A Trace Generation, Visualization, and Performance Analysis Tool for Random Mobility Models

HPCS 2008

April 15, 2008

Alex Aravind and Xiang Cui

University of Northern British Columbia

Mobility Models

- § Research studies on large mobile networks are carried out mainly through **simulation**, due to its cost effectiveness and flexibility

- § A valid, credible, and appropriately detailed simulation model is crucial for meaningful and accurate simulation study

- § As an integral part of the model, **mobility** of participating nodes plays crucial role in the simulation
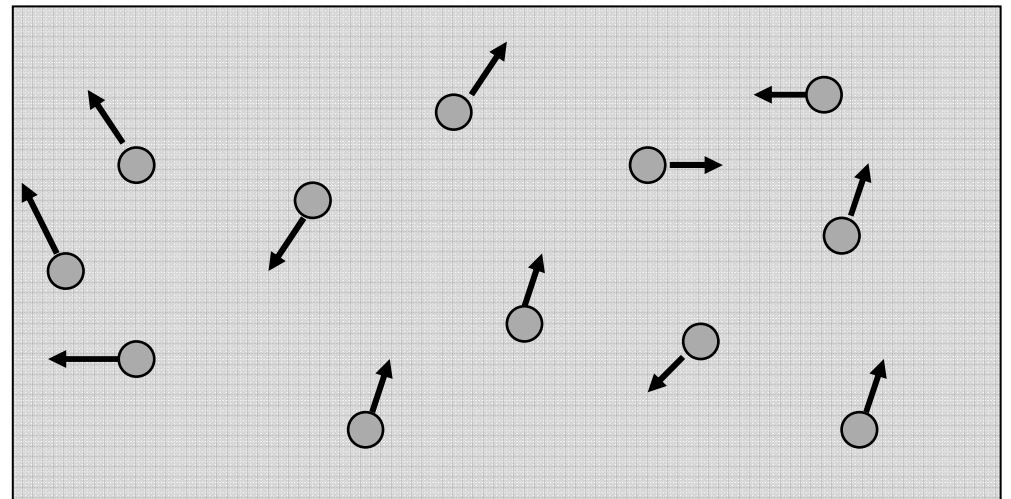
Random Mobility Models

§ The concept of **random mobility** traces back at least to Brownian motion. Many variations suitable for different applications are derived later.

§ The popular one used in **mobile computing context** is **random waypoint model**.

§ In a **random waypoint** mobility model, a node chooses a destination within the region and a speed within a specified range and moves there. Then, it pauses there for a chosen pause time, and these two steps are repeated.

Why Random Mobility Models?

§   Simple to implement

§   Relatively easy to understand

Motivation for Our Work

§ In the late 2004, we started observed the overwhelming use of random waypoint mobility model in simulations, and had some discussions on that.

§ Then, in 2005, we read the article "***MANET Simulation Studies: the Incredibles***" in ACM Mobile Computing and Communication Review, questioning about the credibility of the simulations in MANET.

