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CECS 327-02

Project 2 - A Try of P2P System

Youtube Link - https://youtu.be/PrzpqShtasg

Docker Steps

1. Create a Project Directory
   a. mkdir p2p-system && cd p2p-system
2. Write a Basic P2P Node Application
   a. Making sure that we create a unique uuid for each node
   b. Make a flask server as well to get these request for the peer to peer communication
3. Run these files together

System Design Analysis

Architecture Overview

Type: Peer-to-Peer (P2P) system
Total Nodes: 50 + 1 bootstrap node
Technology Stack:

- Python 3.9
- Flask (API framework)
- Flask-CORS (for cross-origin communication)
- Docker (container orchestration)
- Docker Compose (multi-container deployment)

Components
Bootstrap Node
Acts as the initial registry for all nodes

- Exposes endpoints to:
  - Register new nodes (`/register`)
  - List all known peers (`/peers`)
- Doesn't initiate communication — just a directory.

P2P Nodes (node1 to node50)

- Each has a unique port (`8001–8050`)
- On startup, registers itself with the bootstrap node
- Receives peer list from bootstrap
- Randomly selects a peer to send a message t

Workflow
Startup:

  - nodeX → Registers to `bootstrap` via `POST /register`
  - nodeX → Retrieves peer list from `bootstrap` via `GET /peers`
  - nodeX → Sends a `POST /message` to a random peer
2. Messaging:
  - Messages contain sender ID and custom greeting
  - Peers respond with confirmation + their hostname
3. Health Check:

- ○ Each node has `/status` endpoint
- ○ Bootstrap has `/status` and `/health`

Container Behavior

- Each container is self-contained with its own Flask app and peer registry.
- Docker Compose spins up 51 services (bootstrap + 50 nodes).
- Nodes use internal Docker DNS (e.g., node5:8050) for service discovery.

Challenges Faced

- Connecting to the nodes at first
- Making sure Flask is fully on for the nodes when sending messages
- No other challenges faced

Contributions

Joseph - Dockerfiles and part of p2pnode.py, docs for system architecture
Jayden - Completed p2pnode.py, bootstrap.py, debugging
Dominique - Video demo, screenshots and README

