Contention Aware Web of Things Emulation Testbed

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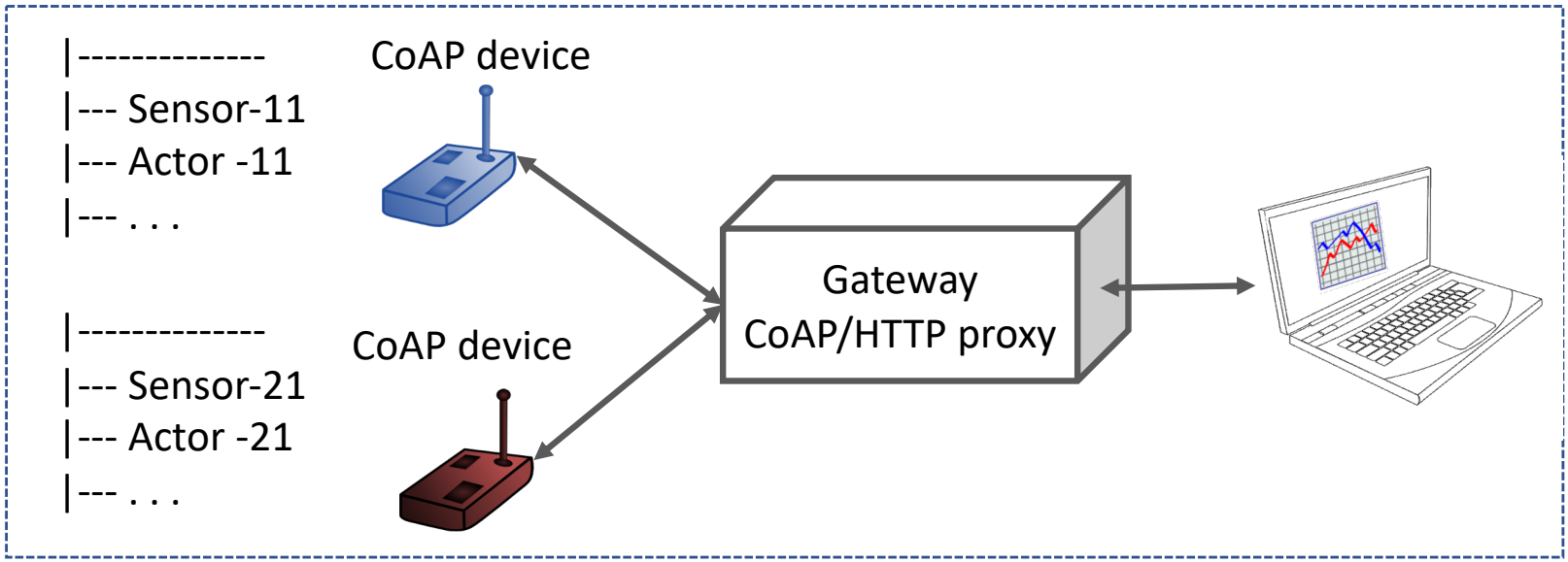
Problem

- Web of Things
  - HTTP , CoAP (Constrained Application Protocol - RFC 7252)
- Real testbeds are not always available
- Emulation tools:
  - Use multicore systems to emulate large number of WoT devices
  - Consider effect of resource contention on test results

Developing a scalable WoT emulation testbed while monitoring impact of resource contention on the test results

