“WHERE” is a Big Question.

Geospatial Big Data

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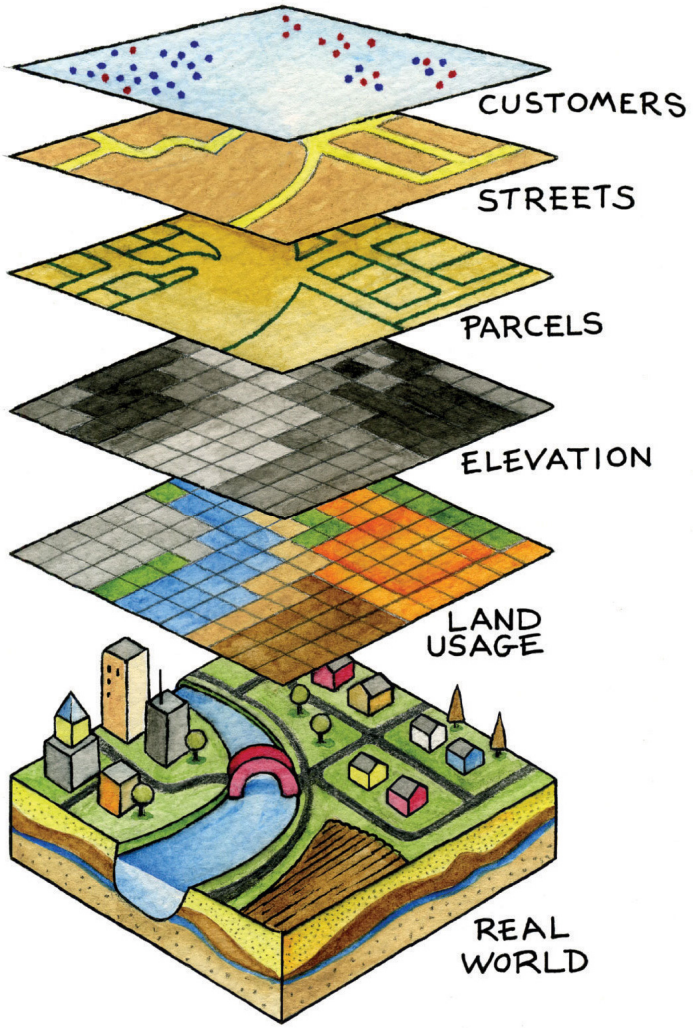
Geospatial Data Layers

- Navigation
- Urban planning
- Land use management
- Natural resource management
- Disaster management



Geospatial Data has always been big.
So, what's new?

- Variety, abundant → Volume
- Velocity → Volume
- Applications → Location-based services

We need big data to answer big questions.

Big Questions:

What do customers/people want?

What does a particular customer/person want?

A person's behavior can be inferred by

Interest:	**What** does she do/have/buy/like?
Social Interaction	**Who** does she contact with?
Mobility	**Where** does she live/go?

Most human activities associate to locations.

Most people have characteristic mobility patterns.

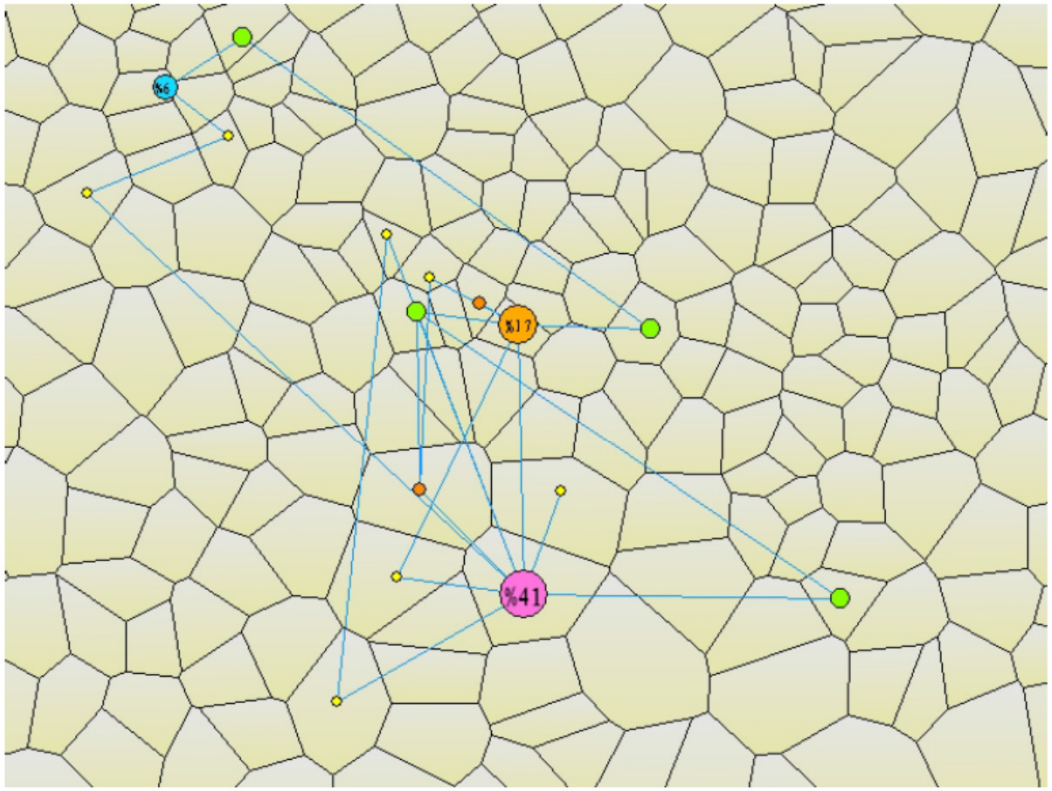


Figure 4. Mobility network associated with a mobile phone user who usually appears at fixed locations.

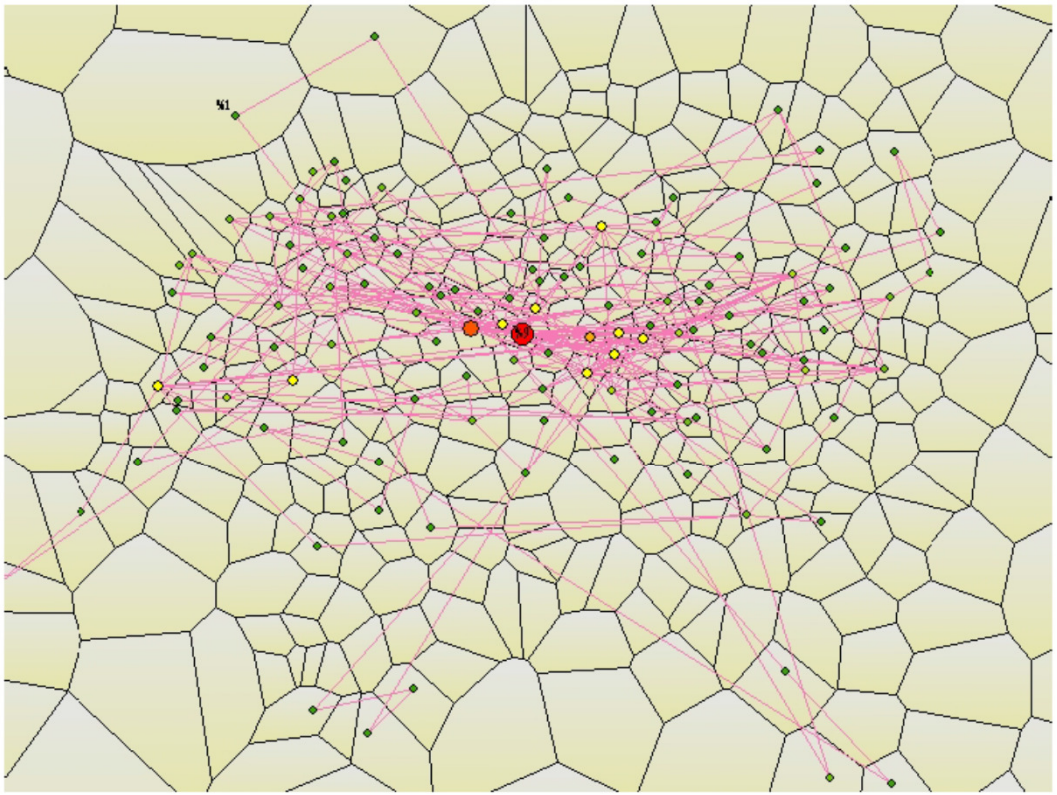


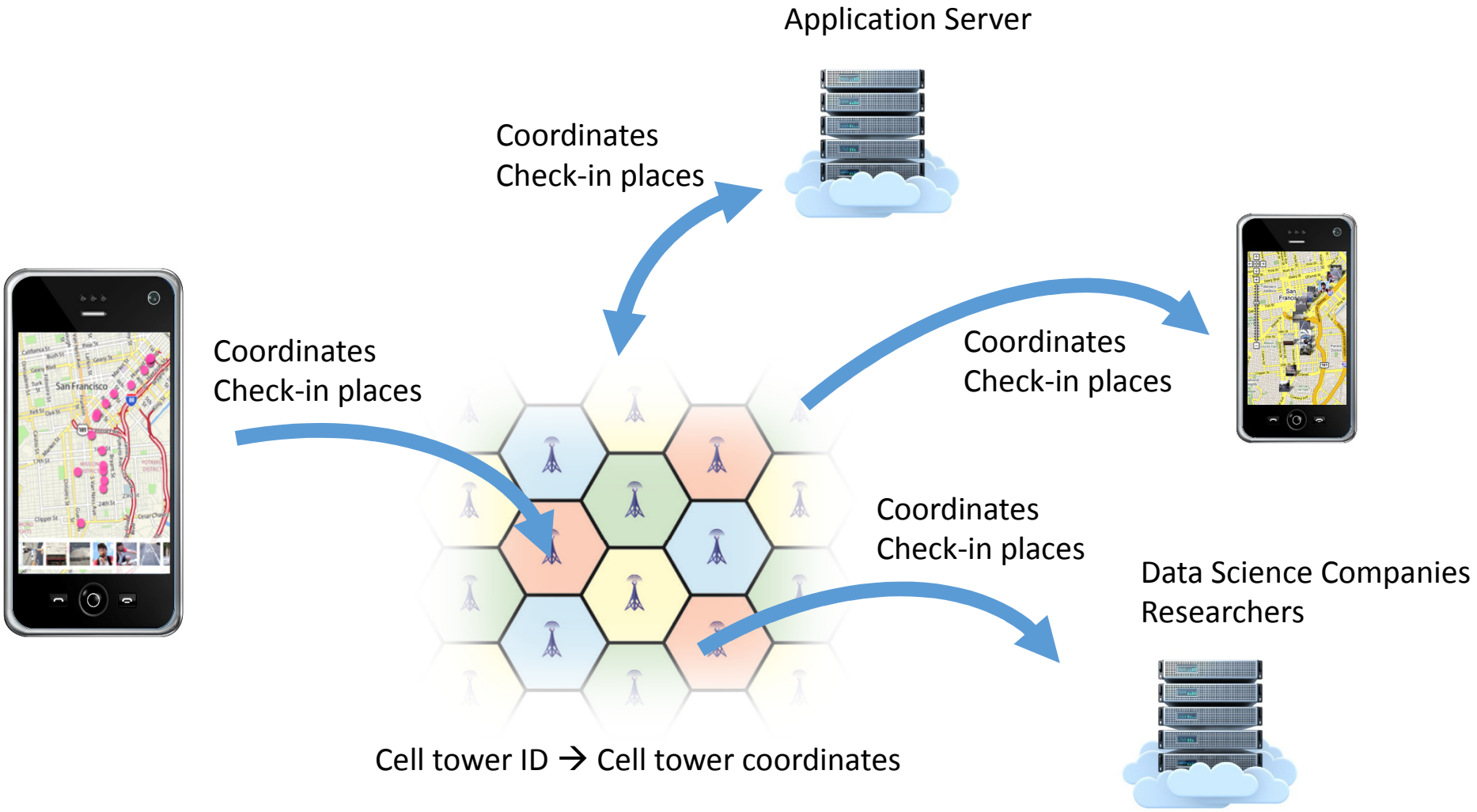
Figure 6. Mobility network associated with a mobile phone user who usually moves across a large set of locations and seldom visits the same place repeatedly.

"Analyzing and Geo-visualizing Individual Human Mobility Patterns Using Mobile Call Records", Chaogui Kang

Most data involving human activities are somehow related to locations and exhibit some patterns.

