UN TRADE STATISTICS

Overview of the Sources and Challenges of **Mobile Positioning Data** for **Statistics**

International Conference on Big Data for Official Statistics

28.10.2014 Beijing

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positium

UNIVERSITY OF TARTU

Agenda

What is Mobile Positioning Data?

What are different sources for the data?

Where can it be used?

What are the challenges of the data?

WHAT IS MOBILE POSITIONING DATA?

What is Mobile Positioning Data?

Tracking the locations of mobile devices in time and space

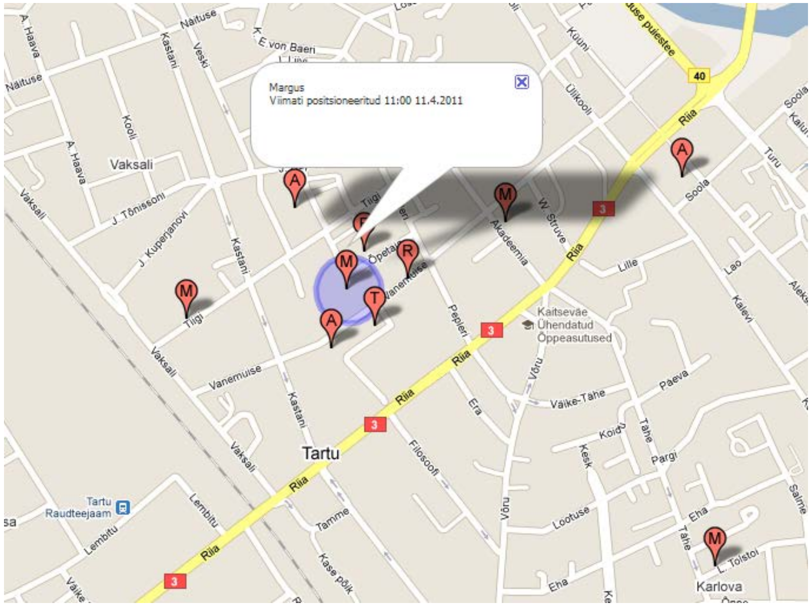
Collected by Mobile Network Operators (MNOs)

Collected by mobile app developers

Collection Methods

Active positioning

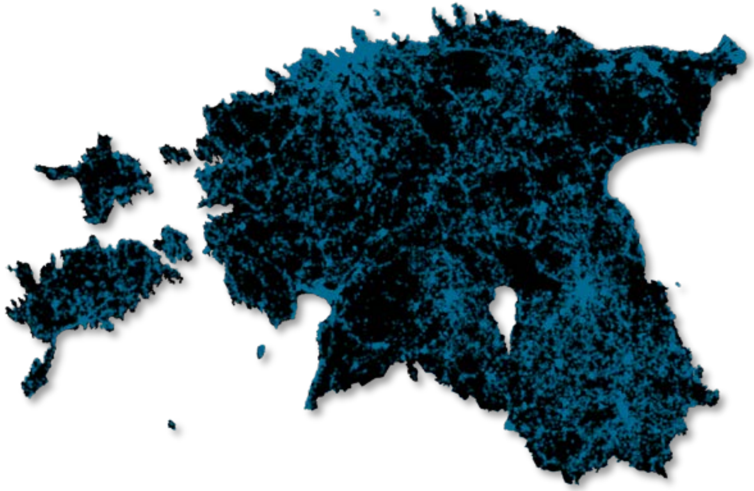
locating individual devices



Margus
Viimati positsioneeritud 11:00 11.4.2011

Passive positioning

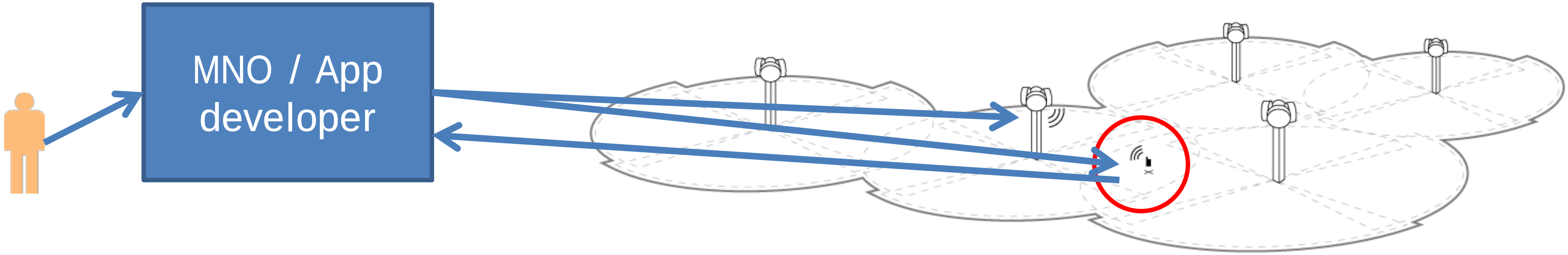
residual mass data



Active Positioning

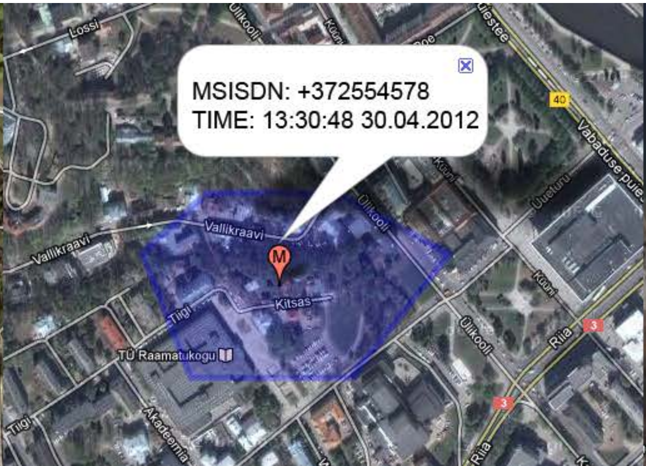
Obtaining real-time location of the mobile device

Usually requires consent from the phone owner



MNO / App developer

MSISDN: +3725264020
TIME: 13:30:48 30.04.2012



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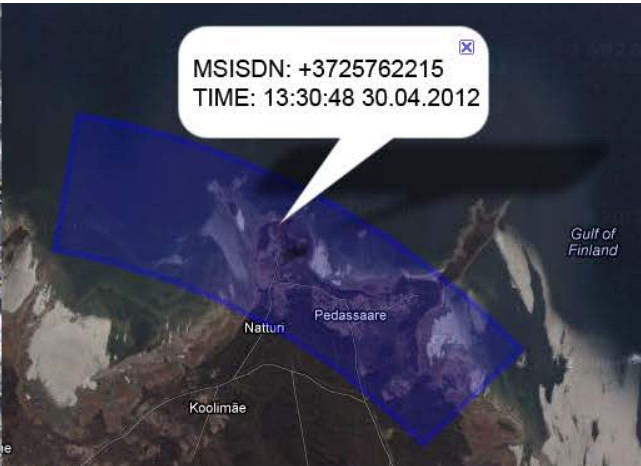

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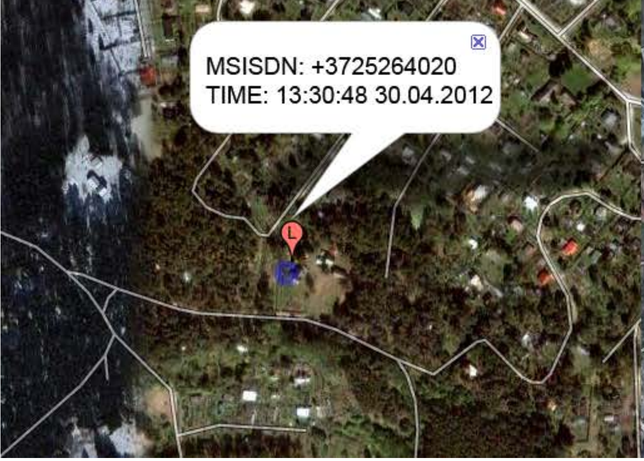
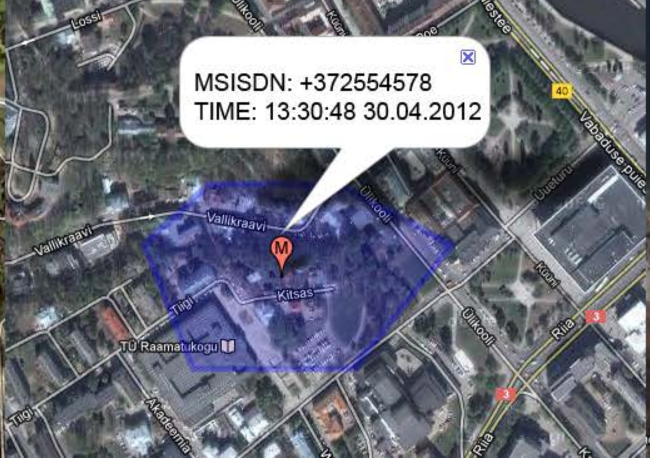
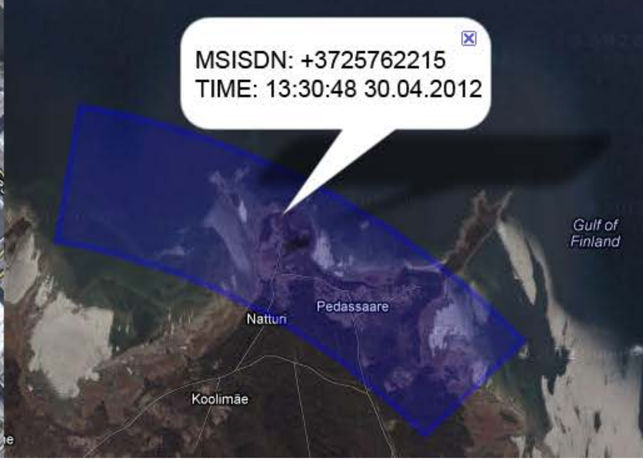






Different accuracy levels:

GPS and A-GPS capability if available

Wireless network (Wifi) location databases

Network antenna-based location databases

Options to Obtain Active Location

Active pinging of the phone via MNO

Terminal-based positioning (apps & GPS)

Advantages / Disadvantages

Advantages

- Additional tool for spatial behaviour research and statistics
- Can be linked to qualitative surveys
- Very small burden for respondents
- Relatively easy to set up and conduct positioning requests

