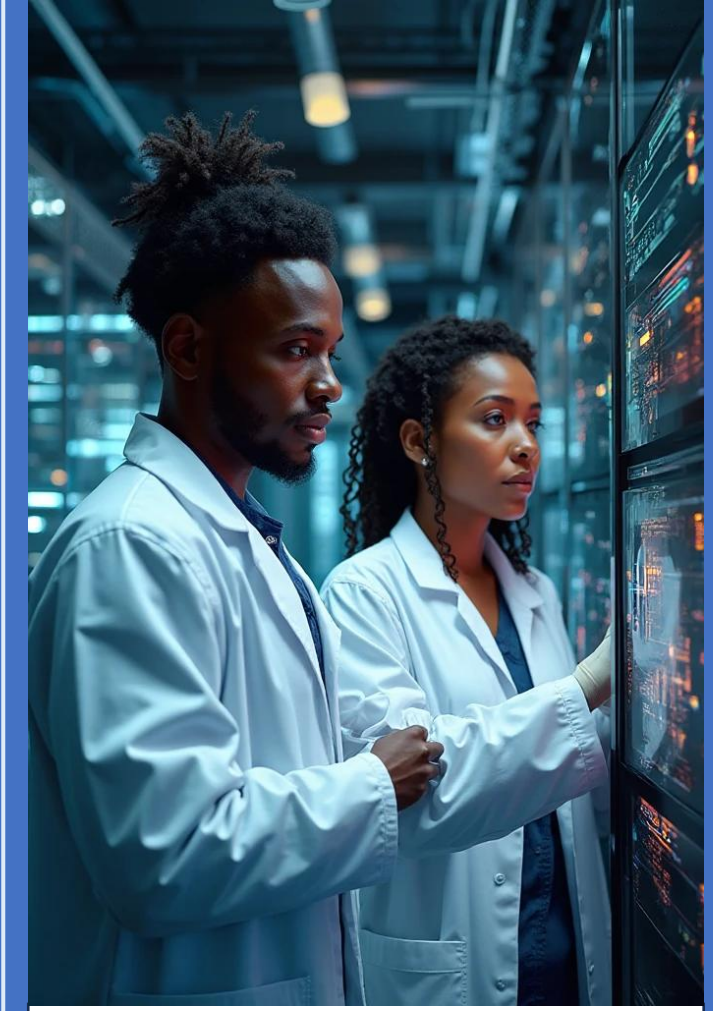


Title: Enhancing Access to Computational Resources through REN-High-Performance Computing and Cloud Infrastructure: The Case of and Covenant University

Presenter: *Chinedu Otuya*
Chief ICT Officer, Nigerian Research and Education Network (NgREN)

30–31 October 2025, Harare, Zimbabwe

1. 🟦Introduction: Context & Motivation

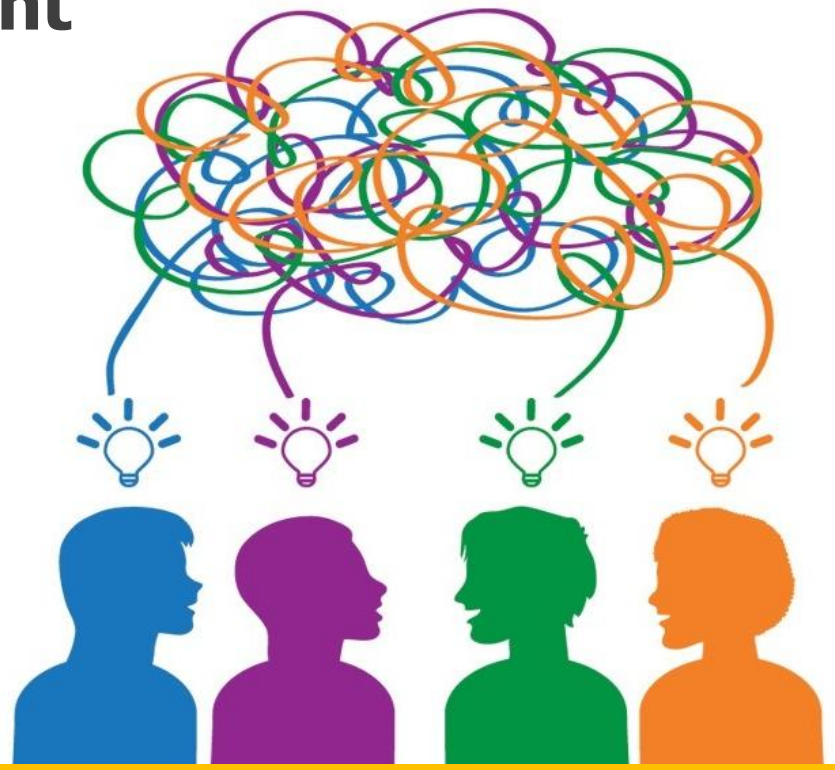
Why Computational Access Matters

- Increasing data-driven research and digital transformation in higher education
- Institutional servers often underpowered and costly to maintain
- Researchers need scalable, collaborative computing environments
- RENs can bridge infrastructure and capacity gap

