libc++: A Standard Library for C++0x

2010 LLVM Developers' Meeting

Why?

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- The C++0x spec introduces several fundamentally new ideas at the language level.
  - Move semantics
  - Perfect forwarding
  - Variadic templates

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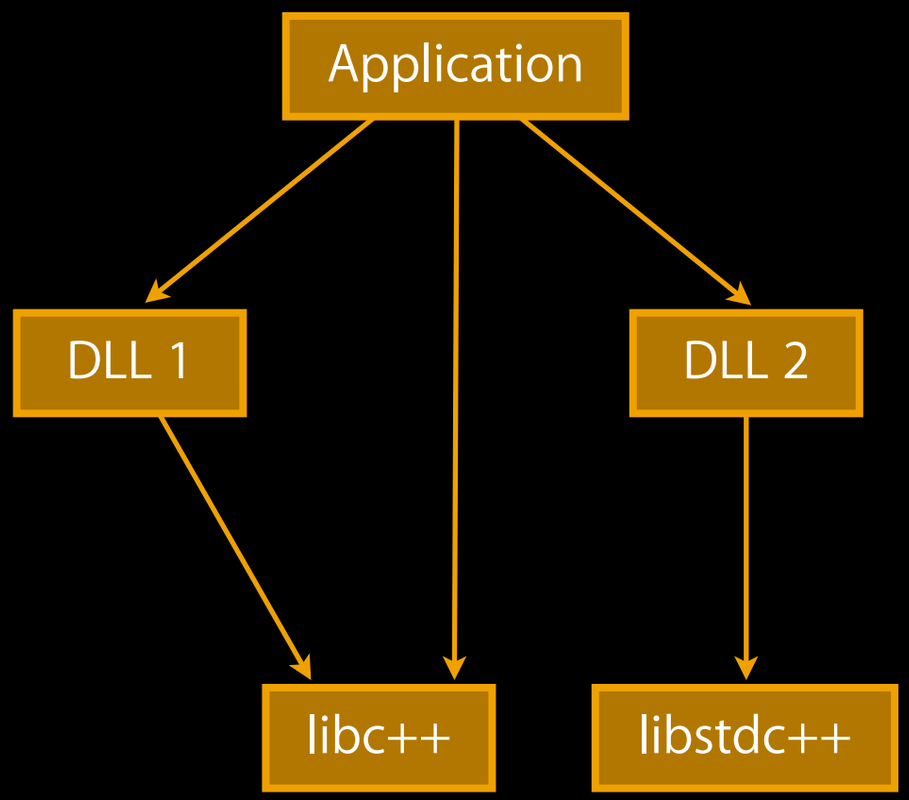
- libc++ is designed from the ground up to take advantage of these new language features.
  - This is not a C++0X implementation layered on top of a C++03 implementation.
  - It has been a C++0X implementation from the beginning.
  - This has driven several low-level design decisions.

Overall Design

libstdc++ (gcc) Interoperability



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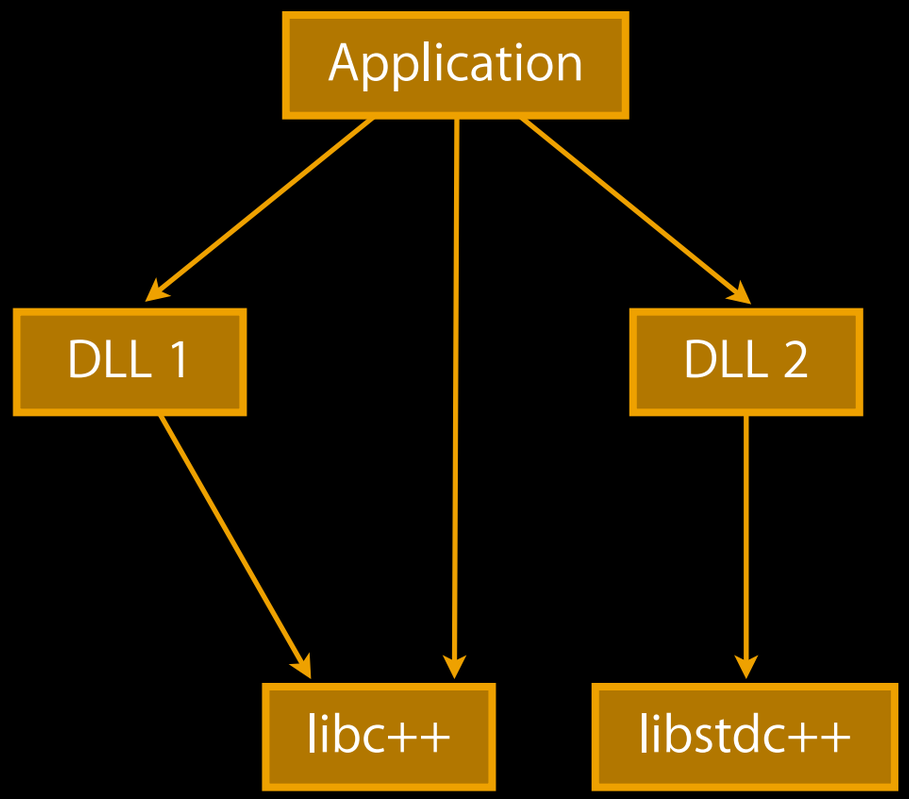

