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PANEL FUTURE TECHNOLOGIES/URBAN/EMPIRICAL

From Today's to Tomorrow's Technologies: The Winners are....

Today's Panelists

- **Moderator:**
  Petre Dini, Concordia University, Canada || China Space Agency Center, China
- **Panelists:**
  Roberto de Bonis, Telecom Italia, Italy
  Evolution of wireless and mobile networks for the Smart urban ecosystem
- **Ian Flood, University of Florida, USA**
  Trends in empirical modeling
- **Steffen Fries, Siemens AG, Germany**
  Security technologies in critical infrastructures
- **Eugen Borcoci, University Politehnica Bucharest, Romania**
  Centralized/Distributed/Centralized…
- **Claus-Peter Rückemann, Leibniz Universität Hannover / Westfälische Wilhelms-Universität Münster (WWU) / North-German Supercomputing Alliance (HLRN), Germany**
  Computation/Performance/…

Directions

- 2G/3G/4G/5G
- Global Security/Privacy
- High Performance/Data Centers/
- Smart Environments/Urban computing
- Do-It-Yourself healthcare systems
- Centralized/Distributed environments
- Agile/Crowdsourcing/…

➔ Open stage

Thanks!

Qs & As

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Panel on FUTURE TECHNOLOGIES/URBAN/EMPIRICAL

Topic: From Today's to Tomorrow's Technologies: The Winners are....

Eugen Borcoci
University Politehnica Bucharest
Electronics, Telecommunications and Information Technology Faculty (ETTI)

Eugen.Borcoci@elcom.pub.ro

Panel on FUTURE TECHNOLOGIES/URBAN/EMPIRICAL

- **Topic: Centralized versus distributed control concepts in networking and services**
  - **Motivation of this talk**
    - **History:**
      - IT – computing, mainframes (~ 60-70'..)
      - Telecom Networks and Services (~70'….)
      - DARPA ….--.> Internet (~ 80'…) (client – server model)
      - Convergence/integration : ICT (~ 2000, ….)
      - INTERNET becomes the global basis for service integration (~2005)

      - Current and Future Internet
        P2P (> 2000), Social networks
        Cloud computing (Data Centres and WANs)
        Internet of Things (IoT)
        New technologies in networking and services: SDN, NFV, ….
        New services and applications in all domains of the society
        ……

Centralized versus distributed control concepts in networking and services

- **Centralization vs. distribution- of M&C ?**
  - **General characteristics**
    - System complexity has continuously grown
    - **Management and control (M&C):** more and more important
      - **Control:** short term actions (routing, session signalling and control, ACL, resource reservation, traffic load balancing, ICMP- related actions, QoS-control, etc)
      - **Management:** mid-long term actions (classic FCAPS + policies, SLAs, orchestration, ….)

- **History- w.r.t. centralization /distribution approach**
  - **A. Computer networks + High level services/applications**
    - 60’-70’: IBM mainframe + radial access, small speed (centralized M&C)
    - 80’- 2015: Distributed Internet + PC/Laptops/…. (distributed M&C)
    - > 2005: Cloud/SDN/NFV – (partially) coming back to 'centralized view'
  - **B. In parallel, telecommunication networks and services:**
    - **usually/traditionally - centralized M&C (e.g., SS7)**
    - **-** still they preserve such approach - e.g., NGN/IMS, etc.
    - started to adopt distributed approach while re-directing towards IP technologies

Centralized versus distributed control concepts in networking and services

- **Question: Today and near future, in converging (large) systems**
  - **what kind of M&C??**
- Most people agree a "natural" answer:
  - **no absolute "winner" (i.e. fully centralized or fully distributed)**
  - **Hybrid M&C approaches** seems to be "better" – however they should be tailored to the specific context/environment
    - **Attempt to take benefit from the native advantages of each approach**
      - *Centralization (+):* overall image on the system, coherent global policies, resource provisioning capabilities, abstraction of the system image/status offered to third parties (upper layers), etc.
      - *Distribution (+):* flexibility, less signalling overhead, good dynamic behaviour (lower response time), better reliability (no single point of failures), fit to autonomic management, P2P native capabilities
    - **Additional requirement**: preserve a convenient degree of inter-operability w.r.t. legacy current systems

Centralized versus distributed control concepts in networking and services

- **Examples of recent technologies:**
- **Software Defined Networking (SDN)**
  - SDN – emergent, promising technology applicable in clouds, WANs, Enterprise, SP networks, etc.
  - SDN – important contribution - to unify and improve M&C
  - High interest: Research groups, Industry groups, Academies, Standards bodies, Fora, etc., currently work on SDN

- **SDN main characteristics**
  - Separation of *Control Plane* from *Data (Forwarding) Plane*
  - **Centrally managed: Network intelligence is (logically) centralized**
  - Programmability
  - Abstraction
  - Independency – on Network equipment vendors

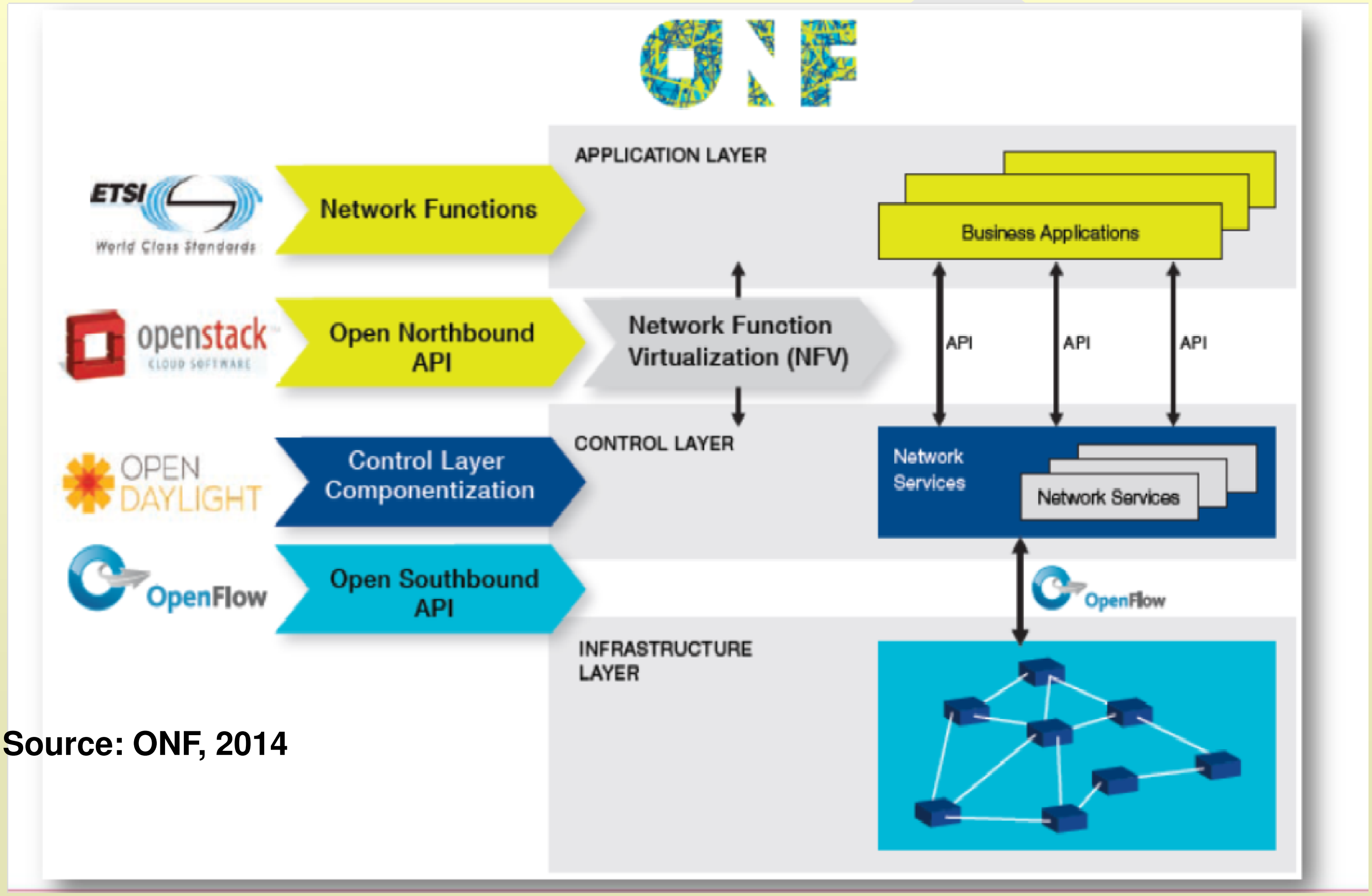
- **Network Function Virtualization**
- Objectives:
  - Using COTS HW to provide **Virtualized Network Functions (VNFs)** through **SW virtualization techniques**
  - Sharing of HW and reducing the number of different HW architectures
  - **Improved flexibility in assigning VNFs to HW**
    - better scalability
    - decouples functionality from location
    - enables time of day reuse

Centralized versus distributed control concepts in networking and services

- **SDN/NFV**
- **Organizations/groups/projects working on SDN/NFV- examples:**
  - OPEN NETWORKING FOUNDATION - ONF
  - INTERNET ENGINEERING TASK FORCE (IETF)s, IRTF
  - EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE
    - INDUSTRY SPECIFICATION GROUP FOR NETWORK FUNCTION VIRTUALIZATION (ETSI NFV ISG)
  - ITU-T Study Group 13
  - OPEN DAYLIGHT- project
  - OPENSTACK- SW tools for building and managing cloud computing platforms
  - ....

