Drone assisted multi-technology rescue operations

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Context & motivation
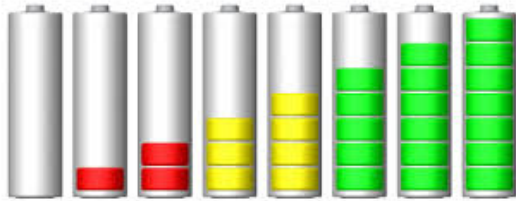
Network infrastructure destroyed !

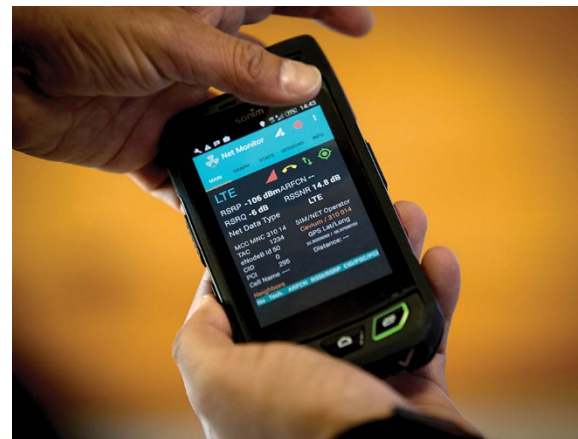**Leverage short range communication for disaster recovery**

