

Towards Realization of an IoT Environment A real-life implementation of an IoT environment & its analytics

<u>Tharinda</u> Nishantha Vidanagama



Wayamba University of Sri Lanka



- Background of IoT and M2M
- New architecture
- Bluetooth Low Energy
- Implementation Scheme
- Real world experiment
- Analytics
- Conclusion

1. Internet of Things & Machine-To-Machine



Explosion of innovative smart devices to assist personal and commercial aspects.

The M2M communication enables new services.



Coupled with Internet for unlimited potential





- When the aged population is projected to grow in the foreseeable future, countries have a major challenge to ensure that their health and social systems are able to cope with it.
- Technology developments and low cost manufacturing have lead to affordable and highly effective devices.
- These devices offer connectivity and interconnectivity.
- Connecting these devices to Internet brings further important benefits.





Challenges

3. IoTAAL applicable architecture



- Ever more user devices and interactions.
- Identify new business opportunities.
- Deploy M2M gateways in service area to allow configuration free, affordable M2M device interaction.

- Identify best access point for certain service and QoS.
- Type of device, Connectivity technologies, Network charges, Energy conservation,...
- Investigate using ETSI M2M architecture



4. ETSI M2M Architecture

<u>E</u>uropean <u>**T**</u>elecommunications <u>**S**</u>tandards <u>I</u>nstitute



- Majority of low-end M2M devices are unable to directly connect to the Internet due to limitations.
- Standardization issues are solved by,



Our focus...

5. Use case: Bluetooth Low Energy (BLE)



Which M2M gateway should manage the BLE tag?

- The M2M gateway with the highest RSSI reading!
- Number of supported devices?
- Connected device limitation?
- Bandwidth limitations?
- Energy?



6. Real Life Experiment



- Exhibition visitors are handed a BLE tag.
- Each exhibit has a fixed smartphone.



Time stamp	Smartphone #	MAC address of BLE tag	RSSI
1405663204726	6	00:1C:4D:40:85:EC	-69
1405663204727	6	D3:BA:D7:E2:22:A6	-81
1405663204728	6	FE:7A:9F:9A:6B:42	-65
1405663204728	6	00:1C:4D:40:BC:B9	-72
1405663204728	6	F8:F3:7C:9F:B7:3E	-64

• Sample data

• Exhibition area



7. Analytics - I



- Shows the number of Participants in the exhibition and their behavior throughout the day
 - Going for lunch
 - Coming to exhibition after office hours.

• Number of active BLE tags during the experiment.



Analytics - II



• Number of maximum RSSI reader change count for 6 selected BLE tags.

- value less than 20 indicate that the user has not moved very much inside the exhibition premises and vice versa.
- Also an increasing value with time of a BLE tag indicates that it is on the move.
- A constant value indicate that it is remaining still.



Analytics - III



 Number of maximum RSSI reader change counts at different ranges for all BLE tags during the experiment

- on average that number of BLE tags moving slowly throughout the exhibition premises are higher except during 10 ~ 11 AM.
- most likely a higher number of visitors interested in the exhibits and obtained long explanations.



Analytics - IV



• Sample session durations for 3 selected BLE tags during 1 hour of the experiment.

- Obtained by counting the number of readers receiving the BLE advertisements during an hour of the exhibition.
- If at least one reader receives BLE advertisements for more than 5 minutes, the BLE tag is active.
- Short durations are ignored as it also indicates testing of BLE tags.



Analytics - V



- Number of sessions with the durations of 50~60 minutes are high.
- Implies that higher number of visitors obtained longer explanations.

• Number of active BLE tags and their session lengths during each hour of the experiment.



Analytics - VI



 Number of active BLE tags with maximum RSSI values read by each reader during the experiment.

- It indicates that on average reader 1 received higher number of maximum RSSI values from BLE tags followed by reader 12 and reader 2.
- most popular exhibit is exhibit 1 followed by exhibit 12 and exhibit 2 obtaining 2nd and 3rd popularities.



8. Potential Benefits and Issues

- **Commercial**: Similar analytics can be used in shopping to observe user preferences
- AAL: Monitor behavior within a household to provide convenience by reorganizing most frequently used appliances or most visited locations within the household.
- **Security**: IPv6/6LoWPAN in BT v4.2, Wi-Fi/cellular already available
- Observe Privacy and anonymity



Described an IoT architecture using todays emerging technology and devices usable for AAL. A real-life event was used to gather the raw data necessary to analyze the proposed system. Importance of the gathered data: Involvement of actual human beings which enable the study of their complex behaviors. Various analytics benefits both end-users and the service provider.

The organizers identified the most popular exhibit based on actual visitor behavior.





Questions or Comments?