Towards Worst-Case Bounds Analysis of the IEEE 802.15.4e

CISTER - Research Center in
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Motivation

The problem

- New communication standards have been issued to address the ever growing demands of the industry such as timeliness and reliability.

- To address these demands it is mandatory to carryout a thorough network planning in terms of latency and resources.

- We must understand these network protocols under worst case conditions.

802.15.4e

- The IEEE 802.15.4e amendment provides important functionalities to address timeliness and reliability in time-sensitive WSN applications, by extending the IEEE 802.15.4-2011 protocol.

- Proposes several MAC behaviours, which besides providing deterministic communications are also fitted with a multi-channel frequency hopping mechanisms to accommodate more nodes and meet constraint timelines.

- Deterministic Synchronous Multichannel Extension (DSME) and Time Slotted Channel Hopping (TSCH) are some of the MAC behaviours which are more suitable for time critical applications.

References

[1] J.-Y. Le Boudec and P. Thiran, Network calculus: a theory of deterministic queuing systems for the internet. Springer Science & Business Media, 2001, vol. 2050.
[2] A. Koubaa, M. Alves, and E. Tovar, "Energy and delay trade-off of the GTS allocation mechanism in IEEE 802.15. 4 for wireless sensor networks," International Journal of Communication Systems, vol. 20, no. 7, pp. 791–808, 2007.

Network Calculus

- It is an analytical model well adapted to controlled traffic sources and provides upper bounds on delays for traffic flows. Thus network calculus would be an ideal analytical choice for modelling DSME and TSCH MAC behaviours.

- Works by modelling the arrival curves and their respective service curves and calculating the delay and latency of the system.

Arrival curve, service curve, delay bound
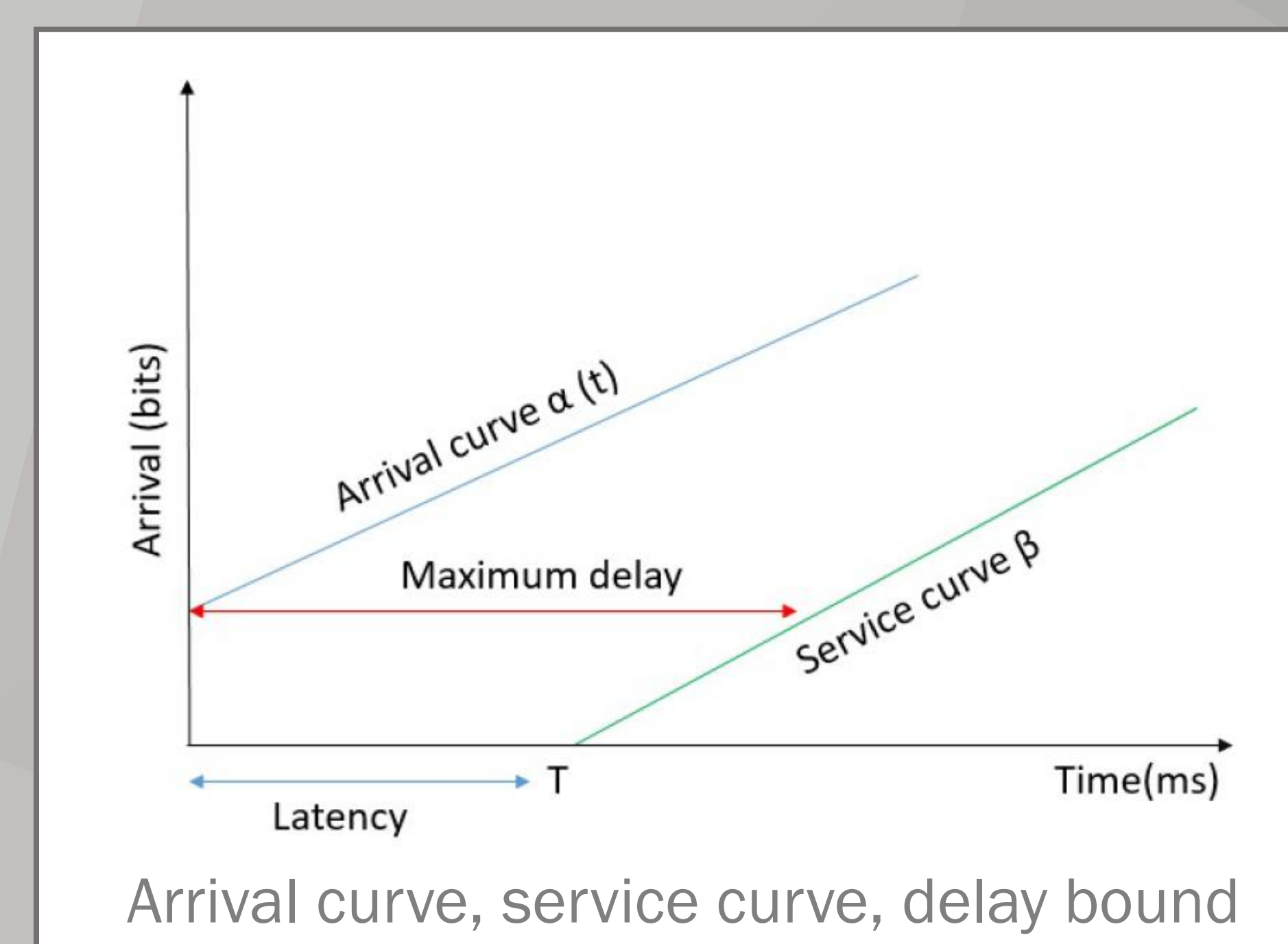
Contributions and Future works

- We modelled the service curves for a star topology based DSME and TSCH networks.

- We also have provided a worse case delay analysis for both DSME and TSCH networks.

- The network model has been extended in the meanwhile to the Low Latency Deterministic Networks (LLDN) MAC behaviour.

- Throughput calculation for all the MAC behaviours.

- As for future work, we plan on implementing these network protocols on real hardware.

Service Curve of DSME MAC