IEC 63173-2

Edition 1.0 2022-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Maritime navigation and radiocommunication equipment and systems – Data interfaces – Part 2: Secure communication between ship and shore (SECOM)

Matériels et systèmes de navigation et de radiocommunication maritimes – Interfaces de données – Partie 2: Communications sécurisées entre le navire et la terre (SECOM)

IEC 63173-2:2022-05(en-fr)

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CONTENTS

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DATA INTERFACES –

Part 2: Secure communication between ship and shore (SECOM)

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Draft	Report on voting
80/1030/FDIS	80/1039/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

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INTRODUCTION

E-navigation has been defined as the means of providing electronic information in a harmonized way, and maritime services have been specified by the International Maritime Organization (IMO). The maritime services are operational services for actors both ashore and onboard. To make the maritime services interoperable between different actors and systems from different manufactures standards, specifications and guidelines in several layers are required, for example technical services and data/product formats. Technical services comprises a set of technical solutions and communications means to provide a maritime service. IMO's e-navigation strategy implementation plan (SIP) requires that all maritime services are IHO S-100 conformant as a baseline. Further, IEC is expected to implement the details as outlined in the SIP.

Secure communication between ship and shore (SECOM) provides standards for secure data exchange with technical services. Further, it contains a technical service interface design that is in accordance with the service guidelines and templates defined by IALA and partly included in IHO S-100.

SECOM specifies service interfaces (APIs) for data exchange, data protection measures to enable secure communication and interfaces for service discoverability. SECOM is applicable for IHO S-100 based products but also other data (payload) formats are supported, i.e. SECOM is generally independent of which data type is exchanged.

The standardisation of a common service interface for data exchange will enable wider technical interoperability where the same service interface can be used for exchanging information regardless of its operational use.

Accordingly, the purpose of SECOM is to:

- facilitate standardized information exchange of, for example, IHO S-100 based products part of maritime services such as route plans, nautical chart updates and navigational warnings;
- facilitate interoperability between maritime IT systems;
- reduce the need to support many different (proprietary) service designs;
- utilize the benefits of service oriented architecture in maritime communication, for example to enable ship systems to interact with port systems on the first call to a specific port.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DATA INTERFACES –

Part 2: Secure communication between ship and shore (SECOM)

1 Scope

The scope of SECOM includes interfaces (APIs) for data exchange (information services), information security measures to enable secure communication and interfaces for service discoverability. SECOM provides technical interoperability, where the same service interface is used for exchanging the information regardless of its operational use, up to the level of exchanging information securely online. Although designed for IHO S-100 based products, SECOM is technically payload agnostic and applicable also for other types of data.

Communication between SECOM information services for data exchange relies on IP based web services. The "last mile" links between a SECOM information service and the end-user application is not defined in this document, thus the communication technology between the vendor API and a ship/shore system can be non-IP based as well as IP based. The informative Annex D describes one such implementation of this. This allows different solutions between the service and shore/ship’s system/applications.

SECOM does not define physical layer or link layer for transport of data between SECOM information services, but requires that the transport supports IP communication. SECOM is applicable for both public (governmental) and private (business) services. SECOM is applicable for ship-shore and shore-ship communication, and can be used for ship-ship communication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IHO S-100:2018, *IHO Universal Hydrographic Data Model, ed. 4.0.0*

RFC 2315, *PKCS #7: Cryptographic Message Syntax*

RFC 2459, *Internet X.509 Public-key infrastructure and attribute certificate frameworks*

RFC 2818, *HTTP Over TLS (2000)*

RFC 2986, *PKCS #10: Certification Request Syntax Specification*

RFC 4122, *A Universally Unique IDentifier (UUID) URN Namespace*

RFC 5246, *TLS version 1.2 (2008)*

RFC 5280, *Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile*

RFC 6960, *X.509 Internet Public Key Infrastructure, Online Certificate Status Protocol – OCSP*

RFC 7231, *Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content*

RFC 8446, *TLS version 1.3 (2018)*

3 Terms, definitions and abbreviated terms

For the purposes of this document the following terms, definitions and abbreviated terms apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
access control
access authorization and access restriction

Note 1 to entry: Access control refers to all the steps that are taken to selectively authorize and restrict entry, contact, or use of assets. Access authorizations and restrictions are often established in accordance with business and security requirements.

[SOURCE: ISO/IEC 27000:2018, 3.1, modified – The definition has been rephrased, and a note to entry added.]

3.1.2
actor
role played by a user or any other system that interacts with the subject

[SOURCE: Unified Modeling Language:2017, 18.2.1.1]

3.1.3
authentication
process to confirm that a claimed characteristic of an entity is actually correct

Note 1 to entry: To authenticate is to verify that a characteristic or attribute that appears to be true is in fact true.

[SOURCE: ISO/IEC 27000:2018, 3.5, modified – The definition has been reformulated, and the note to entry added.]

3.1.4
authentication data
information used to verify the claimed identity of an entity, such as an individual, defined role, corporation or institution

[SOURCE: ISO 21188:2018, 3.4]

3.1.5
authorization
granting of rights, which includes the granting of access based on access rights

[SOURCE: ISO 7498-2:1989, 3.3.10]

3.1.6
certificate
public key and identity of an entity (*authentication data* (3.1.4)), together with some other information, rendered unforgeable by signing the certificate information with the private key of the certifying authority that issued that public key certificate

[SOURCE: ISO 21188:2018, 3.8]

3.1.7
data client
consumer of data

EXAMPLE A vessel.

3.1.8
data server
provider of data

EXAMPLE Navigational warning centre.

3.1.9
digital signature
data appended to, or cryptographic transformation of, a data unit that allows the recipient of the data unit to prove the source and integrity of the data unit and protect against forgery e.g. by the recipient

[SOURCE: ISO 7498-2:1989, 3.3.26]

3.1.10
encryption key
cryptographic secret key used with symmetric cryptographic techniques

3.1.11
hash
string of bits which is the output of a function that calculates a value of the input bytes according to some algorithm, for example checksum calculation, compression, SHA-256

Note 1 to entry: The literature on this subject contains a variety of terms that have the same or similar meaning as hash-code. Modification detection code, manipulation detection code, digest, hash-result, hash-value and imprint are some examples.

Note 2 to entry: NIST SP 800-63B uses "message digest" for "hash".

[SOURCE: ISO/EC 10118-1:2016, 3.3, modified – The definition has been completed, and Note 2 to entry added.]

3.1.12
identity registry
registry that holds the identities and bindings to public keys

3.1.13
integrity
<information security> protection of the accuracy and completeness of information

[SOURCE: ISO/IEC 27000:2018, 3.36, modified – The definition has been rephrased.]

3.1.14
javascript object notation
JSON
lightweight, text-based, language-independent syntax for defining data interchange formats

[SOURCE: IEC 21778:2017]

3.1.15
private key
cryptographic key of an entity's asymmetric key pair which can only be used by that entity

[SOURCE: ISO/IEC 11770-3:2021, 3.32, modified – The definition has been reformulated, and the note to entry added.]

3.1.16
public key
cryptographic key of an entity's asymmetric key pair which can be made public

[SOURCE: ISO/IEC 11770-3:2021, 3.33, modified – The definition has been reformulated and the note to entry deleted.]

3.1.17
public key infrastructure
PKI
structure of hardware, software, people, processes and policies that employs digital signature technology to facilitate a verifiable association between the public component of an asymmetric public key pair with a specific subscriber that possesses the corresponding private key

Note 1 to entry: The public key may be provided for digital signature verification, authentication of the subject in communication dialogues, and/or for message encryption key exchange or negotiation

[SOURCE: ISO 21188:2018, 3.48]

3.1.18
representational state transfer
REST
software architectural style that defines a set of constraints to be used for creating Web services

Note 1 to entry: Web services that conform to the REST architectural style, called RESTful Web services (RWS), provide interoperability between computer systems on the Internet

[SOURCE: Roy Fielding – Representational State Transfer (REST)]

3.1.19
route plan exchange format
RTZ
format based on standardizing a route plan, which consists of waypoints where each waypoint contains information related to the leg from the previous waypoint

Note 1 to entry: The route exchange format is a file – RTZ – containing an XML coded version of the route plan.

[SOURCE: IEC 61174:2015]

3.1.20
scheme administrator
SA
body solely responsible for maintaining and coordinating the protection scheme, by controlling membership of the scheme using the identity registry to ensure that all participants operate according to defined procedures

Note 1 to entry: The SA maintains the top level digital root certificate used to operate the protection scheme and is the only body that can certify the identity of the other participants of the scheme. The SA is responsible for distributing the certificate directly to all registered users participating in the protection scheme.

3.1.21
service
mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description

[SOURCE: OASIS Reference Model for Service Oriented Architecture 1.0]

3.1.22
service consumer
user which uses service instances provided by service providers

Note 1 to entry: All users within the maritime domain can be service customers, for example ships and their crew, authorities, VTS stations, organizations (e.g. meteorological), commercial service providers, etc.

[SOURCE: IALA Service Documentation Guidelines G1128]

3.1.23
service instance
service implementation which can be deployed at different places by same or different service providers

3.1.24
service provider
user which provides instances of services according to a service specification and service instance description

Note 1 to entry: All users within the maritime domain can be service providers, for example authorities, VTS stations, organizations (e.g. meteorological), commercial service providers, etc.

[SOURCE: IALA Service Documentation Guidelines G1128]

3.1.25
service registry
registry (e.g. database) that holds public descriptions (metadata) of services

3.1.26
nonce
random or non-repeating value that is included in data exchanged by a protocol, usually for the purpose of guaranteeing the transmittal of live data rather than replayed data, thus detecting and protecting against replay attacks

[SOURCE: NIST, Computer security resource center]

3.2 Abbreviated terms

AES advanced encryption standard
API application program interface
CA certificate authority
CBC cipher block chaining
CRL certificate revocation list
CSR certificate signing request
DSA digital signature algorithm
DSS digital signature standard
ENC electronic navigational chart
IALA International Association of Marine Aids to Navigation and Lighthouse Authorities
IHO International Hydrographic Organization
IMO International Maritime Organization
ISO International Organization for Standardization
MRN maritime resource name
OCSP online certificate status protocol
OEM original equipment manufacturer
PEM privacy enhanced mail
PKCS public key cryptography standards
PKI public key infrastructure
SA scheme administrator
SSK self signed key
TLS transport layer security
UML unified modeling language
URI uniform resource identifier
URL uniform resource locator (web address)
VTS vessel traffic service
WKT well-known text

4 General description of SECOM

4.1 General

SECOM includes information services interfaces (APIs) for data exchange, information security measures by a SECOM PKI, communication channel security and data protection to enable secure communication. Further, SECOM includes interfaces for service discoverability as shown in Figure 1. The purpose with these included components is for SECOM to provide technical interoperability, where the same service interface is used for exchanging the information regardless of its operational use, up to the level of exchanging information securely online. Although designed for IHO S-100 based products, SECOM is technically payload agnostic and applicable also for other types of data.

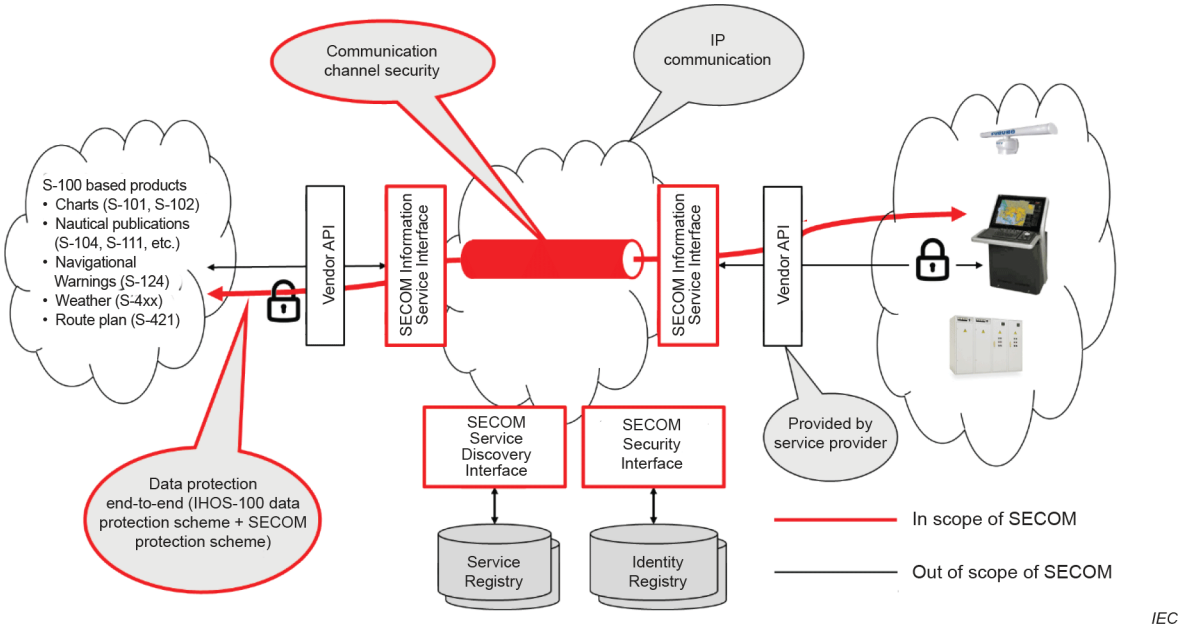


Figure 1 – Overview of SECOM

The SECOM information service interface includes the public side exposed on the Internet as depicted in Figure 1. The "last mile" links between a SECOM information service interface and the end-user application is not defined in this document and hence different solutions between the service instance and shore/ship's system are possible. The informative Annex D describes one such implementation.

SECOM information security contains communication channel security, a variant of PKI (public key infrastructure) and data protection scheme alternatives for the information exchange with full or partial compliance with IHO S-100. The data protection is provided between end-users. SECOM PKI includes the definition of a set of service interfaces for key management.

The service discovery interface includes operations to search for service instances from a service registry to meet some criteria, for example chart updates, navigational warnings, updated estimated time of arrival (ETA) information or route optimization services. The service discovery interface allows the user to choose a service instance to consume.

The information exchange between actors is bi-directional, which means that both the ship/shipping company as well as shore authorities and private service providers can initiate the information exchange and act as information provider. SECOM is thus applicable for both ship-to-shore and shore-to-ship communication. Guidance for implementation is available in Annex D.

4.2 Information service interface

The standardisation of service interfaces for information exchange enables a user that implemented the interface, for example for exchange of S-421 Route Plan (IEC 63173-1), to consume a set of operational services with different purpose, but all based on the exchange (push) of S-421 Route Plan. The standard service interface also contains interfaces for subscription, access request, pulling and dynamic request for the instance capability, status and description. See Annex B for the detailed need for each interface and operation.

Implementing a standardized interface creates significant advantages for a ship as opposed to being forced to implement a vast number of different interfaces in order to adhere to proprietary interfaces from various service providers and consumers. Allowing manufacturers of maritime equipment, such as ECDIS manufacturers, to focus on a standardised service interface will facilitate the implementation of information products onboard ships and generate less requirements for changes onboard when new services are introduced.

Service providers will have similar benefits in producing services based on exchange of standard information products, hereby gaining technical interoperability with all ships having implemented the standard service interface. Since most SECOM interfaces are optional, a service provider of a SECOM information service implementation can decide and pick what to support and hence, enable the possibility to tailor the service to its business operational needs. Each SECOM information service capability can be retrieved from the SECOM information service itself.

The SECOM information service interface is designed for IHO S-100 based products, but does also support arbitrary payloads using the SECOM data protection scheme for the exchange. The data can be sent either as open and signed or encrypted and signed.

4.3 Information security

4.3.1 Measures

SECOM contains several measures to meet the following quality attributes.

- Authentication is a process by which a system verifies the identity of a user (human or machine) who wishes to access it (i.e. to confirm, you are who you claim to be, like a passport). This corresponds to the written signature and official stamp on paper. Authentication is achieved in SECOM on two levels: 1) data authentication through the signature (SECOM data protection), and 2) service authentication through the communication channel security and X.509 (RFC 5280 and RFC 2459) certificates (SECOM communication channel security). Authentication is dependent on unique identities which is achieved by SECOM PKI.
- Integrity is achieved in SECOM by signing data where the checksum is part of the signature, described in SECOM data protection. The signing and verification of the signature is dependent on unique identities which is achieved by SECOM PKI.
- Confidentiality is achieved in SECOM on two levels: 1) data encryption according to SECOM data protection and IHO S-100, and 2) secure communication channel (transport security) for IP and HTTP through TLS and X.509 certificates, described in SECOM communication channel security.
- Access control uses authorization which is the process of determining a set of permissions that is granted to a specific trusted identity. It is achieved in SECOM by the information owner authorizing access to chosen identities from the common identity registry, described in SECOM PKI. Only public interfaces are defined in SECOM (e.g. request access).
- Identification is achieved in SECOM by the common registry for unique identities, bindings to asymmetric key pair and standardized API to SECOM PKI.
- Non-repudiation, i.e. a service intended to protect against the originator's false denial of having created the content of a message and of having sent a message, is achieved in SECOM by signing the data with the private key.

4.3.2 SECOM PKI

SECOM PKI (public key infrastructure) describes the common interface for key management and the expected functionality to provide the binding between identity and key used for signing data and authentication in service interaction.

A SECOM PKI can be provided by any internationally recognized PKI provider complying with the SECOM PKI requirements. A SECOM PKI provides an interface and an identity registry governed by its scheme administrator. There can be several instances of SECOM PKI provided by multiple scheme administrators. An actor can participate/be registered in several instances of SECOM PKI. SECOM compatible equipment are expected to support multiple instances of SECOM PKI.

SECOM does not specify which instance of identity registry to use, and SECOM does not define or constrain number of identity registries.

4.3.3 Communication channel security

When consuming service instances according to SECOM, the Internet transport is protected with TLS and valid certificates from trusted party as stated in SECOM communication channel security. The protection of the channel is a complement to the protection of the data itself and is necessary to be included to secure also other service requests, such as subscription request, access request and notifications. The SECOM communication channel security describes the usage of certificate obtained from a trusted identity registry and thereby enables authentication on the service interaction itself as depicted in Figure 2.

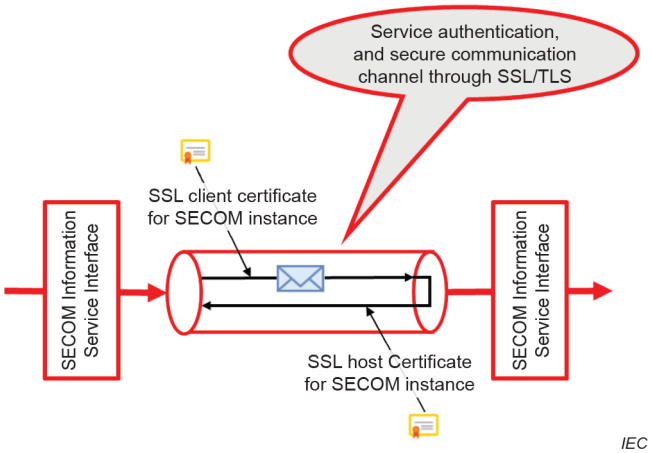


Figure 2 – Secure communication channel

The SECOM communication channel security relies on a SECOM public key infrastructure (SECOM PKI) or public-private key management using X.509 certificates to exchange the keys.

The SECOM communication channel security scheme does not comprise the "last mile" links between the SECOM information service interface and the end-user application. In Annex D, there are informative examples and guidance of how such protection could be achieved.

4.3.4 Data protection

Data protection includes both signing of data for authentication and integrity (digital signature), and optionally encryption of data for confidentiality. Data protection is aligned with the IHO data protection scheme (IHO S-100 part 15).

The digital signature contains both the checksum used to check integrity of received data, and claimed identity for data authentication. The verification of the signature includes access to common public key infrastructure (PKI) where the public key for claimed identity can be downloaded. Whenever data is exchanged, the digital signature shall always be attached and verified as close to the end user as possible. This gives the basic data end-to-end protection, see Figure 1.

The optional encryption of data uses a common protection scheme and offers two alternatives for encryption key management: 1) the existing encryption key management with permits for ENC data, such as IHO, can be used with SECOM information service interface and 2) SECOM also includes its own encryption key management that is specially designed for more dynamic data exchange ship to shore and shore to ship, such as route plan exchange. In the SECOM data protection scheme, the sender of classified data creates a temporary encryption key which is transferred securely before the encrypted data is transferred. The temporary encryption key is encrypted with the receiver's public key, the same key as used for authentication, thus can only be decrypted by the actor having the private key in its possession. The receiver's public key if not already present, can be retrieved from the receiver's SECOM interface PublicKey, see 5.7.16, or from the SECOM PKI interface GetPublicKey, see 8.6.3. This requires a strong key pair long enough for encrypting and decrypting the encryption key.

The data protection described above only protects the data part in the message. To secure the complete message, an additional signature is added, an envelope signature that includes all information of the envelope contained in the uploadObject, including the data and its dataSignature. The parts of the message that are protected by the different signatures are illustrated in Figure 3.

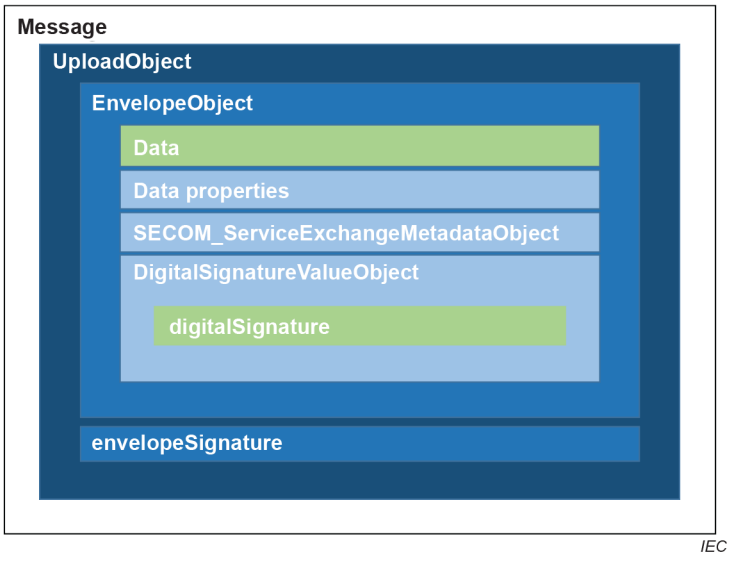


Figure 3 – Illustration of what parts of the message are protected by the two signatures

Another rationale for introducing an envelope signature is to facilitate complete message integrity check at the receiving SECOM information service side thus prohibiting forwarding of corrupt messages during the last mile to the receiver, see Figure 4.

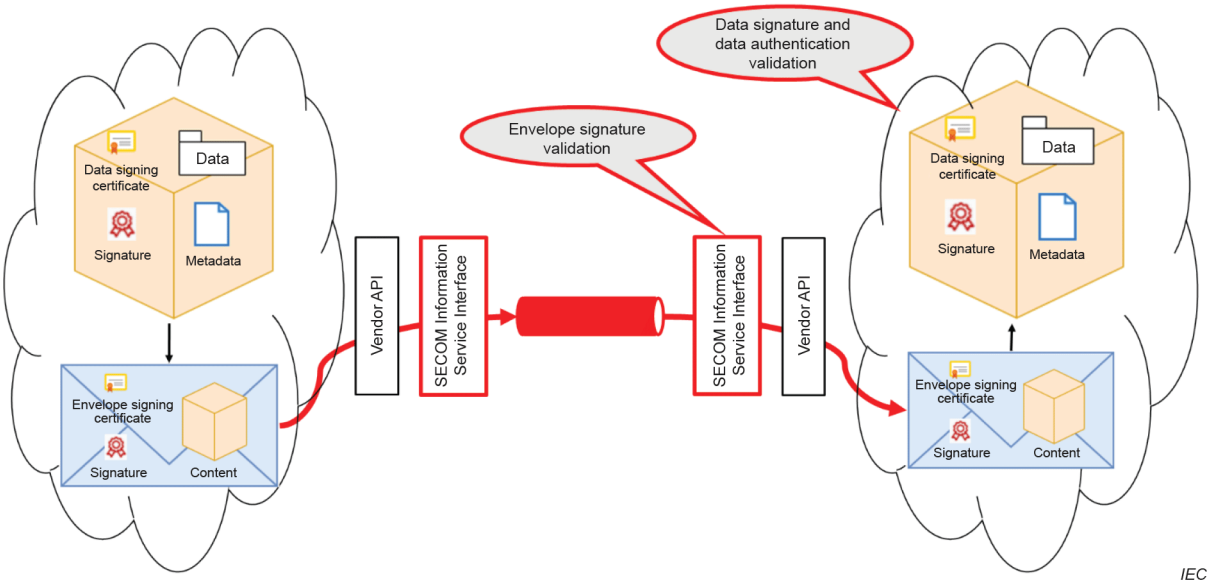


Figure 4 – Envelope and data validation

The SECOM data protection scheme relies on a SECOM public key infrastructure (SECOM PKI) using X.509 certificates to exchange the keys. The private key is generated by the actor and stored internally while the public key is securely uploaded to a SECOM PKI and attached to the identity.

The data protection scheme and the thumbprint of the root certificate indicates the identity registry used in the specific data exchange. The trusted root certificates identified with their thumbprints are expected to be stored in a local trust store.

4.3.5 Certificate revocation status

A certificate revocation list (CRL) is a list of revoked certificates that is downloaded from the certificate authority (CA). Online certificate status protocol (OCSP) is a protocol for checking revocation of a single certificate interactively using an online service called an OCSP responder (see 8.5).

4.4 Service discoverability

To support dynamic use of services, a SECOM service discovery interface has been defined. The intended operational usage is to make it possible for both officers onboard ships and operators ashore to search for service instances to interact with. Some examples from an onboard perspective are a ship that wants to find a provider of route optimization services or a VTS along the intended route to share the route plan with or providers of navigational warnings or electronic navigational charts (ENC). From a shore-based perspective, it is possible to search for registered ships targeted for information requests such as required reporting information, intended route or estimated arrival time. The SECOM service discovery contains common interfaces for discovery of service instances.

A standardized interface for finding service instances reduces the need to support several different proprietary and company specific interfaces. Further, it facilitates increased stability of the implementation, i.e. no new implementation and certification is necessary if a new service registry is used.

SECOM does not specify which service registry to use, and SECOM does not define or constrain the number of service registries, hence there can be several providers of service registries.

SECOM defines only the interface for discovery of service instance, not the registration of service instances in the service registry. This needs to be described by the provider of the chosen service registry.

4.5 Structure of this document

The following clauses are included in SECOM:

- Clause 5 SECOM information service interface;
- Clause 6 SECOM communication channel security;
- Clause 7 SECOM data protection;
- Clause 8 SECOM PKI;
- Clause 9 SECOM service discovery service interface;
- Clause 10 SECOM error cases;
- Clause 11 Test methods and expected results.

5 SECOM information service interface

5.1 General

This Clause 5 describes the SECOM information service interface for exchanging IHO S-100 based products and other payloads. The implementation of the SECOM information service interface supports digital signature and optional data encryption. The SECOM information service interface requires the use of common certificates from the SECOM PKI for authentication between service instances, as described in SECOM communication channel security.

The definition below contains a compilation of several service interfaces that, combined together, constitutes the SECOM information service interface.

In the definition, the expression "consumer" refers to the data client, and the expression "provider" refers to the data server.

- Four of the service interfaces are used for the actual exchange of data; Upload, Upload Link, Get and Get By Link. The Upload service interface is used by providers of information to push data to a consumer with maximum size of 350 kB encoded as Base64 (see RFC 2045). This covers the primary need for exchange of data. The Get interface is used when a consumer pulls data from the provider. For larger amounts of data where the upload (push) cannot be used, the Upload Link interface is used to send a link to the data, and then the data is retrieved with the Get By Link interface.
- The Get Summary interface is used to receive a short summary of available data from where the user can select one or several items to be retrieved by using the Get interface. The Subscription interface is used when a consumer wants to create a subscription to data from the provider. The provider then sends data to the consumer using the Upload service interface. The consumer uses the Remove Subscription interface to delete the subscription. The provider can also "nominate" a consumer by creating a subscription for the consumer using proprietary methods within the provider’s system. The provider then uses the Subscription Notification to inform the consumer that there is an active subscription. The provider can also remove a subscription using proprietary methods, and the provider then uses the Subscription Notification to inform the consumer.
- If a consumer does not have access to data, for example retrieval of specific data is not authorized, the consumer uses the Access interface from the provider. The provider then responds with Access Notification to the consumer with the decision, accept or deny.

- Both the provider and consumer use the Capability interface when requesting information regarding accessible interfaces and available types of data. This facilitates for example functions to ask for which version of the S-100 based Product specification a provider or consumer accepts, and functions to only present accessible interfaces for a certain service instance, thus avoiding incorrect use of the service instance.
- The Ping interface is used to check the technical status of the service instance.
- The EncryptionKey interface is used for secure exchange of the symmetric encryption key.
- The PublicKey interface is used for exchanging public certificates used for data encryption and digital signatures. Through this interface, a consumer can both request a certificate (pull) and upload a certificate (push).

5.2 How to read descriptions of service interface definition

The service interface is described according to the service definition model in IHO S-100:2018, part 14 "Online Data Exchange".

The SECOM information service interface constitutes a set of service interfaces, where each service interface is first described as a specification (technology agnostic) and then a technical design of the service interface in REST technology.

Figure 5 describes how to read the service interface as specified in the UML diagram, showing the interface name with the operation(s) defined, input and output. The input and output is defined in the data exchange model. Each interface provides (exposes) at least one service interface (operation) and may require (consume) other service interface(s).

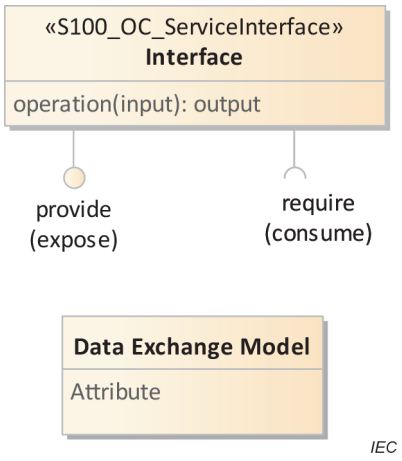


Figure 5 – Service definition model for the service interface definitions

The service specification of the service interface definition describes information for input and output in tables. The multiplicity ("Mult") column describes if data for the attribute is required or not, where 0..1 and 0..* indicates the value may be sent, and 1..* and 1 indicates that value shall be sent (i.e. is required to send). The processing column describes if received data is mandatory or optional to process. If mandatory, the data shall be processed according to the description in dynamic behavior for the service. The processing may include sending asynchronous response. See Table 1.

Table 1 – Read instructions for tables in service interface definitions

<information object>				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
Name of attribute	This describes for the implementer of the service call (i.e. initial sender of request) if the attribute is required to be sent in the service call or if the attribute may be omitted. Describes for the implementer of the service interface (i.e. responder of initial request) if the attribute is required or not. If an attribute is required by the multiplicity but the attribute is not present, the service call is considered "Bad request" and the service call shall be ignored. Alternatives of multiplicity as defined in UML. 0..1 0..* 1..* 1	This describes for the implementer of the service call if processing of the attribute by the receiver of sent data (i.e. implementer of the service interface) is mandatory or optional. This describes for the implementer of the service interface if processing of the attribute is mandatory or optional. Alternatives of processing: Mandatory Optional	This describes the logical (service design independent) encoding of the attribute	The definition and description of the attribute

Each service interface also describes a REST service interface design. A table describes each operation in the interface designed according to REST technology. For service interface designed according to REST, the type of data is JSON. See Annex A for a formal and detailed definition of the whole SECOM information service interface as REST service.

5.3 Service technology and service transportation protocol

The technology (architectural style) chosen is REST (REpresentational State Transfer) upon HTTP/1.1 (RFC 7231).

REST is an architectural style, and an approach to communications that is often used in the development of Web services. The use of REST in SECOM is preferred over other more heavyweight protocols such as SOAP (simple object access protocol) because REST does not leverage as much bandwidth, which makes it a better fit for use in communication between vessels and shore based representation of the same.

REST, which typically runs over HTTP (hypertext transfer protocol), has several architectural constraints.

- Decoupling – Decouples consumers from producers which suits SECOM decentralized architecture well.
- Stateless existence – Also a good prerequisite for a decentralized architecture design.
- Able to leverage a cache – Probably less important in SECOM since most of the interaction is between machines, although for services with man-machine interfaces this is of importance.
- Leverages a layered system – SECOM is dependent on good scaling capabilities which REST supports.
- Leverages a uniform interface – Again since SECOM defines the available services centrally in one or several service registry(s), this constraint supports implementations being decoupled from the services they provide.

The definition of each operation defines additional error messages that the operation specifically shall respond with as a complement to the HTTP response codes defined by HTTP/1.1 (RFC 7231).

5.4 Service interface versioning

The version on the service interface definition follows the version of this document.

The version on the design as REST service interface is reflected in the path for the service instance. The version is defined in the formal REST service definition as OpenAPI specification (Swagger) in Annex A.

Table 2 describes the structure of the versioning of the SECOM service interface.

Table 2 – SECOM Service interface versioning

REST method	URL	base URL with version	SECOM REST operation
POST	https://iec.ch	/v1	/object

Example
POST https://iec.ch/v1/object{…}

NOTE The versioning described here is the version of the SECOM information service interface defined in this document. Version of the service instance itself or other versioning by the manufacturer can be included in the URL.

5.5 Pagination

The Get and Get Summary interfaces may return more than one result. In order to limit the response size, these interfaces support pagination.

When requests to these service interfaces are made, the optional "page" and "pageSize" parameters may be specified by the client. If provided, these allow the client to request how many items are to be returned and the starting point of these items. For example, if a particular request would produce a result consisting of 30 items, setting page = 1 and pageSize = 20 would return the first twenty items; and page = 2, pageSize = 20 would return the remaining ten.

Regardless of whether page or pageSize is specified, the server shall always return the total number of items in the totalItems attribute, and the maximum number of items per page in the maxItemsPerPage attribute.

Errors shall be returned by the server if either an invalid page is asked for or if too many items are requested at a time.

If the page parameter is not present, the server shall send back the first page of the result.

If the pageSize parameter is not present, the server shall send back the maximum number of items per page that it supports.

If the page parameter is set to 0, the server shall not return any items, but shall return maxItemsPerPage. This value shall be constant for any query on the server (so that the client only needs to request this once).

5.6 Common information objects and data types

5.6.1 General

The information objects shared among several interfaces are shown in Table 3 to Table 14.

5.6.2 Basic data types

Table 3 – Basic data types

Name	Description
Integer	A signed integer number, the representation of an integer is encapsulation and usage dependent. EXAMPLE 29, -65547
PositiveInteger	An unsigned integer number greater than 0.
Boolean	A value representing binary logic. The value can be either true or false.
CharacterString	A CharacterString is an arbitrary-length sequence of characters including accents and special characters from repertoire of one of the adopted character sets
Date	A date gives values for year, month and day according to the Gregorian Calendar. Character encoding of a date is a string which shall follow the calendar date format (complete representation, basic format) for date. EXAMPLE 19980918 (YYYYMMDD)
Time	A time is given by an hour, minute and second in the 24-hour clock system. Character encoding of a time shall be a complete representation of the basic format. Complete representation means that hours, minutes and seconds shall be used. Basic format means that separating characters are omitted. Time is preferably expressed as Universal Time Coordinated (UTC). EXAMPLE 183059Z Time may be expressed as a Local Time with a given offset to UTC. EXAMPLE 183059+0100 Time may be expressed as a Local Time without a specified offset to UTC. EXAMPLE 183059 The complete representation of the time of 27 min and 46 s past 15 h locally in Geneva (in winter one hour ahead of UTC), and in New York (in winter five hours behind UTC), together with the indication of the difference between the time scale of local time and UTC, are used as examples. Geneva: 152746+0100 New York: 152746-0500 The service hours for a service that is available all year in an area where Daylight Saving Hour affects the offset to UTC could be expressed as Local Time without specified offset. Opening: 074500 Closing: 161500
DateTime	A DateTime is a combination of a date and a time type. Character encoding of a DateTime shall follow as the above. EXAMPLE: 19850412T101530
byte[]	Array of bytes

5.6.3 SECOM_ExchangeMetadataObject

The objects shown in Table 4 and Table 5 contain metadata attributes with information of protection, compression and public keys used for the digital signature of the data. The order of adding attributes as part of the generation and verification of the envelope signature is achieved by traversing the attributes in the order first to last, i.e. dataProtection, protectionScheme and so on, see 7.3.4.

Table 4 – SECOM_ExchangeMetadataObject

SECOM_ServiceExchangeMetadataObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataProtection	1	Mandatory	Boolean	(S-100) Indicates if the data is encrypted. 0 indicates unencrypted data 1 indicates encrypted data
protectionScheme	1	Mandatory	CharacterString	(S-100) Specification or method used for data protection For example S-63, SECOM
digitalSignatureReference	1	Mandatory	CharacterString	(S-100) Specifies the algorithm used to compute digitalSignatureValue For example "dsa"
digitalSignatureValue	1	Mandatory	DigitalSignatureValueObject	Signed Public Key thumbprint plus the digital signature Table 5
compressionFlag	1	Mandatory	Boolean	(S-100) Indicates if data is compressed. 0 indicates uncompressed 1 indicates compressed

Table 5 – DigitalSignatureValueObject

DigitalSignatureValueObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
publicRootCertificate Thumbprint	0..1	Optional	CharacterString	Claimed Thumbprint for Signed Root Key (X.509 Certificate)
publicCertificate	1	Mandatory	CharacterString	Public Key (X.509 Certificate), PEM encoded Base64 string
digitalSignature	1	Mandatory	CharacterString	(S100) The digital signature in HEX format as one row, no trailing return/new line

5.6.4 Transfer of public key

5.6.4.1 General

In all cases when the payload includes claimed public keys used, for example, for signatures and classified data, the keys need to be converted in a manner to fit inside a JSON format and to secure interoperability. Certificates in PEM format contain line feeds and BEGIN/END header/footer. Line feed encoding characters differ among different operational systems (OS) where for example Unix uses only \n for line feed while Windows uses carriage return + line feed characters (\r\n). In order to secure interoperability between different OS machines, a minified public key is introduced to be used inside the different JSON object payloads. More examples on how to embed PEM encoded keys in payloads can be found in for example IHO S-100:2018, Part 15-7, Data encryption and licensing.

5.6.4.2 Producer

During the build of a payload JSON object and before adding the public key to the same object, the original key is minified into one single line string by:

1) Remove all line feed characters
2) Remove header -----BEGIN CERTIFICATE-----

3) Remove footer -----END CERTIFICATE-----

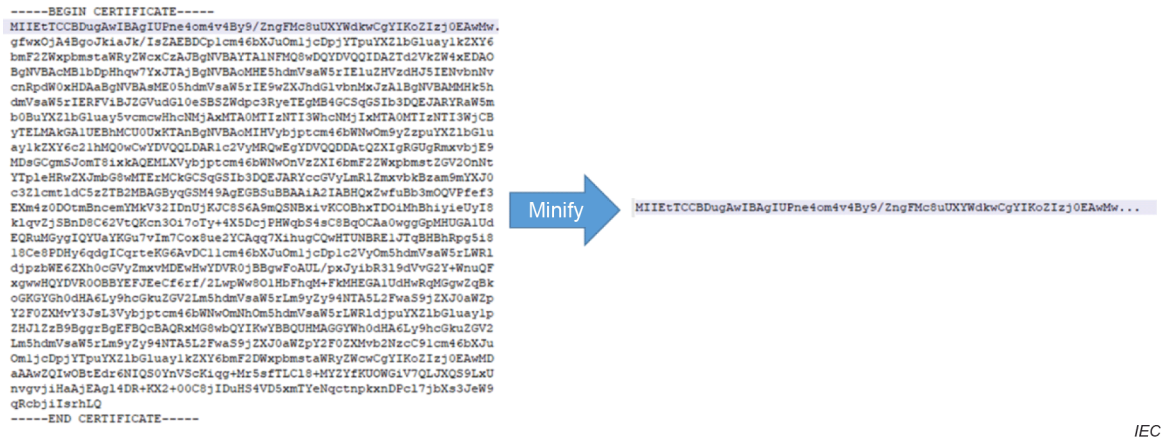
Figure 6 shows an example of the minimisation above using C# .NET. The specific *Environment.NewLine* (the corresponding routine in Java is the *System.lineSeparator()*) is used to ensure that the correct line feed character is used depending on what machine the system is installed on.

```
public string GetMinifiedPemFromCert(X509Certificate2 cert)
{
    var sb = new StringBuilder();
    using (var sw = new StringWriter(sb))
    {
        var writer = new PemWriter(sw);
        writer.WriteObject(DotNetUtilities.FromX509Certificate(cert));
    }
    //1.
    sb.Replace(Environment.NewLine, "");
    //2.
    sb.Replace("-----BEGIN CERTIFICATE-----", "");
    //3.
    sb.Replace("-----END CERTIFICATE-----", "");
    return sb.ToString();
}
```

IEC

Figure 6 – Example in C# of conversion from PEM format to minified public key

Figure 7 shows an example of a public key before and after the conversion.



IEC

Figure 7 – Example of a public key in PEM format converted to a single line string

5.6.4.3 Consumer

For the receiver, the conversion is the opposite. When consuming the transferred payload, the public key is converted back to its original format.

1) Add header -----BEGIN CERTIFICATE-----
2) Add OS specific line feed character
3) Split the public key string from the payload into an array of max 64 characters per row
4) For each element in the array
   a) add element as new row
   b) add OS specific line feed character

5) Add footer -----END CERTIFICATE-----

6) Add OS specific line feed character

Figure 8 shows an example of a conversion using C# .NET where the line feeds are added using .NET.

```
public X509Certificate GetCertFromPem(string publicKeyMinified)
{
    //1.
    string publicKey = "-----BEGIN CERTIFICATE-----";
    //2.
    publicKey += Environment.NewLine;
    //3.
    IEnumerable<string> keyArray = SplitIntoArray(publicKeyMinified, 64);
    //4.
    foreach(var row in keyArray)
    {
        //4a.
        publicKey += row;
        //4b.
        publicKey += Environment.NewLine;
    }
    //5.
    publicKey += "-----END CERTIFICATE-----";
    //6.
    publicKey += Environment.NewLine;

    return new X509Certificate(Encoding.UTF8.GetBytes(publicKey));
}
```

IEC

Figure 8 – Example in C# of conversion from minified public key to PEM format

Figure 9 shows an example of the result when restoring a public key PEM format from a minified string.

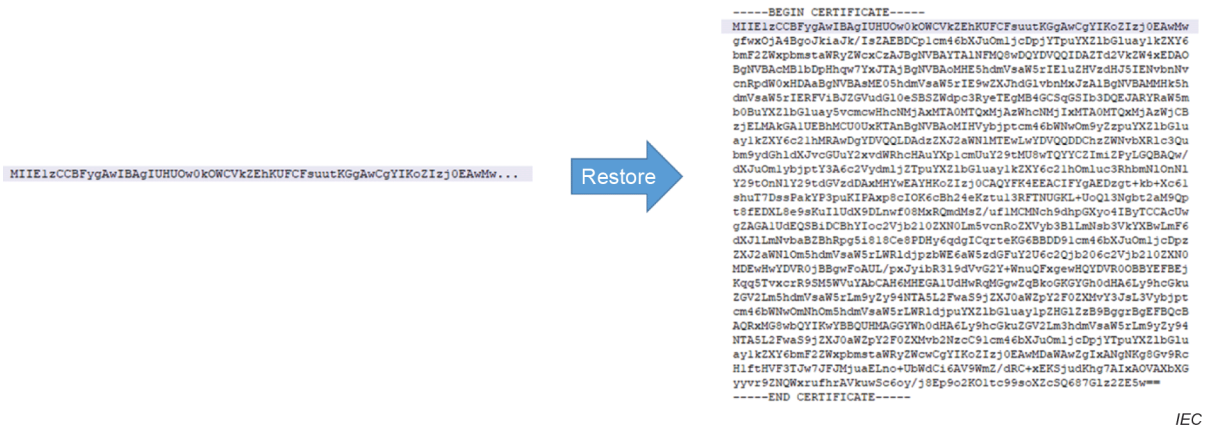


Figure 9 – Example of a minified public key string restored to the original PEM format

5.6.5 PaginationObject

The "Get" and "Get Summary" service interfaces may return more than one result. In order to limit the response size, these interfaces support pagination, for more details, see 5.5. Table 6 shows the attributes included in the PaginationObject.

Table 6 – PaginationObject

PaginationObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
totalItems	1	Mandatory	PositiveInteger	The total number of items that satisfy the query. This is always returned.
maxItemsPerPage	1	Mandatory	PositiveInteger	The maximum number of items the service shall return per page.

5.6.6 ContainerTypeEnum

Container types used in SECOM interface definitions. Table 7 shows the values of the enumeration.

Table 7 – ContainerTypeEnum

ContainerTypeEnum	
Value	**Definition**
0	S100_DataSet
1	S100_ExchangeSet
2	NONE

5.6.7 SECOM_DataProductType

Table 8 contains the supported product types used in SECOM information interfaces 5.7.5, 5.7.6, 5.7.8, 5.7.10 and 5.7.13.

Table 8 – SECOM_DataProductType

SECOM_DataProductType	
Name	**Description**
OTHER	Other data types not covered in this table
S57	S-57 Electronic Navigational Chart (ENC)
S101	S-101 Electronic Navigational Chart (ENC)
S102	S-102 Bathymetric Surface
S104	S-104 Water Level Information for Surface Navigation
S111	S-111 Surface Currents
S122	S-122 Marine Protected Areas (MPAs)
S123	S-123 Marine Radio Services
S124	S-124 Navigational Warnings
S125	S-125 Marine Navigational Services
S126	S-126 Marine Physical Environment
S127	S-127 Marine Traffic Management
S128	S-128 Catalogue of Nautical Products
S129	S-129 Under Keel Clearance Management (UKCM)
S131	S-131 Marine Harbour Infrastructure
S210	S-210 Inter-VTS Exchange Format

SECOM_DataProductType	
Name	**Description**
S211	S-211 Port Call Message Format
S212	S-212 VTS Digital Information Service
S401	S-401 Inland ENC
S402	S-402 Bathymetric Contour Overlay for Inland ENC
S411	S-411 Sea Ice Information
S412	S-412 Weather Overlay
S413	S-413 Marine Weather Conditions
S414	S-414 Marine Weather Observations
S421	S-421 Route Plan
RTZ	Route Plan
EPC	Electronic Port Clearance

5.6.8 SECOM_ResponseCodeEnum

The enumeration in Table 9 is added to the synchronous HTTP response object if a validation error occurs at the SECOM instance level for information to the service consumer. This is used in push interfaces such as Upload, UploadLink and Acknowledgement to provide a more specific error message.

Table 9 – SECOM_ResponseCodeEnum

SECOM_ResponseCodeEnum	
Value	**Definition**
0	Missing required data for the service
1	Failed signature verification
2	Invalid certificate
3	Schema validation error

5.6.9 AckRequest Enum

A flag to indicate that acknowledgement is expected to be returned when the data is delivered to the end user, and/or when the content of the data is processed (opened) by the end user. The value of this enumeration acts as a condition for whether an acknowledgment should be sent (value = 1,2,3) or not (value = 0). It is mandatory to implement the above functionality. Table 10 shows the enumeration values.

Table 10 – AckRequest Enum

AckRequestEnum	
Value	**Definition**
0 (default)	No ACK requested
1	Delivered ACK requested
2	Opened ACK requested
3	Delivered + Opened ACK requested

5.6.10 Common HTTP response codes

In Table 11, HTTP response codes common to all interfaces optional to implement are listed. For mandatory interfaces such as Ping and Capability, code 501 is not applicable. For interfaces using the SECOM_ResponseCodeEnum in Table 9, the corresponding column value is set to null.

Table 11 – Common HTTP codes

HTTP Code	Message
401	Unauthorized
405	Method not allowed
500	Internal server error
501	Not implemented

5.6.11 Well-known text – WKT

Query parameter "geometry" type used in interface Get, Get Summary and Subscription.

WKT is a human readable representation for spatial objects like points, lines, or enclosed areas on a map. SECOM uses a subset of the objects in WKT CRS 2 (see ISO 19162) with EPSG projection 4326 – WGS 84.

The objects used are listed in Table 12.

Table 12 – Supported WKT geometric objects

Supported WKT geometric objects		
Object	**Defintion**	**Example**
Point	A zero-dimensional geometry that represents a single location in coordinate space on a map. The (x,y) coordinate is represented in order (longitude, latitude) and expressed as real value, degree/degree decimal format.	POINT (30 10)
LineString	A curve with linear interpolation between points. Each consecutive pair of points defines a line segment.	LINESTRING (30 10, 10 30, 40 40)
Polygon	A planar surface, i.e. a two-dimensionsal geometry object, defined by 1 exterior boundary and 0 or more interior boundaries. Each interior boundary defines a hole in the polygon.	POLYGON ((30 10, 40 40, 20 40, 10 20, 30 10))
MultiPoint	An array of point objects	MULTIPOINT ((10 40), (40 30), (20 20), (30 10))
MultiLineString	An array of LineString objects	MULTILINESTRING ((10 10, 20 20, 10 40), (40 40, 30 30, 40 20, 30 10))
MultiPolygon	An array of polygon objects	MULTIPOLYGON (((30 20, 45 40, 10 40, 30 20)), ((15 5, 40 10, 10 20, 5 10, 15 5)))
GeometryCollection	A collection of 1 or more geometry objects	GEOMETRYCOLLECTION (POINT (40 10), LINESTRING (10 10, 20 20, 10 40), POLYGON ((40 40, 20 45, 45 30, 40 40)))

5.6.12 Universally Unique Identifier – UUID

A UUID (see RFC 4122) is a 128-bit (16 bytes) number used to identify some entity in an information system. When generated according to standard methods, UUIDs are unique with a probability of duplication close enough to zero. In SECOM, the UUID type is used as data references and as transaction identifiers created by the information owner in the OEM system.

The 128-bit string is represented as 32 hexadecimal digits displayed in five groups separated by hyphens, in the form 8-4-4-4-12 for a total of 36 characters, see Figure 10.

