Privacy preserving data analytics

Coimbra, 11 July, 2019

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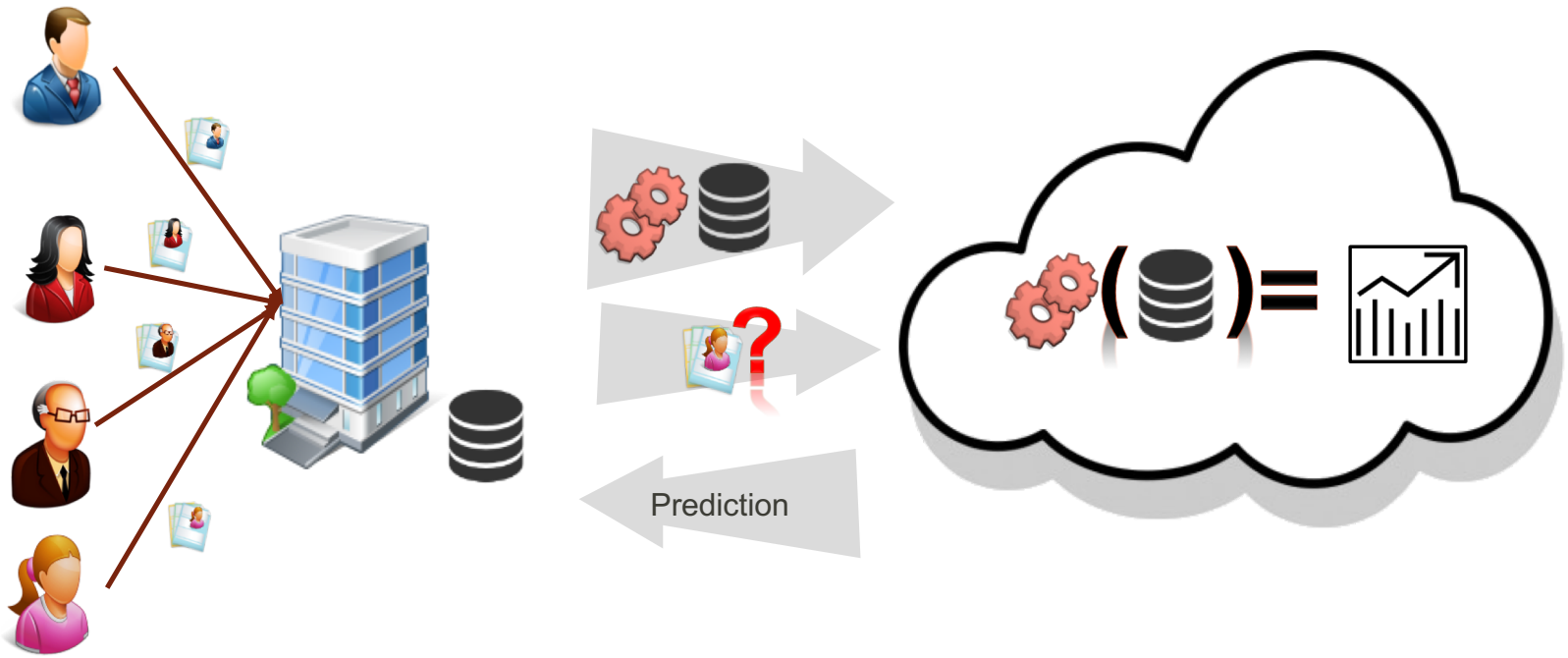
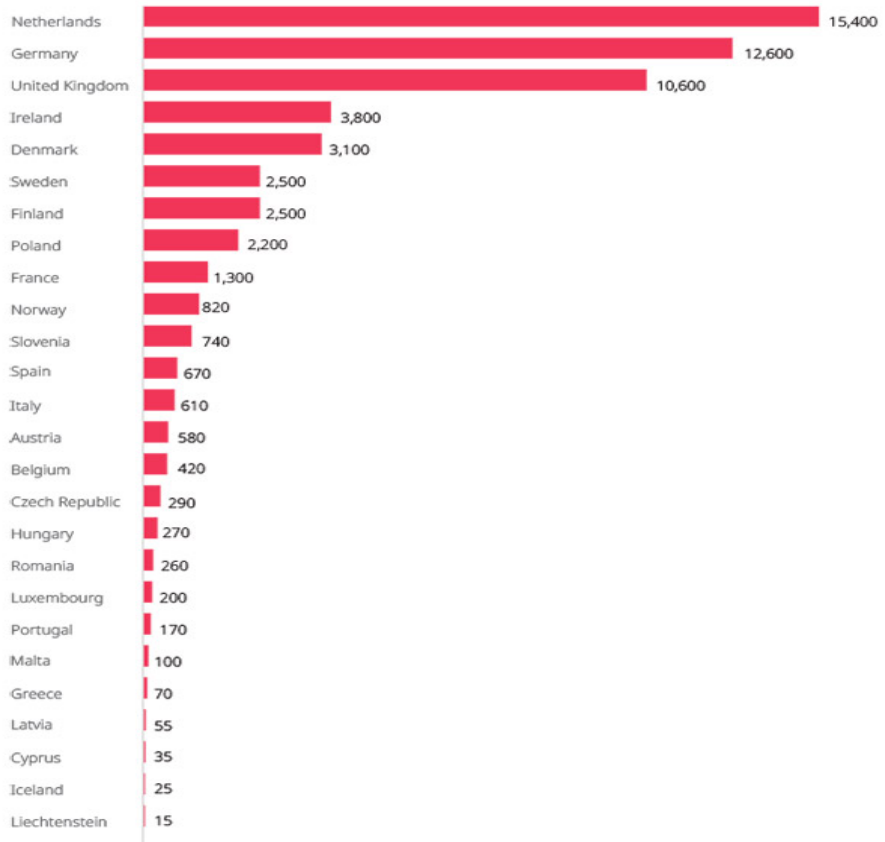
PAPAYA Project

