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Hydrographic Data Processing on a Robust, Network-Coupled Parallel Cluster

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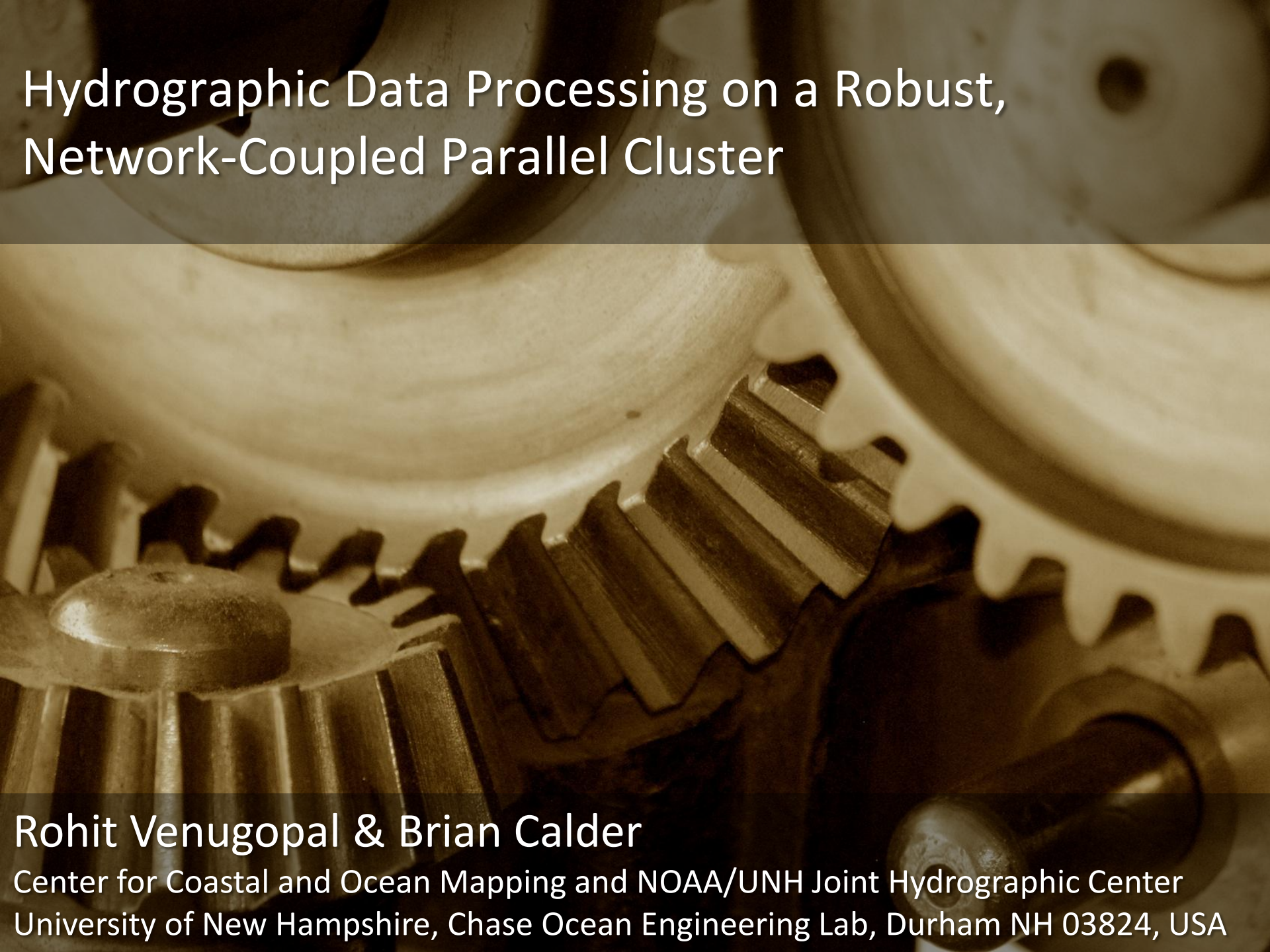
Hydrographic Data Processing on a Robust, Network-Coupled Parallel Cluster



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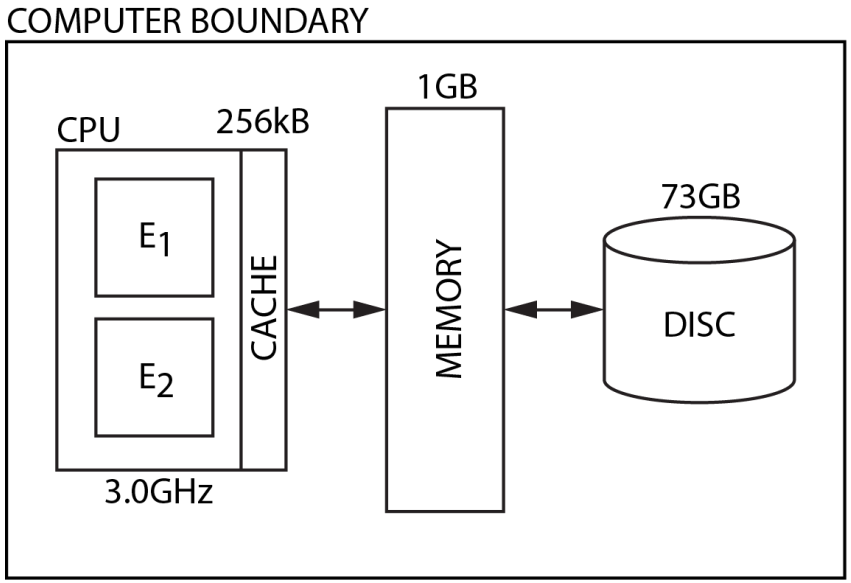
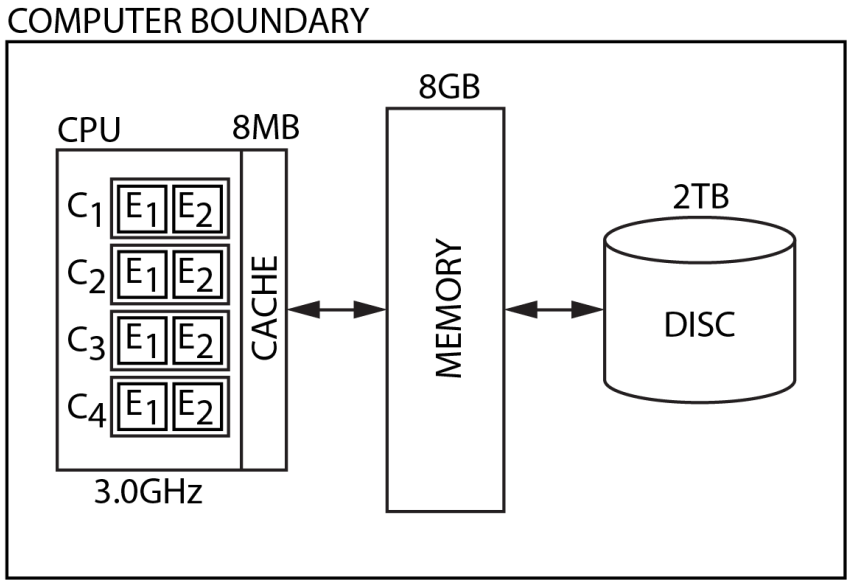
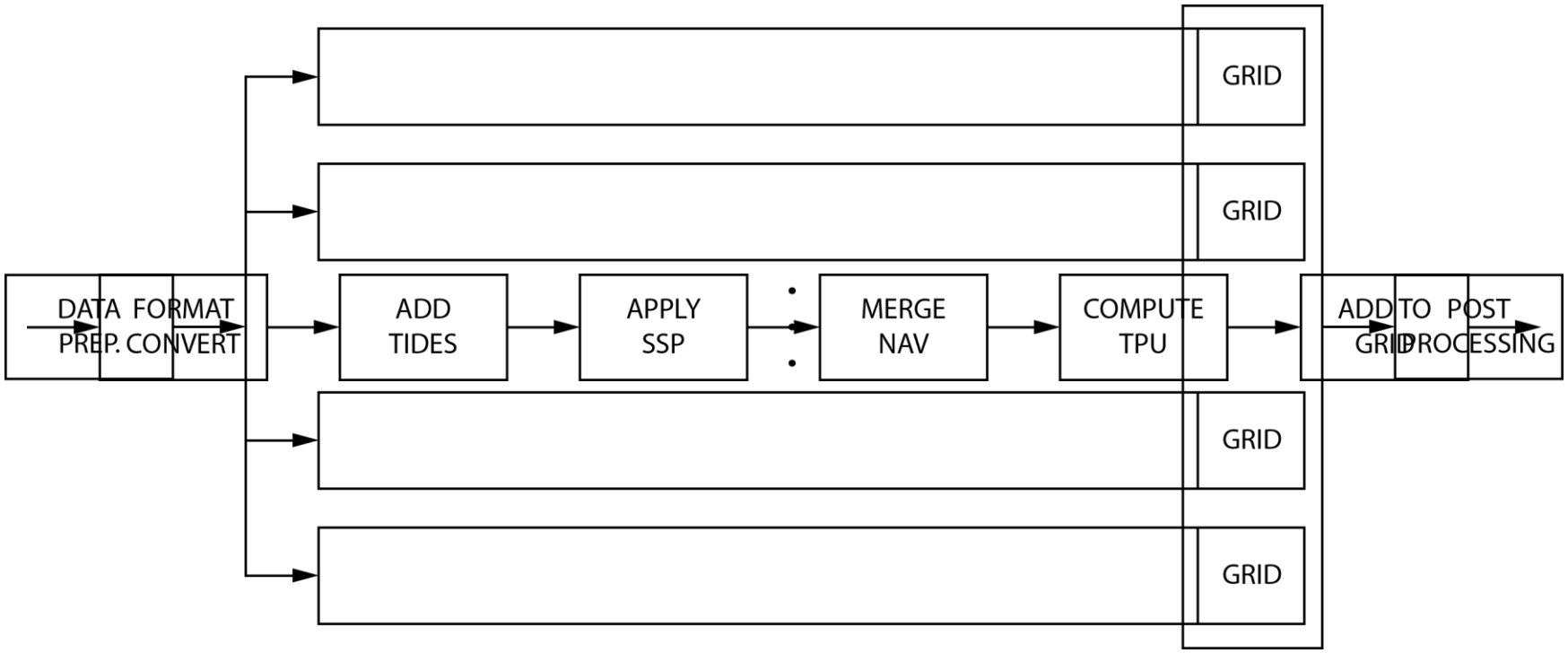
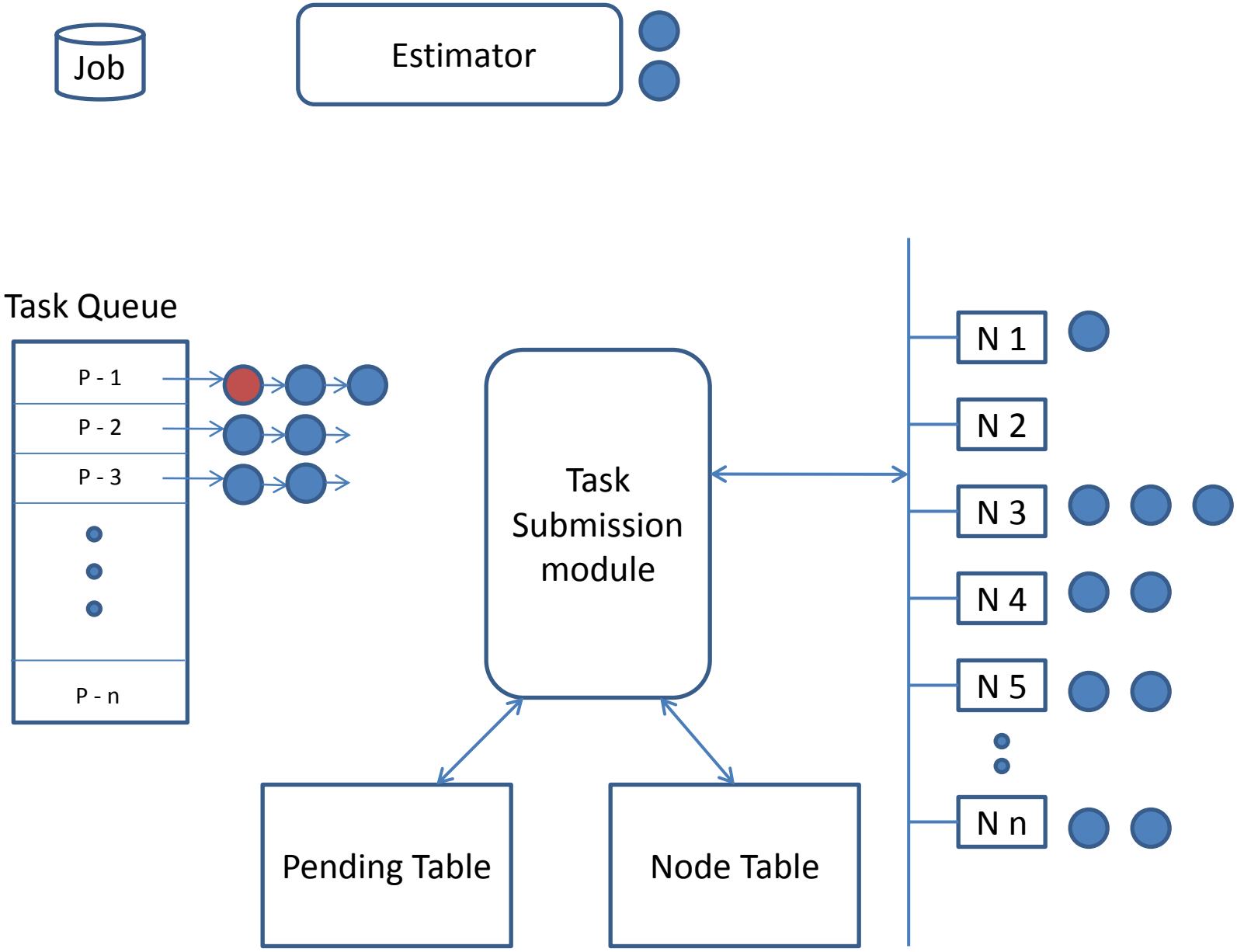


