Learning on the Job
Lessons for a vertical-oriented telecom environment

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http://atnog.av.it.pt

Main partnerships
- IT Sites
  Aveiro | Coimbra | Lisboa
- Instituto Politécnico de Leiria (IPL-STG)
- Instituto Politécnico de Coimbra (ISEC)
- Instituto Politécnico de Lisboa (ISEL)
- Instituto Politécnico de Setúbal (EST)
- Instituto Politécnico de Tomar (ESTT)
- Universidade do Algarve (UAig)
- Universidade de Évora (UEv)
- Universidade da Madeira (UMad)

Not for profit association of:
Universidade de Aveiro
Universidade de Coimbra
Universidade de Lisboa
Altice Labs
Nokia
Universidade de Porto
Universidade da Beira Interior
Instituto Ciências e Tecnologias Empresariais
Instituto de Telecomunicações - Aveiro

PhD researchers ~80
PhD students ~94

Optical communications
Radio communications
Networking, mobile networks, future internet
Electronic design for telecommunications

ATNOG

Future Internet
Flexible Networks
Big Data
M2M
IoT

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ATNoG
Research group dedicated to communication networks, related services, applications and its traffic

- Total ~50 members
  - 10 PhD researchers + 3 External
  - 11 PhD Students
  - 44 researchers
  - ~50 publications/year

- Strong cooperation with international groups and companies
- Multiple lines of work
  - Research
  - Industry cooperation
  - Standardization
  - High practical component
  - Testbeds, implementations, tools...
  - Open Source contributions
  - https://github.com/ATNoG
  - Test infrastructures

So, in the last years, we developed (again) a test infrastructure for 5G

Smart Cloud of Things

LAYER 1 – SCOT IS COMING
Project: Smart Water Grids

• Novel Turbidity Sensors
  – Fiber optical based, multi lamba
  – Developed by Optical Communications Group (IT Av)

• Automatic monitorization, integrated in M2M platform
  – Solar powered, alarms, and high level rules

• Multi radio tecnología
  – LORA, XBee, Bluetooth, Wi-Fi

• Actual product
  – Public Water Grids
  – Wine manufacturers

Pilot: Monitoring of Driving Conditions

• Collect data from multiple sources
  – Users: Crowdsourcing or sensors
  – Public data sources: Social, reports, live traffic, weather...

• Aggregation in real time M2M platform
  – For consumption by traffic specialists

• Provide data reports to multiple stakeholders
  – Users: Calculated driving risk
  – Municipalities: Road conditions and traffic density
  – Scientists: Driving behaviour for better transport planning
SOCIAL

- System focused in Social Care
  - Based on technology, protocols and practices from healthcare
  - Integration of IoT devices
  - **DATA FORMATS** - Strong focus in formal representation of relations between actors and data
  - Developing actual solutions for commercialization

- Local team leads tasks related to cybersecurity
  - Blockchain based secure and auditable logs
  - Design of policies for FHIR environments
  - Creation/validation of policies using natural language
LIFE-PAYT

- Solutions for Smart Cities
  - Improving waste processes through Pay-Throw
  - **MULTIPLE TENANTS** Applied to 5 cities, 3 capitals
  - Focused on a central platform integrated with all municipalities

- Local team responsible for entire software infrastructure
  - High scalability
  - Multitenancy using Virtualization and SDN
  - Collection and processing of IoT data
  - Cybersecurity from design
  - **RGPD compliance**

Pilot: Smart Agriculture

- Multi-dimensional information merging
  - Sensors in pomegranate trees
    * Real time physical and chemical analysis
  - High-value fruit culture

- **UAVs**
  - IR crop maps
  - Mobile sensing
  - Data mules and repeaters
SheepIT

• Animal-based weeding for vineyards
  – Posture control
  – Animal monitoring
• IoT network
  – Animal location and tacking
  – Alarm generation
  – Sensor data gathering

SheepIT

• Animal monitoring
  – Animal wellbeing
    • Activity decrease/increase
  – Activity monitoring
    • Supervised learning techniques
  – Location pasture monitoring
    • Non supervised learning
• Web platform for animal handling
The Outcome:
Smart Cloud of Things (SCoT)

