SensorClone: A Framework for Harnessing Smart Devices with Virtual Sensors

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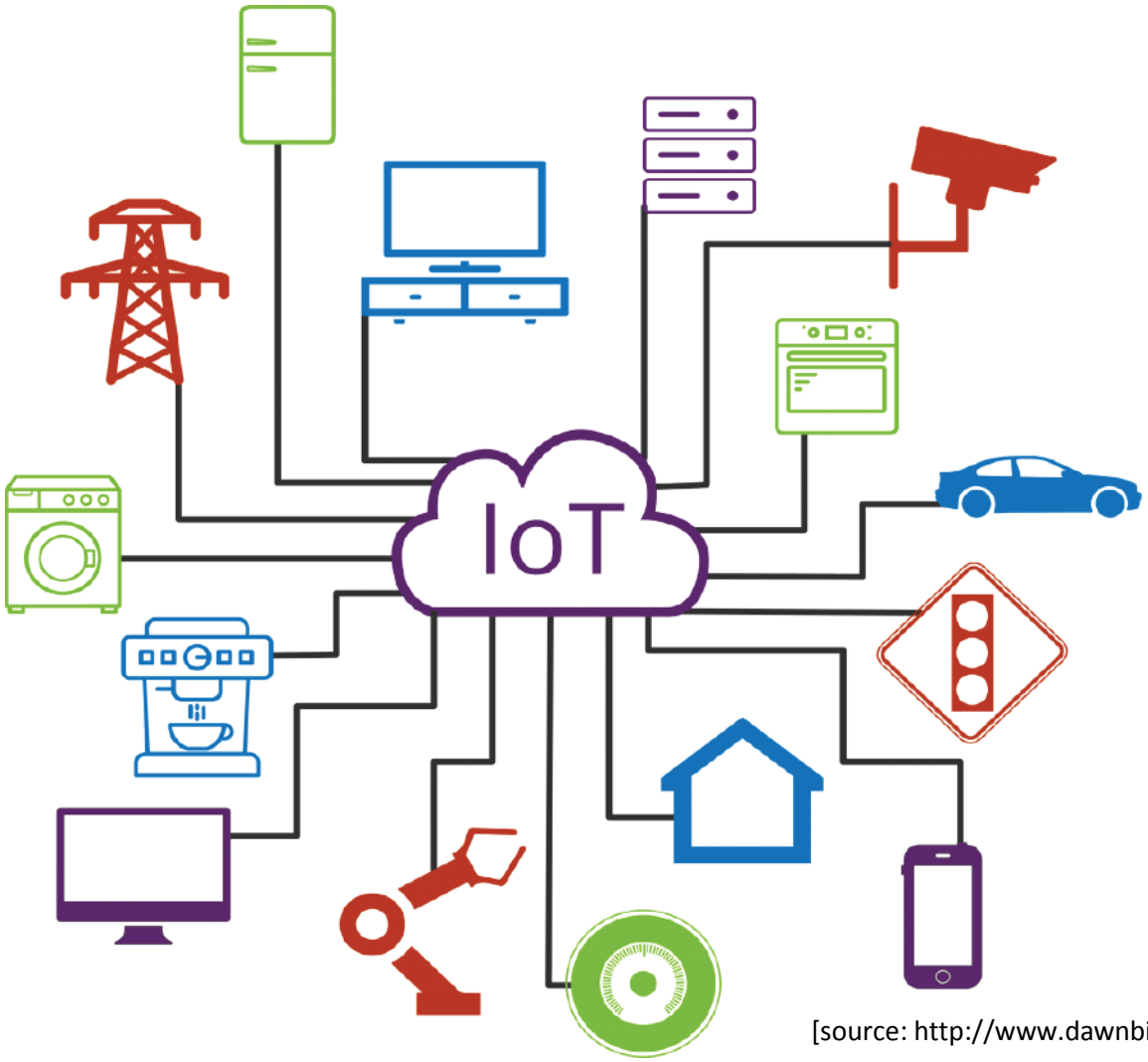
Roadmap

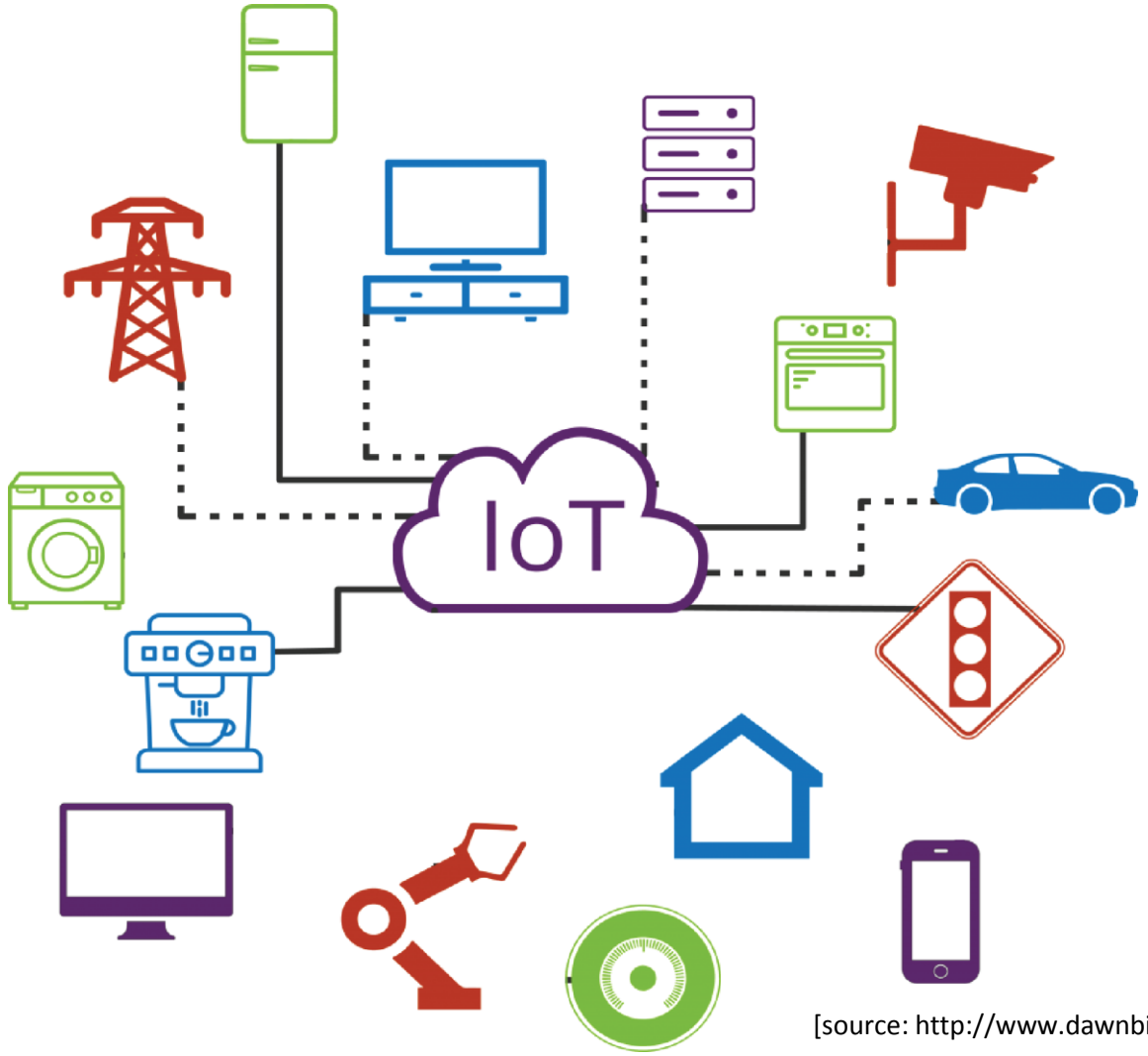
- Background
- Problem statement
- Motivation
- SensorClone
  - Virtual devices
- Experimental evaluation
- Conclusions

