

Towards Highly Productive Computing Platform

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A true story

When: two decades ago

Who: A Chinese parasite-ologist (寄生虫学者)

What: wishing to discover the life-cycle of a parasite inside a human host

Start: he didn't have a patient to work with

Q: How did he proceed with his research?

Multiple choices: is it a) or b)?

a) He used a supercomputer to run a simulation

b) He became a self-inflicted patient

15M+ technical computing users

2. A Growing Global Talent Pool Competes for Jobs

Source: Council on Competitiveness, *Competitiveness Index: Where America Stands*

Large professional workforce in emerging markets

YOUNG PROFESSIONALS, 2003, THOUSANDS

	Engineers	Finance/ Accounting	Life Sciences Researchers	Analysts
China	1,589	945	543	202
United States	667	1615	852	175
India	528	2273	674	537
Russia	486	1082	108	107
Japan	317	702	180	55
Philippines	290	423	14	16
Brazil	158	355	75	16
U.K.	150	165	100	27
Germany	128	137	31	26
Mexico	115	319	23	8
Poland	82	231	25	22
Canada	81	150	89	18
Malaysia	49	83	19	11
Hungary	27	59	2	1
Ireland	22	32	4	3
Czech Republic	15	33	2	5

Emerging Markets

Developed Economies

See changes

Pre-Micros 1990 prior

Early-Micros (1991-1998)

Prime-Micros (1998-now)



Thinking machines



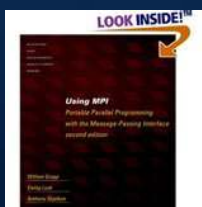
Network of Workstations



Custom chips /
Custom interconnect
Proprietary languages/
tools

RISC Micros chips /
Custom interconnect
Standard MPI
ISV mgmt tools

Commodity chips /
Standard interconnect
Standard MPI
ISV mgmt tools



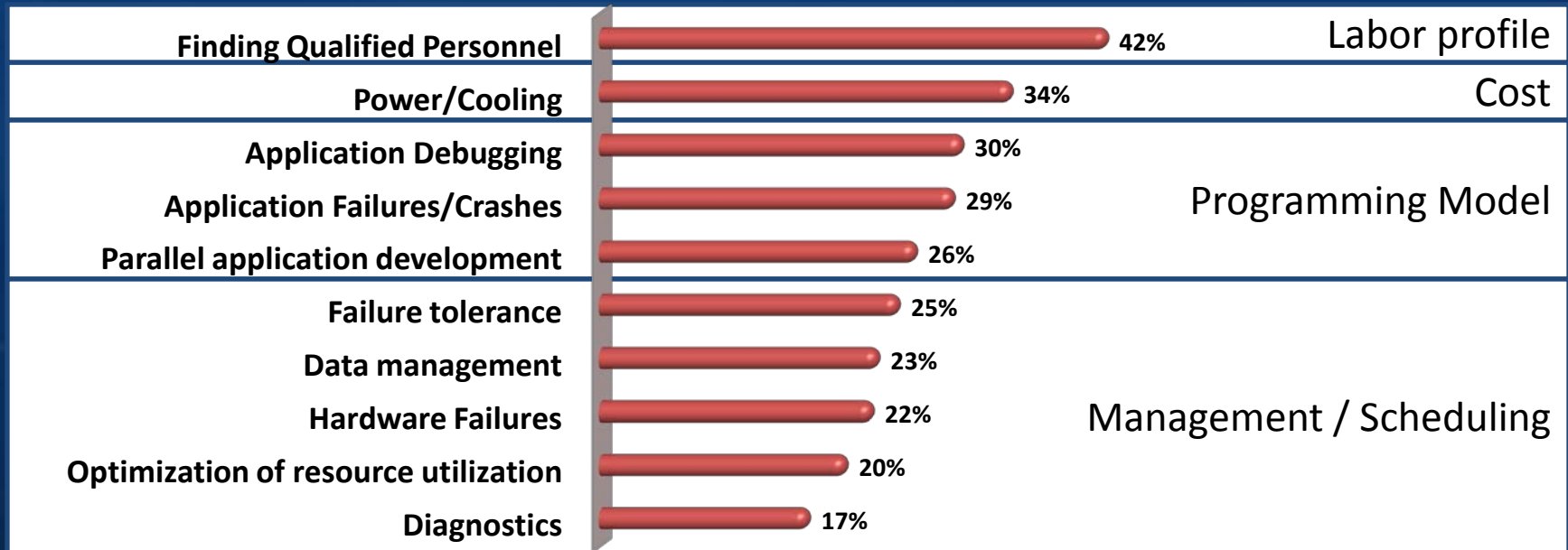
SGE

No integrated programming models, language, runtime debugging, diagnostics and management tools

HPC Customer Pain Points

What are the areas of most difficulty in your organization's HPC systems?

Top 10 pain points, n = 419



Situation summary in one quotes

Federal Plan for High-End Computing, 2004

Science and Technology Policy,
Office of the President

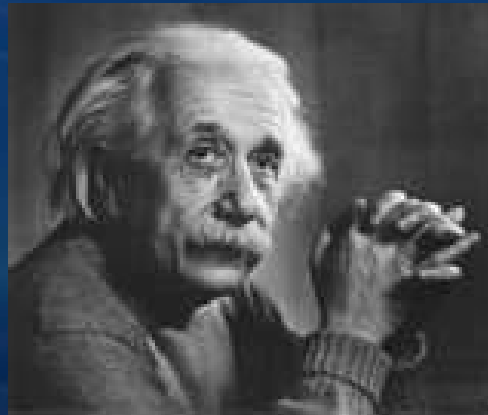
Goal 1: Make scientific computing **easier and more productive to use.**

Emphasis should be placed on **time to solution**, which includes: time to cast the problem into algorithms, write and debug the code, optimize the code, compute the results, analyze those results, and to refine the analysis into improved understanding of the original problem that enables scientific or engineering advances.