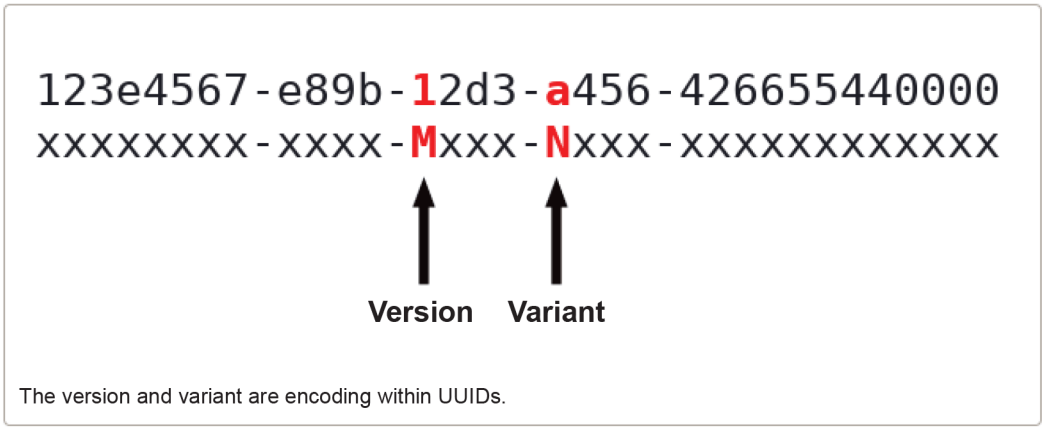


Figure 10 – UUID version and variant

The four-bit M (13th digit) and the first 1 to 3 most significant bit N (17th digit) fields code the format of the UUID itself. In the example in Figure 10, M = 1 i.e. version 1 and N = a i.e. variant 1 since the only possible hexadecimal values are 8 (1000), 9 (1001), a (1010) or b (1011). There are five versions of UUIDs and four variants where variant 1 (big-endian) is the most common. See Table 13 and Table 14.

Table 13 – UUID variants

UUID Variants			
Name	**Binary**	**Hex Digit**	**Description**
0	0xxx	0-7	Reserved, NCS backwards compatibility
1	10xx	8-b	RFC 4122/DCE 1.1 UUIDs
2	110x	c-d	Reserved, Microsoft Corporation backward compatibility
reserved	111x	e-f	Reserved for future definition

Table 14 – UUID versions

UUID Versions		
Name	**Name descr**	**Description**
0	nil	A special case where all bits are set to zero
1	date-time and MAC address	Generated from a time and a node ID
2	date-time and MAC address, security version	Generated from an identifier (usually a group or user id), time, and a node id. RFC 4122 reserves version 2 for "DCE (Distributed Computing Environment) security" UUIDs but without providing any details. For this reason, many UUID implementations omit version-2.
3	name-based	Generated by MD5 (128 bits) hashing of a namespace identifier and name.
4	random	Generated using a random or pseudo-random number.
5	name-based	Generated by SHA-1 (160 bits) hashing of a namespace identifier and name.

The version and variant used when generating the UUID is up to the information owner and hence is outside of SECOM as long as the resulting formatted string complies with the RFC 4122 standard format and can be decoded by the information consumer.

5.6.13 UN/LOCODE

The "United Nations Code for Trade and Transport Locations" is commonly more known as "UN/LOCODE". It is managed and maintained by the UNECE. All details are available from the link below

https://unece.org/trade/uncefact/unlocode

Code of location according to UN/Locode codelist restricted to regular expression [a-zA-Z]{2}[a-zA-Z2-9]{3}. For example SEGOT, USAA7.

5.7 Service interface definitions

5.7.1 General

Table 15 gives an overview of the service interfaces that constitutes the SECOM information service interface. Service interfaces Capability and Ping shall be supported while the remaining interfaces are optional to implement.

Table 15 – Service interfaces overview

Service Interface	Exchange Pattern	Definition	Use case, see Annex B
Upload	ONE_WAY	Interface to send (push) information to consumer	B.2.1, B.2.2, B.2.3, B.2.4, B.2.7
UploadLink	ONE_WAY	Interface to send (push) a link to information for a consumer to get	B.2.6, B.2.8
Acknowledgement	ONE_WAY	Interface to send acknowledgement on uploaded information.	B.2.1
Get	REQUEST_RESPONSE	Interface to ask for (pull) information from provider	B.2.2
Get Summary	REQUEST_RESPONSE	Interface to ask for (pull) an information list from provider	B.2.2
Get By Link	ONE-WAY	Interface to retrieve information from uploaded link	B.2.6, B.2.8

Service Interface	Exchange Pattern	Definition	Use case, see Annex B
Access	REQUEST_CALLBACK	Interface to ask for access to information	B.2.1, B.2.4
Access Notification	ONE_WAY	Interface for notification from access request	B.2.1, B.2.4
Subscription	PUBLISH_SUBSCRIBE	Interface to create subscription of information	B.2.1, B.2.4, B.2.7
Remove Subscription	ONE_WAY	Interface to remove subscription	B.2.1, B.2.4, B.2.7
Subscription Notification	ONE_WAY	Interface for notification from subscription events	B.2.1, B.2.4, B.2.7
Capability	REQUEST_RESPONSE	Interface to ask for the interface capabilities. Mandatory to implement.	B.2.1
Ping	REQUEST_RESPONSE	Interface to check status on the service instance. Mandatory to implement.	B.2.4
Encryption Key	ONE_WAY, REQUEST_CALLBACK	Interface to securely send symmetric key for data encryption	B.2.3 B.2.6
PublicKey	ONE_WAY, REQUEST_RESPONSE	Interface to request (pull) and send (push) a public certificate	B.2.3

5.7.2 Service interface – Upload

5.7.2.1 Specification

The purpose with this interface is to upload (push) information that shall not be larger than a maximum size of 350 kB (Base64 encoded) to an information consumer. An information consumer shall implement this interface in order to receive information while an information provider may implement it.

When uploading (sending) information, acknowledgement can be requested. See interface Acknowledgement for the details of sending acknowledgement.

Uploading (sending) of information can either be within an active subscription of information or uploaded (sent) once as a single message as indicated by the attribute fromSubscription.

The data can be either XML, compressed XML or encrypted binary, typically compressed, as described in the exchange metadata object. The data can contain either one message, such as an S-421 Route Plan (IEC 63173-1) dataset, or a set of messages (files) compressed in a ZIP container and described by an ExchangeSet as described in IHO S-100. The data is encoded as one row Base64 before transferred.

Attached to the data there is a set of metadata describing the protection of the data. The metadata refers to the content in the data attribute, independent of its type. For exchange of an IHO S-100 DataSet, this means that the dataset might be in XML (compressionFlag = false) or in ZIP (compressionFlag = true), or optionally compressed and encrypted (compressionFlag = true and dataProtection = true) and the data is signed (hash calculated and signed). For exchange of an IHO S-100 ExchangeSet (exchange catalogue), the same procedure is used. The IHO S-100 ExchangeCatalogue contains a set of files, the folder is compressed, and optionally encrypted and the data is signed (hash calculated and signed).

Figure 11 shows the interface in UML.

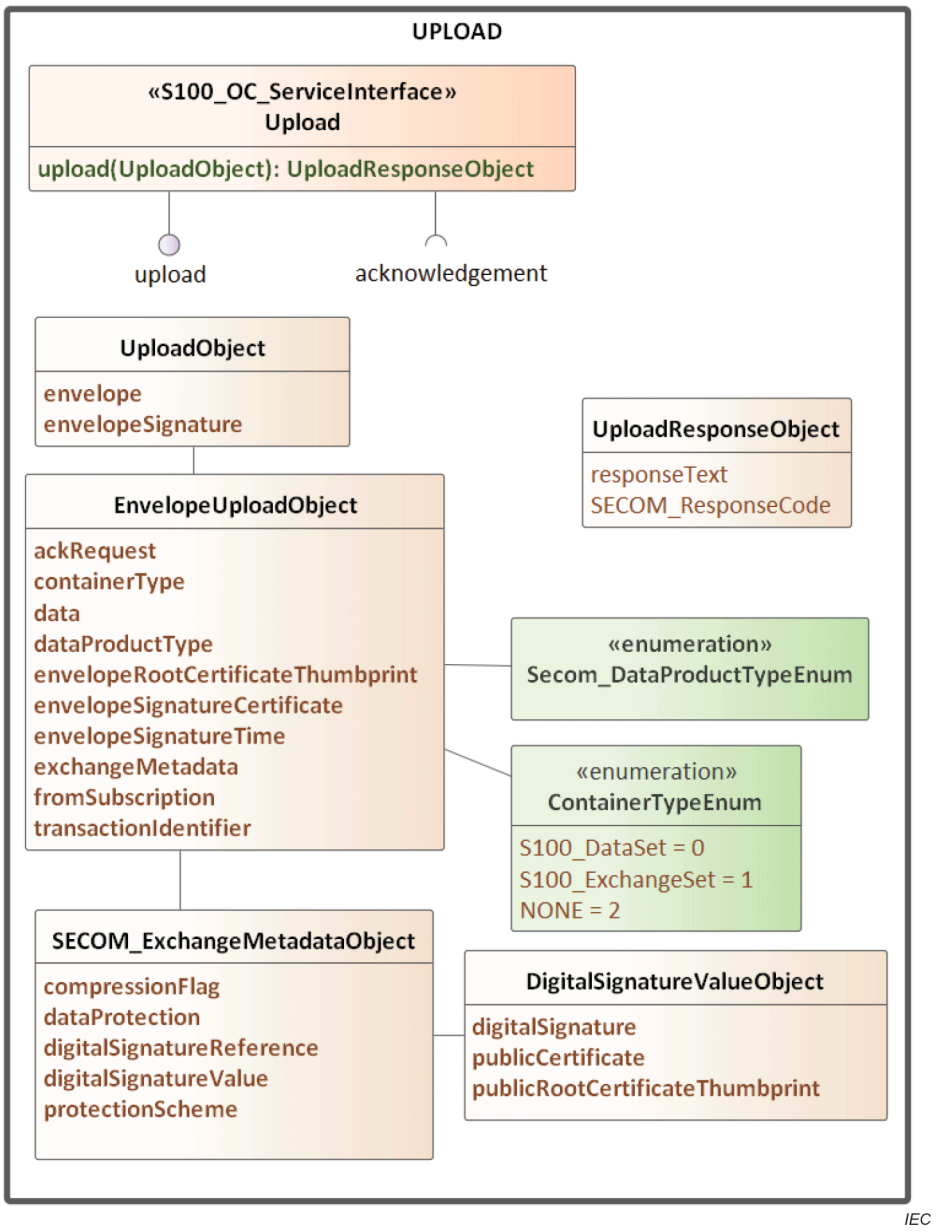


Figure 11 – Upload interface UML diagram

5.7.2.2 Data exchange model

Table 16 and Table 17 describe the data exchanged in the interface.

Table 16 – Information input for Upload interface

UploadObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
envelope	1	Mandatory	EnvelopeUploadObject	The complete EnvelopeObject being uploaded to receiver including data and message properties
envelopeSignature	1	Mandatory	CharacterString	The signature of the EnvelopeObject in HEX format without whitespace or linebreaks
EnvelopeUploadObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
data	1	Mandatory	Base64	The payload XML dataProductType, base64 encoded (e.g. inside a S100_ExchangeSet, S100_DataSet), ZIP or binary. The data can be open, protected and/or compressed.
containerType	1	Mandatory	ContainerTypeEnum	Container type of message in the data object Table 7
dataProductType	1	Mandatory	SECOM_DataProductType.Name	The name column of the SECOM_DataProductType in Table 8
exchangeMetadata	1	Mandatory	SECOM_ExchangeMetadataObject	The exchange metadata contains information regarding protection scheme, compression, signature and claimed identity according to Table 4
fromSubscription	1	Optional	Boolean	Flag to indicate whether the data has been uploaded within an active subscription or not.
ackRequest	1	Mandatory	AckRequestEnum	Flag to indicate that acknowledgement is expected to be returned when the data is delivered to the end user, and/or when the content of the data is processed (opened) by the end user.
transactionIdentifier	1	Mandatory	UUID	Transaction identifier to be used e.g. in acknowledgement
envelopeSignatureCertificate	1	Mandatory	CharacterString	The public certificate of the sender. Used to verify the envelopeObject signature
envelopeRootCertificateThumbprint	1	Optional	CharacterString	Claimed Thumbprint for Signed Root Key (X.509 Certificate)
envelopeSignatureTime	1	Optional	DateTime	Time stamp when the envelope is signed

Table 17 – Information output for Upload interface

UploadResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
SECOM_ResponseCode	0..1	Mandatory	SECOM_ResponseCodeEnum	Additional error code for internal errors Table 9
message	1	Optional	CharacterString	Success or error response message

5.7.2.3 REST design

5.7.2.3.1 General

The service interface and its data exchange model is defined with REST technology.

See Annex A for formal and detailed definition of the service interface as OpenAPI format.

5.7.2.3.2 Operation POST/object

The interface shall be used for uploading (pushing) data to a consumer. The operation expects one single data object and its metadata. The details are described in Table 18. For detailed description of data exchange model, see 5.7.2.2.

Table 18 – REST implementation of Upload

REST Operation			
POST URL/v1/object {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
UploadObject	application/json	1	The data (payload) package with its metadata
Return (out)	**REST Encoding**	**Mult**	**Definition**
UploadResponseObject	application/json	1	Confirmation of upload or error message, including description of incorrect or missing values in payload for the specific service.

5.7.2.3.3 Service response

The REST service instance shall respond with HTTP codes and message according to Table 19.

Table 19 describes internal error codes and messages generated by the service implementer. Error codes and messages generated by the deployment environment shall follow RFC 7231 HTTP1/1 and is out of the scope for SECOM.

See also Table 11 for codes common to all interfaces. For this interface with an extra attribute, SECOM_ResponseCodeEnum, this attribute is set to null for the common response codes.

For tests related to these error codes, see 10.14.

Table 19 – HTTP Response codes and message in response object

HTTP Code	SECOM_ResponseCodeEnum	Message examples
200	null	Message successfully uploaded
400	0	Missing required data for the service
400	1	Failed signature verification
400	2	Invalid certificate
400	3	Schema validation error
403	null	Not authorized to upload
413	null	Request entity too large

5.7.2.4 Dynamic behaviour

Figure 12 describes the dynamic use of the Upload interface and the relation to the Acknowledgement interface.

The Upload interface is used when data is pushed (sent) to another actor. The size of the data is technically constrained by the chosen REST technology to messages less than 350 kB. In the sequence diagram, the left side actor, SECOM service consumer, produces the data to be pushed to the right side actor. The SECOM service consumer invokes the Upload interface (consumes the Upload service interface) and sends data, data signature and complementary metadata to the receiving actor. The complementary metadata contains attributes for the acknowledgement request (optional), transaction identifier, subscription flag and the signature for the complete transferred data package.

The receiver checks the size of data received (normally by the web server) and will respond with HTTP response 413 if the size is too large for the current configuration. A service consumer shall always be prepared to handle such error response. The receiver of data checks the integrity as part of the verify signature step of the data package and responds accordingly with either HTTP response 200 if OK, or with 400 and SECOM_ResponseCodeEnum = 1 if not OK, see Table 19.

The data is then forwarded to a user application, either directly or through vendor specific communication channels. If delivery acknowledgement has been requested, "delivery ACK" is sent asynchronously to the acknowledgement endpoint appointed in the metadata when the data is correctly forwarded to the end-user.

The end-user application verifies access rights and verifies the signatures as received, both as integrity check and authentication of data received.

If opened acknowledgement has been requested, "opened ACK" shall be sent asynchronously to the acknowledgement endpoint appointed in the metadata when the data is correctly opened or processed by the end-user. SECOM does not specify a time limit between receiving a message and sending an "opened ACK".

Further information on message exchange patterns in given in Annex C.

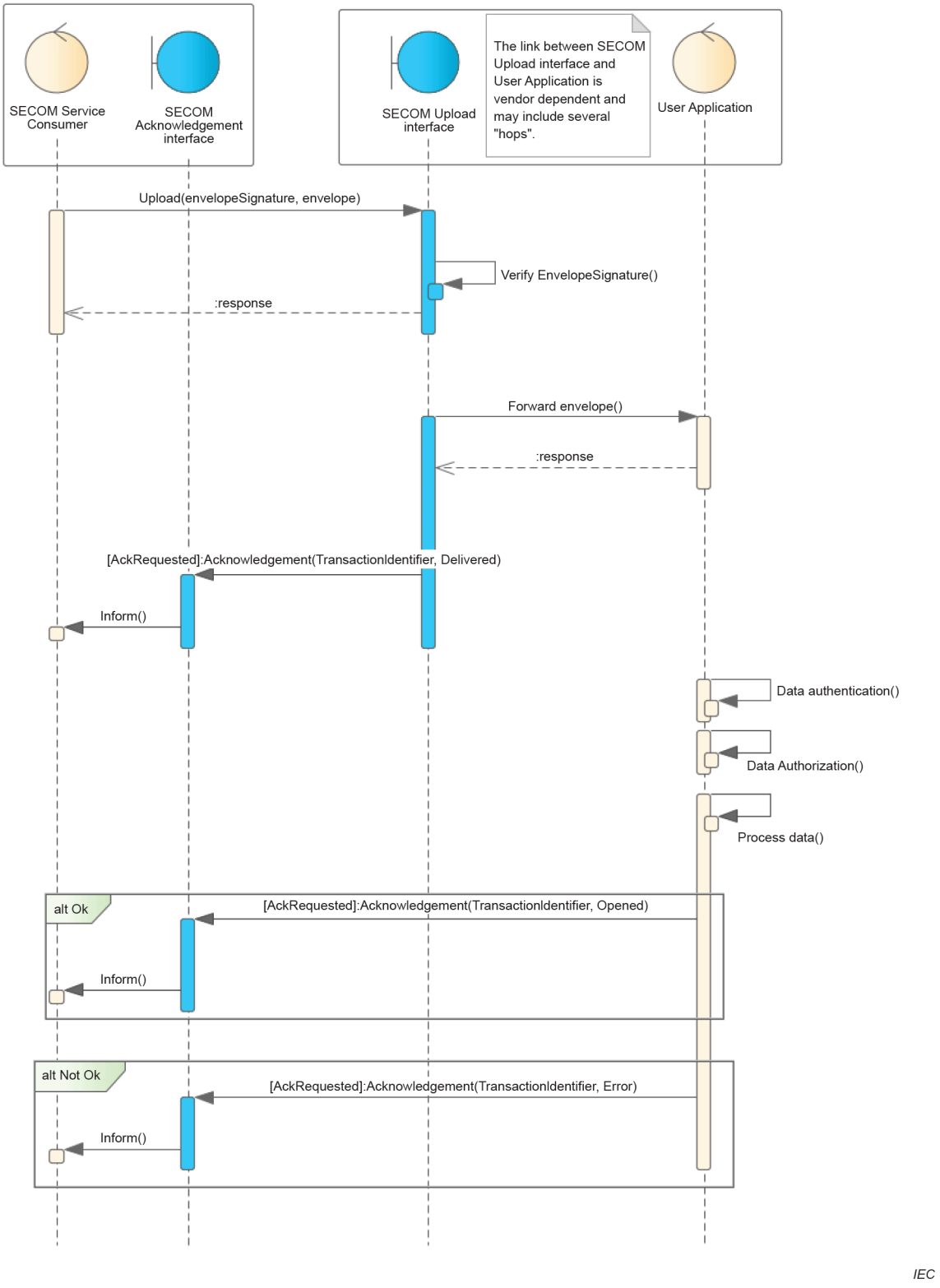


Figure 12 – Sequence diagram for upload signed unclassified data with acknowledgement

NOTE The acknowledgements can be used for supervision and diagnostic purposes.

5.7.3 Service interface – Upload Link

5.7.3.1 Specification

The purpose with this interface is to upload (push) a link to information to a consumer. Hence, a consumer implements this interface in order to receive a link to the information that can be retrieved.

This interface is used when large amounts of data are to be exchanged. The provider of information uploads a link to a consumer, and the consumer then uses the Get by Link interface to pull the data from the provider.

The process of uploading data in a two-step procedure (Upload Link followed by Get By Link) adds a complexity to the signature verification. The transactionIdentifier relates to the actual data but it is still the underlying data that is signed similar to the signing in the Upload interface. Hence, the verification of the data signature can only be done after the data has been downloaded using Get By Link. Figure 13 describes the interface in UML.

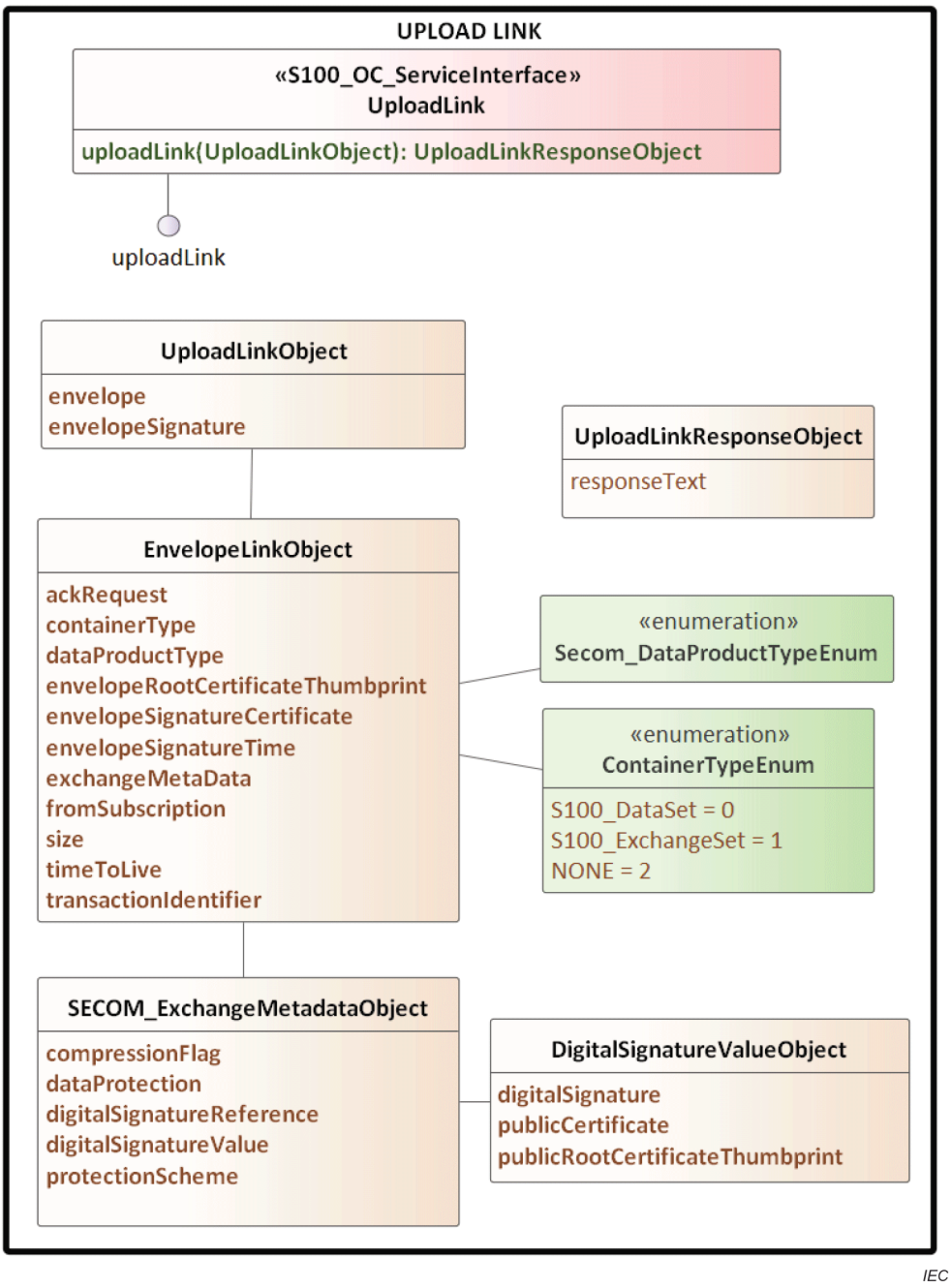


Figure 13 – Update link interface UML diagram

5.7.3.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 20 and Table 21.

Table 20 – Information input for Upload Link interface

UploadLinkObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
envelope	1	Mandatory	EnvelopeLinkObject	The complete EnvelopeLinkObject being uploaded to receiver including message properties
envelopeSignature	1	Mandatory	CharacterString	The signature of the EnvelopeLinkObject in HEX format without whitespace or linebreaks
EnvelopeLinkObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
containerType	1	Mandatory	ContainerTypeEnum	Container type of message in the data object Table 7
dataProductType	1	Mandatory	SECOM_DataProductType. Name	The name column of SECOM_DataProductType in Table 8
exchangeMetadata	1	Mandatory	SECOM_ExchangeMetadataObject	Service exchange metadata with signature, ID etc.
fromSubscription	1	Optional	Boolean	Flag to indicate whether the data has been uploaded within an active subscription or not.
ackRequest	1	Mandatory	AckRequestEnum	Flag to indicate that acknowledgement is expected to be returned when the data is delivered to the end user, and/or when the content of the data is processed (opened) by the end user.
transactionIdentifier	1	Mandatory	UUID	Transaction identifier to be used in acknowledgement and when retrieving the message using Get By Link
envelopeSignatureCertificate	1	Mandatory	CharacterString	The public certificate of the sender, used to verify the envelopeLinkObject signature
envelopeRootCertificate Thumbprint	1	Optional	CharacterString	Claimed Thumbprint for Signed Root Key (X.509 Certificate)
size	1	Optional	PositiveInteger	Size of the data in kBytes to be downloaded.
timeToLive	1	Mandatory	DateTime	DateTime when data will be deleted on server. The data need to be fetched before this time.
envelopeSignatureTime	1	Optional	DateTime	Time stamp when the envelope is signed

Table 21 – Information output for Upload Link interface

UploadLinkResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
SECOM_ResponseCode	0..1	Mandatory	SECOM_ResponseCodeEnum	Additional error code for internal errors, see Table 9
message	1	Optional	CharacterString	Success or error response message

5.7.3.3 REST Design

5.7.3.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.3.3.2 Operation – POST /object/link

The REST operation POST /object/link. The interface shall be used for uploading (pushing) a link to data to a consumer. The details are described in Table 22.

Table 22 – REST implementation of Upload Link

REST Operation			
POST URL/v1/object/link {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
UploadLinkObject	application/json	1	The message link with its metadata
Return (out)	**REST Encoding**	**Mult**	**Definition**
UploadLinkResponseObject	application/json	1	Confirmation of upload or error message

5.7.3.3.3 Service response

The service instance shall respond with HTTP codes and message according to Table 23.

See also Table 11 for codes common to all interfaces. For this interface with an extra attribute, SECOM_ResponseCodeEnum, this attribute is set to null for the common response codes.

For tests related to these error codes, see 10.14.

Table 23 – HTTP Response codes and message in response object

HTTP Code	SECOM_ResponseCodeEnum	Message
200	null	Link successfully uploaded
400	0	Missing required data for the service
400	1	Failed signature verification
400	2	Invalid certificate
403	null	Not authorized to upload link

5.7.3.4 Dynamic behavior

Figure 14 describes the dynamic behavior of the service interface.

The Upload Link service interface is used when data is larger than technically possible to POST in a REST service call such as Upload. The left side actor in the sequence diagram shall send a larger data package to the user (right side in Figure 14).

The data is prepared and compressed to enable reference to a single file. The compressed file is given a unique transaction identifier.

The transaction identifier, together with metadata containing time data if available, size of data and signature, is uploaded (sent) to the user (information consumer).

The receiver of the link (transaction identifier) verifies the envelope signature and checks the metadata, for example size and time to live, and decides if data shall be retrieved immediately or wait until a cheaper connection is established. When ready, the receiving actor invokes the service Get By Link to retrieve the data and forwards it to the end-user application. After received in the end-user application, the data signature can be verified.

The same procedure described in Upload service interface regarding acknowledgement is implemented here as well. The receiving actor shall always send the acknowledgement upon request. SECOM does not specify a time limit between receiving a message and sending an "opened ACK".

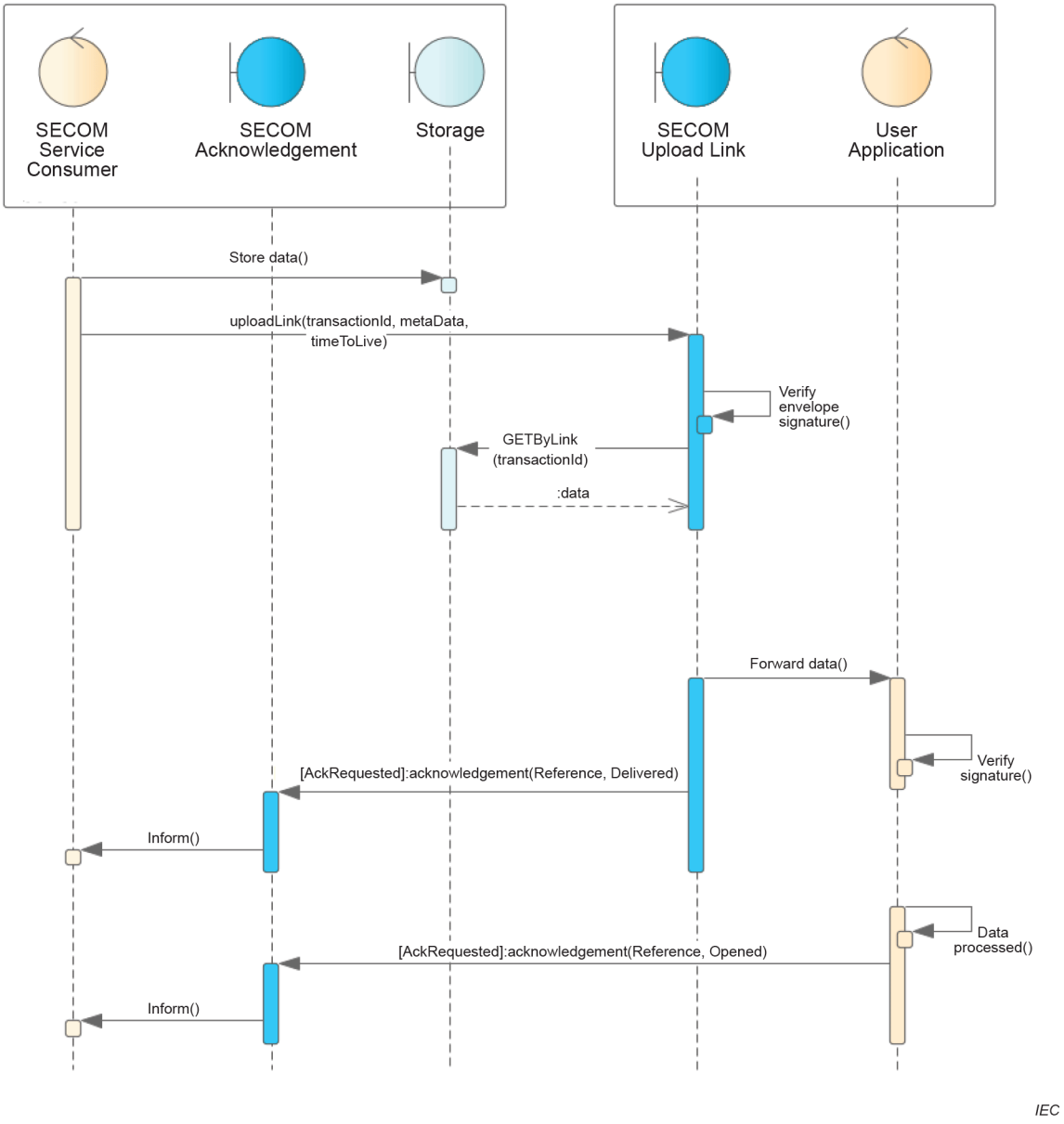


Figure 14 – Sequence diagram for Upload link to large data

5.7.4 Service interface – Acknowledgement

5.7.4.1 Specification

During upload of information, an acknowledgement can be requested which is expected to be asynchronously received when the uploaded message has been delivered to the end system (technical acknowledgement), and an acknowledgement when the message has been opened and/or processed by the end user (operational acknowledgement). The acknowledgement contains a reference to the object delivered and has no time limit.

Figure 15 describes the Acknowledgement interface in UML diagram.

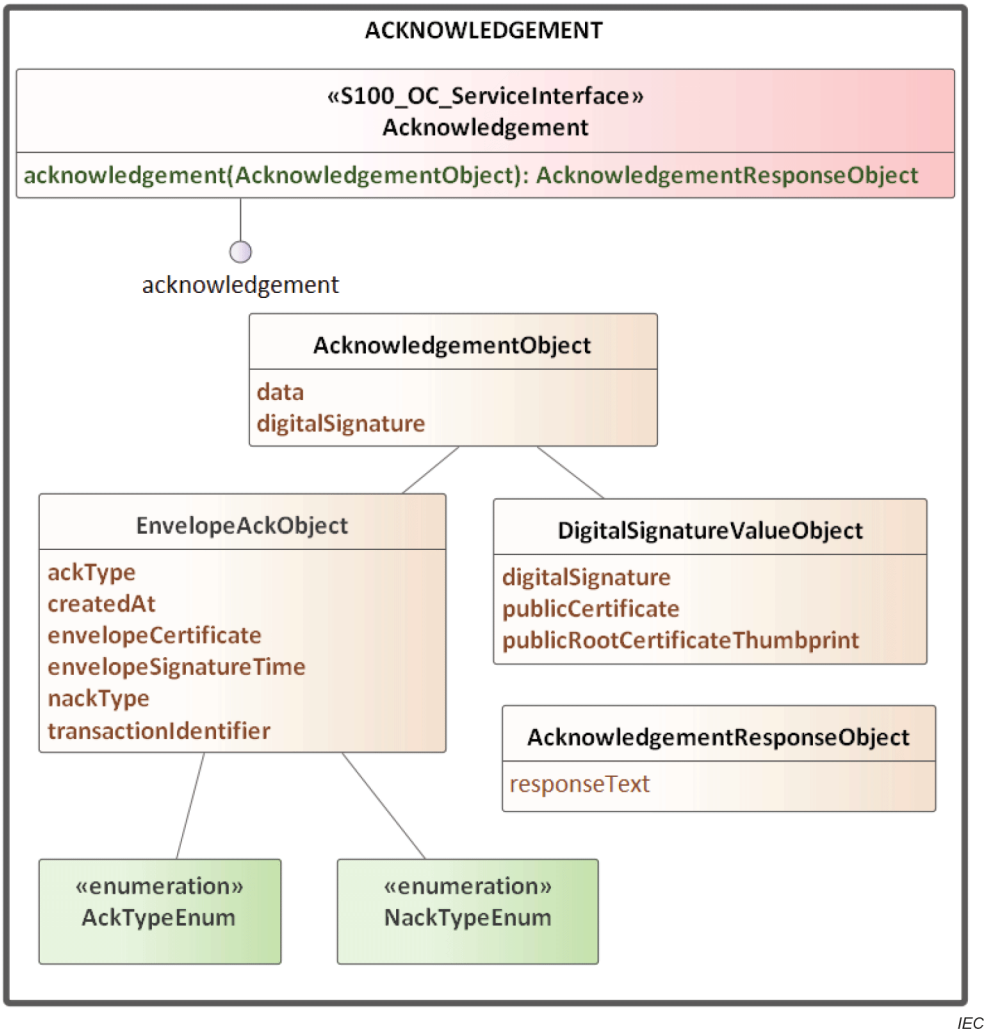


Figure 15 – Acknowledgement interface UML diagram

5.7.4.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 24 to Table 27.

Table 24 – Information input for Acknowledgement interface

AcknowledgementObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
envelope	1	Mandatory	EnvelopeAckObject	The acknowledgment payload to be signed
digitalSignature	1	Optional	CharacterString	The signature ot the EnvelopeAckObject in HEX format without whitespace or linebreaks
EnvelopeAckObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
createdAt	1	Mandatory	DateTime	Creation time for the acknowledgement
envelopeCertificate	1	Mandatory	CharacterString	The public certificate of the sender. used to verify the envelopeObject signature
envelopeRootCertificateThumbprint	1	Optional	CharacterString	Claimed Thumbprint for Signed Root Key (X.509 Certificate)
transactionIdentifier	1	Mandatory	UUID	Reference identifier given in upload
ackType	1	Mandatory	AckTypeEnum	Type of acknowledgement according to Table 27
nackType	0..1	Optional	NackTypeEnum	Information details if error according to Table 25
envelopeSignatureTime	1	Optional	DateTime	Time stamp when the envelope is signed

Table 25 – Enumerations for not acknowledged

NackTypeEnum	
Value	**Definition**
0	XML Schema validation error
1	Unknown data type or version
2	Failed data signature verification
3	Failed decryption
4	Failed decompression

Table 26 – Information output for Acknowledgement interface

AcknowledgementResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	String	Success or error response message
SECOM_ResponseCode	0..1	Mandatory	SECOM_ResponseCodeEnum	Additional error code for internal errors see Table 9

Table 27 – Enumerations for Acknowledgement interface

AckTypeEnum	
Value	**Definition**
1	Delivered ACK Technical acknowledgement such as delivered to end system
2	Opened ACK Operational acknowledgement such as when opened/read by end user.
3	Error

5.7.4.3 REST Design

5.7.4.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.4.3.2 Operation – POST /acknowledgement

The details for operation acknowledgement in the interface are described in Table 28.

Table 28 – REST implementation of acknowledgement

REST Operation			
POST URL/v1/acknowledgement {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
AcknowledgementObject	application/json	1	Object with reference to information and time when delivered
Return (out)	**REST Encoding**	**Mult**	**Definition**
AcknowledgementResponseObject	application/json	1	Confirmation or error message according to Table 26

5.7.4.3.3 Service response

The service instance shall respond with HTTP codes and message according to Table 29.

See also Table 11 for codes common to all interfaces. For this interface with an extra attribute, SECOM_ResponseCodeEnum, this attribute is set to null for the common response codes.

For tests related to these error codes, see 10.12.

Table 29 – HTTP Response codes and response message

HTTP Code	SECOM_ResponseCodeEnum	Message
200	null	Successfully received ACK for <reference>
400	null	Bad request
400	0	Missing required data for the service
400	1	Failed signature verification
400	2	Invalid certificate
403	null	Not authorized to upload ACK

5.7.4.4 Dynamic behavior

Figure 16 describes the dynamic behavior of the Acknowledgement interface. See also the dynamic behavior of Upload interface and Upload Link interface for the operational context of the Acknowledgement interface.

The acknowledgement interface is used in conjunction with Upload, Upload Link and Get. The sender (uploader) of data can request acknowledgement from the receiver enabling the sender to follow (trace) the sent data. This is especially important when uploading (sending) data to a ship that can be offline at the time of sending, but receives the data next time it is online. Also, the sender (responder) of data after a request to Get can request acknowledgement from the receiver.

NOTE When the "opened ACK" is requested in conjunction with Upload Link, the acknowledgement is sent after the data has been received using the Get By Link request.

There are two different acknowledgements defined in SECOM. The first is the "deliver ACK" that is sent by the receiver when data has been accepted and forwarded to the end-user. The second is the "opened ACK" that is sent by the end user when received data is correctly opened and processed.

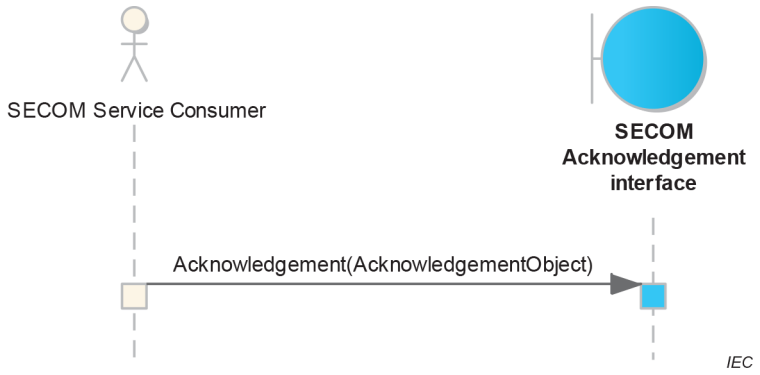


Figure 16 – Sequence diagram for Acknowledgement interface

5.7.5 Service interface – Get

5.7.5.1 Specification

The Get interface is used for pulling information from a service provider. The owner of the information (provider) is responsible for the authorization procedure before returning information.

The consumer can ask for information by its reference, geometry, time or arbitrary query for status on the information product for example. If no filtering parameters are given, all authorized information shall be sent. The information owner decides what information the consumer is authorized to, based on the identity in the TLS client certificate, i.e. the identity the service instance belongs to.

This interface may return many information objects and supports pagination as described in 5.5. If no pagination parameters are given, the result is all messages returned for the first page. Figure 17 shows the Get interface in UML.

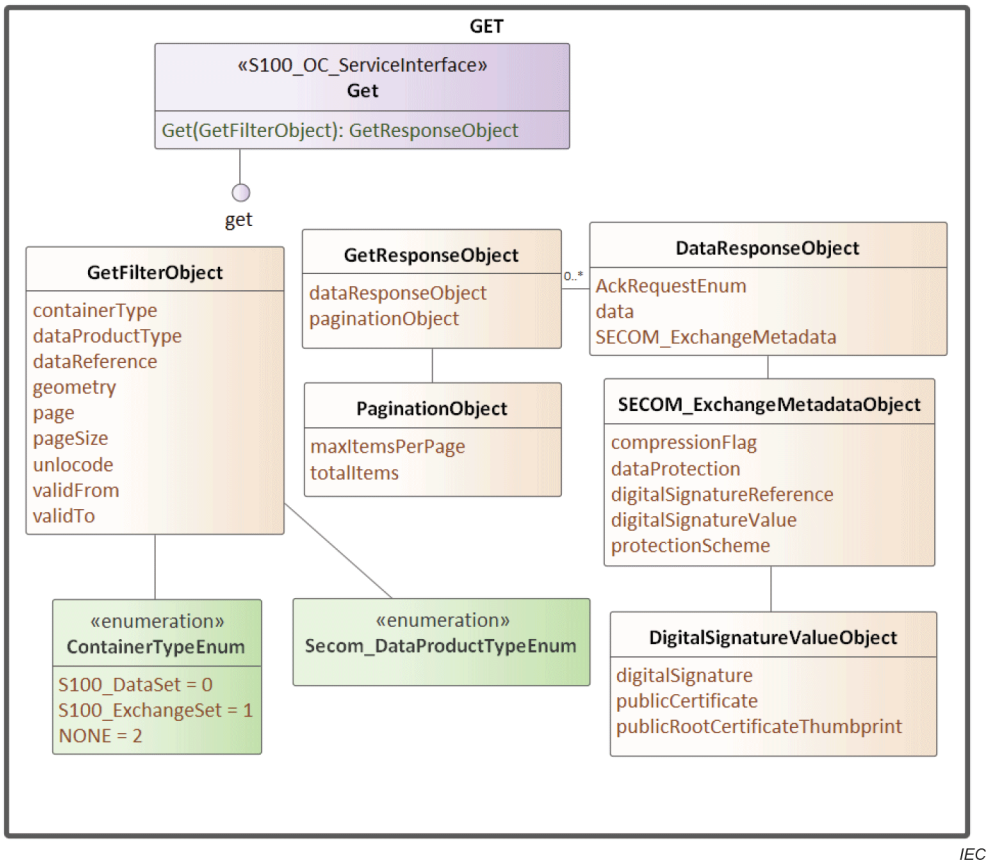


Figure 17 – Get interface UML diagram

5.7.5.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 30 and Table 31.

Table 30 – Information input for Get interface

GetFilterObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataReference	0..1	Mandatory	UUID	Reference to information object, e.g. from Get Summary
containerType	0..1	Mandatory	ContainerTypeEnum	Container type requested, see Table 7
dataProductType	0..1	Mandatory	SECOM_DataProductType.Name	The name column of SECOM_DataProductType in Table 8
productVersion	0..1	Optional	CharacterString	S-100 based Product type version, e.g. 1.0.0
geometry	0..1	Optional	CharacterString	Geometry condition for geo-located information objects, see Table 12
unlocode	0..1	Optional	CharacterString	Code of defined object see 5.6.13
validFrom	0..1	Optional	DateTime	Valid from time
validTo	0..1	Optional	DateTime	Valid until time
page	0..1	Mandatory	PositiveInteger	Requested pagination page
pageSize	0..1	Mandatory	PositiveInteger	Requested pagination page size

Table 31 – Information output for Get interface

GetResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataResponseObject	0..*	Mandatory	DataResponseObject	List containing the data
pagination	1	Mandatory	PaginationObject	Pagination information
DataResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
data	1	Mandatory	Base64	Base64 encoded byte array. The data according to Product Specification embedded in JSON. The data may be encrypted and signed.
exchangeMetadata	1	Mandatory	SECOM_ExchangeMetadataObject	Service exchange metadata with signature, ID etc.
ackRequest	1	Mandatory	AckRequestEnum	Flag to indicate that acknowledgement is expected to be returned when the data is delivered to the end user, and/or when the content of the data is processed (opened) by the end user.

5.7.5.3 REST Design

5.7.5.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.5.3.2 Operation – GET /object

This operation receives a Get request for information. If authorized, the data is sent back in the response. It is up to the service provider to apply relevant authorization procedure and access control to information.

Table 32 describes the logical parameters provided in the interface.

Table 32 – REST implementation of Get

REST Operation			
GET URL/v1/object?parameters: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
dataReference	String	0..1	Information retrieved by using reference given in Get Summary or Upload Link (UUID)
containerType	DataTypeEnum	0..1	Container type requested, see Table 7
dataProductType	SECOM_DataProductType.Name	0..1	Product type requested, e.g. S-122
productVersion	String	0..1	Product type version requested, e.g 1.0.0
geometry	String	0..1	Geometry as search parameter, see Table 12
unlocode	String	0..1	Code of defined object see 5.6.13
validFrom	DateTime	0..1	Time related to validity period start for information object
validTo	DateTime	0..1	Time related to validity period end for information object
page	PositiveInteger	0..1	Requested pagination page
pageSize	PositiveInteger	0..1	Requested pagination page size
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
No body defined	n/a	n/a	n/a
Return (out)	**REST Encoding**	**Mult**	**Definition**
GetResponseObject	application/json	1	Set of messages package with metadata or an error message

5.7.5.3.3 Service response

Table 33 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.15.

Table 33 – HTTP Response code and message of Get

HTTP Code	Message
200	GetMessageResponseObject
400	Bad request
403	"Not authorized to requested information"
404	Information not found

5.7.5.4 Dynamic behavior

Figure 18 and Figure 19 describe the dynamic behavior of the Get interface.

The Get interface is used to pull data from an actor's published information. The service request contains filtering parameters that allows the information owner to search and prepare data to be returned. Once the authentication of the requester has been verified, the preparation of data includes an authorization check against internal access control list and packaging of the data with data signatures. If access is accepted, the requested data is returned, if not, an error messages is given.

If the information owner decides to publish protected data, the consumer needs a possibility to request the encryption key if not already available, to be able to decrypt the protected data. The consumer requests the encryption key by data reference ID and its public certificate used for symmetric key derivation. The information owner encrypts the random key used when encrypting the data with a symmetric key derived from the consumer's public key and its own private key. The information owner sends the protected random key via the consumer's SECOM encryption key interface.

