Specification for interoperability of backend hybrid C-ITS communication

Version 1.6.32

C-Roads Platform
Working Group 2 Technical Aspects
Taskforce 4 Hybrid Communication

Revision information and document handling

Version	Date	Description	Status
1.0	19.06.2019	Draft for approval by Steering Committee	Draft
1.5	02.07.2019	Based on SC meeting on 02-07-2019: Release 1.5 is accepted for C-ROADS deployment by all member states	Final
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Acronyms/explanations

AMQP	Advanced Message Queueing Protocol
APACHE	The Apache HTTP Server, colloquially called Apache, is a free and open-source cross-platform web server software, released under the terms of Apache License2.0.
avc	automated vehicle container
BI	Basic Interface
C-ITS	Cooperative Intelligent Transport Systems
CAM	Cooperative Awareness Message
CRL	In cryptography, a Certificate Revocation List (or CRL) is "a list of digital certificates that have been revoked by the issuing certificate authority (CA) before their scheduled expiration date and should no longer be trusted.
DENM	Decentralized Environmental Notification Message
ETSI	European Telecommunications Standards Institute
EU	European Union
gic	GNSS/Ground Integrity Channel
GHz	Gigahertz
GIS	Geographical Information System: is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.
GNSS	Global Navigation Satellite System, system used for positioning and road segment identification
HLN-RLX	Hazardous Location Notification - Railway Level Crossing
hop	In computer networking, including the Internet, a hop occurs when a packet is passed from one network segment to the next. Data packets pass through routers as they travel between source and destination. The hop count refers to the number of intermediate devices through which data must pass between source and destination. Since store and forward and other latencies are incurred through each hop, a large number of hops between source and destination implies lower real-time performance
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ID	Identifier
IEC	International Electrotechnical Commission
IEEE 802.11	See IEEE 802.11P
IEEE 802.11p	IEEE 802.11p is an approved amendment to the IEEE 802.11 standard to add wireless access in vehicular environments (WAVE), a vehicular communication system. It defines enhancements to 802.11 (the basis of products marketed as Wi-Fi) required to support Intelligent Transportation Systems (ITS) applications.

	This includes data exchange between high-speed vehicles and between the vehicles and the roadside infrastructure, so called V2X communication, in the licensed ITS band of 5.9 GHz (5.85-5.925 GHz).
IP	Internet Protocol
IPv4	Internet Protocol version 4 (IPv4) is the fourth version of the Internet Protocol (IP). It is one of the core protocols of standards-based internetworking methods in the Internet, and was the first version deployed for production in the ARPANET in 1983. It still routes most Internet traffic today, despite the ongoing deployment of a successor protocol, IPv6. IPv4 is described in IETF publication RFC 791 (September 1981), replacing an earlier definition (RFC 760, January 1980). IPv4 is a connectionless protocol for use on packet-switched networks. It operates on a best effort delivery model, in that it does not guarantee delivery, nor does it assure proper sequencing or avoidance of duplicate delivery. These aspects, including data integrity, are addressed by an upper layer transport protocol, such as the Transmission Control Protocol(TCP).
IPv6	Internet Protocol version 6 (IPv6) is the most recent version of the Internet Protocol (IP), the communications protocol that provides an identification and location system for computers on networks and routes traffic across the Internet. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion. IPv6 is intended to replace IPv4. In December 1998, IPv6 became a Draft Standard for the IETF, who subsequently ratified it as an Internet Standard on 14 July 2017.
ISO	International Organisation for Standardization
IETF	Internet Engineering Task Force is an open standards organization, which develops and promotes voluntary Internet standards, in particular the standards that comprise the Internet protocol suite (TCP/IP). It has no formal membership or membership requirements. All participants and managers are volunteers, though their work is usually funded by their employers or sponsors.
II	Improved Interface
ITS G5	ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). ITS-G5 uses the approved amendment of the IEEE 802.11 (standard IEEE 802.11p). This technology (possibly others) uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications.
IVI	Infrastructure to Vehicle Information
IVIM	Infrastructure to Vehicle Information Message
KB	Kilobyte
MAPEM	MAP (topology) Extended Message
m	Metre
ms	Milliseconds
MS	Member State
OCSP	The Online Certificate Status Protocol (OCSP) is an Internet protocol used for obtaining the revocation status of an X.509 digital certificate. It is described in RFC 6960 and is on the Internet standards track. It was created as an alternative to certificate revocation lists (CRL), specifically addressing certain problems

	associated with using CRLs in a public key infrastructure (PKI). Messages communicated via OCSP are encoded in ASN.1 and are usually communicated over HTTP.
OEM	Original Equipment Manufacturer
OV	Organization Validated
PKI	A public key infrastructure (PKI) is a set of roles, policies, hardware, software and procedures needed to create, manage, distribute, use, store and revoke digital certificates and manage public-key encryption.
rcc	RoadConfigurationContainer
RFC	Request For Comments
RO	Road Operator
RTA	Road Traffic Authority
RSP	Roadside ITS-G5 System Profile (short also Roadside System Profile)
SPATEM	Signal Phase and Timing Extended Message
SREM	Signal Request Extended Message
SSEM	Signal Request Status Extended Message
SW	software
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security (TLS), and its now-deprecated predecessor, Secure Sockets Layer (SSL), are cryptographic protocols designed to provide communications security over a computer network. The TLS protocol aims primarily to provide privacy and data integrity between two or more communicating computer applications. When secured by TLS, connections between a client (e.g., a web browser) and a server should have one or more of the following properties: - The connection is private (or secure) because symmetric cryptography is used to encrypt the data transmitted. The keys for this symmetric encryption are generated uniquely for each connection and are based on a shared secret that was negotiated at the start of the session. The server and client negotiate the details of which encryption algorithm and cryptographic keys to use before the first byte of data is transmitted. The negotiation of a shared secret is both secure (the negotiated secret is unavailable to eavesdroppers and cannot be obtained, even by an attacker who places themselves in the middle of the connection) and reliable (no attacker can modify the communications during the negotiation without being detected). - The identity of the communicating parties can be authenticated using public-key cryptography. This authentication can be made optional, but is generally required for at least one of the parties (typically the server). - The connection is reliable because each message transmitted includes a message integrity check using a message authentication code to prevent undetected loss or alteration of the data during transmission. In addition to the properties above, careful configuration of TLS can provide additional privacy-related properties such as forward secrecy, ensuring that any future disclosure of encryption keys cannot be used to decrypt any TLS communications recorded in the past. TLS supports many different methods for exchanging keys, encrypting data, and authenticating message integrity. As a result, secure configuration of TLS involves

	many configurable parameters, and not all choices provide all of the privacy-related properties.
TTL	Time to live (TTL) or hop limit is a mechanism that limits the lifespan or lifetime of data in a computer or network. TTL may be implemented as a counter or timestamp attached to or embedded in the data. Once the prescribed event count or timespan has elapsed, data is discarded or revalidated.
V2I	Vehicle-to-Infrastructure Communication; Information exchange between vehicles and infrastructure.
V2V	Vehicle to Vehicle Communication; information exchange between vehicles.
V2X	Vehicle-to-any communication; X is either infrastructure or car; Including communication between vehicles as well as between vehicles and infrastructure.
WAVE	Wireless Access in Vehicular Environments
WG2	Workgroup 2
WGS84	World Geodetic System is a standard used in cartography
Wi-Fi	Wi-Fi is a family of radio technologies commonly used for wireless local area networking (WLAN) of devices. It is based on the IEEE 802.11 family of standards.
WLAN	Wireless Local Area Network
X.509	In cryptography, X.509 is a standard defining the format of public key certificates. X.509 certificates are used in many Internet protocols, including TLS/SSL, which is the basis for HTTPS, the secure protocol for browsing the web. They are also used in offline applications, like electronic signatures. An X.509 certificate contains a public key and an identity (a hostname, or an organization, or an individual), and is either signed by a certificate authority or self-signed. When a certificate is signed by a trusted certificate authority, or validated by other means, someone holding that certificate can rely on the public key it contains to establish secure communications with another party, or validate documents digitally signed by the corresponding private key. X.509 also defines certificate revocation lists, which are a means to distribute information about certificates that have been deemed invalid by a signing authority, as well as a certification path validation algorithm, which allows for certificates to be signed by intermediate CA certificates, which are, in turn, signed by other certificates, eventually reaching a trust anchor.

e.g.	In Latin “exempli gratia” which stands for: “For Example”
i.e.	In Latin “id est” which stands for “In other words”
w.r.t.	With respect to

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1 Introduction

This specification aims to provide C-ITS service interoperability between C-ITS actors using IP backend communication.

