

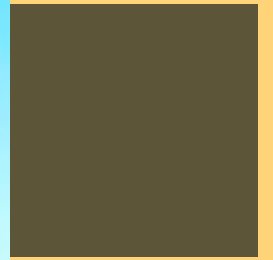


CE 186: Educating Engineers of Infrastructure Intelligence CPS in the Energy Transportation Nexus

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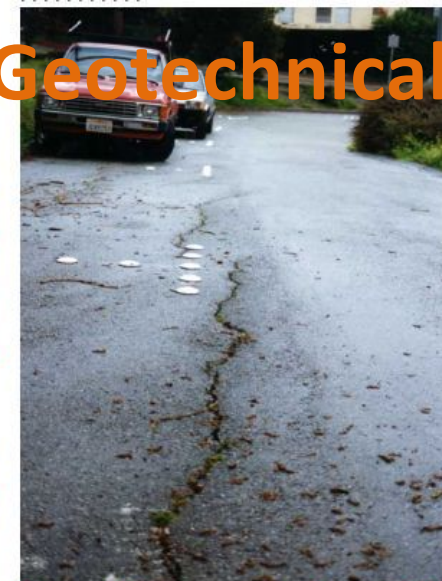
Structural & Materials



Structural & Materials



Geotechnical



En echelon cracks in asphalt pavement caused by slip on the Hayward fault.

Photograph view southward

[Read more...](#)