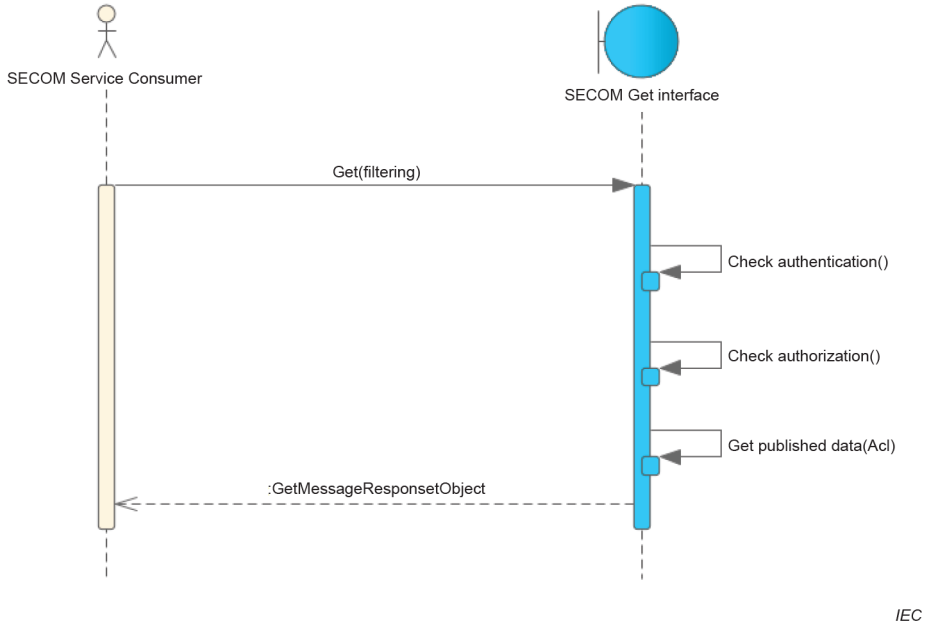


Figure 18 – Sequence diagram for Get interface

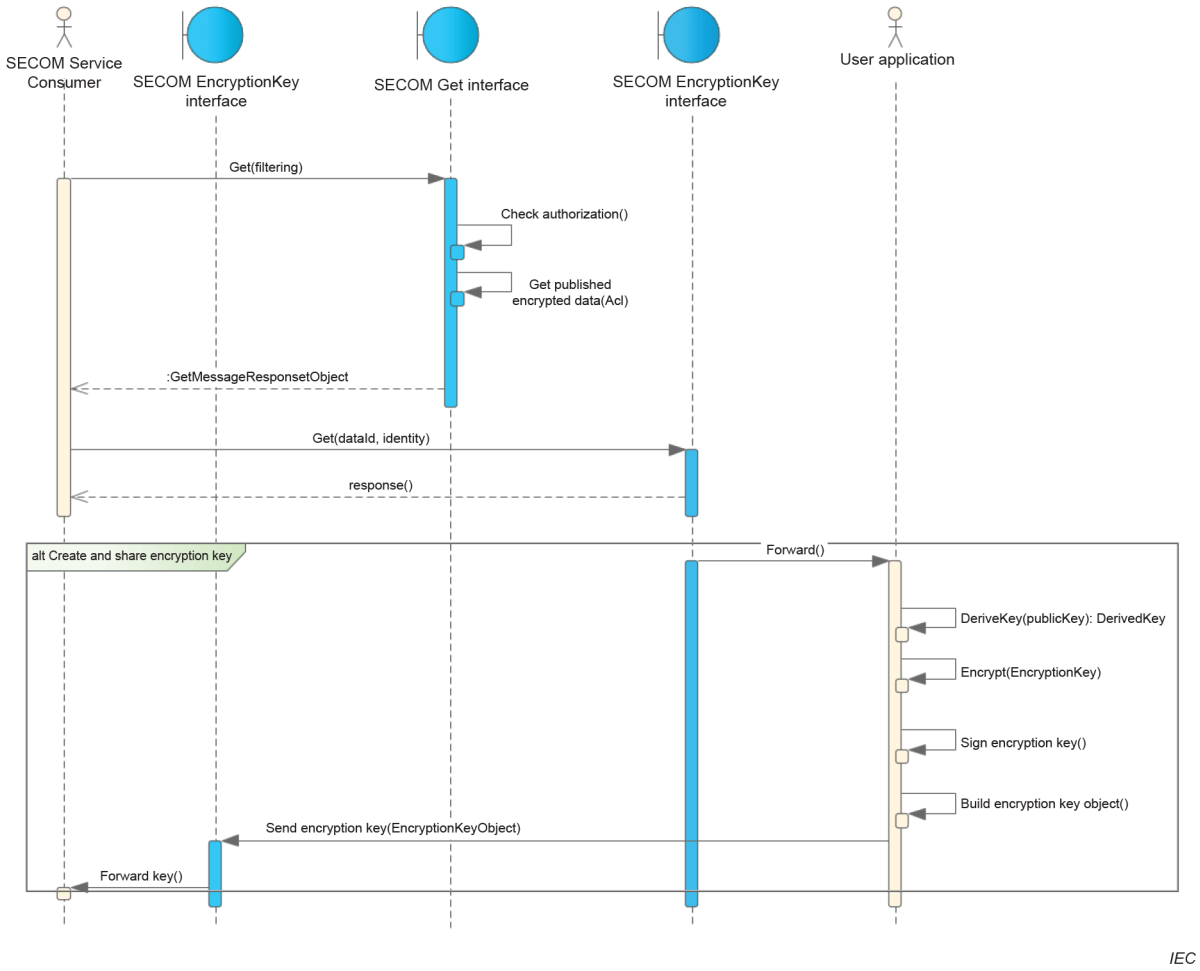


Figure 19 – Sequence diagram for Get interface and classified data

5.7.6 Service interface – Get Summary

5.7.6.1 Specification

A list of information shall be returned from this interface. The summary contains identity, status, size and a short description of each information object. The actual information object shall be retrieved using the Get interface. The consumer can ask for information by geometry, location and time. If no filtering parameters are given, available summary information shall be sent.

NOTE Information known by the information provider can be sensitive. The information provider judges what is available and thus to be included in the response to Get Summary.

This interface may return many information objects and supports pagination described in 5.5.

Figure 20 describes the Get Summary interface in UML diagram.

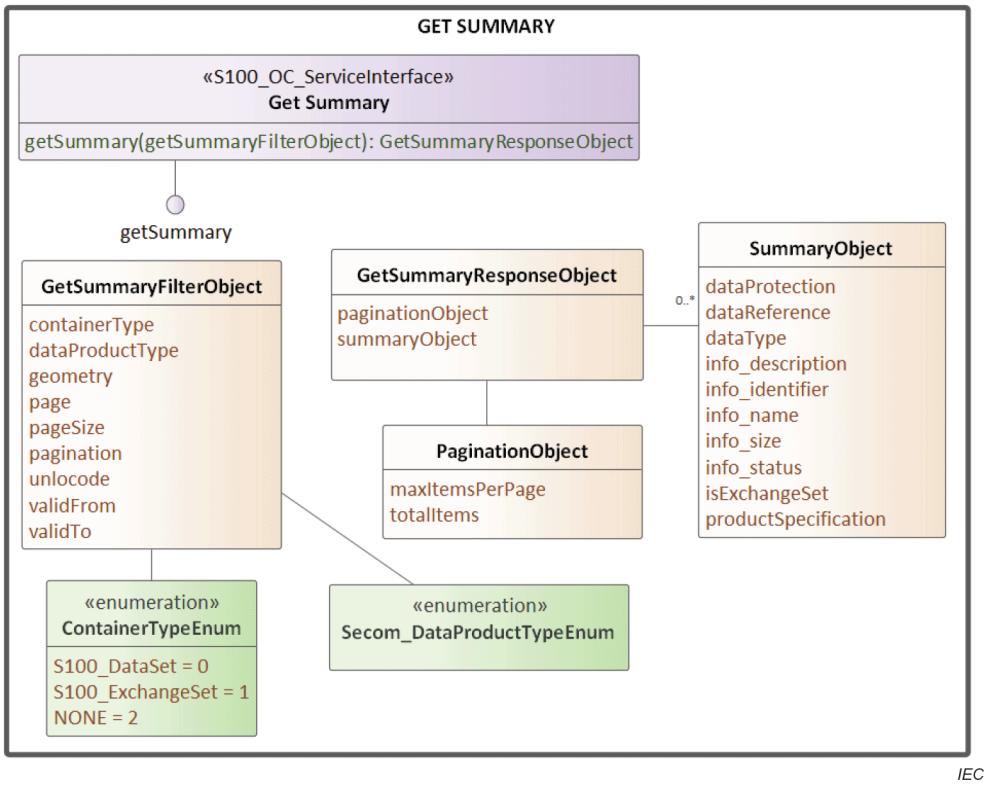


Figure 20 – Get Summary interface UML diagram

5.7.6.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 34 and Table 35.

Table 34 – Information input for Get Summary interface

GetSummaryFilterObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
containerType	0..1	Mandatory	ContainerTypeEnum	Container type requested, Table 7
dataProductType	0..1	Mandatory	SECOM_DataProductType.Name	The name column of SECOM_DataProductType in Table 8
productVersion	0..1	Optional	CharacterString	S-100 based Product type version, e.g. 1.0.0
geometry	0..1	Optional	CharacterString	Geometry condition for geo-located information objects, see Table 12
unlocode	0..1	Optional	CharacterString	Code of defined object, see 5.6.13
validFrom	0..1	Optional	DateTime	Valid from time
validTo	0..1	Optional	DateTime	Valid until time
page	0..1	Mandatory	PositiveInteger	Requested pagination page
pageSize	0..1	Mandatory	PositiveInteger	Requested pagination page size

Table 35 – Information output for Get Summary interface

GetSummaryResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
summaryObject	0..*	Mandatory	SummaryObject	Description of the information object
pagination	1	Mandatory	PaginationObject	Pagination information
SummaryObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataReference	1	Mandatory	UUID	Reference to data
dataProtection	1	Optional	Boolean	Flag indicating if data is encrypted or not
dataCompression	1	Optional	Boolean	Flag indicating if data is compressed or not
containerType	1	Optional	ContainerTypeEnum	Container type, see Table 7
dataProductType	1	Optional	SECOM_DataProductType.Name	The name column of SECOM_DataProductType in Table 8
info_identifier	0..1	Optional	CharacterString	Identifier of the information object, e.g. <S100XC:identifier>, gml:id
info_name	0..1	Optional	CharacterString	Name of the information object, e.g. <S100XC:exchangeCatalogueName>, <S100:datasetFileIdentifier>
info_status	0..1	Optional	CharacterString	Status of the information object, e.g. active, inactive
info_description	0..1	Optional	CharacterString	Description of the information object, e.g. <S100XC:description>, <S100:datasetTitle>
info_lastModifiedDate	0..1	Optional	DateTime	Date for last modified, e.g. <S100XC:date>, <S100:datasetReferenceDate>
info_productVersion	0..1	Optional	CharacterString	S-100 based Product type version, e.g. 1.0.0
info_size	0..1	Optional	PositiveInteger	Size of the data in kB expressed as unsigned long or unsigned int64 with max value = 2^64

5.7.6.3 REST Design

5.7.6.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.6.3.2 Operation – GET /object/summary

This operation receives a Get Summary request. The response contains a summary of available information. The actual information can be retrieved through Subscription request or Get request.

Table 36 describes the REST service interface.

Table 36 – REST implementation of Get Summary

REST Operation			
GET URL/v1/object/summary?parameters: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Defintion**
geometry	String	0..1	Geometry as search parameter, see Table 12
unlocode	String	0..1	Code of defined object, see 5.6.13
validFrom	DateTime	0..1	Time related to validity period start for information object
validTo	DateTime	0..1	Time related to validity period end for information object
page	PositiveInteger	0..1	Page number requested
pageSize	PositiveInteger	0..1	Page size requested
REST Body (in)	**REST Encoding**	**Mult**	**Defintion**
No body defined	n/a	n/a	n/a
Return (out)	**REST Encoding**	**Mult**	**Defintion**
GetSummaryResponseObject	application/json	1	List of information objects available, identified by identity, status and short description or an error message

5.7.6.3.3 Service response

Table 37 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.15.

Table 37 – HTTP Response codes and messages of Get Summary

HTTP Code	Message
200	GetSummaryResponseObject
400	Bad request
403	Not authorized to requested information
404	Information not found

5.7.6.4 Dynamic behavior

Figure 21 describe the dynamic behavior of the Get Summary interface.

The Get Summary interface is used to pull metadata from an actor. The received metadata response might be used for selecting which actual data to be retrieved by a new request using the Get interface in 5.7.5. The service request contains filtering parameters that allows the information owner to search and prepare metadata to be returned. Once the authentication of the requester has been verified, the preparation of metadata includes internal judgement of information availability and packaging the metadata. If metadata is available, the requested metadata is returned, if not, an error messages is returned.

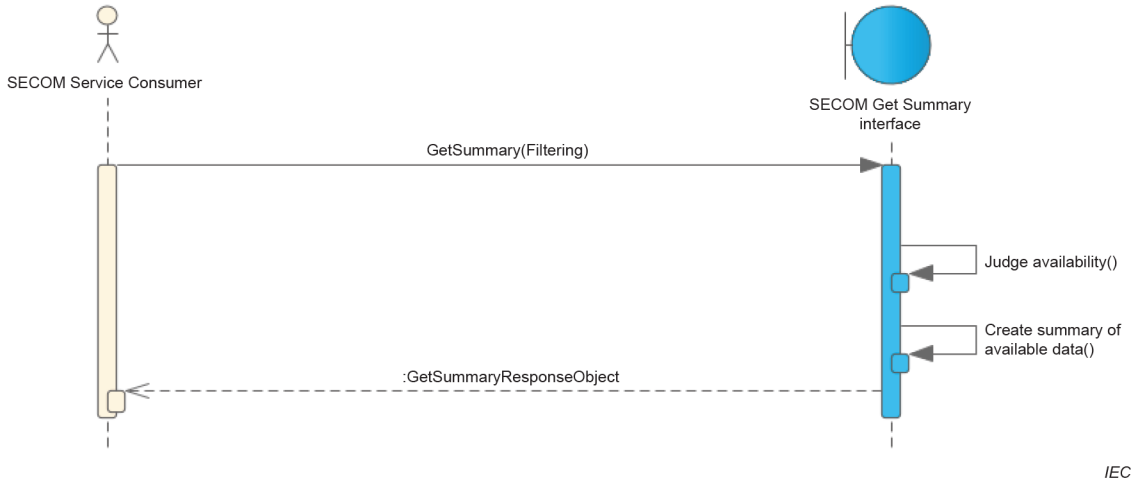


Figure 21 – Sequence diagram for Get Summary interface

5.7.7 Service interface – Get By Link

5.7.7.1 Specification

The Get By Link interface is used for pulling information from a data storage handled by the information owner. The link to the data storage can be exchanged with Upload Link interface. The owner of the information (provider) is responsible for relevant authentication and authorization procedure before returning information.

Figure 22 describes the Get By Link interface in UML.

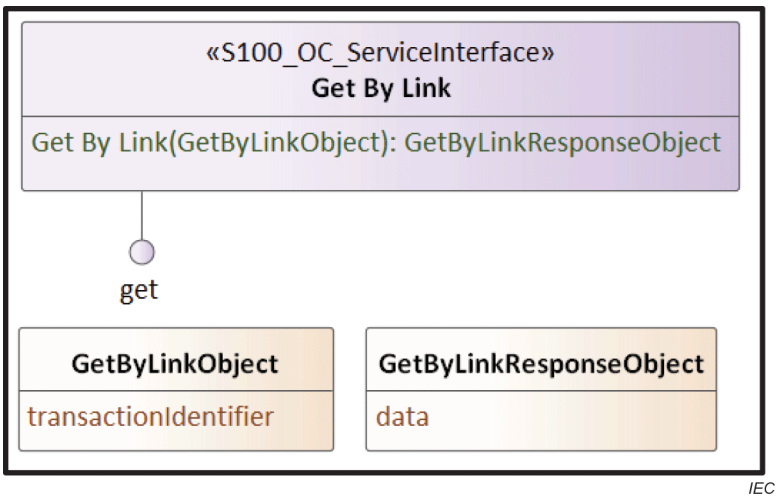


Figure 22 – Get By Link interface in UML

5.7.7.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 38 and Table 39.

Table 38 – Information input for Get By Link interface

GetByLinkObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
transactionIdentifier	1	Mandatory	UUID	Identifier uploaded in Upload Link

Table 39 – Information output for Get By Link interface

GetByLinkResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
data	1	Mandatory	Base64	Data as Base64 encoded binary format

5.7.7.3 REST Design

5.7.7.3.1 General

The service interface is defined with REST technology.

5.7.7.3.2 Operation – GET /object/link

This operation receives a Get By Link request for information. If authorized, the data is sent back in the response. It is up to the service provider to apply relevant authorization procedure and access control to information.

Table 40 describes the logical parameters provided in the interface.

Table 40 – REST implementation of Get By Link

REST Operation			
GET URL/v1/object/link?parameter: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
transactionIdentifier	String	1	Reference to data transaction from Upload Link, UUID
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
No body defined	n/a	n/a	n/a
Return (out)	**REST Encoding**	**Mult**	**Definition**
data	application/octet-stream	1	Data binary

5.7.7.3.3 Service response

Table 41 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.11.

Table 41 – HTTP Response code and message of Get By Link

HTTP code	SECOM_ResponseCodeEnum	Message
200	null	Success
400	null	Bad request
400	2	Invalid certificate
403	null	Not authorized to requested information
404	null	Information with <transactionIdentifier > not found

5.7.7.4 Dynamic behavior

Figure 23 describes the dynamic behavior of the Get By Link interface.

The Get By Link interface is used to retrieve the data object provided by the information owner after invoking the receiver's Upload Link interface. The receiver of the link (transactionIdentifier) checks the metadata, for example size and time to live, and decides if data shall be retrieved immediately or wait until a cheaper connection is established. When ready, the receiving actor invokes the operation Get By Link to retrieve the data. Finally, the data signature verification is achieved using the received data matched to the digitalSignatureValue object from the previously received Upload Link request object.

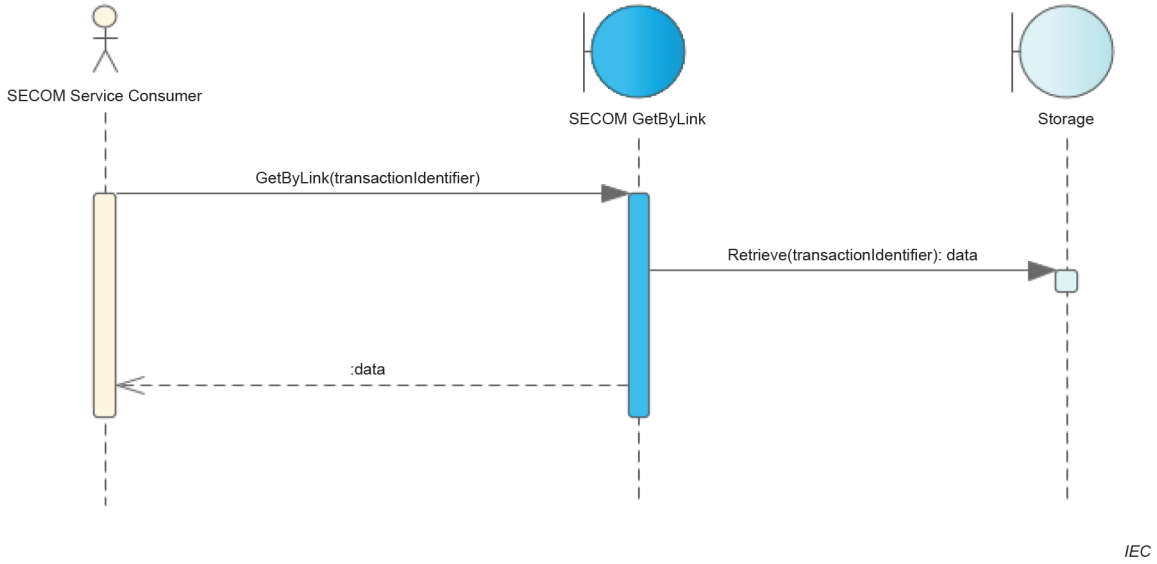


Figure 23 – Sequence diagram for Get By Link interface

5.7.8 Service interface – Access

5.7.8.1 Specification

Access to information can be requested through the Access interface. The result is sent asynchronously through the Access Notification interface.

Figure 24 describes the Access interface in UML diagram.

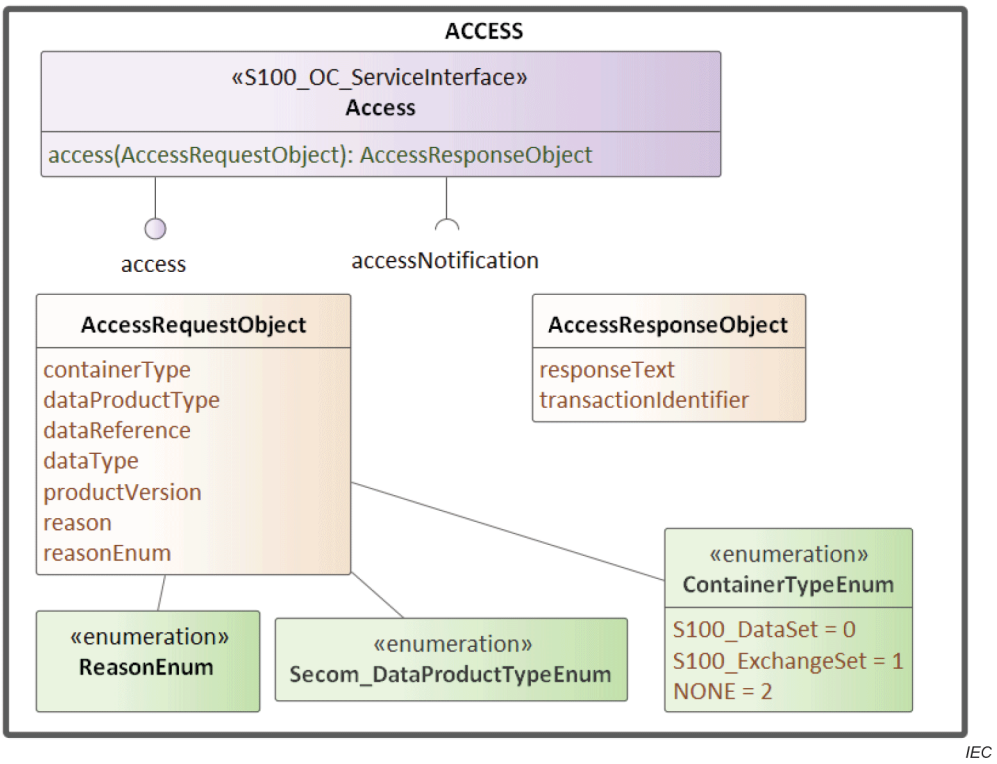


Figure 24 – Access interface UML diagram

5.7.8.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 42, Table 43 and Table 44.

Table 42 – Information input for Access interface

AccessRequestObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
reason	1	Mandatory	CharacterString	Human readable reason for requesting access
reasonEnum	1	Mandatory	ReasonEnum	Machine readable reason for requesting access
containerType	0..1	Mandatory	ContainerTypeEnum	Container type requested, see Table 7
dataProductType	0..1	Mandatory	SECOM_DataProduct Type.Name	The name column of SECOM_DataProductType in Table 8
dataReference	0..1	Mandatory	UUID	Reference to the data requested access to
productVersion	0..1	Optional	CharacterString	S-100 based Product type version, e.g. 1.0.0

Table 43 – Information output for Access interface

AccessResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	CharacterString	Success or error response message

Table 44 – Enumerations for Access interface

ReasonEnum	
Value	**Definition**
0	Required by authority
1	Required by service provider

5.7.8.3 REST Design

5.7.8.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.8.3.2 Operation – POST /access

This operation receives a request for access by a consumer. The result is sent asynchronously.

Table 45 describes the logical parameters in the interface.

Table 45 – Parameter binding for the operation

REST Operation			
POST URL/v1/access {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
AccessRequestObject	application/json	1	Description of reason for requesting access to information
Return (out)	**REST Encoding**	**Mult**	**Definition**
AccessResponsObject	application/json	1	Confirmation or error message. Result from request is sent asynchronous through Access Notification interface.

5.7.8.3.3 Service response

Table 46 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.9.

Table 46 – HTTP Response codes

HTTP Code	Message
200	Success
400	Bad request
403	Not authorized to requested information

5.7.8.4 Dynamic behavior

Figure 25 describes the dynamic behavior of Request Access and Access Notification interfaces.

The Access interface is used to request access to one or several information object(s). The service consumer gets an asynchronous response with the decision through the consumer's Access Notification interface.

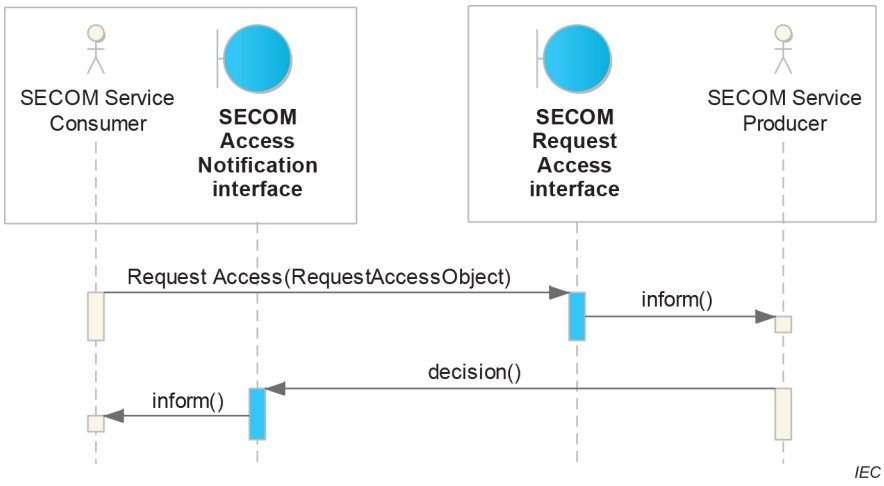


Figure 25 – Sequence diagram for Request Access and Access Notification interface

5.7.9 Service interface – Access Notification

5.7.9.1 Specification

Result from Access request shall be sent asynchronously through the Access Notification interface.

Figure 26 describes the Access Notification in UML diagram.

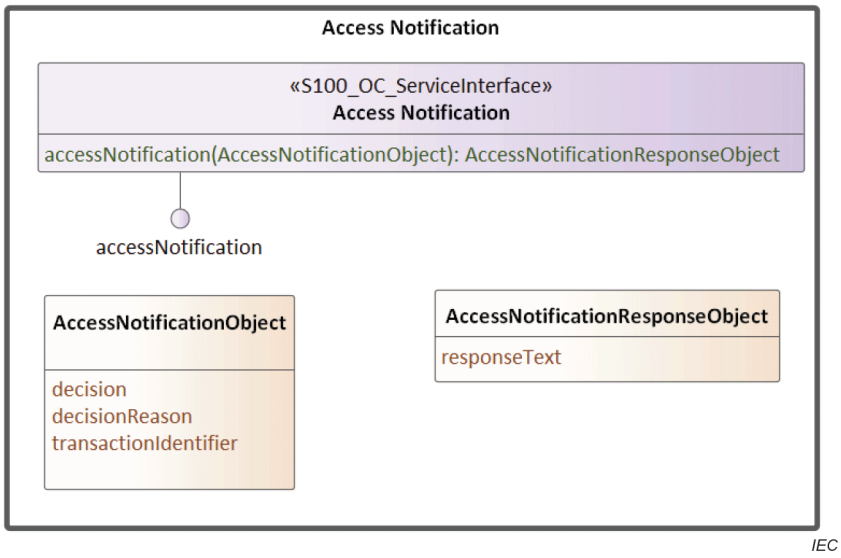


Figure 26 – Access Notification interface UML diagram

5.7.9.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 47 and Table 48.

Table 47 – Information input for Access Notification interface

AccessNotificationObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
decision	1	Mandatory	Boolean	Access request decision, yes or no
decisionReason	1	Optional	CharacterString	Human readable reason for decision
transactionIdentifier	1	Mandatory	UUID	Transaction identifier corresponding to Request Access

Table 48 – Information output for Access Notification interface

AccessNotificationResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	CharacterString	Success response message

5.7.9.3 REST Design

5.7.9.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.9.3.2 Operation – POST /access/notification

This operation receives result from access request.

Table 49 describes the logical parameters in the interface.

Table 49 – Parameter binding for the operation

REST Operation			
POST URL/v1/access/notification {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
AccessNotificationObject	application/json	1	Result from the request for access; True or False and the reason.
Return (out)	**REST Encoding**	**Mult**	**Definition**
AccessNotificationResponseObject	application/json	1	Confirmation or error message

5.7.9.3.3 Service response

Table 50 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.9.

Table 50 – HTTP response codes

HTTP Code	Message
200	Success
400	Bad request

5.7.9.4 Dynamic behavior

This interface is an asynchronous response to service interface Request Access. See Figure 25.

5.7.10 Service interface – Subscription

5.7.10.1 Specification

The purpose of the interface is to request subscription on information, either specific information according to parameters, or the information accessible upon decision by the information provider. Each subscription request reflects one parameter query set.

Figure 27 describes the Subscribe interface in UML diagram.

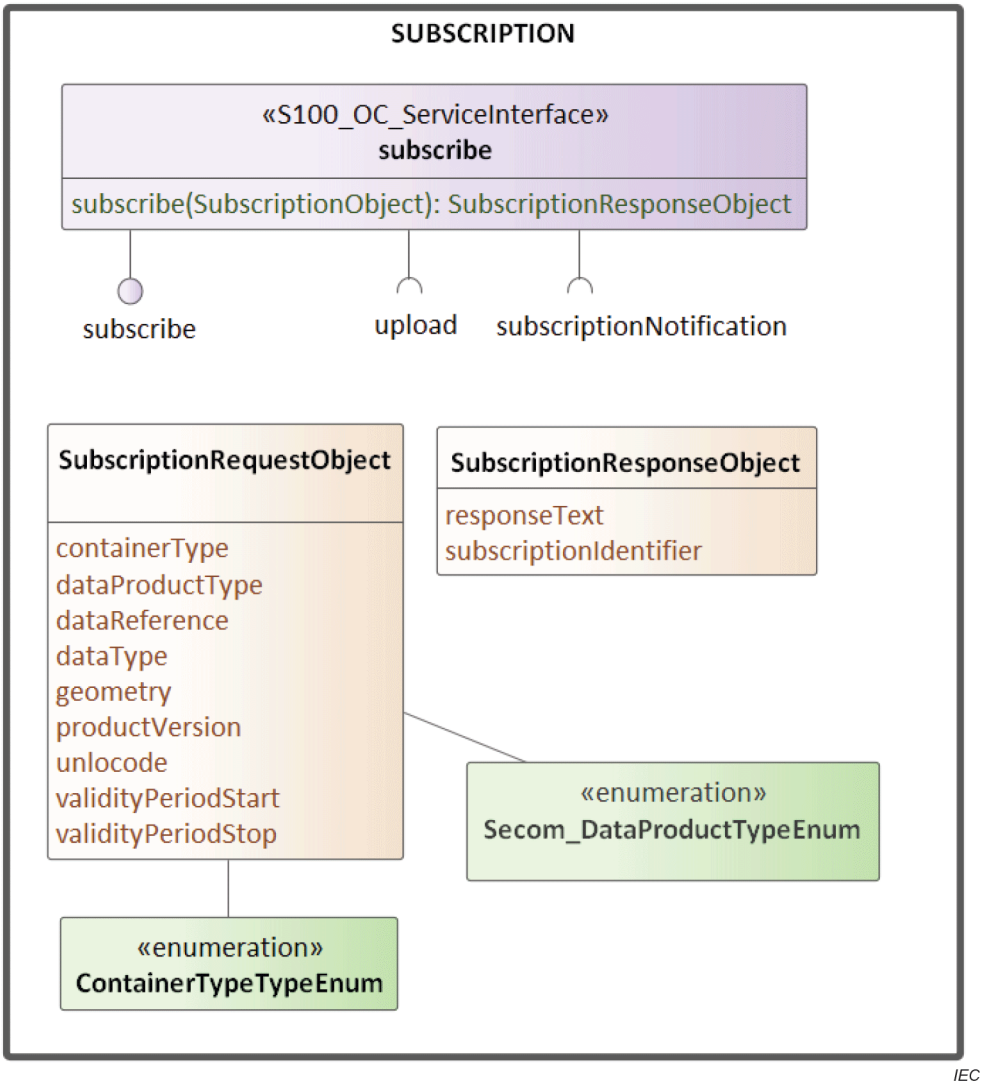


Figure 27 – Subscribe interface UML diagram

5.7.10.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 51 and Table 52.

Table 51 – Information input for Subscription interface

SubscriptionRequestObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
containerType	0..1	Mandatory	ContainerTypeEnum	Container type requested, see Table 7
dataProductType	0..1	Mandatory	SECOM_DataProductType.Name	The name column of SECOM_DataProductType in Table 8
dataReference	0..1	Mandatory	UUID	Reference to data
productVersion	0..1	Optional	CharacterString	S-100 based Product type version, e.g. 1.0.0
geometry	0..1	Optional	CharacterString	Geometry as criteria, see Table 12
unlocode	0..1	Optional	CharacterString	Code of defined object, see 5.6.13
subscriptionPeriodStart	0..1	Optional	DateTime	Start time of subscription
subscriptionPeriodEnd	0..1	Optional	DateTime	End time of subscription

Table 52 – Information output for Subscription interface

SubscriptionResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	CharacterString	Response message
subscriptionIdentifier	0..1	Optional	CharacterString	Subscription identifier, if successful (UUID)

5.7.10.3 REST Design

5.7.10.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.10.3.2 Operation – POST /subscription

This operation receives a request for subscription. If the requester is authorized, a subscription is created and the latest message is sent.

Table 53 describes the logical parameters in the interface.

Table 53 – REST implementation of Subscription

REST Operation			
POST URL/v1/subscription {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
SubscriptionObject	application/json	1	Subscription request including filtering parameters
Return (out)	**REST Encoding**	**Mult**	**Definition**
SubscriptionResponseObject	application/json	1	Confirmation or error message Subscription identifier in return, if ok.

5.7.10.3.3 Service response

Table 54 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.16.

Table 54 – HTTP response codes and messages of Subscription

HTTP Code	Message
200	Subscription successfully created
400	Bad request
403	Not authorized to requested information

5.7.10.4 Dynamic behavior

Figure 28, Figure 29 and Figure 30 describe the dynamic behavior of the service interface.

The Subscription interface is used to request subscription to information objects. Subscription could both be requested by the consumer (Figure 30) and nominated by the producer (Figure 29). Also removing a subscription can be initiated by the consumer as well as the producer. The requested or nominated subscription creation and removal is notified using the Subscription Notification interface seen in Figure 29 and Figure 30.

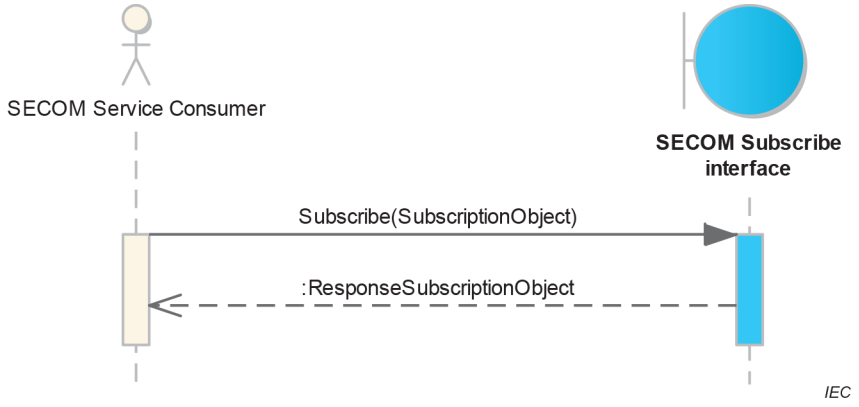


Figure 28 – Sequence diagram for Subscribe interface

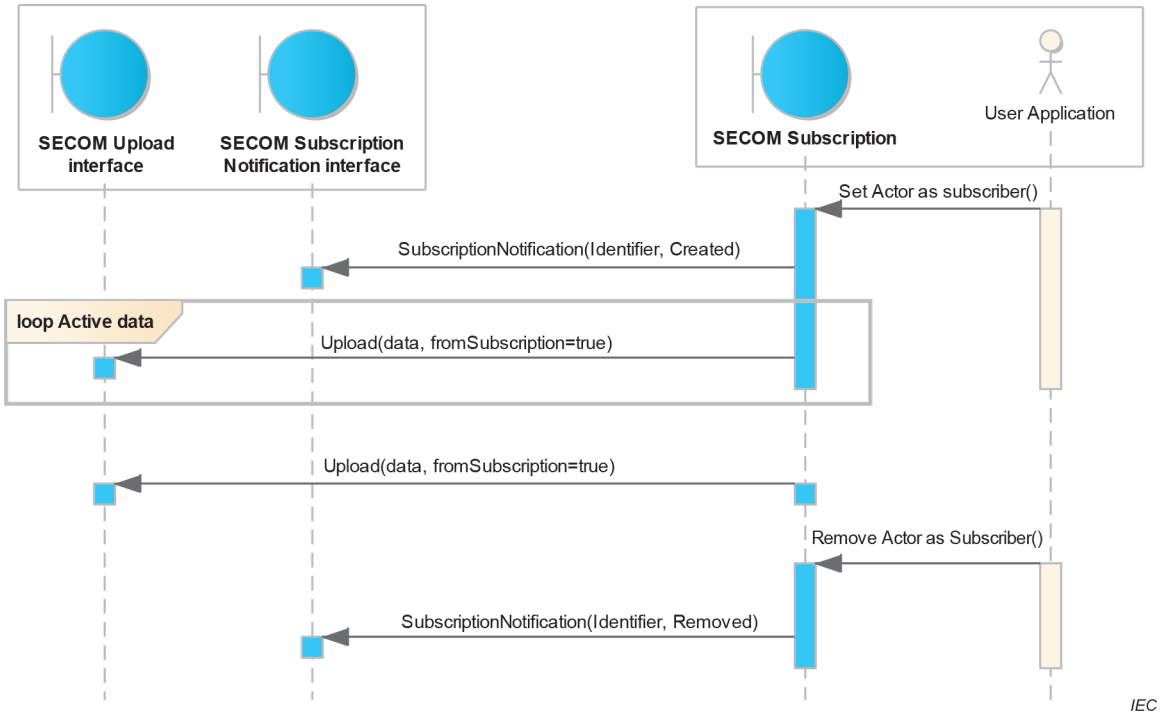


Figure 29 – Operational sequence diagram for Subscription interfaces

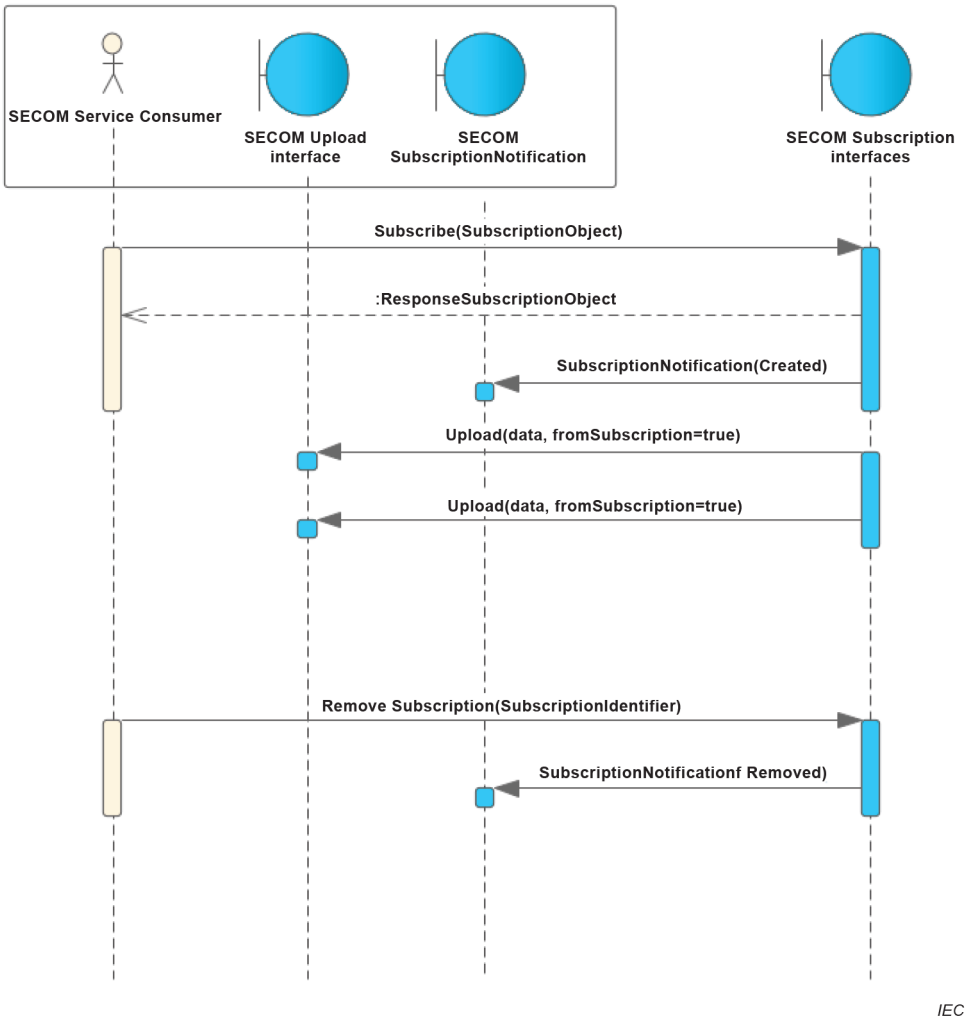


Figure 30 – Sequence diagram for Subscription interfaces with external subscription request

5.7.11 Service interface – Remove Subscription

5.7.11.1 Specification

Subscription(s) can be removed either internally by information owner, or externally by the consumer. This interface shall be used by the consumer to request removal of subscription.

Figure 31 describes the Remove Subscription interface in UML.

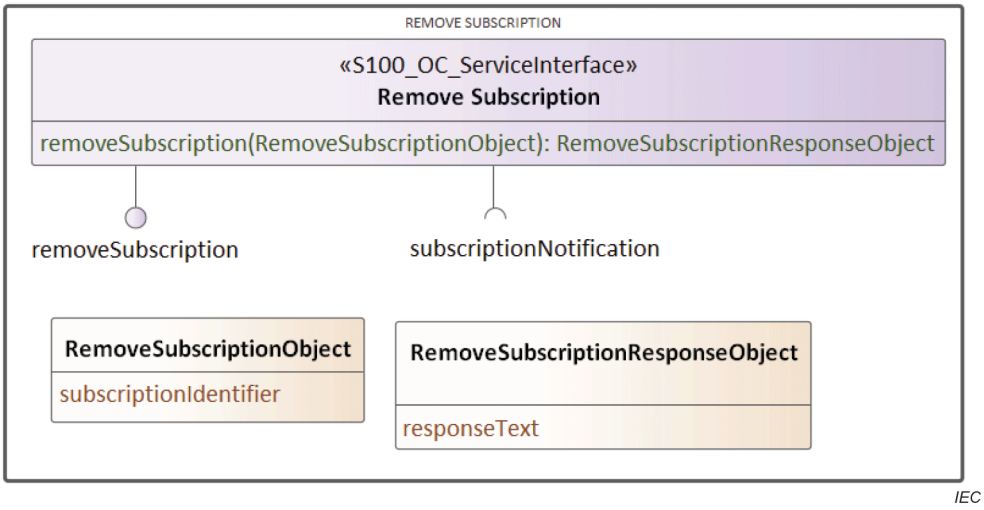


Figure 31 – Remove Subscription interface UML diagram

5.7.11.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 55 and Table 56.

Table 55 – Information input for Remove Subscription interface

RemoveSubscriptionObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
subscriptionIdentifier	1	Mandatory	UUID	Subscription identifier to the subscription to be removed. Received in subscription request or subscription notification.

Table 56 – Information output for Remove Subscription interface

RemoveSubscriptionResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	CharacterString	Response message

5.7.11.3 REST Design

5.7.11.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.11.3.2 Operation – DELETE /subscription

This operation receives a request to remove subscription.

Table 57 describes the logical parameters in the interface.

Table 57 – REST implementation of Remove Subscription

REST Operation			
DELETE URL/v1/subscription {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Description**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Description**
RemoveSubscriptionObject	application/json	1	Specific identity of the information object to remove subscription for. If no ID entity provided, all subscriptions for the caller is removed
Return (out)	**REST Encoding**	**Mult**	**Description**
RemoveSubscriptionResponseObject	application/json	1	Confirmation or error message

5.7.11.3.3 Service response

Table 58 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.16.

Table 58 – HTTP Response codes and messages of Remove Subscription

HTTP Code	Message
200	Subscription <identifier> removed
400	Bad request
403	Not authorized to remove subscription
404	Subscriber identifier not found

5.7.11.4 Dynamic behavior

Figure 32 describes the dynamic behavior of the service interface.

The Remove Subscription interface is used to remove existing subscription(s). See also 5.7.10.4 for an operational description.

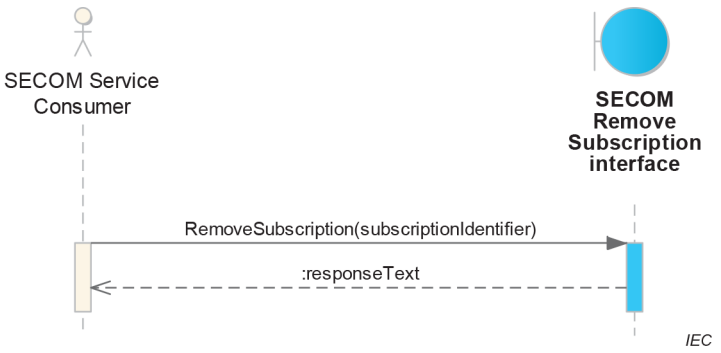


Figure 32 – Sequence diagram for Remove Subscription interface

5.7.12 Service interface – Subscription Notification

5.7.12.1 Specification

The interface receives notifications when a subscription is created or removed by the information provider.

Figure 33 describes the Subscription Notification in UML.

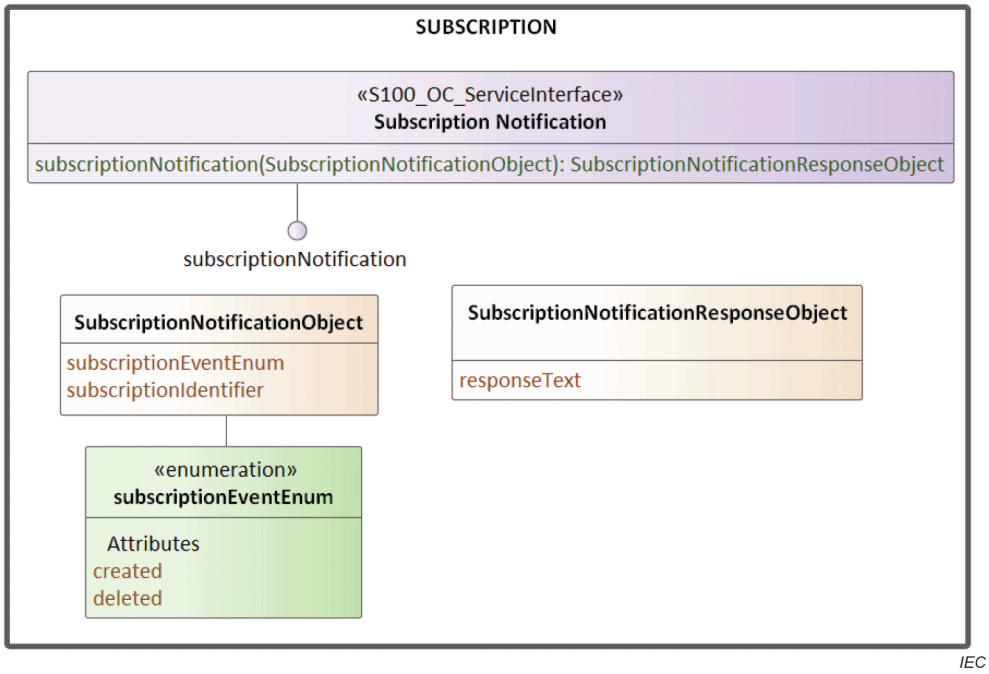


Figure 33 – Subscription Notification interface UML diagram

5.7.12.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 59, Table 60 and Table 61.

Table 59 – Information input for Subscription Notification interface

SubscriptionNotificationObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
subscriptionIdentifier	1	Mandatory	UUID	Identifier of the subscription
eventEnum	1	Mandatory	SubscriptionEventEnum	Subscription event enum according to Table 61

Table 60 – Information output for Subscription Notification interface

SubscriptionNotificationResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
message	1	Optional	CharacterString	Success or error response message

Table 61 – Enumerations for Subscription Notification interface

SubscriptionEventEnum	
Value	**Definition**
1	Subscription created
2	Subscription removed

5.7.12.3 REST Design

5.7.12.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.12.3.2 Operation – POST /subscription/notification

This operation receives notification when subscription is created, either internally by information provider, or externally on request by consumer.

Table 62 describes the logical parameters in the interface.

Table 62 – Information exchange for Subscription Notification

REST Operation			
POST URL/v1/subscription/notification {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Description**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Description**
SubscriptionNotificationObject	application/json	1	Contains the identity of the information object in focus and type of event; Create or Delete.
Return (out)	**REST Encoding**	**Mult**	**Description**
SubscriptionNotificationResponseObject	application/json	1	Confirmation or error message

5.7.12.3.3 Service response

The service shall respond with HTTP codes and message according to Table 63. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.16.

Table 63 – HTTP response codes for Subscription Notification

HTTP Code	Message
200	OK
400	Bad request

5.7.12.4 Dynamic behavior

Figure 34 describes the dynamic behavior of the service interface.

The Subscription Notification interface is used to get notifications on created and deleted subscriptions. See also 5.7.10.4 for an operational description.

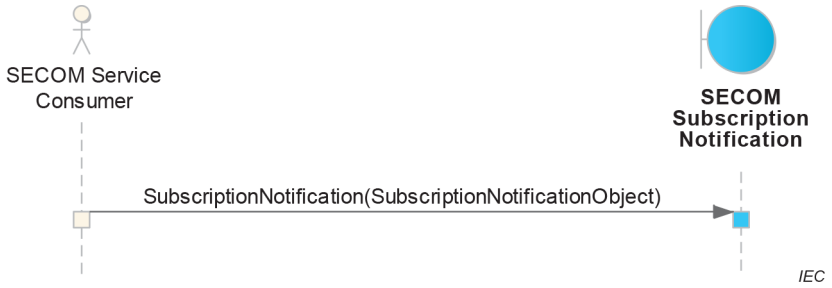


Figure 34 – Sequence diagram for Subscription Notification interface

5.7.13 Service interface – Capability

5.7.13.1 Specification

The purpose of this interface is to provide a dynamic method for asking a service instance at runtime what interfaces are accessible for respective valid payload, formats and versions. If an interface is not implemented, HTTP 501 response should be returned.

Table 64 shows an example of a capability for a specific SECOM information service. This instance is capable of receiving product types S-124 capsulated in a S100_DataSet and RTZ, publishing and sending RTZ as response from Get requests, authorizing access and enabling subscription to RTZ and S-124, supporting encrypted RTZ and open S-124.

Table 64 – Capability example

containerType	S100_DataSet	NONE
dataProductType	S124	RTZ
productSchemaUrl	http://iho.int/s124.xsd	http://cirm.org/rtz/index.html
upload	true	true
uploadLink	true	true
get	false	true
getByLink	false	true
getSummary	false	true
subscription	true	true
access	true	true
encryptionKey	false	true

A SECOM instance implementation shall reflect its capabilities by always validating the product type in Table 8 of incoming requests. If the container type is a single S100_DataSet or a S100_ExchangeSet, the data content or product type is checked and appropriate actions are taken.

Figure 35 describe the capability interface in UML.

