

Context Aware Resource and Service Provisioning Management in Fog Computing Systems

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Introduction

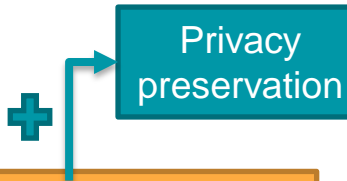
- Distributed processing/computing in the Internet of Things (IoT) domain
- Fog computing paradigm
- Node/link failure in distributed systems
- But, what happens when an important process fails and a decision cannot be made in time?

How is context informed resource management achieved?

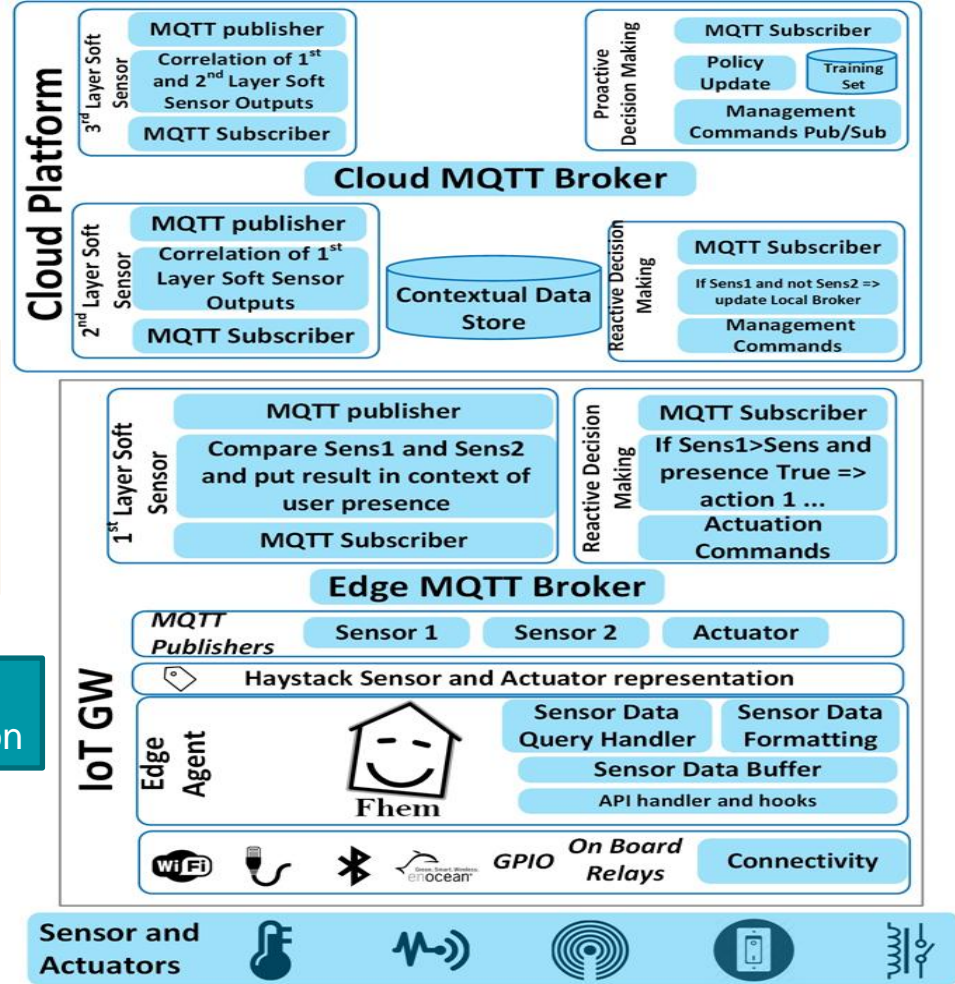


Three main features:

1. MQTT Publish Subscribe
2. Soft sensors
3. Context aware fog level topology disturbance detection and process handover mechanism



Adaptability to the changing context in the controlled IoT system through highly dynamic context informed decision making and resource management at the fog level.



