INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Z.105

(07/2003)

SERIES Z: LANGUAGES AND GENERAL SOFTWARE ASPECTS FOR TELECOMMUNICATION SYSTEMS

Formal description techniques (FDT) – Specification and Description Language (SDL)

SDL combined with ASN.1 modules (SDL/ASN.1)

ITU-T Recommendation Z.105

ITU-T Z-SERIES RECOMMENDATIONS

LANGUAGES AND GENERAL SOFTWARE ASPECTS FOR TELECOMMUNICATION SYSTEMS

FORMAL DESCRIPTION TECHNIQUES (FDT)	
Specification and Description Language (SDL)	**Z.100–Z.109**
Application of formal description techniques	Z.110–Z.119
Message Sequence Chart (MSC)	Z.120–Z.129
Extended Object Definition Language (eODL)	Z.130–Z.139
Testing and Test Control Notation (TTCN)	Z.140–Z.149
User Requirements Notation (URN)	Z.150–Z.159
PROGRAMMING LANGUAGES	
CHILL: The ITU-T high level language	Z.200–Z.209
MAN-MACHINE LANGUAGE	
General principles	Z.300–Z.309
Basic syntax and dialogue procedures	Z.310–Z.319
Extended MML for visual display terminals	Z.320–Z.329
Specification of the man-machine interface	Z.330–Z.349
Data-oriented human-machine interfaces	Z.350–Z.359
Human-computer interfaces for the management of telecommunications networks	Z.360–Z.369
QUALITY	
Quality of telecommunication software	Z.400–Z.409
Quality aspects of protocol-related Recommendations	Z.450–Z.459
METHODS	
Methods for validation and testing	Z.500–Z.519
MIDDLEWARE	
Distributed processing environment	Z.600–Z.609

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation Z.105

SDL combined with ASN.1 modules (SDL/ASN.1)

Summary

This Recommendation defines how Abstract Syntax Notation One (ASN.1) modules can be used in combination with Specification and Description Language (SDL). This text replaces the semantic mappings from ASN.1 to SDL defined in ITU-T Rec. Z.105 (1999). The use of ASN.1 notation embedded in SDL previously defined in ITU-T Rec. Z.105 (1995) is not defined by this Recommendation.

The main area of application of this Recommendation is the specification of telecommunication systems. The combined use of SDL and ASN.1 permits a coherent way to specify the structure and behaviour of telecommunication systems, together with data, messages and encoding of messages that these systems use.

This version of Z.105 Recommendation makes necessary alignments with ASN.1 2002 Recommendations. The important changes include mapping of XML values, improved mapping of bit-string values and added mapping of relevant ASN.1 constructs for extensions.

Source

ITU-T Recommendation Z.105 was approved by ITU-T Study Group 17 (2001-2004) under the ITU-T Recommendation A.8 procedure on 7 July 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

• **Objective**

This Recommendation defines how Abstract Syntax Notation One (ASN.1) modules can be used in combination with Specification and Description Language (SDL). The intention is that the structure and the behaviour of systems are described with SDL, while parameters of exchanged messages are described with ASN.1. This Recommendation defines a mapping of ASN.1 constructs to already existing SDL constructs and contains only a small extension to ITU-T Rec. Z.100 to allow ASN.1 modules to be used.

• **Coverage**

This Recommendation presents a semantic definition for the combination of SDL and ASN.1 modules. A mapping of the ASN.1 data defined in a module to the corresponding SDL constructs defined in ITU-T Rec. Z.100 [1] is given, including the operators that can be applied to the ASN.1 data. The ASN.1 data items can then be used within SDL (using SDL notation).

The use of ASN.1 notation embedded in SDL is defined in ITU-T Rec. Z.107 [2].

• **Application**

The main area of application of this Recommendation is the specification of telecommunication systems. The combined use of SDL and ASN.1 permits a coherent way to specify the structure and behaviour of telecommunication systems, together with data, messages and encoding of messages that these systems use.

NOTE – "Specification" in this Recommendation includes definition of requirements in a standard, Recommendation, or procurement document, and description of an implementation.

A specification conforms to this Recommendation if and only if it conforms to the syntactic and semantic grammar rules for the formal technical language defined by the Recommendation (which includes the referenced ASN.1 and SDL languages). Conformance implies that every possibly dynamic interpretation of the specification conforms to the language rules. A specification that uses extensions of the language does not conform.

A tool does not fully support the language if it rejects some constructs of the language or that has a static or dynamic interpretation of a specification in the language that does not conform to language semantics.

• **Status/stability**

This text replaces the semantic mappings from ASN.1 to SDL defined in ITU-T Rec. Z.105 (1999). The use of ASN.1 notation embedded in SDL previously defined in ITU-T Rec. Z.105 (1995) is not defined by this Recommendation.

Changes to ITU-T Recs X.680 [3], X.681 [4], X.682 [5] and X.683 [6], or Z.100 [1] may require modifications to this Recommendation.

This Recommendation is the complete reference manual describing the combination of SDL and ASN.1 modules.

ITU-T Recommendation Z.105

SDL combined with ASN.1 modules (SDL/ASN.1)

1 Scope

This Recommendation defines how ASN.1 modules can be used in combination with SDL. ASN.1 modules are imported in SDL descriptions so that ASN.1 data definitions are mapped to internal SDL representation using equivalent SDL constructs and forming together with the rest of the SDL description a complete specification.

SDL is a language for the specification and description of telecommunication systems. SDL has concepts for:

- structuring systems;
- defining behaviour of systems;
- defining data used by systems.

ASN.1 is a language for the definition of data. Related to ASN.1 are encoding rules that define how ASN.1 values are transferred as bit streams during communication.

1.1 Objective

The combination of SDL and ASN.1 permits a coherent way of specifying the structure and behaviour of telecommunication systems, together with data, messages, and encoding of messages that these systems use. Structure and behaviour can be described using SDL, and data and messages using ASN.1. Encoding of these messages can be described by reference to the relevant encoding rules that are defined for ASN.1.

The full use of SDL (including data types) is supported by this Recommendation.

1.2 The characteristics of the combination of SDL and ASN.1 modules

Systems described in SDL combined with ASN.1 modules have the following characteristics:

- structure and behaviour are defined using SDL concepts;
- the SDL signal structure, i.e., the signal parameter types and their subtypes are defined in ASN.1 modules;
- internal data may be defined by either ASN.1 types or SDL sorts;
- encoding of data values defined in ASN.1 can be defined by reference to the relevant encoding rules. Encoding is not in the scope of this Recommendation.

1.3 ASN.1 that can be used in combination with SDL

The use of ASN.1 as defined in ITU-T Recs X.680, X.681, X.682 and X.683 is supported in combination with SDL, with a recognition that some ASN.1 constructs cannot be successfully mapped to SDL (or at least the mapping has not been identified and specified in this Recommendation). The constructs that cannot be mapped to SDL will exist in ASN.1 packages used as a source of transformation. During the transformation to SDL they are effectively treated as if not present and should not cause any problems for successful transformation of other constructs. Such constructs are the extension marker and exception marker defined in ITU-T Rec. X.680, which may be present in ASN.1 but are ignored in the transformation to SDL. Some constructs of ASN.1 are never transformed to SDL as such, but contain information that can direct or be used in the transformation. The prominent examples of such constructs are relational constraints as defined in ITU-T Rec. X.682, information object classes and information object sets (see clause 5).

The use of SDL as defined in ITU-T Rec. Z.100 [1] is supported.

ASN.1 modules that are used in the transformation to SDL can also be used for generation of encoders and decoders, provided that encoding rules are defined. The SDL data specification implicitly derived from ASN.1 modules should not be used for generation of encoders and decoders since some information that is relevant for encoding may be lost in the transformation to SDL.

