



## 4<sup>TH</sup> ANNUAL SADC INDUSTRIALISATION WEEK

# Investment in Big Data for Industrial Development and Competitiveness

Dr. Happy Sithole

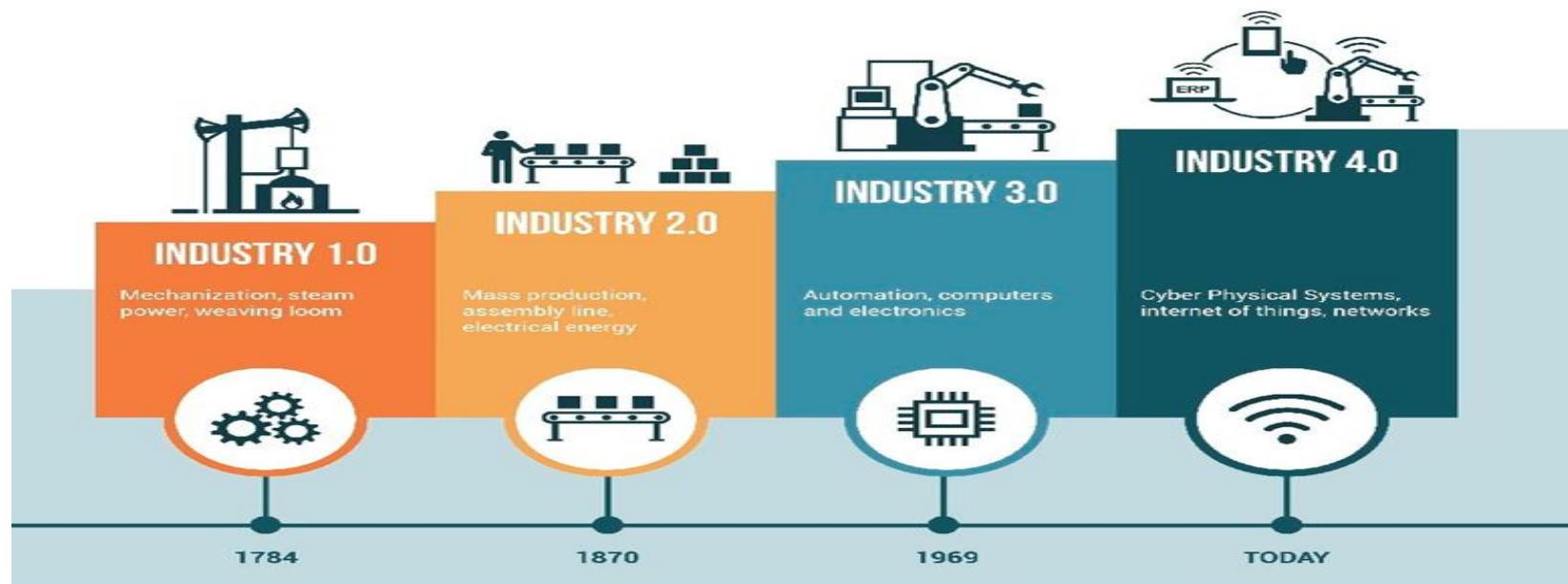
*Center Manager: NICIS*

7<sup>th</sup> August 2019



## Definitions and Concepts

*The Fourth Industrial Revolution aims to leverage differences between the physical, digital, and biological sphere. It integrates cyber-physical systems and the Internet of Things, big data and HPC, robotics, artificial-intelligence based systems and additive manufacturing.*



## FIR Technologies

- The fourth industrial revolution is driven by technological advancement, new and emerging technologies and platforms. Some of the technologies to be embraced in the era of the fourth industrial revolution:
  - *Artificial intelligence and machine learning;*
  - *Advanced robotics and new forms of automation;*
  - *Ubiquitous mobile internet;*
  - *Sensors and the internet of things;*
  - *Blockchain and distributed ledgers;*
  - *3D printing;*
  - *New materials;*
  - *Genetic advances, bio-engineering; and*
  - *Quantum computing.*

## Digital skills for youth: Opportunities & challenges



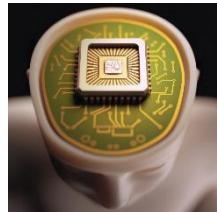
Robots



Internet of  
Things



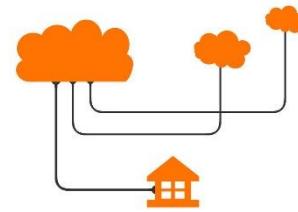
High Performance  
Data Analytics .e.g  
DIRISA



AI/ML/DL



HPC



Cloud  
computing

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## Under threat

TRAVEL AGENTS



TELLERS



SURVEYORS



SUSTAINABILITY  
MANAGER



JOURNALIST



LEGAL ASSISTANT



FINANCE ASSISTANT



APPS DEVELOPER



SOCIAL MEDIA  
STRATEGIST



DATA SCIENTIST



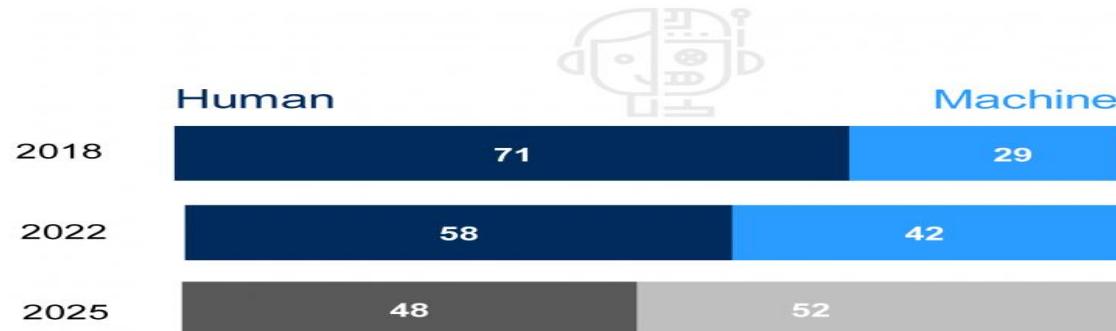
## New jobs

## Are we preparing for the workplace of the future?



### Rate of automation

Division of labour as share of hours spent (%)



Source: Future of Jobs Report 2018, World Economic Forum

## Drivers of Change

Drivers of change, 2015–2020	Rank
Processing power, Big Data	1
Changing nature of work, flexible work	2
Middle class in emerging markets	3
Mobile Internet, cloud technology	4
Geopolitical volatility	5
Climate change, natural resources	6
Sharing economy, crowdsourcing	7
New energy supplies and technologies	8
Young demographics in emerging markets	9
Rapid urbanisation	10
Women's economic power, aspirations	11
Internet of Things	12
Adv. Manufacturing, 3D printing	13
Artificial Intelligence	14
Robotics, autonomous transport	15
Adv. materials, biotechnology	16

Source: World Economic Forum, The Future of Jobs Survey.

Note: Survey based on South Africa only.



