Federated Learning Toolbox

Zentrix Lab

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Motivation

Distributed data across secure zones and institutions

Restrictions on data movement (regulatory, policy, sensitivity)

Need for privacy-preserving analytics across heterogeneous environments

EOSC vision: interoperable, secure, trustworthy research infrastructure

Federated Learning enables collaborative model training while all data remains securely within each institution.

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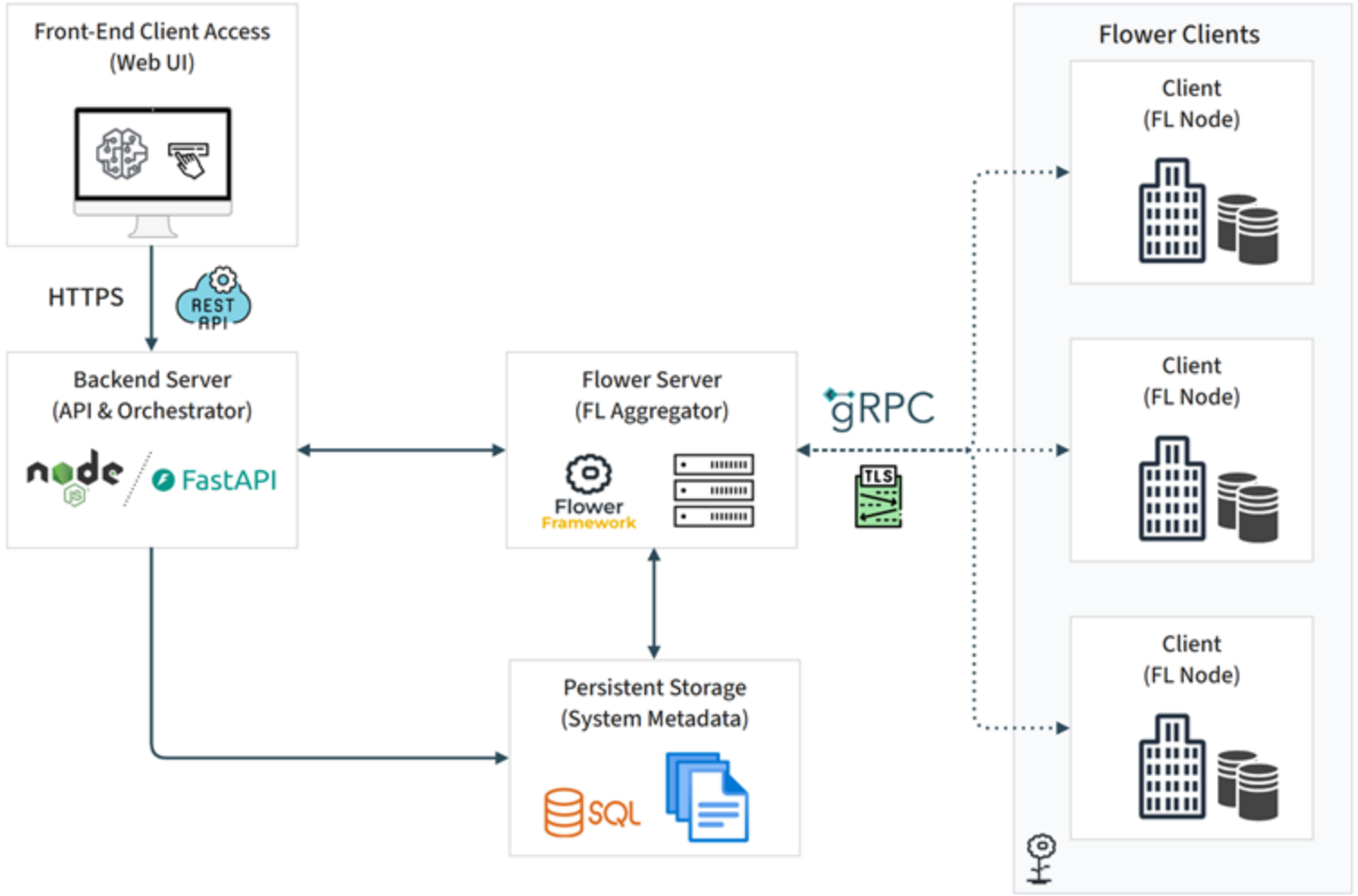
Federated Learning Toolbox - Core Components

Modular architecture combining a user-friendly orchestration layer with Flower-based federated learning execution.