1.4 The structure of this Recommendation

This Recommendation is not self-contained: the mapping defined in this Recommendation is based on ITU-T Rec. Z.100 and ITU-T Recs X.680, X.681, X.682 and X.683. The language as defined in ITU-T Rec. Z.100 applies, except that the <package> production rule is extended to allow direct use of ASN.1 modules. This Recommendation is structured in the following manner:

Clause 3 defines the changes to ITU-T Rec. Z.100 in order to incorporate ASN.1 modules.

Clause 4 defines the mapping of ITU-T Rec. X.680 ASN.1 types and values to ITU-T Rec. Z.100 data in order to incorporate ASN.1 data types and values.

Clause 5 defines the mapping of ASN.1 types defined using information objects, classes and information object sets. The use of ITU-T Rec. X.682 constructs is also treated in this clause.

Clause 6 defines the mapping of parameterized ASN.1 types to ITU-T Rec. Z.100 data in order to incorporate parameterized ASN.1 data types.

Clause 7 defines the additions to the package Predefined needed to support the use of ASN.1.

1.5 Conventions used in this Recommendation

The conventions of ITU-T Rec. Z.100 normally apply: for example, keywords appear in lowercase boldface, and predefined names start with a capital. However, in ASN.1 examples, the ASN.1 conventions are used in order to respect ASN.1 rules and improve readability for ASN.1 users: for example, keywords are in capitals.

For ASN.1 grammar productions, references to original documents are given. However, ASN.1 grammar productions are also copied in this Recommendation in places where this is felt necessary to increase its readability. In case of conflict, the original ASN.1 productions take precedence.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[1] ITU-T Recommendation Z.100 (2002), *Specification and Description Language (SDL)*.

[2] ITU-T Recommendation Z.107 (1999), *SDL with embedded ASN.1*.

[3] ITU-T Recommendation X.680 (2002) | ISO/IEC 8824-1:2002, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.

[4] ITU-T Recommendation X.681 (2002) | ISO/IEC 8824-2:2002, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.

[5] ITU-T Recommendation X.682 (2002) | ISO/IEC 8824-3:2002, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification*.

[6] ITU-T Recommendation X.683 (2002) | ISO/IEC 8824-4:2002, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications*.

3 Package

ASN.1 grammar

ModuleDefinition, **ModuleIdentifier**, **DefinitiveIdentifier**, **Imports** and **Exports** are defined in 12.1/X.680.

Model

The production <package> is extended as follows:

```
<package>      ::=
               <package definition> | <package diagram> | <module definition>
<module definition>     ::=
               ModuleDefinition
```

where **ModuleDefinition** is a non-terminal defined in ITU-T Rec. X.680.

A <module definition> has the same meaning as a <package definition> where:

- **ModuleIdentifier** (without any **DefinitiveIdentifier**) corresponds to the <package name>;
- **Imports** corresponds to the <package use clause>s;
- **Exports** corresponds to the <interface>.

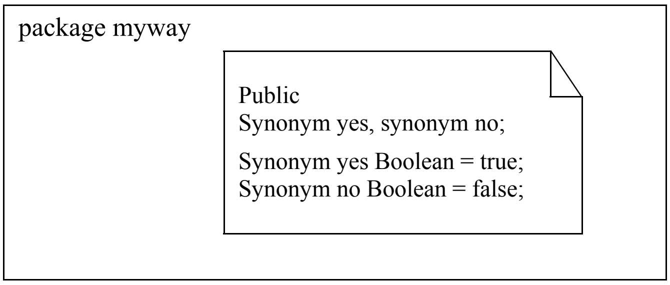
An ASN.1 package is transformed into the equivalent SDL, before it is considered as a package, and before any Z.100 transformations. In this transformation, names are transformed into fully qualified identifiers where SDL requires or allows an identifier rather than a name. However, for conciseness, this is often omitted from the examples in this Recommendation.

Example

The ASN.1 module definition:

```
myway DEFINITIONS ::=
     BEGIN
     EXPORTS yes, no;
     yes  BOOLEAN ::= TRUE
     no   BOOLEAN ::= FALSE
END
```

is the same as:



Similarly, when the package is used in the **imports** of another package:

```
IMPORTS yes FROM myway;
```

This is the same as the <package reference clause>:

use myway/yes;

NOTE – Because SDL does not support object identifier values for package identification, ASN.1 modules with the same **modulereference** but different **DefinitiveIdentifiers** will potentially cause name resolution problems.

4 Definition and use of data

The different definitions of the use of data are described the following way:

ASN.1 grammar	Defining the grammar production rules representing the construction to be represented in SDL.
Model	Describing the transformations of the different parts of the ASN.1 grammar into SDL productions. This part is referencing both the SDL grammar, represented as <SDL grammar rule>, and the ASN.1 grammar, represented as **ASN1GrammarRule**.

4.1 Name mapping

ASN.1 grammar

ASN.1 names are ASN.1 lexical items defined in ITU-T Rec. X.680, 11 such that only letters, digits, and hyphens are allowed in ASN.1 names. If hyphen character is used in SDL, this would be interpreted as the minus operator.

Model

ASN.1 names containing hyphen characters are mapped to lexically similar SDL names except that hyphen characters are converted to underline characters.

Example

The ASN.1 name `my-example-name` is mapped to my_example_name in SDL.

4.2 Variable and data definitions

4.2.1 Type assignment

ASN.1 grammar

TypeAssignment, **Type**, **constrainedType** and **Constraint** are defined in 15.1/X.680.

Model

If the **Type** is a **typereference**, then the **TypeAssignment** is the same as a <syntype definition> containing only the SDL equivalent of the **Type**.

If the **Type** is a **constrainedType**, then the **TypeAssignment** is the same as a <syntype definition> containing only the SDL equivalent of the **Constraint**.

If the **Type** is a neither a **typereference** nor a **constrainedType**, the **TypeAssignment** is represented by a <partial type definition> where <properties expression> is empty and where <formal context parameters> is omitted.

Example

The ASN.1 type assignment:

```
Mytype ::= AnotherType -- typereference
```

is the same as:

syntype Mytype = AnotherType **endsyntype** Mytype; /* full qualification omitted here. */

The ASN.1 type assignment:

```
S ::= INTEGER (0..5 | 10)
```

is the same as:

syntype S = <<**package** Predefined>>Integer **constants** (0..5,10) **endsyntype** S;

The ASN.1 type assignment:

```
Integerlist ::= SEQUENCE OF INTEGER
```

is the same as:

value type Integerlist {**inherits** <<**package** Predefined>>String
< <<**package** Predefined>> Integer> ('' = <<**package**
Predefined>>Emptystring)
}

4.2.2 Value assignment

ASN.1 grammar

ValueAssignment and **XMLValueAssignment** are defined in 15.2/X.680.

Model

The **ValueAssignment** and **XMLValueAssignment** are represented by a <synonym definition item>.

Example

The ASN.1 definition:

```
yes BOOLEAN ::= TRUE
```

is the same as:

synonym yes <<**package** Predefined>>Boolean = <<**package** Predefined>> true;

4.3 Type expressions

4.3.1 Sequence

ASN.1 grammar

SequenceType, **ComponentType**, **ExtensionAndException**, **OptionalExtensionMarker**, **ExtensionAdditionGroup** and **VersionNumber** are defined in 24.1/X.680. **SetType** is defined in 26.1/X.680.

Model

A **SequenceType** is represented as a <structure definition> containing a <field> for each **NamedType** of the **SequenceType**. The <field> contains one <field name>, which is the same as the ASN.1 **identifier** of the **NamedType**, and a <field sort> that is the **Type** transformed to an SDL <sort identifier>.

If the **ComponentType** containing the **NamedType** is **OPTIONAL**, the SDL field has the keyword **optional**.

