inventors for the digital world

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TRiBE
inTeRnet BEyond the usual

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01

Who are we?

Who are we?

Research scientists:

- Aline Carneiro Viana, Inria, Team leader
- Emmanuel Baccelli, Inria
- Cedric Adjih, Inria

Invited researchers:

- Antonio Loureiro, EMBRACE member
- Kleber V. Cardoso, EMBRACE member
- Sand Correa, EMBRACE member

Administrative support

- Laurence Fontana, Inria

Rsearch engineers:

- Duc-Tuyen Ta, jointly with LRI

PhDs:

- Licia Amicchi, Inria CORDI-S
- Rafael Costa
- Hirah Malik
- Iman Hmedoush

Interns:

- Lucas S. de Oliveira, EMBRACE
- Joao Borges, EMBRACE
- Douglas do C. Teixeira, STIC AmSud MOTIf
- Diego Madariaga

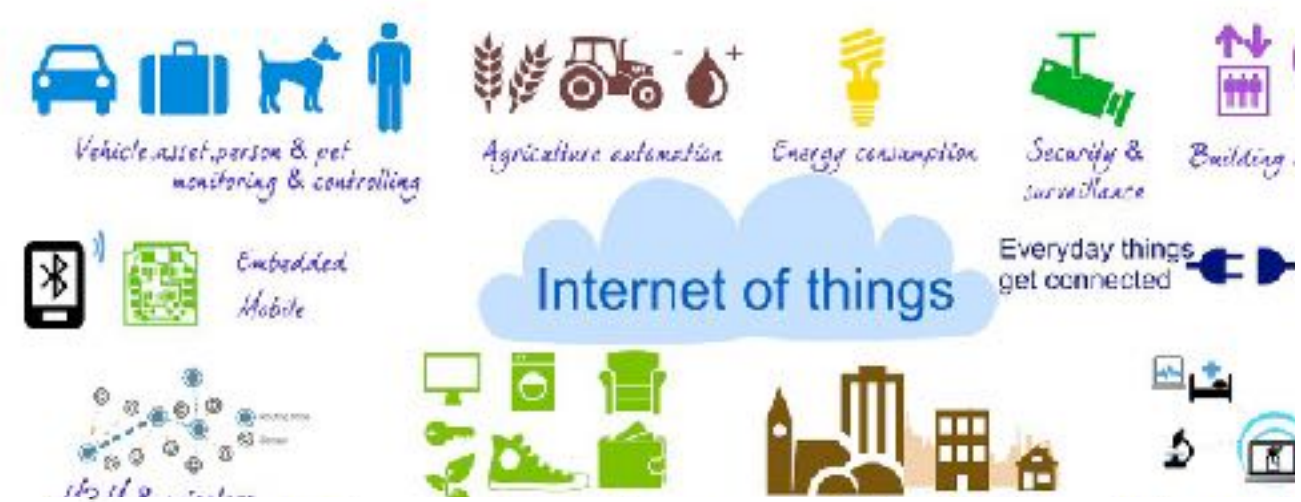
02

Why are we here?

