



University of Glasgow | School of
Computing Science

Securing and Integrating the IoT with a Smart Home Router

Fergus W. Leahy

School of Computing Science
Sir Alwyn Williams Building
University of Glasgow
G12 8QQ

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1 Introduction

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.”

– Mark Weiser, *The Computer for the Twenty-First Century*, 1991

The modern home is becoming increasingly filled with a variety of *connected* devices (laptops, tablets, phones, set-top boxes etc.), providing a myriad of different services to users within the home. On top of this, with the advent use of smart phones and introduction of wearable devices, we too are starting to carry around our own personal network of devices everywhere we go, brushing past many others in our daily lives at home, work and on the street. Although all connected to the Internet, these devices are often encapsulated within their own environment and ecosystem, unable to interconnect, creating a fractured and often complex user experience.

Making matters more interesting, the Internet of Things paradigm is once again becoming a field of great interest due to the advent of cheap, low power wireless embedded devices [1]. However, not much consideration has been made for how these Things should be integrated into the existing home network, with many approaches opting to simply bridge the device to the cloud ([3], [4], [14]), with obvious concerns for security, privacy and up-time.

As these devices enter our homes and pockets, bringing with them their own ecosystems, the user is faced with the increasingly difficult burden of managing all of them and the ecosystems [7], [6]. Due to the sheer number and diversity of these devices, many of which will provide overlapping services and functionality, problems arise in how to ensure these devices not only play nicely together but also ensuring the user’s network and information stays secure against new and unanticipated threats.

In order for these multiple layered networks of devices to truly fade away into the fabric of our everyday lives, a platform and relevant protocols need to be engineered to not only support this heterogeneous network securely, but also aid the user in managing both the network and the privacy of their information.

The Homework home router platform was created to these issues. Rather than assume every user is a network administrator, the project investigated the needs and abilities of the average user in order to propose the future of home networking, re-inventing the protocols, models and architectures to truly suit the home environment. This re-invention of the home router allows a user to easily install, manage and use their home network, without the need of a Cisco qualification.

In regards to the Internet of Things development, previous work demonstrated that it was in need a suitable protocol in order to meet the specific needs of a network of Things [11]. Thus, a new protocol was designed and implemented, which could not only run on even the most constrained battery-powered devices (8MHz), but it could also efficiently scale to support hundreds of Things within the same network.

2 Statement of Problem

The Internet of Things protocol created in [11] proved to be a successful proof-of-concept; However, in order for it to be considered for deployment and integration into existing homes, several issues need to be addressed first.

Security: Due to time constraints the initial design of the IoT protocol didn't consider security concerns. However, the IoT protocol needs to be sufficiently secured to prevent eavesdropping of the transmitted data and injection of false events by perpetrators masquerading as sanctioned participants in the network.

Integration: The current implementation exists as a standalone component with several demo applications. Integration of the IoT protocol into a user-friendly platform is necessary to harness the full power of the Thing's network. The integrated platform would then be able to search and connect to available Things, receive events from the sensors and using user customised rules, use automata to detect if the received events match and then perform actions by pushing commands to actuators in the network.

2.1 Intranet of Things vs Internet of Things

As described earlier in section 1, many previous deployments of Internet of Things networks have taken a cloud first approach, see [3, 4]. Whilst this yields certain benefits, such as easy external access and integration with other services [2, 5], it also poses several questions regards data security, privacy and up-time. For this project, the focus will be on developing a home first platform, in which all Things communication will be kept local, with no cloud processing involved; Thus a more suitable name, the Intranet of Things, will be used.

Outcomes of the project:

- A secured IoT protocol.
- Extended home information platform with IoT controller role, able to capture IoT events and generate ones too.
- Use of automata to implement closed loop control of Things in the home.

3 Background Survey

3.1 State-of-the-art IoT Protocols

3.2 Homework - Smart Home Router

3.3 Symmetric Security - TinySec, MiniSec, ContikiSec

[10, 13, 8]

3.4 Asymmetric Security - TinyECC

[12]

3.5 Other Works

3.5.1 MQTT

3.5.2 IETF Work

[9, 14]

4 Proposed Approach

4.1 Security Architecture

4.1.1 Symmetric Key Cryptography

4.1.2 Asymmetric Key Cryptography

4.2 Implementation of IoT Protocol on TinyOS

4.3 Integration of IoT with Smart Home Router

5 Work Plan

- Secure IoT Protocol
- Implement Secure IoT Protocol on TinyOS
- Port Secure IoT Protocol to Homework Automata

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