Developing a Sustainable High Performance Computing Ecosystem: A Case Study of Southern Africa

Dr Happy Sithole
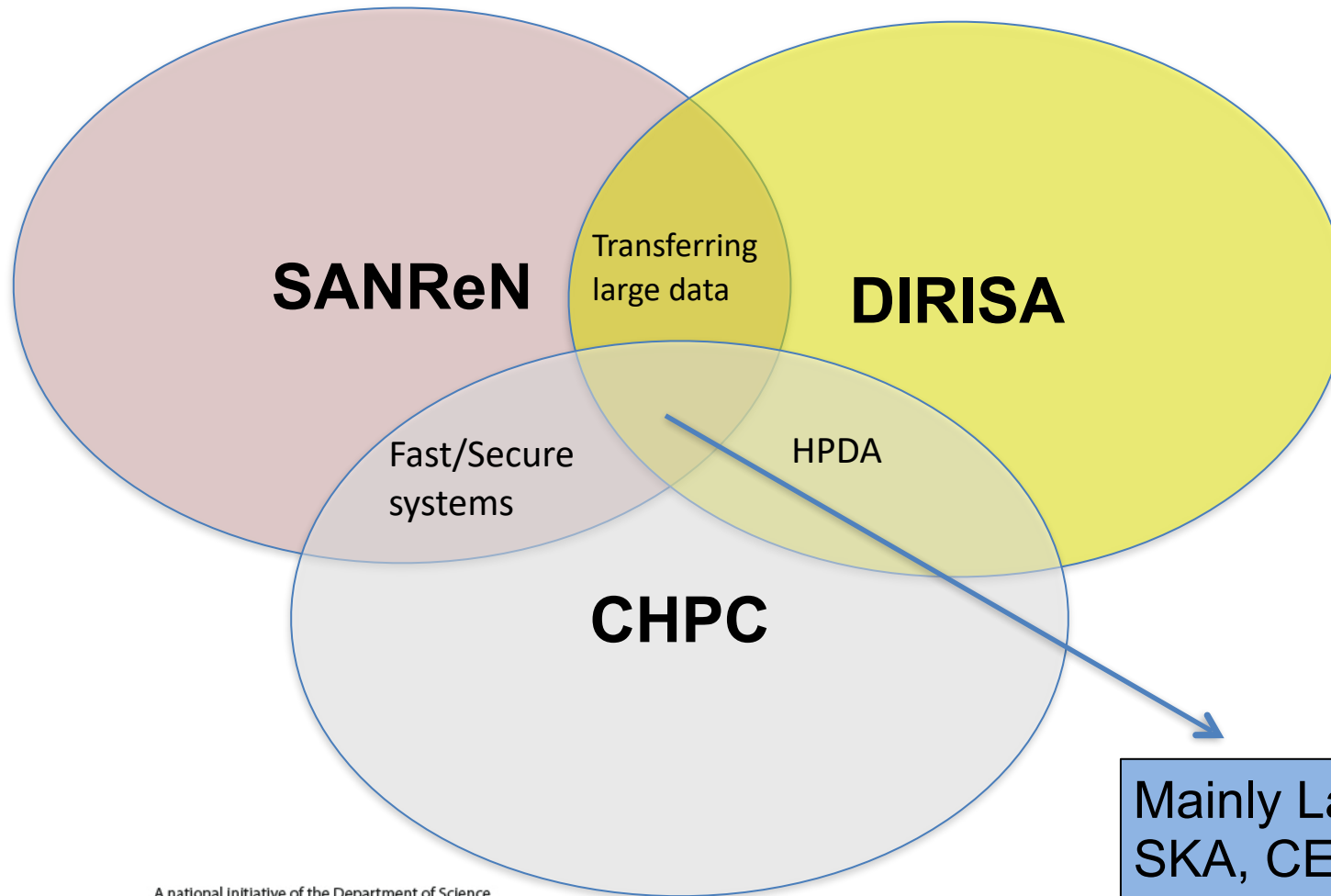
25 September 2023

NICIS
NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM

SANReN

Transferring large data

DIRISA

Fast/Secure systems

HPDA

CHPC

- Common services between any two entities of NICIS

- Intersection of the three entities most crucial, as defines the success of overall NICIS.

- Development of cross-cutting skills internally and within the community

Mainly Large Scale Science projects:
SKA, CERN, 4IR, SADC C.I. Framework, Climate Change (e.g. IPCC)

