Problem

NDCTrack

Connect. Detect. Prevent

The Neighbourhood
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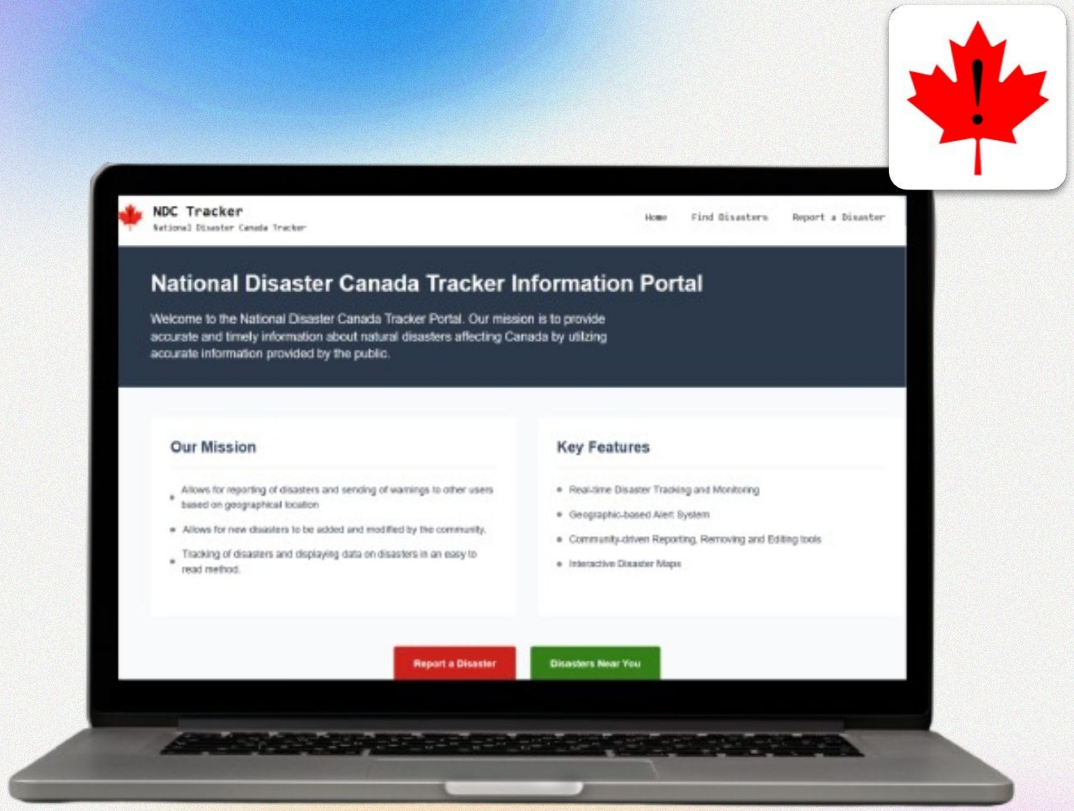
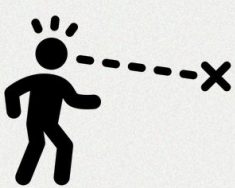


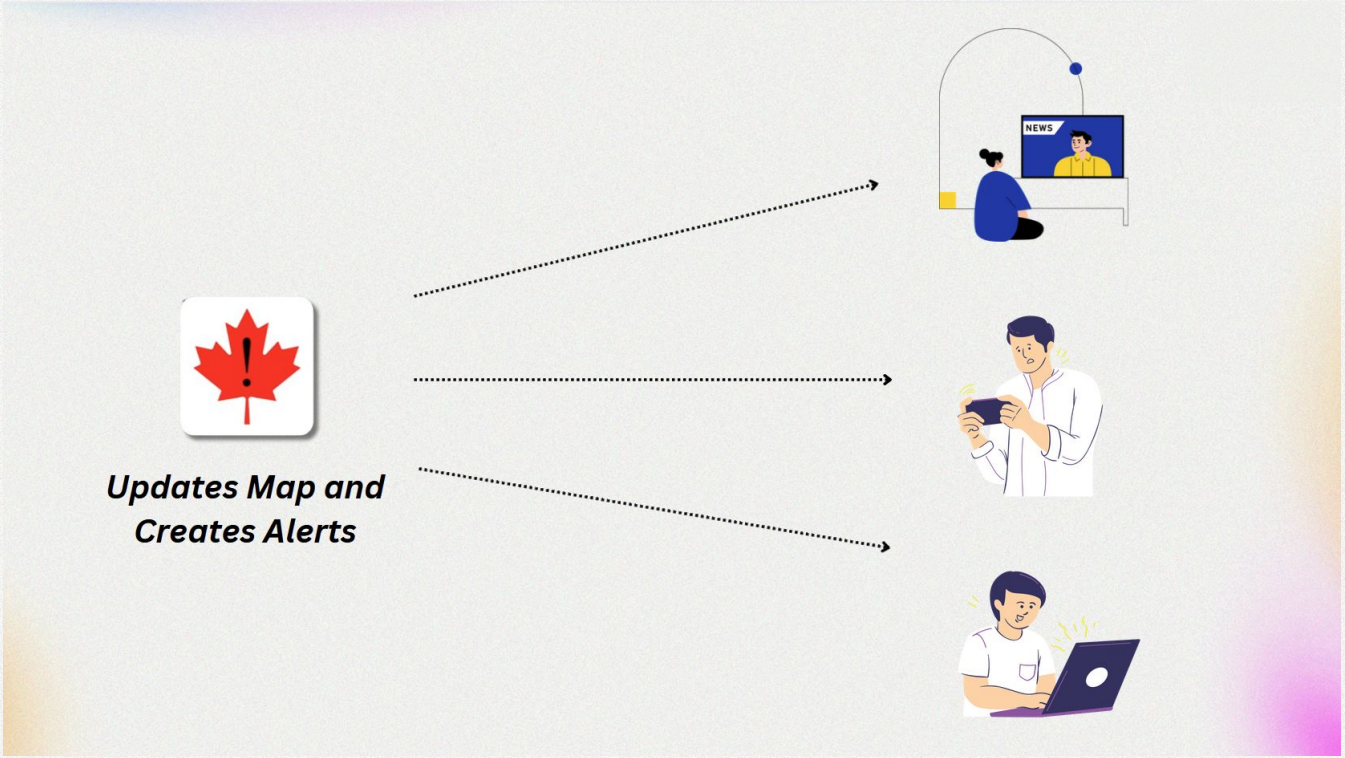
How NDCtrack Works



Bystander: I spot a disaster!

Register Report on NDCtrack

How NDCtrack Works



Demo Time!