1.1 Purpose of this document

The purpose of this document is to provide specifications and profiles for an IP based C-ITS interface needed for interoperability and backend communication.

1.2 Verbal forms of the expression of provisions

In this document, the following verbal forms are used to indicate mandatory requirements:
Shall / Shall not

Recommendations shall be indicated by the verbal forms:
Should / Should not

Permissions shall be indicated by the verbal forms:
May / May not

Possibility and capability shall be indicated by the verbal forms:
Can / Cannot

Inevitability used to describe behavior of systems beyond of the scope of this deliverable shall be indicated by:
Will / Will not

Facts shall be indicated by the verbal forms:
Is / Is not

1.3 Definitions

C-ITS Actors – entities or organisations which operate C-ITS stations and/or provide C-ITS services based on high quality traffic information. C-ITS actors have the responsibility to update their published and supported C-ITS messages.

AMQP (Advanced Message Queuing Protocol) – AMQP is a binary, application layer protocol, designed to efficiently support a wide variety of messaging applications and communication patterns.

AMQP broker – An AMQP message broker is an architectural pattern for message routing. It mediates communication among applications, minimizing the mutual awareness that applications should have of each other in order to be able to exchange messages, effectively implementing decoupling. In this specification, an AMQP broker is used to route C-ITS messages.

Basic Interface (BI) is the data communication interface used for real time exchange of C-ITS messages in the backend communication.

Deployment Model is how a group of C-ITS actors decides to establish the information-sharing network, e.g. using a central AMQP broker(s) which interconnects multiple C-ITS actors, alternatively; information sharing between C-ITS actors can be based on multiple logical point-to-point connections directly between the C-ITS actors.

Hybrid C-ITS – Hybrid communication covers for transmission of C-ITS messages potentially using multiple communication channels; availability of such communication channels may vary depending on policy, location and requirements set.

C-ITS messages - signed messages defined by ETSI and ISO and profiled in the C-ROADS Roadside System Profile (RSP).

Third parties - any organization which is contracted by a C-ITS Actor.

Interchange entity - Specialized SW entity that incorporates an AMQP broker/client plus additional functionality

Capabilities - Description of available data sets

Data sets - Available information and meta-data

-**Trusted Domain name** – Trusted registry of interchange entities approved by the relevant governing body.

Endpoint – The entry point to a service, a process, or a queue or topic destination in service-oriented architecture ~~Editors note:~~

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1.4 References

[1]	AMQP ISO/IEC 19464:2014
[2]	C-ITS Infrastructure Functions and Specifications
[3]	Roadside ITS G5 System Profile
[4]	AMQP Apache-filters-chapter 2: Java Message Service Support
[5]	RFC 8446 Transport Layer Security Protocol
[6]	RFC 6066 Transport Layer Security Extensions
[7]	RFC 5280 Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile
[8]	ISO 3166-1 alpha-2 Country Codes
[9]	ISO 14816:2005 Road transport and traffic telematics — Automatic vehicle and equipment identification — Numbering and data structure
[10]	ISO 14823:2017 Intelligent transport systems — Graphic data dictionary
[11]	ISO/TS 19321:2015 Intelligent transport systems — Cooperative ITS — Dictionary of in-vehicle information (IVI) data structures
[12]	ETSI EN 302 637-3 Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized

	Environmental Notification Basic Service
[13]	ETSI TS 103 301 Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services
[14]	RFC 2616 Hypertext Transfer Protocol — HTTP/1.1
[15]	RFC 2818 HTTP over TLS (HTTPS)

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1.5 Numbering and version handling of requirements

Numbering of requirements are done as requirements are added, which leads to that numbers are not always in a sequential order. Since requirements also have been deleted (see appendix C for details) some numbers are missing.

If requirements are changed between versions of this document according to the change request procedure, this is specified with "/" and stepped up to the number of the release. Version number will be stated in the revision information table.

New requirements will get an index that corresponds to the version number of the release.

HYB_XXX/1 means that this requirement has not changed since the first version of document.

HYB_XXX/1+n means that this requirement has changed in this release or that it is a new requirement introduced in this version.

Please check version history for current numbering of index.

2 Scope of specification

This document provides a description of the functionality and profiles which are needed to provide hybrid communication via interconnection of backend systems to allow sharing of C-ITS information.

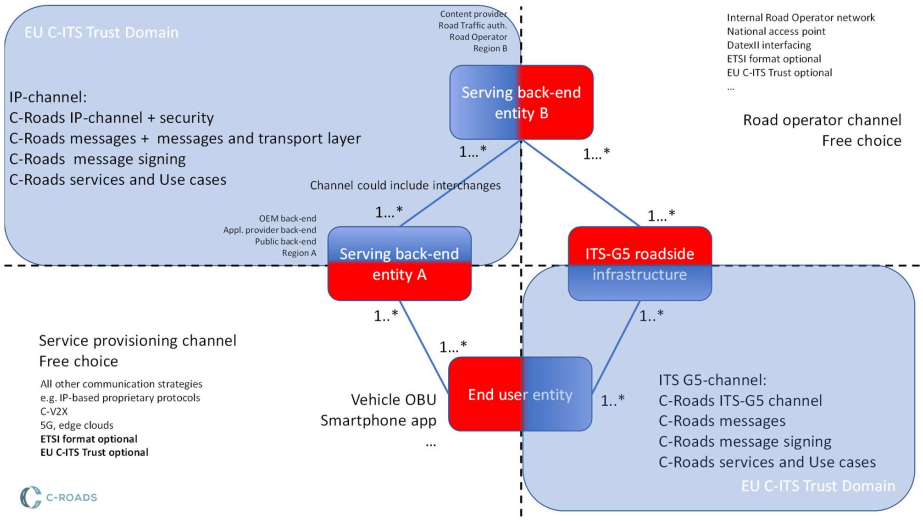

Figure 1 Overview of specification scope

Upper, left part shows the solution area related to hybrid communication via backend communication that is addressed by this document. Following this part, all types of backend entities are connected by communication links.
Lower, left part shows the solution area related to communication between a backend entity and the end-user application and this communication can be performed following different commercial/national strategies.
Upper, right shows road operators network implementation choices to realize C-ITS services in ITS-G5 [3].
Lower, right shows the ITS-G5 communication [3].

3 Basic Interface - IP based interface for backend communication

3.1 Introduction

The C-ITS actors typically operate in one country/region and share information to/from clients. They connect to entities in the relevant country to consume and provide information. To allow information sharing, an Interface/protocol named **BI (Basic Interface)** is specified between C-ITS actors (and their potential third parties), see figure 2.
BI is independent of any deployment model that Member States or C-ITS actors choose to deploy.

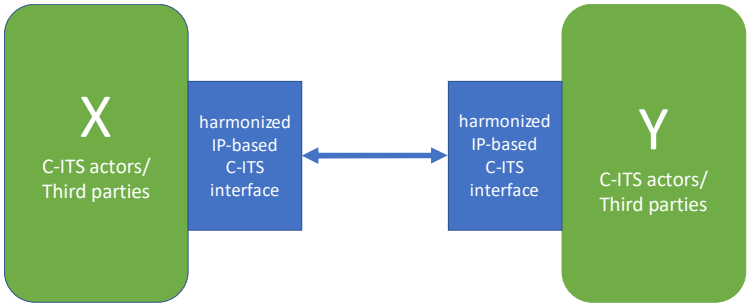

Figure 2: Basic IP interface for C-ITS message exchange

3.2 Functional requirements

Requirement HYB_001/1

- BI shall be used by all C-ITS actors for cross border C-ITS message exchange.

