

# Expanding RISC-V Horizons: Streamlining Heterogeneous Systems Evaluation with Open Source RISC-V AMS VP Framework

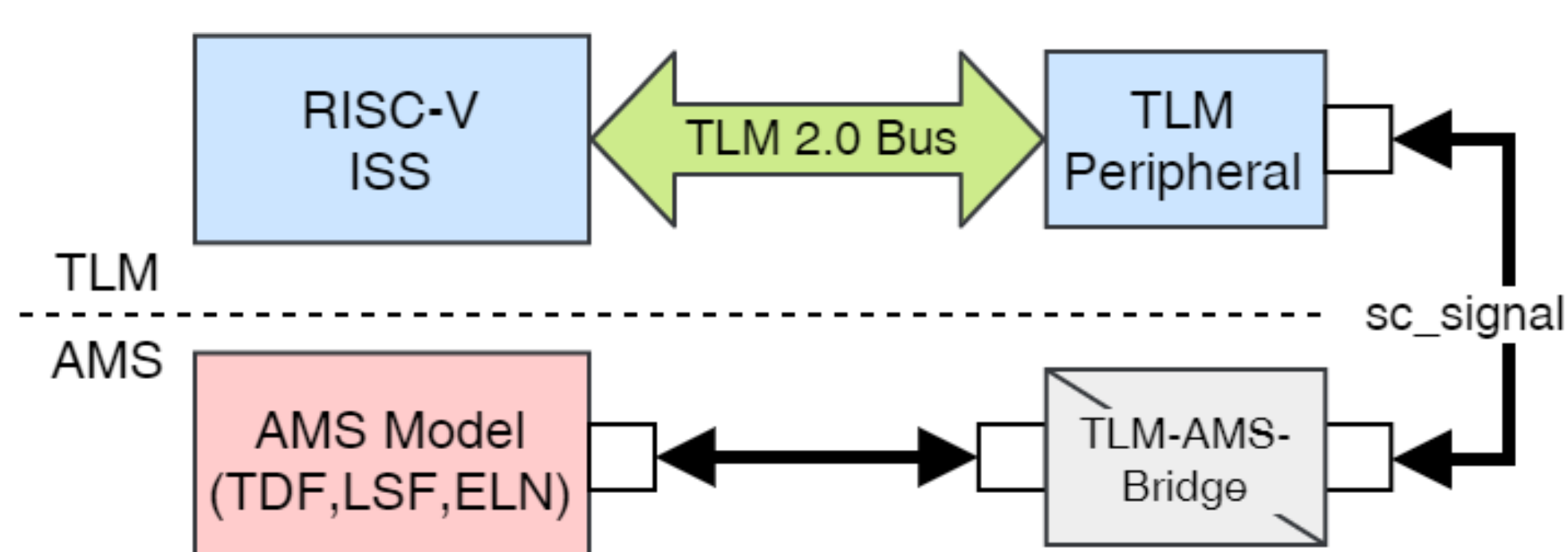
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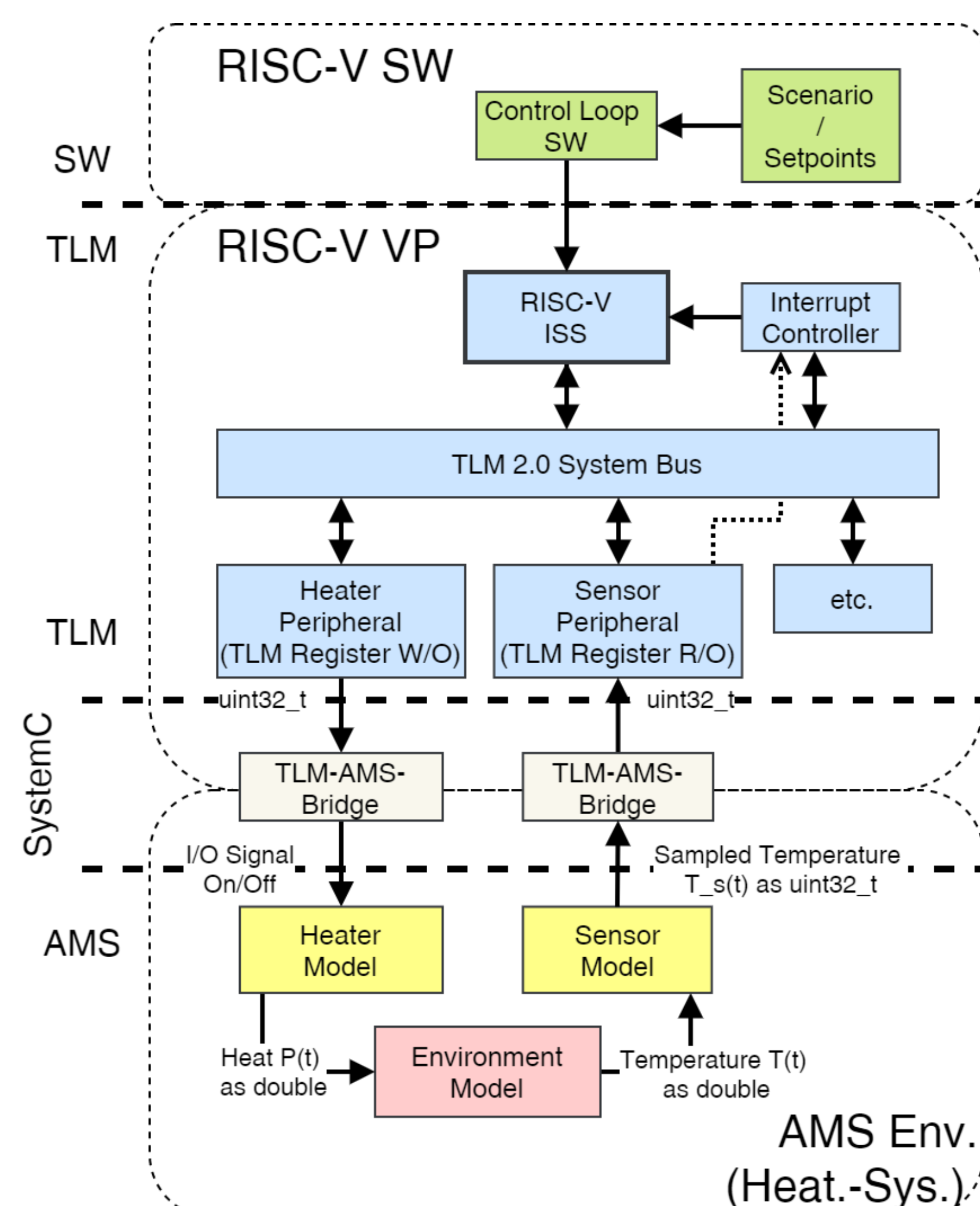
## Problem

