Recommendation X.219

REMOTE OPERATIONS: MODEL, NOTATION AND SERVICE DEFINITION[1)]

(Melbourne, 1988)

The CCITT,

considering

(a) that Recommendation X.200 defines the Reference Model of Open Systems Interconnection (OSI) for CCITT applications;

(b) that Recommendation X.210 defines the service conventions for describing the services of the OSI reference model,

(c) that Recommendation X.216 defines the Presentation Layer service;

(d) that Recommendation X.217 defines the Association Control Service;

(e) that Recommendation X.218 defines the Reliable Transfer service;

(f) that Recommendation X.229 defines the Remote Operations protocol;

(g) that there is a need for common Remote Operations support for various applications;

unanimously declares

that this Recommendation defines the Remote Operation service and notation of Open Systems Interconnection for CCITT Applications as given in the Scope and Field of Application.

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1) Recommendation X.219 and ISO 9072-1 [Information Procesing Systems – Text Communications – Remote Operations, Part 1: Model, Notation and Service Definition] were developed in close collaboration and are technically aligned

CONTENTS

0 *Introduction*

1 *Scope and Field of Application*

2 *References*

3 *Definitions*

4 *Abbreviations*

5 *Conventions*

6 *Remote Operations Model*

7 *Overview of Notation and Service*

8 *Relationship with other Application Service Elements*

9 *Remote Operations Notation*

10 *Service Definition*

11 *Mapping of Notation to Service*

12 *Sequencing Information*

Annex A – Notation Supporting the Specification of application-service-elements and Application Contexts

Annex B – Guidelines for application Protocol Designers on the Use of ROSE

0 Introduction

This Recommendation defines a notation and the services provided by an application-service-element – the Remote Operations Service Element (ROSE) – to support interactive applications in a distributed open systems environment. This Recommendation is one of a set of Recommendations defining sets of application-service-elements commonly used by a number of applications.

Interactions between entities of a distributed application are modeled as Remote Operations, and defined using a Remote Operations Notation. A Remote Operation is requested by one entity; the other entity attempts to perform the Remote Operation and then reports the outcome of the attempt. Remote Operations are supported by the ROSE.

This Recommendation is technically aligned with ISO 9072-1.

1 Scope and Field of Application

This Recommendation defines a Remote Operation (RO-) Notation for defining the services provided to interactive applications. This Recommendation also defines the services provided by the Remote Operation Service Element (ROSE) services. The ROSE services are provided by the use of the ROSE protocol (Recommendation X.229) in conjunction with the Association Control Service Element (ACSE) services (Recommendation X.217) and the ACSE protocol (Recommendation X.227), optionally the Reliable Transfer Service Element (RTSE) services (Recommendation X.218) and the RTSE protocol (Recommendation X.228), and the presentation-service (Recommendation X.216).

No requirement is made for conformance to this Recommendation.

2 References

X.200 Reference Model of Open Systems Interconnection for CCITT Applications (see also ISO 7498).

X.208 Specification of abstract syntax notation (see also ISO 8824).

X.209 Specification of Basic Encoding Rules for the abstract syntax notation (see also ISO 8825).

X.210 Open Systems Interconnection Layer Service Definition Conventions (see also ISO/TR 8509).

X.216 Presentation Service Definition for Open Systems Interconnection for CCITT applications (see also ISO 8822).

X.217 Association Control Service Definition for CCITT Applications (see also ISO 8649).

X.218 Reliable Transfer: Model and Service Definition (see also ISO 9066-1).

X.227 Association Control Protocol Specification for CCITT Applications (see also ISO 8650).

X.228 Reliable Transfer: Protocol Specification (see also ISO 9066-2).

X.229 Remote Operations: Protocol Specification (see also ISO 9072-2).

3 Definitions

3.1 *Reference Model Definitions*

This Recommendation is based on the concepts developed in Recommendation X.200 and makes use of the following terms defined in it:

a) Application Layer;

b) application-process;

c) application-entity;

d) application-service-element;

e) application-protocol-data-unit;

f) application-protocol-control-information;

g) Presentation Layer;

h) presentation-service;

i) presentation-connection;

j) session-service;

k) session-connection;

l) transfer syntax; and

m) user-element.

3.2 *Service Conventions Definitions*

This Recommendation makes use of the following terms defined in Recommendation X.210:

a) service-provider;

b) service-user;

c) confirmed service;

d) non-confirmed service;

e) provider-initiated service;

f) service-primitive; primitive;

g) request (primitive);

h) indication (primitive);

i) response (primitive); and

j) confirm (primitive).

3.3 *Presentation Service Definitions*

This Recommendation makes use of the following terms defined in Recommendation X.216.

a) abstract syntax;

b) abstract syntax name;

c) transfer syntax name;

d) presentation context.

3.4 *Association Control Definitions*

This Recommendation makes use of the following terms defined in Recommendation X.217:

a) application-association; association;

b) application context;

c) Association Control Service Element;

3.5 *Reliable Transfer Definitions*

This Recommendation makes use of the following terms defined in Recommendation X.218:

a) Reliable Transfer Service Element.

3.6 *ROSE Definitions*

For the purpose of this Recommendation the following definitions apply:

3.6.1 **association-initiating-application-entity; association-initiator**

The application-entity that initiates the application-association.

3.6.2 **association-responding-application-entity; association-responder**

The application-entity that responds to the initiation of an application-association by another AE.

3.6.3 **invoking-application-entity; invoker**

The application-entity that invokes the Remote Operation.

3.6.4 **performing-application-entity; performer**

The application-entity that performs a Remote Operation invoked by the other application-entity.

3.6.5 **requestor**

The part of an application-entity that issues a request primitive for a particular ROSE service.

3.6.6 **acceptor**

The part of an application-entity that receives the indication primitive for a particular ROSE service.

3.6.7 **linked-operations**

A set of operations formed by one parent-operation and one or more child-operations.

3.6.8 **parent-operation**

An operation during the execution of which the performer may invoke linked child-operations to be performed by the invoker of the parent-operation.

3.6.9 **child-operation**

An operation which might be invoked by the performer of the linked parent-operation during the execution of the parent-operation, and which is performed by the invoker of the parent-operation.

3.6.10 **Remote Operations**

1) A concept and notation supporting the specification of interactive communication between application-entities. This includes the Remote Operation Service Element and the mapping of the notation onto the service primitives of used application-service-elements.

2) The set of bind-operations, unbind-operations and operations.

3.6.11 **RO-notation**

The notation used for the specification of Remote Operations, defined in this Recommendation.

3.6.12 **ACSE-user**

The application-specific function that performs the mapping of the bind-operation and unbind-operation of the RO-notation onto ACSE.

3.6.13 **Remote Operation Service Element**

The application-service-element defined in this Recommendation.

3.6.14 **ROSE-provider**

The provider of the Remote Operations Service Element services.

3.6.15 **ROSE-user**

The application-specific function that performs the mapping of the operations and errors of the RO-notation onto ROSE.

3.6.16 **RTSE-user**

The application-specific function that performs the mapping of the bind-operation and unbind-operation of the RO-notation onto RTSE.

3.6.17 **operation-interface**

The interface within an application entity between the user element and the application service elements, defined as a set of application service element services (Remote Operations) available to the user element in RO-notation.

4 Abbreviations

AE	application-entity
ACSE	Association Control Service Element
ASE	application-service-element
APDU	application-protocol-data-unit
OSI	Open Systems Interconnection
RO (or ROS)	Remote Operations
ROSE	Remote Operations Service Element
RT (or RTS)	Reliable Transfer
RTSE	Reliable Transfer Service Element

5 Conventions

This Recommendation defines services for the ROSE following the descriptive conventions defined in Recommendation X.210. In § 10, the definition of each ROSE service includes a table that lists the parameters of its primitives. For a given primitive, the presence of each parameter is decribed by one of the following values:

blank not applicable

M mandatory

U user option

C conditional

O presence is a ROSE service-provider option

In addition, the notation (=) indicates that a parameter value is semantically equal to the value to its left in the table.

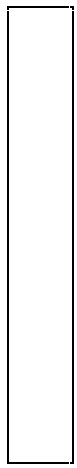
6 Remote Operations Model

In the OSI environment, communication between application processes is represented in terms of communication between a pair of application entities (AEs) using the presentation service. Communication between some application-entities are inherently interactive. Typically, one entity requests that a particular operation be performed; the other entity attempts to perform the operation and then report the outcome of the attempt. This Section introduces the concept of Remote Operations as a vehicle for supporting interactive applications.

The generic structure of an operation is an elementary request/reply interaction. Operations are carried out within the context of an application-association.

Figure 1/X.219 models this view.

Figure 1 = 6 cm



Operations invoked by one AE (the invoker) are performed by the other AE (the performer). Operations may be classified according to whether the performer of an operation is expected to report its outcome:

- in case of success or failure (a result reply is returned if the operation is successful, an error reply is returned if the operation is unsuccessful);
- in case of failure only (no reply is returned if the operation is successful, an error reply is returned if the operation is unsuccessful);
- in case of success only (a result reply is returned if the operation is successful, no reply is returned if the operation is unsuccessful);
- or not at all (neither a result nor an error reply is returned, whether the operation was successful or not).

Operations may also be classified according to two possible operation modes: synchronous, in which the invoker requires a reply from the performer before invoking another operation; an asynchronous, in which the invoker may continue to invoke further operations without awaiting a reply.

The following Operation Classes are defined:

Operation Class 1: Synchronous, reporting success or failure (result or error).

Operation Class 2: Asynchronous, reporting success or failure (result or error).

Operation Class 3: Asynchronous, reporting failure (error) only, if any.

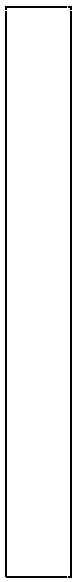
Operation Class 4: Asynchronous, reporting success (result) only.

Operation Class 5: Asynchronous, outcome not reported.

The Operation Class of each operation has to be agreed between application entities (e.g. in an Application Protocol Recommendation).

In some cases it is useful to group operations into a set of linked-operations which is formed by one parent-operation and one or more child-operations. The performer of the parent-operation may invoke none, one, or more child-operations during the execution of the parent-operation. The invoker of the parent-operation is the performer of the child-operations. A child-operation may be a parent-operation of another set of linked-operations in a recursive manner. Figure 2/X.219 models this concept.

