C++0x & C1x: the Dawn of new Standards

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The IBM Rational C/C++ Café

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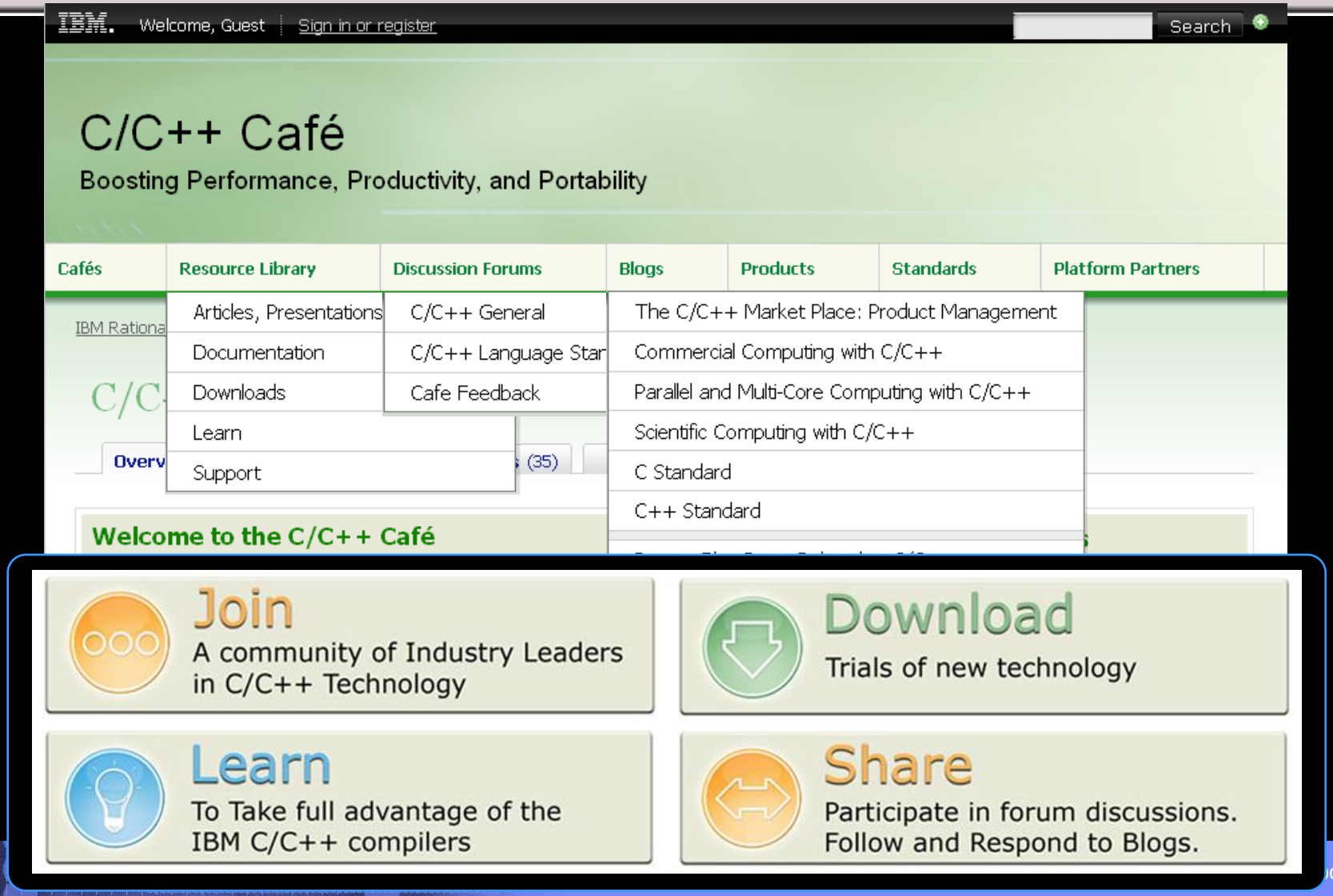

Agenda

- **Is this legal C++03 code?**
- **C++0x/C1x standard**
- **C++ 0x issues since BoostCon 2010**
- **Bonus 1: C++ 0x Compiler Support Survey**
- **Questions?**

Is this legal C++03 syntax?

```
template<class T> using Vec =
vector<T,My_alloc<T>>;

Vec<double> v = { 2.3, 1.2, 6.7, 4.5 };

//sort(v);

for(auto p = v.begin(); p!=v.end(); ++p)

    cout << *p << endl;
```

Hello Concurrent World

```
#include <iostream>
#include <thread> //#1
void hello() //#2
{
   std::cout<<"Hello Concurrent World"<<std::endl;
}
int main()
{
   std::thread t(hello); //#3
   t.join(); //#4
}
```

Is this valid C++ today? Are these equivalent?

```
int x = 0;

atomic<int> y = 0;

Thread 1:
  x = 17;
  y.store(1,
  memory_order_release);
  // or:       y.store(1);


Thread 2:
  while
  (y.load(memory_order_acq
  uire) != 1)
  // or:       while
  (y.load() != 1)

  assert(x == 17);
```

```
int x = 0;

atomic<int> y = 0;

Thread 1:
  x = 17;
  y = 1;

Thread 2:
  while (y != 1)
        continue;
  assert(x == 17);
```