Objectives

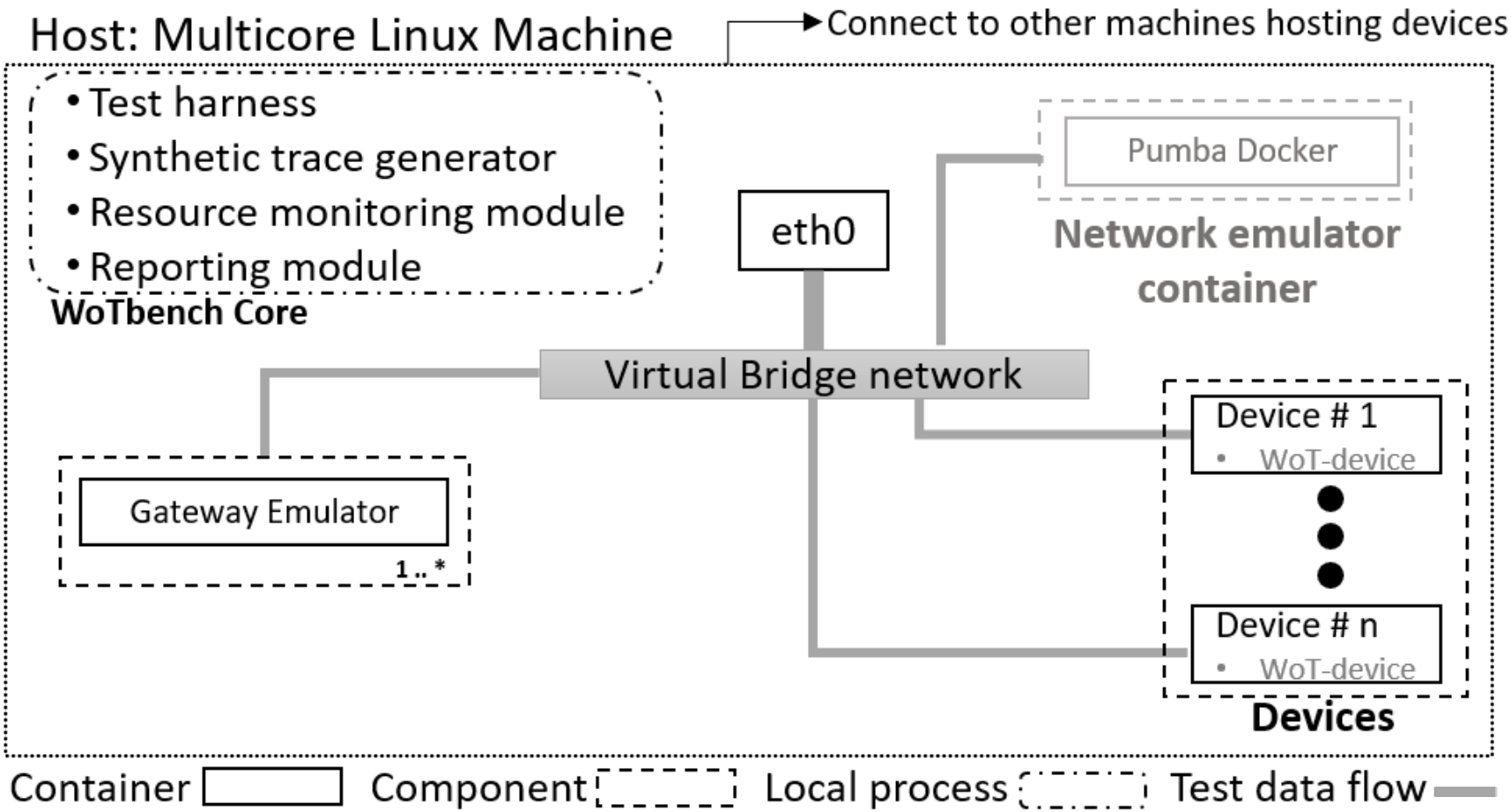
A Web of Things environment with CoAP enabled devices



1. Emulate a large number of devices
2. Evaluate impact of request arrival pattern
3. Compare application layer configurations
4. Consider network characteristics