- M2M Platform
- Based on Eclipse and Apache technologies (fully OSS)
- Interfaces for Streaming and Batch Processing
- Semantic Context Storage
- Already battle proven in various projects
  - With external stakeholders

The Outcome:
Context Organization for IoT sources

IoT devices share data using multiple representations

Most analytical tools require top-down characterization to work (taxonomies, a priori relations and information)

Develop a model to automatically organize IoT data based on content (using semantic and stream similarity features)
Managing data

**LAYER 2 – DATA IS COMING**

Smart Open Campus

SOCA wants to explore the physical reality of the University of Aveiro Campus, as the substrate to potentiate this living environment.

- Data acquisition from multiple sources (sensors, digital/electronic systems existing at the campus)
  - Heterogeneous Interfacing and networking (IoT, M2M, optical networks, etc.)
- **Processing of such data**
  - Big Data, Machine Learning, detection of optimization opportunities
- Provisioning of obtained results
  - Feedback loop into the community (information on crowds, environmental quality, ...)
  - Optimize systems operation (lights, systems availability, access to places, ...)
  - Improve life systems (mobile data visualization, Augmented Reality)
  - Interaction with the community
  - Open APIs for outside participants (Campus operational data and information available)
Smart Open Campus

- Research and deployment themes
  - High performance data transfer over heterogeneous networks
  - Data process and management
  - E-Health and education verticals
    - Personal health and wellbeing monitoring
    - Behavior Monitoring for advising
  - M2M, IoT, Flexible Networks

SKA - Square Kilometre Array

- Distributed, radio telescope with two sites of >3000 Km
  - Mainly in radio dead zones in South Africa and Australia
  - €1.5 billion budget cap
- Direct radio over fiber from each antenna to central correlator
  - 3000 dishes with 420Gb/s from each dish
  - 200K arrays with 16Tb/s from each array
- Driven as a software focused industrial project
  - Highly based on virtualization technologies
  - Currently in the bridging period to the pre-construction phase
- Linked to Portugal by EngageSKA Infrastructure
  - Lead by IT
  - Major research and private national stakeholders
SKA - Square Kilometre Array

- **IT Lead the design** of Virtualized Infrastructure for Telescope Management
  - Based on Openstack and Kubernetes with custom components
  - **Fully OSS**
  - High focus in high scalability and availability

- Contributions to several other areas:
  - Security
  - Testing and validation
  - Precursors
    - Local Radio Telescope, Advanced Power Sources, IoT systems

- World wide prototyping site for the current System Team
  - Prototyping and refining design, preparing pre-construction
  - Prototyping specific technologies

The outcome:
Datacenter @ Instituto de Telecomunicações

- **Unique location**
  - IT building situated at the Universidade de Aveiro Campus (over 15k people and 16 Departments)
  - Located at the center of the City of Aveiro (80k+ pop)
  - Close to railways, seaport and heterogeneous industry
    - <2km away from dedicated railway towards the seaport
    - Currently used in URLL critical communications research
The outcome:
Datacenter @ Instituto de Telecomunicações

- The numbers
  - 400+ Cores
  - 4.5TB RAM
  - 200+ TB HDD
- Heterogeneous architecture
  - Intel, AMD, ARM
  - Edge servers
- Specialized computation
  - CUDA GeForce RTX2080i
- Advanced switching and routing
  - SDN-enabled
- Cutting-edge management and control
  - OpenStack, OSM, ONAP

Running test infrastructures

**LAYER 3 — EXTERNAL SERVICES ARE COMING**
**Amazing @ Instituto de Telecomunicações**

- Advanced Testing and metering
  - Open configurable environment
  - 24x fully configurable wireless nodes, multiple interfaces
  - Software-defined Networking supported
  - Associated mobile network cell
  - Fully robotized mobile vehicle for speedy-based experiments
  - 2 (4) SDR platforms

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**5GO - The Portuguese 5G Mobilizer**

