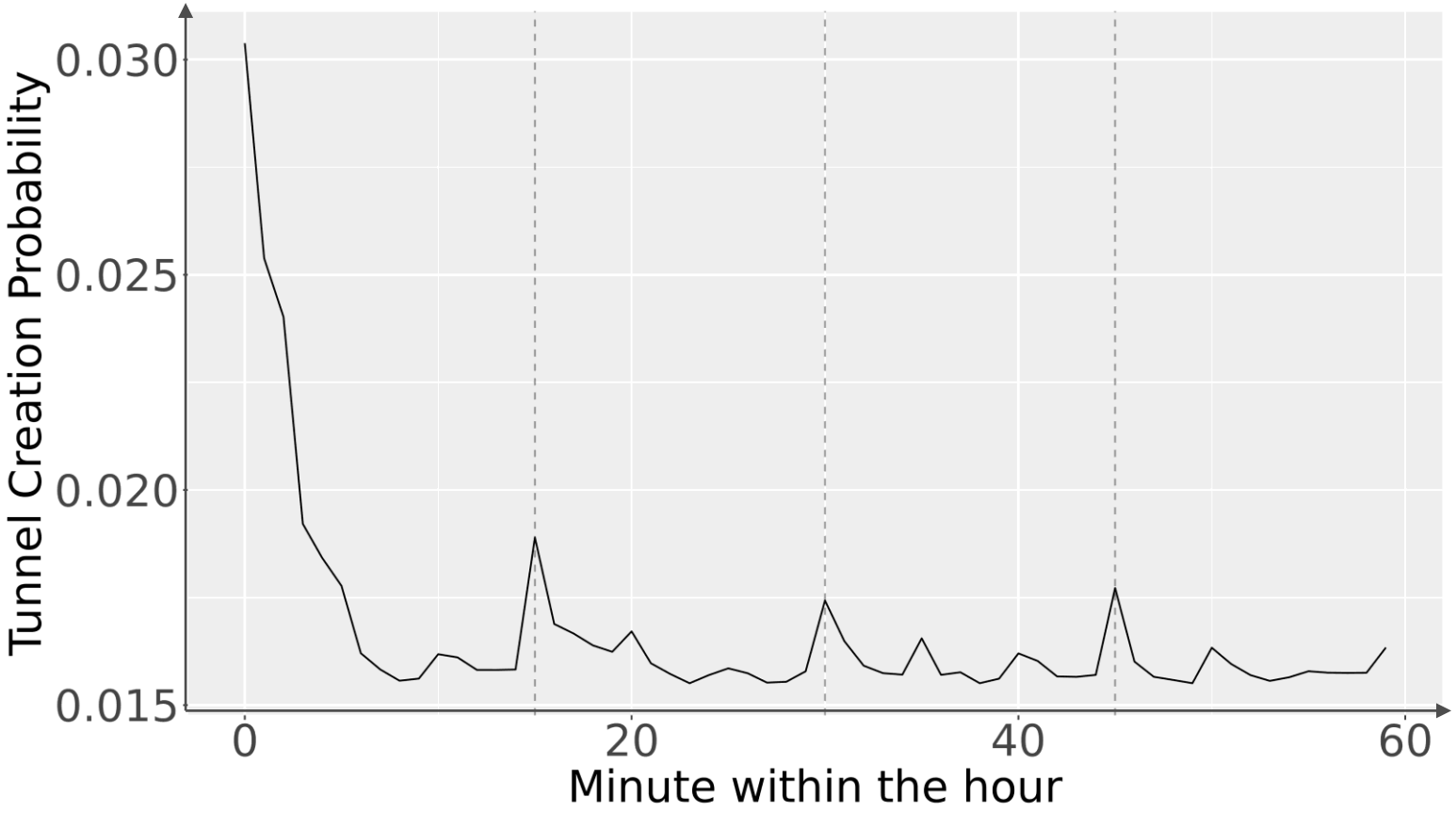


➔ Typical behavior of a day-night-cycle

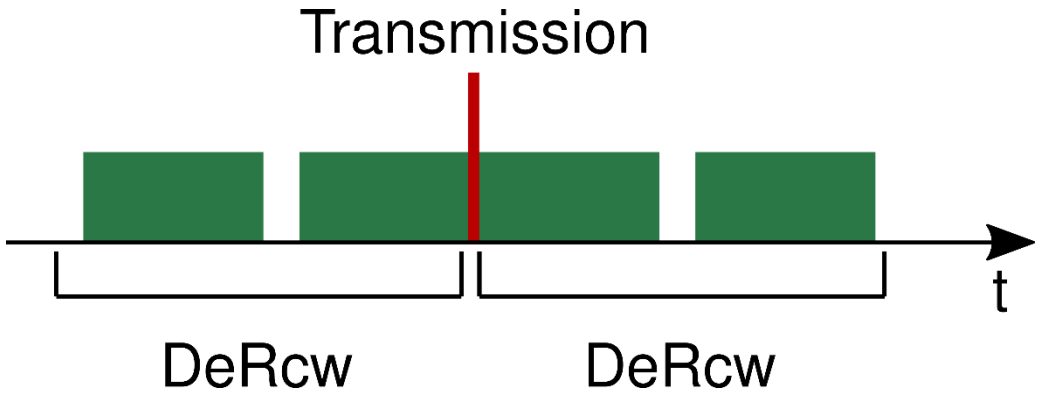
Burstiness of IoT Traffic



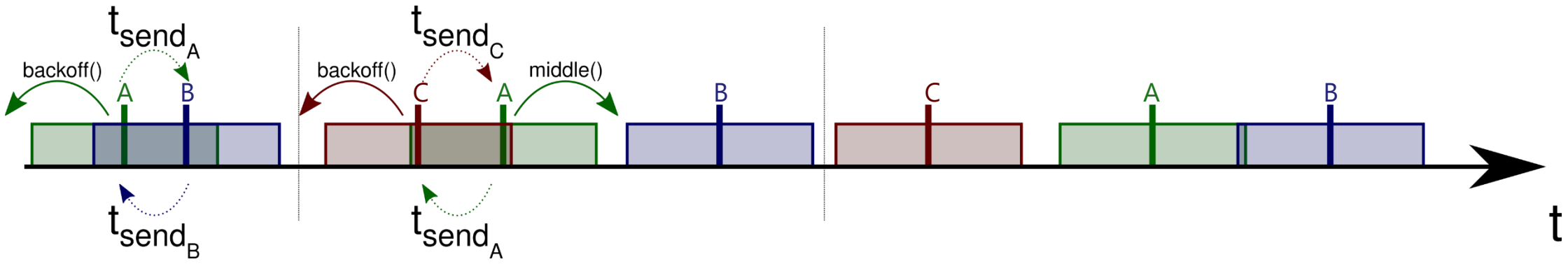
➔ Bursty traffic phases need to be mitigated to avoid collisions

Minimizing the Protocol Overhead

- Use receive windows of LoRaWAN for channel access
- Symmetrical receive windows
  - ➔ Both nodes hear each other
- No additional control messages needed
- Usable with standard LoraWAN devices
  - No special messages
  - No special headers

