BOINC Workshop 11

VOLPEX

PARALLEL EXECUTION IN VOLUNTEER ENVIRONMENT

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RESEARCH GOAL

Power of Community

Enable BOINC to efficiently support apps that require interprocess communication.

- **Goals:**
  - **Easier programming for communicating applications**
  - **Reduce execution time (not increase throughput)**

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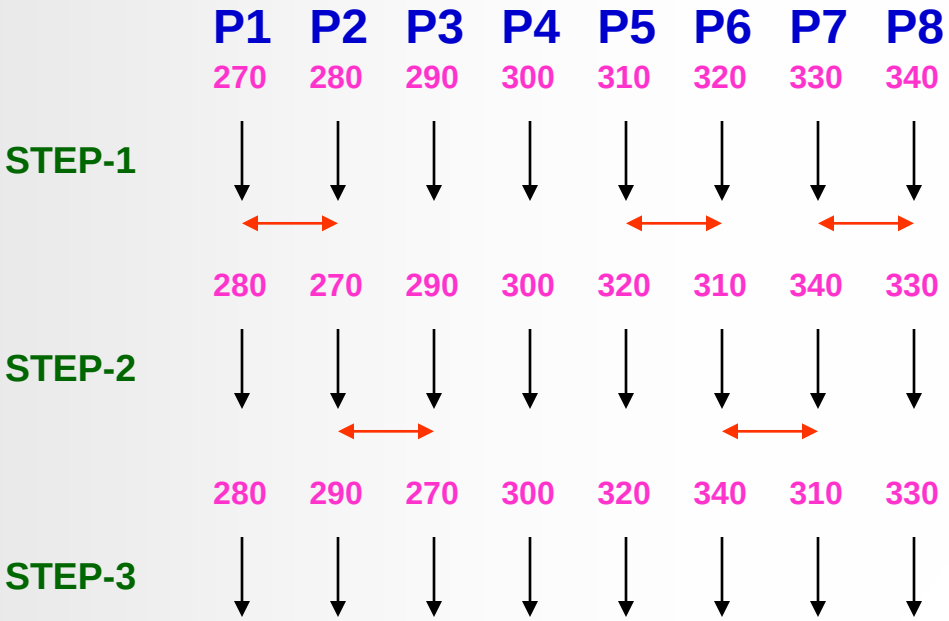
Example Applications

REMD Protein Folding application

Each process runs a standard molecular simulation at different temperature



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Example Applications

- Or many other applications:
  - Differential equation solvers (grid) (synchronous)
  - Game playing with alpha/beta pruning (asynchronous)
  - Search application.
  - …..

- Suitable applications: low to moderate amount and frequency of communication.

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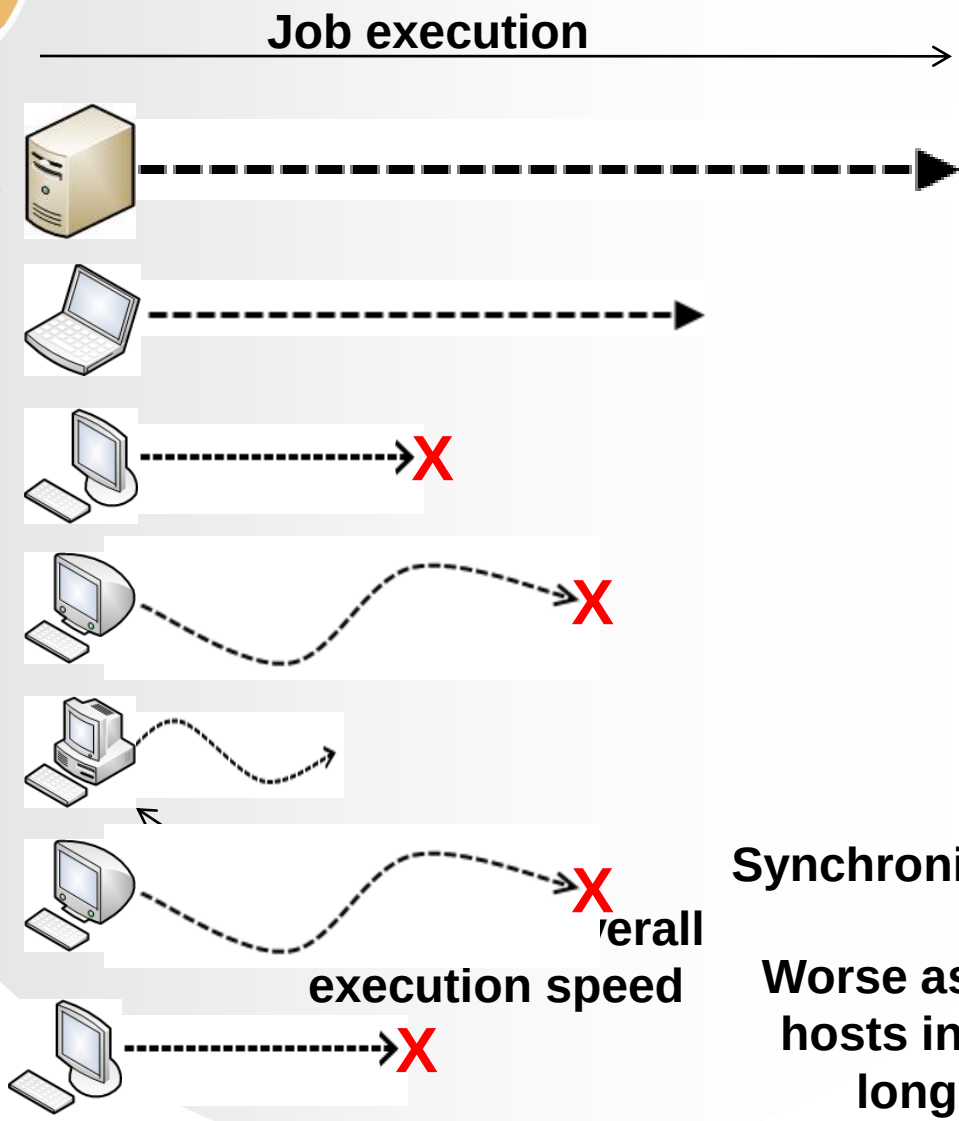
DIFFICULTIES



