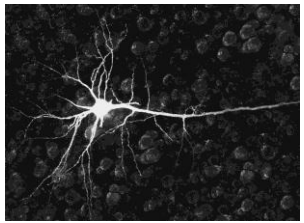
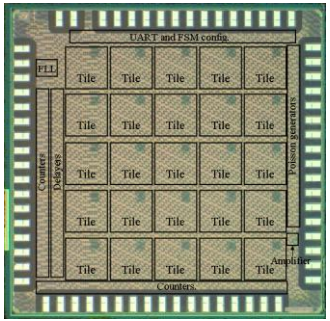
Vos neurones ont de l’énergie !

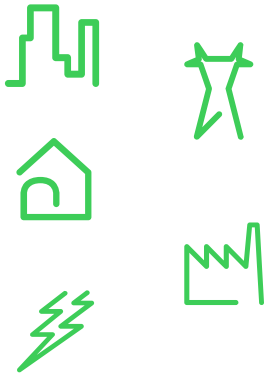
Ou bien l’inverse ?

Presented by: Rodolphe Héliot
Technology Strategy / Analytics for Solutions

Timeline…







2005 2008 2009 2013

Life Is On Schneider Electric

The Schneider Electric you may know…

The Schneider Electric you might not know…

The global specialist in energy management and automation

Connected Offers

Software

Energy Efficiency

Speed drive

Controller

Life Is On Schneider Electric

Trends and rationale

« Large end-to-end systems that will bring control systems online, connecting them with people, and fully integrating them with enterprise systems, business processes and analytics solutions»

source: Industrial Internet Consortium (IIC)

X 2
Increase of the volume of data every two years

1 Billion
Collective volume of data points being generated by Smart meters in the US every day

Beyond basic KPIs
Opportunity to extract value out of collected data

Cloud
Big data storage and analysis across various information inputs

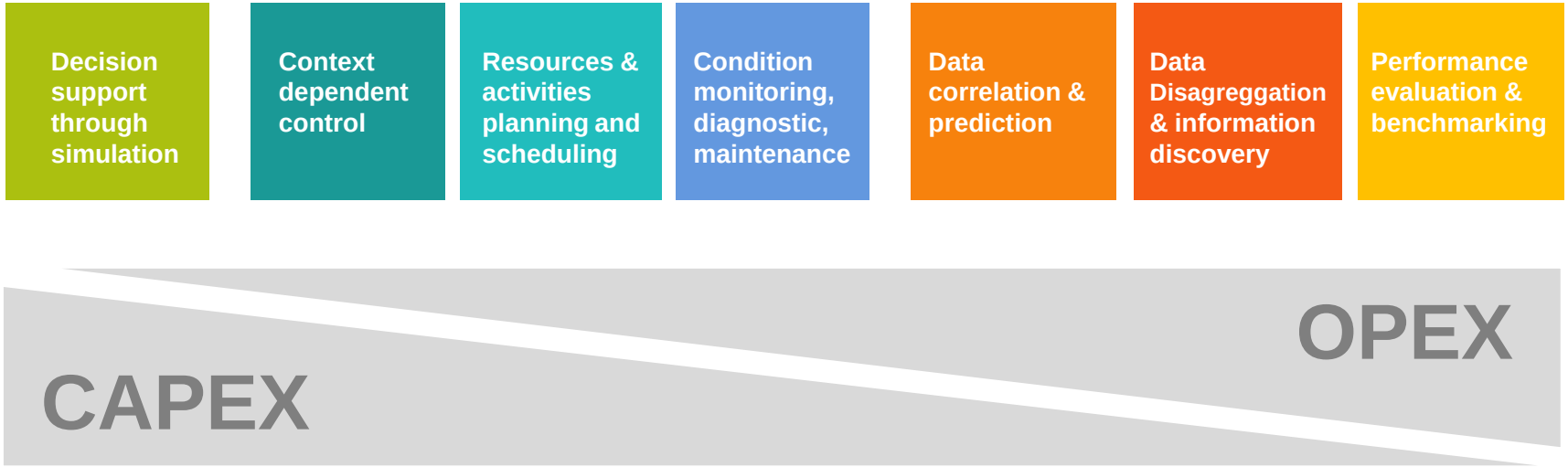
Analytics 3.0

In the new era, big data will power consumer products and services.