Screenshots

```
2025-04-10 10:56:39 node49-1  |  * Serving Flask app 'p2pnode'
2025-04-10 10:56:39 node49-1  |  * Debug mode: on
2025-04-10 10:56:39 node49-1  | WARNING: This is a development server. Do not use it in a production deployment. Use a produ
ction WSGI server instead.
2025-04-10 10:56:39 node49-1  |  * Running on all addresses (0.0.0.0)
2025-04-10 10:56:39 node49-1  |  * Running on http://127.0.0.1:8049
2025-04-10 10:56:39 node49-1  |  * Running on http://172.19.0.39:8049
2025-04-10 10:56:39 node49-1  | Press CTRL+C to quit
2025-04-10 10:56:39 node49-1  |  * Restarting with stat
2025-04-10 10:56:40 node49-1  |  * Debugger is active!
2025-04-10 10:56:40 node49-1  |  * Debugger PIN: 106-407-069
2025-04-10 10:56:40 node49-1  | 172.19.0.37 - - [10/Apr/2025 17:56:40] "GET /status HTTP/1.1" 200 -
2025-04-10 10:56:40 node49-1  | 172.19.0.37 - - [10/Apr/2025 17:56:40] "POST /message HTTP/1.1" 200 -
2025-04-10 10:56:40 node16-1  | Starting as regular node, connecting to bootstrap: http://bootstrap:8000
2025-04-10 10:56:40 node16-1  | Starting P2P node with ID: f7858e6a-6dd6-4815-8850-ddc85c6b2d47
2025-04-10 10:56:40 node16-1  | Node is running on http://localhost:8016
2025-04-10 10:56:40 node16-1  | Successfully registered with bootstrap node at http://bootstrap:8000
2025-04-10 10:56:40 node16-1  | Got 41 peers from bootstrap node
2025-04-10 10:56:40 node16-1  | This is 760ecc060a17, Sending a message to 1c90702b-4ce3-4eeb-a396-9329c7ec2ee7 at http://no
de20:8020
2025-04-10 10:56:40 node16-1  | Sending to http://node20:8020/message
2025-04-10 10:56:40 node16-1  | Got response: b'{\n  "current_node": "541af1cae258",\n  "from": "760ecc060a17",\n  "msg": "T
his is 760ecc060a17, How is your day? ",\n  "reply": "Received message from 760ecc060a17: This is 760ecc060a17, How is your
day? . This is 541af1cae258, It is a good day",\n  "status": "received"\n}\n'
2025-04-10 10:56:40 node16-1  |  * Serving Flask app 'p2pnode'
2025-04-10 10:56:40 node16-1  |  * Debug mode: on
2025-04-10 10:56:40 node16-1  | WARNING: This is a development server. Do not use it in a production deployment. Use a produ
ction WSGI server instead.
2025-04-10 10:56:40 node16-1  |  * Running on all addresses (0.0.0.0)
2025-04-10 10:56:40 node16-1  |  * Running on http://127.0.0.1:8016
2025-04-10 10:56:40 node16-1  |  * Running on http://172.19.0.28:8016
2025-04-10 10:56:40 node16-1  | Press CTRL+C to quit
2025-04-10 10:56:40 node16-1  |  * Restarting with stat
2025-04-10 10:56:40 node16-1  |  * Debugger is active!
2025-04-10 10:56:40 node16-1  |  * Debugger PIN: 910-934-866
2025-04-10 10:56:37 node2-1   | Starting as regular node, connecting to bootstrap: http://bootstrap:8000
2025-04-10 10:56:37 node2-1   | Starting P2P node with ID: a9f6649c-50e7-4603-856b-ea22e807f11c
2025-04-10 10:56:37 node2-1   | Node is running on http://localhost:8002
2025-04-10 10:56:37 node2-1   | Successfully registered with bootstrap node at http://bootstrap:8000
2025-04-10 10:56:37 node2-1   | Got 20 peers from bootstrap node
```

```
p2p-system-bootst...
  p2p-system-bootstrap
  ●
  8000:8000

p2p-system-node4...
  p2p-system-node41
  ●
  8041:8041

p2p-system-node2...
  p2p-system-node22
  ●
  8022:8022

p2p-system-node1...
  p2p-system-node14
  ●
  8014:8014

p2p-system-node9...
  p2p-system-node9
  ●
  8009:8009

p2p-system-node2...
  p2p-system-node29
  ●
  8029:8029

p2p-system-node4...
  p2p-system-node42
  ●
```

```
node41-1   | This is be934d16392e, Sending a message to c3f93e07-4e42-48f1-b971-a00bea5985ef at
http://node1:8001
node41-1   | Sending to http://node1:8001/message
node41-1   | Got response: b'{"current_node":"068f53e8f45b","from":"be934d16392e","msg":"This is
be934d16392e, How is your day? ","reply":"Received message from be934d16392e: This is be934d16392
e, How is your day? . This is 068f53e8f45b, It is a good day","status":"received"}\n'
node41-1   | This is be934d16392e, Sending a message to 67a6b167-42a2-42c1-8474-3f55c0acf75b at
http://node20:8020
node41-1   | Sending to http://node20:8020/message
node41-1   | Got response: b'{"current_node":"6d886ea19aef","from":"be934d16392e","msg":"This is
be934d16392e, How is your day? ","reply":"Received message from be934d16392e: This is be934d16392
e, How is your day? . This is 6d886ea19aef, It is a bad day","status":"received"}\n'
node17-1   |  * Running on http://172.18.0.43:8017
node17-1   | Press CTRL+C to quit
node17-1   | This is 1a0ba81758cd, Sending a message to cd286629-6a7b-4770-9801-4c570741bf2c at
http://node33:8033
node17-1   | Sending to http://node33:8033/message
node17-1   | Got response: b'{"current_node":"79ea5d2af25a","from":"1a0ba81758cd","msg":"This is
1a0ba81758cd, How is your day? ","reply":"Received message from 1a0ba81758cd: This is 1a0ba81758c
d, How is your day? . This is 79ea5d2af25a, It is a bad day","status":"received"}\n'
node17-1   | This is 1a0ba81758cd, Sending a message to 0e964ad0-97d8-4d73-ad60-7aa0a16cfe6c at
http://node6:8006
node17-1   | Sending to http://node6:8006/message
node17-1   | Got response: b'{"current_node":"9c85fb4e72c6","from":"1a0ba81758cd","msg":"This is
1a0ba81758cd, How is your day? ","reply":"Received message from 1a0ba81758cd: This is 1a0ba81758c
d, How is your day? . This is 9c85fb4e72c6, It is a bad day","status":"received"}\n'
node17-1   | This is 1a0ba81758cd, Sending a message to f976b87d-9464-4e46-80dd-6dfda185be4c at
http://node34:8034
node17-1   | Sending to http://node34:8034/message
node17-1   | Got response: b'{"current_node":"ad0fb79fc20a","from":"1a0ba81758cd","msg":"This is
1a0ba81758cd, How is your day? ","reply":"Received message from 1a0ba81758cd: This is 1a0ba81758c
d, How is your day? . This is ad0fb79fc20a, It is a bad day","status":"received"}\n'
bootstrap-1 | 172.18.0.3 - - [12/Apr/2025 05:11:43] "POST /register HTTP/1.1" 200 -
```

```
    status : received
}
jaytran@Jaydens-Air-2 p2p-system % curl -X POST http://localhost:8050/message -H "Content-Type: application/json" -d '{"sender": "Node5", "msg": "Hello Node50!, This is a test"}'
{
  "current_node": "d7c2be685020",
  "from": "Node5",
  "msg": "Hello Node50!, This is a test",
  "reply": "Received message from Node5: Hello Node50!, This is a test. This is d7c2be685020, It is a bad day",
  "status": "received"
}
jaytran@Jaydens-Air-2 p2p-system % curl -X POST http://localhost:8021/message -H "Content-Type: application/json" -d '{"sender": "Node5", "msg": "Hello Node21!, This is a test"}'
{
  "current_node": "709b04fab5b2",
  "from": "Node5",
  "msg": "Hello Node21!, This is a test",
  "reply": "Received message from Node5: Hello Node21!, This is a test. This is 709b04fab5b2, It is a good day",
  "status": "received"
}
jaytran@Jaydens-Air-2 p2p-system % curl -X POST http://localhost:8005/message -H "Content-Type: application/json" -d '{"sender": "Node21", "msg": "Hello Node5!, This is a test"}'
{
  "current_node": "2c94cea90035",
  "from": "Node21",
  "msg": "Hello Node5!, This is a test",
  "reply": "Received message from Node21: Hello Node5!, This is a test. This is 2c94cea90035, It is a good day",
  "status": "received"
}
jaytran@Jaydens-Air-2 p2p-system % curl -X POST http://localhost:8005/message -H "Content-Type: application/json" -d '{"sender": "Node21", "msg": "Hello Node5!, This is a test"}'
{"current_node":"2464fd54a177","from":"Node21","msg":"Hello Node5!, This is a test","reply":"Received message from Node21: Hello Node5!, This is a test. This is 2464fd54a177, It is a bad day","status":"received"}
jaytran@Jaydens-Air-2 p2p-system % curl -X POST http://localhost:8021/message -H "Content-Type: application/json" -d '{"sender": "Node5", "msg": "Hello Node21!, This is a test"}'
{"current_node":"3b6d5b7d2364","from":"Node5","msg":"Hello Node21!, This is a test","reply":"Received message from Node5: Hello Node21!, This is a test. This is 3b6d5b7d2364, It is a bad day","status":"received"}
jaytran@Jaydens-Air-2 p2p-system %
```