Disadvantages

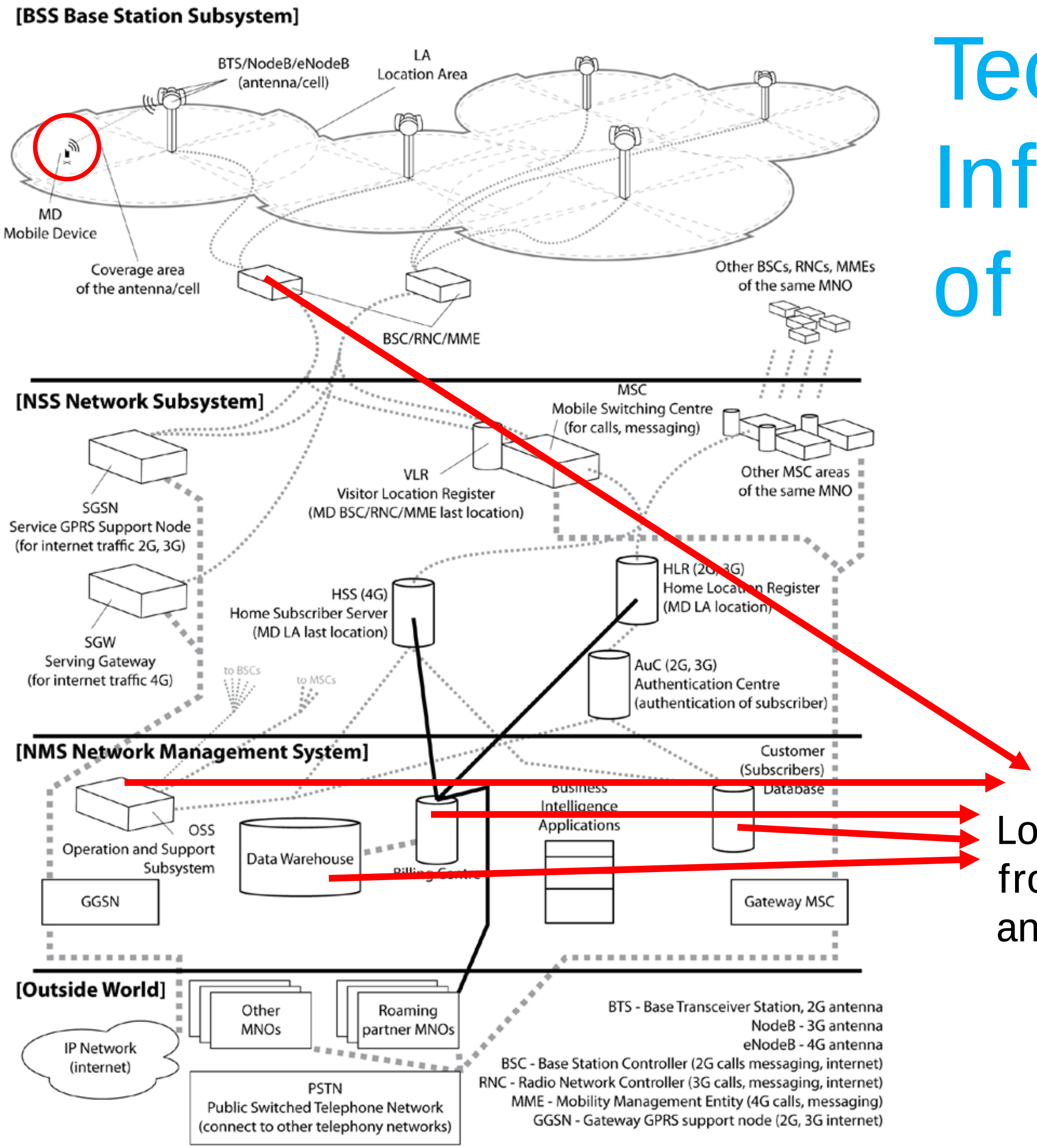
- Small sample size because of the need to get consent from the subscribers
- Technological limits for the number of location requests via MNOs’ network infrastructure

Passive Positioning

Retrieving stored records of the activities of mobile devices from the mobile operator networks or app developers’ databases

Digital geographical footprint left by the mobile device users

Technical Infrastructure of MNO



Location events collected from different registries and databases

Standards

- CDMA (Code Division Multiple Access)
- 15-25 %
- Mostly N-America, Japan

- GSM (Global System for Mobiles)
- 75-85%
- The rest of the World

- Both systems are internally similar but mostly incompatible (roaming)
- Development of LTE (4G) should eliminate the differences

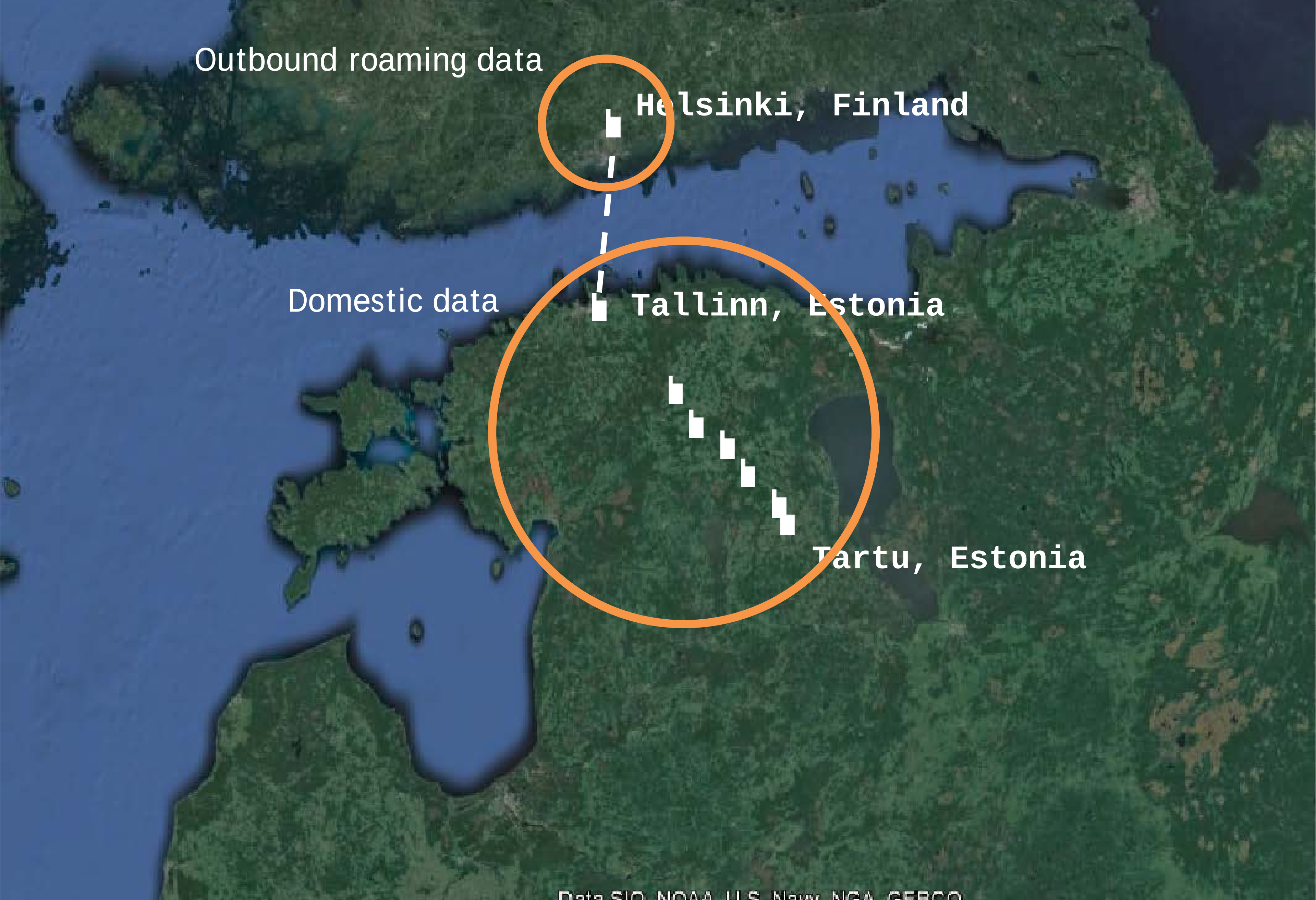
Forms of Passive Positioning Data

Domestic data – home subscribers

Outbound roaming – home subscribers abroad

Inbound roaming – foreign subscribers

My trip to China so far as raw data from my MNO:



Outbound roaming data

Domestic data

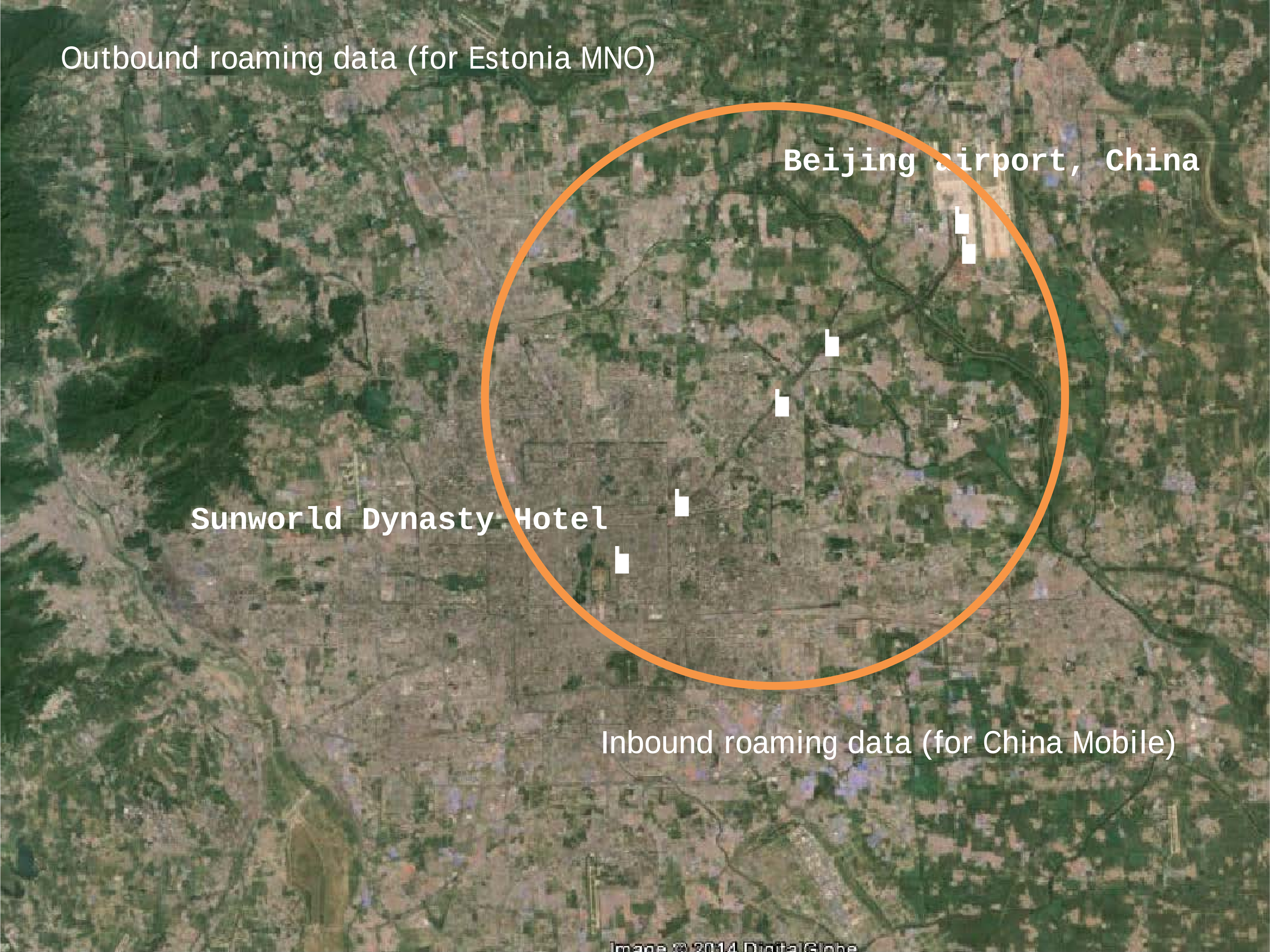
Outbound roaming data

Beijing, China

Helsinki, Finland

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Outbound roaming data (for Estonia MNO)