1. 🟦 Research Gap / Problem Statement

Challenge in Nigeria's Research Ecosystem

- Uneven access to High-Performance Computing (HPC) and Cloud services
- High costs of infrastructure and maintenance
- Limited capacity for advanced research computing
- Fragmented institutional systems ("silos")



RQ1: How does the deployment of Research and Education Network (REN)-enabled High-Performance Computing and cloud infrastructure enhance access to computational resources for research and education in Nigerian universities?

RQ 2: What institutional, technical, and policy strategies can strengthen the sustainability and national adoption of REN-powered HPC and cloud infrastructure across Nigeria's higher education system?

RENs ACROSS THE GLOBE

2. 🟦 Literature Review: Role of Research and Education Networks (RENs)

RENs as Enablers of Shared Infrastructure

High Speed Connectivity

Shared Services and Cost Efficiency

Open Science, Open Infrastructure

Enhancing Research Collaboration

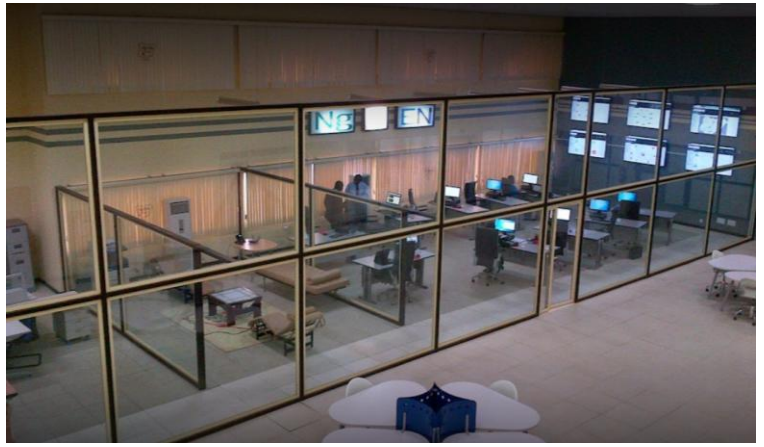
Capacity Building and Human Capital Development

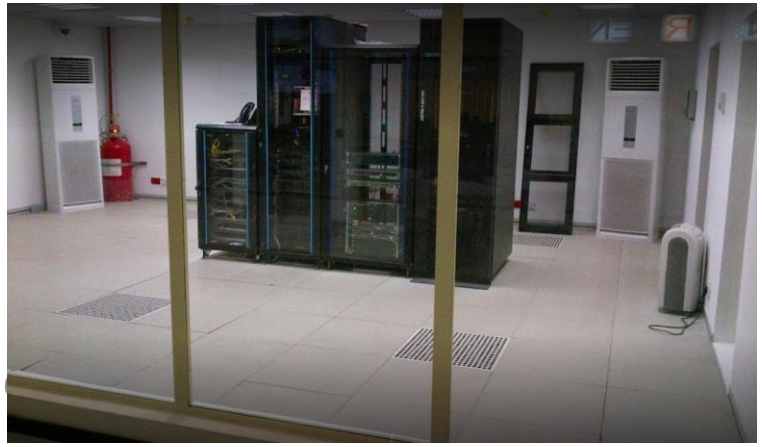
Enabling National and Regional Development (SDG4 –Quality Education, SDG9 –Industry, Innovation and Infrastructure)

Source: AfricaConnect3 (2022); Foley (2016); Steinhart et al (2024)

