

# PCI 2020

24th Pan-Hellenic Conference on Informatics

Athens, Greece (Online)

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## Internet of Things for Human and Industry Application: ALIOT Project and R&D Issues

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School of Computing



Українське  
науково-освітнє ІТ товариство  
Ukrainian  
Scientific and Educational IT Society



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Erasmus+ Programme  
of the European Union

# Contents

1. General information about ALIOT
2. State of the art (before ALIOT, 2016)
3. Principles of development
4. Outcomes (courses, cluster)
5. R&D activities
6. Conclusion. Future steps



# Project Data

## **Title:**

**Internet of Things: Emerging Curriculum for Industry and Human Applications / ALIOT**  
(573818-EPP-1-2016-1-UK-EPPKA2-CBHE-JP)

## **Duration:**

3 years (15/10/2016-14/10/2019+ *10 months cont. 9/2020*)

**Total Budget:** 816 725,00 Euro

## **Grant Holder:**

Newcastle University (UK)

## **National Coordinator**

National Aerospace University KhAI (Ukraine)



# Consortium

## EU

- **University of Newcastle upon Tyne, UK (6)**
- Leeds Beckett University, UK (2)
- University of Coimbra, PT (2)
- Royal Institute of Technology, SE (3)
- ISTI-CNR, IT (3)

## Ukraine

- **National Aerospace University "KhAI" (6)**
- Chernivtsi National University (2)
- East Ukrainian National University (2)
- Odesa National Polytechnic University (3)
- Ternopil National Economic University (1)
- Petro Mohyla Black Sea National University (2)
- Zaporizhzhia National Technical University (1)
- ***Institute for Modeling in Energy Engineering (3) (National Academy of Science)***
- ***IT Alliance (Society)***
- ***SmartME Ukraine (Business)***
- ***Ministry of Education and Science of Ukraine (government)***

**Consortium**

- Newcastle University, UK
- National Aerospace University "KhAI", UA
- Leeds Beckett University, UK
- Coimbra University, PT
- University KTH, Stockholm, SE
- Institute of Information Science and Technologies ISTI-CNR, Pisa, IT
- Chernivtsi National University, UA
- East Ukraine National University, UA
- Odesa National Polytechnic University, UA
- Ternopil National Economic University, UA
- Petro Mohyla Black Sea National University, Mykolaiv, UA
- Zaporizhzhia National Technical University, UA
- Pukhov Institute for Modelling in Energy Engineering, National Academy of Science of Ukraine, Kyiv, UA
- IT-Alliance, UA
- SmartME, UA

**Grantholder:**  
Newcastle University

**National coordinator**  
National Aerospace University "KhAI"

**Project Workpackages:**

- WP1** - Development of Master programme on IoT
- WP2** - Development of Doctoral programme on IoT
- WP3** - Development of Industry training modules on IoT
- WP4** - Capacity building measures
- WP5** - Established IoT Cluster Network
- WP6** - Quality control actions
- WP7** - Sustainability actions
- WP8** - Dissemination and public awareness
- WP9** - Management

**4 MSc courses**

- MC1** Fundamentals of IoT and IoE (Internet of Everything)
- MC2** Data science for IoT and IoE
- MC3** Mobile and hybrid IoT-based computing
- MC4** IoT technologies for cyber physical systems

**4 PhD courses**

- PD1** Simulation of IoT and IoE-based system
- PD2** Software Defined Networks and IoT
- PD3** Dependability and Security of IoT
- PD4** Development and implementation of IoT-based systems

**6 Industrial training modules**

- ITM1** IoT for Smart energy grid
- ITM2** IoT for Smart building and city
- ITM3** IoT for intelligent transport systems
- ITM4** IoT for health systems
- ITM5** IoT for ecology monitoring systems
- ITM6** IoT for industrial systems

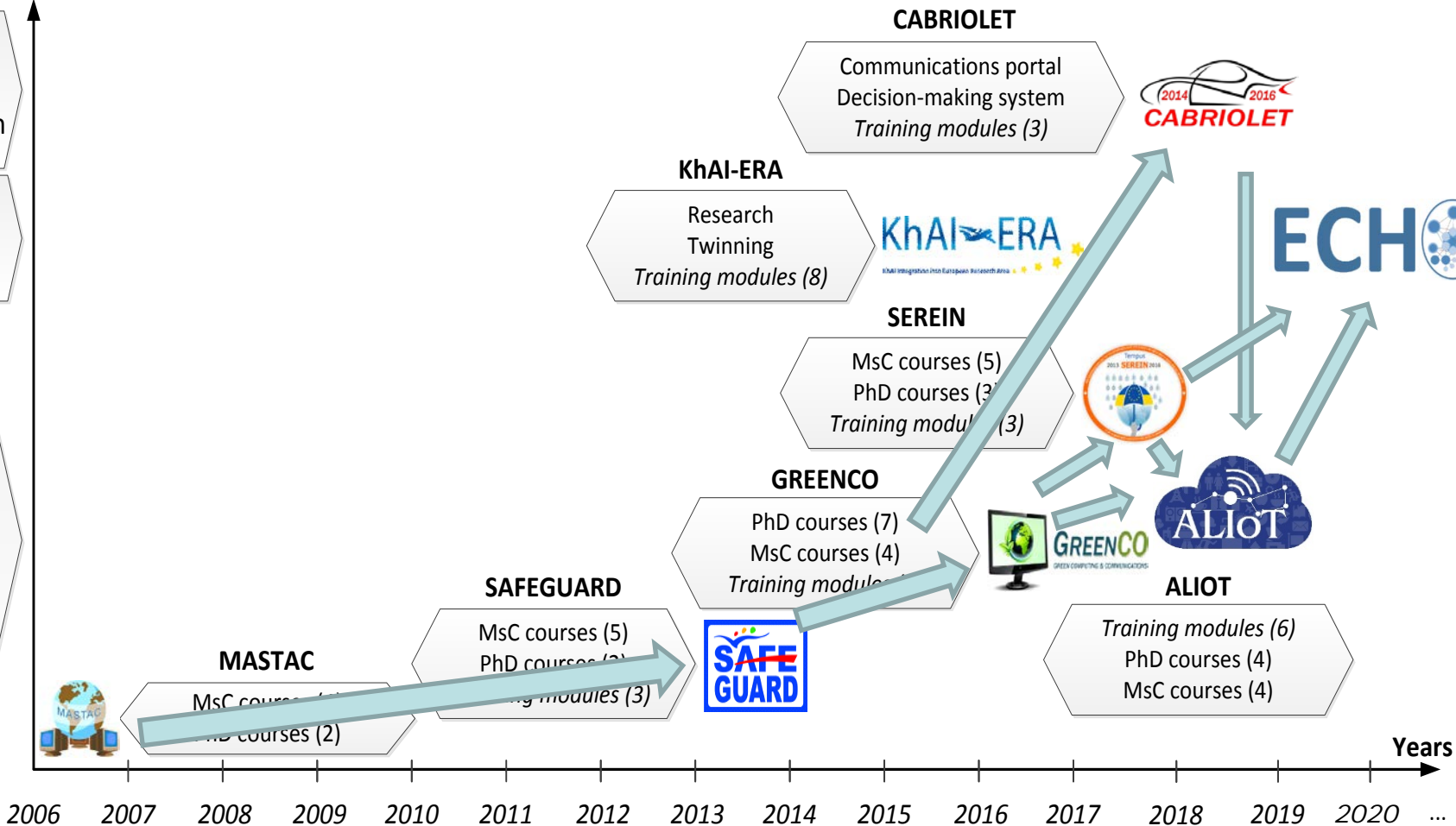


# Trends



Goals

- University-Industry Cooperation
- Research
- Education:
  - MSc
  - PhD
  - In-service
  - Training





