A METHOD FOR OPTIMAL SCHEDULING OF ACTIVE ELECTRONICALLY SCANNED ARRAY (AESA) ANTENNAS

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- Active Electronically Scanned Array (AESA) antennas
- Resource Management Problem
- Models
- Resource Management Algorithm
- Simulations
- Conclusion

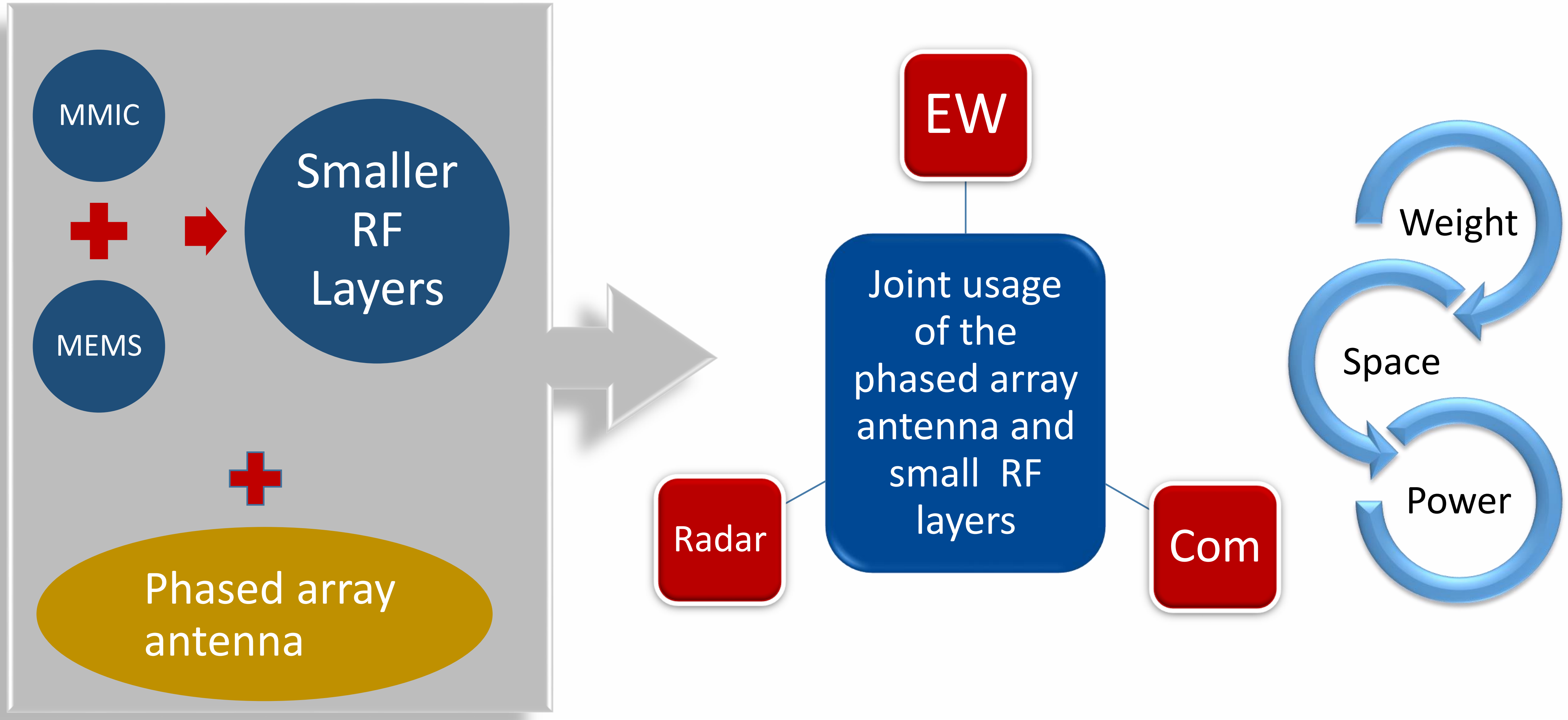
DEFINITION OF THE PROBLEM

Location and Interoperability

Easy to handle on large platforms, like ships, where there exist no tight weight and space limitations

On small platforms, like UAVs and fighters, the problem shall be handled with highest priority

