



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Faculty of Computing and Informatics



Role of High-Performance Computing in Digital Transformation, Data Science and Artificial Intelligence



Presented By:

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Centre Head

India - Namibia Centre of Excellence
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Agenda

01 High Performance Computing

02 HPC in Artificial Intelligence

03 HPC in Digital Transformation

04 HPC PARAM !ARUB

05 OPPORTUNITY





High Performance Computing

HPC is a technology that uses clusters of powerful processors that work in parallel to process massive, multidimensional data sets and solve complex problems at extremely high speeds.



Parallel Computing

Large-scale computations by dividing tasks across multiple processors.

Specialised Applications and storage

Domain-specific applications and massive storage to manage vast amounts of data.

Accelerators (GPUs/FPGAs)

Hardware accelerators like GPUs that boost performance for specific computational tasks.

Resource Management Software

Manages job scheduling, load balancing, and resource allocation across the HPC system.

Existing Challenges

Industries face several challenges related to computational resources that can hinder efficiency, innovation, and competitiveness.

Insufficient Processing Power

Lack of adequate computational power to handle complex simulations, data analysis, and AI workloads.

Inability to Handle Big Data

Limited capacity to process and analyze large datasets, leading to missed insights and opportunities.

High Costs

Managing the high costs of acquiring, maintaining, and upgrading advanced computational infrastructure.

Inadequate Real-Time Analytics

Slower decision-making in industries like finance and healthcare due to the lack of real-time data processing.

Lack of Resources

Skills and expertise required to maintain and update IT infrastructure in a rapidly changing tech landscape.

Performance

Ensuring optimal performance of applications and services, particularly as demand fluctuates.

Why we need HPC ?

Organizations need High-Performance Computing (HPC) to solve complex problems, process large volumes of data, and gain a competitive edge in their respective fields

Accelerated Research and Development

- Faster Innovation
- Cutting-Edge Research

Data-Intensive Tasks

- Big Data Analytics
- Artificial Intelligence and Machine Learning

Cost Efficiency and Competitive Advantage

- Reduction of Time to Market
- Optimization and Efficiency

Advanced Visualization and Rendering

- Graphics and Animation
- Scientific Visualization

Improved Decision-Making

- Real-Time Analytics
- Risk Management

Innovation and New Technologies

- IoT and Edge Computing
- Digital transformation

Impact of High Performance Computing

HPC workloads uncover new insights that advance human knowledge and create significant competitive advantages.

- HPC sequences DNA and automates data mining.
- Artificial intelligence (AI) algorithms and simulations like those enabling self-driving automobiles.
- That analyze terabytes of data streaming from IoT sensors, radar and GPS systems in real-time to make split-second decisions.

- ✓ **Computing and Informatics**
- ✓ **Engineering**
- ✓ **Scientific Domain**
- ✓ **Health and Applied Science**
- ✓ **Natural resources**
- ✓ **Spatial Science**
- ✓ **And many more.....**

HPC Use Cases



HEALTHCARE, GENOMICS AND LIFE SCIENCES

HPC applications in healthcare and life sciences include medical record management, drug discovery and design, rapid cancer diagnosis and molecular modeling. HPC visualization helps scientists gather insights from simulations and quickly analyze data.



BANKING AND FINANCIAL SERVICES

Performs high-frequency trading, risk analysis, and financial forecasting. In addition to automated trading and fraud detection, HPC powers applications in simulations.



