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TRUSTID Multiplier Event in Germany

Project Information and Technology Day – TRUSTID Info and Tech Day

16th and 17th of May 2023

Marios Belk, Cognitive UX GmbH



University
of Cyprus



cognitiveux

Agenda

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Project Information and Technology Day – TRUSTID Info and Tech Day

Gathering and Welcome Speech by the Host – *Dr. Mario Belk*

Introduction and Overview of the TRUSTID Project – *Dr. Mario Belk*

Ensuring Academic Integrity and Trust in Online Learning Environments: Main Outcomes from a Longitudinal Study on the Analysis, Implementation and Evaluation of an AI-centered Proctoring System in Higher Education Institutions – *Dr. Mario Belk*

Coffee Break and Networking

Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces – *Mr. Michail-Panagiotis Bofos and Dr. Argyris Constantinides*

- TRUSTID Live System Demonstration
- Integrating and Using the TRUSTID Open-Source Technology
- Hands-on Interaction with the Open-source TRUSTID Technology

Coffee Break and Networking

Conclusions, Discussions and Networking

TRUSTID Overview

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- *TRUSTID: “Intelligent and Continuous Online Student Identity Management for Improving Security and Trust in European Higher Education Institutions”*
- Part of the actions of Erasmus+ 2020 and in particular the Call *“Strategic Partnerships in **Response to the COVID-19 Situation**: Partnerships for Digital Education Readiness in the field of Higher Education (KA226)”*
- *Duration*: June 2021 - May 2023 (**24 Months**)
- Currently pursuing **Month 24** of the project

Project Partners

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- Department of Electrical and Computer Engineering,
University of Patras, Patras, Greece (*Project Coordinator*)



- Department of Computer Science, University of Cyprus,
Nicosia, Cyprus (*Project Partner*)



- Institute of Systems and Robotics, University of Coimbra,
Coimbra, Portugal (*Project Partner*)



- Cognitive UX GmbH, Heidelberg, Germany (*Project Partner*)

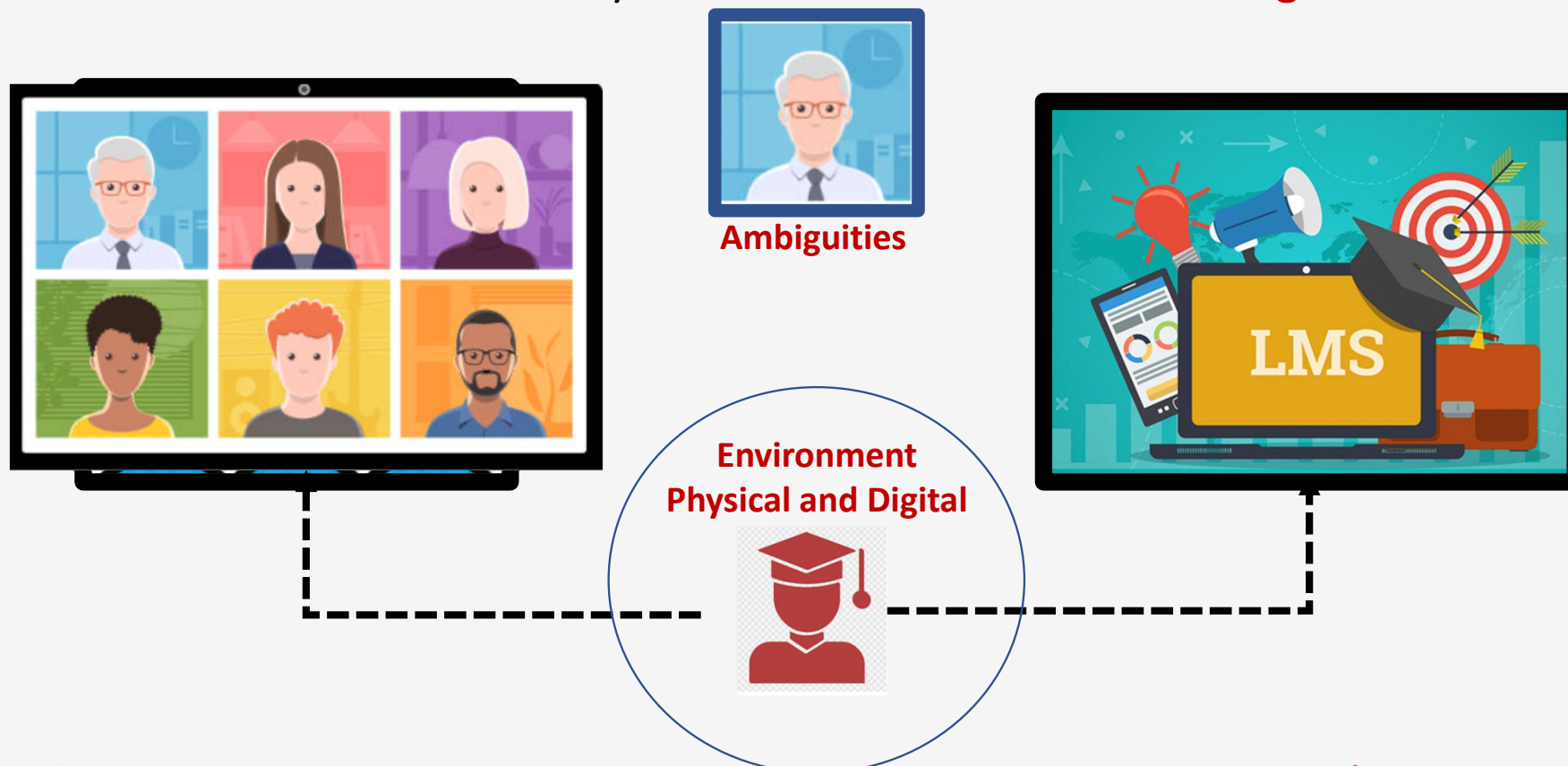


TrustID :: <https://trustid-project.eu>



Covid-19 outbreak: Problem and Challenges in HEI's

- **Before** the Covid-19 outbreak many HEI's followed a **blended learning** educational model



- Challenges

- **Continuously and seamlessly identify students while preserving their privacy and** without interrupting or interfering with the current learning activities of each HEI
- **Provide insights to instructors** in order to take informed decisions for their classes and attendees
- **Provide alternative integration capabilities and modes** of TRUSTID in order to better adapt to specific requirements of each HEI

