Babel/SIDL
Design by Contract: Status

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Overview

- Basic Constructs
- Impact on Babel/SIDL
- Status of Phase I
- Benefits
- Future Work

The SIDL grammar supports optional assertion and sequencing specifications.

- Packages & Versions
- Interfaces & Classes ←
- Inheritance Model
- Methods ←
- Method Modifiers
- Intrinsic Data Types
- Parameter Modes
- And more…

Optional **specifications added here**

Three classic assertion mechanisms supported in the interface descriptions.

Type	Specify…
Invariant	● unchanging properties of instances of a class ● must be true *upon* instance creation and preserved by all routines *before and after* every invocation
Precondition	● when it is valid to invoke a method ● must be true *prior to* invocation
Postcondition	● effects of a method and results it will return ● must be true *after* invocation

Plus method call invocation sequencing!

Method call sequencing enforcement is provided by Babel using object states.

Default initial state.

Explicit final state.

```
interface Vector {
  states { uninitialized, initialized[final] };

  void setData (in double data)
    require in uninitialized;
    ensure now_ready : in initialized;
  …
```

Transition to *initialized* is automatic if library call is successful and all (other) postconditions and invariants met.

Optional assertion label.

Vector.sidl

Pre- and post-conditions are typically used to constrain arguments and results.

Default initial state.

Explicit final state.

```
interface Vector {
  states { uninitialized, initialized[final] };
  …
  Vector axpy (in Vector a, in Vector x)
    require in initialized; a != NULL; x != NULL;
    ensure result_not_null : result != NULL;
  double norm ()
    require object_is_initialized : in initialized;
    ensure result >= 0.0; is pure;
```

An exception is raised if either preconditions or postconditions unmet.

Attributes of instance will *not* be changed.

Vector.sidl

Note: Argument a is vector instead of scalar for illustration purposes only.

A number of additions to the original SIDL grammar were made.

- **Clauses** states, invariant, require, require else, ensure, ensure then

Added for inheritance.

- **Conditional expressions**
  - Logical — implies, or, xor, and
  - Relational — ==, !=; <, <=, >=, >
  - Shift — <<, >>
  - Additive — +, -
  - Multiplicative — *, /, mod, rem
  - Unary — +, -, ~, not, in, is
  - Postfix — method call
  - Logical grouping — ()
- **Terminals** boolean, double, float, integer[1], long[1], character, string, identifier
- **Literal keywords** true, false, null, result, pure

[1]Decimal, Hexadecimal, and Octal.

Optional object states and invariants added to classes and interfaces.

```
Class ::=  [abstract] class name
           [extends scoped-class-name]
           [implements-all scoped-interface-name-list]
           { [ ObjectStates ] [ Invariants ]
            class-methods-list
           } [;]

Interface ::=
            interface name
            [extends scoped-interface-name-list]
            { [ ObjectStates ] [ Invariants ]
              methods-list
            } [;]
```

Object states definition is used to specify list of valid states.

```
ObjectStates ::= states {
                   state-1 [ initial | final ]
                   [, state-2 [ initial | final ] ]
                   …
                   [, state-n [ initial | final ] ]
                   } [;]
```

Default initial state is first item in list.

Default final state is last item in list.

```
states { uninitialized, initialized[final] };
```

Explicit final state.

Invariant definition is used to specify unchanging properties of objects.

```
Invariants ::= invariant AssertionList;

AssertionList ::= [label-1 :] AssertionExpression-1;
                  [[label-2 :] AssertionExpression-2;]
                  …
                  [[label-n :] AssertionExpression-n;]
```

An "is pure" method must be specified elsewhere in this interface.

```
invariant {non-negative : entriesAreNonNegative()};
```

Optional assertion label for debugging messages.

