C++11

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PDF Slides: http://j.mp/cpp11ref

null pointer constant

C++03

```
void foo(char*);
void foo(int);

foo(NULL);
```

null pointer constant

C++03	C++11
void foo(char*); void foo(int); foo(NULL); **//calls second foo**	void foo(char*); void foo(int); foo(**nullptr**); **//calls first foo**

standard types

C++03
sizeof(int) == ? sizeof(char) == 1 byte(== ? bits) sizeof(char) <= sizeof(short) <= sizeof(int) <= sizeof(long)

standard types

C++03	C++11
sizeof(int) == ? sizeof(char) == 1 byte(== ? bits) sizeof(char) <= sizeof(short) <= sizeof(int) <= sizeof(long)	int8_t uint8_t int16_t uint16_t int32_t uint32_t int64_t uint64_t

raw string literals

C++03	C++11
string test="C:\\A\\B\\C\\D\\file1.txt"; cout << test << endl;	string test=R"(C:\A\B\C\D\file1.txt)"; cout << test << endl;
C:\A\B\C\D\file1.txt	C:\A\B\C\D\file1.txt
string test; test = "First Line.\nSecond line.\nThird Line.\n"; cout << test << endl;	string test; test = R"(First Line.\nSecond line.\nThird Line.\n)"; cout << test << endl;
First Line. Second line. Third Line.	First Line.\nSecond line.\nThird Line.\n
	string test = R"(First Line. Second line. Third Line.)"; cout << test << endl;
	First Line. Second line. Third Line.

in-class member initializers

C++03	C++11
class A { public: A(): a(4), b(2), h("text1"), s("text2") {} A(int in_a) : a(in_a), b(2), h("text1"), s("text2") {} A(C c) : a(4), b(2), h("text1"), s("text2") {} private: int a; int b; string h; string s; };	class A { public: A() {} A(int in_a) : a(in_a) {} A(C c) {} private: int a **= 4;** int b **= 2;** string h **= "text1";** string s **= "text2";** };

delegating constructors

C++03	C++11
class A { int a; void validate(int x) { if (0<x && x<=42) a=x; else throw bad_A(x); } public: A(int x) { validate(x); } A() { validate(42); } A(string s) { int x = stoi(s); validate(x); } };	class A { int a; public: A(int x) { if (0<x && x<=42) a=x; else throw bad_A(x); } A() : **A(42)**{ } A(string s) : **A(stoi(s))**{ } };

override

C++03	C++11
struct Base { virtual void some_func(float); }; struct Derived : Base { virtual void some_func(int); **//warning** };	struct Base { virtual void some_func(float); }; struct Derived : Base { void some_func(int) **override**; **//error** };

final

C++11	Java
struct Base1 **final** {}; struct Derived1 : Base1{ **//error** }; struct Base2{ virtual void f() **final**; }; struct Derived2 : Base2 { void f(); **//error** };	**final** class Base1 {} class Derived1 extends Base1 { **//error** } class Base2 { public **final** void f(){}; } class Derived2 extends Base2 { public void f(){}; **//error** }

static_assert

C++11
template<class T> void f(T v){   **static_assert**(sizeof(v) == 4, “v must have size of 4 bytes");   //do something with v } void g(){   int64_t v; // 8 bytes   f(v); }
vs2010/2012 output: 1>d:\main.cpp(5): error C2338: v must have size of 4 bytes

type traits

C++11	Output
#include <type_traits>	
#include <iostream>	
using namespace std;	
struct A { };	
struct B { virtual void f(){} };	
struct C : B {};	
int main()	
{	
cout << "int:" << has_virtual_destructor<int>::value << endl;	int:0
cout << "int:"<< is_polymorphic<int>::value << endl;	int:0
cout << "A: " << is_polymorphic<A>::value << endl;	A: 0
cout << "B: " << is_polymorphic<B>::value << endl;	B: 1
cout << "C: " << is_polymorphic<C>::value << endl;	C: 1
typedef int mytype[][24][60];	
cout << "(0 dim.): " << extent<mytype,0>::value << endl;	(0st dim.): 0
cout << "(1 dim.): " << extent<mytype,1>::value << endl;	(1st dim.): 24
cout << "(2 dim.): " << extent<mytype,2>::value << endl;	(2st dim.): 60
return 0;	
}	

auto

C++03	C++11
map<string,string>::iterator it = m.begin(); double const param = config["param"]; singleton& s = singleton::instance();	**auto** it = m.begin(); **auto** const param = config["param"]; **auto**& s = singleton::instance();

Prefer using **auto** in the following cases:

auto p = new T();
Here is T in the expression. No need to repeat it again.

auto p = make_shared<T>(arg1);
The same as above.

auto my_lambda = [](){};
If you need to store lambda you may use **auto** or **std::function**

auto it = m.begin();
Instead of: map<string,list<int>::iterator>::const_iterator it = m.cbegin();

http://programmers.stackexchange.com/questions/180216/does-auto-make-c-code-harder-to-understand

decltype

C++11

```
int main(){
  int i = 4;
  const int j = 6;
  const int& k = i;
  int a[5];
  int *p;


  int var1;
  int var2;
  int var3;
  int& var4 = i;
  //
  const int var5 = 1;
  const int& var6 = j;
  int var7[5];
  int& var8 = i;
  int& var9 = i;

  return 0;
}
```