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## Alignment

Revised Regional Indicative Strategic

Development Plan, RISDP  
Industrialization Strategy and Roadmap

SADC CI Framework

Regional infrastructure Development

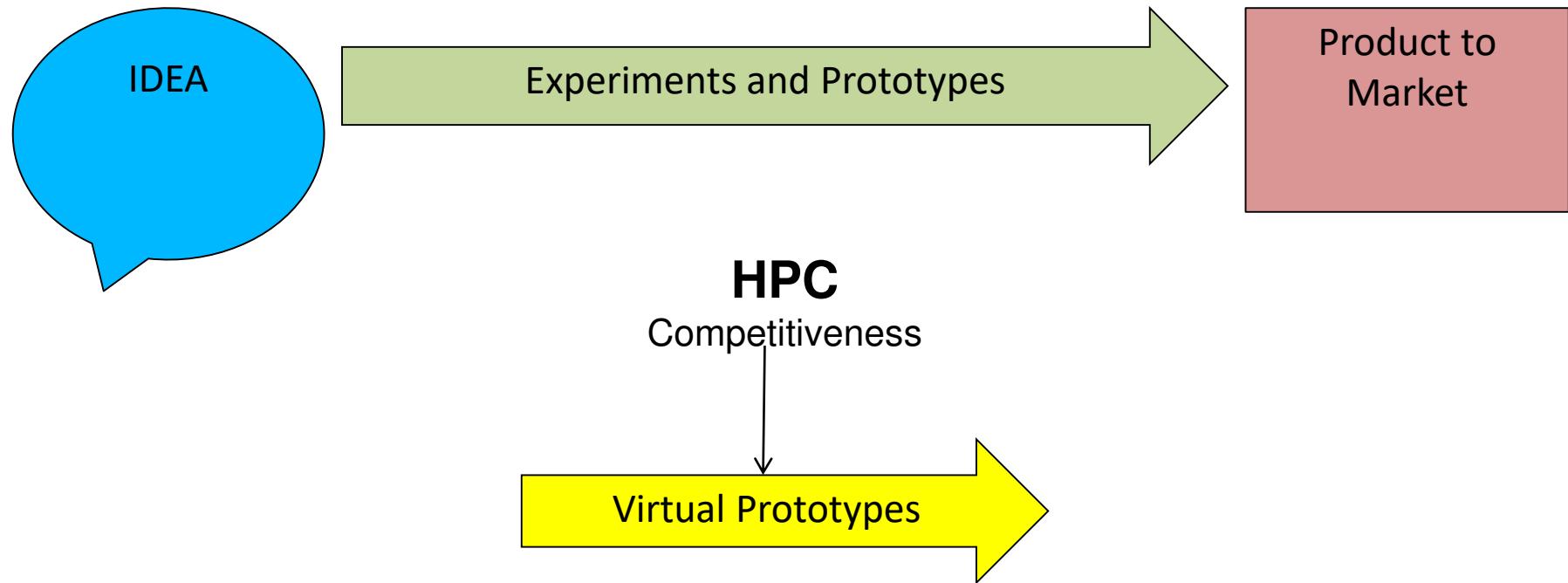
Master Plan, RIMDP



# Components of the Framework

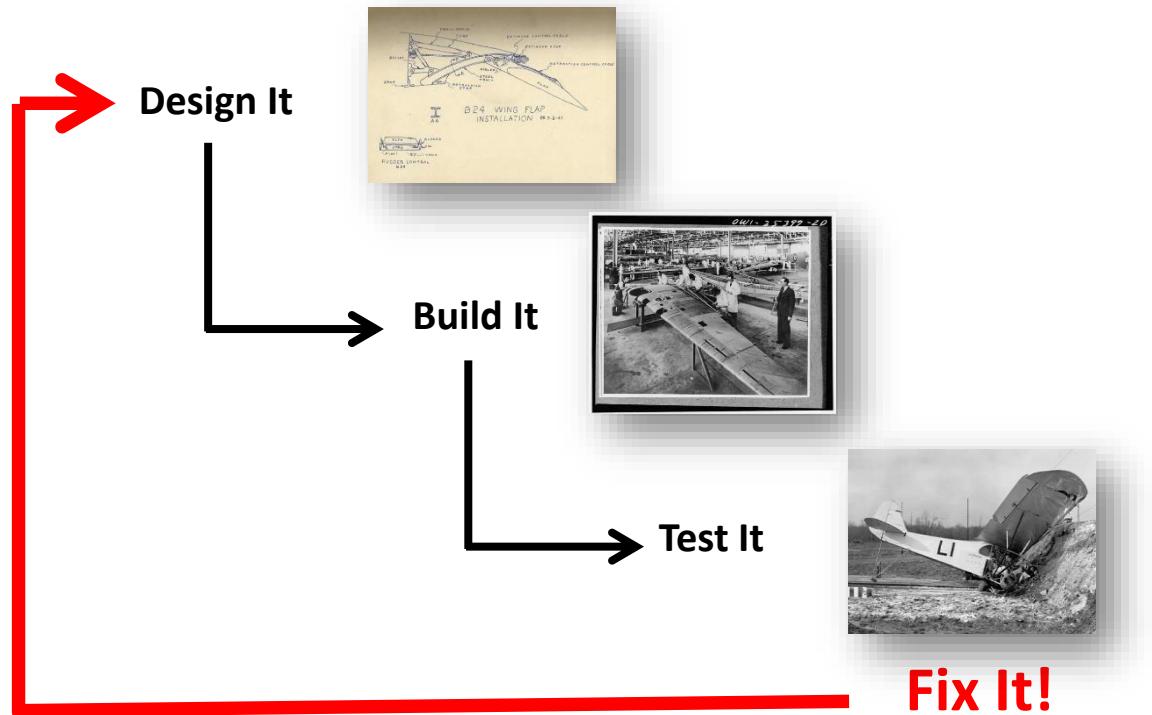
- **Policies** - To enable optimal establishment and utilization of cyber-infrastructure, generation, analysis, transport as well as stewardship of information,
- **Computational Resources** - Ranging from HPC to other computing capabilities (hardware and software) and applications areas,
- **Data** - tools and facilities (including repositories) to enable sharing and efficient data-driven discoveries, technologies and innovations,
- **National Research Networks** - Specialized broadband infrastructure networks and service providers for education, research and innovation,
- **Human Capital** - To make effective use of the Cyberinfrastructure.

## Why HPC?

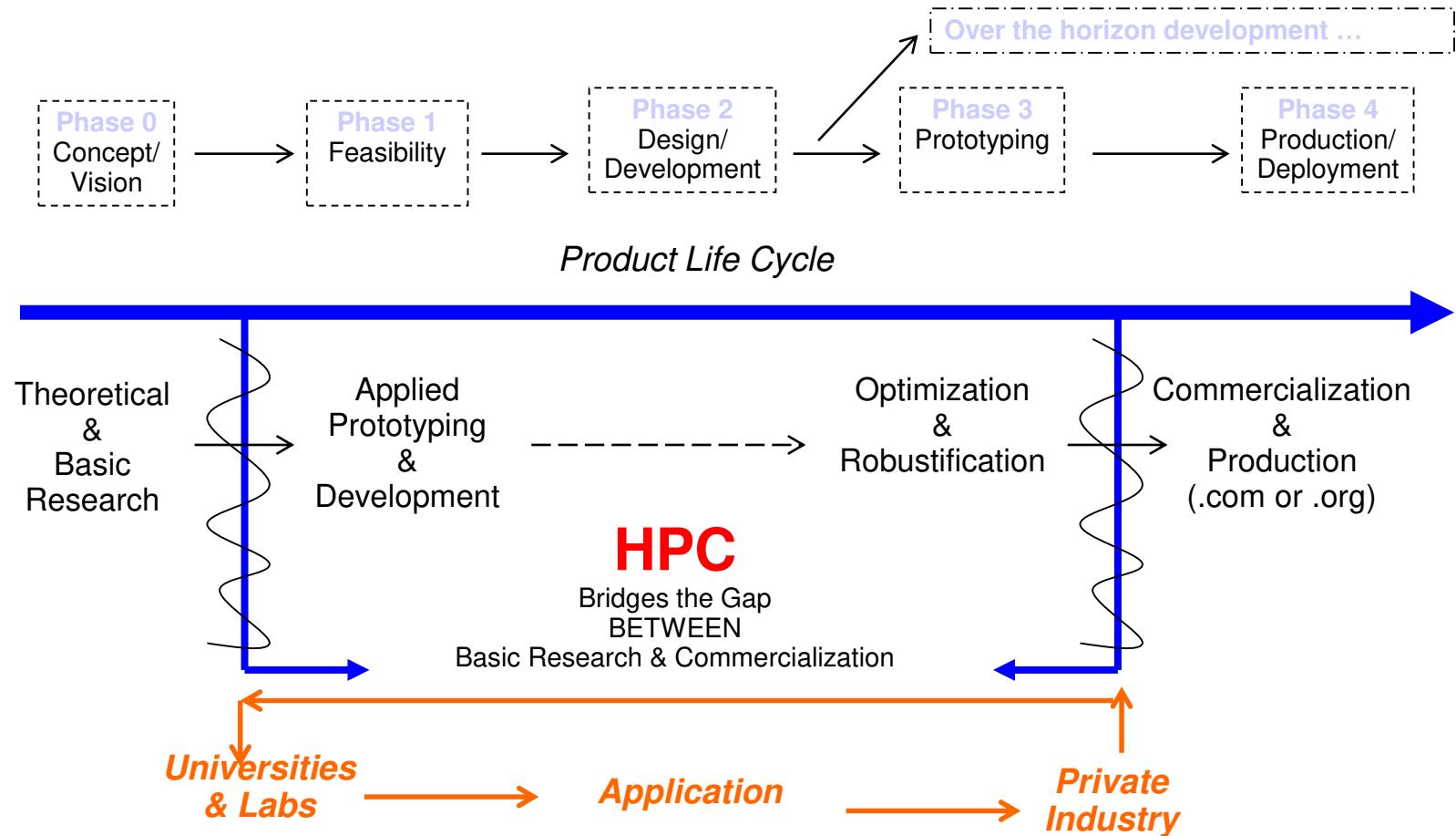


## Out-Compute to Out-Compete

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## Technology Development Continuum



