ELDES
RADAR SYSTEMS FOR METEOROLOGY AND DEFENCE

New Techniques for Assessing Radar ECM Effectiveness

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Presentation Outline

- Improving EW Operational Support (EWOS)
- Radar emulation modelling using SDR techniques
- The anti-ship missile (AShM) threat
- Scenario modelling of anti-ship missile engagement
- Measures of ECM effectiveness and mission effectiveness
- Summary and conclusions

ELDES ® Srl

A small, leading edge technology company specialising in high performance radar emulation and ECM effectiveness equipment and systems

Purpose of the Investigation and Design

- Improve the design and implementation of radar countermeasures for EW operations
- Define alternative methods of determining mission effectiveness
- Investigate new methodologies against using an example AShM operational scenario
- Examine additional methods/displays to further enhance countermeasures EWOS

Definitions Used

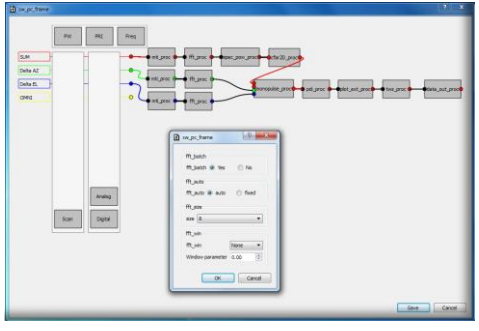
- ECM Effectiveness
  - a measure of the degradation in radar performance when exposed to an ECM technique
- Mission Effect
  - an estimation of the final effect caused by a given single or multiple ECM techniques, including tactics, on a radar

Factors That Determine ECM Effectiveness

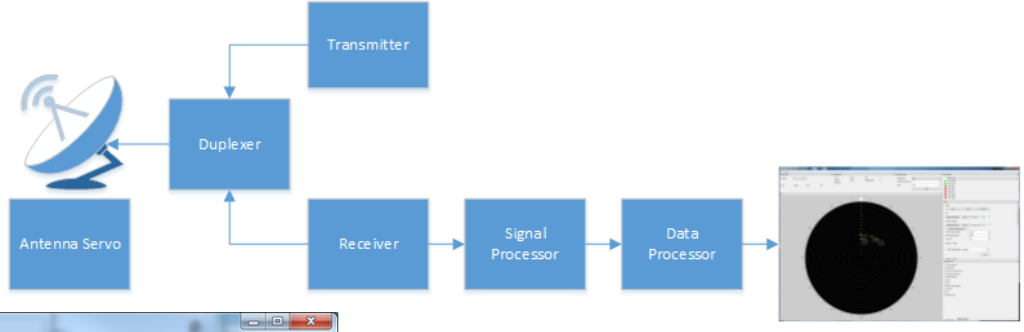
- Success of radar electronic countermeasures (ECM) is affected by many independent variables:
  - ECM transmitted power
  - ECM antenna patterns and scans
  - Radar antenna patterns and scans
  - Radar transmitted power
  - Weather
  - Angle between ECM and radar
  - Terrain and multipath
  - Timeliness of ECM
  - .....

