

IS SMARTGRID INTERESTING? AN ACADEMIC PERSPECTIVE

Anna Scaglione
UC Davis

SMARTGRIDCOMM 2010

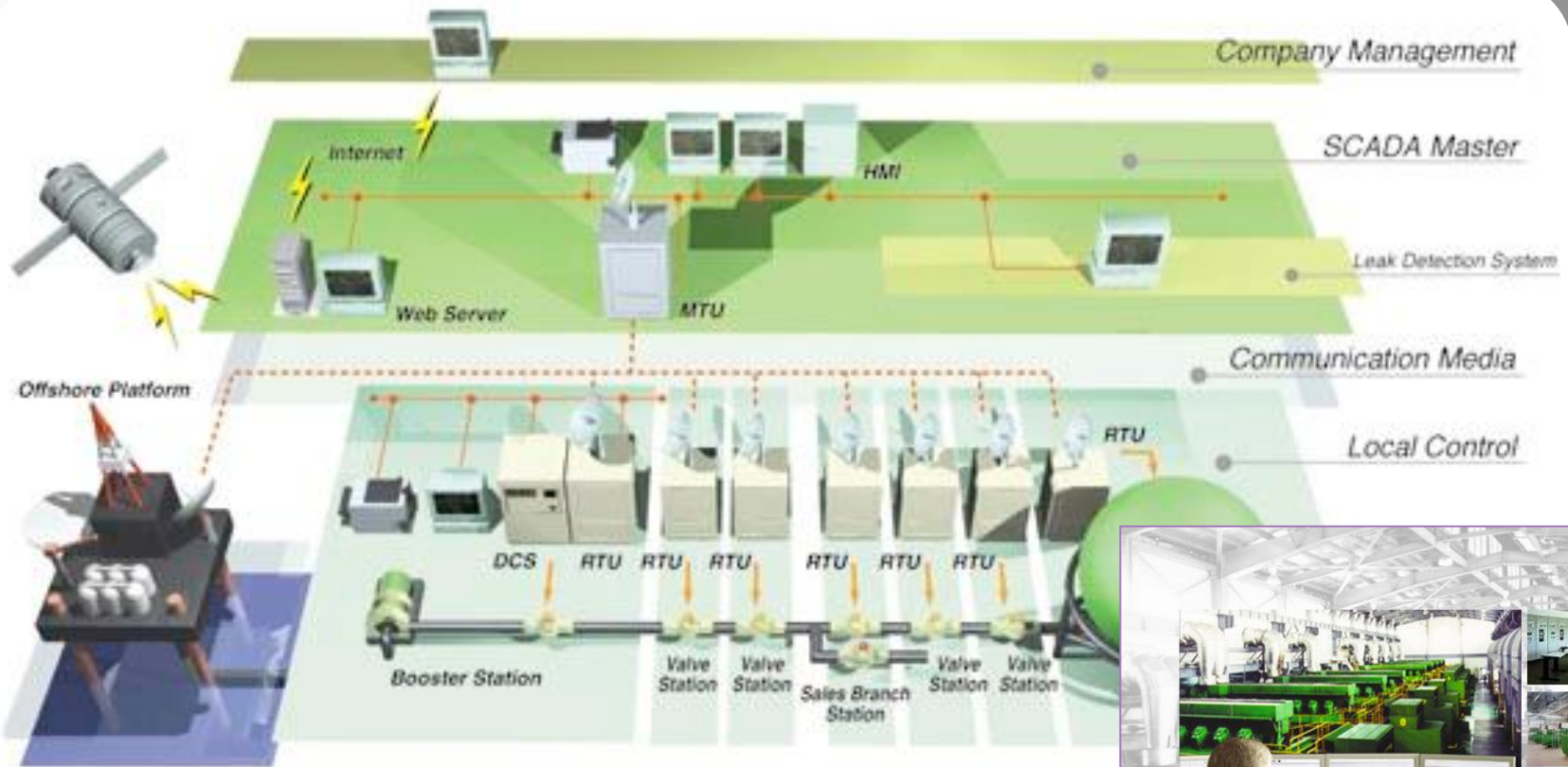
Power grids: the ultimate supply chain

- ▣ Energy moves at the speed of light
 - Just as fast as bits do...
 - Balancing demand, supply in real time