U.S. Geological Survey

Structural & Materials



Geotechnical



Project Management



Structural & Materials



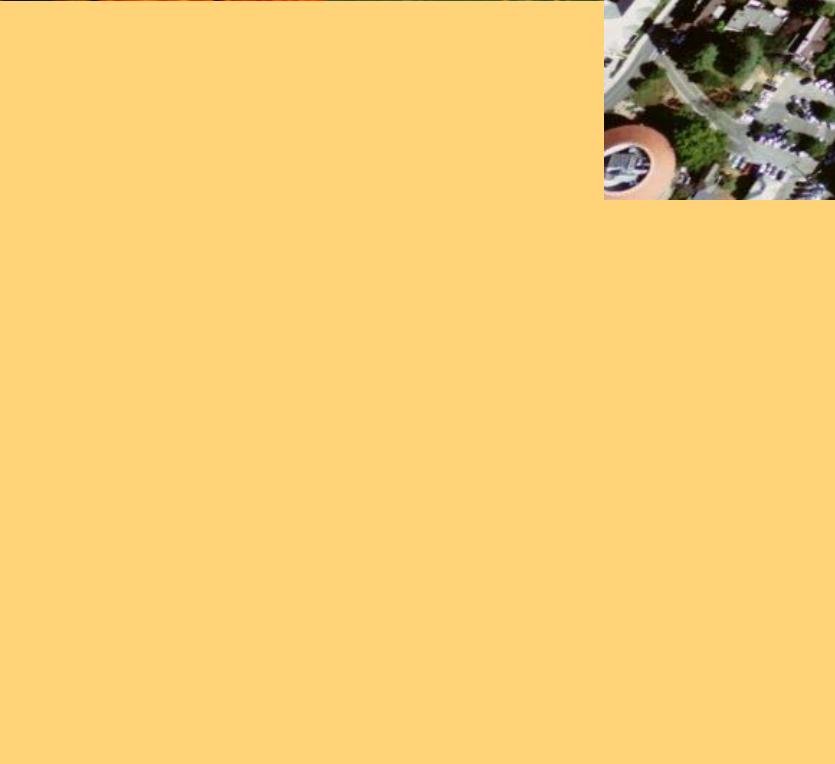
Geotechnical



Project Management



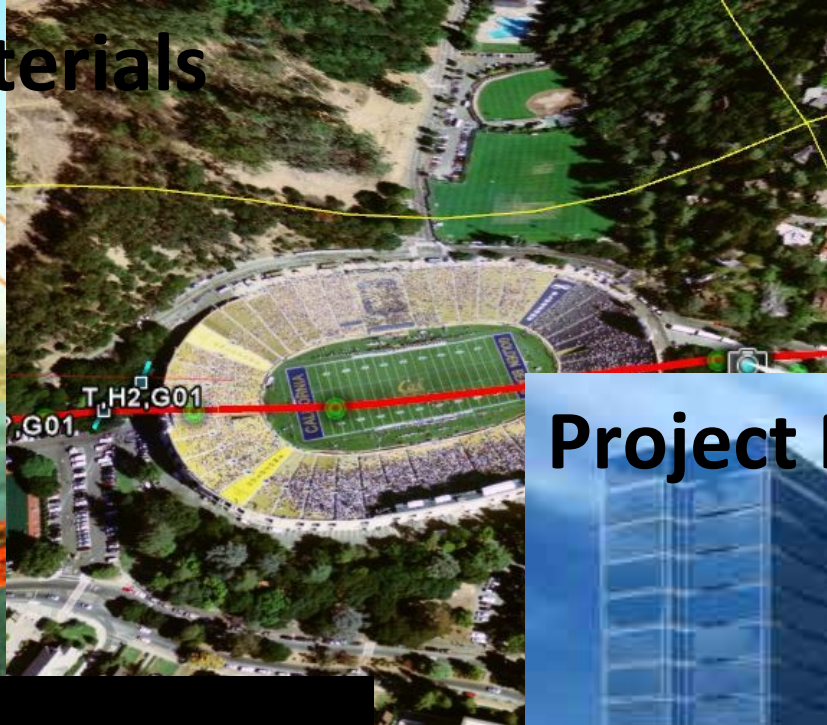
Transportation



Structural & Materials



Geotechnical



Project Management



Energy Climate & Infrastructure

Transportation





Structural & Materials



Geotechnical



Environmental Engineering



Energy Climate & Infrastructure



Structural & Materials



Geotechnical



Environmental



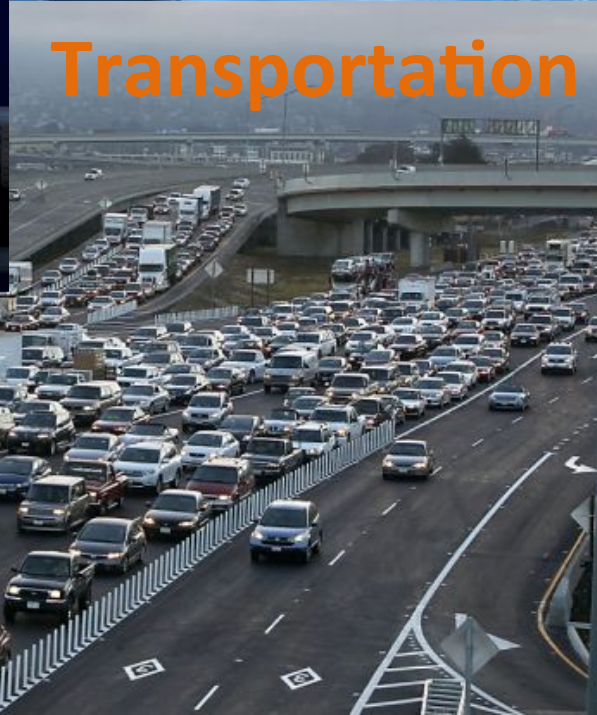
Project Management



Systems



Transportation



Energy Climate & Infrastructure



Structural & Materials

Geotechnical

Environmental

Project Management

Systems

The Sciences of Operation
7 faculty, 3.5 FTE

Transportation

**Energy Climate &
Infrastructure**





Devices that Sense and Actuate are Proliferating As they Network at Scale → New Infrastructure



GLASS



Build the Intelligence of Infrastructure Water, Energy, Transportation

on the
Global Infrastructure of Computation



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The Pedagogical Challenge

- The student background is E7
 - Introduction to programming for engineers
 - Required for all CoE students except EECS
- The reason to take it on
<http://www.watttime.org/about-us/>