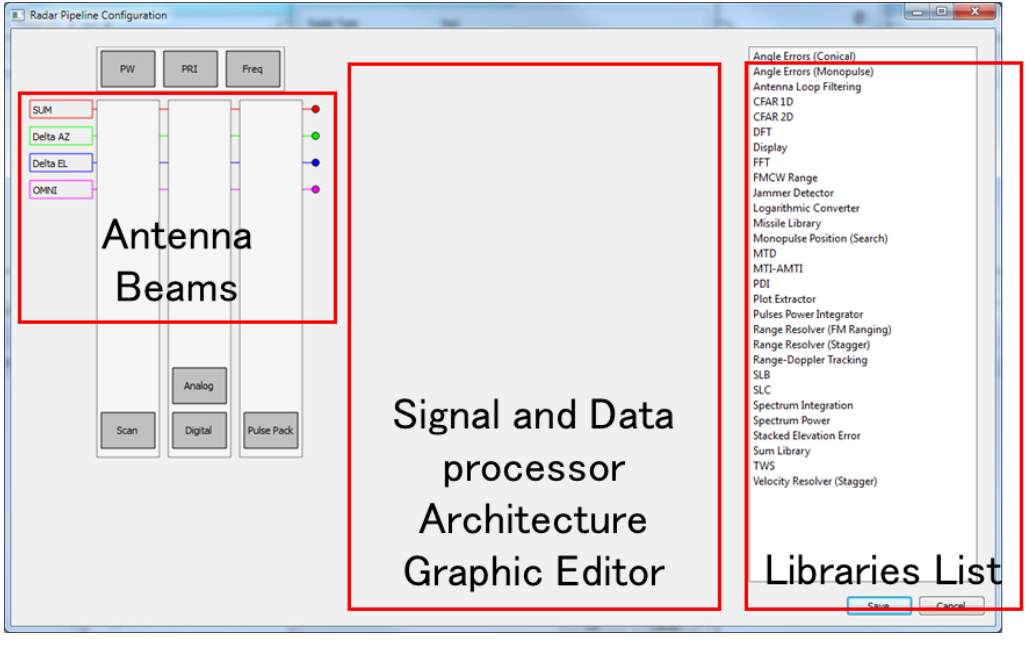
Primary Technology Basis

- Uses well-established in-service software-defined radar (SDR) technology to generate highly accurate HWIL radar emulations
- SDR allows the definition of the desired threat radar which can be based on user ELINT information,
  - Emulate radar emission in real-time
  - Emulate radar receiver processing chain in real-time (unique capability)
  - Emulate other radar behaviour including ECCM
  - Evaluate ECM effectiveness against radar



