Challenges on Mobility with IoT and Big Data

• Moderator
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• Panelists
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→ Towards Energy Storage

- Need for balancing regular energy and clean energy
- Energy storage technologies
  - Picks (balancing)
  - Reliability (back-up)
  - Cost optimization and uniform consumption
- Cost for stored energy (dollar/euro/kilowatt)
- Cost
  - Regular energy + transportation
  - Stored energy + transportation
  - (Regular || Stored) energy + transportation
Energy Storage is Here

• Small scale
  Solar computers
  Wearable devices
  Solar stations

• Medium scale
  Computers
  Highway panels

• Large scale
  Hospitals
  Emergency activities
  Inter-grids for wireless base-stations wireless
  Inter-solar-power units
Energy Storage Technologies

- Solid State Batteries - a range of electrochemical storage solutions, including advanced chemistry batteries and capacitors
- Flow Batteries - batteries where the energy is stored directly in the electrolyte solution for longer cycle life, and quick response times
- Flywheels - mechanical devices that harness rotational energy to deliver instantaneous electricity
- Compressed Air Energy Storage - utilizing compressed air to create a potent energy reserve
- Thermal - capturing heat and cold to create energy on demand
- Pumped Hydro-Power - creating large-scale reservoirs of energy with water

http://energystorage.org/energy-storage/energy-storage-technologies
Energy/Power
Consumption balancing

- The user can reasonably reduce peak power demand by making use of the nighttime power supply from the grid without compromising the amenity.
- The user can also enjoy economic advantage of charging the battery using low-cost nighttime power supply and discharging during peak hours. It makes reduction level of energy purchase.

*4: The battery does not discharge any energy while selling the surplus solar energy.
Case study: Skylar

- Supply Mix (renewable energy sources, such as solar and wind)
- Renewable energy sources are intermittent (not consistently, at demand)
- Power storage (utility scale battery systems)
- Energy storage market ~ 2% in USA
- Battery costs will drop by 40% through 2020
- System 2MW → 150 MW
Example 1

http://energystorage.org/energy-storage/case-studies/aes-energy-storage-angamos-battery-energy-storage-system-bess

AES Energy Storage Angamos Battery Energy Storage System (BESS)

544MW thermal power plant in the town of Mejillones in Northern Chile
Example 2

- **Earning Revenue via Multiple Value Streams: Kaheawa Windfarm Dynamic Power Resource (DPR®) Energy Storage**

First Wind built a second phase to the Kaheawa Wind Project (KWP II) adding an incremental 21 MW of wind generation on the island of Maui on the Maui Electric Company’s 69 kV electric system.

In order to mitigate the effects of wind volatility on an island grid, Xtreme Power designed a 10 MW Dynamic Power Resource® (DPR) to integrate with the 21 MW KWP II facility operating on a 80-200 MW grid.
Example 3

- **Long-Duration Energy Storage on a Grid Scale: Highview Power Storage LAES**

- Liquid Air Energy Storage (LAES) is sometimes referred to as Cryogenic Energy Storage (CES). The word “cryogenic” refers to a gas in a liquid state at very low temperatures. The working fluid is Liquefied Air or Liquid Nitrogen (78% of air). The systems share similar performance characteristics to pumped hydro and can harness industrial low-grade waste heat/waste cold from co-located processes, converting it to power. Size range extends from around 5MW/15MWh to >50MW/250MWh and with capacity and energy being de-coupled, the systems are very well suited to long duration applications.
Statistics i

Global Installed Energy Storage Capacity by Region, World Markets: 2Q 2012

(Megawatts)

- Asia Pacific, 60,435
- Western Europe, 33,075
- North America, 38,584
- Eastern Europe, 12,943
- Latin America, 1,743
- Middle East, 1,418
- Africa, 4,482

(from Pike Research)
Total Capacity Market Share by Top 15 Technology Vendors, World Markets: 3Q 2013