p2p-system-node14-1

⬡ 7c68c700bac2 ⌗ p2p-system-node14:latest

8014:8014 ↗

STATUS
Running (28 minutes ago)

Logs Inspect Bind mounts Exec Files Stats

```
Starting as regular node, connecting to bootstrap: http://bootstrap:8000
Starting P2P node with ID: 66076f57-0c0e-4212-84df-8730a40df469
Node is running on http://localhost:8014
Successfully registered with bootstrap node at http://bootstrap:8000
Got 28 peers from bootstrap node
 * Serving Flask app 'p2pnode'
 * Debug mode: off
This is 7c68c700bac2, Sending a message to 33358b19-d328-4cbb-9f55-eedfef78ffa3 at http://node29:8029
Sending to http://node29:8029/message
Got response: b'{"current_node":"dc1c2d80cc23","from":"7c68c700bac2","msg":"This is 7c68c700bac2, How is your day? ","reply":"Receive
d message from 7c68c700bac2: This is 7c68c700bac2, How is your day? . This is dc1c2d80cc23, It is a good day","status":"received"}\n'
This is 7c68c700bac2, Sending a message to 095d028c-7aaf-4b5e-9cb8-669c6124a299 at http://node7:8007
Sending to http://node7:8007/message
Got response: b'{"current_node":"cab809055a77","from":"7c68c700bac2","msg":"This is 7c68c700bac2, How is your day? ","reply":"Receive
d message from 7c68c700bac2: This is 7c68c700bac2, How is your day? . This is cab809055a77, It is a good day","status":"received"}\n'
This is 7c68c700bac2, Sending a message to 5f261eb4-650f-4632-b7a8-203bb68b2be4 at http://node39:8039
Sending to http://node39:8039/message
Got response: b'{"current_node":"32fbf7cb0bf9","from":"7c68c700bac2","msg":"This is 7c68c700bac2, How is your day? ","reply":"Receive
d message from 7c68c700bac2: This is 7c68c700bac2, How is your day? . This is 32fbf7cb0bf9, It is a bad day","status":"received"}\n'
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
```

