

Final Project Proposal

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Final Project Proposal – Methods for Enabling and Securing Communications at the Network Edge in Restrictive Urban Locations

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Module Number: ACCA6020

Course Name: BEng Embedded Electronic Systems

Abstract

The ability to for a person to communicate (voice/ data) or access applications and services varies depending on their location. In-country Internet Service Providers (ISPs) and cellular providers control the user's ability to communicate and access to various applications and services.

This research aims to create a technological solution that will enable a person to communicate or access services/ applications wherever they are, using whatever free and open network/ bearers are available to communicate or transfer data through a secure method other than virtual private networks. This will ensure that the communications can still happen and that the data is protected, and that the necessary verification has been carried out to ensure that authorized personnel are receiving the data. This will take the form of a Raspberry Pi or be hosted on a phone or smart watch of some description.

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1. Problem Statement

Overview

Communications from a person in a foreign city can be hindered by local network infrastructure. Additionally, the ability to access services or data from their home country, for instance, can be hindered by that country's network policies, which may block access to applications, such as Netflix, for instance. Virtual Private Networks (VPN) have historically been a solution to this as they encrypt the data, thus the application is hidden from view, but VPNs are now being blocked in certain localities.

This research aims to create a solution to enable the requirement for communications from an edge node within a city, with untrusted networks and restrictive network services policies, and the central controller back in the home country.

Use case

This specific use case is to provide a central controller for a displaced person to communicate/ transfer data back to the central controller whilst transiting through a city. Some form of digital agent/ method will be used to dynamically choose a variety of free and open bearers, where an account is not required to enable communications, as is the case with cellular communications for instance, then authentication and data encrypting/ coding will be used to protect the data. This will be required as the user will not be expected to have accounts with ISPs/ Cellular services in that country.

Each service required for this network will use its own protocol that is dependent on the information being exchanged. For instance, a request for Netflix would require HTTP. One of the issues that this research will investigate is the required protocols are not available for the service that is being requested, is there a technological solution to ensure that the service can be provided to the node requesting it using a different protocols, which could be managed on the digital agent.

The technological underpinnings for this research will focus on various protocols that will facilitate a variety of data that will be fed from the node back to the central controller. Each use case will use a different protocol, which is dependent on the data that is being sent by that node to the central controller.

Network Architecture

The network architecture for this research will comprise of the following elements:

- Central controller – all analysis and hosting of services
- Edge node – could be a smart watch or a mobile phone, and will be the mobile person's device for communications back to the central controller
- Digital agent – hosted on the central controller and edge node, and will be responsible for facilitating the following:

- .1 The verification at the network edge – including the key-exchange-like verification stage that ensures the correct recipients receive the data, by revealing they know what it is without revealing the data itself.

Components

There are various components to that will be required for the successful exchange of information from the mobile node the central controller:

Component 1:

- Edge node dynamic bearer selection and verification using authentication, authorization, and authentication (AAA) – what are the most appropriate bearers or networks to use

Component 2

- Information encrypting/ coding methods to protect the data – so the edge node has to prove to the central controller that it knows what the data is without revealing what it is on the wire. This may be a rather granular investigation into

Component 3

- Data exchange between mobile node/ edge node and central controller
- .1 This will include protocol-specific handshaking (if required) and message acknowledgments, for instance

2. Project Aims and Methods

2.1. Aim

The aim of this project is engineer technologies that will enable the C2 at the network edge in a locality where the local network infrastructure will not usually allow, back a central controller that will provide the desired applications and services that the edge node requires.

This project will comprise of a central controller and an edge node, and potentially some form of digital agent hosted on both nodes that will facilitate the information exchange at the network edge, including AAA, data coding/ encrypting, and dynamic bearer selection.

2.2. Methods

This research will follow particular research philosophies, approaches and strategies, as outlined below.

Philosophy

This research will be pursuing the positivism route as the knowledge will be based on real world phenomena. Positivistic research tends to produce experiments and includes the development of software, which will be the output of this research.

Approach

It therefore prudent that this research will pursue deductive reasoning, that is, to start with a theory, then make predictions, and experiment and simulate, as per the Sherlock theory.

Strategies

Appropriate strategies for this research will be experimentation, software development, document review, and straying into case studies as well. This strategy builds on experimental and is typical of development projects, which is more aligned with this research than other research strategies.