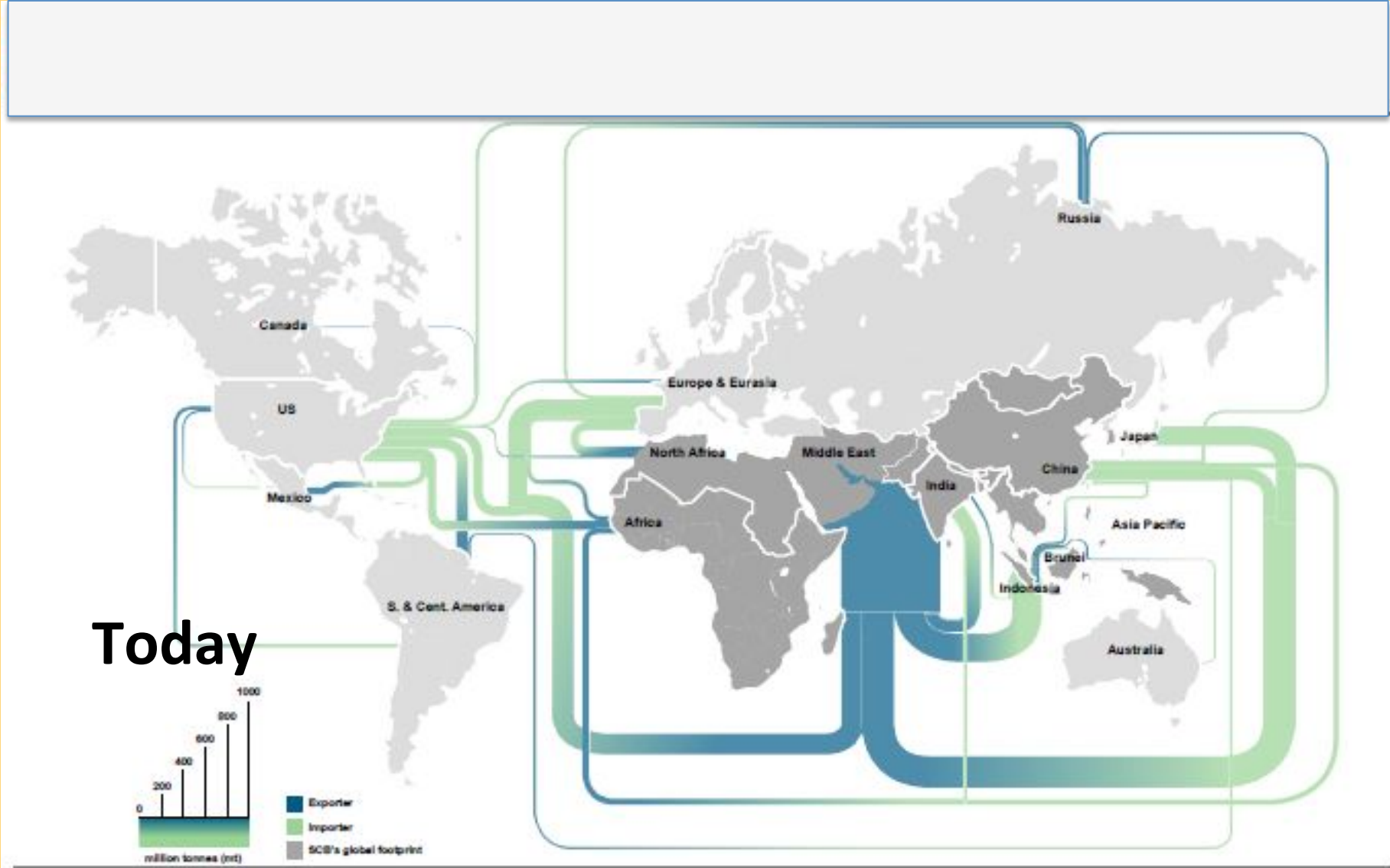
The Op Challenges of Tomorrow

Sustainability, Resilience, Demography

- US Surface Transportation sector accounts for 9% of GDP but 25% of US GHG. Sustainable?
- “Water use has been growing at more than twice the rate of population increase in the last century.” Efficiency?
- “There's no doubt: natural and manmade shocks and stresses will continue to hit the world's cities. The cost of urban disasters in 2011 alone was estimated at over \$380 billion.”
 - Rockefeller Foundation, Resilient Cities
<http://100resilientcities.rockefellerfoundation.org/resilience>
 - <http://www.unwater.org/statistics/en/>



Motivate with the Energy Transportation Coupling Coupled by Oil Today





The Coupling in CE 186





The Coupling in CE 186





System Design Problem – Spring '14

$$J_{VC} = \min \sum_{k=0}^{N-1} C_k (RI_k^2 + VOC I_k)$$

Subject to :

costs → Energy demand on grid
time

Optimization

$$x_{k+1} = x_k + \frac{\Delta t}{Q_{cap}} I_k \quad \text{for } k = 0, \dots, N - 1$$