by Thomas H. Davenport

Our customer would be excited to …

7 Analytic features to address applicative needs



Most relevant algorithms classes

Decision support through simulation	→	Simulation, Optimization, Rules, Visual Analytics
Resources and activities planning and scheduling	→	Optimization, Dynamic Systems Modeling, Simulation
Context-dependent control	→	Dynamic Systems Modeling and Control, Rules, Optimization, Simulation (to test control plans or strategies)
Condition monitoring, diagnostic, maintenance	→	Rules, Dynamic Systems Modeling, Pattern Learning, Pattern Classification, Simulation
Data disaggregation and information discovery	→	Pattern Discovery, Pattern Learning, Optimization, Rules, Visual Analytics
Data correlation and prediction	→	Pattern Learning, Pattern Discovery Dynamic Systems Modeling, Simulation, Visual Analytics
Performance evaluation and benchmarking	→	Pattern Discovery, Pattern Learning, Rules, Dynamic Systems Modeling, Simulation, Visual Analytics

Focus #1: Learning metrics for time series

Learning metrics for time series

Data correlation and prediction

Cao-Tri Do

Rationale and applications

- Time series are fundamental data in industrial applications targeted by Schneider Electric
  - e.g. energy measurements, operational data (temperature, humidity, process setpoints), etc.
- Clustering, classification, regression and forecasting are essential functions for our business:
  - To evaluate and benchmark performance
  - To forecast evolutions or estimate values that can't be measured easily
  - To detect and diagnose, and to predict, abnormal evolution
- State of the art Machine Learning tackles these issues with handcrafted features or metrics
  - In the case of time series: extract values, dynamics, trends, cycles, variance, fourier, wavelets, kernels, etc.

- Issue: finding the good feature/metric for a given application is tedious, and sometimes does not even provide good enough performances
- Our proposal >> automate the learning of features/metrics: "multi-modal, multi-scale metric learning"
  - Find the best combination of basic metrics (modes) and observation scales to get the best performances
  - The resulting comparison criterion must remain easy to interpret, i.e., must be "explainable" to a human expert

- Pilot application: humidity virtual sensors, contactor wear diagnostics…

Cao-Tri Do: Learning metrics for time series

Data correlation and prediction

Technical content and results

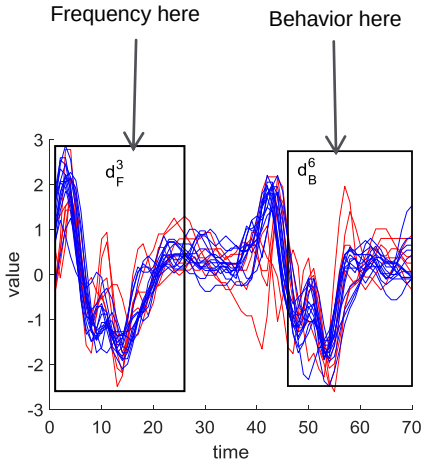
- PhD student (2013-2016)
  - With background in Signal and Image Processing, Control Theory
  - Coached in Schneider Electric by Sylvain Marié (Machine Learning expert)
  - In collaboration with 2 laboratories: GIPSA-lab and LIG (AMA)

- Design and development of a method to learn a combination of multiple metrics (amplitude, behavior, frequency…) at multiple scales

- The method was tested on 30 reference datasets from the scientific literature
  - Results have shown that combining metrics enables us to outperform basic metrics especially on challenging datasets (those requiring combinations and multi-scale)

- Implementation will enable to improve existing and future analytic bricks
  - Time series profiling, Time series classification, Virtual sensor, Forecasting, Advanced Fault detection.

Example result of metric learning:
to classify red from blue curves with best performances, we should combine



Life Is On Schneider Electric

Focus #2: Machine learning techniques for structured/unstructured data fusion

Machine learning techniques for structured/unstructured data fusion

Data correlation and prediction

Condition monitoring, diagnostic, maintenance

Thibaud Rahier

Rationale and applications

- In addition to structured data (like time series), machine learning techniques will in the future take advantage of semi-/un-structured (meta)data from both Schneider systems and outside world
- This will improve the quality of insights that can be produced today and even provide new insights
  - For example, improve asset inspection and fault detection by not only looking at asset sensor data but combining various structured and unstructured information sources: geographical area type, occupation schedule, occupant profile, etc.
  - Similarly, other applications such as forecasting or profiling can be improved by adding contextual information to the time series used
- Challenges remain:
  - … mixing highly heterogeneous structured and unstructured data
  - … dealing with frequent missing values
  - … exhibiting complex dependence structures
  - … incorporating expert knowledge in learning algorithms
- Pilot applications: correlation analysis in Schneider system databases, fault detection and predictive maintenance in electrical networks, UPSs in data centers…

