Year end presentation

PhD student: Giovanni Stanco

‘Performance of wireless networks for IoT and CPS: empirical evaluation and cybersecurity applications’

Tutor: prof. Giorgio Ventre
co-Tutor: prof. Alessio Botta, ing. Flavio Frattini

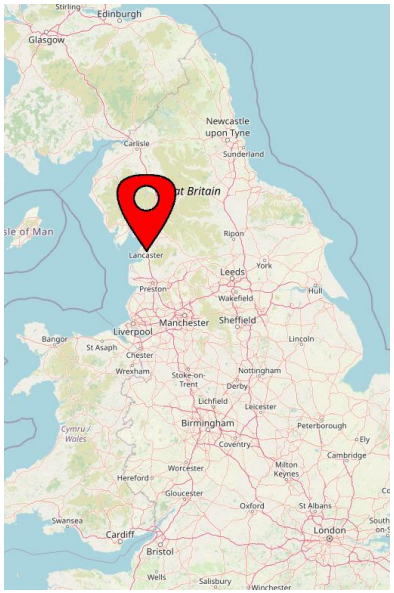
Cycle: XXXV

Year: Third (2021/2022)

Background information

- MSc degree: Telecommunications Engineering
- Research group/laboratory: ARCLAB
- PhD start date – end date: Nov. 2019 – Oct. 2022
- Scholarship type: company funded scholarship
- Partner company: RisLab SRL
- Periods in company: Jan. 2020 – Oct. 2021

- Periods abroad:
  Lancaster University (UK),
  Nov. 2021 – Apr. 2022



Summary of study activities

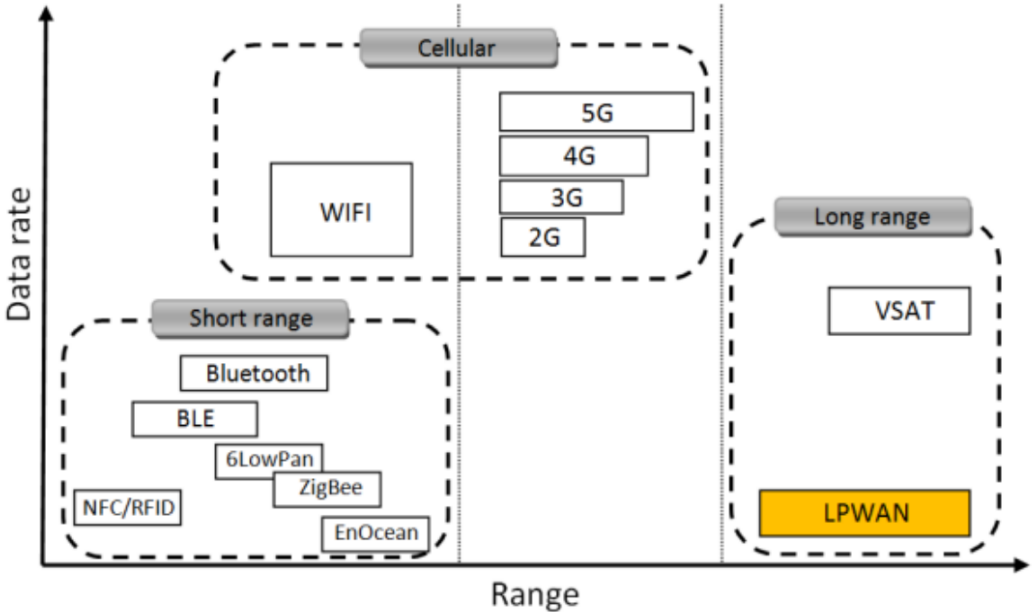
- MSc courses:
  - Protocolli per reti mobili (prof. Avallone)
  - Network security (prof. Romano)
  - Software security per sistemi industriali (prof. Cotroneo, prof. Natella)
- Ad hoc courses:
  - Scientific programming and visualization with Python (prof. Botta)
  - Strategic orientation for STEM research and writing (Dr. Fraser)
  - Statistical data analysis for science and engineering research (prof. Pietrantuono)
  - Version control with Git (Dr. Robin Long)
  - Introduction to the Linux Command Line (Dr. Robin Long)