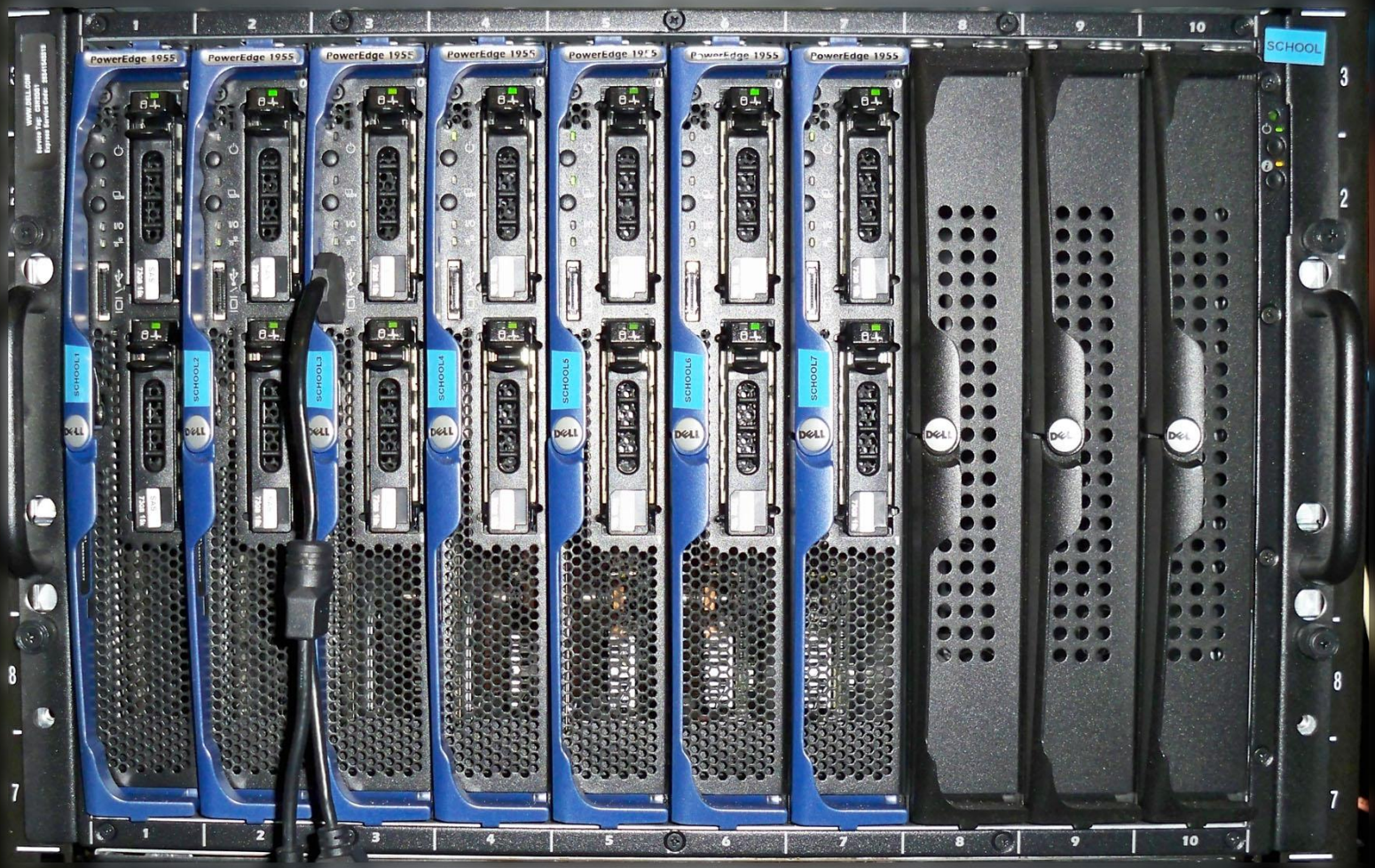
ca. 2000-2001

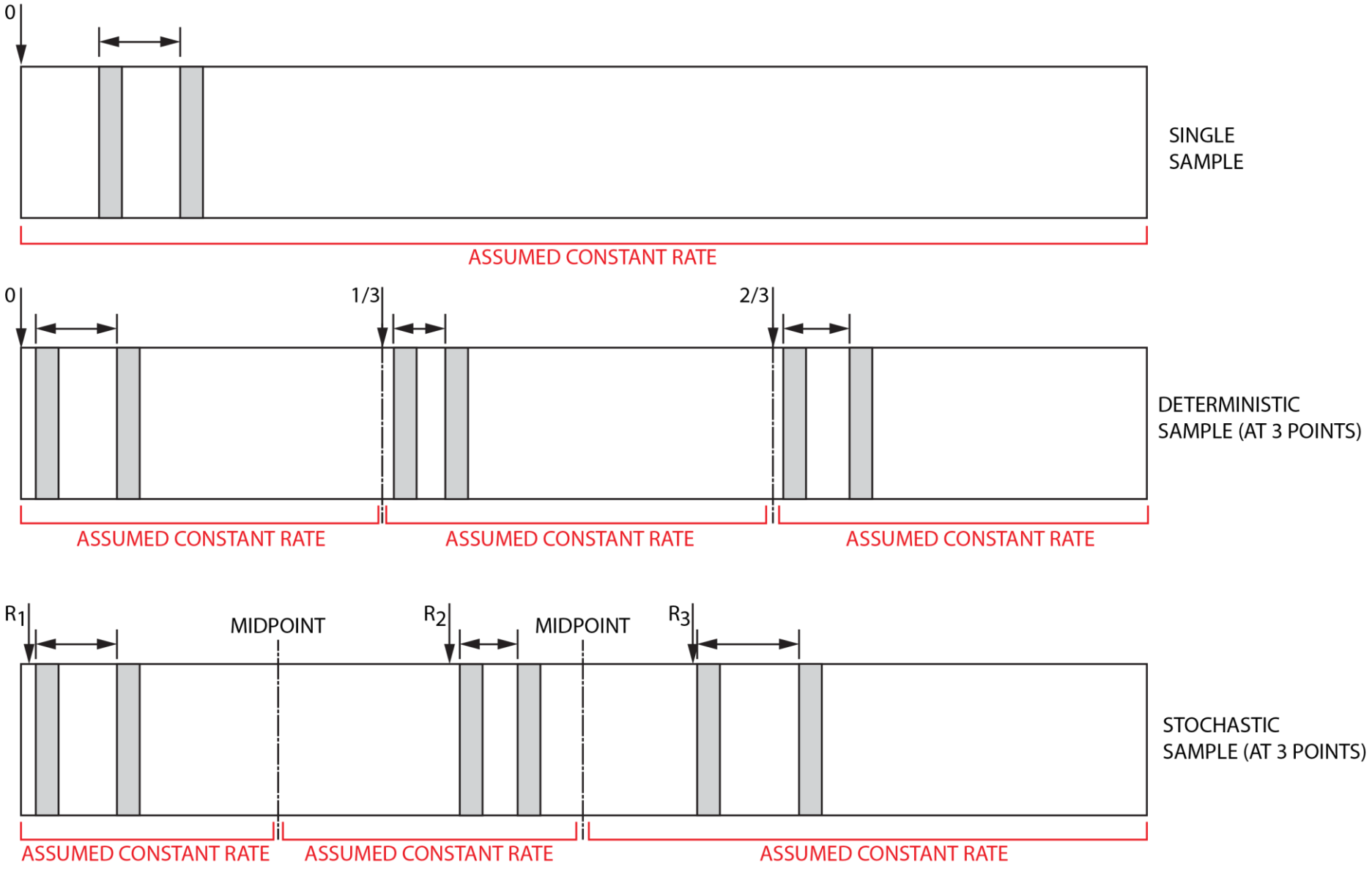


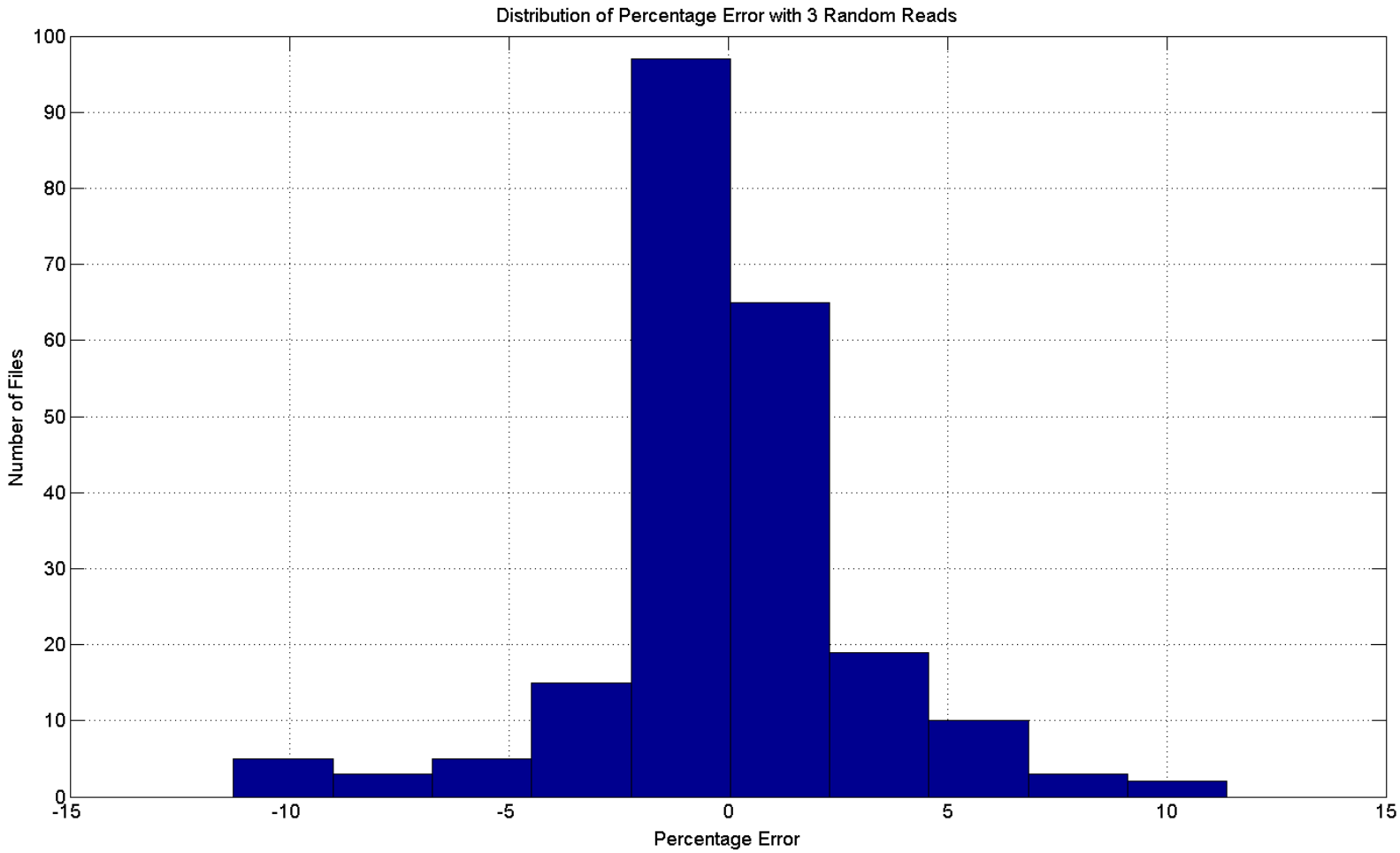
ca. 2011-2012

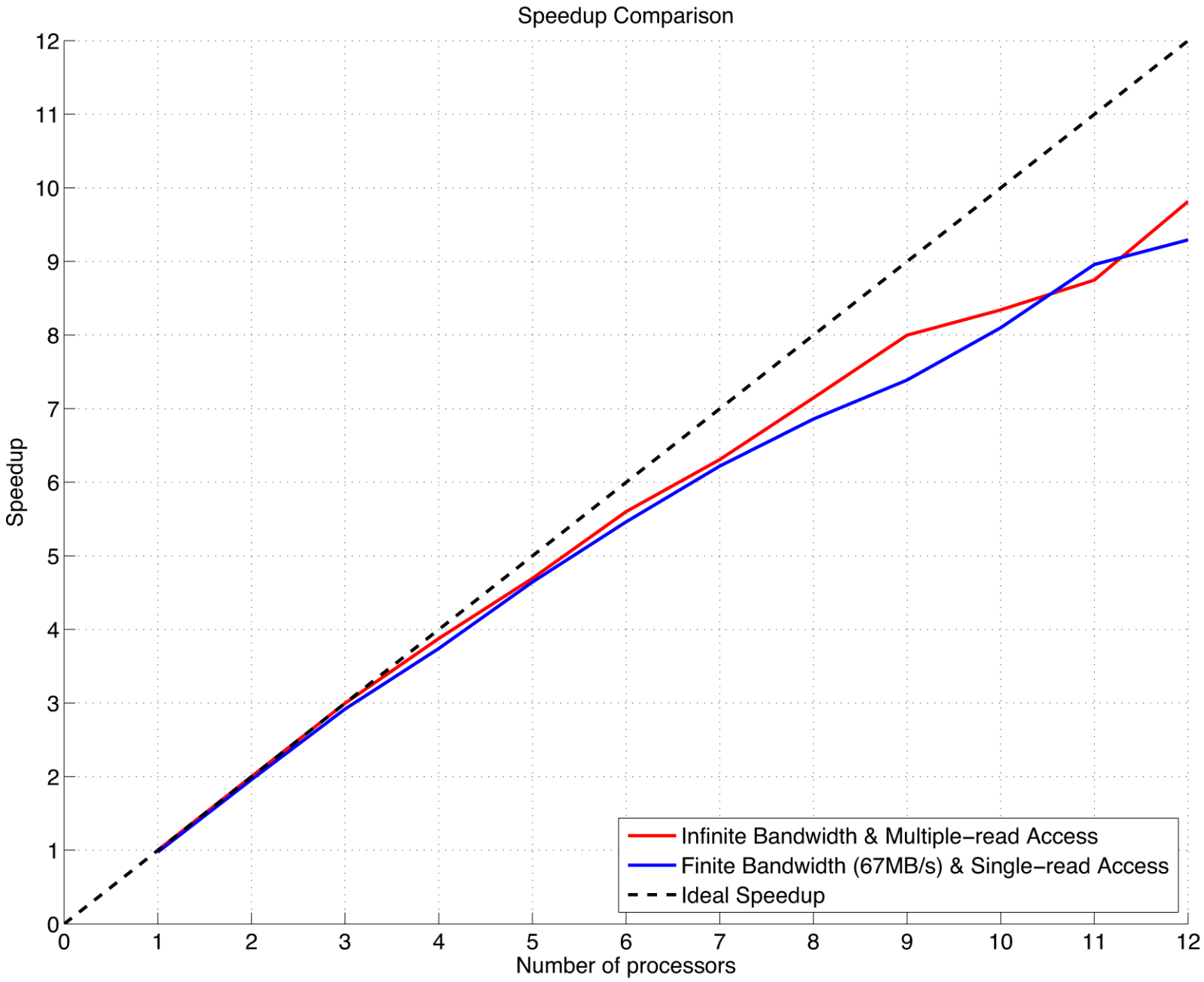

DATA FORMAT
PREP. CONVERT
ADD