A **common software environment for scientific computation encompassing desktop to high-end systems** will enhance productivity gains by promoting ease of use and manageability of systems.

Appealing to the simplicity principle

All things have to be made as simple as possible but not simpler – Albert Einstein



How did we get here?

What anti-patterns can we find on our pursuit of speed

- Programming Model Anti-patterns
- Runtime, Mgmt and Scheduler Anti-patterns

Example: “Baby Names”

```
IEnumerable<BabyInfo> babies = ...;
var results = new List<BabyInfo>();
foreach (var baby in babies)
{
    if (baby.Name == queryName &&
        baby.State == queryState &&
        baby.Year >= yearStart &&
        baby.Year <= yearEnd)
    {
        results.Add(baby);
    }
}
results.Sort((b1, b2) => b1.Year.CompareTo(b2.Year));
```

Anti-Pattern: every dev is an Einstein

```
IEnumerable<BabyInfo> babies = ...;
var results = new List<BabyInfo>();
int partitionsCount = Environment.ProcessorCount;
int remainingCount = partitionsCount;
var enumerator = babies.GetEnumerator();
try {
    using (ManualResetEventSlim done = new ManualResetEventSlim())
        for (int i = 0; i < partitionsCount; i++)
            Thread.Start(() => {
                var baby = enumerator.MoveNext();
                while (baby != null) {
                    lock (results) {
                        if (baby.State == queryState &&
                            baby.Year <= yearEnd) {
                            results.Add(baby);
                        }
                    }
                    baby = enumerator.MoveNext();
                }
                lock (results) {
                    if (results.Count == 0) done.Set();
                }
            });
        done.Wait();
        results.Sort((a, b) => a.Year.CompareTo(b.Year));
}
finally { if (enumerator is IDisposable) ((IDisposable)enumerator).Dispose(); }
```



LINQ Solution

```
var results = from baby in babies AsParallel()
               where baby.Name == queryName &&
                  baby.State == queryState &&
                  baby.Year >= yearStart &&
                  baby.Year <= yearEnd
               orderby baby.Year ascending
               select baby;
```

Anti-patterns of runtime / mgmt / scheduler

- Operational model is the after-thought
 - Fragile application runtime
- The more the merrier
 - Do we really need all those queues, policies and strategies?
- Complex system fails in complex ways
 - Lack of info leads to the blame game
 - Lack of ISV specific tracing & diagnostics

Why Microsoft in HPC?

Current Issues

- ❖ HPC and IT data centers merging: isolated cluster management
- ❖ Developers can't easily program for parallelism
- ❖ Users don't have broad access to the increase in processing cores and data

How can Microsoft help?

- ❖ Well positioned to mainstream integration of application parallelism
- ❖ Have already begun to enable parallelism broadly to the developer community
- ❖ Can expand the value of HPC by integrating productivity and management tools

Microsoft Investments in HPC

- ❖ Comprehensive software portfolio: Client, Server, Management, Development, and Collaboration
- ❖ Dedicated teams focused on Cluster Computing
- ❖ Unified Parallel development through the Parallel Computing Initiative
- ❖ Partnerships with the Technical Computing Institutes

Microsoft's Productivity Vision for HPC

Windows HPC allows you to accomplish more, in less time, with reduced effort by leveraging users existing skills and integrating with the tools they are already using.



Administrator

- Integrated Turnkey HPC Cluster Solution
- Simplified Setup and Deployment
- Built-In Diagnostics
- Efficient Cluster Utilization
- Integrates with IT Infrastructure and Policies



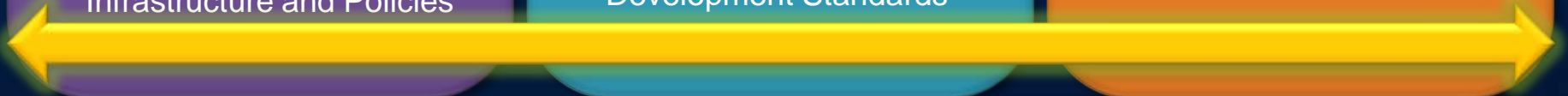
Application Developer

- Integrated Tools for Parallel Programming
- Highly Productive Parallel Programming Frameworks
- Service-Oriented HPC Applications
- Support for Key HPC Development Standards



End - User

- Seamless Integration with Workstation Applications
- Integration with Existing Collaboration and Workflow Solutions
- Secure Job Execution and Data Access





Resources

- Microsoft HPC Web site – Evaluate Today!
 - <http://www.microsoft.com/hpc>
- Windows HPC Community site
 - <http://www.windowshpc.net>
- Windows HPC Techcenter
 - <http://technet.microsoft.com/en-us/hpc/default.aspx>
- HPC on MSDN
 - <http://code.msdn.microsoft.com/hpc>
- Windows Server Compare website
 - <http://www.microsoft.com/windowsserver/compare/default.mspix>



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