Summary of study activities

- PhD schools:
  - UK Cyber Security PhD (University of Surrey, Jan. 2022)
  - "Jacob T. Schwartz International School for Scientific Research - Lipari School on Advanced Networking Systems" entitled Programmability, Security, and Algorithmic Challenges in Future Networks (Lipari, July 2022)

Research area

- Performance and security of wireless networks for IoT and CPS.
- IoT market is forecasted to be worth $ 5.5+ trillion by 2030.
- Resource-constrained devices are used for IoT and CPS.
- Different communications technologies can serve different use cases.



Research activities: overview

- My main contribution is the study of the performance and security of wireless networking technologies for IoT and CPS.
- The activity was carried out in three consecutive steps:
  - Empirical evaluation of the performance of most prominent Low Power Wide Area Networks (LPWAN) using real devices and commercial connectivity
  - Design, implementation, and deployment of a platform for continuous resource monitoring for CPS
  - Using the knowledge acquired to do secure offloading of computational tasks to edge nodes considering the performance of the network

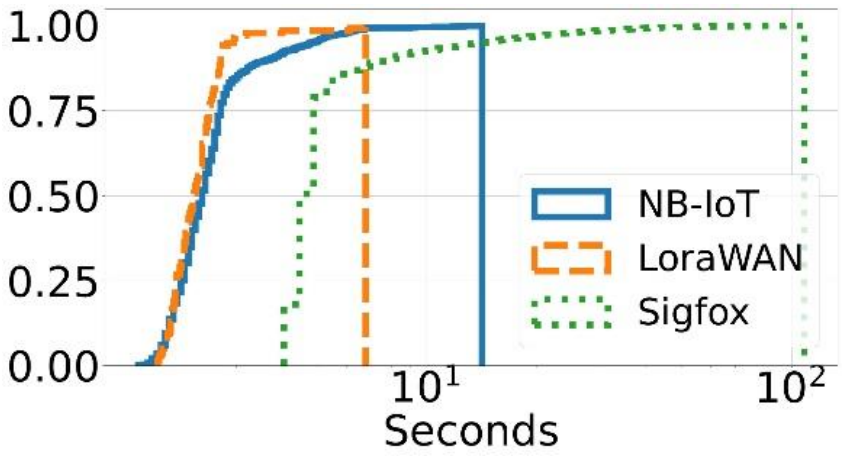
Research activities: step one

- Empirical evaluation of Low Power Wide Area Networks (LPWAN)

Sigfox	LoRaWAN	NB-IoT
ISM Bands (868, 915 MHz)	ISM Bands (868, 915 MHz)	Licensed LTE Bands
Duty Cycle	Duty Cycle	Monthly Bundle
Subscription	Free of charge	Prepaid or subscription

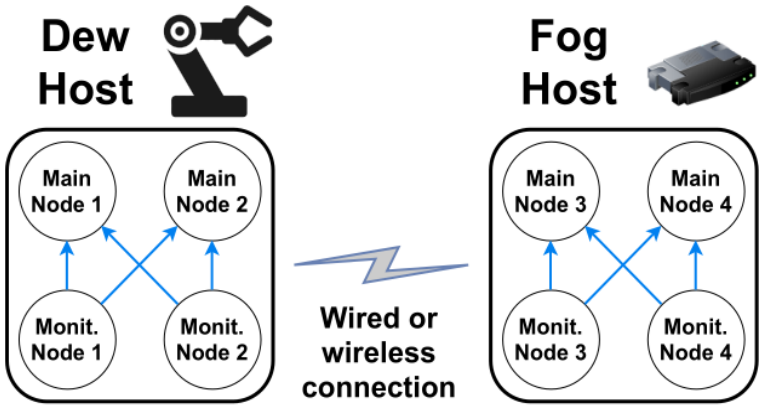
- Collection of periodic messages sent by IoT development boards