TIDES
APPLY
SSP
MERGE
NAV
COMPUTE
TPU
ADD TO POST
GRID PROCESSING
GRID
GRID
GRID
GRID

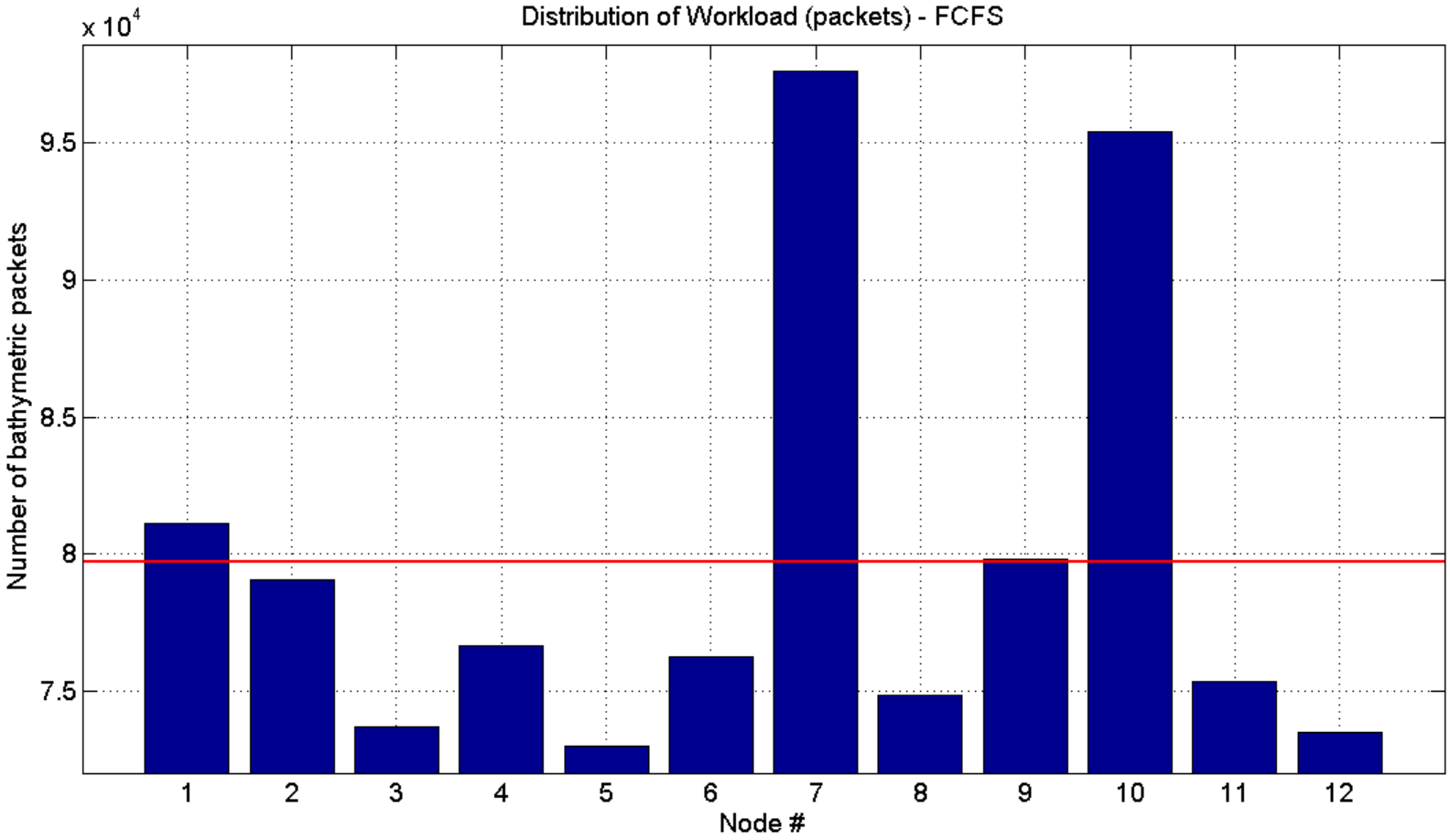

Job
Estimator
Task Queue
P - 1
P - 2
P - 3
P - n
Task Submission module
Pending Table
Node Table
N 1
N 2