Centralized versus distributed control concepts in networking and services

- **SDN- architecture + cooperation with NFV**

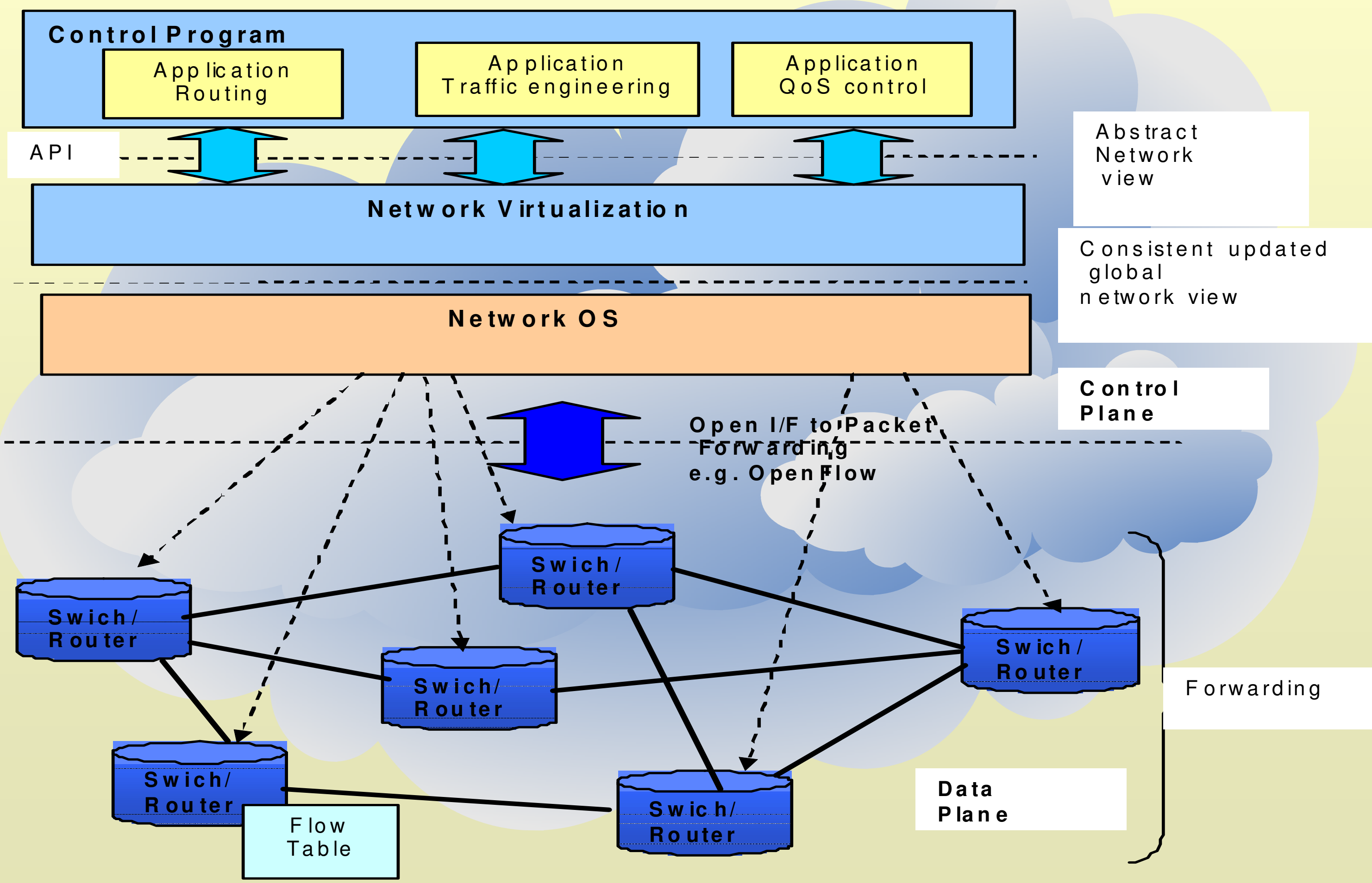


Source: ONF, 2014

Centralized versus distributed control concepts in networking and services

Question on SDN : Centralization/distribution of control ?

- Main SDN concept: logically centralized control /view upon the network



Centralized versus distributed control concepts in networking and services

- **Question on SDN : Centralization/distribution of control ? (cont'd)**
  - Centralization (i.e. controller concept) ➔ issues on: scalability single point of failure, new types of security attacks, real-time response to traffic needs, etc.

  - **Solution?:**
    - Remark: "Centralized control" does not mandatory means the same as "Centralized Control Plane"

    - **Idea: keep (logical) *"Centralized Control"* concept but avoid implementing it centrally (i.e. , no *" Centralized Control Plane"*)**
      - Centralized control plane (implementing in controllers complete set of control-plane protocols) : <u>cannot scale in large network environments</u>

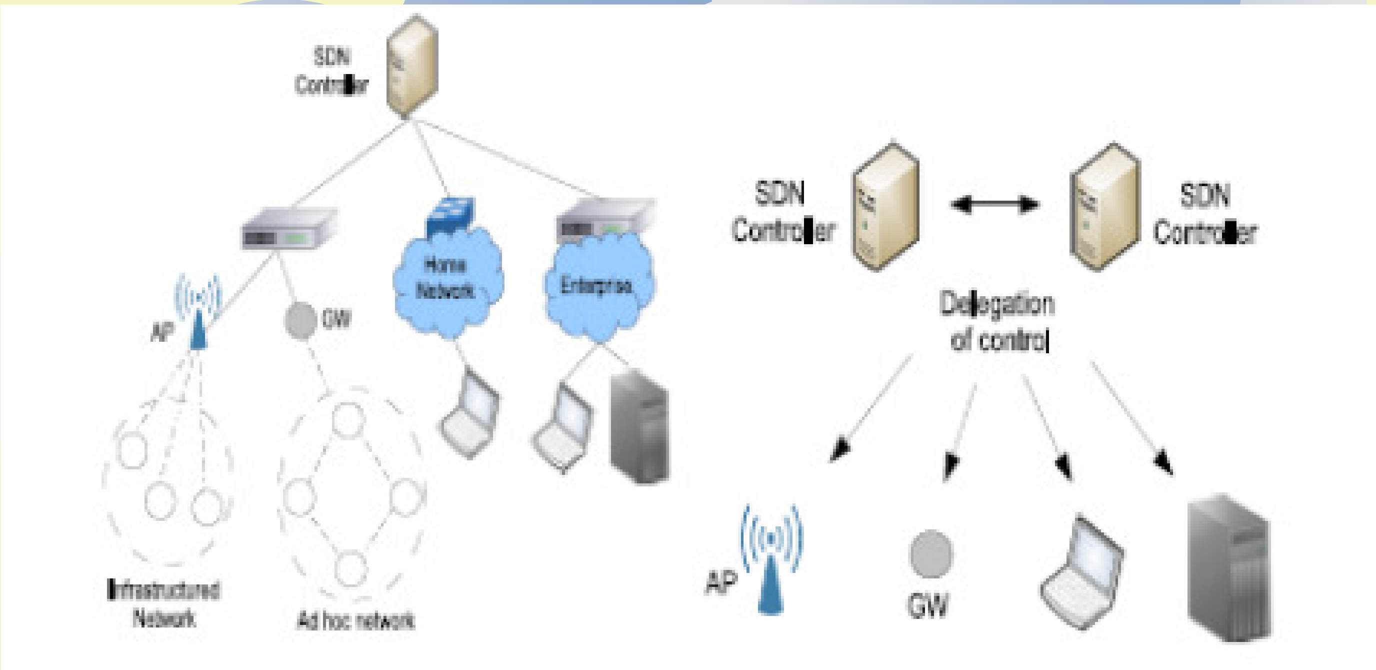
      - On the other side: current Control Plane functions in network devices (or distributed systems) comprising routing, real-time protocols like spanning tree BPDU, LACP, link failure detection mechanisms, ARP, ICMP, etc.- constitute a well defined concept that should be exploited further

Centralized versus distributed control concepts in networking and services

- **Question on SDN : Centralization/distribution of control ? (cont'd)**
  - **Example 1**
  - **SDN: Service Chaining Functions**
  - **IETF draft 2015 proposals : "Service Function Chaining (SFC) Control Plane Components"**, IETF, 2015, draft-ww-sfc-control-plane-05
    - ***SFC management*** (including SFC monitoring and supervision): is likely to be centralized.
    - ***SFC Mapping Rules*** (how to bind a flow to a SFC are likely to be managed by a central SFC Control Element, but the resulting policies can be shared among several Control Elements)
    - ***Path computation*****:** can be either distributed or centralized.
      - *Distributed* : the selection of the sequence of SF functions to be invoked (+ instances and/or SF Forwarder locator info) is computed by a distributed path selection algorithm executed by involved nodes
      - For some TE purposes, the SFP may be constrained by the CPI (fully or partially specified)
    - **SFC Resiliency (including restoration)**
      - Both centralized and distributed mechanism to ensure SFC resiliency can be envisaged

Centralized versus distributed control concepts in networking and services

- **Question on SDN : Centralization/distribution of control ? (cont'd)**
  - **Example 2**
  - **SDN:**
    - Defining a control hierarchy of main controllers (MCs) and secondary controllers (SCs)
    - Delegate some functions to SCs



Source: M. A. Silva Santos, et.al., "Decentralizing SDN's Control Plane", HAL Id: hal-01019919, https://hal.inria.fr/hal-01019919

Centralized versus distributed control concepts in networking and services

- **Conclusions**
  - **No unique/universal solution**
  - Adaptation to the context, system dimension, goals, etc. - is necessary
  - **Hybrid approaches** – greater chances to be adopted
    - Logical centralization of M&C
    - Hierarchical/distributed implementation
    - Allow seamless deployment

Centralized versus distributed control concepts in networking and services

- Thank you !

