



OpenMP 4.0: A Significant Paradigm Shift in Parallelism

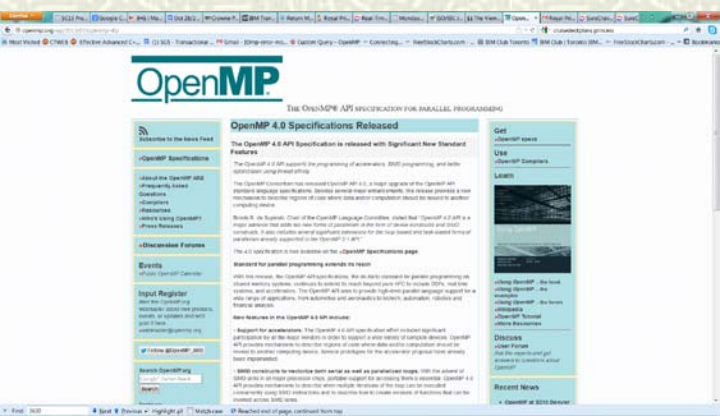
Michael Wong

OpenMP CEO

michaelw@ca.ibm.com

<http://bit.ly/sc13-eval>

SC13





THE OPENMP® API SPECIFICATION FOR PARALLEL PROGRAMMING

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OpenMP 4.0 Specifications Released

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The OpenMP 4.0 API supports the programming of accelerators, SIMD programming, and better optimization using thread affinity

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Standard for parallel programming extends its reach

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- **Support for accelerators.** The OpenMP 4.0 API specification effort included significant participation by all the major vendors in order to support a wide variety of compute devices. OpenMP API provides mechanisms to describe regions of code where data and/or computation should be moved to another computing device. Several prototypes for the accelerator proposal have already been implemented.
- **SIMD constructs to vectorize both serial as well as parallelized loops.** With the advent of SIMD units in all major processor chips, portable support for accessing them is essential. OpenMP 4.0 API provides mechanisms to describe when multiple iterations of the loop can be executed concurrently using SIMD instructions and to describe how to create versions of functions that can be invoked across SIMD lanes.

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Agenda

- # The OpenMP ARB
- # History of OpenMP
- # OpenMP 4.0 Parallelism
- # OpenMP Future Parallelism
- # OpenMP new Mission Statement