N 3
N 4
N 5
N n

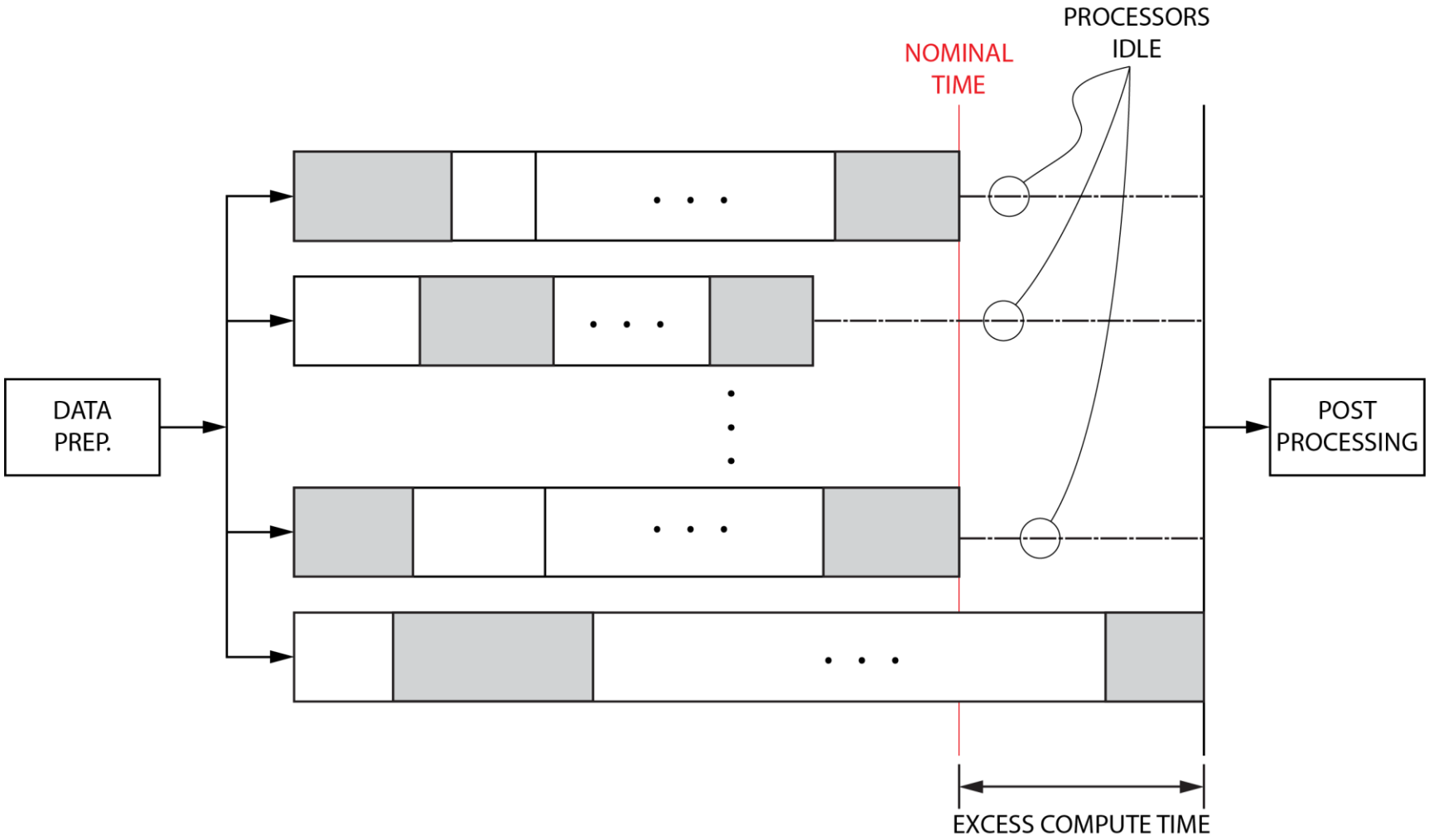

PowerEdge 1955
PowerEdge 1955
PowerEdge 1955
PowerEdge 1955
PowerEdge 1955
PowerEdge 1955
PowerEdge 1955
SCHOOL
SCHOOL1
SCHOOL2
SCHOOL3
SCHOOL4
SCHOOL5
SCHOOL6
SCHOOL7

