# Fog Computing for Sustainable Smart Cities : A Survey

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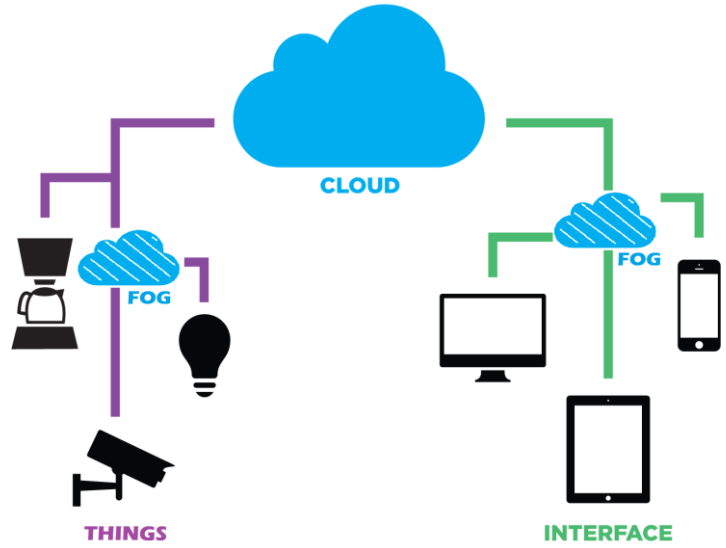
# Outline

- Fog Computing : Overview
- Smart Cities: Scenario
- Fog Computing : Features
- Future Direction
- Conclusion

# Fog Computing

- Edge Analytic
- Differences between Cloud and Fog
  - Store data to the near edge
  - Use local network
  - Process data at the edge devices
  - Edge devices : self-governed, managed, control



# Fog Computing

higher computation capabilities

Less computation capabilities

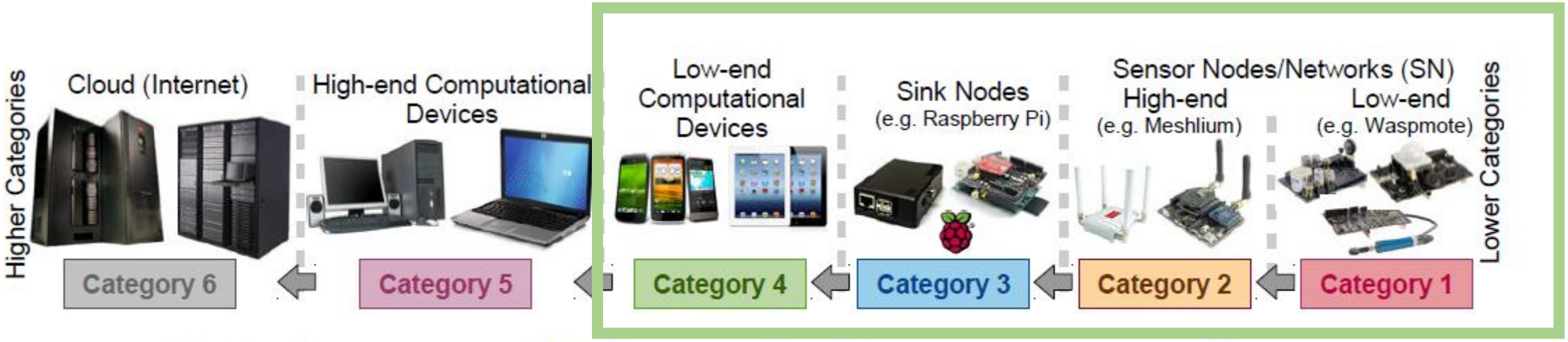



Fig. 1. Categorizations of IoT devices based on their computational capabilities.

