Why MPI Makes You *Scream!* And How Can We Simplify Parallel Debugging?

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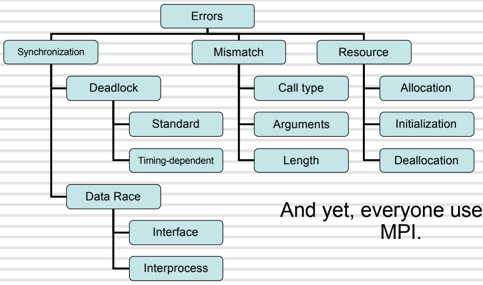
Goals of This BOF

- List what *we* think are the problems
  - And some possible solutions
- Hear what *you* think are the problems
  - Why are they problems for you?
  - How do you solve them now?
  - …?
- Next steps

Jayant DeSouza

- Senior Software Engineer, Intel Corporation
  - Advanced Computing Center, Tools for petaflop architectures
- MPI tool implementer
  - Intel Message Checker

Classification of Errors in MPI

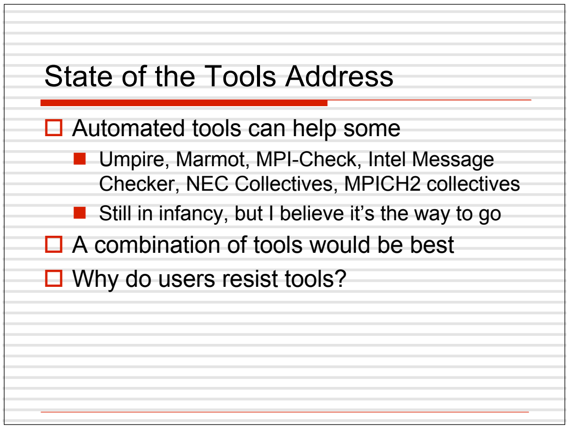


And yet, everyone uses MPI.

User Survey

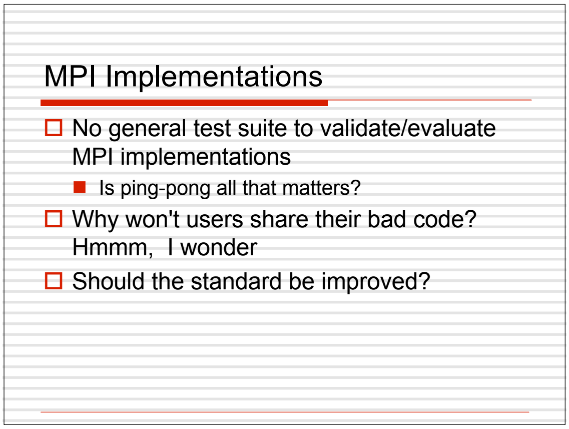
State of the Tools Address

- Compile time lint tool for MPI?
  - MPI-Check?
- printf/write is a difficult debugging model
  - Requires many iterations to narrow down the error
  - But:
    - available on every system
    - real easy to "install", "learn", and get started
- Debuggers
  - Commercial ones may cost a lot (home equity loan)
  - It's hard to scale debugging and debuggers
  - Requires user to do the heavy lifting



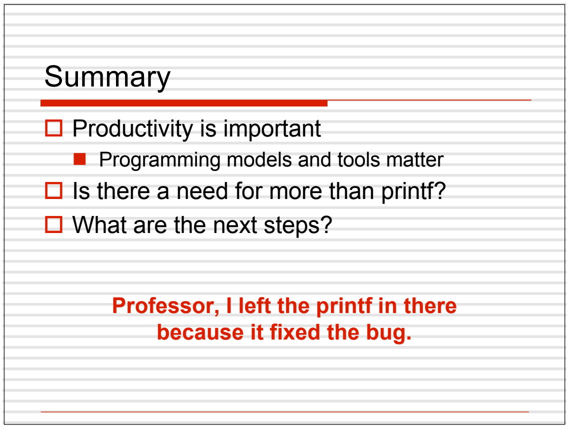
State of the Tools Address

- □ Automated tools can help some
  - ■ Umpire, Marmot, MPI-Check, Intel Message Checker, NEC Collectives, MPICH2 collectives
  - ■ Still in infancy, but I believe it's the way to go
- □ A combination of tools would be best
- □ Why do users resist tools?