Centralized versus distributed control concepts in networking and services

References

- [1] "Software-Defined Networking: The New Norm for Networks" (ONF white paper)
  - https://www.opennetworking.org/images/stories/downloads/white-papers/wp-sdn-newnorm.pdf
- [2] ETSI ISG NFV "Our Role & Activities,"
  - available: http://www.etsi.org/technologies-clusters/technologies/nfv.
- [3] "Network Functions Virtualization Architectural Framework" – ETSI-GS-NFV 002, 2013
- [4] Open Daylight "Why Opendaylight,"
  - available: http://www.opendaylight.org/project/why-opendaylight.
- [5]"The real-time cloud" http://www.ericsson.com/res/docs/whitepapers/wp-sdn-and-cloud.pdf
- [6] JongSeog Ahn SDN/NFV for Cloud Data Centers: Case Study,
  - available: http://www.krnet.or.kr/board/data/dprogram/1841/F1-4.pdf
- [7] H. Li et.al., "Service Function Chaining (SFC) Control Plane Components & Requirements", IETF, 2015, draft-ww-sfc-control-plane-05
- [8] M. A. Silva Santos, et.al., "Decentralizing SDN's Control Plane", HAL Id: hal-01019919,
  - available: https://hal.inria.fr/hal-01019919

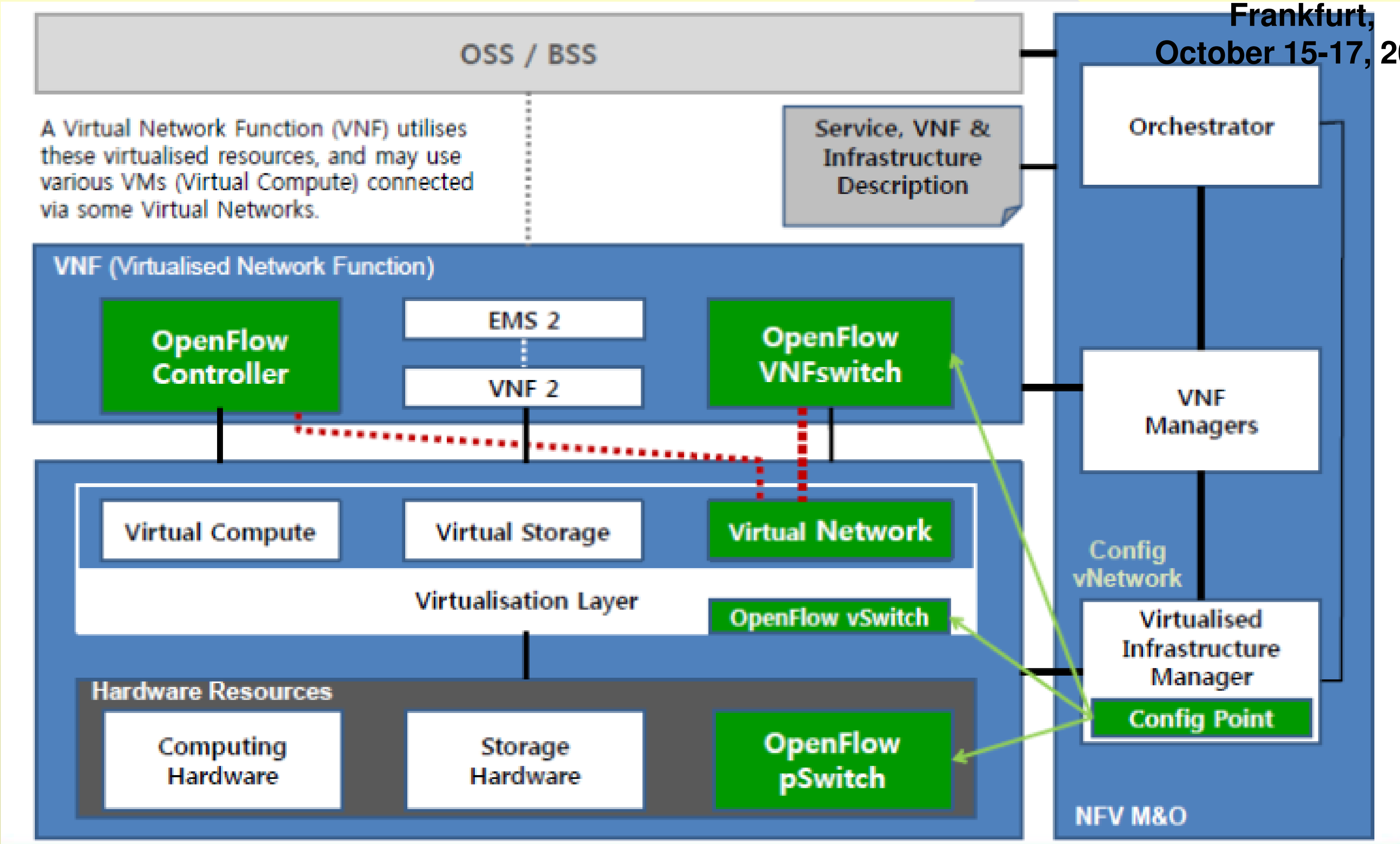
Centralized versus distributed control concepts in networking and services

- Backup slides

Centralized versus distributed control concepts in networking and services

- **SDN and Network Function Virtualization**

"SDN and OpenFlow World Congress", Frankfurt, October 15-17, 2013



SMART | 2015, Panel on Future Technologies, Brussels, Belgium

Cyber Security in Critical Infrastructures

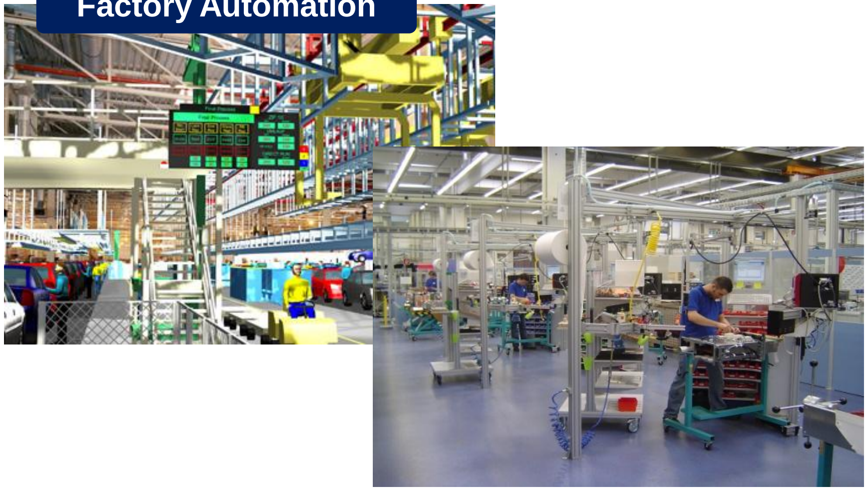
June 25th, 2015

Steffen Fries (steffen.fries@siemens.com), Siemens AG, CT RTC ITS

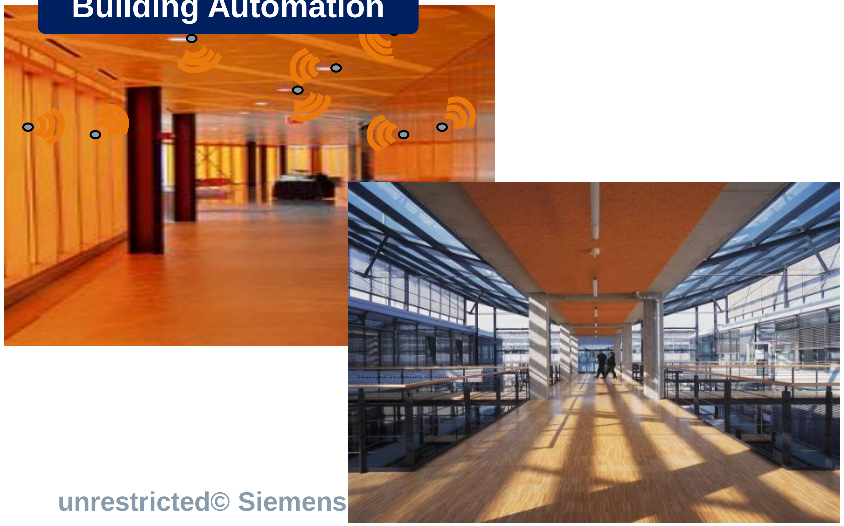
Critical Infrastructure Examples

Process Automation

Factory Automation



Building Automation



Energy Automation

IT-Security Becomes a Pre-requisite for Future Control Systems Driven by Convergence of Safety & Security

