

# Blockchain in IoT for the “Active & Healthy Ageing

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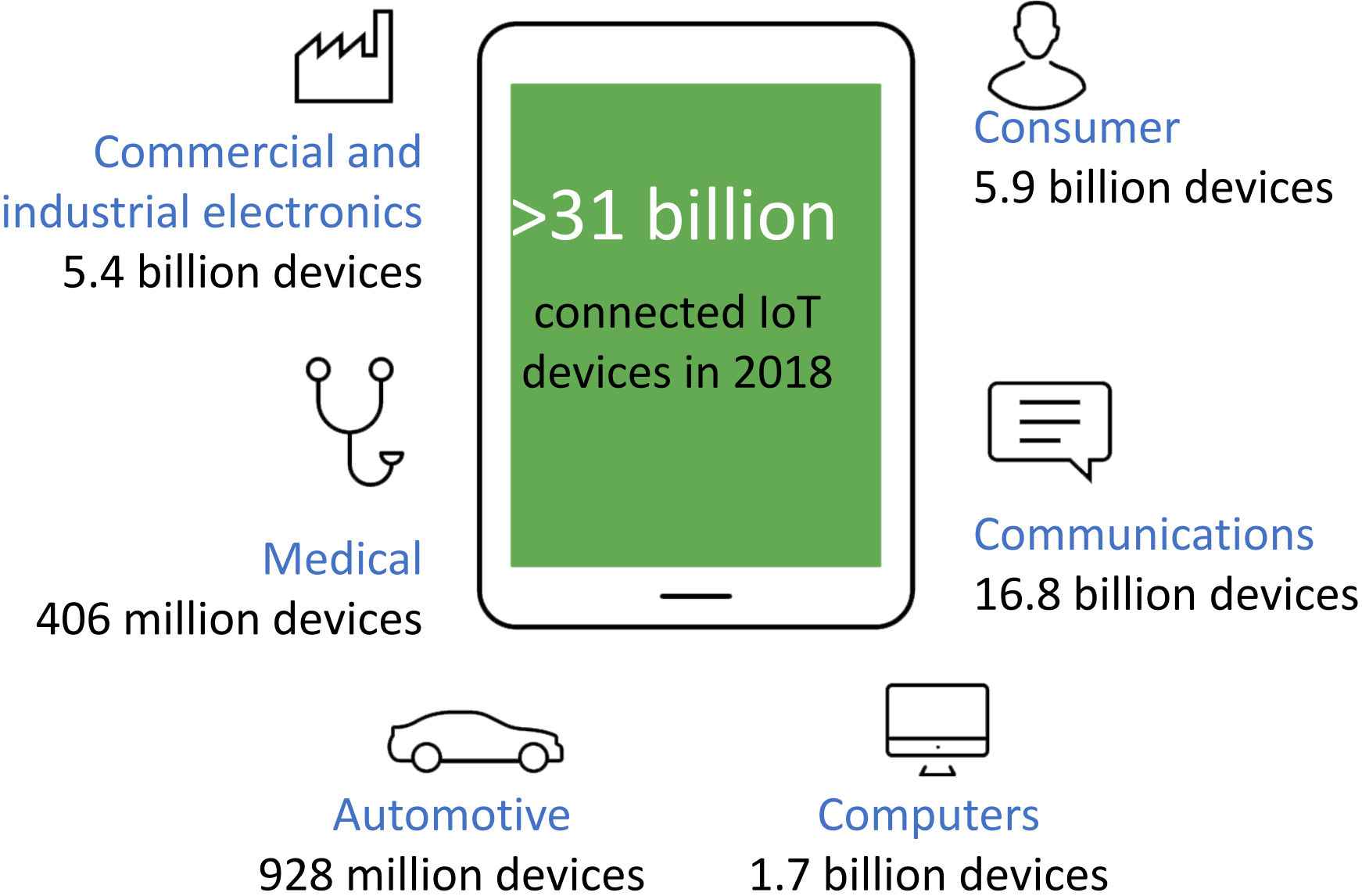
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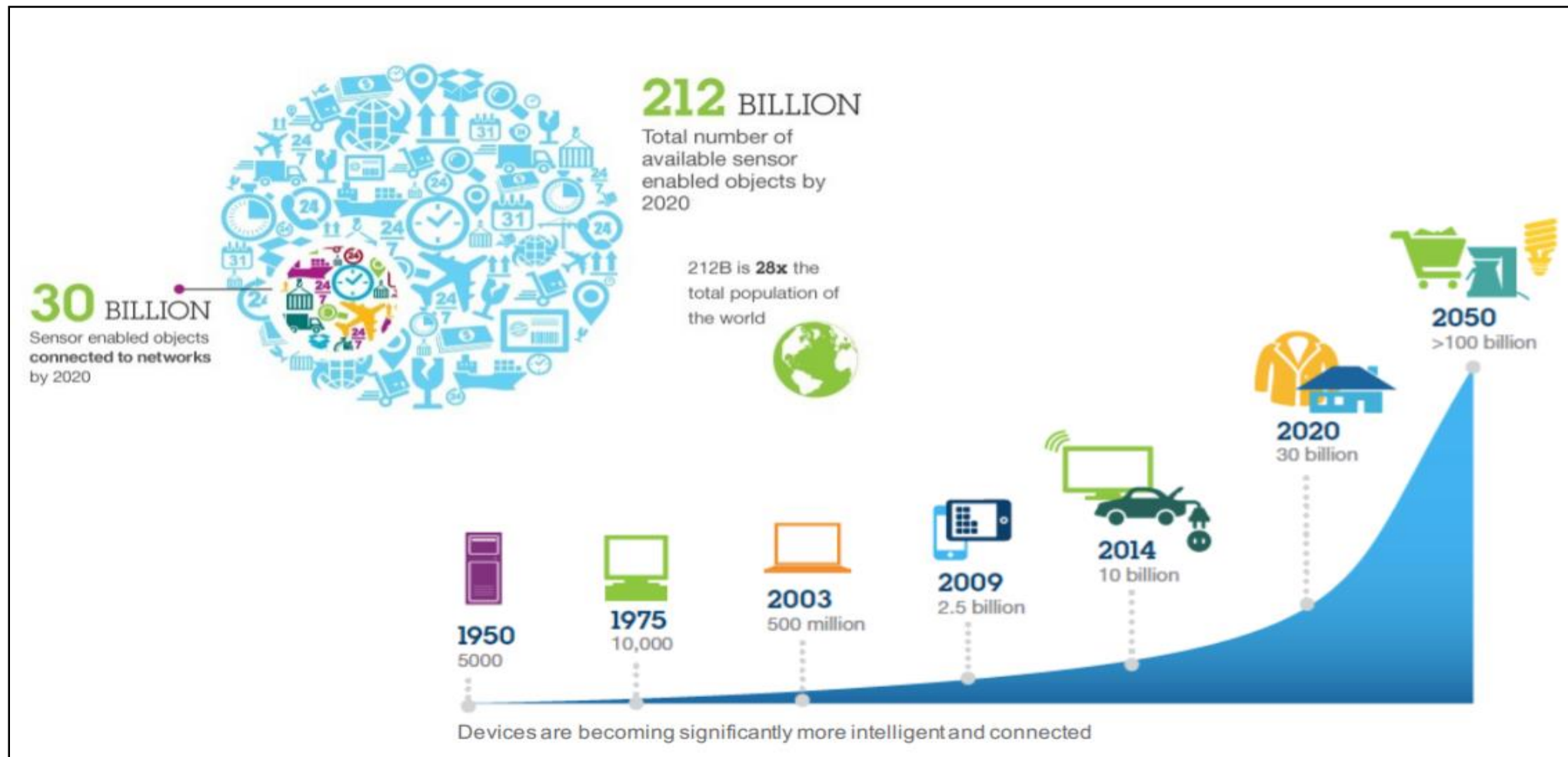
# Overview

