eCoMove

# Cooperative Mobility Systems and Services for Energy Efficiency

| D2.11 | Test report of communication platform |
|---|---|

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|---|---|---|---|
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| **Abstract** | The document describes the tests for the interoperability among different communication platform providers and provides the results of the validation plan tests |
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# Control sheet

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# TERMS AND ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| CCU | Car Communication Unit |
| SHB | Single-Hop-Broadcast |
| PHY | Physical layer |
| MAC | Media Access Control |
| LinkBird | NEC communication Unit |
| CSP | Q-Free communication Unit |

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[4] IEEE P802.11p-2010, Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, Amendment 6: Wireless Access in Vehicular Environments, July 2010.

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# 1. Introduction

The aim of this report is to provide information on the results of the various tests performed during the Communication activity of the eCoMove project. The goals of the verification activity were:

1) Test the functionality provided by the communication platform
2) Test the functions provided by the eCoMessage Bundles
3) Report against the verification requirement document [10]
4) Report on ETSI plug tests

The document has been organized into the following sections:

1) List the requirements defined during the project by the application SPs
2) Presentation of the communication stack
3) Describe the methodology used for the test definition
4) Report on Transport layer test
5) Report on the ETSI-PLUGTEST
6) Report on the Facility Layer test
7) Report on the performance tests
8) Review the Verification plan

# 2. Communication Platform Requirements

With reference to D2.3: eCoMove Communication platform design specification, in the following the Communication Platform requirements are listed. An additional column identify relevant requirement for the tests.

## *2.1. Data Exchange*

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0017 | The eCoMove System Architecture shall provide a high level description of the message sets and data communication protocols to be used in data transfers. | Yes | No |
| ECOM-RQ-IP-0018 | The eCoMove System Architecture shall provide a high level description of data stores and data flows, and shall have a single data dictionary. | n.a. | No |
| ECOM-RQ-IP-0019 | Systems that conform to the eCoMove System Architecture shall exchange information in a manner that permits a given geographic location to be understood by all parties. | n.a. | No |
| ECOM-RQ-IP-0020 | Systems that conform to the eCoMove System Architecture shall exchange information in a manner that permits road and traffic conditions to be understood by all parties. | n.a. | No |
| ECOM-RQ-IP-0021 | The eCoMove System Architecture shall provide a high level description of the message sets used to exchange data with external interfaces. | n.a. | No |
| ECOM-RQ-IP-0022 | The eCoMove System Architecture shall support the use of seamless communications. This shall mean that the use of different communication networks is transparent i.e. switches are made without the intervention of the final user. | IPv6 and NEMO vertical handovers | No |
| ECOM-RQ-IP-0023 | The eCoMove System Architecture shall require systems developed from it to use a communication mechanism that allows flexible routing of messages. | IPv6 and NEMO | No |
| ECOM-RQ-IP-0024 | The eCoMove System Architecture shall require systems developed from it to be able to send and receive information with a pre-defined position accuracy regardless of where the origin and/or destination are located, e.g. in tunnels, urban areas with building, mountains | n.a. | No |
| ECOM-RQ-IP-0025 | The eCoMove System Architecture shall require systems developed from it to use V2V and V2I communications standards that will ensure interoperability across Europe. | ETSI G5 and GeoNetworking protocols | Yes |
| ECOM-RQ-IP-0026 | The eCoMove System Architecture shall require systems developed from it to make use of communication (V2V and V2I) that is minimal and adaptable to future applications. | ETSI G5 and GeoNetworking protocols | No |

## *2.2. Adaptability*

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0027 | Systems that conform to the eCoMove System Architecture shall be able to provide facilities that accommodate the needs of disabled and elderly persons, when relevant. | n.a. | No |
| ECOM-RQ-IP-0028 | Systems that conform to the eCoMove System Architecture which store data about the travel network (e.g. road network, RSU locations, Green Zones) shall allow that data to be entered and updated | n.a. | No |
| ECOM-RQ-IP-0029 | The eCoMove System Architecture shall not constrain its functionality to be implemented in a single topographical domain, be it urban, inter-urban or rural. | IPv6 and ETSI G5 | No |
| ECOM-RQ-IP-0030 | The eCoMove System Architecture shall not constrain its functionality to be implemented by specific local organisations. | n.a. | No |
| ECOM-RQ-IP-0031 | The eCoMove System Architecture shall not constrain user interfaces to be of a particular type, or from a particular manufacturer. | n.a. | No |
| ECOM-RQ-IP-0032 | The eCoMove System Architecture shall not require that each of its user interfaces must operate on a specific item of equipment, unless it is for safety reasons. | n.a. | No |

### 2.3. Continuity

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0036 | The eCoMove System Architecture shall provide functionality that enables checking if quality of information content is continuous and consistent, both in time and space (i.e. as the traveller moves). | IPv6 and NEMO | No |
| ECOM-RQ-IP-0037 | The eCoMove System Architecture shall take into account in the design environmental stress and infrastructure failures. | n.a. | No |

### 2.4. Cost/benefit

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0038 | Whenever possible and practical, the eCoMove System Architecture shall use the same data as input to several parts of its functionality. | n.a. | No |
| ECOM-RQ-IP-0039 | Removed – duplicate | n.a. | No |
| ECOM-RQ-IP-0040 | The eCoMove System Architecture shall aim to have all systems developed from it to be able to use the most cost-effective means of communication available. | Open source, COTS hardware cost based media selection | No |
| ECOM-RQ-IP-0041 | The eCoMove System Architecture shall aim that all systems developed from it enable operating costs to be reduced whenever possible, when compared with the systems that they replace. | Open source, COTS hardware Patent-free | No |

### 2.5. Expandability

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0042 | The eCoMove System Architecture shall allow systems developed from it to have an evolutionary development strategy that enables their continuous upgrading. | Open source, COTS hardware standardisation | No |
| ECOM-RQ-IP-0043 | The eCoMove System Architecture shall provide services that are not constrained to operate in a particular geographic region. | n.a. | No |