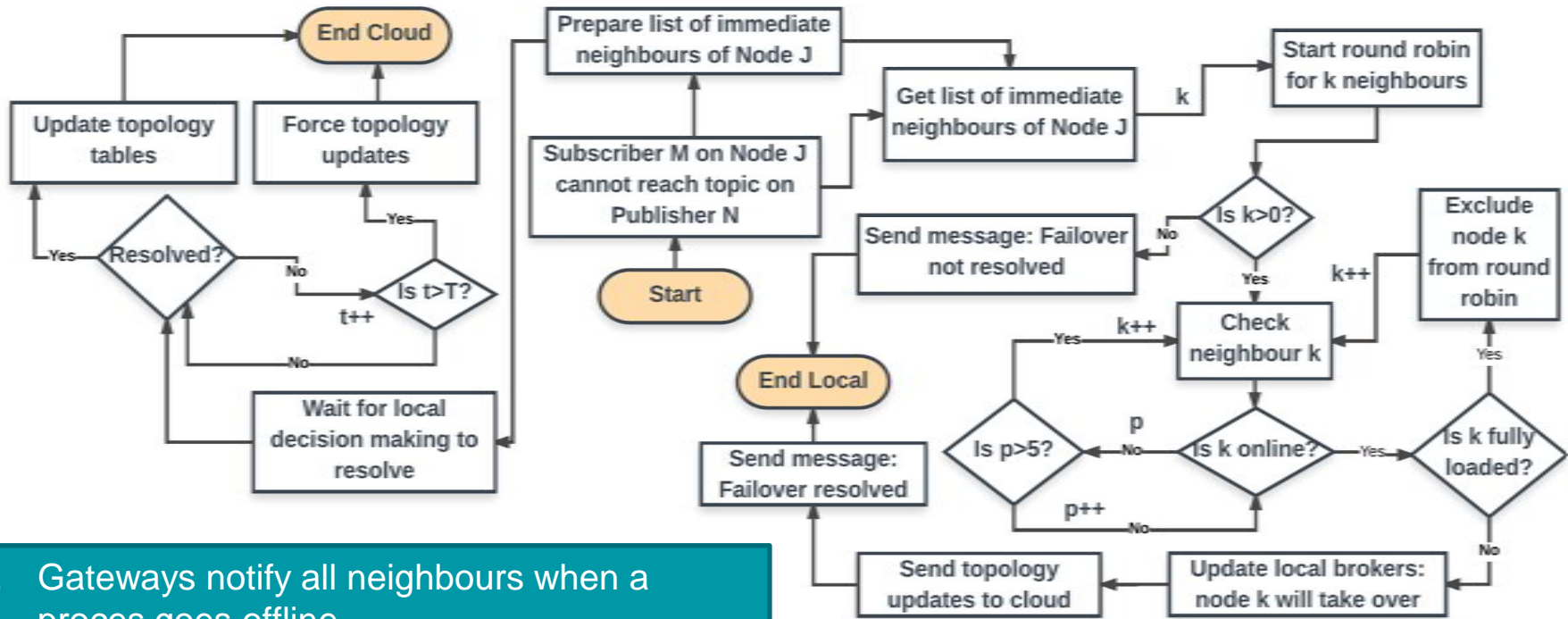
Three main features

1. MQTT is in charge of bridging IoT GWs and ensuring communication with the cloud broker. DA and DM processes from one IoT GW can access results and physical sensor readouts from another GW through the local network.
2. Soft sensors are hierarchically deployed which allows the creation of analytical chains where each step in the DA chain provides deeper insight into the context of the managed IoT system.
3. Topology disturbance detection and processes handover mechanism enables migration of DA and DM processes between IoT gateways.

Research hypothesis

- A software framework comprising hierarchically distributed MQTT brokers and DA (achieved through soft sensors) improves resilience and responsiveness of the fog computing system, while enabling specific privacy policies management.

Failover management and topology update mechanism



1. Gateways notify all neighbours when a proces goes offline
2. Upon handover gateways check for balanced workload

We argue that this software framework can be successfully utilized for:

