



**CCA**  
Common Component Architecture

## Language Interoperable CCA Components via



**CCA Forum Tutorial Working Group**

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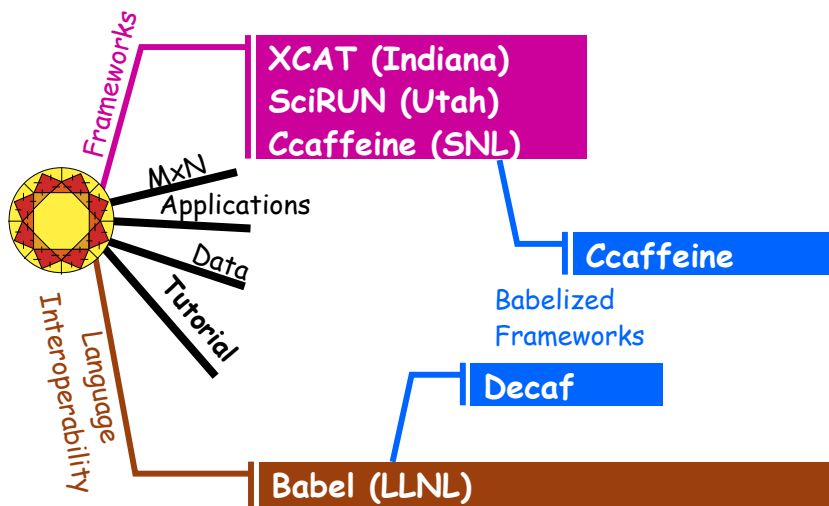
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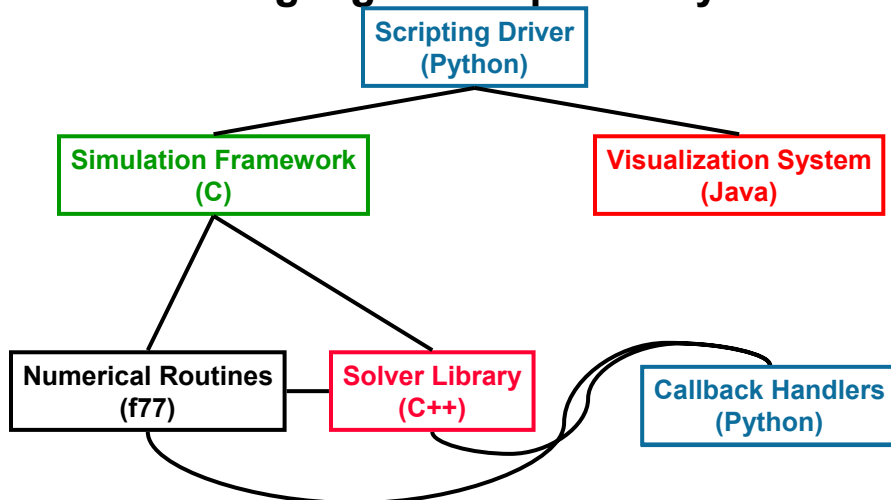
**CCA**  
Common Component Architecture