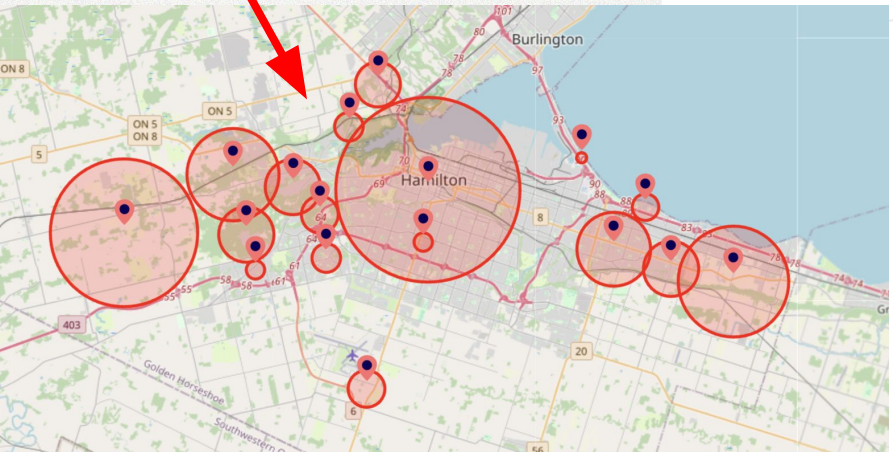
Front End Overview

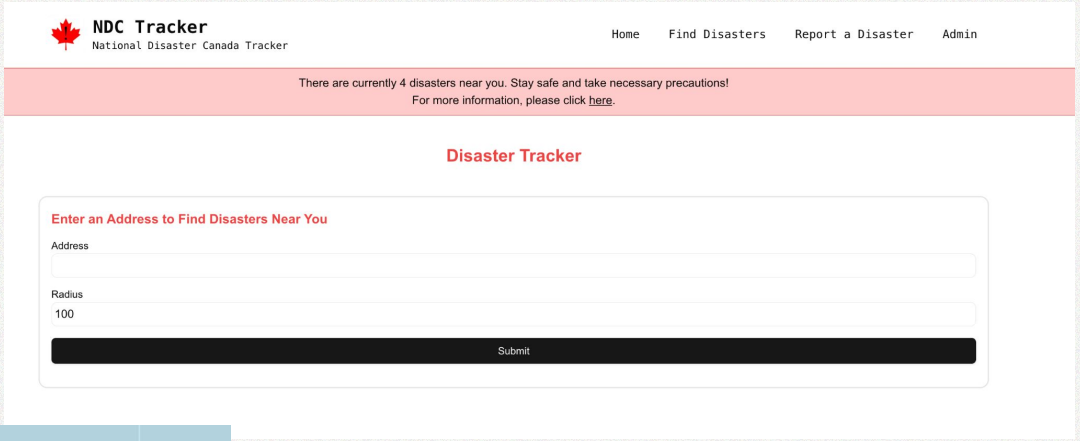
4 Potential User Routes

Home Screen Page

Find Disasters Page

Disasters have an area of effect





Found Disasters:

Earthquake
Major earthquake!!!
Disaster Type: natural
Radius: 50.0 km
Longitude: -118.2437
Latitude: 34.0522

Oil leak
Hazardous oil spill requiring containment
Disaster Type: manmade
Radius: 3.0 km
Longitude: -79.77373983912754
Latitude: 43.26691127633942

Tornado
Severe windstorm causing widespread damage
Disaster Type: natural
Radius: 50.0 km
Longitude: -79.87690025166192
Latitude: 43.251335599504124

Transportation accident
Major vehicle collision incident
Disaster Type: manmade
Radius: 10.0 km
Longitude: -79.91809897193221
Latitude: 43.15423471652471

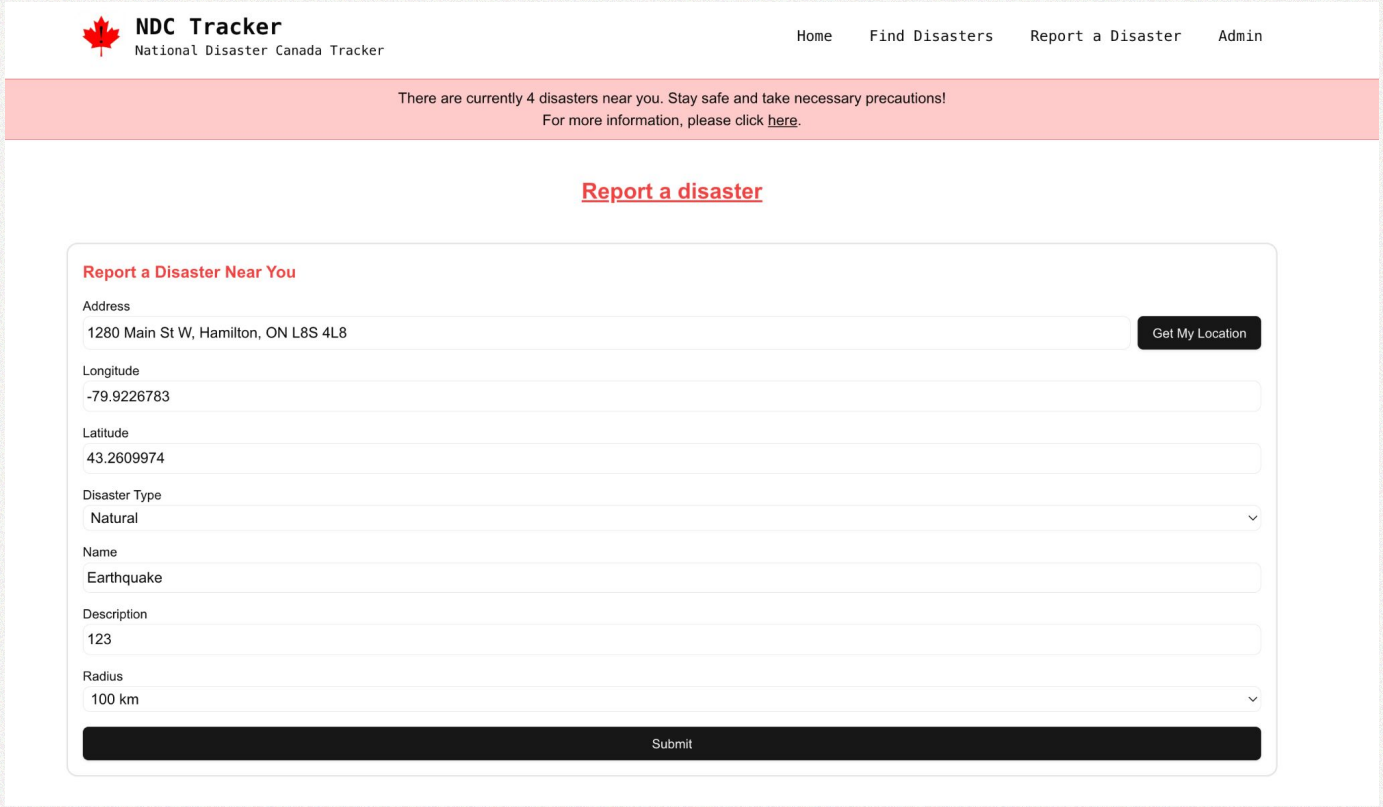
Landslide
Ground movement causing terrain instability
Disaster Type: natural
Radius: 5.0 km
Longitude: -79.88004385453455
Latitude: 43.22583209403948

Food contamination crisis
Widespread food supply contamination
Disaster Type: biological
Radius: 40.0 km
Longitude: -80.08083395630251
Latitude: 43.23032686621058

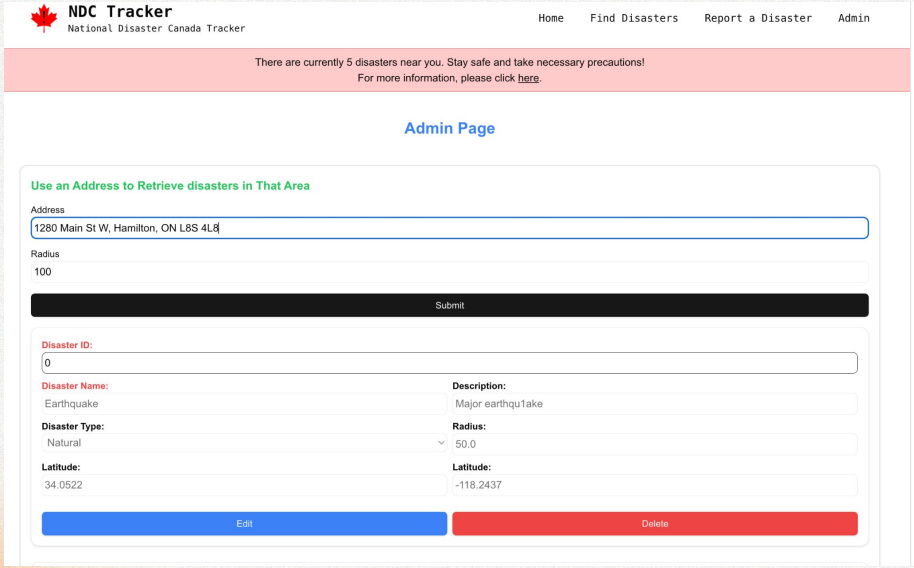
Forest Fire
Rapidly spreading wildfire threatening residential areas
Disaster Type: natural
Radius: 25.0 km
Longitude: -80.00769185869119
Latitude: 43.258683067646025