Requirement HYB_002/1

- BI should be used by all C-ITS actors on national level.

Requirement HYB_003/1

- BI shall be able to exchange C-ITS messages in a secured link.

Functional needs of C-ITS actors:

Requirement HYB_004/1

- BI shall allow C-ITS actors to publish and subscribe to C-ITS messages.

Requirement HYB_005/1

- BI shall allow to filter C-ITS messages according to chapter 3.3.

Requirement HYB_006/1

- BI shall allow to route C-ITS messages according to chapter 3.3.

Requirement HYB_007/1

- Time synchronization
  All C-ITS actors shall be time synchronized with an accuracy equivalent to a stratum 1 level.

Requirement HYB_008/1

- Filtering by AMQP brokers shall be done without reading the AMQP payload (Reference to AMQP ISO/IEC 19464:2014 [1]).

Logging

Requirement HYB_009/1

- Servers (both brokers and clients) should keep a log of the following for at least 3 months:
  - Queue filters
  - Client connect and disconnects
  - System and connection errors

Requirement HYB_010/2

- Servers (both brokers and clients) should keep a log of the following for at least 3 months for message types DENM, IVIM, SREM, SSEM, MAPEM:
  - AMQP Message timestamps precision of at least 1ms (Both arrival and departure)
  - AMQP Message application properties field except application data

Requirement HYB_011/2

- Servers (both brokers and clients) can keep a log of the following for at least 1 month for message types SPATem, CAM:
  - AMQP Message timestamps precision of at least 1ms (Both arrival and departure)
  - AMQP Message application properties field except application data

Latency requirements for AMQP brokers

Requirement HYB_012/1

- A broker shall be able to route a single message with a payload size <500KB in <30ms. (from message arrival to available on client queue)

Requirement HYB_013/1

- A broker shall be able to route 5000 messages with a payload size <500KB in <1000ms. (from message arrival to available on client queues)

Additional information:
- Note that for high intensity information, e.g. SPaT, the minimum required throughput can be substantially higher. In that case the broker may handle the corresponding additional load by using a free choice of scaling mechanisms, e.g. vertical scaling (increasing e.g. the CPU and memory resources of the broker), horizontal scaling (dividing the load over multiple broker instances, can be automated with assistance of the II interface), etc.

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Integrity requirements for AMQP brokers

Requirement HYB_014/1

- A broker shall never remove, alter or add anything to a message payload.

Requirement HYB_015/2

- A broker shall never remove or alter any of the AMQP application properties field.

Requirement HYB_016/2

- A broker should drop malformed AMQP messages that do not adhere to this specification or any extension of it and shall log the event.

3.3 BI protocol specification

BI (Basic Interface) is the interface between C-ITS actors. On this interface the following protocols and profiles, specified below, shall be used for C-ITS services.
This section provides information how AMQP shall be used, also external resources need to be consulted, e.g. Advanced Message Queuing Protocol (AMQP) specification.

BI can allow exchanging non C-ITS messages, outside the C-ITS domain.

Requirement HYB_018/1

- BI shall use Internet Protocol (IPv4) and Transmission Control Protocol (TCP).

Requirement HYB_019/1

- BI shall implement Transport Layer Security (TLS 1.3) according to RFC 8446 [5]. Profiling for TLS is described in chapter 5.

Requirement HYB_020/1

- BI shall use AMQP version 1.0 (ISO IEC 19464 [1]).

3.3.1 Filtering mechanism

The first release of this document focuses more on DENM and IVIM. Other messages filtering process will be detailed in next releases.

Requirement HYB_066/2

- All AMQP Clients and Brokers shall be compatible with Apache Selector filters as the filtering mechanism to ensure interoperability

For more information on Selector filters AMQP Apache-filters-chapter 2: Java Message Service Support [4]
https://svn.apache.org/repos/asf/qpid/trunk/qpid/specs/apache-filters.xml#type-selector-filter

Requirement HYB_067/2

- All AMQP Clients and Brokers shall support filtering on application properties as defined in Tables 1, 2 and 3

Requirement HYB_021/1

- All mandatory fields in Table 1~~Table 1~~ shall be present for publishing for all C-ITS messages.

Requirement HYB_022/2

- All mandatory fields defined in Table 1~~Table 1~~ shall be inside the AMQP application properties field.

Requirement HYB_023/2

- All optional fields defined in Table 1~~Table 1~~ should be inside the AMQP application properties field.

Requirement HYB_024/1

- Filtering shall be requested by consumer based on selected fields defined in Table 1~~Table 1~~,
- Table 2~~Table 2~~, Table 3~~Table 3~~, Table 4 or Table 5.

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Requirement HYB_025/1

- All AMQP messages with a DENM as payload exchanged in BI shall contain information described in
- Table 2~~Table 2~~.

Requirement HYB_026/2

- All mandatory fields defined in
- Table 2~~Table 2~~ shall be inside AMQP application properties field.

Table 1 : Data field for filtering for all C-ITS messages

Name	Value and type	Description	Mandatory/ Optional
publisherId	String A two-letter country code (based on ISO 3166-1 alpha-2 [8]) and a numerical identifier (value between 0 and 16383 including leading zeroes) based on ISO 14816:2005 [9] (same as used for providerIdentifier in IVIM), e.g. "AT00001", "DE15608"	Unique ID of the publisher. It is Linked to the country where the provider wants to register. It could be in one country or several.	M
originatingCountry	Country code (based on ISO 3166-1 alpha-2 [8])	Country code where the C-ITS message is created	M
protocolVersion	string E.g. "DENM:1.4.02.2" or "IVIM:1.2.1"	Represent the version of standard used to create the message, i.e. for DENM the version of ETSI EN 302 637-3 [12], for IVIM, SPATEM the version of ETSI TS 103 301 [13]	M
serviceType	String HLN-RLX ……	Acronym defined in C-Roads_Common C-ITS Service Definitions	O
messageType	String DENM, IVIM, SPATEM, MAPEM, SREM, SSEM, CAM	For this version of the specification the string shall be one of the following: DENM, IVIM, SPATEM, MAPEM, SREM, SSEM, and CAM. The list may be subject to changes in future versions of the specification	M

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longitude	Float Decimal degrees According to WGS84/EPSG:4326	Longitude of the event published; for DENM (eventPosition) and for IVI (referencePosition)	O
latitude	Float Decimal degrees According to WGS84/EPSG:4326	Latitude of the event published; for DENM (eventPosition) and for IVI (referencePosition)	O
quadTree	String Comma separated list of ~~String~~quadtree tiles starting and ending with a comma, e.g. ",2023201202321201 01," (single value) or ",2023201202321201 01,2023201202321201 02,2023201202321201 03," (multiple values chained)	Relevant spatial index location of the C-ITS message	M

Table 2 : Data field for DENM filtering process

Name	Value and type	Description	Mandatory/ Optional
causeCode	String	CauseCode from ETSI_EN_302_637-3 [12]	M
subCauseCode	String	subCauseCode from ETSI_EN_302_637-3 [12]	M

Requirement HYB_028/1

- All AMQP messages with an IVIM as payload exchanged in BI shall contain information described in Table 3~~Table 3~~.

Requirement HYB_029/2

- All optional fields in Table 3~~Table 3~~ should be inside AMQP application properties field.

Requirement HYB_030/1

- Wildcards can be used to obtain a subset of information. Without wildcards, the complete set of information is retrieved. An example for the use of wildcards would be: subset of protocolVersion = 1.* to exclude versions >1.