Babel

## History of Babel & CCA

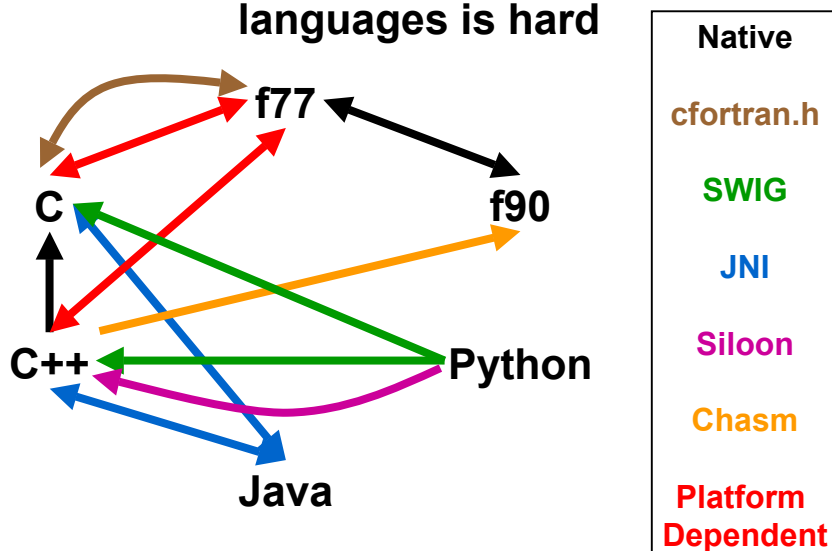


## What I mean by “Language Interoperability”



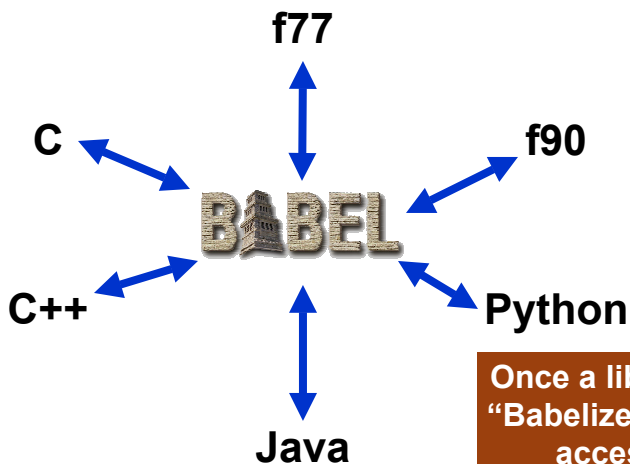
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## One reason why mixing languages is hard



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**Babel makes all supported languages peers**



**This is not an LCD Solution!**

**Once a library has been "Babelized" it is equally accessible from all supported languages**

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## Babel Module's Outline

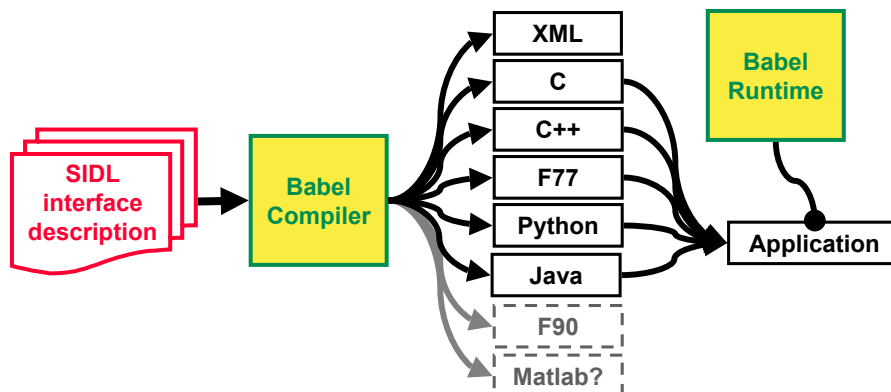
- Introduction
- ➡ Babel Basics
  - What Babel does and how
  - How to use Babel
  - Concepts needed for future modules
- Babel & CCA
  - Decaf Framework
  - Building language independent CCA components
  - Demo

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## Babel's Mechanism for Mixing Languages

- Code Generator

- Runtime Library



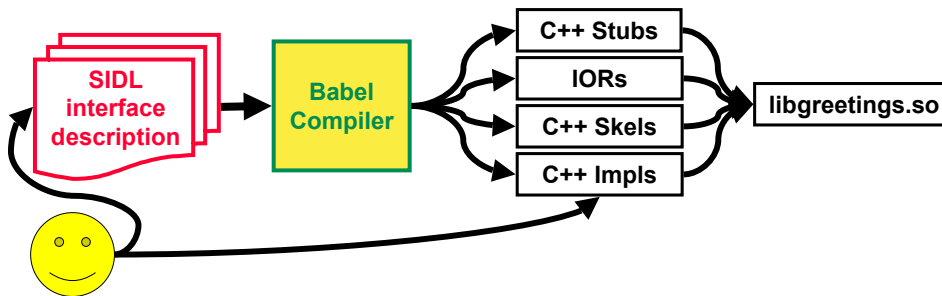
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## greetings.sidl: A Sample SIDL File

```
version greetings 1.0;
package greetings {
    interface Hello {
        void setName( in string name );
        string sayIt ( );
    }
    class English implements-all Hello { }
}
```

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## Library Developer Does This...



