MONGOOSE
a MObility sceNario Generation tOOl for Structured Environments

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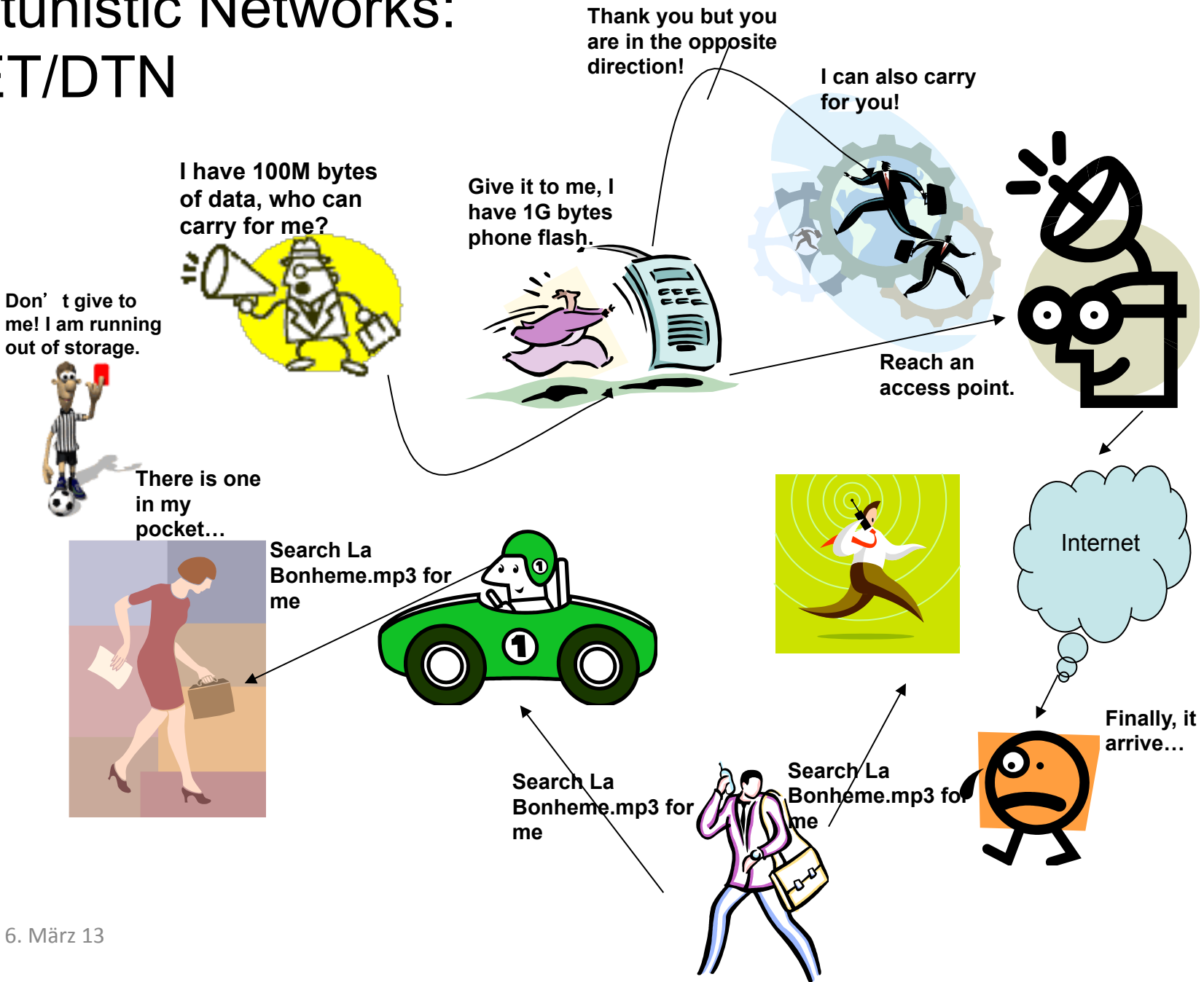
Outline

- Introduction
  - Opportunistic networks
  - Structured scenarios
  - Mobility models
- MONGOOSE: a MObility sceNario Generation tOOl for Structured Environments
- Initial simulation study
- Conclusion & Future Work
- Demo

Opportunistic Networks: MANET/DTN



- 25 Smart Phones distributed
  - 18 mobile
  - 7 fixed
- Granularity of measurement (around 134 sec)
- Log {time; [MAC address]}
- Experiment duration: 6 days
  - from 09:00am to 09:00pm
- Bluetooth radio
- 752 external devices
- 284492 Contacts SP
- 60223 Contacts SP/ED

MONGOOSE

- Creates structured scenarios and allows further mobility models to be easily hooked
- Mobility traces for some traditional random mobility models can also be produced
- The plan structure can be described without programming requirements
- Fine-grained movement traces for shopping mall scenarios as well as for other different structured environments can be generated
- The generated mobility traces are compatible with the OMNeT++ simulator
- Easy to use: starting the program without or with incomplete command line parameters prints a detailed help message

MONGOOSE

- SVG applications to define the environment, made of boundaries, obstacles, walls, paths, intersections and restrictions of the simulated world
- Tested with Inkscape 0.46
- Requires more parameters:
  - simulation time,
  - random seed,
  - higher and lower speed of the nodes,
  - pause between two successive movements
- Configurations:
  - SimplestRWP,
  - RandomWayPoint,
  - StructuredMotion

MONGOOSE

- `MM <output file> <application> <plan> <parameters>`
- `<output file>`: movement traces saved in a file by `-f`
  - ".params" containing the complete set of parameters used for the simulation
  - ".movements.gz" containing the movement data
- `<application>` identifies one configuration
- `<plan>`: input an svg file
- `<parameters>`: simulation time, speed range and pause time of the nodes involved
  - Random seed `-R`
  - Maximum `-h` and minimum speed `-l`
  - Pause time `-p`
  - Scenario duration `-d`
  - Initial skipping `-i`

