How new technology will revolutionize emerging local electricity markets

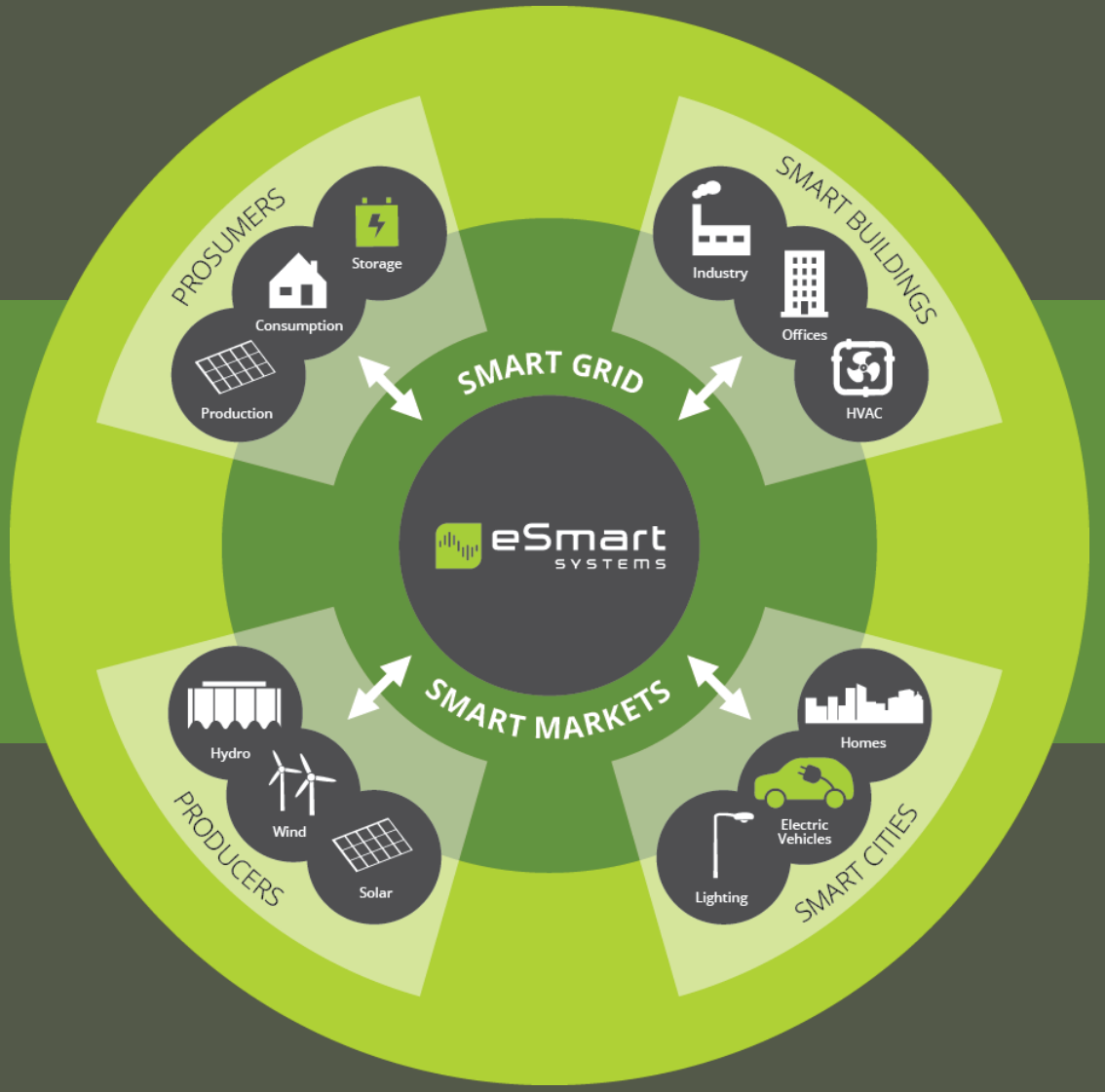
Knut H. H. Johansen
CEO eSmart Systems

22nd November 2017

Intelligence First

+ Powered by values

At eSmart our mission is to build digital intelligence to provide exceptional solutions to our customers and accelerate the transition to sustainable societies



Focus on AI


Microsoft
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Lesson 1: Cloud-Based Solutions Empower Trailblazers Wherever They Are
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eSmart Systems Business Areas

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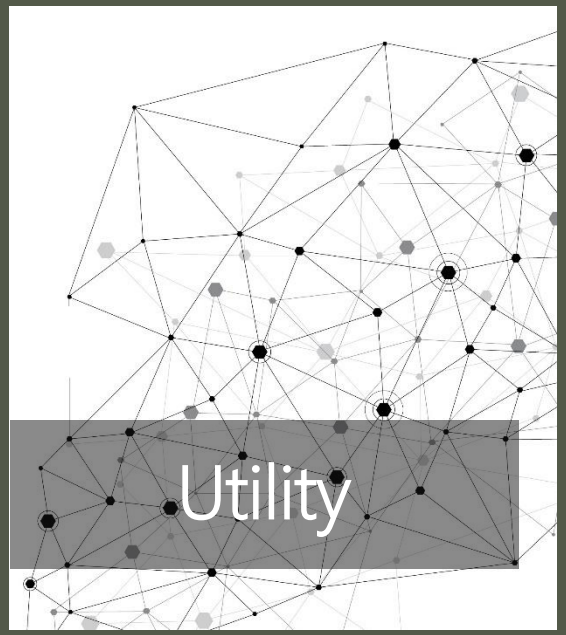

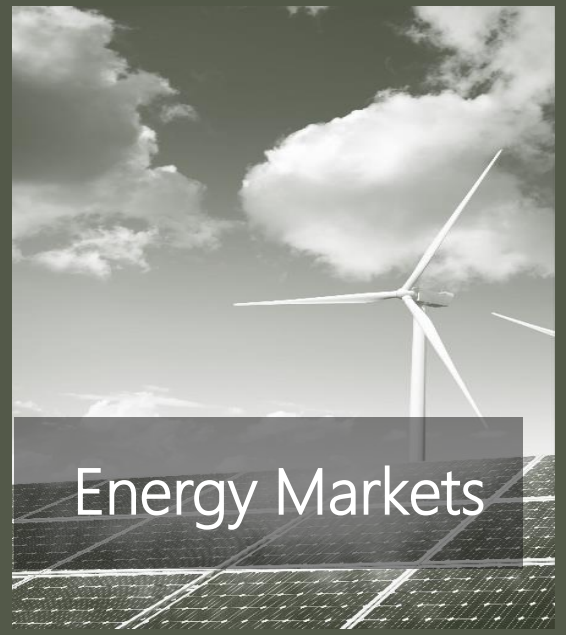

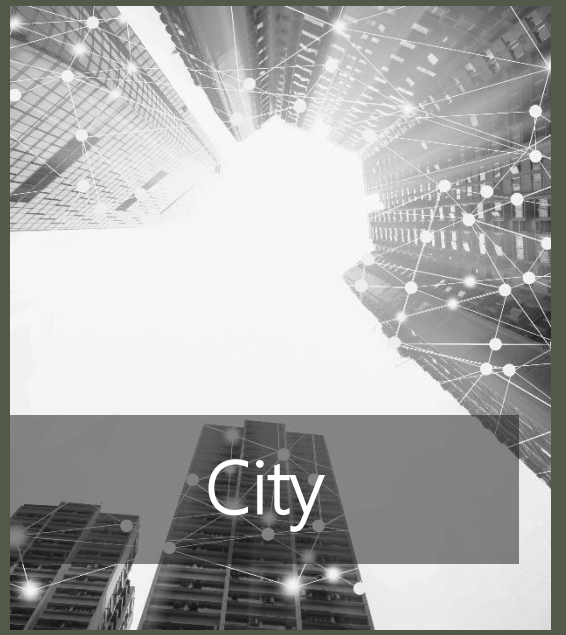

eSmart's foundation

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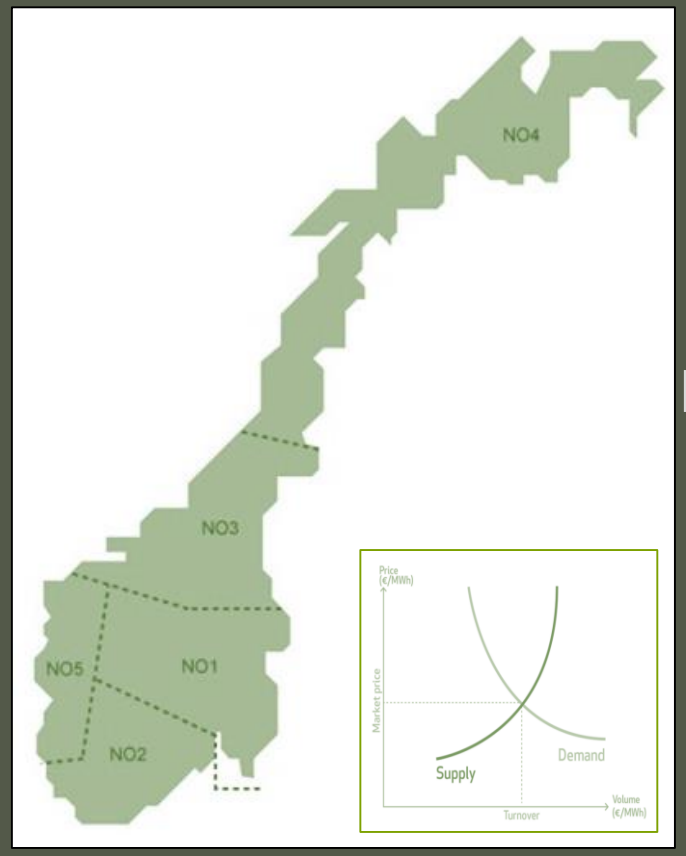
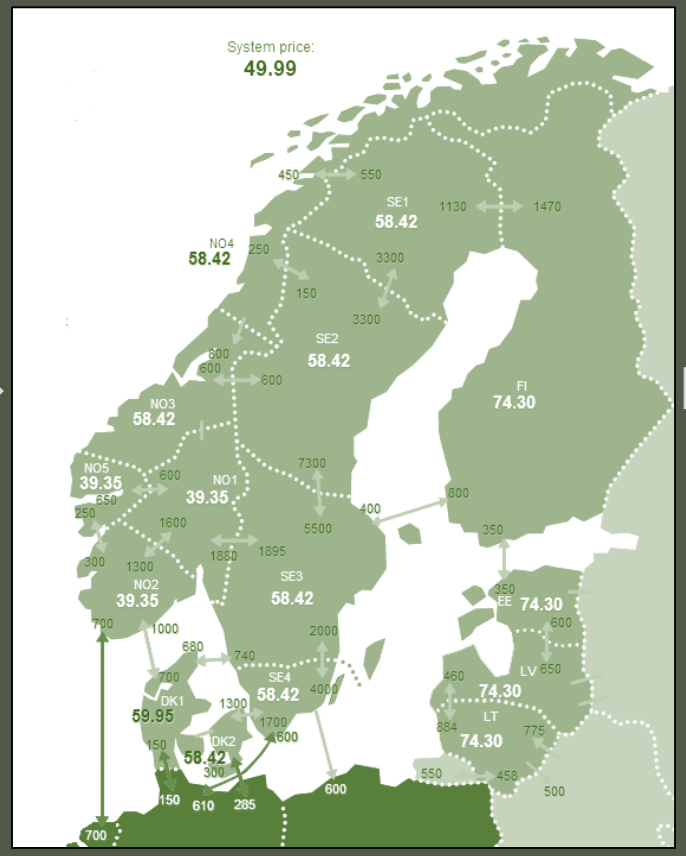
- 20 years of software development for the energy business
- 2 decades of experience with machine learning
- Extensive business knowledge in different markets
- World leading technology vendor
- Long experience with innovation processes
- Generated revenue of 5 billon NOK from innovation