Background



[source: http://www.dawnbit.com/internet-of-things/]

Background



[source: http://www.dawnbit.com/internet-of-things/]

Problem

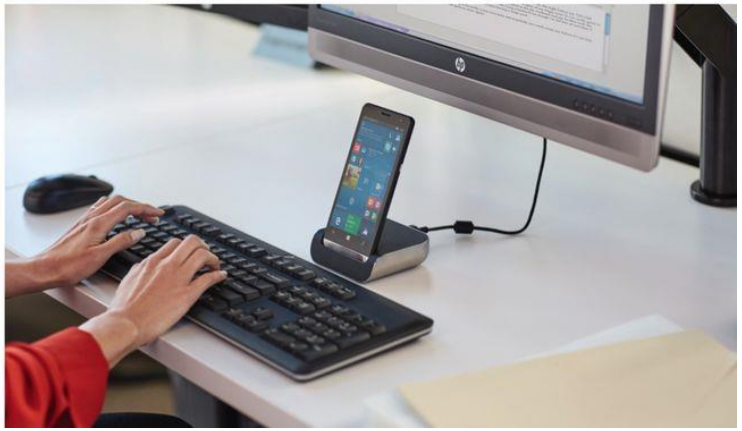
- Network breakdowns
  - Limited coverage
- Oscillating connectivity
  - Drastic high/low latencies
- Hardware failures
- Energy constraints
  - Battery is limited

Internet of disconnected-Things

Motivation: One step further

- Modeling behavior of devices
  - Digital twins
- Smart devices
  - Server in user's pocket

[source: https://www.ge.com/reports/colin-parris-the-data-economy-for-industry-has-arrived/]



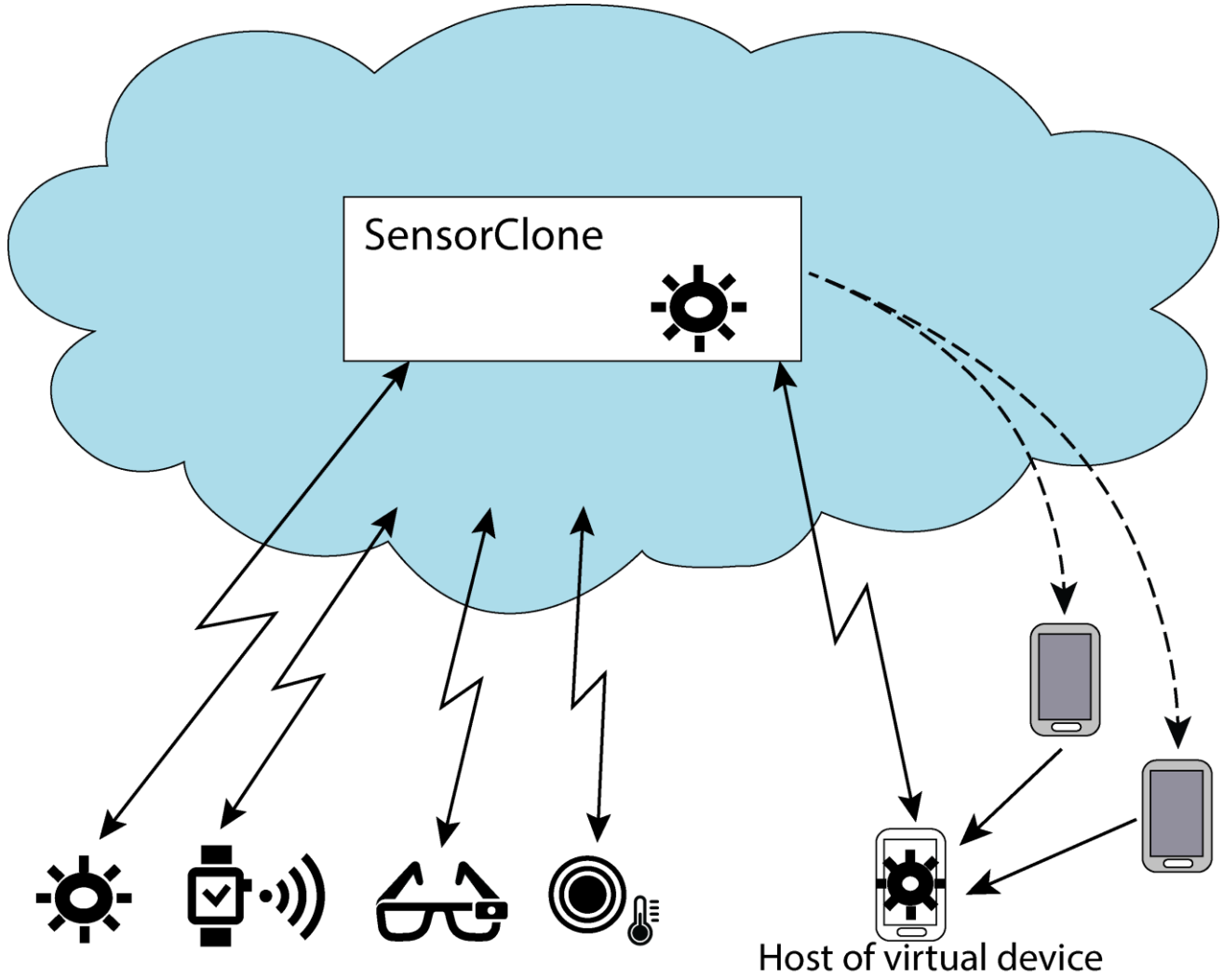
[source: https://www.mnn.com/green-tech/computers/blogs/your-next-computer-will-be-phone]

SENSORCLONE

SensorClone overview

- Virtual devices
  - IoT sensing devices (virtual sensor)
- Opportunistic migration
  - Virtual devices into smart devices