### 2.6. Quality of Data Content

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0046 | The eCoMove System Architecture shall enable all information systems developed from it to provide data with a stated accuracy, either as additional information or as part of the documentation, at all times. | Yes | No |
| ECOM-RQ-IP-0047 | The eCoMove System Architecture shall require all systems developed from it to check all input data for validity, whenever possible, and to report failures. | Yes | Yes, partially only geometrical filtering |
| ECOM-RQ-IP-0048 | The eCoMove System Architecture shall enable all systems developed from it to check data values by comparing different sources, when available, so as to ensure high-accuracy and completeness. | n.a. | No |
| ECOM-RQ-IP-0049 | The eCoMove System Architecture shall require all systems developed from it to use a databases structure that is compatible on local/regional/national level (i.e. data from local/regional and national databases can be exchanged) | n.a. | No |
| ECOM-RQ-IP-0050 | The eCoMove System Architecture shall require all systems developed from it to reject all data communicated to it that fails any validity checks. | Yes | Yes, partially only geometrical filtering |

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-IP-0051 | The eCoMove System Architecture shall require all systems developed from it to be able to adjust the speed with which data is accessed according to the need for that data to accurately reflect the current situation. | Yes | Yes, ??? |
| ECOM-RQ-IP-0052 | The eCoMove System Architecture shall require all systems developed from it to support priority, quality and reliability concepts for dynamic content handling and data fusion algorithms. | QoS parameters on communication services | No |
| ECOM-RQ-IP-0053 | The eCoMove System Architecture shall require all systems developed from it to support digital rights management for all data that it uses, particularly where this data is obtained from other systems, e.g. map data. | Not in eCoMove demonstrators. Security aspects in general is not focus of eCoMove. | No |

## *2.7. Communication platform*

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-SP2-0001 | The eCoMove System developed should be platform Independent | Yes | Yes |
| ECOM-RQ-SP2-0002 | the eCoMove platform should be CVIS compatible | Requirement removed | Na |
| ECOM-RQ-SP2-0003 | the eCoMove platform should be MOOVE compatible | Requirement removed | Na |
| ECOM-RQ-SP2-0004 | eCoMove platforms should be interoperable | Yes | Yes |
| ECOM-RQ-SP2-0005 | SP2 should provide harmonised communication interfaces for every eCoMove platform | Yes | Yes, ETSI specs |
| ECOM-RQ-SP2-0006 | Characteristic distance of V-I communication: The RSU is expected to communicate with vehicles in 300m range | Yes | Yes |
| ECOM-RQ-SP2-0007 | The ecoFVD and ecoTSD message must be delivered to destination node within the range of 100 millisec (single hop API – to – API timing) | Yes | Yes |
| ECOM-RQ-SP2-0008 | The eCoMove platform should support information exchange between central ITS stations and vehicle or roadside ITS stations using 3G communication | Yes | No |

## *2.8. Communication system*

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-SP2-0009 | The eCoMove System shall support two-way roadside-to vehicle communication (point-to-point). | Yes | Yes |
| ECOM-RQ-SP2-0010 | The eCoMove System shall support two-way vehicle-to vehicle communication (point-to-point) | Yes | Yes |
| ECOM-RQ-SP2-0011 | The eCoMove System shall support one-way roadside-to vehicle communication (point-to-multi-point) by broadcasting to a specific area (geo-broadcast) | Single hop broadcast only | Yes |
| ECOM-RQ-SP2-0012 | The eCoMove System shall support one-way vehicle-to-vehicle communication (point-to-multi-point) by broadcasting to a specific area (geo-broadcast) | Single hop broadcast only | Yes |
| ECOM-RQ-SP2-0013 | The eCoMove System shall be able to transport a message into a specific area (geo-cast) | Single hop broadcast only | Yes |
| ECOM-RQ-SP2-0014 | The eCoMove System shall support communication between RSUs | Yes | No |

### *2.9. Requirements not listed in D2.1*

A number of requirements relating to the Communication platform are not listed in D2.1 and D2.2 have been identified in WP2.4.1. They are shown below with numbering starting at 1000.

| REQ NR. | Description | Relevance to Pilot | Communication Platform applicability |
|---|---|---|---|
| ECOM-RQ-SP2-1001 | Timestamps used in external communication shall have an accuracy better than 100 ms. | Yes | Yes, to which timestamp??? |
| ECOM-RQ-SP2-1002 | Vehicle router shall be compatible with vehicle environments, regarding power supply, size headless operation, and other environmental parameters. | No formal, standard-based requirements. | No |
| ECOM-RQ-SP2-1003 | Road Side Units shall be compatible with road side cabinet, unattended operation and environmental parameters. | No formal, standard-based requirements. | No |
| ECOM-RQ-SP2-1004 | Vehicle and Road Side router shall be able to process 100 incoming messages per second. | Yes | Yes |
| ECOM-RQ-SP2-1005 | Communication services should be made available to application on an attached host computer running Windows/OSGi or Linux/OSGi. | Yes | Yes |
| ECOM-RQ-SP2-1006 | Communication platform shall support IPv6 | Yes | No |
| ECOM-RQ-SP2-1007 | Communication platform shall support ETSI GeoNetworking Single Hop Broadcast over IEEE802.11p using ETSI G5 | Yes | Yes |
| ECOM-RQ-SP2-1008 | Communication platform shall support unicast single hop communications V2I and V2V. | Yes | Yes |
| ECOM-RQ-SP2-1009 | Communication platform shall support Service Advertisement. | Yes | No |
| ECOM-RQ-SP2-1009 | Communication platform shall provide emulation facilities to enable development and testing without need for router hardware. | Yes | No |
| ECOM-RQ-SP2-1010 | Router shall maintain a reference clock | Yes | Yes |

# 3. Communication Layers

### *3.1. Access Technology*

Access technology refers to the physical and medium access specification. As described in [2], the Access technology used is based on the ITS-G5 standard ETSI ITS G5 - ETSI ES 202 663 V1.1.0 (2010-01).

### *3.2. Network Layer*

Two main networking layer are considered in the context of eCoMove Project:

- GeoNetworking
- Ipv6 over 3G

Specification of the protocol is provided in [1]

### *3.3. Transport Layer*

The Basic Transport Protocol (BTP) provides an end-to-end, connection-less transport service in the ITS ad hoc network, using the GeoNetworking protocol. Specification of the transport layer for eCoMove is provided in [1].