Disaster Area

Safety Center

Survivor waiting for help   rescuer

Challenges

Various energy levels

Rescue operations might take a long time

Cellular

Wi-Fi

Bluetooth

Mobile devices have multiple network technologies

On the fly cellular communication

UAV characteristics

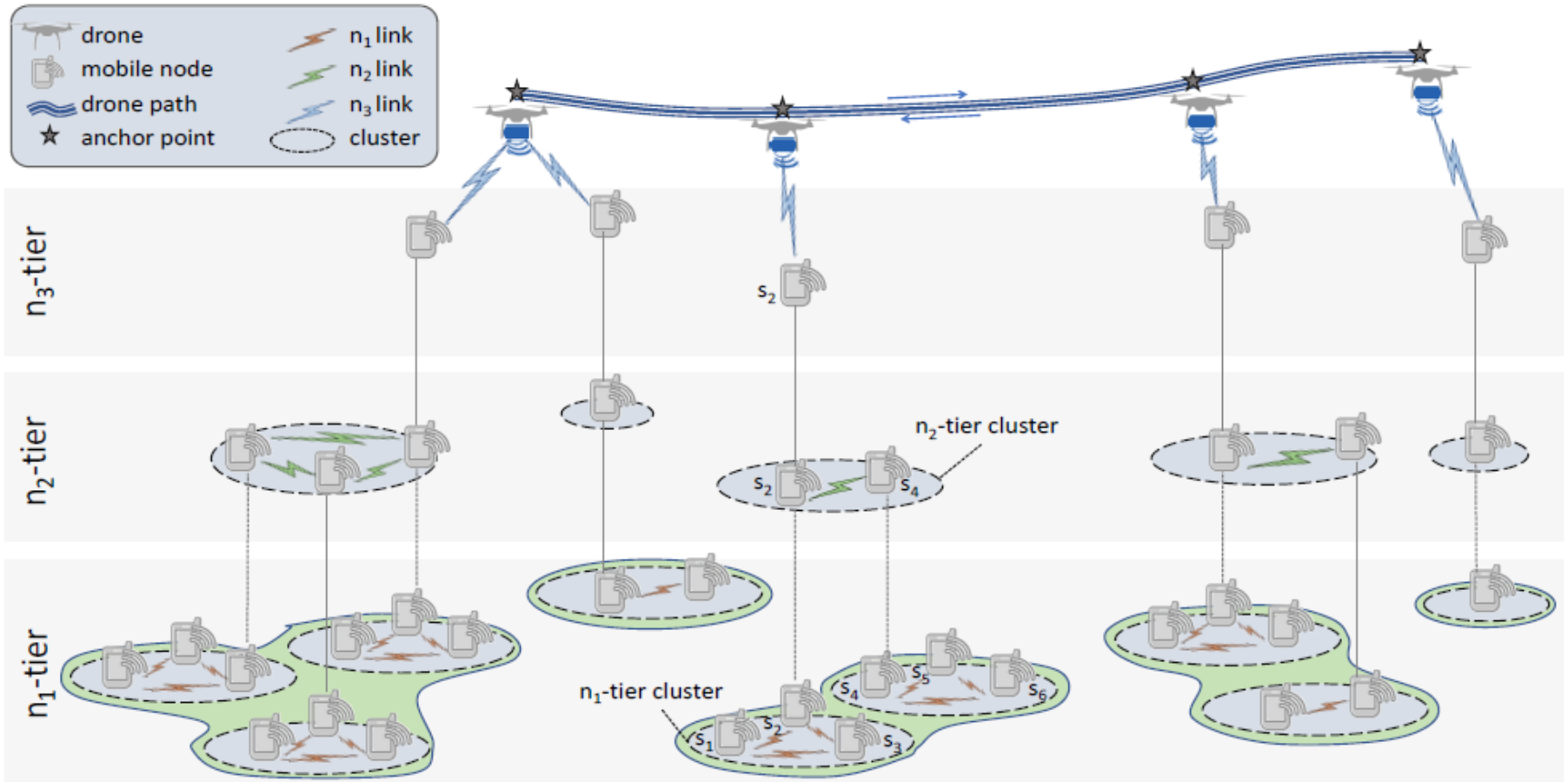|	Multi-rotor drone	Fixed wing drone

- ➤ Mobility
  - ➤ better manoeuvrability can adapt their speed
  - ➤ less flight flexibility

- ➤ Flight autonomy
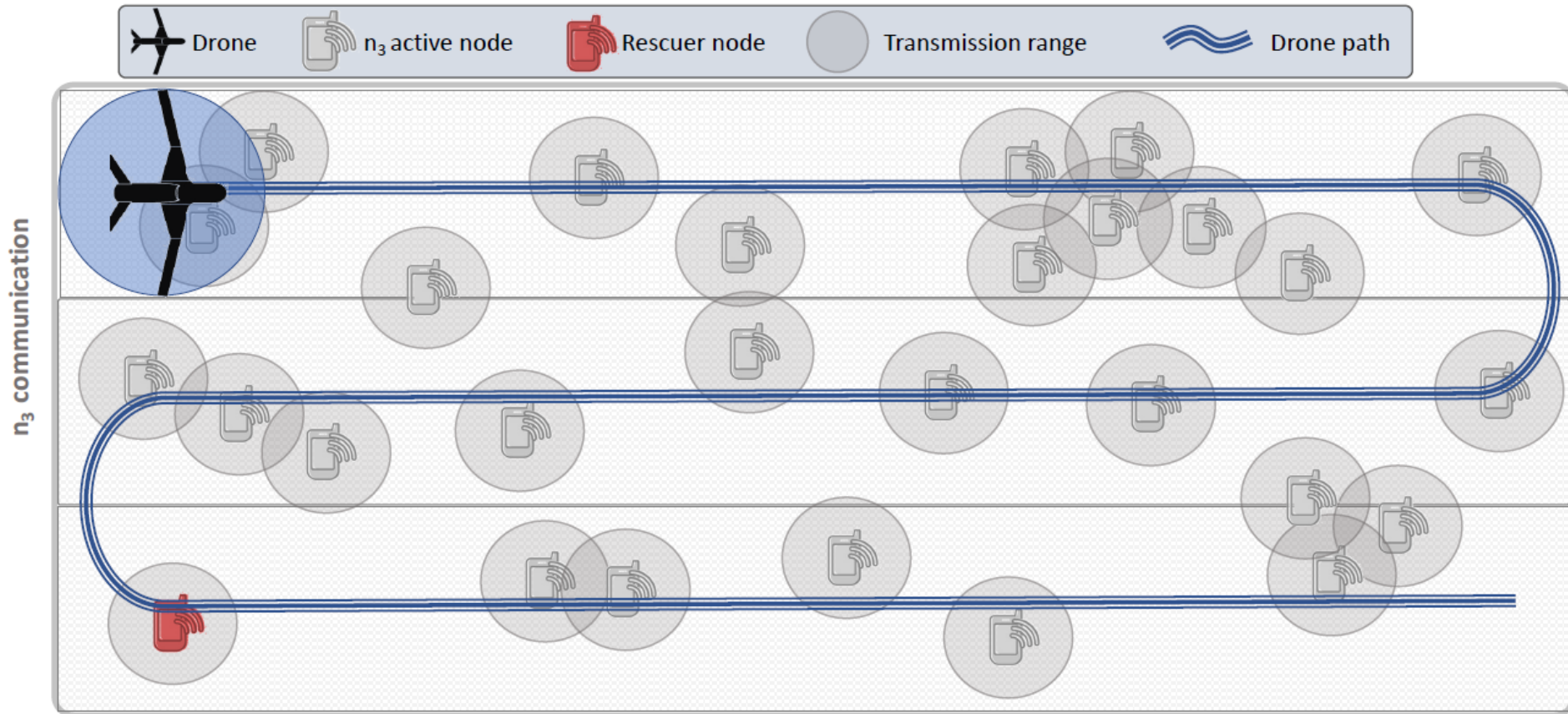 - ➤ Up to 45 min
  - ➤ Up to 2 hours