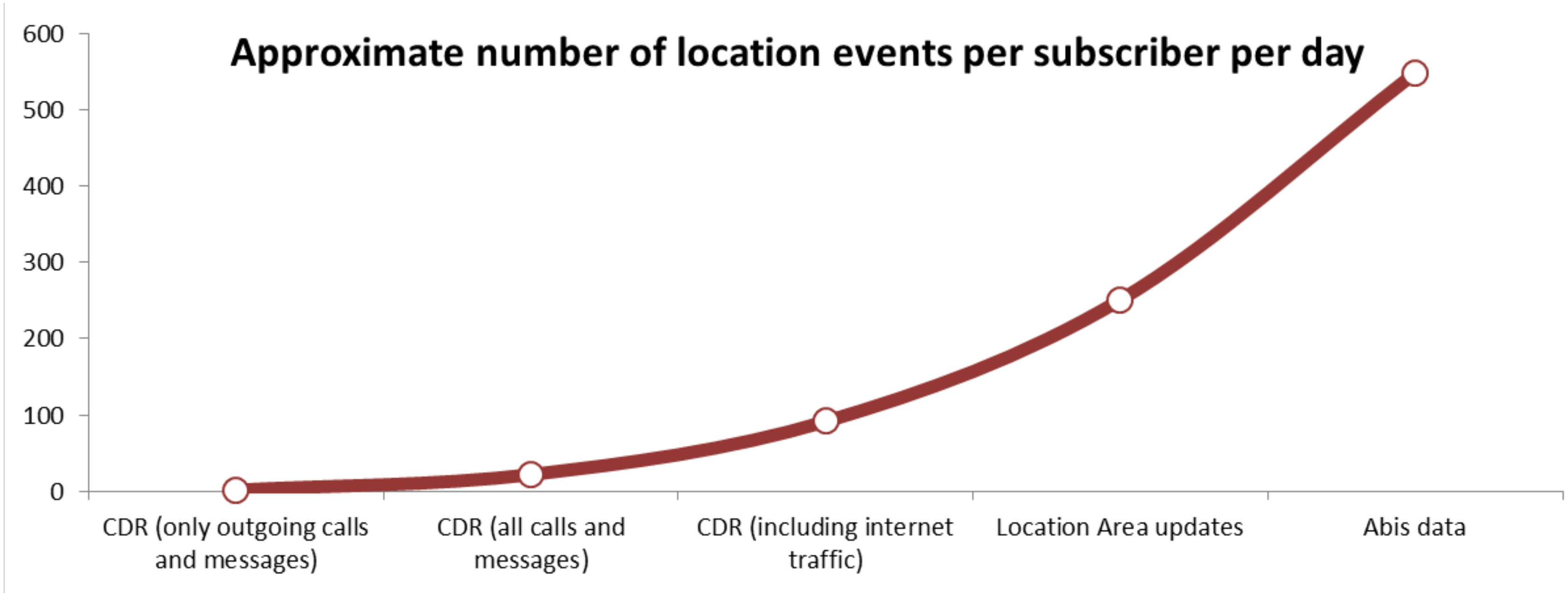
Inbound roaming data (for China Mobile)

Image © 2014 DigitalGlobe

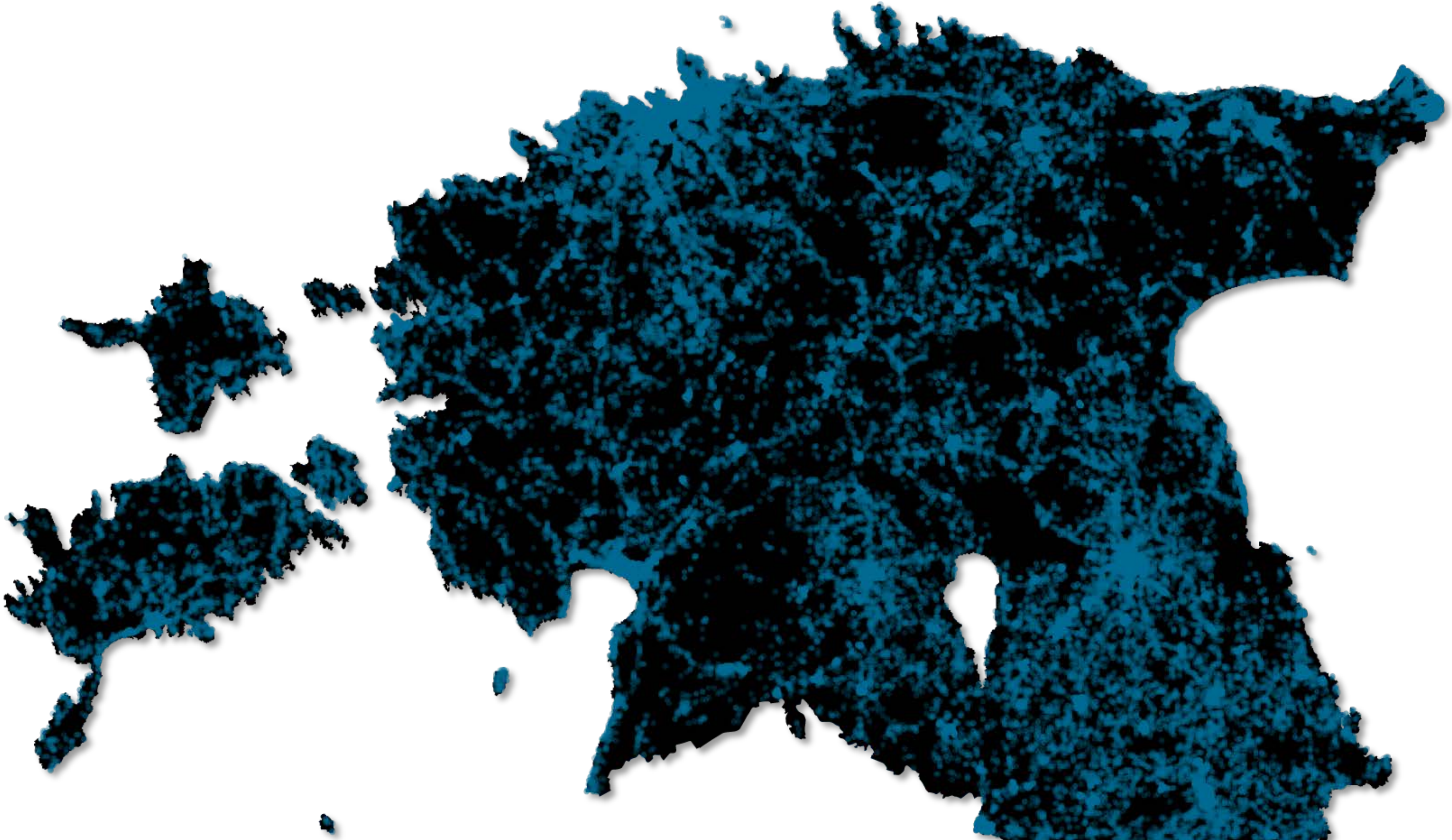
Types of Passive Positioning Data

- CDR – Call Detail Records:
- Outgoing calls, messages (avg 2-3 CDR/subsc/day)
- Incoming calls, messages (avg 2-3 CDR/subsc/day)
- Roaming TAP (Transferred Account Procedure) data – the source for outbound data
- Internet traffic (DDR/IPDR) (avg 150 DDR/subsc/day)
- Location Area updates
- Other network data (handover data, Abis, network probes, etc.)

“Density” of the Different Types



Combining Data for all Subscribers



ONE MONTH OF DATA
150M records / month

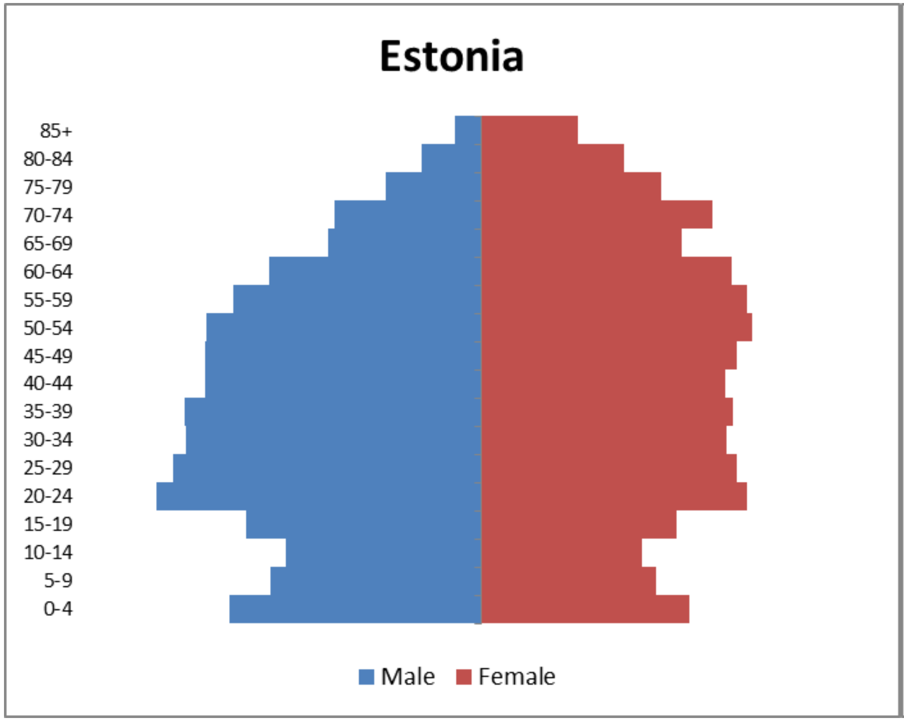
Additional Data

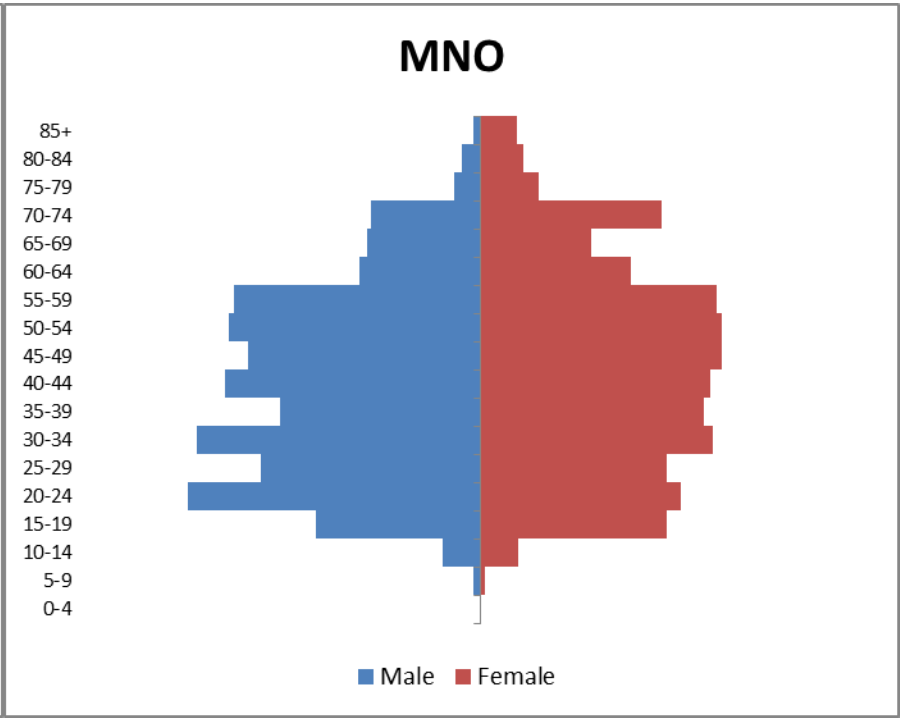
Geographic antennae reference data (needed for inbound roaming and domestic data)

CRM data (demography, phone usage, customer value, average phone bill, etc.)

