[Master's Thesis Defence]

[Location Estimation Methods for Open, Privacy Preserving Mobile Positioning]

department of informatics

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A short terminology

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Thesis' Four Main Parts

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Joke about that was as much as I managed to slim it down

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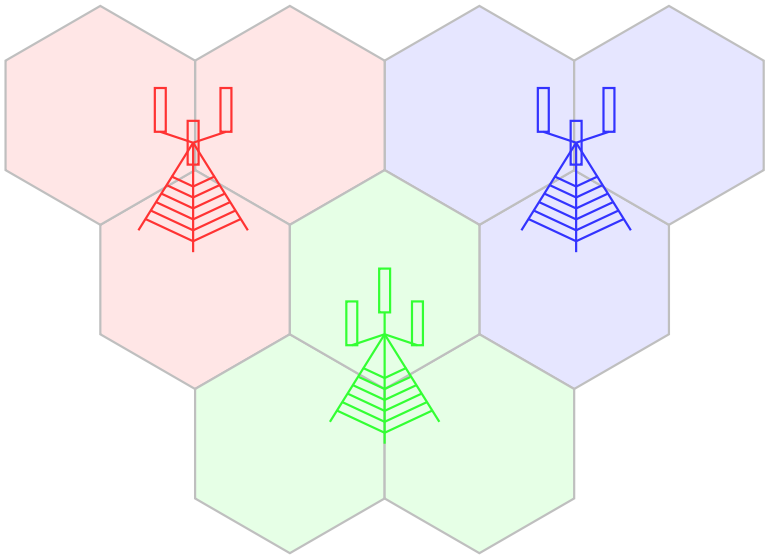

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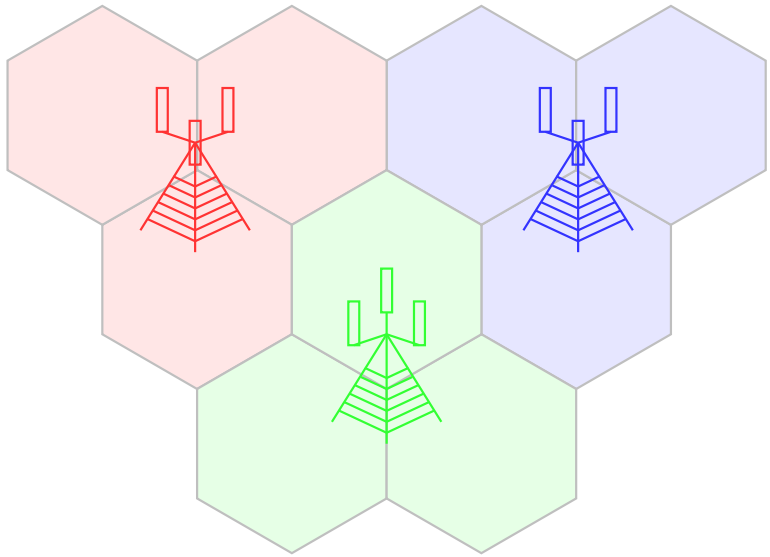

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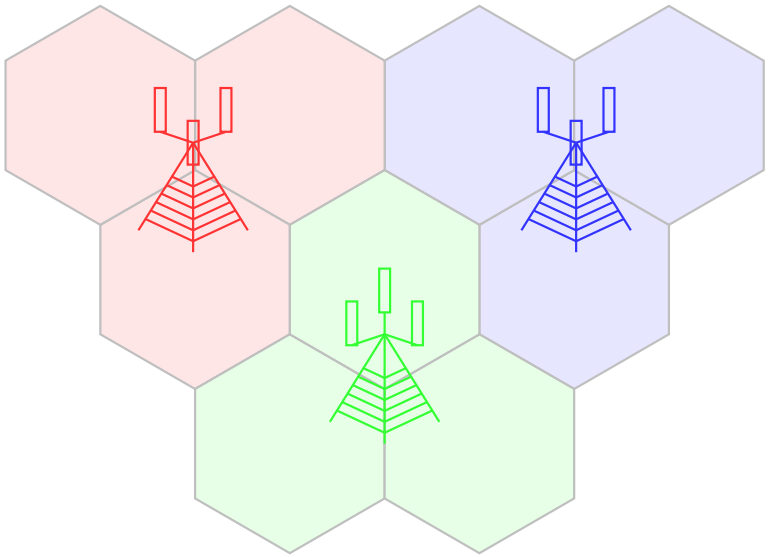

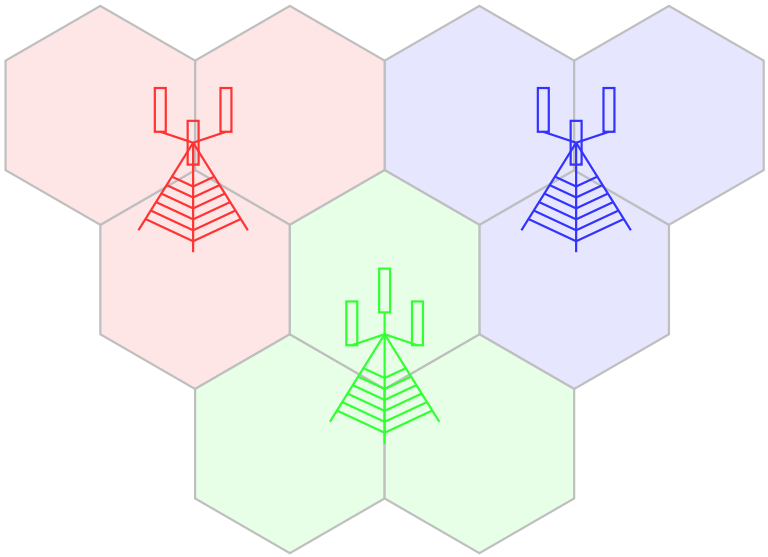

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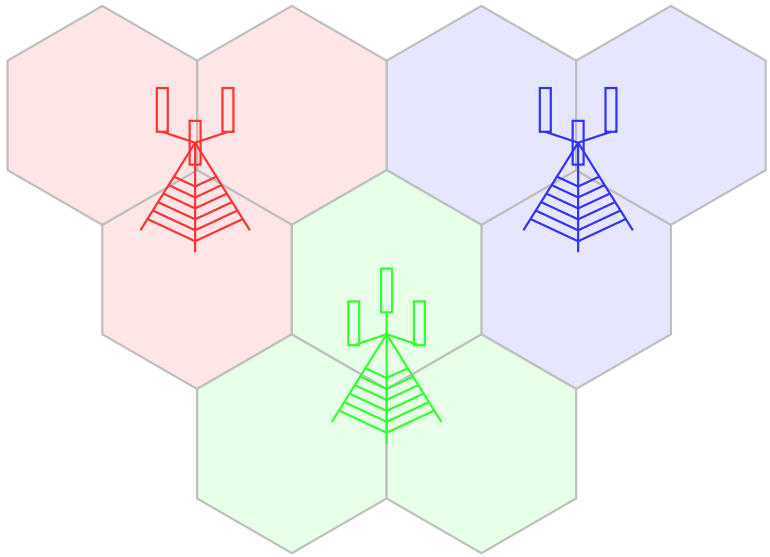