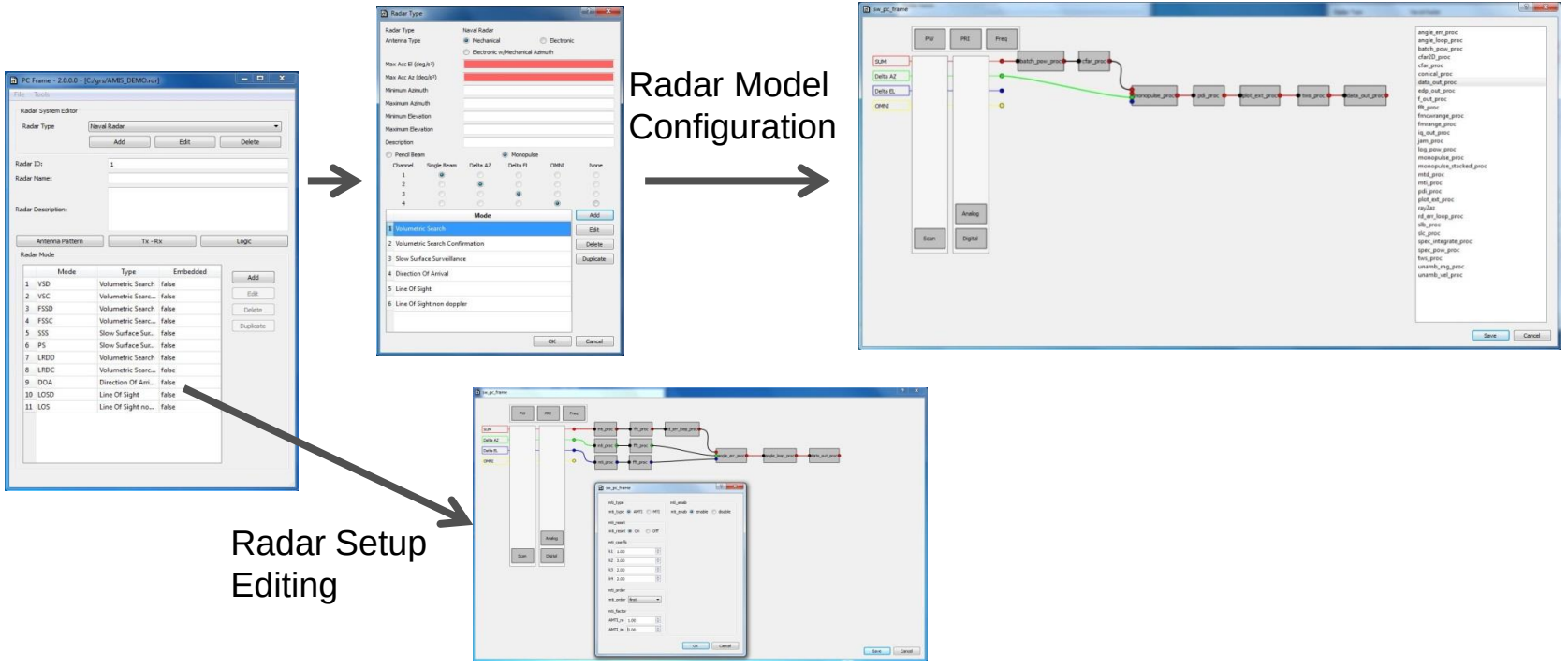
Radar Emulation Data Structure





Software Defined Radar Models Emulated in Real-Time Hardware

- Radar Framework Software: the user can generate his own radar models by linking radar library blocks in a graphic environment



Menu Driven Radar Designs Emulated in Real-Time Hardware

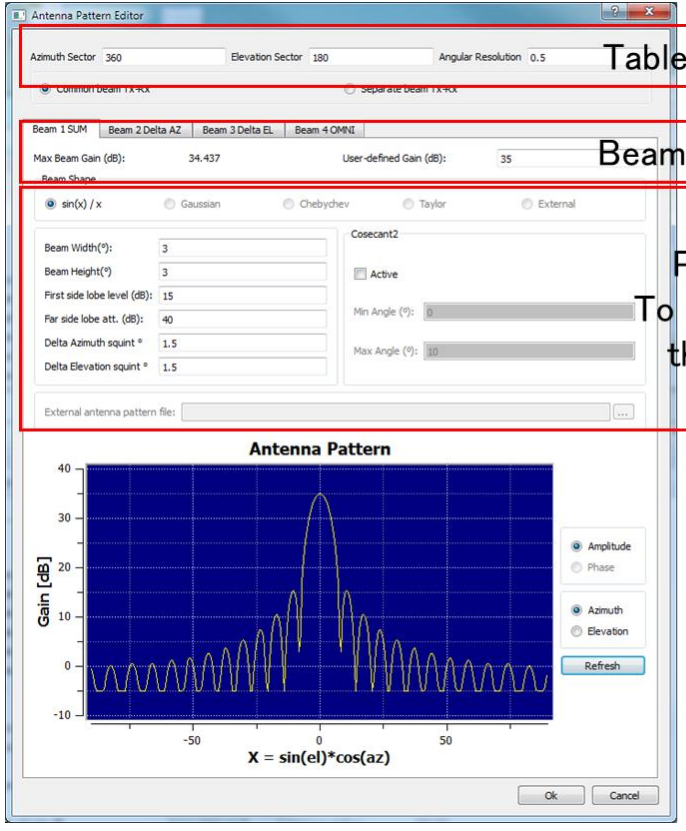
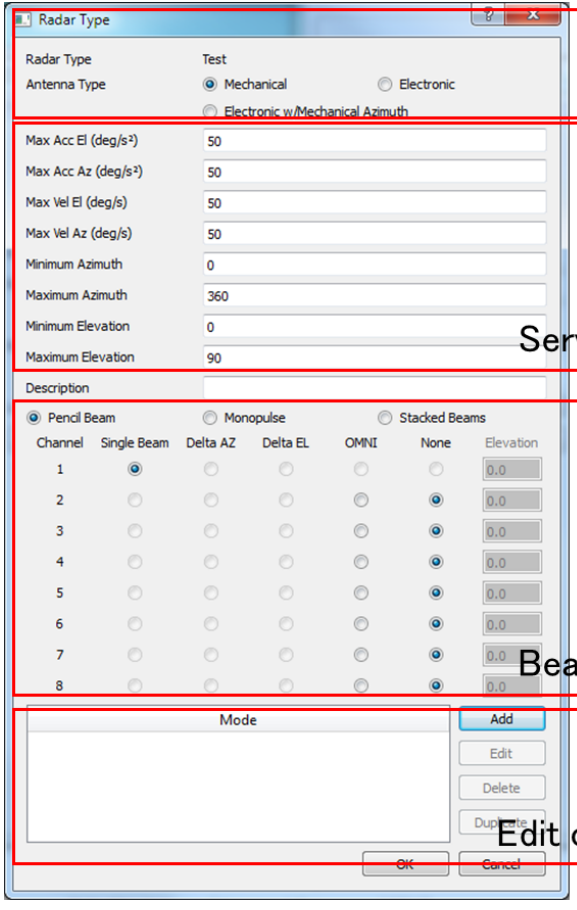