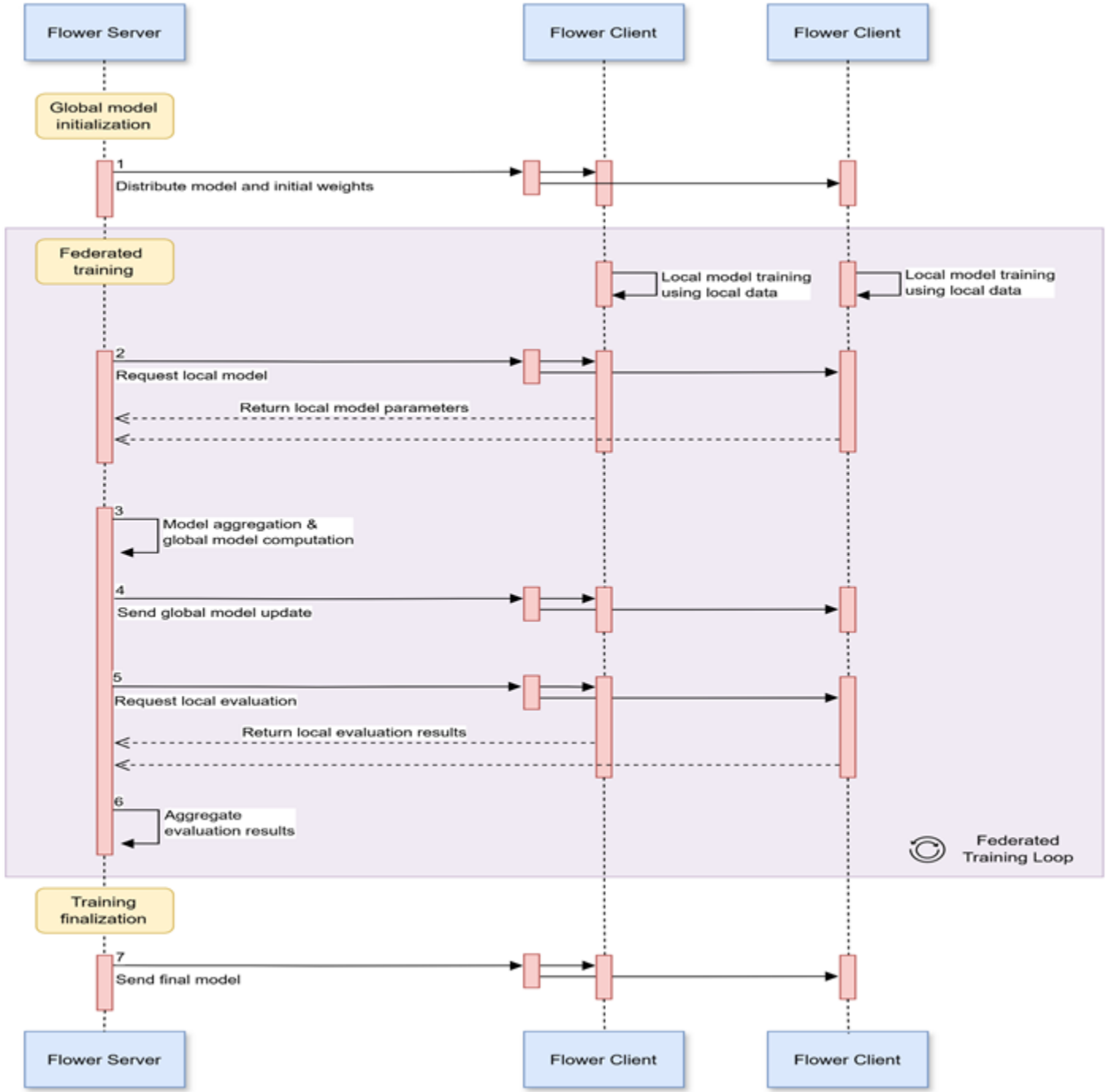
- **Web UI** – configure experiments, monitor training, manage projects
- **Backend / Orchestrator** – handles user management and experiment lifecycle
- **Flower Server** – coordinates rounds and aggregates model updates
- **Flower Clients** – perform local training on private data
- **Metadata Store** – stores configuration, metrics, and model references.



