Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 8: The IDL to TTCN-3 Mapping
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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS).

The present document is part 8 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

Introduction

Object-based technologies (such as CORBA, DCOM, DCE) and component-based technologies (such as CCM, EJB, Microsoft®.NET) use interface specifications to describe the structure of an object-/component-based system and its operations and capabilities to interact with the environment. These interface specifications support interoperability and reusability of objects/components.

The techniques used for interface specifications are often called Interface Definition Language (IDL), for example CORBA IDL, Microsoft® IDL or DCE IDL. These languages are comparable in their abilities to define system interfaces, operations at system interfaces and system structures to various extends. They differ in details of the object/component model.

When considering the testing of object-/component-based systems with TTCN-3, one is faced with the problem of accessing the systems to be tested via the system interfaces as described in an IDL specification. In particular, for TTCN-3 based test systems a direct import of IDL specifications into the test specifications for the use of e.g. system's interface, operation and exception definitions is prevalent to any manual transformation into TTCN-3.

The present document discusses the mapping of CORBA IDL specifications into TTCN-3. This mapping rules out the principles not only for CORBA IDL, but also for other interface specification languages. The mapping can be adapted to the details of other interface specification languages.

The Interface Definition Language (IDL) (chapter 3 in [4]) is a base of the whole Common Object Request Broker Architecture (CORBA) [4] and an important point in developing distributed systems with CORBA. It allows the reuse and interoperability of objects in a system. A mapping between IDL and a programming language is defined in the CORBA standard. IDL is very similar to C++ containing pre-processor directives (include, comments, etc.), grammar as well as constant, type and operation declarations. There are no programming language features like, e.g. if-statements.

The core language of TTCN-3 is defined in ES 201 873-1 [1] and provides a full text-based syntax, static semantics and operational semantics. The IDL mapping provides a definition for the use of the core language with IDL (figure 1).
It makes no difference for the mapping if requested or provided interfaces are required by the test system and SUT. Hence, TTCN can be used on client and server side without modifications to the mapping rules.

The present document is structured similar to the IDL specification document to provide easy access to the mapping of each IDL element.
1 Scope

The present document defines the mapping rules for CORBA IDL (as defined in chapter 3 in [4]) to TTCN-3 (as defined in ES 201 873-1 [1]) to enable testing of CORBA-based systems. The principles of mapping CORBA IDL to TTCN-3 can be also used for the mapping of interface specification languages of other object-/component-based technologies.

The specification of other mappings is outside the scope of the present document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.


[2] Recommendation ITU-T T.50: “International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IAS) - Information technology - 7-bit coded character set for information interchange”.


NOTE: Available at http://www.omg.org/spec/CORBA/.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI ES 201 873-7: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 7: Using ASN.1 with TTCN-3”.

[i.2] Void.

[i.3] Void.

[i.4] Void.


ETS

[i.8] ETSI ES 202 785: “Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; TTCN-3 Language Extensions: Behaviour Types”.

[i.9] ETSI ES 202 786: “Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; TTCN-3 Language Extensions: Support of interfaces with continuous signals”.

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

- **ASN.1** Abstract Syntax Notation One
- **CCM** CORBA Component Model

**NOTE:** By OMG.

- **CORBA** Common Object Request Broker Architecture

**NOTE:** By OMG.

- **DCE** Distributed Computing Environment

**NOTE:** By OSF.

- **EJB** Enterprise JavaBeans™

**NOTE:** By Sun.

- **IDL** Interface Definition Language
- **NET** XML-based component technology

**NOTE:** By Microsoft®.

- **OMG** Object Management Group
- **OSF** Open Software Foundation
- **SUT** System Under Test
- **TTCN** Testing and Test Control Notation
- **XML** eXtended Markup Language

4 Approach

Two different approaches can be identified: the use of either implicit or explicit mapping. The implicit mapping makes use of the import mechanism of TTCN-3, denoted by the keywords language and import. It facilitates the immediate use of data specified in other languages. Therefore, the definition of a specific data interface for each of these languages is required. Currently, ASN.1 data can be used besides the native TTCN-3 types (see ES 201 873-7 [i.1]).

The present document follows the approach of explicit mapping, i.e. IDL data are translated into appropriate TTCN-3 data. And only those TTCN-3 data are further used in the test specification.

5 Lexical Conventions

The lexical conventions of IDL define the comments, identifiers, keywords and literals conventions which are described below.
5.1 Comments

Comment definitions in TTCN-3 and IDL are the same and therefore, no conversion of comments is necessary.

5.2 Identifiers

IDL identifier rules define a subset of the TTCN-3 rules in which no conversion is necessary.

5.3 Keywords

When IDL is used with TTCN-3 the keywords of TTCN-3 shall not be used as identifiers in an IDL module.

5.4 Literals

The definition of literals differs slightly between IDL and TTCN-3 why some modifications have to be made. Table 1 gives the mapping for each literal type.

