Reflective Language for Communications Systems

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It does not reflect PrismTech views, products or capabilities.

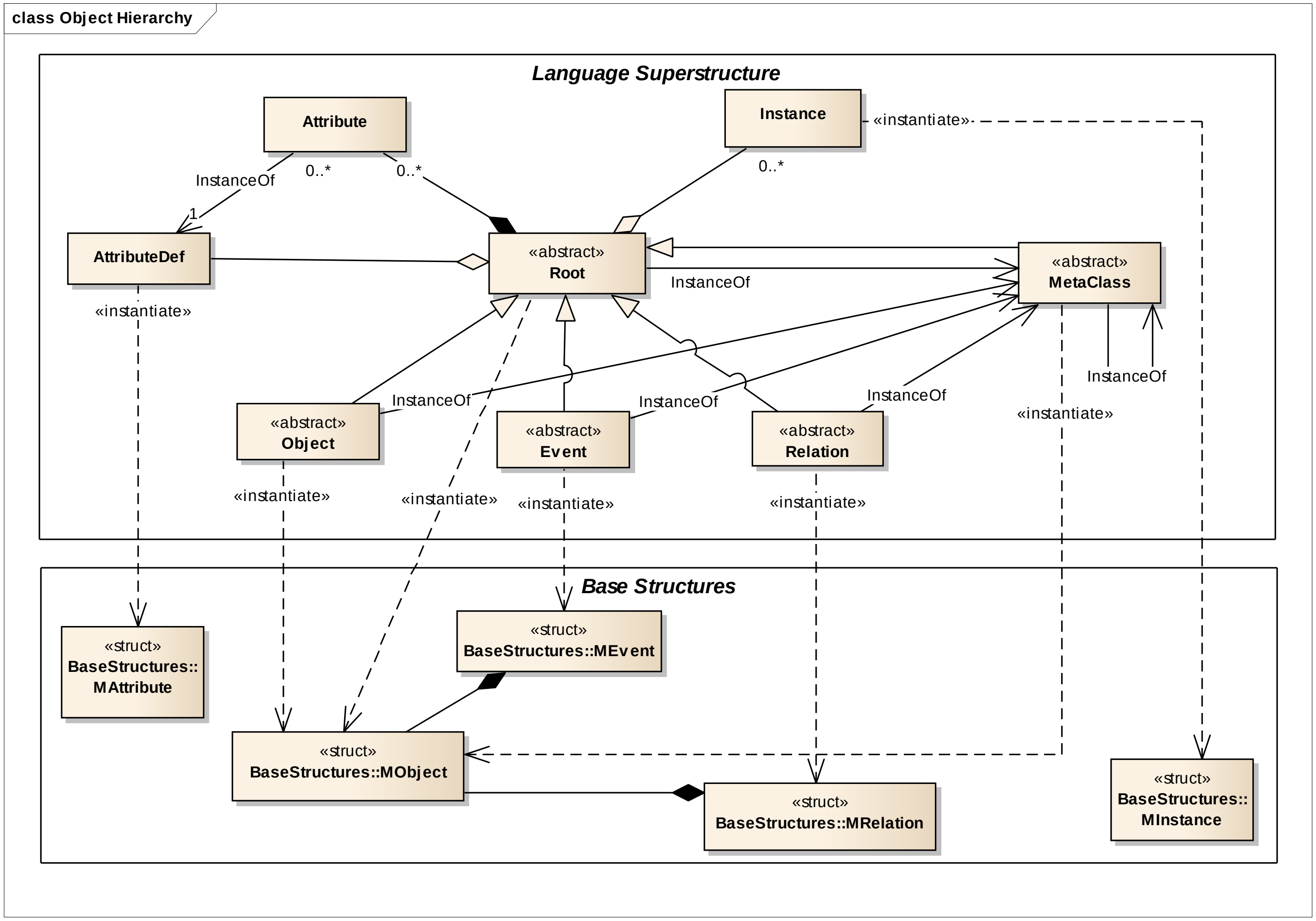
Origins

- **Prior experience in knowledge representation and reasoning, e.g. Frames, Conceptual Dependency, NETL, Cyc, OWL, etc.**
  - Expressive representation or reasoning capability but often limited in domain or scope.
- **Experience with object-oriented languages, e.g. LISP/Flavors, LOOPS, CLOS, Smalltalk, Simula, C++, Java, etc.**
  - Provides the association of state (variables) and behavior (methods) within the concept of an object but limited to current value.
- **Brittleness in existing programming languages, including OO languages.**
  - Weak or no built-in representation of context