Solution

- **WoTbench**: Web of Things benchmark



Emulated WoT-Device

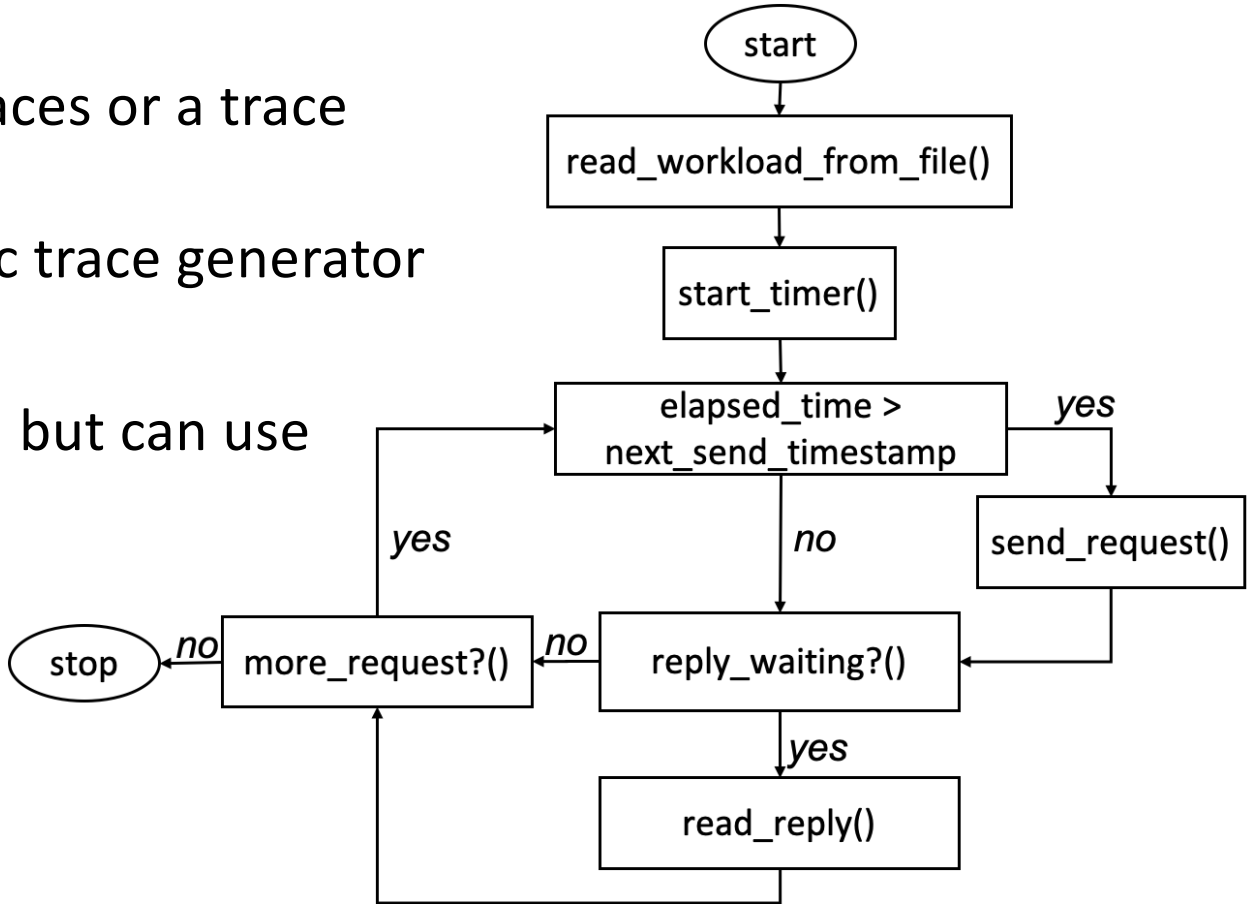
- Uses libCoAP library (https://libcoap.net/)
- List of resources (sensors/actors)
  - Configurable service time specification

Resource name	service time (distribution)	Busy/Sleep
LED Switch	20 msec - e	S
Temp Sensor	5 msec - d	S