C++11

```
int main(){
  int i = 4;
  const int j = 6;
  const int& k = i;
  int a[5];
  int *p;
  //decltype is an operator for querying the type of an expression.
  //similarly to the sizeof operator, the operand of decltype is unevaluated.
  decltype(i) var1;
  decltype(1) var2;
  decltype(2+3) var3;
  decltype(i=1) var4 = i; //there is no assignment i to 1
  // i == 4 as before
  decltype(j) var5 = 1;
  decltype(k) var6 = j;
  decltype(a) var7;
  decltype(a[3]) var8 = i;
  decltype(*p) var9 = i;

  return 0;
}
```

suffix return type syntax

C++11	
template<class T, class U> **???** add(T x, U y) //return type??? { return x+y; }	

suffix return type syntax

C++11	
template<class T, class U> **???** add(T x, U y) //return type??? { return x+y; }	template<class T, class U> **decltype**(x+y) add(T x, U y) **//scope problem** { return x+y; }

suffix return type syntax

C++11	
template<class T, class U> **???** add(T x, U y) //return type??? { return x+y; }	template<class T, class U> **decltype**(x+y) add(T x, U y) **//scope problem** { return x+y; }
template<class T, class U> **decltype**(*(T*)(0)+*(U*)(0)) add(T x, U y) **// ugly!** { return x+y; }	

suffix return type syntax

C++11

```
template<class T, class U>
??? add(T x, U y)
//return type???
{
  return x+y;
}
```

```
template<class T, class U>
decltype(x+y) add(T x, U y)
//scope problem
{
  return x+y;
}
```

```
template<class T, class U>
decltype(*(T*)(0)+*(U*)(0)) add(T x, U y)
// ugly!
{
  return x+y;
}
```

```
template<class T, class U>
auto add(T x, U y) -> decltype(x+y)
{
  return x+y;
}
```

suffix return type syntax

C++03	C++11
struct LinkedList { struct Link { /* ... */ }; Link* erase(Link* p); // ... }; LinkedList::Link* LinkedList::erase(Link* p) { /* ... */ }	struct LinkedList { struct Link { /* ... */ }; Link* erase(Link* p); // ... }; **auto** LinkedList::erase(Link* p) **->** Link* { /* ... */ }

std::function

C++11

```
int sum(int a, int b) { return a + b; }

function<int (int, int)> fsum = &sum;

fsum(4,2);
```

std::function

C++11

```
struct Foo
{
  void f(int i){}
};

function<void(Foo&, int)> fmember = mem_fn(&Foo::f);

Foo foo;
fmember(foo, 42);
```

std::function

C++11

```
struct Foo
{
  void f(int i){}
};

Foo foo;
function<void(int)> fmember = bind(&Foo::f, foo, _1);

fmember(42);
```

std::bind

C++11	output
float div(float a, float b){ return a/b; }	
cout << “6/1” << div(6,1);	6/1 = 6
cout << “6/2” << div(6,2);	6/2 = 3
cout << “6/3” << div(6,3);	6/3 = 2
function<float(float, float)> inv_div = **bind**(div, **_2**, **_1**);	
cout << “1/6” << inv_div(6,1);	1/6 = 0.166
cout << “2/6” << inv_div(6,2);	2/6 = 0.333
cout << “3/6” << inv_div(6,3);	3/6 = 0.5
function<float(float)> div_by_6 = **bind**(div, **_1**, 6);	1/6 = 0.166
cout << “1/6” << div_by_6 (1);	2/6 = 0.333
cout << “2/6” << div_by_6 (2);	3/6 = 0.5
cout << “3/6” << div_by_6 (3);	

std::bind

C++11

```
//Practical usage
linear_congruential_engine<uint64_t, 1103545, 123, 21478>  generator(1127590);
uniform_int_distribution<int> distribution(1,6);
int rnd = distribution(generator);

//Let’s make things a little bit easier:
auto dice = bind( distribution, generator );
int rnd = dice()+dice()+dice();
```

function objects

C++11(deprecated binders and adaptors)	C++11
unary_function, binary_function, ptr_fun, pointer_to_unary_function, pointer_to_binary_function, mem_fun, mem_fun_t, mem_fun1_t const_mem_fun_t const_mem_fun1_t mem_fun_ref mem_fun_ref_t mem_fun1_ref_t const_mem_fun_ref_t const_mem_fun1_ref_t binder1st binder2nd bind1st bind2nd	**Function wrappers** function mem_fn bad_function_call **Bind** bind is_bind_expression is_placeholder _1, _2, _3, ... **Reference wrappers** reference_wrapper ref cref

lambdas

C++03

```
struct functor
{
  int &a;
  functor(int& _a)
  : a(_a)
  {
  }
  bool operator()(int x) const
  {
    return a == x;
  }
};
int a = 42;
count_if(v.begin(), v.end(), functor(a));
```