Development of PCR (Price Coupling of Regions)

1991 (Norway)



1996 – 2000 (Nordic) 2010 – 2013 (Baltics)

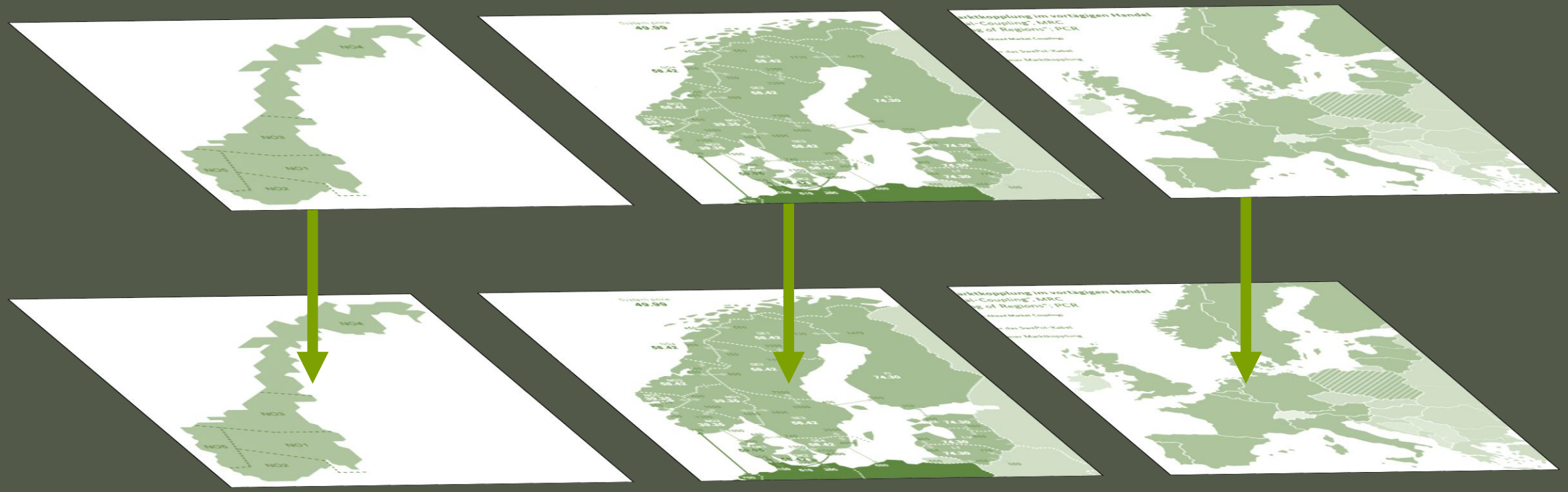


2014 (NWE) -

From the *world's first* spotmarket for electricity to the *world's largest* spotmarket for electricity

The Internal Electricity Market & Local Electricity Markets

TSO – level: matured market



DSO - level: emerging distributed / local markets

Digital Platform

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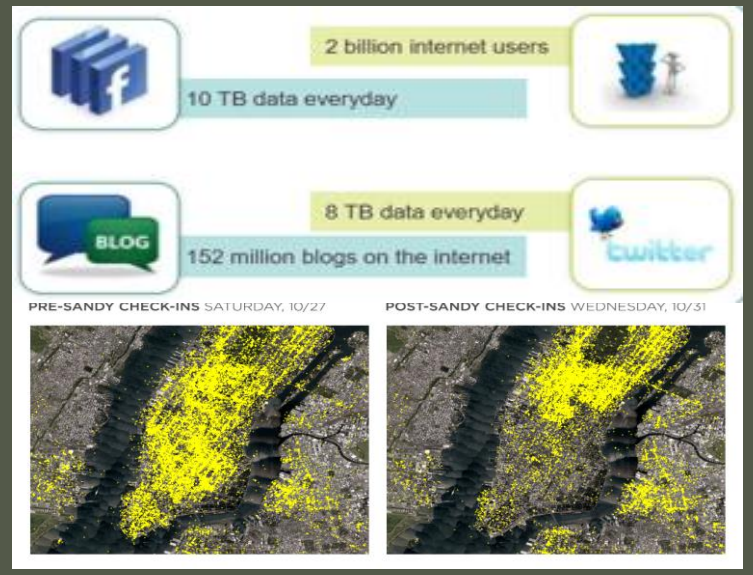
Internal Data

Legacy data systems and traditional data warehouses are not designed to handle the amount & type of data generated by newer internet-scale technologies

Big Data Technology bridges the gap

Big Data Technology will be crucial for the competitive advantages

External Data



90% of the data is coming from net-new data sources – mobile, social media, web and machine-generated data – and this will increase

Rob Bearden CEO - Hortonworks

eSmart SYSTEMS

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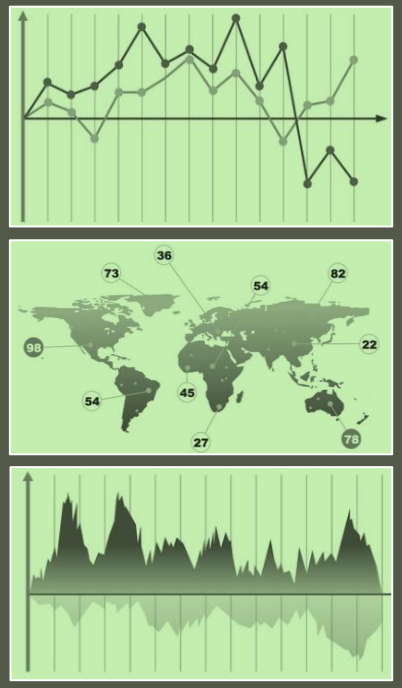
IoT Big Data Real Time Analytics Visualization

- Volume
- Velocity
- Variety
- Veracity

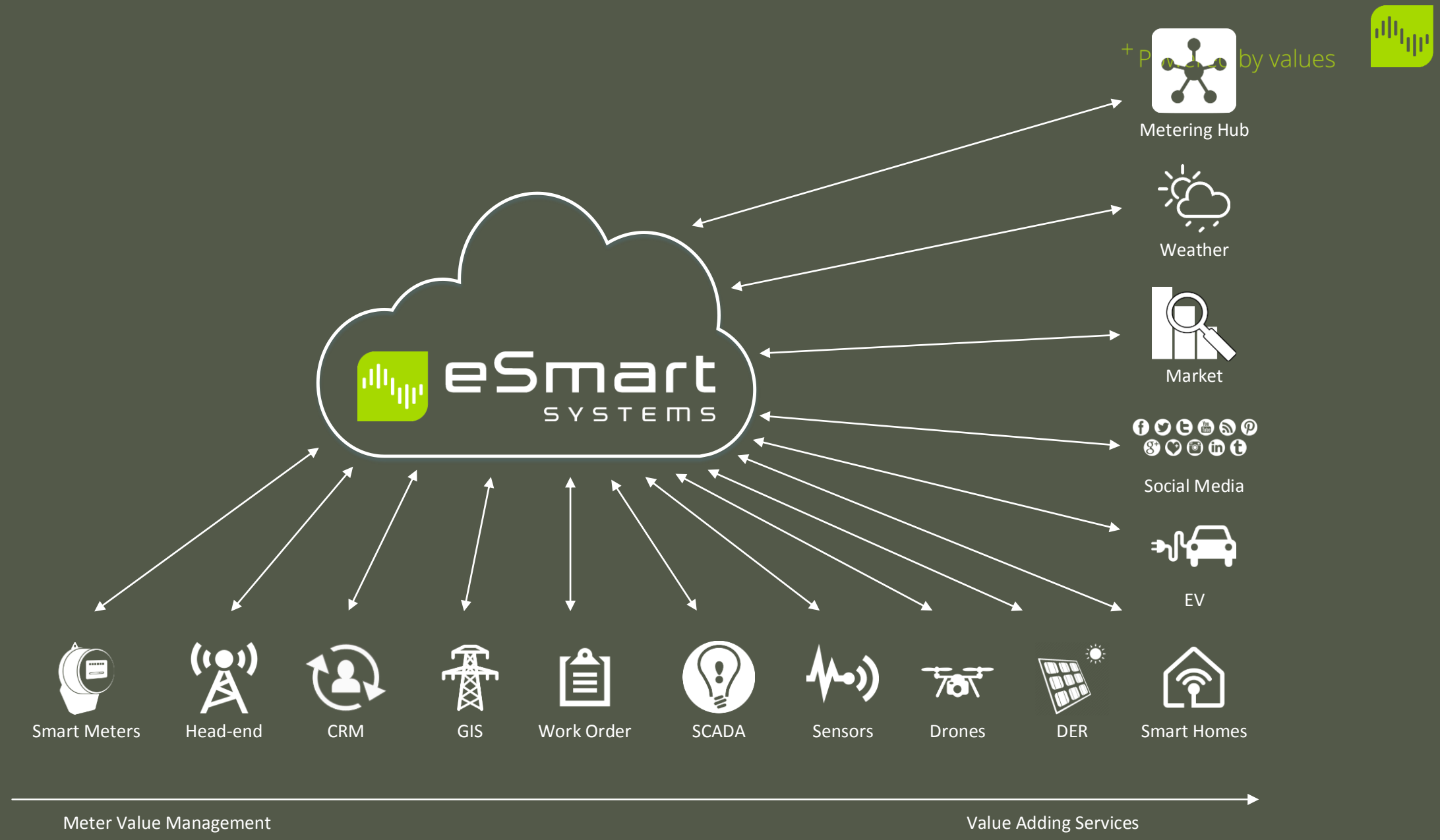


Turning Big Data into Value

The “datafication” of the world
gives us unprecedented amounts of data.

The latest technology together with the latest software and analysis approaches allow us to leverage all types of data to add value.