- ▣ Big challenge/ Big payoff
 - Managing volatility
 - ▣ From a large distributed supply of Renewable Energy
 - From high Wattage load (e.g. PHEV)

- ▣ Tired of our fuel addiction?
 - Today's "grid" is a complex system, with economic and information overlay networks
 - Its adaptation rate is **slow**
 - The legacy systems conforming to traditional SCADA models are inadequate

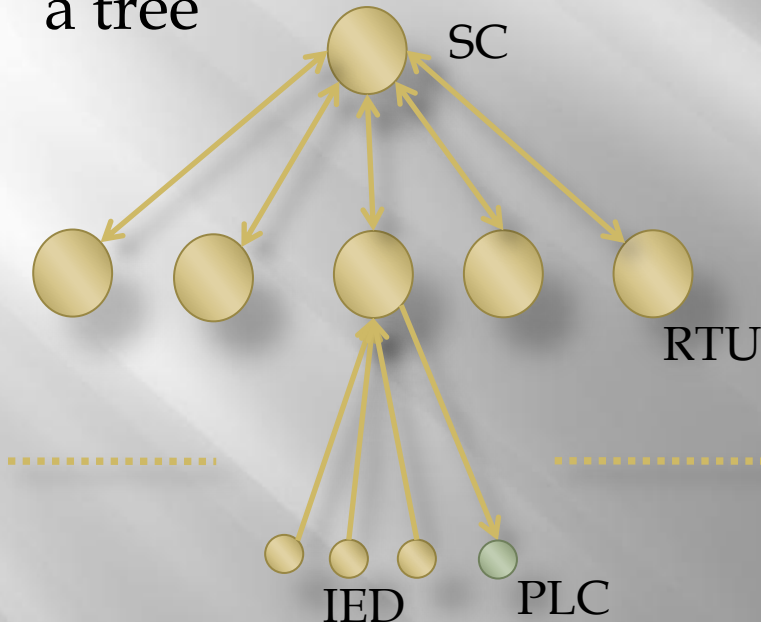
Legacy technology



Today: Cyber versus physical

CYBER INFRASTRUCTURE

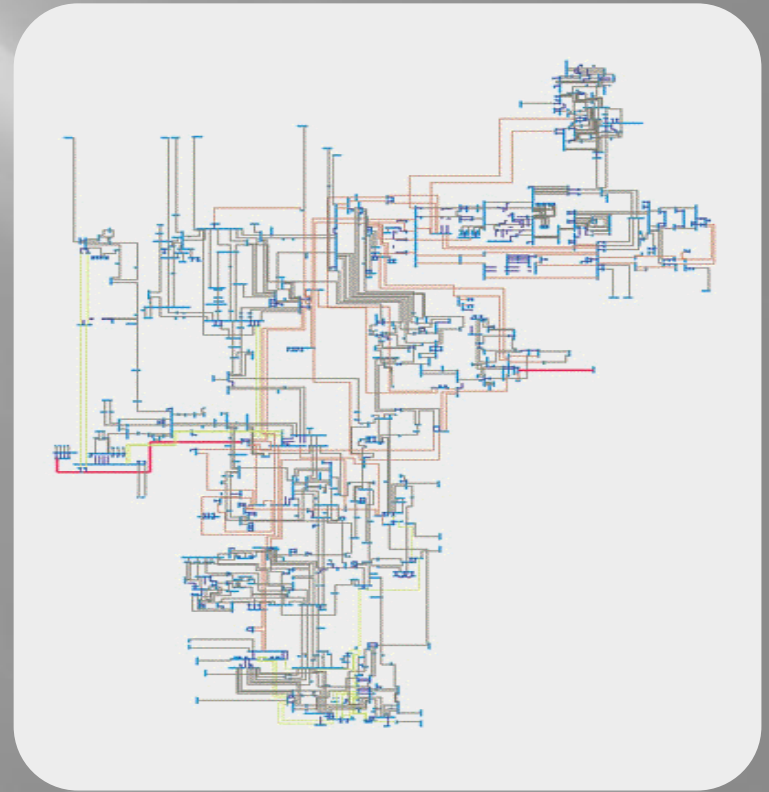
- Information flows over a tree



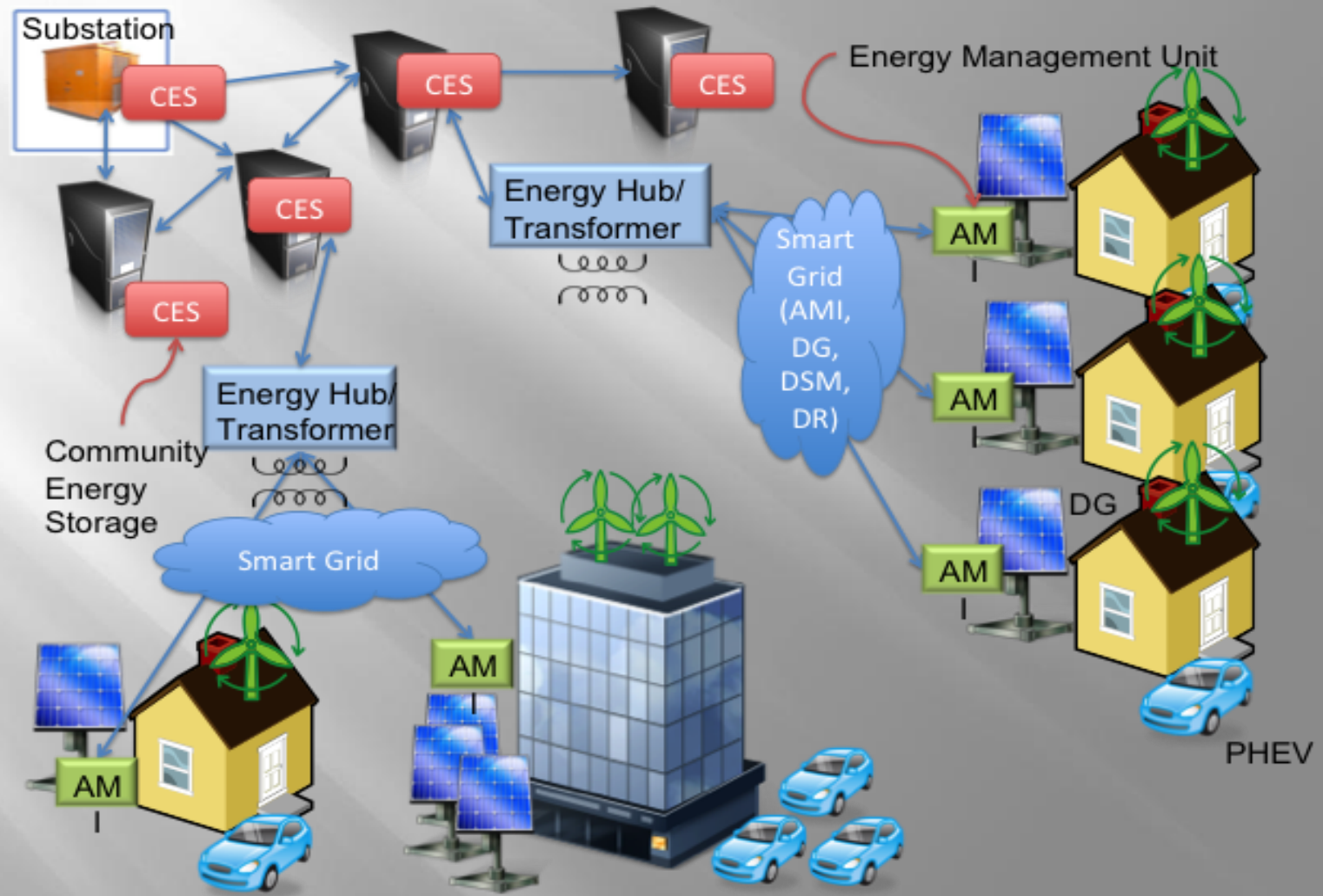
Unsophisticated, naturally presenting a bottleneck