SensorClone overview

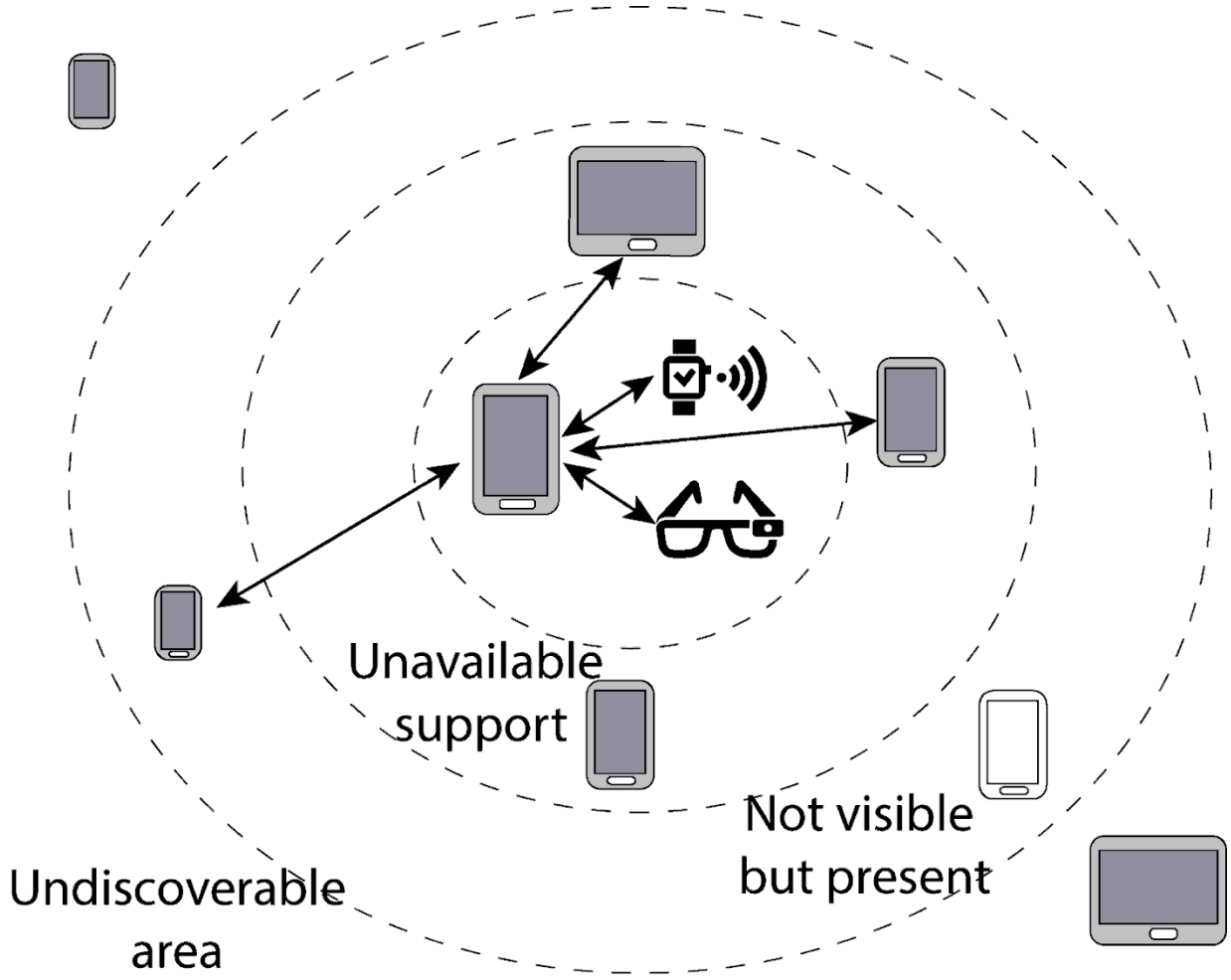


SensorClone benefits

- Reduce energy consumption of IoT devices
  - Duty cycling between physical and virtual devices
  - Minimize network dependency and failure of devices
- Improve scale uptake of IoT services
  - Edge proximity
  - Dense availability

