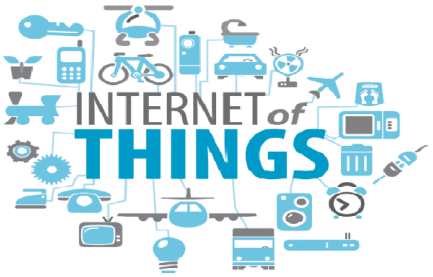


FACULDADE DOM BOSCO
PORTO ALEGRE-RS
REDE SALESIANA BRASIL

Uma introdução ao Sistemas de IoT

Bacharelado em Sistemas de Informação

Internet das Coisas

2019.I

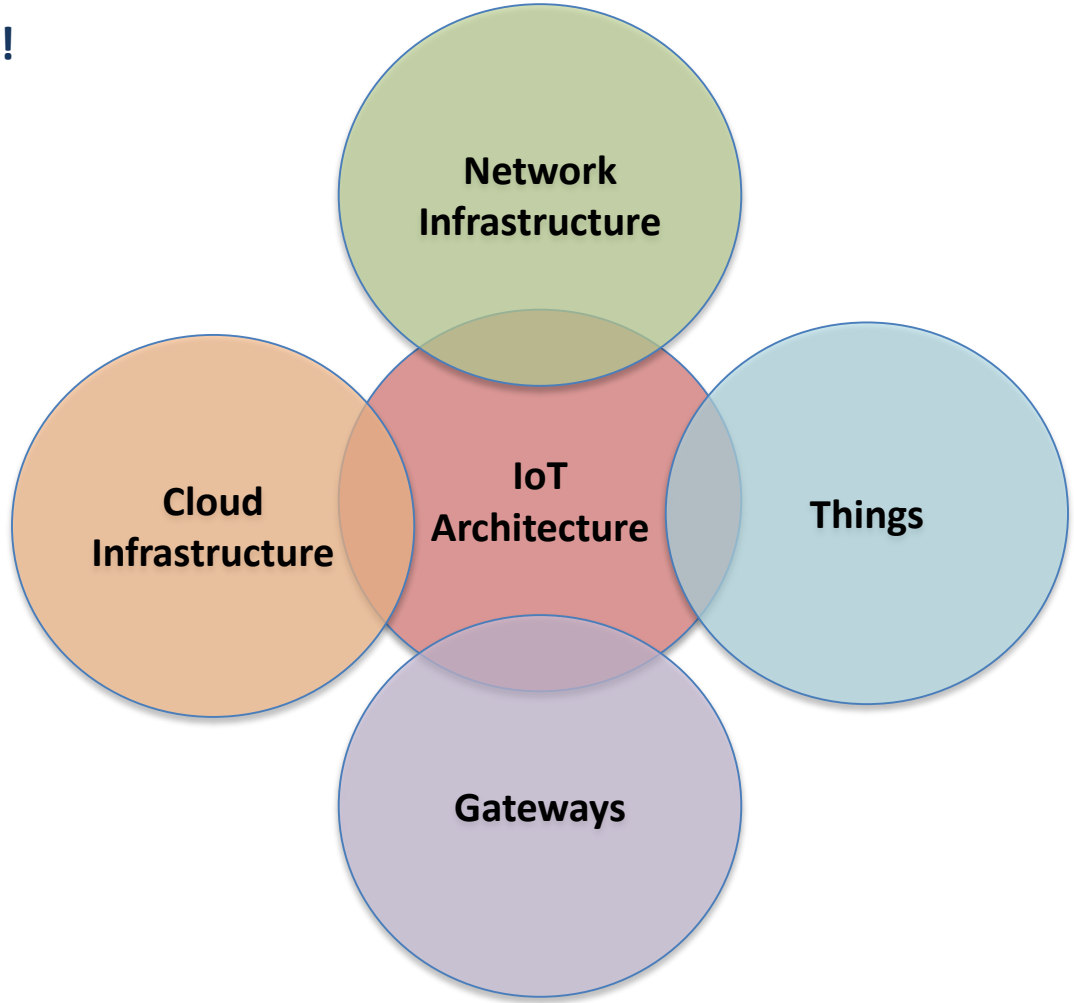
Prof. Filipo Mór

filipomor.com

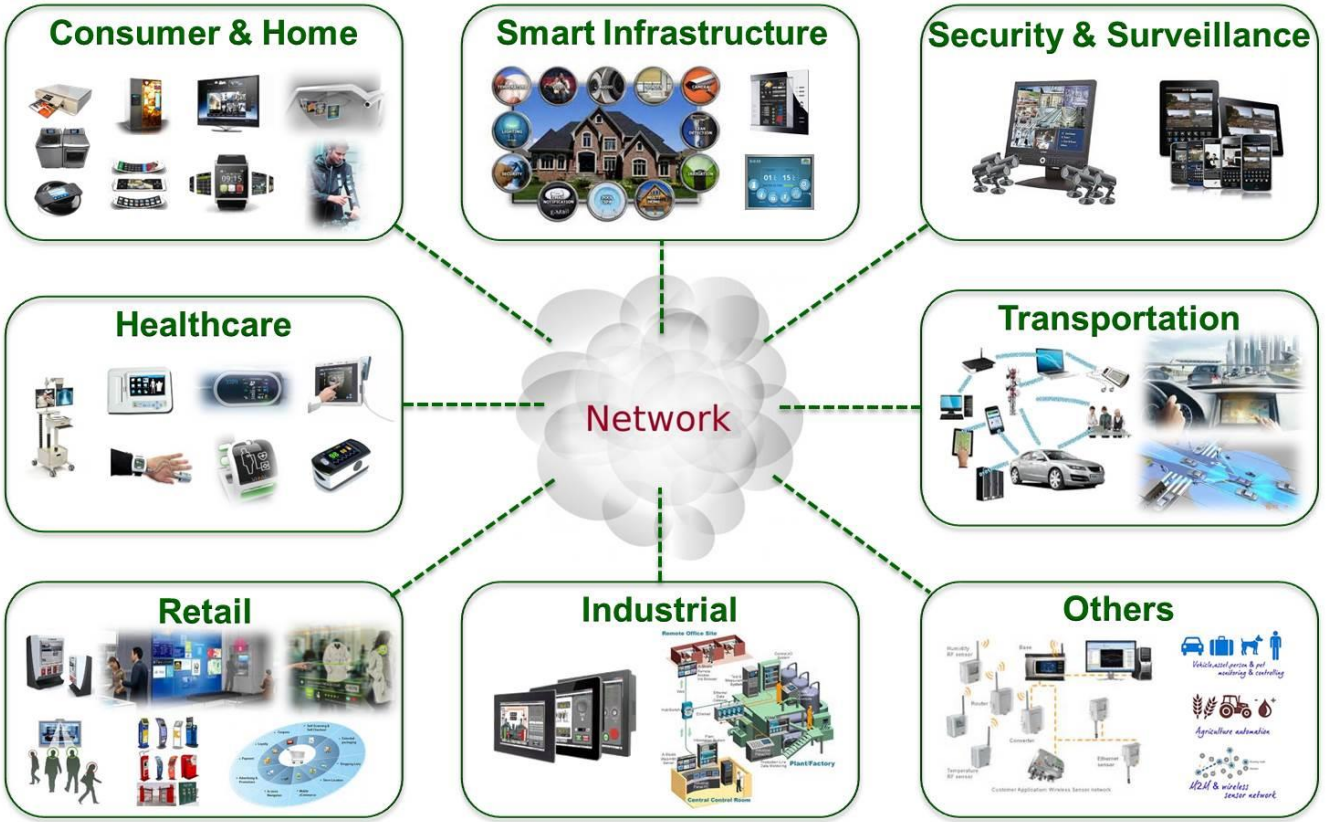
Material gentilmente cedido pelos colegas

César Marcon (Smart City Innovation Center)
Fabiano Hessel (Smart City Innovation Center)
Luiz Giampaoli (Smart City Innovation Center)
Edson Moreno (iSeed – Stefanini)

IoT?!? No Idea!


Network Infrastructure
Cloud Infrastructure
IoT Architecture
Things
Gateways

IoT



Application Example: Smart City, who cares? Which one? Why?

I am a little bit lost, I suppose....

✓ Smart City or Connected+Human+Inteligent+Susteinable City?

✓ The initiative of smart cities is evolving into a new concept called smart and connected communities (SCC), which focus on the past, present, and future of areas that are not big cities but can still benefit from IoT advances.

✓ Investigate the potential of living labs to accelerate open and user-driven innovation development of services enabled by Future Internet to leverage Smart Cities

✓The original IoT vision involves a hyper-connected global ecosystem in which “things” communicate with other “things” whenever needed to deliver highly diversified services to the user. Such communication must be independent of the creator of a given fragment of the infrastructure. In reality, however, each vendor has its own IoT solution that is incompatible with other solutions, thus creating local IoT silos.