Location Data

- Coordinates (latitude, longitude)
- Place name, street address
- Proximity of reference (cell tower id)


Application Server
Coordinates
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Data Science Companies
Researchers
Cell tower ID → Cell tower coordinates

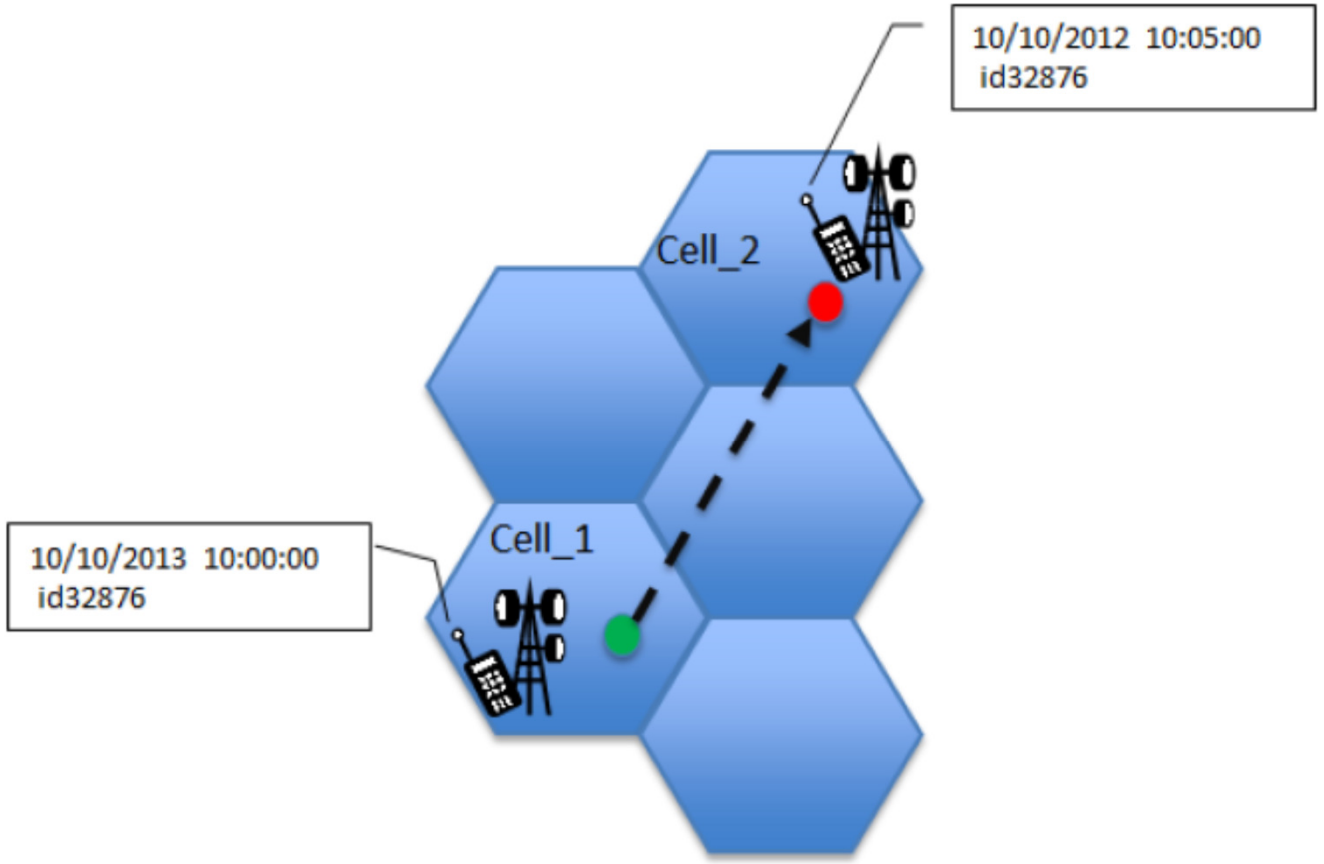
Category of Spatial Analysis

- Area or place categorization
- Area-based population demography or customer segment categorization
- Travelling patterns between areas
- Location analysis
- Route analysis

Research based on Geopatial Big Data

- Mobile network data
- GPS traces
- Social network data
- Crowdsourcing data

Mobile Phone Call Detail Records are geospatial-temporal data



"Use of mobile phone data to estimate visitors mobility flows", Lorenzo Gabrielli, et al.

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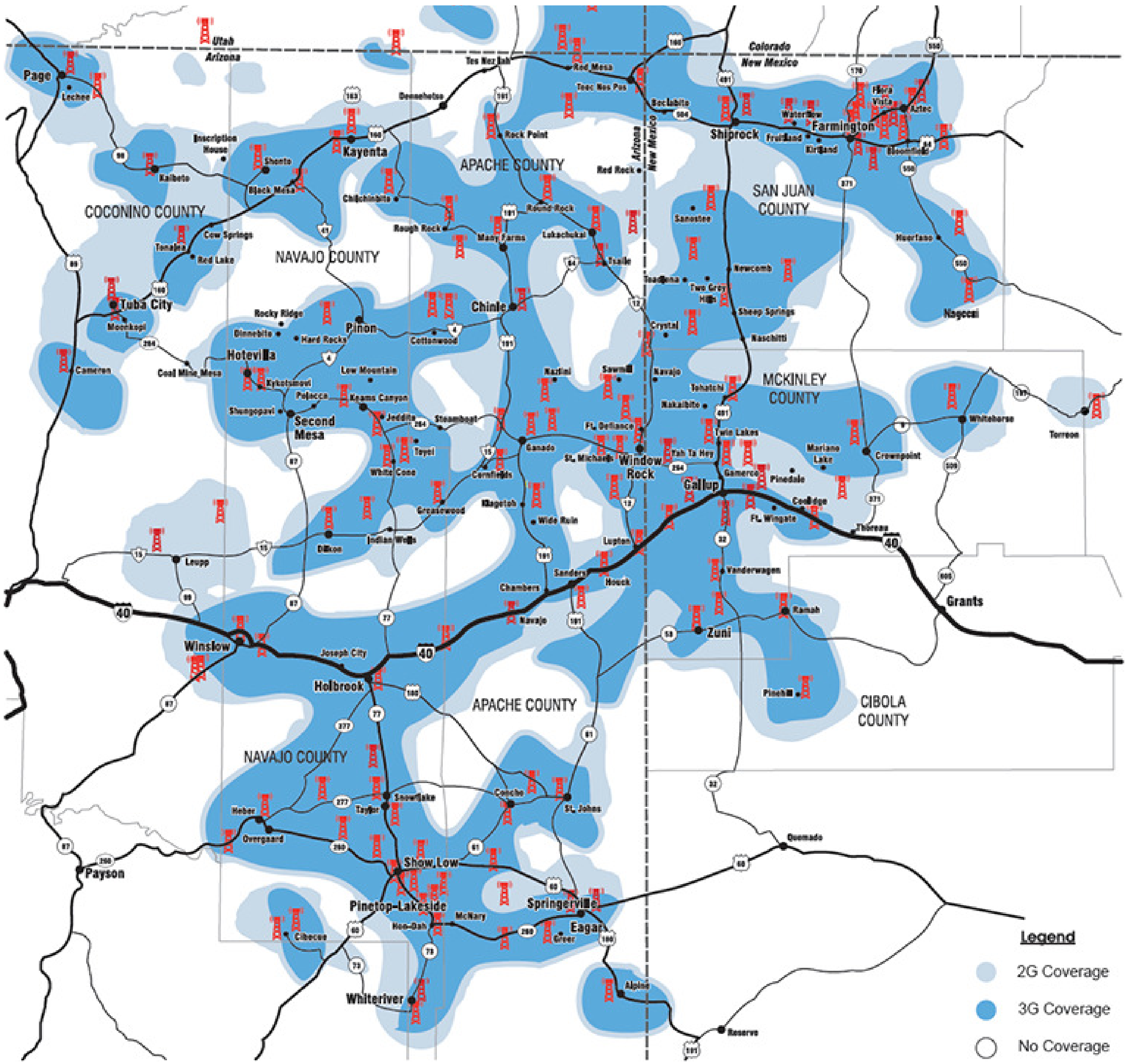

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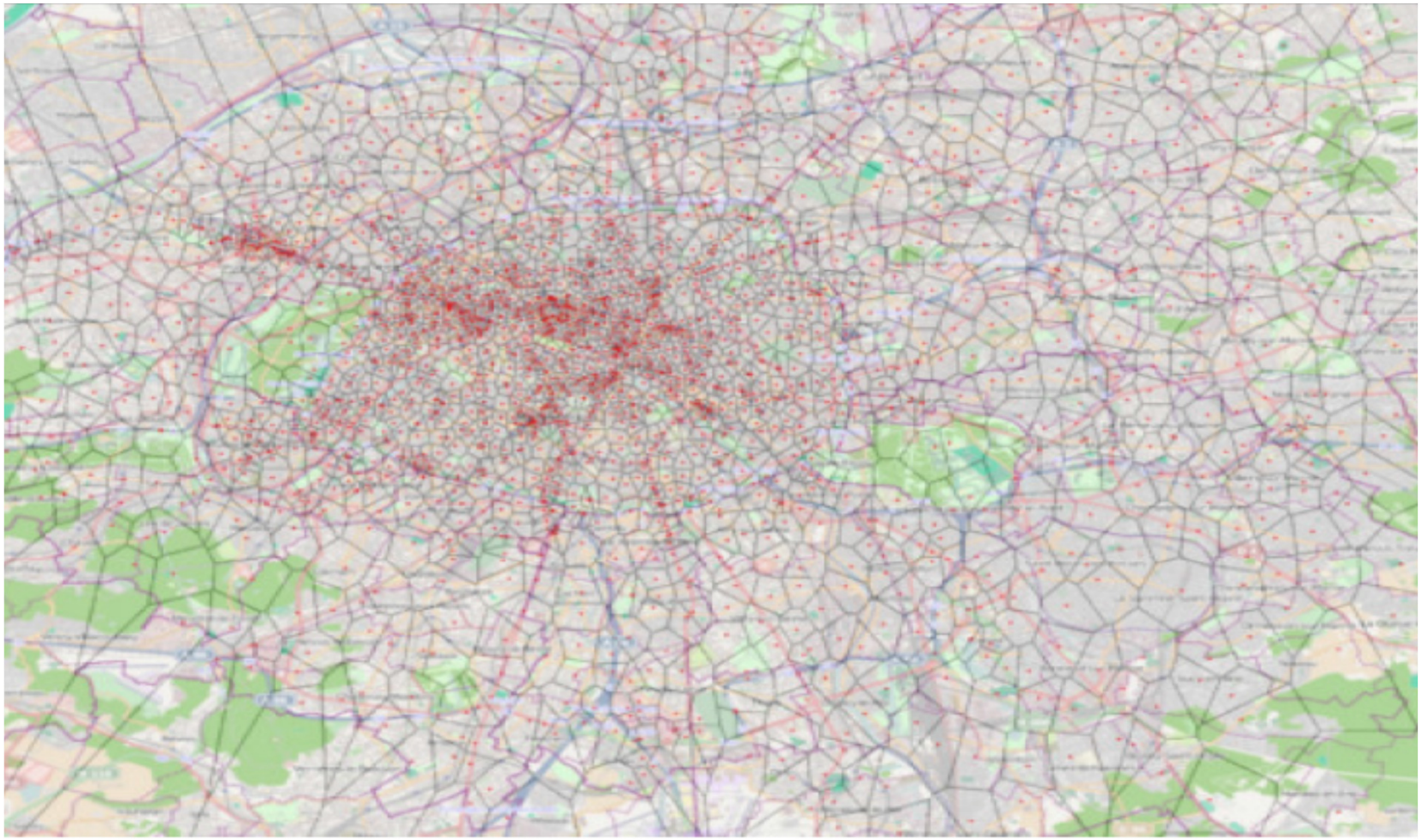
Mobile base station distribution in Paris



“Content Consumption Cartography of the Paris Urban Region using Cellular Probe Data”, Stefato Sahar Hoteit, et al. (Orange)

Mobility pattern from mobile phone records

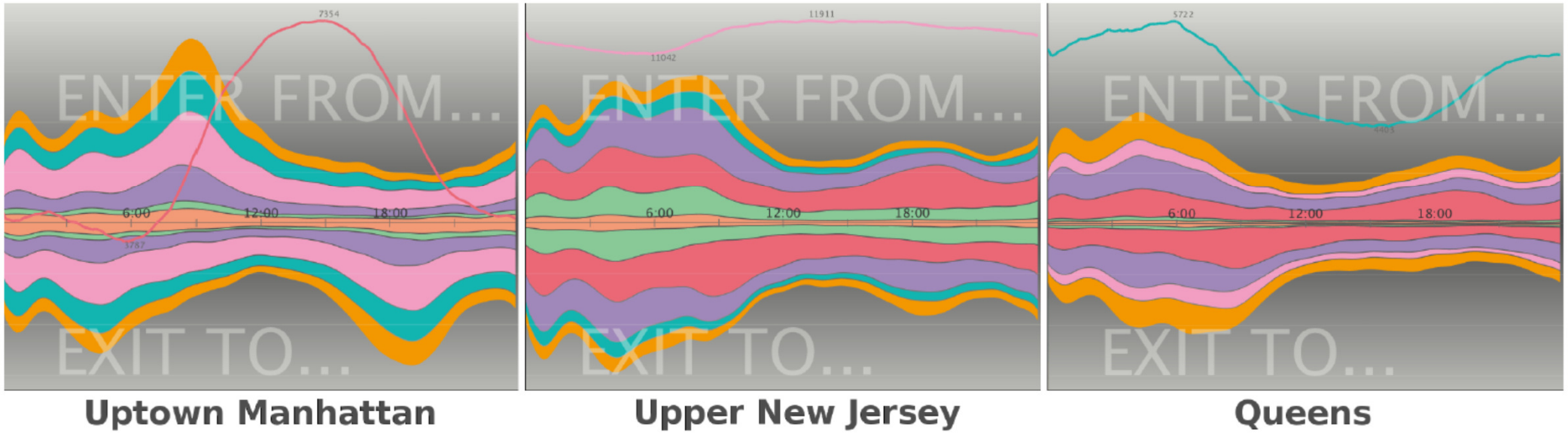


Figure 7: Stack views of Uptown Manhattan, Upper New Jersey, and Queens. Each stack view is augmented with a line chart showing the fluctuation of overall population in the region. Each stack view shows the region's characteristic based on the mobility patterns of mobile users.

"Inferring Human Mobility Patterns from Anonymized Mobile Communication Usage", Y. Tanahashi, et al. (AT&T)

Mobility pattern from mobile phone records

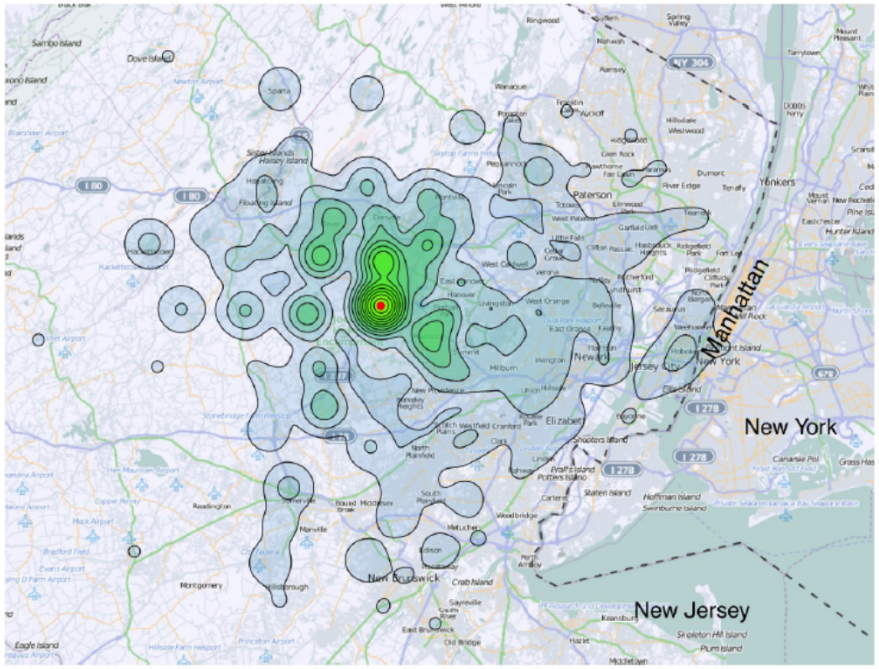


Figure 3: Laborshed of Morristown. The red dot is at the city center. Contour lines divide regions of different concentrations of workers' homes. Workers are identified as those who use their cellphones in Morristown during weekday business hours. Most workers come from nearby areas, but some come from as far as Manhattan.