GOVERNMENT AND DEFENSE

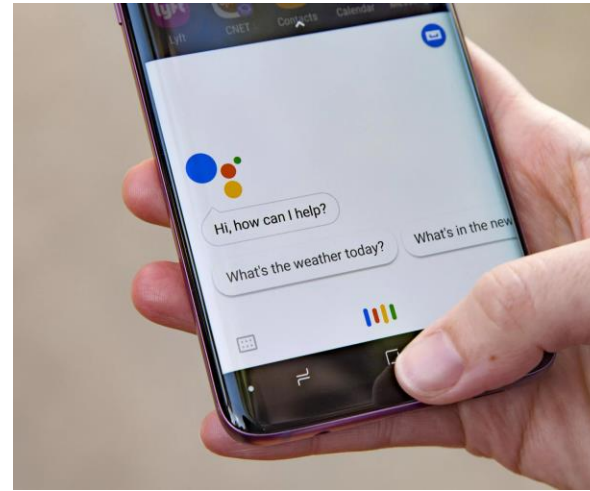
Two growing HPC use cases in this area are weather forecasting and climate modeling, both of which involve processing vast amounts of historical meteorological data and millions of daily changes in climate-related data points. Other government and defense applications include energy research and intelligence work.



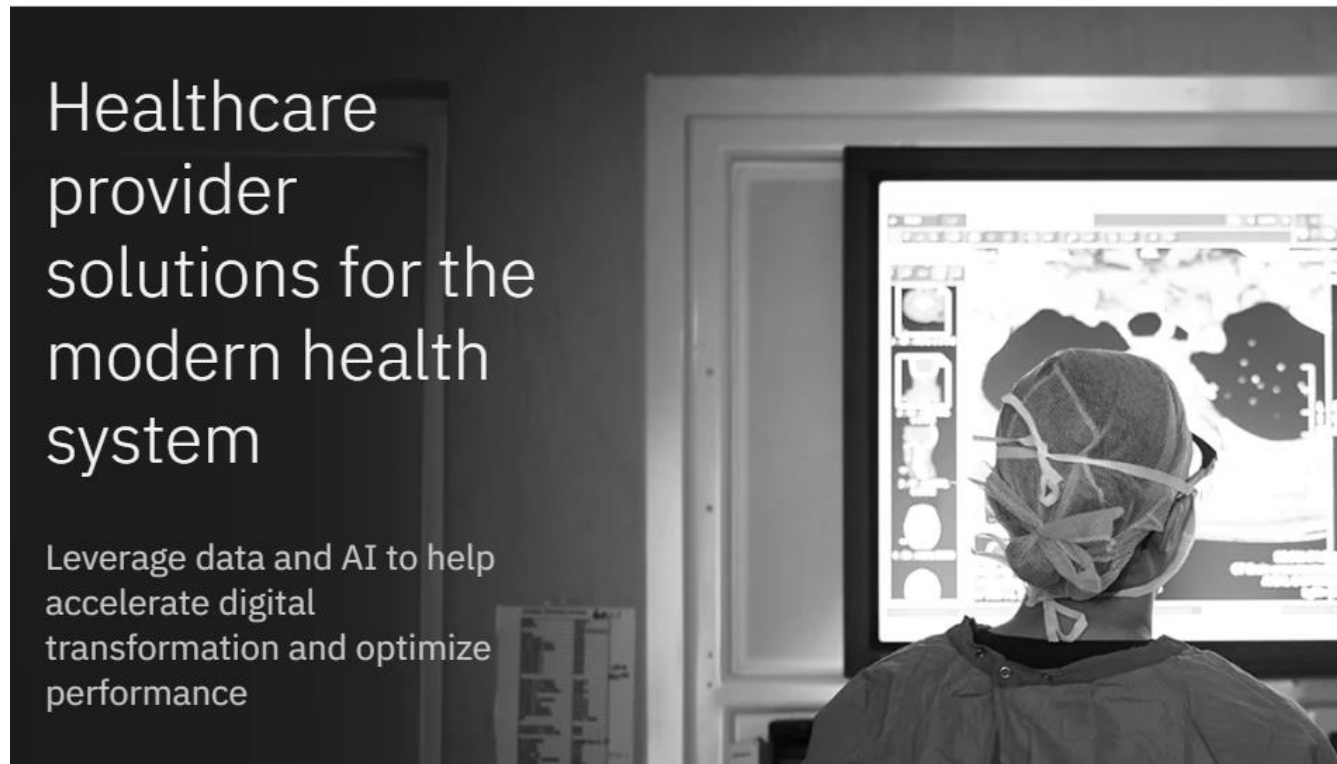
ENERGY AND SEISMIC ANALYSIS

In cases that sometimes overlap with government and defense, energy-related HPC applications include seismic data processing, reservoir simulation and modeling, geospatial analytics, wind simulation and terrain mapping.

