Faculty of Engineering & Architecture
Master in Industrial Sciences: Electronics-ICT

Academic year 2013–2014

Master thesis
Implementation of Recursive InterNetworking Architecture on Android

Mathieu Devos

Promotor:	Prof. Dr. Ir. D. Colle
Copromotor:	Dr. D. Staessens
Internal Promotor:	Dr. Ir. K. Casier
Supervisor:	Ing. S. Vrijders

Nederlandstalig abstract

Nederlandstalige abstract

Abstract

In this literature study we will attempt to clearly state the research question and provide adequate background. This should provide us with enough information to start working on the actual research problem. We will provide a roadmap trying to answer this question and the clearly map the path that will be followed and where potential issues might arise. We will also elaborate on why this research question is relevant at this current time.

The literature study is constructed as follows. First we will describe the origin of the internet and look at how the internet got to where it is right now. In the same chapter we will inspect some other alternatives proposed for internet throughout the years. We will conclude the chapter with some of the shortcomings the current internet model faces. In the following chapter we will state the main research question alongside with the specifics this question poses. Following the main question we will explain the basics of Recursive InterNetworking Architecture (RINA), take a closer look at the IRATI implementation of RINA and finish with the restrictions we might encounter for the Android platform. The next chapter will be specifically about RINA on the android platform with specific sections about the wireless Shim-DIF and WiFi Media Access Control. The final chapter intends to draw a conclusion about the literature study and show the position of the study in the whole thesis.

Table of contents

1 SHIM DIF for 802.11 1

1.1 Introduction 1
1.2 Mapping of 802.11 MAC header 2
1.3 Mapping of 802.2 LLC header 4
1.3.1 SAP addressing 4
1.3.2 DSAP address field 4
1.3.3 SSAP address field 6
1.4 Flow differentiation between port-id 6
1.5 Use of Address Resolution Protocol 6
1.6 Service Definition 6
1.6.1 QoS-cubes supported 6
1.7 Configuration 7
1.7.1 Shim IPC Process info 7
1.7.2 AP to MAC Directory 7
1.7.3 Port-id to CEP-id Directory 8
1.8 Bootstrapping 8
1.9 Application (un)registration 8
1.10 Enrollment 8
1.11 WiFi Shim IPC Process Definition 8

Bibliography 9

Chapter 1

SHIM DIF for 802.11

1.1 Introduction

In this chapter we will stipulate the specifics for a functional Shim DIF over WiFi. Firstly we must note that this is not a fully functional DIF and this DIF will only provide support for RINA DIFs. This DIF uses the 802.11 legacy protocol on which it constructs an adaptor. The purpose of this Shim DIF is to represent 802.11 as a DIF towards the DIF on top of this. Due to this we will not try to improve or change specifics of the 802.11 protocol but we will try to map them as seamlessly as possible towards the RIN Architecture. The Shim DIF will be used as an adaptor, this implies that the very bottom layer will still be 802.11. The layer directly above this Shim DIF will see this Shim DIF as a DIF part of RINA.

802.2	LLC
802.11	MAC
802.11	PHY

Table 1.1: Overview of 802.11 protocol parts

WiFi consists of 3 main parts and the adaptor will try to span over all these. On top we have the 802.2 LLC layer, below that is the 802.11 MAC layer and finally we have the 802.11 physical layer. We must note that the LLC layer is an old protocol that has been reused for this 802.11, it is not likely to be updated soon. The MAC layer has been changed as recently as 2007 with 802.11e. It has several fields reserved for future use and could be changed later on. This means that when this MAC layer is changed that these changes will have to be addressed in the Shim DIF. Finally is the physical layer presented at the bottom of the WiFi scope. We instantly note that this changed quite often but provides no use towards the Shim DIF. This physical layer will thus not be used for the Shim DIF and changes to this should not reflect in the wrap above the WiFi protocol.

The Shim DIF over WiFi is not a fully functional DIF. This means that some limitations apply to this protocol:

- Limited amount of flows who are statically determined by LLC header (802.2 standard(Society, 1998)).
- Only type 2 operation can be used from LLC header. Due to this every LLC PDU needs to be ACKed

These limitations clearly show that the Shim DIF is not a fully functional DIF. It provides support for other DIFs to build further on. We have a limited amount of IPC process within one DIF because each one is linked to a MAC address and these MAC addresses are limited within their scope. Similar issues occur when distinguishing between flows. Due to the static content of LLC headers we note that SAPs are also limited. Finally we note that the WiFi protocol does not guarantee any reliability for the transfer of SDUs.