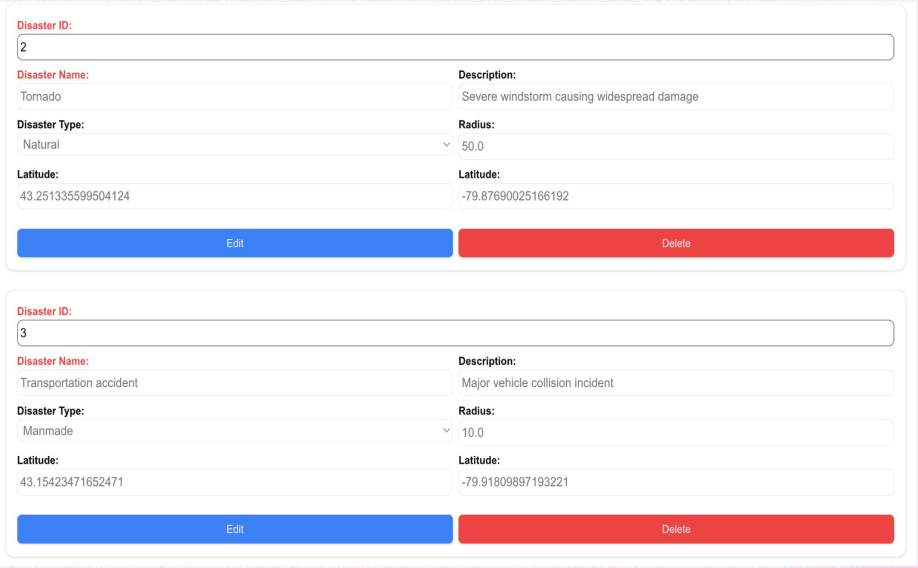
Viral Outbreak
Local outbreak of infectious disease requiring containment
Disaster Type: biological
Radius: 15.0 km
Longitude: -79.96753215231814
Latitude: 43.25268069481346

Report a Disaster Page



Admin Page


NDC Tracker
National Disaster Canada Tracker
Home
Find Disasters
Report a Disaster
Admin
There are currently 5 disasters near you. Stay safe and take necessary precautions!
For more information, please click here.
Admin Page
Use an Address to Retrieve disasters in That Area
Address
1280 Main St W, Hamilton, ON L8S 4L8
Radius
100
Submit
Disaster ID:
0
Disaster Name:
Earthquake
Description:
Major earthqu1ake
Disaster Type:
Natural
Radius:
50.0
Latitude:
34.0522
Latitude:
-118.2437
Edit
Delete


Disaster ID:
2
Disaster Name:
Tornado
Description:
Severe windstorm causing widespread damage
Disaster Type:
Natural
Radius:
50.0
Latitude:
43.251335599504124
Latitude:
-79.87690025166192
Edit
Delete
Disaster ID:
3
Disaster Name:
Transportation accident
Description:
Major vehicle collision incident
Disaster Type:
Manmade
Radius:
10.0
Latitude:
43.15423471652471
Latitude:
-79.91809897193221
Edit
Delete

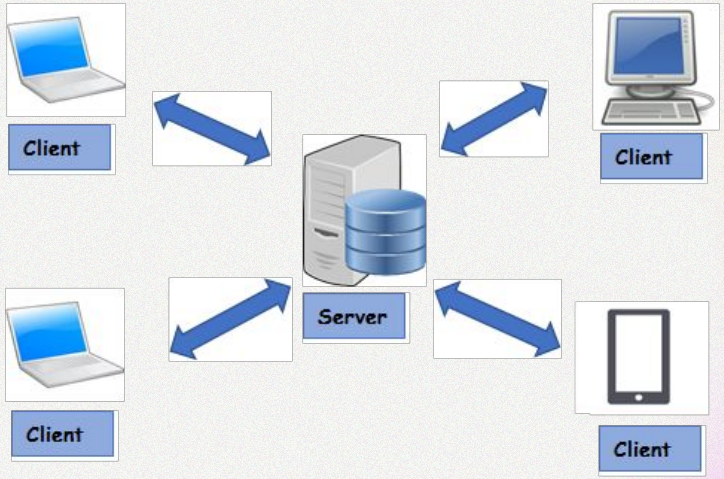
Backend Overview

How We Achieved a
Scalable Distributed Architecture

What We DIDN’T do

Centralized Client/Server Architecture

- One server cannot keep up with large load
- Not horizontally scalable
- Inefficient in handling large volumes
- Not extendable and not adaptable

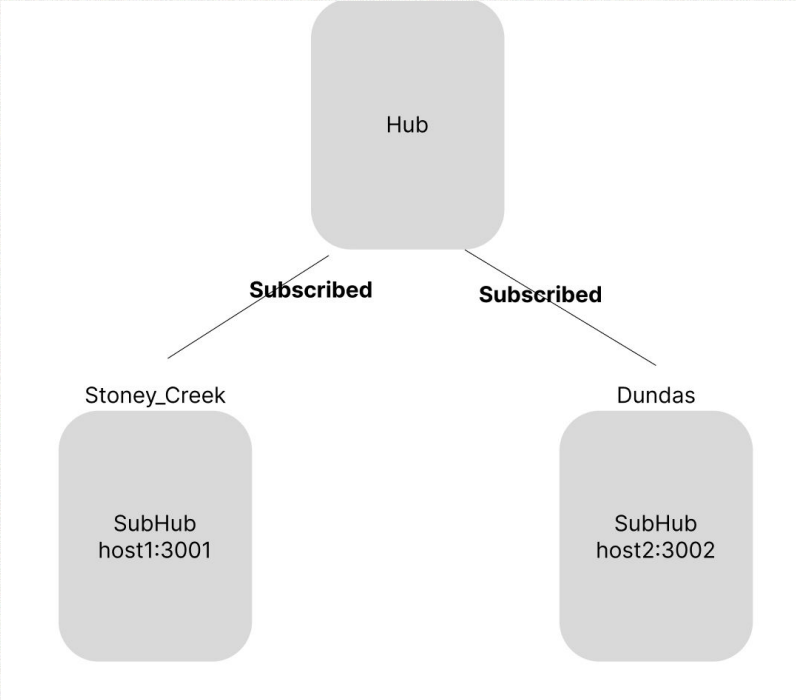


Hubs and SubHubs

Hub - Primary Hub, a server that SubHubs can subscribe to, like DNS

SubHub - A decentralized microservice that local users can view and report disasters to.