- `babel --server=C++ greetings.sidl`
- Add implementation details
- Compile & Link into Library/DLL

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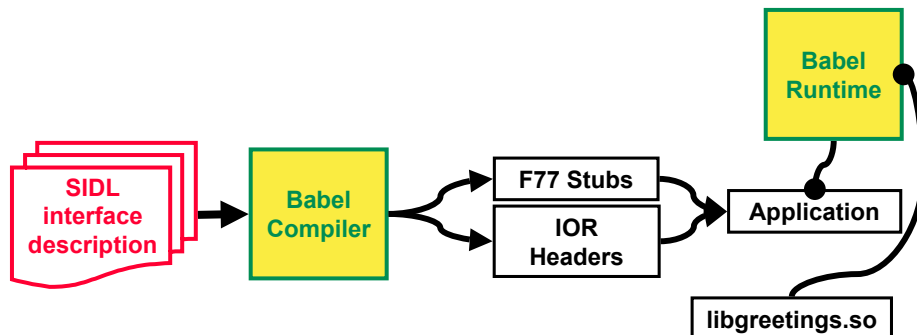
## Adding the Implementation

```
namespace greetings {  
class English_impl {  
private:  
    // DO-NOT-DELETE splicer.begin(greetings.English._impl)  
    string d_name;  
    // DO-NOT-DELETE splicer.end(greetings.English._impl)
```

```
string  
greetings::English_impl::sayIt()  
throw ()  
{  
    // DO-NOT-DELETE splicer.begin(greetings.English.sayIt)  
    string msg("Hello ");  
    return msg + d_name + "!";  
    // DO-NOT-DELETE splicer.end(greetings.English.sayIt)  
}
```

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## Library User Does This...



- `babel --client=F77 greetings.sidl`
- Compile & Link generated Code & Runtime
- Place DLL in suitable location

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## SIDL 101: Classes & Interfaces

- SIDL has 3 user-defined objects
  - **Interfaces** – APIs only, no implementation
  - **Abstract Classes** – 1+ methods unimplemented
  - **Concrete Classes** – All methods are implemented
- Inheritance (like Java/Objective C)
  - Interfaces may **extend** Interfaces
  - Classes **extend** no more than one Class
  - Classes can **implement** multiple Interfaces
- Only concrete classes can be instantiated

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## SIDL 101: Methods and Arguments

- Methods are **public virtual** by default
  - **static** methods are not associated with an object instance
  - **final** methods can not be overridden
- Arguments have 3 parts
  - Mode: can be **in**, **out**, or **inout** (like CORBA)
  - Type: one of (bool, char, int, long, float, double, fcomplex, dcomplex, array<Type,Dimension>, enum, interface, class )
  - Name:

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## Babel Module's Outline

- Introduction
- Babel Basics
  - What Babel does and how
  - How to use Babel
  - Concepts needed for future modules



### Babel & CCA

- History & Current directions
- Decaf Framework
- Building language independent CCA components
- Demo

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## Decaf Details & Disclaimers

