Mobile positioning data in space-time mobility studies

Prof. Rein Ahas
Chair of Human Geography
University of Tartu
Estonia

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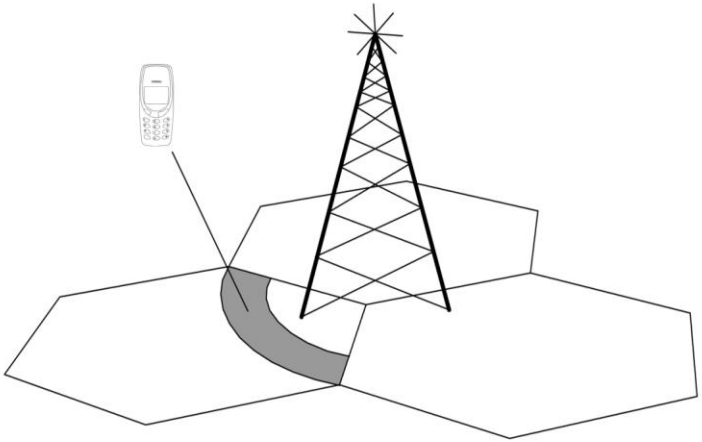
Objective:

- to introduce mobile positioning data
- study of activity spaces with positioning data

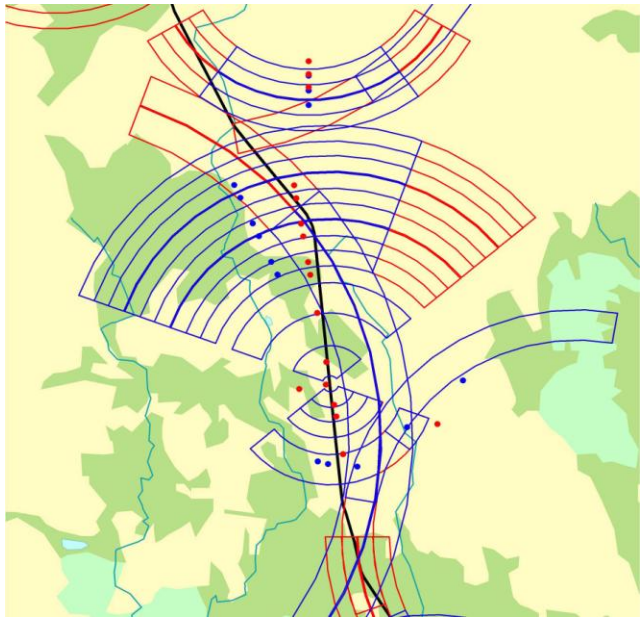
Mobile positioning: finding geographical location of the mobile phone



Cell Global Identity +

Timing Advance

CGI+TA



Active mobile positioning – asking locations with special queries

“Trace phone 50xxxxxxx with 15 min interval 10.03.08-14.03.08”

Network based methods

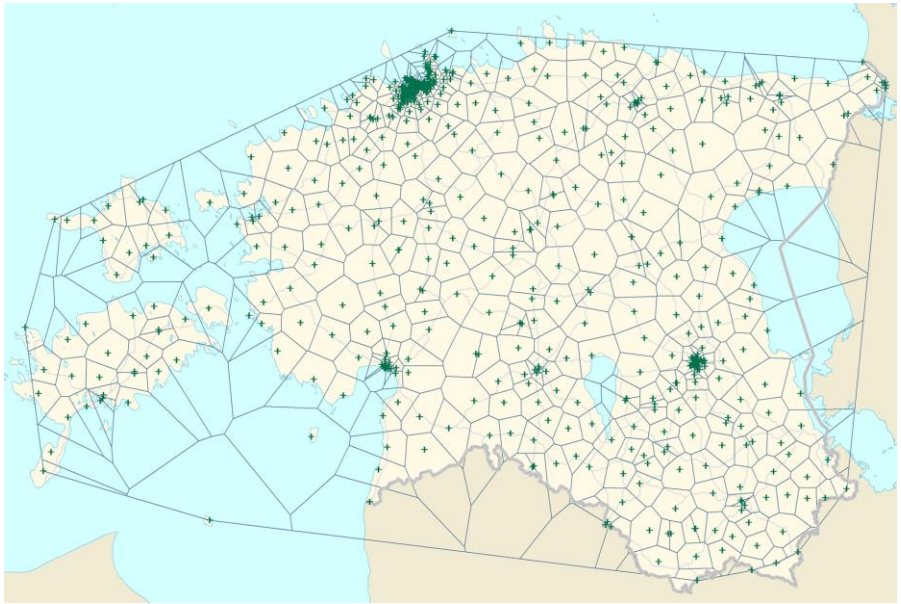
Handset based methods

Passive positioning – location information from memory files of mobile operator

Location of calls

Hand-over between cells

Erlang of antenna



CGI

Research team in Estonia

- Chair of Human Geography, University of Tartu
- Spin-off firm Positium LBS – data, modelling, web solutions
- Contract with 2 biggest mobile operators in Estonia: EMT and Elisa

Experiments with active mobile positioning

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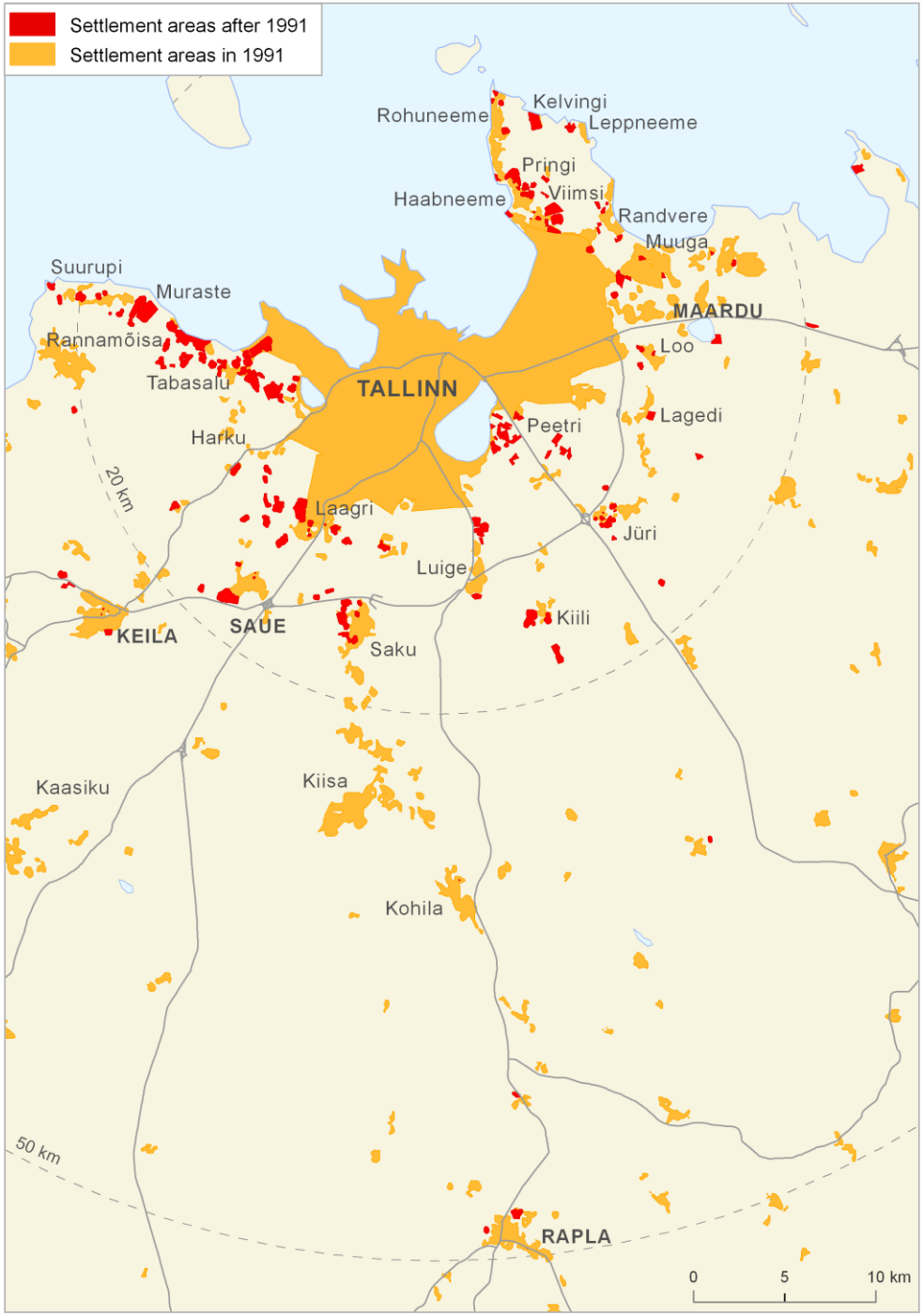
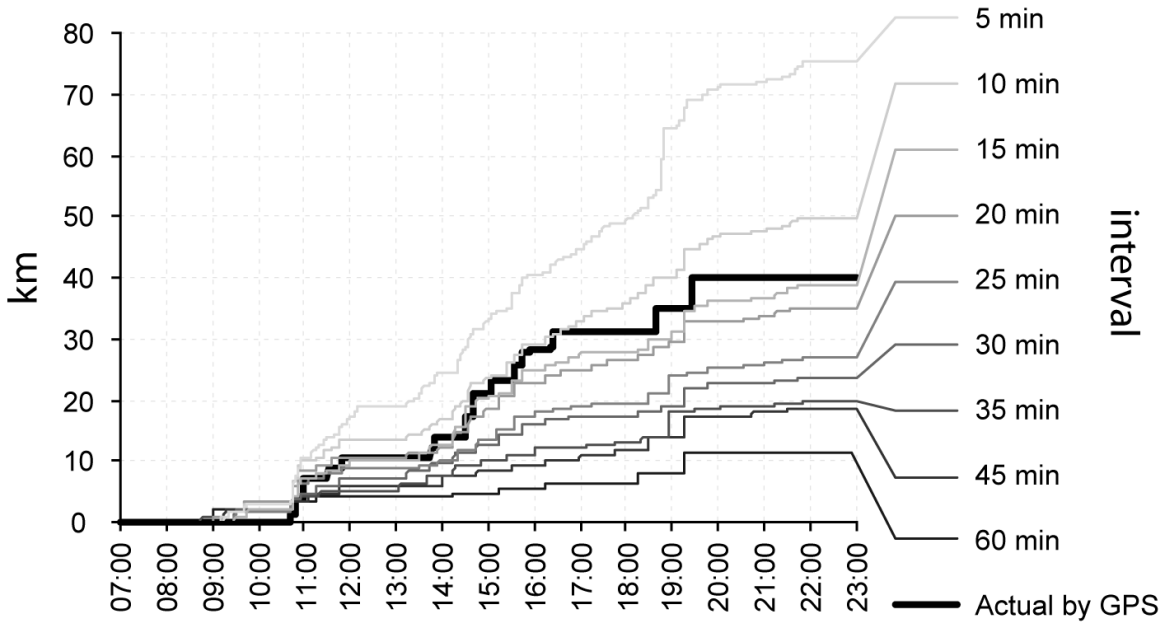
Studying new suburban commuters of Tallinn:

- Sampling – randomly selected 600 families from 5589
- Questionnaire – 60 min questions by polling firm TNS EMOR
- Tracking mobile phones Positium LBS
  - 15 min intervals 06:00-01:00
  - 60 min intervals 00:30-06:00

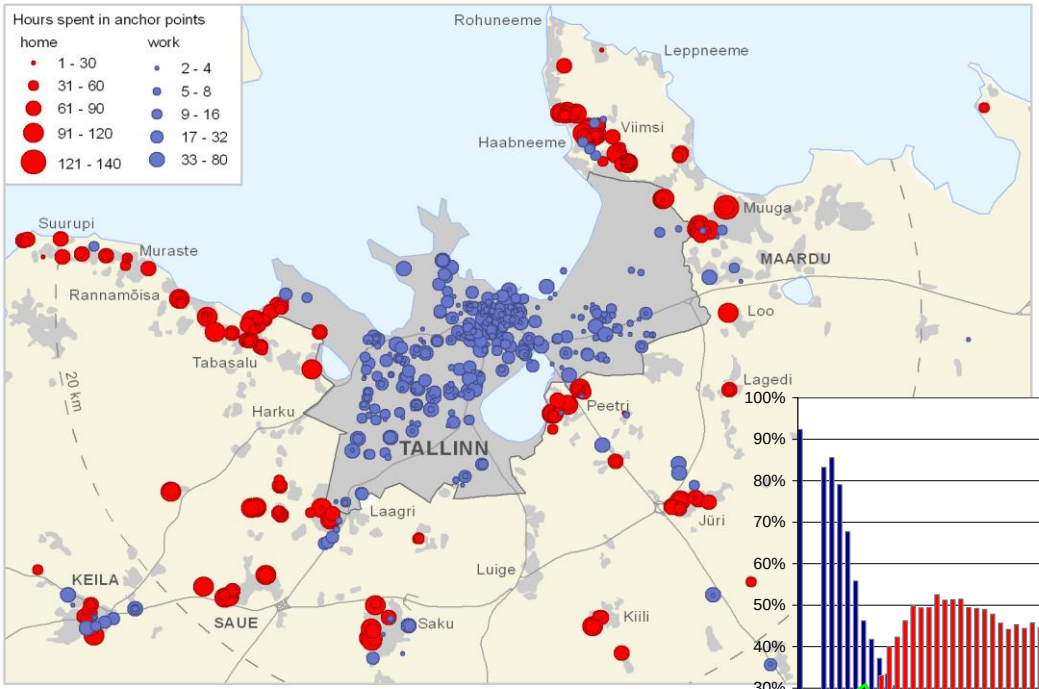
Study area

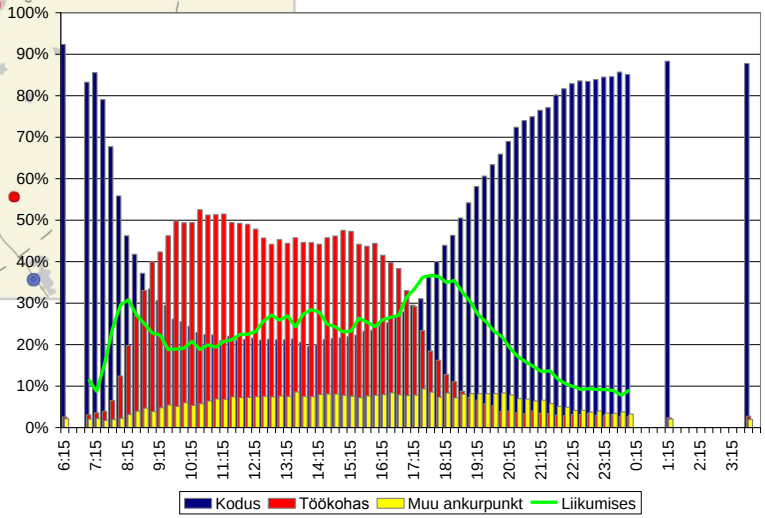

Settlement areas after 1991
Settlement areas in 1991
Rohuneeme
Kelvingi
Leppneeme
Pringi
Viimsi
Haabneeme
Randvere
Muuga
Suurupi
Muraste
MAARDU
Rannamõisa
Loo
Tabasalu
TALLINN
Lagedi
Peetri
Harku
20 km
Laagri
Jüri
Luige
Kiili
KEILA
SAUE
Saku
Kaasiku
Kiisa
Kohila
50 km
RAPLA
0
5
10 km