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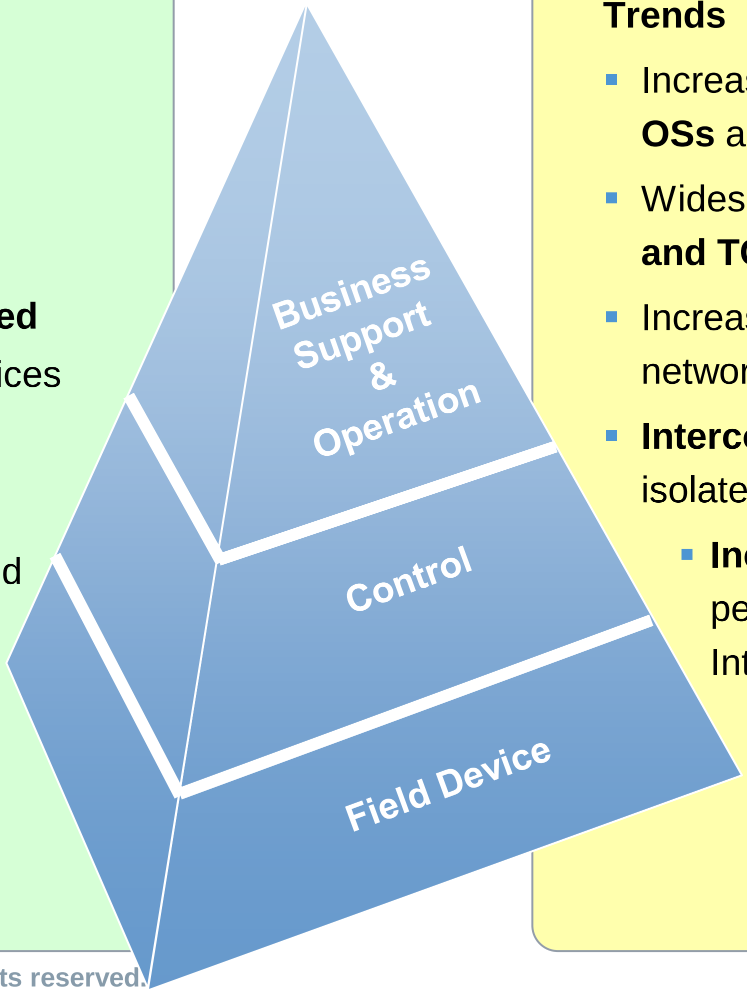
Current Situation

- Predominantly **isolated** communication networks
- Often **proprietary** networks and applications
- **(Limited) Physically secured** access to networks and devices
- **Long lifetime** of control equipment
- Systems are mainly designed for **performance, reliability and safety**, not security
- Often **availability** is the most important security objective



Trends

- Increasing **usage of standard OSs** and applications
- Widespread usage of **Ethernet and TCP/IP** (including Internet)
- Increasing usage of **wireless** networks
- **Interconnection** of formerly isolated networks
  - **Increasing intelligence** in peripheral components (e.g. Intelligent Access Devices)
    - **IT-security becomes a pre-requisite for safety applications**

Remember Cyber Physical Systems are prevalent in Critical Infrastructures

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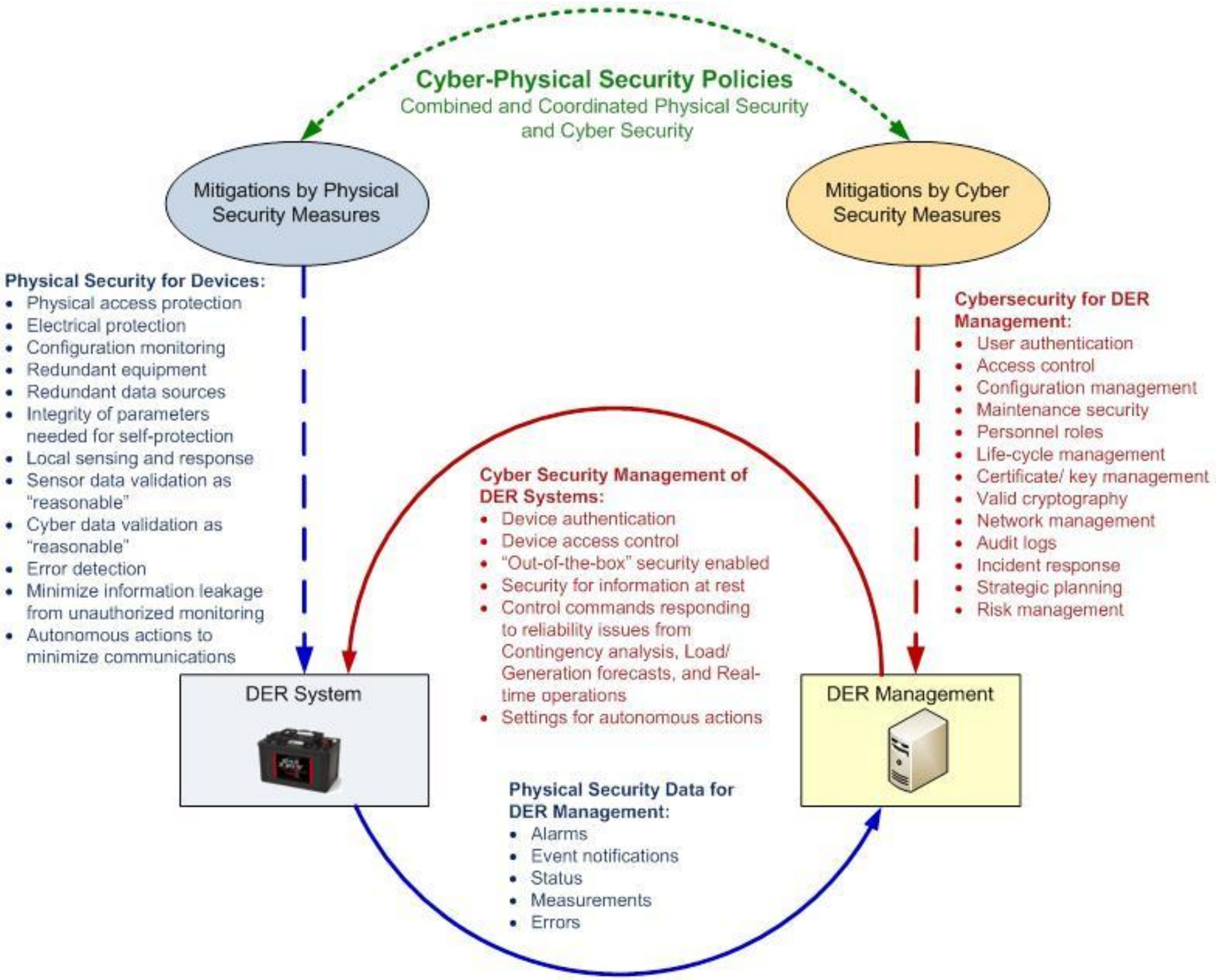
Cyber Physical Systems

- Strong mutual relation between physical and computational components of a system → Effects on physical components also affect the computational part and vice versa
- Examples
  - Smart Grid
  - Process Industry
  - Transportation
  - Healthcare
  - …



Picture taken from IEC TC 57 WG15 internal collection of Smart Grid Standardization

What makes Cyber Security in Critical Infrastructures so important?

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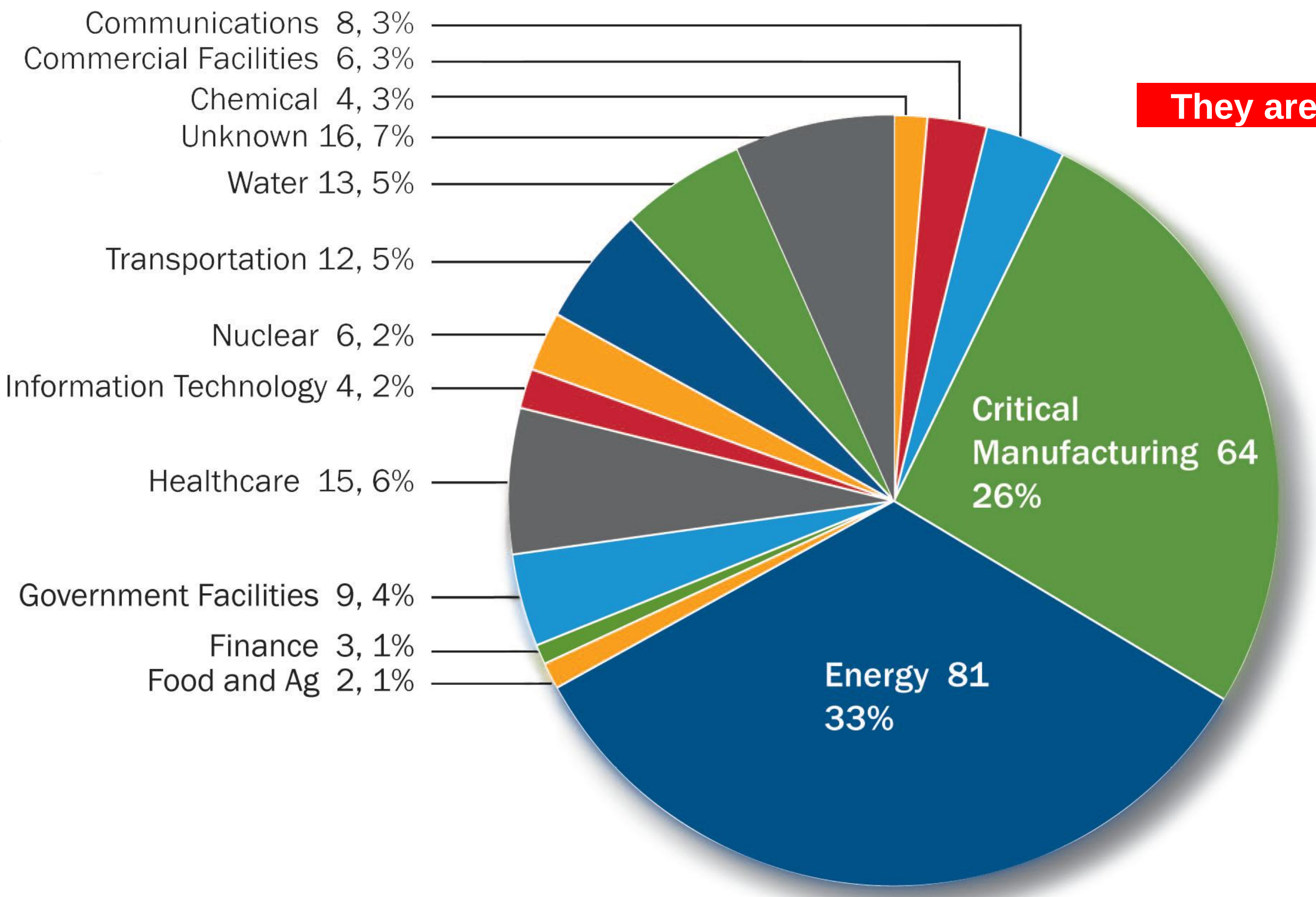

They are Prime Target!