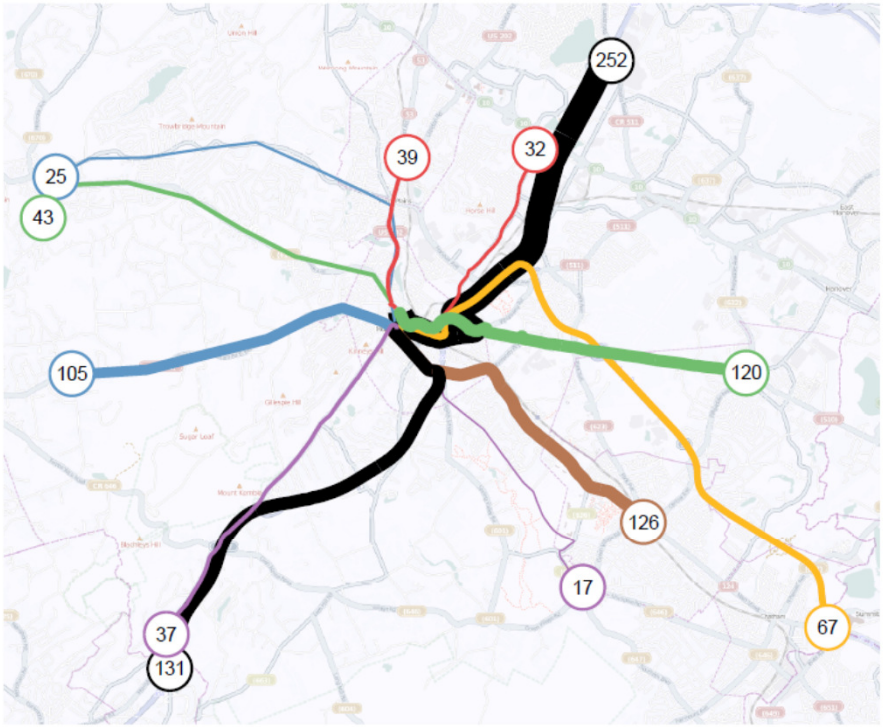


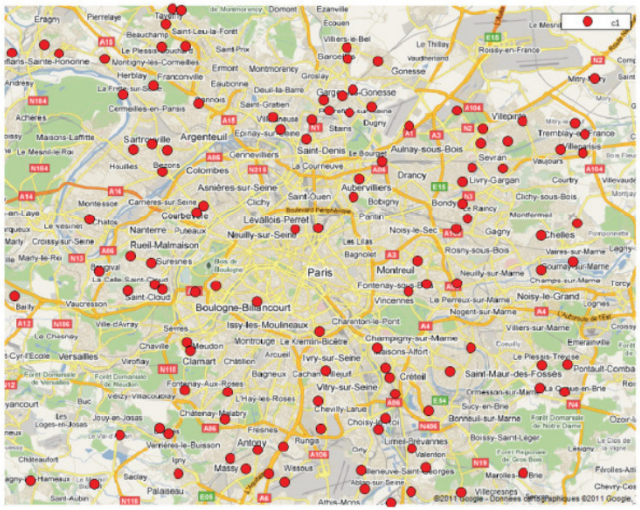
Figure 5: Relative traffic volumes on twelve commuting routes into the center of Morristown as assigned by our route classification algorithms. Line widths are proportional to the estimated volumes. Counts shown at the beginning of each route are normalized to 1,000 moving cellphones.

"Human Mobility Characterization from Cellular Network Data", R. Becker, et al. (AT&T)

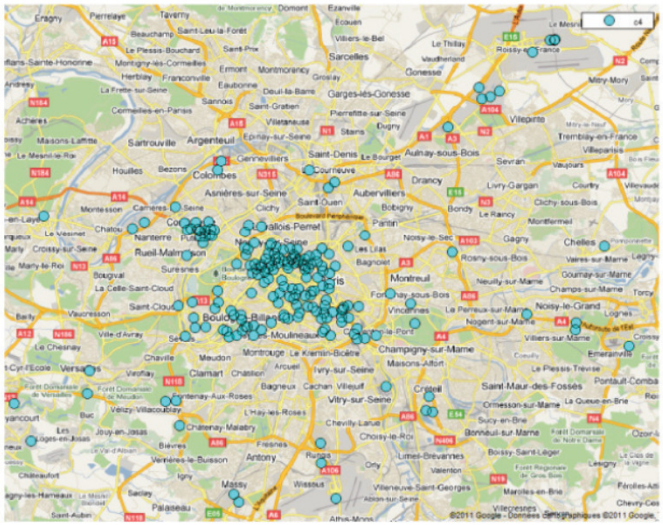
Mobility pattern from mobile phone records

Category A:The "hypermobility" antennas cluster

Category B: Antennas having both mobility and stationarity events



Category C: Antennas having mainly stationarity events



"Urban mobility: velocity and uncertainty in mobile phone data ", Thomas Couronné, et al. (Orange)

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Mobility pattern from mobile phone records

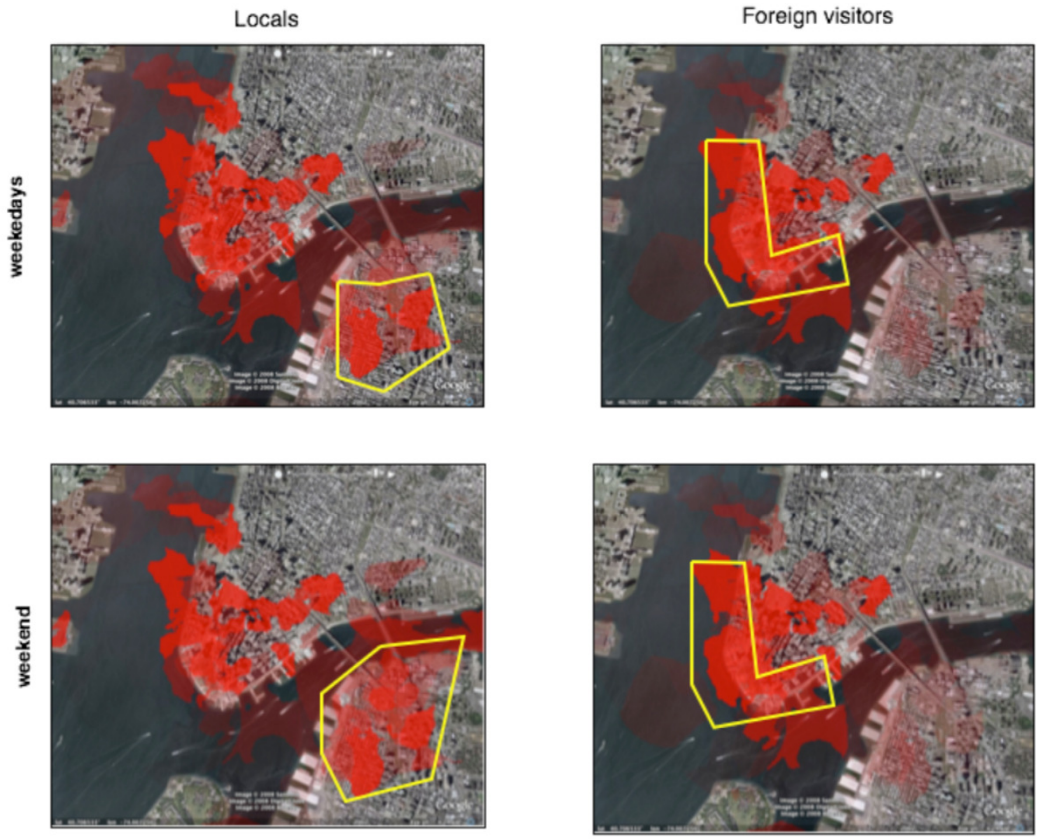


Figure 3. Spatial distribution of locals (New Yorkers) and foreign visitors in the neighborhood of the Waterfall. New Yorkers generate network traffic activity in the financial district and in Brooklyn, a neighborhood not attracting many foreigners compared to the waterfront of lower Manhattan.

"Towards estimating the presence of vistors from the aggregate mobile phone network activity they generate", Fabien Girardin, et al. (AT&T)

Area classification using mobile phone records

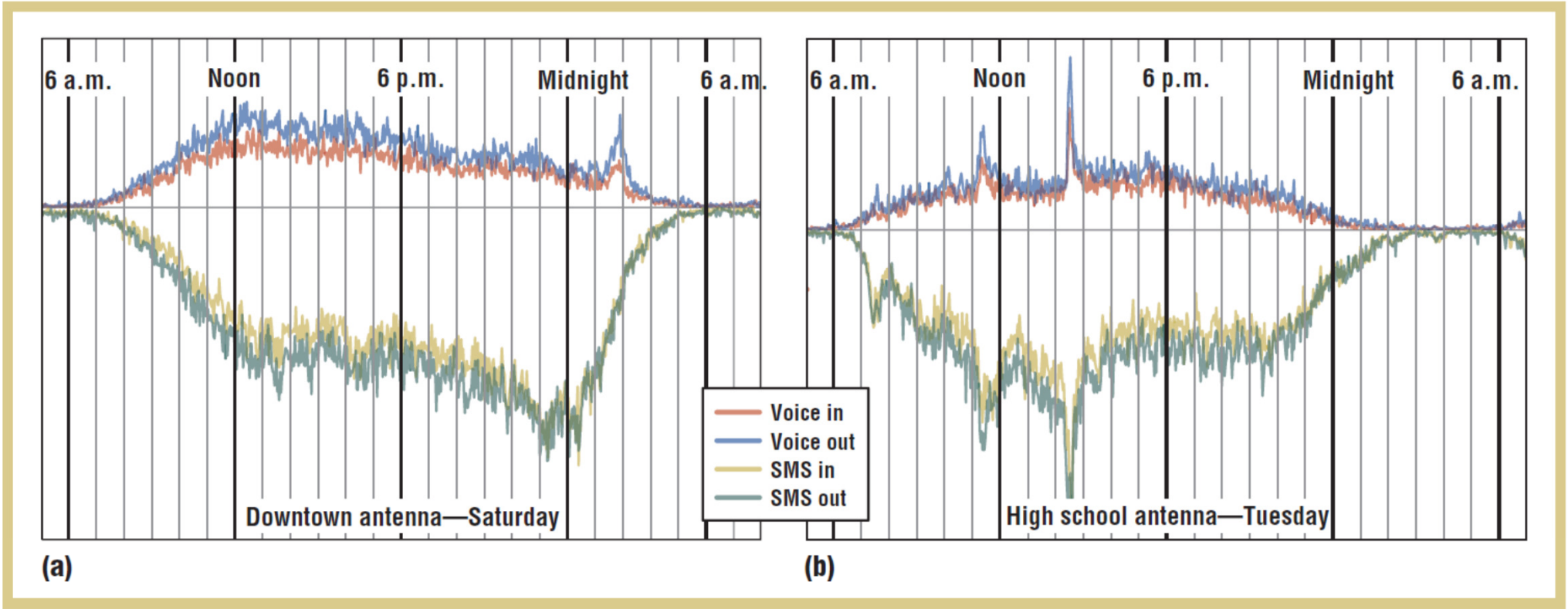
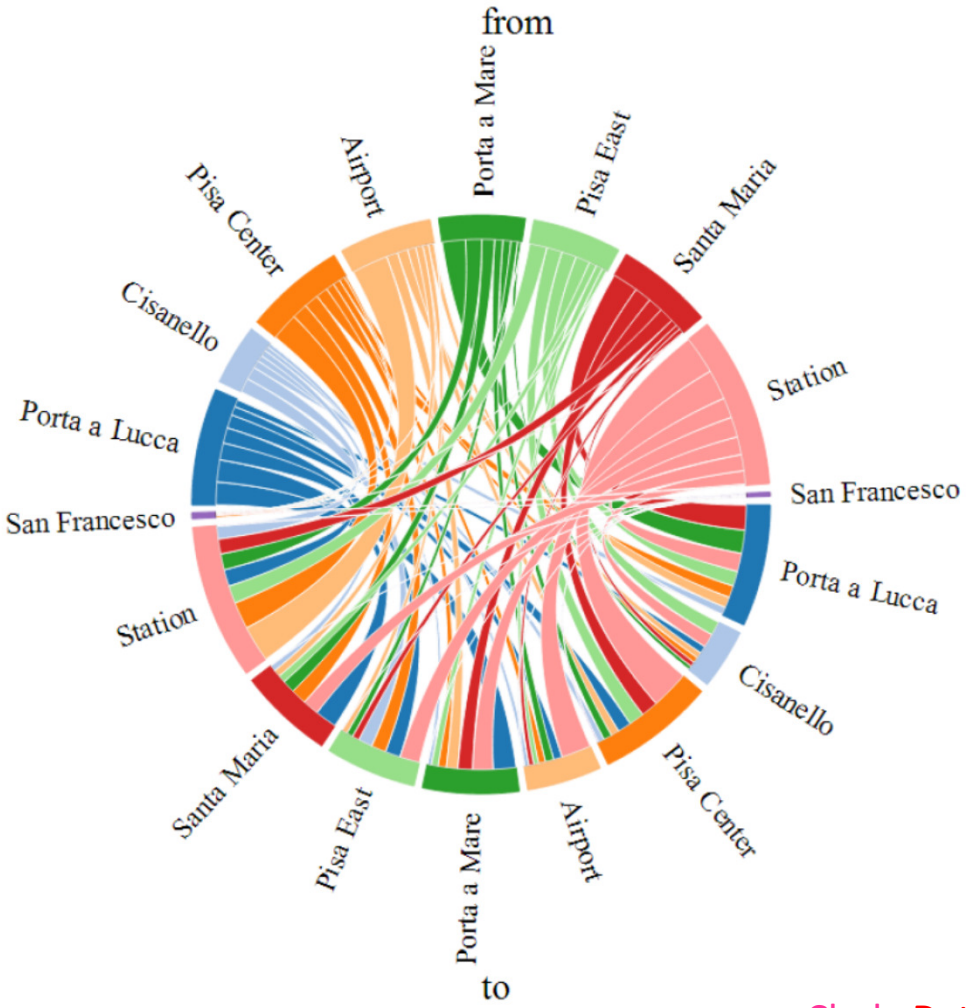


Figure 4. Lip plots of voice call and SMS volumes show unusual spikes highlighting local patterns or events in Morristown, New Jersey. Call volume (plotted upward: inbound, red; outbound, blue) and SMS volume (plotted downward: inbound, light green; outbound, dark green) on two antennas are shown. The antenna in (a) points towards the commercial and restaurant district and the antenna in (b) points toward the high school. A voice peak occurs Saturday at 2 a.m. when the bars close. Both voice and SMS peaks occur Tuesday when the school lets out.