If the **ComponentType** containing the **NamedType** has a **DEFAULT Value**, the SDL field has the keyword **default** and the value is transformed into the <constant expression> after **default**.

A **ComponentType** that is **COMPONENTS OF Type** is represented as a list of ordered <field>, one for each field associated to **Type**. These fields are inserted in the position of the **COMPONENTS OF Type** in the order that the fields exist in the **Type**.

The occurrences of **ExtensionAndException** and **OptionalExtensionMarker** in **SequenceType** are ignored in the transformation.

The occurrences of **ExtensionAdditionGroup** in **ExtensionAddition** are transformed so that version brackets ("[[", "]]") and **VersionNumber** are ignored.

Example

The ASN.1 type:

```
S    ::=  SEQUENCE {
          a    INTEGER,
          b    IA5String OPTIONAL,
          c    PrintableString DEFAULT "d"}
```

is the same as:

value type S
{
    struct
    a <<**package** Predefined>> Integer;
    b <<**package** Predefined>> IA5String optional;
    c <<**package** Predefined>> PrintableString default 'd';
}

NOTE 1 – There is no distinction between use of keyword **SEQUENCE** and **SET**. This is a relaxation compared to ITU-T Rec. X.680.

NOTE 2 – In this Recommendation, tags are not necessary to distinguish between components of the same type: ASN.1 automatic tagging is assumed.

4.3.2 Sequenceof

ASN.1 grammar

SequenceOfType is defined in 25.1/X.680.

Model

Specifying a **SequenceOfType** is the same as specifying the predefined String sort having the SDL transform of **Type** as the first <actual context parameter> and the name Emptystring defined as the literal name for the empty string.

If an ASN.1 size constraint is specified for **Type**, the **SequenceOfType** is a syntype having the transformed size constraint as a <range condition> (see 4.4). The parent sort of the syntype is the **SequenceOfType** without the ASN.1 size constraint. This parent sort has an implicit and unique name and is defined in the nearest scope unit enclosing the occurrence of the **SequenceOfType**.

Example

The ASN.1definition:

```
phonenumber ::= SEQUENCE SIZE (8) OF INTEGER (0..9)
```

is the same as the three SDL definitions:

value type S1
{
    inherits <<**package** Predefined>> String <S2> ('' = Emptystring)
}
syntype S2 = <<**package** Predefined>> Integer **constants** (0..9) endsyntype;
syntype phonenumber = S1 **constants** size (8) endsyntype phonenumber;

4.3.3 Choice

ASN.1 grammar

ChoiceType, **ExtensionAdditionAlternative** and **ExtensionAdditionAlternativesGroup** are defined in 28.1/X.680.

Model

A **ChoiceType** is represented as a <choice definition> containing a <field> for each **NamedType** of the **ChoiceType**.

The occurrences of **ExtensionAndException** and **OptionalExtensionMarker** in **ChoiceType** are ignored in the transformation.

The occurrences of **ExtensionAdditionAlternativesGroup** in **ExtensionAdditionAlternatives** are transformed so that version brackets ("[[", "]]") and **VersionNumber** are ignored.

Example

The ASN.1 choice type:

```
C ::= CHOICE {
a    INTEGER,
b    REAL }
```

is the same as:

value type C **Choice**
{
    a <<**package** Predefined>> Integer;
    b <<**package** Predefined>> Real;
}

4.3.4 Enumerated

ASN.1 grammar

EnumeratedType, **EnumerationItem** and **ExceptionSpec** are defined in 19.1/X.680.

Model

An **EnumeratedType** is represented by a <partial type definition> where <properties expression> is empty and where <formal context parameters> is omitted. For each **EnumerationItem**, the **identifier** is transformed into a <literal signature> that has the same name as the **EnumerationItem**. If the **EnumerationItem** contains a **SignedNumber** (or **DefinedValue**), the <literal name> of the <literal signature> is followed by the SDL transform of the **SignedNumber** (or **DefinedValue** respectively).

The extension markers ("...") and **ExceptionSpec** in **EnumeratedType** are ignored in the transformation to SDL.

The definition:

```
colours ::= ENUMERATED {blue(3),red, yellow(0)};
```

is the same as:

value type colours {
    literals blue = 3, red, yellow = 0
}

4.3.5 Integer

ASN.1 grammar

IntegerType, **NamedNumberList** and **NamedNumber** are defined in 18.1/X.680.

Model

The ASN.1 **IntegerType** is mapped to SDL <<**package** Predefined>> Integer.

Specifying an **IntegerType** with a **NamedNumberList** is the same as specifying a <synonym definition> in the nearest enclosing scope unit with one <synonym definition item> for each **NamedNumber**. The **identifier** of the **NamedNumber** is transformed into the <synonym name>. The <sort> of the <synonym definition item> is <<**package** Predefined>>Integer. The **SignedNumber** or **DefinedValue** of the **NamedNumber** is used as the <constant expression> of the <synonym definition item>.

Example

The ASN.1 definition:

```
Standards ::=  SEQUENCE OF INTEGER{z100(0),x680(1),z10x(2)}
```

is the same as:

value type standards {
inherits
    << **package** Predefined >> String < <<**package** Predefined>> Integer> ("= EmptyString)
}
synonym z100 Integer = 0;
synonym x680 Integer = 1,
synonym z10x Integer = 2;

4.3.6 ValueRange

ASN.1 grammar

ValueRange is defined in 47.4/X.680.

Model

Specifying an ASN.1 **ValueRange** restriction is represented as specifying the contained <sort> and adding the representation of the ASN.1 **ValueRange** restriction after the **constants** keyword in the <syntype>.

Example

The ASN.1 definition:

```
S    ::=  INTEGER(0..5 | 10)
```

is equivalent to:

syntype S = <<**package** Predefined>> Integer **constants** (0..5, 10) endsyntype S;

How the <range condition> is derived is described below.

4.3.7 BitString

ASN.1 grammar

`BitStringType`, `NamedBitList` and `NamedBit` are defined in 21.1/X.680.

Model

The ASN.1 **BitStringType** is mapped to SDL <<**package** Predefined>> Bitstring.

Specifying a **BitStringType** with a **NamedBitList** is the same as specifying a <synonym definition> in the nearest enclosing scope unit with one <synonym definition item> for each **NamedBit**. The **identifier** of the **NamedBit** is transformed into the <synonym name>. The <sort> of the <synonym definition item> is <<**package** Predefined>>Integer. The **number** or the **DefinedValue** is used as the <constant expression> of the <synonym definition item>.

4.3.8 OctetString

ASN.1 grammar

OctetStringType is defined in 22.1/X.680.

Model

The ASN.1 type **OctetStringType** is mapped to SDL <<**package** Predefined >>Octetstring.

4.3.9 Setof

ASN.1 grammar

SetOfType is defined in 27.1/X.680.

Model

Specifying a **SetOfType** is the same as specifying the <<**package** Predefined>> Bag sort having the SDL transform of **Type** as the first <actual context parameter> and the name Emptybag defined as the literal name for the empty bag.

If an ASN.1 size constraint is specified for **Type**, the **SetOfType** is a syntype having the transformed size constraint as a <range condition> (see 4.4). The parent sort of the syntype is the **SetOfType** without the ASN.1 size constraint. This parent sort has an implicit and unique name and is defined in the nearest scope unit enclosing the occurrence of the **SetOfType**.

4.4 Range condition

Model

A range condition defines a set of values. It is used in SDL for defining a syntype. It has an associated parent sort, which is the sort specified in the syntype definition. A value is within the value set if the operator denoted by the operator identifier yields true when applied to the value.

The operator identifier for a given range condition is thus defined as:

value type A

operators o: S -> Boolean;

/* where o is derived from the ASN.1 concrete syntax as explained below */

endvalue type A;

Each Range in the ASN.1 range condition contributes to the properties of the operator defining the value set:

o(V) == range1 or range2 or ... or rangeN

If a syntype is specified without a range condition, then the operator result is true.