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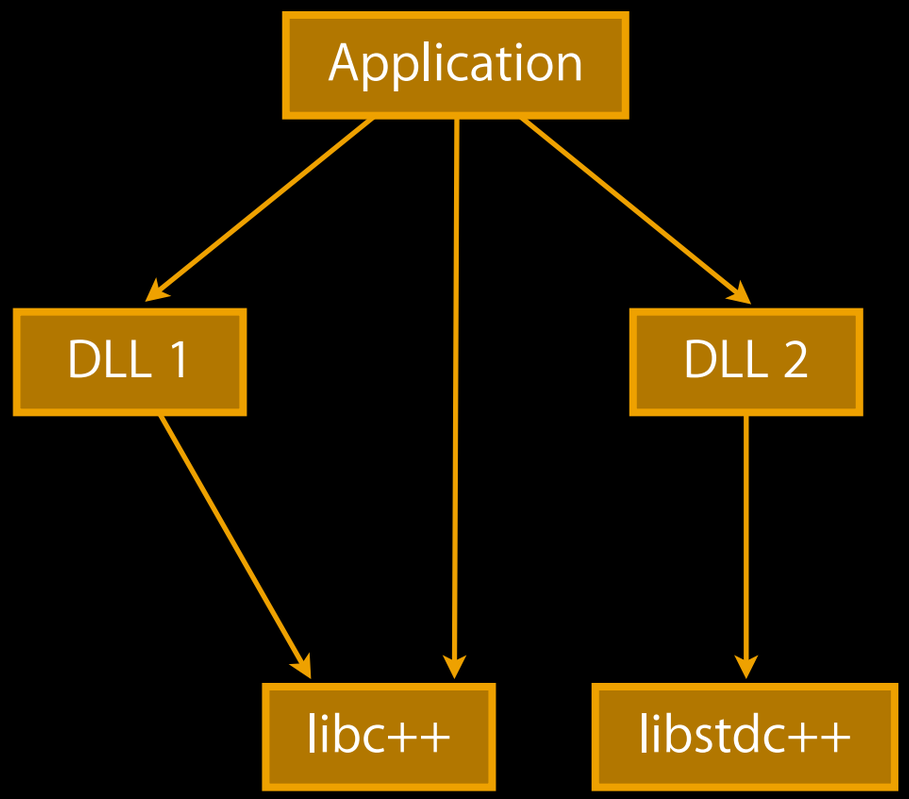

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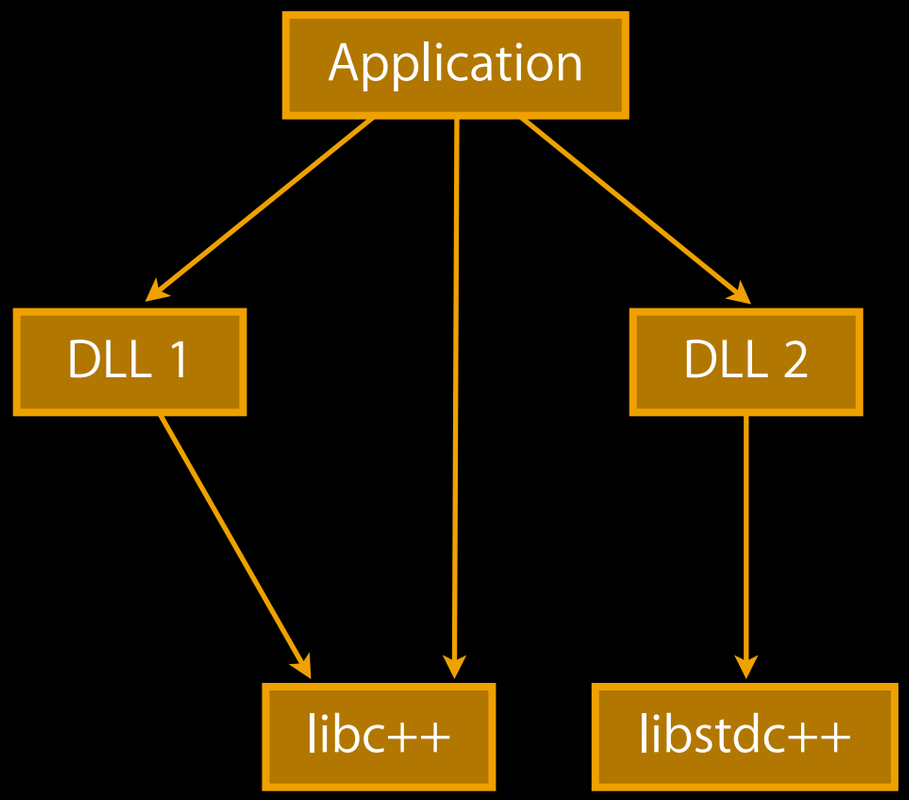

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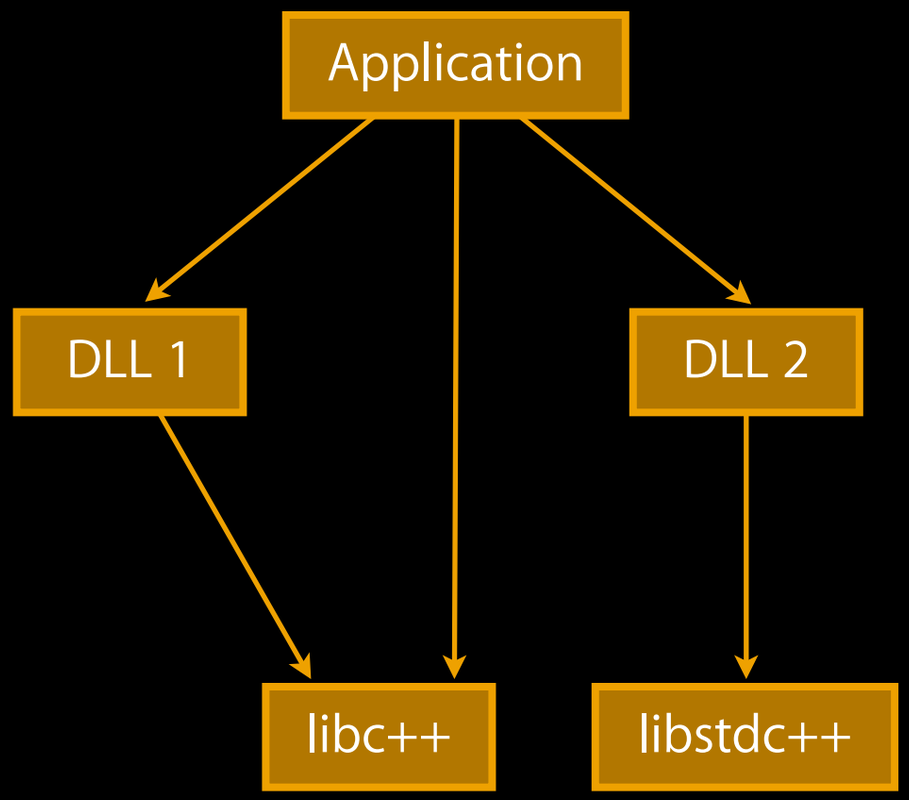