Figure 2 = 7,5 cm



An application-association defines the relationship between a pair of AEs, and is formed by the exchange of application-protocol-control-information through the use of presentation-services. The AE that initiates an application-association is called the association-initiating AE, or the association-initiator, while the AE that responds to the initiation of an application-association by another AE is called the association-responding AE, or the association-responder. Only the association-initiating AE may release an established application-association.

Application-associations are classified by which application-entity is allowed to invoke operations:

Association Class 1: Only the association-initiating application entity can invoke operations.

Association Class 2: Only the association-responding application entity can invoke operations.

Association Class 3: Both the association-initiating and the association-responding application entities can invoke operations.

Linked-operations require Association Class 3.

The Association Class has to be agreed between application-entities (e.g. in an Application Protocol Recommendation).

The functionality of an AE is factored into one user-element and a set of application-service-elements (ASEs). Each ASE may itself be factored into a set of (more primitive) ASEs. The interaction between AEs is described in terms of their use of ASEs.

The specific combination of a user-element and the set of ASEs which comprise an AE defines the application-context.

Figure 3/X.219 illustrates an example of an application-context involving the Remote Operations Service Element (ROSE). Note that this figure is not meant to imply that the application is symmetric. Interactive applications are often inherently asymmetric, that is, either one or both AEs may be permitted to invoke operations, and the operations that either AE may invoke may be different. The rules governing which AE may invoke operations, and which operations an AE may invoke, is defined using the RO-notation in an Application Protocol Recommendation, and determines the application-context.

The set of ASEs available to the user element of the AE at the operation-interface is defined using the Remote Operations (RO-) Notation. The RO-notation is based on the macro concept defined in Recommendation X.208. The complexity of a particular set of ASEs is dependent upon the needs of the application, and is not limited by the Remote Operations concept.

An important characteristic of Remote Operations is that they provide applications with independence from OSI communication services. Since the notation is based on established object-oriented programming principles, automatic tools can be developed to bind Remote Operations into the execution environment of applications.

The ASEs available to the user-element require communication over an application-association. The control of that application-association (establishment, release, abort) is performed either by the Association Control Service Element (ACSE) defined in Recommendation X.217, or the Reliable Transfer Service Element defined in Recommendation X.218 and the Association Control Service Element (ACSE). Communication over the application-association is performed by the Remote Operations Service Element (ROSE) defined in this Recommendation.

An application-specific function performs the mapping of the operations available to the user-element onto either the ACSE services, or the RTSE services; and the ROSE services. The mapping is defined in this Recommendation. The function that performs the mapping of the operations onto the ACSE services, or the RTSE services, and the ROSE services is said to be the user of ACSE, RTSE and ROSE, or the ACSE-user, the RTSE-user, and the ROSE-user.

If the RTSE is included in the application-context, the mapping function is an RTSE-user and a ROSE-user, the ROSE is an RTSE-user, the RTSE is an ACSE-user and a presentation service-user, and the ACSE is a presentation service-user.

If the RTSE is excluded from the application-context, the mapping function is an ACSE-user and a ROSE-user, the ROSE is a presentation service-user, and the ACSE is a presentation service-user.

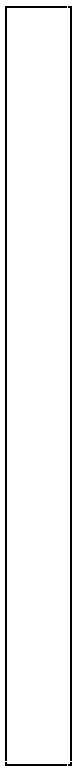
7 Overview of Notation and Service

7.1 *Notation Overview*

This Recommendation defines the RO-notation for the specification of an application-context and the related abstract syntax component of the presentation context.

The functionality of an application-context is provided to the user-element by means of Remote Operations and errors which form the operation-interface.

Figure 3 = 10 cm



The following types of Remote Operations form an operation interface:

– a bind-operation to establish an application-association

– a set of operations and, for each operation, a list of error (negative reply) situations

– an unbind-operation to release an application-association.

The abstract syntax notation of Recommendation X.208 is used for the definition of the following macros:

a) BIND;

b) UNBIND;

c) OPERATION; and

d) ERROR.

These macros provide both a type notation and a value notation for Remote Operations and errors.

The type notation of the BIND macro enables the specification for a bind-operation type and the types for user data values (if any) to be exchanged in the establishment phase of an application-assocation. The value notation of the BIND macro enables the specification of user data values (if any) to be exchanged in the establishment phase of an application-association.

The type notation of the UNBIND macro enables the specification of an unbind-operation type and types for user data values (if any) to be exchanged in the release phase of an application association. The value notation of the UNBIND macro enables the specification of user data values (if any) to be exchanged in the release phase of an application-association.

The type notation of the OPERATION macro enables the specification of an operation and user data types to be exchanged for a request and a positive reply. In addition, the type notation enables the specification of a list of valid negative reply situations. If the operation is a parent-operation, the type notation enables the specification of the list of linked child-operations. The value notation of the OPERATION macro enables the specification of the identifier of an operation.

The type notation of the ERROR macro enables the specification of user data types to be exchanged in a negative reply situation. The value notation of the ERROR macro enables the specification of the identifier of an error.

Additional macros supporting the notation for the specification of application-service-elements and application context are defined in Annex A.

7.2 *Service Overview*

This Recommendation defines the following ROSE services:

a) RO-INVOKE

b) RO-RESULT

c) RO-ERROR

d) RO-REJECT-U

e) RO-REJECT-P

The RO-INVOKE service enables an invoking AE to request an operation to be performed by the performing AE.

The RO-RESULT service enables the performing AE to return the positive reply of a successfully performed operation to the invoking AE.

The RO-ERROR service enables the performing AE to return the negative reply of an unsuccessfully performed operation to the invoking AE.

The RO-REJECT-U service enables one AE to reject the request or reply of the other AE if the ROSE-user has detected a problem.

The RO-REJECT-P service enables the ROSE-user to be informed about a problem detected by the ROSE-provider.

7.3 *Mapping of Notation onto Services*

Note that the function that performs the mapping of the OPERATION macros and ERROR macros of the RO-notation onto ROSE services is said to be the ROSE-user. While the function that performs the mapping of the BIND and UNBIND macros of the RO-notation onto ACSE services or RTSE services respectively is said to be the ACSE-user or RTSE-user respectively.

The specification of the mapping of the RO-notation onto the used services of ACSE, RTSE, and ROSE is given in § 11. Therefore Recommendations using the RO-notation for the protocol specification need not specify the mapping onto these used services.

8 Relationship with other ASEs and Lower Layer Services

8.1 *Other Application Service Elements*

The ROSE is intended to be used with other ASEs in order to support specific interactive information processing tasks. Therefore it is expected that the ROSE will be included in a large number of application-context specifications.

The collection of the ROSE and other ASEs included in an application context are required to use the facilities of the presentation-service in a co-ordinated manner among themselves.

The ROSE requires an existing application-association controlled by ACSE.

For some application context specifications a Reliable Transfer Service Element (RTSE) is included.

A ROSE-user protocol specification uses the RO-notation. It defines one or more abstract syntaxes and provides unique abstract syntax names of type object identifier for each abstract syntax.

If a named abstract syntax specifies operations and errors, the ROSE APDUs defined in Recommendation X.229 are included in that named abstract syntax. If multiple named abstract syntaxes are defined for operations and errors, the ROSE APDUs are included in each named abstract syntax.

If a named abstract syntax specifies a bind-operation, the APDUs specified by the value notation of the BIND macro are included in that named abstract syntax. If the RTSE is included in the application context, the APDUs for the bind-operation share a single named abstract syntax with the RTSE APDUs defined in Recommendation X.228.

If a named abstract syntax specifies an unbind-operation, the APDUs specified by the value notation of the UNBIND macro are included in that named abstract syntax.

The APDUs resulting from the specification of a bind-operation, an unbind-operation, operations and errors and the RTSE APDUs may share a single named abstract syntax.

8.2 *Presentation-Service*

If an application context including RTSE and ROSE is defined, ROSE services do not use the presentation-service.

If an application context including ROSE but excluding RTSE is defined, the ROSE services require access to the P-DATA service and require the use of the duplex functional unit of the presentation-service. The ROSE services neither use, nor constrain the use of, any other presentation service.

A named abstract syntax associated with a compatible transfer syntax (negotiated by the Presentation Layer) constitutes a presentation context.

The object identifier value {joint-iso-ccitt ans1(1) basic-encoding(1)} specified in Recommendation X.209 may be used as a transfer syntax name. In this case the ROSE-user protocol specification need not name nor specify a transfer syntax.

9 Remote Operations Notation

9.1 *General*

The notation used in this Recommendation is defined as follows:

– the data syntax notation and macro notation are defined in Recommendation X.208;

– the Remote Operation macros are defined in § 9.2 of this Recommendation.

A bind-operation defines where an object binding (establishment of an application-association) begins. If such a binding is established, operations may be invoked. An unbind-operation defines where an object binding is released.

An interactive protocol is specified using the Remote Operation and error data types. This section defines those types. It also explains the notational definitions of a particular Remote operation, and of the particular errors it can report. The notation is defined by means of the macro facility defined in Recommendation X.208. This macro definition allows a generalized specification of the mapping onto various execution environments.

The macros enabling the specification of bind-operations, unbind-operations, operations and errors are listed in Figure 4/X.219.

9.2 *Specification of Bind-operations*

A single data value, the argument of the bind-operation, may accompany the request to establish the application-association. Some bind-operations report their outcome, whether success (i.e. the normal outcome) or failure (i.e. the exceptional outcome). Other bind-operations report their outcome only if they fail, and still others never at all. A single data value, the result of the bind-operation, may accompany the positive response. A single data value, the bind-error of the bind-operation, may accompany the negative response.

The notation for a bind-operation type is the keyworkd BIND, optionally followed by the keyword ARGUMENT and the type of the bind-operation's argument, the reference name optionally assigned to it, and the nature of the operation's outcome reporting (if any). If the bind-operation reports success, the keyword RESULT and the type of its result and the reference name optionally assigned to it are specified. If the bind-operation reports failure, the keyword BIND-ERROR and the type of the error-information it reports and the reference name optionally assigned to it are specified.

