Implementation of the SWIM Mobility Model in OMNeT++

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Motivation

Motivation

- Internet of Things (IoT)
  - Over 200 billion devices by 2020 [1]
- Focus of research
  - Opportunistic Networking
- IoT Scenarios
  - Many human oriented scenarios
  - e.g., Smartphone user enabling health monitoring
- Nature of human oriented Scenarios
  - Mobile users
- Scale of Devices in the IoT - Large
  - Require simulators – OMNeT++

Motivation

- OMNeT++ has a number of Mobility Models
  - Random Way Point, Random Direction, etc.
- Human mobility has different characteristics
- Small Worlds in Motion (SWIM) is a Mobility Model that captures these characteristics [2]
- Focus: Develop the SWIM Model to simulate human oriented scenarios
  - Useful for the OMNeT++ community

SWIM Mobility Model*

* A. Mei and J. Stefa, *SWIM: A Simple Model to Generate Small Mobile Worlds*, IEEE INFOCOM, 2009

SWIM

- Based on 2 intuitions of human mobility
  - Regularly visited locations are near to home and,
  - A far location is visited due to its popularity
- Categorizes locations as,
  - Home (Neighboring) location
  - Visiting locations
- Next location selection based on weights

$$w(C) = \alpha \cdot distance(h_A, C) + (1 - \alpha) \cdot seen(C)$$

- $w(C)$ - weight assigned to cell C by node A;
- $distance(h_A, C)$ - function of distance from node A to cell C ;
- $seen(C)$ - number of nodes that node A encountered at cell C;
- α - constant in the range of $[0; 1]$.

SWIM contd…

- Weight function
  - Increases with popularity of a place,
  - Decreases with the distance from the home location
- Empirically verified

Mobility Models in OMNeT++

Mobility Models in OMNeT++

- OMNeT++ has a number of models
  - Available in the **INET framework**
- Simulation of mobility – using 2 methodologies
  - Synthetic models – artificially generated mobility patterns
  - Traces – mobility pattern data collected from actual movements
- Synthetic Models – classified based on the nature of movement
  - Deterministic models – devoid of stochasticity
  - Random models – stochasitic movement patterns
- SWIM – Synthetic model with random destination selection

Mobility Architecture in OMNeT++

- **IMobility** Interface – implemented by mobility models
  - Other models invoke methods in interface to obtain information
- OMNeT++ Base Mobility Implementations
  - Extensible classes to include mobility model specific functionality
  - e.g., **LinearSegmentsMobilityBase** – linear movement and moves in segments
- SWIM – Extends the **LinearSegmentsMobilityBase** model

