Corso di Qualità del Servizio e Sicurezza

Analisi della mobilità in ambienti wireless

18 Aprile 2016

Mobility Generation
GEOGRAPHICAL PATTERNS – EXAMPLE

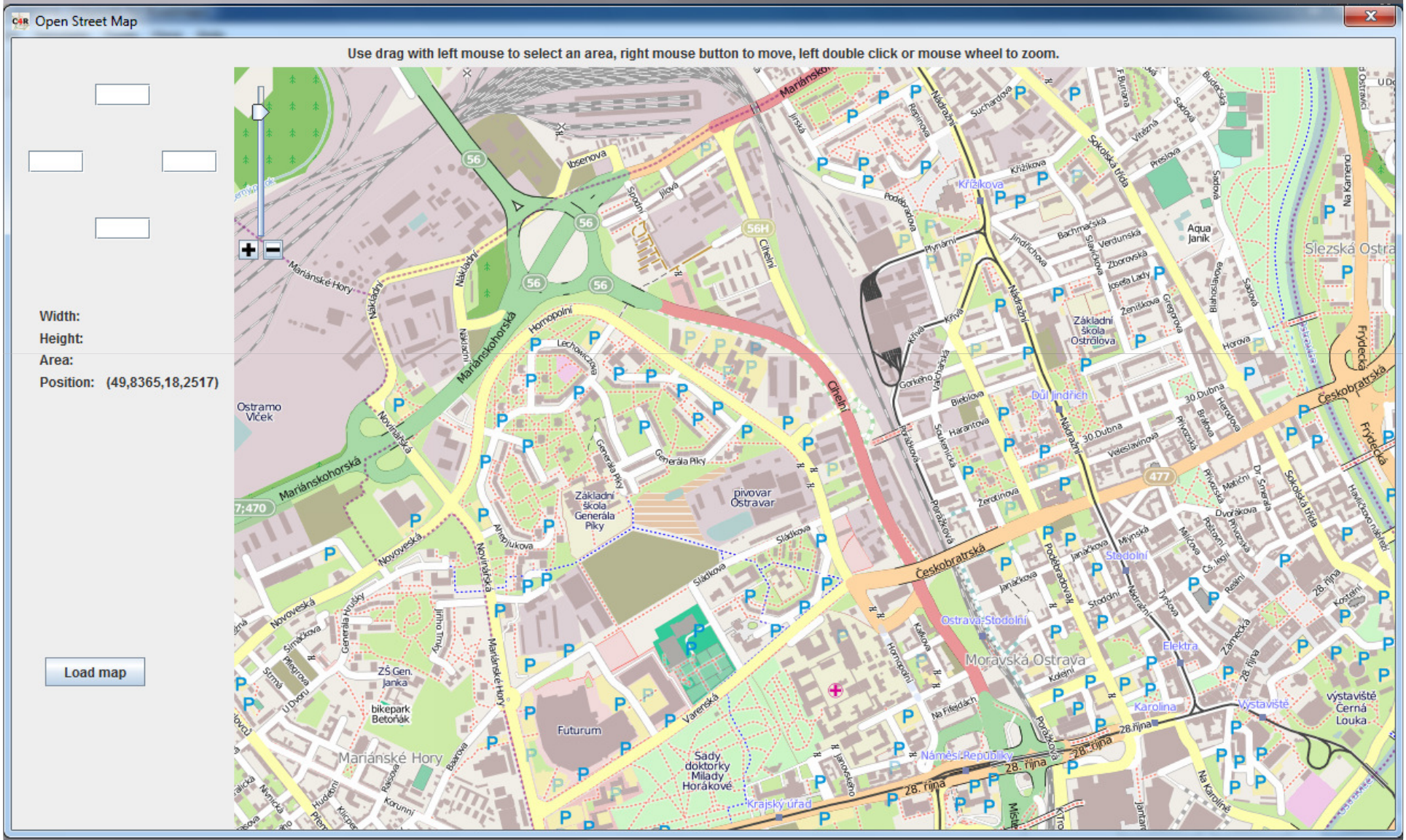
City 4 Roadmaps [Martinez]

It is a mobility generator software based on real roads (www.openstreetmap.org), which can be chosen for the considered coverage area.