"A Tale of One City Using Cellular Network Data for Urban Planning", Richard Becker, et al. (AT&T)

Origin-Destination



"Use of mobile phone data to estimate visitors mobility flows", Lorenzo Gabrielli, et al.

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Human Mobility from Different Sources of Data

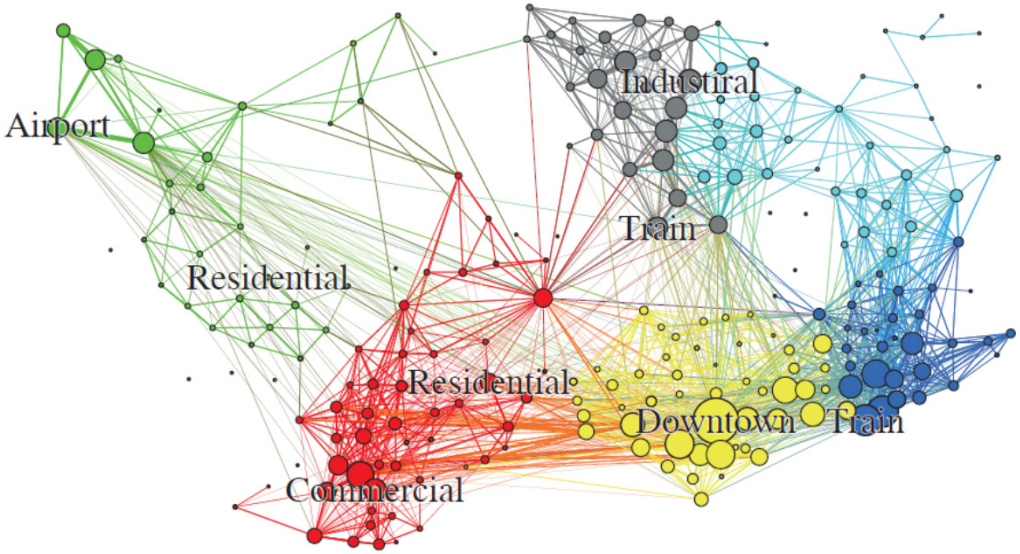


Fig 2: Human Mobility from Cellphone Data

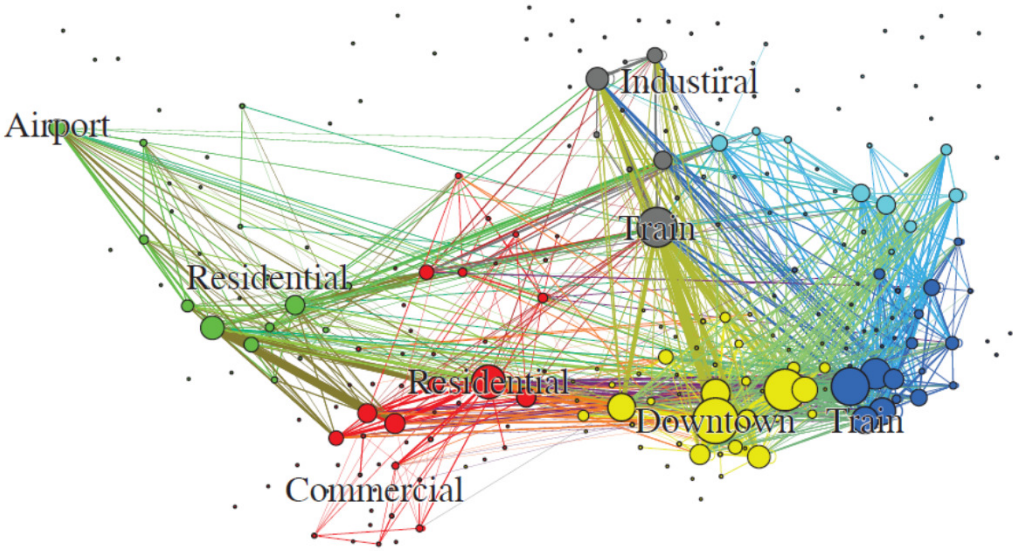


Fig 3: Human Mobility from Transit Data

"Exploring Human Mobility with Multi-Source Data at Extremely Large Metropolitan Scales", Desheng Zhang, et al.

Real-time Event Detection by Social Sensors

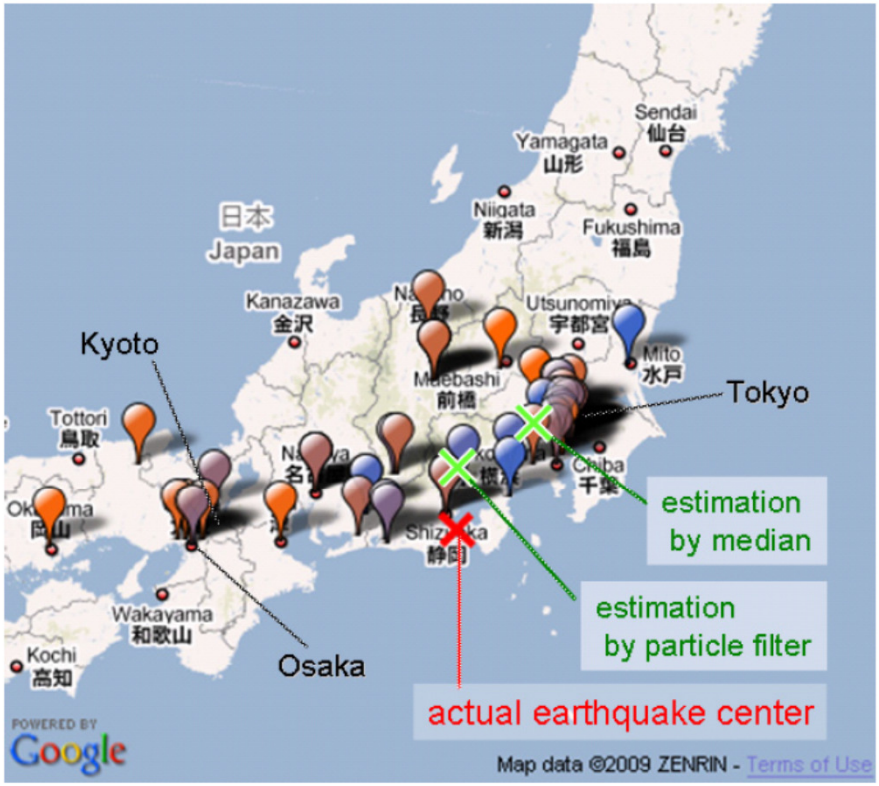


Figure 9: Earthquake location estimation based on tweets. Balloons show the tweets on the earthquake. The cross shows the earthquake center. Red represents early tweets; blue represents later tweets.

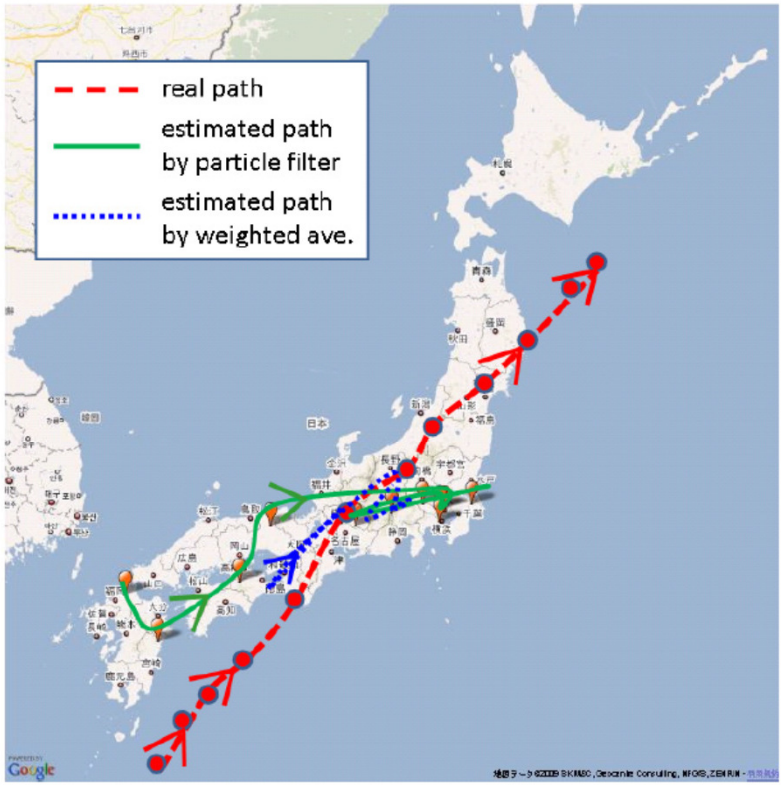


Figure 10: Typhoon trajectory estimation based on tweets.

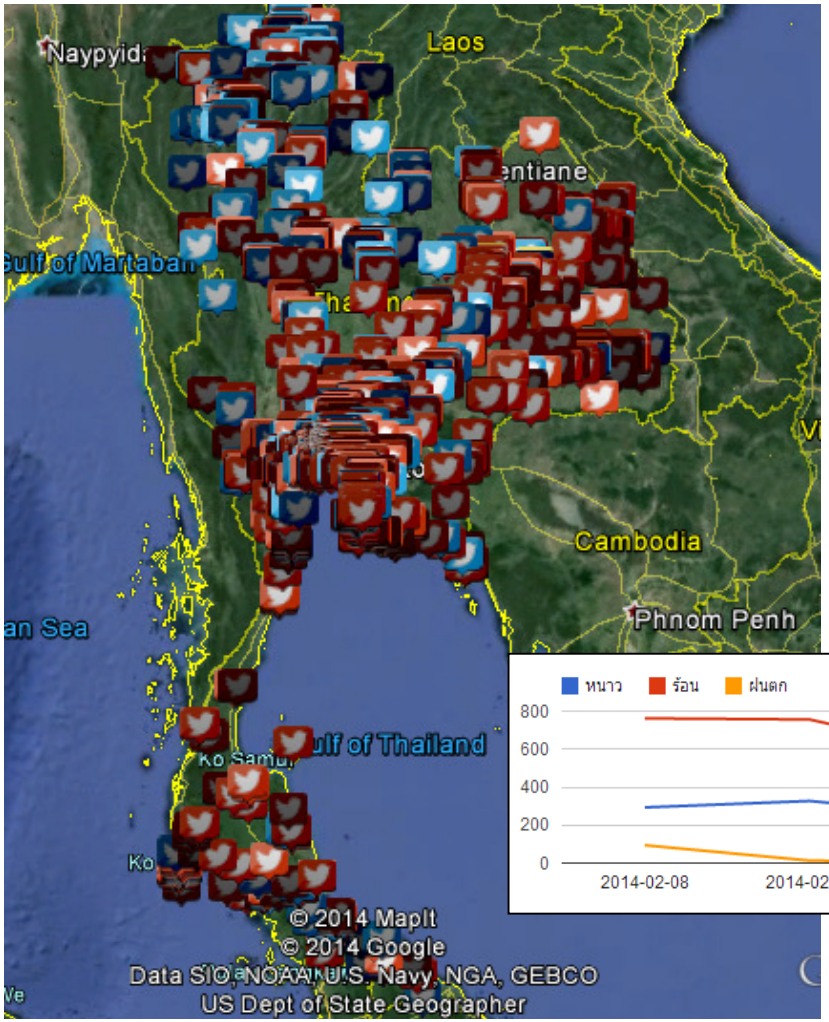
"Earthquake Shakes Twitter Users: Real-time Event Detection by Social Sensors", Takeshi Sakaki, et al.

