

Understanding urban dynamics from digital traces

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Context

50% of the globe's population live in urban areas (just 0.4% of the Earth's surface)
70% are projected to do so by 2050

The greatest wave of urbanization is yet to come

- Great opportunity for improving people life styles
- A potential economic, health and environmental disaster



Transportation

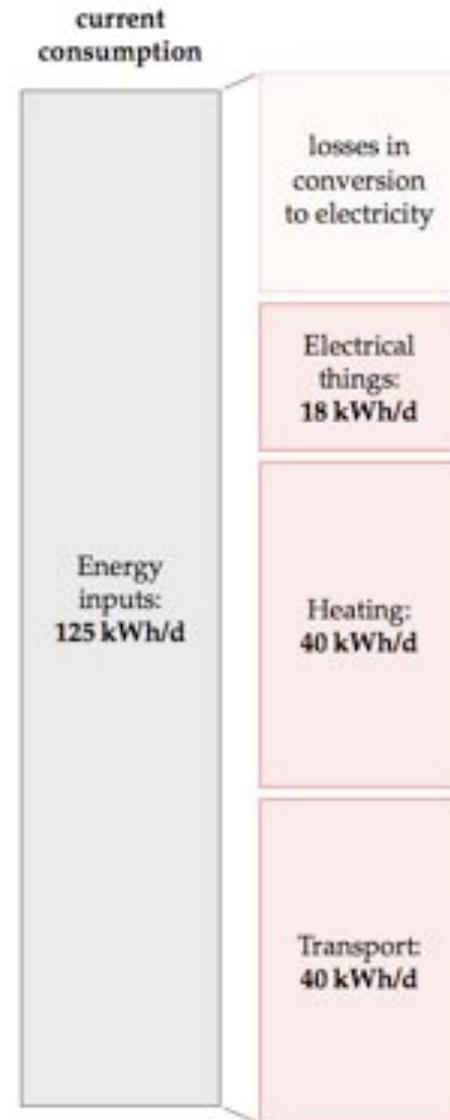
Transportation currently accounts for **one third** of the nation's energy use

Personal mobility consumes about **two thirds** of the total transportation energy use

Given increasing concerns with energy demand and environmental sustainability, urban transportation faces a **grand challenge** of:

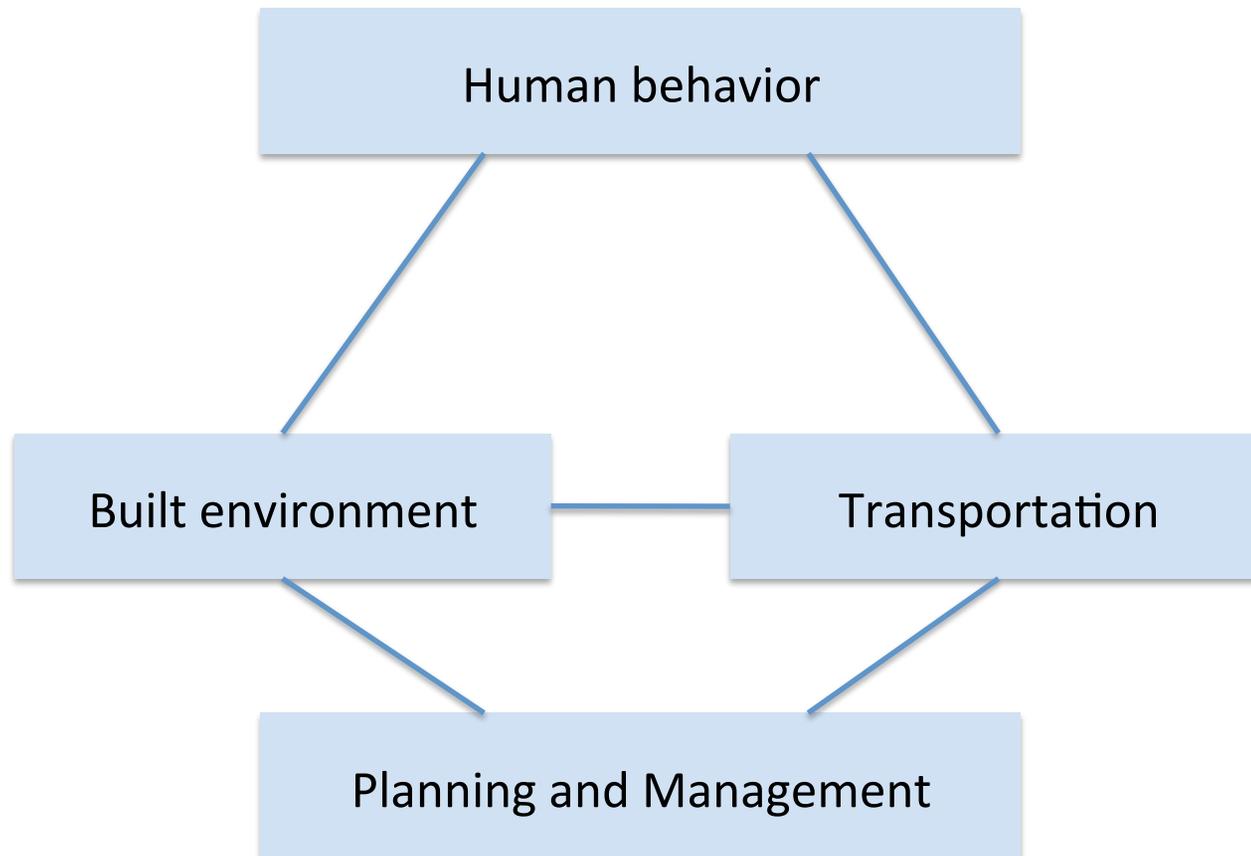
providing access to goods, services and opportunities necessary to enable human development while preserving the environment.