- RISC-V continuously growing ecosystem
- RISC-V applications in Internet-of-Things (IoT) and Cyber-Physical Systems (CPS)
  - Early development and verification
    - Open-source RISC-V Virtual Prototype (VP)
    - Enable Hardware/Software interactions
    - Lack of accurate environment models for CPS



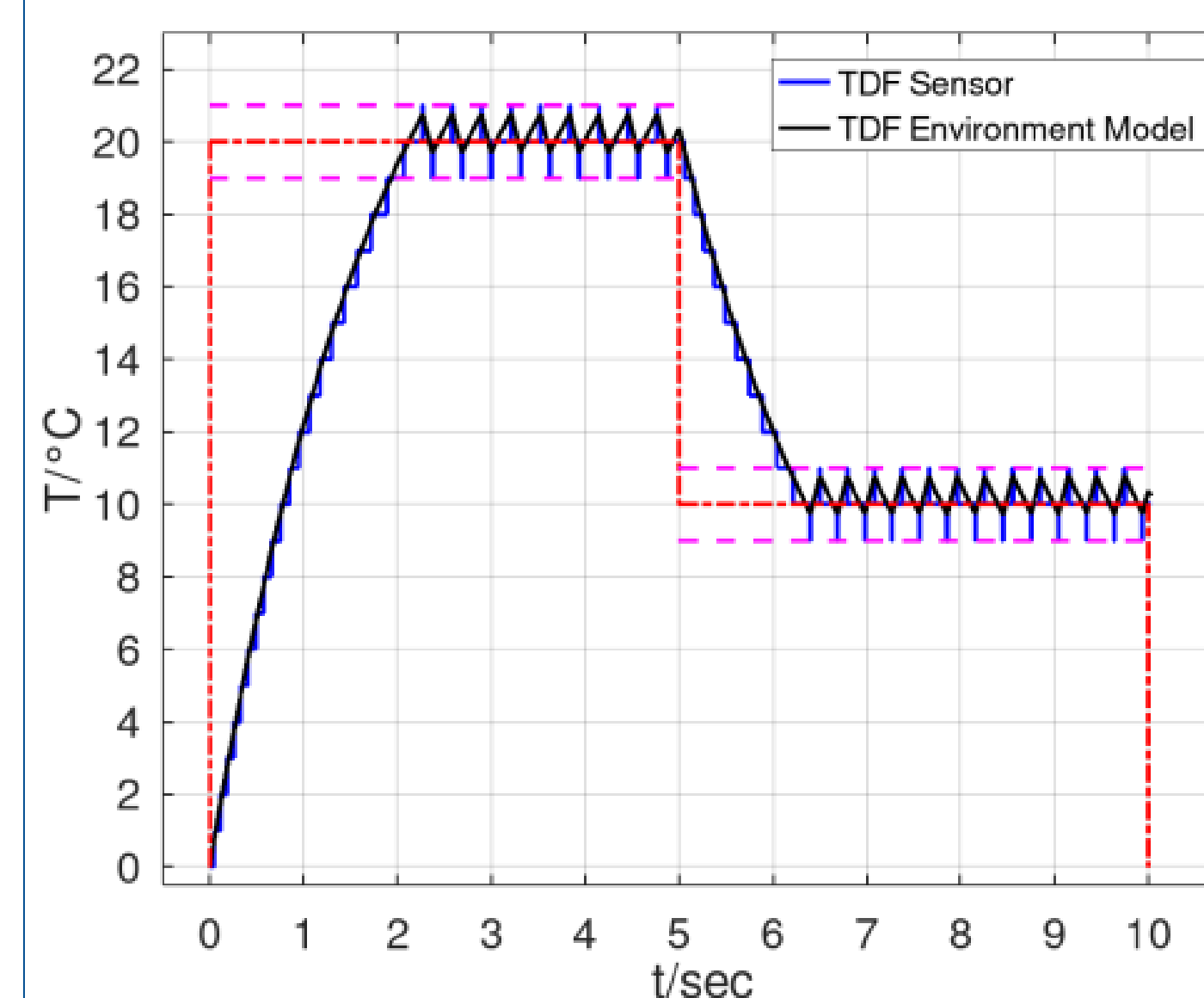
## Heterogeneous Systems Evaluation Framework

- Open source RISC-V AMS VP
  - System-level (SystemC/AMS)
  - TLM-based hardware/software simulation
  - Registers for hardware/software interactions
    - Software and TLM
    - TLM and AMS
- TDF models of computation for physical environments
- AMS-based sensor, heater, and environment models
- Design, simulation, and verification