1.2 Mapping of 802.11 MAC header

Since the physical layer is not to be utilized, we will start the mapping from the lowest layer that will be used. This layer is the 802.11 MAC layer. Here we will use only the header section of the layer. Because DIFs at the bottom of RINA are mostly exceptional compared to other DIFs we will specify the needed changed to use this DIF.

The fields in the 802.11 MAC header **??** that will be used are the *Address Fields* and Payload field.

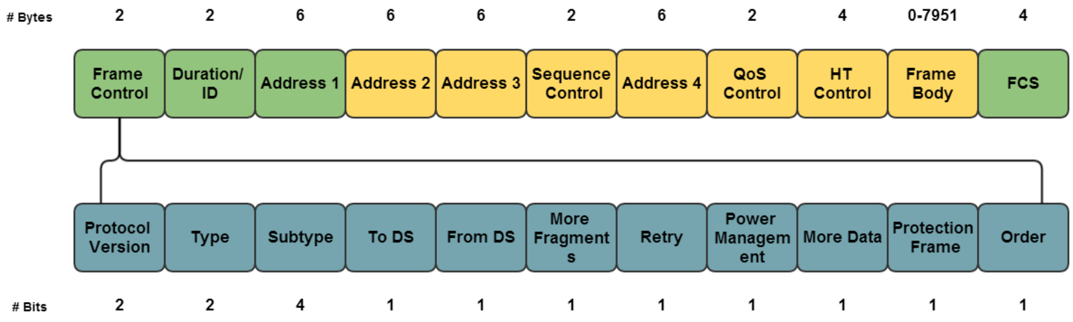

Figure 1.1: 802.11 MAC frame

These 4 address fields will be used according to the 802.11 MAC standard (Society, 2012). This means the following address fields will be mapped:

Address fields The MAC addresses used to bind shim IPC Processes to.

Destination Address (DA) The MAC address corresponding to the WiFi interface that the destination Shim IPC Process is affiliated with.

Source Address (SA) The MAC address corresponding to the WiFi interface that the source Shim IPC Process is affiliated with.

Note that these address fields are not static and change according to the values in the Frame Control field, further details shall not be provided for this as this is provided in the IEEE standard.

Frame Body This will carry the SDUs it receives from the upper DIF. This can be fragmented as 802.11 supports fragmented payload[3]

For the DIF name we will use the SSID (Service Set Identifier). This name is provided by periodical advertisement in a beacon frame.

[2]Only DA and SA have use for RINA in the current development stage.
[3]More Fragments subfield in the Frame Control field

Network Type	**To DS bit**	**From DS bit**	**Address 1**	**Address 2**	**Address 3**	**Address 4**
IBSS (ad hoc)	0	0	DA	SA	BSSID	*N/A*
BSS (infrastructure)	0	1	DA	BSSID	SA	*N/A*
BSS (infrastructure)	1	0	BSSID	SA	DA	*N/A*
WDS	1	1	RA	TA	DA	SA

Table 1.2: Overview of Address Fields[2]

1.3 Mapping of 802.2 LLC header

DSAP address	**SSAP address**	**Control**	**Information**
8 bits	8 bits	8 or 16 bits	M*8 bits

Table 1.3: 802.2 LLC PDU format

The 802.2 LLC header will primarily be used for differentiating between different flows from the (N+1) DIFs. For further information and documentation on this standard we refer to the IEEE document (Society, 1998).

1.3.1 SAP addressing

SAPs will be used to distinguish between different flows, the current address assignments for SAP can be found in the table below.

1.3.2 DSAP address field

The Destination Service Access Point address field will be used to map the CEP-id (Control EndPoint-identifier) for the destination Shim IPC process on. The field is statically determined and contains two 2 of the 8 bits are reserved. One for the LLC standard and the second one for ISO.

Hexadecimal code	**Address Assignment**
00	Null LSAP
02	Individual LLC Sublayer Management Function
03	Group LLC Sublayer Management Function
04	IBM SNA Path Control (individual)
05	IBM SNA Path Control (group)
06	ARPANET Internet Protocol (IP)
08	SNA
0C	SNA
0E	PROWAY (IEC955) Network Management & Initialization
18	Texas Instruments
42	IEEE 802.1 Bridge Spanning Tree Protocol
4E	EIA RS-511 Manufacturing Message Service
7E	ISO 8208 (X.25 over IEEE 802.2 Type 2 LLC)
80	Xerox Network Systems (XNS)
86	Nestar
8E	PROWAY (IEC 955) Active Station List Maintenance
98	ARPANET Address Resolution Protocol (ARP)
BC	Banyan VINES
AA	SubNetwork Access Protocol (SNAP)
E0	Novell NetWare
F0	IBM NetBIOS
F4	IBM LAN Management (individual)
F5	IBM LAN Management (group)
F8	IBM Remote Program Load (RPL)
FA	Ungermann-Bass
FE	ISO Network Layer Protocol
FF	Global LSAP

Table 1.4: SAP Address Assignment

1.3.3 SSAP address field

The Source Service Access Point address field will be used to map the CEP-id (Connection EndPoint-identifier) for the source Shim IPC process on. The field is equal in size to the DSAP.

