

Electronic Warfare South Africa 2019

Electronic Warfare Simulation Cost Saver and Force Multiplier

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ASSOCIATION
OF OLD CROWS

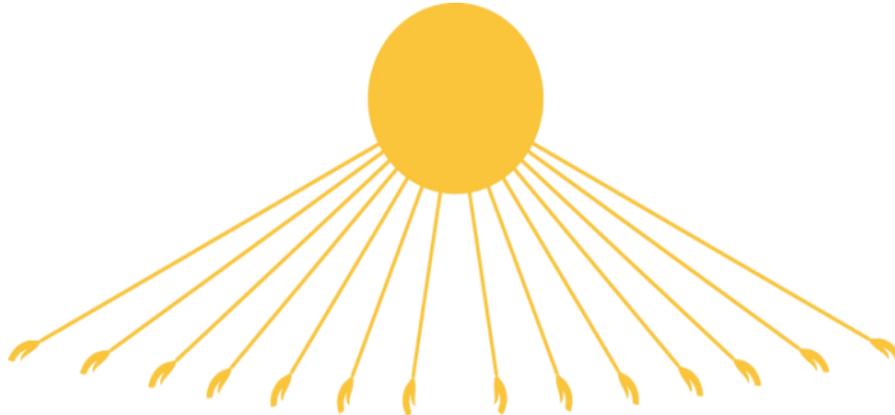
CSIR
our future through science

Outline

- History of Modelling and Simulation
- South African Defence Sector Context
- M&S Use Cases
 - Operational Analysis
 - EW System Optimisation
 - Tactics and Doctrine Development
 - Dynamic Spectrum Access
 - Sensor Test and Evaluation
 - Training
- M&S into the Future
- Role of M&S in SA Defence and Conclusion

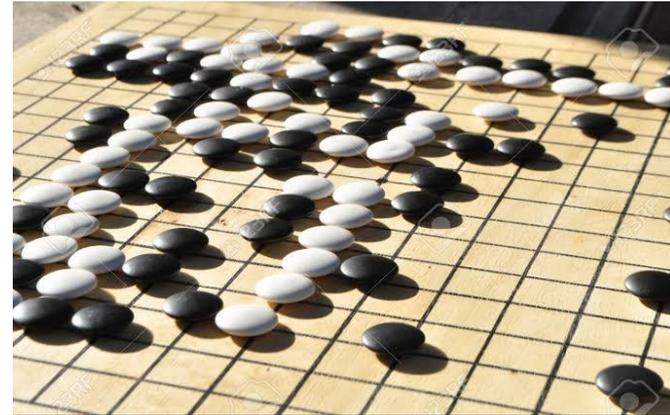
History of Modelling and Simulation

- Today, Modelling and Simulation is extensively used across industries to solve complex problems.
- ~ 3000 BC – Egyptian astronomy.
 - Egyptian priests built circular mud-brick walls to make a false horizon where they could mark the position of the sun as it rose at dawn leading to the discovery of solstices, sun disc and the year is 365 days.



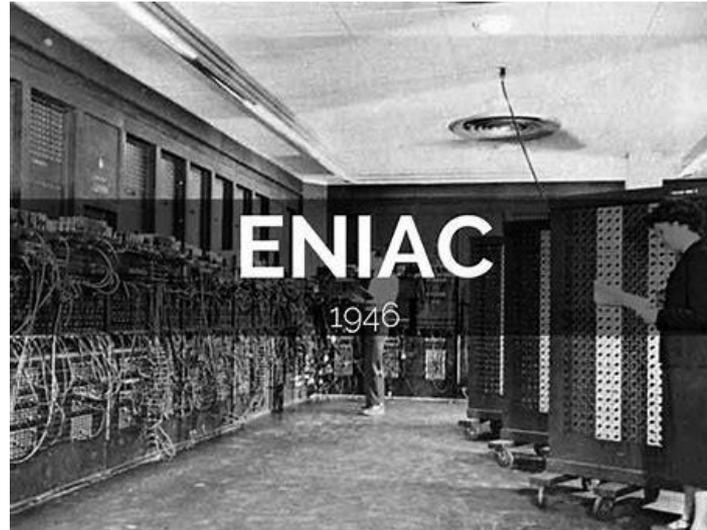
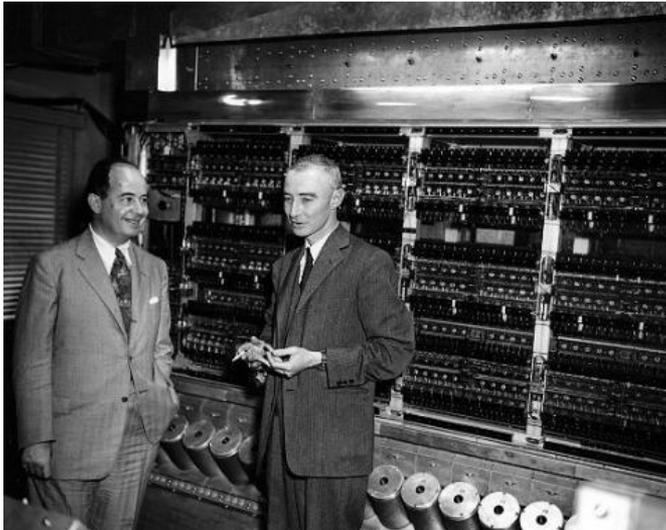
History of Modelling and Simulation

- ~ 500 BC – Thought Based Military Strategy in China.
 - Sun Tzu (famous for the art of war) invented Wei Hai involving the use of color-coded stones to represent opposing armies to develop military strategy and training.
- ~ 600 AD – War Gaming in India.
 - Chess also has a military lineage dating back to India and the Chaturanga military strategy game.