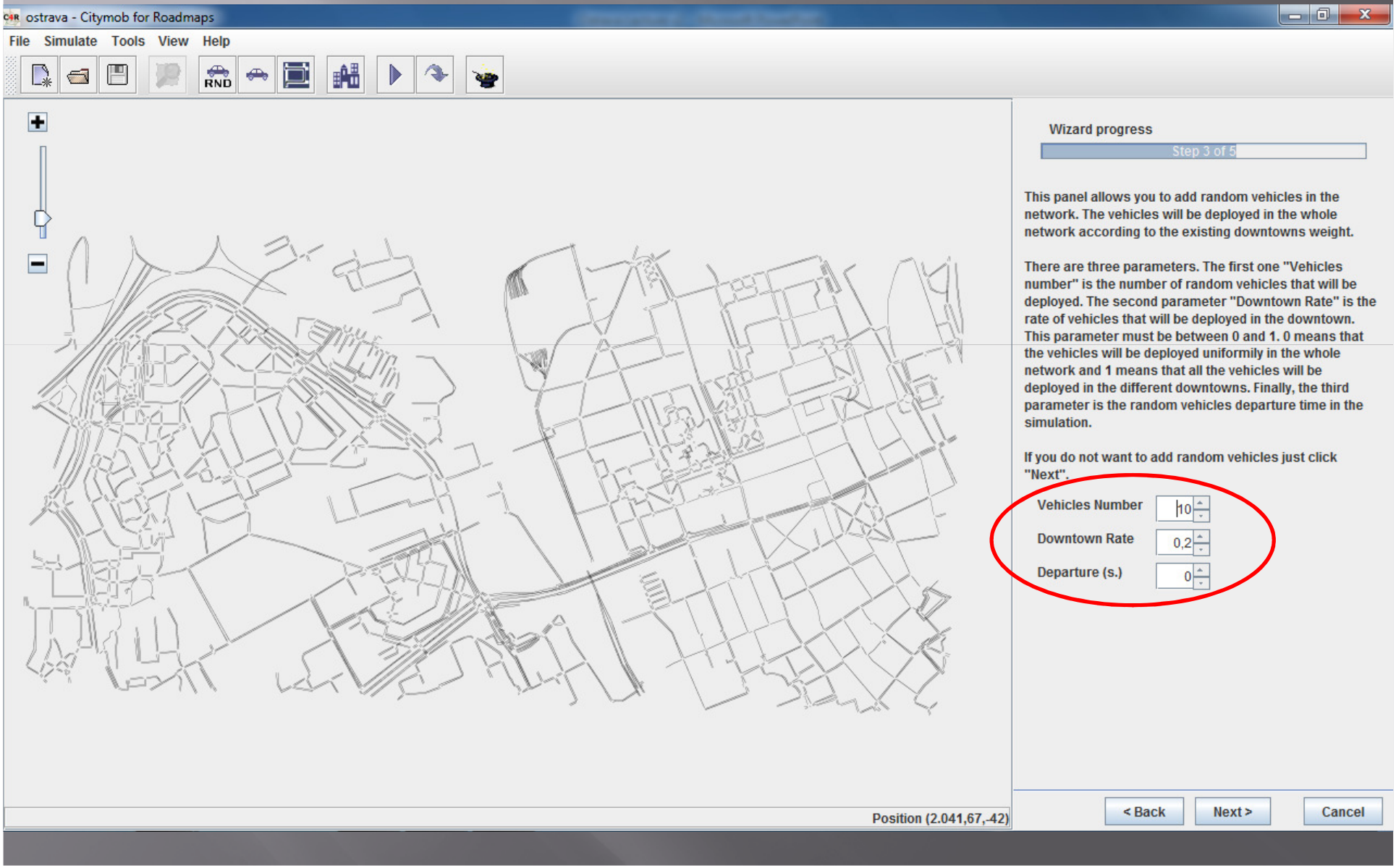
[Martinez] Martinez, F.J., Cano, J.-C., Calafate, C.T., Manzoni, P., "CityMob: A Mobility Model Pattern Generator for VANETs", IEEE ICC Workshops.

Mobility Generation

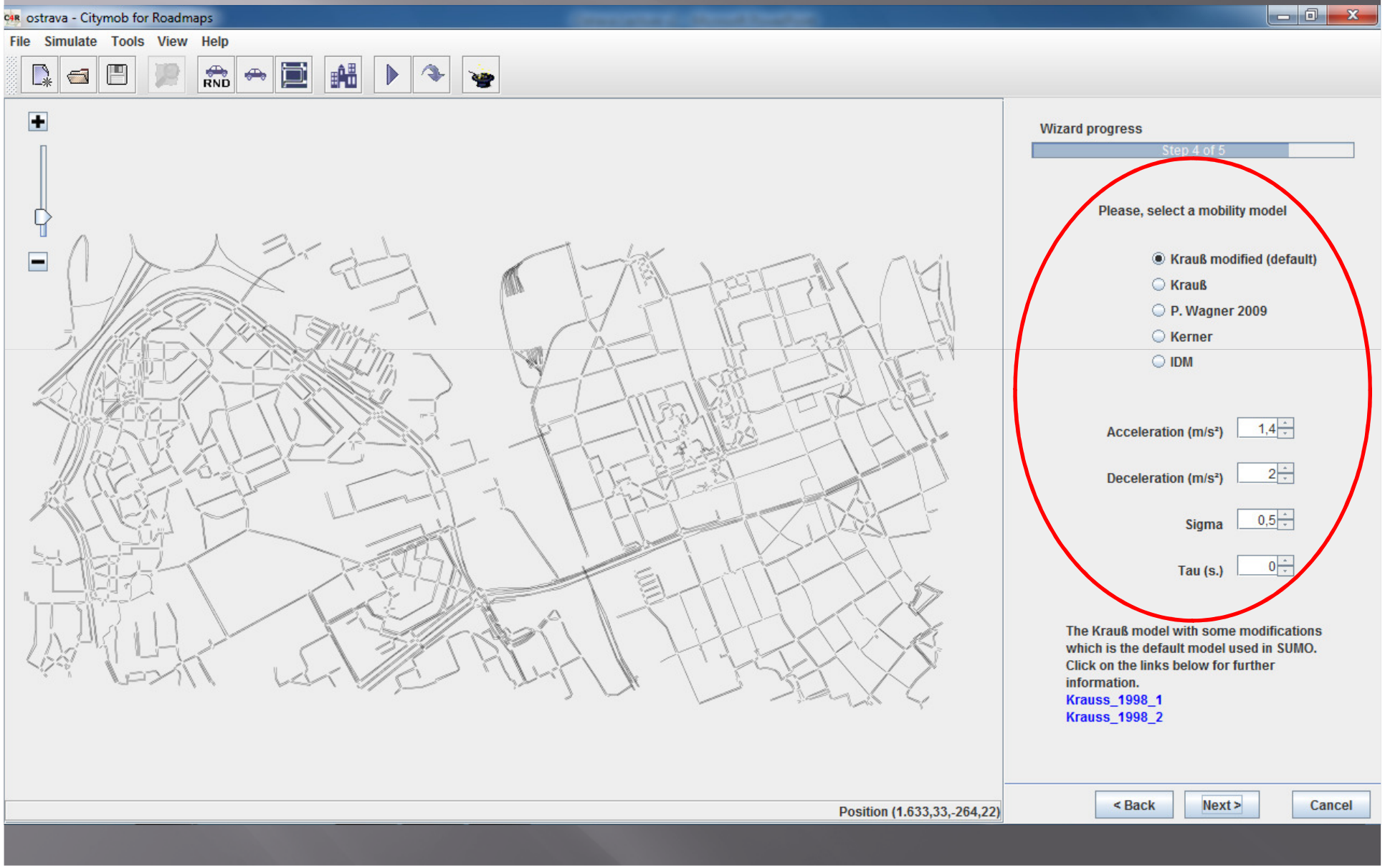
GEOGRAPHICAL PATTERNS – EXAMPLE



Mobility Generation
GEOGRAPHICAL PATTERNS – EXAMPLE



Mobility Generation
GEOGRAPHICAL PATTERNS – EXAMPLE



Mobility Generation
GEOGRAPHICAL PATTERNS – EXAMPLE

ostrava_1.tcl - Blocco note

File Modifica Formato Visualizza ?

