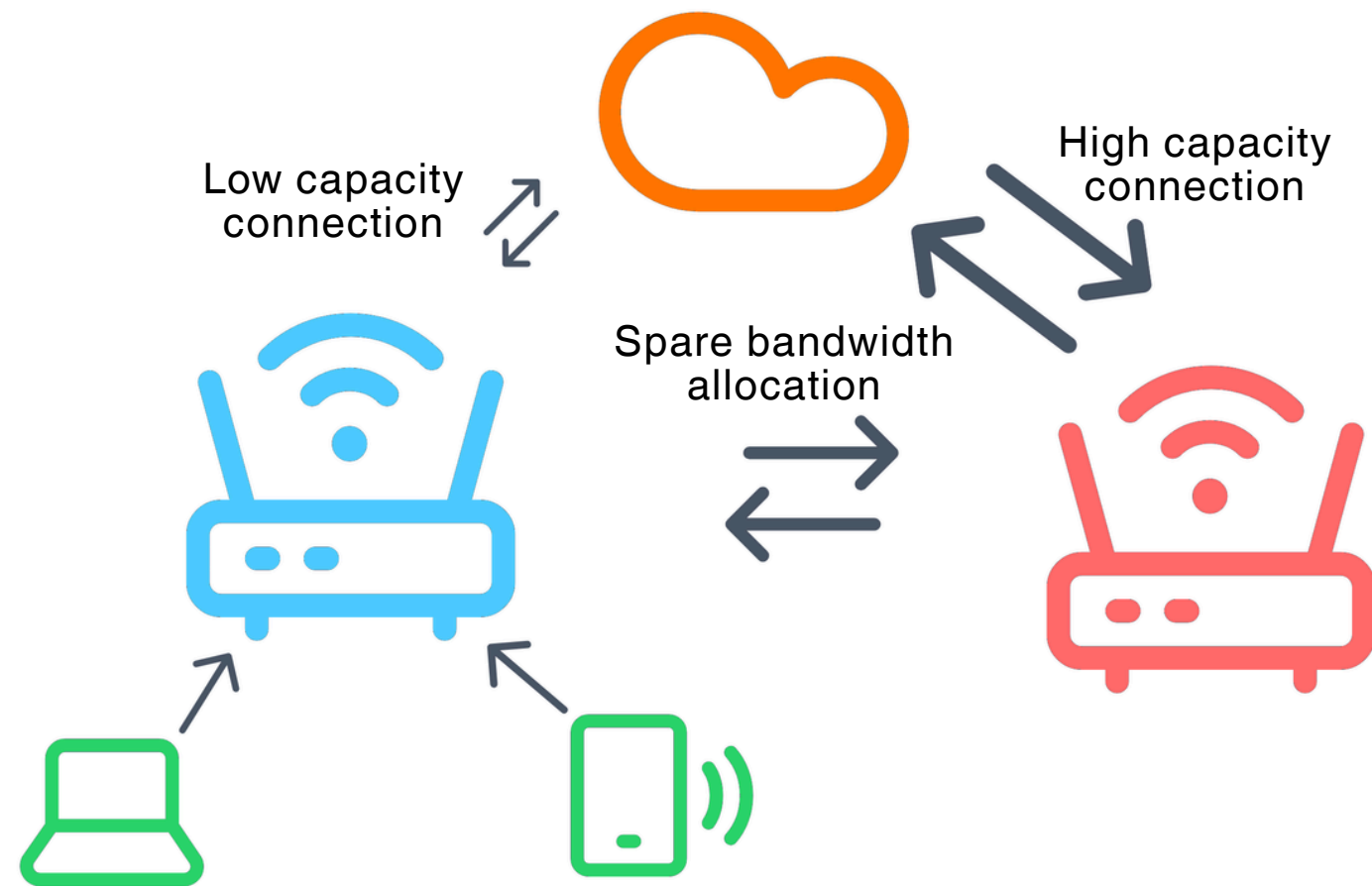


## 1. Background

Surplus **resources cannot be stored**. Participants can **send** these resources to their **neighbours** at every time step. **Find an allocation** that is **fair and stable**. **Such an allocation** is an **equilibrium**.



This **market-level** goal can be **transformed** to a **centralized optimization problem**. This requires an **overview** of the **entire market**.

Alternatively, **participants** can act as **agents** that **allocate** resources using an **allocation strategy**.

