

# IOT IN ACADEMIC INSTITUTIONS IN DEVELOPING COUNTRIES: LESSONS LEARNED

Marco Zennaro, PhD

The Abdus Salam International Centre for Theoretical Physics – Trieste, Italy



# OLÁ!



- Marco Zennaro, Research Scientist, ICTP
  - Studied at KTH in Stockholm
  - Coordinator of the Science, Technology and Innovation Unit
  - Focal Point of the ITU Centre of Excellence in IoT and Big Data and Statistics
  - Visiting Professor at Kobe Institute of Computing in Kobe, Japan
- 

# WHAT IS THE ICTP

---

The Abdus Salam International Centre for Theoretical Physics was founded in 1964, by the late **Nobel Laureate Abdus Salam**

ICTP is administered by **UNESCO** and is located in **Trieste**, Italy

"**Scientific thought is the common heritage of mankind**"

*Abdus Salam*



ACTIVITY  
11 Feb 2019 - 22 Feb 2019  
@ ICTP

Applied Physics

**Winter College on Applications of Optics and Photonics in Food Science I (smr 3272)**

Address: Via Grignano, 9 I - 34151 Trieste (Italy)

Room: Kastler Lecture Hall (AGH)

Secretary: Federica Delconte

Organizer(s): Sarun Sumriddetchkajorn (NECTEC), Anna Grazia Mignani (IFAC-CNR), Cathar Simpson (U. Auckland), Local Organiser: Joseph Niemela

Cosponsor(s): the International Commission for Optics (ICO), the Optical Society (OSA), the International Society for Optics and Photonics (SPIE), the European Optical Society (EOS), Società Italiana di Ottica e Fotonica (SIOF), the International Society on Optics Within Life Sciences (OWLS)

Support E-Mail: [smr3272@ictp.it](mailto:smr3272@ictp.it)

\*\*DEADLINE: 21/10/2018\*\*

ACTIVITY  
18 Feb 2019 - 22 Feb 2019  
@ ICTP

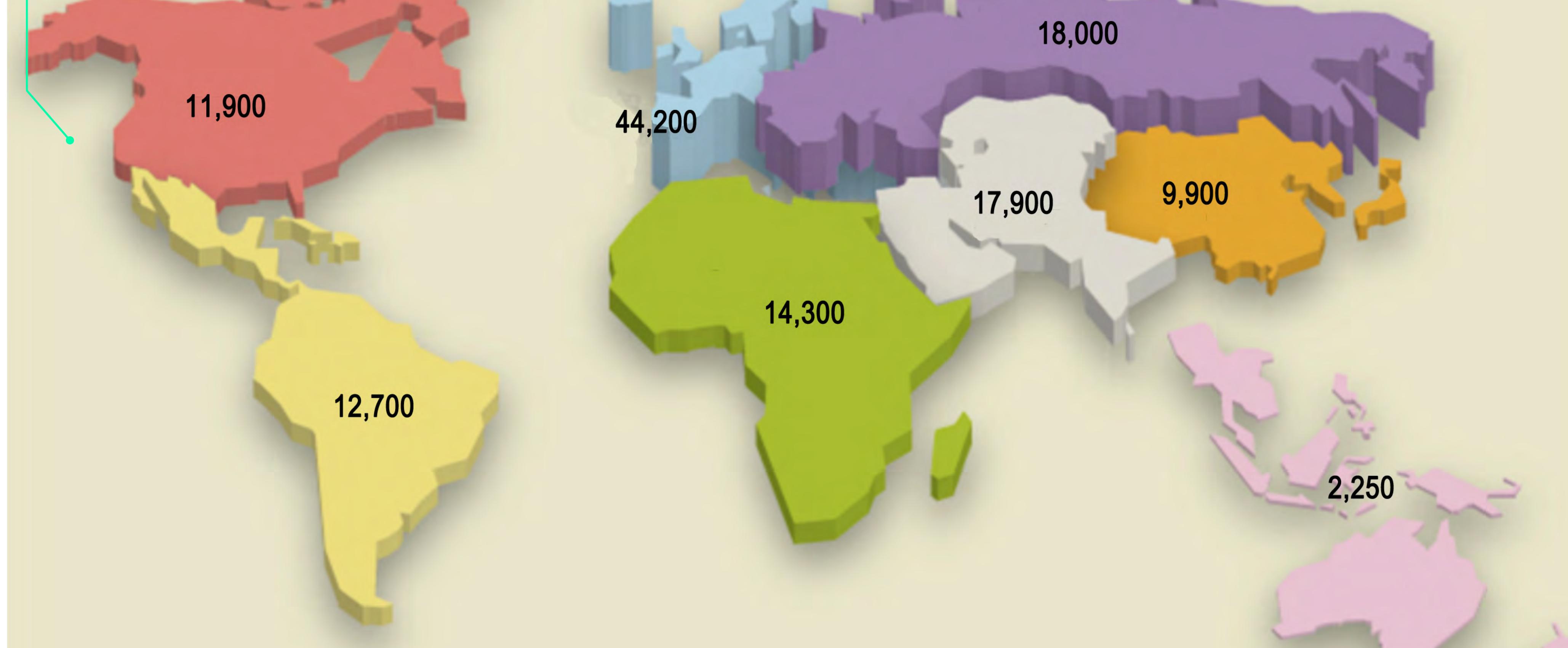
Condensed Matter and Statistical Physics

**Advanced School on Ubiquitous Quantum Physics: the New Quantum Revolution I (smr 3273)**

Address: Via Beirut, 2 - Strada Costiera, 11 I - 34151 Trieste (Italy)

# ACTIVITIES

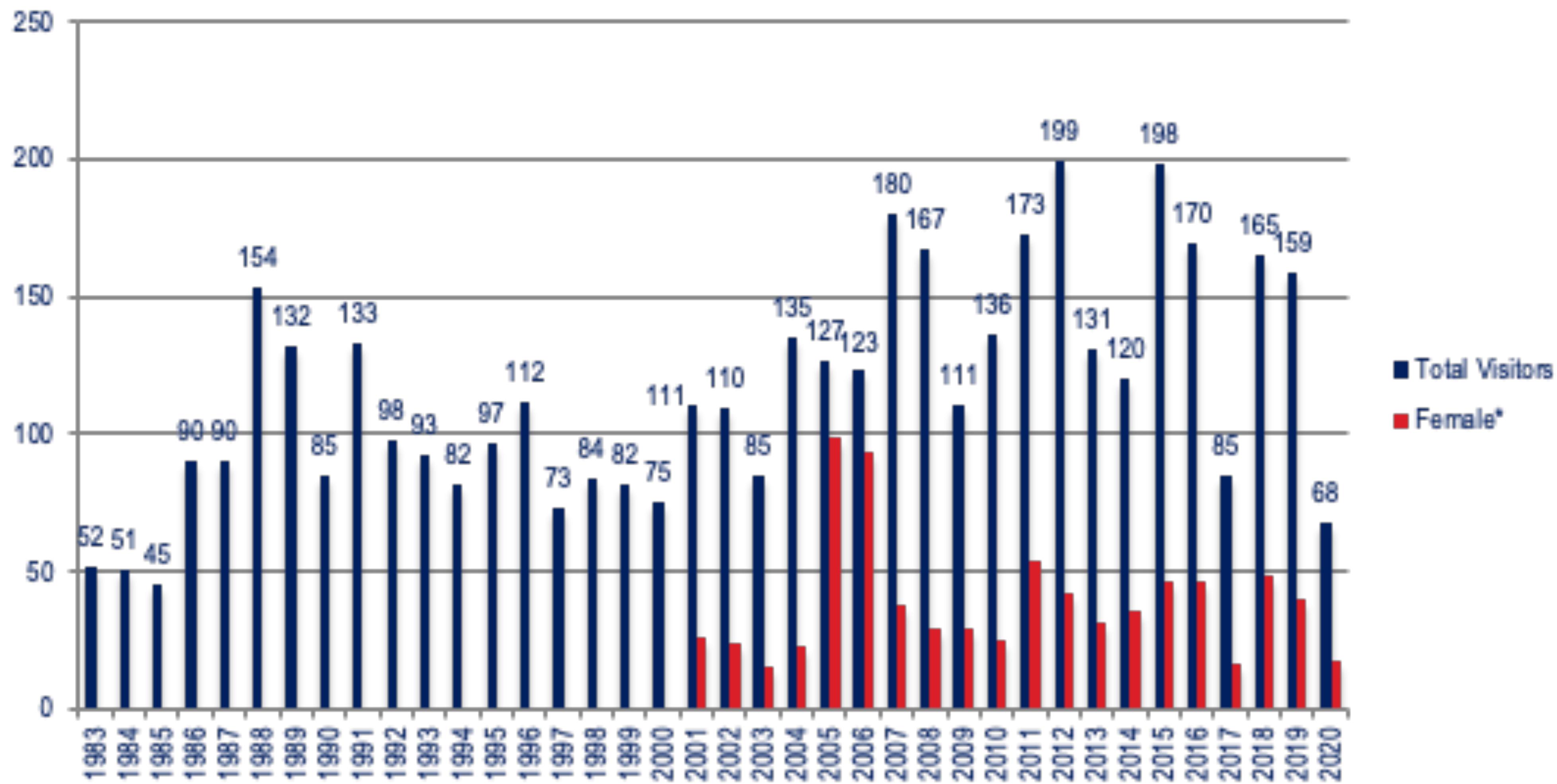
More than **60 activities every year**, in High Energy Physics, Condensed Matter, Mathematics, Earth System Physics and STI (former Applied Physics)



