

Building an African **Bioinformatics** Data Ecosystem, Leveraging **NRENs** to Support Genomics Research and Collaboration

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Presented by; Joachim Ssenkaali
PhD Bioinformatics student (ACE, kampala) & Lecturer of
Physiology (Lira University), jssenkaali@lirauni.ac.ug

Co-authors: Lydia Abolo, Onan Mulumba



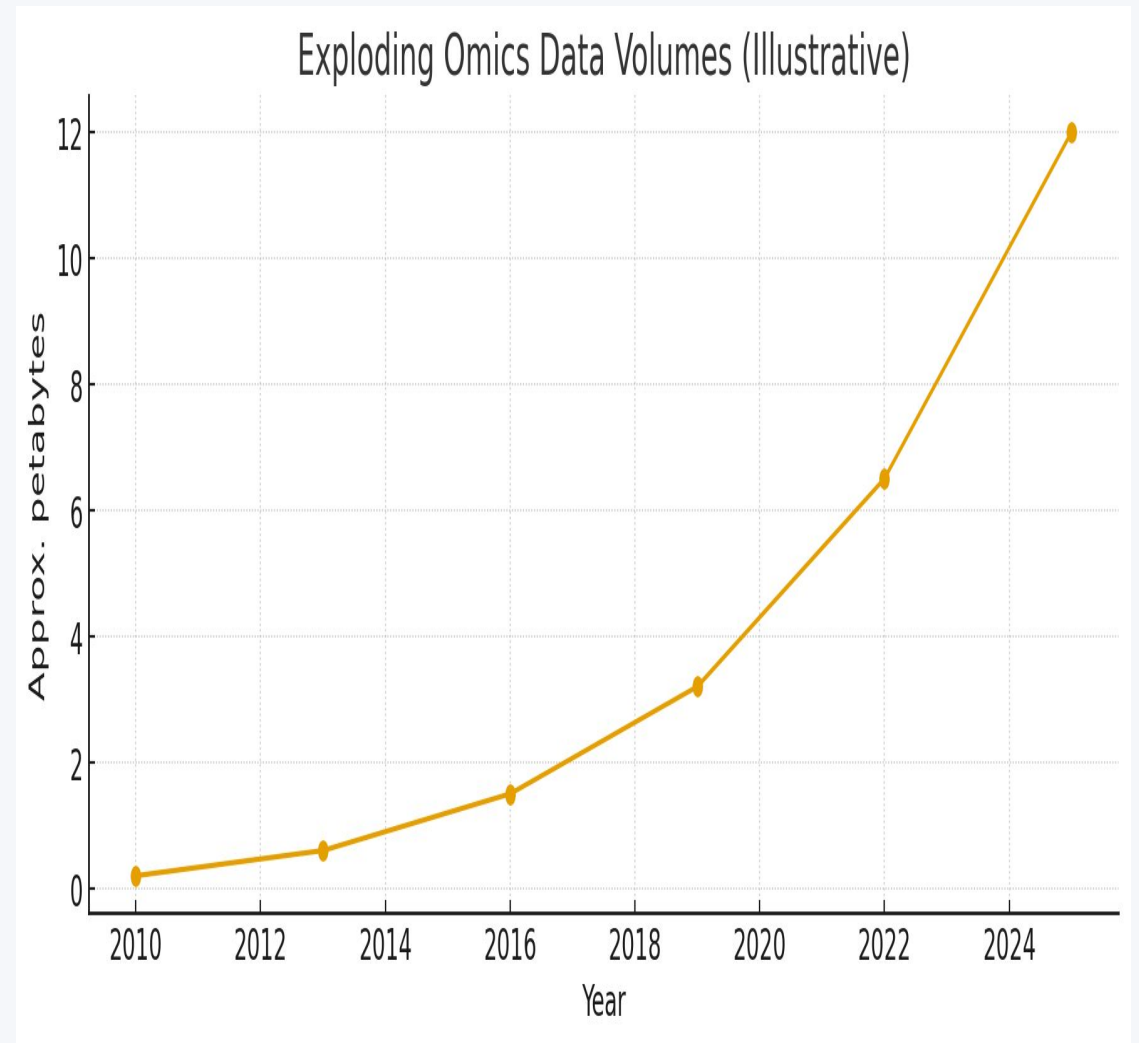
Why Genomics Matters for Africa



- **Unparalleled Opportunity:**
 - Africa hosts the greatest human genetic diversity.
 - Potential for groundbreaking discovery, precision medicine, and improved public health.
- **The Critical Barrier:**
 - Realizing this potential requires managing **terabyte-scale datasets**.