Federated Learning Toolbox Workflow

Federated training workflow:

- Server initializes the global model
- Clients train locally on private datasets
- Clients return model updates
- Server aggregates (e.g., FedAvg) and updates the global model
- Loop continues for multiple rounds until convergence



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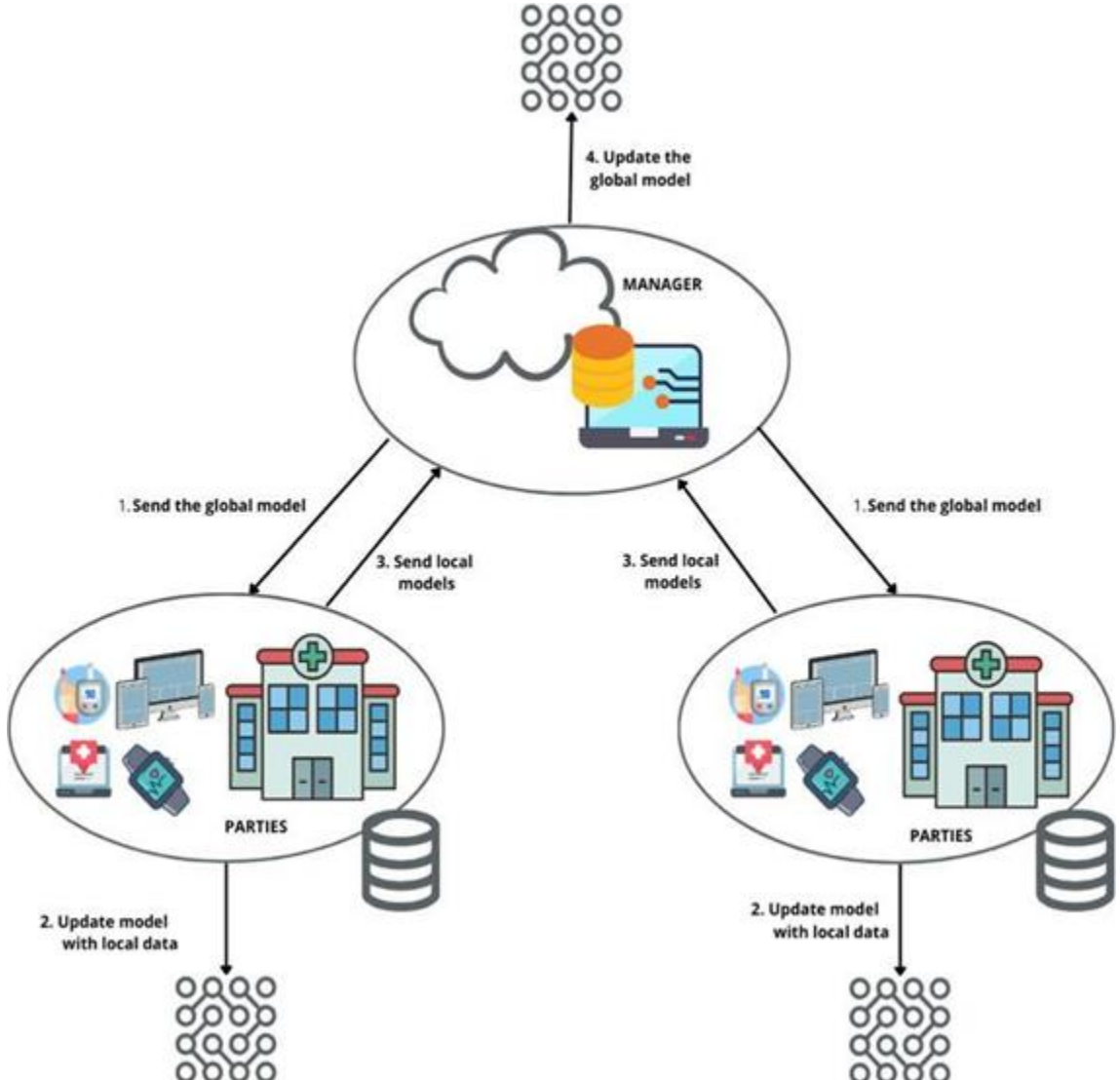
Use Case – Healthcare: Sleep Stage Classification