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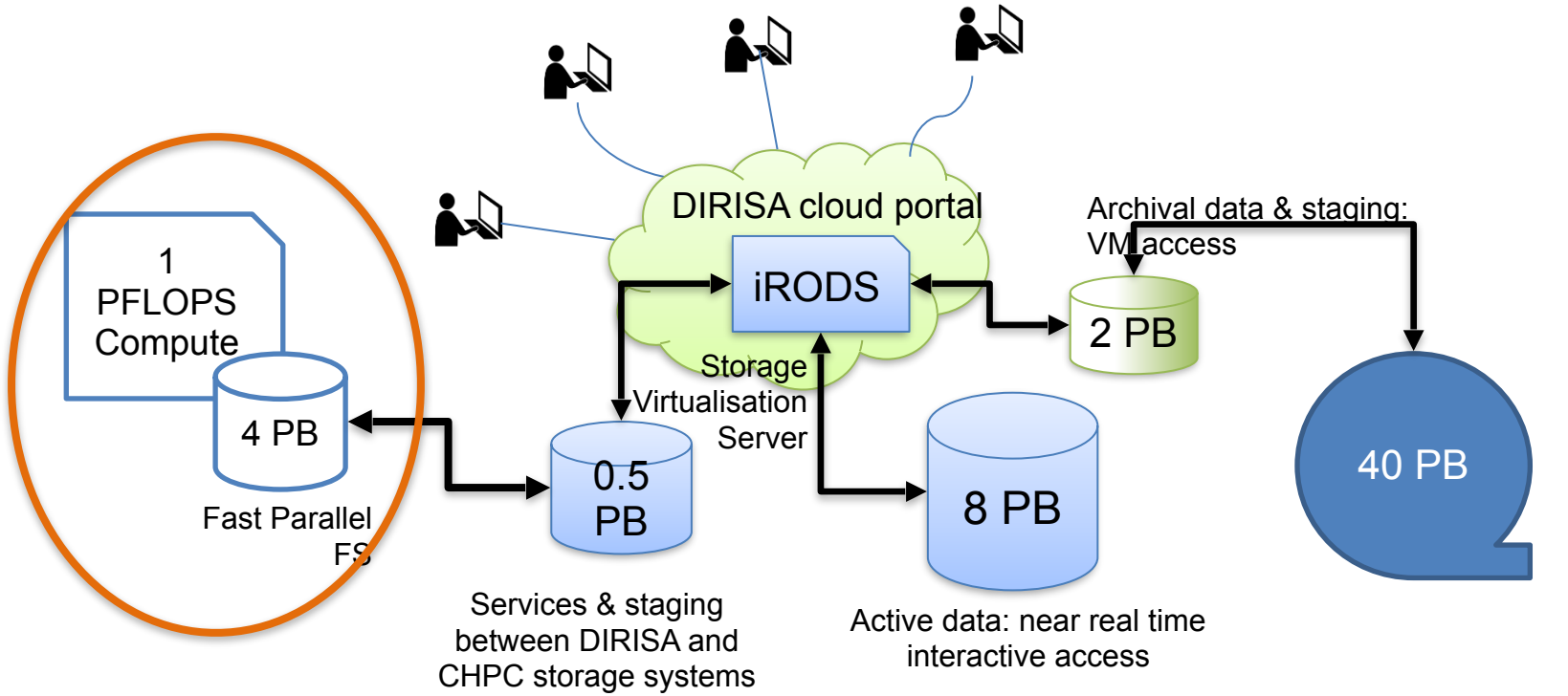
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Strategic Objectives

SO1
- Sustain a **world class** and relevant **national integrated cyberinfrastructure system** for Science and Technology

SO2
- Enable and promote **eScience** in South Africa.

SO3
- Position South Africa to take part in, host and **lead large scale global research and science projects** (e.g. SKA and CERN experiments).

SO4
- Provide **thought leadership** to South Africa's evolving cyberinfrastructure strategy and activities, and facilitate the uptake of advanced cyberinfrastructure.

SO5
- Foster the development of **human capacity in cyberinfrastructure and its application**, and contribute to the transformation of this sector.