§ In these simulations, ***nodes mobility*** model used played key role.
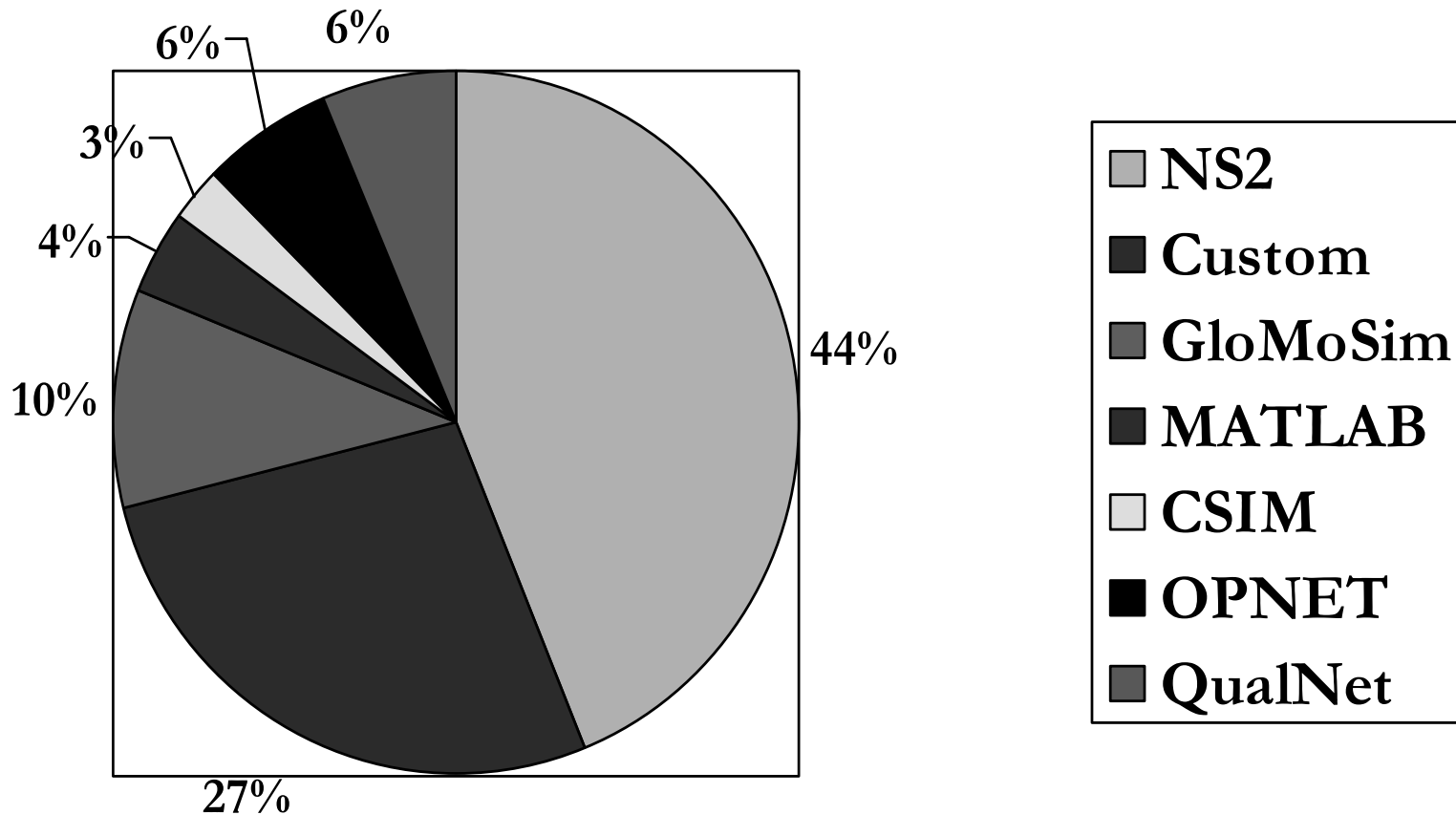
Some Interesting Statistics from the Survey