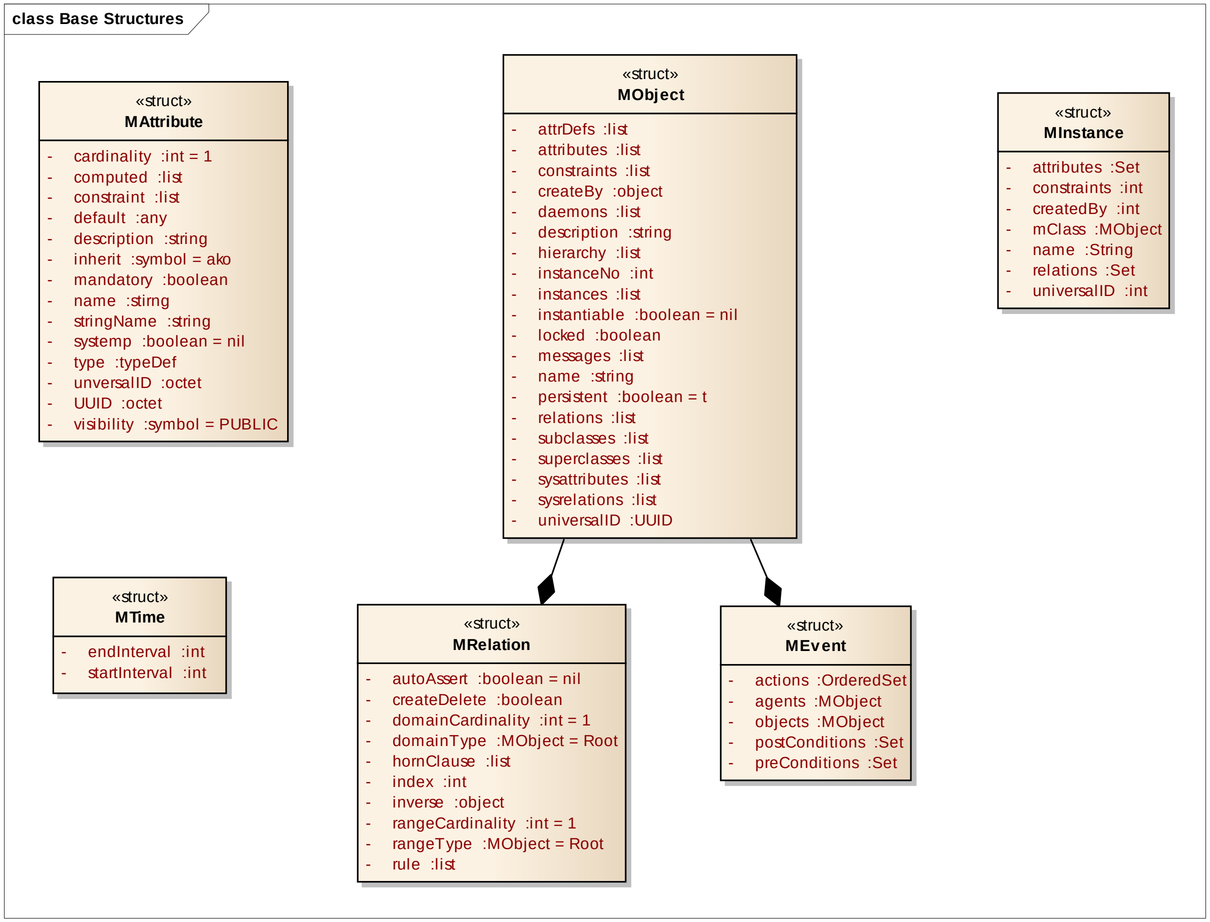
Basic Tenets/Objectives

- **Object-Oriented language paradigm but extended to represent relationships and events/actions as concrete entities.**
- **Incorporate a base set of objects, relations and events and common semantic interpretations within the base system.**
- **Prototype language as an extension of existing OO Language.**
- **Evolutionary optimization of low-level structural representation to improve performance.**
- **Provide capability to link to libraries for special purpose code, device drivers, etc.**