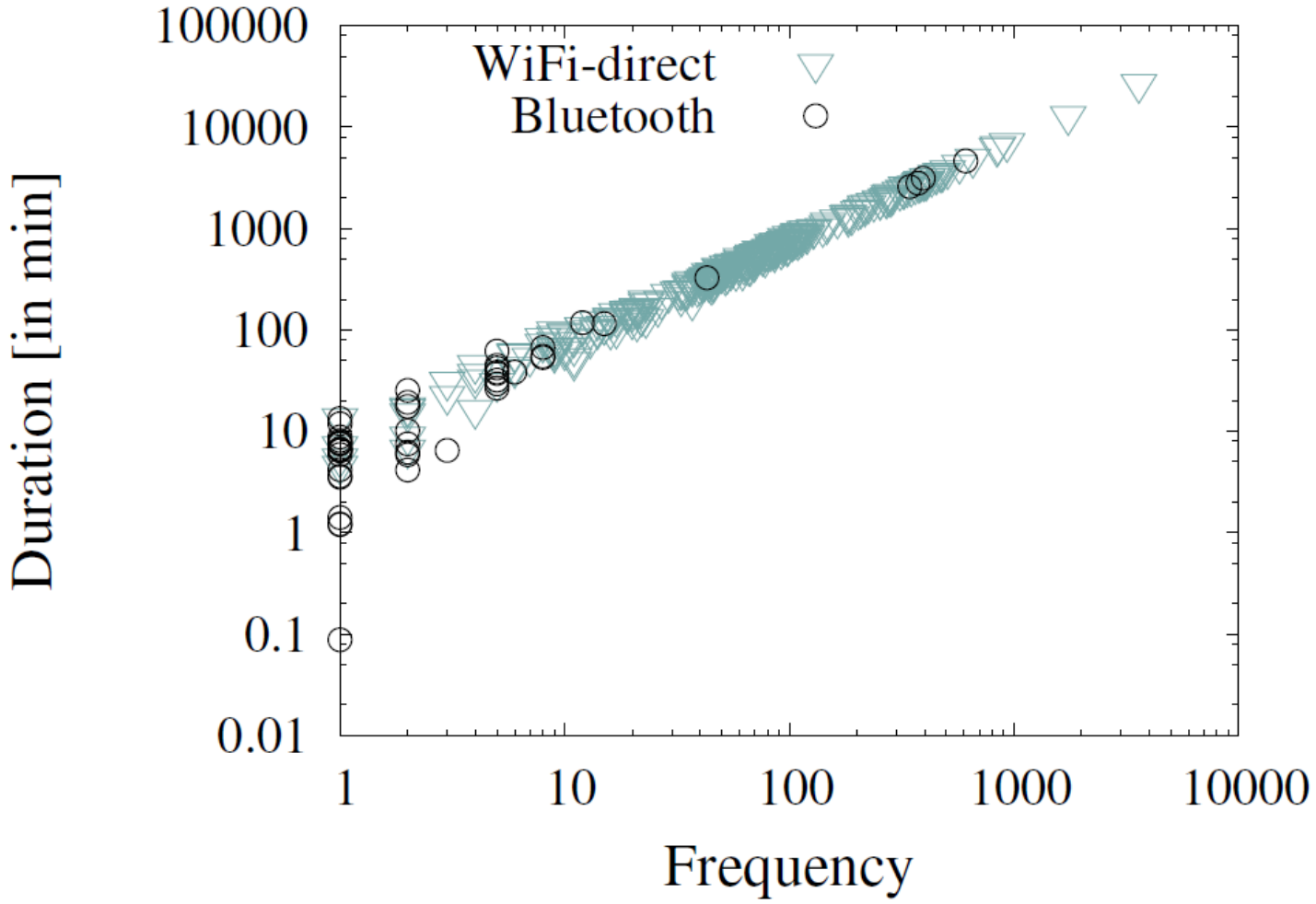
FEASIBILITY

Study

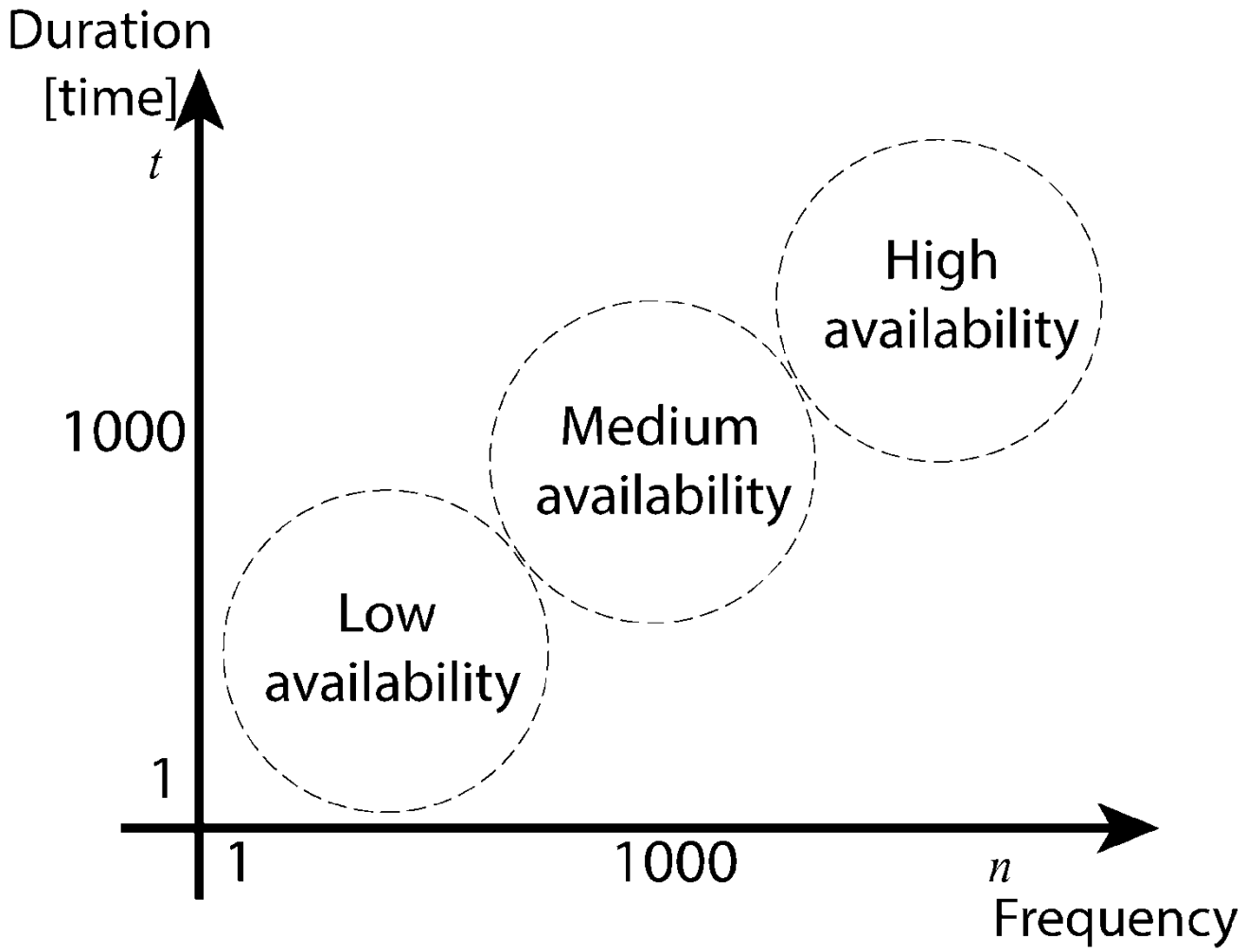


Flores, Huber, et al. **"Social-aware device-to-device communication: a contribution for edge and fog computing?."** *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*. ACM, 2016.

Study


WiFi-direct
Bluetooth
Duration [in min]
100000
10000
1000
100
10
1
0.1
0.01
1
10
100
1000
10000
Frequency