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## Integrated, Information-Based Decision Making

Human, Physical,  
Virtual Sensors



Bots, Actors

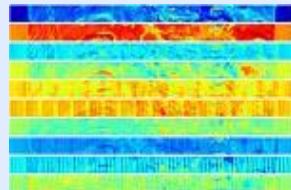


Archives

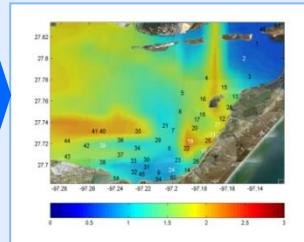
Information  
-Based  
Decisions

Automated  
Provenance

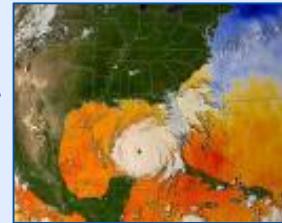
Multimodal



Modeling



Visualizatio



Dashboard



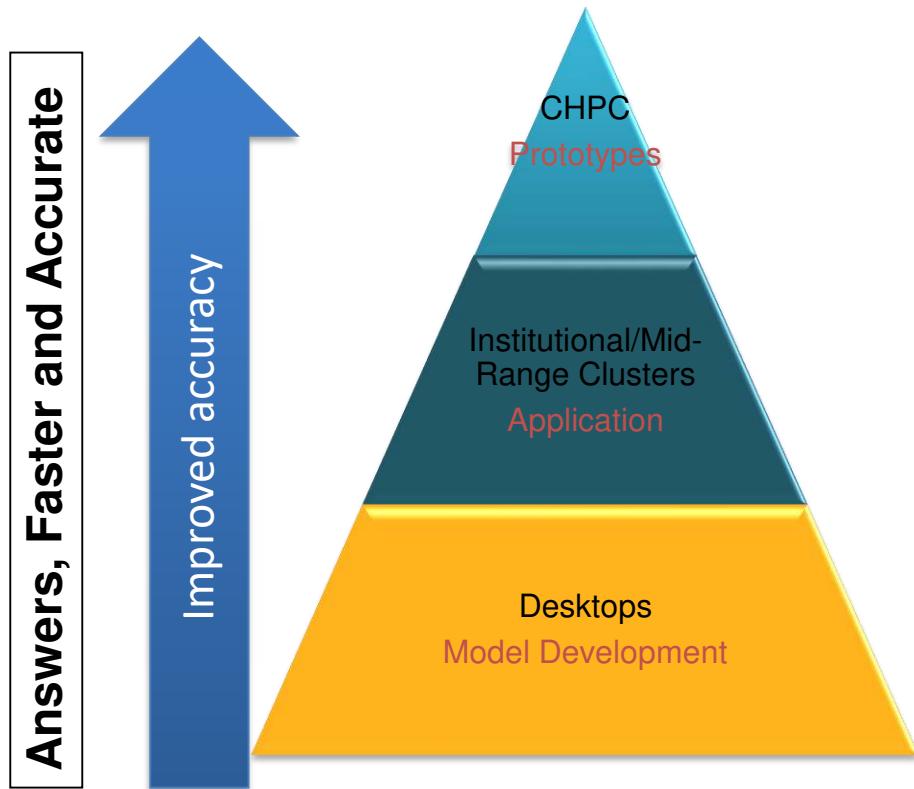
Data  
Fusion

...Seamless  
Computing...

Calibration



## *High Performance Data Analytics Trends*

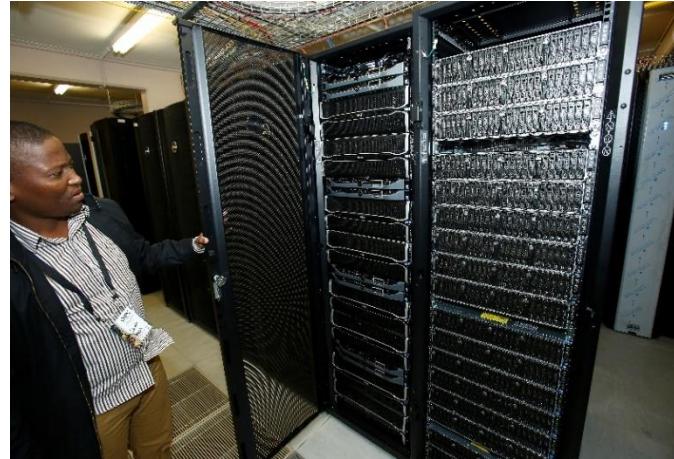


- Uptake of simulation goes beyond traditional Science and Engineering due to the “Big Data Analytics”.
- High fidelity models required for “Virtual prototyping” improve with compute intensity.
- Availability of high quality data and more processing power is enabler.
- Strengths in both domain knowledge and HPC are differentiator.

## *Basics of HPC*



## South Africa HPC PETAFLOP SYSTEM



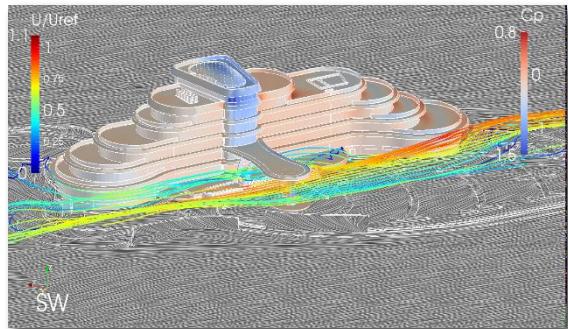
- **World-Class HPC systems**
- **Ranked amongst the fastest in the world**
- **Fastest system in Africa**
- **Utilised efficiently by academics and industry.**
- **Accessible all over the continent**

## Machine Learning and AI Applications

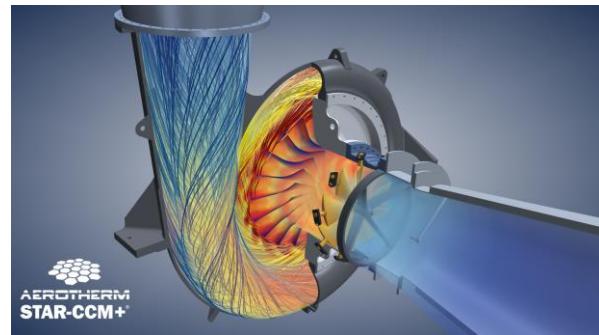


- ❑ **Graphical Processor Unit (GPU) Cluster: 30 V100's**
  - ❑ 6 nodes (36 Intel Gold 6150 CPU's; 3 V100's; PCIe)
  - ❑ 3 nodes (40 Intel Gold 6150 CPU's; 4 V100's; NVLink)
- ❑ Since **September 2018**
- ❑ Immediate Demand from users:
  - ❑ **Transfer of Chemistry Users (MD)**
  - ❑ **Resources for Machine Learning (ML) and AI**
- ❑ Machine Learning applications optimised –  
TensorFlow
- ❑ Big Data Analytics Focused

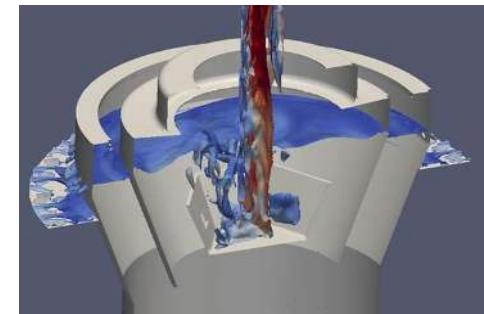
## *Computational Mechanics / Engineering*