Language Superstructure



Base Structures



class Base Structures

«struct»
MAttribute

- cardinality :int = 1
- computed :list
- constraint :list
- default :any
- description :string
- inherit :symbol = ako
- mandatory :boolean
- name :stirng
- stringName :string
- systemp :boolean = nil
- type :typeDef
- unversalID :octet
- UUID :octet
- visibility :symbol = PUBLIC

«struct»
MObject

- attrDefs :list
- attributes :list
- constraints :list
- createBy :object
- daemons :list
- description :string
- hierarchy :list
- instanceNo :int
- instances :list
- instantiable :boolean = nil
- locked :boolean
- messages :list
- name :string
- persistent :boolean = t
- relations :list
- subclasses :list
- superclasses :list
- sysattributes :list
- sysrelations :list
- universalID :UUID

«struct»
MInstance

- attributes :Set
- constraints :int
- createdBy :int
- mClass :MObject
- name :String
- relations :Set
- universalID :int

«struct»
MTime

- endInterval :int
- startInterval :int

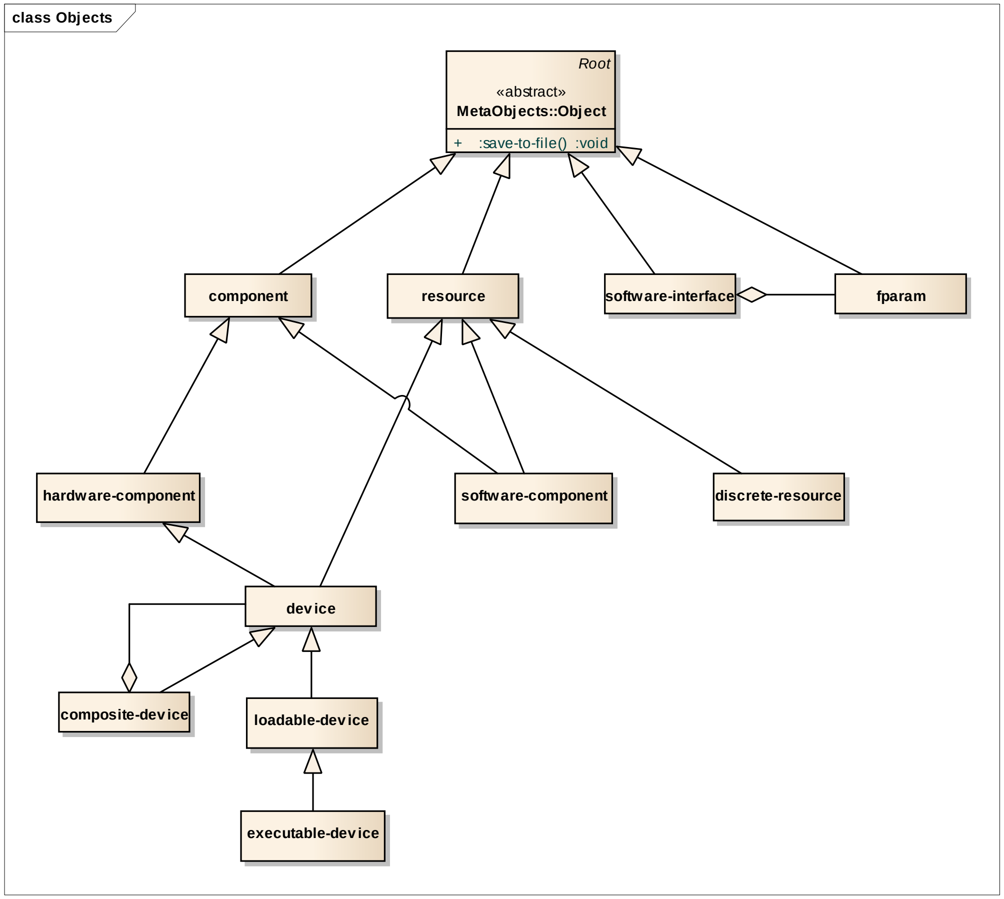
«struct»
MRelation

- autoAssert :boolean = nil
- createDelete :boolean
- domainCardinality :int = 1
- domainType :MObject = Root
- hornClause :list
- index :int
- inverse :object
- rangeCardinality :int = 1
- rangeType :MObject = Root
- rule :list

«struct»
MEvent

- actions :OrderedSet
- agents :MObject
- objects :MObject
- postConditions :Set
- preConditions :Set

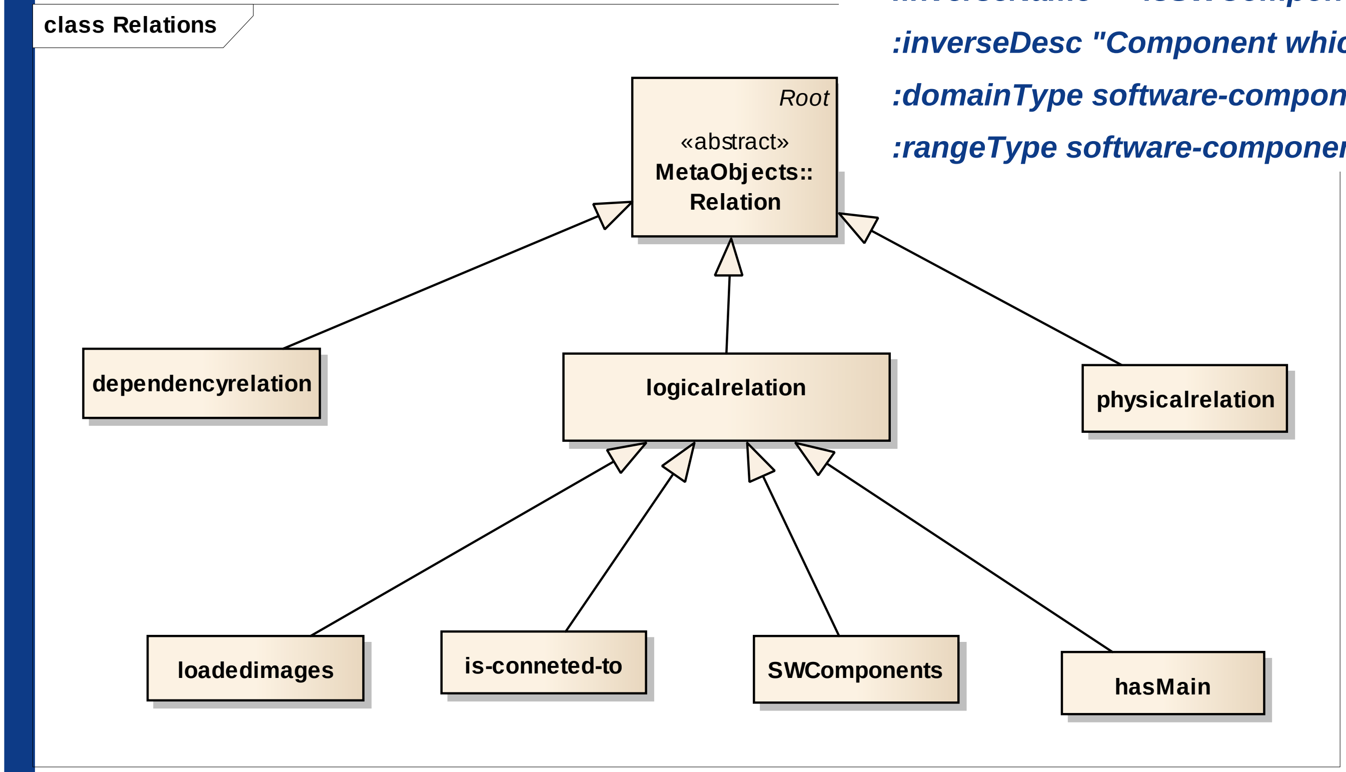
Base Object Hierarchy



```
(def-class resource object
   :name "Resource"
   :instantiable nil
   :description "A physical or logical
     element that is required or used by
     another element to provide some
     capability or function."
   :attributes (
         (id
            :cardinality 1
            :description "A unique identifier"
         )))
(def-method (resource :start) ()
   ; This would link to a .so or .dll library
     implementing the HW/Resource
     interface and logic
   (format t "Processing started for ~a~%"
     self))
```