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OUTLINE

1. Volpex Dataspace
   - IPC for volunteer environment
2. Ensuring Efficiency
   - Process management
   - Host selection
3. Experiments And Evaluation
4. Future Work

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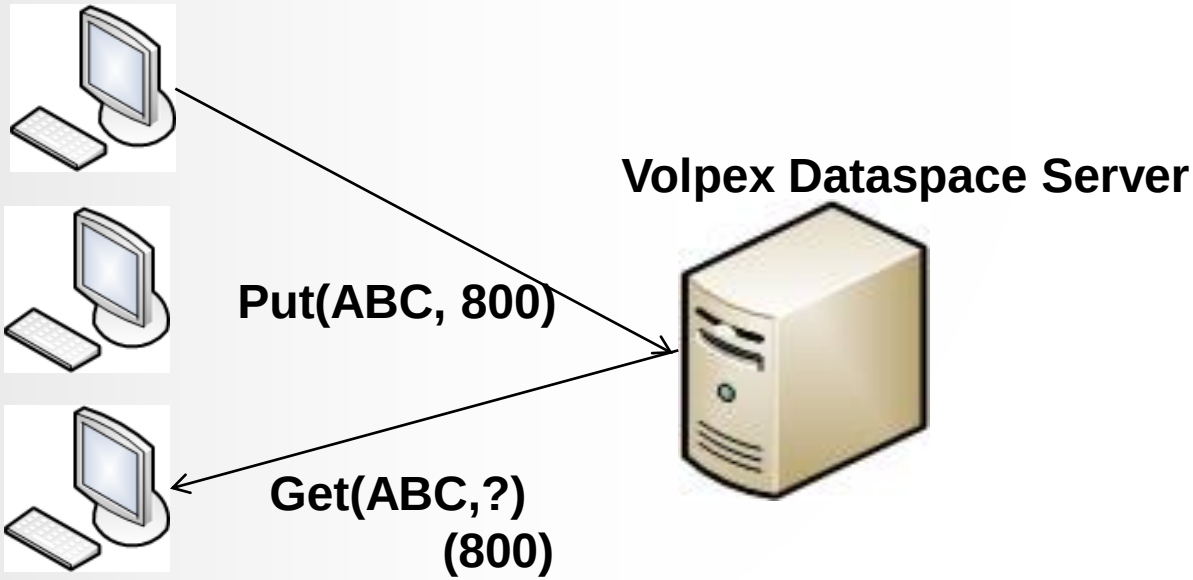
Volpex Dataspace

❖Dataspace: global shared space that processes can use for information exchange without a temporal or spatial coupling.



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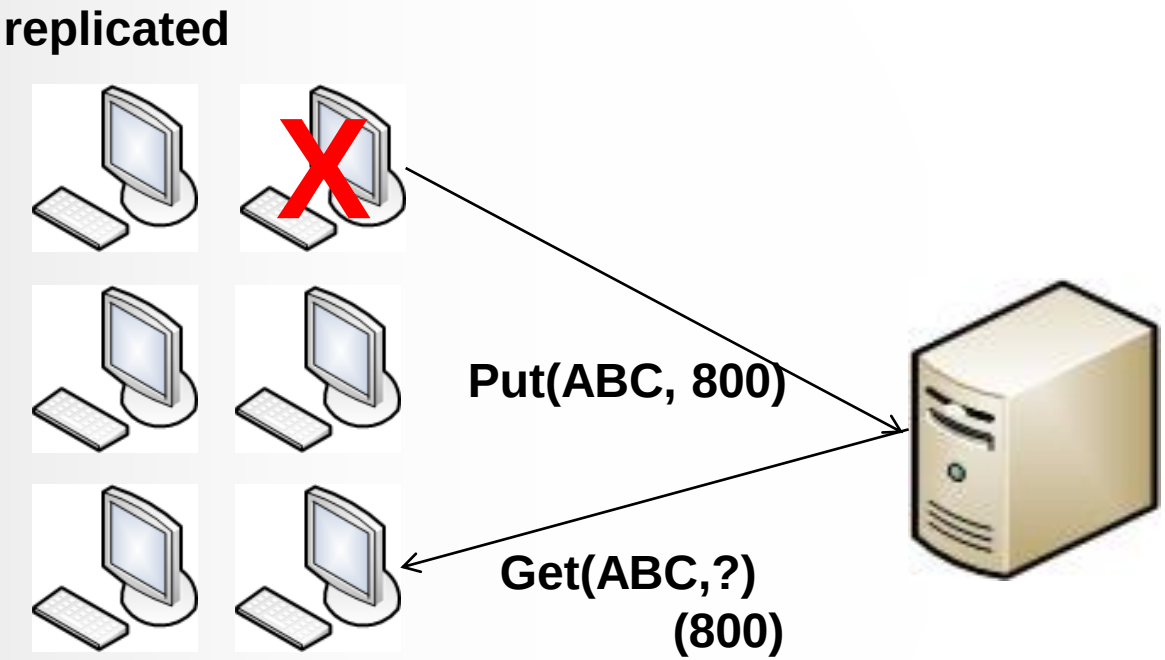
Volpex Dataspace – Fault Tolerance



