

INTERUNIVERSITY PH.D. PROGRAM BETWEEN  
POLITECNICO DI BARI AND UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO  
IN INDUSTRY 4.0

# **Design and evaluation of novel network architectures and innovative communication protocols supporting cybersecurity services in the industry 4.0**

## **PhD candidate**

Ingrid Huso

## **Cycle**

XXXVII

## **Tutors**

Prof. Gennaro Boggia, PhD

Prof. Giuseppe Piro, PhD

## Description of the research program

This research program aims to design and develop novel security architectures and innovative communication protocols to support services for the industry 4.0.

The Internet of Things (IoT) has facilitated the transition from a digital to a smart connected world by enabling end-to-end communication with automated services while minimizing human intervention. Jointly, by incorporating IoT into every domain of industrial developments, Industry 4.0 has had a significant positive impact. In particular, the Industrial Internet of Things (IIoT), by extending the IoT, provides the basis for the Industry 4.0 revolution. Indeed, considering a network of connected devices (i.e., IoT sensors, robots, manufacturing machines), the IIoT accelerates industry automation of internal and external working processes such as transportation, manufacturing, and marketing. In this context, IIoT communication security and privacy issues play a significant role.

In this field, the current scientific literature proposes several interesting ideas leading to the study, design, and implementation of new solutions in order to define the main lines of the research program, as listed below:

- Firstly, a possible IIoT scenario will be studied into detail, characterizing the main element of the industrial network and defining an high level description of the novel communication network. Therefore, the research will focus on highlighting the security issues and challenges in this specific environment. Specifically, confidentiality, integrity, and authentication need to be addressed by the usage of lightweight cryptographic and communication protocols. Moreover, by considering the large amount of connected devices and information/data flows in the industrial environment, a privacy and information preserved architecture should be developed. Furthermore, due to their vulnerability against some network attacks (e.g., MITM, DoS), industrial devices are considered as weak points in the communication network. Thus, the network behavior represents a critical point to be evaluated.
- Secondly, analytical models and simulation tools will be used for the evaluation of the solutions proposed in the previous phase in order to verify the effectiveness of the obtained results. Moreover, a comparison with other state of the art methodologies will be made in order to make further improvements. The results will be scientifically disseminated through journal publications, prestigious conferences, and high impact factor scientific journals.

Finally, during the research program, training activities will have a special attention. Individual study and tutor supervision will be supplemented by attendance at seminars, conferences, workshops, and courses of I, II, and III level organized by the Politecnico of Bari or by external bodies. Additionally, a special attention will be paid to the participation at national or international PhD schools to complete previously acquired knowledge and intensify the chosen research topic.

## Schedule of the research activities

Insert the research activities that you plan or you have completed for the three years, including any period abroad.

### First academic year (completed/planned)

	Description	Period	Activity abroad
<b>State of the Art analysis</b>	Study of the state of the art of Industry 4.0. Specifically, analysis of security practices and possible issues in the field of Industrial Internet of Things (IIoT) communication.	M01 – M04	NO
<b>Study of novel communication protocols</b>	Investigation and study of novel network architecture and innovative security communication protocols for the IIoT.	M04 -M12	NO

### Second academic year (completed/planned)

	Description	Period	Activity abroad
<b>Design of novel security solutions for the Industry 4.0</b>	Design and implementation of innovative security communication protocols enabling both information security and data privacy as well as preventing the network from specific attacks (e.g., DoS attacks) in an IIoT environment.	M13 - M17	NO
<b>Evaluation of the proposed solutions</b>	Evaluation of the identified solutions by developing experimental environments based on both analytical and testbed models that simulate real scenarios.	M18 – M24	NO

### Third academic year (completed/planned)

	Description	Period	Activity abroad
<b>Abroad research activity</b>	In-depth study of the research topics addressed in previous years, during an abroad experience.	M25 – M30	YES
<b>Research activity dissemination</b>	Dissemination of the results obtained from the previous year's research activities.	M25 – M36	NO

## Provisional training and research activities plan

Specify with the related CFU (ECTS) the training activities that you plan to carry out or have completed in the three years (e.g., courses to attend, conferences, seminars, etc.). Please refer to the *Educational regulations of the Doctoral School of Politecnico di Bari*: <http://www.poliba.it/sites/default/files/dottorati/regscudopoliba.pdf>

Specify with the related CFU (ECTS) the research activities that you plan to carry out in the three years (e.g., individual research activity, supervision of students, integrative seminars to be given by the PhD student, activity of manuscript preparation for conferences or journals, activity of patents preparation, etc.).