# Fog Computing

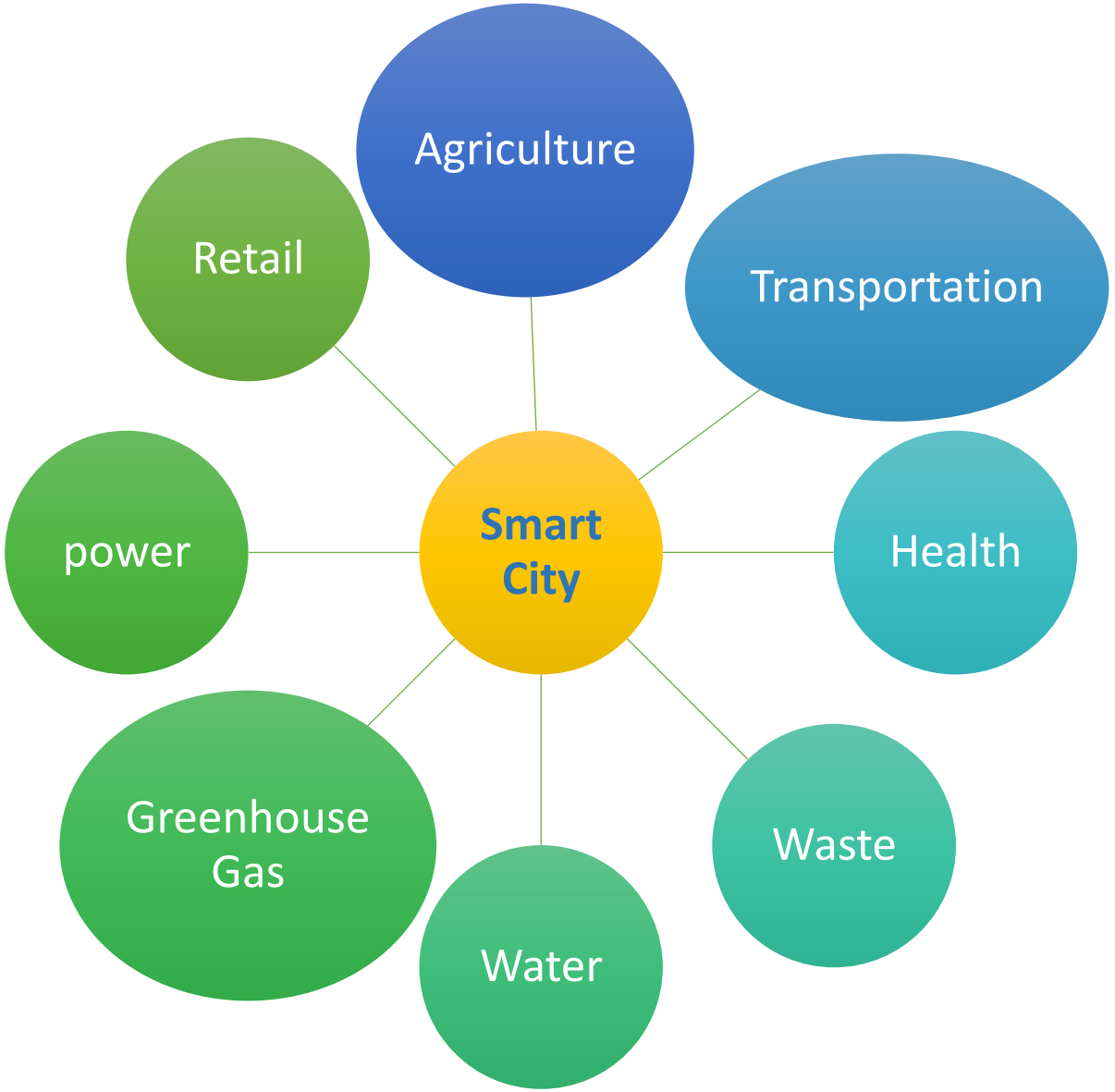
## Advantages

- Low latency
- Higher Availability
- Make big data smaller

## Challenges

- Edge devices are less computationally capable
- Edge devices limits, energy

# Smart Cities



SCENARIOS

# Smart Agriculture

- sensors monitor the plant
- sense the field from sky
- field vehicles capture data on the plant growth