```
# # This file was parsed with Citymob for Roadmaps (C4R) version 1.0#
#Node 0 = random_undefined_0_0$node_(0) set X_ 2094.08$node_(0) set Y_ 476.42$node_(0) set Z_ 0.0
#Node 1 = random_undefined_1_0$node_(1) set X_ 2354.33$node_(1) set Y_ 310.05$node_(1) set Z_ 0.0
#Node 2 = random_undefined_2_0$node_(2) set X_ 99.87$node_(2) set Y_ 587.89$node_(2) set Z_ 0.0
#Node 3 = random_undefined_3_0$node_(3) set X_ 2363.95$node_(3) set Y_ 307.37$node_(3) set Z_ 0.0
#Node 4 = random_undefined_4_0$node_(4) set X_ 2345.17$node_(4) set Y_ 949.64$node_(4) set Z_ 0.0
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#Node 7 = random_undefined_7_0$node_(7) set X_ 2183.79$node_(7) set Y_ 502.41$node_(7) set Z_ 0.0
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#Node 9 = random_undefined_9_0$node_(9) set X_ 118.54$node_(9) set Y_ 128.36$node_(9) set Z_ 0.0
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dest 1142.7416929833369 278.52782213957624 24.039769935939255"$ns_ at 93.0 "$node_(0) setdest 1131.6495335068382 270.58971164979823 13.640000000000008"$ns_ at
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00158056533 342.2535175699035 13.879864140678968"$ns_ at 139.0 "$node_(1) setdest 1382.7762270017322 337.3317361840561 13.539999999999994"$ns_ at 140.0 "$nod
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```

sabato 3 novembre 2012

Mobility Generation

Once the patterns coordinates have been created, they can be used for the desired purposes. In our fields of research, mobility patterns have to be **analyzed** accurately.

Summary

- QoS in Telecommunication Systems
- Wireless Communications and Issues
- Wireless Channel Modeling
- Bandwidth Management
- Mobility Generation
- **Mobility Analysis and Prediction**
- Some Reachable Results and Conclusions
- Research Group Description

Mobility Analysis and Prediction

Let us recall what previously exposed:

Bandwidth Management

Passive Reservation Issues

1) First of all, the time spent in each cell has to be considered (Cell Stay Time – CST);

2) The number of hand-over events has to be evaluated, so the coverage network can know how many cells a mobile host will visit;

3) For 2D scenarios, the exact cells that a mobile host will visit need to be identified.

Let us see how mobility can be "generated" and, then, analyzed.

How can the CST be evaluated?

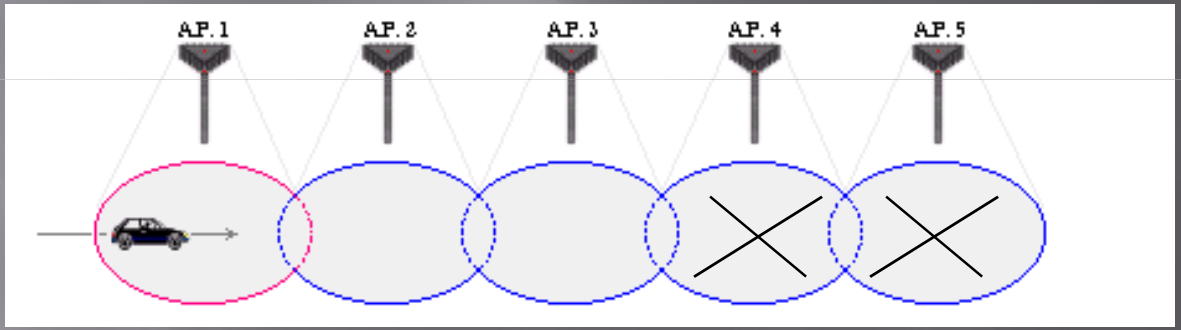
How can the number of h.o. be evaluated?

What cells will a mobile host visit?

Mobility Analysis and Prediction

How to evaluate the CST

Mono-dimensional case: depending on its mobility characteristics, a single user may not visit all the cells of the system:

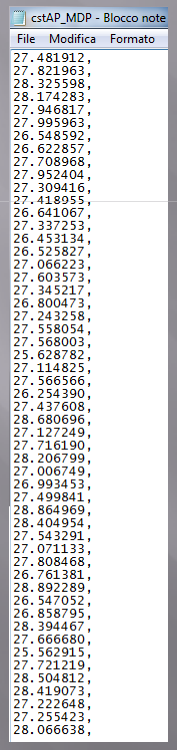


CST can be evaluated by observing users mobility through simulations campaigns, considering the time spent by a single user under a cell coverage area.

