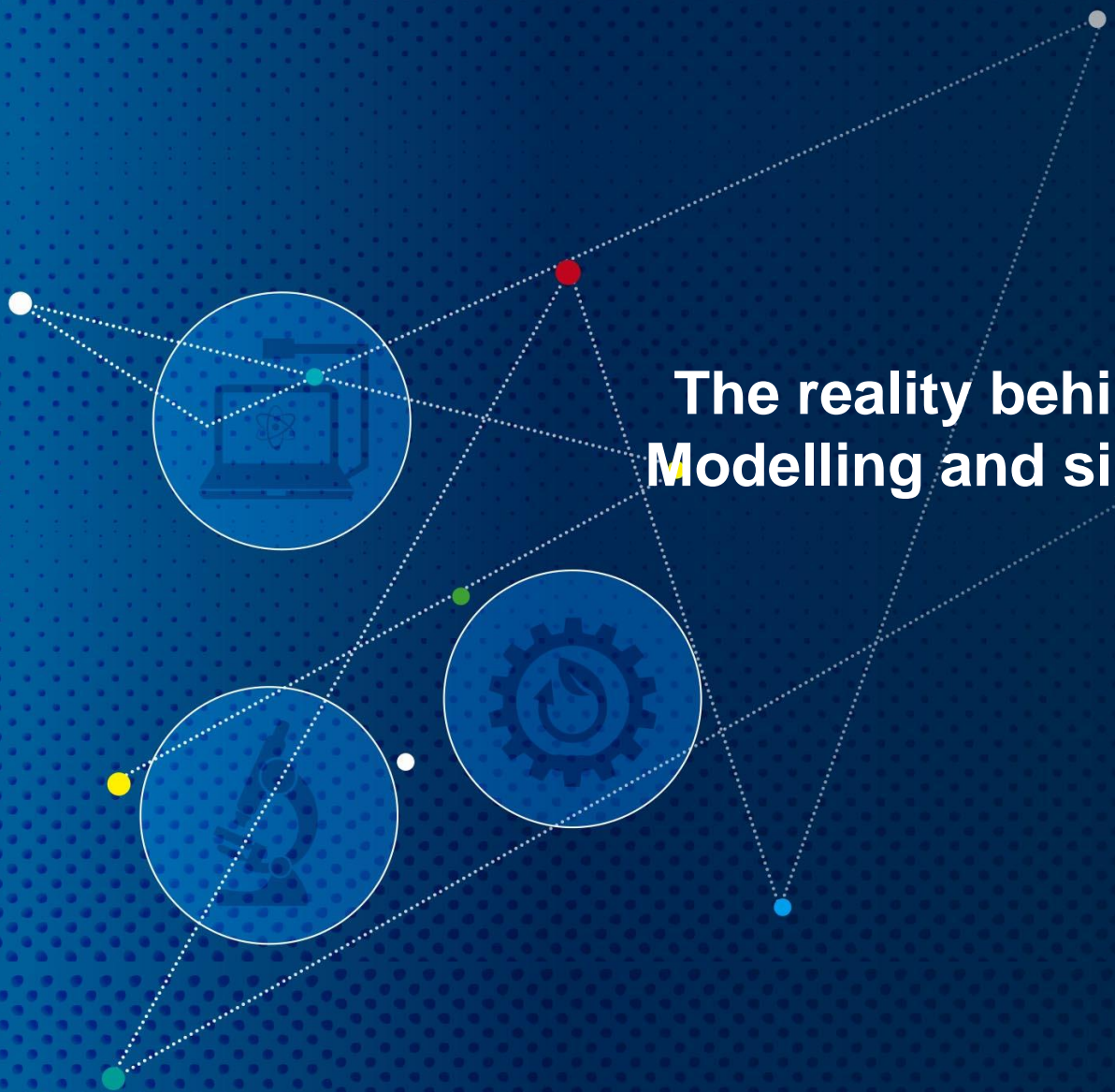


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**The reality behind the assumptions:  
Modelling and simulation support for  
the SAAF**

Kavendra Naidoo

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# Military Aerospace Trends & Strategy