Mobile banking (if SIM card connected to banking account)

Demographic Profiles





Describing 68% of subscribers (29.3% of population)

App-based Data

Application developers

Facebook, Google, Apple, Twitter, Weibo, and many others

No standard data model

Different data types

Advantages / Disadvantages

Advantages

Very large sample size, representative data source

Data is quantitative, methodologically feasible

Passive data collection (no burden on the respondents), high automation level of statistical production

Can be used in very different statistical domains and produce new statistical indicators that are often previously unmeasurable

Cost-effective compared to the data collection methods with same sample size (e.g. population census)

Possible to compile historical statistics and generate near-real time indicators

Good coverage over time and space

Disadvantages

Difficult to access data (legislation and ownership of the data)

Privacy protection aspects and methodological aspects of processing highly sensitive data

Possible bad publicity for providers (MNOs) and users (government) of the data

Very few or almost no qualitative information about the sample

Data quality aspects (geographic accuracy, density of the data, over- and under-coverage issues)

Processing of the data requires powerful computational resources

Does not always correspond to official statistical indicators

APPLICATIONS

Applications

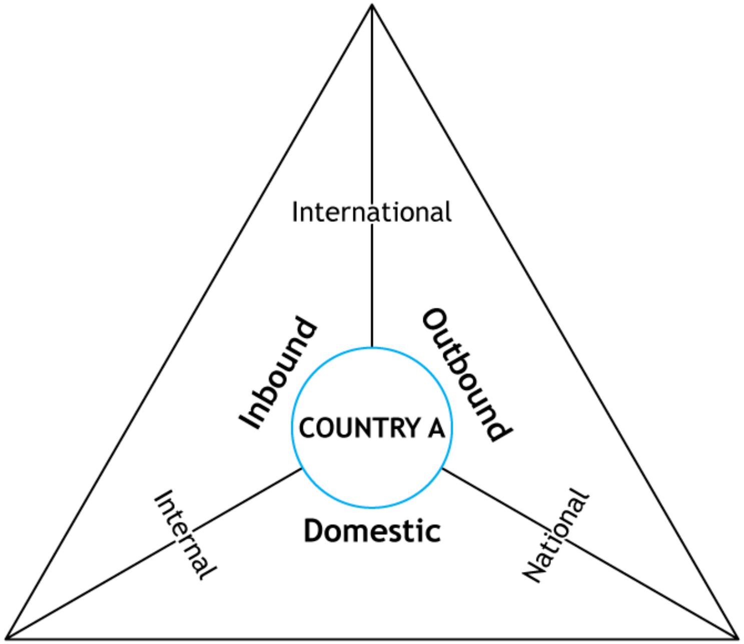
Tourism statistics

Transportation of people

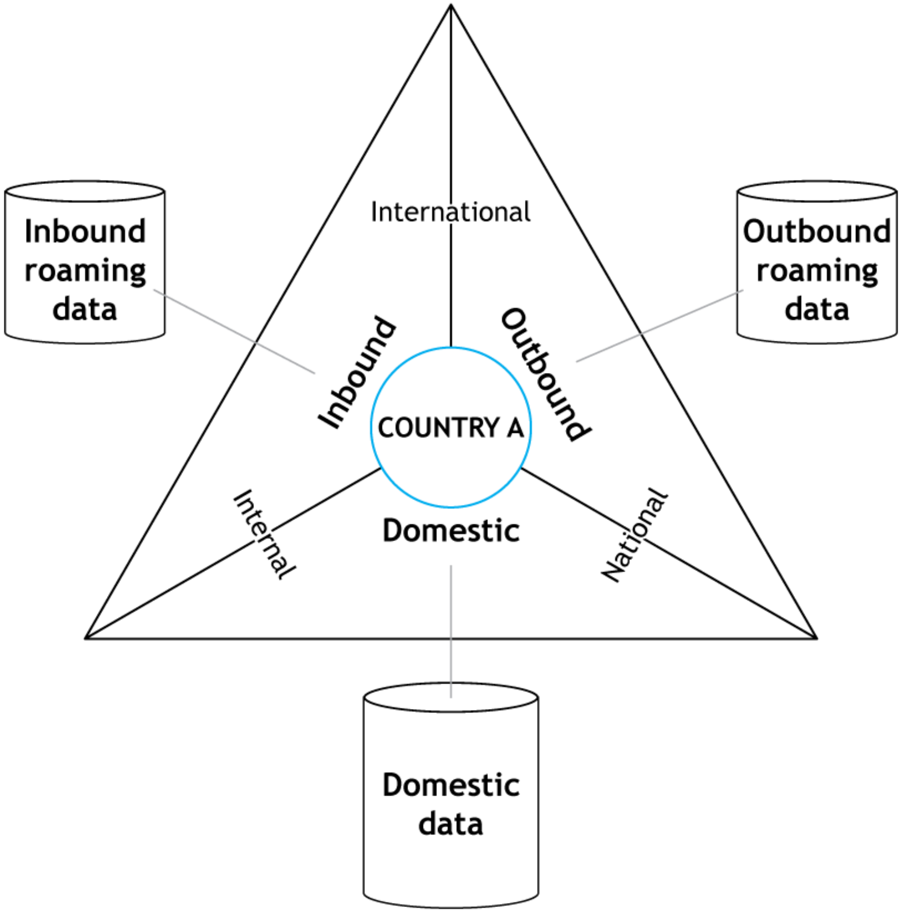
Population statistics

Urban planning, regional planning, econometrics, marketing, events (concert, festivals, sports), pattern of the city, co-presence, segmentation analysis, epidemiology, safety & security, research

Different forms of tourism of a country A



Roughly, the same forms of mobile positioning data exist



Tourism Statistics

Number of trips (I, O, D);

Number of unique travellers (I, O, D);

Duration of the visit in a destination country (I, O, D) / in a smaller sub-regions (I, D);

Breakdown by the country of origin for foreign tourists (I);

Breakdown by the home administrative unit within the country (O, D);

Temporal breakdown: day/week/month (I, O, D);

Overall duration of the trips in spent nights, hours, days present (O, D);

Geographic accuracy: country (I, O, D), lower level administrative units (I, D);

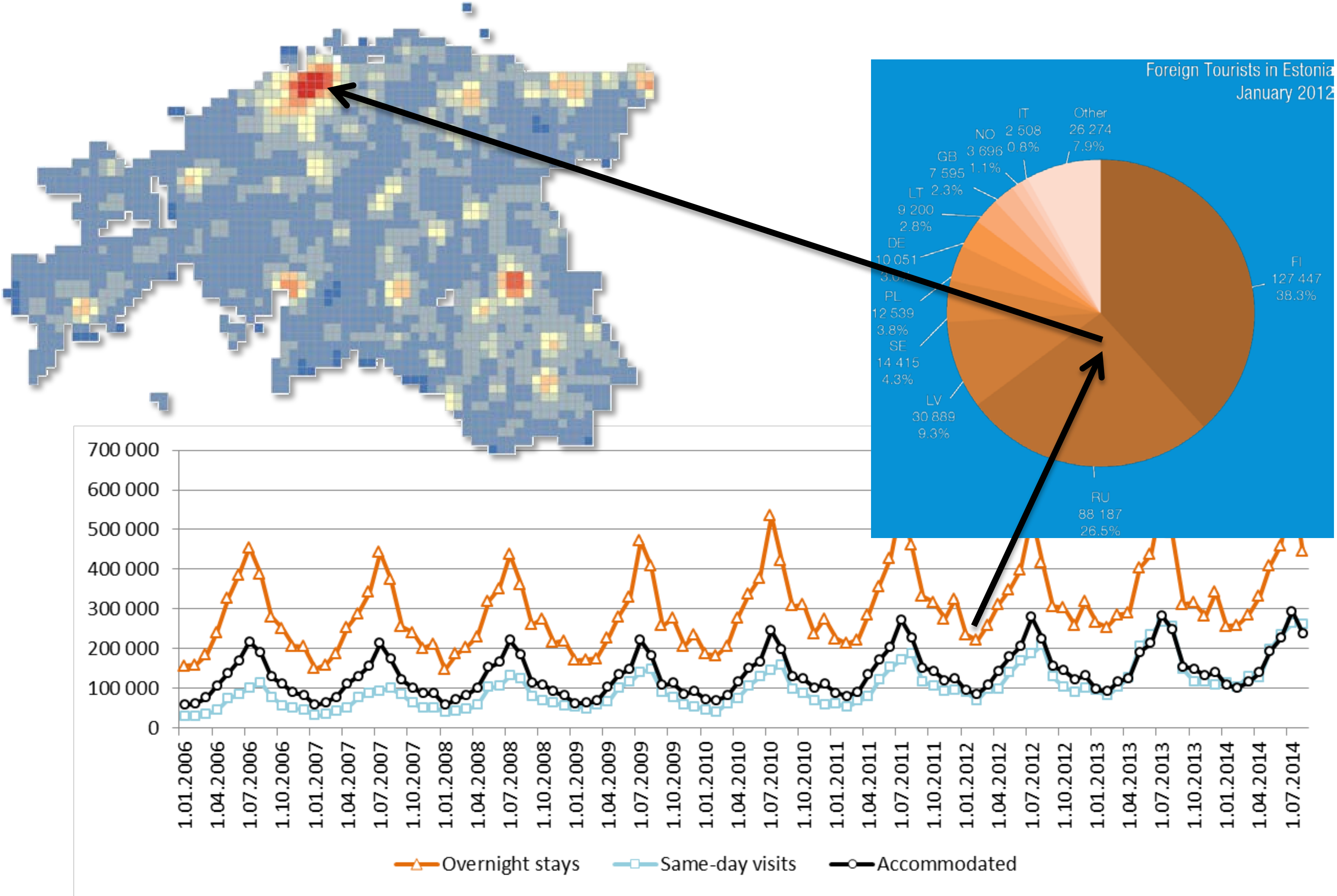
Trajectory of tourism trip (I – only inland, O – only country level, D);

