THE DATACENTER NEEDS AN OPERATING SYSTEM

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THE DATACENTER IS THE NEW COMPUTER

Running today’s most popular consumer apps
• Facebook, Google, iCloud, etc

Needed for big data in business & science

Widely accessible through cloud computing

Our claim: this new computer needs an operating system
WHY DATACENTERS NEED AN OS

Growing diversity of applications
- Computing frameworks: MapReduce, Dryad, Pregel, Percolator, Dremel
- Storage systems: GFS, BigTable, Dynamo, etc

Growing diversity of users
- 200+ Hive users at Facebook

Same reasons computers needed one!
WHAT OPERATING SYSTEMS PROVIDE

Resource Sharing
- time-sharing, virtual memory, …

Data Sharing
- files, pipes, IPC, …

Programming Abstractions
- libraries, languages

Debugging & Monitoring
- ptrace, DTrace, top, …
WHAT OPERATING SYSTEMS PROVIDE

Most importantly: **an ecosystem**

...enabling independently developed software to interoperate seamlessly
Platforms like Hadoop well-aware of these issues

- Inter-user resource sharing, but at the level of MapReduce jobs (though this is changing)
- InputFormat API for storage systems (but what happens with the next hot platform after Hadoop?)

Other examples: Amazon services, Google stack
Platforms like Hadoop well-aware of these issues
• Inter-user resource sharing, but at the level of MapReduce jobs (though this is changing)
• InputFormat API for storage systems (but what happens with the next hot platform after Hadoop?)

The **problems** motivating a datacenter OS are well recognized, but solutions are **narrowly targeted**

Can researchers take a longer-term view?
TOMORROW’S DATACENTER OS

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Data Sharing
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Debugging & Monitoring
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(ptrace, DTrace, top, ...)
RESOURCE SHARING

“To solve these interaction problems we would like to have a computer made simultaneously available to many users in a manner somewhat like a telephone exchange. Each user would be able to use a console at his own pace and without concern for the activity of others using the system.”

– Fernando J. Corbató, 1962
RESOURCE SHARING

Today, cluster apps are built to run independently and assume they own a fixed set of nodes

Result: inefficient static partitioning

What’s the right interface for dynamic sharing?
MEMORY MANAGEMENT

Memory is an increasingly important resource

- In-memory iterative processing (Pregel, Spark, etc)
- DFS cache for MapReduce cluster could serve 90% of jobs at Facebook (HotOS ‘11)

What are the right memory management algorithms for a parallel analytics cluster?
PROGRAMMING AND DEBUGGING

Although there are new programming models for applications, system programming remains hard

- Can we identify useful common abstractions? (Chubby, Sinfonia, Mesos are some examples)
- How much can languages (e.g. Go, Erlang) help?

Debugging is very hard

- Magpie, X-Trace, Dapper are some steps here

Can a clean-slate design of the stack help?
HOW RESEARCHERS CAN HELP

Focus on paradigms, not only performance
  • Industry is spending a lot of time on performance

Explore clean-slate approaches
  • Much datacenter software is written from scratch
  • People using Erlang, Scala, functional models (MR)

Bring cluster computing to non-experts
  • Most impactful (datacenter as the new workstation)
  • Hard to make a Google-scale stack usable without a Google-scale ops team
CONCLUSION

Datacenters are becoming a major platform

To support a thriving software ecosystem like computers do, they need the equivalent of an OS

Researchers can take a long-term systems view to problems arising today to enable this