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Collection, storage and analysis of converged sensor and questionnaire data for clinical trials in the NOMADe project

Gent, 03/05/2022

KU Leuven,
Technology Campus Gent



Outline

- **Background – 2 projects: EDUCAT & NOMADe**
- Problem description – What we need
- Solution: “One workflow does it all ...”
- Requirements for the framework
 - Pseudonymisation
 - Authentication upon login
- Components of the NOMADe framework
 - NOMADe app
 - Questionnaires
 - Flexible « swiping » configuration
 - Live visualization
 - Data streaming
 - Database
 - Basic analysis of measurement data



 2 Seas Mers Zeeën



European Regional Development Fund

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EDUCAT

- An open, modular and adaptive framework for clinical trials
- Application: Obstacle Alerting System (OAS)


KU Leuven team







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European Regional Development Fund

EDUCAT

Empowerment of Disabled people through the User Coproduction of Assistive Technology (2016-2020)

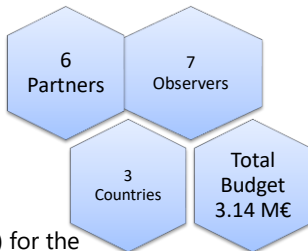
European Project co-funded by Interreg VA 2 Seas


Objective: develop and deliver Assistive Technologies (ATs) for the health sector that are open, modular and able to adapt their assistance (or to be adapted by the user) to the user's needs. For that we need clinical trials, so a versatile measurement framework!

Start date: 01/09/2016, it runs for 4.5 (5) years


Team: Yncréa HdF/ISEN, KU Leuven, Un. of Kent, UK hospitals, Voka Oost-Vlaanderen

Website: www.educate2seas.eu







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NOMADe

NOMADe

- <https://nomadeproject.eu>
- From 1st October 2019 to 30th September 2022 (= > Dec. 2022)
- NMSD (Neuro-Musculo-Skeletal Disorders): research, cross-border sharing of expertise, learning ecosystem.



Écosystème d'apprentissage, R&D et expertise transfrontalier dédié aux troubles neuro-musculo-squelettiques

Leerecosysteem, O&O en grensoverschrijdende expertise gewijd aan neuro-musculoskeletale aandoeningen

Le projet INTERREG FWVL NOMADe vise à développer et coordonner un écosystème transfrontalier d'apprentissage, R&D et expertise spécialisée dans le domaine des troubles neuro-musculo-squelettiques (TNMS).
Het INTERREG FWVL NOMADe project beoogt de ontwikkeling en coördinatie van een regiooverschrijdend ecosysteem van leren, O&O en expertise op het gebied van neuro-musculoskeletale aandoeningen (NMSA).

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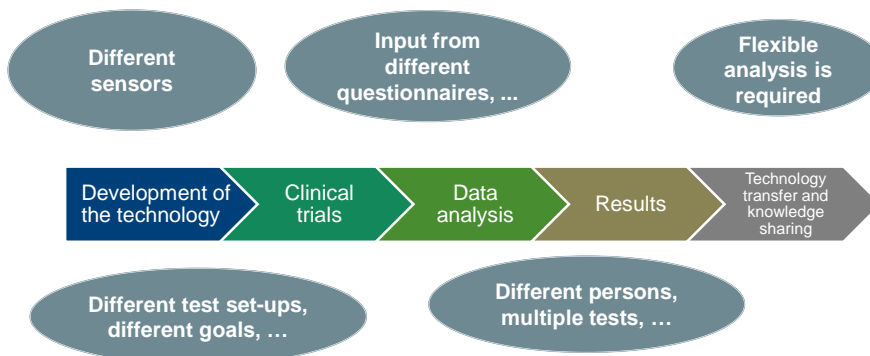
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6

