

# SPI-SNOOPER: Hardware-Software Approach for Transparent Network Monitoring in Wireless Sensor Networks

Mohammad S. Hossain, Woo Suk Lee, and Vijay Raghunathan

School of ECE, Purdue University

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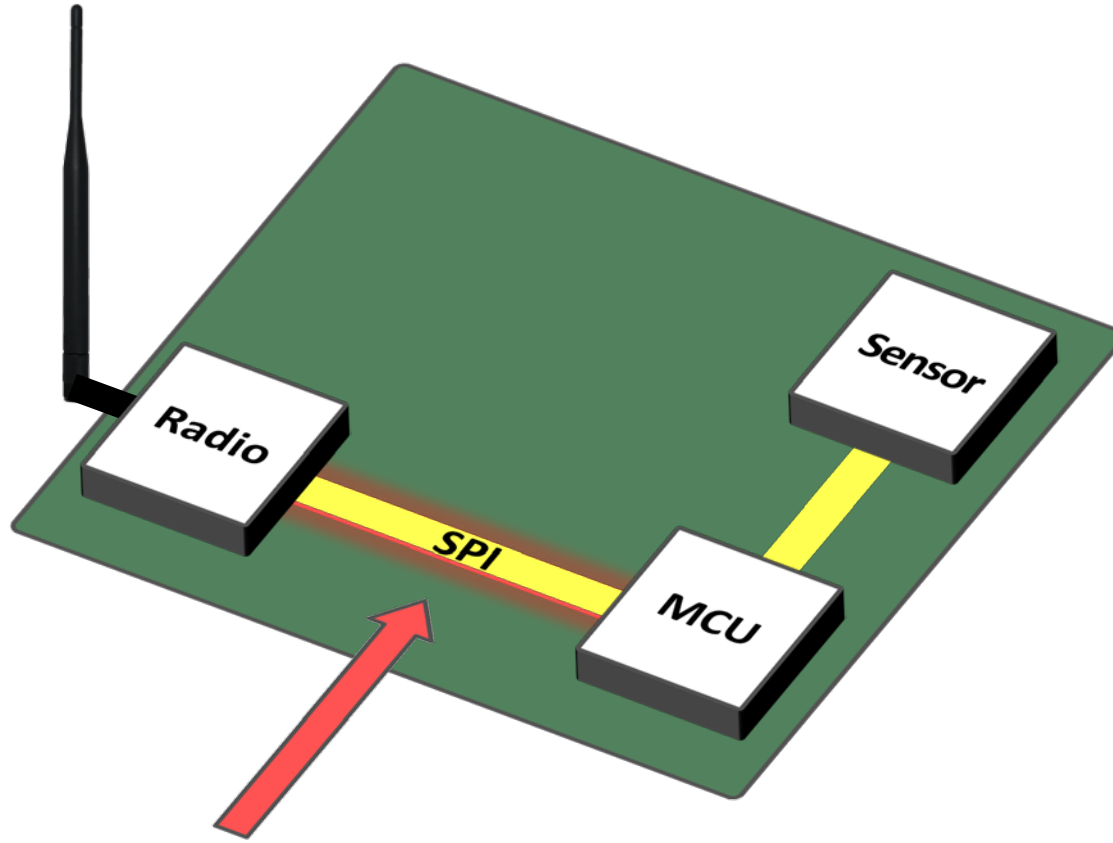
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# Key Idea