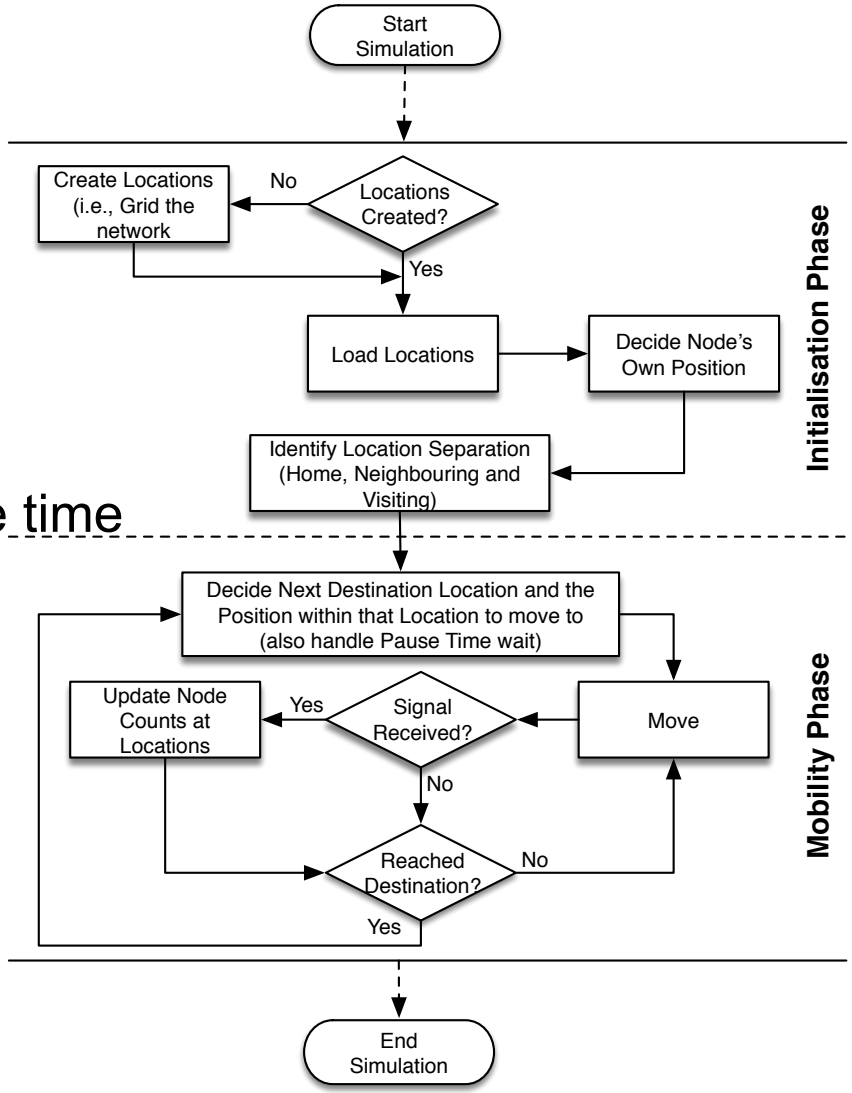
SWIM Implementation in OMNeT++

SWIM Implementation Requirements

- Basic functionality required
  - Constant speed of mobility,
  - Linear movements
- SWIM extends **LineSegmentsMobilityBase**
- Functionality separation in a node
  - **Initialization Phase** – setup activities
  - **Mobility Phase** – activities related to movement of node

SWIM Implementation Flow Chart

- Initialization Phase
  - Create and load locations
  - Decide node's own position
  - Identify location separation
- Mobility Phase
  - Decide next destination and pause time
  - Move
  - Update node counts