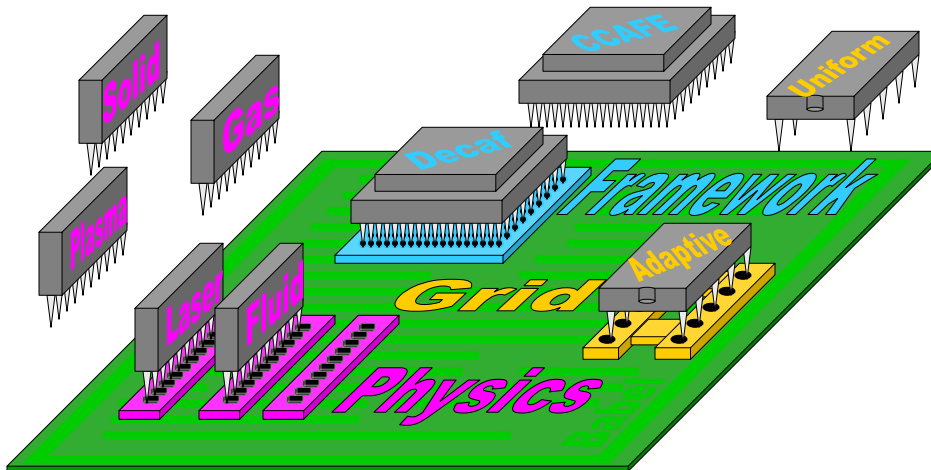
- Babel is a hardened tool
- Decaf is an example, not a product
  - Demonstrate Babel's readiness for "real" CCA frameworks
  - Maintained as a stopgap
  - Distributed in "examples" subdirectory of Babel
- Decaf has no GUI

## The CCA Spec is a SIDL File

```
version gov.cca 0.6;
package gov {
package cca {
    interface Port { }
    interface Component {
        void setServices( in Services svcs );
    }
    interface Services {
        Port getPort( in string portName );
        registerUsesPort( /*etc*/ );
        addProvidesPort( /*etc*/ );
    }
    /*etc*/
}
```

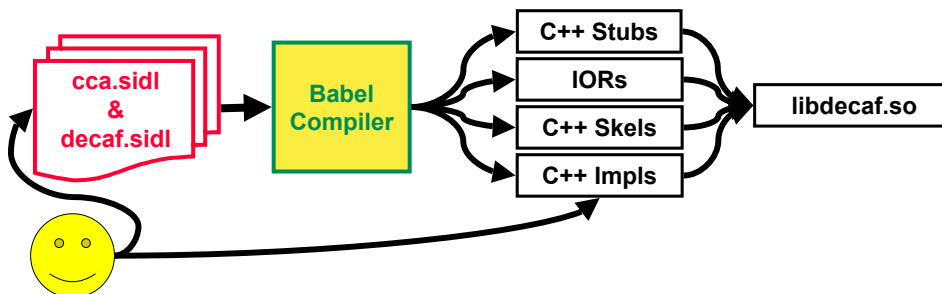


## The CCA from Babel's POV



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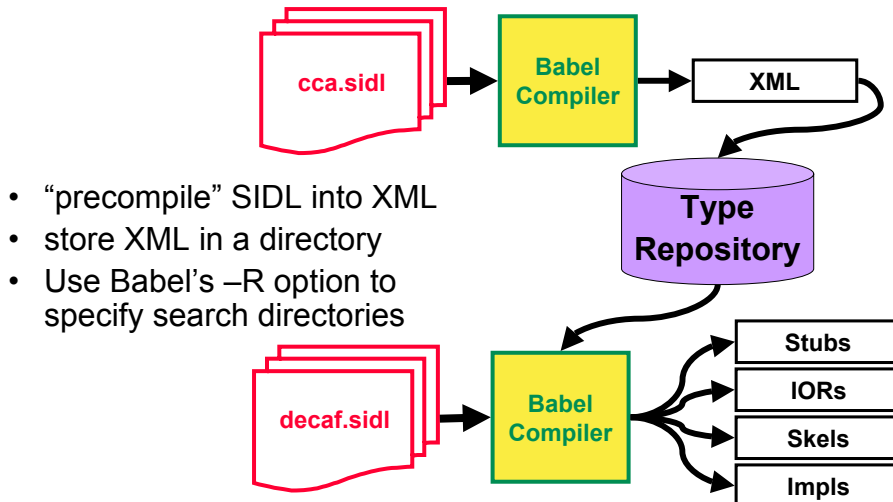
## How I Implemented Decaf



- wrote decaf.sidl file
- `babel --server=C++ cca.sidl decaf.sidl`
- Add implementation details
- Compile & Link into Library/DLL