o 151 Papers presented at MobiHoc between 2000 and 2005.
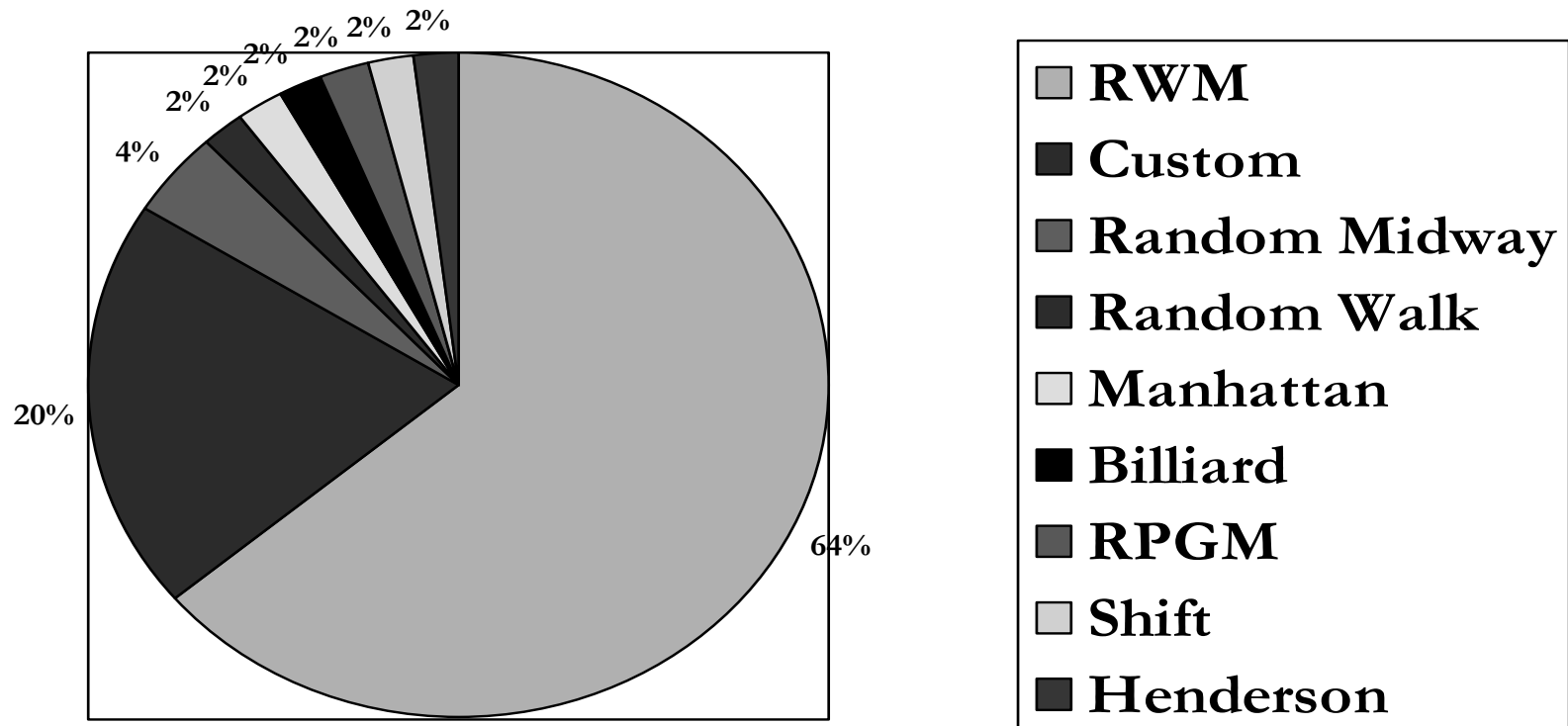
o 115 out of 151 (75.5%) were simulation based.

Some Interesting Statistics from the Survey...

Some Interesting Statistics from the Survey…

Any Issues of Random Way Point Model?

o **Speed Decay**: The average nodal speed consistently decreases over time.

o **Sudden Speed Sharp Turn**: Sudden speed change and sharp turn are dominant.

o **Density Waves**: Nodes converge in the center of the region and disperse, and then reconverge, etc.

The bottomline is …

o   Mobility of nodes is unpredictable, some times too unrealistic, and often complex.

o   So,
  n   Clear **understanding** of mobility model used in the simulation is extremely important, to interpret the results credibly.
  n   Many **options** must be available to choose from.

o   These are not possible with current support of NS2 and GloMoSim.
  n   NS2: random waypoint
  n   GloMoSim: random waypoint, random-drunken (random walk on Grid)

Our Objectives

o   Build a tool which fullfils the mentioned requirements.

o   That is, build a tool that:

   § **Supports** a wide range of random mobility models
   § **Helps** to understand these models before applying them to
      simulations
   § **Provides** nice interface
   § Must be **easy** to use

Many Mobility Models?

