

Ethics and regulations in IoT and robotics

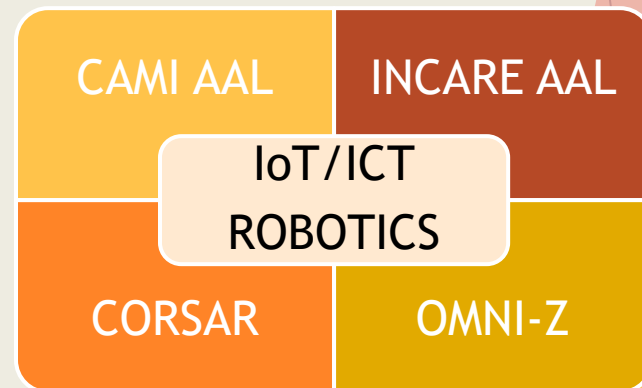
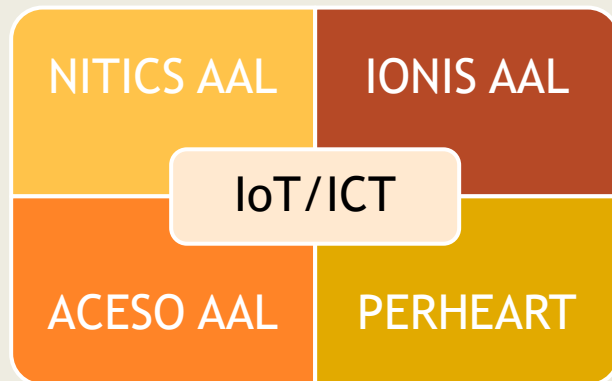
Oana Cramariuc

IT Center for Science and Technology

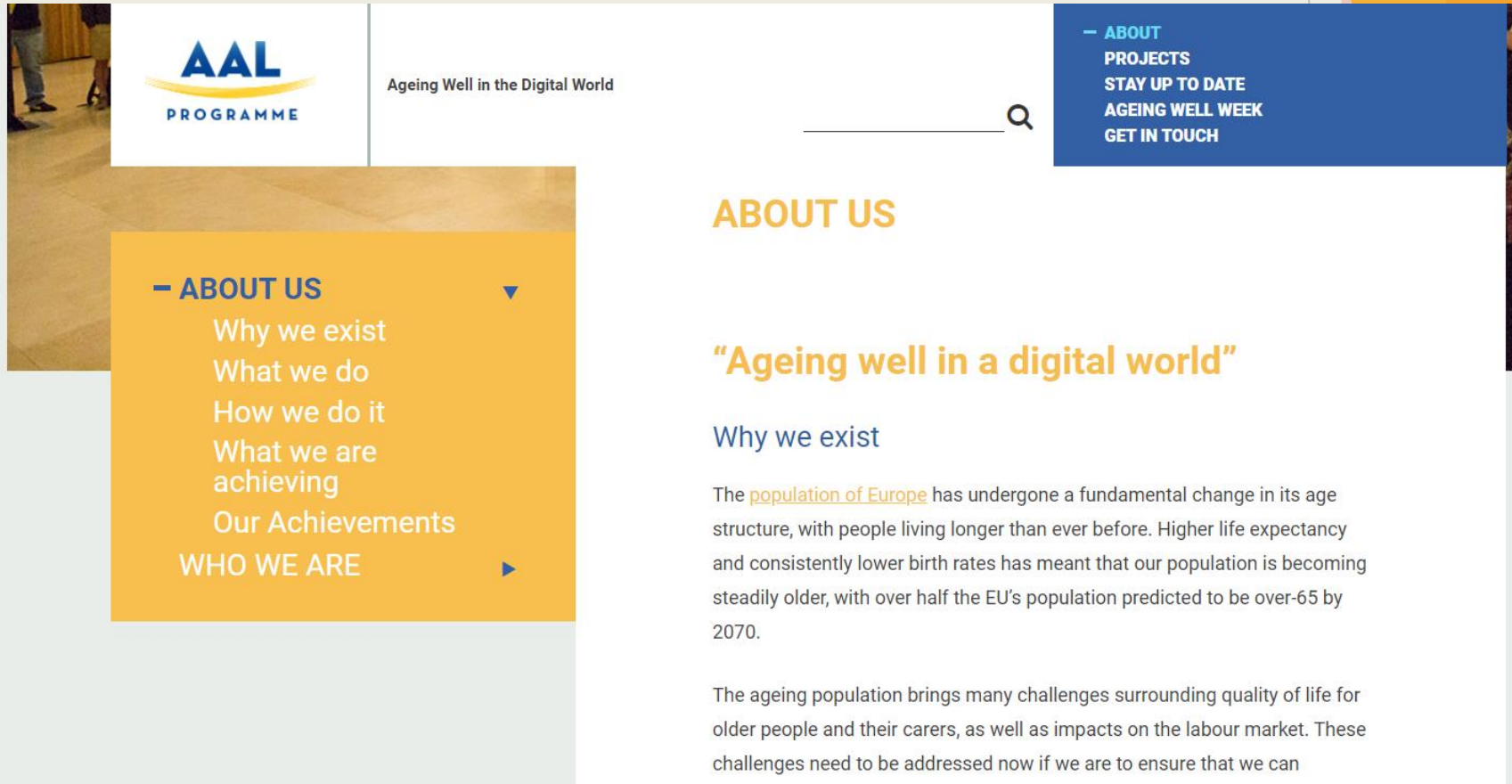
Bucharest, Romania

IT Center for Science and Technology, Romania (CITST)

- ▶ **CITST** is a research-oriented SME established in 2007 in Bucharest, Romania.
- ▶ CITST is targeting to integrate interdisciplinary research into novel products and services. Involvement in several national and European (AAL, ERANET, H2020, MC, Erasmus+) funded R&D projects.
- ▶ The main areas of expertise are in ICT, robotics and user-oriented services.



What is AAL?



The screenshot displays the AAL Programme website. At the top left is the AAL Programme logo. To its right is the tagline "Ageing Well in the Digital World" and a search icon. A blue navigation bar on the right contains the following links: "ABOUT", "PROJECTS", "STAY UP TO DATE", "AGEING WELL WEEK", and "GET IN TOUCH". A yellow navigation menu on the left lists: "ABOUT US" (with a dropdown arrow), "Why we exist", "What we do", "How we do it", "What we are achieving", "Our Achievements", and "WHO WE ARE" (with a right-pointing arrow). The main content area features the heading "ABOUT US" in orange, followed by the sub-heading "Ageing well in a digital world" in orange. Below this is the section "Why we exist" in blue, which contains two paragraphs of text.

AAL
PROGRAMME

Ageing Well in the Digital World

— ABOUT
PROJECTS
STAY UP TO DATE
AGEING WELL WEEK
GET IN TOUCH

— ABOUT US ▼

- Why we exist
- What we do
- How we do it
- What we are achieving
- Our Achievements

WHO WE ARE ►

ABOUT US

“Ageing well in a digital world”

Why we exist

The population of Europe has undergone a fundamental change in its age structure, with people living longer than ever before. Higher life expectancy and consistently lower birth rates has meant that our population is becoming steadily older, with over half the EU’s population predicted to be over-65 by 2070.

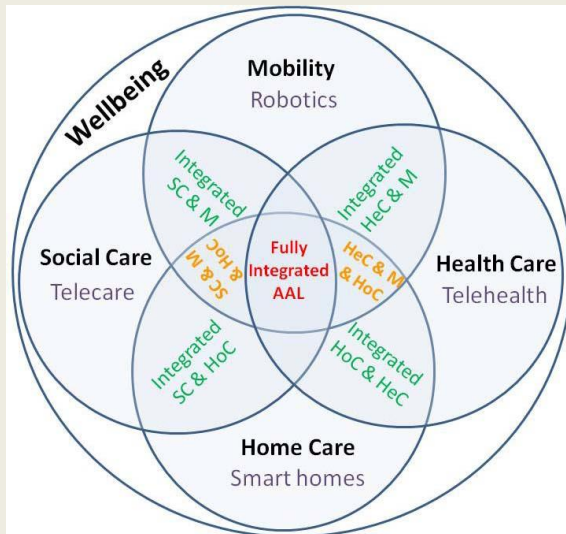
The ageing population brings many challenges surrounding quality of life for older people and their carers, as well as impacts on the labour market. These challenges need to be addressed now if we are to ensure that we can

Impact on product development

- ▶ Reduced digital literacy
- ▶ Possible cognitive impairment
- ▶ Only products that are aligned with the true needs, rights and wishes of the whole value-chain of users and organizations have a good margin of market acceptance and a solid exploitation aim.
- ▶ AAL requires extended pilots with elderly in real life conditions → ethical regulations and protocols have to be followed (e.g., GDPR and in some cases MDR), exit strategy (possible measures to ensure no harm is done - and if possible, good is ensured), etc

Specific project aspects

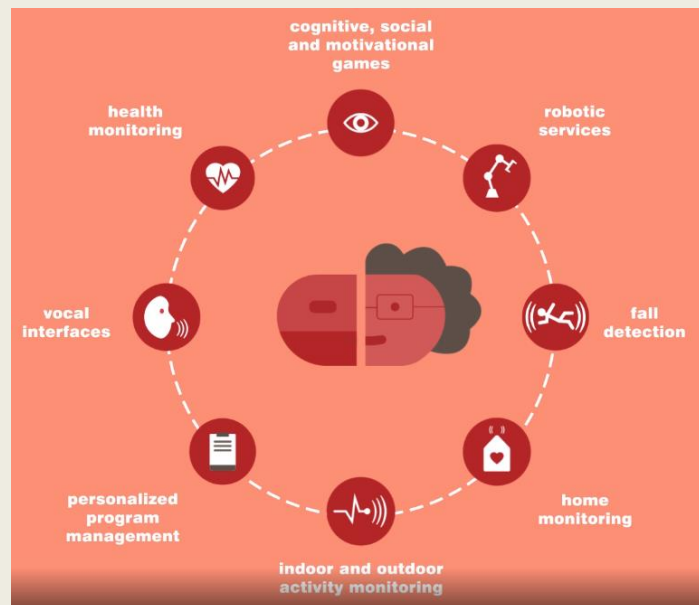
- ▶ NITICS - “Networked infrastructure for innovative home care solutions”, first AAL project (2013-2015), dedicated to monitoring the health and environment of elderly living independently at home.
- ▶ CAMI - “Artificial intelligent ecosystem for self-management and sustainable quality of life in AAL” Offers a fully integrated AAL solution by providing services for health management, home management and well-being Intelligent Ecosystem.