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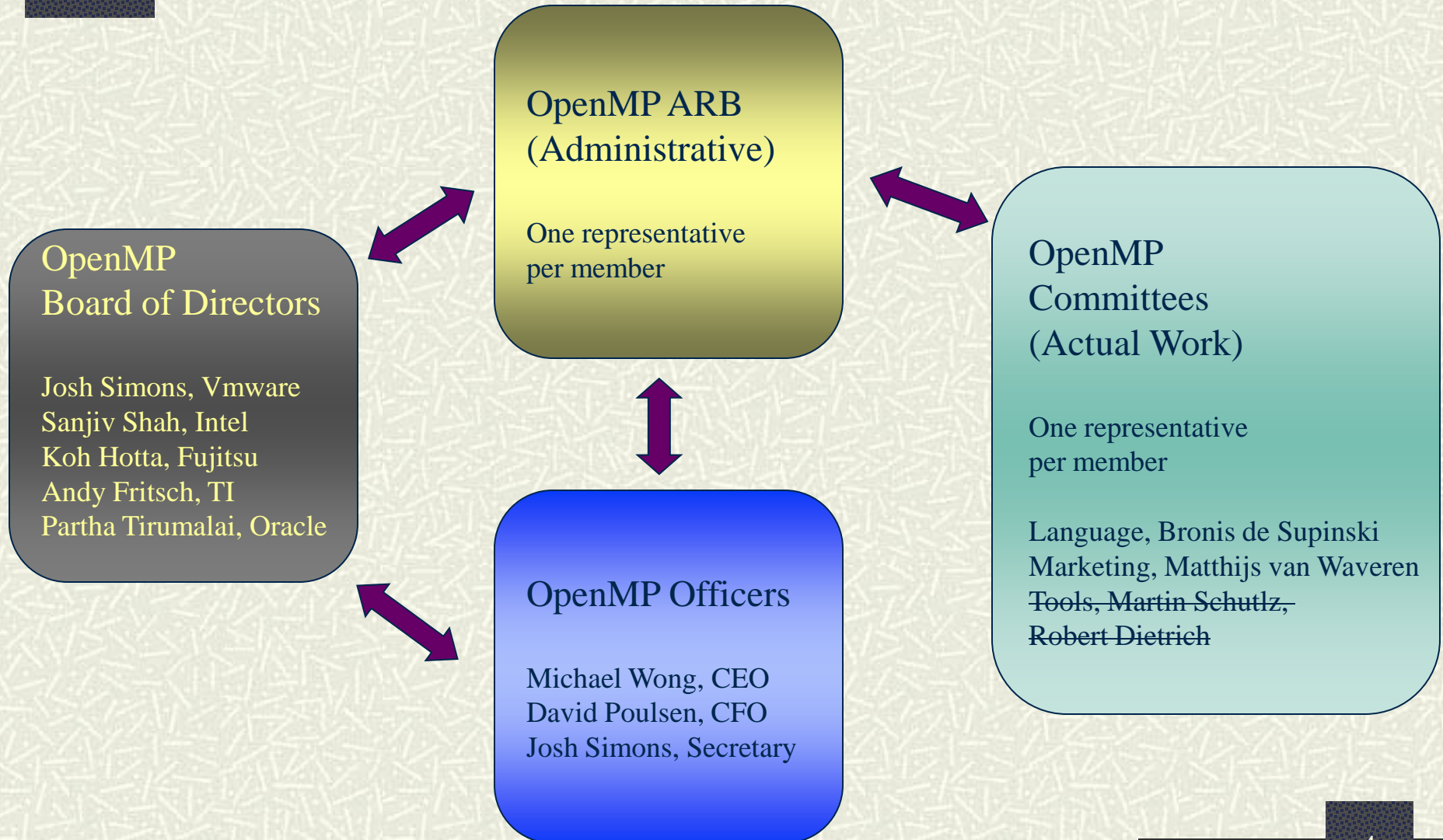
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OpenMP ARB Current Organization