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# Military aerospace trends

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- National security includes other dimensions: social, economic development, environmental, energy security, etc.
- Military budgets constrained
- Changing nature of the threat, asymmetric, non-conventional, innovative, etc.
- Proliferation and availability of technology, information, skills and experience
- Defence Review: official strategy to respond to global, continental and regional military threat



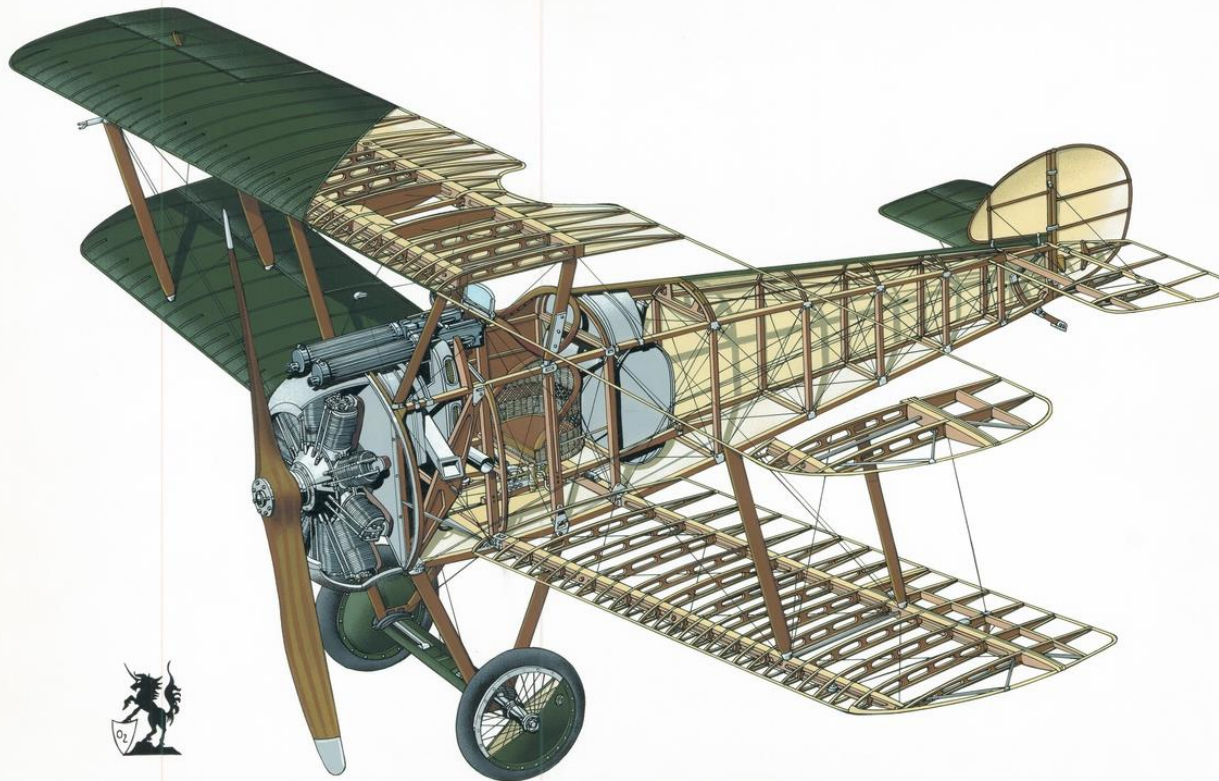
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# Complexity in modern aerial warfare

