Routing protocol evaluation for the IoT

Requirement analysis and experiment design for large-scale test beds.

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ABSTRACT

TODO

Keywords

IoT, routing, MANET, test beds

1. INTRODUCTION

The Internet of Things (IoT) is both a growing market and a budding research field. One central aspect of IoT communications is routing: finding the best paths between nodes and towards sink nodes and gateways is crucial to ensure energy-efficient and smooth network operations. However, practical experience with IoT routing is sparse, and scientific evaluation of such environments is rare. Most routing protocol evaluations are simulation-based, and even fewer of these evaluations have been designed with the IoT in mind. This paper presents a testbed-based evaluation approach tailored to the IoT. The goal is to enable the evaluation of routing protocols which have been created for Low Power and Lossy Networks (LLNs) or Mobile Ad-hoc Networks (MANETs) with regard to their suitability for the IoT.

1.1 Related work

While testbed experiments are rare, research on the foundations needed to conduct life-like experiments has been done for about two decades, and is increasingly focused on the IoT.
[1] provides a summary of issues which should be considered when evaluating a routing protocol. Routing requirements for the IoT-like scenarios of home and building automation, as well as urban LLNs are described in [2], [3] and [4]. [5] discusses influences on transmission range in food monitoring use cases, in particular monitoring bananas during transport. results were achieved both through mathematical analysis as well as well as a simple testbed consisting of four nodes. [6] presents the features and failings of different Wireless Sensor Network Testbeds, along with a requirement analysis for IoT-ready testbeds.

2. IOT SCENARIOS

In order to be able to create an accurate model, the core characteristics which make up the experiment scenario have to be determined. These characteristics are: Network topology, traffic patterns, mobility patterns (if any), scale, energy efficiency requirements, and occasionally specific environmental factors which may influence the operation of the network. Since the IoT is a paradigm which encompasses many different use cases and environments, there is no such thing as *the* typical IoT scenario. For example, a building automation installation in a factory might feature a star topology with scheduled multipoint to point traffic, no mobility, low energy efficiency requirements and an open field, resulting in a wide radio range (TODO: Quelle), while a solution monitoring the insides of a food truck features a mesh topology made necessary by the high density of the truck's contents which result in low radio ranges, and bursty traffic and node mobility whenever the goods are unloaded or rearranged [5]. Table 1 provides an overview of different IoT-like environments as specified by [2], [3] and [4]. Since the aforementioned list of documents is and can not be exhaustive, neither can Table 1. It serves simply as a rough overview.

Therefore, providing a "one scenario fits all" solution is out of scope for this paper. Instead, a specific scenario will be studied and modeled in detail, with the hope that some of the building blocks may be reused as research expands. To achieve this, TODO has been chosen as the scenario to be modeled, as it can be found in a wide range of applications, and its characteristics are the most challenging for routing protocols. TODO: ÃIJber das food truck ding gibt es recht genaue infos, das szenario ist spannend fÃijr uns (weil mesh), die anforderungen sind machbar... danach modeln und etwas abstrakter halten?

3. EXPERIMENT GOALS

What do I actually want to investigate? - what are the metrics by which I determine failure/success? - Which routing protocol characteristics do I want to check * how do they compare in terms of energy efficiency? * how well (reaction time, quality of resolution) do they cope with mobility * route reliability (i.e. how many discoveries/transmissions fail under these conditions?)

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`p2p:` Point-to-point
`mp2p:` Multipoint-to-point
`mp2mp:` Multipoint-to-multipoint

Environment	**Home automation**	**Urban LLN**	**Building automation**
Network Topology	star or mesh	fluctuating	star
Traffic Patterns	few bytes spontaneous scheduled mp2p and p2mp (star) mp2mp (mesh)	low data rates spontaneous scheduled p2mp mp2p	mp2p p2p
Mobility	some mobile (sending) nodes mostly fixed (receiving) nodes	low, but dynamicity through disassociation, defect etc	low
Energy efficiency	high	high	medium
Scale	≥ 250	$\geq 100-10000$ overall, ≥ 250 per subnet	≥ 2000
Other		Tight latency requirements	

Table 1: Overview over requirements for different IoT scenarios[1]

- what do I expect from a routing protocol under my specific IoT conditions in terms of performance, reliability etc? Use [1] as a ref! And maybe my notes from back then?

4. EXPERIMENT DESIGN

Based on the goals: Which topology/topologies, which network size(s), which use cases, how do I want to model them, in how much detail.. etc -> Welche Aspekte der RealitÃd't sollen abgebildet werden?
-> 1 very controlled, simple experiment, then ramp it up to a lange scale (and/ ore more, random durchlÃd'ufe) and see if/how it changes?

Was und wie wird ausgewertet? Welche Implementierungen/ OSe benutz ich? (RIOT!!! ;))

4.1 Experiment Setup

How many nodes, which communication patterns, which mobility patterns (if any), which arrangement...

4.2 Experiment evaluation

Which data do I want to collect and evaluate? What do I want to look for? Is there anything I want to show?

4.3 Choosing the testbed

In order to run the experiments in a lifelike, but still controlled environment, a testbed is needed. Ideally, a testbed suitable for the IoT should be able to provide their users with at least several hundreds, but ideally several thousands of nodes, a diverse range of hardware, and a number of mobile nodes. [6] compares several testbeds with regard to suitability for the IoT, and concludes that the FIT-IoTLab[2] is one of the most suitable facilities. Located all over France, the FIT-IoTLab offers 2,728 nodes in total, featuring three different hardware platforms of different capabilities (TODO:elaborate?) and controllable mobility through a fleet of toy trains. The two more constrained platforms of the IoT-Lab, the Wsn430 and M3 nodes, offer support for RIOT[3]. This combination is unique among all available testbeds, and provides every feature needed to conduct the described experiments. Therefore, it is advised to run the experiments described this paper on the FIT-IoTLab testbed.

[2] `https://www.iot-lab.info`
[3] `https://www.iot-lab.info/operating-systems/`, accessed 19.05.2015

5. CONCLUSION AND OUTLOOK

Outlook: Actually implement this. (Say with which RPs!)

6. REFERENCES

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