Table resolution

Beams Available

Parameters To synthesize the antenna beams



Antenna Type

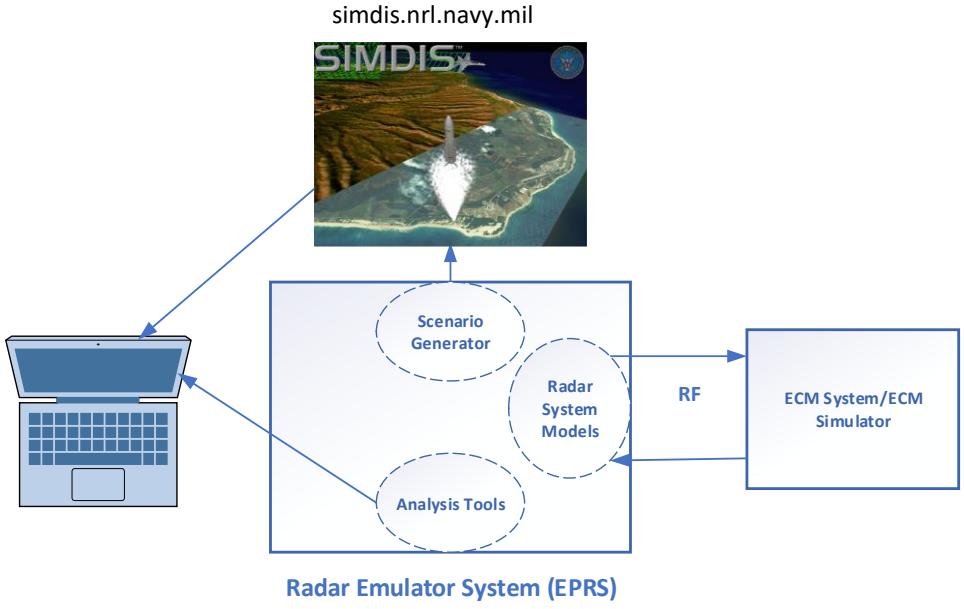
Servo Parameters

Beams Definitions

Edit of architecture

Data Analysis Tools

- Utilise in-built analysis and radar displays provided by the radar emulator (EPRS)
- Integrate off-the-shelf tools for analysis and visualisation (SIMDIS)
- Perform multiple runs of scenario to provide statistical analysis