# VISITING SCIENTISTS

More than **120'000** visits from **188 countries**, **20%** of visitors are women

## ICTP Visitors from Brazil 1983-2020



## Brazilian participation in ICTP Programmes

- 117 Affiliates (from 8 Federated Institutes)
- 145 Associate Members (18 female)
- 3 Postgraduate Diploma Students (2 female)
- 43 TRIL Fellows (12 female)
- 6 STEP Fellows (1 female)
- 43 ICTP-Elettra Students (18 female)

## Brazilian participation in ICTP Programmes

- 117 Affiliates (from 8 Federated Institutes)
- 145 Associate Members (18 female)
- 3 Postgraduate Diploma Students (2 female)
- 43 TRIL Fellows (12 female)
- 6 STEP Fellows (1 female)
- 43 ICTP-Elettra Students (18 female)

# Brazilian Delegation

- visited ICTP in occasion of the G20 Ministerial Meetings, Trieste, 4 August 2021



# Brazil at ICTP

## ICTP Scientific Council Members

- ▶ Carlos Alberto Aragão de Carvalho, 2013
- ▶ Jacob Palis, Chairman 2003-2005
- ▶ Hervasio Guimaraes de Carvalho, 1980-1982



# ICTP Partner Institute in Brazil

- ▶ In 2012, ICTP has officially opened its regional branch in São Paulo, Brazil, to bring its unique blend of high-quality physics and mathematics education and high-level science meetings closer to scientists in South America



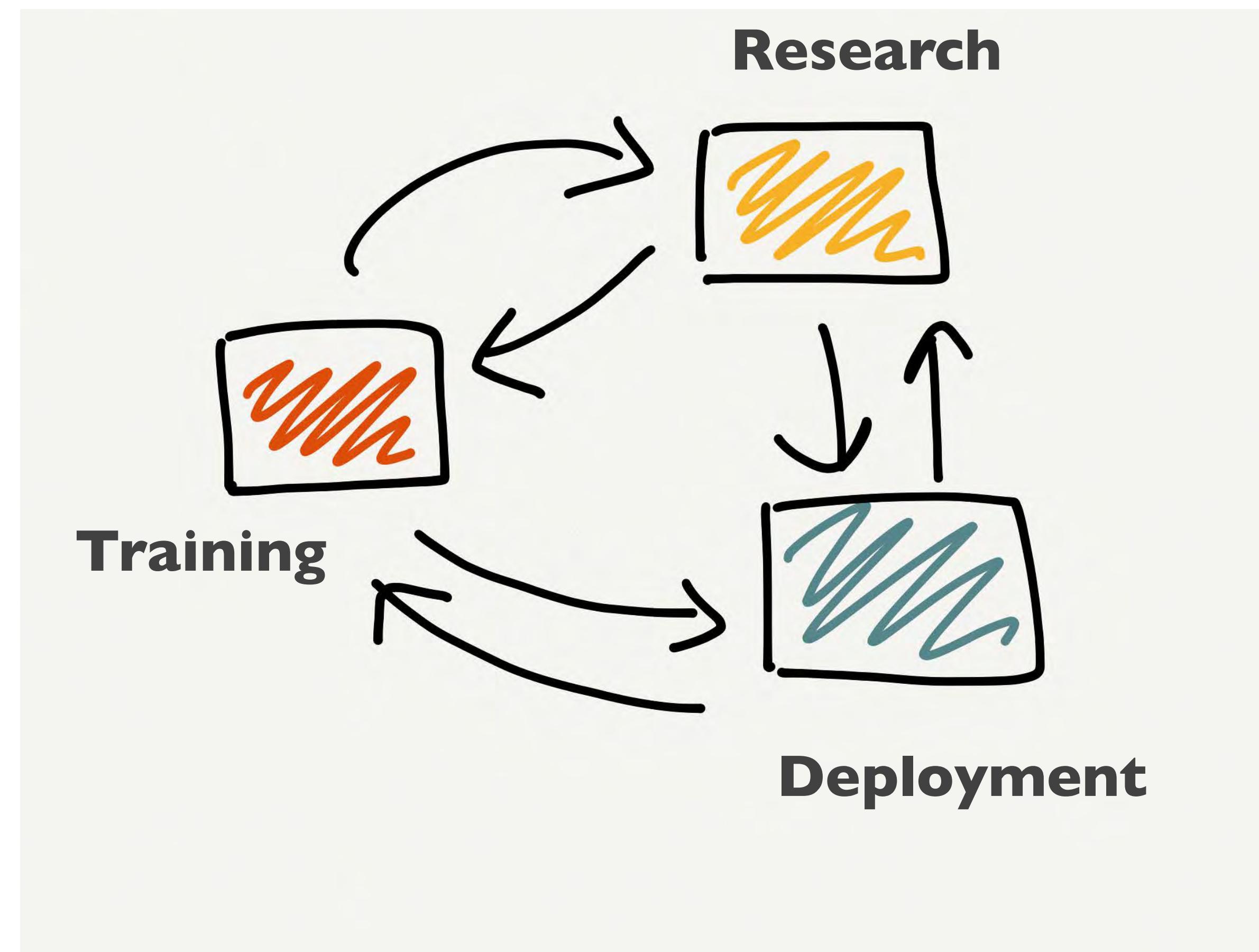
International Centre for Theoretical Physics  
South American Institute for Fundamental Research

*Opening ceremony of ICTP-SAIFR:  
Auditorium of IFT-UNESP,  
São Paulo, Brazil,  
6 February 2012*



