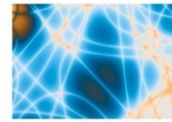# Inatel
Instituto Nacional de Telecomunicações

Information and Communications Technologies

Inatel Labs

NovaGenesis

FUTURE INTERNET AND NOVAGENESIS PROJECT

Antonio Marcos Alberti

Sunday, June 14th, 2015

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Outline

1. Introduction
2. Substrate Resources and Its Integration with Software
3. Software-Defined Networking
4. Information, ID/Loc Splitting, Semantic, Context, and Mobility
5. Autonomic Technologies
6. Security, Privacy, and Trust
7. Services and Applications
8. Simplicity, Sustainability, and Evolvability
9. NovaGenesis Project

1. Introduction

✓ The Internet has invaded most aspects of life and society, changing our lifestyle, work, communication, and social interaction.

✓ Nobody doubts about the fundamental role of the Internet on our society.

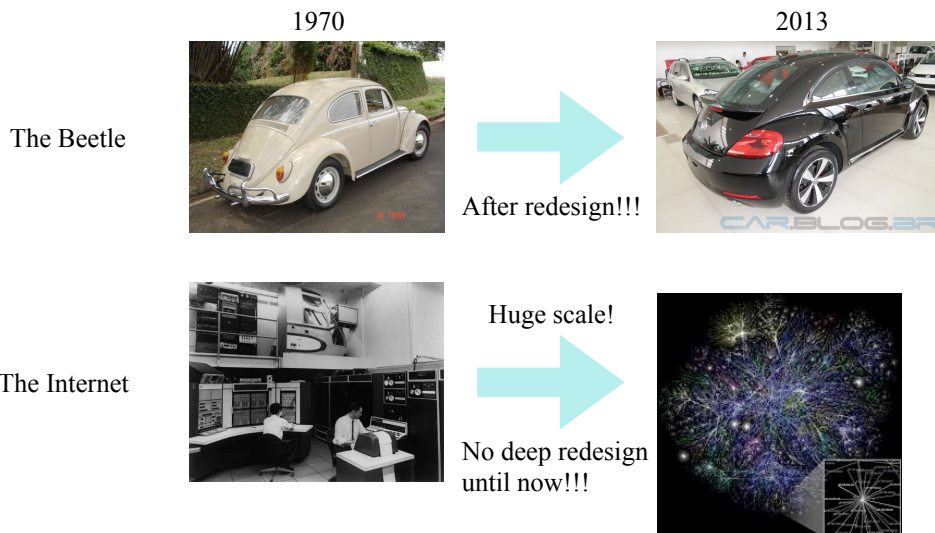## 1. Introduction

✓ Nevertheless, the Internet today is a complex agglomerate of protocols that inherits the grown legacies of decades of patchwork solutions.

✓ It was designed in an era where technological development was completely different from today.

✓ This motivated many people to question the adequacy of the TCP/IP stack to meet our information society needs.

✓ Since this question was first made, a lot of initiatives to reshape the Internet appeared around the world - the so called Future Internet design.

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1. Introduction

✓ The main motto question is:
  □ Considering the current state-of-art on computing and communications, is it possible to design right now a new Internet that best meets our information society needs?

1970   2013

The Beetle   →
                              After redesign!!!

The Internet   Huge scale!
                              →
                              No deep redesign
                              until now!!!

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1. Introduction

✓ What is the scope of a Future Internet?
  □ A new network? Or something broader?
    ▪ A convergent infrastructure for information processing, storage, exchanging, and visualization.
    ▪ It is not limited to its original scope: a network to exchange information among computers.

✓ What is its role on our future society?
  □ A content exchanging infrastructure?
  □ A digital business ecosystem?
  □ A mobility-friendly architecture for social networking?
  □ A high speed optical/wireless network for fast browsing?
    ▪ A convergent infrastructure for all computing and communication needs!
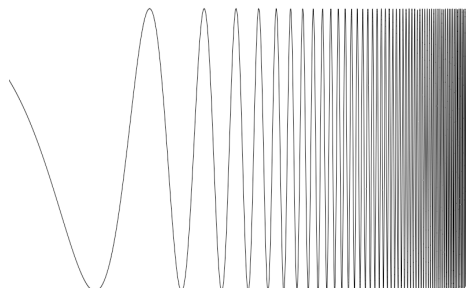
© Antônio M. Alberti 2013

2. Substrate Resources and Its Integration with Software

- ✓ Technology Evolution
- ✓ Capacity and Ubiquity
- ✓ Internet of Things
- ✓ Real World Internet
- ✓ Exposition and Virtualization

Technology Evolution

- ✓ Moore's Law:
  - □ Predicts technological developments in computing power.

- ✓ (Kurzweil, 2005):
  - □ A theory for technological evolution – to describe the exponential growth of technological advances: The Law of Accelerated Returns

Capacity and Ubiquity

✓ (Kurzweil, 2005):

  ▫ Exponential growth trends for:

    ▪ Memory capacity (DRAM in bits per dollar), microprocessor clock speed (Hz), transistors per chip, processor performance (MIPS), magnetic storage (bits per dollar), the number of hosts on the Internet.