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## An Extra Babel Tip



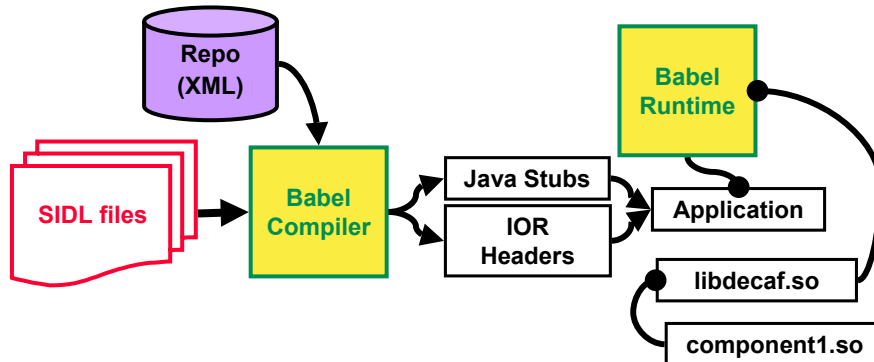
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## How to Use CCA Components and Decaf

- Decaf doesn’t provide a GUI
- Simply program by explicitly
  - creating components
  - connecting ports
  - invoking the “goPort”
- Use Babel as needed to generate bindings in your language of choice
- Make sure Babel Runtime can locate DLLs for Decaf and any CCA components.

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## To Use the Decaf Framework



- `babel --client=Java -Rrepo function.sidl`
- Compile & Link generated Code & Runtime
- Place DLLs in suitable location

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## Example: A Driver in Python

```

import decaf.Framework
import gov.cca.ports.GoPort
if __name__ == '__main__':
    fwk = decaf.Framework.Framework()

    server = fwk.createInstance( "ServerName",
                                "HelloServer.Component", 0 )
    client = fwk.createInstance( "ClientName",
                                "HelloClient.Component", 0 )

    fwk.connect(server,"HelloPort",
               client,"HelloPort" )

    port = fwk.lookupPort(client,"GoPort")
    go = gov.cca.ports.GoPort.GoPort( port )
    go.go()
  
```

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## How to Write and Use Babelized CCA Components

- Define “Ports” in SIDL
- Define “Components” that implement those Ports, again in SIDL
- Use Babel to generate the glue-code
- Write the guts of your component(s)

## How to Write A Babelized CCA Component (1/3)

- Define “Ports” in SIDL
  - CCA Port =
    - a SIDL Interface
    - extends gov.cca.Port

```
version functions 1.0;  
  
package functions {  
    interface Function extends gov.cca.Port {  
        double evaluate( in double x );  
    }  
}
```

## How to Write A Babelized CCA Component (2/3)

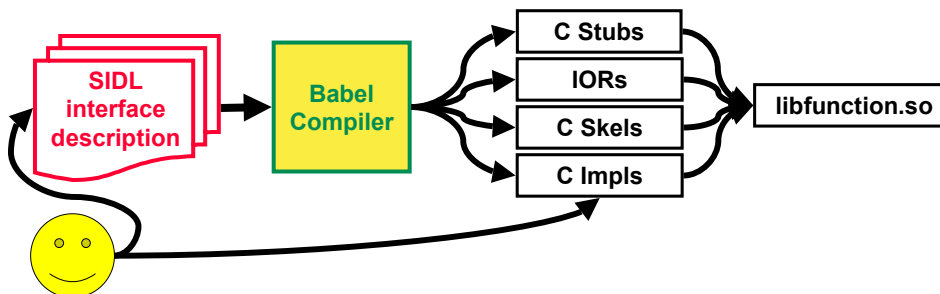
- Define “Components” that implement those Ports
  - CCA Component =
    - SIDL Class
    - implements gov.cca.Component (& any provided ports)

```
class LinearFunction implements functions.Function,
                                gov.cca.Component {
    double evaluate( in double x );
    void setServices( in cca.Services svcs );
}
```

```
class LinearFunction implements-all
    functions.Function, gov.cca.Component { }
```