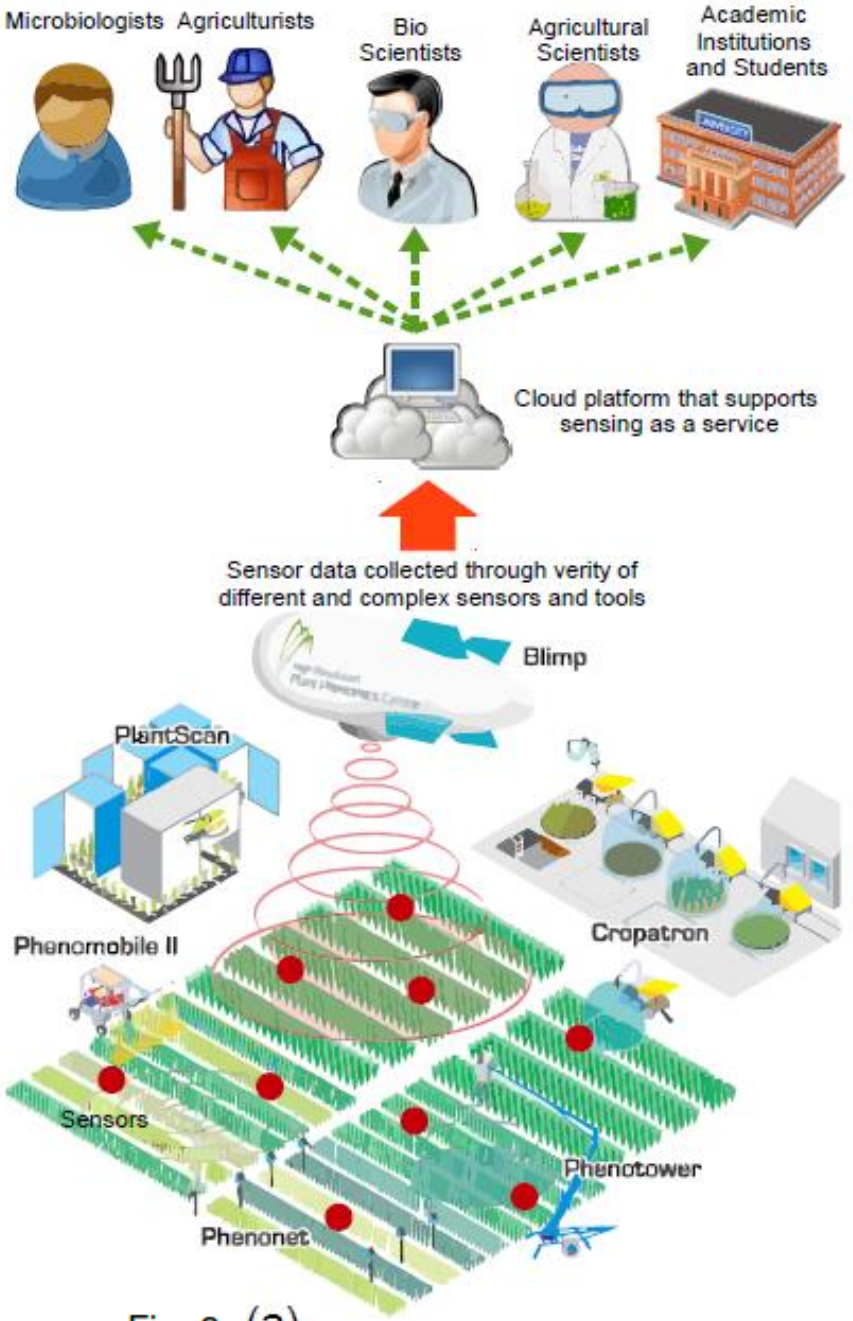



Fig. 2. (a)