DEFINITION OF THE PROBLEM



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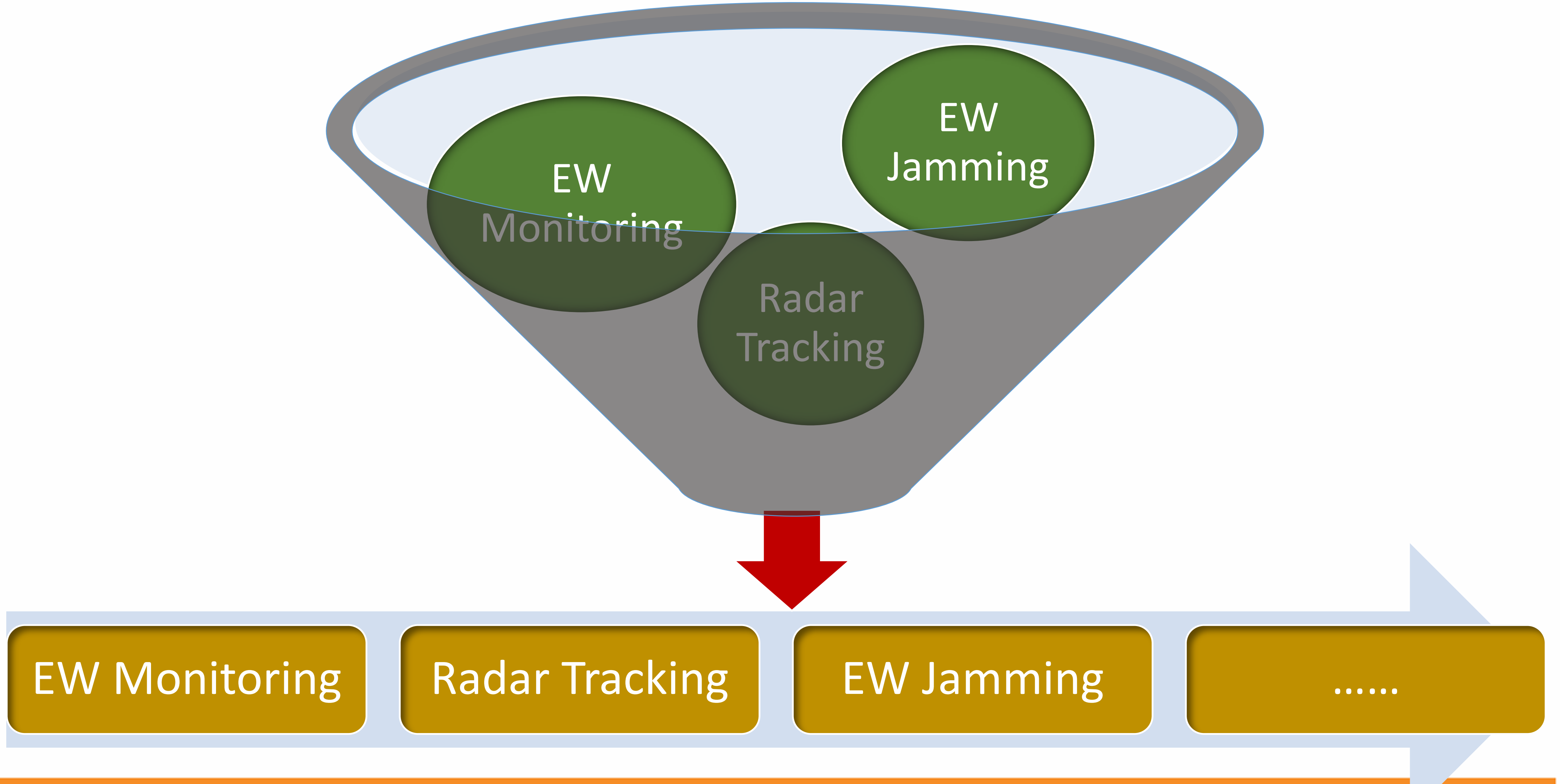

