Storage as a First Class Citizen in HPC Environments.

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CCGSC
September 9, 2010
A Personal Historical Perspective

Me – Erasure codes

Y'all – HPC
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LINDA: Parallel computing with a “tuple space.”

Tuple Space

Data tuples

Processing tuples
LINDA: Parallel computing with a “tuple space.”

- “Linda processes aspire to know as little about each other as possible.
- They never interact directly with each other;
- they only deal with tuple space.”
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SSLS: Shared Single Level Store

Gigantic shared, persistent address space
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SSL - Shared Single Level Store

Gigantic shared, persistent address space

Jim - 1988

Naughton
SVM: Shared Virtual Memory

- Gigantic shared, persistent address space
  - Really big
SVM: Shared Virtual Memory

Gigantic shared, persistent address space

Really big
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HeNCE: Heterogeneous Network Computing Environment.
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Jim - 1991-98
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Mr. Checkpointing:

Jim - 1991-98
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There are two major difficulties with checkpointing:

What did I learn:

1. Fighting the OS / Getting it to work.
2. Mitigating the overhead of getting all those bytes to disk.

Everything else (synchronization, consistency, Lamport time, etc, etc) is in the noise.
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Where's the research?

Getting it to work.

Mitigating the overhead of getting all those bytes to disk.

Synchronization, consistency, Lamport time, etc, etc.

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[Elnozahy/Plank 2004]
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Jim – 1999
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G-Commerce: Brief Foray into Grid Computing
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IBP: Internet Backplane Protocol (Logistical Networking) w/ Micah Beck

Client

malloc()
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IBP: Internet Backplane Protocol (Logistical Networking) w/ Micah Beck

- Best effort
- Time limited
- Location specific

- Which supported third-party transfers.

Client

Jim – 1999 - 2005
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IBP gave data a place to “live” on the network, perhaps moving from site to site.
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Into the land of erasure coding.

I won't bore you with it.
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But there's more...
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2010 Meeting on Staging for HPC
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- Caching
- Code Coupling
- Checkpointing
- Alternative Representations
- Post Processing
- Pre Processing

The Big Iron

The Disks

Jim - 2010

Oh my
What do we make of all this?
What do we make of all this?

1. Checkpointing Sucks.
   - Slow
   - Inelegant
   - Swamps disks and networks to store gigantic files that are almost never read.
   - Enables you to perform “bad fault-tolerance.”
   - Is a manifestation that something is wrong.

![Graph showing Cost of Reliability vs MTBF](image)
What do we make of all this?

2. Band-Aids Are Only Temporary Solutions
   - Non-reusable
   - Cover the wounds but don't address the root cause
   - Are a manifestation that something is wrong.
What do we make of all this?

3. Saving State Sure is Attractive

- Lets you reason about programs
- (In theory) lets balance load
- Allows fault tolerance to fall out naturally

- However, it's really difficult to do.
- This is why the MPI model throws it in the trash can.
What do we make of all this?

4. I Still Think IBP is Pretty Cool & That There Are Lessons To Be Learned From It

- Why do we constrain our view of storage as either the file or the memory segment?
- Why is storage either permanent or limited by program lifetime?
- Why do we jettison best-effort storage resources?
- Why don't we manage the location of storage?
What do we make of all this?

Why are storage and processing not equal first-class citizens in HPC?
When I Close My Eyes and Dream ......

The Big Iron looks like this.

And these guys: are promoted to first class citizens.

And program state is represented explicitly in here!
And these guys compose seamlessly.

Over extremely wide areas ....

...And program state is represented explicitly in here!
When I Close My Eyes and Dream ......

And the Eagles win the Super Bowl... Every Year...

And I retire to that mansion in Capri...
And then I wake up and go back to studying erasure codes.
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