FEDGEN: A FEDerated GENeral "Omics" Cloud Computing Infrastructure

for Precision Medicine and AI Research in Africa

NITheCS
National Institute for
Theoretical and Computational Sciences

Presenter

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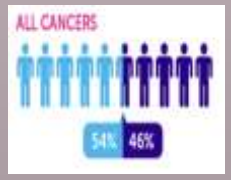
1.0 Introduction

FEDGEN Aim & Objectives

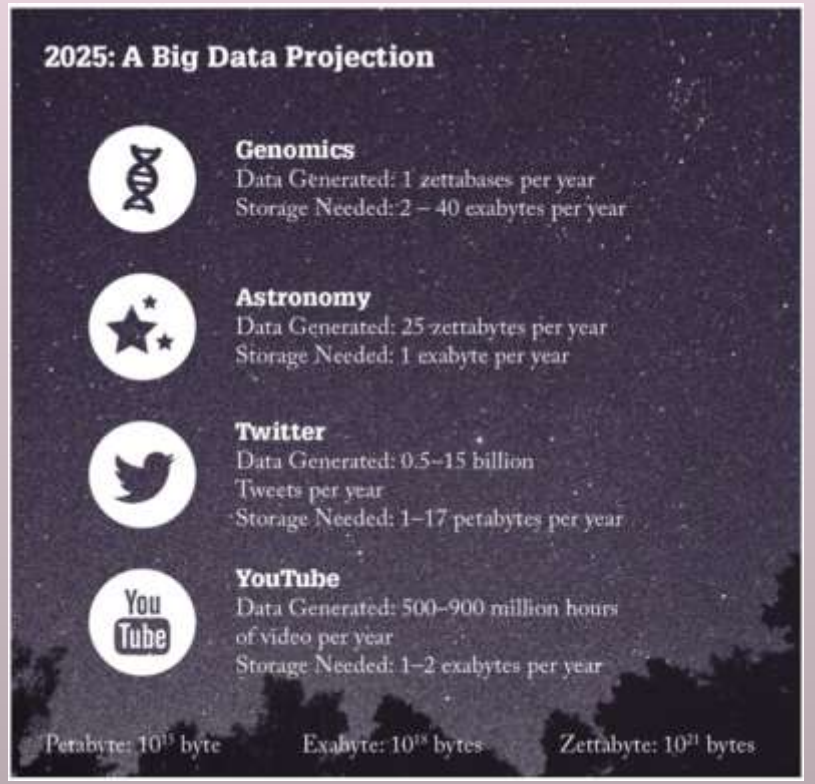
- The aim of the **FED**erated **GEN**eral "Omics" (FEDGEN) project is to develop groundbreaking research artefacts on ***federated cloud computing, artificial intelligence*** and ***general "omics"*** for precision medicine in Africa.

- The specific objectives are to address critical issues in the continent, in the areas of *research capacity/infrastructure, early disease diagnosis*, *public health education, large scale "omics" data analysis/disease modeling etc.*



1.1 Background: "Omics" Big Data

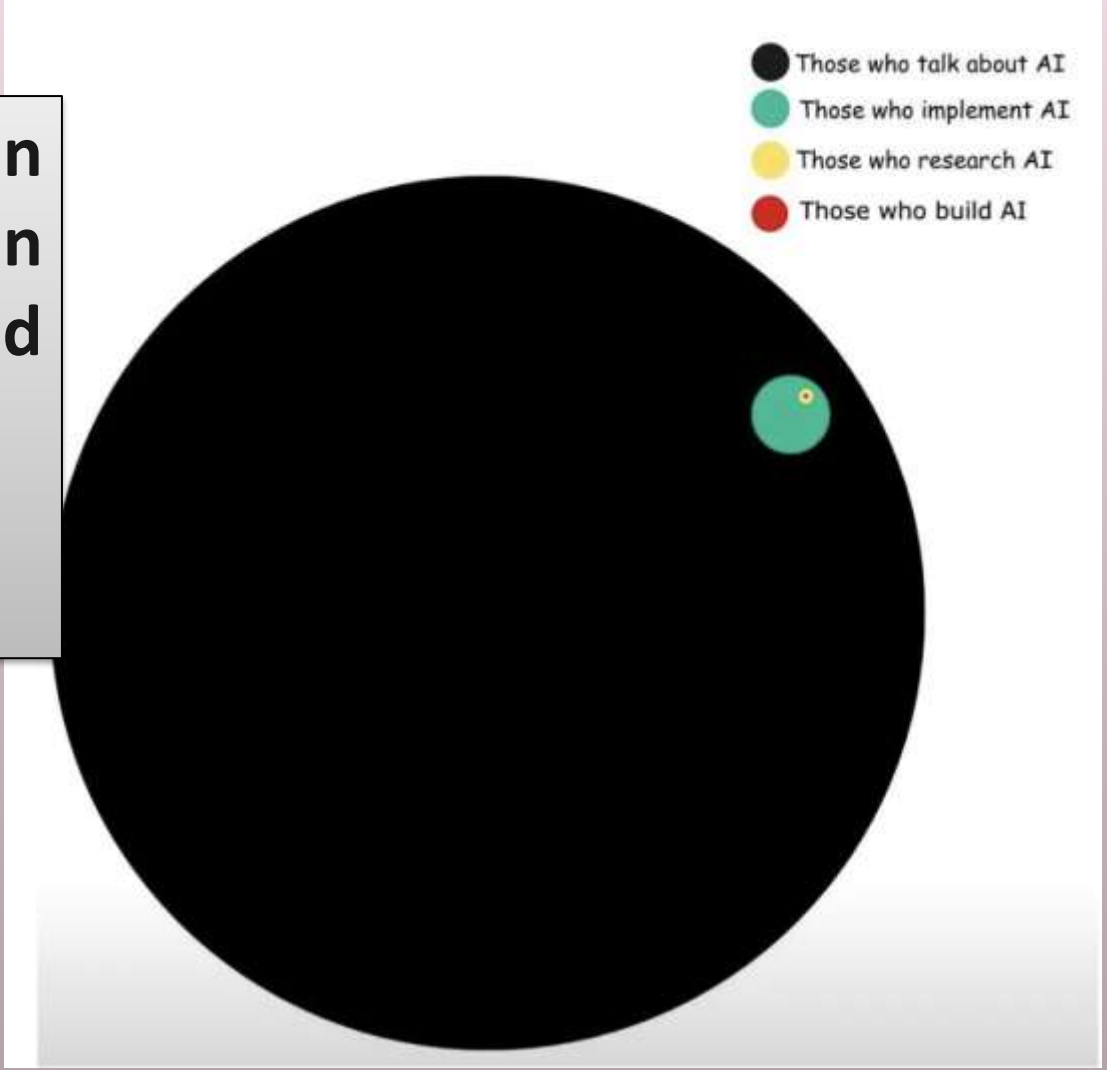
Projecting to the year 2025, Stephen *et al.* compared Genomics (an "Omics" variant) with Astronomy, YouTube, and Twitter. The estimates show that Genomics … is the most demanding of the domains in terms of *data acquisition*, *storage*, *distribution*, and *analysis.* They then called for community-wide planning for the "omics" challenges of the next decade…to realise precision medicine.



1.2 Background: Artificial Intelligence

"Whoever leads in artificial intelligence in 2030 will rule the world until 2100"

-Vladimir Putin
(Russian President)



Source: www.medium.com

1.3 Background: Federated Cloud

The fundamental idea of cloud computing is to deliver computational resources as services over the Internet.

Habibi et al. (2019)

Federated Cloud provides a cost effective alternative for building High Performance Computing (HPC) infrastructure by combining small/medium standalone cloud/HPC facilities into larger ones in order to store and process big data (Habibi et al. (2019).