Repeating visits (I, O, D);

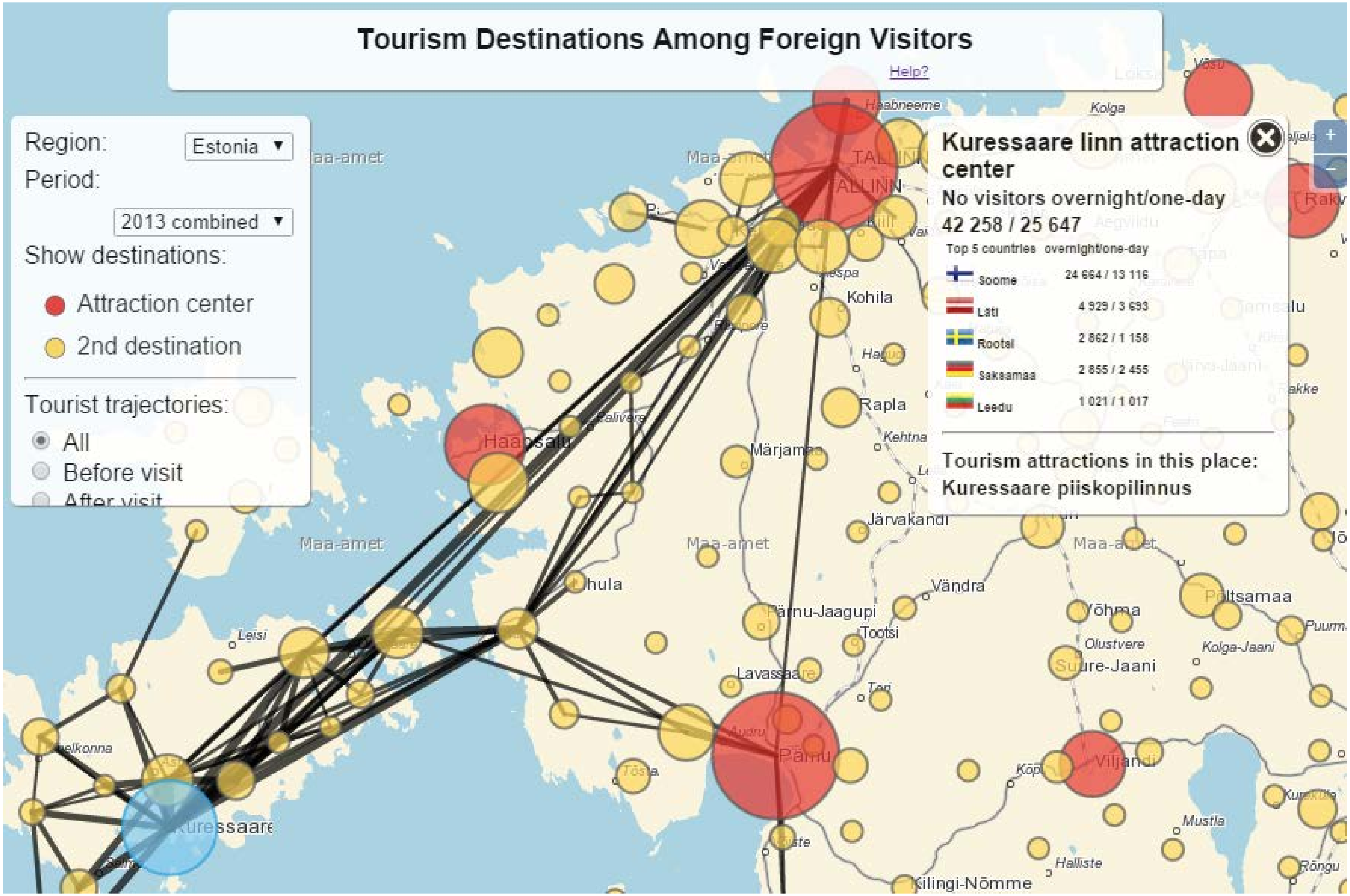
Destination, secondary destinations, transits (I, D);

Destination country, transit countries (O);

Inbound Tourism



Tourist Attraction Centres



Tourism Destinations Among Foreign Visitors

Help?

Region: Estonia ▼

Period: 2013 combined ▼

Show destinations:

🟥 Attraction center

🟨 2nd destination

Tourist trajectories:

● All

○ Before visit

○ After visit

Kuressaare linn attraction center

No visitors overnight/one-day

42 258 / 25 647

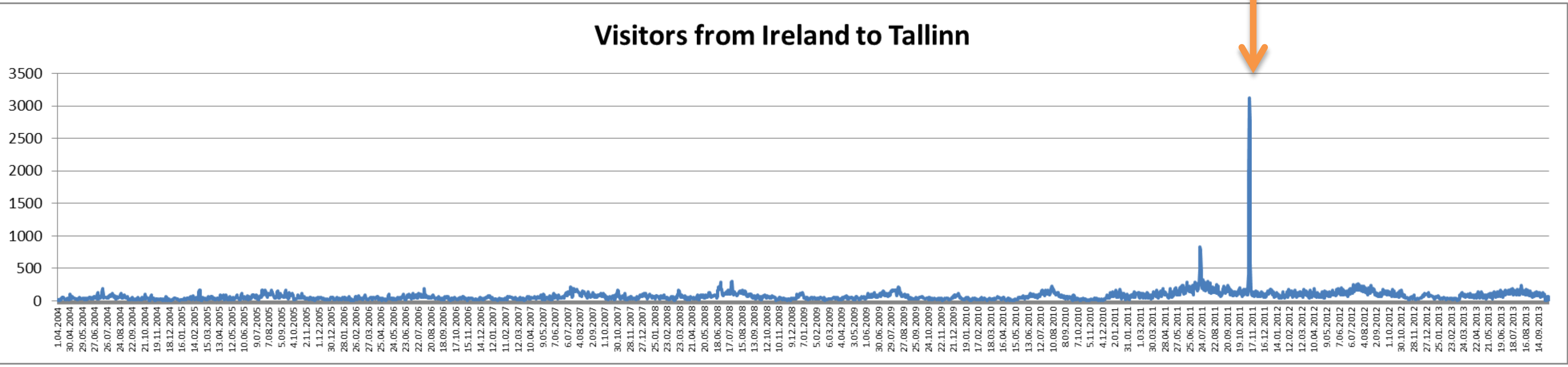
Top 5 countries	overnight/one-day
Soome	24 664 / 13 116
Läti	4 929 / 3 693
Rootsi	2 862 / 1 158
Saksamaa	2 855 / 2 455
Leedu	1 021 / 1 017

Tourism attractions in this place:
Kuressaare piiskopilinnus

http://demo.positium.ee/tourism

Inbound roaming data

Activity of partners' subscribers within home network



Transportation

Origin-destination matrices with hourly and daily travel numbers based on long-term average regular, or actual (for a specific date) data;

Identification of everyday commuting patterns;

Spatial accuracy up to 100 m^2 grid (depending on the available data accuracy);

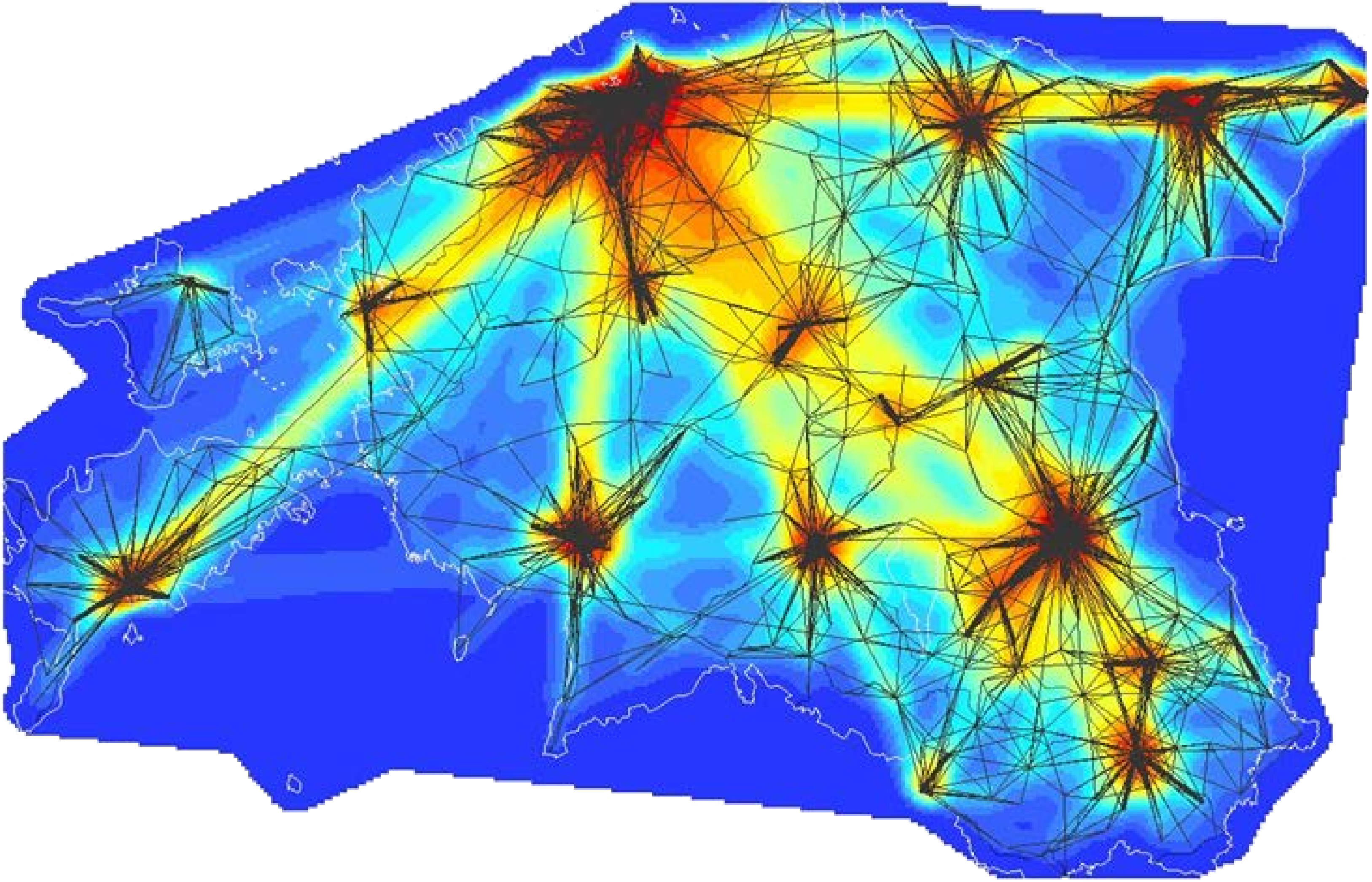
Breakdown based on the demography (depending on the data available from MNO);