TRUSTID Vision

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Design, develop and evaluate a **multi-tier continuous student identification framework**, bootstrapped to HEIs' needs, that will consist of state-of-the-art **intelligent image, voice and interaction data** processing **while preserving their privacy**

Core Objectives

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- **Literature review** on current practices and procedures related to student identity management of EU HEIs and **triangulate findings** with stakeholders' studies at the participating HEIs
- **Design and develop an integrated framework** for student identity management
- Validate the solution through a **User-Centered Design (UCD) methodology**; two formative studies are planned, during the software development process; and one summative study is planned, after the final release of the software
- Create a **repository** that will support **knowledge building**
- **Dissemination and exploitation** activities – *research papers, workshops, seminars, LTTAs, etc.*

Intellectual Outputs

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- **Intellectual Output 1: Analysis & validation** of the TRUSTID framework for HEIs' continuous student identity management (*Conceptual*)
- **Intellectual Output 2: Implementation** of an open-source software toolkit (*Operational*)
- **Intellectual Output 3: Evaluation** and validation reports in the context of three case-studies at different HEIs (*Lessons Learned and Guidelines*)
- **Intellectual Output 4: Knowledge building online community and repository** (*Sustainability*)

Key Achievements and Milestones reached

Intellectual Output 1 – Tasks and Achievements

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IO1 - Needs Analysis and Design of the Theoretical Framework for Continuous Student Identity Management

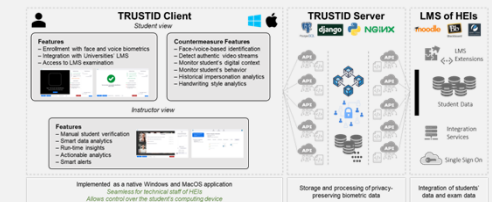
Output: Publications, Other, Dataset

- Task 1.1: Needs Analysis on Identity Management in HEIs
- Task 1.2: Needs Verification at HEIs
- Task 1.3: Specification of the Framework

Achievements and Outputs

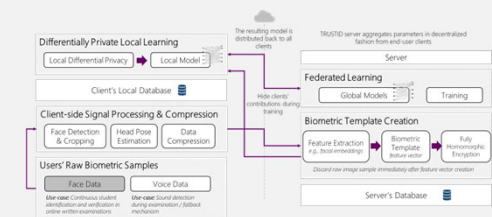
Specifications of the TRUSTID framework

- Refined the framework
- Specifications for the face, voice and interaction identification mechanism
- Specifications for LMS integrations of TRUSTID at UPAT, UCY, UC sites



Privacy-preserving architecture for continuous student identity management

- Designed the privacy-preserving architecture
- Defined the privacy-preserving smartphone wallet
- Defined the flow between client and server applications of TRUSTID towards achieving privacy-preservation of users' biometric data



Intellectual Output 2 - Tasks and Achievements

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IO2 - Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces

Output: Software, Services, Publications

- Task 2.1: Architecture Design
- Task 2.2: Privacy-preserving Biometrics
- Task 2.3: Development of Voice-, Image- and Interaction-based Algorithms
- Task 2.4: Integration and Verification Testing

Achievements and Outputs

Major **improvement** of the **face-based identification** mechanism enrollment and continuous identification

Development of the **voice-based and interaction-based identification** mechanisms

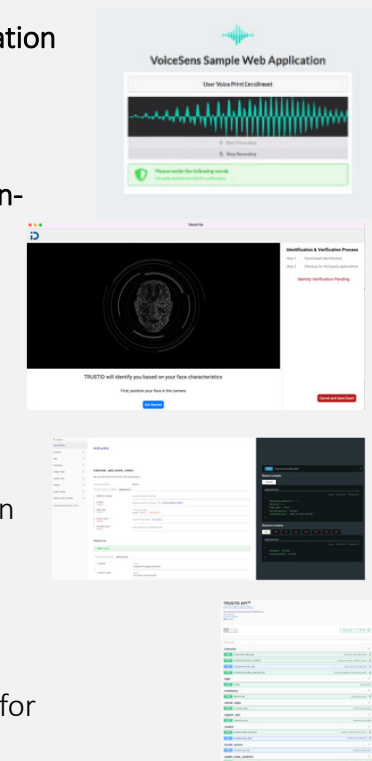
Implemented a new **architecture for privacy-preservation**

Prototype designs and implementations

Development and integration of new features in the **native Windows and MacOS applications**

Mechanisms for **LMS integration**

Application Programming Interface, end-points for service integration



Intellectual Output 3 - Tasks and Achievements

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IO3 - **Evaluation Reports** regarding Efficiency, Effectiveness and User Acceptance of TRUSTID in Three Case Studies at Higher Education Institutions across Europe

Output: Dataset, Publications

- Task 3.1: Design of Experimental Evaluation Methodology
- Task 3.2: Formative Evaluation Report
- Task 3.3: Summative Evaluation Report

Achievements and Outputs

Successfully completed the PoC2 study with 133 participants, which participated in the user evaluation study in which they interacted with various mechanisms of TRUSTID.

Planned and organized the **final summative evaluation study**

Running the final summative formative user study to test the final proof of concept and evaluate its usability and accuracy of implemented identification mechanisms (face, voice, interaction).

Intellectual Output 4 - Tasks and Achievements

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IO3 - **Knowledge Repository** containing Training Webinars, Guides of Best Practices, Integration Guidelines, Training Materials and Forum Discussions on how to Adopt and Deploy Continuous Student Identity Management Solutions in HEIs

Output: Internet, Broadcast, Event, Publications, Video

- Task 4.1: Training Webinars
- Task 4.2: Best Practice Guides
- Task 4.3: System Integration Guidelines (through an Application Programming Interface)

Achievements and Outputs

Deployment of Final Knowledge Repository

<https://trustid-project.eu/kr.php>

Deployment of Final TRUSTID Community Forum

<https://trustid-project.eu/community.php>

TRUSTID GitHub Open-source Code Repository

Available at: <https://github.com/cognitiveux/trustid>

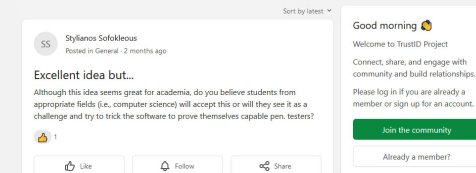
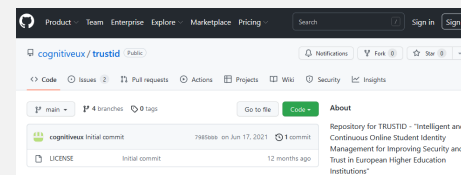
Knowledge Repository