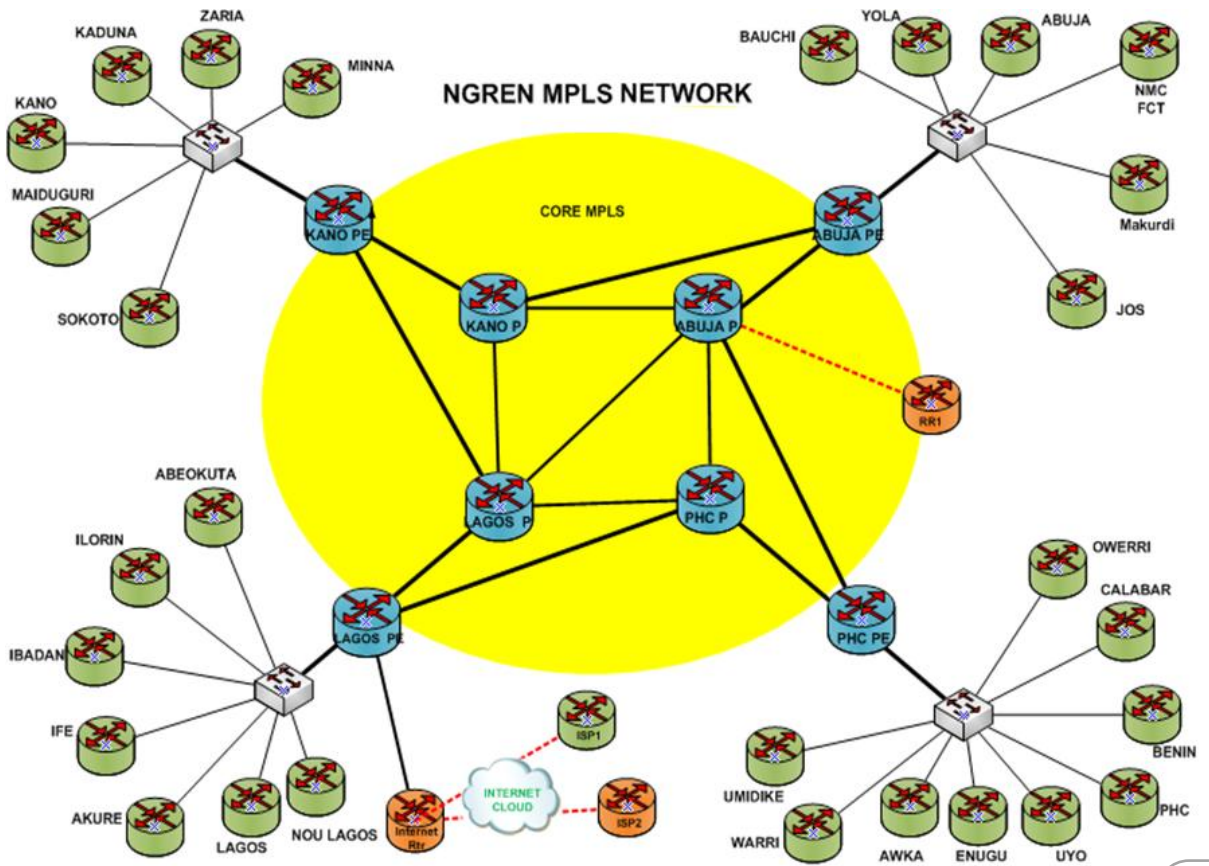
Case Study - NgREN as Nigeria's NREN

- Introducing the Nigerian Research and Education Network (NgREN).
- A member of the West and Central African Research and Education Network (WACREN), which comprises 15 NRENs across West and Central Africa.
- Domiciled at the National Universities Commission (NUC) Secretariat, Abuja.





Case Study: NgREN's Evolution (The Journey So Far - 2010 to 2014)



This phase was formally commissioned on 8th July 2014

Lots of infrastructure acquired with the World Bank support – the basis for the Network Operations till date

World Bank support came in 2012 to help build an initial phase of the network, connecting 27 Universities + NUC and CVC

Approvals of the HME, AGF and CAC to register as entity limited by guarantee in 2012 (21 Feb 2012)

Preliminary discussions, study visits, design, stakeholders' engagement, etc. between 2010 and 2012

Case Study: NgREN's Evolution (2014 to Date)