(from Navigant Research)
Technologies and costs i

TECHNOLOGIES

COST FOR EVERGY STORAGE: $/KW


http://www.osti.gov/scitech/servlets/purl/453759/

Technologies and costs ii

- Long-duration storage, frequent discharge, storage: 4-8 h, 1 cycle/day x 250 days/year
  - Long-duration storage,
- Infrequent discharge, storage: 4-8 h, 20 times/year
  - Short-duration storage, frequent discharge, storage .25-1h, 4 x 15 minutes of cycling x (250 days/year = 1000 cycles/year)
  - Short-duration storage, infrequent discharge, storage .25-1h, 20 times/year

- ? ROI + 5, 10, ? Years
- Environmental impact | cost of maintenance
- Health impact | cost of health insurance

Costs of energy storage systems depend not only on the type of technology, but also on the planned operation and especially the hours of storage needed. Calculating the present worth of life-cycle costs makes it possible to compare benefit values estimated on the same basis.
Challenges

• Costs
  Technology
  Applications

• Social acceptance
  Environmental studies
  Ecology
  Health

• Governmental enforced regulations
  Green certificate
  Cost compensation
Thanks
Panel

Panel ICWMC/VEHICULAR/INTERNET

Theme: Challenges on Mobility with IoT and Big Data

Panelist:

Dr. Nicola Fabiano, Studio Legale Fabiano, Rome, Italy nicola@fabiano.law
Why IoT and Blockchain?
Blockchain

• The Regulations
• The blockchain applications
Digital Single Market

HOW CAN EUROPE BENEFIT FROM BLOCKCHAIN TECHNOLOGIES?

WHAT IS BLOCKCHAIN?

Blockchain is the best known distributed ledger technology. A ledger is a database which keeps a final and definitive record of transactions. Records, once stored, cannot be tampered without leaving behind a clear track. Blockchain enables a ledger to be held in a network across a series of nodes, which avoids one centralised location and the need for intermediaries’ services. This is particularly helpful for providing trust, traceability and security in systems that exchange data or assets. There is a lot of potential for blockchain to be used in many different areas such as financial services, supply chains or healthcare.

Until today, the venture capital industry has invested around €1.2 billion in more than 1,100 startups; 300 of them are European.

Initial Coin Offerings (ICO) which represent new ways for financing blockchain ventures are booming (moving from €250 million in 2016 to around €3 billion in 2017).

10% of global GDP could be stored, via digital assets, through blockchain technology in less than 10 years.

POTENTIAL SECTORS (BEYOND VIRTUAL CURRENCIES)

- **By governments** for citizens’ ID management, taxation reporting, development aid management, voting and regulatory compliance (RegTech).
- **By insurances** for automatic execution of contracts.
- **In finance** for money transfer, peer-to-peer lending and transfer of securities.
- **For media and intellectual property** to directly distribute music, videos and other content.
- **In healthcare** to track transactions.

Sectors currently using blockchain:

- Banking & Finance: 30%
- Professional Services: 4%
- Technology Services: 6%
- Health Care: 8%
- Media, Entertainment & Gaming: 12%
- Energy & Utilities: 3%
- Manufacturing: 3%
- Others: 7%
- Retail: 9%
- Food & Agriculture: 8%
- Energy: 4%
- Real Estate: 6%
- Education: 9%
- Automotive: 9%
- Sports: 8%
- Transportation: 7%
- Music: 9%
- Internet: 9%
- Creative: 8%
- 3D Printing: 4%
- Insurance: 9%
- Art: 6%
- Manufacturing: 3%
- Sport: 9%
The European Commission aims to develop a common approach on Blockchain technology for the EU in the international arena.
Do you have any problem with communication/computational delays in the loops?

And if any, how do you cope with it?