SCENARIOS

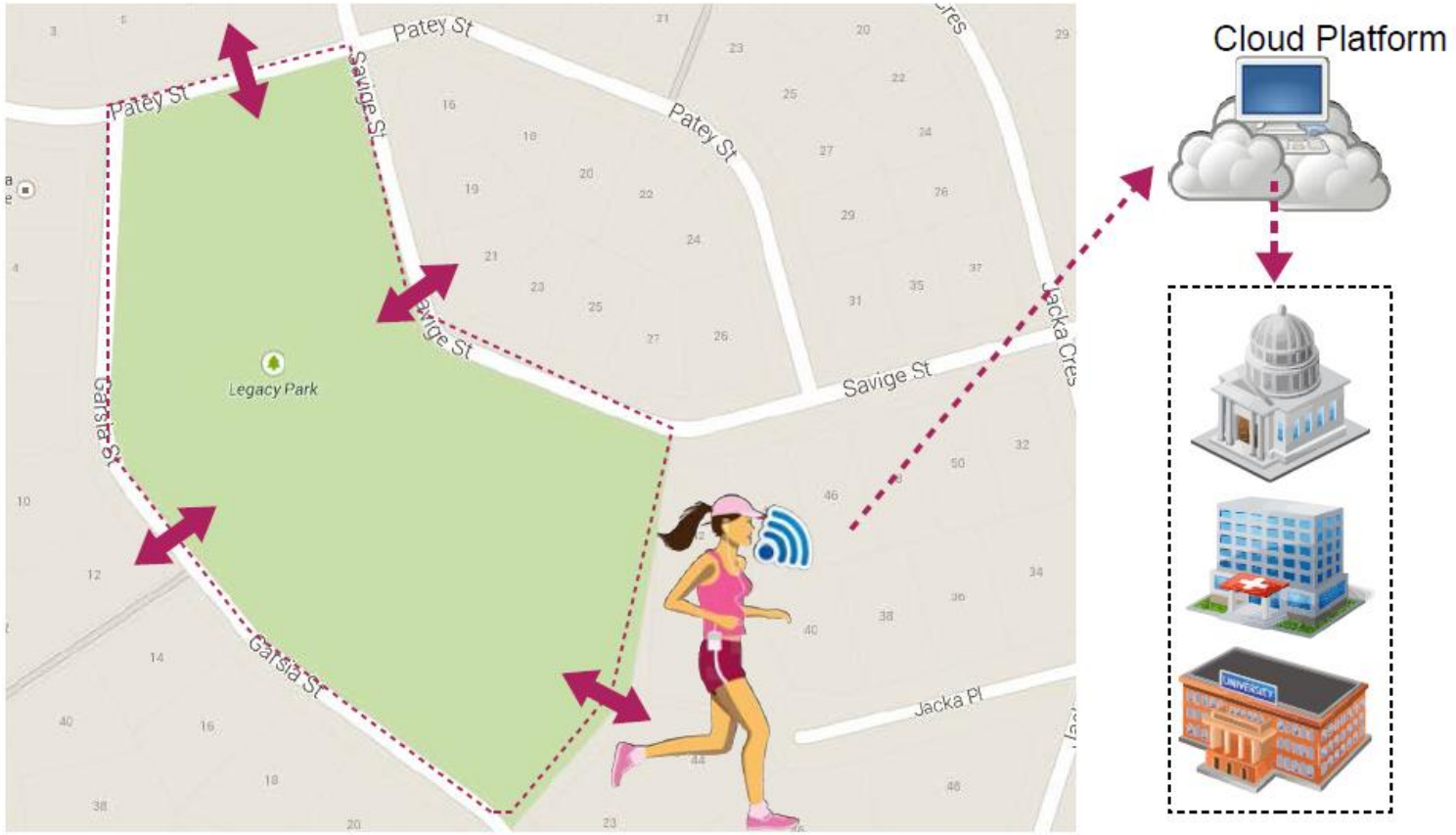
# Smart Transportation


- Air Pollution
- Collect when it is moving
- Real-time when raining

Fig. 2.(b)

SCENARIOS

# Smart Health and well-Being




- light-weight sensors with people
- only when moving and in the park area collect the data

Fig. 2.(c)