lambdas

C++03	C++11
struct functor { **int &a**; functor(**int& _a**) : a(_a) { } bool operator()(**int x**) const { **return a == x**; } }; int a = 42; count_if(v.begin(), v.end(), functor(a));	int a = 42; count_if(v.begin(), v.end(), [**&a**](**int x**){ **return x == a;**}); **C++14** //possible C++14 lambdas count_if(v.begin(),v.end(),[**&a**](**auto x**)**x == a**); http://isocpp.org/blog/2012/12/an-implementation-of-generic-lambdas-request-for-feedback-faisal-vali

lambdas/closures

C++11	test scope	lambda scope
void test() { int x = 4; int y = 5; **[&](){x = 2;y = 2;}**(); **[=]() mutable{x = 3;y = 5;}**(); **[=,&x]() mutable{x = 7;y = 9;}**(); }	 **x**=4 **y**=5 **x**=2 **y**=2 **x**=2 **y**=2 **x**=7 **y**=2	 **x**=2 **y**=2 **x**=3 **y**=5 **x**=7 **y**=9
void test() { int x = 4; int y = 5; auto z = **[=]() mutable{x = 3;++y; int w = x + y; return w; };** z(); z(); z(); }	 **x**=4 **y**=5 **x**=4 **y**=5 **x**=4 **y**=5 **x**=4 **y**=5	 //closure //x,y lives inside z **x**=3 **y**=6 w=9 **x**=3 **y**=7 w=10 **x**=3 **y**=8 w=11

recursive lambdas

```
function<int(int)> f = [&f](int n)
{
  return n <= 1 ? 1 : n * f(n - 1);
};

int x = f(4); //x = 24
```

std::tuple

C++11	python
tuple<int,float,string> t(1,2.f,”text”); int x = **get**<0>(t); float y = **get**<1>(t); string z = **get**<2>(t);	t = (1,2.0,’text’) x = t[0] y = t[1] z = t[2]
int myint; char mychar; **tuple**<int,float,char> mytuple; // packing values into tuple mytuple = **make_tuple** (10, 2.6, 'a'); // unpacking tuple into variables **tie**(myint, **ignore**, mychar) = mytuple;	// packing values into tuple mytuple = (10, 2.6, 'a') // unpacking tuple into variables myint, _, mychar = mytuple
int a = 5; int b = 6; **tie**(b, a) = **make_tuple**(a, b);	a = 5 b = 6 b,a = a,b

std::tuple/std::tie(for lexicographical comparison)

C++03

```
struct Student
{
  string name;
  int classId;
  int numPassedExams;

  bool operator<(const Student& rhs) const
  {
    if(name < rhs.name)
      return true;

    if(name == rhs.name)
    {
      if(classId < rhs.classId)
        return true;

      if(classId == rhs.classId)
        return numPassedExams < rhs.numPassedExams;
    }

    return false;
  }
};

set<Student> students;
```

C++11

```
struct Student
{
  string name;
  int classId;
  int numPassedExams;

  bool operator<(const Student& rhs) const
  {
    return tie(name, classId, numPassedExams) <
      tie(rhs.name, rhs.classId, rhs.numPassedExams);
  }
};

set<Student> students;
```

Uniform Initialization and std::initializer_list

C++03	C++11
int a[] = { 1, 2, 3, 4, 5 }; vector<int> v; for(int i = 1; i <= 5; ++i) v.push_back(i);	int a[] = { 1, 2, 3, 4, 5 }; vector<int> v = { 1, 2, 3, 4, 5 };
map<int, string> labels; labels.insert(make_pair(1, “Open”)); labels.insert(make_pair(2, “Close”)); labels.insert(make_pair(3, “Reboot”));	map<int, string> labels { { 1 , "Open" }, { 2 , "Close" }, { 3 , "Reboot" } };
Vector3 normalize(const Vector3& v) { float inv_len = 1.f/ length(v); return Vector3(v.x*inv_len, v.y*inv_len, v.z*inv_len); }	Vector3 normalize(const Vector3& v) { float inv_len = 1.f/ length(v); return {v.x*inv_len, v.y*inv_len, v.z*inv_len}; }
Vector3 x = normalize(Vector3(2,5,9)); Vector3 y(4,2,1);	Vector3 x = normalize({2,5,9}); Vector3 y{4,2,1};

std::initializer_list

C++11

```
vector<int>    v  = { 1, 2, 3, 4, 5 }; //How to make this works?
```

```
vector<int>    v  = { 1, 2, 3, 4, 5 };
//vector(initializer_list<T> args) is called
```

```
template<class T>
class vector{
  vector(initializer_list<T> args)
  { /*rude, naive implementation to show how ctor
with initiailizer_list works*/
    for(auto it = begin(args); it != end(args); ++it)
      push_back(*it);
  }
//…
};
```

```
//what is initializer_list<T> ?
```

initializer_list<T> is a lightweight proxy object that provides access to an array of objects of type T.