Today less than 0.5% of all data is analyzed



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IoT

The Explosion of Connected Devices

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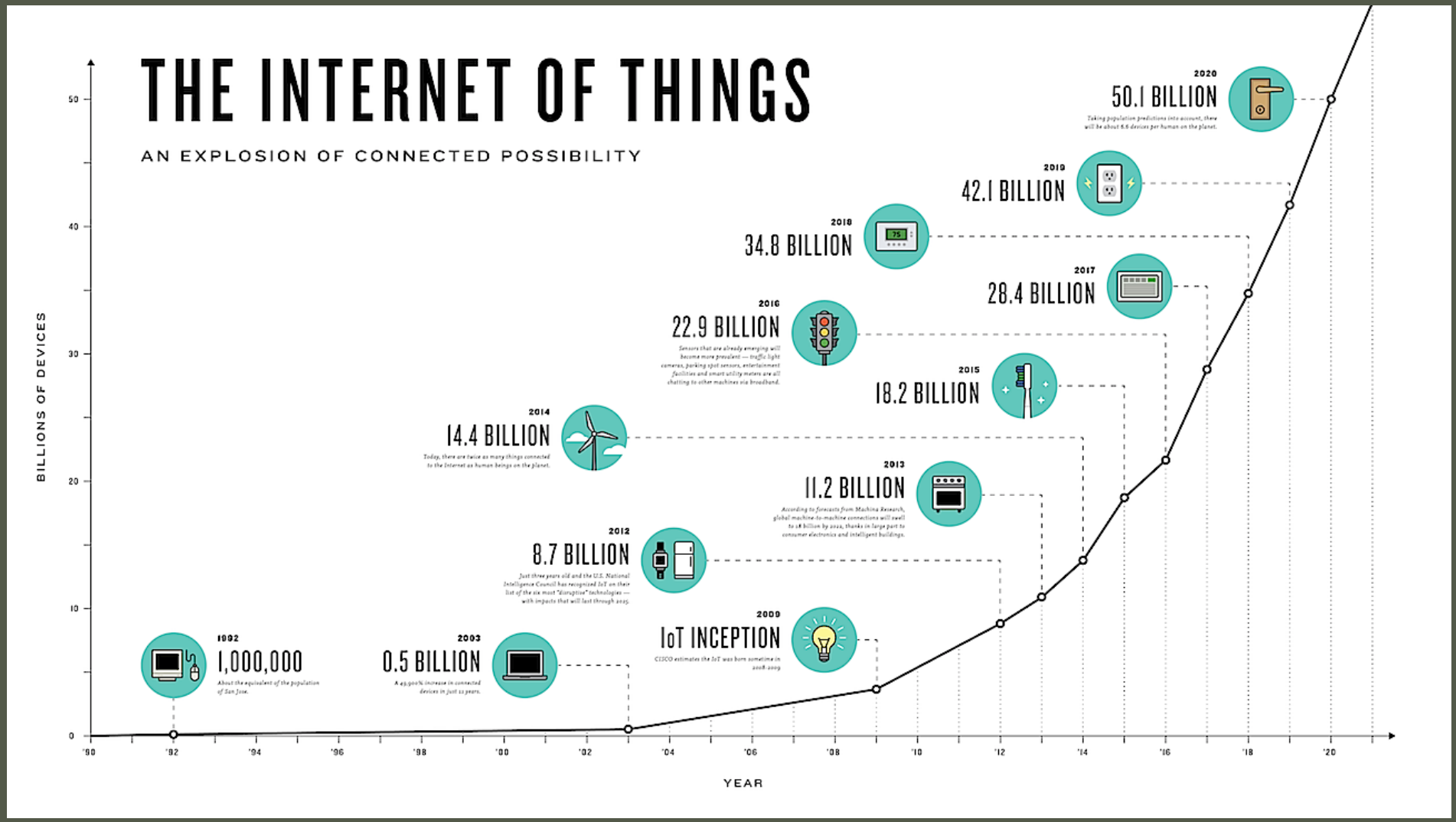

Source: The Internet of Things – infographic The Connectivist based on Cisco data


eSmart
SYSTEMS
EMPOWER
MAIN DASHBOARD
ALL ZONES
15:00 20.09.2016-19:00 20.09.2016
16480 kWh
6340 kWh
17325 kWh
ZONE MAP
14760 kWh
10760 kWh
4760 kWh
6
Tjeneste-
tilbyder

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Big Data

8-PAGE SPECIAL POSTGRADUATE SURVIVAL GUIDE 8TH BIRTHDAY ISSUE!

COSMOS

THE SCIENCE OF EVERYTHING

THE END OF VIOLENCE
Steven Pinker on the new peace p36

DEFEATING POLIO
Will politics jeopardise a cure? p68

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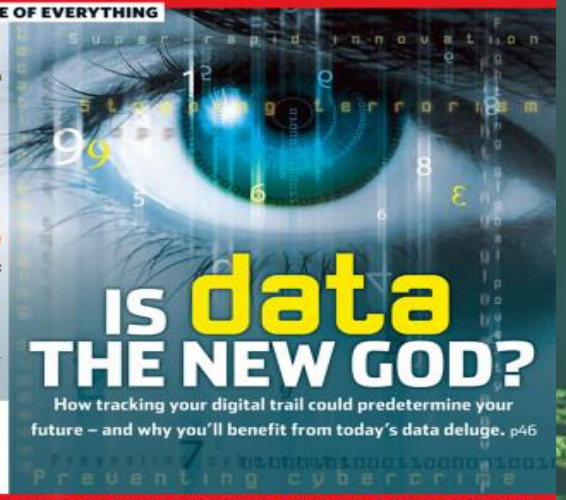
Science's biggest scams p24

GENIUS OF DOGS
Inside the canine brain p41



IS data THE NEW GOD?

How tracking your digital trail could predetermine your future – and why you'll benefit from today's data deluge. p46

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significance

statistics making sense

BIG DATA

SPECIAL ISSUE

DATA AND THE CITY

WHO ARE YOUR FACEBOOK FRIENDS?

MEET THE DATA FAMILY
THEIR EVERY MOVE RECORDED.

The Economist

Obama the warrior
Misgoverning Argentina
The economic shift from West to East
Genetically modified crops blossom
The right to eat cats and dogs

The data deluge

AND HOW TO HANDLE IT: A 14-PAGE SPECIAL REPORT

nature

4 September 2008 : www.nature.com/nature : £10

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

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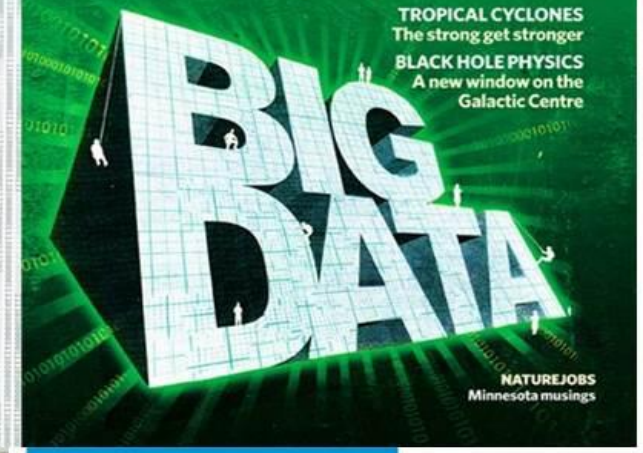
Viral infections for viruses

TROPICAL CYCLONES
The strong get stronger

BLACK HOLE PHYSICS
A new window on the Galactic Centre



BIG DATA

NATUREJOBS
Minnesota musings

MIT Technology Review

"The mobile phone, the Net, and the spread of information—a deadly combination for dictators"

Q+A, p22

BIG DATA WILL SAVE POLITICS

BONO: DATA CAN FIGHT POVERTY AND CORRUPTION

SASHA ISSENBERG: DATA MAKES ELECTIONS SMARTER

JOE TRIPPI: DATA PUTS THE SOUL BACK INTO POLITICS

PLUS: OUR LETTER TO PRESIDENT OBAMA

POPULAR SCIENCE

THE FUTURE NOW

THE CONTROL CENTERS
Using Data to Feed the World, Solve Cold Cases, Battle Malware, Predict Our Fate p32

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Can a Crime Be Prevented Before It Begins? p38

NEW WAYS OF SEEING
A Gallery of Extraordinary Infographics p49

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Juan Enriquez Reprograms Life p3
James Gleick Despises the Bit p58
AND Lawrence Weschler Questions the Cloud p76

SPECIAL ISSUE

DATA IS POWER

HOW INFORMATION IS DRIVING THE FUTURE

Harvard Business Review

The True Measures Of Success

10 Rules for Managing Global Innovation

What Ever Happened To Accountability?

GETTING CONTROL OF BIG DATA

How vast new streams of information are changing the art of management

PAGE 59

Government Executive

GOVERNMENT'S BUSINESS MAGAZINE

MARCH/APRIL 2013

Does Government Ever Really Change?

Five Ways Women Get Ahead

BIG DATA

HOW IT'S MAKING AGENCIES SMARTER

" There are a lot more people
who know how to move data around than
who know what to do with it"

The FOUR V's of Big Data

From traffic patterns and music downloads to web history and medical records, data is recorded, stored, and analyzed to enable the technology and services that the world relies on every day. But what exactly is big data, and how can these massive amounts of data be used?

As a leader in the sector, IBM data scientists break big data into four dimensions: **Volume, Velocity, Variety and Veracity**

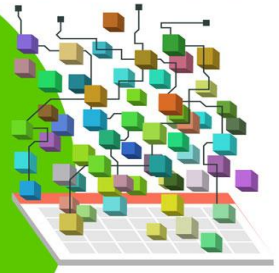
Depending on the industry and organization, big data encompasses information from multiple internal and external sources such as transactions, social media, enterprise content, sensors and mobile devices. Companies can leverage data to adapt their products and services to better meet customer needs, optimize operations and infrastructure, and find new sources of revenue.

By 2015
4.4 MILLION IT JOBS
will be created globally to support big data, with 1.9 million in the United States

Volume
SCALE OF DATA

40 ZETTABYTES
[43 TRILLION GIGABYTES]
of data will be created by 2020, an increase of 300 times from 2005

It's estimated that
2.5 QUINTILLION BYTES
[2.3 TRILLION GIGABYTES]
of data are created each day



6 BILLION PEOPLE
have cell phones

WORLD POPULATION: 7 BILLION

Most companies in the U.S. have at least
100 TERABYTES
[100,000 GIGABYTES]
of data stored

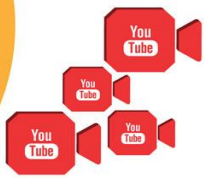
Variety
DIFFERENT FORMS OF DATA

As of 2011, the global size of data in healthcare was estimated to be
150 EXABYTES
[161 BILLION GIGABYTES]

30 BILLION PIECES OF CONTENT
are shared on Facebook every month

By 2014, it's anticipated there will be
420 MILLION WEARABLE, WIRELESS HEALTH MONITORS

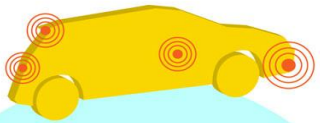
4 BILLION+ HOURS OF VIDEO
are watched on YouTube each month



400 MILLION TWEETS
are sent per day by about 200 million monthly active users

Velocity
ANALYSIS OF STREAMING DATA

The New York Stock Exchange captures
1 TB OF TRADE INFORMATION
during each trading session

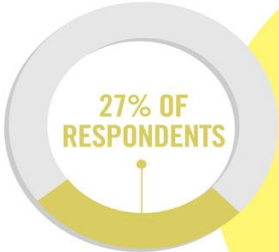


Modern cars have close to
100 SENSORS
that monitor items such as fuel level and tire pressure

By 2016, it is projected there will be
18.9 BILLION NETWORK CONNECTIONS
– almost 2.5 connections per person on earth

Veracity
UNCERTAINTY OF DATA

1 IN 3 BUSINESS LEADERS
don't trust the information they use to make decisions



in one survey were unsure of how much of their data was inaccurate

Poor data quality costs the US economy around
$3.1 TRILLION A YEAR

Sources: McKinsey Global Institute, Twitter, Cisco, Gartner, EMC, SAS, IBM, MEPTEC, QAS