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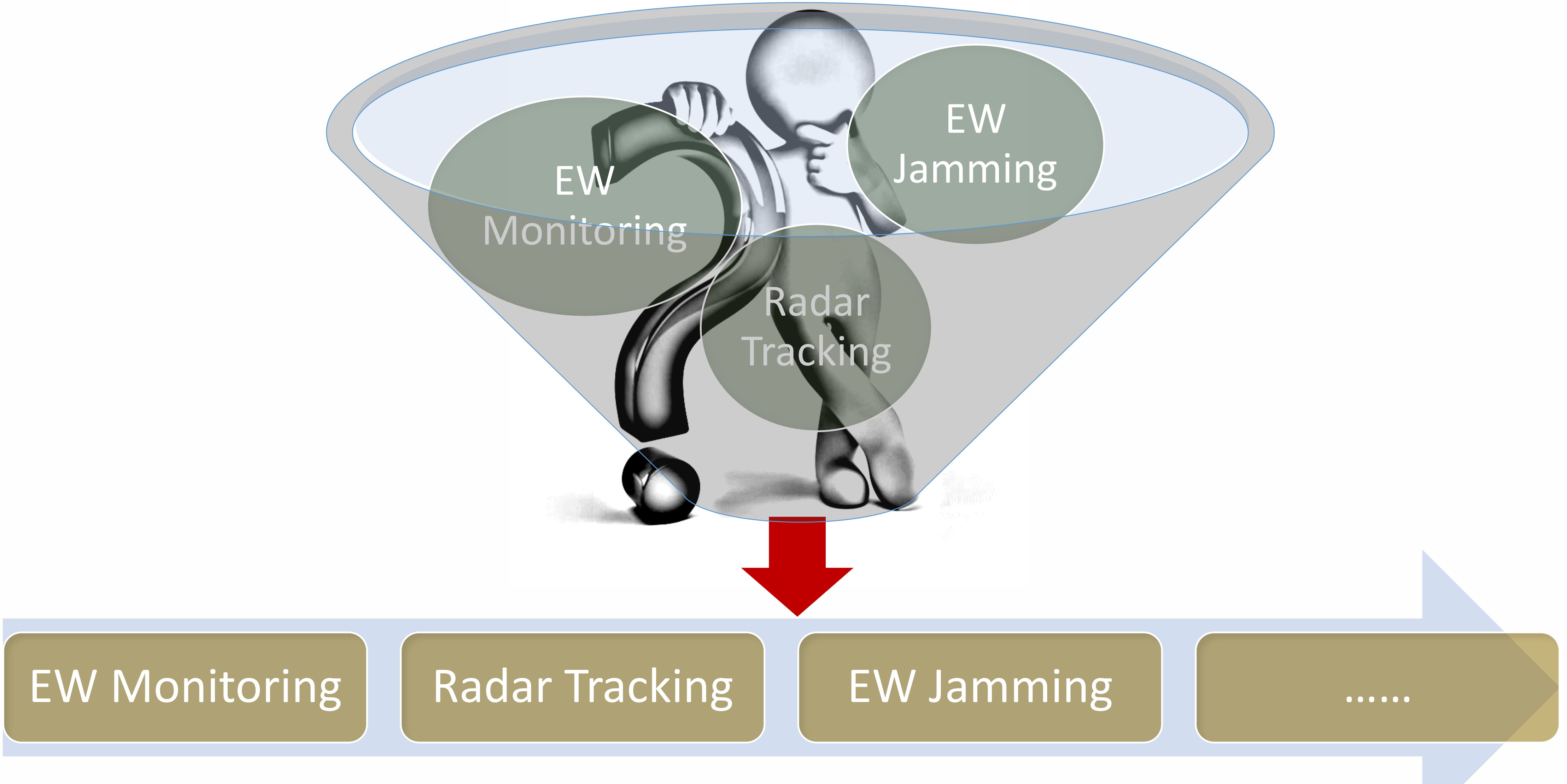

AESA ANTENNAS

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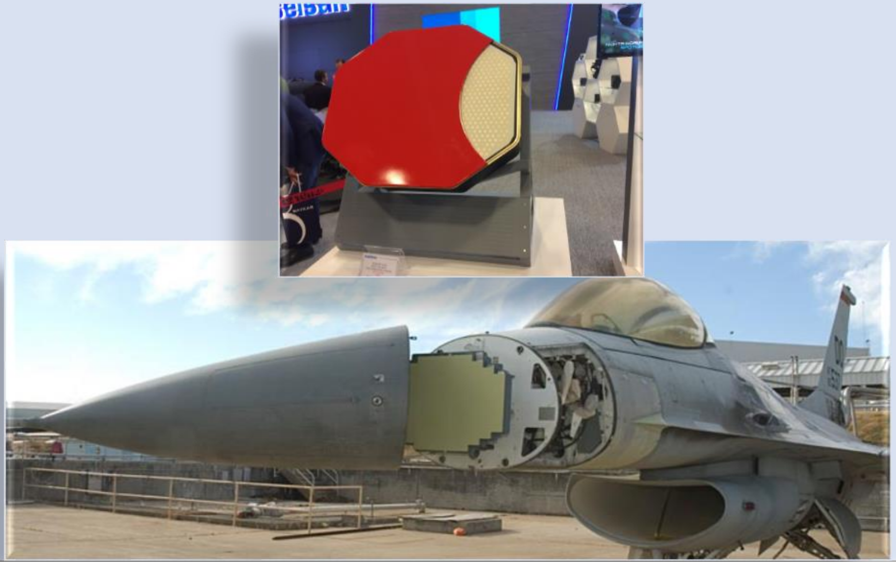
Active phased-array antennas with their high scan rates provide effective

- detection
- tracking opportunities to radars in multi-target environments



Experience gained on multi-function radar studies has opened the road to using a single RF layer and multi-function antenna for all communication, EW and radar payloads

RESOURCE MANAGEMENT PROBLEM

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Multi-dimensional parameter selection problem to determine the parameters that control