Volpex DSS is unique in supporting redundant Put/Get operations

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Related Work: Volpex MPI

- **Volpex MPI:**
  - **An MPI library designed for executing parallel applications in volunteer environment.**
  - **Direct communication between processes.**
  - **Key Features**
    - **Controlled redundancy**
    - **Receiver based direct communication**
    - **Distributed sender based logging**

More detail: "*VolpexMPI: an MPI Library for Execution of Parallel Applications on Volatile Nodes*" by Troy LeBlanc, Rakhi Anand, Edgar Gabriel, and Jaspal Subhlok.

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ENSURING EFFICIENCY

Parallel program executes at the speed of the slowest process

- **Process management**
  - **Simultaneous process starting**
  - **Failure and recovery**
  - **Replica management**
  - **Checkpoint/restart**
- **Host selection.**
- **Integrated with BOINC**

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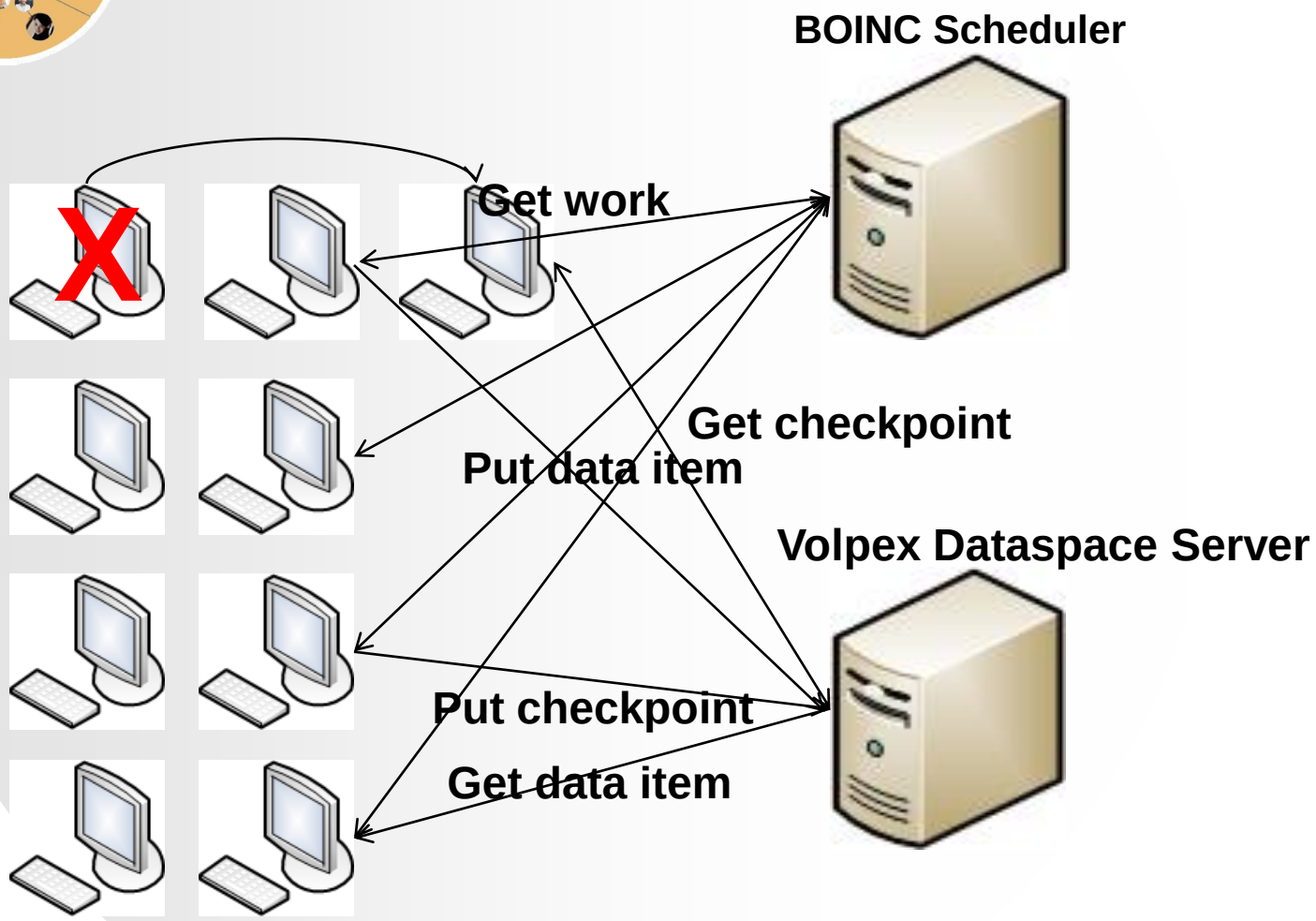
Job execution scheme



