PAROMA-MED

Privacy Aware and Privacy Preserving Distributed and Robust Machine Learning

European Health Data Slice and the evolving European Health Data Space and the use case of the PAROMA-MED Project

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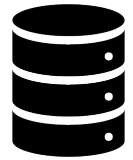
The Shift Toward Data-Driven, Human-Centered Healthcare in Europe

- Growing emphasis on preventive, personalized, and precision medicine
- Rising need for health data to inform research, innovation, and public health
- Cross-border healthcare requires harmonized data infrastructures
- Citizens demand greater control over their health data

Vision of the European Health Data Space (EHDS)



- EU initiative to create a unified framework for health data access and exchange
- Supports both primary use (individual care) and secondary use (research, policymaking)
- Builds trust through strong data governance and citizen-centric control

EHDS: Key Principles

Core Features of the EHDS

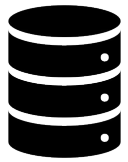
- Interoperability across national and regional health systems
- Data security and compliance with GDPR
- Citizen empowerment and consent-driven data usage
- Support for innovation in AI and digital health

What is a Health Data Slice?

- A thematic or project-specific implementation of EHDS principles
- Offers federated, secure, and policy-aligned data access
- Enables cross-border research while preserving local data governance
- Accelerates specific use cases (e.g., rare diseases, personalized medicine)

Data Ecosystems with 6G

- New capabilities to exploit
  - Terabit-per-second data rates and ultra-low latency
  - Enhanced automation, flexible deployments, and end-to-end slicing techniques.
- Expected impact
  - New application in high-capacity sectors: healthcare, augmented reality, IoT.
  - Secure, private bandwidth for critical systems like Electronic Health Records (EHR).
- Proposed innovations
  - Functional GDPR Approach
    - Continuous transparency and automated privacy validation.
  - Moving beyond accountability to proactive data flow control.



Stakeholder Roles and Needs in Data Utilization

- Data Subject
  - User-centric tools: push notifications, wallet apps, assisted consent management.
  - Empowerment through transparency and control over data rights.
  - Simplified interfaces for informed decisions and data monitoring.

- Data Scientist
  - Access to rich, high-quality data using FAIR principles.
  - GDPR-compliant workflows with continuous consent enforcement.
  - AI models treated as data assets with a managed lifecycle.

- Health Experts
  - Empowering physicians with control over metadata creation.
  - Metadata as assets: linked to ownership, consent, and traceability.
  - Enhanced insights via ML-based processing.

- Businesses and Health Organizations
  - Edge-based Horizontal Federated Learning to ensure data privacy.
  - Secure local processing with data shared only among verified modules.
  - Balancing data monetization with privacy compliance and accountability.