IBM

Some Big Data trivia - What happens in 1 second

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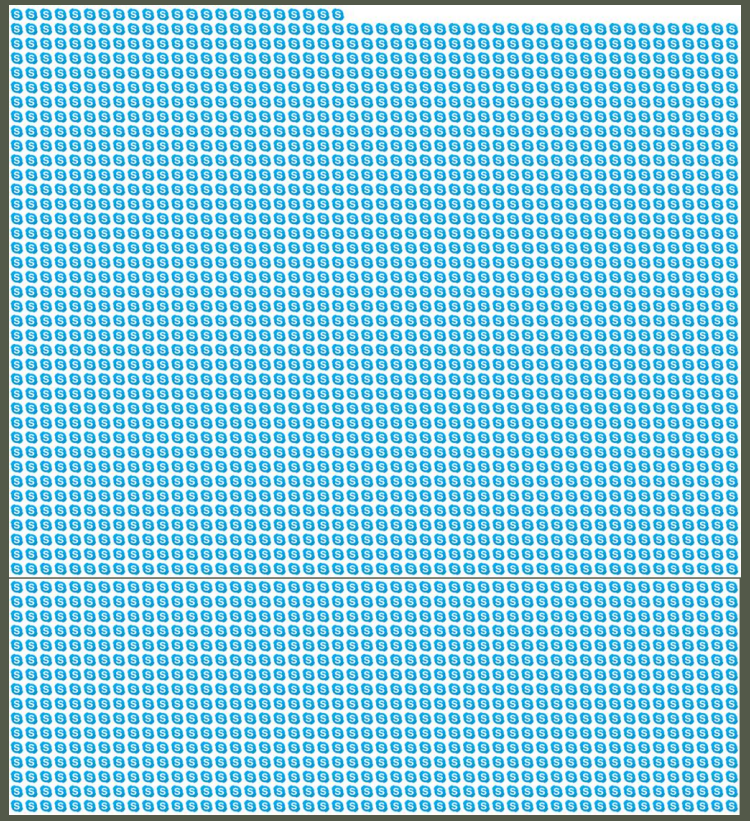
2,373 Skype calls



Some Big Data trivia - What happens in 1 second

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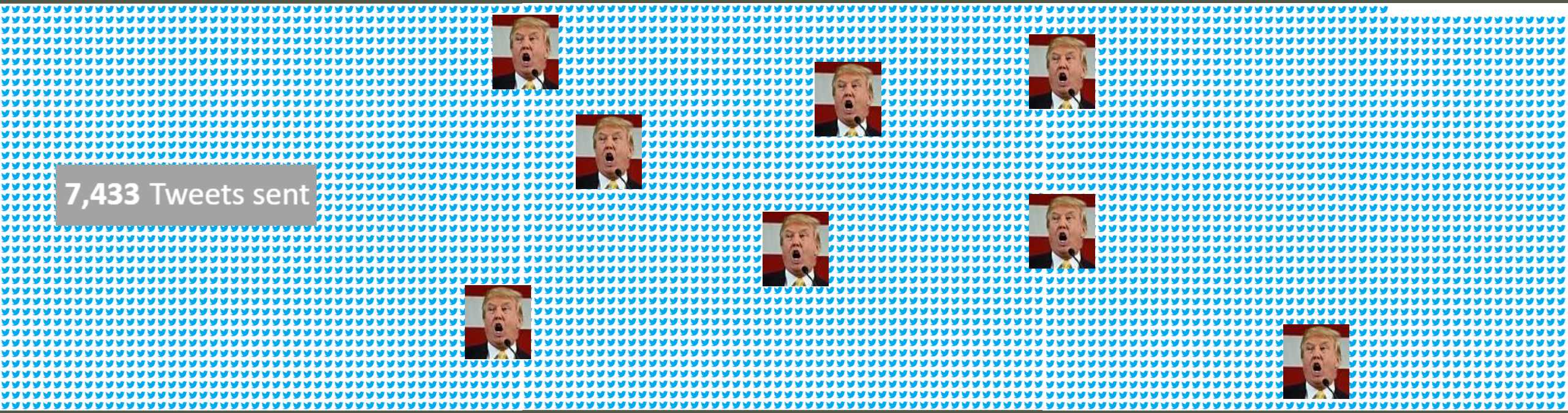

Some Big Data trivia - What happens in 1 second

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57,587 Google searches

Some Big Data trivia - What happens in 1 second

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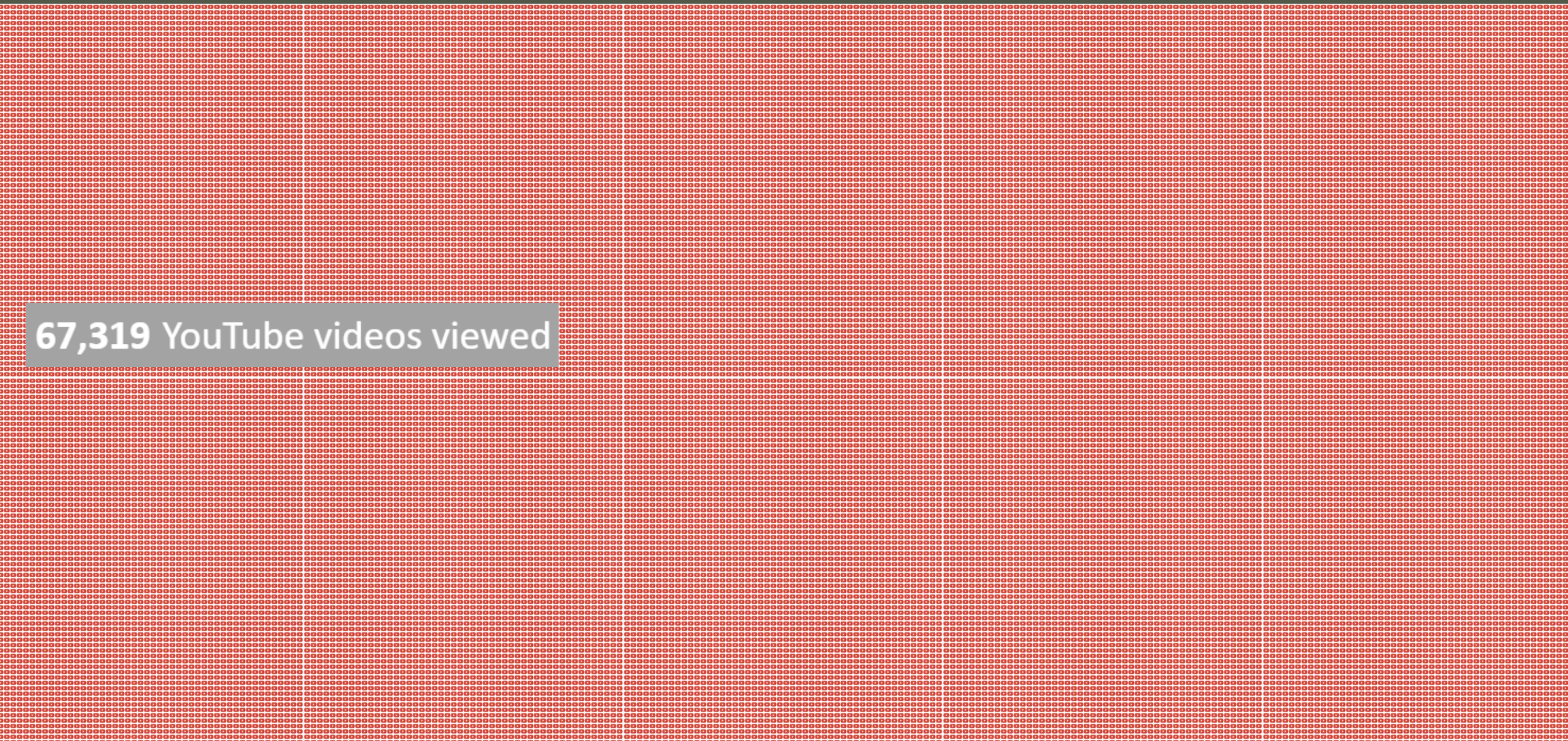


= spam
2,545,417 Emails sent

- Some Big Data trivia

  - More data has been created in the past 2 years than in the entire previous history of the human race

  - By the year 2020, about 1.7 MB of new information will be created every second for every human being on the planet

1.7 MB

1.7 MB/s * 7 000 000 000 = 11.9 Petabytes/sec

1 Zettabyte per day

Zettabyte?


SIBERIA
NORTH AMERICA
UNITED STATES
MEXICO
CHINA
AUSTRALIA
NEW SOUTH WALES
NEW ZEALAND
SOUTH AMERICA
COLOMBIA
PACIFIC OCEAN

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AI

TECH INSIDER

INNOVATION

'Machine learning' is a revolution as big as the internet or personal computers

Drake Baer

Apr. 1, 2016, 1:00 PM

Forbes / Tech

OCT 22, 2015 @ 02:07 AM 44,292 VIEWS

5 Ways Machine Learning Is Reshaping Our World

Bernard Marr

CONTRIBUTOR

Who here remembers taking computer programming in school? Whether you learned program punching holes in a never ending series of cards, or by writing simple DOS or other computer commands, the fact remained that computers needed an incredibly precise set of instructions a task.

The more complicated the task, the more complicated your instructions had to be.

tly how to solve a
itself.

Machine learning algorithms set to transform industries

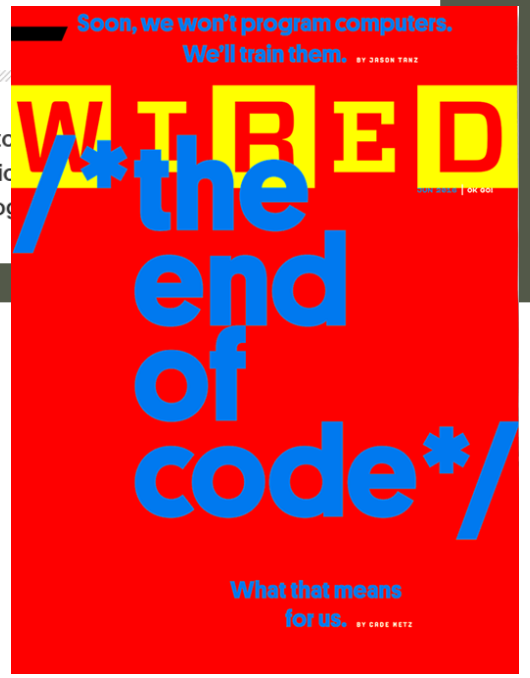
by
Ed Burns
Senior News Writer

Published: 10 Jun 2016

Now is the time for businesses to
place machine learning applicatio
hot advanced analytics technolog

HOW GOOGLE IS REMAKING ITSELF AS A "MACHINE LEARNING FIRST" COMPANY

If you want to build artificial intelligence into every product, you better retrain your army of coders. Check.



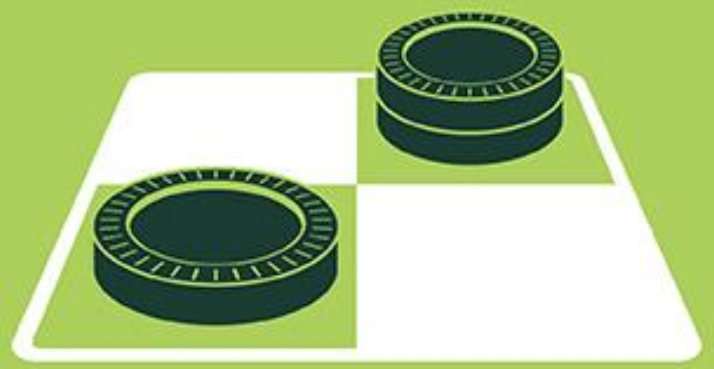
FORTUNE

SEPTEMBER 28, 2016, 5:00 PM EDT

WHY DEEP LEARNING IS SUDDENLY CHANGING YOUR LIFE

ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



MACHINE LEARNING

Machine learning begins to flourish.

DEEP LEARNING

Deep learning breakthroughs drive AI boom.

