Advanced Telecommunications and Networks Group

Learning on the Job

Lessons for a vertical-oriented telecom environment

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http://atnog.av.it.pt

Instituto de Telecomunicações

- IT Sites

  Aveiro | Coimbra| Lisboa

Not for profit association of:

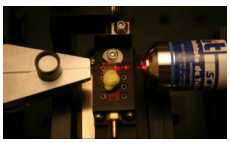
Universidade de Aveiro
Universidade de Coimbra
Universidade de Lisboa
Altice Labs
Nokia
Universidade de Porto
Universidade da Beira Interior
Instituto Ciências e Tecnologias Empresariais

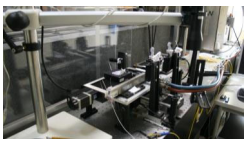
Main partnerships

- 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 (UAlg)
- Universidade de Évora (UEv)
- Universidade da Madeira (UMad)

Instituto de Telecomunicações - Aveiro

PhD researchers	~80
PhD students	~94





Optical communications

Radio communications

Networking, mobile networks, future internet

Electronic design for telecommunications

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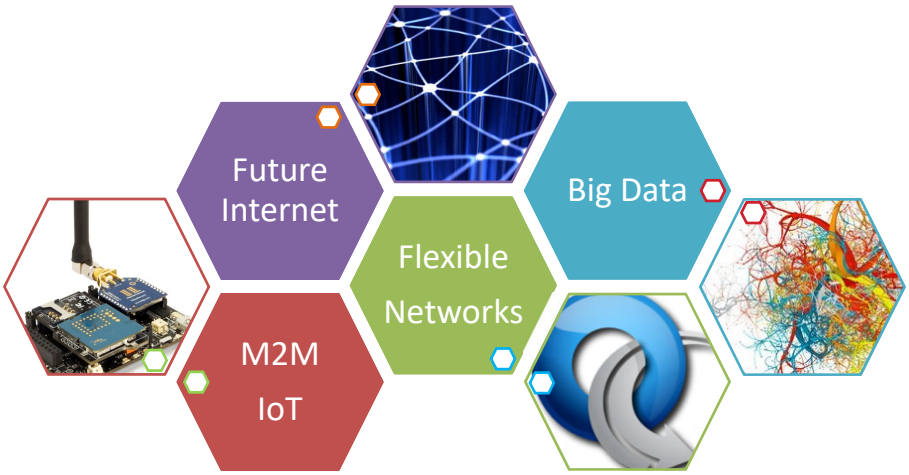

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Research group dedicated to communication networks, related services, applications and its traffic

- 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
- 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 tecnology
  - 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

FHIR

- 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

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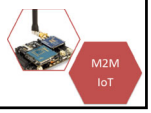
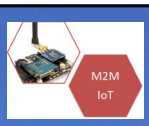
Big Data
M2M IoT

LIFE-PAYT

- Solutions for Smart Cities
  - Improving waste processes through Pay-As-You-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**



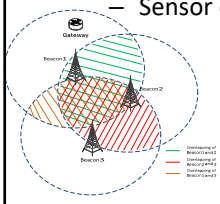
Pilot: Smart Agriculture

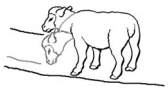


- Multi-dimensional information merging
  - Sensors in pomegranate trees
    - Real time physical and chemical analysis
  - High-value fruit culture
- UAVs
  - IR crop maps
  - Mobile sensing
  - Data mules and repeaters

SheepIT

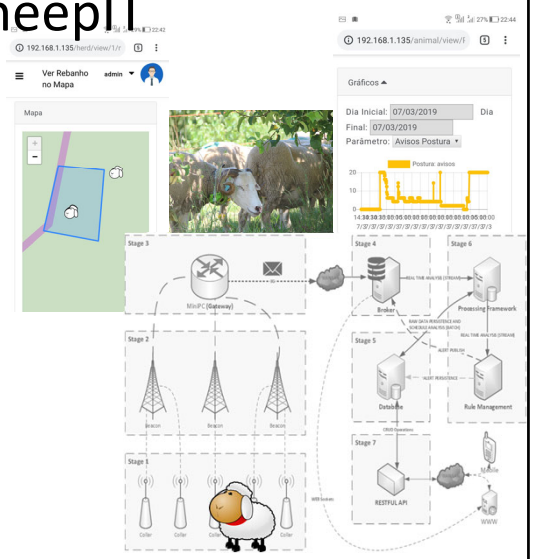
- Animal-based weeding for vineyards
  - Posture control
  - Animal monitoring
- IoT network
  - Animal location and tacking
  - Alarm generation
  - Sensor data gathering



