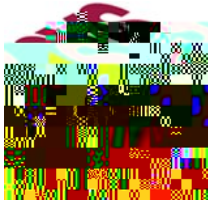




An OMG® Systems Modeling Publication



Kernel Modeling Language™ (KerML™)

Version 1.0 Beta 1

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Table of Contents

-L?@;=?
0=IJ?
IH@ILG;H=?
+ ILG;NCP? / ?@?L?H=?M

#?;NOL? &HP?LNCHA

1SJ? #?;NOLCHA

(?LH?F

(?LH?F , P?LPC?Q

! ;N; 1SJ?M

&N?G #FIQM
#?;NOL? 3 ;FO?M IH=L?N? OSHN;R
* OFNCJFC=CNC?M IH=L?N? OSHN;R
* ?N;>;N; IH=L?N? OSHN;R
-;=E;A?M IH=L?N? OSHN;R
<MNL;=N OSHN;R
<MNL;=N OSHN;R , P?LPC?Q

#?;NOL?1SJCHA

#?;NOL? / ?@?L?H=? "RJL?MMCIHM

'OMN, OMMC>?, @
)C@?

#FIQ1L;HM@?L ?@IL?
@FIQ1L;HM@?LM

"F?G?HMM
1LCA #OH=NCIHM
\\1LCA #OH=NCIHM ,P?LPC?Q

λ

List of Tables

\$L;GG;L -LI>O=NCIH ! ?@CHCNCIHM
" + # + IN;NCIH IHP?HNCIHM
<MNL;=N OSHN;R OSHNB?MCM + IN;NCIH
"M=;J? O?KO?H=?M
, J?L;NIL * ;JJCHA
, J?L;NIL -L?=?>?H=? BCAB?MN NI FIQ?MN
-LCG;LS "RJL?MMCIH , J?L;NIL * ;JJCHA
IL? O?G;HNC=M &GJFC?> / ?F;NCIHMBCJM
IL? O?G;HNC=M &GJFC?> / ?F;NCIHMBCJM 00JJILNCHA (?LH?F O?G;HNC=M
(?LH?F O?G;HNC=M &GJFC?> 0J?=C;FCT;NCIHM
(?LH?F O?G;HNC=M , NB?L &GJFC?> / ?F;NCIHMBCJM

List of Figures

(?L *) OSHN;R);S?LM

1 Scope

1B? (?LH?F * I>?FCHA);HAO;A? (?L *) CM ;H ;JJFC=;NCIH CH>?J?H>?HN GI>?FCHA F;HAO;A? QCNB ; Q?FF ALIOH>?>
Mö¶

2 Conformance

1BCM MJ?=C@C=;NCIH >?@CH?M NB? (?LH?F * I>?FCHA);HAO;A? (?L *) ; F;HAO;A? OM?> NI =IHMNLO=N 9;OI8? I@ L?;F IL
PCLNO;F JF;HH?> IL CG;ACH?> NBCHAM 1B? MJ?=C@C=;NCIH CH=FO>?M NBCM >I=OG?HN ;H> NB? =IHN?HN I@ NB? G;=BCH?
L?;>;<F? @CF?M FCMN? f , 3đđ đđ”` G?F đ.đđ đđđ NXA=IO>?M NBCM >I=OG?HN ;H> NB? G;=B& L?;>CH?

3 Normative References

1B? @IFFIQCHA HILG;NCP? >I=OG?HNM =IHN;CH JLIPCMCIHM QBC=B NBLIOAB L?@?L?H=? CH NBCM N?RN =IHMNCNON? JLIPCMCIHM
I@ NBCM MJ?=C@C=;NCIH

8 !)" /9 , IB C;9<>I??10 D-@- F;>9-@ &<1/525/-@5;: 3?LMCIH
[BNNJM >;N;NL;=E?L C?N@ ILA >I= BNGF L@=](#)

8 F@9 A/@5;: -:3A-3I 2;> F;A:0-@5;: -8 (! (A82), 3?LMCIH
[BNNJM QQQ IGA ILA MJ?= \)#](#)

8) ("9 '4I B AKE2 C>E<@;3>-<45/ H-?4 -:0 ! I??-3I AA@4I:@5/-@5;: C;0I (! AC)
[BNNJM QQQ L@= ?>CNIL ILA L@= L@=](#)
B AKE3

82 2&!9 l' (- ' +.667 (10/2012) l:2;>9 -@5;: @I/4:;8;3E G \$>;/10A>I? 2;> @4I ;<I>-@5;: ;2 ;.61/@ 50I:@525I>
>I35?@>-@5;: -A@4;>5@5I?: GI:I>-@5;: ;2 A:5BI>?-88E A:5=A1 50I:@525I>? -:O @4I5> A?I 5: ;.61/@ 50I:@525I>?
BNNJM QQQ CNO CHN L?= 1 / " 5 &
M?? ;FMI A (:5BI>?-88E (:5=A1 IDI:@525I> ((ID) (% " " - 9I?<-/I
BNNJM NIIFM C?N@ ILA BNGF L@=

85 * &9 + ! ! I@-O-@- l:@I>/4-:3I, 3 ?LMCIH
BNNJM QQQ IGA ILA MJ?= 5 * &

87&-9 ., l\$ F58I F;>9 -@ &<I/525/-@5;:
BNNJM JEQ;L? =;=B?@FS H?N Q?<>I=M =;M?MNO>C?M - - + , 1 " 1 5 1

4 Terms and Definitions

3 ;LCIOM N?LGM ;H> >?@CHCNCIHM ;L? MJ?=C@C?> NBLIOABION NB? <I>S I@ NBCM MJ?=C@C=;NCIH

6 Introduction

6.1 Language Architecture

&H ;>>CNCIH [HH?R](#)

7 Language Description

&H@ILG;NCP?

7.1 Language Description Overview

1BCM =F;OM? JLIPC>?M ;H CH@ILG;NCP? >?M=LCJNCIH I@ (?L *) [F;OM?](#) ACP?M NB? @OFF >?@CHCNCIH I@ NB? (?L *)P?

H A:>I?@>5/@10 :- 91 JLIP<>?M ; Q;S NI L?JL?M?HN ; H;G? NB;N =IHN;CHM ;HS =B;L;=N?L &N CM L?JL?M?HN?> ;M ;
HIH ?GJNS M?KO?H=? I@ =B;L;=N?LM MOLLIOH>?> <S MCHAF? KOIN?M 1B? H;G? =IHMCMNM I@ NB? =B;L;=N?LM C5@45:
NB? MCHAF? KOIN?M g NB? MCHAF? KOIN?M ;L? : ;@ CH=FO>?> ;M J;LN I@ NB? L?JL?M?HN?> H;G? 1B? =B;L;=N?LM
QCNBCH NB? MCHAF? KOIN?M G;S HIN CH=FO>? HIH JLCHN;<F? =B;L;=N?LM CH=FO>CHA <;=EMJ;=? N;< ;H> H?QFCH?
%IQ?P?L NB?M? =B;L;=N?LM G;S <? CH=FO>?> ;M J;LN I@ NB? H;G? CNM?F@ NBLIOAB OM? I@ ;H ?M=;J? M?KO?H=?

7.2.3.1 Dependencies Overview


```
doc /* This is an example of a namespace body. */  
class C;  
datatype D;  
feature f : C;  
namespace N3; // This is a nested namespace.  
}
```

```
doc N9_Doc  
/* This is documentation about namespace N5. */
```

; L?F;NCIHMBCJ <?NQ??H NB? CGJILNCHA H;G?MJ;=? ;H> ;H 59<;>@10 :- 91?<-/1, CH QBC=B ;FF PCMC<F? G?G<?LMBCJM I@ NB? CGJILN?> H;G?MJ;=? <?=IG? CGJILN?> G?G<?LMBCJM I@ NB? CGJILNCHA H;G?MJ;=?

G?G<?LMBCJ CGJILN CM >?HIN?> OMCHA NB? E?SQIL> **import** @IFFIQ?> <S ; KO;FC@C?> H;G? QBC=B C>?HNC@C?M NB? CGJILN?> G?G<?LMBCJ <? G?G<?L H;G? IL G?G<?L MBILN H;G? 1B? G?G<?L ?F?G?HN I@ NB? CGJILN?> G?G<?LMBCJ

7.3.2.1 Types Overview

! I@- 9; 0I8 >I2I>I:/I?:

] C; :>I@I ?E: @-D, [8.2.4.1](#)

] A. ?@>- /@ ?E: @-D, [8.3.3.1](#)

] &I9 - : @5/? , [8.4.3.2](#)

'E<I? =F;MMC@S NBCHAM CH ; GI>?F?> MSMN?G 1B? M?N I@ NBCHAM =F;MMC@C?> <S ; NSJ? CM NB? ID@I: @ I@ NB? NSJ? ?;=B

@?;NOL?M NB;N ;L? HIN ?H> @?;NOL?M M?? <?FIQ =;L>CH;FCNS CM NB? HOG<?L I@ P;FO?M I@ NB? @?;NOL? @IL ; MJ?=C@C=CHMN;H=? I@ CNM @?;NOLCHA NSJ?M

Note. 1B? M?G;HNC=M I@ GOFNCJFC=CNS CM >C@@?L?HN @IL @?;NOL?M NB;N ;L? C>?HNC@C?> ;M I:O 2I-@A>I?. "H> #?;NOL?M ;L? OM?>JLCG;LCFS CH NB? >?@CHCNCIH I@ ;MMI=C;NCIHM ;H> =IHH?=NILM ;H> NB? M?G;HNC=M I@ ?H> @?;NOL?M CM >CM=OMM?> CH=IHDOH=NCIH QCNB NB?G M?? _____ ;H> _____ L?MJ?=NCP?FS

1B? GOFNCJFC=CNS I@ ; NSJ? =;H <?

doc

```
type Original specializes Base::Anything {
```

type

```
classifier Adult;  
classifier Child;  
  
classifier Person
```


7.3.4.2 Feature Declaration

1B?L? ;L? @IOL INB?L ECH>M I@ L?F;NCIHMB CJM NB;N =;H <? >?=F;L?> ;M IQH?> L?F;NCIHMB CJM I@ ; @?;NOL? ?;=B CH>C=;N?> <S
; MJ?=C@C= E?SQIL>

] **disjoint from** g OJ?=C@C?M >CMDICHCHA M??

```

    end feature owner[1] : Person;
    end feature vehicle[*] : Vehicle;
}

```

7.3.4.3 Feature Typing

@?;NOL? NSJCHA L?F;NCIHMB CJ CM >?=F;L?> OMCHA NB? E?SQIL> **specialization** IJNCIH;FES @IFFIQ?> <S ; MBILN H;G?
 ;H> IL ; H;G? 1B? KO;FC@C?> H;G? I@ NB? NSJ?> @?;NOL? CM NB?H ACP?H ;@N?L NB? E?SQIL> **typing** @IFFIQ?> <S NB?
 KO;FC@C?> H;G? I@ NB? NSJ? IL ; @?;NOL? =B;CH M??

MO<M?NNCHA @?;NOL? =;H L?MNLÇ=N ;MJ?=NM I@ NB? MO<M?NN?> @?;NOL? INB?LQCM? CN QÇFF <S>?@;OFN B;P? NB? M;G?


```

}
classifier MotorizedVehicle specializes WheeledVehicle {
    // The effective name is "wheels", the same name as
    // WheeledVehicle::wheels, which is being redefined.
    composite feature redefines wheels[2..4];
}
classifier Automobile specializes MotorizedVehicle {
    // The effective name is "wheels", the same (effective) name
    // as "MotorizedVehicle::wheels", which is being redefined.
    composite feature redefines wheels[4] : AutomobileWheel;
}

```

7.3.4.6 Feature Chaining

```

F1-@A>I /4-5:5:3 CM ;H IQH?> L?F;NC IHMB CJ <?NQ??H NB? IQHCHA /4-5:10 2I-@A>I ;H> ; /4-5:5:3 2I-@A>I. && ; @?;NOL?
B;M ;HS =B;CHCHA @?;NOL?M NB?H CN GOMN B;P? ;N F?;MN NQI 1B? FCMN I@ =B;CHCHA @?;NOL?M I@ ; =B;CH?> @?;NOL? CM =;FF?>
CNM 2I-@A>I /4-5:

```

```
feature uncles subsets parents.siblings;  
feature cousins redefines parents.siblings.children;  
connector vehicle.wheelAssembly.wheels
```

7.3.4.8

1BCM CM ;FMI BIQ INB?L GI>?FCHA F;HAO;A?M =;H <? <OCFN IH (?L *) ! IG;CH MJ?=C@C= G?N;GI>?FM ;H> FC<L;LC?M =;H
;FMI L?OM? (?LH?F G?N;GI>?F ;H> FC<L;LC?M CHB?LCNCHA NB? J;NN?LHM I@ FC<L;LS L?OM? ;<IP? ;M Q?FF ;M NB? G;NB?G;NC=;F
M?G;HNC=M NB?S CHB?LCN @LIG IL? 1BCM ?H;<F?M >IG;CH MJ?=C@C= GI>?F?LM NI OM? N?LG M ;H> MSHN;R @;GCFC;L NI NB?G

&@ ;HS I@ NB? NSJ?M I@ ; @?;NOL? ;L? =F;MM?M NB?H ;FF I@ NB?G GOMN <? &@ ; @?;NOL? B;M =F;MM NSJ?M ;H> HI IQH?>
MO<M?NNCHA IL IQH?> L?>?@CHCNCIH CM ?RJFC=CNFS ACP?H CH NB? @?;NOL? >?F;L;NCIH NB?H NB? @?;NOL? CM CGJFC=CNFS ACP?H ;
>?@;OFN MO<M?NNCHA NI NB? @?;NOL? occurrences @LIG NB? Occurrences FC<L;LS GI>?F M?? OHF?MM ;N F?;MN IH?

A??;/5-05;:?

