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***BXML***

***-***

***Format description***

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# Revisions

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| --- | --- | --- | --- |
| **Version** | **Date** | **Author** | **Comment** |
| 0.1 | 6/10/2016 | L. Burdy |  |
| 0.2 | 1/06/2018 | H. Ruiz Barradas | Circular definitions are removed and some definitions of elements are corrected. |
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# Introduction

## Purpose

The purpose of this document is to describe and illustrate the BXML Format.

BXML is an XML representation of a B Component.

## Convention

The format is described using the Relax NG compact syntax. Relax NG description are given in boxes

element XXX {

attribute XXX { text },

element XXX { XXX },

…

}

In textual description element name appears in **blue**, attribute name in **red**, and attribute value in **orange**.

# Documents

## Applicable documents

|  |  |  |
| --- | --- | --- |
| ***Reference*** | ***Version*** | ***Title*** |
|  |  |  |
|  |  |  |
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## Reference documents

|  |  |  |
| --- | --- | --- |
| ***Reference*** | ***Version*** | ***Title*** |
| http://relaxng.org/compact-20021121.html |  | RELAX NG Compact Syntax |
|  |  |  |
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# Global BXML structure

A BXML file contains 6 different kind of structure:

* Component
* Substitution
* Predicate
* Expression
* Identifier
* Attribute

Each structure is described in Relax NG format in a specific file and corresponds to a pattern.

The main *bxml.rng* file includes the others, it structure is

# A RELAX NG compact syntax pattern for a bxml document.

grammar {

include "substitution.rng"

include "predicate.rng"

include "expression.rng"

include "identifier.rng"

include "attribute.rng"

start = element Machine { … }

Predicate |= …

ReferencedMachine = …

Operation = …

TypeInfo = …

Type =…

}

## Attribute

The BXML is a kind of “open” xml formal. That means that a BXML document can contain additional information. That information can be associated to every element of the BXML document. It is placed in an **Attr** element that can contain any well formed xml.

Attribute =

element Attr { anyElement\* }

anyElement =

element \* {

(attribute \* { text }

| text

| anyElement)\*

}

This element is always optional, if it exists it must be the first child of an element, see examples below.

## Machine

A BXML document main element is **Machine**.

element Machine {

attribute name { text },

attribute type { "abstraction" | "refinement" | "implementation" },

Attribute?,

…

}

The **name** attribute contains the name of component. The **type** attribute indicates if the component is an **abstraction**: MACHINE or SYSTEM, a **refinement** for a REFINEMENT or an **implementation** for an IMPLEMENTATION

Example:

The component:

MACHINE

M1

END

is described:

<Machine name = ‘M1’ type = ‘abstraction’>

<Attr>

<Pos l='4' c='1' s='18'/>

</Attr>

</Machine>

The element **Attr** can be present. In this example, it contains position information.

### Refines

A **Machine** element can contain an optional **Abstraction** element describing the REFINES clause.

element Machine {

…

element Abstraction { Attribute?, text }?,

…

}

This element contains a text that defines the refined component.

Example:

The component:

REFINEMENT

M1\_r

REFINES

M1

END

is described:

<Machine name = ‘M1\_r’ type = ‘refinement’>

<Abstraction>

M1

</Abstraction>

</Machine>

### Parameters and Constraints

Parameters and CONSTRAINTS in a component are described as optional **Parameters** and **Constraints** element.

element Machine {

…

element Parameters {

Attribute?,

element Id { Identifier }+

}?,

element Constraints { Attribute?, Predicate }?,

…

}

Predicate |= element Set { element Id { Identifier } }

A **Parameters** element contains a non-empty list of **Id** element containing identifier description (see II.6).

A **Constraints** element contains a predicate description (see II.4). This predicate contains also specific **Set** elements for sets declared in parameters.

Example:

The component:

MACHINE

MA(p1, ENS1)

CONSTRAINTS

p1 : ENS1

END

is described:

<Machine name = ‘M1’ type = ‘abstraction’>

<Parameters>

<Id value = ‘p1’ />

<Id value = ‘ENS1’ />

</Parameters>

<Constraints>

<Set><Id value = ‘ENS1’/></Set>

<Exp\_Comparison op = ‘:’ >

<Id value = ‘p1’ />

<Id value = ‘ENS1’ />

</Exp\_Comparison>

</Constraints>

</Machine>

### Visibility clauses

INCLUDES, IMPORTS, SEES, EXTENDS, USES are described by optional elements containing a non-empty list of referenced component.

element Machine {

…

element Includes { Attribute?, ReferencedMachine+ }?,

element Imports { Attribute?, ReferencedMachine+ }?,

element Sees { Attribute?, ReferencedMachine+ }?,

element Extends { Attribute?, ReferencedMachine+ }?,

element Uses { Attribute?, ReferencedMachine+ }?,

element Promotes {

Attribute?,

element Promoted\_Operation { Attribute?, text }+

}?,

…

}

ReferencedMachine =

element Referenced\_Machine {

Attribute?,

element Name { text },

element Instance {text}?,

element Parameters { Expression+ }?