Research, development, validation and integrated demonstration of a set of products for the future 5G networks, gathering and harmonizing the efforts of different agents in order to create innovative solutions for the global market

- Development of new products, specific to the construction of 5G networks
- Development / evolution of products and services in key technologies supporting the realization of 5G
- Development / adaptation of products for critical IoT and multimedia applications, using public 5G networks
- Operation and availability of integration platform test and demonstration of ecosystem 5G

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5GO - The Portuguese 5G Mobilizer

- Verticals involved:
  - Energy
  - Transportation (rail)
  - Human interface (body kits)

5GinFIRE Network & Ecosystem

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5GinFIRE Architecture

Our focus:
- **Continuous Integration** (CI) tools for VNF and NS developers
- Contributions to OSM
- Service Function Chaining:
  - General solution for future experimenters encompassing multiple VIM and Physical networks (using ODL)

PASMO – open platform for development and experimentation for mobility (C-ITS)

- **Open platform**
  - Serving SMEs and software developers with a “road environment”
  - V2X infrastructure, sensor monitoring (parking, weather, waves) cellular communication, WiFi, data processing
    - ETSI ITS-G5
    - LTE / LTE-V
    - Gateways multi-technology (BLE, ZigBee, LoRa, Sigfox, etc.)
    - WiFi in walking areas (beach)
Road coverage

Public spaces support
Aveiro S.T.E.A.M.
exploring 5G coverage

“This project is a very important opportunity to support the City of Aveiro transition into a knowledge-based economy. We aim at competing with the stronger national economic centres, being able to attract and retain the necessary talents for our economy to grow and produce more added-value, making Aveiro a more competitive city globally”

José Ribau Eustêncio, Mayor of Aveiro

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The Outcome: Aveiro 5G demonstrator

- Aspects
  - Different systems with heterogeneous technologies, in different maturity levels
  - Different generations of systems, running radio, core and management technologies that are of different generations
  - Different verticals with challenges in different aspects of a complex system
  - Multiple verticals, with very different requirements
  - Different expectations from the verticals
    - Fundamental research POC evaluation (TRL7 for the infra)
    - "service-alike" expectations ("TRL9 for the infra"
  - Sub-systems which are under “semi-professional” production
    - Operation required for other stakeholders
    - Reasonable reasurances expected (at least by some time-periods)
    - Fortunately: no life-threatening real use case
  - Different societal ("political") impact
    - Critical support to some “powerful” stakeholders (customers) – which may make or break all activities
    - Link to comercial infrastructures
    - Will be connected to the “5G cities European Directive”
    - Public perception on multiple projects/verticals

And the lessons?

- Did we learn something that can bound research for the future?
- Did we learn something for
  - Standardization
  - Testing
  - Commercial deployment?
Testing

• Technology changes too fast
  – Almost impossible to keep track with the evolutions
  – Human, HW and SW issue
• Technology layers are way too interconnected
  – If you just need a single vertical solution, the immediate trend is to strip things, deploying as thin as possible
• Technology promises/standards are quite different (sometimes) of what you can deploy
  – Any solution working becomes legacy, impairing change in the future

Comercial deployment

• Verticals require guarantees
  – Value stability (besides reliability)
  – Concerned with data
  – Concerned with liability
  – Concerned with “approved processes”
• Multi-service provision complex
  – Trade-offs for URLL, mIoT and eMBB are tough to manage in high mobility environment
  – Cost/profit numbers unreliable and mostly unknown (how to design for stringent SLAs globally?)
• Evolution paths not really known
  – Overall framework (NSA, SA, etc..) yes
  – Detailed functions are not stable (in implementation)
  – Tussle between early service deployment – and increased legacy – and late more
  – Wrong moves can block a market for years (lost credibility)
Conclusions

• We are in a moving environment
  – Hard to decide investments
• Regardless of press, we are still struggling to find “the path”
  – Which may not even exist
  – Or be very different from country to country

At last, we are now going over-the-hype and the teenager bull years seem to be terminating.

Thank you for your attention!

(and we welcome visiting or permanent researchers. Just contact ruilaa@ua.pt)

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