Precision Medicine = General "omics" + AI + HPC (e.g. Federated Cloud/Supercomputers/Quantum Computing/EdgeComputing)

1.4 Background: Federated Cloud Architecture

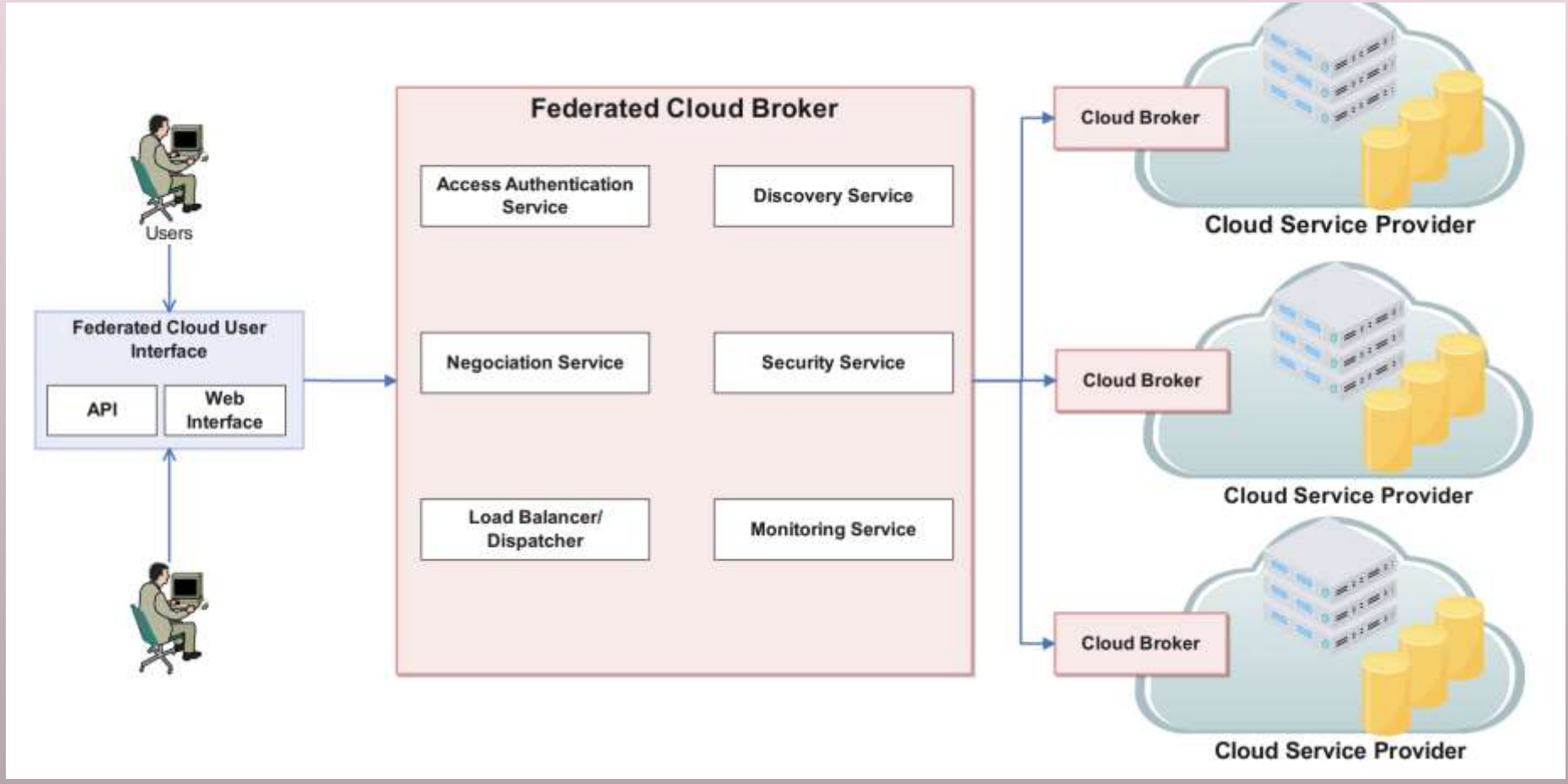


Figure 1.0: Federated Cloud Architecture (Broker Based Federation)

2.0 FEDGEN Infrastructures for Research and Training

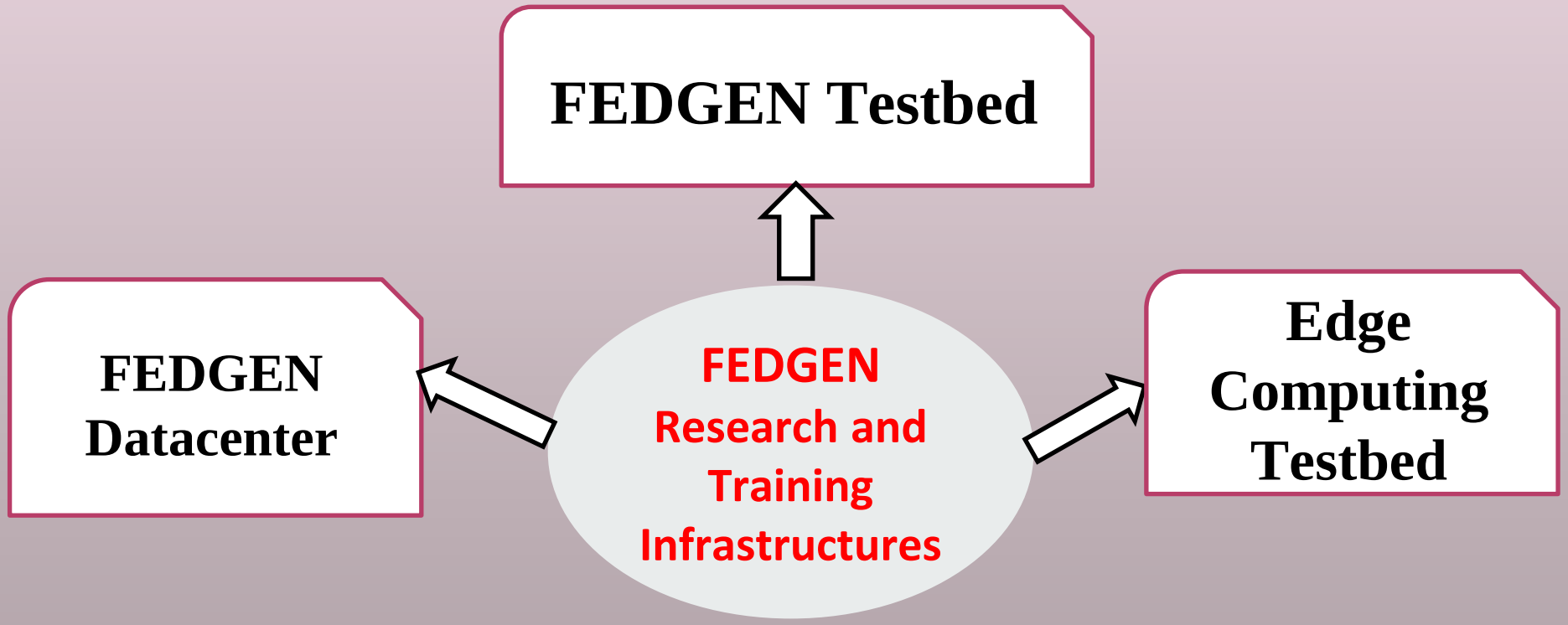


Figure 2.0: FEDGEN Research and Training Infrastructures

2.1 FEDGEN Testbed

- **An experimentation platform for federated cloud computing, AI and "omics" research among regional partner institutions.**

- **Partner Universities in Nigeria, Democratic Republic of Congo (DRC) and Senegal are collaborating to build the FEDGEN Testbed infrastructure. Each site is to host a testbed region, and all the regions will be interconnected to form a pan-African federated cloud/HPC testbed.**