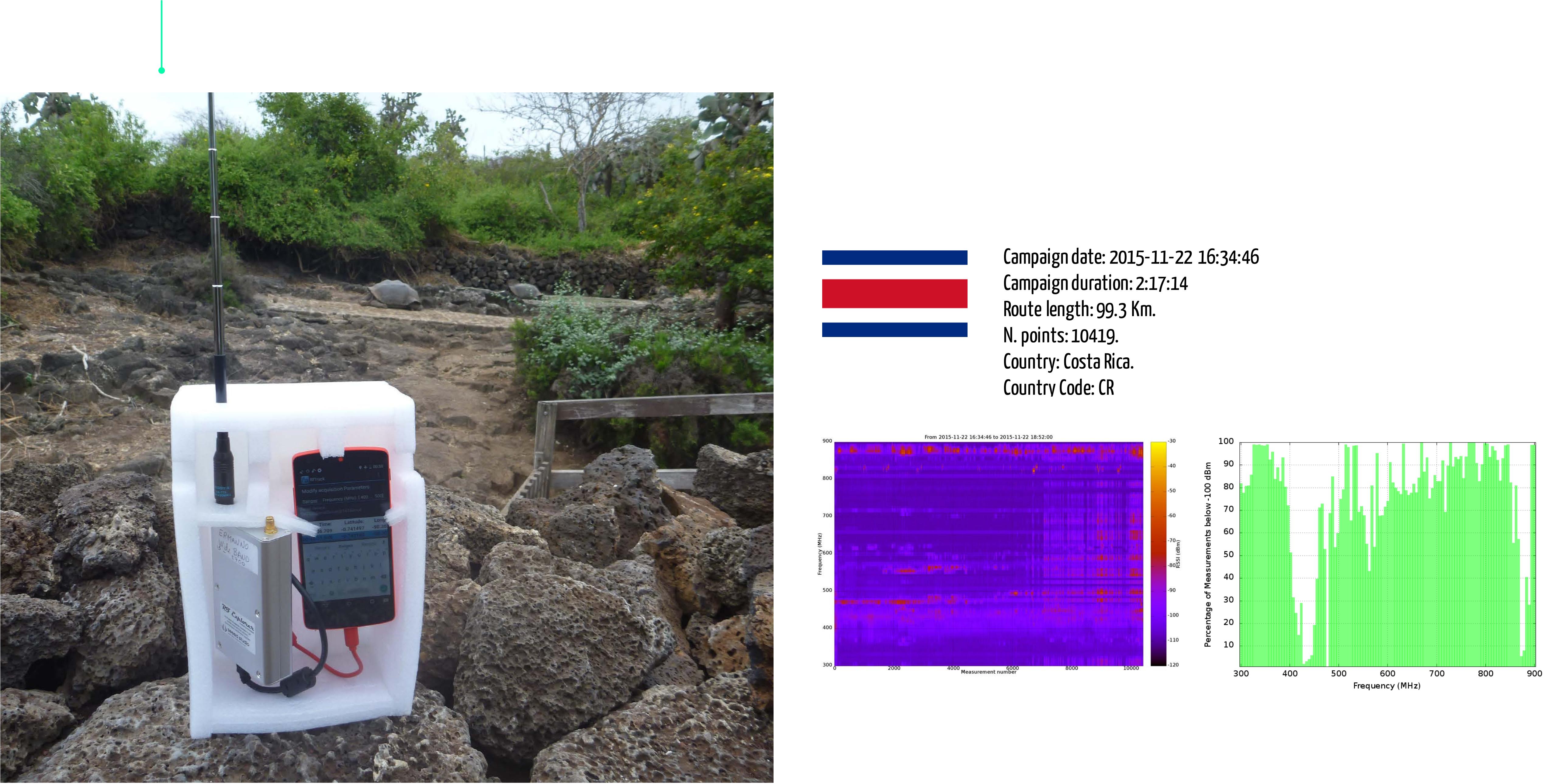
# STI

**Science, Technology and Innovation**









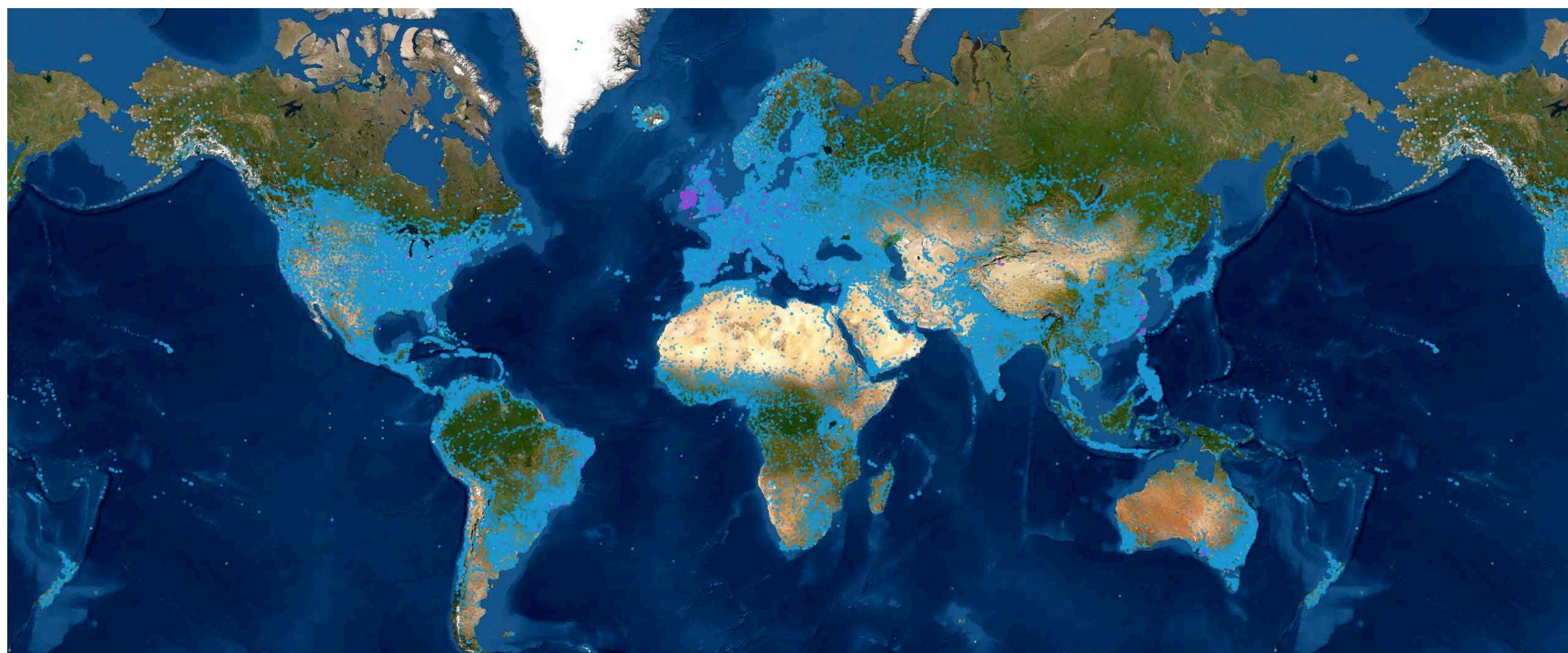




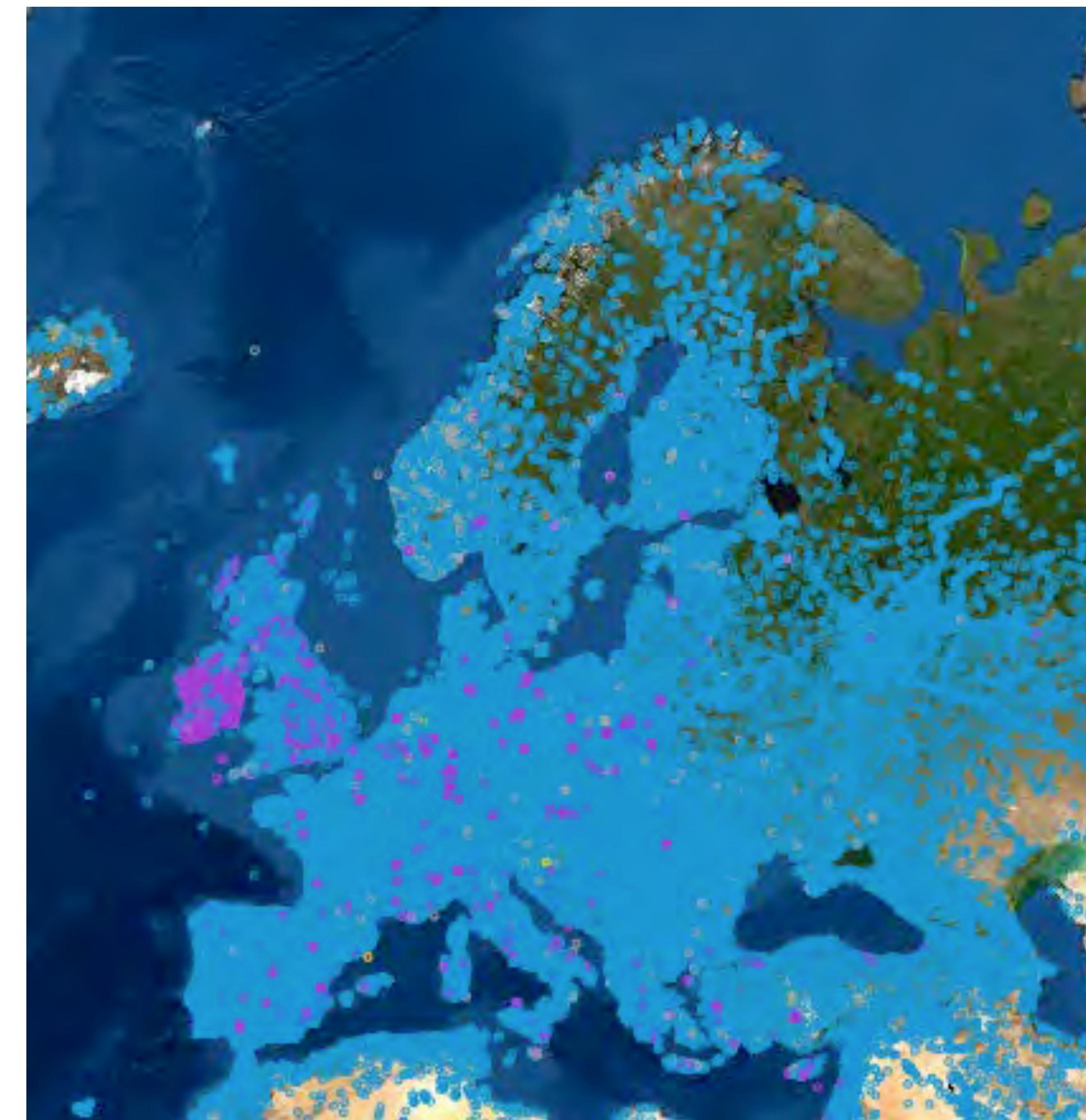
# **IOT4D (FINALLY!)**

# IOT AND DEVELOPMENT

Credit: <https://www.thingful.net>



# IOT AND DEVELOPMENT



# IOT AND DEVELOPMENT



# IOT AND DEVELOPMENT

CLIMATE CHANGE

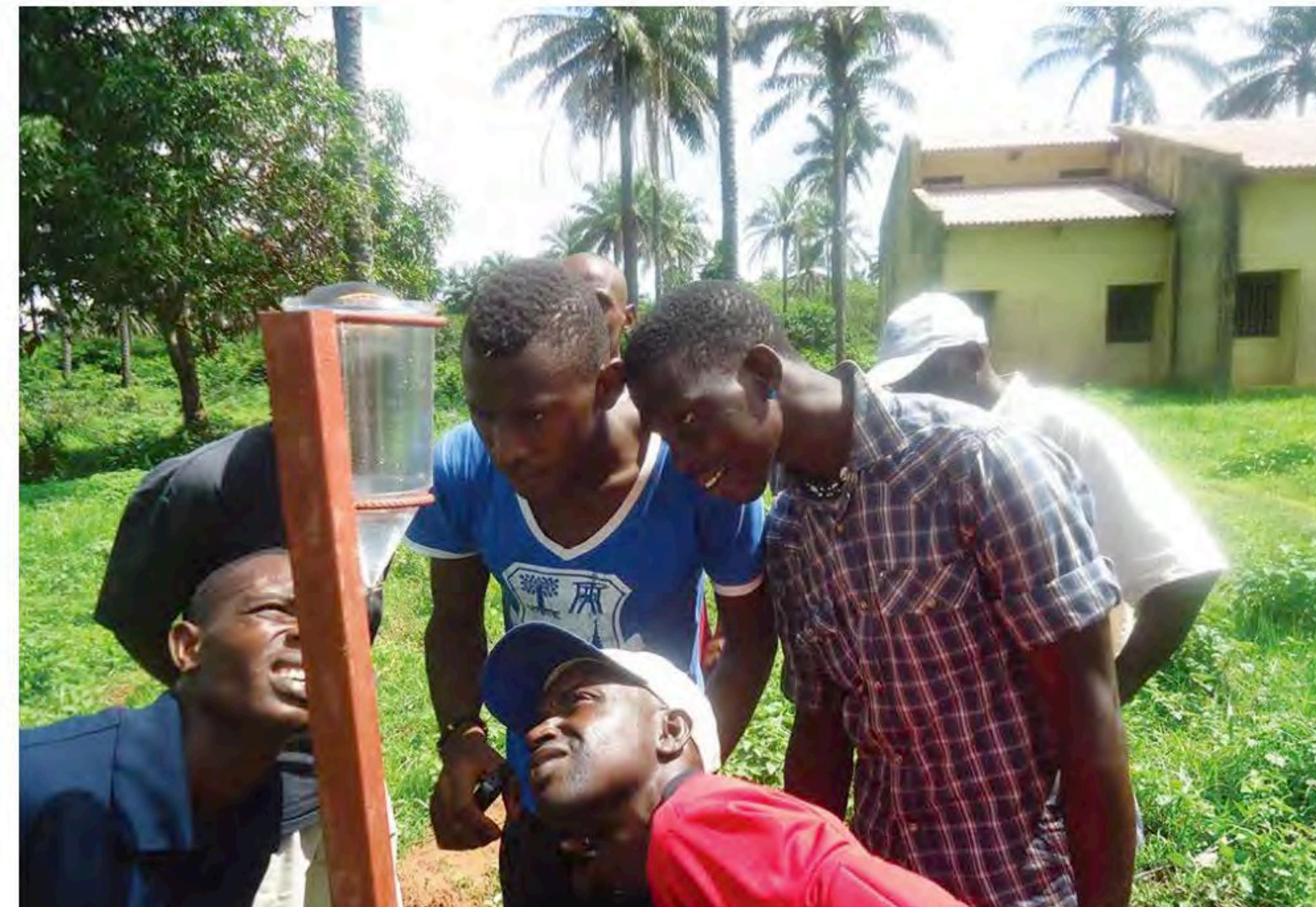
## 54% of Africa's surface weather stations can't capture data properly

With extreme weather events becoming the new normal, forecasting has become more important than ever. It's time African nations invest in observation networks



NEXT NEWS >

By [Maina Waruru](#)  
Last Updated: Tuesday 29 May 2018



# Antarctic seals recruited to measure effects of climate change

*Deep-diving animals collected data that could be used to sharpen projections of rising seas.*

---

Alex Fox

---



## RELATED ARTICLES

[Rescued radar maps reveal past](#)

[Antarctica's sleeping ice wake soon](#)

[Antarctic coast meltdown ice-sheet collapse](#)

---

## SUBJECTS

[Applied physics](#) [Climate](#)

# IOT AND SDG



SUSTAINABLE  
DEVELOPMENT GOALS  
17 GOALS TO TRANSFORM OUR WORLD

1 NO  
POVERTY



2 ZERO  
HUNGER



3 GOOD HEALTH  
AND WELL-BEING



4 QUALITY  
EDUCATION



5 GENDER  
EQUALITY



6 CLEAN WATER  
AND SANITATION



7 AFFORDABLE AND  
CLEAN ENERGY



8 DECENT WORK AND  
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION  
AND INFRASTRUCTURE



10 REDUCED  
INEQUALITIES



11 SUSTAINABLE CITIES  
AND COMMUNITIES



12 RESPONSIBLE  
CONSUMPTION  
AND PRODUCTION



13 CLIMATE  
ACTION



14 LIFE  
BELOW WATER



15 LIFE  
ON LAND



16 PEACE, JUSTICE  
AND STRONG  