Project title	**PAPAYA:** ***PlAtform for PrivAcY preserving data Analytics***
Call	**DS-08 Cybersecurity PPP: Privacy, Data Protection, Digital Identities**
Grant Agreement	**GA no: 786767**
Project Officer	**Mr. Nikolaos Panagiotarakis (H2020, REA)**
Duration	**36 months (1 May 2018 – 30 Apr 2021)**
Consortium	EURECOM, Atos, IBM, Karlstads Universitet, MEDIACLINICS Wearable Health Applications, orange
Project Coordinator	**EURECOM**

Data Analytics as a Service



2019 Data Breaches in Europe



- # Data Breach Notifications
  - ~59K from May 2018 until Jan. 2019
- Average Cost in 2018
  - Global: 3.96M$, Per record: 148$
- Top 3 sectors
  - Health, Financial, Services
- Factors increasing cost
  - Extensive migration to cloud
  - Third party involvement
  - Compliance failures
- Factors decreasing cost
  - Extensive use of encryption
  - Use of security analytics

https://www.bankinfosecurity.com/gdpr-data-breach-reports-to-eu-exceed-59000-a-12006

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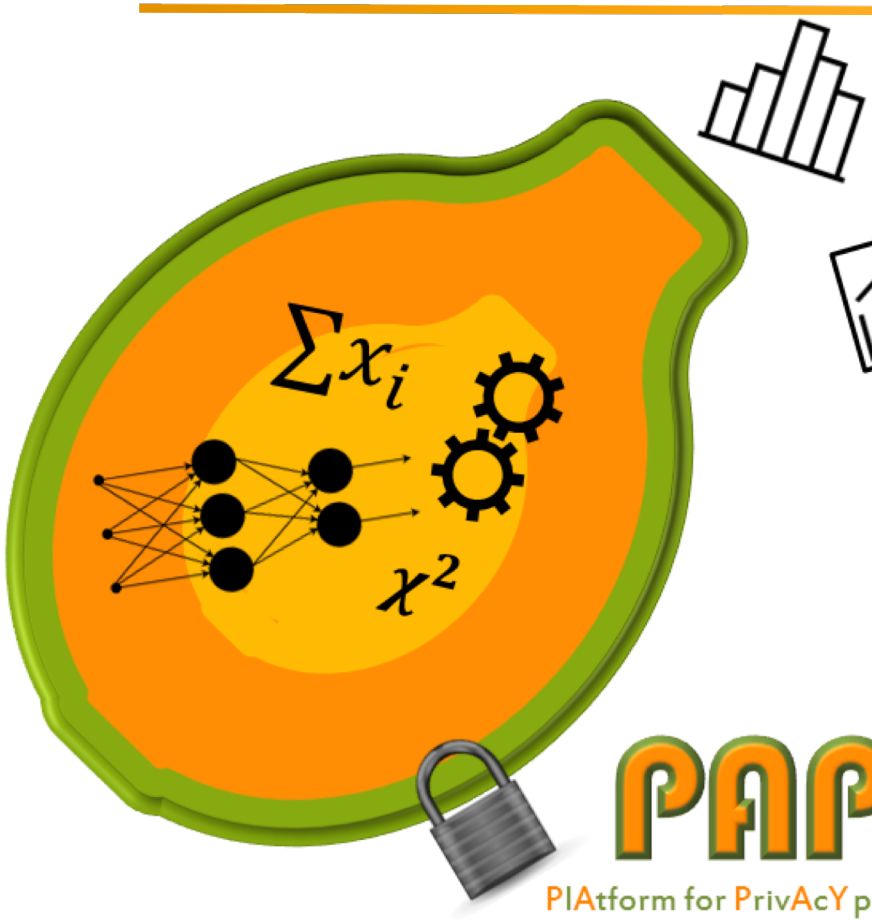

- Objectives
  - Privacy by design
    - PP analytics: processing over protected data
  - Different settings
    - Single vs multiple Dos
    - Third party queriers
  - Integrated platform
    - Common framework
  - User control
    - Transparency, usabilitiy & auditability