Base Relation Hierarchy

```
(defrelation SWComponents logicalrelation
   :name "->hasSWComponents->"
   :description "Sub-components of this component"
   :inverse SwComponentOf
   :inverseName "->isSWComponentOf->"
   :inverseDesc "Component which this component is a part of"
   :domainType software-component
   :rangeType software-component)
```

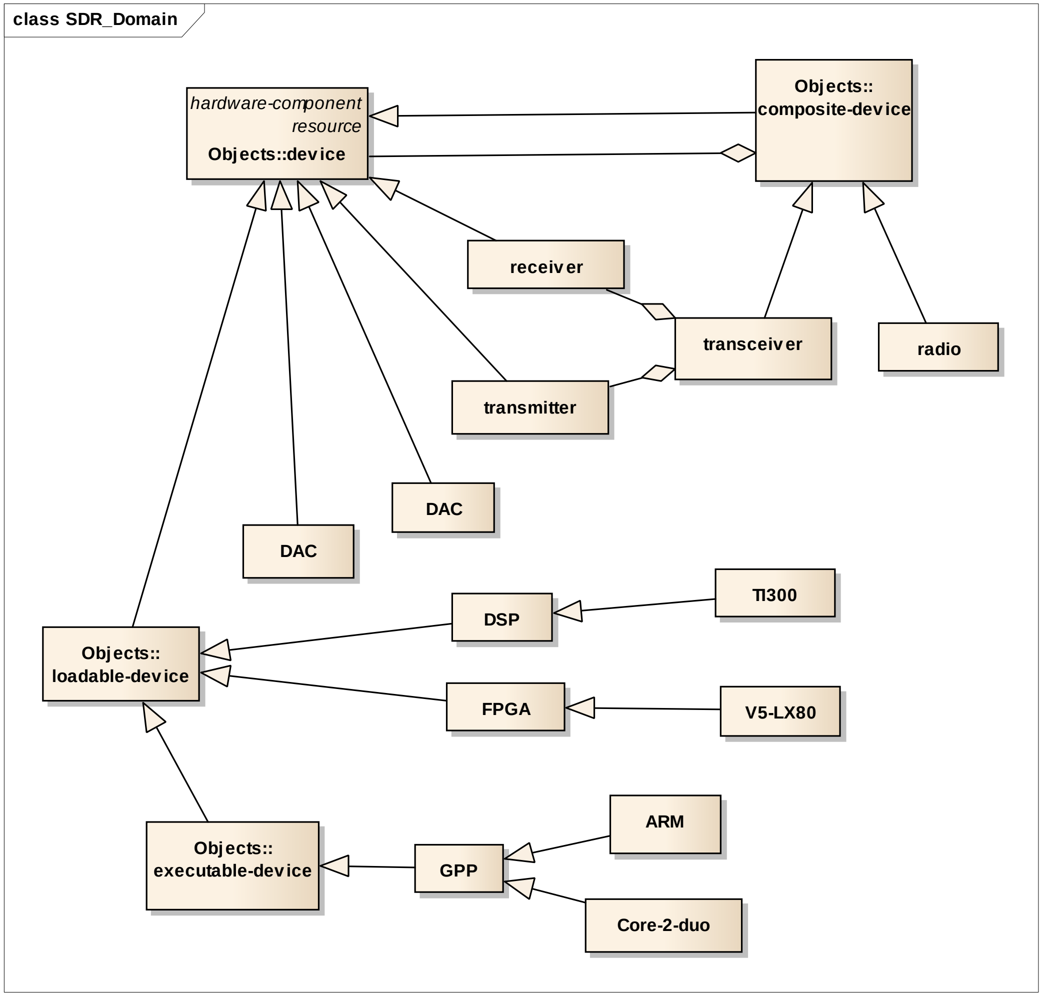


Driving the future of radio communications and systems worldwide

version 2.0

So, what does any of this have to do with communications systems?

Radio Domain Objects



- **Radio hardware components are defined as subclasses of a device.**
- **The composite-device provides a simple but effective characterization of a hierarchical collection of components.**

Define Software Components

```
(setf swc-1
   (tell 'software-component :new
      :props '(
         (name "Math Library")
         (size 800000)
         (language "C")
         )))

(setf swc-2
   (tell 'software-component :new
      :props '(
         (name "Tracking Main")
         (size 2000)
         (language "C")
         )))

(setf swc-3
   (tell 'software-component :new
      :props '(
         (name "IO Library")
         (size 3400)
         (language "ASM")
         )))

(setf swc-4
   (tell 'software-component :new
      :props '(
         (name "Rate 1/2 Viterbi Decoder")
         (size 3000)
         (language "VHDL")
         )))
```

Software Component Definition

```
(tell loaddev-1 :load swc-4)
(tell loaddev-1 :describe)
BeginInstance=SOFTWARE-COMPONENT-4
  InstanceOf->SOFTWARE-COMPONENT
         Name="SOFTWARE-COMPONENT-4"
Attributes:
       NAME="Rate 1/2 Viterbi Decoder"