- ▶ Internet of Things (IoT)
- ▶ Blockchain in the IoT
- ▶ ACTIVAGE Monitoring Platform
- ▶ BaaS (Blockchain-as-a-Service) System
  - ▶ Blockchain and Permission Management
  - ▶ Architecture and Components
  - ▶ Blockchain enabled functionalities in ACTIVAGE Monitoring Platform
- ▶ Scenarios
  - ▶ Register in BaaS / Give Consent
  - ▶ Register in ACTIVAGE from BaaS
  - ▶ Register in ACTIVAGE with BaaS
  - ▶ Login / Logout
  - ▶ Request / Give / Update Permissions

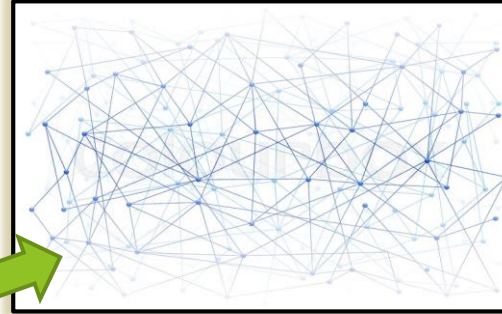
# Connected IoT Devices



# IoT Massive Explosion



# Blockchain in the IoT



## ► What is Blockchain ?

- A continuously growing **list of records** called blocks.
- Each **block** represents a set of transactions and is cryptographically linked to its previous block thus forming a chain.
- A Blockchain is managed by a **peer-to-peer** network of nodes that validate new blocks using a consensus algorithm.

## ► How can Blockchain be used in IoT

- Use of Blockchain technology to **record transactions** based on **autonomous** decisions made by IoT nodes
- Verifiable, secure and permanent method of recording data processed by “smart” machines in the IoT.

# ACTIVAGE Monitoring Platform

ACTIVAGE  
PROJECT

- ▶ ACTIVAGE is ...
  - ▶ a European Multi Centric Large Scale Pilot on Smart Living Environments.
  - ▶ about setting the grounds for **Active and Health Aging (AHA)** Digital Transformation that will change the life of 100 million people across Europe.
- ▶ ACTIVAGE ...
  - ▶ reuses and scales up underlying open and proprietary IoT platforms, technologies and standards
  - ▶ integrates new interfaces needed to provide interoperability across these heterogeneous platforms that will enable the deployment and operation at large scale of Active & Healthy Ageing IoT based solutions and services
- ▶ ACTIVAGE vision ...
  - ▶ support and extend the independent living of older adults in their living environments
  - ▶ respond to real needs of caregivers, service providers and public authorities.



PERSONAL CENTERED  
AHA-IoT ECOSYSTEM

# BaaS system

## Data permission management using Blockchain

- ▶ **Example Platform: ACTIVAGE** Monitoring Platform
- ▶ A list of ACTIVAGE monitoring Platform functionalities can be done via the Blockchain layer
  - ▶ This increases **trust** of the Users to the ACTIVAGE monitoring Platform
- ▶ BaaS enables ACTIVAGE monitoring Platform users to get **registered/login/logout** to the Platform via our **BaaS** system. Each user action to the Platform is logged in the Blockchain as an **immutable transaction**.
- ▶ Each **permission request** to access the Elderly people Data by Caregivers is logged in the Blockchain as an **immutable transaction**. This ensures **traceability** and **accountability**
- ▶ Our proposed solution is partially based on the design of **MedRec** Project

ACTIVAGE  
PROJECT

 MedRec

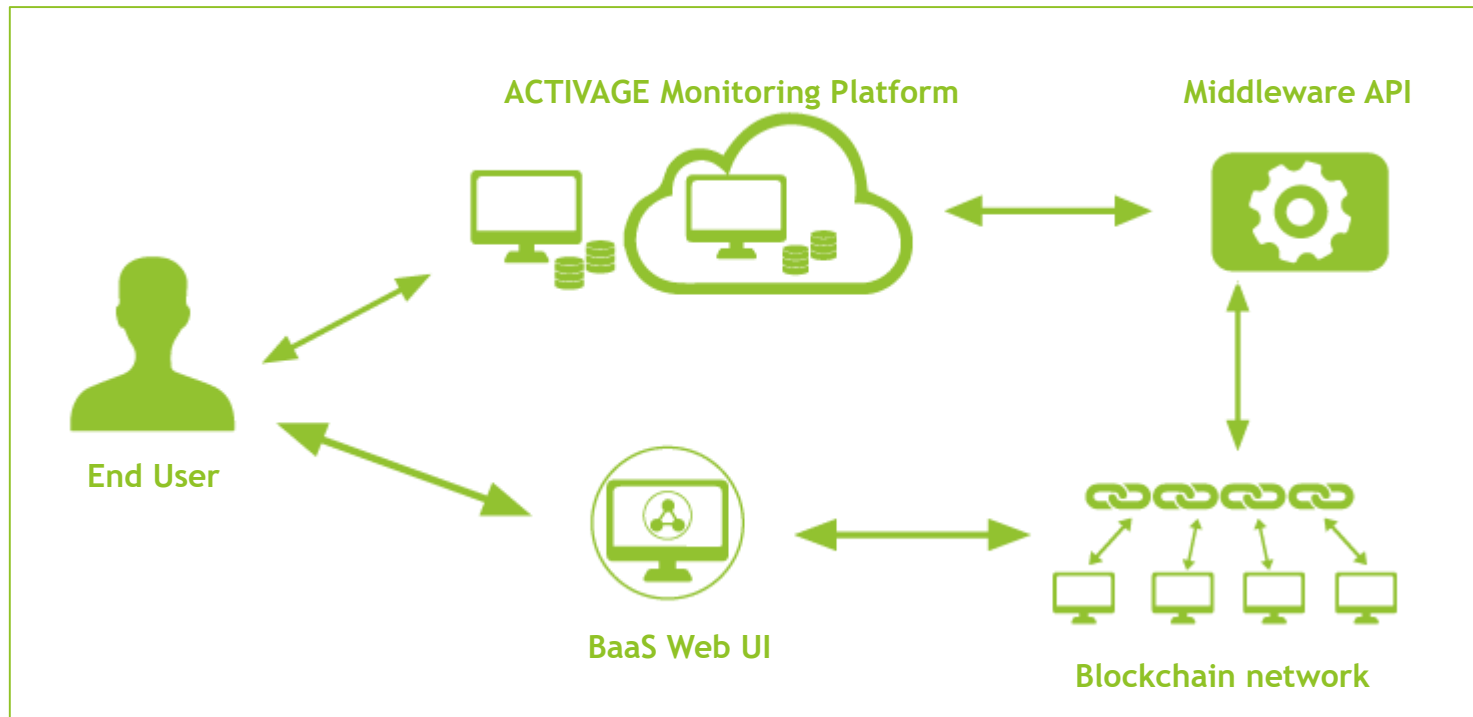
# Blockchain enabled functionalities in ACTIVAGE Monitoring Platform

- ▶ User Registration
- ▶ User Login/Logout
- ▶ Request Permissions
  - ▶ A caregiver *requests* permissions for accessing activity / health related data of an elderly
- ▶ Give Permissions
  - ▶ A elderly *gives* permission to a caregiver for accessing her/his data
- ▶ Update Permissions
  - ▶ An elderly *changes* the permissions given to a caregiver for accessing her/his data



# BaaS system

## Architecture & Components



# BaaS Registration / Consent scenario

1. User accesses the Registration form in the BaaS by clicking on the relevant link
2. Fills in the Registration form with their data and accept Terms by clicking a dedicated checkbox.
3. Upon clicking on the Button 'Register' an email verification is sent to their email address. This is done to verify that user inserted email address is valid.
4. User access their inbox and upon following the relevant link they are redirected to the BaaS and their email is verified
5. After email verification the User can Login the BaaS.

Blockchain as a Service

### Sign-up

Email \*  
user@test.gr

Password \*  
..... 5 / 16

Repeat Password \*  
.....