In the following explanation of how each Range contributes to the operator result, V denotes the argument value. Each contribution must be well-formed, which means that used operators must exist with a signature appropriate for the context.

- If neither of the keywords **MIN** and **MAX** are specified in a **ClosedRange**, a **ClosedRange** contributes with:

  E1 rel1 V and V rel2 E2

  where E1 is Value of **LowerEndValue** and E2 is Value of **UpperEndValue**.

  If "<" is specified for **LowerEndValue** then rel1 is the "<" operator, otherwise it is the "<=" operator.

  If "<" is specified for **UpperEndValue** then rel2 is the "<" operator, otherwise it is the "<=" operator.

  If the keyword **MIN** is specified and the keyword **MAX** is not specified, **Range** contributes with:

  V rel2 E2

  If the keyword **MAX** is specified and the keyword **MIN** is not specified, **Range** contributes with:

  E1 rel1 V

  If both keywords **MIN** and **MAX** are specified, the operator always yields true.

- A **ContainedSubType** contributes with:

  o1(V)

  where o1 is the implicit operator defining the value set for the **Type** mentioned in the **ContainedSubType**.

- A **SizeConstraint** contributes with:

  o1(length(V))

  where o1 is the implicit operator defining the value set for the <range condition> mentioned in the **SizeConstraint**.

- **InnerTypeConstraints** contributes with either:

  if length(V) = 0 **then** true **else** o1(first(V)) **and** o(Substring(V,2,length(V)-1)) **fi**; or

  if length(V) = 0 **then** true **else** o1(take(V)) **and** o(del(take(V), V)) **fi**

  whatever is appropriate for the sort of V. o is the implicit operator **InnerTypeConstraints** contributes to and o1 is the implicit operator for **Range** specified in **InnerTypeConstraints**.

  InnerTypeConstraints has a contribution for each contained **NamedConstraint** that specifies constraints of the field (see 4.2.1) denoted by **Identifier** of the parent sort.

  For the purpose of deriving the contributions, a derived ASN.1 type is created as follows:

  a) the keyword **PRESENT** is added to the **NamedConstraints** that have no ending keyword (**PRESENT**, **ABSENT** or **OPTIONAL**);

b) **NamedConstraints** of the form **Identifier ABSENT** are added for all fields (i.e., Identifiers) not mentioned explicitly in a **NamedConstraint**. The **NamedConstraints** are added to the **InnerTypeConstraints** before the contributions of each **NamedConstraint** are derived.

NOTE – In case the governing type is CHOICE, the derived type may be illegal with respect to ITU-T Rec. X.680, but is used only for the purpose of mapping to SDL and has no impact on the original ASN.1 type or its encoding.

If a **Range** is specified for a **NamedConstraint**, the contribution is:

E and if FPresent(V) then o1(V) else true fi

where E is the present constraint for the field, F (from the operator name FPresent) is the name of the optional field and o1 is the implicit operator for the **Range**. If the **Range** is omitted, the contribution is only the present constraint E.

The present constraint for a field F is:

FPresent(V)

in case the **NamedConstraint** for the field contains the keyword **PRESENT**; and

not FPresent(V)

in case the **NamedConstraint** for the field contains the keyword **ABSENT**. In all other cases, the present constraint is true.

4.5 Value expressions

4.5.1 Choice Value

ASN.1 grammar

ChoiceValue is defined in 28.10/X.680.

Model

A **ChoiceValue** is represented as an <operator application> having the **Value** as argument. The <operator identifier> in the <operator application> contains a <qualifier> representing the **Type** and an operator name being the **identifier**.

Example

The `ChoiceValue`:

```
myvalue : Mychoice
```

is represented as:

myvalue(Mychoice)

In case that a **ChoiceValue** can denote one of several operator applications (i.e., a field of more than one choice sort), a qualifier is used:

```
MyType ::= CHOICE .........
myvalue : Mychoice
```

which is then represented as:

<<type Mytype>> myvalue(Mychoice)

4.5.2 Composite primary

A composite primary is built up of the values for the SDL-representation of respective composite types.

4.5.2.1 Sequence value

ASN.1 grammar

SequenceValue, **XMLSequenceValue**, **ComponentValueList** and **XMLComponentValueList** are defined in 24.17/X.680.

NOTE – There is no distinction between `SetValue` and `SequenceValue`. This is a relaxation compared to ITU-T Rec. X.680.

Model

The **SequenceValue** and **XMLSequenceValue** are mapped to <synonym definition item>. In the mapping, **ComponentValueList** or **XMLComponentValueList** is provided to structure data type constructor in SDL. The SDL data type constructor requires that all the fields are given as input so that fields that are omitted in **ComponentValueList** have to be provided empty in the SDL The application of structure data type constructor will have the same effects in SDL as it would in ASN.1.

Example

```
MYTYPE ::= SEQUENCE{
     a    INTEGER,
     b    INTEGER OPTIONAL,
     c    INTEGER DEFAULT 0,
     d    INTEGER,
     e    INTEGER OPTIONAL,
     f    INTEGER DEFAULT 0
}
```

```
myValue MYTYPE ::= {a 1, b 1, c 1, d 1}
```

In this example fields `a`, `b`, `c` and `d` of `myValue` have a value assigned and fields `e` and `f` have no assignment.

synonym myValue MYTYPE = (. 1, 1, 1, 1, , .);

The consequence would be that fields a, b, c and d of myValue would be set to 1, e would be absent and f would get the default value 0.

4.5.2.2 Sequence of value

ASN.1 grammar

SequenceOfValue and **XMLSequenceOfValue** are defined in 25.3/X.680.

Model

A **SequenceOfValue** `and` **XMLSequenceOfValue** are both represented as:

MkString(E1) // MkString(E2)// ... // MkString(En)

where E1, E2, ..., En are the **Values** of the **SequenceOfValue** or **XMLValueOrEmpty** of the **XMLSequenceOfValue** in the order of appearance. If no **Values** or **XMLValues** are specified, the **SequenceOfValue** or **XMLSequenceOfValue** are represented as the name Emptystring.

The **Type** qualifier of the Composite Primary that contains the **SequenceOfValue** precedes each MkString operator or the Emptystring literal respectively.

4.5.2.3 Object identifier value

ASN.1 grammar

ObjectIdentifierValue is defined in 31.3/X.680.

Model

ObjectIdentifierValue is ignored in the transformation to SDL.

ObjectIdentifierValue is in ASN.1 used to distinguish between the modules that have same names but different object identifiers. Because the module names and object identifiers cannot uniquely be mapped to a package identifier that is used in package use clauses, the object identifier component is ignored in the transformation to SDL. The identification of appropriate module is thus open to manual or tool specific solutions.

4.5.2.4 Real value

ASN.1 grammar

RealValue and **XMLRealValue** are defined in 20.6/X.680.

The form **0** is used for zero values; the alternate form for **NumericRealValue** shall not be used for zero values.

The associated type for value definition and subtyping purposes is:

```
SEQUENCE {
     mantissa  INTEGER,
     base      INTEGER (2|10),
     exponent  INTEGER
          -- The associated mathematical real number is "mantissa"
          -- multiplied by "base" raised to the power "exponent"
     }
```

Model

An ASN.1 **NumericalRealValue** and **XMLNumericRealValue** are mapped to an SDL real sort value with the actual value calculated in the transformation. The **SpecialRealValue** and **XMLSpecialRealValue** shall be transformed to the largest possible positive or negative value respectfully.

NOTE – The transformation of **SpecialRealValue** is not in accordance with the intended ASN.1 semantics because this is a directive to the encoder/decoder to use a special code indicating the $-\infty$ (minus infinite) values. Since encoding is not related to data in SDL transformed from ASN.1data, such relaxation should be acceptable.