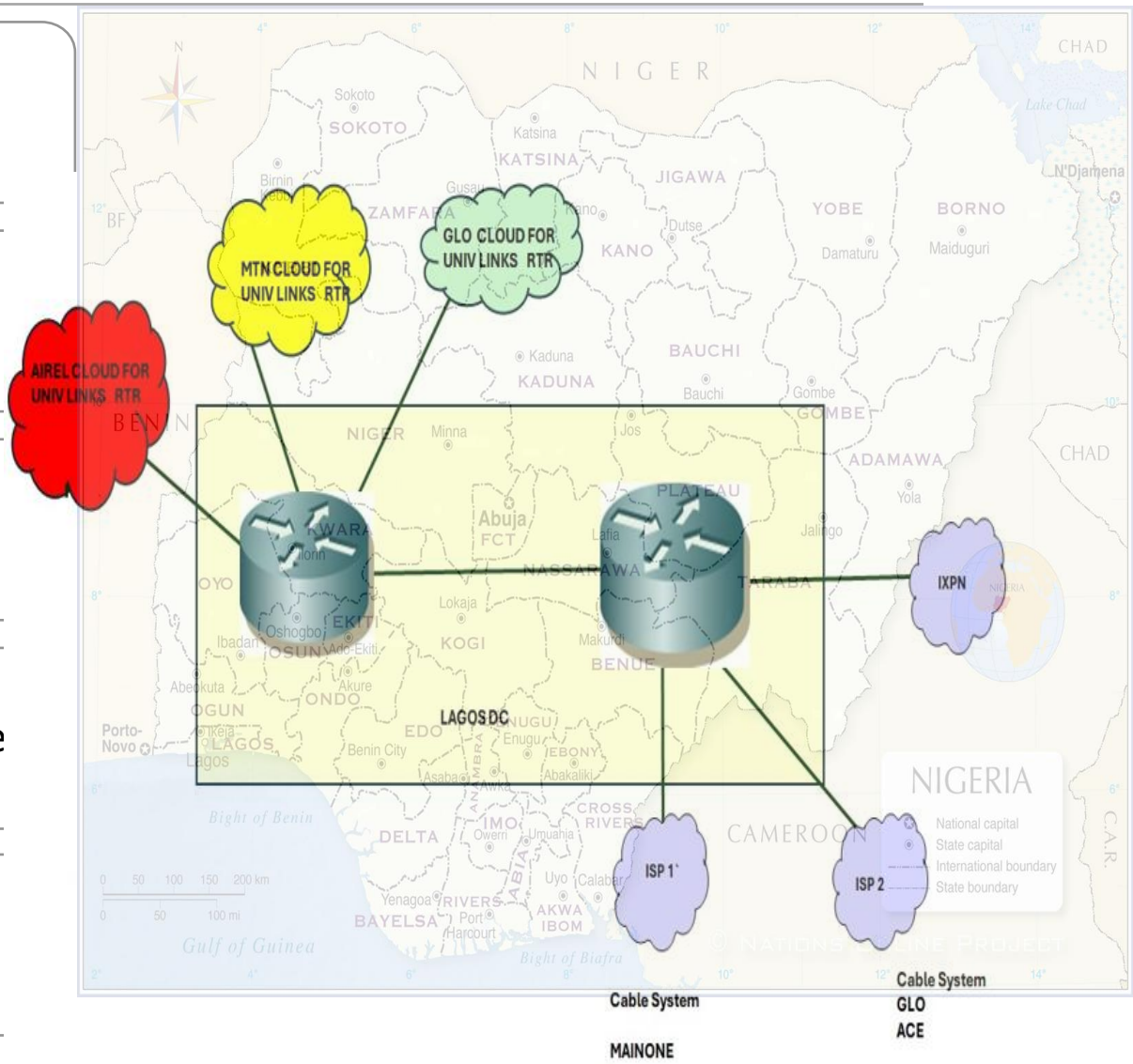
NgREN follows a hybrid governance structure that reflects both government support and member institution ownership through a collaborative initiative between the NUC and CVC.

NgREN strategic oversight and policy direction are provided by NUC Management and representation from member universities.

NgREN is currently sustained by subscriptions paid by participating universities

NgREN has grown beyond the initial intervention of World Bank of 2012 and connects about 45 universities (Federal, State and Private inclusive)

Given the increasing number of institutions on the network the network was redesigned in the diagram herewith



Current Network Diagram (2025)

Case Study – HPC Infrastructure

About 45 Institutions

- Collaboration Services
- Educational Services
- Connectivity Services
- Research Services

Service Providers: Airtel, MTN, Glo, 9Mobile, WACREN, IXPN, Dolphin

Lease line capacity: Approx. 30 Gbps
Internet Capacity: Approx. 30 Gbps

High-Performance Computing (HPC) System
CORE INFRASTRUCTURE

Full stack of IT infrastructure for Service Delivery

Underlying Infrastructure (32TB Storage, 814CPU, 8TB MEM – All Scalable)

Case Study – Cloud Infrastructure

VM on Managed Private Cloud for Education Community:

Universities have requested and have access to VMs running several applications including storage, labs, ERPs

Managed Software's on Private Cloud for Education Community:

moodle

Certification Portals

MONITORING AND EVALUATION

M&E Portal

Web Hosting & DNS

Managed Research Infrastructure Software's on Private Cloud for Education Community:

MATLAB

Anti Plagiarism DrillBit

ProQuest EBSCO ScienceDirect

Infrastructure as a service (IaaS)

Software as a Service (SaaS)

Research Infrastructure Service (RiS)

NgREN Cloud Services

Case Study - Accessing HPC and Multiple Cloud Platforms

Applications on HPC are securely accessed through an Identity Management System or Identity Federation (NgRENID)

eduroam

eduVPN

File Sender

Federated Repository

A cutting-edge repository system that connects and integrates multiple, separate institutional repositories so users can search, access, and use content from all of them through a single interface by metadata harvesting using identity federation.