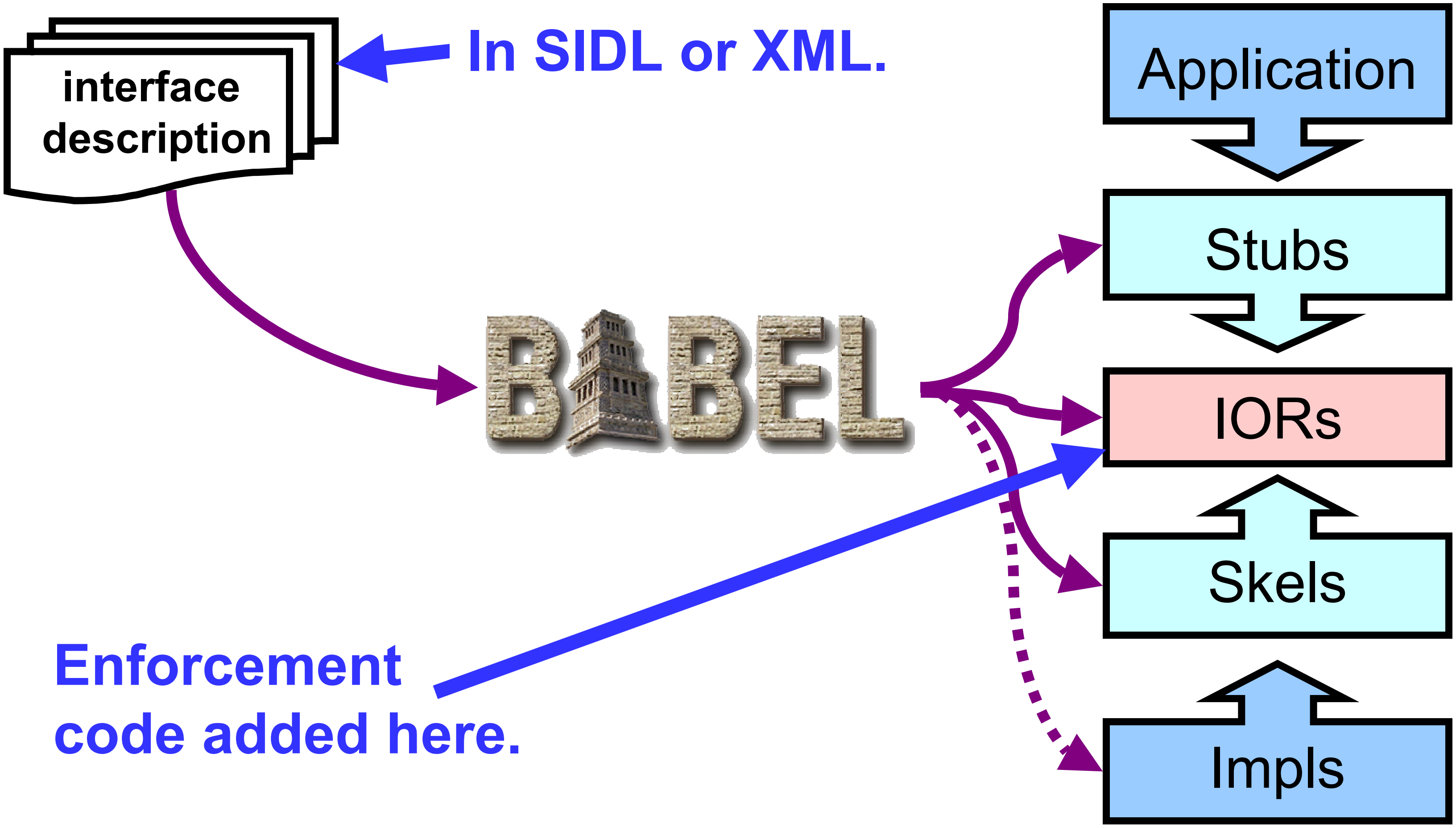
Method definitions allow specification of pre- and post-conditions.

```
ClassMethod ::=    [ ( abstract | final | static ) ]
                  Method

Method ::= ( void | [ copy ] Type ) name [ extension ]
            ( [ ArgumentList ] )
            [ local | oneway ]
            [ throws ScopedExceptionList ]
            [ Requires ] [ Ensures ] ;

Requires ::= require [ else ] AssertionList ;

Ensures ::= ensure [ then ] AssertionList ;
```