Multi-technology communication
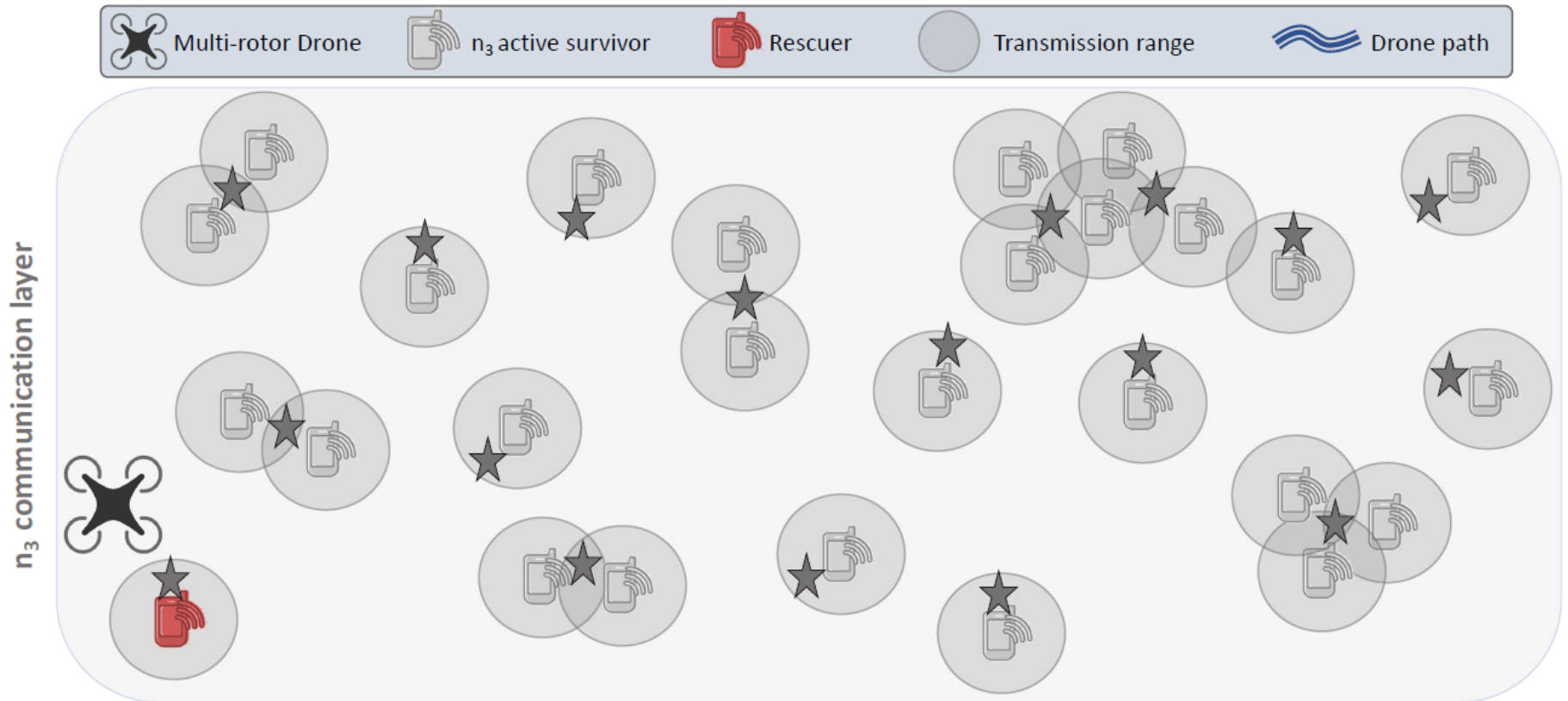

How to locate users ?

Drone path planning ?

Phase 1: Scan & collect survivors locations

