NS-3 Network Simulation: Discovery and Collaboration Protocol

Network Simulation Study

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Abstract

This report presents an NS-3 simulation implementing a two-phase protocol for agent-based networks. The simulation demonstrates discovery and collaboration mechanisms between fixed and mobile agents in a WiFi-based ad-hoc network environment using NS-3.45.

1 Introduction

Modern distributed systems require efficient discovery and collaboration mechanisms for heterogeneous agents. This simulation implements a practical protocol where agents first discover neighbors through broadcasting, then establish peer-to-peer collaboration channels. The system supports both stationary infrastructure nodes (fixed agents) and mobile clients.

2 System Architecture

2.1 Agent Types

Fixed Agents: Stationary access points that serve as infrastructure nodes. They maintain consistent positions and provide network coverage for mobile agents.

Mobile Agents: Client nodes with random walk mobility patterns. They move within a defined boundary and dynamically connect to the network.

2.2 Network Configuration

- **WiFi Standard:** IEEE 802.11n
- **Network Topology:** Infrastructure mode (AP-STA)
- **IP Addressing:** 10.1.1.0/24 subnet
- **Discovery Port:** 8000 (UDP)
- **Collaboration Ports:** 9000+ (UDP)

3 Protocol Design

The protocol operates in two sequential phases with distinct timing and communication patterns.

3.1 Phase 1: Discovery (2s - 22s)

Objective: Enable all agents to identify nearby neighbors within communication range.

Mechanism:

1. All agents start UDP echo servers on port 8000
2. Agents broadcast discovery messages every 2 seconds
3. Broadcast address: 10.1.1.255 (subnet broadcast)
4. Discovery range: 80 meters
5. Duration: 20 seconds

Process:

- Each agent listens for incoming discovery broadcasts
- Upon receiving a broadcast, agents log the sender's address
- Distance-based filtering simulates realistic radio propagation
- Discovery table populated with reachable neighbors

3.2 Phase 2: Collaboration (25s - 95s)

Objective: Establish direct peer-to-peer communication channels between discovered neighbors.

Mechanism:

1. Each agent starts a dedicated UDP server on unique port (9000+)
2. Agents connect to discovered neighbors as clients
3. Bidirectional data exchange every 1 second
4. Packet size: 1024 bytes
5. Duration: 70 seconds

Connection Logic:

- Fixed agents connect to adjacent fixed agents and nearby mobile agents
- Mobile agents connect to the nearest fixed agent and peer mobile agents
- Connection pattern simulates range-limited discovery results

4 Implementation Details

4.1 Mobility Models

Fixed Agents:

- Model: ConstantPositionMobilityModel
- Placement: Linear arrangement with 50m spacing
- Position: $(i \times 50, 0, 0)$ for agent i

Mobile Agents:

- Model: RandomWalk2dMobilityModel
- Initial position: Uniform random in [0, 100] × [0, 100]
- Movement bounds: [-10, 110] × [-10, 110]
- Speed: Uniform random [1.0, 5.0] m/s
- Walk distance: 15 meters per segment

4.2 Communication Stack

- **Physical Layer:** YANS WiFi PHY with default channel model
- **MAC Layer:** 802.11n with SSID "discovery-collab-network"
- **Network Layer:** IPv4 with global routing
- **Transport Layer:** UDP echo protocol

5 Simulation Parameters

Parameter	Value
Fixed Agents	2
Mobile Agents	4
Total Simulation Time	100 seconds
Discovery Start	2 seconds
Discovery Duration	20 seconds
Collaboration Start	25 seconds
Collaboration Duration	70 seconds
Discovery Interval	2 seconds
Discovery Range	80 meters

Table 1: Default simulation parameters

6 Expected Behavior

6.1 Discovery Phase

1. All agents broadcast presence messages
2. Agents within range receive and log broadcasts
3. Discovery table built with neighbor information
4. No direct peer communication established yet

6.2 Collaboration Phase

1. Agents establish dedicated servers
2. Peer-to-peer connections initiated based on discovery results
3. Continuous data exchange between connected pairs
4. Mobile agents maintain connections while moving
5. Connections may break if nodes move out of range