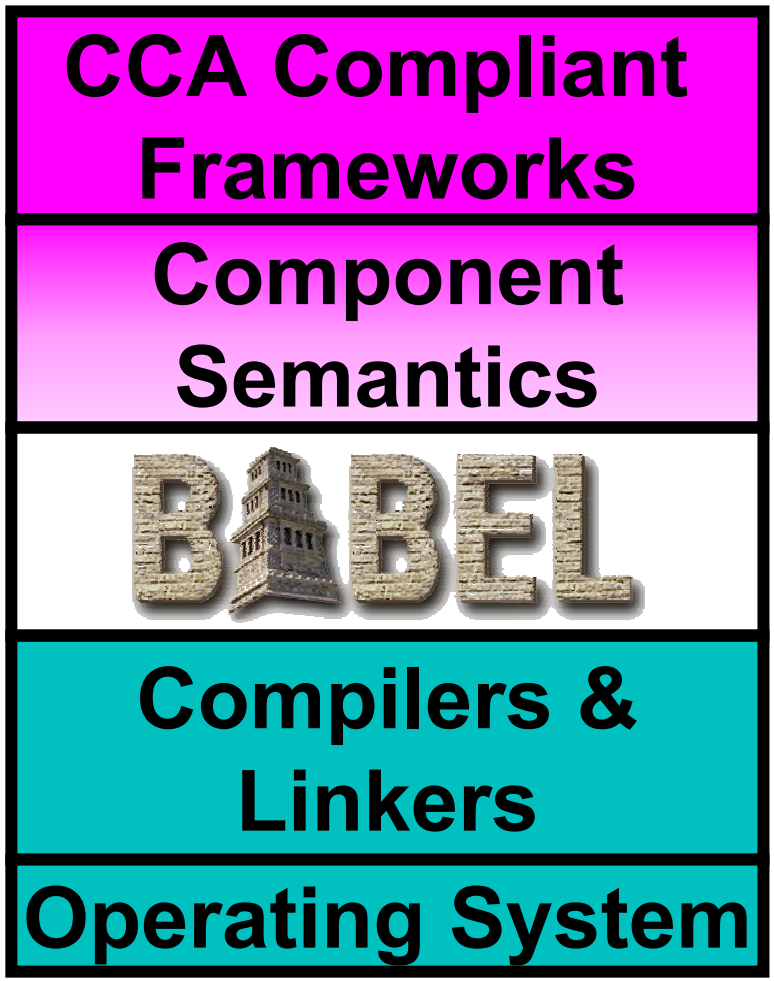
Achieving Language Interoperability with

Gary Kumfert
with
Bill Bosl, Tammy Dahlgren,
Tom Epperly, Scott Kohn, &
Steve Smith

Babel's Scope & CCA



- Babel provides language interoperability, not components.
- We collaborate with CCA to add parallel distributed support
- We also provide tools (Quorum & Alexandria) to facilitate component development and deployment