C. Barnhart Transportation @ MIT initiative, 2009

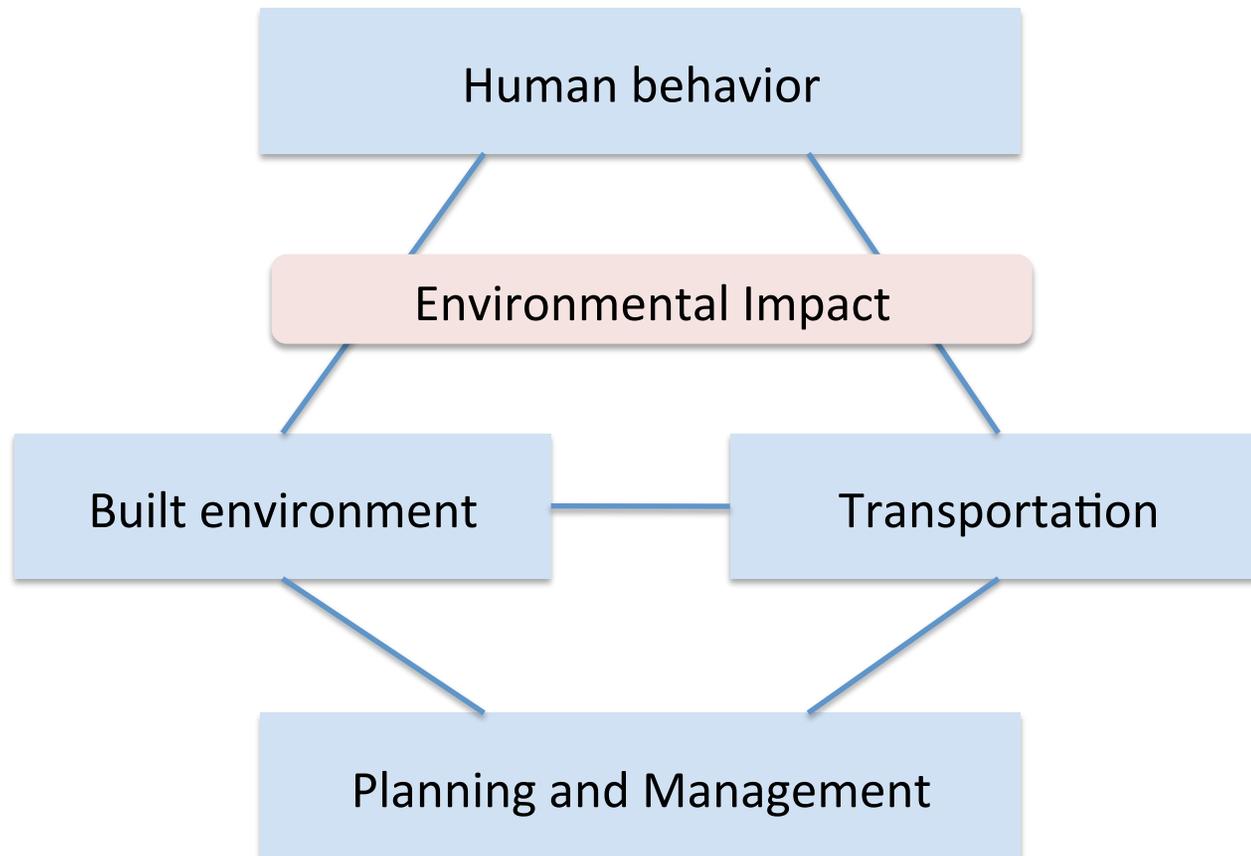


David MacKay, Sustainable Energy - without the hot air, UIT, 2009

Framework



Framework



My research

Designing and evaluating the impact of intelligent transportation systems in reducing transport demand in cities:

- Understanding human behavior in terms of mobility demand
- Analyzing and predicting transportation needs in short and long terms

Applications

- More efficient planning
- More efficient transportation management

Pervasive technologies datasets



Potentials

- possibility to study micro and macro behaviors
- data is becoming more and more available (mobile technologies increasingly adopted by the population)

Privacy concerns in the use of personal data only partially addressed by the EC (*)

(*) Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communication sector (Directive on privacy and electronic communications)

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Mobile Data: A Gold Mine for Telcos

A snapshot of our activities, cell phone data attracts both academics and industry researchers.

By Tom Simonite

THURSDAY, MAY 27, 2010

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Cell phone companies are finding that they're sitting on a gold mine--in the form of the call records of their subscribers.