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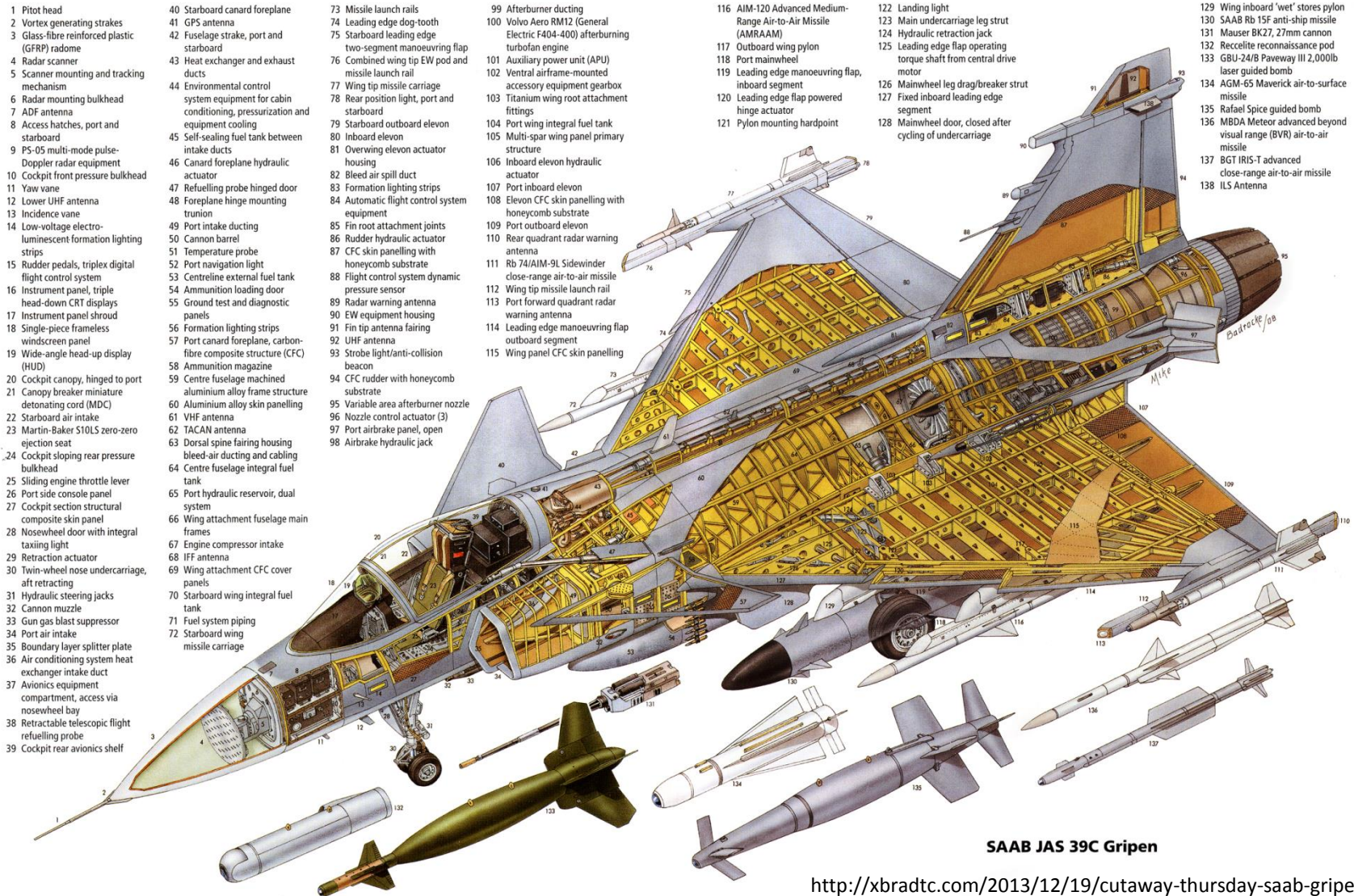
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# Complexity in modern aerial warfare