Internet has changed

Internet has changed

Internet has changed

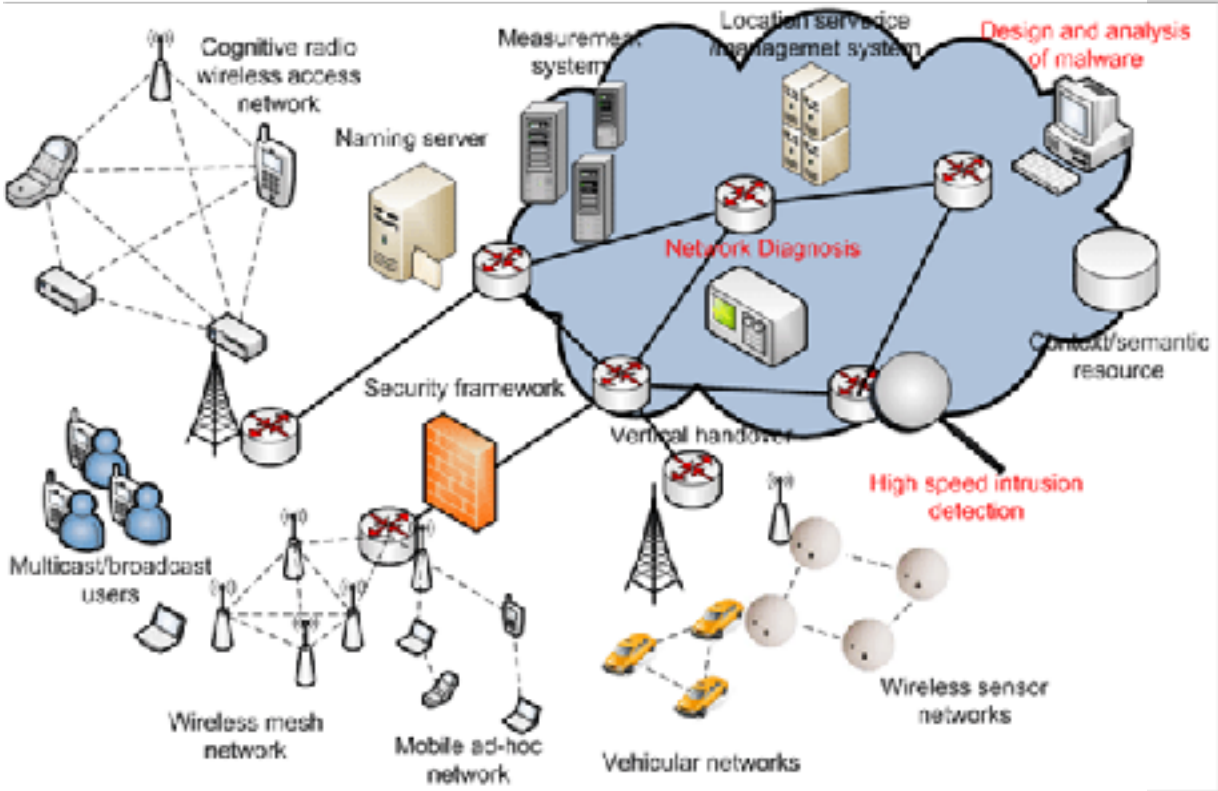


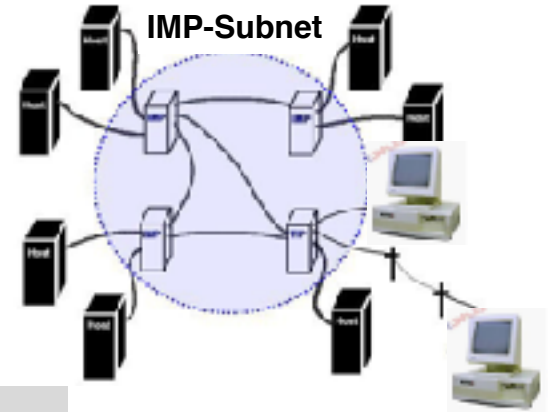
Why are we here?

Today
4,208M users

1995: Internet was fully commercialised in US
16M users

70s





IMP: Interfact Message Processor

Remote Terminal

Devices are new

Low-end IoT devices - limited capabilities

- Sensors, actuators, robots, etc
  - low power requirements
  - seamless integration in interoperable systems

High-end IoT devices - increasing capabilities

- Smart handheld devices
- how uses vary among individuals
- how uses interact with network services and demand resources

Challenges are numerous!!

1. Technologies for accommodating low-end IoT devices

Limited resources → **constrained** software and communication protocols

2. Technologies for leveraging high-end IoT devices' advents

Make **real** life and **virtual** activities seamlessly merged together

3. Articulating the IoT edge with the core of the network

Interaction requirement:

IoT devices ⇄ edge networks ⇄ core networks

Research of the team

Conviction

The success of the IoT is rooted in **appropriate** network designing **choices**

Vision

A **Smart, Unified, and Tactful Internet edge** skilled for answering application, services, or end-users' purposes.

Approach

Combines protocol **design**, data **analytics**, and **experimental** research
Organised around **three** research directions

1. Accommodating Low-end IoT devices

Optimized communication protocols

At low layers: IPv6 stack, newest MAC layers
At top layers: security, lifecycle management, use of machine learning

Tailored embedded software platforms

Flexible-after-deployment, **easier** programming, development **agility**, future-proof **secure**

Unified low-end IoT technology

Standardization process
Unification concepts: e.g., Information Centric Network in low-end IoT devices
RIOT as a **standard open source** software platform