People tracking The Economist Technology Quarterly March 2010 2017

Go with the flow

Visualisation: Data from mobile-phone networks can create maps that show how people are moving around

WHERE is everybody? Being able to monitor the flow of people around a city in real time would provide invaluable information to urban planners, transport authorities, traffic engineers and even some businesses. Bus timetables could take account of hourly or daily variations; advertisers would be able to tell which billboards were most valuable. Such information can be collected via traffic helicopters, roadside cameras, police patrols, sensors embedded in roads, tracking units in vehicles, data from public-transport barcodes and surveys. But the resulting picture is often inadequate, expensive—or both.

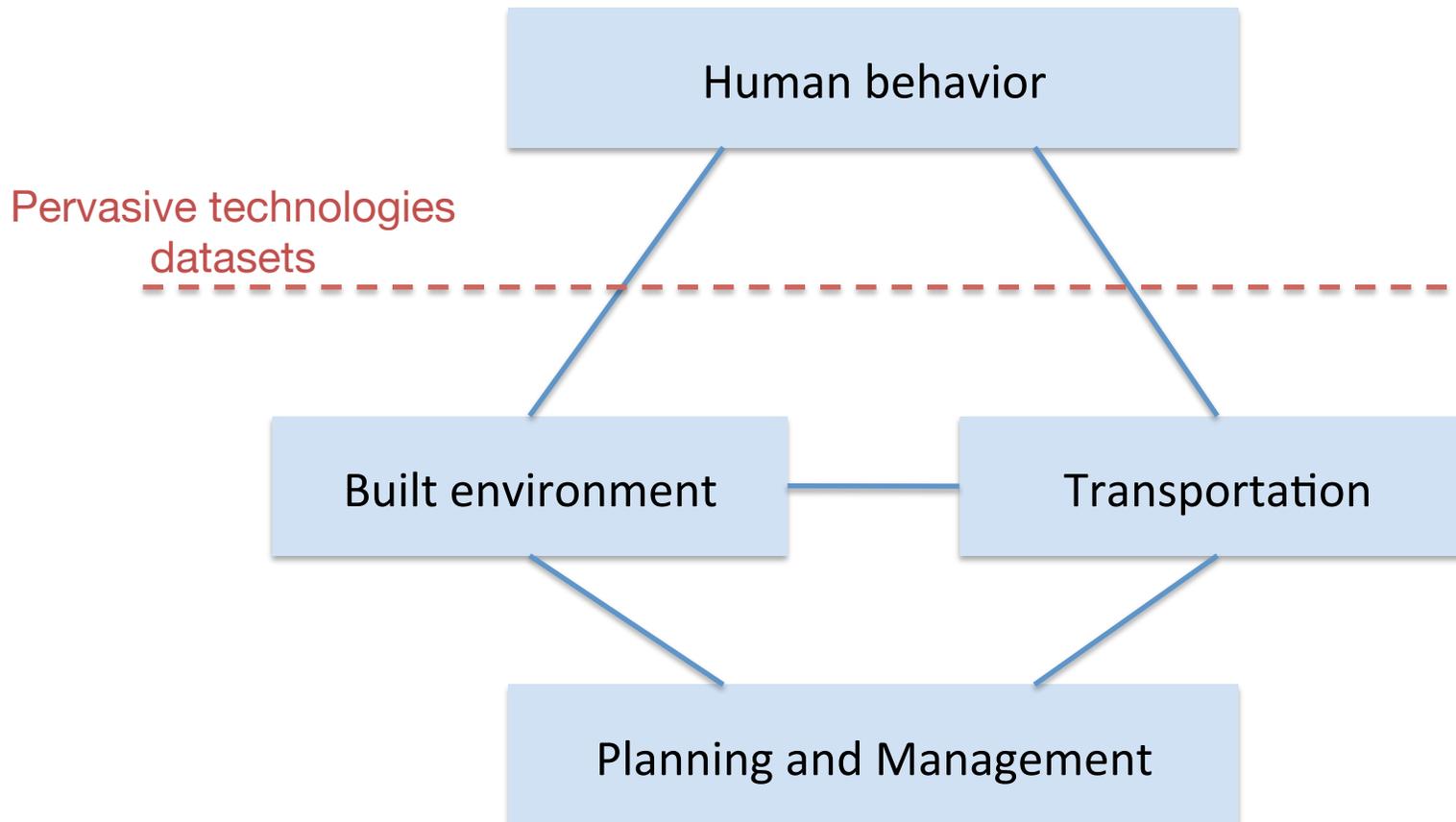
A new scheme devised by researchers at Massachusetts Institute of Technology (MIT) takes a different approach. Given that almost everyone in the developed world now carries a mobile phone, why not use the data from mobile-phone networks? Such networks have to keep track of where subscribers are, as they roam from cell to cell, in order to route calls and text messages. The MIT researchers have been testing the idea using anonymised data from two European operators, Telecom Italia and Mobilkom Austria, to analyse where mobile phones (and therefore people) are at any given moment.

The results take the form of luminous maps adorned with moving and colour-coded arrows, dots and patches of light that indicate the speed and population density of people in the city in question, with an accuracy down to a dozen or so metres. "You see how the city is pulsating," says Carlo Ratti, who is leading the research as head of the Sustainable City Laboratory at MIT.