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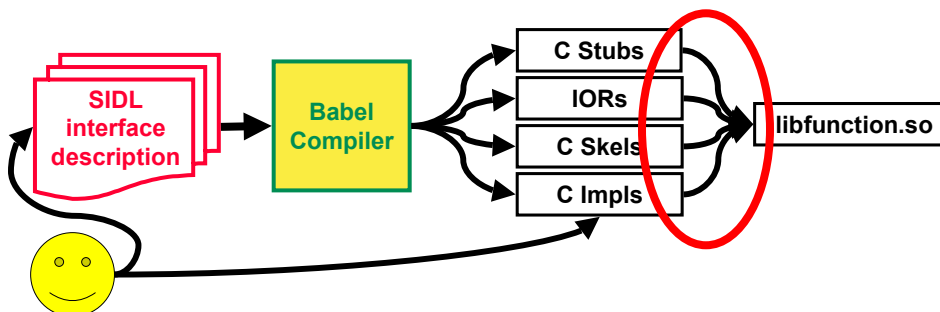
## How to Write A Babelized CCA Component (3/3)



- Use Babel to generate the glue code
  - `babel --server=C --repo function.sidl`
- Add implementation details

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## What's the Hardest Part of this Process?



- Properly building dynamically loadable .so files.

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## Review of “Linkage”

- Static Linked Libraries (\*.a)
  - Symbols are hardcoded
  - Resolved at link-time of application
- Shared Object Libraries (\*.so)
  - Symbols are hardcoded
  - Symbols resolved at load time ( before main() )
- Dynamically Loaded Libraries (\*.so) (\*.dll in Win32)
  - Symbols are determined at run time (by app code)
  - Symbols resolved at run time ( void\* dlopen( char\* ) )

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## What goes into a DLL?



libfoo.so

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## What goes into a DLL?

1. The Type's Impl
  - Where all the guts of the component lives.



libfoo.so

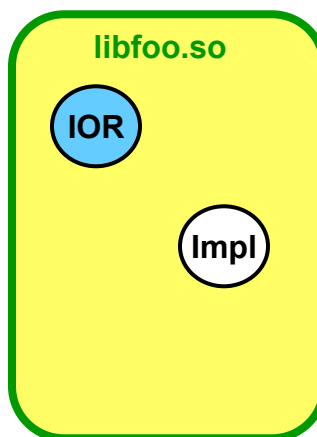
Impl

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## What goes into a DLL?

### 2. The Type's IOR

- IORs (Intermediate Object Representation)
- Always implemented in ANSI C
- Babel Object Model is implemented in IOR
- Dynamic Loading is based on symbols in IOR

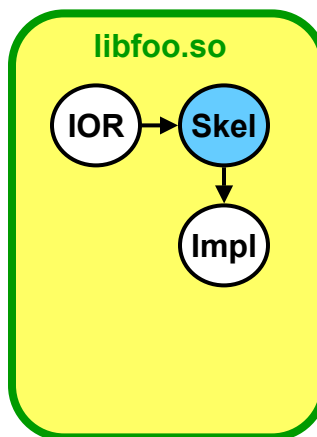


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## What goes into a DLL?

### 3. The Type's Skel

- IORs depend on the Skels
- Skels translate from ANSI C to Impl language
- Skels call Impls



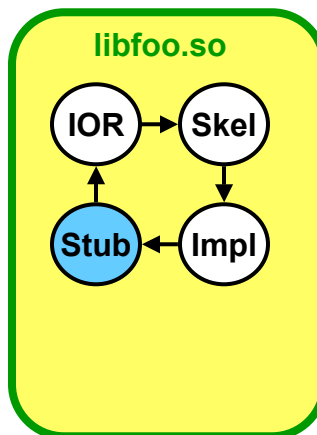
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## What goes into a DLL?

### 4. The Type's Stub

- Impl depends on Stubs
  - class needs to call methods on itself
  - Like “this” pointer in C++
  - self in Python
- Stubs translate from application Language to ANSI C

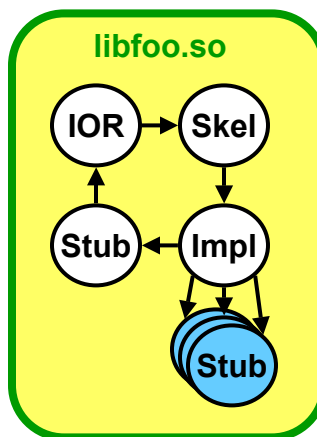


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## What goes into a DLL?