o   Essentially, the following are the parameters involved in a random mobility

    n   Destination

    n   Speed

    n   Direction

    n   Distance

    n   Time

q   Five meaningful combinations and hence five generalized models

    1.   Destination + Speed

    2.   Destination + Time

    3.   Direction + Speed + Distance

    4.   Direction + Speed + Time

    5.   Direction + Distance + Time

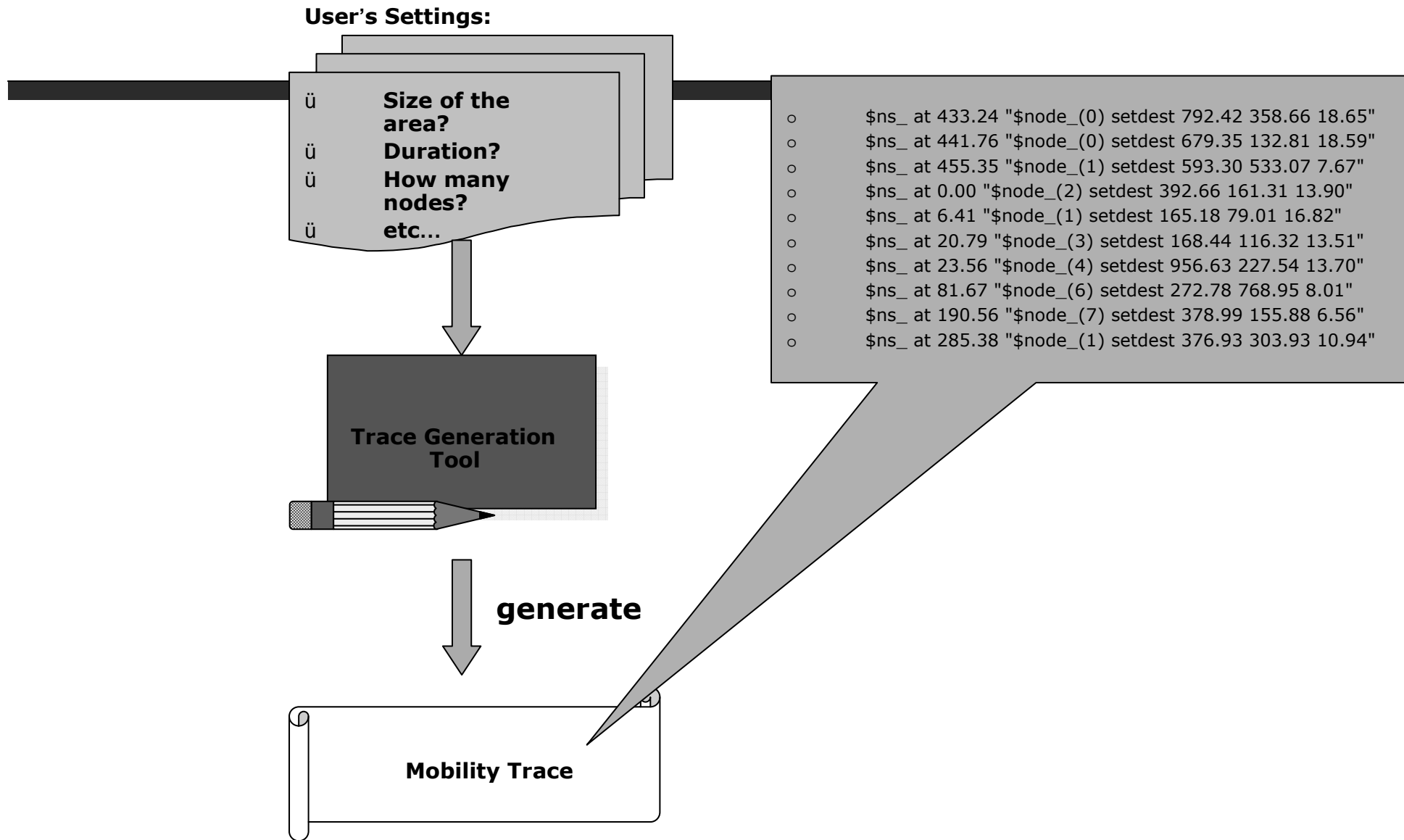# Many Mobility Models…