History of Modelling and Simulation

- 1940s – World War II - Manhattan project for Atomic Bomb.
 - A method named 'Monte Carlo' was developed by researchers and physicists (John von Neumann, Stanislaw Ulan, Edward Teller, Herman Kahn) working on a Manhattan project to study neutron scattering.



History of Modelling and Simulation

- 1960s – The Mathematics of Combat.
 - The first special-purpose simulation languages were developed, such as SIMSCRIPT by Harry Markowitz at the RAND Corporation.
- 1990s – Computing Power Drives Simulation.
 - AVENGER was an early model for close-in, air-to-air combat.

Computers + Mathematics = Computer Simulation!

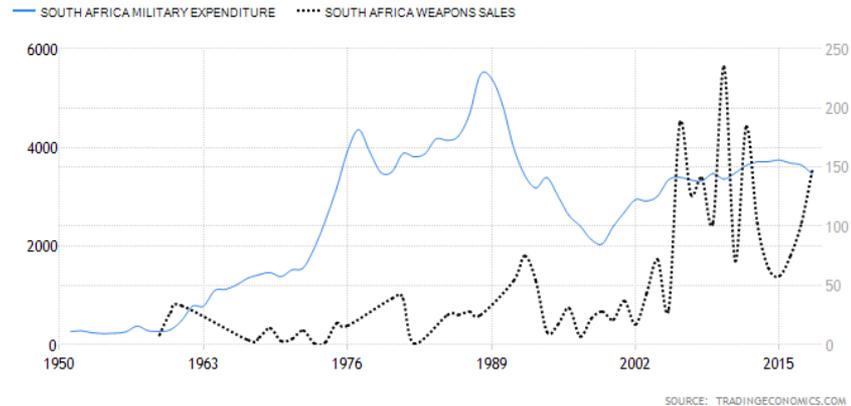


South African Defence Sector

- “The Department of Defence continues to defend and protect the Republic of South Africa through the execution of the borderline safeguarding function, the continued contribution to domestic, regional and continental stability through the deployment of military capabilities and the provision of safety and security related support to the South African Police Service where so directed.”

Dr Sam Gulube, Secretary for Defence

- Bottom Line: The SANDF has a job to do in spite of funding limitations!



- As the industry, research councils, academia, how do we rise up to this challenge?

South African Problem Solvers!

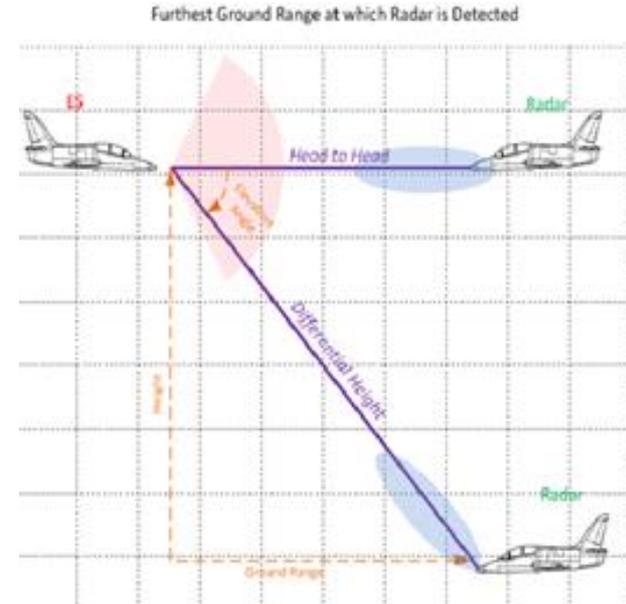
- South Africa has always risen to challenges and surprised the world!



- The CSIR is focussing on stimulating South African industry through innovation:
 - *Project Synapse Strategy.*
 - A strong defence industry underpins a capable defence force.
- Approach to using M&S to solve EW problems.
 - South African Perspective and Global Trends will also be covered.