- Disasters that happen locally will only cause traffic to the SubHub of that region
- Distributed architecture scales horizontally



hub.py & subhub.py

Dynamic Input and Flexible Command Line Tools

```
➜  backend git:(main) ✗ python3 hub.py -h
usage: Hub [-h] [--host HOST] [--port PORT]

Run a hub instance that users can report to

options:
  -h, --help   show this help message and exit
  --host HOST  The host to run the hub on
  --port PORT  The port to run the hub on
```

hub.py - primary hub

Run an API that:

1. Holds records of sub hubs
2. Registers new sub hubs that subscribe to this hub
3. Refers callers to sub hubs within their location & radius

```
➜  backend git:(main) ✗ python3 subhub.py -h
usage: Sub Hub [-h] [--hub-host HUB_HOST] [--hub-port HUB_PORT] [--ip IP] [--host HOST] [--por
               [--existing-disasters EXISTING_DISASTERS]

Run a sub hub instance that users can report to

options:
  -h, --help            show this help message and exit
  --hub-host HUB_HOST   The host of the primary hub
  --hub-port HUB_PORT   The port of the primary hub
  --ip IP               The ip of the sub hub that can be accessible and seen by the primary h
  --host HOST           The host to run the sub hub Flask API on
  --port PORT           The port to run the sub hub Flask on
  --id ID               The id of the sub hub
  --name NAME           The name of the sub hub
  --longitude LONGITUDE
                        The longitude of the sub hub
  --latitude LATITUDE   The latitude of the sub hub
  --radius_km RADIUS_KM
                        The radius of the sub hub in kilometers
  --existing-disasters EXISTING_DISASTERS
                        The path to a CSV file containing existing disasters
```

subhub.py - secondary hub

Run a secondary API that lets users:

1. Add, edit, and remove disasters
2. Search for disasters in their area
3. Persist disasters in CSVs

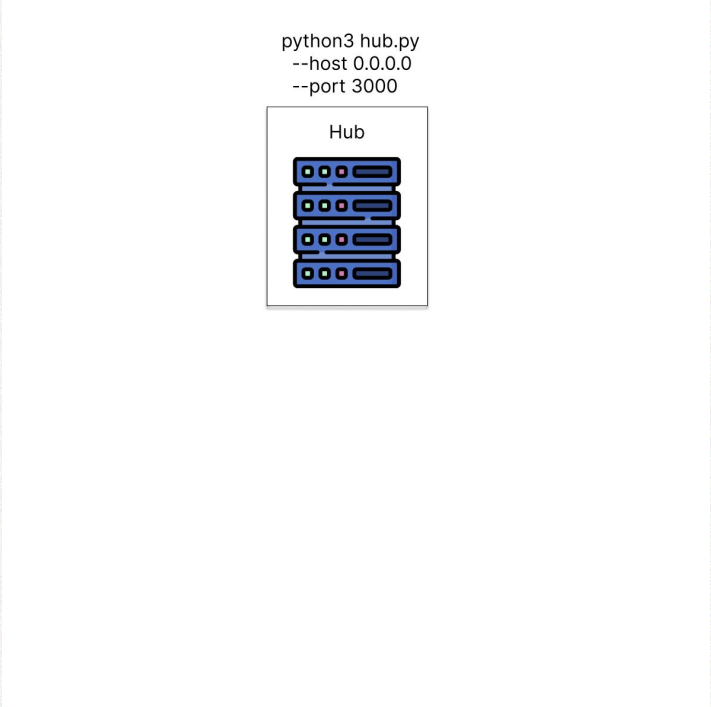
Distributed Architecture Walkthrough

1) Start the hub using the provided entry point

```
python3 hub.py
  --host 0.0.0.0
  --port 3000
```

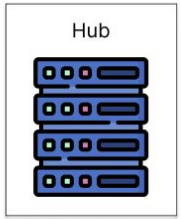
Distributed Architecture

2) A Hub is spawned, now SubHubs can subscribe



Distributed Architecture

3) SubHubs can spawn using **python3 subhub.py <args>**



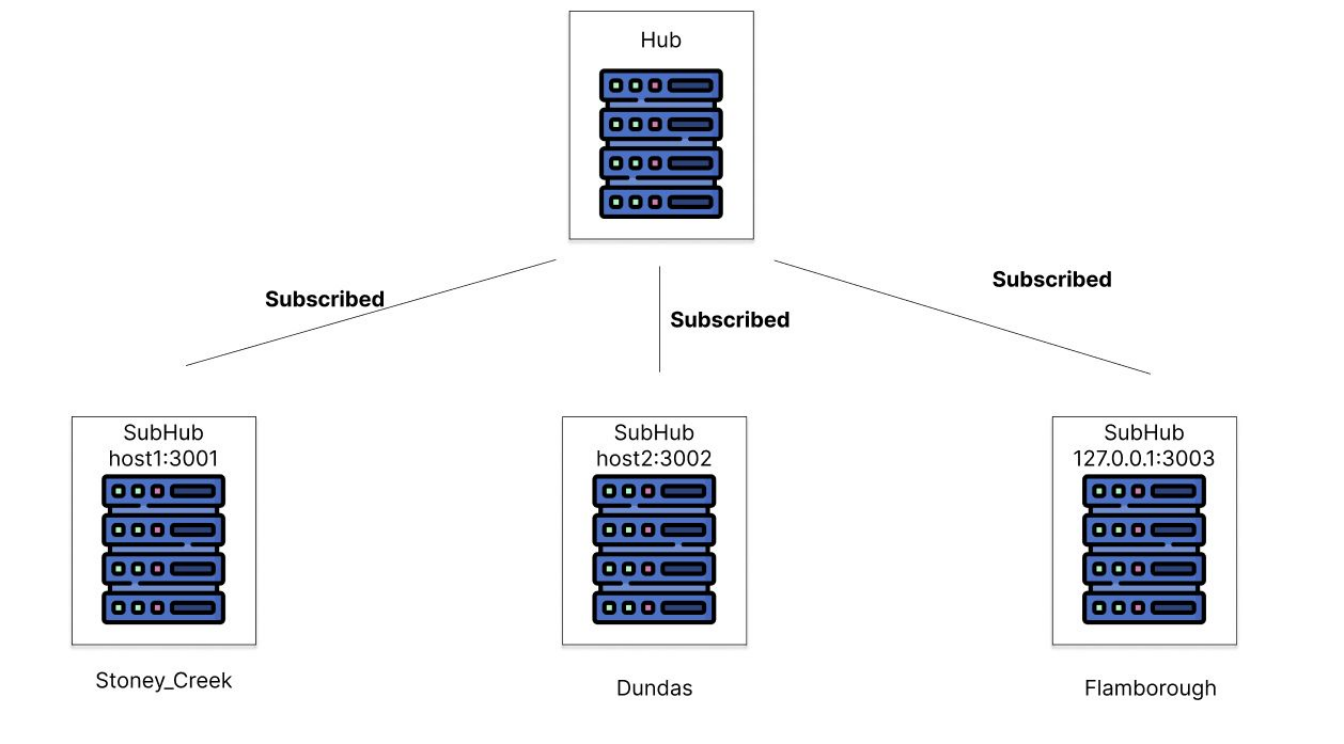

```
python3 subhub.py
  --hub-host 127.0.0.1
  --hub-port 3000
  --ip 40.233.92.183
  --host 0.0.0.0
  --port 3001
  --id 2
  --name Dundas
  --longitude 43.26691127633942
  --latitude -79.77373983912754
  --radius_km 3
  --existing-disasters ./Dundas/Dundas.csv
```

```
python3 subhub.py
  --hub-host 127.0.0.1
  --hub-port 3000
  --ip 40.233.92.183
  --host 0.0.0.0
  --port 3002
  --id 3
  --name Ancaster
  --longitude 43.251335599504124
  --latitude -79.87690025166192
  --radius_km 50
  --existing-disasters ./Ancaster/Ancaster.csv
```

```
python3 subhub.py
  --hub-host 127.0.0.1
  --hub-port 3000
  --ip 40.233.92.183
  --host 0.0.0.0
  --port 3003
  --id 4
  --name Stoney_Creek
  --longitude 43.15423471652471
  --latitude -79.91809897193221
  --radius_km 10
  --existing-disasters ./Stoney_Creek/Stoney_Creek.csv'
```

