Cyber-Physical Systems for Smart Cities: a Mobility Perspective

Jack Stankovic → Tian He → Desheng Zhang

New York City Taxi System
Urban CPS

NYC

Rome

Beijing

Shanghai

San Fran

D.C.

Shenzhen

Hefei

Transportation

500 K

10 TB

Comm.

10 M

1 TB

Payment

16 M

1 TB

Social

3.5 M

60 GB
Research Vision on Mobility

Models

Knowledge

Services

Measure & Predict
- Volume [MobiCom 14] [SigSpatial 15]
- Distance [SenSys12]
- Speed [SenSys 18] [SigSpatial 16]
- Energy [RTSS 18]
- RT Locations [ICCPS 15]
- Routes [Ubicomp 18-1]
- Density [Ubicomp 18-4]
- Time [BIGDATA 13][BIGDATA 14]

Intervene & Alter
- Ridesharing [SenSys 13]
- Delivering [IPSN 15]
- Dispatching [ICCPS 18]
- Transferring [Smartcomp 17]
- Charging [RTSS 18]
- Parking [Ubicomp 17]
- Rebalancing [Ubicomp 18-2]
- Navigation [Ubicomp 18-3]
- Planning [BigData15]
Domain Dimension

Transportation

- Bus [ICCPS 18]
- Taxi [RTSS 12][ICCPS15][SenSys 13]
- Bike [Ubicomp 18-2]
- Truck [SigSpatial 16]
- Metro [Smartcomp 17]
- Personal Vehicles [SenSys 13]
- For-hire Vehicles [Ubicomp 18-3]
- Electric Taxi [Submission 3]
- Electric Bus [RTSS 18]
- Loop Sensors [SigSptial 15]
- Cameras [Ubicomp 17]
- Transit App [SenSys 12]

Communication

- Vehicular Comm [SenSys 18]
- Cellular [Ubicomp 18-4]
- Mobile WIFI [Submission 1]

Payment

- ETC System [Ubicomp 18-1]
- Smartcards [BIGDATA 15]
- Mobile Payment [Submission 2]
Advancing State of the Arts

Provinces [Ubicomp 18-4]

Guangzhou City
Shenzhen City

Nations [SigSpatial 16]

Beijing, Shanghai, Shenzhen

Cross-Domain
[MobiCom 14] [SigSpatial 15] [SenSys 18]

Domain
Transport. Telecom.

Spatial

Temporal

5 Year Vehicular Evolving [Submission 4]

2012 Density

2017 Density

PV Road Coverage: 27.9% (1b)
Cell phones user: 3.37million
Cell towers: 23,704

CBD Area
Two Lessons learned by working with Jack

A Sense of **Completeness** to Position Our Work

<table>
<thead>
<tr>
<th></th>
<th>Hard RT</th>
<th>Soft RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static RT</td>
<td>[1][2]</td>
<td>[3][4][5]</td>
</tr>
<tr>
<td>Dynamic RT</td>
<td>[6][7][8]</td>
<td>Our work</td>
</tr>
</tbody>
</table>

A **Unifying** Theme across all Components for a **Vision** capturing **Imagination**

**Measuring & Intervening**

**Human Mobility**

**at Unprecedented Scale**

of Human History
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Data and More Work @ https://www.cs.rutgers.edu/~dz220/