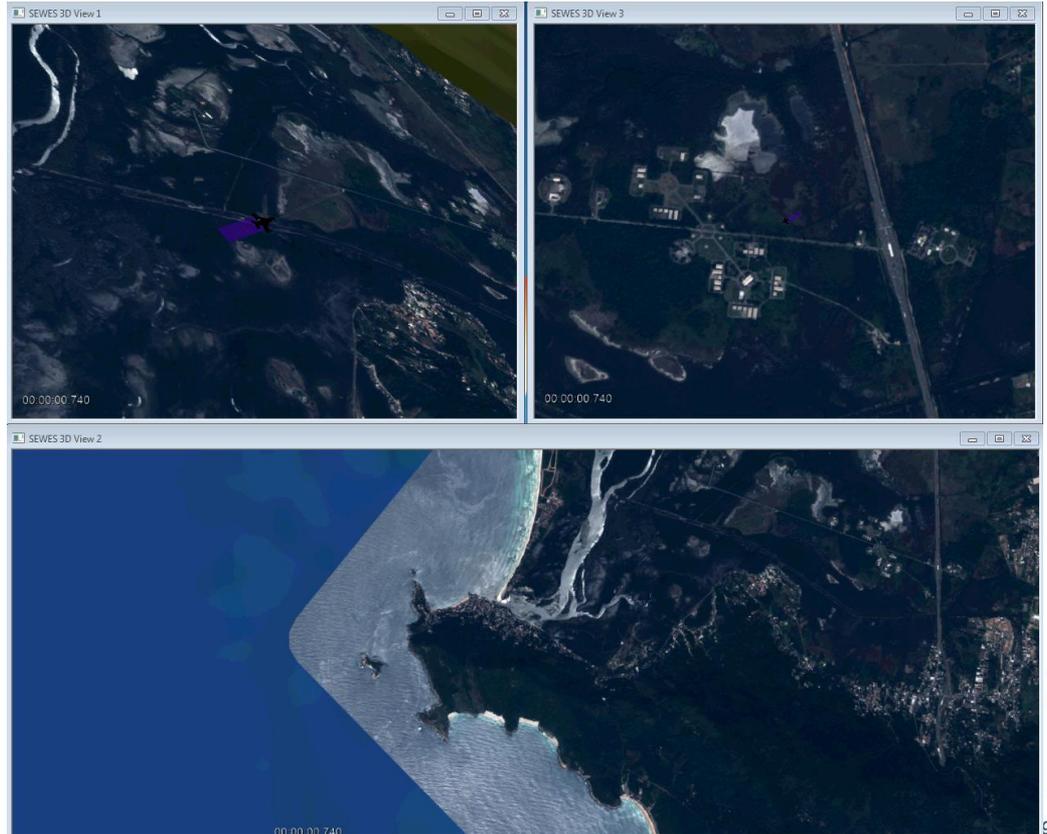
M&S for Operational Analysis

- Problem:
 - To aid military decision makers using R&D by systematic examination of a tactic or other military procedure.
- Challenges:
 - Seldom have access to adversarial systems and controlled conditions.
- Example:
 - Predicting the performance of your fighter aircraft EW mission systems against adversaries.



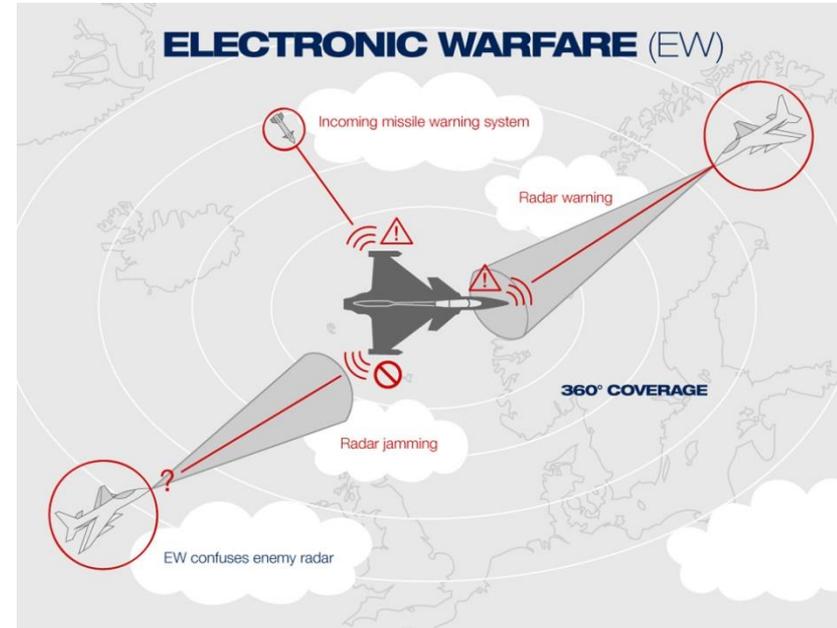
M&S for Operational Analysis

- Utilize constructive M&S.
 - All entities are in the computer.
- Model own + adversary systems.
 - Radar, EW, Aircraft.
- Simulated engagements.
- Visualize results.
 - See the unseen!



M&S for EW System Optimisation

- Problem:
 - Modern EW Systems rely heavily on mission data and software. Optimally configuring mission systems data has a significant impact on the EW Systems effectiveness.
- Challenges:
 - How to generate optimal configurations for EW Systems in a cost effective manner.
- Example:
 - Optimising ESM Receiver Frequency Search Pattern



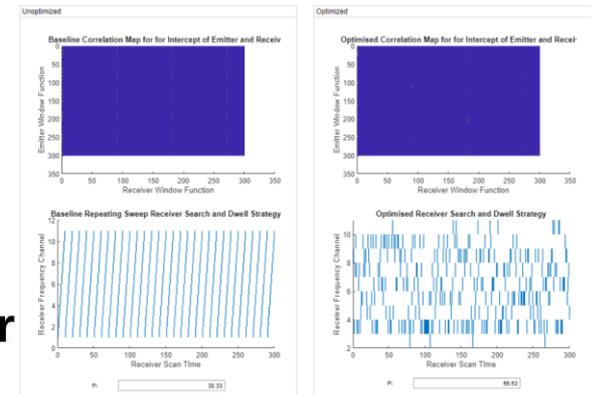
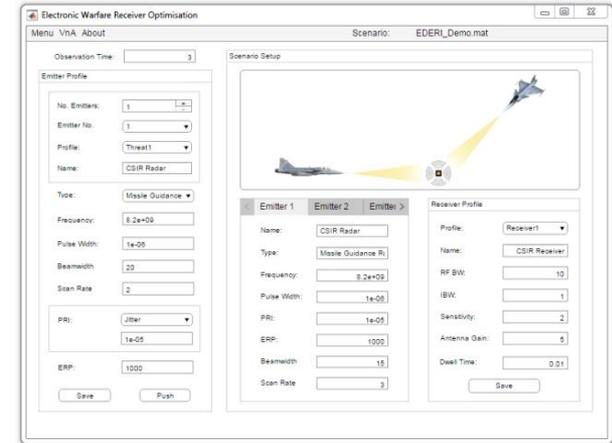
M&S for EW System Optimisation

