Computing over the Internet: Beyond Embarrassingly Parallel Applications

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Overview

- Motivation

- Computing over Large Datasets

- Supporting new Applications
  - MapReduce over the Internet
  - Scientific Workflows

- Conclusion
Motivation

- Volunteer Computing potential increasing
  - PS3, GPU
  - PCs have increased network and storage capabilities

- Limited to embarrassingly parallel apps
  - Master/worker model

- Limitations/Problems with current model
Motivation - Problems

- Current Projects
  - Centralized architecture
  - Data distribution limitations
  - Storage problems

- Not many new projects
  - HPC stonewalled VC
  - New types of applications needed to reach new projects

Unable to take advantage of VC full potential
Goals

• Apply P2P techniques to solve scalability problems in current Volunteer Computing projects

• Introduce storage layer as support for new computing paradigms and application types
  – Allow new projects to use internet-wide computing

• Provide mechanisms to handle more demanding applications
  – Adapt existing Grid applications
  – Support data-intensive applications
  – Jobs with dependencies
Computing over large Datasets

- Amazon Model
  - Store large datasets for free
  - Clients pay for computation and storage used by their applications

- How to adapt to BOINC?
  - Take advantage of previous work with BitTorrent
Previous Work

- Improve data distribution
- BitTorrent
  - Shared input files
  - Proposal for a Collaborative CDN
- Super-peer organization (P2P-ADICS)
  - Data Centers
  - Data Lookup Service: DHT with volunteers
Computing over large Datasets

• BOINC + BitTorrent library

• Wrapper to set BitTorrent as read-only filesystem

• Use large datasets as inputs

• Possible command sequence:
  – fd = open(tracker, objID)
  – read(fd, buffer, offset, len)
BOINC + BT model

```python
fd = open(tracker, objID)
read(fd, buffer, offset, len)
```
BOINC + BT

• Advantages
  – Easy to implement as first version
  – Allows initial testing to evaluate the solution
  – Possible to add read/write support
  – Next step: large outputs or intermediate results as inputs

• Problem
  – Assumes inter-client communication…
    • Solution: Guarantee that at least N% are accessible (public IP)
    • Communication over UDP – hole punching techniques
    • Turn this into a super-peer scenario?
New Applications on BOINC

- Build over storage layer
  - Leverage direct transfers
  - Export information for applications

- MapReduce over the Internet
  - Wider use, but harder to find application

- Scientific Workflows
  - Not too complex for a VC environment
New Applications - MapReduce

- MapReduce over the Internet
  - Adapt “Hadoop” to internet-wide computing
  - Volunteer Cloud Computing?

- Problems with typical applications…
MapReduce over Internet

- Applications that would fit
  - Lower Communication - Computation ratio
  - Longer running time
    - Lower latency requirements
  - More shared files
  - Volunteer genomic computations?

- MapReduce Workflows

- Separate Dimensions
• New types of applications
  – Data-intensive applications
    • E.g.: Handle CERN data-intensive computations
  – Workflow
    • Extremely variable characteristics: long or short running, data-intensive or compute-intensive
New Applications – Current Work

• Handling new applications
  – Science Workflows

• Volunteer storage system
  – Store intermediate results and final output

• Two alternatives
  – Data stored in all nodes: metadata in central server
  – Chosen nodes act as data centers
Current Work - Cliques

• Clique
  – Complete graph: each peer is connected to every node

• Building the overlay/P2P system
  – Peers replicate data between themselves

• Event-driven Simulator
• **Advantages**
  – More resources; Higher availability; Higher transfer speed;

• **Disadvantages**
  – Connectivity; Security; Upload bandwidth restrictions;

• **New Issues**
  – Accountability
  – Byzantine and selfish/rational behaviour
  – Fault Tolerance
  – Security
    • Authorization
    • Authentication
Supporting New Applications

• **Problem**
  – How to find a suitable application?
  – Current Focus
    • Virtual machines, GPU and multiprocessor applications

• **Build around existing application**
  – Don’t develop system that may never be used…

• **No requests for computing against large datasets or workflow apps**

• **Solution: Collaborations with existing/new projects**
Conclusion

• Current Work
  – Building Volunteer Storage Platform
    • Wrapper to use BT as read-only file system

• Leveraging the Storage Layer
  – Working on simulator that uses Cliques to support workflows
  – MapReduce Paradigm
  – Data-intensive applications
  – Combining with virtualization: Volunteer Cloud Computing?

• Finding partners
  – Research is meaningless unless it is advantageous to SOMEONE