MOJ?L=F;MMCHA NI ?CNB?L NB? ;MMI=C;NCIH MNLO=NOL? BinaryLinkObject C@ CN CM ; <CH;LS ;MMI=C;NCIH MNLO=NOL? IL NB?
;MMI=C;NCIH MNLO=NOL? LinkObject INB?LQCM? <INB I@ QBC=B ;L? @LIG NB? Objects FC<L;LS GI>?F M??

composite

MJ?=C;F HIN;NCIH =;H <? OM?> @IL ; <CH;LS =IHH?=NIL CH QBC=B NB? MIOL=? L?F;N?> @?;NOL? CM L?@?L?Hd~~h~~?< >B?

N;LA?N @?;NOL? ;@N?L NB? E?SQL> **then**

<?B;PCIL CM>?=F;L?> ;M ; =F;MMC@C?L M?? [_____](#) OMCHA NB? E?SQIL> **behavior** &@ HI IQH?> MOJ?L=F;MMCHA CM
?RJFC=CNFS ACP?H @IL NB? <?B;PCIL NB?H CN CM CGJFC=CNFS ACP?H ; >?F?6MOJ?L=F;MMCHA C@B? <?B;PCIL d9T \$p%h h a IqIB? · 6X h lh • 6X

```
behavior TakePicture {
```


H CHP;LC;HN CM >?=F;L?> FCE? ;HS INB?L <IIF?;H ?RJL?MMCIH ?R=?JN OMCHA NB? E?SQIL> **inv** CHMN?;> I@ **bool** ;H>
;>>CNCIH;FFS NBCM E?SQIL> G;S <? IJNCIH;FFS @IFFIQ?> <S IH? I@ NB? E?SQIL>M **true** IL **false** NI CH>C=;N? QB?NB?L

] C8-??525/-@5;: ID<>I??5;:?. 1B? /8-??525/-@5;: ;<I>-@;>? ;L? MSHN;=NC=;FFS MCGCF;L NI <CH;LS IJ?L;NILM <ON

CM =I HMC>?L?> ?KOCP;F?HN NI

$$((-x) + (y * z))$$

7.4.9.3 Primary Expressions

\$>\$9 ->E ID<>1??5; :

```
// The primary expression is "getPlatform(id)".  
// The feature chain is "sensors.isActive".  
// Results in a sequence of Boolean values,  
// one for each platform sensor.  
getPlatform(id).sensors.isActive
```


] 85@I>-85:@I3I>

```

end feature server[*] : Computer;
composite step login;
composite step authorize;
composite succession login then authorize;
}

```

7.4.10.3 Item Flow Declaration

H CN?G @FIQ >?=F;L;NCIH CM MSHN;=NC=;FFS MCGCF;L NI ; <CH;LS =IHH?=NIL >?=F;L;NCIH M?? ____ OMCHA NB? E?SQIL>
flow IL succession flow @IL ; MO==?MMCIIH CN?G @FIQ &@ HI IQH?> MO<M?NNCHA IL IQH?> L?>?@CHCNCIH CM ?RJFC=CNFS
ACP?H NB?H NB? CN?G @FIQ CM CGJFC=CNFS ACP?H ; >?@;OFN MO<M?NNCHA NI NB? CN?G @FIQ transfers @LIG NB? Transfers
GI>?F FC<L;LS M?? ____ IL NI NB? MO==?MMCIIH CN?G @FIQ transfersBefore C@ ; MO==?MMCIIH CN?G @FIQ CM <?CHA
>?=F;L?> &@ ;H CN?G @FIQ B;M IQH?> MJ?=C;FCT;NCIHM CH=FO>CHA ;FF @?;NOL? NSJCHAM MO<M?NNCHAM ;H> L?>?@CHCNCIHM
QBIM? A?H?L;F NSJ? CM ; <?B;PCIL IL ; MN?J NB?H NB? LOF?M @IL NB? L?>?@CHCNCIH I@ NB? J;L;G?N?LM I@ NBIM? <?B;PCILM
;H> MN?JM ;L? NB? M;G? ;M @IL NB? L?>?@CHCNCIH I@ NB? J;L;G?N?LM I@ A?H?L;F <?B;PCIL IL MN?J <S ; MJ?=C;FCTCHA MN?J M??

2HFCE? ; L?AOF;L <CH;LS =IHH?=NIL >?=F;L;NCIH NBIOAB ;H CN?G @FIQ >?=F;L;NCIH >I?M HIN >CL?=>NFS MJ?=C@S NB? L?F;N?>

@?;NOL?M @IL NB? CN?G @FIQ &HMN?;> NB? >?=F;L;NCIH ACP?M NB? 1MO,9BF(=1B24#6#0E9<€48F04,8446=p?6qj&F/E072 184E4,84=#0

; <M?H=? I@ ;H CN?G >?=F;L;NCIH ;HS P;FO?M G;S @FIQ ;=LIMM NB? CN?G @FIQ =IHMCMN?HN QCNB NB? NSJ?M I@ NB? MIOL=?
IONJON ;H> N;LA?N CHJON @?;NO??M

flow of


```
metaclass Command {  
    // A metadata feature of this metaclass may annotate  
    // a behavior or a step.  
    subsets annotatedElement : KerML::Behavior;  
    subsets annotatedElement : KerML::Step;  
}  
  
behavior Save specializes UserAction {  
    @Command; // This is valid.  
    redefine step
```



```

package DesignModel {
  import Annotations::*;
  struct System {
    @ApprovalAnnotation {
      approved = true;
      approver = "John Smith";
      level = 2;
    }
  }
  ...
}

package UpperLevelApprovals {
  // This package imports all direct or indirect members
  // of the DesignModel package that have been approvedmembers

```

```

ApprovalAnnotation::approved];

}

&H A?H?L;F ; 85.>->E <- /7-31 CM ; J;=E;A? NB;N CM ?RJ?=N?> NI <? =IGGIHFS ;P;CF;<F? ;H> L?OM?> ;=LIMM G;HS OM?L
GI>?FM T;=E;A? =;H <? ?RJFC=CN?S C>?P?C@C?> ;M ; FC<L;LS J;=E;A? OMCHA NB? E?SQIL> library 1BCM ;FFIQM NIIFCHA
NI C>?HNC@S ;HS ?F?G?HN =IHN;CH?> >CL?=NFS CH ; FC<L;LS J;=E;A? ;M <?CHA ; 85.>->E 18191.: @ @LIG NB;N MJ?=C@C= FC<L;LS
J;=E;A?

library package AddressBooks {
    ...
}

1B? ?@-:O->O 85.>->E <- /7-31?

```


8 Metamodel

8.1 Metamodel Overview

1 BCM =F;OM? JL?M?HNM NB? HILG;NCP? MJ?=C@C=-;NCTH I@ NB? 9I@-9;OI8 @IL (?L*) QBC=B CH=FO>?M NB? (?L*) =IH=L?N?

8.2.1 Concrete Syntax Overview

1B? =IH=L?N? MSHN;R @IL (?L *) CM ; N?RNO;F HIN;NCIH NB;N =;H <? OM?> NI ?RJL?MM IL =IHMNLO=N ;H ;<MNL;=N MSHN;R
L?JL?M?HN;NCIH I@ ; GI>?F 1B?

--	--	--

List property construction		

8.2.2.2 Notes and Comments

```
SINGLE_LINE_NOTE =  
    '/' '/' LINE_TEXT  
  
MULTILINE_NOTE =  
    '/' '*' COMMENT_TEXT '*' '/'  
  
REGULAR_COMMENT =  
    '/' '*' COMMENT_TEXT '*' '/'  
  
COMMENT_TEXT =  
    ( COMMENT_LINE_TEXT | LINE_TERMINATOR ) *  
  
COMMENT_LINE_TEXT =  
    LINE_TEXT
```


default dependency derived differences disjoining disjoint doc else end expr
false feature featured featuring filter first flow for from function hastype if
intersects implies import in inout interaction inv inverse inverting istype
language member metaclass metadata multiplicity namespace nonunique not null of

Notes

1B? N?RN I@ ; F?RC=;F REGULAR_COMMENT IL PREFIX_COMMENT MB;FF <? JLI=?MM?> ;M @IFFIQM <?@IL? CN CM
CH=FO>?> 3D4<9PR#1 <I>SCHAFK>??N N?NB? <I>S I@ ; Comment IL Documentation

/ ?GIP? NB? CHCNC;F / * ;H> @CH;F * / =B;L;=N?LM

/ ?GIP? ;HS QBCN? MJ;=? CGG?>C;N?FS ;@N?L NB? CHCNC;F / * OJ NI ;H> CH=FO>CHA NB? @CLMN FCH?
N?LGCH;NIL C@ ;HS

, H ?;=B MO<M?KO?HN FCH? I@ NB? N?RN

ONLCJ CHCNC;F QBCN? MJ;=? INB?L NB;H FCH? N?LGCH;NILM

1B?H C@ NB? @CLMN L?G;CHCHA =B;L;=N?L CM * L?GIP? CN

1B?H C@ NB? @CLMN L?G;CHCHA =B;L;=N?L CM HIQ ; MJ;=? L?GIP? CN

1B? <I>S N?RN I@ ;

CH=FOHCHA ;FF G<E OJ N?RJF XCBA ;FF FCH? N?LGCH;NILI ;H> QBCN? MJ;=? CH=FO>?> ;MO?HN?>?:? INB?L NB;H QH;N CM

| TypeFeaturing

FeatureElement : Feature =

Feature

| Step

| Expression

| BooleanExpression

,NB?LQM?

```
DifferencingPart : Type =  
  'differences' ownedRelationship += Differencing
```

```

'disjoint'
( typeDisjoined = [QualifiedNames]
| typeDisjoined = FeatureChain
  { ownedRelatedElement += typeDisjoined }
)
'from'
( disjoiningType = [QualifiedNames]
| disjoiningType = FeatureChain
  { ownedRelatedElement += disjoiningType }
)
RelationshipBody

```

```

OwnedDisjoining : Disjoining =
  disjoiningType = [QualifiedNames]
| disjoiningType = FeatureChain
  { ownedRelatedElement += disjoiningType }

```

8.2.4.1.5 Unioning, Intersecting and Differencing

```

Unioning =
  unioningType = [QualifiedNames]
| ownedRelatedElement += OwnedFeatureChain

```

```

Intersecting =
  intersectingType = [QualifiedNames]
| ownedRelatedElement += OwnedFeatureChain

```

```

Differencing =

```


8.2.4.2.2 Subclassification

```
Subclassification =  
  ( 'specialization' Identification )?  
  'subclassifier' subclassifier = [QualifiedName]  
  SPECIALIZES superclassifier = [QualifiedName]  
  RelationshipBody  
  
OwnedSubclassification : Subclassification =  
  superclassifier = [QualifiedName]
```

8.2.4.3 Features Concrete Syntax

8.2.4.3.1 Features

```
Feature =  
  FeaturePrefix  
  ( 'feature'? FeatureD
```

```

InvertingPart : Feature =
    'inverse' 'of' ownedRelationship += OwnedFeatureInverting

TypeFeaturingPart : Feature =
    'featured' 'by' ownedRelationship += OwnedTypeFeaturing
    ( ' ,' ownedTypeFeaturing += OwnedTypeFeaturing ) *

FeatureSpecializationPart : Feature =
    FeatureSpecialization+ MultiplicityPart? FeatureSpecialization*
    | MultiplicityPart FeatureSpecialization*

MultiplicityPart : Feature =
    ownedRelationship += OwnedMultiplicity
    | ( ownedRelationship += OwnedMultiplicity )?
    ( isOrdered ?= 'ordered' ( {isUnique = false} 'nonunique' )?
      | {isUnique = false} 'nonunique' ( isOrdered ?= 'ordered' )? )

FeatureSpecialization : Feature =
    Typings | Subsettings | References | Redefinitions

Typings : Feature =
    TypedBy ( ' ,' ownedRelationship += OwnedFeatureTyping ) *

TypedBy : Feature =
    TYPED_BY ownedRelationship += OwnedFeatureTyping

Subsettings : Feature =
    Subsets ( ' ,' ownedRelationship += OwnedSubsetting ) *

Subsets : Feature =
    SUBSETS ownedRelationship += OwnedSubsetting

References : Feature =
    REFERENCES ownedRelationship += OwnedReferenceSubsetting

```

8.2.4.3.3 Subsetting

```
Subsetting =  
  ( 'specialization' Identification )?  
  'subset' SpecificType  
  SUBSETS GeneralType  
  RelationshipBody  
  
OwnedSubsetting : Subsetting =  
  GeneralType  
  
OwnedReferenceSubsetting : ReferenceSubsetting =  
  GeneralType
```

8.2.4.3.4 Redefini3.60neralType

8.2.4.3.7 Type Featuring

```
TypeFeaturing =  
  'featuring' ( Identification 'of' )?  
  featureOfType = [QualifiedName]  
  'by' featuringType = [QualifiedName]  
  RelationshipBody
```

```
OwnedTypeFeaturing : TypeFeaturing =  
  featuringType = [QualifiedName]
```

8.2.5 Kernel Concrete Syntax

8.2.5.1 Data Types Concrete Syntax

```
DataType =  
  TypePrefix 'datatype'  
  ClassifierDeclaration TypeBody
```

8.2.5.2 Classes Concrete Syntax

```
Class =
```

```
ownedRelationship += ConnectorEndMember
```

```
Function =  
  TypePrefix 'function'  
  ClassifierDeclaration FunctionBody  
  
FunctionBody : Type =
```


[illegible]


```

SequenceExpressionListMember : FeatureMembership =
    ownedMemberFeature = SequenceExpressionList

FeatureChainExpression : FeatureChainExpression =
    ownedRelationship += NonFeatureChainPrimaryExpressionMember '.'
    ownedRelationship += FeatureChainMember

CollectExpression : CollectExpression =
    ownedRelationship += PrimaryExpressionMember '.'
    ownedRelationship += BodyExpressionMember

SelectExpression : SelectExpression =
    ownedRelationship += PrimaryExpressionMember '?.?'
    ownedRelationship += BodyExpressionMember

FunctionOperationExpression : InvocationExpression =
    ownedRelationship += PrimaryExpressionMember '->'
    ownedRelationship += ReferenceTyping
    ( ownedRelationship += BodyExpressionMember
    | ownedRelationship += FunctionReferenceExpressionMember
    | ArgumentList )

BodyExpressionMember : FeatureMembership =
    ownedMemberFeature = BodyExpression

FunctionExpressionMember : FeatureMembership =
    ownedMemberFeature = FunctionReferenceExpression

FunctionReferenceExpression : FeatureReferenceExpression =
    ownedRelationship += FunctionReferenceMember

FunctionReferenceMember : FeatureMembership =
    ownedMemberFeature = FunctionReference

FunctionReference : Expression =
    ownedRelationship += ReferenceTyping

FeatureChainMember : Membership =
    FeatureReferenceMember
    | OwnedFeatureChainMember