- Model multi-emitter threat environment
 - Air Defence Systems, Fighter Aircraft, etc
- Model own platform
 - ESM Receiver
- Apply Optimisation Algorithms to find the optimal receiver search
 - Optimize Probability of Intercept
 - Genetic Algorithm - Survival of the Fittest!



M&S for EW System Optimisation

- Genetic Algorithms can iterate 100's of generations in minutes
 - Charles Darwin's theory of natural evolution
- Can find non-intuitive solutions
 - Still require humans to understand the solutions
- Lab results show increases in Intercept of Probability of over 30%
- Mathematics and Computer Science Driven Globally:
 - Fraunhofer, Germany
 - DSTG, Australia
 - Thales, France
 - Defence University, China



M&S for Tactics and Doctrine Development

- Problem:
 - How to develop tactics and doctrine to guide military forces as they pursue national security objectives.
- Challenges:
 - The modern networked centric battlefield is too complex to purely use the human mind to develop tactics.
- Example:
 - Utilizing constructive simulation to analyse various engagement scenarios and develop tactics.

Scenario Layout

The screenshot displays the Scenario Manager interface for a simulation scenario. The main window shows a satellite map of a coastal region with a grid overlay. Two red arrows point from external text boxes to specific elements on the map: one to a land-based radar icon and another to a ship icon. The radar icon is labeled "Red Radar (20x25)" and the ship icon is labeled "Red Ship (20x25)".

Scenario View

Platform Info

Name	Red Ship
Position [deg]	(lat, lon): (34.1141S, 18.2825E)
Altitude [m]	25

Systems

- Ship
- NavalChaff

Red Ship

Edit Platform Edit System

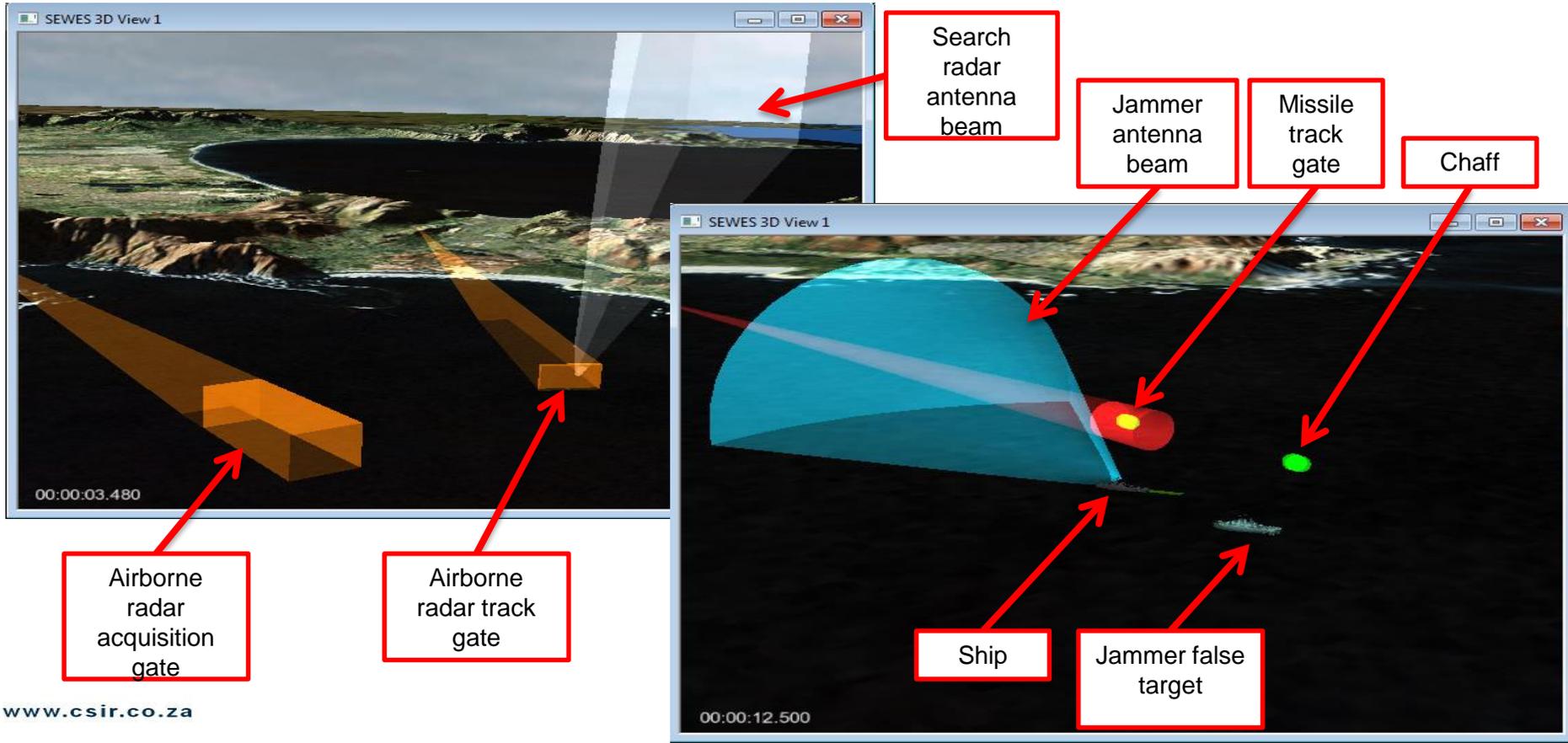
Tool: normal
PlatformLib: none
Status: ready