<table>
<thead>
<tr>
<th>Literal</th>
<th>IDL</th>
<th>TTCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer</td>
<td>no &quot;0&quot; as first digit</td>
<td>no &quot;0&quot; as first digit</td>
</tr>
<tr>
<td>Octet</td>
<td>&quot;0&quot; as first digit</td>
<td>FF96'O</td>
</tr>
<tr>
<td>Hex</td>
<td>&quot;0X&quot; or &quot;0x&quot; as digits</td>
<td>ABO1'D'H</td>
</tr>
<tr>
<td>Floating</td>
<td>1222.44E5 (Base 10)</td>
<td>1222.44E5 (Base 10)</td>
</tr>
<tr>
<td>Char</td>
<td>'A'</td>
<td>&quot;A&quot;</td>
</tr>
<tr>
<td>Wide char</td>
<td>L'A'</td>
<td>A</td>
</tr>
<tr>
<td>Boolean</td>
<td>TRUE, FALSE</td>
<td>true, false</td>
</tr>
<tr>
<td>String</td>
<td>&quot;text&quot;</td>
<td>&quot;text&quot;</td>
</tr>
<tr>
<td>Wide string</td>
<td>L&quot;text&quot;</td>
<td>&quot;text&quot;</td>
</tr>
<tr>
<td>Fixed point</td>
<td>33.33D</td>
<td>(see useful type IDLfixed)</td>
</tr>
</tbody>
</table>


6 Pre-processing

Pre-processor statements are not matched to TTCN-3 because the IDL specification shall be used after pre-processing it.

7 Importing from IDL specifications

The import of module, interface, value and constant declaration are described in this clause. The type and exception declaration as well as the bodies of interfaces are described later.

All imported IDL declarations are in TTCN-3 public by default (see clause 8.2.5 of ES 201 873-1 [1]).

7.1 Importing module declaration

IDL modules are mapped to TTCN-3 modules. Nested IDL modules shall be flattened accordingly to TTCN-3 modules.

As one IDL module can contain many nested IDL modules where several nested modules can have equal names in different scopes, these names can clash. Hence, module names identifiers are to be used which are composed of the identifiers of the upper level IDL modules (from hierarchical point of view) and the nested IDL module name, separated one from each other by two underscores.
According to the IDL scoping rules nested modules have access to the scope of upper level modules. As there are no nested modules in TTCN-3, TTCN-3 modules have to import upper level modules. For avoiding name clashes, a prefix for the imported definitions composed of the identifier of the module from which it is imported shall be used. The prefix and the identifier are separated by a dot (.) as defined in TTCN-3.

IDL EXAMPLE:

```idl
module identifier1 {
    typedef long mylong1;
}
module identifier2 {
    typedef string mystring2;
    typedef mylong1 mylong2;
}
module identifier3 {
    typedef mylong1 long_from_module_1;
    typedef mystring2 string_from_module_2;
    typedef mylong2 long_from_module_1_2;
}
```

TTCN EXAMPLE:

```ttcn
module identifier1 {
    type long mylong1;
}
module identifier1__identifier2 {
    import from identifier1 all;
    type iso8859string mystring2;
    type identifier1.mylong1 mylong2;
}
module identifier1__identifier2__identifier3 {
    import from identifier1 all;
    import from identifier1__identifier2 all;
    type identifier1.mylong1 long_from_module_1;
    type identifier1__identifier2.mystring2 string_from_module_2;
    type identifier1__identifier2.mylong2 long_from_module_1_2;
}
```

7.2 Importing interface declaration

Interfaces are flattened and all interface definitions are stored in one group. In contrast to interfaces in IDL, groups in TTCN-3 do not create a scope. Therefore, prefixes for all identifiers of type definitions inside of the interface shall be used, which are a combination of the interface name and two underscores as the prefix.

Import of single interface definitions from other modules via the importing group statement is possible. This can be used if inheritance is used in the IDL specification.

For each interface, a procedure-based port type is defined for the test specification. It is associated with signatures translated from attributes and operations of the interface.

An IDL attribute is mapped to two signatures: one for the setting of a value and one for getting it. These signatures have names composed of the prefix (interface name and two underscores), attribute name and the word "Set" (except for "readonly") or "Get" correspondingly.

Since an interface can be used in operation parameters to pass object references, an `address` type is also declared in the data part - the concrete implementation is left to the user. Components are used as collection of interfaces or objects.

IDL EXAMPLE:

```idl
interface identifier {
    attribute long attributeId;
    void operationname ( in string param_value ) raises ( ExceptionType );
    ... other body definitions ... 
};
```
TTCN EXAMPLE:

```tcl
group identifierInterface {
    signature identifier__attributeIdGet () return long
    exception ( ... /* and all system exceptions defined in clause 9 */ );
    signature identifier__attributeIdSet (in long identifier__attributeId)
    exception ( ... /* and all system exceptions defined in clause 9 */ );
    signature identifier__operationname (in iso8859string identifier__param_value )
    exception ( ExceptionType, ... /* and all system exceptions defined in clause 9 */ ) ;
    ...other body definitions ...
    type port identifier procedure { ... }
    type charstring identifierObject; /* a possible definition for the address type */
    type identifierObject address; /* a possible definition for the address type */
}
```

Interface inheritance is executed by rolling out all inherited elements. Thus, they have to be handled as defined in the interface itself. Multiple inheritance elements have to be inherited only once! As normally an inherited IDL interface uses types defined in the module, usually it is essential to import the complete mapped TTCN-3 module. All inherited elements have to be rolled out directly in the TTCN-3 group for the interface, even if the inheritance is multiple.

Forward references of interfaces are provided by forward referencing the according port of the interface. Local interfaces are treated as normal interfaces. However it is recommend not to use forward references and to move a TTCN-3 definition of the interface (group) to a place where a forward definition is used first time.

### 7.3 Importing value declaration

In contrast to type `interface`, the IDL type `value` has local operations that are not used outside the object, and are therefore not relevant from the functional testing point of view. However, since the public attributes of `value` instances are used to communicate object states, the IDL `value` type is mapped to the `record` type in TTCN-3.

The example below shows how to map `valuetype` and was used from clause 5.2.5 in [4].