NEW YORK STATE GRID

- Power flows over a random graph



Moving the control at the edges

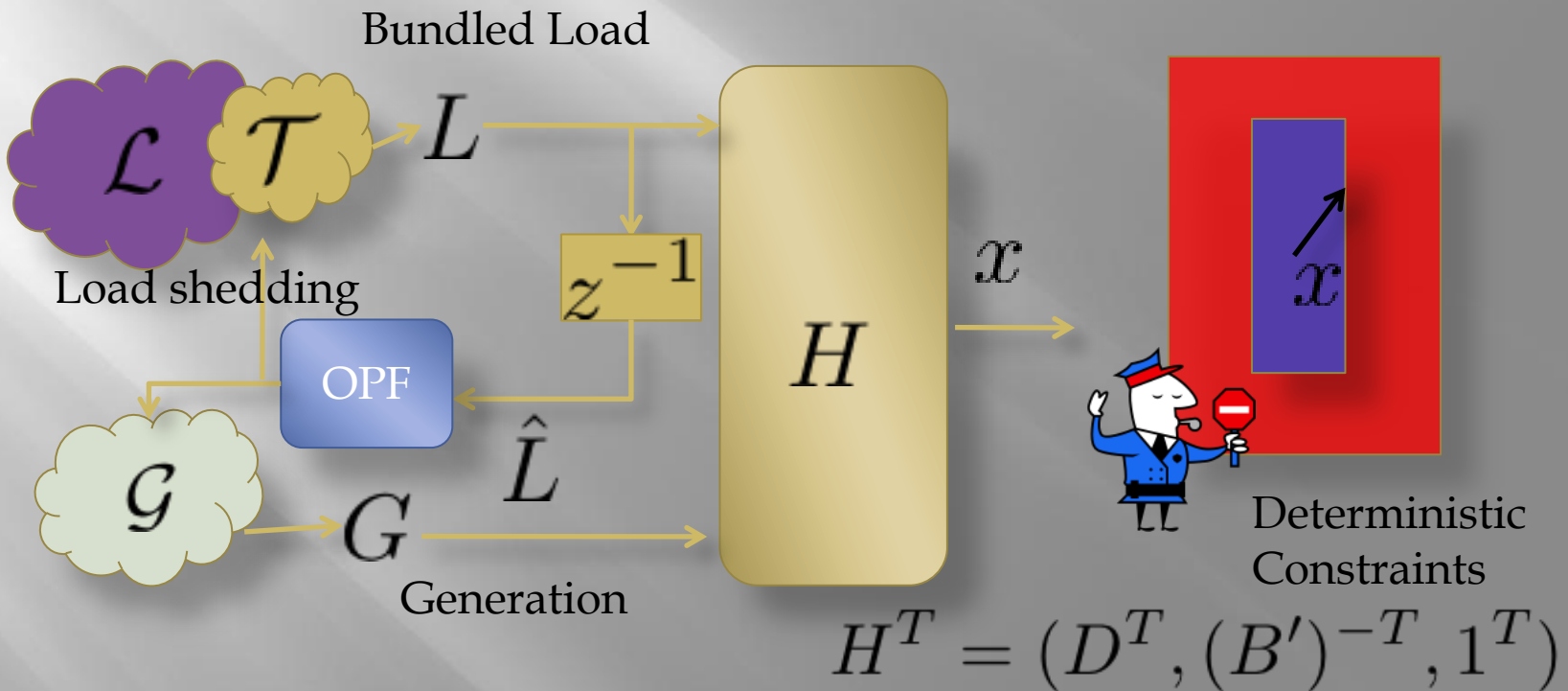


What is the role of communication science

- ▣ If we want to do speed trading with every appliance in the US we need something better than that!
- ▣ Millions of transactions per second
- ▣ Small bursts of critical data going back and forth
- ▣ Challenge? Changing the state of the physical system to serve customers, earn profits, without destabilizing it