# Dynamic Discovery of Internet Object

- Major Challenges : heterogeneity, security, and dynamicity
-

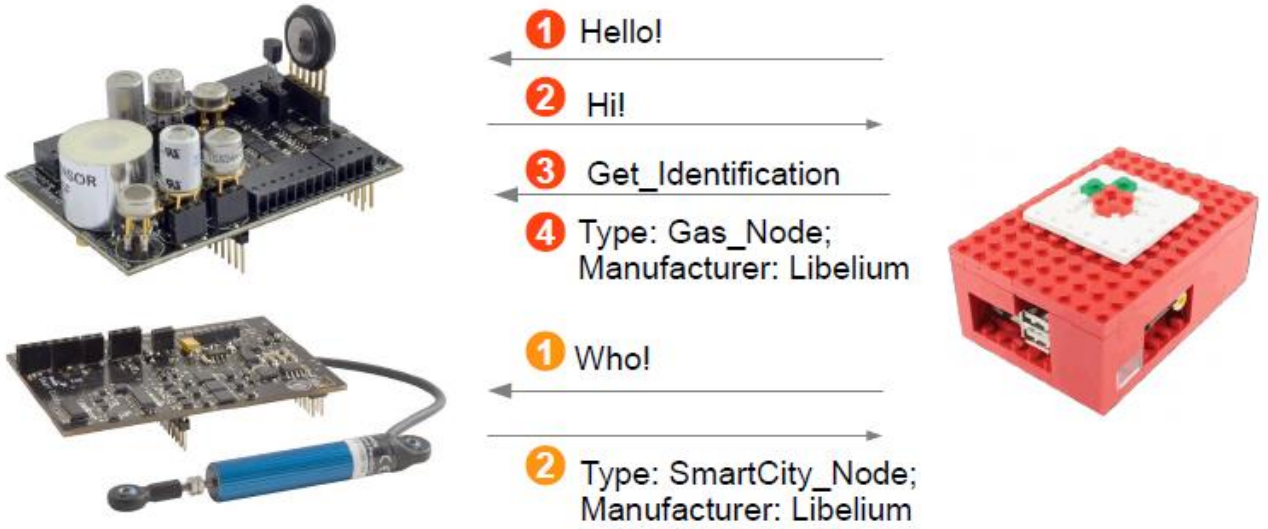



Fig. 10. Heterogeneity in terms of communication sequences.

# Dynamic Configuration and Device Management

- Data be capture by using 2 methods :
  - Base on Frequency : instant events & interval events