MPI Implementations

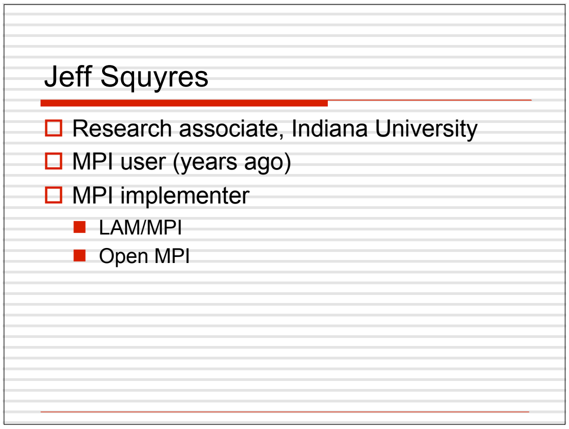
- □ No general test suite to validate/evaluate MPI implementations
  - ■ Is ping-pong all that matters?
- □ Why won't users share their bad code? Hmmm, I wonder
- □ Should the standard be improved?



Summary

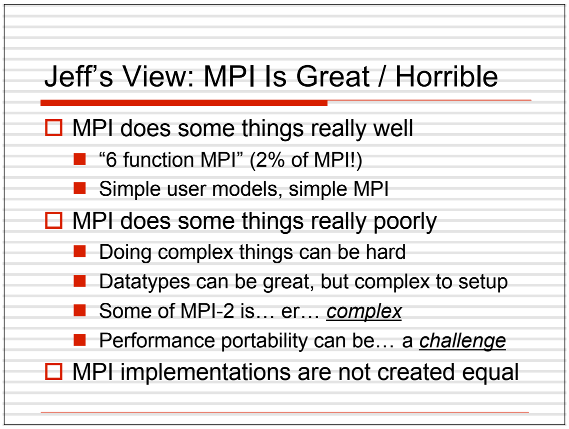
- □ Productivity is important
  - ■ Programming models and tools matter
- □ Is there a need for more than printf?
- □ What are the next steps?

Professor, I left the printf in there because it fixed the bug.



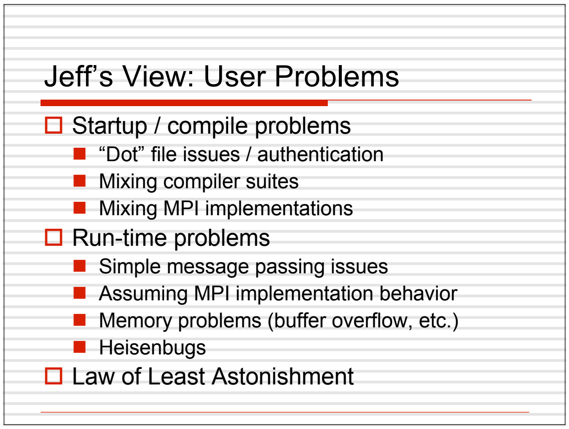
Jeff Squyres

- □ Research associate, Indiana University
- □ MPI user (years ago)
- □ MPI implementer
  - ■ LAM/MPI
  - ■ Open MPI



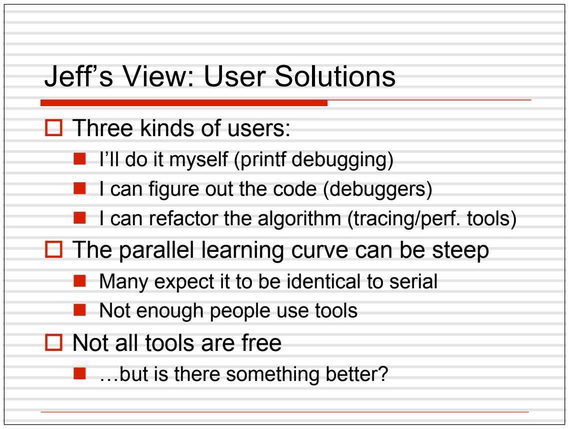
Jeff's View: MPI Is Great / Horrible

- □ MPI does some things really well
  - ■ "6 function MPI" (2% of MPI!)
  - ■ Simple user models, simple MPI
- □ MPI does some things really poorly
  - ■ Doing complex things can be hard
  - ■ Datatypes can be great, but complex to setup
  - ■ Some of MPI-2 is… er… *complex*
  - ■ Performance portability can be… a *challenge*
- □ MPI implementations are not created equal



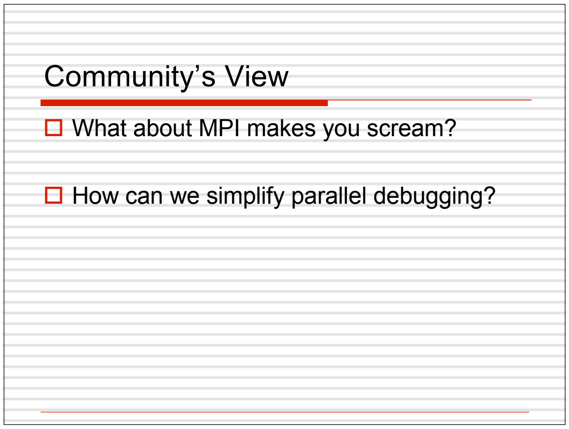
Jeff's View: User Problems

- □ Startup / compile problems
  - ■ "Dot" file issues / authentication
  - ■ Mixing compiler suites
  - ■ Mixing MPI implementations
- □ Run-time problems
  - ■ Simple message passing issues
  - ■ Assuming MPI implementation behavior
  - ■ Memory problems (buffer overflow, etc.)
  - ■ Heisenbugs
- □ Law of Least Astonishment