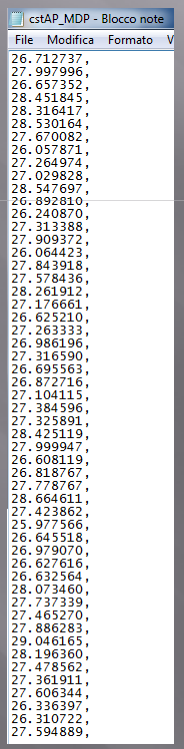
Mobility Analysis and Prediction

How to evaluate the CST – simulation campaigns

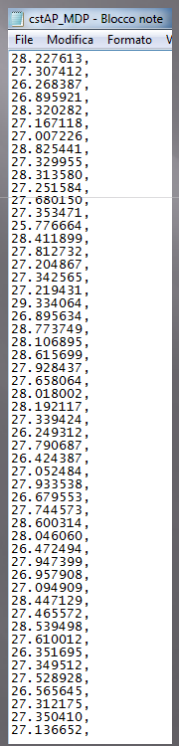
Mono-dimensional case: for each cell of the system the hand-in arrival and hand-out departure times are stored.



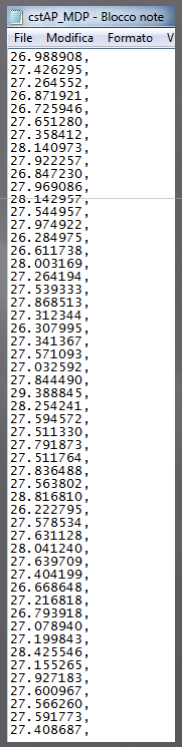
Cell 1



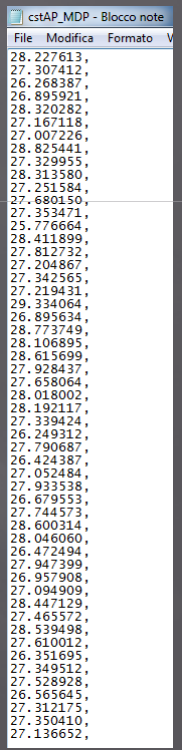
Cell 2



Cell 3



Cell 4

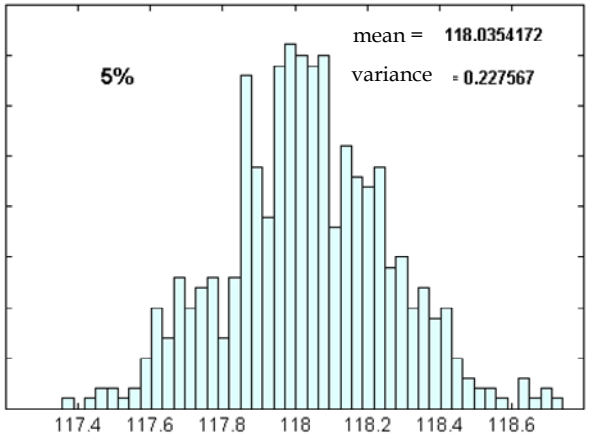


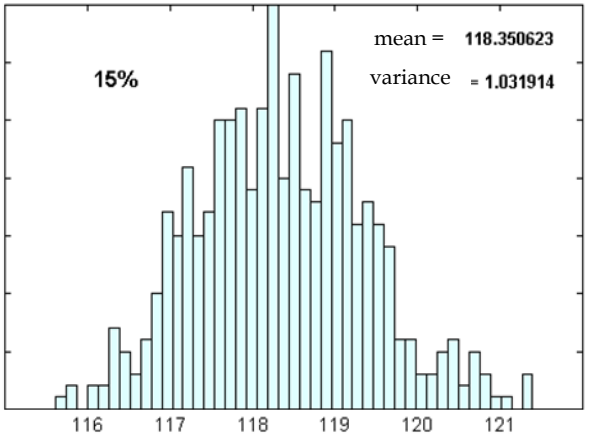
Cell 5

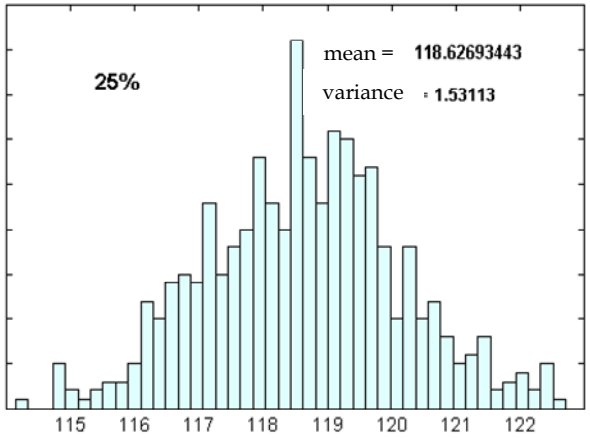
Mobility Analysis and Prediction

How to evaluate the CST – simulation campaigns

Mono-dimensional case: for each run of simulation campaigns the obtained results are averaged.







GAUSSIAN DISTRIBUTIONS CAN BE CONSIDERED!