### *3.4. Facility Layer*

Facility layer refers to the application services for communications, it includes the ecoMessage encoding and decoding and basic communication media handling components. It consists of the following elements:

- ecoMessage API
- Service Communication API
- Announcements API
- Legacy IPv6 interface

Description is provided in [1].

### *3.5. Minimum level of interoperability*

In order to assure interoperability between eCoMove stations, the following level of compliance are considered to be provided by the primary platforms:

- PHY/MAC layer: ETSI ITS G5 - ETSI ES 202 663 V1.1.0 (2010-01) [2].
- Network layer: partial ETSI ITS GeoNetworking - ETSI TS 102 636-4-1 V1.1.1 (2011-06) [6], consisting of two GeoNetworking packet header types: Single-Hop Broadcast (SHB) and GeoUnicast with Hop Limit set to 1 by the packet source.
- Transport layer: ETSI ITS Basic Transport Protocol - ETSI TS 102 636-5-1 V1.1.1 (2011-02) [5].
- Facilities layer messages: ecoMessages specified in eCoMove D2.5 [9] (final version will be D2.13). CAM messages will conform to ETSI TS 102 637-2 V1.2.1 [5]. A revised CAM specification is expected Q3/Q4 2011 and eCoMove will adopt this new revision.

# 4. Test Methodology

## *4.1. Overview*

In order to provide evidence of the interoperability of the different platform and the availability of communication facility services are indicated by application requirements, the methodology of test planned consists of the following main category tests:

1) Transport layer Interoperability Test
2) Facility Layer Interoperability Test

It is distinguished between partner level test and interoperability test. The first is not covered in this test report and is considered to be carried out by each single partner before the interoperability tests. Each partner shall assure that the 4 layer works in its own laboratory. Interoperability tests are planned to guarantee that platforms actually interoperate and that the internal platform operation are conformal with the communication platform specification [1].

## *4.2. Interoperability Test Plan*

This chapter describes the interoperability objectives and expected results. As described in the previous section two interoperability tests are defined:

1) T1 – Transport Layer Interoperability Test (TL)
2) T2 – Facility Layer Interoperability Test (FL)

## *4.3. T1 – Transport Layer Interoperability Test (TL)*

| | Description |
|---|---|
| Objectives | • Test transport communication between stations<br>• Test GeoNetworking protocol (Unicast/single hop, broadcast)<br>• Test Access Media interoperability |
| Extension | Laboratory test with one unit per participant |
| Prerequisite | • Participants shall have tested GeoNetworking Protocol, ITS-M5 access media specification<br>• At least one unit available for the test<br>• Recording Facilities |
| Steps | • Set up access media configuration (channel selection)<br>• Set up unicast/broadcast messages<br>• Set up recording facility<br>• Check for announcement of Stations<br>• Send messages (unicast/broadcast)<br>• Log exchanged messages |
| Expected results | • Successful Station Announcement sending/receiving<br>• Successful Message (Unicast/broadcast) receiving/sending |

## *4.4. T2 – Facility Layer Interoperability Test (FL)*

| | Description |
|---|---|
| Objectives | • Test eCoMessage Facility Layer |

| | |
|---|---|
| | • Test Communication Facility Layer |
| Extension | • Remote laboratory test |
| Prerequisite | • Design network test configuration<br>• Development and test of ecoMessages suite<br>• Development and test of Communication Components<br>• Development of test suites |
| Steps | • Set-up of IPv4/ipv6 network<br>• Set-up of the remote configuration |
| Expected results | • Successful Exchange of ecoMessages<br>• Successful Exchange of UTP/TCP/Packets over Communication Components. |

# 5. Transport Layer Interoperability Test

## *5.1. Introduction*

In the present chapter, the definition and the results of the Laboratory test is provided.

## *5.2. Equipment and Setup*

### *5.2.1. Equipment per provider*

NEC:
1 LinkBird + 1 notebook + antennas

Q-Free:
1 CSP router + 1 notebook + antennas

### *5.2.2. Required Hardware/ Software*

- CCU
  - IEEE 802.11p radio
  - C2X Networking and Transport software (NEC's C2X-SDK2 and Q-Free's Geonetworking component)
- Test Applications

### *5.2.3. PHY/MAC Configurations*

| Parameter | Value |
|---|---|
| Frequency | 5.900 GHz , CCH180 (178) * |
| Channel bandwidth | 20 MHz * |
| Transmit Power | 20 dBm |
| Radio Bit rate | 6 Mbit/s |

*: Bandwith and Frequency shall be in accordance to ETSI specification, See section 5.4.1 Frequency and channel bandwidth.

## *5.3. Lab Tests Definition*

### *5.3.1. Lower Layer / Network Layer tests*

Set static GPS position via configuration or configuration tools.

| 11p box | Latitude | Longitude | GN Address |
|---|---|---|---|
| CSP | 48.4 | 10.000 | 901 / MAC Address |
| LinkBird | 48.4 | 10.002 | 902 / MAC Address |

#### *5.3.1.1. Beacon Test*

During this test it will be verified that the beacon packets get though over the air using IEEE 802.11 with ETSI G5 definitions.

| **Beacon tests** | |
|---|---|
| Test | Comment |
| LinkBird sending beacons, | Test passed. |

| | |
|---|---|
| CSP box receiving them | |
| CSP box sending beacons, LinkBird receiving them | Test passed. |

*5.3.1.2. SHB Test*

The following configurations should be used for triggering an SHB packet:

| Type of message | Configuration setting |
|---|---|
| SHB | Hoplimit = 1 |

| **SHB tests** | |
|---|---|
| Test | Comment |
| LinkBird sending an SHB packet via a test application with Hoplimit 1, CSP receiving the SHB | Test passed. |
| CSP sending a SHB packet via a test application with Hoplimit 1, LinkBird receiving the SHB | Test passed. |

For logs, see Annex

*5.3.1.3. Unicast Test*

The following configurations should be used for triggering a Unicast packet:

| Type of message | Configuration setting |
|---|---|
| Unicast | nodeID = 901 / MAC Address<br>nodeID = 902 / MAC Address |

Note: It should be possible to use the MAC address as a destination GN Address.

| **Unicast tests** | |
|---|---|
| Test | Comment |
| LinkBird sending a Unicast packet via a test application with destination id=902 / MAC Address, CSP receiving it | Test passed.<br>A node shall use the MAC address as a GN Address. |
| CSP sending a Unicast packet via a test application with destination id=901 / MAC Address, LinkBird receiving it | Test passed.<br>A node shall use the MAC address as a GN Address. |

For logs, see Annex

### *5.4. Issues or Deviation from Test Plan*

#### *5.4.1. Frequency and channel bandwidth*

During the test setup there was an issue with the 802.11p channel numbers and channel bandwidth. Conformance with ETSI specification shall be ensured.