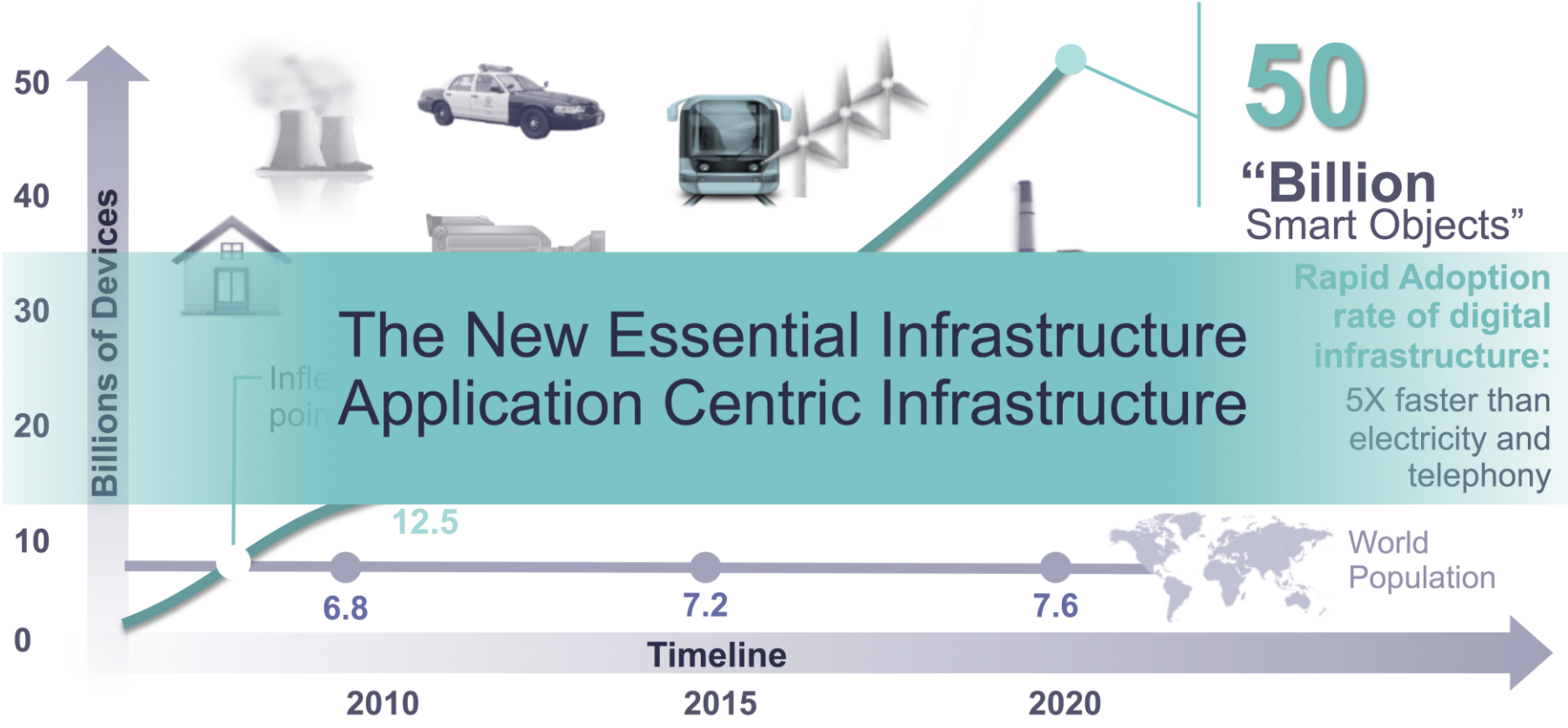
I am a little bit lost, I suppose....

✓ The business model and its underlying technology follow human patterns of behavior, and not vice versa. This means that we – citizens and entrepreneurs – are able to determine which data we want to share with which specific stakeholders for which specific reasons. Do you want your Internet-enabled mattress to pass data about your private behavior to third parties? and "We don't want our data roaming about, and eventually be sold back to us!"

✓ The whole problem arose because most IT developers are preoccupied with what is technically possible. And not what we want as a society. With the Internet of things an awful lot is possible – much of which we will not want.

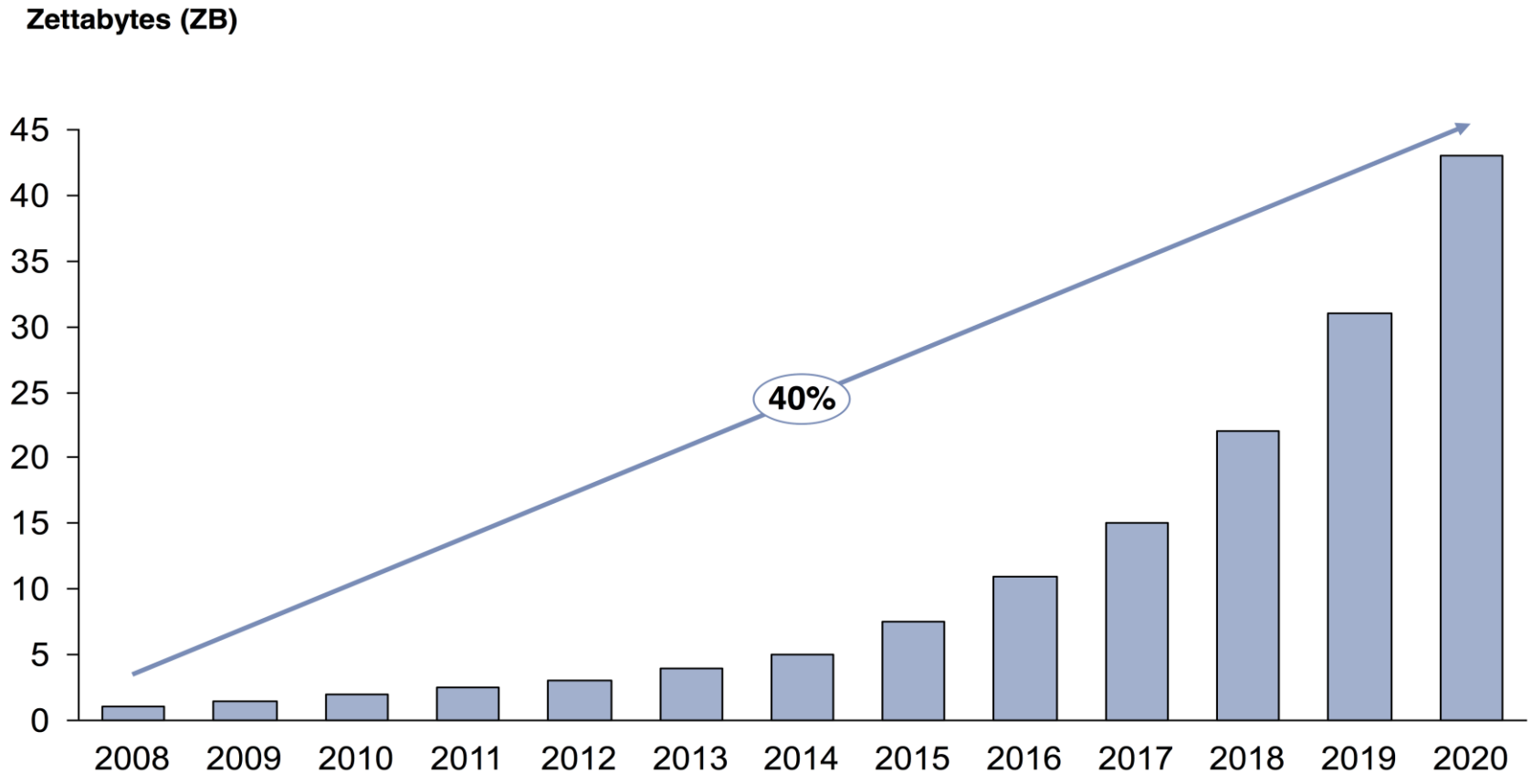
✓ We need to break away from the current dominant model that enables a few huge companies to freely do what they want with our data and our environment

Increasingly Everything will be Connected to Everything



Source: CISCO

The total information to be collected from the "things" connected

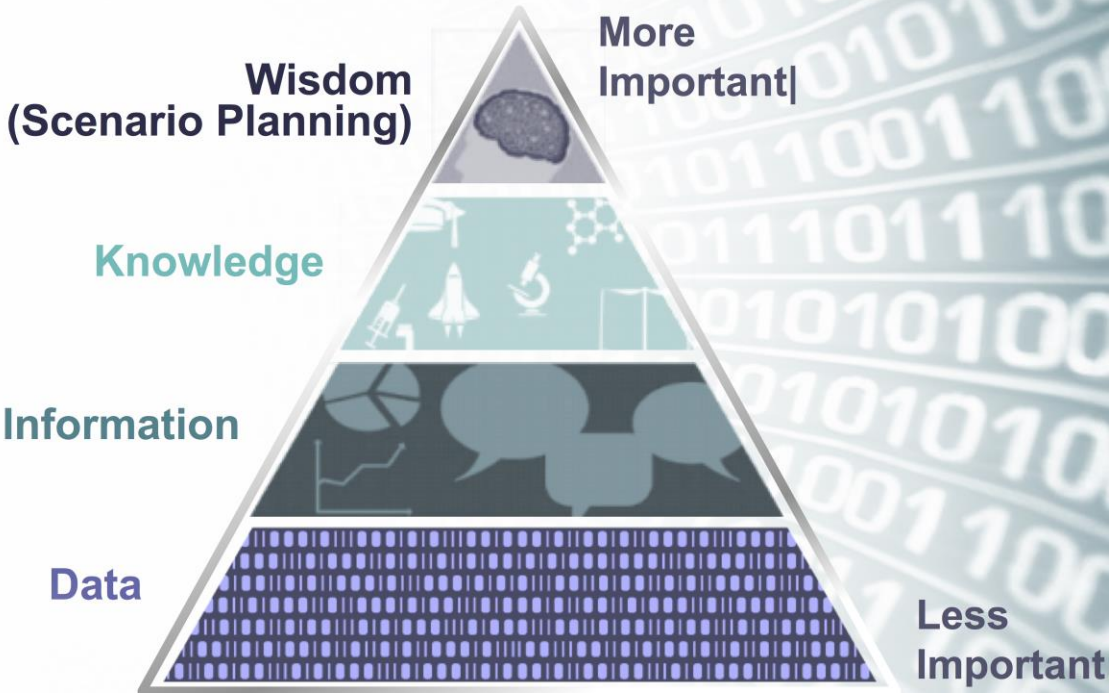


Source: CAGR (Compound Annual Growth Rate) and Oracle

IoT Acceleration: BIG DATA

Big Data Doubles Every Two Years

- 90% of world's data created in last 2 years
- More new data generated in 2012 than prior 5,000 years
- By 2020, 40% of data will come from sensors
- WalMart collects 2.5 petabytes of data hourly from customer transactions



Seizing the Opportunity: Economic Value of The IoE

Economic Value

$19.0* Trillion

Estimate is based on bottom-up analysis of **61 use cases,** including 21 for private sector and 40 in public sector

Private Sector

$14.4T

Includes both industry-specific and horizontal use cases.

- Customer Experience
- Innovation
- Employee Productivity
- Supply Chain
- Asset Utilization

Public Sector

$4.6T

Includes cities, agencies, and verticals such as healthcare, education, defense

- Increased Revenue
- Reduced Cost
- Employee Productivity
- Connected Defense
- Citizen Experience

Value Sources

Innovation/ Revenue	Customer Experience	Asset Utilization	Employee Productivity	Supply Chain/ Logistics
$3.0T	**$3.7T**	**$2.5T**	**$2.5 T**	**$2.7T**

Implementing an IoE for the Public Sector in Brazil could generate an estimated $70.3bn of value

$4.6T

$70.3bn

Citizen $11.2bn

- Telework
- Connected Payments
- Chronic Disease
- Government Services

City $59.1bn

- Urban Mobility
- Travel avoidance
- Smart Grid and Lighting
- Safety and Secutity
- Health Services

Internet of Things

- ✓ Smart Objects and Sensors
- ✓Network of Things
- ✓Self-organizing systems

- ✓ Intelligence at the edge
- ✓Massive Data
- ✓New communication paradigms
- ✓Servitization

Is IoT a Fade?