Educational, Training and Course Material

- Ethical Guidelines and Data Privacy
- TRUSTID Solution Design
- User Needs & User Feedback
- Threat Models and Countermeasures
- Image-based Recognition
- INFOGRAPHIC - Covid19 Impact on Higher Education
- INFOGRAPHIC - Interviews with Stakeholders and Identified Threat Scenarios

Open-source TRUSTID System Code :: hosted on GitHub

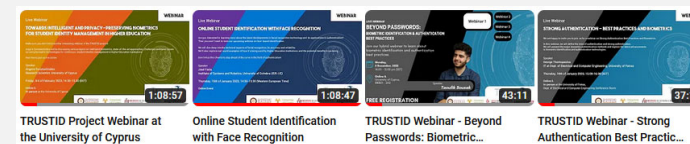
- Main GitHub branch
- TRUSTID Windows Application
- TRUSTID MacOS Application
- Face-based User Identification Algorithms



Webinar

TRUSTID Webinar Events

- UPAT Event
- CUX Event
- ISR-UC Event
- UCY Event



Ensuring Academic Integrity and Trust in Online Learning Environments

Main Outcomes from a Longitudinal Study on the Analysis, Implementation and Evaluation of an AI-centered Proctoring System in Higher Education Institutions

Needs Analysis

- Aims

- Verify the needs analysis with the active involvement of the participating HEIs
 - Identify the current authentication and identity management practices and their drawbacks within the online/distance learning domain
- **Conduct a series of semi-structured interviews** with stakeholders with the university partners
- *Sample:* 31 stakeholders participated from all partner HEIs

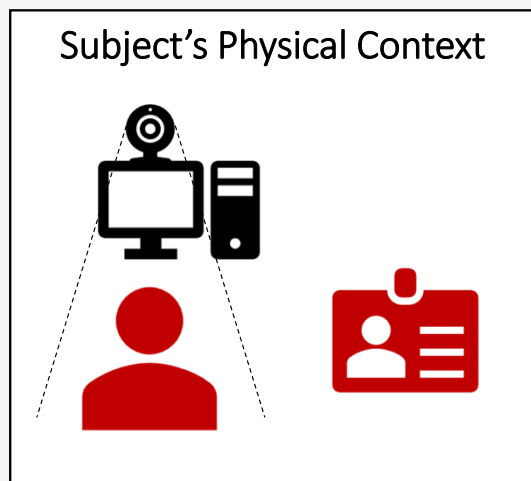
Three-phase methodology

- Phase A: Needs Analysis
- Phase B: Needs Verification Analysis
- Phase C: Countermeasures and Features

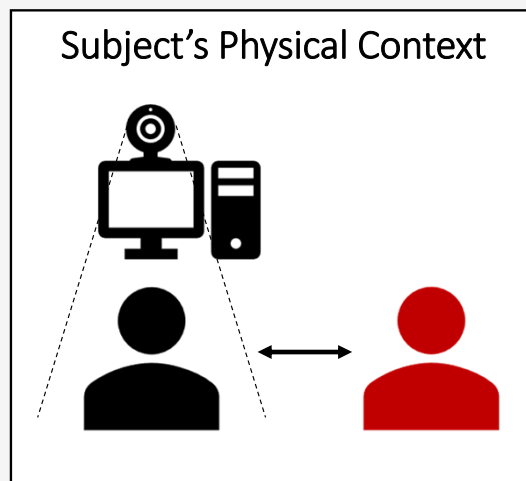
Stakeholder Group	Higher Education Institution 1	Higher Education Institution 2	Higher Education Institution 3
Students	2	3	3
Instructors	3	4	3
System Administrators	2	2	2
Decision Makers	2	1	1
Data Protection Experts	1	1	1
Total	10	11	10

Identification of Impersonation Threat Scenarios

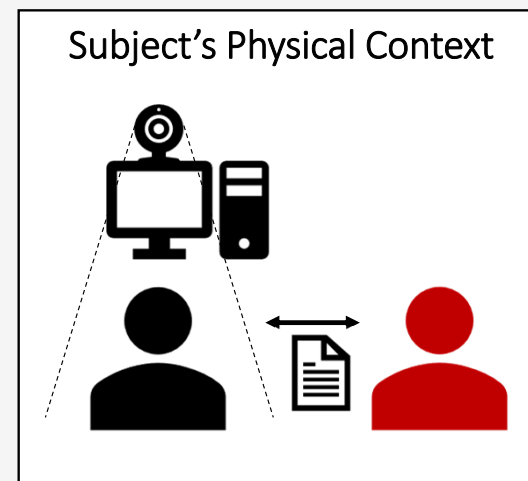
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Subject fakes his/her identity proofs during enrolment



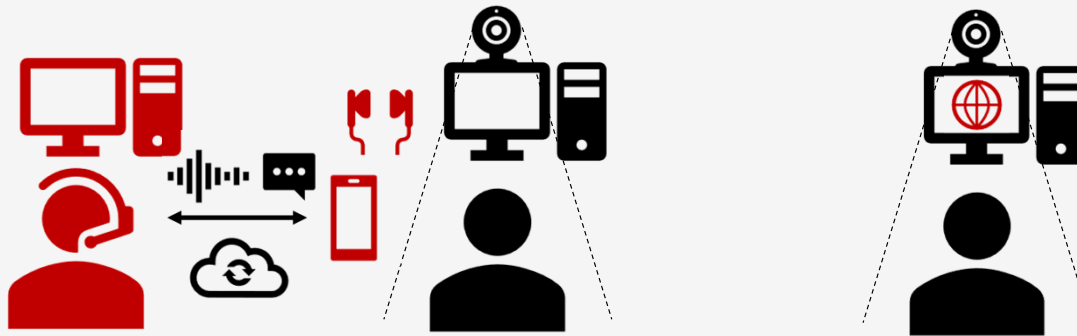
Subject switches seats with another person after enrolment



Exchange of hardcopy written messages

Identification of Communication, Collaboration and Resource Access Threat Scenarios

