5G ICT Technologies and the 4th IR: Enabling the Digital Economy!

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Main Themes

- Defining the 4th IR:

- Developing the RDI Capacity: Science & Tech Research Institutions

- 5G ICT & Convergence of Technologies Enabling 4th IR ?

- Developing the Expert Human Capacity for the 4th IR
  - Test-beds & Relevant Use Cases !

- Developing the Innovation and Entrepreneurial Capacity

- Developing Policy & Technical Regulations: Multi-sectorial !
  - Industry & Job creation & Digital Inclusion in the 4IR Economy ?
  - Bridging the Urban & Rural Divide ?
The CSIR is a science council, classified as a national government Research, Innovation and Entrepreneurship Centre.

The CSIR’s Executive Authority is the Minister of the Department of Science and Technology.

In numbers:

- 71 yrs (1945 - 2016)
- 2411 total staff
- 355 doctoral qualifications
- 500+ Publication equivalents
- R2.15 bn total operating income
- 1691 total in SET base

Wish it could be Replicated in All African Countries!

A young African graduate student @ : IEEE Africon-2015
CSIR Units and Research Centres
A Multidisciplinary SET R&D & Innovation

- **Operating Units**
  - Biosciences
  - Built Environment
  - Defence, Peace, Safety and Security
  - Materials Science and manufacturing
  - **Meraka Institute (Information and Communication Technology R&D)**
  - Modelling and Digital Science
  - Natural Resources and the Environment
  - Implementation Unit

- **National Research Centres**
  - National Laser Centre
  - Energy Centre

- **Emerging Research Areas**
  - Mobile Intelligent Autonomous Systems
  - Nano-Technology
  - Photonics

- **Licensing & Ventures**
Enabling ICT Technologies for 4th IR

- Network Softwarization
- Edge & Cloud Computing
- Smart Mobile Devices
- AI & Blockchain Technologies
- Digital Inclusion
- NDPs / SDGs
- Multi-Sectoral Policy
- Network Softwarization

- Augmented & Virtual Reality, Wearables
- Multilevel Customer Interaction & Customer Profiling
- Big-data & Advanced Analytics, Algorithmic Identity
- Smart & Internetworked Sensors
- High Bandwidth Networks: Spectrum Toolboxes
- Cyber Security, Fraud Detection & Authentication
- Advanced human-machine Interfaces (Local Languages)

Enabling Policy

- 1. Digitalization and integration of vertical and horizontal value chains
- 2. Digitalization of product and service offerings
- 3. Digital business models and customer access

Skills

4IR
A Technology for the 4th IR: 5G ICT

- 5G Wireless ICT Standard & Associated ICT Ecosystem:
  - A Technology enabling the 4th Industrial revolution (4IR)
  - 5G Standard based on 3 Pillars: eMBB, uRLLC & mMTC

- Existing 5G Tech standard (Rel 15 NSA) by 5GPPP is Skewed?
- Impact of 5G on the ICT infrastructure & the 4th IR?
  - CSIR 5G Test-bed & Relevant Use Cases with Industry partners!
  - ICASA 5G Forum, CSIR 5G Research Alliance

- Enabling Policy & Regulation: Affordable Digital Connectivity!

By 2035, the global 5G ICT eco-system value chain will generate product outputs worth in the order of $3.5 trillion and support 22 million new jobs worldwide.

Source: IHS MarkIt, Jan. 2017
• Contributions to 5G Standardization for Rural 5G and connecting the Next Billion with Affordable Broadband : IEEE Com Society CTN Articles...

• 5G & Disruptive Innovation : Affordable Networks

• IEEE 5G Summit & DSA Forum at IEEE Dyspan 2017 !

• Inputs to ITU-Seoul-Korea 2017, and ITU WRC-2019 Standards
Thank you

ITU/5GPP 5G Wireless ICT Standard: NSA 2018
Korea, Finland, … Commercial Q2 2019

Software Defined Networks, Network Slicing, Virtualization & Spectrum Flexibility: Cost of Networks, Industry Verticals