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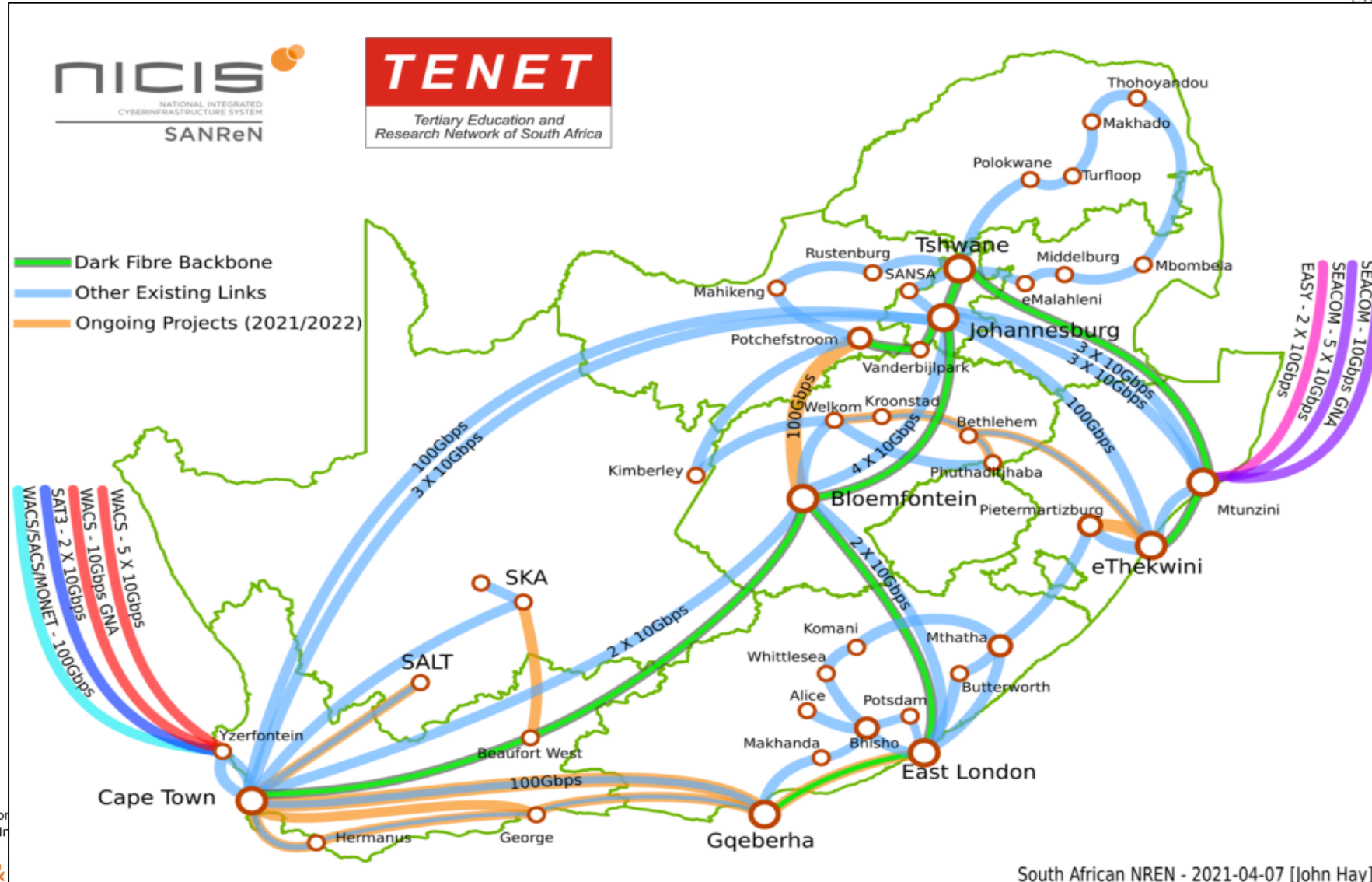
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NICIS
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CYBERINFRASTRUCTURE SYSTEM

1 PFLOPS Compute

4 PB
Fast Parallel FS

DIRISA cloud portal

iRODS

Storage
Virtualisation
Server

2 PB
Archival data & staging: VM access

0.5 PB
Services & staging between DIRISA and CHPC storage systems

8 PB
Active data: near real time interactive access

40 PB

Small, fast — Software defined storage hierarchy — Big, slow

- Open (FAIR) Data & Open Science

- Federated locally and globally ("One-stop-shop" catalogue)

- Certified as Trusted Repository

- Linked to funder systems

- Suite of services for RDM and data intensive analytics

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Network Infrastructure

South African NREN - 2021-04-07 [John Hay]

NICIS Platforms

- **GPU Cluster with 9 Nodes each with 4 NVIDIA – V100 processors.**
- **Mainly used for Machine Learning, Artificial Intelligence and Materials Science applications.**

- **Lengau = "Cheetah"**
- **Installed 2015 with 1.6 PFLOP performance**
- **1 345 Nodes of INTEL processors**
- **Rear-door water cooling system**
- **7 Petabytes of Lustre storage**
- **Close to 100% utilisation**

- **CERN Tier-2 Grid facility**
- **Supports ALICE and ATLAS experiments**

- **OpenStack Cloud named SEBOWA**
- **52 Nodes with INTEL processors**
- **Installed in March 2020**
- **Used for many applications including COVID-19 Data Services**