Nigerian Institutional Repository and Identity System (NIRIS - https://niris.ngren.edu.ng/home)

Case Study - Covenant University (CU) HPC Initiative

CU – Institutional HPC Leadership

- National and Continental Leadership in HPC usage in Bioinformatics, Cancer & Malaria research, Genomics, Machine Learning (ML) & Deep Learning (DL) data analysis.
- HPC cluster implemented via CApIC-ACE (World Bank & AFD support)
- FEDerated GENeral "Omics" (**FEDGEN**) HPC Project
- Global partnerships: Inria and CIRAD
- Extending regional impact through training and federated cloud initiatives: Landmark University, Afe Babalola University, Universite Libre des Pays des Grands Lacs (ULPGL), Goma, Congo DRC

Case Study - Covenant University's FEDGEN Initiative

FEDGEN Apps

- Data Centre
- Coding Hub
- Testbed
- Fed Monitor
- Web Hosting
- Public Health Information System (PHIS)

FEDGEN Testbed

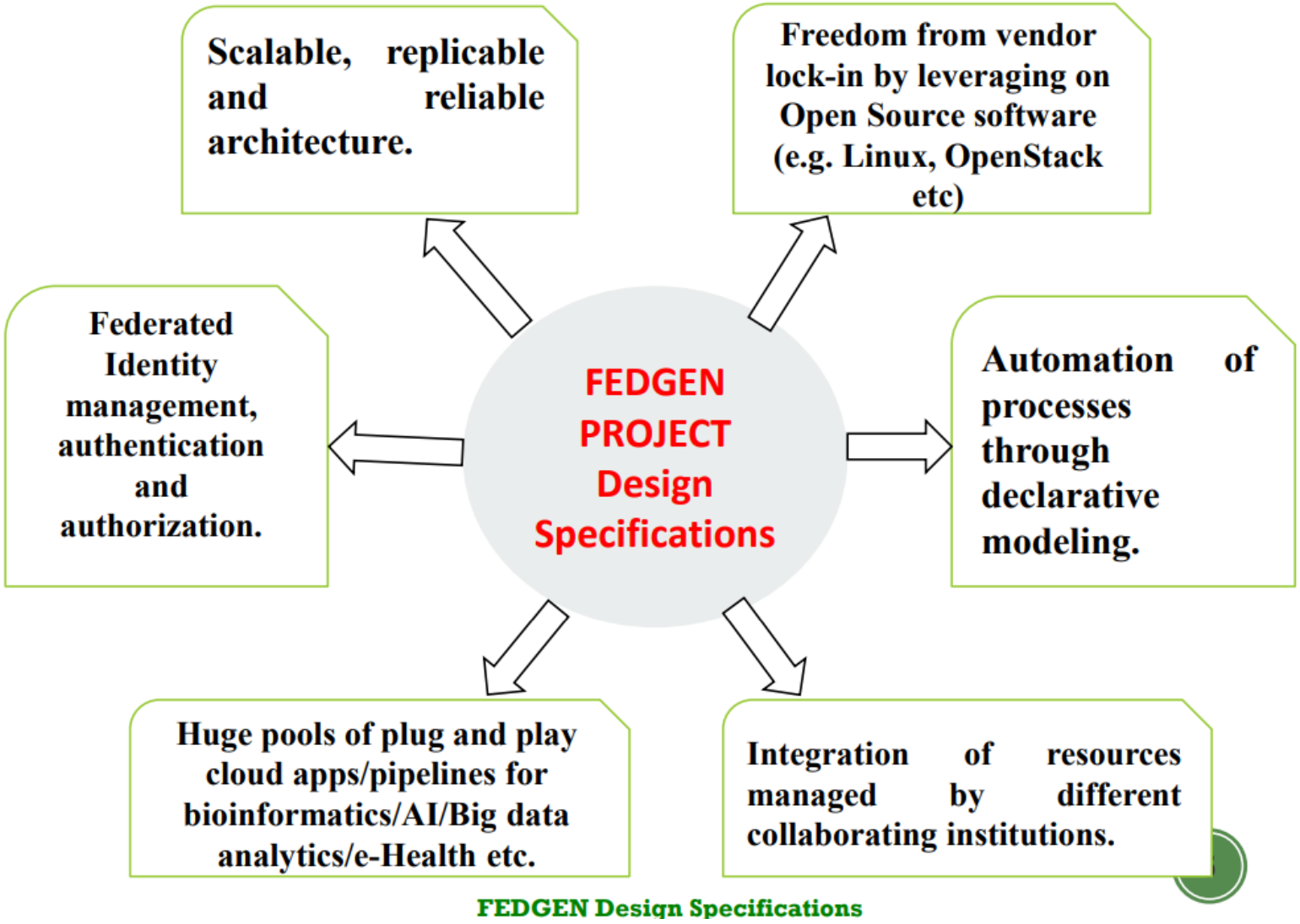
384	24	384 GB	72 TB
CPU cores	Compute Nodes	Memory (RAM)	Storage