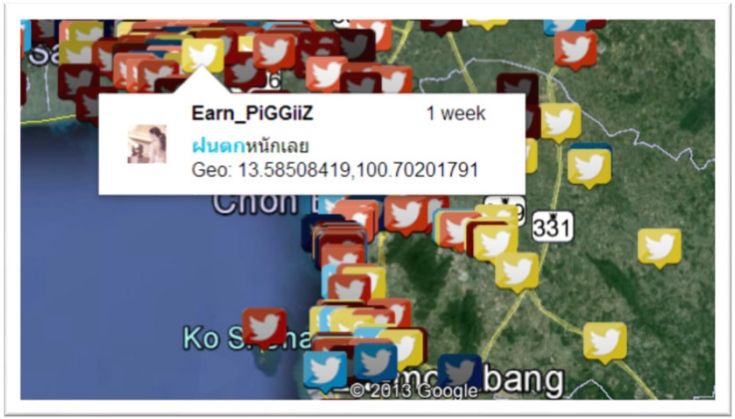
Our Research

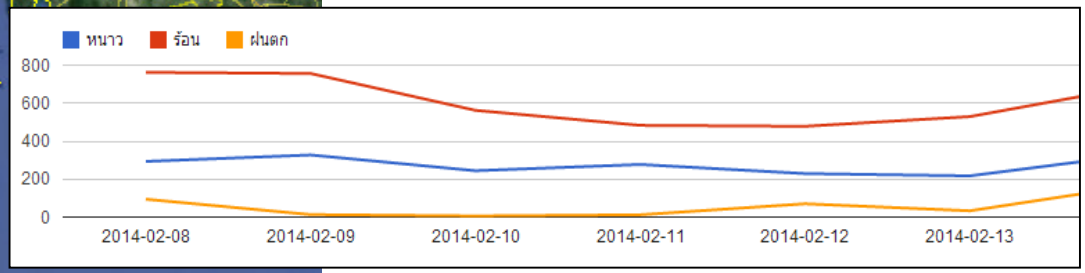
Spatial and mobility analysis using multiple sources of data

- Social network
- GPS traces
- Mobile crowdsourcing
- Mobile network data

Spatial-Temporal Analysis using Social Network Data (Twitter)







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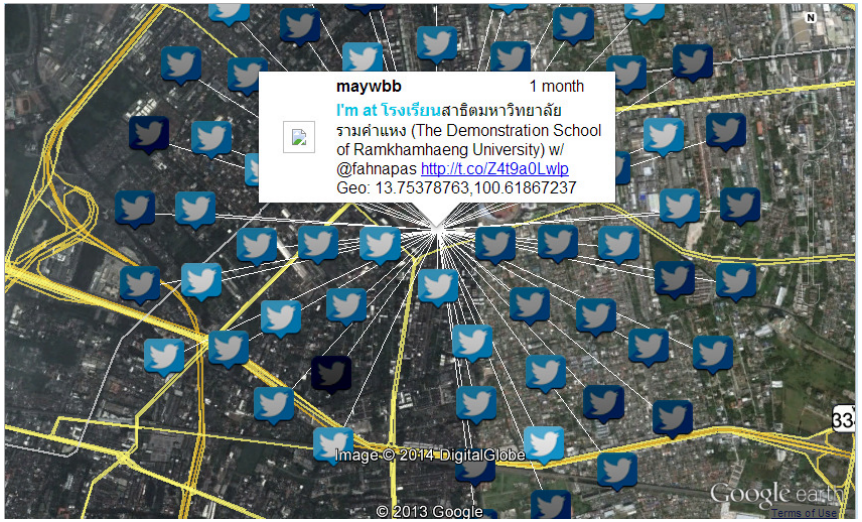
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Image © 2014 DigitalGlobe
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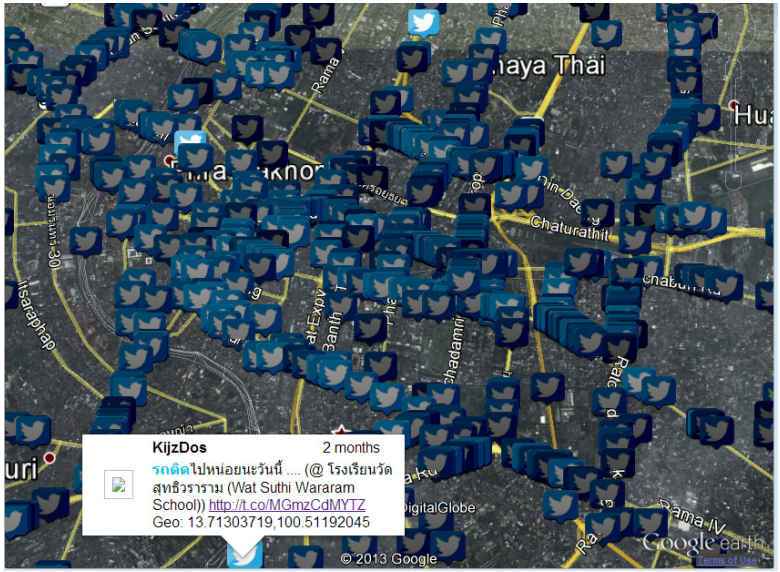
Google earth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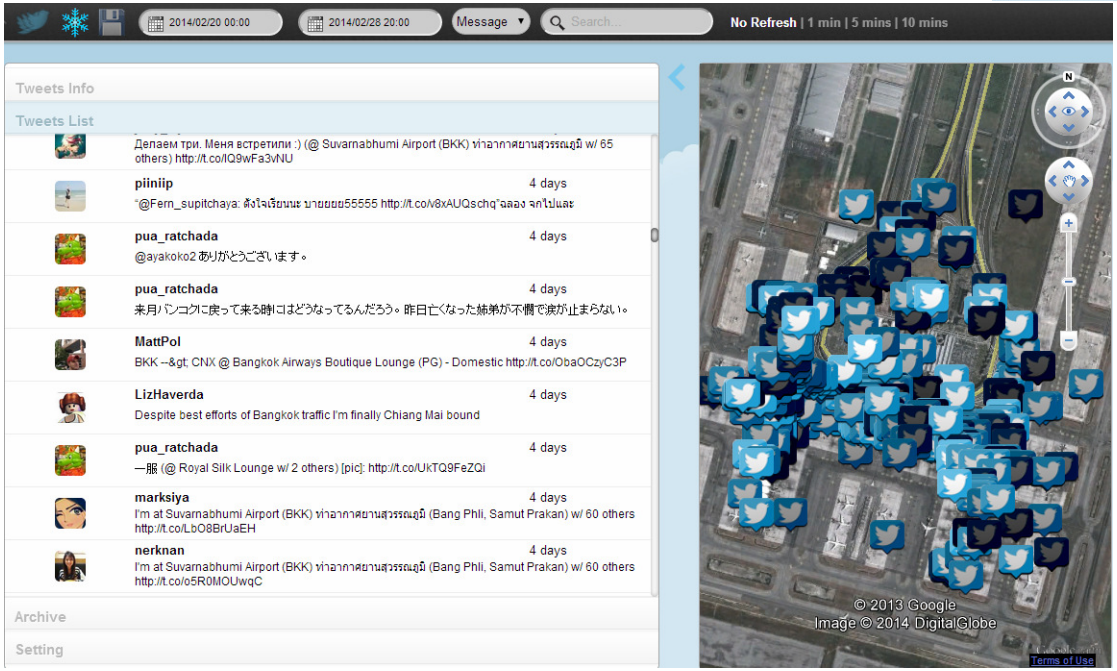
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LizHaverda 4 days
Despite best efforts of Bangkok traffic I'm finally Chiang Mai bound
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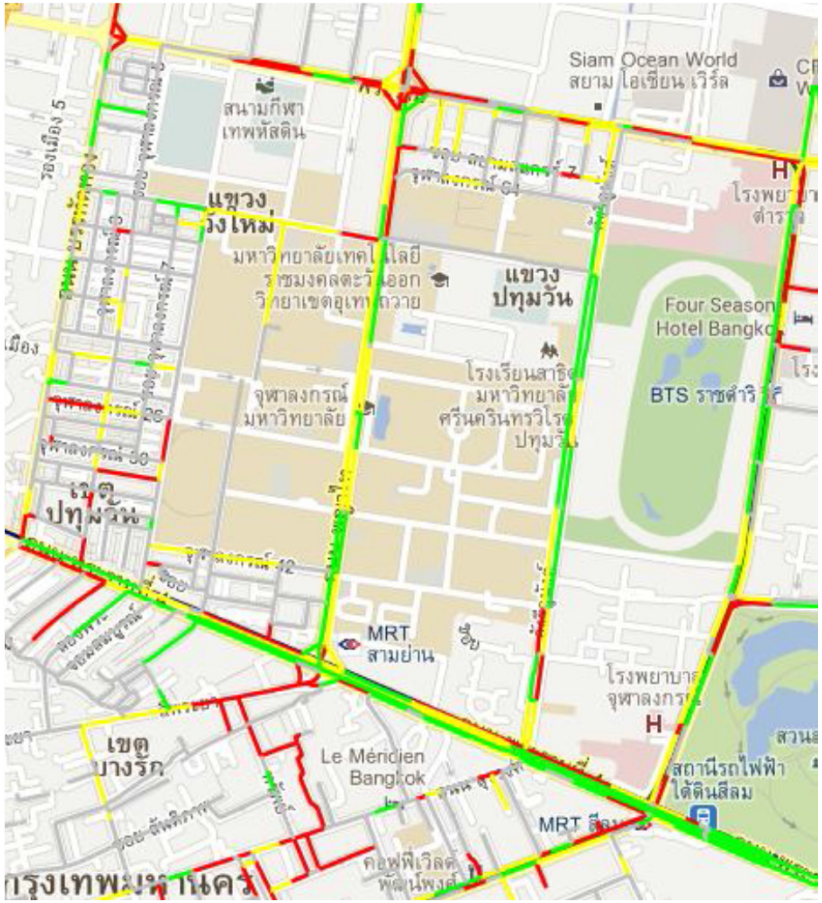
Traffic Analysis using GPS Traces