Table 3 : Data field for IVI filtering process

Name	Value and type	Description	Mandatory/ Optional

iviType	NUMERICAL	iviType	O
pictogramCategoryCode	NUMERICAL or a list of NUMERICALS. Either a single numerical value (e.g. 557) or a comma separated list (e.g. 557,559,612) of numerical values as an IVIM may contain more than one pictogramCategoryCode	The ISO 14823:2017 [10] pictogramCategoryCode is a combined numeral value (nature and serialNumber) referring to a specific sign of the ISO 14823:2017 [10] sign catalogue, e.g. 557 = Maximum speed limit	O
iviContainer	String All valid IviContainer abbreviations in the ISO 19321 standard, e.g. ”gic”, ”rcc”, ”tc”, ”avc” or comma separated combinations of that, e.g. ”gic,tc,avc”	All valid IviContainer types out of the ISO 19321:2015 [11] standard that should be present in the target IVIM after applying filtering	O

Note: Adding filtering element will be included in next release for CAM, SPATEM, MAPEM, SSEM, SREM.

Requirement HYB_098/3

- All AMQP messages with SPATem and MAPem as payload exchanged in BI shall contain information described in Table 4

~~*Requirement HYB_099/3*~~

- ~~All mandatory fields defined in Table 4 shall be inside the AMQP application properties field~~

Requirement HYB_100/3

- All optional fields defined in Table 4 should be inside the AMQP application properties field

Table 4 : Data field for SPATem and MAPem filtering process

Name	Value and type	Description	Mandatory/ Optional
Id	Integer (0 … 65535) NUMERICAL or a list of NUMERICALS. Either a single numerical value or a comma separated list of numerical values as an SPATem/MAPem may contain more than one id.	(IntersectionReferenceID) The combination of region and id must be unique within a country. Reference: C-Roads Platform WG2/TF3 document; “C-ITS Infrastructure Functions and Specifications”	O
~~Region~~	~~Integer (0 … 65535)~~	~~Editors note: Investigate~~	~~M~~

Name	String	Typically human readable and recognizable by road authority.	O

~~Editorial Note: the table above shows the progress on filtering mechanism for SPAtem and MAPem. The tree parameters are only the assumption and are not the final parameters for this topic. The discussion is still onging and futher work is needed to finalize the topics e.g. IntersectionreferenceID (Mandetory or Optional, value/type and generation) and quadtree for signalized intersection messages and the need for other parameters.~~

Requirement HYB_101/3

- All AMQP messages with SSEM and SREM as payload exchanged in BI shall contain information described in Table 5.

~~*Requirement HYB_102/3*~~

- ~~All mandatory fields defined in Table 5 shall be inside the AMQP application properties field~~

Requirement HYB_103/3

- All optional fields defined in Table 5 should be inside the AMQP application properties field

Table 5 : Data field for SREM and SSEM filtering process

Name	Value and type	Description	Mandatory/ Optional
Id	Integer (0 … 65535) NUMERICAL or a list of NUMERICALS. Either a single numerical value or a comma separated list of numerical values as an SPATem/MAPem may contain more than one id.	(IntersectionReferenceID) The combination of region and id must be unique within a country. Reference: C-Roads Platform WG2/TF3 document; “C-ITS Infrastructure Functions and Specifications”	OM
~~Region~~	~~Integer (0 … 65535)~~		~~O~~

~~Editorial Note: the table above shows the progress on filtering mechanism for SSRM and SSEM. The two parameters are only the assumption and are not the final parameters for this topic. The discussion is still onging and futher work is needed to finalize the topics e.g. IntersectionreferenceID (Mandetory or Optional, value/type and generation) and quadtree for signalized intersection messages and the need for other parameters.~~

Requirement HYB_031/1

- C-ITS actors who want to publish information on BI shall register for EN ISO 14816:2005 [9] Road transport and traffic telematics - Automatic vehicle and equipment identification

- Numbering and data structures, in order to obtain the mandatory publisherId as described in Table 1. More information about registration is available in the following references:

https://www.tc278.eu/index.php/14816-register

https://www.tc278.eu/index.php/14816-registers

3.3.2 Configuration parameters

Requirement HYB_032/1

- A broker shall provide a minimum queue length of 200 messages.

Requirement HYB_033/1

- An AMQP Message TTL shall be set based on the validity time of the payload. If this is not applicable the AMQP Message should have a minimum time to live of 60 seconds and a maximum of 10 minutes. A broker can directly enforce TTL policies, i.e. if TTL is not set, or dependent on message types.

Requirement HYB_034/1

- Brokers may set policies for queue management and shall make them available in the documentation.

Requirement HYB_035/1

- Systems that provide data shall be able to support multiple simultaneous receivers of the same data type.

Requirement HYB_036/1

- Consumers of data shall be able to receive data from different providers simultaneously.

3.3.3 Location specification

Requirement HYB_037/1

- Geolocation method shall be based on quadtree, where each quadtree zoomlevel shall be represented by a single character in the string.~~,~~ ~~f~~For complete description please see Appendix A.~~.~~

Requirement HYB_038/1

- ~~C-ITS actors shall publish with a minimum zoom level of 18.~~C-ITS actors shall publish AMQP messages with a minimum quadtree zoom level of 18. The quadtree tiles used shall be selected such that they contain relevant geographic data elements contained in the C-ITS message, or at minimum the geographic reference location of the C-ITS

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message (e.g. referencePosition in IVIM and CAM, eventPosition in DENM, or refPoint in MAPEM).

Additional information: Zoom level refers to the length of the quadtree string, i.e. the individual quadtree strings used shall have a minimum number of characters of 18.

Requirement HYB_039/1

- C-ITS actors shall filter with a maximum zoom level of 18.

Additional information: Zoom level refers to the length of the quadtree string, i.e. the individual quadtree strings used shall have a maximum number of characters of 18.

3.3.4 Application requirements

Requirement HYB_044/1

- The originating C-ITS station shall provide Geonetworking layer parameters consistent with the reference location of the message.

Requirement HYB_045/1

- PacketLifetime in Geonetworking layer parameters should be compliant with latency due to the channel and the meaning of the message.

Requirement HYB_048/1

- Each time a DENM or an IVIM is created and signed by C-ITS actors to be sent on BI , the message shall be repeated at least every 9 min if still valid.

Additional information:
Repetition is needed, since in vehicles, the allowed time window set in the security header is normally 10 minutes and is compared to message reception time, and if message received outside allowed time window, message is discarded.

Requirement HYB_49/1

- When a C-ITS actor receive DENM or IVIM already signed (and their repetitions), it shall store every 9 min the information so it can repeat them through BI.

Additional information:
C-ITS actors need to keep every 9 min messages even if there are considered as duplicate messages.

Requirement HYB_104/3

C-ITS actors shall publish SPATem only after corresponding MAPem has been published

-

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4 Improved Interface - IP based interface for backend communication

4.1 Introduction

To facilitate a scalable solution, an Interface/protocol to automate service discovery and federate information between countries/regions is introduced, this interface/protocol is named **II (Improved Interface)** and provides a control plane for BI. This is needed to avoid manual configurations when data sources are added and to overcome the need for an 'all to all' full mesh of interconnections between the actors. The network scenario is exemplified below.

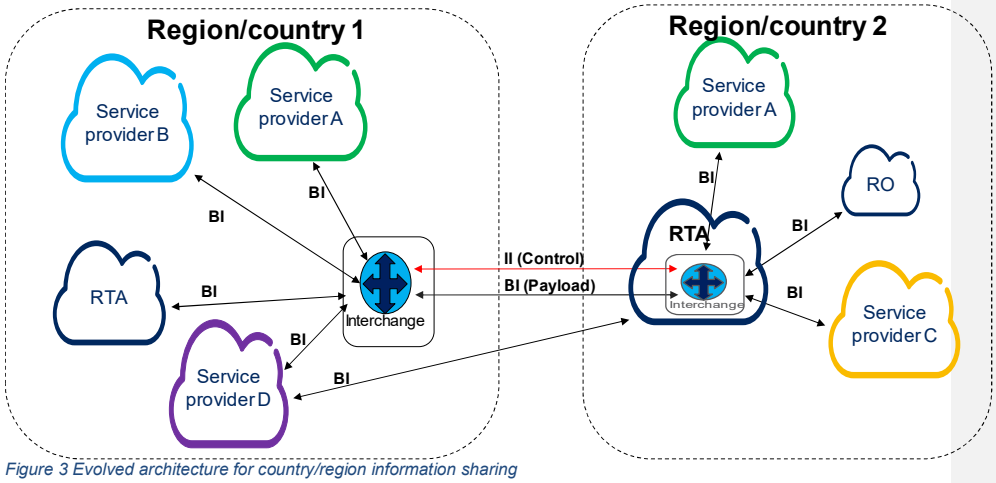

Figure 3 Evolved architecture for country/region information sharing

4.2 Functional requirements

General

Requirement HYB_068/3

- Improved Interface is an optional interface. If implemented it shall be used as control plane between interchange entities and the requirements in chapter 4 shall apply

