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Demand forecasting and smart devices as building blocks for smart micro grids

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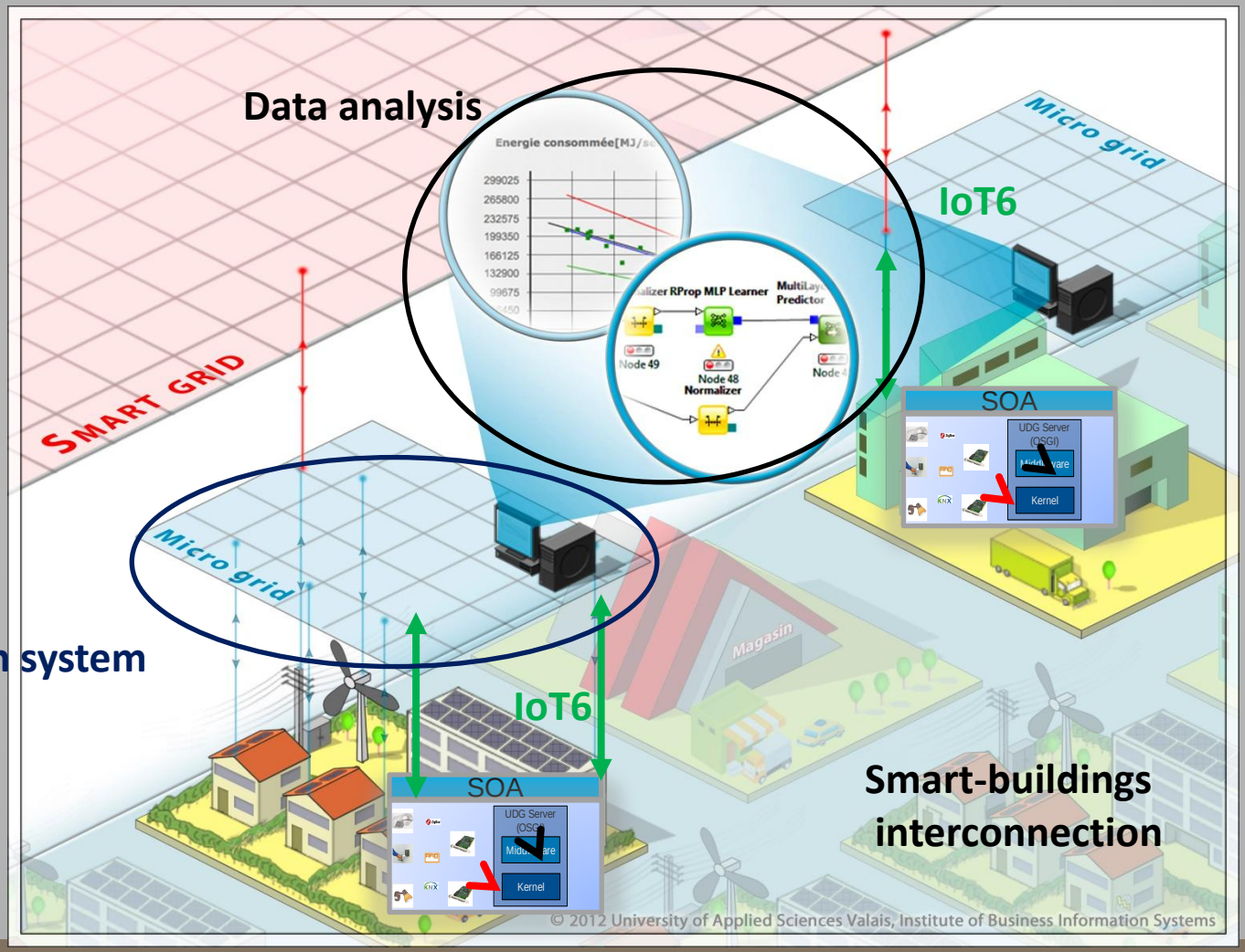
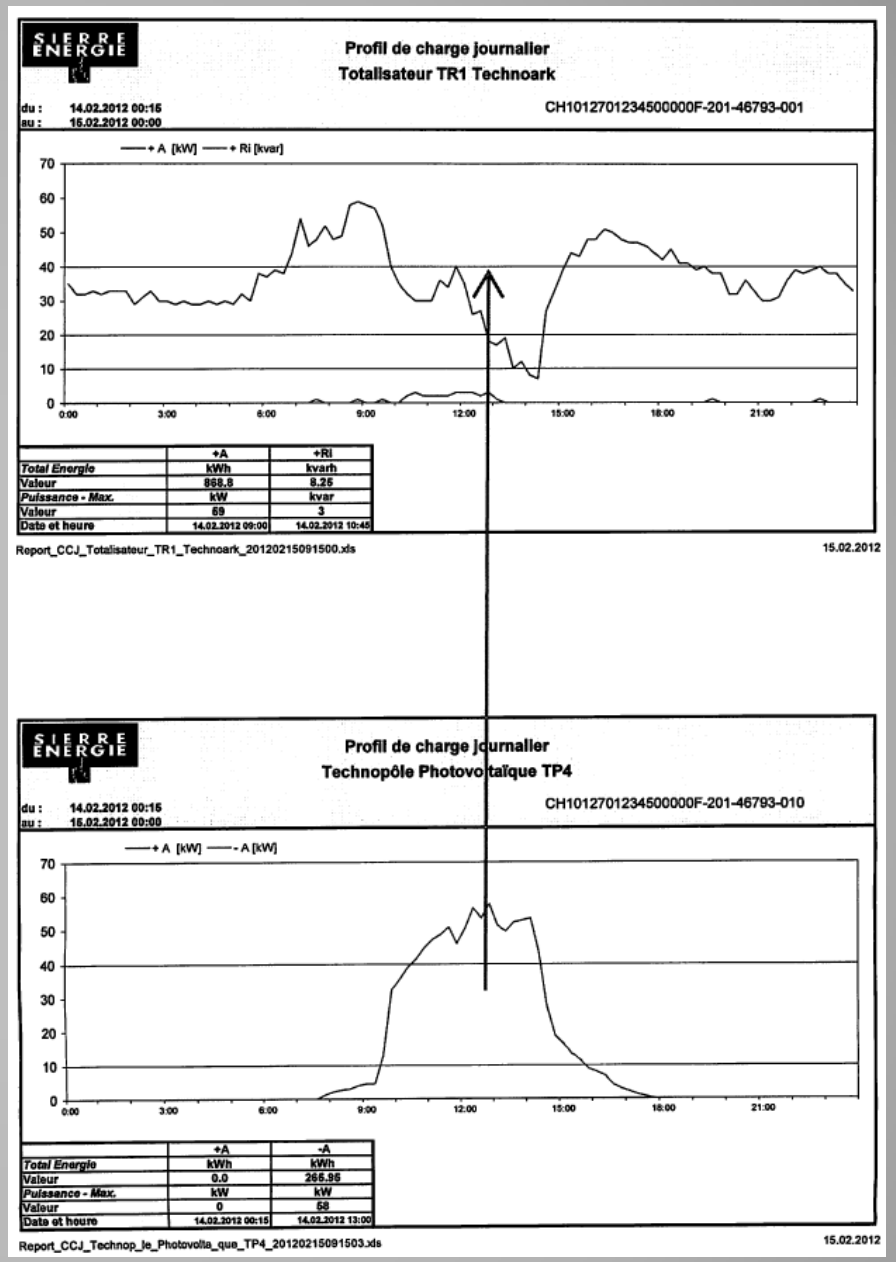
Outline