PAROMA-MED and Data Spaces Ready Approach

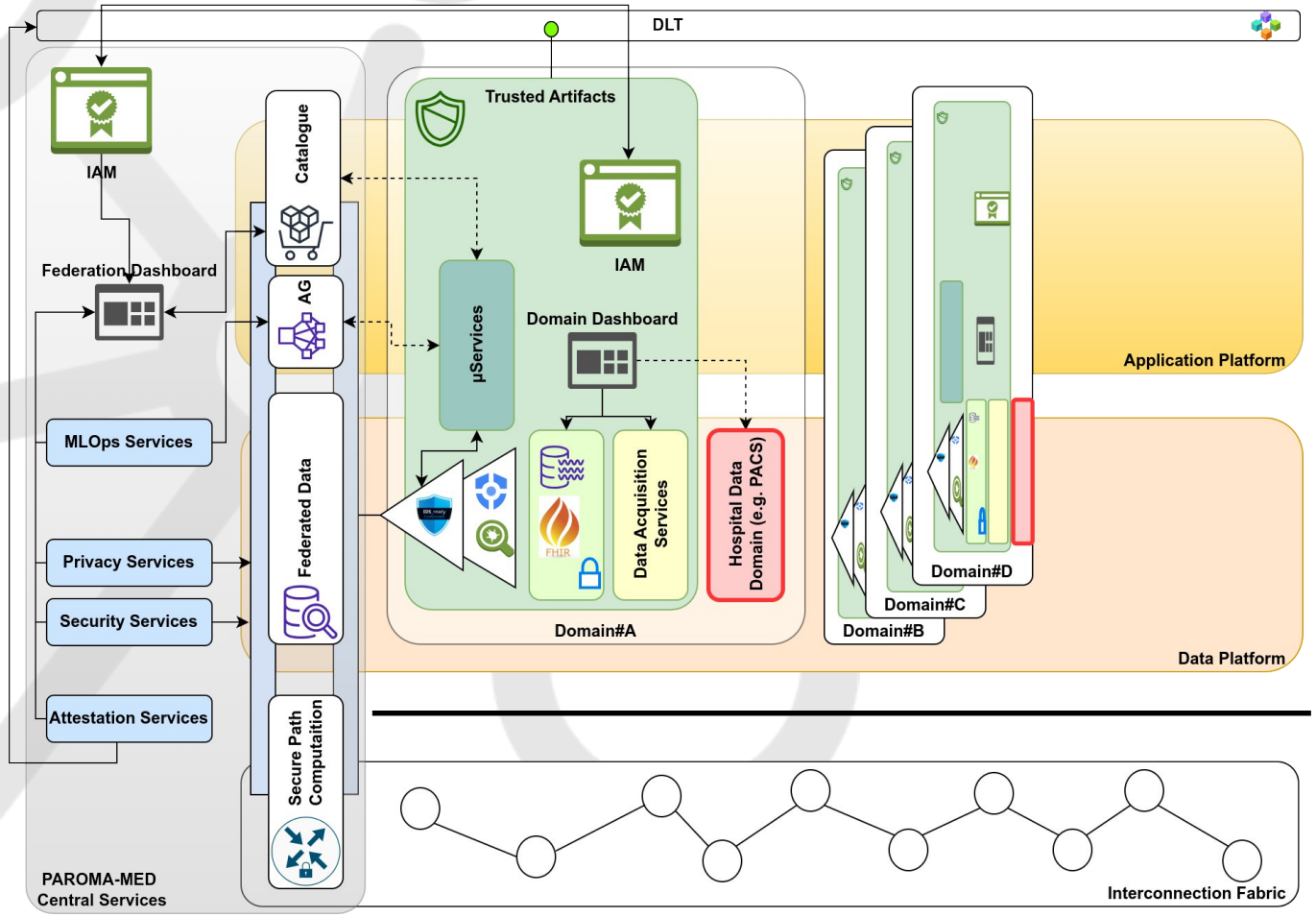
- Take advantage of Data Spaces features:
  - Enable data sharing while maintaining sovereignty principles.
  - Address healthcare-specific challenges like GDPR variations and market fragmentation.

- Apply as core principle:
  - Eliminate actual private data exchange while enabling in-place data processing.

- With overall goal:
  - Support scalable, privacy-respecting Healthcare Data Spaces.
  - Ensure data utilization aligns with user-defined consent options.