#### *5.4.2. Unicast packets*

The station shall be able to use the MAC Address as a GN Address.

# 6. ETSI Plugtest

ETSI Plugtests was organized in Helmond, the Netherland, from 14th to 18th of November 2011. The event consists in the testing of ETSI specification for both the transport and message format. A detail description of the test was defined according to ETSI plugtest specification [9]. Plugtest has been divided in two parts:

1) GeoNetworking Scenarios
2) Facility Scenarios

Tests were also divided in Mandatory and Optional.

### *6.1. Mandatory Tests*

| |
|---|
| 1 TD_GN_BEA_01 Detection of neighbour |
| 2 TD_GN_GBC_01 Broadcasting of CAM messages is correctly handeled |
| 3 TD_GN_GBC_02 DENM message is processed inside its Destination Area |
| 4 TD_GN_GBC_03 Number of re-broadcasts is correctly handled during DENM flooding |
| 5 TD_GN_GBC_04 DENM message is not processed outside its Destination Area |
| 6 TD_GN_GBC_05 Geo-broadcast message caching and DENM expiry handling are correctly implemented |
| 7 TD_GN_DAD_01 Resolution of duplicate Gn address scenario |
| 8 TD_CAM_01 CAM messages with basicVehicle profile are interoperable |
| 9 TD_CAM_02 CAM messages with emergencyVehicle profile are interoperable |
| 10 TD_CAM_03 CAM messages with publicTransportVehicle profile are interoperable |
| 11 TD_CAM_04 CAM messages with basicRIS profile are interoperable |
| 12 TD_DENM_01 DENM re-transmissions are correctly received within the DENM lifetime |
| 13 TD_DENM_02 DENM re-transmissions are not received after the DENM lifetime |
| 14 TD_UC_01 CAM messages generate and interpret the vehicle location parameter correctly |
| 15 TD_UC_02 DENM messages generate and interpret the vehicle location parameter correctly |
| 16 TD_UC_03 DENM messages can include parameters needed by ‘Roadworks warning’ application |
| 17 TD_UC_04 CAM messages can include parameters needed by ‘Traffic jam ahead warning’ and ‘Slow vehicle warning’ application |
| 18 TD_UC_05 DENM messages can include parameters needed by ‘Traffic jam ahead warning’ |
| 19 TD_UC_06 CAM messages can include parameters needed by ‘Car Breakdown warning’ application |
| 20 TD_UC_07 DENM messages can include parameters needed by ‘Car Breakdown warning’ application |

### *6.2. Optional Tests*

| |
|---|
| 1 TD_GN_FWD_01 DENM message is correctly forwarded to its Destination Area |
| 2 TD_GN_FWD_02 DENM message is correctly geo-routed towards its Destination Area |
| 3 TD_GN_FWD_03 DENM message geo-routing is correctly handeled when no suitable forwarder exists |
| 4 TD_DENM_03 DENM information is kept alive as expected during its lifetime |
| 5 TD_UC_08 CAM messages can include parameters needed by ‘Approaching emergency vehicle’ application |
| 6 TD_UC_09 DENM messages can include parameters needed by ‘Approaching emergency vehicle’ application |
| 7 TD_UC_10 DENM messages can include parameters needed by ‘Weather Warning (Wind)’ application |
| 8 TD_UC_11 DENM messages can include parameters needed by ‘Emergency electronic break lights’ application |
| 9 TD_UC_12 CAM messages can include parameters needed by ‘Post crash warning’ application |
| 10 TD_UC_13 DENM messages can include parameters needed by ‘Post crash warning’ application |
| 11 TD_UC_14 DENM messages can include parameters needed by ‘Obstacle warning’ application |
| 12 TD_UC_15 DENM messages can include parameters needed by ‘Wrong way driving in gas stations’ application |
| 13 TD_UC_16 CAM messages can include parameters needed by ‘Motor cycle warning’ application |
| 14 TD_UC_17 DENM messages can include parameters needed by ‘Slow vehicle warning’application |

### *6.3. Logical Architecture*

The tests were conducted in a bilateral way. Each company tested the implementation against all the other companies.

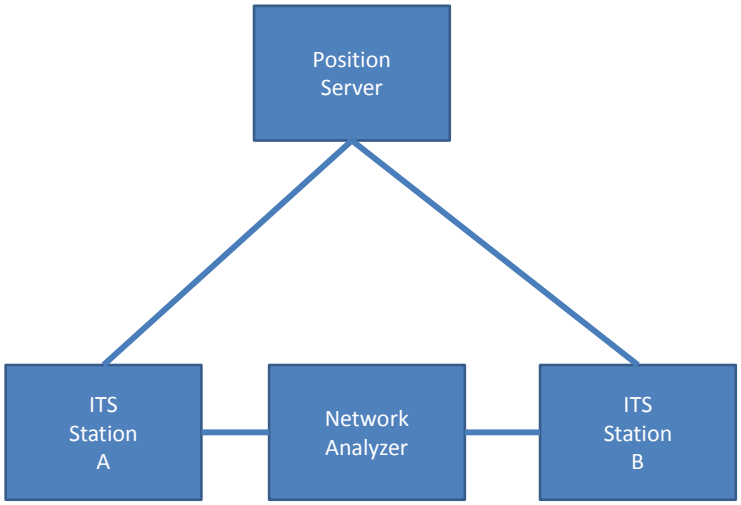


**Figure 1 Logical Architecture**

### *6.4. Test Results*

Multiple companies joined the test event, including eCoMove partners:

1) NEC
2) Q-Free
3) Peek Traffic

All mandatory tests were performed and passed. Companies representing other European projects were also present and interoperability where also demonstrated with these.

The successful test shows that eCoMove communication platform is compatible with other projects, including Drive and Score@F, both on physical layers, network and transport layers and on CAM and DENM message layer with known limitations[1].