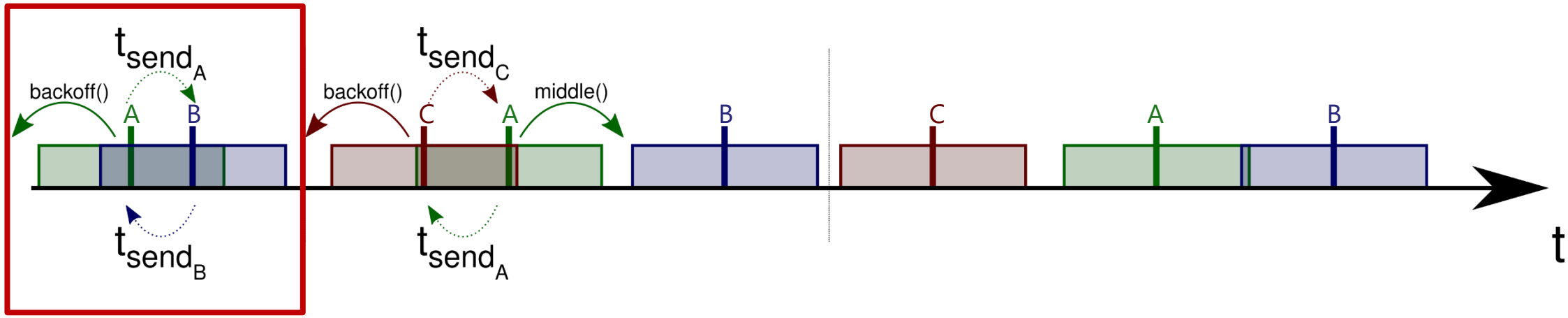


Decentralized Burst Mitigation



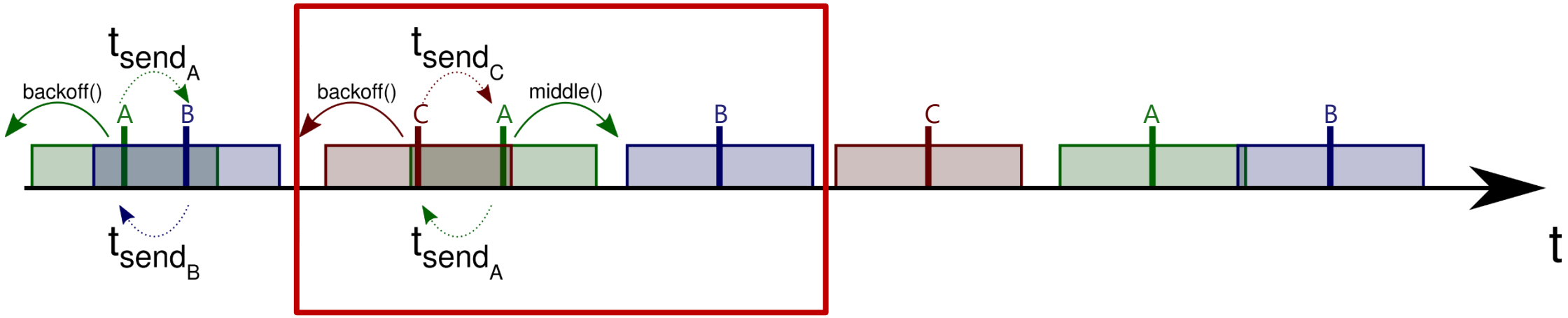
Device	Predecessor	Successor	Slot
A	-	-	t_{sendA}
B	-	-	t_{sendB}
C	-	-	t_{sendC}

Decentralized Burst Mitigation



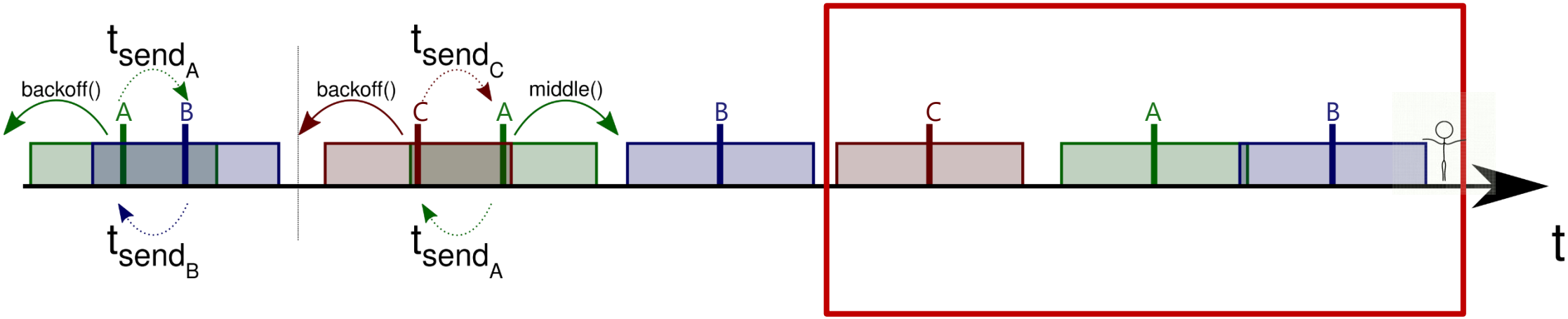
Device	Predecessor	Successor	Slot
A	-	t_{sendB}	t_{sendA} – backoff()
B	t_{sendA}	-	t_{sendB}
C	-	-	t_{sendC}