Example

The ASN.1 definition:

```
r50  REAL ::= { mantissa 5, base 10, exponent 1}
```

is the same as:

synonym r50 Real = 50.0;

4.5.2.5 Integer value

ASN.1 grammar

IntegerValue and **XMLIntegerValue** are defined in 18.9/X.680.

Model

An **IntegerValue** and **XMLIntegerValue** are mapped to an SDL <<**package** Predefined>>Integer sort value with the same actual value.

4.5.2.6 Boolean value

ASN.1 grammar

BooleanValue and **XMLBooleanValue** are defined in 17.3/X.680.

Model

A **BooleanValue** and **XMLBooleanValue** are mapped to an SDL <<**package** Predefined>>Boolean sort value where `TRUE` and **<true>** map to Boolean literal true and `FALSE` and **<false>** map to Boolean literal false.

4.5.3 String primary

ASN.1 grammar

CharacterStringValue and **XMLCharacterStringValue** are defined in 36.3/X.680.

BitStringValue and **XMLBitStringValue** are defined in 21.9/X.680.

Model

An ASN.1 **StringValue** containing a **cstring** (ASN.1 name for character string delimited by " at both beginning and end) represents a <character string literal identifier> consisting of the **Type** and a <character string literal> with the same <text> as the ASN.1 String **Text**. The **Type** for **cstring** is an **IA5Type** as defined by this Recommendation.

A **BitStringValue** containing a **bstring** or **hstring** are mapped to SDL <<**package** Predefined>> Bitstring operators with the same syntax provided that the length of the governing bit string type is not constrained.

Provided that the length of the governing bit string type is constrained, the rules below apply.

A **BitStringValue** containing a **bstring** or **hstring** are mapped to SDL <<**package** Predefined>> Bitstring operators with the same syntax. However, if the length of the **bstring** or **hstring** is smaller then the maximal length of the governing bit string type, the **bstring** or **hstring** is expanded to the maximal length with all trailing bits sets to 0.

A **BitStringValue** defined using **IdentifierList** is evaluated as having the bit value 1 at all bit positions defined by **identifier** listed in **IdentifierList**. The value of the bits remaining until the maximal length of the governing bit string type is set to 0. The resulting string is mapped to SDL <<**package** Predefined>> Bitstring operators preceded by an ' character and followed by the pair of characters 'B.

A **XMLBitStringValue** containing a **xmlbstring** is mapped to SDL <<**package** Predefined>> Bitstring operators preceded by a ' character and followed by the pair of characters 'B. However, if the length of the **xmlbstring** is smaller then the maximal length of the governing bit string type, the **xmlbstring** is expanded to the maximal length with all trailing bits sets to 0.

Example

Use a bit-string type to model the values of a **bit map**, a fixed-size ordered collection of logical variables indicating whether a particular condition holds for each of a correspondingly ordered collection of objects.

```
DaysOfTheWeek ::= BIT STRING {
          sunday(0), monday (1), tuesday(2),
          wednesday(3), thursday(4), friday(5),
          saturday(6) } (SIZE (7))

     sunnyDaysLastWeek1 DaysOfTheWeek ::= {sunday, monday, wednesday}
     sunnyDaysLastWeek2 DaysOfTheWeek ::= '1101000'B
```

The mapping to SDL would give the following:

synonym sunday Integer = 0;
synonym monday Integer = 1;
synonym tuesday Integer = 2;
synonym wednesday Integer = 3;
synonym thursday Integer = 4;
synonym friday Integer = 5;
synonym saturday Integer = 6;
synonym sunnyDaysLastWeek1 DaysOfTheWeek = '1101000'B;
synonym sunnyDaysLastWeek2 DaysOfTheWeek = '1101000'B;

Use a bit-string type to model the values of a **bit map**, a variable-size ordered collection of logical variables indicating whether a particular condition holds for each of a correspondingly ordered collection of objects.

```
DaysOfTheWeekVar ::= BIT STRING {
          sunday(0), monday (1), tuesday(2),
          wednesday(3), thursday(4), friday(5),
          saturday(6) } (SIZE (0..7))

     sunnyDaysLastWeek3 DaysOfTheWeekVar ::= {sunday, monday, wednesday}
     sunnyDaysLastWeek4 DaysOfTheWeekVar ::= '1101'B
```

The mapping to SDL would give the following (not repeating the synonyms for bit names):

synonym sunnyDaysLastWeek3 DaysOfTheWeek = '1101000'B;

synonym sunnyDaysLastWeek4 DaysOfTheWeek = '1101000'B;

4.5.4 Element set specification

ASN.1 grammar

ElementSetSpecs is defined in 46.1/X.680.

Model

Two or more value sets can be combined using this notation. The resulting set is evaluated in the transformation and the result is mapped to SDL.

The extension markers ("...") in **ElementSetSpecs** are ignored in the transformation to SDL.

5 Mapping of ASN.1 types defined in ASN.1 modules using information objects, information object classes and information object sets

5.1 Introduction

ITU-T Rec. X.681 provides the ASN.1 notation that allows information object classes as well as individual information objects and sets thereof to be defined and given reference names. An information object class is a template for a collection of information that makes up the attributes of any member of that class. Information objects provide a generic table mechanism within the ASN.1 language. Such a generic table defines the association of specific sets of field values or types. This feature replaces the earlier MACRO construct (available in ASN.1:1990) and is primarily used to fill in gaps in a type definition dependent on one or more key fields.

This clause assumes that all ASN.1 constructs defined in ITU-T Recs X.681, X.682 and X.683 can be used in ASN.1 modules. It then identifies what information contained in ASN.1 information object classes, information objects and information object sets can be useful when mapped to appropriate SDL targets. The mappings that are possible and useful are defined. It has to be noted that some information will not be represented in SDL because of the differences in nature of the two languages.

5.2 Information object class definition and assignment

ASN.1 grammar

ObjectClassAssignment is defined in 9.1/X.681.

Model

The **ObjectClass** definitions in ASN.1 have no direct correspondence in SDL.

5.3 Information object class field type

ASN.1 grammar

ObjectClassFieldType, **FixedTypeValueFieldSpec** and **FixedTypeValueSetFieldSpec** are defined in 14.1/X.681.

Model

ASN.1 types can be defined using **ObjectClassFieldType** notation to extract information from the fields of information object class specifications without the presence of table constraints. Such ASN.1 types can be mapped to SDL, provided that in their definition only **FixedTypeValueFieldSpec** or **FixedTypeValueSetFieldSpec** are used. The mapping to an SDL value type is done as defined in 4.3 once the meaning of **FixedTypeValueFieldSpec** or **FixedTypeValueSetFieldSpec** is determined from the referenced information object class specifications.

ObjectClassFieldType notation is also used in relation to table constraints as defined in 5.6.2.

Example

If the ASN.1 contains the following specification:

```
EXAMPLE-CLASS ::= CLASS {
     &TypeField                                        OPTIONAL,    -- class field 1
     &fixedTypeValueField          INTEGER       OPTIONAL,    -- class field 2
     &variableTypeValueField       &TypeField    OPTIONAL,    -- class field 3
     &FixedTypeValueSetField       INTEGER       OPTIONAL,    -- class field 4
     &VariableTypeValueSetField    &TypeField    OPTIONAL     -- class field 5
}
WITH SYNTAX {
     [TYPE-FIELD                        &TypeField]
     [FIXED-TYPE-VALUE-FIELD            &fixedTypeValueField]
     [VARIABLE-TYPE-VALUE-FIELD         &variableTypeValueField]
     [FIXED-TYPE-VALUE-SET-FIELD        &FixedTypeValueSetField]
     [VARIABLE-TYPE-VALUE-SET-FIELD     &VariableTypeValueSetField]
}

ExampleType ::= SEQUENCE {
     integerComponent1  EXAMPLE-CLASS.&fixedTypeValueField,         -- field 1
     integerComponent2  EXAMPLE-CLASS.&FixedTypeValueSetField       -- field 2
}

exampleValue ExampleType ::= {
     integerComponent1       123,                   -- field 1
     integerComponent2       456                    -- field 2
}
```

Things that can be mapped to SDL are **`ExampleType`** and **`exampleValue`**:

```
value type ExampleType {
        struct
        integerComponent1   <<package Predefined>> Integer,     /* field 1 */
        integerComponent2   <<package Predefined>> Integer      /* field 2 */
}
synonym exampleValue ExampleType = (. 123, 456 .);
```

5.4 Information object definition and assignment

ASN.1 grammar

ObjectAssignment is defined in 11.1/X.681.