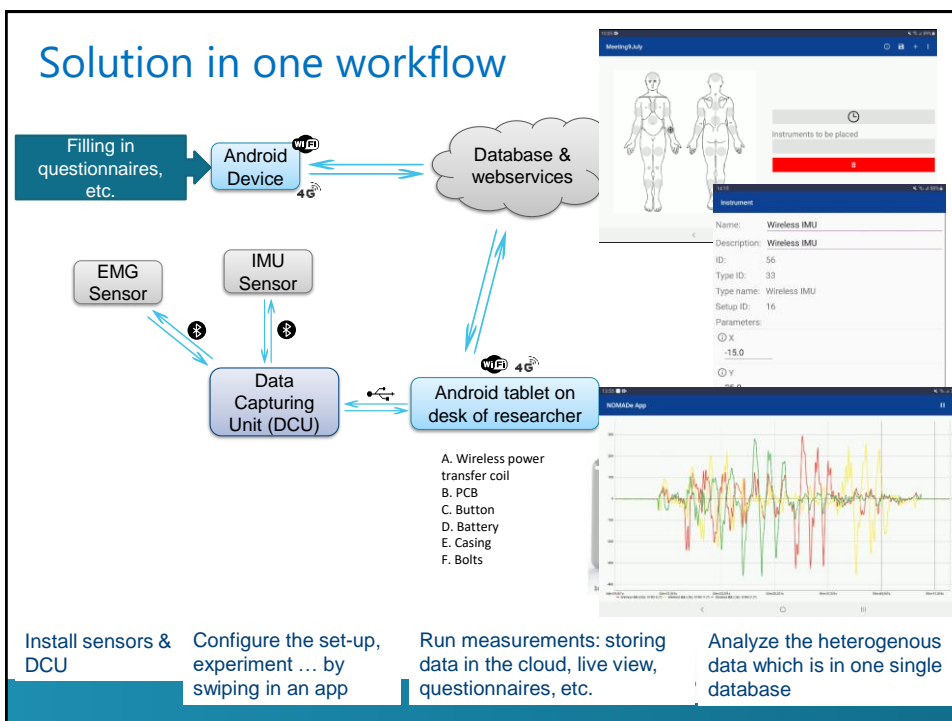
What we need



We need an open, modular and adaptive framework !
We need one single database combining all the heterogenous data !

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Solution in one workflow



Some requirements for the framework

- Pseudonymisation of the persons involved
- Authentication upon login
- Secure and robust (roaming and buffering) communication to the cloud
- Flexible graphic configuration on “off-the-shelf“ Android devices
- Quick detailed first analysis and reporting & Flexible database analysis

➡ A powerful, flexible system for clinical trials

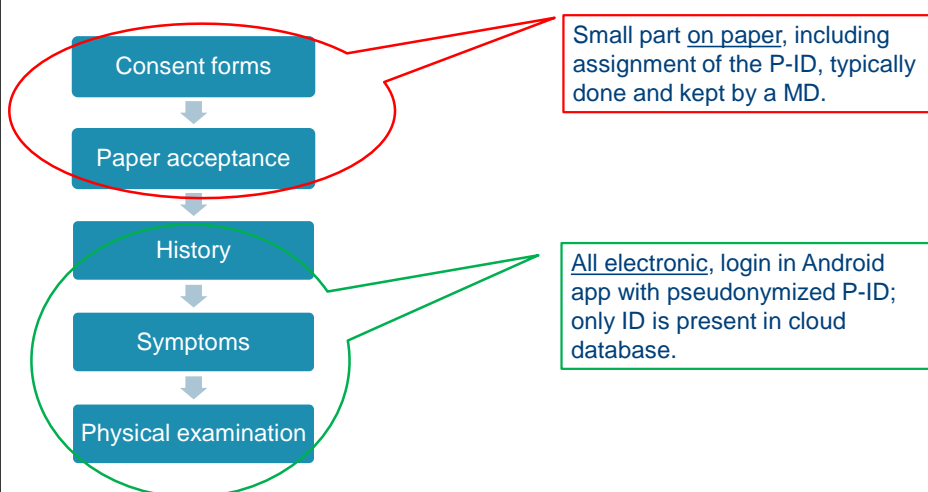
➡ Workflow includes pseudonymization

9

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Pseudonymisation of the persons involved



10

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Authentication upon login – Security

- Authentication:
 - HTTP Digest Access Authentication (RFC 7616)
 - Method to negotiate credentials
 - Confirm the identity of the user before exchanging data
- Login with a user ID and a password
 - User ID is anonymous (list on paper connects the user ID to the persons)
- HTTPS / TLS encryption

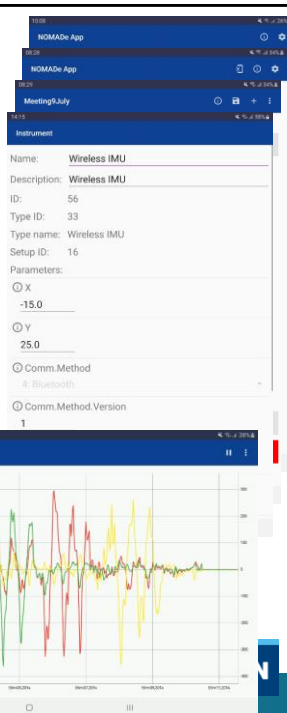


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NOMADe app requirements

- Main tasks of the Android Device:
 - Filling in / Viewing questionnaires
 - The UI (User Interface) is dynamically built on the data in the JSON strings coming from the webserver => easy adding of questionnaires
 - Creating new measurement setups
 - Data stream with DCU
 - TCP data stream with cloud database
 - Live visualization
 - Developer information (debugging), emulating datastreams for server testing