HPC in Artificial Intelligence



AI in Autonomous Vehicle



Healthcare provider solutions for the modern health system

Leverage data and AI to help accelerate digital transformation and optimize performance

HPC in Artificial Intelligence

A wide range of problem types are addressed by AI



Classification

Categorize new input as belonging to an existing set of categories



Clustering

Create a set of categories in which items have similar features



Continuous Estimation

Estimate next numeric value in a sequence; prediction



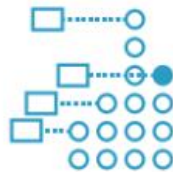
Ranking

Order the results of a query/request using pre-set criteria



Recommendation

Provide recommendations based on a specific set of data; a special type of optimization



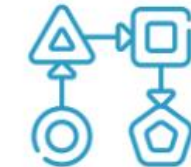
Anomaly Detection

Given a set of data, determine if specific inputs are abnormal; subset of Classification



Data Generation

Generate appropriately novel set of data based on training data



All Other Optimizations

Create a set of outputs that optimize for an objective function

Digital Transformation

EDUCATION

Face to Face



Online Learning

MOBILITY

DRIVER



Autonomous

LOGIN

Passwords



Biometrics

SECURITY

Cyber Security



IOT Security

DECISION

Data & Spreadsheet



Artificial Intelligence

INTERFACES

Buttons



Voice

DATA

Data Volume



Big Data Analytics

INDUSTRIES

Humans



Robots

Smart City

Key Components of a Smart City

What all contribute towards making a city smart?

- Core Infrastructure
- High Quality of Life
- Smart Solutions overlying Basic amenities
- Clean & sustainable environment

SMART GOVERNANCE

- IT connectivity
- Online citizen services

SMART ECONOMY

- Employment Opportunities

SMART ENVIRONMENT

- Pollution
- Green Building
- Renewable Energy

SMART LIVING

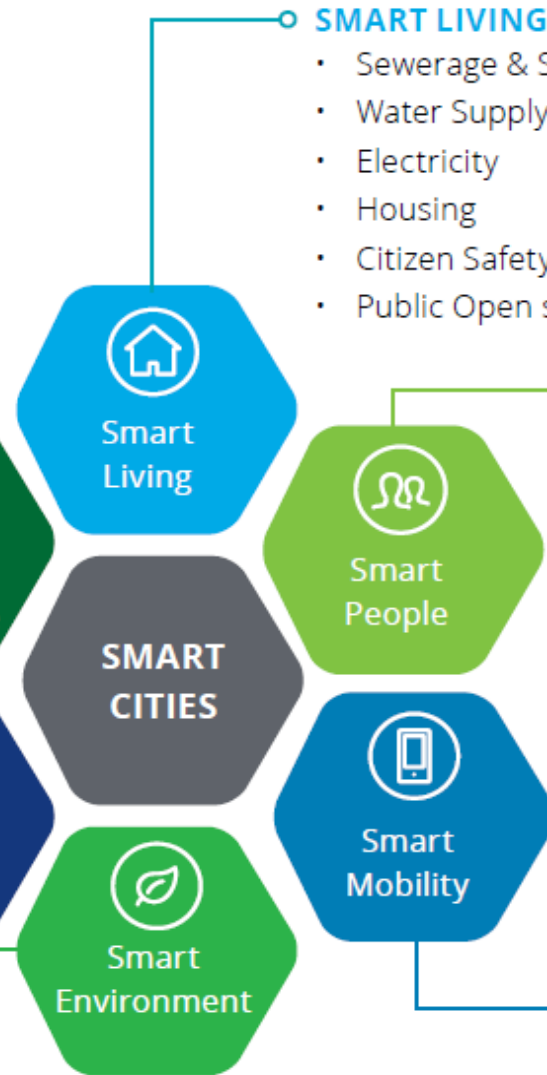
- Sewerage & Sanitation
- Water Supply
- Electricity
- Housing
- Citizen Safety
- Public Open space

