Securely accessing remote sensors in critical infrastructures.

RESEARCH PROJECT 2
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The use of sensors

- Transportation
- Power grid networks
- Health sector
- Smart home
- Infrastructure monitoring

Various sectors where sensors are used. Source: Cisco IBSG, April 2011 Image
Critical Infrastructure

Monitor infrastructure environment
- Quality of Service
- Hardware failure
- Safety
- Maintenance

Challenges
- Often inaccessible
- Expensive on-site visit
- Time consuming to replace
Research question

Can Software Defined Networks (SDN) improve the redundancy and security of a sensor network in critical infrastructure?
Research question

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Devided in 3 subquestions:

◦ How SDN affects redundancy
Research question

Can Software Defined Networks (SDN) improve the redundancy and security of a sensor network in critical infrastructure?

Divided in 3 subquestions:

- How SDN affects redundancy
- How SDN affects scalability
Research question

Can Software Defined Networking (SDN) improve the redundancy and security of a sensor network in critical infrastructure?

Divided in 3 sub questions:
- How SDN affects redundancy
- How SDN affects scalability
- How SDN affects security
Background

Software Defined Networks
• Separation of control and data plane
• Centralized control
• Northbound and Southbound APIs

Background cont.

LoRa

• RF modulation technology
• Physical layer
• Long Range low power
• Fixed gateways
• Network server

The network server connects sensors, gateways and end-user applications and ensures reliable and secure data routing all along the LoRaWAN network. Retrieved from “https://www.actility.com/lorawan-network-server/”
Related Research

In 2014, Andrea Detti et al. published research with the benefits of an SDN-based implementation of a Wireless Mesh Networks (WMN)

• Arbitrary paths for data flows
• Improved traffic engineering algorithms

Source from research paper “Controller selection in a Wireless Mesh SDN under network partitioning and merging scenarios”
Related Research

In 2017, Zhiwei Zhang et al. proposed an Efficient Software-Defined Wireless Sensor Network architecture

• Stable and energy-efficient control plane
• Reduce the control overhead

Source from research paper “Software defined wireless sensor networks application opportunities for efficient network management: A survey”
Methodology

- Literature research
- Select the appropriate hardware
- Implement experiments in hardware
- Evaluation of results
Network control experiment

Network Function Virtualization
- DHCP
- NAT
- IDS

OpenVSwitch (OVS)

SDN Controller
- Faucet controller

LoRa Gateways
- Dragino Gateway
- Raspberry Pi with LoRa shield

The Things Network
Network control experiment

Centralized control, ACLs and QoS
- Fine-grained control of the sensor network
- Load balance flows
- Prioritize critical flows
Network control experiment

Controller failure
- Secondary takes over
- If both fail, work as regular switch
- Never lost connectivity to sensor network server
Network control experiment

Redundant sensor network server
• Load balance between sensor servers
• Automate behavior using northbound APIs
Network control experiment cont.

Individual Sensor Handling

- No control of individual sensors
- Deep packet inspection firewall
Switch failure experiment

Gateway or switch failure
- Deploy backup LoRa gateways
- Disable duplicate flows
- Enable if failure happens
Switch failure experiment
Summary

Redundancy
• Better control over the network
• Automated countermeasures using APIs
• Cost efficient hardware can lead to redundant topologies
• Prioritize critical flows

Scalability
• Network Function Virtualization
• Automated control though APIs
• Cost efficient hardware
Summary

Security

• Improved monitoring centralized alerts for events
• Access lists (ACLs)
• Easier configuration – less errors
Conclusion

Can SDN improve redundancy
Yes, due to better control and automated countermeasures

Can SDN improve scalability
Yes, using virtualized network functions and northbound API

Can SDN improve security
Probably yes, due to easier monitoring of the network

Can Software Defined Networks (SDN) improve the redundancy and security of a sensor network in critical infrastructure?
Yes
Future Research

Virtualized Network Functions
- Develop virtual functions aimed to sensor networks
- Individual sensor handling for LoRa sensors
  - Ways to control individual sensors on network level
Thank you for your attention!