# Challenges. State of the Art

- Cisco predicts more than 24 billion Internet-connected objects by 2020; Huawei forecasts 100 billion IoT connections by 2025;
- McKinsey Global Institute suggests that the financial impact of IoT on the global economy may be as much as \$3.9 to \$11.1 trillion by 2025

## Challenges before start of the ALIOT (2016):

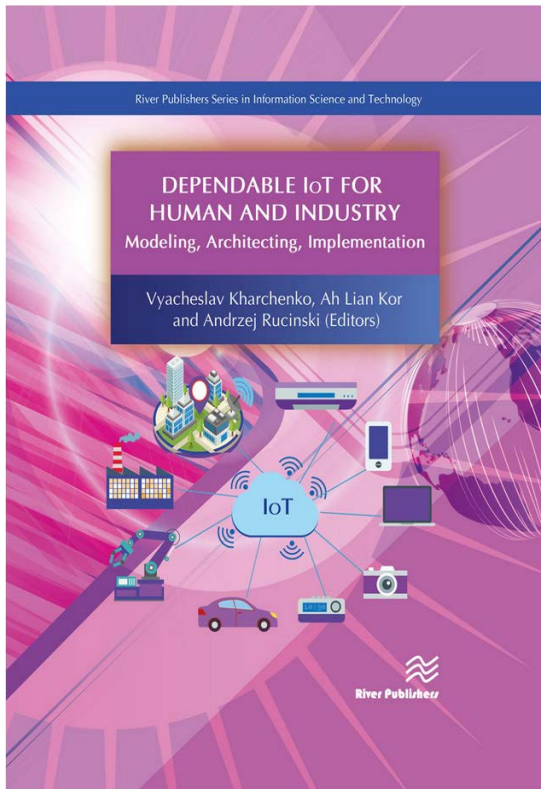
- **Challenge 1:** *absence of MSc and PhD courses in the area of IoT research and development (separate courses in EU, USA)*
- **Challenge 2:** *no single specialty on computing science or engineering covering all aspects of IoT (R&D), production and implementation*
- **Challenge 3:** *context of movement Industry 4.0 (IIoT, Cyber security of industrial systems)*
- **Challenge 4:** *security & privacy issues, device interoperability, regulatory and rights (Gartner prediction)*



# Challenges. State of the Art (2)

[https://www.riverpublishers.com/book\\_details.php?book\\_id=658](https://www.riverpublishers.com/book_details.php?book_id=658)

University code/ Course Name	Credits	Form	Basics	Completeness	Availability	Sum
Internet of Things and Sensor Networks (NC)	2	5	5	3	3	18
Sensor Based Systems (KTH)	2	5	3	2	3	15
M2M Technology Internet of Things (NC)	2	5	1	3	3	14
Human-Computer Interaction (UC)	1	5	1	2	3	12
Intelligent Sensors (UC)	2	5	3	2	3	15
Smart Grid Communications (UC)	2	5	1	2	3	13
Simulation and Modelling (LBU)	5	5	1	1	2	14
Internet of Things (UPU)	2	5	2	3	3	15
Sensor Data Fusion (PU)	3	5	3	2	3	16
Wireless, Sensor and Actuator Networks (RLU)	5	5	2	2	2	16
Smart Cards, RFIDs and Embedded Systems Security (RLU)	5	5	1	2	2	15
Interconnected devices (RLU)	3	5	1	2	2	13
Wireless, Sensor and Actuator Networks (BU)	5	5	2	2	2	7 <sup>16</sup>







# Challenges. State of the Art (3)

**2016** [https://www.riverpublishers.com/book\\_details.php?book\\_id=658](https://www.riverpublishers.com/book_details.php?book_id=658)

**For the IoT programs it is possible to find around 100 opportunities related to this subject area**, moreover in the various faculties among which are Science and Technology, Computer Science, Wireless Embedded Systems, Advanced Computing, Engineering and Built Environment.

**At the European universities there is no abundance and a variety of direct courses on IoT for today.** The education system, as the most inertial part of a sheaf the science-university-industry, is late here.

**The direct program with full-course performed only in 15 Universities in Europe.** The lead country with the biggest number of opportunities for those, who interests in being graduate in IoT, is the UK.

**The most common modules for IoT courses** are Wireless, Sensor and Actuator Networks, and Embedded-Systems Security, Engineering, Intelligent Systems, Robotics, Introduction to smart grids, Human-Computer Interaction, Systems Engineering, Data Processing, Signals and Systems, C Programming.





# Principles

**Principle 1: Interconnection of all IoT domains in the matrix “task, technique, tools – domains”.** The intensive application of IoT on regional and country levels for key domains (health, energy grid, smart cities, transport, ecology, industry) will help to intensify the effort taken to overcome the pointed problems;

**Principle 2: Direct involvement of youth (BSs, MSc, PhD studs), lecturers and engineers in joint education, training and R&D activities.** For the successful and competitive solution it is extremely important to combine related efforts in IoT education, research and engineering;

**Principle 3: Innovation oriented development.** Mandatory outcome in MSc and PhD thesis today is to popularize technology tomorrow. There is no single specialty on computing science or engineering that covers all aspects of IoT research, development and production implementation;

**Principle 4: Vertically integrated education, training and research (ETR) for different types of activities in IT-industry.** The structure of ETR joints different levels and is based on LLL (Life Long Learning) approach as well;



## Principles (2)

**Principle 5: Maximum use of possibilities of international and inter-sectoral cooperation.** International cooperation provides creation of a modernized EU innovative learning system with adapted academic programs to the requirements of UA and EU employers;

**Principle 6: Wide dissemination of success stories as well as project-oriented education.** It is not possible to provide fast response to changing market conditions without the development of a cutting edge IoT curriculum which has extensive applications for industry and human;

**Principle 7: Ecosystem based approach (Internet of departments/universities/ecosystems).** Creating and evolving of professional (university, business, society) communities. Ecosystem-based management is an environmental management approach that recognizes the full array of interactions within an ecosystem, including humans;

**Principle 8: Team work of university and consortium teams.** It means the collaborative effort of a group to achieve a common goal or to complete a task in the most effective and efficient way. Universities from EU and Ukraine work together towards a common goal.