INSTITUTIONS



17 PARTNERSHIPS  
FOR THE GOALS



SUSTAINABLE  
DEVELOPMENT  
GOALS



# IOT AND SDG



## ► SDG 2: ZERO HUNGER:

An estimated 821 million people were undernourished in 2017. Annual cereal production will need to rise to about 3 billion tonnes and annual meat production will need to rise by over 200 million tonnes to reach 470 million tonnes to feed 9.1 billion people by 2050.

## ► SDG 3: GOOD HEALTH AND WELL-BEING:

3 billion people worldwide lack access to basic sanitation. Noncommunicable diseases alone will cost low- and middle-income countries more than \$7 trillion in the next 15 years.





# IOT AND SDG



► SDG 11: SUSTAINABLE CITIES:

Half of humanity – 3.5 billion people – lives in cities today and 5 billion people are projected to live in cities by 2030. The world's cities occupy just 3 per cent of the Earth's land, but account for 60-80 per cent of energy consumption and 75 per cent of carbon emissions.

► SDG 13 & 15: CLIMATE ACTION and LIFE ON LAND:

Given current concentrations and on-going emissions of greenhouse gases, it is likely that by the end of this century, the increase in global temperature will exceed 1.5°C. Global emissions of carbon dioxide (CO<sub>2</sub>) have increased by almost 50 per cent since 1990





# IOT4D AND ICT4D



There is a good paper on the use of ICT in Developing Countries:

**The case for Technology in developing regions, E.Brewer et al., IEEE Pervasive Computing, 2005**

The World Bank's infoDev site catalogs hundreds of ICT projects (<http://www.infodev.org>), albeit not all successful. Most of these projects use existing off-the-shelf technology designed for the industrialized world.