Periodic each ΔT

Phase 2: Drone path planning

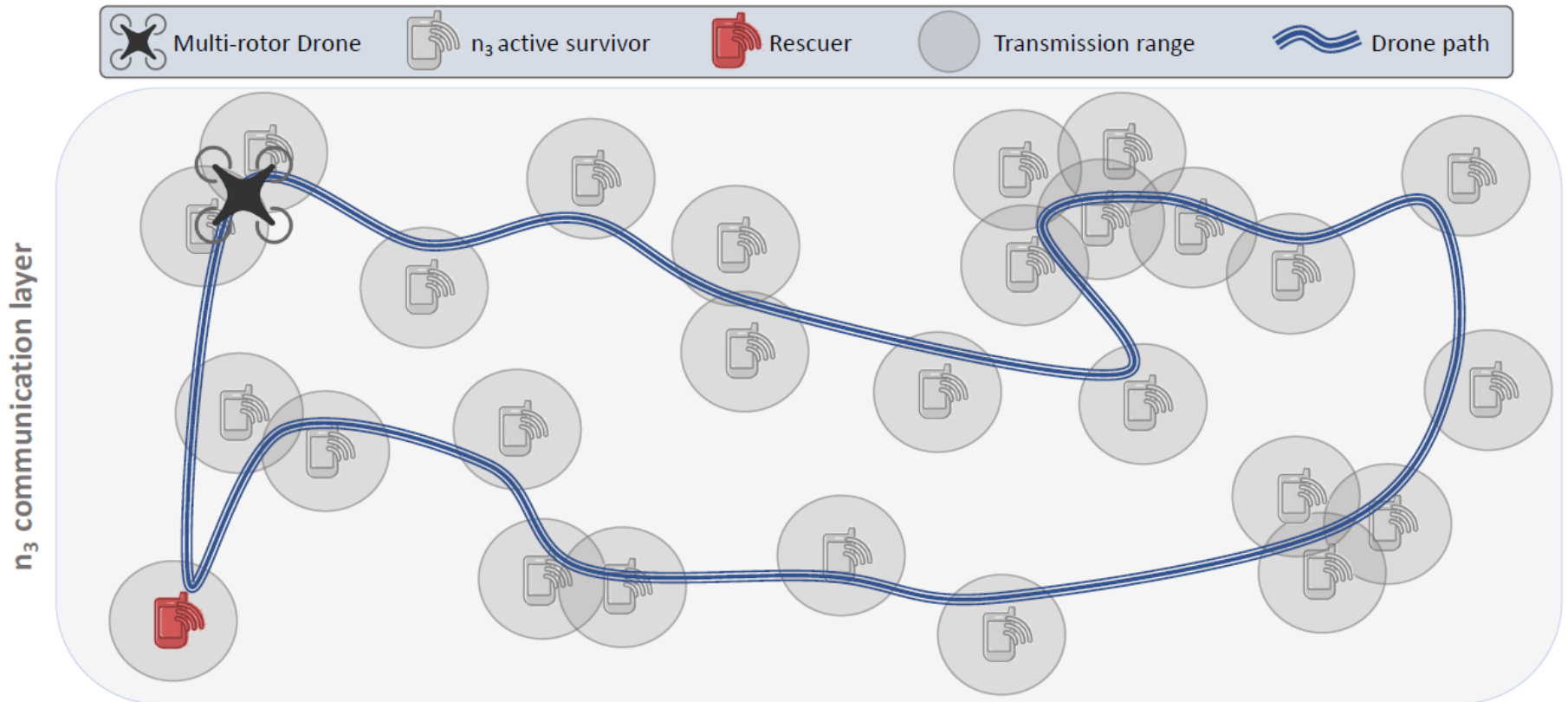## STEP1: Steiner Zones approach to determine the stops

