Illinois Institute of Technology

Advanced Operating System (CS-550)

PA-1

Submitted By:

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Filenames in each peer are in the format -
1KB_<7 digit integer ranging from 0 to 500000>_peer1.txt
Or 1MB_<7 digit integer ranging from 0 to 500000>_peer1.txt
Or 1GB_<7 digit integer ranging from 0 to 500000>_peer1.bin

```
1KB_023316_peer1.txt  1KB_078873_peer1.txt  1KB_134430_peer1.txt  1KB_189987_peer1.txt  1KB_245544_peer1.txt  1KB_301101_peer1.txt  1KB_356658_peer1.txt  1KB_412215_peer1.txt  1KB_467772_peer1.txt
1KB_023317_peer1.txt  1KB_078874_peer1.txt  1KB_134431_peer1.txt  1KB_189988_peer1.txt  1KB_245545_peer1.txt  1KB_301102_peer1.txt  1KB_356659_peer1.txt  1KB_412216_peer1.txt  1KB_467773_peer1.txt
1KB_023318_peer1.txt  1KB_078875_peer1.txt  1KB_134432_peer1.txt  1KB_189989_peer1.txt  1KB_245546_peer1.txt  1KB_301103_peer1.txt  1KB_356660_peer1.txt  1KB_412217_peer1.txt  1KB_467774_peer1.txt
1KB_023319_peer1.txt  1KB_078876_peer1.txt  1KB_134433_peer1.txt  1KB_189990_peer1.txt  1KB_245547_peer1.txt  1KB_301104_peer1.txt  1KB_356661_peer1.txt  1KB_412218_peer1.txt  1KB_467775_peer1.txt
1KB_023320_peer1.txt  1KB_078877_peer1.txt  1KB_134434_peer1.txt  1KB_189991_peer1.txt  1KB_245548_peer1.txt  1KB_301105_peer1.txt  1KB_356662_peer1.txt  1KB_412219_peer1.txt  1KB_467776_peer1.txt
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1KB_023322_peer1.txt  1KB_078879_peer1.txt  1KB_134436_peer1.txt  1KB_189993_peer1.txt  1KB_245550_peer1.txt  1KB_301107_peer1.txt  1KB_356664_peer1.txt  1KB_412221_peer1.txt  1KB_467778_peer1.txt
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1KB_023324_peer1.txt  1KB_078881_peer1.txt  1KB_134438_peer1.txt  1KB_189995_peer1.txt  1KB_245552_peer1.txt  1KB_301109_peer1.txt  1KB_356666_peer1.txt  1KB_412223_peer1.txt  1KB_467780_peer1.txt
1KB_023325_peer1.txt  1KB_078882_peer1.txt  1KB_134439_peer1.txt  1KB_189996_peer1.txt  1KB_245553_peer1.txt  1KB_301110_peer1.txt  1KB_356667_peer1.txt  1KB_412224_peer1.txt  1KB_467781_peer1.txt
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1KB_023331_peer1.txt  1KB_078888_peer1.txt  1KB_134445_peer1.txt  1KB_190002_peer1.txt  1KB_245559_peer1.txt  1KB_301116_peer1.txt  1KB_356673_peer1.txt  1KB_412230_peer1.txt  1KB_467787_peer1.txt
1KB_023332_peer1.txt  1KB_078889_peer1.txt  1KB_134446_peer1.txt  1KB_190003_peer1.txt  1KB_245560_peer1.txt  1KB_301117_peer1.txt  1KB_356674_peer1.txt  1KB_412231_peer1.txt  1KB_467788_peer1.txt
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1KB_023334_peer1.txt  1KB_078891_peer1.txt  1KB_134448_peer1.txt  1KB_190005_peer1.txt  1KB_245562_peer1.txt  1KB_301119_peer1.txt  1KB_356676_peer1.txt  1KB_412233_peer1.txt  1KB_467790_peer1.txt
1KB_023335_peer1.txt  1KB_078892_peer1.txt  1KB_134449_peer1.txt  1KB_190006_peer1.txt  1KB_245563_peer1.txt  1KB_301120_peer1.txt  1KB_356677_peer1.txt  1KB_412234_peer1.txt  1KB_467791_peer1.txt
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1KB_023358_peer1.txt  1KB_078915_peer1.txt  1KB_134472_peer1.txt  1KB_190029_peer1.txt  1KB_245586_peer1.txt  1KB_301143_peer1.txt  1KB_356700_peer1.txt  1KB_412257_peer1.txt  1KB_467814_peer1.txt
1KB_023359_peer1.txt  1KB_078916_peer1.txt  1KB_134473_peer1.txt  1KB_190030_peer1.txt  1KB_245587_peer1.txt  1KB_301144_peer1.txt  1KB_356701_peer1.txt  1KB_412258_peer1.txt  1KB_467815_peer1.txt
^C
root@7d2c28f8c622:/cs550-fall2023-pa1-nbv/bin/files# du -h
12G	.
root@7d2c28f8c622:/cs550-fall2023-pa1-nbv/bin/files#
```