- Smart grids and the IoT
- Smart devices
- Forecasting & Coordination
- Experimentation set-up
- Evaluation
- Conclusion

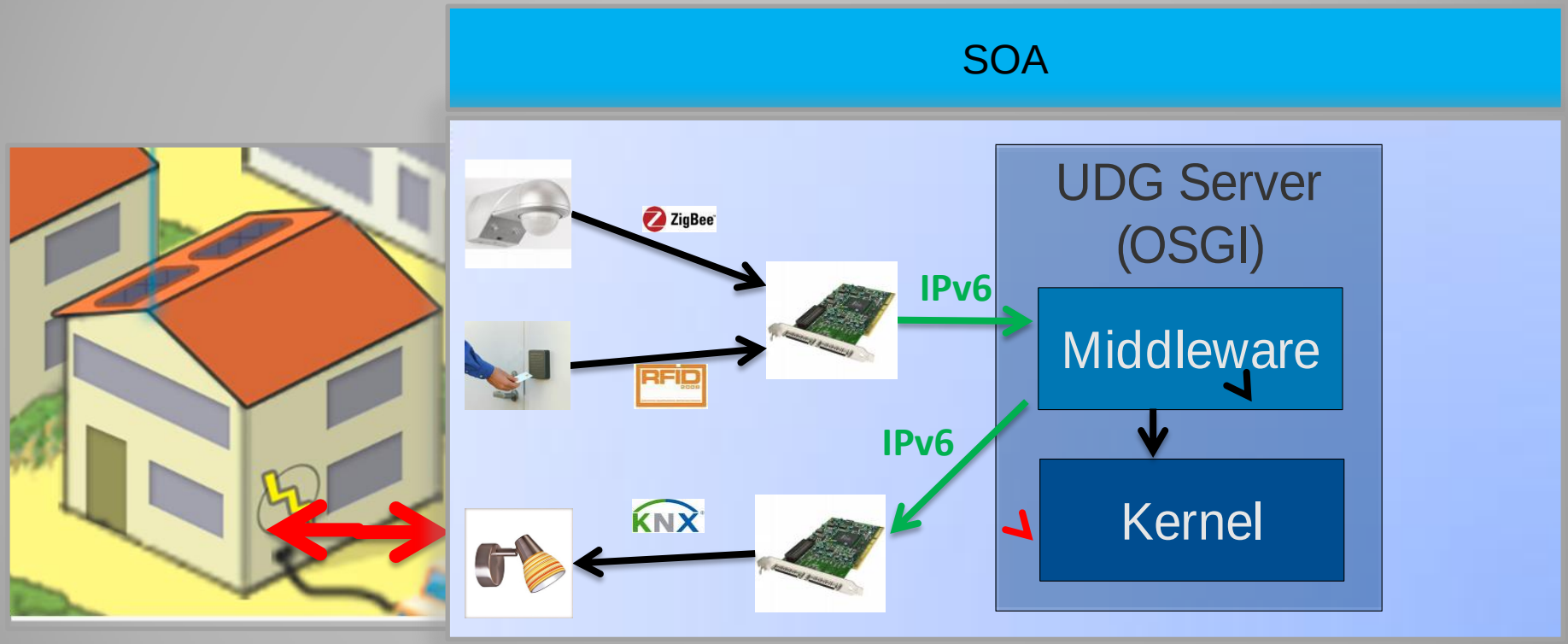
Smart grids and the IoT:
Electric Smart-grid : micro-grid approach



The necessity of Load balancing of the microgrids



Smart grids and the IoT: Legacy devices in building Automation



Inside the house
Smart devices

- What makes a device smart?
  - Can **control** its consumption
  - Can **communicate** with other devices
  - Is **collaborative** to achieve a common goal
- Smart devices build up smart grids

Context of the paper

- Use simulation and mathematical modeling to understand better the mix of smart devices in a smartgrid

- Use the simultion results as input parameters of a true microgrid to help the regulation