The new approach has a number of advantages over other methods. Sensors embedded in streets can accurately count vehicles, for example, but cannot count passengers or detect pedestrians and cyclists. Sensors and cameras also fail to provide "origin-destination" (OD) statistics—jargon for information about where people are travelling to and from, and how long their journeys take. Such information is usually collated using surveys, which are very expensive to carry out. Using data from phone networks promises to be much cheaper. "It's pretty simple: you just need a digital map and you show the data," says Hansrueter Ametsreier, head of marketing at Mobilkom Austria, which is working with MIT to map the city of Graz. "This could be an opportunity for us."

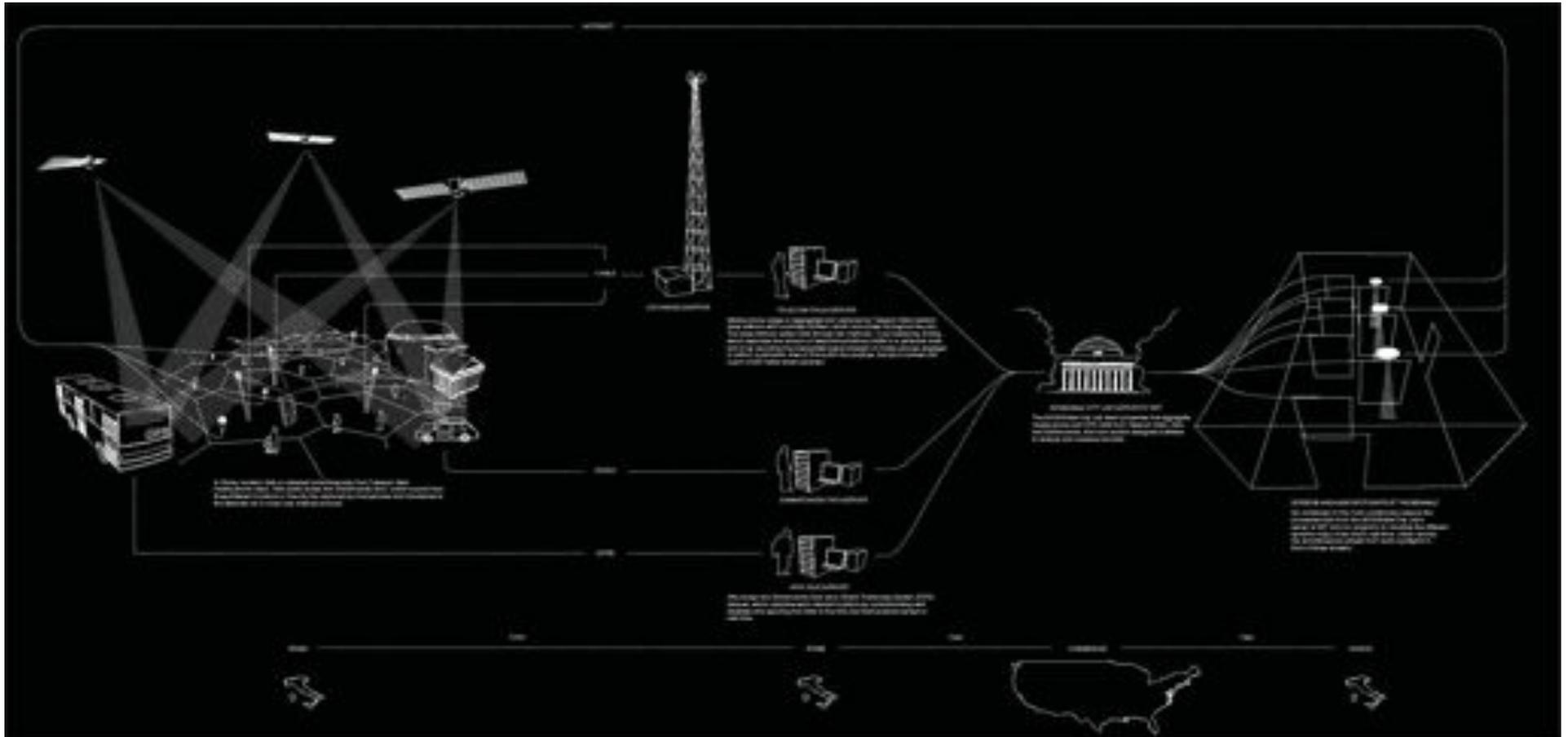
With markets becoming saturated and mobile operators' revenue-growth slowing—there are already 112 mobile devices for every 100 Austrians, for example—providing information about travel patterns could be a lucrative opportunity for tele-

Cyber-physical system



Real time data collection

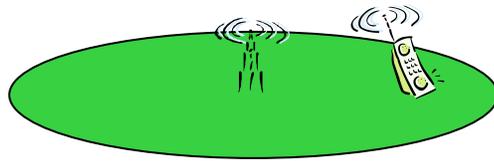
Goal: Extract individual mobility information from telecommunications and transportation networks



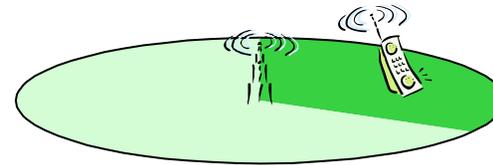
F. Calabrese, M. Colonna, P. Lovisolo, D. Parata, C. Ratti, Real-Time Urban Monitoring Using Cell Phones: a Case Study in Rome, IEEE Transactions on Intelligent Transportation Systems, 2010.