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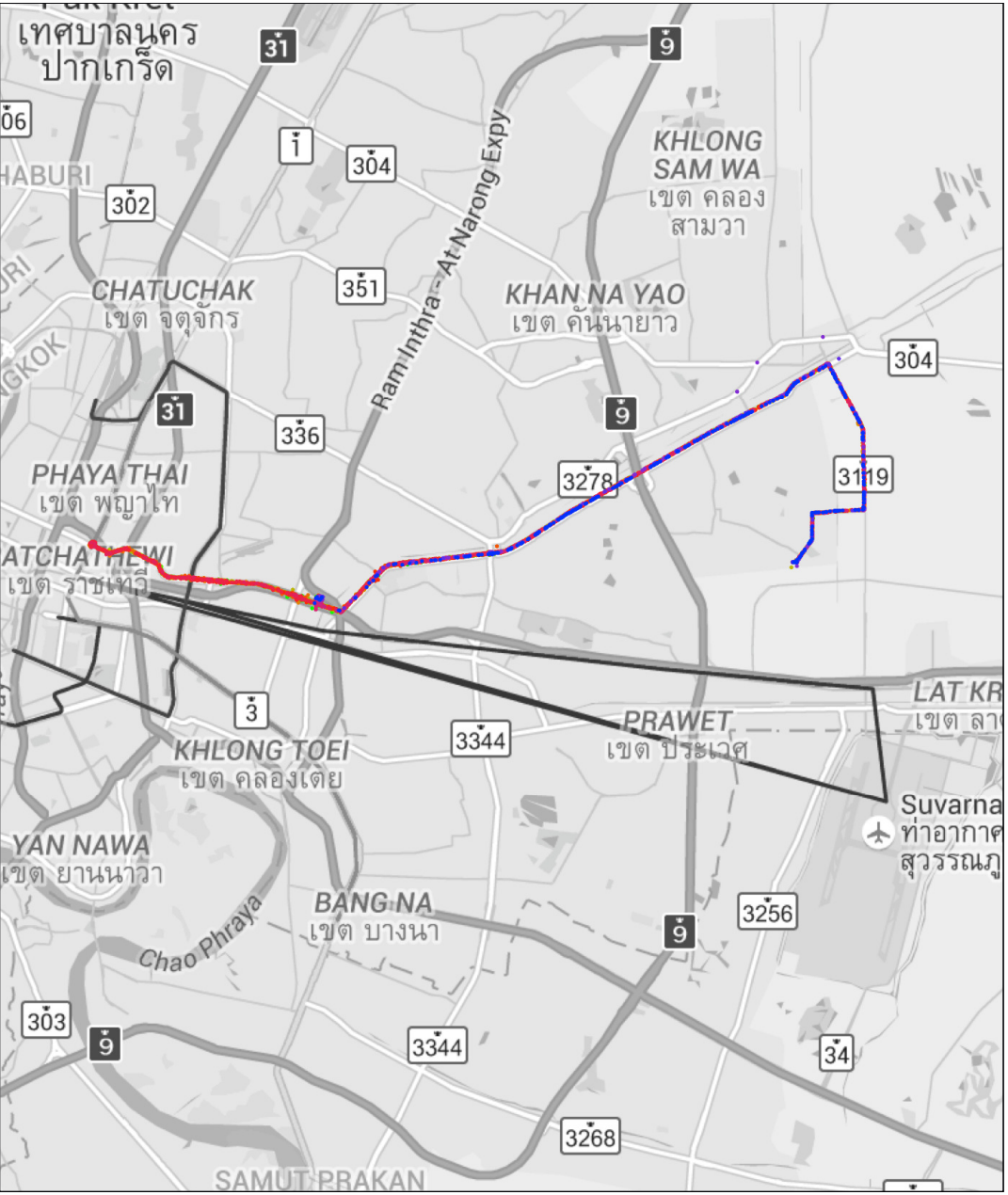
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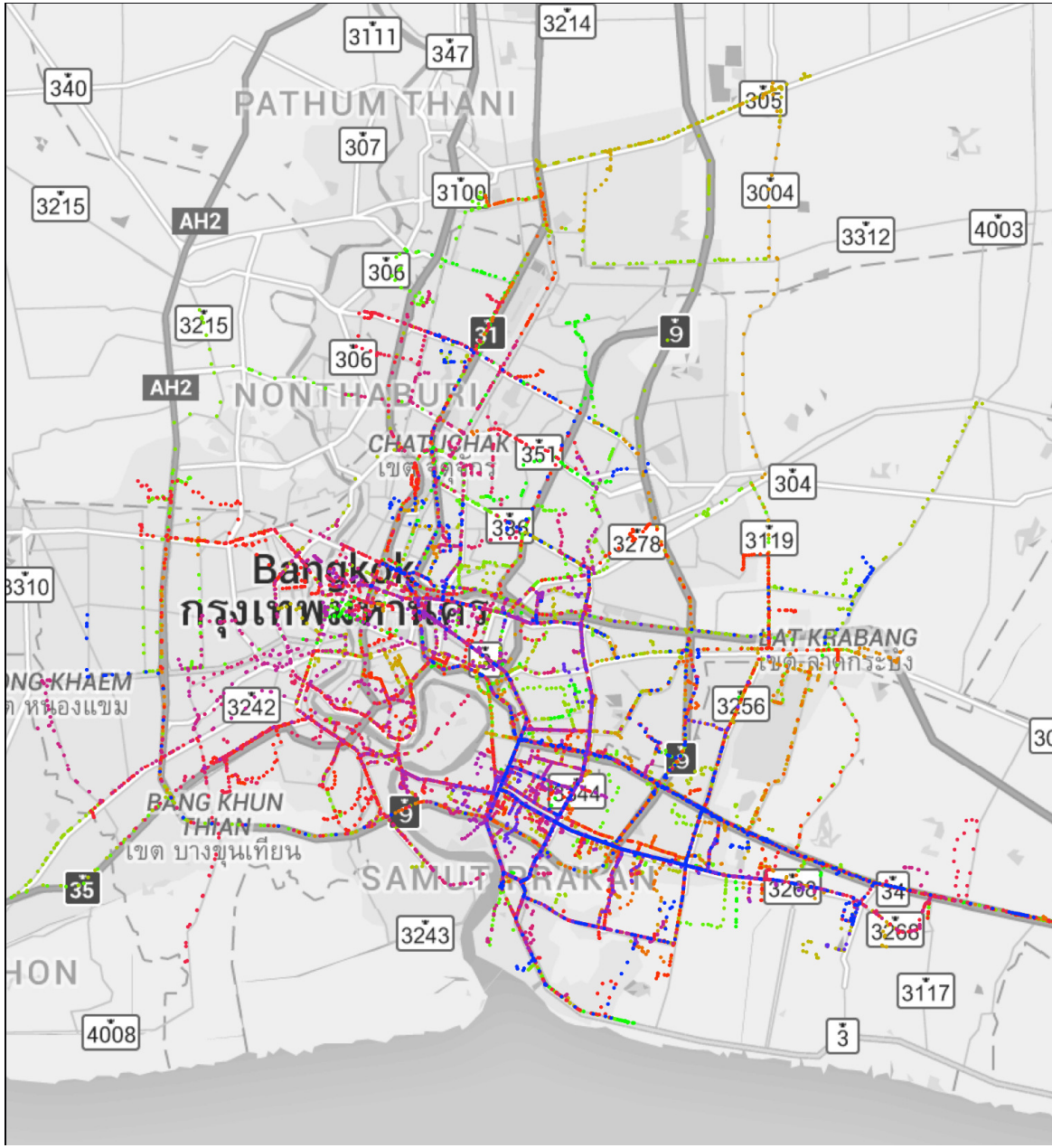
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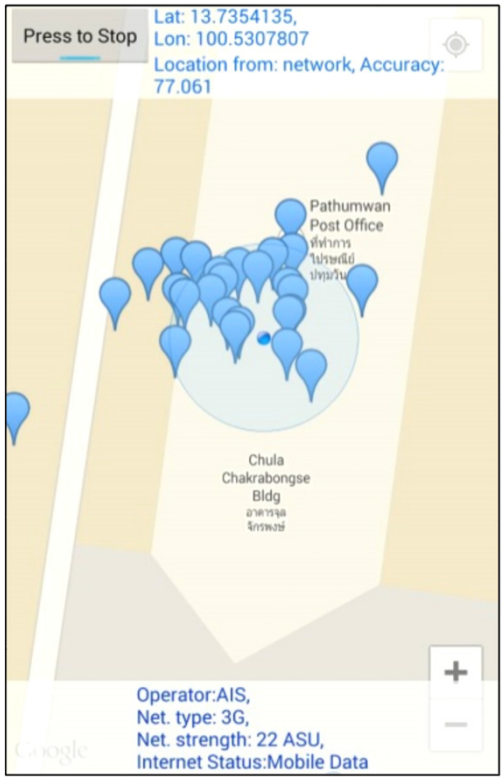
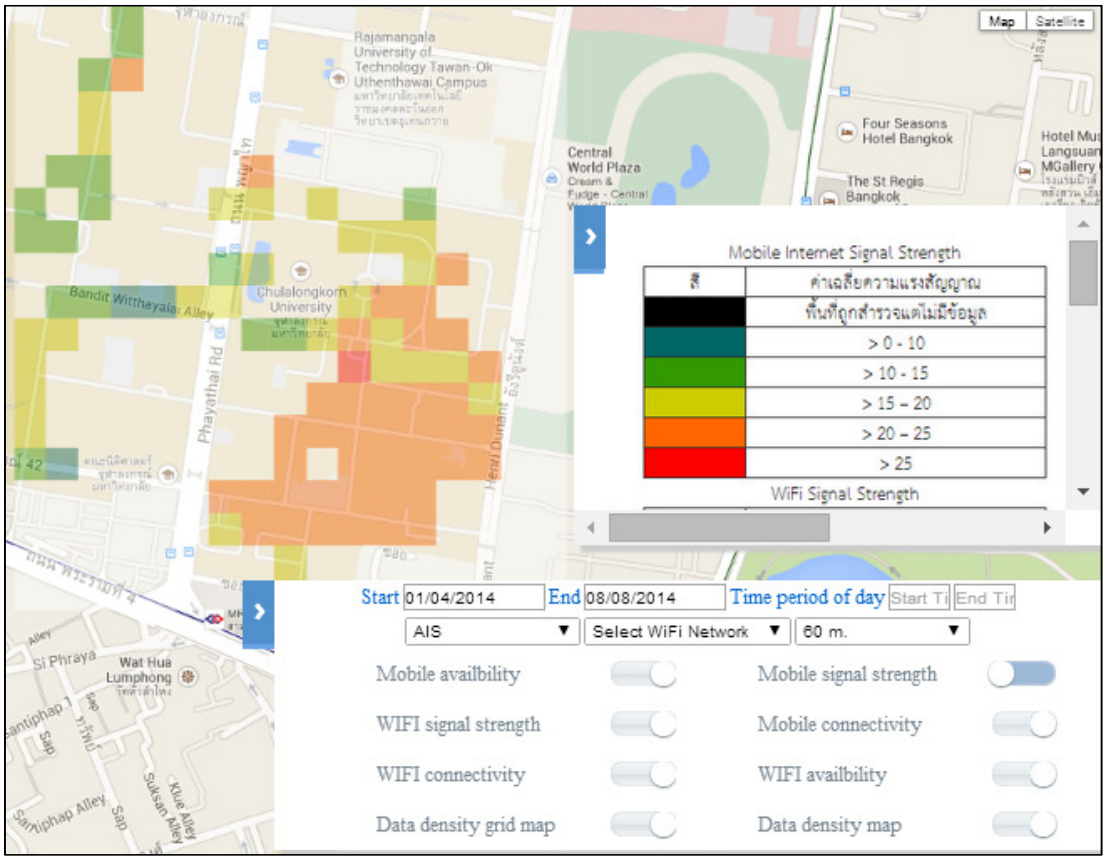
Network Coverage Analysis using Crowdsourced Signal Data





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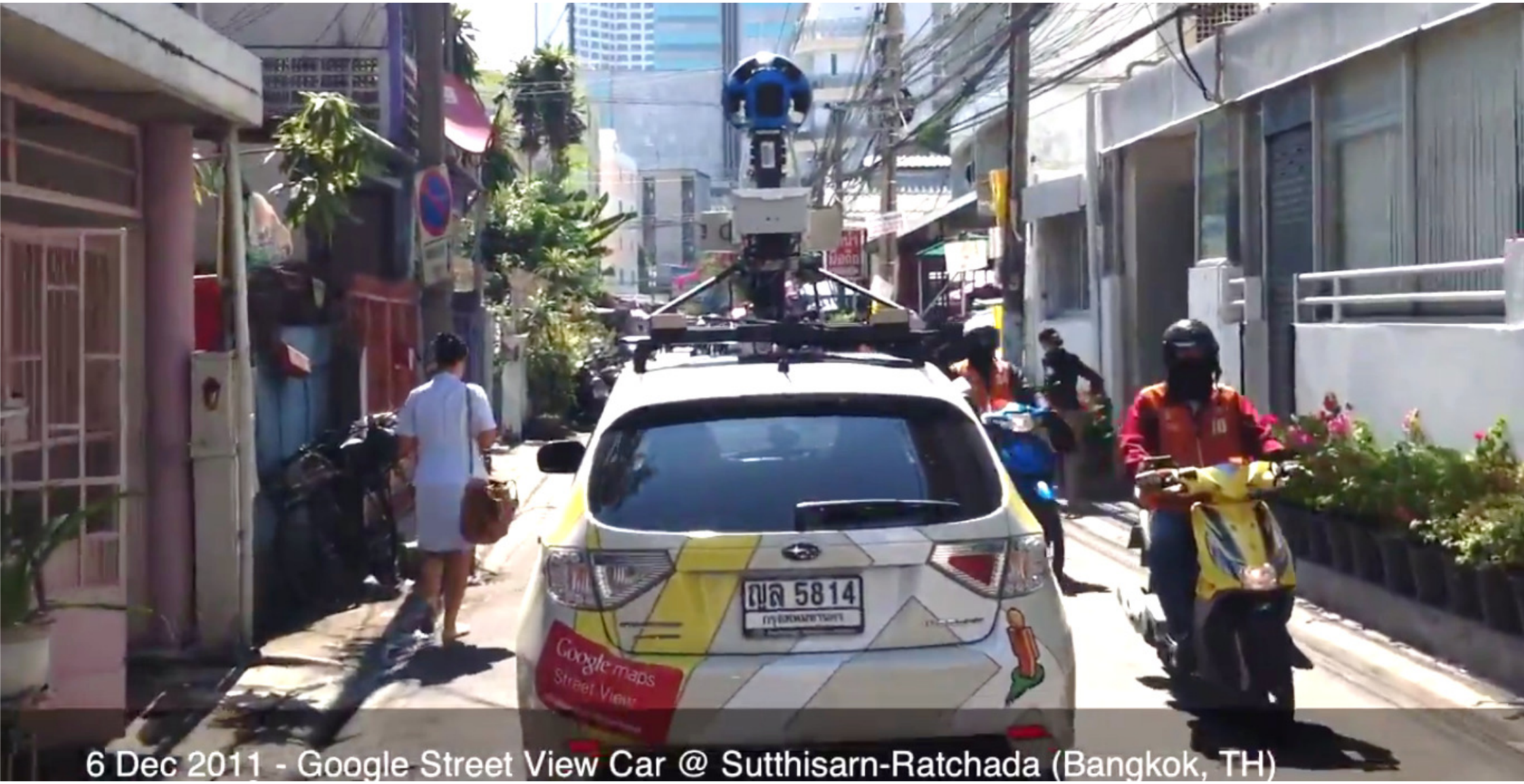
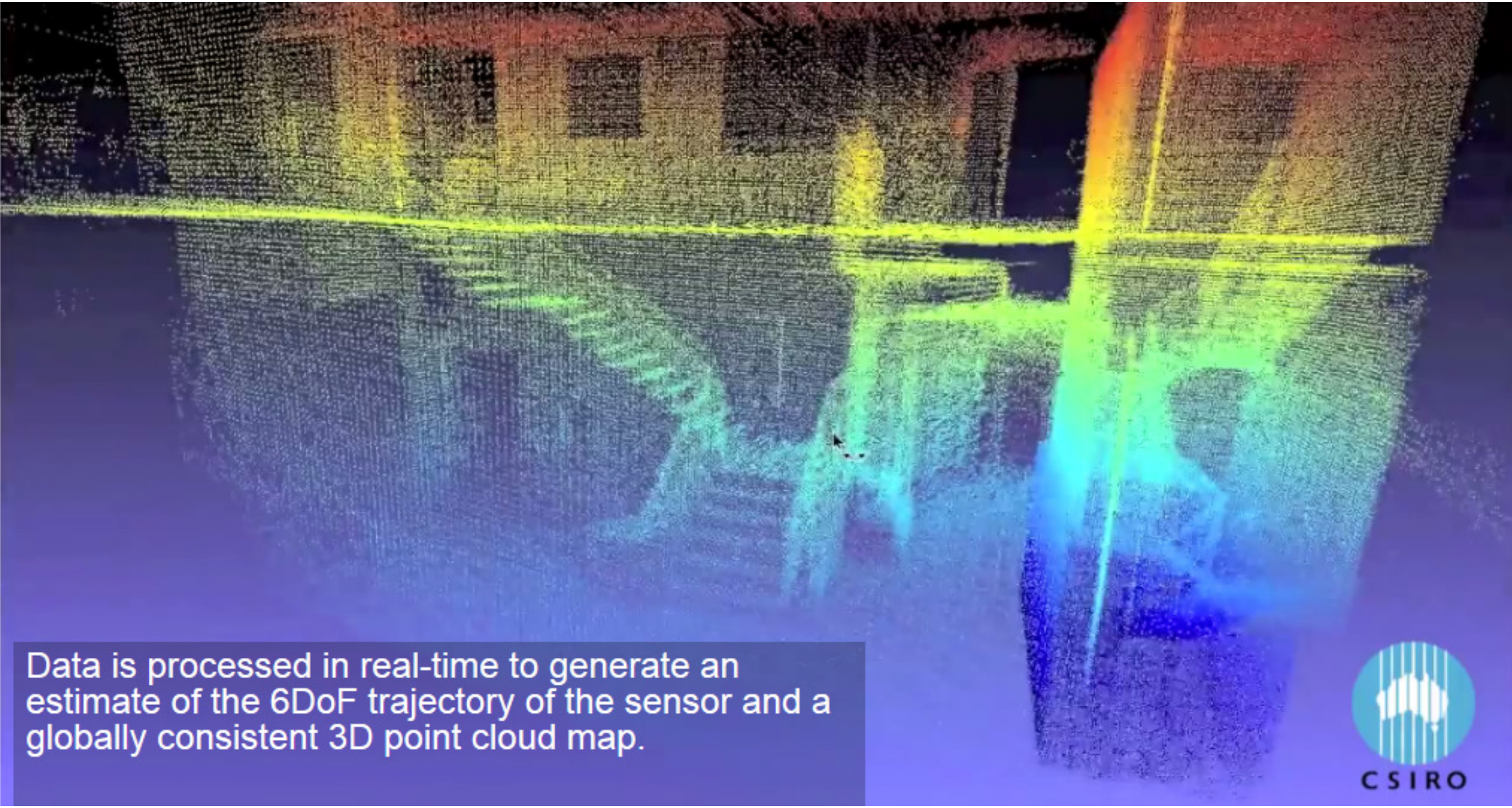
With modern mapping techniques,
everywhere will be on high-resolution map.