1950's 1960's 1970's 1980's 1990's 2000's 2010's

Processing power development

NVIDIA Titan X GPU
250W
26cm x 11cm x 4cm

NEC Earth Simulator

Worlds fastest supercomputer from 2002 to 2004

Used 6.4 MW of power (plus air conditioning)

Housed in a two-story building
65m x 50m x 17m

“Machine learning – the science of building computer programs that improve through experience”

Question/purpose

Data and examples

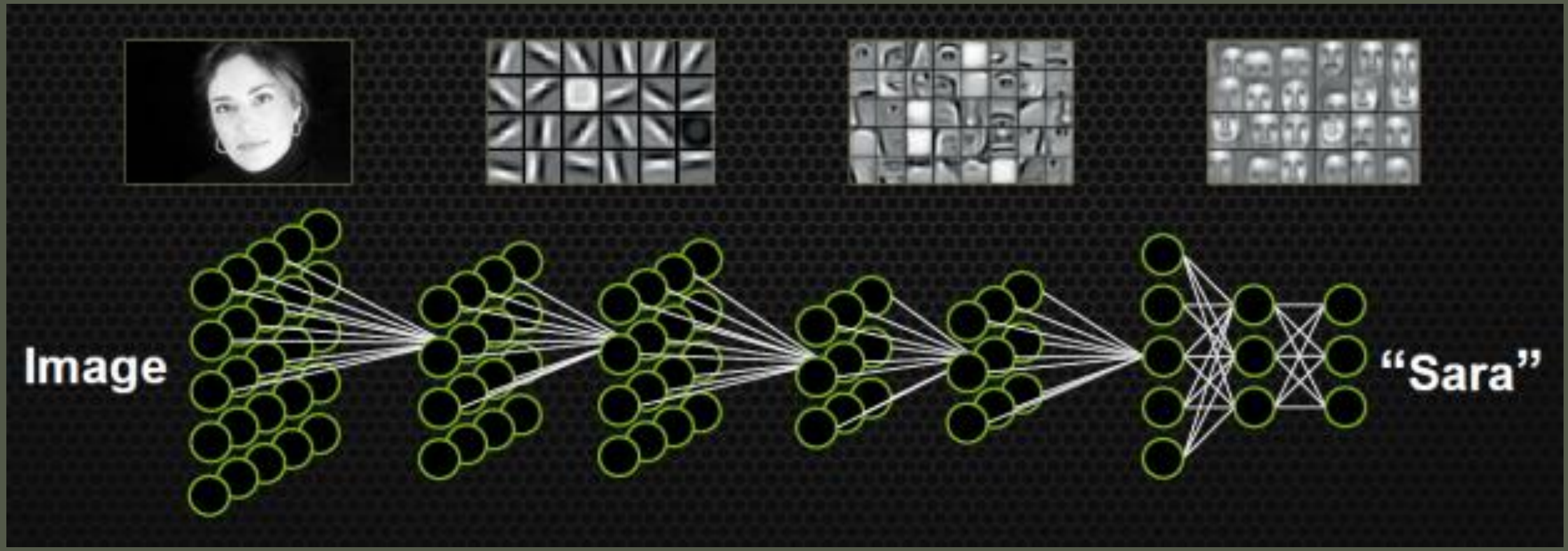
... contains the answer to the questions

Learning algorithm

Predictive model

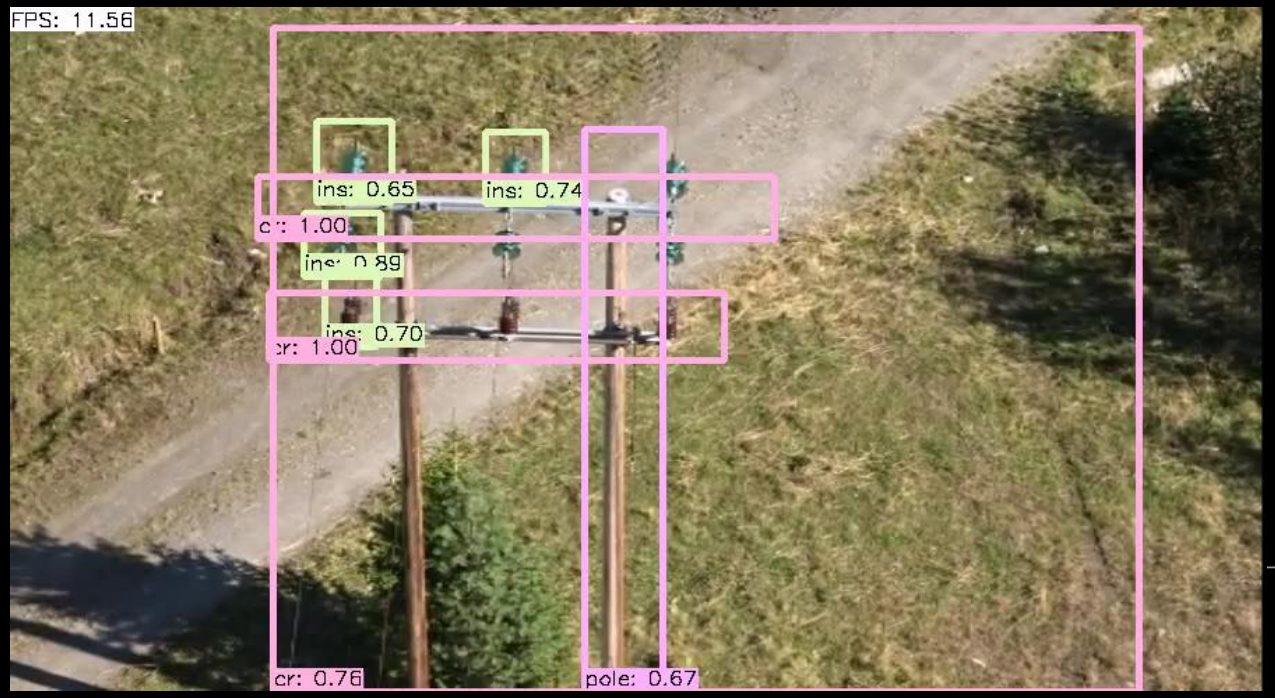
... answers the question on new data

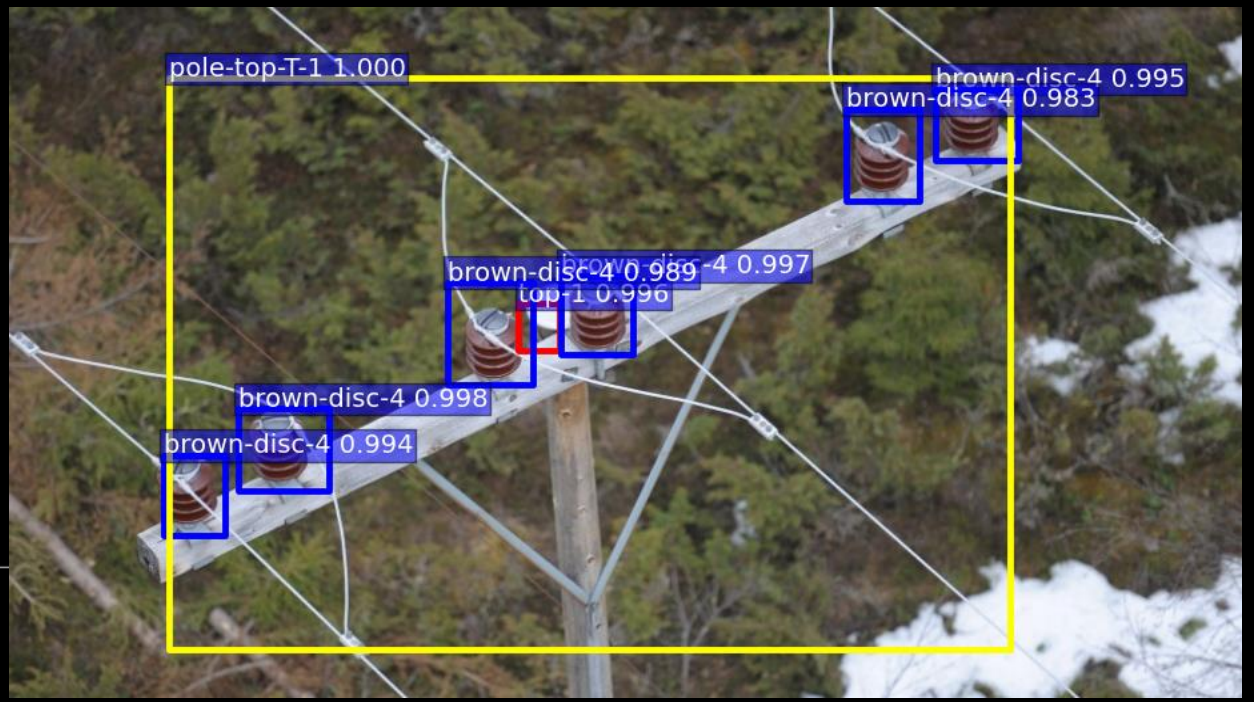
Deep Learning

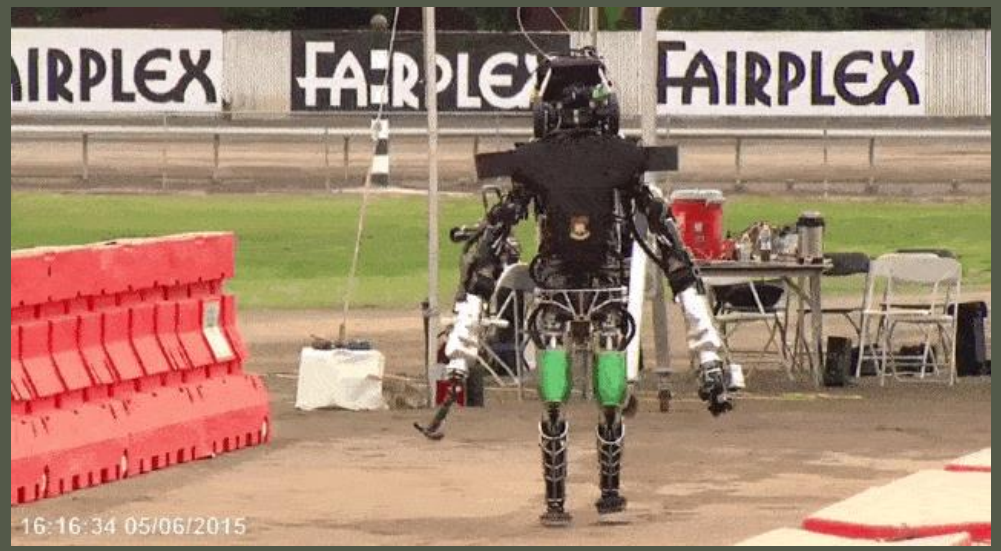



disc-2 0.780
disc-2 0.995
top-1 0.991
disc-2 0.426
brown-disc-4 0.709
brown-disc-4 0.760
disc-2 0.992
top-1 0.943
disc-2 0.984
disc-2 0.992


FPS: 11.61
cr: 0.67
pole: 0.71


FPS: 11.56
ins: 0.65
ins: 0.74
ins: 0.70
cr: 1.00
pole: 0.67


pole-top-T-1 1.000
brown-disc-4 0.995
brown-disc-4 0.983
brown-disc-4 0.997
brown-disc-4 0.989
top-1 0.996
brown-disc-4 0.998
brown-disc-4 0.994