localhost:8000/peers

Pretty-print ☑

```
{
  "peers": {
    "00b0f056-5fd2-4e81-bc64-a07edfa0d4e7": "http://node43:8043",
    "00bbf8d0-de94-4625-81c7-7ce2db603c9a": "http://node2:8002",
    "064cf0e6-9b85-44a7-ba15-765c0acd8e9e": "http://node21:8021",
    "095d028c-7aaf-4b5e-9cb8-669c6124a299": "http://node7:8007",
    "0a29de35-6f7a-4d14-8b85-05e4144287ef": "http://node46:8046",
    "0e964ad0-97d8-4d73-ad60-7aa0a16cfe6c": "http://node6:8006",
    "0f23b492-4eec-4425-b51f-9867b2c7e3b6": "http://node18:8018",
    "169ff50c-57ab-410c-8994-bde3848f12c2": "http://node5:8005",
    "1ad58e36-bd41-4ab5-8021-9dcc9638c5a8": "http://node48:8048",
    "1b01778d-775b-4d1b-9104-9c30f0eeb6a4": "http://node11:8011",
    "1ff833bc-942b-4fdc-806f-90e611f58239": "http://node44:8044",
    "31145d2c-4301-450b-a887-7eae0af2f6f9": "http://node45:8045",
    "329248af-5b8f-4339-a178-f983ff57e2f6": "http://node36:8036",
    "33358b19-d328-4cbb-9f55-eedfef78ffa3": "http://node29:8029",
    "354f48d4-3c03-41fd-98d7-33b192575c9a": "http://node37:8037",
    "37796a04-96ce-4fa4-bb09-0cbf4d0e34ab": "http://node27:8027",
    "3cb9a233-6b31-42fc-a7c5-0c75885e4a99": "http://node19:8019",
    "5f261eb4-650f-4632-b7a8-203bb68b2be4": "http://node39:8039",
    "602398f4-a7f1-4eae-9bfb-ec4389d1e515": "http://node24:8024",
    "62ff17d4-0380-43a8-b910-7b3659d96307": "http://node41:8041",
    "6591bc68-6044-48c6-b77c-1714a48da2e6": "http://node9:8009",
    "66076f57-0c0e-4212-84df-8730a40df469": "http://node14:8014",
    "67a6b167-42a2-42c1-8474-3f55c0acf75b": "http://node20:8020",
    "69975ad5-7581-4ac3-b779-ede9cd4b2492": "http://node50:8050",
    "76e4d5e2-8350-47fb-acd4-f4441ee55c5d": "http://node10:8010",
    "784cb0d8-2753-46e0-b32c-e6adce4e10b9": "http://node31:8031",
    "8231adff-ed0e-479e-b92a-395061cbc9aa": "http://node15:8015",
    "8363c565-880e-4949-8885-41bfb4096014": "http://node25:8025",
    "922a36c8-f416-4938-bb7c-c67e3f5b2866": "http://node8:8008",
    "9aefb0e3-7799-4d8f-860c-794bdc06fbe7": "http://node22:8022",
    "a1511b29-a882-43bb-9f72-2f4965b6bab7": "http://node23:8023",
    "a5b75335-65aa-4f63-9c7d-de697d4b9eff": "http://node3:8003",
    "a9b6adab-79e3-4808-8ef2-368e50f999f8": "http://node12:8012",
    "acdf0f89-7d67-49b5-8549-f1c293cba152": "http://node28:8028",
    "ae458429-3fef-44ad-b05a-eb90fc02fd6a": "http://node35:8035",
    "b053f9cf-8b34-4cbc-951b-fa9468e5efd2": "http://node47:8047",
    "b78e5ad5-79a3-4f4d-b42c-219c8351e2f0": "http://node32:8032",
    "c3f93e07-4e42-48f1-b971-a00bea5985ef": "http://node1:8001",
    "c9c9b4f9-f6cf-4b05-b33b-e29baaa256fe": "http://node4:8004",
    "ccb71a18-beb6-4001-b805-261a8c08f34c": "http://node17:8017",
    "cd286629-6a7b-4770-9801-4c570741bf2c": "http://node33:8033",
    "d7f2e21d-5451-49da-aa81-3571bdaec36d": "http://node40:8040",
    "dd067db5-7ff9-4eff-a662-541d41b0dc33": "http://node42:8042",
    "ddb519d4-3b3c-446d-9bce-623d3320143c": "http://node49:8049",
    "e6bcb4ee-9961-4c69-b1a2-ed4f51e00ea4": "http://node26:8026",
    "e6d5f949-7aff-4c56-bf98-7f22ca782bc8": "http://node16:8016",
    "e937a109-b3a6-4083-aa5c-e3e64bf7bb42": "http://node13:8013",
    "f652003c-8934-4c04-980b-8512af36e4ec": "http://node38:8038",
    "f976b87d-9464-4e46-80dd-6dfda185be4c": "http://node34:8034",
    "fd827490-d310-40eb-bf0c-6ffe98ab661c": "http://node30:8030"
```