**Building aerodynamics**  
*(ECI-JV)*

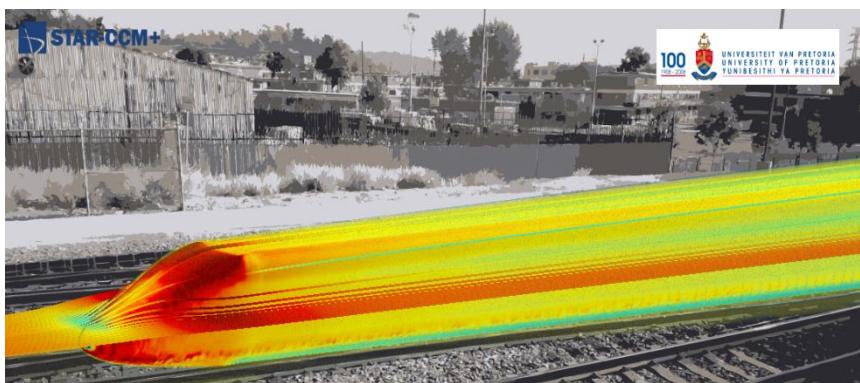


**Centrifugal Steam Compressor**  
*(Aerotherm)*

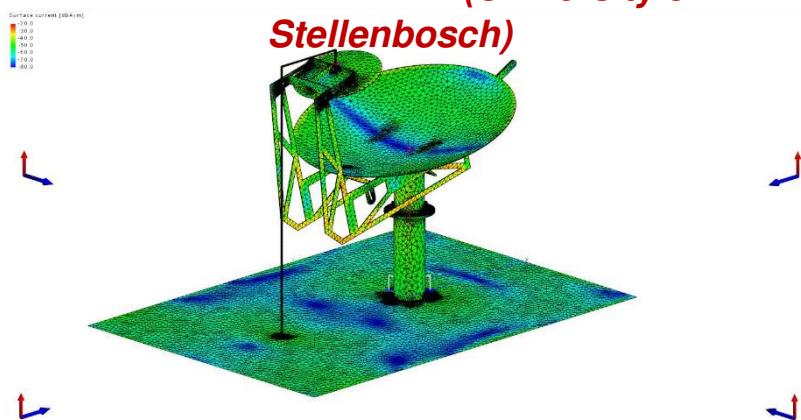


**Elutriator Design**  
*(De Beers Marine)*

**High-speed Train Design** *(UP):*

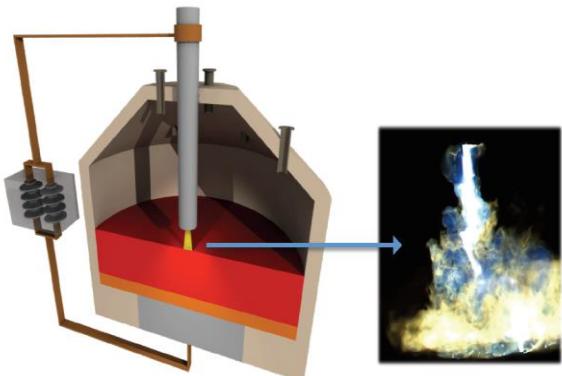


**Radio-Astronomy Dish Design**  
*(University of Stellenbosch)*



## Mineral Processing Applications

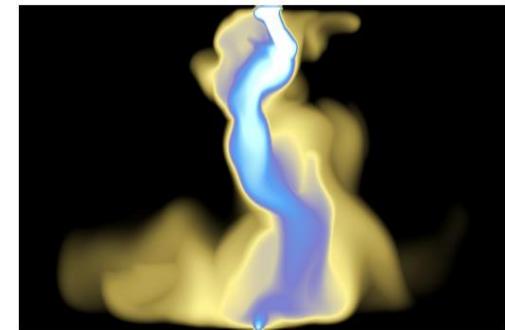
- DC Furnace **Plasma Arc electric smelting** simulations
- **CFD** and Magnetohydrodynamics (**MHD**) simulations
- Resulted in **patent** for Mintek on **arc detection technology**
- **Fully dependent** on **CHPC** for HPC resource requirements



Cross-section of DC Furnace  
Showing Plasma Arc (photo)