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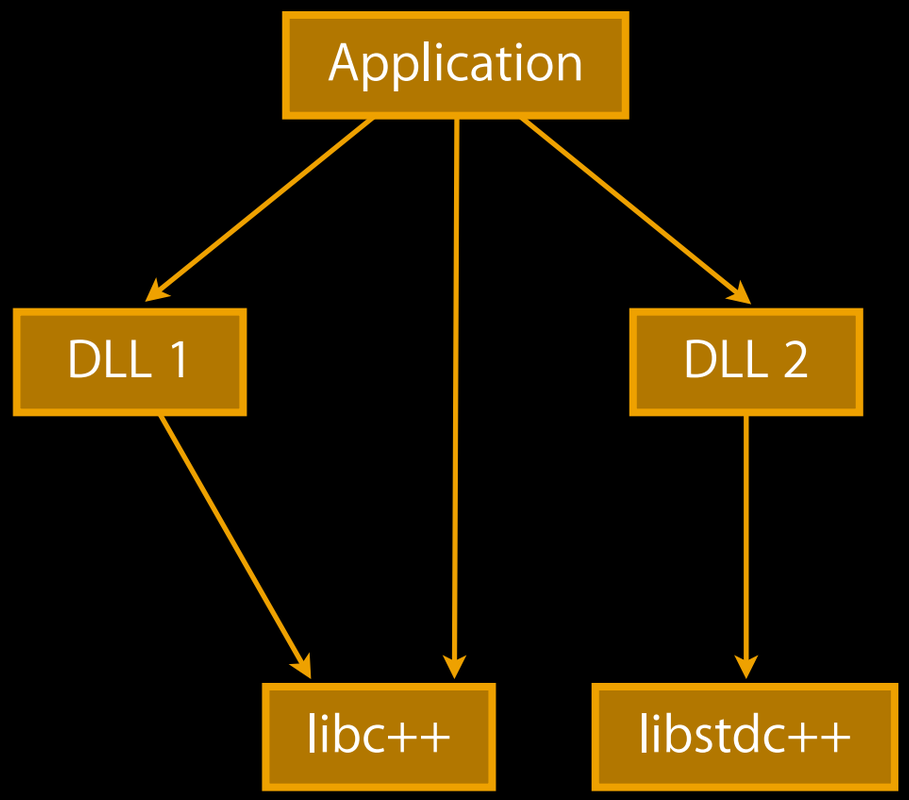

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  - Headers are not used to "moduralize" code.
    - All of the regular expression library is in <regex>.
    - All of the random number library is in <random>.
    - etc.

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  - No configure.
  - Configuration is accomplished via the header <__config>.
- Consequently the entire library builds in **45–60 seconds.**

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- The test harness is purposefully simplistic…
  - $ cd test; testit
- One can cd into any subdirectory and run the tests just for that section and its subdirectories.
  - $ cd <where ever>; testit

A Few libc++ Examples of Excellence…

string

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- This design considered the importance of move semantics from the beginning: minimum `sizeof` leads to faster moving.

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- Associative containers optimize away the space for stateless comparators (and stateless hash functions for the unordered containers).

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deque<int>	libc++	libstdc++
sizeof	48 bytes	80 bytes
Default ctor allocation	0 bytes	576 bytes

libc++ vs g++-4.2 libstdc++

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map<int, int>	libc++	libstdc++
sizeof	24 bytes	48 bytes
Default ctor allocation	0 bytes	0 bytes

libc++ vs g++-4.2 libstdc++

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unordered_map<int, int>	libc++	libstdc++
sizeof	40 bytes	48 bytes
Default ctor allocation	0 bytes	96 bytes

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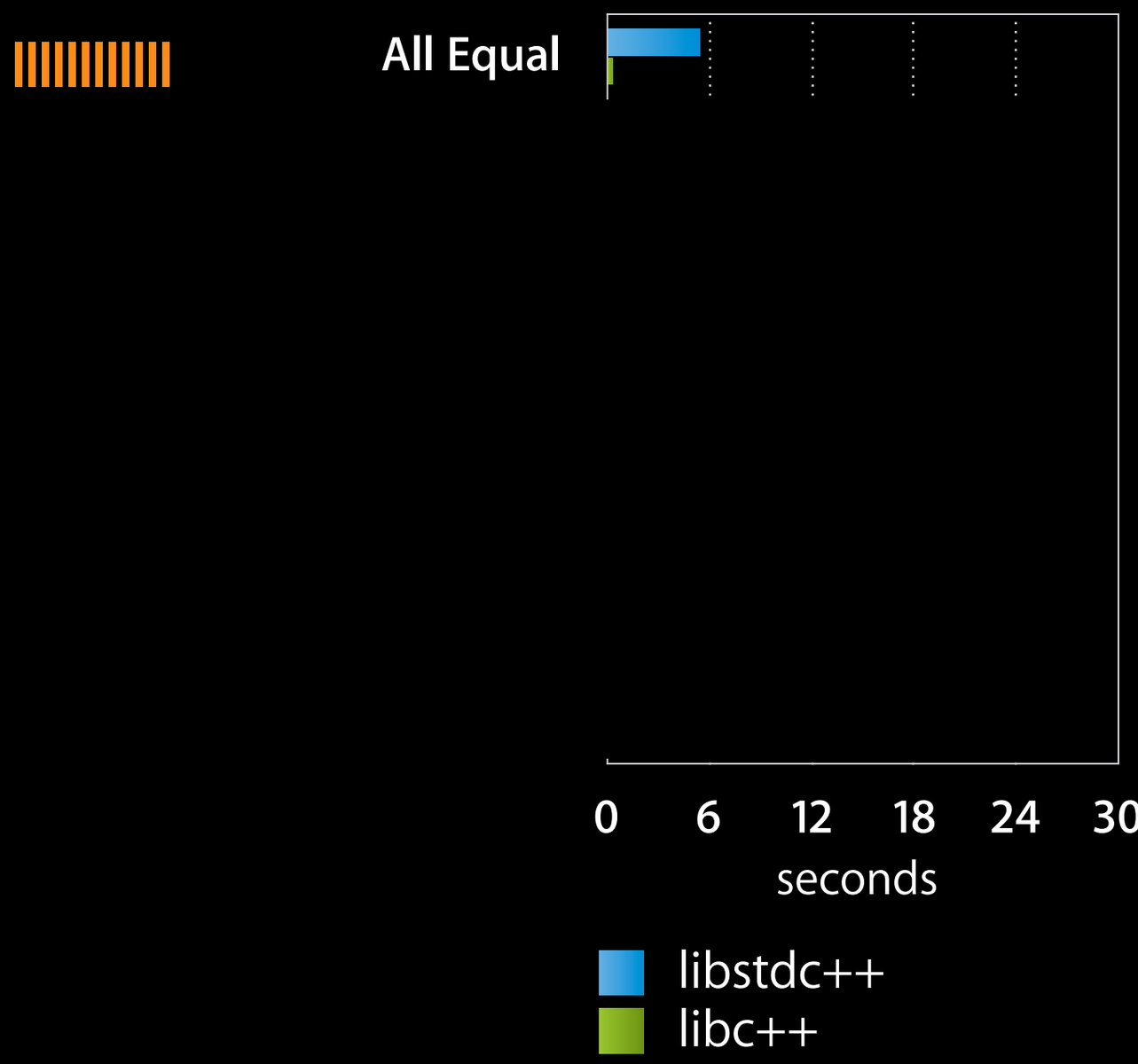