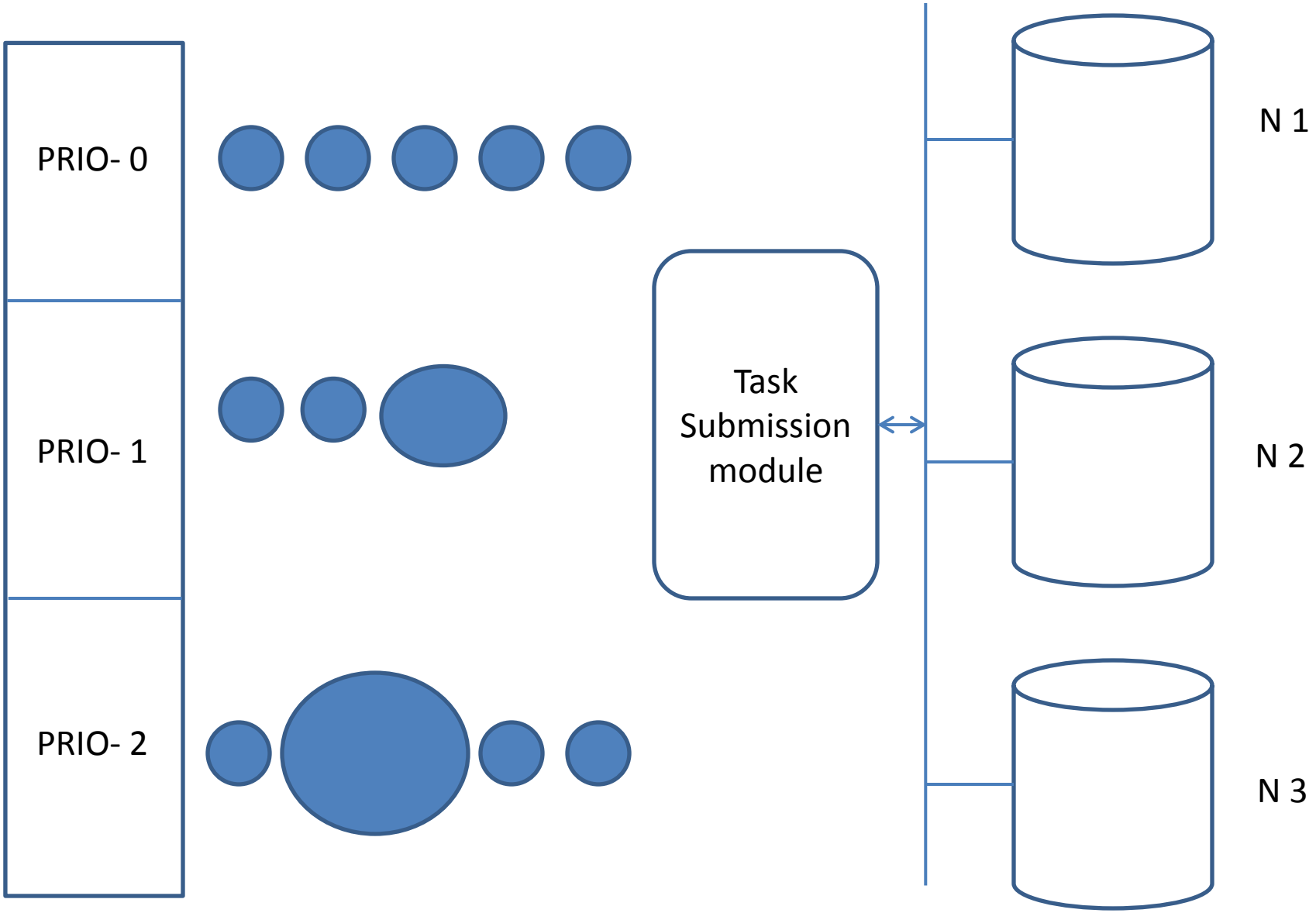

0
SINGLE
SAMPLE
ASSUMED CONSTANT RATE
0
1/3
2/3
DETERMINISTIC
SAMPLE (AT 3 POINTS)
ASSUMED CONSTANT RATE
ASSUMED CONSTANT RATE
ASSUMED CONSTANT RATE
R1
MIDPOINT
R2
MIDPOINT
R3
STOCHASTIC
SAMPLE (AT 3 POINTS)
ASSUMED CONSTANT RATE
ASSUMED CONSTANT RATE
ASSUMED CONSTANT RATE

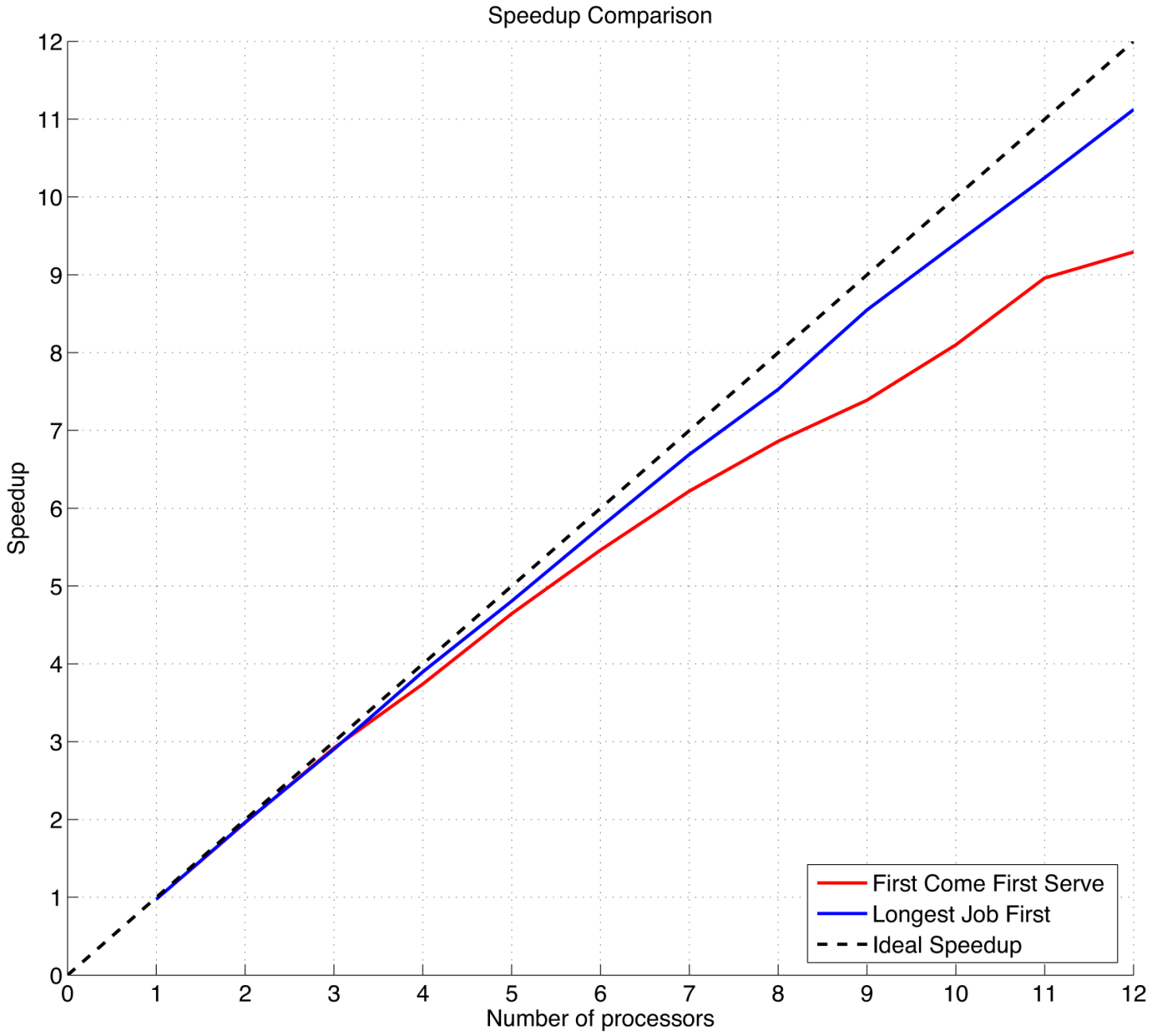

Distribution of Percentage Error with 3 Random Reads
Number of Files
Percentage Error
100
90
80
70
60
50
40
30
20
10
0
-15
-10
-5
0
5
10
15