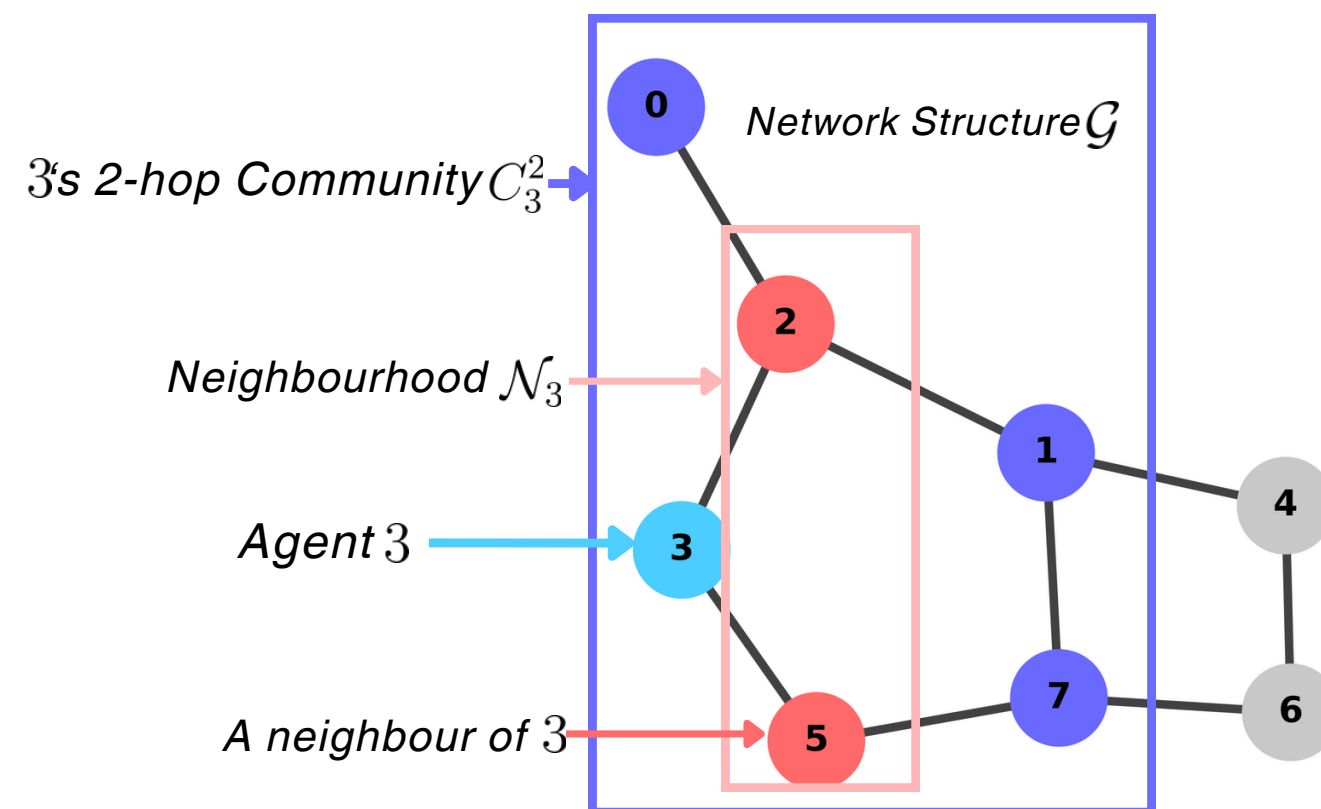
## 2. Research Gap & Question

**Existing agent strategies only aim to maximize** the agents' **own utility**. — **How does an allocation strategy that maximizes the utility received by other agents affect market convergence?**

## 4. Proposed Solution

*Agents maximize the utility of a community around them.*

We introduce the **Agent-Community**, **Community Utility**, and **Community Maximizing Allocation Program (CMAP)**. **CMAP allocates** resources such that all **agents in the community** receive **resources proportional** to their market **contribution**.



## 3. Assumptions & Research Scope

- Agents are **rational**
- Agents are **truthful**
- All **agents** use the **same strategy**
- Agents **cannot know future allocations** of other agents
- Agents have **infinite demand**
- Agents **can't recall** previous **rounds**
- The **network** is **managed**
- Network **admin** decides **allocation strategies**
- **Fairness** is resources **proportional** to **contribution**

## 5. The Allocation Strategy

Every agents applies a **smaller, modified version** of the **centralized optimization program**. The **allocation maximizes** the **community utility** for the **current market**.

Every agent solves the following program:

$$\max_{\mathbf{x}_i(t+1)} \sum_{j \in C_i^k} \left( (\varepsilon_j \cdot v_j) \cdot \log \left( \sum_{p \in \mathcal{N}_j} x_{pj}(t+1) \cdot v_p \right) \right)$$

$$\forall p \neq i : x_{pj}(t+1) = x_{pj}(t)$$

- $\mathbf{x}_i(t+1)$  Allocation of agent  $i$  in the next round
- $x_{pj}$  Allocation from agent  $p$  to agent  $j$
- $\varepsilon_j$  Average endowment of agent  $j$
- $v_j$  Value of agent  $j$ 's resources
- $j \in C_i^k$  agent in the  $k$ -hop community of  $i$
- $p \in \mathcal{N}_j$  agent in neighbourhood of  $j$

## 6. Analysis & Experimental Results

**CMAP** behaves like **Coordinate Ascent**. When agents allocate **one-after-another**, it **converges**. When agent **allocate** at the **same time**, it can **oscillate** and **diverge**.

**Behaviour is identical** for  $k \geq 1$

We measure **Nash Social Welfare & Market Loss**

The **numerical implementation** gets to **98%** of the **equilibrium**. It is **outperformed** by a **self-maximizing strategy** (proportional response).