- ▶ Robotics comes into play: Pepper & Tiago
- ▶ Physical activity - avatar animated by the user performing exercises in front of a Kinect sensor.
- ▶ <http://www.camiproject.eu/>

Specific project aspects

- ▶ IONIS - “Indoor and outdoor NITICSplus solution for dementia challenges” addressing people with cognitive impairment (ethical aspects are even more important).
- ▶ INCARE - “Integrated Solution for Innovative Elderly Care” is offering an integrated solution that enables flexible, scalable and sustainable services to support elderly people by exploiting health monitoring, AI and robotics (www.aal-incare.eu). Two Tiago versions, Turtlebot.



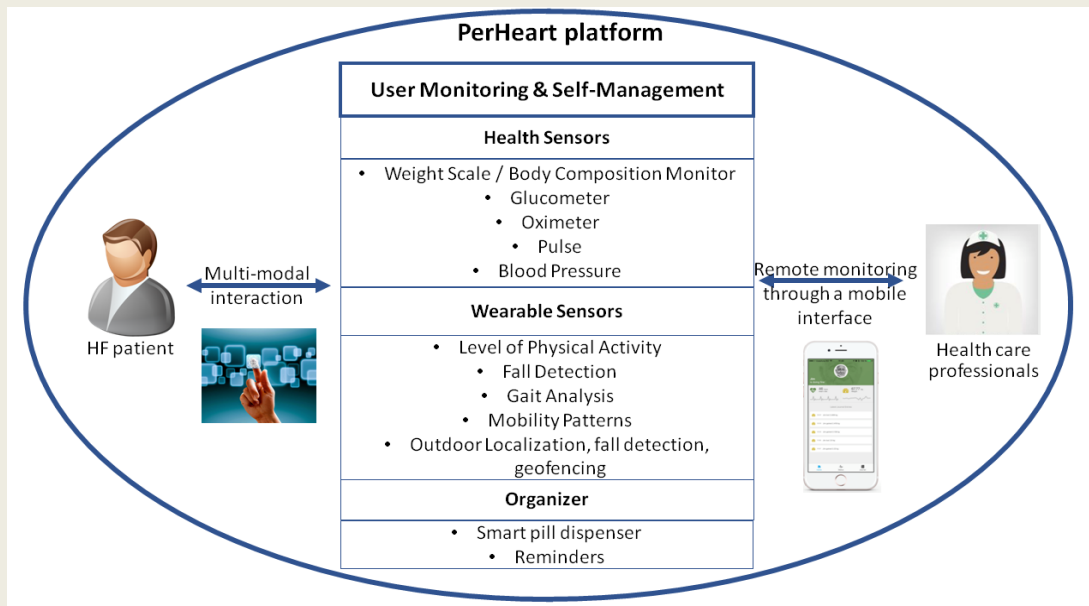
Specific project aspects

- ▶ ACESO - “Patient centric solution for smart and sustainable healthcare” is exploiting modern Artificial Intelligence (AI) technologies in order to build an integrated health and oral-care platform in which intelligent devices use data analytics for adaptable health and wellbeing.



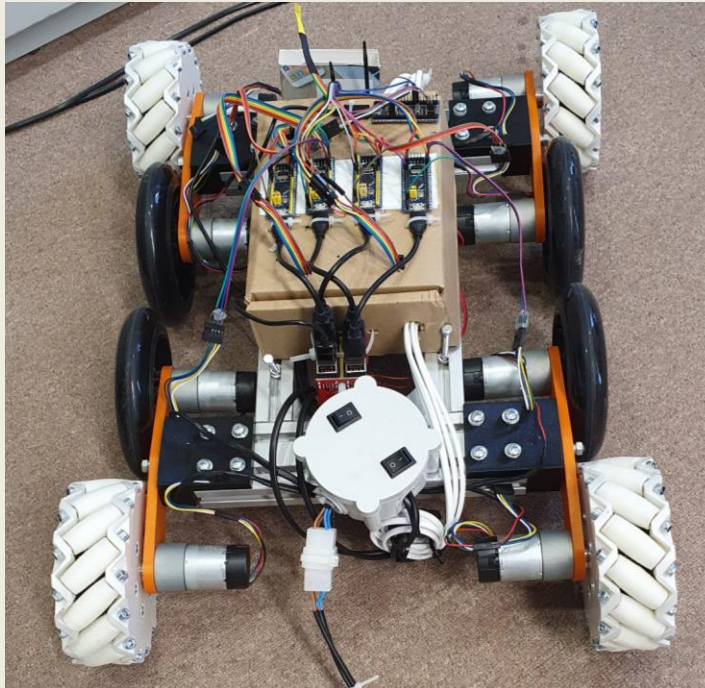
Specific project aspects

- ▶ PerHeart - “Personalized ICT solution to reduce re-hospitalization rates in heart failure elderly patients suffering from comorbidities” is integrating, in a modular design, functionalities dedicated to both HF patients and their health providers while following ethical guidelines and complying with general data protection regulations.

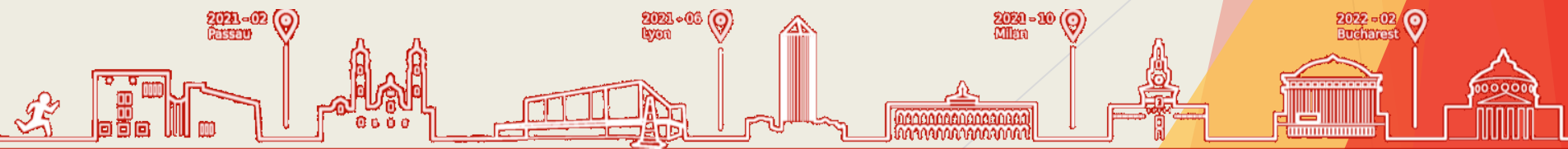


Specific project aspects

- ▶ OMNI-Z is a R&D project funded through local, national, funds which is developing an omnidirectional robotic base capable to overcome small obstacles (e.g. steps). Affordability is also an issue.
- ▶ As opposed to the standard two-wheel differential drive (e.g. Roomba), the omnidirectional drive provides precision positioning in constrained environments.



Integrated Solution for Innovative Elderly Care **INCARE**



Project Info

- ▶ AAL Call 2017 (what is AAL?)
- ▶ Call specific challenge: The challenge lies in developing packages integrating different solutions that address the needs and wishes of end-users and add value to their lives. Packages should be based on existing and/or open platforms.
- ▶ Duration: 01.10. 2018 -- 31.12.2021 (39 months)

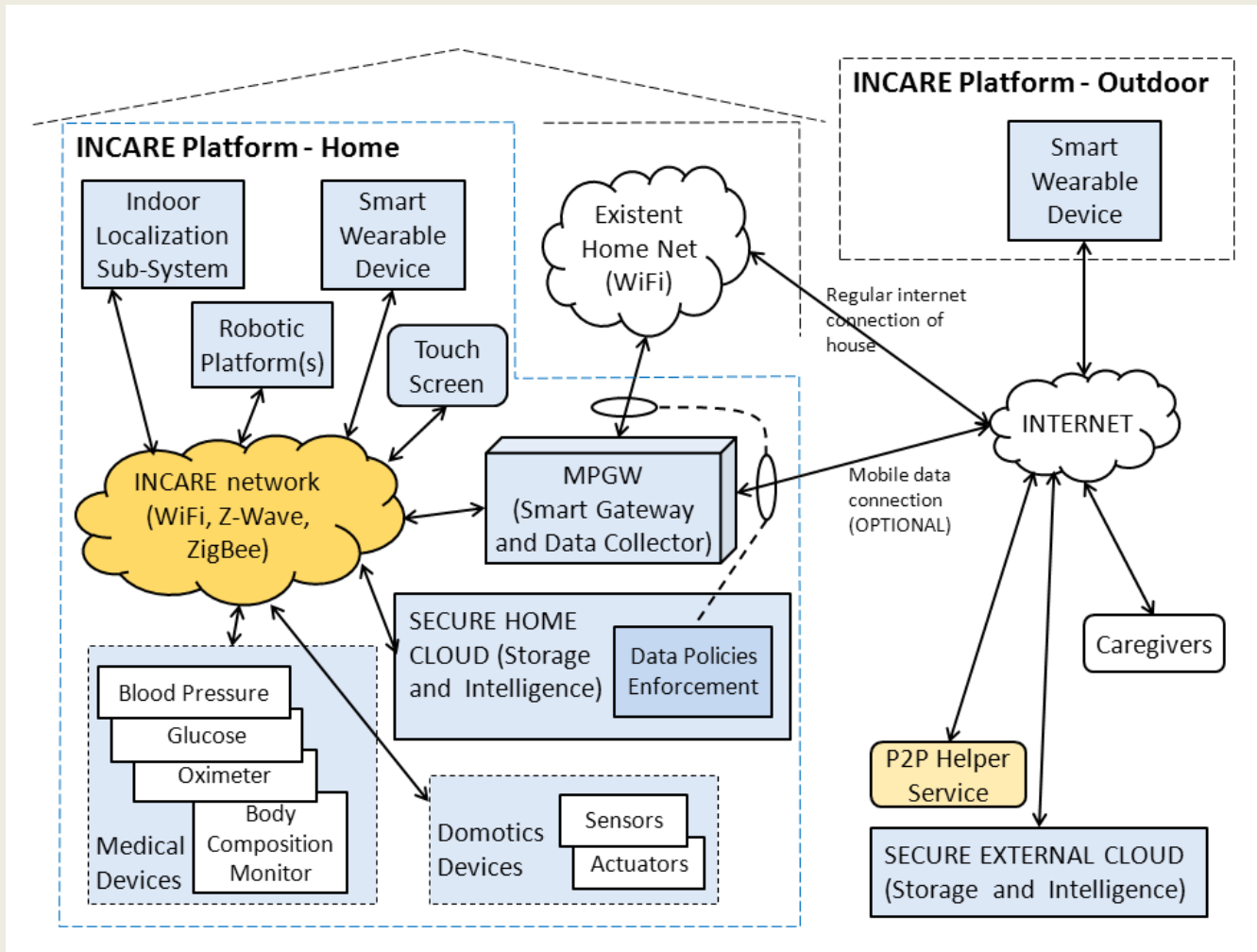
The INCARE consortium

No.	Partner Organisation Name
1 (CO)	Centrul IT pentru Stiinta si Tehnologie
2	ECLEXYS SAGL
3	University Politehnica of Bucharest
4	IZRIIS Institute for research, intergenerational relations, gerontology and ICT**
5	Warsaw University of Technology
6	The Unit for Social Innovation and Research „Shipyards“
7	Bay Zoltán Nonprofit Ltd. for Applied Research
8	SOFTIC LTD