```



```

        ownedRelationship += ParameterRedefinition '='
        ownedRelationship += ArgumentValue

ParameterRedefinition : Redefinition =
    redefinedFeature = [Qualified Name]

BodyExpression : FeatureReferenceExpression =
    ownedRelationship += ExpressionBodyMember

ExpressionBodyMember : FeatureMembership =
    ownedMemberFeature = ExpressionBody

ExpressionBody : Expression =
    '{' FunctionBodyPart '}'

```

Notes

1B? @CLMN ownedRelationship I@ ;H InvocationExpression MBIOF> <? J;LM?> ;M ; FeatureTyping
 C@ NB? N;LA?N Type CM ; Classifier ;H> ;M ; Subsetting C@ NB? N;LA?N

8.2.5.9.2 Item Flows

```
ItemFlow =
    FeaturePrefix 'flow'
    ItemFlowDeclaration TypeBody

SuccessionItemFlow =
    FeaturePrefix 'succession' 'flow'
    ItemFlowDeclaration TypeBody

ItemFlowDeclaration : ItemFlow =
    ( FeatureDeclaration ValuePart?
      ( 'of' ownedRelationship += ItemFeatureMember )?
      ( 'from' ownedRelationship += ItemFlowEndMember
        'to' ownedRelationship += ItemFlowEndMember )?
      | ( isSufficient ?= 'all' )?
        ownedRelationship += ItemFlowEndMember 'to'
        ownedRelationship += ItemFlowEndMember

ItemFeatureMember : FeatureMembership =
    ownedRelatedElement = ItemFeature

ItemFeature : Feature =
    Identification ItemFeatureSpecializationPart ValuePart?
    | ( ownedRelationship += OwnedFeatureTyping
      ( ownedRelationship += OwnedMultiplicity )?
      | ownedRelationship += OwnedMultiplicity
        ( ownedRelationship += OwnedFeatureTyping )?

ItemFeatureSpecializationPart : Feature =
    FeatureSpecialization+ MultiplicityPart?
    FeatureSpecialization*
    | MultiplicityPart FeatureSpecialization+

ItemFlowEndMember : EndFeatureMembership =
    ownedRelatedElement += ItemFlowEnd

ItemFlowEnd : ItemFlowEnd =
    ( ownedRelationship += OwnedReferenceSubsetting '.' )?
    ownedRelationship += ItemFlowFeatureMember
```

```
)
ownedRelatedElement += OwnedExpression
```

8.2.5.11 Multiplicities Concrete Syntax

```
Multiplicity =
    MultiplicitySubset | MultiplicityRange
```

```
MultiplicitySubset : Multiplicity =
    'multiplicity' Identification Subsets
    TypeBody
```

```
MultiplicityRange =
    'multiplicity' Identification MultiplicityBounds
    TypeBody
```

```
OwnedMultiplicity : OwningMembership =
    ownedRelatedElement += OwnedMultiplicityRange
```

```
OwnedMultiplicityRange : MultiplicityRange =
    MultiplicityBounds
```

```
MultiplicitySubset MultiplicityRange =
    MultiplicitySubset MultiplicityRange =
```

```
lement += itvBT9pliance =
```



```

MetadataBodyElement : Membership =
    NonFeatureMember
    | MetadataBodyFeatureMember
    | AliasMember
    | Import

MetadataBodyFeatureMember : FeatureMembership =
    ownedMemberFeature = MetadataBodyFeature

MetadataBodyFeature : Feature =
    'feature'? ( ':'>' | 'redefines')? ownedRelationship += OwnedRedefinition
    FeatureSpecializationPart? ValuePart?
    MetadataBody

```

8.2.5.13 Packages Concrete Syntax

```

Package =
    ( ownedRelationship += PrefixMetadataMember )*
    PackageDeclaration PackageBody

LibraryPackage =
    ( isStandard ?= 'standard' ) 'library'
    ( ownedRelationship += PrefixMetadataMember )*
    PackageDeclaration PackageBody

PackageDeclaration : Package =
    'package' Identification

PackageBody : Package =
    ';'
    | '{' ( NamespaceBodyElement
        | ownedRelationship += ElementFilterMember
        )*
    '}'

ElementFilterMember : ElementFilterMembership =
    MemberPrefix
    'filter' condition = OwnedExpression ';'

```

8.3 Abstract Syntax

8.3.1 Abstract Syntax Overview

TextualRepresentation

AssociationStructure

SuccessionItemFlow

InvocationExpression

FeatureReferenceExpression

OperatorExpression

FeatureChainExpression

3 ;LCIOM ;FN?LH;NCP? C>?HNC@C?LM @IL NBCM "F?G?HN \$?H?L;FFS NB?M? QCFE <? M?N <S NIIFM

S>?@;OFN L?NOLH NB? FC<L;LS +;G?MJ;=? I@ NB? owningRelationship

General Classes

"F?G?HN

Attributes

CM&GJFC?> IIF?;H

Element

Relationship

Dependency

Constraints

>?LCP? HHIN;NCHA "F?G?HN HHIN;N?>"F?G?HN

&& ;H AnnotatingElement B;M annotations NB?H CNM annotatedElements ;L? NB? annotatedElements I@ ;FF
CNM annotations ,NB?LQCM? CNM MCHAF? annotatedElement CM CNM owningNamespace

```
annotatedElement =  
  if annotation->notEmpty() then annotation.annotatedElement  
  else Sequence{owningNamespace} endif
```

8.3.2.3.3 Annotation

Description

H Annotation CM ; / ?F;NCIHMB CJ <?NQ??H ;H AnnotatingElement ;H> NB? Element NB;N CM ;HHIN;N?> <S NB;N
AnnotatingElement

General Classes

/ ?F;NCIHMB CJ

Attributes

;HHIN;N?> "F?G?HN "F?G?HN UL?>?@CH?M N;LA?NW

1B? Element NB;N CM ;HHIN;N?> <S NB? annotatingElement I@ NBCM HHIN;NCIH

;HHIN;NCHA "F?G?HN HHIN;NCHA "F?G?HN UL?>?@CH?M MIOL=?W

A000010469 3me1B? AnnotatingElement NB;N ;HHIN;N?M NB? annotatedElement I@ NBCM Annotation

<I>S ONCHA

kerml	


```

CGJILN?> * ?G<?LMBCJM ?R=FO>?> +;G?MJ;=? 8 9 * ?G<?LMBCJ 8 9

/ ?NOLHM * ?G<?LMBCJM NB;N ;L? NI <?=IG? importedMemberships I@ NB? importOwningNamespace 1B?
excluded J;L;G?N?L CM OM?> NI B;H>F? NB? JIMMC<CFCNS I@ =CL=OF;L &GJILN / ?F;NCIHMBCJM

```

Constraints

+ IH?

8.3.2.4.3 Membership

[KERML-99](#): **deriveMembershipMemberElementId text elementId typo**

Description

```

Membership CM ; Relationship <?NQ??H ; Namespace ;H> ;H Element NB;N CH>C=;N?M NB? Element CM ;
member I@ C ? CM=IHN;CH?> CH NB? +;G?MJ;=? HS memberNames MJ?=@S BIQ NB? memberElement CM C>?HNC@C?>
CH NB? Namespace ;H> Q3aI ;

```

4 B?NB?L IL HIN NB? Membership I@ NB? memberElement CH NB? membershipOwningNamespace CM JO<FC=FS PCMC<F?
IONMC>? NB;N Namespace

Operations

CM ! CMNCHAOOMB;<F?#LIG INB?L * ?G<?LMBCJ IIF?;H

4 B?NB?L NBCM Membership

```
body: if not isRecursive or
    not importedElement.oclIsKindOf(Namespace) or
    excluded->includes(importedElement)
then Sequence{importedMembership}
else importedElement.oclAsType(Namespace).
    visibleMemberships(excluded, true, importAll)->
    prepend(importedMembership)
endif
```

Constraints


```

TiETBT10isRecursive.6260 Td/F8 9.000532.83944A85.868erships

```

```
membership->forall(m1 |
  membership->forall(m2 |
    m1 <> m2 implies m1.isDistinguishableFrom(m2)))
```

8.3.2.4.6 NamespaceImport

[KERML-101: NamespaceImport Description Incorrect](#)

Description

```
NamespaceImport CM ;H &GJILN NB;N CGJILNM Memberships @LIG CNM importedNamespace CHNI NB?
importOwningNamespace && isRecursive = false NB?H IHFS NB? PCMC<F? Memberships I@ NB?
importOwningNamespace ;L? CGJILN?> && isRecursive = true NB?H CH ;>>CNCIH Memberships ;L?
L?=OLMCP?FS CGJILN?> @LIG ;HS ownedMembers I@ NB? importedNamespace NB;N ;L? Namespaces
```

General Classes

&GJILN

Attributes

CGJILN?>+;G?MJ;=? +;G?MJ;=? UL?>?@CH?M N;LA?NW

1B? Namespace QBIM? PCMC<F? Memberships ;L? CGJILN?> <S NBCM NamespaceImport

Operations

CGJILN?> * ?G<?LMBCJM ?R=FO>?> +;G?MJ;=? 8 9 * ?G<?LMBCJ 8 9

```
/ ?NOLHM ;N F?;MN NB? PCMC<F? Memberships I@ NB? importedNamespace && isRecursive = true NB?H
Memberships ;L? ;FMI L?=OLMCP?FS CGJILN?> @LIG ;HS ownedMembers I@ NB? importedNamespace NB;N ;L?
NB?GM?FP?M Namespaces
```

```
body: if excluded->includes(importedNamespace) then Sequence{}
else importedNamespace.visibleMemberships(excluded, isRecursive, isImportAll)
```

Constraints

&JIL&JILN?2FG8LN

1B?NB?1A?enort

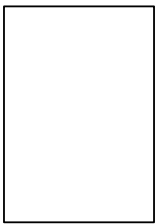
+IH?

Literal Values

JLCP;N?

&H>C=;N?M ; Membership CM HIN PCMC<F? IONMC>? CNM IQHCHA Namespace

JLIN?=N?>



+IH?

Constraints

?H>#?;NOL? #?;NOL? 8 9 UMO<M?NM @?;NOL? IL>?L?>W

FF features I@NBCM Type QCNB isEnd = true

@?;NOL? #?;NOL? 8 9 UMO<M?NM G?G<?L IL>?L?>W

1B? ownedMemberFeatures I@NB?

;FF00J?LNSJ?M 1SJ? 8 9

&& NBCM Type CM =IHDOA;N?> NB?H CM inputs ;L? NB?

P;FC>;N?1SJ? N* IMN, H? IHDOA;NIL

General Classes

1SJ?

Attributes

1B? GIL? general F;MMC@C?L CH NBCM Subclassification

Operations

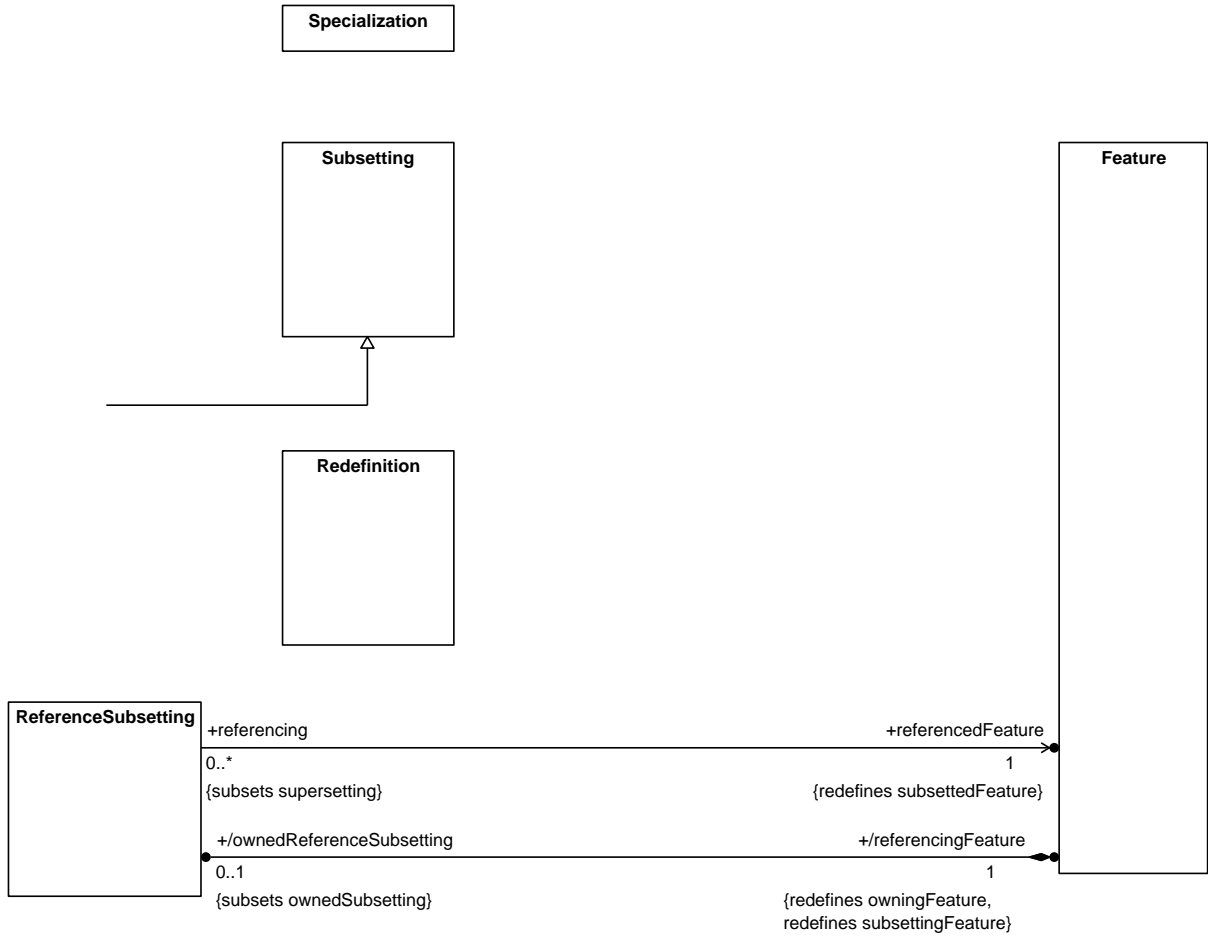
+IH?