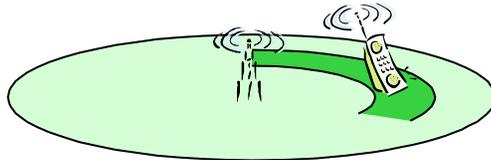
Technology used to locate mobile phones engaged in calls



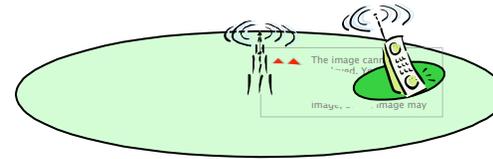
A. Cell ID



B. Angle of Arrival (AOA)



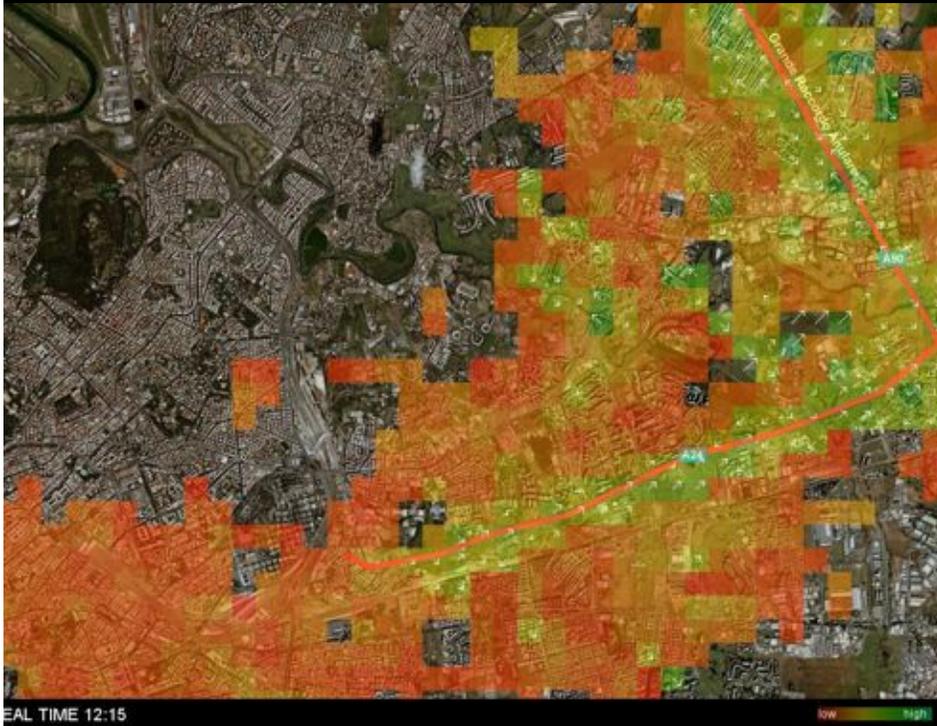
C. Timing Advance (TA)



D. Received Signal Strength (RSS)

Using propagation models and irradiation diagrams, the software engine estimates the mobile phone position finding the point that minimizes the mean square error between measured and estimated mean power received by all base stations.

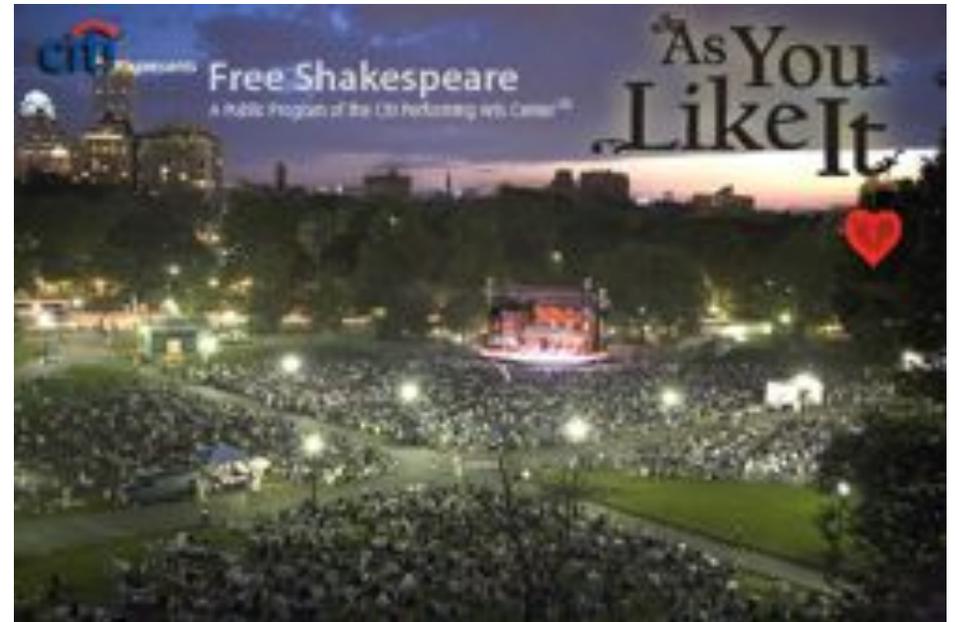
exhibited at the 2006 Venice Biennale of Architecture