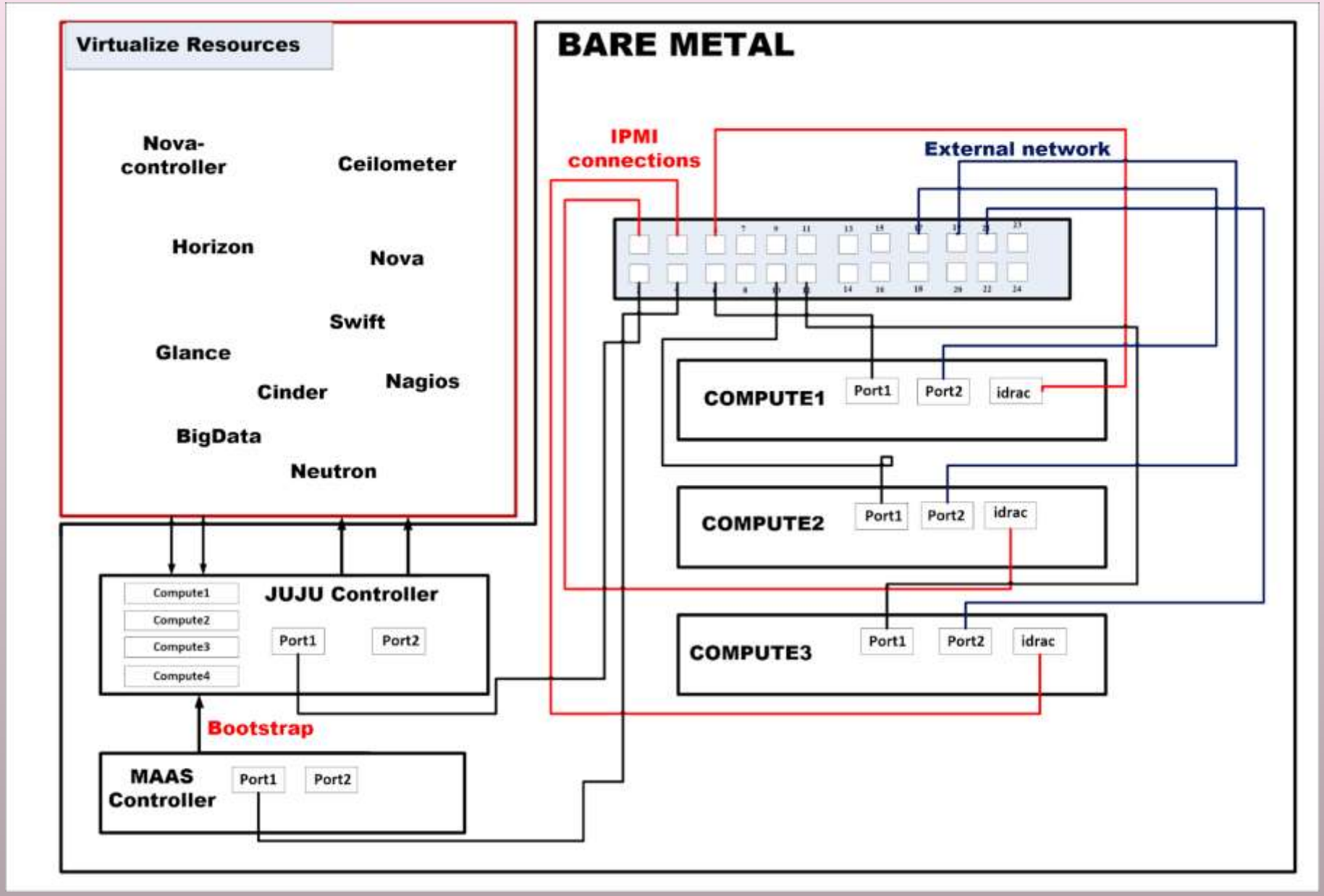


Figure 3.0: Hardware Schematic of a FEDGEN Testbed Region

Figure 4.0: FEDGEN Testbed Laboratory at CApIC-ACE, Covenant University Node

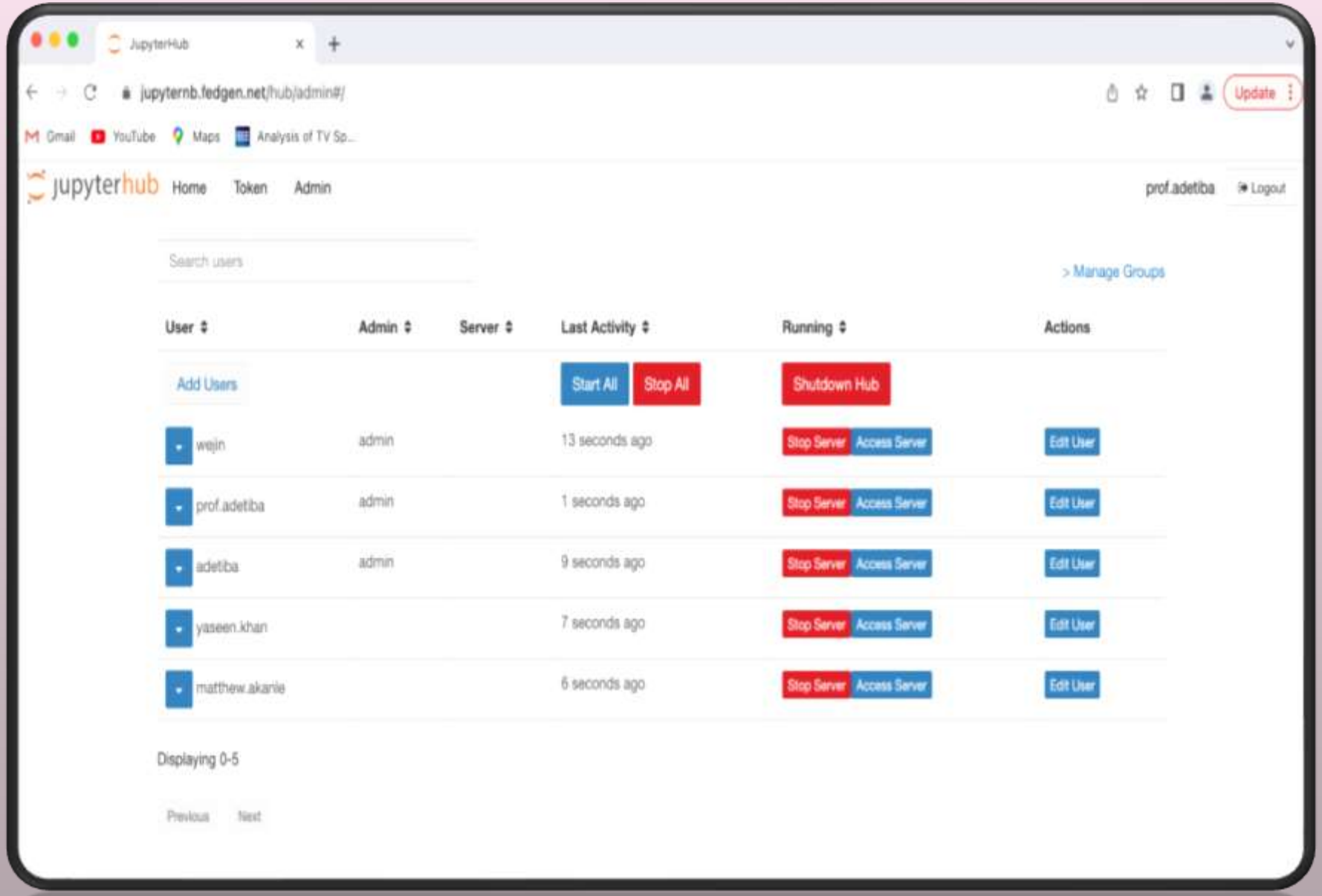


Figure 5.0a: JupyterHub for Research Programming on FEDGEN Testbed (https://jupyternb.fedgen.net)