PAROMA-MED Architecture

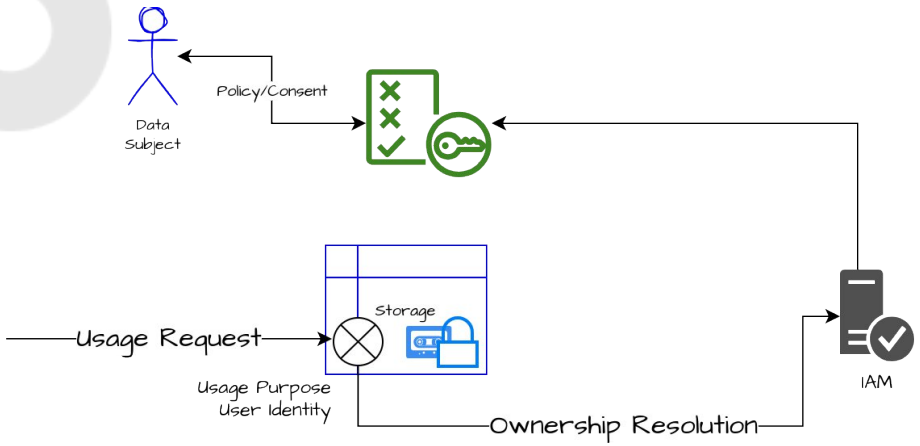
- Hybrid Cloud Design:
  - Combines centralized and decentralized components for domain sovereignty and transparency.
  - Supports compliance with current and evolving legislation.
- Layered Structure:
  - Interconnection Layer: Secure Path Computation for controlled data flow.
  - Data Layer: Federation and ergonomic tools for sovereign data management.
  - Application Layer: Simplified deployment, operation, and monitoring with privacy preservation at its core.

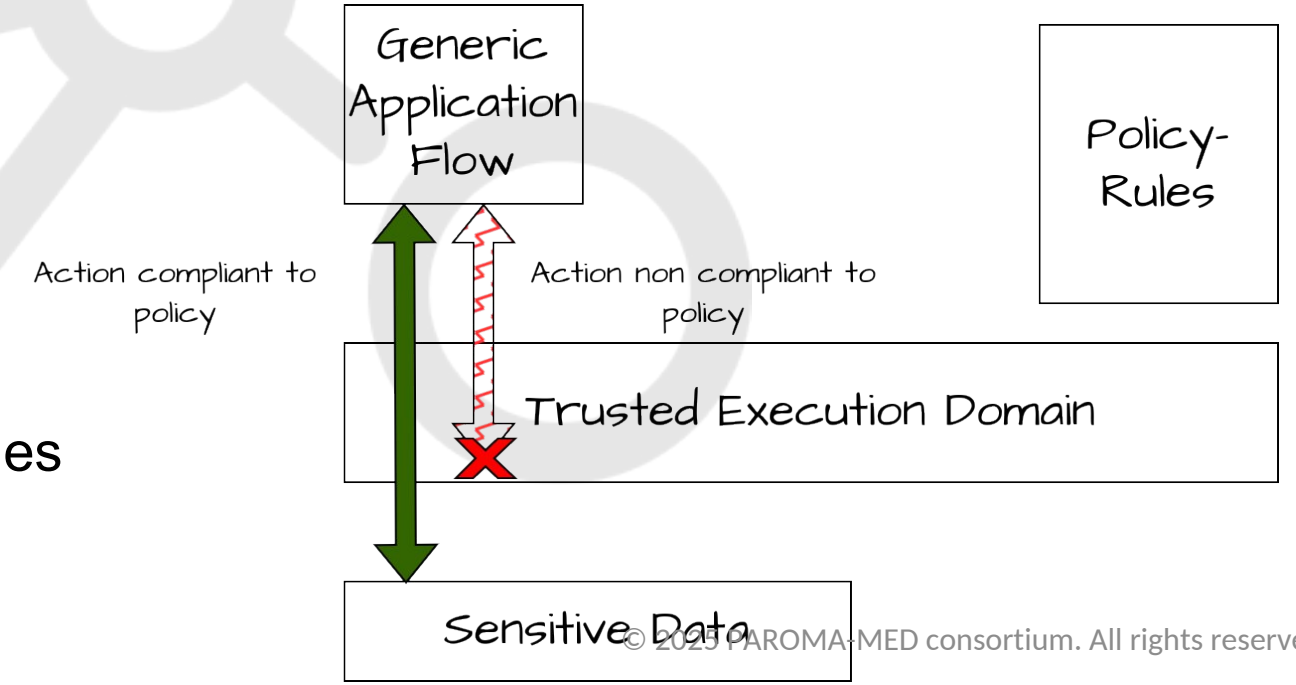


Data Protection and Consent Management

- Dynamic Consent Management:
  - Notifications for missing consent via wallet or web dashboard apps.
  - Consent statements govern data use, enforced by a Protection Layer.