(lat, lon): (34.1133S, 18.3745E) [degrees] : 6 [m] Range 1.4664 [km] Bearing 86.3129 [degrees]

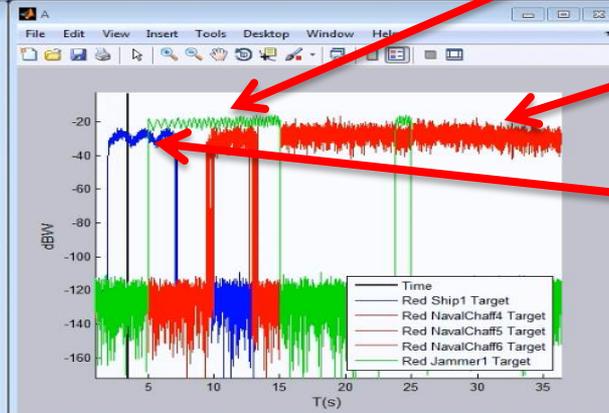
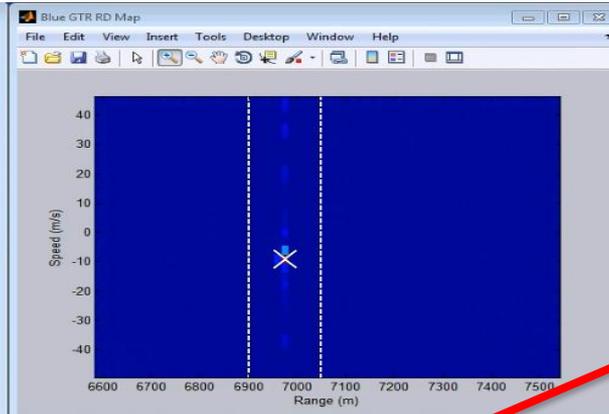
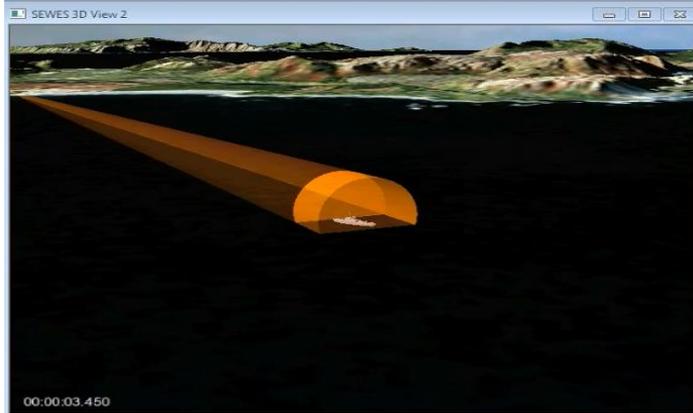
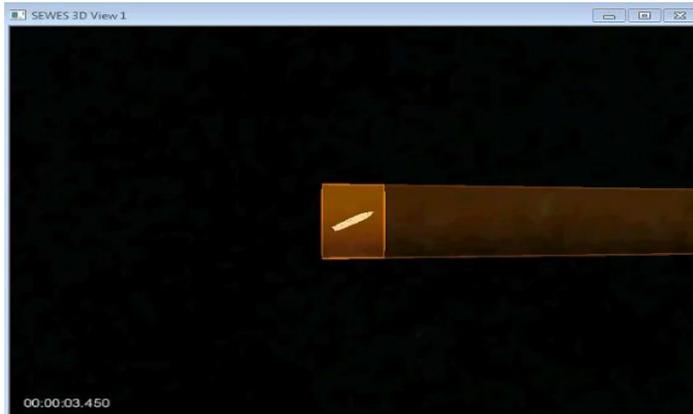
Land based
tracking
radar