Model

Information object definitions in the ASN.1 module have no equivalent mapping in SDL.

5.5 Information from information objects

ASN.1 grammar

InformationFromObjects is defined in 15.1/X.681.

Model

Information from the column of the associated table for an information object or an information object set can be referenced by the various cases of the **InformationFromObjects** notation.

In the ASN.1 module, an ASN.1 type can be specified with fields defined using **InformationFromObjects** notation. Such an ASN.1 type can be mapped to SDL, provided that all occurrences of **InformationFromObjects** notation can be expanded to a value or a type. The ASN.1 type as such is mapped as specified in 4.3, while the semantics of **InformationFromObjects** expansion follows the ASN.1 semantics.

5.6 Constraint specification

ASN.1 grammar

GeneralConstraint,**TableConstraint** and **UserDefinedConstraint** are defined in 8.1/X.682.

Model

The types specified using **TableConstraint** are mapped to SDL according to rules given in 5.6.2. The types specified using **UserDefinedConstraint** cannot be mapped to SDL.

5.6.1 User-defined constraints

ASN.1 grammar

UserDefinedConstraint is defined in 9.1/X.682.

Model

This form of constraint specification can be regarded as a special form of ASN.1 comment, since it is not fully machine-processable. Therefore, ASN.1 type specifications using **UserDefinedConstraint** cannot be mapped to SDL.

5.6.2 Table constraints

ASN.1 grammar

TableConstraint, **SimpleTableConstraint** and **ComponentRelationConstraint** are defined in 10.3/X.682.

Model

Constraint notation can appear (in round brackets) after any use of the syntactic construct "Type". Application designers can use this notation to define a structured data type with further constraints on their field values. Examples of such constraints are restricting the range of some component(s), or to specify a relation between components. The former is a **SimpleTableConstraint** and the latter is a **ComponentRelationConstraint**.

For types with **SimpleTableConstraint**, the following transformation rules apply.

Before the constrained type can be mapped to SDL, some SDL value types need to be constructed from the information object class specification and the constraining information object set specification in the following manner:

a) For each information object set a number of SDL value types are created. The types are generated so that for each field of the information object CLASS associated with the information object set, one SDL value type is generated. The name of the type is the concatenation of the name of the information object set, an underscore ('_') and the name of the matching class field.

b) If the class field is a **FixedTypeValueFieldSpec**, a SDL syntype is constructed. The syntype has a range constraint that is a union of values specified by the matching field of each information object in the information object set.

c) If the information object class field is a **VariableTypeValueFieldSpec**, a SDL choice type is constructed. The choice type is constructed so that all the types found in the matching field of all the information objects belonging to the constraining information object set are included in the choice. The choice field names are derived as lower case equivalents of the matching types.

The constrained ASN.1-type can now be mapped to SDL. The type as such is mapped as defined in 4.3. The SDL field names are the same as ASN.1 field names. The ASN.1 specification of optionality is preserved in the transformation. For each ASN.1 field constrained by an information object set, the SDL type is specified as type constructed from the information object class specification and the constraining information object set specification (items a) to c)).

For ASN.1-type specifications using **ComponentRelationConstraint**, the same type transformation rules are applied. On top of that, for each ASN.1 type with **ComponentRelationConstraint**, a check method that traverses the information object and checks the constraints is also generated. The check method returns "true" if all relational constraints are respected and "false" if any of the relational constraints are violated.

The steps for constructing the check method are:

For each element that is involved in relational constraint (has a **ComponentRelationConstraint** attached to it or is mentioned in any **ComponentRelationConstraint**), a local test variable declaration is generated. The generation follows the following scheme:

'dcl <test var name> <field type>; <test var name> := <field ref>;'

where <test var name> is a unique name for each test variable, <field type> is the type of the element, <field ref> is a reference to the element. If the element is present, the variable is initialized to the value of the corresponding field of the object.

For each relational constraint, one test is generated for each combination of constraining values or types in the object set definition. Each test is generated using the following scheme:

'if (<test expr> and not (<value test>) then { return False; }

where the <test expr> is the result of combining one tests for each constraining value or type using the 'and' operator. For constraining values the test is defined as:

'<test var name> = <test value>'

where <test var name> is the name of the test variable as described above and <test value> is the corresponding value from the object set definition.

For constraining types, the test is defined as:

'<test var name>.<ispresent method>'

where <test var name> is the name of the test variable as described above and the <ispresent method> is the method that checks that the corresponding type is present.

The <value test> is the result of combining one test for each value or type of the constrained element in the object set definition, that corresponds to the values and types in the <test expr> above, using the 'or' operator. For values each test is given as:

'<test var name> = <value>'

where the <test var name> is the name of the variable corresponding to the constrained field and <value> is a value from the object set definition.

For types, the test is defined as:

'<test var name>.<ispresent method>'

where <test var name> is the name of the variable corresponding to the constrained field and the <ispresent method> is the method that checks that the corresponding type is present.

For each String field in the type, a loop is generated according to the following scheme:

'loop(dcl <loop var> Integer := 1; <loop var> <= length(<string field>);
<loop var> := <loop var> + 1) { <loop body> }'

where <loop var> is a unique variable name, <string field> a reference to the treated string field and <loop body> the result of applying the transformations steps in this clause to the elements in the string.

Example 1

An example of a type with **SimpleTableConstraint**:

```
ErrorReturn ::= SEQUENCE
{
  errorCategory ERROR-CLASS.&category({ErrorSet}) OPTIONAL,
  errors SEQUENCE OF SEQUENCE
  {
    errorCode ERROR-CLASS.&code
                        ({ErrorSet}),
    errorInfo ERROR-CLASS.&Type
                        ({ErrorSet})
  } OPTIONAL
}
```

Provided that the specifications of class and object set were:

```
ERROR-CLASS ::= CLASS
{
  &category PrintableString (SIZE(1)),
  &code     INTEGER,
  &Type
}
WITH SYNTAX {&category &code &Type }

ErrorSet ERROR-CLASS ::=
{
  { "A" 1 INTEGER } |
  { "A" 2 REAL } |
  { "B" 1 CHARACTER STRING } |
  { "B" 2 GeneralString }
}
```

The SDL types derived from constraint specification would be:

```
syntype ErrorSet_category = PrintableString (SIZE(1))
  constants 'A', 'B'
endsyntype;

syntype ErrorSet_code = <<package Predefined>> Integer
  constants 1, 2
endsyntype;

value type ErrorSet_Type { choice
  integer          <<package Predefined>> Integer;
  real             <<package Predefined>> Real;
  characterString<<package Predefined>> CharacterString;
  generalString    <<package Predefined>> GeneralString;
}
```

The constructed SDL type would be the following:

```
value type ErrorReturn { struct
  errorCategory ErrorSet_category optional;
  errors String <
    { struct
      errorCode ErrorSet_code,
      errorInfo ErrorSet_Type } > optional;
}
```

No check method would be generated.