}

A referenced machine contains the name of the machine and optionally the name of the instance and instantiated parameters.

The optional **Promotes** element contains a non-empty list of promoted operation described by their name.

Example:

The component:

MACHINE

MA

SEES

I1.Msees

IMPORTS

MB(10)

PROMOTES

op1

END

is described:

<Machine name = ‘MA’ type = ‘abstraction’>

<Imports>

<Referenced\_Machine>

<Name>MB</Name>

<Parameters>

<Integer\_Literal value=’10’/>

</Parameters>

</Referenced\_Machine>

</Imports>

<Sees>

<Referenced\_Machine>

<Name>Msees</Name>

<Instance>I1</Instance>

</Referenced\_Machine>

</Sees>

<Promotes>

<Promoted\_Operation>op1</Promoted\_Operation>

</Promotes>

</Machine>

### Values

The VALUES clause is represented by an optional **Values** element that contain a non-empty list of **Valuation** element describing a valuation by giving an identifier, a reference to its type and an expression.

element Machine {

…

element Values {

Attribute?,

element Valuation {

Attribute?,

attribute ident { text },

attribute typref { xsd:integer },

Expression

}+

}?,

…

}

Example:

The component:

IMPLEMENTATION

MA\_i

REFINES

MA

VALUES

AbsSet = 0..100

END

is described:

<Machine name = ‘MA\_i’ type = ‘implementation’>

<Abstraction>MA</Abstraction>

<Values>

<Valuation ident=’AbsSet’ typref='3603043417'>

<Binary\_Exp op=’..’>

<Integer\_Literal value=’0’/>

<Integer\_Literal value=’100’/>

</Binary\_Exp>

</Valuation>

</Values>

</Machine>

### Sets

Abstract sets and enumerated sets are described in the **Sets** element

element Machine {

…

element Sets {

Attribute?,

element Set {

Attribute?,

element Id { Identifier },

element Enumerated\_Values {

element Id { Identifier }+

}?

}+

}?,

…

}

Abstract set has just an **Id** element, enumerated sets have also an non-empty list of **Id** element contained in an **Enumared\_Values** element.

Example:

The component:

MACHINE

MA

SETS

POSITION;

STATE = {On, Off}

END

is described:

<Machine name = ‘MA’ type = ‘abstraction>

<Sets>

<Set>

<Id value=’POSITION’/>

</Set>

<Set>

<Id value=’STATE’/>

<Enumerated\_Values>

<Id value = ‘On’/>

<Id valie = ‘Off’/>

</Enumerated\_Values>

</Set>

</Sets>

</Machine>

### Constants and variables

Constants and variables are represented in optional elements containing a non-empty list of identifier.

element Machine {

…

element Abstract\_Constants {

Attribute?,

element Id { Identifier }+

}?,

element Concrete\_Constants {

Attribute?,

element Id { Identifier }+

}?,

element Abstract\_Variables {

Attribute?,

element Id { Identifier }+

}?,

element Concrete\_Variables {

Attribute?,

element Id { Identifier }+

}?,

…

}

Example:

The component:

MACHINE

MA

ABSTRACT\_CONSTANTS

MaxNumber,

MinNumber

CONCRETE\_CONSTANTS

PosMin

ABSTRACT\_VARIABLES

Abscissa

CONCRETE\_VARIABLES

Position

END

is described:

<Machine name = ‘MA’ type = ‘abstraction’>

<Abstract\_Constants>

<Id value=’MaxNumber’/>

<Id value=’MinNumber’/>

</Abstract\_Constants>

<Concrete\_Constants>

<Id value=’PosMin’/>

</Concrete\_Constants>

<Abstract\_Variables>

<Id value=’Abscissa’/>

</Abstract\_Variables>

<Concrete\_Variables>

<Id value=’Position’/>

</Concrete\_Variables>

</Machine>

### Properties, invariant and assertions

PROPERTIES, INVARIANT and ASSERTIONS are represented in optional elements containing predicates.

element Machine {

…

element Properties { Attribute?, Predicate }?,

element Invariant { Attribute?, Predicate }?,

…

element Assertions { Attribute?, Predicate+ }?,

…

}

**Properties** and **Invariant** elements contain one predicate, **Assertions** contains a non-empty list of predicate.

Example:

The component:

MACHINE

MA

PROPERTIES

Cte1 : INT &

Cte2 : NAT

INVARIANT

V1 : BOOL

ASSERTIONS

Cte1 < Cte2 ;

Cte2 >= 0 &

Cte2 <= MAXINT

END

is described:

<Machine name = ‘MA’ type = ‘abstraction’>

<Properties>

<Nary\_Pred op =’&’>

<Exp\_Comparison op = ‘:’>

<Id value=’Cte1’/>

<Id value=’INT’/>

</Exp\_Comparison>

<Exp\_Comparison op = ‘:’>

<Id value=’Cte2’/>

<Id value=’NAT’/>

</Exp\_Comparison>

</Nary\_Pred>

</Properties>

<Invariant>

<Exp\_Comparison op = ‘:’>

<Id value=’V1’/>

<Id value=’BOOL’/>

</Exp\_Comparison>

</Invariant >

<Assertions>

<Exp\_Comparison op = ‘<’>

<Id value=’Cte1’/>

<Id value=’Cte2’/>

</Exp\_Comparison>

<Nary\_Pred op =’&’>

<Exp\_Comparison op = ‘>=’>

<Id value=’Cte2’/>

<Integer\_Literal value=’0’/>

</Exp\_Comparison>

<Exp\_Comparison op = ‘<=’>

<Id value=’Cte2’/>

<Id value=’MAXINT’/>

</Exp\_Comparison>

</Nary\_Pred>

</Assertions>

</Machine>

### Variant clause

The VARIANT clause is used in Event B to specify a value decremented by each new event in a refinement. The contents of this clause is similar to the value of the VARIANT keyword in a While loop. This clause is represented by the optional **Variant** element containing un expression :

element Machine {

…

element Variant { Attribute?, Expression }?,

…

}

For example, the following excerpt of refinement

REFINEMENT Sys0\_r

REFINES Sys0

ABSTRACT\_VARIALBES xx

INVARIANT xx : NATURAL

VARIANT xx

…

END

is described by :

<Machine name='Sys0\_r' type='refinement'>

<Abstraction>Sys0</Abstraction>

<Abstract\_Variables>

<Attr>

<Pos l='8' c='1' s='18'/>

</Attr>

<Id value='XX' typref='2701647786'>

<Attr>

<Pos l='9' c='4' s='2'/>

</Attr>

</Id>

</Abstract\_Variables>

…

<Variant>

<Attr>

<Pos l='14' c='1' s='7'/>

</Attr>

<Id value='XX' typref='2701647786'>

<Attr>

<Pos l='15' c='4' s='2'/>

</Attr>

</Id>

</Variant>

…

### Initialisation and operations

INITIALISATION is described by an **Initialisation** element containing a substitution. OPERATIONS and LOCAL\_OPERATIONS contain a non-empty list of operations. EVENTS are also described in an **Operations** element.

element Machine {

…

element Initialisation { Attribute?, Substitution }?,

…

element Local\_Operations { Attribute?, Operation+ }?,

element Operations { Attribute?, Operation+ }?, …

}

Operation =

element Operation {

Attribute?,

attribute name { text },

element Refines { Attribute?, element Id { Identifier }+ }?,

element Output\_Parameters { element Id { Identifier }+ }?,

element Input\_Parameters { element Id { Identifier }+ }?,

element Precondition { Predicate }?,

element Body { Substitution }

}

An operation is described by a name, an optional **Refines** element for system models, input parameters, output parameters and precondition for software models and a substitution **Body**.

Example:

The component:

MACHINE

MA

OPERATIONS

Res <-- Compare(X1, X2) =

PRE

…

THEN

…

END

END

is described:

<Machine name = ‘MA’ type = ‘abstraction’>

<Operations>

<Operation name =’Compare’>

<Output\_Parameters>

<Id value=’Res’/>

</Output\_Parameters>

<Input\_Parameters>

<Id value=’X1’/>

<Id value=’X2’/>

</Input\_Parameters>

<Precondition>

…

</Precondition>

<Body>

…

</Body>

</Operation>

</Operations>

</Machine>

### Type information

BXML format can contain type information.

This information can be associated to each expression. In order to get a “relative” compact description for a component, types are described in a specific TypeInfos element, then types are referenced by an id in the expressions of the component.

element Machine {

…

element TypeInfos { element Type { TypeInfo }\* }

}

TypeInfo =

attribute id { xsd:integer },

Type2

Type2 =

( element Id {attribute value { text } }

| element Unary\_Exp { Unary\_Exp\_type2 }

| element Binary\_Exp { Binary\_Exp\_type2 }

| Struct

| element Generic\_Type { text }

)

Unary\_Exp\_type2 =

attribute op { "POW" },

Type2

Binary\_Exp\_type2 =

attribute op { "\*" },

Type2,

Type2

A **TypeInfos** element contains **Type** elements that are described by an **id** and a type.

A type can be either an **Id** (INTEGER, BOOL, …), a specific **Generic\_Type** element for describing untyped expression (as empty set), a subset of another type, the Cartesian product of two types or a struct.

Example:

The component:

MACHINE

MA

VARIABLES

mySet

INVARIANT

mySet <: c1..c2

END

is described:

<Machine name = ‘MA’ type = ‘abstraction’>

<Abstract\_Variables>

<Id value=’mySet’ typref='3692107306'/>

</Abstract\_Variables>

<Invariant>

<Exp\_Comparison op = ‘<:’>

<Id value=’mySet’ typref='3692107306'/>

<Binary\_Exp op=’..’>

<Integer\_Literal value=’0’ typref = ‘2701647786‘/>

<Integer\_Literal value=’100’ typref = ‘2701647786‘/>

</Binary\_Exp>

</Exp\_Comparison>

</Invariant>

<TypeInfos>

<Type id=‘2701647786’>

<Id value=’INTEGER’/>

</Type>

<Type id = '3692107306'>

<Unary\_Exp op=’POW’>

<Id value=’INTEGER’/>

</Unary\_Exp>

</Type>

</TypeInfos>

</Machine>

## Substitution

A substitution pattern is a choice between all kinds of substitution.