Positioning frequency

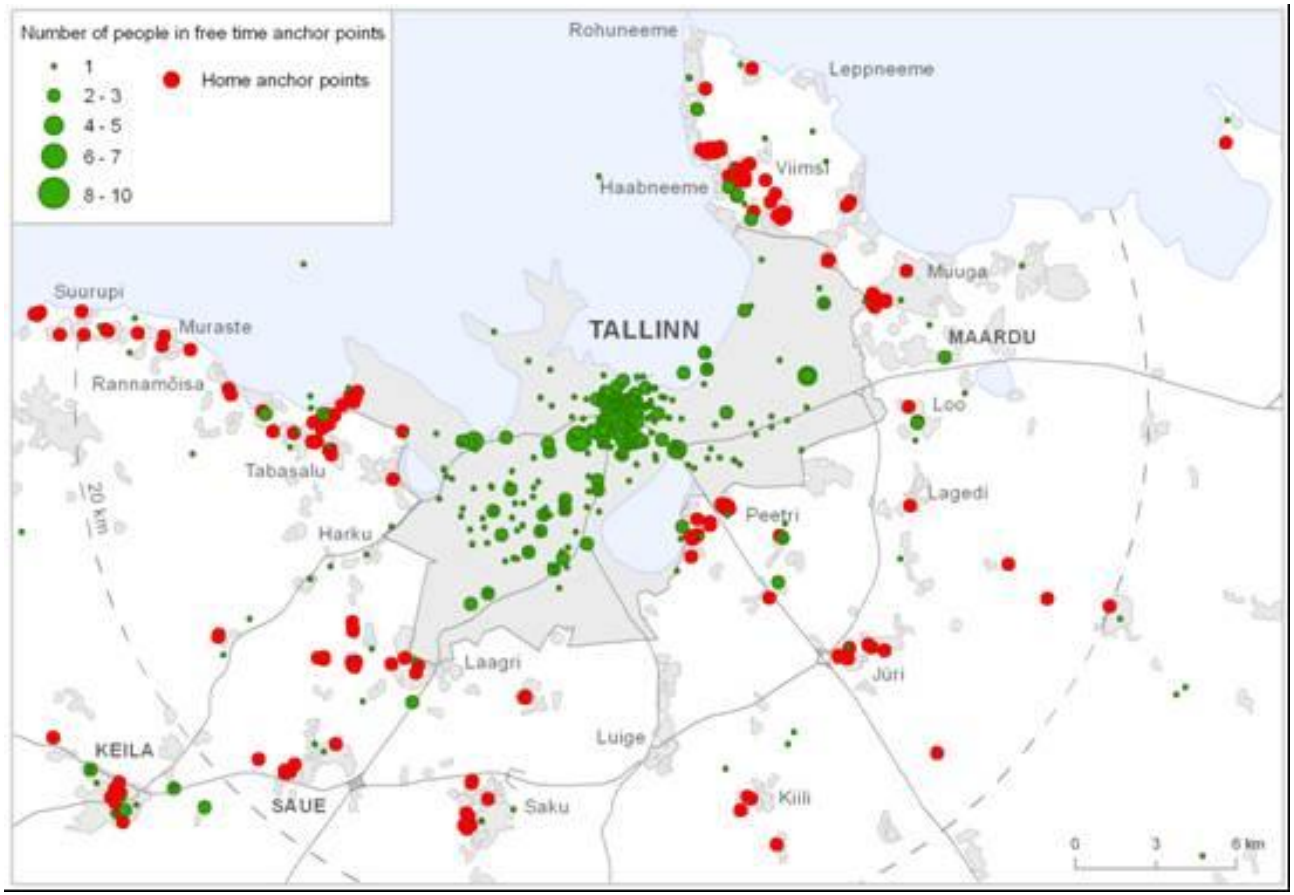


Actual location of home and work; movement

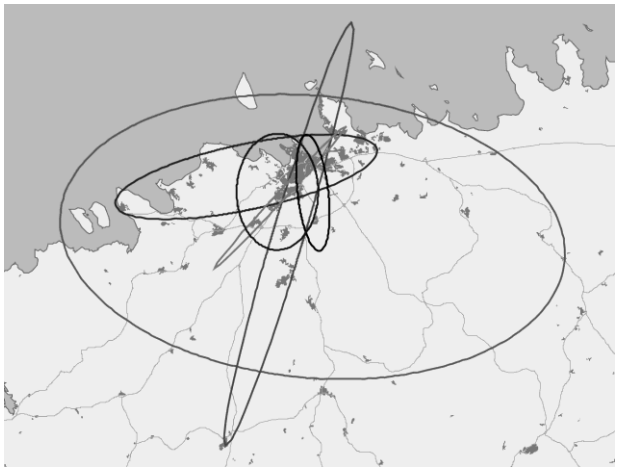




Location of respondents on the free time 18.00-20.00(not work or home anchor points)



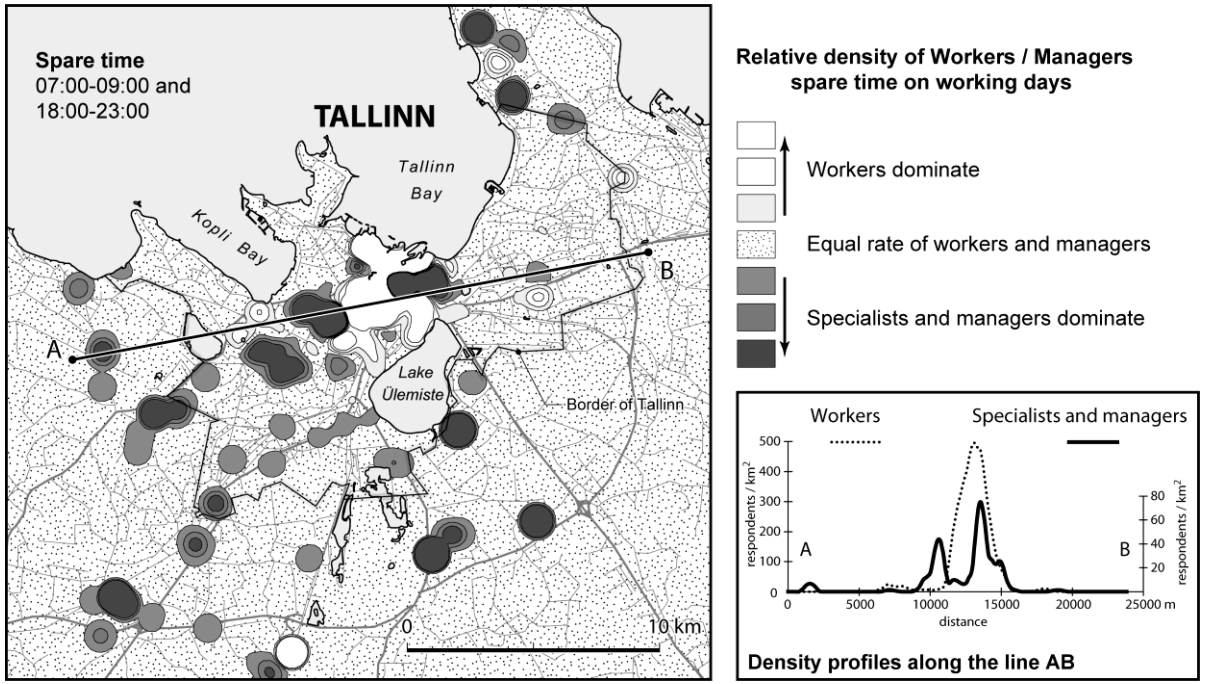
Activity space ellipses (Visar)



Significance of social characteristics of the studied 117 participants on activity-space ellipse parameters by the results of the Kruskal-Wallis test. (*** - P<0.01; ** - P<0.05; * - P<0.1)

	Major axis	**Minor axis**	**Angle**	**Area**
Residental area	Yes***	Yes***	-	Yes***
Age	-	Yes*	-	-
Gender	-	-	-	-
Occupation	Yes**	-	-	Yes*
Education	Yes**	Yes**	-	Yes**
Maritial status	-	-	-	-
Children	-	-	Yes*	-
Pay	-	-	-	-
Resident/commuter	Yes***	Yes***	-	Yes***

Job location: Kernel density



Passive mobile positioning

Passive positioning dataset

- Location of call activities with accuracy of Cell ID
  - Random ID
  - Time
  - Location of Cell
  - *Social features*

  - Random ID allows to link calls of one person !