Mobility Analysis and Prediction

How to evaluate the CST – simulation campaigns

The number of cells that a user will probably visit can be evaluated as follows:

$$C_p = \left\lceil \frac{T_{CHT}}{T_{CST}} \right\rceil$$

$$f(x) = \frac{1}{\mu} e^{-\frac{x}{\mu}}$$

Exponential distribution
(from literature)

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Gaussian distribution

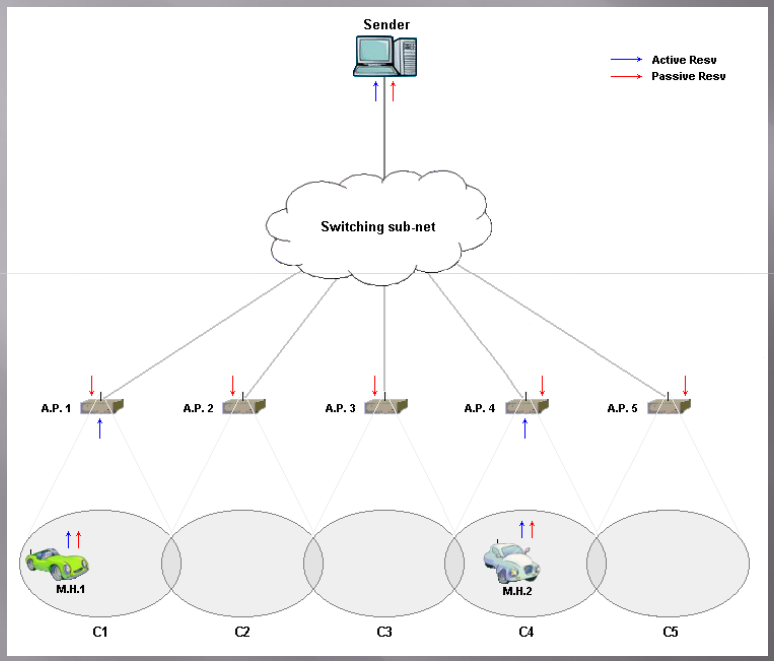
The value of Cp is used only for a quantitive purpose and the assumption of a CST normally distributed has been verified through a KS-test.

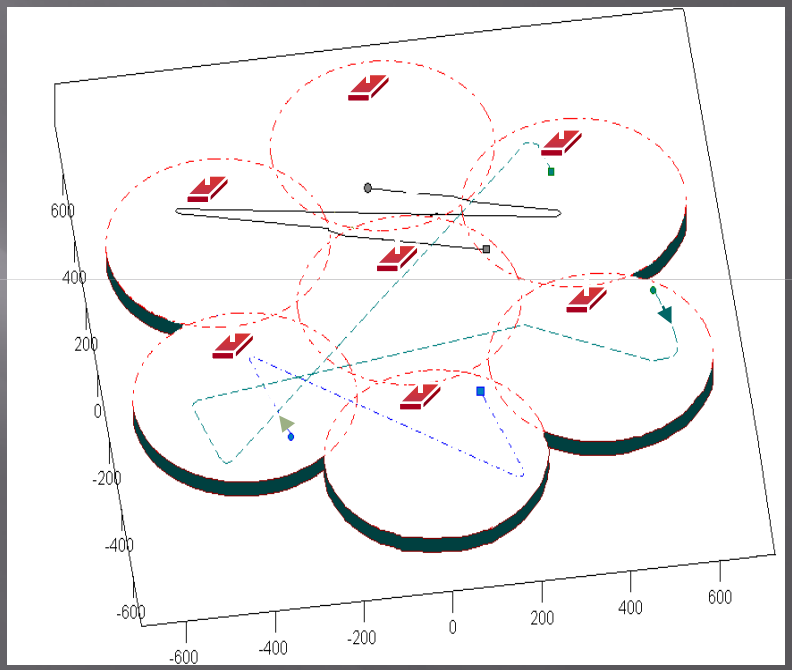
WHAT ABOUT 2D ENVIRONMENT?

Mobility Analysis and Prediction

From 1D to 2D

Let us now consider real scenarios (2D):



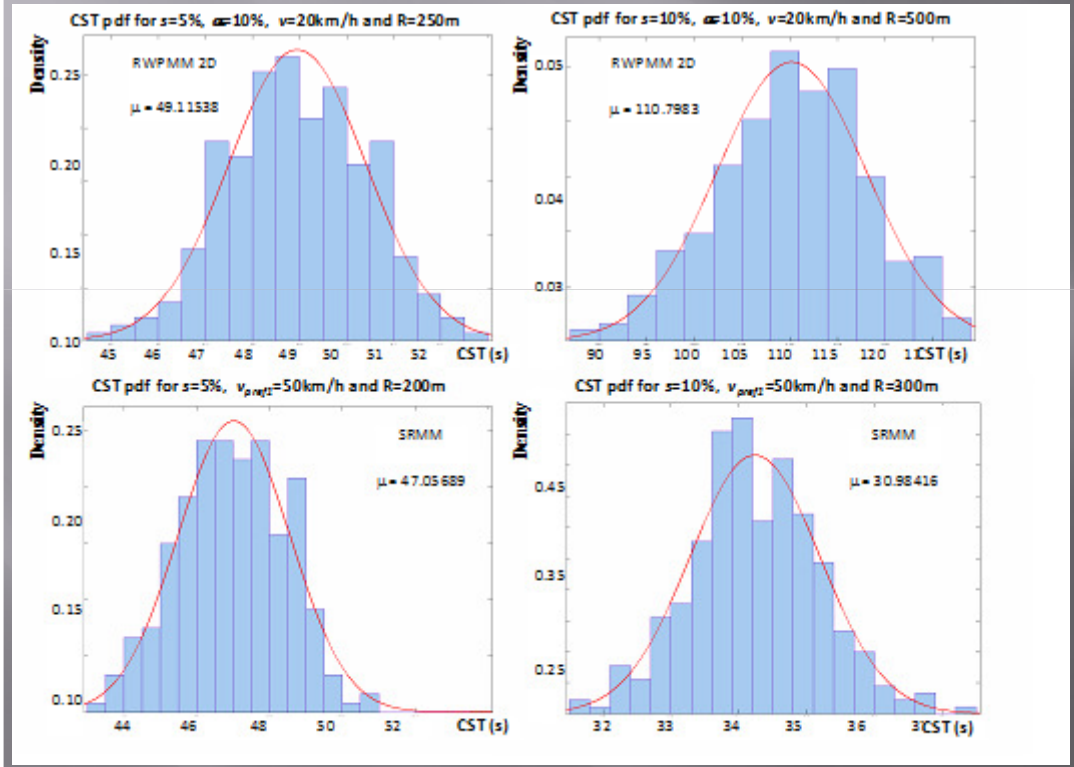


Are there new issues?

