CubeSat programmes in Africa—context and perspectives

11th Annual CubeSat Developers’ Workshop | The Edge of Exploration
April 23-25, 2014

Robert van Zyl
A disruptive technology
A disruptive technology

New ways of utilising existing technology

m-Health

m-Commerce
Electronic banking: 3rd of Kenya’s gross domestic product passes through mobile money

IPEX (CP8) 3MP imager

AAU SAT3 AIS
A disruptive technology

Surge in uptake | leapfrog legacy technology

Mobile phone uptake in Africa vs fixed line technology | 80% penetration
Africa | Ingenuity
Africa | Ingenuity
Africa | Ingenuity

Cansat launch - Ghana, 2013
Africa | Infrastructure
Africa | Infrastructure
Africa | Skilled workforce

- Brazil
- Korea, Rep.
- South Africa

Graph showing the technical R&D workforce per million for Brazil, Korea, Rep., and South Africa from 2004 to 2010.
Dawn of the Africa Nanosat Era

ZACUBE-1  |  TshepisoSAT  |  ZA-003
First nanosatellite in Africa launched, 21 November 2013
Celebrating 155 days in space!
Tshepiso talking to us from space, carrying a message

SANSA is proud to be part of this august scientific journey of discovery ... it is certain to inspire a large transformation of our space technologies and education.

- Dr Sandile Malinga, SANSA CEO
African Space Programme | Context

African Union Commission
African Space Programme | Context

AUC Initiatives

- AMCOST IV, 2007, recommends Space Working Group to identify ways to optimise fragmented and duplicated space initiatives on the Continent
- In 2012 SWG was tasked to draw up African Space Policy and African Space Strategy
  - Kenya: Governance and management
  - Nigeria: Access to space services, ability to access such services
  - Ghana: User needs
  - SA: Market development, development of indigenous private sector
  - AUC: International and intra-continental cooperation
African Space Programme | Context

AUC Initiatives

• African Space Policy
• African Space Strategy
• African Space Programme Implementation
African Space Programme | Context

AUC Initiatives

- African Space **Policy** – APPROVED, Friday, 18 April 2014
- African Space **Strategy**
- African Space Programme **Implementation**
African Space Programme | Context

ASP Policy Principles

• Promoting I-STEM
• Investing in human capital development
• Managing natural resource endowments in a sustainable manner
• Effective private and public sector development
• Innovative resource mobilisation
African Space Programme | Context

ASP Policy Objectives

- Harnessing the potential of space science and technology to address Africa's socio-economic opportunities and challenges.
- Strengthening space technology applications on the continent in order to ensure optimal access to space-derived data, information services and products.
- Developing a sustainable and vibrant indigenous space industry that promotes and responds to the needs of the African continent.
- Adopting good corporate governance and best practices for the coordinated management of continental space activities.
- Coordinating the African space arena
- Promoting an African-led space agenda through mutually beneficial partnerships.
Pan African University

- Establishment of **Pan African University** approved 2008

  - **Space sciences – Southern Africa**
  - Water and Energy Sciences
  - Basic Science, Technology and Innovation
  - Earth and Life Sciences
  - Governance, Humanities and social sciences
African Space Programme | Context

ARMC

  (South Africa, Nigeria, Algeria, Kenya)
SA Space Programme | Perspectives

DST 10-year Innovation Plan

Technology Development and Innovation

- Farmer to Pharma
- Space Science
- Energy
- Climate Change
- Human & Social Science

Human Capital
Centers of Excellence, SA Research chairs initiative, professional development program, etc.

Knowledge Infrastructure
Universities, Science councils, state-owned enterprises, global projects, etc.
F’SATI
Multi-National Institute

Universities of Technology

French Partner Universities

MTech/MSc

DTech/PhD
F’SATI
Multi-National Institute

the dti
Department: Trade and Industry
REPUBLIC OF SOUTH AFRICA

SANS SA
SOUTH AFRICAN NATIONAL SPACE AGENCY

UNIVERSITEIT STELLENBOSCH UNIVERSITY

UF UNIVERSITY OF FLORIDA

CAL POLY

ghana telecom

groupe cesi

technology and development

EADS astrium

clyde space
• F’SATI at CPUT
  – 2008
  – 2012 renewed
• Satellite Programme
  – 2009
  – 2011 PDSR
  – Review 2012
• Africa Space Innovation Centre
  – 2013
• SARChI Research Chair
  • Prof Norman Fitz-Coy, Univ Florida
  • ‘Innovative Small Satellite Technology and Applications for Africa’
• Launch of satellite ZACUBE-1
  – 2013
• Commercialisation
  – 2014
  – 50 graduates to date
  – 15 engineers-in-training
  – 10 000 school learners reached
Student demographics
Serving the industrialisation value chain

Phase 1: Course modules covering satellite technology and applications
Phase 2: Dual Master’s
           Dual Doctorate
Phase 3: Innovation, Africa Space Innovation Centre
Phase 4: Commercialisation (spin out company)

Community Engagement

Kids → Students → Engineers-in-training → Skilled workforce
Making i-STEM cool

... (r)evolutionise space technology to (r)evolutionise STEM education to (r)evolutionise space technology to (r)evolutionise STEM education to ...
Making i-STEM cool

South Africa, 2013

Zambia, 2012
... if not crazy

“Diary of a nanosat’
30 November 2014
Multi-disciplinary/collaborative R&D
But it started with a Cube ...
South African CubeSat activities

ZACUBE-i | National CubeSat missions | CPUT

The financial support of the DST, NRF and DTI is acknowledged.
South African CubeSat activities

ZA-Aerosat | QB50 | Univ Stellenbosch, CPUT

- 50 International CubeSats with science payloads to model the upper layers of the thermosphere
- Launch January 2016
- SU project to design and manufacture 2U CubeSat
- Collaborate with CPUT – supply of comms payload
- Demonstrate passive aerodynamic stabilisation (antennae used like plumes on a shuttlecock)
- Fipex science sensor and new CubeStar star tracker
South African CubeSat activities

ADCS | University of Stellenbosch

- SU & SSC contribution to QB50 teams
- 15 ADCS units for 2U CubeSats will be supplied to teams lacking ADCS capability
- QB50 Altitude 380 to 200 km: Exponential increase in aerodynamic disturbance
- Delivery of 3 units in January 2014 to precursor QB50 flight (2 x 2U CubeSats) in May 2014
South African CubeSat activities

Micropropulsion | University of the Witwatersrand

Corona Ionisation system (Corion)
- Highly miniaturised (<1 gram)
- Efficient, considering... (~20%)
- Low power (<1 Watt)
- Good thrust (~0.3 mN)
- Debris mitigation / orbital maintenance

~1840 V
~0.85 mA
~0.35 mN
South African CubeSat activities

DynaCube | Denel Dynamics internship programme

**CUBESAT BUS**
- In-house designed structure
- PCB Stack
- In-house designed solar panels (with TASC cells)

**PAYLOAD**
- RADFET Dosimeter
- VGA Camera

**GROUND STATION**
- VHF, UHF, S-Band, and Software Defined

**TEAM**
South African CubeSat activities

Payloads for ZACUBE-i | University of Cape Town

- High energy particle sensor
- Reconfigurable
Cape Town, 1 - 5 September 2014