       SIZE=3000
       LANGUAGE="VHDL"
 Relations:
      LOADEDON->(V5-LX80-1)
  EndInstance=SOFTWARE-COMPONENT-4
```

Define Software Components

```
(tell swc-2 :assert 'swcomponents swc-1)
(tell swc-2 :assert 'swcomponents swc-3)

(setf testapp
    (tell 'application :new
        :props '(
            (name "Tracking Application")
            )))

(tell testapp :assert 'hasMain swc-2)
```

Define Software Components

(tell testapp :describe)

```
BeginInstance=APPLICATION-1
 InstanceOf->APPLICATION
        Name="APPLICATION-1"
Attributes:
       NAME="Tracking Application"
 Relations:
      HASMAIN->(SOFTWARE-COMPONENT-2)
 EndInstance=APPLICATION-1
```

Software Application Main

(tell swc-2 :describe)

```
BeginInstance=SOFTWARE-COMPONENT-2
  InstanceOf->SOFTWARE-COMPONENT
         Name="SOFTWARE-COMPONENT-2"
Attributes:
       NAME="Tracking Main"
       SIZE=2000
       LANGUAGE="C"
 Relations:
      SWCOMPONENTS->(SOFTWARE-COMPONENT-1 SOFTWARE-
     COMPONENT-3)
      ISMAINOF->(APPLICATION-1)
  EndInstance=SOFTWARE-COMPONENT-2
```

Hardware Component Definition

```
(def-class V5-LX80 FPGA
   :name "Virtex 5 LX80"
   :description "A model of FPGA"
   :instantiable t
   :attributes (
      (numgates
         :default 60000)
      (maxClockRate
         :default 240)
      (maxImage
         :default 10000)
      (availImage
         :default 10000)
      ))
```

```
(setf loaddev-1
   (tell 'V5-LX80 :new))

(tell loaddev-1 :describe)
BeginInstance=V5-LX80-1
  InstanceOf->V5-LX80
         Name="V5-LX80-1"
Attributes:
 Relations:
  EndInstance=V5-LX80-1

(tell loaddev-1 :get 'maximage)
10000
```