Example 2

An example of a type with `ComponentRelationConstraint`.

```
ErrorReturn ::= SEQUENCE
{
  errorCategory ERROR-CLASS.&category({ErrorSet}) OPTIONAL,
  errors SEQUENCE OF SEQUENCE
  {
    errorCode ERROR-CLASS.&code
                      ({ErrorSet}{@errorCategory}),
    errorInfo ERROR-CLASS.&Type
                      ({ErrorSet}{@errorCategory,@.errorCode})
  } OPTIONAL
}
```

The corresponding SDL type would be the following:

```
value type ErrorReturn {
struct
  errorCategory ErrorSet_category optional;
  errors String <
   { struct
     errorCode ErrorSet_code,
     errorInfo ErrorSet_Type } > optional;
  method Check() -> Boolean
  {
        dcl t1 ErrorSet_category;
        dcl p1 Boolean;
        p1 := this.errorCategoryPresent();
        if (p1 = True)
{
            t1 := this.errorCategory;
        }
        if ((p1 = False) and (this.errorsPresent() =  True))
        {
            return False;
        }
        loop (dcl i1 Integer := 1; I <=length(errors); i1 := i1+1)
        {
            dcl t2 ErrorSet_code, t3 ErrorSet_Type;
            t2 := this.errors[i1].errorCode;
            t3 := this.errors[i1].errorInfo ;
            if (t1="A" and not( t2=1 or t2=2))
            {
            return False;
            }
            if (t1="B" and not( t2=1 or t2=2))
            {
            return False;
            }
            if (t1="A" and t2=1 and not (t3.integerPresent()))
            {
            return False;
            }
```

```
            if (t1="A" and t2=2 and not (t3.realPresent()))
            {
            return False;
            }
            if (t1="B" and t2=1 and not (t3.characterStringPresent()))
{
            return False;
            }
            if (t1="B" and t2=2 and not (t3.generalStringPresent))
{
            return False;
            }
        }
    }
}
```

6 Mapping of parameterized ASN.1 specifications

ITU-T Rec. X.683 [6] defines the way to parameterize ASN.1 specification. All ASN.1 concepts can be parameterized. This feature allows the partial specification of types or values within an ASN.1 module with the specification being completed by the addition of the actual parameters at instantiation time.

ITU-T Rec. Z.100 defines an equivalent concept of formal context parameters.

6.1 Parameterized assignment

ASN.1 grammar

There are parameterized assignment statements corresponding to each of the assignment statements specified in ITU-T Recs X.680 and X.681.

The **ParameterizedAssignment**, **ParameterizedTypeAssignment**, **ParameterizedValueSetTypeAssignment**, **ParameterizedObjectClassAssignment**, **ParameterizedObjectAssignment**, **ParameterizedObjectSetAssignment** constructs are defined in 8.1/X.683.

Model

The use of all forms of **ParameterizedAssignment** is supported within ASN.1 modules.

ParameterizedTypeAssignment can be mapped to SDL as defined in 6.2 relying on the SDL formal context parameters mechanisms.

ParameterizedValueSetTypeAssignment, **ParameterizedObjectClassAssignment**, **ParameterizedObjectAssignment**, **ParameterizedObjectSetAssignment** can be used in ASN.1 modules in order to be used in other ASN.1 specifications but are not mapped to SDL themselves.

6.2 Parameterized type assignment

ASN.1 grammar

ParameterizedTypeAssignment and **ParameterList** is defined in 8.1/X.683.

Model

The difference between ordinary and parameterized ASN.1 types is that **ParameterList** follows the **typereference** and formal parameters contained in **ParameterList** are used in the **Type** definition.

A **Type** defined in ASN.1 using parameters from the **ParameterList** is mapped to the appropriate SDL type (as defined in 4.2.1) provided that ASN.1 parameters are either value or type parameters. Such parameters are mapped to <formal context parameters> of the SDL type. ASN.1 type parameter is mapped to SDL <sort context parameter> and ASN.1 value parameter is mapped to SDL <synonym context parameter>.

ASN.1 parameterized types having parameters that are not types or values cannot be mapped to SDL directly. However, if the parameters can be expanded first into types or values, the resulting ASN.1 type or value can be mapped to SDL as defined in 6.3.

Example

The ASN.1-type definition:

```
TemplateMessage {INTEGER : minSize, INTEGER : maxSize, IndicatorType } ::=
SEQUENCE
{
     asp             INTEGER,
     pdu             OCTET STRING(SIZE(minSize..maxSize)),
     indicator       IndicatorType
}
```

is mapped to SDL type:

value type TemplateMessage
<**synonym** minSize <<**package** Predefined>> Integer; **synonym** maxSize <<**package** Predefined>> Integer; **value type** IndicatorType>
struct
{
asp Integer;
pdu <<**package** Predefined>>Octetstring (**SIZE**(minSize:maxSize));
indicator IndicatorType;
}

6.3 Referencing ASN.1 parameterized type definitions

ASN.1 grammar

ParameterizedType, **ParameterizedValue** and **ActualParameterList** are defined in 9.2/X.683.

Model

ParameterizedType and **ParameterizedValue** references are used in ASN.1 to define new ASN.1 types and values by providing an **ActualParameterList**.

If the **ParameterizedType** definition was such that it was possible to map it to SDL and the **ActualParameterList** contains only **Type** and **Value** parameters, then ASN.1 references to such definitions can be mapped to SDL instantiations of the type with context parameters so that elements of **ActualParameterList** are mapped to <actual context parameters>. Example 1 illustrates one such mapping.

If according to 6.2 the **ParameterizedType** definition could not be mapped to SDL-type definition with context parameters, the references to such **ParameterizedType** definitions can be mapped to SDL so that the meaning of such a type is fully expanded to the level of types defined in clause 4 before a mapping to SDL is done.

If the **ActualParameterList** contains **ValueSet**, **DefinedObjectClass**, **Object** or **ObjectSet**, the mapping of such type to SDL is done in such a way that the meaning of such type is fully expanded to the level of types defined in clause 4 before a mapping to SDL is done. Example 2 illustrates one such mapping.

The ASN.1 types and values derived from referenced ASN.1 parameterized definitions can be mapped to SDL as defined in clause 4.

Example 1

The parameterized type used in the example in 6.2 can be used to define a simple ASN.1 as follows:

```
ActualMessage ::= TemplateMessage{10, 20, BOOLEAN}
```

This can be mapped to SDL type:

value type ActualMessage : TemplateMessage < 10, 20, <<**package** Predefined>> Boolean >

Example 2

What follows is an example of the ASN.1-type definition derived using a parameter that is an information object. The ASN.1 modules needs to contain the relevant information object class definition with parameterized assignment having object of that class as dummy parameter, information object value assignment and parameterized type definition reference.

```
MESSAGE-PARAMETERS ::= CLASS {
     &maximum-priority-level          INTEGER,
     &maximum-message-buffer-size     INTEGER
}
WITH SYNTAX {
     THE MAXIMUM PRIORITY LEVEL IS         &maximum-priority-level
     THE MAXIMUM MESSAGE BUFFER SIZE IS    &maximum-message-buffer-size
}
Message-PDU { MESSAGE-PARAMETERS : param } ::= SEQUENCE {
     priority-level     INTEGER       (0..param.&maximum-priority-level),
     message       BMPString (SIZE    (0..param.&maximum-message-buffer-size))
}
my-message-parameters MESSAGE-PARAMETERS ::= {
     THE MAXIMUM PRIORITY LEVEL IS 10
     THE MAXIMUM MESSAGE BUFFER SIZE IS 2000
}
MY-Message-PDU ::= Message-PDU { my-message-parameters }
```

The semantics of ASN.1 is that with such definition of class, parameterized type definition and object value definition, the type resulting from transformation of MY-Message-PDU is equivalent to:

```
MY-Message-PDU ::=       SEQUENCE {
     priority-level      INTEGER   (0..10),
     message             BMPString (SIZE    (0..2000))
}
```

The resulting ASN.1 type can be mapped to SDL type as:

value type MY_Message_PDU {
struct
priority_level <<**package** Predefined>> INTEGER (0..10);
message <<**package** Predefined>> BMPString (**SIZE** (0..2000));
}

6.4 Referencing ASN.1 parameterized value definitions

ASN.1 grammar

ParameterizedType, **ParameterizedValue** and **ActualParameterList** are defined in 9.2/X.683.