# IOT4D AND ICT4D



The paper claims that there are **four technological requirements** for an ICT4D project to be successful:

**Autonomous Connectivity**

**Low-cost equipment**

**Power resilience**

**Appropriate User Interface**





# IOT TRAINING ACTIVITIES

---

- Argentina (2016, 2019)
- Benin (2014)
- Colombia (2016)
- Costa Rica (2015)
- Ecuador (2014)
- Egypt (2015)
- El Salvador (2017)
- Ethiopia (2017)
- Ghana (2011)
- Guatemala (2019)
- Honduras (2017)
- India (2011, 2019)
- Indonesia (2012 and 2017)
- Japan (2014, 2015, 2016, 2017, 2018 for ICT4D students)
- Kenya (2011)
- Mauritius (2015)
- Myanmar (2020)
- Nepal (2018)
- Nicaragua (2013)
- Rwanda (2015)
- South Africa (2010)
- Thailand (2014, 2016 and 2017)
- Uganda (2020)

**30 activities in 23 countries and 5 at ICTP (Italy)**



# **LESSONS LEARNED**





# AIR QUALITY IN BENIN

2014, Institut de Mathématiques et de Sciences Physiques (IMSP)



# SENSORS FOR GLOBAL DEVELOPMENT FINALISTS



## **Fresh Air in Benin** by Marco Zennaro [source files](#)

We are developing a network of air quality sensors in Benin. There are few air quality sensors in Africa, the problem of pollution is relevant in many big cities. Some pictures are available here:

<https://www.flickr.com/photos/zennaro/sets/72157645018270403/>



#1: mobile connectivity. 3G is not available everywhere, SMS might be the solution

#2: keep the final users in the loop

#3: data privacy vs openness

## LESSONS LEARNED



THE AIR POLLUTION IN  
**NAIROBI, KENYA**

WHO GUIDELINE

11.4

54.26% BELOW THE  
SAFE LEVEL

PM<sub>2.5</sub> 24 HOURS EXPOSURE\*



SUBSCRIBE

CONNECT

EXPLORE

SHARE

Death by air pollution  
in Kenya yearly

**19,112**

Child Deaths  
caused by air pollution  
in Kenya yearly

**6,672**

The top illness caused  
by air pollution  
in Kenya is

**ACUTE LOWER  
RESPIRATORY  
INFECTION**

POLLUTION LEVELS IN NAIROBI

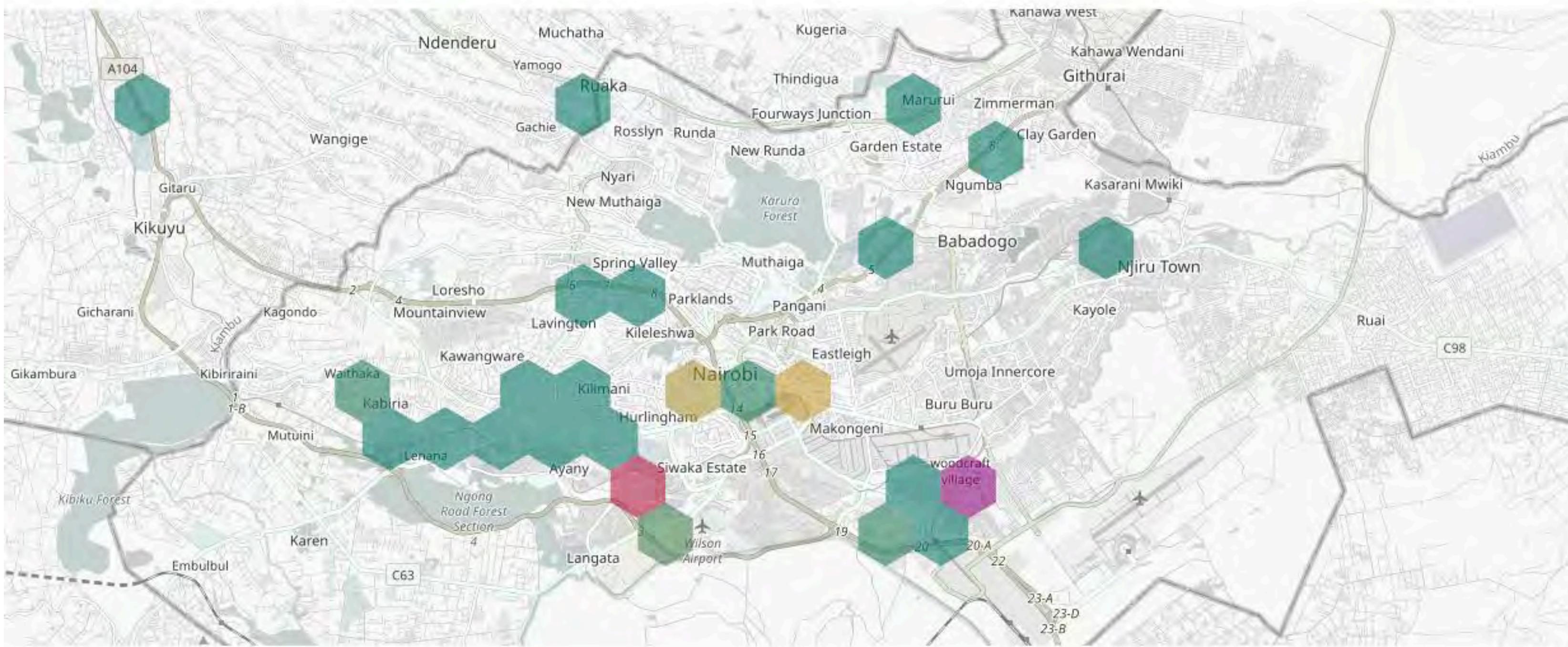
The air in Nairobi has an  
annual average of

**17** µg/m<sup>3</sup>

of PM<sub>2.5</sub> particles.  
That's 70% more than the  
WHO safe level.

## SENSORS IN YOUR AREA

\* Click a sensor to view latest readings.