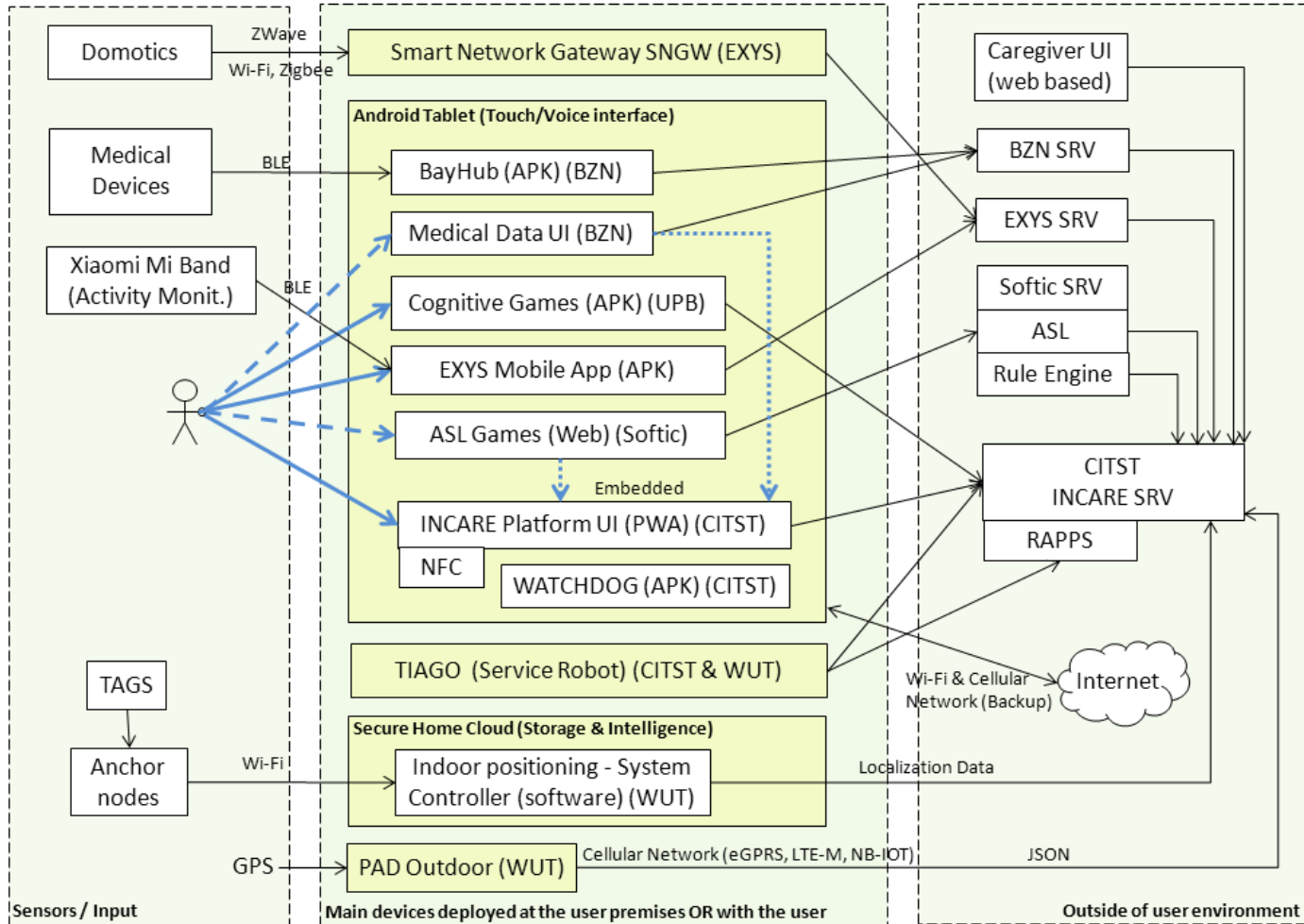
What is INCARE ?

- ▶ INCARE is a digital platform (tablet, server, software) connected to sensors and devices that allow users to monitor different parameters relevant for health and wellbeing while keeping them physically active and engaged with their peers with games, activities and tasks to do.
- ▶ INCARE is also incorporating various robotic platforms to create a realistic environment for human-robot collaborative activities.

Platform layout

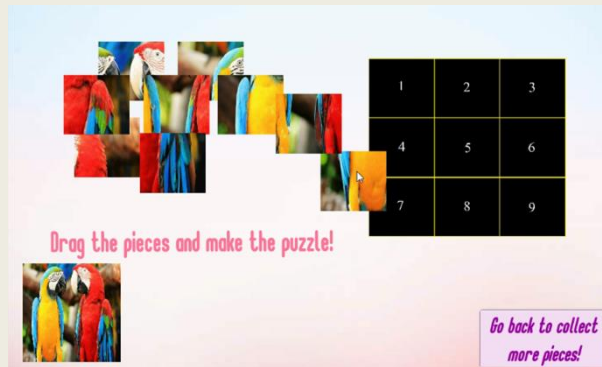


Platform Evolved Architecture



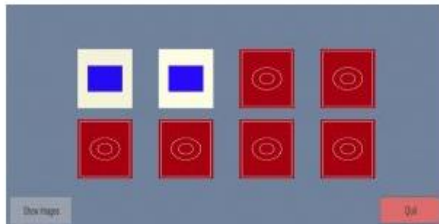
Cognitive Games

- ▶ Games to stimulate attention, memory, reaction speed, logical problem-solving and memory retention
- ▶ Simple to play: games that are challenging but not so difficult that elderly can't complete
- ▶ Users can monitor their progress
- ▶ Game points are used as input for other platform modules



Cognitive Games

Match Game



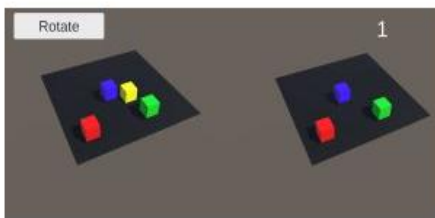
Collect & Create



Collect Objects



Get the Differences



Organize Numbers

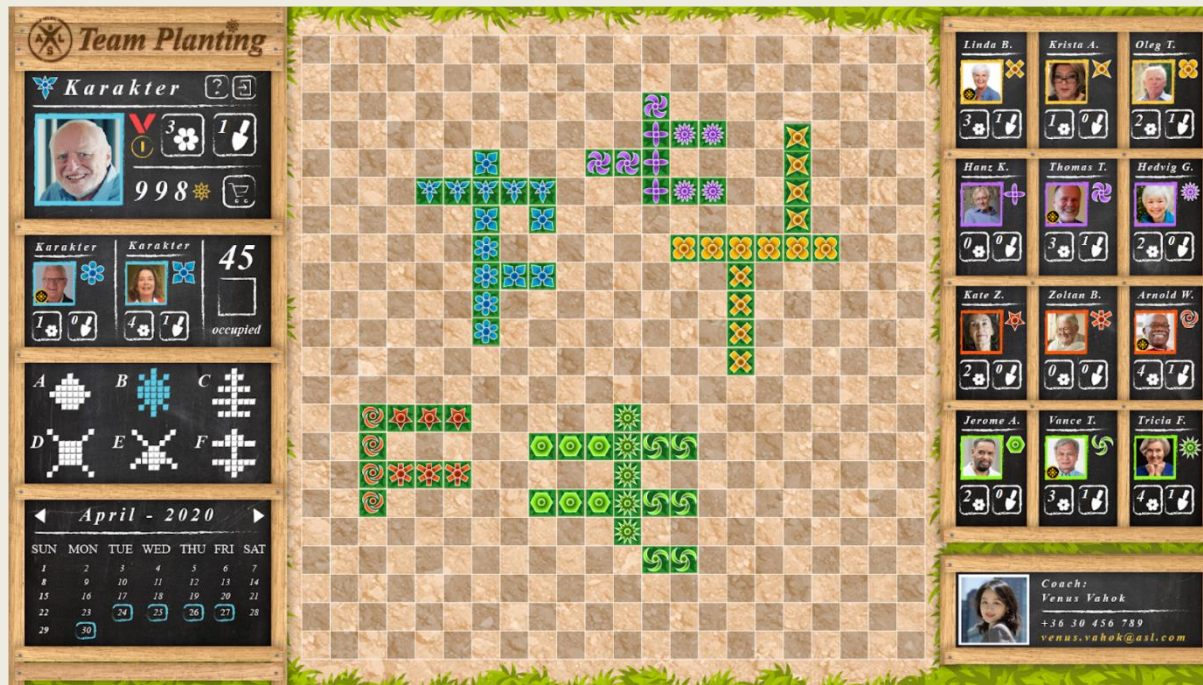
2	3	4	8
1	5	7	12
13	9	14	11
6	10	15	

Object Maze

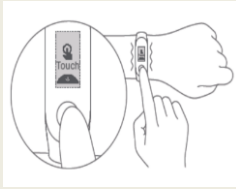


Collaborative game

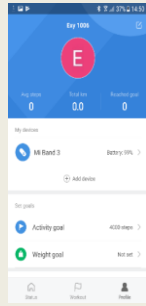
- ▶ Played in a group of 4-6 players.
- ▶ Points awarded from health and activity monitoring as well as from cognitive games are being consumed in the collaborative game.