$$x_k \geq SOC_{min} \quad \text{for } k = 1, \dots, N - 1$$

$$I_k \geq 0 \quad \text{for } k = 0, \dots, N - 1$$

$$I_k \leq I_{max} \quad \text{for } k = 0, \dots, N - 1$$

$$x_0 = SOC_0$$

Mobility demand

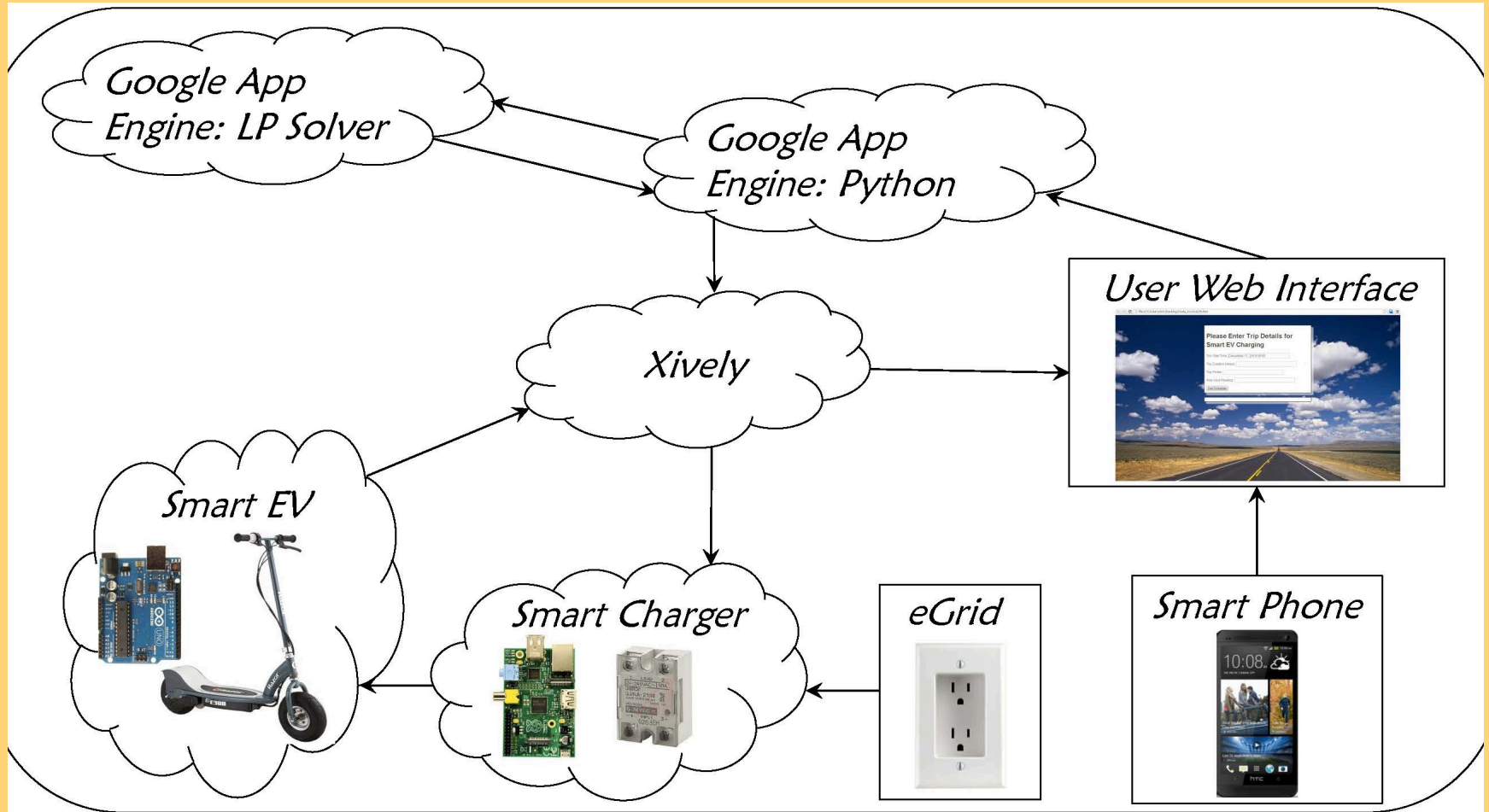
$$x_N = \frac{I_{trip} d_{trip}}{s_{trip} Q_{cap}} + SOC_{min}$$