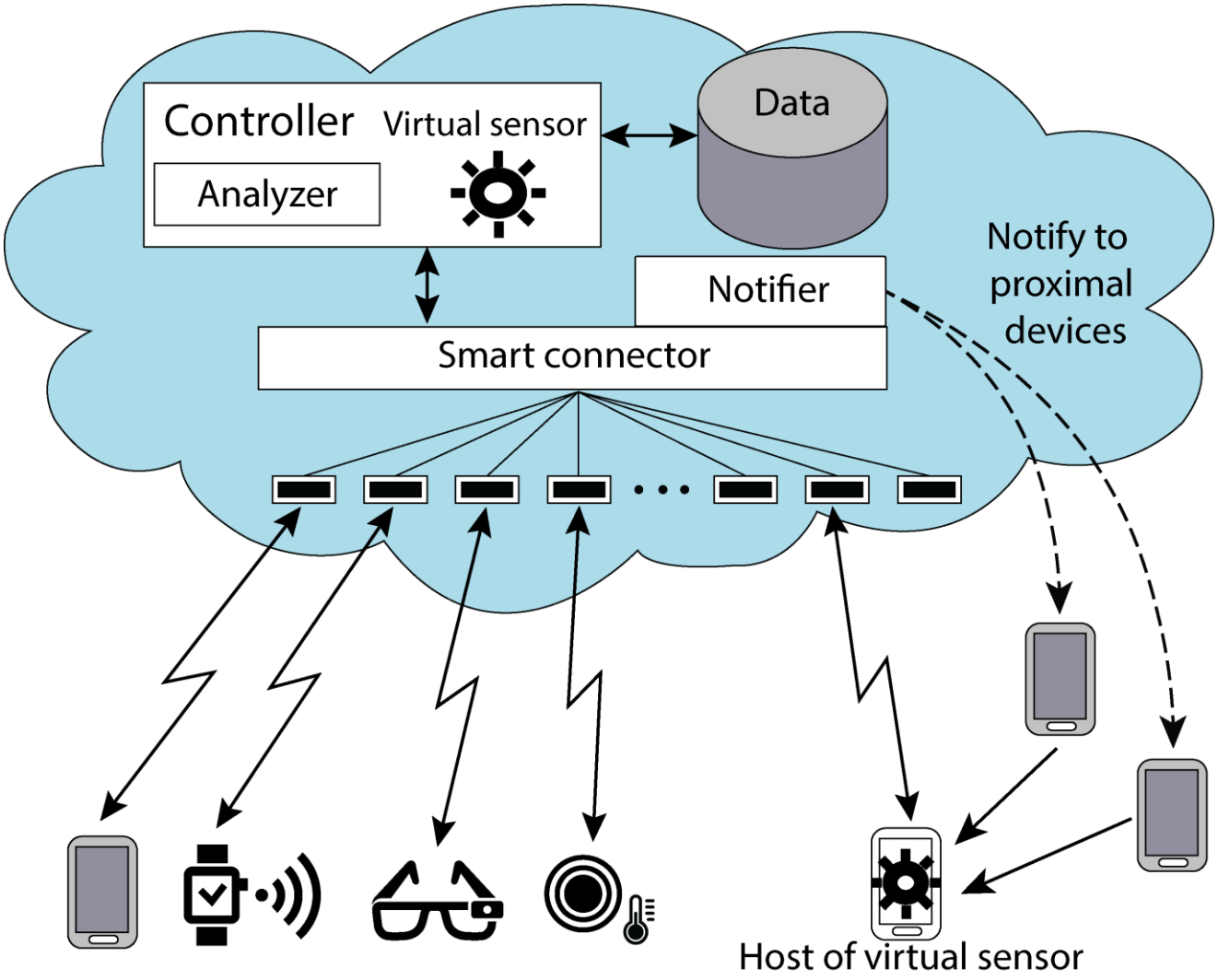
Study



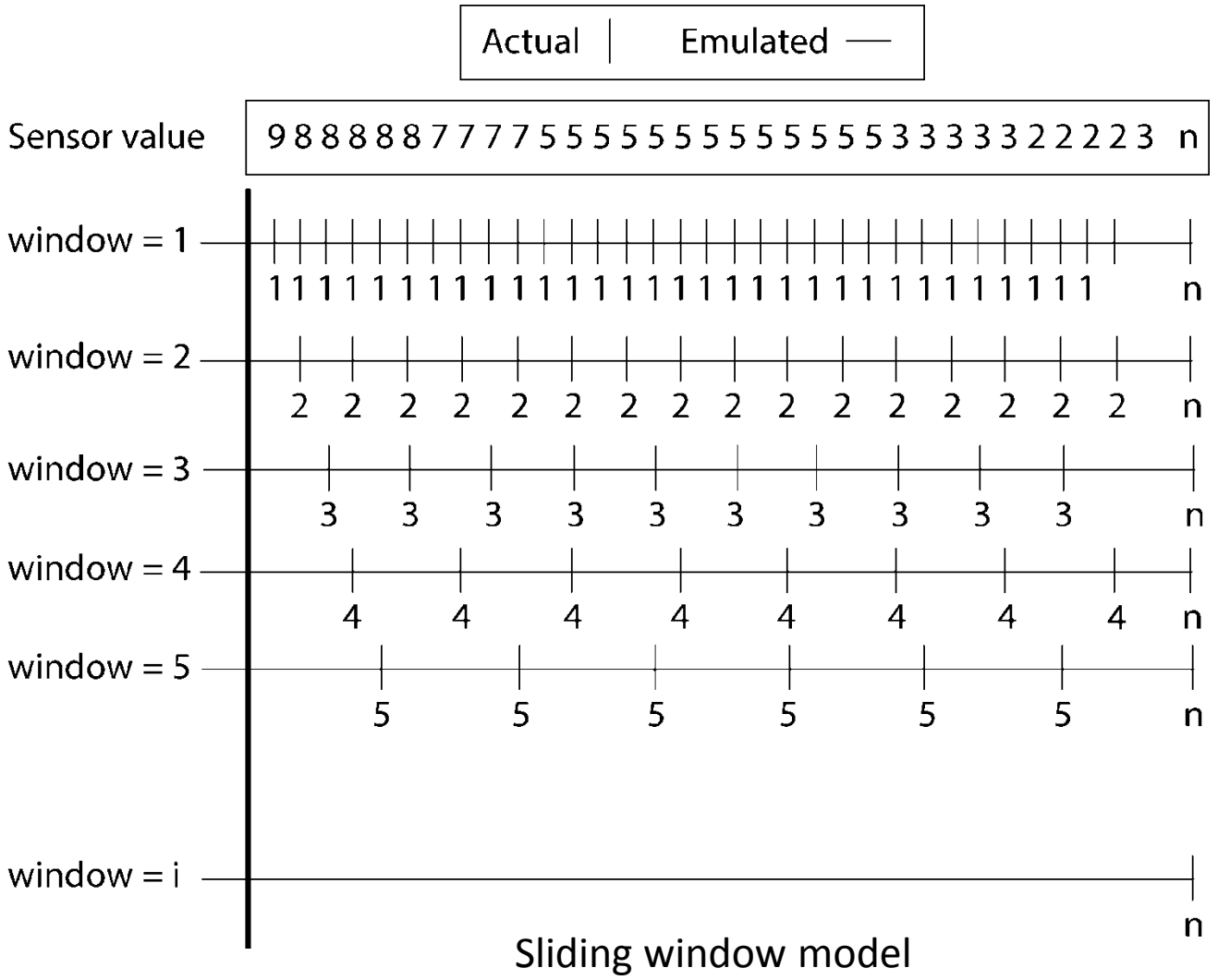
Flores, Huber, et al. **"Social-aware hybrid mobile offloading."** *Pervasive and Mobile Computing* 36 (2016): 25-43.