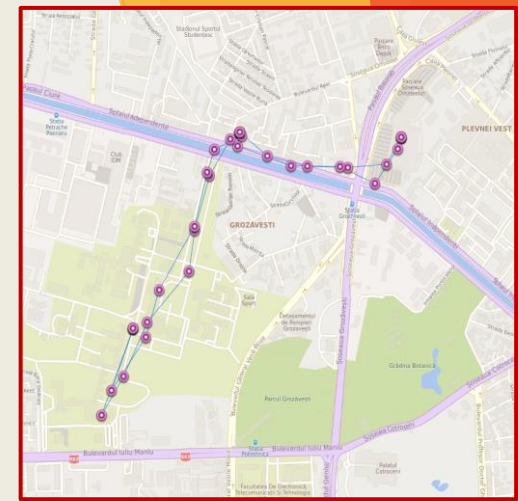
XIAOMI MI Band bracelet




INCARE Activity App




INCARE User Interface




HEALTH



Motion detection multi-sensor



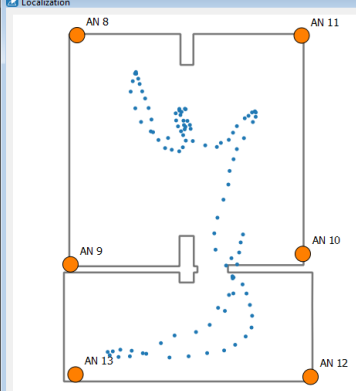
Smart power plugs



Door trigger multi-sensor

© FIT-Europe Domotic devices

Localization

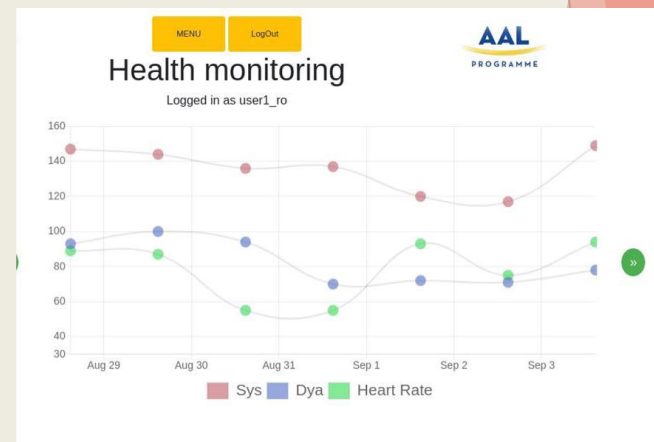
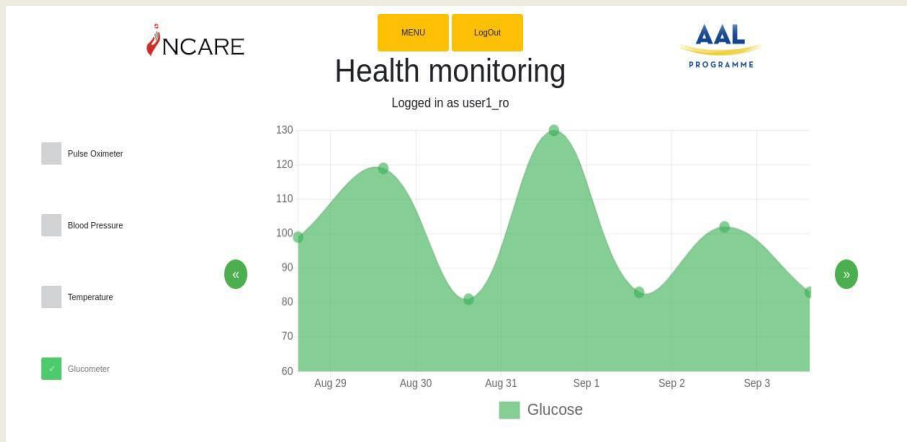


	Id	Name	Track
1	2	UWB white	<input checked="" type="checkbox"/>
2	48	BLE green	<input type="checkbox"/>
3	19	BLE item ...	<input type="checkbox"/>
4	49	BLE white	<input type="checkbox"/>
5	50	BLE pink	<input type="checkbox"/>
6	51	BLE blue	<input type="checkbox"/>

Multimodal user interface

The screenshot displays the main dashboard of the NCARE and AAL PROGRAMME interface. At the top, there are 'MENU' and 'LogOut' buttons. The user is logged in as 'user1_en'. The interface is divided into several sections:

- NCARE Logo:** Located at the top left.
- Activity Menu:** A vertical list on the left with options: Calendar, Activity, Physical activities (highlighted in blue), Mental activities (highlighted in yellow), Social activities (highlighted in red), To Do, Chores: ✓, and Appointments: ✓.
- Central Buttons:** A grid of buttons for Speech, Games, Health, Activity, Calendar, Game for teams, Domotics, and Robot.
- AAL PROGRAMME Logo:** Located at the top right.
- Health Panel:** A vertical list on the right showing health metrics: Health, Glucose: -, Pulse: -, Temperature: -, Blood pressure: -/-, SPO2: -, Activity, Steps 0, and Calories 0.



Multimodal user interface

Speech To Text

Press the button then say the phrase to test the recognition.

Start the recognition

Recognition result

Available or not in the dictionary

Text To Speech

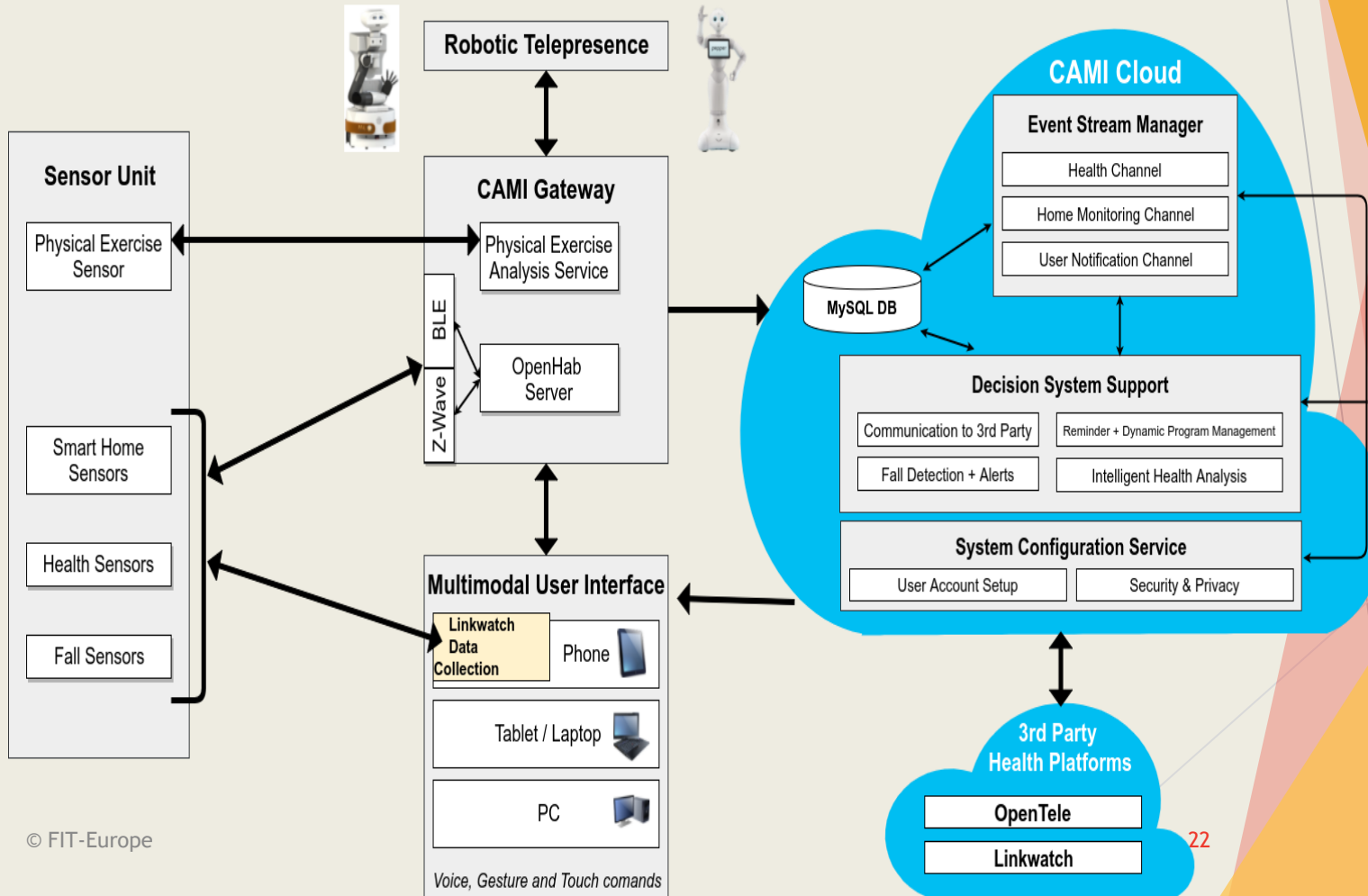
Type text below, then click the Speak button or click the Speak button directly.

You are doing fine. Your systolic blood pressure is 120 mmHg, your diastolic blood pressure is 75 72 bpm and your weight is 68 KG. You have walked 6500 steps and slept 390 minutes.