The value notation for a bind-operation is either an argument value, or a result value or an error value. The value notation for an argument value (if any) is the keyword ARGUMENT followed by a value of the argument type. The value notation for a result value (if any) is the keyword RESULT followed by a value of the result type. The value notation for an error value (if any) is the keyword ERROR followed by a value of the error type.

```
Remote-Operation-Notation {joint-iso-ccitt remote-operations(4) notation(0)}
DEFINITIONS ::=
BEGIN
EXPORTS BIND, UNBIND, OPERATION, ERROR;
– – macro definition for bind-operations
BIND MACRO ::=
BEGIN
TYPE NOTATION          ::= Argument Result Error
VALUE NOTATION         ::= Argument-value | Result-value | Error-value

Argument               ::= empty | "ARGUMENT" Name type (Argument-type)
                           – – Expects any ASN.1 type and assigns it to the variable Argument-type

Result                 ::= empty | "RESULT" Name type (Result-type)
                           – – Expects any ASN.1 type and assigns it to the variable Result-type

Error                  ::= empty | "BIND-ERROR" Name type (Error-type)
                           – – Expects any ASN.1 type and assigns it to the variable Error-type

Name                   ::= empty | identifier

Argument-value         ::= empty | "ARGUMENT" value (Arg-value Argument-type)
                           – – Expects a value for the type in Argument-type, and assigns it to the
                           – – variale Arg-value
                           <VALUE [16] EXPLICIT Argument-type ::= Arg-value>

Result-value           ::= empty | "RESULT" value (Res-value Result-type)
                           – – Expects a value for the type in Result-type, and assigns it to the
                           – – variable Res-value
                           <VALUE [17] EXPLICIT Result-type ::= Res-value>
                           – – Returns the final value as explicitly tagged type

Error-value            ::= empty | "ERROR" value (Err-value Error-type)
                           – – Expects a value for the type in Error-type, and assigns it to the
                           – – variable Err-value
                           <VALUE [18] EXPLICIT Error-type ::= Err-value>
                           – – Returns the final value as explicitly tagged type

END
– – Remote Operations Notation continued
```

FIGURE 4/X.219 (Part 1 of 3)

Formal Definition of Remote Operations Data Types

```
– – Remote Operations Notation continued
– – macro definition for unbind-operations

UNBIND MACRO ::=
BEGIN

TYPE NOTATION          ::= Argument Result Errors
VALUE NOTATION         ::= Argument-value | Result-value | Error-value

Argument               ::= empty | "ARGUMENT" Name type (Argument-type)
                           – – Expects any ASN.1 type and assigns it to the variable Argument-type

Result                 ::= empty | "RESULT" Name type (Result-type)
                           – – Expects any ASN.1 type and assigns it to the Result-type

Error                  ::= empty | "UNBIND-ERROR" Name type (Error-type)
                           – – Expects any ASN.1 type and assigns it to the Error-type

Name                   ::= empty | identifier

Argument-value         ::= empty | "ARGUMENT" value (Arg-value Argument-type)
                           – – Expects a value for the type in Argument-type, and assigns it to the
                           – – variable Arg-value
                           <VALUE [19] EXPLICIT Argument-type ::= Arg-value>
                           – – Returns the final value as explicitly tagged type

Result-value           ::= empty | "RESULT" value (Res-value Result-type)
                           – – Expects a value for the type in Result-type and assigns it to the
                           – – variable Res-value
                           <VALUE [20] EXPLICIT Result-type ::= Res-value>
                           – – Returns the final value as explicitly tagged type

Error-value            ::= empty | "ERROR" value (Err-value Error-type)
                           – – Expects a value for the type in Error-type and assigns it to the
                           – – variable Err-value
                           <VALUE [21] EXPLICIT Error-type ::= Err-value>
                           – – Returns the final value as explicitly tagged type

END
– – Remote Operations Notation continued
```

FIGURE 4/X.219 (Part 2 of 3)

Formal Definition of Remote Operations Data Types

```
– – Remote Operations Notation continued
– – macro definition for operations
OPERATION MACRO ::=
BEGIN
TYPE NOTATION       ::=  ArgumentResultErrorsLinkedOperations
VALUE NOTATION      ::=  value (VALUE CHOICE {
                                    localValue      INTEGER,
                                    globalValue     OBJECT IDENTIFIER})
Argument            ::=  "ARGUMENT" NamedType | empty
Result              ::=  "RESULT" ResultType | empty
ResultType          ::=  NamedType | empty
Errors              ::=  "ERRORS" "{"ErrorNames"}" | empty
LinkedOperations    ::=  "LINKED" "{"LinkedOperationsNames"}" | empty
ErrorNames          ::=  ErrorList | empty
ErrorList           ::=  Error | ErrorList "," Error
Error               ::=  value (ERROR)          – – shall reference an error value
                         | type     – – shall reference an error type if no error value is specified
LinkedOperation-    ::=  OperationList | empty
Names
OperationList       ::=  Operation | OperationList "," Operation
Operation           ::=  value (OPERATION)      – – shall reference an operation value
                         | type     – – shall reference an operation type if no operation value is specified
NamedType           ::=  identifier type | type
END
– – macro definition for operations errors
ERROR MACRO ::=
BEGIN
TYPE NOTATION       ::=  Parameter
VALUE NOTATION      ::=  value (VALUE CHOICE {
                                    localValue      INTEGER,
                                    globalValue     OBJECT IDENTIFIER})
Parameter           ::=  "PARAMETER" NamedType | empty
NamedType           ::=  identifier type | type
END
END   – – end of Remote Operations Notation
```

FIGURE 4/X.219 (Part 3 of 3)

Formal Definition of Remote Operations Data Types

9.3 *Specifications of Unbind-operations*

A single data value, the argument of the unbind-operation, may accompany the request to release the application-association. Some unbind-operations report their outcome, whether success (i.e. the normal outcome) or failure (i.e. the exceptional outcome). Other unbind-operations report their outcome only if they fail, and still others never at all. A single data value, the result of the unbind-operation, or a single data value, the unbind-error of the unbind-operation, may accompany the response.

The notation for an unbind-operation type is the keyword UNBIND, optionally followed by the keyword ARGUMENT and the type of the unbind-operation's argument, the reference name optionally assigned to it, and the nature of the unbind-operation's outcome reporting (if any). If the unbind-operation reports success, the keyword RESULT and the type of its result and the reference name optionally assigned to it are specified. If the Unbind-operation reports failure, the keyword UNBIND-ERROR and the type of the error-information it reports and the reference name optionally assigned to it are specified.

The value notation for an unbind-operation is either an argument value, or a result value or an error value. The value notation for an argument value (if any) is the keyword ARGUMENT followed by a value of the argument type. The value notation for a result value (if any) is the keyword RESULT followed by a value of the result type. The value notation for an error value (if any) is the keyword ERROR followed by a value of the error type.

9.4 *Specification of Operations*

A data value of type operation represents the identifier for an operation that a ROSE-user in one open system may request to be performed by a peer ROSE-user in another open system. A single data value, the argument of the operation, may accompany the request. Some operations report their outcome, whether success (i.e. the normal outcome) or failure (i.e. the exceptional outcome). Other operations report their outcome only if they fail, and still others never at all. A single data value, the result of the operation, accompanies a report of succes; a report of failure identifies the exceptional condition that was encountered.

The notation for an operation type is the keyword OPERATION, optionally followed by the keyword ARGUMENT and the type of the operation's argument, the reference name optionally assigned to it, and the nature of the operation's outcome reporting (if any). If the operation reports success, the keyword RESULT and optionally the type of its result and the reference name optionally assigned to it are specified. If the operation reports failure, the keyword ERRORS and the reference names of the error values or error types it reports are specified. If the operation is the parent-operation of a set of linked-operations, the keyword LINKED-OPERATIONS and the reference names of the linked child-operation values or child-operation types are specified. The reference to error values or child-operation values is preferred, however, the references to types shall be used if the values are defined elsewhere (see § 9.6).

The notation for an operation value is the operation's identifier. If a locally unique identifier (local value) is sufficient, the identifier is of type INTEGER. If a globally unique identifier (global value) is required to allow the unique identification of operations used in several abstract syntaxes, the identifier is of type OBJECT IDENTIFIER.

Child-operations and errors referenced by a specific operation shall share a single named abstract syntax (see sub- § 8.1) with that operation, if the child-operations or errors are identified by local values. The use of global values is not restricted.

9.5 *Specification of Errors*

A data value of type error represents the identifier for an exception condition that a ROSE-user in one open system may report to a peer ROSE-user in another open system, where the exception condition is reporting an exceptional outcome of a previously requested operation. A single data value, the parameter of the error, may accompany the report.

The notation for an error type is the keyword ERROR, optionally followed by the keyword PARAMETER and the type of the error's parameter and the reference name optionally assigned to it.

The notation for an error value is the error's identifier. If a locally unique identifier (local value) is sufficient, the identifier is of type INTEGER. If a globally unique identifier (global value) is required to allow the unique identification of errors used in several abstract syntaxes, the identifier is of type OBJECT IDENTIFIER.

9.6 *Export and Import of Operations and Errors*

Operation values and error values have to be unique within a named abstract syntax. If operations and errors are specified in several ASN.1 modules and are imported to a module specifying a specific named abstract syntax, one of the following rules apply:

1) If local values are used and exported, it is in the responsibility of the designer of the importing module to ensure uniqueness.
2) A module may specify and export operation types and error types. The operation values and error values are assigned in the module importing the types. A single value shall be assigned for each operation type or error type.
3) If global values are assigned and exported, uniqueness is ensured.

However different named abstract syntaxes might be used for conflicting local values.

10 Service Definition

The ROSE services are listed in Table 1/X.219.

TABLE 1/X.219

ROSE Services

Service	Type
RO-INVOKE	Non-confirmed
RO-RESULT	Non-confirmed
RO-ERROR	Non-confirmed
RO-REJECT-U	Non-confirmed
RO-REJECT-P	Provider-initiated

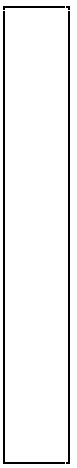
Identification of the named abstract syntax in use is assumed for all ROSE services, however this is a local matter and outside the scope of this Recommendation.