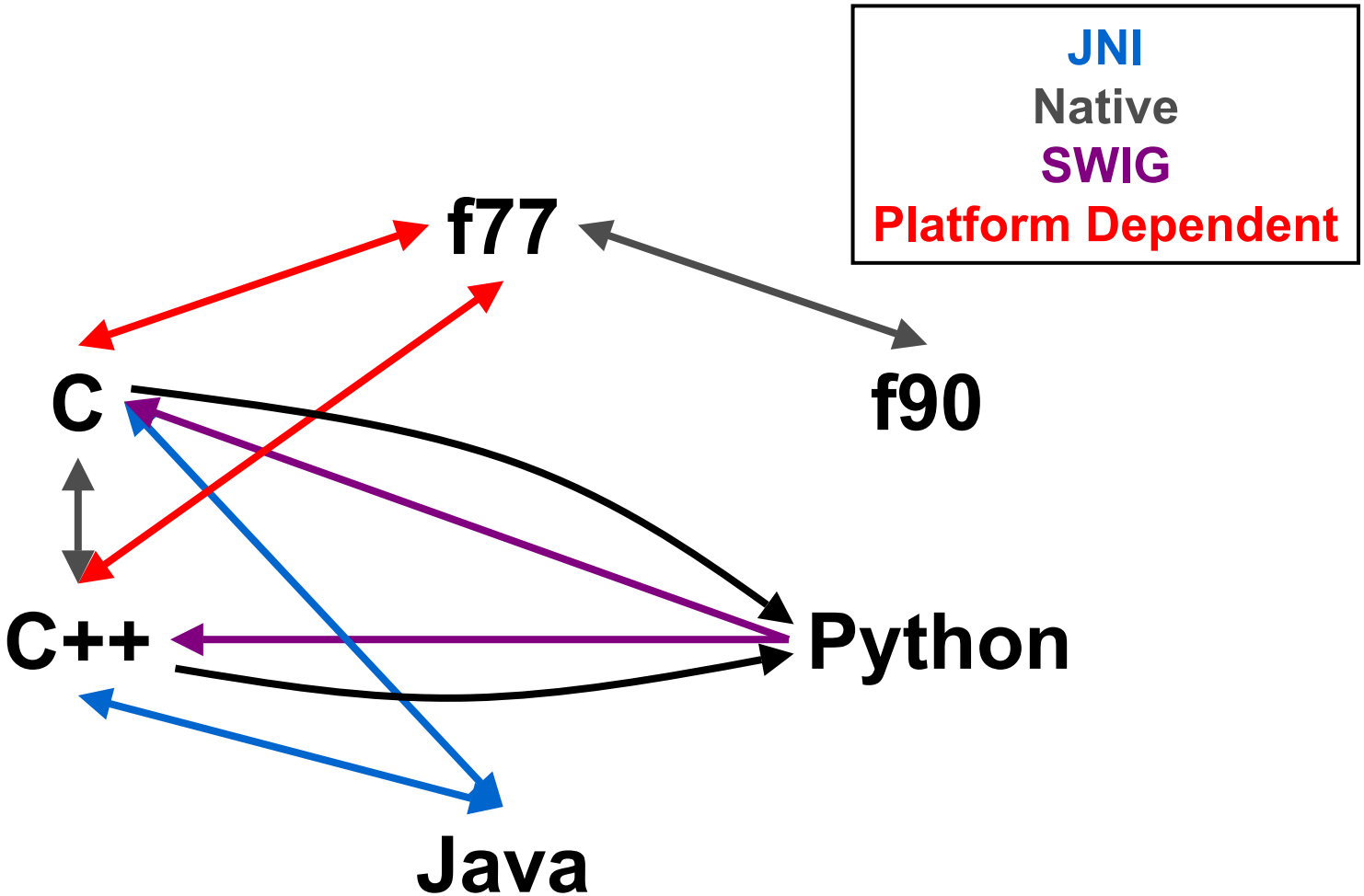
Release Announcement

- C, C++, F77, Python(client)

babel-0.5.0.tar.gz

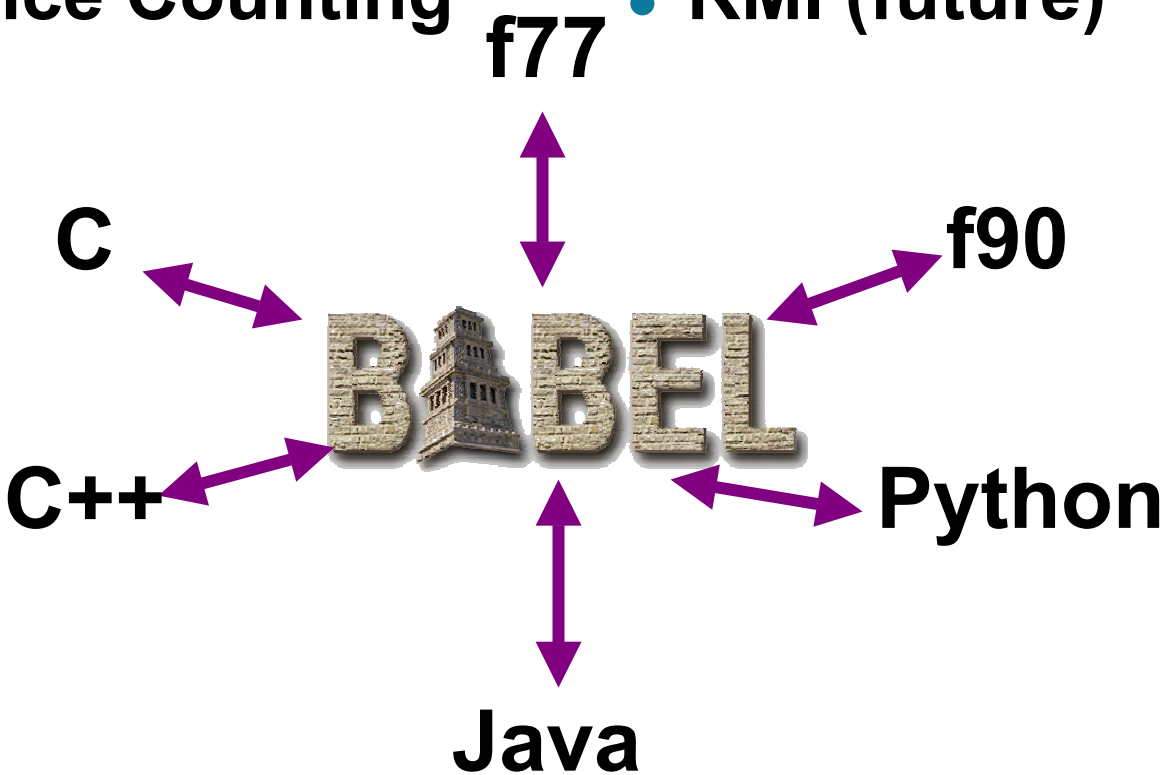
- Babel code generator
  - written in Java
- Babel runtime library
  - written in ANSI C
- Docs (minimal)
  - papers, talks, javadoc html
  - babel101 tutorial