Machine learning techniques for structured/unstructured data fusion

Data correlation and prediction

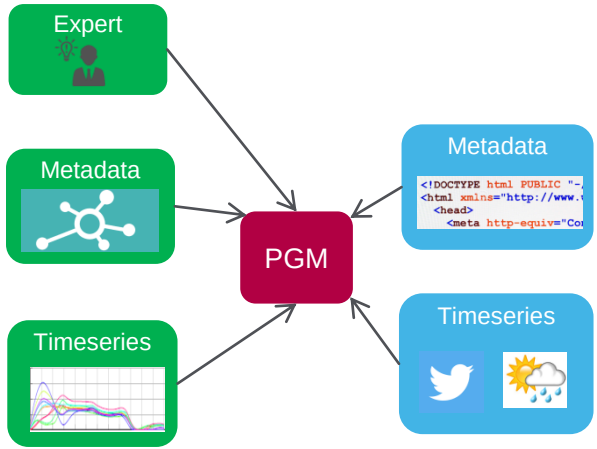
Condition monitoring, diagnostic, maintenance

Technical contents and results

- PhD student (2015-2018)
  - With background in Statistical Prediction and Machine Learning (master thesis at UC Berkeley on the implementation of a robust Classification and Regression Trees algorithm)
  - Coached in Schneider Electric by Sylvain Marié
  - In collaboration with INRIA (F. Forbes)

- Working on an intermediate technical objective: Using cutting-edge Probabilistic Graphical Models methods to aggregate time-series and contextual (meta)data in a unique model

- Working on the "HOMES" building systems metadata set as a starting point



Life Is On Schneider Electric

Focus#3: Distributed management of power flows in electrical networks

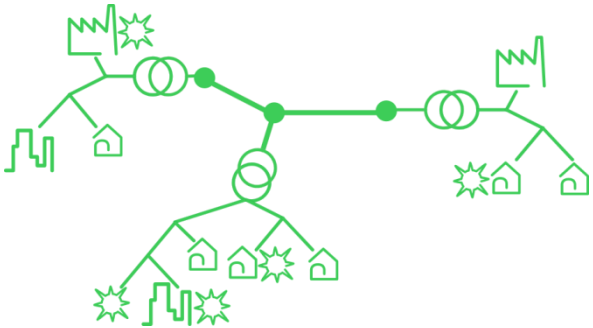
Distributed management of power flows in electrical distribution networks

Context dependent control

Benoit Vinot

Rationale and applications

- Allocating producible or consumable power to each “prosumer” of a given set (sharing a network) while guaranteeing physical feasibility and maximizing economic efficiency is a real challenge:
  - As we do not really know the feasible margins
  - As only some points of the network are equipped with smart meters
  - As voltage and current constraints force the network manager to make compromises between global efficiency and relative “fairness” between prosumers



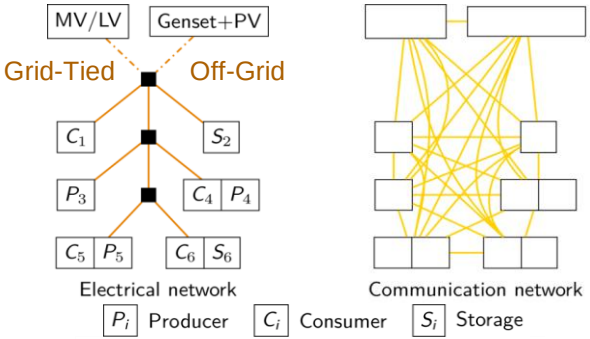
- Pilot applications:
  - Help the grid manager to assign production limits to a set of producers in a fair manner while avoiding overvoltage and excessive current
  - Help the grid manager to assign consumption limits to a set of consumers in a fair manner while avoiding under-voltage

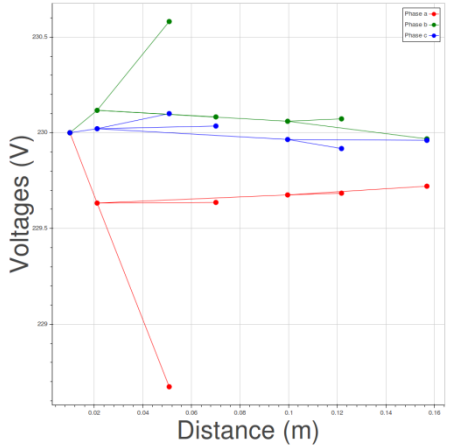
Distributed management of power flows in electrical distribution networks