Challenges

- IoT community focused too much on devices, sensor networks/communication, and ubiquitous computing
- IoT projects all look similar
- It has been a buzz word for too long without delivering real values
- IoT by itself is only one of many puzzle pieces needed to construct viable solutions for solving real world problems

Winning Strategy

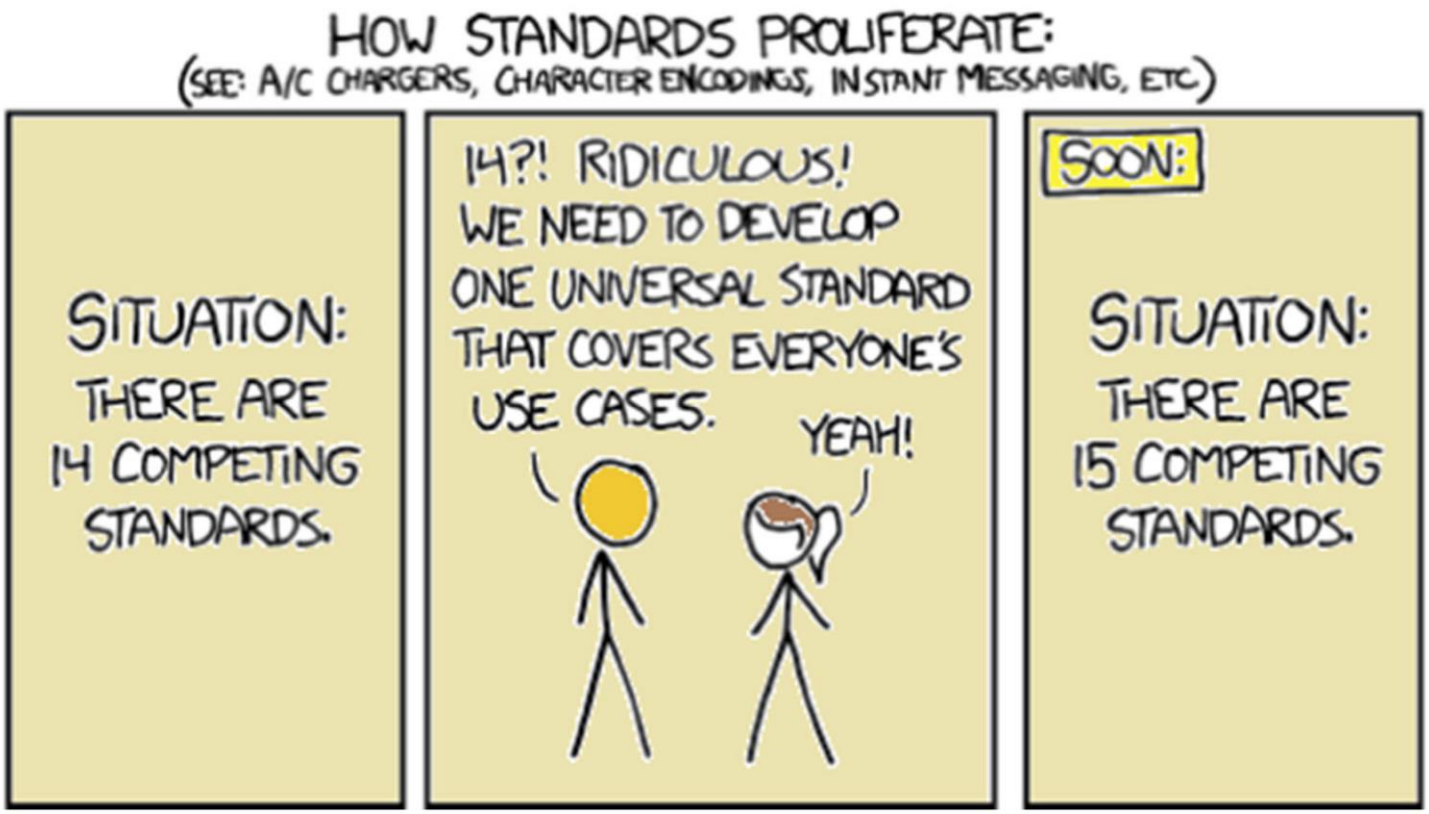
- We need to focus on innovation, values and business models
- Like all competitions, winners differentiate themselves by focusing on unique values
- Focus on solving key pain points in business, living, manufacuring, government issues, not technology
- Have a solution architecture, not an IoT architecture

Source: Institute for Information Industry, Taipei, Taiwan, R.O.C

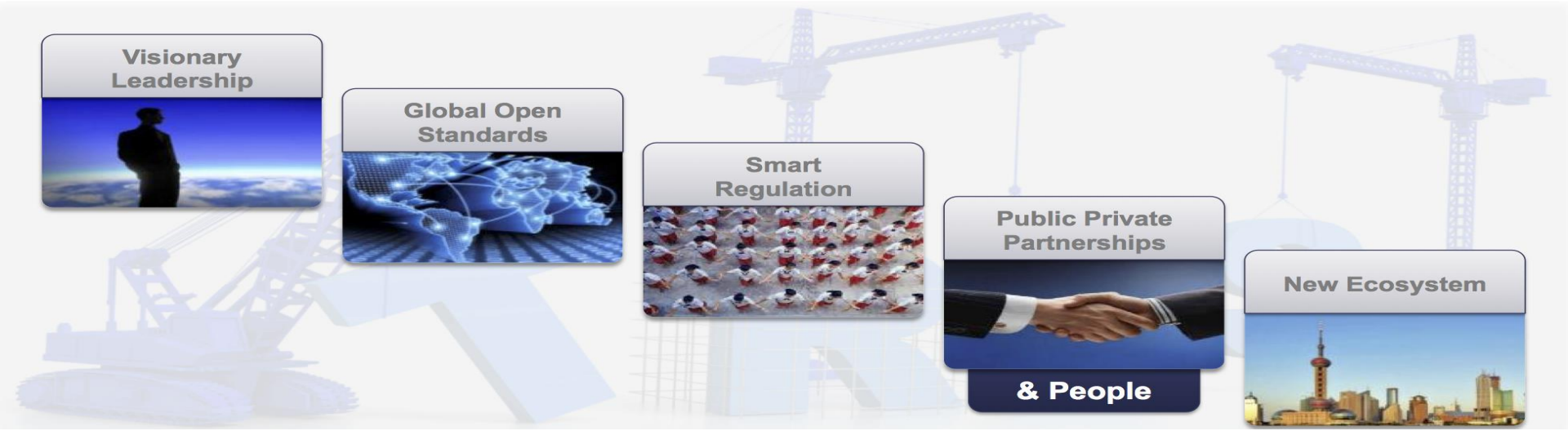
How Smart Objects will Comunicate?

- ✓ Many protocols are currently used such as SensorML, COAP, MQTT, ... each one adhering to a communication paradigm. Another Protocol Battle ?
- ✓Many Operating Systems...
- ✓What Middleware?
- ✓ What Network?
  - ✓“wired” (cable, xDSL, optical, etc.)
  - ✓wireless cellular (GSM, GPRS, EDGE, 3G, LTE-M, WiMAX, etc.)
  - ✓wireless “capillary”/short-range (WLAN, ZigBee, IEEE 802.15.4x, WMBUS, etc.)
- ✓ IoT on Public Networks or on Lower Range/Capillary Networks ?

Interperability: Another killer Standard?



A New Industry



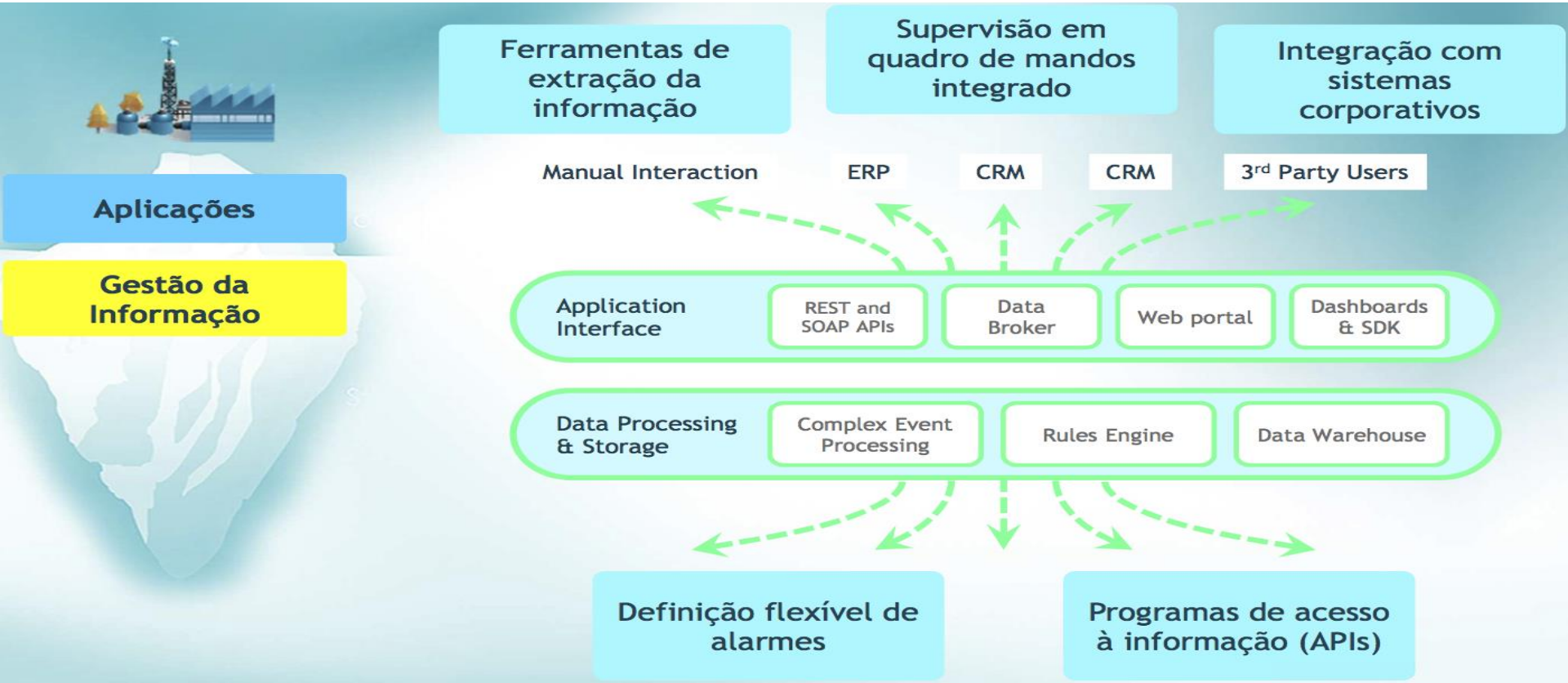
IoT Today

Infraestrutura será absolutamente essencial para integração de todos os players, viabilizando o crescimento ao invés de impedi-lo