PM 2.5

**242.23** µg/m<sub>3</sub>

HUMIDITY

**99.90** % RH

TEMPERATURE

**30.10** °C

PM 2.5

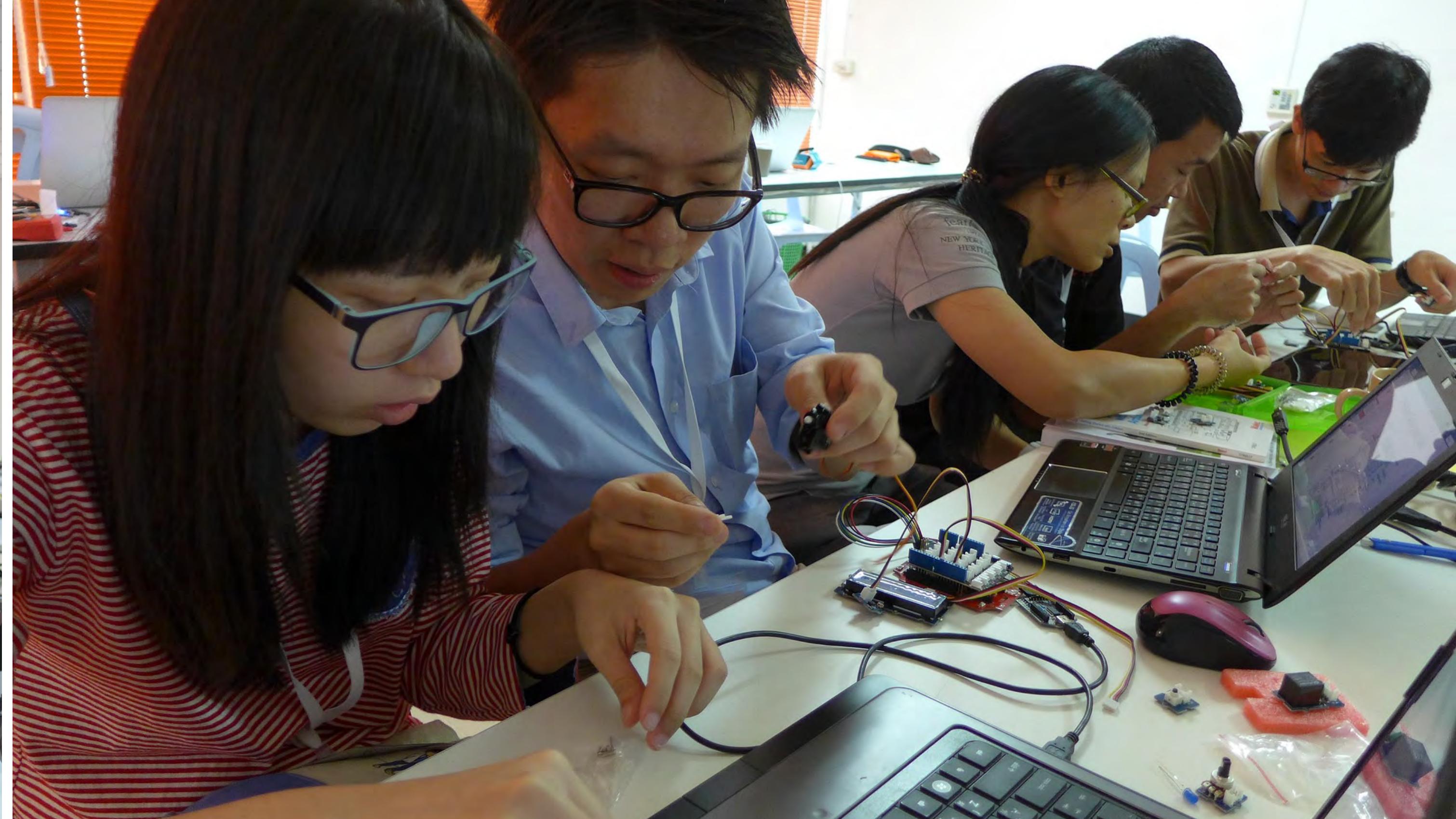
**11.43** µg/m<sub>3</sub>

HUMIDITY

**79.83** % RH

TEMPERATURE

**22.73** °C



# IOT LIVING LABS AT AIT

2016, Asian Institute of Technology (AIT)





#1: mobile connectivity. WiFi is the cheapest solution, but it is hard to plan ahead

#2: sensors need maintenance

#3: scalability is an issue

## LESSONS LEARNED

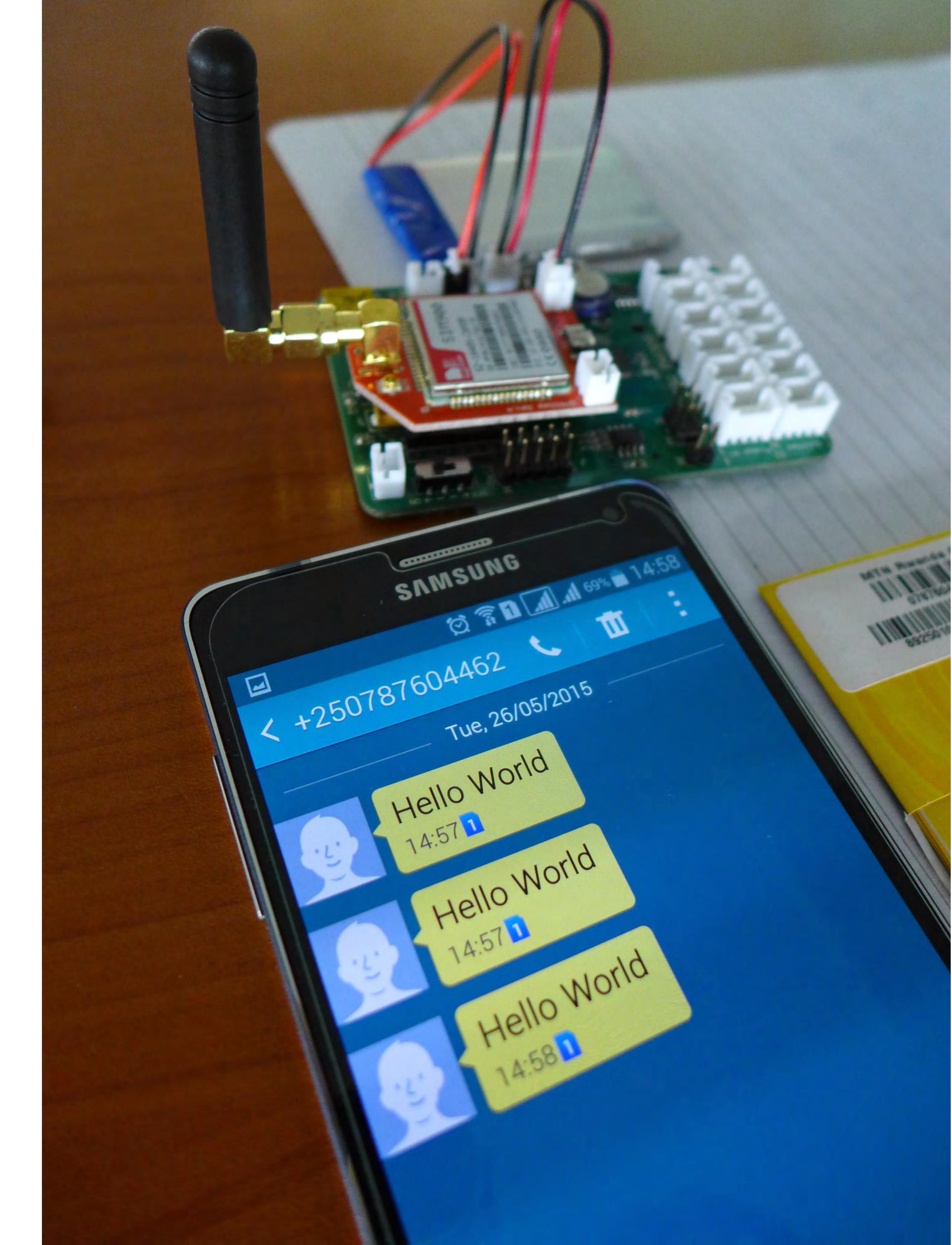




# TEA MONITORING IN RWANDA

2016, University of Rwanda in Kigali

# 4G IN RWANDA







#1: mobile connectivity: 4G in Rwanda.

#2: business model is a strong driver

#3: data ownership

## LESSONS LEARNED







# AFRICAN CENTER OF EXCELLENCE IN INTERNET OF THINGS



HOME COMMUNITY ▾ RESEARCH CONTACT US

Search this website... 