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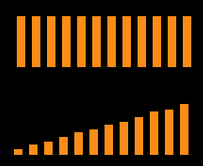

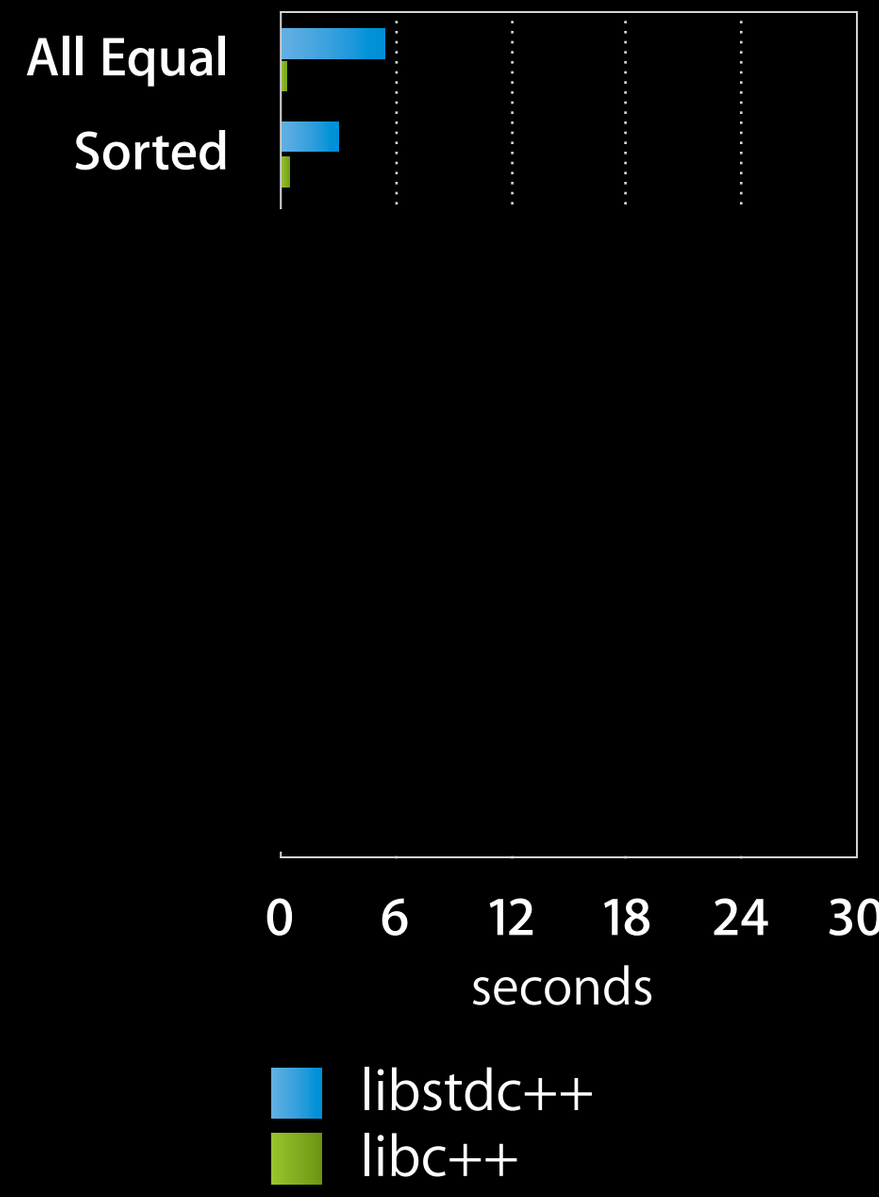

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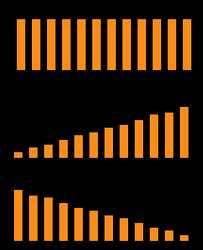