Decentralized Burst Mitigation



Device	Predecessor	Successor	Slot
A	t_{sendC}	t_{sendB}	t_{sendA} + middle()
B	t_{sendA}	-	t_{sendB}
C	-	t_{sendA}	t_{sendC} – backoff()

Decentralized Burst Mitigation



Device	Predecessor	Successor	Slot
A	t_{sendC}	t_{sendB}	t_{sendA}
B	t_{sendA}	-	t_{sendB}
C	-	t_{sendA}	t_{sendC}

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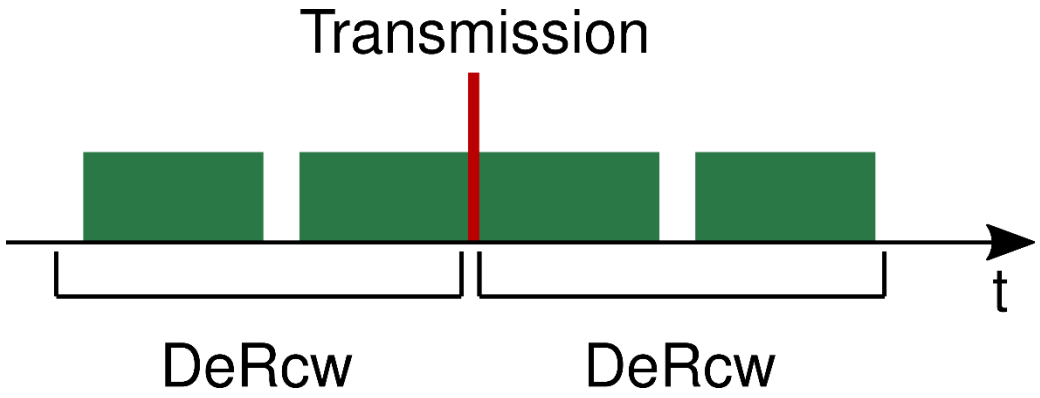

- How many DBM enabled devices are needed for network optimization?
- How much energy can be saved by using DBM?
  - Impact in throughput?
  - Impact on reliabillity?

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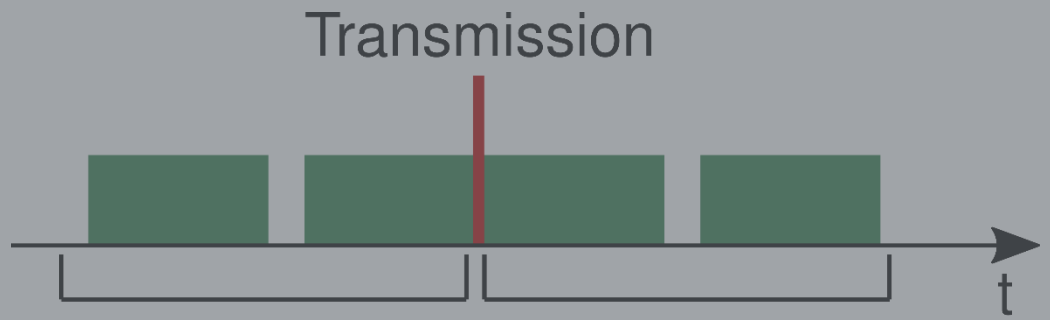

Discussion

- Is this applicable to other protocols?
- Enhancement for energy aware LBT

- How many DBM enabled devices are needed for network optimization?
- How much energy can be saved by using DBM?
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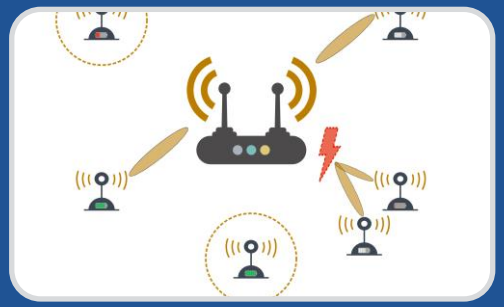
  - Impact on reliabillity?