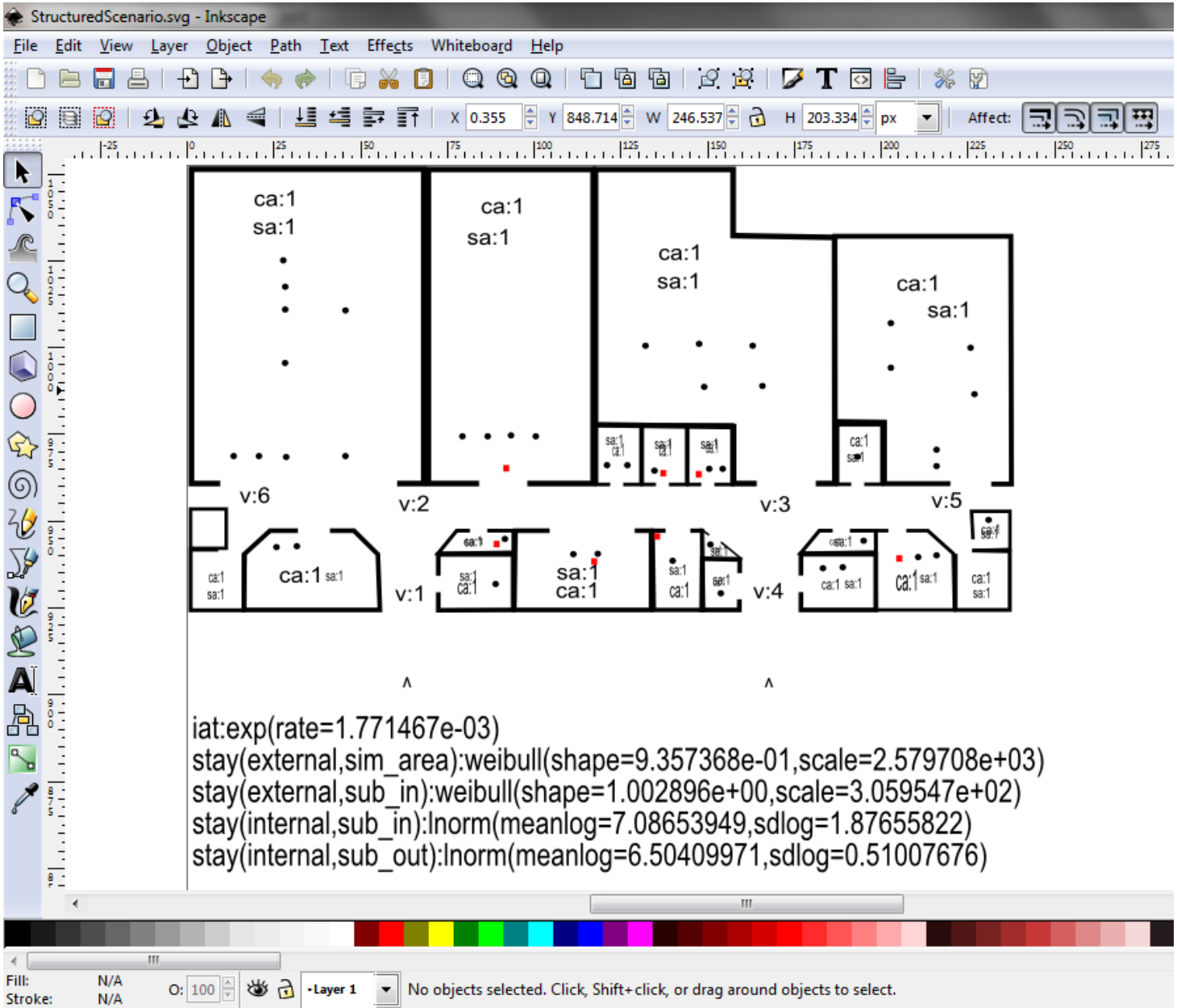
MONGOOSE

- `MM <output file> <application> <plan> <parameters>`
- `MM -f scenario StructuredMotion drawing.svg \`
  `-d 43200 -i 3600 -h 1.65 -l 1.15 -p 2`

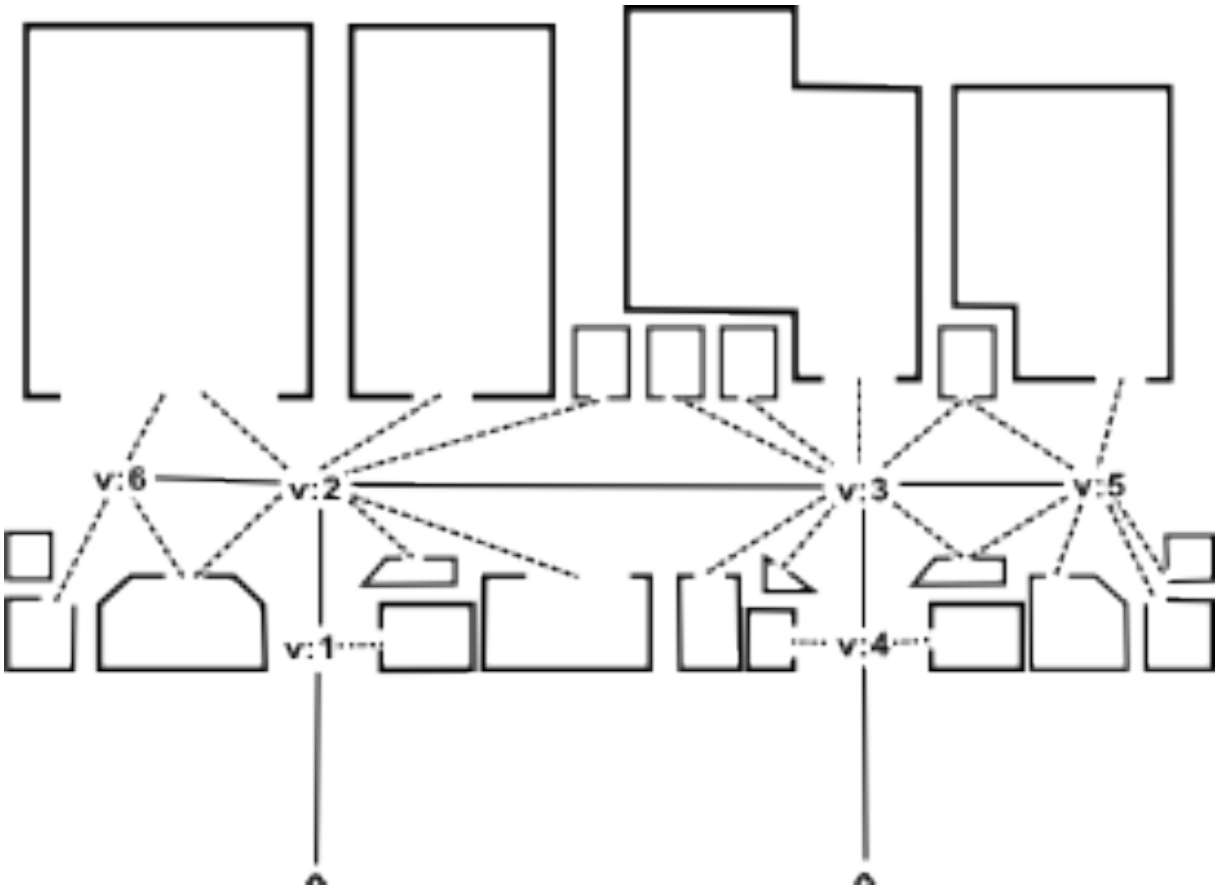
- Supports 5 cumulative distribution functions:
  - Exponential, Gamma, Lognormal, Weibull, Linear
    (system of linear distributions and contiguous codomains)