q Three boundary actions

    n Restart

    n Reflection
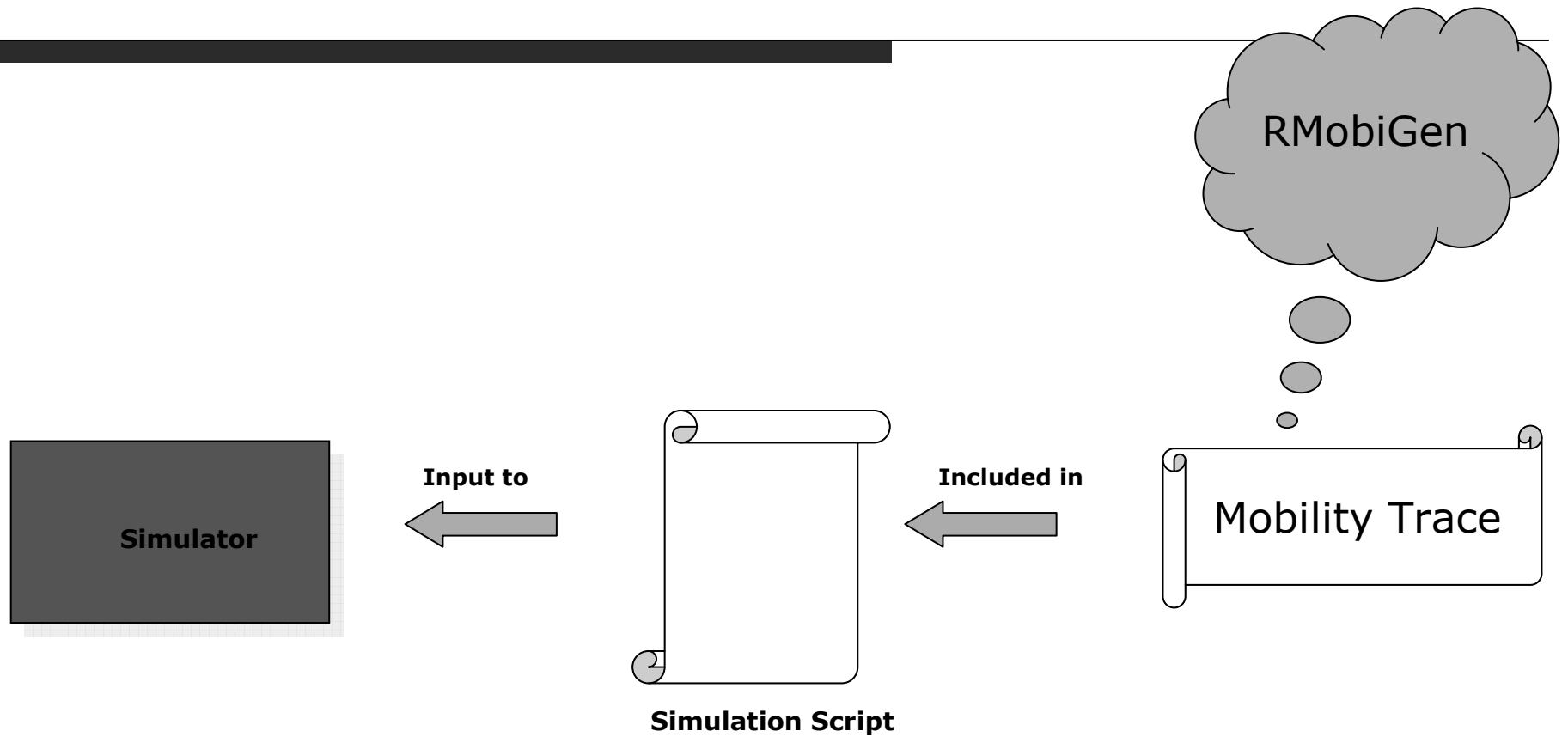
    n Wrap-around

Many Mobility Models…

§ **Random Waypoint**: a particular case of <u>Random destination - speed model</u>

§ **Random Walk**: a particular case of <u>Random direction – speed – distance</u>

§ **Gauss-Markov**: a particular case of <u>Random direction – speed – distance</u> (next values are chosen based on the current values)

Easy to Use?