Jean-Pierre Richard
Overview

- Some situations and problems (➔ me)
- Your situations, problems, way you solve them? (➔ you)
Situation 1: networked control ;)

TO BE OR NOT TO BE
THAT IS THE QUESTION: WHETHER
'TIS NOBLER IN THE MIND TO
SUFFER THE SLINGS AND ARROWS
OF OUTRAGEOUS FORTUNE. OR TO
TAKE ARMS AGAINST A SEA OF
TROUBLES, AND BY OPPOSING,
END THEM? TO DIE; TO SLEEP; NO
MORE; AND BY A SLEEP
TO SAY WE END

Natural loop of audio-phonatory control

Networked loop of audio-phonatory control
Situation 2: computation time...
Situation 3: Internet transmission delay

one week of RTT…

RTT (40km)
Mean = 82 ms
Maxi = 857 ms
Mini = 1 ms

Lille-Lens (France, 40 km) – Source: PhD WJ. Jiang 2008
Situation 3: Internet transmission delay

one week of RTT...

RTT (1640km)
Maxi = 415 ms
Mini = 70 ms

Tunis-Lille (1640 km) – Source: S. Belhaj, ENSIT 2009
Some idea about comm. delay values

<table>
<thead>
<tr>
<th>Other RTT approximated values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>unshared CAN 2m:</strong></td>
</tr>
<tr>
<td><strong>bluetooth 2m:</strong></td>
</tr>
<tr>
<td><strong>Internet:</strong></td>
</tr>
<tr>
<td><strong>orbital stations:</strong></td>
</tr>
<tr>
<td><strong>underwater 1.7km:</strong></td>
</tr>
</tbody>
</table>
Situation 4: Wireless control loops

transmission + sampling + packet loss
Situation 5: Asynchronous sampling

\[ u(t) = u_d(t_k) = g(x(t_k)), \quad t_k \neq kT \]
Situation 5: Asynchronous sampling

\[ \dot{x}(t) = Ax(t) + BKx(t_k), \quad \forall t \in [t_k, t_{k+1}), \quad \forall k \in \mathbb{N}. \]

\[
A = \begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ 0.6 \end{bmatrix}, \quad K = -\begin{bmatrix} 1 & 6 \end{bmatrix}. \quad t_{k+1} = t_k + h_k
\]

Variations of the sampling interval \( h_k \) may induce instability.

Situation 5: Asynchronous sampling

\[
\dot{x}(t) = Ax(t) + BKx(t_k), \quad \forall t \in [t_k, t_{k+1}), \quad \forall k \in \mathbb{N}.
\]

\[
A = \begin{bmatrix} 0 & 1 \\ -2 & 0.1 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \quad K = \begin{bmatrix} 1 & 0 \end{bmatrix} \quad \text{such that } t_{k+1} = t_k + h_k.
\]

Variations of the sampling interval \( h_k \) may induce instability.

[Gu, Kharitonov, Chen - Birkhauser 2003]
Situation 6: bilateral teleoperation

Internet + Hub with/without QoS
The only restriction to the development of long-distance tele-surgery has to do, still today, with its cost. For tele-surgery, you must use a transcontinental ATM line, that you have to book during 6 months, at the price of about 1 million dollars.

Prof. J. Marescaux, Le Monde, January 6, 2010
Situation 6: bilateral teleoperation

Non-dedicated networks with variable QoS (Internet)

Our solution: Time-Delay Systems + Lyapunov theory
Situation 7: vehicles

V2I vs V2V feedback communications (VANET, etc.)
Situation 7: vehicles

Platooning

Influence of Information Flow Topology on Closed-loop Stability of Vehicle Platoon with Rigid Formation*

Yang Zheng, Shengbo Eben Li, Jianqiang Wang, Le Yi Wang, Fellow, IEEE and Keqiang Li
Your situations?
Your problems?
Your solutions?
Some refs…

• A survey of recent results in Networked Control Systems
  J.P. Hespanha, P. Naghshtabrizi, Y. Xu, Proc. of the IEEE, 95 (1), 2007

• Trends in Networked Control Systems
  S. Zampieri, 17th IFAC World Congress, Seoul, 2008

• A switched system approach to exponential stabilization through com. network

• A novel control design for delayed teleoperation based on delay-scheduled LKF

• Recent developments on the stability of syst. with aperiodic sampling: an overview

+ in French…