10.1 *RO-INVOKE Service*

The RO-INVOKE service is used by one ROSE-user (the invoker) to cause the invocation of an OPERATION to be performed by the other ROSE-user (the performer). This service is a non-confirmed service.

The related service structure consists of two service-primitives, as illustrated in Figure 5/X.219.

Figure 5 = 6 cm



10.1.1 *RO-INVOKE Parameters*

Table 2/X.219 lists the RO-INVOKE service parameters.

TABLE 2/X.219

RO-INVOKE Parameters

Parameter name	Request	Indication
Operation-value	M	M (=)
Operation-class	U	
Argument	U	C (=)
Invoke-ID	M	M (=)
Linked-ID	U	C (=)
Priority	U	

10.1.1.1 *Operation-value*

This parameter is the identifier of the operation to be invoked. The value has to be agreed between the ROSE-users. This parameter has to be supplied by the requestor of the service.

10.1.1.2 *Operation Class*

This parameter defines whether a synchronous or an asynchronous reply is expected and the nature of the expected reply, i.e. result and/or error or non (see § 6). This parameter has to be supplied by the requestor of the service. This parameter is used solely to optimize the turn management (see § 8.1.1 of Recommendation X.229).

10.1.1.3 *Argument*

This parameter is the argument of the invoked operation. The type has to be agreed between the ROSE-users. This parameter has to be supplied by the requestor of the service.

10.1.1.4 *Invoke-ID*

This parameter identifies the request of a RO-INVOKE service and is used to correlate this request with the corresponding replies (RO-RESULT, RO-ERROR, RO-REJECT-U, and RO-REJECT-P services) or the invocation of linked child-operations (RO-INVOKE). This paramter has to be supplied by the requestor of the service.

This parameter distinguishes several requests of the service the requestor may have in progress (asynchronous operations). The requestor may begin to reuse Invoke-ID values whenever it chooses, subject to the constraint that it may not reuse an Invoke-ID value that was previously assigned to a request of the service for which it expects, but has not yet received, a reply or the invocation of a linked child-operation.

The ROSE-user to which an RO-INVOKE indication is issued, assumes that an Invoke-ID value violating the above rule is a duplicate; and therefore, it does not perform the invoked operation. Instead, it rejects the duplicate invocation.

If Operation Classes 3, 4 or 5 are used, the requestor of this service may reuse an Invoke-ID value after a reasonably long period of time, or if the reply is carried by other means (e.g. result of a have-you-finished operation).

In some application contexts peer ROSE-users may communicate Invoke-ID values. To support this the type of the Invoke-ID parameter is exported by the module defining the abstract syntax of Remote Operations in § 9 of Recommendation X.229.

10.1.1.5 *Linked-ID*

If this parameter is present, the invoked operation is a child-operatin and the parameter identifies the invocation of the linked parent-operation. This parameter has to be supplied by the requestor of the service. The value is that of the Invoke-ID parameter of the RO-INVOKE indication primitive of the parent-operation.

10.1.1.6 *Priority*

This parameter defines the priority assigned to the transfer of the corresponding APDU with respect to the other APDUs to be exchanged between the AEs. The lower the value, the higher the priority. If several APDUs with the same priority are awaiting transfer, they are transferred “first in, first out”.

Note 1 – The Priority parameter has an effect in the case of a two-way alternate association in that it prioritizes the sending of APDUs, and may be used to determine when to request the Turn to send APDUs. The Priority parameter may also have a local effect in the case of a two-way simultaneous association.

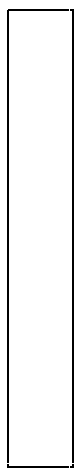
Note 2 – The Priority of a reply (RO-RESULT, RO-ERROR, and RO-REJECT-U) should normally be higher (lower in value) than the priority of the corresponding invocation.

10.2 *RO-RESULT service*

The RO-RESULT service is used by a ROSE-user to reply to a previous RO-INVOKE indication in the case of a successfully performed operation. This service is a non-confirmed service.

The related service structure consists of two service-primitives, as illustrated in Figure 6/X.219.

Figure 6 = 6 cm



10.2.1 *RO-RESULT Parameters*

Table 3/X.219 lists the RO-RESULT service parameters.

TABLE 3/X.219

RO-RESULT Parameters

Parameter name	Request	Indication
Operation-value	U	C (=)
Result	U	C (=)
Invoke-ID	M	M (=)
Priority	U	

10.2.1.1 *Operation-value*

This parameter is the identifier of an invoked and successfully performed operation. This parameter has to be supplied by the requestor of the service. The value is that of the corresponding RO-INVOKE indication primitive. This parameter shall be present only if the Result parameter is present.

10.2.1.2 *Result*

This parameter is the result of an invoked and successfully performed operation. The type has to be agreed between the ROSE users. This parameter has to be supplied by the requestor of the service.

10.2.1.3 *Invoke-ID*

This parameter identifies the corresponding invocation (see § 10.1.1.4). This parameter has to be supplied by the requestor of the service. The value is that of the corresponding RO-INVOKE indication primitive.

10.2.1.4 *Priority*

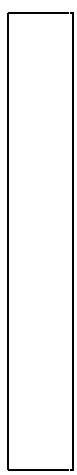
This parameter defines the priority assigned to the transfer of the corresponding APDU (see § 10.1.1.6).

10.3 *RO-ERROR service*

The RO-ERROR service is used by a ROSE-user to reply to a previous RO-INVOKE indication in the case of an unsuccessfully performed operation. This service is a non-confirmed service.

The related service structure consists of two service-primitives as illustrated in Figure 7/X.219.

Figure 7 = 6 cm



10.3.1 *RO-ERROR Parameters*

Table 4/X.219 lists the RO-ERROR service parameters.

TABLE 4/X.219

RO-ERROR Parameters

Parameter name	Request	Indication
Error-value	M	M (=)
Error-parameter	U	C (=)
Invoke-ID	M	M (=)
Priority	U	

10.3.1.1 *Error-value*

This parameter identifies the error that occurred during the execution of the operation. The value has to be agreed between the ROSE-users. This parameter has to be supplied by the requestor of the service.

10.3.1.2 *Error-parameter*

This parameter provides additional information about the error. The type (if any) has to be agreed between the ROSE-users. This parameter has to be supplied by the requestor of the service.

10.3.1.3 *Invoke-ID*

This parameter identifies the corresponding invocation (see § 10.1.1.4). This parameter has to be supplied by the requestor of the service. The value is that of the corresponding RO-INVOKE indication primitive.

10.3.1.4 *Priority*

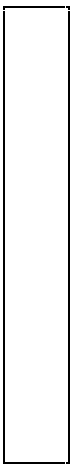
This parameter defines the priority assigned to the transfer of the corresponding APDU (see § 10.1.1.6).

10.4 *RO-REJECT-U*

The RO-REJECT-U service is used by a ROSE-user to reject a request (RO-INVOKE indication) of the other ROSE-user if it has detected a problem. The RO-REJECT-U service may also be used by a ROSE-user to reject a reply (RO-RESULT indication, RO-ERROR indication) from the other ROSE-user. However, to avoid violating the sequencing rules of other ASEs in some application contexts, a ROSE-user may choose not to use the RO-REJECT-U service to reject replies. This service is a non-confirmed service.

The related service structure consists of two service-primitives, as illustrated in Figure 8/X.219.

Figure 8 = 6 cm



10.4.1 *RO-REJECT-U Parameters*

Table 5/X.219 lists the RO-REJECT-U service parameters.

TABLE 5/X.219

RO-REJECT-U Parameters

Parameter name	Request	Indication
Reject-reason	M	M (=)
Invoke-ID	M	M (=)
Priority	U	

10.4.1.1 *Reject-reason*

This parameter specifies the reason for rejection as follows:

a) *Invoke-problem:* user-reject of an RO-INVOKE indication primitive with values:

– duplication-invocation

signifies that the Invoke-ID parameter violates the assignment rules of § 10.1.1.4.

– unrecognized-operation:

signifies that the operation is not one of those agreed between the ROSE-users

– mistyped-argument:

signifies that the type of the operation argument supplied is not that agreed between the ROSE-users

– resource-limitation:

the performing ROSE-user is not able to perform the invoked operation due to resource limitation

– initiator-releasing:

the association-initiator is not willing to perform the invoked operation because it is about to attempt to release the application-association

– unrecognized-linked-ID

signifies that there is no operation in progress with an Invoke-ID equal to the specified Linked-ID

– linked-response-unexpected

signifies that the invoked operation referred to by the Linked-ID is not a parent-operation

– unexpected-child-operation

signifies that the invoked child-operation is not one that the invoked parent-operation referred to by the Linked-ID allows.

b) *Return-result-problem:* user-reject of an RO-RESULT indication primitive with values:

– unrecognized-invocation:

signifies that no operation with the specified Invoke-ID is in progress

– result-response-unexpected:

signifies that the invoked operation does not report a result

– mistyped-result:

signifies that the type of the Result parameter supplied is not that agreed between the ROSE-users.

c) *Return-error-problem:* user-reject of an RO-ERROR indication primitive with values:

– unrecognized-invocation:

signifies that no operation with the specified Invoke-ID is in progress

– error-response-unexpected:

signifies that the invoked operation does not report failure

– unrecognized-error:

signifies that the reported error is not one of those agreed between the ROSE-users

– unexpected-error:

signifies that the reported error is not one that the invoked operation may report

– mistyped-parameter:

signifies that the type of the error parameter supplied is not that agreed between the ROSE-user.

This parameter has to be supplied by the requestor of the service.

10.4.1.2 *Invoke-ID*

This parameter identifies the corresponding invocation (see § 10.1.1.4). This parameter has to be supplied by the requestor of the service. The value is that of the rejected RO-INVOKE indication, RO-RESULT indication, or RO-ERROR indication primitive.

10.4.1.3 *Priority*

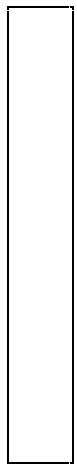
This parameter defines the priority assigned to the transfer of the corresponding APDU (see § 10.1.1.6).

10.5 *RO-REJECT-P*

The RO-REJECT-P service is used to advise a ROSE-user of a problem detected by the ROSE-provider. This service is a provider-initiated service

The related service structure consists of a single service-primitive, as illustrated in Figure 9/X.219.