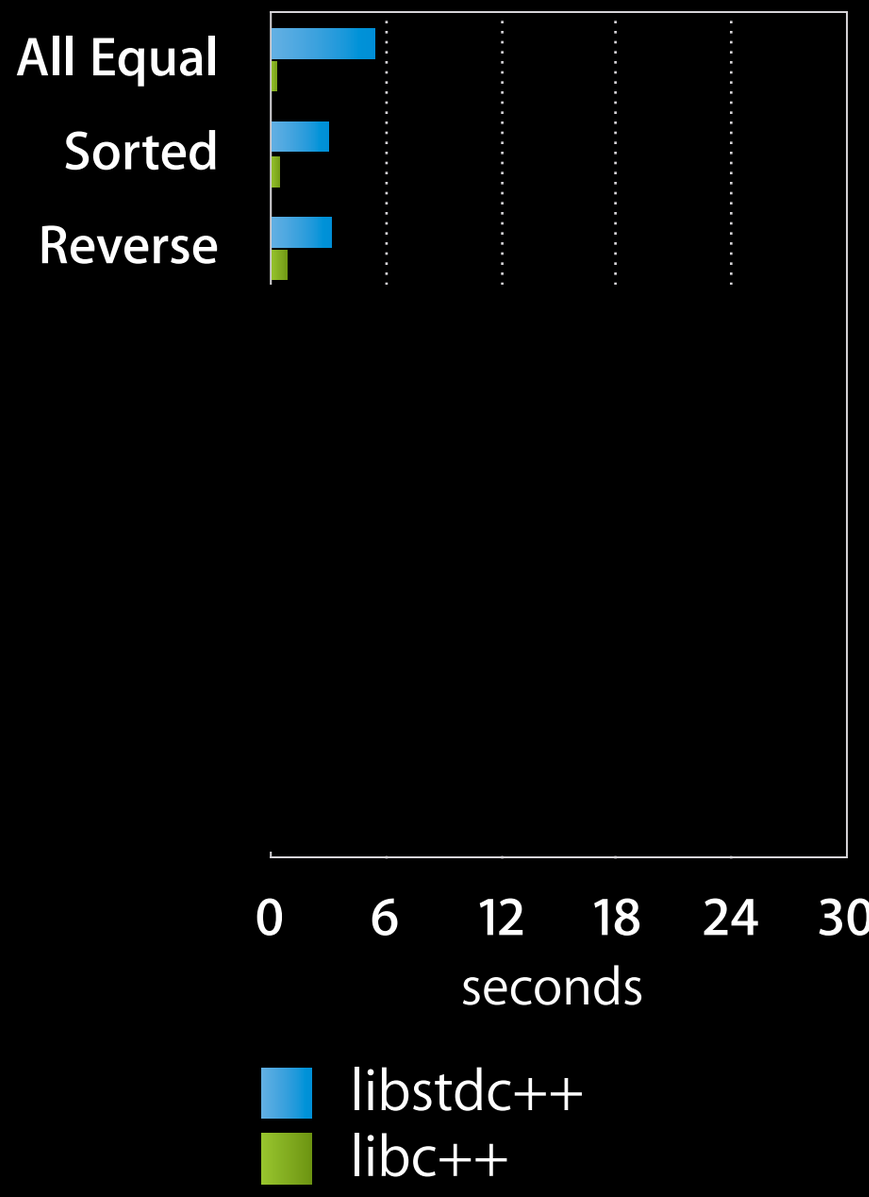

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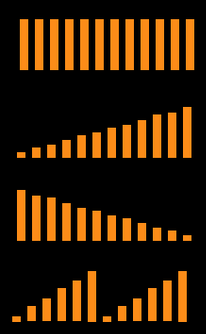