FAIRPLEX
16:16:34 05/06/2015


DARPA Robotics Challenge Finals


Boston Dynamics


Boston Dynamics

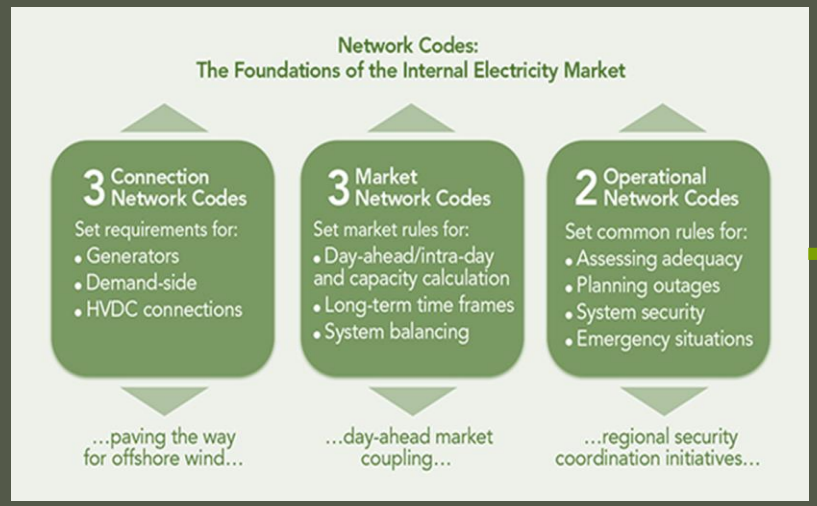

Boston Dynamics


Boston Dynamics

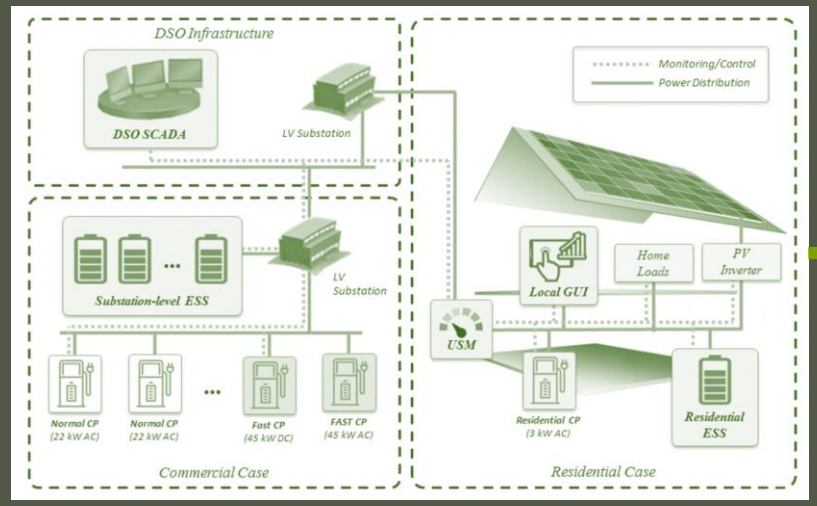
Digital intelligence in energy management solutions

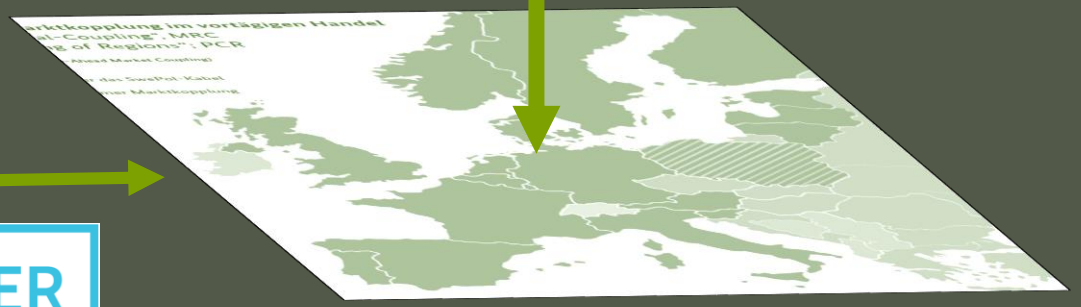
+ Consumption and production predictions
+ Segmentation of customer data
+ Optimal switching
+ Market behavior predictions
+ Risk monitoring
+ Fault detection
+ Automated image analysis
+ Predictive maintenance
+ Intelligent asset management

The Internal Electricity Market & Local Electricity Markets



TSO – level: matured market

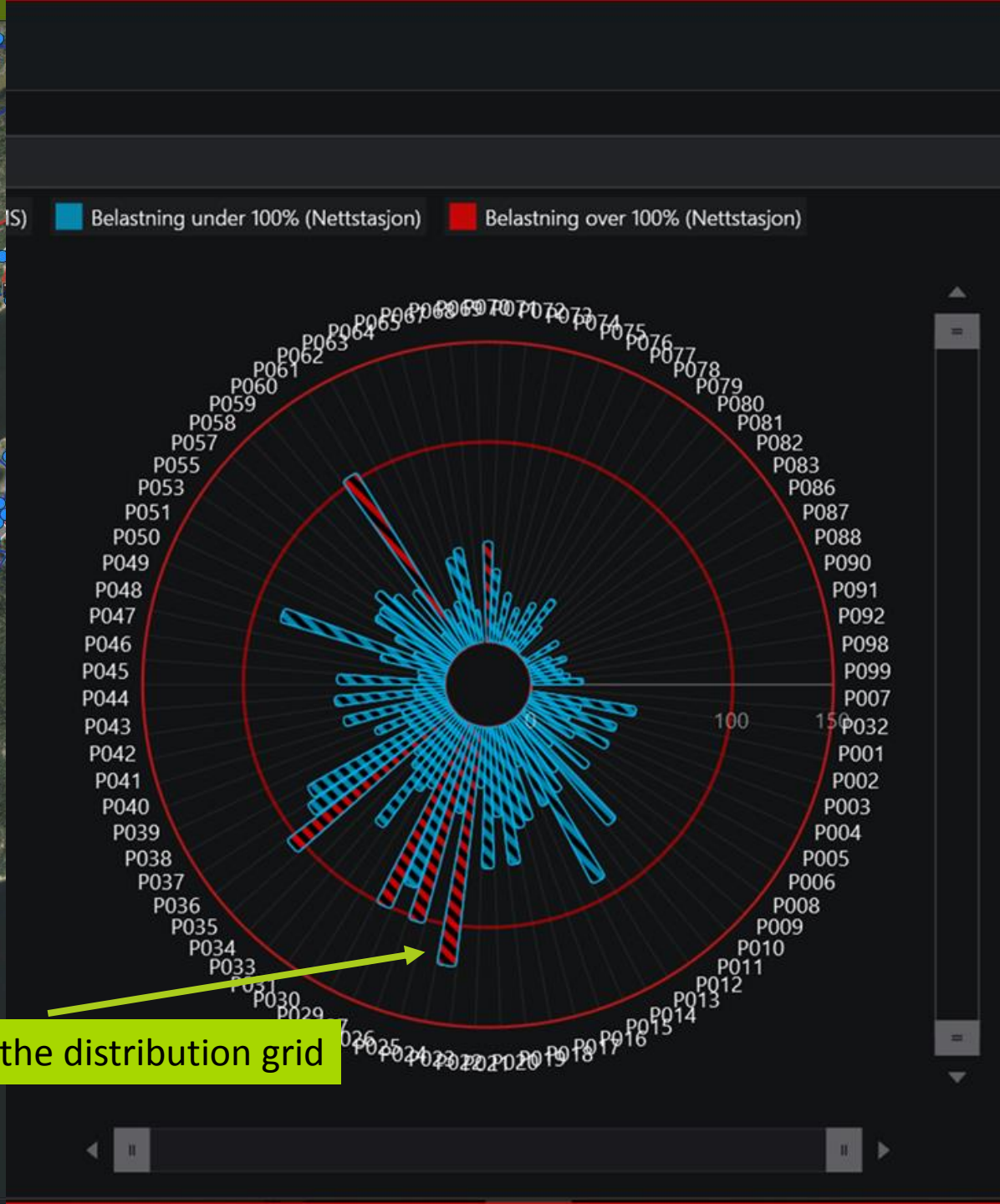




EMPOWER

INVADE

DSO - level: emerging distributed / local markets



Congestions in the distribution grid

Local Energy Markets and Demand side flexibility


+ Powered by values
eSmart
15:30
EMPOWER
18 January 2017
12:00
00:00
23:59
30 kW
91 kW
2°
100 75 50 25
kW
Consumption
Generation
Storage
Notifications
2
Charge electric vehicle
Connected units

"Develop and verify a local market place and innovative business models to encourage active participation of prosumers, exploiting the flexibility created for the benefit of all connected to the local grid"

- EUR 6 million budget
- Project period 2015-2018
- Three pilot areas
  - Hvaler, Norway
  - Wolpertshausen, Germany
  - Malta
- Platform provider and technology development partner in the project is eSmart Systems

EMPOWER ©

Technology changes drive market changes

- DER technology development and price drop
- Electricity market changes
- ICT and analytics development
  - Internet of energy
  - Time series data
  - Microsoft Azure cloud
  - Real-time analytics
  - Artificial intelligence and deep neutral networks

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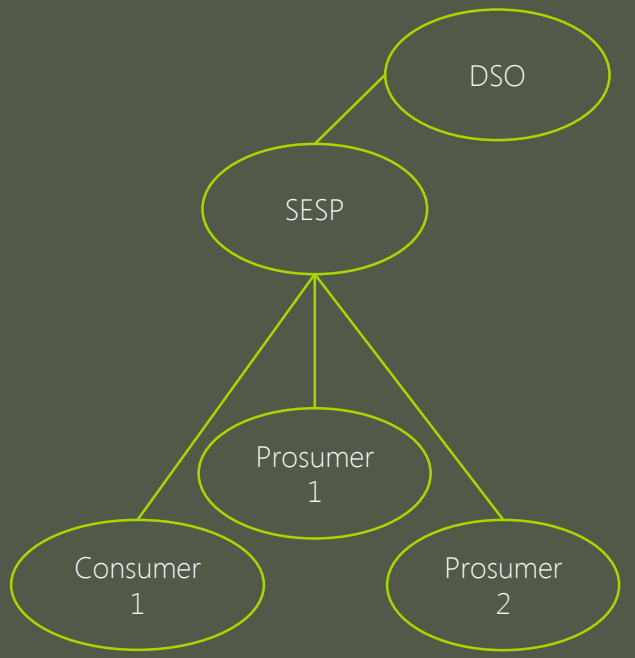
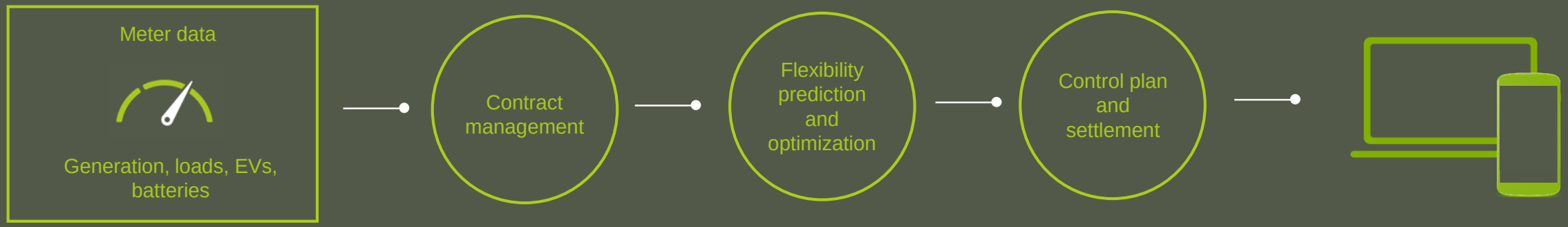
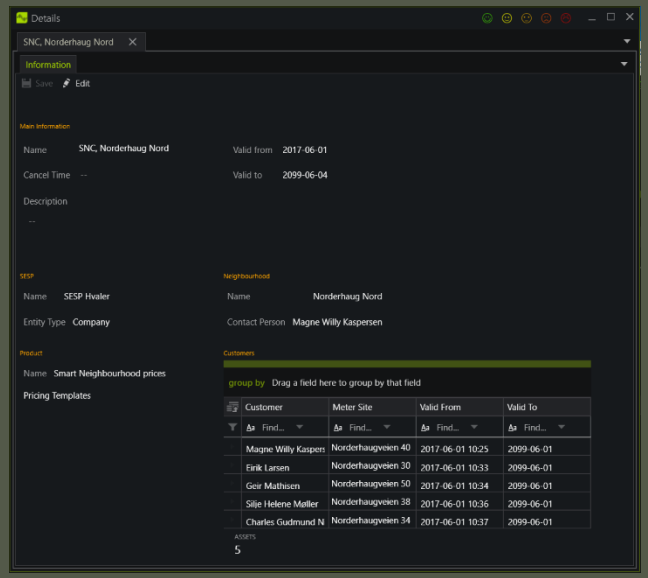
The Energy Flexibility Concept in EMPOWER