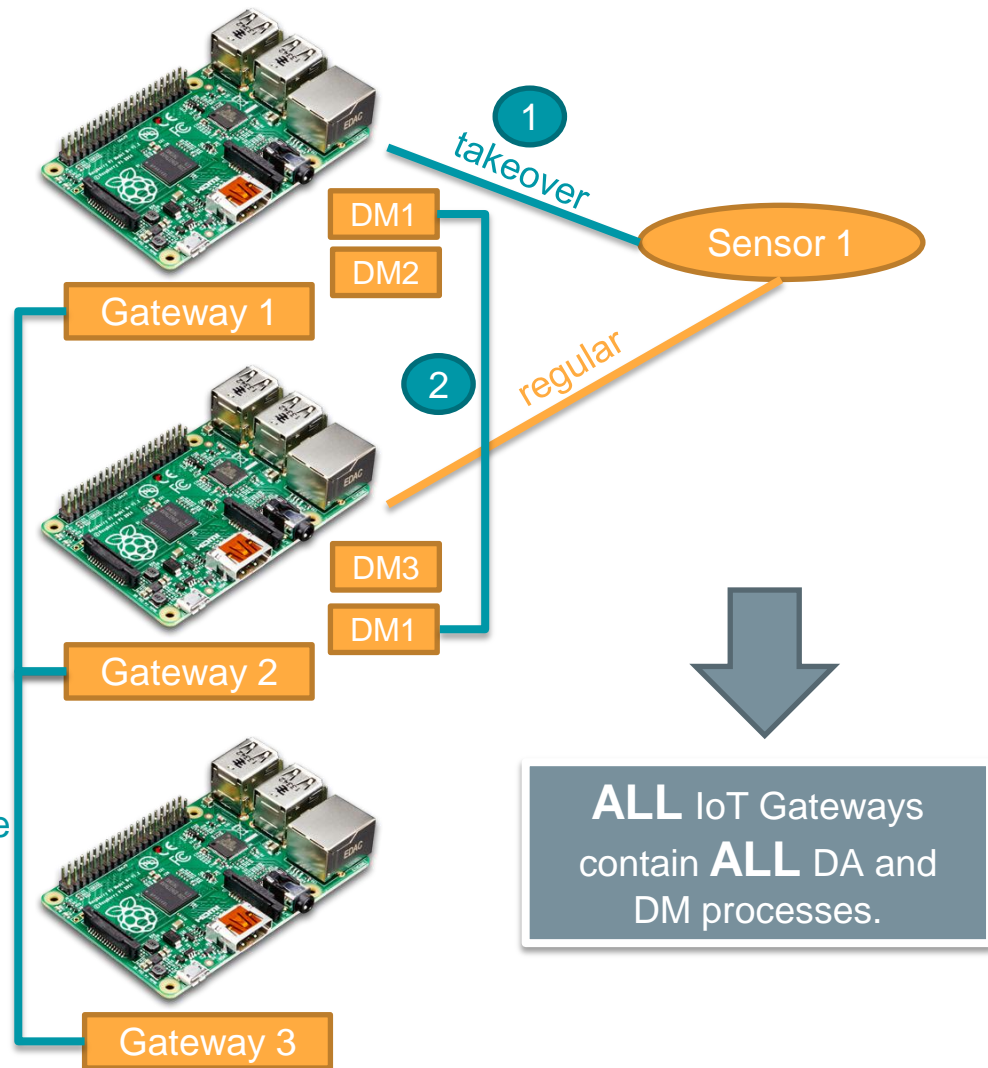
- Performing smart actuation and **context informed notification services** towards end users and administrators of the underlying system (i.e. smart building, smart home, etc.)
- **Enabling additivity** in the fog system itself through context informed failover and handover management

Experiments and results

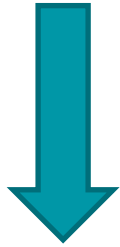
➤ Three features are validated

1. Ability of IoT GWs to take over data streams
2. Ability of IoT GWs to take over DA and DM processes
3. System capability to self maintain while ensuring privacy

3
If data is not reachable



Simulation



- 20 IoT Gateways with 50 DA and 50 DM processes
- Each Gateway operates 5 processes (maximum 10 processes)



- When 10 Gateways fail, the rest of the Gateways will take over all processes, providing **50% fault tolerance** to the system