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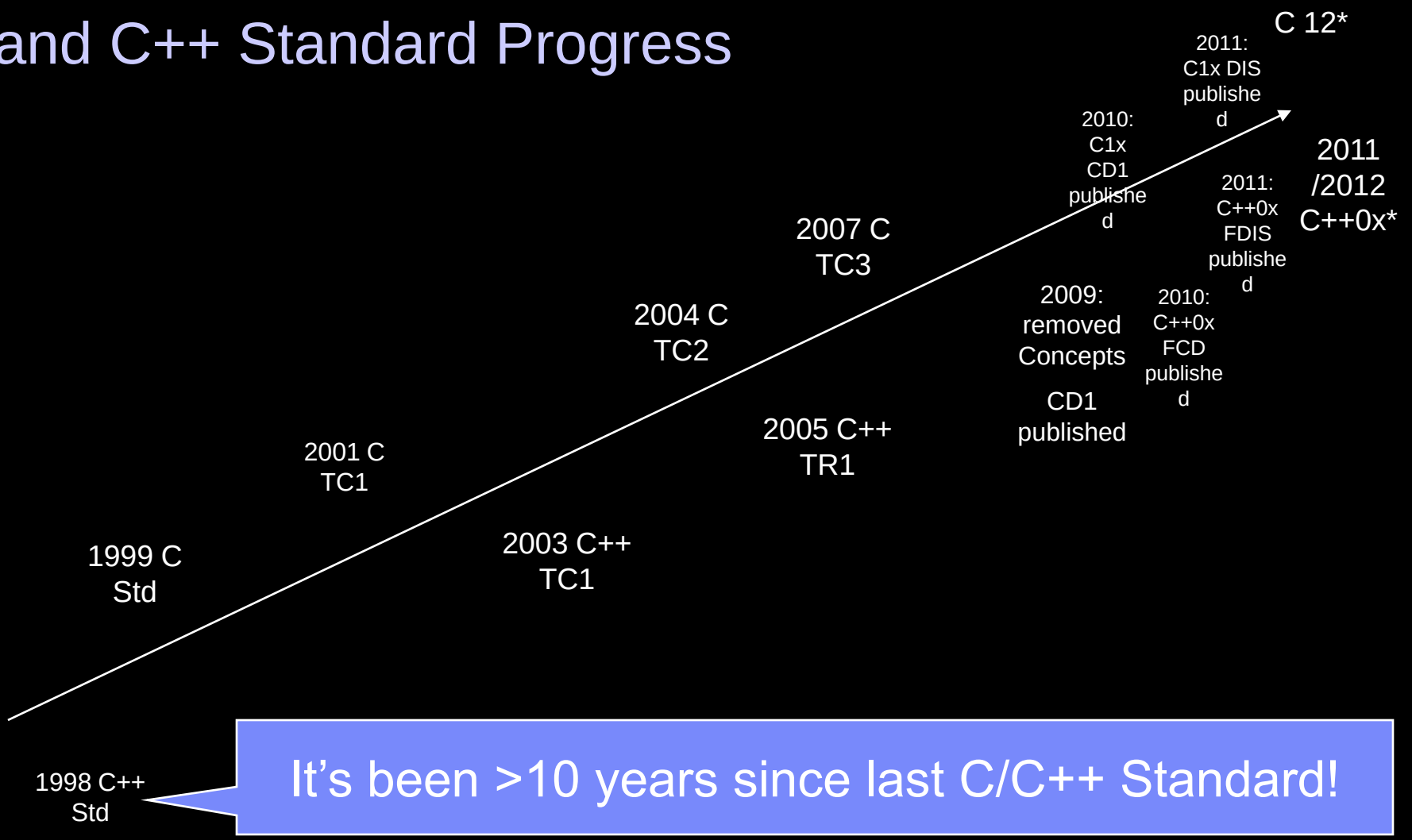
C and C++ Standard Progress



*Ratification date subject to change without notice

Major stages of C++0x

Major Stages

SC22 Reg. Ballot (complete)	Ideally all major features present. Usually few comments.
SC22 CD Ballot (optional, 3 months)	Nearly all major features in near-final form. After ballot, need to allow time for disposition of comments and completion of all major features.
SC22 FCD Ballot * (required, 4 months)	All major features in essentially final form. After ballot, need to allow time for disposition of comments.
JTC1 FDIS Ballot (required, 2 months + publication time)	Final text. **Note:** This is an up-down ballot, and no comments are allowed. The only way for a NB to express displeasure is to vote No on the whole standard.

* JTC1 is planning to replace the FCD stage with the ISO DIS stage. This would extend the ballot period to 5 months, but the change is not expected to happen in time to affect us.