SMART PEOPLE

- Education
- Health
- Entertainment & Cultural Activities

SMART MOBILITY

- Transport
- Traffic
- Walkability



HPC helps in managing and analysing vast amounts of data from sensors and IoT devices to improve city infrastructure, traffic management, and public services.

HPC and Digital Transformation

Impact of HPC on Digital Transformation



Speed and Efficiency

Accelerates data processing and business processes



Innovation

Facilitates the development of new products and services by handling complex simulations and analyses.



Competitive Advantage

Enables businesses to stay ahead by leveraging advanced analytics and insights.



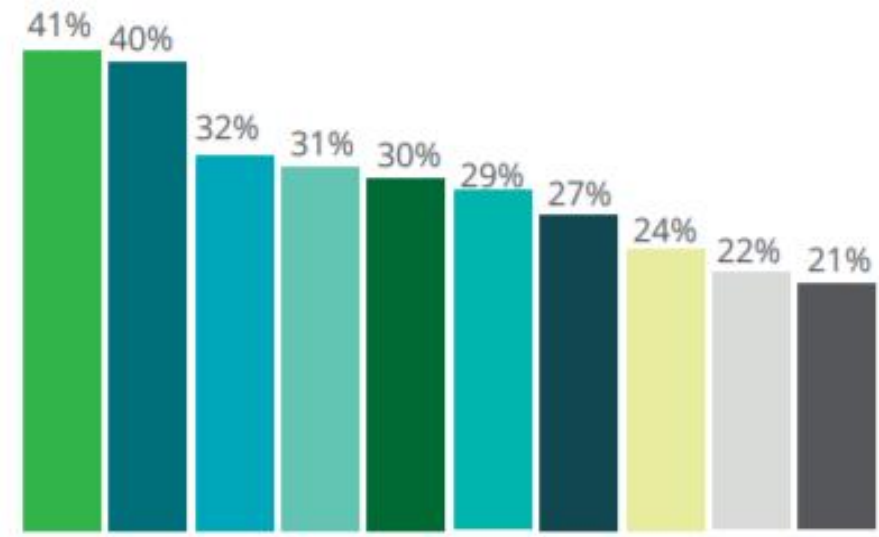
Handling Big Data

Ability to handle large-scale data and analyses that drive business innovation.

Impact on Organization

TRENDING QUESTION

Which of the following issues will have the greatest impact on your organization over the next 5 years?



- Changing regulatory environment
- Emergence of new businesses or delivery models
- Evolving economic/trade landscape
- Smart and autonomous technologies
- More powerful and tech-savvy customer
- Blurred lines between the physical and digital worlds
- Blurred lines between industries
- Increasing threat of cyber risk
- Uncertain impact on workforce
- Potential geopolitical instability

Increased demand for accelerated AI

Increased high computation and real time processing

Increased specialized hardware requirements

Edge GPUs:

High Security, Low Latency applications based near the source as in smart and secure spaces including theme parks, stadiums, cruise ships, resorts, schools, airports, factories, smart cars, trucks, planes, ships, ports

Large Scale GPU:

Differentiating applications such as Drug Discovery, R&D, Realtime Personalization, Deep Learning, Neural Networks, Data or Image Labelling

SAAS / PAAS:

Customer Facing Systems such as CRM, Martech, Ad Tech, Commerce, Sales, Customer Service, Call Center, Field Service

General Purpose Compute:

Large Enterprise applications such as ERP, EAM, Billing, Booking, Etc

Growing Compute Requirements

Good News apart?