Hand Coded Language Interoperability



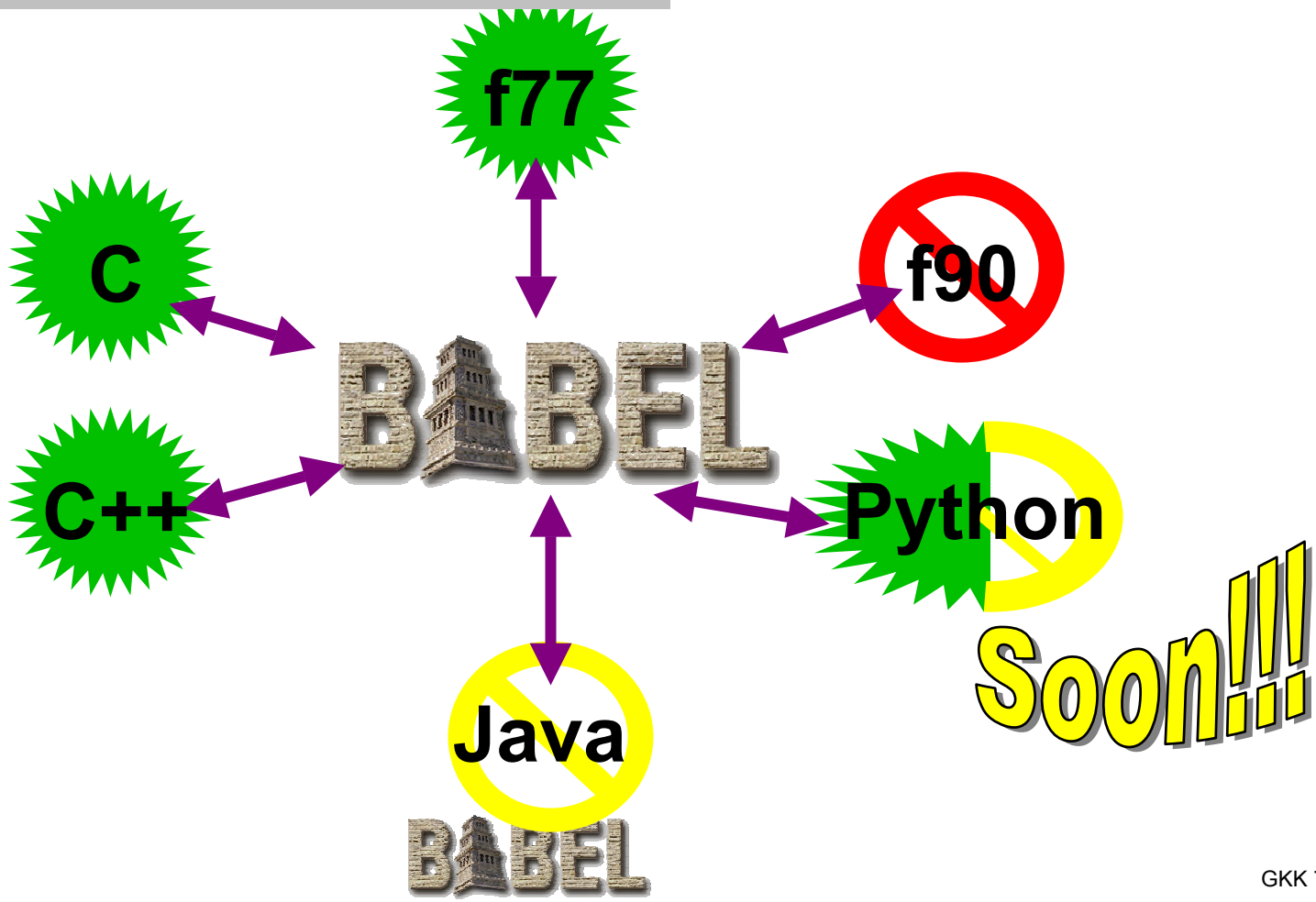
Babel Enabled Language Interoperability

- Truly Object Oriented
- Reference Counting
- Exception Handling
- RMI (future)



Babel Enabled Language Interoperability

What's In This Release:



Babel Has Two Types of Customers

Developers

- Have a code
- Want to increase their user base
- Will learn SIDL
- Want Babel general and powerful

Users

- Have a problem
- Want to solve their problem
- May never see SIDL
- Want software that's easy & trustworthy

Babel's Design Priorities

- Performance
- Developer/User dichotomy
- What's natural for each language?
  - Could expose C array structs in C++
  - C++ style would be SIDL::array<T>

```
template <>
array<item_t> : public array_mixin
    < array_t, item_t,
      item_cxx_wrapper_t>  { }
```

SIDL (Scientific Interface Definition Language)

- Builds on Industry IDL technology
  - CORBA
  - COM
- Designed for Scientific Apps
  - complex types
  - dynamic multidimensional arrays

```
version Hello 1.0;

package Hello {
   class World {
      string getMsg();
   }
}
```

```
version MySolverLib 0.1.0;

import ESI;

package MySolverLib {
  interface MatrixGenerator { ... }
  class OptionDatabase {
    void getOption( in string name,
                    out string val);
  }
  class Vector implements-all ESI.Vector {
    void setOptions( in OptionDatabase db );
  }
  class Bizarre implements MatrixGenerator {
     ...
     void setData( in array<dcomplex,2> a );
  }
}
```

Many forms of language interoperable interfaces

Human Compatible

SIDL

Scientific Interface Definition Language

Co ler Compatible

IOR

Internal Object Representation

XML

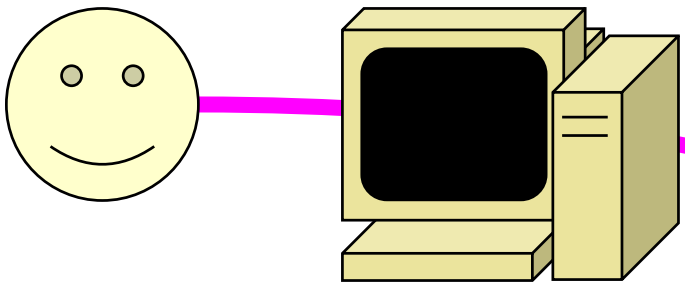
eXtensible Markup Language

Web Compatible

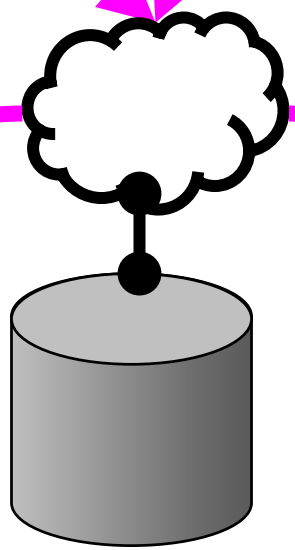
XML enables...