[1] Q-Free platform does not support multi-hop GeoNetworking features, refer to section 3.5 Minimum level of interoperability.

# 7. Facility Layer Interoperability Test

## *7.1. Introduction*

The eCoMove Interoperability Test 1 aims at testing the interoperability between the different CCU hardware used in the project. During this test the following topics will be covered:

- PHY/MAC - verify that packets get trough over the air using IEEE 802.11p with ETSI G5 definitions
- Transmission of Single Hop Broadcast packets
- Transmission of Unicast packets
- Verification of SHB/Unicast payload

For these tests static configurations will be used.

On 24th of January2012 a physical meeting and on 3rd of February 2012 a remote test were performed. List of action points were collected and corrected during the following days followed be a 3rd remote verification meeting.

In the following sections, some details of the test are presented with the test results.

## *7.2. Communication set up*

This section describes the configuration used during the test.

### *7.2.1. Q-Free*

Q-Free Communication Unit (Q-Free Router) is connected to an application unit (laptop) and a Monitor for verification. The router and laptop units are connected via an Ethernet switch.

### *7.2.2. NEC*

NEC Communication Unit (LinkBird) is connected to the application unit (laptop) and to an external monitor unit (laptop) for verification. The units are connected via an Ethernet switch.

### *7.2.3. Network*

Anetwork Ethernet switch allows the two communication platform to be connected physically in order to test the eCoMessage over UDP and HTTP. The configuration with the common Ethernet switch was used in the second part of the interoperability test.

## *7.3. IPv6 Discussion*

Although IPv6 was not the focus of the interoperability tests in Heidelberg, NEC and Q-Free discussed on the various possible approach for IPv6 configuration.

## *7.4. Verification steps*

### *7.4.1. Check Message ID definition*

Message ID (in ItsPduHeader) where checked against relevant ETSI specifications [3] and eCoMove document [8]

| | |
|---|---|
| TPEGmessageID | 101 |
| TSPDMmessageID | 102 |
| VPMmessageID | 103 |
| SRMmessageID | 104 |
| EcoCAMmessageID | 105 |
| SLAMmessageID | 106 |
| ITMmessageID | 107 |
| SAmessageID | 150 |
| CAM | 1 |
| DENM | 2 |

### *7.4.2. Check Message BTP/UDP/HTTP port configuration*

Ports were verified against the table defined in [1].

| | |
|---|---|
| UDPPortGeneric | 5001 |
| BTPPortCAM | 5000 |
| BTPPortDENM | 5005 |
| BTPPortVPM | 5100 |
| BTPPortSRM | 5101 |
| BTPPortTspdm | 5102 |
| BTPPortTPEGM | 5103 |
| BTPPortSlam | 5104 |
| BTPPortItm | 5105 |
| BTPPortEcoCam | 5106 |
| SABTPdestinationPort | 5150 |
| HTTP | 8080 |

### *7.4.3. Check other parameters*

Other configuration parameters [1]

| | |
|---|---|
| GNEtherType | 0x0707 |
| SARepetitionInterval | 2 |
| CAMrepetitionInterval | 2 |
| eCoMoveUcHopLimit | 1 |
| eCoMoveUcLifetimeMultiplier | 0 |

#### 7.4.4. *Check time stamps*

Check time stamp against UTC time. Position is not relevant for the current tests.

#### 7.4.5. *Check beacon messages*

Beacon messages were correctly received by both parties.

#### 7.4.6. *Check ecoMessage over G5 SHB*

The following table shows the test held and the results.

| Message | Comment | Status | Direction |
|---|---|---|---|
| CAM | Some internal validation rule of the values shall be met (physical meaningful values) | Ok | Q-Free->NEC:ok<br>Q-Free<-NEC:ok |
| ECOCAM | | Ok | Q-Free->NEC:ok<br>Q-Free<-NEC:ok |
| SAM | Table shall be filled in; Use CalmServiceIdTable Load/Add to add entries. | Ok | Q-Free->NEC:ok<br>Q-Free<-NEC:ok |
| SLAM | | Ok | Q-Free->NEC: Ok<br>Q-Free<-NEC: X |
| TPEGM | The size limit of the message shall be less than 1500 octets. | Ok | Q-Free->NEC: ok<br>Q-Free<-NEC: ok |
| TSPDM | | Ok | Q-Free->NEC: ok<br>Q-Free<-NEC: ok |
| VPM | | Ok | Q-Free->NEC: Ok<br>Q-Free<-NEC: Ok |
| ITM | | Ok | Q-Free->NEC: Ok<br>Q-Free<-NEC: X |
| SRM | No test, this message is revoked from the ecoMessage suite. | Not applicable | Q-Free->NEC: n.a.<br>Q-Free<-NEC: n.a. |

Test marked with X was later resolved and successfully tested later in a separate session using datagram channel.

#### 7.4.7. *Check ecoMessage over G5 unicast*

Scenario:
One unit send a CAM message and the other unit reply another CAM message using unicast.

Results:
CAM over unicast ok
(Q-Free -> NEC) Ok
(NEC -> Q-Free) GN Address

For testing the GeoNetworking addresses has been set manually. Subsequent test has been performed to check GN address compliance.

#### *7.4.8. Check ecoMessages over UDP*

Scenario:
A CAM message is sent using a datagram URL. The datagram URL used in the test is:
datagram://168.254.34.0:5001

Results:
NEC -> Q-Free: Ok
Q-Free -> NEC: Ok

#### *7.4.9. Check ecoMessages over HTTP*

Scenario:
A CAM message is sent using a HTTP url. The address used for the test is:
http://168.254.34.0/ecomessages/message

Results:
NEC -> Q-Free: Ok

# 8. Specific Test Report

## *8.1. Introduction*

In this section specific test report for the communication performance are described.