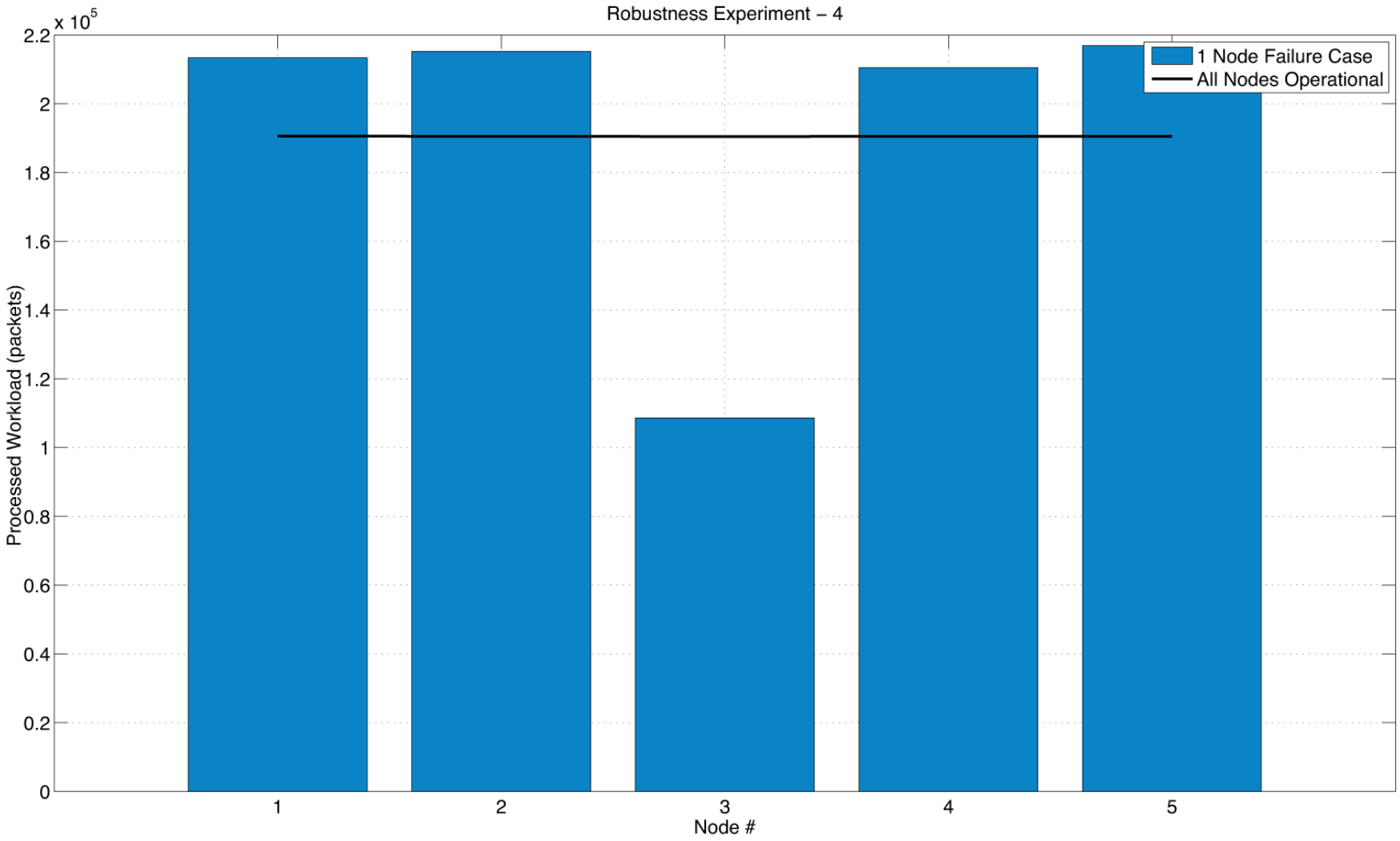

Speedup Comparison
Speedup
Number of processors
0
1
2
3
4
5
6
7
8
9
10
11
12
Infinite Bandwidth & Multiple−read Access
Finite Bandwidth (67MB/s) & Single−read Access
Ideal Speedup

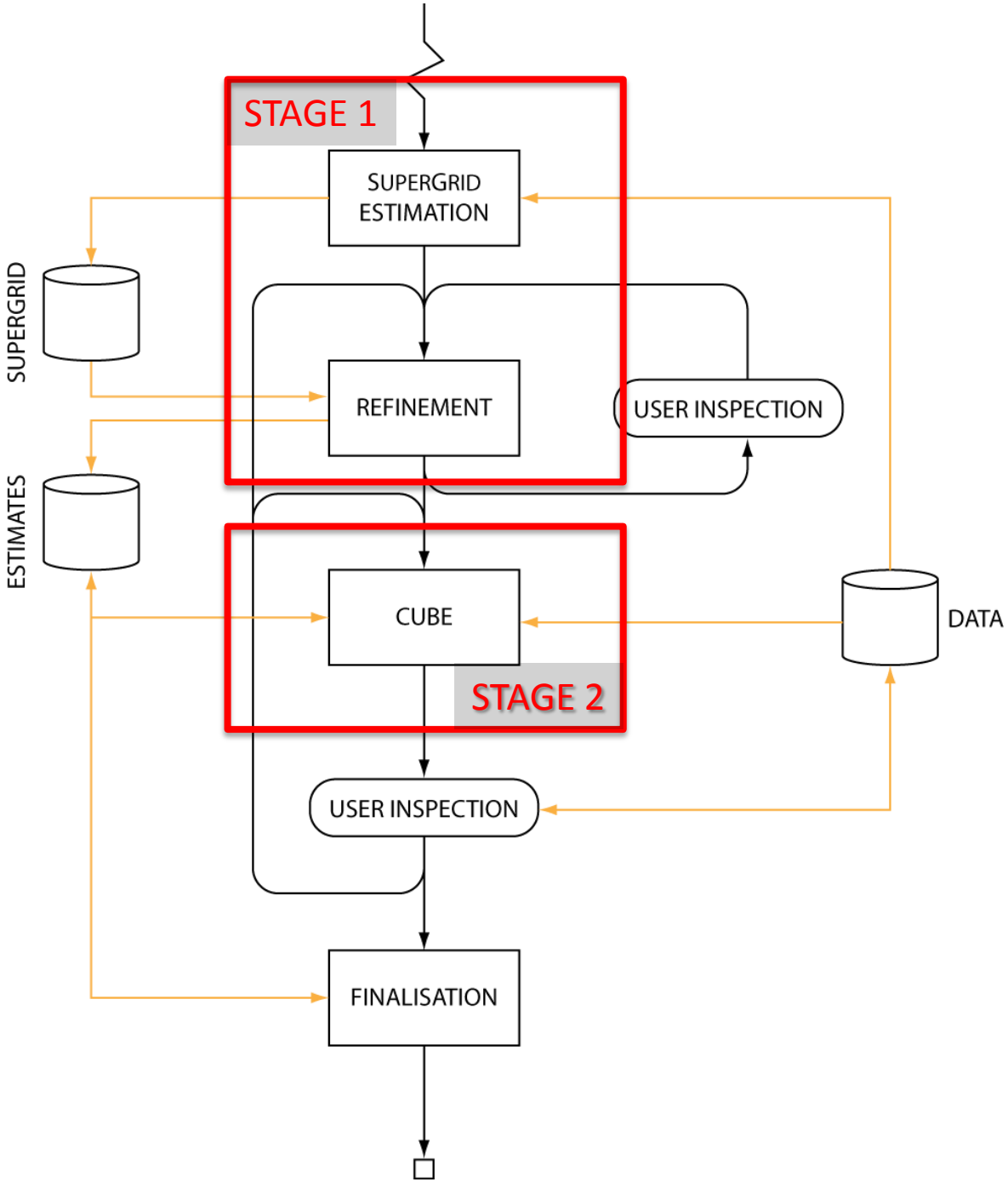

Distribution of Workload (packets) - FCFS
x 10^4
Number of bathymetric packets
9.5
9
8.5
8
7.5
1
2
3
4
5
6
7
8
9
10
11
12
Node #