...Type Descriptions on Shared Repositories

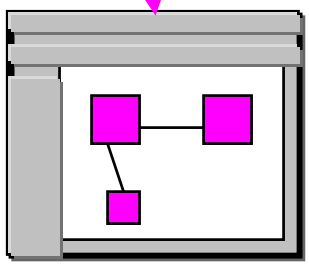
...automated creation via higher-level tools



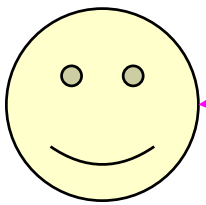
CCAScript



...automated search & discovery by advanced builders

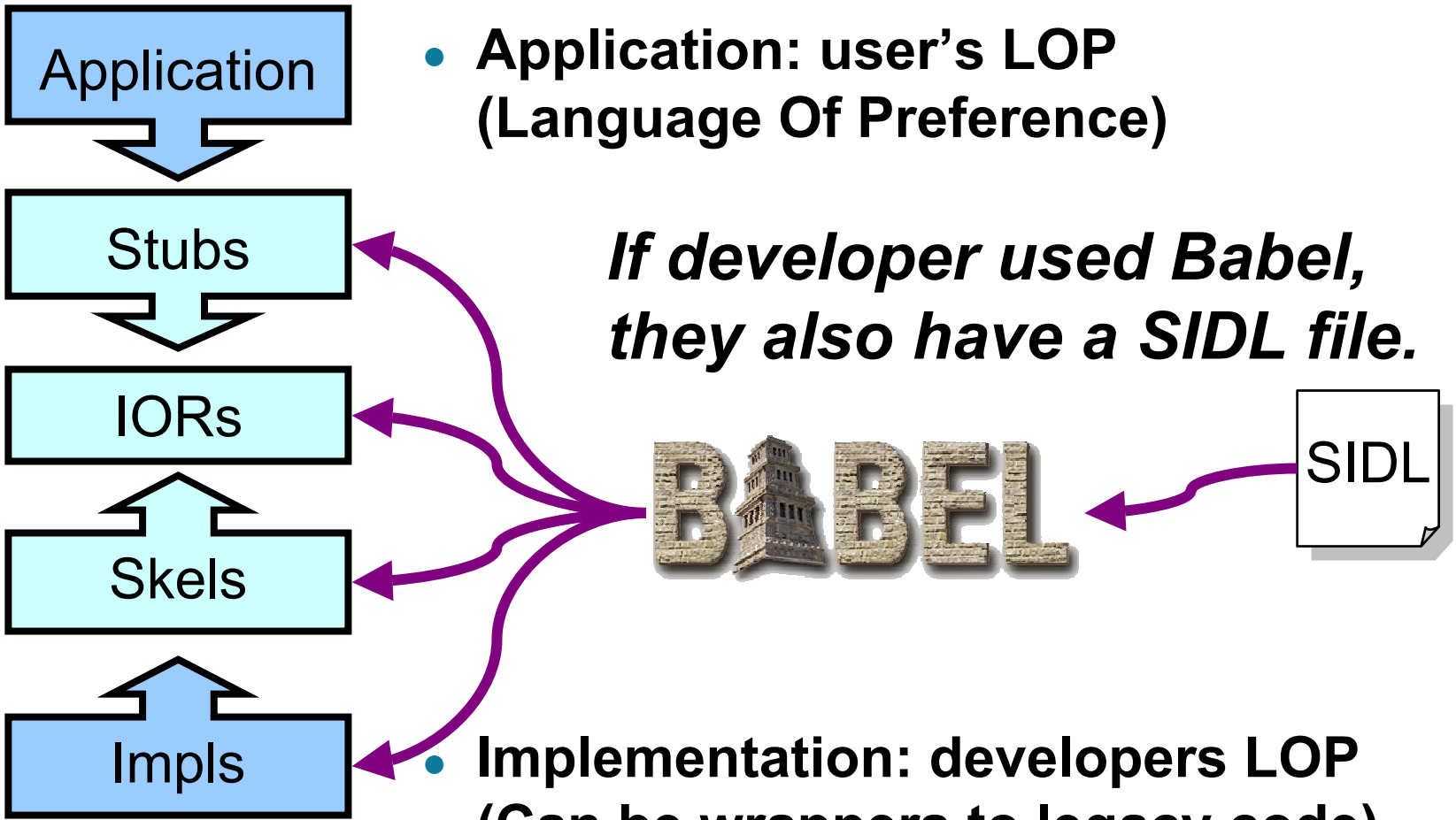


...Browsing for Types



BABEL

Language Interoperability: How Babel Makes it Work

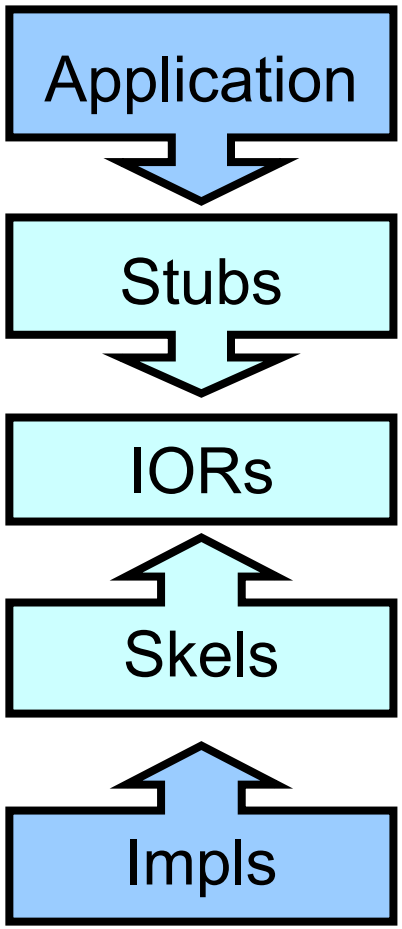


- **Application: user's LOP (Language Of Preference)**

If developer used Babel, they also have a SIDL file.