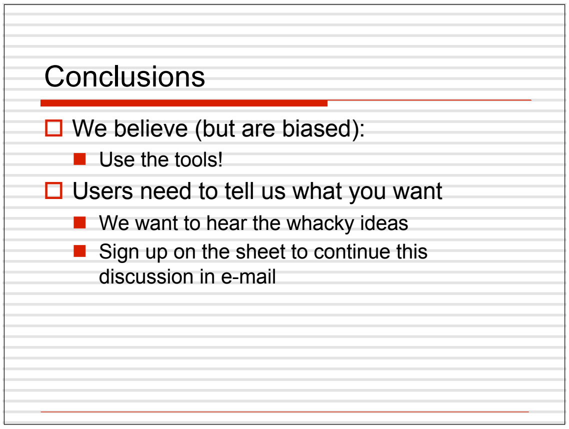
Jeff’s View: User Solutions

- Three kinds of users:
  - I’ll do it myself (printf debugging)
  - I can figure out the code (debuggers)
  - I can refactor the algorithm (tracing/perf. tools)
- The parallel learning curve can be steep
  - Many expect it to be identical to serial
  - Not enough people use tools
- Not all tools are free
  - …but is there something better?



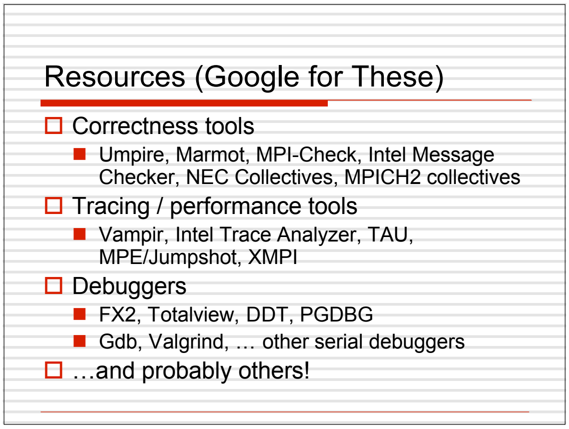
Community’s View

- What about MPI makes you scream?
- How can we simplify parallel debugging?



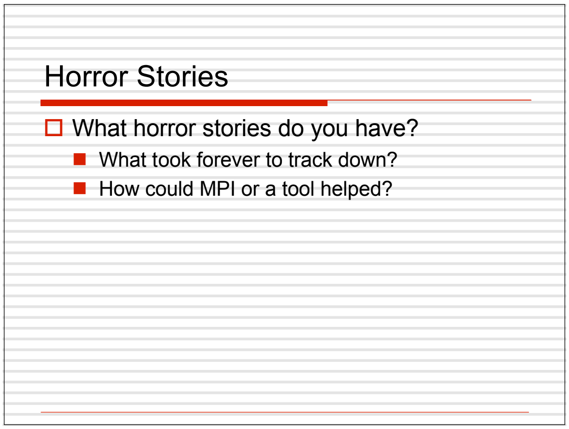
Conclusions

- We believe (but are biased):
  - Use the tools!
- Users need to tell us what you want
  - We want to hear the whacky ideas
  - Sign up on the sheet to continue this discussion in e-mail



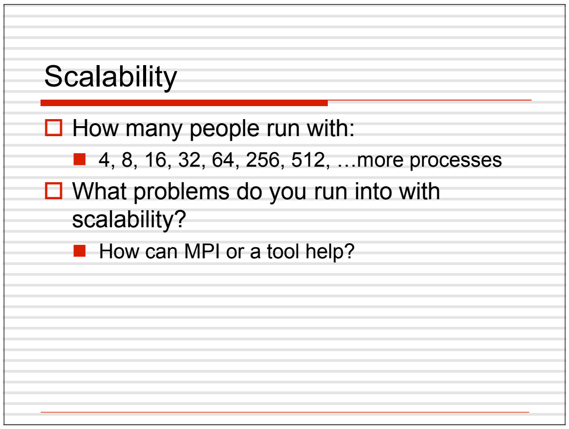
Resources (Google for These)

- Correctness tools
  - Umpire, Marmot, MPI-Check, Intel Message Checker, NEC Collectives, MPICH2 collectives
- Tracing / performance tools
  - Vampir, Intel Trace Analyzer, TAU, MPE/Jumpshot, XMPI
- Debuggers
  - FX2, Totalview, DDT, PGDBG
  - Gdb, Valgrind, … other serial debuggers
- …and probably others!