**IDL EXAMPLE:**

```idl
valuetype EmployeeRecord {
    // note this is not a CORBA::Object
    // state definition
    private string name;
    private string email;
    private string SSN;
    // initializer
    factory init(
        in string name, in string SSN );
}
```

**TTCN EXAMPLE:**

```tcl
type record EmployeeRecord {
    iso8859string name,
    iso8859string email,
    iso8859string SSN
}
```

### 7.4 Importing constant declaration

Constant declarations can be transformed by use of literal (see table 1) and operator mapping for floating-point and integer values (see table 2).
Table 2: Operators for constant expressions

<table>
<thead>
<tr>
<th>Operator</th>
<th>IDL</th>
<th>TTCN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unary floating-point</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Negative</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Binary floating-point</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addition</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Subtraction</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multiplication</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Division</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><strong>Unary integer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Negative</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bit-complement</td>
<td>~</td>
<td>not4b</td>
</tr>
<tr>
<td><strong>Binary integer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addition</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Subtraction</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multiplication</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Division</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Modulo</td>
<td>%</td>
<td>mod</td>
</tr>
<tr>
<td>Shift left</td>
<td>&lt;&lt;</td>
<td>&lt;&lt;</td>
</tr>
<tr>
<td>Shift right</td>
<td>&gt;&gt;</td>
<td>&gt;&gt;</td>
</tr>
<tr>
<td>Bitwise and</td>
<td>&amp;</td>
<td>and4b</td>
</tr>
<tr>
<td>Bitwise or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bitwise xor</td>
<td>^</td>
<td>xor4b</td>
</tr>
</tbody>
</table>

IDL EXAMPLE:

```idl
const long number = 017; // 017 == 0xF == 15
const long size = ( ( number << 3 ) % 0x1F ) & 0123;
```

TTCN EXAMPLE:

```ttcn
const long number := "17"O;
const long size := ( ( number << 3 ) mod '1F'0'H ) and4b '0123'O;
```

8 Importing type declaration

Type declaration mapping will be shown in the following clauses.

A construct for naming data types and defining new types by using the keyword `typedef` is provided by IDL. This can be done under TTCN-3 via the keyword `type`, too.

To enhance readability and to provide a clear distinction, mapped IDL data types get the prefix IDL and the extension attribute "variant" as done in TTCN-3 for type `IDLfixed` (see clause D.2.3.0 in ES 201 873-1 [1]).

8.1 IDL basic types

IDL basic data types are mapped to predefined or useful types in TTCN-3.

8.1.1 Integer and floating-point types

Integer and floating-point types are mapped onto the corresponding useful types `short`, `unsignedshort`, `long`, `unsignedlong`, `longlong`, `unsignedlonglong`, `IEEE754float`, `IEEE754double`, and `IEEE754extdouble`.

IDL EXAMPLE:

```idl
const long size = ( ( number << 3 ) % 0x1F ) & 0123;
const float decimal = 15.7;
```
TTCN EXAMPLE:

```tcl
const long size := ( ( number << 3 ) mod '1F'H ) and4b '0123'O;
const IEEE74f16t decimal := 15.7;
```

8.1.2 Char and wide char type

The IDL char and wide char type represent a single and wide character. They are mapped to the self defined type iso8859char and type uchar.

IDL EXAMPLE:

```tcl
const char letter = 'ABCD';
const wchar wideLetter = L'ABCD';
```

TTCN EXAMPLE:

```tcl
type universal charstring uchar length();
type uchar iso8859char ( char ( 0,0,0,0 ) .. char ( 0,0,0,255)) with { variant "8 bit" };
const iso8859char letter := char ( 65, 66, 67, 68 );
const uchar wideLetter := char ( 65, 66, 67, 68 );
```

8.1.3 Boolean type

The IDL boolean type is equivalent to the TTCN-3 boolean type.

IDL EXAMPLE:

```tcl
const boolean isValid = TRUE;
```

TTCN EXAMPLE:

```tcl
const boolean isValid = true;
```

8.1.4 Octet type

Octet cannot be mapped onto an integer type because it has the special feature that it will not change its internal ordering if transferred between different system architectures. To represent it octet is mapped to octetstring.

IDL EXAMPLE:

```tcl
const octet data = 0x55;
```

TTCN EXAMPLE:

```tcl
const octetstring data = '55'H
```

8.1.5 Any type

The IDL any type is mapped onto anytype in TTCN-3 which was especially introduced for this mapping.

IDL EXAMPLE:

```tcl
typedef any AllTypes;
```

TTCN EXAMPLE:

```tcl
type anytype AllTypes;
```

8.2 Constructed types

IDL provides the three constructed types struct, union, and enum. Recursive construction of types is only permitted with the sequence template.
8.2.1 Struct

**struct** is used to collect ordered data in one place where it is mapped onto **record** in TTCN-3.

**IDL EXAMPLE:**

```idl
typedef struct NC {
  string id;
  string kind;
} NameComponent;
```

**TTCN EXAMPLE:**

```tcc
type record NameComponent {
  iso8859string id,
  iso8859string kind
}
```

8.2.2 Discriminated unions

In IDL, unions are discriminated to determine the actual type. Therefore, a **record** type is used, which contains two members. The first one stores the discriminator information using an enumeration type. The second member is a TTCN-3 union type which members are defined according to the specified IDL union members.

In addition, two types are defined to express the link between discriminator's type and union's type: a type to reflect the discriminating type of a union and an enumeration to distinguish the discriminated cases. Using the information provided by these type definitions, the marshalling/unmarshalling for discriminated unions is possible in an unambiguous manner: to encode or decode a union value, we use the value of the kind field to resolve the corresponding chosen option and calculate then the real value for the discriminator by resolving this value in the discriminator enumeration.