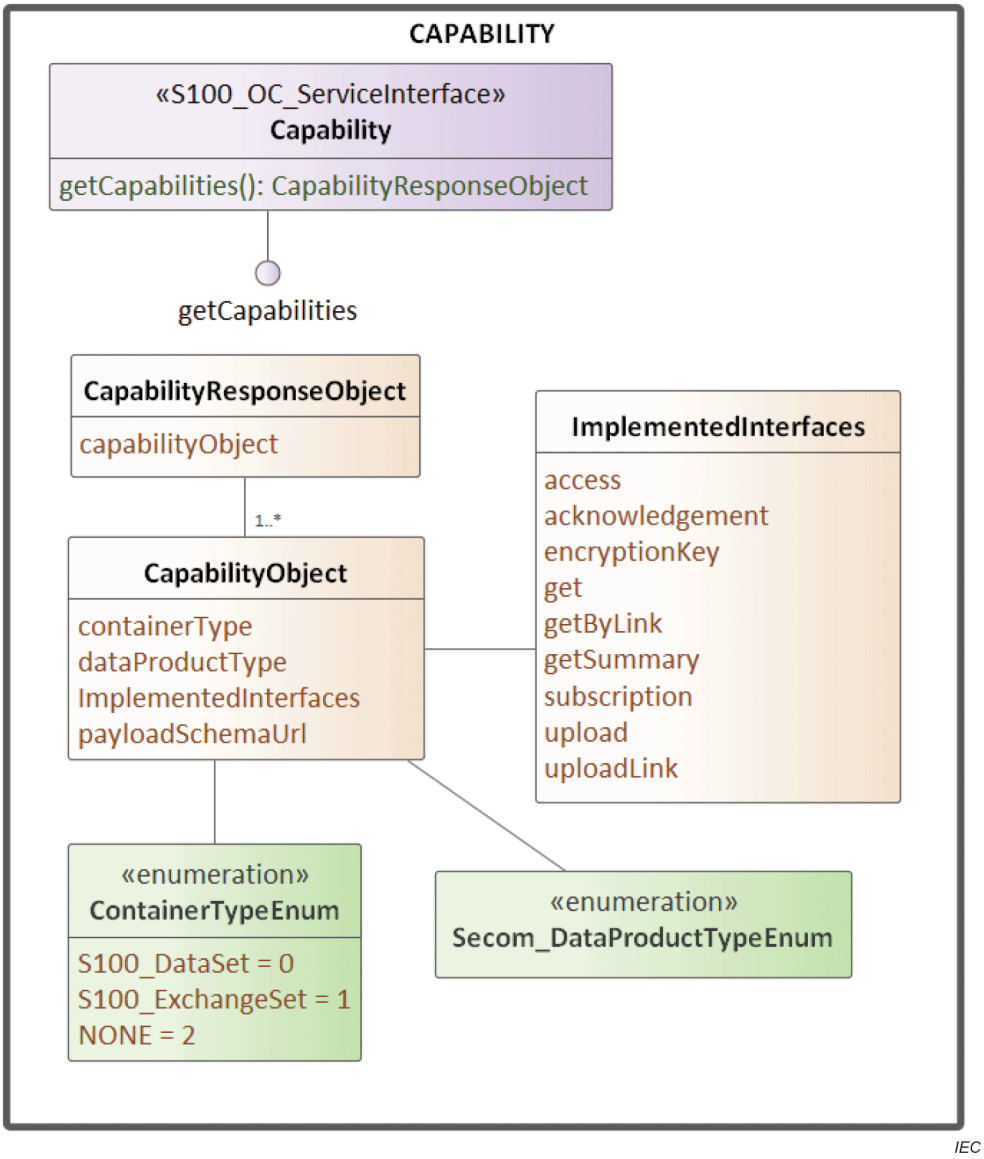


Figure 35 – Capability interface UML diagram

5.7.13.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 65.

Table 65 – Information output for Capability interface

CapabilityResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
capability	1 ..*	Optional	CapabilityObject	List of capability objects
CapabilityObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
containerType	1	Optional	ContainerTypeEnum	The container type of the data attribute, see Table 7
dataProductType	1	Optional	SECOM_DataProductType.Name	The name column of SECOM_DataProductType in Table 8
productSchemaUrl	1	Optional	URL	The schemaUrl attribute of the S100 Product
implementedInterfaces	1	Optional	ImplementedInterfaces	List of service interfaces implemented with the payload (product) in focus
serviceVersion	1	Optional	CharacterString	Version of service instance, for example New Editions denoted as n.0.0 Revisions denoted as n.n.0 Clarifications denoted as n.n.n
ImplementedInterfaces				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
upload	1	Optional	Boolean	True if service interface is implemented
uploadLink	1	Optional	Boolean	True if service interface is implemented
get	1	Optional	Boolean	True if service interface is implemented
getByLink	1	Optional	Boolean	True if service interface is implemented
getSummary	1	Optional	Boolean	True if service interface is implemented
subscription	1	Optional	Boolean	True if service interface is implemented
access	1	Optional	Boolean	True if service interface is implemented
encryptionKey	1	Optional	Boolean	True if service interface is implemented

5.7.13.3 REST Design

5.7.13.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.13.3.2 Operation – GET /capability

This operation receives request for service interface capabilities. The result contains the interfaces provided by the service instance, and the information product type handled.

Table 66 describes the logical parameters in the interface.

Table 66 – REST implementation of Capability

REST Operation			
GET URL/v1/capability {body}: return			
REST Parameter (in)	**Type**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**Type**	**Mult**	**Definition**
No body defined	n/a	n/a	n/a
Return (out)	**Type**	**Mult**	**Definition**
CapabilityResponseObject	application/json	1..*	Description of service capabilities; Which interfaces that are valid for the specific service instance, the accepted payload format and version, and specific requirements in payload etc.

5.7.13.3.3 Service response

Table 67 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.17.

Table 67 – HTTP response codes and messages of Capability

HTTP Code	Message
200	OK

5.7.13.4 Dynamic behavior

Figure 36 describes the dynamic behavior of the service interface.

The Capability interface is used to retrieve information of a SECOM instance's supported interfaces and payload.

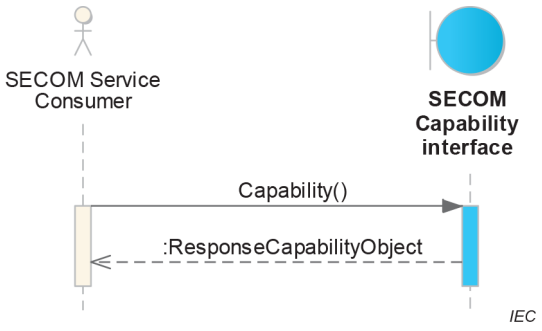


Figure 36 – Sequence diagram for Capability interface

5.7.14 Service interface – Ping

5.7.14.1 Specification

The purpose of the interface is to provide a dynamic method to ask for the technical status of the specific service instance.

Figure 37 describes the Ping interface in UML.

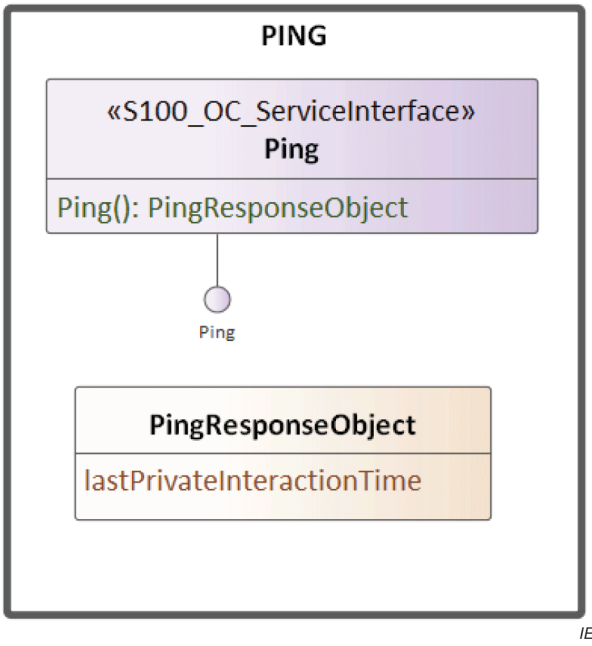


Figure 37 – Ping interface UML diagram

5.7.14.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 68.

Table 68 – Information output for Ping interface

PingResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
lastPrivateInteractionTime	0..1	Optional	DateTime	Describes the time for last interaction with end user application

5.7.14.3 REST Design

5.7.14.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.14.3.2 Operation – GET /ping

This operation receives a request for status on the service instance.

Table 69 describes the logical parameters in the interface.

Table 69 – REST implementation of Ping

REST Operation			
GET URL/v1/ping {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Description**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Description**
No body defined	n/a	n/a	n/a
Return (out)	**REST Encoding**	**Mult**	**Description**
PingResponseObject	application/json	1	Status of the service instance.

5.7.14.3.3 Service response

Table 70 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.18.

Table 70 – HTTP response codes of Ping

HTTP Code	Message
200	ResponsePingObject

5.7.14.4 Dynamic behavior

Figure 38 describes the dynamic behavior of the ping service interface.

The Ping interface is used for retrieve information of the current status (version and last interaction time) of a service instance.

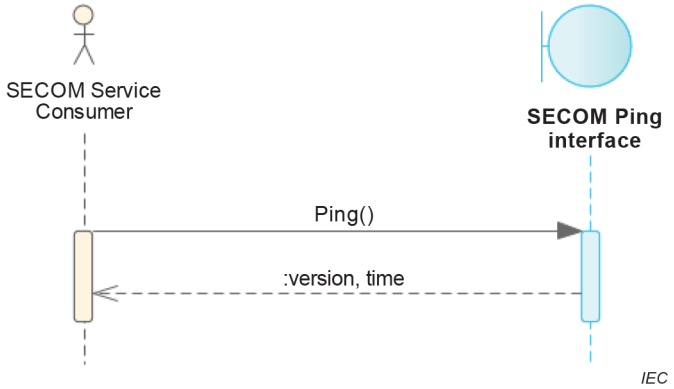


Figure 38 – Check status on service

5.7.15 Service interface – EncryptionKey

5.7.15.1 Specification

The purpose of the interface is to exchange a temporary secret key.

Figure 39 describes the Encryption Key interface in UML.

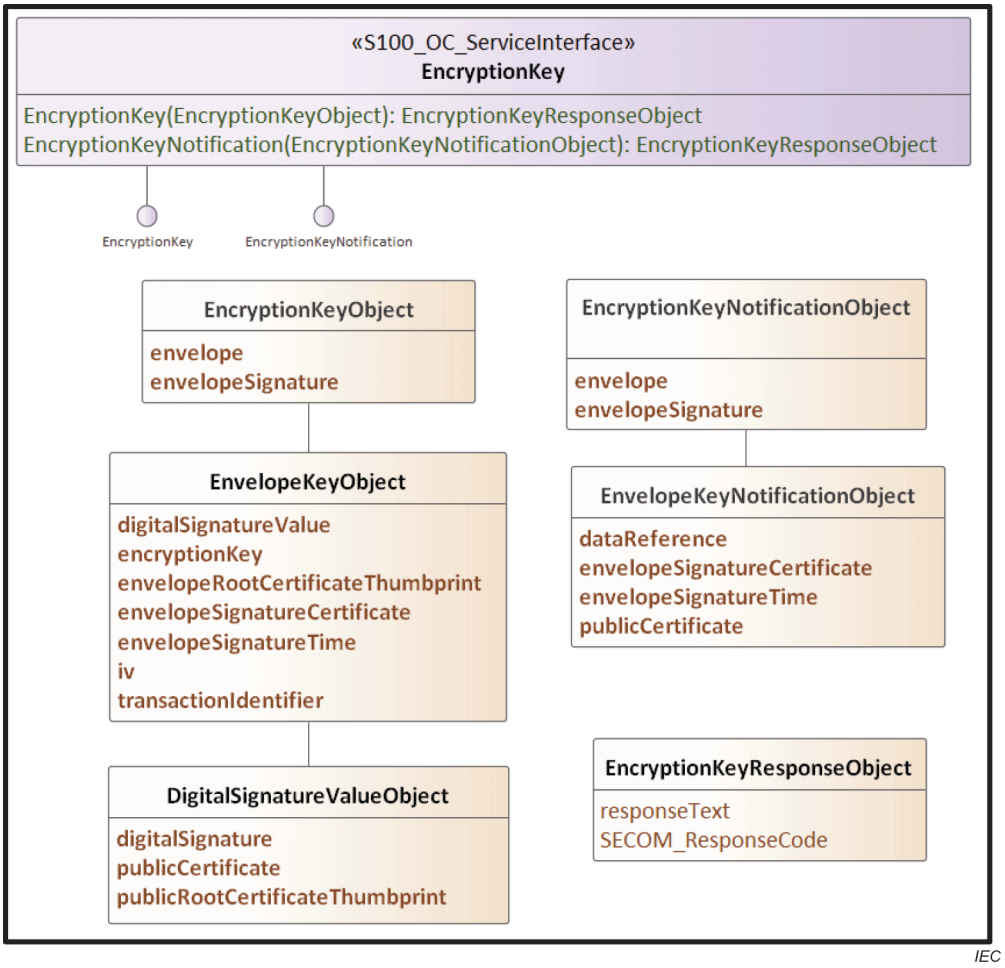


Figure 39 – Encryption Key interface UML diagram

5.7.15.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 71, Table 72 and Table 73.

Table 71 – Information input for Encryption Key interface

EncryptionKeyObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
envelope	1	Mandatory	EnvelopeKeyObject	The complete EnvelopeKeyObject being uploaded to receiver including data and message properties
envelopeSignature	1	Mandatory	CharacterString	The signature of the EnvelopeKeyObject in HEX format without whitespace or linebreaks
EnvelopeKeyObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
encryptionKey	1	Mandatory	Base64	The protected symmetric encryption key
iv	1	Mandatory	Base64	Inititalisation vector
transactionIdentifier	1	Mandatory	UUID	Identifier to the transaction with the encrypted data
digitalSignatureValue	1	Mandatory	DigitalSignatureValue Object	See Table 5
envelopeSignatureCertificate	1	Mandatory	CharacterString	The public certificate of the sender, used to verify the envelopeLinkObject signature
envelopeRootCertificateThumbprint	1	Optional	CharacterString	Claimed Thumbprint for Signed Root Key (X.509 Certificate)
envelopeSignatureTime	1	Optional	DateTime	Time when encryptionKey envelope is signed

Table 72 – Information input for Encryption Key Notification interface

EncryptionKeyNotificationObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
envelope	1	Mandatory	EnvelopeKeyObject	The complete EnvelopeKeyNotificationObject being uploaded to receiver including data and message properties
envelopeSignature	1	Mandatory	CharacterString	The signature ot the EnvelopeKeyNotificationObject in HEX format without whitespace or linebreaks
EnvelopeKeyNotificationObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataReference	1	Mandatory	UUID	Information identifier retrieved by using reference from response in Get Summary request (UUID)
publicCertificate	1	Mandatory	CharacterString	Public certificate of data consumer for deriving shared symmetric key
envelopeSignatureCertificate	1	Optional	CharacterString	The public certificate of the sender, used to verify the EnvelopeKeyNotificationObject signature Key (X.509 Certificate)
envelopeSignatureTime	1	Optional	DateTime	Time when envelope is signed

Table 73 – Information output for Encryption Key interface

EncryptionKeyResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
SECOM_ResponseCode	0..1	Mandatory	SECOM_ResponseCodeEnum	Additional error code for internal errors
message	1	Optional	CharacterString	Success or error response message

5.7.15.3 REST Design

5.7.15.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.15.3.2 Operation – POST /encryptionkey

This operation is used to upload (push) an encrypted secret key to a consumer.

Table 74 describes the logical parameters in the interface.

Table 74 – REST implementation of EncryptionKey upload

REST Operation			
POST URL/v1/encryptionkey {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Description**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Description**
EncryptionKeyObject	application/json	1	The protected encryption key with its metadata
Return (out)	**REST Encoding**	**Mult**	**Description**
EncryptionKeyResponseObject	application/json	1	Response from service

5.7.15.3.3 Service response

Table 75 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.6.

Table 75 – HTTP response codes of EncryptionKey upload

HTTP Code	Message
200	EncryptionKeyResponseObject
400	Bad request

5.7.15.3.4 Operation – POST /encryptionkey/notify

This operation enables a consumer to request an encrypted secret key from a producer by providing a reference to the encrypted data and a public certificate for symmetric key derivation used to protect the temporary encryption key during transfer. The response is sent asynchronously using the consumer's encryption key operation described in 5.7.15.3.2. Table 76 describes the REST implementation.

Table 76 – REST implementation of EncryptionKey notification

REST Operation			
POST URL/v1/encryptionkey/notify {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
EncryptionKeyRequestObject	application/json	1	The encryption key request object
Return (out)	**REST Encoding**	**Mult**	**Definition**
EncryptionKeyResponseObject	application/json	1	HTTP code with message

5.7.15.3.5 Service response

Table 77 describes the service response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.6.

Table 77 – HTTP response codes of EncryptionKey notification

HTTP Code	Message
202	Notification received
403	Not authorized

5.7.15.4 Dynamic behavior

Figure 40 and Figure 41 describes the dynamic behavior of the EncryptionKey service interface.

The information owner decides to protect the information and generates a random key and initialization vector which are used to encrypt the data. In order for the information consumer to decrypt the data, the random key is protected using a derived symmetric key using the information consumer's public certificate together with the information owner's private key. The encrypted random key is signed and the random key, initialization vector, signature and the information owner's public key are put in the payload object and uploaded to the information consumer's EncryptionKey interface. See Figure 40.

The information owner decides to publish protected information and internally stores the generated random key and initialization vector. The service consumer retrieves the protected encryption key by notifying the information owner through his SECOM EncryptionKey notification interface. The information owner protects the encryption key with a derived symmetric key, derived using the publicKey from the notification request body together with its own private key. The encryption key is encrypted with the derived key and the encrypted encryption key is signed and sent to the service consumer's SECOM EncryptionKey interface. Finally the consumer gets the encryption key from its SECOM instance and can decrypt the retrieved protected information. See Figure 41.

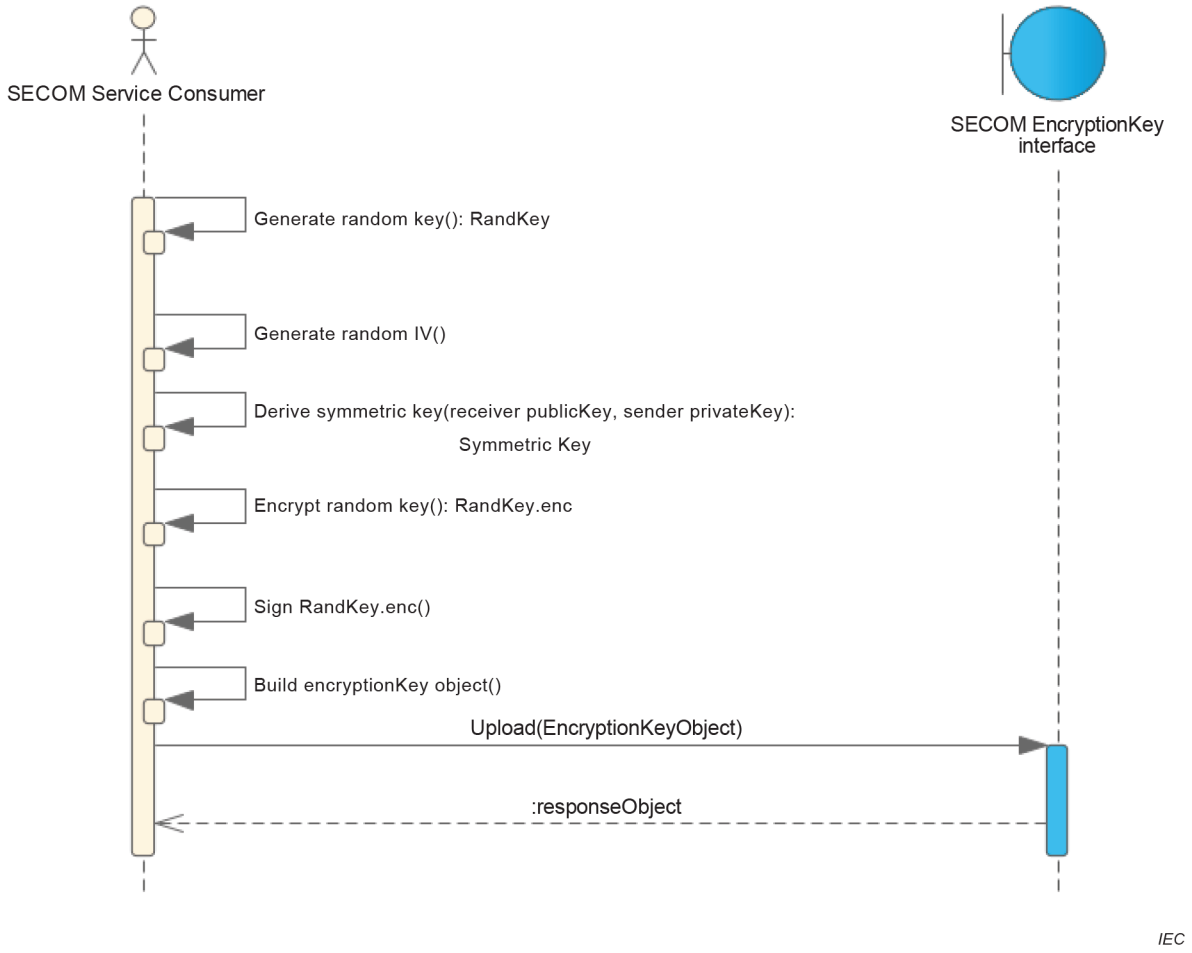


Figure 40 – Operational sequence diagram for EncryptionKey upload interface

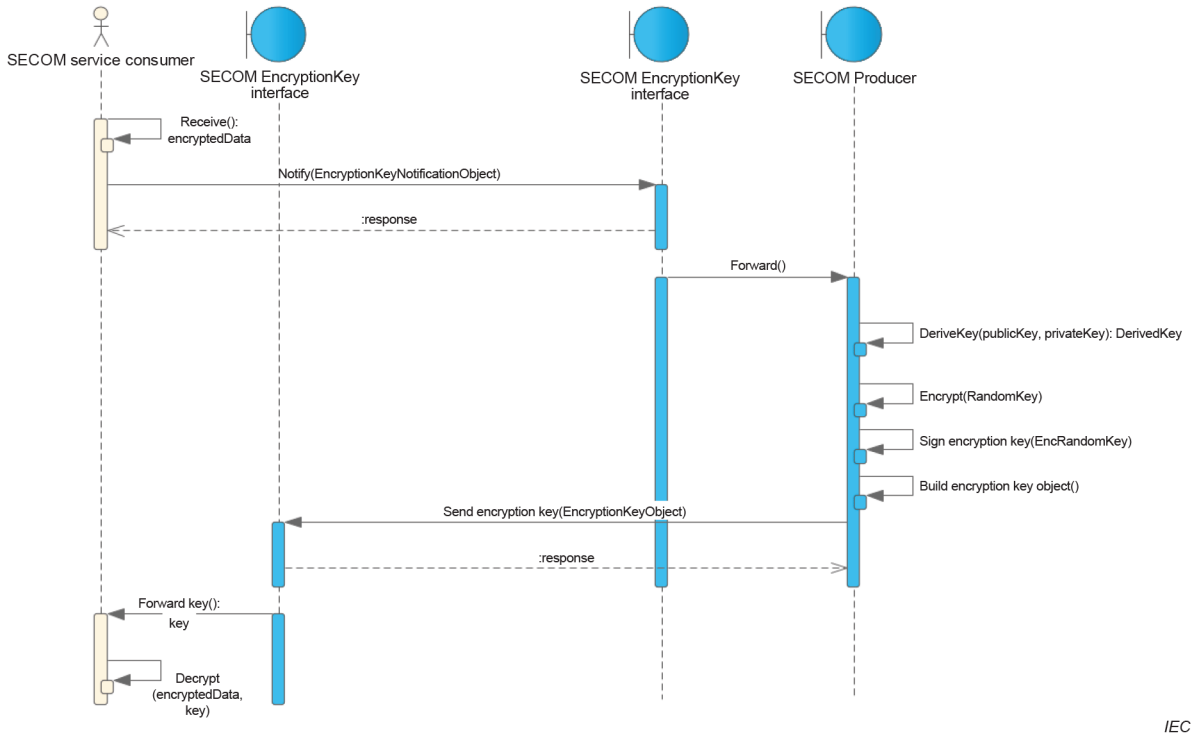


Figure 41 – Operational sequence diagram for EncryptionKey notification interface

5.7.16 Service interface – PublicKey

5.7.16.1 Specification

The purpose of this interface is to request (pull) a public key and to send (push) a public key.

The purpose of the boolean attribute "dataProtection" set to true is to retrieve the public certificate of the data recipient doing the decryption. The returned certificate is later used to derive a symmetric Diffie-Hellman key to protect the transfer of an encryption key. The "dataProtection" set to false indicates a request for the public certificate used for the verification of the digital signature.

The purpose of the string attribute "certificateThumbprint" is to retrieve the public certificate related to this identifier.

Figure 42 shows the PublicKey UML diagram.

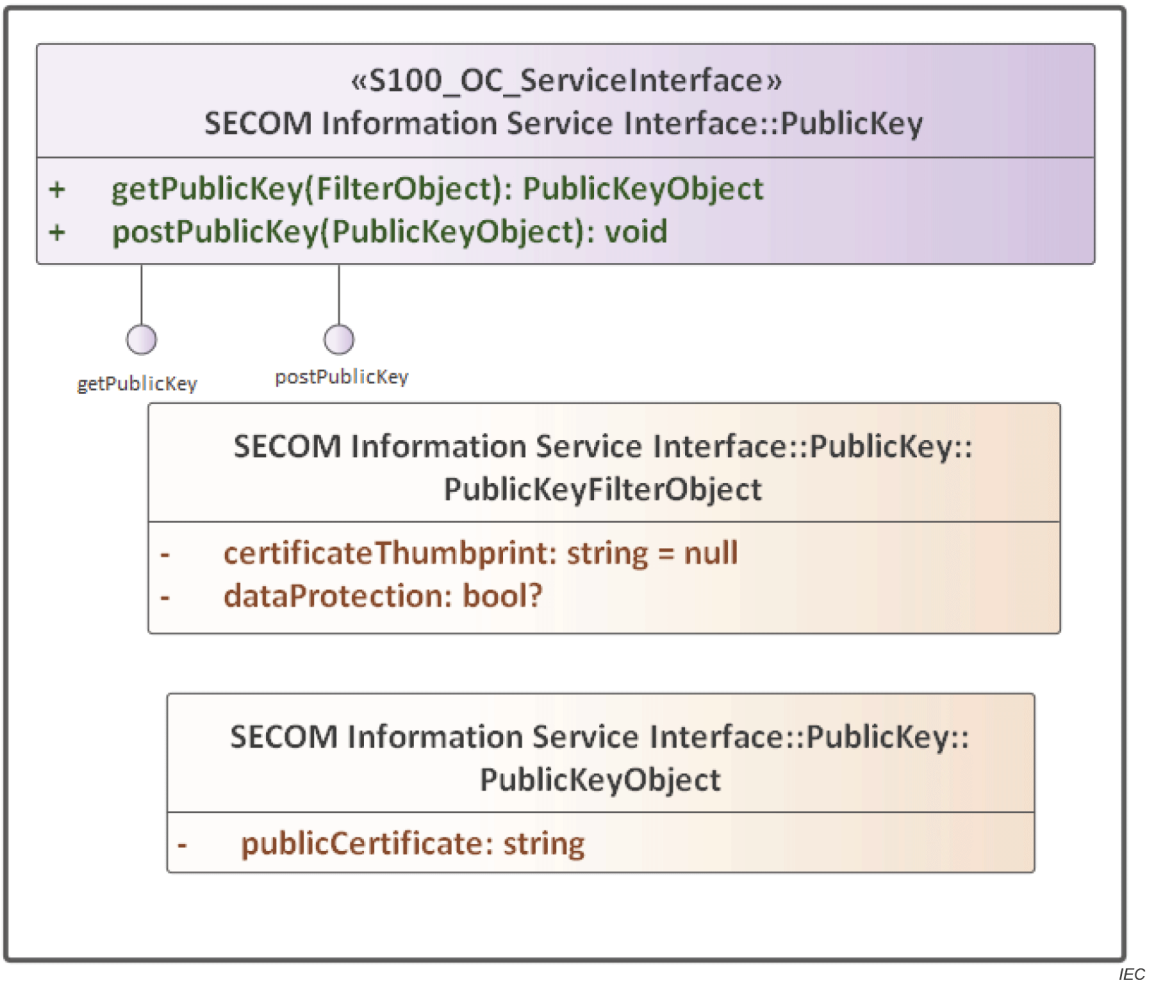


Figure 42 – PublicKey interface UML diagram

5.7.16.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 78 and Table 79.

Table 78 – Information input for PublicKey interface

PublicKeyFilterObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
dataProtection	0..1	Mandatory	Boolean	Flag indicating public certificate needed for encryption key exchange
certificateThumbprint	0..1	Mandatory	CharacterString	Claimed Thumbprint for signed key (X.509 Certificate)

Table 79 – Information output for PublicKey interface GET and information input for PublicKey interface POST

PublicKeyObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
publicCertificate	1	Mandatory	Base64	Public certificate x.509 in PEM format, Base64 encoded byte array.

5.7.16.3 REST Design

5.7.16.3.1 General

The service interface and its data exchange model is defined with REST technology.

5.7.16.3.2 Operation Get /publicKey

This operation receives a get request for a public key. If authorized, the key is sent back in the response. It is up to the service provider to apply relevant authorization procedure and access control to information.

Table 80 describes the logical parameters provided in this operation.

Table 80 – REST implementation of PublicKey (GET)

REST Operation			
GET URL/v1/publicKey?parameters: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
dataProtection	Boolean	0..1	Flag indicating that the requested key is for symmetric key derivation in exchange of a random encryption key
certificateThumbprint	String	0..1	Claimed Thumbprint for signed key (X.509 Certificate)
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
No body defined	n/a	n/a	n/a
Return (out)	**REST Encoding**	**Mult**	**Definition**
PublicKeyObject	application/json	1	Public certificate x.509 in PEM format, Base64 encoded byte array.

5.7.16.3.3 Service response

Table 81 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.7.

Table 81 – HTTP response code and message of PublicKey (GET)

HTTP Code	Message
200	PublicKeyObject
400	Bad request
403	Not authorized to requested information
404	Not found

5.7.16.3.4 Operation – POST /publicKey

This operation uploads (pushes) a public key.

Table 82 describes the logical parameters provided in this operation.

Table 82 – REST implementation of PublicKey (POST)

REST Operation			
POST URL/v1/publickey {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Description**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**REST Encoding**	**Mult**	**Description**
PublicKeyObject	application/json	1	Public certificate x.509 in PEM format, Base64 encoded byte array.
Return (out)	**REST Encoding**	**Mult**	**Description**
ResponseObject	application/json	1	Response from service

5.7.16.3.5 Service response

Table 83 describes the service instance response. See also Table 11 for codes common to all interfaces.

For tests related to these error codes, see 10.7.

Table 83 – HTTP response code and message of PublicKey (POST)

HTTP Code	Message
200	OK
400	Bad request

5.7.16.4 Dynamic behaviour

Figure 43 describes the dynamic behaviour of the PublicKey service interface. A consumer can request a public X.509 certificate by filter combinations from Table 78 or upload (push) a public X.509 certificate.

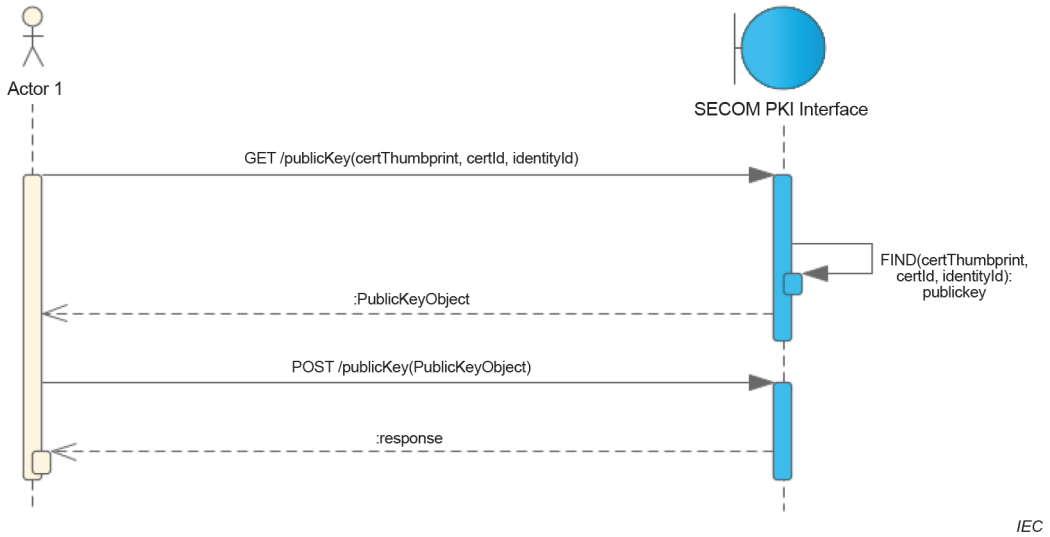


Figure 43 – Operational sequence diagram for PublicKey interface

6 SECOM communication channel security

6.1 General

The rationale to define the communication channel security is to protect the transfer of data and to facilitate authentication on the transfer when using SECOM information services. Both parties in the communication need to follow the same communication scheme to achieve interoperability when exchanging information with web services.

The SECOM information service interface is focused on the exchange of data, and this data shall always be signed. The SECOM information service interface also contains supporting service interfaces where no operational data is exchanged but still authentication is needed to verify who actually did the request, here called "service authentication". When a consumer for instance requests to subscribe to information, or asks for access to information, it is essential to authenticate the consumer before executing the request. For this purpose, a client certificate issued from SECOM PKI (see Clause 8) shall be exchanged enabling the service instance provider to authenticate the service instance consumer.

In this context, the service instance provider is the actor exposing an instance of SECOM information service interface, i.e. acting as server waiting for request. The service instance consumer is another service instance or application making a request to a SECOM information service instance, i.e. acting as client and initiating the service request. When a ship sends (uploads) information, such as a S-421 Route Plan (IEC 63173-1), to a VTS, the VTS is acting as service instance provider (server) and the ship is acting as the service instance consumer (client). Vice versa, when the VTS is sending (uploading) information, such as recommended change of route (S-421), the ship is acting as service instance provider (server) and the VTS is acting as the service instance consumer (client). Hence, as the SECOM information service interface is designed, most actors need to have the capability to act as both service instance provider (server) and service instance consumer (client).

Clause 6 describes technology and procedures for the protection of IP and HTTP based communication channels for web services, such as service instances based on SECOM information services.

6.2 Secure transfer

6.2.1 Secure communication channel

Encryption of channel by the use of Transport Layer Security, TLS version 1.2 (RFC 5246) and TLS version 1.3 (RFC 8446) shall be supported.

HTTP over TLS shall be used according to RFC 2818.

HTTP/1.1 shall be used according to RFC 7231.

This document describes business-to-business communication with mutual authentication, where both client and server authenticate each other using certificate-based TLS mutual authentication (TLS client-side X.509 authentication). See Figure 44.

Service authentication shall be based on X.509 certificates (RFC 5280 and RFC 2459).

Certificates shall be possible to be revoked, hence the authentication procedure shall contain a check against the certificate revocation list (CRL) or OCSP.

6.2.2 Authentication procedure

The authentication procedure in a service request is outlined in Figure 44 and describes how the client certificate shall be verified that it is issued from a SECOM PKI. The server (host) certificate shall be verified that it is issued by a trusted certificate authority, which does not need to be SECOM PKI.

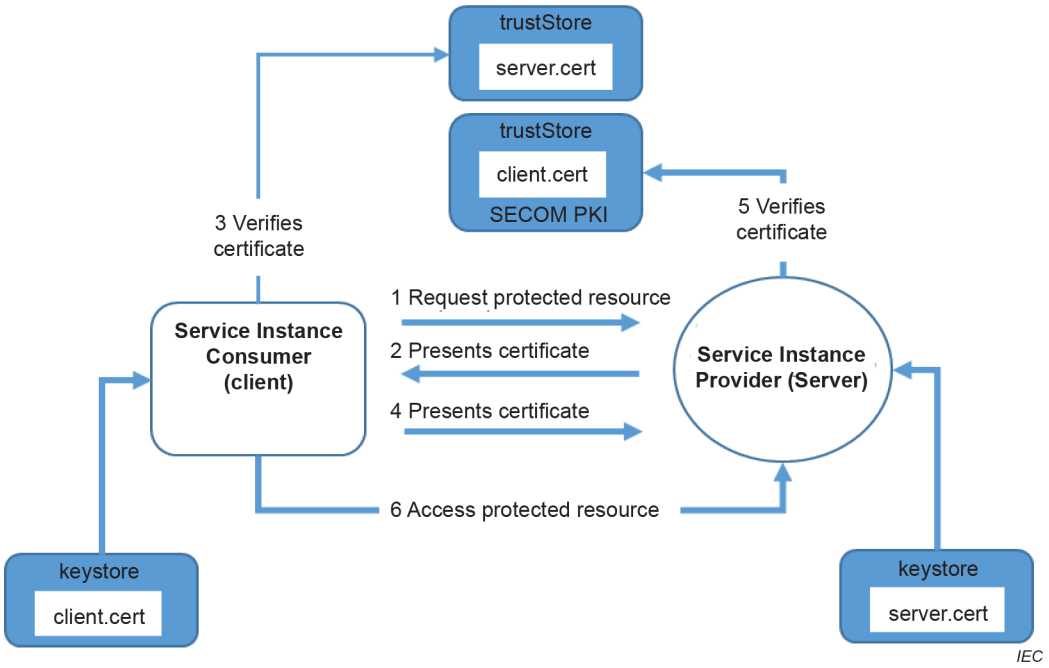


Figure 44 – Principle for service authentication

The procedure to verify the server's certificate shall be:

1) the client shall verify that the server's certificate is valid;
2) the client shall verify that the server's certificate is issued by trusted CA, normally issued by one of the trusted certificate authorities on the market but can also be issued by SECOM PKI;
3) the client shall verify that the server's domain name corresponds to the domain name in the certificate.

The procedure to verify the client's certificate shall be:

4) the server shall verify that the client's certificate is valid;
5) the server shall verify that the client's certificate is issued by SECOM PKI.

7 SECOM data protection

7.1 General

The SECOM data protection includes digital signature on the data exchanged that facilitate end-to-end data authentication. The digital signature includes a checksum and claimed identity. The checksum facilitates the data integrity check. The checksum shall be encrypted with the claimed identity (private key for the sender), which facilitates data authentication by the receiver using the public key of the sender.

The SECOM data protection also describes optional encryption of data.

For information regarding private and public keys, see Clause 8.

7.2 Data compression and packaging

The use of compression may be applied on data. The individual IHO S-100 based Product Specifications provides the details for use of compression.

If compression of classified data is applied, the data shall be compressed before encrypted.

The compression shall use ZIP algorithm and method DEFLATE. The encryption and digital signature feature of ZIP are not used.

SECOM data compression and packaging is aligned with data compression and packaging in IHO S-100. See IHO S-100:2018, Part 15-5, Data compression and packaging.

NOTE IHO S-100:2018, ed 4.0.0, is the latest released version at the time of writing of this document.

7.3 Data authentication and signing

7.3.1 General

SECOM is based on the same technology for data signing as described in IHO S-100:2018, Part 15-8, Data authentication, and uses a standard algorithm and key exchange mechanism widely available and used.

The digital signature uses asymmetric public key algorithms within SECOM PKI scheme to unbreakingly bind data with the identity of the issuer.

The scheme relies on asymmetric encryption of a checksum of the data. By verifying the signature against the issuer’s public key, and also verifying the issuer’s public key against a top level identity, the user is assured of the signer’s identity. A detailed technical description of digital signatures is beyond the scope of this document and the reader is referred to the NIST Digital Signature Standard (DSS–FIPS Publication 186-3) for more detailed explanation.

The difference between the SECOM data authentication scheme and the data authentication scheme described in IHO S-100:2018, Part 15-8, is that SECOM is designed for duplex information exchange, hence an actor such as a ship is both sender and receiver of information, both server and client in the scheme. This means that the number of data servers will increase a lot in comparison to the assumption in IHO S-100 which is designed primarily for a shore server providing information to ships (clients). It also means that each client needs to get access to a lot more public keys for data authentication. But the principle remains the same.

The payload and the signature for authentication and integrity purpose is always exchanged which is also described in the SECOM information service interface.

7.3.2 Data formats and standards for digital signatures, keys and certificates

This description is aligned technically with the corresponding description in IHO S-100:2018 (ed. 4.0.0, Part 15-8.3).

The following categories of content are required for data authentication.

1) Key pairs, private and public keys (See Clause 8).
2) Certificate signing requests and digitally signed public keys. When a public key is itself digitally signed, it is referred to as a "certificate". When the public key is signed by its corresponding private key it is referred to as a "self-signed" certificate. These are laid out as X.509 (RFC 5280 and RFC 2459) records and can be either DER (ISO/IEC 9594-8) or PEM (RFC 2045) encoded to be sent to the SECOM PKI for signing. When embedded within XML files, keys shall be PEM encoded so that the plain text can be inserted as an XML element.
3) The digital format of the signed public keys ("certificates") (See Clause 8).

PEM format defines a textual encoding of the multiple large numbers required by the Digital Signature Algorithm (DSA) (along with the DSA parameters required by the DSA algorithm). PEM encoding allows the embedding of public keys within JSON and XML objects.

More information on creation of keys and signing request is found in Clause 8.

Digital signatures in SECOM (and S-100) are implementations of the Digital Signature Standard (DSS). The DSS uses the Secure Hash Algorithm (SHA-256, see ISO/IEC 10118-1) to create a message digest (hash) of the file content that is 256 bits long. The message digest is then input to the DSA to generate the digital signature for the message using an asymmetric encryption algorithm and the "private key" of the signer's key pair.

In the DSA algorithm, a signature is a sequence of two integers. By convention, these are referred to as R and S (an "R,S pair"). The format of digital signatures when embedded in XML files is as follows:

```
<digitalSignature>

302C021433796C6647CC1C55A67DC72FA7C6E157A6594B2B02145D3768B44F3A6ABA1

1A77178B738AD3B6A0DE344

</digitalSignature>
```

The R,S pair are represented by a hexadecimal encoding (digits 0-9, letters A-F). The encoding of the two R,S large integers is an abstract syntax notation one (ASN.1) sequence 2. These are produced natively by the openssl implementation and can be generated and verified without the need to unpack the individual R and S integers. This encoding conveniently wraps the two integers into a single Hexadecimal encoded string. For example, the ASN.1 schema for the above example is:

```
SEQUENCE (2 elem)

  INTEGER (158 bit) 357903468461694385184092679318935791752802642315
  INTEGER (158 bit) 351274375691773793245737972991313380578601275707
```

7.3.3 Creation of digital signature

This description is aligned technically with the corresponding description in IHO S-100:2018 (ed 4.0.0, Part 15-8.6).

As stated in 4.1, the SECOM data protection scope is between end users. Since the data transfer might occur over non-secure communication channels, for example the "last mile", the original data needs to be signed by the information owner. The signature is created by:

1) the information owner creates a digital signature for the data using the DSA algorithm and their private key as described in 7.3.2;
2) the R,S pair making up the digital signature is stored as an ASN.1 sequence of 2 elements in the digitalSignature field of a DigitalSignatureValueObject.

In the resulting json, the signature looks as follows:

```
"digitalSignature":"302C021433796C6647CC1C55A67DC72FA7C6E157A6594B2B02145D3768B44F3A6ABA11A77178B738AD3B6A0DE344"
```

The signature shall always be exchanged together with the data content.

7.3.4 Creation of envelope signature

For interfaces designed for pushing data, i.e. with REST method POST, an extra layered signature is added containing not only the data but also the metadata, see Table 86 for the ones concerned. The main reason for adding another layer of signature is to ensure data integrity end to end for the complete payload where the data and metadata are packaged in an envelope object. To ensure interoperability between different environments, programming languages and server operating systems, the signing is processed using a custom serializing procedure described herein.

The basic idea is to parse attributes in an envelope and concatenate their values to a comma-separated value string (CSV). As a separator, a dot has been chosen. The reason for a separating dot is mainly to show where properties start/end in the long combined string. The size of the final signature is not affected by these added characters.

The order of each added attribute (see Table 16, Table 20, Table 24, Table 71 and Table 72) is achieved by adding the attribute names in the order the attributes appear in each payload table. For envelope objects including other objects as attributes, the same order is applied for each object sub-structure. The next step is to transverse the ordered object and its sub-objects and add the attribute values following the order. The CSV now contains all data needed for the signature.

The conversion from each attribute datatype to its string representation needs to be environment and location agnostic. Therefore, a set of string conversion rules is defined that need to be performed in order for the signature creation and verification to work for both sender and receiver actor. In Table 84, the different rules for each datatype conversion to string is listed, and Table 85 shows the interfaces the conversion applies to.

Table 84 – Conversion rules

Datatype	Rule	Example
DateTime	1. Convert datetime object to integer Unix timestamp in seconds 2. Parse integer as string	Input: 2020-07-01T15:00:00 Output: "1593608400"
bool	Convert bool value to lower case string	Input: True Output: "true"
Guid	Convert guid object to lowercase string	Input:[0f8fad5b-d9cb-469f-a165-70867728950e] Output: "0f8fad5b-d9cb-469f-a165-70867728950e"
enum	1. Convert enum to its integer representation 2. Parse integer as string	Input: Third: 3 Output: "3"
byte[]	Convert byte array to Base64String	Input: {10, 20, 30, 40, 0, 0, 0, 0} Output: "ChQeKDI8RlA="
integer	Parse integer as string	Input: 17 Output: "17"
null	Represent null value as empty string	Input: null Output: ""

EXAMPLE Signing an acknowledgement envelope is performed as follows.

1) Set start value of result; CSV = ""

2) Add properties according to the ordering in Table 24 producing an array: [createdAt, envelopeCertificate, transactionIdentifier, ackType, nackType, envelopeSignatureTime]

3) Start adding values from the traversed array

   a) Convert DateTime createdAt to a Unix timestamp string; CSV += "1593608400."

   b) envelopeCertificate is already a string; CSV += "MIIE1zCCBFygAwIBAgIU."

c) Convert Guid transactionIdentifier to lowercase string; CSV += "10f032cc-2c31-4441-b6e5-bc0511983cd0."

d) Convert AckEnum ackType to integer and then string; CSV += "2."

e) Convert NackEnum nackType value null to empty string; CSV += "."

f) Convert DateTime envelopeSignatureTime to a Unix timestamp string; CSV += "1593608405"

4) Remove last dot delimiter

5) CSV now contains; "1593608400.MIIE1zCCBFygAwIBAgIU.10f032cc-2c31-4441-b6e5-bc0511983cd0.2,,1593608405"

6) Finally convert the generated string to a byte array using UTF8 encoding; CSV[] = ConvertToArray(CSV)

7) Use CSV[] as input to the DSA algorithm

Table 85 – Interfaces with envelope signature

Section	Interface	Type
5.7.2	Service interface – Upload	EnvelopeUploadObject
5.7.3	Service interface – Upload Link	EnvelopeLinkObject
5.7.4	Service interface – Acknowledgement	EnvelopeAckObject
5.7.15	Service interface – EncryptionKey	EnvelopeKeyObject

7.3.5 Verification of digital signature

The purpose of the digital signature is to verify data integrity and authenticate the data. Digital signature verification is an algorithm which operates on three independent pieces of data:

1) some content which requires validation (the format of this content is arbitrary);
2) a Public Key, suitably encoded. In the DSA algorithm adopted this Public Key is composed of a set of DSA parameters together with a Public Key;
3) a signature. In the DSA algorithm a signature is composed of two numbers, by convention these are referred to as R and S (an R,S pair).

A signature verification process identifies whether the R,S pair authenticate the content against the given Public Key. This can only result in a true or false result.

DSA digital signature verification achieves two results:

- Authentication: The implementing system verifies the data server public key ("content") and the signature in the data server certificate ("signature") against the SA public key ("Public Key") to confirm that the supplier's public key in the certificate is valid and that the data server is a bona fide member of the designated data protection scheme;
- Integrity Check: The implementing system verifies the data file signature ("signature") and the data server public key in the data server certificate ("Public Key") against the data file ("content"). This verifies the content of the data file.

If this validation check is successful, then it proves that the data file has not been corrupted in any way and that the identity of the data server within the dataset signatures is validated by the scheme administrator’s (SA’s) identity as defined in the SA root certificate.

The signature is calculated on the original data, so before calculating the signature all compression, encryption and Base64 encoding needs to be reversed in the following order.

1) Binary data encoded as Base64 is reverted back to bytes.
2) If the binary data is compressed, it needs to be reverted.
3) If the data is encrypted, the data is decrypted using the appropriate key (assuming the receiver has received the key and has been able to decrypt it).

4) If the previous steps are successful, the data should now be an array of bytes and a SHA-256 hash can be calculated.
5) The hash calculated in step 4) is then used together with the public key in the digitalSignatureValue as input to the DSS verification.

NOTE If the data in the message is encrypted, the SECOM instance will not be able to decrypt the data part in the message, since this requires access to the private key of the end receiver.

7.3.6 Verification of envelope signature

When receiving a signed SECOM message, the receiving SECOM instance can verify that the message remains as the sender sent it (data integrity) by validating the envelope signature. This is done by recalculating the signature hash from the message data and verifying it toward the sender's certificate that is included in the message. This however only verifies that the certificate in the message is the one used to sign it. It is also important to verify that the certificate used is issued by a trusted CA to prove the claimed identity of the sender.

The verification process is similar to the signing process.

1) All properties are serialized and concatenated as text using the same principle as in the signing process in 7.3.4.
2) The text is converted to an array of bytes using UTF8 encoding.
3) A hash is calculated for the byte array created in step 2), using SHA-256.
4) The hash calculated in step 3) is verified according to DSA using the public key from the sender certificate.

This verification can be done by anyone receiving the message, which means that if the message is sent via a vendor API, the receiving SECOM instance can perform this verification before passing the message on to its final recipient.

7.3.7 Example of commands for data authentication

Table 86 shows examples of commands for signature creation and verification.

Table 86 – Command examples

Description	Example commands

Sign data	`openssl dgst -sha256 -sign privateKey.pem data.txt > data.sig`
	
	`xxd -u -ps data.sig > data.sig.hex`

Verify signature	`xxd -r -u -ps data.sig.hex > data.sig`
	
	`openssl dgst -sha256 -verify publicKey.pem -keyform pem`
	
	`-signature data.sig data.txt`

7.4 Data encryption

7.4.1 General

The use of data encryption is optional and, if available, is typically specified in each S-Product Specification. If it is described as optional in an S-Product Specification, the data server decides as the information owner if the data shall be encrypted.