☒ I accept the [TERMS OF SERVICE](#)

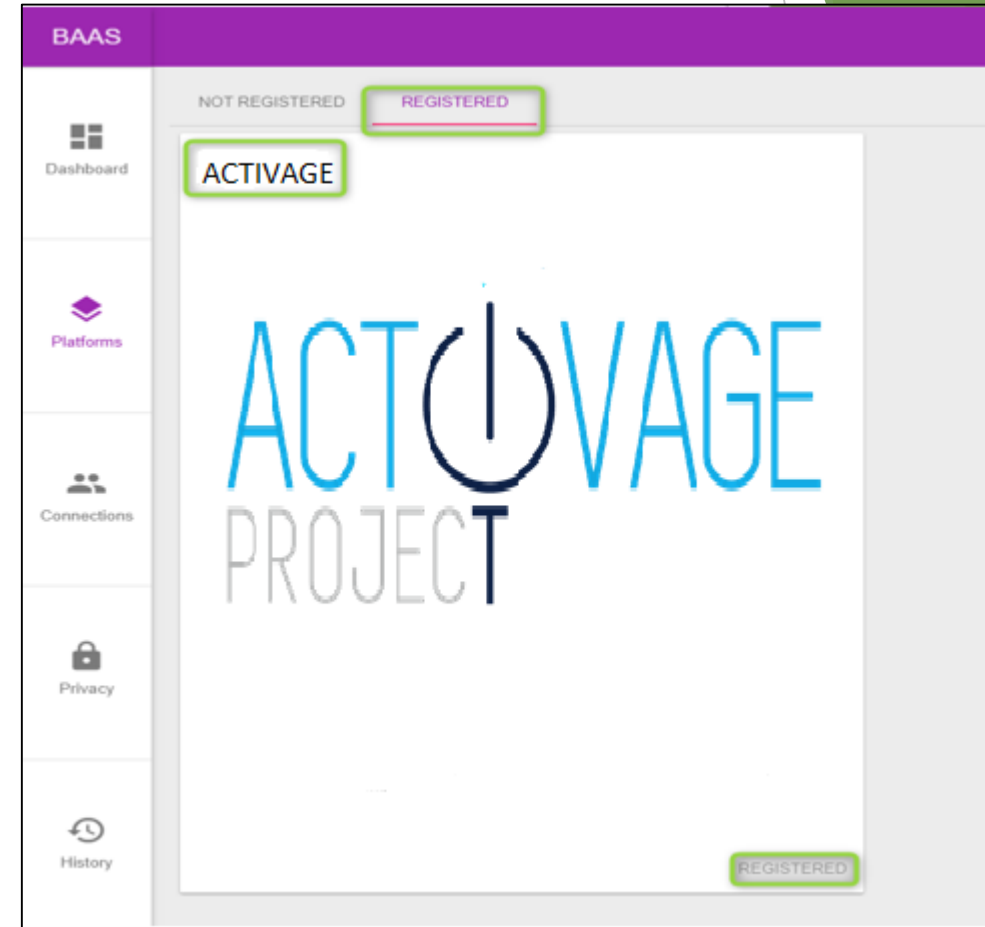
[SIGN UP](#)

[I already have an account](#)

# User Registration to ACTIVAGE

## Entry point: BaaS

1. User Logs in to BaaS with their account
2. User goes to Platforms > Not Registered Platforms, chooses ACTIVAGE from the list and clicks on the 'Register' button
3. User is redirected to ACTIVAGE and fills in the Registration Form
4. An email is sent to the User from ACTIVAGE to verify their email address
5. After email verification, the User can login to ACTIVAGE
6. The next time the User logs in the BaaS, ACTIVAGE is among their 'Registered Platforms'



# User Registration scenario

## Entry point: ACTIVAGE

1. User fills in the Registration Form in ACTIVAGE Platform (option: Register via BaaS)
2. ACTIVAGE Platform sends the Patient's valid credentials to the middleware API over a Restful Web Service
3. The middleware API sends the registration request to the user via email and redirects them to the Blockchain Web Interface Registration Form
4. The user is registered via the BaaS Registration Form and the Blockchain Web Interface logs in the Blockchain the newly Registered User

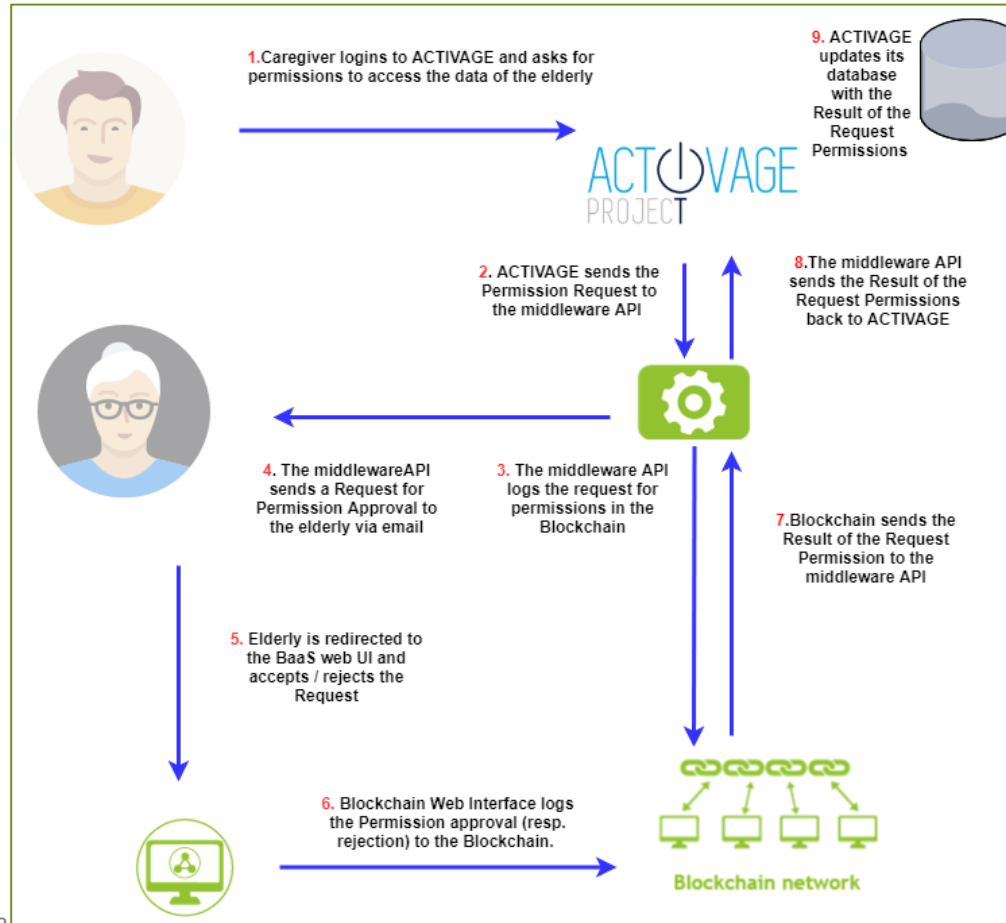
# Login / Logout scenario

Entry point: ACTIVAGE

1. The user logs in /logs out to/from ACTIVAGE with ACTIVAGE Platform credentials
2. ACTIVAGE sends a request for user login/logout to the middleware API over a Restful Web Service
3. The middleware API updates the list with online Users that are kept within the Blockchain by adding/removing the User to/from the list.

# Request Permissions scenario

## Entry Point: ACTIVAGE



# BaaS User/View Granted Permissions to another User

- In ACTIVAGE, an **elderly** can view permissions given to **caregivers**

The screenshot shows the BAAS (Backend as a Service) interface. On the left is a sidebar with navigation links: Dashboard, Platforms, Connections, Privacy, and History. The main area displays two user cards for 'myAirCoach' with email addresses 'johndoe@iti.gr' and 'kou@iti.gr', each with a 'VIEW CONTRACT' button. A 'Contract' modal is open, showing the contract address '0xc7dad4b265884f835b0edfa1759e5456671d7902' and a table of permissions.