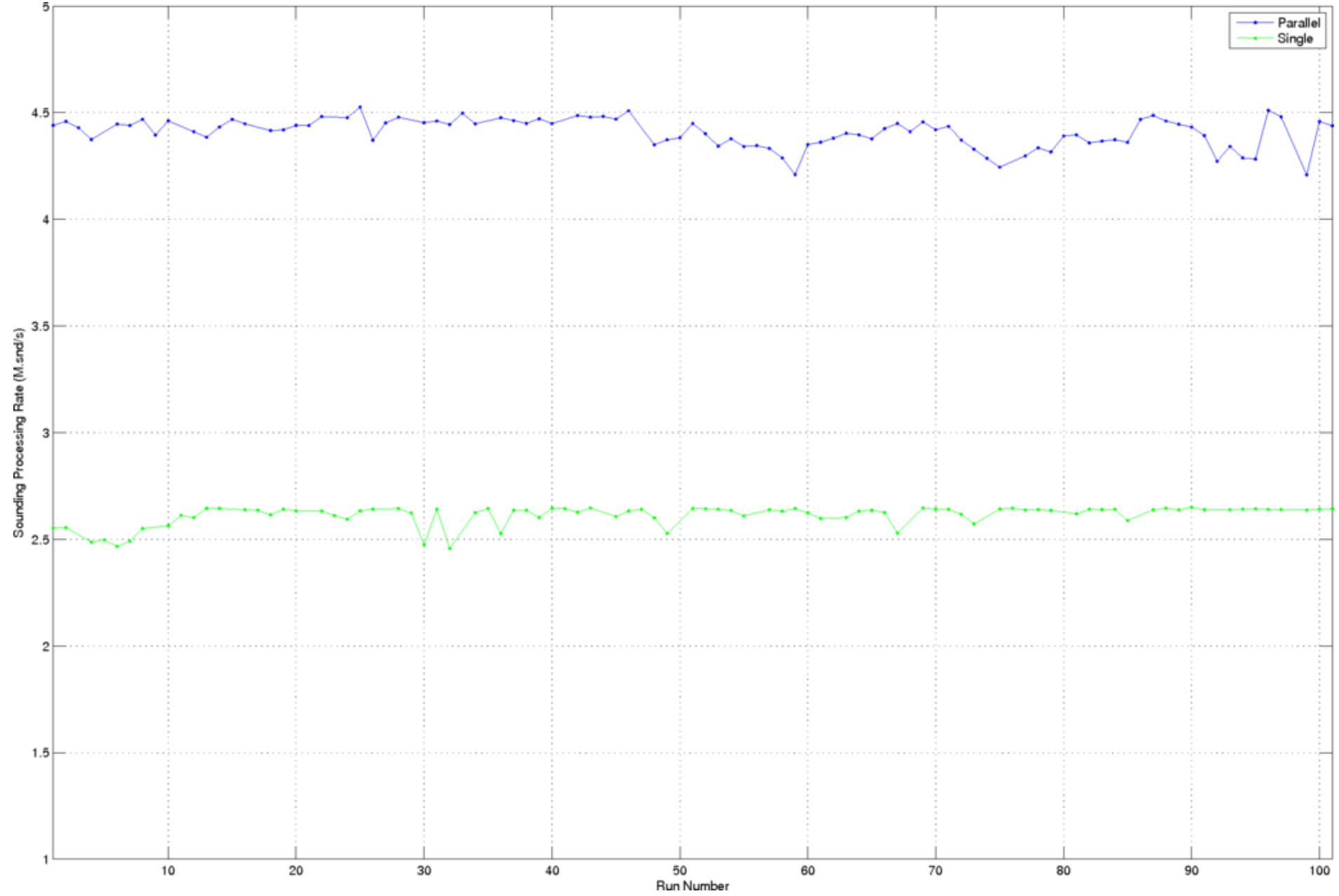

PROCESSORS
IDLE
NOMINAL
TIME
DATA
PREP.
POST
PROCESSING
EXCESS COMPUTE TIME

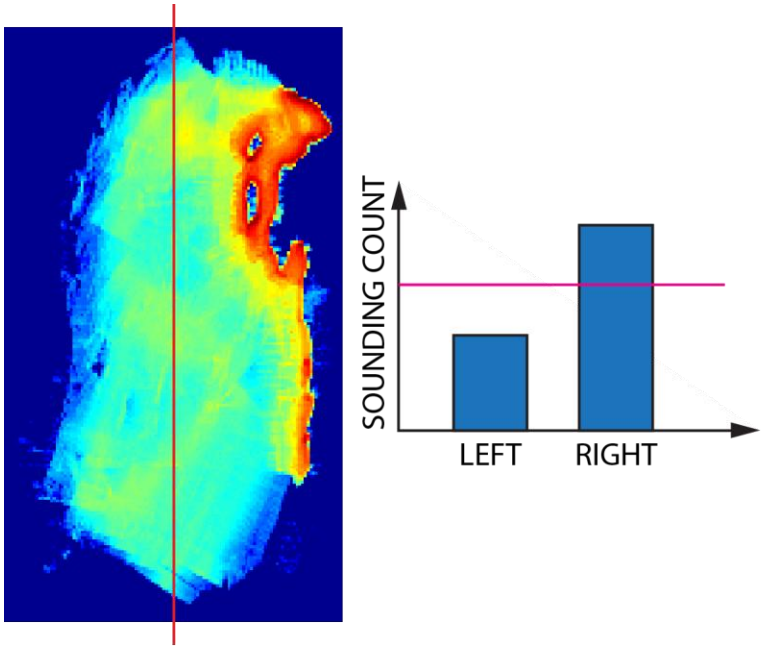

PRIO- 0
PRIO- 1
PRIO- 2
Task Submission module
N 1
N 2
N 3

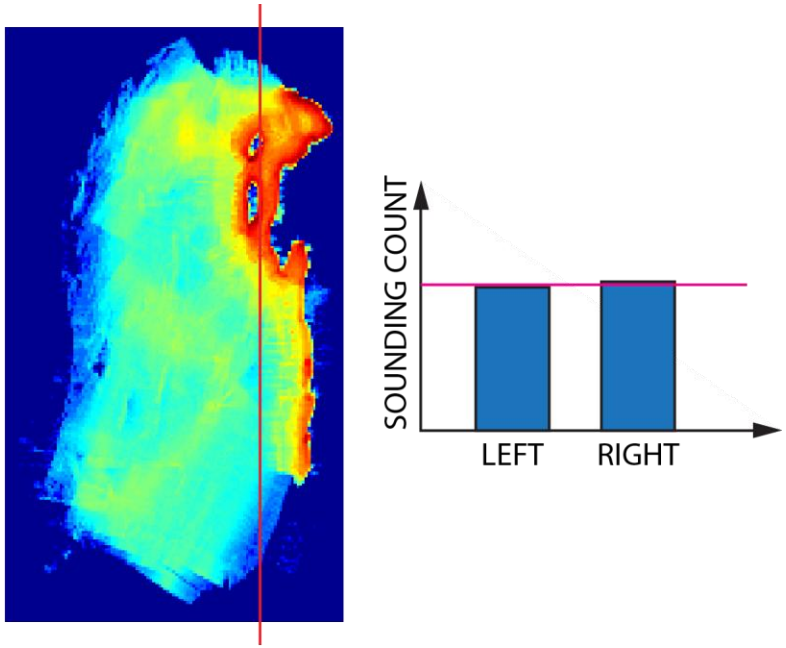

Speedup Comparison
Speedup
Number of processors
0
1
2
3
4
5
6
7
8
9
10
11
12
First Come First Serve
Longest Job First
Ideal Speedup

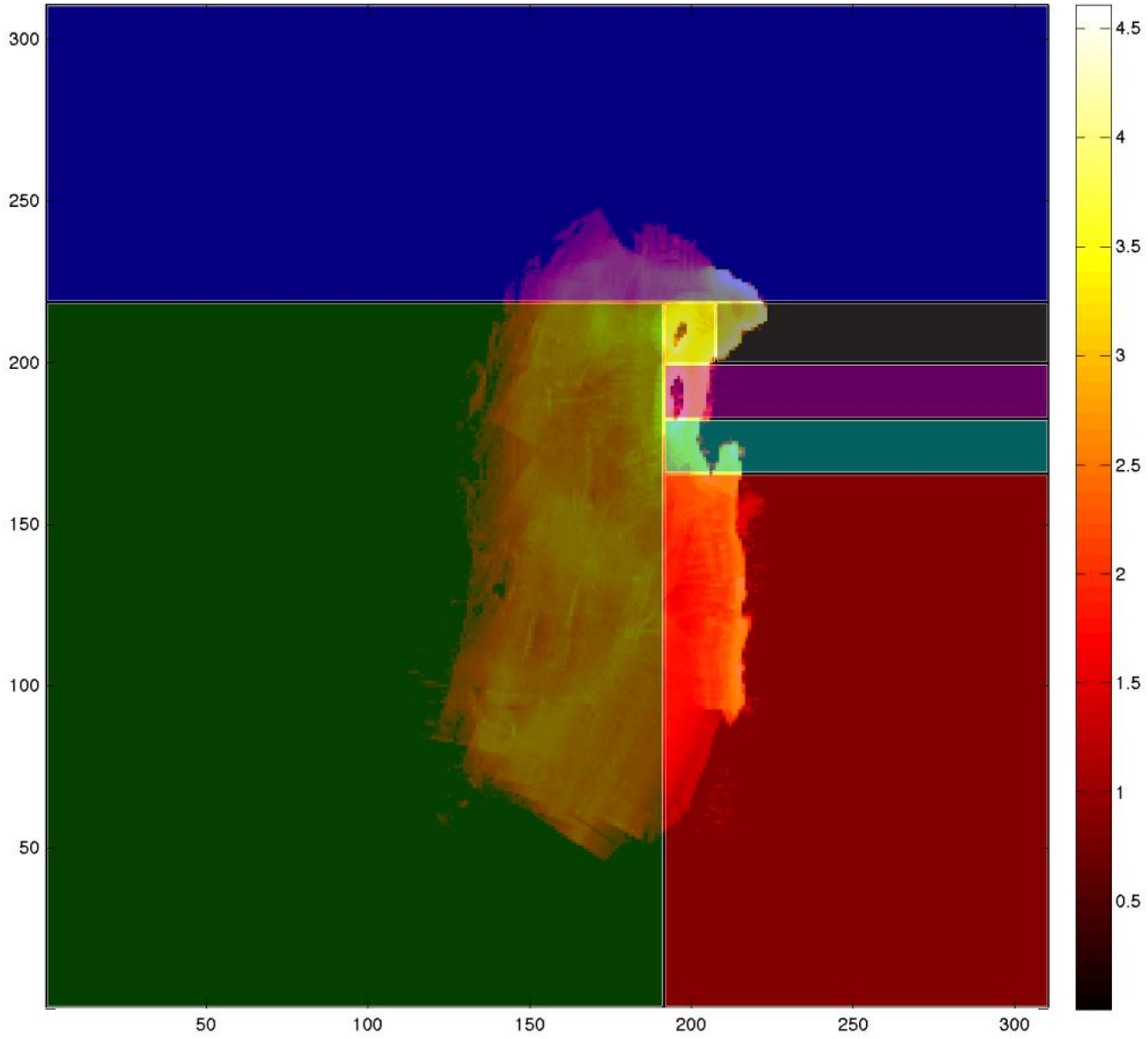

Robustness Experiment – 4
x 10^5
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Processed Workload (packets)
1 Node Failure Case
All Nodes Operational
1
2
3
4
5
Node #