- `iat:F(α,β,..)`
- `stay[(external,[sim_area|sub_area])|`
  `(internal,[sub_in|sub_out])]:F(α,β,..)`

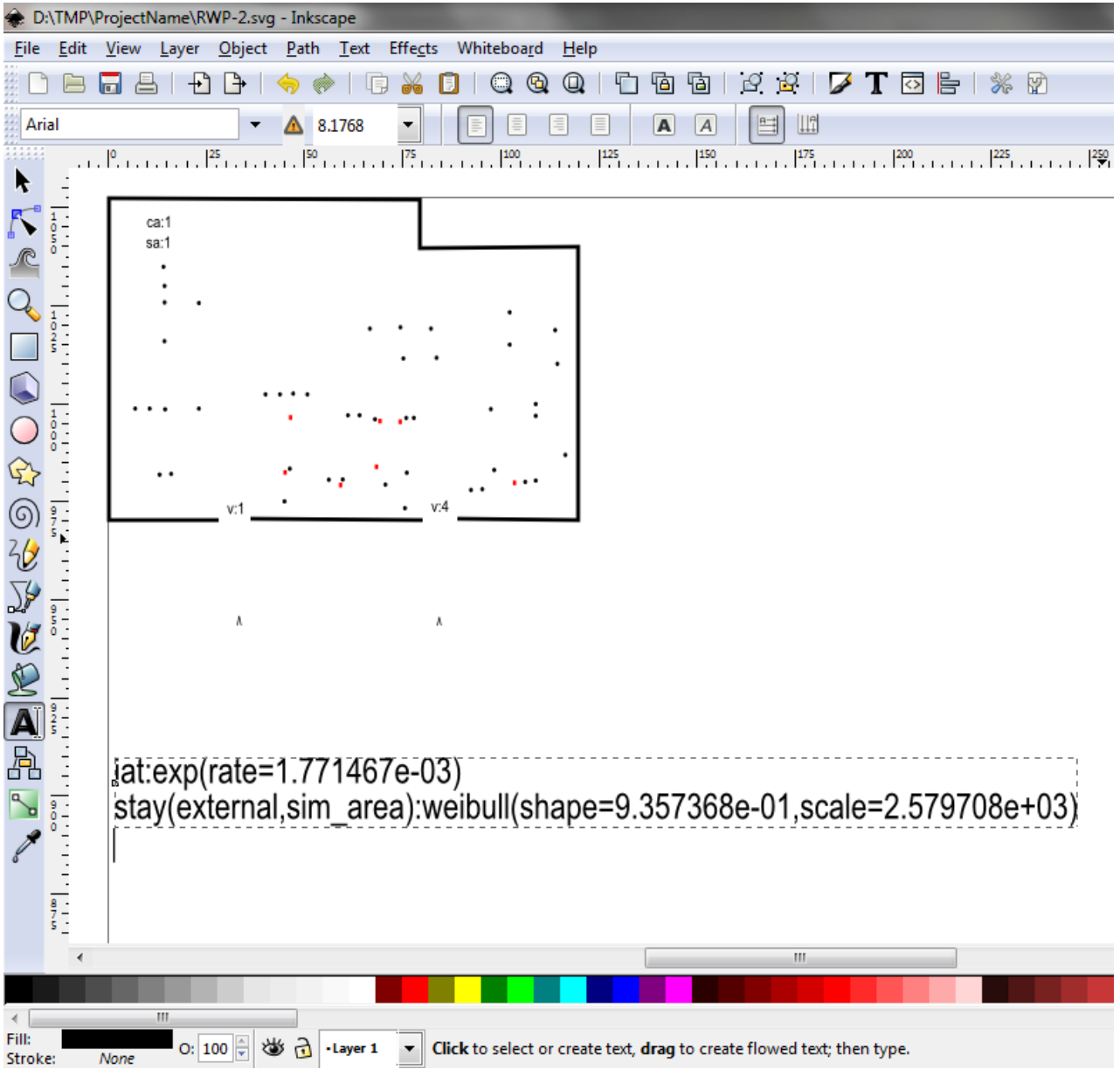
StructuredMotion



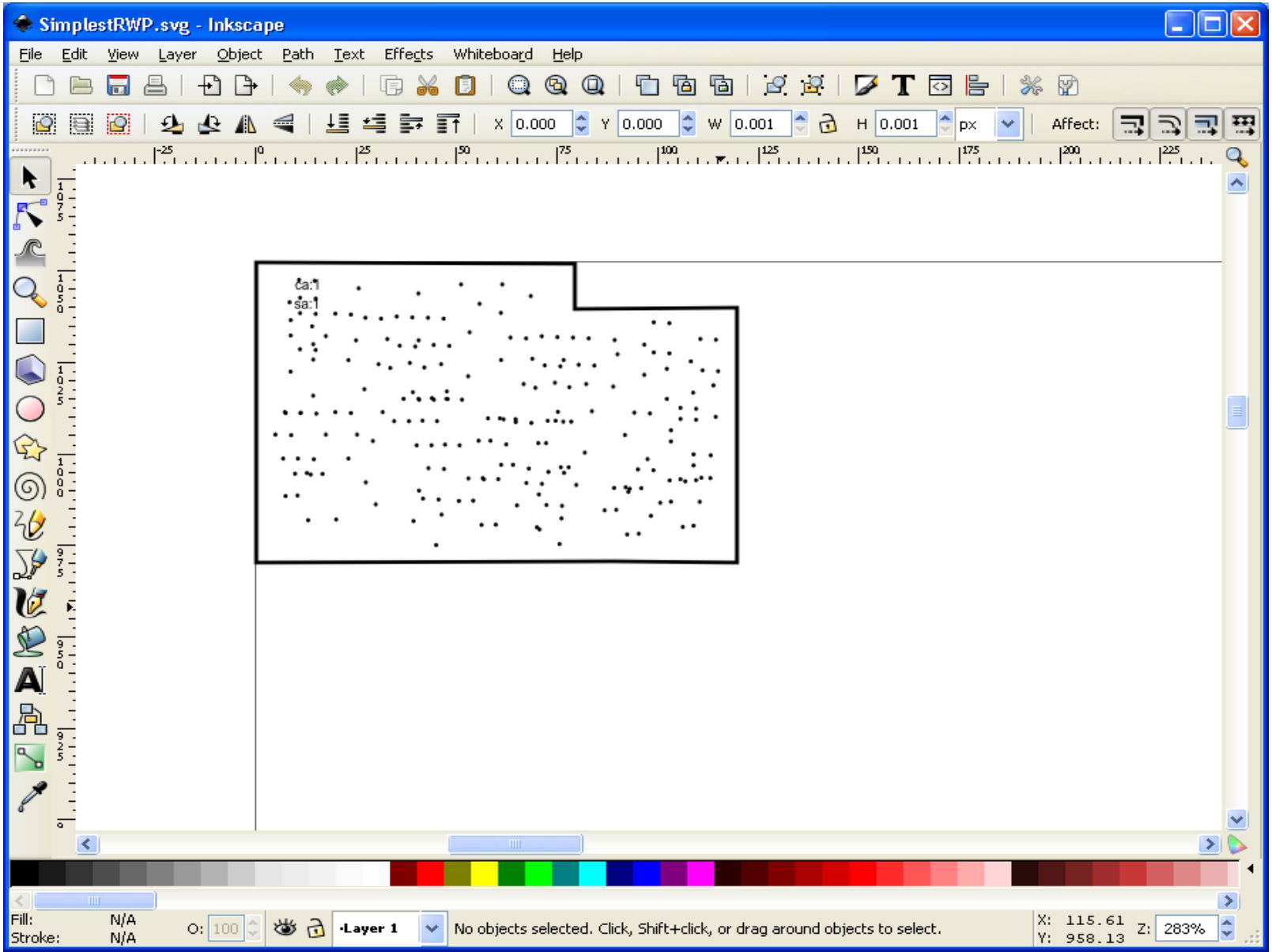
Pathway graph



RandomWayPoint



SimplestRWP



Simulation Study

- Performance of 2 DTN routing protocols
  - Epidemic:
    - Flood the network
  - Prophet
    - Consider previous encounters
- Different mobility models
  - Random Walk (rw)
  - Random Walk with Inter-arrival time (irw)
  - Random Way-Point with Inter-arrival time (irwp)
  - Shopping Mall (sm)
- Mixim / OMNet++
- HPC

Simulation Scenarios

- 45 sellers
- 10880m^2
- Scale simulation playground 2px=1m
- Same attraction level 1
- No fixed nodes
- N. customers varying according to the inter-arrival time distribution

Shopping Mall Scenario Based on 4 MMs

- Our Shopping Mall
  - `MM -f scenario StructuredMotion drawing.svg -d 43200 \ -i 3600 -h 1.65 -l 1.15 -p 2`
  - `iat: exp(rate=1.771467e-03) (4)`
  - `stay(externals,sim_area): weibull(shape=9.3573e-01, scale=2.5797e+03) (5)`
  - `stay(externals,sub_area): weibull(shape=1.0028e+00, scale=3.0595e+02) (6)`
  - `stay(internals,sub_in): lnorm(meanlog=7.08653949, sdlog=1.87655822) (7)`
  - `stay(internals,sub_out): lnorm(meanlog=6.50409971, sdlog=0.51007676)`

Shopping Mall Scenario Based on 4 MMs

- Random Way-Point with inter-arrival time
  - `MM -f scenario RandomWayPoint RWP.svg -d 43200 \ -i 3600 -h 1.65 -l 1.15 -p 2`
- Random Walk with inter-arrival time
  - `MM -f scenario RandomWayPoint RWP.svg -d 43200 \ -i 3600 -h 1.65 -l 1.65 -p 0`
  - `iat: exp(rate=1.771467e-03) (4)`
  - `stay(externals,sim_area): weibull(shape=9.3573e-01, scale=2.5797e+03) (5)`