- Computer Mediated Scenarios



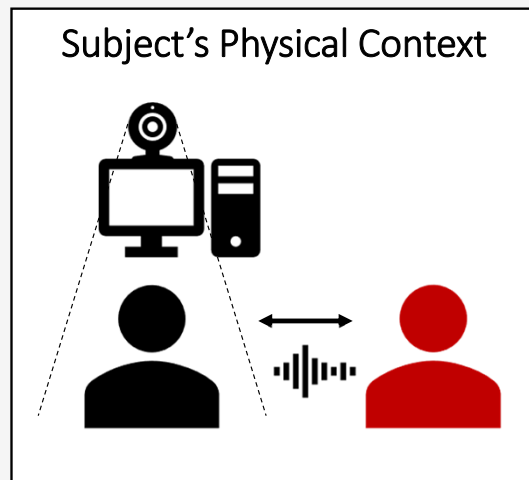
Remote communication/collaboration between a smartphone or another computer of the subject and another remote computer

B₁: Communication through voice or chat
B₂: Collaboration through mobile application (e.g., remote desktop connection)

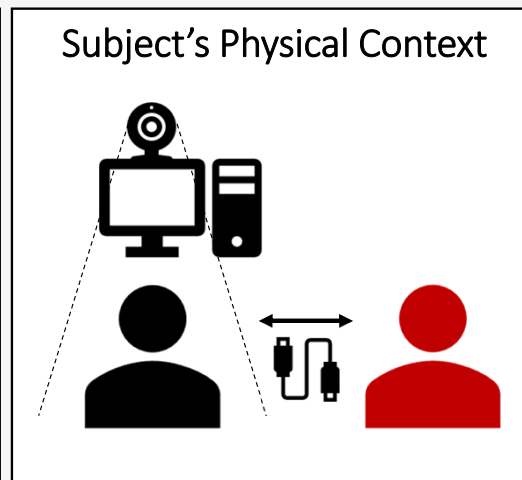
Subject seeks for help from online resources, search engines, which are not allowed based on the examination policy

Identification of Communication, Collaboration and Resource Access Threat Scenarios

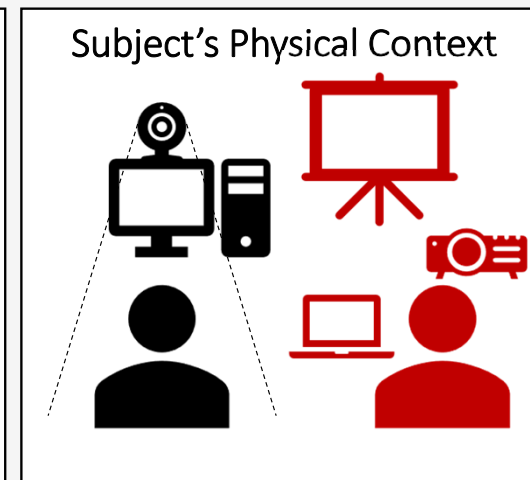
- In-situ Scenarios



Interaction with another person in the same room through voice



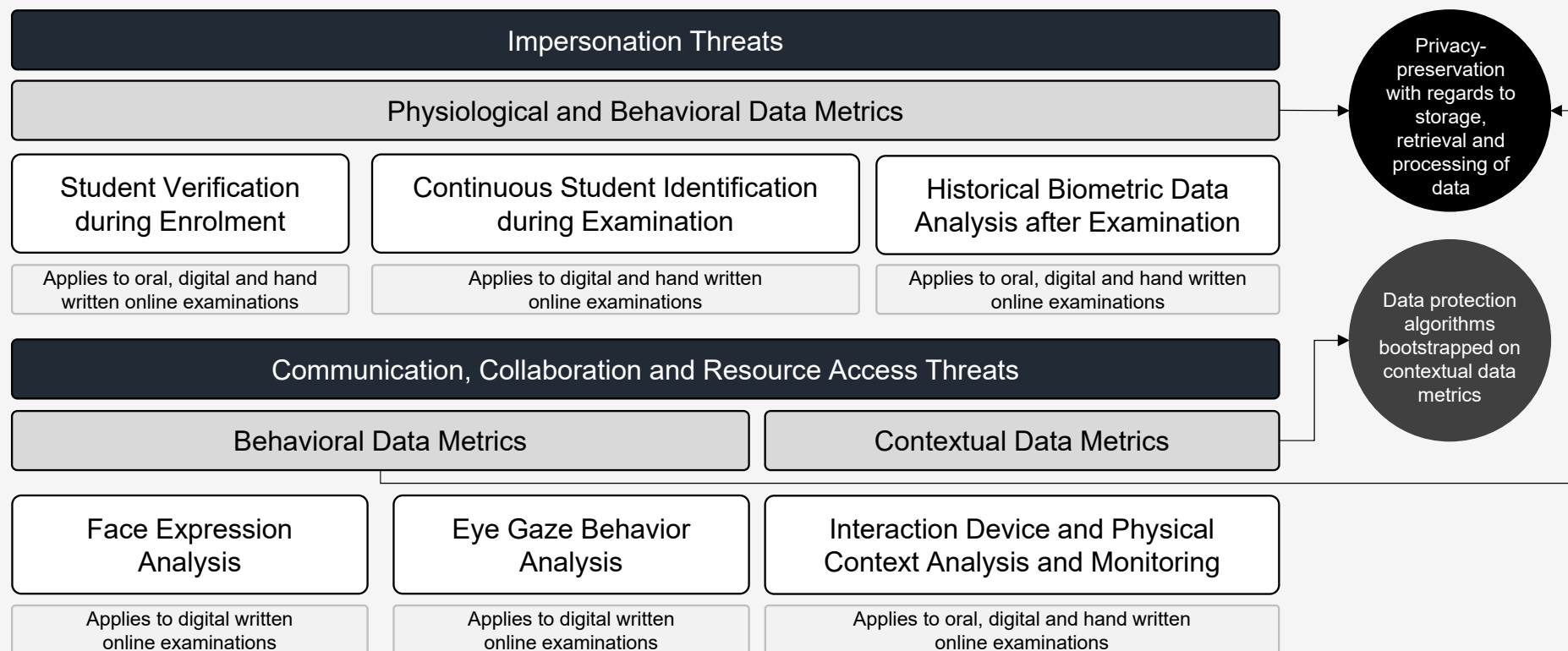
Another person that is in the same room as the subject is interacting with the examination using other devices of the subject's computer



Projection of answers on a whiteboard

Threat Model, Data Metrics and Countermeasures

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Threat model composed in terms of impersonation, communication, collaboration, resource access threats