Research steps

The research will follow generic research methodology steps, that is:

1. Identify the research topic
2. Compose the aims, objectives and any questions of the research topic
3. Conduct background research on the topic area, and develop a hypothesis
4. Develop a hypothesis
5. Test the Hypothesis, gather data
6. Analyse results
7. Report

This method enables the process of identifying your topic area, making a hypothesis, and then testing and reporting on the progress of that hypothesis based on qualitative/

These methods will likely be confirmed through the literature review stage of this research.

3. Project Tasks and How They will be achieved

This project comprises of the following work packages (WP):

- **WP1 Background Research**
 - .1 WP1.1 Methods of urban communications out of country
 - .2 WP1.2 Dynamic bearer selection and
 - .3 WP1.3 Data verification and protection methods
- **WP2 Protocol/ Network Design**
 - .1 WP2.1 Protocol design
 - .2 WP2.2 Development of verification and data protection methods
- **WP3 Scenario Simulation**
 - .1 WP3.1 Simulation
- **WP4 Results Analysis and Report Write Up**
 - .1 WP4.1 Analysis of simulations
 - .2 Dissertation write up

3.1. Outcomes

OC1 – Produce a literature study on current limitations of applications and services over some network bearers/ country specific ISPs, and include current methods that aim to get around this such as VPN, or novel - this will include 'crypto'-like methods that use methods such as hash tables to ensure that the data is being sent to the intended recipient

OC2 – Interim Viva Presentation

OC3 – Produce a network schematic and PCB drawing for any microcontroller and related circuitry.

OC4 – Simulate the network on Proteus and any other simulation software that will be required.

OC5 – Results analysis and captured all outcomes into the Final Report.

OC6 – Final Viva

OC7 – Poster and Q&A

5. Resources

This research will require software, hardware, data, people, and financial resources, as outlined below.

Software

This research will require the following software resources:

- EasyPC OR KiCAD
- Proteus
- PICC
- Command line for enabling the various protocols that will be used for communicating between the nodes and the central controller

Hardware

This research will require the following hardware:

- Microcontroller or Development board, such as PIC/Raspberry Pi
- Any electronic components required as part of the circuitry
- Nodes
- Antenna (if not part of the development board/ microcontroller)

Data

This research will not be accessing data on people as it is not required due to the specific nature of the use case.

People

This research will require the following resource:

- 1 x Researcher (Author of this Report)
- 1 x Supervisor

Institution (employer/university) resources

This research can access employer laboratories when required.

Finances

This research will require funding from the university and/or employer for mainly hardware. Costings are to be confirmed, and this will vary depending on the nodes and development boards/ microcontrollers that actually get decided upon.

6. Timescales

This research’s timescales can be observed in the Gantt chart in Figure 1 or in the image link below. Each stage in the chart maps to a specific outcome in section 3.1.



Figure 1 - Gantt chart



Gantt Chart.png

References

- [1] European Commision - Directorate-General for Communication, "Smart cities," European Commision, [Online]. Available: https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en.

Final Project Proposal

GRADEMARK REPORT

FINAL GRADE

71 /100

GENERAL COMMENTS

Intro / A&O (400 words)		
Project title; Identification of a specific problem to be investigated; Well-defined aims and SMART objectives; Explaining why this project is worth doing; Discussion of what the project needs to do in order to be a success; Description any deliverables that will be produced at the end of the project	20	17
Excellent introduction, aims and objectives. Clear list of project deliverables.		
Background to the Project / Literature Review (400 words)		
Description of how the work to be done by in the project relates to the work identified in the literature review; Discussion of any ethical issues raised by the project Identifying what has already been done within the field; Topic familiarity; Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites; Selection of relevant models & concepts	20	13

Excellent background material, although more references required.		
Project Design (500 words)		
Clear statement of which development methods are to be used and why they are appropriate; Clear statement of which tools are to be used and why they are appropriate; Clear description of how data collected will be analysed	30	19.5
Very good clear description of which development methodologies, tools and materials are to be used in the project, although no success criteria are provided.		
Resources / Planning (200 words)		
List of any deliverables; Clear diagram showing both timing and resource use; Completed ethics form; Limited and relevant appendices	15	9.75
Good project plan, although the Gantt chart should contain a list of the tasks with their durations, and not just their outcomes.		
Ethics form completed,		
Document Presentation		

Correct spelling, grammar and punctuation; Flow of narrative/fluency; Coherence; Word processed ; Correct use of referencing with bibliography; Strict word limit	15	11.25
Well presented document, although some bullet points seem a little odd. Generally well-structured and well-written.		
TOTAL	100	70.5

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