**IDL EXAMPLE 1:**

```idl
union MyUnion switch( long ) {
  case 0 : boolean b;
  case 1 : char c;
  case 2 : octet o;
  case 3 : short s;
}
```

**TTCN EXAMPLE 1:**

```tcc
type long MyUnion__Switch;
type union MyUnionType {
  boolean b,
  iso8859string c,
  octetstring o,
  short s
}
type enumerated MyUnionEnumType {
  boolean_b, iso8859string_c, octetstring_o, short_s
}
type record MyUnion {
  MyUnionEnumType kind,
  MyUnionType value
}
```

**IDL EXAMPLE 2:**

```idl
Enum MyDiscr {
  BOOLEAN_DISCR,
  CHAR_DISCR,
  OCTET_DISCR,
  SEQ_DISCR,
  SHORT_DISCR
};
union MyUnion switch( MyDiscr ) {
  case BOOLEAN_DISCR : boolean b;
  case SHORT_DISCR : short s;
}
```
TTTCN EXAMPLE 2:

type enumerated MyDiscr {
    BOOLEAN_DISCR, CHAR_DISCR, OCTET_DISCR, SEQ_DISCR, SHORT_DISCR
}
type MyDiscr MyUnion__Switch;
type enumerated MyUnion__CasesType {
    case BOOLEAN_DISCR,
    case SHORT_DISCR
}
type union MyUnionType {
    boolean b,
    short s
}
type enumerated MyUnionEnumType {
    boolean_b,
    short_s
}
type record MyUnion {
    MyUnionEnumType kind_,
    MyUnionType value_
}

8.2.3 Enumerations

Enumerations are equally defined in IDL and TTCN-3.

IDL EXAMPLE:

denum NotFoundReason {
    missing_node,
    not_context,
    not_object ;
}

TTCN EXAMPLE:

type enumerated NotFoundReason {
    missing_node,
    not_context,
    not_object };

8.3 Template types

IDL supports the template types sequence, string, wide string and fixed type.

8.3.1 Sequence

IDL sequence is mapped to record of in TTCN-3 to maintain order and to allow unbounded sequences.

IDL EXAMPLE 1:

typedef sequence<NameComponent> Name;

TTCN EXAMPLE 1:

type record of NameComponent Name;

IDL sequences with a specified maximum size are mapped to record of with limited number of elements to maintain order and restrict the maximum number of elements.

IDL EXAMPLE 2:

typedef sequence<NameComponent, maximum_size> Name;
TTCN EXAMPLE 2:

```tcl
type record length (0, maximum_size-1) of NameComponent Name;
```

### 8.3.2 String and wstring

`string` and `wstring` types are sequences of `char` and `wchar`. Therefore, `string` and `wstring` are mapped to the useful type `iso8859string` and `universal charstring`.

**IDL EXAMPLE:**
```
const string name = "My String";
const wstring wideName = L"My String";
```

**TTCN EXAMPLE:**
```
const iso8859string name := "My String";
const universal charstring wideName := "My String";
```

### 8.3.3 Fixed types

The `fixed` type represents a fixed-point decimal number. It is mapped to the corresponding useful type `IDLfixed` in TTCN-3 (see clause D.2.3.0 in ES 201 873-1 [1]).

**IDL EXAMPLE:**
```
typedef fixed<12,7> myFix;
```

**TTCN EXAMPLE:**
```
template IDLfixed myFixTemplate := { 12, 7, ? }; // e.g. in module definition part
var IDLfixed myFix := { 12, 7, "12345.1234567" }; // e.g. in module control part
```

### 8.4 Complex declarator

The last kind of type declarators are the complex `array` and `native` types.

#### 8.4.1 Arrays

**IDL array** is equal to the TTCN-3 `array` type.

**IDL EXAMPLE:**
```
typedef long NumberList[100];
```

**TTCN EXAMPLE:**
```
type long NumberList[100];
```

#### 8.4.2 Native types

Native types are used to allow implementation of dependent types. TTCN-3 provides the type `address` to address entities inside a SUT. Hence, `address` can be used for mapping of type `native` and concrete implementation is left to the user.

**IDL EXAMPLE:**
```
typedef native MyNativeVariable;
```

**TTCN EXAMPLE:**
```
type MyNativeVariable address;
```
9 Importing exception declaration

In IDL, exceptions are used in conjunction with operations to handle exceptional conditions during an operation call. Thus, a special struct-like exception type is provided which has to be associated with each operation that can trigger this exception. TTCN-3 also supports the use of exceptions with procedure calls by binding it to signature definitions. However, it provides no special exception type. Hence, exceptions are defined by using type record.

A definition of an exception is shown in the following example. The use of exception binding in signature definitions and exception catching is shown in the context of operation declaration.