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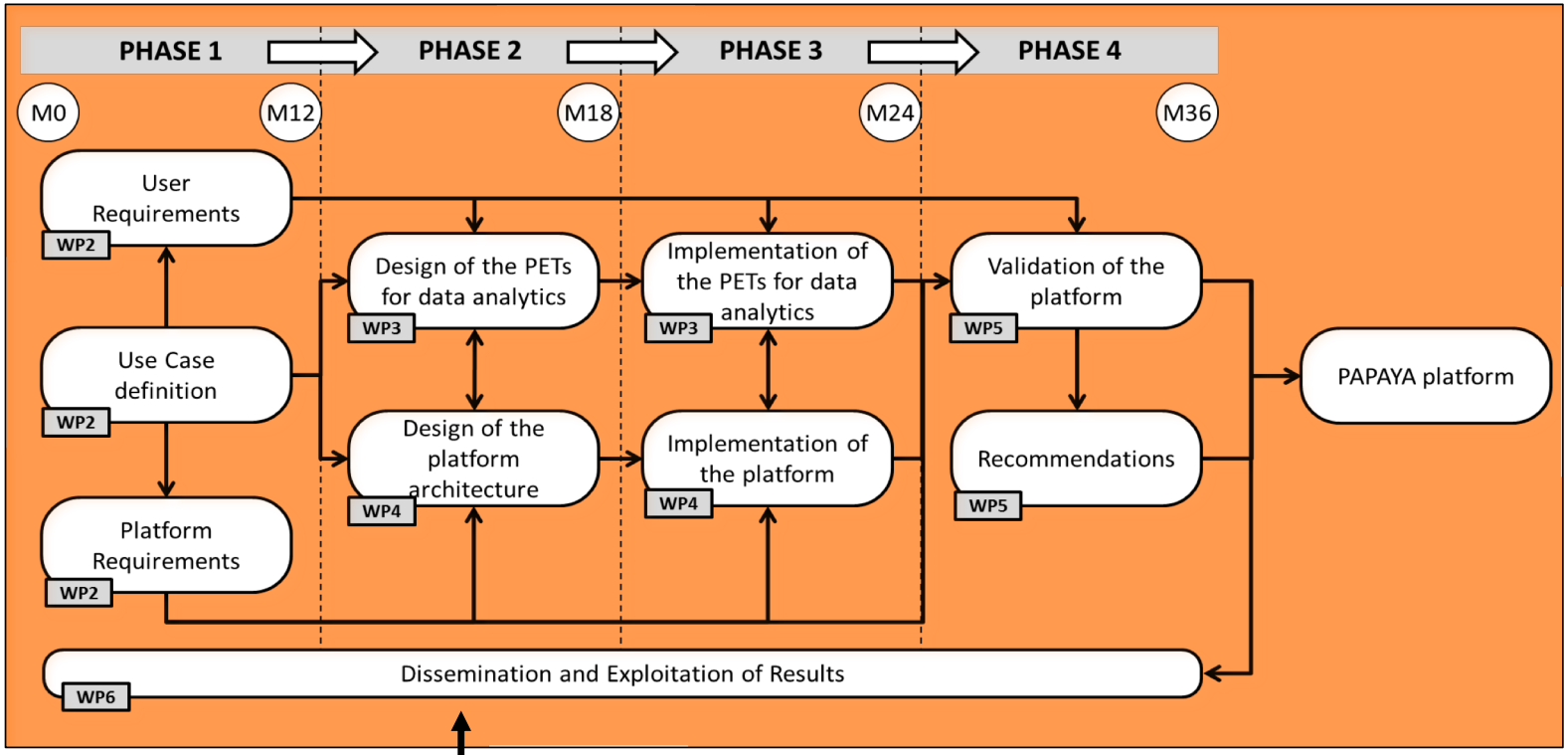
PIAtform for PrivAcY preserving data Analytics

Project Roadmap



PAPAYA Use Cases

[D2.1]

- Healthcare umbrella
  - Arrhythmia detection
  - Stress detection

MEDIACLINICS
Wearable Health Applications

- Mobility and phone usage umbrella
  - Mobility analytics
  - Mobile usage analytics
  - Threat detection