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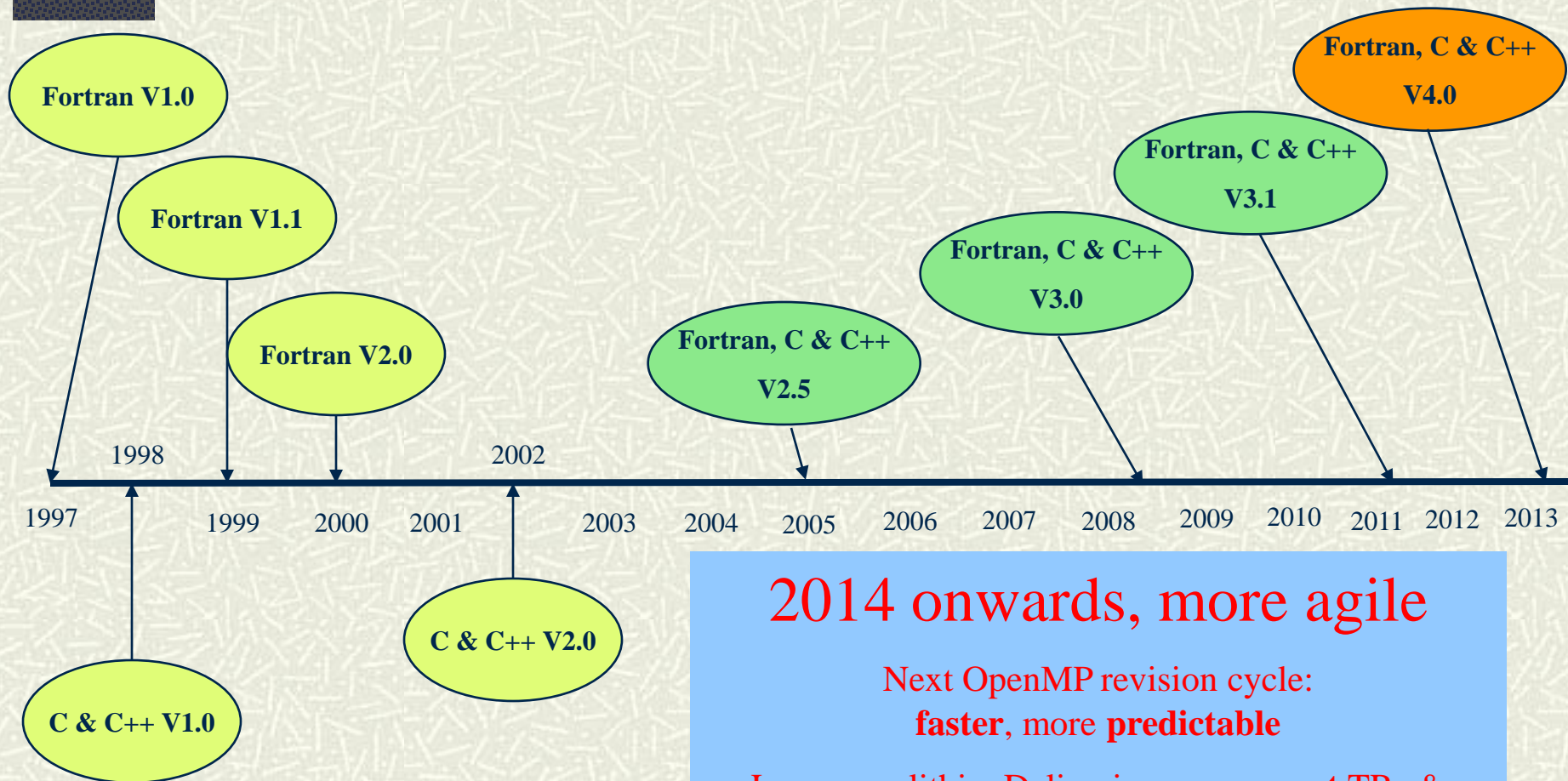
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A brief history of OpenMP API