Shopping Mall Scenario Based on 4 MMs

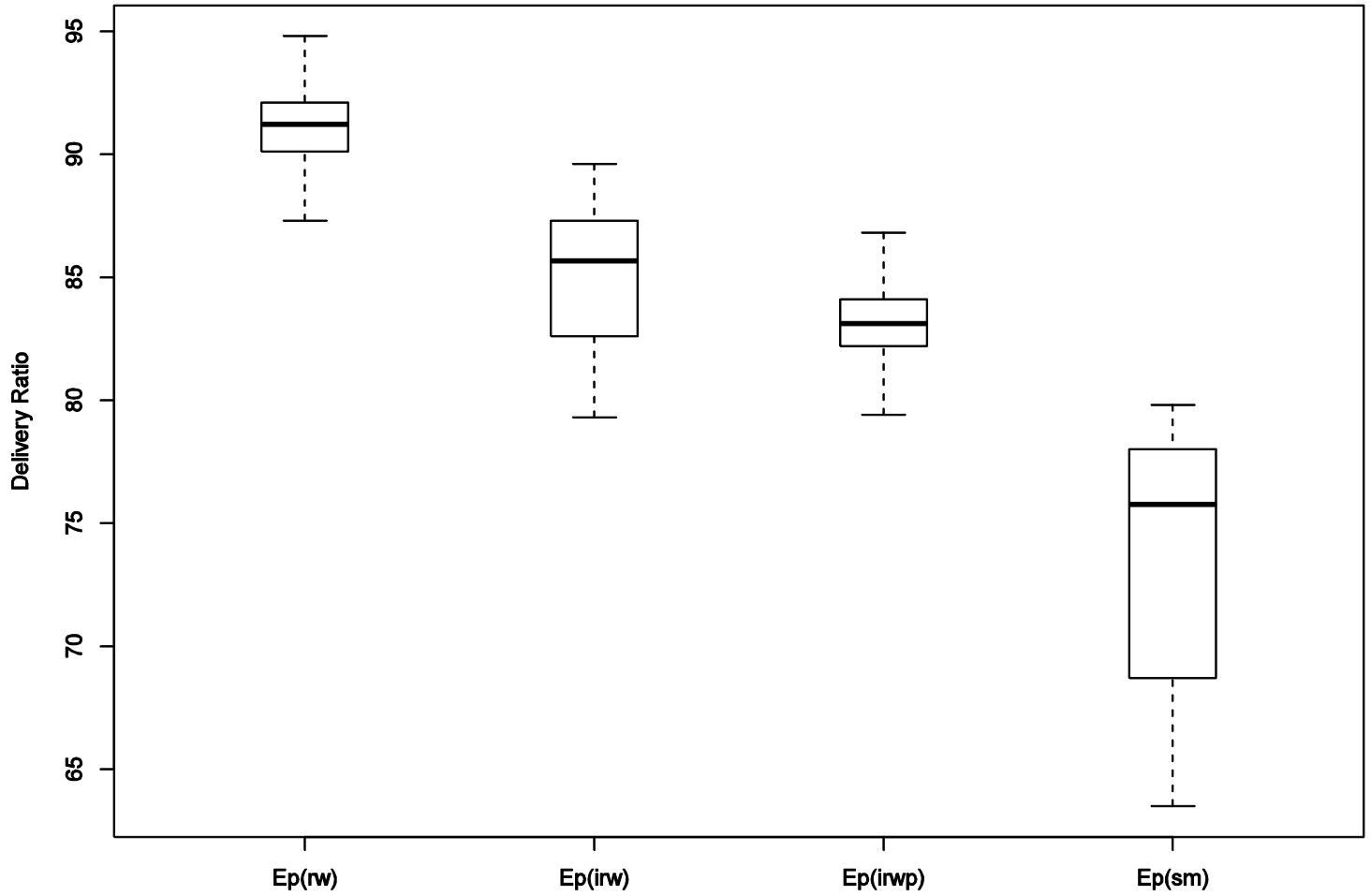
- Random Walk
  - `MM -f scenario SimplestRWP Simple.svg -d 43200 \ -i 3600 -h 1.65 -l 1.65 -p 0`
- 225 nodes always present
  - 45 sellers + mean of customers in a steady state following the inter-arrival time distribution

Settings

- Network level
- No retransmission
- Free space propagation
  - 30m
  - 120s
- Buffer size 100 slots
  - 10% n. of messages
  - 1 message per slot
- Minimum interval between two messages: 0.1s
- Random sender and receiver
  - Customers and Sellers combinations
  - 95% confidence interval