SENSORCLONE ARCHITECTURE

SensorClone



Virtual sensor

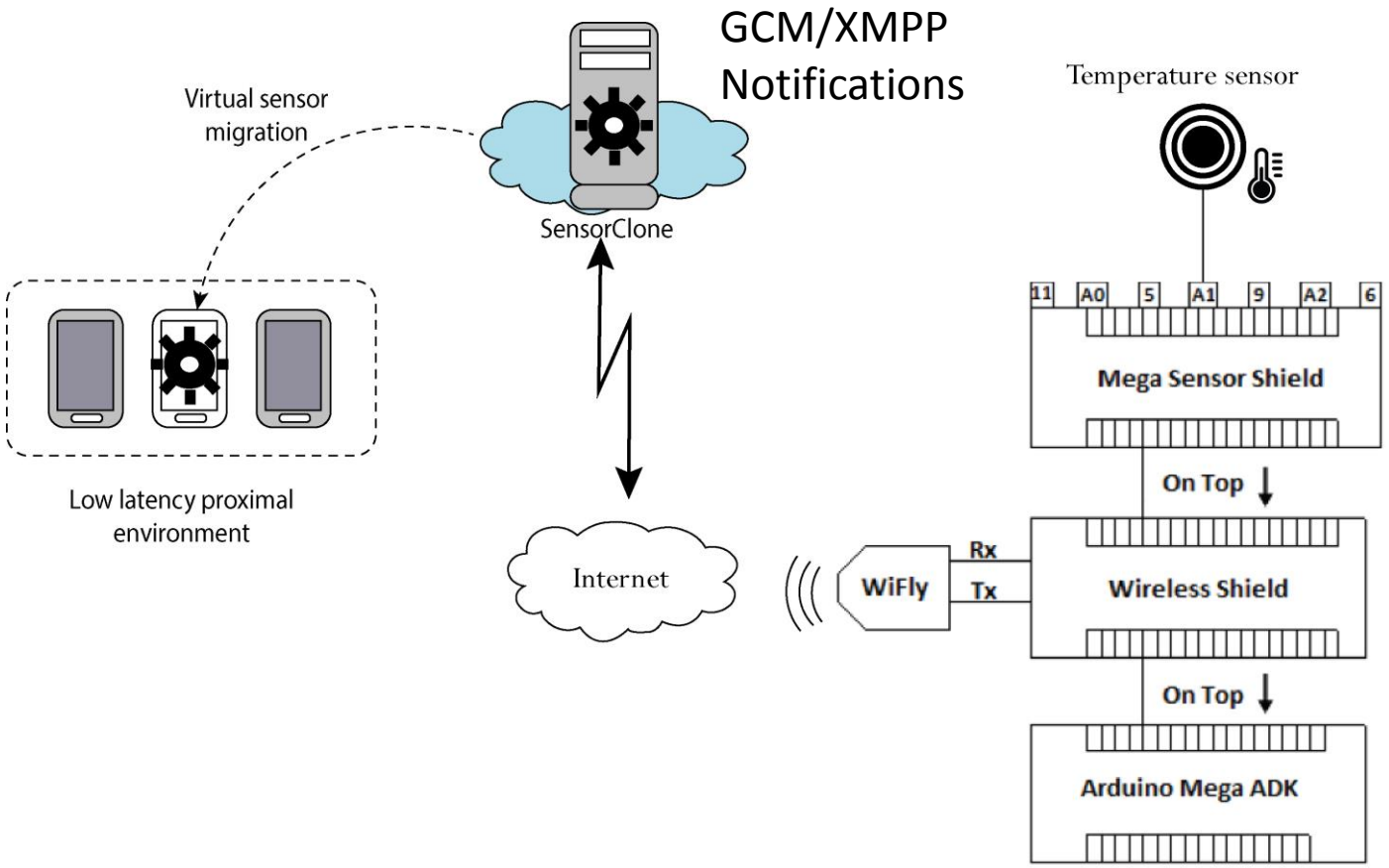


Sliding window model

EXPERIMENTAL TESTBED

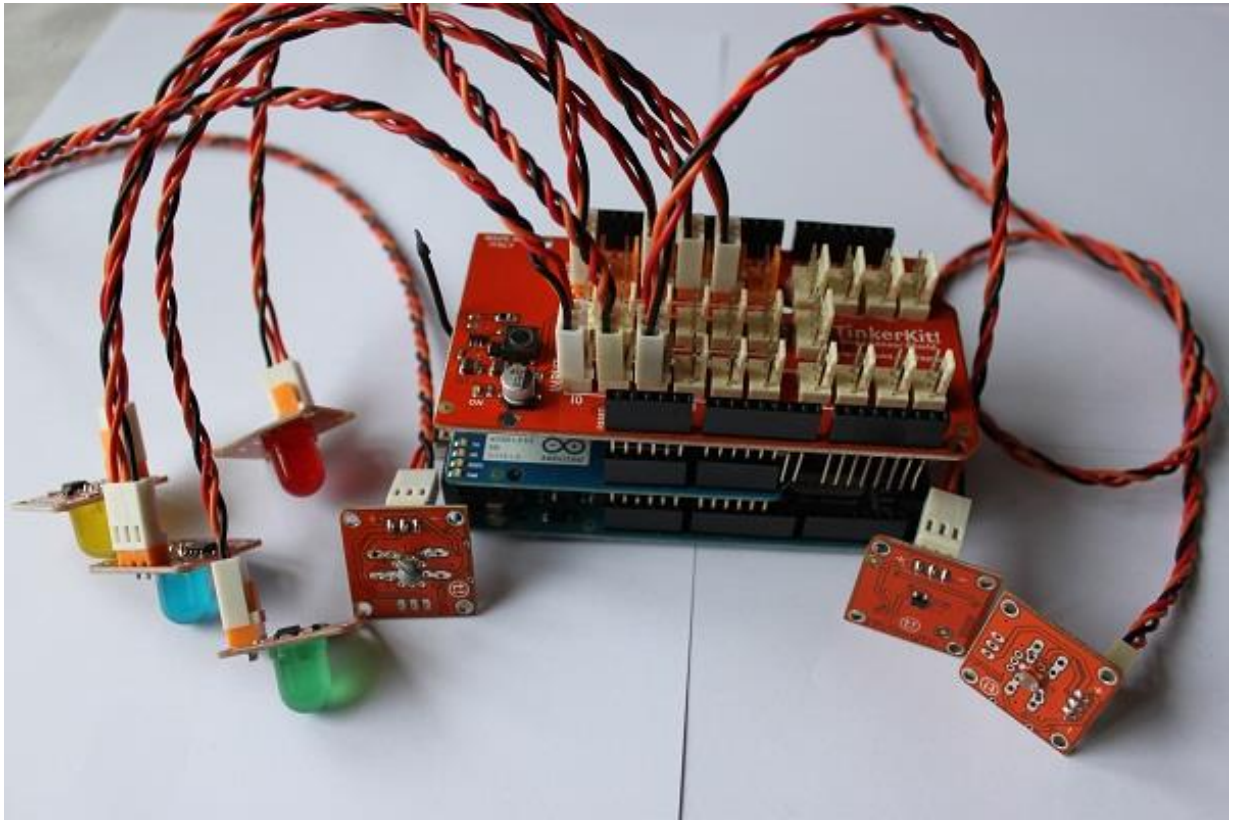
Evaluation

- Experimental setup composition

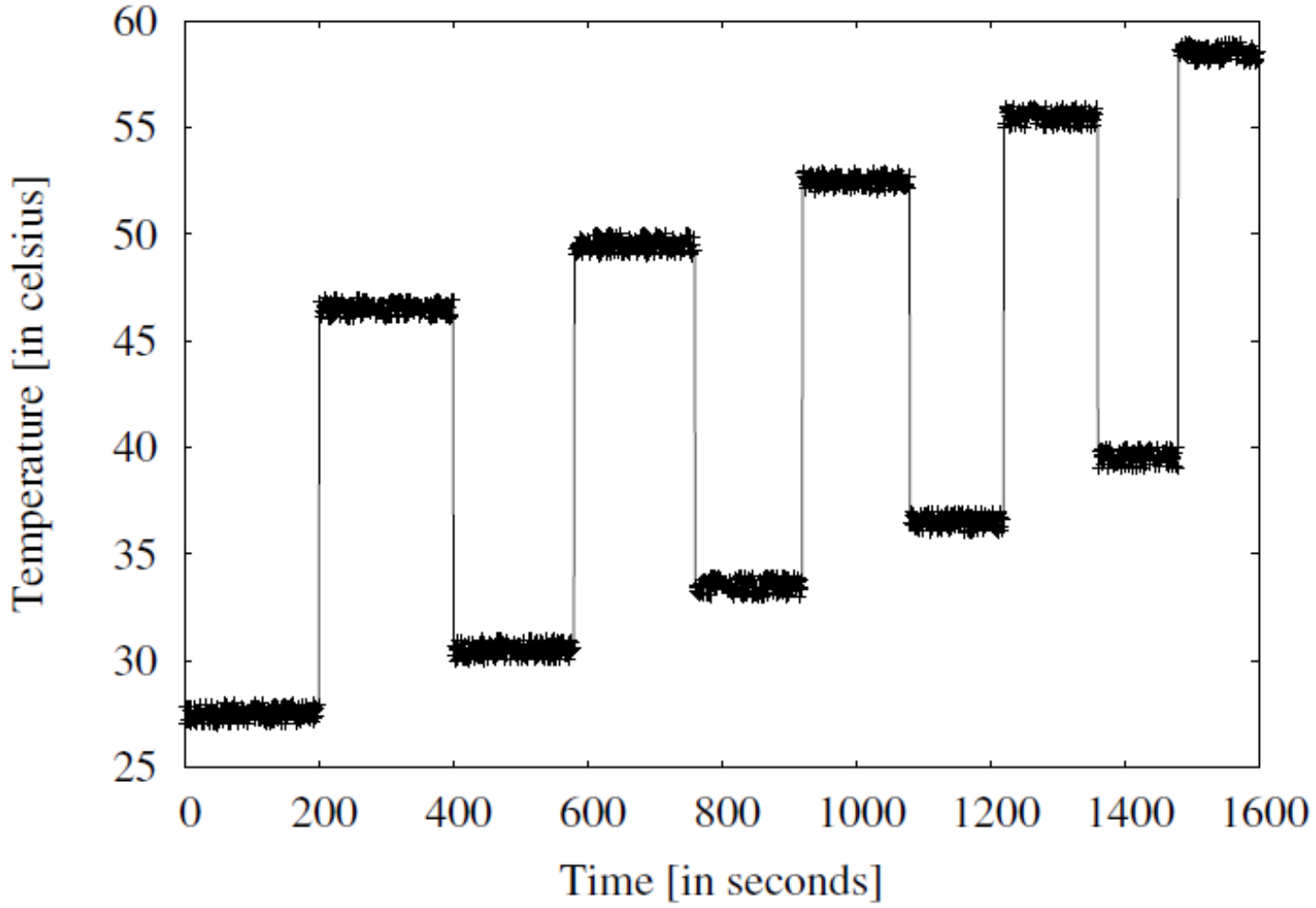


Evaluation

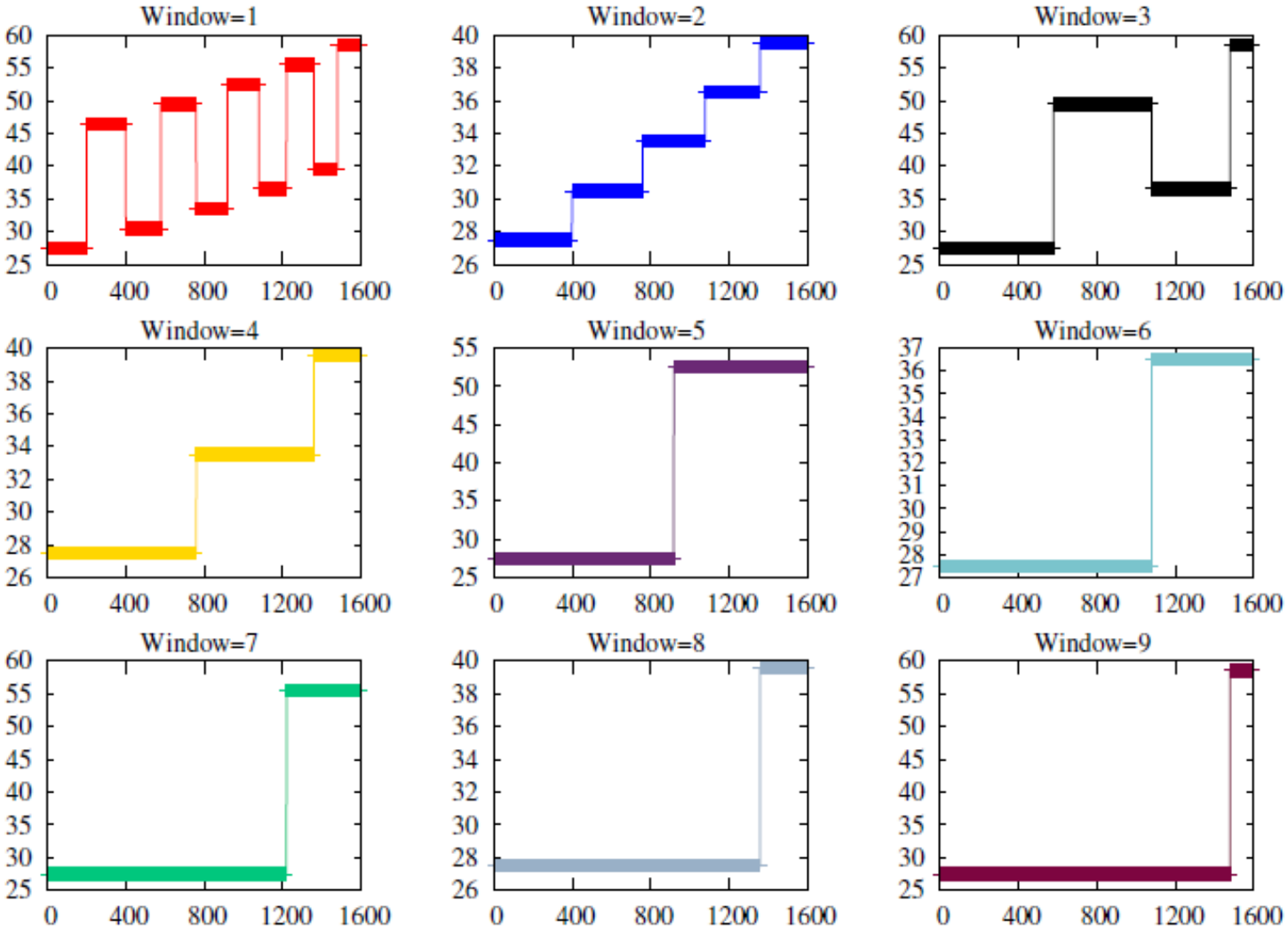
- Experimental setup composition



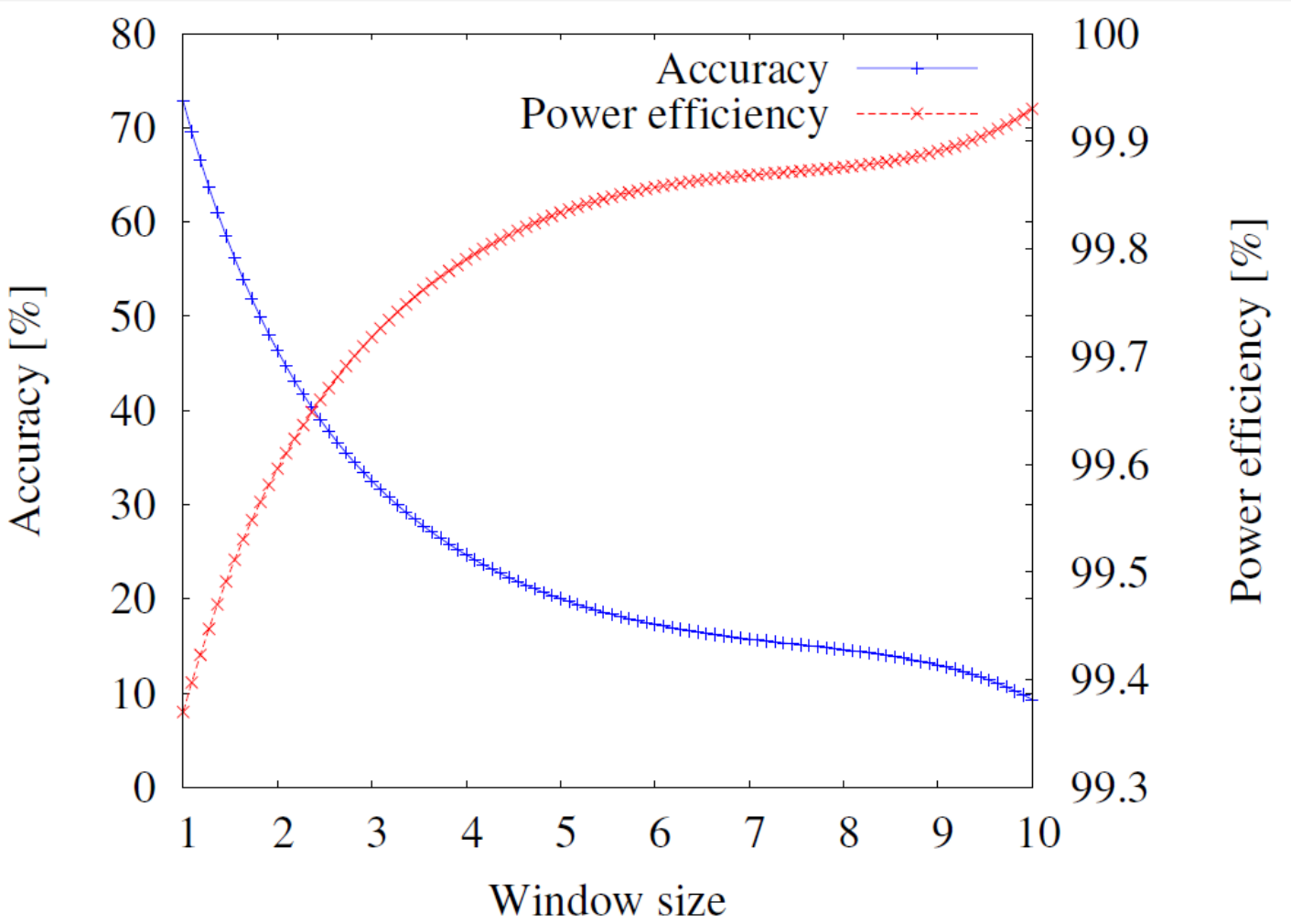
Results


Temperature [in celsius]
60
55
50
45
40
35
30
25
0
200
400