Database

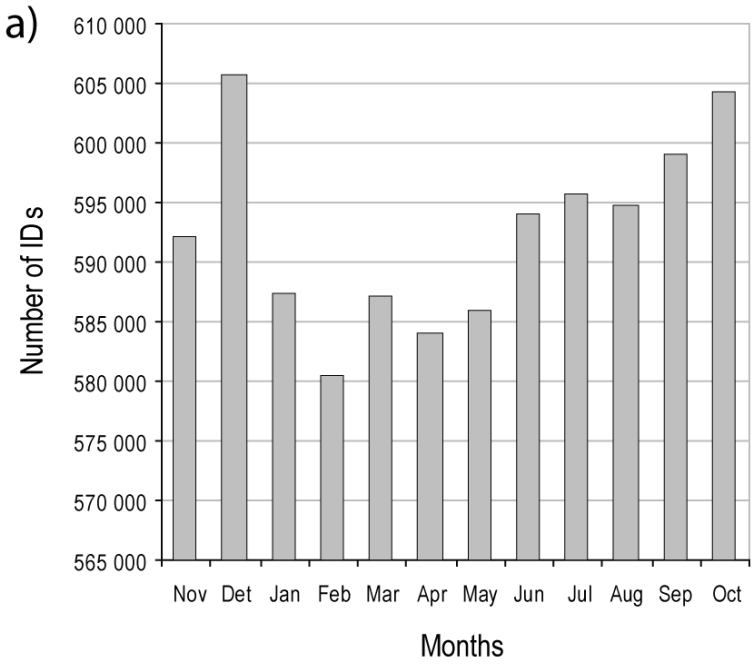
alg : Table

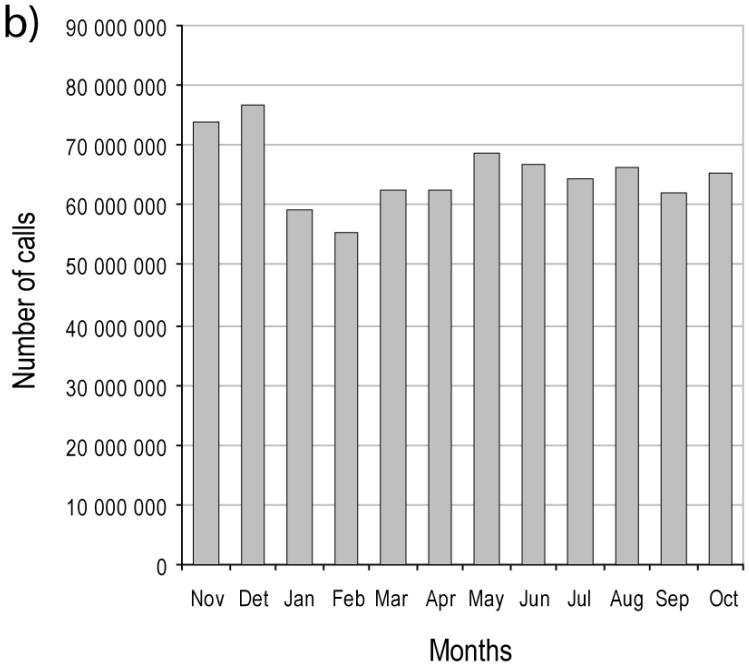
pos_usr_id	call_time	cell_id
4185076	12.08.2007 12:11:39	523
4185076	12.08.2007 12:12:31	274
4185076	12.08.2007 12:56:05	277
5433301	12.08.2007 19:59:19	2307
5479234	12.08.2007 20:34:23	2687
4185076	12.08.2007 21:12:11	274
4185076	12.08.2007 21:36:01	270
4185076	12.08.2007 21:37:01	270
4185076	12.08.2007 21:37:14	277
4185076	12.08.2007 21:41:18	277
4185076	12.08.2007 23:11:16	314
4185076	12.08.2007 23:12:47	1732
4185076	13.08.2007 9:01:54	270
4185076	13.08.2007 10:34:33	3112
4185076	13.08.2007 10:37:17	2433
5433301	13.08.2007 10:40:30	1506
4185076	13.08.2007 11:04:52	314
5433301	13.08.2007 12:37:11	1506
4185076	13.08.2007 13:22:20	2311
4185076	13.08.2007 15:06:02	1506
280165	13.08.2007 16:05:36	1506
5479234	13.08.2007 16:24:16	2756
5479234	13.08.2007 16:27:36	1729
5479234	13.08.2007 16:29:36	329
5479234	13.08.2007 16:30:53	327
280165	13.08.2007 16:55:00	1507
5479234	13.08.2007 16:56:47	2145
5433301	13.08.2007 17:54:59	1506
5479234	13.08.2007 19:55:05	1729
5479234	13.08.2007 19:57:26	1729
5479234	13.08.2007 21:03:03	1732
5479234	13.08.2007 21:08:18	314
5479234	13.08.2007 21:11:20	1731
5479234	13.08.2007 21:59:29	1732
5479234	13.08.2007 22:17:47	1732
5479234	13.08.2007 22:22:09	1732
4185076	13.08.2007 22:29:35	3112
5479234	13.08.2007 22:30:55	1732
5479234	13.08.2007 23:24:51	1731
5479234	14.08.2007 0:03:13	1732
5479234	14.08.2007 0:32:24	2302
5479234	14.08.2007 1:06:16	2302
5479234	14.08.2007 1:21:48	2302

Positium LBS database

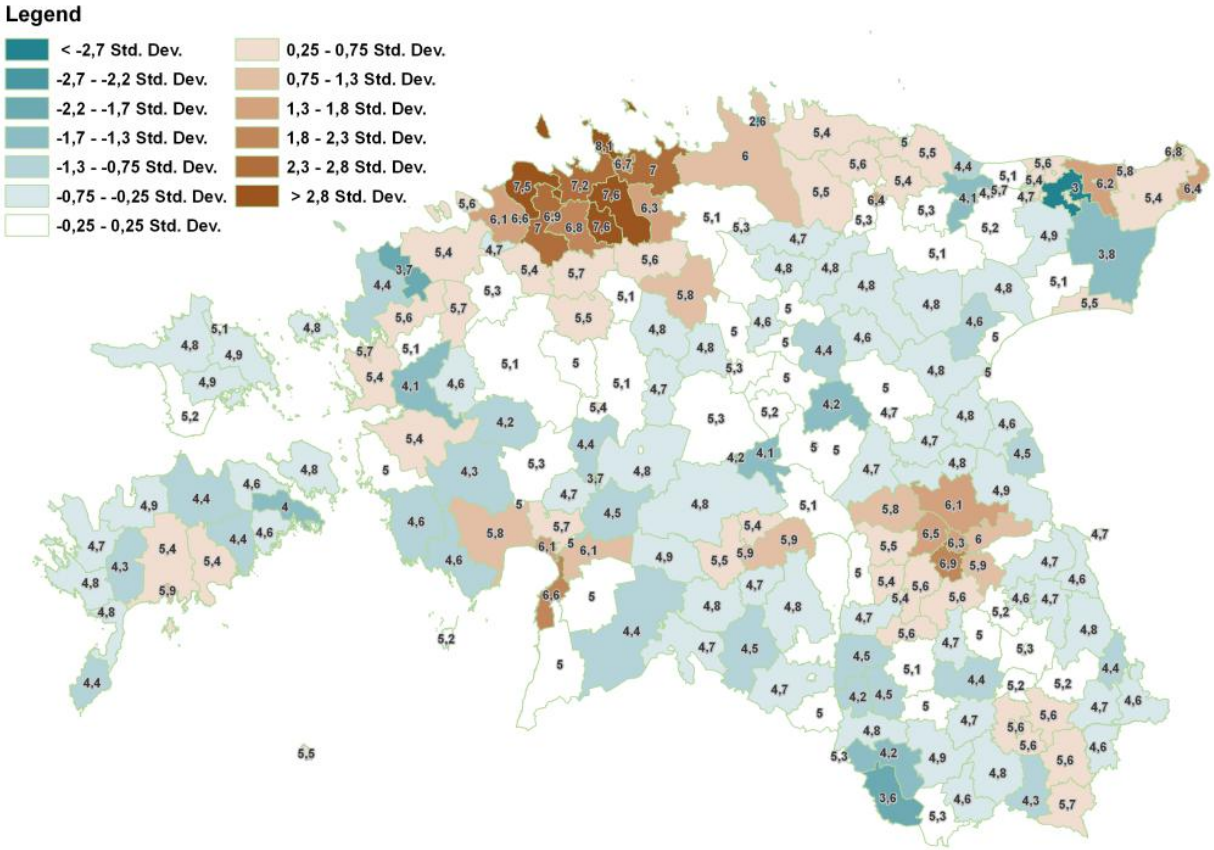
- Estonian users 600 000 active phone cards since 2006
- Foreign users (roaming) since 2004
- Data management model (interpolation, evaluation, bias): Ericsson, Nokia

Database


a)
610 000
605 000
600 000
595 000
590 000
585 000
580 000
575 000
570 000
565 000
Number of IDs
Nov Det Jan Feb Mar Apr May Jun Jul Aug Sep Oct
Months


b)
90 000 000
80 000 000
70 000 000
60 000 000
50 000 000
40 000 000
30 000 000
20 000 000
10 000 000
0
Number of calls
Nov Det Jan Feb Mar Apr May Jun Jul Aug Sep Oct
Months

Number of calls out: average per day



Age and geography in distribution of calls

total	Tallinn	Tallinn surroundings	Regional centers	Regional center surroundings	County centers	County center surroundings	Rural areas	Total
5-9	-15	-15	-13	-15	-13	-14	-14	-14
10-14	-12	-10	-12	-13	-11	-13	-13	-12
15-19	6	3	-3	-3	3	-3	-5	0
20-24	17	15	8	7	10	7	2	11
25-29	16	15	9	8	7	2	0	10
30-34	15	12	6	5	3	-1	-2	8
35-39	13	11	4	5	0	-2	-3	5
40-44	12	9	5	0	-1	-2	-4	3
45-49	5	5	1	-3	-5	-5	-6	-1
50-54	1	-1	-5	-5	-8	-7	-9	-5
55-59	-3	-4	-8	-11	-9	-10	-10	-7
60-64	-8	-7	-11	-12	-11	-12	-13	-11
65-69	-11	-12	-12	-13	-14	-14	-14	-13
70-74	-14	-13	-15	-15	-14	-15	-15	-15
75-79	-14	-14	-15	-14	-15	-15	-14	-14
80+	-14	-14	-14	-13	-14	-15	-14	-15
Total	7	5	0	-2	-3	-6	-7	0

Finding regularly visited places

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Regularly visited places

- **Anchor points** are locations where people regularly stay
  - Common anchors as landmarks
  - Personal anchors
- **Personal anchors:** Home, work, shopping, family, friends, second home…
- **Meaningful places…**