Context dependent control

Technical contents and results

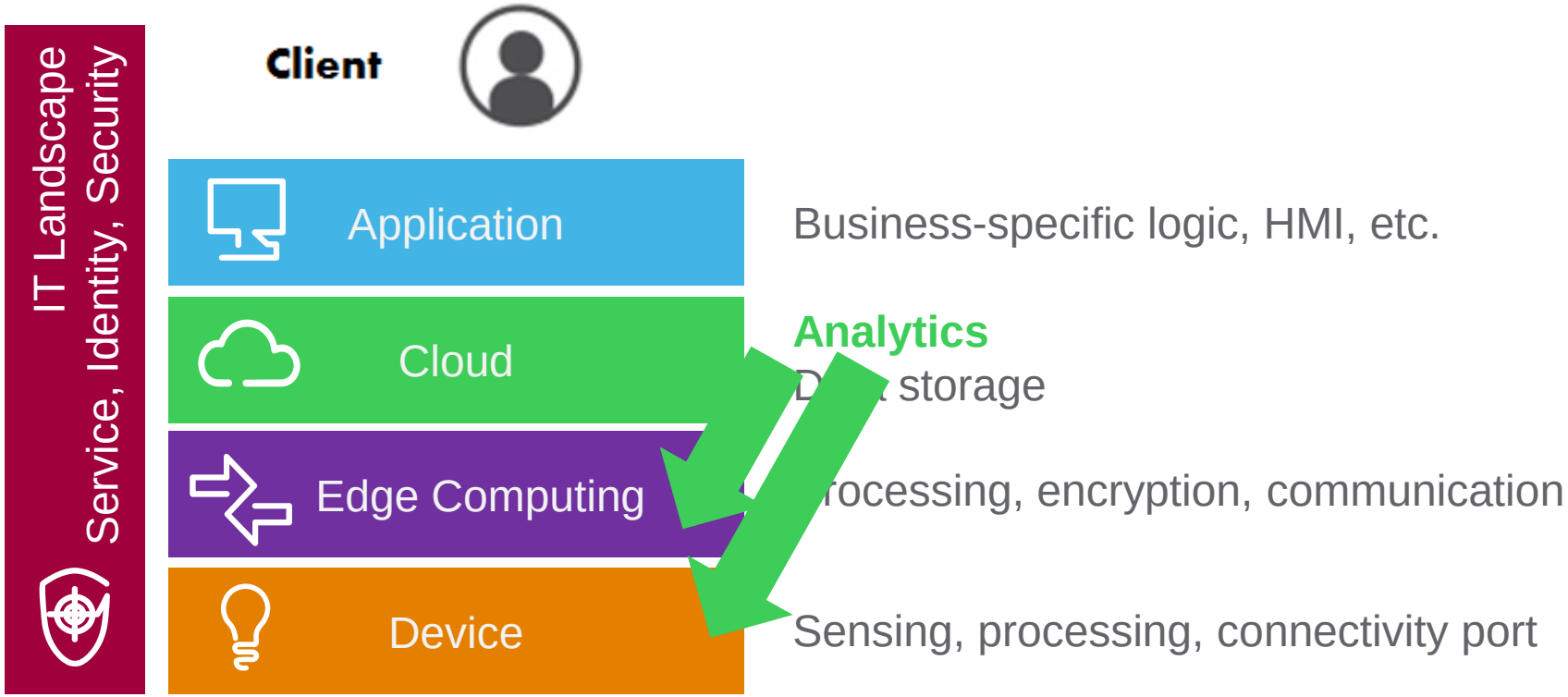
- PhD student (2015-2018)
  - Background in Mathematical Modeling and Simulation (MSc)
  - In collaboration with 2 laboratories: G2E-lab and INRIA
- Development of a power flow simulation tool
  - Will allow taking into account network physical constraint
- Development of a machine learning based model of the network
  - Will allow estimating physical parameters where no meters are available
  - At this stage, using data from the ADRES European project
- Development of a power allocation service
  - Will allow robust control of grid physics+economics





Looking forward

A connected offer - technology stack




Thank you!
Life Is On
Schneider Electric

Questions?

Contact: rodolphe.heliot@schneider-electric.com

References

"How Smart, Connected Products Are Transforming Competition" by Michael E. Porter and James E. Heppelmann, *Harvard Business Review*, Nov. 2014

http://www.industrialinternetconsortium.org/

"Analytics 3.0 In the new era, big data will power consumer products and services" by Thomas H. Davenport, *Harvard Business Review*, Dec. 2013

"Powering a new era of operational intelligence with the Internet of Things" Keynote by P. Banerjee, *IoT world forum 2015*, http://www.iotwf.com/iotwf2015/keynotes

http://www.schneider-electric.com/b2b/en/campaign/internet-of-things/overview.jsp

"The Industrial Internet of Things: An Evolution to a Smart Manufacturing Enterprise" by John Conway, *Schneider Electric Whitepaper*, 2015