Mobility Analysis and Prediction

From 1D to 2D

Other simulation campaigns have been carried out in order to evaluate **CST** distribution.

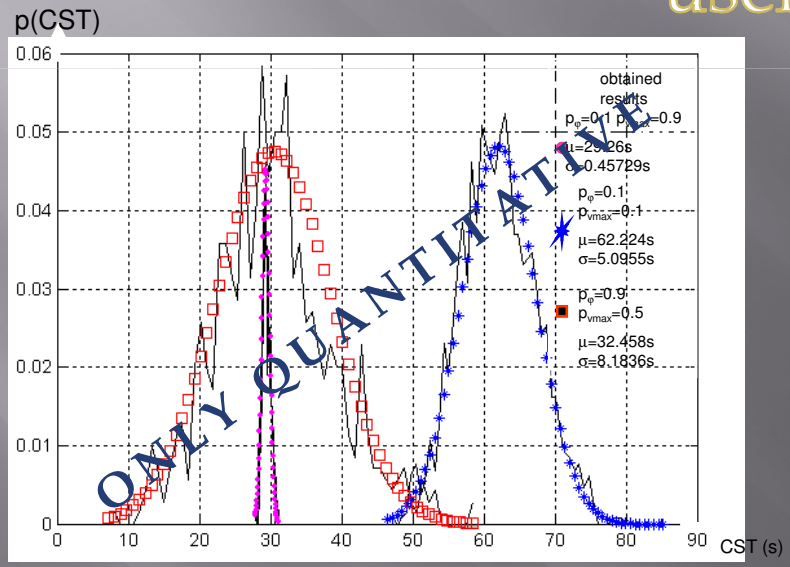


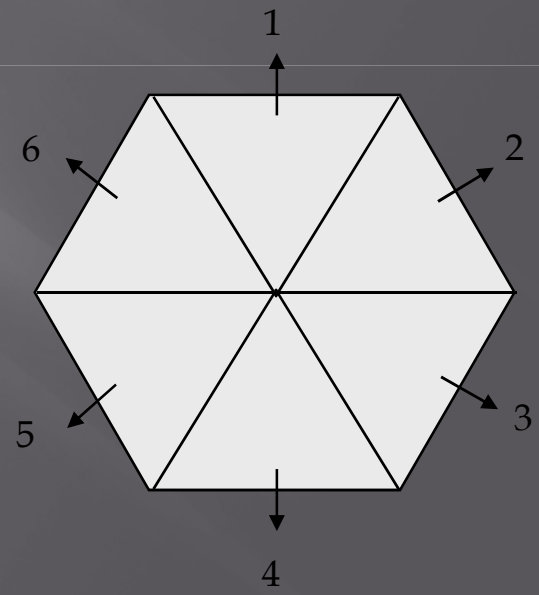
The same considerations of the previous case (1D) can be made for 2D models (like RWP and SR). The hypothesis of Gaussian distribution is still valid.

What is the new issue?

Mobility Analysis and Prediction
From 1D to 2D

The CST knowledge is not enough for users description in a 2D environment, because it gives **only a quantitative** knowledge of the number of cells that a user will visit.



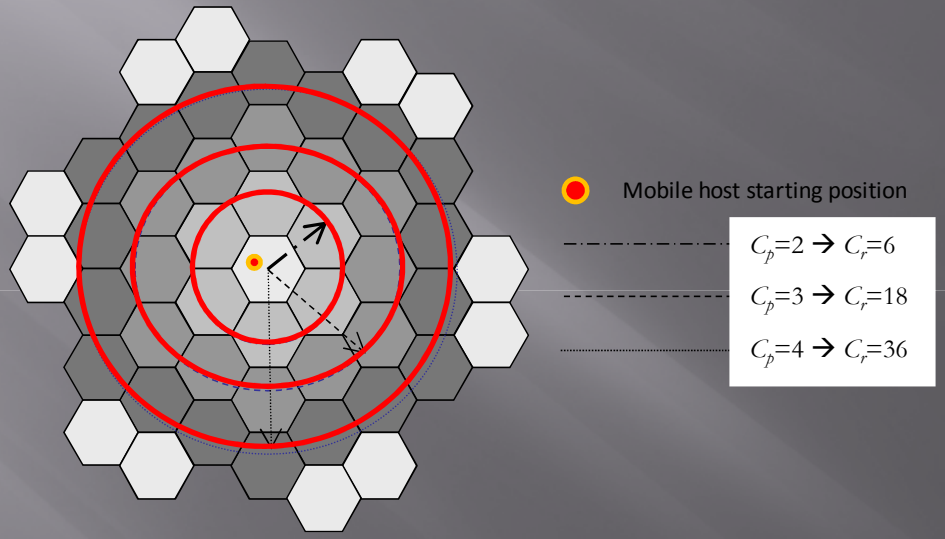


The possibly preferred movement directions of users must be taken into account, so a **qualitative** analysis becomes feasible.

Mobility Analysis and Prediction

From 1D to 2D

WHY QUALITATIVE ANALYSIS IS NEEDED IN 2D?