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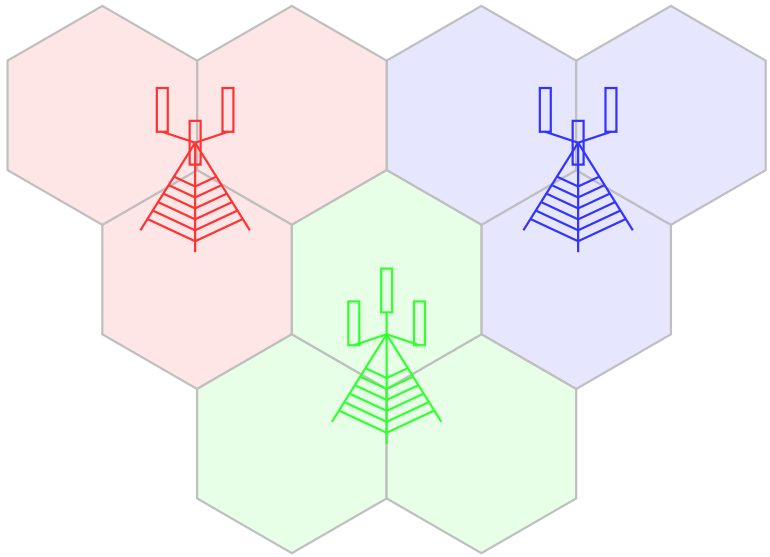

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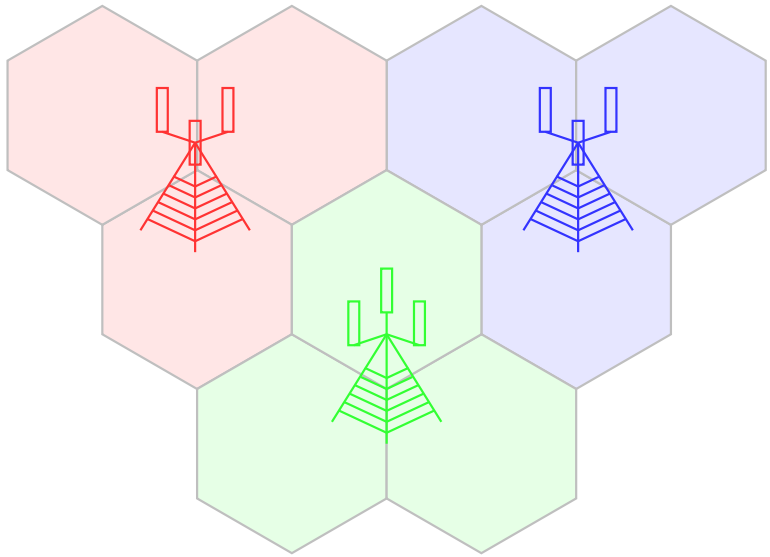

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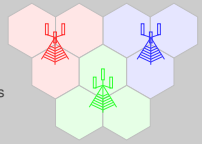
Background - Cellular Networks



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- Give example of frequency re-use. Explain what TDMA is (instead of own frequency, each unit gets a timeslot), how it relates to propagation delay and can be used for determining location.
- Cells are not really hexagons.
- Little bit about how neighboring cells work

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Emphasis on more available in thesis

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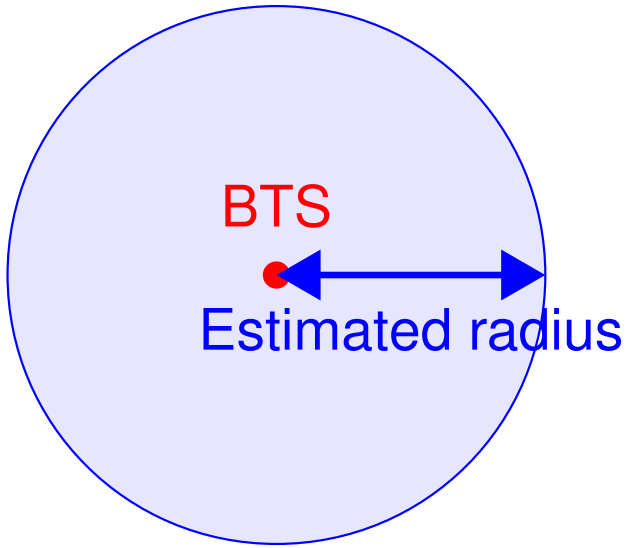

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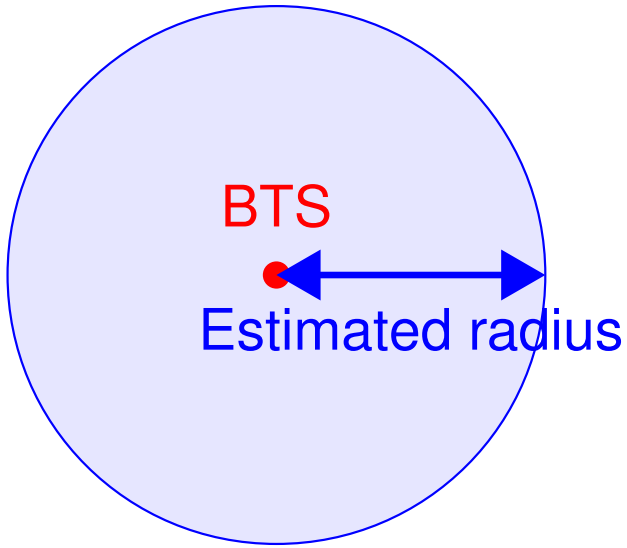

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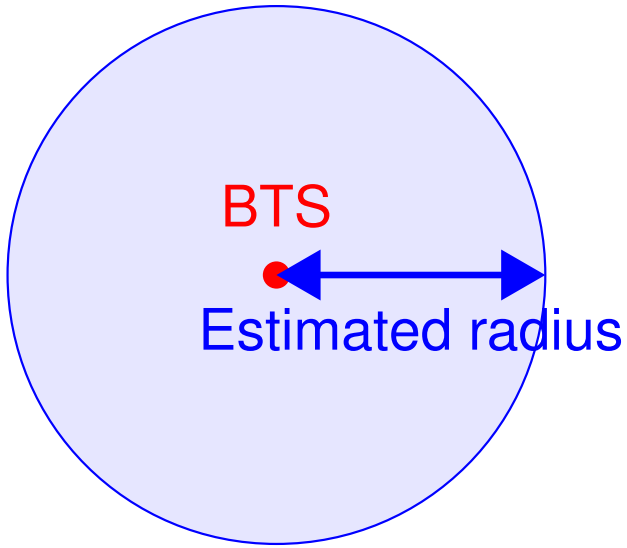