Average number of trips per person per day;

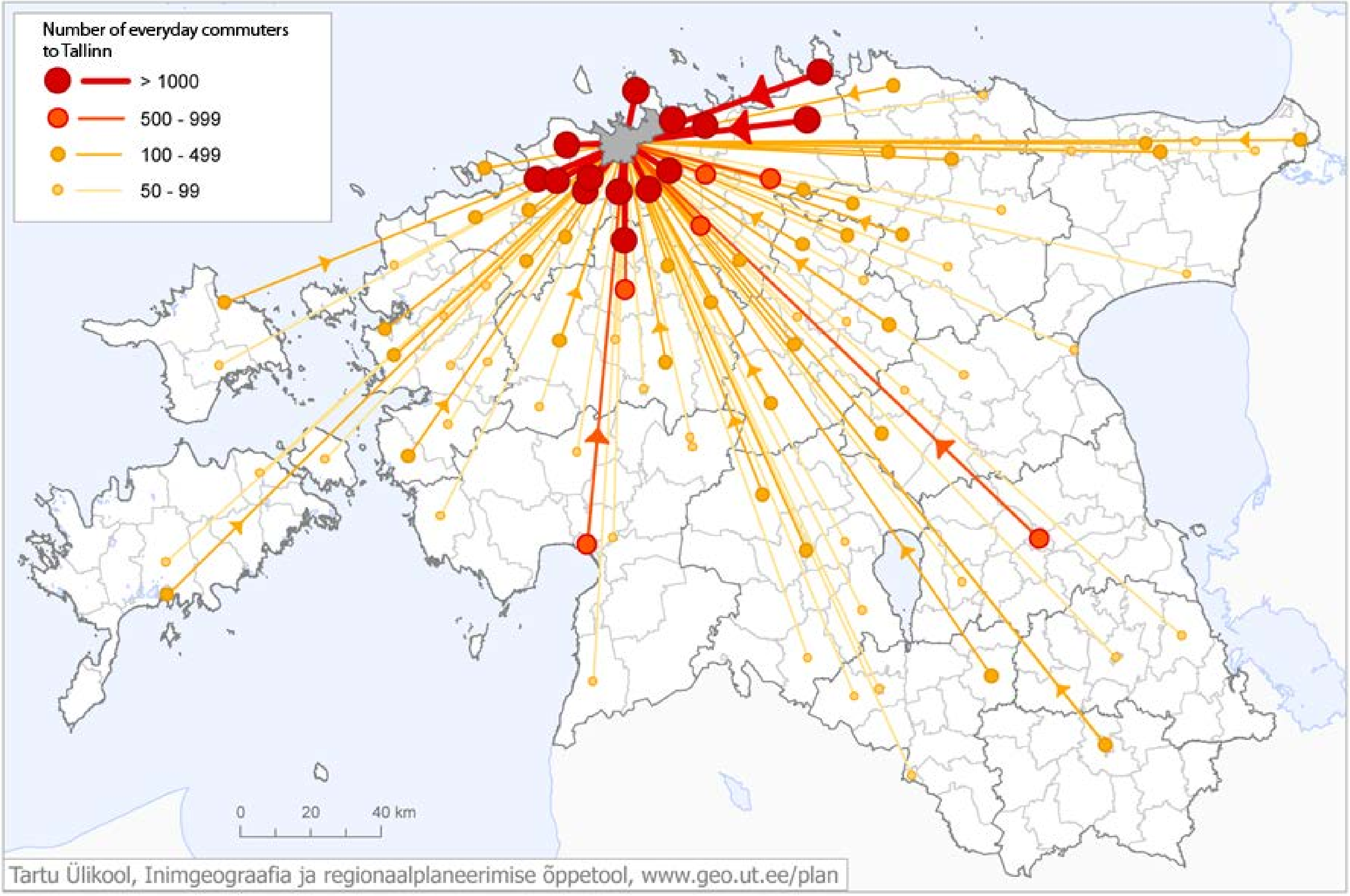
Average or actual distance travelled;

Average or actual travel times;

Commuters

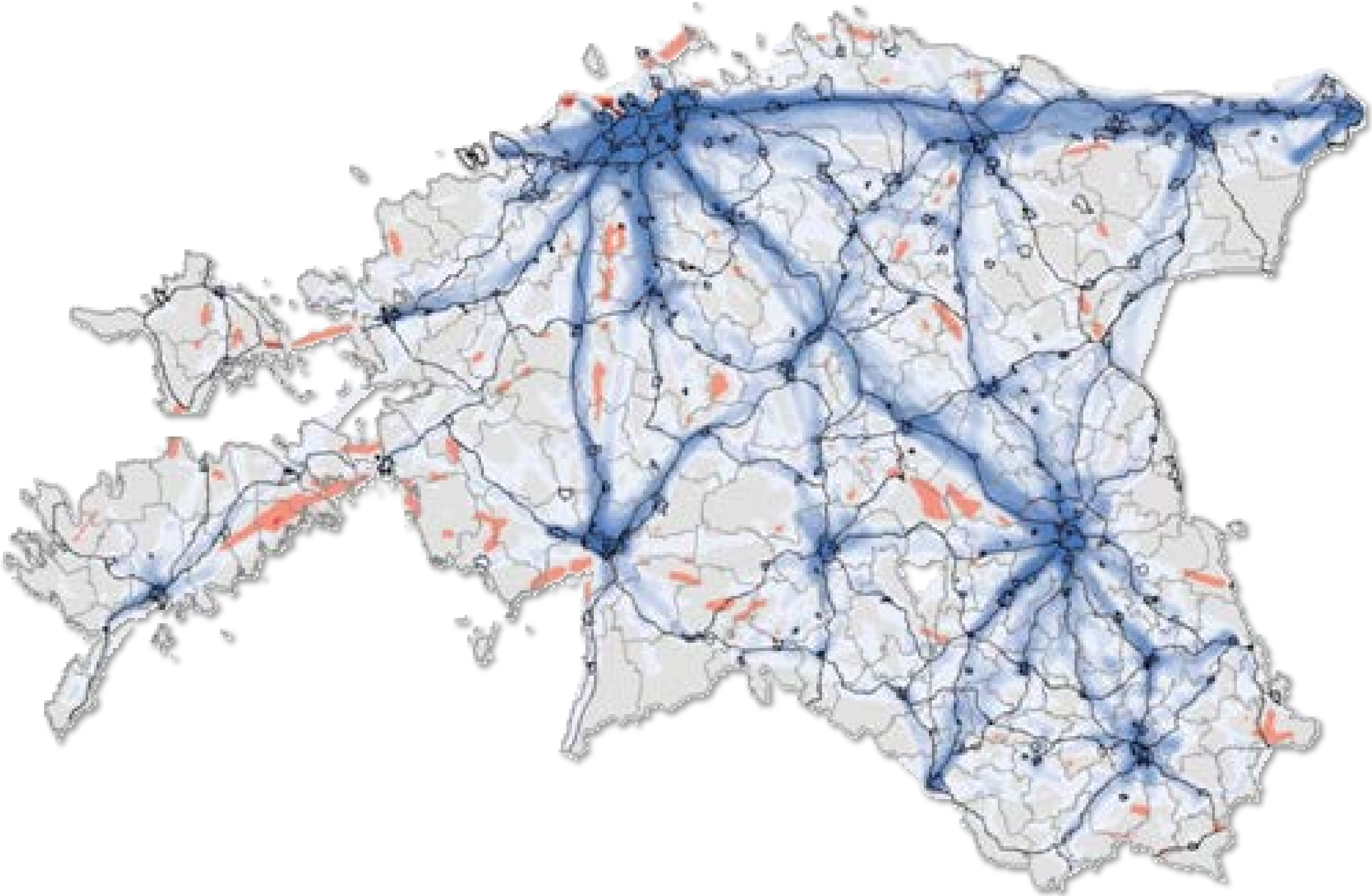


Commuters to Tallinn



Tartu Ülikool, Inimgeograafia ja regionaalplaneerimise õppetool, www.geo.ut.ee/plan

Traffic



Population

The number of residences geographically distributed according to available accuracy;

The number of workplace, school, secondary home, and other regular locations;

Internal migration based on the change of the residences within the country;

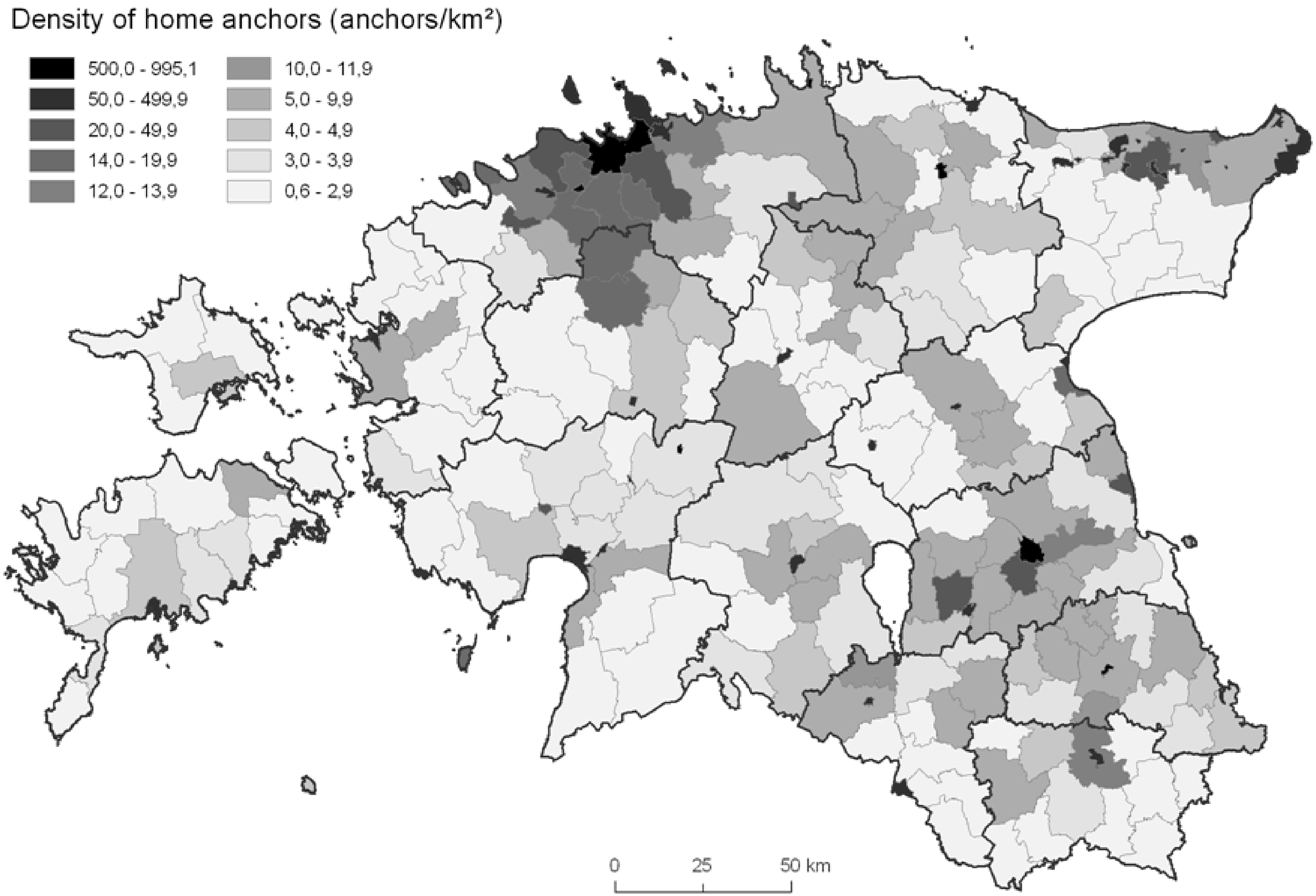
Change of workplace over time;