20m coverage area

T1-T3 – EnOcean

Temperature sensors

C1-C3 – EnOcean Contact sensors

S1-S3 – EnOcean Switches

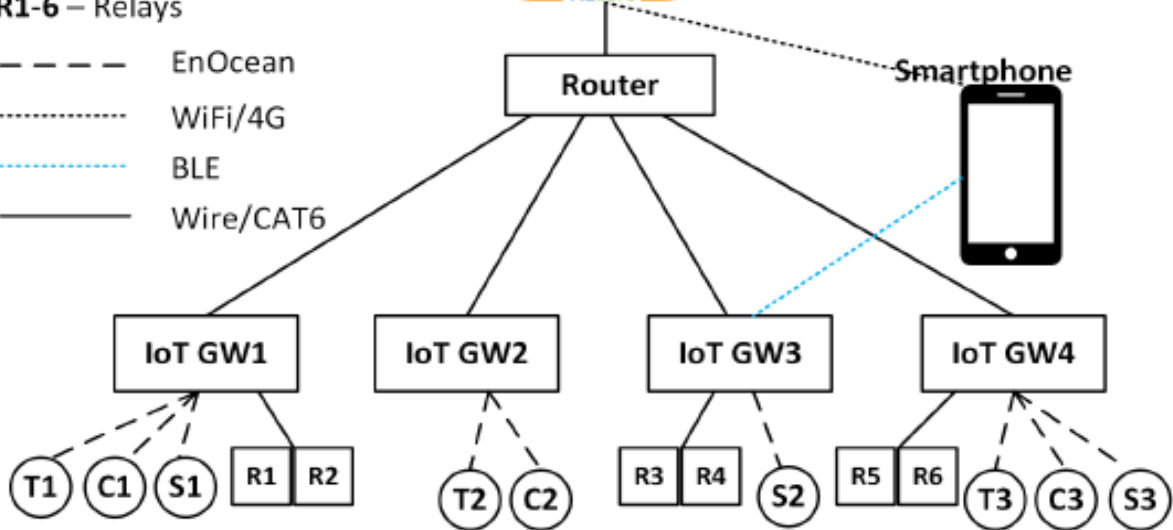
R1-6 – Relays