# Workpackages

**WP1: Development of master Curriculum on IOT** – strategy for the UA needs analysis, development of master curriculum, lecture books and teaching plan, purchase and installation of needed hardware and software, scheme for the implementation of curriculum and delivery of guest lectures.

**WP2: Development of doctoral Curriculum on IOT** – strategy for the development and introduction of doctoral modules.

**WP3: Capacity building measures** – system for comprehensive training in the relevant theoretical and analytical skills needed to design and introduce the above approach for involved E&C engineering departments.

**WP4: Establishment of Multi-Domain IOT Cluster Network on the base of involved ICT departments of 7 Ukrainian universities.**

**WP5: Quality control actions** – actions taken by project team for assessment and assurance of quality control of main WP

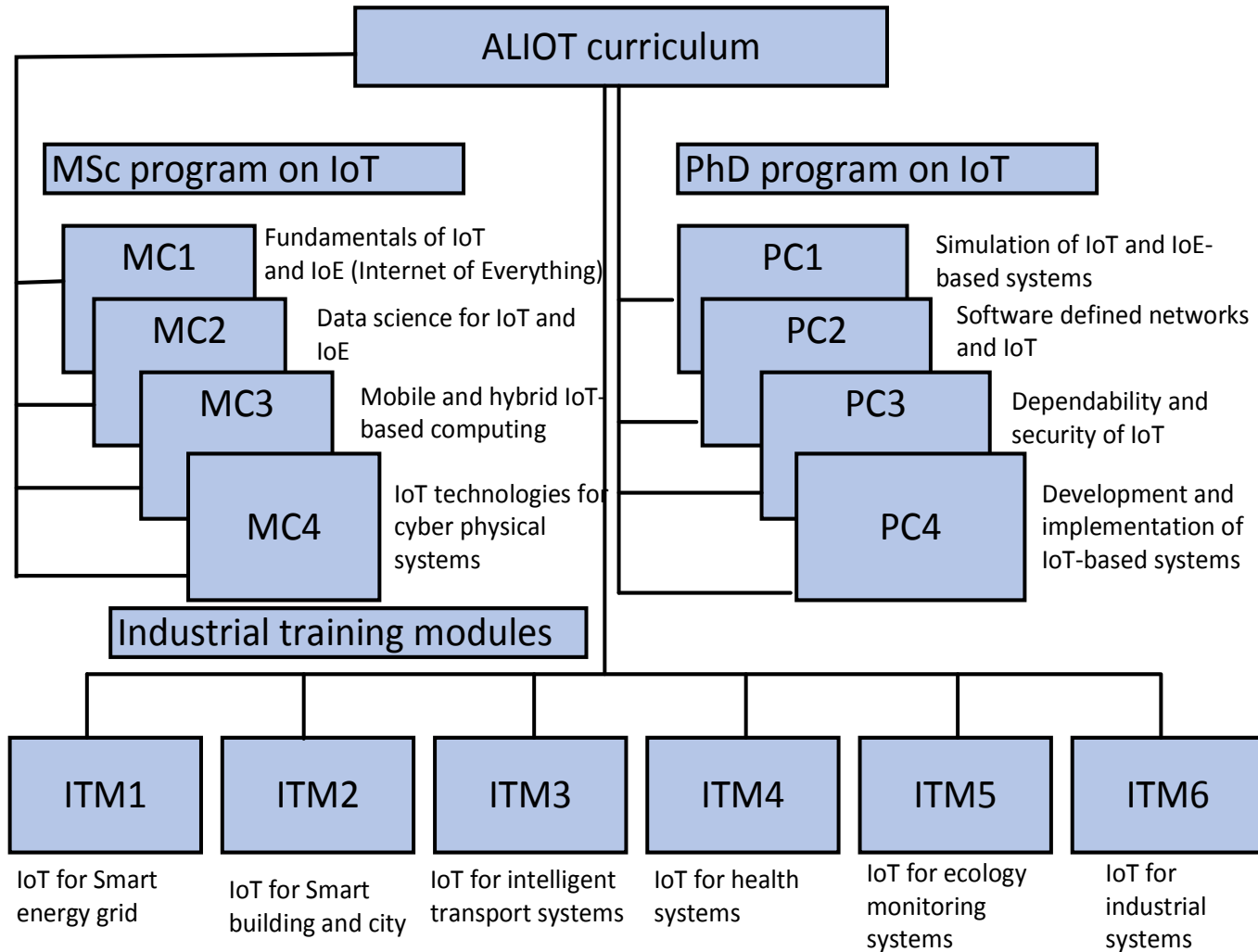
**WP6: Sustainability actions** – describe the mechanisms to be implemented to achieve the institutional and financial sustainability of the results.

**WP7: Dissemination & Public awareness** - includes the specific measures aimed on broad dissemination of main WPs outcomes.

**WP8: Project Management** – describes the working methodology adopted for effective coordination and management procedures.