**Contract**

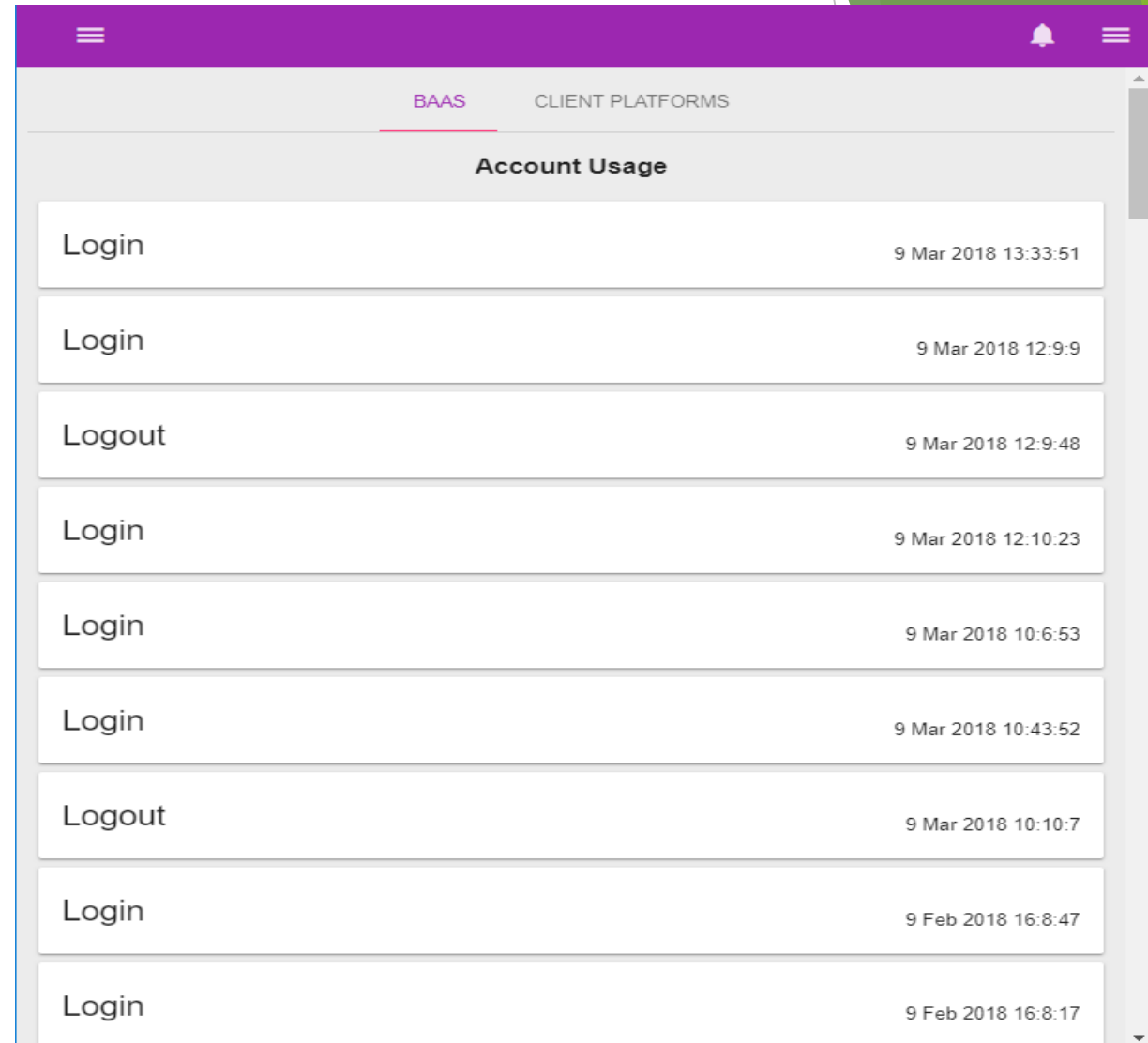
Address: 0xc7dad4b265884f835b0edfa1759e5456671d7902

Permissions:

Fields	[Write]	[Read]	[Update]	[Delete]
Asthma Control Questionnaire (ACQ)	✓	✓	✓	✓
Socioeconomics	✗	✓	✓	✓
Asthma Quality of Life Questionnaire (AQLQ)	✓	✓	✓	✓
Diet	✗	✓	✓	✓
Spirometry	✗	✓	✓	✓
Pulse	✓	✓	✓	✓
Inhaler Use	✗	✓	✓	✓
ACD Score	✓	✓	✓	✓
Temperature	✓	✓	✓	✓
Lung Model	✓	✓	✓	✓

# User / View Transaction History

- ▶ User can overview their **Historical Transactions**, e.g.
  - ▶ Register / Login / Logout to BaaS
  - ▶ Register / Login / Logout to ACTIVAGE
  - ▶ Register / Login / Logout to other Platforms



The screenshot displays a web interface with a purple header bar containing a menu icon, a notification bell, and another menu icon. Below the header, there are two tabs: 'BAAS' (selected) and 'CLIENT PLATFORMS'. The main content area is titled 'Account Usage' and contains a table of transaction history.

Account Usage	
Login	9 Mar 2018 13:33:51
Login	9 Mar 2018 12:9:9
Logout	9 Mar 2018 12:9:48
Login	9 Mar 2018 12:10:23
Login	9 Mar 2018 10:6:53
Login	9 Mar 2018 10:43:52
Logout	9 Mar 2018 10:10:7
Login	9 Feb 2018 16:8:47
Login	9 Feb 2018 16:8:17