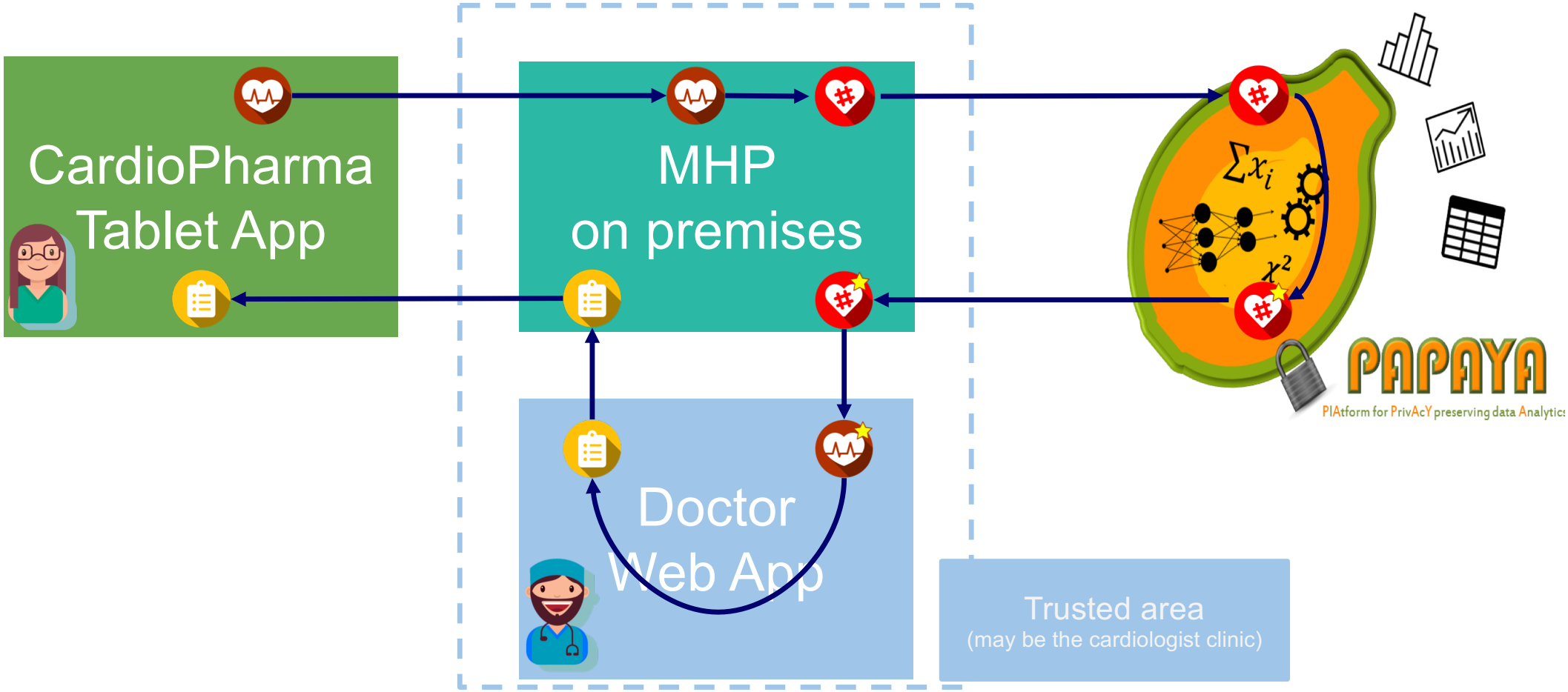
orange™

PAPAYA Analytics

[D3.1]

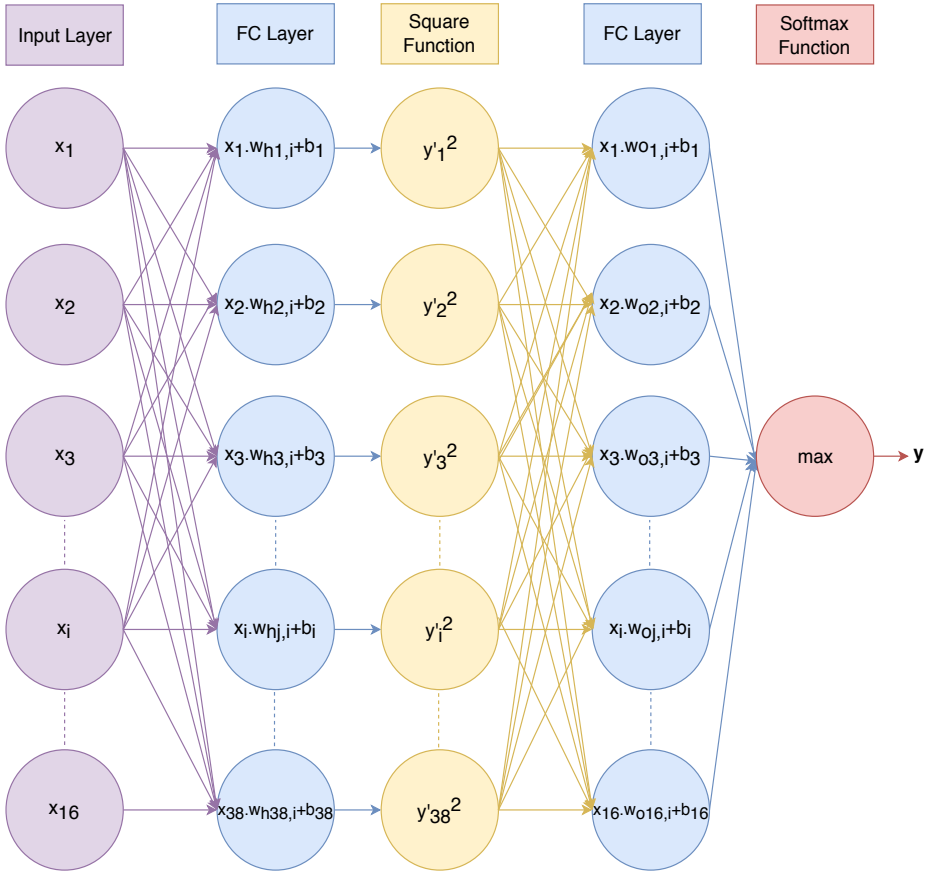
- Neural Network classification
  - Arrhythmia detection, Threat detection
- Collaborative Neural Network training
  - Stress detection
- Trajectory clustering
  - Mobility analysis
- Counting (& and set operations)
  - Mobile phone usage