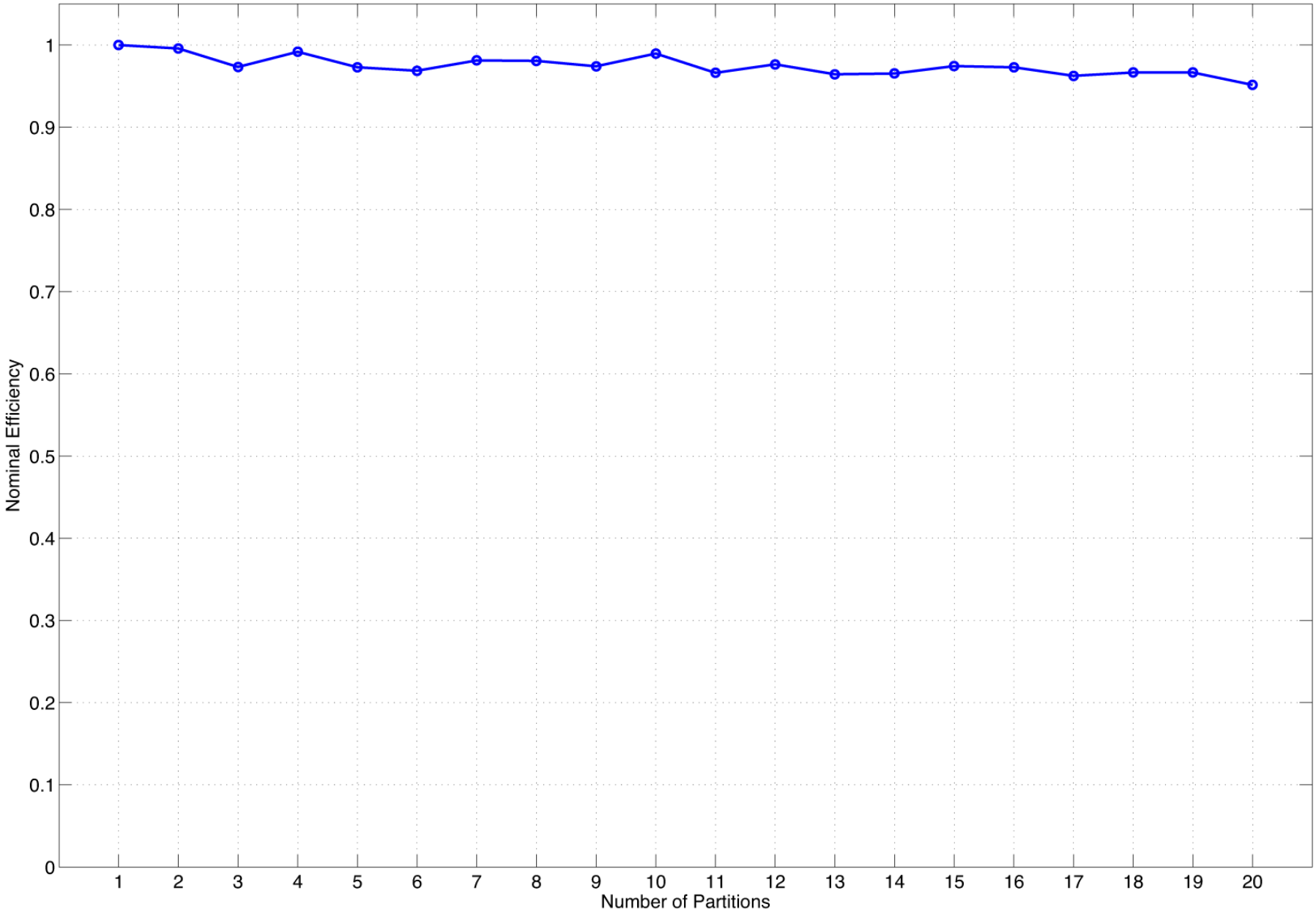

STAGE 1
SUPERGRID ESTIMATION
SUPERGRID
REFINEMENT
USER INSPECTION
ESTIMATES
CUBE
DATA
STAGE 2
USER INSPECTION
FINALISATION

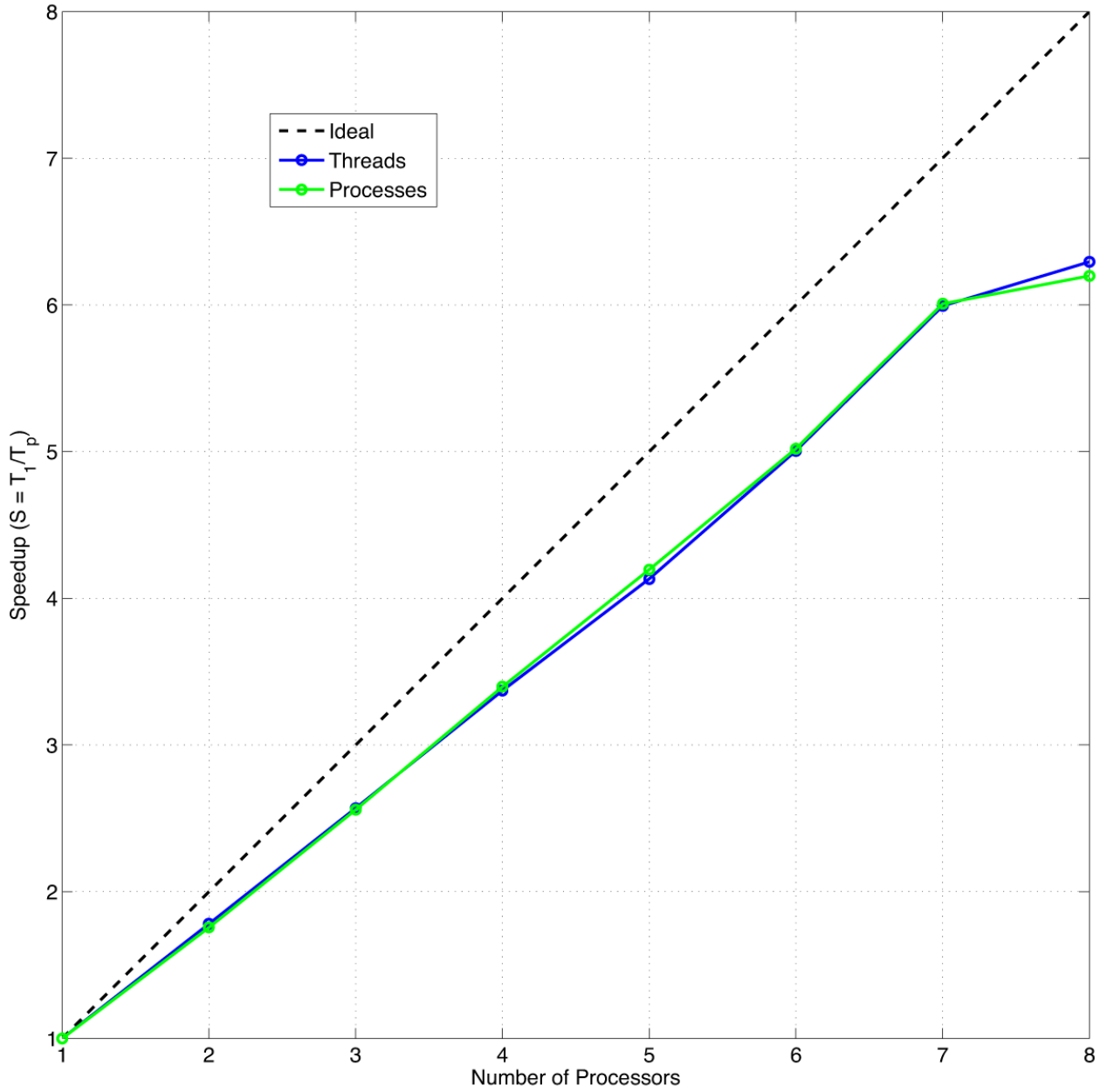

Parallel
Single
Sounding Processing Rate (M.snd/s)
Run Number
5
4.5
4
3.5
3
2.5
2
1.5
1
10
20
30
40
50
60
70
80
90
100


SOUNDING COUNT
LEFT
RIGHT


SOUNDING COUNT
LEFT
RIGHT


300
250
200
150
100
50
50
100
150
200
250
300
4.5
4
3.5
3
2.5
2
1.5
1
0.5


Nominal Efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Number of Partitions


Ideal
Threads
Processes
Speedup (S = T1/Tp)
Number of Processors
1
2
3
4
5
6
7
8

Conclusions

- Most hydrographic processing can be made “embarrassingly parallel”
- Efficiency is mainly about load balancing
- Close to optimal balancing constructed through approximate data volume estimates
- Very high efficiencies are [theoretically] possible
  - Speed up is then almost linear
  - I/O, Cache, Memory Bandwidth limits will constrain
- Algorithms can be robust to node/task loss
- “Optimal” algorithm may be a hybrid
  - Multi-node (multi-processor) for load distribution
  - Multi-threaded within the node for efficient utilisation