Source: ICS Report September 2014 – February 2015

The chart illustrates the number of ICS-CERT responses to sector specific cyber security threat across the critical infrastructure sectors. Any percentage total is the percentage as it relates to the total responses between 09/2014 - 02/2015.

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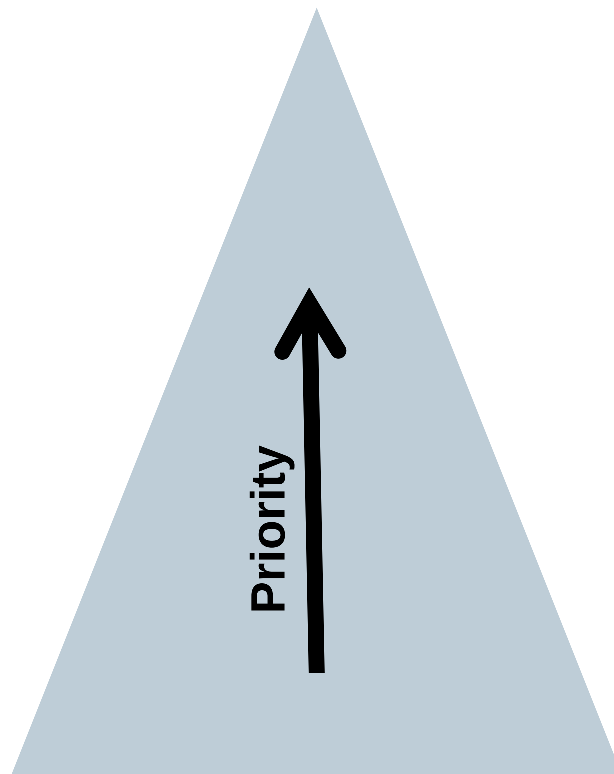
The CIA Pyramid is Turned Upside Down In Industrial Automation and Control Systems

Industrial Automation and Control Systems	Office IT Systems
Availability	Confidentiality
Integrity	Integrity
Confidentiality	Availability



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Cyber Security Requirements – The Moving Target

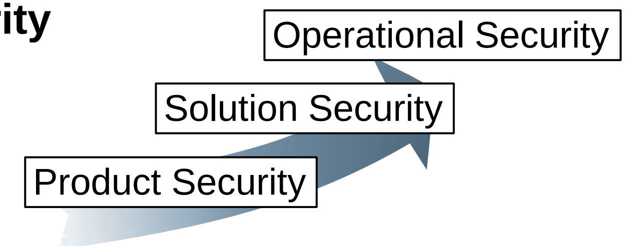
Awareness

- Cyber Security is on top of the agenda
- Media exposure on vulnerability or incidents is high
- Cyber Security incidents have a cross-division impact

Regulation

- Increased Attention on Critical Infrastructure
- Actual and upcoming regulation:
  - EU: Data Protection Regulation
  - DE: Protection Profile (Smart Metering)
  - DE: Sicherheitskatalog (certified risk mgt.)
  - FR: Industrial Control System
  - US: NERC CIPv5

Focus Shifting from Product Security to e2e Security



IEEE, ISO, IEC, CEN, ETSI, CENELEC, IETF, DKE, bdew, NERC, Bundesamt für Sicherheit in der Informationstechnik, enisa

Shift in Customer requirements towards

- Life-cycle management (e.g. Incident & Vulnerability handling, Security Patch management)
- Solution-Security (e.g. e2e security)
- Compliance of solutions (Certification)

Conclusions

- **Security is ideally by design**

- **Challenges still exist (examples)**
  - Performance and latency when used in constraint devices by still providing appropriate protection
  - Storage of critical /sensitive information (long term keys, root of trust, policies, …)
  - Integration of cryptography into systems (design, infrastructure support, long term stability, …)
  - Connected processes (personnel, data / system / service life cycle …)
  - Business cases (ownership, …)

- **Security is a process, a way, not the final goal**

The Future of Empirical Modeling:

models developed based on observations of a system rather than on theoretically derived principles;

scope of application is vast, but the technology is currently very limited.

Ian Flood,

UF Research Foundation Professor,

Holland Professor,

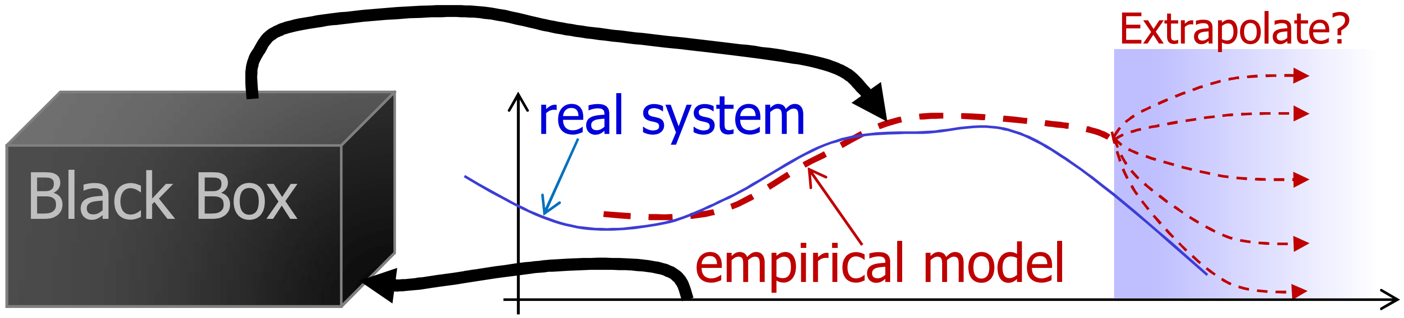
Rinker School, College of Design, Construction and Planning,

University of Florida

(flood@ufl.edu)

Some Critical Challenges to Empirical Modeling:

- limited ability to extrapolate (beyond the set of solutions used in their development)
- are *black box* devices (providing no explanation of their output)



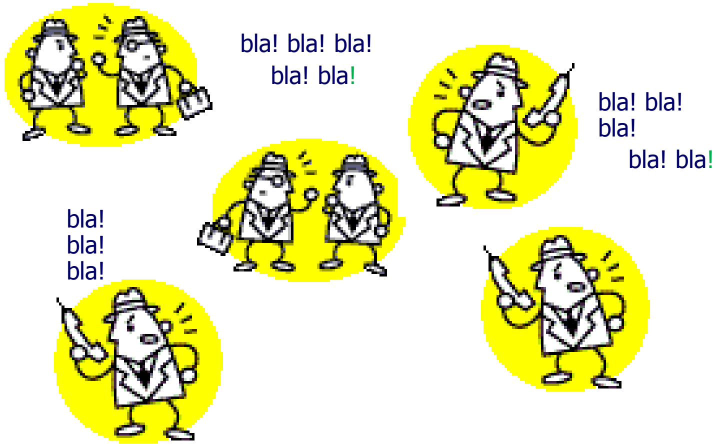
- the number of observations required increases geometrically with the number of independent variables:

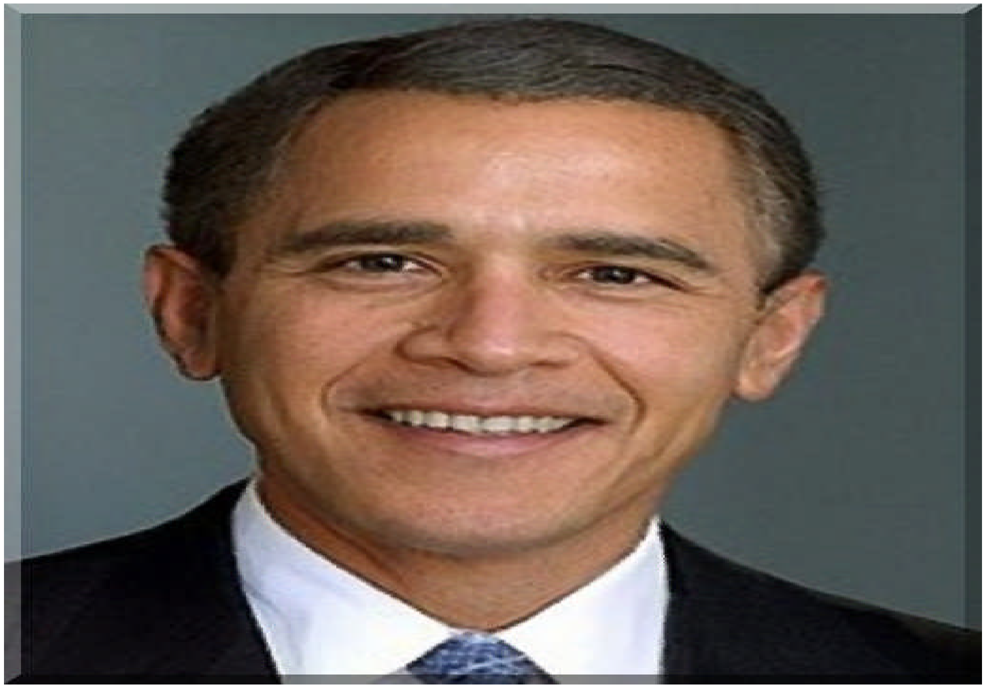
# independent variables:	1	2	3	4	5	6	7	8	9
# observations (5/variable):	5	25	125	625	3,125	15,625	78,125	390,625	1,953,125