Certificates

Requirement HYB_069/3

- Security for Improved Interface shall be as described in chapter 5 Transport Layer Security

DNS configuration

Requirement HYB_072/3

- The relevant governing body shall approve, handle registration and maintenance of interchange entities in the DNS

Requirement HYB_071/3

- Interchange entities shall be discoverable if registered as subdomain of a trusted domain name

Requirement HYB_070/3

- Interchange entities shall be registered in DNS as subdomain of a master trusted domain name (e.g. c-its-interchange.eu) or any other trusted domain name with the same trust/security level as the master domain name

Interchange discovery

Requirement HYB_073/3

- Interchange entities shall automatically discover other interchange entities in the network based on a list of trusted domain names provided by the relevant governing body

Control channel establishment

Requirement HYB_074/3

- An interchange entity shall establish a control channel to all other active interchange entities in the network to be able to share valid subscriptions and capabilities

Capabilities exchange

Requirement HYB_075/3

- Interchange entities shall send updated capabilities to all other interchange entities

Requirement HYB_076/3

- Interchange entities shall receive and maintain capabilities from all other interchange entities

Requirement HYB_077/3

- Interchange entities shall maintain updated capabilities of all their connected C-ITS actors (clients)

Subscription exchange

Requirement HYB_078/3

- Interchange entities shall receive subscription requests from all other interchange entities

Requirement HYB_079/3

- Interchange entities shall send subscription requests on behalf of their own C-ITS actors (clients) to other interchange entities

Requirement HYB_080/3

- An interchange entity shall be able to redirect their clients to other interchange entities where requested data is available, both for new subscriptions and for active data transfers between interchange entities

Requirement HYB_081/3

- An interchange entity should be able to provide data available from other interchange entities to their C-ITS actors~~clients~~

Additional information:
The interchange entity either fetch information available on other interchanges on behalf of its connected clients or maintains information on where information is available and redirects its connected clients to the data source

Requirement HYB_082/3

- Interchange entities shall respond to subscription requests either by providing data or a rejection if the data is not available

Data exchange

Requirement HYB_083/3

- Interchange entities shall use Basic Interface for data exchange

4.3 Improved Interface protocol specification

Certificates

Requirement HYB_084/3

- The relevant governing body shall handle the issuing of certificates and approval of trusted certificate authorities

DNS configuration

Requirement HYB_085/3

- For any given Interchange entity an DNS A record shall be created in one of the trusted domain names

Requirement HYB_086/3

- Each interchange entity shall have one DNS SRV record entry in one of the trusted domain names to identify the control channel. The symbolic name used shall be “IXC” for II

Requirement HYB_087/3

- The target host name pointing to the Interchange entity in the SRV records shall be identical to the Interchange entities DNS A record

Requirement HYB_088/3

- The relevant governing body shall publish a list of trusted domain names

Interchange discovery

Requirement HYB_089/3

- An Interchange entity shall periodically, at least every 12 hours check for new and updated DNS SRV records with the symbolic name “IXC” on all trusted domain names to maintain an updated list of addresses and ports of other available interchange entities

Control channel establishment

Requirement HYB_090/3

- The control channel shall use HTTPS [15] with mutual authentication based on the allocated Interchange entity certificates, using the address and port obtained from the interchange discovery procedure

Capabilities exchange

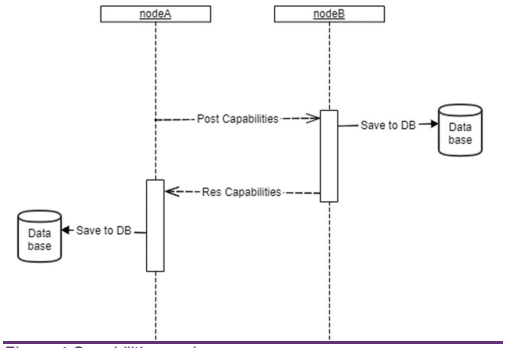

Figure 4 Capabilities exchange sequence

Requirement HYB_105/3

- For posting capabilities to other interchange entities, HTTP POST request shall be used to the endpoint formated in the following way:
  <receiving interchange II base URL>/capabilities

Requirement HYB_091/3

- An interchange entity shall send their capabilities to all other interchange entities when capabilities change and at regular intervals of maximum 24 hours

Requirement HYB_092/3

- The capabilities exchange shall use the JSON format defined in appendix C and properties as defined in table 6.
  If the capability exchange contains JSON properties not defined in this document, then these JSON properties can be ignored but the capability exchange shall be processed using the defined properties.

- Additional information: This requirement is to ensure compatibility with future releases.

Requirement HYB_093/3

- The interchange entity shall send the capabilities exchange using HTTPS POST [15] with its capabilities as JSON payload defined in appendix C and using properties as defined in table 6

Requirement HYB_094/3

- An interchange entity receiving a capability request from another interchange entity shall respond to the HTTPS POST [15] with their own capability in the same ~~JSON format~~ JSON format defined in appendix C and using properties as defined in table 6

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Table 6 : Interchange Capabilities

Property name	Type	Mandatory/Optional	Description
version	string	mandatory	Improved Interface json format version Starting with release 1.7 this value shall be version 1.0
name	string	mandatory	name of the interchange
capabilities	array of json objects	mandatory	can be empty if no datasets are available
messageType	string	mandatory	messageType of dataset (from BI application properties, chapter 3.3.1 Table 1)
publisherId	string	mandatory	publisherId of dataset (from BI application properties, chapter 3.3.1 Table 1)
originatingCountry	string	mandatory	originatingCountry of dataset (from BI application properties, chapter 3.3.1 Table 1)
protocolVersion	string	mandatory	protocolVersion of dataset (from BI application properties, chapter 3.3.1 Table 1)
quadTree	array of strings	mandatory	quadTree tiles for coverage of the entire dataset
causeCode	array of strings	mandatory if messageType is "DENM"	causeCodes available in the dataset
iviType	array of strings	mandatory if messageType is "IVI"	iviTypes available in the dataset

Subscription exchange

Requirement HYB_095/3

- The subscription exchange shall use the JSON format defined in appendix D.
  If the subscription exchange contains JSON properties not defined in this document,

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then these JSON properties can be ignored but the subscription exchange shall be processed using the defined properties.

- Additional information: This requirement is to ensure compatibility with future releases.

Requirement HYB_106/3

- For the request of new subscriptions to other interchange entities, HTTP POST request shall be used to the endpoint formated in the following way:
  <receiving interchange II base URL>/subscriptions

Requirement HYB_096/3

- The interchange entity shall send the subscription request using HTTP POST [14] with its subscriptions as JSON payload using properties as defined in table 7.

Requirement HYB_097/3

- An interchange entity receiving a subscription request from another interchange entity shall respond to the request with HTTP 202 [14] containing a JSON payload defined in annex D~~y~~ and using properties as defined in table 8.
  The JSON payload shall contain~~containing~~ endpoint(s) which the requesting interchange entity can ~~be~~ used ~~to~~ ~~request~~poll the status of the subscription request by using an HTTP GET request to those endpoint(s).

Requirement HYB_107/3

- An interchange entity receiving a HTTP GET request from another interchange entity to the endpoint with the following format
  <receiving interchange II base URL>/<requesting interchange name>/subscriptions
  shall respond to the request with HTTP 200 [14] containing the requesting interchange entities existing subscriptions in the JSON payload defined in annex D and using properties as defined in table 8. The JSON payload shall contain endpoint(s) (path property) which the requesting interchange entity can use to terminate the subscription by using an HTTP DELETE request to those endpoint(s).