✓ (Saracco, 2009):

  ▫ Consistent technological developments in:

    ▪ Computing – is achieving teraflops right now and evolution proceeds to petaflops in the next decade.
    ▪ Display technology – has advanced enormously in later years.
    ▪ Consumer electronics, such as handsets, laptops, HDTVs, e-books, video games, GPSs, etc.

Capacity and Ubiquity

✓ How to meet this demand?

  ▫ Mobile Access: 5G, Cognitive Radio (CR).

  ▫ Fixed Access: Fiber-To-The-Home (FTTH).

  ▫ Core: State-of-the-art optical transmission and switching.

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Capacity and Ubiquity

✓ The technological evolution leads to price reduction → Ubiquity.

✓ More and more devices are becoming computationally capable and connected to the Internet (e.g. clothing, buildings).

✓ Inexpensive computing → Ubiquitous Computing (smart environments and ambient intelligence).

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Internet of Things

✓ Consequences of Ubiquitous Computing:

▫ Connectivity anywhere, anytime, in anyplace, to anyone.

▫ The rise of the NEDs (Network Enabled Devices) army.

▫ The appearance of the Internet of Things (IoT) and Real World Internet (RWI).

Exposition and Virtualization

✓ Exponential growth → diffuse substrate of digital technologies composed by processing, storage, display and communication resources.

✓ Much of the communication equipment today → become computers, with CPUs, Operating Systems, etc.

✓ Exposition: to make this diffuse substrate of hardware resources transparently and uniformly available to software by means of descriptors and metadata, containing its capacities, utilization, states, limitations, etc.

Exposition and Virtualization

✓ Virtualization: to emulate in software some hardware substrate functionality.

✓ Another definition: To create an abstraction (indirection) layer between equipment (routers, switches, radios, etc) and software, in such way that resources can be used concurrently/transparently/uniformly by different software instances.

✓ Exposition+Virtualization allows multiple Virtual Networks (VNs) to share the same Substrate Network (SN).

3. Software-Defined Networking

✓ Definitions
✓ OpenFlow

Definitions

✓ It is a new paradigm to redesign communication networks considering a software engineering point of view.

✓ The argument is that current networks are essentially designed to "master the complexity" behind existing technologies, rather than to "extract simplicity" from the learned lessons.

✓ Prof. Scott Shenker defends the idea that abstractions played a big role on computer science, shielding high level software from the complexity existing in the lower levels.

✓ Thus, why not to define good abstractions for ICT?

Definitions

✓ SDN means to rethink network architectures considering the important role of abstractions.

✓ Software-defined also means that some functionality is defined by software, i.e. it works accordingly to some controlling software.

✓ Both definitions share the software-controllability aspect, since Shenker et al. proposal is also based on software-controlled equipment.

OpenFlow

✓ Probably the best well-known SDN initiative.

✓ It covers the structure of an OpenFlow switch, as well as the protocol used by the control program (controller) to generate the network view and to configure forwarding tables.

✓ A diversity of controllers can be used together with OpenFlow: NOX, HyperFlow, DevoFlow, and Onix.

✓ A special controller called FlowVisor enables the creation of isolated slices of resources through the orchestration of OpenFlow switches and controllers.

4. Information, ID/Loc Splitting, Semantic, Context and Mobility

- ✓ Names, Identifiers, Locators, and Addresses
- ✓ Information-centrism
- ✓ ID/Loc Splitting
- ✓ Mobility
- ✓ Semantic, Context, Context-Awareness and Ontology

Names, Identifiers, Locators, and Addresses

- ✓ A name are symbols used to denote one or more individual existence, while an address denotes position to where one or more than one individual existence can inhabit/be attached.

- ✓ An identifier are symbols used to unambiguously identify some individual existence from others in some scope, while a locator denotes the current position(s) where an individual existence(s) is/are inhabiting/attached in some space.

- ✓ Self-certifying names are meaningless names generated by mathematical hash functions (e.g. MD5 or SHA-1).

Information-centrism

✓ Information as a key ingredient in design.

✓ Information is in everywhere, i.e. contracts, location, police, IDs, descriptors, naming, etc.

✓ "*Information is everything and everything is information*" (PSIRP, 2009).

✓ Forwarding and routing using information names.

ID/Loc Splitting

✓ Future networks need to separate identifiers (ID) from locators (Loc) → the so called ID/Loc splitting.

✓ This split is required not only for physical entities (e.g. hosts), but also for virtual entities as well as for content.

Mobility

✓ The challenge is to comprehensively support user, terminal, service, application, virtual networks, information, and other real and virtual entities mobility.

Encryptedruler

blakeburris

We need a mobility-friendly environment.

Jeff Geerling

Semantic, Context, Context-Awareness, and Ontology

✓ Situation-Awareness

▫ According to (Baker et al., 2009) "*... being aware of its physical environment or situation and responding proactively and intelligently based on such awareness*".

✓ Context-Awareness

▫ To be aware of relevant contexts.

✓ Ontology

▫ For (TripCom, 2008) "*an ontology is a formal definition of terminology and relationships among the terms in a computer-processable form*".