Cross-border migration based on the regular travels between different countries;

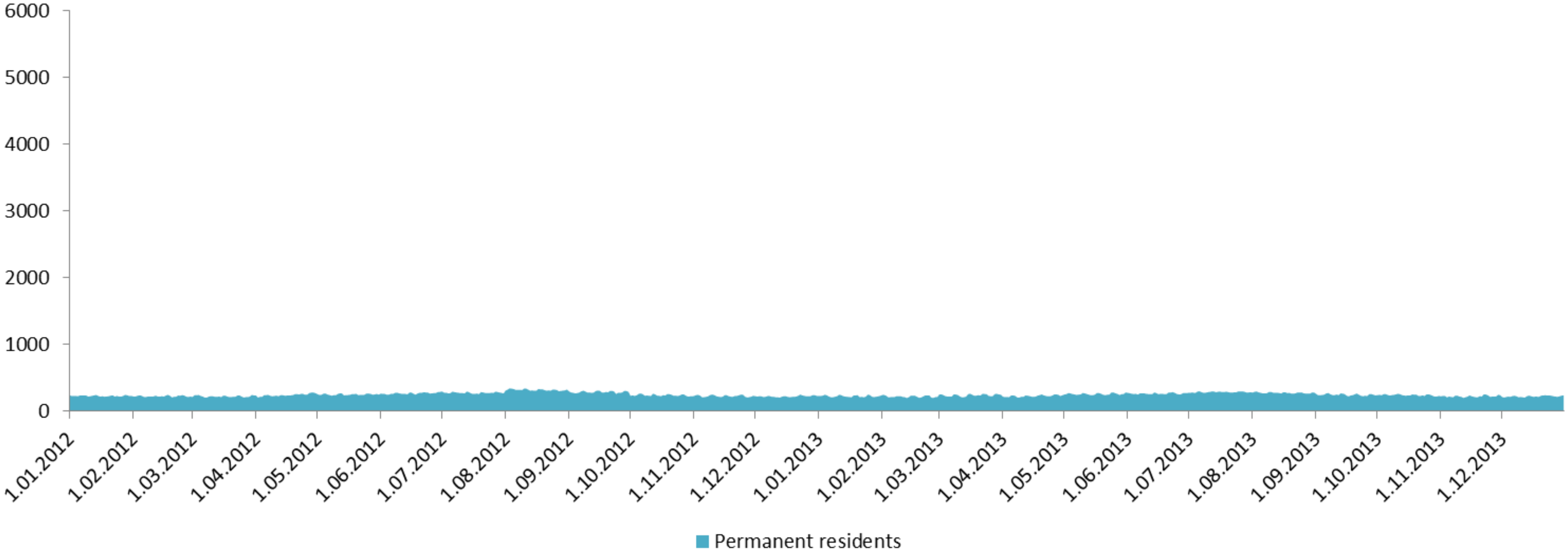
Population grid statistics (1 km^2);

Temporary population (hourly, daily, weekly, monthly, etc.);

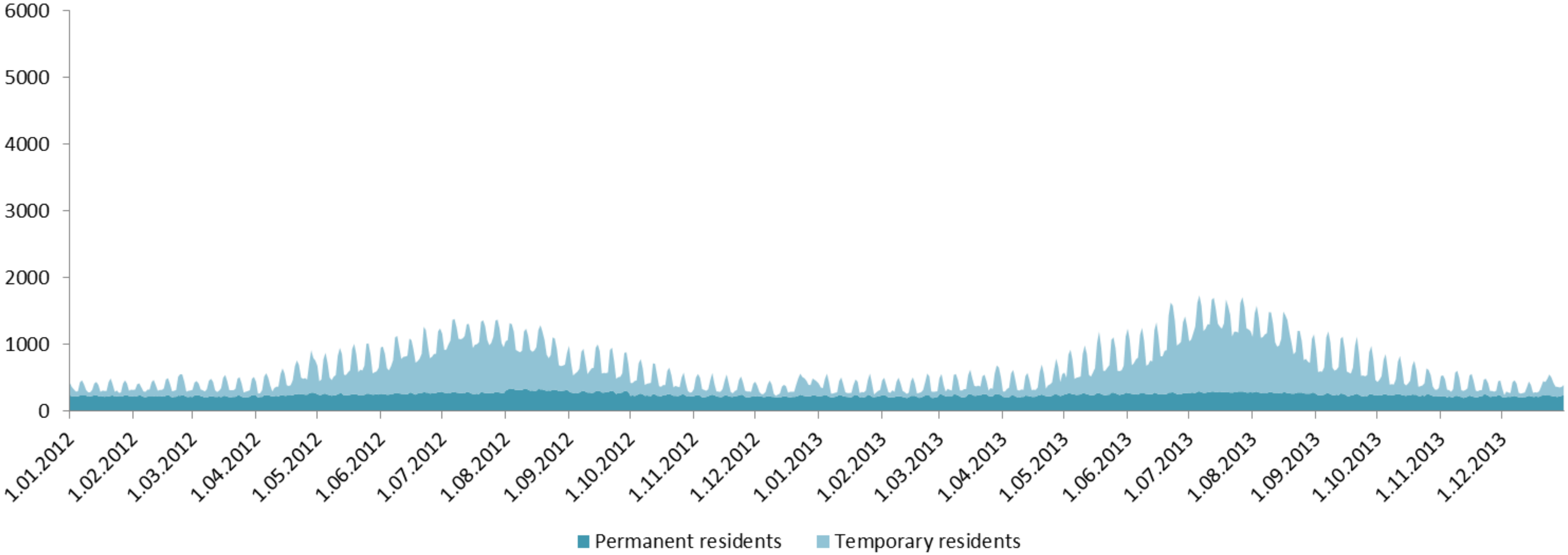
Home Anchors



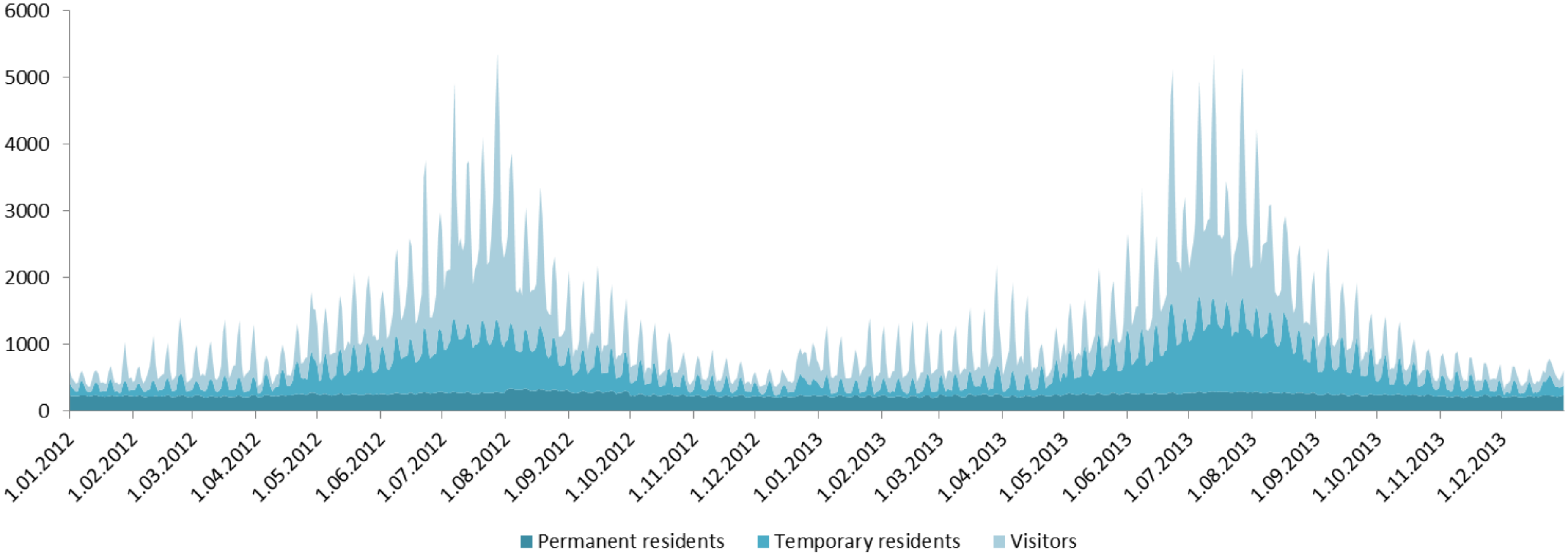
Temporary Population



Temporary Population



Temporary Population



CHALLENGES

Main Challenges

Access

Technological

Methodological

Access to the Data

Data can be processed if one is true:

1. Consent has been given
2. Data is processed fully anonymously
3. Legal obligation to provide the data

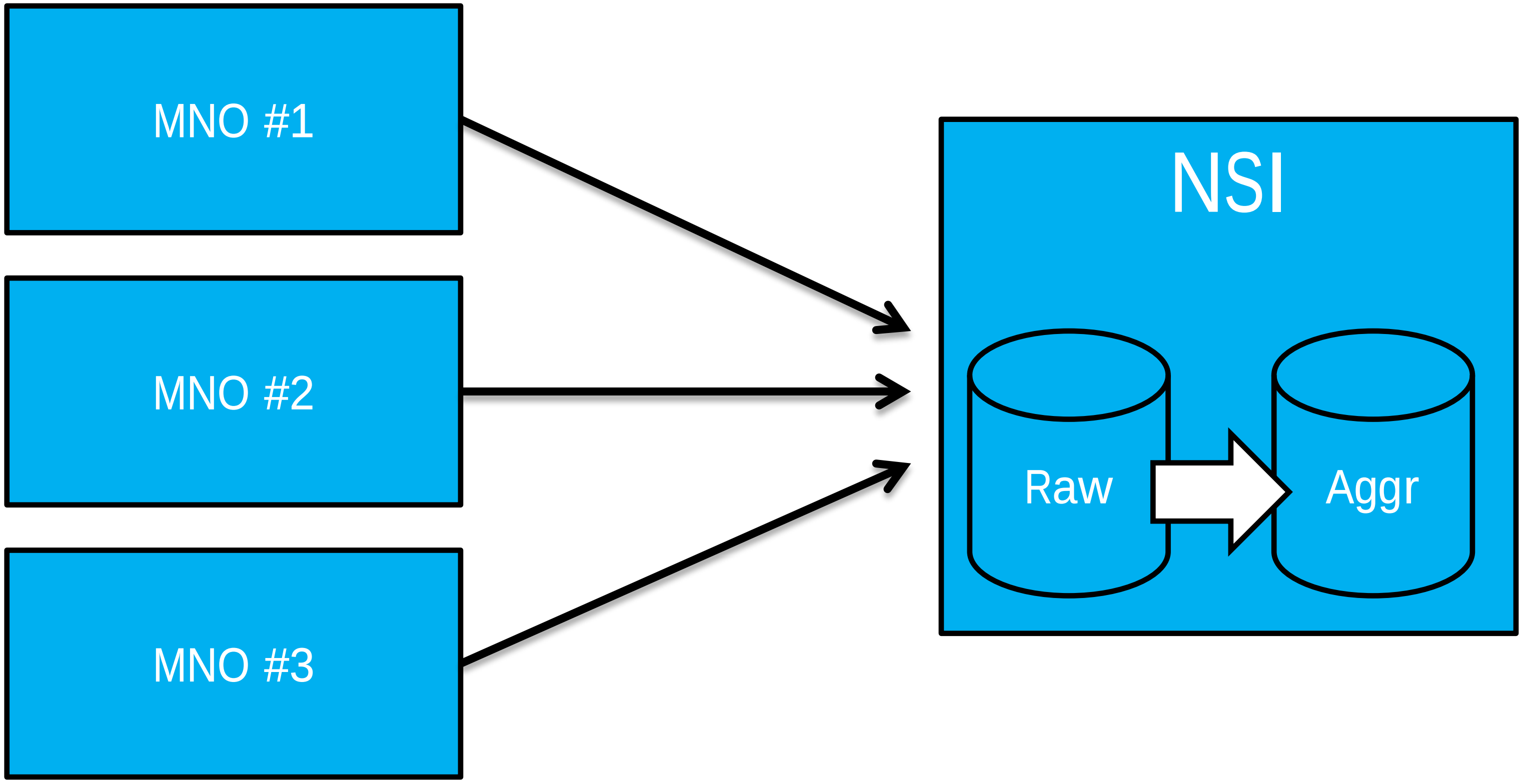
Privacy protection legislation, Telecommunication data legislation, National statistics act

Access to the Data

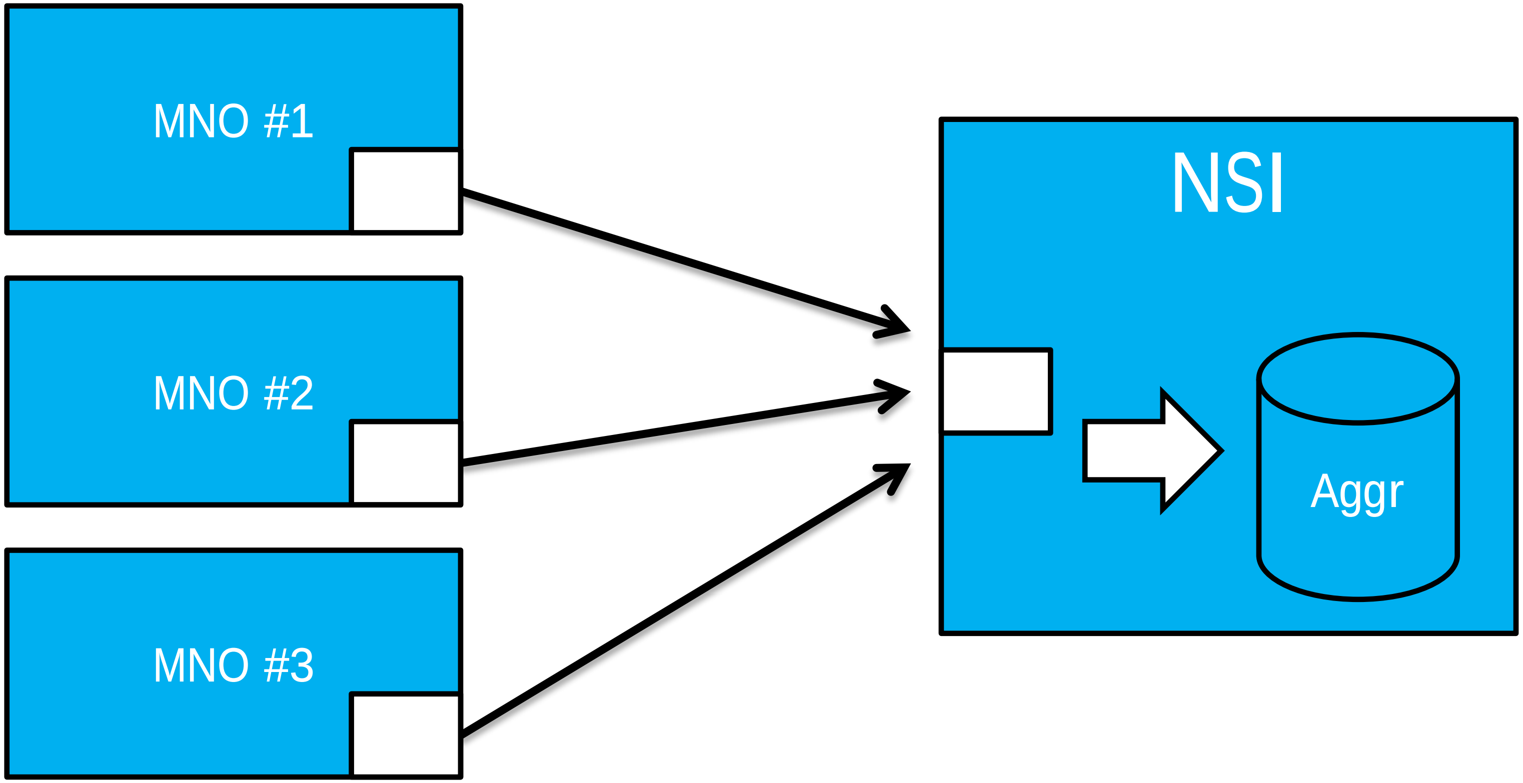
Business aspect for MNOs

Administrative aspect – who is processing the data?

Who is Processing?



Who is Processing?



Technological Challenges

Tightly connected to the methodology

Processing of a large data

Requirements for fast processing = need for resources

Data update, revisions, maintenance, semi-automatic QA system, reference data, etc.

Methodological Challenges

Processing anonymous data

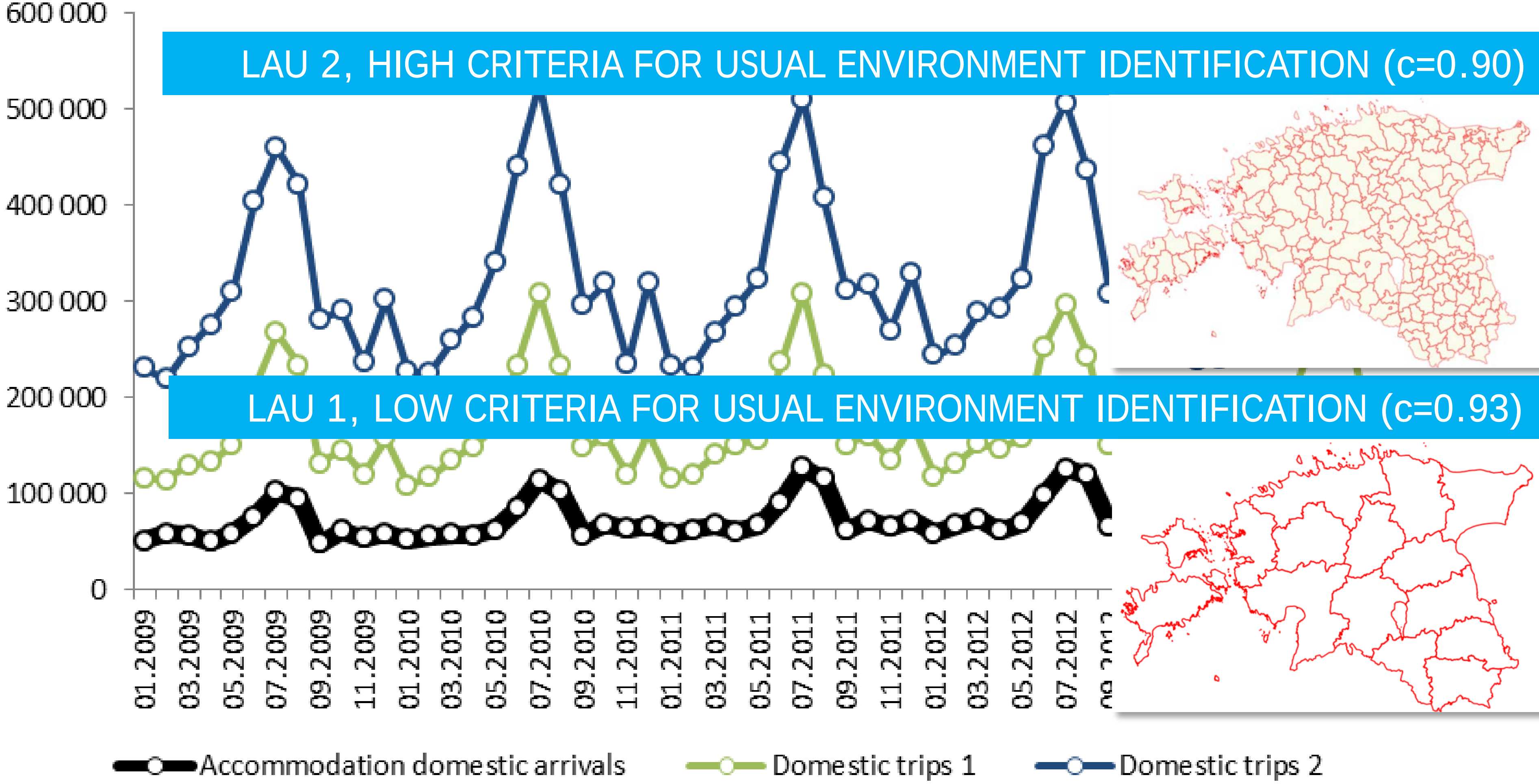
Filtering out usable data & eliminating causes for bias (M2M, accidental roaming, missing records, incorrect data)

Core methodology (general data model)

Domain-specific methodology

Definitions

Quantitative Definitions



LAU 2, HIGH CRITERIA FOR USUAL ENVIRONMENT IDENTIFICATION (c=0.90)

LAU 1, LOW CRITERIA FOR USUAL ENVIRONMENT IDENTIFICATION (c=0.93)

Reference Data and Estimations

Mobile positioning data = sample defined by the subscribers of the MNO

Estimation for general population is required

Comparing to reference data

Population census, accommodation statistics, traffic data, surveys, land coverage data,

EUROSTAT Feasibility Study on the Use of Mobile Positioning Data for Tourism Statistics

Read the consolidated report or in-depth reports:

http://epp.eurostat.ec.europa.eu/portal/page/portal/tourism/methodology/projects_and_studies

Thank You!

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