BABEL-ized Libraries Make Large Scale Software Easier to Fabricate, Maintain, and Evolve

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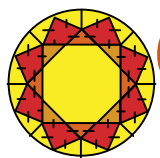
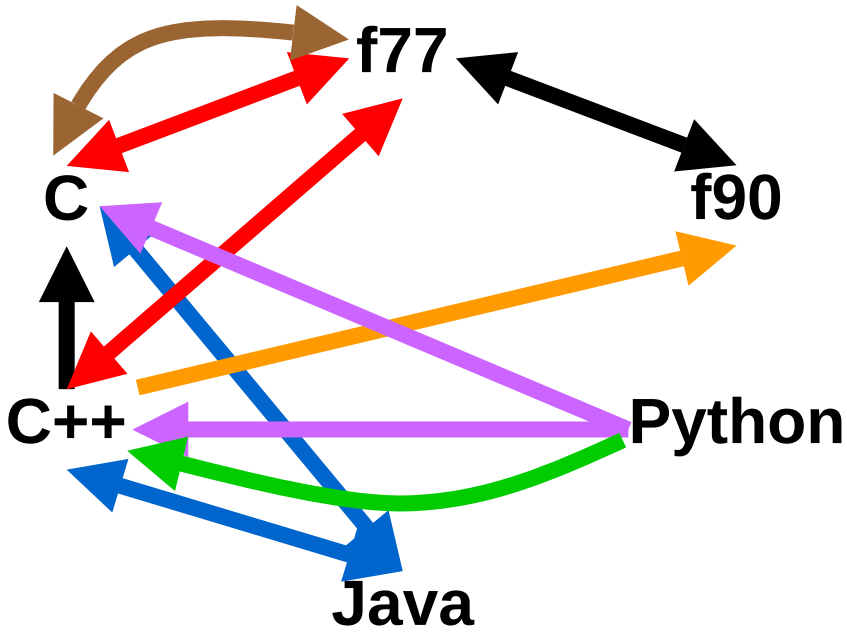
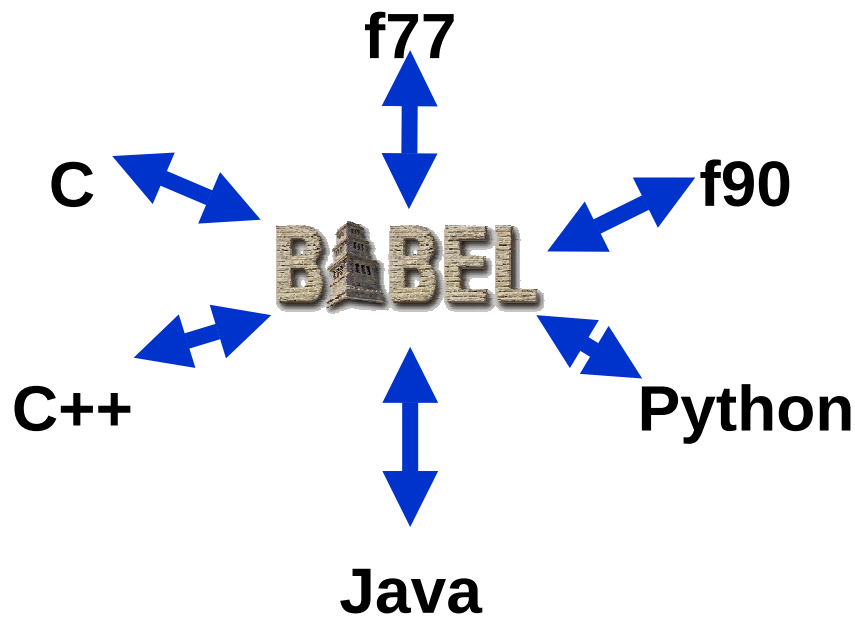