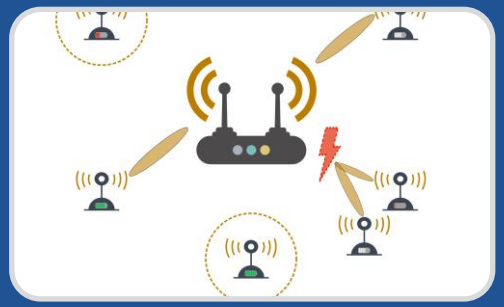
Conclusions



IoT Networks

- ALOHA as channel access results in high collision probabilities
- DESYNC as decentralized approach insufficient

Conclusions



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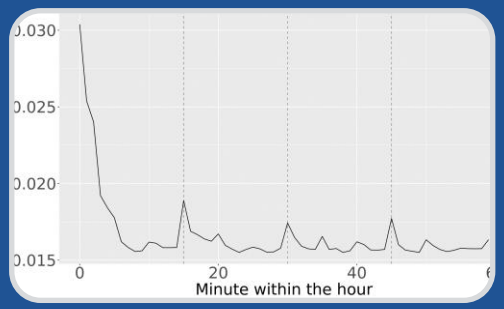
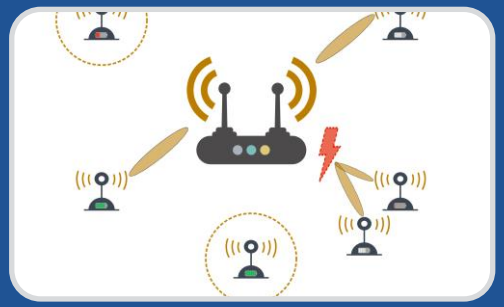


Bursty Traffic

- IoT devices behave in a correlated fashion
- Devices are synchronized ➔ no Poisson process

Conclusions



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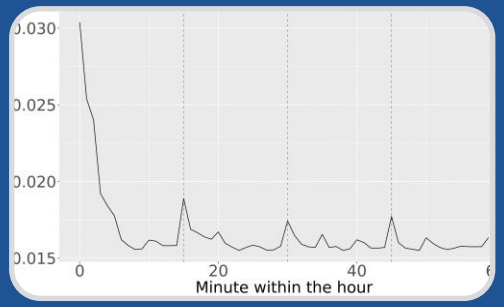

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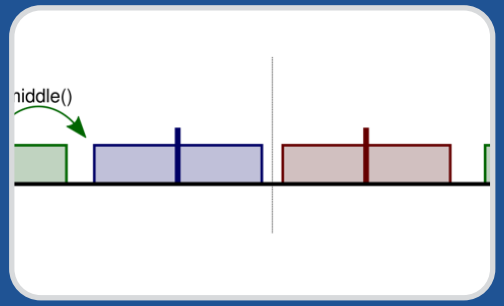

Decentralized Burst Mitigation

- DESYNC inspired approach without message overhead
- Compatible with non DBM networks to reduce collisions

Conclusions

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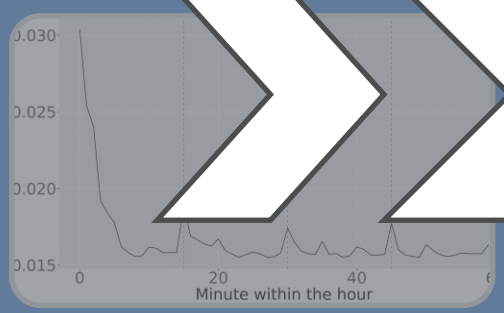
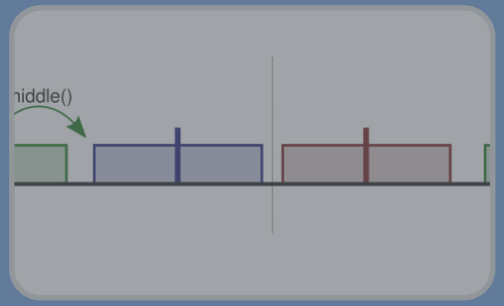


Future Work

- Parameter and feasabillity study
- Controller to switch channel access

- Devices are synchronized ➔ no Poisson process



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