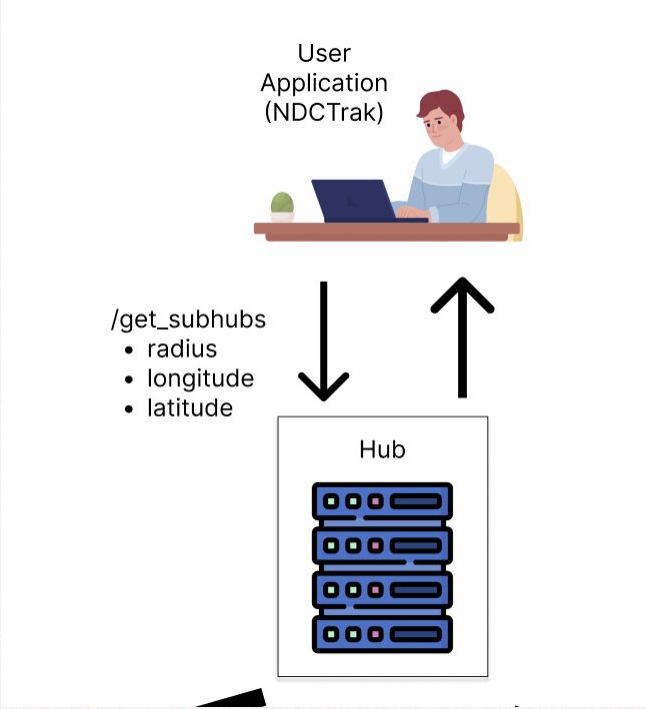
Distributed Architecture

4) Now SubHubs are subscribed to the Hub and discoverable by users



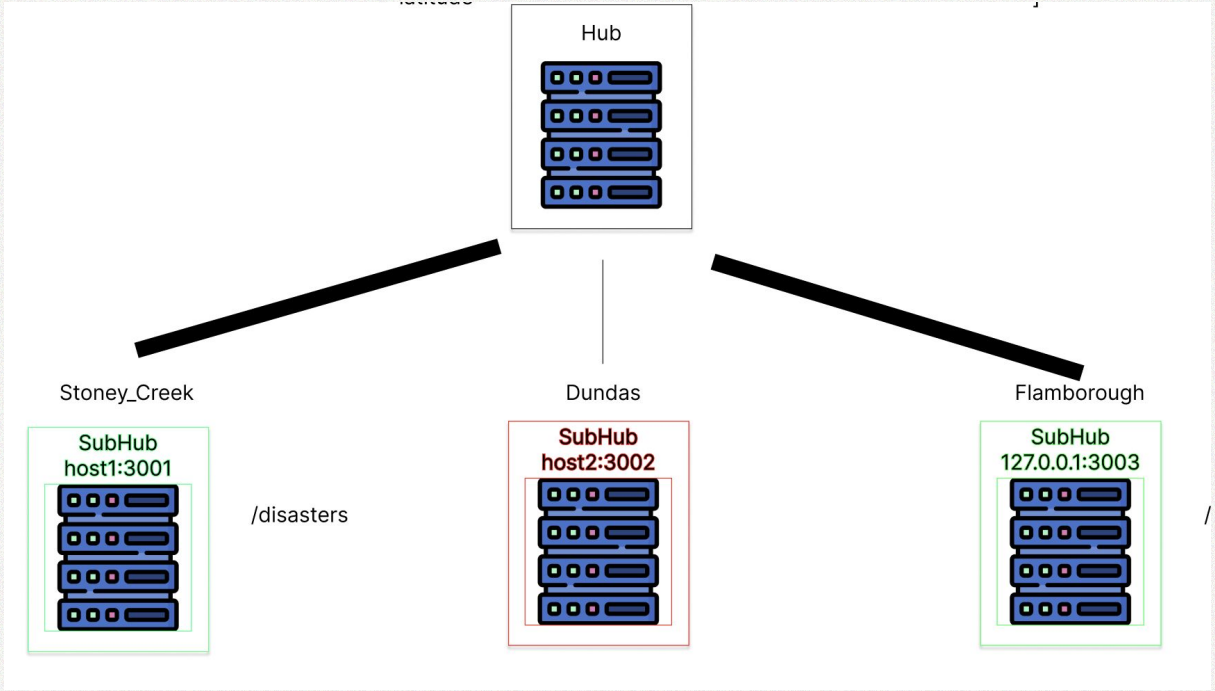
Distributed Architecture

5) A User wants to find disasters near them



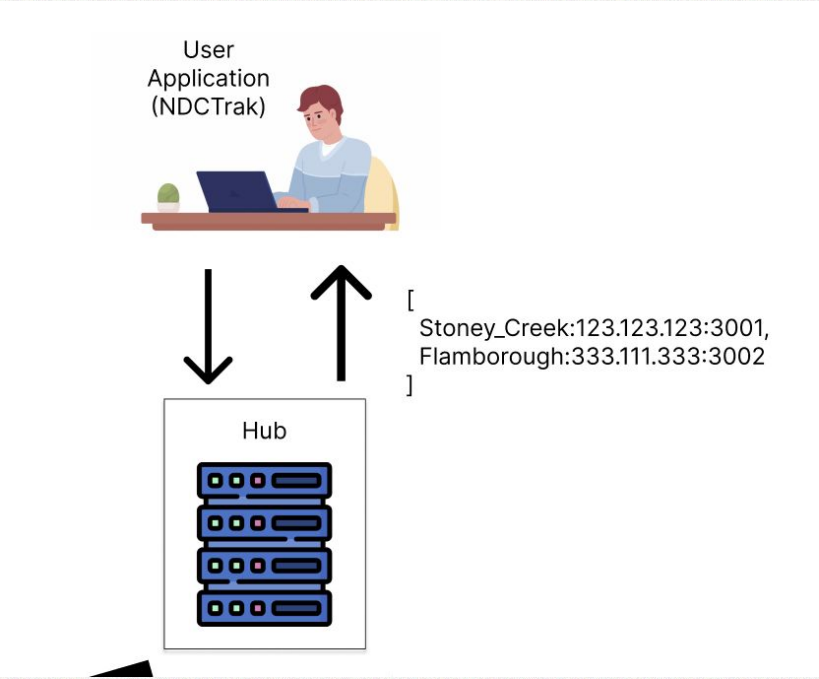
Distributed Architecture

6) Hub finds the SubHubs that are within their radius



Distributed Architecture

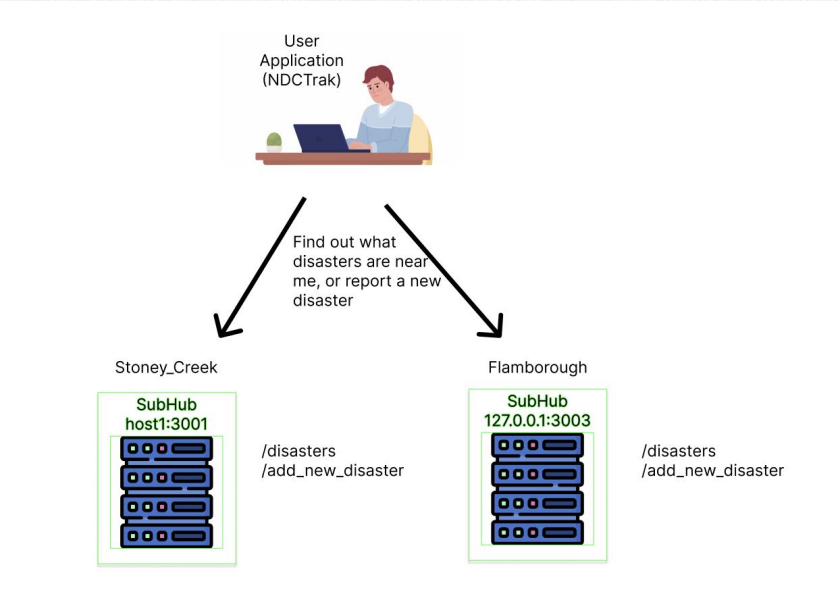
7) User Application finds the Host and Ports of how to reach the SubHubs across the network (host:port)



Distributed Architecture

8) User Application can now DIRECTLY talk to SubHub microservices

1. Report Disasters
2. View Disasters in the Area



Backend
Extensibility and Adaptability

Data Model

To enhance extensibility, OOP and Factory Design principles were used:

1 Abstract Class - Disaster

3 Subclasses - DisasterNatural, DisasterBiological, DisasterManMade

1 Factory Class - DisasterFactory

```python
class DisasterNatural(Disaster):
    def __init__(self, disaster_id, disaster_type, name, description, longitude, latitude, radius_km):
        super().__init__(disaster_id, disaster_type, name, description, longitude, latitude, radius_km)
        self.severity = None
        self.affected_species = None

    def set_severity(self, severity):
        self.severity = severity

    def set_affected_species(self, affected_species):
        self.affected_species = affected_species


class DisasterBiological(Disaster):
    def __init__(self, disaster_id, disaster_type, name, description, longitude, latitude, radius_km):
        super().__init__(disaster_id, disaster_type, name, description, longitude, latitude, radius_km)
        self.pathogen = None
        self.transmission_rate = None

    def set_pathogen(self, pathogen):
        self.pathogen = pathogen

    def set_transmission_rate(self, transmission_rate):
        self.transmission_rate = transmission_rate


class DisasterManMade(Disaster):
    def __init__(self, disaster_id, disaster_type, name, description, longitude, latitude, radius_km):
        super().__init__(disaster_id, disaster_type, name, description, longitude, latitude, radius_km)
        self.cause = None
        self.economic_impact = None

    def set_cause(self, cause):
```

```python
class DisasterFactory():
    def create_disaster(self, disaster_id, disaster_type, name, description, longitude, latitude, radius_km):
        if disaster_type == 'natural':
            return DisasterNatural(disaster_id, disaster_type, name, description, longitude, latitude, radius_km)
        elif disaster_type == 'biological':
            return DisasterBiological(disaster_id, disaster_type, name, description, longitude, latitude, radius_k
        elif disaster_type == 'manmade':
            return DisasterManMade(disaster_id, disaster_type, name, description, longitude, latitude, radius_km)
        else:
            raise ValueError(f"Invalid disaster type: {disaster_type}. Valid types are: {valid_disaster_types}")
```

```python
class Disaster():
    def __init__(self, disaster_id, disaster_type, name, description, longitude, latitude, radius_km):
        self.disaster_id = disaster_id
        self.disaster_type = disaster_type
        self.name = name
        self.description = description
        self.longitude = longitude
        self.latitude = latitude
        self.radius_km = radius_km

    def to_dict(self):
        return {
            'disaster_id': self.disaster_id,
            'disaster_type': self.disaster_type,
            'name': self.name,
            'description': self.description,
            'longitude': self.longitude,
            'latitude': self.latitude,
            'radius_km': self.radius_km
        }
```

Bash Script + TMUX

backend > up.sh

```
#!/bin/bash

# start up tmux sessions with these commands

# python3 hub.py --host 0.0.0.0 --port 3000

# python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3001 --id 0 --name Hamitlon --longitude 43.26691127633942 --latitude -79.77373983912754 --radius_km 1183.31

# python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3002 --id 1 --name Burlington --longitude 43.3255 --latitude 79.7990 --radius_km 1183.31

tmux kill-ses -t hub
tmux kill-ses -t subhub0
tmux kill-ses -t subhub1
tmux kill-ses -t subhub2
tmux kill-ses -t subhub3
tmux kill-ses -t subhub4

tmux new-session -d -s hub 'python3 hub.py --host 0.0.0.0 --port 3000'

sleep 1

tmux new-session -d -s subhub0 'python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3001 --id 2 --name Dundas --longitude 43.26691127633942 --latitude -79.77373983912754 --radius_km 3 --existing-disasters ./Dundas/Dundas.csv'

tmux new-session -d -s subhub1 'python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3002 --id 3 --name Ancaster --longitude 43.251335599504124 --latitude -79.87690025166192 --radius_km 50 --existing-disasters ./Ancaster/Ancaster.csv'

tmux new-session -d -s subhub2 'python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3003 --id 4 --name Stoney_Creek --longitude 43.15423471652471 --latitude -79.91809897193221 --radius_km 10 --existing-disasters ./Stoney_Creek/Stoney_Creek.csv'

tmux new-session -d -s subhub3 'python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3004 --id 5 --name Hamilton_Mountain --longitude 43.22583209403948 --latitude -79.88004385453455 --radius_km 5 --existing-disasters ./Hamilton_Mountain/Hamilton_Mountain.csv'

tmux new-session -d -s subhub4 'python3 subhub.py --hub-host 127.0.0.1 --hub-port 3000 --ip 40.233.92.183 --host 0.0.0.0 --port 3005 --id 6 --name Flamborough --longitude 43.23032686621058 --latitude -80.08083395630251 --radius_km 40 --existing-disasters ./Flamborough/Flamborough.csv'
```

Dockerfiles

backend > docker > hub > Dockerfile

```dockerfile
# This Dockerfile sets up a Python 3.8 environment for running a Python application.
# It installs the required dependencies from requirements.txt and sets up the working directory.
# The application is configured to run with customizable host and port arguments.
# Example of how to build and run this container:
# 1. Build the Docker image:
#    docker build -t hub .
# 2. Run the Docker container:
#    docker run -p 3000:3000 hub
FROM python:3.8

WORKDIR /app

COPY requirements.txt .

RUN pip install -r requirements.txt

COPY . .

ARG HOST=0.0.0.0
ARG PORT=3000

ENV HOST=${HOST}
ENV PORT=${PORT}

CMD ["python3", "hub.py", "--host", "${HOST}", "--port", "${PORT}"]
```

backend > docker > subhub > Dockerfile

```dockerfile
COPY requirements.txt .

RUN pip install -r requirements.txt

COPY . .

# Set default values for the arguments
ARG HUB_HOST=127.0.0.1
ARG HUB_PORT=3000
ARG IP=40.233.92.183
ARG HOST=0.0.0.0
ARG PORT=3001
ARG ID=2
ARG NAME=Dundas
ARG LONGITUDE=43.26691127633942
ARG LATITUDE=-79.77373983912754
ARG RADIUS_KM=3
ARG EXISTING_DISASTERS=./Dundas/Dundas.csv

# Set environment variables based on the arguments
ENV HUB_HOST=${HUB_HOST}
ENV HUB_PORT=${HUB_PORT}
ENV IP=${IP}
ENV HOST=${HOST}
ENV PORT=${PORT}
ENV ID=${ID}
ENV NAME=${NAME}
ENV LONGITUDE=${LONGITUDE}
ENV LATITUDE=${LATITUDE}
ENV RADIUS_KM=${RADIUS_KM}
ENV EXISTING_DISASTERS=${EXISTING_DISASTERS}

CMD ["python3", "subhub.py", "--hub-host", "${HUB_HOST}", "--hub-port", "${HUB_PORT}", "--ip", "${IP}", "--host", "${HOST}", "--port", "${PORT}", "--id", "${ID}
", "--name", "${NAME}", "--longitude", "${LONGITUDE}", "--latitude", "${LATITUDE}", "--radius_km", "${RADIUS_KM}", "--existing-disasters", "$
{EXISTING_DISASTERS}"]
```

