



# WiSe (Wireless Sensornet) Laboratory

WESTERN MICHIGAN UNIVERSITY

## Opportunistic Networks and Their Privacy and Security Challenges

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### 1. Opportunistic Networks – The Missing Link?

- ❖ Communication network forms the backbone of any organization or service
  - Including emergency response systems
    - Delays, even chaos, in responses most often blamed on communications breakdown
    - Also blamed on lack of other resources
- ❖ We have invented an entirely new category of computer networks: **Opportunistic Networks**, or **Oppnets** – can help in such problems
  - In oppnets, diverse systems—not deployed originally as oppnet nodes—join an oppnet dynamically in order to perform certain tasks they have been invited (or ordered) to participate in

### 2. Objectives

- ❖ Oppnets are envisioned to provide, among others:
  - Bridges between disjoint communication media
  - Additional platforms for offloading tasks
  - Additional sensing modalities by integrating existing independent sensory systems

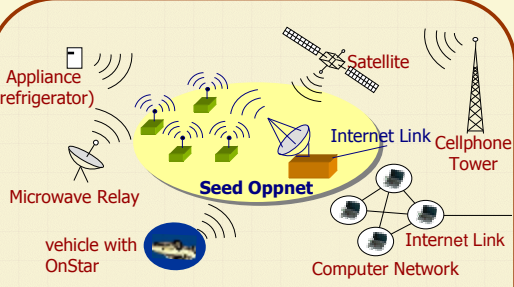


Figure 3. Expanded Oppnet

### 4. Example Emergency Application

- ❖ Seed oppnet is deployed after a man-made or natural disaster
- ❖ Seed orders (in emergency!) many helpers to join:
  - computer network – ordered via wired Internet link
  - cellphone tower – via Bluetooth-enabled cellphone
  - satellite – via a direct satellite link
  - home area network – via embedded processors in a refrigerator
  - microwave data network – via a microwave relay
  - BANs (body area networks) on or within bodies of occupants in an overturned car – via OnStar™
- ❖ Example shows how an oppnet can leverage resources—such as communication, computation, sensing, storage, etc.—available in its environment

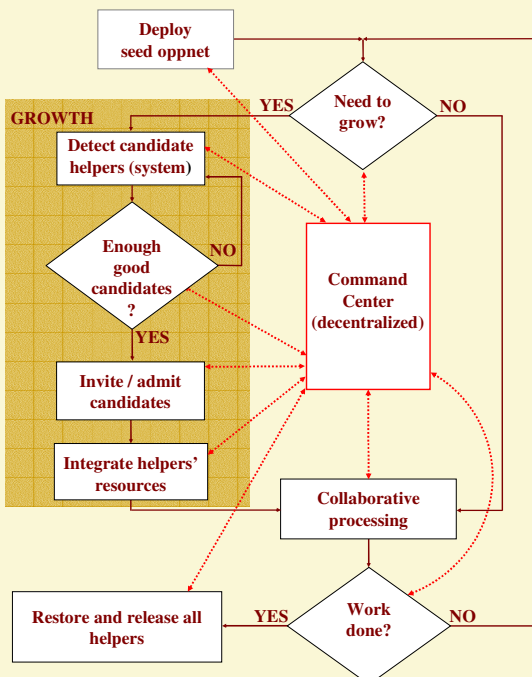


Figure 1. Basic Oppnet Operations

### 5. Privacy Challenges

- ❖ Privacy is the „make it or break it” issue for oppnets
  - As for any pervasive computing technology
- ❖ Protecting oppnet from helpers and helpers from oppnet
- ❖ Assuring privacy
  - Privacy of data storage and processing
  - Privacy of communication based on its patterns
    - E.g., broadcast/multicast from/to the base station
- ❖ Using trust and increasing it
  - Routing through more trusted systems
  - Using shared secrets with b-cast authentication
  - Using digital signatures

### 6. Security Challenges

- ❖ Prevent malicious helpers from joining
- ❖ Prevent common attacks
  - MITM (man-in-the-middle)
  - Packet dropping
  - DoS attacks on weak devices
  - ID spoofing
- ❖ Develop „good” lightweight cryptographic primitives
- ❖ Use Intrusion Detection (ID) – when prevention fails
  - Heterogeneous – real-time ID and response
  - Secure distribution of information amongst nodes about malicious entities

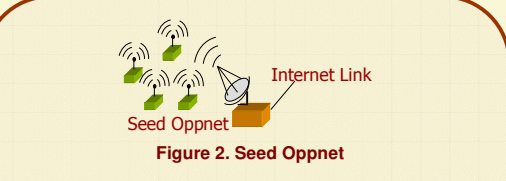


Figure 2. Seed Oppnet

### 3. Seed Oppnet and Expanded Oppnet

- ❖ First, a pre-designed **seed oppnet** is deployed (Fig.2)
- ❖ Seed oppnet growth (cf. GROWTH block in Fig. 1)
  - Detect candidate helpers
  - Evaluate candidates
  - Invite and admit selected candidates
    - Candidate that joins oppnet becomes a **helper**
  - Integrate helpers' resources
- ❖ Seed oppnet grows into **expanded oppnet** (Fig. 3)
- ❖ Collaborative processing
  - Oppnet determines useful helper functionalities
  - Oppnet offloads tasks to helpers
  - Oppnet manages offloaded tasks

### 7. Other Research Challenges (cf. Fig. 1)

- ❖ Detecting candidate helpers in diverse communication media
  - Integrate disparate technologies
    - Possible solution: virtualize at the network layer to seamlessly enable communication between devices in different medium
      - Similar to virtual machines in grid computing
  - Distinguish between devices found in the same communication medium
    - Differentiate between devices by services rendered
  - Classify and evaluate candidate's usefulness and reliability
    - Categorize as computation, communication, sensory, storage, etc., resource
    - Usefulness depends on oppnet's goals
- ❖ Inviting candidates and admitting the ones that accept invitation
  - Candidates are helpers not slaves
  - But in emergencies, mandatory „call to arms”
- ❖ Integrating helpers' resources
  - Managing network dynamics, offloading tasks to helpers that are best suited for given jobs, coordinating tasks
- ❖ Collaborative processing
  - Data integration, information fusion
- ❖ Restoring and releasing helpers
  - To minimize oppnet's intrusiveness w.r.t. helpers