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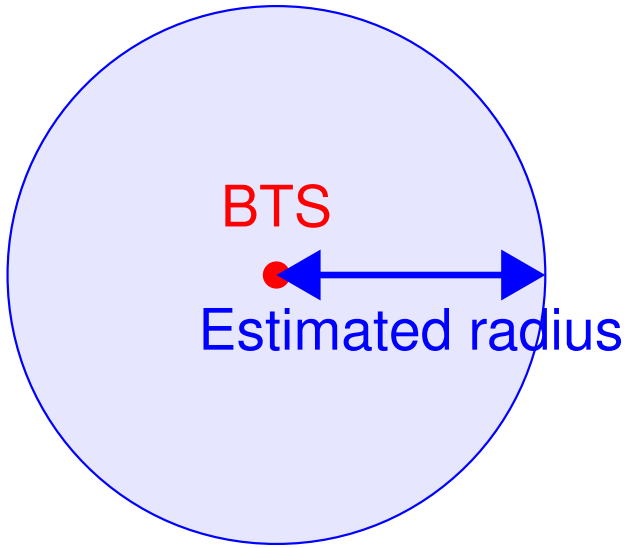

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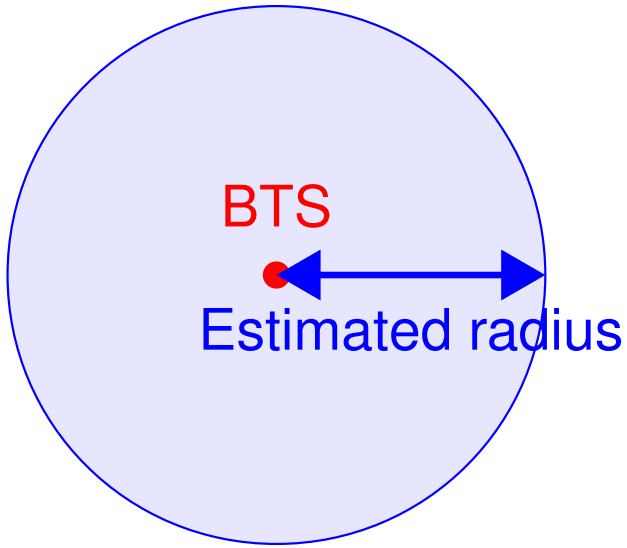

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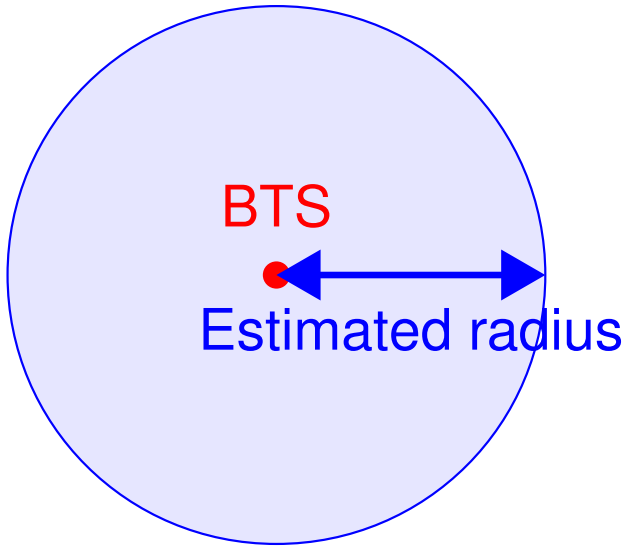

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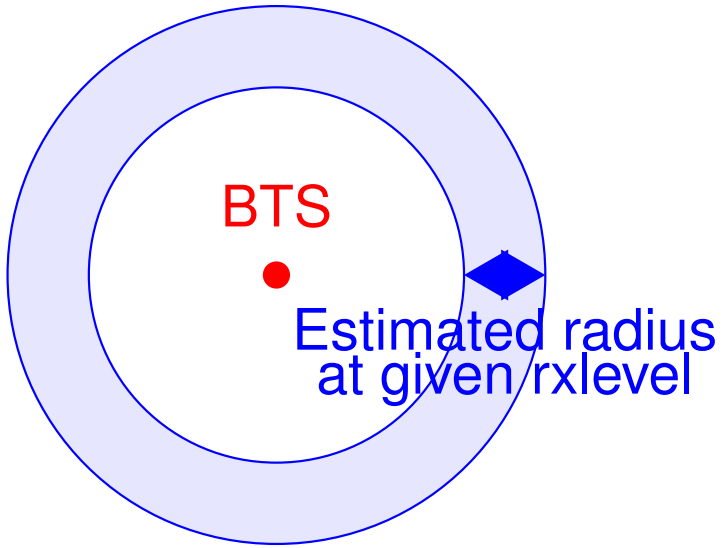

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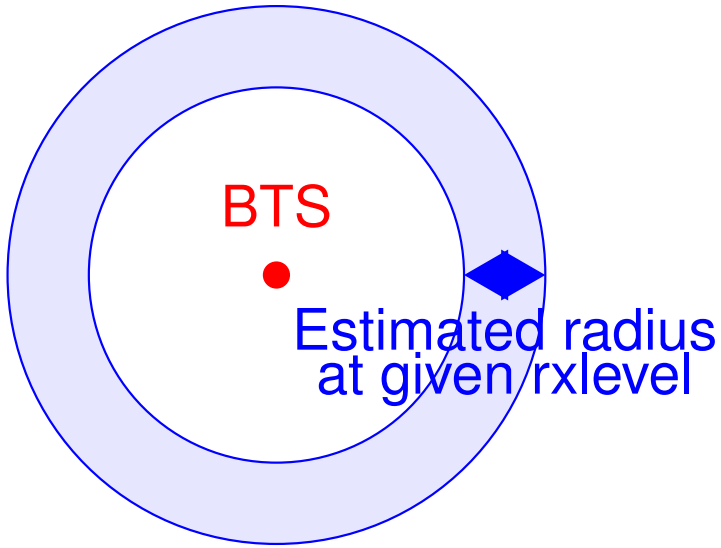

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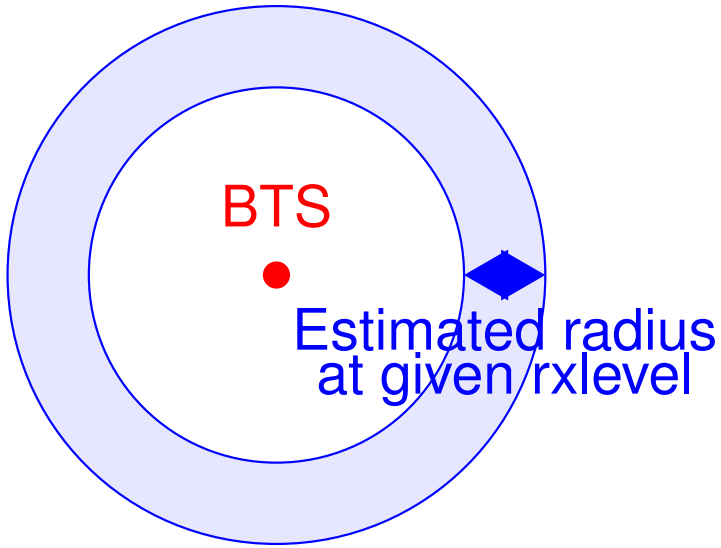