Modeling urban mobility – special events

Goal: Modeling and predicting non-routine additive origin-destination flows in the city

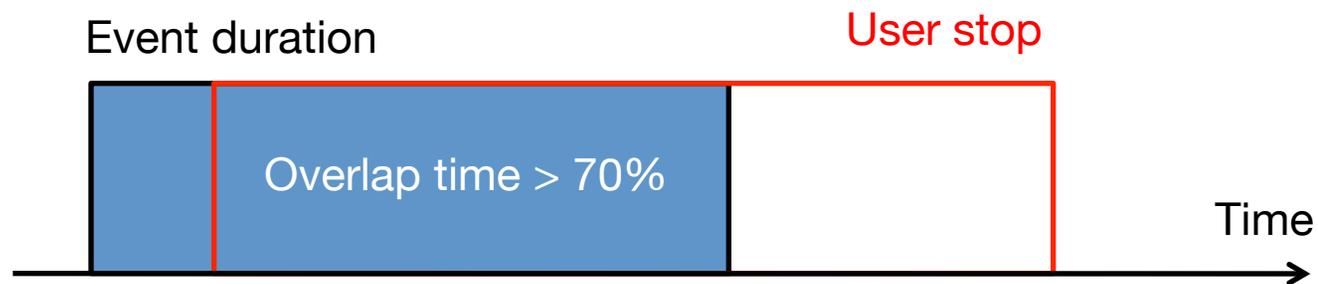
Improving event planning and management, with possible applications for emergency response



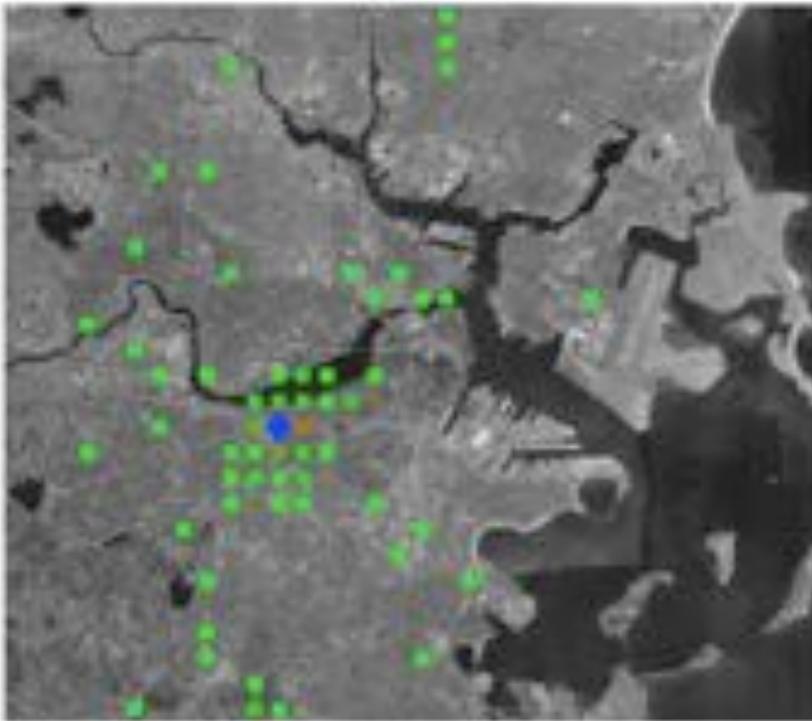
F. Calabrese, F. Pereira, G. Di Lorenzo, L. Liu, C. Ratti, The geography of taste: analyzing cell-phone mobility and social events. In International Conference on Pervasive Computing, 2010.