DONE in 9/2007

DONE in 9/2008

DONE in 3/2010

DONE in 3/2011

In MADRID

C++0x goals

- Overall goals
  - Make C++ a better language
    - for systems programming
    - for library building
  - Make C++ easier to teach and learn
    - generalization
    - better libraries
- Massive pressure for
  - More language features
  - Stability / compatibility
    - Incl. C compatibility
- Insufficient pressure for
  - More standard libraries
    - The committee doesn't have the resources required for massive library development

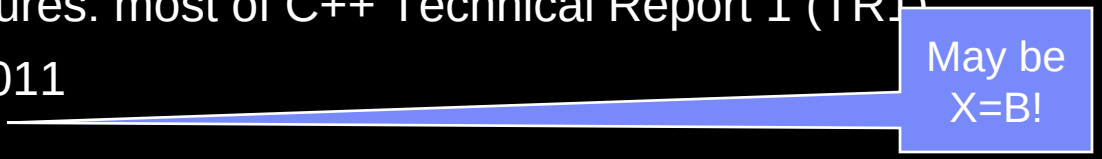
C++0x: areas of language change

- Machine model and concurrency
  - Memory model
  - Threads library, thread pools, futures
  - Atomic API
  - Thread-local storage
- Support for generic programming
  - concepts
  - **auto**, **decltype**, template aliases, Rvalue references, …
  - initialization
- Etc.
  - improved **enum**s
  - **long long**, C99 character types, etc.
  - …
- Modules and dynamically linked libraries
  - Postponed for a TR

Removed June 2009

C++0x, C1x

- **C++0x: Codename for the planned new standard for the C++ programming language**
  - Will replace existing ISO/IEC 14882 standard published in 1998 (C++98) and updated in 2003 (C++03)
  - Many new features to core language
  - Many library features: most of C++ Technical Report 1 (TR1)
  - FDIS in March 2011
  - X=A,B,C,D,E,F?
  - C++11?
- **C1x: Codename for the planned new standard for the C programming language**
  - Will replace existing ISO/IEC 9899 standard published in 1999
  - DIS in March 2011



What's in C++0x?

- **Memory Model and Concurrency [N2138]**
- **Concurrent Libraries [N2094]**
- **Initialization [N2116]**
- **Rvalue references [N2118]**
- **Other primary features**
  - Constant expressions, automatic types
- **Expanded Library from most of TR1**
- **140 features, 600 bug fixes to the standard**
- **What's out?**
  - Concepts [N2081]
  - Garbage Collection (Replaced by smaller proposal)

What's in C1x?

- Alignment specificaiton
- _Noreturn specifier
- Type-generic expressions
- Multithreading support
- Unicode
- Deprecate gets
- Bounds checking interfaces
- Analyzability features
- Subnormal macros
- Anonymous structs and unions
- Static assertions
- Create and pen mode for fopen
- Quick_exit
- Macros for constructing complex values

What is C++0x?

- **Simplifying simple tasks**
  - **Deducing types, ranged for loops,**
- **Initialization**
  - **Uniform { }, no accidental narrowing**
- **Support for low-level programming**
  - **Standard layout types, unions, generalized constant expr**
- **Tools for writing classes**
  - **Init list constructor, inheriting constructor, move, user-defined literals**
- **Concurrency**
  - **Memory model, threads, locks, atomics, mutex, future, shared_future, atomic_future, promise, async()**
- **Standard library components**
  - **Containers, regular expression, random numbers, time, resource mgmt, utility, metaprogramming, Garbage collection ABI**

Sum of all things C++0x

- • __cplusplus
- • alignments
- • attributes
- • atomic operations
- • auto (type deduction from initializer)
- • C99 features
- • enum class (scoped and strongly typed enums)
- • copying and rethrowing exceptions
- • constant expressions (generalized and guaranteed; constexpr)
- • decltype
- • default template parameters for function
- • defaulted and deleted functions (control of defaults)
- • delegating constructors
- • Dynamic Initialization and Destruction with Concurrency
- • explicit conversion operators
- • extended friend syntax
- • extended integer types
- • extern templates
- • for statement ; see range for statement
- • generalized SFINAE rules
- • Uniform initialization syntax and semantics
- • unions (generalized)
- • user-defined literals
- • variadic templates
- • in-class member initializers
- • inherited constructors
- • initializer lists (uniform and general initialization)
- • lambdas
- • local classes as template arguments
- • long long integers (at least 64 bits)
- • memory model
- • move semantics; see rvalue references
- • Namespace Associations (Strong using)
- • Preventing narrowing
- • null pointer (nullptr)
- • PODs (generalized)
- • range for statement
- • raw string literals
- • right-angle brackets
- • rvalue references
- • static (compile-time) assertions (static_assert)
- • suffix return type syntax (extended function declaration syntax)
- • template alias
- • template typedef ; see template alias
- • thread-local storage (thread_local)
- • unicode characters

List of Standard features and papers (110504)

- **C++0x (FDIS):**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2011/n3291.pdf
- **C++0x (FCD)**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2010/n3092.pdf
- **c++0x (CD1):**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2009/n3000.pdf
- **Summary of Core language and Library State:**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2009/n2869.html
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2009/n2870.html
- **Summary of C++0x CD1**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2009/n2871.html
- **Summary of C++ TR1**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2007/n2364.html
- **TR1(DTR):**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2005/n1836.pdf
- **Decimal TR(PDTR):**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2008/n2732.pdf
- **Math(FCD):**
  - http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2008/n2717.pdf
- **C1x(DIS)**
  - http://www.open-std.org/jtc1/sc22/wg14/www/docs/n1570.pdf

What are the STD documents and their status?