2014 onwards, more agile

Next OpenMP revision cycle:
faster, more predictable

Less monolithic: Delivering **concurrent** TRs &
language extensions

OpenMP is a living language

OpenMP internal Organization

OpenMP ARB

Language WG

Marketing
WG

Today

Accel

Error

Task

Tools

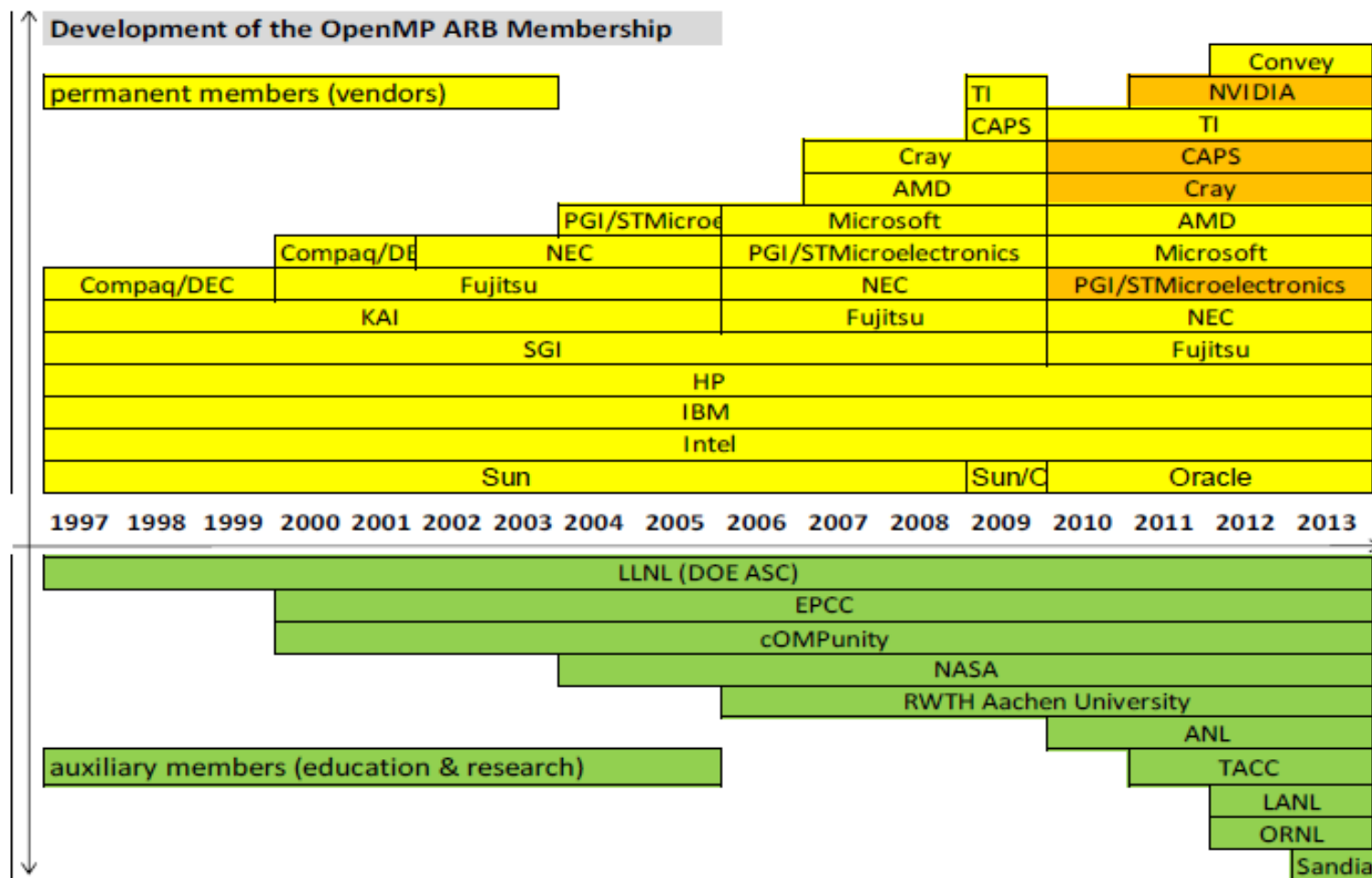
Affinity

Fortran
2003

OpenMP Members growth

26
members
and
growing

From Dieter An Mey, RWTH Aachen 2012



Members added since 2012

- # Red Hat/GCC
- # Barcelona SuperComputing Centre
- # University of Houston

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OpenMP 4.0

- July: Released OpenMP 4.0 after 5 years

*“This represents collaborative work by many of the brightest in industry, research, and academia, building on the consensus of 26 members. **We strive to deliver high-level parallelism that is portable across 3 widely-implemented common General Purpose languages, productive for HPC and consumers, and delivers highly competitive performance.** I want to congratulate all the members for coming together to create such a momentous advancement in parallel programming, under such tight constraints and industry challenges. With this release, the OpenMP API will move immediately forward to the next release to bring even more usable parallelism to everyone. – Michael Wong*

Compilers coming

- # GCC close to complete, expected in mid 2014
- # Intel 13.1 compiler supports Accelerators
- # Clang support for OpenMP completed and released in Clang 3.4
- # Cray, TI, IBM, Oracle coming online

Significant Paradigm Shift

- # “OpenMP feels like a new language.”
 - The most pervasive parallelism
 - Supporting HPC and consumers

 - # OpenMP adoption scorecard.
 - How are we doing?
 - Learning, compilers, and books.

 - # What’s next for OpenMP?
-

More usable parallelism

- # With OpenMP 4.0, modern OpenMP code **breaks from traditional Shared Memory Parallelism**, and works on heterogeneous devices across different memory architecture
 - Provide high level way of programming parallelism
 - And non-proprietary
 - Still supports HPC, but now also consumer parallelism
 - Error Model, tasks dependency, accelerators
-

We're All Learning OpenMP 4.0

- # The world is still in the early stages of gaining field experience using the new language features, individually and together.
 - Includes everyone: OpenMP members, authors, developers.
 - # Example now published separately from spec
-

Compilers, Tools, and Books

Using OpenMP: Implementations.

- Compilers: Several available now or soon (2014).
 - GNU/GCC mid 2014
 - Intel
 - Clang
- Tools: Rice University HPCTools Kit, IBM POMP support

Learning OpenMP: Books, Tutorials, Videos, webinars.