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Research in Technology

- Evaluate technology for HPC and cloud
- Investigate and develop technology to improve HPC systems
- Provide a consulting service for HPC and cloud technology
- Collaborate with users with special applications to drive efficiency
- Operate experimental systems
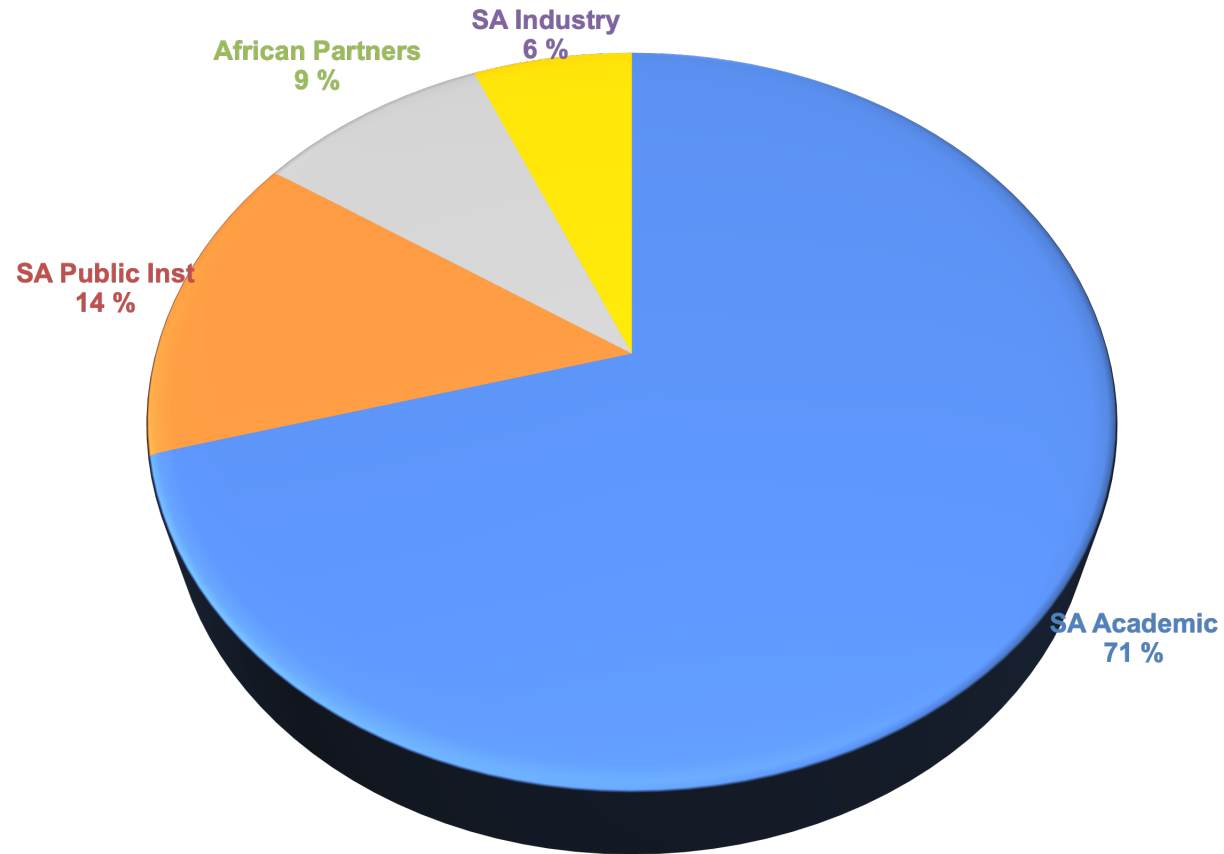
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User Categories

SA Industry
6 %

African Partners
9 %

SA Public Inst
14 %

SA Academic
71 %

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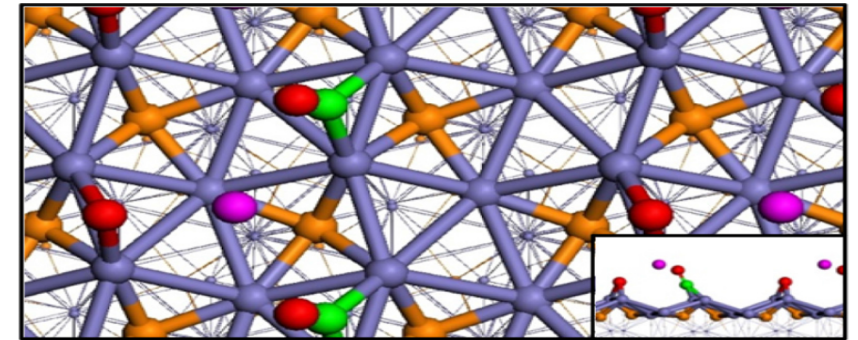
Materials Science / Chemistry / Health
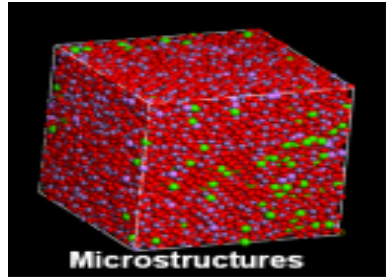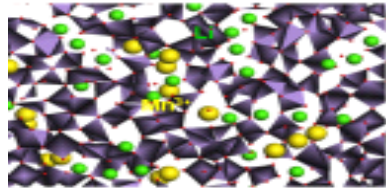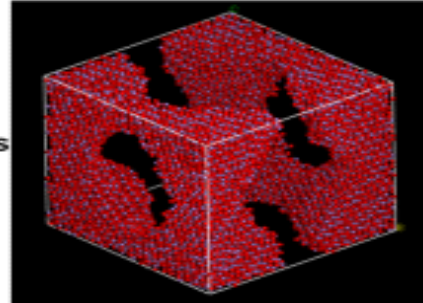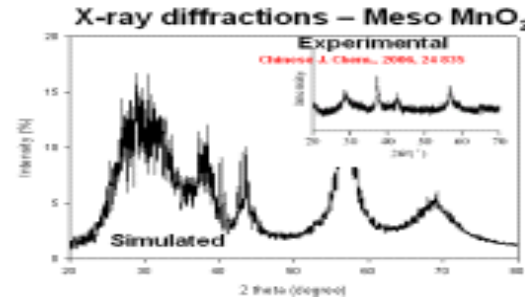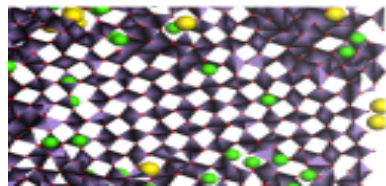
Computational Catalysis
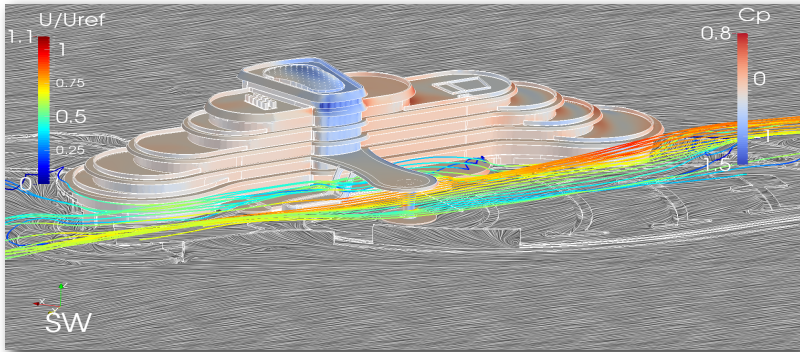(Comp Chem / Materials Science)