A std::initializer_list object is **automatically** constructed when:

```
vector<int> v{1,2,3,4,5};//list-initialization
v = {1,2,3,4,5};//assignment expression
f({1,2,3,4,5});//function call
for (int x : {1, 2, 3})//ranged for loop
  cout << x << endl;
```

Uniform Initialization

C++11

```
//but wait!!! How then does this work??
struct Vector3{
float x,y,z;
Vector3(float _x, float _y, float _z)
 : x(_x), y(_y), z(_z){}
//I don't see ctor with std::initializer_list!
};

Vector3 normalize(const Vector3& v){
  float inv_len = 1.f/ length(v);
  return {v.x*inv_len, v.y*inv_len, v.z*inv_len};
}

Vector3 x = normalize({2,5,9});
Vector3 y{4,2,1};
```

The answer is:

now you can use {} instead of ()

But what about following case:

```
struct T {
  T(int,int);
  T(initializer_list<int>);
};

T foo {10,20};  // calls initializer_list ctor
T bar (10,20);  // calls first constructor
```

Initializer-list constructors **take precedence over other constructors** when the initializer-list constructor syntax is used!

So, be careful! Consider following example:

```
vector<int> v(5); // v contains five elements {0,0,0,0,0}
vector<int> v{5}; // v contains one element {5}
```

Uniform Initialization

C++11	
Uniform initialization solves many problems:	
Narrowing int x = 6.3; **//warning!** int y {6.3}; **//error: narrowing** int z = {6.3}; **//error: narrowing** vector<int> v = **{** 1, 4.3, 4, 0.6 **}**; **//error: double to int narrowing**	
"The most vexing parse" problem struct B{ B(){} }; struct A{ A(B){} void f(){} }; int main(){ A a(B()); **//this is function declaration!** a.f(); //compile error! return 0; }	struct B{ B(){} }; struct A{ A(B){} void f(){} }; int main(){ A a**{**B()**}**; //calls B ctor, then A ctor. Everything is ok. a.f(); //calls A::f return 0; }

Uniform Initialization and std::initializer_list

```
// Don't mix std::initializer_list with auto
int n;
auto w(n);     // int
auto x = n;    // int
auto y {n};    // std::initializer_list<int>
auto z = {n};  // std::initializer_list<int>
```

using

C++03

```
typedef int int32_t; // on windows
typedef void (*Fn)(double);
```

```
template <int U, int V> class Type;

typedef Type<42,36> ConcreteType;
```

```
template<int V>
typedef Type<42,V> MyType;
//error: not legal C++ code

MyType<36> object;
```

```
template<int V>
struct meta_type{
  typedef Type<42, V> type;
};
typedef meta_type<36>::type MyType;
MyType object;
```

using

C++03	C++11
typedef int int32_t; // on windows typedef void (*Fn)(double);	**using** int32_t = int; // on windows **using** Fn = void (*)(double);
template <int U, int V> class Type; typedef Type<42,36> ConcreteType;	template <int U, int V> class Type; **using** ConcreteType = Type<42,36>;
template<int V> struct meta_type{ typedef Type<42, V> type; }; typedef meta_type<36>::type MyType; MyType object;	**template <int V>** **using** MyType = Type<42, V>; MyType<36> object;

explicit conversion operators

C++03

```
struct A { A(int){}; };
void f(A){};

int main(){
A a(1);
f(1);  //silent implicit cast!
return 0;
}
```

explicit conversion operators

C++03

```
struct A {explicit A(int){}; };
void f(A){};

int main(){
A a(1);
f(1);  //error: implicit cast!
return 0;
}
```

explicit conversion operators

C++03	C++11
struct A { A(int) {} }; struct B { int m; B(int x) : m(x) {} operator A() { return A(m); } }; void f(A){} int main(){ B b(1); A a = b; **//silent implicit cast!** f(b); **//silent implicit cast!** return 0; }	struct A { A(int) {} }; struct B { int m; B(int x) : m(x) {} **explicit** operator A() { return A(m); } }; void f(A){} int main(){ B b(1); A a = b; **//error: implicit cast!** f(b); **//error: implicit cast!** return 0; }

explicit conversion operators

C++03	C++11
struct A { A(int) {} }; struct B { int m; B(int x) : m(x) {} operator A() { return A(m); } }; void f(A){} int main(){ B b(1); A a = b; **//silent implicit cast!** f(b); **//silent implicit cast!** return 0; }	struct A { A(int) {} }; struct B { int m; B(int x) : m(x) {} **explicit** operator A() { return A(m); } }; void f(A){} int main(){ B b(1); A a = **static_cast<**A**>**(b); f(**static_cast<**A**>**(b)); return 0; }

control of defaults: default and delete

C++11

```
class A
{
  A& operator=(A) = delete;  // disallow copying
  A(const A&) = delete;
};

struct B
{
  B(float); // can initialize with a float
  B(long) = delete; // but not with long
};

struct C
{
  virtual ~C() = default;
};
```

enum class - scoped and strongly typed enums

C++03	C++11
enum Alert { green, yellow, red }; //enum Color{ red, blue }; //error C2365: 'red' : redefinition Alert a = 7; **// error (as ever in C++)** int a2 = red; **// ok: Alert->int conversion** int a3 = Alert::red; **// error**	**enum class** Alert { green, yellow, red }; **enum class** Color : **int**{ red, blue }; Alert a = 7; **// error (as ever in C++)** Color c = 7; **// error: no int->Color conversion** int a2 = red; **// error** int a3 = Alert::red; **//error** int a4 = blue; **// error: blue not in scope** int a5 = Color::blue; **//error: not Color->int conversion** Color a6 = Color::blue; **//ok**

user-defined literals

C++03	C++11
123 // int 1.2 // double 1.2F // float 'a' // char 1ULL // unsigned long long	1.2_i // imaginary 123.4567891234_df // decimal floating point (IBM) 101010111000101_b // binary 123_s // seconds 123.56_km // not miles! (units) Speed v = 100_km/1_h; int **operator ""** _km(int val){ return val; } Practical usage: http://www.codeproject.com/Articles/447922/Application-of-Cplusplus11-User-Defined-Literals-t