Constraints

+IH?

8.3.3.3 Features Abstract Syntax

8.3.3.3.1 Overview



Feature

Relationship

FeatureInverting

Constraints

P;FC>;N?"H>#?;NOL? * ?G<?LMBCJ&M"H>

1B? ownedMemberFeature I@ ;H EndFeatureMembership GOMN <? ;H ?H> Feature

ownedMemberFeature.isEnd

8.3.3.3.3 Feature

KERML-83: OCL errors in specialization constraints

KERML-20: Validation constraints are missing in the KerML abstract syntax

KERML-78: Some Feature constraints have no description

KERML-12: OCL errors in validateFeatureChainingFeatureNotOne and validateFeatureChainingFeaturesNotSelf

KERML-18: Semantic constraints for subtypes of LiteralExpression are missing

KERML-118: deriveFeatureFeaturingType conflicts with owningType

KERML-80: Incorrect OCL for validateFeatureChainingFeatureNotOne and

1B? Feature NB;N ;L? =B;CH?> NIA?NB?L NI >?N?LGCH? NB? P;FO?M I@ NBCM Feature >?LCP?> @LIG NB?
chainingFeatures I@ NB? ownedFeatureChainings I@ NBCM Feature

4 B?NB?L NB? P;FO?M I@ NBCM Feature =;H =B;HA? IP?L NB? FC@?NCG? I@ ;H CHMN;H=? I@ NB? >IG;CH

CM2HCKO? IIF?;H

4 B?NB?L IL HIN P;FO?M @IL NBCM Feature GOMN B;P? HI >OJFC=;N?M IL HIN

IQH?>#?;NOL? B;CHCHA #?;NOL? B;CHCHA 8 9 UMO<M?NM MIOL=? / ?F;NCIHMBCJ IQH?> / ?F;NCIHMBCJ IL>?L?>W

1B?

Operations

>CL?= \mathbb{N} CH#1L NSJ? 1SJ? #?;NOL? !CL?= \mathbb{N} CH (CH> 8 9

body

```

isEnd and owningType <> null implies
  let i : Integer =
    owningType.ownedEndFeature->indexOf(self) in
    owningType.ownedSpecialization.general->
      forAll(supertype |
        supertype.endFeature->size() >= i implies
          redefines(supertype.endFeature->at(i))

```

=B?=E#?;NOL?"H>OJ?=C;FCT;NCIH

&& ; Feature B;M isEnd = true ;H> ;H owningType NB;N CM ;H Association IL ; Connector NB?H CN GOMN
>CL?=NFS IL CH>CL?=NFS MJ?=C;FCT? *Links::Link::participants* @LIG NB? (?LH?F 0?G;HNC=)C<L;LS

```

isEnd and owningType <> null and
(owningType.ocIsKindOf(Association) or
owningType.ocIsKindOf(Connector)) implies
  specializesFromLibrary('Links::Link::participants')

```

=B?=E#?;NOL?&N?G#FIQ#?;NOL?/?>?@CHCNCIH

&& ; Feature CM NB? @CLMN ownedFeature I@ ; @CLMN IL M?=-IH> ItemFlowEnd NB?H CN GOMN >CL?=NFS IL CH>CL?=NFS
MJ?=C;FCT? ?CNB?L i im= lf)mp lies

;; Feature CM ; parameter I ;H owningType NB;N CM ; Behavior IL Step

```
isComposite and
ownedTyping.type->includes(oclIsKindOf(Structure)) and
owningType <> null and
(owningType.oclIsKindOf(Structure) or
owningType.type->includes(oclIsKindOf(Structure))) implies
    specializesFromLibrary("Occurrence::Occurrence::suboccurrences")
```

BỘ GIÁO DỤC VÀ ĐÀO TẠO

```
closure(typingFeatures()).typing.type->  
asOrderedSet()
```

P;F>;N?#?;NOL? B;CHCHA#?;NOL? IH@ILG;H=?

" ;=B chainingFeature INB?L NB;H NB? F;MN GOMN =IH@ILG NI ;FF NB? featuringTypes I@ NB? H?RN Feature CH

OJ?=C;FCT;NCIH

Attributes

IQHCHA#?;NOL? #?;NOL? 8 9 UMO<M?NM NSJ?>#?;NOL? L?>?@CH?M IQHCHA1SJ?W

typedFeature NB;N CM ;FMI NB? owningRelatedElement I@ NBCM FeatureTyping

NSJ? 1SJ? UL?>?@CH?M A?H?L;FW

1B? Type NB;N CM <?CHA ;JJFC?> <S NBCM FeatureTyping

P;FC>;N? / ?>?@CHCNCIH#?;NOLCHA1SJ?M

1B? redefiningFeature I@ ; Redefinition GOMN B;P? ;N F?;MN IH? featuringType

Subsetting CM Specialization CH QBC=B NB? specific

TypeFeaturing CM ; Featuring Relationship

Description

Structure CM ; Class

Description

H Association CM ; Relationship ;H> ; Classifier NI ?H;<F? =F;MMC@C=;NCIH I@ FCHEM <?NQ??H NBCHAM CH NB?

1B? relatedTypes

+IH?

Operations

+IH?

Constraints

=B?=E MMI=C;NCIHONLO=NOL? CH;LSOJ?=C;FCT;NCIH

<CH;LS MMI=C;NCIHONLO=NOL? GOMN >CL?=NFS IL CH>CL?=NFS MJ?=C;FCT? NB? <;M? MMI=C;NCIHONLO=NOL?
Objects::BinaryLinkObject @LIG NB? (?LH?F O?G;HNC=)C<L;LS

endFeature->size() = 2 implies
specializesFromLibrary("Objects::BinaryLinkObject")

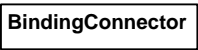
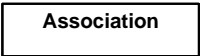
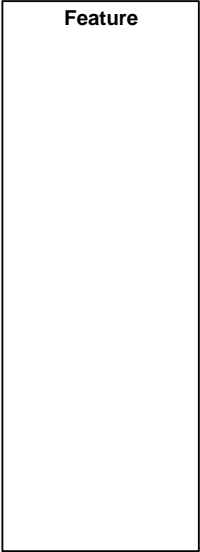
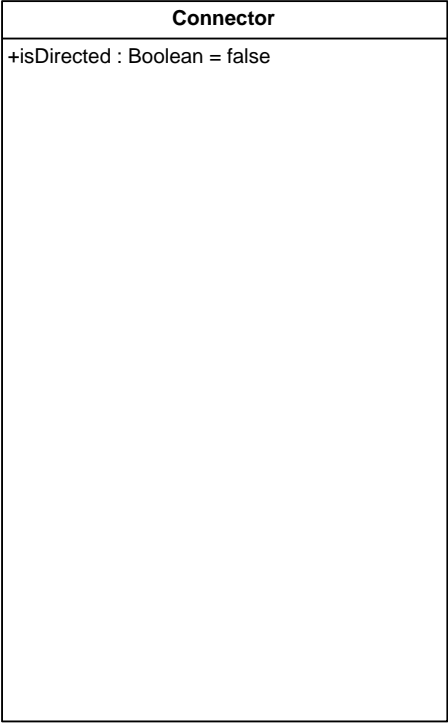
=B?=E MMI=C;NCIHONLO=NOL?OJ?=C;FCT;NCIH

H MMI=C;NCIHONLO=NOL? GOMN >CL?=NFS IL CH>CL?=NFS MJ?=C;FCT? NB? <;M? MMI=C;NCIHONLO=NOL?
Objects::LinkObject @LIG NB? (?LH?F O?G;HNC=)C<L;LS

specializesFromLibrary("Objects::ObjectLink")

8.3.4.5 Connectors Abstract Syntax

8.3.4.5.1 Overview



Succession

Step


```
triggerStep =  
  if transitionStep = null or  
    transitionStep.ownedFeature.size() < 2 or  
    not transitionStep.ownedFeature->at(2).oclIsKindOf(Step)  
  then Set{}  
  else Set{transitionStep.ownedFeature->at(2).oclAsType(Step)}  
  endif
```

8.3.4.6 Behaviors Abstract Syntax

8.3.4.6.1 Overview




```
exists(oclIsKindOf(Structure)) implies  
specializesFromLibrary('Objects::Object::ownedPerformance')
```

=B?=EON?J0J?=-C;FCT;NCIH

ON?J GOMN >CL?=-NFS IL CH>CL?=-NFS MJ?=-C;FCT? NB? <;M? ON?J *Performances::pF11 906plies*

P;FC>;N?-;L;G?N?L*?G<?LMBCJ-;L;G?N?L%;M!CL?=-NCIH

1B? ownedMemberParameter I@; ParameterMembership GOMN B;P?; HIH HOFF direction

ownedMemberParameter.direction <> null

8.3.4.7 Functions Abstract Syntax

8.3.4.7.1 Overview



H Expression CM ;

```
/ ?NOLH QB?NB?L NBCM Expression CM GI>?F F?P?F ?P;FO;<F? 1B? visited J;L;G?N?L CM OM?> NI NL;=E JIMMC<F?
=CL=OF;L Feature L?@?L?H=?M 00=B =CL=OF;L L?@?L?H=?M ;L? HIN ;FFIQ?> CH GI>?F F?P?F ?P;FO;<F? ?R JL?MMCIHM
```

```
H Expression NB;N CM HIN INB?LQCM? MJ?=@;FCT?> CM GI>?F F?P?F ?P;FO;<F? C@ ;FF I@ CN B;M HI
ownedSpecialziations ;H> ;FF CNM HIH CGJFC=CN features ;L? ?CNB?L in J;L;G?N?LM NB? result parameter IL
; L?MOFN Expression IQH?> PC; ; ResultExpressionMembership 1B? parameters GOMN HIN B;P? ;HS
ownedFeatures IL ; FeatureValue ;H> NB? L?MOFN Expression GOMN <? GI>?F F?P?F ?P;FO;<F?
```

```
body: ownedSpecialization->isEmpty() and
ownedFeature->forAll(f |
    (f.oclIsKindOf(Relationship) and
```

>?LCP?"RJL?MMC1H / ?MOFN

&& ;H Expression B;M ; parameter

Note:

Constraints

=B?=E-L?>C=;N?0J?<C;FCT;NCIH

-L?>C=;N? GOMN >CL?<NFS IL CH>CL?<NFS MJ?<C;FCT? NB? <;M? -L?>C=;N? *Performances::BooleanEvaluation* @LIG
NB? (?LH?F 0?G;HNC=)C<L;LS

specializesFromLibrary("Performances::BooleanEvaluation")

8.3.4.7.7 ResultExpressionMembership

Description

ResultExpressionMembership CM ; FeatureMembership NB;N CH>C=;N?M NB;N NB? ownedResultExpression
JLIPC>?M NB? L?MOFN P;FO?M @IL NB? Function IL Expression NB;N IQHM CN 1B? IQHCHA Function

Operations

+IH?

Constraints

P;FC>;N? / ?NOLH - ;L;G?N?L * ?G<?LMBCJ , QHCHA1SJ?

1B? owningType I@ ; ReturnParameterMembership GOMN <? ; Function IL Expression

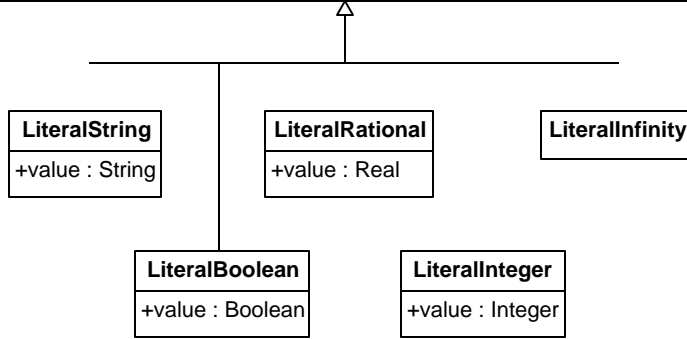
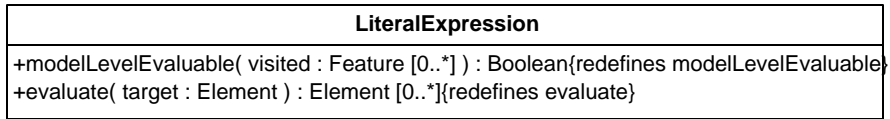
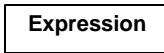
owningType.oclIsKindOf(Function) or owningType.oclIsKindOf(Expression)

P;FC>;N? / ?NOLH - ;L;G?N?L * ?G<?LMBCJ - ;L;G?N?L%;M ! CL?=NCIH , ON

1B? ownedMemberParameter I@ ; ReturnParameterMembership GOMN B;P? ; direction = out

ownedMemberParameter.direction = ParameterDirectionKind::out

8.3.4.8 Expressions Abstract Syntax



FeatureChainExpression CM ;H OperatorExpression QBIM? IJ?L;NIL CM " . " QBC=B L?MIFP?M NI NB?
Function *ControlFunctions*::'.'

```
targetFeature =  
    let nonParameterMemberships : Sequence(Membership) = ownedMembership->
```

```

body: if not target.ocIsKindOf(Type) then Sequence{}
else
  let feature: Sequence(Feature) =
    target.oclAsType(Type).feature->select(f |
      f.ownedRedefinition.redefinedFeature->
        includes(referent)) in
    if feature->notEmpty() then
      feature.valuation.value.evaluate(target)
    else if referent.featuringType->isEmpty()
      then referent
    else Sequence{}
    endif endif
endif

```

GI>?F)?P?F"P;FO;<F? PCMCN?> #?;NOL? 8 9 IIF?;H

FeatureReferenceExpression

```
else nonParameterMemberships->first().memberElement.oclAsType(Feature)
endif
```

P;F6 ??`\$õñ\$ôõñöL?