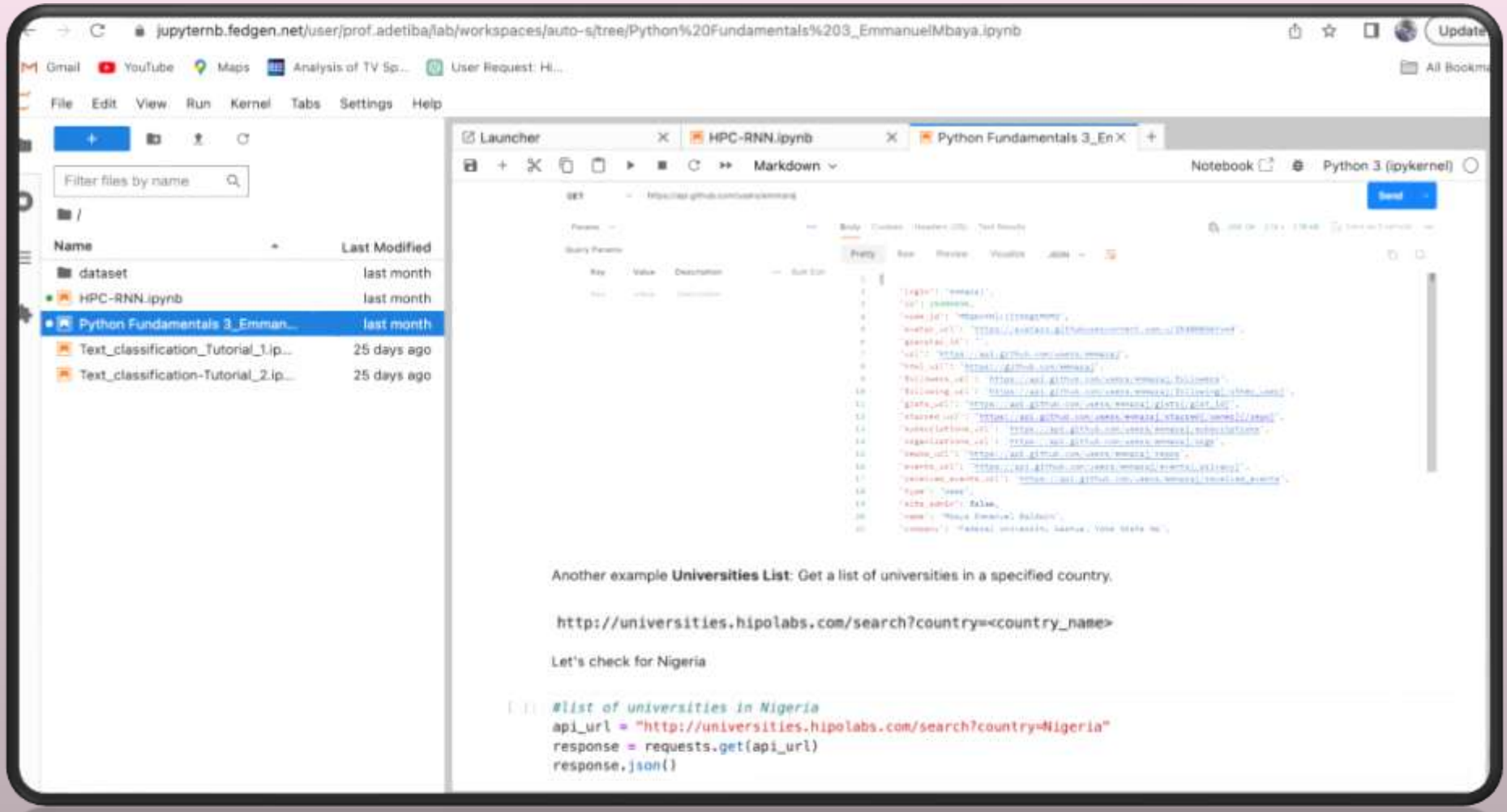


Figure 5.0b: JupyterHub for Research Programming on FEDGEN Testbed (https://jupyternb.fedgen.net)

2.2 FEDGEN Datacenter

- **Servers Specs**
  - ✓ **Models:** Supermicro, NVIDIA, Intel
  - ✓ **Frontend Server:** 24 CPU Cores, 3.84TB Hard Disk, 128GB RAM.
  - ✓ **Flash Storage:**16 CPU Cores, 1TB RAM, 30.72TB Hard Disk.
  - ✓ **GPU Server:** NVIDIA A100 40GB (PCIe), Processor - 20 x Intel(R) Xeon(R) Silver 4210R CPU @ 2.40GHz (1 Socket, 13.75MB Cache (85 Watt). Memory - 16x 64GB 2933MHz DDR4
  - ✓ **Backend Servers:** 120 CPU Cores, 1.536TB RAM, 5.76TB Hard Disk.
  - ✓ **Network:** 10Gbe Mikrotik Switch, 1Gbe Mikrotik Switch, 24x Mikrotik SFP+(10Gbit) module.

Vision 2029

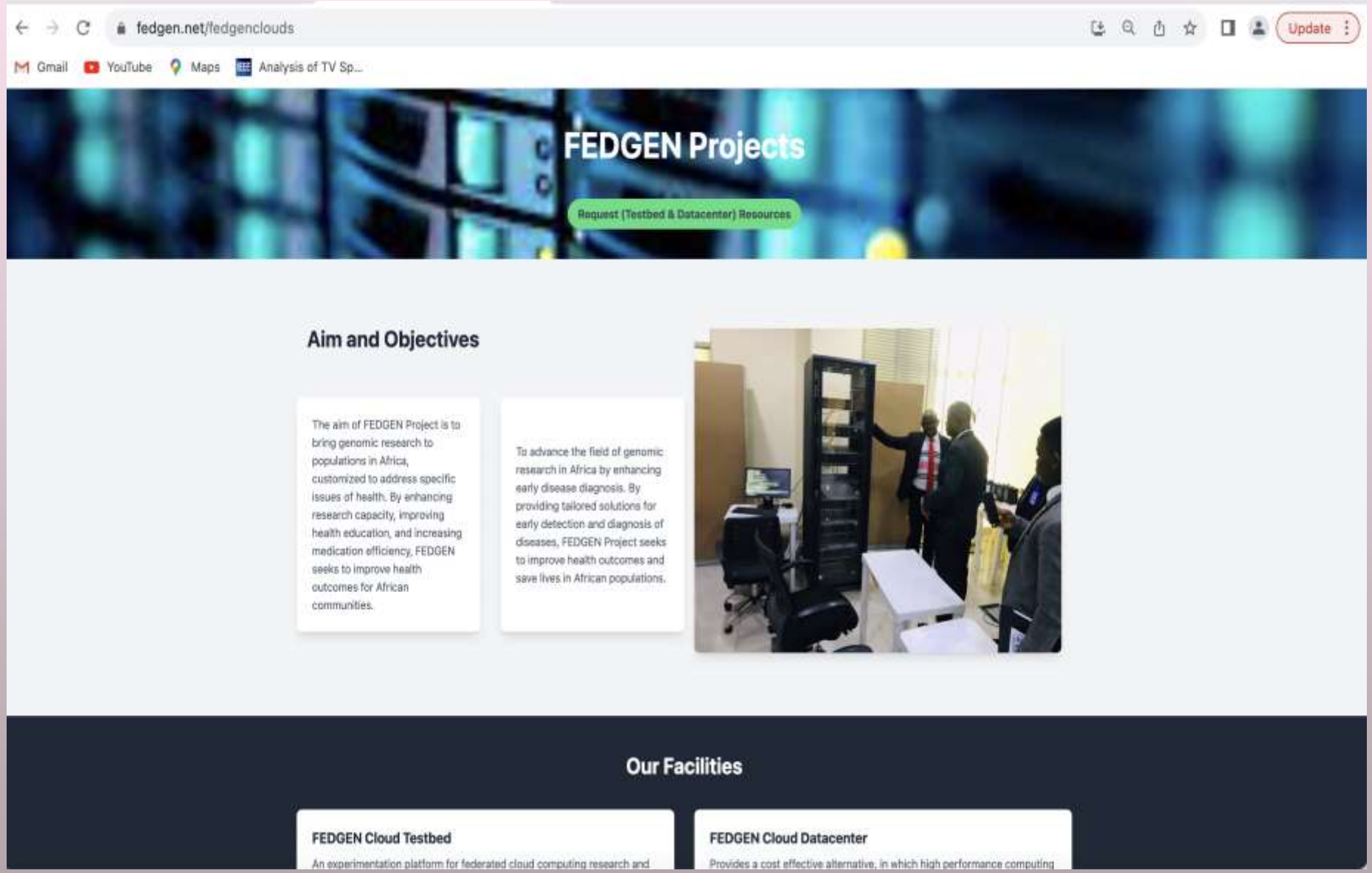


Figure 6.0: Online Plaform to Request for Computation Resources on FEDGEN (https://fedgen.net/fedgenclouds)