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PROCESSES MANAGEMENT

Power of Community

- **Simultaneous process starting:**
  - **All processes start computation together**
  - **Volpex jobs have highest (infinite) priority: uninterruptible by other jobs.**
  - **While waiting for all processes of a Volpex job to be ready: host can do other finite priority volunteer jobs.**
  - **Use of boinc_temporary_exit()**

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PROCESSES MANAGEMENT

Power of Community

- **Failure and recovery**
  - **Dead instance spotted by heartbeat mechanism: process instances regularly send heartbeat to Volpex DSS.**
  - **Slow instance detected when very old checkpoint commit attempted.**
  - **"Hot Spare" replaces the dead/slow process. Degree of replication maintained.**

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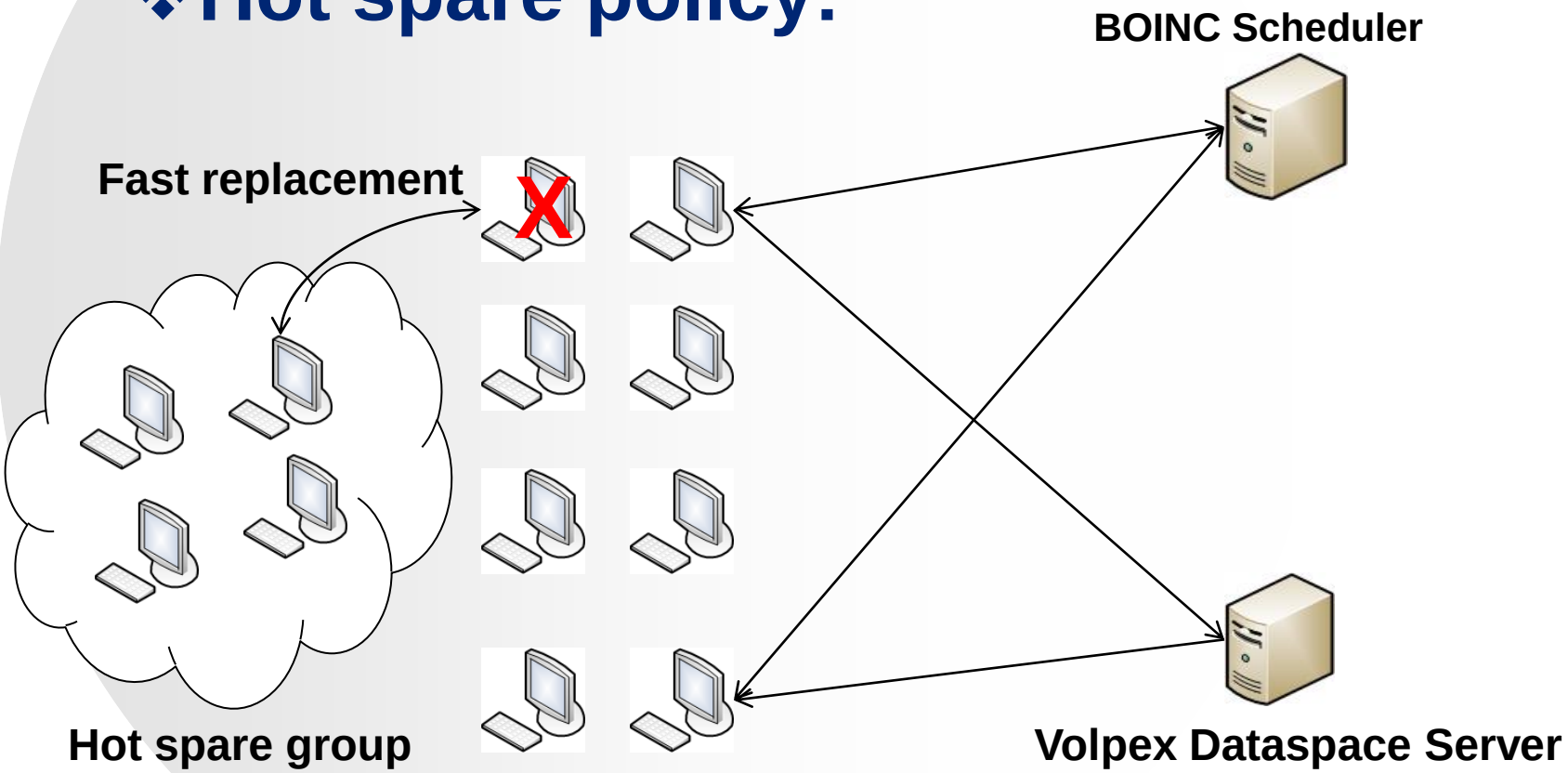
PROCESSES MANAGEMENT

Power of Community

❖Hot spare policy:



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PROCESSES MANAGEMENT

Power of Community

❖Checkpointing:

- ➢Process instance commits and uploads checkpoints to Volpex DSS (only stores latest checkpoint for each process).
- ➢Volpex_time_to_checkpoint()
  Volpex_checkpoint(char* checkpoint)
- ➢Restarted process instance requests checkpoint from Volpex DSS.