IoT Today

Source: Telefonica/Vivo, 2013 (adaptado)

IoT Today



Source: Telefonica/Vivo, 2013 (adaptado)

IoT Today

Source: Telefonica/Vivo, 2013 (adaptado)

IoT Today

Aplicações

Gestão da Informação

Gestão de Dispositivos

Gestão da Conectividade

- Disponibilidade da comunicação é chave
- Gestão complexa e altos custos para garantir níveis de serviços
- A rede móvel é a alternativa mais vantajosa

- Infraestrutura e tecnologia de ponta
- Mobilidade
- Integração global
- Experiência na gestão de grandes volumes

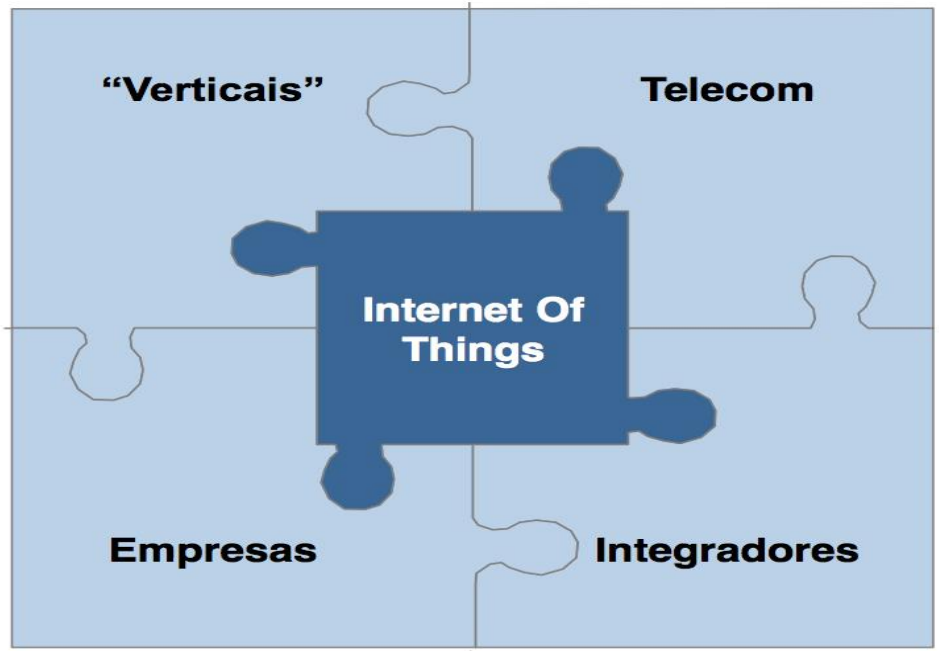
Source: Telefonica/Vivo, 2013 (adaptado)

IoT Today

Source: Telefonica/Vivo, 2013 (adaptado)

Para que a IoT ganhe escala e se massifique é necessária a evolução de todos as "peças" envolvidas no processo

Cada setor da economia é um "vertical", com características próprias, (padrões, regulamentos, etc) e que na era da IoT deverão evoluir para características comuns



Na era da IoT conectividade tende a ser commodity e as operadoras de telecom devem evoluir na cadeia de valor para não serem apenas "tubos" por onde passam as informações

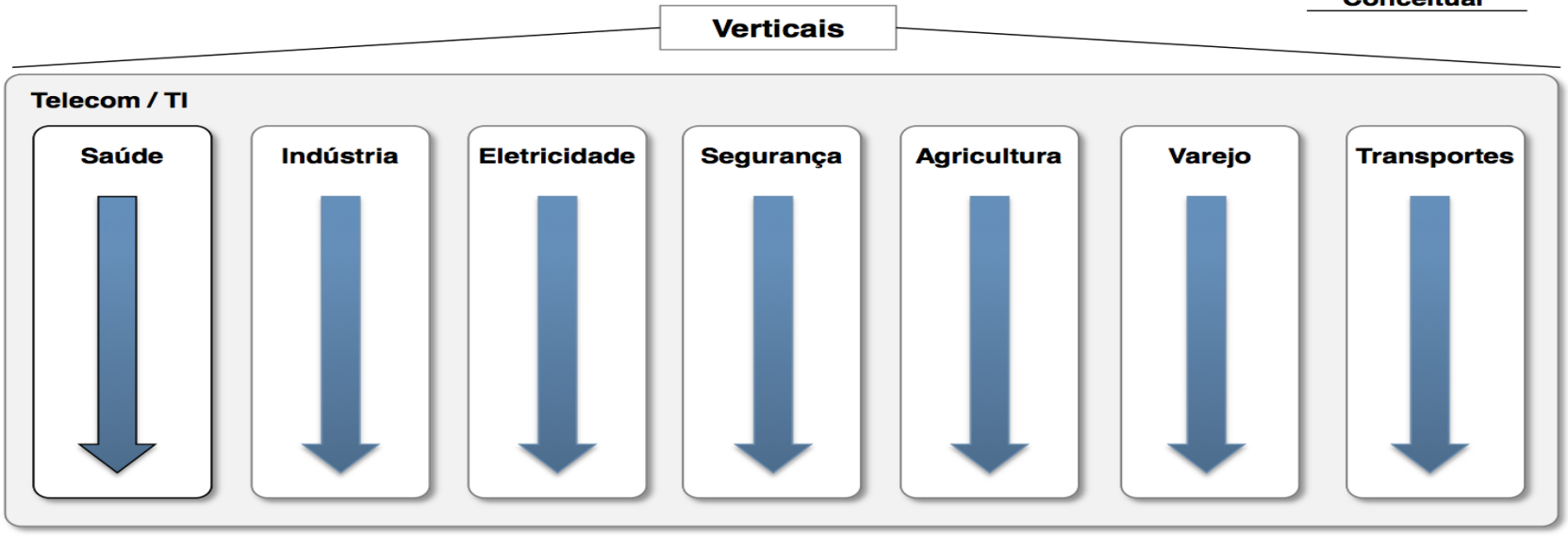
As empresas precisam estar preparadas para entrarem na era do "Big Data" assim como deverão rever suas formas de atuação na era da IoT

Os integradores de soluções terão um dos papéis mais importantes na era da IoT, e deverão desenvolver soluções mais inteligentes e flexíveis do que hoje em dia

Source: Estratégia Oi

Os setores da economia deverão repensar a forma como atuam e também como interagem entre si...

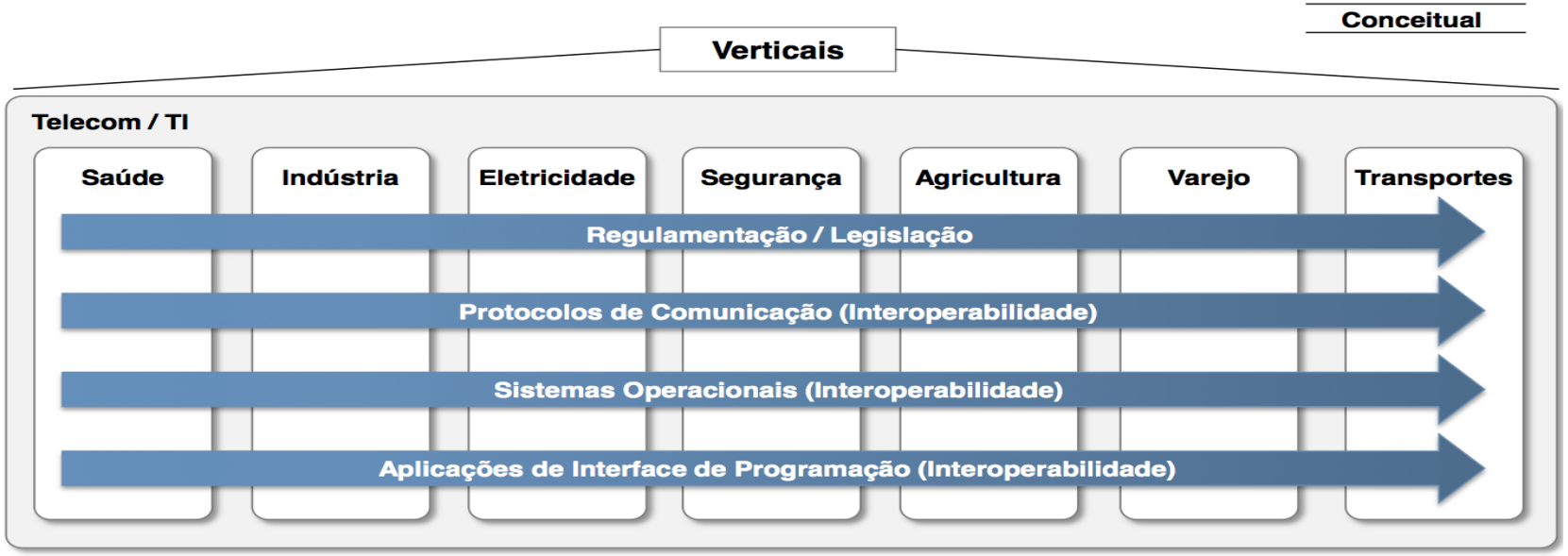
Conceitual



Cada "vertical" possui características específicas que dificultam a integração horizontal de aplicações e serviços	• Regulamentação / Legislação • Protocolos de comunicação • Sistemas Operacionais • Aplicações de interface de programação abertas

Source: Estratégia Oi

Passando de uma realidade de padrões verticais para uma de padrões horizontais, que possibilitarão o desenvolvimento sustentável da IoT



Todas os regulamentos / legislações, assim como sistemas de TI devem seguir um mesmo padrão para que as barreiras verticais sejam superadas e o IoT se desenvolva plenamente

Source: Estratégia Oi

Is the new paradise for the market, for the industry and for the cities?

✓We must remain cautious, as advancements in IoT will come with grave consequences if it is not suitably protected.

✓Common problems have been observed within the security of IoT and these issues are extremely vulnerable to hackers. So let's change the dynamics of security from the ground up.