Energy Storage – Battery Development
(Materials Science)

Drug-Design Molecular Modelling
(Computational Chemistry)

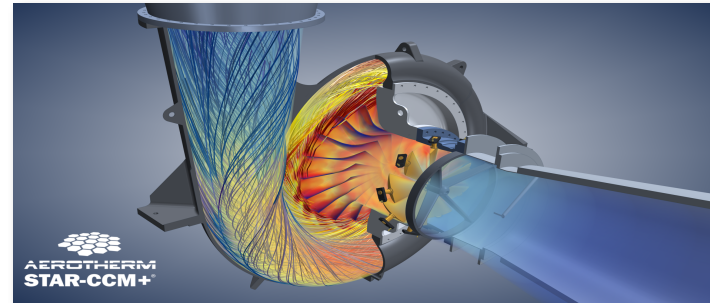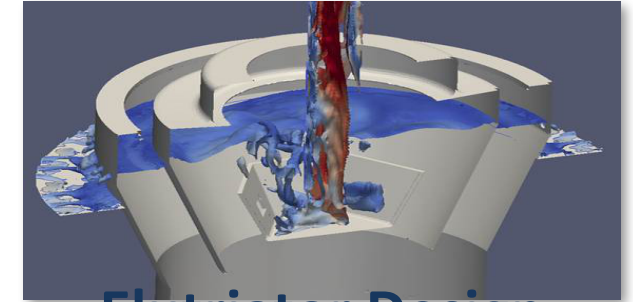A national initiative of the Department of Science and Innovation and implemented by the CSIR

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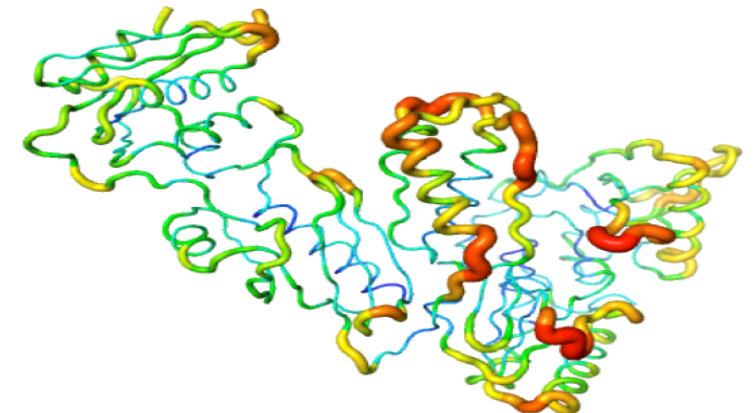
HPC Applications: Engineering

Computational Mechanics / Engineering

Building aerodynamics
(ECI-JV)