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HOST SELECTION POLICY

Power of Community

- Criteria for selecting volunteer hosts to assign to a Volpex job:
  - CPU speed
  - Memory capacity
  - Disk space
  - Upload bandwidth
  - Predicted availability

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HOST SELECTION POLICY

Power of Community

- **Future availability prediction based on**
  - ***Last valued predictor:*** **availability in the last hour**
  - ***Predictability:*** **the number of availability changes in the past 2 weeks.**

- **In essence: select hosts which change availability very rarely.**

- **Method partly based on :** ***Exploiting Non-Dedicated Resources for Cloud Computing*** **Artur Andrzejak, Derrick Kondo, David P. Anderson. (NOMS10)**

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IMPLEMENTATION STATUS

Power of Community

- Volpex utilities: for scientists to submit, abort or query status of a Volpex job.
- Modified BOINC scheduler: includes host selection for Volpex job.
- Modified Volpex DSS: handles new type of requests, manages application execution.

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EXPERIMENTS AND EVALUATION

Power of Community

- **Experiment Scheme:**

- **Application: Sieve of Eratosthenes, REMD Protein Folding**
- **Number of processes: 10 for Sieve and 16 for Folding**
- **Level of replication: 1, 2, 3**
- **Pool of around 80 nodes: On campus & global**
- **Host Selection Policies:**
  - **Random/Naïve**
  - **Minimum threshold on CPU, memory, diskspace, upload bandwidth and predicted availability**

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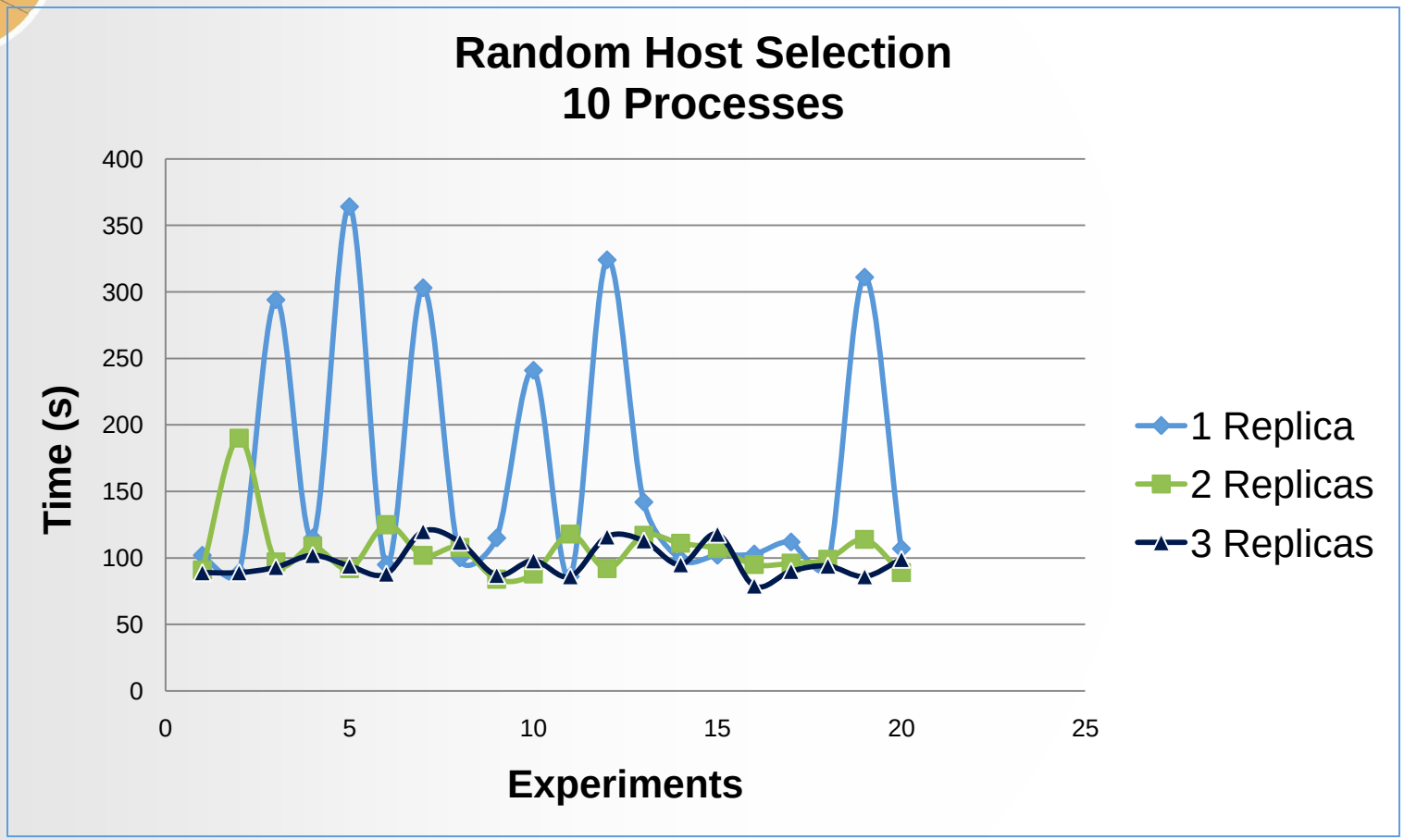
Sieve of Eratosthenes