&& ;H InvocationExpression>I?M HIN B;P? ;H ownedTyping NB;N CM ; Behavior IL ;H ownedSubsetting I@ ;
Feature NB;N CM NSJ?> <S ; Behavior NB?H CN GOMN IQH ; BindingConnector between itself and its
result parameter.

```
not ownedTyping->exists(oclIsKindOf(Behavior)) and
not ownedSubsetting.subsettedFeature.type->exists(oclIsKindOf(Behavior)) implies
    ownedFeature.selectByKind(BindingConnector)->exists(
        relatedFeature->includes(self) and
        relatedFeature->includes(result))
```

=B?=E&HPI=;NCIH"RJL?MMC IH ! ?@;OFN 3;FO? CH>CHA IHH?=NIL

H InvocationExpression GOMN IQH ; BindingConnector <?NQ??H NB? featureWithValue ;H> value
Expression I@ ;HS FeatureValue NB;N CM NB? ????=NCP?>?@;OFN P;FO? @IL ; Feature I@ NB? CHPIE?> Type I@ NB?
InvocationExpression

TBD

>?LCP?&HPI=;NCIH"RJL?MMC IH LAOG?HN

1B? arguments I@ ;H InvocationExpression ;L? NB? value Expressions I@ NB? FeatureValues I@ CNM
IQH?> CHJON parameters

LiteralBoolean CM ; LiteralExpression

1B? *Integer* P;FO? NB;N CM NB? L?MOFN I@ ?P;FO;NCHA NBCM

P;FO? OMLCHA

1B? *String*

MetadataAccessExpression CM ;FQ;SM GI>?F F?P?F ?P;FO;<F?

body: true

Constraints

=B?=E * ?N;>;N; ==?MM"RJL?MMCIOHJ?=C;FCT;NCIH

MetadataAccessExpression GOMN >CL?=-NFS IL CH>CL?=-NFS MJ?=C;FCT? NB? <;M? MetadataAccessExpression
Performances::metadataAccessEvaluations @LIG NB? (?LH?F O?G;HNC=)C<L;LS

specializesFromLibrary("Performances::metadataAccessEvaluations")

8.3.4.8.13 NullExpression

Description

NullExpression CM ;H Expression NB;N L?MOFNM CH ; HOFF P;FO?

General Classes

General Classes

&HPI=;NCIH"RJL?MMC IH

Attributes

IJ?L;NIL ONLCHA

H operator

8.3.4.9

General Classes

#?;NOL?

Attributes

+ IH?

Operations

+ IH?

Constraints

=B?=E&N?G#?;NOL? / ?>?@CHCNCIH

```
H ItemFeature GOMN L?>?@CH? NB? Feature Transfers::Transfer::item @LIG NB? ( ?LH?F 0?G;HNC= )C<L;LS
ownedRedefinition.redefinedFeature->
    redefinesFromLibrary( "Transfers::Transfer::item" )
```

8.3.4.9.3 ItemFlow

[KERML-14](#): validateItemFlowItemFeature documentation is wrong

Description

```
H ItemFlow CM ; Step NB;N L?JL?M?HNM NB? NL;HM@?L I@ I<D?NM IL>;N; P;FO?M @LIG IH? Feature NI ;HINB?L
ItemFlows =;H N;E? HIH T?LI NCG? NI =IGJF?N?
```

General Classes

IHH?=NIL
ON?J

Attributes

CHN?L;=NCIH &HN?L;=NCIH 8 9 UL?>?@CH?M ;MMI=C;NCIH <?B;PCIL IL>?L?>W

```
1B? Interactions NB;N NSJ? NBCM ItemFlow Interactions ;L? <INB Associations ;H> Behaviors QBC=B
=;H NSJ? Connectors ;H> Steps I H>
```

1B? Feature NB;N JLIP<>?M NB? CN?GM =;LLC?> <S NB? ItemFlow &N GOMN <? ;H IQH?> output I@ NB? source

```

sourceOutputFeature =
    if connectorEnd->isEmpty() or
        connectorEnd.ownedFeature->isEmpty()
    then null
    else connectorEnd.ownedFeature->first()
    endif

```

>?LCP?&N?G#FIQ1;LA?N&HJON#?;NOL?

```

1B? targetInputFeature I@ ; ItemFlow CM NB? @CLMN ownedFeature I@ NB? M?=IH> connectorEnd I@ NB?
ItemFlow

```

```

targetInputFeature =
    if connectorEnd->size() < 2 or
        connectorEnd->at(2).ownedFeature->isEmpty()
    then null
    else connectorEnd->at(2).ownedFeature->first()
    endif

```

P;FC>;N?&N?G#FIQ&N?G#?;NOL?

```

H ItemFlow GOMN B;P? ;N GIMN IH? ownedFeature NB;N CM ;H ItemFeature
ownedFeature->selectByKind(ItemFeature)->size() <= 1

```

8.3.4.9.4 ItemFlowEnd

Description

```

H ItemFlowEnd CM ; Feature NB;N CM IH? I@ NB? connectorEnds ACPCHA NB? source IL target I@ ;H ItemFlow
#IL ItemFlows NSJ?> <S FlowTransfer IL CNM MJ?=<C;FCT;NCIHM ItemFlowEnds GOMN B;P? ?R;=NFS IH?
ownedFeature

```

H

Constraints

4 B?NB?L NBCM FeatureValue CM ; =IH=L?N? MJ?=@C=;NCIH I@ NB? <IOH> IL CHCNC;F P;FO? I@ NB? featureWithValue IL
DOMN ; >?@;OFN P;FO? NB;N G;S <? IP?LLC>>?H

CM&HCNC;F IIF?;H

4 B?NB?L NBCM FeatureValue MJ?=@C?M ; <IOH> P;FO? IL ;H CHCNC;F P;FO? @IL NB? featureWithValue

P;FO? "RJL?MMCIIH UL?>?@CH?M IQH?>* ?G<?L"F?G?HNW

1B? Expression

Operations

+ IH?

Constraints

=B?=E * ?N;=F;MMOJ?=C;FCT;NCIH

```
Metaclass GOMN >CL?=NFS IL CH>CL?=NFS MJ?=C;FCT? NB? <;M? Metaclass Metaobjects::Metaobject @LIG NB?  
( ?LH?F O?G;HNC= )C<L;LS
```

```
specializesFromLibrary( "Metaobjects::Metaobject" )
```

8.3.4.12.3 MetadataFeature

[KERML-20](#): Validation constraints are missing in the KerML abstract syntax

Description

```
MetadataFeature CM ; Feature NB;N CM ;H Annod0.0sngElemen
```

B?=E C@ NBCM MetadataFeature B;M ; metaclass QBC=B CM ; ECH> I@ *SemanticMetadata*.

body: specializesFromLibrary('Metaobjects::SemanticMetadata')

CMOSH\;=NC= IIF?;H

B?=E C@ NBCM MetadataFeature B;M ; metaclass NB;N CM ; ECH> I@ *KerML::Element* (@4-@ 5?, 5@ 5? 2>; 9 @4I

```
specializesFromLibrary("Metaobjects::metaobjects")
```

```
P;FC>;N? * ?N;>;N;#?;NOL? HHIN;N?>"F?G?HN
```

```
1B? annotatedElements I@;
```


+includeAsMember(element : Element) : Boolean

1B? condition Expression GOMN <? GI>?F F?P?F ?P;FO;<F?

condition.isModelLevelEvaluable

8.3.4.13.3 LibraryPackage

Description

LibraryPackage CM ; Package NB;N CM NB? =IHN;CH?L @IL ; GI>?F FC<L;LS LibraryPackage CM CNM?F@ ; FC<L;LS
Element ;M ;L? ;FF Elements NB;N ;L? >CL? =NFS IL CH>CL? =NFS =IHN;CH?> CH CN

General Classes

- ;=E;A?

; <MNL;=N MSHN;R M?? ;FMI IH NB? P;LCIOM ECH>M I@ =IHMNL;CHNM CH NB? ; <MNL;=N MSHN;R >>CNCIH;FFS INB?L
M?G;HNC= =IHMNL;CHNM L?KOCL? L?F;NCIHMB CJM <?NQ??IHr 4 8Q 4 2 4 €; Ĩ GIđ ??GŸŁ HŸ? 4 žr NI Ńi b ` ŃDe0Ÿ" @§E

Semantic Constraint	Implied Relationship	Target
checkFeatureValuation Specialization	Subsetting	1B?



] /; :/->;A:O CM NLO? C@ NB? @CLMN M?KO?H=? B;M NB? M?=IH> ;M B?;> NB? @IOLNB ;M N;CF ;H> NB? NBCL> ?F?G?HN
CH <?NQ??H

? ? <

```
1B?      checkFeatureSpecialization
```


<-4? ?0 2 2



Semantic Constraint	Implied Relationship	



Notes

composite feature b : C subsets

```
...  
end feature
```


connector

```
step s subsets Performances::performances {  
  step s1 subsets Performances::Performance::enclosedPerformance;  
  composite step
```



```
        x > 0  
    }
```

8.4.4.8.2 Expressions and Invariants

Expressions

QB?L? NB?M? InvocationExpressions ;L? NB?H M?G;HNC=;FFS CHN?LJL?N?> ;M>?M=LC<?> ;<IP?

1B?

QB?L? *src* CM ;H Expression M?G;HNC=;FFS ?KOC?;F?HN NI NB? Expression

```
expr : ControlFunctions::'.' subsets Performances::evaluations {  
  feature redefines ControlFunctions::'.'::source = src {  
    feature redefines ControlFunctions::'.'::source::target  
    redefines f;  
  }
```

```
class C {  
    metadata M;  
}
```

```
QIOF> ?P;FO;N? NI NQI Metaobjects: ;H CHMN;H=? I@ NB? Metaclass ML?JL?M?HNCHA NB? MetadataFeature  
;HHIN;NCIH IH C ;H> ;H CHMN;H=? I@ KerML::Class
```

8.4.4.10.1 Interactions

H

CM J;LM?> QCNB i : T ;M ;H ItemFeature ;H> B;PCHA NQI ItemFlowEnds IH? L?@?L?H=CHA f1 QCNB ;H IQH?>
#?;NOL? L?>?@CHCHA f1_out ;H> IH? L?@?L?H=CHA f2 QCNB ;H IQH?> #?;NOL? L?>?@CHCHA f2_in

BindingConnector

Multiplicity B;M ; P;FO? @IL ?;=B CHMN;H=? I@ NB? featuringType NB;N CM NB? =;L>CH;FCNS I@ NB? CHMN;H=?M I@ CNM
IQHCHA Feature NB;N ;L? @?;NOL?> <S NB;N M;G? CHMN;H=? I@ NB? featuringType

```
classifier C1 {  
  feature f {  
    // Implied TypeFeaturing by C2.  
    // Gives the cardinality of the values of
```

Note. 1B? (?L *) N?RNO;F HIN;NCTH AL;GG;L IHFS ;FFIQM LiteralExpressions ;H>
FeatureReferenceExpressions ;M NB? bound Expressions CH ; MultiplicityRange M?? _____
%IQ?P?L NB? ;<MNL;=N MSHN;R ;FFIQM ;L<CNL;LS Expressions M?? _____

1B? checkMultiplicityRangeExpressionTypeFeaturing =IHMNL;CHN L?KOCLM NB;N NB? bound Expressions I@
; MultiplicityRange B;P? NB? M;G? featuringTypes ;M NB? MultiplicityRange 1B? featuringTypes I@
; MultiplicityRange ;L? >N?LGCH?> <S NB? checkMultiplicityTypeFeaturing =IHMNL;CHN _____ &@

<? NL?;N?> ;M C@ NB? L?@F?=-NCP? Metaclasses I@ CNM annotatedElements Q?L? CNM featuringTypes &H NBCM =;M?
NB? MetadataFeature >?@CH?M ; G;J @LIG CNM annotatedElements ;M CHMN;H=?M I@ NB?CL Metaclasses NI ;
MCHAF? CHMN;H=? I@ NB? metaclass I@ NB? MetadataFeature

#OLNB?L ; GI>?F F?P?F ?P;FO;<F?

9 Model Libraries

9.1 Model Libraries Overview

9;OI8 85.>->E CM ; =IFF?=NCIH I@ FC<L;LS GI>?FM NB;N =;H <? L?OM?> ;=LIMM G;HS OM?L GI>?FM (?L *) CH=FO>?M NBL?? MN;H>;L> GI>?F FC<L;LC?M NB? O?G;HNC=)C<L;LS M?? NB? !;N; 1SJ?)C<L;LS M?? ;H> NB? #OH=NCIH)C<L;LS M?? " ;=B FC<L;LS GI>?F CH NB?M? MN;H>;L> GI>?F FC<L;LC?M =IHMCNM I@ ; MCHAF? LIIN H;G?MJ;=? QCNB IH? NIJ F?P?F ?F?G?HN NB;N CM ; MN;H>;L> FC<L;LS J;=E;A? QCNB HI MO<J;=E;A?M FF I@ NB?M? FC<L;LS GI>?FM ;L? >?M=LC<?> @IL L?@?L?H=? CH MO<=F;OM?M I@ NBCM =F;OM?

1B? HILG;NCP? G;=BCH? L?;>;<F? L?JL?M?HN;NCIH @IL ?;=B I@ NB?M? GI>?F FC<L;LC?M CM ; JLIID?=N CHN?L=B;HA? @CF? @ILG;NN?> ;==IL>CHA NI NB? MN;H>;L> @IL ?

Constraints

+ IH?

9.2.2.2.4 exactlyOne

Element

* OFNCJFC=CNS / ;HA?

Description

exactlyOne CM ; MultiplicityRange L?KOCLCHA ; =;L>CH;FCNS I@ ?R;=NFS IH?

General Types

H;NOL;FM

Features

+ IH?

Constraints

+ IH?