- Collaborative training of a sleep-stage classifier across multiple hospitals
- Each hospital runs a client on its own PSG/EEG datasets
- Raw sleep recordings never leave the hospital, only model updates and evaluation metrics are exchanged
- Enables cross-hospital model improvement without sharing sensitive data



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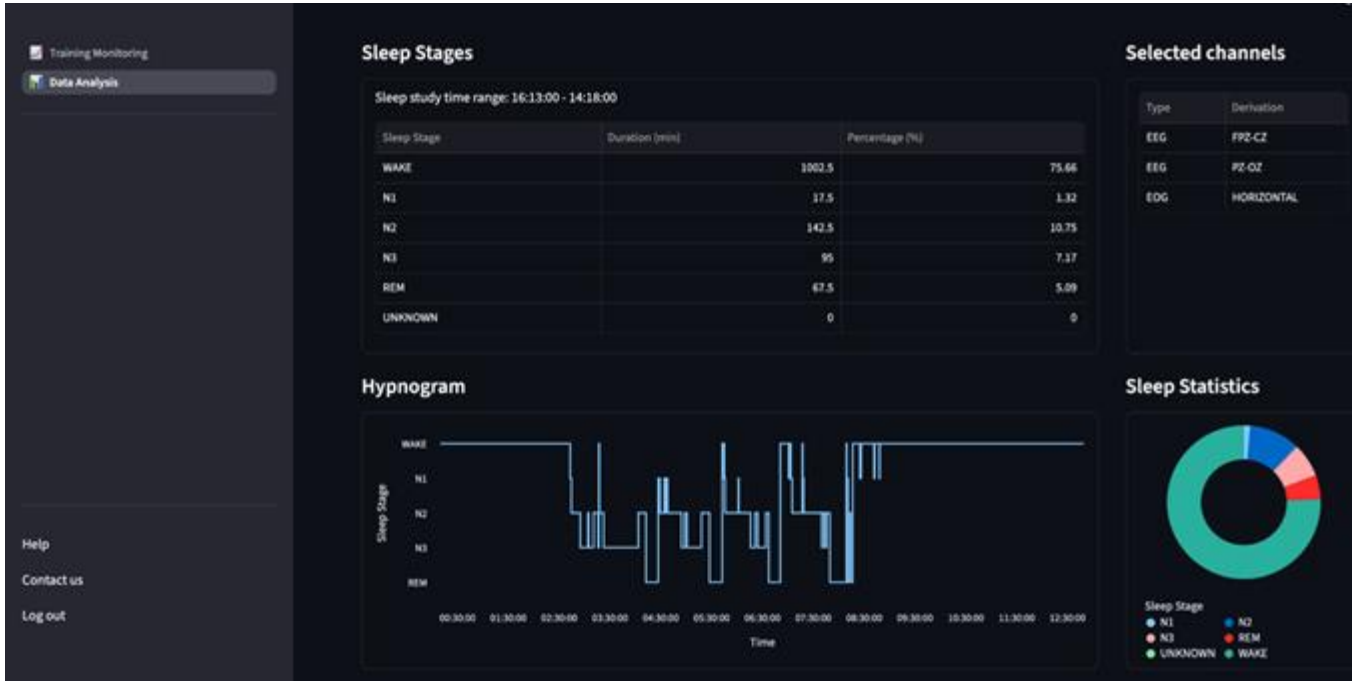
Use Case – Healthcare: Sleep Stage Classification

- Live monitoring of federated rounds and model convergence
- Global and per-client metrics (loss, accuracy, evaluation curves)
- Visualization of client participation and dropouts
- Insight into training stability and round-to-round dynamics