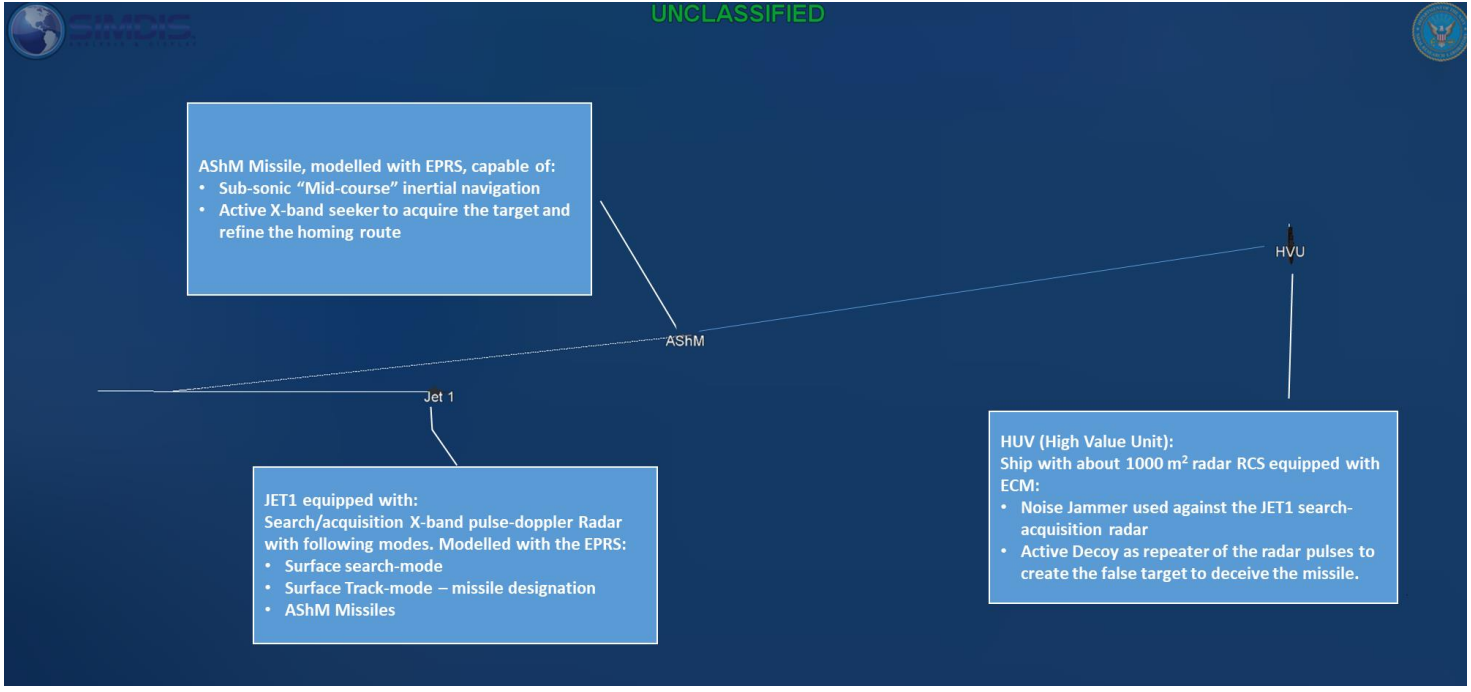


Anti-Ship Missile Threat

- Navies face both legacy and latest state-of-the-art anti-ship missile threats
- Newest threats are hypersonic leaving little or no time to detect and respond in traditional ways
- ASM tactics are changing from deceiving the seeker head to deceiving the acquisition radar as a result