➔ Minimize the number of stops

Phase 2: Drone path planning

## STEP2: TSP Path planning based on CONCORDE TOOL

→ Shortest path passing through all stops

Simulation

➢ **The Opportunistic Network Environment (The ONE)**

➢ **Up to 200 survivor nodes**

➢ **Each survivor has a mobile device featuring 3 network technologies (e.g. Bluetooth, WiFi, Cellular) with different Transmission Range (RC) and Energy Consumption (EC)**
  - TR (Bluetooth) < TR (WiFi) < TR (Cellular)
  - EC (Bluetooth) < EC (WiFi) < EC (Cellular)

➢ **Drone Path-Time = $T_{Hovering}$ + T_{moving}**
  - Drone speed = 10m/s ➜ T_{moving}

  - Drone minimum Hovering time: $T_{Hovering}$=5s
  - Drone-Survivor data exchange time=2s

$T_{hovering}$=max(2,5)
=5s

$T_{hovering}$=max((2+2+2) , 5)
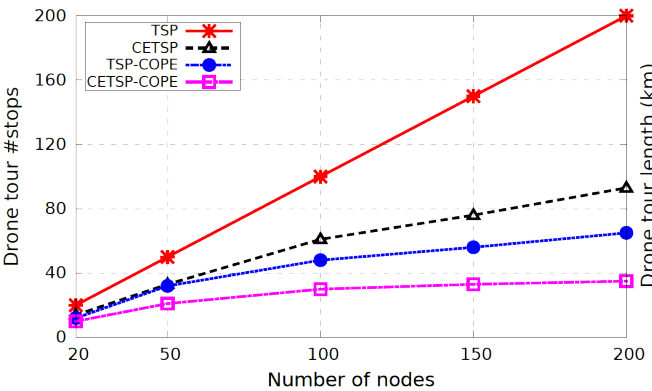=6s
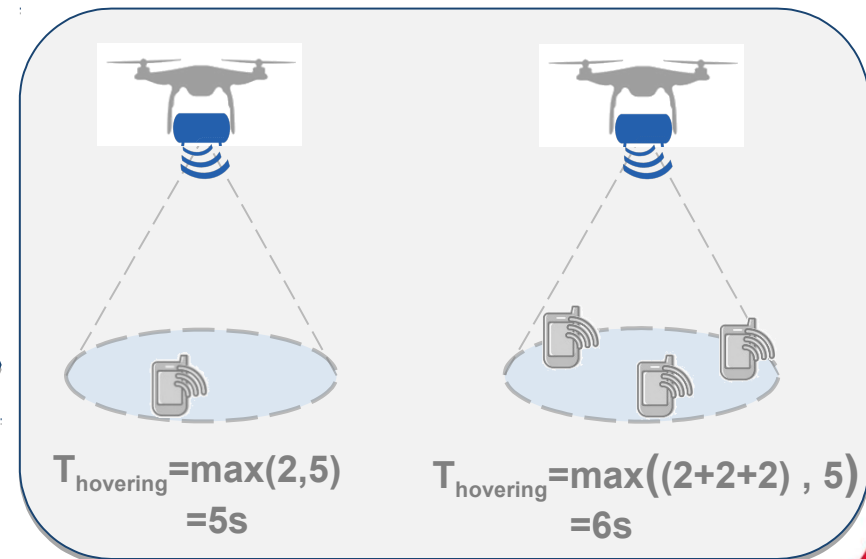
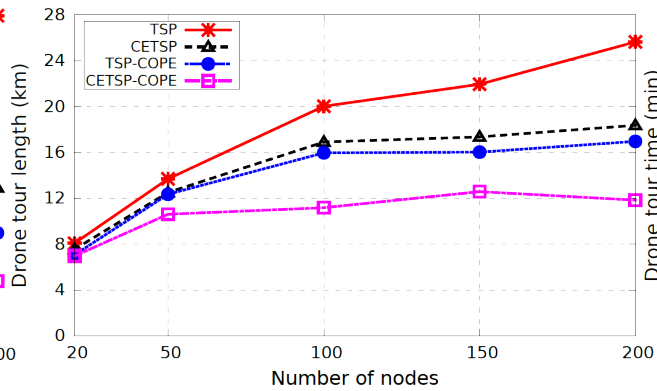# Simulation – comparison of 4 path planning approaches
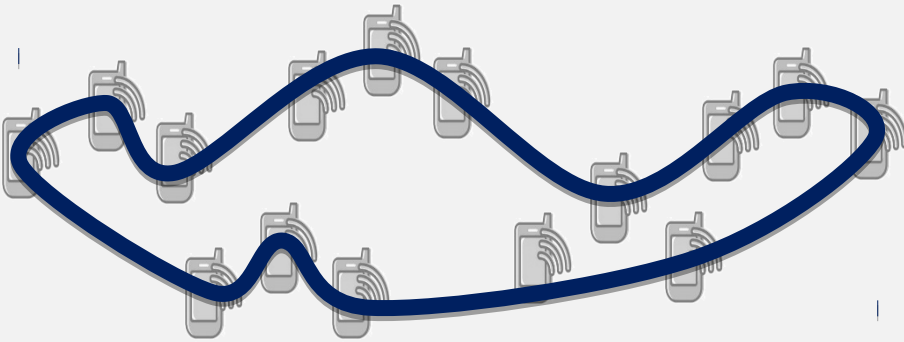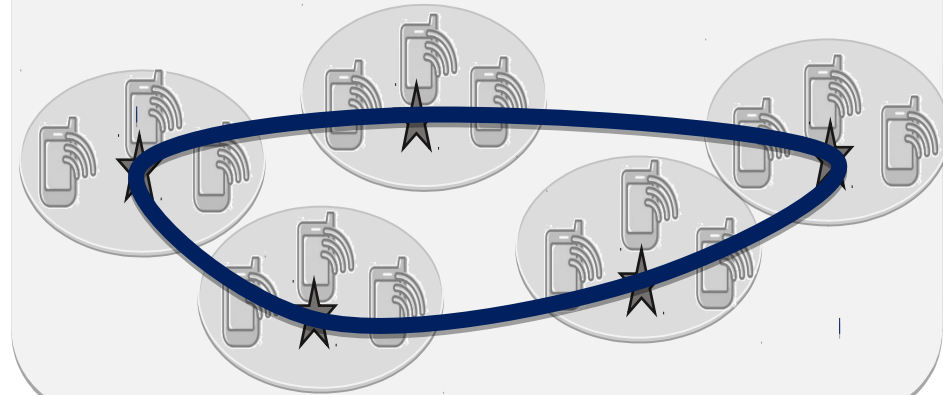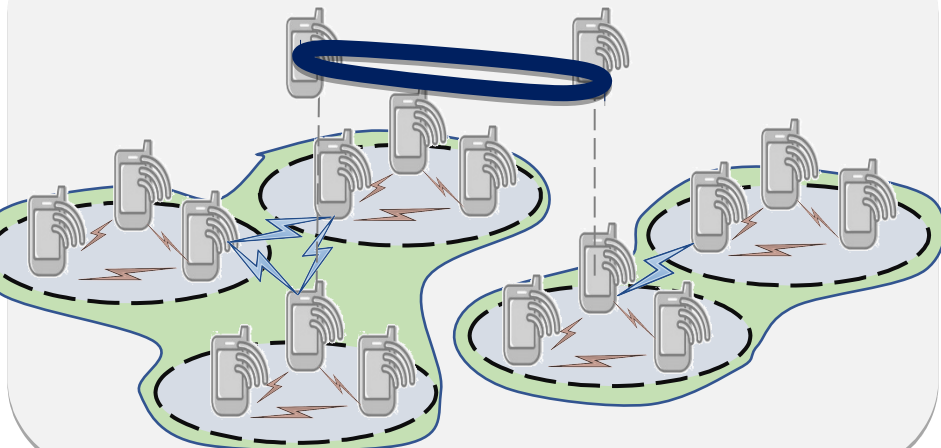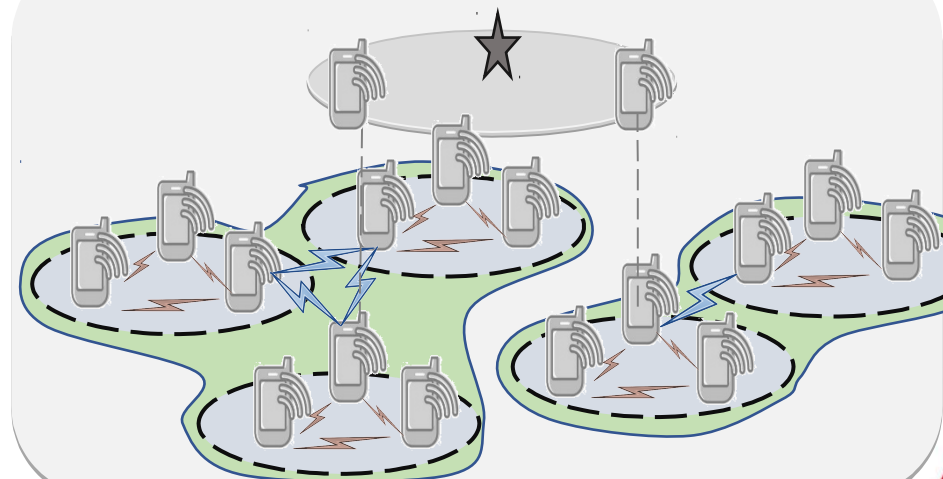
Results