✓Proprietary closed source development is a recurring trait in IoT devices that have been breached; and even though this is seen as a more traditional approach, it is outdated.

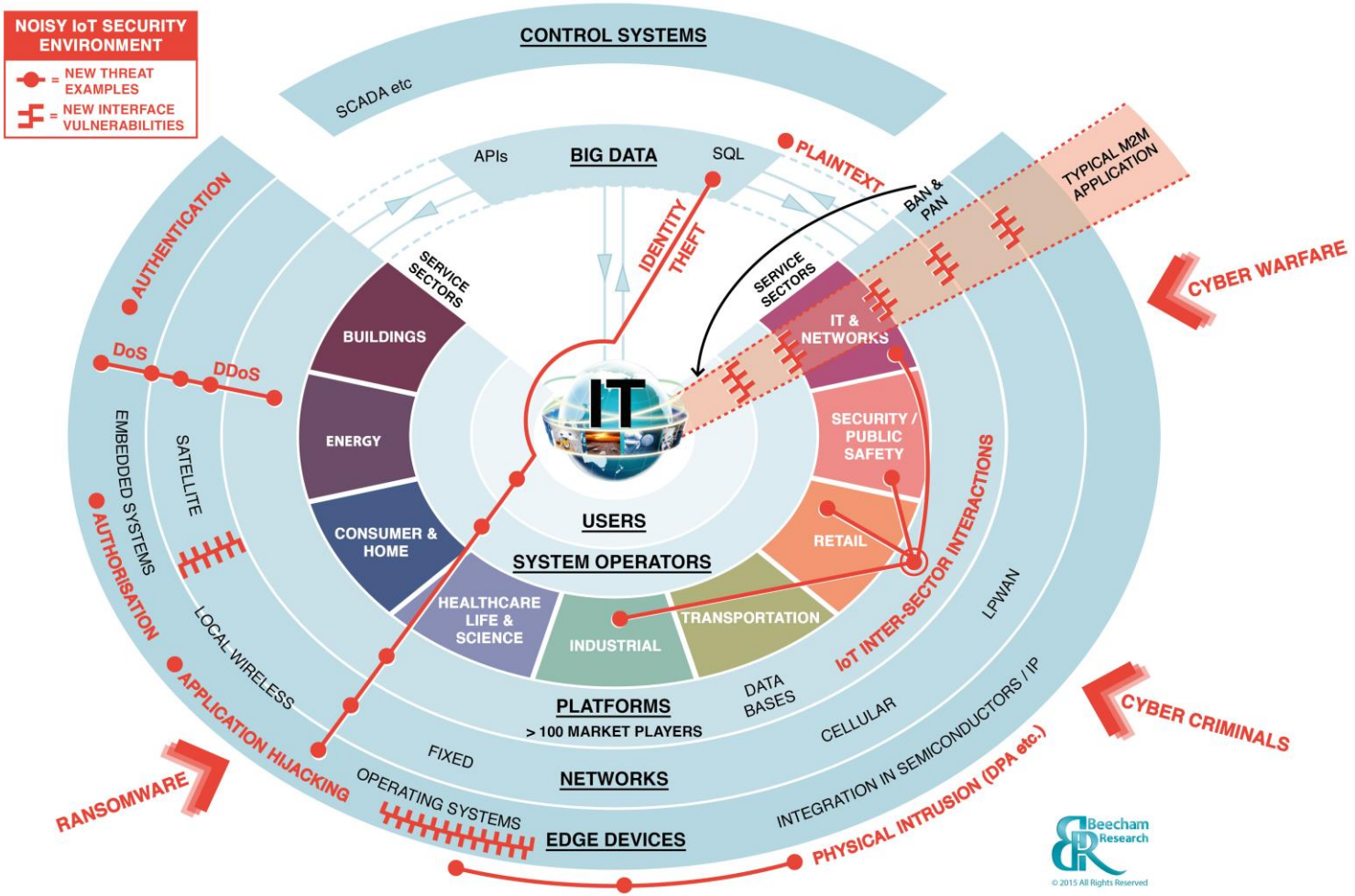
Is the new paradise for the market, for the industry and for the cities?

✓ Firmware binary code is easily accessible online with debugging tools and interactive disassemblers such as jTag also available. Security by obscurity simply doesn't exist anymore – if it ever did.

✓Secure boot needs to be enforced as the firmware update system in today's devices is flawed in that it's not signed.

✓The hackers behind the attacks were able reverse engineer the code, modify it, re-flash the firmware and reboot to execute arbitrary code.

IoT Security Threat Map



Some vulnerabilities of IoT applications

✓ The potential for applications inside edge devices to be hijacked;

✓ Increasing accessibility through communications enabling (Distributed) Denial-of-Service and Denial-of-Sleep attacks;

✓The complexities of IoT systems targetting multiple sector verticals;

✓ The proliferation of internal interfaces and their introduction of weaknesses in advanced IoT solutions.

Security

http://www.ibtimes.co.uk/samsung-smart-home-system-found-vulnerable-hacking-1557973

https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/

http://fusion.net/story/192189/internet-connected-baby-monitors-trivial-to-hack/

http://thehackernews.com/2016/02/asus-router-security-hack.html

Security

http://www.theregister.co.uk/2016/04/04/devastating_bug_pops_secure_doors_at_airports_hospitals/

https://www.wired.com/2016/03/hacker-says-can-hijack-35k-police-drone-mile-away/

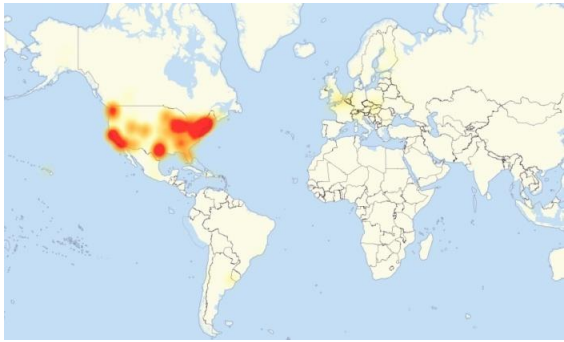
http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm456815.htm

Security

“Mirai is a huge disaster for the Internet of Things,” Xiongmai said in an email to IDG News Service. “(We) have to admit that our products also suffered from hacker's break-in and illegal use.”

Mirai has been found spreading to at least 500,000 devices, according to internet backbone provider Level 3 Communications.

Malware that can build botnets out of IoT devices was at least partly responsible for a massive distributed denial-of-service attack that disrupted U.S. internet traffic on Friday, according to network security companies.



(source: computerworld.com, October, 21, 2016 (last Friday))

HACKERS MAKE NEW CLAIM IN SAN FRANCISCO TRANSIT RANSOMWARE ATTACK

by Tom Spring

November 28, 2016 , 3:30 pm

The San Francisco Municipal Transport Agency said by Sunday it had contained a ransomware attack that occurred Friday which impacted its internal computer and

Major challenges for IoT (2017-2018)

- ✓ IoT Security
  - ✓Security will be complicated by the fact that many "things" use simple processors and operating systems that may not support sophisticated security approaches (Edge device, Root of Trust)
- ✓ IoT Analytics
  - ✓New analytic tools and algorithms are needed now, but as data volumes increase through 2021, the needs of the IoT may diverge further from traditional analytics.
- ✓IoT Device (Things) Management
  - ✓Tools must be capable of managing and monitoring thousands and perhaps even millions of devices.

(source: Gartner, PRPL Foundation, IDC, Mckinsey)

Major challenges for IoT (2017-2018)

- ✓ Low Power, Short-Range IoT Networks
  - ✓Low-power, short-range networks will dominate wireless IoT connectivity through 2025, far outnumbering connections using wide-area IoT networks
- ✓ IoT Processors
  - ✓As with all hardware design, there are complex trade-offs between features, hardware cost, software cost, software upgradability and so on. As a result, understanding the implications of processor choices will demand deep technical skills
- ✓IoT Operating Systems
  - ✓Traditional operating systems (OSs) such as Windows, Android and iOS were not designed for IoT applications.

(source: Gartner, PRPL Foundation, IDC, McKinsey)

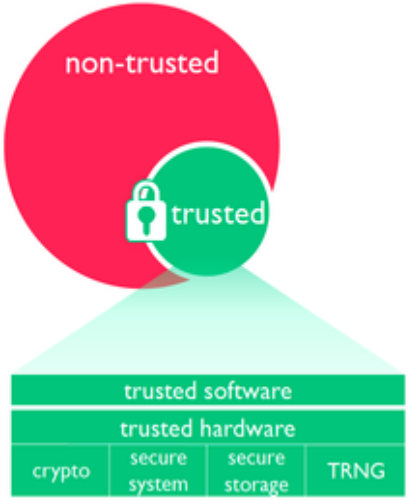
Major challenges for IoT (2017-2018)

- ✓ IoT Platforms
  - ✓IoT platforms bundle many of the infrastructure components of an IoT system into a single product.
- ✓ IoT Standards and Ecosystems
  - ✓Standards and their associated APIs will be essential because IoT devices will need to interoperate and communicate, and many IoT business models will rely on sharing data between multiple devices and organizations
  - ✓Many IoT ecosystems will emerge, and commercial and technical battles between these ecosystems will dominate areas such as the smart home, the smart city and healthcare.

(source: Gartner, PRPL Foundation, IDC, McKinsey)

Security Solution?