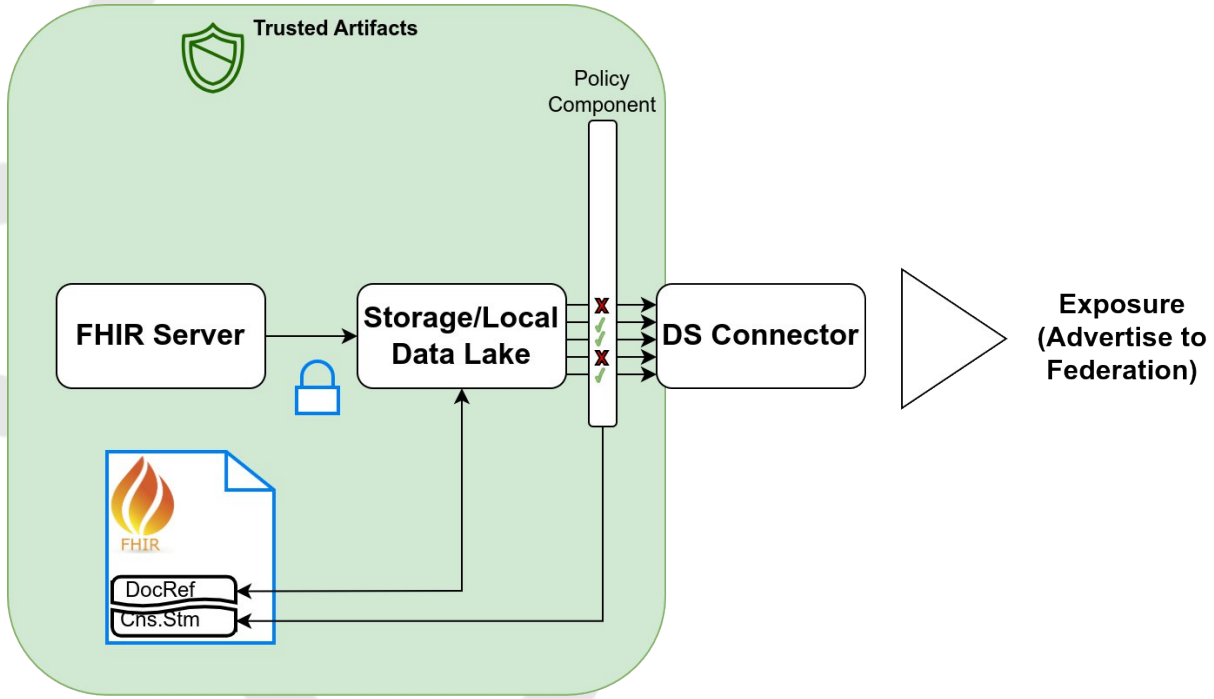
- Protection Layer Roles:
  - Validate adherence to consent policies.
  - Block non-compliant actions dynamically.
  - Enable updates to consent policies as needed.