## *8.2. Round Trip Time Analysis*

In order to measure the transmission time, two units where used and tested into two different situations:

A) Wired Ethernet: The two application units are connected on the same LAN and can exchange message using the datagram channel

B) G5 using Communication Router: The two units communicate via the communication unit using the G5 channel

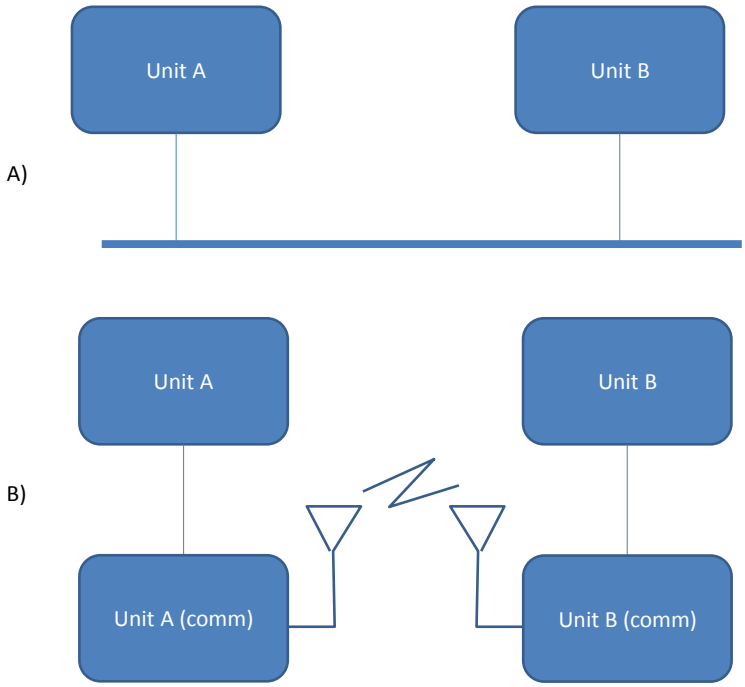


**Figure 2 - Round Trip test scenarios**

For both the use cases, the unit A is equipped with an application that generates a message, timestamp it, send on the channel and wait for the reply. The unit B is listening and when it receives the message, it just echo it to the same transmitting unit. The unit A then will get the timestamp of the transmitting and receiving event and compute the total elapsed time.

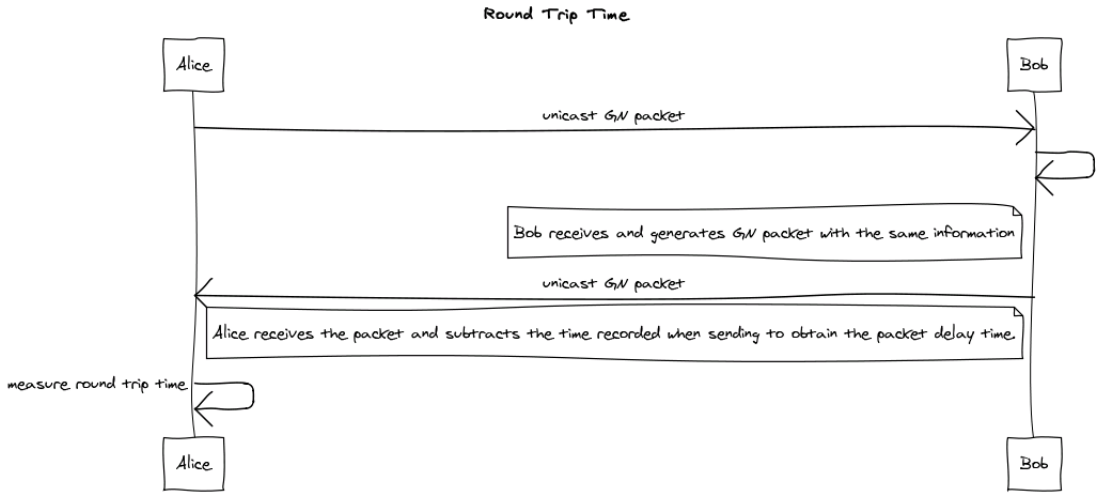


**Figure 3 - Round Trip Time sequence diagram**

The total time is due to the following reasons:

1) The message sending stack in the AU
2) The communication sending stack in the AU
3) The network delay
4) The communication receiving stack in the AU
5) The message receiving stack in the AU
6) Any load in the AU
7) OSGi framework delay as for example due to the EventAdmin