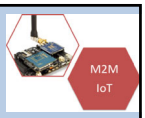


SheepIT

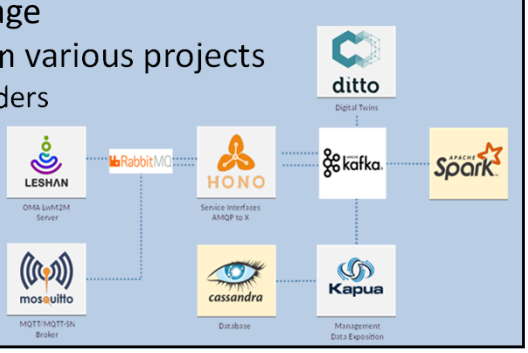
- Animal monitoring
  - Animal wellbeing
    - Activity decrease/increase
  - Activity monitoring
    - Supervised learning techniques
  - Location pasture monitoring
    - Non supervised learning
- Web platform for animal handling



The Outome:
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



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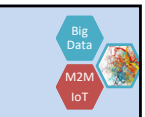
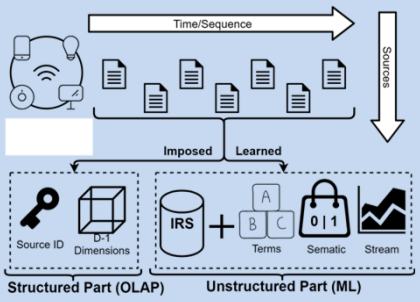
The Outcome:
Context Organization for IoT sources





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)

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Managing data

LAYER 2 – DATA IS COMING

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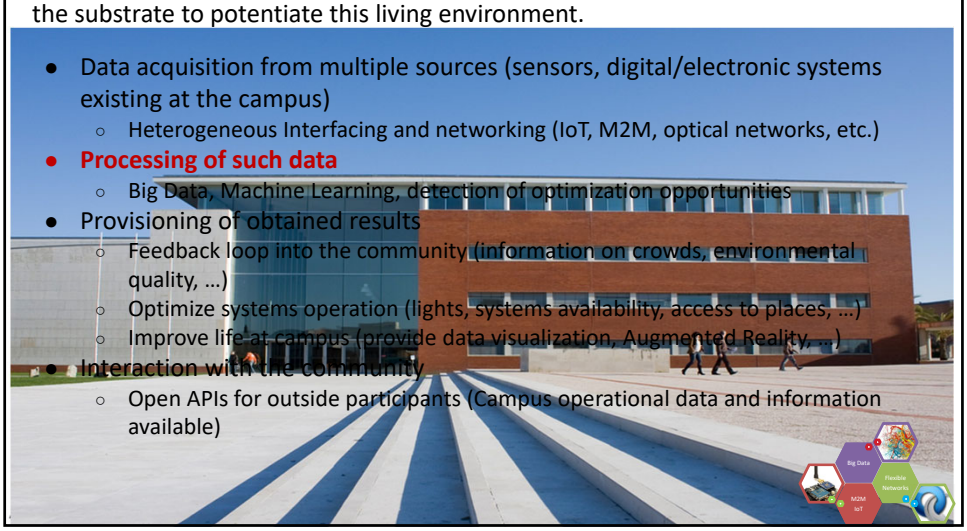
Smart Open Campus

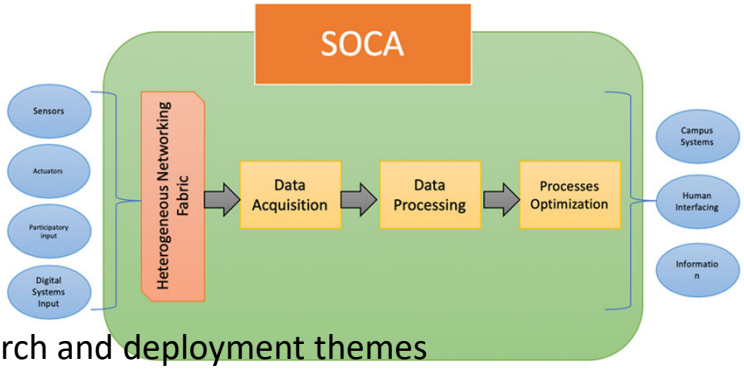
SOCA

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 at campus (provide 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 advisoring

