National Integrated CyberInfrastructure System (NICIS)

Sub-title: NICIS—an initiative in support of advancing Research and Innovation in the Higher Education Sector.

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Higher Education internationally is facing many contemporary challenges: growing student numbers; under-preparedness; rising costs, retaining faculty; developing ICT driven teaching and learning paradigms, e.g. MOOCs; distance and multi-site multi-media etc.

Research in all domains is being impacted by developments. Research has become more: global and multi-disciplinary; integrative and complex; there are growing concern re research reproducibility—or non-reproducibility; the inexorable move towards Open Data and onwards to Open Science; the rising tide of Citizen Science, etc.

The term "Data" has become a buzzword. Incorrectly the focus is often placed solely on "Big Data", whereas the full spectrum ranging from Extreme Data, through Big Data and the frequently overlooked Long Dark Tail should be catered for. Not only has the Data tsunami impacted on commerce, business and industry, but so too on research and innovation.

Will the so-called Fourth Industrial Revolution have any impact on the University?

How does the University respond to these challenges? The question has in fact been asked whether the University in its current form will exist 15 years hence.

Research Infrastructures: in EU parlance the term 'Research Infrastructures' (RI) refers to "**facilities, resources and related services** used by the research community to conduct top-level research in their respective fields, ranging from social sciences to astronomy, genomics to nano-technologies, etc. Examples include singular large-scale research installations, collections, special habitats, libraries, databases, biological archives, clean rooms, integrated arrays of small research installations, high-capacity/high speed communication networks, highly distributed capacity and capability computing facilities, data infrastructure, research vessels, satellite and aircraft observation facilities, coastal observatories, telescopes, synchrotrons and accelerators, networks of computing facilities, as well as infrastructural centres of competence which provide a service for the wider research community based on an assembly of techniques and know-how." It is now recognised that Research Infrastructures are fundamental to effective Education, Research and Innovation.

Recently the Department of Science and Technology initiated the SARIR (South African Research Infrastructure Roadmap) in order to enhance the SA Research Infrastructure landscape. This initiative will, as it matures, support a wide spectrum of disciplines.

Cyberinfrastructure: some years ago now, 2006, the Department of Science and Technology, with much foresight, commenced investing in the South African national Cyberinfrastructure. This resulted in the establishment of stand-alone entities, namely the CHPC (Centre for High Performance Computing); SANReN (South African National Research Network)--which now working together with TENET are collectively recognised as the South African NREN (National Research and Education Network). In 2008 DST accepted a proposal that it should initiate a national Very Large Data-Base initiative, which is now being matured into DIRISA (Data Intensive Research Initiative for South Africa). Besides these, the SAGrid initiative enabled the SA High Energy Physics (HEP) community to meaningfully collaborate in the CERN Higgs Boson experiment.

NICIS: a DST initiated review recommended in late 2013 that all the extant, but then stand-alone DST funded Cyberinfrastructure initiatives be combined into the SA National Integrated Cyber-Infrastructure System (NICIS)—this process is still underway. It is important to note that NICIS provides cyberinfrastructure technology and advanced services at the Tier 1 (i.e. national level). The review recognised the vital need to develop and grow Tier 2 (collaborative, disciplinary or regional) as well as Tier 3 (institutional) cyberinfrastructures. Consequently, to achieve an effective and mature national cyberinfrastructure ecosystem requires the collaboration of multiple partners.

A growing number of countries, noting the positive consequence which innovation has on their economies, are enabling their cyber / e-infrastructures to support innovating sectors of their commerce and industry. These developments span even basic and secondary education to high-tech industry.

In order to achieve the maximum outcome from cyberinfrastructure investments—national, regional and local—appropriately skilled people are needed. Education, research and innovation require people not only technology. People are needed to push the technology boundaries; to maintain and restore the advanced systems and technologies; to effectively utilise the developing computational, analytic, data science and visualisation tools (mathematical, software and technology) in conducting their research and innovation. Cohorts of mid-career researchers in many disciplines have now been overtaken by these developments and need to be up-skilled so as to cope with the new order. A NICIS initiative is aimed at addressing this need.

These developments offer both significant challenges and major opportunities to Higher Education Institutions. Treating these developments as an imposed but necessary add-on will not achieve the required end-goal. Deep introspection and even modification of principles, strategies and practices will be required.

An effective Cyberinfrastructure is not an automatic panacea towards enhancing the national Research and Innovation agenda—but it certainly is an important and essential building block towards reaching that goal.