SECOM supports use of IHO S-100:2018, Part 15-6, Data encryption algorithm for both shore to ship, and ship to shore.

7.4.2 Encryption algorithm

The algorithm for encryption used in SECOM shall be the same as described in IHO S-100:2018, Part 15-6, Data encryption, and is summarised below.

When data is encrypted, the algorithm shall be the advanced encryption standard (AES) in cipher block chaining (CBC) mode of operation. It is always assumed that the complete data (payload) shall be encrypted.

The AES block cipher algorithm is a symmetric-key algorithm. This means that the same key is used for encryption and decryption. The algorithm defines how one block of plain text is converted to one block of cipher text and vice versa. The block size of the AES is always 16 bytes (128 bit). The key length can be chosen from 128 bit, 192 bit or 256 bit. The corresponding variants are named AES-128, AES-192, or AES-256.

The AES algorithm can only encrypt one block of plain text. For larger messages, a block cipher mode of operation shall be used. This protection scheme chooses the cipher block chaining (CBC) mode for encryption of more than one block of data. In this mode of operation, it is required that the length of the plain text shall be an exact multiple of the block size. Padding is required.

The padding method that shall be used is described in PKCS#7 (RFC 2315). It adds N bytes to the message until its length is a multiple of 16 bytes. The value of each byte is N. Note that if the original plain text already has a multiple of 16 as length, a full block of 16 bytes each having the value of 16 shall be added.

7.5 Creation and transfer of encryption key

7.5.1 General

SECOM supports both encryption key management as described in IHO S-100:2018, 15-7 "Data encryption and licensing", and as described here. The provider of information decides which encryption key scheme (data protection scheme) to use.

The scheme described in IHO S-100:2018, 15-7, is focused on information from shore to ship, where the data server has submitted the symmetric keys used for data encryption wrapped in permits and linked to a hardware ID for the data client.

If S-100:2018, 15-7 Data encryption and licensing, is not applied, an alternative SECOM encryption key management scheme may be used. This scheme is suitable where an actor acts as both data server and data client, such as a ship sharing its route plan to several other actors, and other actors may send updated or optimized route plans back to the ship. In the SECOM encryption key management scheme, the symmetric key used for data encryption is generated as a temporary key and sent to the data client through a dedicated and protected service interface. The symmetric key shall only be used in limited time (session).

For details on encryption key management according to IHO S-100:2018, see reference 15-7 Data encryption and licensing.

7.5.2 SECOM encryption key management

The secret key shall be a temporary symmetrical key that is generated for the specific exchange of data. The encryption key shall be transferred to the client using the service interface defined in 5.7.15. The order of transfer of data and encryption key shall be insignificant and encryption key may be transferred before or after the encrypted data.

The secret key shall be valid and used only for a limited time. Figure 45 and Figure 46 shows the principal interaction between server and client for exchange of classified data with the SECOM key management scheme. The procedure used is a Diffie-Hellman key exchange method. The receiver's public certificate is retrieved either from the receiver's SECOM PublicKey interface in 5.7.16 (Figure 45) or from the SECOM PKI GetPublicKey interface in 8.6.3 (Figure 46).

The data server is responsible for deciding when to create a new encryption key.

If the data server has decided to encrypt its data, and the data client responds with an updated data edition, the data client shall also encrypt the responded data.

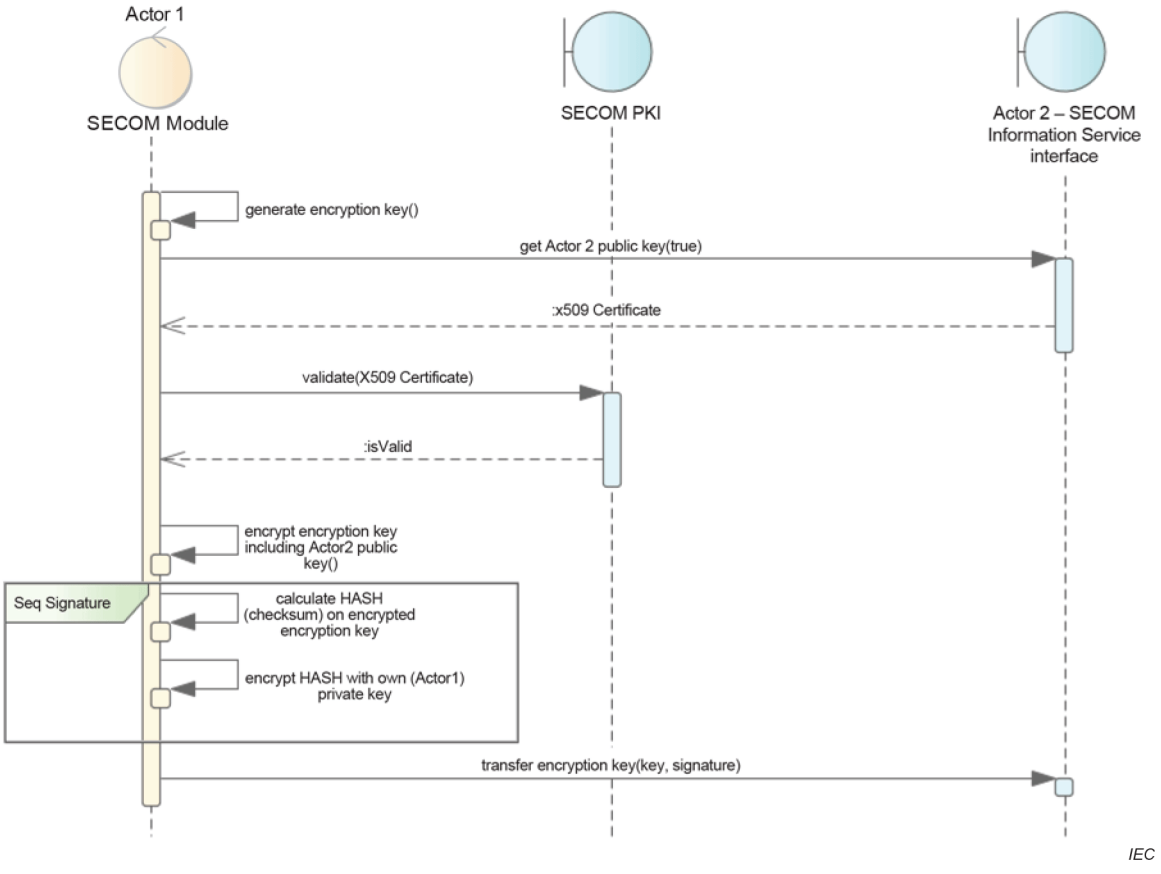


Figure 45 – Sequence for SECOM encryption key management

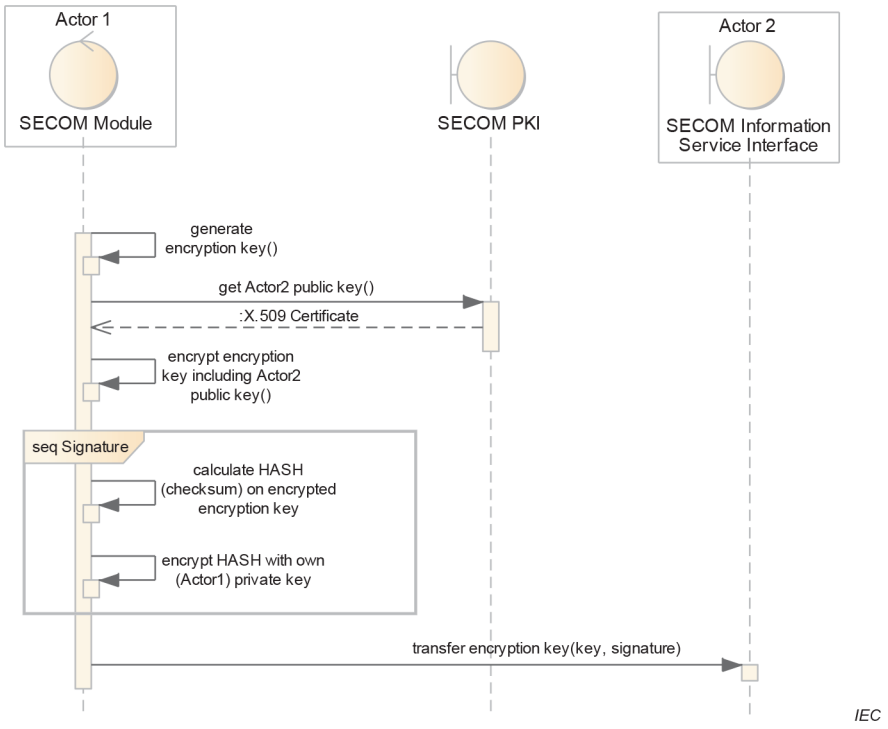


Figure 46 – Alternative sequence for SECOM encryption key management

7.5.3 Generate encryption key

The encryption key shall be generated as a random number that corresponds to the encryption algorithm and key length selected according to 7.4.2.

A random initialization vector (IV) shall be added to be used in the encryption and decryption procedure. The IV shall be generated as a random number and be used onetime only, i.e. it is important to never reuse IVs with the same encryption key. For AES, the size of the IV is always 16 bytes, i.e. equal to the block size described in 7.4.2. The rational for using an IV is to comply with the current encryption AES standard and hence to ensure compatibility with existing commercial frameworks such as .NET and Java where the underlying methods always require an IV.

Before the transfer of the encryption key, it shall be protected (encrypted). The protection of the encryption key shall include use of receiver's public asymmetric key (from SECOM PKI).

Since both receiver and sender use the elliptic curve cryptography (ECC) algorithm in asymmetric keys, pair the keys and encrypt the encryption key with the ECC pair (own private paired with the receiver's public key).

7.5.4 Sign the protected encryption key

Before the transfer, the protected encryption key shall be signed with the sender's private asymmetric key (from SECOM PKI). The signing procedure shall be same procedure as for signing any data as described in 7.3 according to digital signature standard (DSS).

7.5.5 Transfer of the encryption key

The protected encrypted key and the signature shall then be transferred to the receiver using the SECOM information service interface (5.7.15).

The receiver authenticates the signature using the sender's public asymmetric key previously stored, retrieved from the PublicKey interface, see 5.7.16, or retrieved from the SECOM PKI interface GetPublicKey, see 8.6.3. If authentication passes, the receiver shall use its private asymmetric key (from SECOM PKI) together with the sender's public asymmetric key to derive the shared symmetric key using a Diffie-Hellman algorithm (see 7.5.2) and use that derived key to decrypt the encryption key.

7.5.6 Example

An example with openssl is shown in Table 87.

Table 87 – Example of commands

Derive shared key from receiver's Public Key and sender Private Key	`openssl pkeyutl -derive -inkey Actor1PrivateKey.pem -peerkey Actor2PublicKey.pem -out sharedSecret.tmp`
Calculate hash of shared key	`openssl dgst -sha256 -out sharedSecret_hashed.tmp sharedSecret.tmp`

Parse the raw valued derived key	`$temp = (Get-Content -Path .\sharedSecret_hashed.tmp -Raw)`
	
	`$sharedKey = $temp.Substring($temp.IndexOf("=") + 2, 64)`

Encrypt secret key with derived shared key and initialization vector	`openssl enc -aes-256-cbc -nosalt -p -K $sharedKey -iv $iv -e -in encryptionKey.bin -out encryptionKey.enc`

Create digital signature for the encrypted secret key	`openssl dgst –sha256 –sign actor1PrivateKey.pem encryptionKey.enc > encryptionKey.enc.sign`
	
	`xxd -u -ps encryptionKey.enc.sign > encryptionKey.enc.sign.hex`

The signed and encrypted secret key together with the initialization vector shall then be uploaded to the SECOM information service interface of the receiver.

8 SECOM PKI

8.1 General

Clause 8 describes the functionality expected from SECOM PKI and the public interfaces exposed to users for key management.

The main functionality is to provide an interface to access the storage in an identity registry for public keys and identities for authentication purposes. The public keys are signed and wrapped in X.509 certificates (RFC 5280 and RFC 2459) when exchanged, see 8.4. It is possible to check certificates using a standard API for the purpose, OCSP (online certificate status protocol) and CRL (certificate revocation list), see 8.5. It is possible to retrieve public keys for a certain identity from SECOM PKI, and to retrieve identity for a certain public key, see 8.6.3.

A SECOM PKI is governed by a scheme administrator (SA). There can be several instances of SECOM PKI provided by multiple SAs, and an actor can be registered in several instances of SECOM PKI. SECOM compatible equipment are expected to support multiple instances of SECOM PKI.

The private key is generated by the actor and is never exchanged on the Internet. The corresponding public key is uploaded securely to the SECOM PKI for signing and storage, see 8.4. The public key is uploaded to SECOM PKI through a certificate signing request (CSR) as described in 8.2.5 and 8.4. If the signing request is accepted by SECOM PKI, it is signed and the resulting certificate is stored in SECOM PKI and also returned.

SECOM does not define nor constrain the number of identity registries, hence there can be several providers of identity registries. The data protection scheme used is described in the attached exchange metadata object.

SECOM does not specify which identity registry to use. See Annex D.

8.2 Scheme

8.2.1 General

The scheme is aligned with IHO S-100:2018, Part 15.8, Data authentication. The description and terminology of participants in the scheme is aligned with IHO S-100.

There are several types of users of the scheme:

- the scheme administrator (SA), of which there is only one within a SECOM PKI instance;
- the data server (DS), of which there are many;
- the data client (DC), of which there are many;
- the original equipment manufacturer (OEM), of which there are many.

A more detailed explanation of these terms is given in 8.2.2 to 8.2.4.

8.2.2 Scheme administrator

The scheme administrator (SA) is solely responsible for maintaining and coordinating the scheme.

The SA is responsible for controlling membership of the scheme and ensuring that all participants operate according to defined procedures. The SA maintains the top level digital root certificate used to operate the scheme and is the only body that can certify the identity of the other participants of the scheme.

8.2.3 Data servers

Data servers (DS) are responsible for the encryption and digital signing of the datasets in compliance with the procedures and processes defined in the scheme.

8.2.4 Data clients

Data clients (DC) are the end users of datasets and will receive protected information from the data servers to access and use the datasets and services. The data client’s software application (OEM system) is responsible for authenticating the digital signatures and decrypting the dataset information in compliance with the procedures defined in the scheme.

8.2.5 Procedure

The following is a list of the steps taken by each participant in the scheme before digital signing of data files.

1) Scheme creation and setup (in the creation of a SECOM PKI)
   - The scheme administrator (SA) creates their own public/private key pair and self-signs it.
   - The SA puts their self-signed public key (also known as their "root certificate") in the public domain.
   - The SA public key ("root certificate" with its thumbprint) is embedded where required in OEM systems ("truststore").
2) Data server setup (where anyone can act as data server, e.g. ship, shore)
   - The data server creates a public and private key pair.
   - The data server signs their public key (with their private key) creating a self signed key (SSK).
   - The data server’s SSK is sent to the SA for validation when applying to get the keys signed by a SECOM data protection scheme (also sometimes called a "certificate signing request"). The SA may have its own administrative or technical requirements for acceptance of the data server. Such administrative or technical requirements are outside the scope of SECOM.
3) Data server identity verification
   - If accepted, the SA verifies the data server’s SSK and identity.
   - The SA signs the data server’s SSK with its own private key to produce an SA signed data server certificate. The data server certificate is stored and bound to the identity of the data server in the identity registry.
   - The data server certificate is then returned to the data server.
   - The data server verifies that the data server certificate authenticates against the SA public key.
4) The data server can then produce digital signatures of data.

8.3 Generation of public and private key

The asymmetric key pair shall be generated according to one of the following algorithm and key-length pairs; RSA ≥ 2 048, DSA ≥ 1 024, EC ≥ 224 and EdDSA ≥ 256.

For IHO S-100:2018, the asymmetric key pair is generated as digital signature algorithm (DSA) keys with 1 024 bits length.

The asymmetric key pair shall be generated by each participant in the scheme.

These are all PEM encoded DSA keys together with their DSA key parameters. See Table 88 for an example of basic commands. The actual commands needed are dependent on the PKI provider’s implementation.

Table 88 – Creation of public and private key pairs – Example of basic commands

Task	Command
SA-1 create DSA parameters	`openssl dsaparam 1024 -out dsaparam.txt`
SA-2 create SA root key and self signed root certificate	`openssl req -x509 -sha256 -nodes -days 365 -newkey dsa:dsaparam.txt -keyout iho.key -out iho.crt`
SA-3 sign a verified certificate signing request	`openssl x509 -req -in CSR.csr -sha256 -CA iho.crt -CAkey iho.key -CAcreateserial -out signedicds.crt`

8.4 Certificate signing request

The public key shall be PEM X509v3 format encoded and packaged in PKCS#10 (RFC 2986) certificate signing request.

The certificate signing request is sent securely to SECOM PKI through the defined service interface in 8.6.2.

The public key is signed by the SECOM PKI CA certificate.

8.5 Certificate revocation

8.5.1 General

The administration of certificates occurs outside the SECOM interface and it is the SA that is responsible for update, creation, signing and revocation processes.

There are two main techniques to check revocation status on a certificate: CRL and OCSP.

8.5.2 CRL – Certificate revocation list

CRL in SECOM PKI shall be based upon a standard CRL that is published upon set intervals. Between the set intervals, a delta CRL may be published that always refers back to the last published CRL. This results in a CRL handling that lessens the overall need for large data-packets to be forwarded to ships under way.

The need for end users to subscribe to the CRL is the trade-off from OCSP that should be weighed against the ability to check credentials locally without an OCSP response. The issue of transferring a large single file over low bandwidth transmission could be mitigated by the use of an intermediate delta CRL that handles the CRL.

8.5.3 OCSP – Online certificate status protocol

OCSP main advantage over CRL is the ability to centralize the revocation list and validation of certificates to a single point. However, a centralized certificate verification function increases the need for communication and transmission. If a latency is introduced into verifying a certificate added to the latency of a payload-transfer, the increased time for delivery could be high.

The largest gain in using OCSP is the centralization of revocation and that a revoked certificate is not needed to be added and updated to several local CRL-lists. This also decreases the need of endpoint systems to pull, update and retain a CRL. The decrease in endpoint use is spread across several systems need for transmission and calls/requests for information towards centralized IT-clusters.

8.6 SECOM PKI service interface

8.6.1 General

The security service interface includes the operations shown in Table 89. While the CRL and the OCSP interfaces are open, the remaining interfaces CSR, GetPublicKey and Revoke require authentication and PKI provider specific authorisation.

Table 89 – PKI interface overview

PKI Interface	Exchange Pattern	Definition	Provider of information	Consumer of information
CSR	REQUEST_RESPONSE	Interface to send public keys in a certificate signing request and get them signed by the SECOM PKI provider.	Mandatory	Mandatory
GetPublicKey	REQUEST_RESPONSE	Interface to request a signed Public Key from the Scheme Administrator (SA).	Mandatory	Mandatory
CRL	REQUEST_RESPONSE	Interface to retrieve a Certificate Revocation List (CRL), complete or delta.	Mandatory	Mandatory
OCSP	REQUEST_RESPONSE	Interface to check revocation status of certificates with the Online Certificate Status Protocol (OCSP).	Mandatory	Mandatory
Revoke	ONE_WAY	Interface to revoke a certificate	Mandatory	Mandatory

8.6.2 Service interface – CSR

8.6.2.1 Specification

The purpose of this interface is to send public keys in a certificate signing request and get them signed by the SECOM PKI. The signing request shall be according to PKCS #10 described in RFC 2986.

Figure 47 shows the interface in UML; Table 90 and Table 91 describe the data exchanged in the interface.

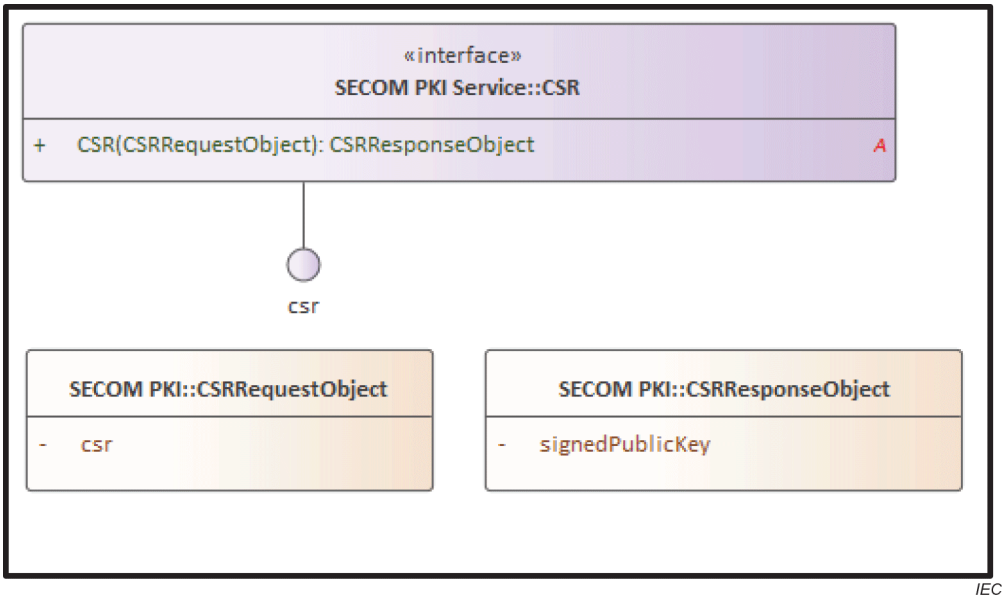


Figure 47 – CSR interface UML diagram

8.6.2.2 Data exchange model

Table 90 – Information input for CSR interface

SignRequestObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
csr	1	Mandatory	string	A PEM encoded PKCS#10 CSR

Table 91 – Information output for CSR interface

SignRequestResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
signedPublicKey	1	Mandatory	string	PEM encoded PKCS#10

8.6.2.3 REST design

8.6.2.3.1 General

The service interface and its data exchange model is defined with REST technology.

8.6.2.3.2 Operation – POST /csr

This operation is used to request signing of public key by the SECOM PKI. The signed public key is sent back in the response.

Table 92 describes the logical parameters in the interface.

Table 92 – REST implementation of CSR

REST Operation			
POST URL/v1/csr{body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
Not applicable (no parameters accepted)			
REST Body (in)	**REST Encoding**	**Mult**	**Definition**
SignRequestObject	text/plain	1	Sign request as string, a PEM encoded PKCS#10 CSR (Certificate Signing Request)
Return (out)	**REST Encoding**	**Mult**	**Definition**
SignRequestResponseObject	application/pem-certificate-chain	1	Confirmation or error message

8.6.2.3.3 Service response

The service shall respond with HTTP codes and message according to Table 93.

Table 93 – HTTP response codes and message in response object

HTTP Code	Message
200	OK
201	Created
401	Unauthorized
403	Not authorized
404	Not found

8.6.2.4 Dynamic behavior

Figure 48 shows the dynamic behavior of a certificate signing request. Actor 1 creates or updates self-signed certificates to its end application which issues a request to the SECOM PKI. The PKI returns a signed public-private key pair.

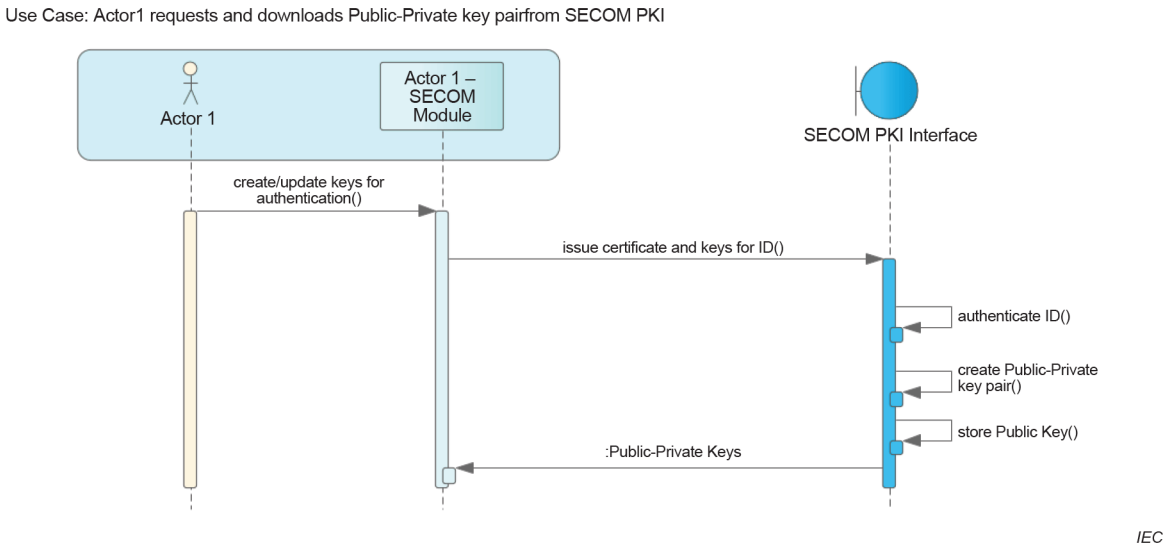


Figure 48 – Operational sequence diagram for CSR

8.6.3 Service interface – GetPublicKey

8.6.3.1 Specification

The purpose with this interface is to facilitate fetching of a public key from a PKI provided by a thumbprint. In order to optimize bandwidth, SECOM interfaces exchange certificate thumbprints instead of the complete certificate(s). The service interface consumer needs a way to retrieve the corresponding public certificate using the exchanged certificate thumbprint. Figure 49 shows the interface in UML.

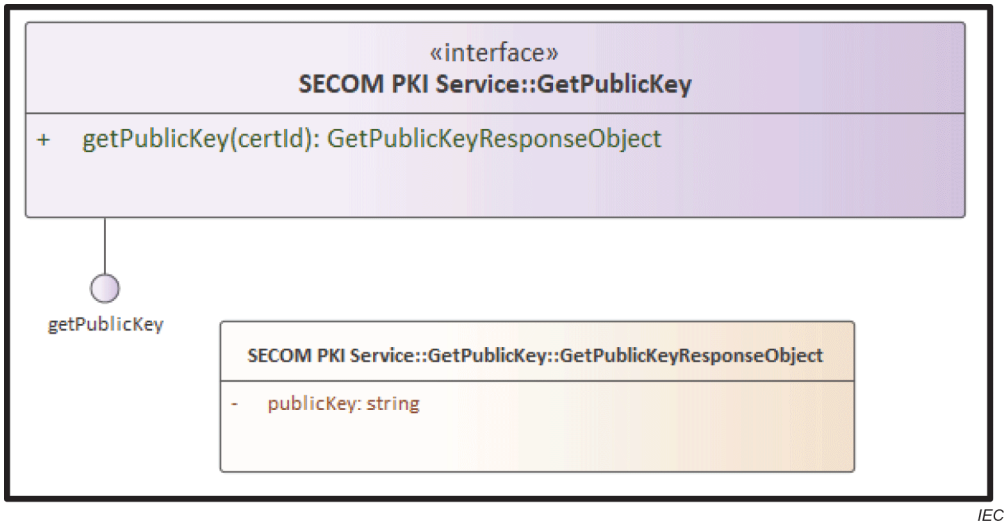


Figure 49 – GetPublicKey interface UML diagram

8.6.3.2 Data exchange model

Information objects in the data exchange are shown in Table 94 and Table 95.

Table 94 – Information input for GetPublicKey interface

GetPublicKeyObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
certThumbprint	0..1	Mandatory	string	Thumbprint of claimed public key, Base64 encoded
certId	0..1	Mandatory	string	The serial number of the certificate given in decimal
identityId	0..1	Mandatory	string	Identifier of the identity related to the certificate, e.g. a MRN urn:mrn:org:ca:env:identity

Table 95 – Information output for GetPublicKey interface

GetPublicKeyResponseObject				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
publicKey	0..1	Mandatory	string	Public Key (X.509 Certificate)

8.6.3.3 REST design

8.6.3.3.1 General

The service interface and its data exchange model is defined with REST technology.

8.6.3.3.2 Operation – GET /publicKey

This operation is used to fetch the full content of a public key from the SECOM PKI. The public key is sent back in the response.

Table 96 describes the logical parameters in the interface.

Table 96 – REST implementation of GetPublicKey interface

REST Operation			
GET URL/v1/publicKey/parameter: return			
REST Parameter (in)	**Encoding**	**Mult**	**Definition**
certThumbprint	string	0..1	Thumbprint of claimed public key, Base64 encoded
certId	string	0..1	The serial number of the certificate given in decimal
identityId	string	0..1	Identifier of the identity related to the certificate, e.g. a MRN urn:mrn:org:ca:env:identity
REST Body (in)	**Encoding**	**Mult**	**Definition**
n/a	n/a	n/a	n/a
Return (out)	**Encoding**	**Mult**	**Definition**
GetPublicKeyResponseObject	application/x-pem-file	1	Binary PEM encoded X.509 Certificate

8.6.3.3.3 Service response

The service shall respond with HTTP codes and message according to Table 97.

Table 97 – HTTP Response codes and message in response object

HTTP Code	Message
200	OK
401	Unauthorized
403	Not authorized
404	Not found

8.6.3.4 Dynamic behavior

Figure 50 shows the dynamic behavior of get request to retrieve a X.509 public certificate.

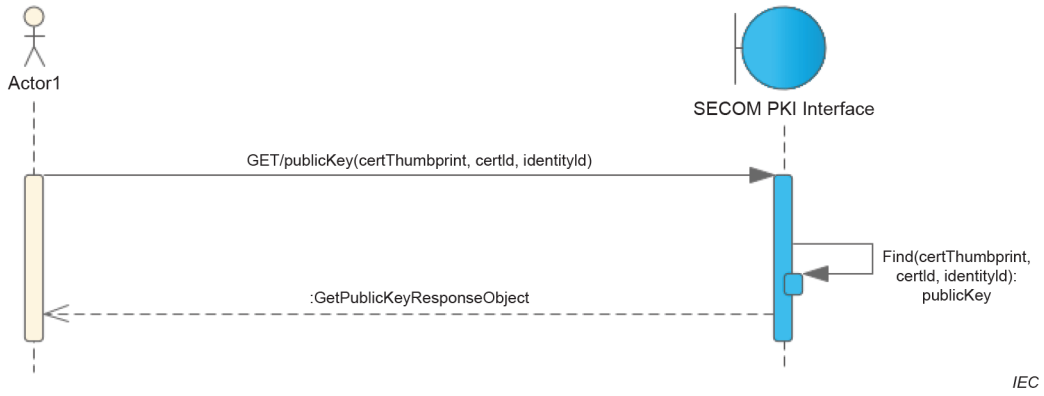


Figure 50 – Operational sequence diagram for GetPublicKey

8.6.4 Service interface – CRL

8.6.4.1 Specification

The purpose with this interface is to retrieve a certificate revocation list. Figure 51 shows the interface in UML.

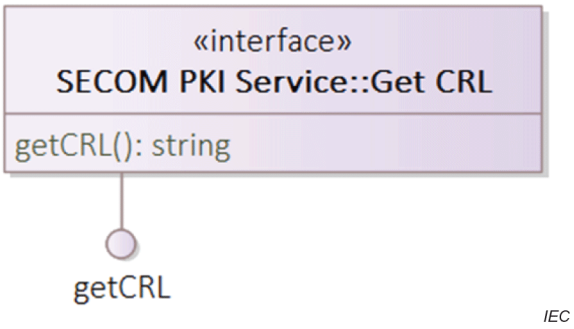


Figure 51 – GetCRL interface UML diagram

8.6.4.2 Data exchange model

The exchanged data in the service interface is described in detail in RFC 5280.

8.6.4.3 REST design

8.6.4.3.1 General

CRL shall be based on RFC 5280.

8.6.4.3.2 Operation – GET /crl

The REST operation crl is described in RFC 5280. Table 98 shows the REST implementation of the CRL interface.

Table 98 – REST implementation of CRL

REST Operation			
GET URL/v1/crl/parameter: return			
REST Parameter (in)	**Encoding**	**Mult**	**Definition**
caAlias	string	1	Certificate Authority alias e.g. a MRN urn:mrn:org:ca:env:identity
REST Body (in)	**Encoding**	**Mult**	**Definition**
n/a	n/a	n/a	n/a
Return (out)	**Encoding**	**Mult**	**Definition**
CRL	application/x-pem-file	1	Binary PEM encoded X.509 CRL

8.6.4.3.3 Service response

The service shall respond with HTTP codes and message according to Table 99.

Table 99 – HTTP response codes and message in response object

HTTP Code	Message
200	OK
401	Unauthorized
403	Not authorized
404	Not found

8.6.4.4 Dynamic behaviour

Figure 52 shows the dynamic behaviour for retrieving a certificate revocation list.

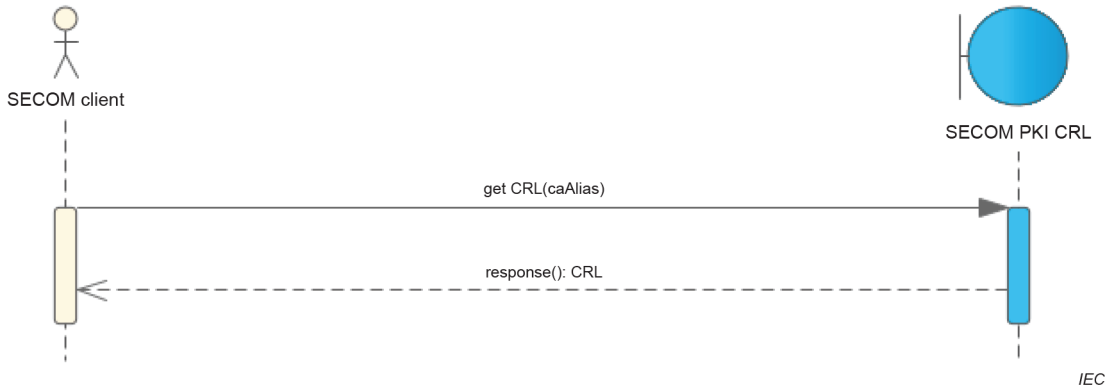


Figure 52 – Operational sequence diagram for CRL

8.6.5 Service interface – OCSP

8.6.5.1 Specification

The purpose with this interface is to check revocation status of certificates with the OCSP protocol. Figure 53 shows the interface in UML.

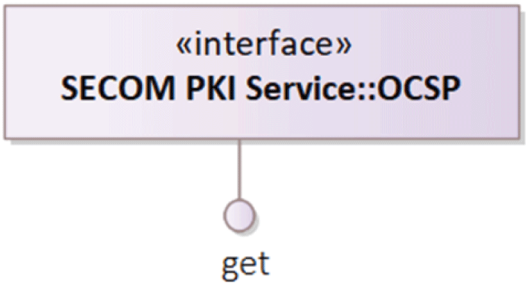


Figure 53 – GetOCSP interface UML diagram

8.6.5.2 Data exchange model

The exchanged data in the service interface is described in detail in RFC 6960.

8.6.5.3 REST design

8.6.5.3.1 General

OCSP shall be based on RFC 6960.

8.6.5.3.2 Operation – GET /ocsp

The REST operations for OCSP is described in RFC 6960. Table 100 shows the REST implementation of the OCSP interface.

Table 100 – REST implementation of OCSP

REST Operation			
GET URL/v1/ocsp/parameter: return			
REST Parameter (in)	**Encoding**	**Mult**	**Definition**
caAlias	string	1	Certificate Authority alias e.g. a MRN urn:mrn:org:ca:env:identity
REST Body (in)	**Encoding**	**Mult**	**Definition**
n/a	n/a	n/a	n/a
Return (out)	**Encoding**	**Mult**	**Definition**
ocsp-response	application/ocsp-response	1	RFC 6960

8.6.5.3.3 Service response

The service shall respond with HTTP codes and message according to Table 101.

Table 101 – HTTP response codes and message in response object

HTTP Code	Message
200	OK
401	Unauthorized
403	Not authorized
404	Not found

8.6.5.3.4 Operation – POST /ocsp

The REST operations for OCSP is described in RFC 6960. Table 102 shows the REST implementation of the OCSP interface.

Table 102 – REST implementation of OCSP

REST Operation			
POST URL/v1/ocsp/{body}: return			
REST Parameter (in)	**Encoding**	**Mult**	**Definition**
n/a	n/a	n/a	n/a
REST Body (in)	**Encoding**	**Mult**	**Definition**
ocsp-request	application/ocsp-request	1	RFC 6960
Return (out)	**Encoding**	**Mult**	**Definition**
ocsp-response	application/ocsp-response	1	RFC 6960

8.6.5.3.5 Service response

The service shall respond with HTTP codes and message according to Table 103.

Table 103 – HTTP response codes and message in response object

HTTP Code	Message
200	OK
201	Created
401	Unauthorized
403	Not authorized
404	Not found

8.6.5.4 Dynamic behaviour

Figure 54 shows the dynamic behaviour of an online check of a certificate’s validity.

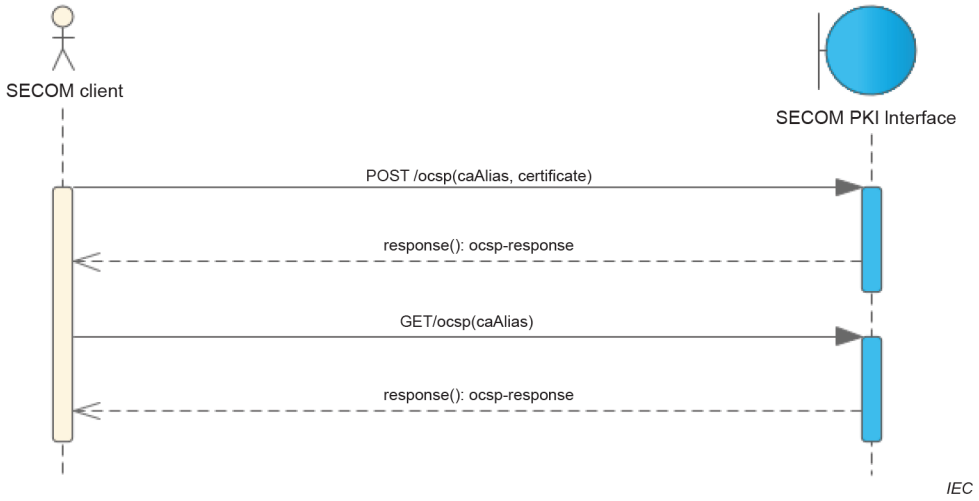


Figure 54 – Operational sequence diagram for OCSP

8.6.6 Service interface – Revoke

8.6.6.1 Specification

The purpose with this interface is to revoke a certificate. Figure 55 shows the interface in UML.

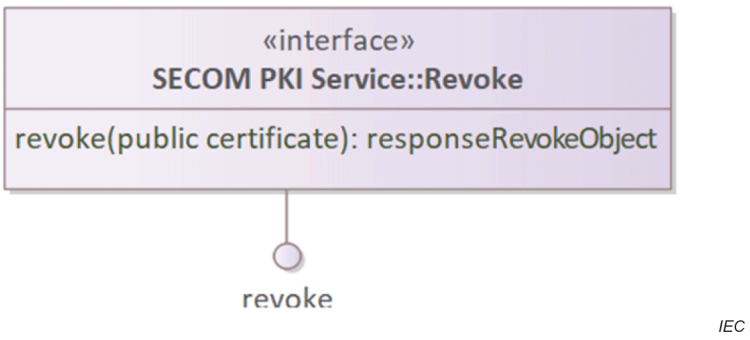


Figure 55 – PostRevoke interface UML diagram

8.6.6.2 Data exchange model

The exchanged data in the service interface is described in detail in Table 104, Table 105 and Table 106.

Table 104 – Information input for Revoke interface

CertificateRevocation				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
RevocationReason	0..1	Mandatory	RevocationReason Enum	The reason the certificate has been revoked
RevokedAt	0..1	Mandatory	DateTime	The date the certificate revocation should be activated

Table 105 – Enumerations for Revoke interface

RevocationReasonEnum		
Index	**Value**	**Description**
1	unspecified	Enum UnspecifiedEnum for unspecified
2	keycompromise	Enum KeycompromiseEnum for keycompromise
3	cacompromise	Enum CacompromiseEnum for cacompromise
4	affiliationchanged	Enum AffiliationchangedEnum for affiliationchanged
5	superseded	Enum SupersededEnum for superseded
6	cessationofoperation	Enum CessationofoperationEnum for cessationofoperation
7	certificatehold	Enum CertificateholdEnum for certificatehold
8	privilegewithdrawn	Enum PrivilegewithdrawnEnum for privilegewithdrawn
9	aacompromise	Enum AacompromiseEnum for aacompromise

Table 106 – Information output for Revoke interface

RevocationResponse				
Attribute	**Mult**	**Processing**	**Type**	**Definition**
Message	0..1	Optional	string	Response message

8.6.6.3 REST design

8.6.6.3.1 General

Revoke shall be based on RFC 6960.

8.6.6.3.2 Operation – POST/revoke

Table 107 shows the REST implementation of the Revoke interface.

Table 107 – REST implementation of Revoke

REST Operation			
POST URL/v1/revoke/parameter {body}: return			
REST Parameter (in)	**Encoding**	**Mult**	**Definition**
certId	application/json	1	The serial number of the certificate given in decimal
REST Body (in)	**Encoding**	**Mult**	**Definition**
CertificateRevocation	application/json	1	Revocation reason and activation time
Return (out)	**Encoding**	**Mult**	**Definition**
RevocationResponse	application/json	1	Response message

8.6.6.3.3 Service response

The service shall respond with HTTP codes and message according to Table 108.

Table 108 – HTTP response codes and message in response object

HTTP Code	Message
200	OK
201	Created
401	Unauthorized
403	Not authorized
404	Not found

8.6.6.4 Dynamic behaviour

Figure 56 shows the dynamic behaviour of a revoke request.

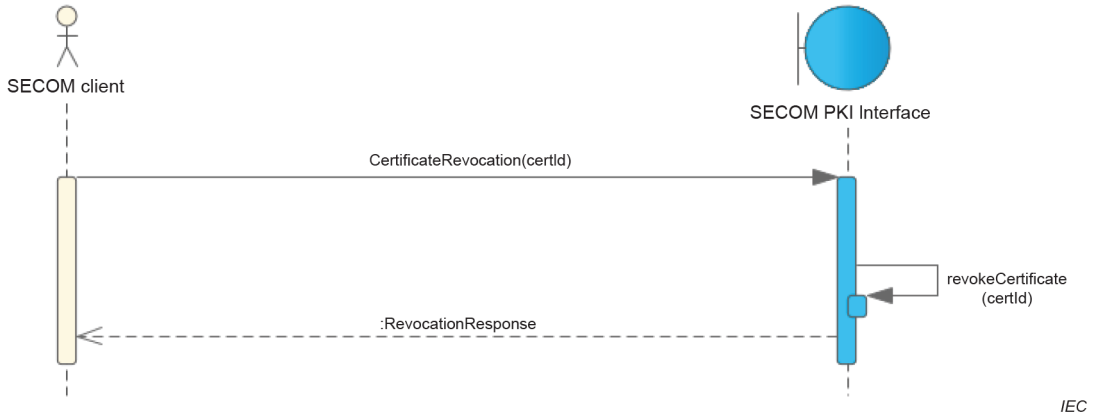


Figure 56 – Operational sequence diagram for Revoke

9 SECOM service discovery service interface

9.1 General

The rationale to standardize the service discoverability is to gain interoperability for searching for the service to consume. To encourage a service oriented approach and to get the desired flexibility and scalability, it is foreseen to be important to define a common service interface to find other services to consume. Services to consume need to be registered in a service registry, thus making the service endpoint searchable. The SECOM service discovery interface is placed in front of a service registry. See Annex B.

SECOM does not define the number of service registries, thus SECOM supports several providers of service registries, each implemented with the defined SECOM service discovery interface.

SECOM does not specify which service registry to use.

9.2 Service interface – Search service

9.2.1 Specification

The purpose of this interface is to search for service instances to consume. Figure 57 shows the information model UML diagram.

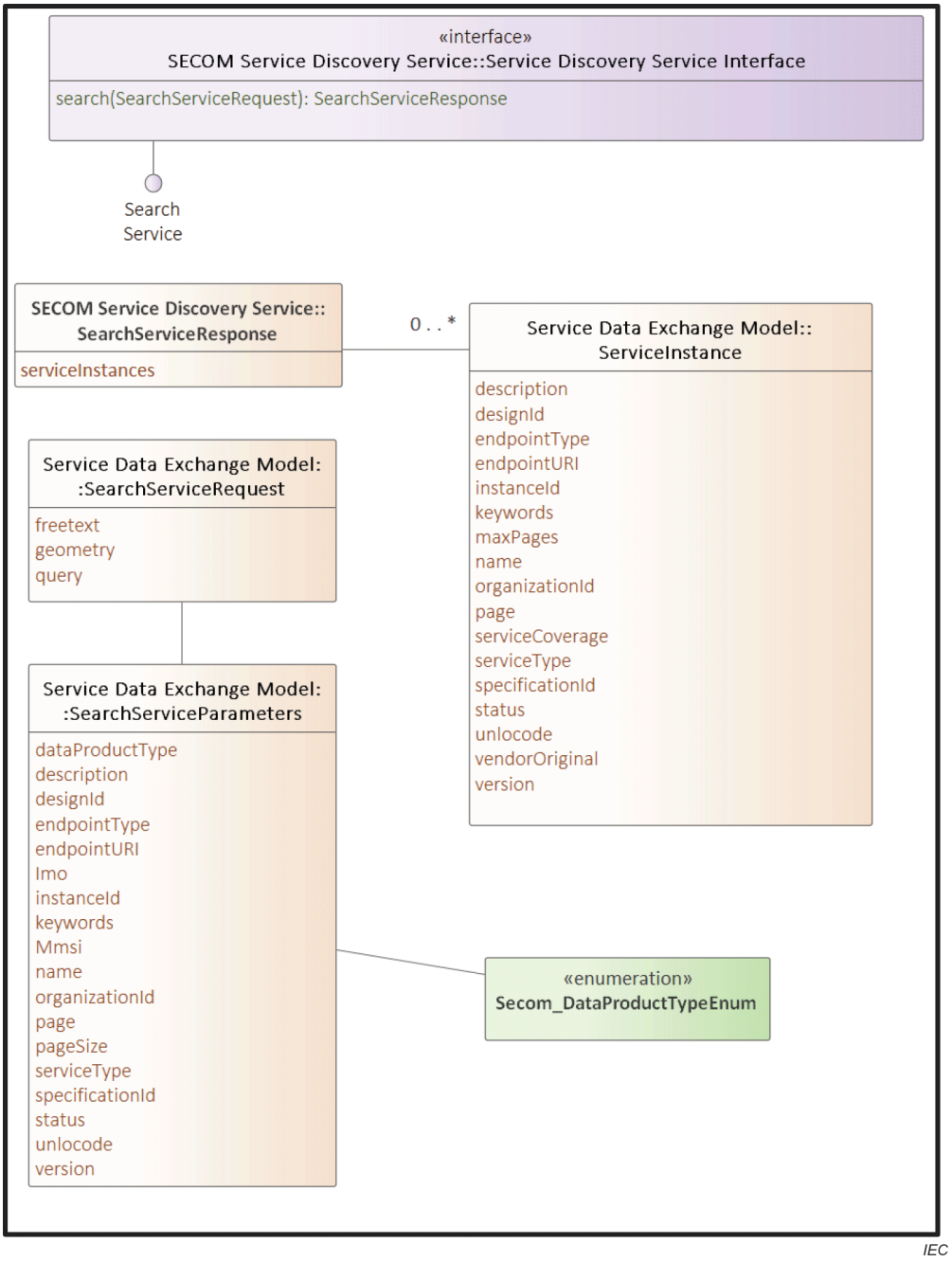


Figure 57 – Search service UML information diagram

9.2.2 Data exchange model

The operation shall be used for searching for service instance(s) to consume based on provided parameters. This interface caters for searching a service registry by combining query parameters separated by AND/OR together with possible geometry search criteria and free text; an example is provided in Clause D.7.

Table 109 describes the logical parameters in the interface, Table 110 describes the available search parameters for the query and Table 111 describes the output response.

Table 109 – Information input for search service interface

SearchFilterObject				
Attribute	**Type**	**Mult**	**Processing**	**Definition**
query	SearchParameters	0..1	Mandatory	Search query based on parameters in SearchParameters, Table 110
geometry	string	0..1	Mandatory	WKT geometry, see Table 12 for example a route plan as linestring
freetext	string	0..1	Mandatory	Free text search

Table 110 – Information input for search parameter object

SearchParameters				
Attribute	**Type**	**Mult**	**Processing**	**Definition**
name	string	0..1	Mandatory	From S-100 Service Model
status	string	0..1	Mandatory	From S-100 Service Model
version	string	0..1	Mandatory	From S-100 Service Model
keywords	string	0..1	Mandatory	From S-100 Service Model
description	string	0..1	Mandatory	From S-100 Service Model
dataProductType	SECOM_DataProductType	0..1	Mandatory	Name column from Table 8
specificationId	MRN	0..1	Mandatory	From IALA Service Model G1143
designId	MRN	0..1	Mandatory	From IALA Service Model G1143
instanceId	MRN	0..1	Mandatory	From IALA Service Model G1143
Mmsi	string	0..1	Mandatory	From IALA Service Model G1128
Imo	string	0..1	Mandatory	From IALA Service Model G1128
serviceType	string	0..1	Mandatory	From IALA Service Model G1128
unlocode	string	0..1	Mandatory	Code of defined object, see 5.6.13
endpointUri	URI	0..1	Mandatory	From IALA Service Model G1128
page	PositiveInteger	0..1	Mandatory	Requested pagination page
pageSize	PositiveInteger	0..1	Mandatory	Requested pagination page size

Table 111 – Information output for search service interface

ResponseSearchObject				
Attribute	**Type**	**Mult**	**Processing**	**Defintion**
searchServiceResult	SearchObjectResult	0..*	Optional	List of type SearchObjectResult
SearchObjectResult				
Attribute	**Type**	**Mult**	**Processing**	**Defintion**
instanceId	string	1	Optional	MRN Service instance identity (refer IALA G1143)
version	string	1	Optional	S100_OC_ServiceMetaData, version of the service instance
name	string	1	Optional	S100_OC_ServiceMetaData, name on the service instance
status	string	1	Optional	S100_OC_StatusType, status on the service
description	string	1	Optional	S100_OC_ServiceMetaData , description of the service instance
dataProductType	SECOM_DataProductType	0..1	Mandatory	Name column from Table 8
organizationId	string	1	Optional	MRN, organization identity of the registrator (refer IALA G1143)
endpointUri	string	1	Optional	URI, endpoint to the service instance
endpointType	string	1	Optional	S100_OC_ServiceTechnology i.e. REST
keywords	string	0..1	Optional	S100_OC_ServiceMetaData, a list of keywords associated with the service Searchable keywords for discoverability.
unlocode	string	0..1	Optional	Code of defined object, see 5.6.13
instanceAsXml	string	0..1	Optional	Original XML based on service registry used. (refer IALA G1128)

9.2.3 REST design

9.2.3.1 General

The service interface and its data exchange model is defined with REST technology.