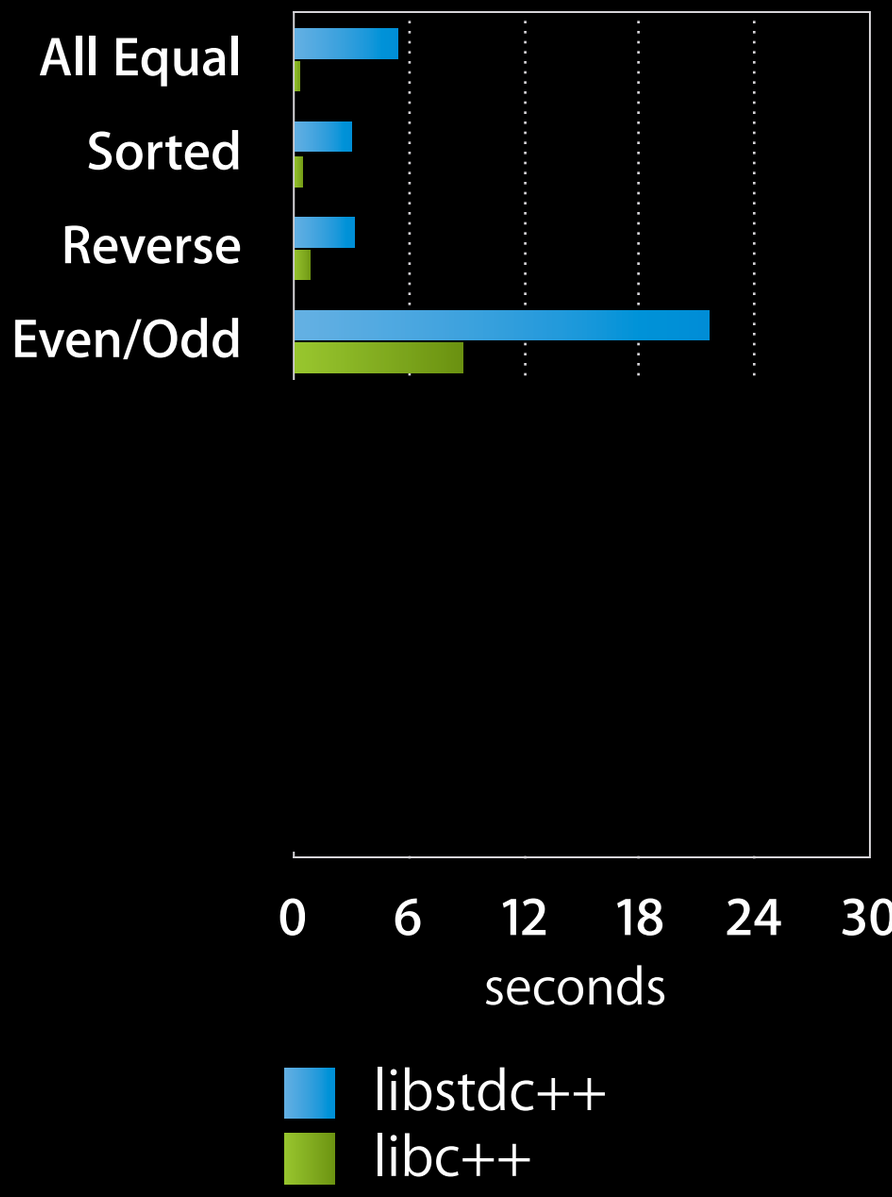

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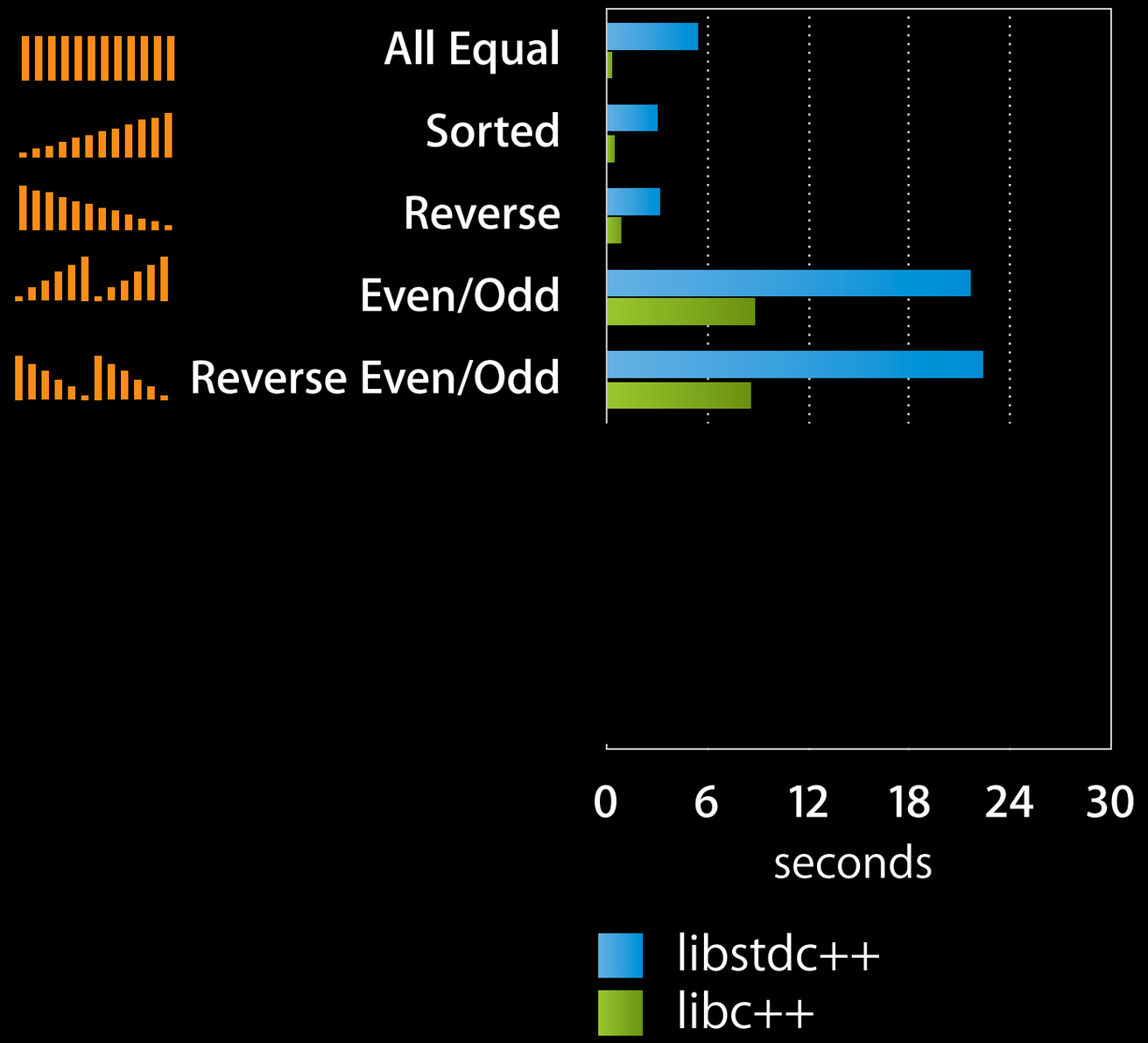

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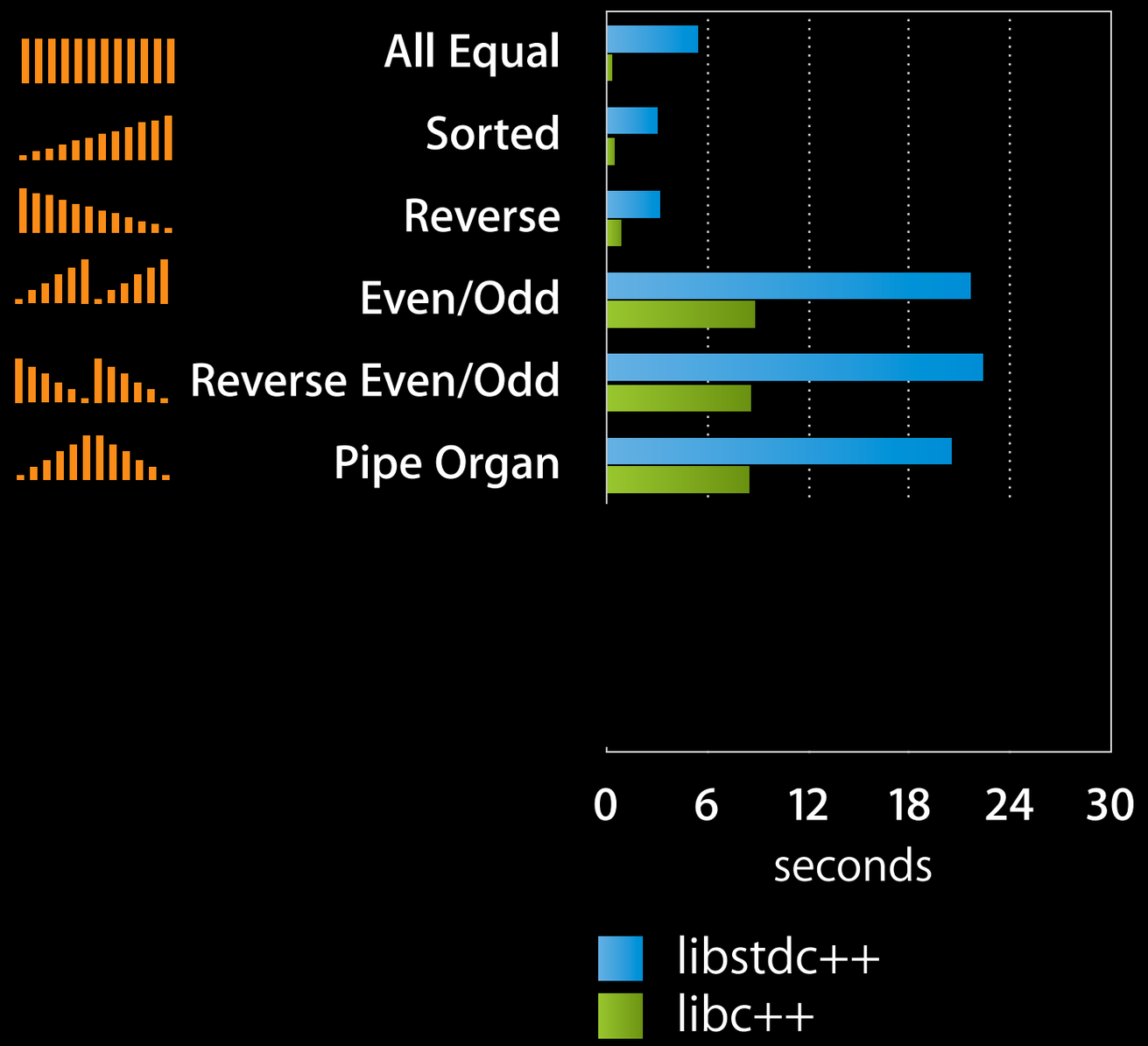