 - This demands robust, scalable, and collaborative data infrastructure that is currently **fragmented and inadequate**.

Genomics is Data-Intensive

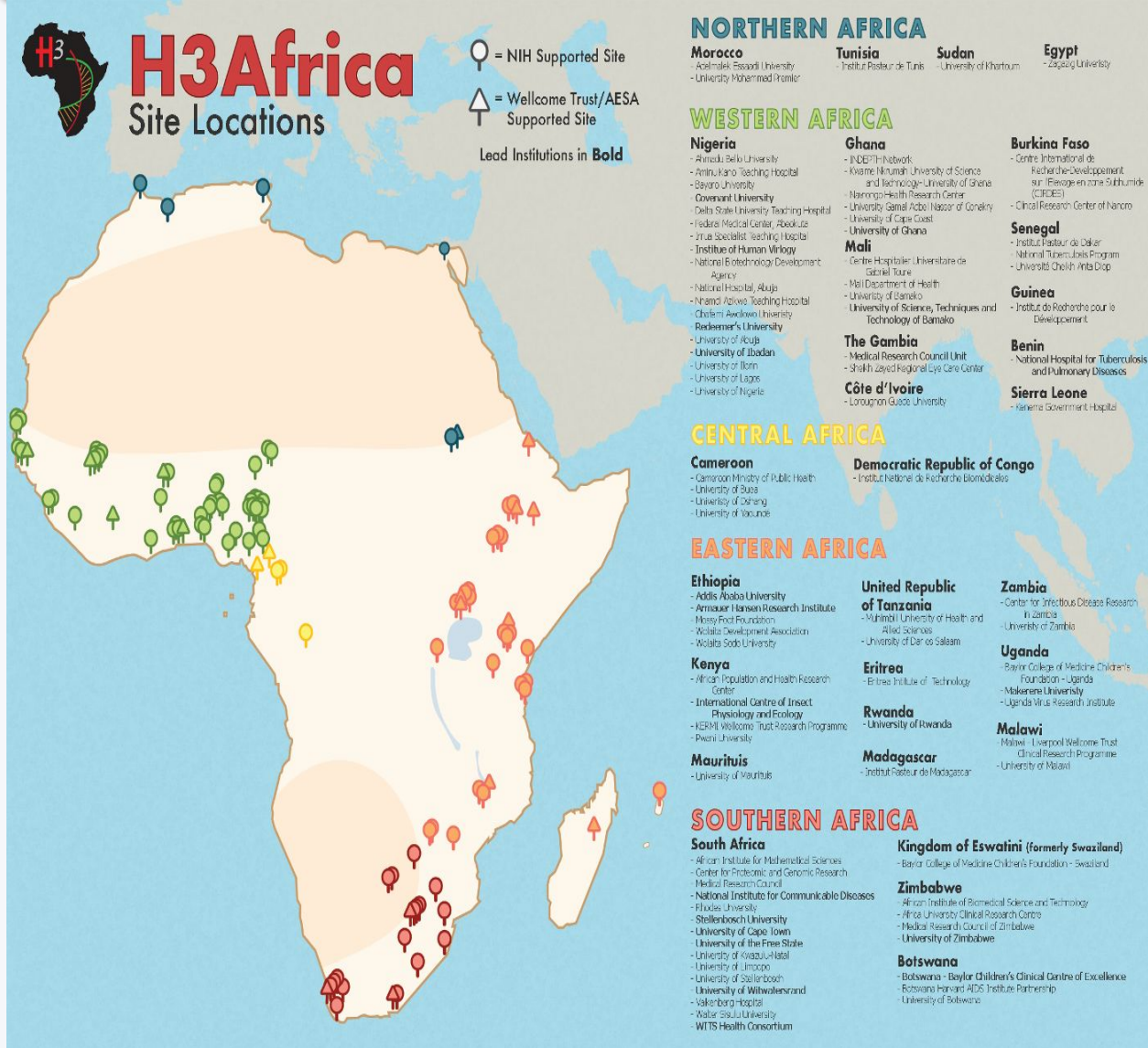
- **Local Capacity is Growing:**
 - Initiatives like the **African BioGenome Initiative (ABI)** are expanding local sequencing.
- **But a "Data Chasm" Persists:**
 - **Challenge:** Managing, analyzing, storing, and sharing vast datasets.
 - **Result:** Data is often **siload** or sent **off-continent** for analysis and storage.
- **The Consequences:**
 - Undermines **scientific sovereignty**.
 - Delays the **translation of research into local health benefits**.
- Exploding omics volumes require HPC, secure platforms, and high-bandwidth networks