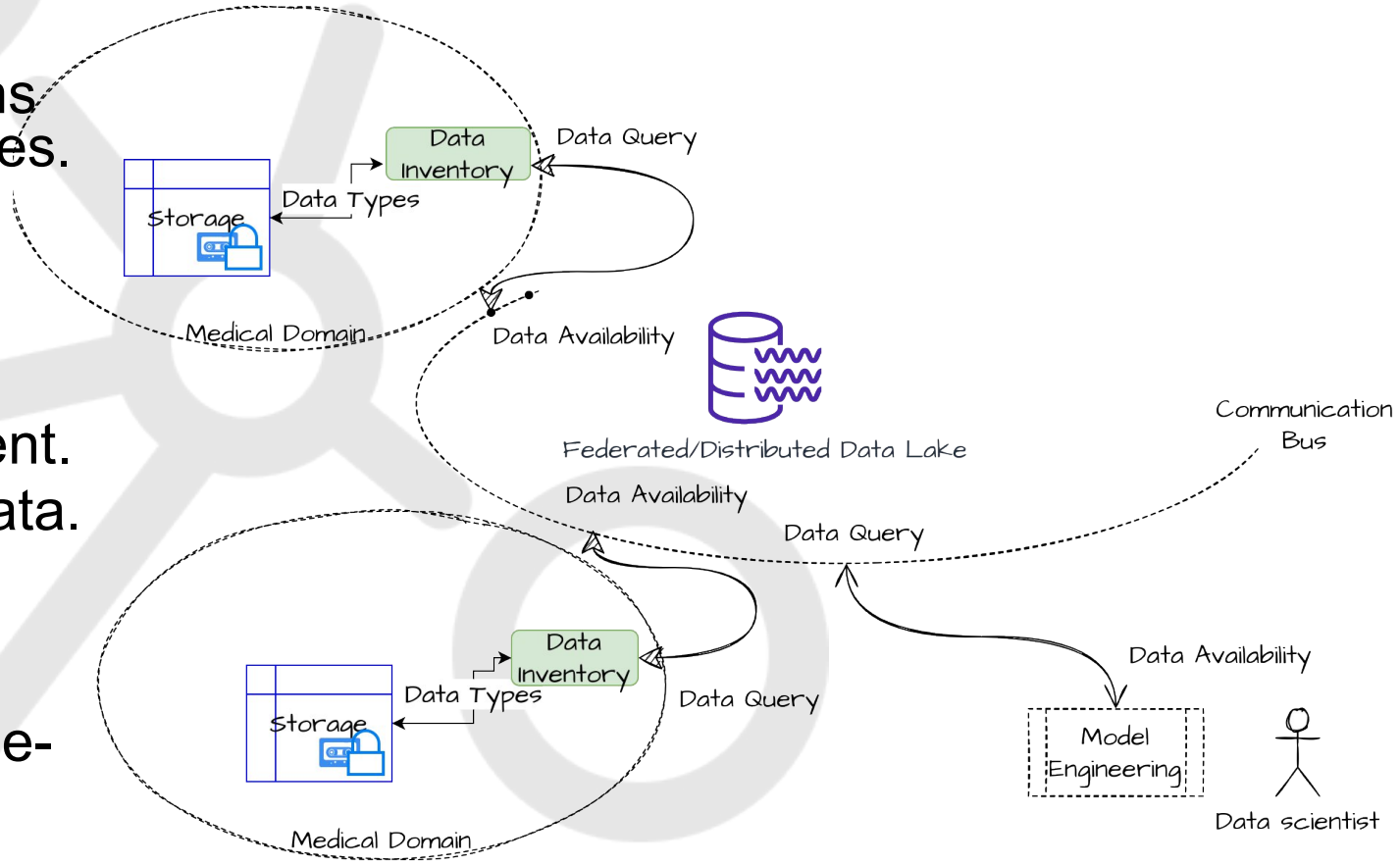
Data Exposure Approach

- Fast Healthcare Interoperability Resources (FHIR) server combined with secure object storage.
- Constraints from policies indicated by the individual consents are applied and the result updates are pushed through the Data Space Connnector



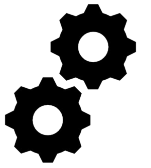
Enabling Federated Learning

- Federated Query Process:
  - Queries resolve across domains while adhering to privacy policies.
- Data categorized into:
  - Directly usable data.
  - Data requiring additional consent.
  - Unknown relevance/quantity data.
- AI Model Training:
  - Data processed in isolated, time-limited environments.