- **Library TR1: Draft Technical Report**
- **C++0x: Final Draft International Standard (FDIS), has 13/14 TR1 libraries**
- **C1x: Draft International Standard (DIS)**
- **Special Math Library: Final Committee Draft**
- **Decimal Floating Point TR: Draft Technical Report**
- **POSIX C++: working draft, target 2012/13**
- **C++ ABI: working draft, ongoing discussion on mangling, and common-vendor interoperability**

Feature and defect count

- **Language**
  - 70 features
  - 300 defects (in the C++ Standard)
- **Runtime**
  - 70 features
  - 230 defects (in the C++ Standard)
- **Too many features to be done in one release**
  - stage across many compiler releases over several years
  - not all Standard defects translate into compiler issues

Performance Opportunities, Parallelism, Usability in future C++0x features

- **Improve Execution Time**
  - memory model, concurrency/atomics, rvalue references, pods, variadic template, Concepts, auto
- **Increase Compile Time**
  - Concepts, most template features (except variadic template)
- **Decrease Compile Time**
  - Variadic template
- **Improve usage/teachability**
  - Auto, initialization, decltype
- **Supports concurrency**
  - Atomics, fences, basic mutlithreading library, futures

Features for whom?

- **Library enhancements**
- **For Class writers**
  - Move, rvalue ref, deleted and default functions, delegating, inheriting
- **For Library writers**
  - Static assert, explicit conversion, variadic template, decltype
- **For you**
  - >>, auto, range-based for, nullptr, unicode, raw strings, uniform init, init lists, lambda, trailing return, template aliases, concurrency
- **For everyone else**
  - Class enum, unrestricted union, time library, local types as template args, C99 compat, scoped allocators, constexpr, user-defined literals, relaxed POD, extern template, sizeof on class data members, & and && member functions, in-class init of static data member, attributes

C++0x Library

- **Start with original C++98 library**
  - Improved performance with rvalue reference
  - Used variadic templates to improve compile time
  - Potential binary incompatibility with C++98 library strings
  - Reference counting not allowed
- **Added 13/14 TR1 libraries**
  - Reference wrapper, smart ptrs, return type determination, enhanced member pointer adapter, enhanced binder, generalized functors, type traits, random numbers, tuples, fixed size array, hash tables, regular expressions, C99 cmpat
- **Added threading, unique_ptr,forward_list, many new algorithms**

Removed or Deprecated features

- **Auto as a storage class**
- **Export semantics**
- **Register semantics**
- **Exception specification**
- **Auto_ptr**
- **Bind1st/bind2nd**

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Since BoostCon 2010

- **FCD released and National ballots returned**
- **All national ballots comments addressed through 3 meetings**
- **Released FDIS in Mar 2011 in Madrid**
- **Proof reading done on completed document**
- **Submitted to ISO for next stage National Ballot**
- **Once approved, will ship as C++11**

FCD ballot comments at Aug 2010 meeting

- **All National bodies approved with comment, except one**
- **Fewer comments then from CD1 (~500)**
  - Japan 110
  - Great Britain 142
  - Finland 19
  - US 208
  - Switzerland 36
  - Germany 23
  - Canada 24

	Unresolved	Accepted	Modified	Rejected	Total
CWG	8	72	4	39	123
LWG	123	28	5	25	181
Editor	19	167	9	20	215

Key FCD comments

- **A few comments asking specifically that unimplemented features be removed**
  - Generalized constant expressions (constexpr): gcc
  - Unrestricted unions: gcc
  - alias templates: EDG
  - explicit conversion operator functions: gcc 4.5
  - Delegating constructors: IBM
  - Raw strings: gcc 4.5
  - noexcept: gcc 4.6
  - Implicitly-defined move constructors/assignment operator functions: gcc
  - Non-static data member initializers: fairly similar feature in Microsoft C++/CLI
- **Features that were actually unimplemented at the time were:**
  - Move semantics for *this
  - Inheriting constructors
  - User-defined literals
- **What happened to noexcept and the issue with terminate vs undefined?**

Nov 2010 Fermi Lab meeting

- **The most controversial meeting**
  - "The atomics have become unstable at Fermi Lab"
  - Virtual controls, alignment and noreturn attributes
  - Noexcept default on destructors and delete operators
  - Noexcept in standard library
  - Restricting implicit move generation
  - Implicit inference of noexcept

Mar 2011 Madrid meeting

- **Dealt with key issues/controversies early**
- **Resulted in smooth FDIS with unanimous support**
- **Key design Issues were:**
  - Possible Removal of several features
  - Complications with range_for found in Boost
  - Reconsider the impact of noexcep
  - Issue with a few keyword places with hiding and overriding rules
  - Race condition with copying thrown exceptions