Epidemic

Delivery ratio



rw
Random
Walk

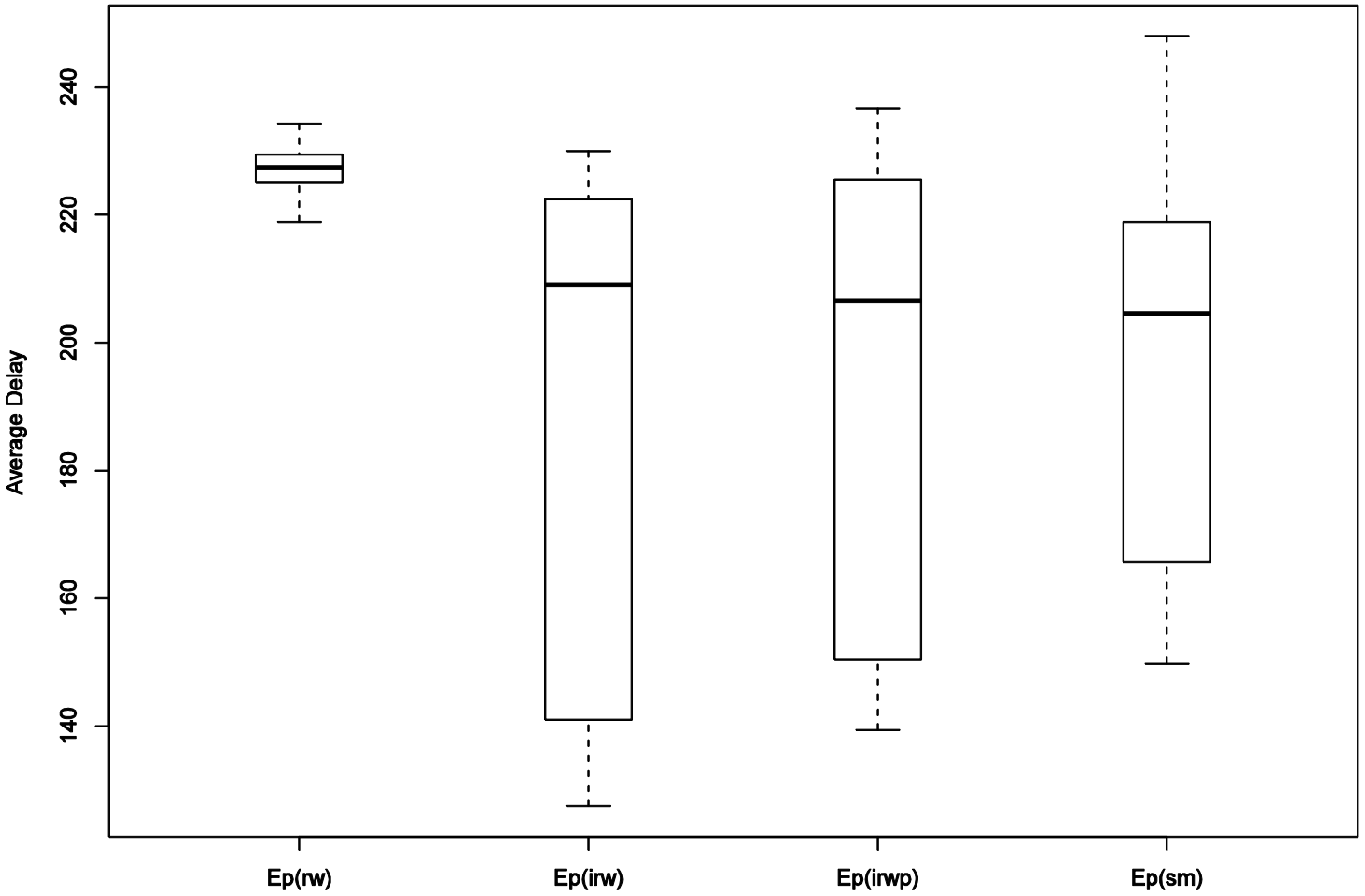
irw
Random
Walk
inter-arrival

irwp
Random
Way-Point
inter-arrival

sm
Shopping
Mall

Epidemic

Average Delay



rw
Random
Walk

irw
Random
Walk
inter-arrival

irwp
Random
Way-Point
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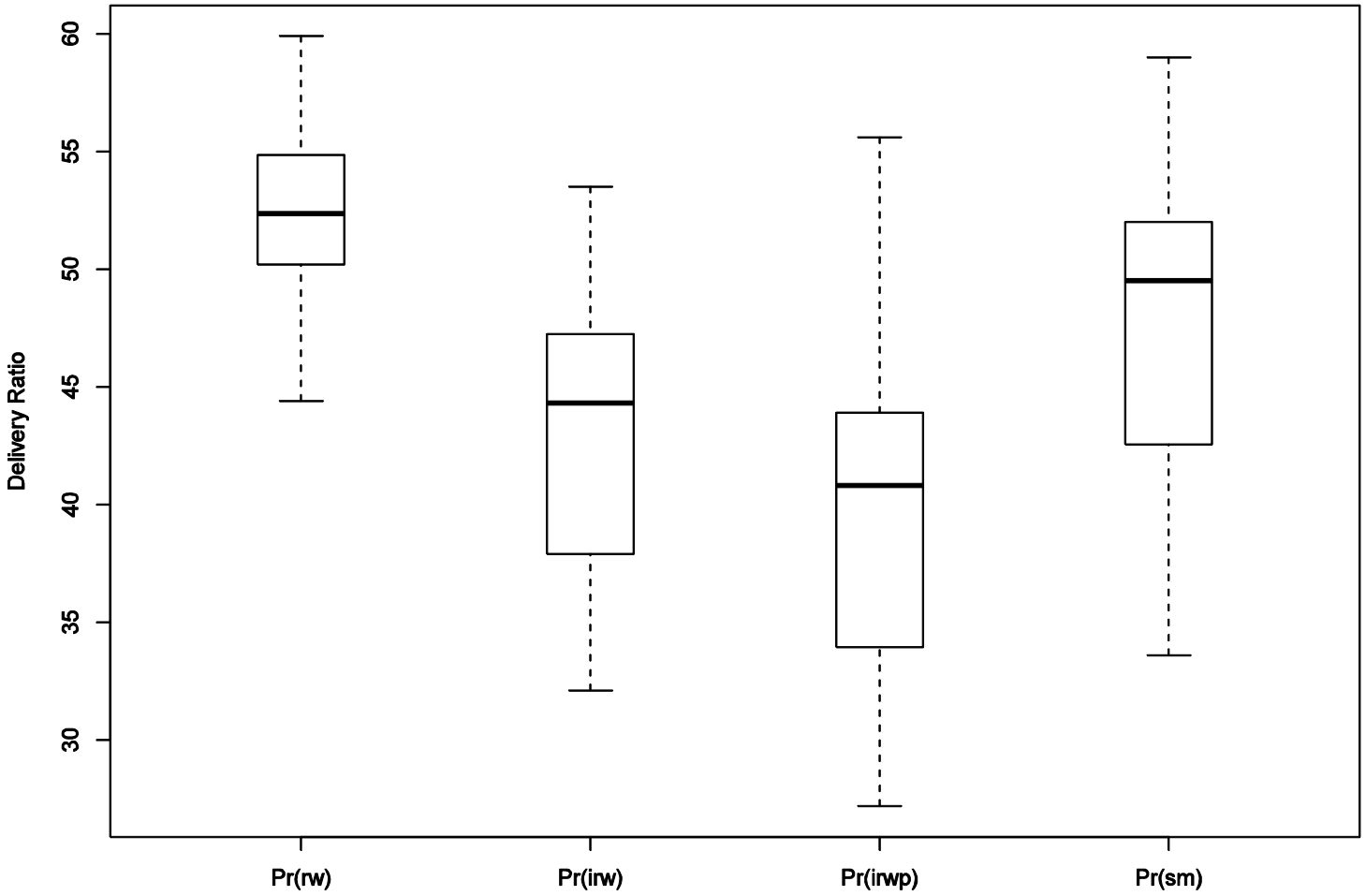
sm
Shopping
Mall