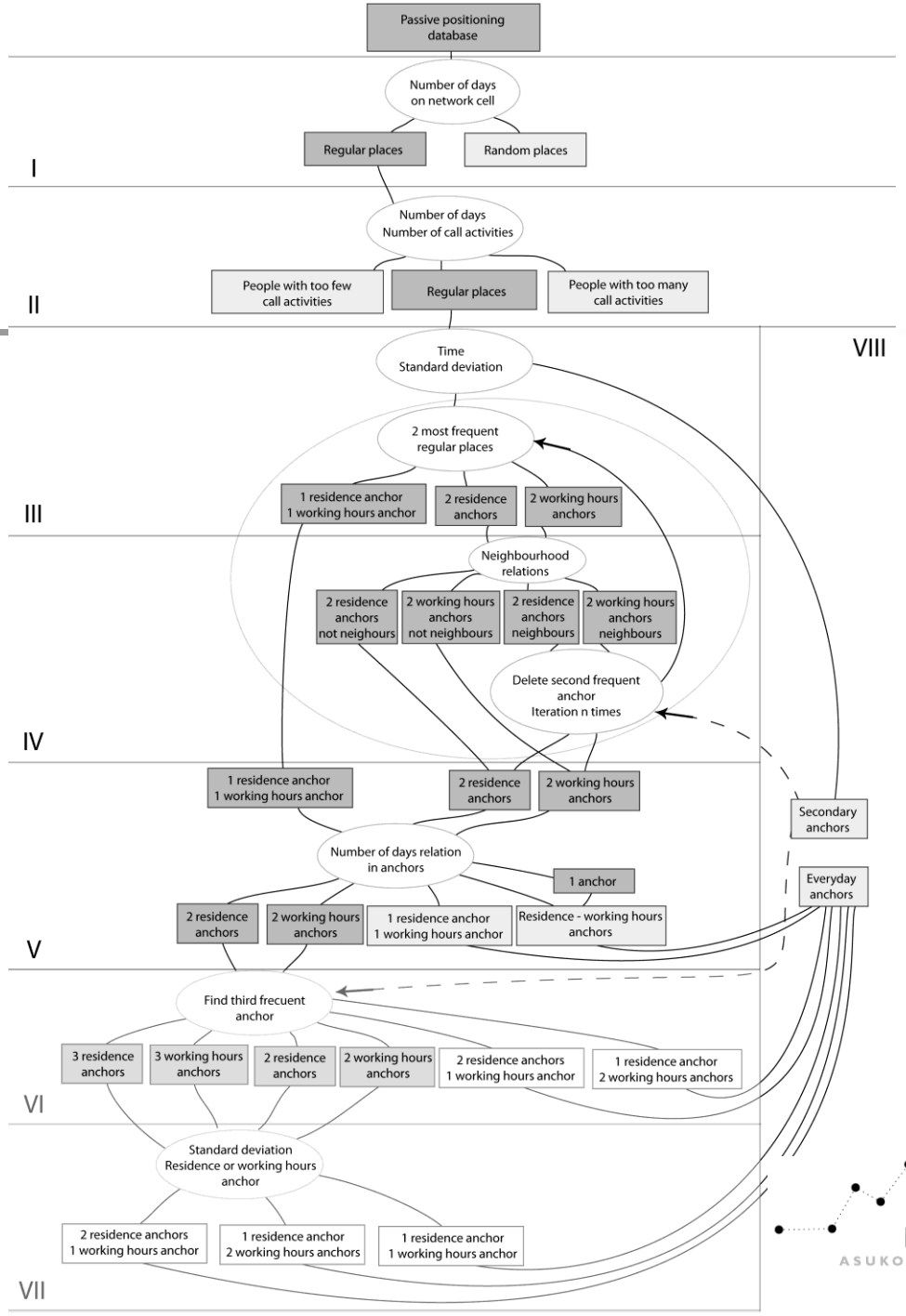
Mobile phone as “third place”

- *The mobile phone can be viewed as a “place”*

- Phone can be third important location after home and work

Kopomaa T. 2004

Model for detecting regularly visited places



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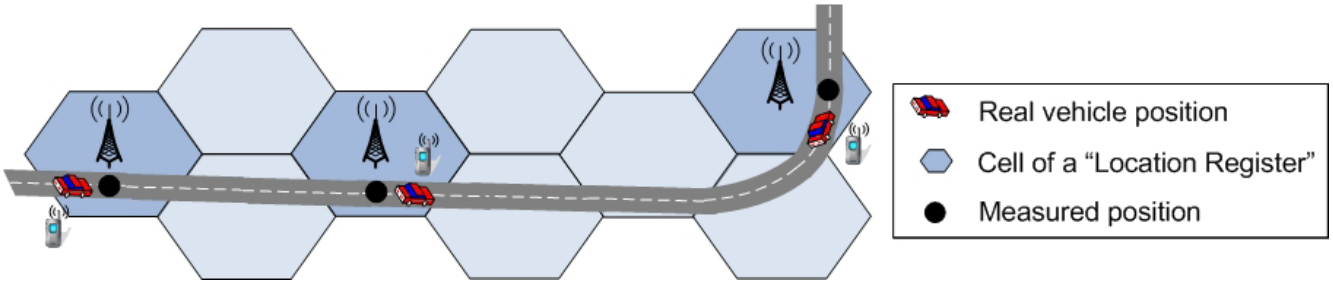
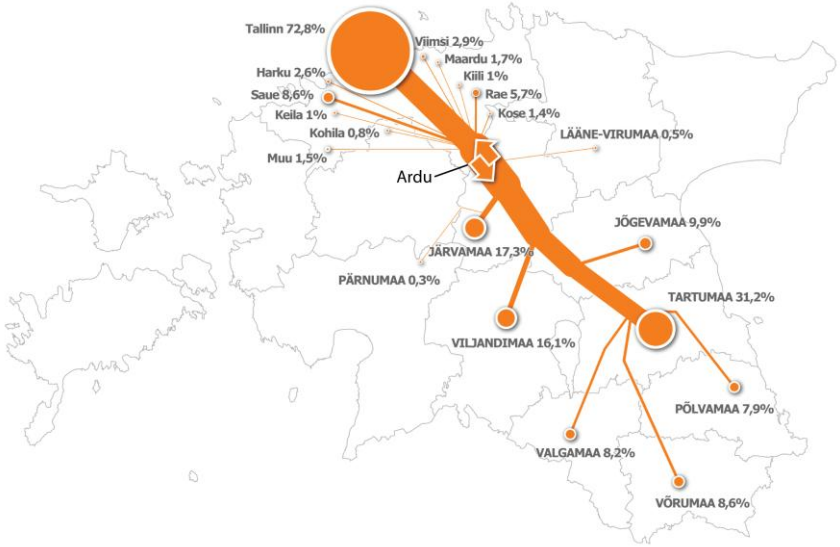
Anchor points modeled

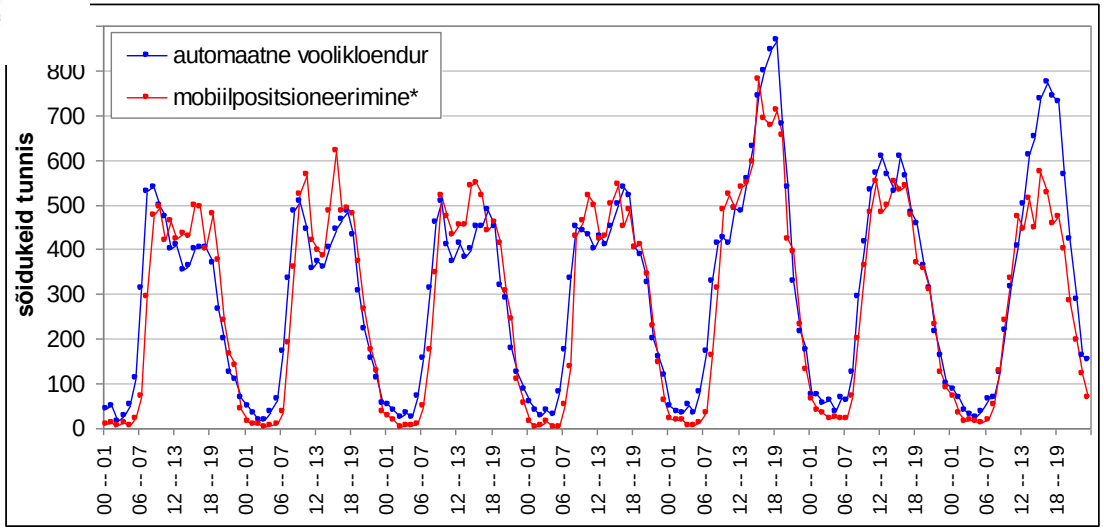
1. Home
2. Work-time
3. School
4. Secondary anchors 1,2,3
5. Non regular – local tourism
6. Second home

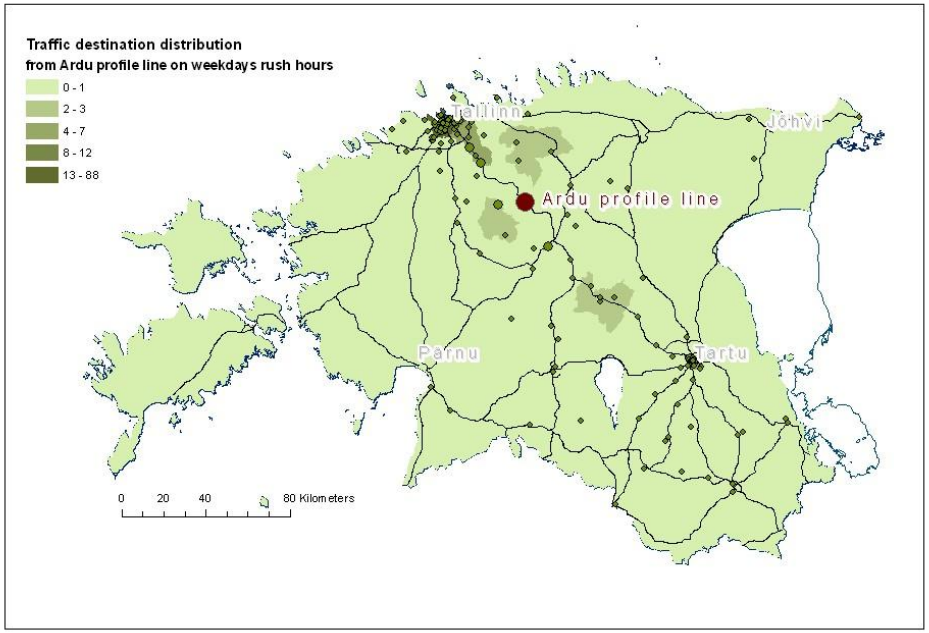
Modelling traffic from Cell ID data



Modeled movements in Tallinn Tartu highway 46 km versus traffic counter: 1 week, november

