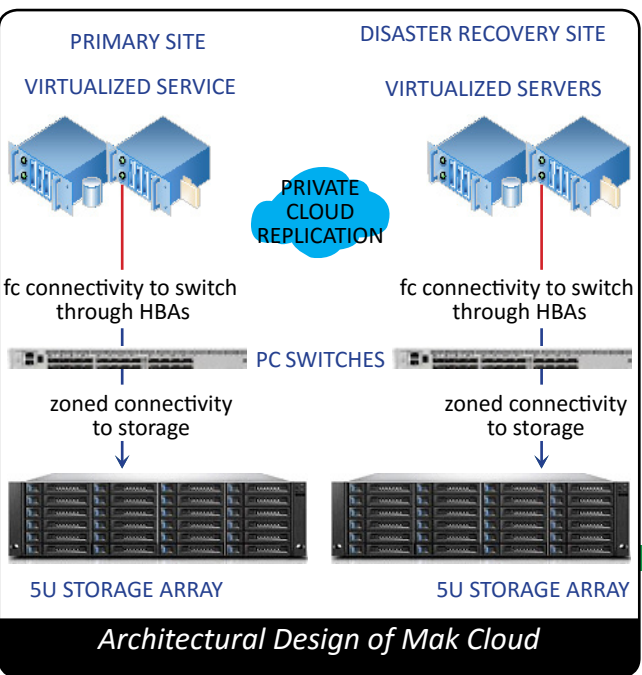


## Description of the Mak Research Private Cloud Computing

It has been an interesting journey for Makerere University to now be in an excellent position to have the first-of-its-kind Research private cloud computing situated at the College of Engineering, Design, Art and Technology. Makerere University is increasing its standing as a continental research leader. In FY2019/2020, the University received an allocation of UGX 30 Billion from the Government of Uganda to support research activities. These funds were sustained in the budget for FY2020/2021. Furthermore, the University secured donor funding from Sida amounting to UGX 1,645,294,715 to support an Integrated Cloud Infrastructure System, which has robust capacities for research data repository, as well as, an Integrated Hotspot Solution for all strategic areas of Makerere University-Main Campus.

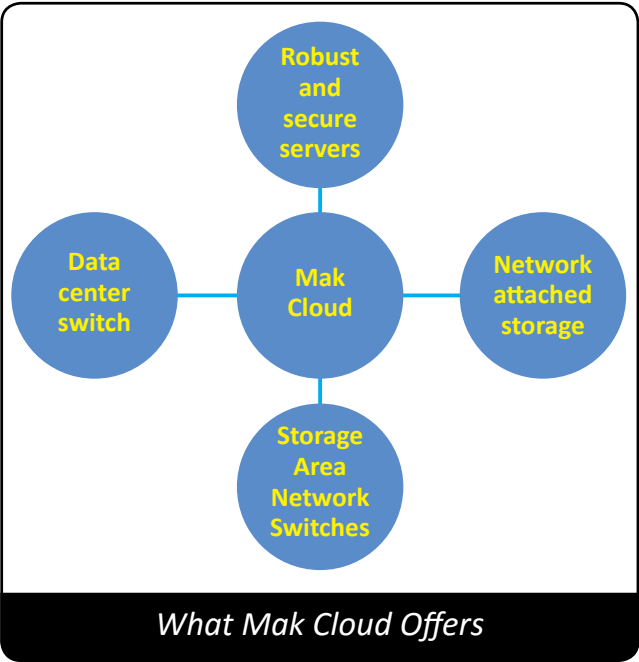
On behalf of Makerere University, Professor Tonny Oyana, who is the Principal Investigator Mak-Sida Project 381, wishes to express our deepest appreciation for the funding support that has enabled us to establish Mak Research private cloud computing. We strongly believe that now an opportunity exists for capacity building in the Directorate of ICT Support (DICTS) to develop relevant IT knowledge and skills to grow cloud-based computing and storage applications to support Makerere University research.



