AWCN Project on Studying the Impact of Protocol Conversions on Multi-hop Routing

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I. Aim

The aim of this project is to extend the study on the impact of protocol conversion in a multi-technology IoT system during best effort transmission while routing in a multi-hop fashion. With fragmentation being the key issue while implementing multi-hop routing across nodes of varying technologies, this project tries to study the packet drop in multiple combination of conversions and also studies the effect of fragmentation and recombining at every node in the route. This is an implementation project that is to be performed on a four hop network comprising of two Raspberry Pis and two laptops.

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 equipment 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.

The most efficient technique to implement protocol conversion is to follow a decode and forward approach- retrieving the packet payload first and then appending the new technology header to the retrieved payload. But this approach comes with its own set of drawbacks. The main and most crucial one here is the issue of fragmentation. With lack of proper recombination of fragments, the resultant transmission could incur larger overheads, since transmission of every wireless packet involve transmission of a series of header fields along with. This leads to considerable network resource wastage.

The aim of this project is to study the impact of protocol conversion in best effort transmission modes, effect of possible combination of conversions and implementation of fragmentation and de-fragmentation associated with conversions in a multi-hop transmission. The setup includes data transmission over a network of four nodes- two laptops and two RPis.

III. First Deliverable

Here, the students are expected to implement a best effort transmission service for communication in three protocols- Bluetooth, ZigBee and WiFi.

A. Implementation

Implement a socket program that will generate 100 packets of each technology at a source laptop, and ensure that the packets reach the destination laptop in best effort transmission mode.

B. Outcomes expected

Study the packet drops and energy based issues associated with the same for each technology.

IV. Second Deliverable

Next task is to implement multiple combinations of protocol conversion to study the impact of one versus multiple conversions

A. Implementation

Implement a socket program that will generate 100 packets of one technology. Transmit it over to the destination laptop in a multi-hop manner with 2 RPis in between. Perform the study with no conversions, one conversion and multiple conversions. Study at least 4 such conversion combinations.

B. Outcomes expected

Show the impact of protocol conversion in each of these cases by comparing packet drops in each case.

V. Third Deliverable

Next task is to implement de-fragmentation as well before transmission after conversion.

A. Implementation

Implementation similar to the second deliverable.

B. Outcomes expected

Show the improvement/ decline in performance of packet drops while implementing de-fragmentation versus the same with no-fragmentation- the result from second deliverable).

VI. References

1) https://www.imore.com/how-get-started-using-raspberry-pi -for setting up RPi
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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.