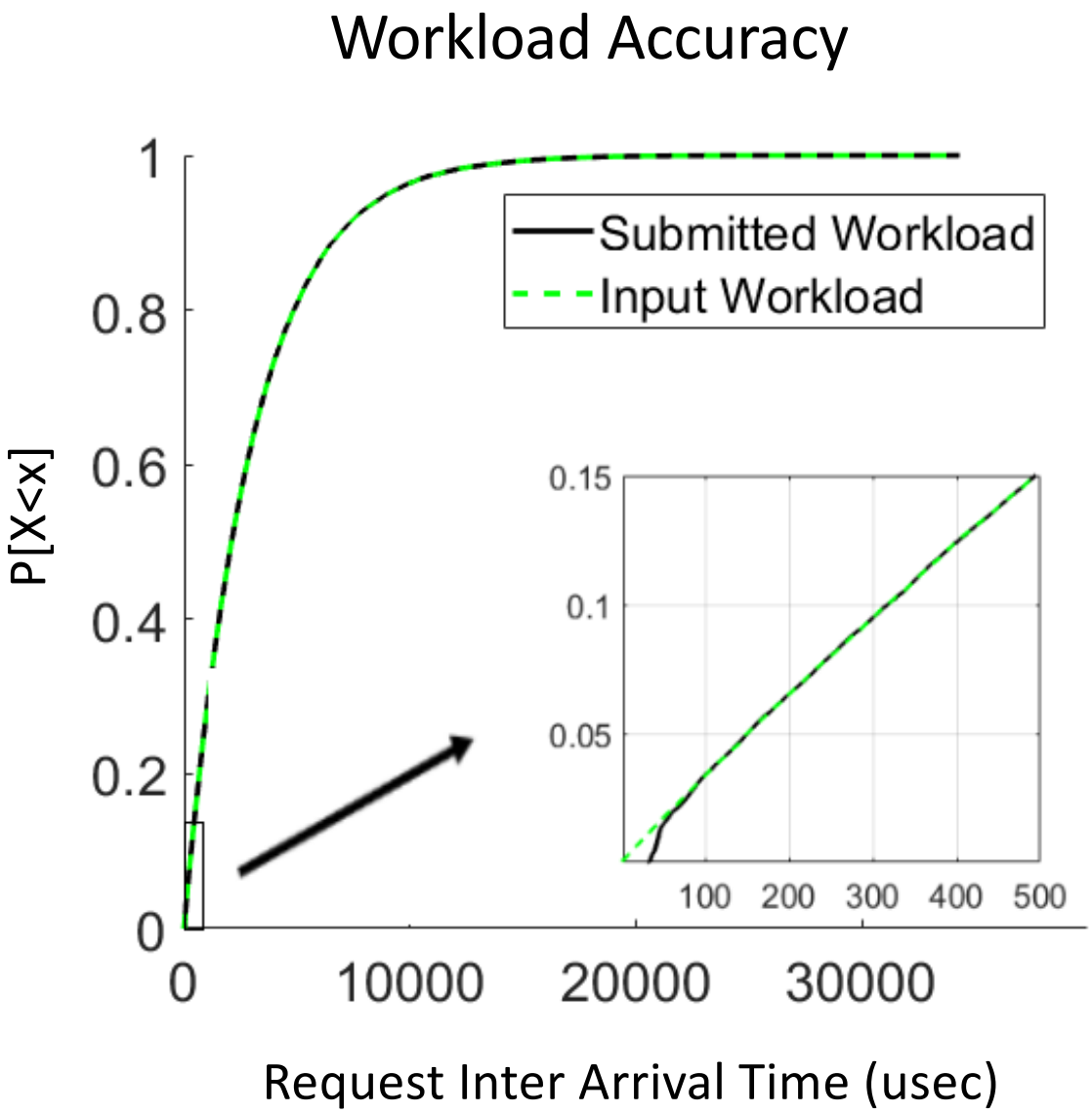
- Running on Docker containers
  - Lightweight
  - WoT-device can be replaced by custom applications that support CoAP