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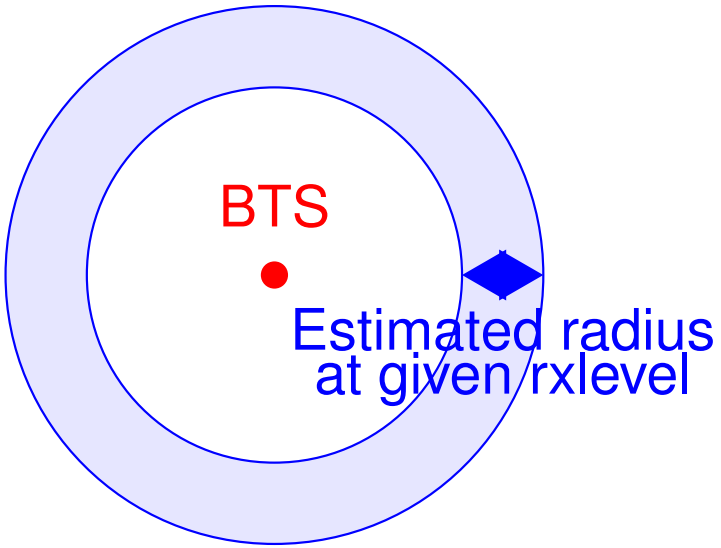

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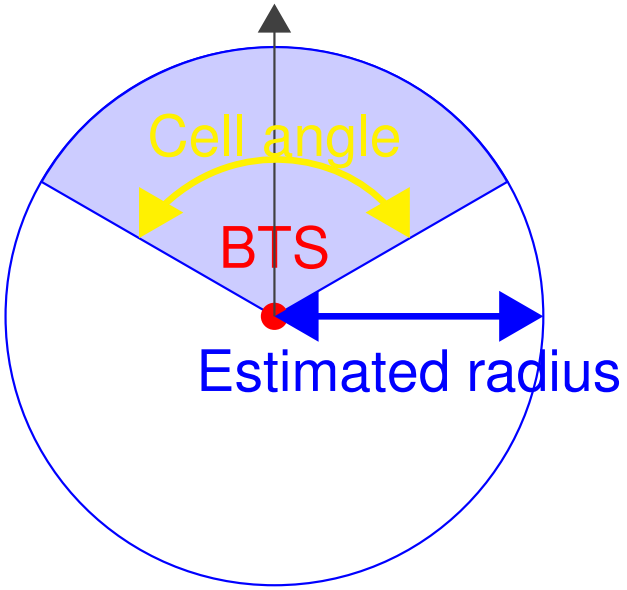

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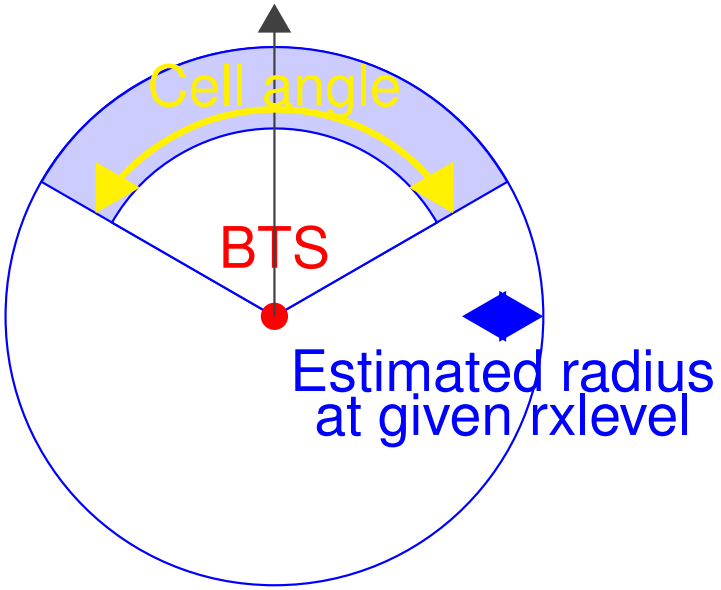

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Say quickly what onion routing is. Can elaborate here if time.

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Also say something about the problem of licenses

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Suggested Location Provider (Brief Summary)

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Say this will only be very brief, more in thesis

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  - Bootstrapping: *If system relies on amending queries, how to bootstrap a new area: No data exists to generate replies that can be amended*

Suggested Location Provider (Brief Summary)

- In addition the following issues where addressed:
  - Data gathering:
    - Direct upload
    - Pre-generated database (estimated or gathered)
    - Clients amend query results if needed
  - Bootstrapping: *If system relies on amending queries, how to bootstrap a new area: No data exists to generate replies that can be amended*

Say that we looked into, but did not conclude, about the bootstrapping

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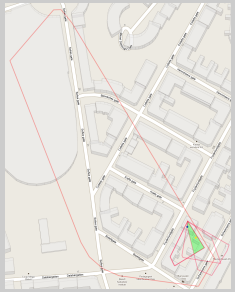
What is a unique network measurement


Sofies gate
Mikkel Dobloug's Gate
Collets gate
Henrichsens gate
Bennetches gate
Kaasa eiendom AS
Frydenlundgata
Krafts gate
Bislettgata
Dalsbergstien
Coop Mega Bislett
Bislett fysikalske institutt
Pedagogisk VikarSentral Oslo
Barnevakt i Oslo
Schwensens gate
Revisorhuset AS

Intersecting Areas Method



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Make joke about nobody perfect