Requirement HYB_108/3

- An interchange entity receiving a subscription status request from another interchange entity shall respond to the request with HTTP 200 [14] containing a JSON payload defined in annex D and using properties as defined in table 9.

Requirement HYB_109/3

- Unless mechanisms are in place to prevent looping of messages, an interchange entity shall not re-distribute AMQP messages coming from another interchange entity to any other interchange entity.

Additional information:
This requirement is to prevent looping of messages in the network

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Request

Table 7 : Interchange Subscription Request

Property name	Type	Mandatory/Optional	Description
version	string	mandatory	Improved Interface json format version Starting with release 1.7 this value shall be version 1.0
name	string	mandatory	name of the interchange
subscriptions	array of objects	mandatory	array of subscription requests
selector	string	mandatory	JMS-selector filter. Needs to be checked against the capabilities of the interchange that the request is being sent to.
createNewQueue	boolean	optional	Should this request result in a new separate queue. (Defaults to false if not present)
queueConsumerUser	string	optional	If this request results in a new separate queue (createNewQueue is true), this is the username (certificate Common Name) that should have access to this queue. (Defaults to the username(Common Name) of the requesting interchange if not present)

Response

Table 8: Interchange Subscription Response

Property name	Type	Mandatory/Optional	Description
version	string	mandatory	Improved Interface json format version Starting with release 1.7 this value shall be version 1.0
name	string	mandatory	name of the interchange

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subscriptions	array of objects	mandatory	array of subscription requests
id	string	mandatory	Identifier of the subscription. (generated by the interchange that receives the subscription request)
selector	string	mandatory	JMS-selector filter. Needs to be checked against the capabilities of the interchange that the request is being sent to.
createNewQueue	boolean	optional	Should this request result in a new separate queue. (Defaults to false if not present)
queueConsumerUser	string	optional	If this request results in a new separate queue (createNewQueue is true), this is the username (certificate Common Name) that should have access to this queue. (Defaults to the username(Common Name) of the requesting interchange if not present)
path	string	mandatory	URL path the requesting node can poll to check the status of the request (GET) The URL path can also be used to terminate the subscription (DELETE)
status	string/enum	mandatory	Status of the request. Possibilities: “REQUESTED” The request is being processed. “CREATED” The data is ready for consumtion. “ILLEGAL” The request is rejected (eg. request too large) “NOT_VALID”

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			The request selector is not a valid selector. "NO_OVERLAP" The request does not match any available dataset.

Status poll response

Table 9: Interchange Subscription Status poll response

Property name	Type	Mandatory/Optional	Description
id	string	mandatory	Identifier of the subscription. (generated by the interchange that receives the subscription request)
selector	string	mandatory	JMS-selector filter. Needs to be checked against the capabilities of the interchange that the request is being sent to.
createNewQueue	boolean	optional	Should this request result in a new separate queue. (Defaults to false if not present)
queueConsumerUser	string	optional	If this request results in a new separate queue (createNewQueue is true), this is the username (certificate Common Name) that should have access to this queue. (Defaults to the username(Common Name) of the

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			requesting interchange if not present)
path	string	mandatory	URL path the requesting node can poll to check the status of the request (GET) The URL path can also be used to terminate the subscription (DELETE)
status	string/enum	mandatory	Status of the request. Possibilities: “REQUESTED” The request is being processed. “CREATED” The data is ready for consumtion. “ILLEGAL” The request is rejected (eg. request too large) “NOT_VALID” The request selector is not a valid selector. “NO_OVERLAP” The request does not match any available dataset.
messageBrokerUrl	string	mandatory only if status is “CREATED”	in order to support for instance load-balancing the message broker can provide a different amqp endpoint url than the node itself.

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queueName	string	mandatory only if status is "CREATED"	The name of the queue where the data is available. (generated by the interchange that receives the subscription request)

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~~Editors note: Work in progress, complete sequence of Subscription exchange procedure to be added~~

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5 Transport layer security

5.1 TLS profile

Requirement HYB_050/1

- For the transport layer protection TLS with mutual authentication shall be used, a Commercial, well establish CA shall be used for issuing standard X.509 certificates for long lived security associations between backend entities.

Requirement HYB_051/1

- Certificates renewal periods should follow security best practices.

Requirement HYB_052/2

- Security gateways/firewalls shall be configured to further enhance security according to latest industry standards.

Requirement HYB_053/1

- TLS 1.3 as specified in RFC 8446 [5] shall be supported.

Requirement HYB_054/1

- Earlier versions of TLS shall not be supported.

Requirement HYB_055/1

- The rules on allowed and mandatory cipher and suites allowed and mandatory extensions given in TLS 1.3 RFC 8446 [5]) shall be followed.

Requirement HYB_056/1

- Mutual authentication shall be done with X.509 certificates.

Requirement HYB_057/1

- The whole certificate chain should be sent in the TLS handshake.

Requirement HYB_058/1

- Certificate Status Requests (OCSP stapling) as specified in RFC 6066 [6] and Section 4.4.2.1 of RFC 8446 [5] shall be supported and used.

Requirement HYB_059/1

- Later releases and verified revisions of TLS shall be supported.

5.2 TLS Certificates

The certificates used for authentication are standard X.509 TLS certificates RFC 5280 [7] and are supported by almost all CAs.

The TLS certificates are issued and signed by a trusted subordinate CA (sub CA) for interchange network certificates.

Requirement HYB_060/1

- The sub CA may belong to any of the trusted root CAs.

Requirement HYB_061/1

- The sub CA may be a national CA or a commercial CA.

Requirement HYB_062/1

- The TLS certificates used shall be Organization Validated (OV) certificates where both the domain and the organisation are validated.

Requirement HYB_063/1

- TLS certificates shall be version 3 certificate according to RFC 5280 [7].

Requirement HYB_064/1

- The public key algorithm shall be id-ecPublicKey with secp256r1 or secp384r1.

Requirement HYB_065/1

The security level of the signature algorithm shall be at least as strong as the public keys in the certificate, minimum 128 bit key length.

6 Appendix A – Quadtree

Note: Since different algorithms produce different results, a common algorithm still needs to be agreed on, e.g. the one described in the following link

https://docs.microsoft.com/en-us/bingmaps/articles/bing-maps-tile-system

Quadtree is a method to build a data structure for distributing data streams w.r.t. geographic areas (single points, lines or links, areas), and used often in GIS (Geographic Information Systems) and backend servers.
Algorithm are explained in:

http://www.cs.tau.ac.il/~haimk/seminar12b/Quadtrees.pdf

More detailed with C-ITS relations of single points e.g. send as events and DENM messages and the request for a specific region / area: https://jimkang.com/quadtreevis/
Quadtreepath designates the consecutive tiles you have to go through to obtain the desired tile. The number of characters for a quadtreepath is equal to the zoom level of this tile. For example: “1122” has 4 characters and designates a tile of level 4 and is somewhere in Siberia. Level 0 being the world.
At each level you slice each tile in 4 which means that you need 4 symbols to identify each of them.
It could be anything like “a, b, c and d” OR “hl, hr, bl, br”. We chose to do it with “0, 1, 2 and 3”.

0 being the top left tile.
1 the top right tile.
2 the bottom left tile.
3 the bottom right tile.

There is no limit for the number of level but we chose to stop at level 18, in Europe it represents a size of ~175m.