departure time

Battery level



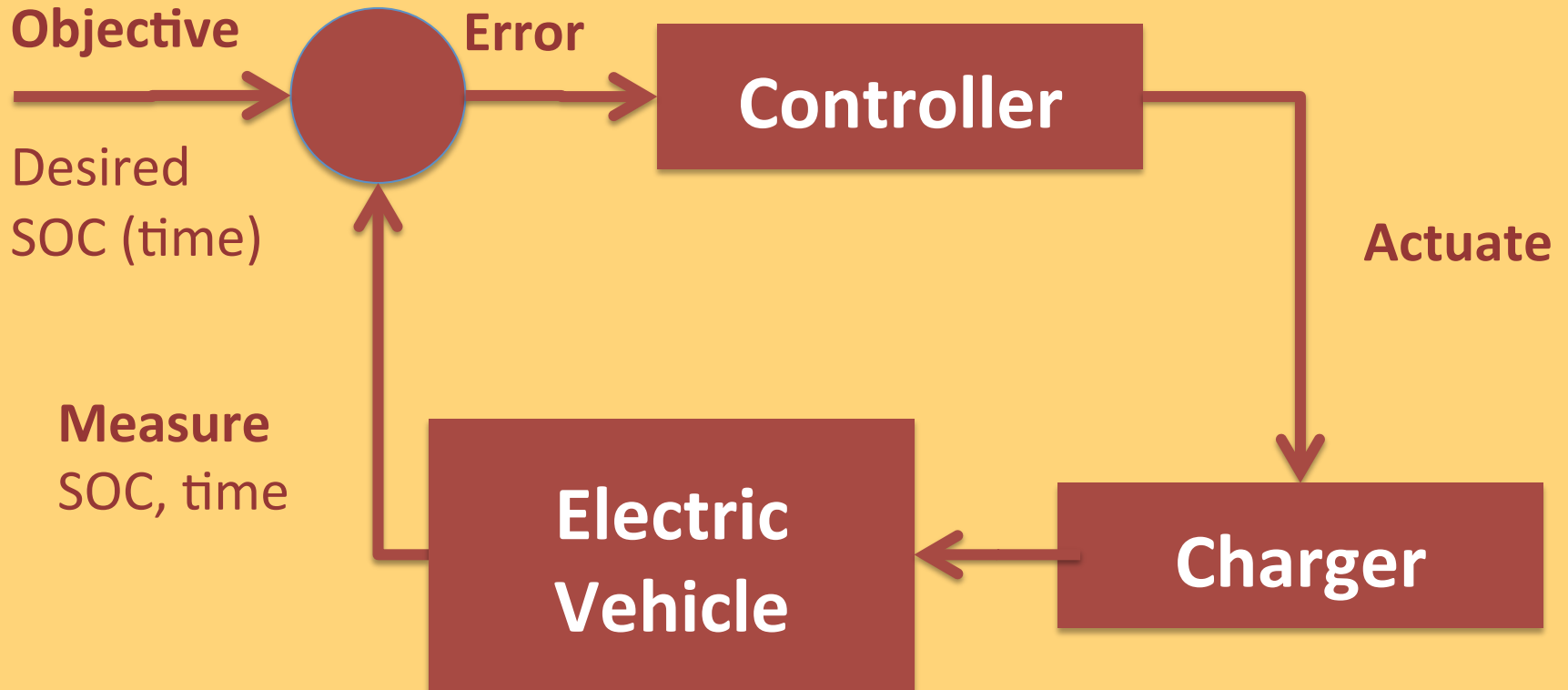
The Controller on the Global Infrastructure of Computation





Solving the optimization problem yields the controller

Close the Loop over the Cloud





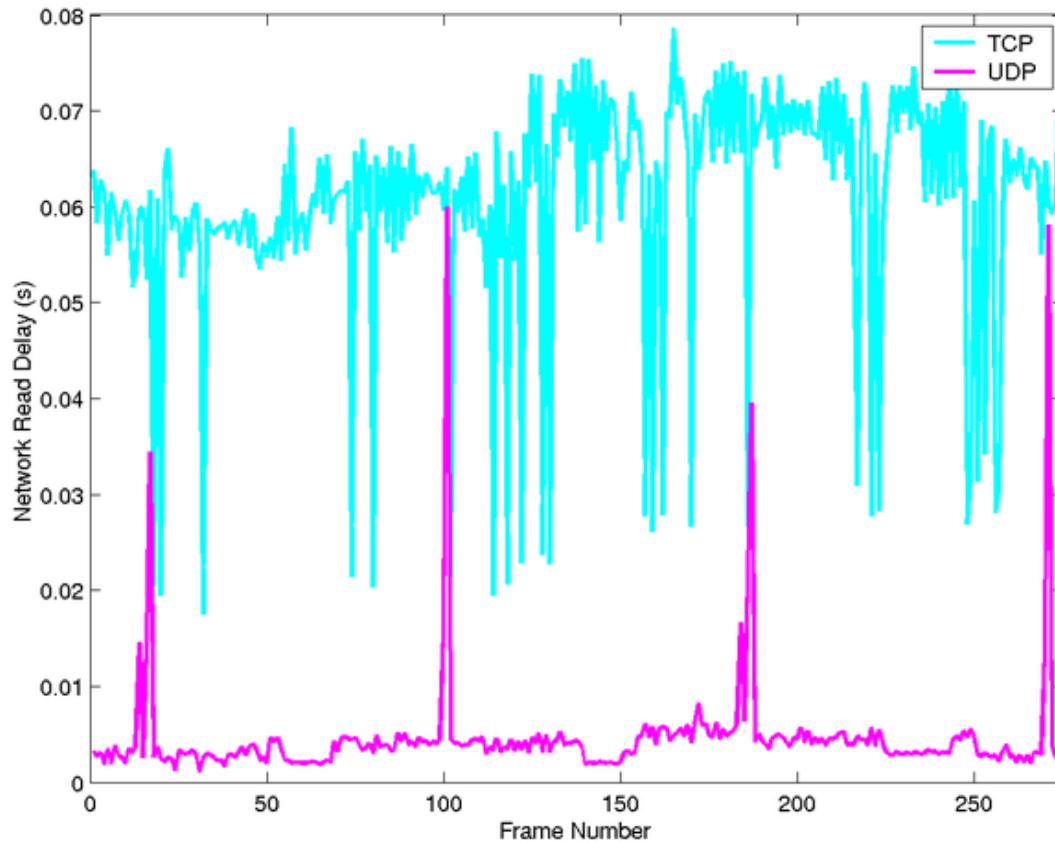
CE 186 Focus: Building the Intelligence of Infrastructure