department of informatics

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Test System

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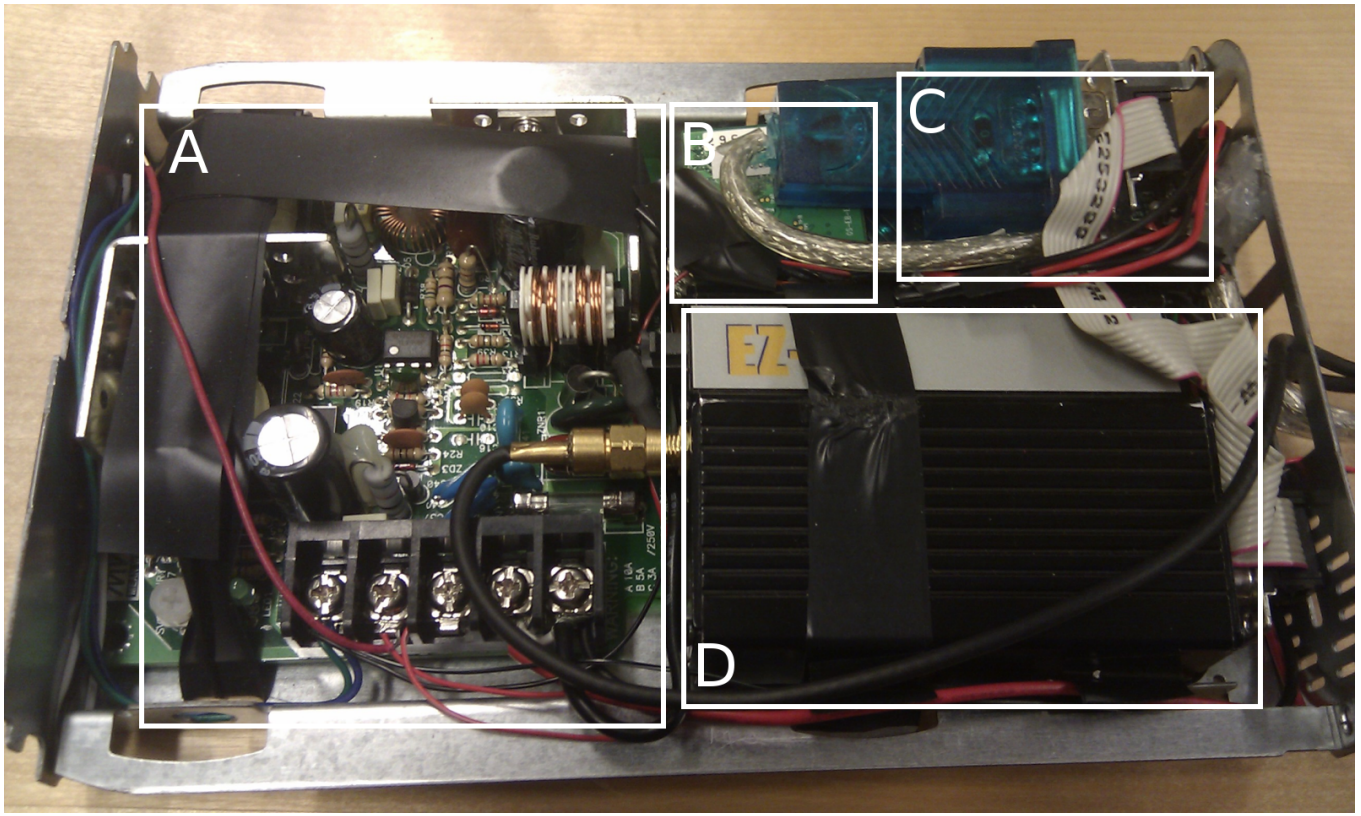
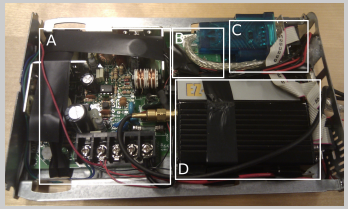
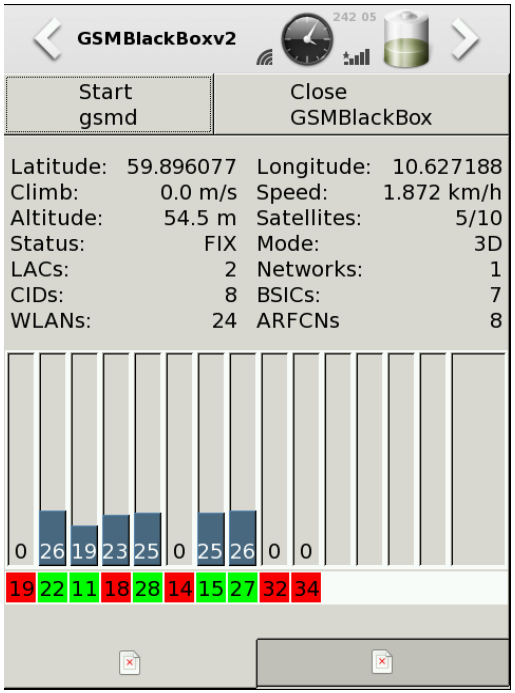
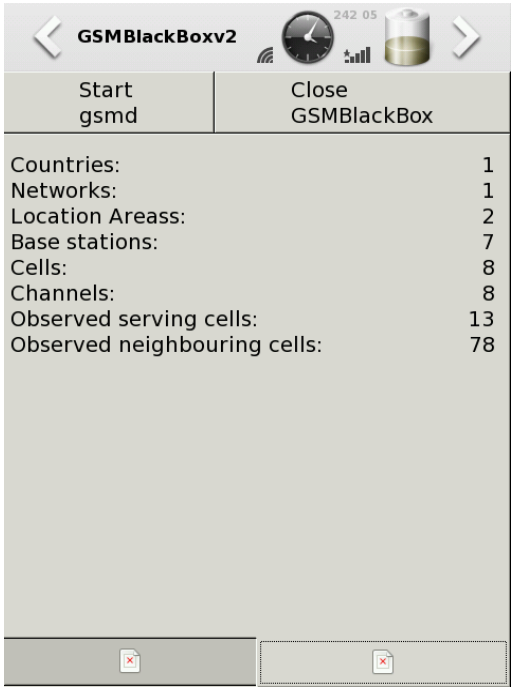

A
B
C
D

Hardware logger



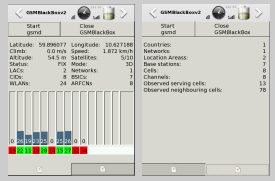

GSMBlackBoxv2
Start gsmd
Close GSMBlackBox
Latitude: 59.896077
Longitude: 10.627188
Climb: 0.0 m/s
Speed: 1.872 km/h
Altitude: 54.5 m
Satellites: 5/10
Status: FIX
Mode: 3D
LACs: 2
Networks: 1
CIDs: 8
BSICs: 7
WLANs: 24
ARFCNs 8
0 26 19 23 25 0 25 26 0 0
19 22 11 18 28 14 15 27 32 34

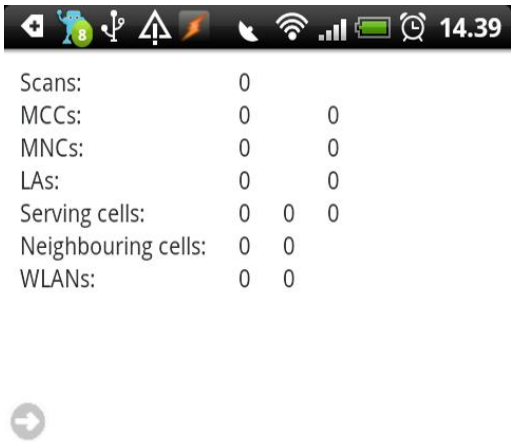

GSMBlackBoxv2
Start gsmd
Close GSMBlackBox
Countries: 1
Networks: 1
Location Areass: 2
Base stations: 7
Cells: 8
Channels: 8
Observed serving cells: 13
Observed neighbouring cells: 78