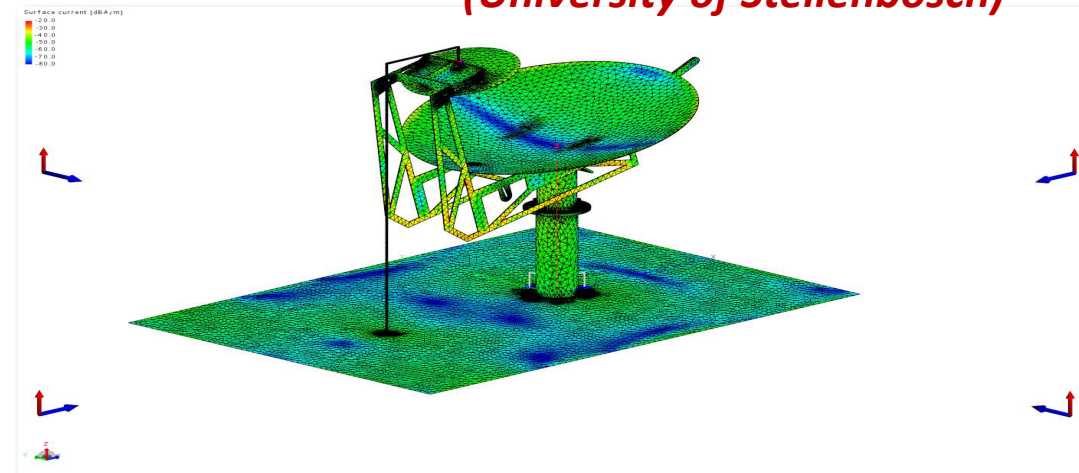**Centrifugal Steam Compressor**

(Aerotherm)

Elutriator Design

(De Beers Marine)

Radio-Astronomy Dish Design

(University of Stellenbosch)

High-speed Train Design *(UP)*:

HPC Applications: Astronomy

- **Testing and Evaluation** of compute, network and data infrastructures

- Data Transfer Node (**DTN/Globus**) Setup

- Active **Research Programme** at CHPC (Software Requirements, Benchmarking Imaging Pipelines, etc.)

- Physical **Hosting of MeerKAT Data Servers**
  - Peraplex Data Storage Pods (20 PB)
  - IBM Tape Library (>20 PB)
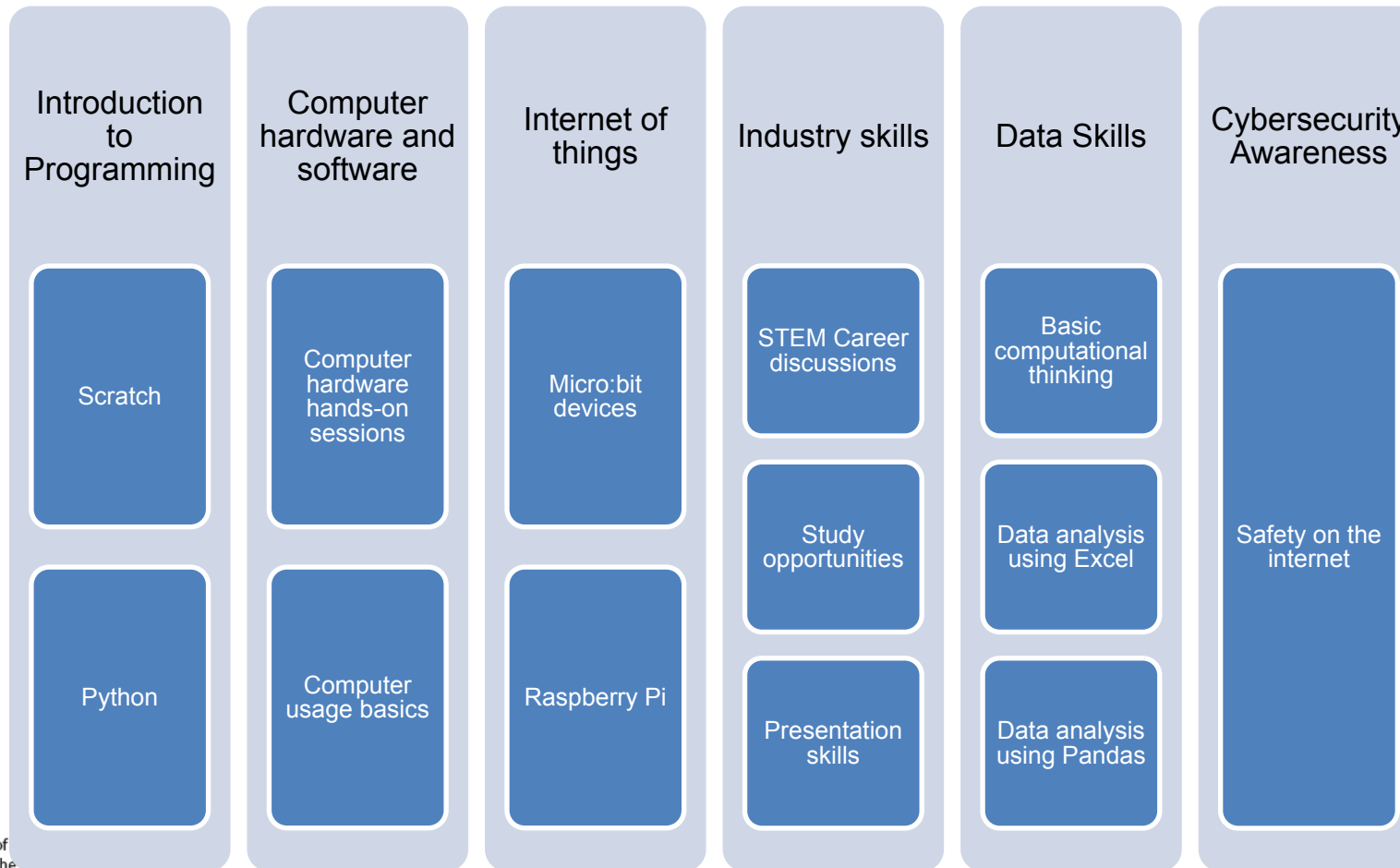
NICIS HCD Pipeline
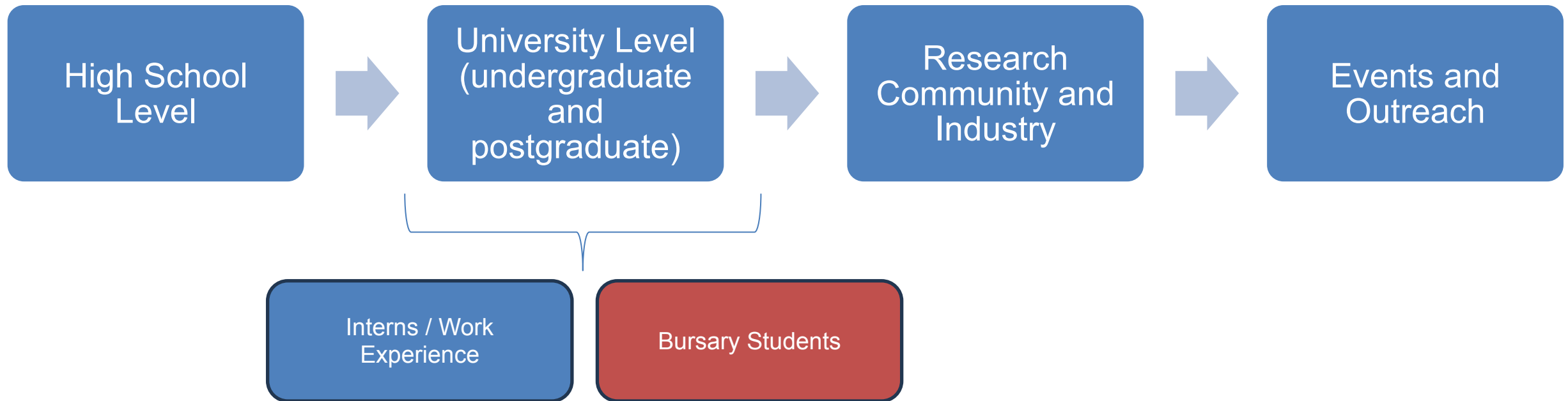
High School Level