Move Semantics

C++03

```
typedef vector<float> Matrix;

//requires already created C
void Mul(const Matrix& A, const Matrix& B, Matrix& C);

//need to manage lifetime manually using new/delete
void Mul(const Matrix& A, const Matrix& B, Matrix* C);

//please, don’t forget to call delete
Matrix* operator*(const Matrix& A, const Matrix& B);

//no need to manage lifetime manually, but adds some
//performance and abstraction penalty
shared_ptr<Matrix> operator* (const Matrix& A, const
Matrix& B);
```

Move Semantics

C++03	C++11
typedef vector<float> Matrix;	typedef vector<float> Matrix;
//requires already created C void Mul(const Matrix& A, const Matrix& B, Matrix& C);	
//need to manage lifetime manually using new/delete void Mul(const Matrix& A, const Matrix& B, Matrix* C);	
//please, don’t forget to call delete Matrix* operator*(const Matrix& A, const Matrix& B);	//Cool syntax, no abstraction or performance //penalty! Thanks to move semantics! Matrix operator*(const Matrix& A, const Matrix& B);
//no need to manage lifetime manually, but adds some //performance and abstraction penalty shared_ptr<Matrix> operator* (const Matrix& A, const Matrix& B);	
	Matrix A(10000); Matrix B(10000); Matrix C = A * B;

Move Semantics

C++11

```
typedef vector<float> Matrix;

Matrix operator*(const Matrix& A, const Matrix& B);
{
  Matrix ret(A.size()); //ret.data = 0x0028fabc
  //ret.size = 100000
  //matrix multiplication algorithm
  //
  return ret; //vector<float>(vector<float>&&)
  //C.data = ret.data, C.size = ret.size
  //ret.data = nullptr, ret.size = 0
}//~vector<float>()
 //delete ret.data; //"delete nullptr;" is ok.

Matrix A(10000);
Matrix B(10000);
Matrix C = A * B;

//C.data = 0x0028fabc
//C.size = 100000
```

```
template<class T>
class vector
{
  T* data;
  size_t size;

public:
  vector(vector<T>&& rhs)
  : data(rhs.data)
  , size(rhs.size)
  {
    rhs.data = nullptr;
    rhs.size = 0;
  }
  ~vector()
  {
    delete[] data;
  }
//...
};
```

Move Semantics

C++03	C++11
typedef vector<float> BigObj; void f(BigObj&); //reference to lvalue //test1 BigObj x = createBigObject(); //BigObj(const BigObj&) f(x); //BigObj(const BigObj&) f(createBigObject()); //BigObj(const BigObj&) //test3 BigObj createBigObject() { BigObj object(100000); //value return object; //BigObj(const BigObj&) }//~BigObj BigObj x = createBigObject();	typedef vector<float> BigObj; void f(BigObj**&&**); //reference to rvalue void f(BigObj&); //reference to lvalue //test1 BigObj x = createBigObject(); f(x); //BigObj(const BigObj&) f(createBigObject()); //BigObj(BigObj**&&**) //test2 BigObj x = createBigObject(); f(**move**(x)); // move makes from input value – rvalue. //test3 BigObj createBigObject() { BigObj object(100000); //prvalue return object; //BigObj(BigObj**&&**) }//~BigObj BigObj x = createBigObject();

constexpr

C++03	C++11
``template<int N> struct Fib{ enum { value = Fib<N-1>::value + Fib<N-2>::value }; }; template<> struct Fib<1>{ enum { value = 1 }; }; template<> struct Fib<0> { enum { value = 0 }; }; cout << Fib<15>::value;```	```constexpr int Fib(int n) { return n<=2 ? 1 : Fib(n-1)+Fib(n-2); } cout << Fib(15); //compile time int a = 15; cout << Fib(a); //runtime```

C++03:

```
template<int N>
struct Fib{
  enum {
    value = Fib<N-1>::value + Fib<N-2>::value
  };
};

template<> struct Fib<1>{
  enum { value = 1 };
};

template<> struct Fib<0> {
  enum { value = 0 };
};

cout << Fib<15>::value;
```

C++11:

```
constexpr int Fib(int n)
{
 return n<=2 ? 1 : Fib(n-1)+Fib(n-2);
}

cout << Fib(15); //compile time

int a = 15;
cout << Fib(a); //runtime
```

range-for, begin, end

C++03	**C++11**
vector<int> v; for(vector<int>::iterator i = v.begin(); i != v.end(); ++i) total += *i; sort(v.begin(), v.end()); int a[] = {1,2,3,4,5}; sort(&a[0], &a[0] + sizeof(a)/sizeof(a[0]));	vector<int> v; **for(auto d : v)** total += d; sort(**begin(v), end(v)**); int a[] = {1,2,3,4,5}; sort(**begin(a), end(a)**);