- SESP = smart energy service provider (aggregator)
- The SESP and DSO enter contract for flexibility services
- The SESP enters flexibility contracts with flexible consumers and prosumers
  - Up: Increased generation, decreased load, storage discharging
  - Down: Decreased generation, increased load, storage charging

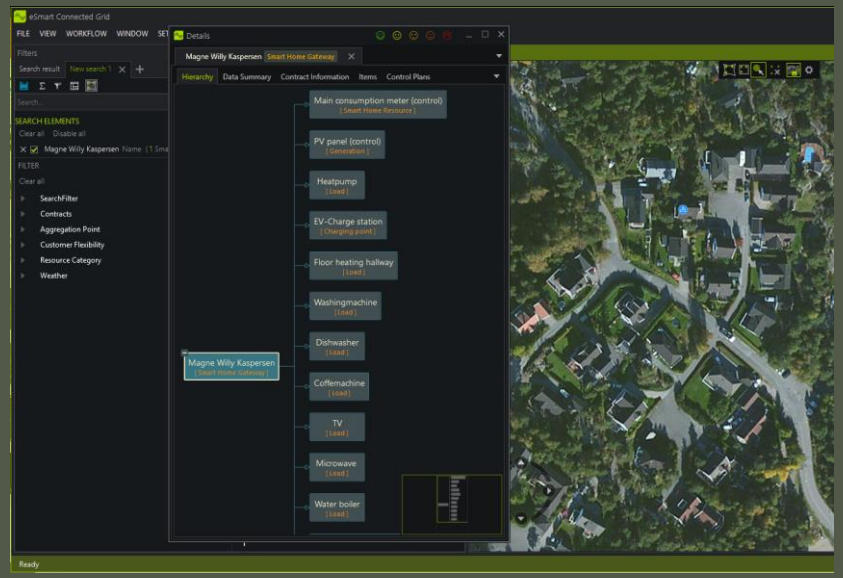




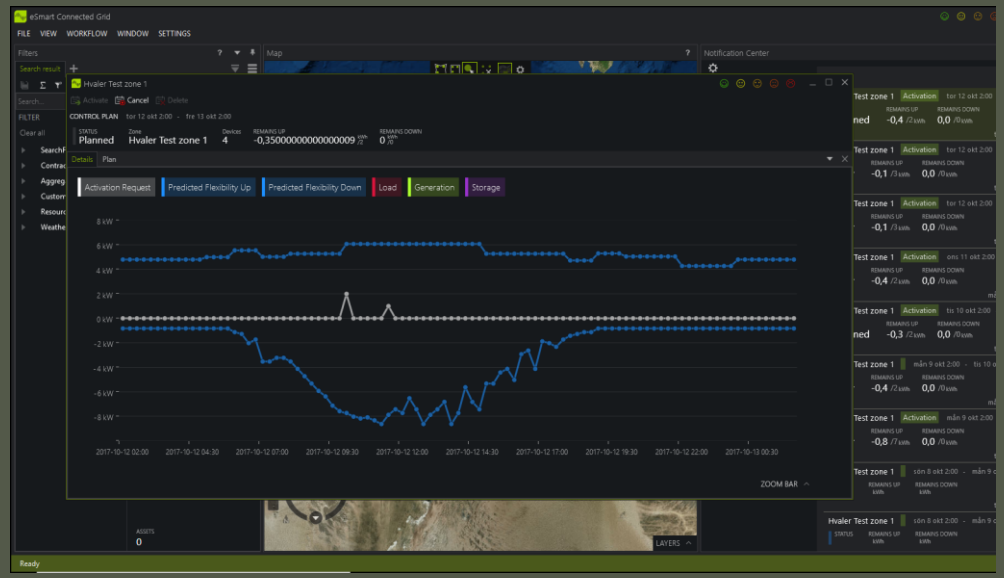
EMPOWER Client



- Screenshot illustrating an energy contract between a neighbourhood and the SESP



- Screenshot illustrating the appliances connected to the grid by one of the pilot customers at Hvaler, in Norway.



- Screenshot illustrating a request for flexibility from the DSO, represented by the white, dotted line.
- The blue dotted lines represent the available flexibility aggregated by the prosumer contracts that the SESP has in the affected area

Prosumer App

PROSUMER'S ENERGY CONTROL CENTER

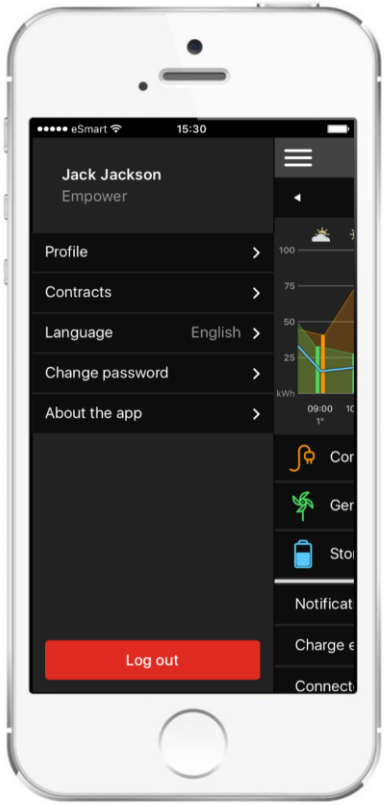
+Visualization of energy resources, both single devices and summarized, historical values and predicted

+The opportunity to decline participation in a control plan

+Contract information on

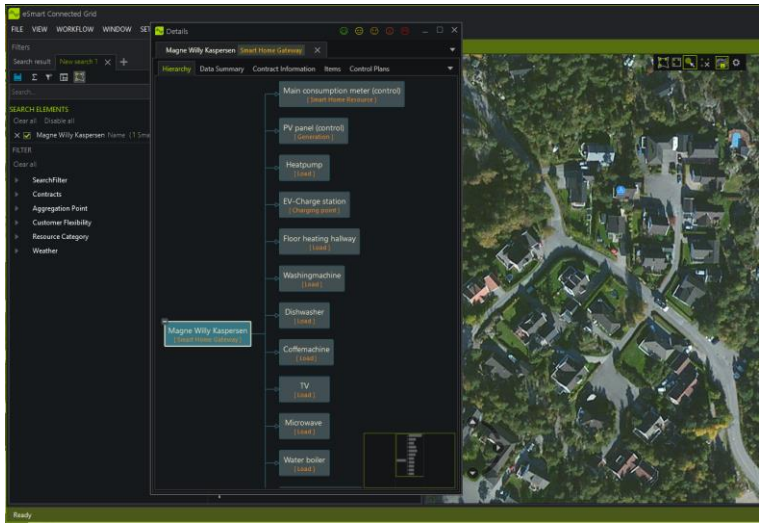
- +Energy contracts
- +Flexibility contracts
- +Service contracts

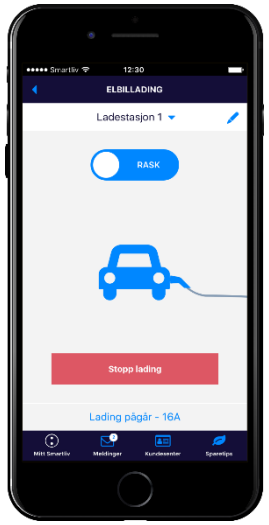
+Monetary balance overview. Net value from participation of control plans, economic values, and overview of purchased and sold energy

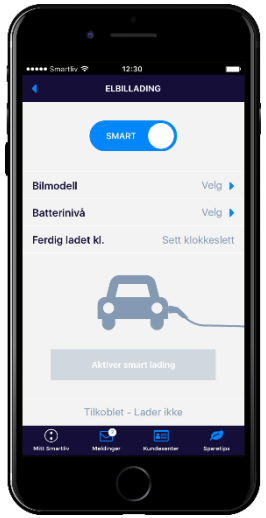


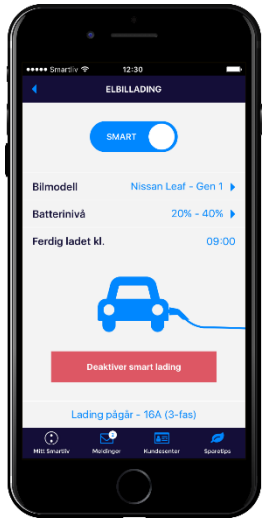
Charging infrastructure asset management, control and optimization

EV charging station monitoring and asset management – optimization of capacity utilization, avoided capacity investments, and intelligent management based on predictions and artificial intelligence







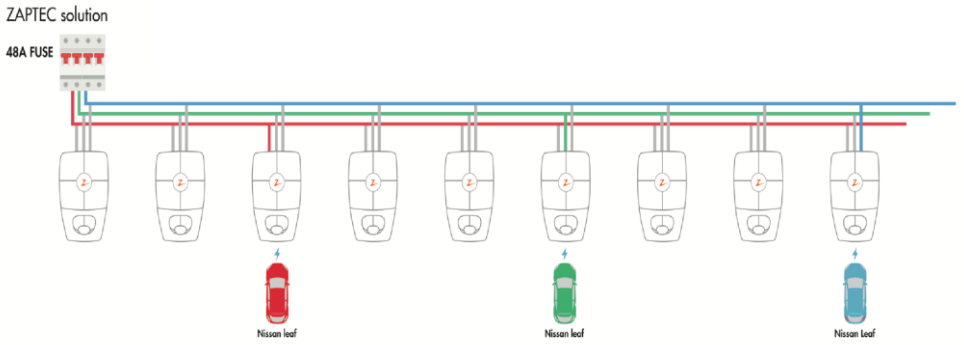


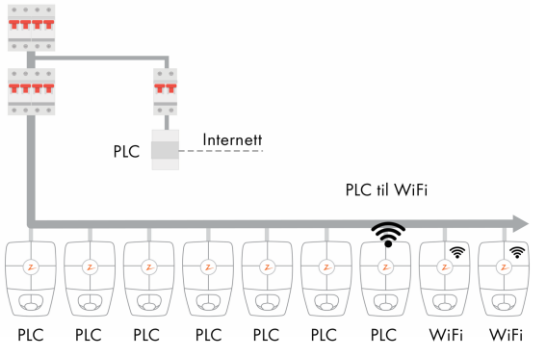
PARTNERS

+ eSmart solutions for monitoring and management are vendor-independent
+ Integrations are put in place for all relevant hardware suppliers
+ Zaptec and Schneider are both existing partners on EV charging solution deliveries