- some other challenges:
  - variance in the input values (amplitude, noise…
  - variance in the input format (rotation, translation, size shift…
  - uncoupling signals…

The future for empirical modelling: massive, richly structured models, inspired in part by biological systems:

- brain provides effective **empirically derived** solutions to many complex problems
- overcomes many of the challenges identified earlier:
  - eg: face recognition: spatial interpolation, translation, rotation, scaling, distortion, amplitude, noise:
  - eg: following a single conversation amongst a chattering crowd: uncoupling signals, etc…





Which US president(s) do you recognize?

Image: Adapted from Washington's Blog March 2013

- arguably **the brain** is the ultimate black box

  …but as we start to analyze its organization and operation we are discovering:
  - many parts of the brain, at least, model the world as a set of **meaningful** features within a rich **hierarchical** structure
- so, empirical models do not have to be black boxes
  - they can develop **richly structured models** of the world
  - …where the internal structure is an **insightful analog** of the internal structure of the problem being modeled
- can resolve the issue of exponential explosion in number of observations required to develop the model:
  - the sub models are low dimensional so need relatively few training examples
- **Deep Learning** (Hinton et al.) is one of several attempts at developing models with rich internal structures
  - however, to date applications have been fairly limited (character recognition for example). [1]

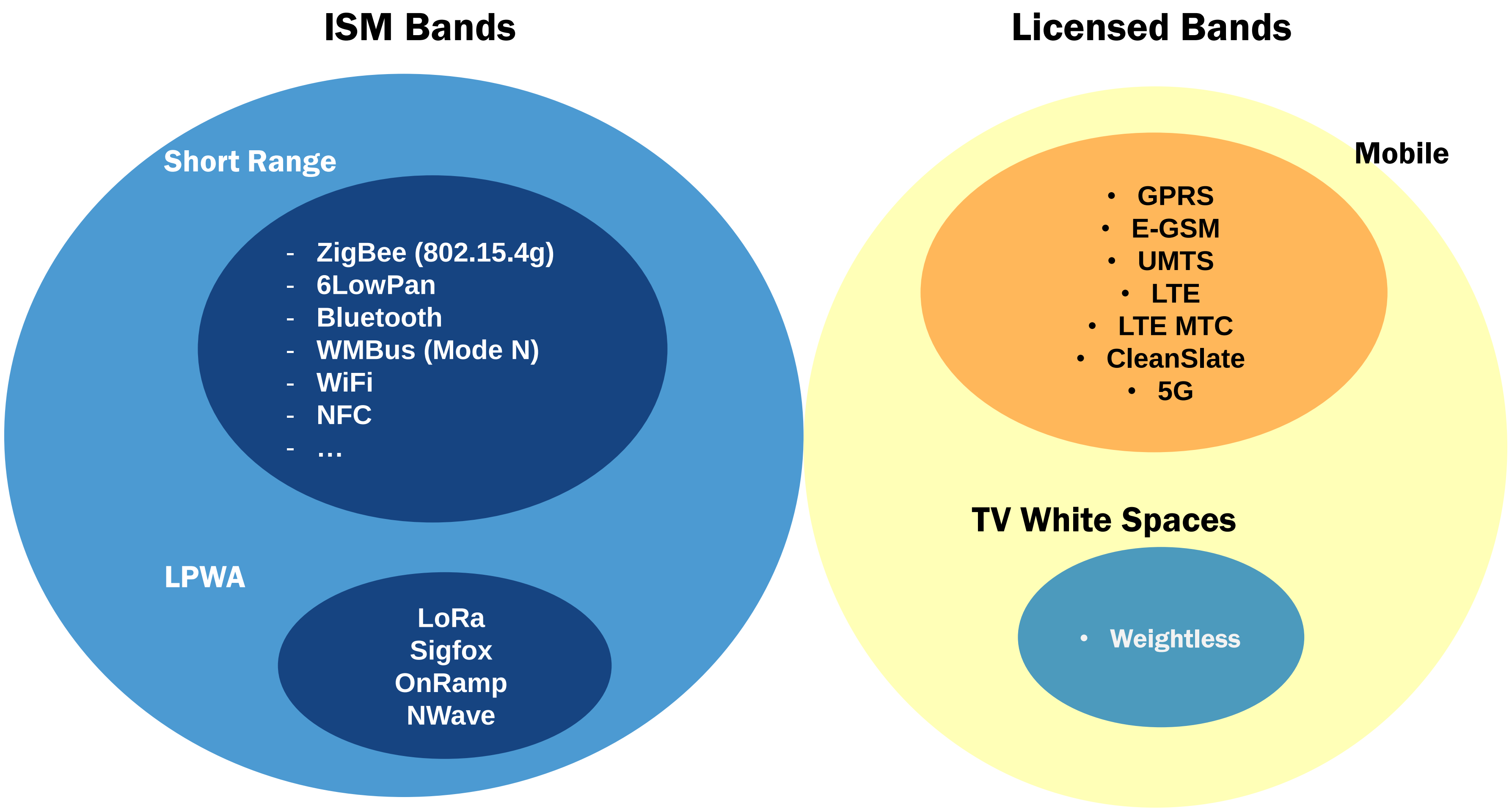
1. Ruslan Salakhutdinov and Geoffrey Hinton (2009). "Deep Boltzmann Machines." Proc. 12th Intl. Conf. on Artificial Intelligence and Statistics (AISTATS), Clearwater Beach, Florida, USA. Vol. 5 of JMLR: W&CP 5. pp448-455.

Evolution of wireless and mobile networks for the Smart urban ecosystem

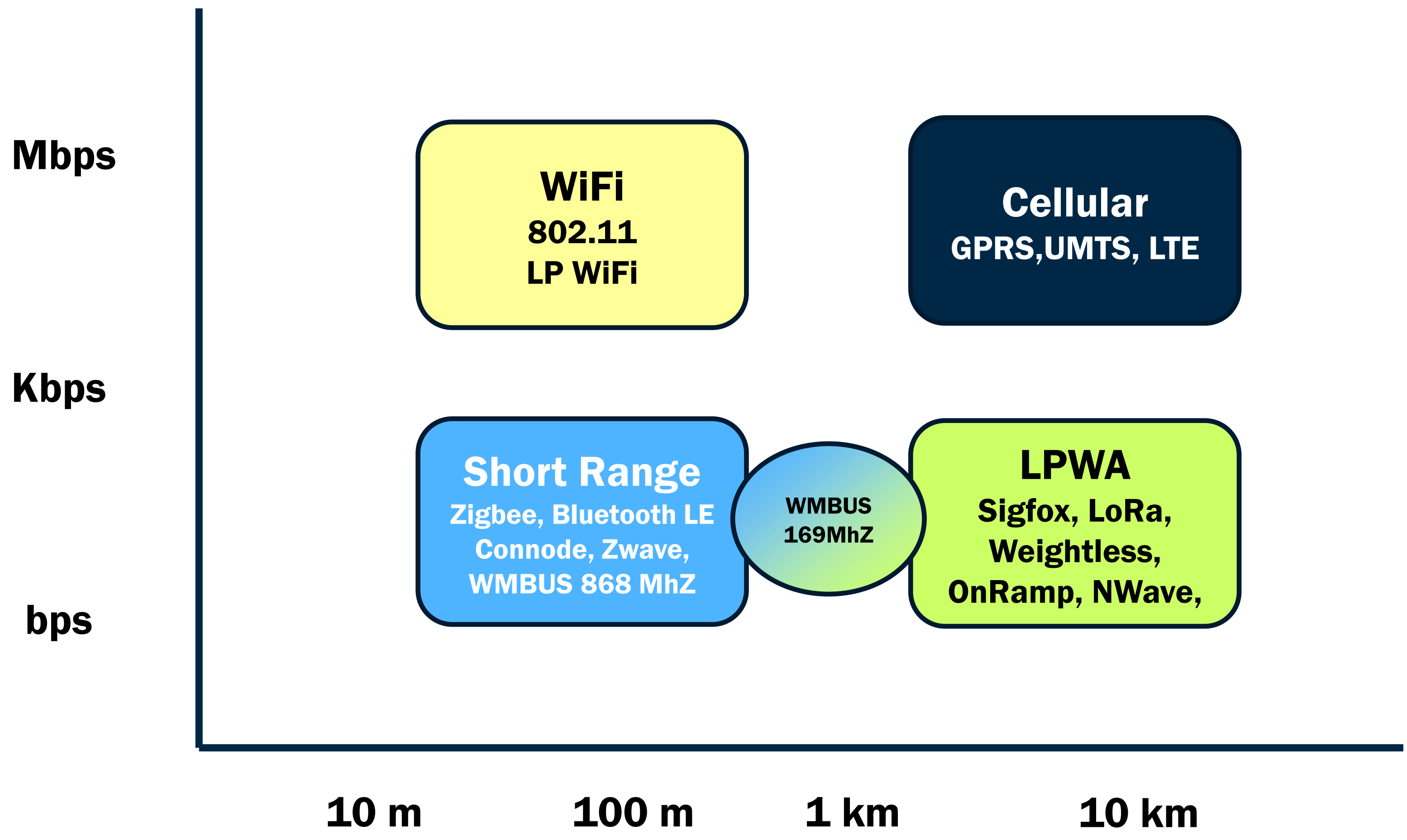
Bruxelles, July 26th 2015

Roberto De Bonis

The wireless network landscape, different views: Licensed vs Unlicensed



The wireless network landscape, different views: Range vs Throughput



The wireless network landscape: Spectrum Issues

TV spectrum (White spaces)