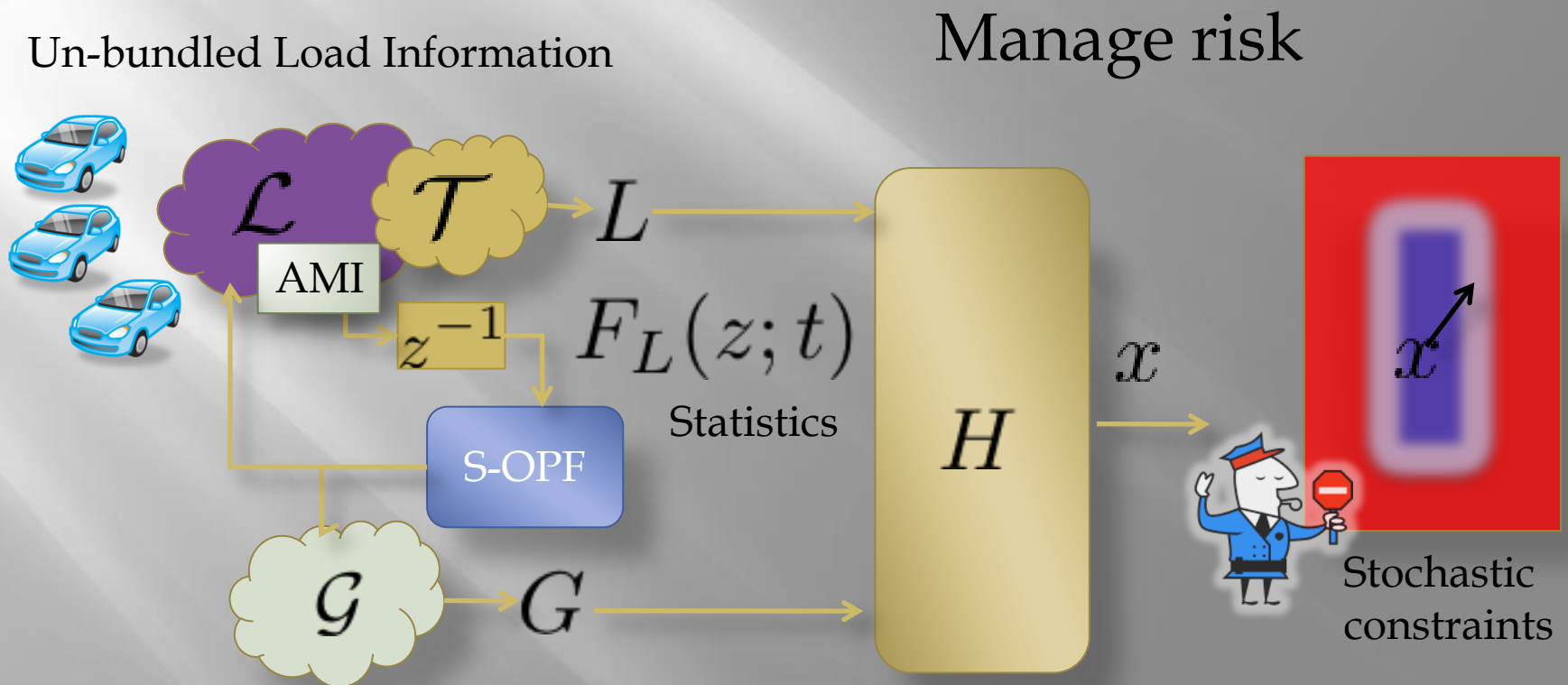
Classical Optimal Power Flow (OPF)

- Every hour: look at the bundled load try to enforce deterministic constraints



Accurate statistical modeling

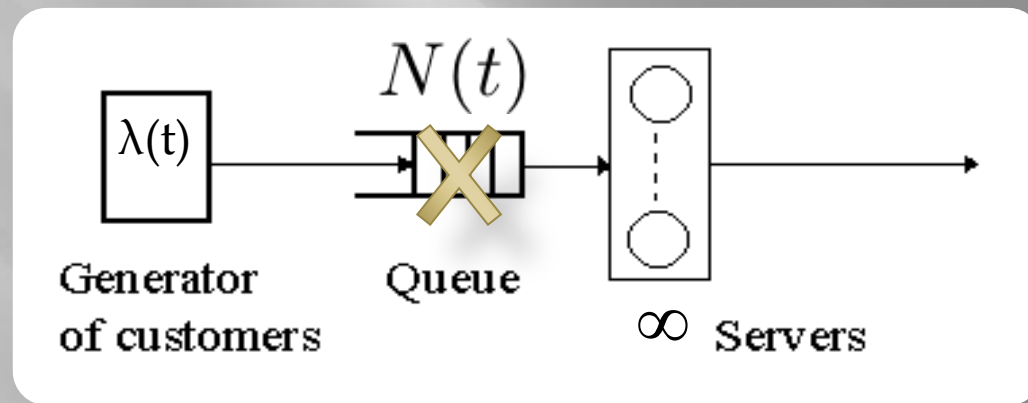
- Use AMI data and derive accurate statistics (not only predictions...) for high Wattage loads, renewable, etc.



