

**Topic for a Bachelor/Master/Pre-Thesis, Master Project,
or to work on as a Student Research Assistant**

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Extension of the clock synchronization test framework “clknetnsim” by WLAN delay models

In the context of Industry 4.0 and the Industrial Internet of Things (IIoT), the need for an accurate common time base among network elements and devices is becoming increasingly important. Furthermore, time-critical applications in telecommunications, smart power grids, data centers, industrial automation, and time-sensitive and distributed computing networks are demanding decreasing time variations between networked devices.

To evaluate real-world implementations of clock synchronization protocols, such as Network Time Protocol (NTP) or Precision Time Protocol (PTP), the Linux test framework “clknetnsim” (<https://mlichvar.fedorapeople.org/clknetnsim>) provides a promising starting point. Currently, it allows testing the Linux clock synchronization protocol implementations `ntpd`, `linuxptp`, and `chrony` over simulated network conditions. However, so far only simple delay models with focus on wired network scenarios are supported.

On the other hand, many research works exist in the area of modeling throughput and delay characteristics of wireless connections. For example, Bianchi et al. (<https://www.eng.buffalo.edu/~tmelodia/papers/bianchi.pdf>) designed Markov models that consider the WLAN technology and its channel access mechanisms. Since then, various implementations of these models have become publicly available ^{1 2 3 4 5}

Consequently, the aim of this work is to extend the Linux clock synchronization test framework “clknetnsim” by WLAN-specific delay models, such as those introduced by Bianchi et al. The extended framework shall be evaluated by comparing simple wired and wireless network scenarios.

Summarized, the following tasks have to be solved:

- Familiarization with the fundamentals of the framework “clknetnsim” as well as its supported NTP and PTP implementations
- Familiarization with Bianchi's WLAN throughput/delay models and available implementations
- Conception and implementation of a clknetnsim extension for integrating WLAN delay models
- Experimental evaluation using suitable network scenarios
- Detailed documentation of all work steps

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Start date:	To be defined
Submission date:	To be defined

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¹<https://github.com/gxercavins/bianchi>

²<https://github.com/JasonZhang1993/Saturation-Throughput>

³<https://github.com/segmentation-fault/BianchiPy>

⁴<https://github.com/zzkkcc/ns3-wireless-DCF-saturationThroughput>

⁵<https://github.com/wn-upf/Komondor/tree/master/Documentation/Validation/bianchi>