Atomics have become unstable

- **C and C++ atomics are slightly incompatible**
  - C has _Atomic as a qualifier on all types
  - C and C++ support different atomic operations
  - Different mutexes

Operations available on atomic types

	atomic_flag	atomic_bool, atomic<class_type>	atomic_address, atomic<T*>	atomic_integral-type, atomic<integral-type>
test_and_set, clear	Y			
is_lock_free		Y	Y	Y
load, store, exchange, compare_exchange_weak+strong		Y	Y	Y
fetch_add (+=), fetch_sub (-=), ++, --			Y	Y
fetch_or (|=), fetch_and (&=), fetch_xor (^=),				Y

Override controls, alignment, and noreturn attribute

- **Attributes, keywords or contextual keywords**

```
class [[base_check]] Derived
   : public Base {
  public:
    virtual void f [[override]]
   ();
    virtual double g [[final]] (
   int );
    virtual void h [[hiding]] ();
};
```

- .

- Post Fermi-lab

```
class Derived explicit : public
Base {
   public:
      virtual void f () override;
      virtual double g( int ) final;
       virtual void h() new;
};
```

Fails for types hiding types

```
struct X {/*...*/};

struct Y {/*...*/};

class B {

typedef X value_type;

};

class D explicit : public B {

typedef Y value_type; // well-
   formed if "new" can only
   appertain to functions

};
```

- removed the "hiding" feature and the "explicit" annotation on classes
- We don’t know the best solution, so delay this until later

Alignment and noreturn attributes

- **alignas in C++, _Alignas in C**
- **[[noreturn]] in C++, _Noreturn in C**

The problem with range-based for

```
#include <vector>
namespace n
{
  struct X { void begin(); };
  struct Y { void begin(); };
  template<typename T> void begin(T& t) { t.begin(); }
}
int main()
{
  std::vector<n::X> v;
  for (auto i : v) // error
  {
    // ...
  }
}
```

- Produces this error
- error: call of overloaded 'begin(std::vector<n::X>)&' is ambiguous

Range-for problem found from Boost

- **A good solution was found, read N3271**
- **specifies that the range-based for loop should look for member functions begin() and end() first**
  - fall back to the current ADL-based behavior only when the type of the range does not contain either "begin" or "end".

Race condition in copying exceptions

- **A new C++0x feature is the ability to capture exceptions**
  - and rethrows them later without knowing what type they are
  - Allows you to propagate the exceptions across threads
    - Capture exception in one thread,
    - pass std::exception_ptr object across to the other thread
    - Use std::retrow_exception() on that other thread to rethrow
    - Std::async, std::;promise, std::packaged_task's exception propagation is build on this feature
- **Problem**
  - Original proposal required the exception be copied when it was captured with std::current_exception()
  - C++ABI did not store the copy constructor for exception objects
  - std::;current_exception() has no copy ability, so copy not req'd
  - **if any thread modified the object, then we have race**

Common idiom?

- **Catch exceptions by non-const reference, to add further info to the exception, then rethrow**
  - Propagated from another thread through std::async, using std::shared_future or std::;expception_ptr
  - Some platforms allow copying the exception, and some do not

```
try
{
   x = f();
}
catch (Y& y)
{
   y.modify();
   throw;
}
```

```
try
{
shared_future<X>
sp = async(f);
   x = sp.get();
}
catch (Y& y)
{
   y.modify();
   throw;
}
```

Proposed Solutions

- **Current proposed resolution:**
  - make current_exception() copy
  - and make rethrow_exception() copy
- **Known issues:**
  - Pessimizes cases that don't need the copy
  - Doesn't work for reference classes
  - Doesn't work for mutating copy classes
  - Breaks Itanium ABI compatibility

C++ ABI

```
void __cxa_throw(void* thrown_exception,
                 std::type_info* tinfo,
                 void (*dest)(void*) );
```

- **When the client writes “throw X”, the compiler creates a call to __cxa_throw().**
  - Pass void* to an X.
  - Pass type_info* for X.
  - Pass pointer to ~X().
- **Does not pass information on how to copy an X.**

Option 1 for fixing C++ABI

```
void __cxa_throw_copyable(
        void* thrown_exception,
        std::type_info* tinfo,
        void (*dest)(void*),
        void (*copy)(void* d, void* s, size_t sz) );
```

- **Problems:**
  - Our previous OS's do not have this function.
  - Thus, code compiled for C++0x, even if it did not use exception_ptr, could not run on our current and previous OS's.

Option 2 for fixing C++ABI

```
void __cxa_throw(void* thrown_exception,
                 std::type_info* tinfo,
                 void (*dest)(void*) );
```

- **But store copy constructor pointer in type_info.**
  - Which copy constructor pointer?
  - Expensive to extract for *every* call to typeid().
  - ODR violation when mixing C++03/C++0x weak type_info's for same type.