470-800 MHz

ISM bands

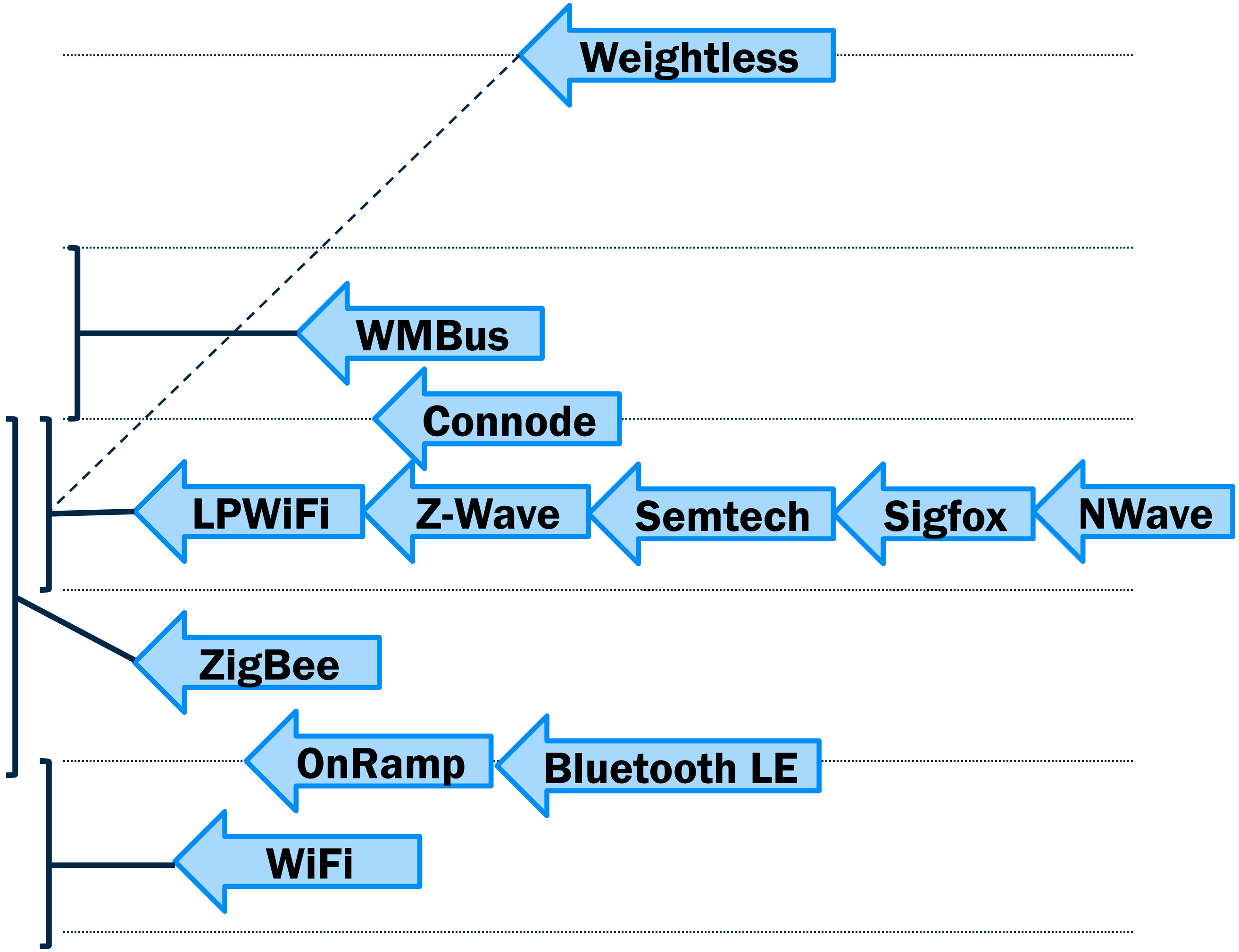
169 MHz (EU)

868 MHz (EU)

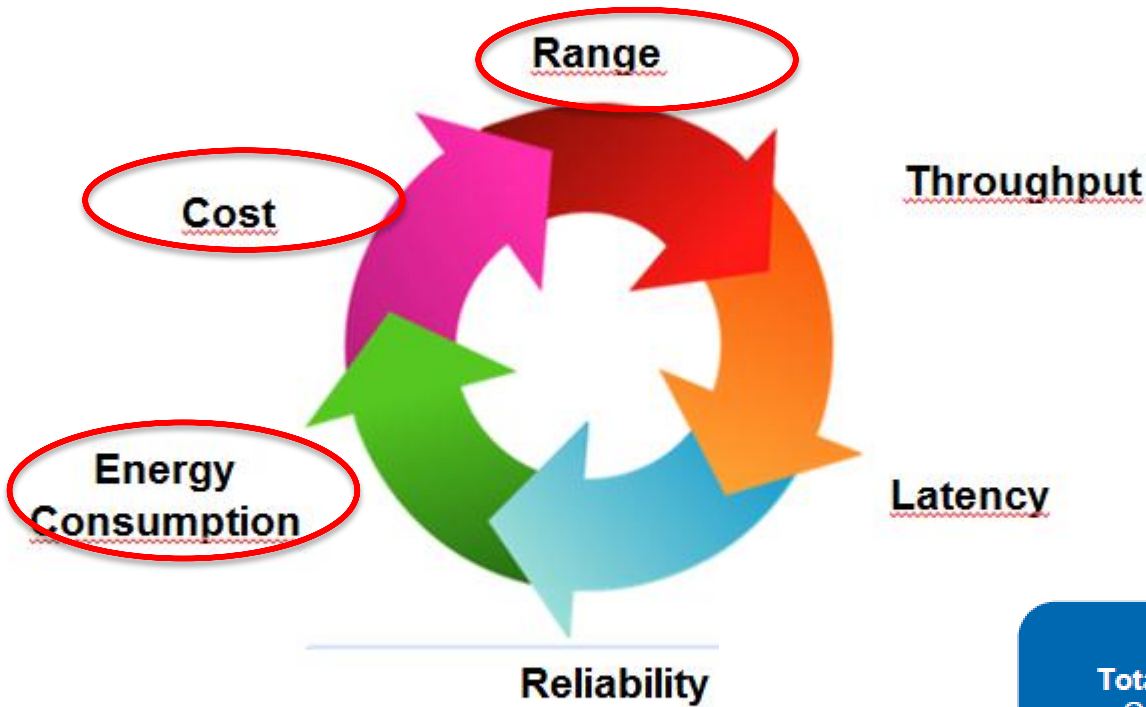
915 MHz(US)