Cloud DB

1. Massive MTC
   - Smart Interconnected Sensors (IoT): E_Health, Prec-Farming, Smart-City,…

2. Enhanced MBB
   - Ultra High Def Video & Hologram Comm. Augmented/ Virtual Reality
   - Immersive EDU, VoD

3. Affordable Broadband
   - Industry Automation & Control, Robotics/Drones, Self-driving Vehicles

4. Ultra Low Latency & Reliable Networks
   - Digital Inclusion

+ Big-Data + AI
5G Time Lines

Global Cellular Devices Installed Base

- **Cellular Handsets**
- **Cellular IoT**

- **3G Evolution**
- **4G**
- **4G Evolution**
- **5G NSA**
- **5G SA**
- **5G Evolution**

- **eMBB**
- **mMTC**
- **uRLLC**

**Installed Base Devices (Millions of Units)**

- **2010**
- **2011**
- **2012**
- **2013**
- **2014**
- **2015**
- **2016**
- **2017**
- **2018**
- **2019**
- **2020**
- **2021**
- **2022**
- **2023**
- **2024**
- **2025**
- **2026**
- **2027**
- **2028**
- **2029**
- **2030**

**Window of Opportunity**

- **Personal Transformation**
- **Society & Business Transformation**
Supporting Innovation & Entrepreneurship

With the right R&D and innovation frameworks 5G can boost the creation of new service industry, improve competitiveness of local businesses, allowing Africa to compete regionally and on a global level.

…… Mobile World Congress-2018

How to create the Virtuous Eco-system for the Creation of the MPESA’s of 5G and 4th IR Tech & Service Industry

CSIR + TIA + DTI + Innovations Hubs

Nurturing Innovative & Creative Science & Technology Ideas
Technology Test-beds & Use Cases Studies

- CSIR with Industry Partners, such as Ericsson studied 5G Enabled Relevant Use Cases for 4\textsuperscript{th} IR in emerging economies, report to be launched at ITU World-2018, Durban.

- **Technology test-beds**: are crucial platforms to perform a controlled testing of relevant 4IR use cases before introduction commercially.

  - Help us in expert human capacity development.
  - Support Policy & Technical Regulation development with evidence based research.
  - Have a feel of the actual performance of the technology on relevant use cases
  - Be part of a global RDI test-beds, contribute to Standards, Conformance testing & peer-review.
  - “IEEE 5G Roadmap & Testbed” Work-groups.
Affordable Broadband & Digital Inclusion! A 5G Test-bed at the CSIR!

<table>
<thead>
<tr>
<th>Usage Scenario</th>
<th>Applications</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enhanced Mobile Broadband: eMBB</strong></td>
<td>UHD Video, Virtual Reality, cloud gaming</td>
<td>1, 10, 50 Gb/s . (6-15 GHz band)</td>
</tr>
<tr>
<td><strong>Ultra Reliable Low Latency Comms uRLLC</strong></td>
<td>Industrial Control &amp; Automation, Robots, Drones, Self-driving cars,</td>
<td>Low latency ~ 1.5 ms</td>
</tr>
<tr>
<td><strong>massive Machine Type Comms mMTC</strong></td>
<td>Smart-City/home Prec. AGRI, S-Health</td>
<td>Energy efficiency, Low BW</td>
</tr>
<tr>
<td><strong>Affordable Broadband Rural (4th Leg of 5G)</strong></td>
<td>Ultra low cost rural connectivity . <strong>5GRange-Cell</strong>,</td>
<td>5-100 Mb/s Low Power/ Green Energy Networks</td>
</tr>
</tbody>
</table>

Network Slicing, Spectrum Flexibility and Toolboxes: Dynamic Spectrum Access Networks (DSAN)
Addressing 75%+ BB Unconnected in Africa

- How to get the Terabytes/sec submarine cable bandwidth inland!
  - Rural Community Networks!
  - Internet for All
  - Long Range Cell?
  - FW - TVWS
  - Broadband ~ GDP
Spectrum a Crucial National Resource!
Audits ICASA, CSIR, FCC,.. High Underutilization!
Dynamic Spectrum Management for Wireless Networks
Affordable BB & 5G eMBB!

Patented Technology for Spectrum Sharing and Improved 5G Network Capacity

Network Capacity = Spectral Efficiency × Amount of Spectrum × Number of Base Stations

Available TV White Space Channels Per Mesozone
WSD Tx EIRP = 4 Watt, Ant. HAAT = 30 m, N = 25001, NNI = 1284, WSD Inter Tx Distance = 7 km

SKA Radio Quite Zone

CSIR Geo-Location Spectrum Database

Main System Page

User Location
Location: -25.2494, 28.1925
Total available ch: 14
Max contiguous bandwidth: 32880 Hz (i.e. 8 = 4)

Channel Table

http://whitespaces.meraka.org.za

Our future through science
Creating the Ecosystem for Dynamic Spectrum Sharing (DSS)

CSIR Supporting ICASA & Africaan Regulators:

ICASA DSS Regulation :
March 2018:

DSS Capacity Building
CSIR, ICASA, FCC,....
Tutorial.... SADEC/CRASA

Spectrum Sensing:
Datascience & AI

Digital Innovations (Our world...)

