

**African Strategy for
Fundamental and Applied Physics**

C&4IR WG CONVENERS :

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Speaker: Prof Dharm Singh Jat

Town Hall Meeting : 2021-07-13

Outline

- **Working Group Structure**
- **C&4IR WG: SCOPE**
- **Emerging field: Hype Cycles**
- **The power of combining AI and IoT**
- **4IR:AI and the Internet of Things**
- **Blockchain and Edge Computing Architectures**
- **Raspberry Pi and opensource Software**
- **HPC: Applications**
- **C&4IR WG: PLAN**

Working Group Structure

GROUP CONVENERS

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The topics below were extracted from the discussion at the AFLS2020

- **Data Science**
- **Machine Learning/Deep Machine Learning**
- **Artificial intelligence**
- **Quantum science and technology**
- **Distributed computing**
- **Distributed analysis**
- **Computational physics**
- **African infrastructure for networks and cloud services E-Learning: Moocs**
- **High performance computing**
- **Open source software, platform**
- **Internet and bandwidth capacities → building industries?**
- **Data center**
- **Governance and Policy**

Emerging field: Hype Cycles

Hype Cycles provide a graphic representation of the maturity and adoption of technologies and applications, and how they are potentially relevant to solving real business problems and exploiting new opportunities.

Gartner Hype Cycle for Artificial Intelligence, 2020



Plateau will be reached:

○ less than 2 years

● 2 to 5 years

● 5 to 10 years

▲ more than 10 years

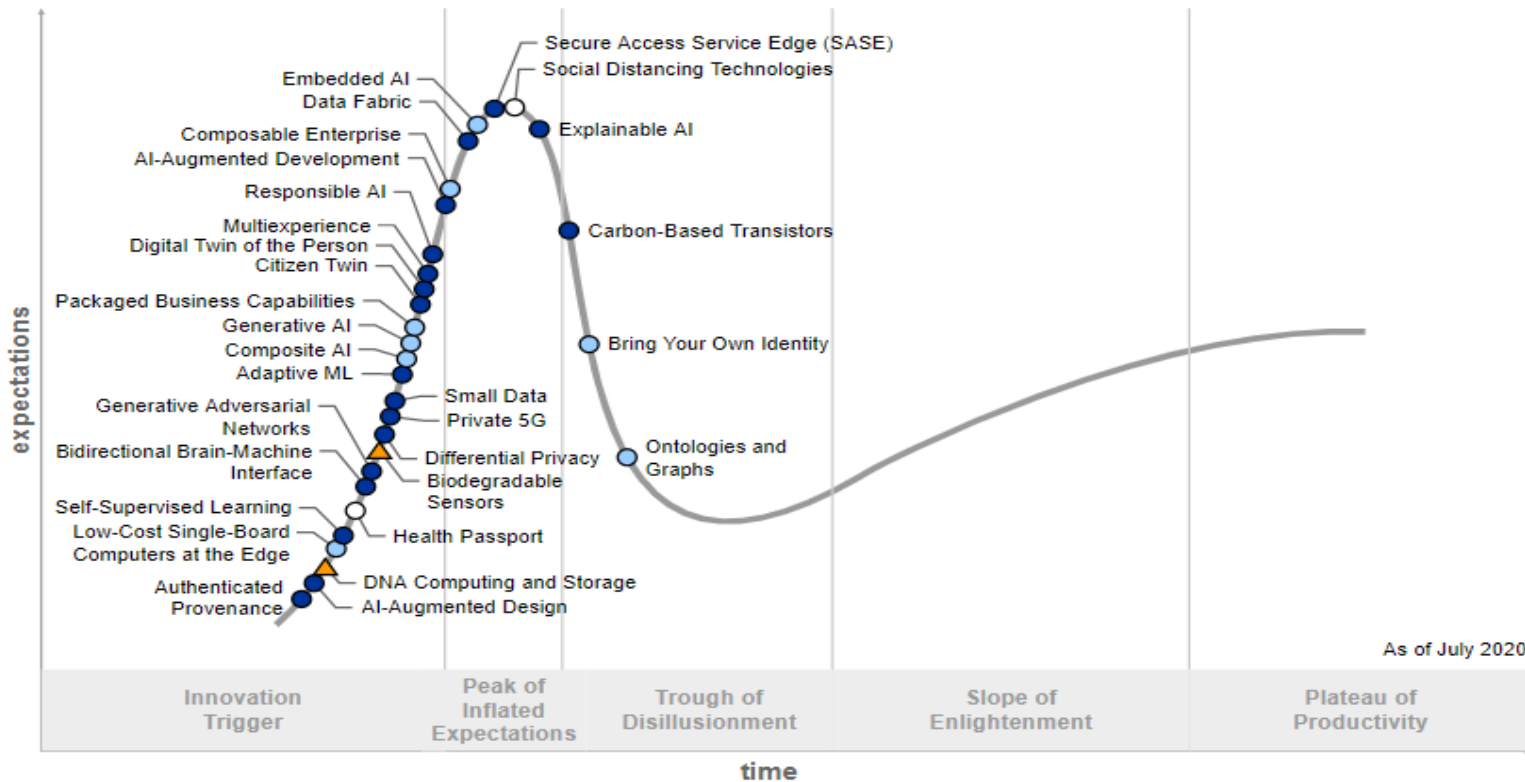
⊗ obsolete before plateau

As of July 2020

gartner.com/SmarterWithGartner

Gartner Hype Cycle for Emerging Technologies, 2020

This Hype Cycle specifically focuses on the set of 30 emerging technologies that show promise in delivering a high degree of competitive advantage over the next five to 10 years .



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The fourth Industrial Revolution emerges from AI and the Internet of Things

The key essence of Industry 4.0 Concept is the enhancement of efficiency in the process of industry by way the utilization of connectivity, computing, data, IoT and Artificial Intelligence.

The five characteristics of Industry 4.0

1. Industry 4.0 is interconnection
2. Industry 4.0 is data
3. Industry 4.0 is Integration
4. Industry 4.0 is Innovation
5. Industry 4.0 is transition

Segment of Enterprise in Industry 4.0

Technology Provider

- Artificial Intelligence (AI)
- Internet of Things
- Edge Computing
- Blockchain
- Virtual & Augmented Reality
- Robotics / Automation

Infrastructure Provider

- Internet Service Provider (ISP)
- HPC System
- Cloud Computing
- Telecommunication

Technology and Infrastructure User

- Universities and Research Institute.
- Capital Goods Industries (e.g. Machinery, equipment, Process plant equipment, Textile machinery, etc.)
- Consumer Goods Industries (e.g. Automotive, Communication, Electronics, etc.)
- Industrial Services (e.g. Logistics, Maintenance, Engineering, etc.)

Industry Vision 4.0

Industry 4.0 is focused on creating smart and secure environment in the manufacturing process.

Industry 4.0 is focused on creating intelligent products, processes and procedures. The essence of the industry vision 4.0 is in the Internet of Things and Artificial Intelligence.

Computers and automation put together, in particular based on cyber physical production systems that integrate communications, Internet of things (IoT) computing, data processing and physical elements and wherein these system transform the traditional factories into smart factories.

India has made rapid strides in four pillars of Industry 4.0

PM Narendra Modi, in his address at the World Economic Forum's Davos Agenda, said India has made rapid strides in four pillars of Industry 4.0 using technology:

- 1. connectivity,**
- 2. automation,**
- 3. artificial intelligence and machine learning, and**
- 4. real-time data.**



"Industry 4.0 is for humans, not robots. We must ensure that technology becomes a tool for ease of living and not a trap," PM Modi said.