What sets us



Inside Business

This news is your business

NUST houses N\$3m supercomputer

...invites government and industries to use the 'Ultimate Cheetah'

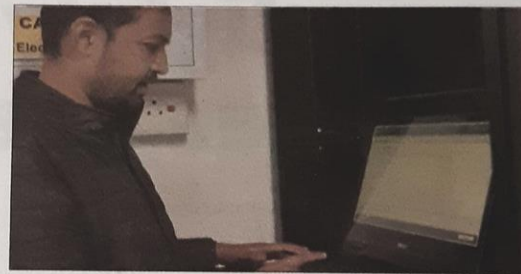
■ Maihapa Ndjavera

THE Namibia University of Science and Technology (NUST), through the India-Namibia Centre of Excellence in IT (INCEIT), houses a N\$3 million super-fast computer called the Param !Arub.

The machine is currently operating on 17.7 TF (trillion floating-point operations per second), has one master node and four parallel computing nodes comprised of 5 320 cores that enable superfast operations with 480 GB of memory and 154 terabytes of storage space.

The word "!"Arub" means cheetah in the Khoekhoegowab language and is quite befitting the super computer as Namibia is the cheetah capital of the world. The word 'Param' means 'ultimate' in the Indian Hindi language and when translated 'Param !Arub' then means 'ultimate cheetah'.

According to the head of the INCEIT, Jain Arpit the name of the supercomputer fits perfectly as the multi-million-dollar machine



Super fast... The Param !Arub has 480 GB of memory, 154 terabytes of storage space and has high computational speeds. Photo: Contributed

complex computations at high speeds. It supports cluster storage, data visualisation, enhanced graphical processing," added Arpit.

The HPC is further armed with many scientific and research domain software applications through which many complex tasks of computation and analysis of performance can be evaluated.

The super computer was created by the Centre for Development of Advance Computing (CDAC) in India which is a technical arm of their Ministry of Electronics and

tailored with the required technologies for the fourth industrial revolution (4IR), such as information security and big data analytics powered by high-performance computing," Arpit explained.

He added that with these programmes, expertise can be gained in the IT domain, with more practical exposure to deliver the requirements of specific organisations.

"With the hands-on application of the latest tools of big data technologies, professionals can transform their work with more efficient tools

- Strategic Partnership Opportunities
- Expertise and Experience
- Comprehensive Research Approach
- Timely and Actionable Insights
- Client-Centric Approach
- Global Market Coverage
- Cutting-edge Research Technology
- Industry-Specific Expertise
- Interdisciplinary Approach

PARAM !ARUB

High Performance Computing

- The name is inspired from the fastest animal Chetah.
- The word **PARAM** is from Indian language means Ultimate.
- **!ARUB** from Nama Damara native language of Namibia which means the animal Chetah one of the fastest animal and found more in Namibia.
- Our High-Performance Computing device is ultimate fastest supercomputer which can serve whole nation.



HPC Infrastructure



Master Node

- ❑ **1 node** (Dell PowerEdge R-640)
- ❑ 32 cores
- ❑ 2 x Intel Xeon Gold 6130, 16-core, 2.10 GHz
- ❑ 192 GB of physical memory
- ❑ Compute power of **1.075 Teraflops**

Compute Nodes

- ❑ **4 nodes**
- ❑ 128 cores
- ❑ 2 x Intel Xeon Gold 6130, 16-core, 2.10 GHz
- ❑ 96 GB of physical memory per node
- ❑ Compute power of **4.3 Teraflops**