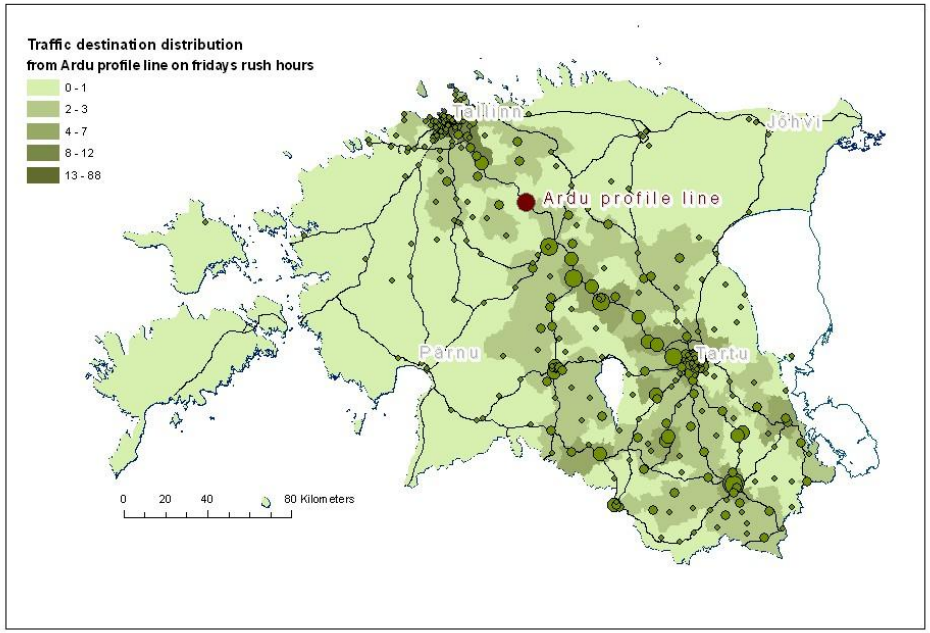






Wednesday

Eevening rush hours

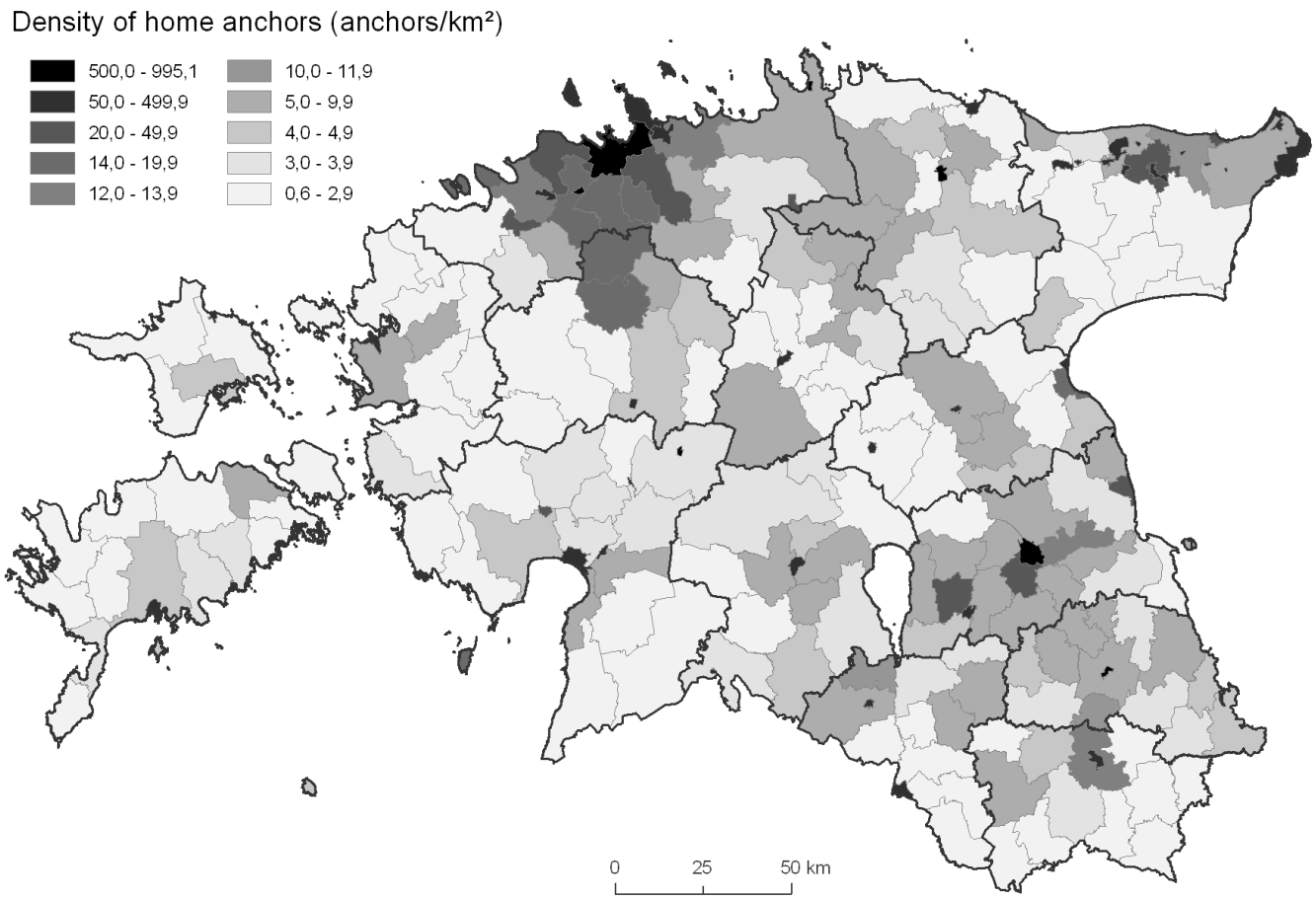


Friday

Evening rush hours

Some expamples

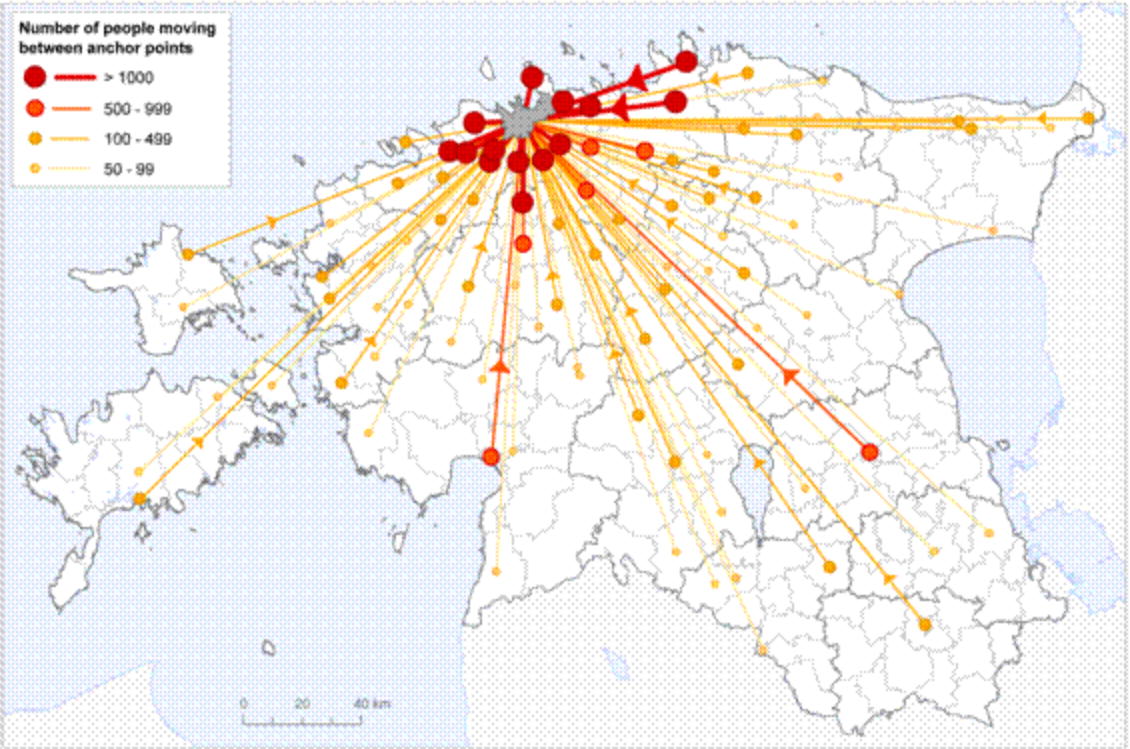
Location of homes