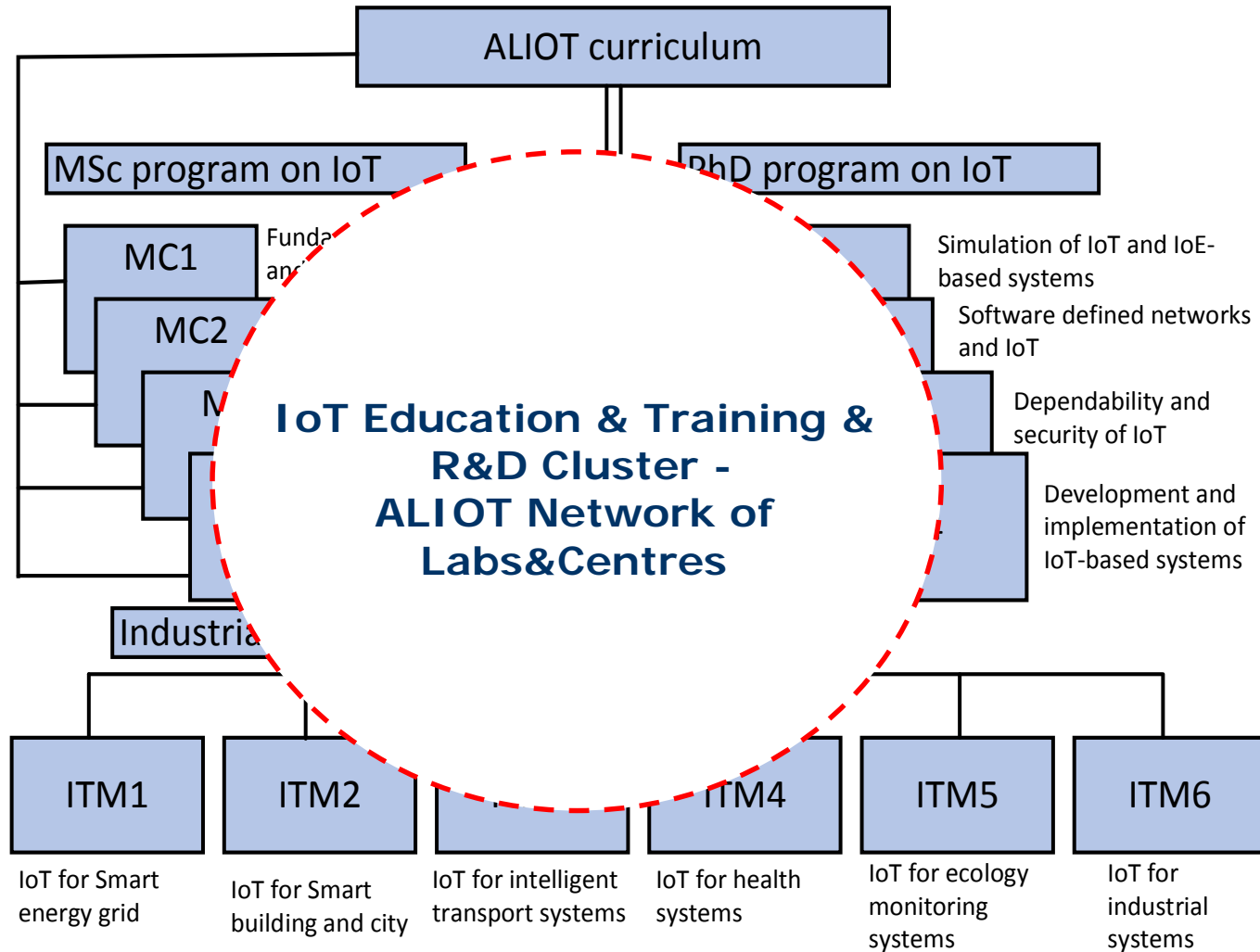


# Curriculum structure





# Curriculum structure





# Curriculum (2)

## **An innovative and multi-domain MSc programme on IoT (4 courses):**

MC1 Fundamentals of IoT and IoE (Internet of Everything)

MC2 *Data science for IoT and IoE*

MC3 Mobile and hybrid IoT-based computing

MC4 IoT technologies for cyber physical systems

## **Doctoral Training for PhD programme on IoT (4 courses):**

PC1 *Simulation of IoT and IoE-based systems*

PC2 Software defined networks and IoT

PC3 *Dependability and security of IoT*

PC4 Development and implementation of IoT-based systems

## **Capacity Building for Staff: Industrial training modules (6 courses):**

ITM1 IoT for Smart energy grid

ITM 2 IoT for Smart building and city

ITM 3 IoT for intelligent transport systems

ITM 4 IoT for health systems

ITM 5 *IoT for ecology monitoring systems*

ITM 6 *IoT for industrial systems*



# Requirements to courses

## **Structure**

- 3 (4) modules
- 3 (4) credits
- Lectures, Practice, Program
- Language – English
- Based on EU and UA (academia and industry) experience

## **Lectures**

- 20-25 slides
- Textbook
- Glossary
- Tests

## **Practice**

- Labs (research-oriented)
- Seminars
- Projects

## **Editions**

- Course: lectures and practicum
- Industry-oriented training books





**Multi-book for lecturers, students,  
engineers, researchers**

**Internet of Things and Everything /**

V. Kharchenko (edit.),

National Aerospace University KhAI, 2019:

Volume 1, Concepts and Technologies, 615p.

Volume 2, Modelling and Development, 547p.

Volume 3, Assessment and Implementation, 918p.

**15 books for practicum, labs  
and trainings**

(2450p.)

**[www.aliot.eu.org](http://www.aliot.eu.org)**

## Edited books





# IoT cluster network

## IoT cluster network

- Goal and tasks
- Structure
- Coordination
- Development
- Sustainability

## ALIoT IoT cluster specialization

**KhAI:** Industrial IoT, Cybersecurity and AR/VR technologies;

**EUNU:** IoT for Ecology, Medicine, Transport;

**PMBSSU:** Wireless communications and intelligent information IoT systems;

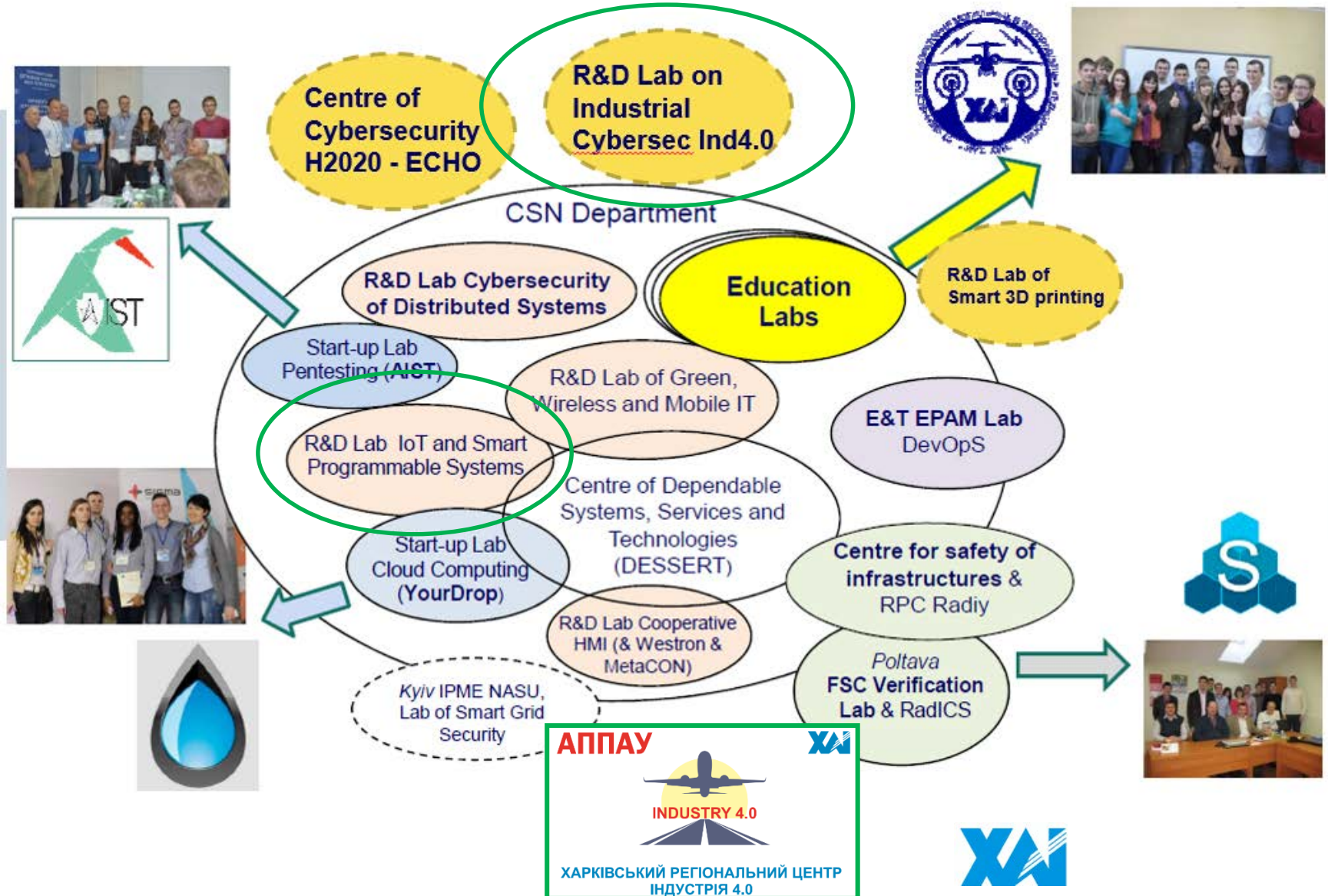
**ONPU:** IoT for Intelligent electrical systems;