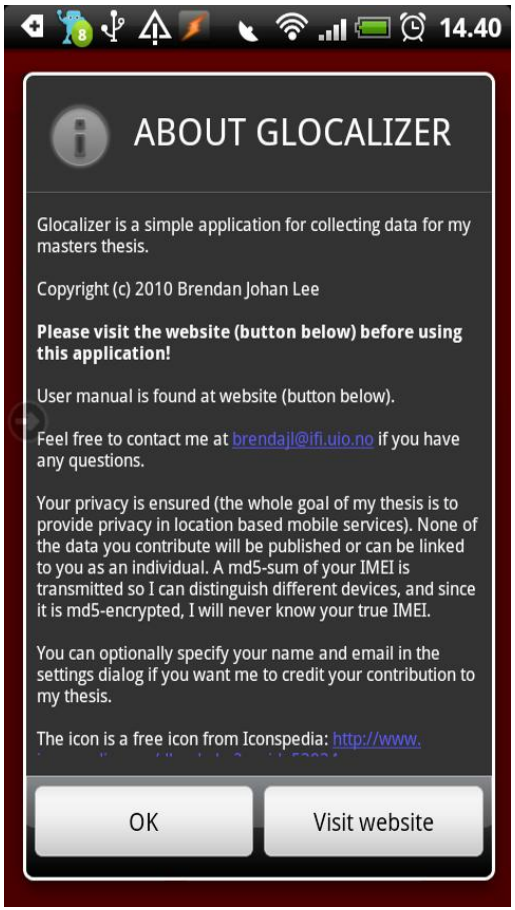
Master's Thesis Defence

2011-06-21

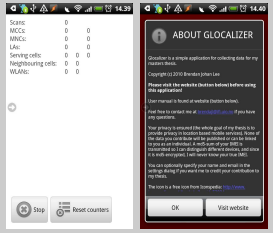
OpenMoko Software

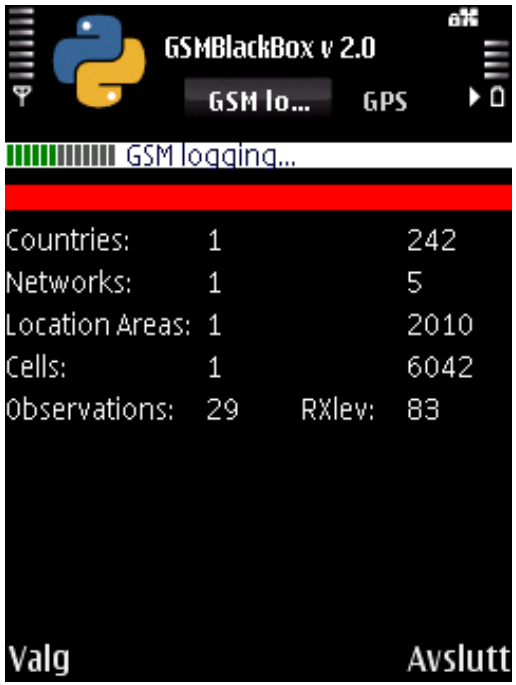



14.39
Scans: 0
MCCs: 0 0
MNCs: 0 0
LAs: 0 0
Serving cells: 0 0 0
Neighbouring cells: 0 0
WLANs: 0 0
Stop
Reset counters


14.40
ABOUT GLOCALIZER
Glocalizer is a simple application for collecting data for my masters thesis.
Copyright (c) 2010 Brendan Johan Lee
Please visit the website (button below) before using this application!
User manual is found at website (button below).
Feel free to contact me at brendajl@ifi.uio.no if you have any questions.
Your privacy is ensured (the whole goal of my thesis is to provide privacy in location based mobile services). None of the data you contribute will be published or can be linked to you as an individual. A md5-sum of your IMEI is transmitted so I can distinguish different devices, and since it is md5-encrypted, I will never know your true IMEI.
You can optionally specify your name and email in the settings dialog if you want me to credit your contribution to my thesis.
The icon is a free icon from Iconspedia: http://www.
OK
Visit website

Android Software




GSMBlackBox v 2.0
GSM lo...
GPS
GSM logging...
Countries: 1 242
Networks: 1 5
Location Areas: 1 2010
Cells: 1 6042
Observations: 29 RXlev: 83
Valg
Avslutt


GSMBlackBox v 2.0
GPS
WLAN
GSM logging...
Latitude: 59.89570959048
Longitude: 10.627234068091
Satellites: 4 H acc: 169.86
Altitude: 80.50 V acc: 14.00
Speed: 1.95 Acc: 9.46
Heading: 198.15 Acc: 120.46
Valg
Avslutt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GPS
WLAN
GSM logging...
evalg-ice
prod
itfbu_1
ITFBU-Simula
avoice
allkopionline
itfbu_1
ITFBU-Online
ITFBU-COMP
prod
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Nets: 35
Obs: 78
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Symbian Series 60 Software

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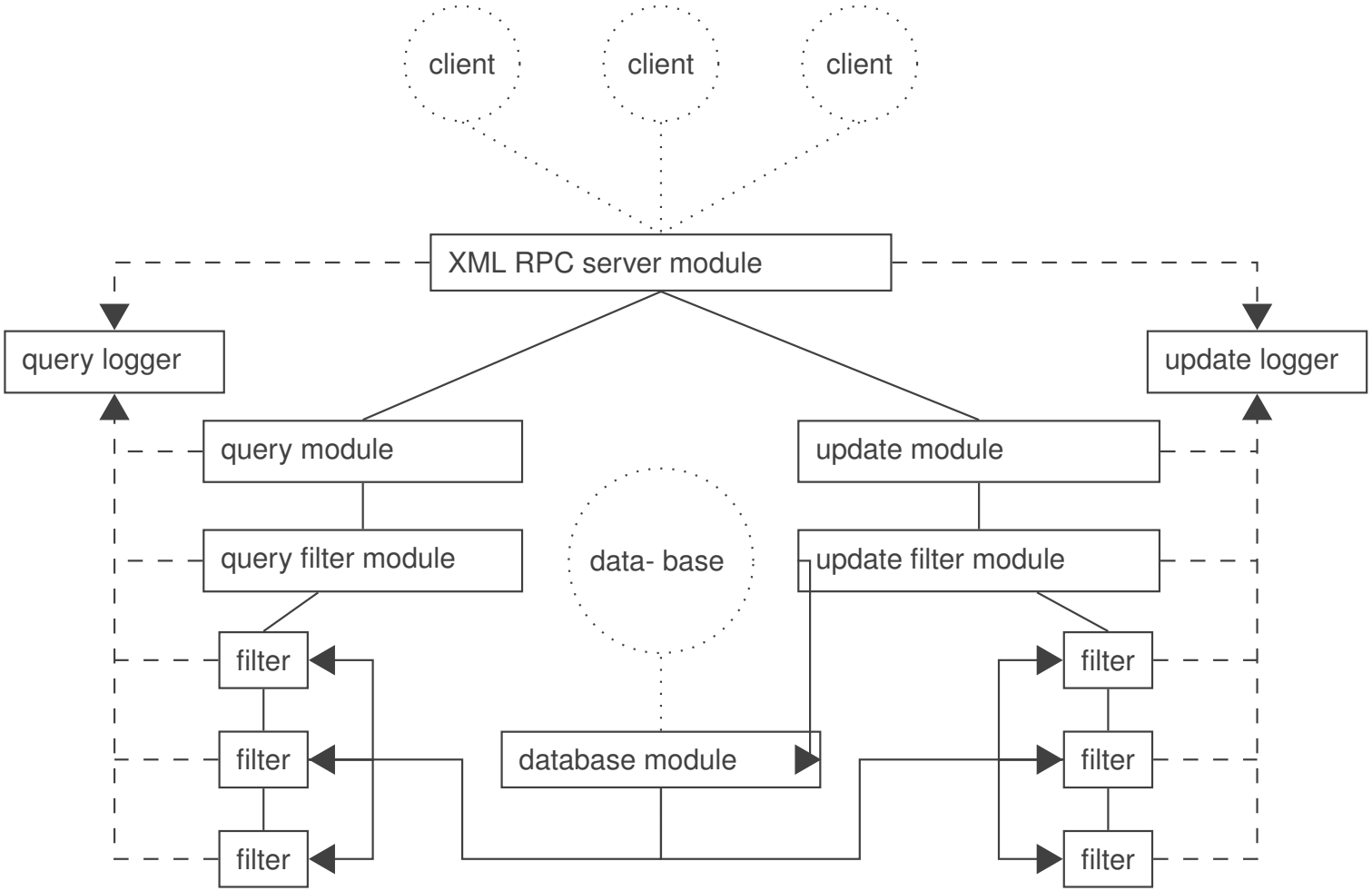
client
client
client
XML RPC server module
query logger
update logger
query module
update module
query filter module
data- base
update filter module
filter
filter
filter
database module
filter
filter
filter