FEDGEN Data Center

396	4	7	3.06 TB	65 TB
CPU cores	GPU nodes	Compute Nodes	Memory (RAM)	Storage

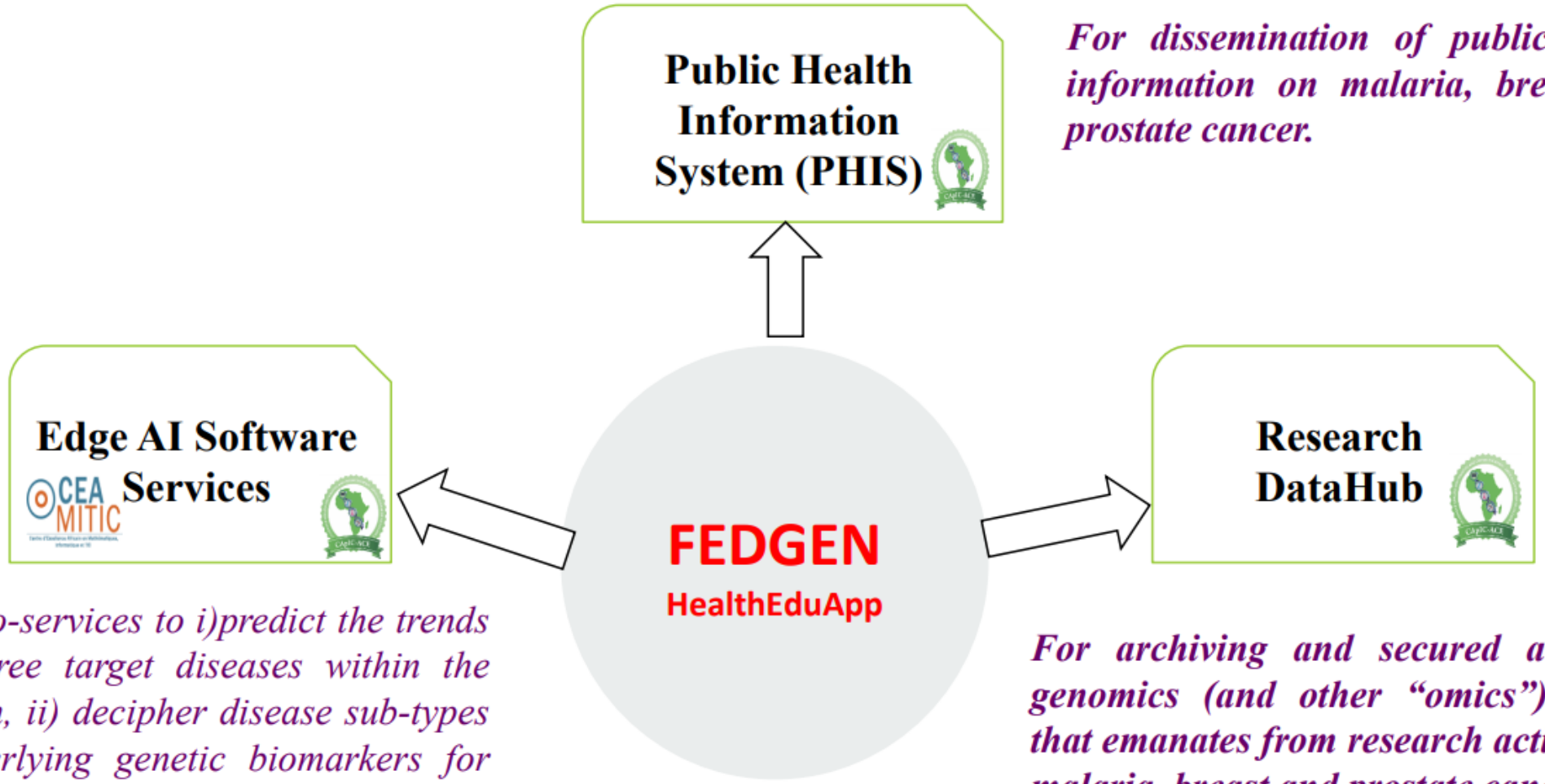
Case Study - Covenant University's FEDGEN Initiative