SKA - Square Kilometre Array

- Distributed, radio telescope with two sites of >3000 Km
  - Mainly in radio dead zones in South Africa an Australia
  - €1.5 billion budget cap
- Direct radio over fiber from each antenna 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

instituto de telecomunicações

Big Data

- 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

kubernetes OpenFlow Open Source MANO OPEN DAYLIGHT openstack

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Running test infrastructures

LAYER 3 – EXTERNAL SERVICES ARE COMING

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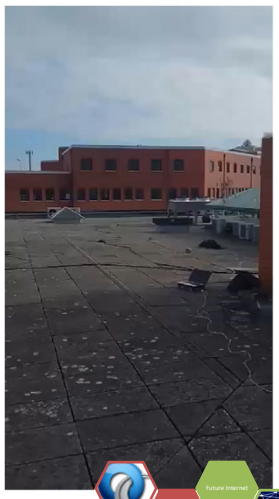
Amazing @ Instituto de Telecomunicações

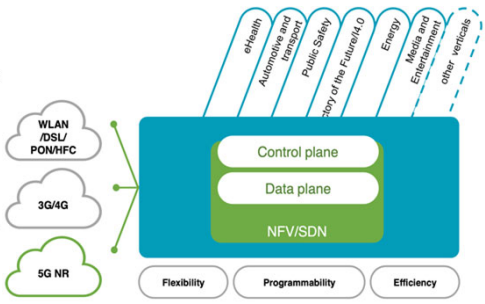
- Advanced Testing and metering
  - **Open configurable environment**
  - 24x fully configurable wireless nodes, multiple interfaces
  - Software-defined Networking supported
  - Associated mobile network cell
  - Fully robotized mobile vehicle for speedy-based experiments
  - 2 (4) SDR plaforms



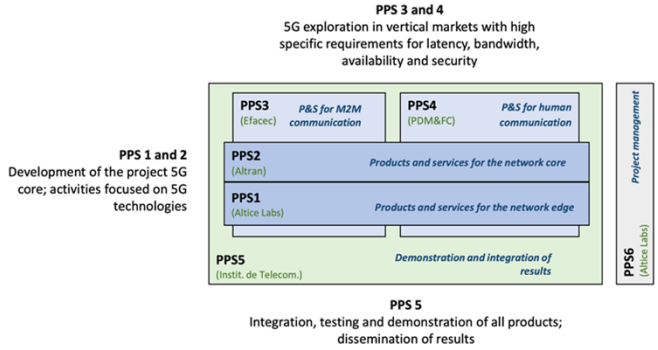
5GO - The Portuguese 5G Mobilizer

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 servic in key technologies supporting the realization of 5G
- Development / adaptation of products for critica IoTand multimedia applications, using public 5G networks
- Operation and availability of integration platforn test and demonstration of ecosystem 5G