Ship with
chaff and
coherent
jammer

Visualisation Symbology



Active and Passive Countermeasure



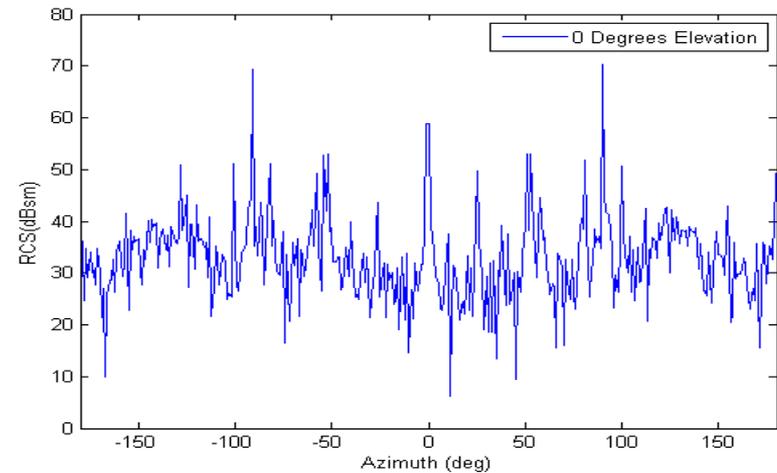
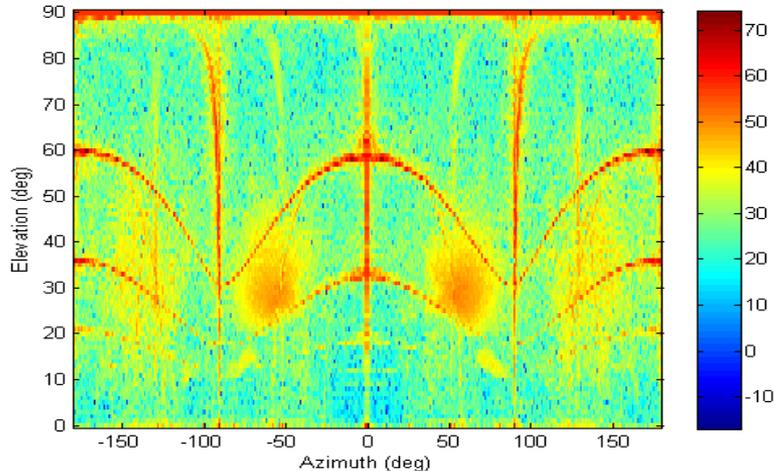
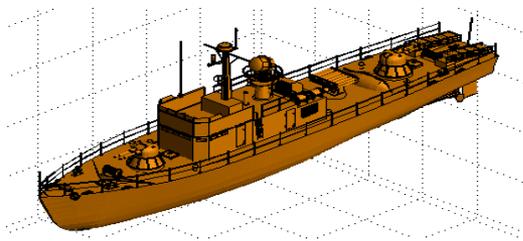
Jammer
Power
Return

Chaff Power
Return

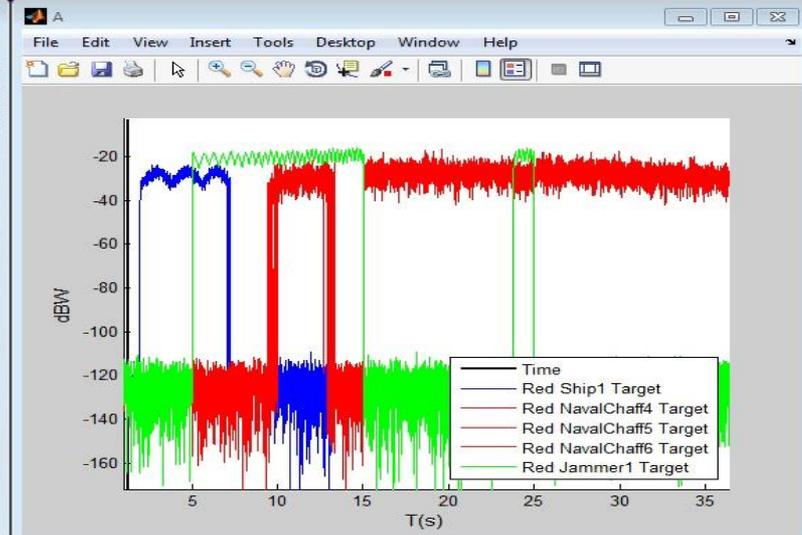
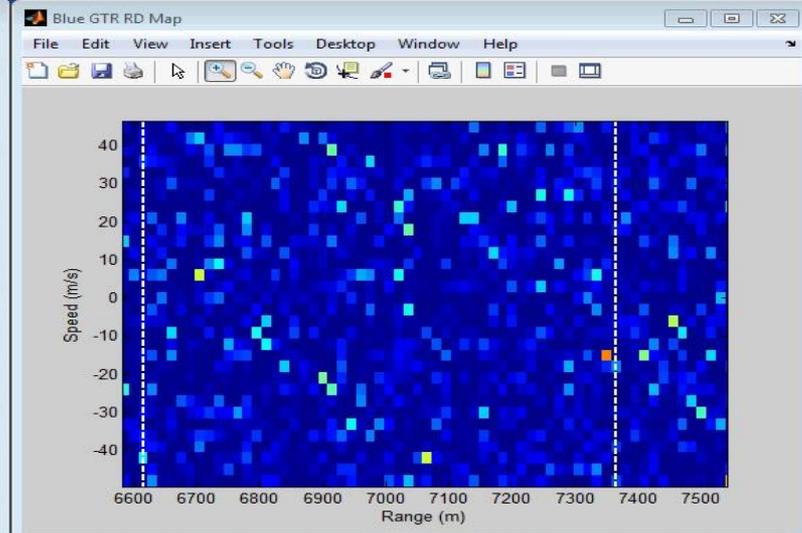
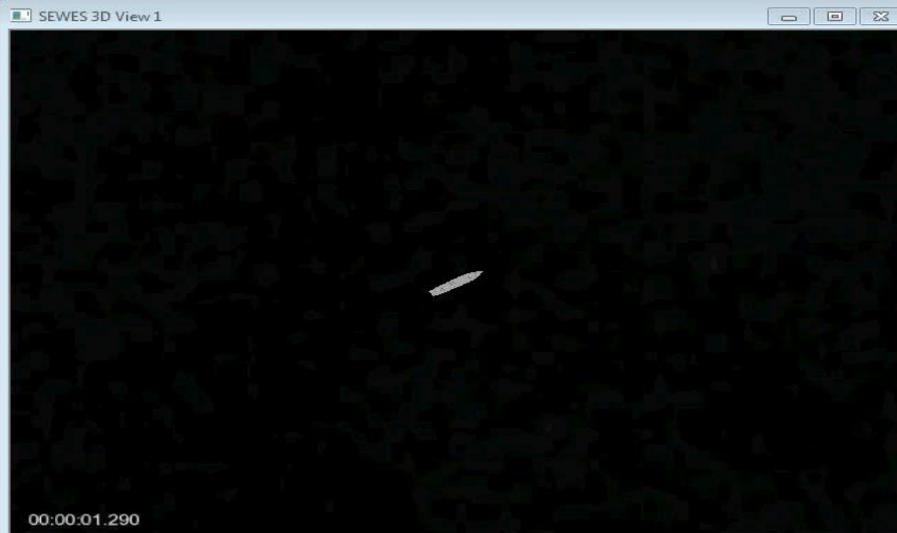
Ship Power
Return