3.0 Ongoing Research and Development Projects

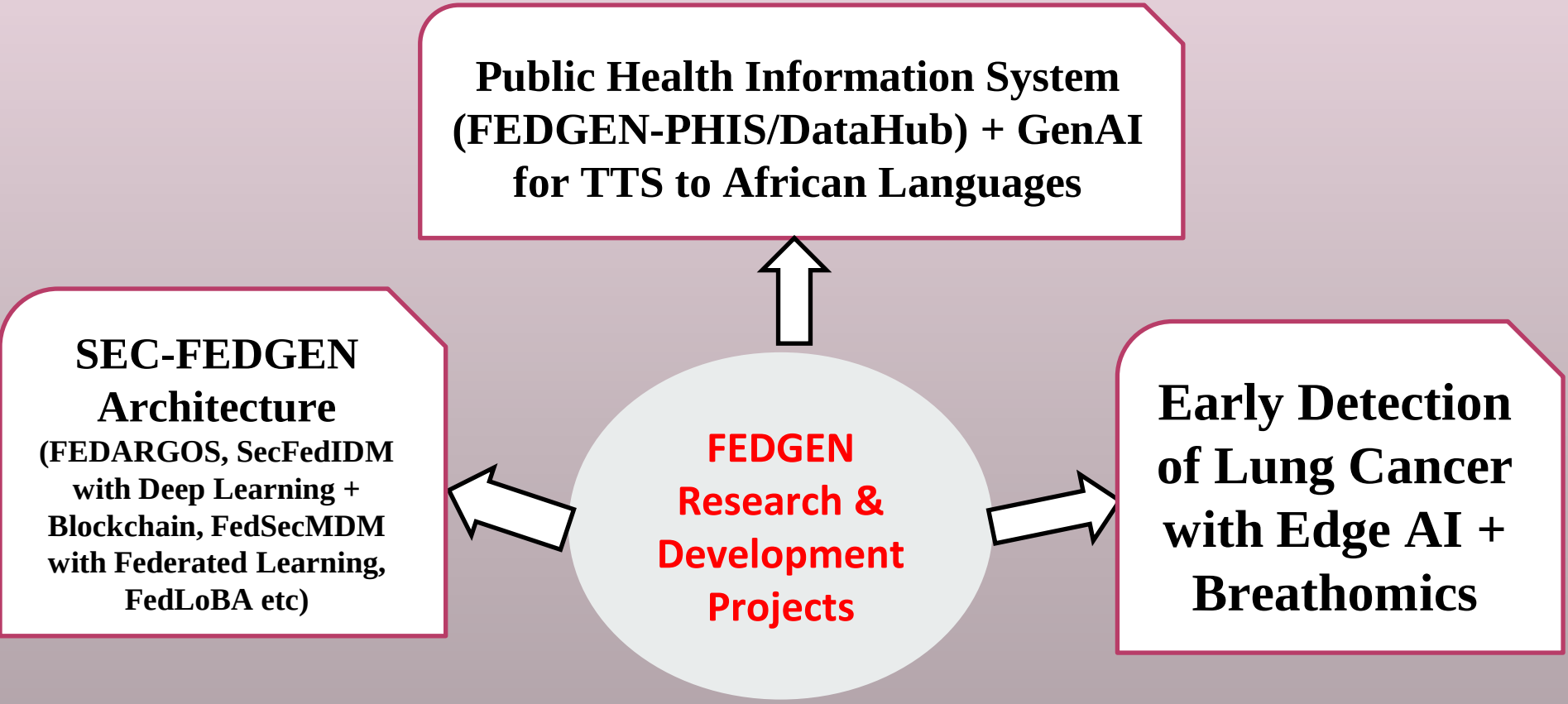


Figure 7.0: FEDGEN Ongoing Research and Development Projects

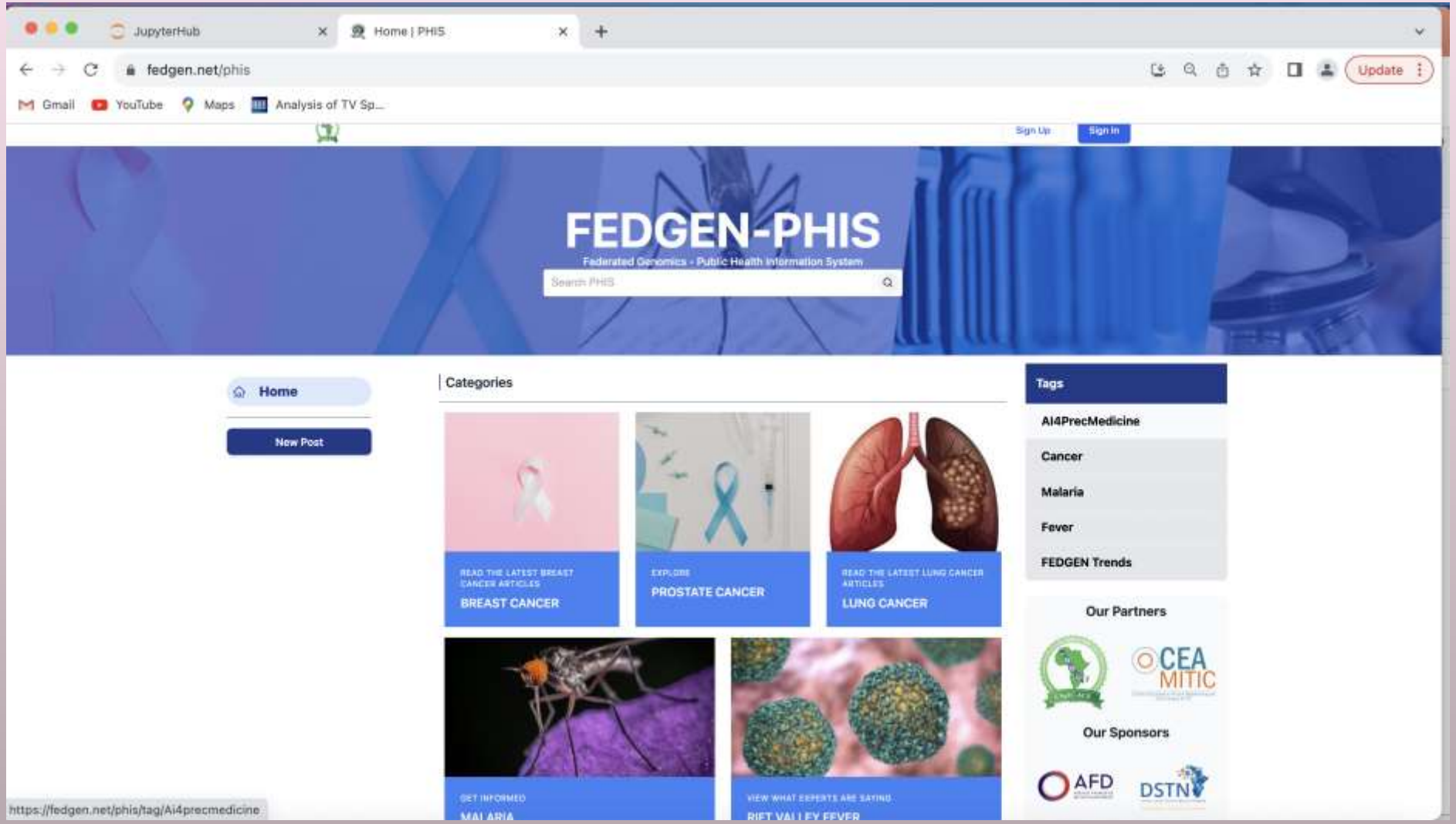


Figure 8.0: Deployed FEDGEN-PHIS Homepage (https://fedgen.net/phis)

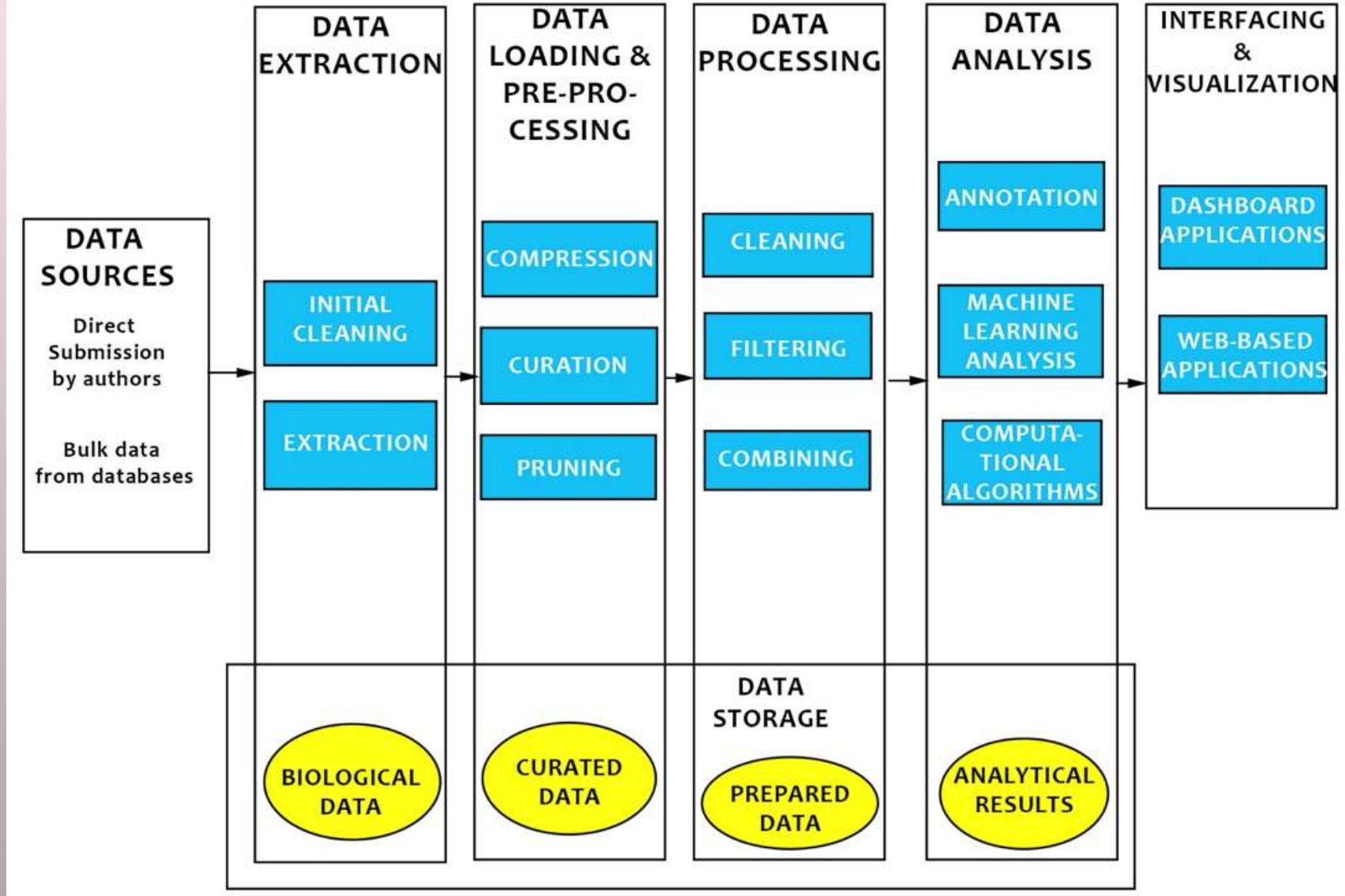


Figure 9.0: Reference Architecture for FEDGEN-DataHub (Design and Implementation Ongoing)

IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Date of publication xxxx 00, 0000, date of current version xxxx 00, 0000.