- **Implementation: developers LOP (Can be wrappers to legacy code)**

Language Interoperability: How Babel Makes it Work



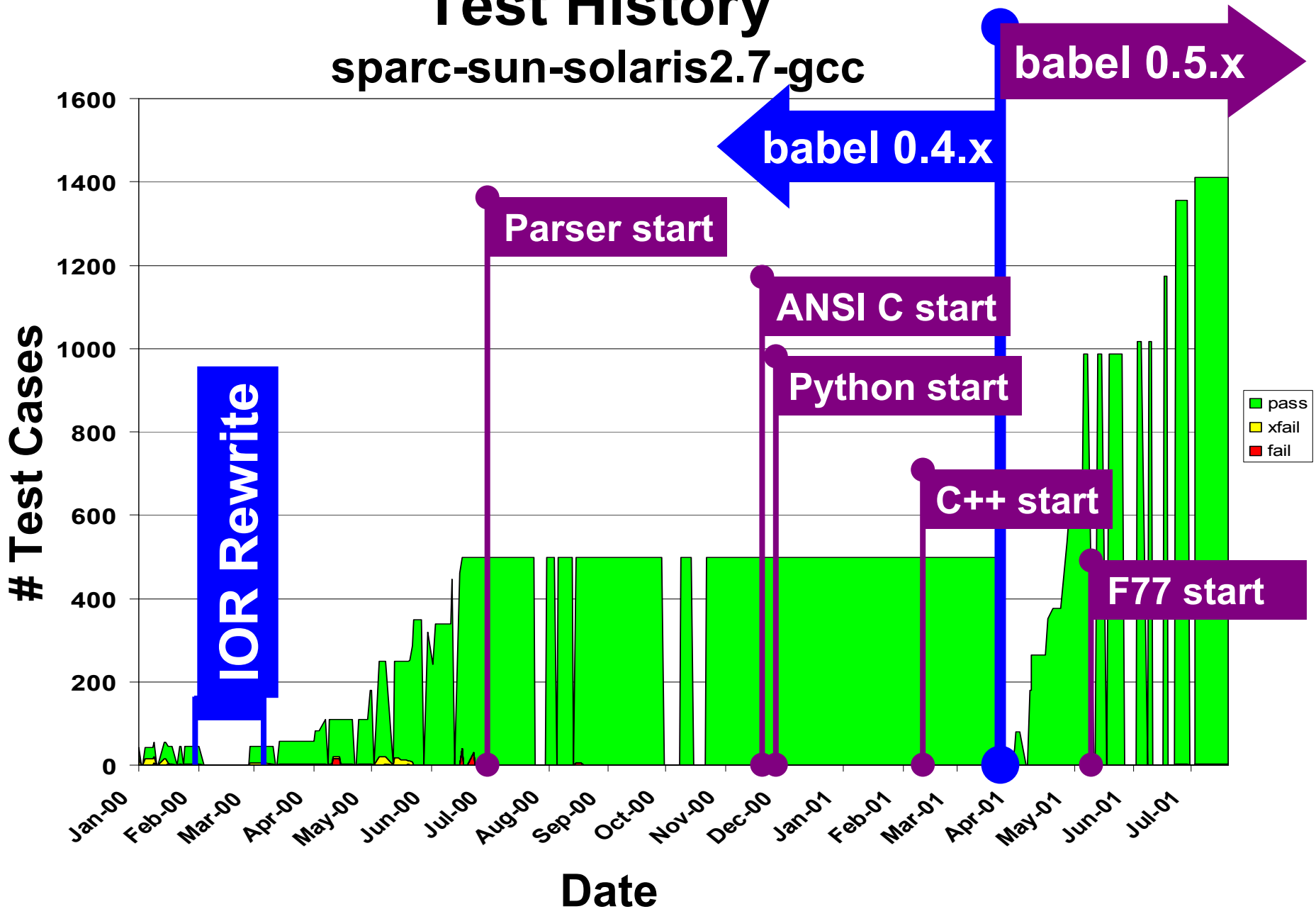
- **Application: user's LOP (Language Of Preference)**
- **Client Side Stubs: user's LOP to C**
- **Internal Object Representation (IOR): Always in C**
- **Server Side Skeletons: translates IOR (in C) to developer's LOP**
- **Implementation: developers LOP (Can be wrappers to legacy code)**

How Much Language Interoperability Have We Achieved?

- 1431 test cases (and counting)