- the task revisit interval time
- task dwell duration

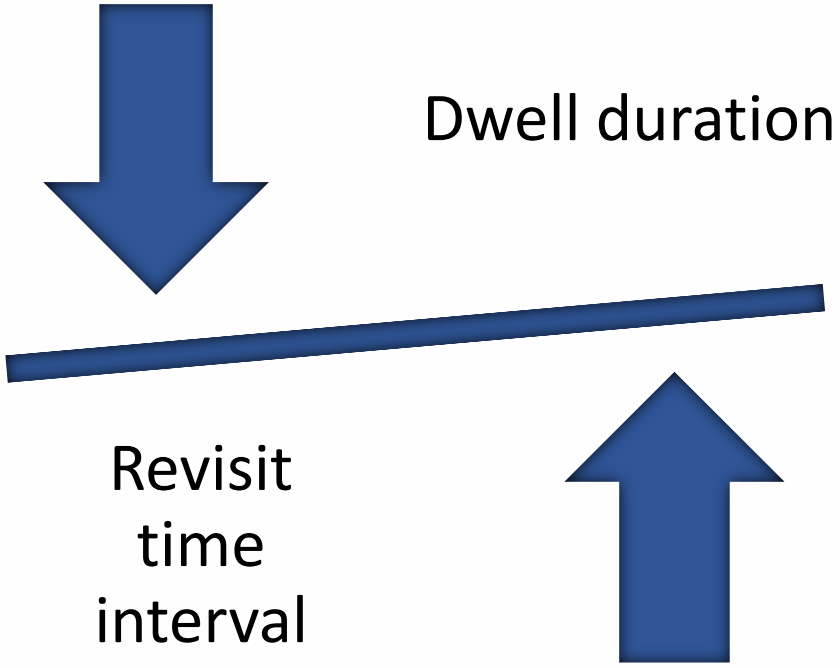
Scheduling of radar functions of multi-functional radars

Optimization of scan regime of EW receivers for the target list

Optimization of antenna beam allocation among the functions of both radar and EW systems

RESOURCE MANAGEMENT PROBLEM

Method for both radar and EW systems use the same AESA antenna infrastructure.



for each function of radar and EW payloads

RESOURCE MANAGEMENT PROBLEM

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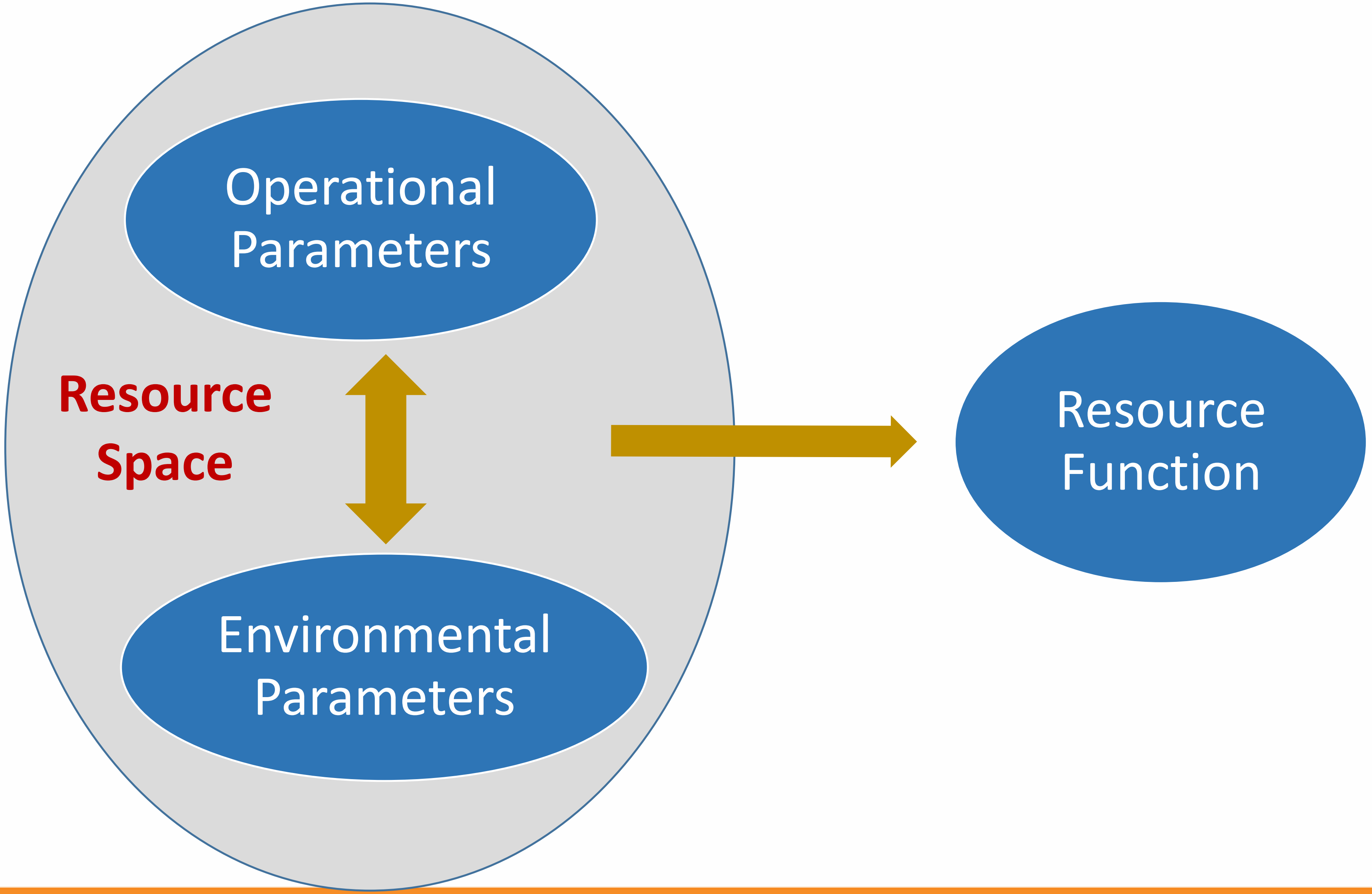