FUNCTIONALITY

+ Asset management
+ Phase and load balancing
+ Work flow and error management
+ Flexibility control and optimization based on building, plan or grid input
+ Integrated booking, payment and energy system functionality





Evolution toward an EMPOWER marketplace

+ Powered by values

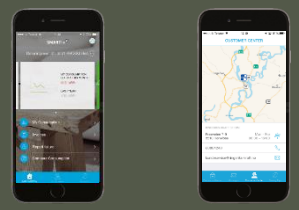
Value

Monitoring

Management and optimization

Flexibility and DR trading

Peer to peer trading of energy and flexibility



Time

Statnett and eSmart Cooperation – Demand Response

Large scale demand response in Northern Norway

Aggregated load per node minimum 100kW

Private households, office buildings, industrial sites

Hardware installation, aggregation, value added services

Switch order from operations center

Customer compensation

Safe switching

+ Powered by values

eSmart activities

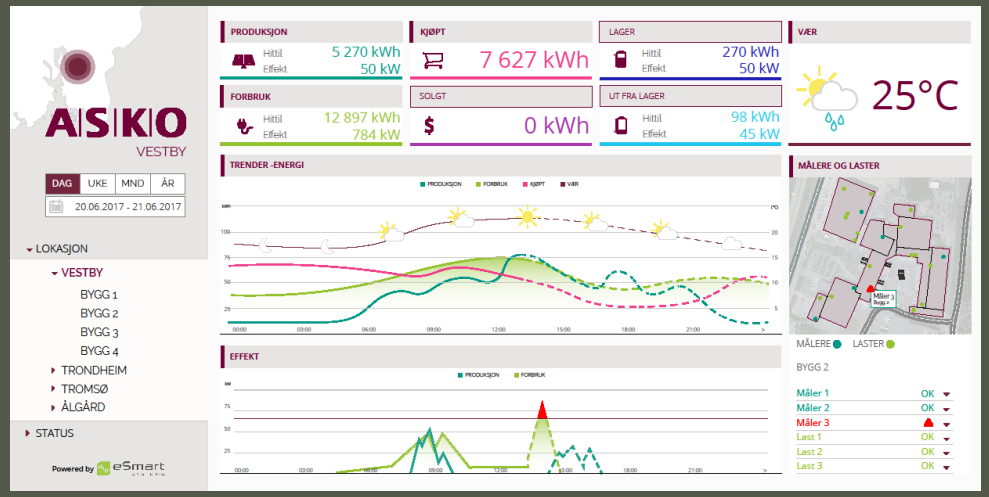
Solutions for the market participants to capture the value of flexibility

Customer projects

- ASKO
- Statkraft
- Statnett

R&D projects

- H2020
- Research council



Statnett
Fremtiden er elektrisk

CHARGEFLEX

Statkraft

EMPOWER

ASKO
– vi forsyner Norge med mat

INVADE

STATSBYGG

Competence development through PhDs
Many prospects in Norway and abroad

Key Stakeholders and Value Proposition

+ Powered by values

PROSUMER

+ Cost reductions
+ Convenience and reliability
+ Revenue streams

BRP/SESP/RETAILER

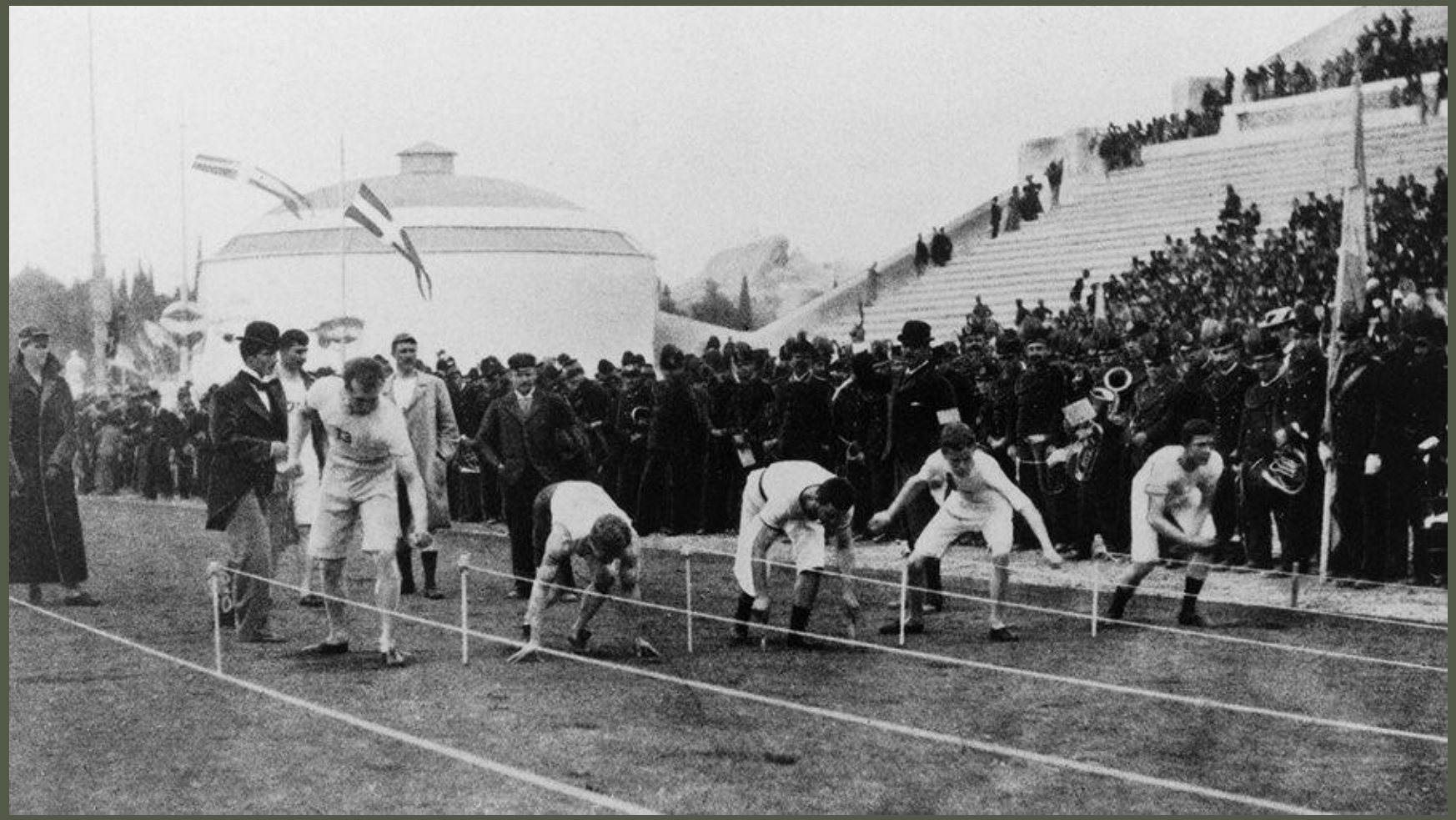
+ Real-time overview
+ Optimal market positioning
+ Imbalance cost reductions
+ New revenue streams

DSO/TSO

+ Real-time overview
+ Optimal market positioning
+ Imbalance cost reductions
+ Relieve grid congestions
+ Postpone investments
+ Improved asset management

How to start?

+ Powered by values



The variety of stances among runners in the 100-meter sprint at the first modern Olympic Games, held in Athens in 1896, is surprising to the modern viewer. Thomas Burke (second from left) is the only runner in the crouched stance—considered best practice today—an advantage that helped him win one of his two gold medals at the Games.

Digital Intelligence

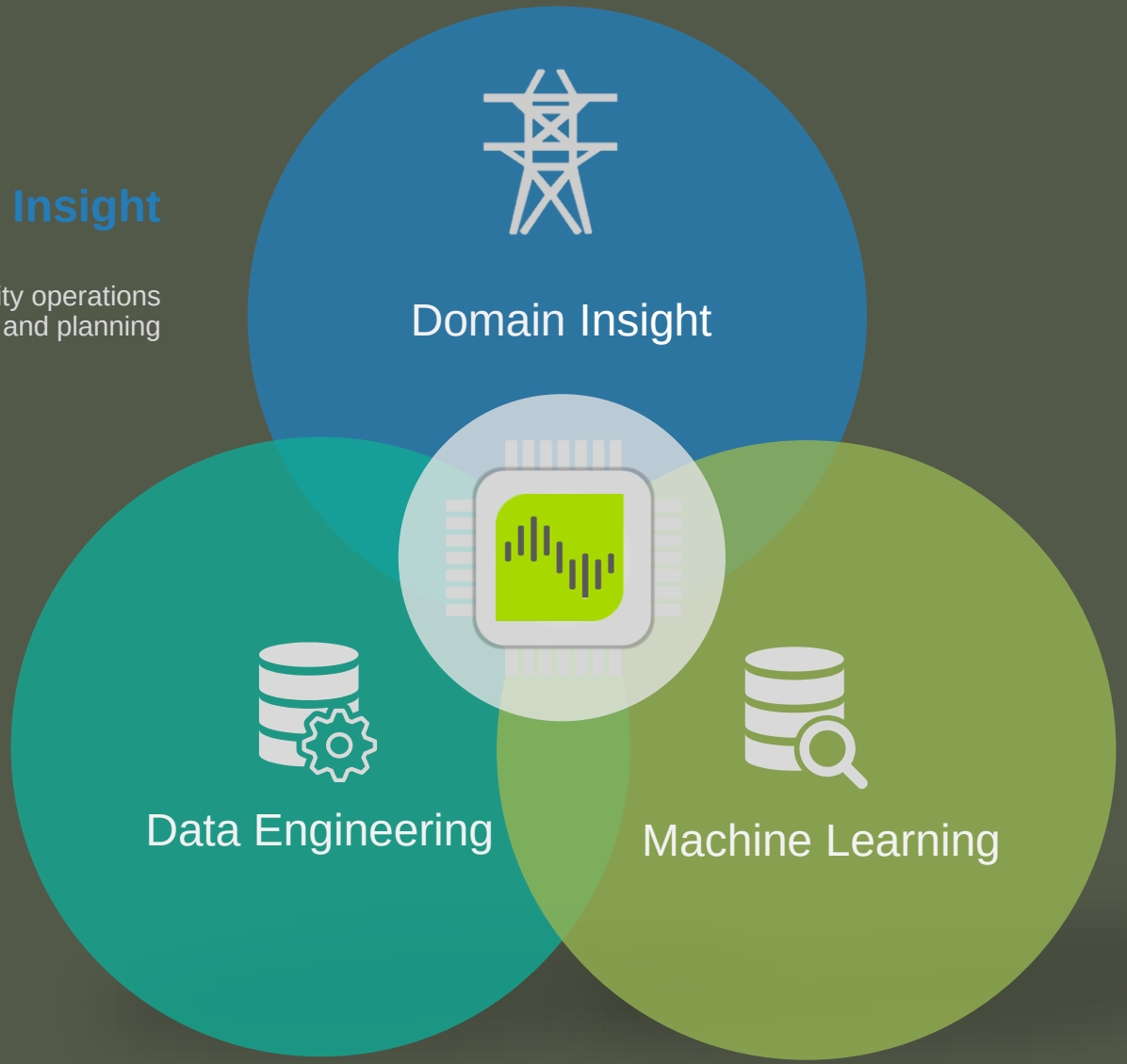
+ Powered by values

Domain Insight

Deep insight in utility operations and planning

Data Engineering

IoT, Storage, Graph, Security, Microservices, CICD



Machine Learning

Deep learning, detection, prediction, segmentation, recommendation