TCP vs UDP delays

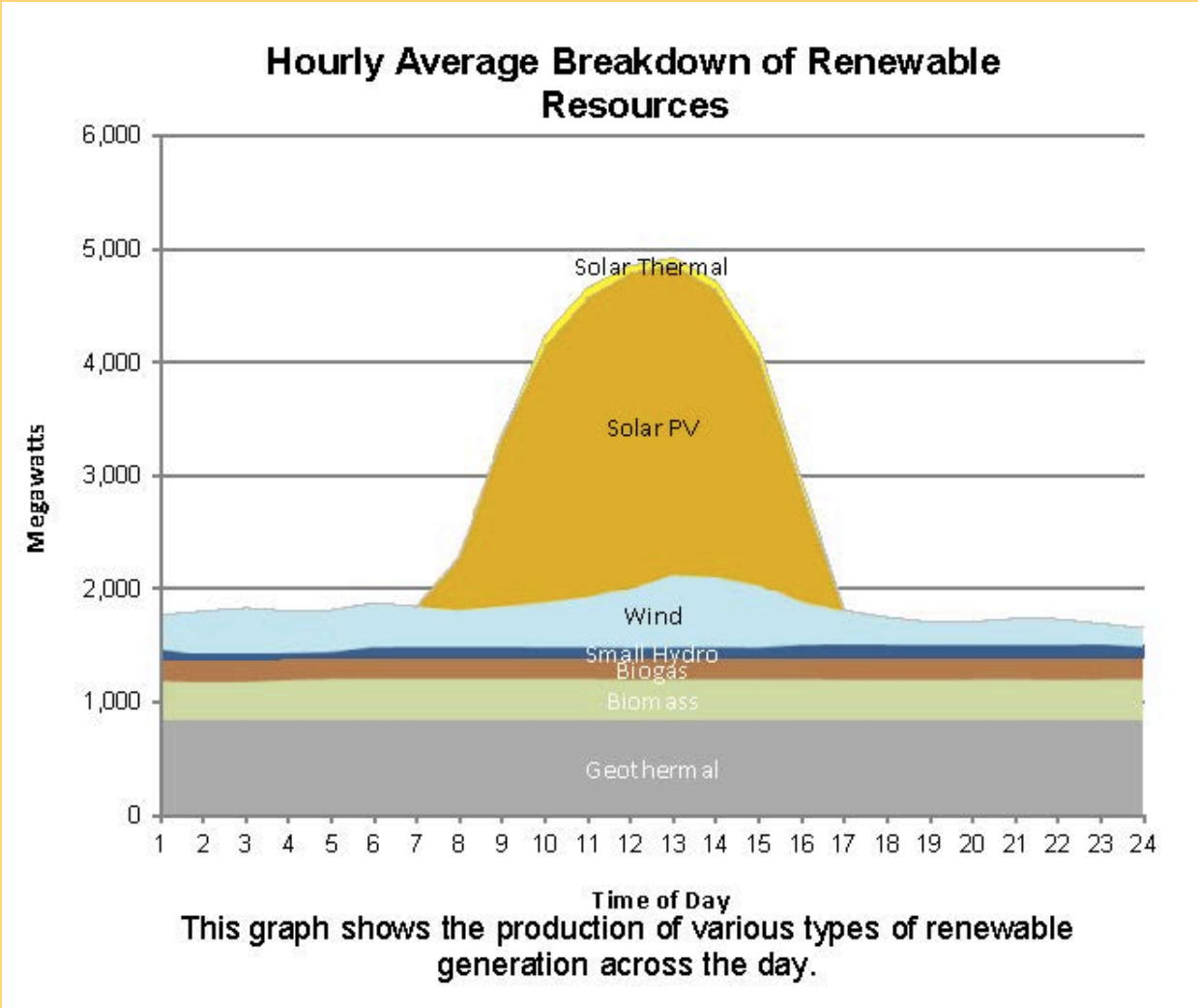
- From <http://wwwx.cs.unc.edu/~sud/courses/249/project/alf.html>