**IDL EXAMPLE:**

```idl
exception NotFoundException {
    NotFoundReason why;
    Name rest_of_name;
}
```

**TTCN EXAMPLE:**

```tcc
// definition of an exception type
type record NotFoundException {
    NotFoundReason why,
    Name rest_of_name }
// definition of a template for the
// defined exception type
template NotFoundException
NotFoundExceptionTemplate ( NotFoundReason reason, Name name ) := { why := reason, rest_of_name := name }
```

In addition to user defined exceptions, there are CORBA system exceptions defined in chapter 4 in [4]. In order to make them available for use in TTCN-3, the following definitions are to be used:

```tcc
// CORBA system exceptions
type record UNKNOWN{}    // the unknown type record
type record BAD_PARAM{}    // an invalid parameter was passed
type record NO_MEMORY{}    // dynamic memory allocation failure
type record IMP_LIMIT{}    // violated implementation limit
type record COMM_FAILURE{} // communication failure
type record INV_OBJREF{} // invalid object reference

type record NO_PERMISSION{} // no permission for attempted op.
type record INTERNAL{} // ORB internal error
type record MARSHAL{} // error marshaling param/result

type record INITIALIZE{} // ORB initialization failure
type record NO_IMPLEMENT{} // operation implementation unavailable

type record BAD_TYPECODE{} // bad typecode

type record BAD_OPERATION{} // invalid operation
type record NO_RESOURCES{} // insufficient resources for req.
type record NO_RESPONSE{} // response to req. not yet available

type record TRANSIENT{} // transient failure - reissue request

type record FREE_MEM() // cannot free memory

type record INV_IDENT{} // invalid identifier syntax

type record INV_FLAG{} // invalid flag was specified

type record COM_ARRAY{} // error accessing array

// CORBA system exceptions
```

In addition to user defined exceptions, there are CORBA system exceptions defined in chapter 4 in [4]. In order to make them available for use in TTCN-3, the following definitions are to be used:
10 Importing operation declaration

Apart from attributes, operations are the main part of interface definitions in IDL and are used, for instance, in the CORBA scheme as procedures which can be called by clients. Procedure calls in general are supported by TTCN-3 by means of synchronous communication operations which are used in combination with ports.

IDL supports an optional oneway attribute for operations which implies best-effort invocation semantics without a guarantee of delivery but with a most-once invocation semantics. Message or procedure-based ports can be used for oneway procedures because both would be a valid mapping based upon IDL. However, the use of procedure-based ports for oneway procedures is recommended because the IDL specification does not guarantee that oneway calls are non-blocking or asynchronous. Furthermore, CORBA implements oneway procedures by synchronous communication, too. Use of non-blocking or blocking procedures for oneway operations is left to the user. Mapped oneway operations acquire an additional variant attribute (see example).

The parameter attributes in, inout and out describe the transmission direction of parameters and can be mapped directly to the communication parameter attributes in TTCN-3 because they have the exact same semantics.

A raise expression specifies all user-defined exceptions which can be thrown by an operation. In addition, all CORBA system exceptions as defined in clause 9 can be raised. The raise expression can be mapped directly to TTCN-3 because it can be indicated by the procedure signature definition by specifying the list of exceptions.

A context expression provides access to local properties of the called operation. These properties consist of a name and a string value. The context expression can be matched by redefining the operation with the context parameters included in the operation parameters (see clause 4.6 in [4]). The additional parameter shall be of type array containing a type record for each context parameter. The record itself contains two variables of type string for the context name and value.
IDL EXAMPLE:

```c
// NotFoundException is defined clause "Exception declaration"

string remoteProc1( in long Par11, out long Par12, inout string name1 )
    raises( NotFoundException )
    context( "MyContext1" );

// oneway procedure: no return value and no inout or out allowed!!!
oneway void remoteProc2( in long Par21, in long Par22, in string name2 );
```

TTCN EXAMPLE:

```c
// only operation definition

type record IDLContextElement {
    iso8859string name,
    iso8859string value_
}

type record of IDLContextElement IDLContext;

signature RemoteProcSignature1{
    in long Par11, out long Par12,
    inout charstring name1, in IDLContext context )
    return iso8859string
    exception( // user-defined exception
        NotFoundException,
        SYSTEM_EXCEPTION
    );

signature RemoteProcSignature2{
    in long Par21, in long Par22,
    in iso8859string name2 )
    exception ( SYSTEM_EXCEPTION )
    with { variant "IDL:oneway FORMAL/01-12-01 v.2.6" };

type port RemoteProcPort procedure {
    out RemoteProcSignature1;
    out RemoteProcSignature2
}

type component CorbaSystem {
    port RemoteProcPort PCO
}
```

11 Importing attribute declaration

An attribute is like a set- and get-operation pair to access a value. If an attribute is marked as `readonly`, only the get-operation is used. Therefore, attribute mapping can be done by the operation mapping.

12 Names and scoping

The name definition scheme of IDL does not collide with the name definition in TTCN-3. Scoping is more restrictive in IDL than in TTCN-3, where the IDL scoping rules have to be mapped appropriately to allow seamless mapping. IDL uses nested scopes for modules, interfaces, structures, unions, operations and exceptions and identifiers are scoped in types, constants, enumeration values, exceptions, interfaces, attributes and operations. The hierarchical scopes in TTCN-3 are module, control part of module, function, testcase and statement blocks within control part of module, function and testcase.

Furthermore, TTCN-3 supports no overloading of identifiers so that no identifier name can be used more than once in a scope hierarchy. However, IDL allows redefinition of self defined types if defined inside a `module`, `interface` or `valuetype`. Hence, identifiers have to be mapped by using their path name including all `interface` and `valuetype` names as designated in IDL and TTCN-3. The use of module names is not necessary because they are reflected by the TTCN-3 module structure. An underscore is used as a separator and existing underscores are doubled.
Several new identifiers are generated during transformation of IDL types by adding to the original IDL type identifier suffixes like: "Type", "Enum", "Object", "Interface", etc. This approach and the use of TTCN-3 keywords in IDL modules can cause a name clashes, which are to be resolved by a suffix ":":

NOTE: ES 201 873-1 [1] clause A.1.5 table A.2 defines the keywords of the core language. However, TTCN-3 language extensions (see [i.5] to [i.9], but other extensions may also be published after the publication of the present document) may define additional keywords and rules for handling those keywords in TTCN-3 modules requiring the given extension.