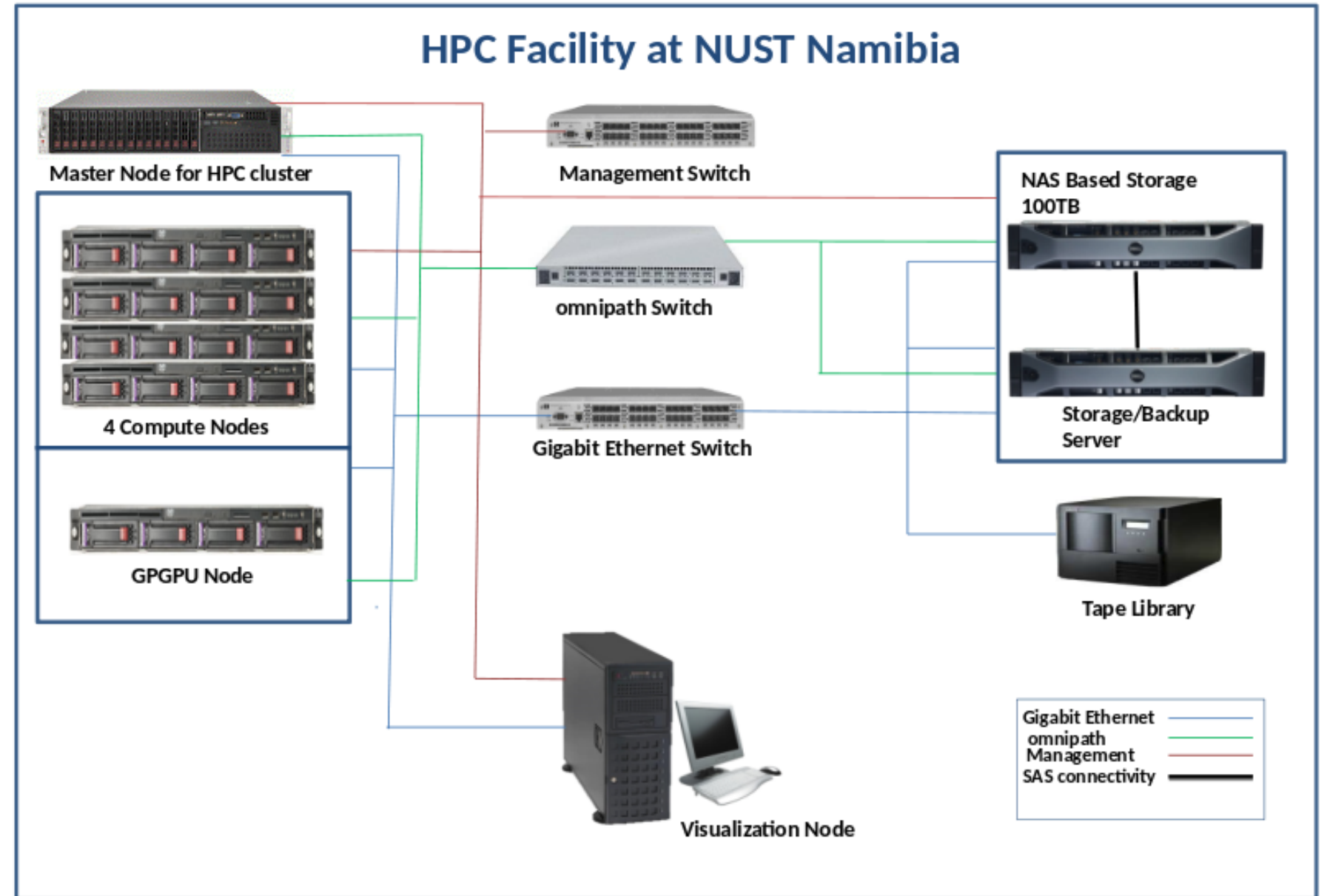
Compute Node with GPU

- ❑ **1 node** (Dell PowerEdge R-740)
- ❑ 32 cpu cores
- ❑ 2 x Intel Xeon Gold 6130, 16-core, 2.10 GHz
- ❑ 96 GB of physical memory
- ❑ GPU accelerator 1 x NVIDIA Tesla v100
- ❑ Compute power of **8.075 Teraflops/s**