9.2.3.2 Operation – POST /searchService

This operation searches for service. If no parameters given, a complete list of services is given in result.

Table 112 describes the logical parameters in the interface.

Table 112 – REST implementation for Search Service

REST operation			
POST URL/v1/searchService {body}: return			
REST Parameter (in)	**REST Encoding**	**Mult**	**Definition**
No parameters defined	n/a	n/a	n/a
REST Body (in)	**Encoding**	**Mult**	**Definition**
SearchServiceObject	application/json	1	Search object
Return (out)	**Encoding**	**Mult**	**Definition**
ResponseSearchObject	application/json	0..*	list of services

9.2.3.3 Service response

Table 113 describes the service response.

Table 113 – HTTP response codes

HTTP Code	Message
200	Array of FindServiceResponseObject
400	Bad request
404	Information not found

10 SECOM error cases

10.1 Error cases

In this Clause 10, possible error cases are outlined. Although SECOM is designed for S-100 based products, SECOM is technically payload agnostic and applicable also for other types of data. As a consequence, error cases are not focused on invalid test data, since this is covered in end-user application and thus not in scope for this document.

Instead, error cases are described referring to SECOM test objectives as outlined below.

- Message integrity
- Data integrity
- Transport confidentiality
- Data protection
- Service identity
- Client identity
- Client authorization
- Bandwidth optimization
- Large message transfer
- Closed loop communication
- Service discoverability
- Information push
- Information pull
- Subscribe to data

- Service information
- Service condition

10.2 General

In Table 11, HTTP response codes common to all interfaces are listed. For interfaces using the SECOM_ResponseCodeEnum in Table 9, the corresponding column value is set to null. Below are some examples of errors resulting in such common HTTP response code.

- For unauthenticated requests from a non SECOM authenticated requester, HTTP response code 401 "Unauthorized" is the expected response.
- SECOM interface REST method (POST/ GET) not supported for an implemented interface returns HTTP response code 405 "Method not allowed".
- Erroneous requests regarding wrong endpoint, wrong request format and/or erroneous supplied mandatory parameters results in 500 "Internal server error".
- If an interface in a SECOM service instance is not implemented, HTTP response code 501 "Not implemented" is the expected response.

10.3 Message integrity

The intention of message integrity is to ensure that the complete message is unchanged between SECOM services, i.e. not including last mile from vendor API to end user application. Envelope signing is the proposed solution to cater for this in SECOM. The envelope shall be signed in the sending instance and verified in the receiving instance according to 7.3.4 and 7.3.6.

Errors might be attributable to parsing attributes in the message, i.e incorrect datatype conversion and/or wrong attribute ordering, usage of incorrect private key, incorrect/revoked public certificate and possible differences in key-length for the DSA algorithm, see 7.3.3.

In case of such errors, HTTP response code 400 in combination with SECOM_ResponseCodeEnum 1 – "Failed signature verification" or 2 – "Invalid certificate" are expected.

10.4 Data integrity

Data integrity ensures the data transmitted is accurate and consistent end to end. This implies that verification of payload signature shall be performed in the end user application. However, if the sending end user application signs the data with a SECOM PKI key, it is possible to check data integrity already in the receiving SECOM service instance, thus eliminating further transfer of incorrectly signed data to the end user application.

The payload shall be signed in the sending end user application, then verified in the receiving service instance and/or verified in the receiving end user application, according to 7.3.3 and 7.3.5.

Errors related to failure of verification of data signatures are related to the following HTTP response codes for the interfaces Upload, Upload Link and Acknowledgement:

- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 1 "Failed signature verification";
- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 2 "Invalid certificate".

10.5 Transport confidentiality

Transport confidentiality ensures communication channel protection between SECOM service instances. Channel encryption in SECOM is realized using TLS according to 6.2. Errors related to the deployment environment shall follow RFC 7231 HTTP1/1.

HTTP response code 401 "Unauthorized" is expected if the presented service instance certificate in the TLS session fails authentication. This can be sent from either the service acting as a client and the server, since SECOM uses mutual authentication.

10.6 Data protection

Data protection ensures that information is confidential except for the intended recipient. In the SECOM implementation, AES is used for this purpose as described in 7.4.2. SECOM service interface EncryptionKey is used for exchange of the temporary secret key for decryption of encrypted data. The SECOM PublicKey interface facilitates request of a public key for data encryption in end user application.

In the EncryptionKey request operation, HTTP response code 403 "Not authorized" is expected if the requesting service instance identity is unauthorized according to the provided service instance certificate.

Error cases for the EncryptionKey upload operation are outlined below.

- HTTP response code 400 "Bad request" is expected if provided attributes in EncryptionKeyObject are incorrect and/or malformed.
- HTTP response code 400 "Error" with SECOM_ResponseCode = 0 "Missing required data for the service" is expected if mandatory provided attributes in EncryptionKeyObject are missing.
- HTTP response code 400 "Error" with SECOM_ResponseCode = 1 "Failed signature verification" is expected if the envelopeSignature cannot be verified.
- HTTP response code 400 "Error" with SECOM_ResponseCode = 2 "Invalid certificate" is expected if the provided envelopeSignatureCertificate is invalid.

Errors related to the PublicKey interface are listed below:

- HTTP response code 400 "Bad request" is expected if provided attributes in PublicKeyFilterObject are missing, incorrect and/or malformed.
- HTTP response code 403 "Not authorized to requested information" is expected if the requesting service instance identity based on provided service instance certificate is unauthorized to requested publicCertificate as indicated in PublicKeyFilterObject.
- HTTP response code 404 "Not found" is expected if requested publicCertificate based on provided certificateThumbprint in PublicKeyFilterObject cannot be found.

10.7 Service identity

SECOM service identification is based on the corresponding identity found in the SECOM service instance certificate from the SECOM PKI. SECOM interfaces Upload, Upload Link, Acknowledgement, Access, Get, Get Summary and Get By Link relies on SECOM service instance identification. Errors related to the Service instance identity are implicitly handled in validation of the provided service certificate.

10.8 Client identity

Client identification is realized in SECOM by usage of end user client certificate authentication (X.509 PKI). Note that identification is only possible if SECOM PKI is used for end user certificates. Client identification is performed in SECOM interfaces Acknowledgement, Access, Get, Get Summary and Get By Link. Errors related to the client identity are handled in validation of the provided client certificate.

10.9 Client authorization

Facilitation of client access to information in SECOM is based on corresponding service instance authorization, since it cannot be assumed that the client, i.e. end user application, is registered in SECOM PKI. For authorization purposes, SECOM implements interfaces Access and Access Notification.

The following error cases are possible for the Access interface:

- HTTP response code 400 "Bad request" is expected if provided attributes in AccessRequestObject are missing, incorrect and/or malformed.
- HTTP response code 403 "Not authorized to requested information" is expected if the requesting service instance identity lacks access to desired information, i.e the specified combination of attributes containerType, dataProductType, dataReference and/or productVersion.

The following error cases are possible for the Access Notification interface:

- HTTP response code 400 "Bad request" is expected if provided attributes in AccessNotificationObject are missing, incorrect and/or malformed.

10.10 Bandwidth optimization

Minimize size of data package sent to reduce required bandwidth is facilitated in SECOM by use of data compression. Errors attributable to compression relates to interfaces Upload and Get and is informed to the receiving end user through the Acknowledgement interface.

In the Acknowledgment interface, the end user application is expected to return attribute nackType with nackTypeEnum = 4 "Failed decompression" when experiencing decompression failures.

10.11 Large message transfer

Large message transfer, i.e. message sizes exceeding 350 kB, is implemented in SECOM by providing a link to data which is facilitated by interfaces Upload Link and Get By Link.

Errors in the Upload Link interface are attributable to the following.

- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = null is expected if provided attributes in UploadLinkObject are incorrect and/or malformed.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 0 "Missing required data for the service" is expected if provided mandatory attributes in UploadLinkObject are missing.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = null is expected if provided attributes in AcknowledgementObject are incorrect and/or malformed.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = null is expected if provided attributes in AcknowledgementObject are incorrect and/or malformed.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 1 "Failed signature verification" is expected if envelopeSignature attribute fails to verify according description in 7.3.6.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 2 "Certificate failure" is expected if envelopeSignatureCertificate is found not to be valid.
- HTTP response code 403 "Not authorized to upload link" with SECOM_ResponseCodeEnum = null is expected if client authorization fails, which is based on provided client certificate in the corresponding upload message.

Errors in the Get By Link interface are attributable to the following:

- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = null is expected if provided attributes in GetByLinkObject are incorrect and/or malformed.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 2 "Certificate failure" is expected if provided client certificate cannot be authenticated in a SECOM PKI compliant identity register.
- HTTP response code 403 "Not authorized to requested information" with SECOM_ResponseCodeEnum = null is expected if client authorization fails, which is based on provided client certificate.
- HTTP response code 404 "Information with <transactionIdentifier> not found" is expected upon requesting information with the wrong transactionIdentifier.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 4 "Link expired" is expected when a Get By Link request is made after the time specified in timeToLive parameter.

10.12 Closed loop communication

Notification of message received, read etc. to ensure consistent dialogue between end-user applications is realized in SECOM by using the Acknowledgement interface which can be used in combination with upload and download of information. Acknowledgement can be requested upon delivery to the vendor API and/or when the message is opened in the end-user application.

The following error cases are possible for the Acknowledgement interface irrespective of requested ackType.

- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = null is expected if provided attributes in AcknowledgementObject are incorrect and/or malformed.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 0 "Missing required data for the service" is expected if provided mandatory attributes in AcknowledgementObject are missing.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 1 "Failed signature verification" is expected if digitalSignature attribute fails to verify according to description in 7.3.5.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCodeEnum = 2 "Invalid certificate" is expected if envelopeCertificate is found not to be valid.
- HTTP response code 403 "Not authorized to upload ACK" with SECOM_ResponseCodeEnum = null is expected if client authorization fails, which is based on provided client certificate in the corresponding upload message, see 10.9.

Additionally, in case of a requested ackType = "Opened", the following error cases are also possible as end-user application response.

- NackTypeEnum = 0 "XML Schema validation error" is returned if previously uploaded/downloaded data fails schema validation in the end user application according to stated containerType and dataProductType provided with the uploaded message.
- NackTypeEnum = 1 "Unknown data type or version" is returned when previously uploaded/downloaded message contains an unknown data type or version, i.e. not in the enumerated list of allowed dataProductType.
- NackTypeEnum = 2 "Failed data signature verification" is returned when the digital signature for the payload cannot be verified as described in 7.3.5.
- NackTypeEnum = 3 "Failed decryption" is returned when the payload cannot be decrypted using the received encryption key from the EncryptionKey interface.
- NackTypeEnum = 4 "Failed decompression" is returned when the payload cannot be decompressed using a compliant tool for unzipping the received compressed data.

10.13 Service discoverability

Search for services by means of service metadata in order to locate relevant services for consumption is implemented in the SECOM Search Service interface. Expected errors are related to search results when querying the service registry and/ or incorrect attribute format specified in SearchFilterObject.

HTTP response code 400 "Bad request" is expected if provided attributes in SearchFilterObject are incorrect.

Non-existent search results generates HTTP response code 404 "Information not found".

10.14 Information push

Information is shared by uploading data to a service which implements service interfaces to push information, i.e. Upload interface and Upload Link.

Possible errors emanating from the Upload interface are specified below:

- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 0 "Missing required data for the service" is expected if provided mandatory attributes in UploadObject are missing.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 1 "Failed signature verification" is expected if envelopeSignature attribute fails to verify according description in 7.3.6.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 2 "Invalid certificate" is expected if envelopeSignatureCertificate is found not to be valid.
- HTTP response code 400 "Bad request" together with SECOM_ResponseCode = 3 "Schema validation error" is expected if the provided payload is found not to be valid according to related schema. This validation is only possible for non-encrypted payload.
- HTTP response code 403 "Forbidden" together with SECOM_ResponseCode = null is expected if the requester is not authorized to Upload information to the service instance.
- HTTP response code 413 "Request entity too large" together with SECOM_ResponseCode = null is expected if the uploaded message size exceeds 350 kB.

Errors in the Upload Link interface are outlined in 10.11.

10.15 Information pull

Functions for retrieval of information by downloading data from a service are realized in SECOM service interfaces, Get, Get Summary and Get by link.

In the Get interface, the following error cases possible.

- HTTP response code 400 "Bad request" is expected if provided attributes in GetFilterObject are incorrect and/or malformed.
- HTTP response code 403 "Not authorized to requested information" is expected if the requester, i.e. corresponding identity for SECOM service instance, is not authorized to resulting information according to attributes provided in the GetFilterObject.
- HTTP response code 404 "Information with <dataReference> not found" is expected when non-existent information is requested according to attributes in the GetFilterObject.

Error cases in Get Summary interface are listed below.

- HTTP response code 400 "Bad request" is expected if provided attributes in GetSummaryFilterObject are incorrect and/or malformed.
- HTTP response code 403 "Not authorized to requested information" is expected if the requester, i.e. corresponding identity for SECOM service instance, is not authorized to resulting information according to attributes provided in the GetSummaryFilterObject.
- HTTP response code 404 "Information not found" is expected when non-existent information is requested according to attributes in the GetSummaryFilterObject.

Possible errors in the Get By Link are described under 10.11.

10.16 Subscribe to data

Subscribe to information to receive subsequent updates is implemented in SECOM service interfaces for Subscription request, remove and notify.

Errors in a subscription request are related to whether the requester is authorized to required data or not, in which case HTTP response code 403 "Not authorized to requested information" is returned. HTTP response code 400 "Bad request" is expected in the case information for a supplied attribute in SubscriptionRequestObject is missing and/or malformed.

Following the subscription request, a subscription notification is sent to the requester. HTTP response code 400 "Bad Request" is expected in the case a notification is sent for a non-existing subscriptionIdentifier, supplied parameters are malformed and/or missing.

Errors in the removal subscription interface used by the consumer to request removal of subscription are attributable to either of the following reasons.

- Request for a removal of a subscription with a non-existent subscriptionIdentifier results in HTTP response code 404 "Subscriber identifier not found". The same response code is expected if the requester does not exist as a subscriber.
- The requester is not authorized to remove the referenced subscription results in 403 "Not authorized to remove subscription".
- HTTP response code 400 "Bad Request" is expected in the case a removal is sent for a non-existing subscriptionIdentifier, supplied parameter is malformed and/or missing.

10.17 Service information

In order to facilitate information regarding service accepted payloads, payload versions, formats and endpoints, SECOM implements a service capability interface. Possible errors are the following.

- Consequential errors in the requesting service emanating from response CapabilityResponseObject attributes missing or not compliant with definitions referenced in Table 65.

10.18 Service condition

This is to cater for a contextual service status to check service operation. In SECOM, the Ping interface is used for checking the last interaction time with the related end-user application and SECOM service status in a ping response. Errors might be attributable to wrong endpoint registered in the service registry. Other errors are indicated by usage of common HTTP response codes in 5.6.10.

11 Test methods and expected results

11.1 General

A simulator or test arrangements with the following characteristics is required:

- capable of importing and exporting SECOM compliant data;
- capable of examining content of SECOM compliant data;
- capable of editing the imported and exported SECOM compliant data if necessary.

Test material is organized in folders and is provided in machine readable form at http://cirm.org/secom.

A simulator or test arrangements for SECOM PKI with the following characteristics is required:

- at least one scheme administrator which includes a private/public key pair and contains self-signed public key;
- at least one data server which generates public and private key pair and produces digital signature of the data;
- at least one data client which generates its public and private key pair and produces digital signature of the data;
- manufacturer document specifying the encryption algorithm for the data and means to encrypt and to decrypt the message if provided;
- manufacturer document specifying the encryption algorithm for the digital signature and means to generate and to verify the signature;
- instance is required to have a valid trusted SSL certificate.

Test methods are separated into four different EUT's:

- ship/shore equipment;
- SECOM Information service equipment;
- SECOM PKI equipment;
- service discovery equipment.

See descriptions in Annex F.

11.2 Communication channel security test

This test is mandatory for all other tests in this Clause 11.

Confirm by the inspection of documented evidence that the EUT provides use of Transport Layer Security, TLS version 1.2 (RFC-5246) and TLS version 1.3 (RFC-8446).

Confirm by the inspection of documented evidence that the EUT provides HTTP over TLS as specified in RFC-2818.

Confirm by the inspection of documented evidence that the EUT provides HTTP/1.1 as specified in RFC-7231.

Confirm by analytical evaluation that the EUT supports service authentication based on X.509 certificates and supports the revoke which checks against the Certificate Revocation List (CRL) or OCSP.

11.3 Data protection test

11.3.1 Data Compression and packaging

Confirm by analytical evaluation that the compression uses ZIP algorithm and DEFLATE methods.

11.3.2 Data authentication and signature

Confirm by analytical evaluation that the EUT creates a digital signature using the DSA algorithm and its private key and that the signature is stored as an ASN.1 sequence of 2 elements in the digitalSignature of DigitalSignatureValueObject if provided.

11.3.3 Encryption

Confirm by analytical evaluation or by the inspection of the documented evidence that the EUT supports the IHO S-100:2018, Part 15-6, Data encryption algorithm.

When each message is encrypted, the message shall be verified based on the proper encryption algorithm before it is processed. This test applies to all encrypted SECOM messages.

Confirm by analytical evaluation that the message is encrypted or decrypted with AES algorithm as specified in 7.4.2.

11.3.4 Digital signature test

When a message includes a digital signature in an Envelope or ExhangeMetadata object, the following test shall be applied.

Confirm by analytical evaluation that the digital signature is generated or verified correctly as specified in 7.3.3, 7.3.4, 7.3.5 and 7.3.6.

11.4 SECOM ship/shore test

11.4.1 General

This test describes message exchange between two imaginary end applications divided into data push (upload) and pull (download). For each test method, there is a corresponding set of test data available. The test data is organized into separate zip archives reflecting whether the data exchange is unprotected (open.zip), protected (protected.zip) or size optimized (compressed.zip). The auth.zip archive includes the client/server, intermediate and root certificates used. Inside each archive, the payload json file, for example uploadObject.json, getSummaryResponse.json etc., can be found and used when executing the tests. See Table 114.

Table 114 – Test data reference

Upload test		
File	**Description**	**Defintion**
upload\open\UploadObject.json	Upload request object	Table 16
upload\open\ EnvelopeUploadObject.txt	Upload envelope conversion for signature creation	7.3.4
upload\open\Ack_technical.json	Acknowledgement request, delivered ack	Table 24
upload\open\Ack_operational.json	Acknowledgement request, opened ack	Table 24
upload\open\EnvelopeAckObject.txt	Acknowledgement envelope conversion for signature creation	7.3.4
upload\compressed\UploadObject.json	Upload request object compressed	Table 16
upload\compressed\ SignatureEnvelopeUploadObject.txt	Upload envelope conversion for signature creation	7.3.4
upload\protected\ UploadObjectRequest.json	Upload request object protected	Table 16
upload\protected\ SignatureEnvelopeUploadObject.txt	Upload envelope conversion for signature creation	7.3.4
upload\protected\ EncryptionKeyRequest.json	EncryptionKey request object	Table 72
upload\protected\ SignatureEnvelopeKeyObject.txt	EncryptionKey envelope conversion for signature creation	7.3.4
upload\protected\ Ack_technicalRequest.json	Acknowledgement request, delivered ack	Table 24
upload\protected\ Ack_operationalRequest.json	Acknowledgement request, opened ack	Table 24
upload\protected\ SignatureEnvelopeAckObject.txt	Acknowledgement envelope conversion for signature creation	7.3.4
upload\link\open\UploadLinkObjRequest.json	UploadLink request object	Table 20
upload\link\open\SignatureEnvelopeLinkObject.txt	UploadLink envelope conversion for signature creation	7.3.4
upload\link\open\Ack_technicalRequest.json	Acknowledgement request, delivered ack	Table 24
upload\link\open\Ack_operationalRequest.json	Acknowledgement request, opened ack	Table 24
upload\link\open\SignatureEnvelopeAckObject.txt	Acknowledgement envelope conversion for signature creation	7.3.4
upload\link\compressed\UploadLinkObjRequest.json	UploadLink request object compressed	Table 20
upload\link\compressed\SignatureEnvelopeLinkObject.txt	UploadLink envelope conversion for signature creation	7.3.4
upload\link\protected\ UploadObjectRequest.json	UploadLink request object protected	Table 20
upload\link\protected\ SignatureEnvelopeUploadObject.txt	UploadLink envelope conversion for signature creation	7.3.4
upload\link\protected\ EncryptionKeyRequest.json	EncryptionKey request object	Table 72
upload\link\protected\ SignatureEnvelopeKeyObject.txt	EncryptionKey envelope conversion for signature creation	7.3.4
upload\dataSet.s421.xml	Payload data used in tests including transfer of data	Table 8

Download test		
File	**Description**	**Defintion**
download\dataset.s421_a.xml	Published information dataset a	Table 8
download\dataset.s421_b.xml	Published information dataset b	Table 8
download\dataset.s421_c.xml	Published information dataset c	Table 8
download\open\GetSummaryQuery.txt	GetSummary request	Table 35
download\open\GetSummaryResponse.json	GetSummary response object	Table 36
download\open\GetQuery-2a41c736-9004-4622-a170-1e9b3764de82.txt	Get request query	Table 31
download\open\GetResponse-2a41c736-9004-4622-a170-1e9b3764de82.json	Get response object	Table 32
download\open\GetQuery-cb0c1b4d-1348-4d68-b037-ca2eb1569512.txt	Get request	Table 31
download\open\GetResponse-cb0c1b4d-1348-4d68-b037-ca2eb1569512.json	Get response object	Table 32
download\open\GetQuery-ea7c7ac3-4a18-499e-aefd-c587fa3f399d.txt	Get request	Table 31
download\open\GetResponse-ea7c7ac3-4a18-499e-aefd-c587fa3f399d.json	Get response object	Table 32
download\compressed\GetSummaryQuery.txt	GetSummary request	Table 35
download\compressed\GetSummaryResponse.json	GetSummary response object	Table 36
download\compressed\GetQuery-5d43d57d-b07d-4ff9-aece-d60ab622af14.txt	Get request	Table 31
download\compressed\GetResponse-5d43d57d-b07d-4ff9-aece-d60ab622af14.json	Get response object	Table 32
download\compressed\GetQuery-21b801f8-6b64-469e-a2ab-bb57a7b38602.txt	Get request	Table 31
download\compressed\GetResponse-21b801f8-6b64-469e-a2ab-bb57a7b38602.json	Get response object	Table 32
download\compressed\GetQuery-ecd5ad61-5e7b-4c08-bad3-f0ca93762c38.txt	Get request	Table 31
download\compressed\GetResponse-ecd5ad61-5e7b-4c08-bad3-f0ca93762c38.json	Get response object	Table 32
download\protected\GetSummaryQuery.txt	GetSummary request	Table 35
download\protected\GetSummaryResponse.json	GetSummary response object	Table 36
download\protected\EncryptionKeyRequest.json	Get EncryptionKey request object	Table 74
download\protected\SignatureEnvelopeKeyRequestObject.txt	EncryptionKey envelope conversion for signature creation	7.3.4
download\protected\EncryptionKeyRequest.json	EncryptionKey request object	Table 72
download\protected\SignatureEnvelopeKeyObject.txt	EncryptionKey envelope conversion for signature creation	7.3.4
download\protected\GetQuery.txt	Get request	Table 31
download\protected\GetResponse.json	Get response object	Table 32
download\openedAck\GetSummaryQuery.txt	GetSummary request	Table 35
download\openedAck\GetSummaryResponse.json	GetSummary response object	Table 36
download\openedAck\GetQuery,txt	Get request	Table 31
download\openedAck\GetResponse.json	Get response object	Table 32
download\openedAck\Ack_operationalRequest.json	Acknowledgement request, opened ack	Table 24
download\openedAck\Signature-EnvelopeAckObject.txt	Acknowledgement envelope conversion for signature creation	7.3.4

Common		
File	**Description**	**Defintion**
auth\environment.json	Example of environment setup for two SECOM information service instances	n/a
auth\Keystore_secomtest01.p12	Server certificate for SECOM instance #1	n/a
auth\Keystore_secomtest02.p12	Server certificate for SECOM instance #2	n/a
auth\SECOM_IdReg.crt	Intermediate certificate from PKI provider	n/a
auth\SECOM_Root.crt	Root certificate from PKI provider	n/a

11.4.2 Prerequisites SECOM ship/shore EUT

Ship/Shore equipment according to Clause F.3.

The following are prerequisites for a ship/shore EUT to be able to perform tests:

- means for validating X.509 certificate;
- means for verifying digital signatures according to 7.3.5 and 7.3.6;
- means for creating digital signatures according to 7.3.3 and 7.3.4;
- means for data protection according to 7.5;
- means for data compression according to 7.2.

11.4.3 Upload data

11.4.3.1 Actors

Ship/shore sender EUT – Ship/shore receiver EUT

11.4.3.2 Testdata

The related folders are:

- upload\open\
- upload\compressed\
- upload\protected\
- upload\link\open\
- upload\link\compressed\
- upload\link\protected\
- auth.zip

11.4.3.3 Method

Table 115 contains the test execution steps.

Table 115 – Upload test method steps

Step	Applicable for sender EUT	Applicable for receiver EUT
1	Use the simulator or test arrangements as the EUT to export an UploadObject message as a single message. Confirm by observation that the data attribute in Table 16 is encoded as Base64 and that the size does not exceed 350 kB. If provided, confirm by the analytical evaluation that data is compressed successfully. If provided, confirm by the analytical evaluation that the data is encrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7. Confirm by observation that the Upload message is set with fromSubscription. If provided, confirm by analytical evaluation that the envelopeRootCertificateThumbprint is encoded according to X.509. Confirm by observation that the remaining attributes are encoded and set according to Table 16.	Use the simulator or test arrangements as the EUT to import an Upload message. Confirm by observation that the UploadObject message is valid. Confirm by observation that the envelope certificate is valid and confirm by observation that the envelopeSignature is processed and that the envelopeSignature is verified. If provided, confirm by analytical evaluation that the data is decrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7. If provided, confirm by the analytical evaluation that the data is decompressed successfully. Confirm by observation that the publicCertificate attribute in the DigitalSignatureValueObject in Table 5 is valid and confirm by observation that the digital dataSignature is processed and verified correctly. Confirm by observation that the dataProductType can be validated against its schema (XSD). Confirm by observation that the decompressed, decrypted data can be processed and viewed successfully.
2	Import the acknowledgement message to the EUT and confirm by observation that the acknowledgement is processed correctly with a valid transaction identifier and that there is an indication with invalid acknowledgement.	If attribute ackRequest from Table 10 is equal to 2 or 3: Confirm by observation that Opened Acknowledgement message is exported with a valid transaction identifier. (for acknowledgement test, see 11.5.5)

11.4.4 Download data

11.4.4.1 Prerequisites

The download occurs in two steps: get a list of published messages (request to Get Summary) and select one of the received messages as input to interface Get request.

When downloading protected data, refer to 5.7.15.4 and specifically Figure 41.

11.4.4.2 Actors

Ship/Shore data consumer EUT – Ship/Shore data producer EUT.

11.4.4.3 Testdata

The related folders are:

- download\open\
- download\compressed\
- download\protected\
- download\openedAck\
- auth.zip

11.4.4.4 Method

Table 116 contains the test execution steps.

Table 116 – Download test method steps

Step	Applicable for data consumer EUT	Applicable for data producer EUT
0	Use the simulator or test arrangement to perform a (simulated) GetSummary request with no optional parameters.	Use the test data to prepare a set of published messages encoded as for example S100_DataSet S421 If provided, confirm by the analytical evaluation that data is compressed successfully. If provided, confirm by the analytical evaluation that the data is encrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7.
1	Use the simulator or test arrangements as the EUT to import a GetSummaryResponseObject message.	Use the simulator or test arrangements as the EUT to export a GetSummaryResponseObject message from Table 36.
2	Use the simulator or test arrangements as the EUT to select one SummaryObject from the GetSummaryResponseObject and observe the value of the dataReference attribute.	
3	Use the simulator or test arrangement to perform a (simulated) Get request with selected attribute dataReference from step 2.	
4	Use the simulator or test arrangements as the EUT to import a GetResponseObject message. Confirm by observation that the GetResponseObject message is valid. Confirm by observation that the envelope certificate is valid and confirm by observation that the envelopeSignature is processed and that the envelopeSignature is verified. If provided, confirm by the analytical evaluation that the data is decrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7. If provided, confirm by the analytical evaluation that the data is decompressed successfully. Confirm by observation that the publicCertificate attribute in the DigitalSignatureValueObject in Table 5 is valid and confirm by observation that the digital dataSignature is processed and verified correctly. Confirm by observation that the dataProductType can be validated against its schema (XSD). Confirm by observation that the decompressed, decrypted data can be processed and viewed successfully.	Use the simulator or test arrangements as the EUT to export a GetResponseObject message as a single message and confirm by observation that the attributes are encoded according to Table 32.
5	If attribute ackRequest from Table 10 is equal to 2 or 3, confirm by observation that Opened Acknowledgement message is exported with a valid transactionId. (for Acknowledgement test, see 11.5.5)	Import the acknowledgement message to the EUT and confirm by observation that the acknowledgement is processed correctly with a valid transaction identifier and that there is an indication with invalid acknowledgement.

11.5 SECOM Information Service test

11.5.1 General

This test describes message exchange between a SECOM consumer client and a SECOM information service instance EUT. Hence, the EUT in focus are the SECOM information service operation interfaces where all test methods terminate inside the EUT. For each interface test, there is a corresponding set of test data available. The test data is found in the interface.zip archive where the payload json file naming reflects the operation under test, see Table 117.

Table 117 – Test data reference

File	Test	Description	Defintion
interface\accessRequest.json	11.5.3.2	Access request object	Table 43
interface\accessResponse.json	11.5.3.2	Access response object	Table 44
interface\accessNotificationRequest.json	11.5.4.2	Access notification request object	Table 45
interface\accessNotificationResponse.json	11.5.4.2	Access notification response object	Table 49
interface\ Ack_technicalRequest.json	11.5.5.3	Acknowledgement request, delivered ack	Table 24
interface\ Ack_operationalRequest.json	11.5.5.3	Acknowledgement request, opened ack	Table 24
interface\capabilityResponse.json	11.5.6.2	Capability response object	Table 66
interface\EncryptionKeyRequest.json	11.5.7.3	EncryptionKey request object	Table 72
interface\Signature-EnvelopeKeyObject.txt	11.5.7.3	EncryptionKey envelope conversion for signature creation	7.3.4
interface\GetEncryptionKeyRequest.json	11.5.8.3	Get EncryptionKey request object	Table 72
interface\Signature-EnvelopeKeyRequestObject.txt	11.5.8.3	EncryptionKey envelope conversion for signature creation	7.3.4
interface\GetQuery.txt	11.5.9.3	Get request query	Table 31
interface\GetResponse.json	11.5.9.3	Get response object	Table 32
interface\GetSummaryQuery.txt	11.5.11.3	GetSummary request query	Table 35
interface\GetSummaryResponse.json	11.5.11.3	GetSummary response object	Table 36
interface\GetByLinkQuery.txt	11.5.10.3	GetByLink request query	Table 39
interface\GetByLinkResponse.bin	11.5.10.3	GetByLink response object	Table 40
interface\publicKeyRequest.txt	11.5.12.2	GetPublicKey query	Table 81
interface\publicKeyResponse.json	11.5.12.2	GetPublicKey response object	Table 82
interface\ping.json	11.5.14.2	Ping response object	Table 69
interface\subscriptionRequest.json	11.5.15.3	Subscription request object	Table 52
interface\subscriptionResponse.json	11.5.15.3	Subscription response object	Table 53
interface\subscriptionNotificationCreatedRequest	11.5.16.2	Subscription Notification request object for created	Table 60
interface\subscriptionNotificationCreatedResponse	11.5.16.2	Subscription Notification response object for created	Table 61
interface\subscriptionNotificationDeletedRequest	11.5.16.2	Subscription Notification request object for deleted	Table 60
interface\subscriptionNotificationDeletedResponse	11.5.16.2	Subscription Notification response object for deleted	Table 61
interface\subscriptionRemoveRequest	11.5.17.3	Remove Subscription request object	Table 56
interface\subscriptionRemoveResponse	11.5.17.3	Remove Subscription response object	Table 57
interface\uploadObject.json	11.5.18.2	Upload request object	Table 16
interface\uploadLinkObject.json	11.5.19.2	UploadLink request object	Table 20

File	Test	Description	Defintion
interface\dataSet.s421.xml		Payload data used in tests including transfer of data	Table 8
auth\environment.json	all	Example of environment setup for two SECOM information service instances	n/a
auth\Keystore_secomtest01.p12	all	Server certificate for SECOM instance #1	n/a
auth\Keystore_secomtest02.p12	all	Server certificate for SECOM instance #2	n/a
auth\SECOM_IdReg.crt	all	Intermediate certificate from Pki provider	n/a
auth\SECOM_Root.crt	all	Root certificate from Pki provider	n/a
swagger\SECOM_Information_Service_Interface.json	all	SECOM REST Api definition	Clause A.2

11.5.2 Prerequisites SECOM information service EUT

SECOM information service equipment according to Clause F.4. The following are prerequisites for a SECOM service instance to be able to perform tests.

- Instance shall be registered in an identity registry simulated or real.
- Instance shall be registered in a service registry simulated or real.
- Instance shall have access to an agreed SECOM compliant PKI simulated or real.
- Instance shall have a valid SECOM PKI compliant certificate simulated or real.
- Instance shall be implemented according to OpenAPI definition in Annex A.2.
- Instance communication applies to Clause 6.
- Instance request is authenticated according to 4.3.1.
- A web client for consuming the SECOM instance REST API.
- A web client HTTP request header that contains a valid TLS certificate.

The following tests are required before the information service test is performed.

- Confirm by observation that all REST messages are defined as OpenAPI format as in Clause A.2.
- Confirm by observation that all service interfaces includes the correct version as specified in Table 2.

11.5.3 Access

11.5.3.1 Test data

The related files are:

- interface\accessRequest.json
- interface\accessResponse.json

11.5.3.2 Method

Table 118 contains the test execution steps.

Table 118 – Access test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send an Access message. Confirm by observation that all attributes in Table 42 are provided. Confirm by observation that the client can perform a request to "Access" interface.	Use the simulator or test arrangements as the EUT to receive an Access message and confirm by observation that the message is verified and processed correctly.
2	Import the response message to the client and confirm by observation that response was processed correctly in addition to the HTTP code and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code.

11.5.4 Access notification

11.5.4.1 Test data

The related file is:

- interface\accessNotification.json

11.5.4.2 Method

Table 119 contains the test execution steps.

Table 119 – Access Notification test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send an Access Notification message as a single message. Confirm by observation that all attributes in Table 47 are provided. Confirm by observation that the client can perform a request to "Access Notification" interface.	Use the simulator or test arrangements as the EUT to import an Access Notification message and confirm by observation that the message is verified and processed correctly.
2	Import the response message to the client and confirm by observation that response was processed correctly in addition to the HTTP code and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code.

11.5.5 Acknowledgement

11.5.5.1 Prerequisites

One of test cases 11.5.10, 11.5.18 or 11.5.19 has been performed with the attribute ackRequest not set to 0 (no ack requested).

11.5.5.2 Test data

The related files are:

- interface\Ack_technicalRequest.json
- interface\Ack_operationalRequest.json

11.5.5.3 Method

Table 120 contains the test execution steps.

Table 120 – Acknowledgement test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send an Acknowledgement message object as a single message. Confirm by observation that all attributes in Table 24 are provided. Confirm by observation that the client can perform a request to "Acknowledgement" interface.	Use the simulator or test arrangements as the EUT to import an Acknowledgement message and confirm by observation that the message is verified and processed correctly. Confirm by observation that the envelopeCertificate is valid. Confirm by observation that the digitalSignature is valid. Confirm by observation that createdAt is later than the transaction time of the related payload exchange. Confirm by observation that the transactionIdentifier correlates with the related payload exchange. Confirm by observation that the ackType is as expected. Confirm by observation that the envelopeSignatureTime is within an acceptable time limit regarding the related payload exchange.
2	Import the response message to the client and confirm by observation that response was processed correctly in addition to the HTTP code and that there is an indication of the error message if provided.	Confirm by observation that the AcknowledgementResponseObject from Table 26 response message is exported with correct HTTP code and if error, a correct SECOM_ResponseCode from Table 9 value is set.

11.5.6 Capability

11.5.6.1 Test data

The related file is:

- interface\capabilityResponse.json

11.5.6.2 Method

Table 121 contains the test execution steps.

Table 121 – Capability test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send a Capability request message. Confirm by observation that the client can perform a request to data producer's "Capability" interface.	Use the simulator or test arrangements as the EUT to import a Capability get request message and confirm by observation that the message is verified and processed correctly. Confirm by observation that the response message is built according to Table 65
2	Import the CapabilityResponseObject response message to the client and confirm by observation that response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code

11.5.7 EncryptionKey

11.5.7.1 Prerequisites

Data producer has created a temporary encryption key and an initialization vector according to 7.5.3. Data producer has protected the information using the temporary encryption key and the initialization vector. Data producer has received the data consumer's public certificate. Data producer has sent/will send protected information to consumer.

11.5.7.2 Test data

The related files are:

- interface\EncryptionKeyRequest.json
- interface\Signature-EnvelopeKeyObject.txt

11.5.7.3 Method

Table 122 contains the test execution steps.

Table 122 – EncryptionKey test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Confirm by observation that the encryption of the temporary encryption key is according to 7.5.3 using the consumer's public certificate. Confirm by observation that all attributes in the EnvelopeKeyObject in Table 71 are encoded correctly. Confirm by observation that the digitalSignature is created according to 7.3.3. Confirm by observation that the envelopeSignature is created according to 7.3.4. Use the simulator or test arrangements as client to send an EncryptionKeyObject message as a single message. Confirm by observation that the client can perform a request to data producer's "EncryptionKey" interface.	Use the simulator or test arrangements as the EUT to import an EncryptionKeyObject message and confirm by observation that the message is verified and processed correctly. Confirm by observation that the received public certificate is valid. Confirm by observation that the received envelope certificate is valid. Confirm by observation that the received envelopeSignature is valid. Confirm by observation that the received digitalSignature is valid. Verify decryption of the encryption key according to 7.5.5.
2	Import the response message to the client and confirm by observation that response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code.

11.5.8 EncryptionKey Notification

11.5.8.1 Prerequisites

Data producer has published protected information. Data producer has stored the related temporary encryption key. Message retrieved according to test case in 11.5.11 and attribute dataProtection = true.

11.5.8.2 Test data

The related files are:

- interface\EncryptionKeyNotificationRequest.json
- interface\Signature-EnvelopeKeyNotificationObject.txt
- auth.zip

11.5.8.3 Method

Table 123 contains the test execution steps.

Table 123 – EncryptionKey notification test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send a request EncryptionKeyNotificationObject message as a single message. Confirm by observation that all attributes in Table 72 are encoded correctly. Confirm by observation that the client can perform a request to data producer's "EncryptionKey" interface.	Use the simulator or test arrangements as the EUT to import an EncryptionKeyNotificationObject message and confirm by observation that the message is verified and processed correctly. Confirm by observation that the received public certificate is valid. Confirm by observation that the received envelopeSignature is valid. Confirm by observation that the dataReference relates to the previously stored temporary encryption key.
2	Import the response message to the client and confirm by observation that response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code.
3		Confirm by observation that a separate work process is activated, using the stored temporary key, initialization vector, consumer's public certificate and dataReference to build an EncryptionKeyObject. Proceed according to 11.5.7.

11.5.9 Get

11.5.9.1 Prerequisites

Data producer has published information accessible for consumer. Client has consumed data producer's SECOM information service endpoint "Get Summary" according to 11.5.11 and received a reference to the accessible data to be downloaded.

11.5.9.2 Test data

The related files are:

- interface\GetQuery.txt
- interface\GetResponse.json
- auth.zip

11.5.9.3 Method

Table 124 contains the test execution steps.

Table 124 – Get test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements to import a request URL with parameter values according to Table 30. Confirm by observation that all attributes included in the input query are encoded as expected. Confirm by observation that the attribute dataReference from "Get Summary" response is set. Confirm by observation that the client can perform a request to data producer's "Get" interface.	Use the simulator or test arrangements as the EUT to receive, interpret and validate a GET query and find the related published data. Confirm by observation that the response message is built according to Table 31.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the error message if provided. If data protection is provided, confirm by the observation that the data is decrypted correctly. If the encryption key needed for decryption is not available, get the encryption key according to 11.5.8. Confirm by observation that the encryption key related to the protected data has been uploaded. Confirm by observation that the data is decrypted successfully. If data is compressed, confirm by observation that data is uncompressed successfully. The decrypted and/or decompressed data can now be used to validate the data digital signature according to 7.3.5. If any errors, confirm by observation that acknowledgement is requested by the data producer and if so, send a "Not acknowledged ack" according to 11.5.5. If provided, confirm by observation that the pagination information is processed correctly.	Confirm by observation that the response message is exported with correct HTTP code. If provided, confirm by observation that EUT sends the first page when the page parameter is not present or maximum number of items per page when pageSize is not present or no items when the page parameter is set to 0.

11.5.10 Get By Link

11.5.10.1 Prerequisites

Data producer has published data files exceeding 350 kB. Data producer has uploaded a link using data consumer's SECOM service interface UploadLink.

11.5.10.2 Test data

The related files are:

- interface\GetByLinkQuery.txt
- interface\GetByLinkResponse.bin
- auth.zip

11.5.10.3 Method

Table 125 contains the test execution steps.

Table 125 – Get By Link test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements to import a query according to Table 38. Confirm by observation that the attribute transactionIdentifier is encoded as required. Confirm by observation that the client can perform a request to the data producer's "Get by Link" interface.	Use the simulator or test arrangements as the EUT to receive, interpret and validate a "Get by Link" query and find the related published data. Confirm by observation that the published data is added to the response object according to Table 39.
2	Import the response message to the client and confirm by observation that response was processed correctly and that there is an indication of the error message if provided. If data protection is provided, confirm by observation that the data is decrypted correctly. If the encryption key needed for decryption is not available, get the encryption key according to 11.5.8. Confirm by observation that the encryption key related to the protected data has been uploaded. Confirm by observation that the data is decrypted successfully. If data is compressed, confirm by observation that data is uncompressed successfully. The decrypted and/or decompressed data can now be used to validate the data digital signature according to 7.3.5. If any errors, confirm by observation that acknowledgement is requested by data producer and if so, send a "Not acknowledged ack" according to 11.5.5.	Confirm by observation that the response message is exported with correct HTTP code.

11.5.11 Get Summary

11.5.11.1 Prerequisites

Data producer has published information accessible for consumer

11.5.11.2 Test data

The related files are:

- interface\GetSummaryQuery.txt
- interface\GetSummaryResponse.json
- auth.zip

11.5.11.3 Method

Table 126 contains the test execution steps.

Table 126 – Get Summary test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to import a request URL with parameter values according to Table 34. Confirm by observation that all attributes included in the input query are encoded as expected. Confirm by observation that the client can perform a request to "Get Summary" interface.	Use the simulator or test arrangements as the EUT to receive, interpret and validate a "Get Summary" query and finds the related published meta-data. Confirm by observation that the response message is built according to Table 35.
2	Receives the response message and confirm by observation that the response was processed correctly and that there is an indication of the error message if provided. If provided, confirm by observation that the pagination information is processed correctly.	Confirm by observation that the response message is sent with correct HTTP code. If provided, confirm by observation that the EUT sends the first page when the page parameter is not present or maximum number of items per page when pageSize is not present or no items when the page parameter is set to 0.

11.5.12 Get Public Key

11.5.12.1 Test data

The related files are:

- interface\publicKeyRequest.txt
- interface\publicKeyResponse.json
- auth.zip

11.5.12.2 Method

Table 127 contains the test execution steps.

Table 127 – Get Public Key test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as the client to send a Get Public Key message and confirm by observation that the message is encoded as in Table 78.	Use the simulator or test arrangements as the EUT to receive a Get Public Key message and confirm by observation that the message is processed correctly. Confirm by observation that the response message is built according to Table 79.
2	Receives the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and the requested public key is included.

11.5.13 Upload Public Key

11.5.13.1 Test data

The related files are:

- interface\publicKeyRequest.json
- auth.zip

11.5.13.2 Method

Table 128 contains the test execution steps.

Table 128 – Upload Public Key test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as the client to upload a Public Key message and confirm by observation that the message is encoded as in Table 79.	Use the simulator or test arrangements as the EUT to receive a Public Key message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and the requested public key is included.

11.5.14 Ping

11.5.14.1 Test data

The related files are:

- interface\ping.json
- auth.zip

11.5.14.2 Method

Table 129 contains the test execution steps.

Table 129 – Ping test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to post a Ping request message.	Use the simulator or test arrangements as the SECOM Ping interface to receive and interpret a Ping request.
2	Import the Ping response message to the client and confirm by observation that response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code and proper attributes according to Table 68.

11.5.15 Subscription

11.5.15.1 Prerequisites

This test methods only covers the related operations for the subscription interface. For the test for actual data transfer with the subscription, see the test methods in each operation.

11.5.15.2 Test data

The related files are:

- interface\subscriptionRequest.json
- interface\subscriptionResponse.json
- auth.zip

11.5.15.3 Method

Table 130 contains the test execution steps.

Table 130 – Subscription test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as the client to send a Subscription message as a single message. Confirm by observation that the message is encoded as defined in Table 51.	Use the simulator or test arrangements as the EUT to receive a Subscription message and confirm by observation that the message is verified and processed correctly.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is exported with correct HTTP code and proper attributes in ResponseSubsciptionObject. Confirm by observation that an active subscription list is available.

11.5.16 Subscription Notification

11.5.16.1 Test data

The related files are:

- interface\subscriptionNotificationCreatedRequest.json
- interface\subscriptionNotificationCreatedResponse.json
- interface\subscriptionNotificationDeletedRequest.json
- interface\subscriptionNotificationDeletedResponse.json
- auth.zip

11.5.16.2 Method

Table 131 contains the test execution steps.

Table 131 – Subscription Notification test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Confirm by observation that client sends a Subscription Notification message with proper subscriptionIdentifier and eventEnum value according to Table 59.	Receive the subscription Notification message to the EUT and confirm by observation that message was processed correctly.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is sent with correct HTTP code and proper attributes in ResponseSubsciptionNotificationObject

11.5.17 Remove Subscription

11.5.17.1 Prerequistes

An active subscription exists

11.5.17.2 Test data

The related files are:

- interface\subscriptionRemoveRequest.json
- interface\subscriptionRemoveResponse.json
- auth.zip

11.5.17.3 Method

Table 132 contains the test execution steps.

Table 132 – Remove Subscription test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as client to send a Remove Subscription message with proper subscription identifier as a single message. Confirm by observation that the message is encoded as defined in Table 55.	Use the simulator or test arrangements as the EUT to receive a Remove Subscription message and confirm by observation that the message is verified and processed correctly.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the error message if provided.	Confirm by observation that the response message is sent with correct HTTP code and proper attributes in ResponseRemoveSubsciptionObject. Confirm by observation that the removed subscription was deleted from an active subscription list.

11.5.18 Upload

11.5.18.1 Test data

The related files are:

- interface\UploadObject.json
- auth.zip

11.5.18.2 Method

Table 133 contains the test execution steps.

Table 133 – Upload test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements as the client to import an UploadObject message as a single message. Confirm by observation that the data attribute in Table 16 is encoded as Base64 and that the size does not exceed 350 kB. If provided, confirm by analytical evaluation that the data is encrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7. If provided, confirm by analytical evaluation that data is compressed successfully. Confirm by observation that the Upload message is set with fromSubscription. If provided, confirm by analytical evaluation that the envelopeRootCertificateThumbprint is encoded according to X.509. Confirm by observation that the remaining attributes are encoded and set according to Table 16. Confirm by observation that the HTTP request header contains a valid certificate. Confirm by observation that the client can perform a request to SECOM information service "Upload" interface.	Use the simulator or test arrangements as the EUT to receive an Upload message. Confirm by observation that the UploadObject message is valid. Confirm by observation that the dataProductType is as expected. If not, return status code 501. Confirm by observation that the client certificate is valid. Confirm by observation that the envelope certificate is valid and confirm by observation that the envelopeSignature is processed and that the envelopeSignature is verified.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided.	Confirm by observation that the response message is sent with correct HTTP code and SECOM_ResponseCodeEnum as specified in Table 9.

11.5.19 Upload Link

11.5.19.1 Test data

- interface\UploadLinkObj.json
- auth.zip

11.5.19.2 Method

Table 134 contains the test execution steps.

Table 134 – Upload Link test method steps

Step	Applicable for SECOM client	Applicable for SECOM service EUT
1	Use the simulator or test arrangements with at least three large files of at least 2 MB and select a file as the client to send an Upload Link message as a single message. Confirm by observation that the data attribute in Table 20 is encoded as Base64. If provided, confirm by analytical evaluation that the data is encrypted correctly with the encryption algorithm and that the temporary encryption key is shared according to 11.5.7. If provided, confirm by analytical evaluation that data is compressed successfully. If provided, confirm by observation that the Upload message is set with fromSubscription. If provided, confirm by analytical evaluation that the envelopeRootCertificateThumbprint is encoded according to X.509. Confirm by observation that the remaining attributes are encoded and set according to Table 20. Confirm by observation that the client can perform a request to the "Upload Link" interface.	Use the simulator or test arrangements as the EUT to import an UploadLink message and confirm by observation that the message is verified and processed correctly. Confirm by observation that the UploadObjectLink message is valid. Confirm by observation that the dataProductType is as expected. If not, return status code 501. Confirm by observation that the client certificate is valid. Confirm by observation that the envelope certificate is valid and confirm by observation that the envelopeSignature is processed and that the envelopeSignature is verified.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided.	Confirm by observation that the response message is exported with correct HTTP code and SECOM_ErrorCode as specified in Table 8.