	Min	Avg	90th perc.	Max
LRW	1.8 s	2.4 s	2.7 s	6.8 s
NBI	1.6 s	2.7 s	3.7 s	14.1 s
SFX	4.1 s	6.3 s	8.0 s	108.3 s

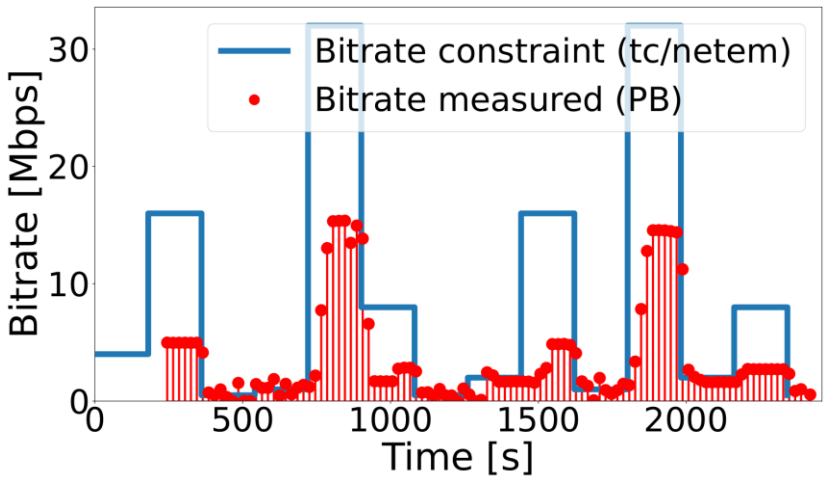


Research activities: step two

- Monitoring platform for CPS
  - Continuous and automatic performance monitoring
  - Based on independent monitoring entities ('nodes')
  - Communicating the monitored quantities to other applications
  - Use case in a robotics application for Search and Rescue activities

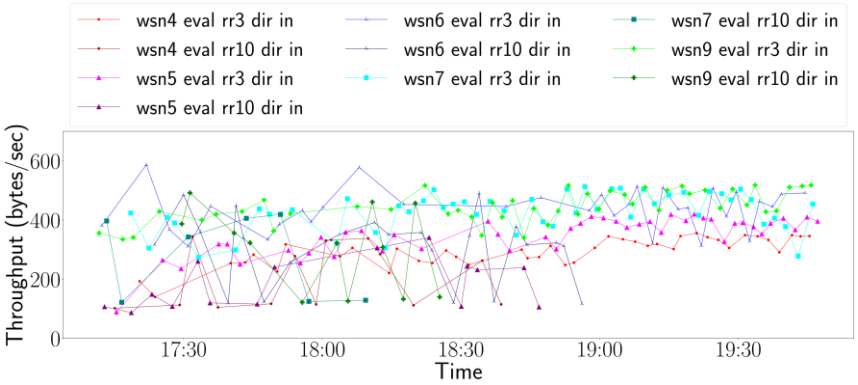


Monitoring nodes implemented
CPU utilization
Battery charge
Socket queue size
Passive bitrate
Achievable throughput
Application latency