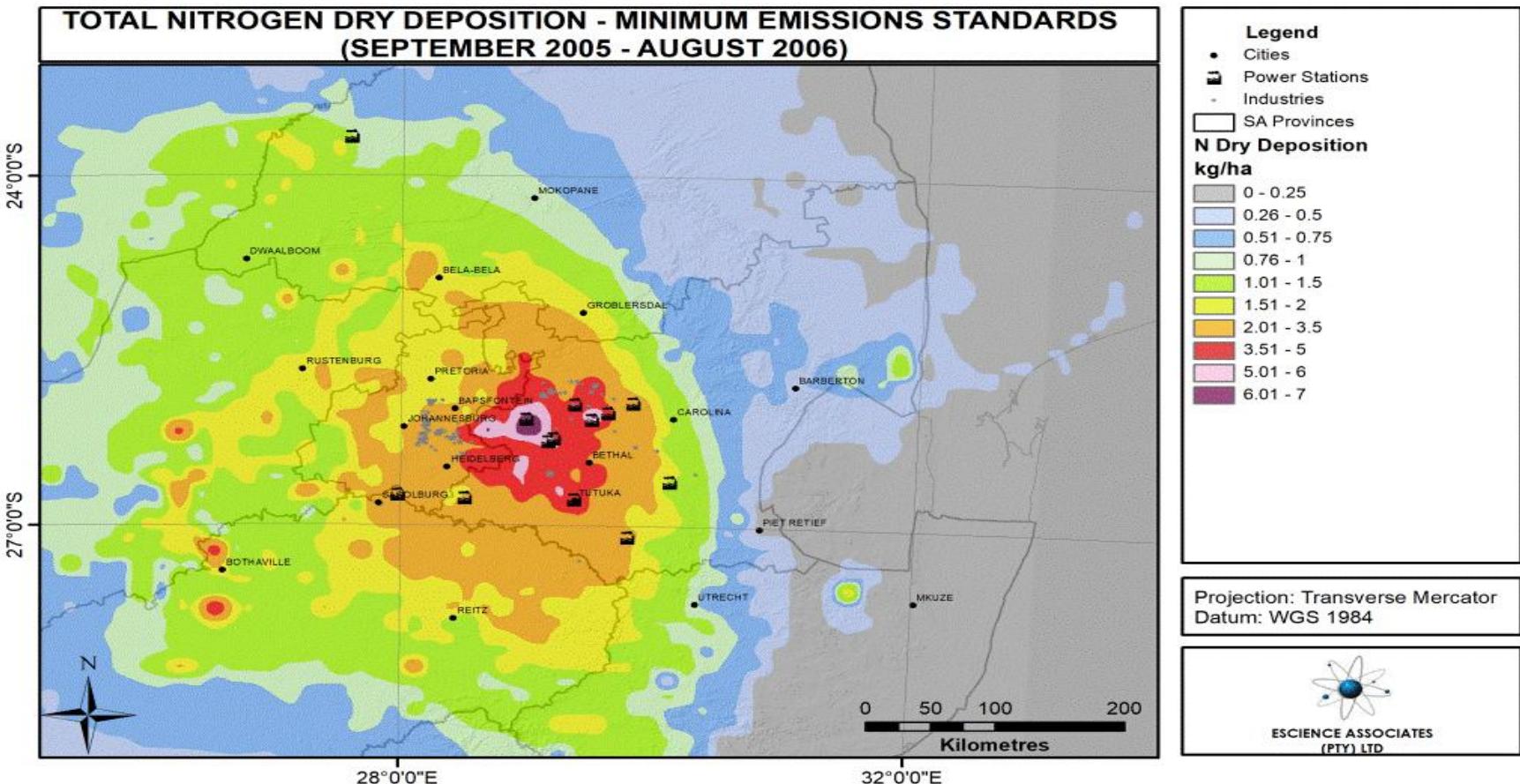


Photographic Image



Simulated

## Environmental Applications



## Weather and Climate Applications

### South African Weather Service (SAWS)

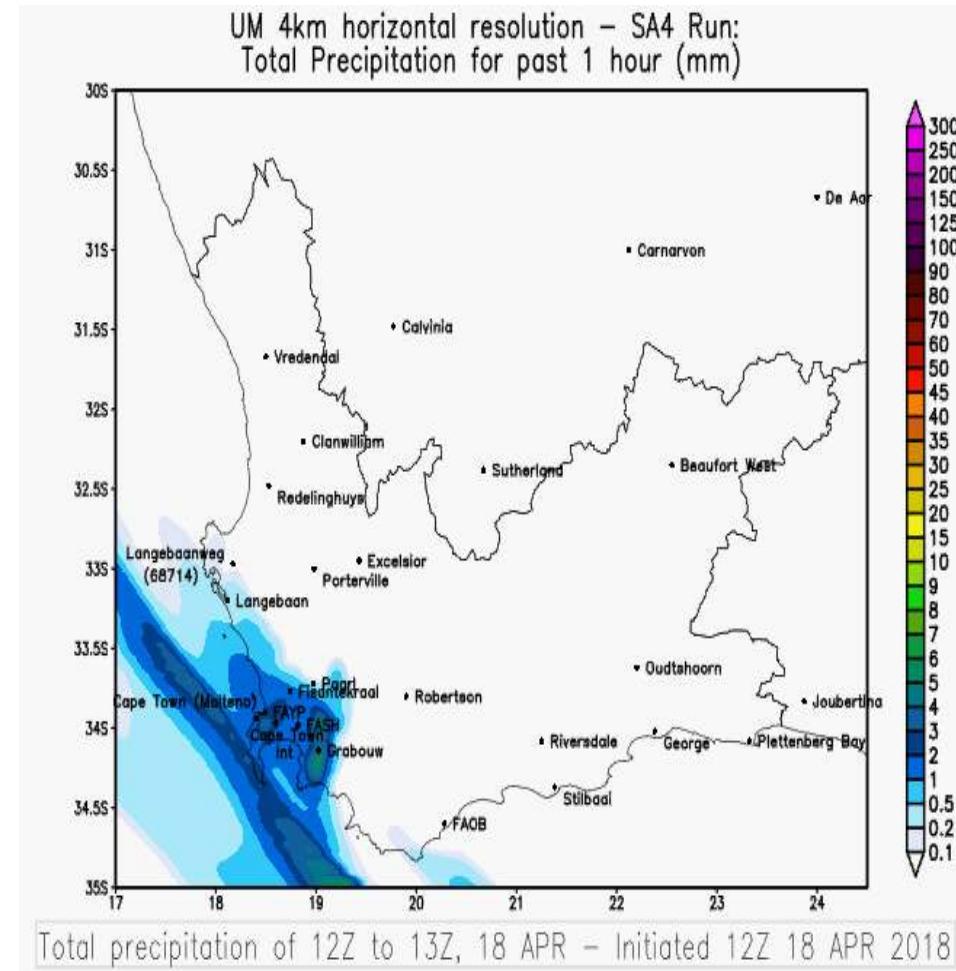
CHPC-SAWS MoU:

- CHPC is ***Fail-Over Facility***
- All ***SAWS Research*** done at CHPC



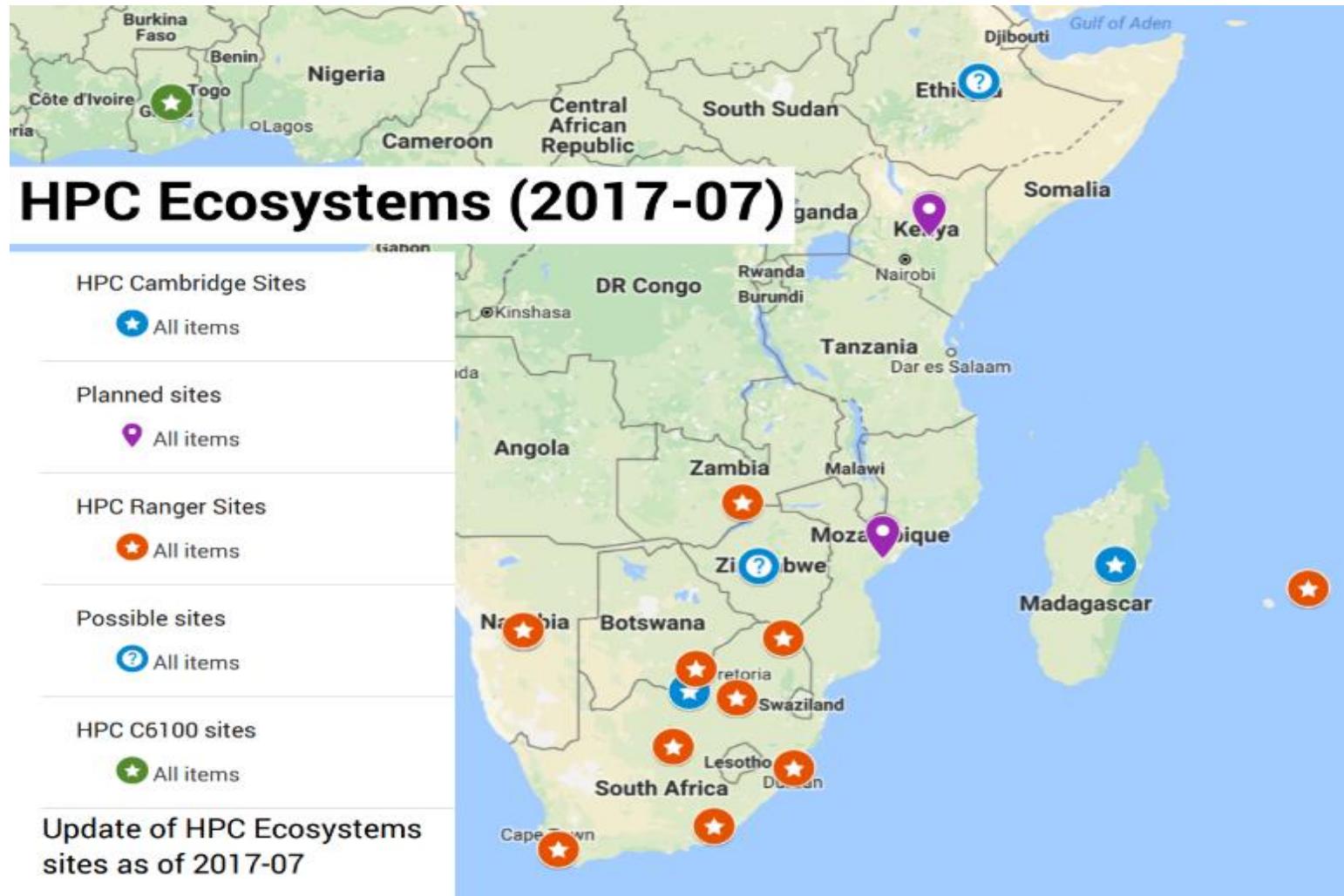
South African  
Weather Service

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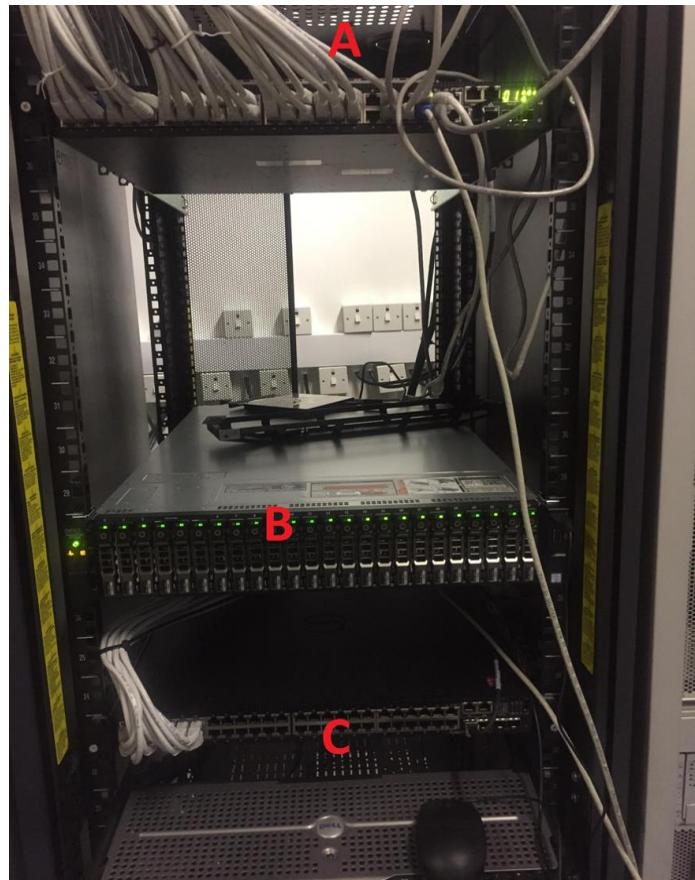
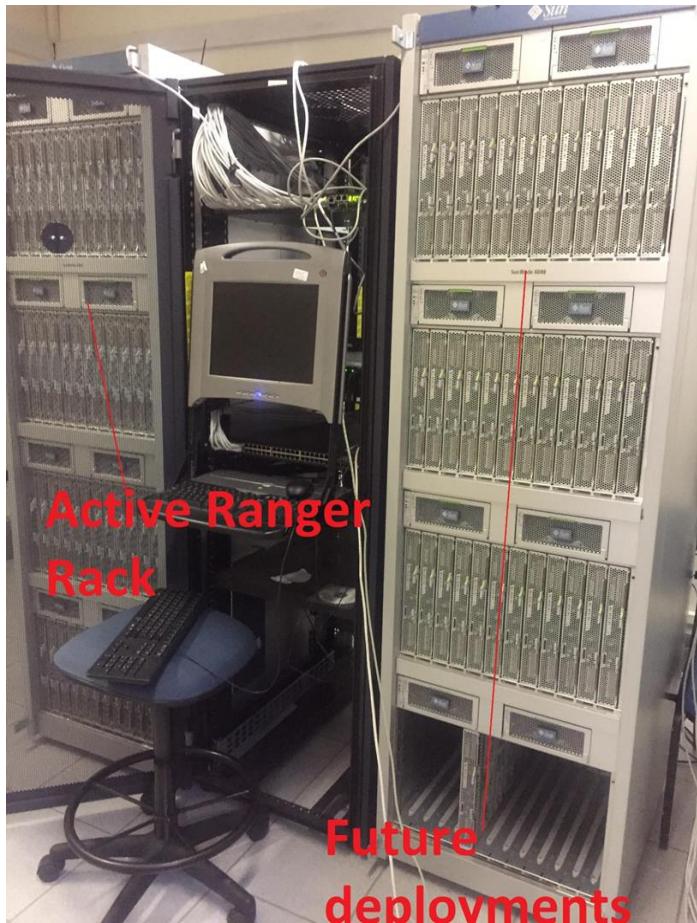
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	Infrastructure			Staff		
	Power & Cooling	Datacentre ID'ed	Equipment Shipped	SysAdmin / Linux	Dedicated time	SysAdmin Course
Mauritius : University of Mauritius (UoM)	✓	✓✓	✓✓	✓✓	✓✓	✓✓
Namibia : Namibia University of Science & Technology (NUST)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Botswana : University of Botswana (UB)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Namibia : University of Namibia (UNAM)	✓	✓✓	✓✓	✓✓	✓✓	✓✓
Zambia : ZAMREN	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Madagascar : University of Antananarivo (IOGA)		✓✓	✓✓	✓	✓	✓
Ghana : GSSTI	✓✓	✓✓	✓✓	✓	✓✓	✓
Mozambique : MoRENet	✓	✓✓	✓✓	✓✓	✓✓	✓✓
Kenya : NACOSTI	✓	✓✓			✓✓	

## University of Botswana HPC Cluster



## ZIMBABWE CHPC



## *Cluster deployed in Ghana*



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## SADC-TACC Workshop@TACC



19 Southern African scholars attend workshop at TACC – Source Stem-Trek

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# SADC Delegates @ SC'15



# 4<sup>th</sup> ANNUAL SADC INDUSTRIALISATION WEEK

## US/Pan-African Workshop: HPC On Common Ground @ SC16



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## Understanding Risk in Shared CyberEcosystems (URISC@SC17) in Denver, Colorado-US.



## Building the Skills

**ISC'13 Champions**



**ISC'14 Champions**



**ISC'15 Runner-Up**



**ISC'16 Champions**



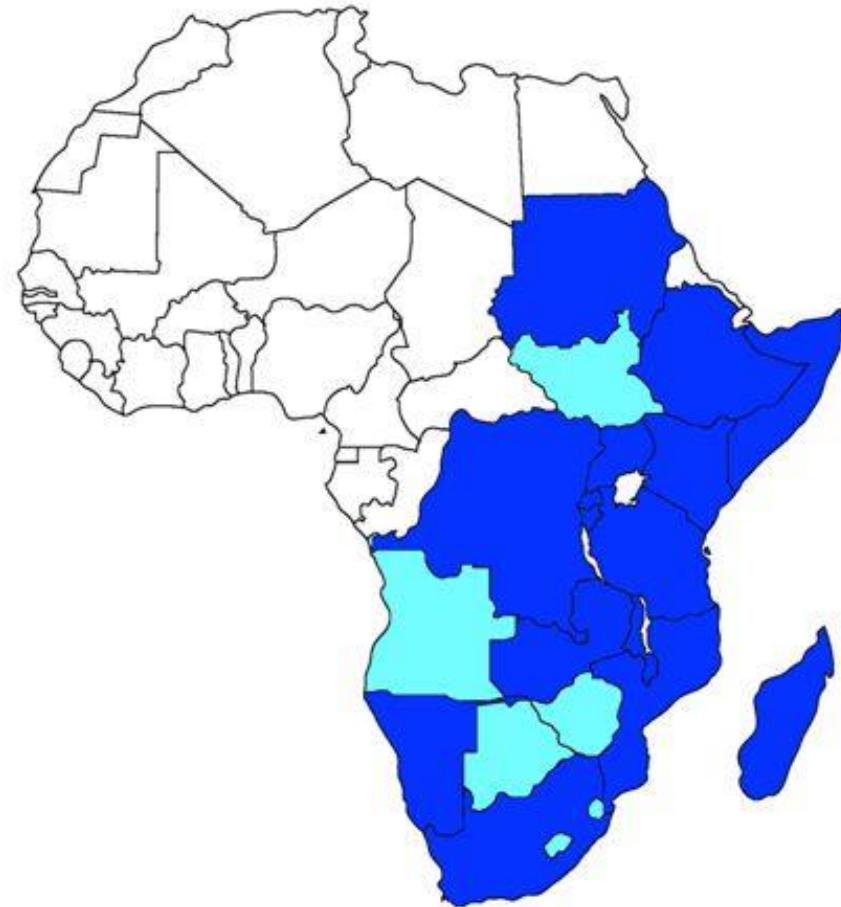
**ISC'17 2<sup>nd</sup> Place**

**ISC'18 3<sup>rd</sup> Place**

**ISC'19 1<sup>st</sup> Place**

# What is Ubuntunet Alliance?

- The regional Research and Education Network of Eastern and Southern Africa (ESA) region
- NRENs from 15 countries
  - TERNET, Tanzania
  - Eb@le, DRC
  - EthERNET, Ethiopia
  - iRENALA, Madagascar
  - KENET, Kenya
  - MAREN, Malawi
  - MoRENet, Mozambique
  - XNet, Namibia
  - RwEdNet, Rwanda
  - SomaliREN, Somalia
  - SudREN, Sudan
  - TENET, South Africa
  - RENU, Uganda
  - ZAMREN, Zambia
  - BERNET, Burundi
- Operates **UbuntuNet**, the data network interconnecting member NRENs