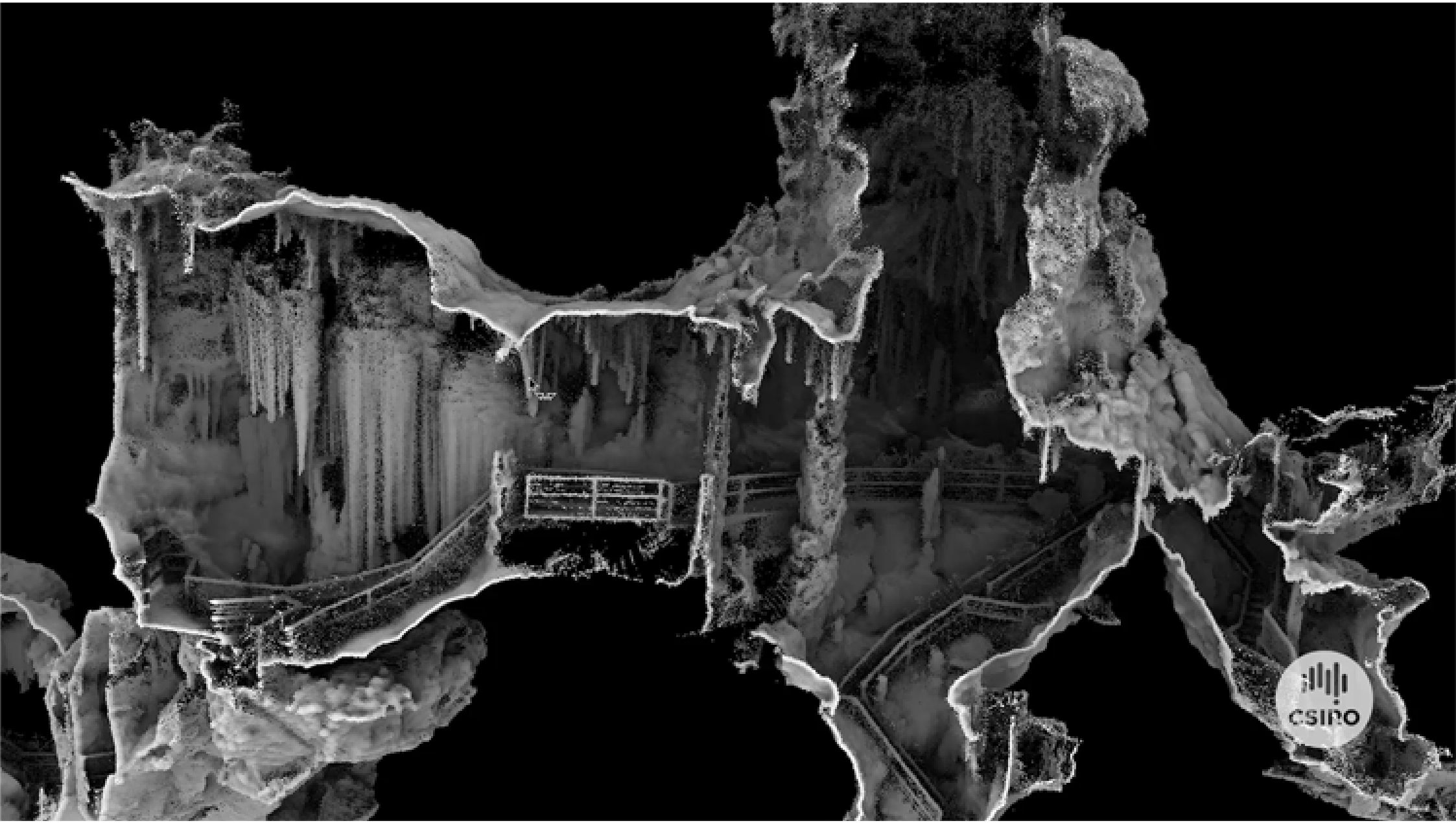


6 Dec 2011 - Google Street View Car @ Sutthisarn-Ratchada (Bangkok, TH)


CATLIN

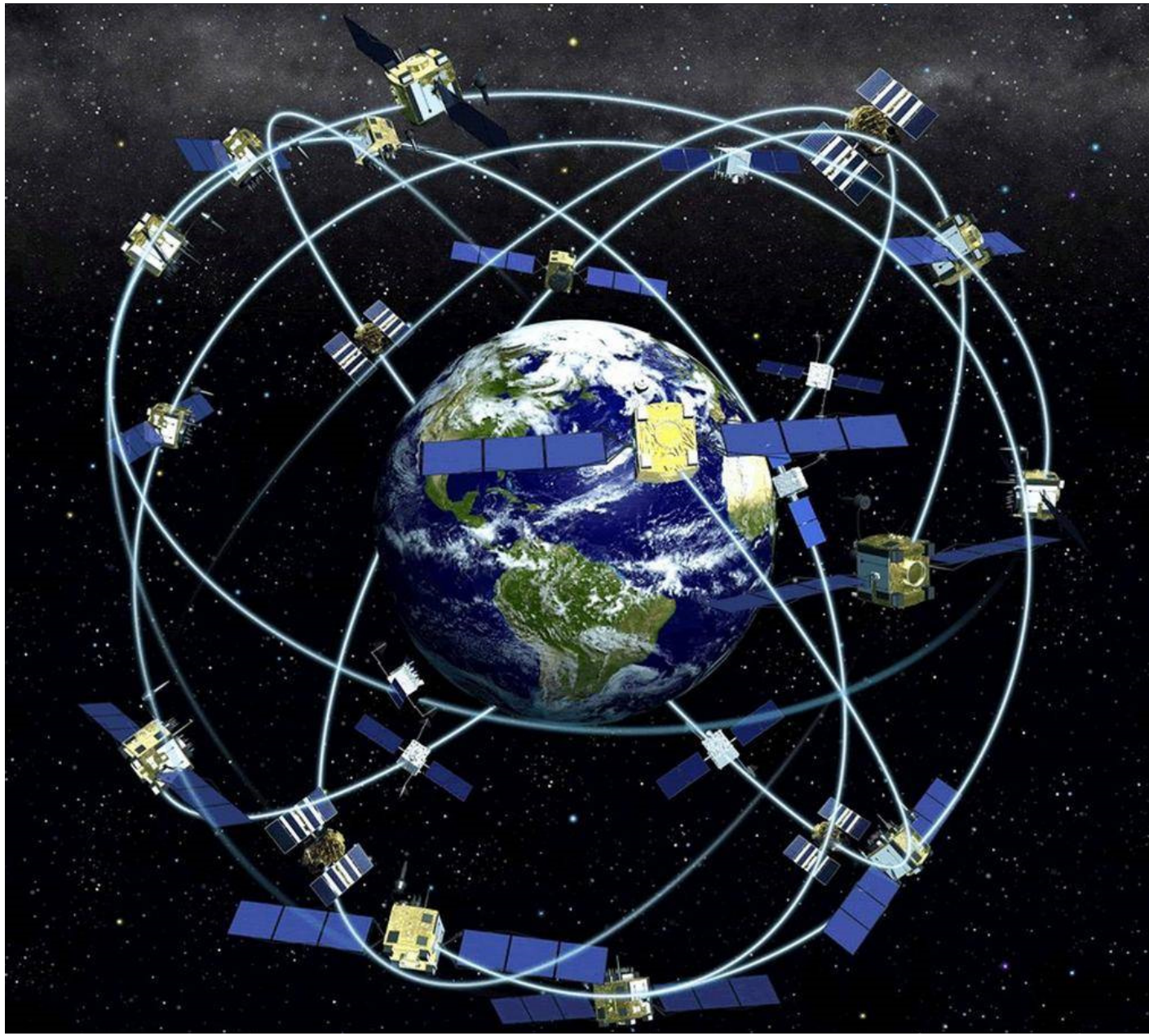

UAV LiDAR solutions


Data is processed in real-time to generate an estimate of the 6DoF trajectory of the sensor and a globally consistent 3D point cloud map.
CSIRO


CSIRO

With modern positioning techniques, everything can be located.

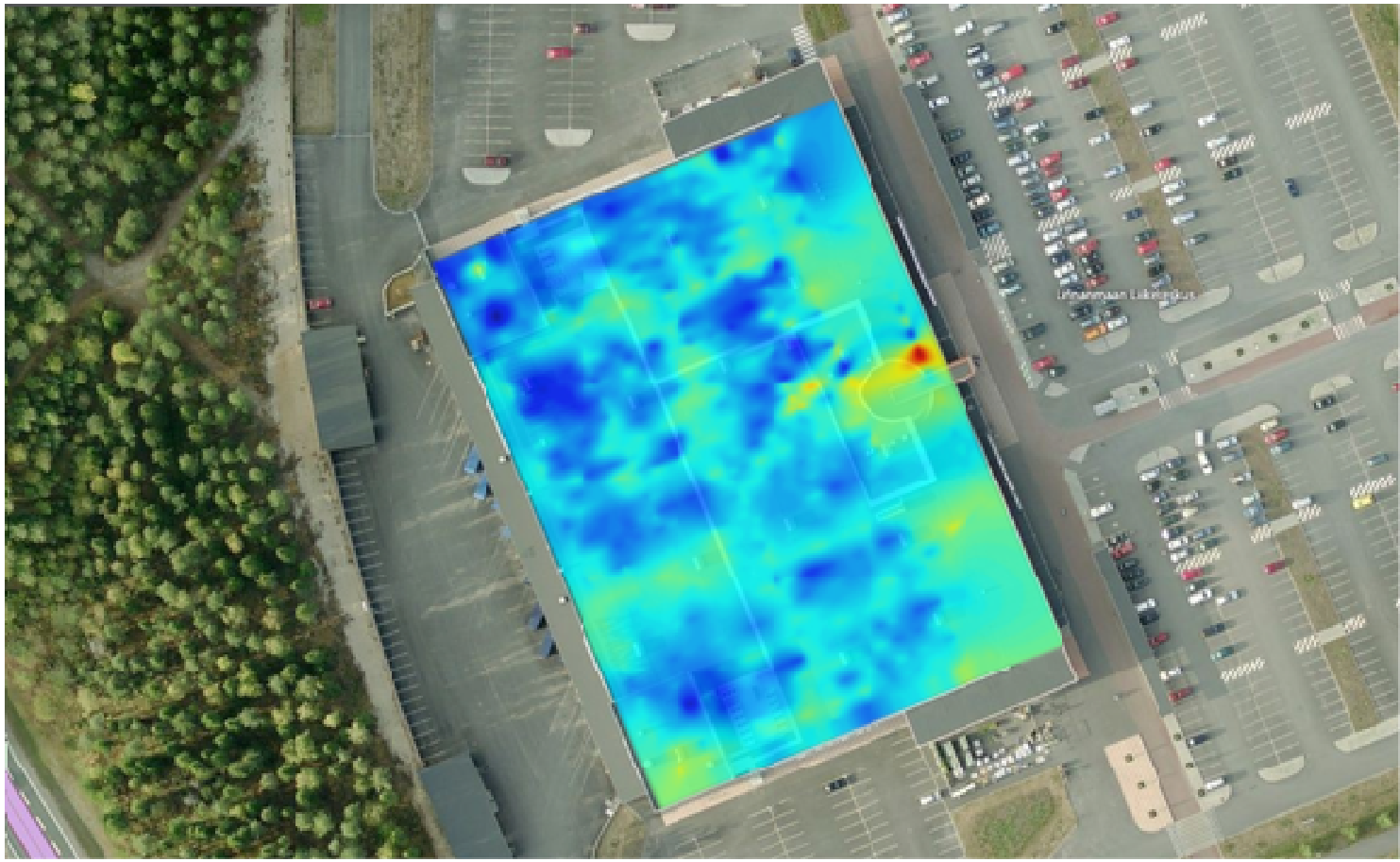
GPS



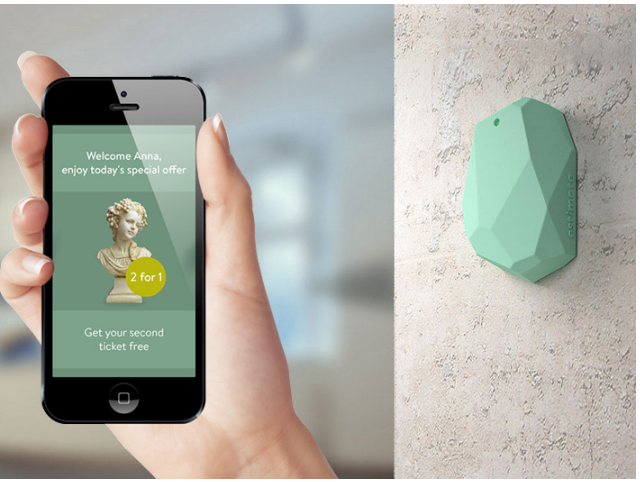
Finger Print

Signal strength of nearby WiFi access points

Magnetic field distortion by steel structure

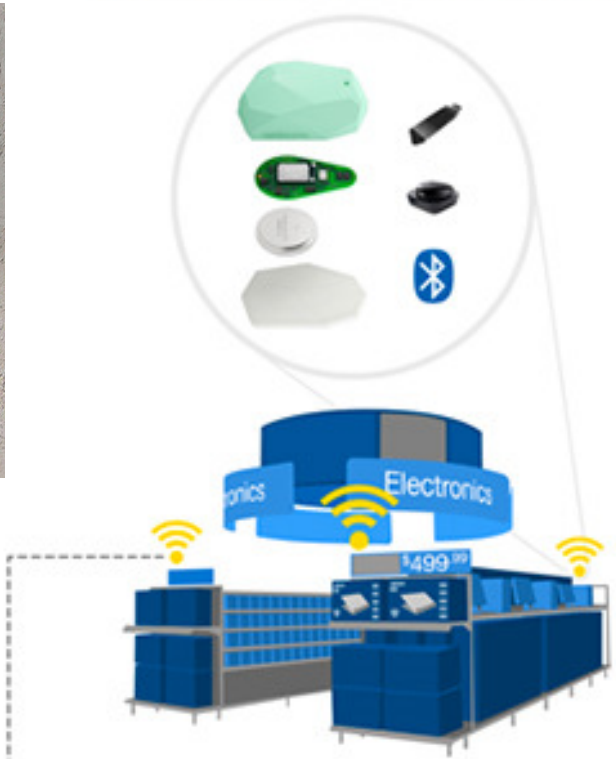


Beacon



HOW iBEACONS WORK

Bluetooth Low Energy (BLE) beacons are small enough to be located anywhere



Each beacon transmits a unique one way ID

THERE ARE MANY PRACTICAL BUSINESS APPLICATIONS OF iBEACON TECHNOLOGY.