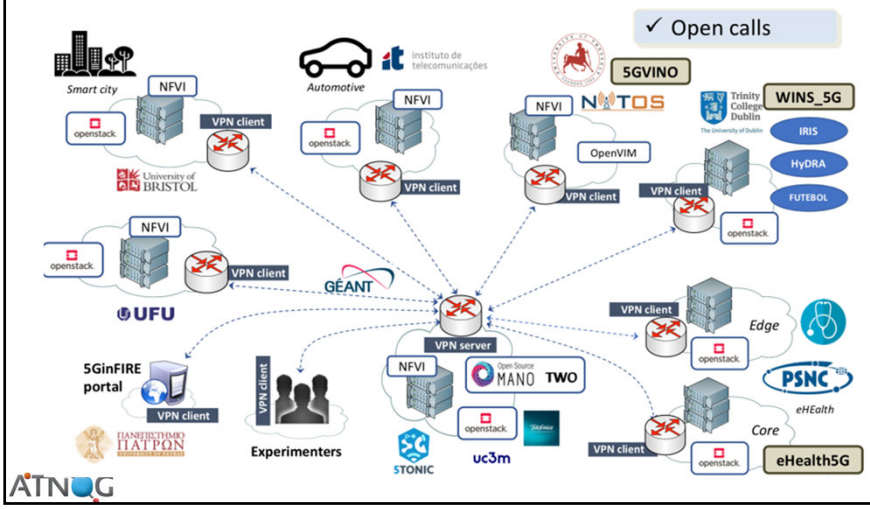


5GO - The Portuguese 5G Mobilizer

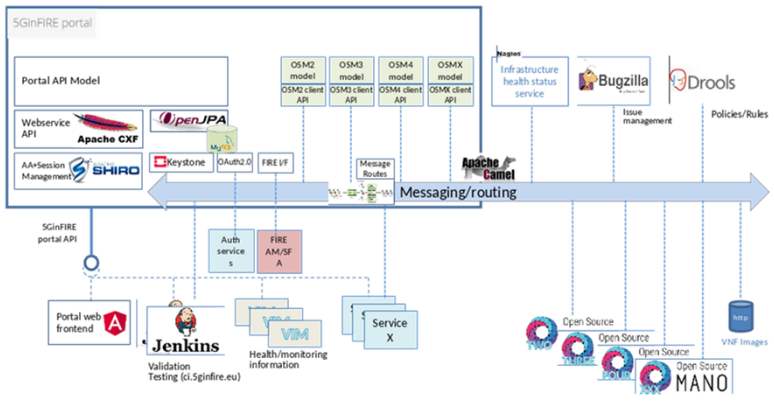


- Verticals involved:
  - Energy
  - Transportation (rail)
  - Human interface (body kits)

5GinFIRE Network & Ecosystem



5GinFIRE Architecture

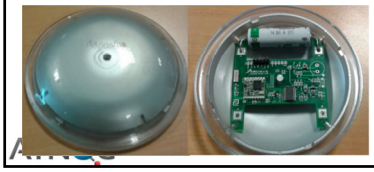


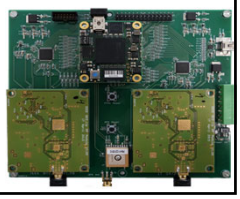
Our focus:

- **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)

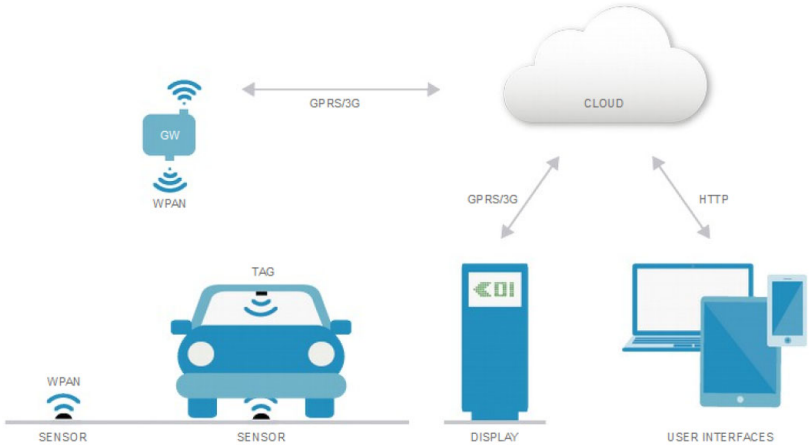
- **Open platform**
  - Serving SMEs and software developers with a “road environment”
  - V2X infrastructure, sensor monitoring (parking, weather, waves) cellular communication, WiFi, data processing
    - ETSI ITS-G5
    - LTE / LTE-V
    - Gateways multi-technology (BLE, ZigBee, LoRa, Sigfox, etc.)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





Road coverage

Public spaces support



Aveiro S.T.E.A.M.
exploring 5G coverage

The Outcome: Aveiro 5G demonstrator

- Aspects
  - **Technology**
    - 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
  - **Verticals**
    - Multiple verticals, with very diferent 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-threating real use case
  - **Society**
    - 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 diferent (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 struglling to find “the path”
  - Which may not even exist
  - Or be very diferent from country to country

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

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Thank you for your attention!

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

Rui Aguiar

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