The Infrastructure Gap & “Data Chasm”

- Limited computing, storage, and governance hinder local analysis
- Data often siloed or stored off-continent, affecting sovereignty and timeliness
- Local sequencing capacity grows (ABI), but data management lags

Current Interventions & Persistent Gaps



- **Existing Strategic Initiatives:**
 1. **H3Africa & H3ABioNet:** Built bioinformatics nodes, biorepositories, and ethical guidelines.
 2. **High-Performance Computing (HPC):** e.g., Ilifu Cloud (SA), ACE-Makerere (Uganda).
- **The Systemic Gaps They Expose:**
 1. **Sustainability:** Grant-dependent, no long-term funding.
 2. **Fragmented Access:** No single login for distributed resources.
 3. **Data Mobility:** Poor connectivity hinders cross-border data transfer.
 4. **Data Governance:** A patchwork of policies stifles collaboration.

The Foundational Solution: National Research & Education Networks (NRENs)

What are NRENs?

- high-capacity internet backbones for universities and research institutions.
- **Examples:** RENU (Uganda), TENET (South Africa), Ubutunet Alliance (Regional).

The Core Value Proposition:

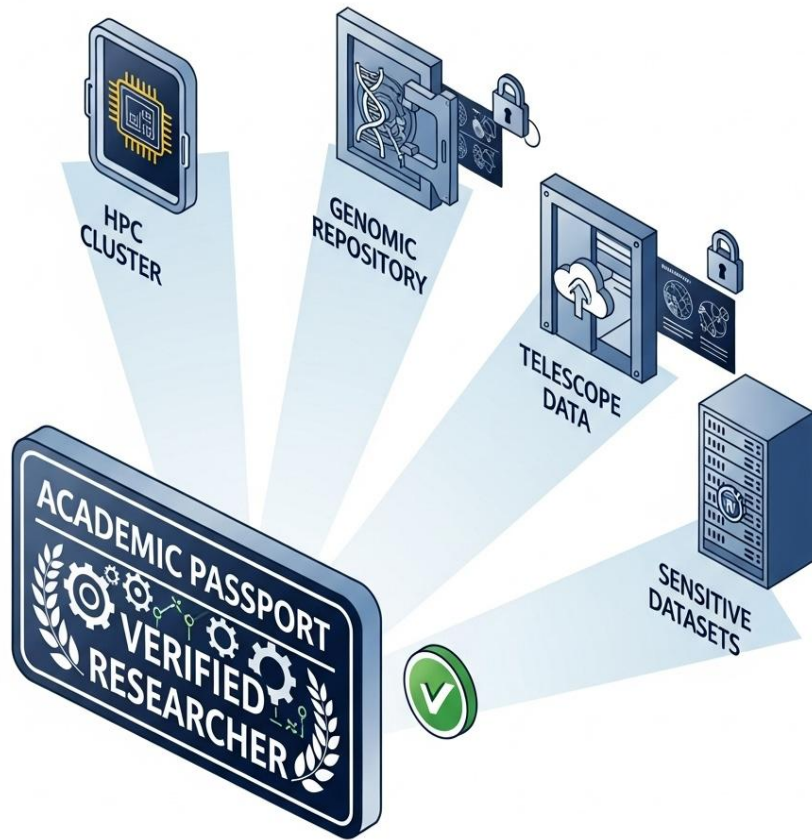
- They provide a **permanent, sustainable infrastructure** funded by institutional membership, outlasting short-term project grants.