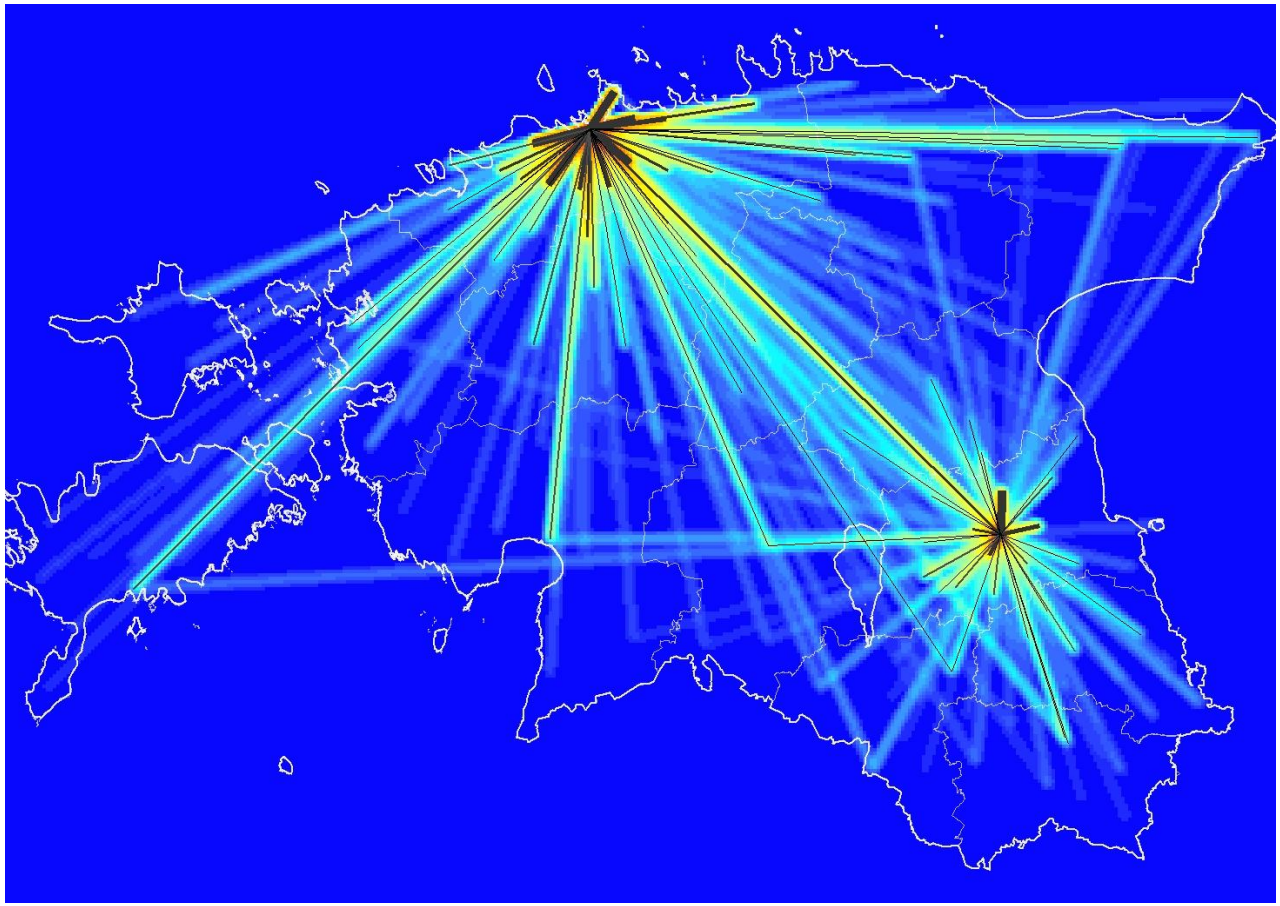
Commuters to Tallinn

Work place in Tallinn city: min 12 visits per month

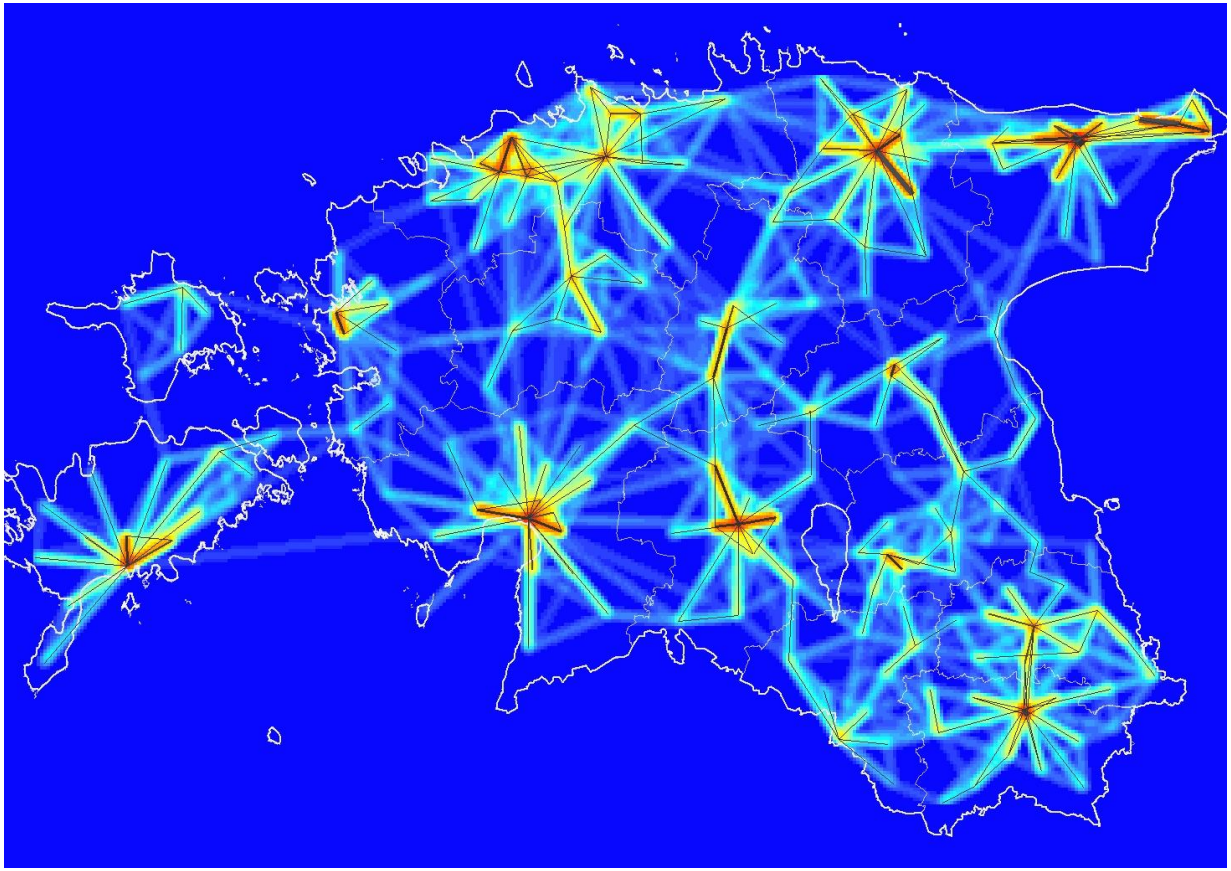
Home outside of Tallinn: min 12 visits per month