IDL EXAMPLE:

```idl
interface identifier {
  ... body definitions ...
};
// an example of the identifier, which can cause a name clash
typedef long identifierObject;
```

TTCN EXAMPLE:

```ttcn
group identifierInterface {
  ... body definitions ...
    type port identifier procedure { ... }
  // the suffix ":" is used only where necessary
  // to resolve the name clash
type charstring identifierObject_;
  type identifierObject_ address;
}

type long identifierObject;
```

To indicate the special treatment of TTCN-3 statements derived from IDL, TTCN-3 provides a new mechanism to attach attributes to language elements. The use of attributes makes code more readable and requires no special naming scheme. Therefore, the `variant` attribute can be used to indicate the derivation of types from IDL and the special treatment for encoding by the test system. This is used in TTCN-3 for the `IDLfixed` useful type:

```ttcn
type record IDLfixed {
  unsigned short digits,
  short scale,
  charstring value_
} with { variant "IDL:fixed FORMAL/01-12-01 v.2.6" };
```

Names of new types which are specially defined for the IDL mapping and their use in conjunction with IDL shall always begin with the word IDL to provide better distinction.
Annex A (informative):
Examples

A.1 Example

The following example shows how a mapping would look like if a complete IDL and TTCN-3 specification, including a test case, is used. It is only intended to give an impression of how the different elements have to be mapped and used in TTCN-3.

Some parts are used from the CORBA standard like the Naming Service with slight modifications to cover more IDL elements.

A.1.1 IDL specification

```idl
module ttcnExample {
  // ***********
  // Basic Types
  // ***********
  const long number = 017; // 017 == 0xF == 15
  const long size = ( ( number << 3 ) % 0x1F ) & 0123;
  const float decimal = 15.7;
  const char letter = 'A';
  const wchar wideLetter = L'A';
  const boolean isValid = TRUE;
  const octet anOctet = 0x55; // limited to 8 bit
  const string myName = "my name";
  const wstring wideMyName = L"my name";
  typedef string MyString;

  // ****************
  // Constructed Types
  // ****************
  typedef struct NC {
    MyString id;
    MyString kind;
  } NameComponent;

  union MyUnion switch ( long ) {
    case 0 : boolean b;
    case 1 : char c;
    case 2 : octet o;
    case 3 : short s;
  }

  enum NotFoundReason { missing_node, not_context, not_object };

  // ***************
  // Template Types
  // ***************
  typedef sequence <NameComponent> Name;
  typedef sequence <NameComponent> Key;
  typedef fixed<12,7> Fix;

  // ***************
  // Complex Declarator
  // ***************
  typedef long NumberList[100];

  native MyNativeVariable;
```
valuetype StringValue string;

valuetype EmployeeRecord {
    // note this is not a CORBA::Object
    // state definition
    private string name;
    private string email;
    private string SSN;

    // initializer
    factory init(in string name, in string SSN);
};

interface NamingContext {
    attribute string object_type;
    readonly attribute Key external_form_id;

    exception NotFoundException {
        NotFoundReason why;
        Name rest_of_name;
    };

    MyString bind(in Name n, inout Object obj, out Object myObj )
        raises( NotFoundException ) context ( "Hostname" );
    oneway void rebind( in Name n, in Object obj );
}; // end of interface NamingContext

A.1.2 Derived TTCN-3 specification

module ttcnExample {
    import from IDLaux all;

    // ********************************
    // Mapping of the IDL Specification
    // ********************************

    // *****************
    // Mapping of Basic Types
    // *****************

    const long number := oct2int('17'O);
    const long size := oct2int(int2oct(oct2int(int2oct(number,4)<<3) mod hex2int('1F'H),4) and4b '0123'O);
    const IEEE754float decimal := 15.7;

    type universal charstring uchar length(1);
    type uchar iso8859char (char (0,0,0,0) .. char (0,0,0,255)) with { variant "8 bit" };
    type iso8859char letter := "A";
    const uchar wideLetter := "A";
    const boolean isValid := true;
    const octetstring anOctet := hex2oct('55'H);

    const iso8859string myName := "my name";
    const universal charstring wideMyName := "my name";

    type iso8859string MyString;
    // *****************
    // Constructed Types
    // *****************
struct NameComponent {
    MyString id,
    MyString kind
};

union MyUnion {
    boolean b,
    iso8859char c,
    octetstring o,
    short s
};

enumerated NotFoundReason {
    missing_node,
    not_context,
    not_object
}

record of NameComponent Name;
record of NameComponent Key;

fixed template IDLfixed fixTemplate := { 12, 7, ? };

long numberList[100];

record EmployeeRecord {
    iso8859string name,
    iso8859string email,
    iso8859string SSN
};

record of IDLContextElement IDLContext;

group NamingContextInterface {
    charstring NamingContextObject;
    NamingContextObject address;
}
// attribute object_type
signature NamingContext__object_typeGet () return iso8859string
  exception ( SYSTEM_EXCEPTION );
signature NamingContext__object_typeSet ( in iso8859string NamingContext__object_type )
  exception ( SYSTEM_EXCEPTION );

template NamingContext__object_typeSet ObjectTypeSetSignatureTemplate := {
  object_type := "my object type"
}

// attribute external_from_id
//
signature NamingContext__external_form_idGet() return Key
  exception ( SYSTEM_EXCEPTION );