--- EnOcean

..... WiFi/4G

..... BLE

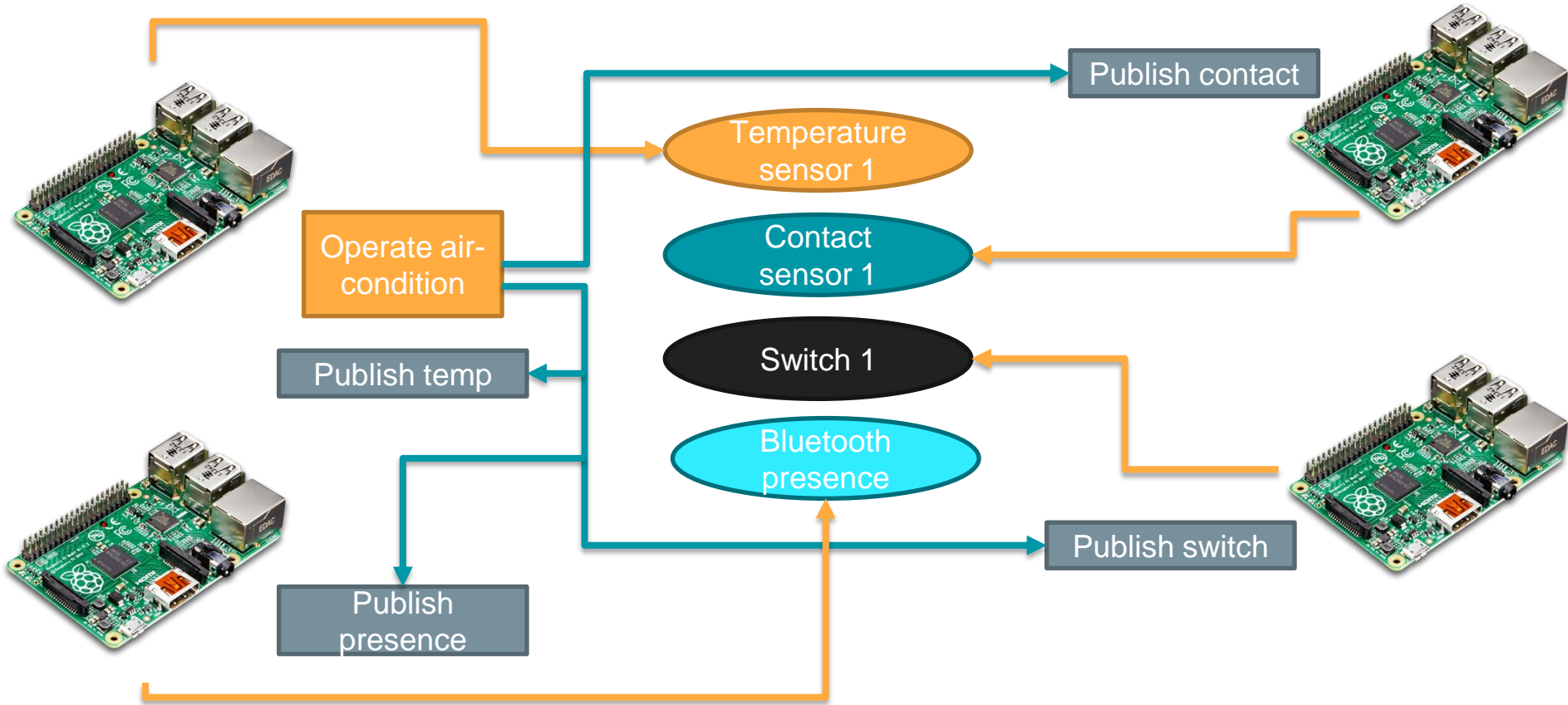
— Wire/CAT6



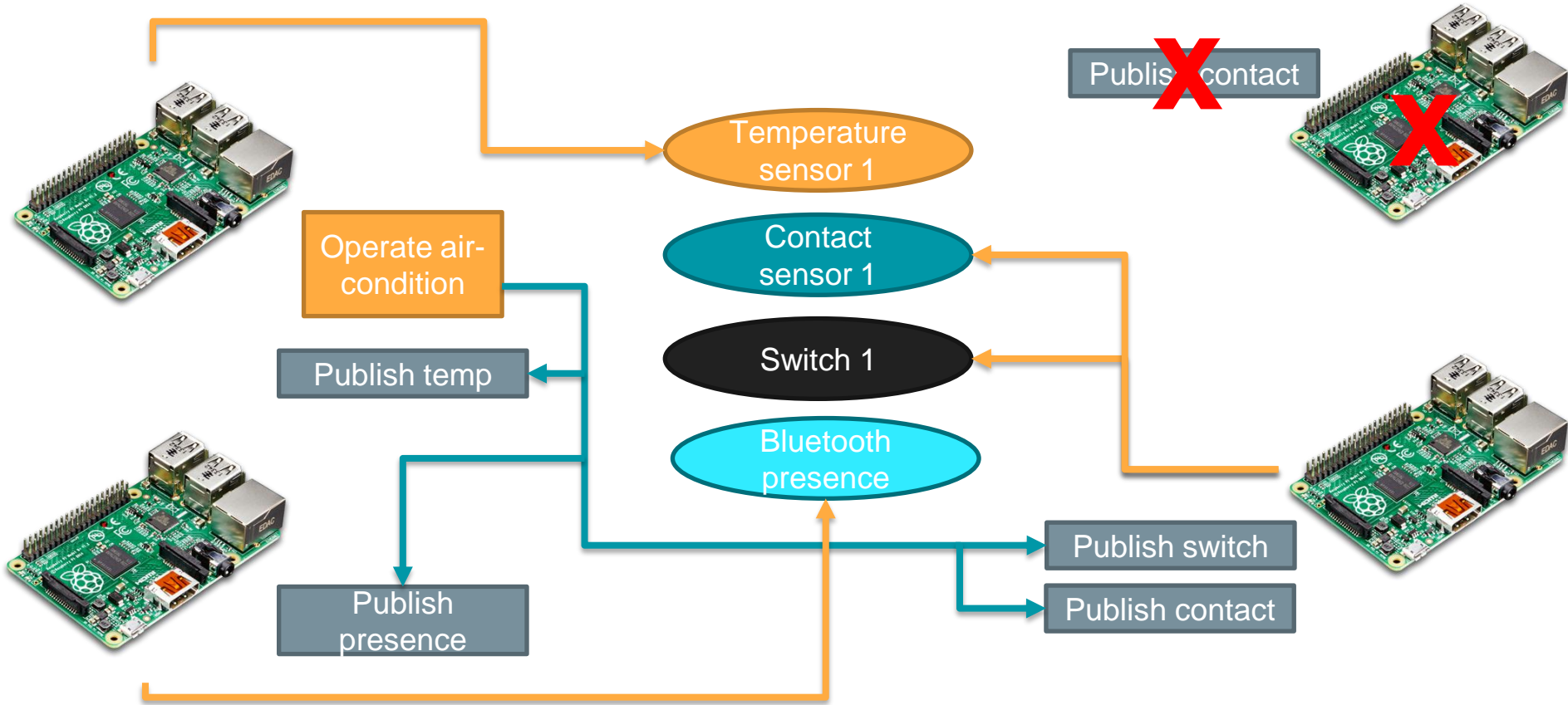
Experiments and results (cont'd)