Replication helps reduce variability in job's execution time

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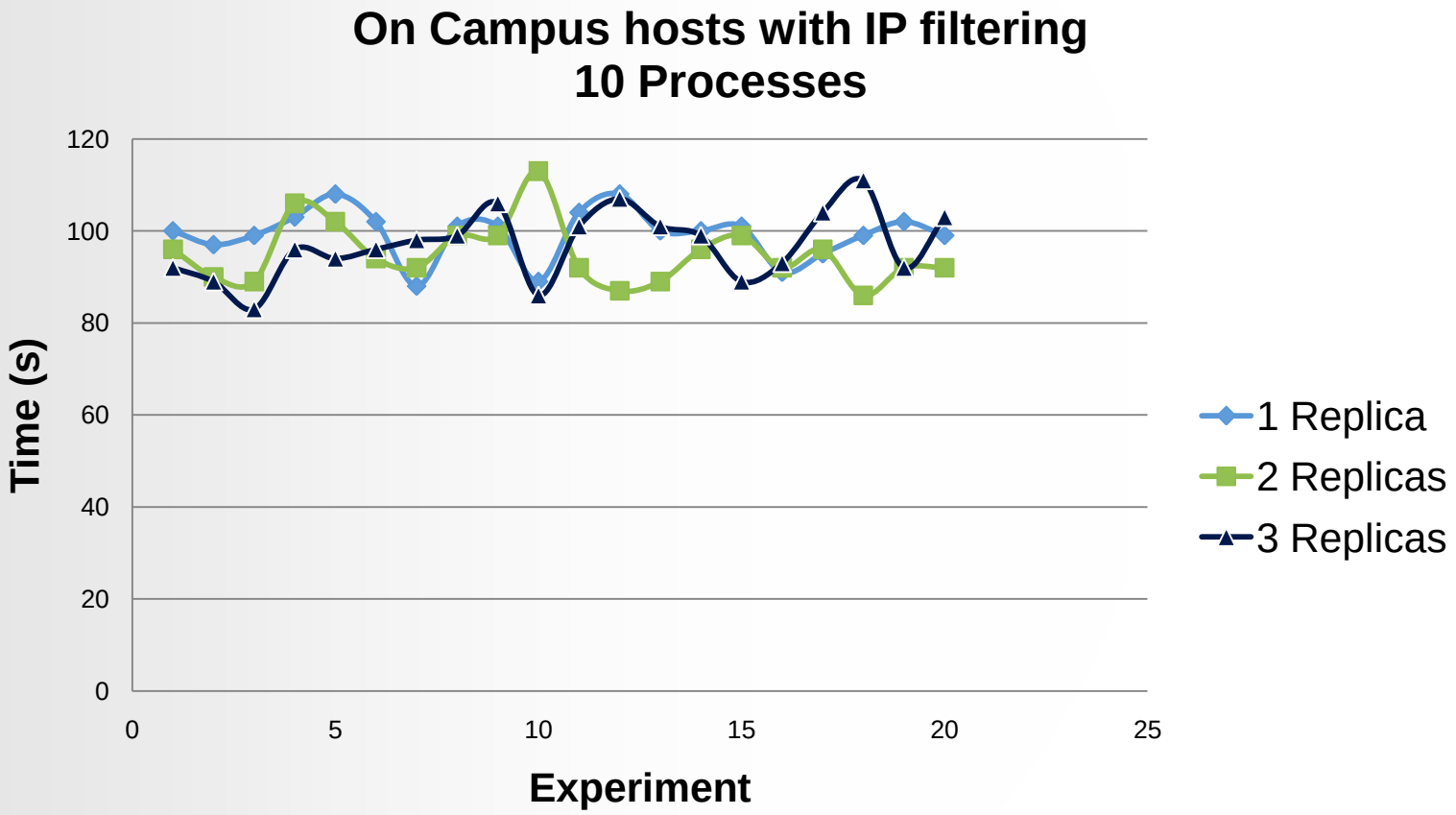
Sieve of Eratosthenes



For on-campus nodes, replication does not have remarkable effect.