User's Settings:

- ü **Size of the area?**
- ü **Duration?**
- ü **How many nodes?**
- ü **etc...**

Trace Generation Tool

generate

Mobility Trace

- o $ns_ at 433.24 "$node_(0) setdest 792.42 358.66 18.65"
- o $ns_ at 441.76 "$node_(0) setdest 679.35 132.81 18.59"
- o $ns_ at 455.35 "$node_(1) setdest 593.30 533.07 7.67"
- o $ns_ at 0.00 "$node_(2) setdest 392.66 161.31 13.90"
- o $ns_ at 6.41 "$node_(1) setdest 165.18 79.01 16.82"
- o $ns_ at 20.79 "$node_(3) setdest 168.44 116.32 13.51"
- o $ns_ at 23.56 "$node_(4) setdest 956.63 227.54 13.70"
- o $ns_ at 81.67 "$node_(6) setdest 272.78 768.95 8.01"
- o $ns_ at 190.56 "$node_(7) setdest 378.99 155.88 6.56"
- o $ns_ at 285.38 "$node_(1) setdest 376.93 303.93 10.94"

Easy to Use…

RMobiGen

Simulator

Input to

Simulation Script

Included in

Mobility Trace

Understand the Mobility?

§ Visualization
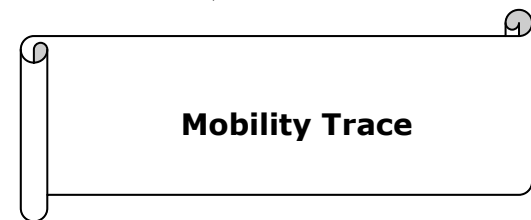
§ Animation

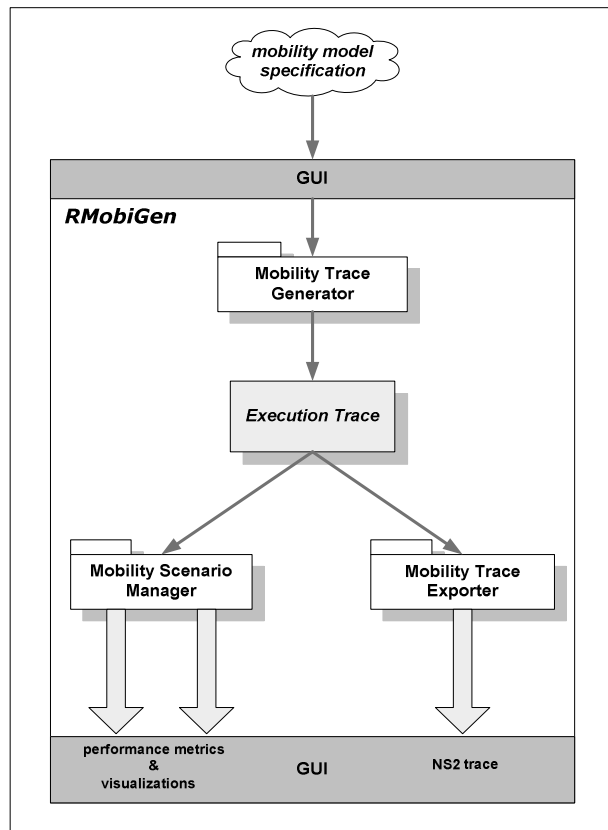§ Individual Trace

§ Snapshots

§ Etc.

§ Statistical insights

§ Movement Metrics

§ Connectivity Metrics

§ Etc.

Trace Analysis Tool

Statistical Metrics
Visualizations

Mobility Trace

RMobiGen Architecture

Main Components:

- § *Mobility Trace Generator:* Generating the mobility trace.

- § *Mobility Trace Manager:* Extracting various statistical insights and providing visualizations.