Deployed fog computing testbed

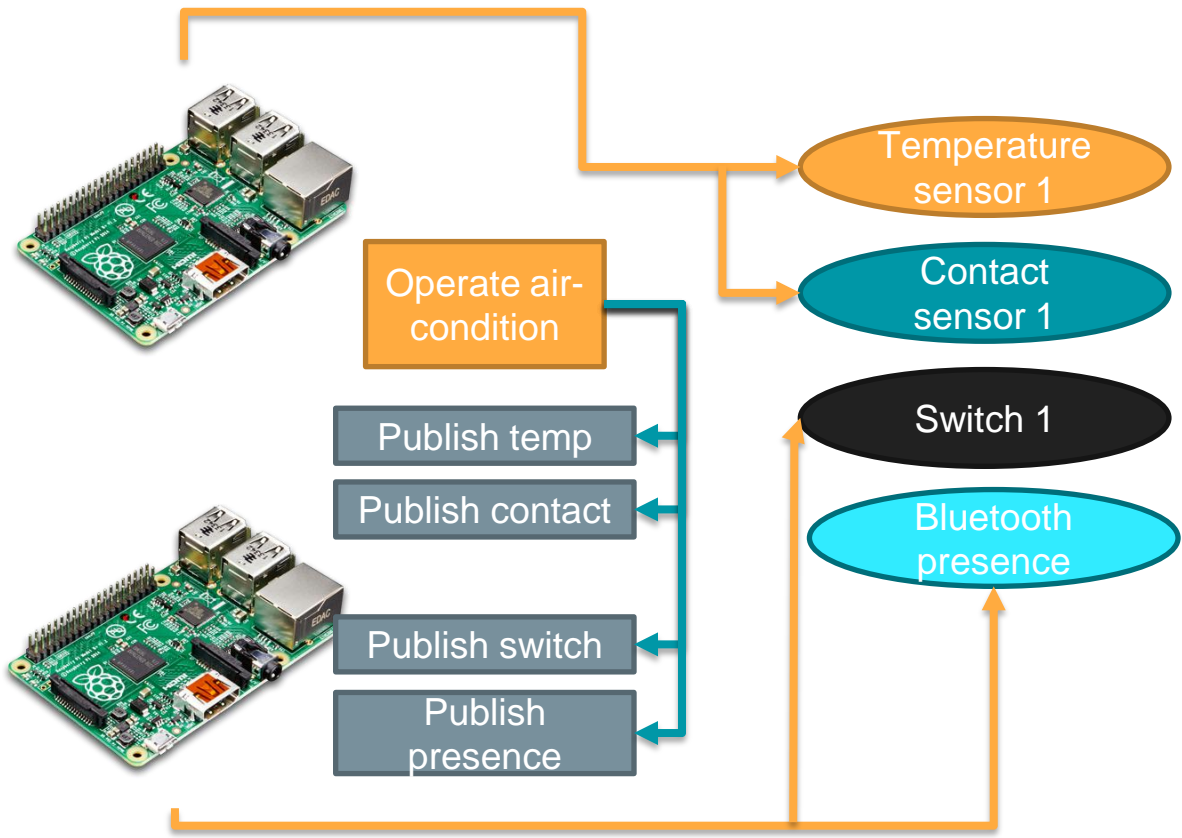
Processes and data streams handover



Processes and data streams handover



Processes and data streams handover