Security and Privacy Framework

- Privacy-by-Design:
  - Identity and Access Management (IAM), anonymization and OpenID Connect (OIDC).
  - Role-Based (RBAC) and Attribute-Based (ABAC) access control models.

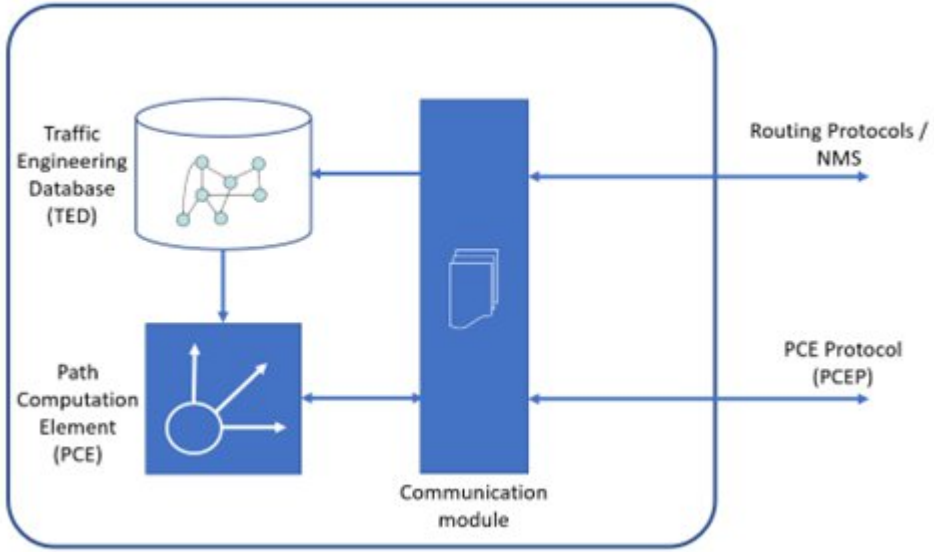


- Zero Trust Security:
  - Comprehensive protection for APIs, data handling, and federation partners.
  - Privacy-preserving data storage and processing across borders.

- Key Benefits:
  - Automated federation partner attestation.
  - Federated identity and access management.
  - Flexible and secure access to private data while ensuring user preferences and regulatory compliance.

PAROMA-MED Network and Interconnect Platform

- Path Computation Element (PCE):
  - A specialized network entity for:
  - Dynamic path computations optimizing network performance.
  - Gathering data from Network Management Systems (NMS) for enhanced routing.
- Key Features:
  - Supports multi-layer networks with Quality-of-Service (QoS) guarantees.
  - Security, privacy, performance, and traffic volume constraints.
- Innovations:
  - Patent-protected framework: “Path Computation in a Communication Network.”
  - Advances beyond traditional bandwidth/latency paradigms.
  - Tailors network slices for secure, private, and trustworthy 5G/6G communications.



Implementation Status

- Core Architectural Integrations:
  - Dataspace Connector
    - Built on Eclipse Dataspace Components.
    - Incorporates Dynamic Attribute Provisioning Service and Broker Extensions for proof of concept.
  - FHIR Server (HAPI-FHIR):
    - Coupled with a production-grade object storage solution.
    - Integrated with DICOM backends for seamless data ingestion.
  - Consent Management System:
    - Manages consent options for each field of personal and medical data.
    - Enables tailored configuration for diverse use cases.
  - Application in Federated Learning:
    - Utilizes consent options for data advertisement via Dataspace Connectors.
    - Supports contract negotiation for GDPR-compliant data provisioning.
- Pilot Success and Next Steps:
  - Proof of Concept: Demonstrated effectiveness in federated learning scenarios.
  - Future Workshops: Evaluate performance with citizens and medical experts.

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Thank you!

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