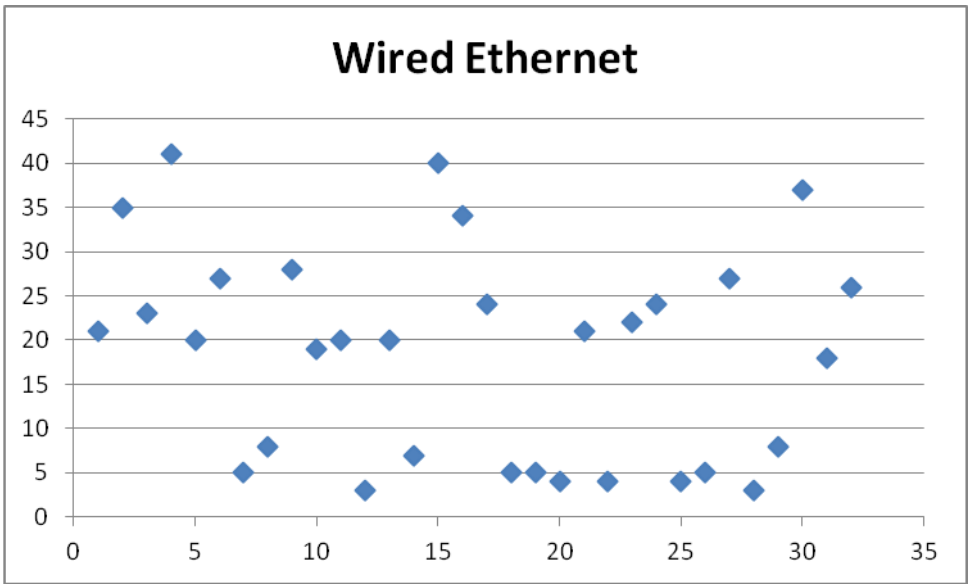


**Figure 4 Dispersion Diagram of the Wired Ethernet case**

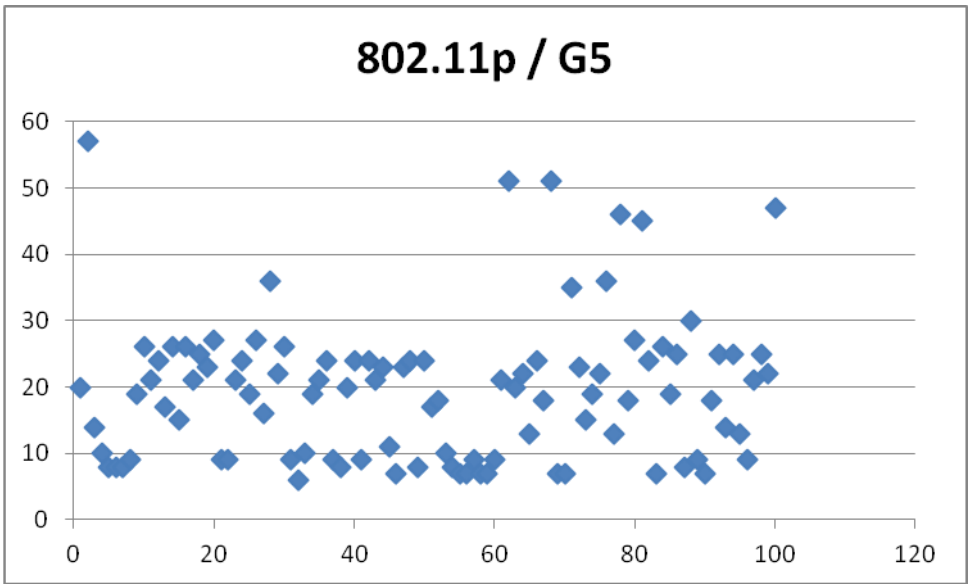


**Figure 5 Dispersion Diagram of the G5 case**

**Table 1 Performance statistics**

| Round trip time (ms) | Wired Ethernet | G5 |
|---|---|---|
| Average | 18.4 | 19.4 |
| Standard Deviation | 11.8 | 10.7 |

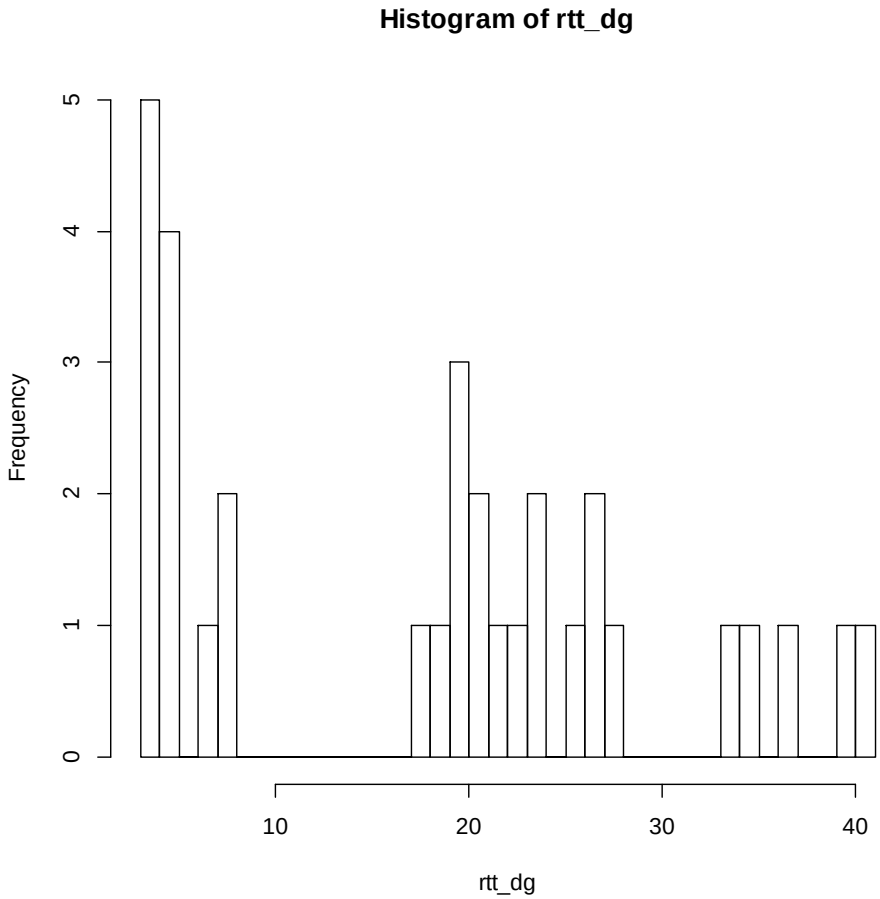


**Figure 6 Histogram of the RTT of the Wired Ethernet case**

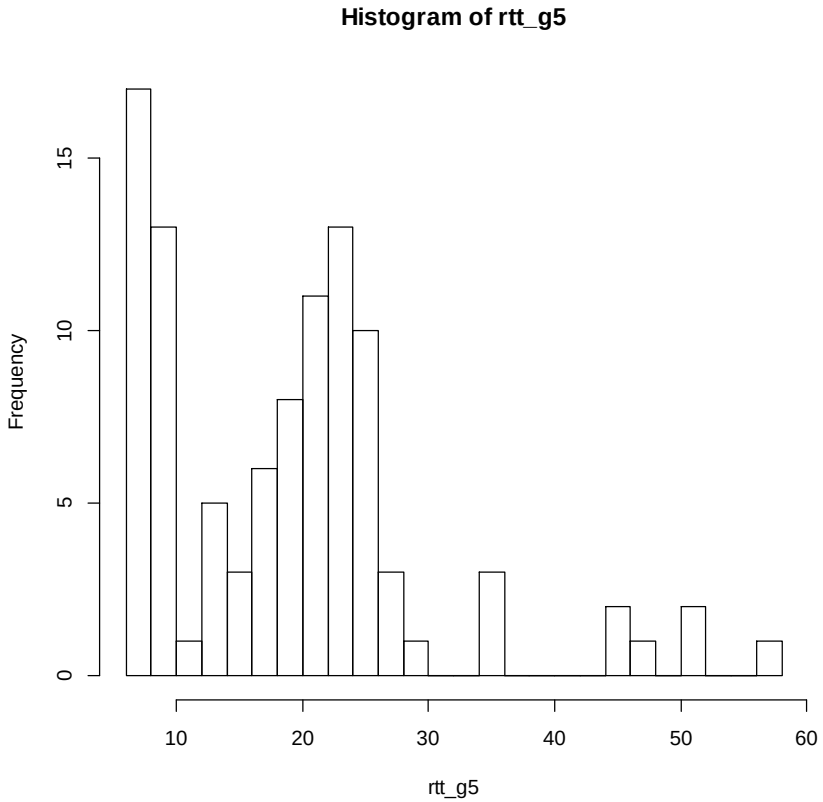


**Figure 7 Histogram of the RTT of the G5 case**

In Figure 6 and Figure 7 are reported the histogram of the RTT, while Table 1 summarize the performance. The average RTT is below the required time (20ms). The impact of the radio channel is limited (1ms).