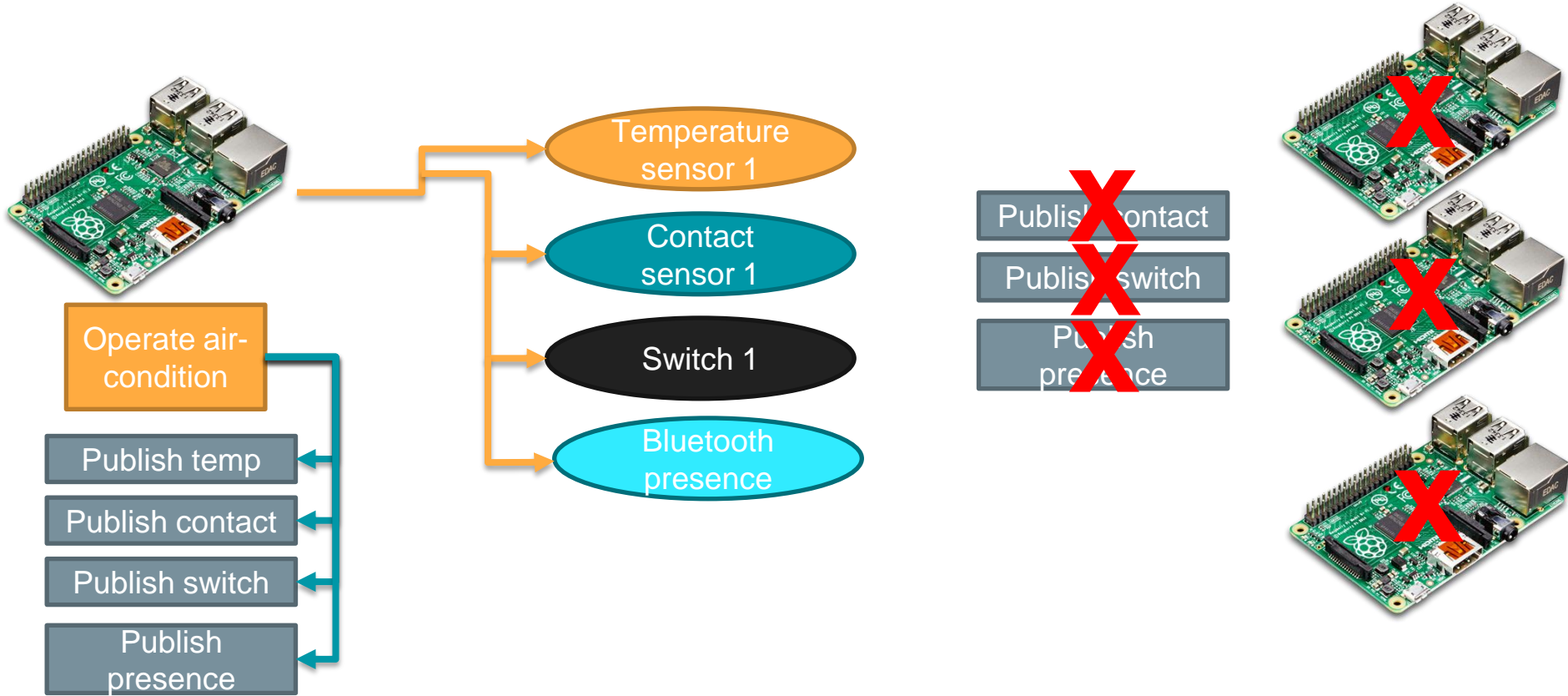
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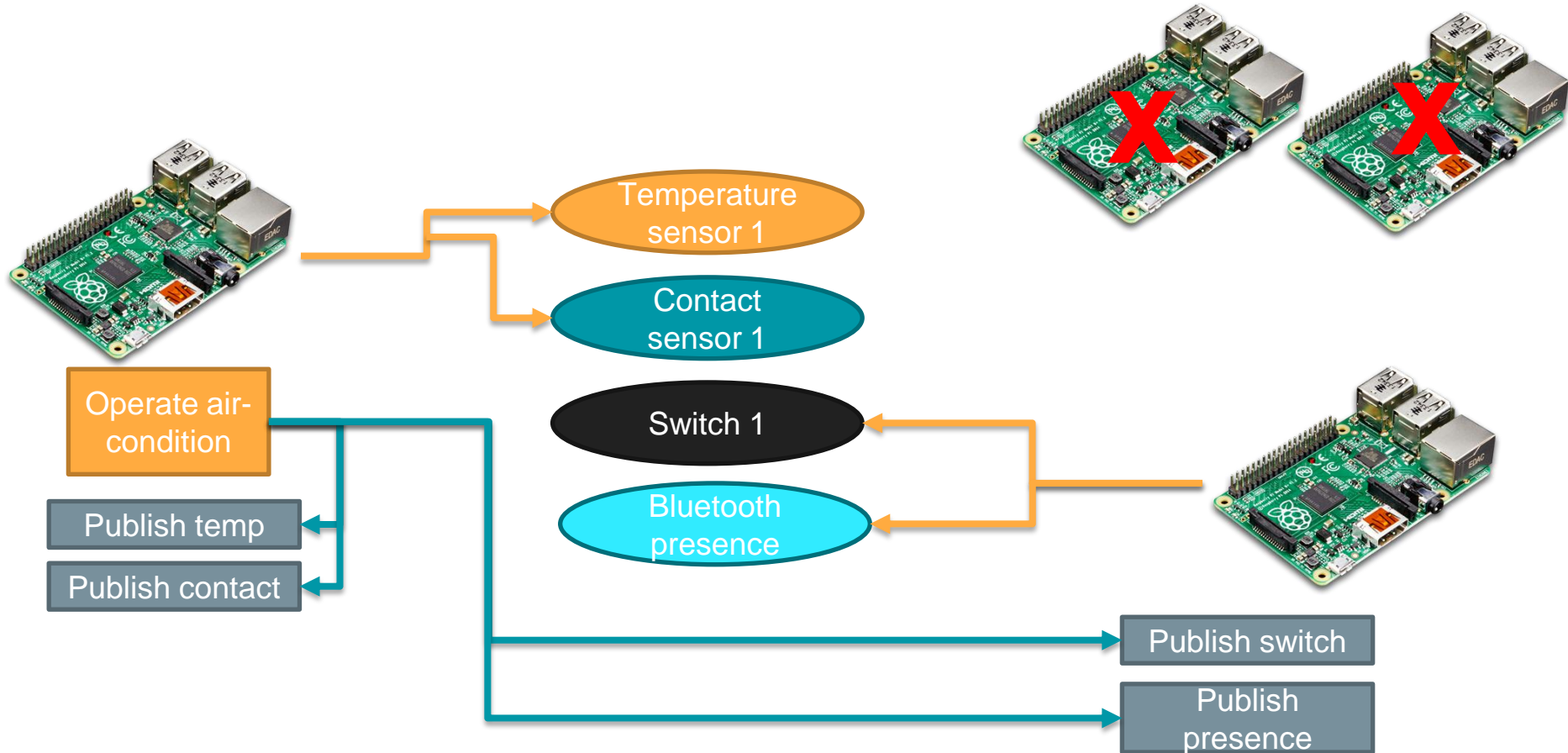
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Processes and data streams handover