FEDGEN Design Specifications



FEDGEN Design Specifications

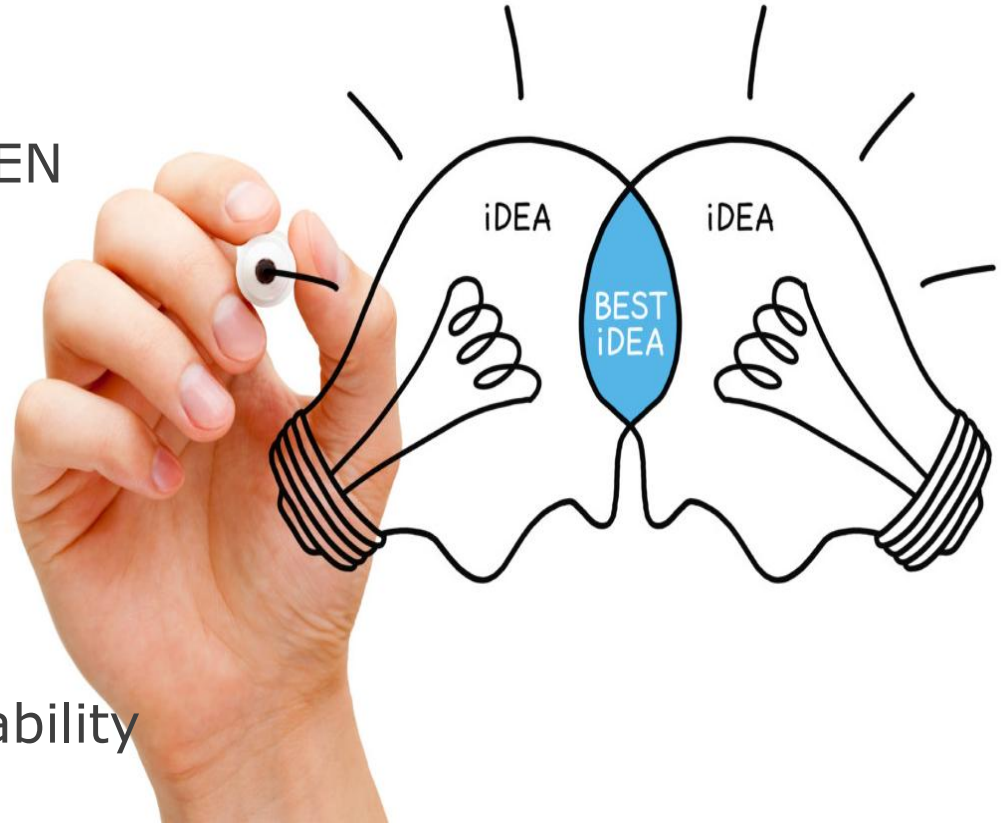
Case Study - Covenant University's FEDGEN Initiative



Case Study NgREN–Covenant Synergy

Integrating Institutional and National Infrastructure

- Integrating Institutional and National Infrastructure
- Covenant University's cloud platform leverages NgREN services
- Federated access to shared national HPC resources:
  - ACE Equipment Finder: https://ace.edu.ng/eq_finder
  - SPESSE M & E Portal: https://centresadmin.spesse.edu.ng/
- Demonstrates scalability, collaboration, and sustainability
- Serves as model for other Nigerian universities



3. 🟦Methodology

Qualitative Case Study - examine how REN-enabled HPC and cloud infrastructure enhance access to computational resources in Nigerian higher education

Purposive Sampling of 2 key institutions - demonstrating both national coordination and institutional implementation

Data Source: Secondary data from reports, policy papers, and publications analyzed to assess frameworks, services, and capacity-building

Descriptive Analysis of Results:

- **NgREN:** Centralized HPC and cloud boost scalability, reliability, and shared institutional access.
- **CU:** Institutional HPC and federated cloud drive interdisciplinary research and capacity building.
- **Synergy:** National–institutional integration ensures equitable access, cost efficiency, and sustainability

