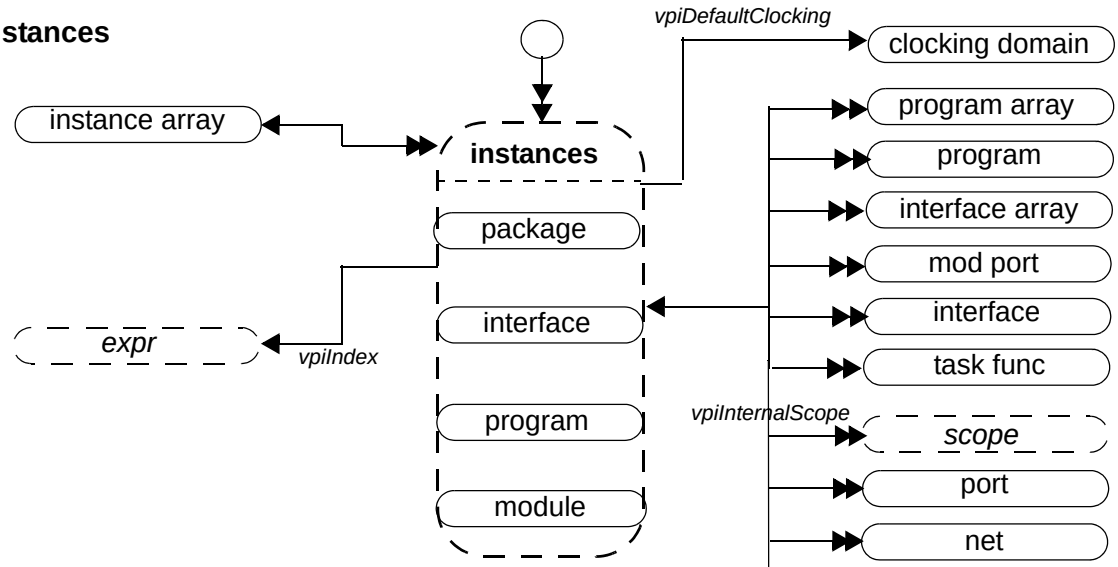
VPI Extensions to SystemVerilog

December 2003

SYNOPSYS®

Instances

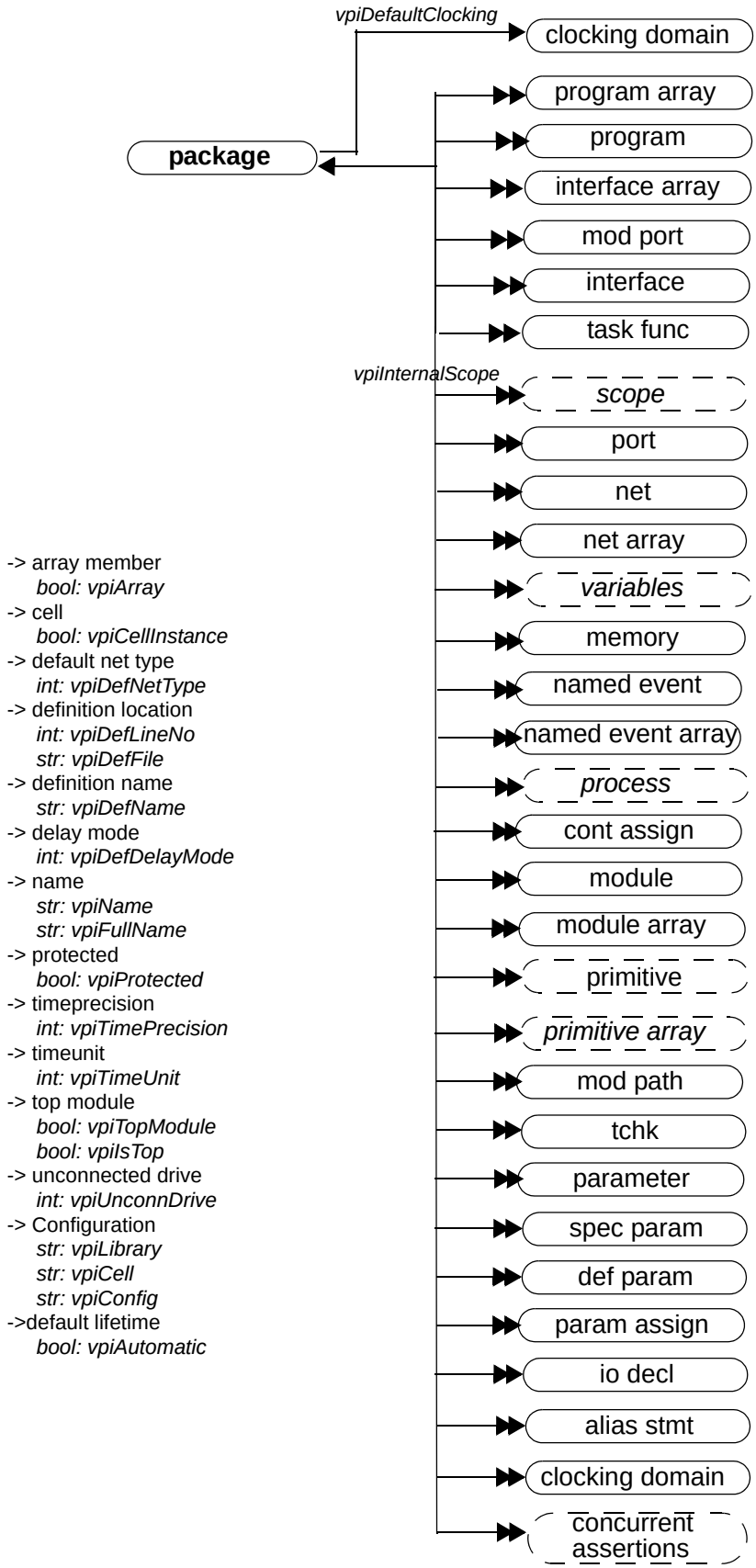


-> array member
bool: vpiArray
-> cell
bool: vpiCellInstance
-> default net type
int: vpiDefNetType
-> definition location
int: vpiDefLineNo
str: vpiDefFile
-> definition name
str: vpiDefName
-> delay mode
int: vpiDefDelayMode
-> name
str: vpiName
str: vpiFullName
-> protected
bool: vpiProtected
-> timeprecision
int: vpiTimePrecision
-> timeunit
int: vpiTimeUnit
-> top module
bool: vpiTopModule
bool: vpiIsTop
-> unconnected drive
int: vpiUnconnDrive
-> Configuration
str: vpiLibrary
str: vpiCell
str: vpiConfig
->default lifetime
bool: vpiAutomatic

NOTES

1. Top-level instances shall be accessed using **vpi_iterate()** with a NULL reference object.
2. Passing a NULL handle to **vpi_get()** with types **vpiTimePrecision** or **vpiTimeUnit** shall return the smallest time precision of all modules in the instantiated design.
4. If a module is an element within a module array, the **vpiIndex** transition is used to access the index within the array. If a module is not part of a module array, this transition shall return NULL.

Package


vpiDefaultClocking
clocking domain
program array
program
package
interface array
mod port
interface
task func
vpiInternalScope
scope
port
net
net array
variables
memory
named event
named event array
process
cont assign
module
module array
primitive
primitive array
mod path
tchk
parameter
spec param
def param
param assign
io decl
alias stmt
clocking domain
concurrent assertions
-> array member
bool: vpiArray
-> cell
bool: vpiCellInstance
-> default net type
int: vpiDefNetType
-> definition location
int: vpiDefLineNo
str: vpiDefFile
-> definition name
str: vpiDefName
-> delay mode
int: vpiDefDelayMode
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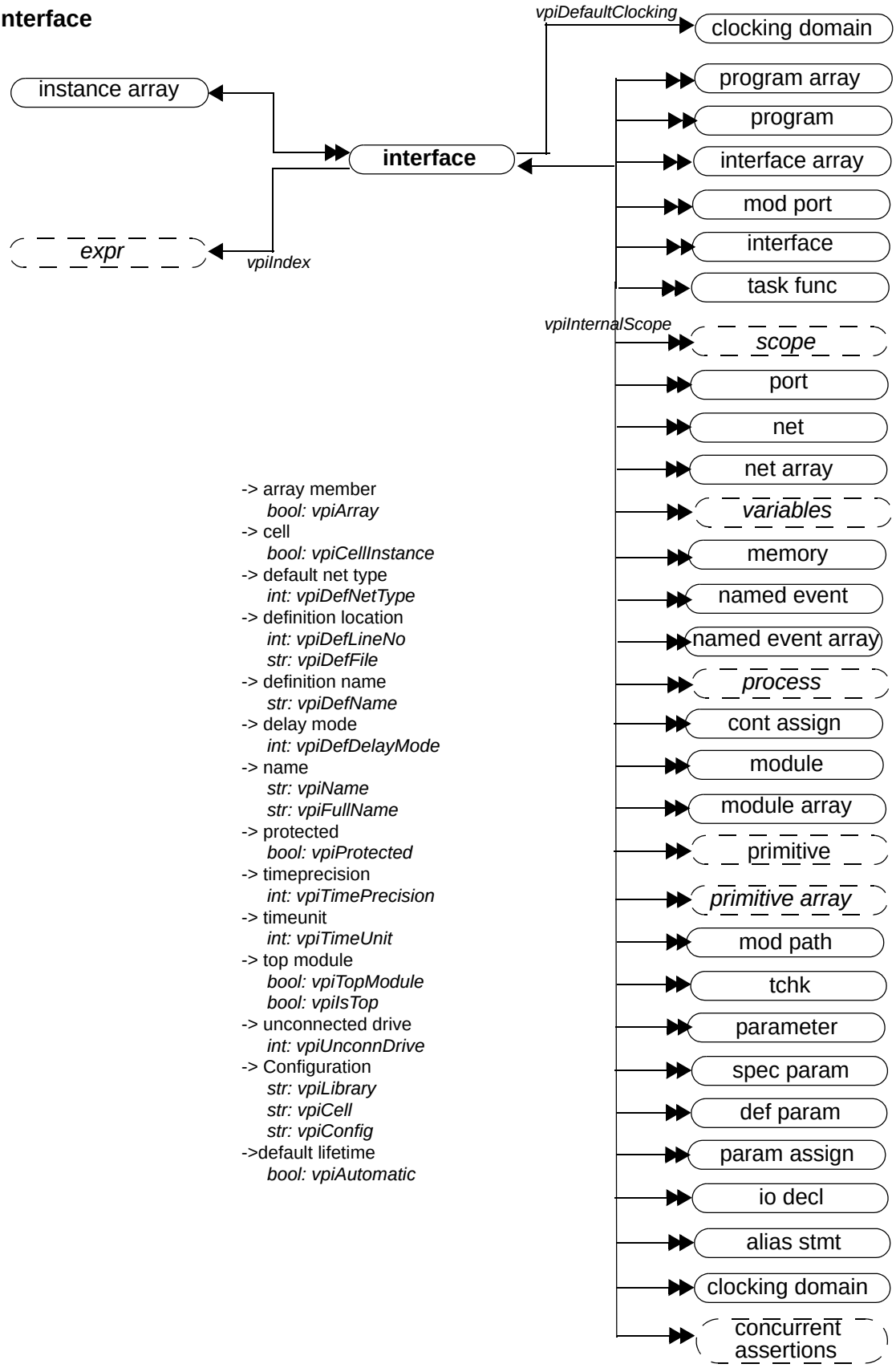
-> top module
bool: vpiTopModule
bool: vpiIsTop
-> unconnected drive
int: vpiUnconnDrive
-> Configuration
str: vpiLibrary
str: vpiCell
str: vpiConfig
->default lifetime
bool: vpiAutomatic