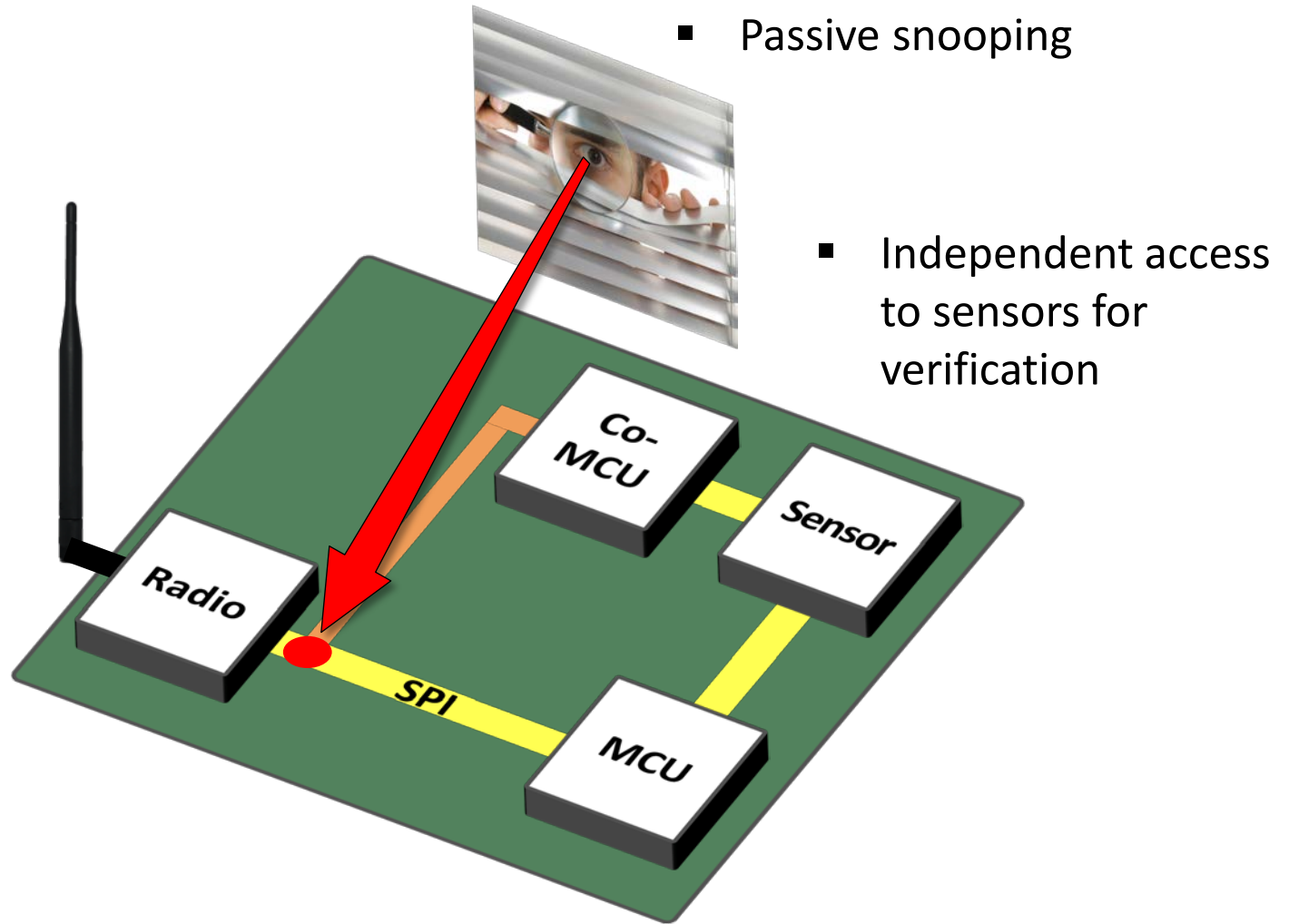
- ▶ Locally process monitoring/control tasks
  - Fundamental purpose of monitoring is a timely control
  - Monitor/control internally to avoid the costly wireless communication
  
- ▶ Employ a reliability co-processor
  - Implement the monitoring and controlling algorithm onboard
  - Physically and logically separate the monitoring and controlling tasks from main applications
  - Provide a fail-safe mechanism for monitoring and controlling tasks