# 9. Verification plan

With reference to [10], the following table summarize the test results.

| Test Scenario ID | Test Short Description | Notes | Result |
|---|---|---|---|
| SP2.4.1-<1>-<1> | Message communication over different media has been performed (GN,UDP,HTTP) Communication API are based on CVIS specification and implementation. EcoMessages are based on the some specification of SimTD. | Interoperability with SimTD, CVIS, SAFESPOT can not be implemented since new features are added. Development and design is based on the aforementioned projects. Application layer is not part of the Communication and EcoMessage levels. Inerrability between platform has been tested in different occasions (ETSI plugtests, mainly and in-lab test) | Passed (platform level) |
| SP2.4.1-<1>-<2> | Test has been performed with internet connection or via 3G connection. | 3G connection has been tested with the communication unit. | Passed (laboratory) |
| SP2.4.1-<1>-<3> | Different configuration for two way communication has been tested and testing bundled exchanged among implementation. Example bundles are provided to easy application development. | NA | Passed |
| SP2.4.1-<1>-<3> | Two way communication has been test in laboratory environment | All real environment test will be performed in the integration phase. | Passed (laboratory) |
| SP2.4.1-<1>-<4> | A test unit start sending ecoMessages via SHB, nearby units receive them | Within the scope of eCoMove only single hop broadcast is defined | Passed (single hop broadcast) |
| SP2.4.1-<1>-<5> | Vehicle to vehicle single hop broadcast has been tested. Transmission is checked both via logging and by receiving the messages. | Only SHB is considered in eCoMove | Passed (single hop broadcast) |

| | | | |
|---|---|---|---|
| SP2.4.1-<1>-<6> | All communication media (broadcast/geonetworking, UDP, HTTP) for communication between RSUs | | Passed |
| SP2.4.1-<1>-<7> | Not applicable | Depends on the configuration (antenna, position, target area, obstacles), based on ETSI specification. To be tested and tuned onsite. To be carried out in following phases. | Not applicable |
| SP2.4.1-<1>-<8> | Time is measured between the transmission of a message in one unit and the receiving of the same message in the same unit, echoed from a second unit | A unit is running a echoing application. Time of transmission and receiving is the half the time of round trip. | Passed (see specific section) |

| **Test Scenario ID** | Test Short Description | Notes | Result |
|---|---|---|---|
| SP2.4.2-<1>-<1> | EcoCam is generated successfully | Application is not part of the verification of ecoMessages | Passed (only the generation part) |
| SP2.4.2-<1>-<2> | Among the other message the DENM message contains information on traffic event. Also TPEG message can deliver the traffic situation information | Content is not considered. TPEG message encoding/decoding is not in the scope of ecoMessage activity | Passed (creation of a TPEG and DENM message and transmission) |
| SP2.4.2-<3>-<1> | eCoMessage specification is based on ETSI specification and formalized using ASN.1 | | Passed |
| SP2.4.2-<1>-<3> | eCoMessage specification is based on ETSI specification and includes CAM and DENM messages | | Passed |
| SP2.4.2-<1>-<4> | All positioning information uses WGS84 geographical | Test with EcoMap is not part of the current verification test. | Passed |

| | |
|---|---|
| | coordinate system which is map independent |

# Annexes

### *Annex A: SHB log*

An SHB packet send from CSP and received by LinkBird:

```
0000  ff ff ff ff ff ff 00 00  00 00 03 01 07 07 01 50   ........ .......P
0010  00 00 00 08 00 01 00 00  00 00 00 00 03 01 00 00   ........ ........
0020  00 01 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   ....A... ........
0030  00 00 fe 57 e2 e2 61 73  64 66                     ...W..as df
```

An SHB packet send from LinkBird and received from CSP:

```
0000  ff ff ff ff ff ff 00 0b  6b 2e d4 96 07 07 01 50   ........ k......P
0010  00 00 04 04 00 01 00 00  00 0b 6b 2e d4 96 cf 64   ........ ..k....d
0020  55 99 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   U...A... ........
0030  00 00 fe 57 00 00 38 38  38 38                     ...W..88 88
```

### *Annex B: Unicast log*

A Unicast packet send from CSP and received from LinkBird:

```
0000  00 0b 6b 2e d4 96 00 00  00 00 03 01 07 07 01 20   ..k..... ....... 
0010  00 00 00 08 00 0a 00 00  00 00 00 00 03 01 00 00   ........ ........
0020  00 01 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   ....A... ........
0030  00 00 00 a9 00 00 00 00  00 00 00 00 03 01 00 00   ........ ........
0040  00 01 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   ....A... ........
0050  00 00 00 00 00 0b 6b 2e  d4 96 cf 95 75 10 1c d9   ......k. ....u...
0060  41 00 05 f5 e1 00 fe 57  5a a4 61 73 64 66         A......W Z.asdf
```

A Unicast packet send from LinkBird and received from CSP:

```
0000  00 00 00 00 03 01 00 0b  6b 2e d4 96 07 07 01 20   ........ k...... 
0010  00 00 00 08 00 07 00 00  00 0b 6b 2e d4 96 cf 8c   ........ ..k.....
0020  7f 2f 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   ./..A... ........
0030  00 00 9e 64 60 00 00 00  00 0b 6b 2e d4 96 cf 8c   ...d`... ..k.....
0040  7f 2f 1c d9 41 00 05 f5  e1 00 00 00 00 00 00 00   ./..A... ........
0050  00 00 00 00 00 00 00 00  03 01 cf 8c 7f 2f 1c d9   ........ ...../..
0060  41 00 05 f5 e1 00 fe 57  00 00 38 38 38 38         A......W ..8888
```