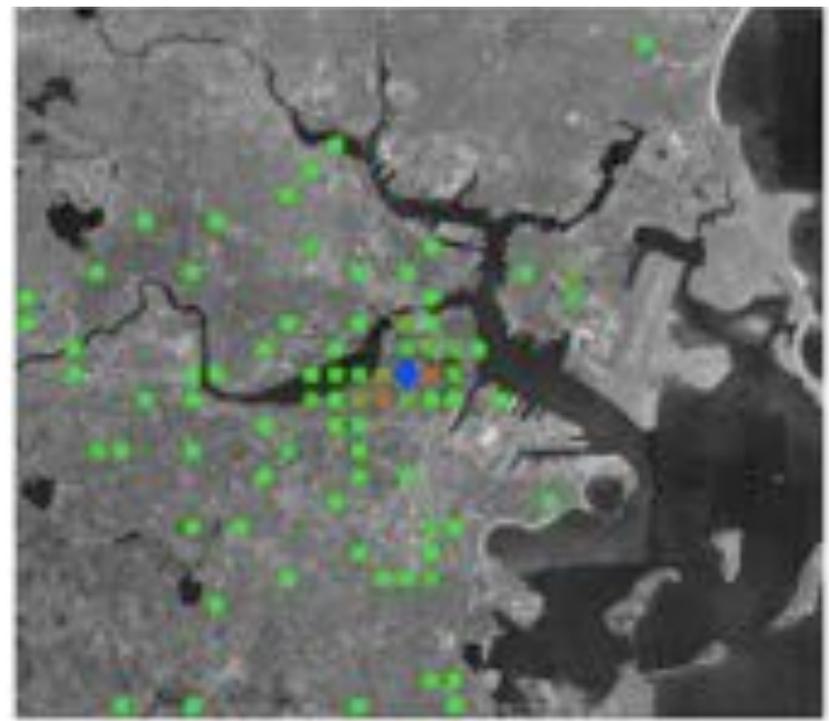
Attendance inference



Origins of attendees



(b) Boston Red Sox vs. Baltimore Orioles at Fenway Park, 2009-9-9

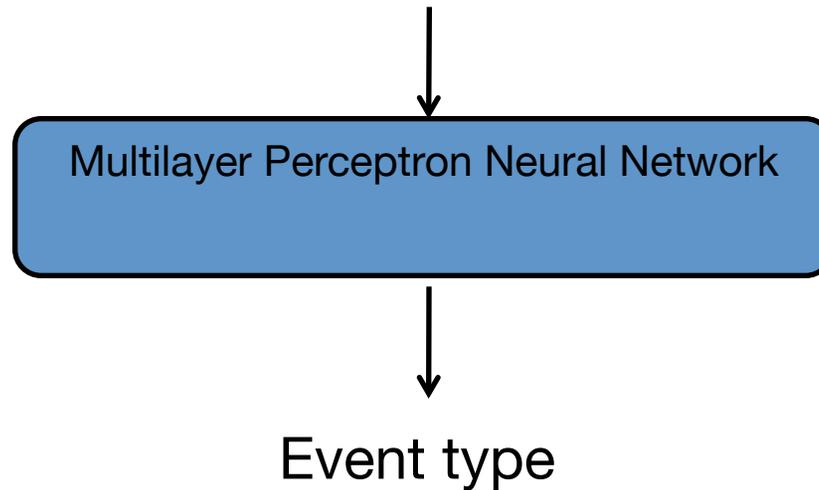


(d) Shakespeare on the Boston Common, 2009-8-13



Event types and attendance origins

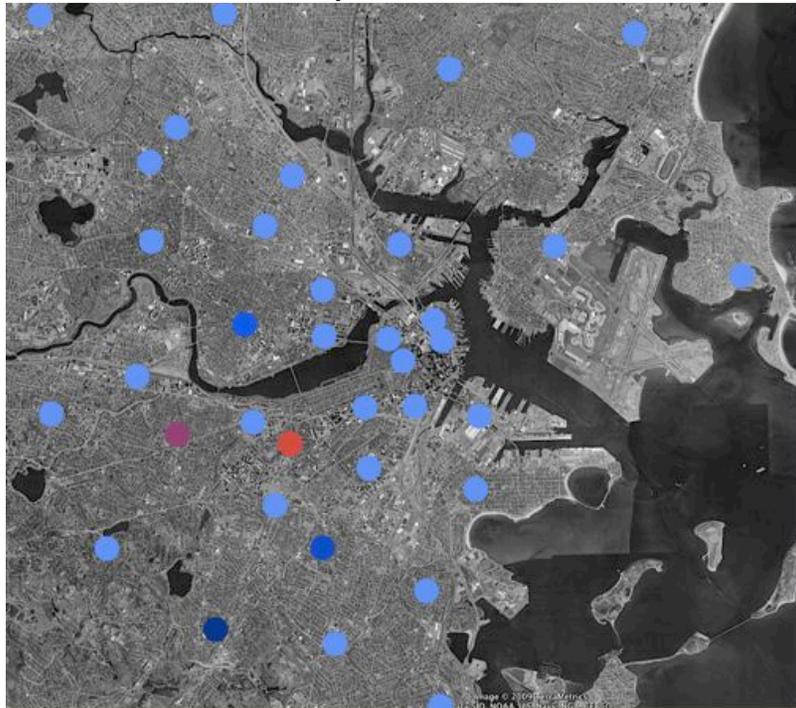
ZIPCODE	02215	02139	02114	02115	02108
COUNT	7	5	7	11	9
PERCENT.	7%	5%	7%	11%	9%