The *substitution.rng* file structure is:

Substitution =

( element Bloc\_Sub { … }

| element Skip { … }

| element Assert\_Sub { … }

| element If\_Sub { … }

| element Becomes\_Such\_That { … }

| element Assignement\_Sub { … }

| element Select { … }

| element Case\_Sub { … }

| element ANY\_Sub { … }

| element LET\_Sub { … }

| element Becomes\_In { … }

| element VAR\_IN { … }

| element Nary\_Sub { … }

| element Operation\_Call { … }

| element While { … }

)

Variables =

element Variables {

Attribute?,

element Id { Identifier }+

}

### BEGIN

A BEGIN substitution is described by a **Bloc\_Sub** element.

element Bloc\_Sub { Attribute?, Substitution }

Example:

The substitution:

BEGIN

skip

END

is described:

<Bloc\_Sub>

<Skip/>

</Bloc\_Sub>

Note: In order to obtain the **Bloc\_Sub** element in the BXML file, substitution BEGIN skip END must be written BEGIN BEGIN skip END END in the body of an operation.

### skip

A skip substitution is represented by a empty **Skip** element.

### Assignment

An assignment can be a multiple assignment, so the **Assignement\_Sub** element contains a **Variables** element with a non-empty list of expression and a **Values** element with also a non-empty list of expression.

element Assignement\_Sub {

Attribute?,

element Variables { Attribute?, Expression+ },

element Values { Attribute?, Expression+ }

}

Example:

The substitution:

xx, ff(yy) := yy,xx

is described:

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

<Binary\_Exp op=’(‘>

<Id value=’ff”/>

<Id value=’yy’/>

</Binary\_Exp>

</Variables>

<Values>

<Id value=’yy’/>

<Id value=’xx’/>

</Values>

</Assignement\_Sub>

### ASSERT

ASSERT substitution is described by a **Assert\_Sub** element containing two elements: **Guard** and **Body**.

element Assert\_Sub {

Attribute?,

element Guard { Attribute?, Predicate },

element Body { Attribute?, Substitution }

}

Example:

The substitution:

ASSERT

xx=yy

THEN

skip

END

is described:

<Assert\_Sub>

<Guard>

<Exp\_Comparison op=’=‘>

<Id value=’xx”/>

<Id value=’yy’/>

</Exp\_Comparison>

</Guard>

<Body>

<Skip/>

</Body>

</Assert\_Sub>

### IF

IF substitution is described in an **If\_Sub** element that contains a **Condition** and a **Then** element, an optional **Else** element and an attribute **elseif** with possible value **yes** or **no** that indicates if the IF corresponds to an ELSIF structure.

element If\_Sub {

attribute elseif { "yes" | "no" },

Attribute?,

element Condition { Attribute?, Predicate },

element Then { Attribute?, Substitution },

element Else { Attribute?, Substitution }?

}

Example:

The substitution:

IF xx=2

THEN

xx := 1

ELSIF xx = 3

THEN

xx := 2

ELSE

xx := 3

END

is described:

<If\_Sub elseif=’no’>

<Condition>

<Exp\_Comparison op=’=‘>

<Id value=’xx”/>

<Integer\_Literal value=’2’/>

</Exp\_Comparison>

</Condition>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’1’/>

</Values>

</Assignement\_Sub>

</Then>

<Else>

<If\_Sub elseif=’yes’>

<Condition>

<Exp\_Comparison op=’=‘>

<Id value=’xx”/>

<Integer\_Literal value=’3’/>

</Exp\_Comparison>

</Condition>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’2’/>

</Values>

</Assignement\_Sub>

</Then>

<Else>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’3’/>

</Values>

</Assignement\_Sub>

</Else>

</If\_Sub>

</Else>

</If\_Sub>

### SELECT

The SELECT substitution contains a **When\_Clauses** element and an optional **Else** element. A **When\_Clauses** element contains a non-empty list of **When** elements that contain a **Condition** and a **Then**.

element Select {

Attribute?,

element When\_Clauses {

Attribute?,

element When {

Attribute?,

element Condition { Attribute?, Predicate },

element Then { Attribute?, Substitution }

}+

},

element Else { Attribute?, Substitution }?