Arrhythmia detection with Neural Networks



Privacy vs. Neural Networks

- Advanced Privacy technologies
  - FHE, MPC
- Challenges
  - **Additional overhead**: Computation, memory and bandwidth
  - **Complex operations** (sigmoid, tanh, etc.)
  - **Real numbers** (vs. integers with PETs)
- Goal
  - Reduce NN complexity
  - Use low degree polynomials
  - Use integers
  - Keep good level of accuracy
- Solution for PAPAYA
  - ⇒Generate a dedicated NN model from scratch



PP arrhythmia classification based on 2PC

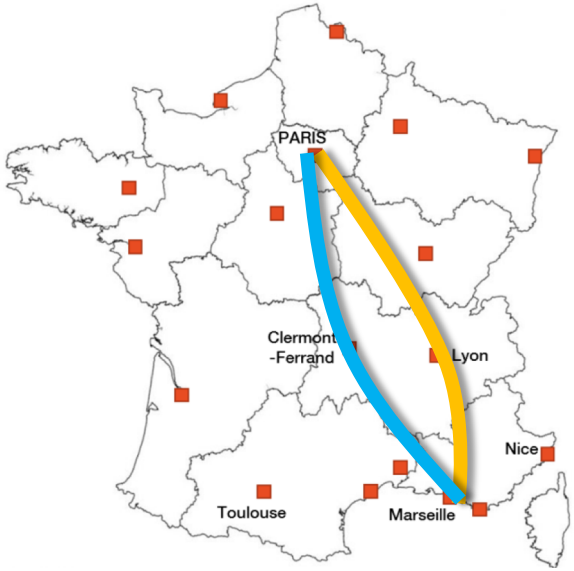
[IFIP Summer School on Privacy'19]

- NN architecture optimization
  - PCA to reduce input size
  - Minimum number of hidden layers with good accuracy
- Approximate non linear operations
  - Square (x^2) instead of sigmoid ($\mathrm{f(t)} = \frac{1}{1+e^{-t}}$)
  - Simple max instead of softmax $\left(\mathrm{f}(i) = \frac{e^i}{\sum_{i=1}^{n} e^i} \; where \; i = 1, \ldots, n\right)$
- Approximate real numbers
  - Truncation: $\times 10^r$
- Performance
  - 62ms to classify one heartbeat, 400 ms to classify 10