Model

ParameterizedValue references are used in ASN.1 to define new ASN.1 values by providing an **ActualParameterList**.

ParameterizedValue references are mapped to SDL in such a way that the meaning of such a value specification is fully expanded to the level of value assignments defined in clause 4 before a mapping to SDL is done.

6.5 Referencing other ASN.1 parameterized definitions

ParameterizedValueSetType, **ParameterizedObjectClass**, **ParameterizedObjectSet** and **ParameterizedObject** are defined in 9.2/X.683.

ASN.1 modules can contain the specification of value sets, object classes, object sets and objects defined by referencing the **SimpleDefinedType** with **ActualParameterList**. Such specifications are not mapped to SDL.

7 Additions to package Predefined

The following definitions shall be added to the package Predefined in order to support the combination of ASN.1 modules with SDL.

```
syntype NumericChar = Character constants
' ',  '0',  '1',  '2',  '3',  '4',  '5',  '6',
'7',  '8',  '9' endsyntype;
/* */
/*      NumericString sort        */
/*      Definition                */
value type NumericString
    inherits String < NumericChar > ( '' = emptystring )
    adding
        operators ocs in nameclass
            '' ( ('0':'9') or '''' or (' ') )+ '' -> this NumericString;
/*  character strings of any length of any characters from a space ' ' to a '9'      */
axioms
    for all c in NumericChar nameclass (
    for all cs, cs1, cs2 in ocs nameclass (
    spelling(cs) == spelling(c)                          ==> cs  == mkstring(c);
/*  string 'A' is formed from character 'A' etc.      */
    spelling(cs) == spelling(cs1) // spelling(cs2),
    length(spelling(cs2)) == 1                           ==> cs  == cs1 // cs2;
    ));
endvalue type NumericString;
/* */
syntype PrintableChar = Character constants
' ',  '0',  '1',  '2',  '3',  '4',  '5',  '6',
```

```
'7',  '8',  '9',  'A', 'B', 'C', 'D', 'E',
'F',  'G', 'H', 'I',   'J',  'K', 'L', 'M',
'N', 'O', 'P',  'Q', 'R', 'S',  'T', 'U',
'V', 'W','X', 'Y', 'Z', 'a',  'b',  'c',
'd',  'e',  'f',  'g',  'h',  'i',  'j',   'k',
'l',   'm', 'n',  'o',  'p',  'q',  'r',   's',
't',   'u',  'v',  'w', 'x',  'y',  'z',  '''',
'(',  ')',   '+',  ',',   '-',   '.',   '/',   ':',
'=',  '?'
constants;
/* */

/*   PrintableString sort        */
/*   Definition                  */
value type PrintableString
     inherits String < PrintableChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
                              '''' ( (' ':'&') or '''''' or ('(': '?') )+ '''' -> this PrintableString;
/*   character strings of any length of any characters from a space ' ' to a '?'      */
axioms
     for all c in PrintableChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                         ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.      */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                          ==> cs  == cs1 // cs2;
     ));
endvalue type PrintableString;
/* */
syntype TeletexChar = Character constants
/*   characters specified in Table 3/X.680      */ endsyntype;
/* */
/*   TeletexString sort    */
/*   Definition            */
value type TeletexString
     inherits String < TeletexChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   characters specified in Table 3/X.680      */ -> this TeletexString;
axioms
     for all c in TeletexChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                         ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.      */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                          ==> cs  == cs1 // cs2;
     ));
endvalue type TeletexString;
syntype VideotexChar = Character constants
/*   characters specified in Table 3/X.680      */ endsyntype;
/* */
```

```
/*   VideotexString sort         */
/*   Definition                  */
value type VideotexString
     inherits String < VideotexChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   characters specified in Table 3/X.680      */ -> this VideotexString;
axioms
     for all c in VideotexChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                              ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.     */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                               ==> cs  == cs1 // cs2;
     ));
endvalue type VideotexString;

syntype IA5Char = Character endsyntype;

syntype IA5String = Charstring endsyntype;

value type GeneralChar
     literals /*    All G and all C sets + SPACE + DELETE in Table 3/X.680    */
operators
     gchr           ( Integer ) -> this GeneralChar;
endvalue type;

value type UniversalChar
     literals /*    see 37.6/X.680   */
operators
     uchr           ( Integer ) -> this UniversalChar;
endvalue type;
/* */

/*   UniversalCharString sort       */
/*   Definition                     */

value type UniversalCharString
     inherits String < UniversalChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   see 37.6/X.680   */ -> this UniversalCharString;
axioms
     for all c in UniversalChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                              ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.     */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                               ==> cs  == cs1 // cs2;
     ));
```

```
endvalue type UniversalCharString;
/* */

/*   UTF8String sort       */
syntype UTF8String = UniversalCharString endsyntype;
/* */

/*   GeneralCharString sort   */
/*   Definition               */
value type GeneralCharString
     inherits String < GeneralChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   All G and all C sets + SPACE + DELETE in Table 3/X.680    */
-> this GeneralCharString;
/*   character strings of any length of any characters from a space ' ' to a '?'       */
axioms
     for all c in GeneralChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                        ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.      */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                         ==> cs  == cs1 // cs2;
     ));
endvalue type GeneralCharString;
/* */

syntype GraphicChar = GeneralChar constants
/*   All G+SPACE+DELETE as specified in Table 3/X.680    */
endsyntype;
/* */

/*   GraphicCharString sort   */
/*   Definition               */

value type GraphicCharString

     inherits String < GraphicChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   All G + SPACE + DELETE as specified in Table 3/X.680       */
-> this GraphicCharString;
axioms
     for all c in GraphicChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                        ==> cs  == mkstring(c);
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                         ==> cs  == cs1 // cs2;
     ));
endvalue type GraphicCharString;
```

```
syntype VisibleChar = Character constants
/* characters specified in Table 3/X.680 */
endsyntype;
/* */

/*   VisibleString sort     */
/*   Definition             */
value type VisibleString
     inherits String < VisibleChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   characters specified in Table 3/X.680      */
-> this VisibleString;
axioms
     for all c in VisibleChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                          ==> cs  == mkstring(c);
/*   string 'A' is formed from character 'A' etc.      */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                           ==> cs  == cs1 // cs2;
     ));
endvalue type VisibleString;

syntype BMPChar = UniversalChar CONSTANTS /* see 37.15/X.680 */ endsyntype;
/* */
/*   BMPCharString sort       */
/*    Definition              */
value type BMPCharString
     inherits String < BMPChar > ( '' = emptystring )
     adding
          operators ocs in nameclass
/*   see 37.15/X.680*/ -> this BMPCharString;
axioms
     for all c in BMPChar nameclass (
     for all cs, cs1, cs2 in ocs nameclass (
     spelling(cs) == spelling(c)                          ==> cs  == mkstring(c);
/* string 'A' is formed from character 'A' etc. */
     spelling(cs) == spelling(cs1) // spelling(cs2),
     length(spelling(cs2)) == 1                           ==> cs  == cs1 // cs2;
     ));
endvalue type BMPCharString;
/* */

value type NULL
literals NULL

endvalue type;
```

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	**Languages and general software aspects for telecommunication systems**

Printed in Switzerland
Geneva, 2003