Dynamic Input

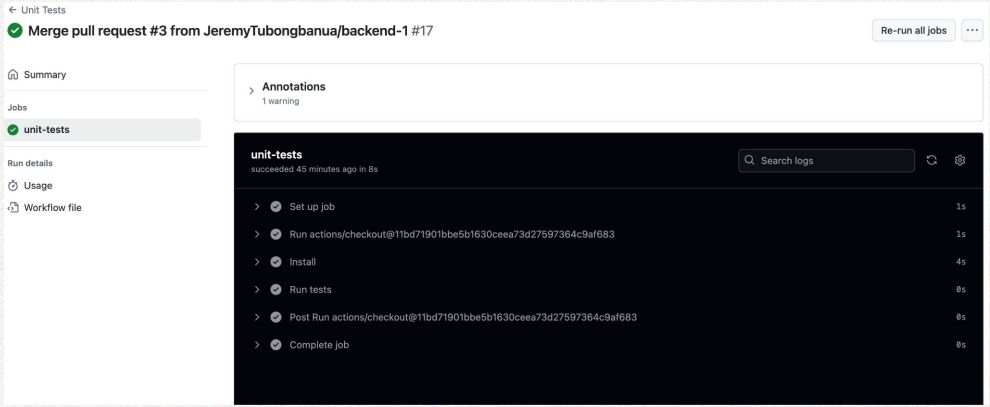
```
➜  backend git:(main) ✗ python3 hub.py -h
usage: Hub [-h] [--host HOST] [--port PORT]

Run a hub instance that users can report to

options:
  -h, --help   show this help message and exit
  --host HOST  The host to run the hub on
  --port PORT  The port to run the hub on
```

```
➜  backend git:(main) ✗ python3 subhub.py -h
usage: Sub Hub [-h] [--hub-host HUB_HOST] [--hub-port HUB_PORT] [--ip IP] [--host HOST] [--por
               [--existing-disasters EXISTING_DISASTERS]

Run a sub hub instance that users can report to

options:
  -h, --help            show this help message and exit
  --hub-host HUB_HOST   The host of the primary hub
  --hub-port HUB_PORT   The port of the primary hub
  --ip IP               The ip of the sub hub that can be accessible and seen by the primary h
  --host HOST           The host to run the sub hub Flask API on
  --port PORT           The port to run the sub hub Flask on
  --id ID               The id of the sub hub
  --name NAME           The name of the sub hub
  --longitude LONGITUDE
                        The longitude of the sub hub
  --latitude LATITUDE   The latitude of the sub hub
  --radius_km RADIUS_KM
                        The radius of the sub hub in kilometers
  --existing-disasters EXISTING_DISASTERS
                        The path to a CSV file containing existing disasters
```

Unit Tests and Continuous Integration

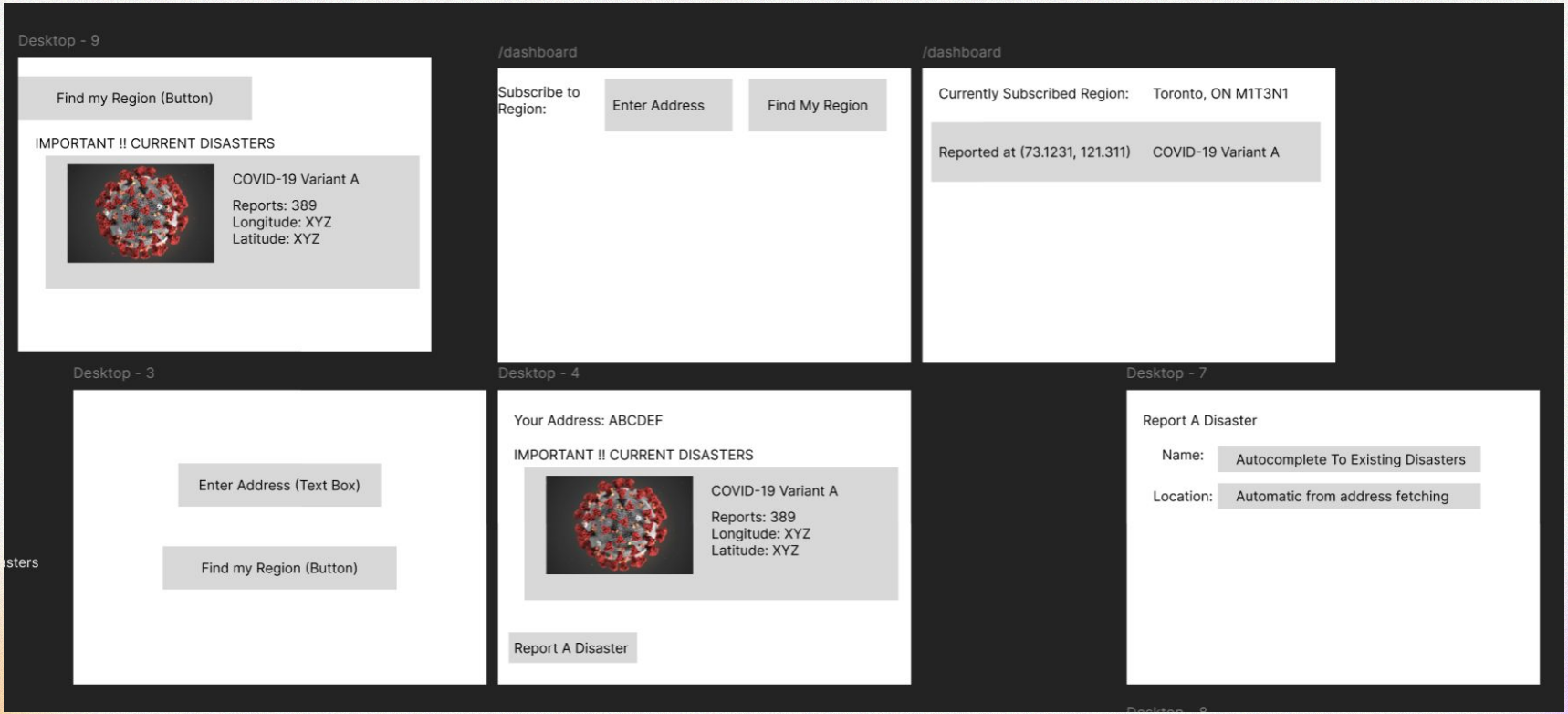
github > workflows > ci.yaml

```yaml
name: Unit Tests

on:
  workflow_dispatch:
  push:
    branches: [main]
  pull_request:
    branches: [main]

permissions:
  contents: read

jobs:
  unit-tests:
    runs-on: "ubuntu-latest"
    steps:
      - uses: actions/checkout@11bd71901bbe5b1630ceea73d27597364c9af683 # v4.2.2
      - name: Install
        working-directory: backend
        run: |
          pip3 install -r requirements.txt
          pip3 install pytest

      - name: Run tests
        run: pytest backend/tests
```