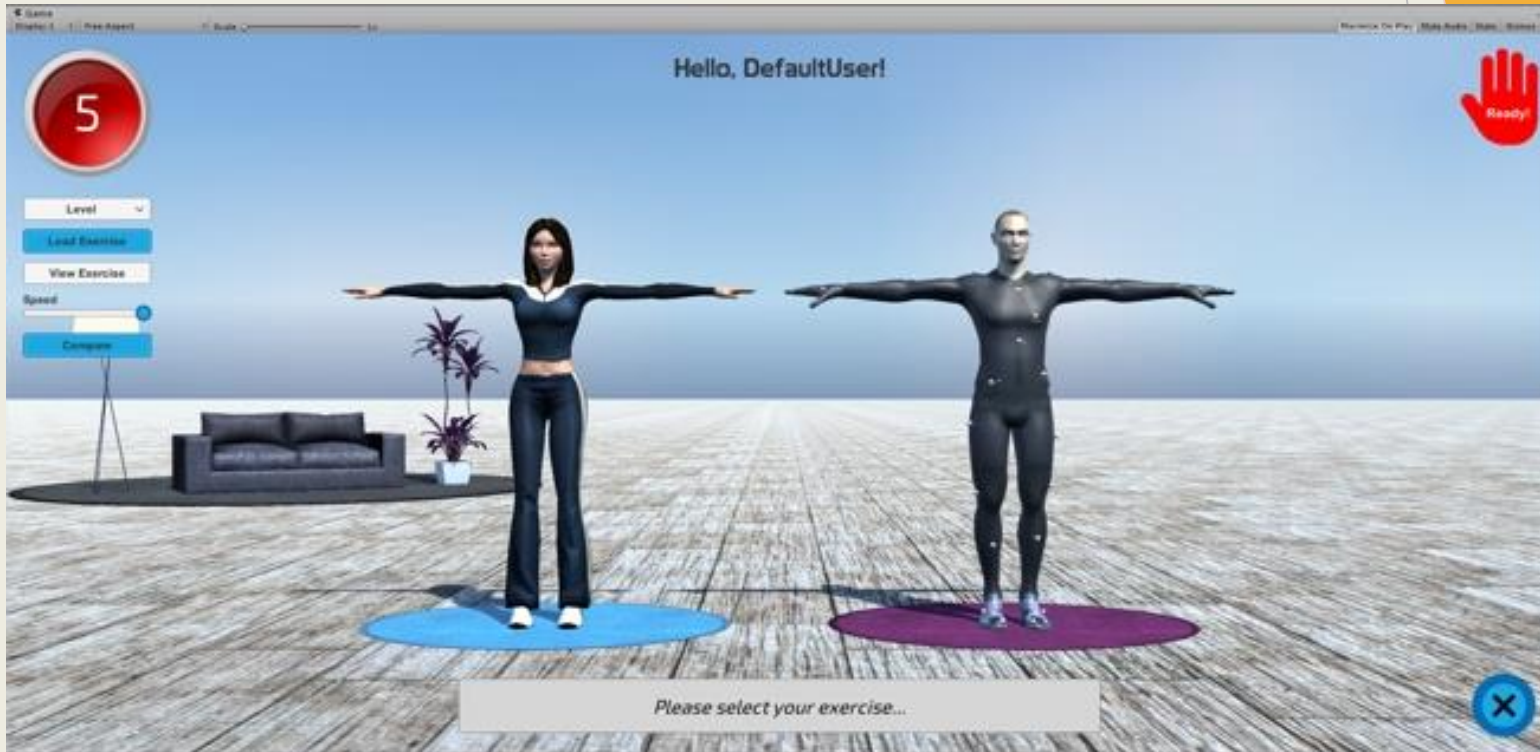
Speak

1. Hello.
2. Who are you?
3. How will be the weather today? | What is the forecast for today?
4. Display my Calendar. | Open my calendar.
5. What I have scheduled for today? | What plans do I have for today?
6. What is my health status? | Display Health Status.
7. How much have I walked today?
8. How much did I walked today?
9. What is my blood pressure?
10. What is my weight?
11. What is my heart rate? | Which is my heart rate?
12. Display my last health measurements.
13. Display health status. | Show my last health measurements.
14. What time is it?
15. How is my health measurements?

Additional implementations in CAMI



Physical exercise in CAMI

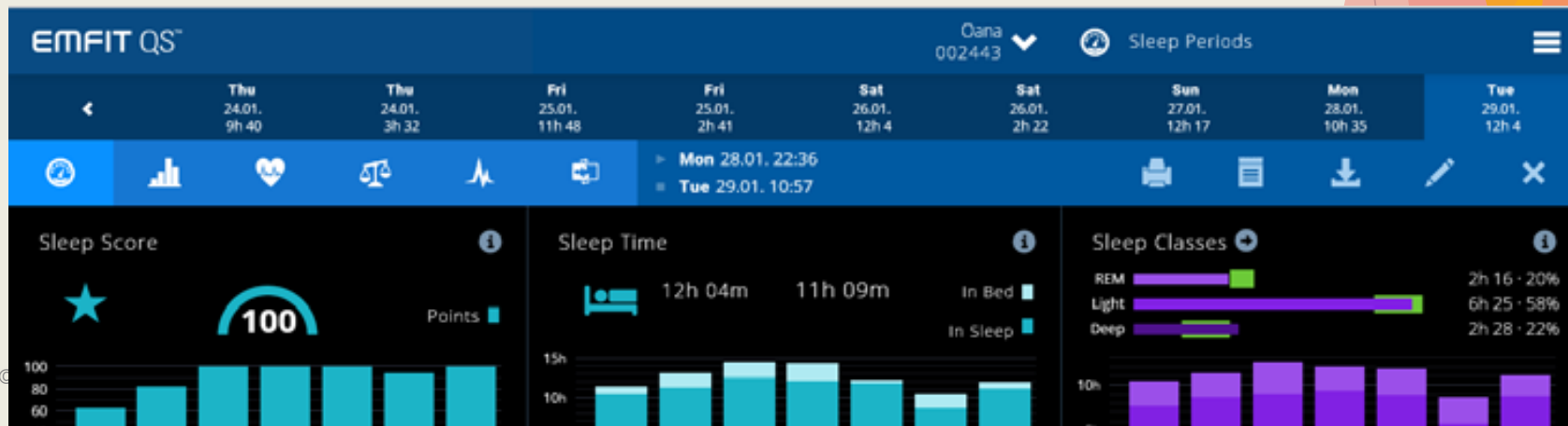


The user avatar must reproduce the movements of the trainer's avatar. The user movements are captured using a Kinect v2 sensor.

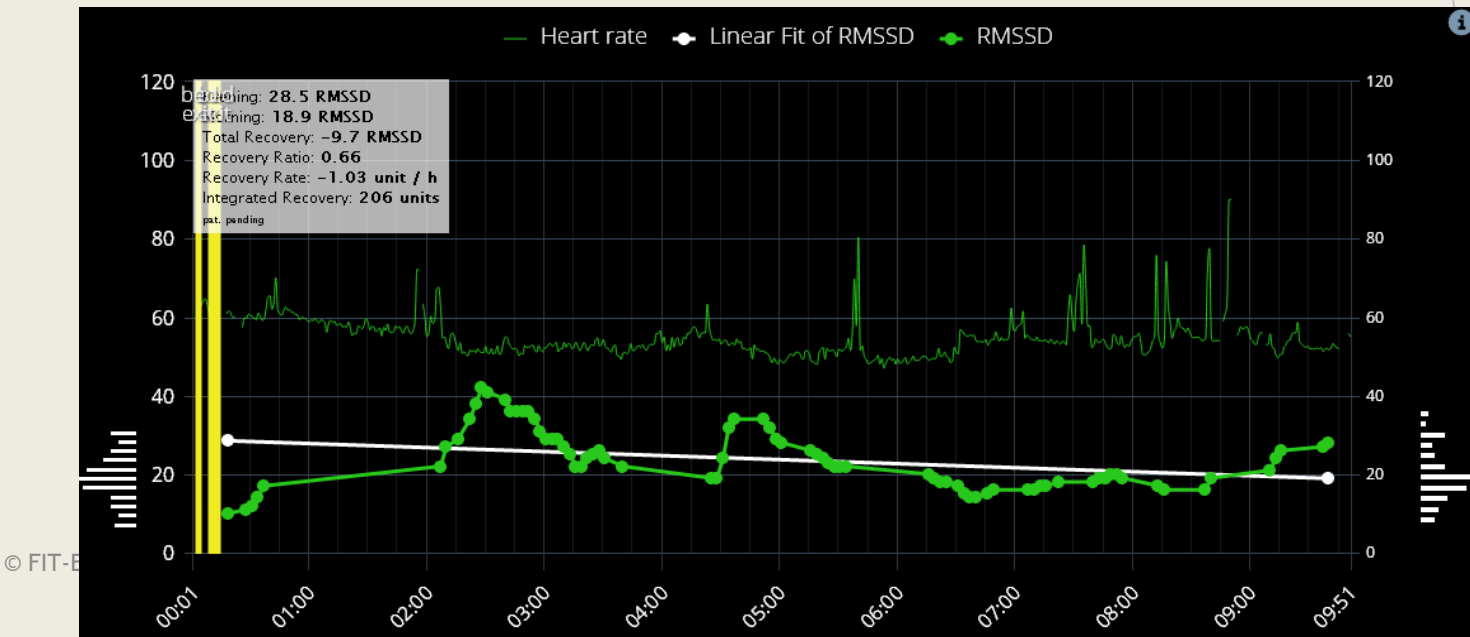
Additional features in IONIS - sleep monitoring



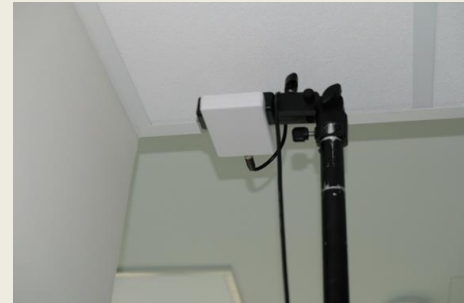
Emift sensor, Finnish product, originated in TUT, lots of research papers