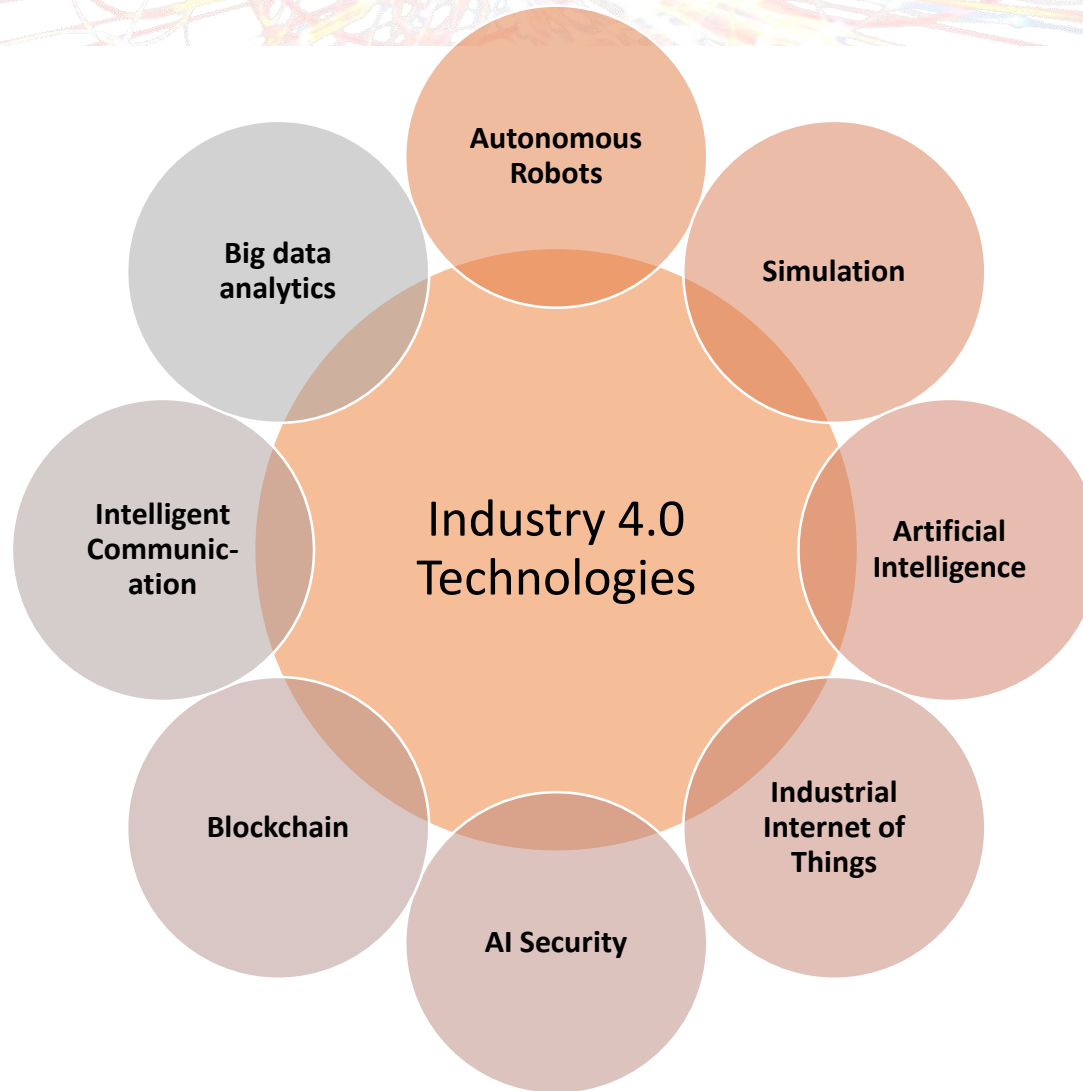
The Prime Minister Shri Narendra Modi addressed the World Economic Forum's Davos summit via video conferencing on 28th Jan 2021

Fourth Industrial Revolution technologies driven by artificial intelligence (AI) are expected to fundamentally change the world;