“Defining” a Radio

```
(def-class lmr-radio radio
   :name "Land Mobile Radio"
   :description "A trunked, handheld radio used by public safety and first responders."
   :instantiable t
   :attributes (
      (minFreq
         :description "Minimum operating frequency"
         :cardinality 1
         :default 250.1
         :units MHz)
      (maxFreq
         :description "Maximum operating frequency"
         :cardinality 1
         :default 338.0
         :units MHz)))

(tell 'lmr-radio :assert 'parts '(arm TI300 transceiver))
(tell 'receiver :assert 'parts 'ad-24)
(tell 'transmitter :assert 'parts 'class-c-PA)
```

“Defining” a Radio

BeginClass:LMR-RADIO

SuperClass->(RADIO)

ClassType=CLASS

ClassName=*"Land Mobile Radio"*

isLocked=NIL

isInstantiable=T

isPersistent=T

InstancesCount=0

AttributeDefinitions:

MAXFREQ:

Description=*"Maximum operating frequency"*

Cardinality=1

DefaultValue=338.0

InheritRel=AKO

DataType=NIL

MINFREQ:

Description=*"Minimum operating frequency"*

Cardinality=1

DefaultValue=250.1

InheritRel=AKO

DataType=NIL

Attributes:

Relations:

PARTS->(ARM TI300 TRANSCEIVER)

EndClass:LMR-RADIO

Defining a Radio

```
(tell 'lmr-radio :print-hierarchy)
PARTS hierarchy of:
LMR-RADIO - "Land Mobile Radio"
..ARM - "ARM Processor"
..TI300 - "Texas Instruments 300 DSP"
..TRANSCEIVER - "Transceiver"
....V5-LX80 - "Virtex 5 LX80"
....ARM - "ARM Processor"
....TI300 - "Texas Instruments 300 DSP"
....TRANSMITTER - "Transmitter"
......CLASS-C-PA - "Class C Power Amplifier"
....RECEIVER - "Receiver"
......AD-24 - "24 bit ADC"
```

Instantiating a Radio

(setf lmr1 (tell 'lmr-radio :new))

```
BeginClass:LMR-RADIO
   SuperClass->(RADIO)
     ClassType=CLASS
     ClassName="Land Mobile Radio"
      isLocked=NIL
isInstantiable=T
  isPersistent=T
InstancesCount=1
AttributeDefinitions:
  MAXFREQ:
     Description="Maximum operating
       frequency"
     Cardinality=1
    DefaultValue=338.0
      InheritRel=AKO
        DataType=NIL
MINFREQ:
     Description="Minimum operating
       frequency"
     Cardinality=1
    DefaultValue=250.1
      InheritRel=AKO
        DataType=NIL
Attributes:
  LAST-INSTANCE=LMR-RADIO-1
Relations:
  PARTS->(ARM TI300 TRANSCEIVER)
EndClass:LMR-RADIO
```

Instantiating a Radio

```
(tell lmr1 :print-hierarchy)
PARTS hierarchy of:
LMR-RADIO-1 - "LMR-RADIO-1"
..ARM-1 - "ARM-1"
..TI300-1 - "TI300-1"
..TRANSCEIVER-1 - "TRANSCEIVER-1"
....V5-LX80-2 - "V5-LX80-2"
....ARM-2 - "ARM-2"
....TI300-2 - "TI300-2"
....TRANSMITTER-1 - "TRANSMITTER-1"
....RECEIVER-1 - "RECEIVER-1"
```

Summary

- **Objective is to extend the expressiveness of an executable language to incorporate:**
  - Objects, Relations and Events as first-class objects in the system.
  - Context – expressed as the set of relationships asserted for an object
    - Logical, physical, spatial, temporal
  - State – The value of the properties for an object.
    - Incorporate historical values enabling the ability to query an object about it's state at a given point in time or in relation to an event.
  - Inference and Reasoning – Representing heuristics as a set of conditions tied to assertions or action via relationships.
  - Hypotheses – The ability to define a set of assumptions or assertions that allow exploration of alternatives concurrently within the same knowledge space.