# Thank you for your attention!

## Questions?



ACT VAGE  
PROJECT

G H O S T

# BACKUP SLIDES

# CERTH BaaS Application Front-end ADMIN View DASHBOARD

BAAS

Dashboard

Blocks

Transactions

Accounts

Contracts

Code Editor

9426  
Last Block

547  
Transactions Count

19  
Users

4  
Contracts

RecentTransactions

Hash

Value

Block #

Timestamp

0x9aff91d4efa74df688a4754c5c44c0d8f260a086fbc4a043679d1c5b5a89a192

0

9426

Nov 23, 2017 1:48:26 PM

0xca07e4969624659344b13ae0f24b9d1e5dcea549d5499066f453d32e586f436b

0

9425

Nov 23, 2017 1:48:04 PM

0xb7afb7e4ec3ca655eb655f3a9fee66eb1cf8fadb050a8b4e8d12ee86fd6f77a1

0

9424

Nov 23, 2017 1:45:45 PM

0x004d0402590eb0a406be4e64b89ee13c527344ebdcceb0e858d97e1f3820a412

0

9422

Nov 23, 2017 1:43:06 PM

0x503919d384ff8ab5c6065063c039ba5560b8413c4c34abb020044294c32b382e

0

9421

Nov 23, 2017 1:42:25 PM

BLOCKS

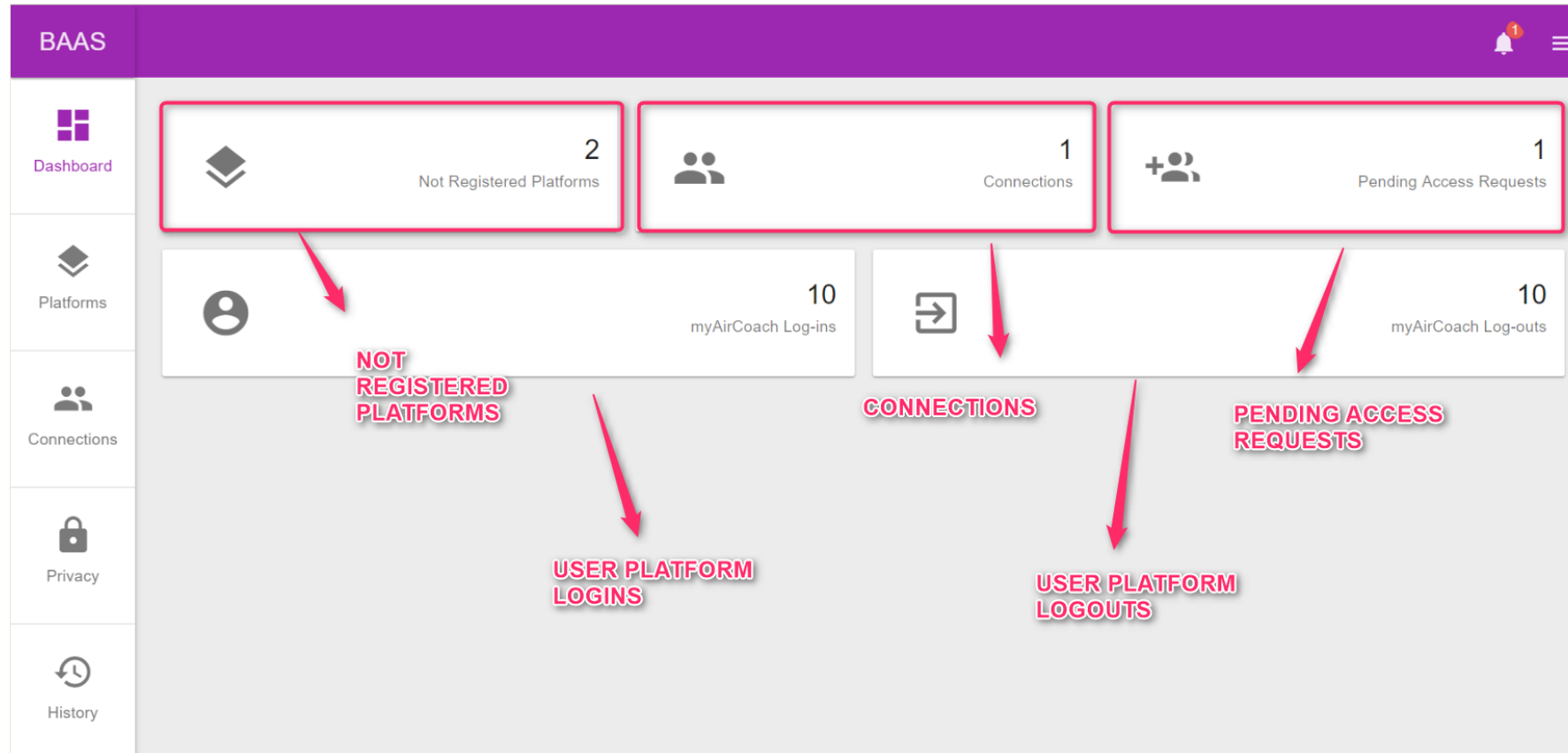
TRANSACTIONS

USERS

SMART CONTRACTS

MOST RECENT TRANSACTIONS

# CERTH BaaS Application Front-end USER View DASHBOARD



# Admin / Contracts

BAAS

Administrator

Dashboard

Blocks

Transactions

Accounts

Contracts

Code Editor

Registrar Contract (RC)

Contract Address

0x2440036fa4c9d2d5c09cf7f61140ed5c47780ac5

Summary Contract (SC)

Platform Contract (PL)

Patient Provided Relationship Contract (PPR)

Name	Type	Inputs	Outputs
getUsers	function	[]	[{"name":"","type":"bytes32[]"}]
getUserSC	function	[{"name":"_uid","type":"bytes32"}]	[{"name":"","type":"address"}]
getPlatforms	function	[]	[{"name":"","type":"bytes32[]"}]
getUserNumber	function	[]	[{"name":"","type":"uint256"}]
checkIfPlatformExists	function	[{"name":"_platform","type":"bytes32"}]	[{"name":"","type":"bool"}]
addOwnerAddressRC	function	[{"name":"_addr","type":"address"}]	[]
deleteUser	function	[{"name":"_uid","type":"bytes32"}]	[]
getPlatformPL	function	[{"name":"_platform","type":"bytes32"}]	[{"name":"","type":"address"}]
createPlatformPL	function	[{"name":"_platform","type":"bytes32"}, {"name":"_tempPL","type":"address"}]	[]
createUserSC	function	[{"name":"_uid","type":"bytes32"}, {"name":"_tempSC","type":"address"}]	[]
deletePlatform	function	[{"name":"_platformUid","type":"bytes32"}]	[]
getPlatformNumber	function	[]	[{"name":"","type":"uint256"}]
deleteRC	function	[]	[]
checkIfUserExists	function	[{"name":"_uid","type":"bytes32"}]	[{"name":"","type":"bool"}]

# Admin / Accounts

BAAS Administrator	
Accounts	
Email	Account
dapp1@gmail.com	083c94f0c35c50a044363845a6640da1abfb6cd2
dapp2@gmail.com	f76a77d0ba5598e1a8a1532deae397ed4209c592
Miki@gmail.com	50834d8cd3a0d387ece4924e49f5c70af5dff7a2
Ryan@gmail.com	cceeaddd331ba0f8e63cd9c8a38e524c5b0301450
eli@gmail.com	e89169a48f53ecc48c95f5b41beabdac77d8b9e2
stefan@gmail.com	9c44a5c6b8fc27eb89a62c5f7ad96db310083f3
svo@gmail.com	624a97875f5d7552d482a36d0f8c13d5981a29b
flavio@gmail.com	be304220c39f90add95f21c0d4186a508f78ed
guli@gmail.com	c8a92bc84ac7e2217c7345ab31006771f653a9e7
test_user@gmail.com	31cc4f87062b112599c2162ef77211ebcaa1417e
Page: 1 Rows per page: 10 1 - 10 of 19	

# Admin / Dashboard

BAAS

Administrator

Dashboard

Blocks

Transactions

Accounts

Contracts

Code Editor

11802

Last Block

302

Transactions Count

19

Users

4

Contracts

RecentTransactions

Hash	Value	Block #	Timestamp
0xf83df752f548db251a0164c2369494329c44d528814f094bd0fc5e93df533	0	11802	May 11, 2018 1:33:00 PM
0x6b0064831f8b92583a2e9889e12c052d1b648129f7a8d1766c5a43db9e96d1	0	11687	Apr 12, 2018 1:22:37 PM
0x5c48f3c794065c515f992121d340e3d731e26ec06fe5a392d89d1d7e2c2853	0	11657	Mar 30, 2018 9:50:50 AM
0x9f018f056db7db0acd710b325fcca469df3772b8afc71929f6b87188db1d72	0	11656	Mar 30, 2018 9:48:39 AM
0xc949b7930e1a467a33500793ac1b0c7e89cd0f21049488bad2e8878a90	0	11655	Mar 30, 2018 9:48:38 AM