Visualization Node

- ❑ **1 node**(Dell PowerEdge R-740)
- ❑ 32 cpu cores
- ❑ 2 x Intel Xeon Gold 6130, 16-core, 2.10 GHz
- ❑ 96 GB of physical memory
- ❑ Nvidia Quadro 1x P4000
- ❑ CUDA Cores **1792**

HPC Architecture



Opportunity



HPC as a Service

We offers HPC as a Service (HPCaaS) to various industries, research institutions, and government bodies to meet their computational needs



**ACCESS TO
SUPERCOMPUTING
INFRASTRUCTURE**



**SCALABLE
RESOURCES**



**DIVERSE
APPLICATION SUPPORT**



**EXPERTISE AND
TECHNICAL SUPPORT**

HPC as a Research

UNESCO Chair
on

Secure High-Performance Computing
for Higher Education and Research



- Establish the high-level Super Computing facility in Namibia.
- Establish programmes leading to a Ph.D. degree in the related field of Smart and Secure Environment (SSE)
- Promote research in the field of SSE in Namibia, the Southern African Development Community (SADC) region
- Create a platform for national and international exchanges of ideas through conferences and workshops
- Collaborate with UNESCO, Category 2 centres under the auspices of UNESCO and other UNESCO Chairs to develop relevant programmes and activities.

Education and Skill Development

HPC utilized to train students and researchers in fields like computational science, AI, and data analytics, preparing the next generation of experts.

NUST offers industry demanding advanced computing programmes as mentioned



Doctor of Philosophy in Computer Science



Master in Data Science



Bachelor in Artificial Intelligence

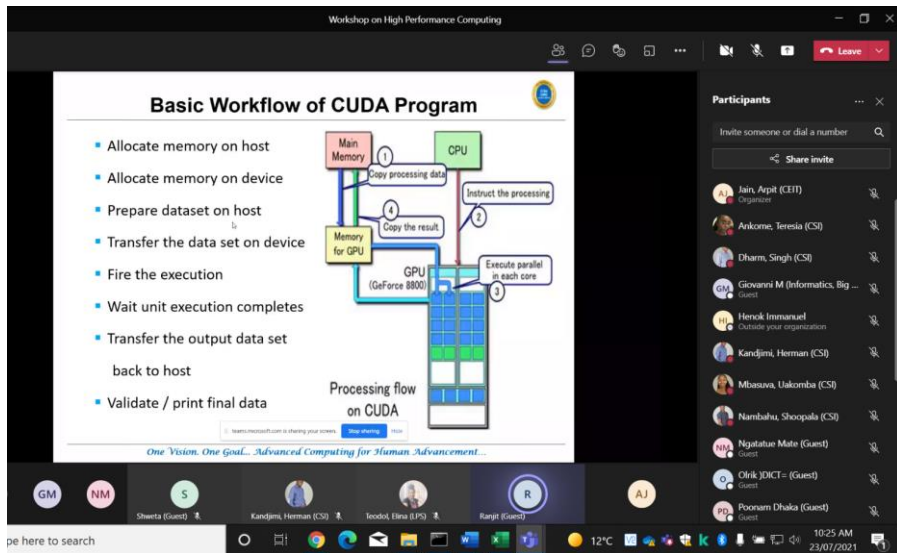


Certificate in Big Data Technologies



Certificate in High Performance Computing

HPC Workshops



Workshop on High Performance Computing

Basic Workflow of CUDA Program

- Allocate memory on host
- Allocate memory on device
- Prepare dataset on host
- Transfer the data set on device
- Fire the execution
- Wait until execution completes
- Transfer the output data set back to host
- Validate / print final data