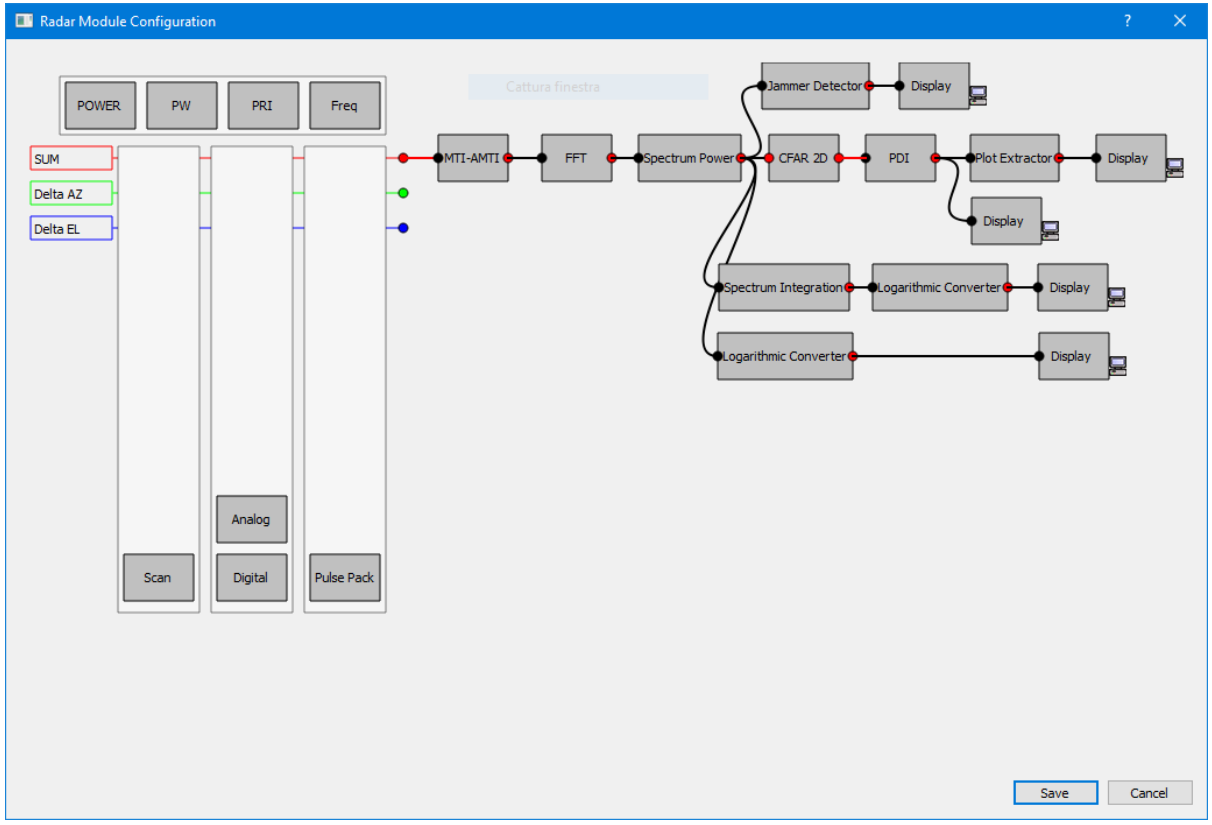
Test Scenario Details

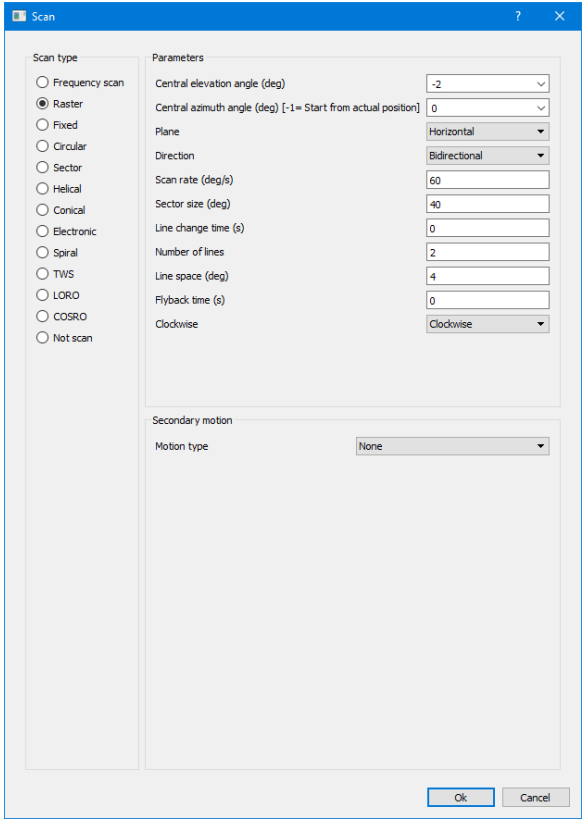
- **Test scenario will be run 4 times**
- **Effectiveness of ECM will be examined**
- **Overall mission effect will be determined**