**ChNU:** Cyber-Physical and IoT Systems;

**TNEU:** Cybersecurity applications for IoT;

**ZPTU:** IoT for Smart home and Robotics.

# CSNCS Department: E&R&D Centers&Labs + Kharkiv Region Centre Industry 4.0



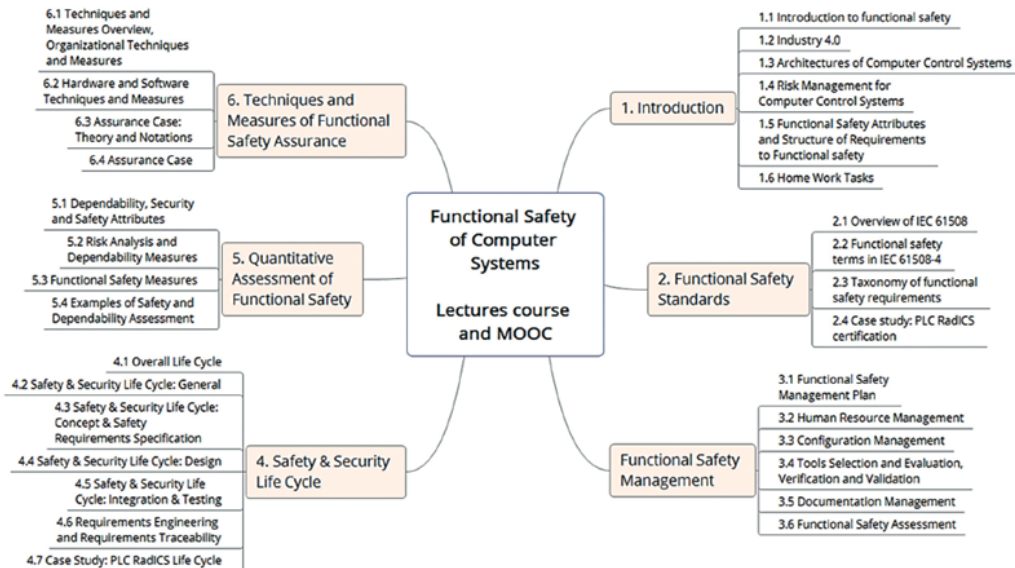


On-line course for MSc (2016+) and PhD (2017+) students  
<https://habrahabr.ru/post/329598/>  
 Prof. Vladimir Sklyar

## IoT Security: Implementation of Project-oriented Approach in Online Learning

РИСУНОК 1

### СТРУКТУРА МООС «ФУНКЦИОНАЛЬНАЯ БЕЗОПАСНОСТЬ КОМПЬЮТЕРНЫХ СИСТЕМ»



**Владимир СКЛЯР**

Д.т.н.,  
 профессор кафедры  
 компьютерных систем  
 и сетей ХАИ

# IoT courses and projects in KhAI . PC4

## Rapid Development Technologies for IoT in Project-oriented Learning

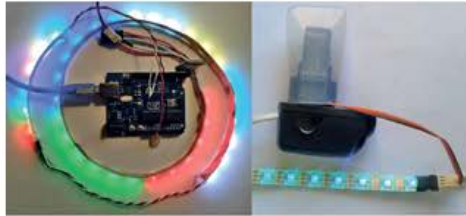


Рис. распределение элементов с управлением от мобильных устройств по Bluetooth (протокол и цвет модуля управления)



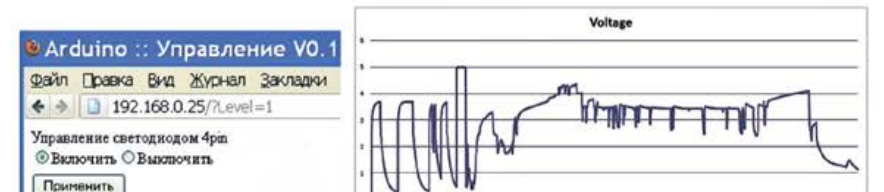
**Анатолий ПЛАХТЕЕВ**

К.т.н., доцент кафедры компьютерных систем и сетей, Национальный аэрокосмический университет «ХАИ»

«Вещь» имеет три главные составляющие: встроенное микропроцессорное устройство, которое имеет свой IP-адрес и подключение к Интернету; прикладное программное обеспечение; различные сервисы для сбора, хранения и обработки данных. Вещи связаны с физическим миром и являются источниками громадных объемов данных (Big Data) для виртуального пространства. Они также активно взаимодействуют с мобильными устройствами, например, такими, как планшеты, смартфоны, умные часы и пр.

Взрывной рост числа «вещей» требует изменения технологий их проектирования и обучения специалистов

A set of labs on IoT-based devices and systems have been developed and implemented by Dr A. Plakhteev and Dr D. Uzun groups on two courses





# IoT courses and projects in KhAI. IoT system for forest fire monitoring (ITM5)

Winner of NASA hackathon in Ukraine (Region TV)

<https://www.facenews.ua/news/2017/362497/>

## Ukrainian Students Can Launch a Successful Start-up to Million!



**УКРАИНСКИЙ СТУДЕНТ ИМЕЕТ ВСЕ ШАНСЫ  
НА УСПЕШНЫЙ ЗАПУСК СТАРТАПА  
НА МИЛЛИОН!**

*Современная IT-индустрия ставит высокие требования перед начинающими специалистами. Для успешного старта в IT недостаточно только посещать лекции и получать отличные*