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SecFedIDM-V1: A Secure Federated Intrusion Detection Model with Blockchain and Deep Bidirectional Long Short-Term Memory Network

Emmanuel Baldwin Mbaya[1,2,4], Emmanuel Adetiba[1,2,3], (Member IEEE), Joke A. Badejo[1,2], (Member IEEE), John Wejin[1,2], Oluwadamilola Oshin[1,2], (Member IEEE), Olisaemeka Isife[2], Surendra Thakur[6], Sibusiso Moyo[7], and Ezekiel F. Adebiyi[2]

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ABSTRACT Cloud computing is a technology for efficiently using computing infrastructures and a business

 Figure 10.0a: Publications on FEDGEN(Revised Version Submitted to IEEE Access)

International Conference on Informatics and Intelligent Applications
ICIIA 2021: **Informatics and Intelligent Applications** pp 78–91 | Cite as

Home › Informatics and Intelligent Applications › Conference paper

FEDGEN Testbed: A Federated Genomics Private Cloud Infrastructure for Precision Medicine and Artificial Intelligence Research

Emmanuel Adetiba, Matthew Akanle, Victor Akande, Joke Badejo, Vingi Patrick Nzanzu, Mbasa Joaquim Molo, Victoria Oguntosin, Oluwadamilola Oshin & Ezekiel Adebiyi

Conference paper | First Online: 23 January 2022

339 Accesses | 2 Citations

Part of the Communications in Computer and Information Science book series (CCIS,volume 1547)

TELKOMNIKA Telecommunication Computing Electronics and Control
Vol. 20, No. 2, April 2022, pp. 279~295
ISSN: 1693-6930, DOI: 10.12928/TELKOMNIKA.v20i2.20503 ❒ 279

Monitoring and resource management taxonomy in interconnected cloud infrastructures: a survey

Vingi Patrick Nzanzu[1,3,4], Emmanuel Adetiba[1,2,3], Joke Atinuke Badejo[1,3], Mbasa Joaquim Molo[1,3], Claude Takenga[3,4], Etinosa Noma-Osaghae[1], Victoria Oguntosin[1], Sadeeq Suraju[3]
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[5]Infokom GmbH, Entreprise NTIC, Neubrandenburg, Germany

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ABSTRACT

Cloud users have recently expanded dramatically. The cloud service providers (CSPs) have also increased and have therefore made their infrastructure more complex. The complex infrastructure needs to be distributed appropriately to various users. Also, the advances in cloud computing have led to the development of interconnected cloud computing environments (ICCEs). For

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RESEARCH ARTICLE

FEDARGOS-V1: A Monitoring Architecture for Federated Cloud Computing Infrastructures

VINGI PATRICK NZANZU[1,2,3], EMMANUEL ADETIBA[1,2,4], (Member, IEEE), JOKE A. BADEJO[1,2], (Member, IEEE), MBASA JOAQUIM MOLO[1,2,3], MATTHEW BOLADELE AKANLE[1,2], KALIMUMBALO DANIELLA MUGHOLE[1,2], VICTOR AKANDE[2], OLUWADAMILOLA OSHIN[1,2], (Member, IEEE), VICTORIA OGUNTOSIN[1], CLAUDE TAKENGA[2,3,5], MAISSA MBAYE[6,7], (Member, IEEE), DAME DIONGUE[6,7], (Member, IEEE), AND EZEKIEL F. ADEBIYI[2,8]
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International Conference on Intelligent Systems Design and Applications
ISDA 2022: **Intelligent Systems Design and Applications** pp 408–417 | Cite as

Home › Intelligent Systems Design and Applications › Conference paper

Interference Detection Among Secondary Users Deployed in Television Whitespace

Joachim Notcker, Emmanuel Adetiba, Abdultaofeek Abayomi, Oluwadamilola Oshin, Kenedy Alila Greyson, Ayodele Hephzibah Ifijeh & Alao Babatunde

Conference paper | First Online: 01 June 2023

57 Accesses

Part of the Lecture Notes in Networks and Systems book series (LNNS,volume 717)

Abstract

Interference is one of the significant issues in television white space (TVWS) that limits the scalability of secondary user networks, lowers the quality of service, and causes harmful destruction to primary users. Interference among secondary users is one of the severe problems in TVWS because there is no legal rule that governs the coexistence of secondary