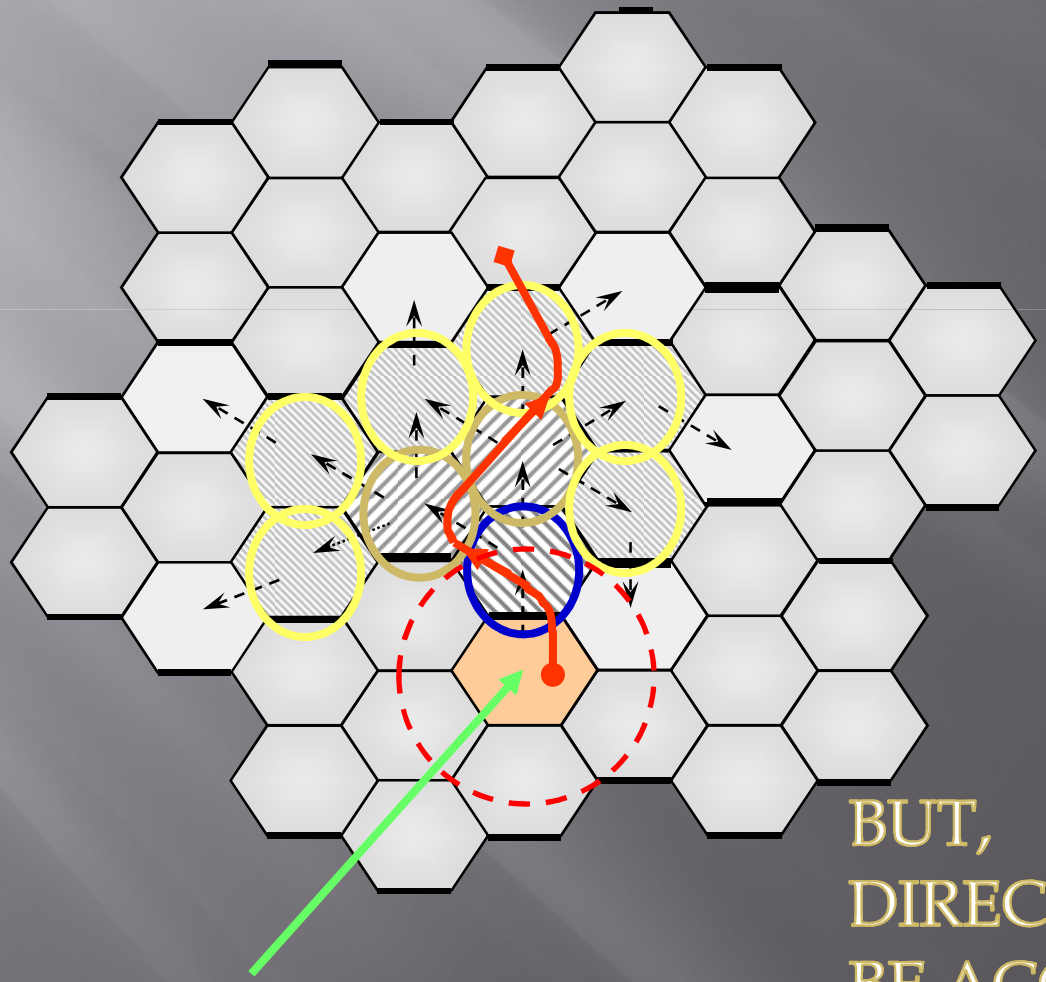
$$C_r = 3 \cdot C_p \cdot (C_p - 1)$$

The number of cells on which the reservations must be made increases in polynomial way, following the illustrated rule: the bandwidth wastage is not negligible (for Cp=5 we have Cr=60!!!).

Mobility Analysis and Prediction

From 1D to 2D

WHY QUALITATIVE ANALYSIS IS NEEDED IN 2D?



The number of passive reservations is drastically reduced because the circular reservation is not needed now, since directional information is available.

BUT, HOW CAN DIRECTIONAL BEHAVIOR BE ACCOUNTED FOR?

Mobility Analysis and Prediction

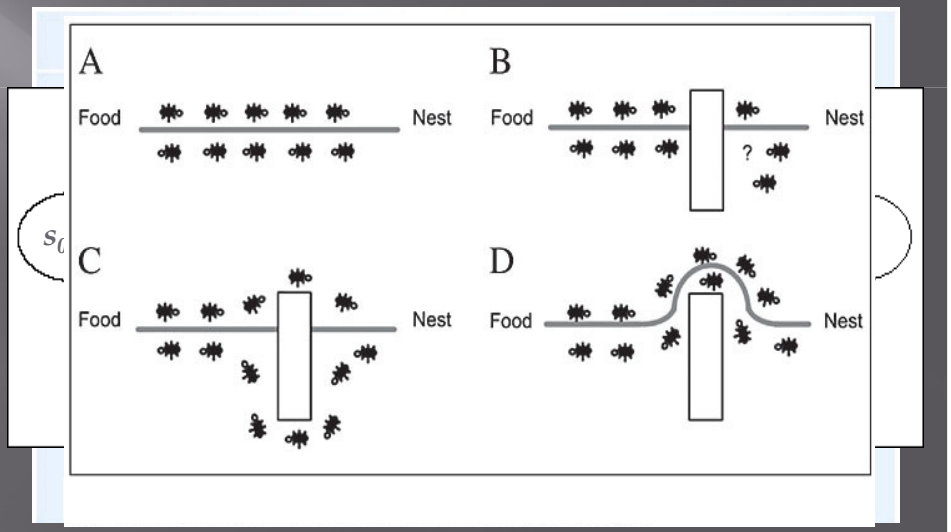
DIRECTIONAL ANALYSIS IN 2D SCENARIOS

There are many works in literature which use many "tools" to account for directional behaviors:

NEURAL NETWORKS

MARKOV CHAINS

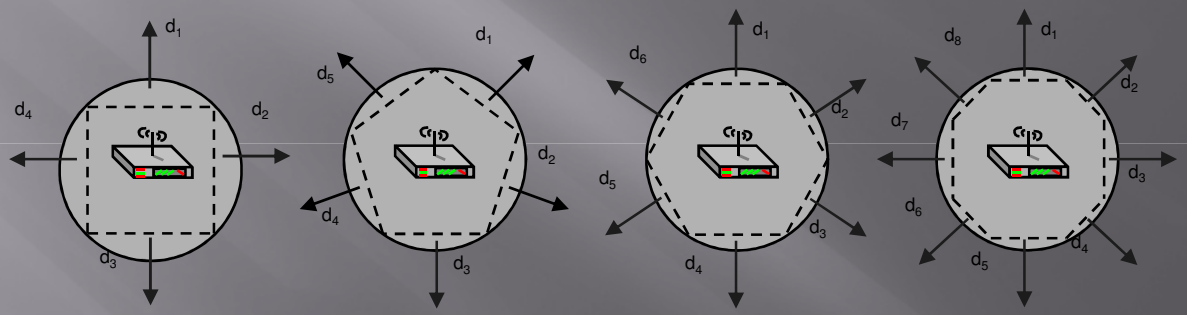
SWARM INTELLIGENCE



ANALYTICAL AND STATISTICAL TOOLS

Mobility Analysis and Prediction
A PRACTICAL EXAMPLE

Coverage areas can be approximated through n-side regular polygons and n directions can be considered:



Then a *nxn* matrix can be considered, where the rows indicate the hand-in directions and the columns the hand-out directions; the elements are defined as:

$$M(x,y) = p_{x,y} = p_{cMIP}(x,y) = p(\text{out to } y \in S_{ho}\ t = t_0 + CST \mid \text{in from } x \in S_{ho}\ t = t_0)$$

Mobility Analysis and Prediction

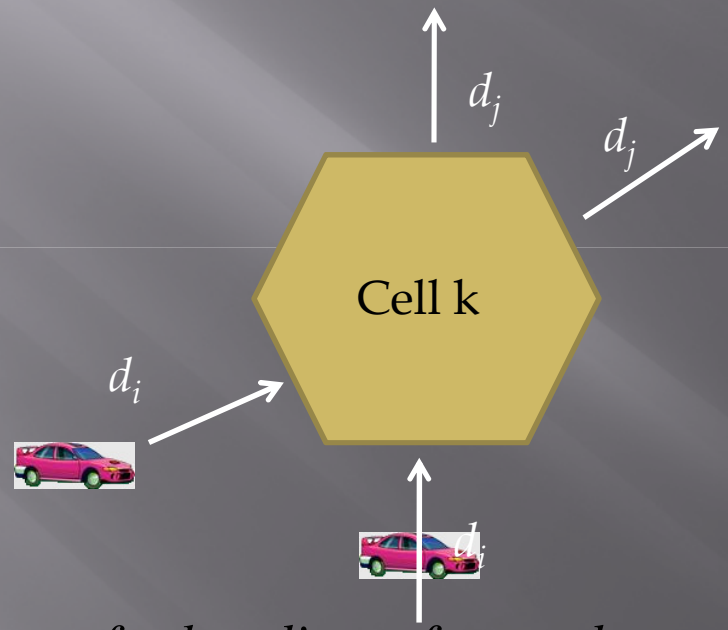