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- 1 Pitot head
- 2 Vortex generating strakes
- 3 Glass-fibre reinforced plastic (GFRP) radome
- 4 Radar scanner
- 5 Scanner mounting and tracking mechanism
- 6 Radar mounting bulkhead
- 7 ADF antenna
- 8 Access hatches, port and starboard
- 9 PS-05 multi-mode pulse-Doppler radar equipment
- 10 Cockpit front pressure bulkhead
- 11 Yaw vane
- 12 Lower UHF antenna
- 13 Incidence vane
- 14 Low-voltage electro-luminescent formation lighting strips
- 15 Rudder pedals, triplex digital flight control system
- 16 Instrument panel, triple head-down CRT displays
- 17 Instrument panel shroud
- 18 Single-piece frameless widescreen panel
- 19 Wide-angle head-up display (HUD)
- 20 Cockpit canopy, hinged to port
- 21 Canopy breaker miniature detonating cord (MDC)
- 22 Starboard air intake
- 23 Martin-Baker S10LS zero-zero ejection seat
- 24 Cockpit sloping rear pressure bulkhead
- 25 Sliding engine throttle lever
- 26 Port side console panel
- 27 Cockpit section structural composite skin panel
- 28 Nosewheel door with integral taxiing light
- 29 Retraction actuator
- 30 Twin-wheel nose undercarriage, aft retracting
- 31 Hydraulic steering jacks
- 32 Cannon muzzle
- 33 Gun gas blast suppressor
- 34 Port air intake
- 35 Boundary layer splitter plate
- 36 Air conditioning system heat exchanger intake duct
- 37 Avionics equipment compartment, access via nosewheel bay
- 38 Retractable telescopic flight refuelling probe
- 39 Cockpit rear avionics shelf

- 40 Starboard canard foreplane
- 41 GPS antenna
- 42 Fuselage strake, port and starboard
- 43 Heat exchanger and exhaust ducts
- 44 Environmental control system equipment for cabin conditioning, pressurization and equipment cooling
- 45 Self-sealing fuel tank between intake ducts
- 46 Canard foreplane hydraulic actuator
- 47 Refuelling probe hinged door
- 48 Foreplane hinge mounting trunion
- 49 Port intake ducting
- 50 Cannon barrel
- 51 Temperature probe
- 52 Port navigation light
- 53 Centreline external fuel tank
- 54 Ammunition loading door
- 55 Ground test and diagnostic panels
- 56 Formation lighting strips
- 57 Port canard foreplane, carbon-fibre composite structure (CFC)
- 58 Ammunition magazine
- 59 Centre fuselage machined aluminium alloy frame structure
- 60 Aluminium alloy skin panelling
- 61 VHF antenna
- 62 TACAN antenna
- 63 Dorsal spine fairing housing bleed-air ducting and cabling
- 64 Centre fuselage integral fuel tank
- 65 Port hydraulic reservoir, dual system
- 66 Wing attachment fuselage main frames
- 67 Engine compressor intake
- 68 IFF antenna
- 69 Wing attachment CFC cover panels
- 70 Starboard wing integral fuel tank
- 71 Fuel system piping
- 72 Starboard wing missile carriage

- 73 Missile launch rails
- 74 Leading edge dog-tooth
- 75 Starboard leading edge two-segment manoeuvring flap
- 76 Combined wing tip EW pod and missile launch rail
- 77 Wing tip missile carriage
- 78 Rear position light, port and starboard
- 79 Starboard outboard elevon
- 80 Inboard elevon
- 81 Overwing elevon actuator housing
- 82 Bleed air spill duct
- 83 Formation lighting strips
- 84 Automatic flight control system equipment
- 85 Fin root attachment joints
- 86 Rudder hydraulic actuator
- 87 CFC skin panelling with honeycomb substrate
- 88 Flight control system dynamic pressure sensor
- 89 Radar warning antenna
- 90 EW equipment housing
- 91 Fin tip antenna fairing
- 92 UHF antenna
- 93 Strobe light/anti-collision beacon
- 94 CFC rudder with honeycomb substrate
- 95 Variable area afterburner nozzle
- 96 Nozzle control actuator (3)
- 97 Port airbrake panel, open
- 98 Airbrake hydraulic jack

- 99 Afterburner ducting
- 100 Volvo Aero RM12 (General Electric F404-400) afterburning turbofan engine
- 101 Auxiliary power unit (APU)
- 102 Ventral airframe-mounted accessory equipment gearbox
- 103 Titanium wing root attachment fittings
- 104 Port wing integral fuel tank
- 105 Multi-spar wing panel primary structure
- 106 Inboard elevon hydraulic actuator
- 107 Port inboard elevon
- 108 Elevon CFC skin panelling with honeycomb substrate
- 109 Port outboard elevon
- 110 Rear quadrant radar warning antenna
- 111 Rb 74/AIM-9L Sidewinder close-range air-to-air missile
- 112 Wing tip missile launch rail
- 113 Port forward quadrant radar warning antenna
- 114 Leading edge manoeuvring flap outboard segment
- 115 Wing panel CFC skin panelling