Passive Countermeasure

- Land based radar tracking a ship, deploying chaff

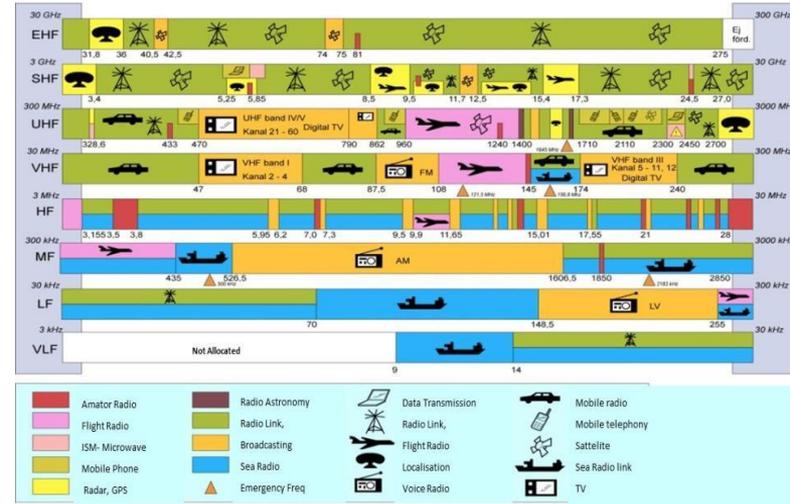


- RCS of Ship simulated from wireframe input



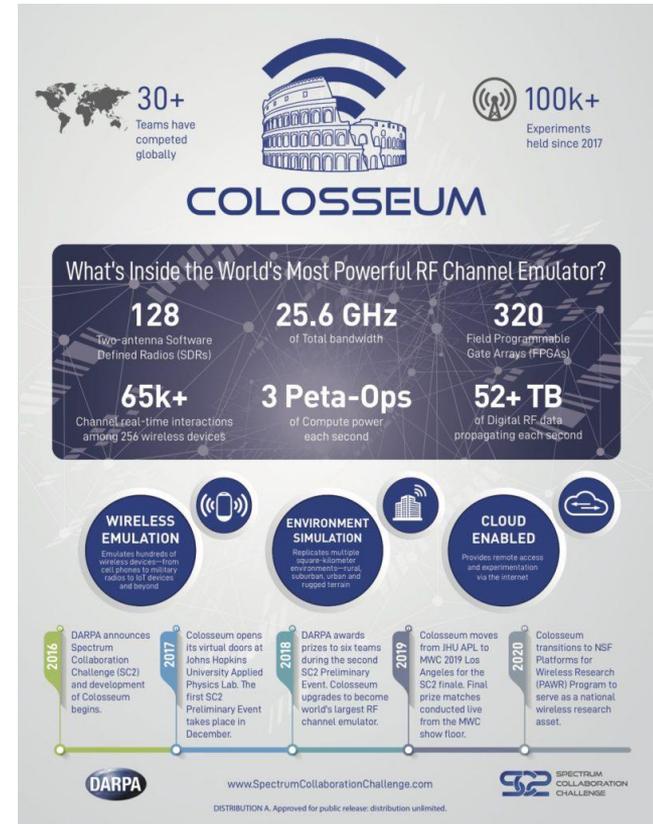
M&S for Dynamic Spectrum Access

- Problem:
 - The EMS spectrum is contested and congested. Technologies such as 5G will exacerbate this problem as demand for high bandwidth data exponentially rises.
- Challenges:
 - How to ensure freedom of operation in the EMS for defence forces?
- Example:
 - DARPA Spectrum Collaboration Challenge (SC2)



M&S for Dynamic Spectrum Access

- Participation in the DARPA Spectrum Collaboration Challenge (SC2)
 - World's first collaborative machine intelligence competition to overcome spectrum scarcity.
 - Competitors reimagine spectrum access strategies and develop a new wireless paradigm in which radio networks will autonomously collaborate to share the RF spectrum.
 - Colosseum: World's Most Powerful RF Emulator!