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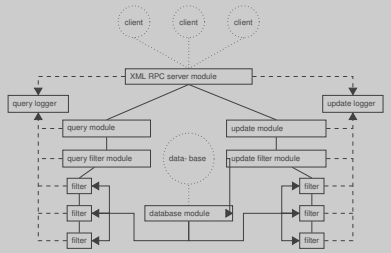

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Say that the example of Intersecting Areas method is a printout from this tool

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- For the exact handsets and amount of data, see thesis.
- For a description of the DCM method, see thesis (no time here).

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- Second test
  - Single dataset for Android, three for Symbian Series 60

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- Second test
  - Single dataset for Android, three for Symbian Series 60
  - Dataset randomly split in two

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    2. Run algorithm on measurement and log
    3. Re-add training for tested point
- Second test
  - Single dataset for Android, three for Symbian Series 60
  - Dataset randomly split in two
  - Half of set used for training, half for testing

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  - System trained on all data
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- Second test
  - Single dataset for Android, three for Symbian Series 60
  - Dataset randomly split in two
  - Half of set used for training, half for testing
  - Repeated on the virgin dataset 10 times

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Two Individual Tests

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    1. Remove training for tested point
    2. Run algorithm on measurement and log
    3. Re-add training for tested point
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  - Single dataset for Android, three for Symbian Series 60
  - Dataset randomly split in two
  - Half of set used for training, half for testing
  - Repeated on the virgin dataset 10 times
  - All algorithms tested over all datasets
  - Hence 30 Symbian and 10 Android tests for each algorithm
- Each test was done individually for Android and Symbian S60 data

Individually for each handset type since different data - S60 lacking neighboring cell info, and the possibility of comparing the performance on the different platforms/handsets

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Problems and Results

- The penalty value for *DCM* is not static over different data sets, different areas and different handsets. Systems should therefore be continuously calibrated, which highly complicates using *DCM*
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No time to talk about the penalty value. Please see thesis.

Algorithm	Time on 8218	time on L7555
1	.000050	.000019
2	.000071	.000038
6	.047350	.017171
6.1	.047350	.017171
7	.027986	.024339
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8	.075265	.041472
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Nothing specific to note here other than that the time spent training is trivial compared to the time spent estimating locations and is also a one time event. And that training time for CGI and E-CGI as expected is much lower.

Algorithm	Time on 8218	time on L7555
1	0.005383	0.008095
2	0.005621	0.008930
3	0.749295	11.088524
4	16.210149	17.802947
5	18.815485	14.625443
6	0.021477	0.023968
6.1	0.037931	0.008301
7	0.003671	0.003938
7.1	0.003632	0.004676
8	0.005185	0.005112
8.1	0.005067	0.006172