}

Example:

The substitution:

SELECT xx=2

THEN

xx := 1

WHEN xx = 3

THEN

xx := 2

ELSE

xx := 3

END

is described:

<Select>

<When\_Clauses>

<When>

<Condition>

<Exp\_Comparison op=’=‘>

<Id value=’xx”/>

<Integer\_Literal value=’2’/>

</Exp\_Comparison>

</Condition>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’1’/>

</Values>

</Assignement\_Sub>

</Then>

</When>

<When>

<Condition>

<Exp\_Comparison op=’=‘>

<Id value=’xx”/>

<Integer\_Literal value=’3’/>

</Exp\_Comparison>

</Condition>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’2’/>

</Values>

</Assignement\_Sub>

</Then>

</When>

</When\_Clauses>

<Else>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’3’/>

</Values>

</Assignement\_Sub>

</Else>

</Select>

### CASE

The CASE substitution is described with a **Case\_Sub** element, this element contains a **Value** element and a **Choices** element and an optional **Else** element. The **Choices** element contains a non-empty list of **Choice** element that contains a non-empty list of **Value** and a **Then**.

element Case\_Sub {

Attribute?,

element Value { Attribute?, Expression },

element Choices {

Attribute?,

element Choice {

Attribute?,

element Value { Attribute?, Expression }+,

element Then { Attribute?, Substitution }

}+

},

element Else {

Attribute?,

element Choice {

Attribute?,

element Then { Attribute?, Substitution }

}

}?

}

Example:

The substitution:

CASE xx OF

EITHER 0,2 THEN

xx := 1

OR 3 THEN

xx := 2

ELSE

xx := 3

END

END

is described:

<Case\_Sub>

<Value>

<Id value=’xx’/>

</Value>

<Choices>

<Choice>

<Value>

<Integer\_Literal value=’0’/>

</Value>

<Value>

<Integer\_Literal value=’2’/>

</Value>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’1’/>

</Values>

</Assignement\_Sub>

</Then>

</Choice>

<Choice>

<Value>

<Integer\_Literal value=’3’/>

</Value>

<Then>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’2’/>

</Values>

</Assignement\_Sub>

</Then>

</Choice>

</Choices>

<Else>

<Assignement\_Sub>

<Variables>

<Id value=’xx’/>

</Variables>

<Values>

< Integer\_Literal value=’3’/>

</Values>

</Assignement\_Sub>

</Else>

</Case\_Sub>

### ANY

An ANY substitution is described by a **ANY\_Sub** element that contains a **Variables** element, a **Pred** element and a **Then** element.

element ANY\_Sub {

Attribute?,

Variables,

element Pred { Attribute?, Predicate},

element Then { Attribute?, Substitution }

}

Example:

The substitution:

ANY r1,r2 WHERE

r1 : NAT &

r2 : NAT

THEN

skip

END

is described:

<ANY\_Sub>

<Variables>

<Id value=’r1’/>

<Id value=’r2’/>

</Variables>

<Pred>

<Nary\_Pred op=’&’>

<Exp\_Comparison op =’:’>

<Id value=’r1’/>

<Id value=’NAT’/>

</ Exp\_Comparison >

<Exp\_Comparison op =’:’>

<Id value=’r2’/>

<Id value=’NAT’/>

</ Exp\_Comparison >

</Nary\_Pred>

</Pred>

<Then>

</Skip>

</Then>

</ANY\_Sub>

### LET

The LET Substitution is described in a **LET\_Sub** element that contains an element **Variables** with a non-empty list of identifier, an element **Values** with a non-empty list of valuation and an element **Then**.

element LET\_Sub {

Attribute?,

Variables,

element Values {

Attribute?,

element Valuation {

Attribute?,

Expression,

attribute ident { text }

}+

},

element Then { Attribute?, Substitution }

}

Example:

The substitution:

LET r1,r2 BE

r1 = 1 &

r2 =2

IN

skip

END

is described:

<LET\_Sub>

<Variables>

<Id value=’r1’/>

<Id value=’r2’/>

</Variables>

<Values>

<Valuation ident=’r1’>

<Integer\_Literal value=’1’/>

</Valuation>

<Valuation ident=’r2’>

<Integer\_Literal value=’2’/>

</Valuation>

</Values>

<Then>

</Skip>

</Then>

</ANY\_Sub>

### Becomes in

The “becomes in” substitution is described in a **Becomes\_In** element with a **Variables** element and a **Value** element containing an expression

element Becomes\_In {

Attribute?,

Variables,

element Value { Attribute?, Expression }

}

Example:

The substitution:

y1, y2 :: INT\*NAT

is described:

<Becomes\_In>

<Variables>

<Id value=’y1’/>

<Id value=’y2’/>

</Variables>

<Value>

<Binary\_Exp op=’\*’>

<Id value=’INT’/>

<Id value=’NAT’/>

</Binary\_Exp>

</Value>

</Becomes\_In>

### Becomes such that

The “becomes such that” substitution is described in a **Becomes\_Such\_That** element with a **Variables** element and a **Pred** element containing a predicate.

element Becomes\_Such\_That {

Attribute?,

Variables,

element Pred { Attribute?, Predicate }

}

Example:

The substitution:

y1, y2 :(

y1 : INT &

y2 : NAT

)

is described:

<Becomes\_Such\_That>

<Variables>

<Id value=’y1’/>

<Id value=’y2’/>

</Variables>

<Pred>

<Nary\_Pred op=’&’>

<Exp\_Comparison op =’:’>

<Id value=’y1’/>

<Id value=’INT’/>

</ Exp\_Comparison >

<Exp\_Comparison op =’:’>

<Id value=’y2’/>

<Id value=’NAT’/>

</ Exp\_Comparison >

</Nary\_Pred>

</Pred>

</Becomes\_Such\_That>

### Local variable

Local variables are described in a **VAR\_IN** element containing a **Variables** element and a **Body** element with a substitution.

element VAR\_IN {

Attribute?,

Variables,

element Body { Attribute?, Substitution }

}

Example:

The substitution:

VAR l1, l2

IN

skip

END

is described:

<VAR\_IN>

<Variables>

<Id value=’l1’/>

<Id value=’l2’/>

</Variables>

<Body>

<Skip/>

</Body>

</VAR\_IN>

### Sequence, Parallel and Choice

The CHOICE substitution is described in a **Nary\_Sub** element with attribute **op** equal to ‘**CHOICE**’.

Sequential substitutions are described in the same element with **op**=’**;**’ and parallel substitution with **op**=’**||**’. Those binary substitutions are described as N-ary.

element Nary\_Sub {

Attribute?,

attribute op { "||" | ";" | "CHOICE" },

Substitution+

}

Example:

The substitution:

CHOICE

x1 := 1 ||

x2 := 2

OR

x1 := 1 ||

x2 := 2 ;

x3 := 3

END

is described:

<Nary\_SUB op=’CHOICE’>

<Nary\_SUB op=’||’>

<Assignement\_Sub>

<Variables>

<Id value=’xx1’/>

</Variables>

<Values>

<Integer\_Literal value=’1’/>

</Values>

</Assignement\_Sub>

<Assignement\_Sub>

<Variables>

<Id value=’xx2’/>

</Variables>

<Values>

<Integer\_Literal value=’2’/>

</Values>

</Assignement\_Sub>

</Nary\_SUB>

<Nary\_Sub op='||'>

<Assignement\_Sub>

<Variables>

<Id value=’xx1’/>

</Variables>

<Values>

<Integer\_Literal value=’1’/>

</Values>

</Assignement\_Sub>

<Nary\_Sub op=';'>

<Assignement\_Sub>

<Variables>

<Id value=’xx2’/>

</Variables>

<Values>

<Integer\_Literal value=’2’/>

</Values>

</Assignement\_Sub>

<Assignement\_Sub>

<Variables>

<Id value=’xx3’/>

</Variables>

<Values>

<Integer\_Literal value=’3’/>

</Values>

</Assignement\_Sub>

</Nary\_Sub>

</Nary\_Sub>

</Nary\_Sub>

### Operation call

An operation call is described in an **Operation\_Call** element containing a **Name** element, two optional elements for input and ouput parameters.

element Operation\_Call {

Attribute?,

element Name {

Attribute?,

element Id { Identifier }

},

element Input\_Parameters { Attribute?, Expression+ }?,

element Output\_Parameters { Attribute?, Expression+ }?

}

Example:

The substitution:

BEGIN

opa;

res, flag <-- opb(xx)

END

is described:

<Bloc\_Sub>

<Nary\_SUB op=’;’>

<Operation\_Call>

<Name>

<Id value=’opa’/>

</Name>

</Operation\_Call>

<Operation\_Call>

<Name>

<Id value=’opb’/>

</Name>

<Input\_Parameters>

<Id value=’xx’/>

</Input\_Parameters>

<Output\_Parameters>

<Id value=’res’/>

<Id value=’flag’/>

</Output\_Parameters>

</Operation\_Call>

</Nary\_SUB>

</Bloc\_Sub>

### While loop

The while loop substitution is described in an element **While** that contains elements **Condition**, **Body**, **Invariant** and **Variant**.

element While {

Attribute?,

element Condition { Attribute?, Predicate },

element Body { Attribute?, Substitution },

element Invariant { Attribute?, Predicate },

element Variant { Attribute?, Expression }

}

Example:

The substitution:

WHILE counter < 5 DO

counter := counter + 1

INVARIANT

counter : NAT

VARIANT

10 – counter

END

is described:

<While>

<Condition>

<Exp\_Comparison op=’<’>

<Id value=’counter’/>

<Integer\_Literal value=’5’/>

</Exp\_Comparison>

</Condition>

<Body>

<Assignement\_Sub>

<Variables>

<Id value=’counter’/>

</Variables>

<Values>

<Binary\_Exp op=’+’>

<Id value=’counter’/>

<Integer\_Literal value=’1’/>

</Binary\_Exp>

</Values>

</Assignement\_Sub>

</Body>

<Invariant>

<Exp\_Comparison op =’:’>

<Id value=’counter’/>

<Id value=’NAT’/>

</ Exp\_Comparison >

</Invariant>

<Variant>

<Binary\_Exp op=’-’>

<Integer\_Literal value=’10’/>

<Id value=’counter’/>

</Binary\_Exp>

</Variant>

</While>

## Predicate

A predicate pattern is a choice between 5 kinds of predicate.