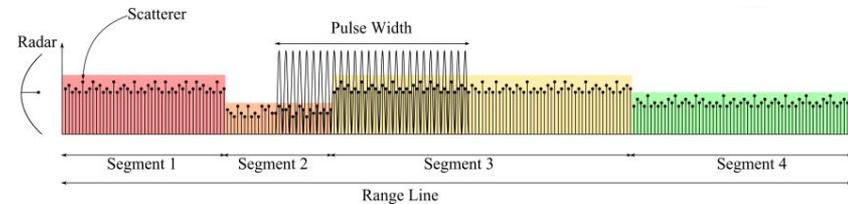
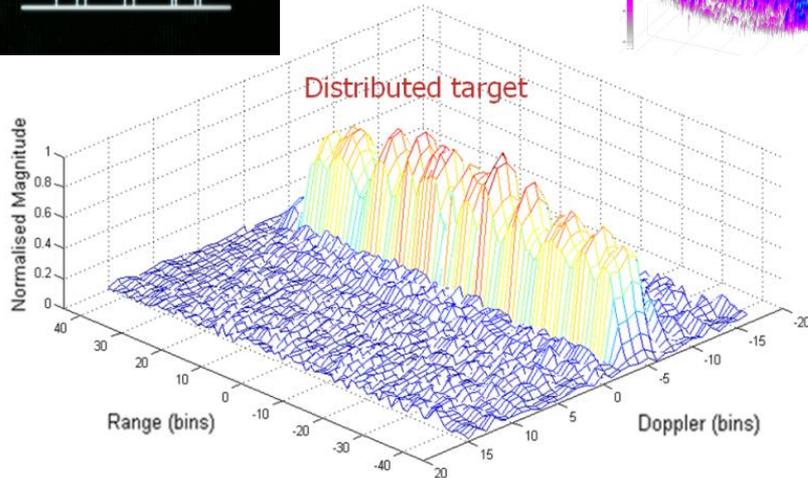
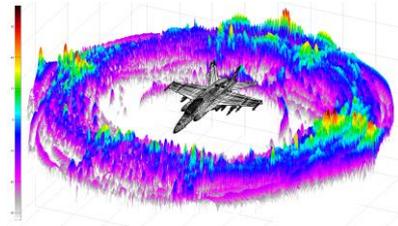
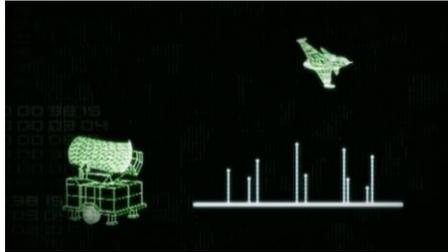


M&S for Sensor Test and Evaluation

- Problem:
 - Modern sensors such as Radar and EW systems are very complex. Operational test and evaluation is required for sensor performance characterisation.
- Challenges:
 - Recreating a realistic battlefield and environment to a sensor can be prohibitively expensive and may lack repeatability.
- Example:
 - Using hardware-in-the-loop (HWIL) simulation for Radar test and evaluation.
 - CSIR ENIGMA System
 - EWST Chameleon
 - Mercury Lab DRFM

M&S for Sensor Test and Evaluation

- Hardware-in-the-loop (HWIL) simulation is the use of physical hardware systems for T&E of highly complex systems such as Radar.



M&S for Fighter Pilot Training

- Problem:
 - With the evolving threat environment in the military environment, most air forces are discovering the need to train using a modern air-to-air combat doctrine.
- Challenges:
 - Credible and realistic training conditions are very costly. Older aircraft are used as the aggressor or red forces but they are not representative of modern threats.
- Example:
 - Solutions for Adversary Air Training in the form of training pod based solutions.

M&S for Fighter Pilot Training

- CSIR Inundu Pod
 - Radar Threat Simulator and ECM Training Pod.
 - Simplified aircraft integration.
 - Currently working on air-to-air baseline.
 - Fitted to older 2nd or 3rd Generation Aircraft
- Cubic SLATE Pod
 - Secure LVC Advanced Training Environment (SLATE).
 - Fitted to F-15 and F/A18 aircraft.
 - Training for ARFL, USAF.
 - Injects Threats into Aircraft.
 - Uses Datalink.

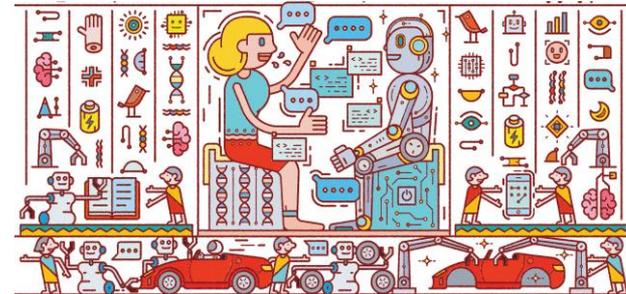


M&S into the Future

- M&S is a powerful tool BUT it does have limitations.
 - Models need to be verified and validated.
 - Models are created for specific purposes.



- EW M&S Trends
 - Interoperability
 - LVC and War Gaming
 - Collaborative Intelligence



Role of M&S in South African Defence

- “A capable defence industry is a key part of overall defence capability and the credibility of national defence strategy”

Defence Industry Strategy, National Defence Industry Council (NDIC)



- Where to from here?
 - M&S is a key tool for the Innovation Value Chain!
- Call to Action
 - Academia, Research Councils, Acquisition, Industry and the Defence Force need strong synergy and cooperation to create a capable defence force and industry!
 - M&S is be a powerful tool or medium for collaboration!

Thank you