2. Leveraging high-end IoT devices' advents

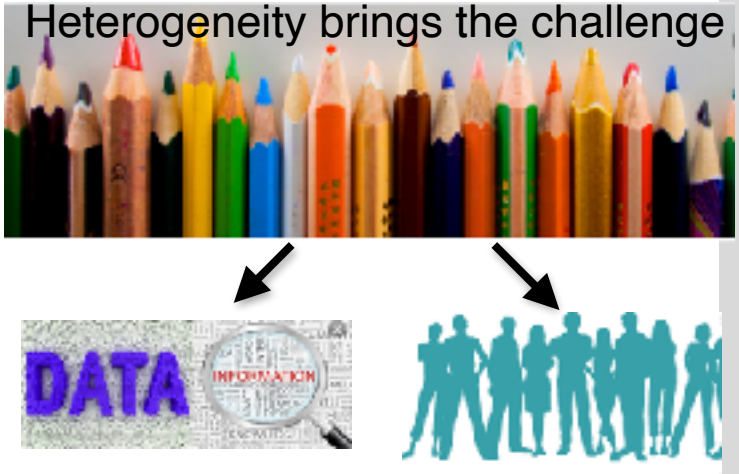
The quest for meaningful data

Need to integrate and scale up data analysis

Expanding edge networks' usage understanding

Human-driven prediction models

Humans have **habits** but also an "**exploration to new things**" aspect



3. Integrating edge-core networks

Machine learning (ML) enhanced protocols and softwares

From Low-end IoT  ML algorithms

Security of the edge/core compound at IoT deployment

Access authorization, securing data-at-rest and data-at-flight

Decentralized network mechanisms and architectures

Moving computation transparently to the edge

Edge network offloading

03

We are transferring!

Technology transfer

Open-access IoT testbed development

Design of large open IoT-Lab testbeds in France
Combining **IoT**-centric and **Cloud**-centric elements

IoT software platform development

Build upon RIOT

Standardization for IoT

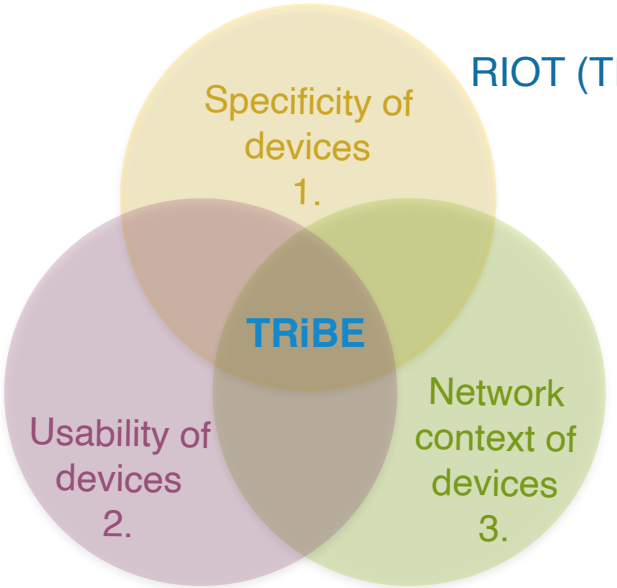
GranData company (SF, USA)

04

What is our position in the community?

What are our collaborators?

Where we place the focus of IoT research…



RIOT (TRiBE) *vs* Zephyr (Intel)
FreeRTOS (Amazon)
mbedOS (ARM)

Human behavior analysis

vs

Barabási Lab (NU, USA)
HuMNet Lab (UCB, USA)
MIT Media Lab (MIT, USA)
KDD Lab (Italy)

NPA (LIP6/CNRS)
EUROCOM
RIO (LS2N/Polytech Nantes)
IRIT/ENSEEIHT (Toulouse)
L2S/CentraleSupelec
ROCS (Univ. Paris Sud)
Thales, Huawei, Nokia Bell Labs

What are our **collaborators?**

Int./France

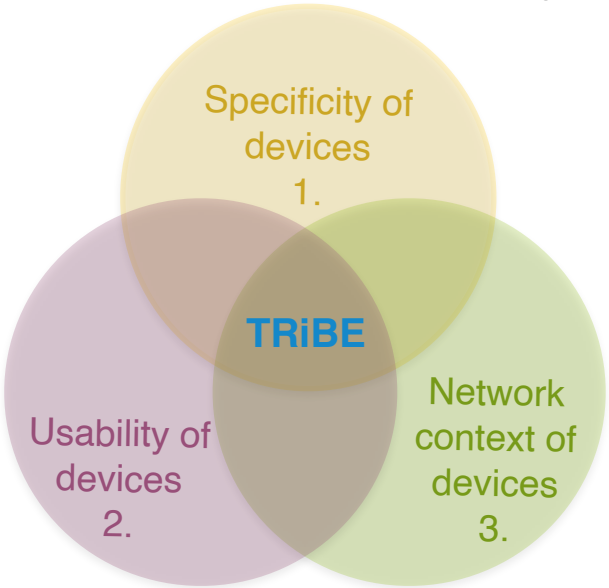
RIOT (TRiBE):

Freie Universitat Berlin (DE)
Hamburg University of Applied Sciences (DE)
Fujitsu Research Lab (JP)
IISc Bangalore (IN)