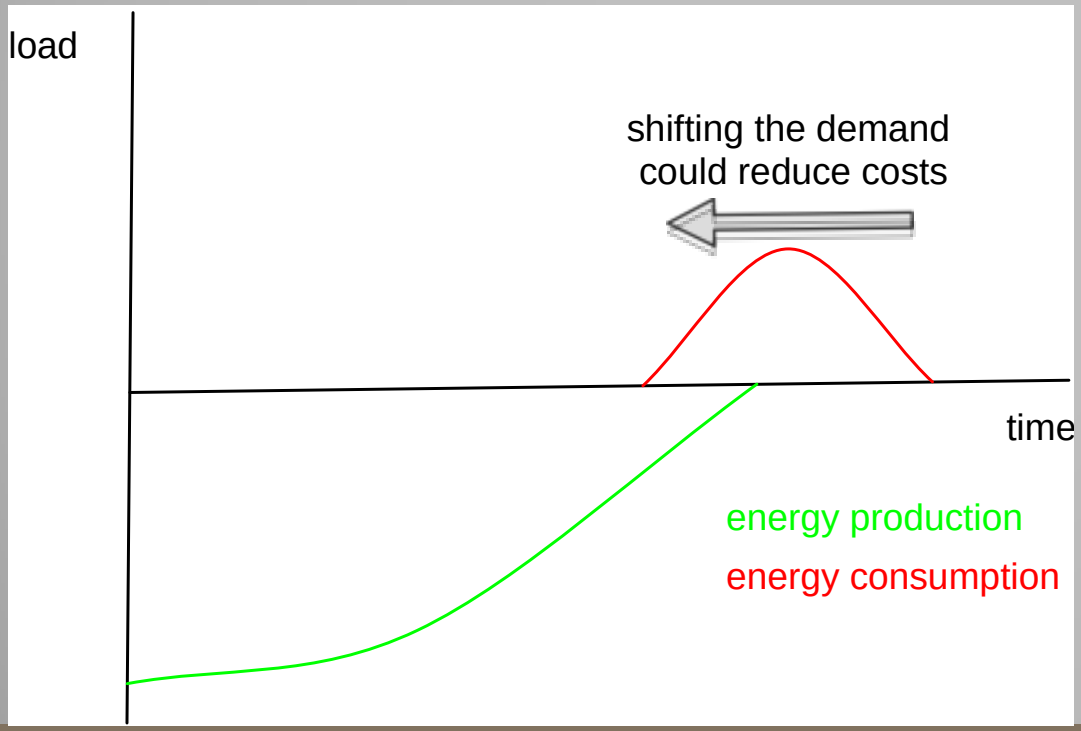
Coordination of smart devices

- Production and consumption should be locally coordinated to avoid external costs.

- Initial plan for the microgrid is generated randomly and we have:
  - Constant demanding devices
  - peak-loading device

Coordination of smart devices

- Idea: smart devices can shift their peaks to reduce costs



- Respects, e.g.
  - Number of peaks
  - Minimal distance between peaks

Experimental set-up

- Scenario: 4 peak consumers, 3 constant consumers, 1 peak producer
- Initial peak distribution is random (respecting minimal and maximal distance of peaks, and total number of peaks)
- The devices communicate with a coordinator that gives back information to the devices
- The devices collaborate to achieve a gobal goal

Experimental set-up

- Cost function for a time interval [s,e]:

Definition 1 $cost(s, e, d_0) = \sum_{t=s}^{t=e} c(l(d_0(t))$

$$c(l(d_0(t))) = \begin{cases} \text{buyprice}_t * l(d_0(t)) & l(d_0(t)) > 0 \\ \text{sellprice}_t * l(d_0(t)) & l(d_0(t)) < 0 \end{cases}$$

- Very conservative prices:
  - Buying energy from provider: 0.2/unit
  - Selling energy to provider : 0.05/unit
- Simulation on 100 units of time