# Typical Wireless Sensor Node Architecture

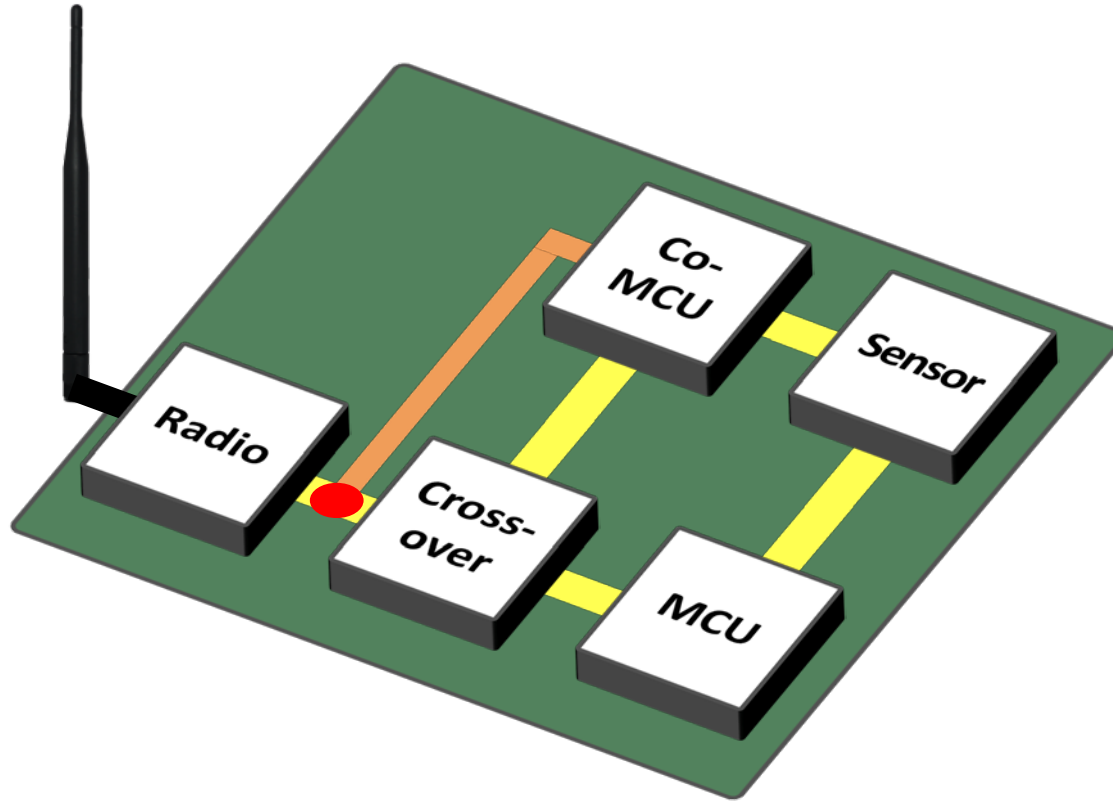


- SPI bus carries the contents of network communication
- Most radio ICs used in sensor nodes use the SPI bus for interfacing