# Admin / Transactions

BAAS

Administrator

Dashboard

Blocks

Transactions

Accounts

Contracts

Code Editor

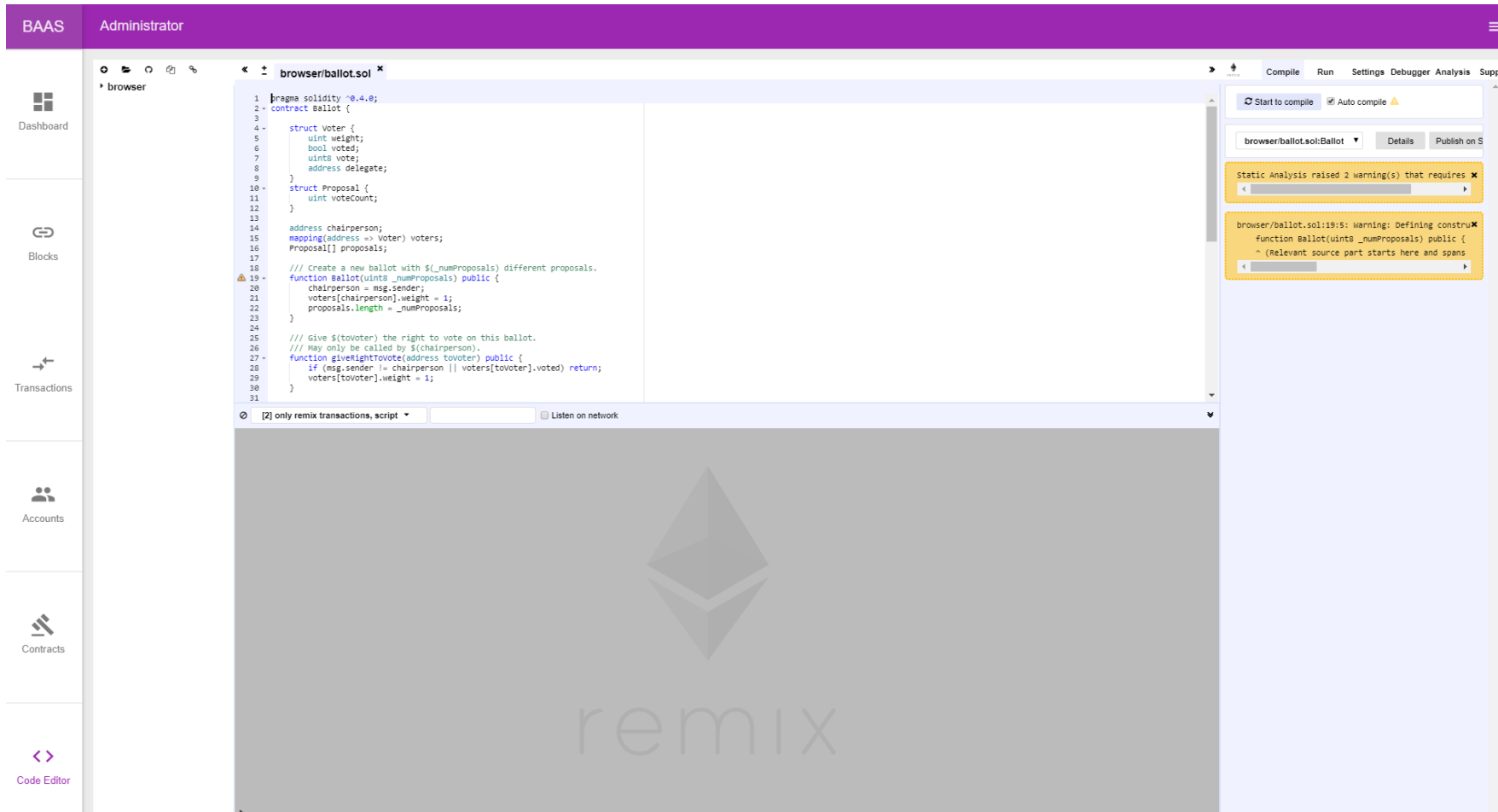
Transactions

Hash	Value	Block #	Timestamp
0x25f663c4975cf746f8d46c5c76e837423eb1a4fd7846125c84f7abbe76ec2523	0	10322	null
0x25f663c4975cf746f8d46c5c76e837423eb1a4fd7846125c84f7abbe76ec2523	0	10322	null
0x25f663c4975cf746f8d46c5c76e837423eb1a4fd7846125c84f7abbe76ec2523	0	10322	null
0x25f663c4975cf746f8d46c5c76e837423eb1a4fd7846125c84f7abbe76ec2523	0	10322	null
0x25f663c4975cf746f8d46c5c76e837423eb1a4fd7846125c84f7abbe76ec2523	0	10322	null
0x5a20e4b2c985252e6474439a7a2cd159f76e804764c819c6cacc82f449ec29e9	0	10322	null
0x5a20e4b2c985252e6474439a7a2cd159f76e804764c819c6cacc82f449ec29e9	0	10322	null
0x5a20e4b2c985252e6474439a7a2cd159f76e804764c819c6cacc82f449ec29e9	0	10322	null
0x5a20e4b2c985252e6474439a7a2cd159f76e804764c819c6cacc82f449ec29e9	0	10322	null
0x5a20e4b2c985252e6474439a7a2cd159f76e804764c819c6cacc82f449ec29e9	0	10322	null

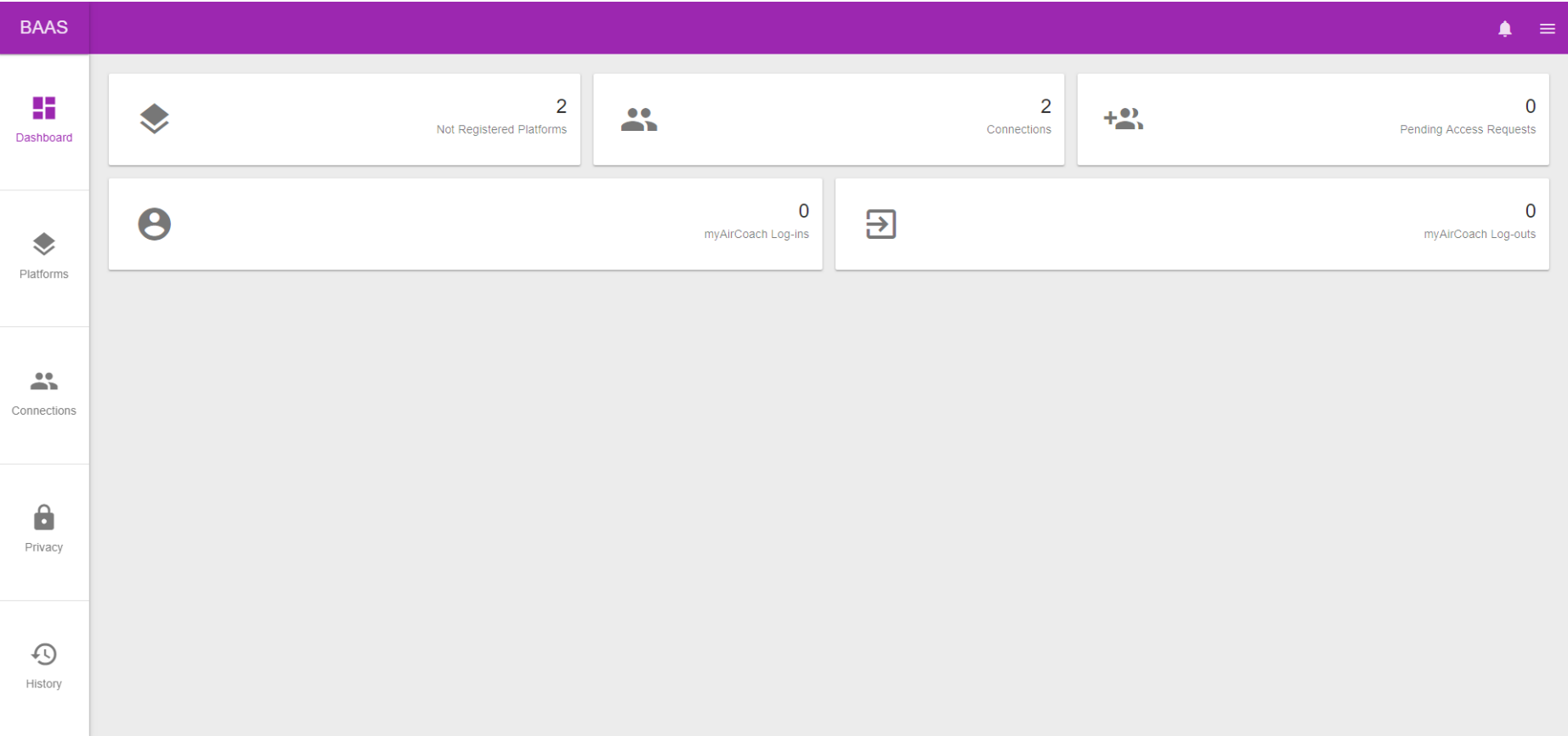
Page: 1 Rows per page: 10 1 - 10 of 302 < >



