

Summer Internship at SUTD Singapore

Supervised by Dr. Lim Hock Beng and Dr. Vishram Mishra at the Center For Smart Systems, SUTD

Don Kurian Dennis
1301CS17

Projects

Worked along with Aditya Gupta,
Rishabh Goel, Ryui Yi and SiYuan
Wang

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Major Projects

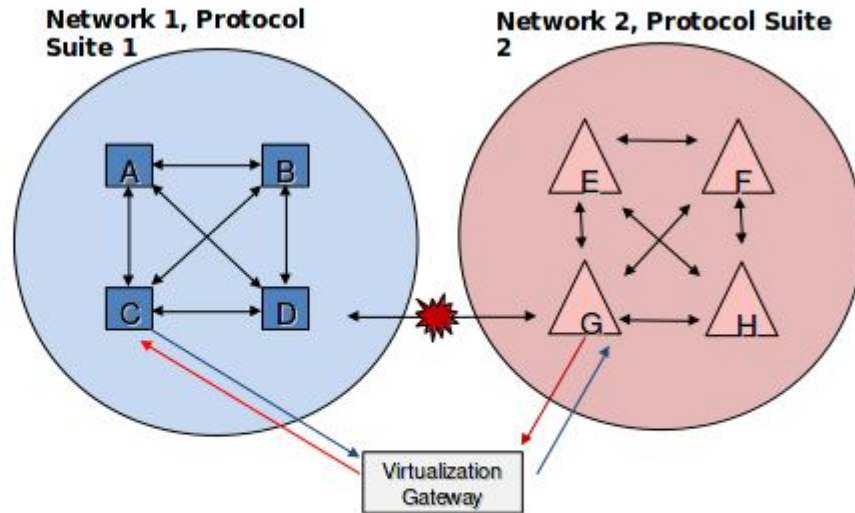
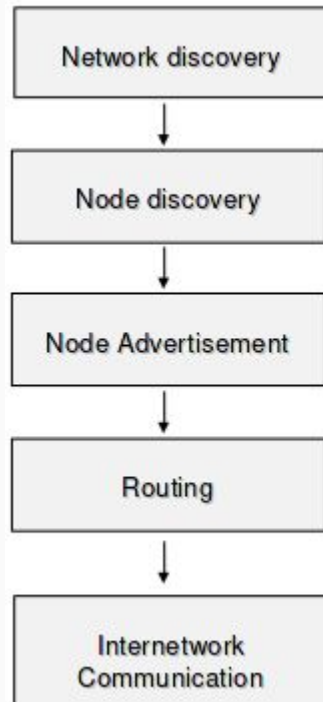
- Universal IoT Gateway
- AirQ

Minor Projects

- BATMAN and Mesh Routing
- Ontology Based DB Management
- Lab Infrastructure Assembly