// exception notFoundException
type record NamingContext__NotFoundException {
  NotFoundReason why,
  Name rest_of_name
}

template NamingContext__NotFoundException
  NamingContext__NotFoundExceptionTemplate ( NotFoundReason reason, Name name ) := {
    why := reason,
    rest_of_name := name
  }

// bind procedure
//
signature NamingContext__BindSignature
  { in Name n, inout address obj, inout address myObj, in IDLContext context } return MyString
  exception ( NamingContext__NotFoundException, SYSTEM_EXCEPTION );

template NamingContext__BindSignature
  NamingContext__BindTemplate ( charstring object, IDLContext con ) := {
    n := { {"name" , ""} },
    obj := object,
    myObj := ?,
    context := con
  }

// rebind procedure
//
signature NamingContext__RebindSignature( in Name n, in address obj )
  exception ( SYSTEM_EXCEPTION )
  with { variant "IDL:oneway FORMAL/01-12-01 v.2.6" };

template NamingContext__RebindSignature
  NamingContext__RebindTemplate ( address object ) := {
    n := { {"name" , ""} },
    obj := object
  }

type port NamingContext procedure {
  out NamingContext__object_typeGet;
  out NamingContext__object_typeSet;
  out NamingContext__external_form_idGet;
  out NamingContext__BindSignature;
}

// component is necessary for test case
type component CorbaSystemInterface {
  port NamingContext PCO;
}

// somewhere has main test component MyMTC to be defined
type component MyMTC {
  port NamingContext NamingContextPCO;
}
testcase MyNamingServiceTestCase() runs on MyMTC system CorbaSystemInterface {

// examples to show how above definitions can be used inside a
// testcase definition

var CorbaSystemInterface myCorbaSystem := CorbaSystemInterface.create;
connect( self:NamingContextPCO, myCorbaSystem:PCO ); myCorbaSystem.start;

// Fixed Type
var IDLfixed fix := { 12, 7, "12345.1234567" };

// Native
var address MyNativeVariable;

// Procedure Calls
var MyString myResult1;
var Key myResult2;
var MyString myResult3;
var address object, myObject, resultObject, resultMyObject;
var IDLContextElement contextElement := {
    name := "Hostname",
    value_ := "disen"
}
var IDLContext contextParameter := { contextElement };

// procedure get object_type
NamingContextPCO.call( ObjectTypeGetSignature )
{ [] NamingContextPCO.getreply( ObjectTypeGetSignature value * )
    -> value myResult1 {} }

// procedure set object_type
NamingContextPCO.call( ObjectTypeSetSignatureTemplate );

// procedure get external_from_id
NamingContextPCO.call( ExternalFormIdGetSignature )
{ [] NamingContextPCO.getreply( ExternalFormIdGetSignature value * )
    -> value MyResult2 {} }

// procedure bind (with template)
NamingContextPCO.call( BindTemplate( object, contextParameter ) )
{ [] NamingContextPCO.getreply( BindTemplate( * ) value * )
    -> value myResult3
    param( resultObject, resultMyObject ) sender mySender {} ]
NamingContextPCO.catch( BindSignature,
    NamingContext__NotFoundExceptionTemplate )
{ setverdict( fail );
    stop; }
}
}  

// procedure bind (without template)
// NamingContextPCO.call( 
//   BindSignature:{ myName, object, myObject, contextParameter } ) 
//   [] NamingContextPCO.getreply( BindSignature:{ -, *, myObject } 
//     value * ) -> value myResult3 param{ resultObject, resultMYObject } sender mySender
// }

// procedure rebind
// NamingContextPCO.call( RebindSignature:{ myName, object} ); // or use a template

// raising an exception
//
// this would be used to raise an exception inside of procedure bind
// if defined by TTCN-3 (if used on server side).
// var NamingContext__NotFoundException myNotFoundException := { 
//   why := missing_node, 
//   rest_of_name := "noname"
// }
// NamingContextPCO.raise( BindSignature, myNotFoundException );
// end of testcase MyNamingServiceTestCase

}
Annex B (informative):
Mapping lists

B.1 IDL keyword and concept mapping list

Table B.1 lists the mapping of keywords and concepts of IDL to TTCN-3 keywords or concepts. Literal and operator mapping can be seen in tables B.1 and B.2.