Figure 10.0b: Published Studies on FEDGEN

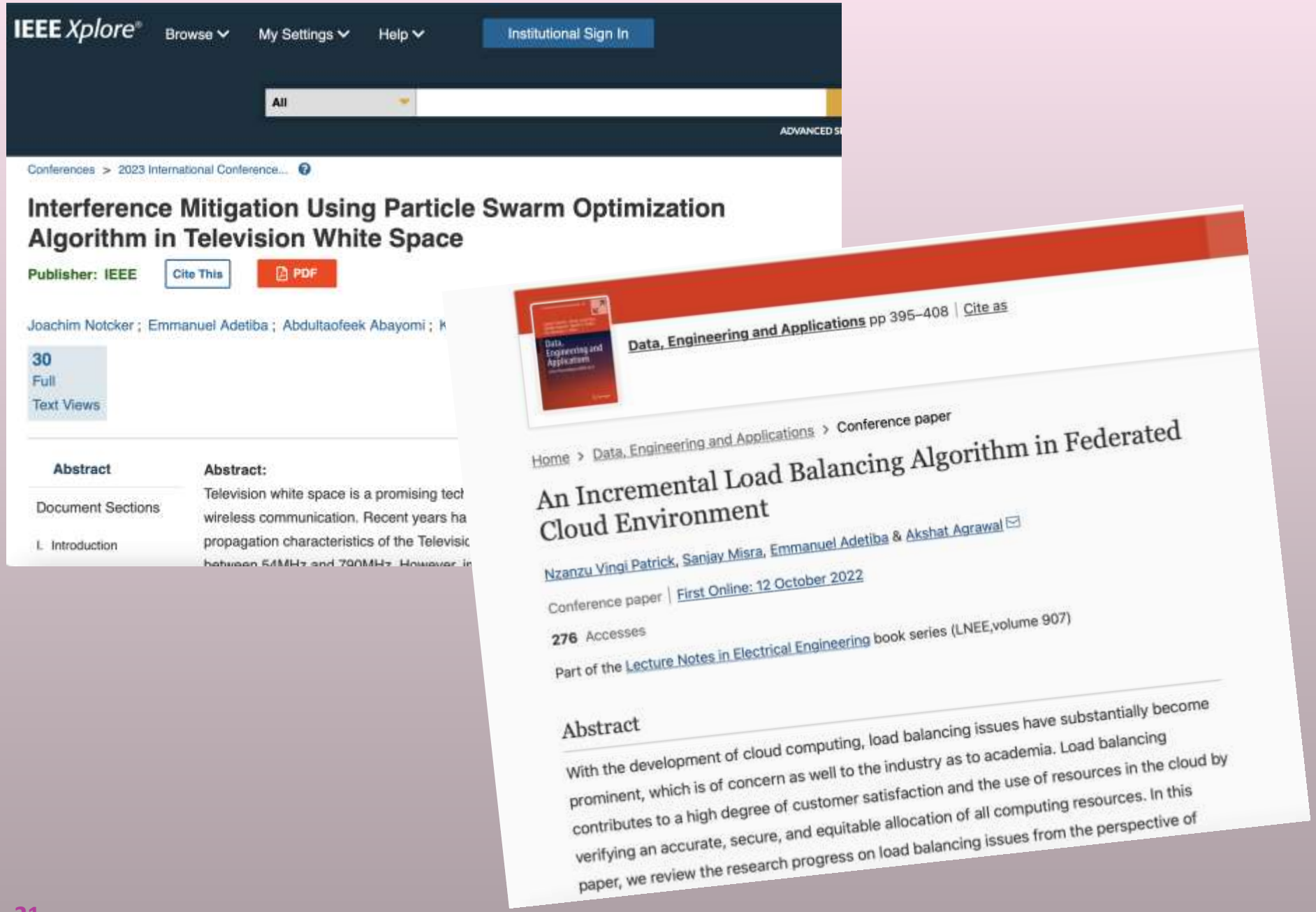


Figure 10.0c: Published Studies on FEDGEN Cont'd

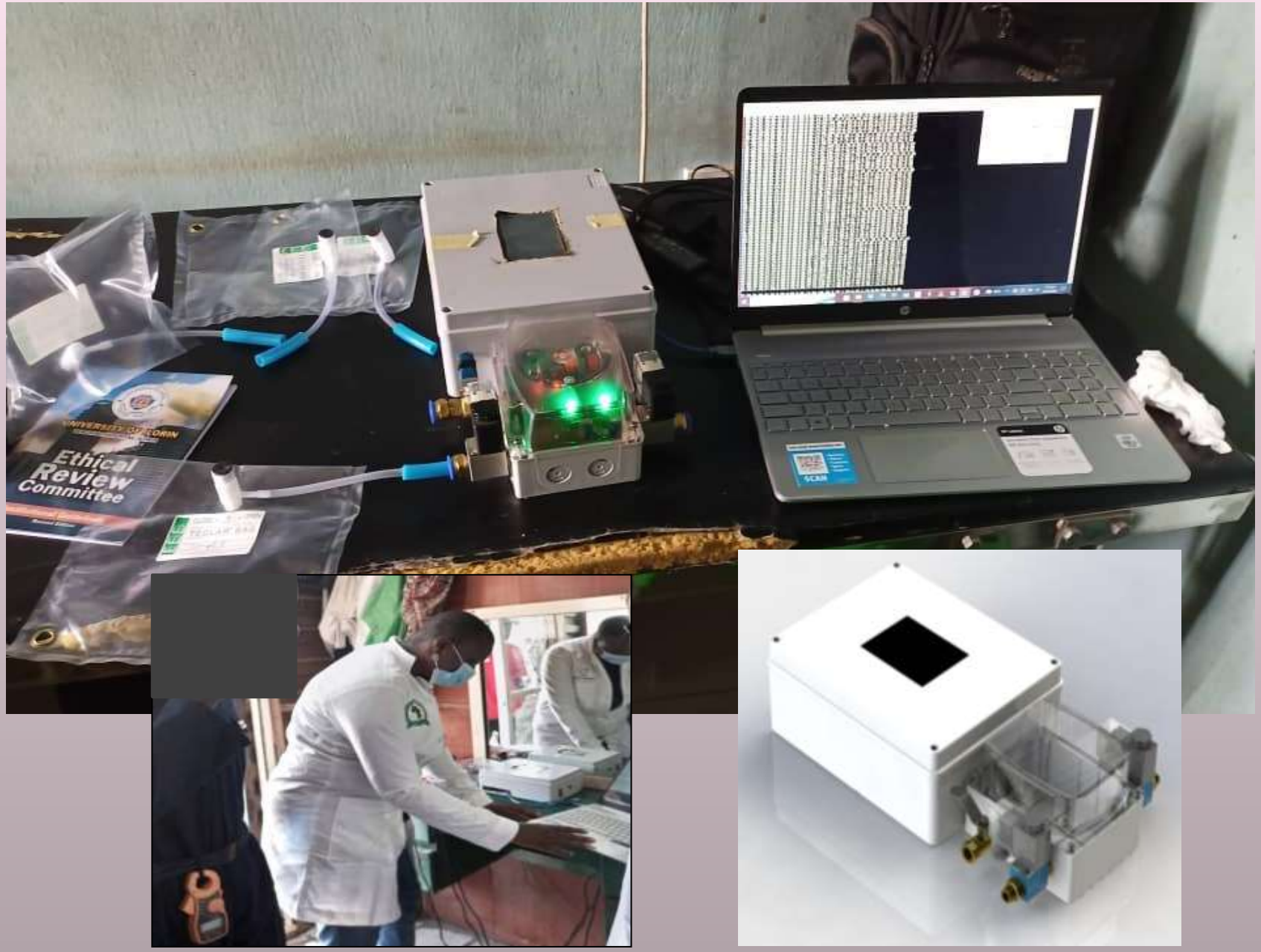


Figure 11.0: Electronic Nose with Edge AI and Breathomics for Early Detection of Lung Cancer

4.0 FEDGEN Postgraduate Trainings, Short Courses and Internships

- 10 M.Eng. (ICE) and 1 M.Sc (CS) @ CU Completed.
- 2 M.Eng. (ICE) and 7 M.Sc(CS) @ CU Ongoing.

- 4 Ph.D (ICE) @ CU, Nig. (Ongoing)
- 2 Ph.D (CS) @ CU, Nig. (Ongoing)
- 1 Ph.D (CS) @ UGB, Senegal (Ongoing)

FEDGEN Capacity Building Activities

- 2 FEDGEN Bootcamps and 2 HPC Workshops Completed (100+ Trainees)
- 6+ Internships Awarded.

FEDGEN Team Collaborative Short Courses with KZN eSkill CoLab, DUT + Stellenbosch University (Coming Soon)

Figure 12.0: FEDGEN Capacity Building Activities

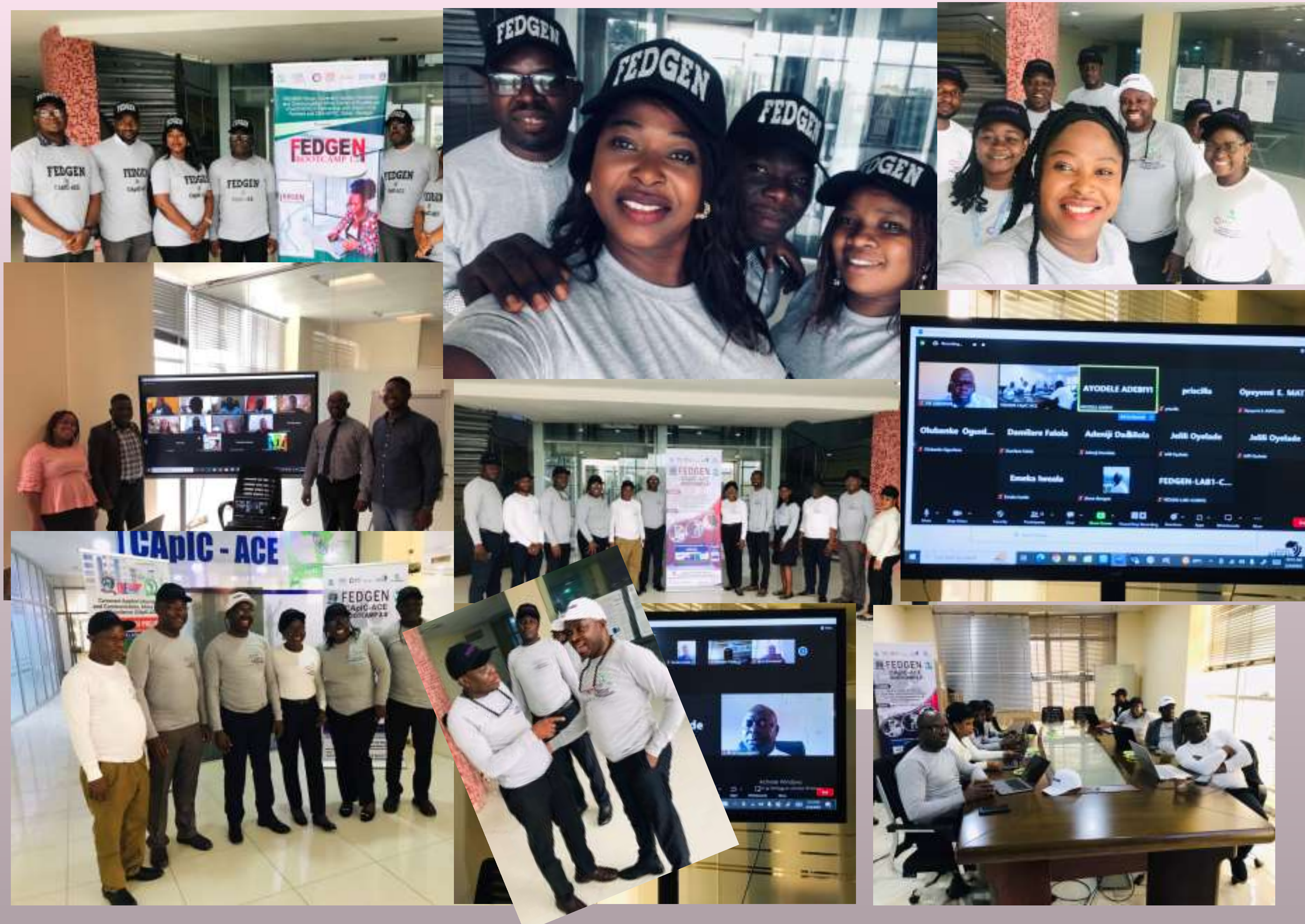
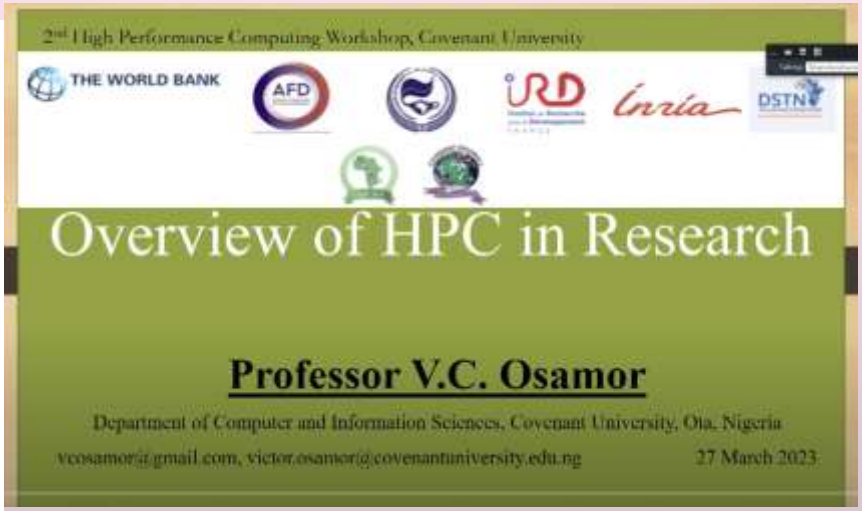