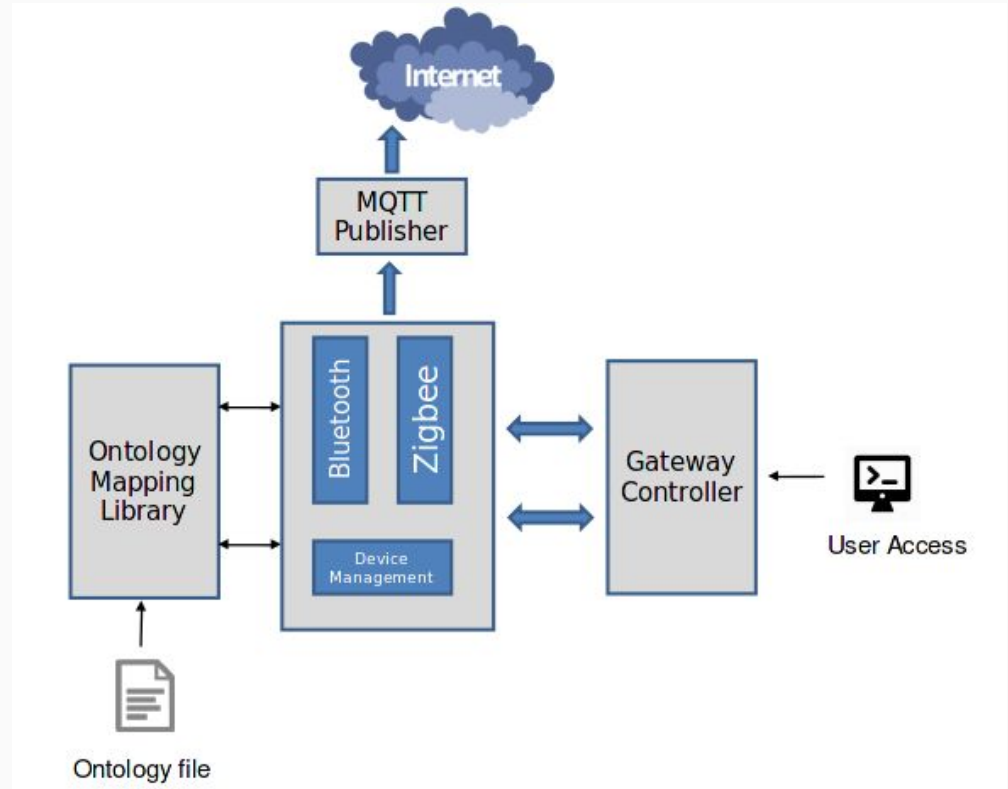
Universal Internet of Things Gateway

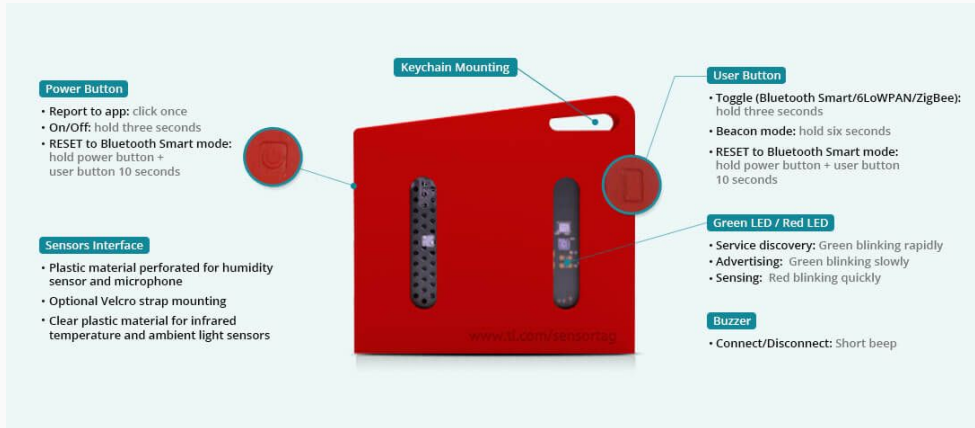
- Each protocol stack, manufacturer standard and individual device requires a different gateway - Bluetooth, Zigbee, WiFi
- No Interoperability - no way to communicate between or interface gateways.
- Try to unify this diversity and present a universal protocol interfacing
- Using the principle of ontology database and some guiding principles



Ontology Infrastructure

- Device manufacturer publishes its device ontology onto a publisher site
- PHY Protocol + MAC ID key to ontology mapping
- Anyone can download that ontology and use it





Accomplishments

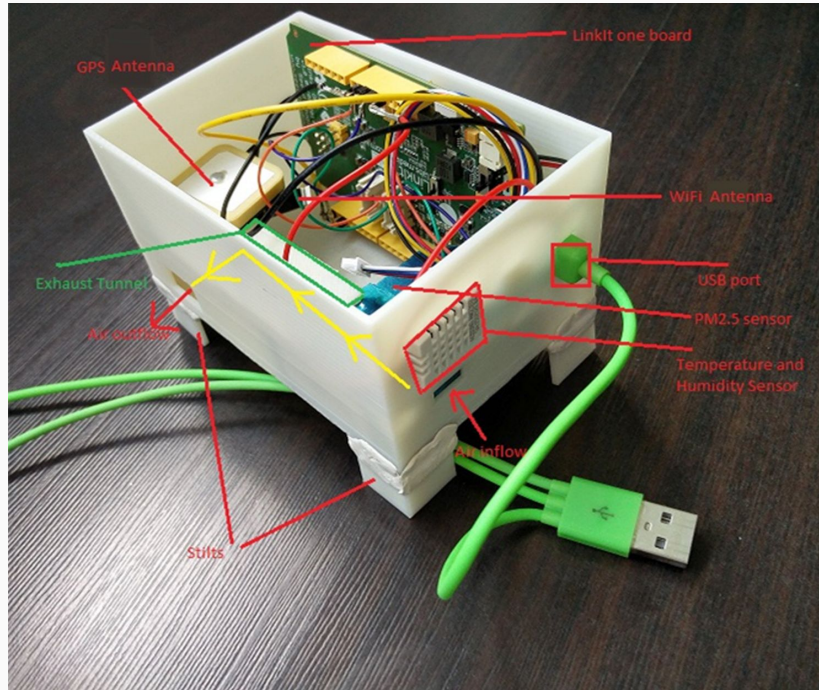
- Implemented Bluetooth Stack Server-Client driver
- Wrote a wrapper for BlueZ so as to make the glib event-callback architecture compatible with our message queue architecture
- Build the protocol and packet frame for communicating between different parts of IoT Gateway
- Wrote MQTT queue-dispatch process