How NRENs Bridge the Gap (1/3): Sustainable Infrastructure

- **Problem:** Project-based digital resources face perpetual funding uncertainty.
- **NREN Solution: A Permanent Backbone**
 - Funded through stable **institutional membership models**.
 - Ensures core connectivity and services endure **beyond the lifecycle of any single research grant**.
 - Provides a foundational platform for long-term research.



How NRENs Bridge the Gap (2/3): Unified Access Remaining Systemic Gaps



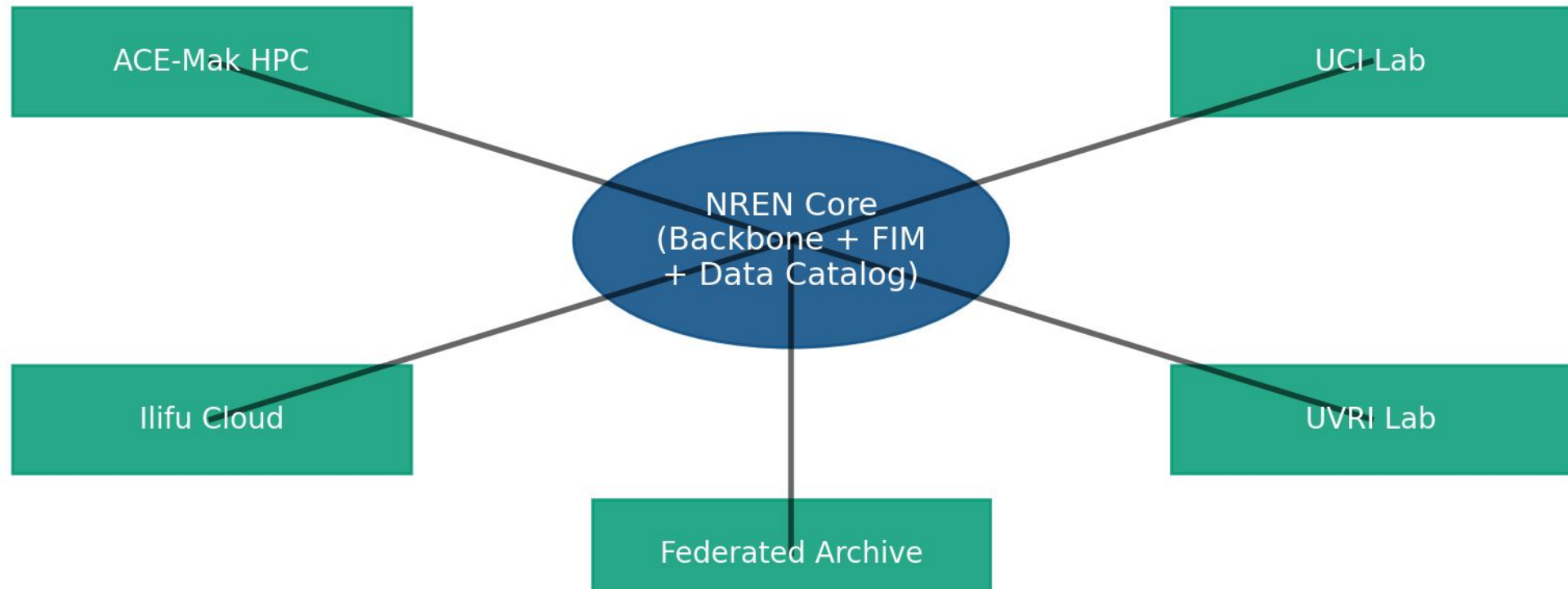
- **Problem:** Researchers need multiple logins for different resources across institutions.
- **NREN Solution: Federated Identity Management (FIM)**
 - Implements systems like the international **eduGAIN** framework.
 - Acts as an "**academic passport**" – a single university login grants secure access to resources across the continent.
 - Breaks down digital silos and accelerates collaboration.