ARM TrustZone Principles



Separation

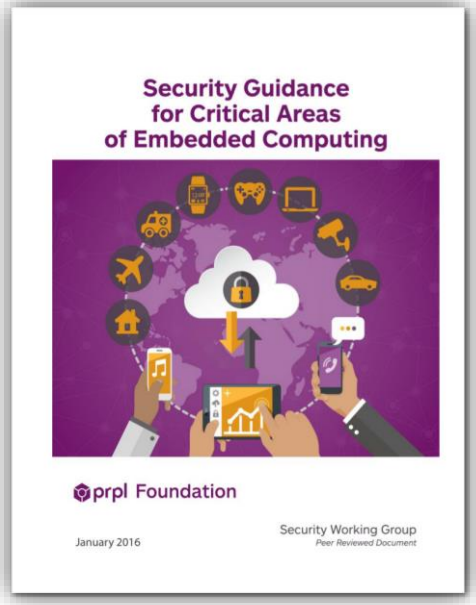
- Isolate trusted resources from non-trusted
- Isolate non-trusted software
- Reduce attack surface of key components

Trusted Software

- Provision of security services
- Small, well reviewed code

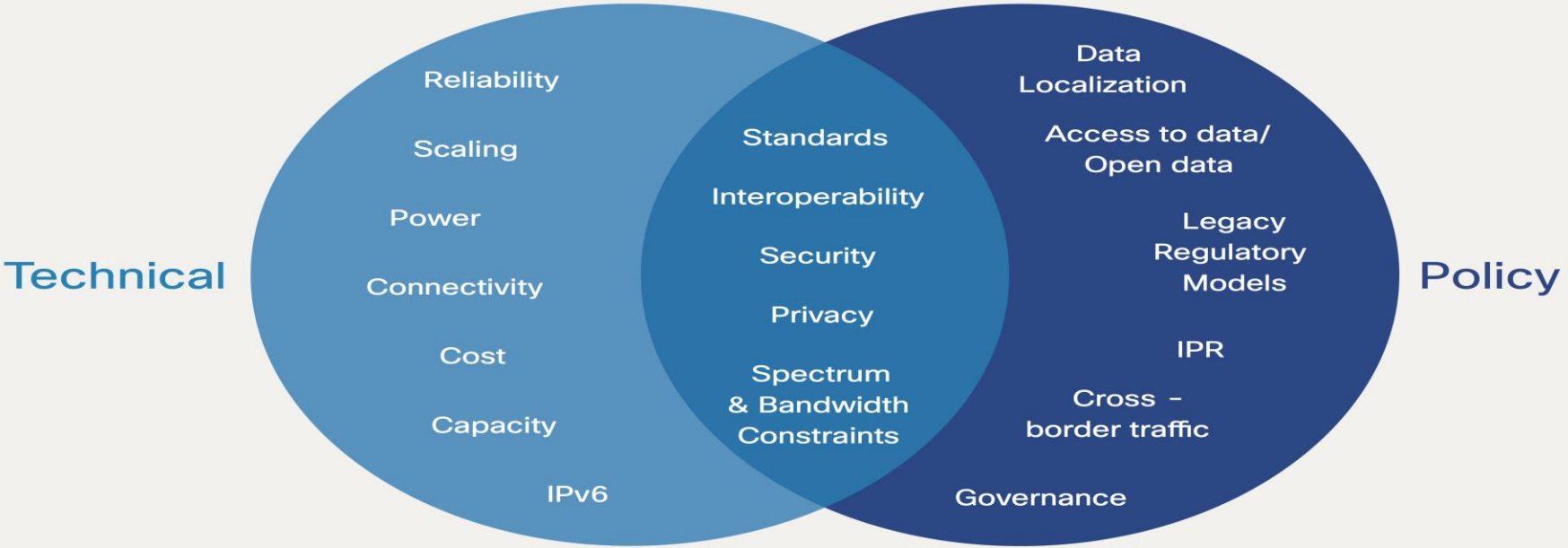
Trusted Hardware

- Hardware assist for cryptography
- Secure access validation built into SoC



PRPL is a open-source, community-driven, non-profit foundation, based on MIPS processors

Brazil (and World) Challenges



Source: Pepper, R. & Garrity, J. (2014) The Internet of Everything: How the Network Unleashes the Benefits of Big Data. Global IT Report 2014. WEF. http://www3.weforum.org/docs/GITR/2014/GITR_Chapter1.2_2014.pdf

Some Examples

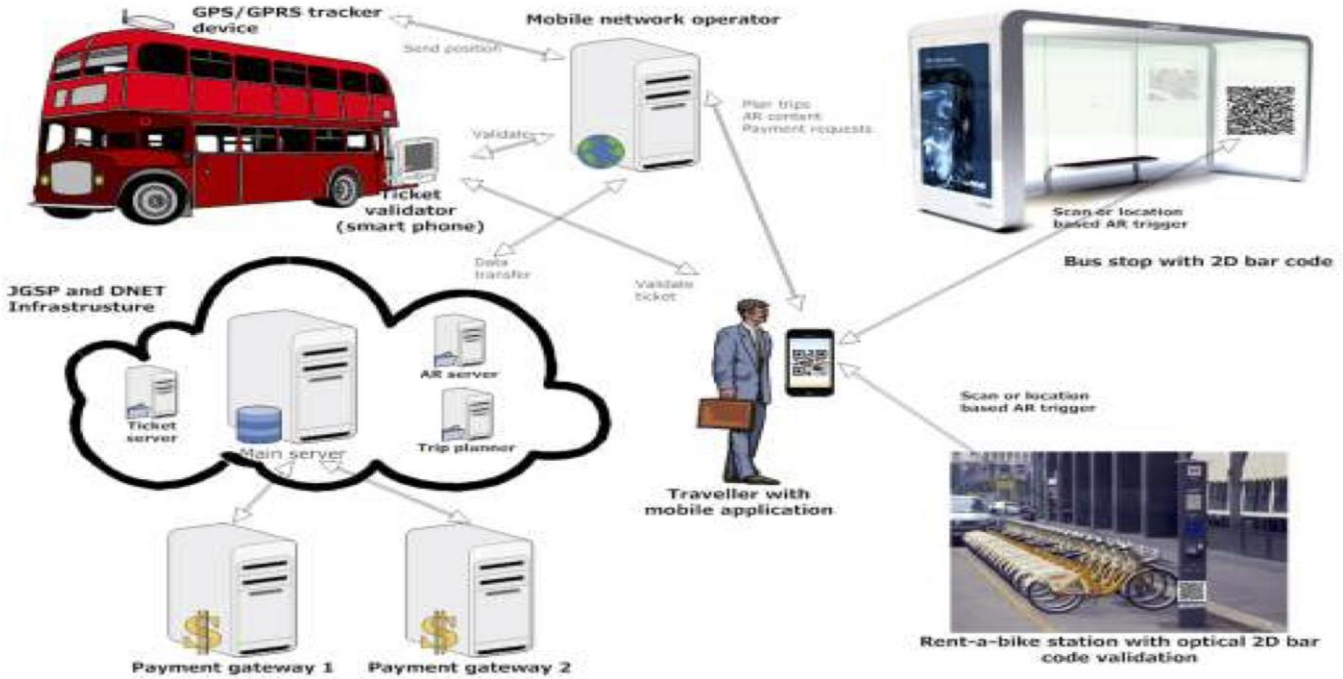
OUTSMART: *"Is about essential city services, the **Utilities**, including water, energy, mobility and waste removal as well as the Environment."*