Solution: use good style

- **Catch by value instead of by reference.**
  - Force a copy of Y *exactly* when and where you need it.

```
try
{
   shared_future<X> sp = async(f);
   x = sp.get();
}
catch (Y y)
{
   y.modify();
   throw y;
}
```

Noexcept is a replacement for empty throw spec

- **At March 2011 meeting, deprecated throw-specifcations**
  - throw(), throw (A, B)
- **Check out**
  - "Boost Exception Specification Rationale", "A Pragmatic Look at Exception Specifications"
    - "A non-inline function is the one place a 'throws nothing' [i.e., throw()] exception-specification may have some benefit with some compilers."
- **Replacement is:**
  - void f() **noexcept** {…}
    - Optionally takes a compile-time constant expression
      - True: f will not throw
- **Issues/controversy:**
  - If user violates the promise, should it terminate, or be undefined

Noexcept default on destructors and delete operators

- **Tentative resolution from Aug 2010 meeting**
- **Every destructor/delete op will be noexcept by default**
  - Unless a member or base destructor is noexcept(false)
  - can still explicitly override the default with noexcept(false)
  - Why is this good?
    - Inherently unsafe to use a type with throwing destructor
      - Can lead to 2 exceptions in flight, which violates C++ rules, leading to immediate terminate
    - Could break some code

Applying noexcept to the Standard Library

- **Started applying noexcept liberally to Standard library in Nov 2010 meeting**
  - All empty exception specifications e.g. throw()
  - All descriptions with throws nothing
  - Analyze all move constructors
  - a little too enthusiastically
  - Why?
    - How to you test something if it is all noexcept?

Conservative use of noexcept N3297

- **Liberally application of noexcept was reversed in Mar 2011 meeting with this paper**
  - Hard to test if all functions are not allowed to throw
  - Guidelines for marking noexcept
    - No library destructor should throw.
    - Wide contract is unconditionally noexcept
    - If Swap function, move-constructor, move-assignment is conditionally-wide, then mark as conditionally noexcept
    - Extern “C” functions (atomics) are unconditionally noexcept
  - Lead to some controversial points where it was not clear whether noexcept should be applied
    - See N3269: shared_future(future<R>&& rhs) should be allowed to throw

Implicit deduction of noexcept

```
template< class T > auto forward_with_side_effect( T& t )
noexcept( noexcept(bar(t)) && noexcept(foo(t)) ) -> decltype(foo(t))
{
bar(t);
return foo(t);
}
```

- Ease the burden of writing complicated noexcept declarations
- Going too far with a relative new feature
- Rejected soundly but may be resurrected with more experience

To move or not to move, that is the question!

- **FCD: compilers should implicitly generate move constructors and move assignment operators akin to the copy constructors and copy assignment operators that are currently auto generated.**
  - N3153: Implicit Move Must Go by Dave Abrahams, and N3174: To move or not to move by Bjarne Stroustrup.
  - can breakages be limited by restricting the cases in which the move members are implicitly generated, or whether implicit generation should be abandoned altogether?

Alternatives

- **1.Generate move operations unless a user-specified copy, move, or destructor is declared (e.g., =default), using the default state as the moved-from state**
  - 1.Details: See the “Moving right along” paper
- **2.briefly: generate unless a copy, move, or destructor is declared (e.g., =default), using the state resulting from member moves as the moved-from state).**
  - **1.Details: N3174**
  - 2.This breaks more invariants than [1] but is simpler to implement.
- **3.Generate move operations unless a copy operation is declared (e.g., =default).**
  - 1.This is the FCD status quo which will become the standard unless we see a large majority for an alternative
- **4.Generate move operations only if the programmer asks for it using =default.**
- **5.Never generate move operations.**

Tightened the conditions for generating implicit move: N3203 (Option 2)

- **Treats copy, move and destruction as a group**
  - if you specify any of them manually then the compiler won't generate any move operations
- **if you specify a move operation then the compiler won't generate a copy**
- **would have been nice to prevent implicit generation of copy operations under the same circumstances,**
  - but for backwards compatibility this is still done when it would be done under C++03,
  - though this is deprecated if the user specifies a destructor or only one of the copy operations.

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C++0x Compilers

- **C++0x support publicly available in 110510**
  - GNU 4.6, Mar 28, 2011
  - Intel 12.0 (EDG), Nov 7, 2010
  - IBM xlC++ 11.1, Apr 23, 2010
  - Microsoft Visual C++ 2010, Apr 12, 2010
  - HP aC++ A.06.22 (EDG), Dec, 2008
  - Comeau 4.3.10.1 (EDG), Oct 6, 2008
  - Borland/CodeGear C++ Builder 2009 Compiler 6.10, 2H 2008
- **No C++0x features available publicly as of 100509 on their latest compiler, but we do know from their blogs about their future plans**
  - Sun Studio 12
- **Clang/LLVM status**
  - Language very sparsely supported
  - Library 98% done

All information based on publicly available data

Updated page of C++0x support

- **http://wiki.apache.org/stdcxx/C%2B%2B0xCompilerSupport**
  - Maintained by Martin Sebor, me, and other compiler Tech leads from other company

IBM XL C++ and z/OS C++ compiler status (April, 2011)