Human behavior analysis:

Sapienza Univ. of Rome (IT)
CNR (IT)
Univ. of Porto (PT)
UFMG, UFG, UTFPR (BR)
GranData (USA)

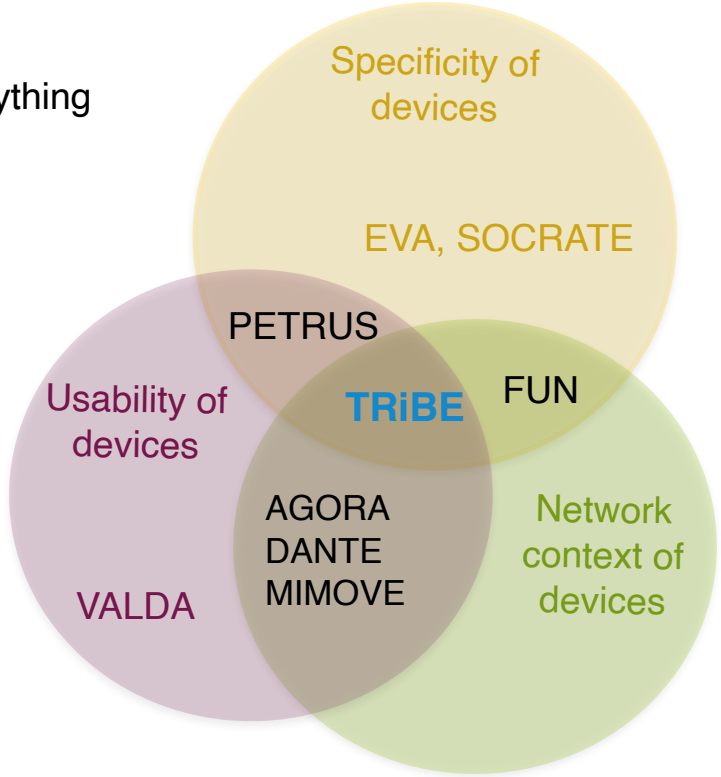
ENSAE CNRS (FR)



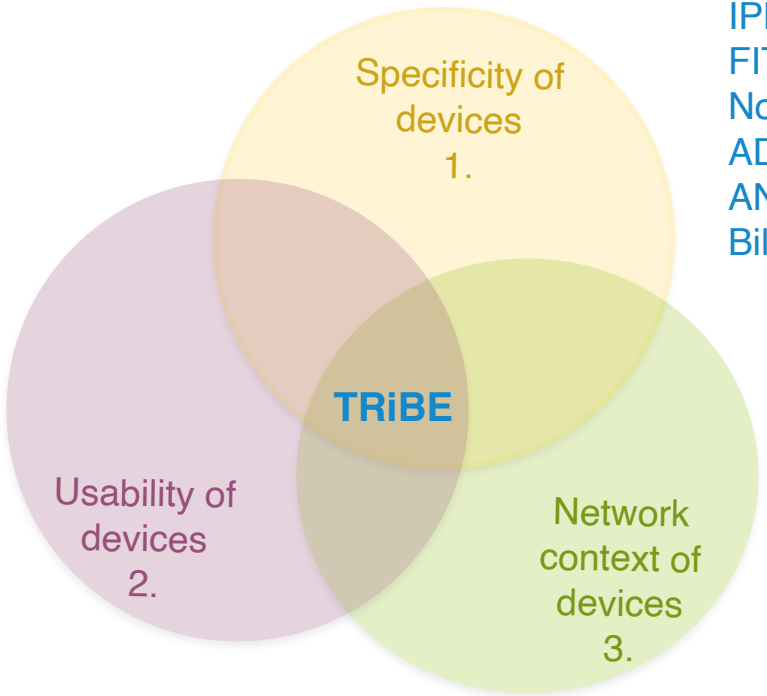
NPA (LIP6/CNRS)
IRIT/ENSEEIHT (Toulouse)
ROCS (Univ. Paris Sud)
Telecom SudParis
Nokia Bell Labs

Positioning within Inria

Theme: Networks and Telecommunications
Challenge nº 11: Toward a trustworthy Internet of Everything



Collaborations within Inria



IPL RIOT-FP: EVA, GRACE PROSECCO, TEA
IPL SPAI: INDES
FIT IoT-LAB: DIANA, FUN, AGORA
Nokia ADR: SOCRATE, EVA
ADT SytaRIOT: SOCRATE
ANR under submission: COMETE, ENSAE/CNRS
Bilateral collaboration: AGORA, COMETE ENSAE/CNRS

Merci beaucoup