Major Challenges

- Handling multiple client-server communication in single message queue and making sure it is stable even in individual child crashes.
- IPC between the bluetooth server, the gatttool client and the MQTT queue-dispatch module
- Understanding the BLE specifications and GATT Profiles and adapting the BlueZ library to our use case (BlueZ is very new and not very well documented)
- Wrote MQTT queue-dispatch process

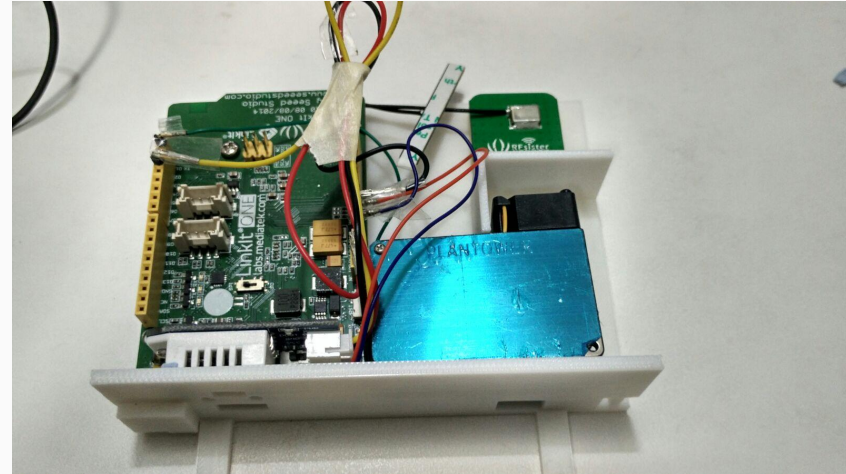
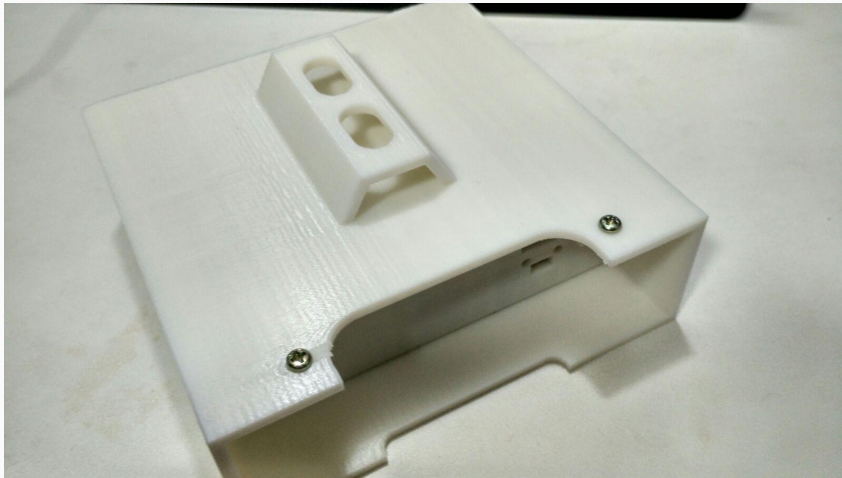
AirQ

- 22 air quality monitoring stations
- Singapore land mass is 719.1 km²
- Therefore each station covers approximately 32.7km² of land
- Data is usually extrapolated in areas further away from these stations- therefore accuracy in question.



- AirQ is an IoT device which collects real-time air quality and environmental data remotely; sends data to a server for processing
- Sensors: PM2.5, PM10, Temperature and Humidity
- Communication Technology: WiFi and 3G.
- AirQ is small and inexpensive- can be deployed in large scale for fine measurements

AirQ Enclosed in 3D Printed Design



AirQ Architecture



AirQ: Haze monitoring
Kit



WiFi Router/ 3G Unit



Server/Data Cloud

Accomplishments

- Interfaced the PM Sensors, Temperature Humidity and Other Sensors with LinkitOne
- Wrote the WiFi module, fall back logger
- Wrote the initial GSM Module
- AirQ costs 120\$ as opposed to original current used machines which cost close to 5000\$.
- Linked WiFi/GSM to server uplink through MQTT
- Successfully demonstrated 5 prototype AirQ at MakerFaire Singapore

Major Challenges

- Different sensors had different polling, settling and reading rates. Handling them in a single thread was challenge.
- Since the device was to work off main power, remotely, ensuring reliability and rigorously testing.
- The GSM stack of the LinkitOne board had a manufacturing bug - identifying, reporting and getting a update-fix
- Reliable logging mechanisms in a constrained environment when uplink is down

Conclusion

Universal IoT Gateway was demonstrated in front of delegates from ST Engineering. They were extremely pleased with the presentation and we fulfilled all deliverables. The technology has now been transferred to ST Engineering for commercial development.

AirQ was also presented in front of delegates from ST Engineering and National Environment Agency. Again the deliverables were well met and NEA is working on integrating AirQ into its existing arsenal of sensors.

AirQ was also presented at Maker Faire Singapore with great success

Thank You