Figure 9 = 6 cm



10.5.1 *RO-REJECT-P Parameters*

Table 6/X.219 lists the RO-REJECT-P service parameters.

RO-REJECT-P Parameters

Parameter name	Indication
Invoke-ID	O
Returned-parameters	O
Reject-reason	O

10.5.1.1 *Invoke-ID*

This parameter identifies the corresponding invocation (see § 10.1.1.4). This parameter is supplied by the ROSE-provider. The value is that of the rejected RO-INVOKE request, RO-RESULT request, RO-ERROR request or RO-REJECT-U request primitives. This parameter may be omitted if an Invoke-ID is not available.

10.5.1.2 *Returned-parameters*

This parameter contains the parameters of the RO-INVOKE request, RO-RESULT request, RO-ERROR request or RO-REJECT-U request primitives, if the corresponding APDU could not be transferred by the ROSE-provider. This parameter and the parameter Reject-reason are mutually exclusive.

10.5.1.3 *Reject-reason*

This parameter specifies the reason for rejection as follows:

d) *General-problem*: provider-reject of an APDU with values:

– unrecognized-APDU:

signifies that the type of the APDU, as evidenced by its Type Identifier, is not one of the four defined by Recommendation X.229

– mistyped-APDU:

signifies that the structure of the APDU does not conform to Recommendation X.229.

– badly-structured-APDU:

signifies that the structure of the APDU does not conform to the standard notation and encoding, defined in Recommendation X.208 and X.209.

This parameter is supplied by the ROSE-provider. This parameter and the parameter Returned-parameters are mutually exclusive.

11 Mapping of Notation on Service

11.1 *Application Context and Operations*

This section describes how an application-context is specified by means of the notation provided by the macros defined in § 9.

Such an application-context specification consists of:

a) a bind-operation specified by means of the BIND macro, and

b) an unbind-operation specified by means of the UNBIND macro, and

c) a set of operations specified by means of the OPERATION macro, and

d) a set of errors related to operations and specified by means of the ERROR macro.

The Remote Operations (i.e. bind-operation, unbind-operation and operations) may be invoked by the user-element.

An association-initiating user-element established an application-association by invoking a bind-operation. If the application-association is established, operations may be invoked by the user-element. When the association-initiating user-element wishes to release the application-association, it invokes an unbind-operation.

11.2 *Mapping of Remote Operations on ACSE Services, RTSE Services, and ROSE Services*

The bind-operation and the unbind-operation are mapped either on ACSE services, or the RTSE services.

The operations are mapped on the ROSE services.

11.2.1 *Mapping on ACSE services*

The bind-operation is mapped on the A-ASSOCIATE services and the unbind-operation mapped on the A-RELEASE service.

11.2.1.1 *Mapping of a Bind-operation*

A bind-operation is mapped on the A-ASSOCIATE service.

11.2.1.1.1. *Invocation of a Bind-operation*

The invocation of a bind-operation is mapped on the A-ASSOCIATE request and A-ASSOCIATE indication service primitives.

The argument value of the bind-operation is mapped on the User Information parameter of the service primitives.

11.2.1.1.2 *Reply of a Bind-operation*

The reply of a bind-operation is mapped on the A-ASSOCIATE response and A-ASSOCIATE confirm service primitives.

If the bind-operation was successfully performed, the Result parameter of the service primitives is “accepted”, and the result value of the bind-operation is mapped on the User Information parameter of the service primitives.

If the bind-operation was not successfully performed, the Result parameter value of the service primitives is “rejected (permanent)”, and the error value of the bind-operation is mapped on the User Information parameter of the service primitives.

11.2.1.2 *Mapping of a Unbind-operation*

An unbind-operation is mapped on the A-RELEASE service.

11.2.1.2.1 *Invocation of an Unbind-operation*

The invocation of an unbind-operation is mapped on the A-RELEASE request and the A-RELEASE indication service primitives.

The argument value of the unbind-operation is mapped on the User Information parameter of the service primitives. The Reason parameter value of the service primitives is “normal”.

11.2.1.2.2 *Reply of an Unbind-operation*

The reply of an unbind-operation is mapped on the A-RELEASE response and A-RELEASE confirm service primitives.

If the unbind-operation was successfully performed, the Reason parameter value of the service primitives is "normal", the result value of the unbind-operation is mapped on the User Information parameter of the service primitives, and the Result parameter of the service primitives is "affirmative".

If the unbind-operation was not successfully performed, the Reason parameter value of the service primitives is "not finished", the error value of the unbind-operation is mapped on the User Information parameter of the service primitives, and the Result parameter of the service primitives is "affirmative".

11.2.2 *Mapping on RTSE services*

The bind-operation is mapped on the RT-OPEN service and the unbind-operation mapped on the RT-CLOSE service.

11.2.2.1 *Mapping of a Bind-operation*

A bind-operation is mapped on the RT-OPEN service.

11.2.2.1.1 I*nvocation of a Bind-operation*

The invocation of a bind-operation is mapped on the RT-OPEN request and RT-OPEN indication service primitives.

The argument value of the bind-operation is mapped on the User-data parameter of the service primitives. The Dialogue-mode parameter value is "two-way-alternate".

11.2.2.1.2 *Reply of a Bind-operation*

The reply of a bind-operation is mapped on the RT-OPEN response and RT-OPEN confirm service primitives.

If the bind-operation was successfully performed, the Result parameter of the service primitives is "accepted", and the result value of the bind-operation is mapped on the User-data parameter of the service primitives.

If the bind-operation was not successfully performed, the Result parameter value of the service primitives is "rejected (permanent)", and the error value of the bind-operation is mapped on the User data parameter of the service primitives.

11.2.2.2 *Mapping of an Unbind-operation*

An unbind-operation is mapped on the RT-CLOSE service.

11.2.2.2.1 *Invocation of an Unbind-operation*

The invocation of an unbind-operation is mapped on the RT-CLOSE request and the RT-CLOSE indication service primitives.

The argument value of the unbind-operation is mapped on the User-data parameter of the service primitives. The Reason parameter value of the service primitives is "normal".

11.2.2.2.2 *Reply of an Unbind-operation*

The reply of an unbind-operation is mapped on the RT-CLOSE response and RT-CLOSE confirm service primitives.

If the unbind-operation was successfully performed, the Reason parameter value of the service primitives is "normal", and the result value of the unbind-operation is mapped on the User-data parameter of the service primitives.

If the unbind-operation was not successfully performed, the Reason parameter value of the service primitives is "not finished", and the error value of the unbind-operation is mapped on the User-data parameter of the service primitives.

11.2.3 *Mapping on ROSE services*

An operation is mapped on the ROSE services.

11.2.3.1 *Invocation of an Operation*

The invocation of an operation is mapped on the RO-INVOKE service.

The value assigned to the operation is mapped on the Operation-value parameter of that service. The value of the Named-Type in the ARGUMENT clause of the OPERATION macro is mapped on the Argument parameter of that service.

11.2.3.2 *Reply of an operation*

If an operation was succesfully performed, the reply is mapped on the RO-RESULT service.

The value of the Named-Type in the RESULT clause of the OPERATION macro is mapped on the Result parameter of that service.

If an operation was not successfully performed, the reply is mapped on the RO-ERROR service.

In this case one of the errors in the Identifier List of Error Names in the ERROR clause of the OPERATION macro may be applied. The value assigned to the applied error is mapped on the Error parameter of that service. The value of the Named-Type in the PARAMETER clause of the ERROR macro of the applied error is mapped on the Error-parameter parameter of that service.

12 Sequencing Information

This section defines the interaction among the Remote Operations, and the interaction among the ACSE service and the ROSE services.

12.1 *Sequencing Information for Remote Operations*

12.1.1 *Bind-operation*

12.1.1.1 *Usage Restrictions*

A bind-operation is not used on an established application-association. A successfully performed bind-operation establishes an application-association.

12.1.1.2 *Disrupted Remote Operation*

The bind-operation does not disrupt any Remote Operation.

12.1.1.3 *Disrupting Remote Operations*

There are no disrupting Remote Operations.

12.1.1.4 *Collisions*

A bind-operation collision results when the user-elements in both AEs simultaneously invoke a bind-operation on each other. In this case two independent application-associations are established.

12.1.2 *Unbind-operation*

12.1.2.1 *Usage Restrictions*

An unbind-operation is only used on an established application-association. It is only used by the user-element which invoked the bind-operation. It is only used when no replies from Operation Class 1 or 2 operations are outstanding.

The application-association ceases to be established no matter whether the unbind-operation is performed successfully or not.

12.1.2.2 *Disrupted Remote Operations*

An unbind-operation does not disrupt Remote Operations in the case of Assoication Class 1 and Operation Class 1 or 2 operations.

In all other cases an unbind-operation may disrupt operations. However, if in a specific application-context Operation Classes 3, 4 or 5 and/or Association Class 2 or 3 are used, it is assumed that either the disruption is acceptable or the application-context provides operations to avoid the disruption.

12.1.2.3 *Disrupting Remote Operations*

There are no disrupting Remote Operations.

12.1.2.4 *Collisions*

Because only the association-initiator may release the application-association, there is no collision.

12.1.3 *Operations*

12.1.3.1 *Usage Restrictions*

Operations are only used on an established application-association.

12.1.3.2 *Disrupted Remote Operations*

Operations do not disrupt any Remote Operations.

12.1.3.3 *Disrupting Remote Operations*

Operations may be disrupted by an unbind-operation (see § 12.1.2.2).

12.1.3.4 *Collisions*

There are no collisions of operations.

12.1.4 *Further Sequencing Information*

Disrupting services are not visible at the operation-interface. However operations may be disrupted by services (see § 12.2).

Bind-operations and unbind-operations are disrupted by the A-ABORT, A-P-ABORT, RT-U-ABORT and RT-P-ABORT services.

Operations are disrupted by the A-ABORT, A-P-ABORT, RT-U-ABORT, RT-P-ABORT, RO-REJECT-U and RO-REJECT-P services.

In addition an operation may be disrupted by the A-RELEASE service. But this reflects only the disruption of an operation by an unbind-operation. The disrupted operations are not considered in the disrupted services of § 12.2.