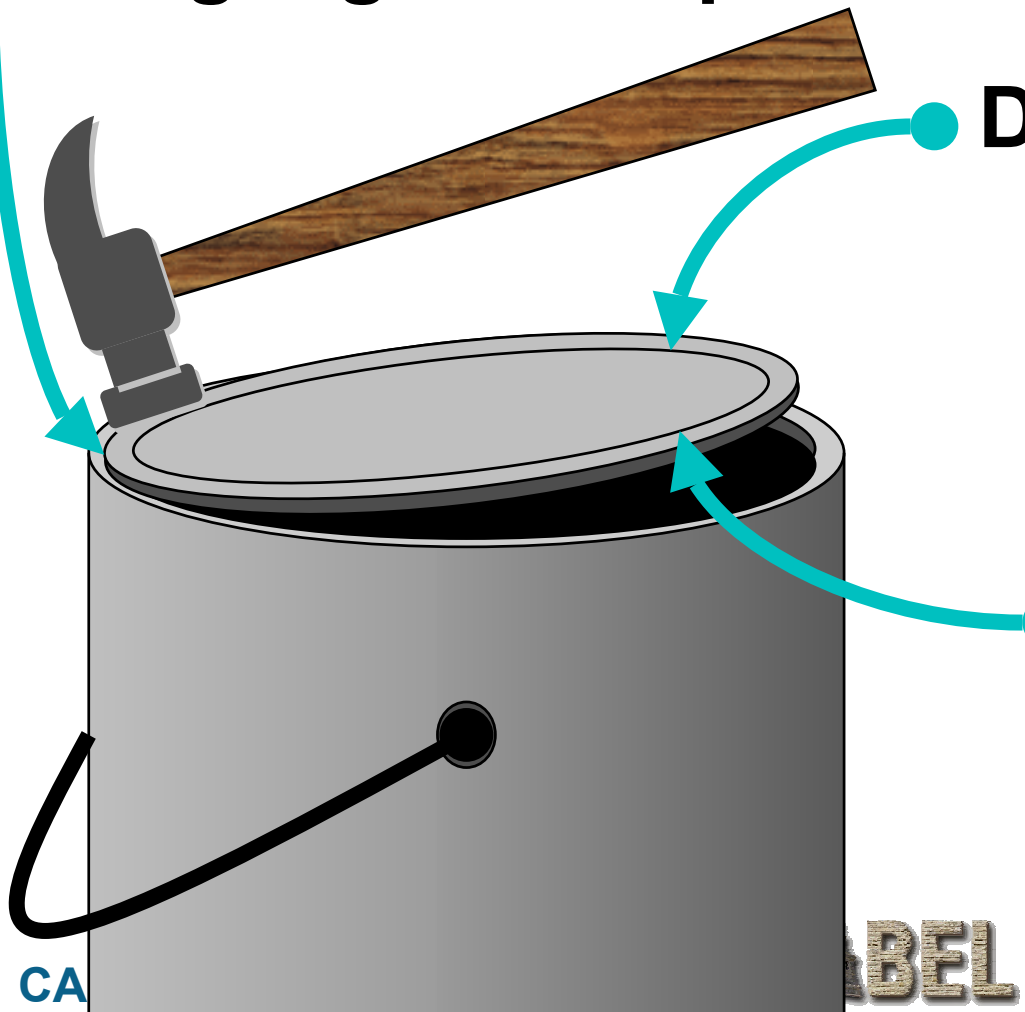
Test History

sparc-sun-solaris2.7-gcc



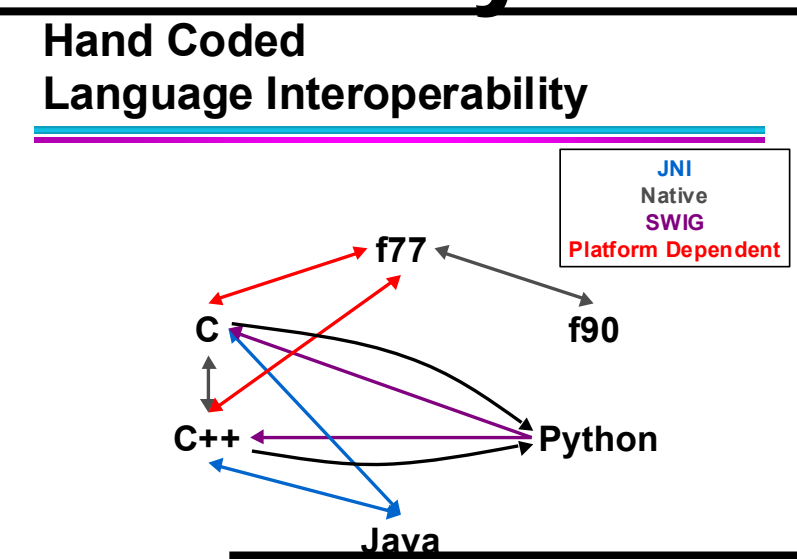
What we foresee, based on experience with our tests...

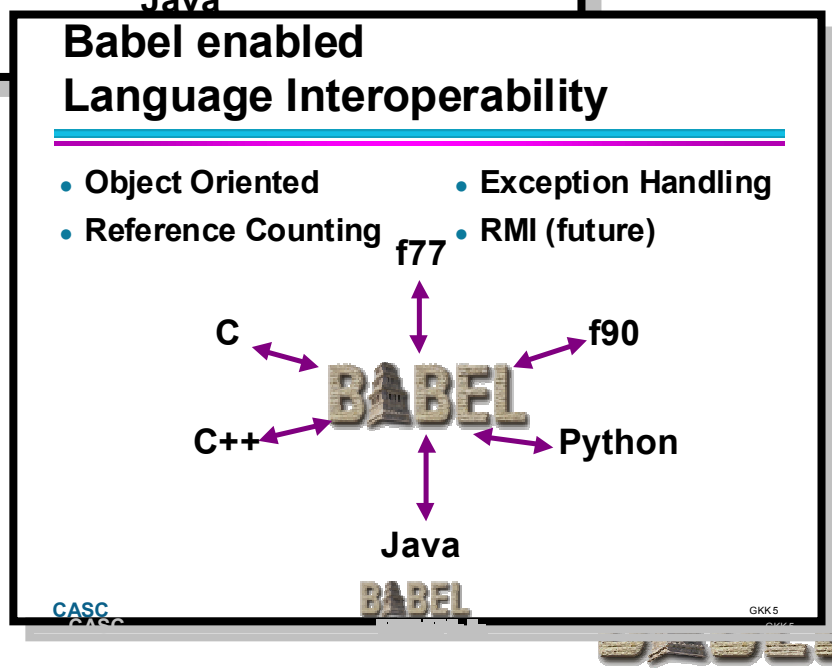
- Language Interoperability



- Developer Concerns:
  - Configuration,
  - Packaging,
  - & Deployment
- User Concerns:
  - Installation
  - Trust

These aren't new problems... But they are on a larger scale





- **Developer Concerns:**
  Configuration,
  Packaging,
  & Deployment
- **User Concerns:**
  Installation
  Trust

For Example...

- Consider the following statements...
  - Java is more port
  - C is m
  - C++
- "portal
  - Java c mpiled (like C)
  - C is m s hard to parse (as C++)
  - C++ ca bind to C or Java easier than F77
- BUT F77 is also more portable than C because of header/library issues

Babel's regression tests have the worst of all worlds!!!

For Example...

