CPS: Synergy: Collaborative Research: *TickTalk*: Timing API for Federated Cyber-physical Systems

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Challenges:

- Community-scale CPS programming: time as a first-order concept, multi-tenancy, and device (sensor, actuator) power management related to timing
- Application developers handle these complex issues on a case-by-case basis. This holds back widespread adoption of community-scale CPS.

Solution:

- Meta-language—*TickTalk*—and a compilation strategy that embed the notions of *timing islands* and *timing-failure resilience*
- Network-wide runtime supporting a resilient synchronization mechanisms
- Hardware mechanisms for optimizing power needed to achieve timing goals

Scientific Impact:

- Fault-resilient, energy-aware abstractions for programming large-scale time-dependent IoT systems

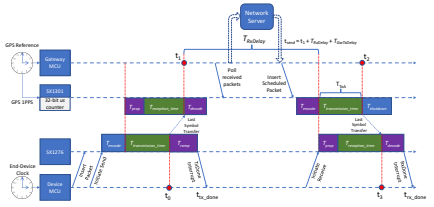
Broader Impacts:

- Programming tools and a methodology to enable non-specialist developers to create applications that aggregate, process and take action on information in large scale, distributed CPS – such as smart and connected communities
- Reference designs for sensor and actuator hardware architectures supporting TickTalk-based timing mechanisms

Broader Impacts (education and outreach):

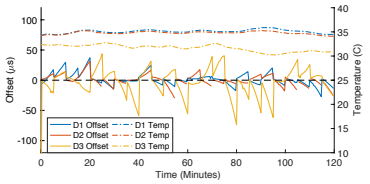
- Improving accessibility of CPS-related courses by abstracting away low-level complexities of time-related program behavior
- Lowering the barrier of CPS programming to engage high school students

LongShoT – Low-Power Distributed Time Synchronization



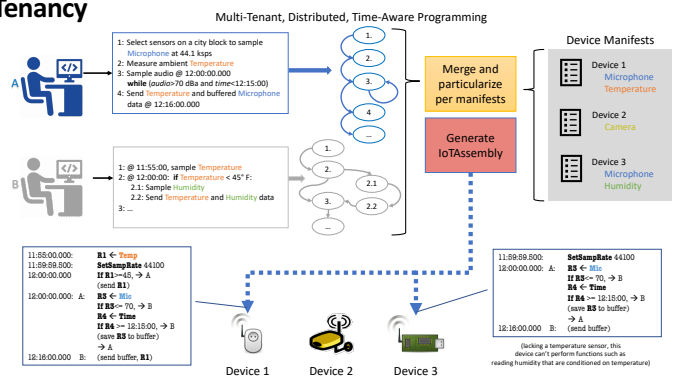
Reference design for piggybacking precise NTP-like synchronization on LP-WAN data traffic

C. Ramirez, A. Sergeyev, A. Dyussenova, and B. Iannucci. "LongShoT: Long-Range Synchronization of Time." 2019 18th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN). April, 2019. DOI 10.1145/3302506.3310408



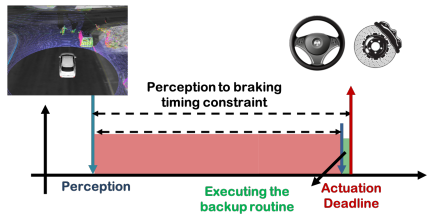
Synchronization performance and local clock drift with devices at distances up to 4 km.
Future work: improved drift modeling and compensation

IoTAssembly and Multi-Tenancy



Work in Progress – PlanB

- A flexible and reliable design methodology for time-sensitive Cyber-Physical Systems (CPS)
- Before a timing constraint fails, execute a backup routine
- Instead of performing WCET/WCRT analysis for the whole program, limit it to backup routines



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