CCA
Common Component Architecture

Babel: Tool of choice for mixing more than 2 languages

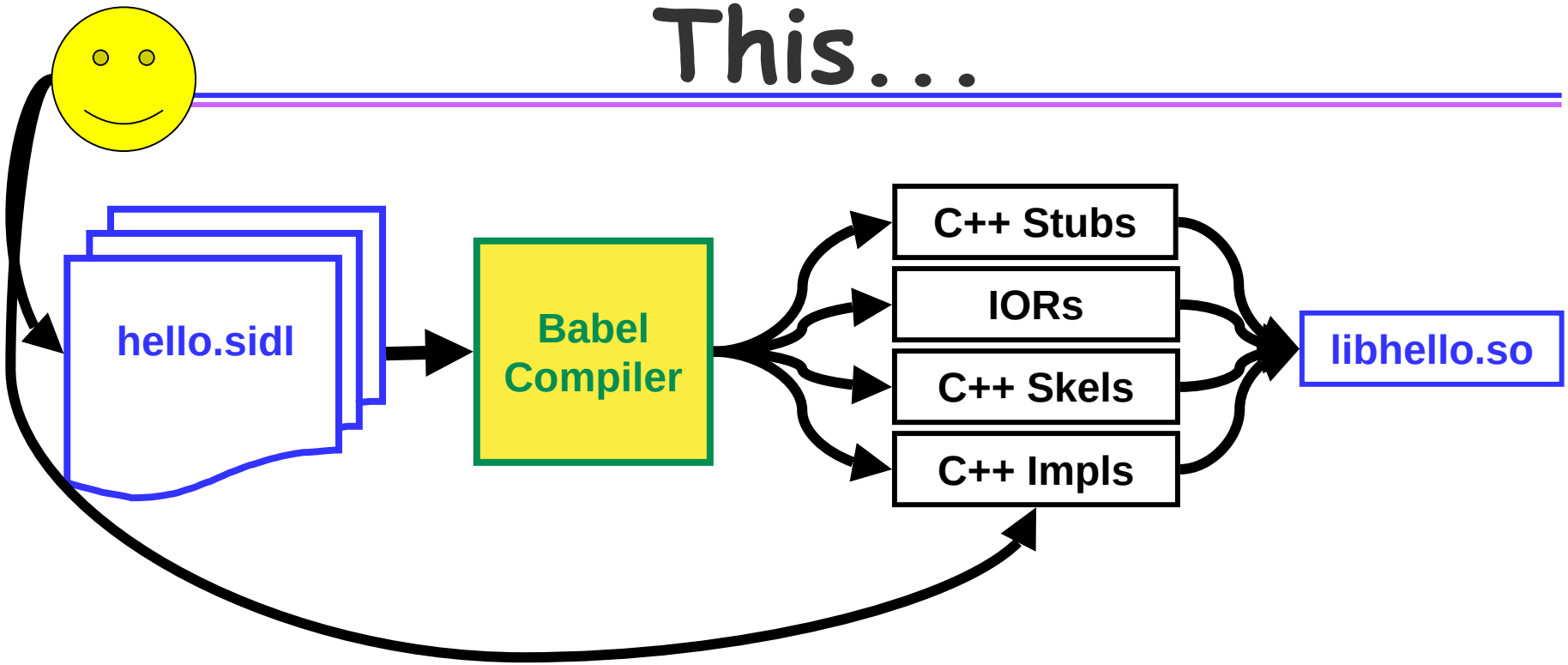


Native	cfortran.h
SWIG	JNI
Siloon	Chasm
Platform	Dependent



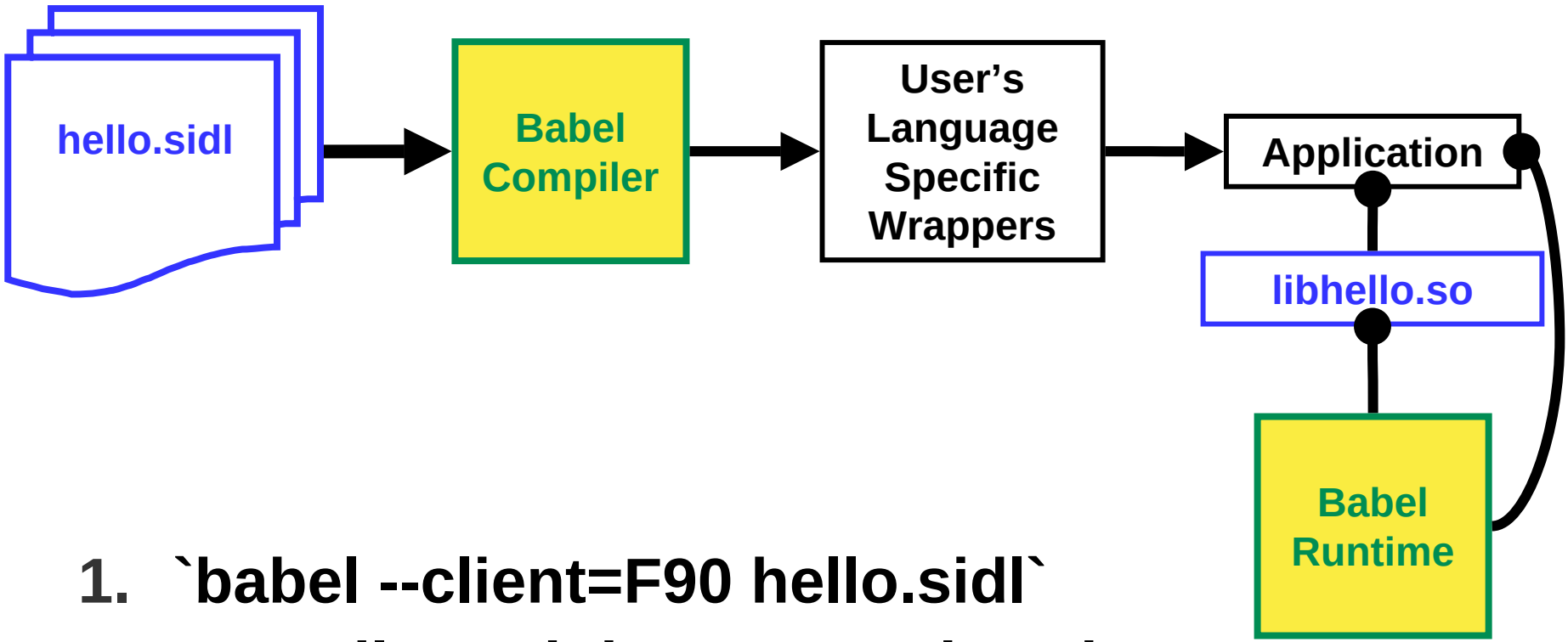
Not a LCD Solution.
Supports polymorphism, reference counting, and exceptions in all languages.