Memory management (unique_ptr is safe replacement for unsafe deprecated auto_ptr)

C++11
unique_ptr<int> p1(new int(42)); unique_ptr<int> p2 = p1; //Compile error. Only "move" operation is possible. unique_ptr<int> p3 = move(p1); //Transfers ownership. p3 now owns the memory and p1 is nullptr. p3.reset(); //Deletes the memory. p1.reset(); //Does nothing.
unique_ptr<int> createUniqueResource() {   unique_ptr<int> ret(new int(42));   return ret; //no need to move(ret); }
F* OpenFile(char* name); void CloseFile(F*); /* custom deleter */ unique_ptr<F, function<decltype(CloseFile)>> file(OpenFile("text"), CloseFile); file->read(1024);

Memory management (shared_ptr = ref(+weak) thread safe counter)

```
void test()
{
    shared_ptr<int> p( new int(42) );          ref count = 1, weak count = 0
    {
        shared_ptr<int> x = p;                 ref count = 2, weak count = 0
        {
          shared_ptr<int> y = p;               ref count = 3, weak count = 0
        }                                      ref count = 2, weak count = 0
    }                                          ref count = 1, weak count = 0
    // use weak_ptr to break reference-count cycles
    weak_ptr<int> wp = p;                      ref count = 1, weak count = 1 – note ref count is still 1
    shared_ptr<int> ap = wp.lock();            ref count = 2, weak count = 1
    {
          shared_ptr<int> y = ap;              ref count = 3, weak count = 1
    }                                          ref count = 2, weak count = 1
}                                  ap dtor:    ref count = 1, weak count = 1
                                   wp dtor:    ref count = 1, weak count = 0
                                   p dtor:     ref count = 0, weak count = 0 - destroy p!
```

Variadic templates

C++03	C++11
void f(); template<class T> void f(T arg1); template<class T, class U> void f(T arg1, U arg2); template<class T, class U, class Y> void f(T arg1, U arg2, Y arg3); template<class T, class U, class Y, class Z> void f(T arg1, U arg2, Y arg3, Z arg4); f(“test”,42,’s’,12.f); //… till some max N.	template <class **...**T> void f(T**...** args); f(“test”,42,’s’,12.f);

Variadic templates

<table>
<tr><th>C++11</th><th>C++11(call sequence)</th></tr>
<tr><td rowspan="3">
<pre>
template<class T>
void print_list(T value)
{
  cout<<value<<endl;
}

template<class First, class ...Rest>
void print_list(First first, Rest ...rest)
{
  cout<<first<<","; print_list(rest...);
}

print_list(42,"hello",2.3,'a');
</pre>
</td><td>
<pre>
print_list(first = 42, ...rest = "hello",2.3,'a')
  42
  print_list(first = "hello", ...rest = 2.3,'a')
    hello
    print_list(first = 2.3, ...rest = 'a')
      2.3
      print_list(value ='a') //trivial case
      a
</pre>
</td></tr>
<tr><td>Output</td></tr>
<tr><td>42,hello,2.3,a</td></tr>
</table>

Tuple definition using variadic templates

C++11

```
template<class... Elements>
class tuple;

template<>
class tuple<> {};

template<class Head, class... Tail>
class tuple<Head, Tail...> : private tuple<Tail...>
{
  Head head;
  //
};
```

"LISP-style" definition:
A tuple is either:

- An empty tuple, or

- A pair (head, tail) where head is the first element of the tuple and tail is a tuple containing the rest(...) of the elements.

Variadic templates

C++11

```cpp
template<int... Elements> struct count;

template<> struct count<>
{
  static const int value = 0;
};

template<int T, int... Args>
struct count<T, Args...>
{
  static const int value = 1 +
     count<Args...>::value;
};

//call
int x = count<0,1,2,3,4>::value;
```

Haskell

```haskell
count [] = 0
count (T:Args) = 1 + count Args


//call
count [0,1,2,3,4]
```

Variadic templates(sizeof... operator)

C++11	
`template<int... Elements> struct count;` `template<> struct count<>` `{` `  static const int value = 0;` `};` `template<int T, int... Args>` `struct count<T, Args...>` `{` `  static const int value = 1 +` `     count<Args...>::value;` `};` `//call` `int x = count<0,1,2,3,4>::value;`	`template<int... Elements>` `struct count` `{` `  static const int value = sizeof...(Elements);` `};` `/*` `sizeof...() – return the number elements in a parameter pack` `*/` `//call` `int x = count<0,1,2,3,4>::value;`

std::string

Interprets a signed integer value in the string:
int **stoi**(const std::string& str, size_t *pos = 0, int base = 10);
long **stol**(const std::string& str, size_t *pos = 0, int base = 10);
long long **stoll**(const std::string& str, size_t *pos = 0, int base = 10);

Interprets an unsigned integer value in the string:
unsigned long **stoul**(const std::string& str, size_t *pos = 0, int base = 10);
unsigned long long **stoull**(const std::string& str, size_t *pos = 0, int base = 10);

Interprets a floating point value in a string:
float **stof**(const std::string& str, size_t *pos = 0);
double **stod**(const std::string& str, size_t *pos = 0);
long double **stold**(const std::string& str, size_t *pos = 0);