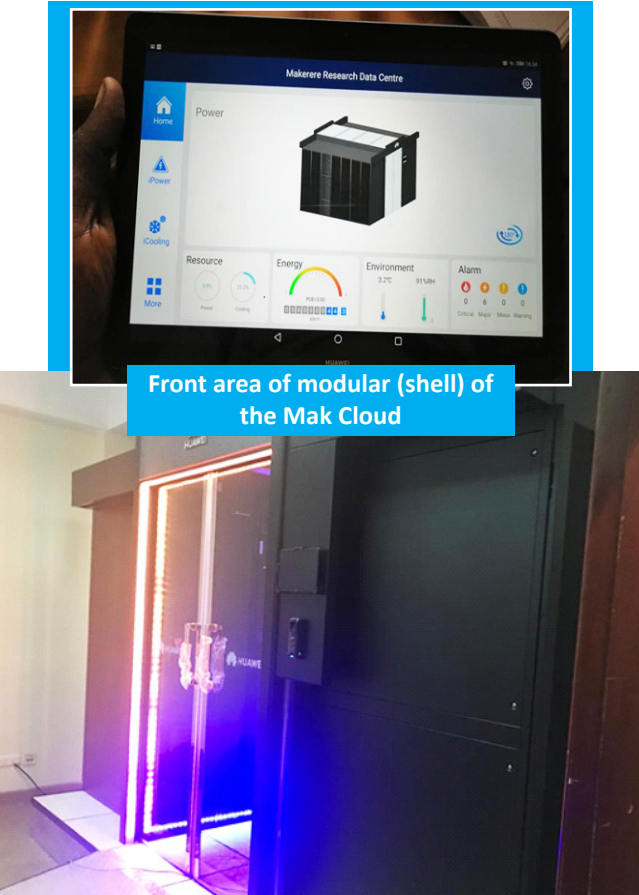
System Specifications for Mak Research Private Cloud Computing		
Servers (Dell PowerEdge R740XD x4)	Storage (Dell EMC ME4084 Storage Array)	FusionModule2000 Smart Modular Data Centre
Chassis up to 24 x 2.5" Hard Drives including, 2 CPU Configuration, Form factor: Rack (2U) Trusted Platform Module 2.0 Intel Xeon Gold 6222V 1.8G, 20C/40T, 10.4GT/s, 27.5M Cache, Turbo, HT (115W) DDR4-2400 (Proposed server must be able to Scalable Up to two Intel® Xeon® processors, up to 28 cores per processor) 256GB RAM RDIMM, 2666MT/s, DUAL Rank, 24 DDR4 DIMM slots, Supports RDIMM /LRDIMM, speeds up to 2666MT/s, 3TB Supports registered ECC DDR4 DIMMs only Internal SD Module - 2x 64GB microSDHC/SDXC Card Two (2) 1.92TB SSD SATA Mix Use 6Gbps 512 2.5in	Chassis format: All-in-one (dual controllers, internal drive bays, networking) with expansion options Rack size: 5U or less Controllers - 2 hot-swappable per chassis (dual active) Processor: Intel® 2-core, 2.2GHz Internal storage: At least must support 84x 3.5" drive bays (2.5" drive carriers supported as well) System memory 8GB per controller 120TB RAW Capacity required with combination of 85TB of SSD 512e SAS12 2.5 Read Intensive 35TB of HDD 15K 512n SAS12 2.5	Integrated modular rack infrastructure system consists of Hot- and/or cold-aisle containment system (air conditioning system) Uninterruptible Power System and Power Distribution System Environmental monitoring system Access Control and Surveillance system Management System

## Why was it established and what it offers?

- 1) The effective establishment of a private cloud research service platform for Makerere University will provide rapid access to flexible and low-cost IT resources. Makerere University has a population of over 35,000 students and 1,434 academic staff with academic programs in major academic disciplines in engineering, law, business, education, life sciences, architecture, arts and humanities, physical sciences and mathematics, social and behavioural sciences, and medicine and health sciences. Building research computing and simulation capacity will not only support core activities in cloud computing, but this will also provide required support for more complex research, innovations, and simulation tasks. We can leverage current IT resources in RENU and NITA-U to deliver low-cost IT research resources.
- 2) The integrated cloud infrastructure system with modular data centre solution, server, and storage with capacities for data repository will fully enable Data Mobility and Migration Data-at-rest encryption for all 17 Mak-Sida projects and prepare Makerere University for the Fourth Industrial Revolution. This revolution will bring enormous positive benefits to research, which is a core mandate of Makerere University.
- 3) The proposed integrated hotspot solution for selected strategic areas of Makerere University-Main Campus builds on earlier Phase 1 work. This solution will further increase Internet access to students and staff. The wide benefits for Phase one are already evident in the usage statistics and will further push the e-online teaching and learning as well as the research agenda of Makerere University. As part of the cost-sharing agreement, Makerere University management purchased an 850 million UGX Border Router that enhances Internet bandwidth to more than 10 Gigabits per second.
- 4) Research areas and simulation in cloud computing. DICTS has urgent requirements in backbone technologies in cloud computing to support more complex research, innovations and simulation tasks. We can leverage current IT resources in Research and Education Network for Uganda (RENU) and National Information Technology Authority-Uganda (NITA-Uganda) to deliver low-cost IT resources.