http://fi-ppp-outsmart.eu/

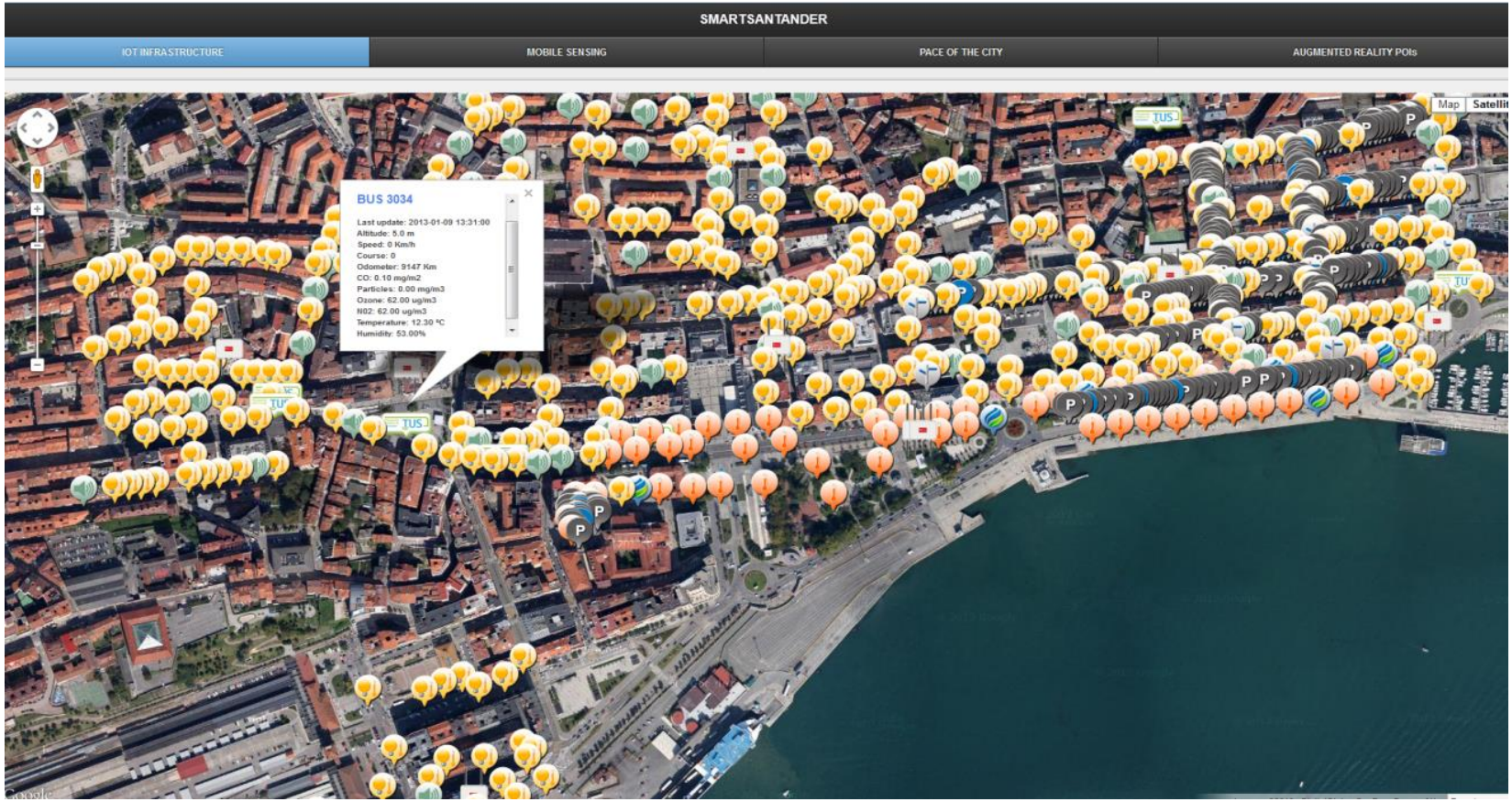
Some Examples - Belgrad

mTicketing in Novi Sad

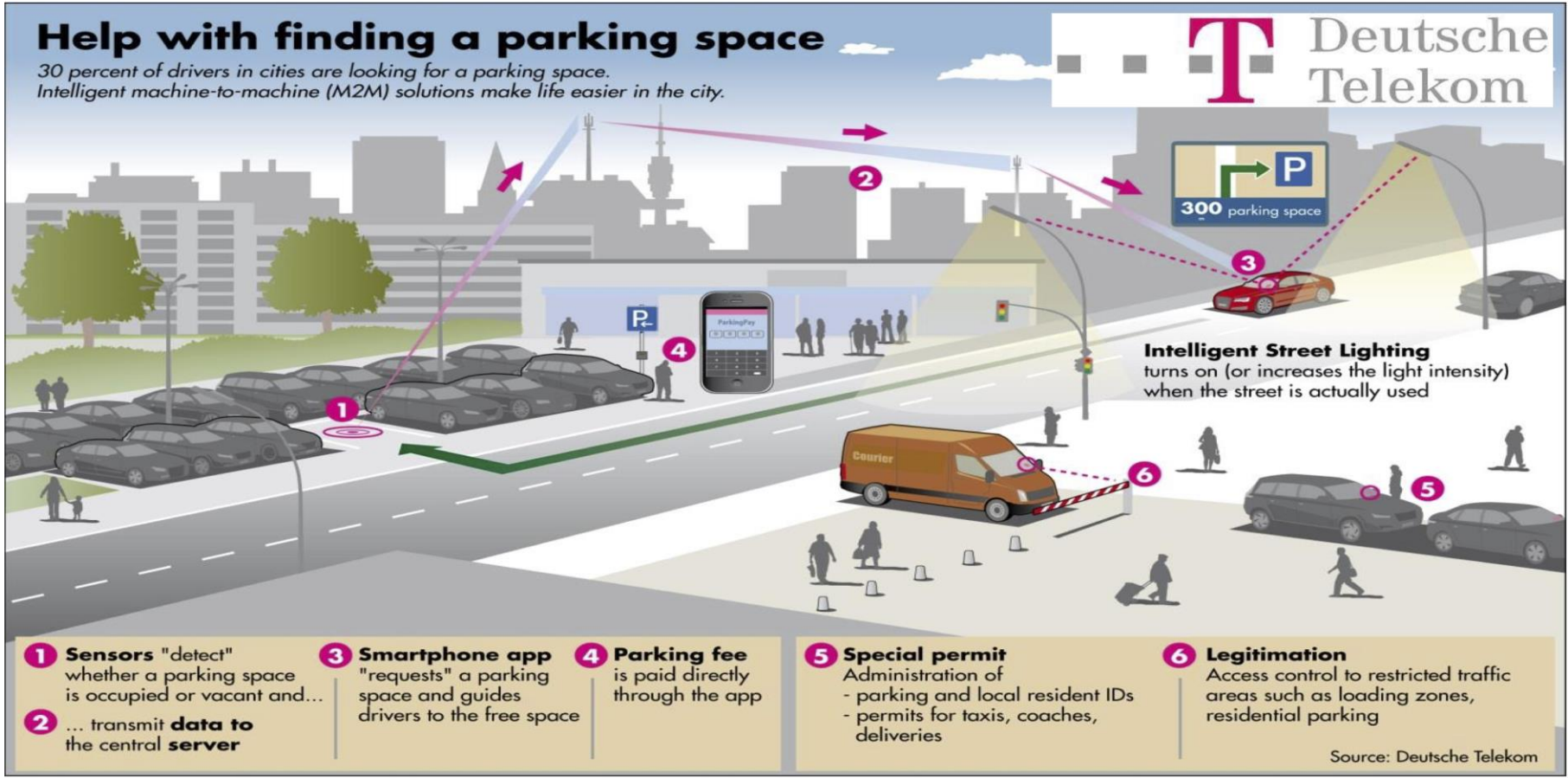
- CIP-PSP MobiWallet



Some Examples - Santander



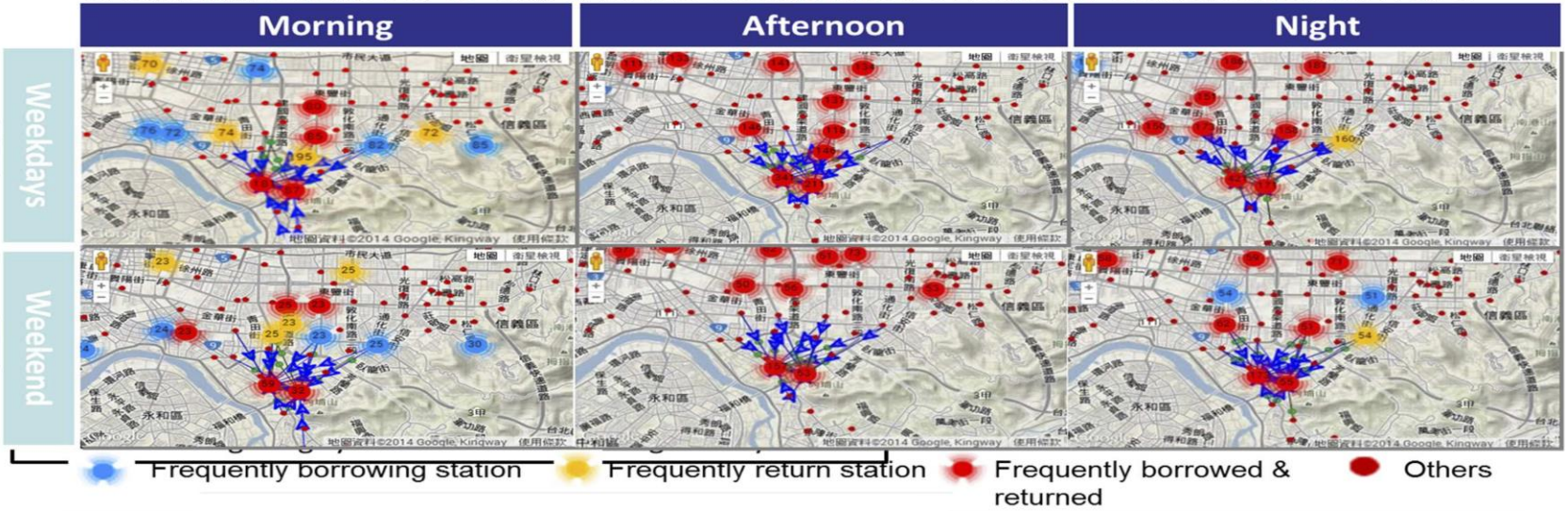
Some Examples - Pisa

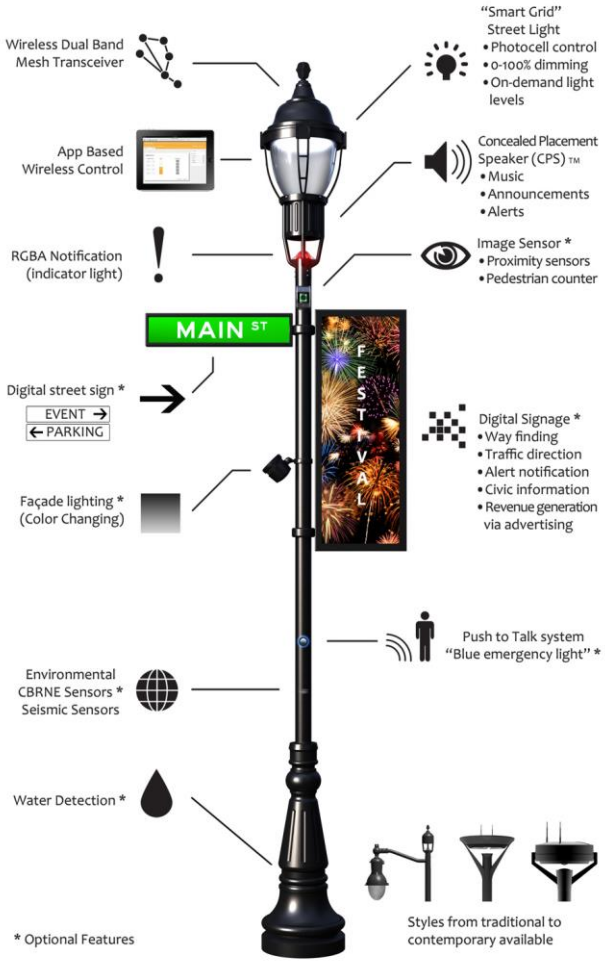


Some Examples - Taiwan

Smart City：Real-time monitoring and management of u-Bike/Subway hot spots

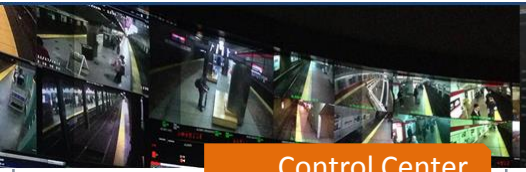
- Provide real-time monitoring of traffics route hot spots, identify patterns of activities in different periods, to avoid congestions and to maximize uses
- Analyze the ride/activities information to identify popular public activity areas, combined with personal preferences & stores promotions to provide O2O shopping services, to expand the economic benefits of transportation hubs

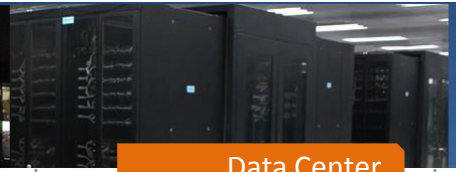



Wireless Dual Band Mesh Transceiver
"Smart Grid" Street Light
• Photocell control
• 0-100% dimming
• On-demand light levels
App Based Wireless Control
Concealed Placement Speaker (CPS) ™
• Music
• Announcements
• Alerts
RGBA Notification (indicator light)
Image Sensor *
• Proximity sensors
• Pedestrian counter
MAIN ST
FESTIVAL
Digital street sign *
EVENT
PARKING
Digital Signage *
• Way finding
• Traffic direction
• Alert notification
• Civic information
• Revenue generation via advertising
Façade lighting * (Color Changing)
Push to Talk system "Blue emergency light" *
Environmental CBRNE Sensors * Seismic Sensors
Water Detection *
* Optional Features
Styles from traditional to contemporary available

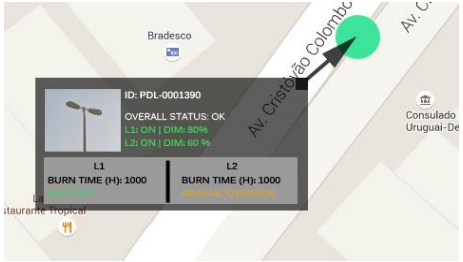

CITYLIGHT Street Lamp
CITYLIGHT is a hybrid urban illumination system driven by two distinct sources: human-power and electricity. The lamp uses energy saving LED as light source to replace traditional bulbs. Located in public areas, the lamps are connected to outdoor fitness facilities which carry and transfer human power generated to the light system. The interactive linear lighting pattern in the central of the pole indicates if the LED lamp is being charged by human-power and presents current battery status, which encourages people to participate the green exercise.