Commercialised by ICT & technology industries

Digital Systems & Technologies (Localised)

Applied in Mining, Manufacturing, Logistics, Research, Government, etc.

RD&I

Communications

Manufacturing

Transport & Logistics

Health

Research & Education

Automation

Interoperability

Trust & Security

Flexible Access

Multi-Disciplinarity

Skills

Data Science

Information Technology

Statistics

Computer Science

Electronic Engineering

Mathematics

Communications Engineering

Computer Engineering

Domain Skills
Relevant Use Case 1: Resource Optimization!

Optimise use of Resources (reduce cost)

Predict Demand (effective planning)

Customise your offerings (efficient delivery)
Relevant Use Case 2

Human Augmented Robotics Intelligence (HARI)
Blind Guiding Robot ..........MWC-2018
Smart Sensors, Cloud AI Analytics, Low latency 5G Network
Relevant Use Case 3

5G eMBB

Smart -Education Use Case & Capacity building for existing human resource.

For the Digital Transformation of Society & Industry.

* Adult Education?

Ignites several senses:

35% More knowledge retention.

Sourced: © VR-ED
The Migration Towards the Ubiquitous Networked Society

Success Factor: Enabling the MPESA of 5G!

<table>
<thead>
<tr>
<th>Generation</th>
<th>Wireless Network</th>
<th>Speed (kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>Basic voice service, Analog-based protocols</td>
<td>2.4</td>
</tr>
<tr>
<td>2G</td>
<td>Designed for voice, Improved coverage and capacity, First digital standards (GSM, CDMA)</td>
<td>64</td>
</tr>
<tr>
<td>3G</td>
<td>Designed for voice with some data consideration (multimedia, text, internet), First mobile broadband</td>
<td>2,000</td>
</tr>
<tr>
<td>4G</td>
<td>Designed primarily for data, IP-based protocols (LTE), True mobile broadband</td>
<td>100,000</td>
</tr>
<tr>
<td>5G</td>
<td>Designed with Low Latency, Reliable MTC, Enhanced Mobile BB Emb</td>
<td>1-30 Gbps</td>
</tr>
</tbody>
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5G Use Cases:
- Smart Medical Care
- Safe Cities
- Smart Finance
- Data & Net Security
- Smart Edu : VR/LBS
- Smart-Agriculture / Biodiversity
- Smart Transportation
- Automation / Mining

Enablers:
- AI & Machine Learning
- Datascience
- Block Chain
- Smart Networked Sensors
4th IR Innovation & Entrepreneurship: The Digital Economy (Best Practices from Bangaluru-India, KAIST-Korea, Ideon-Sweden)
Transforming the 4th Industrial Revolution to A Solutions Revolution!
Summary Points 1

- A desire to harness and effectively utilize Digital Opportunities in ICT Infrastructure and Innovative Services.
- Synergetic Thinking for Digital Inclusion & Shared Benefits:
  - Emerging Technologies & Public Private Partnerships
- Efficient Use of National Spectrum Resources:
  - Example tool: ~ CSIR GLSD/5GS-Tool ~ Ofcom /FCC
  - Co-existence manager : GL-DSA System
- Supporting Resource Constrained Regulatory & Policy Authorities in the Development of Innovative Technical Regulations:
  - ICASA, Ghana-NCA, Botswana-BOCRA, Tanzania-TCRA, Malawi, …
Summary Points 2

- Affordable Broadband & Digitally Including the next 4 Billion Should be an Emerging Market Strategy for the 4th IR?
- 4th IR Requires Multidisciplinary Research & Transformative Technical Regulation & Policy!
- Transforming the 4th IR into a Solutions Revolution!
- Build Innovation & Entrepreneurship frameworks to Benefit from the 5G ICT & 4th IR: Services, Industry & Job creation for Socio-economic development.
In the Space Ship Earth there are No Passengers, We are all Crews!

......M. Macluhan.

Thank You!
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