Library Developer Does This...



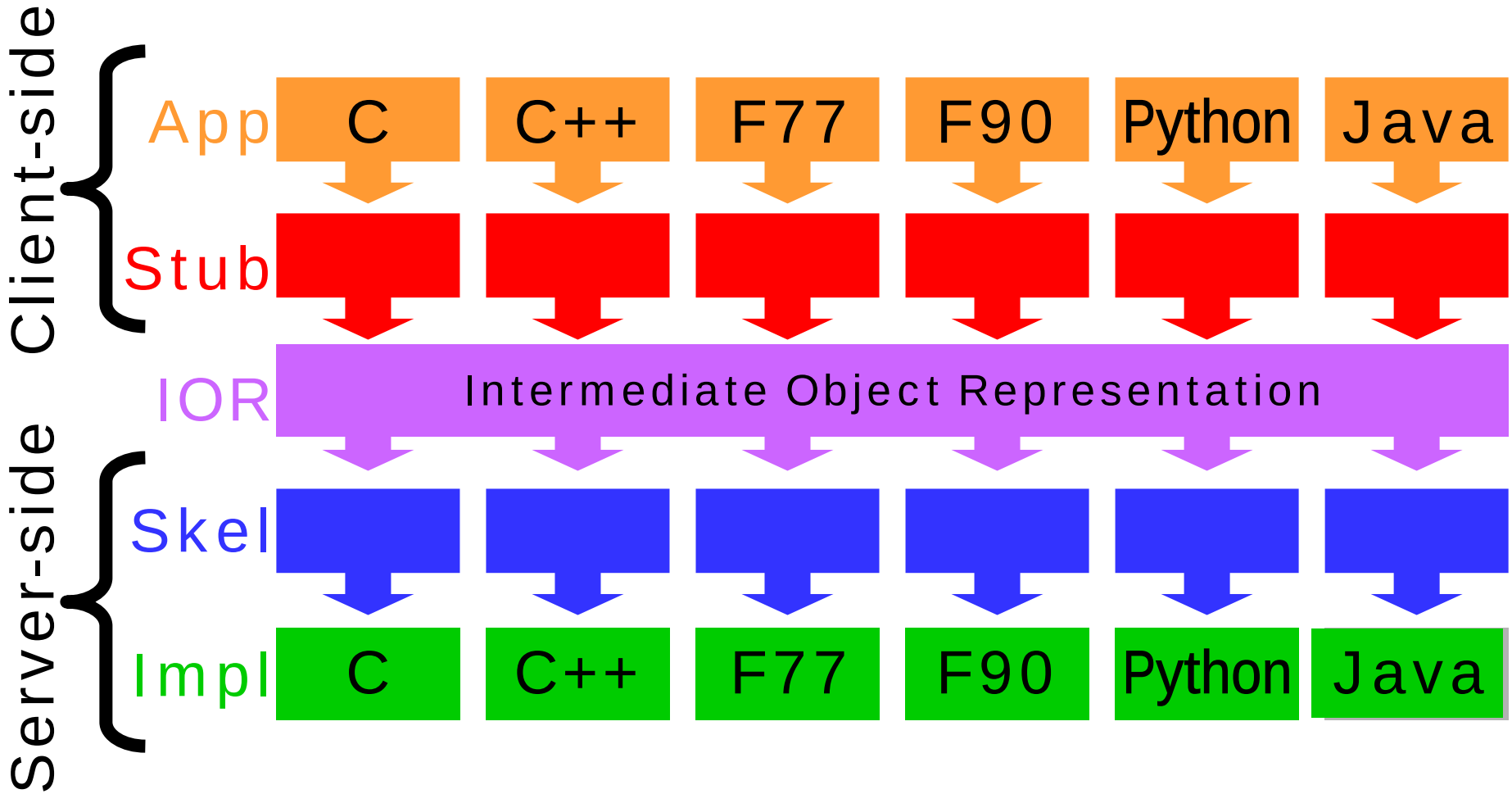
1. Write SIDL File
2. `babel --server=C++ hello.sidl`
3. Add implementation details
4. Compile & Link into Library/DLL