### First academic year (completed/planned)

	Description	Period	Duration	CFU
<b>PhD courses</b>	SCUDO Course - Smart Education for Industry 4.0	07/06/22 – 30/06/22	20 hours	2
	SCUDO Course - Physical Layer Security for wireless communication	Second semester	20 hours	2
<b>Master's degree courses</b>	Smart Antennas	Second semester	60 hours	6
<b>Participation to seminars and international congresses or workshops</b>	5G International PhD School 2021	30/11/21 - 02/12/21	17 hours	3
	Pisa Summer School 2022 - Enabling Technologies for Industrial Internet of Things	20/07/22 - 27/07/22	52 hours	6
<b>Presentation of research products at international congresses or workshops</b>	IEEE International Conference on Smart Internet of Things (SmartIoT) 2022	19/08/22 – 21/08/22	3 days	3
<b>TOTAL OF CFU FOR TRAINING ACTIVITIES</b>				<b>22</b>
<b>Individual research activity and tutor supervision</b>				<b>27</b>
<b>Students' supervision</b>				<b>7</b>
<b>Preparation of manuscripts for conferences or journals</b>				<b>4</b>
<b>TOTAL OF CFU FOR RESEARCH ACTIVITIES</b>				<b>38</b>
<b>TOTAL OF CFU FOR YEAR I</b>				<b>60</b>

**Second academic year (completed/planned)**

	<b>Description</b>	<b>Period</b>	<b>Duration</b>	<b>CFU</b>
<b>PhD courses</b>	SCUDO Course 2022/2023		20 hours	2
<b>Master's degree courses</b>				
<b>Participation to seminars and international congresses or workshops</b>	5G International PhD School 2022	December 2022	3 days	3
<b>Presentation of research products at international congresses or workshops</b>	IEEE Global Communications Conference 2022 (GLOBECOM)	4/12/22 – 8/12/22	5 days	5
	IEEE International Conference on Communications 2023 (ICC)	28/05/2023 – 01/06/2023	5 days	5
<b>TOTAL OF CFU FOR TRAINING ACTIVITIES</b>				<b>15</b>
<b>Individual research activity and tutor supervision</b>				30
<b>Students' supervision</b>				8
<b>Preparation of manuscripts for conferences or journals</b>				7
<b>TOTAL OF CFU FOR RESEARCH ACTIVITIES</b>				<b>45</b>
<b>TOTAL OF CFU FOR YEAR II</b>				<b>60</b>

**Third academic year (completed/planned)**

	<b>Description</b>	<b>Period</b>	<b>Duration</b>	<b>CFU</b>
<b>PhD courses</b>				
<b>Master's degree courses</b>				
<b>Participation to seminars and international congresses or workshops</b>	IEEE International Conference on Communications 2024 (ICC)	9/06/24 – 13/06/24	5 days	5
<b>Presentation of research products at international congresses or workshops</b>	IEEE 21st Consumer Communications & Networking Conference 2024 (CCNC)	12/01/24 – 15/01/24	4 days	4

<b>TOTAL OF CFU FOR TRAINING ACTIVITIES</b>	<b>9</b>
<b>Individual research activity and tutor supervision</b>	<b>35</b>
<b>Students' supervision</b>	<b>8</b>
<b>Preparation of manuscripts for conferences or journals</b>	<b>8</b>
<b>TOTAL OF CFU FOR RESEARCH ACTIVITIES</b>	<b>51</b>
<b>TOTAL OF CFU FOR YEAR III</b>	<b>60</b>
<b>TOTAL OF CFU FOR THE WHOLE PHD COURSE</b>	<b>180</b>