Interface


vpiDefaultClocking
clocking domain
instance array
program array
program
interface
interface array
mod port
expr
vpiIndex
interface
task func
vpiInternalScope
scope
port
net
net array
variables
memory
named event
named event array
process
cont assign
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-> unconnected drive
int: vpiUnconnDrive
-> Configuration
str: vpiLibrary
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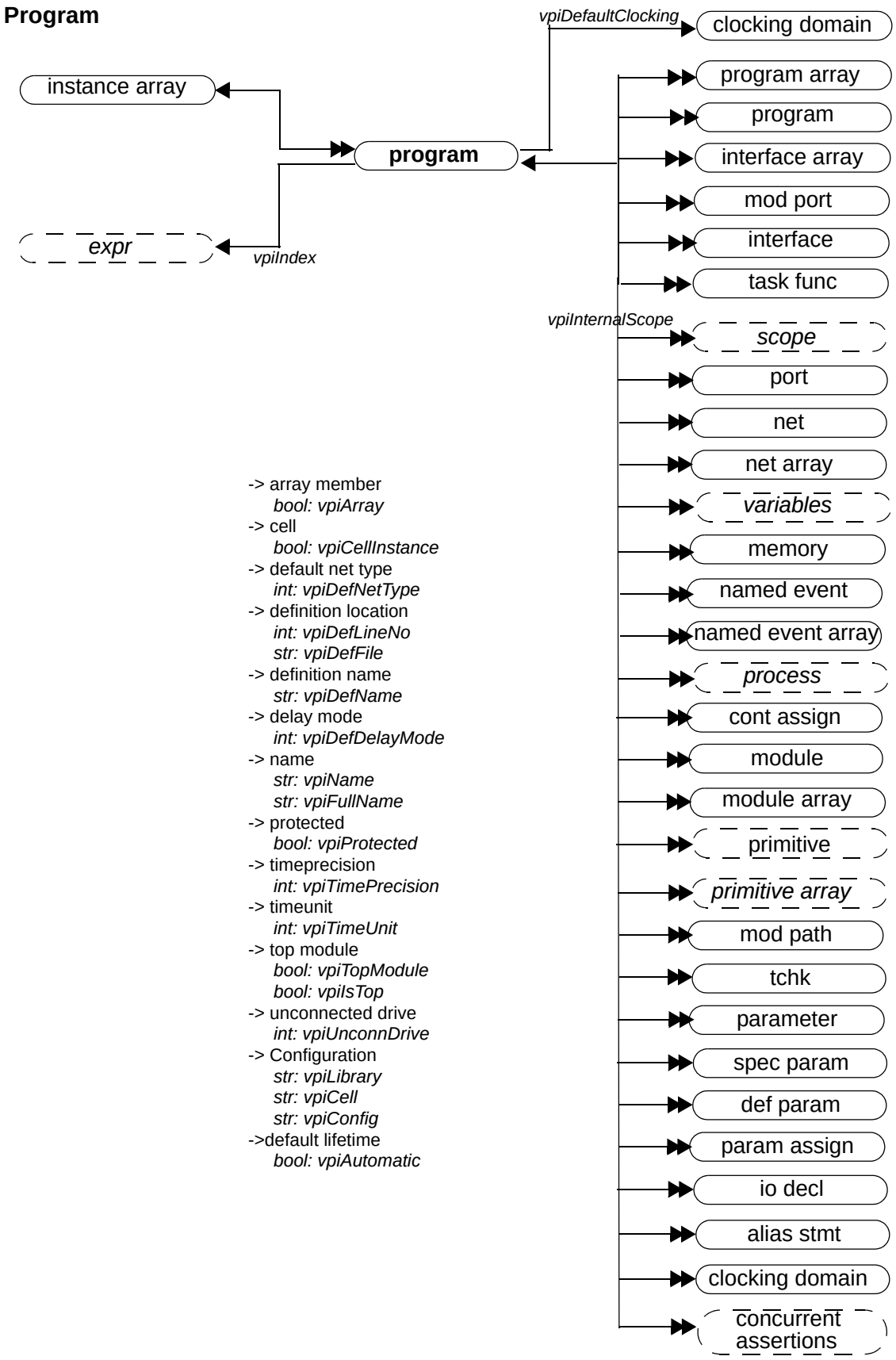
Program
vpiDefaultClocking
clocking domain
instance array
program array
program
interface array
mod port
interface
task func
vpiInternalScope
scope
port
net
net array
variables
memory
named event
named event array
process
cont assign
module
module array
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primitive array
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-> unconnected drive
int: vpiUnconnDrive
-> Configuration
str: vpiLibrary
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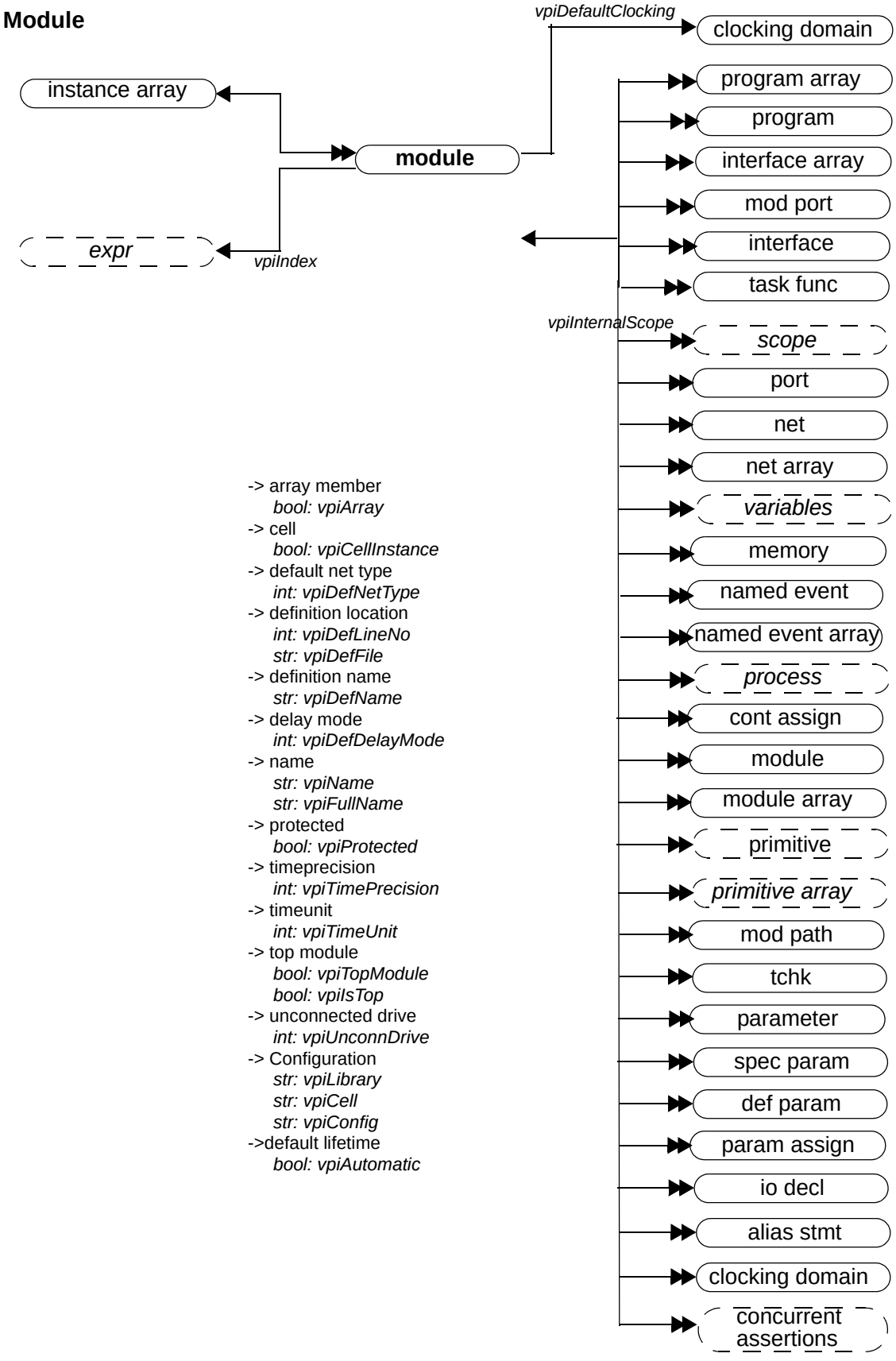
Module
vpiDefaultClocking
clocking domain
instance array
program array
program
module
interface array
mod port
expr
vpiIndex
interface
task func
vpiInternalScope
scope
port
net
net array
variables
memory
named event
named event array
process
cont assign
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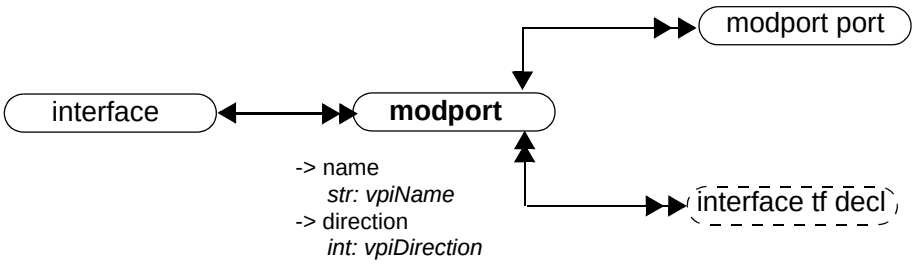
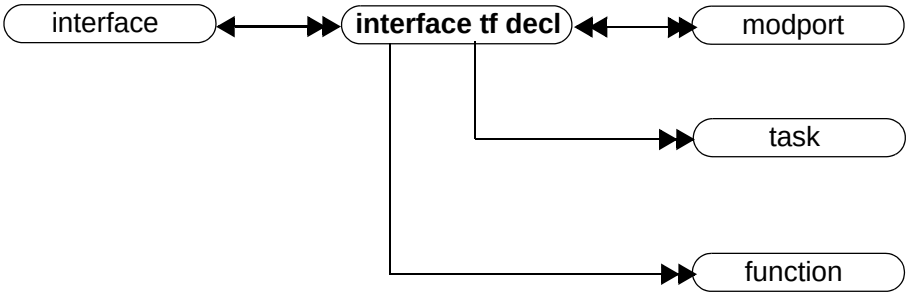
-> unconnected drive
int: vpiUnconnDrive
-> Configuration
str: vpiLibrary
str: vpiCell
str: vpiConfig
->default lifetime
bool: vpiAutomatic

Modport



Interface tf dec;

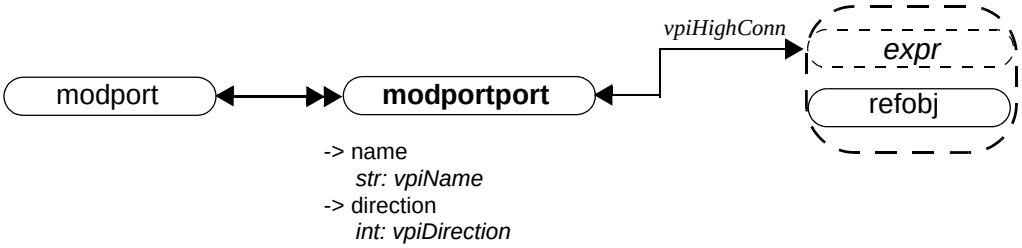


-> type
vpiType
-> access type
int: vpiAccessType
vpiExport
vpiImport
vipForkJoin
vpiExtern

NOTE

vpiIterate(vpiTaskFunc) can return more than one task/function declaration for modport tasks/functions with an access type of **vpiForkJoin**, because the task or function can be imported from multiple module instances.