- DIRISA Coding School
  - Introducing python programming and data science concepts to high school learners
- CHPC Learn how to code
  - Introducing scratch programming to high school learners

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High School Level

Introduction to Programming	Computer hardware and software	Internet of things	Industry skills	Data Skills	Cybersecurity Awareness
Scratch	Computer hardware hands-on sessions	Micro:bit devices	STEM Career discussions	Basic computational thinking	Safety on the internet
Python	Computer usage basics	Raspberry Pi	Study opportunities	Data analysis using Excel	
			Presentation skills	Data analysis using Pandas	

University Level

- CHPC Student Cluster Competition (SCC)
  - Promote and develop HPC skills in undergraduate students
- DIRISA Student Datathon Challenge (SDC)
  - Promote data skills and problem solving through technology.
- SANReN Cybersecurity Challenge (CSC)
  - Promote interest in Cybersecurity
- Annual competitions have selection, national and international rounds
- Participation across all provinces and universities in South Africa and also includes SADC region

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University Level

Student Cluster Competition
- Build super-computer
- Reproducibility challenge
- Test benchmarks
- Apply optimization techniques

Cybersecurity Challenge
- Capture the Flag
- Attack and Defend teams
- Social engineering attacks
- Hacking challenge

Student Datathon Challenge
- Data Exploration Modelling and Visualisation
- Artificial Intelligence, Machine Learning and Natural Language Processing
- Problem solving using data and technology
- Conducting research and producing poster / abstract

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University Level

- CHPC Monthly Coding Challenges
  - Learning continuation after coding summer school.
- DIRISA Datathon Training
  - Continued training programme linked to the Datathon Challenge
- National E-Science Postgraduate Teaching and Training Platform (NEPTTP)
  - Develop human capital skills to conduct cutting-edge research in the field of e-Science i.e. South African Research Infrastructure Roadmap (SARIR), the Square Kilometre Array (SKA) etc.
- SANReN Guest Lectures and Training
  - Presentations on cybersecurity awareness and training focusing on network security and social engineering at SU / Android security and pen testing at RU
  - Postgraduate Modules at UWC (Information security risks / Mobile security forensics)