Additional features in IONIS - sleep monitoring

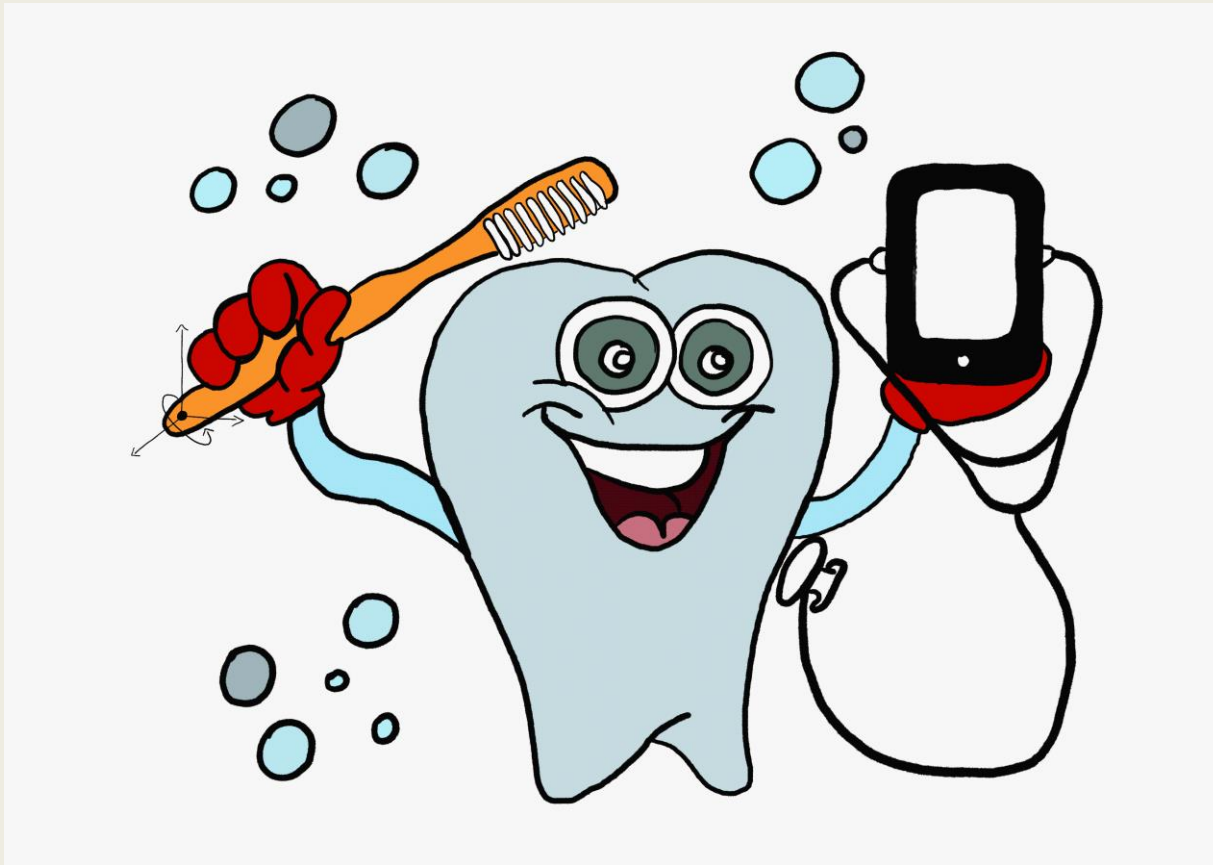


Additional features in IONIS - indoor person and object localization



The UWB-BLE tags are intended for accurate persons tracking. Therefore, the tag is equipped with two radio modules. UWB interface (higher power consumption) is used for localization purposes, BLE radio sends packets containing additional data.

Additional features in ACESO - intelligent toothbrush



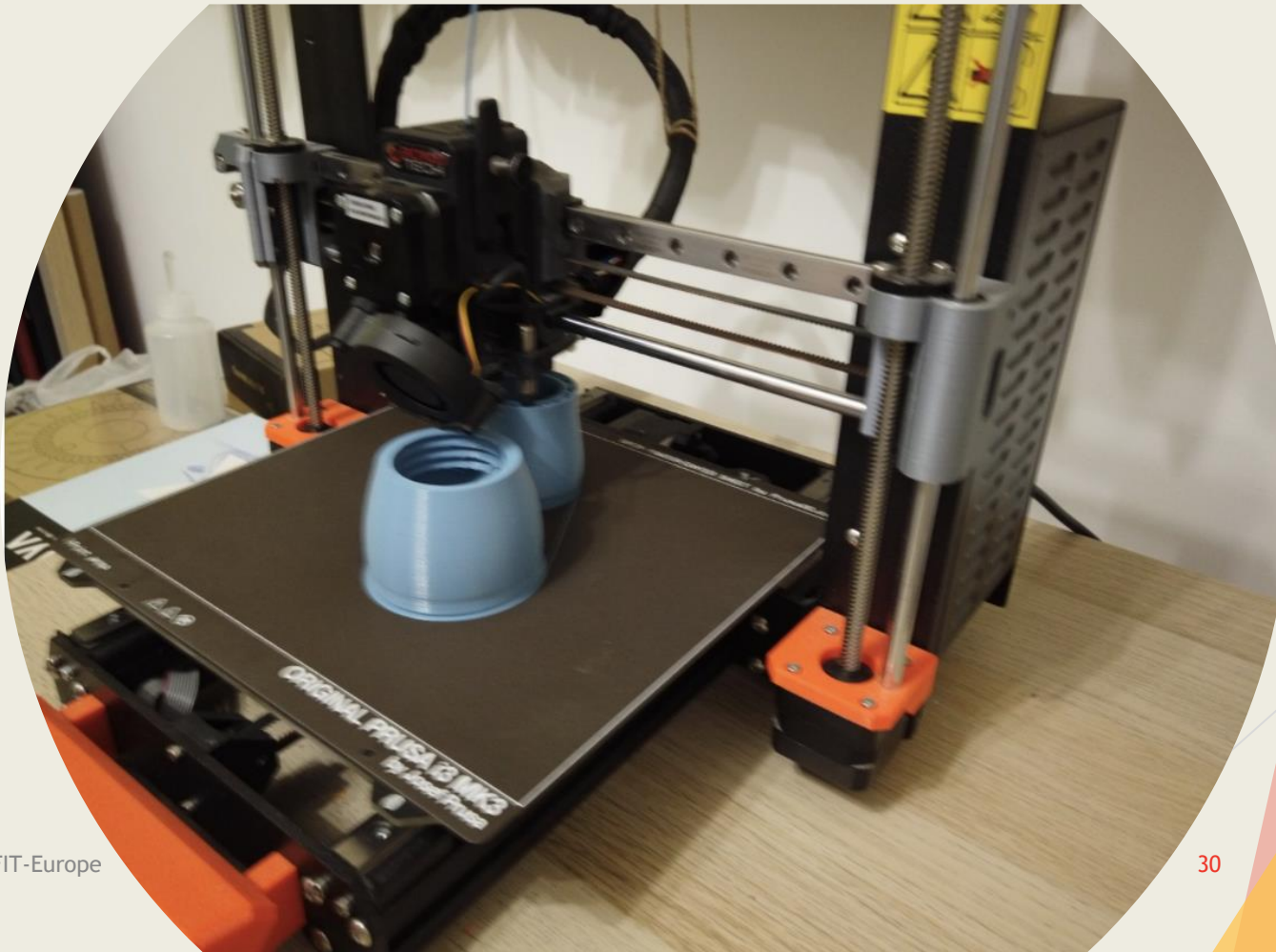
Additional features in ACESO - intelligent toothbrush



Additional features in ACESO - intelligent toothbrush



Additional features in ACESO - intelligent toothbrush



INCARE box and real life pilots

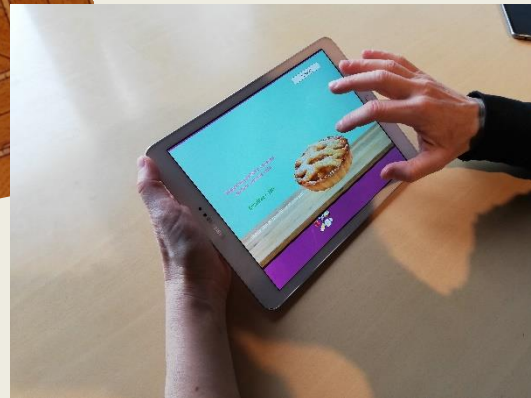
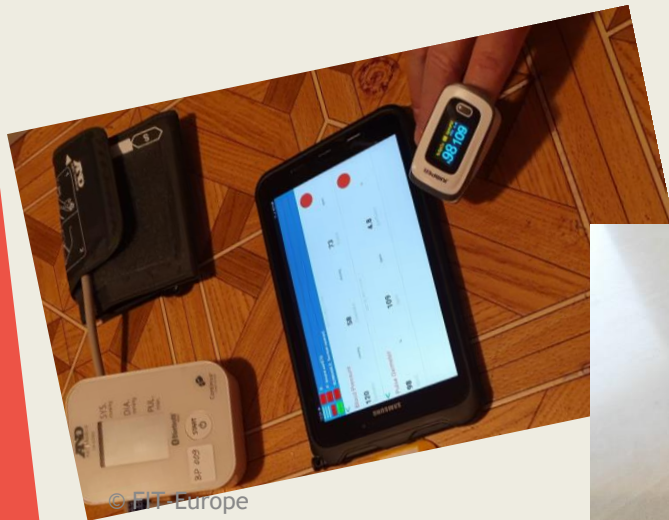


INCARE box and real life pilots



Pilots in real life environments

- ▶ Ethical approval (interventional versus non-interventional studies).
- ▶ Health data particularly sensitive (encryption is not enough, pseudonymisation is not enough)
- ▶ General Data Protection Regulation - GDPR - compliance (informed consent is not enough, AI poses problems, etc)
- ▶ COVID challenges



18/11/2021

33

GDPR and personal data

- ▶ Pseudonymisation' of data (defined in Article 4(5) GDPR) means replacing any information which could be used to identify an individual with a pseudonym, or, in other words, a value which does not allow the individual to be directly identified.
- ▶ Data can be considered 'anonymised' when individuals are no longer identifiable. A person does not have to be named in order to be identifiable. If there is other information enabling an individual to be connected to data about them (e.g. GPS coordinates).
- ▶ Where data has been anonymised, the original information should be securely deleted to prevent any reversing of the 'anonymisation' process. In most cases, if this deletion does not take place then the data is classified as 'pseudonymised' rather than 'anonymised', and is still considered personal data.