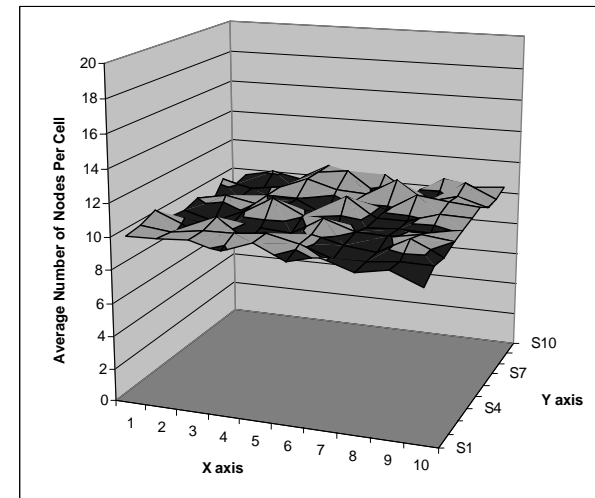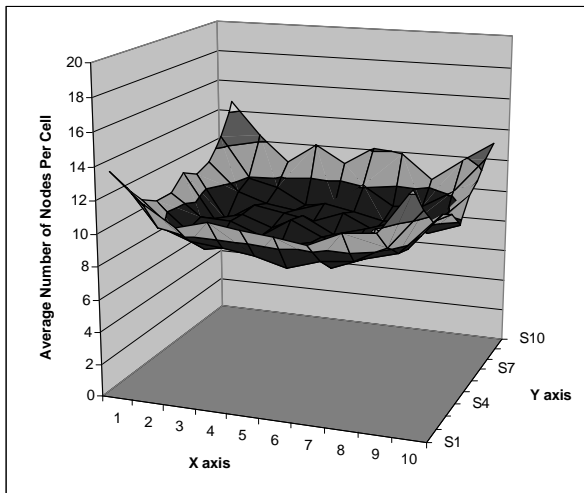- § *Mobility Trace Exporter:* Converting the mobility trace into NS2 format.

Verification

o **"Speed Decay of Random Waypoint"**
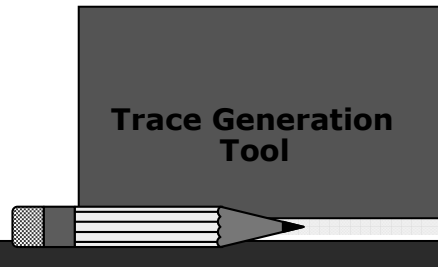

o **"Center Clustering of Random Waypoint"**
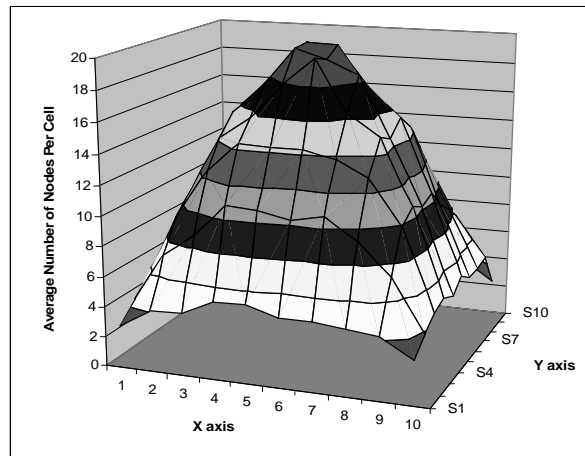
o **"Nodes converge on the edges and corners in random direction models with restart"** by **Michael McGuire**

o **"Uniform nodes distribution in random direction models with reflection and wraparound:** by **J.-Y. Le Boudec**

Existing Tools…

Trace Generation Tool

Trace Analysis Tool

Name	Developed by	Trace Analysis Tool		Trace Generation Tool	GUI
		statistical	Visual		
nam	*USC/ISI*		√		
setdest	*CMU*			√	
mobgen	*Colorado school of mines*			√	
BonnMotion	*Univ. of Bonn*	√		√	
iNSpect	*Colorado school of mines*		√		√

Existing Tools…

§ Each one addresses a specific issue

§ Not generic

§ Most of them are command-line based

§ None of them is comprehensive

Existing Tools…

Trace Generation Tool

Trace Analysis Tool

Name	Developed by	Trace Analysis Tool		Trace Generation Tool	GUI
		statistical	Visual		
nam	*USC/ISI*		√		
setdest	*CMU*			√	
mobgen	*Colorado school of mines*			√	
BonnMotion	*Univ. of Bonn*	√		√	
iNSpect	*Colorado school of mines*		√		√
RMobiGen	***UNBC***	√	√	√	√

Summary

§ RMobiGen is:

  § **Comprehensive**: Trace generation tool & trace analysis tool, extensive analysis functionalities supported.

  § **Generic**: Supports the five generic mobility models. Various mobility can be obtained by supplying different parameters.

  § **User-Friendly**: Graphical User Interface.

  § **Convenient**: Direct access from Internet, no need for any installation.

  § Available at: *http://web.unbc.ca/~csalex/research*

Questions ?