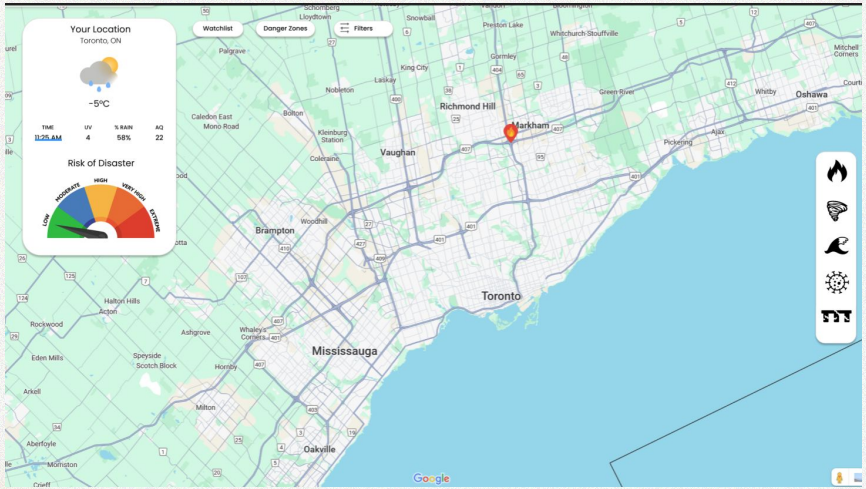


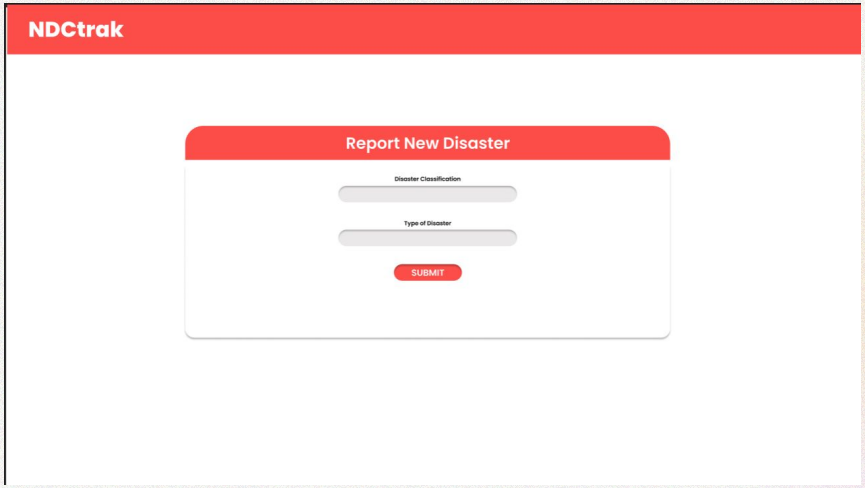
Initial Figma Prototyping

Initial Design: iteration 1

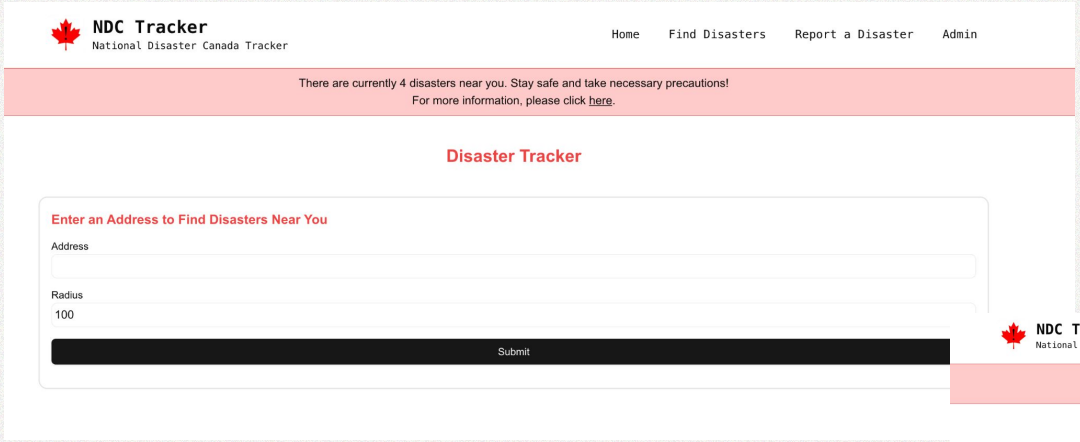


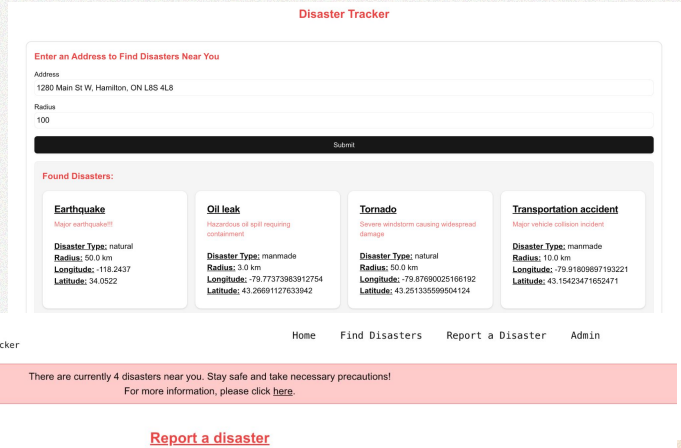
Initial Design: iteration 2

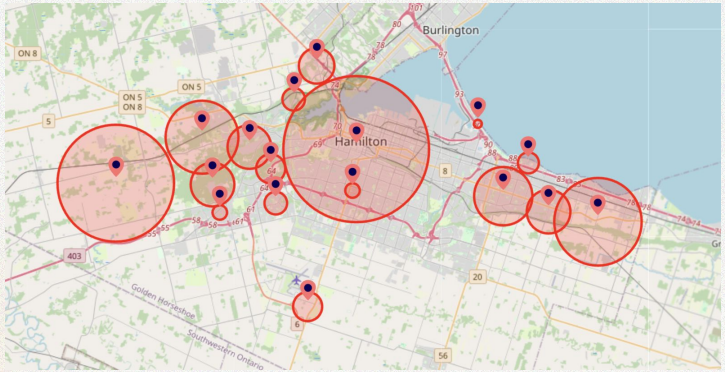


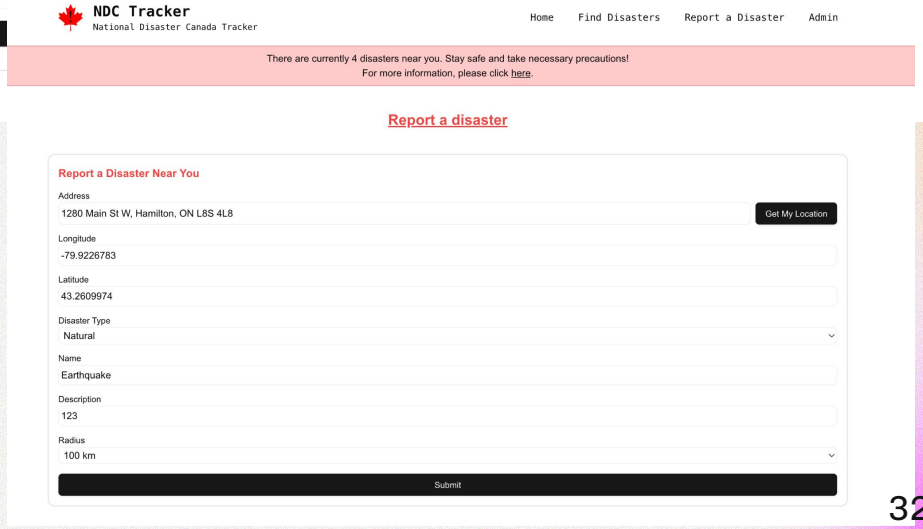


Initial Design: iteration 3





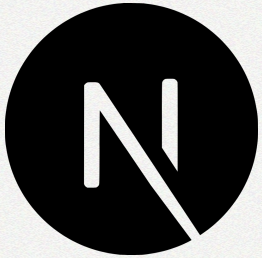


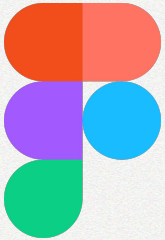


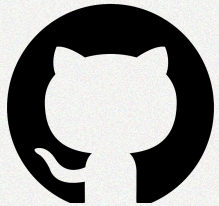
Development Stack & Toolkit

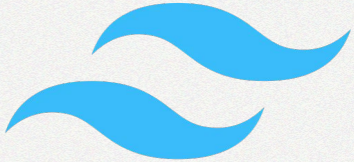
Frontend Technologies

- **Developer Tools:**
  - Git
  - Github
  - NPM
  - VScode
- **Frontend Technology Stack:**
  - React.js
  - Next.js
  - shadcn/ui
  - TailwindCSS
- **Libraries**
  - React-hook-form
  - Leaflet.js
  - React-Leaflet
  - Zod
- **Prototyping & Design:**
  - Figma









Backend Technologies

- **Developer Tools:**
  - Git
  - Github
  - NPM
  - VScode
- **Backend Technology Stack:**
  - Flask
  - Python
  - Docker
  - Github Actions
  - Tmux
  - Shell Scripts

Technical Challenges

- Implementing the interoperability and subscription between Hubs and Sub Hubs
- Map interactivity was difficult to properly implement with radius markers and location markers
- Interaction between backend and frontend was difficult to implement
- Implementing scalability techniques within the server architecture was to brainstorm and also implement

Future Improvements

- Improve **responsiveness** for the frontend to allow for a better user experienced
- Allow users to add **more detail** for the disasters when reporting
  - Severity levels which could be indicated on the map
  - Incorporate more complex data models to enhance complexity of disaster tracking
- Improve **UX** by adding filters and more options for deleting/editing disasters
- Add a footer.
- Add a form of **immediate communication** with emergency services and **notifications**
- Support for **multiple languages** (most notably french)

Thank You!