Because all Remote Operations are mapped on services, and disrupting Remote Operations (unbind-operation) are represented by services, no disrupting Remote Operations are considered in the disrupting services clauses of § 12.2.

12.2 *Sequencing Informations for Services*

12.2.1 *ACSE Services*

The sequencing information for ACSE services are described in Recommendation X.217. Additional information is provided in this clause.

12.2.1.1 *Disrupted ROSE Services*

In addition to the disrupted services defined in Recommendation X.217 all ROSE services except the RO-REJECT-P service are disrupted by the A-ABORT and A-P-ABORT services and may be disrupted by the A-RELEASE service (see § 12.2.3.6).

12.2.1.2 *Disrupting ROSE Services*

There are no disrupting ROSE services.

12.2.2 *RTSE Services*

The sequencing information for RTSE services are described in Recommendation X.218. Additional information is provided in this section.

12.2.2.1 *Disrupted ROSE Services*

In addition to the disrupted services defined in Recommendation X.218 all ROSE services except the RO-REJECT-P service are disrupted by the RT-U-ABORT, RT-P-ABORT and the negative RT-TRANSFER confirm services.

12.2.2.2 *Disrupting ROSE Services*

There are no disrupting ROSE services.

12.2.3 *ROSE Services*

This section describes the interaction among the ROSE services. Interactions with ACSE services are described in § 12.2.1, and interactions with RTSE services are described in § 12.2.2.

12.2.3.1 *RO-INVOKE Service*

12.2.3.1.1 *Type of Service*

The RO-INVOKE service is a non-confirmed service.

12.2.3.1.2 *Usage Restriction*

The RO-INVOKE service is only used on an established application-association.

12.2.3.1.3 *Disrupted Services*

The RO-INVOKE service does not disrupt any services.

12.2.3.1.4 *Disrupting Services*

The RO-INVOKE service is disrupted by the RO-REJECT-P service.

12.2.3.1.5 *Collision*

There are no collisions of the RO-INVOKE service.

12.2.3.2 *RO-RESULT*

12.2.3.2.1 *Type of Service*

The RO-RESULT service is a non-confirmed service.

12.2.3.2.2 *Usage Restriction*

The RO-RESULT service is only used on an established application-association and in reply to an RO-INVOKE service.

12.2.3.2.3 *Disrupted Services*

The RO-RESULT services does not disrupt any services.

12.2.3.2.4 *Disrupting Services*

The RO-RESULT service is disrupted by the RO-REJECT-P service.

12.2.3.2.5 *Collisions*

There are no collisions of the RO-RESULT service.

12.2.3.3 *RO-ERROR*

12.2.3.3.1 *Type of Service*

The RO-ERROR service is a non-confirmed service.

12.2.3.3.2 *Usage Restriction*

The RO-ERROR service is only used on an established application-association and in reply to an RO-INVOKE service.

12.2.3.3.3 *Disrupted services*

The RO-ERROR service does not disrupt any service.

12.2.3.3.4 *Disrupting Services*

The RO-ERROR service is disrupted by the RO-REJECT-P service.

12.2.3.3.5 *Collisions*

There are no collisions of the RO-ERROR service.

12.2.3.4 *RO-REJECT-U*

12.2.3.4.1 *Type of Service*

The RO-REJECT-U service is a non-confirmed service.

12.2.3.4.2 *Usage Restriction*

The RO-REJECT-U service is only used on an established application-association and in reply to RO-INVOKE, RO-RESULT and RO-ERROR services.

12.2.3.4.3 *Disrupted Services*

The RO-REJECT-U service does not disrupt any service.

12.2.3.4.4 *Disrupting Services*

The RO-REJECT-U service is disrupted by the RO-REJECT-P service.

12.2.3.4.5 *Collisions*

There are no collisions of the RO-REJECT-U service.

12.2.3.5 *RO-REJECT-P*

12.2.3.5.1 *Type of Service*

The RO-REJECT-P service is a provider initiated service.

12.2.3.5.2 *Usage Restriction*

Not applicable.

12.2.3.5.3 *Disrupted Services*

The RO-REJECT-P service disrupts all other ROSE services.

12.2.3.5.4 *Disrupting Services*

The RO-REJECT-P service is not disrupted by any other service.

12.2.3.5.5 *Collision*

If the ACSE service or an RTSE service cause an abort or the release of an application-association, it is a local matter to inform the service-user about outstanding RO-REJECT-P services for Returned-parameters.

12.2.3.6 *Additional Sequencing Information*

The usage restrictions for unbind-operations (§ 12.1.2.1) and the mapping of unbind-operations onto the A RELEASE service prevents the disruption of ROSE services, if only Association Class 1 and Operation Classes 1 and 2 are used.

If Association Classes 2 or 3, or Operation Class 3, 4 or 5 are used, the A-RELEASE service may disrupt ROSE services. In this case it is the responsibility of the application-context designer, either to accept this disruption or to provide means (e.g. operations) to prepare for the release of an application-association.

ANNEX A

(to Recommendation X.219)

Notation Supporting the Specification of Application-service-elements and Application Contexts

This Annex is an integral part of this Recommendation.

This Annex provides a notation supporting the specification of application-service-elements and application contexts which are specified by means of the RO-notation. The RO-notation may be used to specify the bind-operation and the unbind-operation of an application context. Additionally the RQ-notation may be used to specify operation types and error types of several application-service-elements (ROSE-user ASEs). If the RQ-notation is combined with other notations, other specification tools defined elsewhere might be used.

This Annex defines two macros supporting the specification of application-service-elements and application contexts. The formal definition of these macros is shown in Figure A-1/X.219.

A.1 *Application-service-elements*

The notation supports the unique identification of an ASE.

If an ASE is an ROSE-user, the notation additionally supports the specification of the characteristics of the ASE. The operation-interface and the protocol of an ROSE-user ASE are specified by a set of operation types and a set of error types.

The protocol specified for a specific ASE may be inherently:

a) symmetric, or

b) asymmetric.

In the symmetric case both ASE-users may invoke the same set of operation types.

In the asymmetric case one ASE-user (called supplier in the context of this Annex) provides some information-processing functionality which is used by the peer ASE-user (called consumer in the context of this Annex). In this case a specific operation type may be:

1) invoked by the consumer, and/or

2) invoked by the supplier

of the information-processing functionality.

Note – A particular allocation of the terms “supplier” and “consumer” is often intuitive. One might naturally consider a file system, e.g., to be called a supplier and its user to be called a consumer. Strictly speaking, however, the asignment of the two terms is arbitrary.

If an ASE uses the concept of linked-operations, a specific operation type may be invoked as a child-operation. The invoker of the child-operation is the performer of the linked parent-operation. Operation types solely invoked as child-operations shall not be included in the ASE specification, they are listed in the type specification of their parent-operations.

The error types the operations may report are not included in the ASE specification, they are listed in the type specification of the operations.

The set of the remaining operations (operations not solely invoked as child-operations), and who is allowed to invoke this operations may be reflected by a formal notation specifying the ROSE-user ASE.

A.1.1 *Specification of an Application-service-element*

An ASE may be specified by a formal notation supported by the **APPLICATION-SERVICE-ELEMENT** macro (see Figure A-1/X.219).

```
Remote-Operations-Notation-extension {joint-iso-ccitt remote-operations(4) notation-extension(2)}

DEFINITIONS ::=

BEGIN

EXPORTS     APPLICATION-SERVICE-ELEMENT, APPLICATION-CONTEXT, aCSE;

IMPORTS     OPERATION, BIND, UNBIND FROM     Remote-Operation-Notation
                                             {joint-iso-ccitt remote-operations(4) notation(0)};

– – macro definition for ASEs

APPLICATION-SERVICE-ELEMENT-MACRO ::=

BEGIN

TYPE NOTATION               ::= SymmetricAse | ConsumerInvokes SupplierInvokes | empty

VALUE NOTATION              ::= value (VALUE OBJECT IDENTIFIER)

SymmetricAse                ::= "OPERATIONS" "{"OperationList"}"

ConsumerInvokes             ::= "CONSUMER INVOKES" "{"OperationList"}" | empty

SupplierInvokes             ::= "SUPPLIER INVOKES" "{"OperationList"}" | empty

OperationList               ::= Operation | OperationList "," Operation

Operation                   ::= value (OPERATION)

END

aCSE APPLICATION-SERVICE-ELEMENT ::= {joint-iso-ccitt remote-operations(4) aseID-ACSE(4)}

– – Remote Operations Notation extension continued
```

FIGURE A-1/X.219 (Part 1 of 2)

Formal Definition of ASE and Application-context Data Types

The type notation of the **APPLICATION-SERVICE-ELEMENT** macro enables the specification of an ASE. The value notation of the **APPLICATION-SERVICE-ELEMENT** macro enables the specification of a unique identifier for the ASE.

The notation for an ASE type is the keyword **APPLICATION-SERVICE-ELEMENT** optionally followed by the specification of operations.

If the protocol specified for the ASE is symmetric, the keyword **OPERATIONS** and the reference names of the operations are specified.

If the protocol specified for the ASE is asymmetric, the keywords **CONSUMER INVOKES** and the reference names of the operations the consumer may invoke, and/or the keywords **SUPPLIER INVOKES** and the reference names of the operations the supplier may invoke, are specified.

A.2 *Application Contexts*

In the context of this Annex an application context explicitly identifies:

a) a bind-operation,

b) an unbind-operation, and

c) a set of application-service-elements.

and requires one or more identified abstract-syntaxes.

The set of application-service-elements contains:

1) ASEs not using the RO-notation, i.e. the ACSE, optionally the RTSE, and optionally others; and

2) optionally the ROSE and ROSE-user ASEs.

If the application context contains ROSE-user ASEs with an asymmetrical protocol, the notation supports the specification whether the association-initiator or the association-responder is the consumer of such an ASE.

The identification of the bind-operation, the unbind-operation, the application-service-elements, and the abstract-syntaxes may be reflected by a formal notation specifying the application context.

A.2.1 *Specification of an Application Context*

An application context may be specified by a formal notation supported by the **APPLICATION-CONTEXT** macro (see Figure A-1/X.219).

The type notation of the **APPLICATION-CONTEXT** macro enables the specification of the application context. The value notation of the **APPLICATION-CONTEXT** macro enables the specification of a unique identifier for the application context.