Gateway Emulator

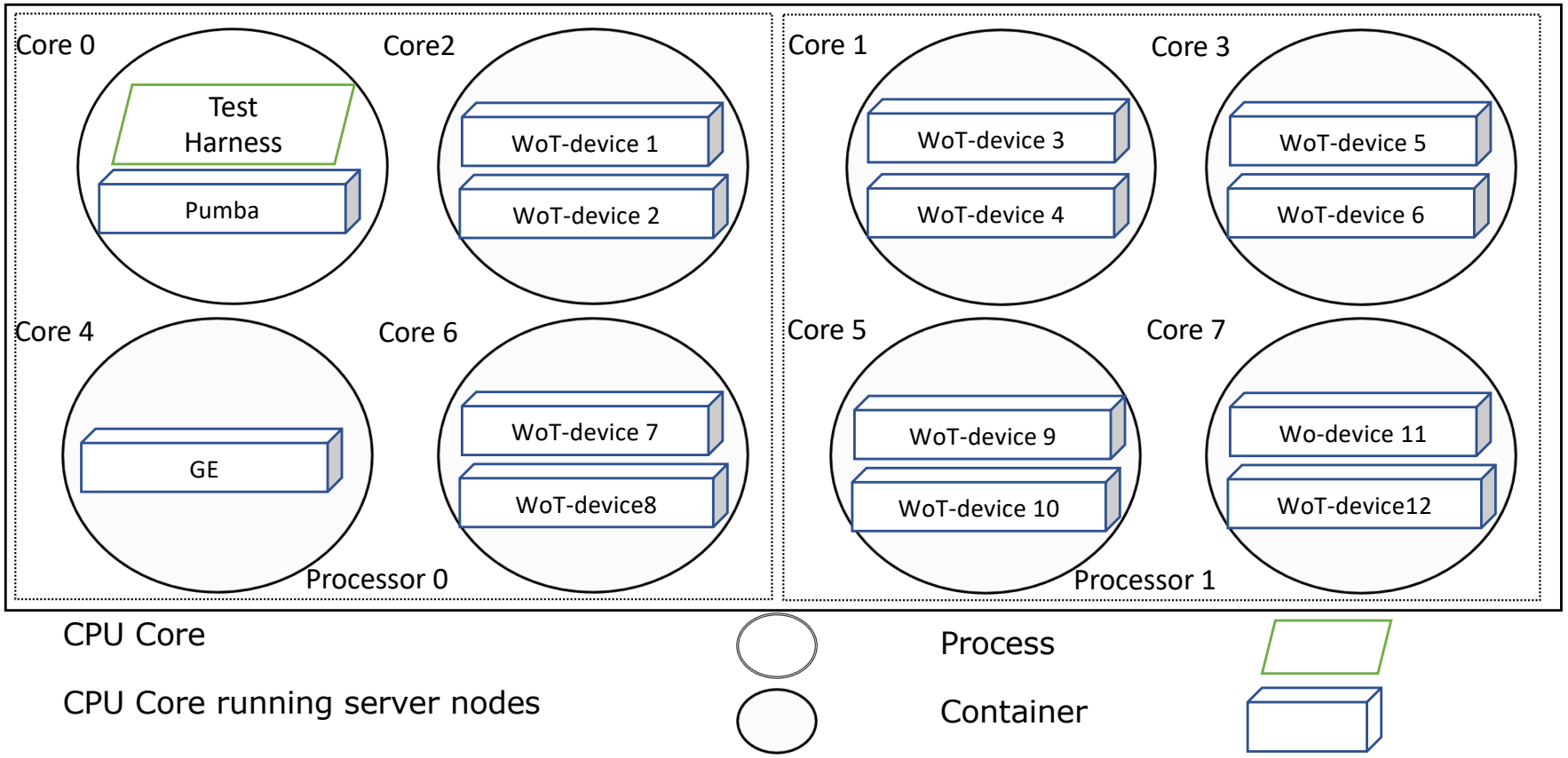
- Role of a load generator in conventional Web benchmarking tools
- Use realistic access traces or a trace generated by synthetic trace generator
- Async/single threaded but can use multiple instances