FEATURES

# Dynamic Configuration and Device Management

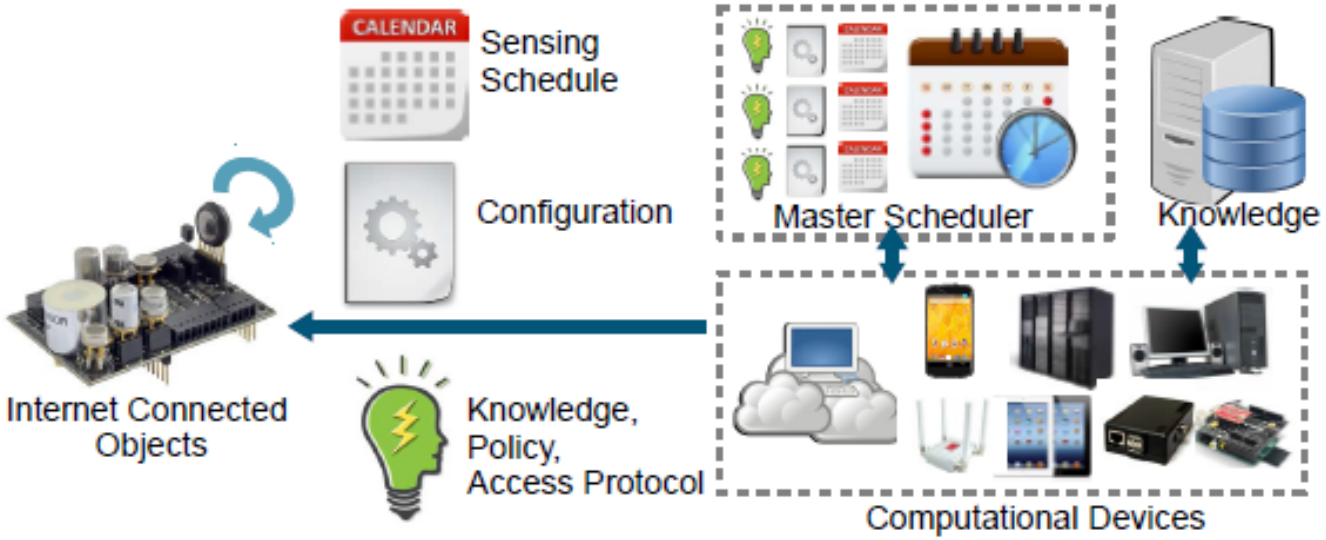
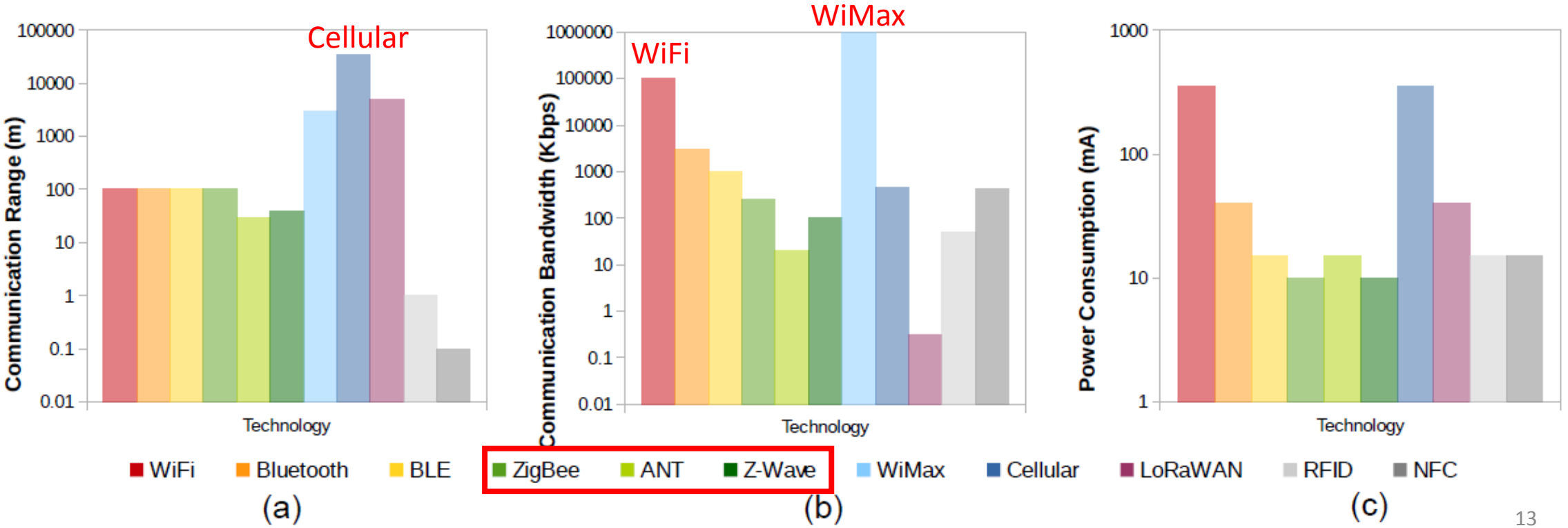



Fig. 14. Dynamic configuration ICOs and fog gateways based on context

# Multi-Protocol Support : Communication Level

- Comparison in communication range, bandwidth, power consumption



# Multi-Protocol Support : Application Level

Table I. Performance Comparison Between HTTP and MQTT [Dutta 2013]

| Characterisitcs | | 3G | | Wi-Fi | |
|---|---|---|---|---|---|
| | | HTTP | MQTT | HTTP | MQTT |
| Received Messages | Messages / Hour | 1,708 | 160,278 | 3,628 | 263,314 |
| | Percent Battery / Hour | 18.43% | 16.13% | 3.45% | 4.23% |
| | Percent Battery / Messages | 0.01709 | 0.00010 | 0.00095 | 0.00002 |
| | Messages Received | 240/1024 | 1024/1024 | 524/1024 | 1024/1024 |
| Send Messages | Messages / Hour | 1,926 | 21,685 | 5,229 | 23,184 |
| | Percent Battery / Hour | 18.796% | 17.806% | 5.446% | 3.66% |
| | Percent Battery / Messages | 0.00975 | 0.00082 | 0.00104 | 0.00016 |

The tests were done by sending and receiving 1024 messages of 1 byte each.