**Background**

- About ACEIoT
- ACEIoT Brochure
- ACEIoT Video

**Announcements**

**Academic Programs**

- Short Courses
- Master's Studies
- PhD Studies
- Public talks/Seminars

**Center Reports**

- Annual action Plan Fiscal year 2018-2019

## IoT Tech News



INTERNET OF THINGS  
TRENDIER & SMARTER

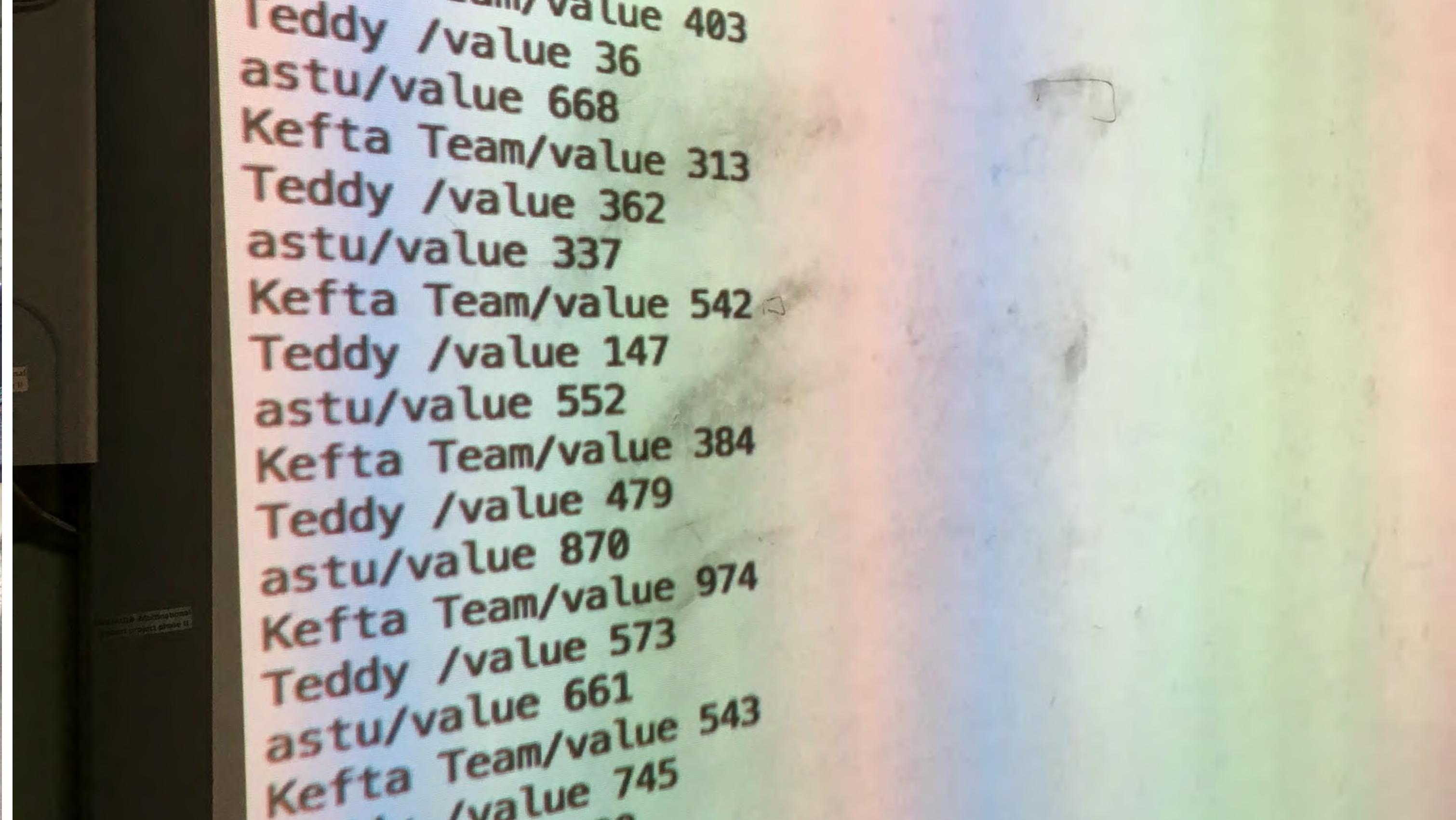
Internet of Things – The Bright Wave of the Future

**Events**



Blockchain EXE meetup





# IOT IN ETHIOPIA

2017, Addis Ababa University

- #1: internet connectivity is key
- #2: type approval of equipment
- #3: data ownership, including servers

## LESSONS LEARNED

# Kenya's Communications Authority (CA) to Scrutinize IoT Devices Before Sale

By **Kenn Abuya** - May 21, 2018 0



**14**  
SHARES





# LOW COST WEATHER STATIONS

2017, Palembang (Indonesia) and Mauritius

#1: calibration is an issue

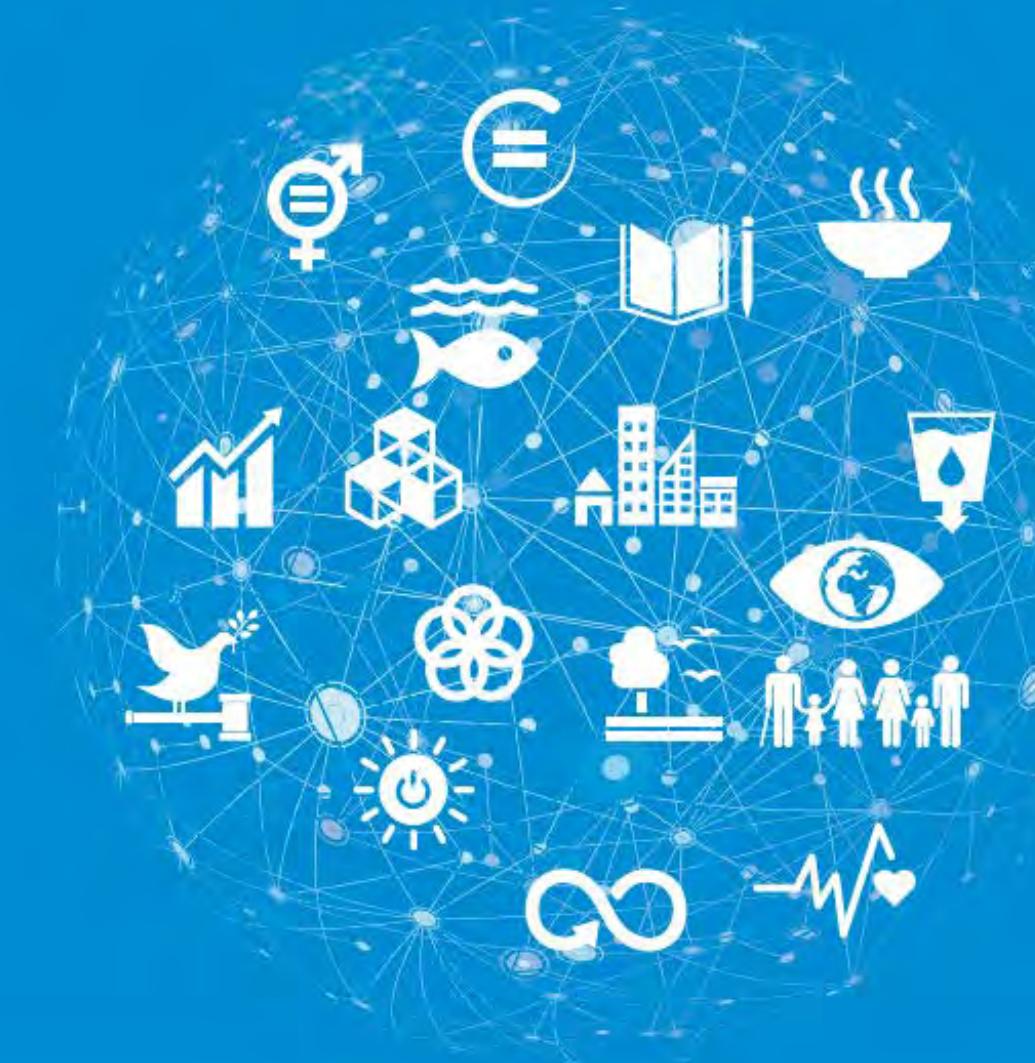
#2: connectivity (interesting to report from unconnected sites!)