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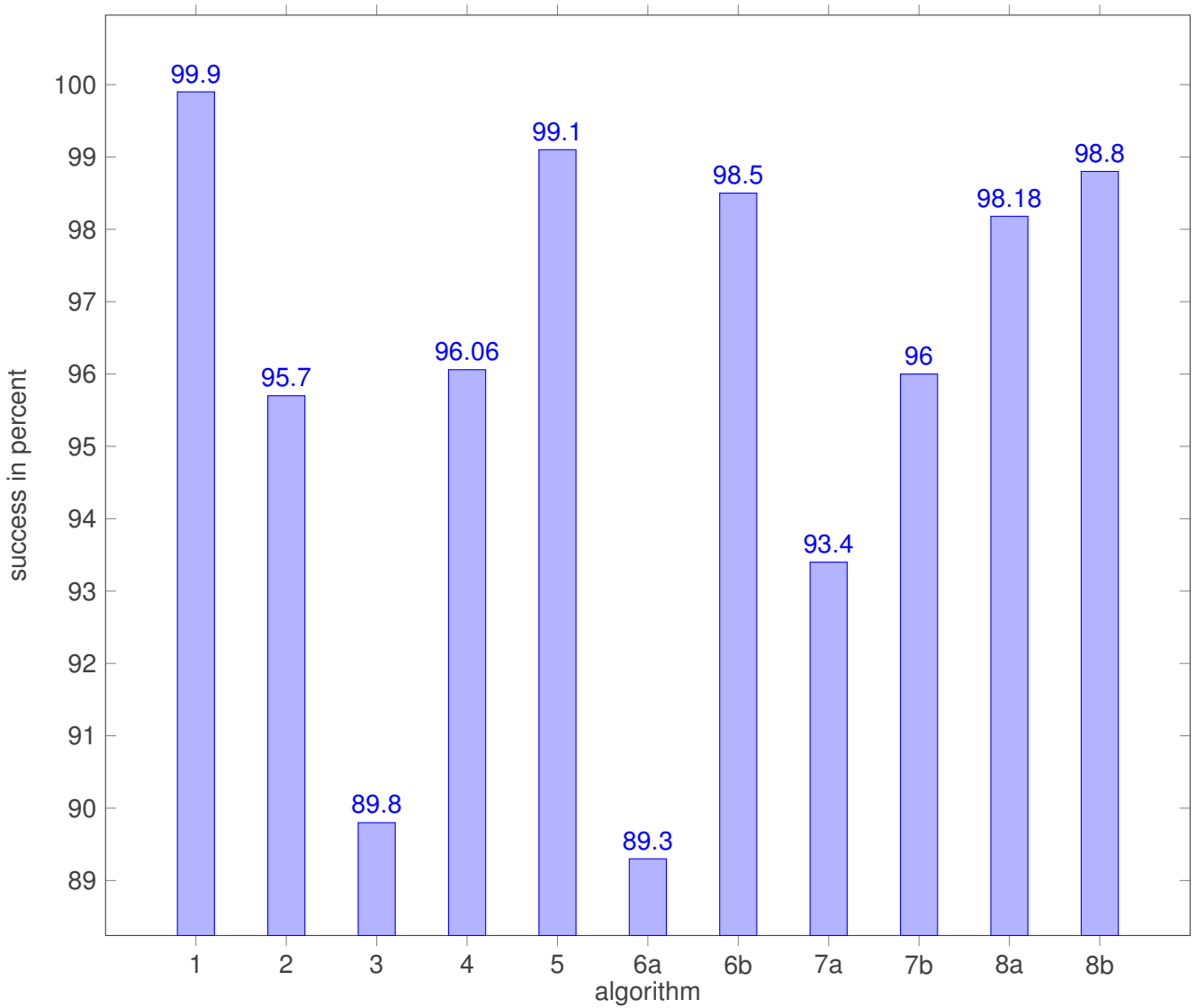
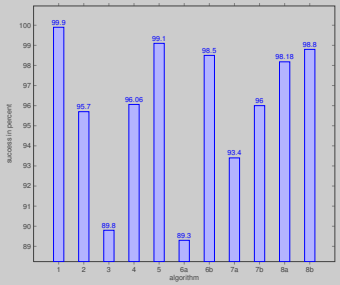
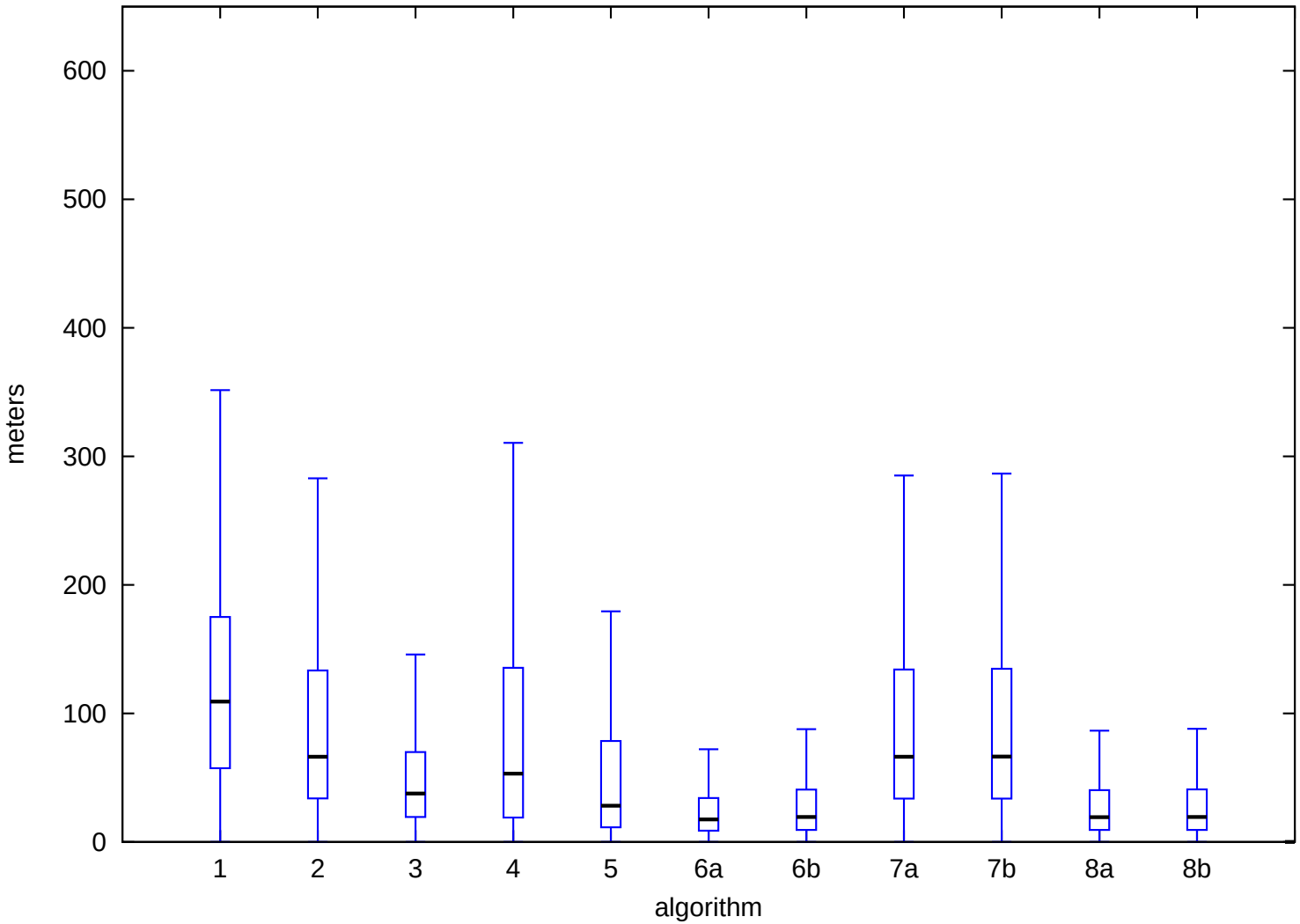
- Processing time for DCM MUCH higher than Intersecting Areas
- Processing time for Intersecting Areas somewhat higher than CGI AND E-CGI
- The weird unexplainable processor difference on algo 3


success in percent
100
99
98
97
96
95
94
93
92
91
90
89
99.9
95.7
89.8
96.06
99.1
89.3
98.5
93.4
96
98.18
98.8
1
2
3
4
5
6a
6b
7a
7b
8a
8b
algorithm



- CGI clearly but not surprising highest success
- E-CGI fairly low, but could match CGI if fall-back to CGI was used
- Naturally DCM and Intersecting Areas relying on WLAN are much lower since WLAN not everywhere
- Intersecting Areas is somewhat outperformed by DCM
- However, when using fall-back to E-CGI Intersecting Areas outperforms or matches DCM


meters
600
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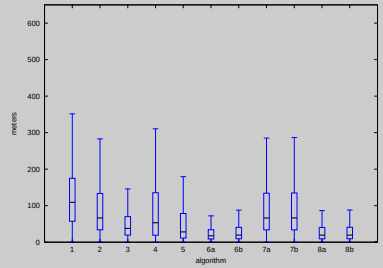
8b
algorithm



- The Intersecting Areas method is the most precise method compared to both CGI, E-CGI (not surprising) and DCM.
- Methods relying solely on neighboring cells (not WLAN) have much lower precision, hardly providing any benefits compared to E-CGI.
- Methods relying on both neighboring cells and WLAN have a somewhat lower precision.
- This is due to neighboring cells being much larger than WLAN hot spots.
- However, relying solely on WLAN generally only works in urban areas with high WLAN-density.

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Future Work

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