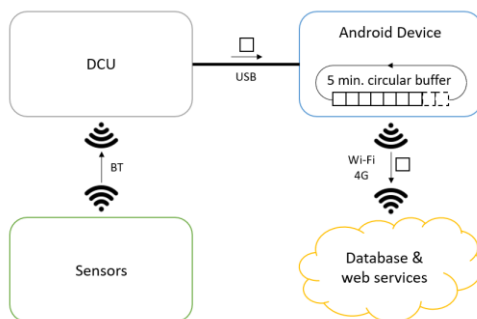


Connecting to the cloud database – Data streams

- Data stream every 20 ms from DCU to Android Device (AD), with ack
- Oversampling possible, currently tested x2 (100 Hz)
- Acyclic data stream for commands/responses between DCU and AD
- A cycle counter is used to identify each message, and check for missing ones
- Between Android Device (AD) and cloud database:
 - Every 20 ms for the cyclic data
 - Acyclic messages (questionnaires, set-ups, ...)
- Wi-Fi or 4G

Connecting to the cloud database – Robustness

- Robustness:
 - Small local buffer for the cabled USB-communication
 - Circular buffer of 5 minutes in the Android device, for the wireless link to the database => roaming and buffering is ok
 - Every block of 1500 messages arrived in the database is acknowledged



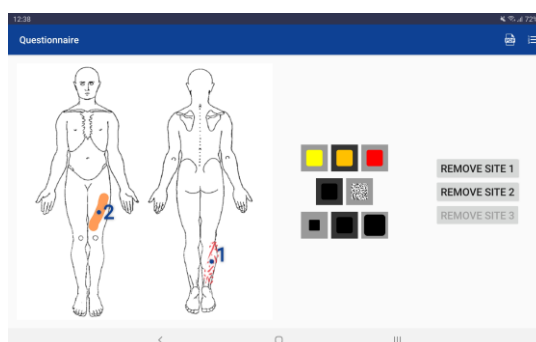
15

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Questionnaire system

- **Movie 1** questionnaires



16

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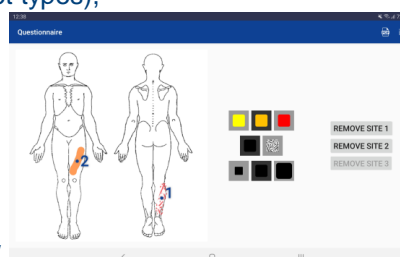
Database implementation to achieve Body chart

Beside the normal question types (or bullet types),

- 1) Separate answers (No bullet)
- 2) One answer (Radio buttons)
- 3) Multiple answers (Checkboxes)

NOMADe has a fourth question type:

- 4) Body Chart (Coordinates)

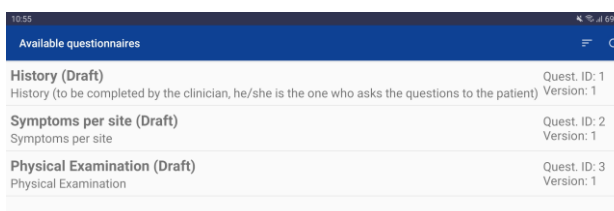


This question type allows the app to show selected coordinates as answers for this question.

Coordinates as JSON: `[{x: ... ,y: ...},{x: ... ,y: ...},...]`

Database implementation

- Database moved to Laravel framework
- Transfer of historic data
- Allowing re-editing of an already filled in questionnaire, reconnecting the TCP connection, ... (refer to the app changes)
- **3 questionnaires (PT)**



Some experiments ...

- NOMADe app:
 - Configuring the measurement setup by swiping ([movie 3](#))
 - Measurements: live visualization and streaming to the database ([movie 4](#))

19

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Basic analysis of measurement data

- Setups, measurement list and basic properties, ... are all available in the app.
- Database:
 - Holds all the heterogenous information (measurements, questionnaires and answers, setups, etc.)
 - Access via read-only queries by data analysts
 - Access for quick measurement analysis via MATLAB livescript (all researchers) (demo: [html](#))

20

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Data analysis - Livescript

- Contains:
 - Get measurement from database
 - Connect and get list
 - Select measurement + which part?
 - Get measurement from local previously saved m-object
- From either one of the previous:
 - Filtering and cutting options
 - Plot all measurement information (standard plots for each instrument type)
 - Extract from m-object to workspace variables
 - Save m-object
 - Save workspace variables to .mat file
 - Save results in Word, html, pdf
- Of course linked to the app:
 - Measurement ID, Setup ID, etc.

Thank you for your attention !

Any questions ?