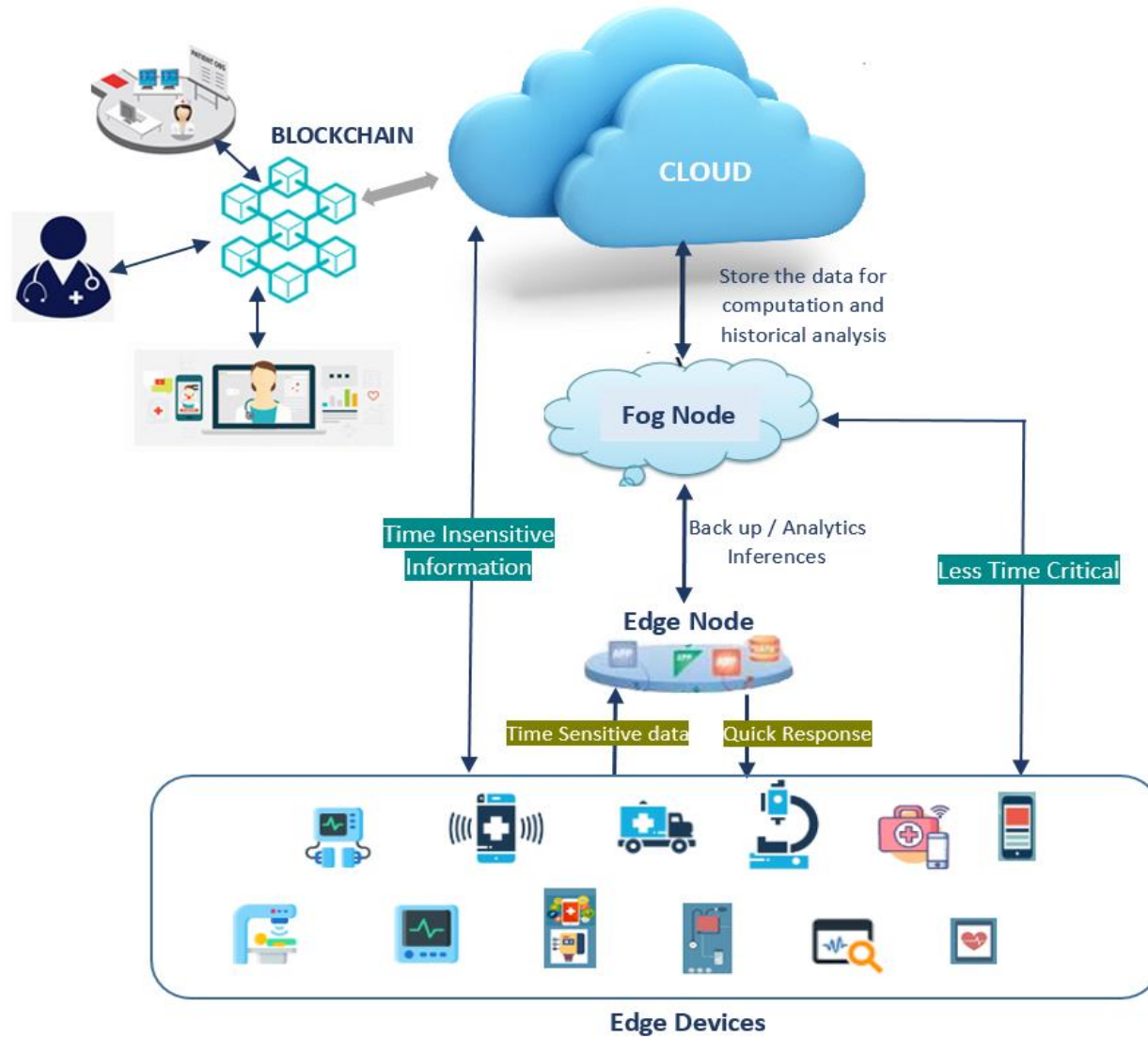
- **in a recent global survey, 63% of CEOs said they believe that AI will have a larger impact than the internet.**

<https://www.weforum.org/events/the-davos-agenda-2021/sessions/harnessing-the-fourth-industrial-revolution-eastern-hemisphere>