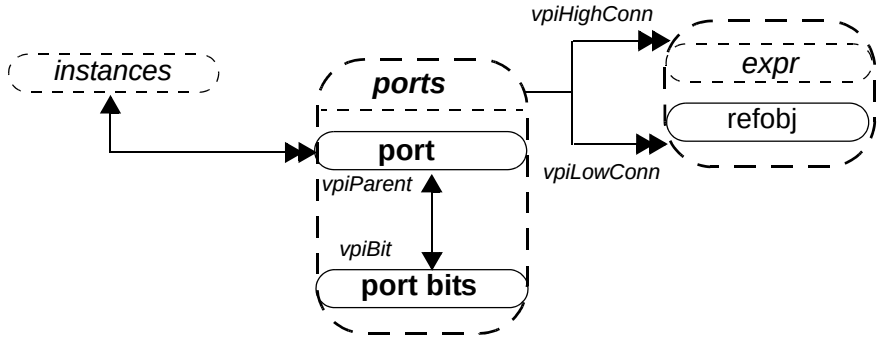
ModPort Ports



NOTES

1. For simple port declaration inside a modport, the HighComm represents the signal in the interface (type expr).
2. For hierarchical port declaration, the HighComm will be a RefObj of type **vpiModPort**.
3. Direction for hierarchical ports should be **vpiUndefined**.

Ports

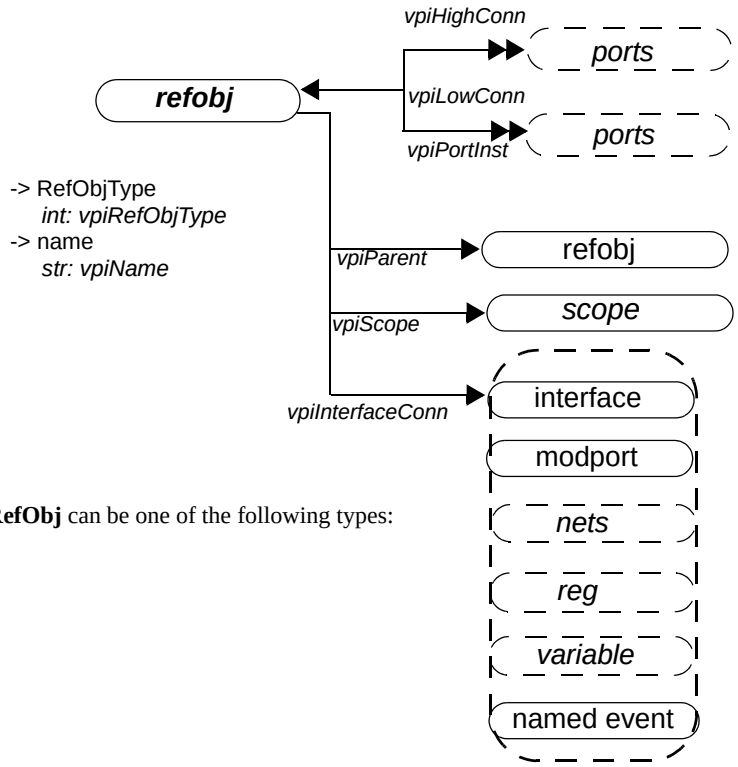


-> connected by name
bool: vpiConnByName
-> delay (mipd)
vpi_get_delays()
vpi_put_delays()
-> direction
int: vpiDirection
-> explicitly named
bool: vpiExplicitName
-> index
int: vpiPortIndex
-> name
str: vpiName
-> port type
int: vpiPortType
-> scalar
bool: vpiScalar
-> size
int: vpiSize
-> vector
bool: vpiVector

NOTES

1. **vpiPortType** shall be one of the following three types: **vpiPort**, **vpiInterfacePort**, and **vpiModportPort.** Port type depends on the formal, not on the actual.
2. **vpi_get_delays, vpi_put_delays** delays shall not be applicable for **vpiInterfacePort** and **vpiModPortPort.**
3. **vpiHighConn** shall indicate the hierarchically higher (closer to the top module) port connection.
4. **vpiLowConn** shall indicate the lower (further from the top module) port connection.
5. **vpiLowConn** of a **vpiInterfacePort** or a **vpiModPortPort** shall always be **vpiRefObj**.
6. Properties scalar and vector shall indicate if the port is 1 bit or more than 1 bit. They shall not indicate anything about what is connected to the port.
7. Properties index and name shall not apply for port bits.
8. If a port is explicitly named, then the explicit name shall be returned. If not, and a name exists, then that name shall be returned. Otherwise, NULL shall be returned.
9. **vpiPortIndex** can be used to determine the port order. The first port has a port index of zero.
10. **vpiHighConn** and **vpiLowConn** shall return NULL if the port is not connected.

RefObj



NOTES

1. **vpiRefObjType** of **vpiRefObj** can be one of the following types:
   - **vpiInterface**
   - **vpiModport**
   - **vpiNet**
   - **vpiReg**
   - **vpiVariable**

12. **vpiPort** and **vpiPortInst** is defined only for **vpiRefObj** where **vpiRefObjType** is **vpiInterface**.

Examples

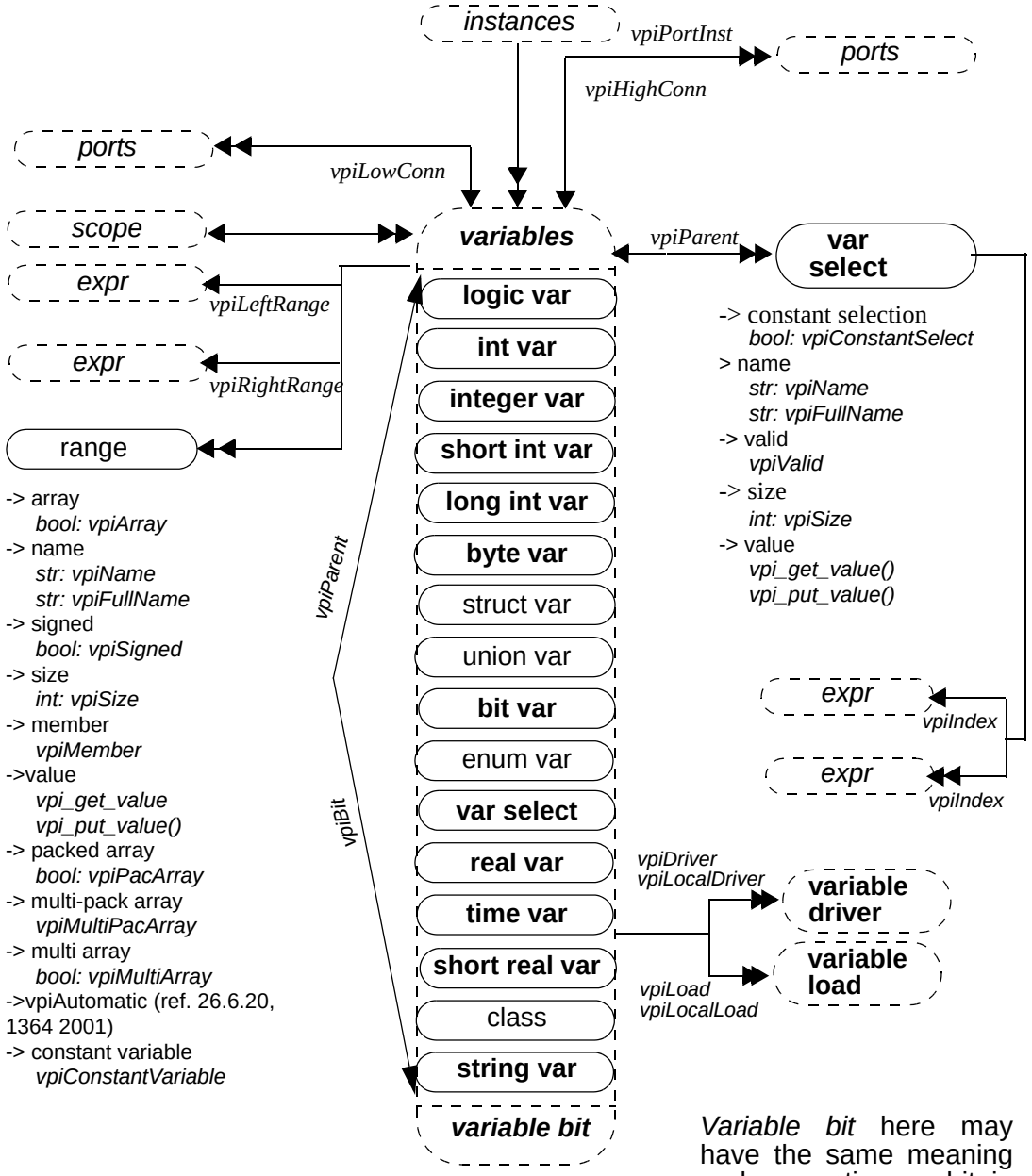
These objects are newly defined objects needed for supporting the full connectivity through ports where the ports are vpiInterface or vpiModport or any object inside modport or interface.

RefObjs are dummy objects and they always have a handle to the original object.

```
interface simple ()

logic req, gnt;

modport slave (input req, output gnt);
modport master (input gnt, output req);

}
module top()

interface  simple i;

child1 i1(i);
child2 i2(i.master);
```

```
endmodule

/**********************************

for port of i1,

     vpiHighConn = vpiRefObj  where vpiRefObjType =  vpiInterface

for port of i2 ,

      vpiHighConn =  vpiRefObj  where vpifullType = vpiModport

***************************************/

module child1(interface simple s)

   c1 c_1(s);
   c1 c_2(s.master);

endmodule

/***************************

for port of child1,

  vpiLowConn = vpiRefObj where vpiRefObjType = vpiInterface

for that refObj,

  vpiPort is  = port of child1.
  vpiPortInst is  = s, s.master
  vpiInterfaceConn  is  = i.

for port of c_1 :

  vpiHighConn is a vpiRefObj, where full type is vpiInterface.

for port of c_2 :

  vpiHighConn is a vpiRefObj, where full type is vpiModport.
```

Variable



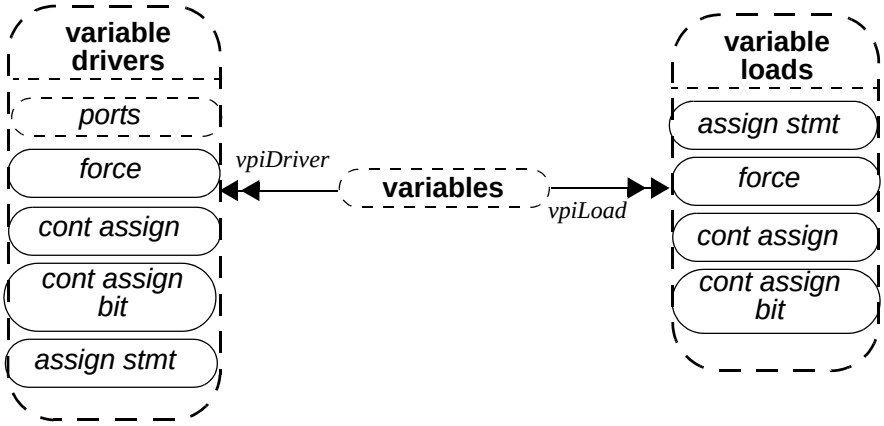
Variable bit here may have the same meaning and semantics as bit in 26.6.7