localhost:8014

Pretty-print ☑

```
{
  "message": "Node 66076f57-0c0e-4212-84df-8730a40df469 is running!"
}
```

localhost:8014/peers

Pretty-print ☑

```
{
  "peers": {
    "00bbf8d0-de94-4625-81c7-7ce2db603c9a": "http://node2:8002",
    "064cf0e6-9b85-44a7-ba15-765c0acd8e9e": "http://node21:8021",
    "095d028c-7aaf-4b5e-9cb8-669c6124a299": "http://node7:8007",
    "0e964ad0-97d8-4d73-ad60-7aa0a16cfe6c": "http://node6:8006",
    "1ad58e36-bd41-4ab5-8021-9dcc9638c5a8": "http://node48:8048",
    "1ff833bc-942b-4fdc-806f-90e611f58239": "http://node44:8044",
    "329248af-5b8f-4339-a178-f983ff57e2f6": "http://node36:8036",
    "33358b19-d328-4cbb-9f55-eedfef78ffa3": "http://node29:8029",
    "354f48d4-3c03-41fd-98d7-33b192575c9a": "http://node37:8037",
    "37796a04-96ce-4fa4-bb09-0cbf4d0e34ab": "http://node27:8027",
    "3cb9a233-6b31-42fc-a7c5-0c75885e4a99": "http://node19:8019",
    "5f261eb4-650f-4632-b7a8-203bb68b2be4": "http://node39:8039",
    "602398f4-a7f1-4eae-9bfb-ec4389d1e515": "http://node24:8024",
    "6591bc68-6044-48c6-b77c-1714a48da2e6": "http://node9:8009",
    "784cb0d8-2753-46e0-b32c-e6adce4e10b9": "http://node31:8031",
    "922a36c8-f416-4938-bb7c-c67e3f5b2866": "http://node8:8008",
    "9aefb0e3-7799-4d8f-860c-794bdc06fbe7": "http://node22:8022",
    "a5b75335-65aa-4f63-9c7d-de697d4b9eff": "http://node3:8003",
    "a9b6adab-79e3-4808-8ef2-368e50f999f8": "http://node12:8012",
    "acdf0f89-7d67-49b5-8549-f1c293cba152": "http://node28:8028",
    "ae458429-3fef-44ad-b05a-eb90fc02fd6a": "http://node35:8035",
    "b053f9cf-8b34-4cbc-951b-fa9468e5efd2": "http://node47:8047",
    "dd067db5-7ff9-4eff-a662-541d41b0dc33": "http://node42:8042",
    "e6bcb4ee-9961-4c69-b1a2-ed4f51e00ea4": "http://node26:8026",
    "e937a109-b3a6-4083-aa5c-e3e64bf7bb42": "http://node13:8013",
    "f652003c-8934-4c04-980b-8512af36e4ec": "http://node38:8038",
    "f976b87d-9464-4e46-80dd-6dfda185be4c": "http://node34:8034"
  }
}
```