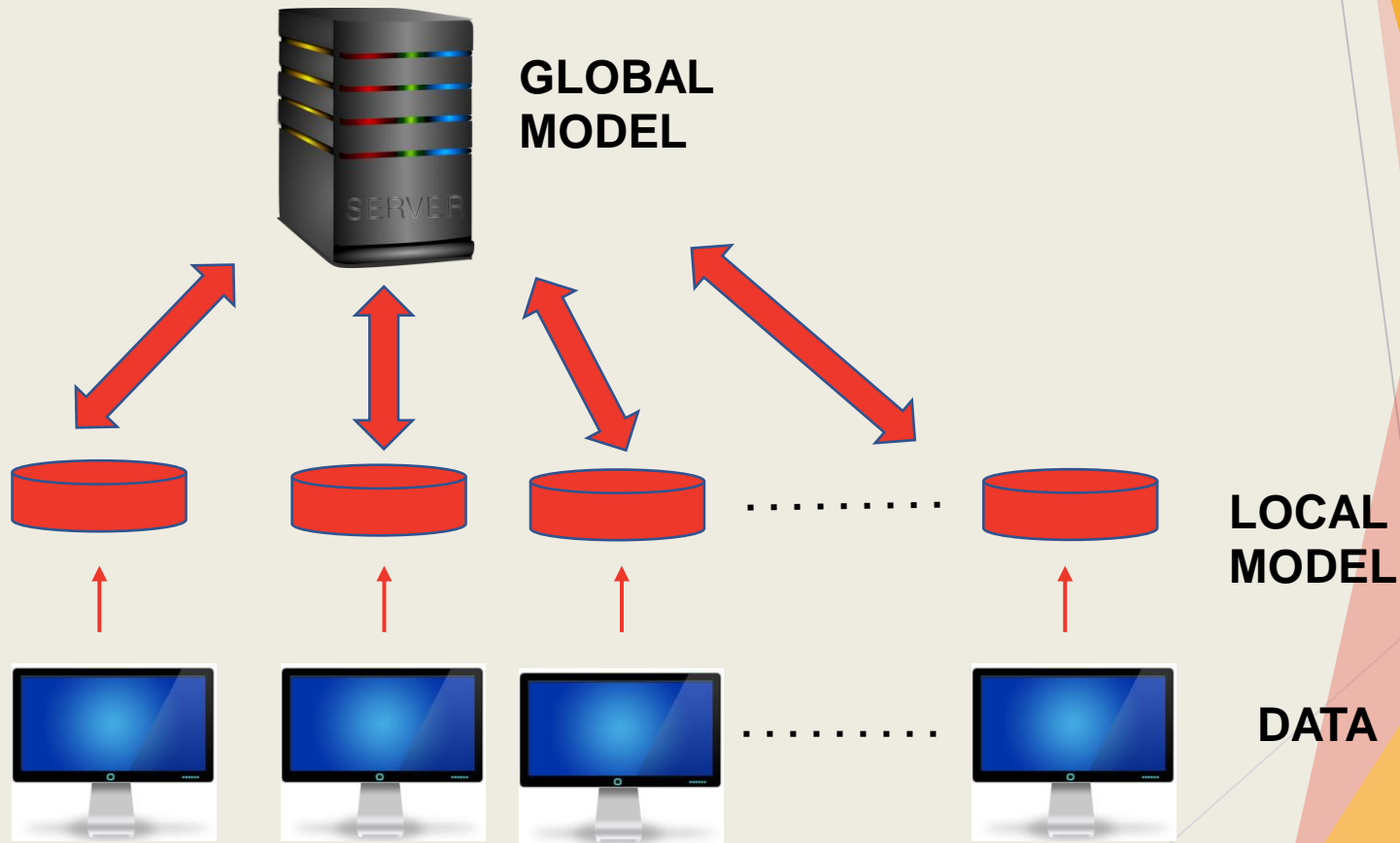
GDPR and AI

- ▶ GDPR does in some cases restrict - or at least complicate - the processing of personal data in an AI context.
- ▶ Art 22 within the GDPR affects AI-based decisions on individuals, particularly those related to automated decision making and profiling.
 - ❑ Trustworthy AI
 - ❑ Explainable AI
- ▶ AI requirements originating from GDPR compliance
 - ❑ Transparency, including traceability, explainability and communication;
 - ❑ Diversity, non-discrimination and fairness, including the avoidance of unfair bias, accessibility and universal design, and stakeholder participation;

[https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641530/EPRS_STU\(2020\)641530_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641530/EPRS_STU(2020)641530_EN.pdf)

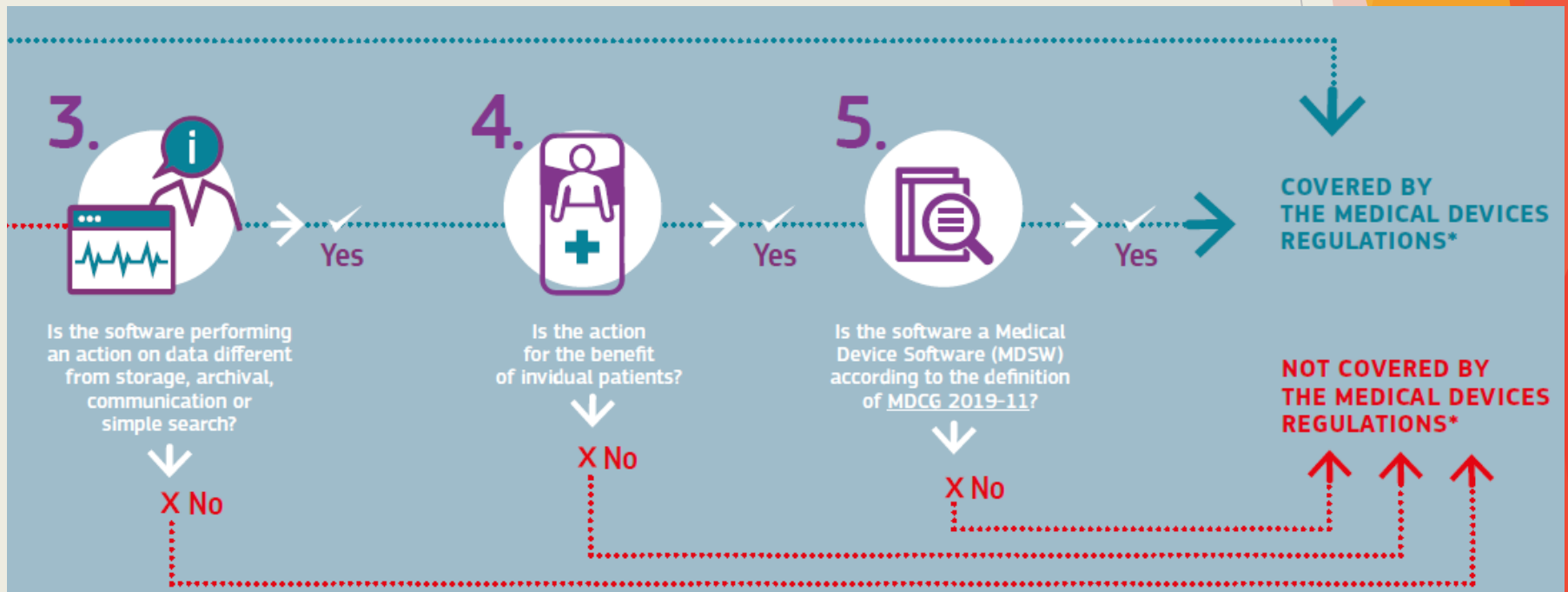
GDPR and health data

- ▶ Adds one more layer of complications (Federated learning, distributed AI)



Medical devices regulation (MDR)

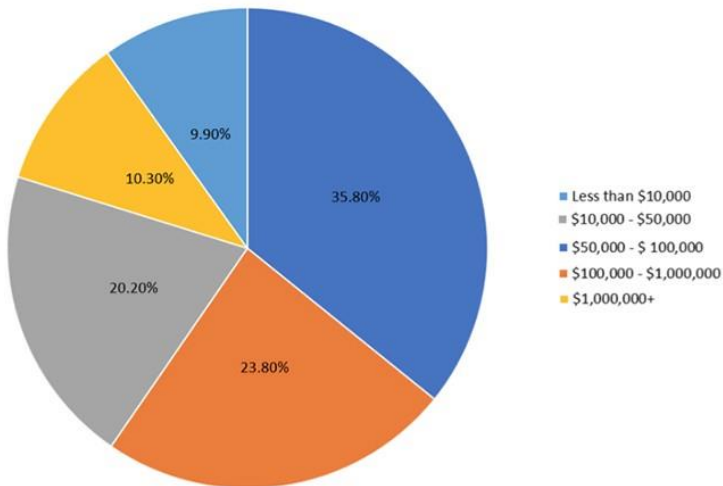
- ▶ MDR - software which is displaying medical data becomes a medical device



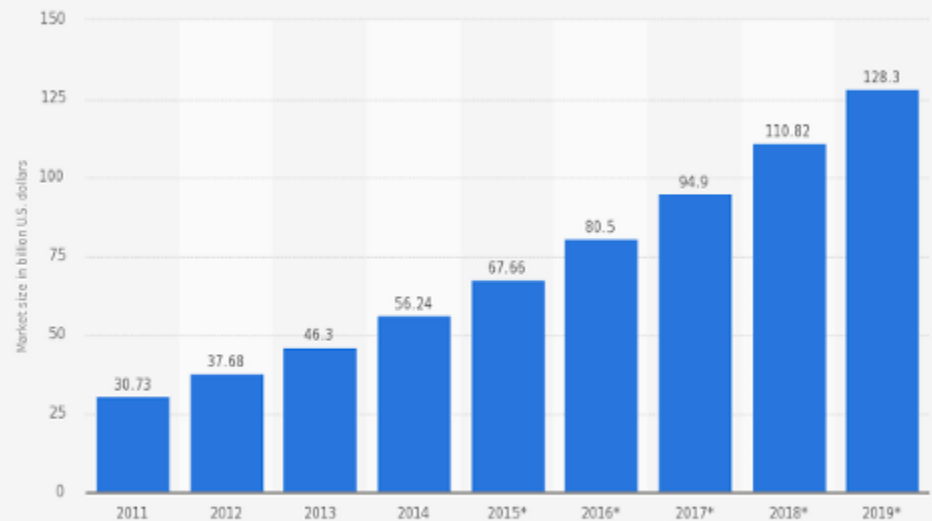
Economical aspects

- ▶ CE certification
- ▶ GDPR officer: organisations are required to appoint a DPO (data protection officer) if they are a public authority, monitor data subjects on a large scale or process special categories of sensitive data. GDPR penalties can reach up to 20 Million Euros.
- ▶ MDR certification: cost 5% - 10 % of the company's annual revenue
- ▶ Ethical approval

How much are businesses spending on GDPR compliance?