Research Community and Industry

- SANReN TRANSITS Training
  - Computer Security and Incident Response Team (CSIRT) personnel training. Expertise in operational, organisational, legal and technical areas.
- CHPC-NITheCS-ICTP (International Centre for Theoretical Physics) Training
  - HPC for sustainable development
- CHPC-NITheCS Coding Summer School
  - Train researchers in various domains on fundamentals of python, bash, data science, HPC and computational sciences.
- HPC Ecosystems Training
  - System administrators, OpenHPC. Africa wide.
- SIGHPC Education Global Seminar Series

Research Community and Industry

- DSI Hardware and Coding Workshops
    - Train representatives from all provinces on robotics and coding
- BRICS Future Skills Challenge
    - Multi-day online skills Olympics across BRICS nations focused on solving real world problems in specific future skills area.
    - SANReN Cybersecurity expert – Dr Heloise Meyer.
- CHPC Winter School
    - Practical HPC course and Parallel Programming. Intermediate course on using HPC cluster and parallel programming.
- CHPC Induction Course
    - Self-study online course to introduce the CHPC cluster and functions

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Events and Outreach

- NICIS National Conference
- DIRISA National Research Data Workshop
- SANReN ZA-REN Week
- Attending various expo's:
  - World Science Forum
  - Working World Expo 2023 / World of Work Week
  - International Super Computing Conference (ISC) 2023, HPC 2023
  - International Data Week (IDW) 2023
  - CSIR-NICIS Nelson Mandela Day Outreach
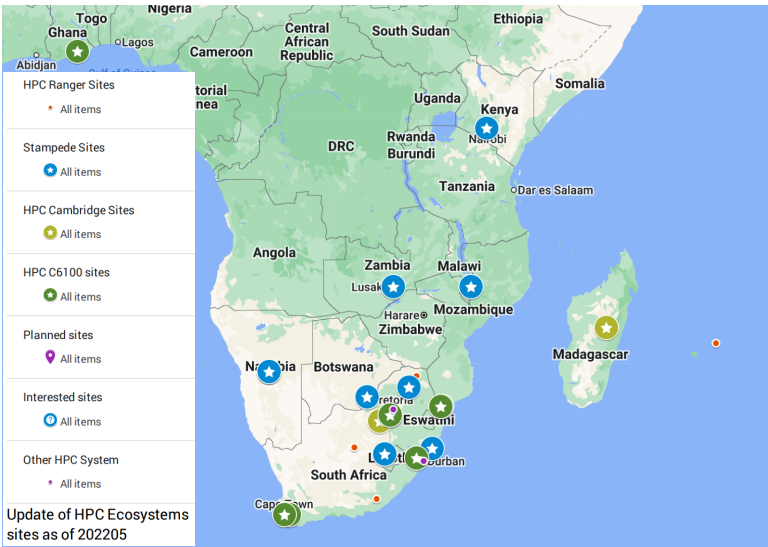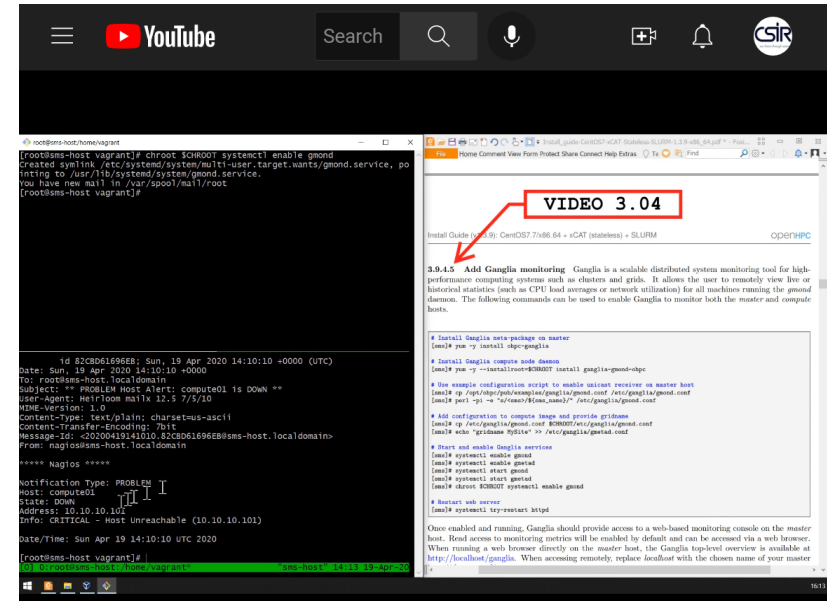 - National Science Week

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35 systems in **12 countries**.

Trained **400+ HPC SysAdmins**.

Online OpenHPC Virtual Training Lab

HPC Ranger Sites
• All items

Stampede Sites
• All items

HPC Cambridge Sites
• All items

HPC C6100 sites
• All items

Planned sites
• All items

Interested sites
• All items

Other HPC System
• All items

Update of HPC Ecosystems sites as of 202205

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• UFH
• UL
• UniVen
• UNMW- Mahikeng
• Sol Plaatjie
• UKZN
• US
• Wits
• UniZulu
• DUT
• UM
• SMU

Website: www.nicis.ac.za

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