RESOURCE MANAGEMENT PROBLEM

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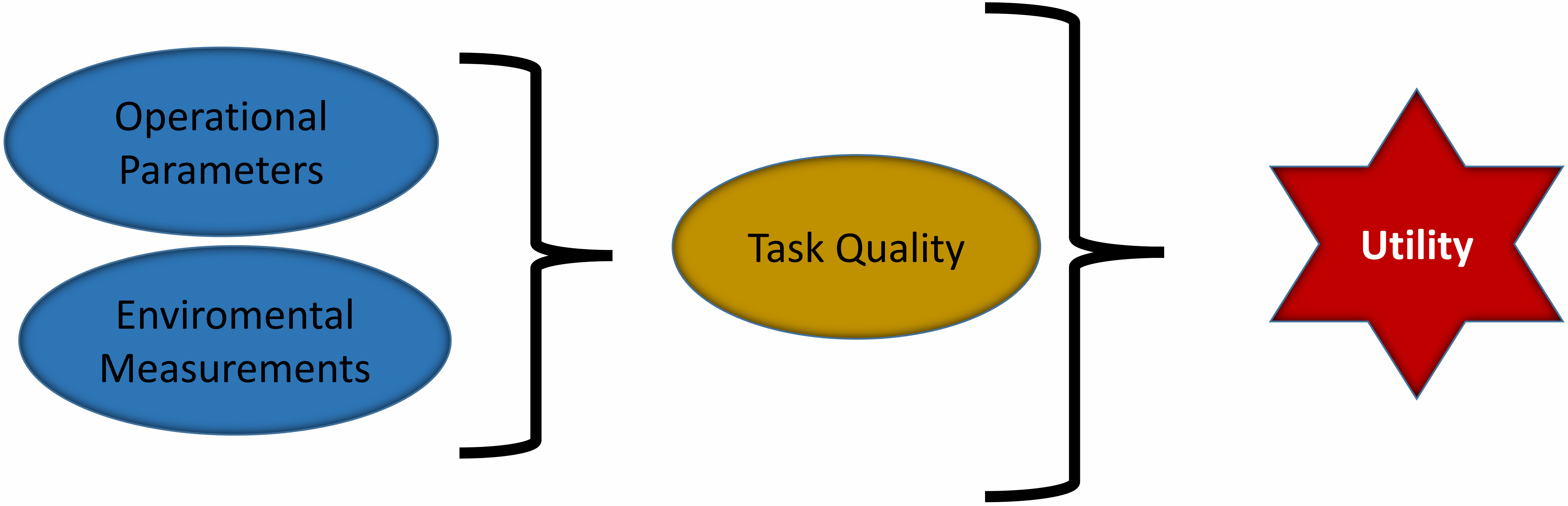