5. Autonomic Technologies
✓ Autonomic Computing
✓ Autonomic Communications

Self-emergent social behavior

Axel Rouvin

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Autonomic Computing
✓ Why autonomic computing?
  ▫ Accelerated returns:
    ▪ Boom in diversity, scale and complexity.

  ▫ Human capability limitations:
    ▪ Highly stressful job and deep sense of failure.

  ▫ OPEX:
    ▪ Human resources are expensive.

  ▫ Rapid adaptation to the environment.

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Autonomic Computing

✓ (IBM, 2001):

- A famous manifesto → autonomic computing.

- "*Computing systems' complexity appears to be approaching the limits of human capability*".

- Bio-inspired → human autonomic nervous system governs various functions without our awareness.

- Computational systems → manage themselves according to high-level objectives outlined by human operators.

- Reduce human interference and OPEX.

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p3

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6. Security, Privacy and Trust

✓ Requirements and Challenges

Väsk

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Ds02006

Requirements and Challenges

- Built in or inherent;

- Change to consented communications, e.g. publish/subscribe paradigm;

- Establishment of trusted networks → entities, services, users, etc.

- How to evaluate trust and reputation?

- Privacy → To help users to protect and preserve their privacy;

- To identify, assess, monitor, analyze and sort risks, vulnerabilities and threats;

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7. Services and Applications
✓ Service-centric Approaches
✓ Internet of Services
✓ Digital Business Ecosystems

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Service-centric Approaches

✓ Software design → changing from component-based to service oriented design: service-centrism.

✓ The idea → applications are flexibly and dynamically constructed by the composition of distributed software services or utilities.

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Internet of Services

✓ Above a certain level of abstraction everything can be viewed as a service → Internet of Services.

✓ (Villasante, 2009):
  □ "*Internet of Services – Supporting the service economy (70% of GDP in modern societies)*".

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Digital Business Ecosystems

✓ Dynamic service compose-ability → integrate business processes with applications and services, creating the so called Digital Business Ecosystems (DBEs).

✓ DBEs → the new savannah.

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8. Simplicity, Sustainability and Evolvability

✓ Simplicity

✓ Sustainability

✓ Evolvability

http://www.idsia.ch/~juergen/locoart/locoart.html

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Simplicity

✓ To call attention on how difficult it is to design with simplicity we can evoke Leonardo Da Vinci's:

  □ "*Simplicity is the ultimate sophistication*".

✓ Or as Einstein said:

  □ "*Make everything as simple as possible, but no simpler.*"

Jürgen Schmidhuber: Low Complexity Art

http://www.idsia.ch/~juergen/locoart/locoart.html

Sustainability

✓ Ops! We need to redesign the Internet again...

✓ Sustainability can be defined as the property of maintaining a certain level/situation in the course of time.

✓ Akari also aims to project a sustainable network, capable to evolve and support information society requirements in the next decades.

Evolvability

✓ Evolvability is a definition related to biological systems.

✓ (Rowe & Leaney, 1997):
  ▫ "*the ability of a system to adapt in response to changes in its environment, requirements and implementation technologies.*"

Darwin evolutionary tree.

Qz10

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Natural language names: Portuguese, English, etc.

Self-certifying names generated from existences' immutable patterns.

Name binding among namespaces enable to represent relationships.

NAMING

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IDENTIFICATION AND LOCALIZATION

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EXPOSITION & DISCOVERY

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My photos
repository app

Antony

App 1

My smartphone

Scalifax

App 2

My tablet

Photo <-> **Repos. App** <-> **Scalifax** <-> **My smartphone** <-> **App 1** <-> **Antony**

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Today

Owner
sends

Internet

The
receiver
accepts
all

Facilitates
spam!

COMMUNICATION MODEL

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Future

Owner publishes → Internet → **Receiver subscribes only the desired content.**

Minimization of spam problem!

COMMUNICATION MODEL

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MOBILITY

Today

ID=**143.106.52.3**
LOC=**143.106.52.3**

Local Net 1

ID=**10.0.0.3**
LOC=**10.0.0.3**

Local Net 2

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MOBILITY

Future

ID=FFFF12211243865…
LOC=FEFEF1421412411…

Local Net 1

ID=FFFF12211243865…
LOC=AAAA2734573453…

Local Net 2

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SOCIAL DEVICES

Representatives

Social Devices

"THINGS" NEED SERVICES TO REPRESENT THEM TOWARDS CONTRACT-BASED TRUSTABLE SELF-ORGANIZATION

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The Essence of NovaGenesis Model

Smart Future Internet Architecture

Evolutionary Pressures

People
Policies, Rules, Regulations, etc.

Self-Organizing
Assistants, Controllers, Managers, etc.

Self-Organizing
Physical World Representatives

Physical World

Environmental Pressures

NovaGenesis in the Media

TEDxInatel
TV Unisinos
G1
Engenharia É
TecMundo
BNAméricas

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The NovaGenesis Team

2015

2013

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Thank You!

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mendeley.com/profiles/antonio-marcos-alberti/
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