Library User Does This...



1. `babel --client=F90 hello.sidl`
2. Compile & Link generated Code & Runtime
3. Place DLL in suitable location

Another view of Babel's 2-Stage Wrapping Architecture



New Story

Babel is a Language Interoperability Tool, but...

... observed recurring themes (benefits) when Babel was applied in scientific software, not directly related to mixing languages

Babel and Fabrication of Large Scale Scientific SW

- Automates the tedious and mechanical process of connecting languages
- SIDL as a design & negotiation tool
- Reduce dependency entanglement among developers
  - Software expert does SIDL design
  - Everyone else codes whatever they like (in whatever language they like) to add implementation to stubbed out codes
  - Maps well to multidisciplinary teams

Fabrication Examples

- SIDL supports multi-lingual standards
  - CCA, TSTT, TOPS
- People like arguing designs in SIDL
  - Easy to pick up
  - No distracting implementation details
  - Easy to e-mail, no special editors (like UML)
- Hypre is mostly numerical researchers, not OOP software engineers.
  - Lead controls the interfaces
  - Researchers implement the guts

Babel and Maintenance of Large Scale Scientific SW

- Preserve functionality & correctness in the face of external change
- Generated language wrappers are more robust and portable than ad-hoc solutions.
- Babel adds new languages ~ 1/year
- Good software practices encoded in Babel avoids lots of bugs
  - reference counting
  - exception handling
  - semantic checking (in development)

Maintenance Example

- **NWChem uses Babel to connect Fortran 77 to Fortran 77**
  - **2 Fortran 77 codes, some C in each**
  - **Fortran 77 has no binary standard**
    - **some add an underscore to linker symbols**
    - **some don't**
    - **g77 adds two if one already exists, just one otherwise**
  - **The two codes weren't designed for each other, and each made a different assumption.**
  - **They found it easier to wrap both in Babel and let Babel hide the underscore issue inside each library**

Babel and the Evolution of Large-Scale Scientific SW

- Internal change for new capabilities
- Fast Prototyping with Scripting
  - Empower and exploit creativity of users
- High Performance with compiled code
- Polymorphism – create new functionality without
  - Changing existing code
  - Making lots of copies

Evolution Example

- **CCA Forum**
  - **started with 3 “reference frameworks”**
    - **none were interoperable**
  - **Babel later adopted for frameworks to support components multiple languages**
    - **Side effect: Also made components work with frameworks in multiple languages.**
  - **Next generation of CCA frameworks (Ccaffeine, XCAT3 and SCIRun2) will all seamlessly load each other’s Babelized components.**
    - **Will also bridge between older component models and Babel**
    - **Frameworks can also expose themselves as a component to another framework**

Scientific Computing Software is Dominated by Change

- **Changed more often than software of similar size in other fields**
  - **A twenty-year-old LLNL program changed substantively 75 times in one year. It was not a period of major new development or a new machine.** -- Paul F. DuBois, LLNL
- **Both developers and users make changes**
- **Software changes track scientific progress (hard to predict)**
- **Application area may change or expand**
- **Hardware will change, especially high performance, large-scale exotics**

Babelized Libraries appear very "Change Oriented."

- **Project:** http://www.llnl.gov/CASC/components
- **Project Team Email:** components@llnl.gov
- **Mailing Lists:** majordomo@lists.llnl.gov

  subscribe babel-users *[email address]*

  subscribe babel-announce *[email address]*