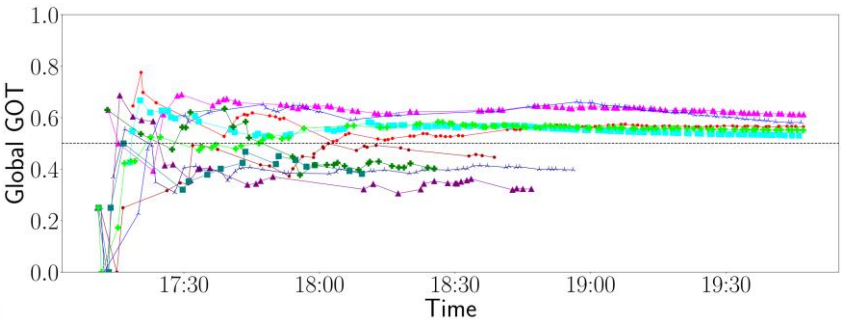


Research activities: step three

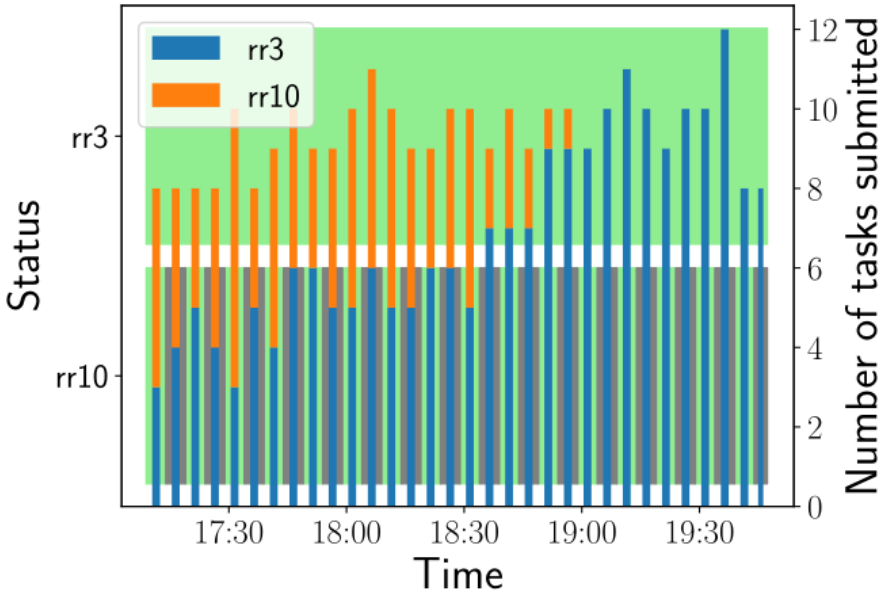
- Security application based on network monitoring
  - Task offloading: decision on the best edge node based on the network performance
    - Throughput measurement



    - Edge node classification



    - Task assignment



Research products

[P1]	Giovanni Stanco, Alessio Botta, Giorgio Ventre *DewROS: a platform for informed Dew Robotics in ROS* **2020 8th IEEE International Conference on Mobile Cloud Computing, Services, and Engineering (Mobile Cloud), Oxford (United Kingdom)**
[P2]	Giovanni Stanco, Alessio Botta, Flavio Frattini, Ugo Giordano, Giorgio Ventre *Comparing the performance of LPWAN technology for IoT: the case of Sigfox, LoRaWAN and NB-IoT* **2022 IEEE International Conference on Communications, Seoul (South Korea)**
[P3]	Giovanni Stanco, Alessio Botta, Flavio Frattini, Ugo Giordano, Giorgio Ventre *Survey: 'On the security of the IoT wireless communication technologies'* **Journal article under review**
[P4]	Giovanni Stanco, Matthew Bradbury, Alessio Botta, Flavio Frattini *Assessing Network Performance as Behavioural Trust in IoT Computation Offloading* **Conference paper under review**

Third year credits

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	1,20	2,10	6,70	0	10
Bimonth 2	4	0,80	5,20	0	10
Bimonth 3	1,20	1,80	7	0	10
Bimonth 4	0	1,50	8,50	0	10
Bimonth 5	6	0	4	0	10
Bimonth 6	0	0	10	0	10
Total	**12,40**	**6,20**	**41,40**	**0**	**60**

PhD thesis overview

- Problem statement
  - Knowledge and trust of wireless networks for IoT and CPS is not enough for them to be used in applications having strict security requirements (e.g. in banks)
- Objective
  - Shedding lights on the performance and security of these technologies to use them in real, novel use cases
- Methodology
  - Experimentations on real testbeds
  - Testing in controlled and uncontrolled conditions
  - Creation of approaches based on such information for security purposes

PhD thesis overview

- Originality and contribution
  - Survey about security features of short range and long range networks for IoT and classification of attacks (105 paper)
  - Comparison of the most widespread LPWAN on the same device
  - Investigating their performance in a real deployment
  - Metrics never considered in previous work (e.g. message latency)
  - Use of these metrics for trusted offloading to edge nodes. Previous work did not consider network performance for this application.

THANK YOU
FOR YOUR ATTENTION