You can find the exact method to obtain the size of a tile by following these links:
https://wiki.openstreetmap.org/wiki/Zoom_levels
https://docs.microsoft.com/en-us/bingmaps/articles/bing-maps-tile-system

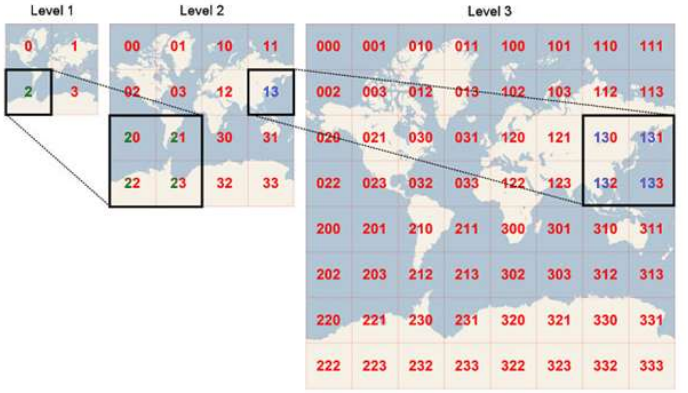


Figure 4 Quadtree structure

7 Appendix B – Deployment Models

The image below provides a simplified view of C-Roads deployment model which consist of two different approaches; centralized approach (model B) and decentralized approach (model A) to allow flexibility of the deployments and ensure the interoperability between all Member States. It is depicted how C-ITS actors or a group of C-ITS actors within one/different Member states can establish the informationsharing network to share C-ITS messages with each other through backend commuication.

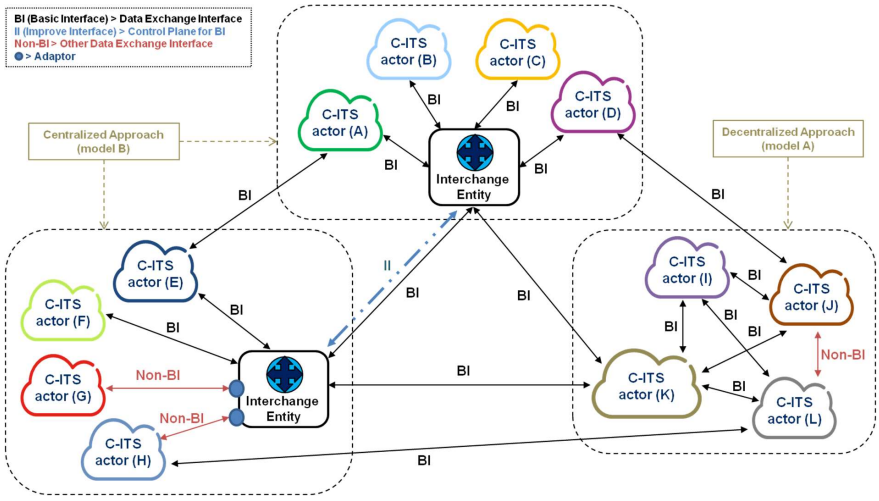


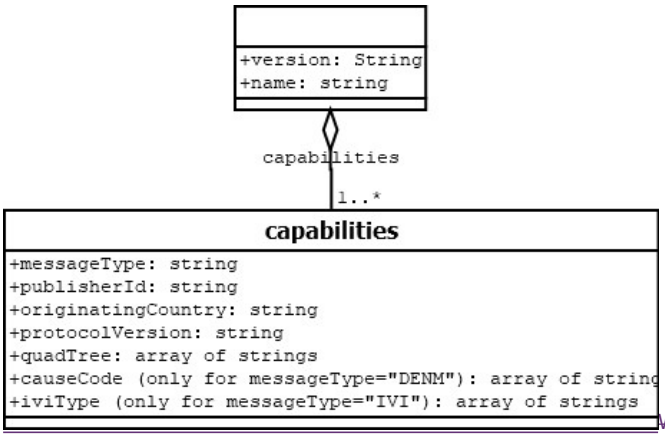
Figure 5 Deployment models

Based on the centralized approach (model B); each group of C-ITS actors can establish an Interchange Entity to interconnect with each other. Each Interchange Entity can connect to every other Interchange Entity and route data from all other interconnected Interchange Entities to be able to serve it to their own interconnected C-ITS actors.

Alternatively;
Based on the decentralized approach (model A); each C-ITS actors can interconnect via multiple logical point-to-point connections with each other or with every other Interchange Entities to be able to share information.

Information about Basic Interface (BI) and Improved Interface (II) can be found in chapter 3 and 4 respectively

8 Appendix C – Capabilities exchange JSON format



~~Work in progress, to be defined~~

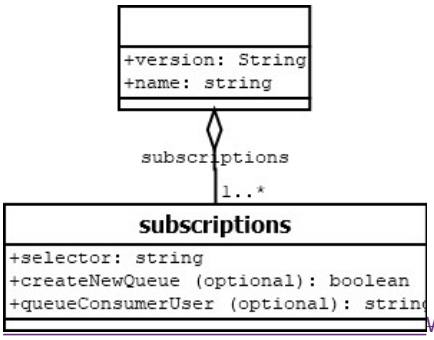
Capability example

```
{
  "version": "1.0",
  "name": "a.c-its-interchange.eu",
  "capabilities": [
        {
            "messageType": "DENM",
            "publisherId": "SE-12345",
            "originatingCountry": "SE",
            "protocolVersion": "DENM:1.2.2",
            "quadTree": [
                "01220111",
```

```
                "01200132"
            ],
            "causeCode": ["6","4","5"]
        },
        {
            "messageType": "DENM",
            "publisherId": "NO-12345",
            "originatingCountry": "NO",
            "protocolVersion": "DENM:1.2.2",
            "quadTree": [
                "01230122",
                "01230123"
            ],
            "causeCode": ["3","4","5"]
        }
    ]
}
```

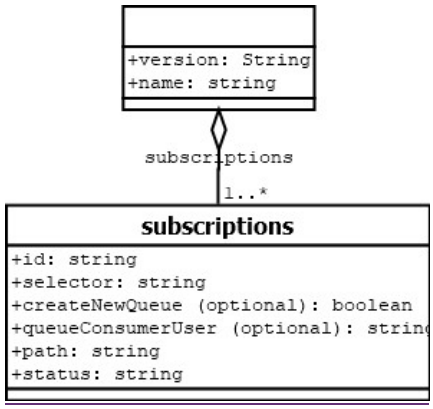

9 Appendix D – Subscription exchange JSON format

Request

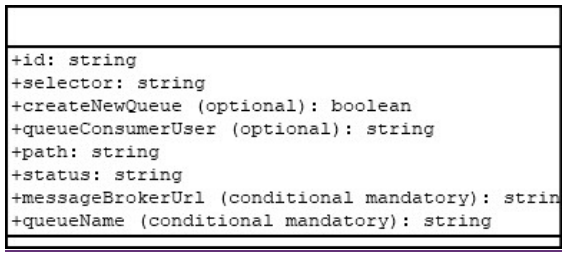


~~Work in progress, to be defined~~

Response



Status response



Subscription exchange examples

Request

```
{
  "version": "1.0",
  "name": "a.c-its-interchange.eu",
  "subscriptions": [
    {
        "selector": "messageType='DENM' AND originatingCountry='SE'"

    },
    {
        "selector": "messageType='DENM' AND originatingCountry='NO'",
```

```
        "createNewQueue": true,
        "queueConsumerUser":"client1"
    }
  ]
}
```

Response

```
{
  "version": "1.0",
  "name": "a.c-its-interchange.eu",
  "subscriptions": [
    {
      "id": "{id1}",
      "selector": "messageType='DENM' AND originatingCountry='SE'",
      "path": "/subscription/{id1}",
      "createNewQueue": false,
      "queueConsumerUser":"a.citsinterchange.eu",
      "status": "REQUESTED"
    },
    {
      "id": "{id2}",
      "selector": "messageType='DENM' AND originatingCountry='NO'",
      "path": "/subscription/{id2}",
      "createNewQueue": true,
      "queueConsumerUser":"client1",
      "status": "REQUESTED"
    }
  ]
}
```

Formaterat: Indrag: Vänster: 2,25 cm, Första raden: 0,25 cm

Status response

```
{
 "id": "{id2}",
 "selector": "messageType='DENM' AND originatingCountry='NO'",
 "path": "/subscription/{id2}",
 "createNewQueue": true,
 "queueConsumerUser":"client1",
 "queueName":"{queuename}",
 "messageBrokerUrl": "amqps://b.c-its-interchange.eu:5671",
 "status": "CREATED"
}
```