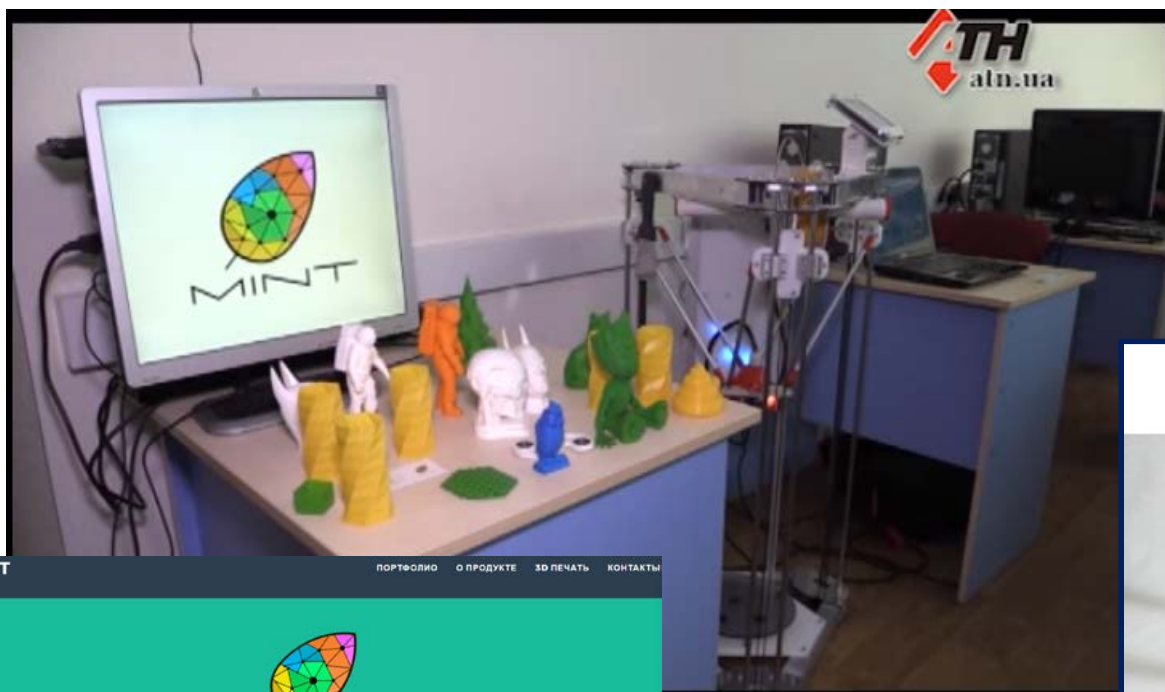




# IoT courses and projects in KhAI. 3D fabric (ITM6)

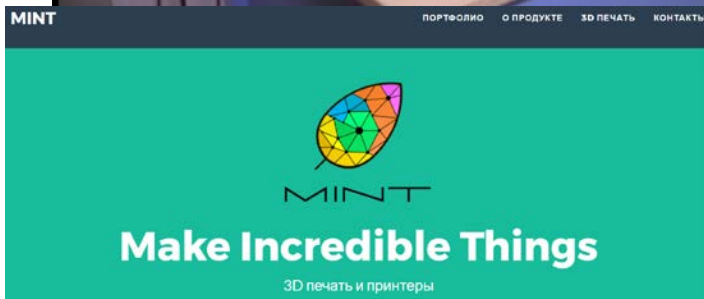
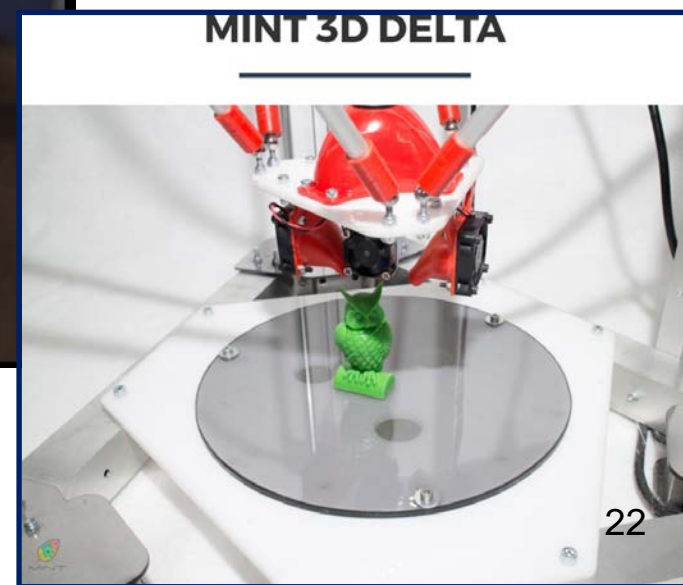
MSc- and BSc-students developed and organized start-up company MINT

<https://atn.ua/obshchestvo/v-harkove-mozhet-poyavitsya-fabrika-3d-printerov>



Network and IoT-based 3D smart printing

Region TV



<http://mint3d.net/>





# Activities: Courses and Specialties

## Development of courses

### Opening of new IoT related specialties (first in Ukraine)

**BSc, MSc (2017):** Programmable mobile systems and IoT

**MSc and PhD(2018):** Cyber security of industry (IIoT) systems

### PhD and MSc thesis development and defenses

#### PhD

Models and methods of IoT smart building automation systems  
cyber security assurance (M. Qahtan, 2018, March)

Assurance case-based methods and tools for FPGA (IoT) systems  
cyber safety (O. Illiashenko, 2018, December)

Models and methods development of multi-parametrized (IoT)  
FPGA systems (A. Perepelitsyn, 2018, December)

Methods of safety assessment of I&C systems (E.Babeshko, April  
2019)

Models and methods of IoT based mobile health system  
availability and cyber security assurance (A. Strielkina, 2020)

Cryptography methods for IoT in post quantum stage (O.Vambol,  
2021)

### MSc (12, 2018-2020)



# Activities: Courses and Specialties (2)

## IoT related events

CyberIoT WS/session, IEEE-DESSERT 2018-2020;

Kharkiv region cluster Industry 4.0 (Dep of CSNCS)

APPAU cooperation

Round table with 7 industry companies (similar RPC Radiy)

## Centre at the KhAI opening (October 2018)

Management office

Targeted R&D labs

Cyber security and IIoT centre at the Dep

Department of CSNCS (on supporting

APPAU, PhoenixContact)

## KhAI IT Cup and IT Holliday (2018-2020)

IoT related quests

mini hackathons for students and scholars

22-23.03  
503 КАФ(РК), ХАИ

ALIoT

### EMBEDDED SYSTEMS INNOVATIVE HACK 2019

Хотите получить уникальный опыт участия в стартапах по разработке встроенных веб-приложений, игр и средств обеспечения безопасности для встроенных устройств?

Тогда не теряйте времени! Собирайте команду и приходите на **ESIH 2019**. Именно здесь у Вас есть возможность разработать собственный стартап с шансом дальнейшего продвижения.

Регистрация уже открыта! Успейте зарегистрироваться до **20.02.2019** - количество мест ограничено.

✉ a.perelitsyn@csn.kh.ai

☎ 050-193-77-79  
066-571-28-15

🌐 Подробная информация, план мероприятия и регистрация участников по QR-коду



# ALIoT Training: IoT Gaming



**Internet of Things**

**(Safe, Secure, Green...) Internet of**

**(Safe, Secure, Green...) Things**

**Internet of Automotive,...**

**Buildings, Business,...**

**Clothes, Cars,...**

**Drones, ... Dreams,...**

...

**Peoples,...**

...