Data metrics for analyzing and monitoring physiological, behavioral and contextual data

Suggested countermeasures and features for addressing the identified threats

Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces

Intellectual Output 2 (IO2)

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- Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces
- *Lead:* Cognitive UX GmbH
- *Participating Partners:*
 - University of Patras
 - University of Cyprus
 - University of Coimbra ISR
- *Output type:* Services / structures – E-learning platform
- *Media:* Software, Service, Publications

IO2 - Tasks and Task Leaders

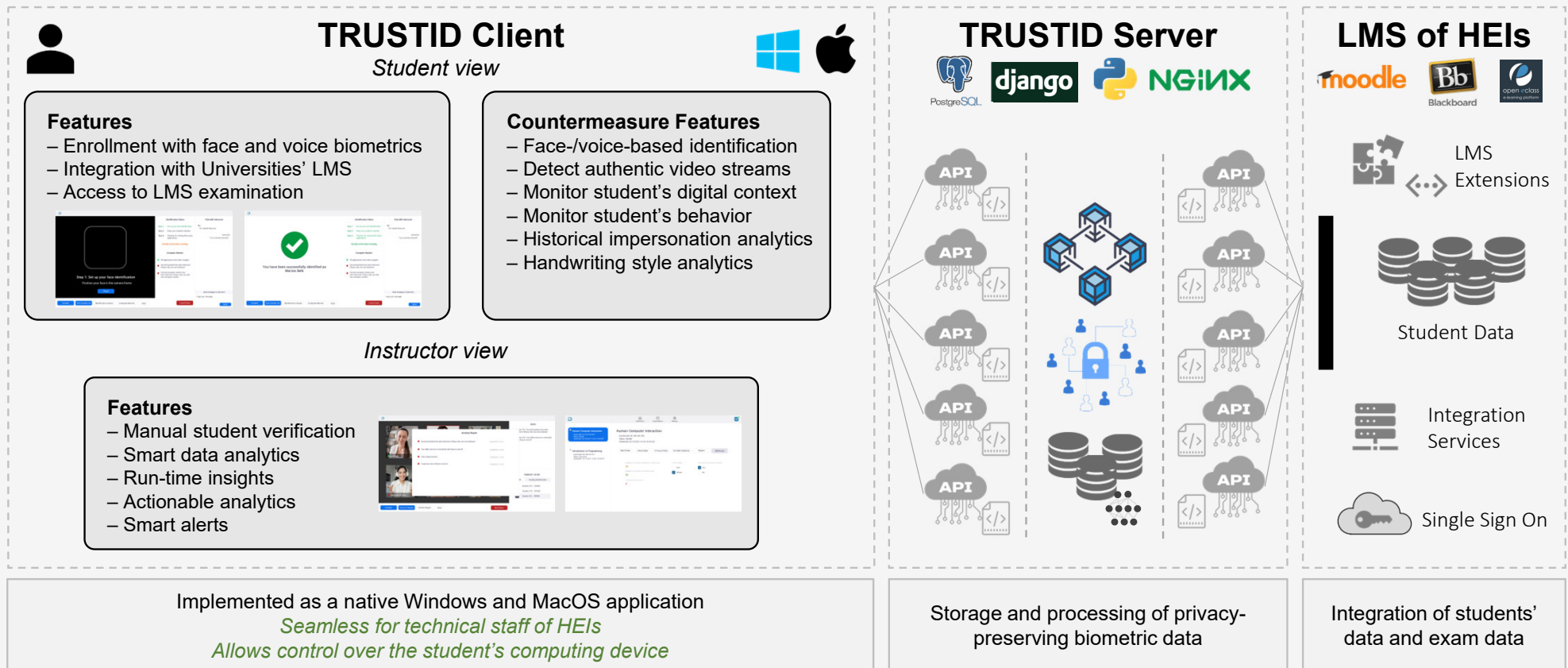
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- Task 2.1: Architecture Design
 - **Lead: Cognitive UX GmbH**
 - *Participating:* University of Patras, University of Cyprus, University of Coimbra
- Task 2.2: Privacy-preserving Biometrics
 - **Lead: University of Cyprus**
 - *Participating:* University of Patras, University of Coimbra, Cognitive UX GmbH
- Task 2.3: Development of Voice-, Image- and Interaction-based Algorithms
 - **Lead: Cognitive UX GmbH**
 - *Participating:* University of Patras, University of Cyprus, University of Coimbra
- Task 2.4: Integration and Verification Testing
 - **Lead: Cognitive UX GmbH**
 - *Participating:* University of Patras, University of Cyprus, University of Coimbra

TRUSTID High-level Framework

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Client Application

Windows and MacOS

Integrated Login

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TRUSTID :: Intelligent Student Identity Management

TRUSTID

Email

Password

Organization

- University of Cyprus 
- University of Patras 
- University of Coimbra 

Login

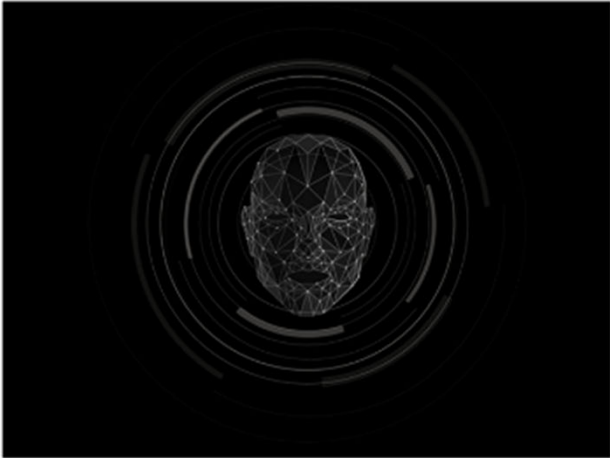
Register Face Biometrics

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Face Enrollment

Register Face Biometrics



TRUSTID needs your consent to collect your face data
Please select I consent to continue

I consent

Cancel Enrollment

Biometrics Process

- Step 1 - Consent
- Step 2 - Face Biometrics

Biometrics Ready


Register Voice Biometrics

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Voice Enrollment

Register Voice Biometrics



TRUSTID needs your consent to collect your voice data
Please select I consent to continue

I consent

Cancel Enrollment

Biometrics Process
Step 1 - Consent
Step 2 - Voice Biometrics

Biometrics Ready

Control and Manage Biometrics

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TRUSTID :: Intelligent Student Identity Management