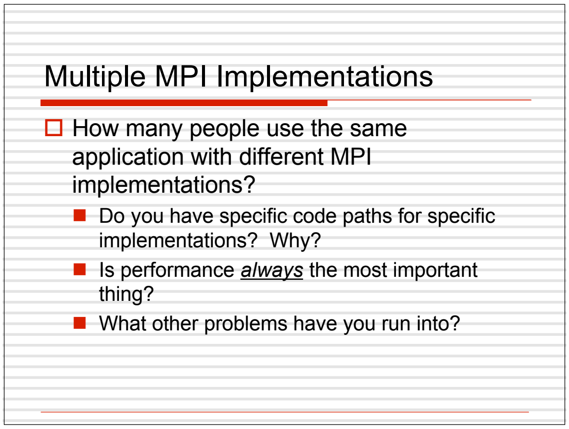
Horror Stories

- What horror stories do you have?
  - What took forever to track down?
  - How could MPI or a tool helped?



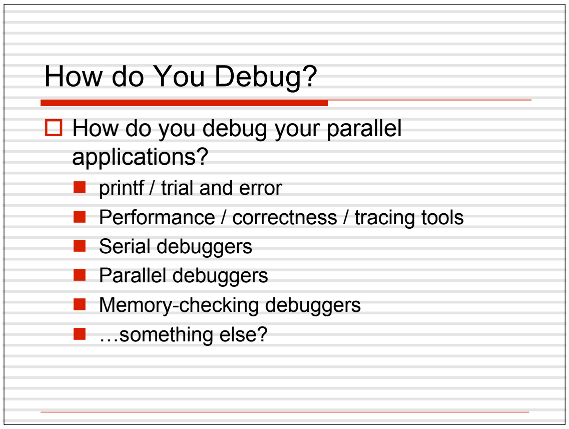
Scalability

- How many people run with:
  - 4, 8, 16, 32, 64, 256, 512, …more processes
- What problems do you run into with scalability?
  - How can MPI or a tool help?



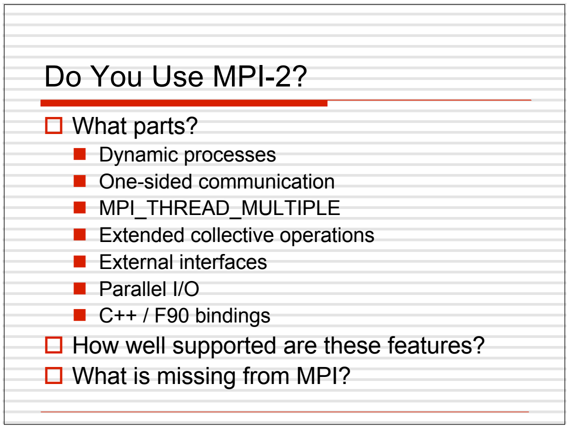
Multiple MPI Implementations

- How many people use the same application with different MPI implementations?
  - Do you have specific code paths for specific implementations? Why?
  - Is performance *always* the most important thing?
  - What other problems have you run into?



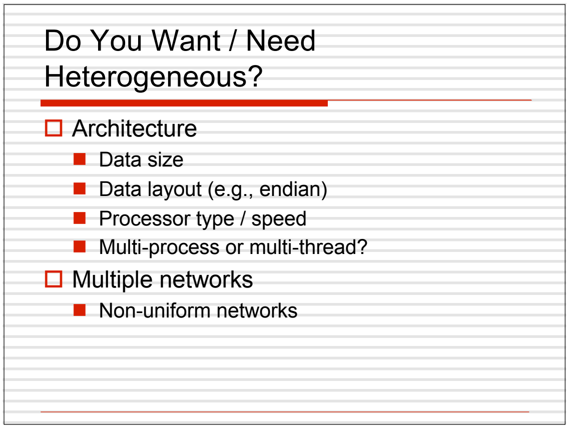
How do You Debug?

- How do you debug your parallel applications?
  - printf / trial and error
  - Performance / correctness / tracing tools
  - Serial debuggers
  - Parallel debuggers
  - Memory-checking debuggers
  - …something else?



Do You Use MPI-2?

- What parts?
  - Dynamic processes
  - One-sided communication
  - MPI_THREAD_MULTIPLE
  - Extended collective operations
  - External interfaces
  - Parallel I/O
  - C++ / F90 bindings
- How well supported are these features?
- What is missing from MPI?



Do You Want / Need Heterogeneous?

- Architecture
  - Data size
  - Data layout (e.g., endian)
  - Processor type / speed
  - Multi-process or multi-thread?
- Multiple networks
  - Non-uniform networks