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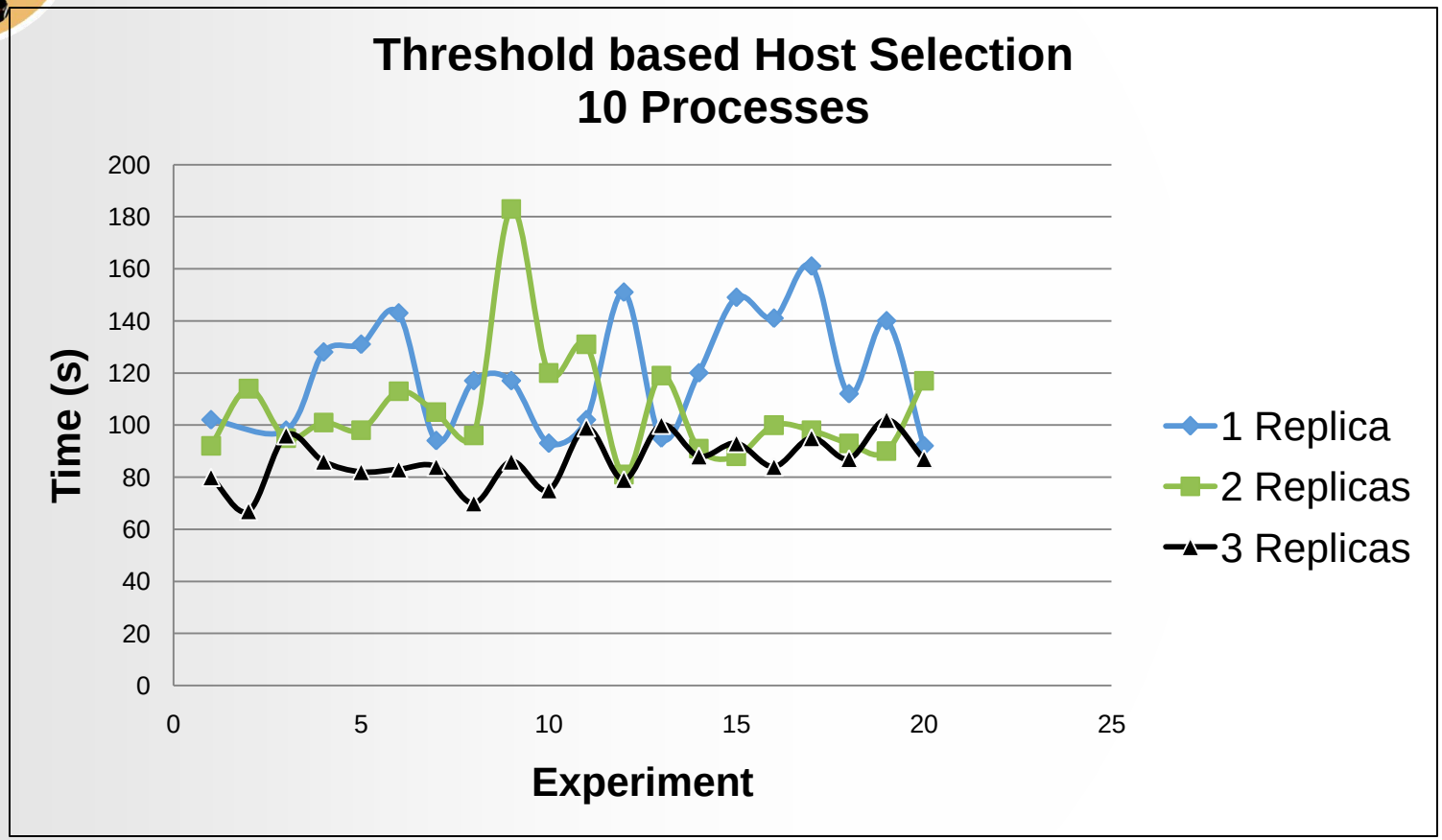
Sieve of Eratosthenes



Minimum threshold for host selection helps stabilize the execution time even w/o replication.

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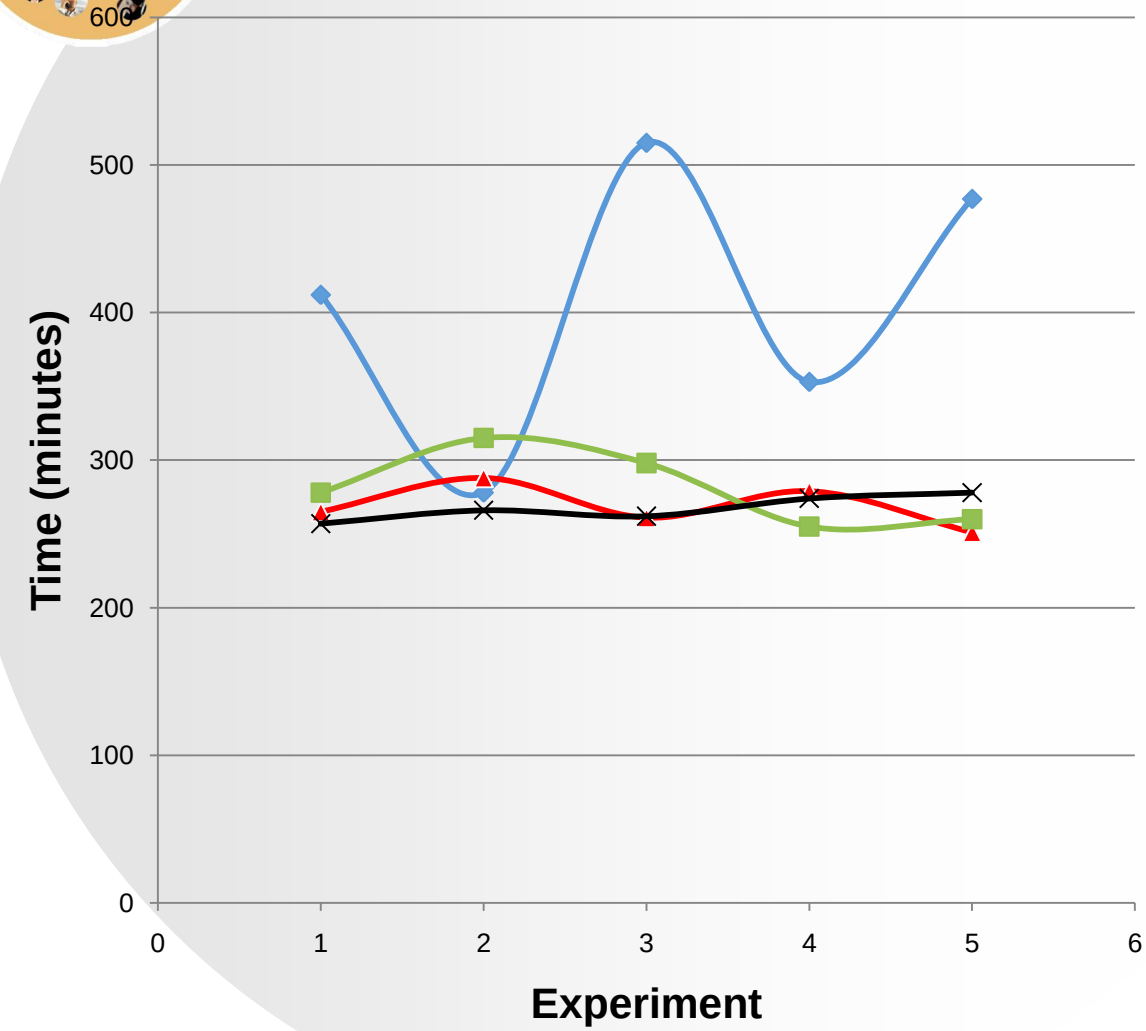
REMD for Protein Folding