The notation for an application context type is the keyword **APPLICATION-CONTEXT**, followed by the keywords **APPLICATION SERVICE ELEMENTS** and the reference names of ASEs not using the RO-notation, followed by the keyword **BIND** and the reference name of the bind-operation type, followed by the keyword **UNBIND** and the reference name of the unbind-operation type, optionally followed by the specification of ASEs using operations, followed by the keywords **ABSTRACT SYNTAXES** and the reference names of the abstract syntaxes.

If the application context contains ROSE-user ASEs, the keywords **REMOTE OPERATIONS** and the reference name of the ROSE, followed by the specification of ASEs with a symmetrical protocol, and/or the specification of ASEs with an asymmetrical protocol is used. The specification of ASEs with a symmetrical protocol is the keywords **OPERATIONS OF** and the reference names of that ASEs. The specification of ASEs with an asymmetrical protocol is the keywords **INITIATOR CONSUMER OF** and the reference names of ASEs the consumer of which is the association-initiator, and/or the keywords **RESPONDER CONSUMER OF** and the reference names of ASEs the consumer of which is the association-responder.

A.2.2 *Mapping of Notation onto Service*

The application context identifier and the list of abstract syntax names specified by means of the **APPLICATION-CONTEXT** macro are mapped either on the RT-OPEN services of RTSE, if RTSE is included in the application context; or else on the A-ASSOCIATE services of ACSE.

The application context value is mapped onto the Application Context Name parameter of the RT-OPEN or A-ASSOCIATE services.

The abstract syntax names are mapped onto the Presentation Context Definition List parameter and the Presentation Context Definition Result List of the RT-OPEN or A-ASSOCIATE services.

```
– – Remote Operations Notation extension continued
– – macro definition for application contexts
APPLICATION-CONTEXT MACRO ::=
BEGIN
TYPE NOTATION          ::=  NonROelements Binding ROelements AbstractSyntaxes
VALUE NOTATION         ::=  value (VALUE OBJECT IDENTIFIER)
NonROelements          ::=  "APPLICATION SERVICE ELEMENTS" "{"AseList"}"
Binding                ::=  "BIND" type – – shall reference a bind-operation type
                            "UNBIND" type – – shall reference an unbind-operation type
ROelements             ::=  "REMOTE OPERATIONS" "{"AseID"}" – – identifying ROSE
                            SymmetricAses AsymmetricAses | empty
SymmetricAses          ::=  "OPERATIONS OF" "{"AseList"}" | empty
AsymmetricAses         ::=  InitiatorConsumerOf ResponderConsumerOf
InitiatorConsumerOf    ::=  "INITIATOR CONSUMER OF" "{"AseList"}" | empty
ResponderConsumerOf    ::=  "RESPONDER CONSUMER OF" "{"AseList"}" | empty
AbstractSyntaxes       ::=  "ABSTRACT SYNTAXES" "{"AbstractSyntaxList"}"
AseList                ::=  AseID | AseList "," AseID
AseID                  ::=  value (APPLICATION-SERVICE-ELEMENT)
AbstractSyntaxtList    ::=  AbstractSyntax | AbstractSyntaxList "," AbstractSyntax
AbstractSyntax         ::=  value (OBJECT IDENTIFIER) – – identifying abstract syntax
END
END                    – –  end of Remote Operations Notation extension
```

FIGURE A-1/X.219 (Part 2 of 2)

Formal Definition of ASE and Application-context Data Types

ANNEX B

(to Recommendation X.219)

Guidelines for Application Protocol Designers on the Use of ROSE

This Annex is not part of this Recommendation.

This Annex provides examples and guidelines for application protocol designers on the user of ROSE.

B.1 *Examples for Operations and Errors*

This section provides examples for the definition of operations and errors.

B.1.1 *Operation Classes*

This clause provides examples for the definition of operations of Operation Class 1 to 5.

The operation **operationExample12** of Operation Class 1 or 2 (see example below) reports success (result of type **ArgumentType12**) or failure (errors **errorExample1** or **errorExample2**). The argument of the operation **operationExample12** is of type **ArgumentType12**. The value of the operation **operationExample12** is **1**.

```
operationExample12    OPERATION
                      ARGUMENT      ArgumentType12
                      RESULT        ResultType12
                      ERROR         {errorExample1, errorExample2]
                      ::= 1
```

The operation **operationExample3** of Operation Class 3 (see example below) reports failure (error **errorExample1**) only, if any. The argument of the operation **operationExample3** is of type **ArgumentType3**. The value of the operation **operationExample3** is **2**.

```
operationExample3     OPERATION
                      ARGUMENT      ArgumentType3
                      ERROR         {errorExample1}
                      ::= 2
```

The **operationExample4** operation of Operation Class 4 (see example below) reports success (result of type **ResultType4**) only. The argument of the operation **operationExample4** is of type **ArgumentType4**. The value of the operation **operationExample4** is **3**.

```
operationExample4     OPERATION
                      ARGUMENT      ArgumentType4
                      RESULT        ResultType4
                      ::= 3
```

The operations **operationExample51** and **operationExample52** of Operation Class 5 (see example below) reports no outcome. The argument of the operation **operationExample51** is of type **ArgumentType4**, the operation **operationExample52** has no argument. The value of the operation **operationExample51** is **4**, the value of the operation **operationExample52** is **5**.

```
operationExample51    OPERATION
                      ARGUMENT      ArgumentType4
                      ::= 4

operationExample52    OPERATION
                      ::= 5
```

B.1.2 *Linked-operations*

The example below shows the definition of a set of linked-operations consisting of the parent-operation **parent-op12** and the child-operations **operationExample51** and **operationExample52**.

```
parent-op12           OPERATION
ARGUMENT              ArgumentType12
RESULT                ResultType12
ERROR                 {errorExample1, errorExample2]
LINKED                {operationExample51, operationExample52}
::= 6
```

B.1.3 *Errors*

Errors (see **errorExample1** and **errorExample2** below) reports failure. The parameter of the error **errorExample1** is of type **ParameterType1**, the error **errorExample2** has no parameter. The value of the error **errorExample1** is **1**, the value of the error **errorExample2** is **2**.

```
errorExample1         ERROR
                      PARAMETER     ParameterType1
                      ::= 1
```

```
errorExample2        ERROR
                     ::= 2
```

B.2 *Examples for Bind-operations and Unbind-operations*

This clause provides examples for the definition of bind-operations and unbind-operations.

B.2.1 *Bind-operations*

Bind-operations are used to establish an application-association.

The request of the bind-operation **BindExample1** to establish an application-association is accompanied by the argument of type **BindArgumentType1**. The positive response to the application-association establishment is accompanied by the result of type **BindResultType1**. The negative response to the application-association establishment is accompanied by the bind-error of type **BindErrorType1**.

```
BindExample1 ::=     BIND
                     ARGUMENT        BindArgumentType1
                     RESULT          BindResultType1
                     BIND-ERROR      BindErrorType1
```

The request of the bind-operation **BindExample2** to establish an application-association is accompanied by the argument of type **BindArgumentType1**. The positive response to the application-association establishment is not accompanied by any user data. The negative response to the application-association establishment is accompanied by the bind-error of type **BindErrorType1**.

```
BindExample2 ::=     BIND
                     ARGUMENT        BindArgumentType1
                     BIND-ERROR      BindErrorType1
```

Note that argument, result and bind-error of a bind-operation are optional. Neither the request of the bind-operation **BindExample3** to establish an application-association nor the response to the application-association establishment are accompanied by any user data.

```
BindExample3 ::=     BIND
```

B.2.2 *Unbind-operations*

Unbind-operations are used to release an application-association.

The request of the unbind-operation **UnbindExample1** to release an application-association is accompanied by the argument of type **UnbindArgumentType1**. The response to the application-association release is accompanied either by the result of type **UnbindResultType1** or by the unbind-error of type **UnbindErrorType1**.

```
UnbindExample1 ::=   UNBIND
                     ARGUMENT        UnbindArgumentType1
                     RESULT          UnbindResultType1
                     UNBIND-ERROR    UnbindErrorType1
```

The request of the unbind-operation **UnbindExample2** to release an application-association is accompanied by the argument of type **UnbindArgumentType 1**. The response to the application-association release is optionally accompanied by the unbind-error of type **UnbindErrorType1**.

```
UnbindExample2 ::=   UNBIND
                     ARGUMENT        UnbindArgumentType1
                     UNBIND-ERROR    UnbindErrorType1
```

Note that argument, result and unbind-error of an unbind-operation are optional. Neither the request of the bind-operation **UnbindExample3** to release an application-association nor the response to the application-association release are accompanied by any user data.

```
UnbindExample3 ::=   UNBIND
```

B.3 *Export and Import of Operations and Errors*

This clause gives examples how to export and import operations and errors.

The example below shows how to export operation and errors. The **operation10** and **error10** have local values. **OperationTypeA** and **ErrorTypeA** are types, and specific values have to be assigned in the importing modules. The **operation11** and **error11** have globally unique values.

```
ExportingModule {objectidentifier1} DEFINITIONS ::=
BEGIN

        EXPORTS         operation10, OperationTypeA, operation11, error10, ErrorTypeA,
                        error11;
        IMPORTS         OPERATION, ERROR, BIND, UNBIND
                        FROM Remote-Operation-Notation
                                {joint-iso-ccitt remote-operation(4) notation(0)};

        operation10     OPERATION
                        ARGUMENT        ArgumentType10
                        RESULT          ResultType10
                        ERROR           {error10}
                        ::= 10

        OperationTypeA  ::=
                        OPERATION
                        ARGUMENT        ArgumentTypeA
                        RESULT          ResultTypeA

        operation11     OPERATION
                        ARGUMENT        ArgumentType11
                        RESULT          ResultType11
                        ERROR           {error11}
                        ::= {objectidentifier2component11}

        error10         ERROR
                        PARAMETER       ParameterType10
                        ::= 10

        errorTypeA      ::=
                        ERROR
                        PARAMETER       ParameterTypeA

        error11         ERROR
                        PARAMETER       ParameterType11
                        ::= {objectidentifier2component12}

END
```

The example below shows how to import operations and errors. The **operation10** and **erro10** have loval values defined in the exporting module. The designer of the importing module is responsible for the uniqueness of these values within the abstract syntax. The operation **operation13** is of type **operationTypeA** and has the value **13** assigned. The error **error13** is of type **ErrorTypeA** and has the value **13** assigned. The **operation11** and **error11** have globally unique values defined in the exporting module.

```
ImportingModule {objectidentifier3} DEFINITIONS ::=
BEGIN

        IMPORTS         operation10, OperationTypeA, operation11, error10, errorTypeA,
                        error11
                        FROM ExportingModule {objectidentifier1};

        operation13     OperationTypeA  ::= 13
        error13         ErrorTypeA      ::= 13

END
```

B.4 *Definition of Application-service-elements*

This clause gives examples how to define application-service-elements. The examples refer to the operations and errors defined in the examples of clause B.1.