- **Released in XL C/C++ for AIX/Linux V10.1 in mid 2008**
  - -qlanglvl=extended0x option (umbrella option for all future 0x features)
  - long long,
  - sync C99 preprocessor (Empty macro arguments, Variadic macros, Trailing comma in enum definition, Concatenation of mixed-width string literals)
- **In C/C++ for AIX for V11.1, in 2Q 2010 (include all of above)**
  - Variadic template
  - Auto
  - Decltype
  - Namespace association
  - Delegating constructor
  - Static assert
- **Supports Boost 1.40**

- **in zOS XL C/C++ V1R11**
  - Extern template
  - Extended friend
  - -qwarn0x
- V1R12
  - Long long
  - C99 preprocessor
  - Auto
  - Decltype
  - Variadic template
  - Namespace association
  - Delegating constructor
  - Static assert

All information subject to change without notice

GNU

- **http://gcc.gnu.org/projects/cxx0x.html**
- **4.3/4.4/4.5/4.6 support:**
  - http://gcc.gnu.org/gcc-4.3/cxx0x_status.html
  - http://gcc.gnu.org/gcc-4.4/cxx0x_status.html
  - http://gcc.gnu.org/gcc-4.5/cxx0x_status.html
  - http://gcc.gnu.org/gcc-4.6/cxx0x_status.html
- **-std=c++0x or -std=gnu++0x**
- **GNU will write their own C++0x library, libstdC++, as they have always done:**
  - http://gcc.gnu.org/onlinedocs/libstdc++/manual/status.html#id476343
  - Possibly the biggest holdback from their completion
- **Usually supports latest Boost (Boost 1.46.1)**
- **Additional Branch**
  - Concepts
  - Lambda
  - Delegating constructors
  - Raw strings

All information based on publicly available data

GNU 4.3/4.4/4.5/4.6 (110410)

- **4.3: Rvalue Reference, Variadic Template, Static Assert, Decltype, Right Angle Bracket, C99 Preprocessor, Extern Templates, __func__, Long long**
- **4.4:Extending variadic template template parameters, Auto, multideclarator auto, removing auto as storage-class specifier, new function declarator syntax, Propagating exceptions, Strongly-typed enums, New character types, Unicode string literals, Standard Layout types, Default and deleted functions, Inline namespaces**
- **4.5:Initializer lists, Lambdas, Explicit conversion, Raw string literals, UCN Literals, Extending sizeof, Local and unamed types as template arguments**
- **4.6: null pointer, forward declaration of enums, constexpr, unrestricted unions, range-based for, noexcept, move special member functions,**

Intel and likely HP/Comeau (use EDG frontend)

- **Intel C++ 12.0 has**
  - -qstd=c++0x (Linux/Mac OS X), /Qstd:c++0x (Windows)
    - rvalue references
    - Standard atomics
    - Support of C99 hexadecimal floating point constants when in —Windows C++ mode
    - Right angle brackets
    - Extended friend declarations
    - Mixed string literal concatenations
    - Support for long long
    - Variadic macros
    - Static assertions
    - Auto-typed variables
    - Extern templates
    - __func__ predefined identifier
    - Declared type of an expression (decltype)
    - Universal character name literals
    - Strongly-typed enums
    - Lambdas

- Intel C++ Standard Library is based on Microsoft on Windows (uses Dinkwumare) and GNU on Linux (uses GNU's libstdC++), Boost 1.39
- HP aC++ V6 has been quiet about their C++ support, but will likely peggy-back on EDG as they move to new versions, uses STLport 5.1.7 as C++ Library, libstd runtime library matches Rogue Wave Version 1.2.1. , libstd_v2 runtime library matches Rogue Wave Version 2.02.01. Boost 1.38
- Comeau is also very active in delivering C++0x as soon as EDG delivers it to them, runs on multiple platforms, uses their own libcomo 36 based on an old SGI C++ Std Library

All information based on publicly available data

MS VS C++ 2010

- **http://blogs.msdn.com/vcblog/archive/2010/04/06/c-0x-core-language-features-in-vc10-the-table.aspx**
  - Lambdas
  - Auto
  - Static_assert
  - Rvalue references
  - decltype
  - Nullptr
  - Extern templates
  - Right angle brackets
  - Local and unamed types as template arguments
  - Long long
  - Exception_ptr
- **Supports Boost 1.40**
- **Traditionally bought from Dinkumware C++ Library**

All information based on publicly available data

Sun Studio (Version 13 and higher?)