1.4 Flow differentiation between port-id

Flow allocation is set up from the (N+1) DIF while the data transfer is handled by the (N) Shim DIF. For this we utilize the mapping on the LLC header. Every flow will be distinguished by the different CEP-ids who are linked to the SAPs.

The instantiation of the flow is handled by the WiFi protocol. Once the flow has been allocated it will map the CEP-ids to the SAPs which provide EndPoints for this particular flow. The amount of flows is limited by the number of different SAPs one interface can be mapped to.

1.5 Use of Address Resolution Protocol

Reuse text from Ethernet shim DIF? Exact same mapping after all.

1.6 Service Definition

In this section the different QoS-cubes that are supported will be addressed.

1.6.1 QoS-cubes supported

The WiFi protocol supports several QoS-cubes, they are a combination of following possibilities.

ID	Depends on QoS-cube
Name	Depends on QoS-cube
Average bandwidth Average SDU bandwidth	To be filled in after WiFi Shim IPC Process Definition
Peak bandwidth-duration	
Peak SDU bandwidth-duration	
Burst period	
Burst duration	
Undetected bit error rate	
Partial delivery	
Order	
Max allowable gap in SDUs	
Delay	
Jitter	

Table 1.5: Overview of 802.11 protocol parts

1.7 Configuration

Every Shim IPC Process is assigned to one WiFi interface. This leads to a one-on-one mapping from Shim IPC Process to a specific MAC address. Before the Shim DIF can become operational it needs a basic amount of information. This information is comprised of:

1.7.1 Shim IPC Process info

Here the Shim IPC Process is given. The WiFi device name is determined by the OS and is bound to the Shim IPC Process. The DIF name is announced as the SSID in a beacon frame. Note that this is only periodically announced and is not included in every frame. Also the mapping of flows is stored here under *CEP-id* to *SAP* linking.

1.7.2 AP to MAC Directory

A directory is needed for the mapping of *AP name* to *MAC address*. For this purpose the WiFi Shim DIF will use the Address Resolution Protocol (ARP). This is the same as the Ethernet Shim DIF **(insert citep)**.

1.7.3 Port-id to CEP-id Directory

1.8 Bootstrapping

Upon creation the Shim IPC Process it communicates with the OS to address the traffic from WiFi towards the Shim IPC Process. This traffic must be part of the same DIF (SSID), the MAC address must be the same as the interface the Shim IPC process is bound to. Finally the SAP must be the one registered to the Shim IPC Process. When these conditions are fulfilled we assume that all traffic is RINA traffic and should be handled by the Shim IPC Process.

1.9 Application (un)registration

Insert image to clearly show AP process in (N+1) DIF compared to Shim IPC Process in (N) DIF and with WiFi protocol below that.

If an Application Process (AP) from (N+1) DIF registers with the Shim IPC Process in (N) DIF, it has to follow a set of rules. Depending on this ruleset the operation is accepted or rejected. Note that the link that maps the AP with the Shim IPC Process is a static one as it is represented by a ARP cache entry, which is a static database entry. This entry maps the *AP name* to the *MAC address*. Since this MAC address is bound to the Shim IPC process this indirectly links the AP to the Shim IPC Process. Finally when an AP un-registers the Shim IPC Process removes the entry in the ARP cache thus resulting in the removal of the link between the AP and the Shim IPC Process. A final note must be added here that ARP caches are limited in size, this means that MAC addresses are always 6 bytes and the AP name is limited to only 4 bytes.

1.10 Enrollment

All members with an interface active in the same SSID are assumed to be in the same Shim DIF. When a new member enlists in this Service Set it is enrolled in the Shim DIF. Since SAPs are assigned in a static manner this leads to no extra functions for IPC Processes as it can directly map the CEP-id to the SAP on a one-to-one scale.

1.11 WiFi Shim IPC Process Definition

Bibliography

Society, I. C. (1998). Part 2: Logical Link Control. *IEEE Network*.

Society, I. C. (2012). Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. *IEEE Network*.