600
800
1000
1200
1400
1600
Time [in seconds]

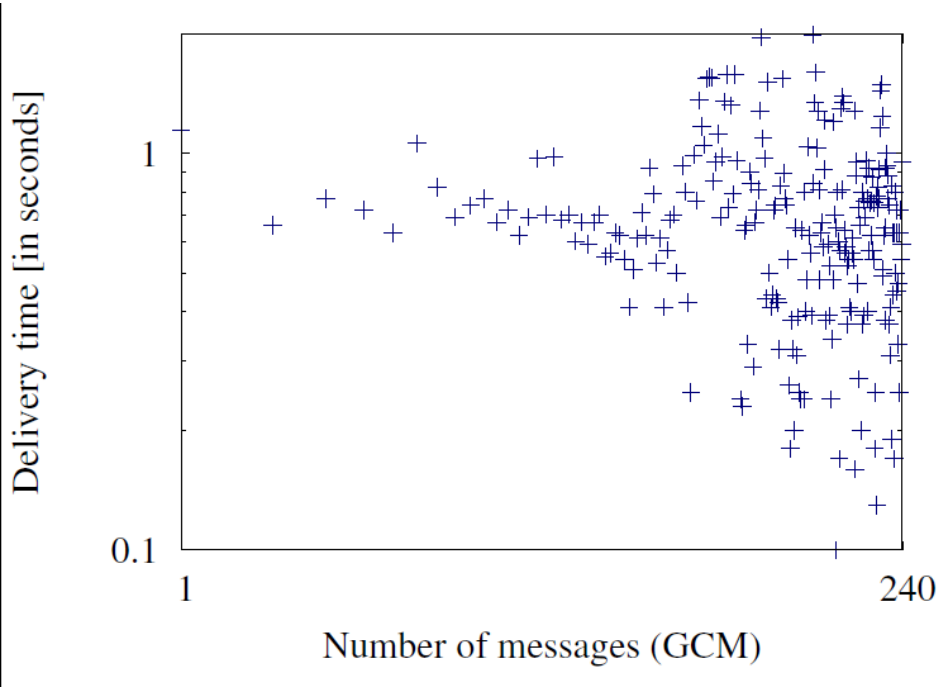
Results

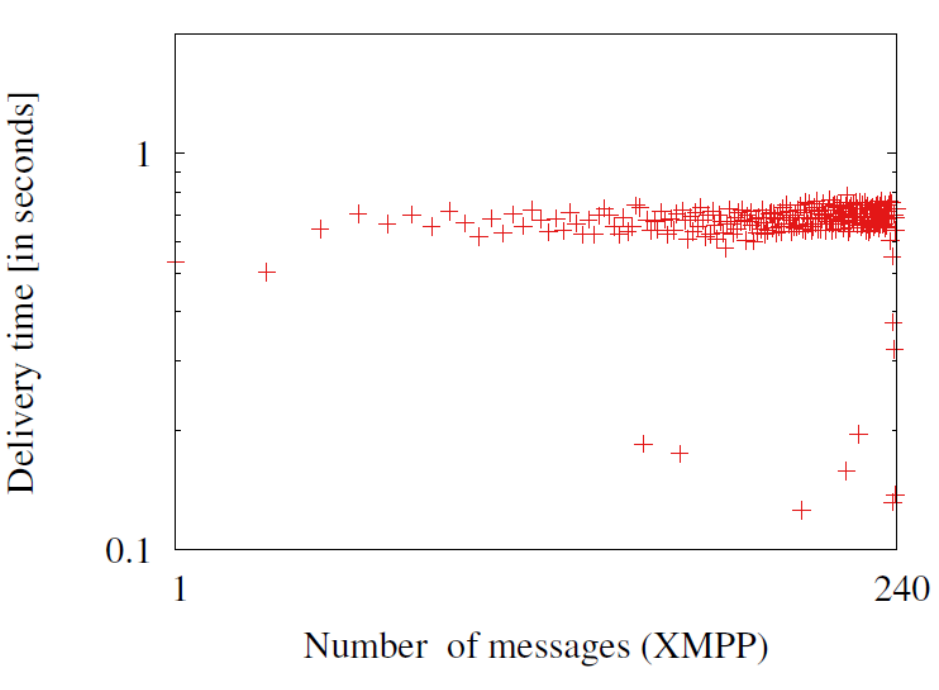

Window=1
Window=2
Window=3
Window=4
Window=5
Window=6
Window=7
Window=8
Window=9
0
400
800
1200
1600

Results


Accuracy
Power efficiency
Accuracy [%]
Power efficiency [%]
Window size
0
10
20
30
40
50
60
70
80
99.3
99.4
99.5
99.6
99.7
99.8
99.9
100
1
2
3
4
5
6
7
8
9
10

Results





Mechanism	**Average delivery** (mean) [s]	**Median delivery** (median) [s]	Delivery variability (SD)
GCM	0.75	0.66	0.69
XMPP	0.6	0.75	0.10

Table 2: Summary statistics of message delivery time for both mechanism.

Conclusions

- SensorClone helps to avoid an Internet of disconnected-Things
- We demonstrate the potential of opportunistic migration of virtual devices
- We show the feasibility of our framework based on a case study of a virtual sensor

QUESTIONS

Thanks!

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