For type equivalence rules, see 7.15

NOTES

1. A var select is a word selected from a variable array.
2. The boolean property **vpiArray** shall be TRUE if the variable handle references an array of variables, and FALSE otherwise. If the variable is an array, iterate on **vpiVarSelect** to obtain handles to each variable in the array.
3. **vpi_handle (vpiIndex, var_select_handle)** shall return the index of a var select in a 1-dimensional array. **vpi_iterate (vpiIndex, var_select_handle)** shall return the set of indices for a var select in a multidimensional array, starting with the index for the var select and working outward
4. **vpiLeftRange** and **vpiRightRange** shall apply to variables when **vpiArray** is TRUE, and represent the array range declaration. These relationships are only valid when **vpiArray** is TRUE.
5. **vpiSize** for a variable array shall return the number of variables in the array. For non-array variables, it shall return the size of the variable in bits.
6. **vpiSize** for a var select shall return the number of bits in the var select. This applies only for packed var select.
7. Variables whose boolean property **vpiArray** is TRUE do not have a value property.
8. **vpiBit** iterator applies only for logic, bit, packed struct, and packed union variables.
9. **vpiIndexType** is valid only for associative array.
10. **cbSizeChange** will be applicable only for dynamic and associative array if both value and size change, size changes cb first. This cb fires after size change occurs and before any value changes for that variable. The value in the callback is new size of the array

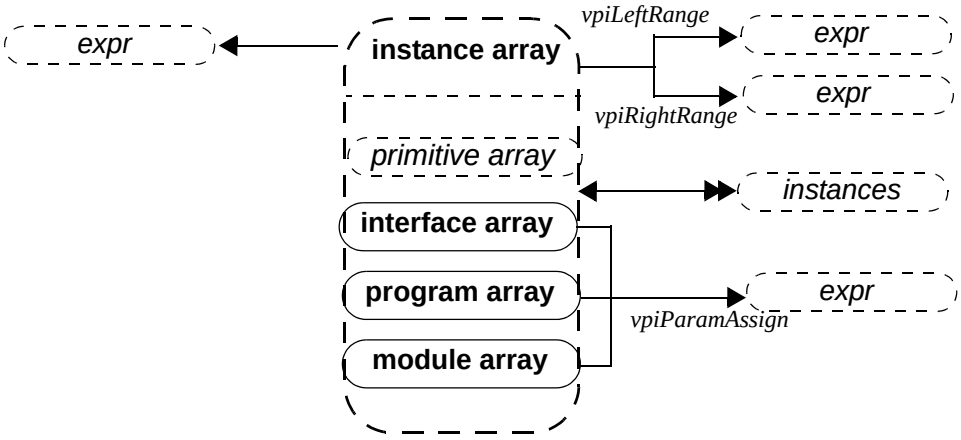
Variable Drivers and Loads



NOTES

1. **vpiDrivers/Loads** for a structure, union, or class variable will include the following:
   - Driver/Load for the whole variable
   - Driver/Load for any bit/part select of that variable
   - Driver/Load of any member nested inside that variable
2. **vpiDrivers/Loads** for any variable array should include the following:
   - Driver/Load for entire array/vector or any portion of an array/vector to which a handle can be obtained.

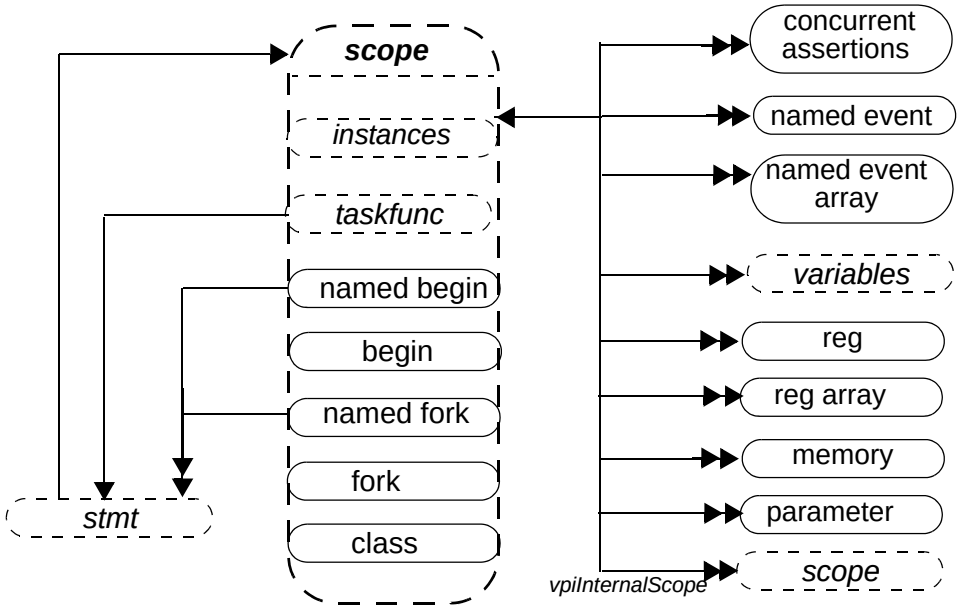
Instance Arrays (26.6.2)



NOTE

Param assignments can only be obtained from non-primitive instance arrays.

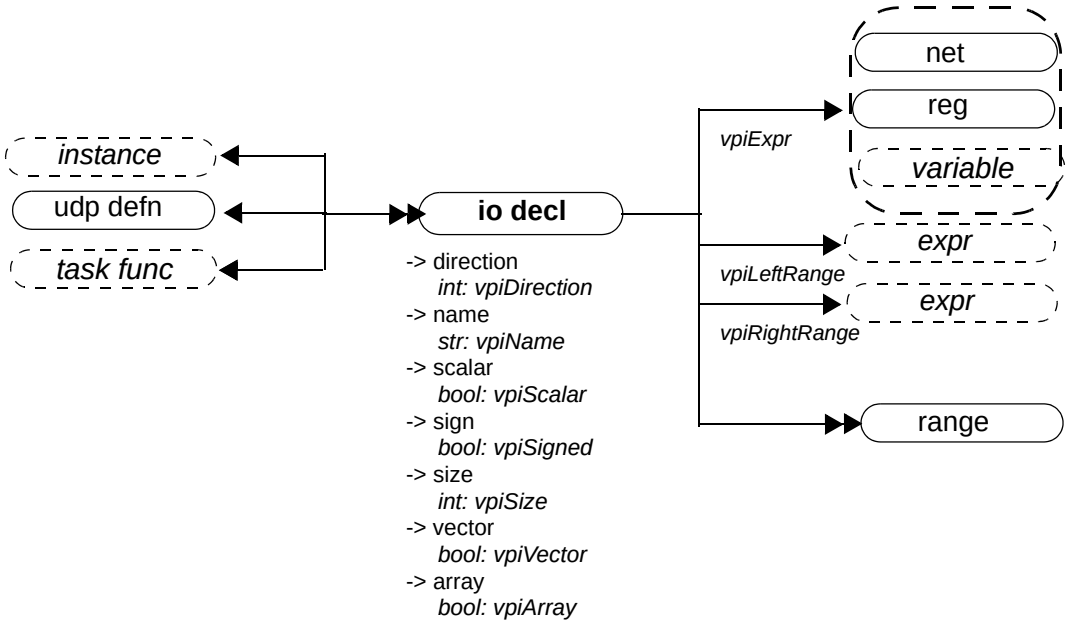
Scope (26.6.3)



NOTE

Unnamed scopes shall have valid names, though tool dependent.

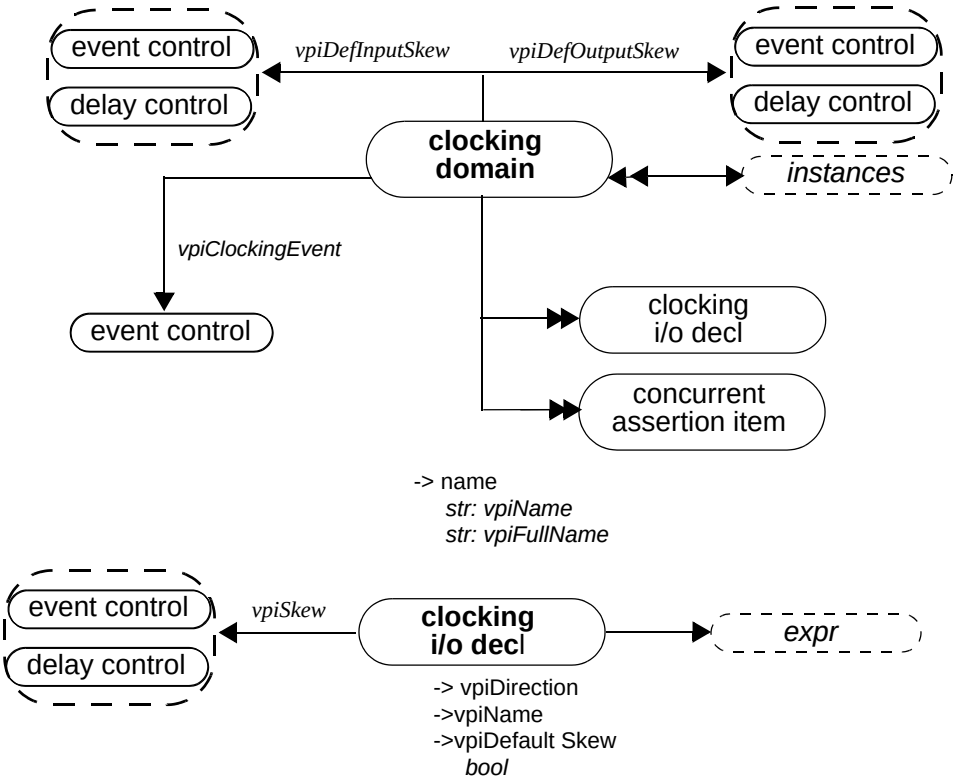
IO declaration (26.6.4)



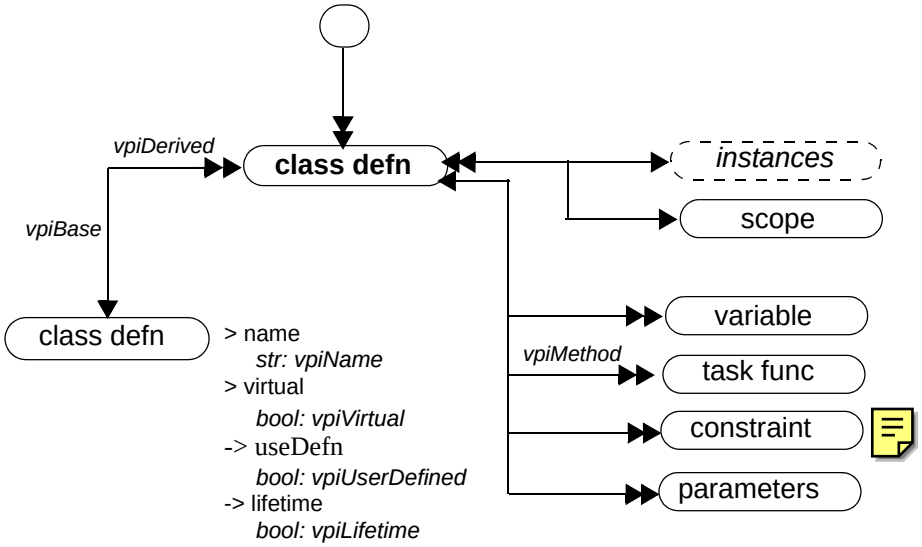
NOTE

vpiDirection returns **vpiRef** for pass by ref ports.