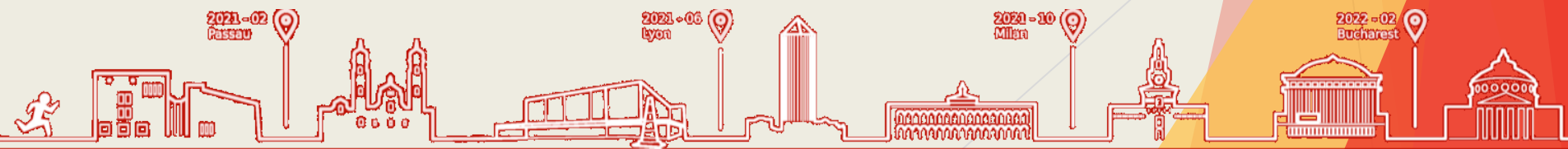
Size of the cloud computing and hosting market worldwide from 2011 to 2019 (in billion U.S. dollars)**



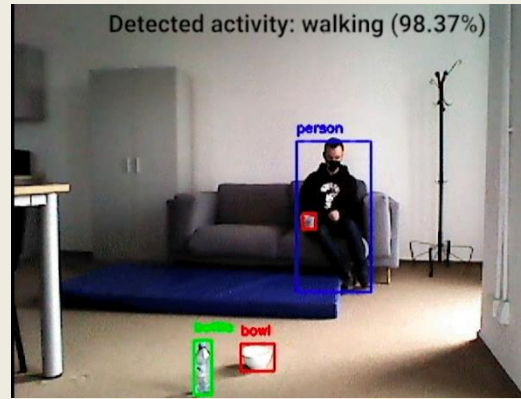
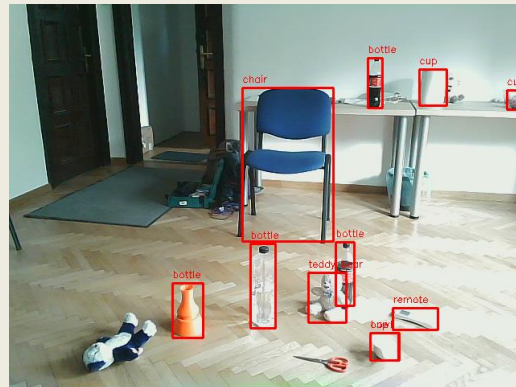
Sources:
4Q1 Research; Website (cloudnaiser.com)
© Statista 2016

Additional information:
Worldwide; 4Q1 Research; 2011 to 2015

ROBOTICS, projects and ethics



Robotics at CITST



ROBOTIS OpenMANIPULATOR PRO RM-P60-RNH



6DOF (Degrees of Freedom)
645mm Range
3Kg Payload & 0.05mm Repeatability
Powered by 6 x DYNAMIXEL Pro+ Servomotors

Tiago x 2 in INCARE



Robotic ethics - EU bodies

- ▶ **European Group on Ethics in Science and New Technologies (EGE):** The EGE is an independent advisory body of the President of the European Commission. It was founded in 1991. The EGE provides the Commission with high quality, independent advice on ethical aspects of science and new technologies in relation to EU legislation or policies.
- ▶ **EU-Robotics / European Robotics Forum :** euRobotics is a Brussels based international non-profit association for all stakeholders in European robotics. It was founded in September 2012 with the aim to strengthen Europe's competitiveness and to ensure industrial leadership of manufacturers, providers and end-users of robotics technology-based systems and services.
<https://www.eu-robotics.net/>

Other major initiatives

- ▶ One of the leading initiatives calling for a responsible development of AI has been launched by the Future of Life Institute and has culminated in the creation of the ‘Asilomar AI Principles’.
- ▶ This list of 23 fundamental principles to guide AI research and application has been signed by hundreds of stakeholders,⁸ with signatories representing predominantly scientists, AI researchers and industry.
- ▶ <https://futureoflife.org/ai-principles/>

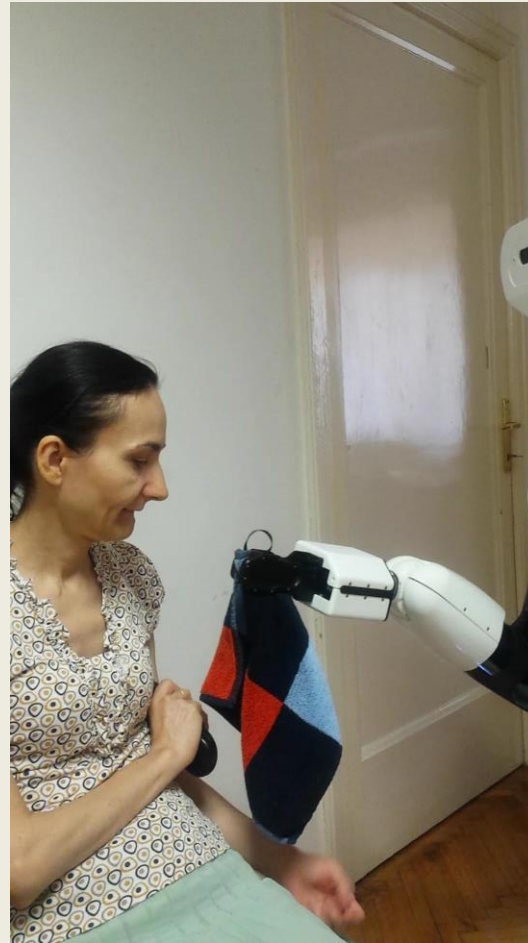
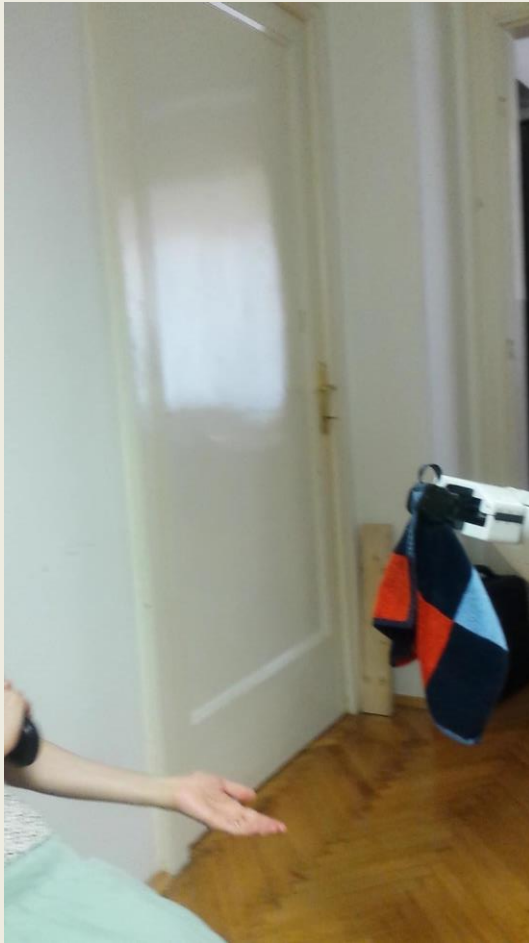
Asilomar AI Principles (selection of)

- ▶ 1) **Research Goal:** The goal of AI research should be to create not undirected intelligence, but beneficial intelligence.
- ▶ 6) **Safety:** AI systems should be safe and secure throughout their operational lifetime, and verifiably so where applicable and feasible.
- ▶ 7) **Failure Transparency:** If an AI system causes harm, it should be possible to ascertain why.
- ▶ 10) **Value Alignment:** Highly autonomous AI systems should be designed so that their goals and behaviors can be assured to align with human values throughout their operation.
- ▶ 13) **Liberty and Privacy:** The application of AI to personal data must not unreasonably curtail people's real or perceived liberty.

The list of signatories includes:

- ▶ **Stephen Hawking** Director of research at Dept. of Applied Mathematics and Theoretical Physics at Cambridge, 2012 Fundamental Physics Prize laureate for his work on quantum gravity
- ▶ **Elon Musk** Founder, CEO & CTO of SpaceX, Co-Founder & CEO of Tesla Motors, Co-Founder of OpenAI & Solar City

Robot should be safe and secure



Transportation Attendant

Process initiated by the user:

- ▶ Voice command
- ▶ Predefined command buttons

Continuous interaction with the user:

- ▶ Asking for the order
- ▶ All direct (physical) interactions require confirmation (vocal or by the button)

How much help is too much?

- ▶ Bringing liquids

Versus

- ▶ Bringing a book
- ▶ Detecting and picking up objects from the floor, highest rating in a survey conducted at TU Wien



THE END

Thank you for your attention !

Questions, please ...