Converts a (un)signed/decimal integer to a string/wstring:
to_string
to_wstring

std::array

C++03	C++11
char arr1[] = "xyz"; //'\0' is added to the end int arr2[] = {2112, 90125, 1928};	**array**<char, 3> arr1 = {'x', 'y', 'z'}; **array**<int, 3> arr2 = {2112, 90125, 1928};
int* x = arr2; //**ok**	int* x = arr2; //**error** x = arr2.**data**(); //**ok**
cout << sizeof(arr1) - 1 << endl; cout << sizeof(arr2) / sizeof(int) << endl;	cout << arr1.**size**() << endl; cout << arr2.**size**() << endl;
arr2[-42] = 36; //**oops**	arr2.**at**(-42) = 36; //throws std::out_of_range exception

http://stackoverflow.com/questions/6111565/now-that-we-have-stdarray-what-uses-are-left-for-c-style-arrays

std::vector

C++03	C++11
void c_style_f(int* x){} void test(){ vector<int> v; if(!v.empty()) c_style_f(&v[0]); if(!v.empty()) c_style_f(&v.front()); if(!v.empty()) c_style_f(&*v.begin()); }	void c_style_f(int* x){} void test(){ vector<int> v; c_style_f(v.**data**()); }
vector<int> v; v.push_back(1); //capacity = 1 v.reserve(20); //capacity = 20 vector<int>(v).swap(v); //capacity = 1 ~~//very intuitive!~~	vector<int> v; v.push_back(1); //capacity = 1 v.reserve(20); //capacity = 20 v.**shrink_to_fit**(); //capacity = 1
struct Some_type{ Some_type(int _x, int _y, int _z) : x(_x), y(_y), z(_z){} int x,y,z; }; vector<Some_type> v; v.push_back(Some_type(1,2,3));	struct Some_type{ Some_type(int _x, int _y, int _z) : x(_x), y(_y), z(_z){} int x,y,z; }; vector<Some_type> v; v.**emplace_back**(1,2,3);

STL

std::regex

```
bool equals = regex_match("subject", regex("(sub)(.*)") );
```

std::chrono

```
auto start = high_resolution_clock::now();
some_long_computations();
auto end = high_resolution_clock::now();
cout<<duration_cast<milliseconds>(end-start).count();
```

std::ratio

```
using sum = ratio_add<ratio<1,2>, ratio<2,3>>;

cout << "sum = " << sum::num << "/" << sum::den;
cout << " (which is: " << ( double(sum::num) / sum::den ) << ")" << endl;
```

Output: sum = 7/6 (which is: 1.166667)

STL

New algorithms:

std::all_of, std::none_of, std::any_of,
std::find_if_not, std::copy_if, std::copy_n,
std::move, std::move_n, std::move_backward,
std::shuffle, std::random_shuffle,
std::is_partitioned, std::partition_copy,
std::partition_point, std::is_sorted,
std::is_sorted_until, std::is_heap_until,
std::min_max, std::minmax_element,
std::is_permutation, std::iota

Threads and memory model

Threading support:

thread, mutex, condition variable, future/promise, package task

Memory model:

atomic, fence

Difference between std::thread and boost::thread:

http://stackoverflow.com/questions/7241993/is-it-smart-to-replace-boostthread-and-boostmutex-with-c11-equivalents

std::thread

C++11

```cpp
#include <thread>
#include <iostream>

int main()
{
   using namespace std;
   thread t1([](){
      cout << “Hi from
       thread” << endl;});

   t1.join();
   return 0;
}
```

Java

```java
public class TestThread {


  public static void main(String[] args) throws
InterruptedException {
     Thread t1 = new Thread(new Runnable() {
       public void run() {
         System.out.println(“Hi from thread");
       }
     });
     t1.start();

     t1.join();
  }
}
```

std::mutex

C++11

```
#include <iostream>
#include <thread>
//version without mutex!!!
using namespace std;

void run(size_t n){
    for (size_t i = 0; i < 5; ++i){
        cout << n << ": " << i << endl;
    }
}

int main(){
    thread t1(run, 1);
    thread t2(run, 2);
    thread t3(run, 3);

    t1.join();
    t2.join();
    t3.join();

    return 0;
}
```

Output(may vary)

```
1: 0
1: 1
1: 2
1: 3
1: 4
23: 0
3: 1
3: 2
3: 3
3: 4
: 0
2: 1
2: 2
2: 3
2: 4
```

std::mutex

<table>
<tr><th>C++11</th><th>Output(is defined within run)</th></tr>
<tr><td>

```
#include <iostream>
#include <thread>
#include <mutex>

using namespace std;

mutex m;

void run(size_t n){
  m.lock();
  for (size_t i = 0; i < 5; ++i){
    cout << n << ": " << i << endl;
  }

  m.unlock();
}

int main(){
  thread t1(run, 1);
  thread t2(run, 2);
  thread t3(run, 3);

  t1.join();
  t2.join();
  t3.join();

  return 0;
}
```