11.6 SECOM PKI Service test

11.6.1 Prerequisites PKI EUT

SECOM PKI equipment according to Clause F.5.

The following are prerequisites for SECOM PKI instance to be able to perform tests.

- SECOM PKI instance shall have a valid trusted SSL certificate.
- SECOM PKI instance shall be implemented according to OpenAPI definition in Clause A.3.
- SECOM PKI instance containing a CRL in accordance with RFC 5280.
- At least one scheme administrator which includes a private/public key pair and contains self-signed public key.
- At least one data server which generates its public and private key pair and produces digital signature of the data, refer to 8.3.
- At least three data clients which generate their public and private key pair and produce digital signature of the data.
- Instances communication applies to Clause 6.
- Instance request is authenticated according to 4.3.1.
- A web client for consuming the SECOM instance REST API.
- A web client HTTP request header that contains a valid TLS certificate.

11.6.2 CRL

11.6.2.1 Test data

The related files are:

- pki\Request_CRL.txt
- pki\Response_CRL,txt
- pki\Response_CRL_PemDecoded.txt
- pki\Response_CRL_PemEncoded.txt

11.6.2.2 Method

Table 135 contains the test execution steps.

Table 135 – CRL test method steps

Step	Applicable for SECOM client	Applicable for SECOM PKI EUT
1	Use the simulator or test arrangements as the client to invoke a CRL request with CRL request message and confirm by observation that the message includes mandatory attributes in Table 98 as described in RFC 5280.	Use the simulator or test arrangements as the EUT to receive a CRL request message and confirm by observation that the message is processed correctly.
2	Receives the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided together with a PEM encoded CRL.	Confirm by analytical evaluation that the response message (CRL) is sent with correct HTTP code.

11.6.3 OCSP

11.6.3.1 Test data

The related folder is:

- pki\ocsp*

11.6.3.2 Method

Table 136 contains the test execution steps.

Table 136 – OCSP test method steps

Step	Applicable for SECOM client	Applicable for SECOM Pki EUT
1	Use the simulator or test arrangements as the client to invoke a OCSP request with OCSP request message and confirm by observation that the message includes mandatory attributes in as described in RFC 6960.	Use the simulator or test arrangements as the EUT to receive a OCSP request message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that the response was processed correctly and that there is an indication of the response message if provided.	Confirm by analytical evaluation that the response message (OCSP-response) is sent with correct HTTP code.

11.6.4 Revoke

11.6.4.1 Test data

The related files are:

- pki\Request_CertificateRevocation.txt
- pki\Response_CertificateRevocation.json

11.6.4.2 Method

Table 137 contains the test execution steps.

Table 137 – Revoke test method steps

Step	Applicable for SECOM client	Applicable for SECOM Pki EUT
1	Use the simulator or test arrangements as the client to invoke a Revoke request with a certificate revoke message and confirm by observation that the message includes mandatory attributes as described in Table 104.	Use the simulator or test arrangements as the EUT to receive a certificate revocation request message and confirm by observation that the message is processed correctly.
2	Use the simulator or test arrangements as the client to receive a certificate revocation response message and confirm by observation that the message is processed correctly.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and corresponding message.

11.6.5 CSR

11.6.5.1 Test data

The related file is:

- pki\csr-example.txt

11.6.5.2 Method

Table 138 contains the test execution steps.

Table 138 – CSR test method steps

Step	Applicable for SECOM client	Applicable for SECOM Pki EUT
1	Use the simulator or test arrangements as the client to invoke a CSR request with a CSR message and confirm by observation that the message includes mandatory attributes in Table 90 according to PKCS #10 described in RFC 2986. Refer to 8.4.	Use the simulator or test arrangements as the EUT to receive a CSR request message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that response was processed correctly and that there is an indication of the response message if provided.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and public key is signed accordingly.

11.6.6 GetPublicKey

11.6.6.1 Test data

- pki\RequestPublicKey.txt
- pki\ResponsePublicKeyPemDecoded.txt
- pki\ResponsePublicKeyPemEncoded.txt

11.6.6.2 Method

Table 139 contains the test execution steps.

Table 139 – GetPublicKey test method steps

Step	Applicable for SECOM client	Applicable for SECOM Pki EUT
1	Use the simulator or test arrangements as the client to invoke a GetPublicKey request with a GetPublicKey message and confirm by observation that the message includes the serial number of the claimed public key as defined in Table 94.	Use the simulator or test arrangements as the EUT to receive a GetPublicKey request message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that response was processed correctly and that there is an indication of the response message if provided. Verify the GetPublicKeyResponseObject by examining the received PEM decoded public certificate.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and the requested public key in PEM format is included.

11.7 SECOM Service Discovery test

11.7.1 General

Service Discovery equipment according to Clause F.6. This interface caters for searching a Service Registry by combining query parameters separated by and/or together with possible geometry search criteria; an example is provided in Clause D.7.

11.7.2 Prerequisites Service Discovery EUT

The following are prerequisites for SECOM Service Discovery instance to be able to perform the tests.

- Confirm by observation that all REST messages are defined as OpenAPI format as in Annex A.
- Confirm by observation that all service interfaces include the correct version as specified in Table 2.
- EUT Instance shall be implemented according to OpenAPI definition in Clause A.4.
- SECOM client instance shall be registered in an identity registry simulated or real.
- SECOM client instance shall be registered in a service registry simulated or real.
- SECOM client instance shall have access to an agreed SECOM compliant PKI simulated or real.
- SECOM client instance shall have a valid SECOM PKI compliant certificate simulated or real.
- A web client for consuming the SECOM instance REST API.
- A web client HTTP request header that contains a valid TLS certificate.

11.7.3 Search service – By geometry

11.7.3.1 Test data

The related files are:

- serviceDiscovery\Request_SearchService_geometry.txt
- serviceDiscovery\Response_SearchService_geometry.txt

11.7.3.2 Method

Table 140 contains the test execution steps.

Table 140 – Search service by geometry test method steps

Step	Applicable for SECOM client	Applicable for SECOM Service discovery EUT
1	Use the simulator or test arrangements as the client to invoke a Search request with a SearchFilterObject message as a single message. Confirm by observation that the attributes in Table 109 are encoded as specified. Specify a geometry search according to WKT geometry, see Table 12.	Use the simulator or test arrangements as the EUT to receive a Search request with a search message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that response was processed correctly and that there is a response message according to ResponseSearchObject together with expected HTTP code and message. Expected response shall be all registered service instances in the service registry with coverage area according to the provided geometry search parameter.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and correct list of service instance information accordingly.

11.7.4 Search service – Without specified search criteria

11.7.4.1 Test data

The related files are:

- serviceDiscovery\Request_SearchService_empty.txt
- serviceDiscovery\Response_SearchService_empty.txt

11.7.4.2 Method

Table 141 contains the test execution steps.

Table 141 – Search service empty query test method steps

Step	Applicable for SECOM client	Applicable for SECOM Service discovery EUT
1	Use the simulator or test arrangements as the client to invoke a Search request with a SearchFilterObject message as a single message. Confirm by observation that the attributes in Table 109 are encoded as specified. Ensure that no search criteria is provided in the SearchFilterObject.	Use the simulator or test arrangements as the EUT to receive a Search request with a search message and confirm by observation that the message is processed correctly.
2	Receive the response message and confirm by observation that response was processed correctly and that there is a response message according to ResponseSearchObject together with expected HTTP code and message. Expected response shall be all registered service instances in the service registry.	Confirm by analytical evaluation that the response message is sent with correct HTTP code and correct list of service instance information accordingly.

Annex A
(normative)

REST service interface definitions

A.1 Purpose

Annex A describes the formal definitions of the SECOM service interfaces in OpenAPI[1] format. The json files are available at http://cirm.org/secom.

A.2 SECOM information service REST interface definition

The OpenAPI file is available at swagger\SECOM_Information_Service_Interface.json

A.3 SECOM PKI service REST interface definition

The OpenAPI file is available at swagger\SECOM_PKI_Interface.json

A.4 SECOM discovery service REST interface definition

The OpenAPI file is available at swagger\SECOM_Service_Discovery_Interface.json

[1] The OpenAPI Specification (OAS) defines a standard, language-agnostic interface to RESTful APIs https://swagger.io/.

Annex B
(informative)

Operational use cases and profiles

B.1 Purpose

Annex B describes use cases or profiles that describe usage of the service interface in different operational contexts. The use cases described are based on a generic voyage, from Busan to Quebec via Stockholm, where typical service usage is derived. Each service usage/call is described in a use case. The use cases are:

– route plan exchange ship-shore and shore-ship (Enhanced monitoring);
– pilot routes;
– route optimization;
– search for services to consume;
– chart (ENC) updates;
– navigational warnings.

The service interface is focused on the exchange of information products and not designed towards a specific operational service. Different operational services will require different exchange patterns and also different sets of active interfaces such as subscription. An enhanced monitoring service for example will most likely not allow ships to subscribe to route plans from them, but the enhanced monitoring service will want to subscribe to route plans from the ship.

Based on a set of defined use cases for a certain actor, the profile for that actor can be defined. Hence, a ship service interface profile is the sum of all service interfaces used in the use cases for the ship.

B.2 Use cases and service interface profiles

B.2.1 UC-1 Ship shares route plan with service providing enhanced monitoring

B.2.1.1 Pre-requisites

A service provider of enhanced monitoring, for example a VTS, exposes a discoverable service interface to receive S-421 Route Plans (IEC 63173-1), receives acknowledgement and receives subscription notifications.

Searching and finding of the service in the service registry is according to Clause 9.

The ship exposes a discoverable service interface for enhanced monitoring (receive S-421 Route Plan).

B.2.1.2 Description

In this use case for route plan exchange, an exchange between a ship and a VTS has been selected but also other scenarios and actors such as ports, fleet operation centres and various service providers could have similar route plan exchanges as the VTS. The ship/shipping company is the information owner of the route plan and as such chooses which actors should be granted access to the route plan. Some of the information in the route plan can be sensitive from a business perspective, for example the arrival port and arrival time and thus there is a need to protect the route plan from unauthorized actors.

The VTS can use the route plan to monitor that the ship stays within the planned corridor as defined in the route plan or in the VTS system. The VTS can receive updates of the ship position through for example automatic identification system (AIS) and compare these ship positions against the route plan for the vessel. The shore centre is able to detect not only if the ship deviates from the planned route geometry but also if the planned schedule is not kept. The VTS can also use the route plan information to foresee possible dangerous situations. The VTS may contact the ship by different means.

1) The ship wants assistance and searches for an appropriate service in the service registry similar to the use case described in B.2.5.
2) The ship checks the supported SECOM interfaces of the discovered service by calling the service capability endpoint, see 5.7.13 .
3) The ship prepares a S-421 Route Plan together with metadata for an UploadObject, see Table 16.
4) The S-421 is signed and the signature is added to the SECOM_ServiceExchangeMetadata part of the UploadObject.
5) The ship nominates the enhanced monitoring service and adds the service to its list of subscribers in order to provide possible route plan updates enroute. The service is added to the ship's whitelist.
6) The ship sends (uploading, pushing) the S-421 Route Plan to the enhanced monitoring service.
7) The VTS verifies the signature and the certificate and hence authenticates the sender (the ship) and the route message's integrity.
8) The VTS checks the route against local conditions and either confirms the original route plan or makes a new proposed one. If the latter, the enhanced monitoring service makes a proposal and sends (uploads) the proposed S-421 Route Plan to the ship and requests an operational acknowledgement (see 5.7.4) when delivered to the ship and processed by an operator on the ship.
9) The ship receives the proposed S-421 Route Plan and sends an operational acknowledgment when the officer on watch opens the message.
10) When the voyage is ended, the enhanced monitoring service is removed from the list of subscribers and a subscription notification message is sent.

B.2.1.3 Service interfaces required

Table B.1 describes used interfaces in this use case.

Table B.1 – UC-1 Ship shares route plan with service providing enhanced monitoring

Service interface	Ship	Enhanced monitoring
Upload	YES; step 6)	YES; step 8)
Acknowledgement	YES; step 9)	
Subscription	YES; step 5)	
Subscription Notification	YES; step 5), 10)	
Remove Subscription	YES; step 10)	
Capability	YES; step 2)	
NOTE The steps refer to B.2.1.2.		

B.2.2 UC-2 Pilot routes

B.2.2.1 Pre-requisites

The service provider of a pilot route service exposes a discoverable service interface to receive a S-421 Route Plan and receive acknowledgement.

The ship exposes a discoverable service interface to receive the S-421 Route Plan proposal.

B.2.2.2 Description

Planning a route passing through previous unvisited areas could be tedious and difficult. The officer of the watch on board might need to consider unknown obstacles such as shallow waters, speed and size of the ship, local regulations etc. and in most cases a pilot is needed. When the pilot boards the ship, a pilot route candidate could be included into the route that is loaded into the ship's ECDIS system and if the pilot agrees, it can be used for navigation into or out from the port.

To facilitate the voyage planning into the port of Stockholm, the ship wants to use known and safe local routes used by pilots, i.e. pilot routes. A pilot route service is an onshore service that can provide pilot routes to ships when planning their voyages. The ship can get one or several pilot routes in return and can choose among the returned routes which to add to their planned route plan.

If a pilot route service supports a functionality to receive and interpret route plans (S-421), this input could be used for the service to calculate and return the closest pilot route(s).

1) The ship searches in trusted service registry for service instance that can provide the ship with pilot routes (reference routes in S-421) – rough search by area or unlocode to get the right service instance.
2) The ship calls the service instance Get Summary with detailed search parameters relevant for the service (GET object/summary?geometry=route as line and/or unlocode=X, etc.) – search for the relevant information object the service instance can provide.
3) The pilot route service Instance interprets the Get Summary request and returns the summary of the information it can provide.
4) The ship receives the summary of the information the service can provide.
5) The ship selects the information it wants to download and calls the service instance Get object?dataReference.
6) The pilot route service Instance returns the selected information including the signature.
7) The ship receives the pilot route and verifies the signature.

B.2.2.3 Service interfaces required

Table B.2 describes the used interfaces in this use case.

Table B.2 – Required service interfaces in UC-3

Service interface	Ship	Pilot route service
Upload		YES; step 6)
Get	YES; step 5)	
Get Summary	YES; step 2)	
NOTE The steps refer to B.2.2.2.		

B.2.3 UC-3 Route optimization

B.2.3.1 Pre-requisites

A route optimization service provider exposes a discoverable service interface to receive S-421 Route Plans (IEC 63173-1).

Searching and finding the service in the service registry is according to Clause 9 SECOM service discoverability and not included in this use case.

The ship exposes a discoverable service interface for route optimization (receive S-421 Route Plan).

The ship is aware of that the route optimization service provides encrypted Route Plans.

B.2.3.2 Description

Given that both a ship and a route optimization service provider support SECOM and S-421, the ship can send a planned route to the service provider and receive in return its route optimized for defined parameters such as weather, wind currents etc. The optimized route can be imported directly into the ECDIS without the need for converting formats or transport by, for example, USB-stick. In this use case, the route optimization provider wants to be certain that only the specific ship can access the optimized route and therefore encrypts the route plan.

1) The ship sends its route and its public certificate to the route optimization provider.

   NOTE If the ship does not send its public certificate, the route optimization provider can request the ship's public certificate used for encryption by invoking the ship's SECOM PublicKey interface.

2) The Route optimization provider optimizes the received route and decides to protect the optimized route.
   a) Route optimization provider creates a random symmetric encryption key and encrypts the optimized route.
   b) Before exchanging the random encryption key, route optimization provider needs to protect the encryption key using a derived symmetric key.
   c) Route optimization provider derives a symmetric key using the public certificate received, together with its own private key.
   d) Route optimization provider encrypts the random encryption key with the derived symmetric key.
   e) Route optimization provider sends the protected encryption key payload using the ship's SECOM EncryptionKey interface.
3) The Route optimization provider uploads the protected optimized route to the ship's SECOM Upload interface.
4) The ship derives the same symmetric key using the public key sent by the route optimization service together with its private key and uses that to decrypt the encryption key.
5) The ship decrypts the optimized route with the decrypted encryption key.

B.2.3.3 Service interfaces required

Table B.3 shows the interfaces used in this use case.

Table B.3 – Required service interfaces in UC-3

Service interface	Ship	Route optimization service
Upload	YES; step 1)	YES; step 3)
EncryptionKey		YES; step 2)e)
PublicKey	YES; step 1)	
NOTE The steps refer to B.2.3.2.		

B.2.4 UC-4 Enhanced monitoring service requests route plan from/for ship for monitoring

B.2.4.1 Pre-requisites

The ship has not shared a S-421 Route Plan with an enhanced monitoring service.

The ship exposes a discoverable service interface to receive a S-421 Route Plan proposal.

The service provider of the enhanced monitoring exposes a discoverable service interface to receive a S-421 Route Plan, receive acknowledgement and receive subscription notifications.

B.2.4.2 Description

This use case is similar to UC-1 but the VTS initiates the communication instead of the ship. The VTS operator identifies the ship through AIS and wants the ships route plan. The operator searches for a service using MMSI as the search parameter. See Annex E for further description of the access process and the use of a whitelist.

1) Enhanced monitoring service wants to check the SECOM Information service condition for the ship and invokes the ship's SECOM Ping interface and confirms that the service is in operation.
2) Enhanced monitoring requests subscription on S-421 Route Plan from the ship and implicitly requests access.
3) The ship checks access rights to its route plan.
   a) If access, the ship sends (uploads) the S-421 Route Plan.
   b) If subscription is created, the ship notifies subscription created.
   c) If no access, the ship responds with 403 "Not authorized".
   d) Enhanced monitoring sends Access request with the reason "Enhanced monitoring service for area X".
   e) Ship receives and displays the access request from the enhanced monitoring service and can accept or reject the request.
4) When the voyage is ended, the subscription is removed by the ship and a notification is sent to the enhanced monitoring service.

B.2.4.3 Service interfaces required

Table B.4 describes used interfaces in this use case.

Table B.4 – Required service interfaces in UC-4

Service interface	Ship	Enhanced Monitoring
Upload	YES; step 3)a)	
Request Access		YES; step 2)
Access Notification	YES; step 3)e)	
Subscription		YES; step 2)
Subscription Notification	YES; step 3)b), 4)	
Remove Subscription	YES; step 4)	
Ping	YES; step 1)	
NOTE The steps refer to B.2.4.2.		

B.2.5 UC-5 Discover service instance to consume

B.2.5.1 Pre-requisites

The service end point (URL) is known and accessible for one or more service registries.

B.2.5.2 Description

B.2.5.2.1 General

A service registry functionality enables service consumers, for example ships, to search for services, i.e. service endpoints to interact with. As ships are also registered, it is also possible to search for ships and thus the use case is applicable shore-ship and ship-shore. The search is performed according to pre-defined parameters given in Table 110 such as geometry, service types, freetext and IMO number. This makes it possible to search for already known services, available route optimization services or which services are available in a given area or along the planned route. Other examples of service search scenarios are for instance ship wants to find MSI Service Provider along its route.

B.2.5.2.2 Ship perspective

- Ship wants to find MSI service provider along its route.
- Ship wants to find Enhanced Monitoring Services (VTS's) along its route.
- Ship wants to find Port and start Port Call Synchronization.
- Ship wants to find Pilot Route Service and get valid pilot routes.
- Ship wants to find Under Keel Clearance Monitoring service and start the procedure to receive speed recommendations.

Ship searches for service provider by Name, Type, Keyword, UN/Locode, Geometry (the route or marked area), based on known values.

The ship is given a list of service end points (URLs) and other descriptive information about the services in return.

B.2.5.2.3 VTS perspective

- VTS wants to find service for ship to ask for its monitored route.
- VTS wants to find service for ship to send information.
- VTS wants to find service for ship to send local MSI.
- Maritime rescue co-ordination centre (MRCC) wants to find service for rescue unit to send search area and search pattern to.

B.2.5.2.4 Port perspective

- Port wants to find service for ship to ask for its monitored route.
- Port wants to find service for ship to send information.

VTS/MRCC/Port searches for service provider (ship) by Name, Type, Keyword, MMSI, IMO, based on known values.

The VTS/MRCC/Port is given a list of service end points (URLs) and other descriptive information about the services in return.

B.2.5.3 Service interfaces required

This use case only references the Service interface "Search service" described in 9.2; therefore, no table with required Service interfaces is included.

B.2.6 UC-6 Chart (ENC) updates

B.2.6.1 Pre-requisites

A service provider of ENC charts, for example an ENC distributor, exposes a discoverable service interface to distribute ENC (S-57/S-101) data.

Searching and finding the service in the service registry is according to Clause 9.

The ship exposes a discoverable service interface for ENC charts inside S100_ExchangeSet (receive S-57/S-101).

B.2.6.2 Description

SECOM provides one common interface between the VAR (value added reseller) and the distributor, and between the distributor ant the users that could be used in ENC distribution. The common interface facilitates interoperability and reduces development costs and efforts to support several different proprietary interfaces.

SECOM could also facilitate for VAR to provide other types e-navigation services.

A common service registry or interoperable registries allows users to seamlessly interact with different service providers and vice versa, ensuring that provided services can be used by a multitude of users.

1) The ship has an active subscription to a defined set of ENC charts or has purchased a new set of charts outside SECOM.
2) Updated/new ENC charts are ready for distribution.
3) ENC distributor sends updated charts packed in a S100_ExchangeSet to the ship by consuming the ship's SECOM UploadLink interface.
4) The ship SECOM instance receives the link to the updates and stores the link.
5) In the next port, the ship retrieves the updated ENC charts from ENC SECOM instance GetByLink interface.

B.2.6.3 Service interfaces required

Table B.5 describes used interfaces in this use case.

Table B.5 – Required service interfaces in UC-6

Service interface	Ship	ENC distributor
UploadLink		YES; step 3)
GetByLink	YES; step 4)	
NOTE The steps refer to B.2.6.2.		

B.2.7 UC-7 navigational warning service

B.2.7.1 Pre-requisites

A service provider of navigational warning, for example a costal administration, exposes a discoverable service interface to distribute NAVWARN (S-124) data.

The navigational warning service has a configurable subscription function that include predefined areas (such as whole service area and sub areas), subscription duration, and push frequency (e.g. once per day, every 8 h, every hour, right away).

Available NAVWARN datasets are query enabled within the service to expose location and issue date and time for filtering available datasets to relevant datasets for a vessel's voyage.

SECOM PKI is used to sign the NAVWARN datasets.

The ship exposes a discoverable service interface (Upload) for NAVWARN datasets. The navigational warning service pushes any NAVWARN dataset, according to subscription criteria, which is not already in the ship system.

B.2.7.2 Description

The purpose with the navigational warning service is to provide the service consumer, i.e. ship, with only those warnings that are relevant for a specific area that intersects with the route under navigation and at the time of scheduled route. Moreover, the warnings could be displayed directly in ECDIS and automatically deleted when they are expired and no longer valid. The service is not intended to relieve the service users from ordinary receipt of maritime safety information (MSI) as part of the global maritime distress and safety system (GMDSS), which every ship, while at sea, has to comply to.

The notices/navigational warnings do not have to be limited to specific transmission times but could be sent as soon as warnings are registered in national/regional management systems.

1) The ship searches the service registry according to geography preferences and discovers a published navigational warning service according to Clause 9.
2) The ship requests subscription by consuming the NAVWARN service SECOM Subscription interface providing a route waypoint list as a geometry parameter.
3) The NAVWARN service responds to the ship with a message and subscriptionIdentifier.
4) New NAVWARN datasets are ready for distribution.
5) The Navigational Warning Service sends new NAVWARN datasets to the ship by consuming the ship's SECOM Upload interface, supplying parameter fromSubscription = "true".
6) The ship SECOM instance receives the datasets and receives consecutive NAVWARN throughout the duration of the voyage.
7) Ending the subscription alternatives.
   a) If the ship wants to terminate the subscription of NAVWARN service, for example due to another route plan, it consumes the NAVWARN "Remove Subscription" interface and the NAVWARN service responds by sending a "Subscription Notification" of the approved removal.
   b) When the voyage ends (i.e. current datetime > last waypoint ATA) or when leaving the NAVWARN coverage area, the navigational warning service consumes the ships Subscription Notification interface with eventEnum = "Subscription removed" for the subscriptionIdentifier in step 3).

B.2.7.3 Service interfaces required

Table B.6 describes used interfaces in this use case.

Table B.6 – Required service interfaces in UC-7

Service interface	Ship	NAVWARN distributor
Upload	YES; step 5)	
Subscription		YES; step 2)
Remove Subscription		YES; step 7) a)
Subscription Notification	YES; step 7) a), 7) b)	
NOTE The steps refer to B.2.7.2.		

B.2.8 UC-8 Updates for detailed bathymetry and tidal and water level forecasts

B.2.8.1 Pre-requisites

A service provider of detailed bathymetry (S-102) and tidal and water level forecast (S-104), for example a chart distributor, exposes a discoverable service interface to distribute S-102 and S-104 data.

Searching and finding of the service in the service registry is according to Clause 9.

The ship exposes a discoverable service interface for detailed bathymetry and tidal and water level forecast inside S100_ExchangeSet (receive S-102/S-104).

B.2.8.2 Description

SECOM provides one common interface between the VAR (value added reseller) and the distributor and between the distributor and the users that could be used in detailed bathymetry and tidal and water level forecast distribution. The common interface facilitates interoperability and reduces development costs and efforts to support several different proprietary interfaces.

SECOM could also facilitate for VAR to provide other types e-navigation services.

A common service registry or interoperable registries allows users to seamlessly interact with different service providers and vice versa ensuring that provided services can be used by a multitude of users.

1) The ship has an active subscription to a defined set of detailed bathymetry and tidal and water level forecast or has purchased a new set of detailed bathymetry and tidal and water level forecast outside SECOM.
2) Updated/new detailed bathymetry and tidal and water level forecast are ready for distribution.
3) Distributor sends updated detailed bathymetry and tidal and water level forecast packed in a S100_ExchangeSet to the ship by consuming the ship's SECOM UploadLink interface.
4) The ship SECOM instance receives the link to the updates and stores the link.
5) In the next port, the ship retrieves the updated detailed bathymetry and tidal and water level forecast from SECOM instance using GetByLink interface.

B.2.8.3 Service interfaces required

Table B.7 describes used interfaces in this use case.

Table B.7 – Required service interfaces in UC-8

Service interface	Ship	ENC distributor
UploadLink	YES; step 5)	YES; step 3)
GetByLink	YES; step 4)	
NOTE The steps refer to B.2.8.2.		

Annex C
(informative)

Message exchange patterns

C.1 Purpose

This Annex C contains the used message exchange patterns.

C.2 Message exchange pattern

C.2.1 Generic message exchange patterns

C.2.1.1 General

HTTP-based communication has been used when describing the sequences, hence the default return (if no other information) is the HTTP code from the HTTP protocol. The sequences also do not describe the authentication and authorization procedures.

C.2.1.2 ONE_WAY

Fire-and-forget, sends data to consumer without expecting information back, other than a technical response as described in Figure C.1.

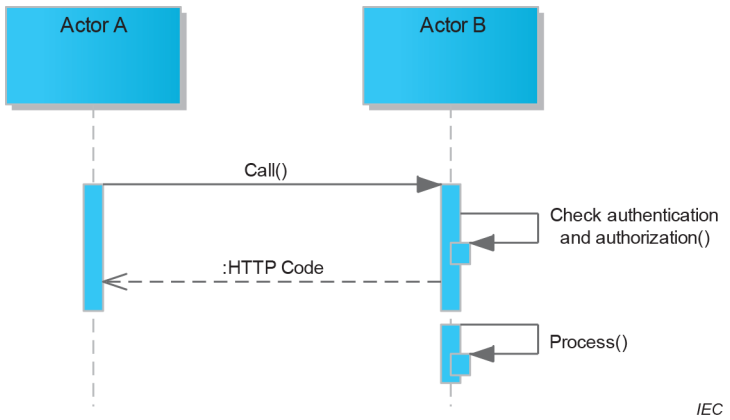


Figure C.1 – Message Exchange Pattern – ONE_WAY

C.2.1.3 REQUEST_CALLBACK

Sent messages are expected to result in message sent asynchronously back, such as optimized route, as described in Figure C.2.

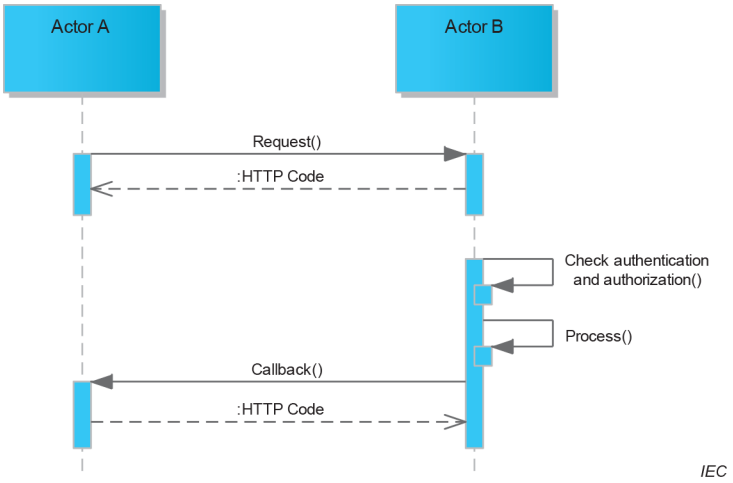


Figure C.2 – Message Exchange Pattern – REQUEST_CALLBACK

C.2.1.4 REQUEST_RESPONSE

Consumer requests information from a provider, and if authorized, information is sent back synchronously in the response, as described in Figure C.3.

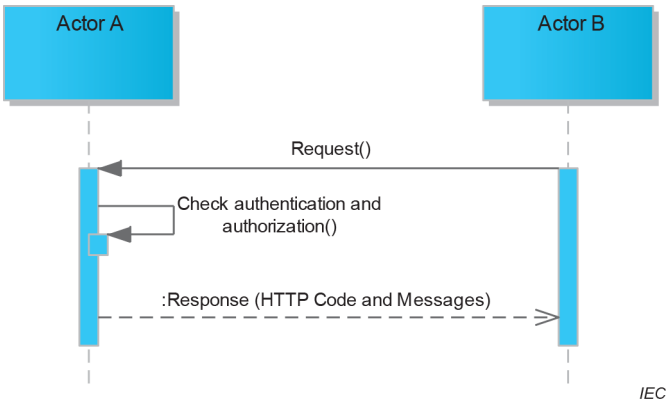


Figure C.3 – Message exchange pattern – REQUEST_RESPONSE

C.2.1.5 PUBLISH_SUBSCRIBE (Provider nominates)

The parent on the provider side nominates a consumer and sends messages until either provider or consumer ends the subscription.

All uploaded message can be combined with acknowledgement when the sent message has been forwarded to the parent, as described in Figure C.4.

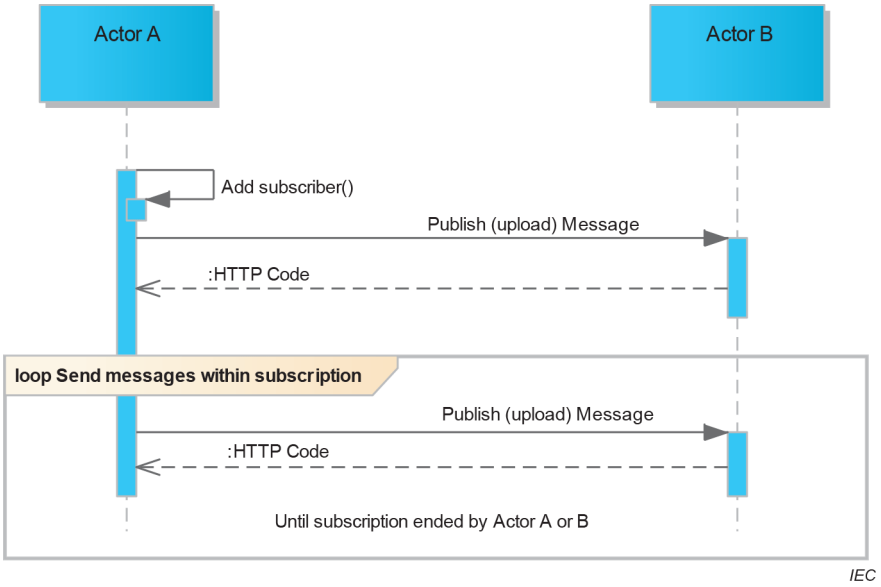


Figure C.4 – Message exchange pattern – PUBLISH_SUBSCRIBE (Provider nominates)

C.2.1.6 PUBLISH_SUBSCRIBE (Consumer requests)

Consumer requests subscription on a provider. The provider either rejects or accepts the subscription request. If accepted, message(s) in given subscription are sent, and then all updated messages are sent to the consumer until either provider or consumer ends the subscription. See Figure C.5.

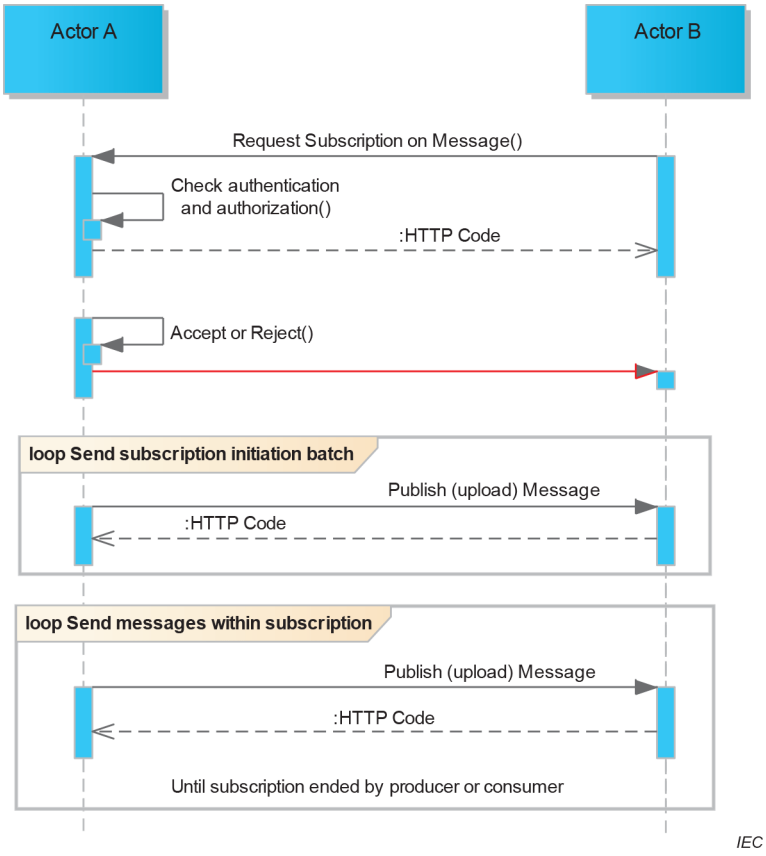


Figure C.5 – Message exchange pattern – PUBLISH_SUBSCRIBE (Consumer request)

C.2.2 Alternative and error sequences

C.2.2.1 Incorrect uploaded message

For Incorrect uploaded message, see Figure C.6.

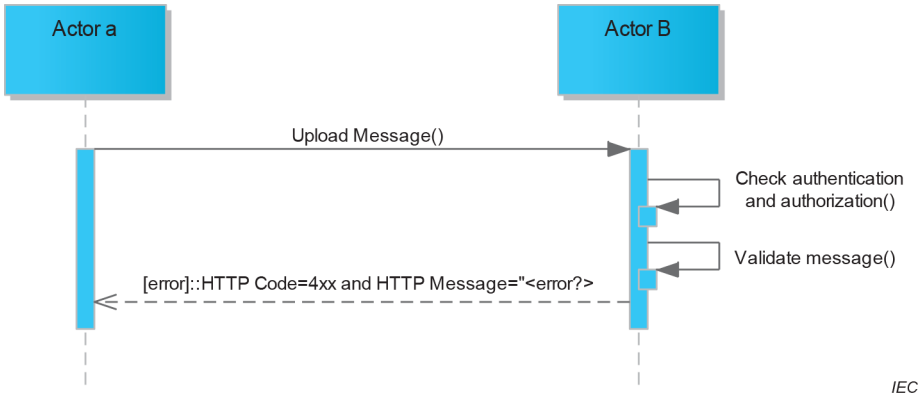


Figure C.6 – Error sequence; Incorrect uploaded message

C.2.2.2 Unauthorized uploaded message

For unauthorized upload message, see Figure C.7.

Figure C.7 – Error sequence; Unauthorized upload of message

C.2.2.3 Unauthorized subscription request

For unauthorized subscription request, see Figure C.8.

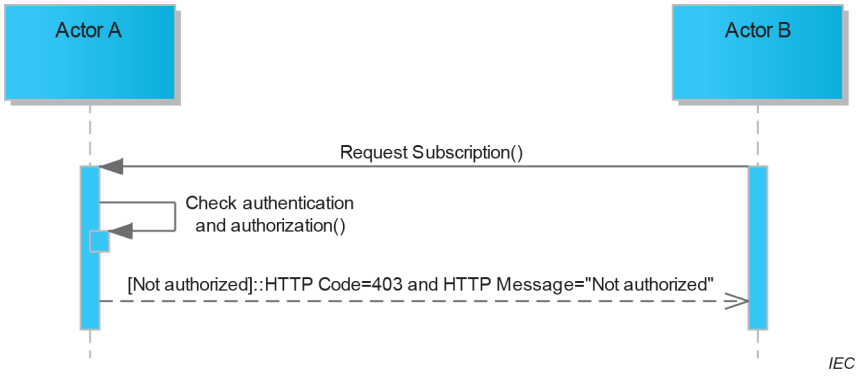


Figure C.8 – Error sequence; Unauthorized subscription request

Annex D
(informative)

Guidance on implementation

D.1 Purpose

This Annex D contains examples of SECOM deployment both onboard ship with 460-Gateway and shore side application.

Figure D.1 shows the elaborated scope for SECOM in the context of vendor specific private API towards, for example, a ship.

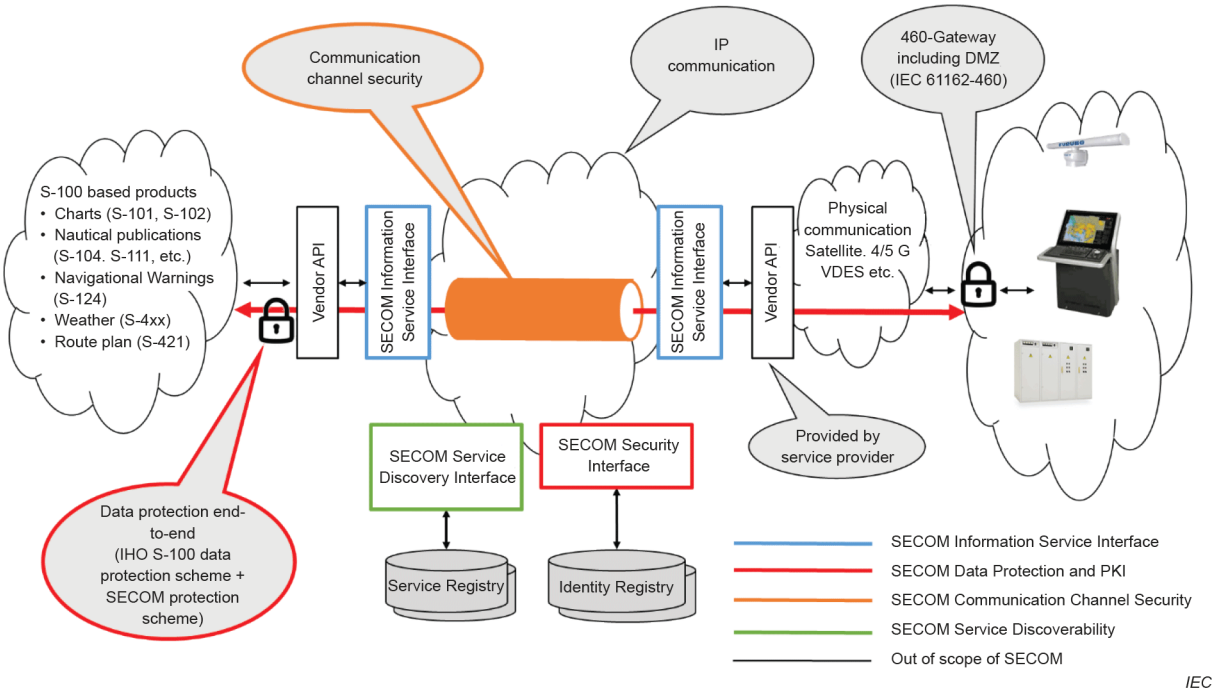


Figure D.1 – Overview of SECOM

Figure D.2 shows the different use of certificates for data authentication and communication channel protection. For security reasons, the recommendation is to use different certificates for signing of data and for encrypting the communication channel. The certificate used for signing data (data authentication) shall be a dedicated "user" certificate and the certificate used for channel protection shall be a service certificate for the actor.

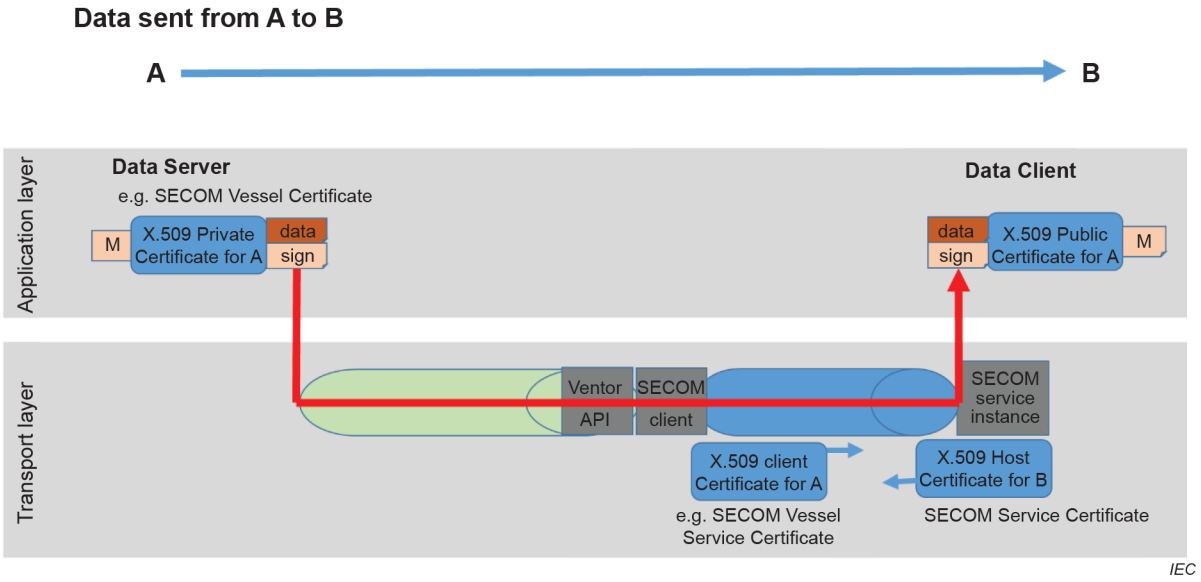


Figure D.2 – Overview of certificate usage

D.2 On ship

Figure D.3 shows a SECOM service with exposed and registered SECOM interfaces deployed outside the ship in a new DMZ.

Onboard ship:

- the external firewall on the 460-Gateway opens one outgoing port to the SECOM service, and opens ports for SECOM PKI and SECOM service registry (normally HTTPS 443);
- the firewall on the uncontrolled network on the ship opens corresponding outgoing ports from/to the SECOM service, SECOM PKI and SECOM service registry.

Outside ship:

- the exposed SECOM service for the ship is deployed outside the ship (shoreside) in a new DMZ;
- the URL to this SECOM service is registered in the SECOM service registry and can be consumed by other SECOM actors;
- the internal firewall opens one incoming port to the SECOM service;
- the external firewall opens one incoming port where the ship SECOM service is consumed, and a range of outgoing ports where the ship consumes other SECOM services.

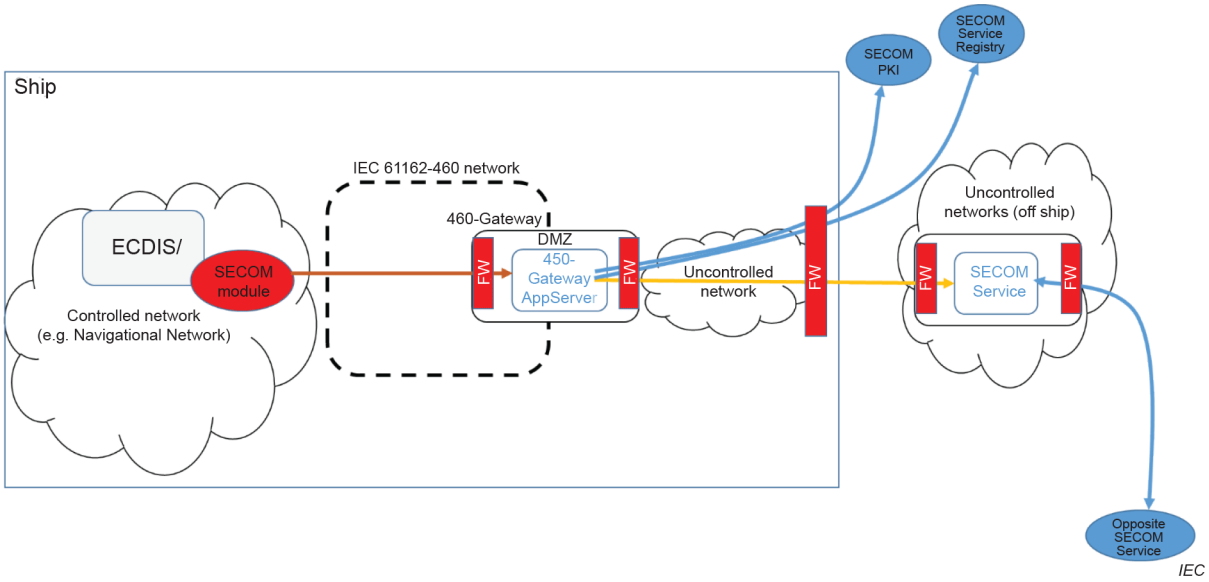


Figure D.3 – Deployment example for SECOM on ship

D.3 On shore

Figure D.4 shows where a DMZ is used between the operational application onshore and the exposed SECOM service.

- The exposed SECOM interface is deployed in the DMZ.
- The URL to this SECOM service is registered in the SECOM service registry and can be consumed by other SECOM actors.
- The internal firewall opens one incoming port to the SECOM service.
- The external firewall opens one incoming port to the SECOM service, and opens a range of outgoing ports to other SECOM services, and ports to SECOM PKI and SECOM service registry.
- The firewall on the uncontrolled network opens corresponding incoming and outgoing ports to and from SECOM service.

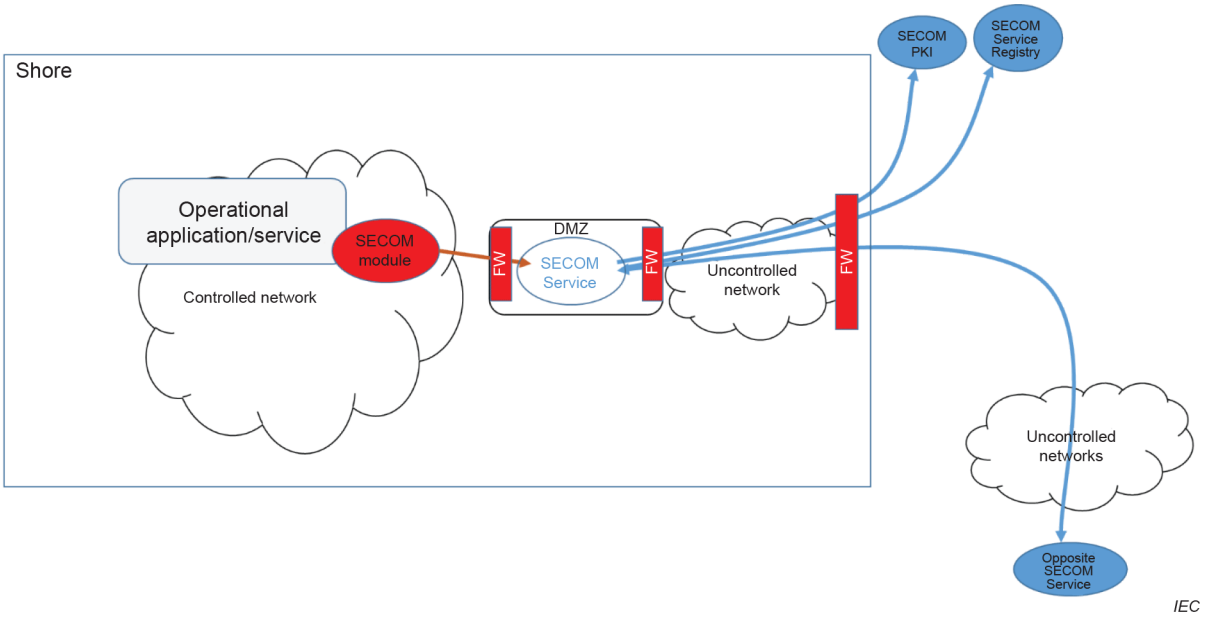


Figure D.4 – Deployment example for SECOM on shore

D.4 Service composition

There is no requirement for a monopoly of a single shore service provider or for a monopoly of a single provider of "vendor API + gateway". There is a freedom to any actor to implement services which could be useful for a ship. Further, there is no requirement that onboard at ship side there should be only a single "vendor API + gateway" to provide access to transfer of information. The reality is that there could be any amount of parallel implementation, for example S-124 services could be offered for separate geographical areas by different service providers, and for example there could be multiple implementations of identity registry and service registry either geographically separated or even geographically parallel. (See Figure D.5).