clocking domain



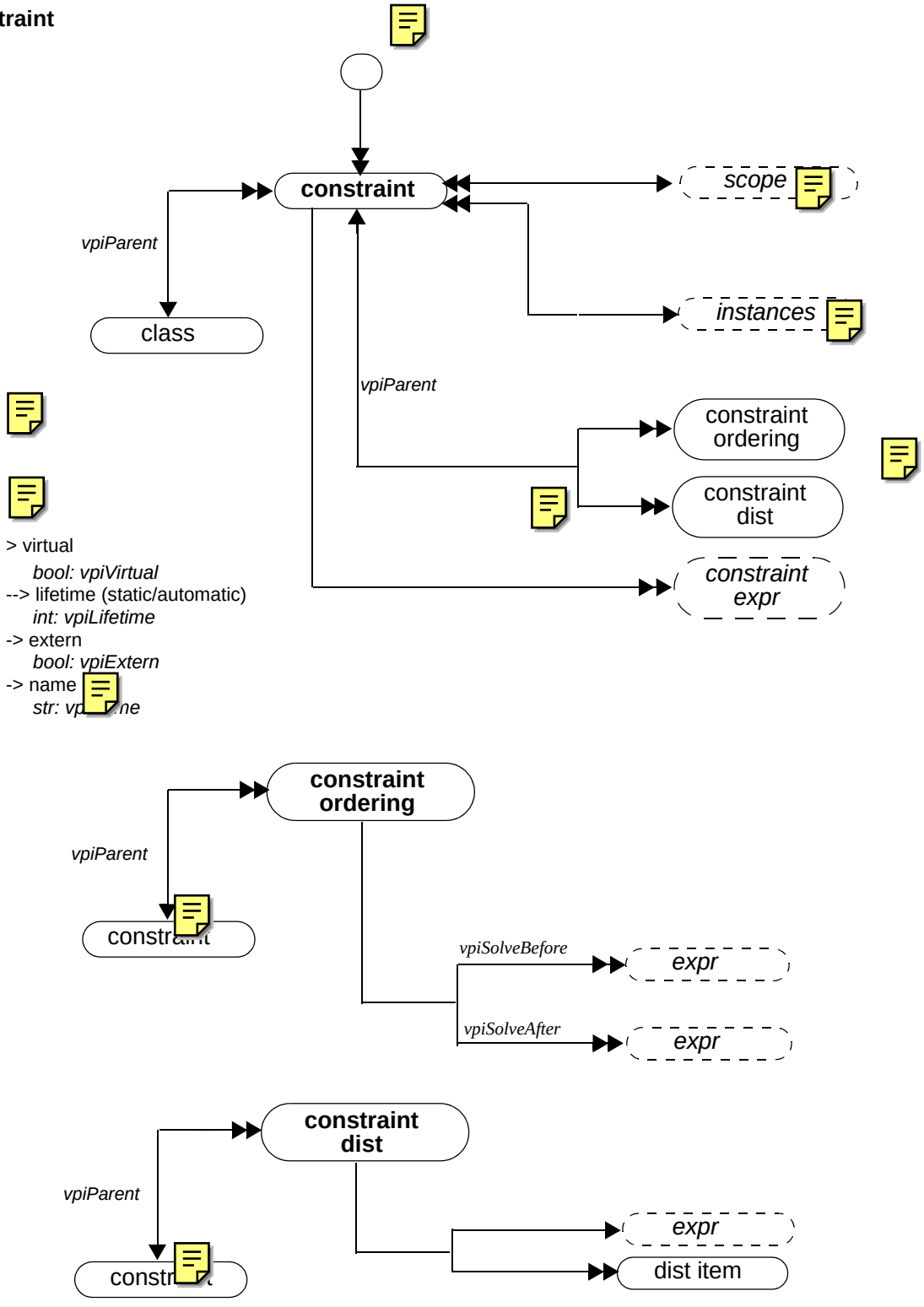
Class Object Definition

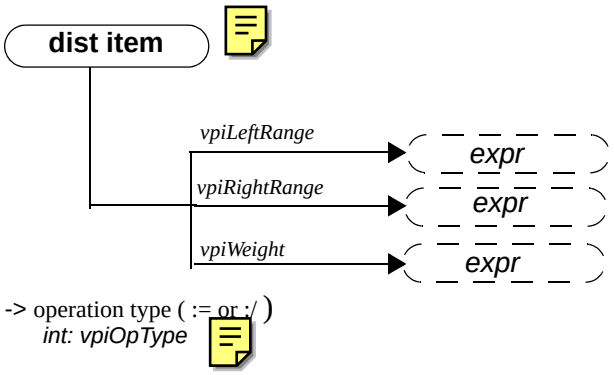


NOTE

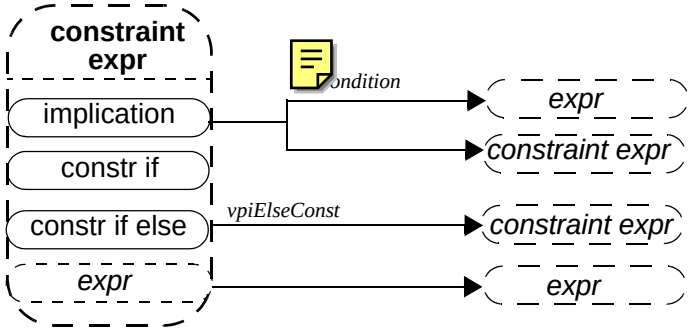
1. **ClassDefn** handle is a new concept. It does not correspond to any **vpiUserDefined** (class object) in the design. Rather it represents the actual type definition of a class.
2. Should not call **vpi_get_value**/**vpi_put_value** on the non-static variables obtained from the class definition handle.

Constraint


constraint
scope
vpiParent
class
instances
vpiParent
constraint ordering
constraint dist
constraint expr
> virtual
bool: vpiVirtual
--> lifetime (static/automatic)
int: vpiLifetime
-> extern
bool: vpiExtern
-> name
constraint ordering
vpiParent
vpiSolveBefore
expr
vpiSolveAfter
expr
constraint dist
vpiParent
expr
dist item

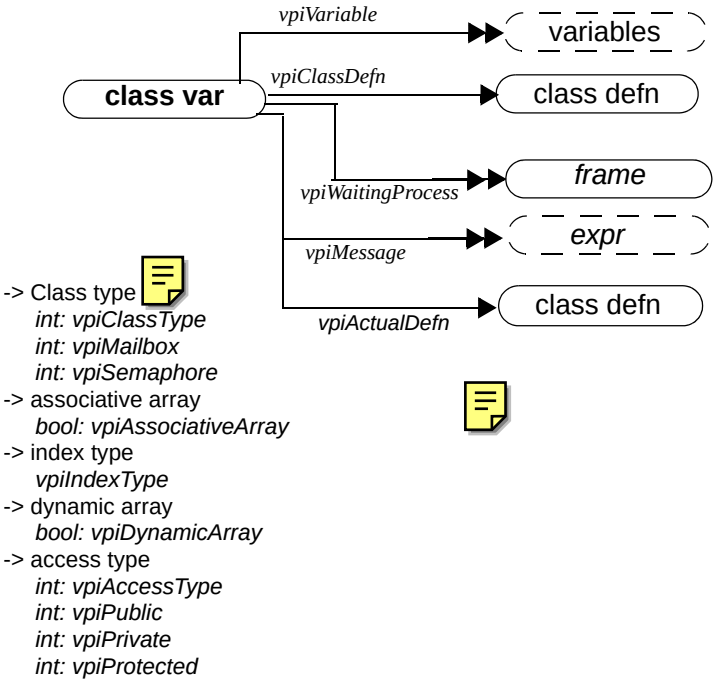


-> operation type (:= or :/)
int: vpiOpType



-> constraint expr type
vpiExpr
vpiImplication
vpiIfExpr
vpiIfElseExpr

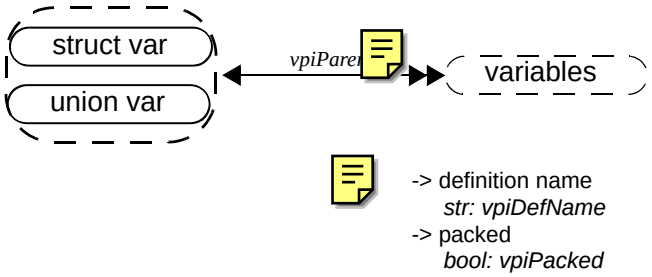
Variables (26.6.8)



NOTES

1. **vpiWaiting/Process** iterator on mailbox/semaphores will show the processes waiting on the object:
   — Waiting process means either frame or task/function handle.
2. **vpiMessage** iterator shall return all the messages in a mailbox.
3. **vpiClassDefn** returns the ClassDefn which was used to create the handle.
4. **vpiActualDefn** returns the ClassDefn that handle object points to when the query is made.
5. **vpiClassDefn/vpiActualDefn** both shall return NULL for built-in classes.

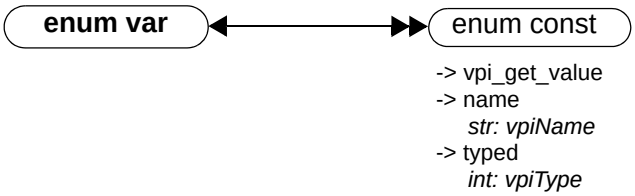
Structure/Union



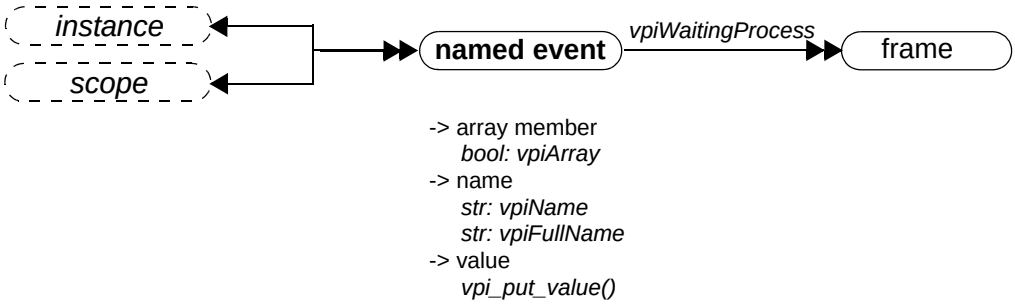
NOTES

vpi_get_value/vpi_put_value cannot be used to access values of entire unpacked structures and unpacked unions.