**Talking Trees**

...

**Talking Wines**

...  
700



## Topics of the Game winners

**IoT Brain Storming Game, ALIoT-ERASMUS+ project, Leeds, UK, July 11, 2018**



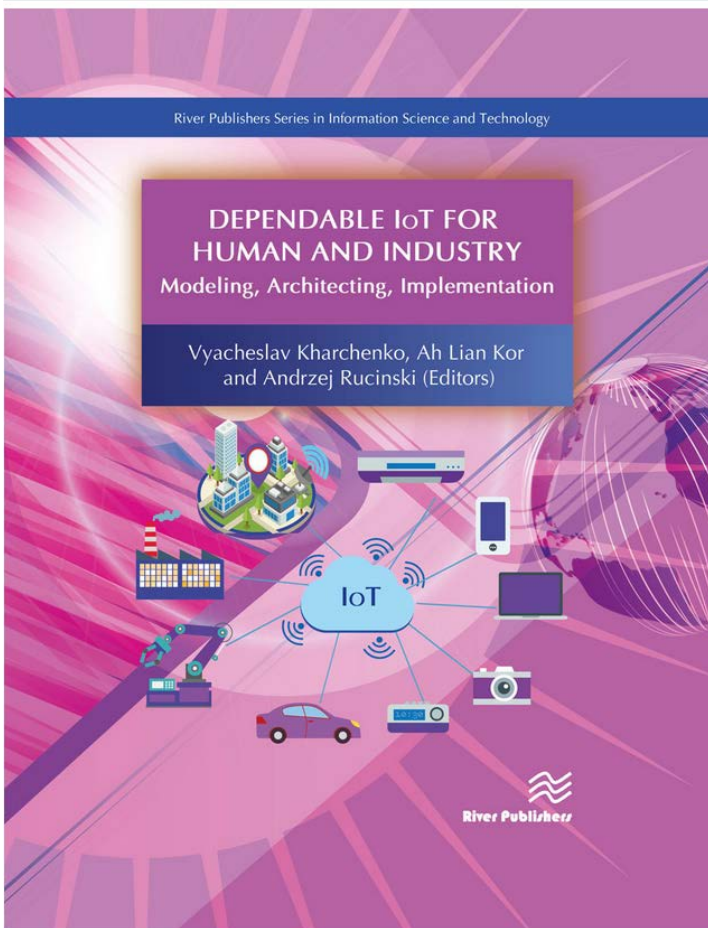
# ALIoT Project: R&D Directions

- Development and modeling of secure and safe **mobile and IoT systems** (e-health, smart city)
- Development of **industrial IoT**: artificial intelligence, digital twins and predictive analytics for Industry 4.0
- FPGA for implementation of security functions (cryptography, steganography) in **IoT and cloud systems** (FPGA as a service)
- Assurance (Safety and Security) Case assessment of **IoT based systems**
- Pre and post accident UAV and **Internet of Drones** based monitoring systems of NPP and other objects of critical infrastructures
- Development of **IoT systems** of monitoring of forest fires
- Augmented reality for abstract painting and **Internet of Galleries**





# River Publishers book



**River Publishers Series in Information Science and Technology**

## **Dependable IoT for Human and Industry Modeling, Architecting, Implementation**

**Editors:**

Vyacheslav Kharchenko, National Aerospace University KhAI, Ukraine

Ah Lian Kor, Leeds Beckett University, UK

Andrzej Rucinski, University of New Hampshire, USA

**ISBN:** 9788770220149

**e-ISBN:** 9788770220132

**Price:** € 95.00

**Available:** December 2018

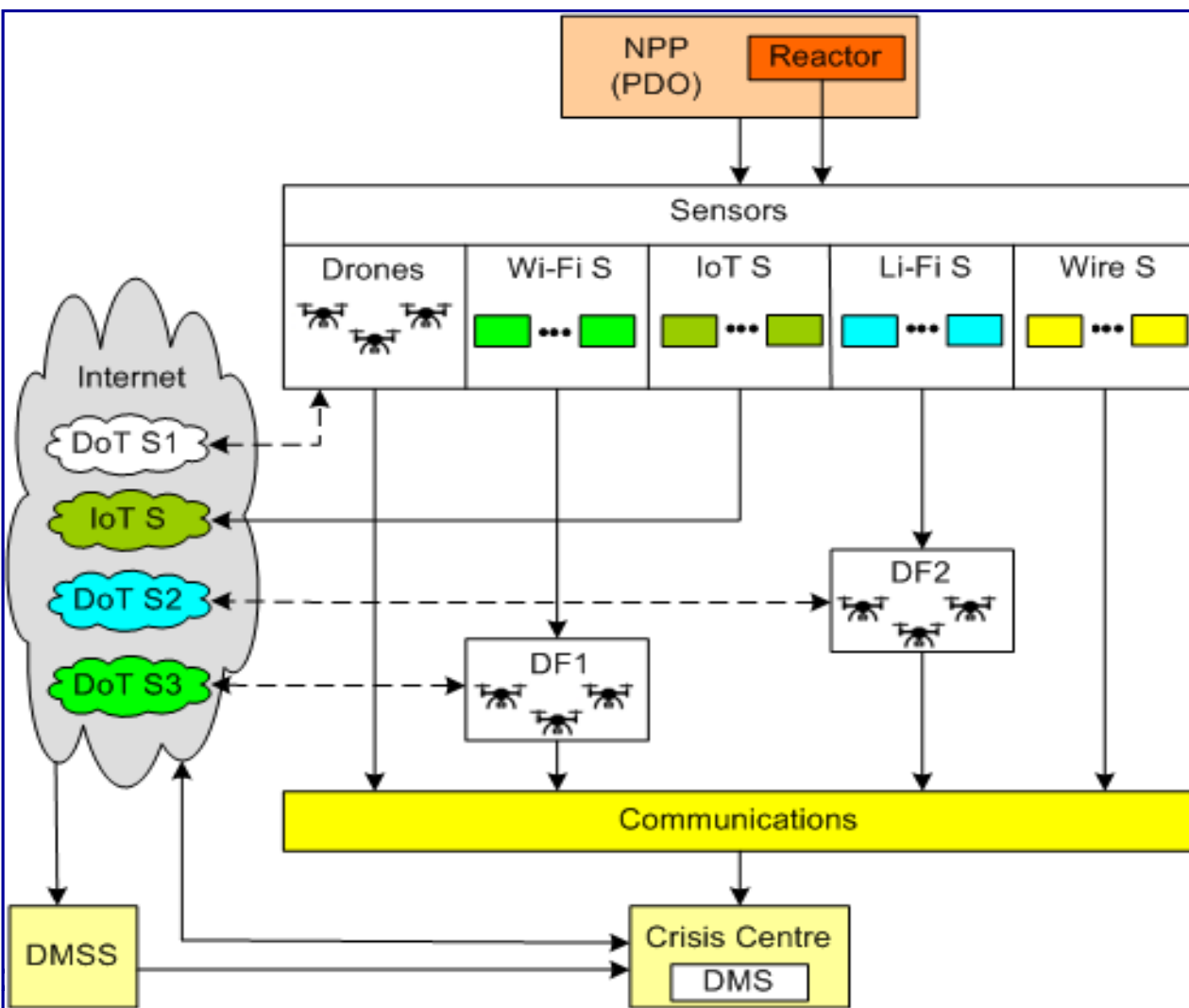
[https://www.riverpublishers.com/book\\_details.php?book\\_id=658](https://www.riverpublishers.com/book_details.php?book_id=658)