Gateway Emulator



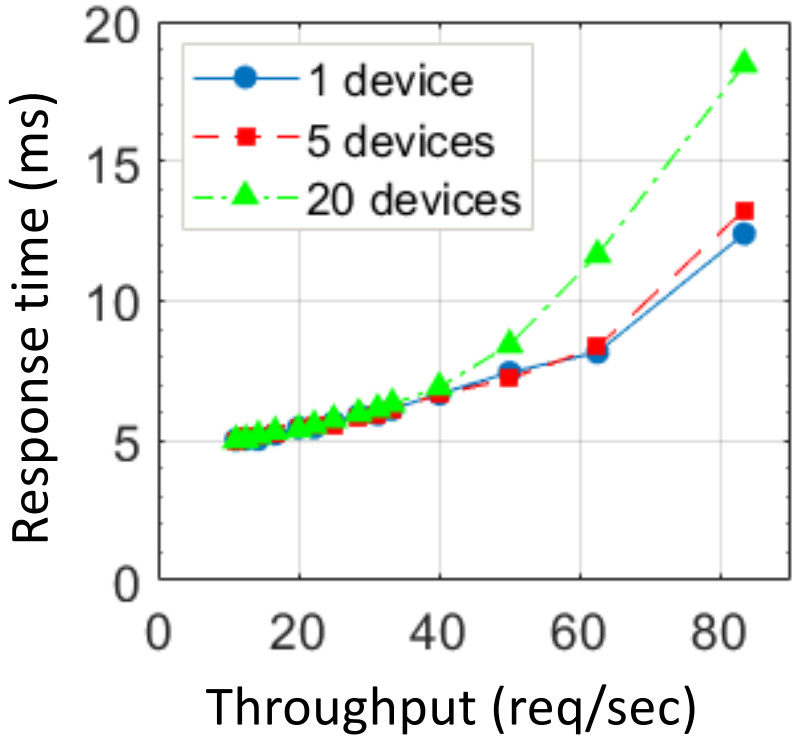
Deployment



- Example of deployment decisions: use of processor affinity
- Device capability can be emulated by CPU share