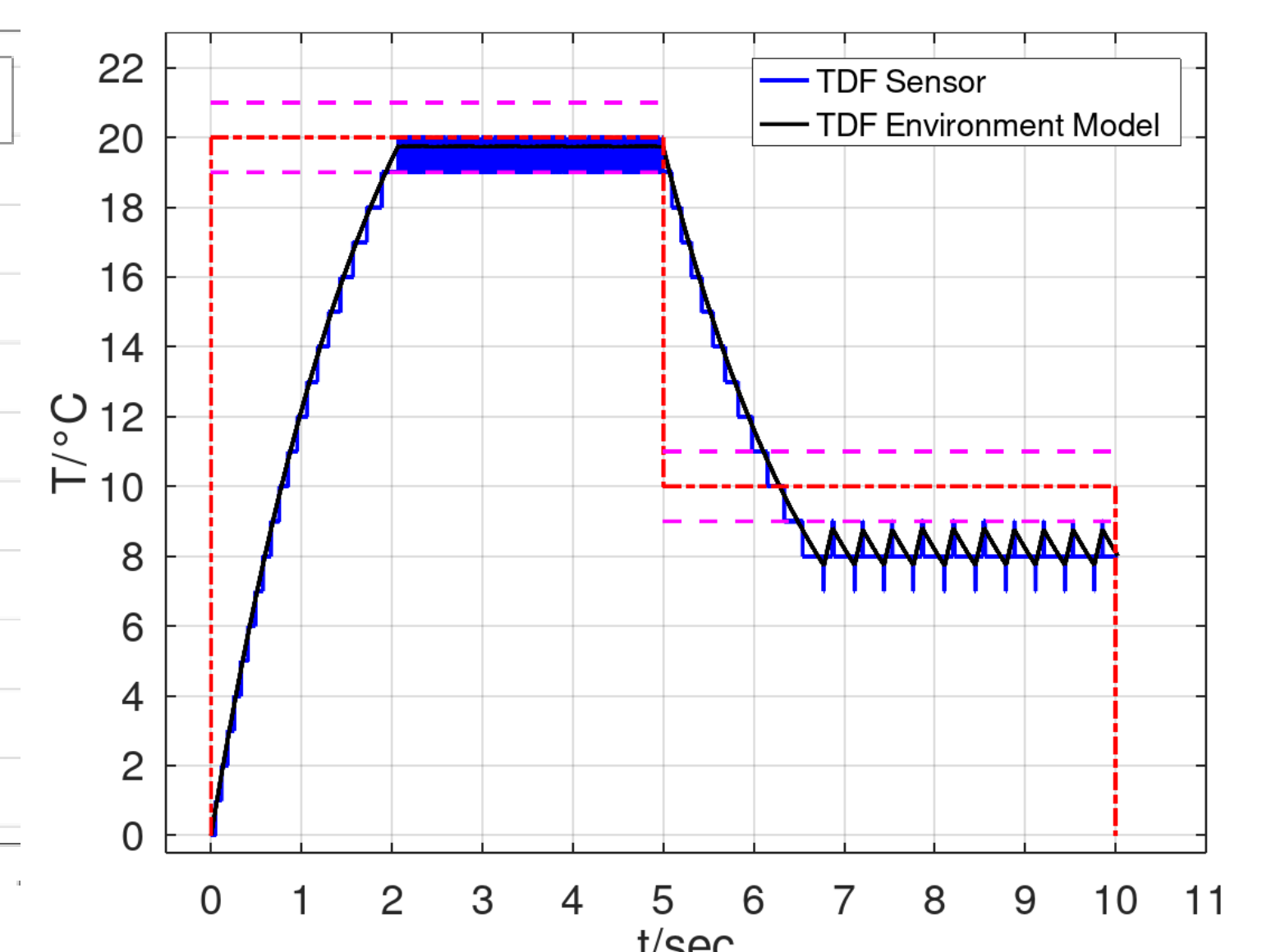


## Experimental Evaluation

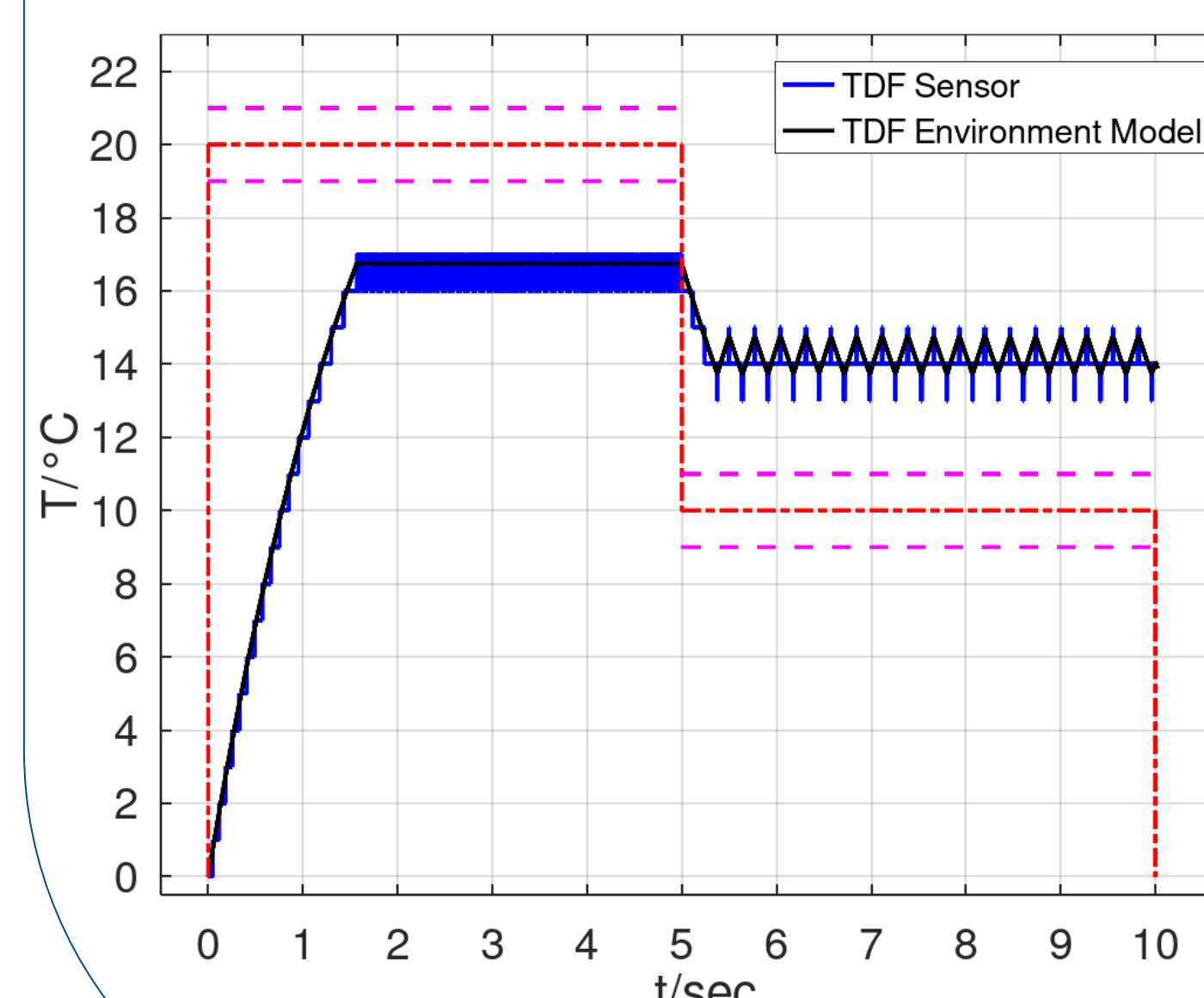
- Temperature control algorithm
  - Hysteresis controller
  - Lightweight design
  - Finite state machine based.
- Fault Injection evaluation