Event types and attendance origins

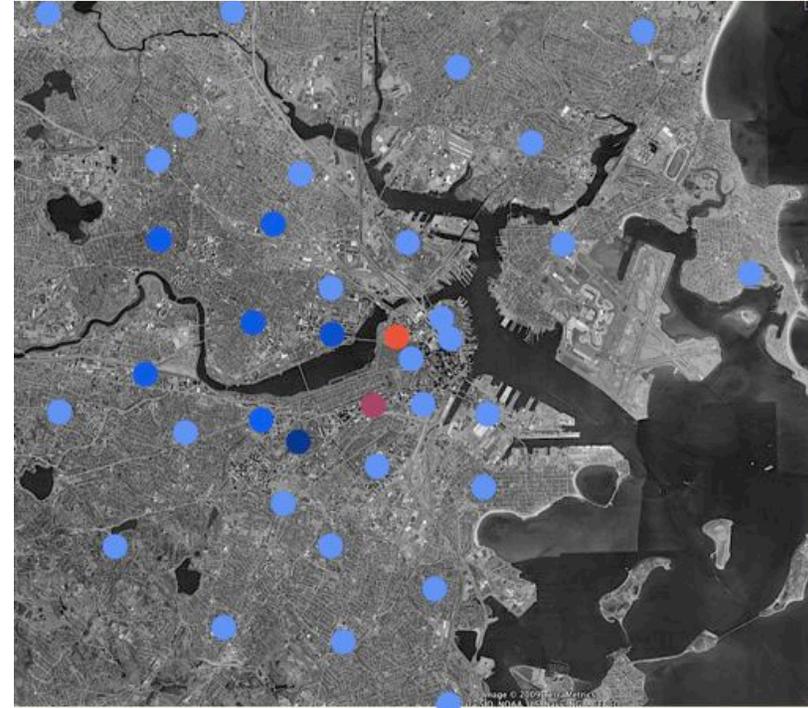
Features	All attendees		Exc. event zipcode		Obs
	Precision	Improvement	Precision	Improvement	
Fixed baseline	35%				Always choose same class
Random baseline	23.34%				Random choice
Zipcode	89.36%	54.36%	59.57%	24.57%	All attendees
Distance	51.06%	16.06%	48.9%	13.9%	All att. Resolution 2000m

Sport



Circles are centroids of zipcode areas

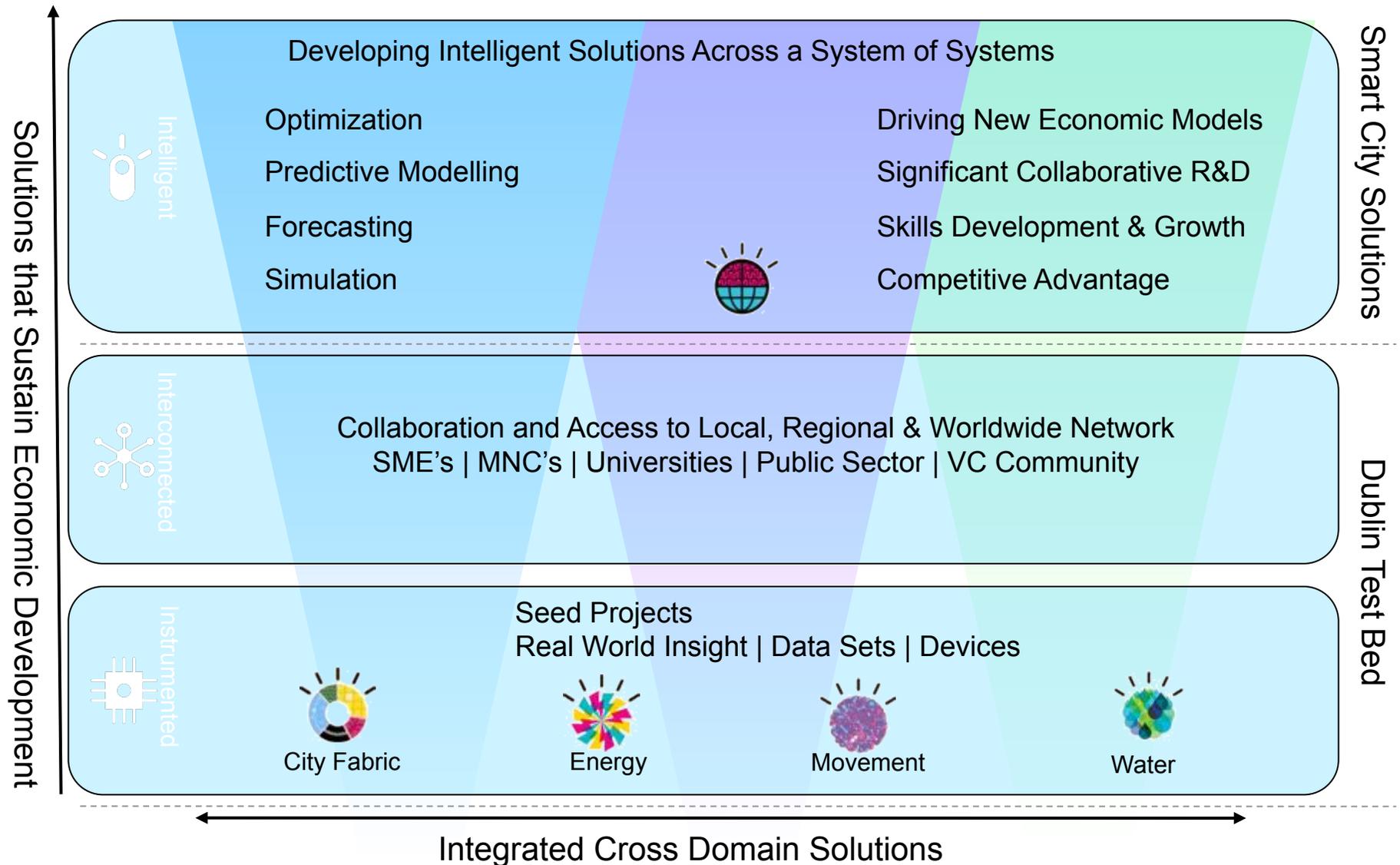
Cinema



Attendance probability



The Smarter Cities Technology Centre merges Collaborative Research & Smarter Cities opportunities





Thanks
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