9.2.2.2.5 naturals

Element

#?;NOL?

Description

General Types

+ ;NOL;F
>;N; 3 ;FO?M

Features

+ IH?

Constraints

+ IH?

9.2.2.2.6 oneToMany

Element

* OFNCJFC=CNS / ;HA?

Description

General Types

H;NOL;FM

Features

+ IH?

Constraints

+ IH?

9.2.2.2.9 zeroToMany

Element

* OFNCJFC=CNS / ;HA?

Description

zeroToMany

MMI=C;NCIH

Description

CH;LS)CHE CM ;)CHE QCNB ?R;=NFS NQI J;LNC=CJ;HN #?;NOL?M <CH;LS MMI=C;NCIH FF INB?L <CH;LS ;MMI=C;NCIHM CH
FC<L;LC?M IL OM?L GI>?FM MJ?=C;FCT? CN >CL?=NFS IL CH>CL?=NFS

General Types

)CHE

Features

J;LNC=CJ;HN HSNBCHA UL?>?@CH?M J;LNC=CJ;HN IL>?L?> HIHOHCKO?W

1B? J;LNC=CJ;HNM I@ NBCM CH;LS)CHE QBC=B ;L? L?MNLG=N?> NI <? ?R;=NFS NQI

MIOL=? HSNBCHA UMO<M?NM J;LNC=CJ;HNW

1B? J;LNC=CJ;HN NB;N CM NB? MIOL=? I@ NBCM CH;LS)CHE

N;LA?N HSNBCHA UMO<M?NM J;LNC=CJ;HNW

1B? J;LNC=CJ;HN NB;N CM NB? N;LA?N I@ NBCM CH;LS)CHE

NI OIOL=?M HSNBCHA 8 9

1B? ?H> #?;NOL? I@ NBCM CH;LS)CHE =ILL?MJ IH>CHA NI NB? sourceParticipant

NI 1;LA?NM HSNBCHA 8 9

1B? ?H> #?;NOL? I@ NBCM CH;LS)CHE =ILL?MJ IH>CHA NI NB? targetParticipant

Constraints

+ IH?

9.2.3.2.2 binaryLinks

Element

#?;NOL?

Description

8HI H;G?9 HSNBCHA

8HI H;G?9 HSNBCHA

Constraints

+ IH?

9.2.3.2.3 Link

Element

MMI=C;NCIH

Description

)CHE CM NB? GIMN A?H?L;F MMI=C;NCIH * CHMN;H=? I@ * MMI=C;NCIH FF INB?L MMI=C;NCIHM CH FC<L;LC?M IL OM?L
GI>?FM MJ?=C;FCT? CN >CL?=NFS IL CH>CL?=NFS OJ?=C;FCT;NCIHM I@)CHE ;L? >IG;CHM I@ #?;NOL?M MO<M?NNCHA

Constraints

+IH?

9.2.3.2.5 SelfLink

8HI H;G?9 HSNBCHA

8HI H;G?9 HSNBCHA

Constraints

+ IH?

9.2.4 Occurrences

9.2.4.1 Occurrences Overview

Occurrences

1BCM FC<L;LS ;>>M ; GI>?F I@ NBCHAM ?RCMNCHA CH NC G? ;H> MJ;=? MN;LNCHA QCNB *Occurrence* NB? GIMN A?H?L;F F;MM
M?? QBC=B =F;MMC@C?M A:E@45:3 NB;N N;E?M OJ NC G? ;H> MJ;=? ;H> *occurrences* NB? GIMN A?H?L;F #?;NOL?
NSJ?> ?RCMN;ES RH NCCCHA CH NC G? ~~hcccha~~ n;LN;MN ;H> MJ;=? ;H>M OJ ~~h~~ MN?FA @ ~~D~~ ~~Ch~~ \$P 4 ~~ca~~ d

Time and Space Slices

10G? MFC=?M ;L? *portions*

Description

%;JJ?HM ?@IL? CM ; 4 CNBION ;MMI=C;NCIH FCHECHA ;H earlierOccurrence NI ; laterOccurrence CH>C=;NCHA NB;N

?;LFC?L , ==OLL?H=? , ==OLL?H=? UL?>?@CH?M ?;LFC?L , ==OLL?H=?W

F;N?L , ==OLL?H=? , ==OLL?H=? UL?>?@CH?M F;N?L , ==OLL?H=?W

Constraints

+ IH?

9.2.4.2.5 HappensLink

Element
$$\text{MMI}=\text{C};\text{NCIH}$$

Description

```
% ;JJ?HM) CHE CM NB? G IMN A?H?L;F ;MMI=C;NCIH NB;N ;MM?LNM N?GJIL;F L?F;NCIHMBJCM <?N?H ; sourceOccurrence ;H>
; targetOccurrence 1B?S =;HHIN B;JJ?H CH NC?G? <? ;=OLL?H=?M G;ECHA NB?G >CMDICHN QCNB ) CHE , <?N
```

General Types

CH;LS)CHE

Features

B;JJ?HMOIOL1?;LFC?L,==OLL?H1>. .H?.NCH;FANC?L,=4DB&ù-OL1?;LFOLMMOLL?H1>. .H?.NCH;FANOLMMDB&ùs

Features

CM/OH1I IGJF?NCIH IIF?;H

! ?N?LGCH?M QB?NB?L 1L;HMCNCIH-?L@ILG;H=?M =IGJIM?> OH>?L runToCompletionScope =;H B;JJ?H >OLCHA
ON;N?- ?L@ILG;H=? entry -?L@ILG;H=?M =IGJIM?> OH>?L NBCM , ==OLL?H=?

DOMN , ONMC>? , @ , ==OLL?H=?M , ==OLL?H=? 8 9 UMO<M?NM IONMC>? , @ , ==OLL?H=?MW

, ==OLL?H=?M NB;N B;P? HI MJ;=? <?NQ??H MIG? I@ NB?CL MJ;=? MFC=?M ;H> MIG? MJ;=? MFC=?M I@ NBCM I==OLL?H=?

FI=;F FI=E FI=E

FI=;F Clock NI <? OM?> ;M NB? =ILL?MJIH>CHA NCG? L?@?L?H=? @IL NBCM Occurrence ;H> <S>?@;OFN ;FF
ownedOccurrences S>?@;OFN NBCM CM NB? MCHAF?NIH Clocks::universalClock

G;NCHA , ==OLL?H=?M , ==OLL?H=? 8 9 UMO<M?NM DOMN , ONMC>? , @ , ==OLL?H=?MW

, ==OLL?H=?M NB;N B;P? HI MJ;=? <?NQ??H NB?HYS-^ſ_ſſ^ſ, ;H> MIG?S^ſ_ſſNBCOLL?H 9 UMO<M?NM DOMN , OOMC>? , @ , ==OLLNBCOLL?H , ==OLL?H=?M 36

1L;HM@?LM @IL QBC=B NBCM , ==OLL?H=? CM NB? sourceParticipant

IONMC>? , @ , ==OLL?H=?M , ==OLL?H=? 8 9 UMO<M?NM QCNBION , ==OLL?H=?MW

, ==OLL?H=?M NB;N ;L? =IGJF?N?FS M?J;L;N? @LIG NBCM IH? CH MJ;=? HIN H?=?MM;LCFS CH NC? M?? successors ;H>
predecessors

JILNCIH , @ , ==OLL?H=? 8 9 UMO<M?NM QCNBCHW

FF I==OLL?H=?M NB;N NBCM IH? CM within

1B? =IHN?RN ,==OLL?H=? QCNBCH QBC=B NBCM ,==OLL?H=? N;E?M JF;=? S >?@;OFN CN CM NBCM ,==OLL?H=? CNM?F@
%IQ?P?L NBCM CM IP?LLC>>?H @IL ownedPerformances

NBCHAM
, ==OLL?H=?

Features

+ IH?

Constraints

+ IH?

9.2.4.2.15 OutsideOf

Element

- ILNCTH, @ CM ; 4 CNBCH NB;N PCHEM CM

0;G? ;M NB? MIOL=? - ;LNC=CJ;HN QB?H CN CM ;H I==OLL?H=?

General Types

OJ;=?OFC=? , @

Features

MJ;=?OBIN , ==OLL?H=? , ==OLL?H=? UL?>?@CH?M MJ;=?OFC=? , ==OLL?H=?W

1B? J;LNC=CJ;HN CH NBCM OJ;=?OBIN , @)CHE NB;N CM NB? spaceSliceOccurrence

MJ;=?OBIN , @ , ==OLL?H=? 8 9 UMO<M?NM MJ;=?OFC=? , @W

FF spaceSlicesOf NBCM , ==OLL?H=? NB;N ;L? I@ ; BCAB?L innerSpaceDimension NB;H NBCM , ==OLL?H=?

MJ;=?OBINN?> , ==OLL?H=? , ==OLL?H=? UL?>?@CH?M MJ;=?OFC=?> , ==OLL?H=?W

1B? J;LNC=CJ;HN CH NBCM OJ;=?OBIN , @)CHE NB;N CM NB? spaceSliced Occurrence

Constraints

+ IH?

9.2.4.2.20 SpaceSliceOf

Element

MMI=C;NCIH

Description

OJ;=?OFC=? , @CM ; - ILNCIH , @ NB;N FCHEM CNM spaceSliceOccurrence NI CNM spaceSlicedOccurrences spaceSliceOccurrence S @H

9.2.4.2.21 SurroundedBy

Element

MMI=C;NCIH

Description

1B? J;LNC=CJ;HN CH NBCM 1CG?OFC=? , @)CHE NB;N CM NB? portionOccurrence

Constraints

+ IH?

9.2.4.2.23 Within

Element

MMI=C;NCIH

Description

4 CNBCH =F;MMC@C?M ;FF ;H> IHFS FCHEM NB;N ;L? %;JJ?HM !OLCHA ;H> &HMC>? , @ 1B?S FCHE NB?CL largerOccurrence NI
NB?CL smallerOccurrence CH>C=;NCHA NB? largerOccurrence

%;JJ?HM 4 BCF?
4 CNBCH

Features

MJ;=?1CG? ICH=C>?HN,==OLL?H=?M,==OLL?H=? 8 9 UMO<M?NM NCG? ICH=C>?HN,==OLL?H=?M QCNBCHW
,==OLL?H=?M NB;N NBCM IH? =IGJF?N?FS CH=FO>?M CH <INB MJ;=? ;H> NCG? CH=FO>CHA NBCM IH?
NB;N,==OLL?H=? ,==OLL?H=? UL?>?@CH?M F;LA?L,==OLL?H=?W
NBCM,==OLL?H=? ,==OLL?H=? UL?>?@CH?M MG;FF?L,==OLL?H=?W

Constraints

+ IH?

9.2.4.2.25 Without

Element

MMI=C;NCIH

Description

4 CNBION =F;MMC@C?M ;FF FCHEM NB;N ;L? %;JJ?HM !OLCHA IL &HMC>? , @ IL <INB 1B?S FCHE NB?CL separateOccurrenceToo
NI NB?CL separateOccurrence CH>C=;NCHA NB;N NB? ,==OLL?H=?M>I HIN IP?LF;J CH NCG? ;H> IL MJ;=? HI @IOL
>CG?HMCIH;F JICHN CM CH <INB ,==OLL?H=?M 1BCM G?;HM HI ,==OLL?H=? CM 4 CNBION CNM?F@

General Types

CH;LS)CHE

Features

M?J;L;N? ,==OLL?H=? ,==OLL?H=? UL?>?@CH?M N;LA?NW

M?J;L;N? ,==OLL?H=? 1 II ,==OLL?H=? UL?>?@CH?M MIOL=?W

QCNBION,==OLL?H=?M,==OLL?H=? 8 9 UMO<M?NM NIOIOL=?MW

FF,==OLL?H=?M NB;N ;L? successors successorsoutsideOf I@ NBCM IH?

Constraints

+ IH?

9.2.5 Objects

9.2.5.1 Objects Overview

#.6I/ℓ? ;L? #//A>>I:/I?

Description

General Types

)CHE , <D?= \mathbb{N}
CH;LS)CHE

Features

Features

CHH?LOJ;=? !CG?HMCIH &HN?A?L UL?>?@CH?M CHH?LOJ;=? !CG?HMCIHW

Constraints

+ IH?

9.2.5.2.4 Curve

Element

ONLO=VOL?

Description

, <D?=NM I@

1B? structuredSpaceObjectCells I@ innerSpaceDimension CH NBCM ONLO=VOL?>0J;=? , <D?=@

Constraints

+IH?

9.2.5.2.11 Surface

Element

ONLO=VOL?

Description

, <D?=@ I@ innerSpaceDimension

General Types

, <D?=@

Features

A?HOM &HN?A?L 8 9

1B? HOG<?L I@ BIF?M CH NBCM OOL@;=? ;MMOGCHA CN

50 I>-8 EB-8A-05; : ? ; L? EB-8A-05; : ?

?P;FO;NCIHM

Features

+ IH?

Constraints

+ IH?

9.2.6.2.3 Evaluation

Element

#OH=NCIH

Description

H "P;FO;NCIHM CM ; - ?L@ILG;H=? NB;N ?H>M QCNB NB? JLI>O=NCIH I@ ; L?MOFN

General Types

- ?L@ILG;H=?

Features

)CN?L;F"P;FO;NCIH CM ; MJ?=C;FCT;NCIH I@ "P;FO;NCIH @IL NB? =;M? I@)CN?L;F"RJL?MMCIHM

General Types

"P;FO;NCIH

Features

L?MOFN ! ;NF@3FO;AIU?M?LOIHMOIOMOFN W&dYB ` B?=?MOFN @)B?M ;CN?L;F"P;FO;NCIH JIQ?MC2CM ; F[] ; MJ9HAF =;NF@3FO;AN q& uPaT,` B '

\$%&'()*+,-./:;<=>?@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 « ¬ ® ¯ ° ± ² ³ ´ µ ¶ · ¸ ¹ º » ¼ ½ ¾ ¿ À Á Â Ã Ä Å Æ Ç È É Ê Ë Ì Í Î Ï Ñ Ò Ó Ô Õ Ö × Ø Ù Ú Û Ü Ý Þ ß à á â ã

enclosedPerformances

Constraints

+IH?