The server uses these microlocation trigger IDs to tell either the mobile device, or another system, to perform a contextual action designed by the business owner.

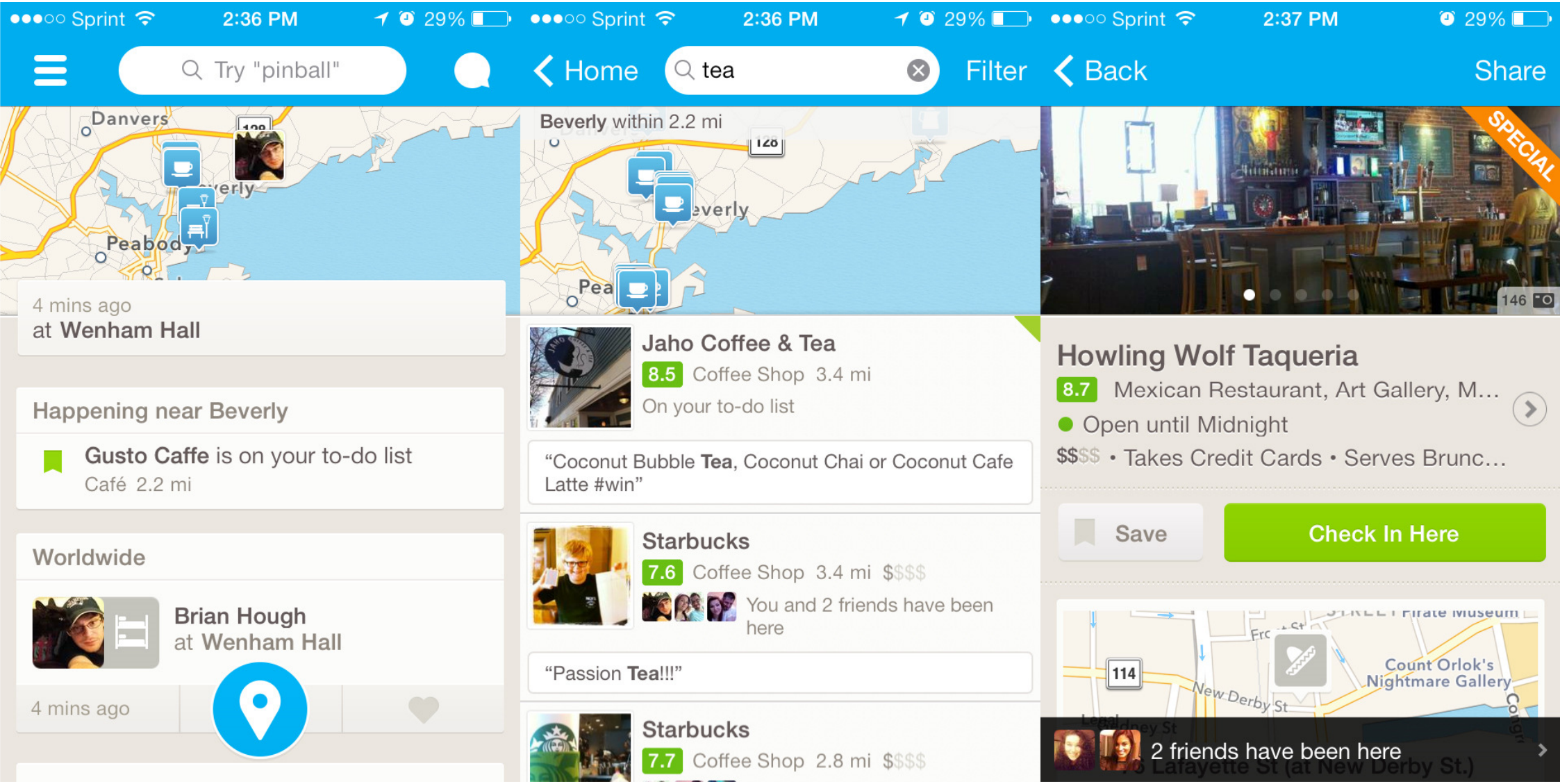
Dynamic in-store displays and contextual information

Light


Indoor Location-Based Services Using LED Lighting
How it Works
1. ByteLight-enabled GE LED fixtures "communicate" a unique light pattern using Visible Light Communication and Bluetooth Low Energy
2. Connected shoppers opt-in to "listen" with retailer's app on any smartphone and tablet with a camera and/or Bluetooth Smart
3. Camera detects unique light pattern and Bluetooth signal emitted by GE Lumination™ LED Luminaires; application notifies ByteLight platform of shopper's position and direction with sub-meter accuracy
4. Platform ties to retailer's digital marketing systems to deliver location-based services and personalized content to each shopper
ByteLight

Any kind of smart devices with known locations can be used as sensors that collect geospatial data.

Consumer Sensors



Online
Shopping

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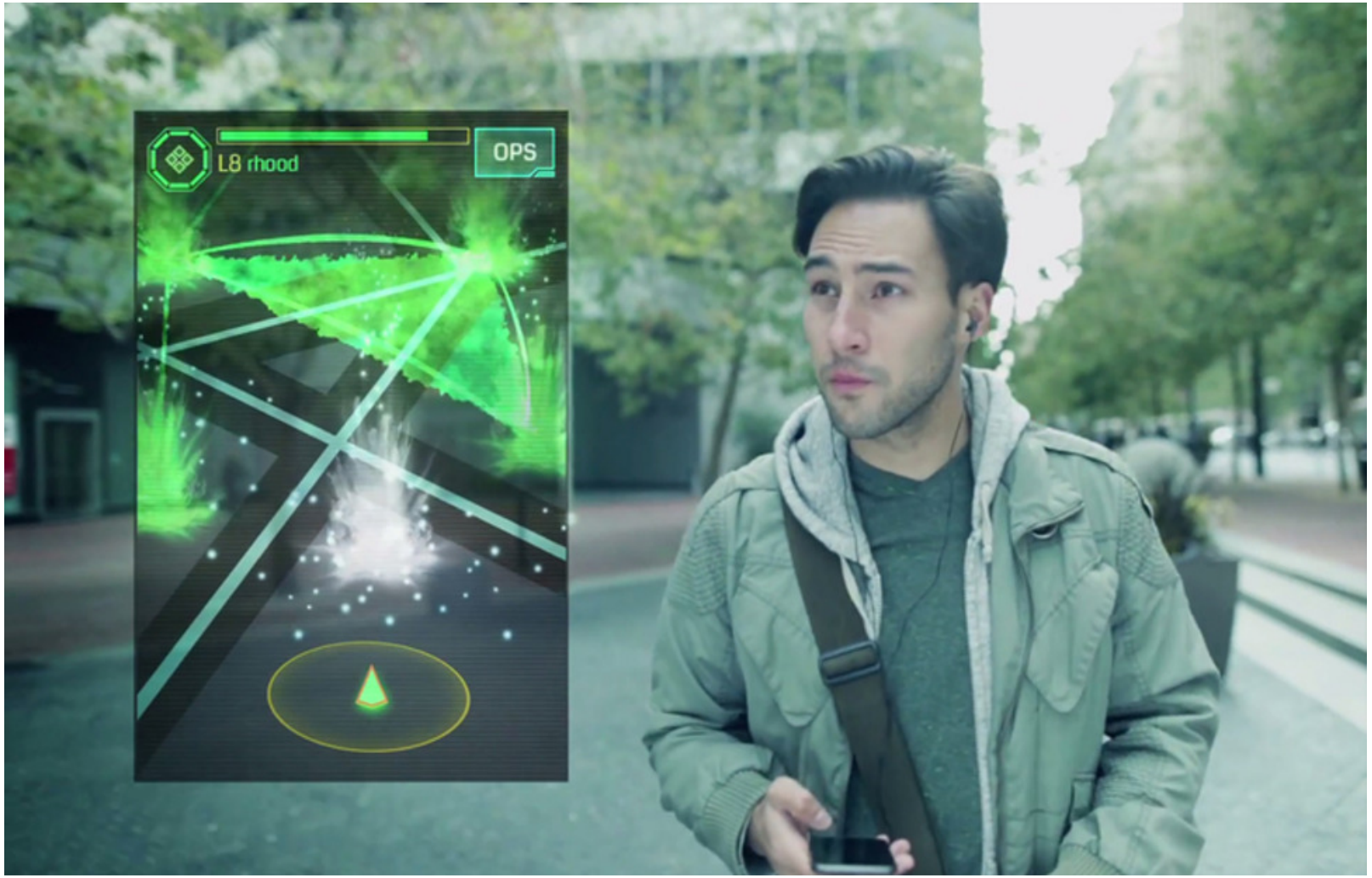
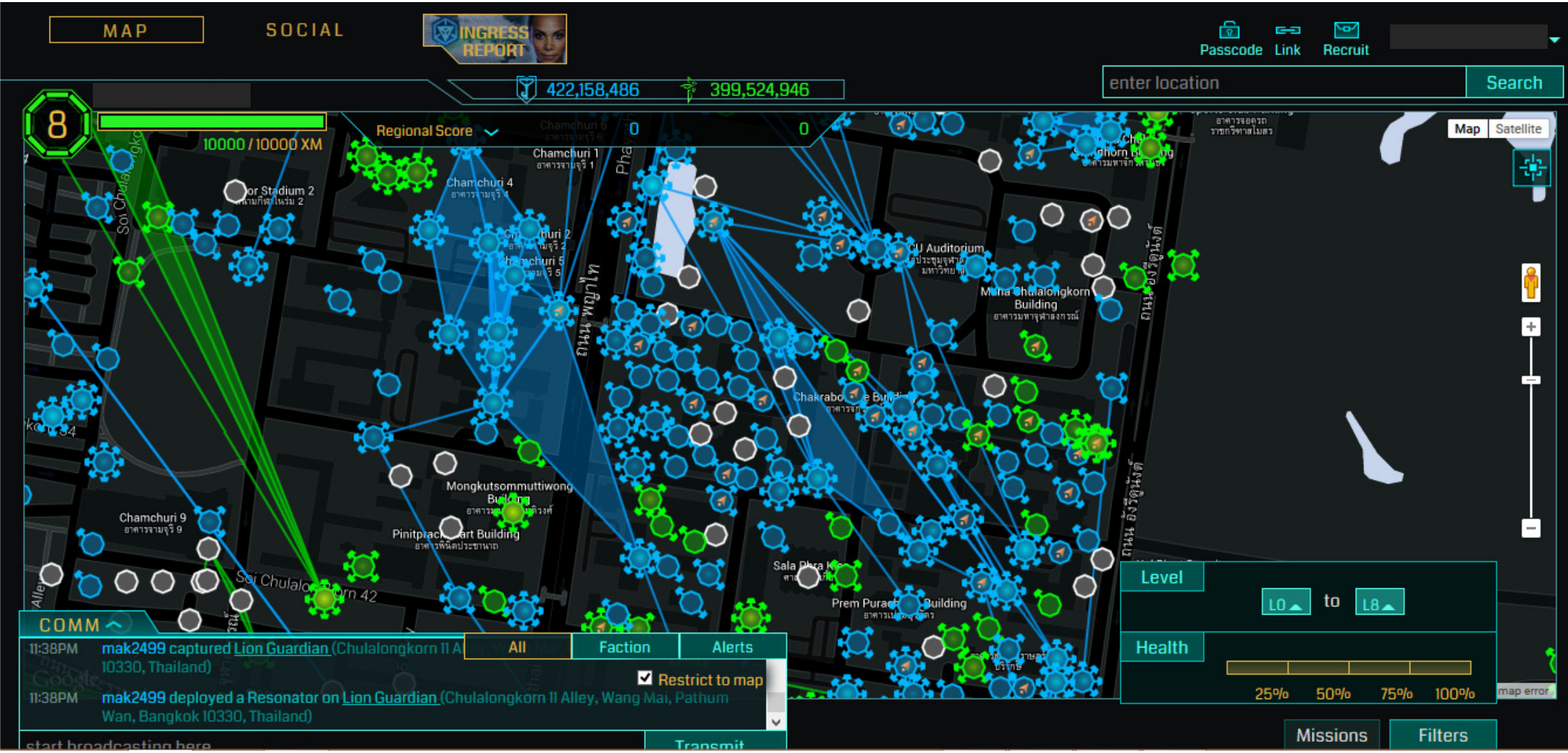
Human Mobility Sensors




MAP
SOCIAL
INGRESS REPORT
Passcode
Link
Recruit
422,158,486
399,524,946
enter location
Search
8
10000 / 10000 XM
Regional Score
0
0
Map
Satellite
Chamchuri 1
Chamchuri 4
Chamchuri 9
Mongkutsommuttiwong Building
Pinitpracha Art Building
CU Auditorium
Maha Chulalongkorn Building
Prem Purachatra Building
Soi Chulalongkorn 42
Level
L0
to
L8
Health
25%
50%
75%
100%
map error
COMM
All
Faction
Alerts
Restrict to map
11:38PM mak2499 captured Lion Guardian (Chulalongkorn 11 Alley, Wang Mai, Pathum Wan, Bangkok 10330, Thailand)
11:38PM mak2499 deployed a Resonator on Lion Guardian (Chulalongkorn 11 Alley, Wang Mai, Pathum Wan, Bangkok 10330, Thailand)
start broadcasting here
Transmit
Missions
Filters


ยินดีต้อนรับ
Welcome
180.00
SAMSUNG
คู่ชีวิต
20:38
AIS


EASY PASS
ช่องอัตโนมัติ
EASY PASS
5
A
6
A
EASY PASS
เฉพาะรถ 4 ล้อ
EASY PASS
เฉพาะรถ 4 ล้อ
EASY PASS
เฉพาะรถ 4 ล้อ
EASY PASS
เฉพาะรถ 4 ล้อ
3.2ม.