RESOURCE MANAGEMENT PROBLEM

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MAXIMIZE TOTAL UTILITY

WHEN

RESOURCE FUNCTION IS LESS THAN TOTAL AVAILABLE RESOURCE

$$maximise: u(v_t) = \sum_{k=1}^{K} u_k\big(q_k(v_{tk}, e_{tk})\big)$$

$$subject\ to: g(v_t) \leq 0$$

$$where: g(v_t) = \left(\sum_{k=1}^{K} g_k(v_{tk}, e_{tk})\right) - \hat{r}_t$$

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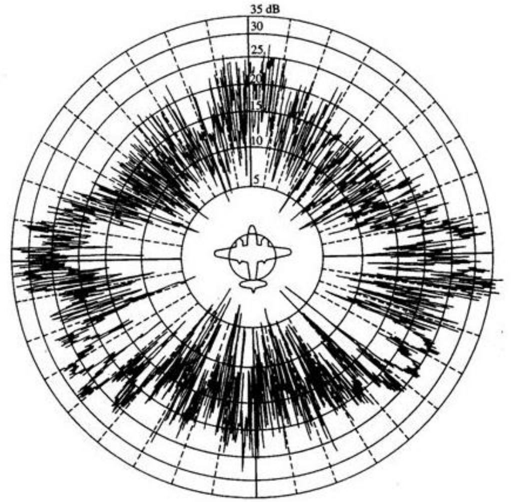
RCS MODEL

RCS of radar targets is modeled using Swerling I Model. In Swerling I Model, RCS is assumed as a Rayleigh distributed random variable which is independent on sequential scans.



RECEIVED POWER

Received power of the radar platform, which is the target of EW system, is calculated using free space loss model.

$$P_R = \frac{P_T G_T A_{eR}}{4\pi r^2}$$

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PLATFORM ACCELERATION MODEL

Platform motion is modeled using Singer Acceleration Model. In this model, acceleration of the platform is modeled by a Markov process.

$$x_{k+1} = \begin{bmatrix} 1 & T & (\theta T - 1 + e^{-\theta T})/\theta^2 \\ 0 & 1 & (1 - e^{-\theta T})/\theta \\ 0 & 0 & e^{-\theta T} \end{bmatrix} x_k + w_k$$

$$Var(w_k) = \Sigma.2\Theta$$

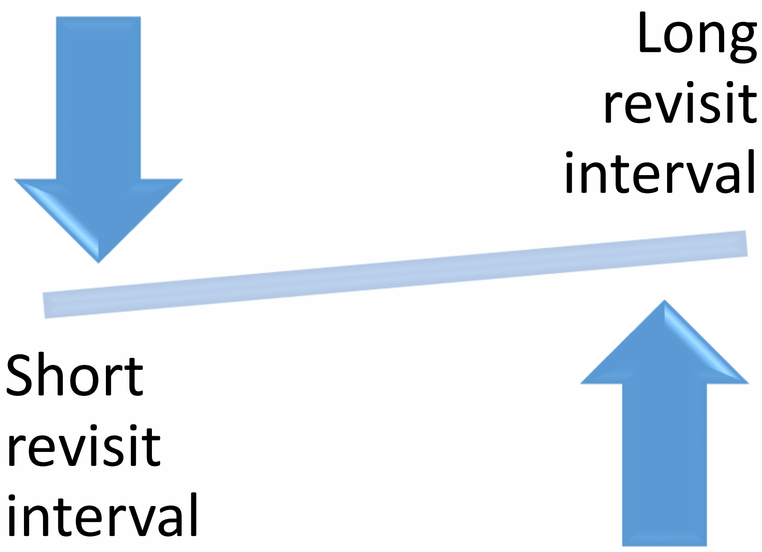
ASSUMPTIONS:

- Multiple targets tracked by AESA have enough distance separation
- Antenna beam is directed to estimated position of the target when the track is updated
- Beam positioning power loss is observed if there exists an offset between the estimated and actual positions of the target
- Power loss is modeled by a Gaussian loss function matched with antenna beam width
- The angular estimation error is equal to a fraction of half beam width
- Fraction of half beam width is called track sharpness

RESOURCE MANAGEMENT ALGORITHM

AIM :