Enum, Enum Constant

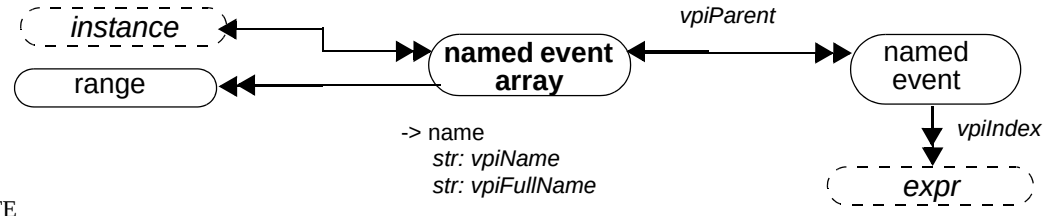


Named Events



NOTE

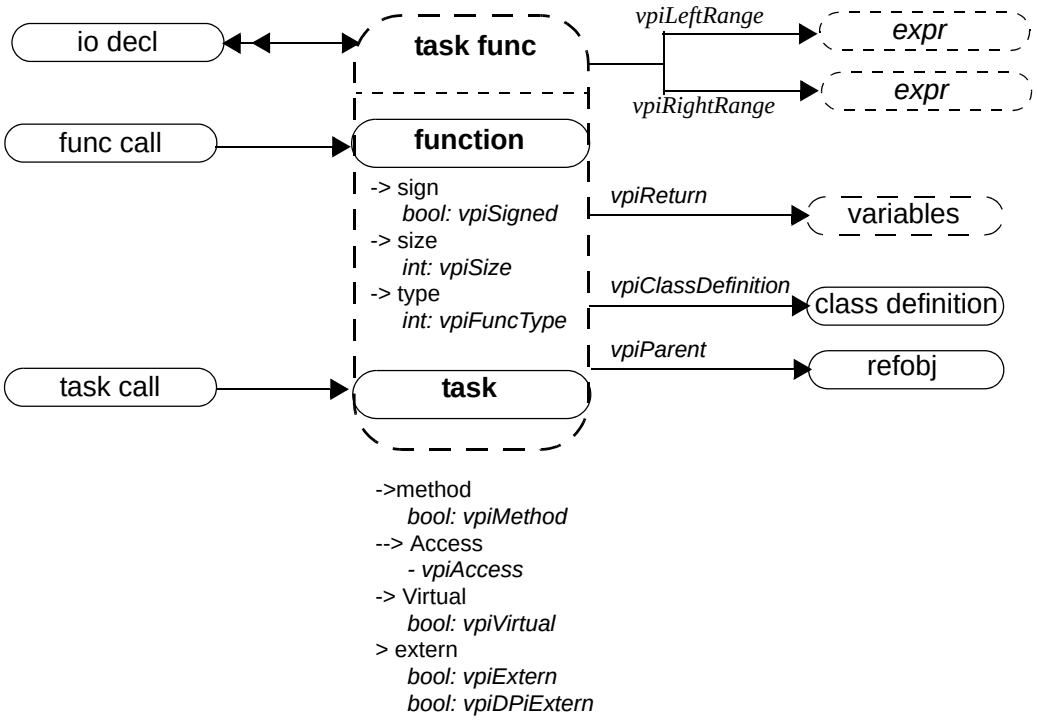
The new iterator (**vpiWaitingProcess**) returns all waiting processes, identified by their frame, for that namedEvent.



NOTE

vpi_iterate(vpiIndex, named_event_handle) shall return the set of indices for a named event within an array, starting with the index for the named event and working outward. If the named event is not part of an array, a NULL shall be returned.

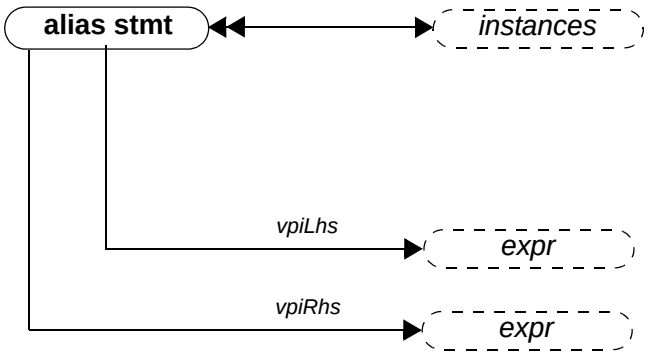
Task Function Declaration



NOTE

1. A Verilog HDL function shall contain an object with the same name, size, and type as the function.
2. **vpiInterfaceTask/vpiInterfaceFunction** shall be true if task/function is declared inside an interface or a modport of an interface.
3. For function where return type is a user-defined type, **vpi_handle** (vpiReturn,Function_handle) shall return the implicit variable handle representing the return of the function from which the user can get the details of that user-defined type.
4. **vpiReturn** will always return a var object, even for simple returns.

Alias Statement



Examples

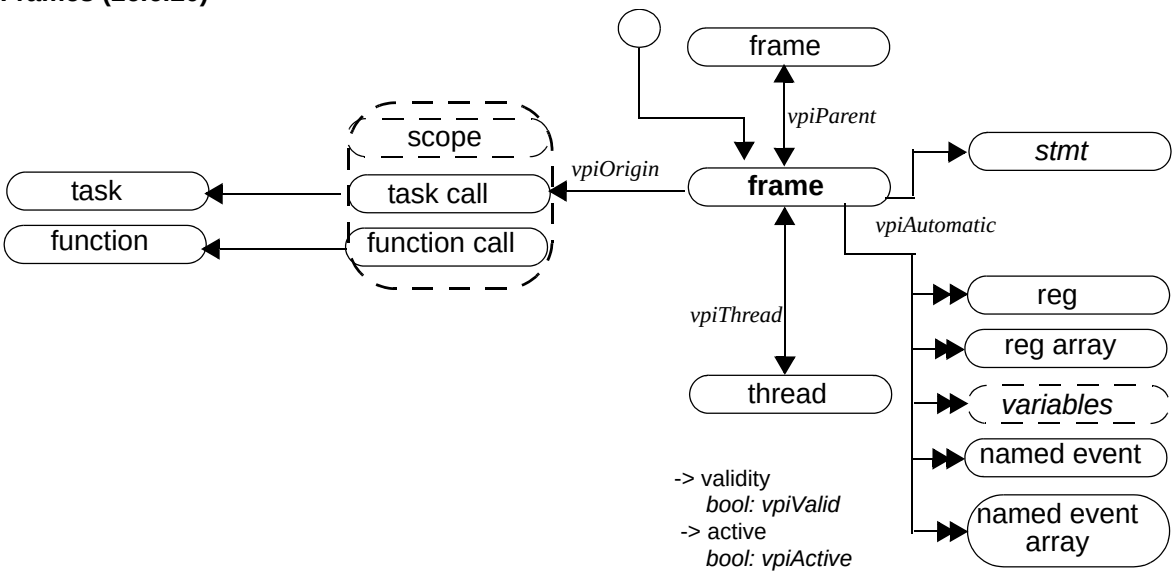
```
alias a=b=c=d
```

Results in 3 aliases:

```
alias a=d
alias b=d
alias c=d
```

d is Rhs for all.

Frames (26.6.20)

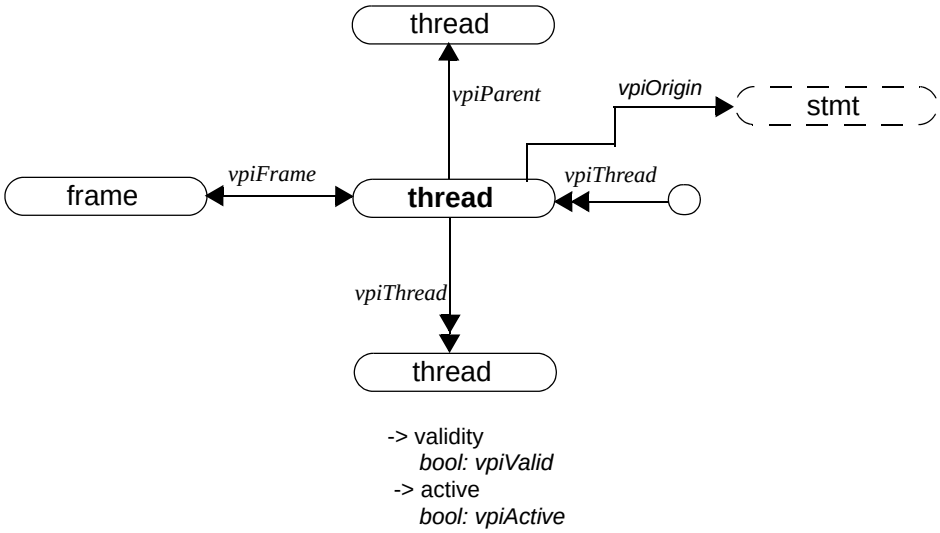


NOTES

1. The following callbacks shall be supported on frames:
   - **cbStartOfFrame**: triggers whenever any frame gets executed.
   - **cbEndOfFrame**: triggers when a particular thread is deleted after all storage is deleted.

Comment to editors: Please note that we have changed the **vpiParent** handle from the LRM. **vpiOrigin** now gives the originating scope or task/function call.

Threads

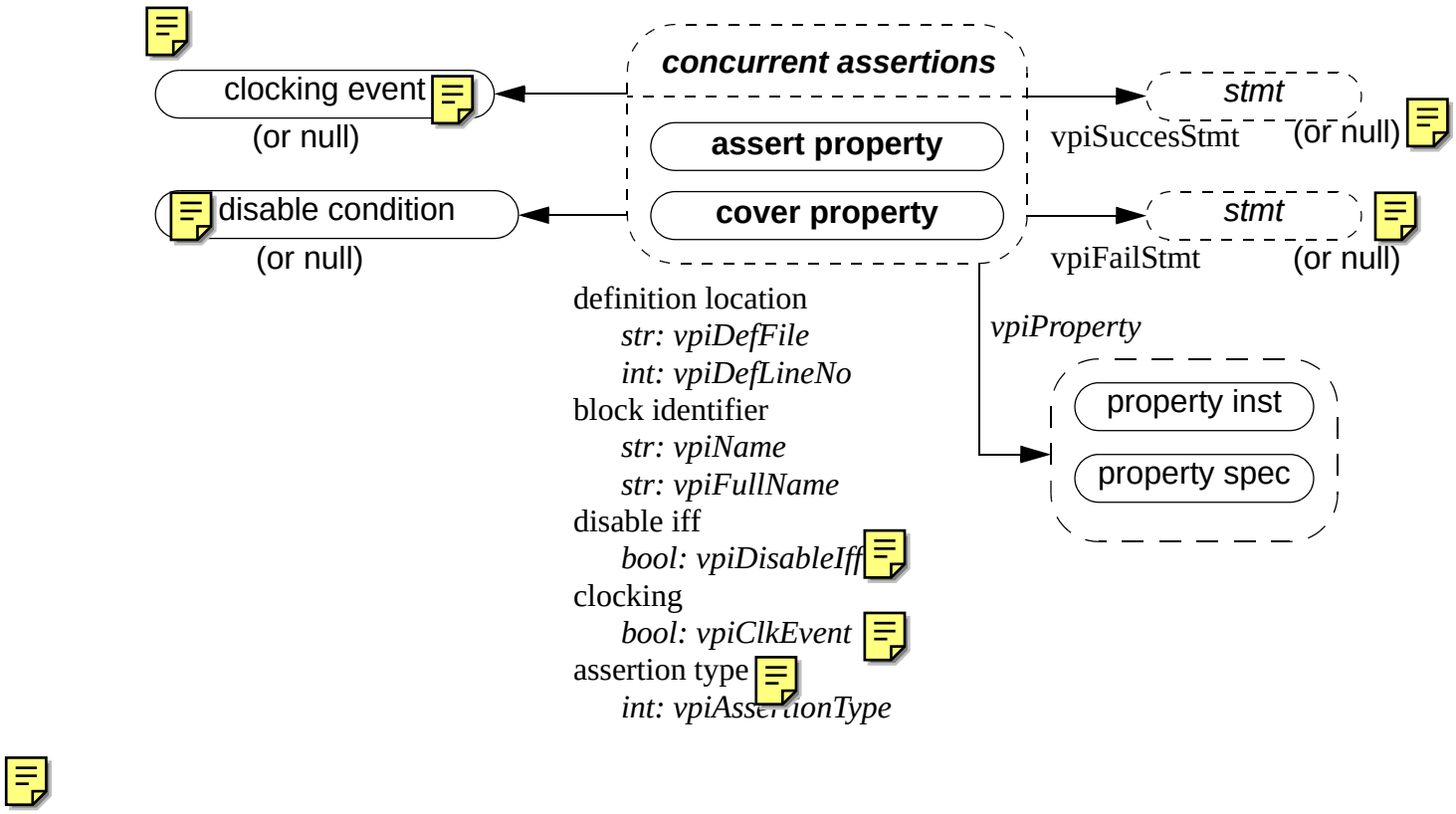


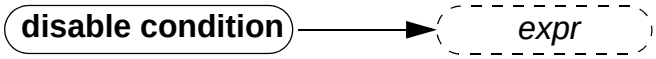
NOTES

The following callbacks shall be supported on threads

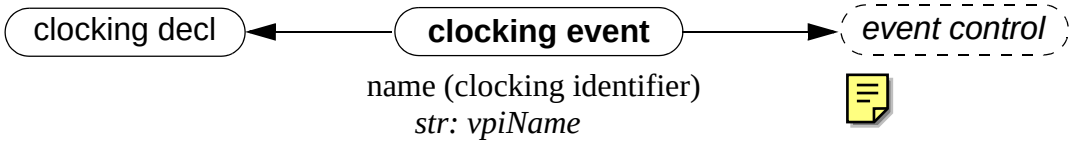
- **cbStartOfThread**: triggers whenever any thread is created
- **cbEndOfThread**: triggers when a particular thread gets deleted after storage is deleted.
- **cbEnterThread**: triggers whenever a particular thread resumes execution

.