- 116 AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)
- 117 Outboard wing pylon
- 118 Port mainwheel
- 119 Leading edge manoeuvring flap, inboard segment
- 120 Leading edge flap powered hinge actuator
- 121 Pylon mounting hardpoint

- 122 Landing light
- 123 Main undercarriage leg strut
- 124 Hydraulic retraction jack
- 125 Leading edge flap operating torque shaft from central drive motor
- 126 Mainwheel leg drag/breaker strut
- 127 Fixed inboard leading edge segment
- 128 Mainwheel door, closed after cycling of undercarriage

- 129 Wing inboard 'wet' stores pylon
- 130 SAAB Rb 15F anti-ship missile
- 131 Mauer BK27, 27mm cannon
- 132 RecceLite reconnaissance pod
- 133 GBU-24/B Paveway III 2,000lb laser guided bomb
- 134 AGM-65 Maverick air-to-surface missile
- 135 Rafael Spice guided bomb
- 136 MBDA Meteor advanced beyond visual range (BVR) air-to-air missile
- 137 BGT IRIS-T advanced close-range air-to-air missile
- 138 ILS Antenna

SAAB JAS 39C Gripen



# The Defence Review

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- **DEFENCE SCIENCE, ENGINEERING & TECHNOLOGY CAPABILITY – GUIDELINE**
- **49. Science, Engineering and Technology (SET) will be one of the major power bases of the future South African State.** As a developing nation, South Africa is currently fortunate to have a strong SET capability in some areas which can be used as a future **force multiplier** for the Defence Force.
- **50. A growing percentage of relevant defence technologies are developed in the commercial domain, resulting in defence forces becoming increasingly reliant on the use of commercial technologies. An agile SANDF will need to exploit technology opportunities through:**
  - **rapid technology acquisition,**
  - **use of civil technologies and infrastructure, and rapid adaption and creation of new doctrine and tactics, as well as their implementation.**

# The Defence Review

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- 51. Further thereto, fewer single nations are able to design, develop and produce new weapon systems due to the rise in complexity and cost to do so. Current trends indicate that there will be **increasing multi-national collaboration to develop new weapon systems**. This requires the concerted development of a strong Defence Science, Engineering and Technology (DSET) capability to become a
  - **smart-buyer of weapon systems,**
  - **to effectively participate in international collaborative efforts and**
  - **have the required depth of know-how to support and upgrade technologies.**

52. Having a strong DSET will further allow the Defence Force to **leverage the capabilities of the national SET** spectrum to meet future defence demands.

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## Modelling and simulation

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- Mathematical representation of reality
- Appropriate level of fidelity for task at hand
- Battlespace level simulation with multiple interacting entities
- Unpredictable emergent behaviour
- Tactics, doctrine evaluation and development
- Training
- Acquisition
- Operations planning
- Innovation

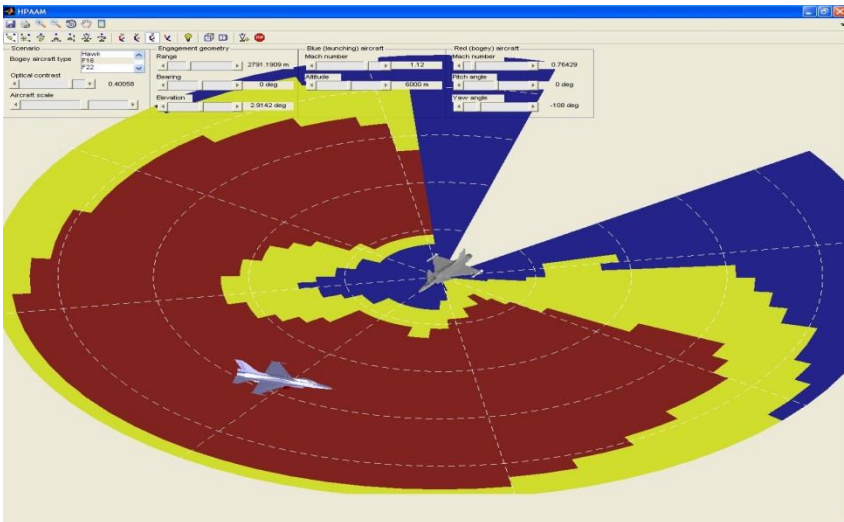
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# Simulating the fight