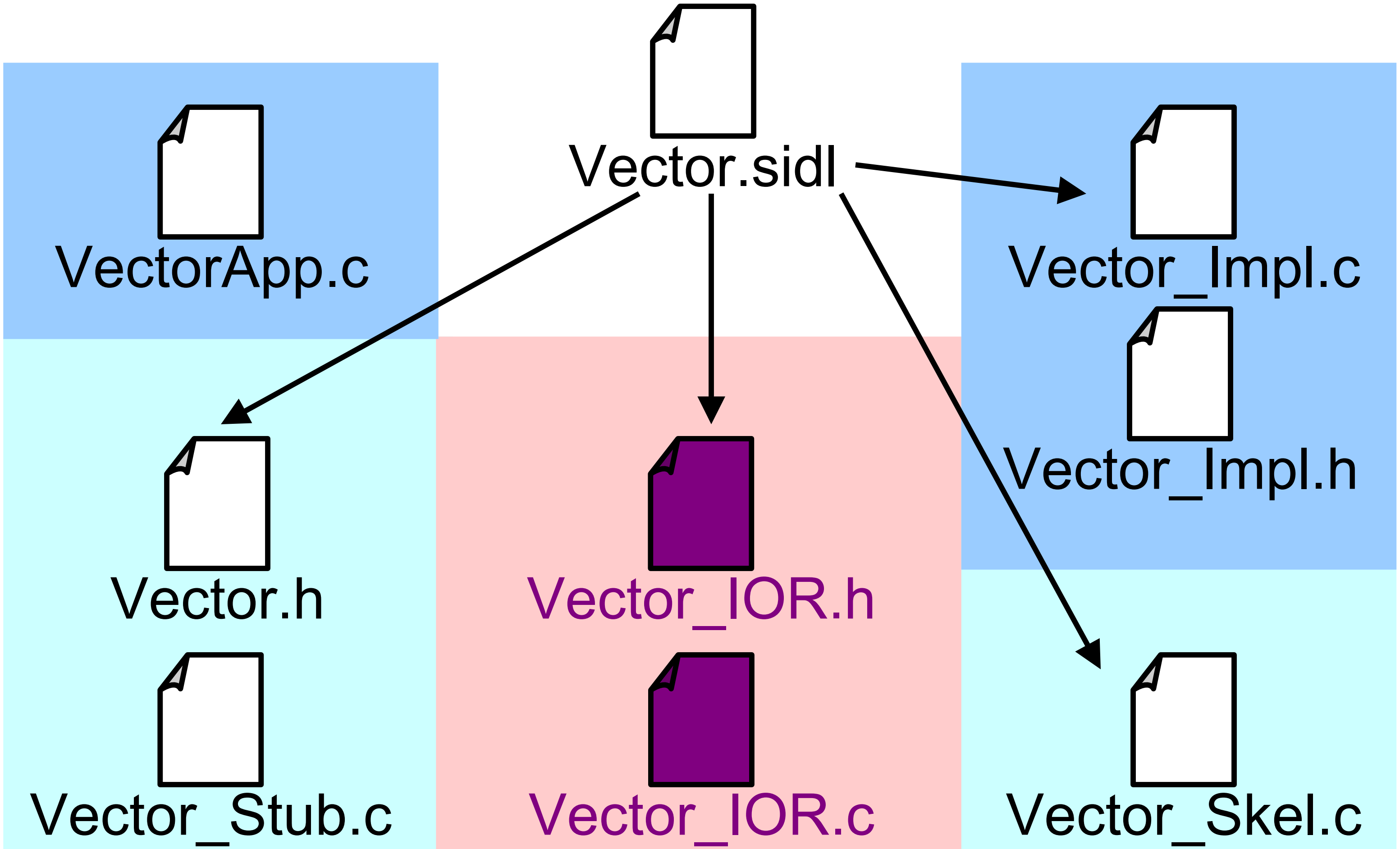
The modifications had a significant impact on the grammar and symbol table.

Area	Impact
SIDL Grammar	• Added — 42 terminal symbols/lexical tokens (↑ 91%) — 21 productions (↑ 140%) • Modified 3 productions
Symbol Table	• Added 17 classes (↑ 77%) • Modified 4 classes
XML DTD	• Added 5 elements (↑ 22%) • Modified 3 elements