#3: data exchange

## LESSONS LEARNED

# ITU REPORT ON IOT4D

## Harnessing the Internet of Things for Global Development



A CONTRIBUTION TO THE UN BROADBAND COMMISSION  
FOR SUSTAINABLE DEVELOPMENT

## Acknowledgements

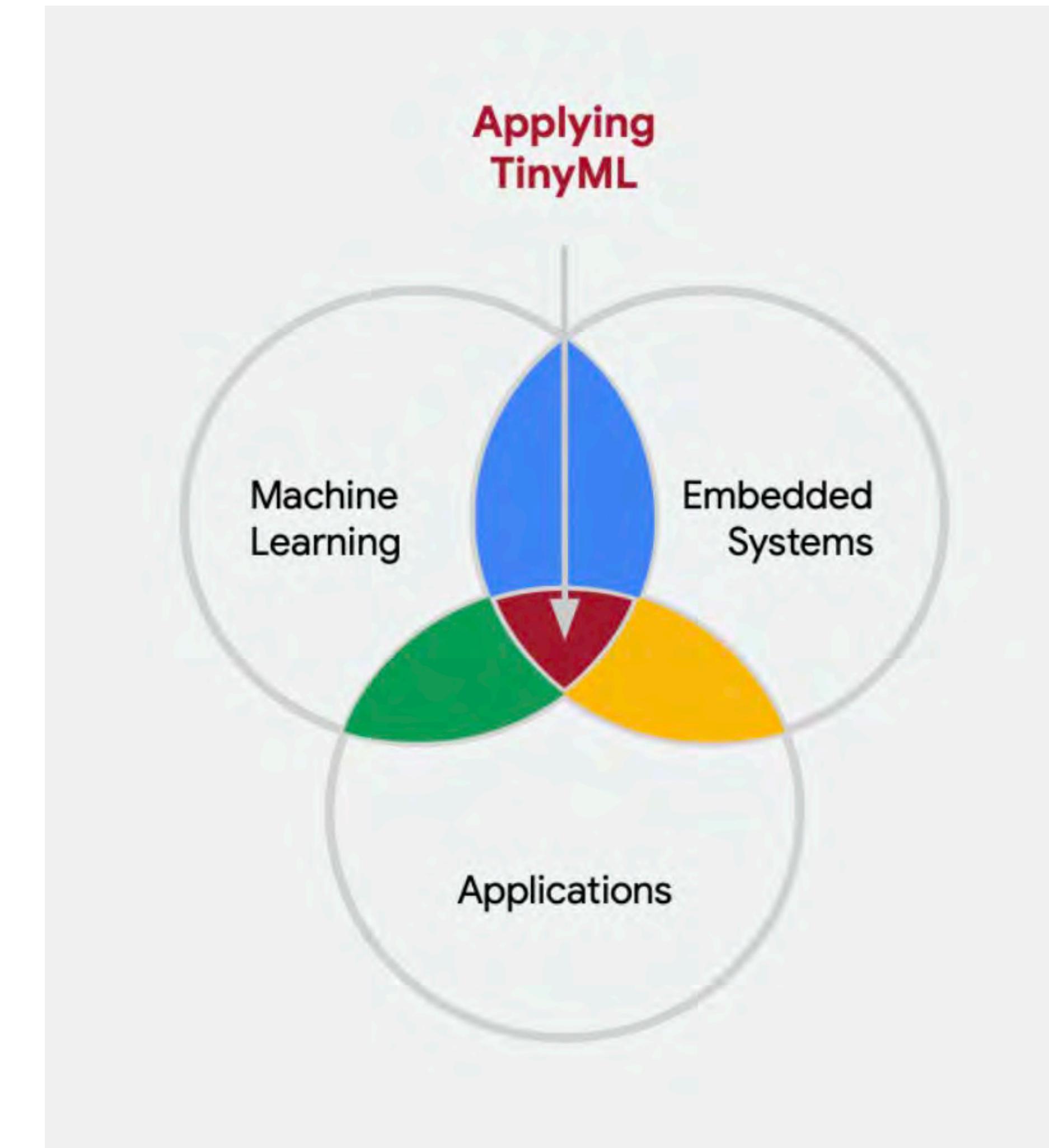
This report has been written by Phillipa Biggs (ITU), John Garrity (Cisco), Connie LaSalle, Anna Polomska (ITU), under the supervision of Dr. Robert Pepper (Cisco) as a contribution to the UNESCO Broadband Commission for Sustainable Development.

Mitch Hulse and Mary Carol Madigan provided research support, with additional review performed by Dr. Ruba Borno (Cisco).

The authors wish to thank the following people and organizations who generously contributed time and insights through interviews and discussion to this report (listed alphabetically by project, and individual's name):

- American Red Cross (Abi Weaver)
- DAI (Robert Ryan-Silva)
- Echo Mobile (Zoe Cohen, Jeremy Gordon)
- Integra (John Waugh, Eric White)
- International Center for Theoretical Physics (Marco Zennaro)
- Kopernik.info (Edwin Mulianto)
- Network Startup Resource Center (Jonathan Brewer)

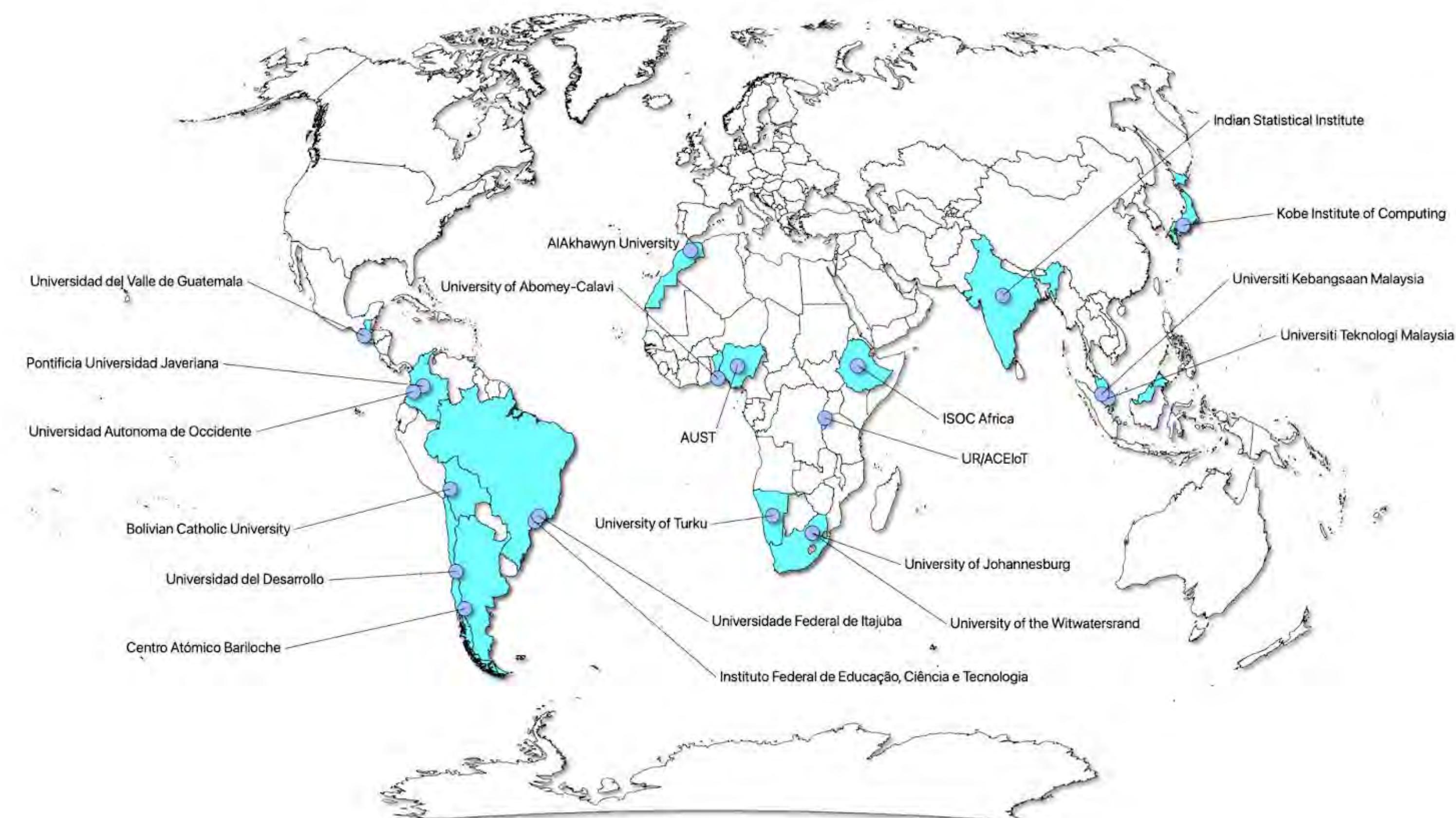
# TINYML



Credit: <https://github.com/tinyMLx/courseware/tree/master/edX>

# TINYML NETWORK

---



# TINYML NETWORK

Course Name	Date of Course	Target Audience	Language of Instruction	Language of Materials	Course Website	Materials Link
edX tinyML Specialization	Launched 2020-2021	Everyone	English	English	<a href="#">link</a>	<a href="#">link</a>
SciTinyML 2021	October 2021	Everyone	English	English	<a href="#">link</a>	<a href="#">link</a>
Harvard CS249r	Sept-Dec 2020	Graduate Students	English	English	<a href="#">link</a>	<a href="#">link</a>
UNIFEI IESTI01-T01	Jan-July 2021	Undergraduate Students	Portuguese	English	<a href="#">link</a>	<a href="#">link</a>
UNIFEI IESTI01-T02	Aug-Dec 2021	Undergraduate Students	Portuguese	English	<a href="#">link</a>	<a href="#">link</a>
CRESTLEX 3.0	June 2021	Middle and High School Students and Teachers	English	English	<a href="#">link</a>	<a href="#">link</a>



# THANK YOU!



Marco Zennaro, PhD

<http://users.ictp.it/~mzennaro/>

[mzennaro@ictp.it](mailto:mzennaro@ictp.it)