Example: Electrical Vehicle “Traffic” Model

□ Possible model for EV

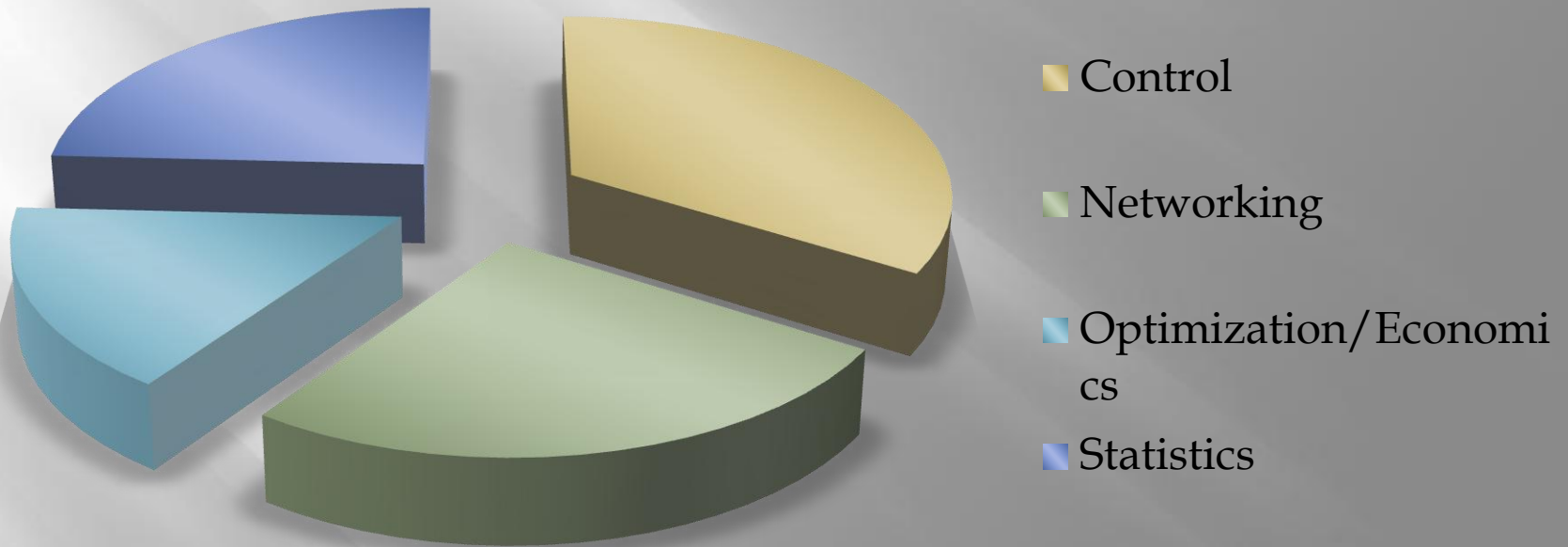
- Mt/GI/ ∞ queueing system [Eick et al. '94]
- EV arrive with a time-dependent rate $\lambda(t)$
 - semi-periodic in our case, i.e., customers arrive more frequently during the evening and early night hours on each day



- Reasonable(untested) assumption: Poisson arrival
- GI : charging time S random < 8 hours; rate approximately constant
- ∞ Servers \rightarrow once plugged the device is ON = served

The engineering tools

Ingredients for a good SmartGrid architect



Key points

- ▣ Shifting the energy management to the edge of the system, rather than centrally
 - Microgrids, Community Energy Storage
 - To be successful, new technologies should operate as an overlay system, coexisting with the power grid infrastructure
- ▣ A “risk based” (instead of “worst case”) approach:
 - Mine the data and model physical and demand volatility with full statistics
 - Use opportunistic and flexible paradigms for resource allocation
- ▣ Interesting?
 - Controlling the demand, managing traffic, prices and resources over large footprints
 - It is rocket-science! It is really interesting!