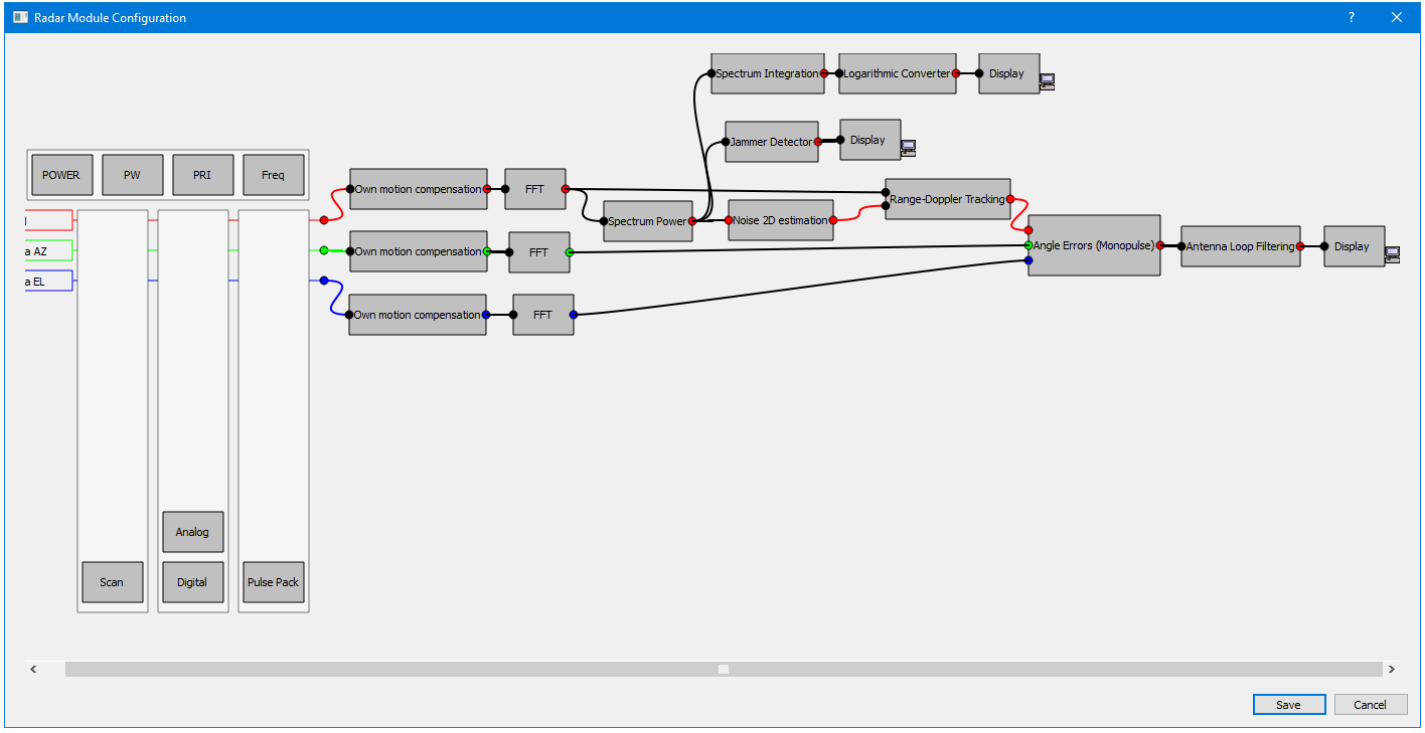
Test Scenario No Jamming

Search/Acquisition Radar Model

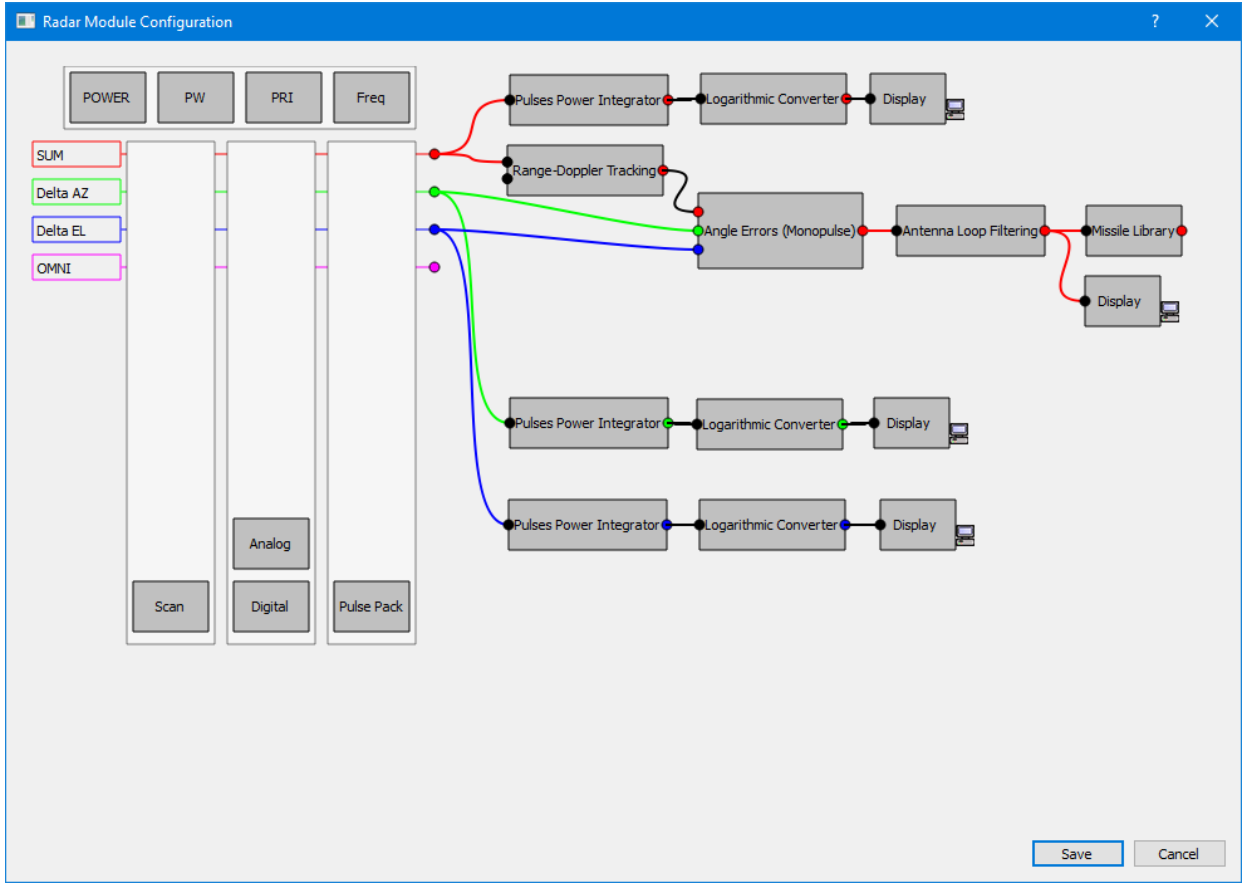




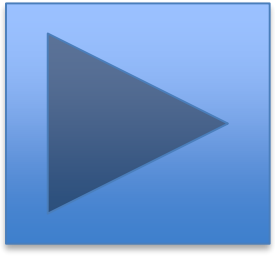
Tracking Radar Model



ASM Radar Model



Acquisition Phase Video with ECM



Acquisition Radar Analysis

An acquisition radar used to launch the missile

The scenario uses a noise jammer. ECM effectiveness is computed by looking at the time the target is correctly acquired vs the total jamming time

Scenario	time target lock-on (sec)	time target not lock-on (sec)	Acq. Dist. (ready to launch) (Km)	Effectiveness
Run 1…. No Jammer	60.0	0.00	36.1	0%
Run 2 …. Jammer	28.50	31.50	30.1	52%
Run 3 …. Jammer	24.00	36.00	27.3	60%
Run 4 …. Jammer	27.60	32.40	28.2	54%
Run 5 …. Jammer	25.80	34.20	29.7	57%
Average Run W/Jammer	27.15	32.85	28.8	54.75%

ASM Tracking Video with ECM

ASM Tracking Radar

Monopulse tracking radar guiding the missile

The scenario uses an active decoy to create a false target that is initially inside the range gate which then moves to seduce the missile. ECM effectiveness is computed by looking at when the seeker is locked onto the right target and when it is locked onto the wrong target or in break-lock