Industry 4.0 related research streams

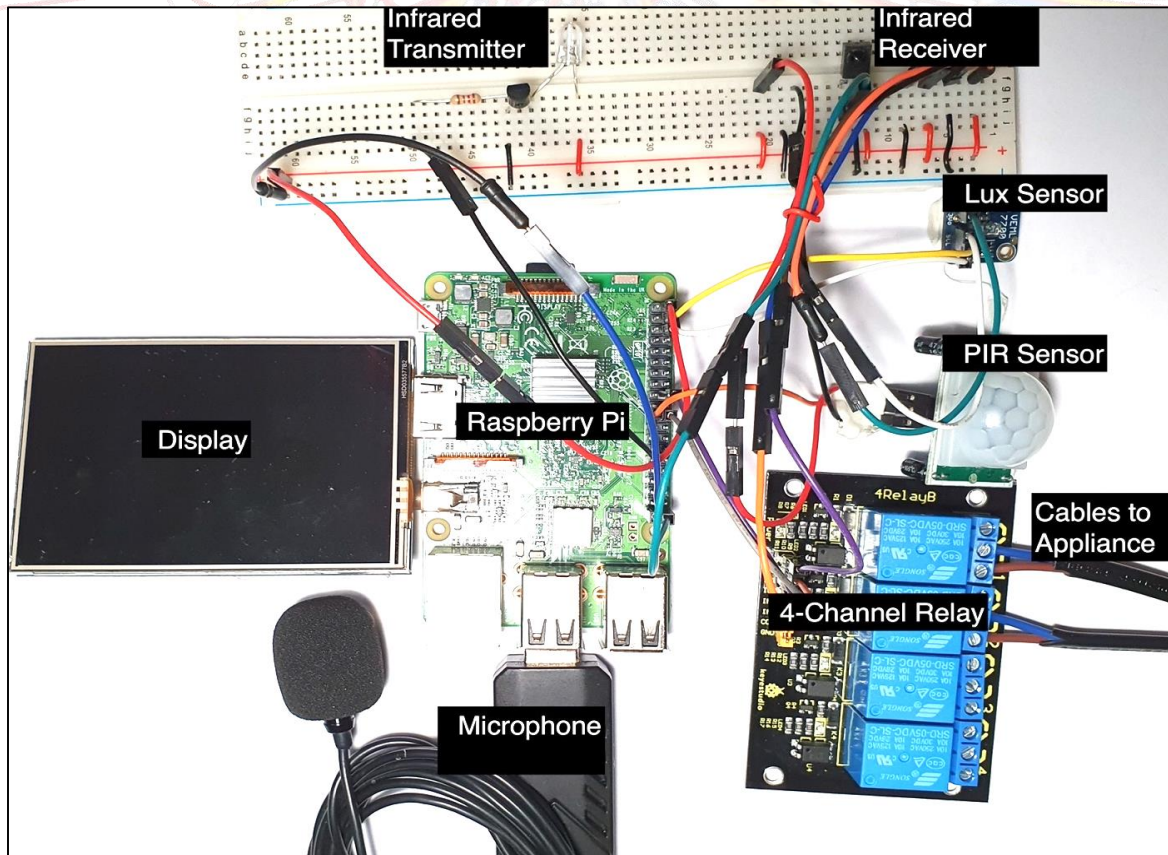


Blockchain and Edge Computing Architectures



D.S. Jat, Jain, A., (2020). Edge Computing Paradigm with Blockchain Technology, CSI Journal of Computing, Vol. 3(3), pp4-8.

Voice Activity Detection Based Smart Home Automation System



Hardware: Raspberry Pi

Software: CMUSphinx is an open source speech recognition system

Phonetic Dictionary for Oshiwambo commands.

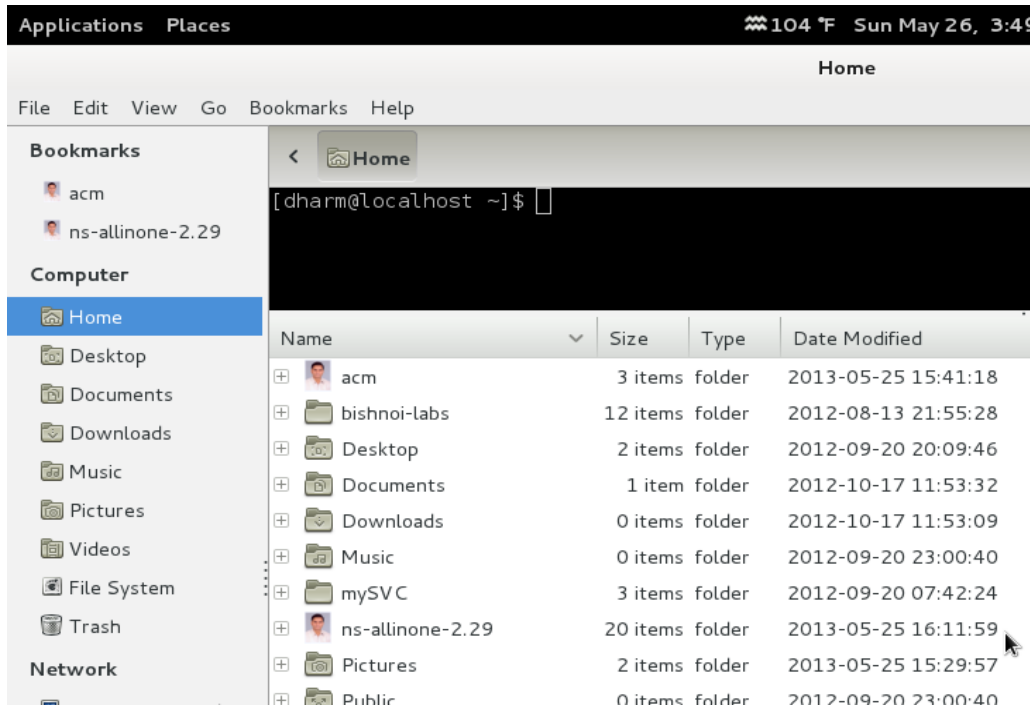
Jat, D. S., Limbo, A. S., & Singh, C. (2020). Speech-based automation system for the patient in orthopedic trauma ward. In Smart Biosensors in Medical Care (pp. 201-214). Elsevier, Academic Press.

Rwandan Student at Tea Factory deployed Humidity sensors etc.