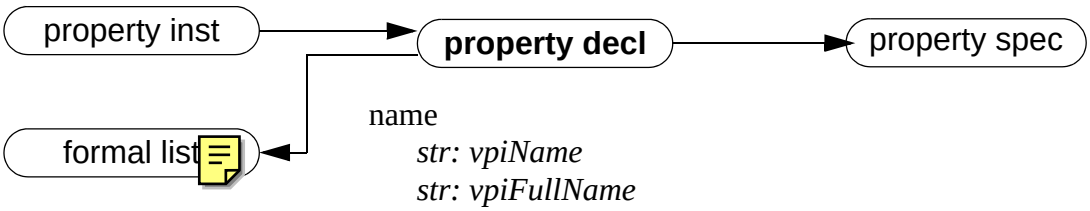

concurrent assertions
clocking event
(or null)
disable condition
(or null)
assert property
cover property
stmt
vpiSuccesStmt
(or null)
stmt
vpiFailStmt
(or null)
vpiProperty
property inst
property spec
definition location
str: vpiDefFile
int: vpiDefLineNo
block identifier
str: vpiName
str: vpiFullName
disable iff
bool: vpiDisableIff
clocking
bool: vpiClkEvent
assertion type
int: vpiAssertionType



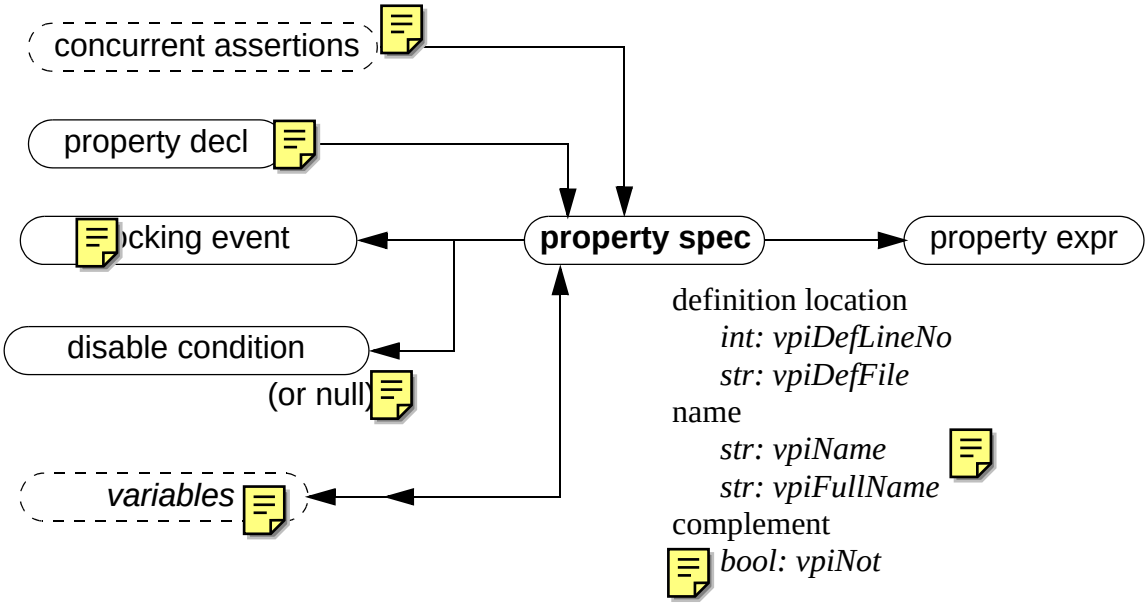
definition location
int: vpiDefLineNo
str: vpiDefFile

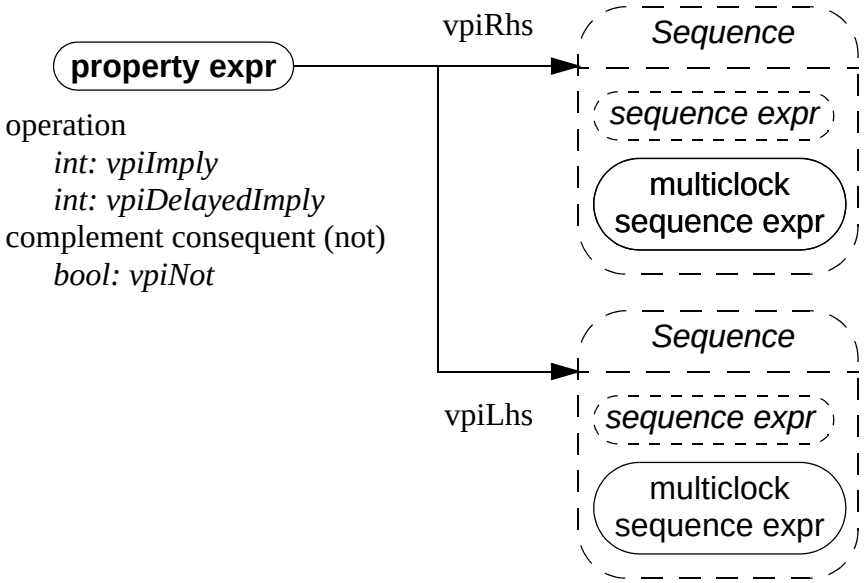


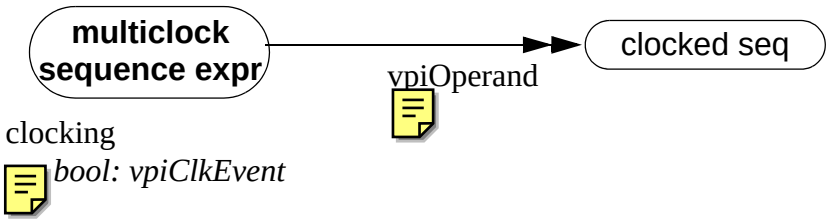
name (clocking identifier)
str: vpiName
str: vpiFullName
definition location
int: vpiDefLineNo
str: vpiDefFile
inferred or declared
bool: vpiInferred

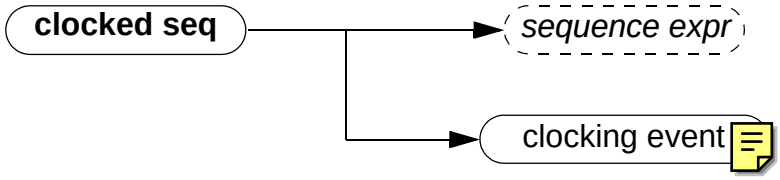


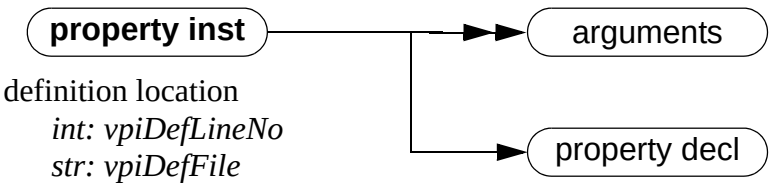
name
str: vpiName
str: vpiFullName
definition location
str: vpiDefFile
int: vpiDefLineNo

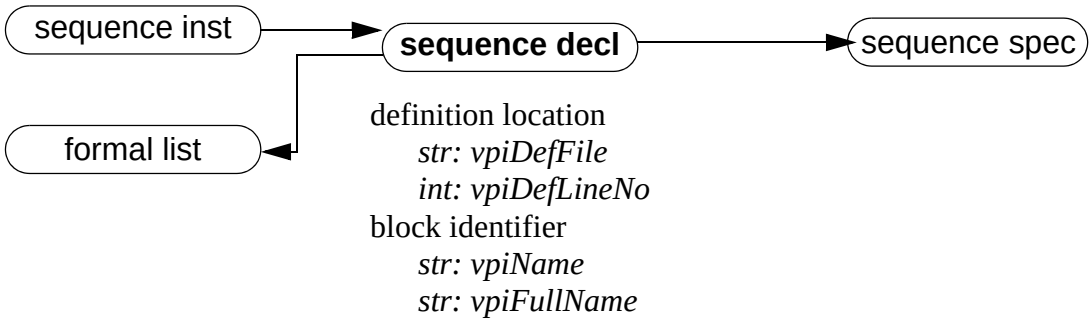

concurrent assertions
property decl
cking event
property spec
property expr
disable condition
(or null)
variables
definition location
int: vpiDefLineNo
str: vpiDefFile
name
str: vpiName
str: vpiFullName
complement
bool: vpiNot


property expr
operation
int: vpiImply
int: vpiDelayedImply
complement consequent (not)
bool: vpiNot
vpiRhs
Sequence
sequence expr
multiclock sequence expr
vpiLhs
Sequence
sequence expr
multiclock sequence expr

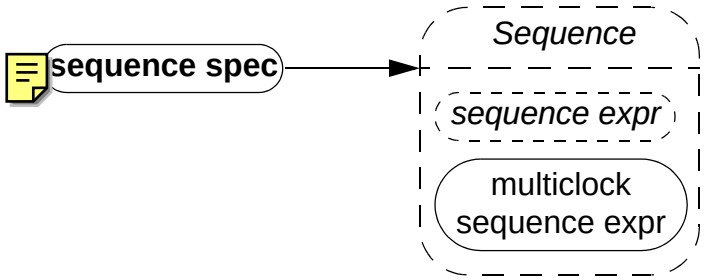

multiclock sequence expr
clocked seq
vpiOperand
clocking
bool: vpiClkEvent

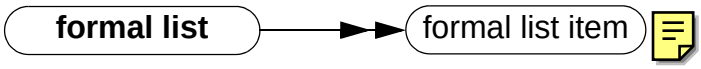

clocked seq
sequence expr
clocking event

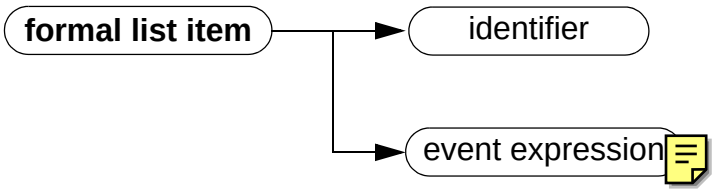

property inst
arguments
definition location
int: vpiDefLineNo
str: vpiDefFile
property decl

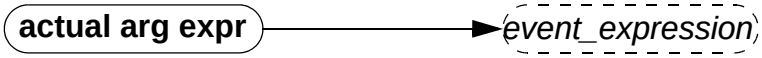


definition location
str: vpiDefFile
int: vpiDefLineNo
block identifier
str: vpiName
str: vpiFullName