Service composition is about how to handle this multiplicity of SECOM compliant services. It is assumed that at the shore side, SECOM compliant services could be implemented ignoring the possible existence of other parallel SECOM compliant services at the shore side.

Onboard a ship, the situation might be such that there is a need to be a client for multiple SECOM compliant shore services when a single SECOM compliant shore service is unable to provide all services needed. Such a situation could be solved either by a single SECOM compliant "vendor API + gateway" or by multiple parallel SECOM compliant "vendor API + gateways" onboard the ship. In the case of a single SECOM compliant "vendor API + gateway" onboard the ship, the provider/manufacturer of the "vendor API + gateway" would implement within his transfer service a connection to all required separate implementations of SECOM compliant shore services or registries. In the case of multiple SECOM compliant "vendor API + gateways" onboard the ship, each separate provider/manufacturer of a "vendor API + gateway" would implement within his transfer service a connection to a subset of required separate implementations of SECOM compliant shore services or registries.

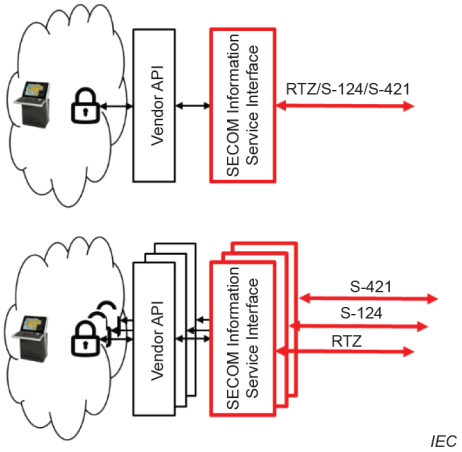


Figure D.5 – Service composition

A list of available service registries could be provided by different organisations such as IHO, IALA, CIRM or coastal states.

D.5 Private side security

Since the SECOM standard does not comprise standardization of the communication methods and interfaces on the private side, i.e. the communication link between vendor applications and its SECOM service instance(s), an example is described of a way to secure the communication. Figure D.2 shows a deployment example of a connectivity where the link between the ship network and its SECOM service needs to be secured.

In order to secure this open part of the communication, one could use the HMAC (hash-based message authentication code) authentication mechanism. HMAC is a mechanism for calculating a message authentication code using a hash function in combination with a shared secret key between the two parties involved in sending and receiving the data (frontend client and back-end HTTP service). The main use for HMAC is to verify the integrity, authenticity, and the identity of the message sender.

The server provides a public APP ID and a shared secret key (API key – shared only between server and client) to the client. The secret key exchange only occurs the first time the client registers with the server, i.e. the key is securely stored on each side. After the client and server has agreed on the API Key, for each new request the following process occurs.

1) The client creates a unique HMAC (hash) representing the request originated from it to the server. This is done by extending the request data with, for example, the public APP id, the request URI, the request content, the HTTP method, a time stamp and a nonce in order to produce a unique hash by using the API key.
2) The client then sends that hash to the server, along with all the information it was going to send already in the request.
3) When the server receives the request along with the hash, it tries to reconstruct the hash by using the received request data from the client along with the API Key. Once the hash is generated on the server, the server will be responsible for comparing the hash sent by the client with the regenerated one. If they match, the server considers this request authentic and can proceed to process it.

D.6 SECOM PKI

D.6.1 General

An informal description of SECOM PKI instance(s) is given exemplified as approached by the Maritime Connectivity Platform (MCP). The MCP build on the analysis, design choices, and experience with the testbed implementations during the EU projects EfficienSea2 and STM Validation Project and the SMART Navigation Project funded by the Republic of Korea (see https://maritimeconnectivity.net).

D.6.2 Structure and Functionality

D.6.2.1 General

The MCP specifies three core components and their interoperability: the Maritime Identity Registry (MIR), the Maritime Service Registry, and the Maritime Messaging Service. The MIR is responsible for identity management and providing security functionality to the other components. As shown in Figure D.6, the MIR consists of MIR governance and several MIR instances. In summary, MIR governance and instances together typically provide the following functionality.

1) Identity Management: The MIR enables that each maritime entity (such as a device, human, organization, service, or ship) can be registered as a participant of the MCP and be equipped with a unique identity. The identity is given in terms of a MRN (Maritime Resource Name). While MIR governance harmonizes the MRN namespace governed by the MCC and sets out criteria for the registration process, it is up to the MIR instances to implement and have certified concrete identity registries. The following terminology is used:
   a) MCP entity: an entity registered at some MIR instance;
   b) MCP namespace: the subspace of the MRN namespace that is governed by the MCC.
2) Public Key Infrastructure (PKI): The MIR enables that each MCP entity holds a cryptographic identity in terms of a public/private key pair and a certificate bound to their ID within the MCP. While the cryptographic identity of a MCP entity can change over time (due to updates of key material), the MIR ensures that each MCP entity holds only one valid cryptographic identity at any point in time bound to their ID within the MCP. MIR governance provides criteria as to the use and management of cryptographic identities but, similarly to above, it is up to the MIR instances to implement and have certified concrete PKIs.
3) Authentication and authorization for web services: The MIR enables that MCP entities benefit from login, single sign-on, and authorization for API access of web services, as well as secure integration of web services based on the widely used standards OAUTH 2.0 and OpenID Connect. To this end, MIR governance provides criteria as to interoperability and configurations while the MIR instances deliver concrete OAUTH 2.0/OpenID Connect platforms.

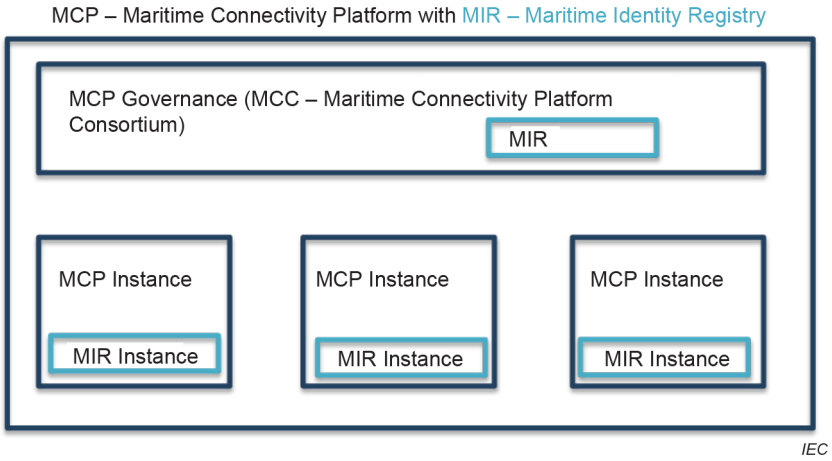


Figure D.6 – Structure of MIR within MCP

D.6.2.2 Governance and profiles

The focus of the MCP is currently changing from only providing reference implementations and a testbed to including governing several operational MCP instances as well as ensuring their interoperability. At the time of writing, there are two emerging operational instances: one is evolving from the STM project; the second is being deployed by the SMART project of the Republic of Korea. Hence, the MCP has to strike a balance between laying down criteria according to which the emerging deployments can be endorsed as MCP instances while remaining open to both, ongoing refinements of the first set of requirements (e.g. with respect to security) as well as new developments and technologies the MCP might wish to utilize (e.g. with respect to distributed PKI). This is why the MIR adopts the following approach of profiles.

The MCP will not develop a single set of criteria that every MIR instance has to comply with but rather allow several MIR profiles to coexist. Each MIR profile contains a set of requirements that define what MIR instances have to guarantee to be compliant with the profile. In addition, a profile will typically contain requirements that define what MIR governance is supposed to guarantee (e.g. to maintain operability and overall security). Each MCP instance can choose which of the current MIR profiles it aims to fulfil. While the MCC is not able to carry out assessments as to whether a MIR instance adheres to a profile itself (in particular with respect to security), it will endorse organizations that can provide this.

Two distinct MIR profiles can either be compatible in that one is a refinement of the other, or they can be non-compatible. To allow non-compatible profiles ensures that the MCP can evolve into different branches. This is to enable that an MCP instance or a cluster of MCP instances may adopt new developments without having to ensure downwards compatibility. As usual, downwards compatibility entails the risk of being forced to carry over security vulnerabilities or simply being bogged down by obsolete technology. Therefore, the approach of coexisting profiles is also meant to ensure that the MCP can evolve as a whole. The WG IDSec (Working Group Identity Security) will formulate requirements that will pin down how the profiles are managed and harmonized.

D.6.3 Identity management

D.6.3.1 The MCP namespace

As explained above, the MCP namespace is a subspace of the Maritime Resource Name (MRN) space, which is an official URN namespace. The syntax definitions below use the Augmented Backus-Naur Form as specified in RFC 5234.

The syntax for a MRN is as follows:

```
<MRN>::= "urn" ":" "mrn" ":" <OID> ":" <OSS>
            [ rq-components ]
            [ "#" f-component ]
<OID>::= (alphanum) 0*20(alphanum / "-") (alphanum)
<OSS>::= <OSNID> ":" <OSNS>
<OSNID>::= (alphanum) 0*32(alphanum / "-") (alphanum)
<OSNS>::= pchar *(pchar / "/")
```

The rules for alphanum and pchar are defined in RFC 3986.

The optional rq-components and f-component are specified in RFC 8141.

"mrn" specifies that the URN is within the MRN namespace. The Organization ID (OID) refers to an organization that is assigned a subspace of MRNs such as IMO, IALA, or the MCP. Syntactically, it is a string that is unique across the "mrn" scheme. The Organization Specific String (OSS) is specified and managed by the governing organization in a consistent way conform to the definitions of the MRN namespace. In particular, each organization structures the OSS into two parts: the Organization Specific Namespace ID (OSNID), and the Organization Specific Namespace String (OSNS). The OSNID identifies a particular type of resource (uniquely within the governing organization), while the OSNS identifies the particular resource (uniquely for its type within the governing organization). Altogether, this ensures that the resulting URN is globally unique.

For a MRN governed by the MCC, the OID reads "mcp", and the OSNID specifies one of the following types used within the MCP: device, organization, user, vessel, service, mir, mms, and msr. The latter three types are to be used for entities of the three MCP components MIR, Maritime Messaging Service, and Maritime Service Registry respectively. Moreover, the definition of the OSNS takes into account the distributed structure of the MCP. Identities can be provided and managed by several identity providers. In detail, the syntax of a MRN governed by the MCC (short: MCP MRN or MCP name) is as follows:

```
<MCP-MRN>::= "urn" ":" "mrn" ":" "mcp" ":" <MCP-TYPE> ":" <IPID> ":" <IPSS>
<MCP-TYPE>::= "device" | "org" | "user" | "vessel" | "service" |
              "mir" | "mms" | "msr"
<IPID>::= <CountryCode> | (alphanum) 0*20(alphanum / "-") (alphanum)
<IPSS>::= pchar *(pchar / "/")
```

"mcp" specifies that the governing organization is the MCC. The next element is MCP-TYPE. As explained above, this pins down one of the types currently used within the MCP. The Identity Provider ID (IPID) refers to a national authority or other kind of organization that acts as an identity provider within the MCP. If the identity provider is a national authority, then the IPID is a country code as defined by ISO 3166-1 alpha-2. Otherwise it will be a string of the same syntax as that for OIDs. The IPID is unique across the urn:mrn:mcp namespace. The Identity Provider Specific String (IPSS) can be defined and managed by the respective identity provider in a way that is consistent and conforms to the definitions of the MRN namespace and requirements laid down by the MCC. In particular, the identity provider ensures that the IPSS identifies a particular resource uniquely for its type within the domain of the identity provider. Altogether, this will ensure that the resulting URN is globally unique.

Examples:

- urn:mrn:mcp:user:dma:alice – valid MCP MRN for a user, where dma specifies the ID Provider, and the subsequent IPSS string is defined to give the username.
- urn:mrn:iala:aton:gb:sco:6789-1 – valid MRN for a marine aid to navigation (AtoN), where gb stands for United Kingdom, sco for Scotland, and the number is the Scottish asset identifier. In this example, this is not a MCP MRN.
- urn:mrn:mcp:device:mirX:aton:gb:sco:6789-1 – valid MCP MRN for the same AtoN, where mirX specifies the ID Provider, and the subsequent IPSS string is defined to first specify the type of the device, and then to follow the country-specific convention of the IALA scheme.
- urn:mrn:mcp:service:mirY:org1:instance:s124/busan – valid MCP MRN for a service instance, where mirY and org1 specifies the ID Provider and the organization respectively. Note the use of the character slash ("/") in the last element. It should be converted to percent-encoded ‘%2F’ by following RFC 8141 when the MRN is included as a part of a URL, for example,
  "http://example.com/urn:mrn:mcp:service:mirY:org1:instance:s124%2Fbusan".

The following requirements pin down how the MCP namespace can be managed decentrally.

- ID1 The MCC can delegate the assignment of part of the MCP namespace to other organizations that act as identity providers. More concretely, this means that the organization, say X, has to hold an IPID, say string "nameofx", and is then responsible for the namespace with the prefix "urn:mrn:mcp:<MCP-TYPE>:nameofx".
- ID1.1 The MCC ensures that each IPID refers to at most one identity provider.
- ID1.2 Each Identity Provider ensures to respect all syntax prescribed in the MRN specification. Moreover, each Identity Provider ensures that each IPSS of their name space refers to at most one entity of their domain.
- ID1.3 The MCC can give recommendations on how to structure the IPSS, for example to harmonize the syntax for particular types of entities. These recommendations will not be binding. However, the MCC reserves the right that a particular syntax can be binding with respect to conformance to certain profiles.

Note that ID1.1 and the second part of ID1.2 together ensure uniqueness: one MCP MRN is assigned to at most one entity. This is a general requirement for any URN. ID1.3 allows to harmonize the IP specific strings while not principally restricting the governance of an IP provider over its namespace.

EXAMPLE There are two ID providers, MIR X and MIR Y. Assume the MCC assigns the IPID "mirx" to MIR X, and "miry" to MIR Y respectively. The MCC ensures that the strings "mirx" and "miry" are not assigned to any other MIR. MIR X is responsible for the namespace "urn:mrn:mcp:<MCP-TYPE>:mirx:*", and MIR Y is responsible for the namespace "urn:mrn:mcp:<MCP-TYPE>:miry:*" respectively. They might decide to employ the same syntax for the IP specific string, and make this part of a profile they both adhere to. Other ID providers are not bound to use the same syntax. However, if they do not comply to it, they cannot be compliant to that profile.

Finally, the following is to ensure a good practice of transparency and interoperability:

- ID2 Every Identity Provider shall publish the syntax that describes their name space as well as provide a reference implementation that recognizes the strings of their namespace.

D.6.3.2 Further requirements for a strong notion of maritime identity

The vision of the MCP is to enable a strong concept of digital maritime identity. Hence, requirements that go beyond what is commonly required of URNs are established. Firstly, every MCP entity shall have a name within the MCP namespace. This gives a clear concept of MCP entity: those entities that are registered under an MCP MRN name. Secondly, one MCP entity shall not have several MCP MRNs. For example, this supports law enforcement: when a maritime entity gets discovered and blacklisted for "bad behaviour" (e.g. fake emergency signalling), then it cannot simply revert to another MCP identity and participate as usual.

- ID3 Every entity of the MCP shall hold exactly one MCP MRN (i.e. MRN governed by the MCP). This does not exclude that a MCP entity can hold other MRNs, but these shall be within namespaces governed by other organizations (e.g. IMO). Also, we will formulate exceptions concerning legacy MRNs within the MCP namespace.

Hence, the AtoN in the example above can be identified by its IALA MRN, or its MCP MRN respectively. However, Requirement ID3 rules out that the AtoN can be referred to by a second MCP MRN. The following requirements implement ID3 in a decentral manner.

- ID3.1 Each Identity Provider shall ensure that each entity they register holds at most one MCP MRN within their namespace.
- ID3.2 Each holder of a maritime entity shall ensure that this entity is registered with at most one MCP identity provider.

Note that practically it will not be possible to avoid that a "bad player" will seek to register their entity at several different Identity Providers and thereby obtain several MCP identities for it. However, ID3.1 ensures that they can obtain at most as many identities as there exist Identity Providers. And ID3.2 ensures that, when it is discovered that an entity holds several MCP MRNs of different providers, then it is clear that they have violated a rule (and action can be tied to this).

D.6.4 Public Key Infrastructure

D.6.4.1 General

In addition to a unique ID in the form of a MCP MRN, each MCP entity is provided with a cryptographic identity. This consists of a public/private key pair and a certificate for the public key bound to their ID. In the following, the concept of the PKI that enables this, as well as a first set of requirements for it, are described. Issues that need to be addressed and refined in the future are also identified.

In D.6.4.2.1, MCP core concepts of cryptographic identity and decentral PKI are explained. In D.6.4.3, requirements on cryptographic keys and mechanisms are specified. In D.6.4.4, the format of MCP certificates is described. Moreover, D.6.4.5 shows how a service can use an intermediary level of service certificates. For example, this is necessary if a service comes with cryptographic requirements that do not allow the direct use of the MCP ID credentials. Finally, in D.6.4.6, further aspects to be considered are identified.

D.6.4.2 Core concepts

D.6.4.2.1 Cryptographic identity

The cryptographic ID of a MCP entity consists of a public/private key pair and a certificate bound to their MRN. The certificate is issued by the identity provider responsible for the entity. The latter is clearly defined by the IPID string within the MRN of the entity.

Given an entity with MRN A (short: entity A), and its identity provider P, we use the following notation:

- pkA is the public key of A, and prA is the private key of A respectively;
- certP(A, pkA, V) is the certificate of A signed by its identity provider P. The certificate contains the MRN A, the public key of A, and the validity period V of the certificate (the precise format is provided in D.6.4.4).

The key pair is for use with a digital signature scheme. Hence, each MCP entity A can be verified by another party B to be the originator of a message or other data. As usual, this involves the following steps.

1) Entity A signs the message, say M, using its private key prA. The result is a cyphertext C.
2) Entity A makes available its certificate certP(A, pkA, V), and transmits the signed message M||C.
3) Entity B obtains the certificate, and receives the signed message.
4) Entity B validates the certificate. As a result, B trusts that pkA is the valid public key of the MCP entity with MRN A. (Necessary requirements on certificate validation will be specified.)
5) Entity B uses pkA to verify whether the ciphertext C is indeed the digital signature of M. If the verification is successful, then B has assurance that M indeed originates from A.

NOTE 1 Without 4), B only has assurance that M originates from the holder of the private key counterpart of pkA.

NOTE 2 B does not necessarily need to be an MCP entity.

At the time of writing, the MCC does not prescribe a policy on how to use ID credentials. They could be used as long-term credentials to obtain short-term credentials for use for a service, or they could be directly used as working credentials. Also see D.6.4.5 on a related issue.

D.6.4.2.2 Decentral PKI

One of the principles of the MCP is to make do without a global notion of trust: in the international context of the MCP, it is not possible to expect that all parties trust each other and each other's security management uniformly. Rather, the goal of the MCP is to provide the transparency that enables organizations to decide on whom to trust in which context, and to provide the technical framework to translate such decisions into executable policies. For the PKI, we put forward the following three principles.

1) A security breach within the realm of one identity provider's PKI instance shall not enable an attacker to impersonate an entity within the realm (i.e. namespace) of another identity provider.
2) A security breach within an organization or set of organizations predefined by the MCC to carry out some task shall not enable an attacker to impersonate any MCP entity, unless the identity provider of the entity coincides with (one of) the organization(s). In short, this means identity providers' PKI instances can always remain secure independently from any central or distributed management by the MCC.
3) It is possible for everyone to obtain assurance as to the security level of any identity provider's PKI instance.

The first two principles immediately imply that a classical hierarchical PKI with a root CA hosted by the MCC will not do. We illustrate this by giving examples of impersonation attacks. Assume a hierarchical PKI structure with MCC root CA as shown in Figure D.7. To verify a MCP certificate certP(A, pkA, V), a receiving party has to verify the signature of the identity provider P with the public key of P provided in an intermediary certificate certMCC(P, pkP, V) issued by the MCC root CA. Further, to verify the intermediary certificate, the receiving party has to verify the signature of the MCC with the public key provided in the MCC root certificate certMCC(MCC, pkMCC, V). The latter provides the trust anchor accepted by the receiving party.

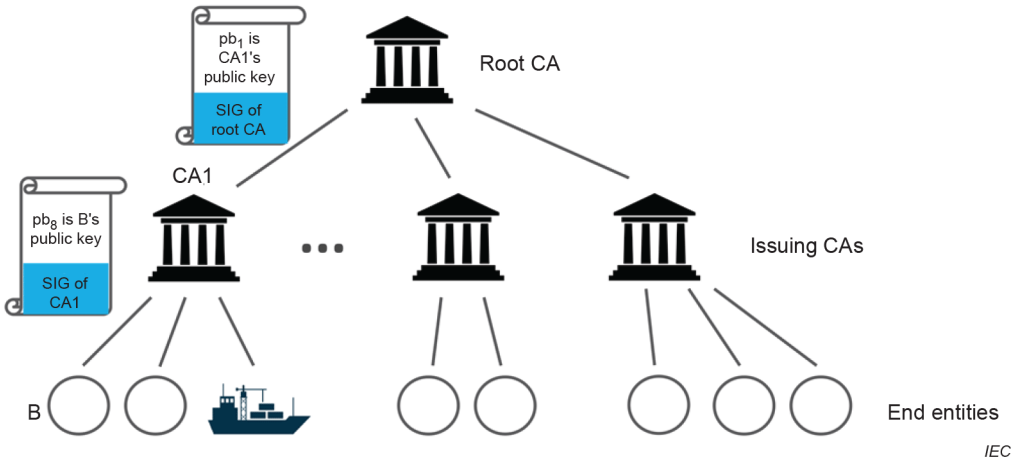


Figure D.7 – Hierarchical X.509 PKI Structure

Examples:

- Single point of attack: Assume the MCC root key prMCC is compromised. This will allow an attacker to impersonate any MCP entity A. Say P is the identity provider responsible for A. First, the attacker generates a key pair pkI(P), prI(P) and generates a fake certificate for P with their own key pkI(P): certMCC(P, pkI(P), V). This is possible since the attacker knows prMCC. Second, the attacker generates a key pair pkI(A), prI(A) and generates a fake certificate for A and their own key pkI(A): certI(P)(P, pkI(A), V). This is possible since they know prI(P). Altogether, the attacker can now present a valid certificate chain that establishes pkI(A) to be the public key of A while they know the private counterpart prI(A). Hence, they can impersonate A. Altogether, this violates principle 2) above.

- Weakest Link I: Say the attacker wishes to impersonate entity A of identity provider P. Note that, in classic X.509 certificate validation, it is only verified that there is a certificate chain up to a trusted root certificate. Say the attacker can easily obtain fake certificates signed by another identity provider P', perhaps, because the attacker is a state actor and P' is under their governance. Then, analogously to above, they only need to generate their own key pair pbI(A), prI(A) and generate a fake certificate for A and pbI(A) signed by P': certP'(A, pbI(A), V). Since there is no check whether P' is indeed the identity provider of A, this gives the attacker a valid certificate chain and corresponding private key, with which they can impersonate A. This violates principle 1) above.
- Weakest Link II: Assume P is an identity provider of low security level, for example with a vetting procedure that can easily be undermined. Assume an attacker aims to join the MCP under a false identity so that they are able to inject fake messages without the risk of being traced. The attacker will simply choose P as the identity provider from whom to obtain their false identity. Without principle 3) in place, a receiving party has no way to consider the low security level of P when processing the information within the message.

This motivates the following requirements.

- PKI1.1 (PKI Structure) There shall be no root CA at the top level of the MCC. Every identity provider that hosts a PKI instance shall provide their own root CA.
- PKI1.2. (Validation of IPID) When a receiving party verifies a MCP certificate, say certP(A, pkA, V), it shall verify that the certificate is indeed signed by the identity provider responsible for A. The identity provider responsible for A can be read by the receiving party from the IDIP string within the MRN A.

The following requirements ensure that information on root certificates and security levels are made publicly available.

- PKI1.3. Every identity provider shall publish their currently valid root certificate in a suitable fashion. For example, this can be made accessible via their web page, or they can commission a generally accepted authority or assurer to do so.
- PKI1.4. Every identity provider shall make their security level publicly accessible in a suitable fashion. For example, they can provide a link from their web page to the database of their certification body.
- PKI1.5. The MCC will provide a list of identity providers, links to obtain their root certificates, and security levels. However, the MCC will not provide any warranty for this information.

D.6.4.2.3 Security requirements and profiles

Security requirements to be defined will fall into the following categories:

1) requirements on vetting – this can be specified similarly to classes such as EV (extended validation);
2) requirements on certificate revocation;
3) requirements on the validity period of certificates;
4) requirements on security of keys and origin of signing – CA side (including requirements on HSMs);
5) requirements on security of keys and origin of signing – MCP entity side (including requirements on HSMs).

The requirements will be dependent on the currently emerging profiles:

- MCP entities generate their ID key pair themselves and in own responsibility and provide this to the responsible CA for certification.
- The CA (perhaps together with a manufacturer) provisions the initial ID key pair and certificate securely within HSMs (for/within endpoints) to be distributed to the MCP entities.

D.6.4.3 Cryptographic requirements

The cryptographic mechanism approved for ID digital signatures is the elliptic curve digital signature algorithm or ECDSA (FIPS 186-3) with the appropriate hash algorithm from the SHA-2 family (FIPS 180-3). The approved elliptic curve domain parameters are specified by reference to standardized curves. Table D.1 gives the combinations that are approved.

Table D.1 – Domain parameters

ECDSA key size (bits)	Hash algorithm	Elliptic curve domain parameters
384	SHA-384	P-384 [FIPS 186-3] (= secp384r1)
256	SHA-256	P-256 [FIPS 186-3] (= secp256r1)

D.6.4.4 Certificate format

The format of the MCP ID certificates is specified in D.6.4.4. The format is based on the X.509 standard. The standard information present in an X.509 certificate includes the following items:

- version – which X.509 version applies to the certificate (which indicates what data the certificate includes);
- serial number – a unique assigned serial number that distinguishes it from other certificates;
- algorithm information – the algorithm used to sign the certificate;
- issuer distinguished name – the name of the entity issuing the certificate (MCP);
- validity period of the certificate – start/end date and time;
- subject distinguished name – the name of the identity the certificate is issued to;
- subject public key information – the public key associated with the identity.

The subject distinguished name field consists of the items in Table D.2.

Table D.2 – Subject distinguished name field items

Field	User	Vessel	Device	Service	MMS	Organization
CN (CommonName)	Full name	Vessel name	Device name	Service Domain Name	MMS name	Organization Name
O (Organization)	Organization MRN					
OU (Organizational Unit)	"user"	"vessel"	"device"	"service"	"mms"	"organization"
E (Email)	User email					Organization email
C (Country)	Organization country code					
UID	Entity MRN					Organization MRN

The following gives an example of the Subject distinguished name field for a vessel with identity provider idp1:

C=DK, O=urn:mrn:mcp:org:idp1:dma, OU=vessel, CN=JENS SØRENSEN, UID=urn:mrn:mcp:vessel:idp1:dma:jens-soerensen

In addition to the information stored in the standard X.509 attributes listed above, the X509v3 extension SubjectAlternativeName (SAN) extension is used to store extra information. There already exists some predefined fields for the SAN extension, but they do not match the need in maritime related fields. Therefore, the "otherName" field is used, which allows for using an object identifier (OID) to define custom fields. The OIDs currently used are not registered at ITU, but are randomly generated using a tool provided by ITU (see http://www.itu.int/en/ITU-T/asn1/Pages/UUID/uuids.aspx). Table D.3 shows the fields defined, the OIDs of the fields and which kind of entities that use the fields.

Table D.3 – Fields and object identifiers

Field	OID	Used by
Flagstate	2.25.323100633285601570573910217875371967771	Vessels, Services
Callsign	2.25.208070283325144527098121348946972755227	Vessels, Services
IMO number	2.25.291283622413876360871493815653100799259	Vessels, Services
MMSI number	2.25.328433707816814908768060331477217690907	Vessels, Services
AIS shiptype	2.25.107857171638679641902842130101018412315	Vessels, Services
Port of register	2.25.285632790821948647314354670918887798603	Vessels, Services
Ship MRN	2.25.268095117363717005222833833642941669792	Services
MRN	2.25.271477598449775373676560215839310464283	Vessels, Users, Devices, Services, MMS
Permissions	2.25.174437629172304915481663724171734402331	Vessels, Users, Devices, Services, MMS
Subsidiary MRN	2.25.133833610339604538603087183843785923701	Vessels, Users, Devices, Services, MMS
Home MMS URL	2.25.171344478791913547554566856023141401757	Vessels, Users, Devices, Services, MMS
URL	2.25.245076023612240385163414144226581328607	MMS

Encoding of string values in certificates follows the specifications defined in RFC 5280, and where possible it is highly recommended to use UTF-8.

D.6.4.5 Service certificates

Several maritime services come with requirements concerning cryptography and/or certificate formats that might make it impossible to employ MCP ID credentials directly. For example, if an identity provider issues certificates for ECDSA with 384 bits key size, this will not meet the real-time requirements and low bandwidth conditions of Automatic Identification System (AIS) and VHF Data Exchange System (VDES). While the service has to then provide its own CA, the service CA can automatically issue its service certificates based on MCP ID credentials. We provide an example of how this can be done based on the concept of certificate signing requests (CSRs), also known as certification requests. The most common format for CSRs is defined by the PKCS#10 standard RFC 2986.

In the following, the steps carried out by an MCP entity to request a service certificate, and the steps performed by the service CA to issue the certificate respectively are shown as an example. The example follows the implementation of the Haptik CA from the project Haptik. This functionality will also be embedded in a web service and secured by the MCP OpenID Connect/OAuth 2.0 framework.

The MCP entity

1) generates a fresh key pair for use with the service,
2) builds a X.500 name for use in the service certificate,
3) builds a corresponding PKCS#10 CSR,
4) signs the CSR with their private MCP ID key, and
5) sends the CSR together with their MCP ID certificate to the service CA.

On receipt, the service CA

6) checks whether the CSR is valid,
7) builds a X.509v3 certificate according to the CSR and additional information provided by the CA such as issuer, serial number and validity period,
8) signs this with their CA private key, and
9) sends the new certificate to the requesting MCP party.

NOTE This pattern is also applicable when the MCP ID keys are mainly used as enrolment keys to obtain shorter lived "working keys".

D.6.4.6 Integration of other PKI systems

In the spirit of decentrality, the PKI remains open for PKI systems other than X.509, and also agile for update of certificate formats. Care will be taken to accommodate the necessary flexibility when defining usage of certificates. More to this point is provided by example of the P3KI approach.

D.6.5 Authentication and authorization for web services

For authentication and authorization in web services, the MCP offers users the ability to use OpenID Connect (OIDC). OpenID Connect is a token based authentication protocol that is built as a layer on top of the OAuth 2.0 authorization protocol.

A service provider can choose to use the MCP based OpenID Connect authentication for their web service. This means that when a user wants to use the service, they first login with their MCP credentials and receive an OIDC token from MCP that contains information about the user and what organization they belong to. The user can then use this token to authenticate themselves with the web service. The service provider can also choose to implement authorization based on the information in the token.

Table D.4 shows the claims that an MCP OpenID Connect token contains.

Table D.4 – MCP OpenID Connect token

Attribute	Description
preferred_username	The username of the user in the parent organization.
email	The email of the user.
given_name	First name of the user.
family_name	Last name of the user.
name	Full name of the user.
org	The Maritime Resource Name of the organization the user is a member of.
permissions	List of permissions for this user assigned by the organization the user is a member of.
mrn	The Maritime Resource Name of the user.
roles	List of roles that the user has in the role hierarchy.
acting_on_behalf_of	List of organizations that the user is allowed to act on behalf on excluding the user's own organization

D.6.6 Profile "Basic Requirements"

The profile "Basic Requirements" V1.0 consists of the following requirements:

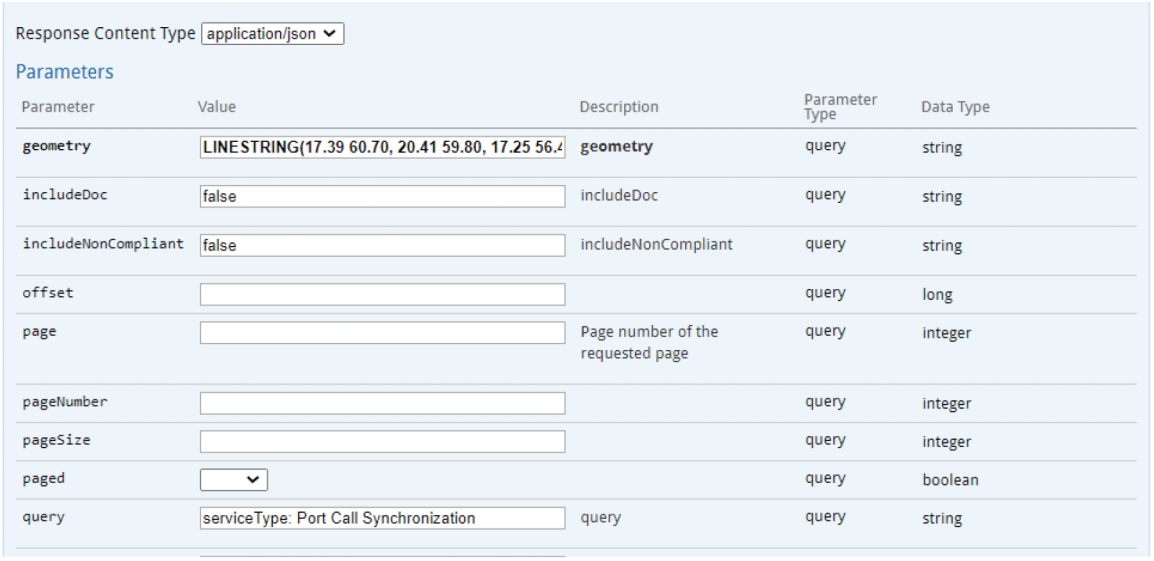
1) Identity Management
   - MCP MRN syntax as specified in D.6.3.1.
   - ID1, ID1.1 to ID1.3: decentral management of MCP MRNs.
   - ID2: transparency of syntax.
   - ID3, ID3.1 to ID3.2: strong notion of MCP entity.
2) PKI
   - PKI1.1 – PKI1.5: decentral PKI concept.
   - The cryptographic requirements as specified in D.6.4.3.
   - The certificate format as specified in D.6.4.4.

D.7 SECOM service discovery

D.7.1 Example 1: geometry combined with serviceType search

Request

Search for services with provided geometry inside service coverage area and service type "Port Call Synchronization". See Figure D.8 and Figure D.9.



IEC

Figure D.8 – Request find service with geometry and query

Query =

https://serviceregistry.navelink.org/api/_searchGeometryWKT/serviceInstance?geometry=LINESTRING(17.39 60.70, 20.41 59.80, 17.25 56.43)&includeDoc=false&includeNonCompliant=false&query=serviceType%3A Port Call Synchronization

Response


```
[
  {
    "id": 136,
    "name": "Port of Gavle",
    "version": "1.0",
    "publishedAt": "2020-11-16T10:53Z",
    "lastUpdatedAt": "2020-11-18T13:50Z",
    "comment": "This service is used to report arrival times to Port of Gävle and get confirmation or recommended RTA...",
    "geometry": {
      "type": "Polygon",
      "coordinates": [
        [
          [
            17.011284173205137,
            60.6578395558192
          ],
          [
            17.390312493517627,
            60.86243493611962
          ],
          [
            17.011284173205137,
            60.6578395558192
          ]
        ]
      ]
    },
    "geometryContentType": null,
    "keywords": "Voyageplan,Route,VIS,RTZ,ETA,SEGVX,SEKAS,Gavle",
    "status": "released",
    "unlocode": "SEGVX",
    "mmsi": "",
    "imo": "",
    "instanceAsXml": {
      "id": 147,
      "name": "SMA-MCP-PRODUCTION_Service_Instance-Port_of_Gavle_PCS.xml",
      "comment": "",
      "content": "<?xml version=\"1.0\" encoding=\"UTF-8\"?>\r\n<ServiceInstanceSchema:serviceInstance ...",
      "contentContentType": "text/xml"
    },
    "instanceAsDoc": null,
    "implementedSpecificationVersion": null,
    "docs": null,
    "compliant": true,
    "instanceId": "urn:mrn:mcp:service:navelink:sma:instance:vis:portofgavle",
    "organizationId": "urn:mrn:mcp:org:navelink:sma",
    "endpointUri": "https://vis.stm.sjofartsverket.se/portofgavle",
    "endpointType": null,
    "serviceType": "Port Call Synchronization",
    "designId": "urn:mrn:mcp:service:navelink:navelink:design:vis:rest:2.2",
    "specificationId": "urn:mrn:mcp:service:navelink:navelink:specification:vis:2.2"
  },
  {
    "id": 155,
    "name": "Facilitation of ship to shore reporting service",
    "version": "1.0.0",
    "publishedAt": "2020-11-19T13:48Z",
    "lastUpdatedAt": "2020-11-19T13:55Z",
    "comment": "The route plan of a ship must be reported to a coastal ..",
    "geometry": {
      "type": "Polygon",
      "coordinates": []
      }
  }
]
```


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Figure D.9 – Response from service registry

D.7.2 Example 2: Search with AND/OR condition

Request

Search for services with specific IMO and MMSI OR services with name containing "Baltic".

Query = (imo: 9443255 AND mmsi: 276779000) OR name: Baltic

https://serviceregistry.navelink.org/api/_search/serviceInstance?includeDoc=false&includeNonCompliant=false&query=(imo: 9443255 AND mmsi: 276779000) OR name: Baltic

Response

See Figure D.10.

```
[
  {
    "id": 62,
    "name": "Baltic Queen",
    "version": "1.0.0",
    "publishedAt": "2020-11-09T15:29Z",
    "lastUpdatedAt": "2020-11-26T15:06Z",
    "comment": "Ship voyage information mainly for meeting point calculation."
  },
  {
    "id": 61,
    "name": "Baltic Princess",
    "version": "1.0.0",
    "publishedAt": "2020-11-09T15:29Z",
    "lastUpdatedAt": "2020-11-26T15:06Z",
    "comment": "Ship voyage information mainly for meeting point calculation."
  },
  {
    "id": 148,
    "name": "Baltic Bright",
    "version": "1.0.0",
    "publishedAt": "2020-11-17T12:56Z",
    "lastUpdatedAt": "2020-12-03T09:17Z",
    "comment": "Provides voyage plans for Baltic Bright in RTZ 1.1STM."
  },
  {
    "id": 143,
    "name": "Baltic Navigational Warning Service",
    "version": "0.1",
    "publishedAt": "2020-11-16T13:51Z",
    "lastUpdatedAt": "2020-12-03T13:49Z",
    "comment": "The service provides Navigational Warnings in the Baltic region and Swedish T&P info."
  }
]
```


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Figure D.10 – Response from service registry

Annex E
(informative)

Use of white list

E.1 Purpose

A white list is an access control list of actors to whom a protected actor has granted access to information (for example from whom it is possible to receive S-421 based route plans). The protected actor manages its access control list. New entries for the access control list could originate from internal needs of the protected actor (for example, protected actor needs reference route to enter a port, protected actor needs weather optimization from external service provider) or from external needs (for example, a VTS centre would like to know the route plan of the protected actor i.e. vessel).

A white list is commonly used to enhance cyber security as it limits access to the information owner to other actors which have been granted the access before their attempts to access the information owner. The white list is also an effective tool against misbehaving by other actors which could be granted the access when properly behaving.

This Annex E contains a description and discussion around access principles, authorization and the internal use of white list to mitigate unwanted requests for information.

The white list management may include the methods below:

- the protected user as the owner of the information (for example, a ship in the case of a voyage plan) initiates the interaction and thereby spontaneously white-lists a service;
- other actors request access through an interface: if this is allowed, there can be "rules for behaviour", for example, how often an actor is allowed to send a request;
- the IMO or IALA e-navigation may evolve to provide "endorse services" through a trusted third party;
- other actors use a semi-administrative method (for example an automated email) to request white-listing from the protected actor. This may be supported by an entry in a service registry with an "administrative" email address for manual processing of such requests.

E.2 Authorization to access data

The next step after authentication of the actor is authorization, hence when the actor is known, the question is if the actor is allowed to read data from the protected actor, or if the actor is allowed to access the service of the protected actor.

The recommendation is to always consider authorization both to the service as well as authorization to data. The authorization depends on the design. The design decision can be that data is constrained to authorized actors only, or that the data is open for all actors; the importance is that this authorization is a conscious design decision.

The discussion and guidelines below is based on the assumption that data is exchanged through an information service that can perform authentication and authorization on the request and on its data. The fundamentals of the discussions are also to adhere to data authorization in general with the difference that, if there is no information service that handles the authorization, the data is forwarded until there is a component that can perform the authorization procedure.

Hence, the authorization procedure can be implemented in the information service representing the information owner, and/or authorization procedure can be implemented in the application of the information owner. If the information owner is a ship, the authorization may take place on shoreside service representing the ship and/or it may take place in the onboard systems.

- Authorization/access to upload (push) information to the protected actor:
  - the data server may be authorized based on predefined rules or list; or
  - the data server may get the response Not authorized to push data and may need to request access from the protected actor.
- Authorization/access to download/retrieve/get (pull) information from the protected actor:
  - the data client may be authorized based on predefined rules or list; or
  - the data client may get the response Not authorized to pull data and may need to request access from the protected actor.
- Authorization/access to be added in a subscription list of a service provider, hence new or updated data according to the subscription list of the service provider is uploaded (pushed) to the subscriber (i.e. protected actor)
  - If the subscriber (i.e. protected actor) is appointed (nominated) by the data server, the subscriber (data client) may also automatically be given access to data according to a subscription list.
  - If a data client (i.e. protected actor) requests to be a subscriber, the authorization procedure of the service provider is engaged:
    a) the data client may be authorized based on predefined rules or list of the service provider; or
    b) the data client may get the response Not authorized to data subscription and may need to request access from the service provider.

E.3 Access control list

From a ship point of view, access control is about who has rights to access data from or to the ship. Reasons to limit the access can be various, for example a ship does not wish that other actors see how they plan weather optimization, a ship wishes to limit who can ask for their data (motivation could be for example reduction of the management burden to accept or reject request), a ship wishes to block an actor (for example, if the actor is harmful, too aggressive, causes too much administrative burden, causes too much communication cost to be paid by the ship, etc.), a ship wishes to limit who can propose changes to the plans of the ship, etc.

The recommendation is to implement an access control list that contains the identifier to data and a list of actors with access rights to the data (white list). The use or no use of this facility to limit access will be under control of the ship.

The identifier to data can be to individual data objects (for example, S-421.RouteId) or a group of data based on filtering parameters (for example, S-421.routeStatus=Monitored or Terminated). It may also be to all data of a certain product (for example, all S-124 Navigational Warnings).

The actor is recommended to be identified with an identity from SECOM PKI, which ensures binding to keys and authenticated actor.

The access rights are typically specified as Read, Create, Update, Delete or None.

E.4 Authorization based on predefined rules or list

Both the data server and data client are recommended to implement a predefined white list (access control list) that can be

- manually updated by an operator or administrator,
- automatically updated based on rules, or
- a combination of both.

E.5 Manually updated list

The manually updated access control list is foreseen to be predefined by some administrator onboard or by a fleet operation centre. During sailing, there may be less time for manual update of the access control list.

E.6 Rule based handling on request to information (rule based authorization)

Rule based authorization requires more knowledge and trusted information about the requesting actor. Some examples of a rule are:

- allow read access to my S-421 Route Plan for all actors or services provided by (coastal state?) authority along my route;
- allow upload of S-421 recommended routes from all actors/services provided by (coastal state?) authority along my route.

This requires trusted information about the service provider, such as "provided by authority" or compliant with e-navigation service (for example MS1). This information may be possible to retrieve when searching for services. The information can be either in the format of a parameter in a registry that is "vetted" or a separate service (for example, Endorsement Service) where further information of the service provider can be retrieved.

E.7 Rule based request for information

An application has a rule to automatically request the active route plan from the ship. For example, a VTS identifies a ship via AIS but has not received its route plan.

E.8 Procedure when receiving "Not authorized"

Not authorized can refer to the service request itself or it can refer to the requested data object. When receiving this response, consuming the Access interface for requesting access can be performed.

Annex F
(informative)

Test and simulators

F.1 Purpose

The purpose is to give an overview of the test equipments required.

Three different types of EUTs are identified: Ship/Shore equipment, PKI equipment and Service Discovery equipment.

Overall, the test can be separated into two steps. The first step is to test the EUT using prepared test data without any live connections to other equipment and simulators. The second step is to connect the EUT to simulators where also the dynamic behavour can be tested.

F.2 Manual testing

The first initial step is manual tests of the EUT using prepared test data, open source tools and reference data for comparison as Figure F.1.

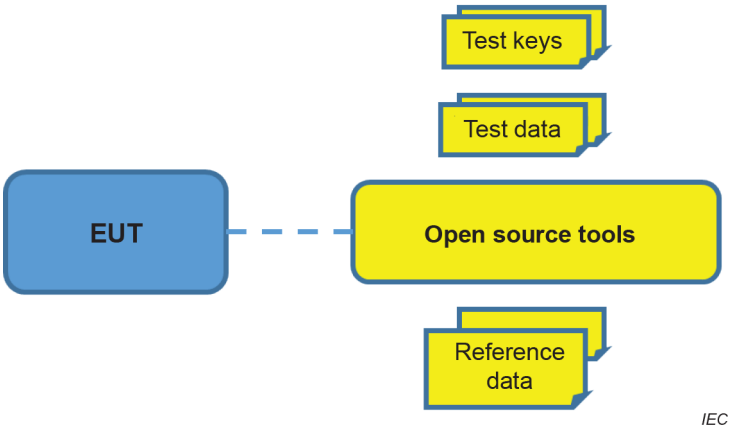

Figure F.1 – Manual testing

F.3 Ship and shore equipment

The main target for SECOM is the ship and shore equipment that shall exchange data in a secure way. See Figure F.2.

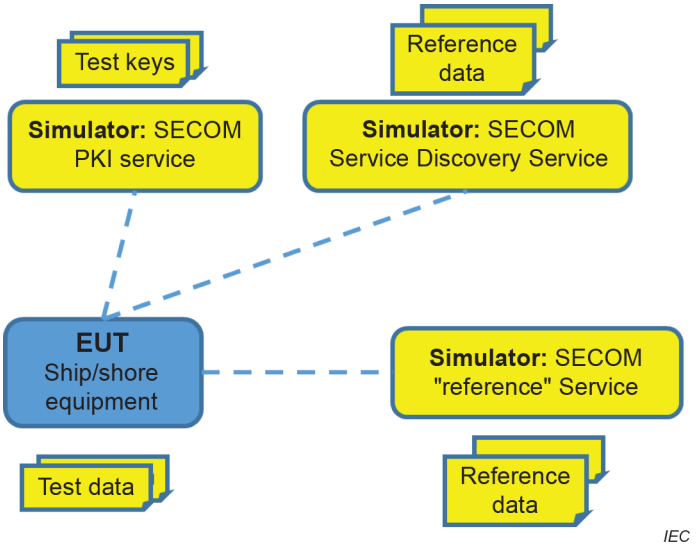

Figure F.2 – Overview of test equipment for ship and shore equipment

F.4 SECOM information service equipment

If the EUT is a SECOM Information Service, the simulator is a reference ship/shore REST-client equipment. See Figure F.3.

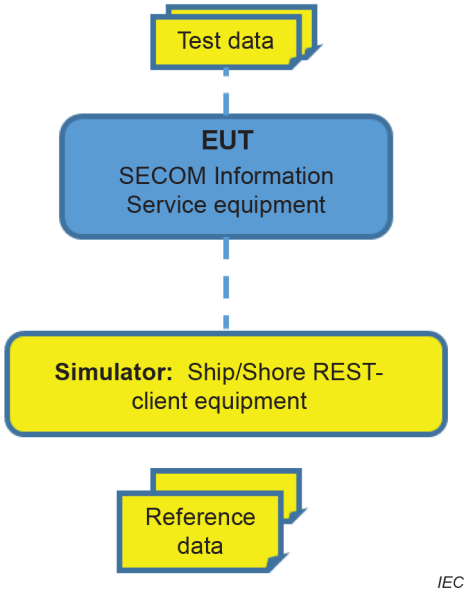

Figure F.3 – Overview of test equipment for SECOM information service equipment

F.5 SECOM PKI equipment

If the EUT is a SECOM PKI, the simulator is a reference ship/shore equipment. See Figure F.4.

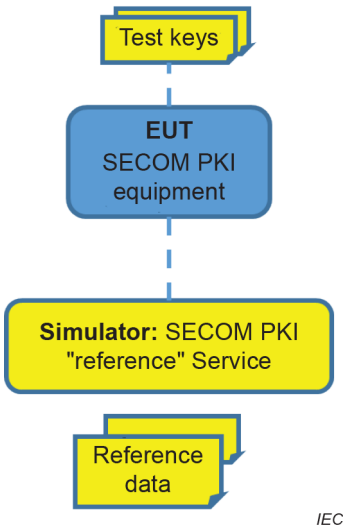

Figure F.4 – Overview of test equipment for SECOM PKI equipment

F.6 SECOM Service Discovery equipment

If the EUT is a SECOM service discovery, the simulator is a reference ship/shore equipment. See Figure F.5.

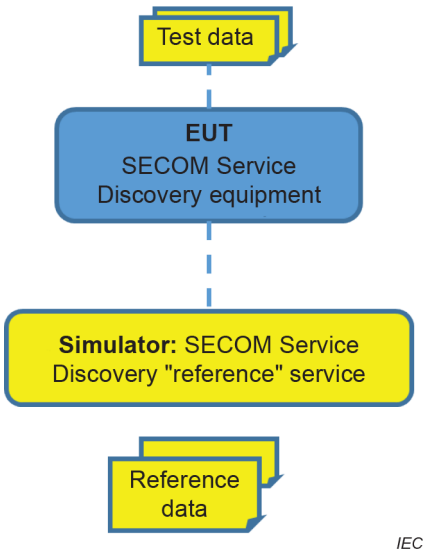

Figure F.5 – Overview of test equipment for SECOM service discovery equipment

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