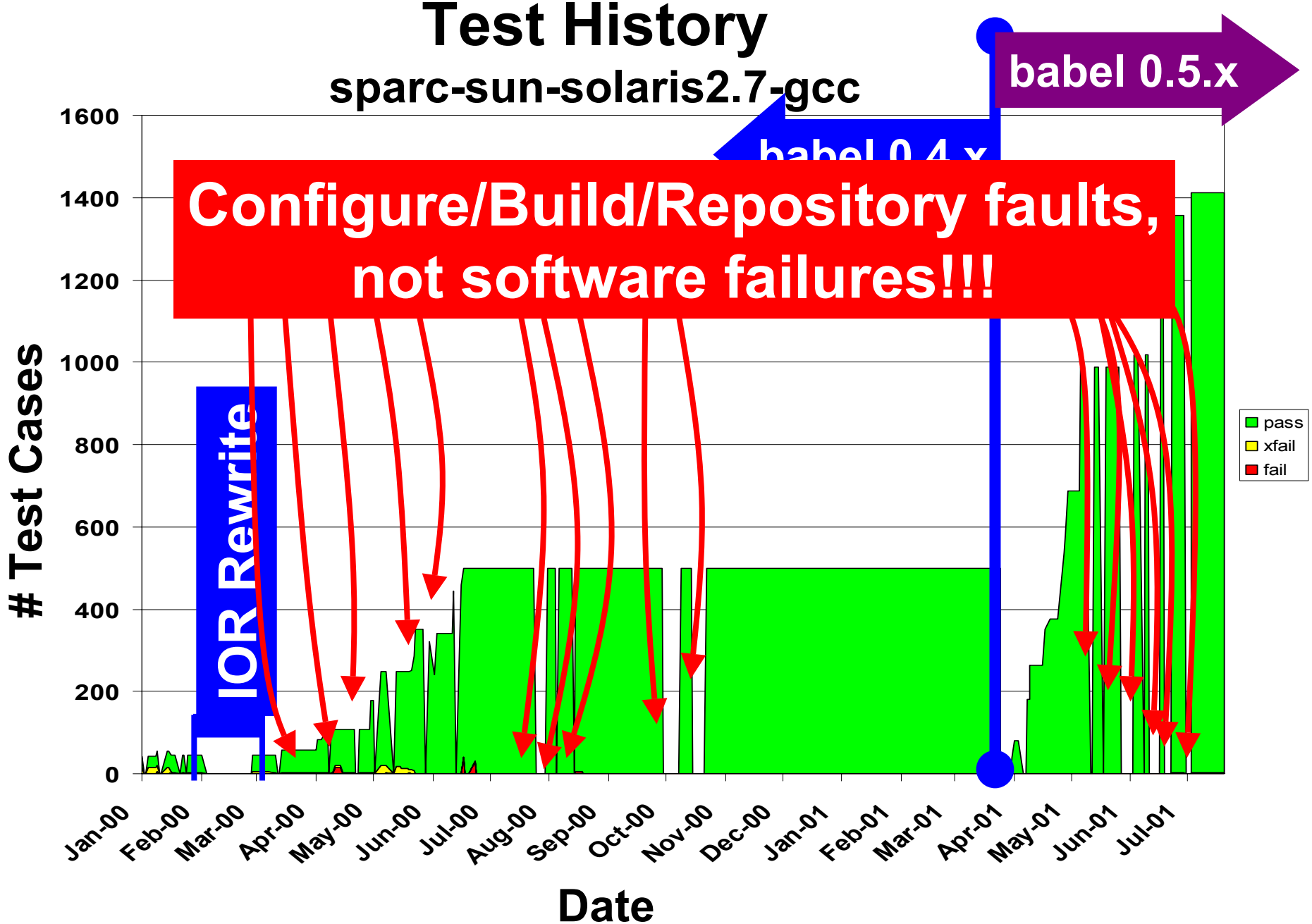
- To support Python and Java
  - All libraries must be shared (*.so) not statically linked (*.a)
- C++ shared libraries are problematic
  - Exception support is platform/compiler dependent
  - Linking issues when interoperating with other languages
- Can create valid shared library with uncatchable exceptions

Babel's Configuration/Build

- GNU Make
- Autoconf
  configuration
- Automake
  build Makefiles
- Libtool
  shared libraries
- CUTE
  custom testing
- python's own
  build system
- java's built-in
  (broken) make
- helper scripts
- fixes to autoconf,
  automake &
  libtool
- lots of hacks

Test History

sparc-sun-solaris2.7-gcc



Problems affect the User too...

- How does a user get and install "language interoperable" software?
  - Binary: if supplied by developer
  - Source:
    - Assume "configure; make install"?
- How to link into application?
  - If any C++ code, must use C++ linker
  - Which C++ to use?
    C++ has no std binary interface

Crux of the problem

- We're building 21st century technology...
- ... using 30 year old tools.

C++ | F77 | Python | Java

C

Autoheader | libtool (perl/sh)

aclocal | Automake (perl)

Autoconf (M4)

Make

Bourne shell

Solution

- Integrated config, build, package, test and management system.
  - no make inside!
    - can have action create many files
    - understands directories
  - uses real database
  - program all aspects in one language
  - MUST BE OPEN SOURCE