# SPI-SNOOPER Hardware Architecture



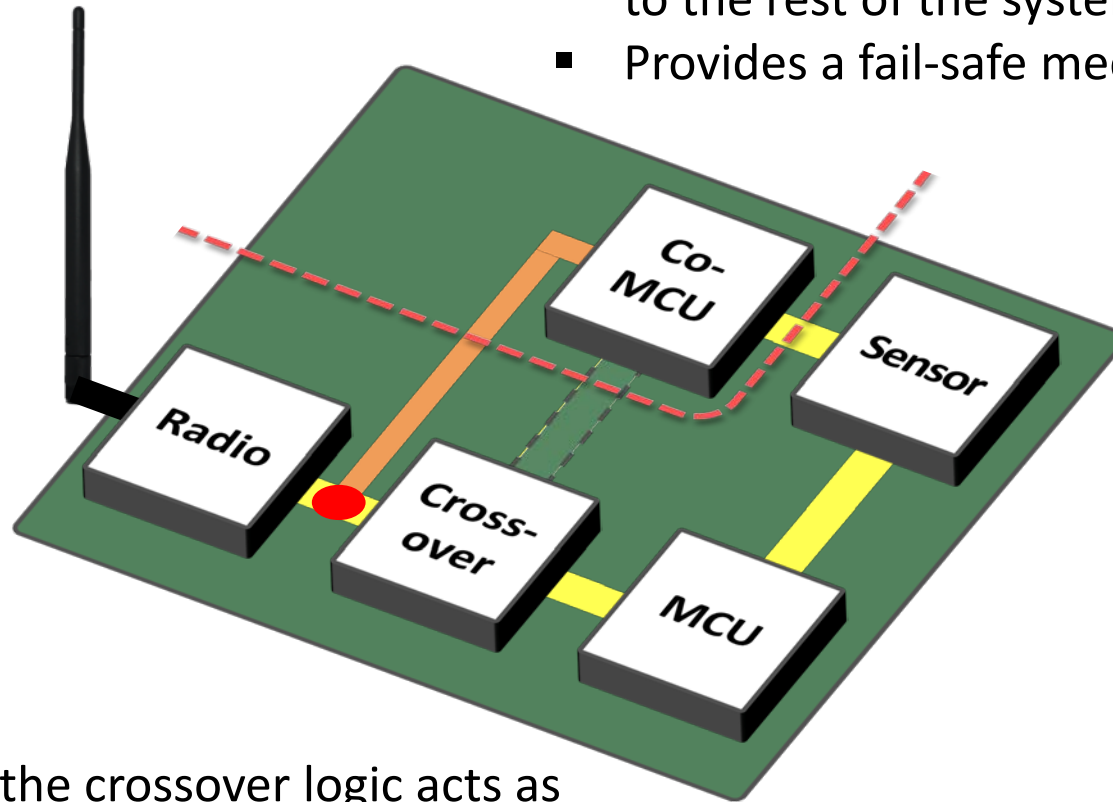
# SPI-SNOOPER Hardware Architecture



- Crossover logic settings determine if the circuit operates in **passive monitoring mode** or **active control mode**

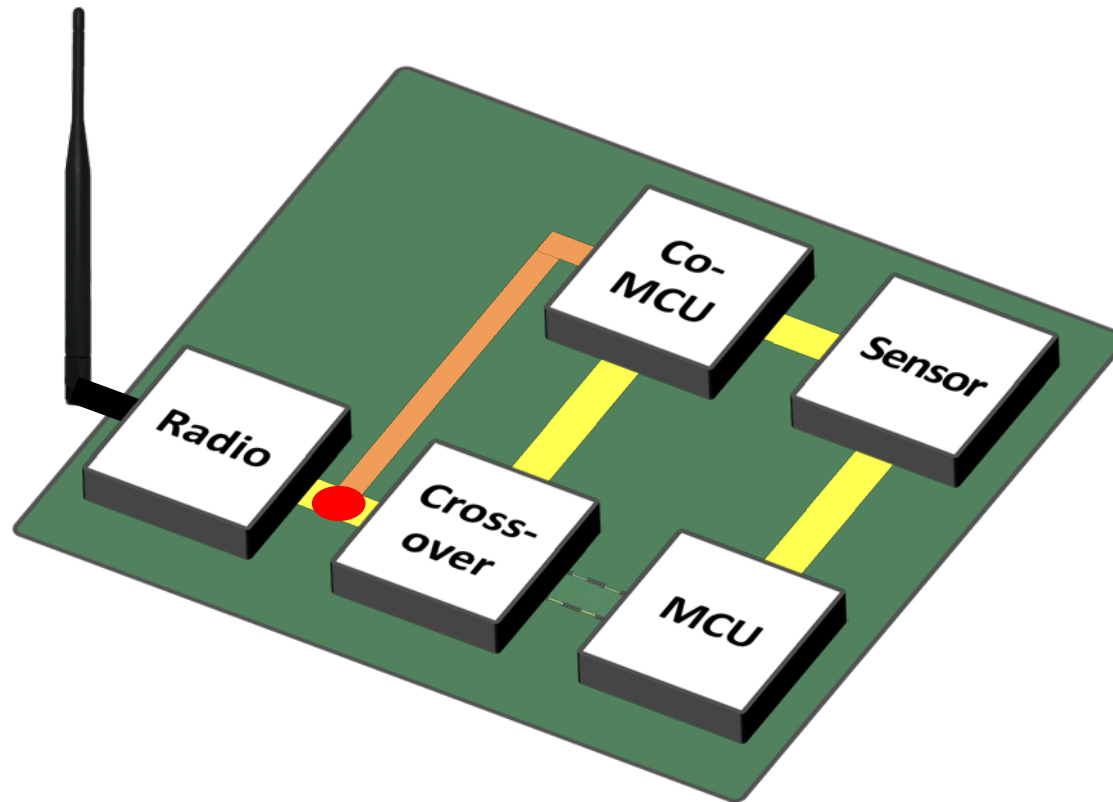
# Mode of Operation – Passive Monitoring