The large spikes for UDP are losses



Renewables by time of day California, Sunday Dec 15th, 2013



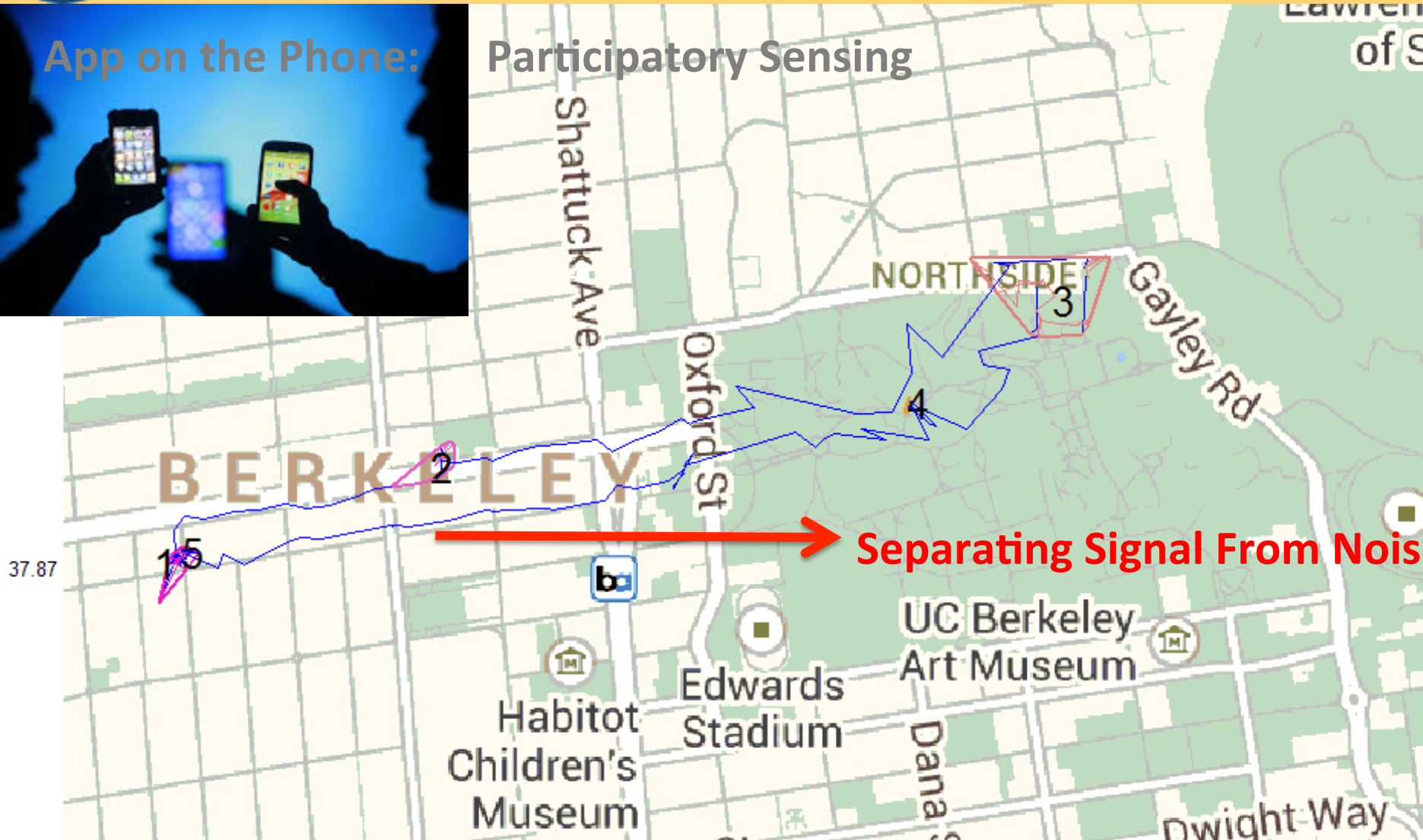


Skills : Signal Processing

App on the Phone:

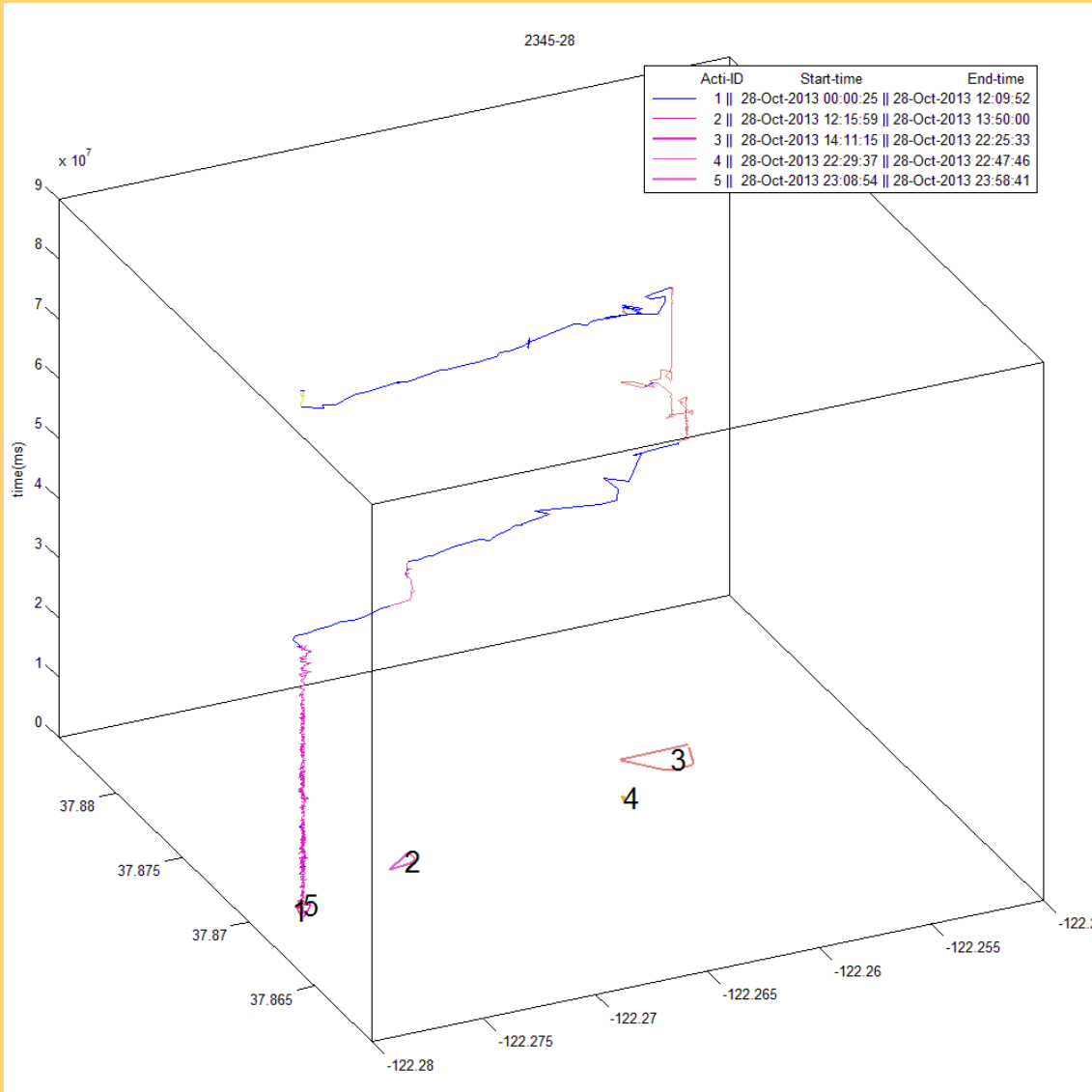


Participatory Sensing





Skills : Machine Learning



What time do I go home?

Can one learn Home and Work?

Build the Intelligence of Infrastructure Water, Energy, Transportation

on the
Global Infrastructure of Computation



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