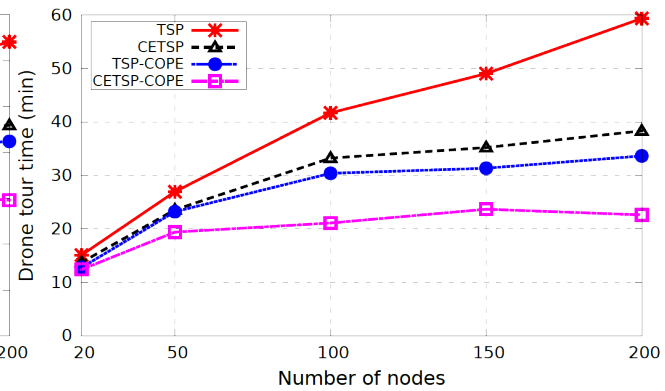## Various densities (# survivor-nodes; 20, 50, 100, 150, 200)

Number of Stops   Path length   Path time
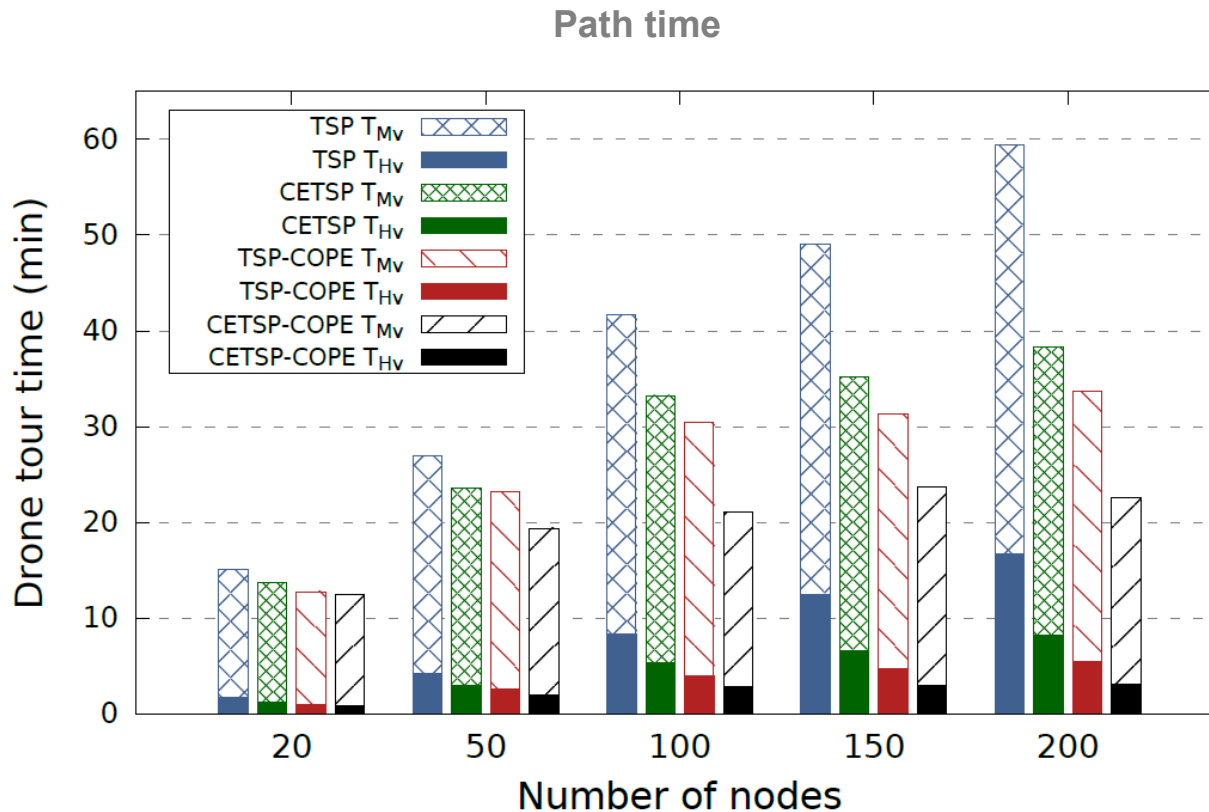
Results

Various densities (# survivor-nodes; 20, 50, 100, 150, 200)

Drone Path-Time= $T_{Hovering}$ + T_{moving}

Path time

Conclusion

During disaster scenarios:

➢ **Leverage nowadays mobile devices**
- ▪ **Exploit available communication technologies**
- ▪ **Take initial energy levels into account**

➢ **Exploit flying cell tower (BS carried by UAV)**
- ▪ **Drone limited autonomy**
- ▪ **Limited number of UAVs because of its high cost**
- ➔ **compute the shortest path for the UAV**

Thank you for your attention !