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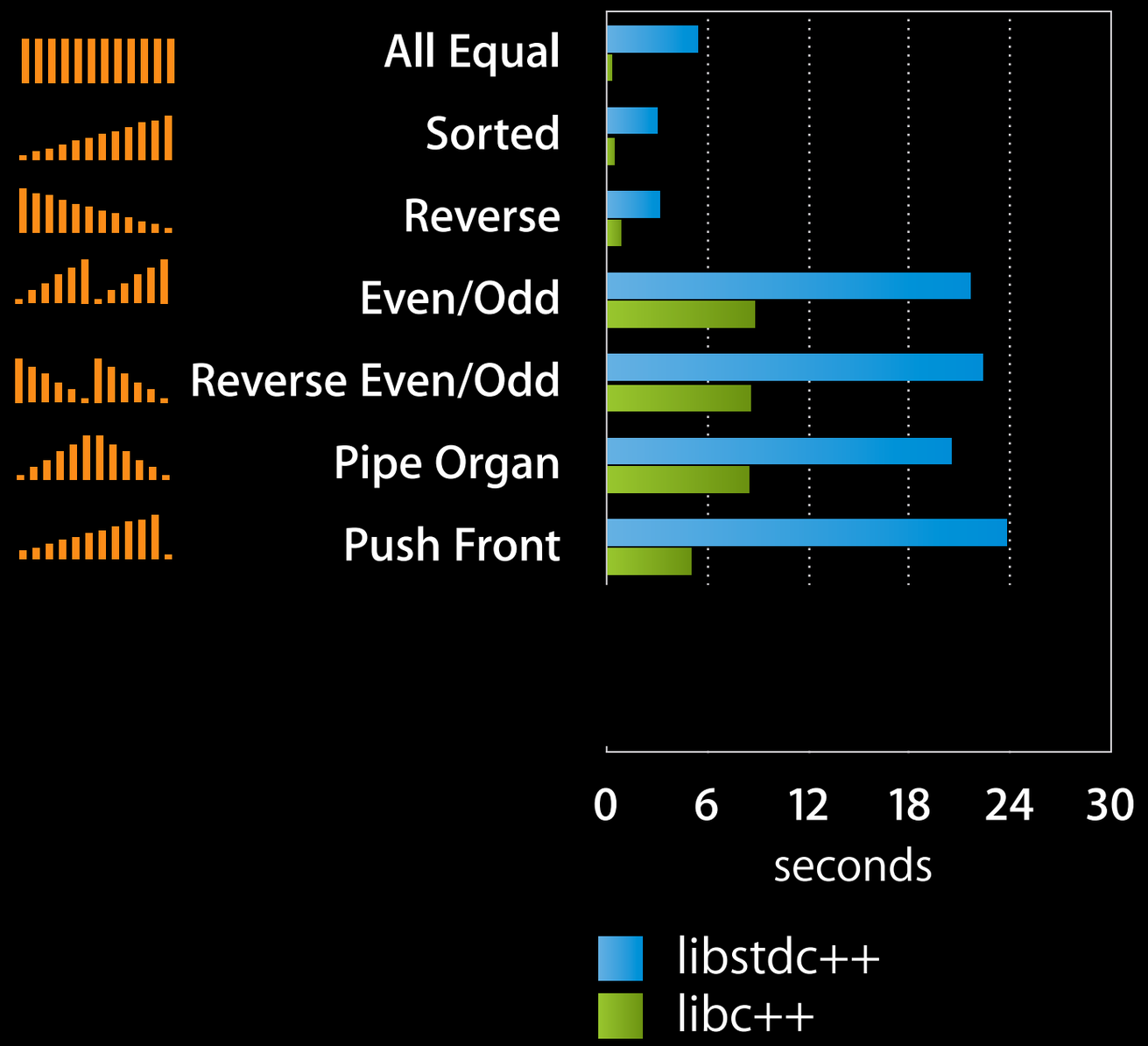

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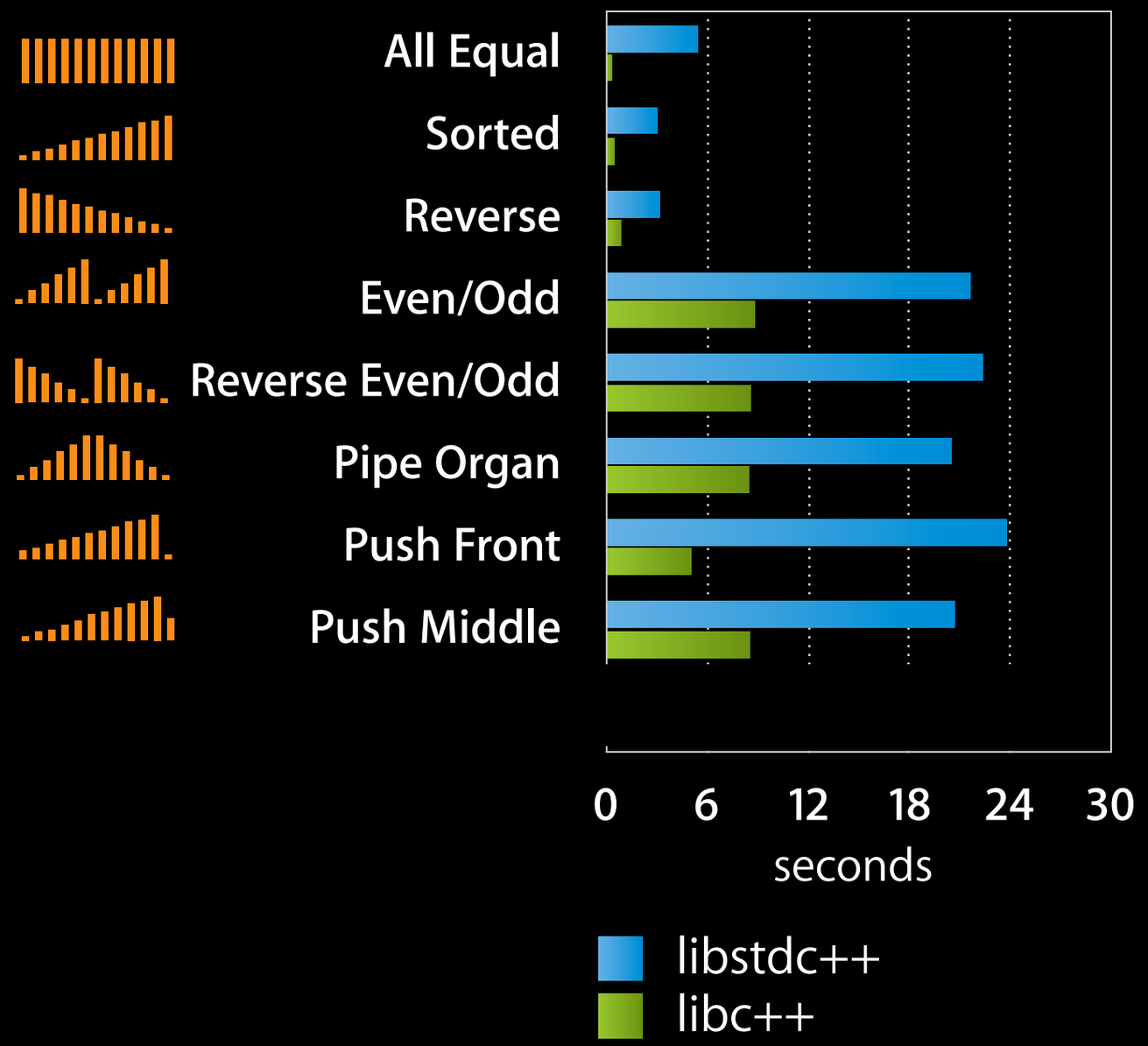