- Tutorials: day long and in booth
- Books and articles coming
- [More videos posted based on SC and other talks](#)
- [Webinars in the plan](#)

OpenMP 4.0 Features

- # **Support for accelerators**
- # **SIMD constructs to vectorize both serial as well as parallelized loops**
- # **Error handling (cancel construct)**
- # **Thread affinity**
- # **Task groups and dependency**
- # **Support for Fortran 2003**
- # **User-defined reductions**
- # **Sequentially consistent atomics**
- # **OMP_DISPLAY_ENV environment variable**
- # **array section syntax for C/C++**

OpenACC1 compared to OpenMP 4.0 (by Dr. James Beyer)

OpenACC1

- # Parallel (offload)
 - Parallel (multiple “threads”)
- # Kernels
- # Data
- # Loop
- # Host data
- # Cache
- # Update
- # Wait
- # Declare

OpenMP 4.0

- # Target
- # Team/Parallel
- #
- # Target Data
- # Distribute/Do/for/Simd
- #
- #
- # Target Update
- #
- # Declare Target

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OpenMP future features

- # OpenMP Tools: Profilers and Debuggers
- # Consumer style parallelism: event/async/futures
- # Enhance Accelerator support
- # Additional Looping constructs
- # Transactional Memory, Speculative Execution
- # Task Model refinements
- # CPU Affinity
- # Common Array Shaping
- # Full Error Model
- # Interoperability
- # Rebase to new C/C++/Fortran Standards

Future OpenACC vs future OpenMP

(by Dr. James Beyer)

OpenACC2

- # enter data
- # exit data
- # data api
- # routine
- # async wait
- # parallel in parallel
- # **tile**
- # **Linkable**
- # **Device_type**

OpenMP future

- # Unstructured data environment
- # declare target
- #
- # Parallel in parallel or team
- # **tile**
- # **Linkable**
- # **Device_type**

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The Future Mission of OpenMP

- # OpenMP's new mission statement
 - “Standardize directive-based multi-language high-level parallelism that is performant, productive and portable”
 - Updated from
 - "Standardize and unify shared memory, thread-level parallelism for HPC”

Marketing

- # Larger booth with bigger tables, 10 stools
- # Booth mini-talks, giveaways, cake, beer
- # More talks and tutorials, speaker gifts

Brochures/Guides

- # OMP WelcomeGuide(for serious prospects)
- # OMP Meetings and Email Lists(for new members)
- # OMP Membership Brochure(given out at conferences)
- # OMP FAQ(given out at conferences)
- # OMPScheduleFlier(SC related talks and schedules)
- # OpenMPbrochure-SC13(given out at SC 13)

OpenACC (Statement in 2011)

- # A spinoff from 4 OpenMP Members
 - NVIDIA, PGI, Cray, CAPS
- # To address immediate customer needs
- # To hold the IP
- # And to Beta test the OpenMP Accelerator implementation
- # In time, will be folded back to OpenMP in some form
- # We continue to aim to merge in future

External linkage

Multicore association

- For closely distributed systems, have API
- They carry our brochures

OpenFPGA

- C-code->(impulse)->verilog
- C-code->(impulse)->verilog->(VPR)->FPGA-image
- C-code-with-OpenMP->(impulse-exploiting-openMP)->verilog->(VPR)->FPGA-image

Standard C++ Foundation

- I am serving as Director and Vice-President

Major Website update

- # Prepare for multiple devices
 - any screen size,
 - windows to phones
 - touch-friendly/-enabled
 - designed for offline reading
- # Links to Stack Overflow, Reddit on OpenMP related questions

Future meetings

- # <http://openmp.org/calendar.html>
- # Winter 2014: Jan 27-31, Intel Santa Clara
- # Spring 2014: April , London, UK
- # July/August: possible 3rd meeting
- # Fall 2013:Sept/Oct, IWOMP 2014: Brazil

- # Continue to drive to ratify 4.1 and 5.0

OpenMP future

- # **More agile**
- # More rapid releases
- # More technical Reports
- # More consumer-style parallelism
- # Deliver faster than ISO
- # Deliver experimental and proprietary parallelism
- # Allows you to be productive on several languages
- # Supported by many vendors

OpenMP internal Organization

OpenMP ARB

Language WG

Marketing WG

Today

Accel

Error

Task

Tools

Affinity

Fortran
2003

Future

TM

Async/Event

Interop

C++11

C11

Memory
Model, Loops,
Object
oriented

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