Dashboard Examinations Biometric Models AC

Edit Biometrics

Actions

 Voice Created on: 06/12/2022 12:47:50	Update Delete
 Face Created on: 06/12/2022 12:48:50	Update Delete

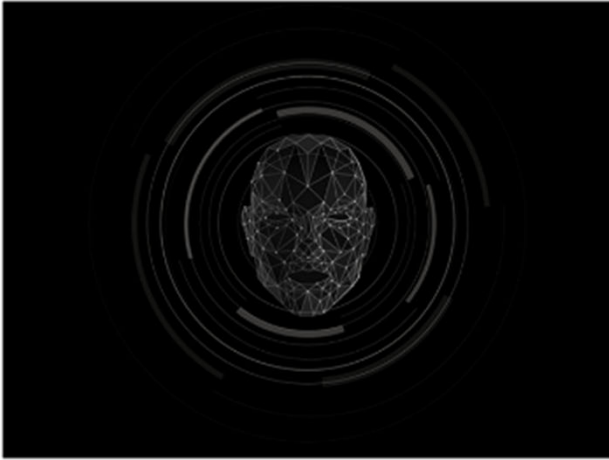
Continuous Face Identification

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Face Identification

Face-based Identification



TRUSTID will identify you based on your face characteristics
First, position your face in the camera frame

[Get Started](#)

Identification and Verification Process

- Step 1 - Face-based identification
- Step 2 - Voice-based identification
- Step 3 - Checkup for third-party applications

Identity Verification

[Cancel](#)


Continuous Voice Identification

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Voice Identification

Voice-based Identification



Identification and Verification Process

- Step 1 - Face-based identification
- Step 2 - Voice-based identification
- Step 3 - Checkup for third-party applications

Identity Verification

Your voice is now being recorded - Please speak loudly and clearly

Capture

Cancel

Digital Written Examination Scenario

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Written Examination

Multiple Choice Questions

What does the ERASMUS acronym stand for?

- European Committee Agency Scheme for the Mobility of University Students
- European Community Action Scheme for the Mobility of University Students
- European Continental Agility Scheme for the Mobility of University Students
- European Congress Ambassador Scheme for the Mobility of University Students

Monitoring

- Camera capture is enabled
- Voice capture is enabled
- Checkup running applications is enabled

TRUSTID will periodically capture your photo and voice for continuous identification purposes and will checkup the running applications and processes on your computer

User Feedback Mechanism

- I will impersonate with another person
- I will open a forbidden application

Send Feedback

Close Exam




Oral Examination Scenario

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Oral Examination

Oral Examination in Progress



Start Voice Capture

Stop Voice Capture

Monitoring

Camera capture is enabled

Checkup running applications is enabled

TRUSTID will periodically capture your photo and voice for continuous identification purposes and will checkup the running applications and processes on your computer

User Feedback Mechanism

I will impersonate with another person

I will open a forbidden application

Send Feedback

Close Exam

Examination Management Dashboard

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TRUSTID :: Intelligent Student Identity Management

Dashboard Examinations Management

Management

Add a new exam Add Exam

Edit existing exams Edit Exams

Enroll students to exam Enroll

Examination Management

Add Exam


Additional Material Yes No

Exam Duration:

Exam Type:

Name:

Privacy Policy

Scheduled date 

Edit Exam

Name	ID	Date	Enrolled Students
Introduction	61667302972	07/12/2022 00:00:00	59

LMS Integration and Synchronization Tools

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Upload and Enroll to Exam

Upload and Enroll Students:

Upload students:

C:\Users\laryr\Downloads\test_users (1).csv

First name	Last name	Email
Adamos	Adamou	aadamou@live.com

Exam id	Exam name
61667302972	Introduction to F

Select Exam:

61667302972

Select all students: Yes

All students selected

View Enroll Students

Students Enrolled in Exam: Introduction

First name	Last name	Email
Christou	Panikos	panikoschristou@yahc
Georgiou	Mariaeleni	mgeorg04@ucy.ac.cy
Panagi	Paraskevi	ppanag03@ucy.ac.cy
Tsakilioti	Evangelia	euatsakilioti@gmail.co
Tzamou	Maria	mtzamo01@ucy.ac.cy
Sofocleous	Elena	sofokleous.elena@ucy
Sofocleous	Elena	elenadepp1524@gma
Aristodemou	George	george.arist@gmail.co

TRUSTID Backend – Application Programming Interface

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TRUSTID API
[Base URL: localhost:11000/backend]
http://localhost:11000/backend/swagger/

The endpoints for interacting with the TRUSTID server
Terms of service
Contact the developer
BSD License

Scheme: Django Login Authorize

Filter by tag

- instructor**
 - POST /instructor/add_exam instructor_add_exam_create
 - POST /instructor/enroll_students instructor_enroll_students_create
 - GET /instructor/list_exam instructor_list_exam_list
 - POST /instructor/update_exam_details instructor_update_exam_details_create
- login**
 - POST /login login_create
- monitoring**
 - POST /monitoring monitoring_create
- refresh_token**
 - POST /refresh_token refresh_token_create
- register_user**
 - POST /register_user register_user_create
- student**
 - POST /student/identification student_identification_create
 - GET /student/list_exam student_list_exam_list
- trustid_version**
 - GET /trustid_version trustid_version_list
- update_exam_condition**
 - POST /update_exam_condition update_exam_condition_create

login login_create

POST /login

Creates a JSON Web Token if the provided credentials are correct

Parameters Cancel

Name	Description
data required (body)	Edit Value Model <pre>{ "email": "string", "password": "string"}</pre> Cancel

Parameter content type:

Execute

Responses Response content type: application/json

Code	Description
201	<p>JSON Web Token has been created successfully. The value is returned in <code>resource_obj</code>.</p> <p>Example Value Model</p> <pre>{ "message": "string", "resource_name": "string", "resource_obj": {}}</pre>

Web API – Documentation

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Search...