9.2.6.2.16 trueEvaluations

Element

IIF?;H"RJJ?MMCIH

Description

trueEvaluations CM ; MO<M?N I@ booleanEvaluations

! 1??-31'>- :?2I>? ;L? '>- :?2I>? NB;N >I HIN B;P? NB? ;>>CNCIH;F =;J;<CFCNC?M I@ #FIQ1L;HM@?LM &1:0\$I>2;>9- :/1?
;H> A//1<I\$1>2;>9- :/1? ;L? \$1>2;>9- :/1?

#FIQ1L;HM?L CM ; 1L;HM?L C>?HNC@SCHA ;H IONJON @?;NOL? I@NB? source NI JC=E OJ CN?GM @LIG ;H> ;H CHJON @?;NOL?
I@NB? target

Description

General Types

NL;HM@?LM
#FIQ1L;HM@?L

Features

8HI H;G?9 , ==OLL?H=?

8HI H;G?9 , ==OLL?H=?

Constraints

+ IH?

9.2.7.2.5 flowTransfersBefore

Element

#?;NOL?

Description

General Types

NL;HM@?LM ?@IL?
#FIQ1L;HM@?L ?@IL?

Features

8HI H;G?9 , ==OLL?H=?

8HI H;G?9 , ==OLL?H=?

Constraints

+ IH?

9.2.7.2.6 MessageTransfer

Element

$$\&HN?L;=NCIH$$

Description

* 2MM;A?1L;HMc?L CM ; 1L;HMc?L NB;N>I?M HIN MJ?=?CS O ,==OLD. a,`E6 4 PöB j=(A ?" `B,ÖA

Features

8HI H;G?9 ,==OLL?H=?

8HIH,G?59,BHDJfKsEe

Constraint000 687.4260 TdF6 1TdF6 10.0000 4 901483B442B49F48F0CF>TjETBT72.0000594.5332 10.0019 10.0000 Tf9.2.7.2.7

Description

Constraints

+IH?

9.2.8.2.2 BooleanEvaluationResultToMonitorPerformance

Element

Description

?B;PCIL

Description

H "P;FO;NCIH / ?MOFN * IHCNIL-?L@ILG;H=? CM ; #?;NOL? * IHCNIL-?L@ILG;H=? NB;N Q;CNM @IL=B;HA?M CH result I@ ;H
"P;FO;NCIH C>?HNC@C?> <S onOccurrence

Constraints

Features

?FM? F;OM? ,==OLL?H=? 8 9

ConstraintsTypes

+ IH?

9.2.9.2.3 IfPerformance

Element

?B;PCIL

GeneralTypes

H &@-?L@ILG;H=? CM ; -?L@ILG;H=? NB;N >?N?LGCH?M QB?NB?L NB? if "P;FO;NCIH result CM NLO? <S QB?NB?L NB?
ifTrue =IHH?=NIL B;M ; P;FO?

General Types

-?L@ILG;H=?\$3 e# M N# ;M ?a F%9% RP& ö ; D#% ``?LBQ a & 4 2Q% ` B M s d#À

9.2.9.2.5 IfThenPerformance

Element

?B;PCIL

Description

H &@ 1B?H-?L@ILG;H=? CM ;H &@ -?L@ILG;H=? QB?L? then I==OLM ;@N?L ;H> IHFS ;@N?L NB? if "P;FO;NCIH result CM NLO?

General Types

&@ -?L@ILG;H=?

Features

NB?H F;OM? ,==OLL?H=? 8 9

Constraints

+ IH?

9.2.9.2.6 LoopPerformance

Element

?B;PCIL

Description

) I I J -?L@ILG;H=? CM ; -?L@ILG;H=? QB?L? body I==OLM L?J?;N?>FS CH M?KO?H=? CN?L;N?M ;M FIHA ;M NB? while ?P;FO;NCIH L?MOFN CM NLO? <?@IL? ?;=B CN?L;NCIH ;H> ;@N?L NB? JL?PCIOM IH? ?R=?JN NB? @CLMN NCG? ;H> NB?

9.2.9.2.7 MergePerformance

J NSJ?> <S ;H MMI=C;NCIH >?@CH?> NI ACP? ; P;FO? NI NB? *transitionLinkSource* I@

NLCAA?L1;LA?N ,==OLL?H=?

Constraints

+IH?

9.2.11 State Performances

9.2.11.1 State Performances Overview

1B? &@-@I\$I>2;>9-:/I J;=E;A?=IHN;CHM ; FC<L;LS GI>?F @IL NB? M?G;HNC=M I@ MN;N? <;M?> <?B;PCIL CH=FO>CHA
&@-@I\$I>2;>9-:/I? ;H> &@-@I '>-: ?5@5;: \$I>2;>9-:/I?

The *trigger*


```

>?@?LL;<F? * ?MM;A?1L;HM@?L 8 9 UMO<M?NM ;==?JN;<F?W

>I - ?L@ILG;H=? UMO<M?NM GC>>F?W

?HNLS - ?L@ILG;H=? UMO<M?NM NCG?"H=FIM?> , ==OLL?H=?MW

?RCN - ?L@ILG;H=? UMO<M?NM NCG?"H=FIM?> , ==OLL?H=?MW

CH=IGCHA1L;HMCNCIH1LCAA?L * ?MM;A?1L;HM@?L 8 9

1L;HM@?L NB;N NLCAA?L?> ; NL;HMCNCIH CHNI NBCM MN;N? J?L@ILG;H=?

CM1LCAA?L !OLCHA IIF?;H

GC>>F? - ?L@ILG;H=? 8 9 UMO<M?NM NCG?"H=FIM?> , ==OLL?H=?M OHCIHW

HIH ! I * C>>F? - ?L@ILG;H=? 8 9 UMO<M?NM GC>>F?W

```

Constraints

+IH?

9.2.11.2.2 StateTransitionPerformance

Element

?B;PCIL

Description

General Types

1L;HMCNCIH - ?L@ILG;H=?

Features

```

;==?JN;<F? * ?MM;A?1L;HM@?L 8 9 UMO<M?NM NLCAA?L1;LA?N CH=IGCHA1L;HM@?LM1IO?F@
NL;HMCNCIH)CHEOIOL=? ;==?JN;<F?W

CM1LCAA?L !OLCHA IIF?;H

NL;HMCNCIH)CHEOIOL=? ON;N? - ?L@ILG;H=? UL?>?@CH?M NL;HMCNCIH)CHEOIOL=?W

NL;HMCNCIH)CHEOIOL=? ;==?JN;<F? * ?MM;A?1L;HM@?L 8 9

NL;HMCNCIH)CHEOIOL=? ;==?JN?> * ?MM;A?1L;HM@?L 8 9

NL;HMCNCIH)CHE1;LA?N , ==OLL?H=? 8 9

NLCAA?L * ?MM;A?1L;HM@?L 8 9 UMO<M?NM ;==?JN;<F? NL;HMCNCIH)CHEOIOL=? ;==?JN?> L?>?@CH?M NLCAA?LW

NLCAA?L1;LA?N CH=IGCHA1L;HM@?LM1IO?F@ 1L;HM@?L 8 9

```

Constraints

Constraints

+IH?

9.2.12.2.3 BasicTimeOf

Element

#OH=NCIH

Description

BasicTimeOf L?NOLHM NB? *TimeOf* ;H *Occurrence* ;M ; *Real* HOG<?L L?F;NCP? NI ; *BasicClock*

General Types

NCG?#FIQ IHMNL;CHN

1B? *currentTime* I@ ; MH;JMBIN I@ ; *Clock* CM ?KO;F NI NB? *TimeOf* NB? MH;JMBIN L?F;NCP? NI NB;N *Clock*

9.2.12.2.5 DurationOf

Element

I , =OL

?B;PCIL

Description

;H=?F ;FF I<M?LP;NCIHM I@ ; ACP?H *ChangeSignal* @IL ; ACP?H

ONLO=NOL?

Description

ChangeSignal CM ; MCAH;F NI <? M?HN QB?H NB? *Boolean* L?MOFN I@ CNM *changeCondition* "RJL?MMCIH =B;HA?M @LIG @;FM? NI NLO?

General Types

, <D?=@

Features

" ;=B *Performance I@ ObserveChange Q* ;CNM @IL NB? L?MOFN I@ NB? *Boolean changeCondition I@* ; ACP?H *ChangeSignal NI* =B;HA? @LIG @;FM? NI NLO? ;H> QB?H CN >I?M M?H>M NB? *ChangeSignal NI* ; ACP?H I<M?LP?L *Occurrence*

General Types

- ?L@ILG;H=?

Features

=B;HA? , <M?LP?L , ==OLL?H=?

=B;HA?OCAH;F B;HA?OCAH;F

NL;HM@?L 1L;HM@?L ?@IL? 8 9

@N?L Q;CNCHA @IL NB? =IH>CNCIH =B;HA? C NB@?@qM?H CNH>M 3h 't'0%o ẽ` pRs ẽNI >3h @S9%o ẽ€ ẽNN. b I• ẽ4 € & ẽÄ ẽ

FeadiisraintTjETBT72.00072252890 TdF6 10.0000 Tf2D3FB83E43F TjETBT72.0000356.99.8.994766.0000 Tf0 6ce

ChangeSignal\$ 4 € =p 3đ· E@ ẽ n hE@ ẽ h iTm ẽcˆ E@ ẽ P D5 ẽ n hD5 ẽB M C' ẽ ẽ(C' ẽ Y\$!ˆ ẽY#\$98B@7O9B-?>Cb b5 Tm

9.2.14 Triggers

9.2.14.1 Triggers Overview

1BCM J;=E;A? =IHN;CHM @OH=NCIHM NB;N L?NOLH *ChangeSignals* @IL NLCAA?LCHA QB?H ; *Boolean*=IH>CNCIH =B;HA?M
@LIG @;FM? NI NLO? ;N ; MJ?=C@C= NCG? IL ;@N?L ; MJ?=C@C= NCG? >?F;S

9.2.14.2 Elements

9.2.14.2.1 TimeSignal

Element

ONLO=\VOL?

Description

TimeSignal CM ; *ChangeSignal*

"P;FO;NCH

Features

=FI=E FI=E

1B?

9.2.15.2 Elements

9.2.15.2.1 CartesianCurrentDisplacementOf

Element

JICHN - ICHN T'20 4 2M 24 2

Description

defaultFrame CM ; @CR?> *SpatialFrame* OM?> ;M ; OHCP?LM;F >?@;OFN

General Types

OJ ;NC;F#L;G?


```
(point1.spaceTimeEnclosedOccurrences->includes(point2) or  
point2.spaceTimeEnclosedOccurrences->includes(point1)) implies  
  isZeroVector(displacementVector)
```


Description

metaobjects CM ; MJ?=C;FCT;NCIH I@ objects

```
G?N;=F;MM @LIG NB? * , # GI>?F CM G;JJ?> CHNI ; Metaclass CH NB? ( ?L * ) J;=E;A?  
p 1B? * , # G?N;=F;MM H;G? CM G;JJ?> OH=B;HA?>  
p $?H?L;FCT;NCIHM I@ NB? * , # G?N;=F;MM ;L? G;JJ?> NI ownedSpecializations  
p FF JLIJ?LNC?M @LIG NB? * , # G?N;=F;MM ;L? G;JJ?> NI
```


/ ;NCIH;F

Features

+IH?

Constraints

+IH?

9.3.2.2.4 Natural

Element

! ;N;1SJ?

Description

+ ;NOL;F CM NB? NSJ? I@ HIH H?A;NCP? CHN?A?LM ?RN?H>?> QCNB ; P;FO? @IL JIMCNCNP? CH@CHCNS

General Types

! ;N;3 ;FO?
&HN?A?L

Features

+IH?

Constraints

+IH?

9.3.2.2.5 Number

Element

! ;N;1SJ?

Description

! ;N;1SJ?+IH?

9.3.2.2.6 NumericalValue

Element

! ;N; 1SJ?

Description

HSNBCHA

Features

?F?G?HNM HSNBCHA 8 9 UHIHOHCKO?W

Constraints

+ IH?

9.3.3.2.4 KeyValuePair

Element

! ;N; 1SJ?

Description

(?S 3 ;FO? - ;CL CM ;H ;<MNL;=N ! ;N; 1SJ? NB;N L?JL?M?HNM ; NOJF? I@ ; key ;H> ;H ;MMI=C;N?> P;FO? val

General Types

! ;N; 3 ;FO?

Features

E?S HSNBCHA

P;F HSNBCHA

Constraints

+ IH?

9.3.3.2.5 List

Element

! ;N; 1SJ?

Description

0?KO?H=? CM ; P;LC; <F? MCT? IFF?=NCIH I@ QBC=B NB? elements ;L? HIHOHCKO? ;H> IL>?L?>

General Types

, L>?L?> IFF?=NCIH

Features

+ IH?

Constraints

+ IH?

9.3.3.2.6 Map

Element

! ;N; 1SJ?

Description

* ;J CM ; P;LC; 4 650 IF 6P #;0Că

1B? IL>?LCHA G;S <? <S E?S I@ NB? (?S3 ;FO?- ;CL ?F?G?HNM IL <S IL>?L I@ =IHMNLO=NCIH IL ;HS INB?L G?NBI> 1B?
?MM?HNC;F ;MJ?=N CM NB;N IL>?LCHA CM G;CHN;CH?> ;H> AO;L;HN?> ;=LIMM :==?MM?MNI NB? ,L>?L?> * ;J

General Types

* ;J
,L>?L?> IFF?=NCIH

Features

?F?G?HNM (?S3 ;FO?- ;CL 8 9 UL?>?@CH?M IL>?L?>W

Constraints

+IH?

9.3.3.2.9 OrderedSet

Element

! ;N;1SJ?

Description

H ,L>?L?>O?N CM ; P;LC;<F? MCT? IFF?=NCIH 8 NB? elements ;H> IL>?L?>

General Types General Types

,L>?L?> IFF?=NCIH
2HCKO? IFF?=NCIH

Features

?F?G?HNM HSNBCHA 8 9 UL?>?@CH?M ?F?G?HNM IL>?L?>W

Constraints

+IH?