- **Steve Clamage's post (080516):**
  - http://forums.sun.com/thread.jspa?threadID=5296590
  - "Right now, we are working on providing binary compatibility with g++ as an option in the next compiler release. "
  - "We won't release an official (stable, fully-supported) product with C++0X features until the standard is final. Until then, any feature could change in unpredictable ways. "
  - "Beginning some time next year, we expect to have Express releases with some C++0X features. Express releases are our way of providing compilers with experimental features that might not be stable yet. It gives our customers a chance to try them out and provide feedback before they become part of a stable release. "
- **No known plans on C++0x Library based on Steve Clamage's post (070917):**
  - http://forums.sun.com/thread.jspa?threadID=5165721
  - Ships with libCstd, an ancient version of Rogue Wave C++ library from 1999 for binary compatibility
  - Ships with STLport 4.5.3 for enhanced performance
  - Boost 1.34.1
  - Can work with open source Apache C++ Standard Library derived from Rogue Wave 4.1.2
  - "A new C++ standard is in progress, planned for completion in 2009. We will release a new compiler, C++ 6.0, conforming to the new standard, including a fully-conforming standard library as the default. The new library will be shipped as part of Solaris.
    We also plan to maintain compatibility with C++ 5.x and libCstd as an option. Details are still in the planning stage. "

All information based on publicly available data

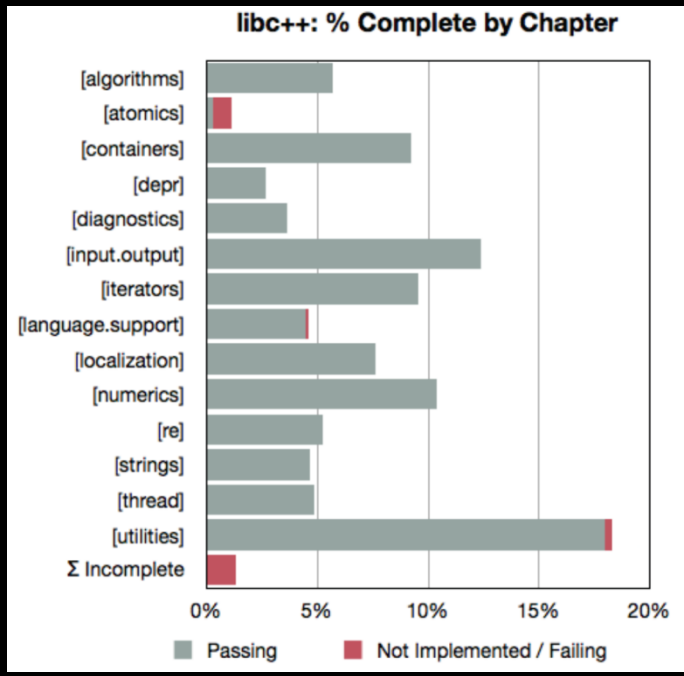
Borland/CodeGear C++Builder Compiler 6.10 2009

- http://www.codegear.com/article/38534/images/38534/CBuilder2009Datasheet.pdf
- **Rvalue references**
- **decltype**
- **Variadic templates (in testing)**
- **Scoped enumerations**
- **static_assert**
- **explicit conversion operators**
- **Attributes [[final]] and [[noreturn]]**
- **alignof**
- **Type traits**
- **Unicode character types and literals**
- **long long**
- **variadic macros**
- **Dinkumware C++Std Library**
- **Boost 1.35**

All information based on publicly available data

Clang/llvm

- **Core language:http://clang.llvm.org/cxx_status.html**
  - Very far from complete, can't compile basic tests
  - Variadic template, rvalue ref, extern templ, inline namespace, long long
- **Library:http://libcxx.llvm.org/index.html**
- **On Mac OS X/i386/x86_64**
- **Writes its own library libc++.a:**
  - About 98% complete
  - Only missing atomics



Food for thought and Q/A

- **This is the chance to get a copy before you have to pay for it:**
  - C++ : http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2011/n3291.pdf
  - C: http://www.open-std.org/jtc1/sc22/wg14/www/docs/n1570.pdf
- **Participate and feedback to Compiler**
  - What features/libraries interest you or your customers?
  - What problem/annoyance you would like the Std to resolve?
  - Is Special Math important to you?
  - Do you expect 0x features to be used quickly by your customers?
- **Talk to me at my blog:**
  - http://www.ibm.com/software/rational/cafe/blogs/cpp-standard

My blogs and email address

- michaelw@ca.ibm.com
- Rational C/C++ cafe:
  http://www.ibm.com/software/rational/cafe/community/ccpp
- My Blogs:
- C++ Language & Standard
  http://www.ibm.com/software/rational/cafe/blogs/cpp-standard
- Parallel & Multi-Core Computing
  http://www.ibm.com/software/rational/cafe/blogs/ccpp-parallel-multicore
- Commercial Computing
  http://www.ibm.com/software/rational/cafe/blogs/ccpp-commercial
- Boost test results
  http://www.ibm.com/support/docview.wss?rs=2239&context=SSJT9L&uid=swg27006911
- C/C++ Compilers Support Page
  http://www.ibm.com/software/awdtools/ccompilers/support/
- C/C++ Feature Request Interface
  http://www.ibm.com/support/docview.wss?uid=swg27005811
- XL Fortran Compiler Support Page
  http://www.ibm.com/software/awdtools/fortran/xlfortran/support/
- XL Fortran Feature Request Interface
  http://www.ibm.com/support/docview.wss?uid=swg27005812

Acknowledgement

- **Some slides are borrowed from committee presentations by various committee members, their proposals, and private communication**