WCN Project on Studying the Impact of Protocol Conversions

Team 4

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I. Aim

The aim of this project is to study the impact of protocol conversion in a multi-technology IoT system. This is achieved by implementing multiple ways of protocol conversion on a practical and commonly used multi-technology IoT platform- a Raspberry Pi.

II. Introduction

With newer and better applications getting introduced into Internet of Things (IoT) domain, the need for larger number of technologies biased towards satisfying application specific requirements are increasing. But interconnecting standardized or non-standardized, multi-vendor, modern or legacy equipments which work in a plurality of technologies require specialized multi-technology gateway devices. At scale, it might be more cost and energy efficient to deploy these gateways with fewer active interfaces simultaneously making them heterogeneous in terms of their technology support, but this results in another major issue while routing the packets across these gateways- protocol conversion.

Protocol conversion offers several challenges like frame format differences, conversion complexities (like missing fields or even impossibility of conversion in some cases), fragmentation issues etc. The overhead associated to the same can be quantified in terms of cost, packet loss, delay, energy or link utilization. For instance, there have been studies which depict that conversion from IPv6 to 6LoWPAN, BSN to WiFi and ZigBee to Bluetooth introduce worst case overhead of 100ms in RTT, 100% Time Delay Miss Ratio and upto 10% packet

loss, respectively. These parameters actually vary with respect to how the conversion logic is implemented.

Conversion implemented at a relay gateway generally involves two approaches-one, where the new header is appended to the received packet, and the other, where the packet payload is retrieved first and the new technology header is appended only to the payload. While the former is similar to amplify and forward approach employed in less complex relay systems, the latter is closer to the idea of decode and forward approach in more efficient relaying schemes.

The aim of this project is to study the impact of protocol conversion using both the approaches in a multi-technology system. The setup includes two laptops communicating a stream of packets through a Raspberry Pi acting as the relay gateway.

III. First Deliverables

Here, the students are expected to get familiar with the devices and implement a proper packet based relay at the RPi.

A. Implementation

Implement a socket program that will generate 100 WiFi packets at a source laptop, and ensure that the packets reach the destination laptop as the same WiFi packets by relaying it over the Rpi. Ensure that this is done at the packet level and not at the application level (this implies you cannot implement a file based approach at the RPi where you save the packet payload into a file, which is further retrieved and transmitted as new WiFi packets).

B. Outcomes expected

Show the performance of the WiFi based packet relaying. You have to measure the delay associated with relaying and compare it against a direct transmission from source to destination without relaying. Since the advantage of relaying comes from an energy point of view (range of transmission is directly correlated with the transmission energy), come up with an energy based benefit that the relaying has provided in this case.

IV. Second Deliverables

Next task is to implement protocol conversion based on the two methods mentioned above.

A. Implementation

Implement a socket program that will generate 100 WiFi packets at a source laptop, and ensure that the packets reach the destination laptop after relaying and getting converted at the Rpi. Both methods of protocol conversions have to be implemented and studied separately. Protocol conversion from WiFi to Bluetooth (both inbuilt interfaces) is done by separating out the payload and adding the new header at the RPi. This is performed for the initial 100 packets. Protocol conversion from WiFi to Zigbee (Zigbee is an added interface) is done by considering the entire WiFi packet and adding the new header at the RPi before transmitting again. This is also performed for the 100 WiFi packets.

B. Outcomes expected

Show the impact of protocol conversion in each of these cases by comparing against the delay and fragmentations from the first deliverable.

V. Third Deliverables

Next task is to implement parallel transmission over Bluetooth and ZigBee after conversion.

A. Implementation

This is similar to the second deliverable, but here instead of having two separate cases of studying protocol conversion, the conversions and transmissions are done over two interfaces (Zigbee and Bluetooth) in parallel to the destination laptop.

B. Outcomes expected

Show the improvement in delay from the outcome of second deliverable case resulting from parallel transmissions.

VI. Marks Distribution

The project will be evaluated for 100 Marks, reduced to 40 Marks. Distribution of 40 Marks is as follows:

1) Weekly meeting & interactions: 4 Marks
2) First phase: 8 Marks

3) Second phase: 12 Marks
4) Third phase: 12 Marks
5) Final seminar and demo: 4 marks

VII. References

1) https://www.imore.com/how-get-started-using-raspberry-pi -for setting up RPi
2) https://www.raspberrypi.org/documentation/remote-access/vnc/ - Rpi VNC setup
3) https://spin.atomicobject.com/2016/07/18/xbee-tutorial/ -ZigBee setup
4) R. Narayanan and C. S. R. Murthy, "A Probabilistic Framework for Protocol Conversions in IIoT Networks With Heterogeneous Gateways," in IEEE Communications Letters, vol. 21, no. 11, pp. 2456-2459, Nov. 2017.