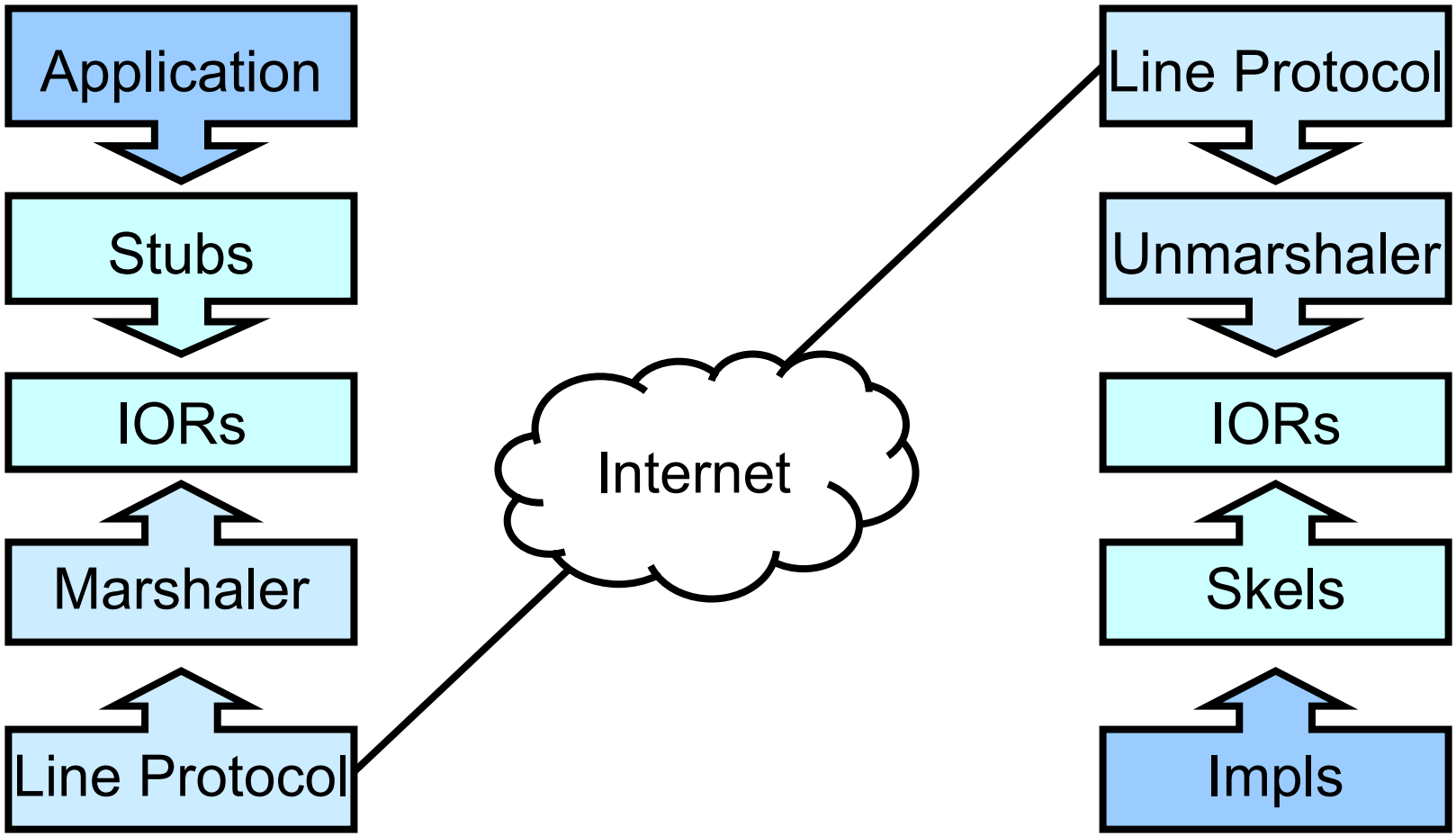
In the mean time...

- Babel works on other platforms, just not automated config/testing
  - Java code generator (precompiled)
  - ANSI C runtime library (no problem)
- Babel's tests are (necessarily) pathological worst-case examples
- We didn't create these problems, we just exercise them aggressively

Future Babel: Will Provide More Build Help

- "babel.make"
  - currently lists code generated
  - may add additional flags, macros, etc.
- configure
  - currently used for regression tests
  - may generate artifacts useful for developers
    - helper scripts
    - warnings

Farther Future Babel: Will Do Distributed Computing



Closing Remarks

- Babel Beta 0.5 is released
- Babel enables language interoperability
  - connect C, C++, F77, and Python
  - provide a uniform object-model, even in non-OO languages.
- Deploying & Installing Language Interoperable Code in General
  - is still very hard
  - has broken every tool we use

The End

babel-announce@llnl.gov
babel-users@llnl.gov

http://www.llnl.gov/CASC/components
components@llnl.gov

Bill Bosl, Tammy Dahlgren,
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A.3. Can HPC and Component Technology REALISTICALLY be integrated?

- Yes.
- But HPC Components have huge (and unique) hurdles:
  - Diverse Architectures
  - Diverse OS's
  - Integration of SPMD and Dist. Comp.
  - Archaic Pkg/Devel/Config/Build tools
  - Non-CS trained (or interested) users

B.3. Can the HPC community really afford yet another compiler such as Babel?

- Is language interoperability important?
- How important?

B.3. How is the Java subset of C++ inadequate as an HPC IDL?

- What is a “Java subset of C++” ?
- How does one
  - use it to bind to other languages?
  - get a common inheritance model?
  - get a common exception model?

B.5. What is the role of traditional (parallel) tools in component technology?

- Hopefully, they're replaced by **modern** parallel tools.

B.9. What will be the configuration issues for components...to be portable and high-performance?

- Lots.
- Lack of Configuration, Packaging, & Deployment tools
  - is the #1 Achilles heel for components
  - is the #1 day-to-day pain in Babel development
  - #1 cause for failure in regression tests

C.1. Will anyone actually make the effort to componentize their applications software?

- Yes.
  - But it will be messy.
- Efforts to Babelize at LLNL:
  - hypre - want OOP in ANSI C & automatic F77 bindings
  - ALPS - want scripting interface for laser plasma physics
  - SAMRAI - framework used in ALPS

D.4. Should components be viewed as mostly a library/runtime developer technology?

- No.
- I used components in this PowerPoint Presentation
- Users can use components without knowing they're using them.
  - This is harder to achieve in UNIX than other platforms

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