</td><td>1: 0
1: 1
1: 2
1: 3
1: 4
2: 0
2: 1
2: 2
2: 3
2: 4
3: 0
3: 1
3: 2
3: 3
3: 4</td></tr>
</table>

std::lock_guard+std::mutex

C++11

```
#include <iostream>
#include <thread>
#include <mutex>

using namespace std;

mutex m;

void run(size_t n){
  m.lock();
  for (size_t i = 0; i < 5; ++i){
    cout << n << ": " << i << endl;
  }

  m.unlock();
}

int main(){
  thread t1(run, 1);
  thread t2(run, 2);
  thread t3(run, 3);

  t1.join();
  t2.join();
  t3.join();

  return 0;
}
```

```
#include <iostream>
#include <thread>
#include <mutex>

using namespace std;

mutex m;

void run(size_t n){
  lock_guard<mutex> lm(m); //ctor – m.lock(), dtor – m.unlock()
  for (size_t i = 0; i < 5; ++i){
    cout << n << ": " << i << endl;
  }
}

int main(){
  thread t1(run, 1);
  thread t2(run, 2);
  thread t3(run, 3);

  t1.join();
  t2.join();
  t3.join();

  return 0;
}
```

std::async

C++11

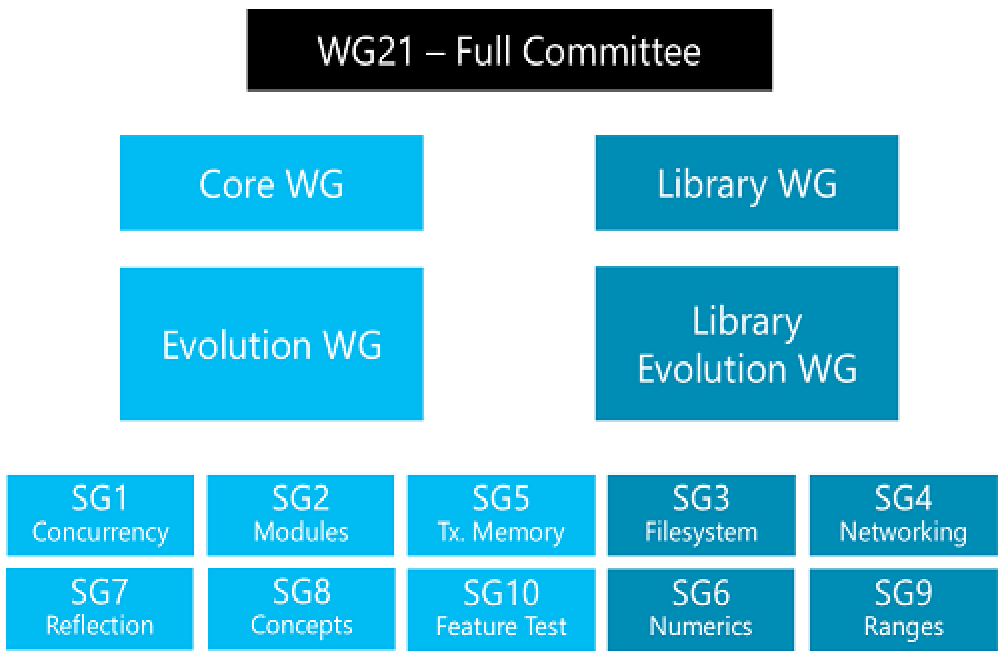
```
#include <iostream>
#include <future>

using namespace std;

int Fib(int n){
  return n<=2 ? 1 : Fib(n-1)+Fib(n-2);
}

int calc1(){  return Fib(30); }

int calc2(){  return Fib(40); }

int main()
{
  // start calc1() asynchronously
  future<int> result1 = async(calc1);
  // call calc2() synchronously
  int result2 = calc2();
  // wait for calc1() and add its result to result2
  int result = result1.get() + result2;
  cout << "calc1()+calc2(): " << result << endl;
  return 0;
}
```

Deprecated idioms

C++11
Now that we have C++11, we can use new features instead of following idioms:
nullptr
Move_Constructor
Safe_bool
Shrink-to-fit
Type_Safe_Enum
Requiring_or_Prohibiting_Heap-based_Objects
Type_Generator
Final_Class
address_of
http://stackoverflow.com/questions/9299101/what-c-idioms-are-deprecated-in-c11

C++11 compiler support

gcc	icc	msvc(with NOV CTP)	Ibm xlc	clang
38/39 Not implemented: threads, regex	27/39 Full STL support	24/39 Full STL support(without init. list)	17/39 Not implemented: threads, regex	37/39 Full STL support



links

- http://www.isocpp.org
- http://www.cplusplus.com
- http://www.stroustrup.com/C++11FAQ.html
- http://channel9.msdn.com/Events/GoingNative/GoingNative-2012/Keynote-Bjarne-Stroustrup-Cpp11-Style
- http://channel9.msdn.com/Events/Build/BUILD2011/TOOL-835T
- http://channel9.msdn.com/posts/C-and-Beyond-2011-Herb-Sutter-Why-C
- http://channel9.msdn.com/Events/Lang-NEXT/Lang-NEXT-2012/-Not-Your-Father-s-C-
- http://cpprocks.com/cpp11-stl-additions/
- http://cpprocks.com/c11-a-visual-summary-of-changes/#!prettyPhoto
- http://wiki.apache.org/stdcxx/C++0xCompilerSupport