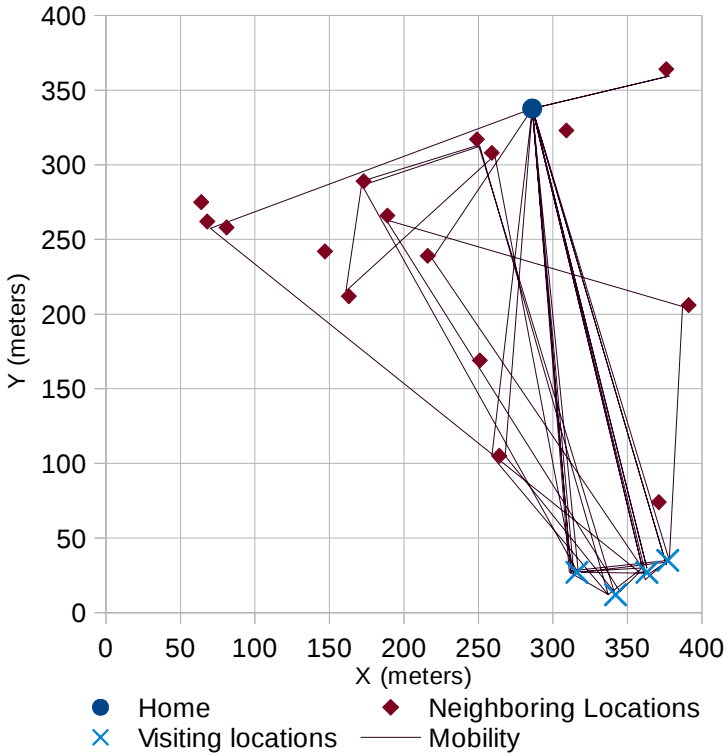
SWIM Configurable Parameters

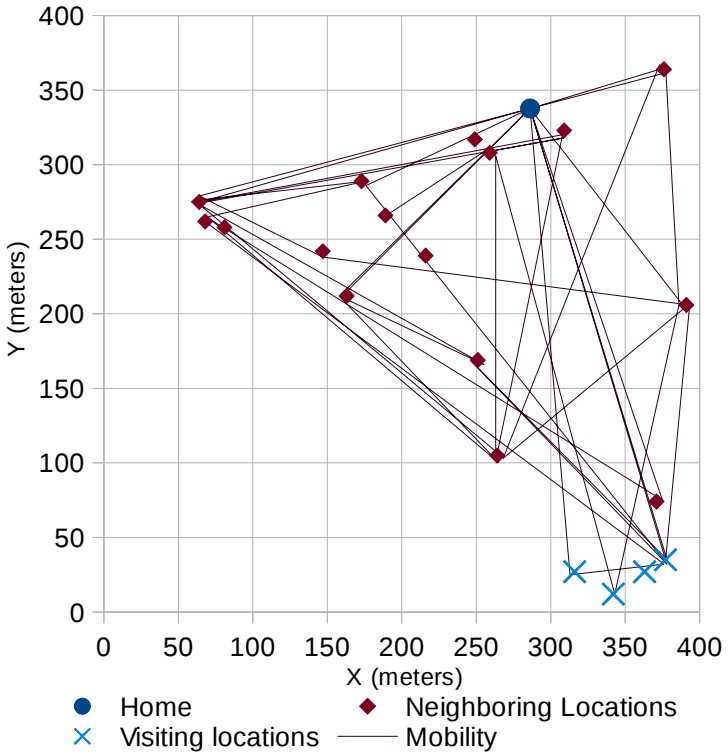
- **neighbourLocationLimit** – distance to determine location separation
- **noOfLocations** – locations to create from movement area
- **alpha** – SWIM α value
- **initialX**, **initialY**, **initialZ** – initial coordinates of a node
- **maxAreaX**, **maxAreaY**, **maxAreaZ** – movement area
- **waitTime** – pause time after reaching a destination
- **speed** – velocity of node when moving

Evaluations

Evaluations

- Focused on how destinations are selected
  - Emphasis on **Visiting Locations** (lower α)
  - Emphasis on **Neighboring Locations** (higher α)





Summary and Future Work

Summary

- SWIM – an empirically validated mathematical model to model human mobility, proposed by authors of [2]
- Based on 2 intuitions related to human mobility
  - Regularly travelled locations lie close to home
  - Further locations are visited due to their popularity
- Purpose of this work – implementation of the SWIM model in OMNeT++
- Currently available at Github (search: **SWIM mobility**)

Future Work

- Our work with SWIM – use in opportunistic networks
- Organic Data Dissemination (ODD) – Communication Model ([3])
  - Opportunistic networks
  - Internet of Things
- ODD – Currently as an OMNeT++ model
- SWIM is ideally suited for evaluating ODD – but not all scenarios
- Key lacking area – reactiveness
  - Destinations change (while in motion) due to external events
  - e.g., an emergency, change of plans

References

References

[1] IDC IVIEW, *Digital Universe in 2020*, December 2012

[2] A. Mei and J. Stefa, *SWIM: A Simple Model to Generate Small Mobile Worlds*, IEEE INFOCOM, 2009

[3] A. Foerster et al, *A Novel Data Dissemination Model for Organic Data Flows*, MONAMI 2015, September 2015, Santander Spain

Thank You.

Questions?