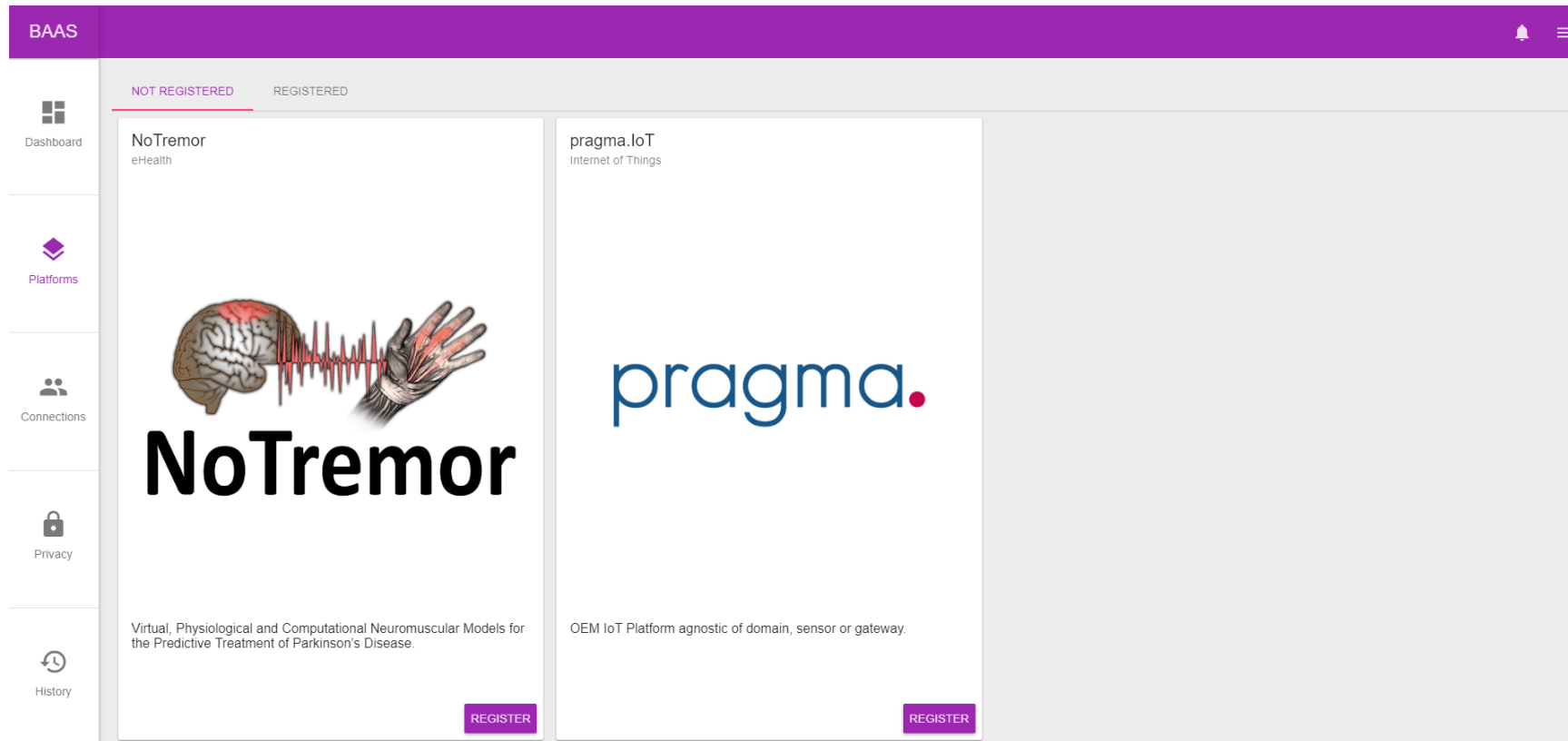
# Admin / REMIX Integrated Code Editor for Solidity