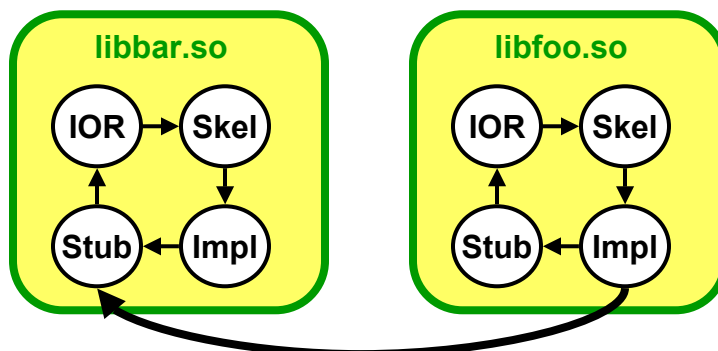
### 5. Stubs for all the other types that are

- passed as arguments,
- return values, or
- manipulated internally in the Type's Impl



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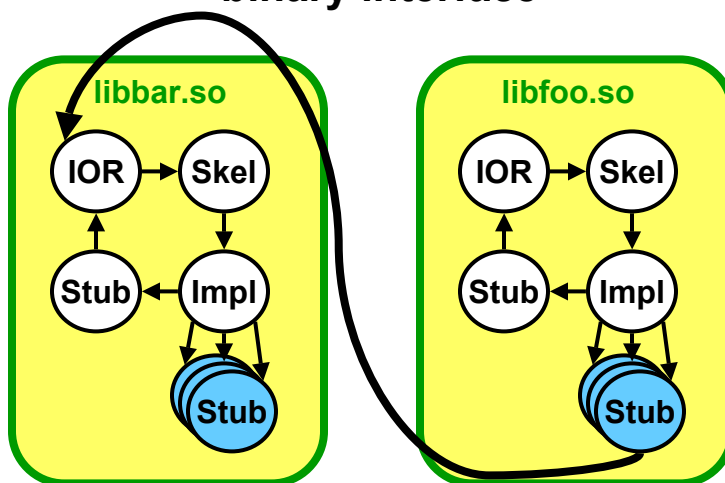
**Q: Why not keep each Stub exclusively with its own Impl?**



**A:** Works only if bar\_Impl and foo\_Impl are implemented in the same language

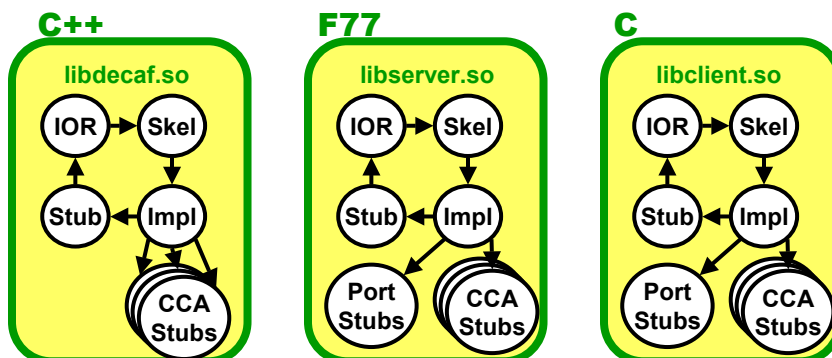
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**IORs provide a language-independent binary interface**



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## What you'll see with the upcoming "Hello World" demo



And a "main" in any of



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## Contact Info

- Project: <http://www.llnl.gov/CASC/components>
  - Babel: language interoperability tool
  - Alexandria: component repository
  - Quorum: web-based parliamentary system
  - Gauntlet (coming soon): testing framework
- Bug Tracking: <http://www-casc.llnl.gov/bugs>
- Project Team Email: [components@llnl.gov](mailto:components@llnl.gov)
- Mailing Lists: [majordomo@lists.llnl.gov](mailto:majordomo@lists.llnl.gov)
  - subscribe babel-users [email address]
  - subscribe babel-announce [email address]

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