- Co-MCU is architecturally transparent to the rest of the system
- Provides a fail-safe mechanism



- By default, the crossover logic acts as pass through and connects the radio to the main MCU

# Mode of Operation – Active Controlling



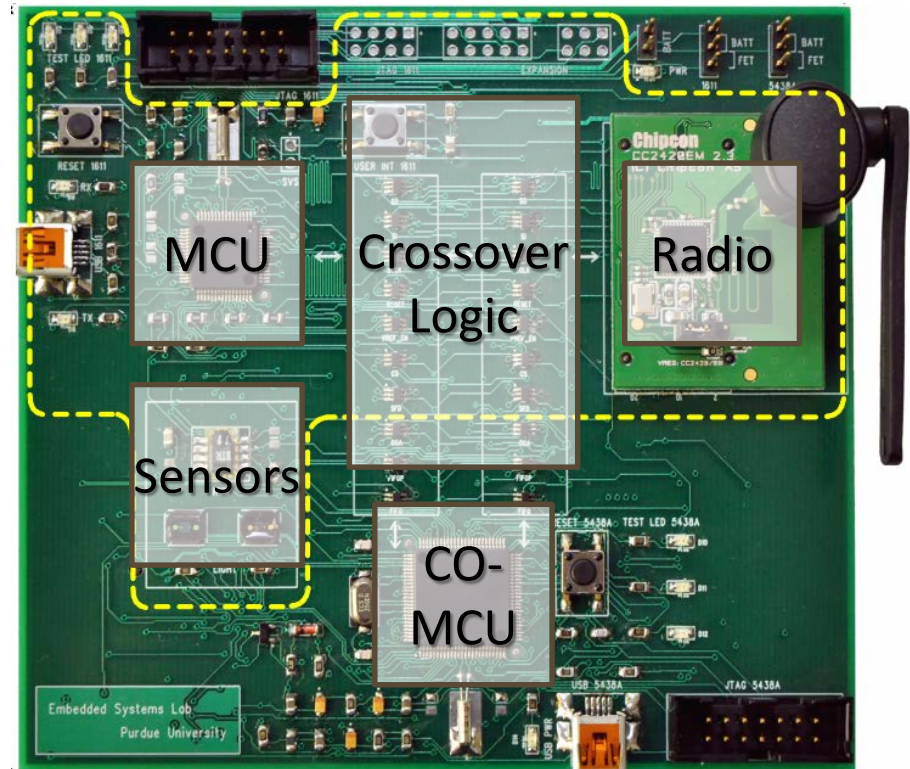
- If an anomaly is detected, main MCU is isolated from the bus
- Co-MCU is connected to the radio to take over control