A PRACTICAL EXAMPLE (n=6)

How the elements of the matrix *M* can be obtained?

Mobility Analysis and Prediction

A PRACTICAL EXAMPLE (n=6)

How the elements of the matrix M can be obtained?



$$M_k(i,j) = \frac{Number\_of\_handins\_from\_d_i\_and\_handout\_to\_d_j}{Number\_of\_total\_handins\_from\_d_i}$$

All the elements are averaged on the number of mobile host

Mobility Analysis and Prediction

A PRACTICAL EXAMPLE (n=6)

	1	2	3	4	5	6
1	0.0137	0.0244	0.2779	0.3663	0.3034	0.0256
2	0.0325	0.0132	0.0399	0.3700	0.5056	0.0549
3	0.3708	0.0430	0.0125	0.0316	0.0521	0.5054
4	0.3692	0.2798	0.0249	0.0129	0.0248	0.2994
5	0.3743	0.5094	0.0440	0.0328	0.0127	0.0437
6	0.0318	0.0426	0.5094	0.3769	0.0427	0.0145

M(5,2)=0.5094

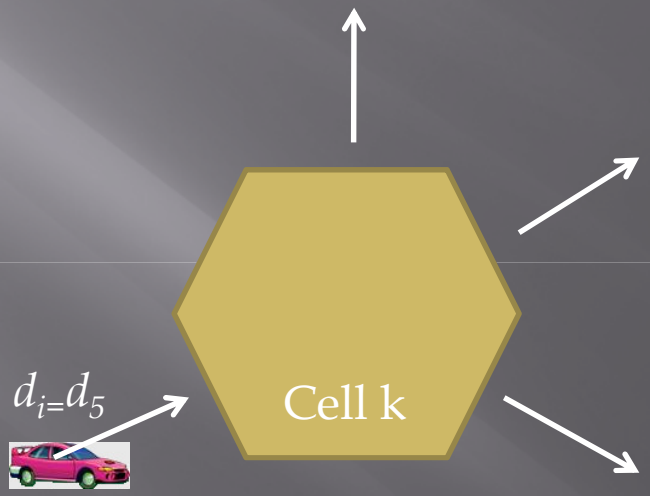
All the elements are averaged on the number of mobile host

Mobility Analysis and Prediction

A PRACTICAL EXAMPLE (n=6)

HOW TO USE THE MATRIX

	1	2	3	4	5	6
1	0.0137	0.0244	0.2779	0.3663	0.3034	0.0256
2	0.0325	0.0132	0.0399	0.3700	0.5056	0.0549
3	0.3708	0.0430	0.0125	0.0316	0.0521	0.5054
4	0.3692	0.2798	0.0249	0.0129	0.0248	0.2994
5	0.3743	0.5094	0.0440	0.0328	0.0127	0.0437
6	0.0318	0.0426	0.5094	0.3769	0.0427	0.0145



HOW MANY NEIGHBORS DO WE WANT TO CONSIDER?

1 → Reserve on next cell on direction d_2

2 → Reserve on next cells on directions d_2 and d_1

3 → Reserve on next cells on directions d_2, d_1 and d_3

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