# Mobility

- highlight the importance of Dynamic Discover & Configuration

# General Data Considerations

- long-term value → send & store in the cloud
- short-term value → act immediately & being discarded

- Q: How reliable and current the data is?

# Context Discovery and Awareness

- Context Discovery

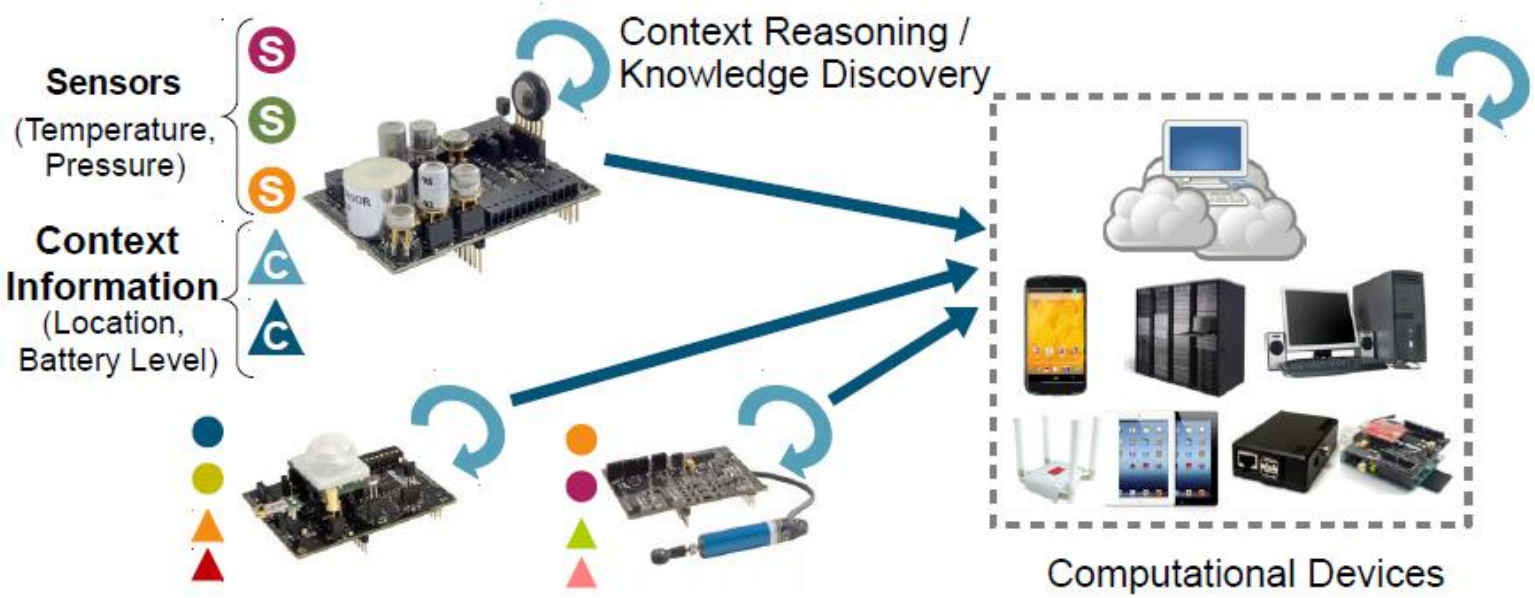



Fig. 18. Context Discovery

# Semantic Annotation

- using semantic metadata to annotation a given resource
- 3 types of Metadata
  - Structural
  - Descriptive
  - Administrative
- responsibility of semantic annotation could be assigned to fog gateway

# Future Direction

- Provide a framework that others can use it to test different approaches, techniques, and algorithms.
- Providing support for existing data analysis framework
- Let the plugins can be easily removed to avoid resource wastage when not required in a given fog gateway.

# Conclusion

- Have analysed and evaluated different types of fog computing and edge analytics research platform.
- Have discussed the major trends in this field.

# Q&A