Register files -

```
Peer started!
[Server]: Waiting for a peer ...
[Client]: What do you want to do?
        [0] - Register
        [1] - Search a file
        [2] - Obtain a file
0
[Client]: Connected!
[Client]: Peer ID:peer1
[Client]: Updated peer files!
[Client]: What do you want to do?
        [0] - Register
        [1] - Search a file
        [2] - Obtain a file
1
```

CIS screenshot-

```
1KB_056492_peer1.txt
1KB_461688_peer1.txt
1KB_492521_peer1.txt
1KB_075774_peer1.txt
1KB_317623_peer1.txt
1KB_416917_peer1.txt
1KB_360183_peer1.txt
1KB_480946_peer1.txt
1KB_273317_peer1.txt
1KB_299009_peer1.txt
1KB_324866_peer1.txt
1KB_440553_peer1.txt
1KB_129622_peer1.txt
1KB_413501_peer1.txt
1KB_413539_peer1.txt
1KB_344764_peer1.txt
1KB_211007_peer1.txt
1KB_362162_peer1.txt
1KB_280291_peer1.txt
1KB_429237_peer1.txt
1KB_441600_peer1.txt
1KB_306787_peer1.txt
1KB_243917_peer1.txt
1KB_082592_peer1.txt
1KB_471355_peer1.txt
1KB_408880_peer1.txt
1KB_140317_peer1.txt
1KB_088106_peer1.txt
1KB_285571_peer1.txt
1KB_104620_peer1.txt
1KB_082220_peer1.txt
1KB_138795_peer1.txt
1KB_147596_peer1.txt
1KB_029247_peer1.txt
1KB_010314_peer1.txt
```

Search files

```
Peer started!
[Server]: Waiting for a peer ...
[Client]: What do you want to do?
        [0] – Register
        [1] – Search a file
        [2] – Obtain a file
1
[Client]: File name:zl.txt
[Client]: Connected!
[Client]: peer1 peer1.mynetwork
[Client]: What do you want to do?
        [0] – Register
        [1] – Search a file
        [2] – Obtain a file
1
[Client]: File name:1KB_130040_peer1.txt
[Client]: Connected!
[Client]: peer1 peer1.mynetwork
[Client]: What do you want to do?
        [0] – Register
        [1] – Search a file
        [2] – Obtain a file
1
[Client]: File name:
```

Do a weak scaling scalability study to measure search time of 10K requests per peer, on 1 node and 2 nodes. Report the average and standard deviation. Plot your data in figures graphically.

Each file request attempt time stamps are captured in the logs,
file - weak_scale_search_1_node.log
1 node: mean and standard deviation

Standard Deviation	**s = 1.178265**
Variance	s^2 = 1.3883083
Count	n = 10000
Mean	$\overline{x}$ = 5.0757
Sum of Squares	SS = 13881.695

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{13881.695}{10000-1}}$$

$$s = \sqrt{\frac{13881.695}{9999}}$$

$$s = \sqrt{1.3883083}$$

Each file request attempt time stamps are captured in the logs,
file - weak_scale_search_2_nodes.log

2 node: mean and standard deviation

Standard Deviation	**s = 2.1986762**
Variance	s^2 = 4.8341772
Count	n = 10000
Mean	$\overline{x}$ = 11.7175
Sum of Squares	SS = 48336.938