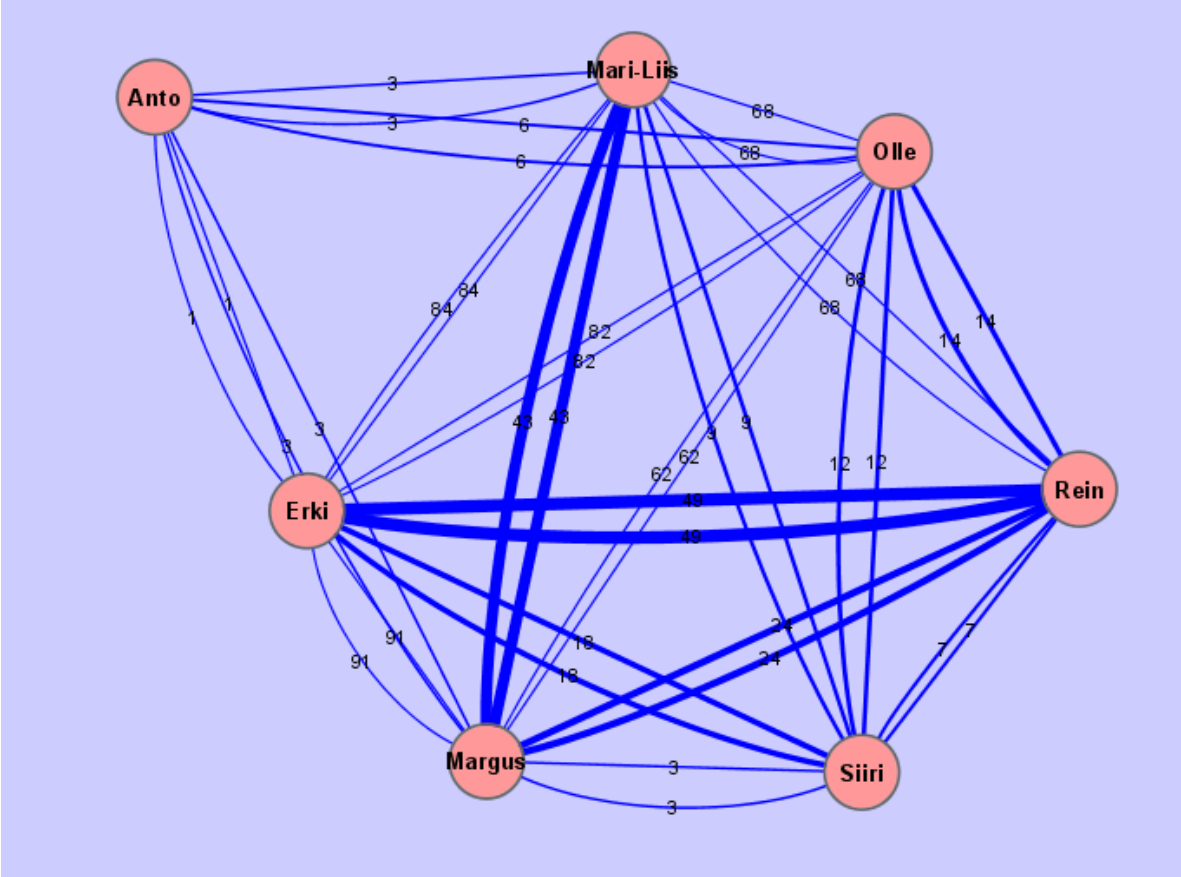
Everyday home-work connections in Estonia: Major Cities



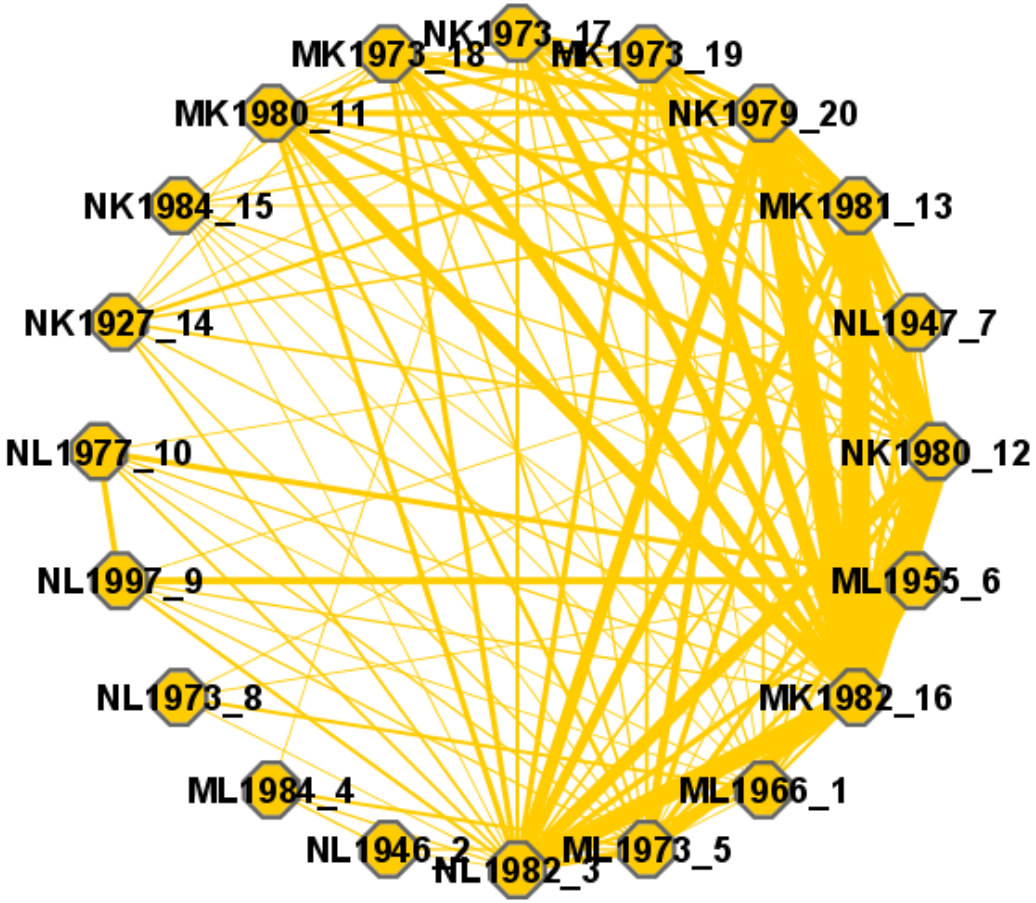
Everyday home-work connections in Estonia: Regional Centres



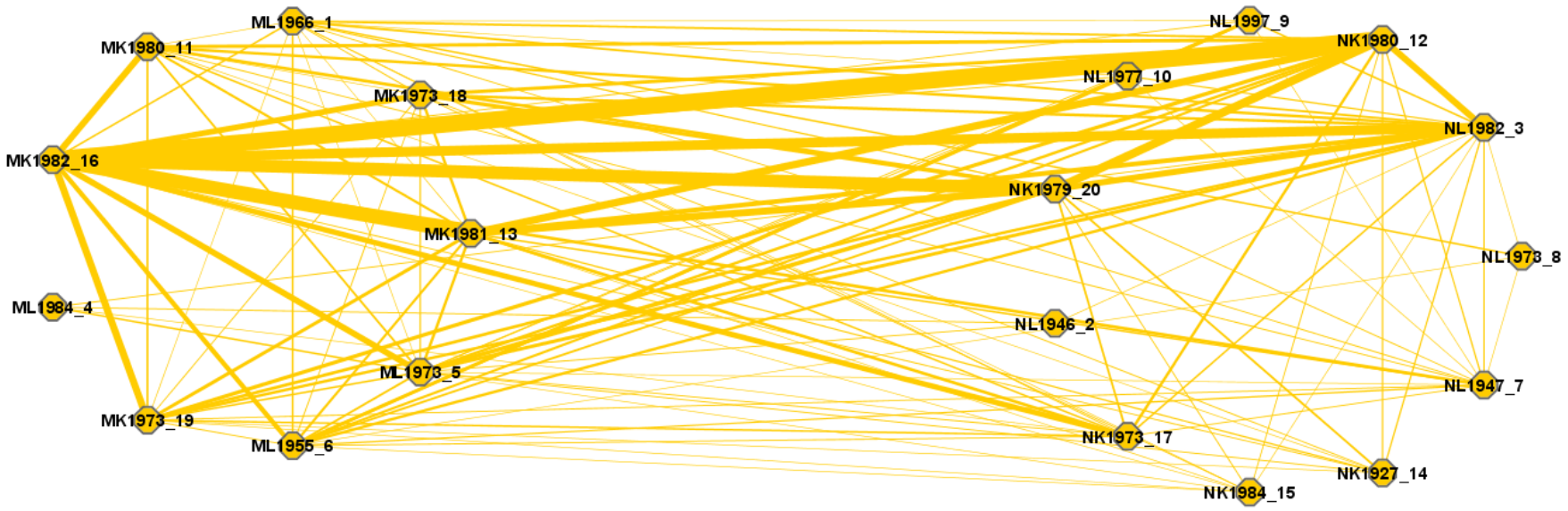
Research team



Number of connections



Networks of regularly visted places



Conclusions

Stregnths of passive mobile positioning data

- Mobile phones are everywhere, people like to carry them on
- Digital data, no bias from questioning or digitalization
- Actual locations
- Good spatial accuracy
- Cost effective
- Real time applicability

Problems with passive mobile positioning data

- Accsess to data is difficult
- Surveillance & privacy issues
- High quantity of data

Methodological issues

- How & when they use mobile phones?
- Number of call activities?
- Radio coverage?
- Too quantitative “moving dots”?

Thank you!

Ahas, R. Aasa, A., Roose, A., Mark, Ü., Silm, S. 2008. Evaluating passive mobile positioning data for tourism surveys: An Estonian case study. **Tourism Management 29(3): 469–486.**

Ahas, R., Aasa, A., Silm, S., Aunap, R., Kalle, H., Mark, Ü. 2007. Mobile positioning in space-time behaviour studies: Social Positioning Method experiments in Estonia. **Cartography and Geographic Information Science 34(4): 259-273.**

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