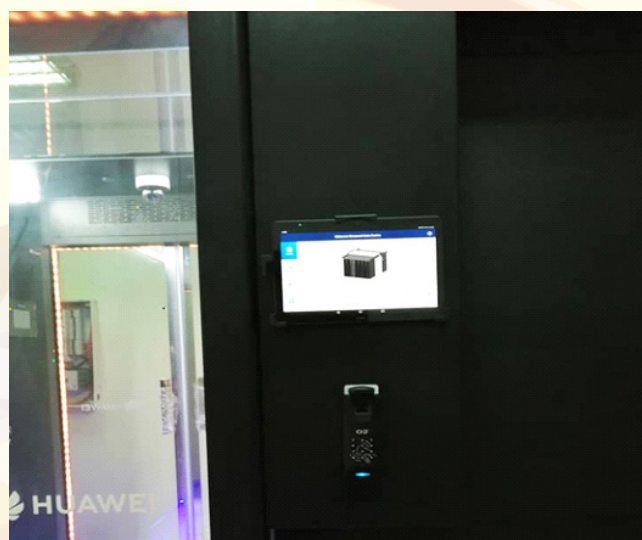
## Mak Research Private Cloud Computing in Pictures







Panel 1: Access control module of the Mak Cloud



Panel 2: Access control module of the Mak Cloud

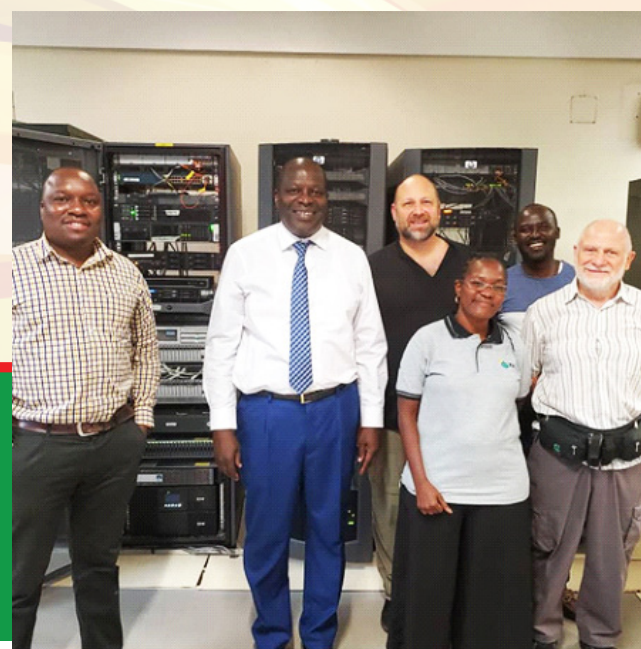


Panel 3: Interior view of the Mak Cloud

## Conclusion and Recommendation

The implementation of a modular data centre has been successful. All the components of the system that is, rack infrastructure systems (hot- or cold-aisle containment system), power system (UPS, battery, and power distribution panel), precision cooling system, access control, and surveillance system, environmental monitoring system, active equipment (servers, storage, switches, and network video recorder) have been tested and are fully functional after installation and general configurations. Although the major components of the equipment were procured under this project, the following items that are listed below need to be addressed for a complete N+1 data centre.

- 30KVA Generator complete with a changeover switch
- Fireproof door and sealing off the extra door in the data centre
- Fire Suppression System
- Fireproof paint for the walls
- Two Air conditioner to extract the hot air
- Storage for the Disaster Recovery Centre
- Additional Servers for Different systems
- Fibre Optic cable complete with Switches from the disaster recovery centre to the Primary Data centre



Inspecting the Broad Router

## Credits and Acknowledgment

- Appreciation to Mak-Sida for their continued good will and solid support for ensuring a successful Cost Sharing Model
- Project Team Members
- Our DSV Partners, Stockholm University
- Funding Support from Sida

### 1. Embassy of Sweden

- Dr. Gity Behravan - Senior Research Advisor

### 2. Makerere University Management

- Prof. Barnabas Nawangwe - Vice Chancellor
- Prof. William Bazeyo - Former DVC (F&A)
- Prof. Buyinza Mukadasi - Director, DRGT

### 3. Project team members

#### A. DSV, Stockholm University

- Prof. Uno Fors - Co-PI, DSV
- Prof. Caroline Wamala - DSV

#### B. CoCIS/DICTS Team

- Professor Tonny Oyana - Principal Investigator
- Mr. Samuel Mugabi - Director, DICTS
- Dr. Florence Kivunike - CoCIS
- Dr. Paul Mukwaya - CAES
- Mr. Alex Mwebaze - DICTS
- Mr. Juma Katongole - DICTS
- Mr. David Gaamuwa - DICTS
- Mr. Tony Oluka - DICTS
- Mr. Arthur Moses Opio - DICTS
- Ms. Lily Asiimwe - CoCIS



MAKERERE UNIVERSITY

## COLLEGE OF COMPUTING AND INFORMATION SCIENCES IN PARTNERSHIP WITH STOCKHOLM UNIVERSITY

Project 381: Integrating ICT-based support  
in Research, Teaching and  
Innovations



## Commissioning of Mak Research Private Cloud Computing

12<sup>th</sup> February 2021