Contention Issue

- Effect of contention for shared resources on test results

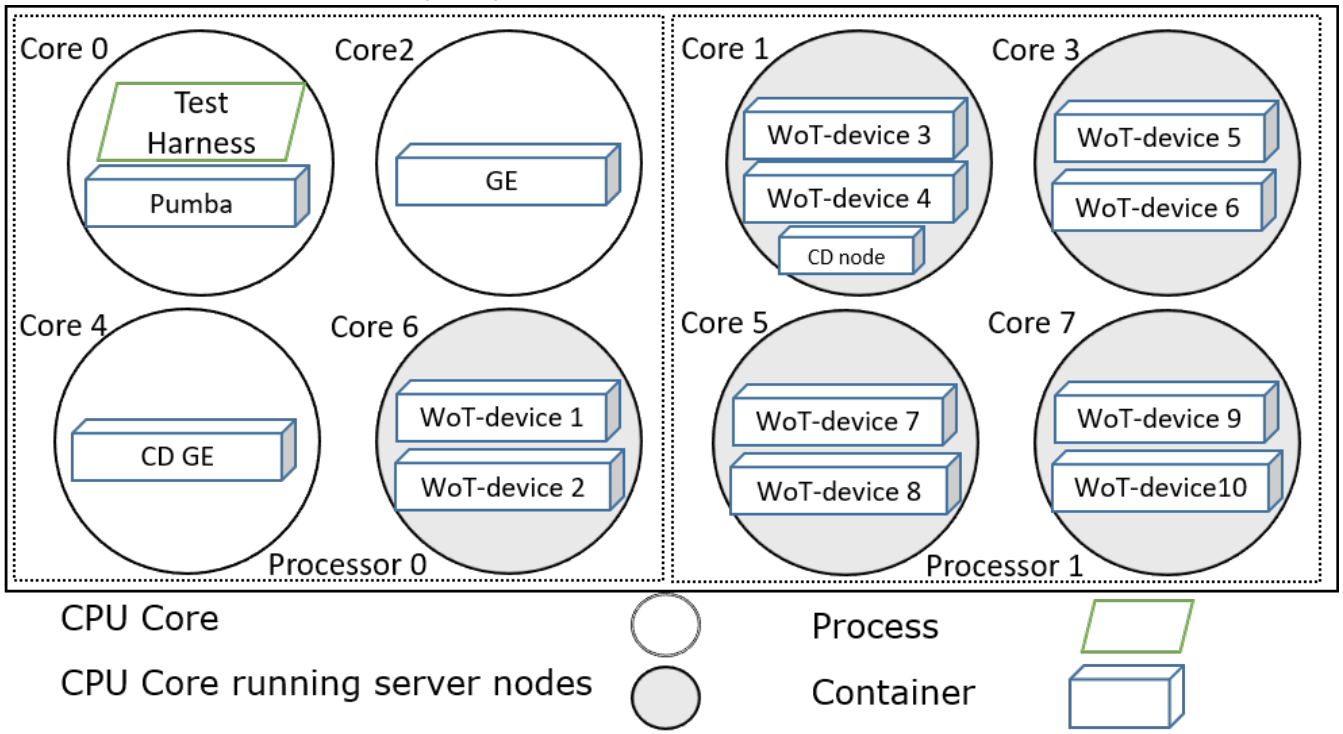


- Test infrastructure lacks capacity to emulate this scenario.

Contention Detection Module

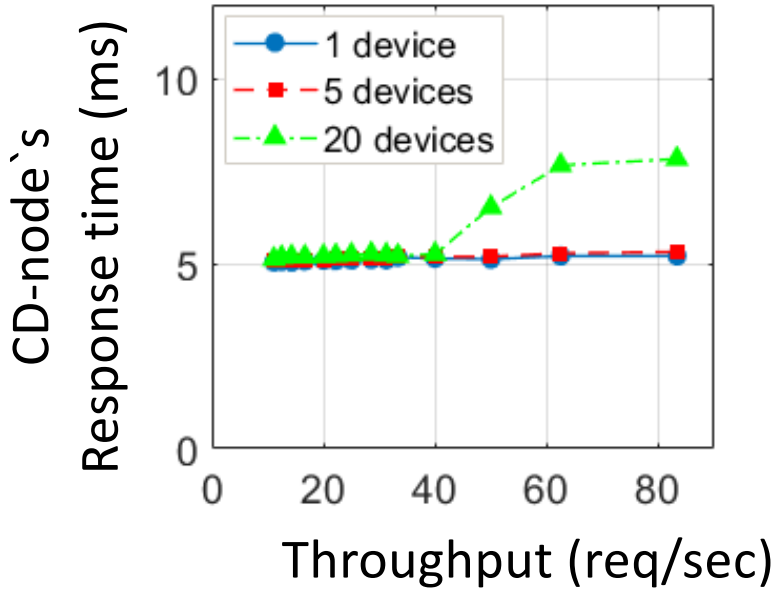
- An instrumented, lightweight WoT-device → CD node
- An extra Gateway Emulator
- A controlled workload