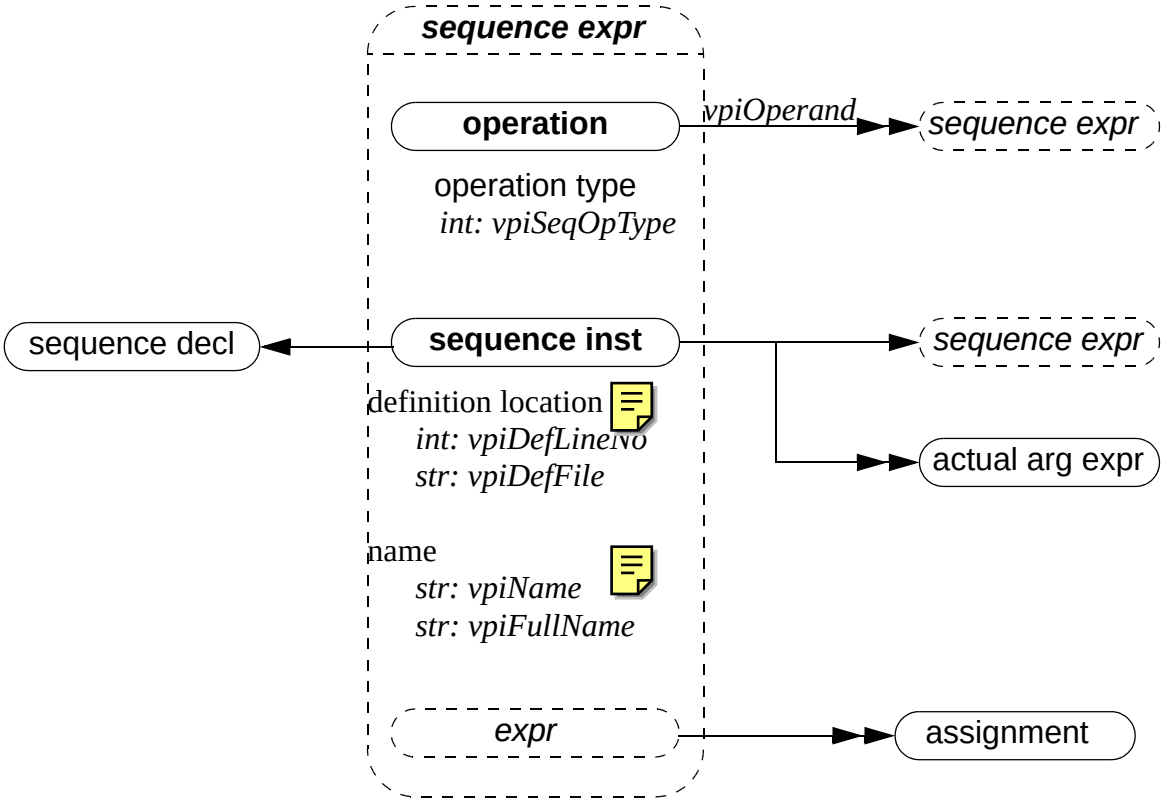






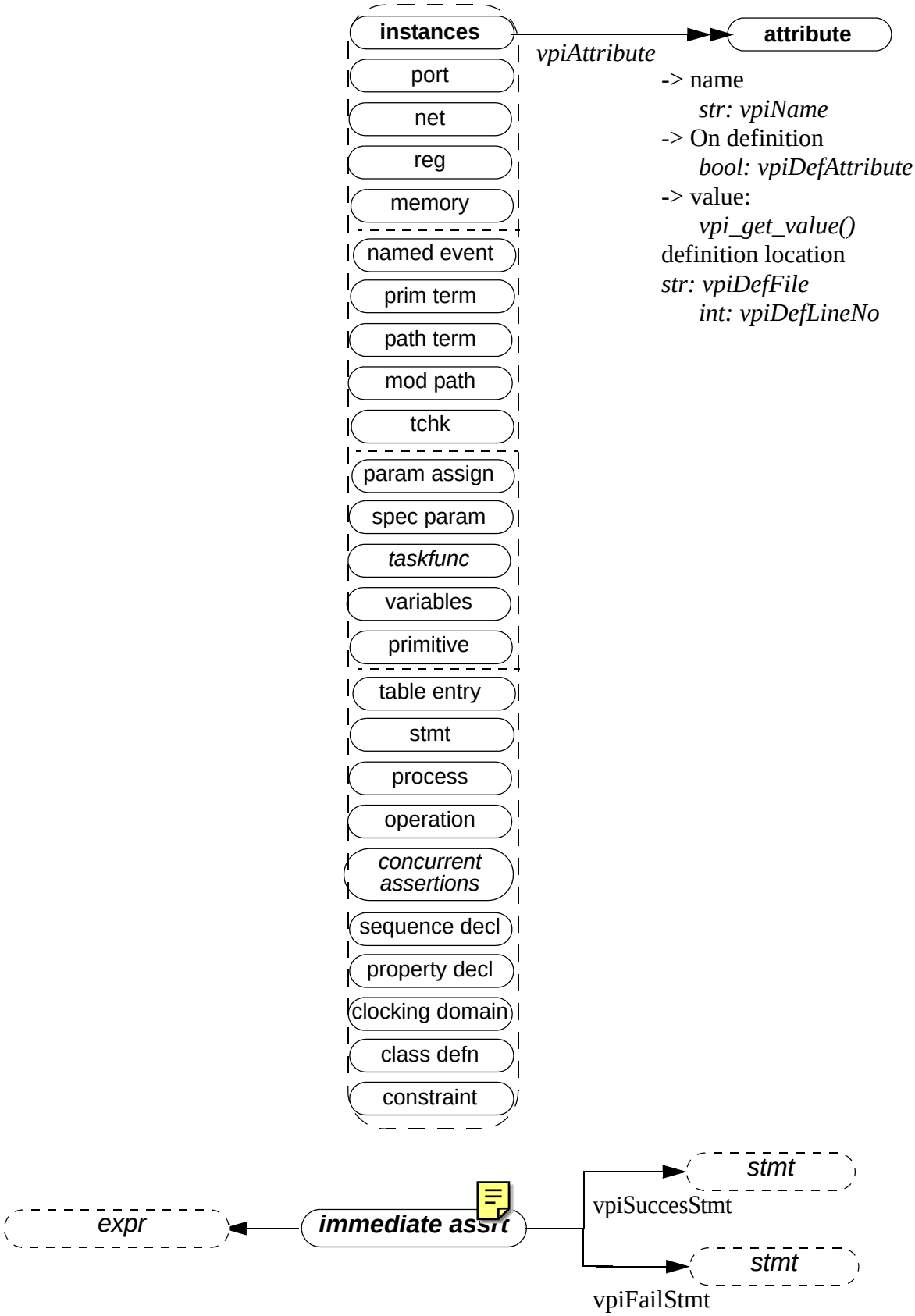


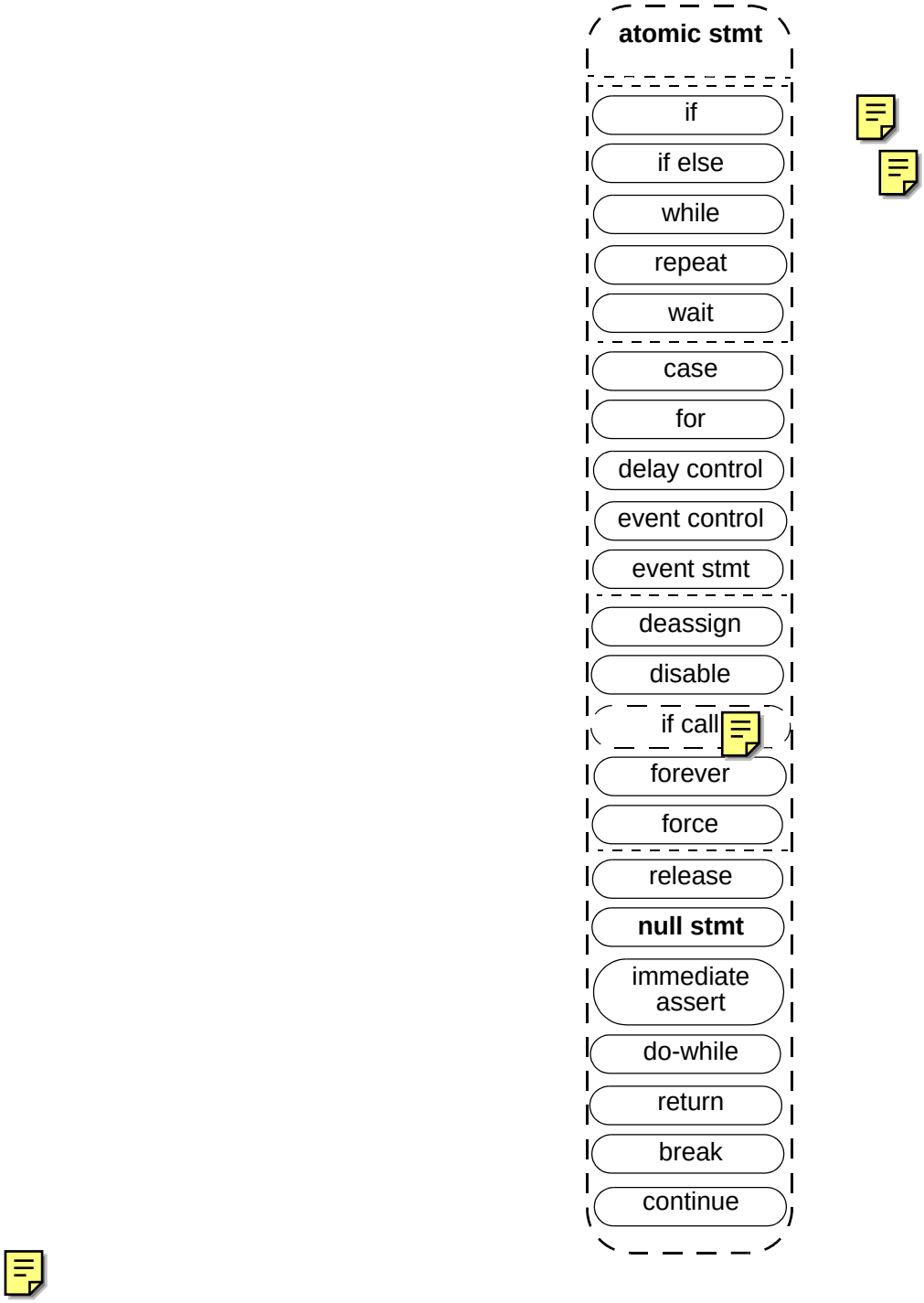
connected by name
bool: vpiConnectByName
explicitly named
bool: vpiExplicitName
argument index
int: vpiPortIndex
name
str:vpiName



int: vpiSeqOpType is one of:

and, **intersect, or,**
first_match,
throughout, within,
##,
[*], [*=], [*->]


instances
port
net
reg
memory
named event
prim term
path term
mod path
tchk
param assign
spec param
taskfunc
variables
primitive
table entry
stmt
process
operation
concurrent assertions
sequence decl
property decl
clocking domain
class defn
constraint
vpiAttribute
attribute
-> name
str: vpiName
-> On definition
bool: vpiDefAttribute
-> value:
vpi_get_value()
definition location
str: vpiDefFile
int: vpiDefLineNo
expr
immediate assrt
stmt
vpiSuccesStmt
stmt
vpiFailStmt


atomic stmt
if
if else
while
repeat
wait
case
for
delay control
event control
event stmt
deassign
disable
if call
forever
force
release
null stmt
immediate assert
do-while
return
break
continue