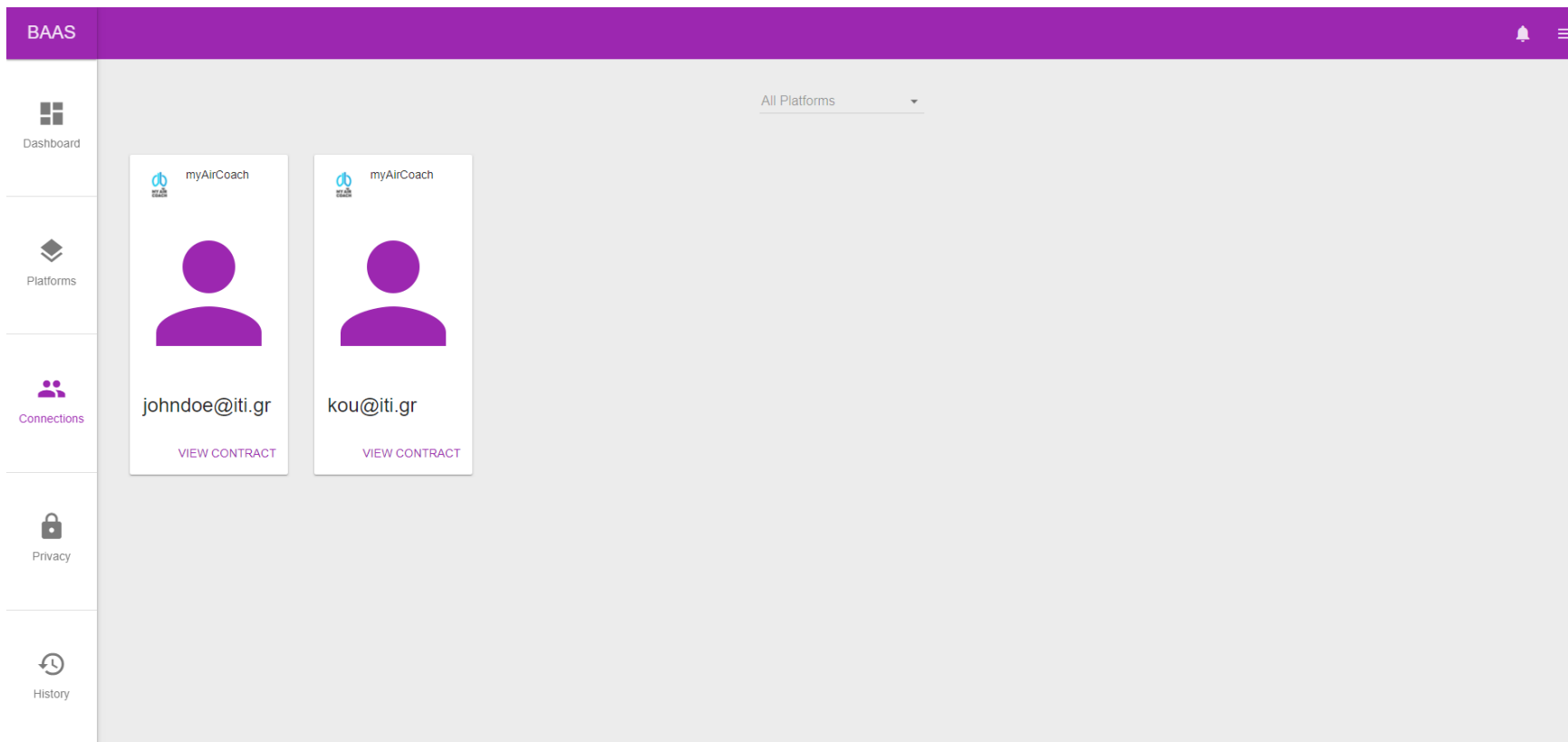
# User / Dashboard



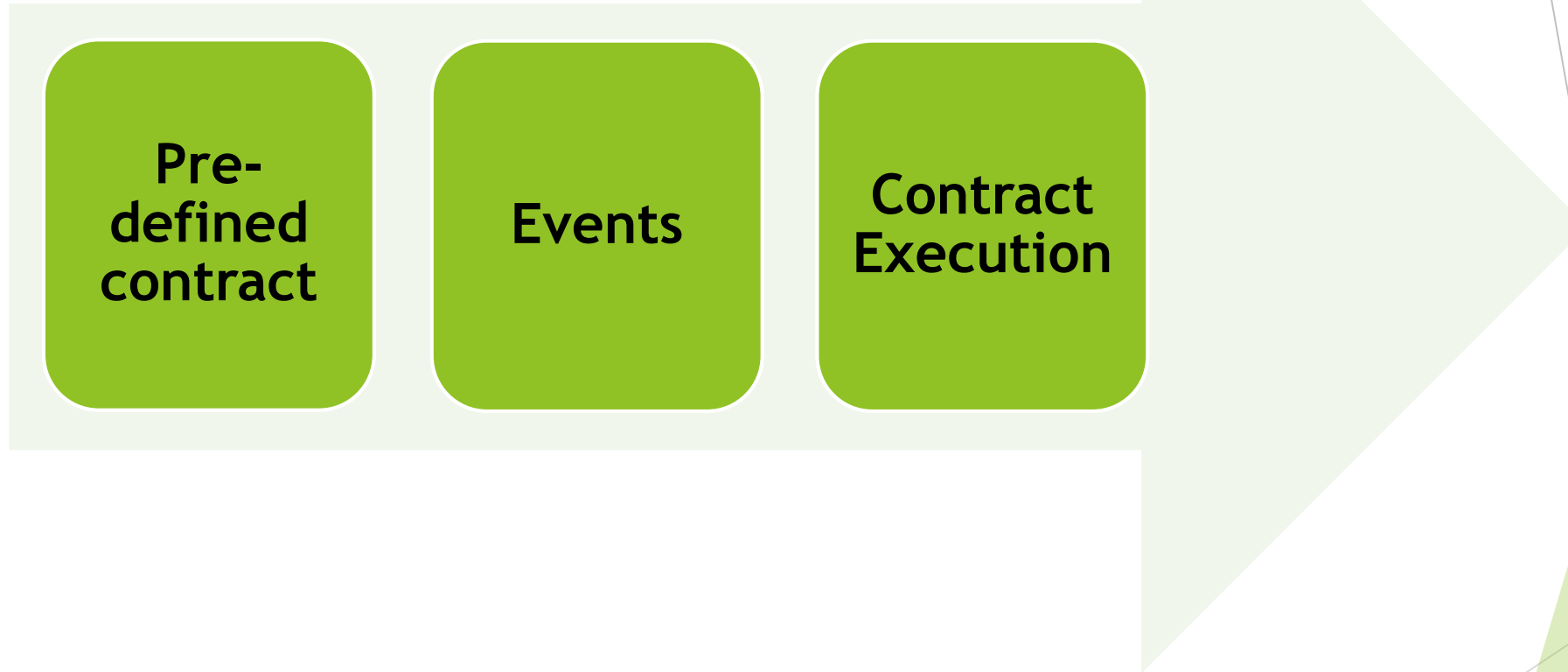
# User / Platforms



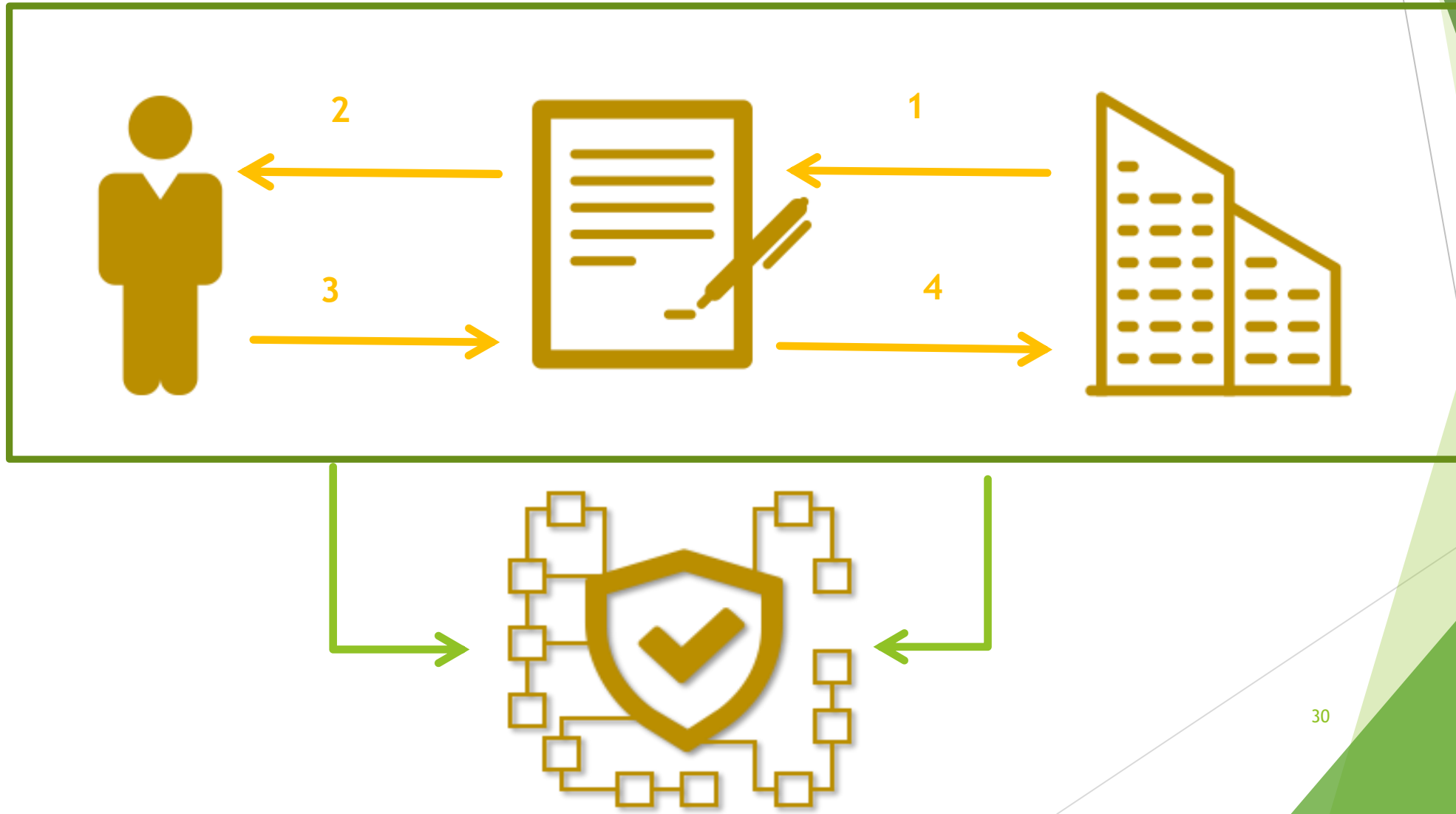
# User / Connections



# Smart Contracts



# Employee Smart Contract Example



# Applications of our BaaS solution to other domains

- ▶ Energy consumption
- ▶ IoT device identification
- ▶ Supply Chain
  - ▶ Product Identification / Avoid Counterfeiting
- ▶ Ownership Rights
- ▶ Transaction monitoring

# BaaS system

## URL, Users, and Roles

▶ <http://160.40.49.101:8080/dashboard/#!/login>

▶ Role1: **User**

▶ Username: kostakis@gmail.com

▶ Password: 12345678

▶ Role2: **Admin**

▶ Username: admin@ACTIVAGE.gr

▶ Password: 12345678



# Blockchain in Healthcare Platforms



## ► MedRec<sup>1</sup>

- An MIT project which proposes a novel, decentralized Electronic Health Records (EHR) management system using Blockchain

## ► MyHealthMyData (MHMD)<sup>2</sup>

- An Horizon 2020 Research and Innovation Action which leverages Blockchain to enable Patients to allow, refuse, and withdraw access to their Data according to different types of potential usage.



## ► MedChain<sup>3</sup>

- A pioneering community driven solution to securely store Electronic Medical Records (EMR) and electronic Protected Health Information (ePHI) on the Blockchain