Evaluation I

What are the effects of a varying number of smart devices?

	c	c+p	2 sc	4 sc	4sc+sp
Mean	1475,7	1119,5	1117,0	1114,6	1090,0
std. dev.	25,4	71,0	71,0	71,0	80,4

c: consumers, p: producer,

sc: smart consumers, sp: smart producer

→Decrease the costs when local production and smarter

→ The smart devices cannot operate fully with this setup

Adding Forecasting

- Different approaches exist:
  - Large grids: ARIMA method : linear time series, possible if a large number of consumers, remove the non linear effect of each device
  - Micro grids : actually based on neural nets or hybrid methods
- Our approach :
  - We extract usage patterns for electricity out of load curves by using classifiers that extract the load curve of one device using single signature and the global signature.
  - We also collect usage information of smart devices

Evaluation II

- Results not differ from first set because:
  - Assuming random peaks for devices is not realistic
  - Assuming only short term adaptation of the consumption and the production is very constraining for the forecasting
- However the simulation system is now ready and we should have better results with a more realistic setup (extracted from real data)

Conclusion

- Introducing smart devices into existing grids have a positive impact to reduce costs
- Introducing smart producer helps to reduce costs but make it more sensitive to the diverse consumers and to the load plan (increase of the StdDev)

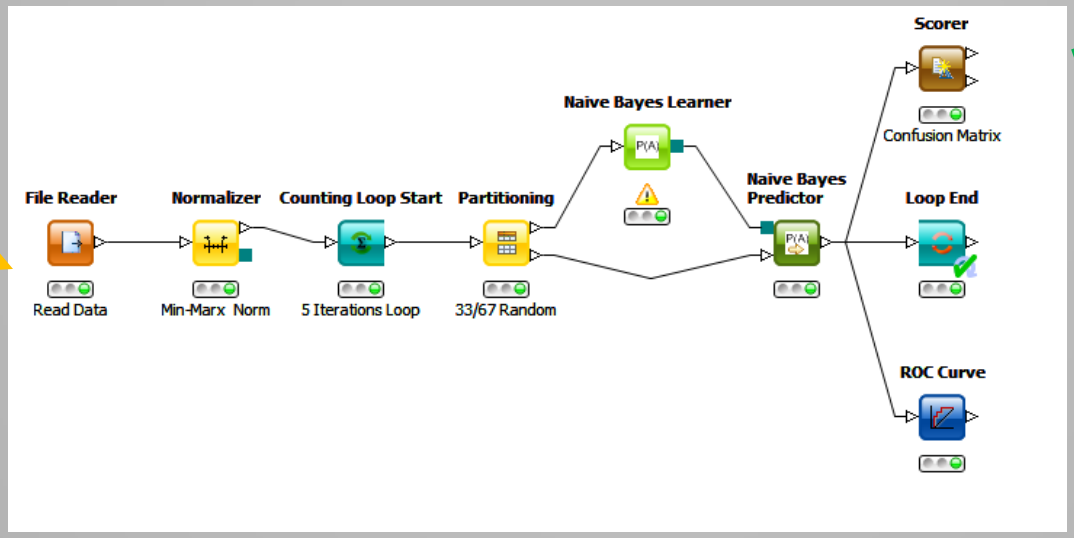
- More work needs to be done, e.g.
  - Bigger scenarios
  - Better coordination schemes
  - Long term forecasting

Conclusion 2:
part of a bigger picture using data to predict consumption

Low frequency parameters (load curves)

High frequency parameters(device mesures)

Energy predictions (meteo, long term climate stats



Load curves

Next ¼ hour instructions

Next ¼ rate

Conclusion 3:
taking advantage of IPv6

- One unified framework where all non ip devices can discuss inside an holisitic IPv6 network.
- Service oriented information system
- Legacy Device as a Service → LDaaS
- Thanks all the partners IoT6

Questions?

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