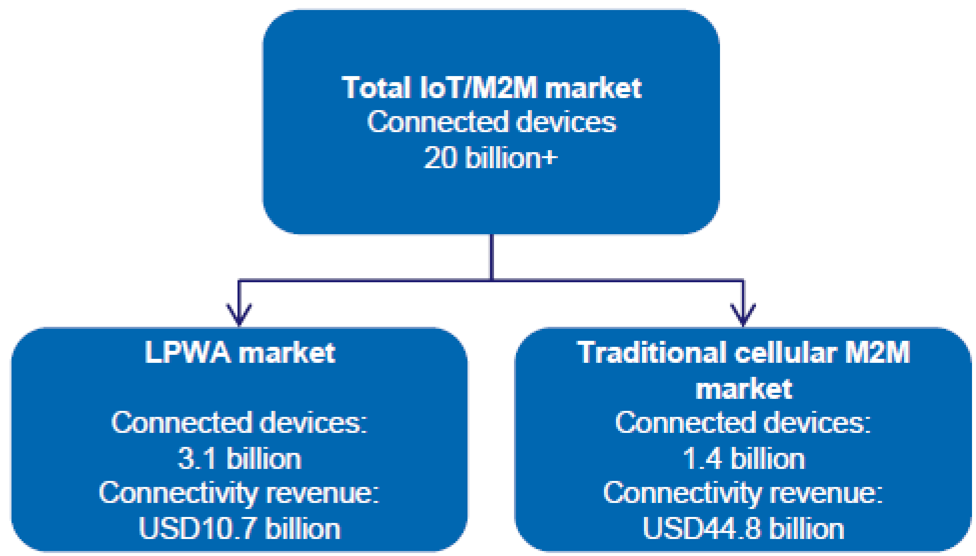
2,4 GHZ

5,8 GHZ



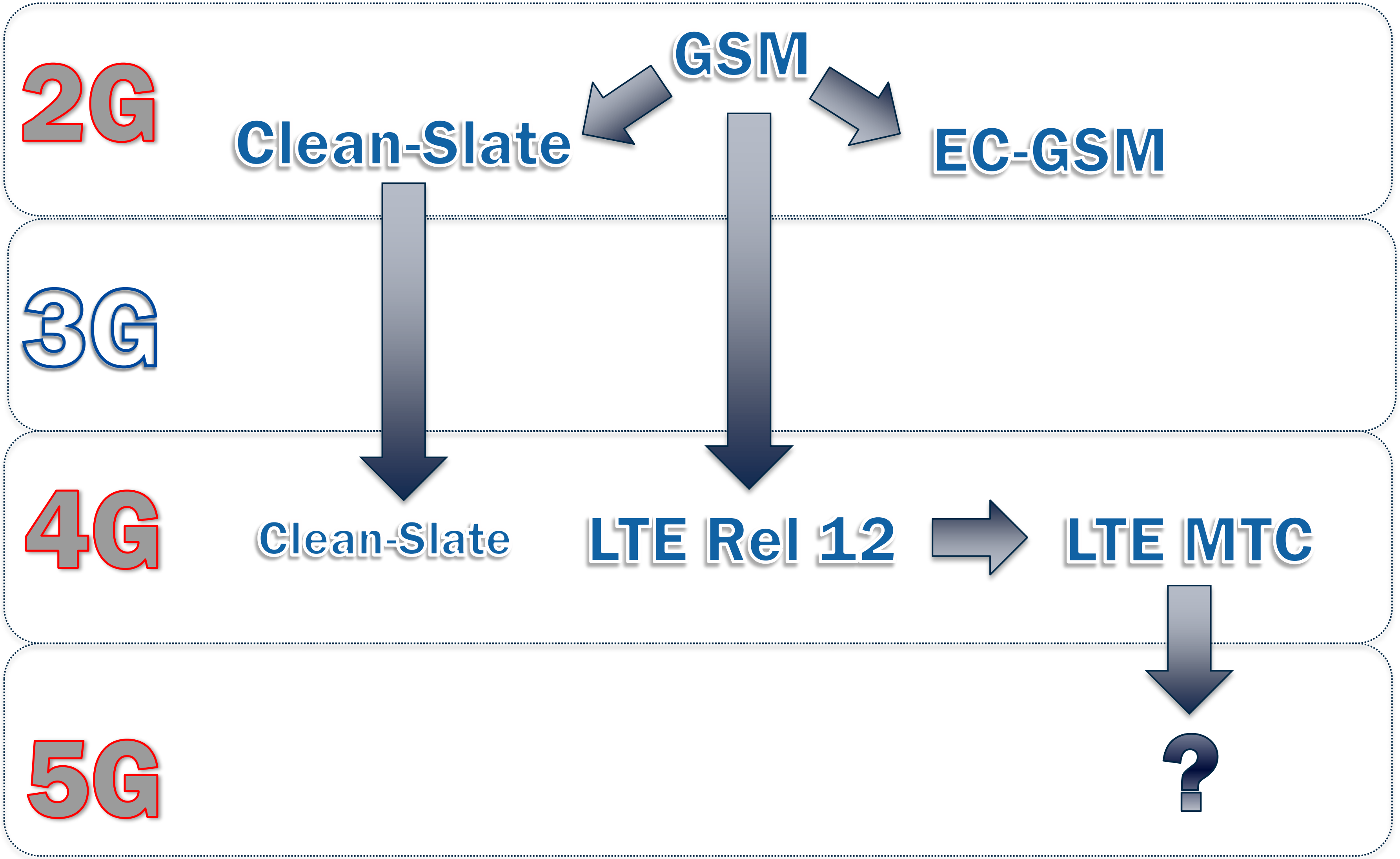
Not only Broadband





Forecast of connectivity revenues from LPWA services [Source: Analysys Mason, 2014]

Current Mobile Networks path to IoT



The Winner is...

Not a single solution for all applications

Too many winners means no winner

Maybe the winner will be the first to let the market start

Traditional standardisation seems not be be fast enough

What about the big OTT?

Grazie

DataSys / International Expert Panel:
From Today's to Tomorrow's Technologies: The Winners are . . .

Experiences and Critical Issues Regarding Future High End Solutions

DataSys / Panel on FUTURE TECHNOLOGIES/URBAN/EMPIRICAL 2015)
June 25, 2015, Brussels, Belgium

IARIA

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[2] Leibniz Universität Hannover, Hannover, Germany
[3] North-German Supercomputing Alliance (HLRN), Germany

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Excerpt of $\tau\varepsilon\chi\nu\iota\kappa\acute{o}\varsigma$- & $\lambda\acute{o}\gamma o\varsigma$-related issues:

- **Lifecycles:** Commonly < 5 years.
- **Integrability:** Weak.
- **Cost-savings:** Staff, development processes.
- **Focus:** Application-centric.

Examples on "challenges":

- *Weaknesses regarding management, hierarchies, experiences.*
- *Decision Making.*
- *Auditing and Peer Review on Management and Decisions.*
- *Sustainability of "political" visions.*
- Drifting standards.
- Technology Integration.
- Reuse.
- Licensing.
- "Sourcing".
- Heterogeneous components.
- Energy.
- Independence of funding.
- *Long-term Knowledge.*
- *Data-centric application creation and modeling.*

Criteria to figure out a winning technology:

- **Commercial success?**
- **Features?**
- **Revisions?**
- **Number of users?**
- . . .

Precursor elevated "winners" in retrospective and undecided stati:

- Flint stone objects — Stone age
- Copper objects — Copper age
- Alloy objects — Bronze age
- Iron tools — Iron age
- . . .
- Industrialisation/technisation (post quaternary) — Anthropocene
- Objects from artificial material, buildings, street/infrastructures — Concrete age
- Silicon based computing tools — Silicon age
- Data/content — Information age
- Content in practice? — Knowledge age
- . . .

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- Objects from artificial material, buildings, street/infrastructures — Concrete age
- Silicon-based computing tools — Silicon age
- Data/content — Information age
- Content in practice? — Knowledge age
- . . .

Criteria to figure out a winning technology:

- Commercial success?
- Features?
- Revisions?
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- . . .

Precursor elevated "winners" in retrospective and undecided stati:

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- Copper objects — **Copper age**
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Examples: Commercial aspects and technological features

Technology	"Commercial +"	"Features +"
Fire	?	?
Flint stones	Resource owners and producers	Specialised tools, consumer?
Metal alloy	Conquerors and merchants	Specialised tools, consumer?
Iron ware	Conquerors and merchants	Specialised tools, consumer?
Transistor ware	Industry	Specialised tools, consumer?
Communication	Producers of mobile devices	User?
Digital photography	Disk/storage/media producers	User?
Aviation technology	Industry	Traveler?

Technology	"Commercial -"	"Features -"
. . .		
Communication	Non-electronic providers	Users' qualities . . .?
Digital photography	Classical photography	High-end users?
. . .		Application/content?
		Long-term/data?
		Privacy/security?

"?" does not mean that we do not know answers.

Definitions of terms and view points is the crucial issue.

- **Long-term sustainability of universal knowledge**.
- Technologies, which are **not closely bound to special hardware and software**.
- Technologies, which are **not embraced-and-extended and which are not split among many developing parties**.
- **Technologies & principles, which worked well** (over generations/different politics).
- Technologies, which are **easy to implement in different environments**.
- Candidates: TEX, LATEX, BibTEX, SGML/HTML/XML FORTRAN, C, ..., TCP/IP, Unix tools, sed, Perl, Tcl, ..., Unified Modeling Language (UML), Universal Decimal Classification (UDC), Individual apps - not on long-term, Social networks - not considered technology, Technology services, Communication technology (e.g., ethernet, mail), Encryption technology (e.g., PKI), Radio Frequency Identification (RFID), Internet of Things (IoT), Internet of Sensors (IoS), . . . or electricity and probably "0 and 1"

What and why-not Issues

- **Major interests:** Content and structure.
- **Current stage:** Not information age but digital stone age, "digital hunters-and-gatherers" age.
- **Issues:** Standards missing, pseudo-bodies, many "best practices" dominated by interest groups. Deficits in standardisation - "continuous-patchday" mentality.
- **Hint:** Reasonable limitation might support development, contrary: Industry producing/hunting for quantity. Example: 19th century collapse of uncontrolled railroad development, control goal in Europe consolidated the development, added goals, linked with a philosophy.
- **Aristoteles' view vs. others' view:** Philosophy "vs." No quality frameworks, no projectability, no ideas about goals.

Conclusions on Candidate Conditions – ... a technology with:

- **Long-term knowledge and data-centric solutions – long-term disaster-resistant knowledge infrastructures.** *From retrospective to prospective: If mentality and expertise do not advance then "tools" and commerce will be the "winners" instead of "knowledge".*
- **Technology with methodologies/principles and algorithms approved over long periods of time**.
- **Technology widely independent from speculation / fluctuation**.
- **Integratable technologies with efficient implementation curve**.
- **Reasonable interests, background in research and/or society**.
  Candidate: Dyadic philosophy, term "Electro-Dyadic-Age",
  (or simplified 'digital', 'binary' or a successor-term).
  Implementation: Basic communication & storage technologies and organisation of logical workflows.
  Vision: Strategies on technologies with perception of content!
- **A lot of content/data/solutions should be expected to be consistent/work for long periods of time – supported by constant conditions and sustainable funding.**