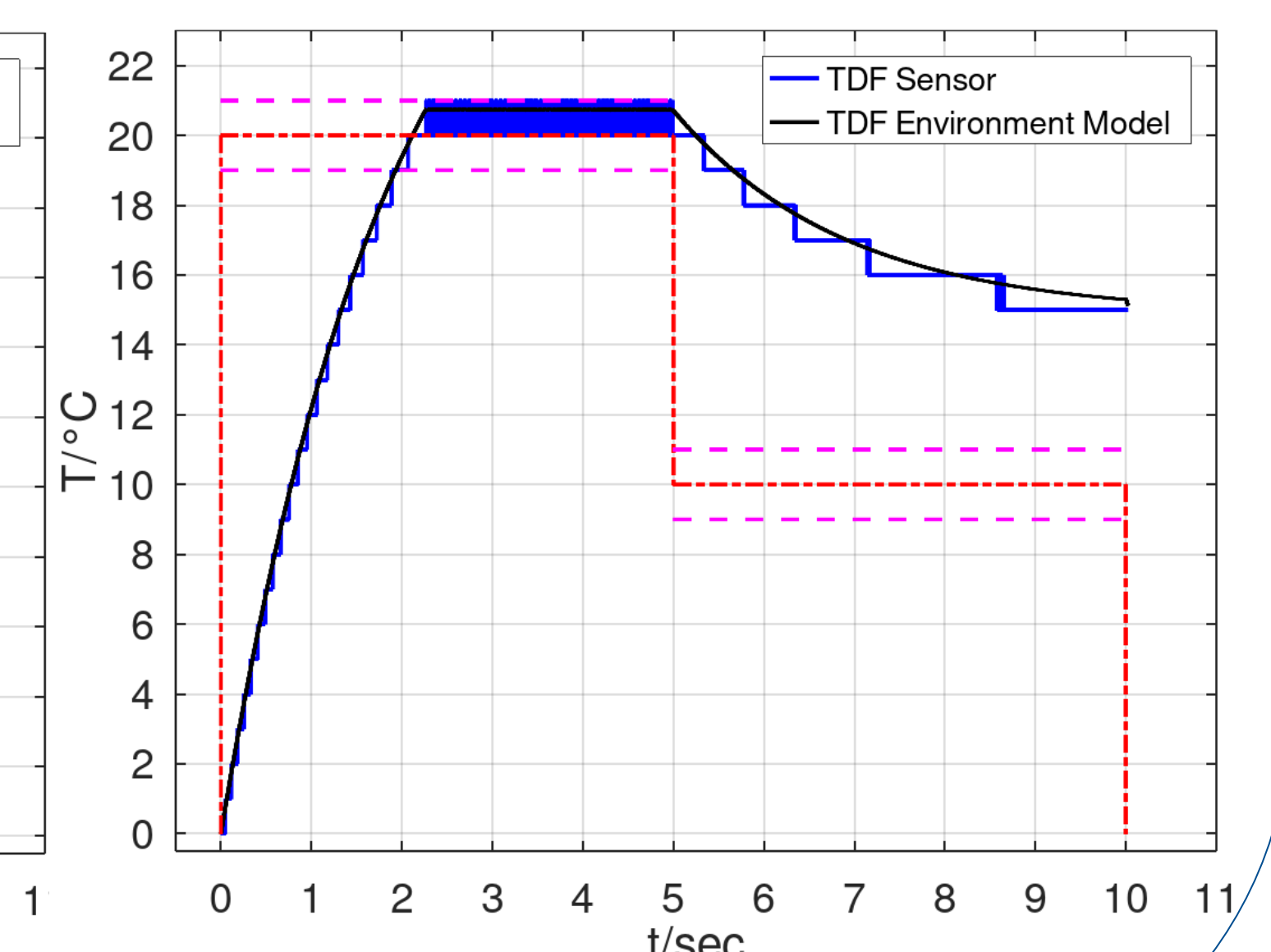
Heat control for two setpoints (20 °C and 10 °C)



Fault injection in TLM module



Fault injection in ISS



Fault injection in control loop software

## More Research

- Cross-level and hybrid modeling (VP in the Loop)
  - Register-Transfer Level (RTL) and RISC-V AMS VP framework
- Automated refinement of non-functional properties of VPs, e.g., time and energy consumption
- Development of library with primitive building blocks for CPS
  - Sensors, actuators, Analog-to-Digital Converters
- Verification using advanced techniques
  - Fuzzing
  - Symbolic execution
- Virtual Environment GUI (VP breadboard)
  - Interactive simulation of off-chip “devices”
- Verification of embedded firmware