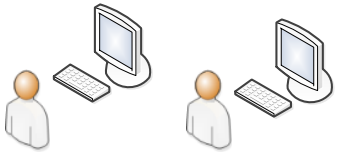
Smart Public Lightning Proof of Concept





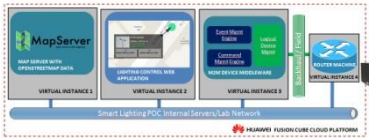
Control Center





Data Center

Servidor



Backhaul

Infraestrutura de Comunicação

Field

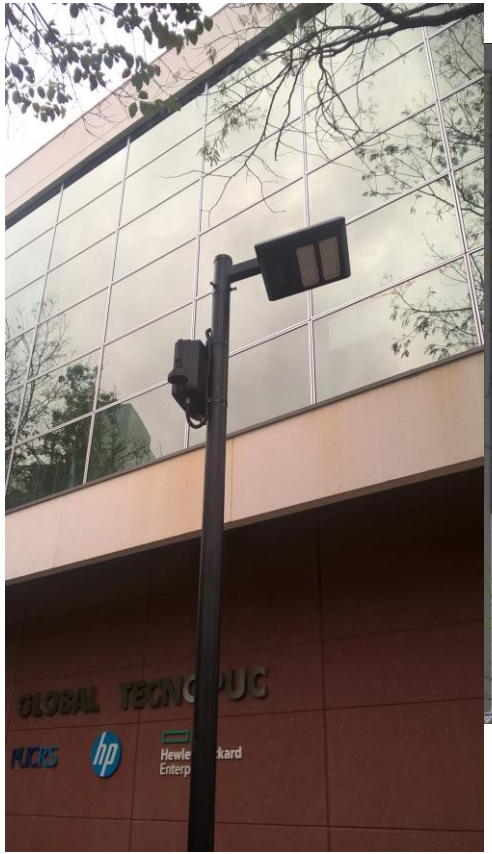
HUAWEI
EG860 CPE

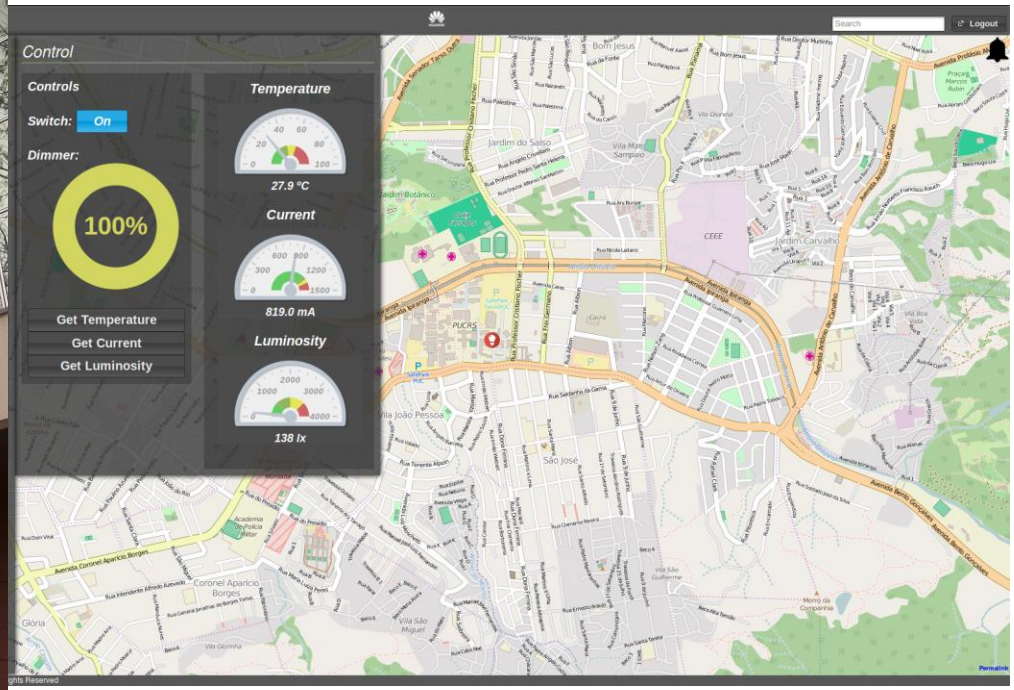
PUCRS
IoT Gateway Logic

ZigBee Mesh Network

PUCRS
Light Point Controller

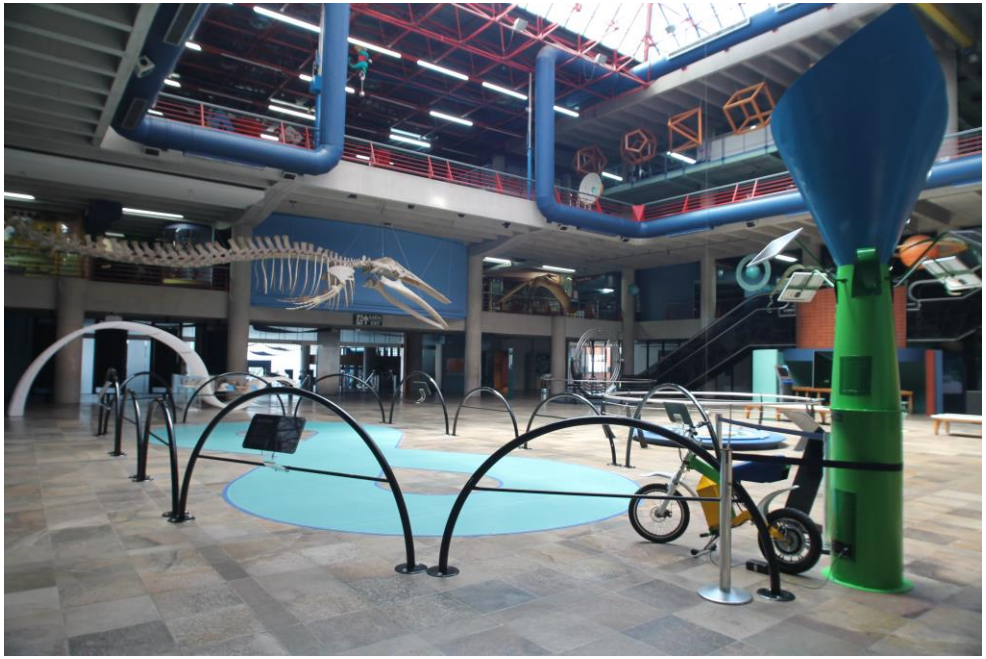
Smart Public Lightning Proof of Concept





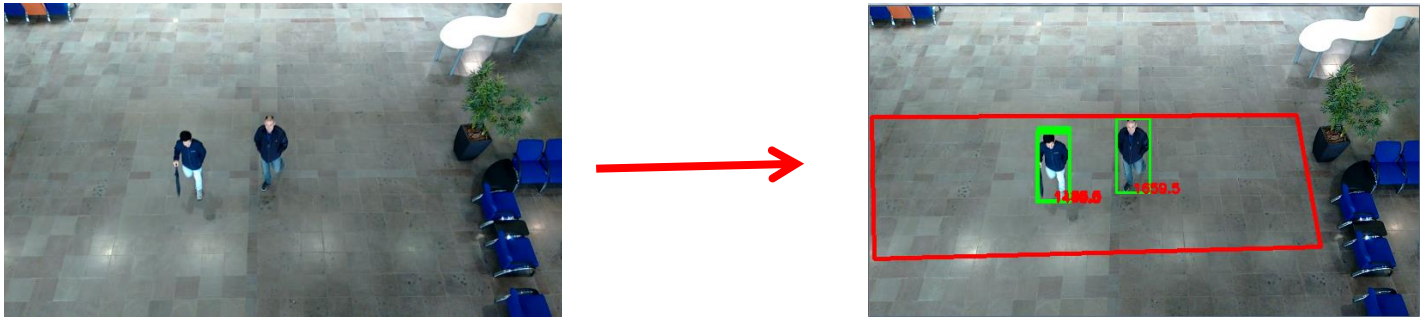
- Gerenciamento Remoto
- Fácil de adicionar novos sensores
- Fácil de adicionar novos serviços
- Solução aberta

Green Campus



Detecção de Movimento – Automóveis (Estacionamento)

Detecção de Movimento – Pessoas



Saguão do prédio da Faculdade de Informática

Security and Health Proof of Concept

INTEGRATED COMMAND CENTRE OF PORTO ALEGRE (CEIC)

VIDEO FEED

VPN

ROUTER

VM

Internal Lab Network

VIDEO STREAMING SERVER - FFmpeg

FFMPEG

DATA CAPTURE MIDDLEWARE

VIDEO/ VITALS FEED

SAMU EMERGENCY CENTRAL

VPN

VIDEO FEED AND PATIENT VITALS FROM ALS AMBULANCE

3G

2G

LTE

VIDEO FEED and CAMERA PROGRAMMING

FUSION CUBE CLOUD PLATFORM
Huawei PUCRS Smart City Innovation Center Laboratory

HUAWEI

SAMU ALS - ADVANCED LIFE SUPPORT AMBULANCE INTERIOR

CITY STREETS – EMERGENCY SITUATION/MEDEVAC

Challanges and Opportunities

1. To create collaborative initiatives for the development of solutions (local problems, global solutions) that can be replicated in other cities;
2. Solutions are not only technological, they must contemplate multidisciplinary teams. Think the city to its fullness (Green City);
3. Consider the expansion of communication infrastructure;
4. Promote and support an IoT ecosystem for the city (Living City), including support for start-ups, incubators and technology transfer;
5. Facilitate innovation and development, eliminating constraints that slow innovation (eg restrictions related to data transmission or administrative);
6. Promote and facilitate interoperability across the IoT ecosystem for cities, fostering investment, competition, and enabling low-cost solutions;
7. Ensure privacy and security;

A Major Challenge of Smart Cities/IoT

Global Cooperation !!!

FACULDADE DOM BOSCO
PORTO ALEGRE-RS

Thank You

Prof. Filipo Mór
filipomor.com