Cyber-Physical Clouds: Risks and Opportunities

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Cyber-Physical Systems

Computation

Physical

Communication

Control

Intersection between computational and physical systems

increasing the adaptability, autonomy, efficiency, functionality, reliability, safety, and usability
Cyber-Physical Clouds

Involving large scale of analytics, storage, users...

Delay-sensitive, real-time decisions, Data fusion/aggregation/computation in small scale
Cyber-Physical Cloud

Application areas

Fundamental Research

Aerospace
Automotive
Finance
Transportation
Home
Agriculture
Medical
Building
Energy
Chemical
City
Materials
Internet of Things

“Recently, many people have asked me about the Internet of Things (IoT). I am tempted to say that, while I know a thing or two about the Internet, I don't know much about Things in general.”
– Jennifer Rexford

“Check with my under-undergraduate advisor, Dr. Seuss.”
T H E  A R P A  N É T W O R K
IoT

IoE
Fundamentally, it is about connect
WiFi-Honk!

Connected Roads

- Distracted pedestrians
  - Smartphone: music, video, game, SMS, camera, ...
  - Shut out external audio warning
- Automakers (Honda, Audi, GM, etc.) are investing big
- Our Idea: Give alerts to smartphone using WiFi!
## Vehicular Communication Protocol?

**Protocol** | **Range** | **Mobility** | **Deployment**
--- | --- | --- | ---
DSRC | < 1 Km | > 60 Mph | Expensive<br>Hard to retrofit
WiFi | < 100 m | < 5 Mph | Long association time<br>Unsuitable for Car2X communication
Cellular | < 10 Km | > 60 Mph | Long association time
WiFi is Everywhere, But...

Client → WiFi Hotspot/Direct Mode → AP

- Active/Passive Scanning
- Authentication Request
- Authentication Response
- Association Request
- Association Response

2 to 3 seconds
## WiFi Beacon Stuffing

<table>
<thead>
<tr>
<th>Beacon Interval</th>
<th>Time Stamp</th>
<th>SSID</th>
<th>Supported Rates</th>
<th>Capability Info</th>
<th>Information Element</th>
<th>BSSID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>32 Bytes</td>
<td></td>
<td></td>
<td></td>
<td>6 Bytes</td>
</tr>
</tbody>
</table>

- **Geo Position**
- **Speed**
- **Direction of Travel**
Inventory/Factory Safety
More Safety Applications
Finding People of Interest in a Crowd with Their Names
A Cyber-Physical Cloud Example

- Coke production
  - Connects the whole process of
    - Farming corns
    - Manufacturing high fructose corn syrup and coke
    - Distribution
    - Retail centers
    - Social network
    - Potential customers
Sensors in corn field monitors growing condition
Through *local computing/connectivity*, the system tells the irrigation system to water the corn.
Field can tell facility to be prepared for more load such as more workers/machinery.
Customer sentiments collected from social feed
Sample soda from that place to find out route that soda took in the supply chain.
Shows the supply chain: purchase, distribution, bottling plant, where the corn was grown,
Identify the commonality of problem:
The bottling plant
Identify the commonality of problem:
The bottling plant
Identify the problem area within the plant:
One common machine
Identify the problem source and Notify technician
Technician receives an alert for inspection
Customer at a retail store receives a data coupon
Customer can get a guide to find the product in the store
Customer can find the produce in the store
Retail store can see customers’ dwell time in the store
Risks and Challenges
Risks

- Privacy and Security
- Model vs. Reality
  - Real system, human, and adversary are NOT deterministic
  - Resiliency
- Environmental Impact - eSmog
Challenges/Opportunities

- **Battery**
  - Energy efficiency/harvesting

- **Verification of Software and Hardware**
  - Realistic models and proof of correctness

- **Failover Strategies**

- **Incentivization of Social/User Participation**
Challenges/Opportunities cont’d

- Tradeoff between Local vs. Global Architecture

- Cloud-Fog Interface

- Global configuration consistency during the interactions of local action

- Research Interactions
  - Network engineering and data science
  - Architecture and algorithms
  - HCI and user experience
  - Economics and production process
Thank You!
Credits

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Snapchat has entered into a consent decree with the FTC to address concerns over the company's privacy policy, app description, and in-app notifications after the ephemeral messaging service was at the center of a huge data breach last year, exposing 4.6 million usernames and phone numbers.

According to the FTC, the security breach was in direct contradiction to promises made by the service around security and disappearing messages.

FTC Chairwoman Edith Ramirez had this to say:

"Snapchat’s failure to secure its Find Friends feature resulted in a security breach that enabled attackers to compile a database of 4.6 million Snapchat usernames and phone numbers."