The *predicate.rng* file structure is:

# A RELAX NG compact syntax pattern for a predicate.

Predicate =

element Binary\_Pred { … }

| element Nary\_Pred {… }

| element Unary\_Pred {… }

| element Quantified\_Pred {… }

| element Exp\_Comparison {… }

### Binary predicate

Conjonction, disjonction, implication, equivalence and conditional conjonction are described with a **Binary\_Pred** element with an attribute op corresponding to the operator and with two predicates.

element Binary\_Pred {

Attribute?,

attribute op { "&" | "or" | "=>" | "<=>" | "cand" },

Predicate,

Predicate

}

### N-ary predicate

Conjonction can also be described with a **Nary\_Pred** element in order to obtain a more compact xml file.

element Nary\_Pred {

Attribute?,

attribute op { "&" },

Predicate\*

}

### Unary predicate

Negation is described with an **Unary\_Pred** element.

element Unary\_Pred {

Attribute?,

attribute op { "not" },

Predicate

}

### Quantified predicate

Universal and existential predicate are described with a **Quantified\_Pred** element containing an attribute type, variables and a Body element.

element Quantified\_Pred {

Attribute?,

attribute type { "!" | "#" },

Variables,

element Body { Attribute?, Predicate }

}

### Expression comparison

Equalities, belonging, inclusion and comparison predicates are described in an **Exp\_Comparison** element with an attribute corresponding two the operator and two expressions.

element Exp\_Comparison {

Attribute?,

attribute op { ":" | "/:" | "<:" | "/<:" | "<<:" | "/<<:" | "=" | "/=" | "<="

| "<" | ">=" | ">" | "rgt" | "rlt" | "rle" | "rge" },

Expression,

Expression

}

## Expression

An expression pattern is a choice between the different kinds of expression. An optional **typeref** attribute can be associated to every expression.

The *expression.rng* file structure is:

# A RELAX NG compact syntax pattern for an expression.

Expression =

element Binary\_Exp { Bynary\_Exp\_type }

| element Nary\_Exp { Nary\_Exp\_type }

| element Unary\_Exp { Unary\_Exp\_type }

| element Quantified\_Exp { Quantified\_Exp\_type }

| element Quantified\_Set { … }

| Struct

| element Record { Record\_type }

| element Boolean\_Exp {… }

| element EmptySet { … }

| element EmptySeq { … }

| element Id { Identifier }

| element Integer\_Literal { … }

| element Boolean\_Literal {… }

| element STRING\_Literal {… }

Struct =

element Struct { Struct\_type }

### Binary expression

Binary expressions are described in a **Binary\_Exp** element with the corresponding operator.

Function application and relation image are binary expressions

Bynary\_Exp\_type =

Attribute?,

attribute typref { xsd:integer }?,

attribute op { "," | "\*" | "\*\*" | "+" | "+->" | "+->>" | "-" | "-->" | "-->>"

| "->" | ".." | "/" | "/\" | "/|\" | ";" | "<+" | "<->" | "<-"

| "<<|" | "<|" | ">+>" | ">->" | ">+>>" | ">->>" | "><"

| "||" | "\/" | "\|/" | "^" | "mod" | "|->" | "|>" | "|>>" | "["

| "(" | "'" | "<'" | "rplus" | "rminus" | "rmul" | "rdiv" | "rpow"

},

Expression,

Expression

Example:

The expression:

ff(xx)

is described:

<Binary\_Exp op=’(‘>

<Id value=’ff/>

<Id value=’xx’/>

</Binary\_Exp>

### N-ary expression

Extensive sets and extensive sequences are described with a **Nary\_Exp** element.

Nary\_Exp\_type =

Attribute?,

attribute typref { xsd:integer }?,

attribute op { "[" | "{" },

Expression+

Example:

The expression:

{1,3,5,7}

is described:

<Nary\_Exp op=’{‘>

<Integer\_Literal value=’1’/>

<Integer\_Literal value=’3’/>

<Integer\_Literal value=’5’/>

<Integer\_Literal value=’7’/>

</Binary\_Exp>

### Unary expression

Unary expressions are described in an **Unary\_Exp** element.

Projections, iteration expressions are described as unary expressions

Unary\_Exp\_type =

Attribute?,

attribute typref { xsd:integer }?,

attribute op { "max" | "min" | "card" | "dom" | "ran" | "POW" | "POW1"

| "FIN" | "FIN1" | "union" | "inter" | "seq" | "seq1" | "iseq"

| "iseq1" | "-" | "~" | "size" | "prj1" | "prj2" | "perm"

| "first" | "last" | "id" | "iterate" | "closure" | "closure1"

| "tail" | "front" | "rev" | "conc" | "succ" | "pred" | "rel" | "fnc"

},

Expression

Example:

The expression:

prj1(NAT,NAT)(x1 |-> x2)

is described:

<Binary\_Exp op=’(‘>

<Unary\_Exp op=’prj1’>

<Binary\_Exp op=’,’>

<Id value=’NAT’/>

<Id value=’NAT’/>

</Binary\_Exp>

</Unary\_Exp>

<Binary\_Exp op=’|->’>

<Id value=’x1’/>

<Id value=’x2’/>

</Binary\_Exp>

</Binary\_Exp>

### Quantified expression

Lambda expression, quantified sum and product, quantified union and intersection are described with a **Quantified\_Exp** element containing the corresponding operators, a Variables pattern, a predicate and an expression