# Internet of Drones Based NPP (CI) Accidents Monitoring System

## Principles of IoDreAMS:

- diversity of data, sensors, communications, analytic teams to minimize common cause failure/event;
- multi-functional application of drone fleets and Internet of Drones technology;
- use of high protected private cloud for expert team access (DMSS) ...
- Big data analysis and AR (augmented reality) support

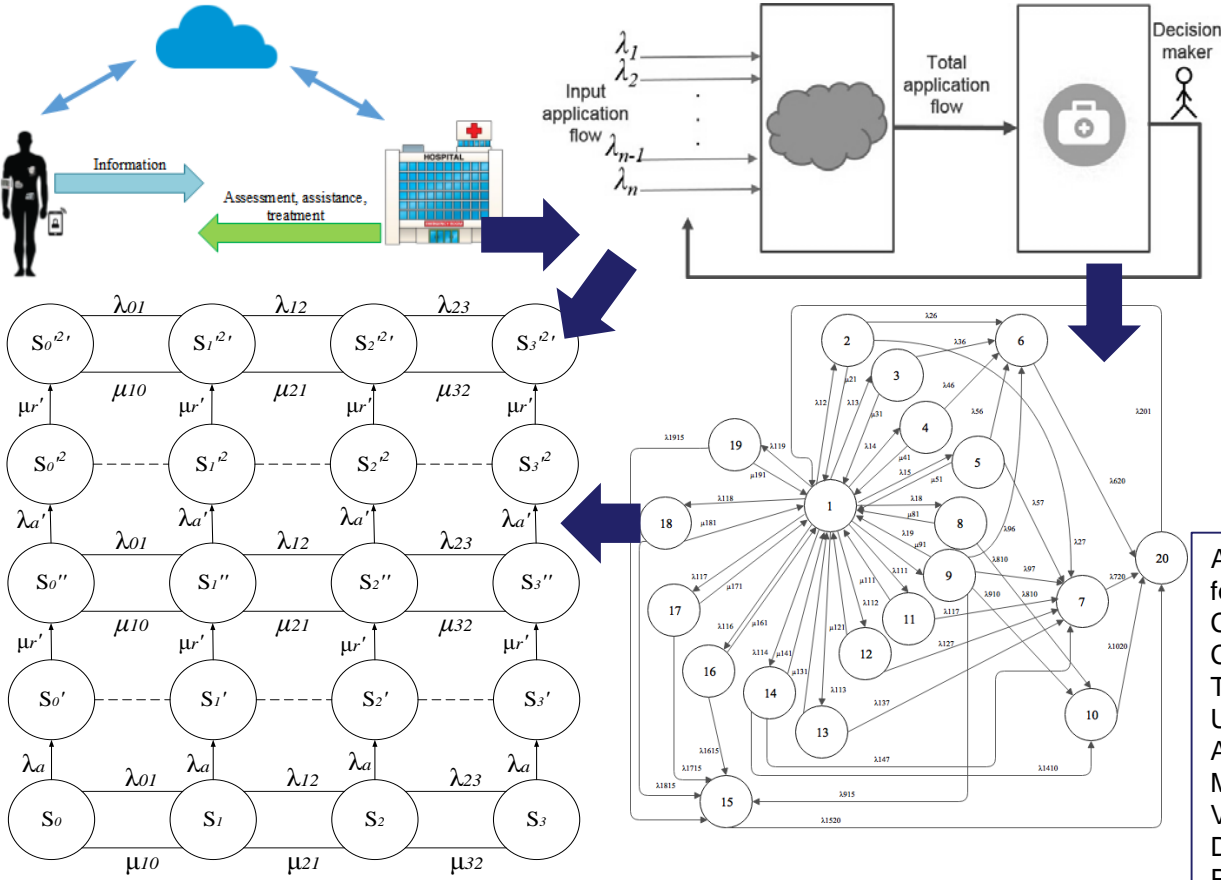
A. Sachenko, V.Kharchenko, H.Fesenko, V.Kochan, M.Yastrebenetsky. Application of UAV systems for NPP accidents monitoring, part 1-2 // Nuclear and Radiation Safety, 2017, 4; 2018, 1  
 H. Fesenko, A. Sachenko, V.Kharchenko, R.Hiromoto, V.Kochan, A.Strielkina. An Internet of Drone-Based Multi-Version Post-Severe Accident Monitoring System: Structures and Reliability / V. Kharchenko, Ah Lian Kor, A.Rucinski (eds). Dependable IoT for Industry and Human Domains, RPs, Denmark, 2018 (accepted)



# Modelling and Assessment of IoT e-health system

Problems of availability/safety/security assessment of IoT based (high availability) systems) such as PAMS, Health Control Systems for Insulin Injection, Smart Grid Substations...

**(complexity of models and parametrization)**



IoT based health systems for diabetics:

- a lot of patients/devices;
- failures of devices, communications and cloud resources;
- SW faults;
- changing of vulns numbers (basing on ODB)

A.Strielkina, V.Kharchenko, D.Uzun. Availability Models for Healthcare IoT Systems: Classification and Research Considering Attacks on Vulnerabilities// 9th IEEE Conference on Dependable Systems, Services and Technologies, DESSERT, 24-27 May, 2018, Kyiv, Ukraine

A.Strielkina. Modelling and Availability Assessment of Mobile Healthcare IoT Using ATA and Queueing Theory/ V. Kharchenko, Ah Lian Kor, A.Rucinski (eds). Dependable IoT for Industry and Human Domains, River Publishers, Denmark, 2018



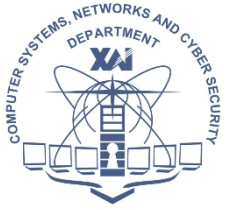


# Conclusions

**The project ALIOT ensures adaptation of academic programs** in Ukraine and other countries to the needs of the national and European labor markets, thus enhancing the opportunities of academic and labor abundant.

**The ALIOT covers hot domains of IoT applications such** as health systems, intellectual transport systems, ecology and Industry 4.0 systems, smart grid, smart buildings and city.

**The ALIOT allowed expanding and accelerating of R&D** on several topics (multi-domain application of safe and secure IoT: regulation, modeling and development)



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[v.kharchenko@csn.khai.edu](mailto:v.kharchenko@csn.khai.edu)**

**Thank you very much!**

**Ευχαριστω πολυ!**

**Щиро Вам дякую!**