- Authentication
- instructor >
- login >
- monitoring >
- refresh_token >
- register_user >
- student >
- trustid_version >
- update_exam_condition >

Documentation Powered by ReDoc

instructor

instructor_add_exam_create

The view that allows instructors to add examinations

AUTHORIZATIONS: **Bearer**

REQUEST BODY SCHEMA: application/json

additional_material	boolean (Additional material)
duration <i>required</i>	integer (Duration in minutes) [0..9223372036854776000]
exam_type <i>required</i>	string (Exam type) Enum: "Oral" "Written"
privacy_policy <i>required</i>	string (Privacy policy) non-empty
scheduled_date <i>required</i>	string <date-time> (Scheduled date)

Responses

^ 200 Success

RESPONSE SCHEMA: application/json

message	string A general message description
resource_name	string The name of the resource

POST /instructor/add_exam

Request samples

Payload

application/json

```
{
  "additional_material": true,
  "duration": 0,
  "exam_type": "Oral",
  "privacy_policy": "string",
  "scheduled_date": "2021-12-13T13:28:55Z"
}
```

Response samples

200 400 401 403 404 405 415 500

application/json

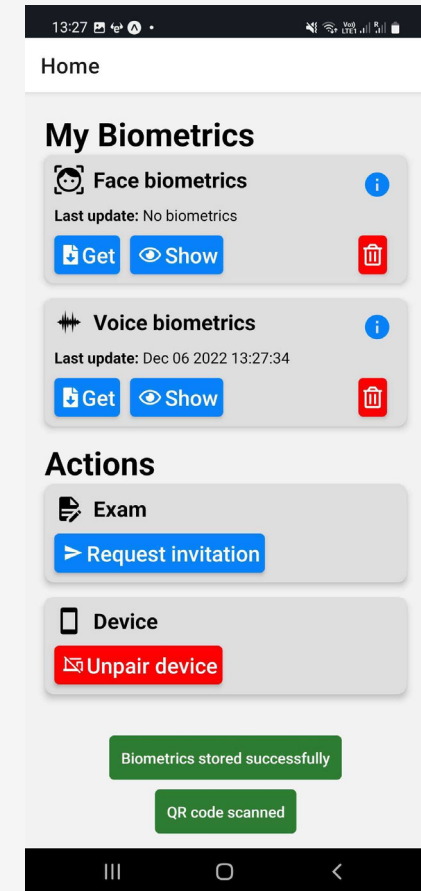
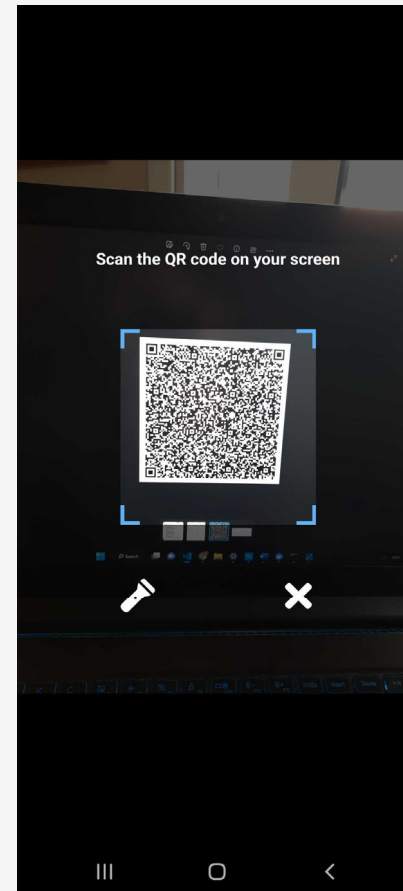
```
{
  "message": "string",
  "resource_name": "string"
}
```

Wallet for biometrics models

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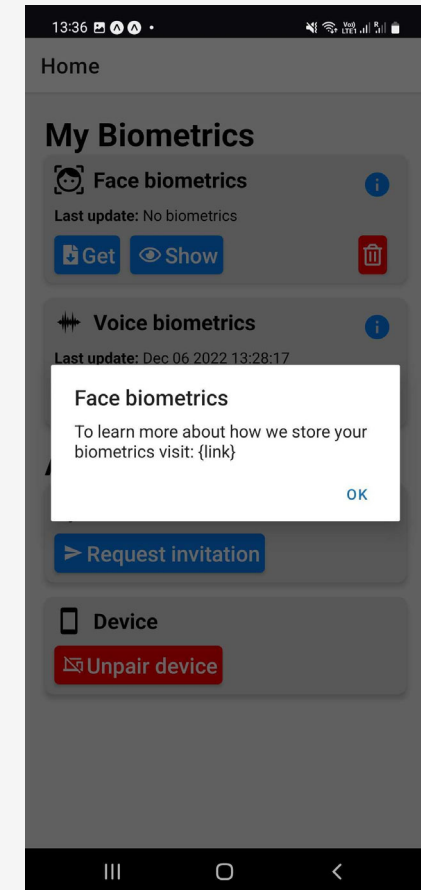
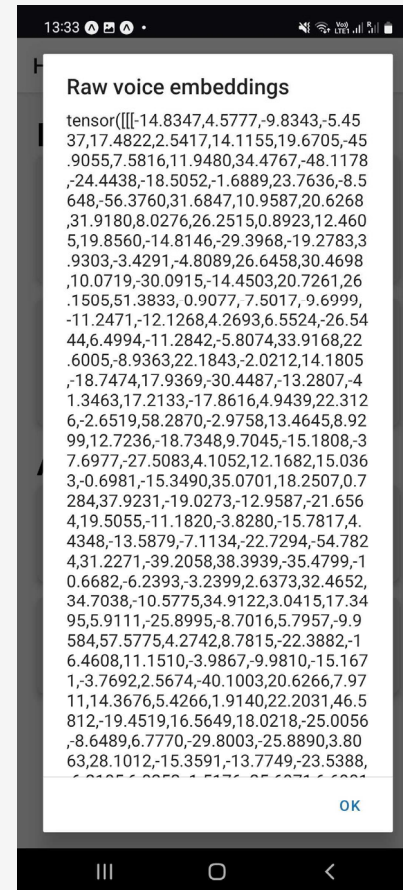


- Pair mobile application with TRUSTID system to fetch and store the biometric models locally