Quantified\_Exp\_type =

Attribute?,

attribute typref { xsd:integer }?,

attribute type { "%" | "SIGMA" | "PI" | "RSIGMA" | "RPI" | "INTER"

| "UNION" },

Variables,

element Pred { Attribute?, Predicate },

element Body { Attribute?, Expression }

Example:

The expression:

%xx.(xx : NATURAL | xx \* 2)

is described:

<Quantified\_Exp type=’%‘>

<Variables>

<Id value=’xx’/>

</Variables>

<Pred>

<Exp\_Comparison op=’:’>

<Id value=xx’/>

<Id value=’NATURAL’/>

</Exp\_Comparison>

</Pred>

<Body>

<Binary\_Exp op=’\*’>

<Id value=’xx’/>

<Integer\_Literal value=’2’/>

</Binary\_Exp>

</Body>

</Quantified\_Exp>

### Quantified Set

Comprehension sets are described in a **Quantified\_Set** element containing variables and a predicate

element Quantified\_Set {

Attribute?,

attribute typref { xsd:integer }?,

Variables,

element Body { Attribute?, Predicate }

}

Example:

The expression:

{xx | xx : NATURAL & xx mod 2 = 0}

is described:

<Quantified\_Set>

<Variables>

<Id value=’xx’/>

</Variables>

<Body>

<Binary\_Pred op=’&’>

<Exp\_Comparison op=’:’>

<Id value=xx’/>

<Id value=’NATURAL’/>

</Exp\_Comparison>

<Exp\_Comparison op=’=’>

<Binary\_Exp op=’mod’>

<Id value=xx’/>

<Integer\_Literal value=’2/>

</Binary\_Exp>

</Exp\_Comparison>

</Binary\_Pred>

</Body>

</Quantified\_Set>

### Struct and record

Set of records are described in a **Struct** element containing a non-empty list of **Record\_Item** elements with a **label** attribute and an expression.

Records in extension are described in a **Record** element containing a non-empty list of **Record\_Item** elements with a **label** attribute and an expression.

Struct =

element Struct { Struct\_type }

Struct\_type =

Attribute?,

attribute typref { xsd:integer }?,

element Record\_Item {

Attribute?,

attribute label { text },

Expression

}+

Record\_type =

Attribute?,

attribute typref { xsd:integer }?,

element Record\_Item {

Attribute?,

attribute label { text },

Expression

}+

Example:

The expression:

struct(l1 : NAT, l2 : BOOL)

is described:

<Struct>

<Record\_Item label=’l1’>

<Id value=’NAT’/>

</Record\_Item>

<Record\_Item label=’l2’>

<Id value=’BOOL’/>

</Record\_Item>

</Struct>

### Terminal expression

The bool operator is described with a **Boolean\_Exp** element containing a predicate. All terminal expressions are described with a specific element.

| element Boolean\_Exp {

Attribute?,

attribute typref { xsd:integer }?,

Predicate

}

|element EmptySet {

Attribute?,

attribute typref { xsd:integer }?

}

| element EmptySeq {

Attribute?,

attribute typref { xsd:integer }?

}

| element Id { Identifier }

| element Integer\_Literal {

Attribute?,

attribute typref { xsd:integer }?,

attribute value { xsd:integer }

}

| element Boolean\_Literal {

Attribute?,

attribute typref { xsd:integer }?,

attribute value { "TRUE" | "FALSE" }

}

| element STRING\_Literal {

Attribute?,

attribute value { text },

attribute typref { xsd:integer }?

}

Example:

The expression:

bool([] = {}) = bool(“empty seq” = “empty set”)

is described:

<Exp\_Comparison op=’=’>

<Boolean\_Exp>

<Exp\_Comparison op=’=’>

<Empty\_Seq/>

<Empty\_Set/>

</Exp\_Comparison>

</Boolean\_Exp>

<Boolean\_Exp>

<Exp\_Comparison op=’=’>

<STRING\_Literal value=’empty seq’/>

<STRING\_Literal value=’empty set’/>

</Exp\_Comparison>

</Boolean\_Exp>

</Exp\_Comparison>

## Identifier

An identifier pattern described the attributes that can be associated to an identifier.

# A RELAX NG compact syntax pattern for an identifier.

Identifier =

Attribute?,

attribute value { text },

attribute suffix { text }?,

attribute typref { xsd:integer }?,

(attribute instance { text },

attribute component { text })?

The **value** attribute contains the name of the identifier. The **suffix** attribute is used for $0 variable. For renamed variable, the attributes **instance** and **component** are used.

Example:

The expression:

xx$0 =Msees.var

is described:

<Exp\_Comparison op=’=’>

<Id value=’xx’ suffix=’0’/>

<Id value=’Msees.var’ instance=’Msees’ component=’var’/>

</Exp\_Comparison>

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