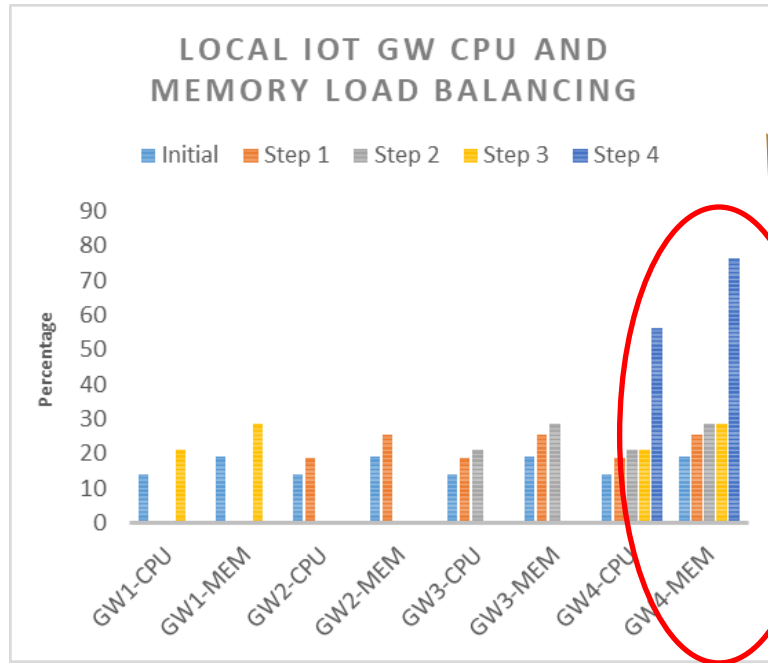
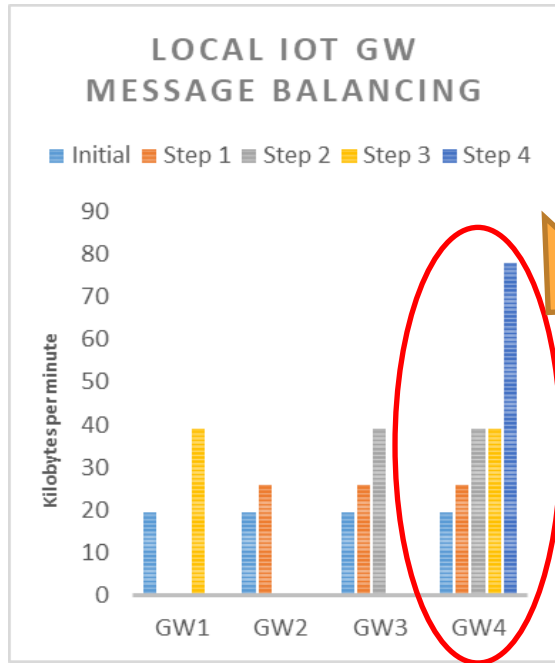


Processes and data streams handover



Experiments and results

- The deployed fog computing system is capable of withstanding failure of all but one IoT GW (75% redundancy).



Future work

- Bluetooth low energy based microlocation detection service
- Integrate cloud based management of fog computing topology and resource distribution with software defined networking (SDN) controllers and OpenFlow enabled switches

Conclusion

- Framework for management of resources and service provisioning
- Context informed failover and handover management between IoT GWs
- Adapting to topology changes and performing timely failover and handover
- Use case upgradeable fog computing platform

Thank you.