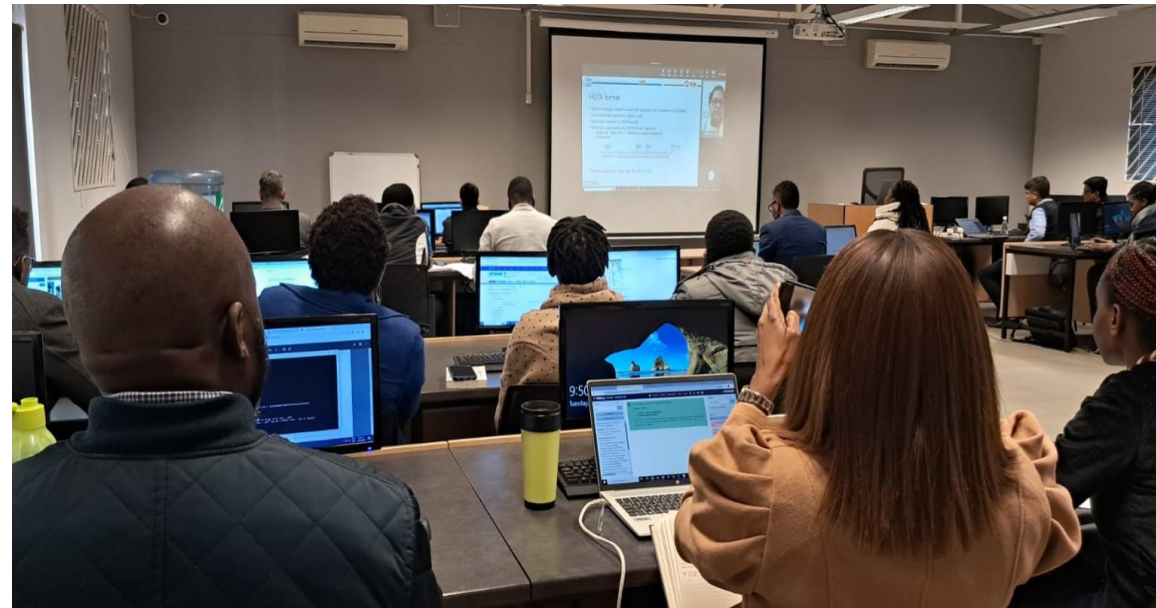
Processing flow on CUDA

1. Copy processing data from Main Memory to GPU Memory for GPU. 2. Instruct the processing. 3. Execute parallel in each core. 4. Copy the result from GPU Memory to Main Memory.

Participants

- Jain, Arpit (CSIT) Organizer
- Ankone, Teresia (CSI)
- Dharm, Singh (CSI)
- Giovanni M (Informatics, Big ... Guest)
- Henok Immanuel (Online your organization)
- Kandjimi, Herman (CSI)
- Mbasawa, Ukomba (CSI)
- Nambahu, Shoopala (CSI)
- Nyagatso Mate (Guest) Guest
- Oluk, YDICT- (Guest) Guest
- Poonam Dhaka (Guest) Guest

One Vision. One Goal... Advanced Computing for Human Advancement...



High-Performance Computing (HPC) is a critical enabler of innovation across numerous industries, from scientific research and AI development to engineering, finance, and healthcare.

Industries need HPC to stay competitive, optimize operations, innovate quickly, and tackle complex challenges that require vast computational power and data processing capabilities.

By offering immense computational power, HPC accelerates problem-solving, drives breakthroughs, and enhances efficiency.

The opportunities presented by HPC, from scientific research to AI development and smart city planning, are vast and growing.

Conclusion

Lets engage, collaborate and exchange our innovative ideas to harness the power of High-Performance Computing (HPC) in accelerating scientific research, optimize industry operations, and drive technological advancements for shaping a prosperous future for Namibia.

Contact us at:



NAMIBIA
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THANK YOU