9.3.3.2.10 Set

Element

! ;N;1SJ?

Description

O?N CM ; P;LC;<F? MCT? IFF?=NCIH I@ QBC=B NB? elements ;L? OHCKO? ;H> OHIL>?L?>

9.3.4.2.2 CartesianVectorValue

Element

NB?CL ;JJFC=;NCIHM QBC=B =;H

```

abstract function 'all'{
    return : Object[0..*];
}

abstract function 'istype'{
    in seq: Anything[0..*];
    abstract feature 'type': Anything;
    return : Boolean[1];
}

abstract function 'hastype'{
    in seq: Anything[0..*];
    abstract feature 'type': Anything;
    return : Boolean;
}

abstract function '@'{
    in seq: Anything[0..*];
    abstract feature 'type': Anything;
    return : Boolean[1];
}

abstract function '@@'{
    in seq: Metaobject[0..*];
    abstract feature 'type': Metaobject;
    return : Boolean[1];
}

abstract function 'as'{

```

```
    { in x: DataValue[1]; in y: DataValue[1]; return : DataValue[1]; }  
abstract function '**'  
    { in x: DataValue[1]; in y: DataValue[1]; return : DataValue[1]; }  
abstract function '^'  
    { in x: DataValue[1]; in y: DataValue[1]; return : DataValue[1]; }  
abstract function '%'
```


9.4.6.1 String Functions Overview

```
abstract function '**' specializes ScalarFunctions::'**'  
  { in x: NumericalValue[1]; in y: NumericalValue[1];
```



```
function '<' specializes NumericalFunctions::'<'
  { in x: Real[1]; in y: Real[1]; return : Boolean[1]; }
function '>' specializes NumericalFunctions::'>'
  { in x: Real[1]; in y: Real[1]; return : Boolean[1]; }
function '<=' specializes NumericalFunctions::'<='
  { in x: Real[1]; in y: Real[1]; return : Boolean[1]; }
function '>=' specializes NumericalFunctions::'>='
  { in x: Real[1]; in y: Real[1]; return : Boolean[1]; }

function max specializes NumericalFunctions::max
  { in x: Real[1]; in y: Real[1]; return : Real[1]; }
function min specializes NumericalFunctions::min
```


9.4.12.2 Elements

```
function '+' specializes IntegerFunctions:: '+'
  { in x: Natural[1]; in y: Natural[0..1]; return : Natural[1]; }
function '*' specializes IntegerFunctions:: '*'
  { in x: Natural[1]; in y: Natural[1]; return : Natural[1]; }
function '/' specializes IntegerFunctions:: '/'
  { in x: Natural[1]; in y: Natural[1]; return : Natural[1]; }
function '%' specializes IntegerFunctions:: '%'
  { in x: Natural[1]; in y: Natural[1]; return : Natural[1]; }

function '<' specializes IntegerFunctions:: '<'
  { in x: Natural[1]; in y: Natural[1]; return : Boolean[1]; }
function '>' specializes IntegerFunctions:: '>'
  { in x: Natural[1]; in y: Natural[1]; return : Boolean[1]; }
function '<=' specializes IntegerFunctions:: '<='
  { in x: Natural[1]; in y: Natural[1]; return : Boolean[1]; }
function '>=' specializes IntegerFunctions:: '>='
  { in x: Natural[1]; in y: Natural[1]; return : Boolean[1]; }

function max specializes IntegerFunctions:: 6730IntegerFunctions:: '<='
  { in x: Nat2474ural[1]; in
```

```
return : UnitBoundedReal[1];  
}
```


9.4.16.2 Elements

```
abstract function isZeroVector {
  doc
  /*
   * Return whether a VectorValue is a zero vector.
   */

  in v: VectorValue[1];
  return : Boolean[1];
}

abstract function '+' specializes DataFunctions::'+' {
  doc
  /*
   * With two arguments, returns the sum of two VectorValues.
   * With one argument, returns that VectorValue.
   */

  in v: VectorValue[1];
  in w: VectorValue[0..1];
  return u: VectorValue[1];
  inv zeroAddition { w == null or isZeroVector(w) implies u == w }
  inv commutivity { w != null implies u == w + v }
}

abstract function '-' specializes DataFunctions::-'-' {
  doc
  /*
   * With two arguments, returns the difference of two VectorValues.
   * With one arguments, returns the inverse
   * of the given VectorValue, that is, the VectorValue that,
   * when added to the original VectorValue, results in
   * the zeroVector.
   */

  in v: VectorValue[1];
  in w: VectorValue[0..1];
  return u: VectorValue[1];
  inv negation { w == null implies isZeroVector(v + u) }
  inv difference { w != null implies v + u == w }
}

abstract function sum0 {
  doc
  /*
   * Return the sum of a collection of VectorValues.
   * If the collection is empty, return a given zero vector.
   */

  in coll: VectorValue[*] nonunique;
  in zero: VectorValue[1];
  inv precondition { isZeroVector(zero) }
```



```
doc
/*
 * Construct a NumericalVectorValue whose elements are a
 * non-empty list of component NumericalValues.
 * The dimension of the NumericalVectorValue is equal to
 * the number of components.
 */

in components: NumericalValue[1..*] ordered nonunique;
```

```
in v: NumericalVectorValue[1];
in w: NumericalVectorValue[1];
return x: NumericalValue[1];
inv commutivity { x == inner(w, v) }
inv zeroInner { isZeroVector(v) or isZeroVector(w) implies isZero(x) }
}
```



```
in w : CartesianVectorValue[1];
```

```

    in expr secondValue[0..1] { return : Boolean[1]; }
    return : Boolean[1];
}

function 'implies'{
  in firstValue: Boolean[1];
  in expr secondValue[0..1] { return : Boolean[1]; }
  return : Boolean[1];
}

abstract function collect {
  in collection: Anything[0..*] ordered nonunique;
  in expr mapper[0..*] {
    in argument: Anything[1];
    return : Anything[0..*] ordered nonunique;
  }
  return : Anything[0..*] ordered nonunique;
}

abstract function select {
  in collection: Anything[0..*] ordered nonunique;
  in expr selector[0..*] {
    in argument: Anything[1];
    return : Boolean[1];
  }
  return : Anything[0..*] ordered nonunique;
}

function selectOne {
  in collection: Anything[0..*] ordered nonunique;
  in expr selector1[0..*] {
    in argument: Anything[1];
    return : Boolean[1]; }
  return : Anything[0..1] =
    collection->select {in x; selector1(x)}[1];
}

abstract function reject{

```

```

return : Boolean[1]; }

```

```
    }  
    return : Boolean[1];  
}
```

```
in collection: Anything[0..*] ordered nonunique;  
in expr test[0..*] {
```

```
    return : Boolean[1];  
}
```

```
return : Boolean[1];
```

```
    return : Boolean[1] = collection->forall {in x; x};  
}
```

```
    return : Boolean[1] = collection->exists {in x; x};  
}
```

```
return : Boolean[1];
```



```

        inout seq1 = group;
        in seq2 = create(occ);
    }

    return : Occurrence[1] = occ;
}

function addNewAt {
    doc
    /*
    * Add a newly created occurrence to the given ordered group of occurrences at the given
    * index and return the new occurrence.
    */

    inout group: Occurrence[0..*] ordered nonunique;
    inout occ: Occurrence[1];
    in index: PositionStep;

    private composite step : addAt {
        inout seq = group;
        in values = create(occ);
        in startIndex = index;
    }

    return : Occurrence[1] = occ;
}

behavior removeOld {
    doc
    /*
    * Remove a given occurrence from a group of occurrences and destroy it.
    */

    inout group: Occurrence[0..*] ordered nonunique;
    inout occ: Occurrence[0..1];

    private composite step removeStep : remove {
        inout seq = group;
        in values = occ;
    }
    private succession removeStep then destroyStep;
    private composite step destroyStep : s and de2 lnn s= group;
}

```


10 Model Interchange

10.3 Model Interchange Projects

<>;61/0 5:@I>/4-:3I 258I CM =IHN;CHM ; MCHAF? JLID?=N M?LC;ECT?> ;M ; M?N I@ GI>?F CHN?L=B;HA? @CF?M ;L=BCP?> OMCHA
NB? 7&- @ILG;N 87&-9 1B? ;L=BCP? MB;FF =IHN;CH ; GI>?F CHN?L=B;HA? @CF? @IL ?;=B I@ NB? LIIN H;G?MJ;=?M CH NB?
JLID?=N ?;=B @ILG;NN?> CH IH? I@ NB? @ILG;NM FCMN?> CH _____ &H ;>>CNCIH NB? ;L=BCP? MB;FF =IHN;CH ;N CNM NIJ F?P?F
?R;=NFS IH? @CF? H;G?> .project.json ;H> ?R;=NFS IH? @CF? H;G?> .meta.json (?L *) JLID?=N CHN?L=B;HA?
@CF? MB;FF B;P? NB? @CF? ?RN?HMCIH .kpar (?L *) -LID?=N L=BCP?

, NB?L NB;H NB? OM? I@ NB? @CF? ?RN?HMCIH ACP?H CH

10.4.6 Model Serialization

```
LIIN H;G?MJ;=? G;JM NI ; '0 , + 0=B?G; array QCNB P;FO?M ?KO;F NI NB? M?LC;FCT;NCIH ;M >?M=LC<?> CH NB?
JL?=?>CHA MO<=F;OM?M I@ ;FF GI>?F ?F?G?HNM CH NB? IQH?LMBCJ NL?? LIIN?> CH NB;N H;G?MJ;=?
```



```
classifier Garage {  
    feature stores : Bicycle [*];  
}cle [*];
```

classifier MyWheel **unions**

@N?L NB? CHMN;HNC;NCIHM CH *5@4;A@ /;::1/@;>? NB? MN?JM ;<IP? JLI>O=? NB? @IFFIQCHA ;NIGM #CLMN ; =L?;N?M ;M
G;HS ;MMI=C;NCIH ;NIGM @IL NB? =IHH?=NIL fixWheel ;M NB? =IHH?=N?> @?;NOL? QCNB NB? GIMN P;FO?M CH rollsOn
;MMCAH?> CH *5@4;A@ /;::1/@;>?

```
#atom
assoc MyBikeWheel1_Fork1_BWF_Link specializes BikeWheelFixed;
#atom
assoc MyBikeWheel2_Fork2_BWF_Link specializes BikeWheelFixed;
```

?@IL? <;MMCAHM J;LNC=CJ;HN @?;NOL?M NB? IH? NI IH? =IHH?=NIL ?H> GOFNCJFCNC?M L?KFCc"& 034c L?KFCc"& 00KS,` 0'3dA6 2 "` D 6


```

}

classifier MyBikeBasket_Fork_BBF_Link
    unions MyBikeFork1_Basket1_BBF_Link, MyBikeFork1_Basket2_BBF_Link;

#atom
classifier MyBike specializes Bicycle {
    feature redefines carrier : MyBikeBasket [2];
    connector redefines carrierFixed : MyBikeBasket_Fork_BBF_Link [2]
        from carrier [*] to holdsWheel [1];
}

```

A.3.5 Timing for structures

C8-??I? ;L? =F;MMC@C?LM @IL NBCHAM NB;N ?RCMN CH NCG? ;//A>>I:/I? ;M =IGJ;L?> NI HOG<?LM IL INB?L G;NB?G;NC=;F
?HNCNC?M &N OMO;FFS G;NN?LM QB?H NB?M? NBCHAM =IG? CHNI ;H> AI ION I@ ?RCMN?H=? ;N F?;MN L?F;NCP? NI ?;=B INB?L #IL
?R;GJF? CH MNLO=NOL?M CN CM NSJC=;FFS CHN?H>?> NB;N J;LNM ?RCMN @IL ;N F?;MN ;M FIHA ;M NB? NBCHA NB?S ;L? J;LN I@ &H NB?


```
struct MyBikeTimeCoincident unions MyWheel, MyBikeFork, MyBike;
```

```
#atom
```

```
struct MyBike
```

```
assoc MyBike_During_Parts_Link specializes HappensDuring
  unions MyBike_During_Wheel1_Link, MyBike_During_Fork1_Link,
    MyBike_During_Wheel2_Link, MyBike_During_Fork2_Link;

struct MyBikeParts unions MyWheel, MyBikeFork;

#atom
struct MyBike specializes Bicycle {
  feature redefines rollsOn : MyWheel;
  feature redefines holdsWheel : MyBikeFork;
  feature redefines allParts : MyBikeParts [4];

  feature redefines self : MyBike;
  connector redefines b_during_ap : MyBike_During_Parts_Link [4]
```

```
#atom
struct MyWheel2End specializes Wheel;
#atom
struct MyWheel2 specializes Wheel {
    feature redefines endShot : MyWheel2End;
}
struct MyBikeFork1End specializes BikeFork;
#atom
struct MyBikeFork1 specializes BikeFork {
    feature redefines endShot : MyBikeFork1End;
}
struct MyBikeFork2End specializes BikeFork;
#atom
struct MyBikeFork2 specializes BikeFork {
    feature redefines endShot : MyBikeFork2End;
}
#atom
struct MyBikeEnd
```



```
#atom
behavior MyManufacture specializes Manufacture;
#atom
behavior MyPaint specializes Paint;
#atom
behavior MyManufacture specializes Manufacture {
    feature redefines timeEnclosedOccurrences : MyPaint [1];
    step redefines paint : MyPaint;
}
```

A.3.7 Timing for behaviors, Decisions and merges

! ?=CMCIHM ;H> G?LA?M ;L? MN?JM NB;N ?H;<F? M?KO?H=?M NI <? M?F?=N?> >OLCHA ?R?=ONCIH L;NB?L NB;H ;B?;> I@ NCG? CH

```
}  
behavior Admit;  
behavior Touchup;  
behavior MarkForRecycling;  
behavior Ship;
```

behavior


```
behavior Manufacture {  
  feature objectToFinish : Product [1];  
  step paint : Paint [1]{
```



```
}  
#atom  
behavior MyManufacture #Tg03T##atom\Tj5kczess00d176T62MjWfXcedeejmgEE62d106j0j0333A)TjEE02j06eTj
```