10 Appendix E – Deleted requirements

- *Requirement HYB_017*
- *Requirement HYB_027*
- *Requirement HYB_040*
- *Requirement HYB_041*
- *Requirement HYB_042*
- *Requirement HYB_043*
- *Requirement HYB_046*
- *Requirement HYB_047*
- *Requirement HYB_099*
- *Requirement HYB_102*
-
-

Formaterat: Teckensnitt:Inte Kursiv, Svenska (Sverige)

Formaterat: Liststycke, Punktlista + Nivå: 1 + Justerad vid: 0,63 cm + Indrag vid: 1,27 cm

Formaterat: Teckensnitt:(Standard) Calibri, Kursiv, Teckenfärg: Anpassad färg(RGB(31;73;125)), Engelska (USA)

Formaterat: Teckensnitt:(Standard) Calibri, Kursiv, Teckenfärg: Anpassad färg(RGB(31;73;125))

Formaterat: Liststycke, Punktlista + Nivå: 1 + Justerad vid: 0,63 cm + Indrag vid: 1,27 cm

Sida 2: [1] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [1] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [2] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [2] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [3] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [3] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [4] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [4] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [5] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [5] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [6] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [6] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [7] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [7] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [8] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [8] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [9] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [9] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

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Engelska (USA)

Sida 2: [10] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [11] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [11] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [12] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [12] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [13] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [13] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

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Engelska (USA)

Sida 2: [14] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

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Engelska (USA)

Sida 2: [15] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [16] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [16] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [17] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [17] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [18] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [18] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

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Engelska (USA)

Sida 2: [19] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

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Engelska (USA)

Sida 2: [20] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [21] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [21] Formaterat	**Persson Kjell, IKTtvs**	**2020-05-12 17:58:00**

Engelska (USA)

Sida 2: [22] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 2: [22] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 2: [23] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 2: [23] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 2: [24] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 2: [24] Formaterat	Persson Kjell, IKTtvs	2020-05-12 17:58:00

Engelska (USA)

Sida 28: [25] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:03:00

Teckensnitt:11 pt

Sida 28: [26] Formaterat	Persson Kjell, IKTtvs	2020-04-24 11:57:00

Beskrivning, Justerat, Ingen numrering

Sida 28: [27] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:00:00

Teckensnitt:11 pt, Inte Fet, Engelska (USA)

Sida 28: [28] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:00:00

Fließtext, Justerat, Indrag: Vänster: 0,05 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [29] Formaterad tabell	Persson Kjell, IKTtvs	2020-04-24 12:04:00

Formaterad tabell

Sida 28: [30] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:00:00

Teckensnitt:11 pt, Inte Fet, Engelska (USA)

Sida 28: [31] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:00:00

Teckensnitt:11 pt, Inte Fet, Engelska (USA)

Sida 28: [32] Formaterat	Persson Kjell, IKTtvs	2020-04-24 12:00:00

Teckensnitt:11 pt, Inte Fet, Engelska (USA)

Sida 28: [33] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [34] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [35] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [36] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [37] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [38] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [39] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [40] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [41] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [42] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [43] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [44] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [45] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [46] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [47] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [48] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [49] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [50] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [51] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [52] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [53] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [54] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [55] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [56] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [57] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [58] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt

Sida 28: [59] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [60] Formaterat	**Persson Kjell, IKTtvs**	**2020-04-22 12:59:00**

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [61] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt

Sida 28: [62] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [63] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [64] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt

Sida 28: [65] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt, Engelska (USA)

Sida 28: [66] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 28: [67] Formaterat	Persson Kjell, IKTtvs	2020-04-22 12:59:00

Teckensnitt:11 pt

Sida 28: [68] Formaterat	Persson Kjell, IKTtvs	2020-04-21 17:51:00

Indrag: Vänster: 1 cm, Ingen numrering

Sida 28: [69] Formaterat	Persson Kjell, IKTtvs	2020-05-13 10:54:00

Teckenfärg: Anpassad färg(RGB(77;77;77))

Sida 29: [70] Formaterat	Persson Kjell, IKTtvs	2020-05-13 10:57:00

Teckensnitt:(Standard) Arial, 11 pt, Teckenfärg: Anpassad färg(RGB(77;77;77)), Engelska (USA)

Sida 29: [71] Formaterat	Persson Kjell, IKTtvs	2020-05-13 10:57:00

Teckensnitt:(Standard) Arial, 11 pt, Teckenfärg: Anpassad färg(RGB(77;77;77)), Engelska (USA)

Sida 29: [72] Formaterat	Persson Kjell, IKTtvs	2020-05-13 10:58:00

Punktlista + Nivå: 1 + Justerad vid: 1,63 cm + Indrag vid: 2,27 cm

Sida 30: [73] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Teckensnitt:Fet

Sida 30: [74] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Teckensnitt:Engelska (USA)

Sida 30: [75] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Fließtext, Justerat, Indrag: Vänster: 0,05 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [76] Formaterad tabell	Persson Kjell, IKTtvs	2020-04-24 16:22:00

Formaterad tabell

Sida 30: [77] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Teckensnitt:Engelska (USA)

Sida 30: [78] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Teckensnitt:Engelska (USA)

Sida 30: [79] Formaterat	Persson Kjell, IKTtvs	2020-04-24 16:20:00

Teckensnitt:Engelska (USA)

Sida 30: [80] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [81] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [82] Formaterat	Persson Kjell, IKTtvs	2020-05-08 12:04:00

Teckensnitt:Teckenfärg: Röd, Engelska (USA)

Sida 30: [83] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [84] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [85] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader, Kantlinje: Överkant: (Ingen kantlinje), Nederkant: (Ingen kantlinje), Vänster: (Ingen kantlinje), Höger: (Ingen kantlinje), Mellan : (Ingen kantlinje)

Sida 30: [86] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:11 pt, Engelska (USA)

Sida 30: [87] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [88] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [89] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [90] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader, Kantlinje: Överkant: (Ingen kantlinje), Nederkant: (Ingen kantlinje), Vänster: (Ingen kantlinje), Höger: (Ingen kantlinje), Mellan : (Ingen kantlinje)

Sida 30: [91] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [92] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [93] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [94] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader, Kantlinje: Överkant: (Ingen kantlinje), Nederkant: (Ingen kantlinje), Vänster: (Ingen kantlinje), Höger: (Ingen kantlinje), Mellan : (Ingen kantlinje)

Sida 30: [95] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:

Sida 30: [96] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [97] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [98] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [99] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:

Sida 30: [100] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:Engelska (USA)

Sida 30: [101] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [102] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader, Kantlinje: Överkant: (Ingen kantlinje), Nederkant: (Ingen kantlinje), Vänster: (Ingen kantlinje), Höger: (Ingen kantlinje), Mellan : (Ingen kantlinje)

Sida 30: [103] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [104] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:00:00

Teckensnitt:

Sida 30: [105] Formaterat	Persson Kjell, IKTtvs	2020-04-27 18:03:00

Teckensnitt:Fet

Sida 30: [106] Formaterat	Persson Kjell, IKTtvs	2020-04-27 18:02:00

Beskrivning, Justerat

Sida 30: [107] Formaterad tabell	Persson Kjell, IKTtvs	2020-04-27 18:04:00

Formaterad tabell

Sida 30: [108] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Teckensnitt:Engelska (USA)

Sida 30: [109] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [110] Formaterat	Persson Kjell, IKTtvs	2020-05-08 12:04:00

Teckensnitt:Teckenfärg: Röd, Engelska (USA)

Sida 30: [111] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Teckensnitt:Engelska (USA)

Sida 30: [112] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Fließtext, Indrag: Vänster: 0,13 cm, Höger: 0,06 cm, Kontroll av enstaka rader

Sida 30: [113] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Teckensnitt:11 pt, Engelska (USA)

Sida 30: [114] Formaterat	Persson Kjell, IKTtvs	2020-04-22 13:01:00

Teckensnitt:Engelska (USA)