<table>
<thead>
<tr>
<th>IDL</th>
<th>TTCN-3</th>
<th>IDL</th>
<th>TTCN-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALSE</td>
<td>false</td>
<td>module</td>
<td>module</td>
</tr>
<tr>
<td>Object</td>
<td>address</td>
<td>native</td>
<td>address</td>
</tr>
<tr>
<td>TRUE</td>
<td>true</td>
<td>octet</td>
<td>octetstring</td>
</tr>
<tr>
<td>abstract</td>
<td>has to be rolled out</td>
<td>oneway</td>
<td>operation with variant attribute</td>
</tr>
<tr>
<td>any</td>
<td>anytype</td>
<td>operation</td>
<td>signature for procedure</td>
</tr>
<tr>
<td>array</td>
<td>array</td>
<td>out</td>
<td>out</td>
</tr>
<tr>
<td>attribute</td>
<td>get (and set)</td>
<td>raises</td>
<td>exception</td>
</tr>
<tr>
<td>boolean</td>
<td>boolean</td>
<td>readonly</td>
<td>only a get-operation for the attribute</td>
</tr>
<tr>
<td>char</td>
<td>iso8859char</td>
<td>sequence</td>
<td>record of</td>
</tr>
<tr>
<td>const</td>
<td>const</td>
<td>short</td>
<td>short</td>
</tr>
<tr>
<td>context</td>
<td>additional</td>
<td>string</td>
<td>iso8859string</td>
</tr>
<tr>
<td>enum</td>
<td>enumerated</td>
<td>struct</td>
<td>record</td>
</tr>
<tr>
<td>exception</td>
<td>record</td>
<td>typedef</td>
<td>type</td>
</tr>
<tr>
<td>fixed</td>
<td>IDLfixed</td>
<td>union</td>
<td>record, enumerated, union</td>
</tr>
<tr>
<td>float</td>
<td>IEEE754float</td>
<td>unsigned long</td>
<td>unsignedlong</td>
</tr>
<tr>
<td>double</td>
<td>IEEE754double</td>
<td>unsigned long long</td>
<td>unsignedlonglong</td>
</tr>
<tr>
<td>long double</td>
<td>IEEE754extdouble</td>
<td>unsigned short</td>
<td>unsignedshort</td>
</tr>
<tr>
<td>in</td>
<td>in</td>
<td>valuetype</td>
<td>record</td>
</tr>
<tr>
<td>inout</td>
<td>inout</td>
<td>wchar</td>
<td>universal charstring</td>
</tr>
<tr>
<td>interface</td>
<td>group, port</td>
<td>wstring</td>
<td>universal charstring</td>
</tr>
<tr>
<td>local</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>long</td>
<td>long</td>
<td></td>
<td></td>
</tr>
<tr>
<td>long long</td>
<td>longlong</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## B.2 Comparison of IDL, ASN.1, TTCN-2 and TTCN-3 data types

<table>
<thead>
<tr>
<th></th>
<th>IDL</th>
<th>ASN.1</th>
<th>TTCN-2</th>
<th>TTCN-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>ObjectInstance (X.500 Distinguished name)</td>
<td>IA5String</td>
<td>address</td>
<td></td>
</tr>
<tr>
<td>any</td>
<td>SEQUENCE {typecode, anyValue}</td>
<td>CHOICE</td>
<td>anytype</td>
<td></td>
</tr>
<tr>
<td>array</td>
<td>SEQUENCE OF (with sizeConstraint subtype)</td>
<td>SEQUENCE SIZE(n) OF array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boolean</td>
<td>BOOLEAN</td>
<td>BOOLEAN</td>
<td>boolean</td>
<td></td>
</tr>
<tr>
<td>char</td>
<td>GraphicString</td>
<td>GraphicString or IA5String(SIZE(1))</td>
<td>iso8859char (self defined type)</td>
<td></td>
</tr>
<tr>
<td>enum</td>
<td>ENUMERATED</td>
<td>ENUMERATED</td>
<td>enumerated</td>
<td></td>
</tr>
<tr>
<td>exception</td>
<td>SPECIFIC ERRORS</td>
<td>SEQUENCE record</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fixed</td>
<td>See note</td>
<td>See note IDLfixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>float</td>
<td>REAL</td>
<td>See note IEEE754float</td>
<td></td>
<td></td>
</tr>
<tr>
<td>double</td>
<td>REAL</td>
<td>See note IEEE754double</td>
<td></td>
<td></td>
</tr>
<tr>
<td>long double</td>
<td>REAL</td>
<td>See note IEEE754extdouble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>long</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>long</td>
<td></td>
</tr>
<tr>
<td>long long</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>longlong</td>
<td></td>
</tr>
<tr>
<td>native</td>
<td>See note</td>
<td>See note address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>octet</td>
<td>OCTET STRING</td>
<td>OCTET STRING SIZE(1))</td>
<td>octetstring</td>
<td></td>
</tr>
<tr>
<td>sequence</td>
<td>SEQUENCE OF (with optional sizeConstraint subtype for IDL bounds)</td>
<td>SEQUENCE OF record of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>short</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>short</td>
<td></td>
</tr>
<tr>
<td>string</td>
<td>GraphicString</td>
<td>GraphicString iso8859string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>struct</td>
<td>SEQUENCE</td>
<td>SEQUENCE record</td>
<td></td>
<td></td>
</tr>
<tr>
<td>union, switch, case</td>
<td>CHOICE (with ASN.1 TAGS)</td>
<td>SEQUENCE record, enumerated, union</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unsigned long</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>unsignedlong</td>
<td></td>
</tr>
<tr>
<td>unsigned long long</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>unsignedlonglong</td>
<td></td>
</tr>
<tr>
<td>unsigned short</td>
<td>INTEGER</td>
<td>INTEGER</td>
<td>unsignedshort</td>
<td></td>
</tr>
<tr>
<td>valuetype</td>
<td>See note</td>
<td>See note record</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wchar</td>
<td>See note</td>
<td>GraphicString or BMPString(SIZE(1)) universal charstring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wstring</td>
<td>See note</td>
<td>GraphicString universal charstring</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Mapping of this type was not considered.
Annex C (informative):

Bibliography


A. Yin (2001): "Testing Operation-Based Interfaces Exemplified for CORBA with ADL and TTCN-3". Diplomarbeit, Telecommunication Network Group, Faculty of Electrical Engineering and Computer Science, Technical University Berlin, Germany.


ISO/IEC 9646-3: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 3: The Tree and Tabular Combined Notation (TTCN)".

ISO/IEC 646: "Information technology - ISO 7-bit coded character set for information interchange".

IEEE 754: "IEEE Standard for Floating-Point Arithmetic".

ISO/IEC 8859-1: "Information technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No.1".

ETSI ES 202 789: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; TTCN-3 Language Extensions: Extended TRI".
## History

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