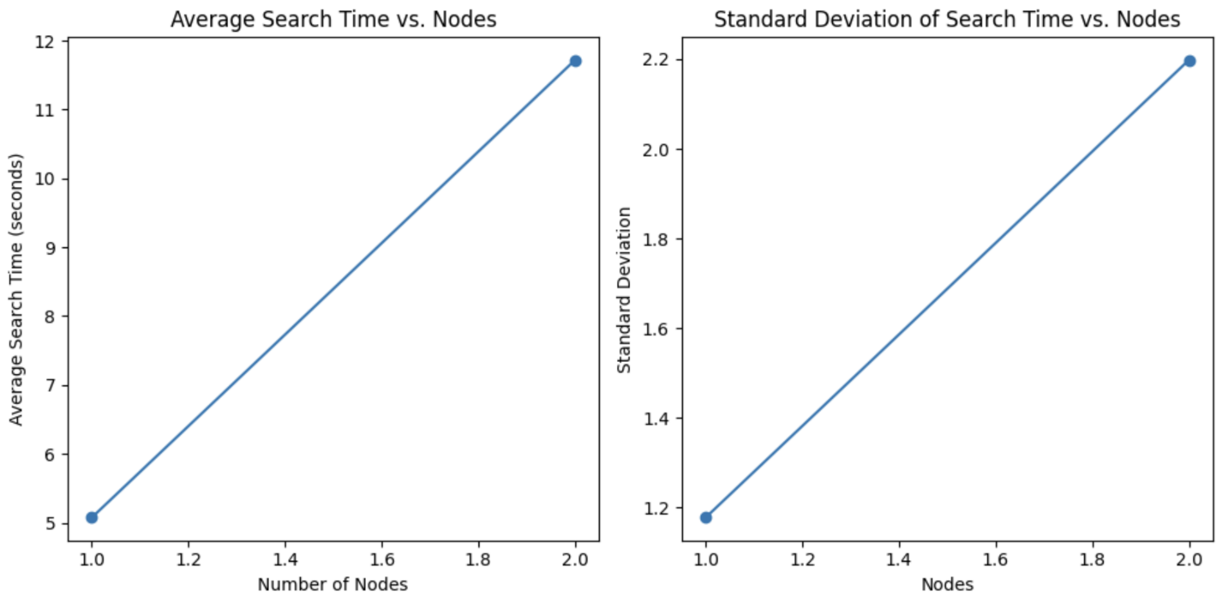
Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{48336.938}{10000-1}}$$

$$s = \sqrt{\frac{48336.938}{9999}}$$



Do a strong scaling scalability study that measures the search and transfer time of 10K small files (1KB), on 1 node and 2 nodes. Repeat the study on 1K medium files (1MB). Repeat the study on 8 large files (1GB). Report the average and standard deviation. Plot your data in figures graphically.

1 Node - Strong scale - 10K 1KB files test performed from peer2 to the files available in peer1:
Log file: strong_scale_search_1KB_node1.log

Standard Deviation	**s =**	**2.0141041**
Variance	s^2 =	4.0566154
Count	n =	10000
Mean	$\overline{x}$ =	6.8095
Sum of Squares	SS =	40562.097

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{40562.097}{10000-1}}$$

$$s = \sqrt{\frac{40562.097}{9999}}$$

1 Node - Strong scale - 1K 1MB files test performed from peer2 to the files available in peer1:
File name: strong_scale_search_1MB_node1.log

Standard Deviation	**s =**	**15.118464**
Variance	s^2 =	228.56794
Count	n =	1000
Mean	$\overline{x}$ =	30.925
Sum of Squares	SS =	228339.38

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{228339.38}{1000-1}}$$

$$s = \sqrt{\frac{228339.38}{999}}$$

$$s = \sqrt{228.56795}$$

$$s = 15.118464$$

1 Node - Strong scale - 8 1GB files test performed from peer2 to the files available in peer1:
Filename: strong_scale_search_1GB_node1.log

Standard Deviation	**s = 686.582**
Variance	s^2 = 471394.84
Count	n = 8
Mean	$\overline{x}$ = 8905.625
Sum of Squares	SS = 3299763.9

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{3299763.9}{8-1}}$$

$$s = \sqrt{\frac{3299763.9}{7}}$$

2 Nodes - Strong scale - 10K 1KB files test performed from peer2 to the files available in peer1:
Filename: strong_scale_search_1KB_nodes_2_peer1.log

Standard Deviation	**s =**	**6.8668427**
Variance	s^2 =	47.153529
Count	n =	9979
Mean	$\overline{x}$ =	18.677623
Sum of Squares	SS =	470497.91

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{470497.91}{9979-1}}$$

$$s = \sqrt{\frac{470497.91}{9978}}$$

2 Nodes - Strong scale - 10K 1KB files test performed from peer1 to the files available in peer2:
Filename: strong_scale_search_1KB_nodes_2_peer2.log

Standard Deviation	**s = 6.8915257**
Variance	s^2 = 47.493127
Count	n = 10000
Mean	$\overline{x}$ = 18.8326
Sum of Squares	SS = 474883.77

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{474883.77}{10000-1}}$$

$$s = \sqrt{\frac{474883.77}{9999}}$$

2 Nodes - Strong scale - 1K 1MB files test performed from peer1 to the files available in peer1:
Filename: strong_scale_search_1MB_nodes_2_peer1.log

Standard Deviation	**s =**	**22.437087**
Variance	s^2 =	503.42286
Count	n =	1000
Mean	$\overline{x}$ =	40.242
Sum of Squares	SS =	502919.44

Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{502919.44}{1000-1}}$$

$$s = \sqrt{\frac{502919.44}{999}}$$

2 Nodes - Strong scale - 1K 1MB files test performed from peer1 to the files available in peer2:
Filename: strong_scale_search_1MB_nodes_2_peer2.log

Standard Deviation	**s =**	**22.158029**
Variance	s^2 =	490.97825
Count	n =	1000
Mean	$\overline{x}$ =	39.223
Sum of Squares	SS =	490487.27

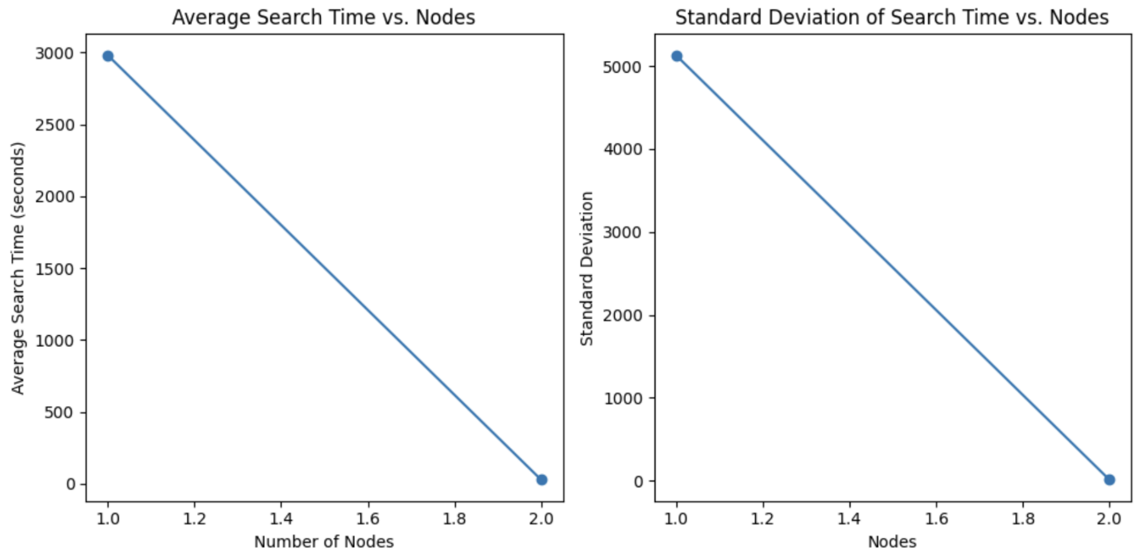
Solution

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}}$$

$$s = \sqrt{\frac{SS}{n-1}}$$

$$s = \sqrt{\frac{490487.27}{1000-1}}$$

$$s = \sqrt{\frac{490487.27}{999}}$$



Can you deduce that your P2P centralized system is scalable up to 2 nodes? Does it scale well for some file sizes, but not for others? Based on the data you have so far, what would happen if you had 1K peers with small, medium, and large files? What would happen if you had 1 billion peers?

*i)*Yes, scaling up to two nodes is doable. Scalability, however, is influenced by a variety of elements, such as the system's architecture, design, and implementation.
Every peer (node) in a typical P2P system communicates directly with every other peer on the network. As a result, if your system is designed to run on just two nodes, it can be regarded as scalable because it can effectively manage a relatively small number of nodes.

A p2p system, on the other hand, is typically designed to function with additional p2p nodes to distribute the load and give fault tolerance. Therefore, it might be a little inaccurate to refer to it as "scalable" with only 2 p2p nodes.

ii)The size of the files shared can also affect scalability. We encountered this issue while working on a P2P system. Some p2p systems work well with small files, while others struggle with larger files because of bandwidth and latency limitations.

iii)Managing 1,000 p2p connections can be very resource-intensive, and it would require powerful algorithms to exchange data efficiently.

The performance of the system would depend on the capabilities and design of the system.

Small p2p files can be widely distributed among peers, particularly if the system supports simultaneous downloading and uploading.

Larger p2p files may have issues with bandwidth, storage and latency, but medium-sized p2p files might also work well.

iv)If your P2P system is centralized, one billion peers is a sizable number of peers. You'll need to control connections, monitor your resources, and make sure your data transmission and reception processes are effective. All of this would require a significant amount of infrastructure, bandwidth, and processing power.

At such a size, centralized systems could experience congestion and single points of failure, so you might want to think about decentralization or a hybrid strategy. To effectively manage a large number of peers, you might also want to think about how centralized or decentralized your system is.