# Implementation

- ▶ Based around a commonly-used sensor node design (TELOS)
- ▶ Suitably enhanced with the co-processor and crossover logic



TELOS



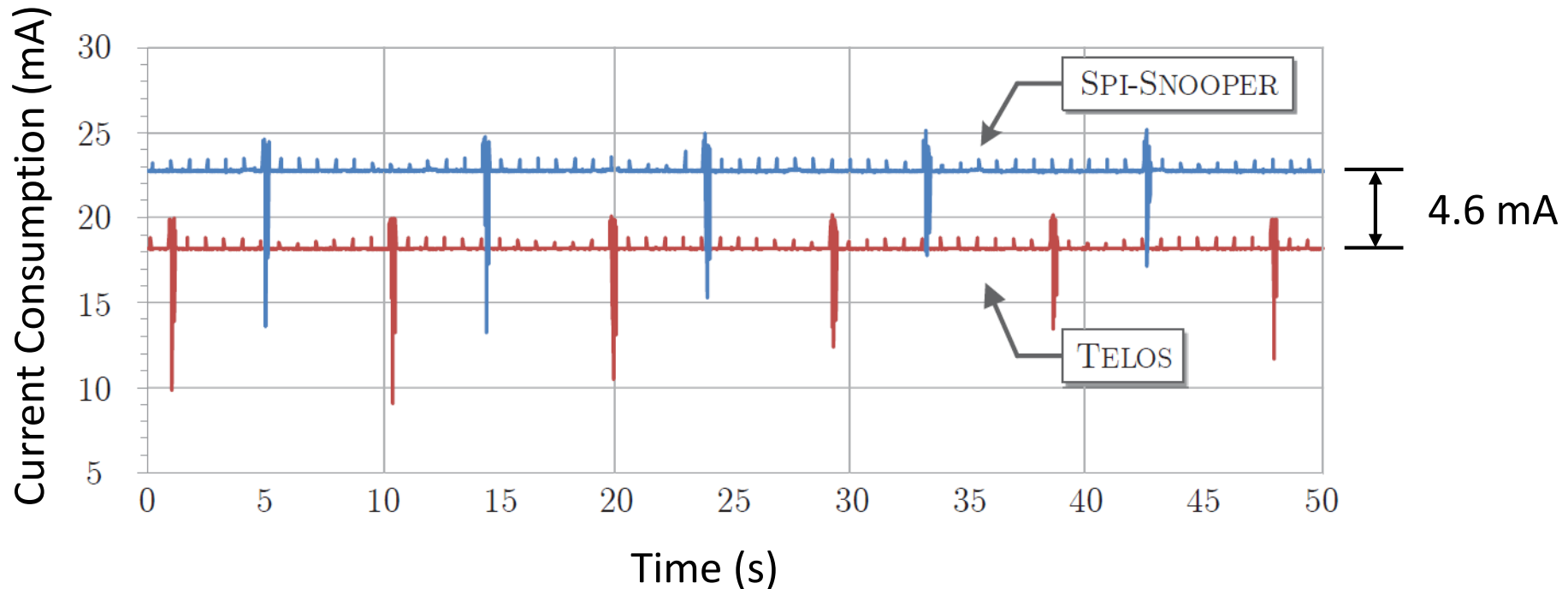
SPI-SNOOPER



# Power Consumption

## ► Experimental conditions

- Running the same application on each main MCU
- Measured maximum current for energy budget allocation
- Modern MCUs (2016 vs. 2012) have even lower power consumption and even better low-power modes



# Conclusion

- ▶ SPI-SNOOPER is the first wireless embedded system that incorporates a dedicated co-processor providing transparent network monitoring in wireless sensor networks
- ▶ SPI-SNOOPER supports a passive monitoring as well as an active controlling of device operations