How NRENs Bridge the Gap (3/3): High-Speed Data Mobility

- **Problem:** Transferring terabytes of data over commercial internet is slow and costly.
- **NREN Solution: Science Data Networks**
 - **High-speed, low-latency backbones** are designed for data-intensive research.
 - Can implement "**Science DMZ**" architectures for optimized, high-capacity data flow.
 - Enables seamless transfer of data from a sequencer in Kampala to an HPC cluster in Cape Town.

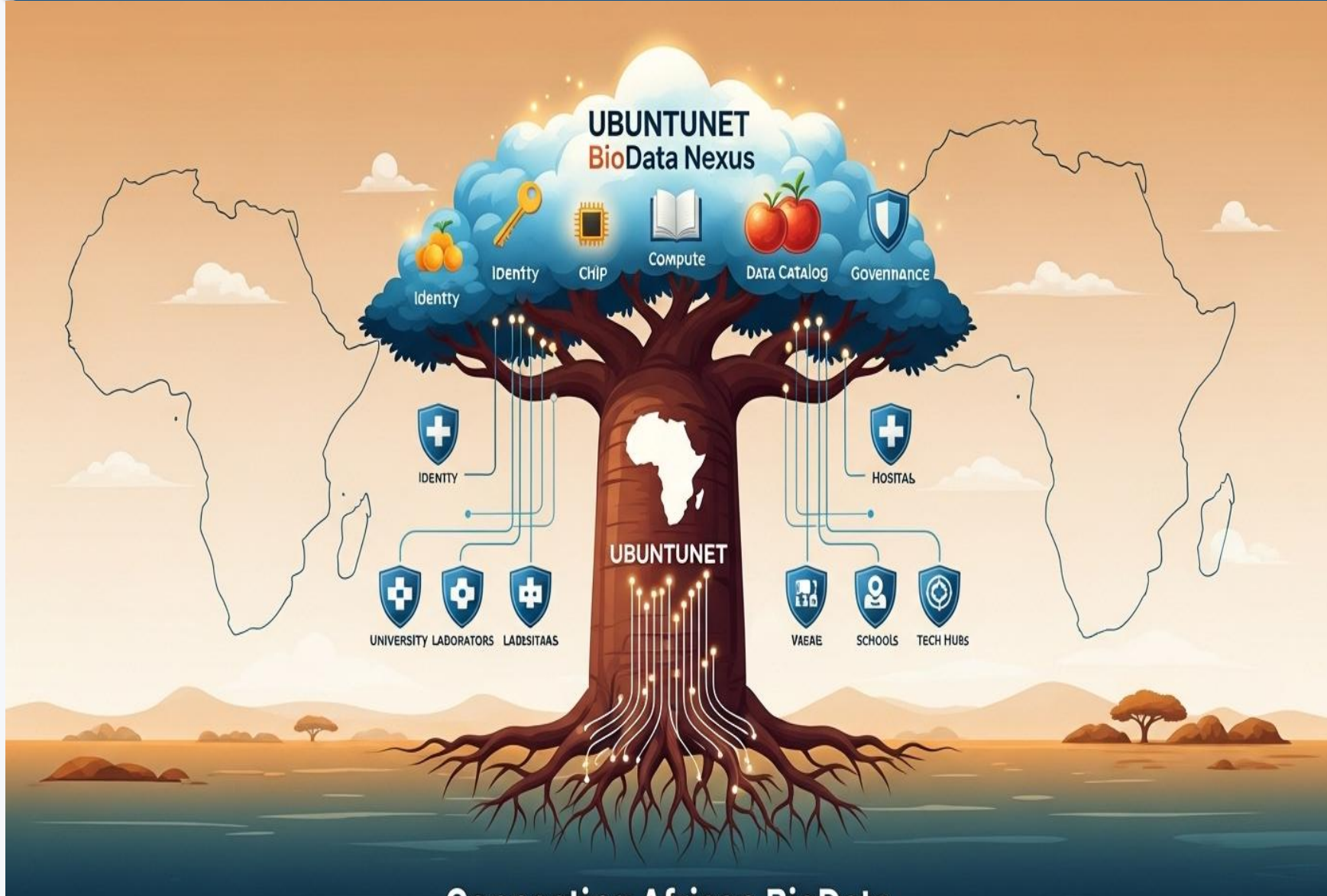


NREN Pillars: Sustainability • Unified Access • Data Mobility • Governance



Federated model via NREN core: Backbone + FIM + Data Catalog connecting labs, HPC, and archives.