Figure 13.0: FEDGEN Bootcamps 1.0 and 2.0 in Pics

Figure 14.0: 2nd HPC Workshop in Pics



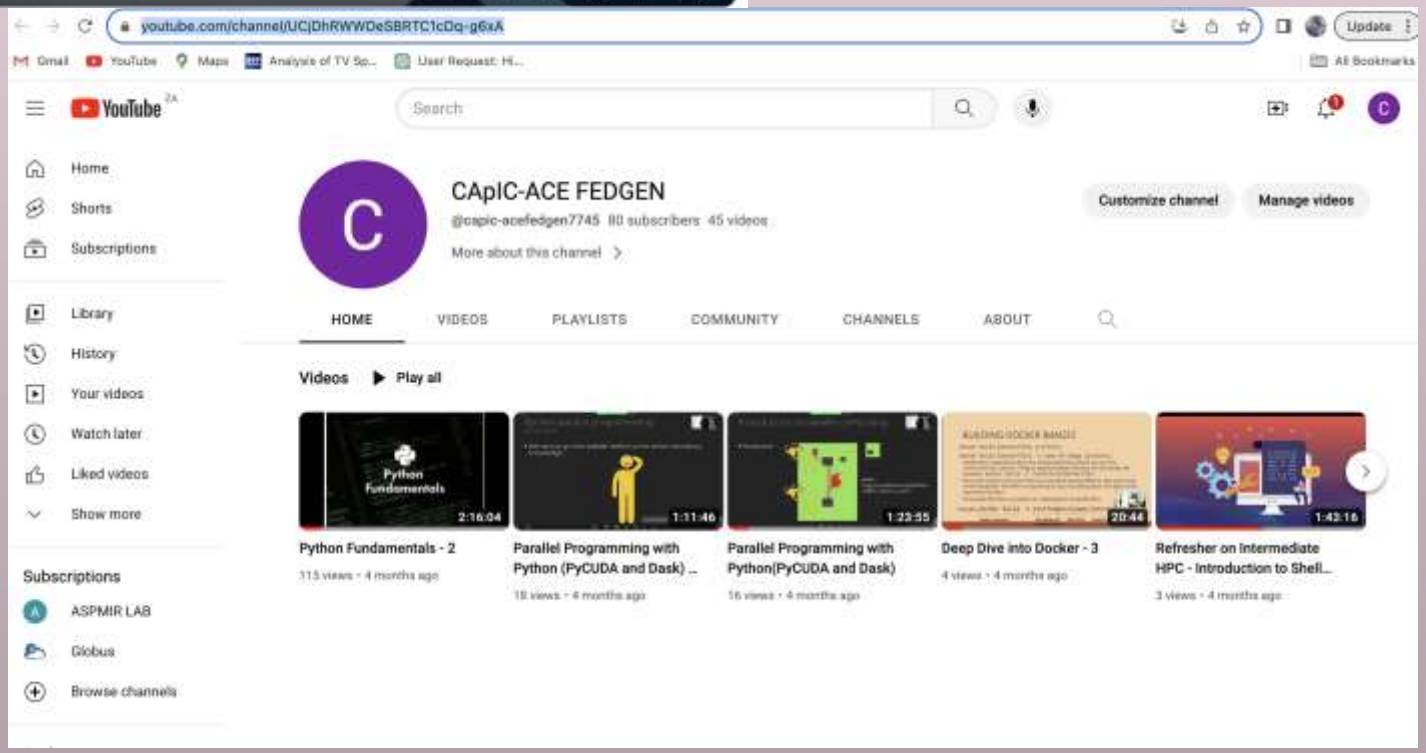


Figure 15.0: FEDGEN YouTube Channel (https://www.youtube.com/@capic-acefedgen7745/videos)

5.0 Next Steps on FEDGEN Research and Collaborations in South Africa

- **Joint Grant Proposals Writing: NITheCS @ Stellenbosch University, RSA + CApIC-ACE @ Covenant University, Nig. and KZN eSkill Co-Lab @ DUT, Durban, RSA.**

- **Joint Supervision/Exchange of Postgraduate Students and Writing/Publishing of High Impact Manuscripts.**

- **Collaboration on Short Courses in Cloud & HPC, AI, Big "Omics" Data Analytics etc.**

6.0 Project Team and Partners

Covenant University, Nigeria

CApIC-ACE Center Leader/CRG PI: Prof. Emeka Iweala,

CApIC-ACE Deputy Center Leader/FEDGEN Principal Investigator: Prof. Emmanuel Adetiba,

Co-Investigators (Informatics & Comm. Engng.): Dr. Joke A. Badejo, Dr. Oluwadamilola Oshin

Co-Investigators (Health): Prof. Olubanke Ogunlana, Prof. Grace Olasehinde

Principal System Engineer: Engr. Boladele Akanle

System Engineers: Engr. Oladipo Olaleye, Engr. F.O . Sweet-Williams, Engr. John Wejin

Principal Software Engineer: Mrs Priscilla Ajayi

South Africa Collaborators/Partners

- Prof. Surendra Thakur, Director NEMISA KZN eSkills Co-Lab, Durban University of Technology (DUT), Durban, KwaZulu Nata, South Africa.

- Prof. Sibusiso Moyo, DVC Research, Innovation and Engagements, Stellenbosch University (SU), Stellenbosch, Western Cape, South Africa.

- Prof. Francesco Petruccione, Director, NITheCS, Stellenbosch University (SU), Stellenbosch, Western Cape, South Africa.

- Suresh Maslamoney, Systems Administrator, H3Abionet, University of Cape Town, Cape Town, Western Cape, South Africa.

West/Central Africa and International Collaborators

- Prof. Ezekiel Adebiyi, FEDGEN Co-Principal Investigator, German Cancer Research Center, Germany
- Emeritus Prof. Israel Esan Owolabi and Dr. Temitayo Ejidokun, Afe Babalola University, Ado-Ekiti, Nigeria
- Prof. F.A. Ibikunle and Prof. A.A. Adebiyi, Landmark University, Omu-Aran, Nigeria
- Prof. C. Takenga and Prof. B. Mushage, ULPGL, Goma, Democratic Republic of Congo(DRC)
- Prof. Maïssa Mbaye, Prof. Cherif Diallo and Dr. Dame Diongue (DSTN Partners), Gaston Berger University, Dakar, Senegal.

Sectoral/Industry Supports

- IBM, Nigeria
- HPE, Nigeria
- ACE Medicare, Nigeria
- ATOS, INRIA and IRD, France

7.0 Conclusion

The FEDGEN research project is a bold step to develop home grown federated cloud infrastructure and capacity for HPC, precision medicine and AI within the African space. We acknowledge all our partners, collaborators and funding agencies for unparalled supports and commitments to the project.

Thanks For Your Attention

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