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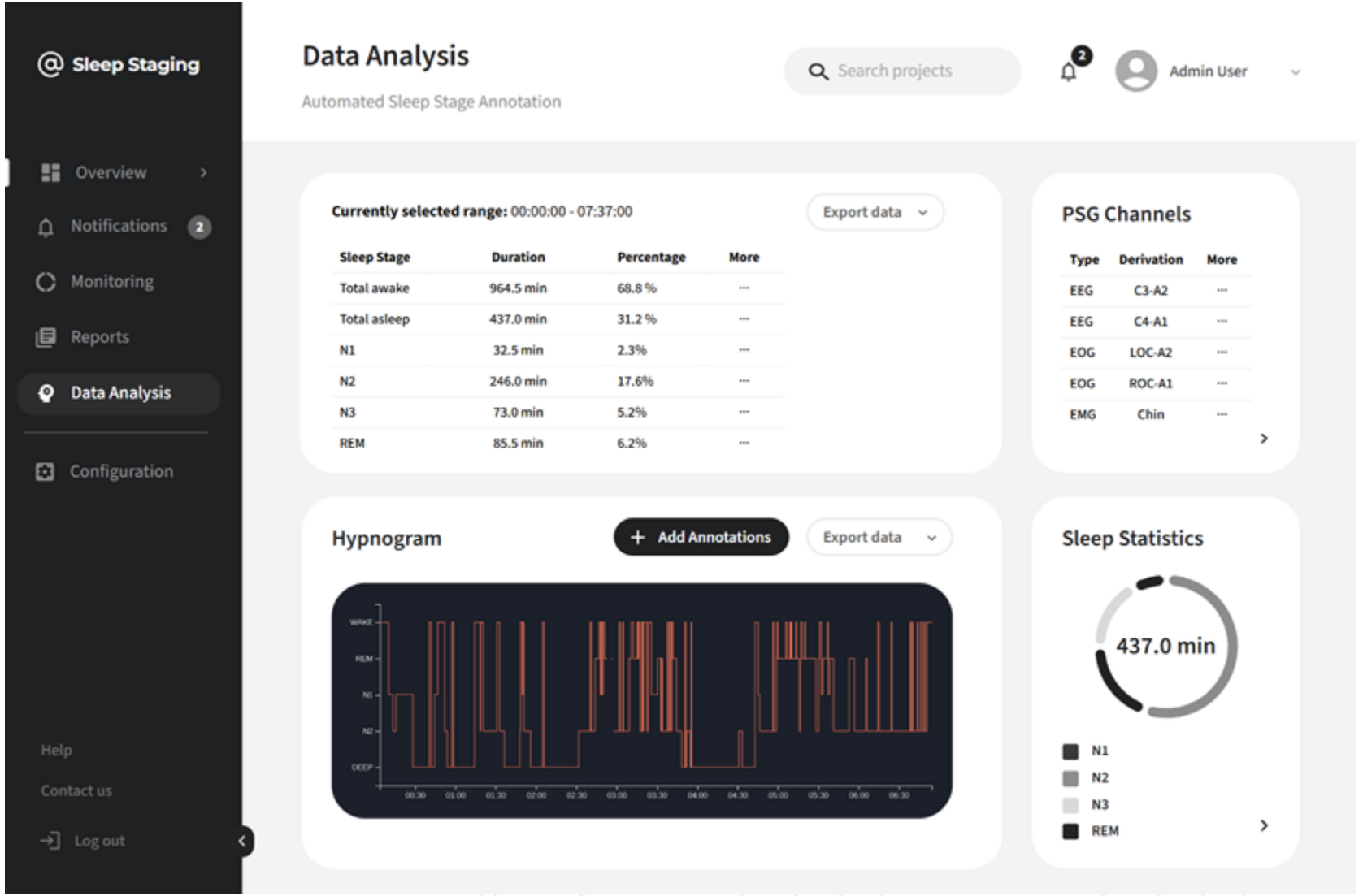
Use Case – Healthcare: Sleep Stage Classification

- Local application of the trained global model on new EEG data
- Hypnogram visualization and per-stage statistics remain **within the hospital's environment**
- No inference results are sent back to the central server



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Summary & Next Steps

- Flower-based FL engine wrapped in a user-friendly toolbox
- Supports privacy-preserving training across multiple institutions
- Proven in the sleep staging use case with real clinical workflows
- Next steps: integration with TITAN security stack (SSI/DID, TEEs, DLT)

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Thank you for your attention

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