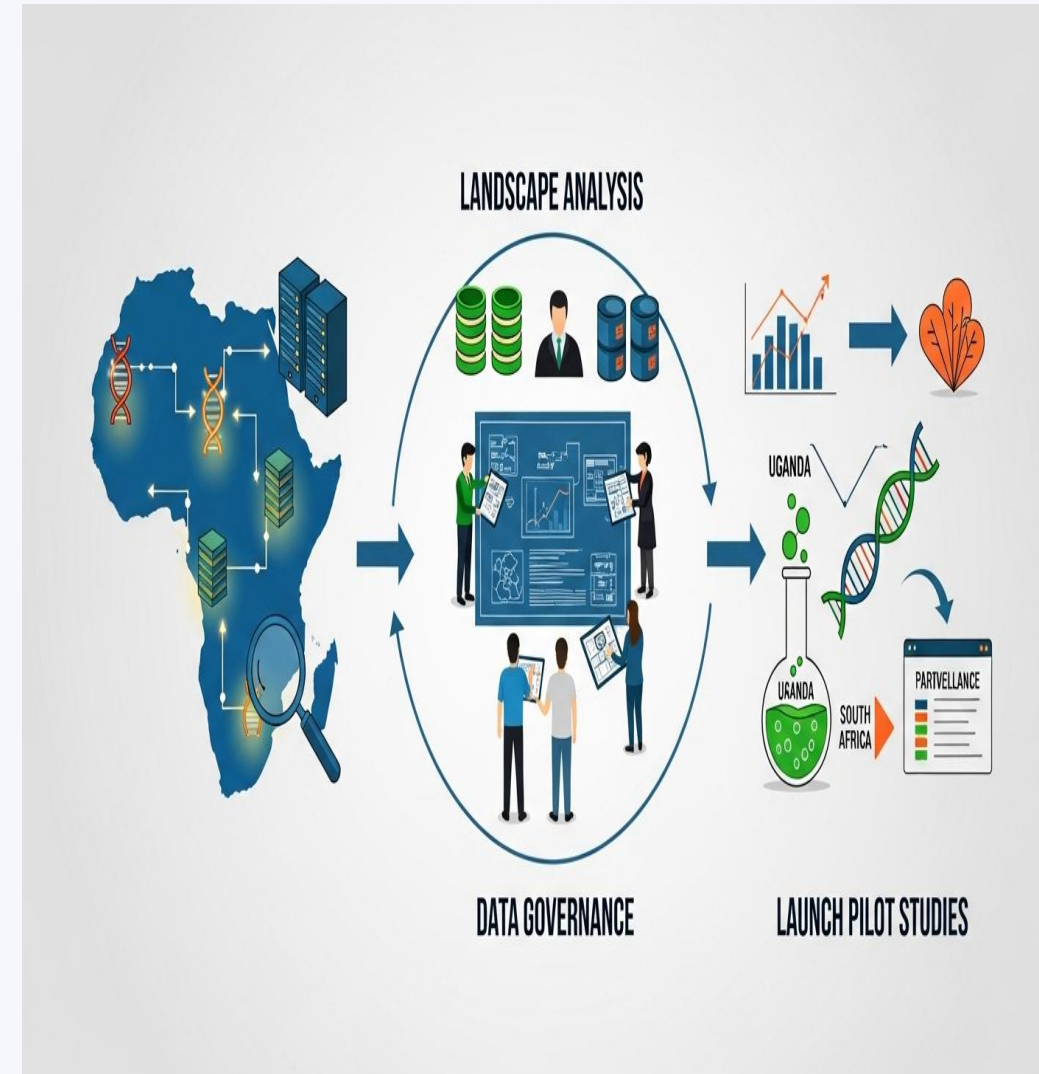
The Vision: The UbuntuNet BioData Nexus



- A **federated genomics data ecosystem** built on the existing NREN infrastructure.
- **Core Principles:**
 - **Federated:** Connects existing resources instead of replacing them.
 - **Secure:** Built with integrated data governance and identity management
 - **Sovereign:** Keeps data and control within African institutions
 - **Sustainable:** Based on a long-term, cost-sharing model.

Framework for Action - Phase 1: Foundation & Piloting

- 1. Landscape Analysis:**
 - Map all existing genomic data generators, computational resources, and repositories.
- 2. Multi-Stakeholder Task Force:**
 - Bring together NRENs, bioinformaticians, and policymakers to draft governance blueprints.
- 3. Launch Pilot Studies:**
 - e.g., A pathogen surveillance project transferring data from Uganda to South Africa for analysis.



Framework for Action - Phase 2: Service Integration & Capacity



- **Hybrid Infrastructure:**
 - **Core Shared Resource:** A central, cloud-based HPC for baseline access.
 - **Federated Resource Pool:** Integrates major existing HPC clusters into a "virtual supercomputer."
- **Unified Services:**
 - **Federated Identity (FIM):** Single sign-on across the ecosystem.
 - **Federated Data Catalog:** Makes datasets discoverable across the continent (FAIR principles)
 - resource credits & fair use (EOSC model)
- **Applied Training:** Conduct workshops on the live BioData Nexus itself

Framework for Action - Phase 3: Sustainability & Policy

- 1. Pan-African Data Governance Policy:**