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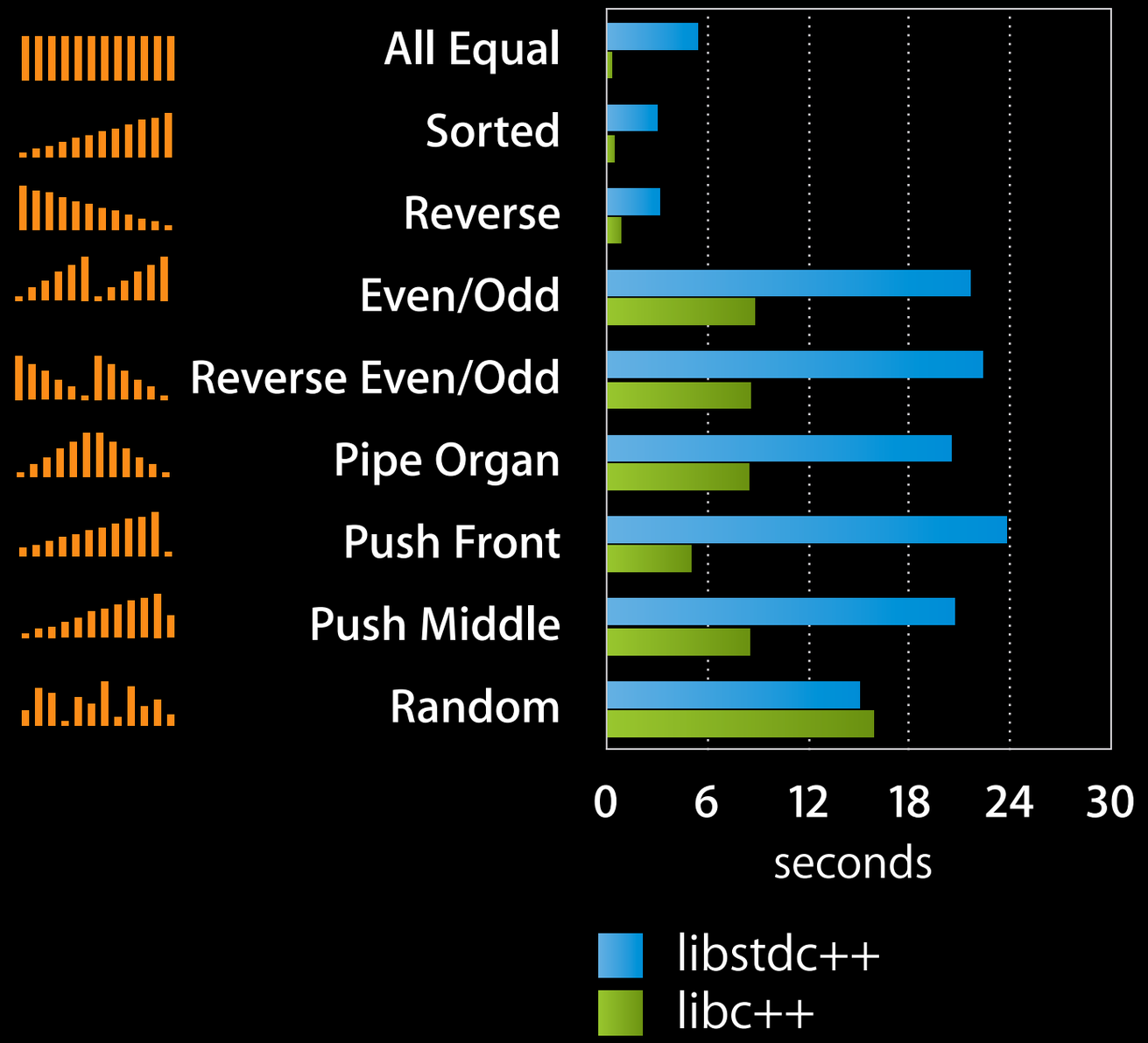

New Facilities in C++0x…

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  - Array support.

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- Separate types for time durations and points in time.
- Full suite of common units: hours, minutes…nanoseconds.
- Add and subtract durations and time points with natural syntax.

```
system_clock::time_point t0 = system_clock::now();
...
auto t1 = system_clock::now();
nanoseconds ns = t1 - t0;
```

Much easier and safer than working with timeval, timespec, or C's new xtime.

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  - Ability to get a return value from a thread.
- Everything works with the new <chrono> facility for timed locking, timed sleeping, etc.

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  - Twenty (yes 20!) random number distributions:
    - uniform_real_distribution
    - bernoulli_distribution
    - gamma_distribution
    - fisher_f_distribution
    - etc.

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  - Full iterator support for iterating to the next match, and for tokenizing keywords/expressions out of a stream.

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- <tuple>
  - pair on steroids.
  - Implements empty member optimization as an extension.
  - Currently requires variadic templates and rvalue reference.

Wrap Up…

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    - http://home.roadrunner.com/~hinnant/libcppabi.zip
  - Future: We would like to run on top of gcc's libsupc++ in addition to libc++abi.

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  - Debug mode
  - Performance tests
  - Porting to more platforms

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