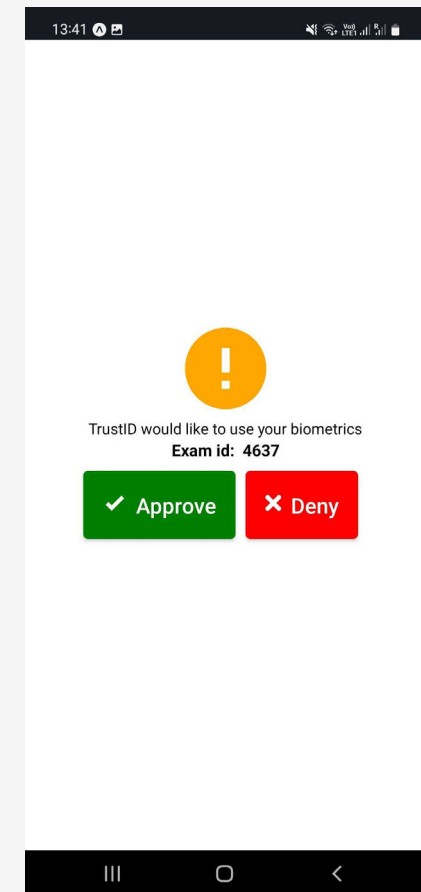
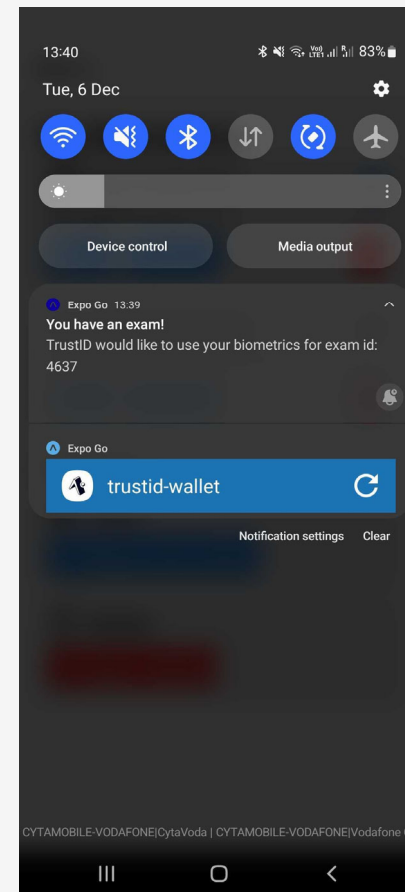
Wallet for biometrics models

- Management of biometrics models
 - Display
 - Delete
 - Privacy policy



Wallet for biometrics models

- Push notification for approval of sharing of biometrics models during online examination



User Study Scenarios for Proof of Concept 2

Aims of the Evaluation

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We conducted a user study aiming to evaluate:

- i) the resilience of TRUSTID to impersonation attacks during an online examination by evaluating the implemented face- and voice-based identification mechanism;
- ii) usability and user experience of end-users based on their interactions with the TRUSTID system; and
- iii) perceived security and privacy of users towards the TRUSTID system

Study Design 1/2

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Type of study

- Studies are held virtually
 - Researchers from each partner HEI communicate with the participants through an off-the-shelf communication tool, Zoom

Sample size, user profiles and duration

- Recruit 133 students and/or instructors
- *Duration*: ~20-30 minutes

Preparation phase

- Invite participants through the following URL:
 - https://trustid-project.eu/participate_upat.php
 - https://trustid-project.eu/participate_uc.php
 - http://trustid-project.eu/participate_ucy.php
- Ask participants to subscribe to the PoC2 user evaluation study
 - Read information about the method of study, planned dates, etc.
 - Provide email so that we can communicate during the PoC2 study period

Evaluation Phase

- **Step 1:** Participants download and install the implemented applications (Windows or MacOS)
- **Step 2:** Instructors enroll participants in the user study and they receive their login credentials in their email
- **Step 3:** Evaluate specific threat scenarios and functionalities
 - *Type of examination:* Digital oral, Digital written
 - *Impersonation threats*
 - Perform the student verification step based on *face-based* and *voice-based* identification
 - Continuous student identification based on *face* and *voice* data
 - *Collaboration/communication threats*
 - Monitoring the students' computing device's running applications and processes
 - *Other functionalities:*
 - Management of biometric models (Enroll/Update/Delete)
 - Integration of the new version of face-based identification which uses GRPC
 - Management of Examinations and LMS integration
 - Moodle integration - fetch students' information and automatically enroll to TRUSTID
 - Instructors upload .csv with students' information exported from other LMS
 - Add/Update examination to the TRUSTID system
- **Step 4:** Conduct semi-structured interviews and focus groups to receive feedback from the participants about their experience with the TRUSTID solution

Resilience to Impersonation Attacks

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Summary of the sample and the collected data

Mock Examination Type	# of Participants	# of Face Images	Audio Samples Length (in minutes)
<i>Online Written</i>	65	1804	75.68
<i>Online Oral</i>	68	1530	123.47
Totals	133	3334	199.15

Summary of the sample and the collected data for impersonation attacks

Mock Examination Type	# of Participants	# of Face Images	Audio Samples Length (in minutes)
<i>Online Written</i>	24	391	31.04
<i>Online Oral</i>	32	582	52.73
Totals	56	973	83.77

Summary of the results for each identification case

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Identification Case	Face Recognition (Success Rate)	Voice Recognition (Success Rate)
<i>Student identification in order to join examination</i>	100%	100%
<i>Continuous student identification prior to performing an impersonation attack</i>	94.80%	91.36%
<i>Continuous student identification while performing an impersonation attack</i>	76.57%	78.53%

Questionnaire Results

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Question	Disagree	Moderate	Agree
Overall, how simple and clean is the TRUSTID software's user interface?	3	10	89
Overall, how intuitive to navigate is the TRUSTID software's user interface?	2	11	89
Overall, what's your opinion on the way features and information in the TRUSTID software are laid out?	5	10	87
Overall, how secure do you find the face identification process?	9	22	71
Overall, how secure do you find the voice identification process?	12	23	67
Overall, do you like the idea to be identified with face-based biometric identification during an online examination?	21	20	61
Overall, do you like the idea to be identified with voice-based biometric identification during an online examination?	26	24	52

Key Findings

What worked well in PoC2:

- The System Usability Score was calculated to be 78, which is a high score (Any score above 68 would be considered above average[1]).
- Face enrollment.
- Face identification in both the registration and continuous monitoring phases.
- Continuous monitoring of running processes and detection of forbidden communication/collaboration tools.

Improvements for PoC3:

- Voice enrollment and voice identification issues in some cases. Relevant quotes:

“The voice registration wasn't successful the first few times” ~ P6

“The voice registration did not work, I had to change my default microphone input in windows for it to work” ~ P7

“Voice recognition didn't work at first, but worked once I put headphones on, even though the microphone used was always the same, an independent one from the headphones” ~ P14

[1] <https://www.usability.gov/>

Thank you

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