UbuntuNet  
Alliance



## Conclusion

- **Cyber-infrastructure will play a critical role in enhancing industrial development in SADC**
- **The development in Cyber-Infrastructure and skills is visible for research institutions and need to be harnessed for industrial development**
- **To enhance easy access to data, which will be key to FIR technologies, cross country connectivity need to be addressed as a matter of urgency.**
- **A regional infrastructure plan will ensure sustainability, and should be given priority.**

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Webiste: [www.chpc.ac.za](http://www.chpc.ac.za)

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# BACK-UP SLIDES

# Users at the CHPC: Institutions

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Total Life Time Hours of Lengau: 537 million]

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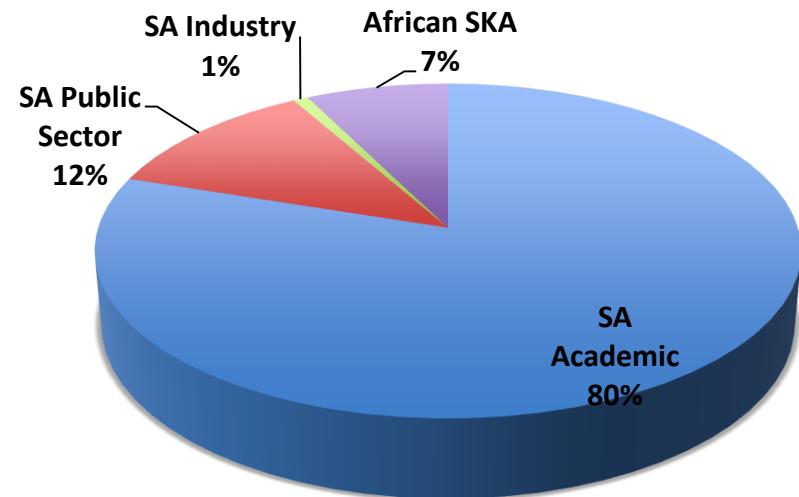
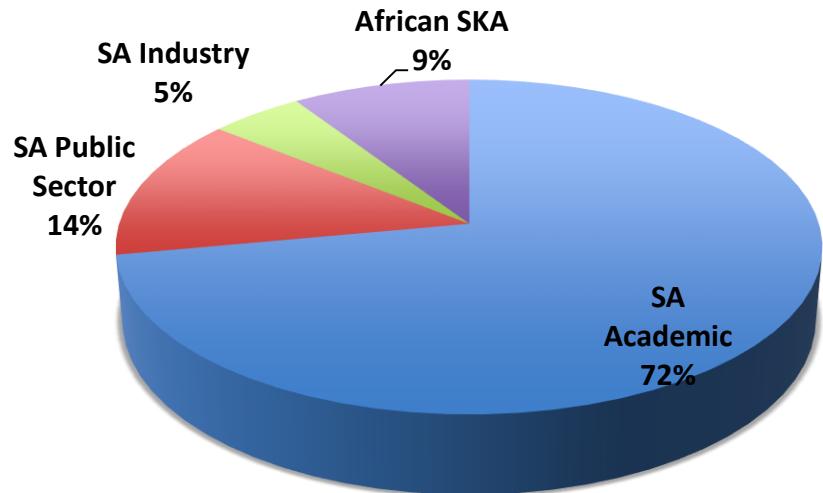
19 Jan – 18 Jul 2019

**# Research Programmes**

**210 Active Programmes**

**# Core Hours**

**97 million hours**



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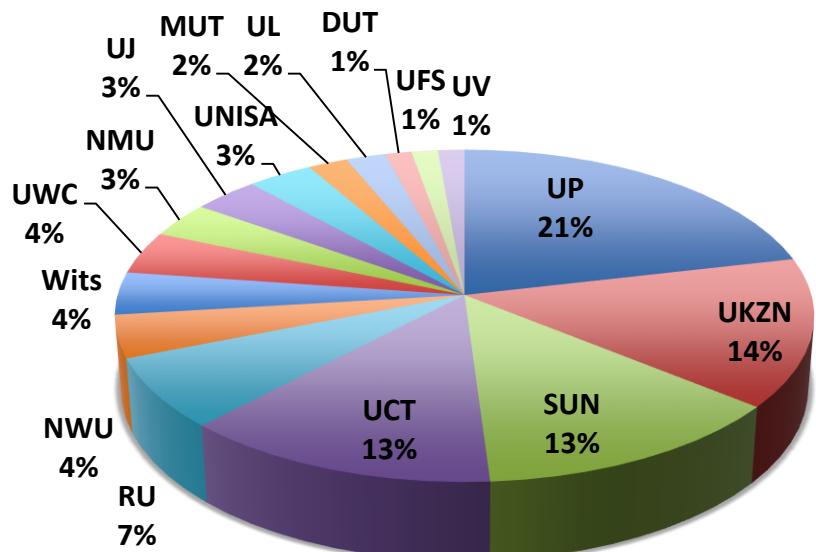
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### SOUTH AFRICAN ACADEMIC:

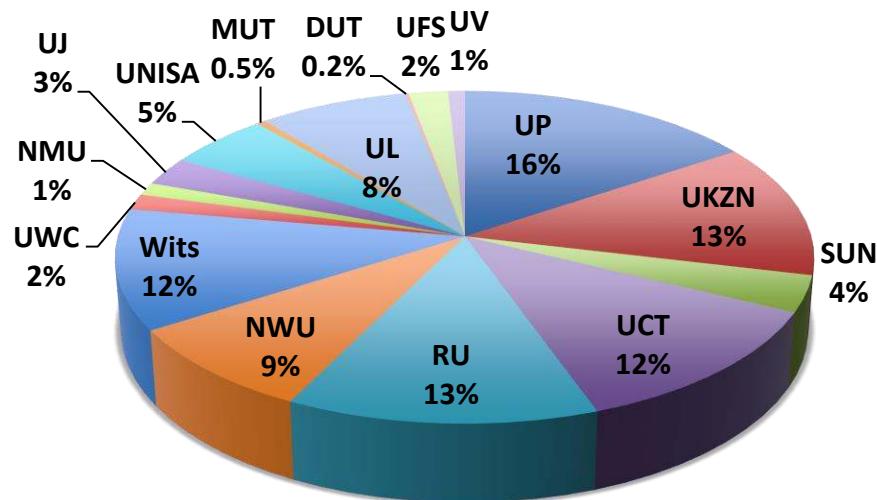
**# Research Programmes**

**151 Active Programmes**



**# Core Hours**

**78 million hours**



### SOUTH AFRICAN PUBLIC

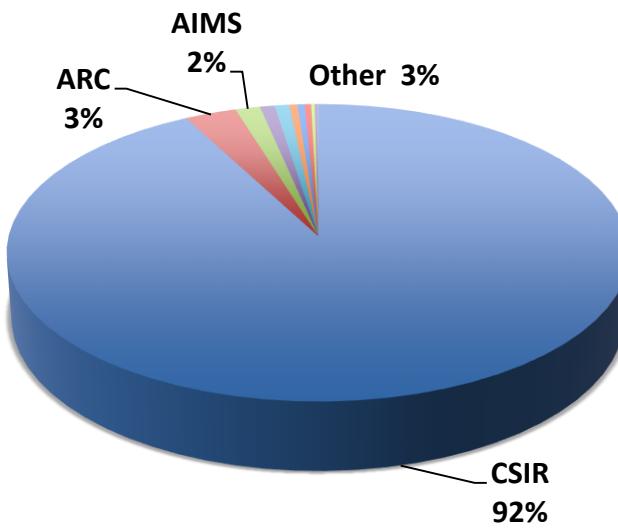
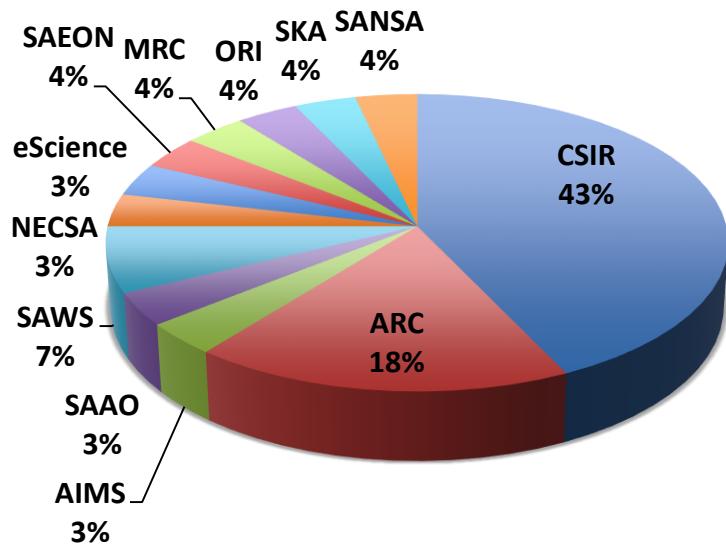
**SECTOR:**  
*# Research Programmes*