Prophet

Delivery ratio



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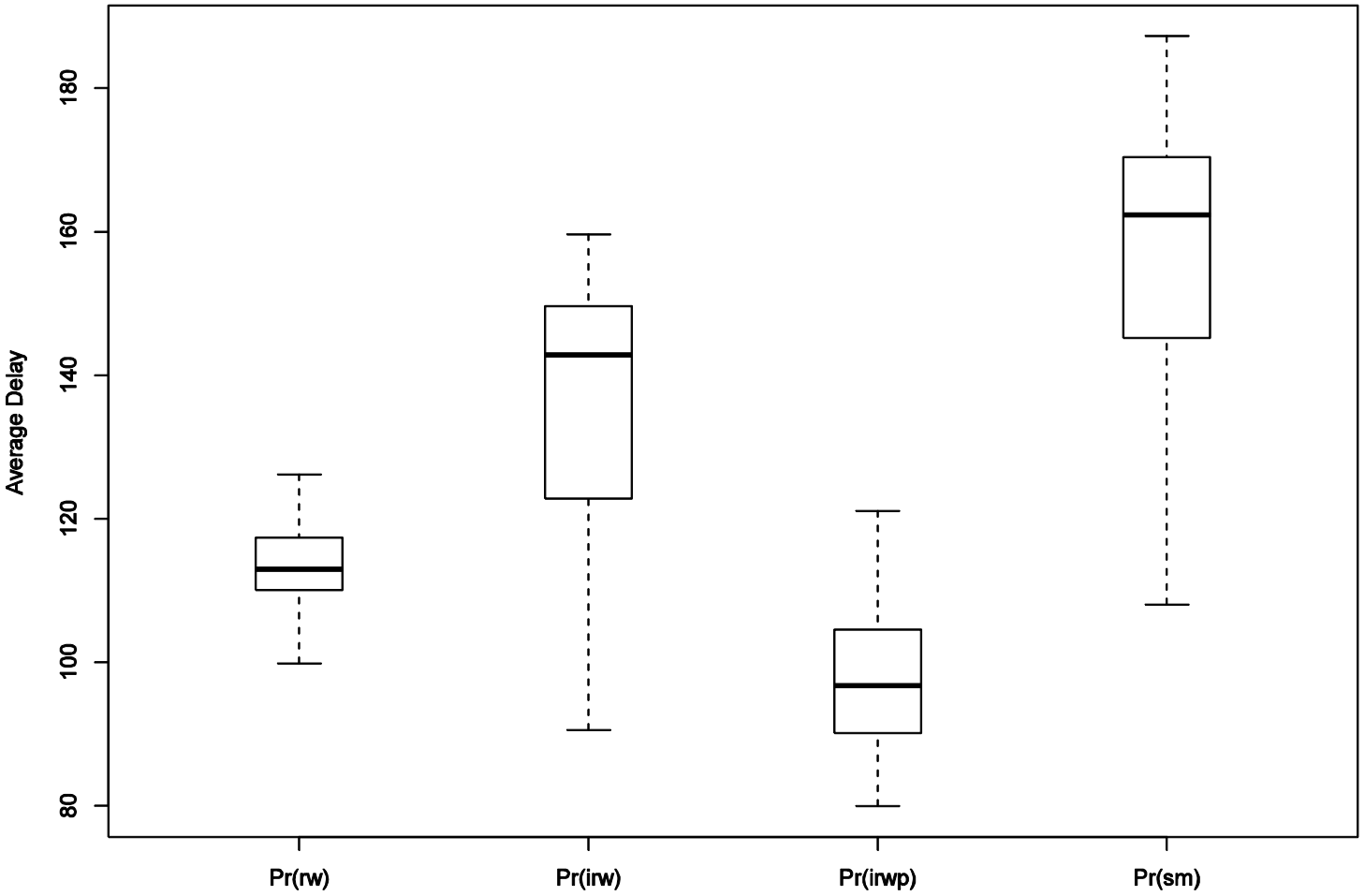
Average Delay



rw
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Walk

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irwp
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Conclusion & Future Work

- MONGOOSE: a MObility sceNario Generation tOOl for Structured
- Generates fine-grained mobility traces for
  - Structured scenarios (e.g. shopping malls, urban areas, museums, schools, hospitals, music festivals, amusement parks, stadiums and airports)
  - Some traditional random based mobility models
  - Two groups of nodes, internals and externals, with different mobility patterns
- Given proper parameters it can produce different kind of scenarios
- Allows further mobility models to be easily plugged-in
- Reduces programming requirements as the plan structure can be drawn by means of SVG graphics editors
- Shown that the choice of a mobility model affects the performance of routing protocols
- We would like to
  - add further mobility models
  - provide related parameters to generate more realistic mobility scenarios
  - consider group relationships and more sub-populations expressing different mobility patterns.

Thank you!

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- Adriano Galati, Chris Greenhalgh,
  "*Human Mobility in Shopping Mall Environments*",
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- Adriano Galati, Karim Djemame, Chris Greenhalgh,
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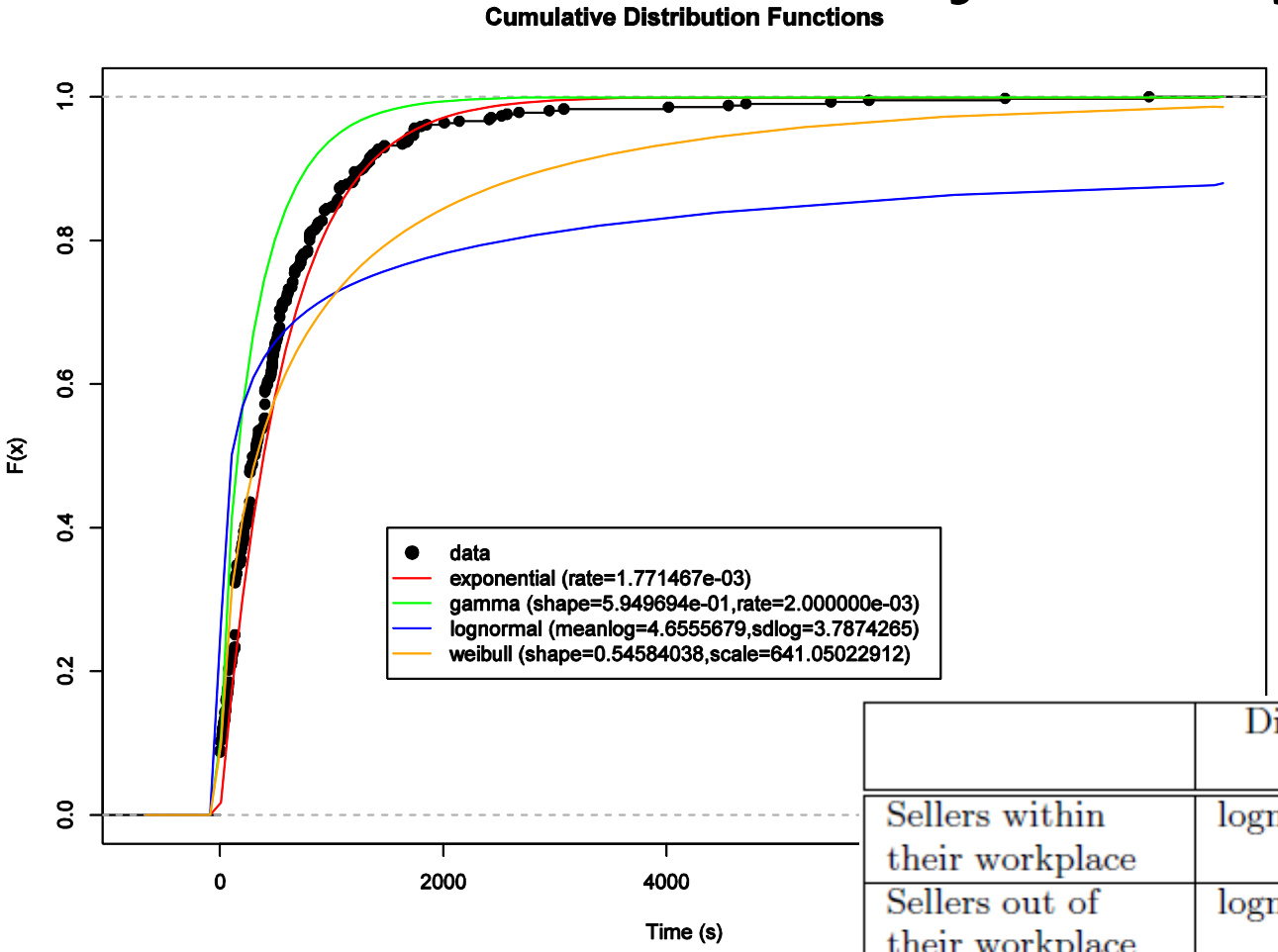
  at the IEEE Wireless Days Conference, IFIP - November 21st-23rd 2012, Dublin, Ireland.
- Adriano Galati, Chris Greenhalgh,
  "*Exploring Shopping Mall Environment for Ubiquitous Computing*",
  In Ubicomp at a Croassroads, Imperial College London, January 6th and 7th 2009