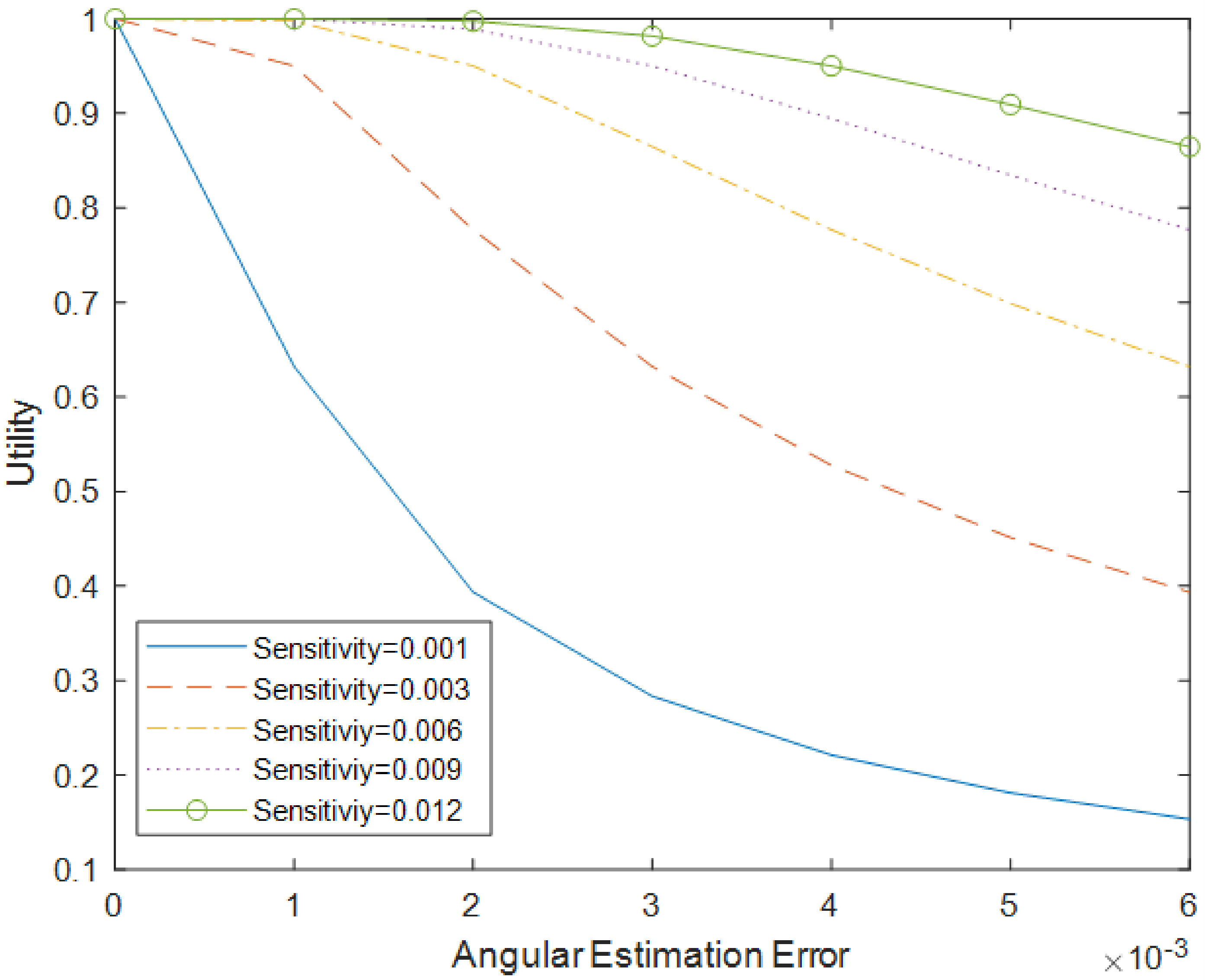
Optimization is required to calculate the most suitable revisit interval to minimize track loading



Minimize track loading

FORMULATION :

- Track sharpness is formulated as function of revisit interval time and dwell duration
- The utility function describes the satisfaction that is associated with the achieved track accuracy
- Utility of each task is formulated as function of track sharpness and sensitivity
- Multiplication of track sharpness and 3dB beam width gives angular estimation error



When EW system's target radar is surface stationary and airborne

Simulations are performed to see the impact of following parameters on the utility of EW task

- EW system's target radar output power
- Sensitivity
- Number of radar tasks

Utility of EW task when target radar output power is medium and target radar platform is surface stationary

	sensitivity=0.001	sensitivity =0.003	sensitivity =0.006	sensitivity =0.009	sensitivity =0.012
N=2	0.66616685048	0.94134631246	0.98096918595	0.99259031501	0.99542914321
N=6	0.66616685048	0.94134631246	0.98096918595	0.99259031501	0.99542914321
N=10	0.63199650171	0.94134631246	0.98096918595	0.99259031501	0.99542914321
N=15	0.52605503343	0.94134631246	0.98096918595	0.99259031501	0.99542914321
N=20	0.52605503343	0.91473866327	0.98096918595	0.99259031501	0.99542914321
N=25	0.52605503343	0.86204778347	0.98096918595	0.99259031501	0.99542914321
N=32	0.38264025015	0.86204778347	0.98096918595	0.99259031501	0.99542914321