**29 Active Programmes**

**19 Jan – 18 Jul 2019**

**# Core Hours**

**11 million hours**



### SOUTH AFRICAN INDUSTRY

#### SECTOR:

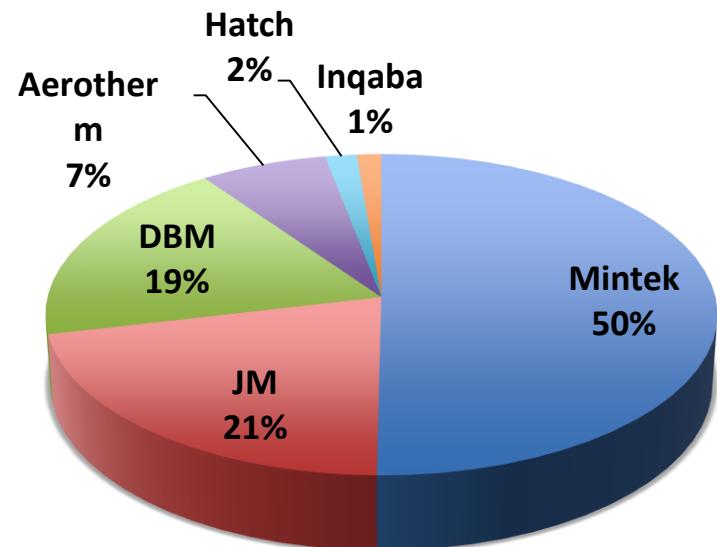
**# Research Programmes**

**10 Active Programmes**

**19 Jan – 18 Jul 2019**

**# Core Hours**

**1 million hours**



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# Users at the CHPC: Institutions

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AFRICAN SKA PARTNERS:

(La)

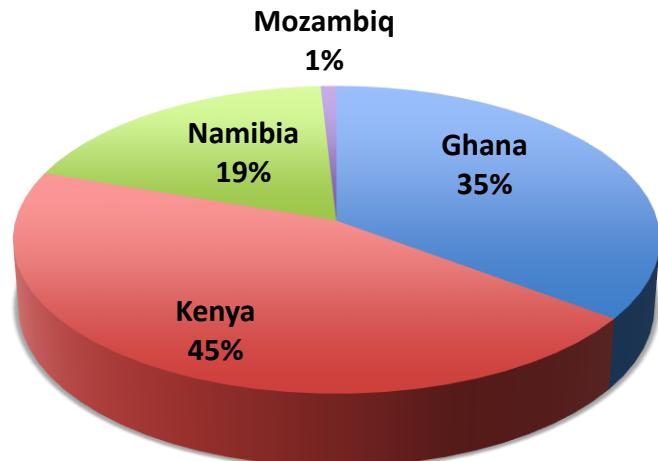
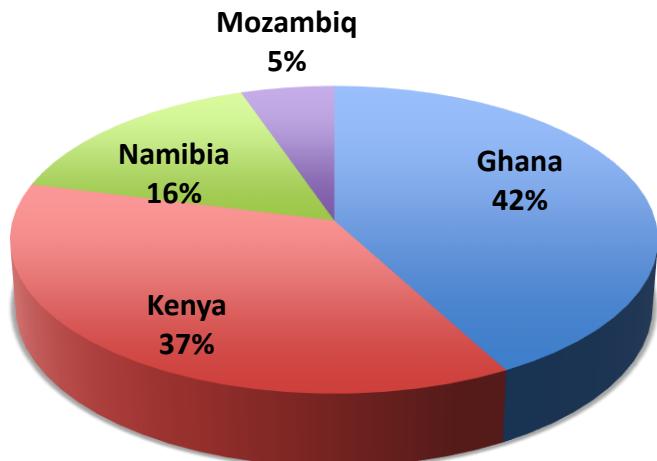
19 Jan – 18 Jul 2019

**# Research Programmes**

**19 Active Programmes**

**# Core Hours**

**7 million hours**

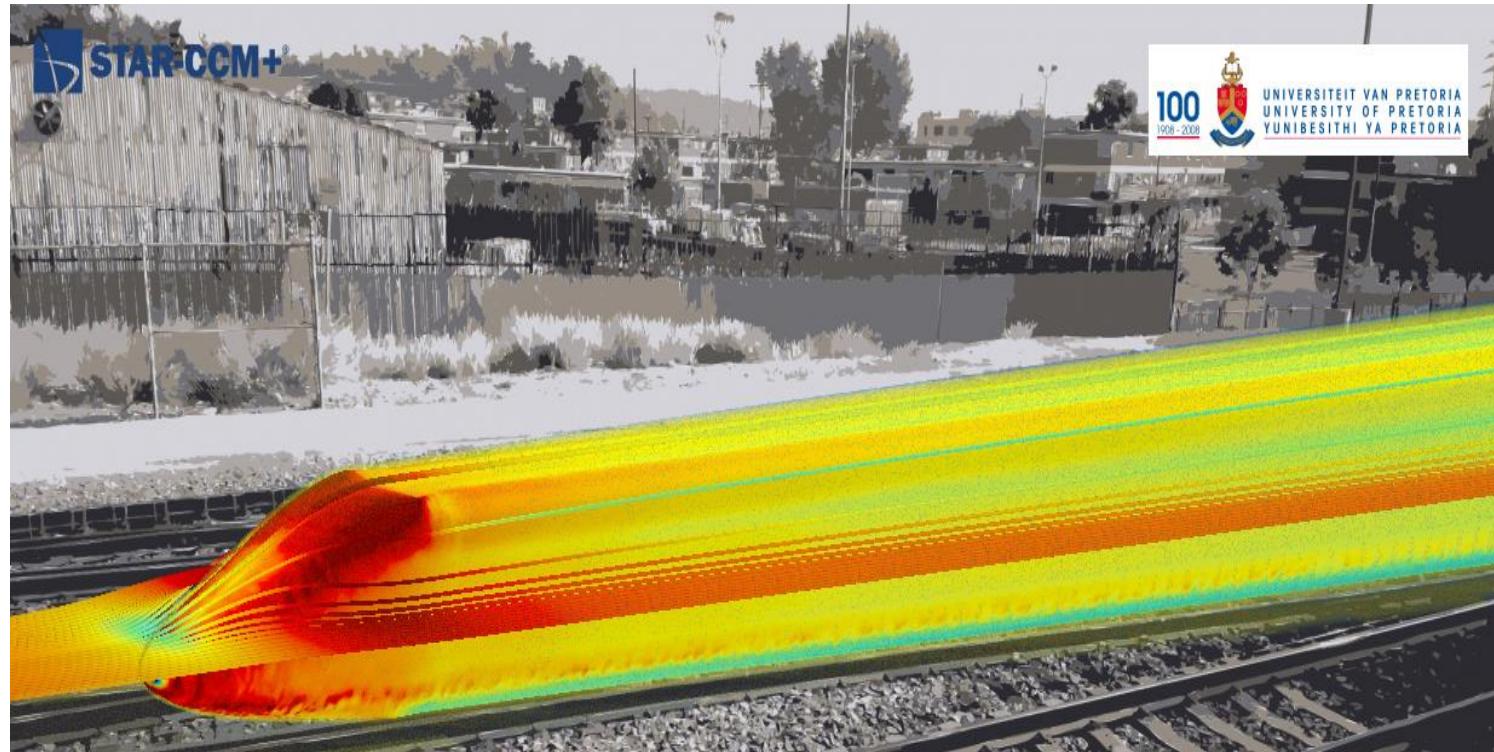


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UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

TRANSNET



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Train Nose