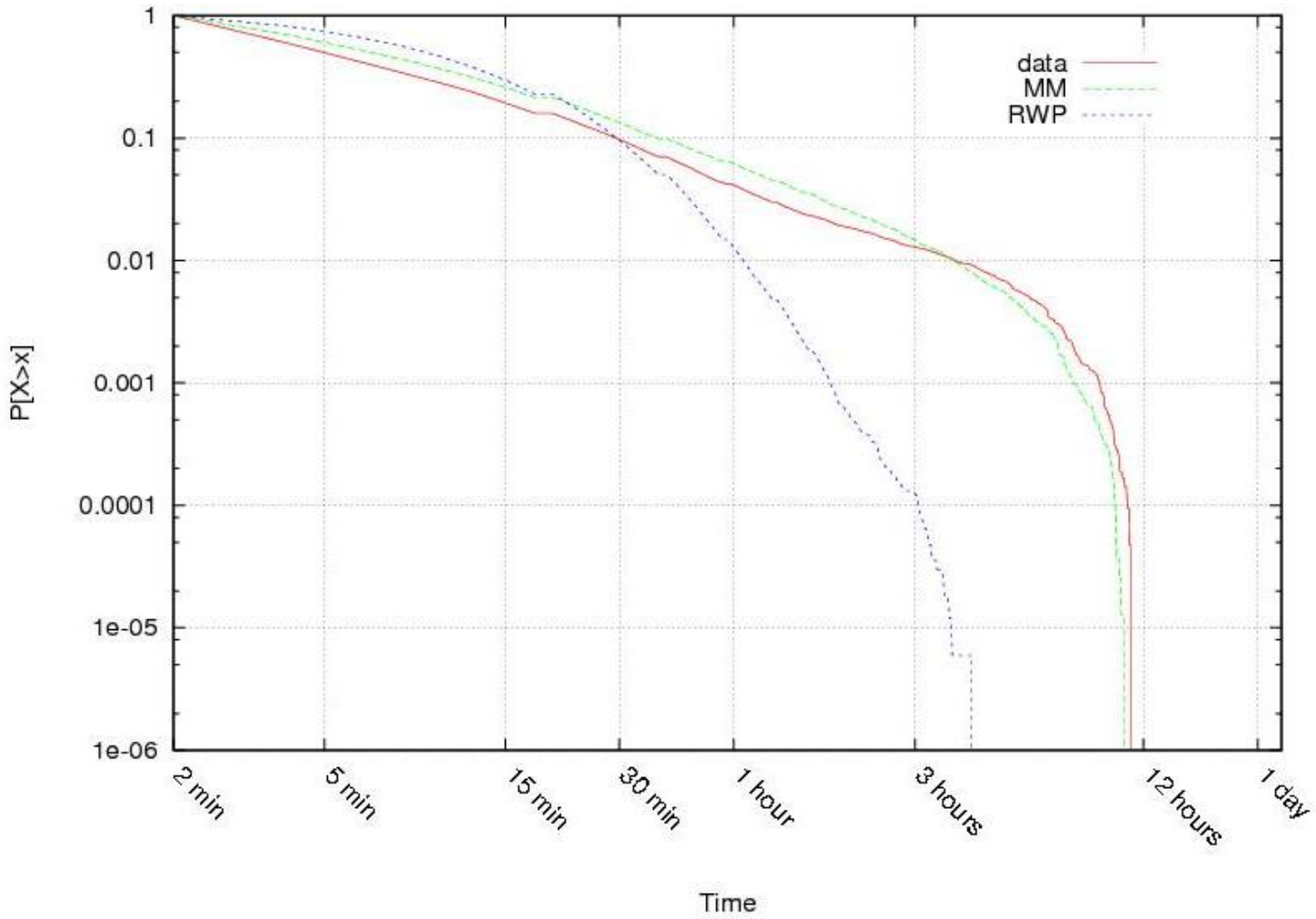
Sensitivity Analysis



	Dist.	Parameters	K-S test distance
Sellers within their workplace	lognorm	$\mu = 7.086539$ $\sigma = 1.876558$	0.1405
Sellers out of their workplace	lognorm	$\mu = 6.504099$ $\sigma = 0.510076$	0.1902
Customers' interarrival time	exp	$\beta = 1.771e-03$	0.1144
Customers within the mall	weibull	$\alpha = 9.357e-01$ $\beta = 2.579e+03$	0.0639
Customers within a single shop	weibull	$\alpha = 1.002e+00$ $\beta = 3.059e+02$	0.3519

Validation

Comparison between synthetic and real traces: cumulative distributions of inter-contact time



Validation

Comparison between synthetic and real traces: cumulative distributions of contact duration