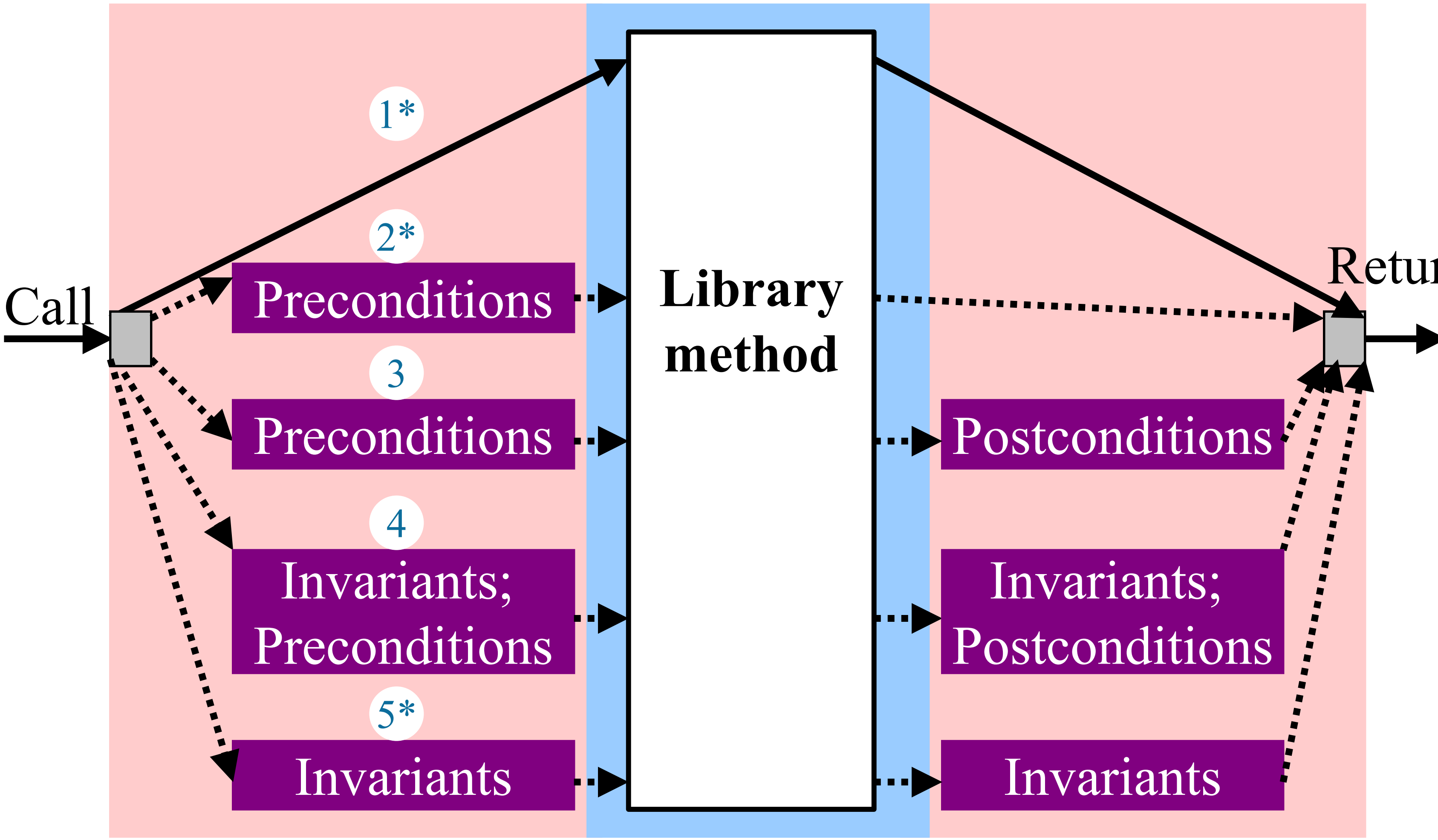
Expanded glue code generated from enhanced interface descriptions.



The generated checks added to the IOR files.



Five basic execution paths available through the IOR.



*Method call sequencing enforcement cannot be supported.

There are still several features that need to be completed/addressed.

- DTD/XML support
- Assertion enforcement options
  - Dynamic switching basis
    - Class, object, method, etc.
  - Assertion type combinations
    - Preconditions only, pre & post, invariants, etc.
  - Assertion expression evaluation levels
    - State checks only, cheap only, etc.
- Generated code

Benefits of including these contracts in Babel/SIDL include…

- Better designs and documentation
  - Behavior and call ordering more explicit
- Improved debugging and reliability
  - Runtime checking of consistency between specifications and code
  - Runtime checking of client call ordering
- Better support for reuse
- Supported regardless of native support in the underlying implementation language

Future work focuses on adding and/or exploring additional features such as…

- Terminals
  - float and double complex
  - non-primitive SIDL types (e.g., arrays)
- Operation: power x^y
- Literal keyword: old
  - Pre-method state?
  - Guarded postconditions associated with superclasses
    (old precondition) implies original_postcondition
- Assertion exception policies
- Domain-specific features – to be determined

An assessment of your level of interest and anticipated usefulness is needed.

- **Is this capability of interest to you? Why or why not?**
- **Do you anticipate adopting this at some point? If so, within what context?**

Thank You!