Students of NUST of Namibia report back that

- Simulation gives them confidence.
- These are realistic experiences that prepare us for network and computer communication professionals



Lal Chand Bishnoi, Dharm Singh and Shailendra Mishra. Simulation of Video Transmission over Wireless IP Network in Fedora Environment. Special issues on IP Multimedia Communications, IJCA (1):9-14, October 2011

HPC-AI infrastructure...

- The HPC and AI system will strengthen application development of packages such as
 - ✓ **Bioinformatics, Climatology, Astrophysics, Computational Fluid Dynamics, Computational Chemistry, Molecular Dynamics, Finite Element Analysis, Agriculture etc.,**

- This will also accelerate R&D in the war against COVID-19 through faster simulations, medical imaging, and forecasting.



HPC: Applications

PARAM!Arub system

Machine Learning / Deep Learning Application Development

Most of the popular python based machine learning/deep learning libraries are installed on PARAM!Arub system.

Weather Research and Forecasting (WRF)

The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs.

Code Aster

Code_Aster is a free and open source software package for finite element analysis, and numerical simulation in structural mechanics.

Ferret

Ferret is an interactive computer visualization and analysis environment designed to meet the needs of oceanographers and meteorologists analyzing large and complex gridded data sets.

Abinit 9.0.2

ABINIT is a package whose main program allows one to find the total energy, charge density and electronic structure of systems made of electrons and nuclei (molecules and periodic solids) within Density Functional Theory (DFT), using pseudopotentials and a plane wave basis.

Openmx

OpenMx is free and open source software for use with R that allows estimation of a wide variety of advanced multivariate statistical models. OpenMx consists of a library of functions and optimizers that allow you to quickly and flexibly define an SEM model and estimate parameters given observed data.

OOFEM

OOFEM is parallel, object-oriented finite element code for solving mechanical, transport and fluid mechanics problems.

Lammps 29oct2020

The Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) is a classical molecular dynamics code designed for high-performance simulation of large molecular systems.

EMBOSS

EMBOSS is a comprehensive sequence analysis package. It contains over 150 command-line tools for analyzing DNA/protein sequences that include pattern searching, phylogenetic analysis, data management, feature predictions, proteomics and more.

NAMD 2.11

NAMD is a molecular dynamics simulation package designed for high performance simulation of a large bio-molecular system.

Openfoam

OpenFOAM has an extensive range of features to solve anything from complex fluid flows involving chemical reactions, turbulence and heat transfer, to acoustics, solid mechanics and electromagnetics.

Two Documents are shared:

1. Shared collaborative sheet

- The purpose here is to provide ideas and themes that would be worth pursuing in order to prepare contribution and to prepare future working subgroups.

2. Questions and Suggestions for a survey

The purpose of this document is to collect questions/suggestions specific to the computing and data mining to complement the survey that the **particle physics working group** is launching.

Data:

- What is the order of magnitude of the data you are exploiting?
- Is it locally stored or geographically distributed?
- Are there specific blocking points to the use of this data?

Infrastructure:

- From where are you working on your data?
- Between CPU, Storage, Network, what are the strengths and the weaknesses of the infrastructures you are using (or 3 questions like: how would you rate network, CPU storage you are using?)?
- What would be the most important infrastructure you would like to see being improved?

Artificial Intelligence

- Do you foresee a need for AI in your field: if yes, for what purpose?

Training

- Are there training facilities you can access to?
- What kind of training would you like to have to improve your ability to use computing to improve the result of your work?



C&4IR WG: PLAN

African Workshop

Topic: Computing and Fourth Industrial Revolution (C&4IR)

11 August 2021 - (<http://dsmlai.nust.na/>)



Organisers:

ASFAP Computing and 4IR (C&4IR) Working Group and The Namibia University of Science and Technology (NUST).

Themes of the workshop include, but are not limited to, the following:

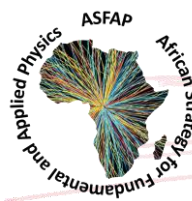
- **Intelligent Communication and Automation System**
- **Data Analytics and Intelligent tools**
- **IoT, Edge Computing, AI, Machine Learning and Deep Learning**
- **Security: Cyber Security, Blockchain**
- **Federated and shared computing**
- **Training and sharing knowledge**
- **Software Architecture and Artificial Intelligence**

Panel Discussion:

This workshop will assemble a panel of experts on Computing and 4IR to showcase latest development as well as to answer questions.

<https://africanphysicsstrategy.org/?p=302>

<https://dsmlai.nust.na/workshop>



THANK YOU