Deployment with CD module



Contention Detection Module

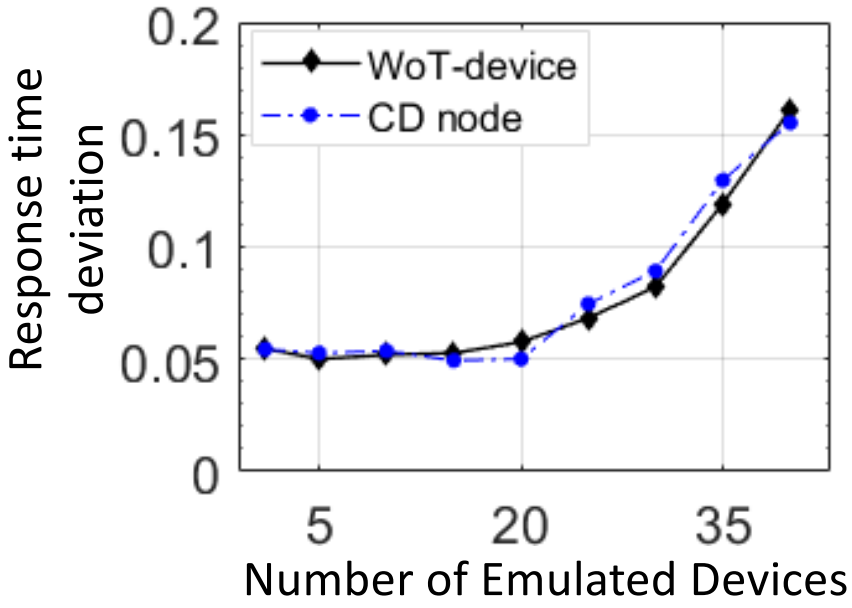
- CD workload:
  - Deterministic inter-arrival time
  - Deterministic service time



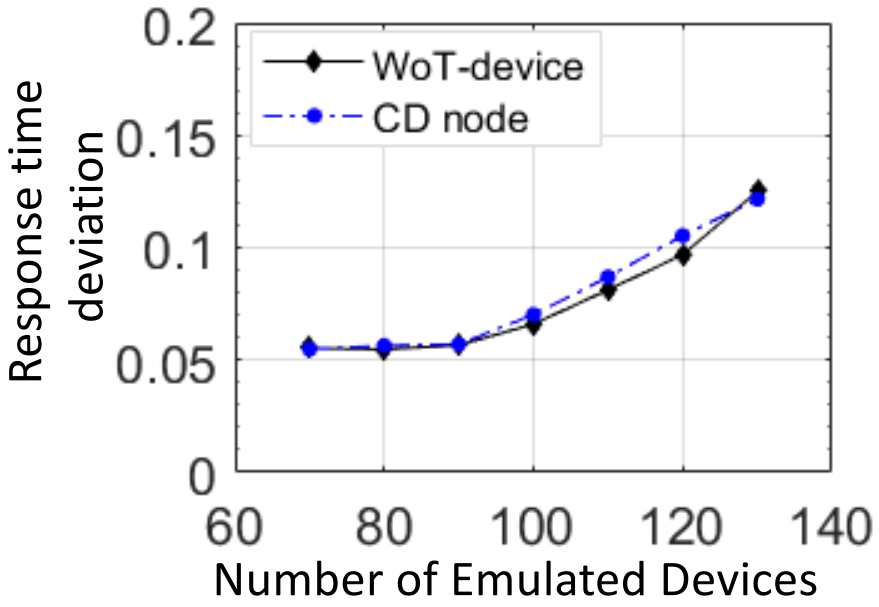
- CD-node response time starts to increase at the same throughput that the response time of actual devices increase.

Contention Detection Module

$$\text{Response Time Deviations} = \frac{\text{Response time} - \text{Service time}}{\text{Service time}}$$



CPU intensive workload



Non-CPU intensive workload

- CD-node can follow the response time of WoT-devices for both CPU and non-CPU intensive workloads

Summary

- WoTbench is designed to be deployed on commodity multicore hardware
- Use cases are capacity planning, testing protocol configuration and effect of network characteristics
- Contention in shared resources of multicore machine can impact emulation results
- Contention Detection module is designed to detect such effect and approve/reject test results
- Future work will focus on auto deployment techniques for WoTbench

Thank you!

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