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FUTURE WORK

- More experiments:
  - Higher number of processes
  - More applications
  - Communication pattern (local/global, synch/asynch)
  - Size and frequency of communication
- More in depth study on:
  - Host selection policy
  - Optimal checkpoint interval
- Granting credits to hosts:
  - Granting credit to hot spares
  - Granting credit to host that fails mid-way

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If you have application?

We would be happy to help you in employing Volpex for your application.

Students / postdocs interested in working on Volpex welcome to contact us.

Our team contacts:

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Our Website: http://volpex.cs.uh.edu

VOLPEX

PARALLEL EXECUTION

IN VOLUNTEER ENVIRONMENT

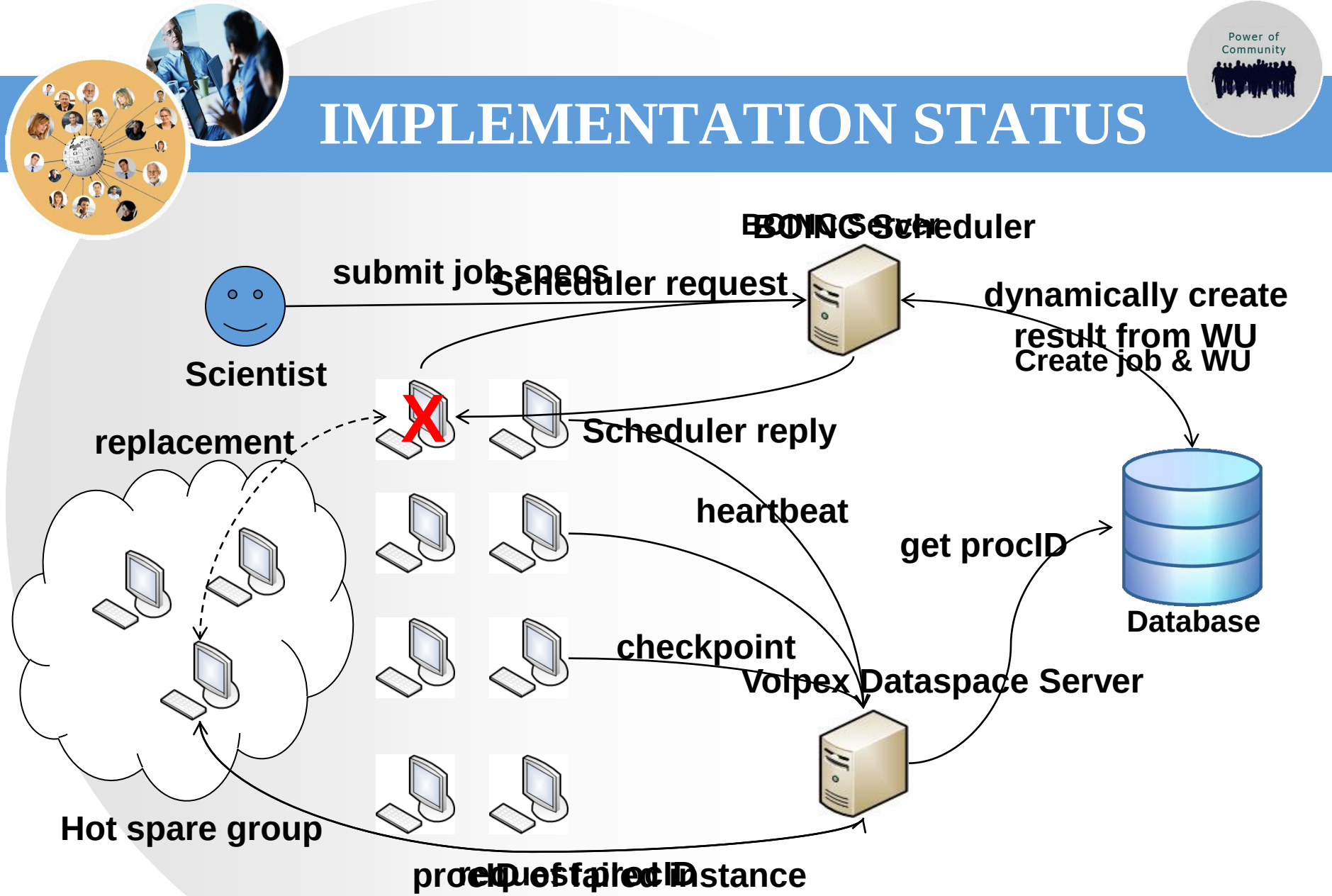
BOINC

Power of Community

Thanks for listening!

NSF

IMPLEMENTATION STATUS



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