4. 🟦 Impact and Case Outcomes

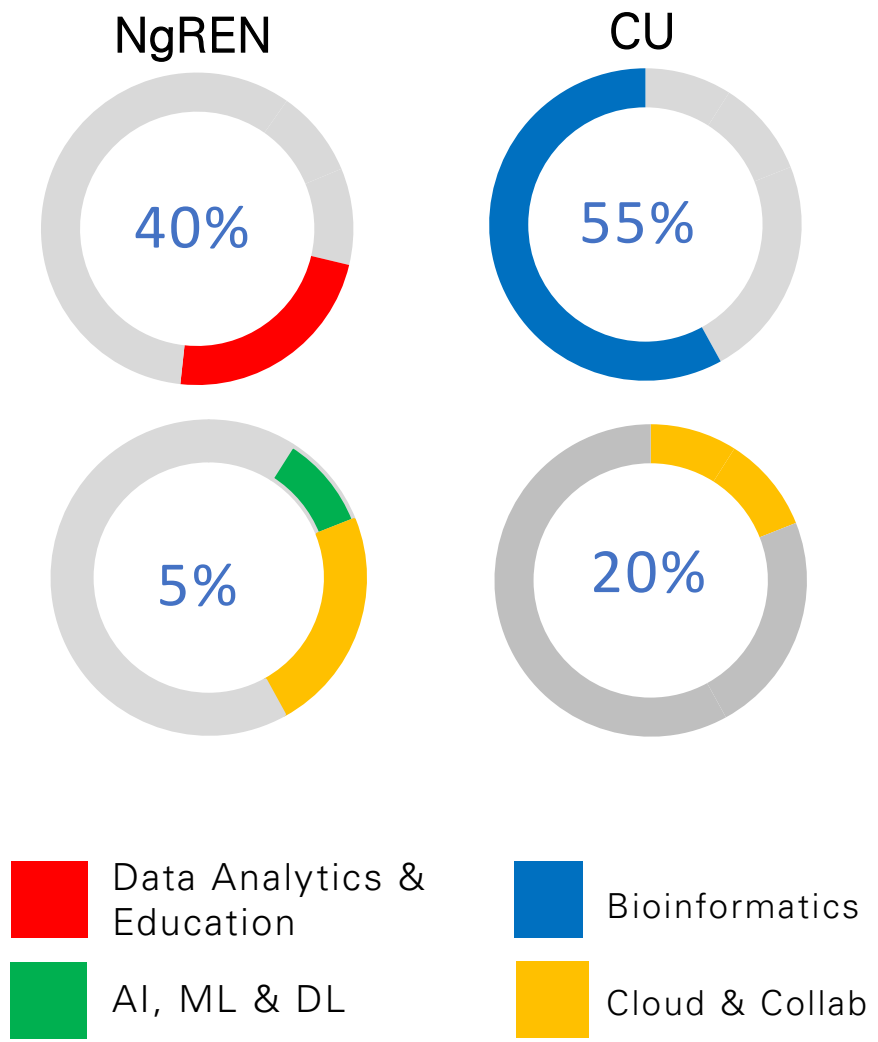
Research and Educational Impact

- Democratized access to HPC and cloud resources
- Reduced duplication and infrastructure costs
- Strengthened collaboration and national visibility
- Empowered AI, Bioinformatics, Cancer & Malaria research, Genomics, Machine Learning (ML) & Deep Learning (DL) data analysis

Enhanced Access to Computational Resources through REN-enabled HPC and Cloud

Category	NgREN Applications	% Usage (NgREN)	Covenant University Applications	% Usage (CU HPC)
AI & ML	National AI training environments; predictive analytics for education	5%	Jupyter Notebook,Coding Lab, NLP, and predictive modelling for academic data	15%
Scientific & Engineering	Shared access to simulation software, MATLAB	15%	MATLAB, Computational modelling	5%
Bioinformatics & Health	National data analytics and storage	0%	Genomic data analysis, PHIS (Public Health Information System)	55%
Data Analytics & Education	Moodle LMS hosting, ACE Equipment Mapper, national dashboards	45%	Educational data mining	5%
Cloud & Collaboration	Virtual servers, federated access, eduroam, ERPS, NgREN, ACE & SPESSE Websites	35%	CApiC-ACE Website, Federated cloud platform, resource sharing initiatives	20%

Source: Monitoring Tools - PRTG, Cacti, Grafana and Prometheus



Conclusion

Toward Inclusive Access to Digital Research Power

NgREN and Covenant University showcase a working model

Bridging resource and capacity divides

Next step: National HPC Federation for Nigeria

“Every researcher, educator, and student should have access to the tools for innovation.”

Recommendations

Key Takeaways

- Shared REN infrastructure is scalable and cost-effective
  - Institutional collaboration drives national impact
  - Cloud + HPC = critical enabler for digital transformation
  - Strong partnerships (government, universities, donors, private sector) are essential

Thank You

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