Privacy vs. Clustering

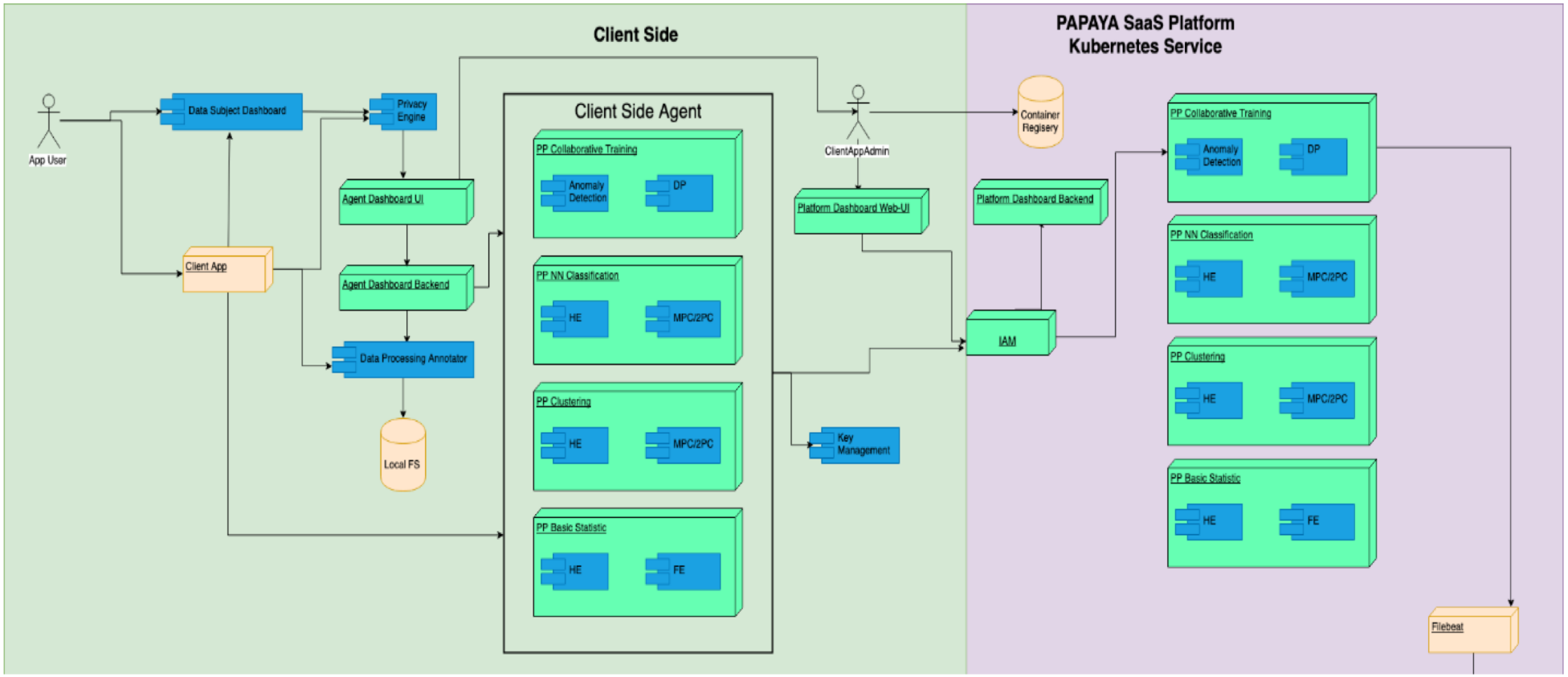
- Objective
  - Encrypted trajectory clustering
- Challenges
  - Processing of Personal data (location, ID, etc.)
  - Sophisticated distance computation
  - Comparisons
- PAPAYA solution

⇒ Approximate distance + use 2PC



PAPAYA Architecture (v1)

[D4.1 available soon]



Thank you

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PAPAYA Dashboards

- Platform Dashboard (Web application)
  - Service catalog
  - Service Add/Delete/Update
  - Application Create/Delete/Deploy
  - Application monitoring for service owners
- Agent Dashboard
  - Agent Configuration
  - Data processing logs
- Data Subject Toolbox
  - Explaining PP Analytics
  - Data Disclosure Visualization Tool
  - Annotated Log view tool
  - Privacy Engine