The application-service-element **element1** includes the operations **operationExample12** and **operationExample3** and the errors **errorExample1** and **errorExample2**. Note, the errors are included indirectly by the definition of the operations. The application-service-element **element1** is symmetric, i.e. both user-elements may invoke the operations **operationExample12** and **operationExample3**.

element1 APPLICATION-SERVICE-ELEMENT
OPERATIONS {**operationExample12, operationExample3**}
::= {**objectidentifierOfElement1**}

The application-service-element **element2** includes the operations **operationExample3** and **operationExample4** and the error **errorExample1**. The application-service-element **element2** is asymmetric, i.e. only one user-element (that in the consumer role) may invoke the operations **operationExample3** and **operationExample4**.

element2 APPLICATION-SERVICE-ELEMENT
CONSUMER INVOKES {**operationExample3, operationExample4**}
::= {**objectidentifierOfElement2**}

The application-service-element **element3** includes the operations **operationExample12** and **operationExample51** and the errors **errorExample1** and **errorExample2**. The application-service-element **element3** is asymmetric, i.e. only one user-element (that in the supplier role) may invoke the operations **operationExample12** and **operationExample51**.

element3 APPLICATION-SERVICE-ELEMENT
SUPPLIER INVOKES {**operationExample12, operationExample51**}
::= {**objectidentifierOfElement3**}

The application-service-element **element4** includes the operations **parent-op12**, **operationExample51** and **operationExample52** and the errors **errorExample1** and **errorExample2**. Note, the child-operations **operationExample51** and **operationExample52** are included indirectly by the definition of the parent-operation **parent-op12**. The application-service-element **element4** is asymmetric, i.e. only one user-element (that in the consumer role) may invoke the operation **parent-op12** and only the other user-element (that in the supplier role) may invoke the child-operations **operationExample51** and **operationExample52** during the execution of the parent-operation **parent-op12**.

element4 APPLICATION-SERVICE-ELEMENT
CONSUMER INVOKES {**parent-op12**}
::= {**objectidentifierOfElement4**}

The application-service-element **element5** includes the same operations and the errors as the application-service-element **element4**. The only difference is, that the user-element in the supplier role may invoke the operation **operationExample52** either as a child-operation, or outside a set of linked-operations (as a non-child-operation).

element5 APPLICATION-SERVICE-ELEMENT
CONSUMER INVOKES {**parent-op12**}
SUPPLIER INVOKES {**operationExample52**}
::= {**objectidentifierOfElement5}**

B.5 *Definition of Application Contexts*

This clause gives examples how to define application contexts for several Association Classes. The examples refer to the application-service-element defined in the examples of clause B.4, and the bind-operations and unbind-operations defined in the examples of clause B.2.

The application context **context1** includes the application-service-elements ACSE, RTSE, ROSE, and **element2**; the bind-operation **BindExample1** and the unbind-operation **UnbindExample3**. The association-initiator may invoke the operations **operationExample3** and **operationExample4**. The association-responder is not allowed to invoke any operation (Association Class 1).

context1 APPLICATION-CONTEXT
APPLICATION SERVICE ELEMENTS {**aCSE, rTSE**}
BIND **BindExample1**
UNBIND **UnbindExample3**
REMOTE OPERATIONS {**rOSE**}
INITIATOR CONSUMER OF {**element2**}
ABSTRACT SYNTAXES { { **joint-iso-ccitt association-control(2)**

abstract-Syntax(1)
apdus(0) version1(1)},
objectidentifierOfAbstracSyntax1}

::= {**objectidentifierOfContext1**}

The application context **context2** includes the application-service-elements ACSE, ROSE, **element2**, and **element3**; the bind-operation **BindExample1**; and the unbind-operation **UnbindExample3**. The association-responder may invoke the operations **operationExample3**, **operationExample4**, **operationExample12** and **operationExample51**. The association-initiator is not allowed to invoke any operation (Association Class 2).

context2	**APPLICATION-CONTEXT**	
	APPLICATION SERVICE ELEMENTS	{**aCSE**}
	BIND	**BindExample1**
	UNBIND	**UnbindExample3**
	REMOTE OPERATIONS	{**rOSE**}
	INITIATOR CONSUMER OF	{**element3**}
	RESPONDER CONSUMER OF	{**element2**}
	ABSTRACT SYNTAXES	{ { **joint-iso-ccitt association-control(2)** **abstractSyntax(1)** **apdus(0) version1(1)},** **objectidentifierOfAbstracSyntax2**}
	::= {**objectidentifierOfContext2**}	

The application context **context3** includes the application-service-elements ACSE, RTSE, ROSE, and **element2**; the bind-operation **BindExample1**; and the unbind-operation **UnbindExample3**. The association-responder may invoke the operations **operationExample3** and **operationExample4**. The association-initiator is not allowed to invoke any operation (Association Class 2).

context3	**APPLICATION-CONTEXT**	
	APPLICATION SERVICE ELEMENTS	{**aCSE, rTSE**}
	BIND	**BindExample1**
	UNBIND	**UnbindExample3**
	REMOTE OPERATIONS	{**rOSE**}
	RESPONDER CONSUMER OF	{**element2**}
	ABSTRACT SYNTAXES	{**objectidentifierOfAbstracSyntax3**}
	::= {**objectidentifierOfContext3**}	

The application context **context4** includes the application-service-elements ACSE, ROSE, and **element2**; the bind-operation **BindExample3**; and the unbind-operation **UnbindExample3**. The application context **context3** is symmetric, i.e. both the association-initiator and the association-responder may invoke the operations **operationExample12** and **operationExample3** (Association Class 3).

context4	**APPLICATION-CONTEXT**	
	APPLICATION SERVICE ELEMENTS	{**aCSE**}
	BIND	**BindExample3**
	UNBIND	**UnbindExample3**
	REMOTE OPERATIONS	{**rOSE**}
	OPERATIONS OF	{**element1**}
	ABSTRACT SYNTAXES	{**objectidentifierOfAbstracSyntax4**}
	::= {**objectidentifierOfContext4**}	

The last two examples assume a single named abstract syntax.

B.6 *Releasing Application-associations in an Orderly Way*

B.6.1 *Introduction*

This Recommendation defines five Operation Classes based upon the outcomes they report, and three Association Classes based upon whether the association-initiator, the association-responder, or both may invoke operations. This clause defines the rules that ensure orderly release of application-associations and the Operation Classes invoked over it.

B.6.2 *Objectives*

The rules of this paragraph are intended to achieve one of the following two objectives, depending upon the situation:

a) *The Exactly-Once Objective:* Ideally an application entity should be able to count on the invocation of an operation causing that operation to be performed exactly once, that is, not several times and not none at all.

b) *The At-Most-Once Objective:* In come circumstances the Exactly-Once Objective cannot be achieved. A lesser but still useful objective is that invoking an operation will cause that operation to be performed at most once, that is, perhaps not at all but never twice.

B.6.3 *Definition of Rules*

The following **general rules** apply in all circumstances:

G1 The performer shall report the result or error of each confirmed operation over the same application-association by means of which the operation was invoked.

G2 The initiator shall not release the application-association until all operations it invoked have been confirmed.

The following **specific rules** apply in certain circumstances:

S1 Each time it exercises the RO-INVOKE service, the invoker shall supply a different Invoke-ID (unless reattempting an invocation) even across a succession of application-associations. This enables the performer to achieve the At-Most-Once Objective by suppressing duplicates.

S2 If the performer encounters a duplicate Invoke-ID in the RO-INVOKE service, it shall exercise the RO-REJECT-U service with duplicate-invocation as the Reject-reason. This helps to achieve the Exactly-Once Objective.

S3 The association-initiator shall reject any invocations it has not performed before releasing the application-association.

S4 The association-initiator shall respond to any invocations it has performed before releasing the application-association.

B.6.4 *Application of Rules*

The general rules always apply. The specific rules govern application-associations of particular Association Classes, and operations (invoked by means of such associations) of particular Operation Classes, as follows:

a) *Application-associations of Association Class 1:* For operations of Operation Classes 1 and 2, no specific rules apply. For operations of Operation Class 3, 4 and 5, specific rules S1 and S2 apply.

b) *Application-associations of Association Class 2 and 3:* For operations of Operation Classes 1 and 2, specific rules S3 and S4 apply. (Any invocation issued by the association-responder after the association-initiator has issued a release are lost. Response-rejects may be lost as well.) For operations of Operation Class 3, 4, and 5, specific rules S1, S2, S3 and S4 apply.

For protocols containing only operations of Operation Classes 1 or 2, the only constraint upon the values of the Invoke-IDs the invoker supplies to the RO-INVOKE service is that they be distinct over the life of the application-association.

Application-entities make Invoke-IDs unique to an invoker and across consecutive application-associations by exchanging presentation-addresses at application-association establishment time and, for each presentation-address, making Invoke-IDs integers that increase monotonically over some reasonable long period of time.

To ensure that an operation of Operation Classes 3, 4, or 5 has been performed exactly once, an application-entity shall elicit the duplicate-invocation Reject-reason by invoking the operation twice (or more) with the same Invoke-ID. Otherwise, the At-Most-Once Objective is all that is assured, suggesting that, on average, the invoker does not care whether a non-confirmed operation is perfomed.

B.6.5 *Observations*

Every operation of Operation Classes 1 or 2 is performed exactly once.

The usefulness of non-confirmed operations or conditionally confirmed operations may depend on the specific application. Protocol designers should be advised to define only operations of Operation Classes 1 or 2 unless some very specialized requirements exists.