Scenario	Time target locked-on (sec)	Time target not locked-on (sec)	ECM Effectiveness
Run Without ECM	21.00	0.00	0%
Run 1…With ECM	3.36	17.64	84%
Run 2…With ECM	2.90	18.09	87%
Run 3…With ECM	1.91	19.30	92%
Run 4…With ECM	3.15	17.85	85%
Average			87%

Overall Mission Effect Analysis

Following table shows the overall mission effect computed on 4 runs

Scenario	Missile launched	Target Miss-Distance (m)	Miss-distance Threshold exceeded?	ECM effective	Mission overall effect
Run 1	Y	197.0	Y	Yes	75%
Run 2	Y	183.0	Y	Yes	
Run 3	N	NA	NA	Yes	
Run 4	Y	7.50	N	No	

Overall Optimal Mission for AShM Protection

Summary and Conclusions

- Illustrated the use of programmable radar emulation for radar modelling in EWOS CM development
- Example of new visual and analysis EWOS tools – integrated displays, SIMDIS, etc
- Provided an alternative method for determining effectiveness of radar countermeasures in a complex scenario
- Further analysis tools are currently being investigated – waterfall displays, 3D plots, enhanced SIMDIS displays and more integrated data collection and analysis programs

Thank You for Your Attention

Questions?

For further information and demonstrations please visit us at Stand A19