- Critical to account for security sensitive engineering data
- Understanding the drivers of a mission outcome
- Thousands of missions faster than real-time at a fraction of the cost
- Design the mission or platform for success
- Canvas for collaboration, experiments, analysis, understanding and innovation





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Screen shot from IMAX production: Operation Red Flag  
Nellis Air Combat Training System

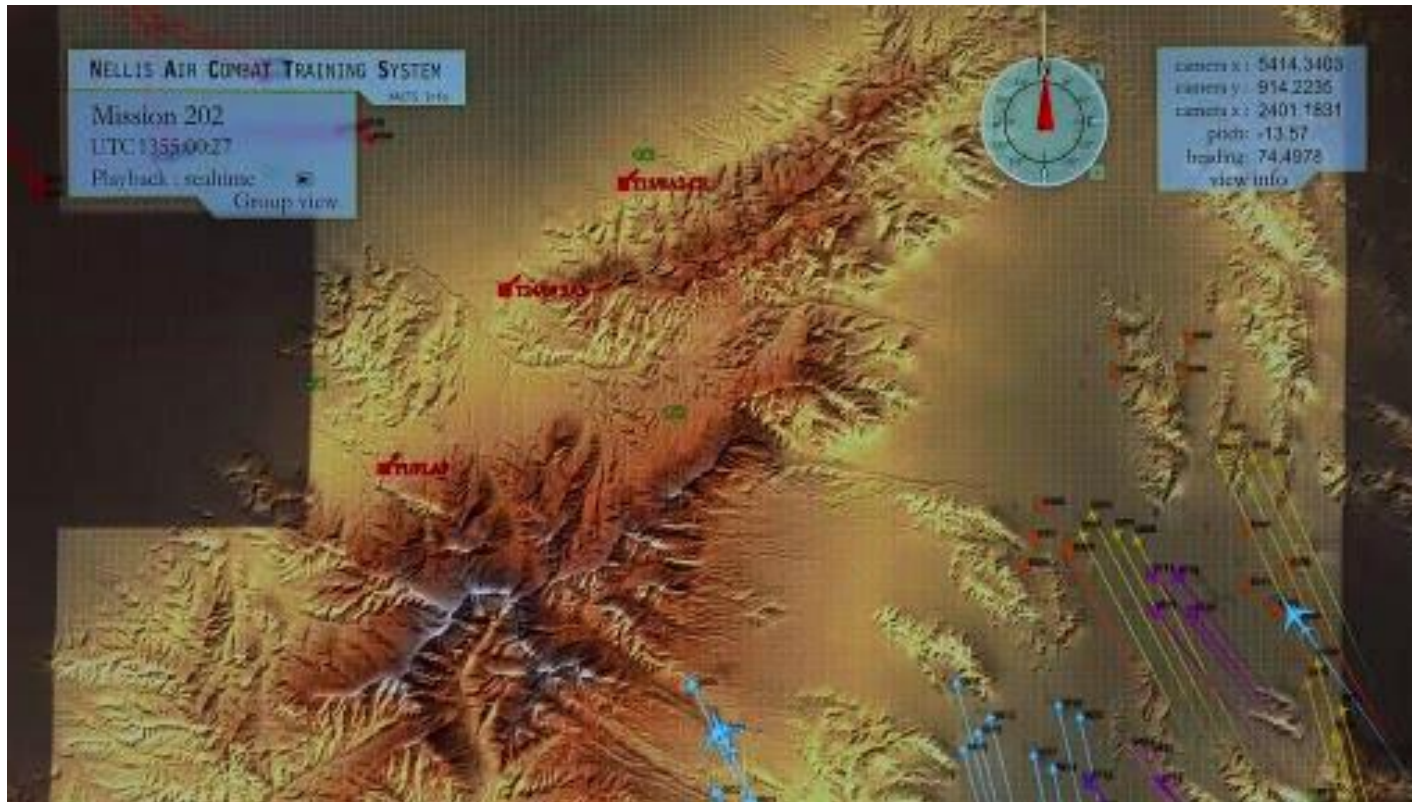
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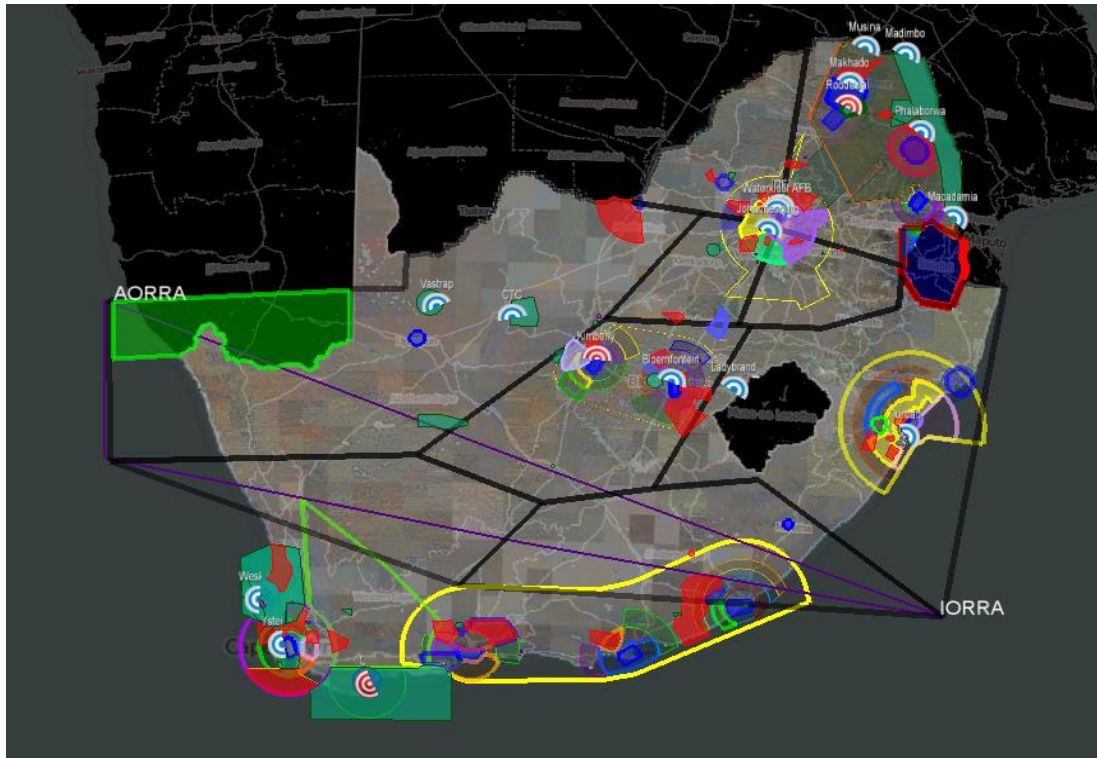


Screen shot from IMAX production: Operation Red Flag  
Nellis Air Combat Training System



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“In-house” developed Mission Simulation Framework

# Simulating the fight

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“In-house” developed Mission Simulation Framework







# Unmanned systems



- Autonomous flight a reality
- Significant platform advances
- Ongoing payload advancements
- Thousands of COTS systems
- Reduced Cost and improved access in some classes
- Increased cost, complexity and restricted access in other classes
- SA developing unmanned systems for decades and has operated a UAV squadron previously



# Unmanned systems

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- Understanding the entire problem
- Identify Friend or Foe
- Can you see and confirm the nature of the threat
- Required system functions and performance
- Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)
- Acquisition
- Bringing into service and integration into operations for mission effectiveness

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# Unmanned systems

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- Concept of Operations including C4ISR
- Sensor Performance
- Data Management and Data Fusion
- Damage tolerance for hostile environment
- Endurance and mass (including power)
- Time and distance



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Thank you

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