SIMULATION

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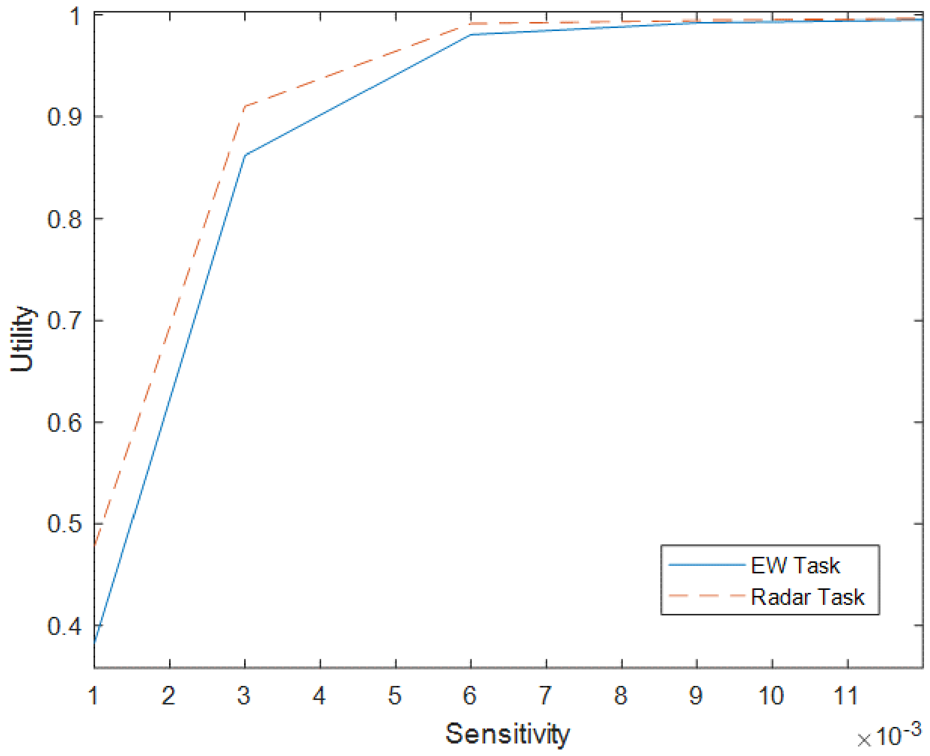
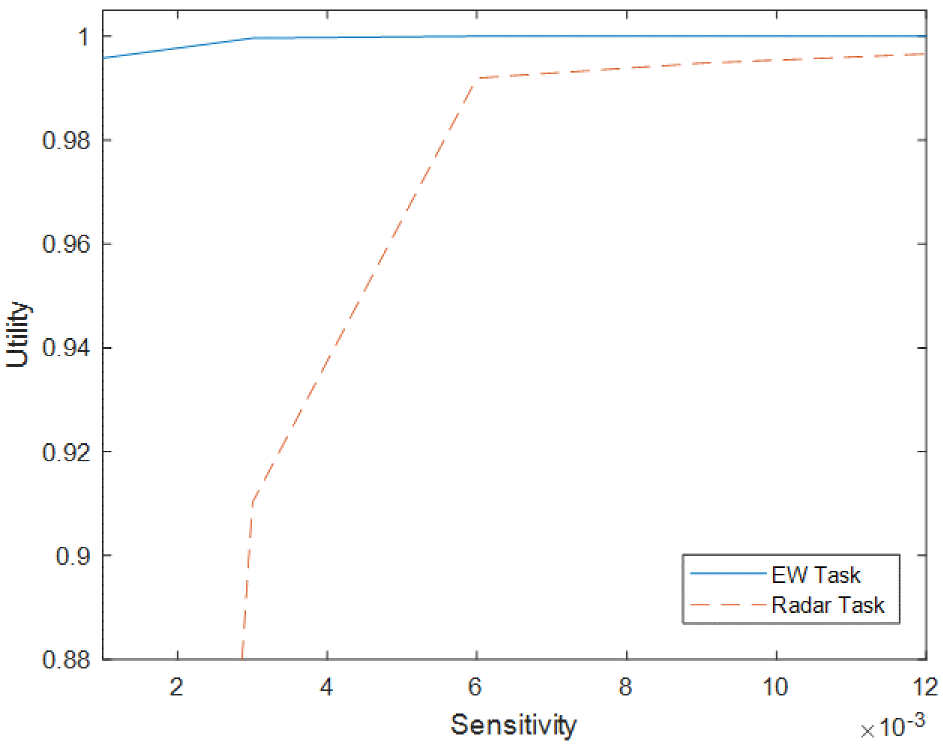
EW task and radar task utilities when target radar platform is stationary



EW task and radar task utilities when target radar platform is airborne



CONCLUSION

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- ✓ A method for optimal scheduling of Active Electronically Scanned Array (AESA) antennas is proposed
- ✓ Resource management algorithm is studied when the resources are utilized by both EW task and radar tasks
- ✓ Analysis has been made for various cases and consistent results are achieved showing that EW task and radar tasks can utilize the same resources
- ✓ Analysis has been made by assuming that target radar’s antenna is stationary and beam is always directed towards AESA
- ✓ For the search radar case this is not a valid assumption and further research can be performed to handle scanning target radar antennas

THANK YOU


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V/UHF Communications Jammer System
HF Communications Jammer System
Naval Platform Electronic Support Systems
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Manpack RCIED Jammer
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