 - Formalize a continent-wide data sharing and access agreement.
- 2. Sustainable Financial Model:**
 - Mixed model: Institutional cost-sharing, fee-for-service for industry, strategic government funding.
- 3. Ecosystem Expansion:**
 - Onboard new members and integrate with global initiatives as an equal partner.



Benefits, Alignment & Call to Action

- Resilience via federation;
- sovereignty via local stewardship
- Alignment with global trends (GRIN; FAIR; EOSC)
 - **EOSC (European Open Science Cloud):** Demonstrates a successful federated resource-sharing model.
 - **GRIN (Genomics Research and Innovation Network):** Successfully created a federated IT infrastructure for genotype-phenotype data across multiple hospitals



Selected references: Choudhury et al., 2020; Stephens et al., 2015; Rotimi et al., 2014; Mulder et al., 2016; Ouma et al., 2023; GÉANT, 2022; Dart et al., 2013; World Bank Group, 2024; European Commission (EOSC).

Conclusion & Call to Action

(Visual: A hopeful image of an African researcher looking at a screen displaying genomic data, with the NREN network visible in the background.)

- Africa's genomic potential is limited by a **data chasm**, not a lack of scientific ambition.
- **NRENs provide the missing foundational layer** of trust, policy, and cyberinfrastructure to bridge this chasm.
- The **UbuntuNet BioData Nexus** offers a practical, phased framework for a unified, sovereign, and sustainable bioinformatics ecosystem.

We call upon the UbuntuNet Alliance and its member NRENs to formally champion this model and recognize bioinformatics as a priority use case