



# Operational Mission Analysis and Simulation using STK

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# Abstract



The capability to model, simulate, and analyze projected operational missions for new and potential weapon systems is critical to selling those systems to customers.

The Satellite Tool Kit suite of software is being used to simulate and analyze both tactical and strategic systems in representative operational environments. Clear three-dimensional visualizations and quantitative analyses allow the demonstration and evaluation of the effectiveness of new systems in achieving mission objectives.

This simulation and analysis capability improves the developer's strength as a system integrator, and facilitates the establishment of system requirements, validation of system designs, and will allow simulated interaction between new or proposed systems and other military assets.



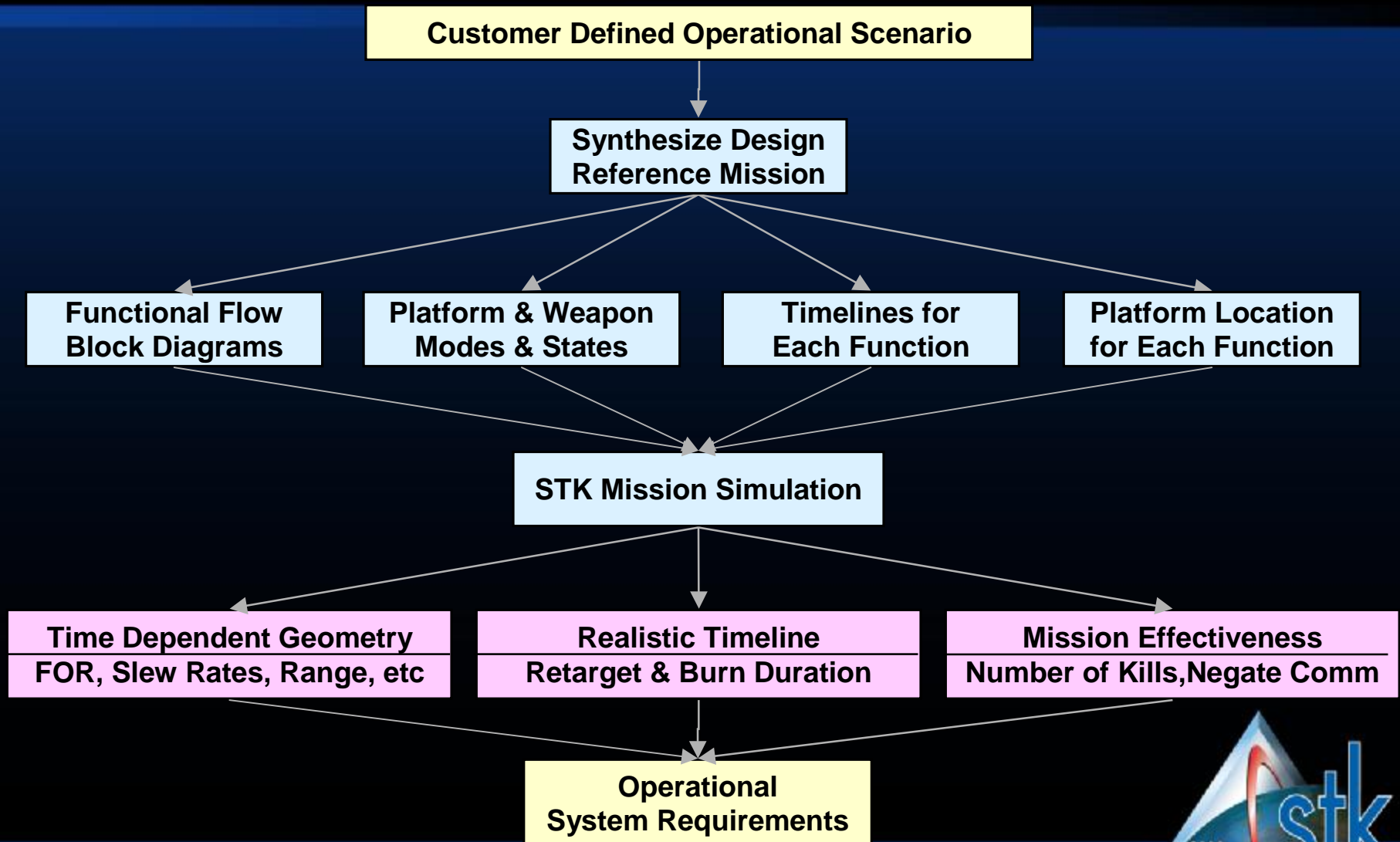
# Role of Operational Mission Analysis & Simulation



- Assess Proposed/Evolving Design
  - Exercise proposed solutions in simulated missions to see how they meet customer defined needs and mission objectives
  - Generate data for system design, mission planning & support planning
- Evaluate Figures of Merit against System Requirements & Mission Objectives
  - Assure requirements flow from customer need & mission objectives
  - Assess mission effectiveness measures & system robustness (flexibility)
- Predict/Validate System Performance
  - Gain better understanding of system operational potential & limits
  - See how well the system performance satisfies system requirements
- Educate Users and Market the System
  - Show stakeholders how the system meets their needs
  - Demo new concepts of operation for entirely new systems
  - Demo system capabilities to potential customers



# Systems Engineering Approach



# Operational Mission Description



Mission: Support Hostage Rescue Operation

## Objectives:

- Prevent Alarm of Assault
- Provide Close Support During Assault, Rescue, Withdrawal
- Minimize Collateral Casualties
- Prevent Egress of Terrorists (escape)
- Prevent Ingress of Reinforcements

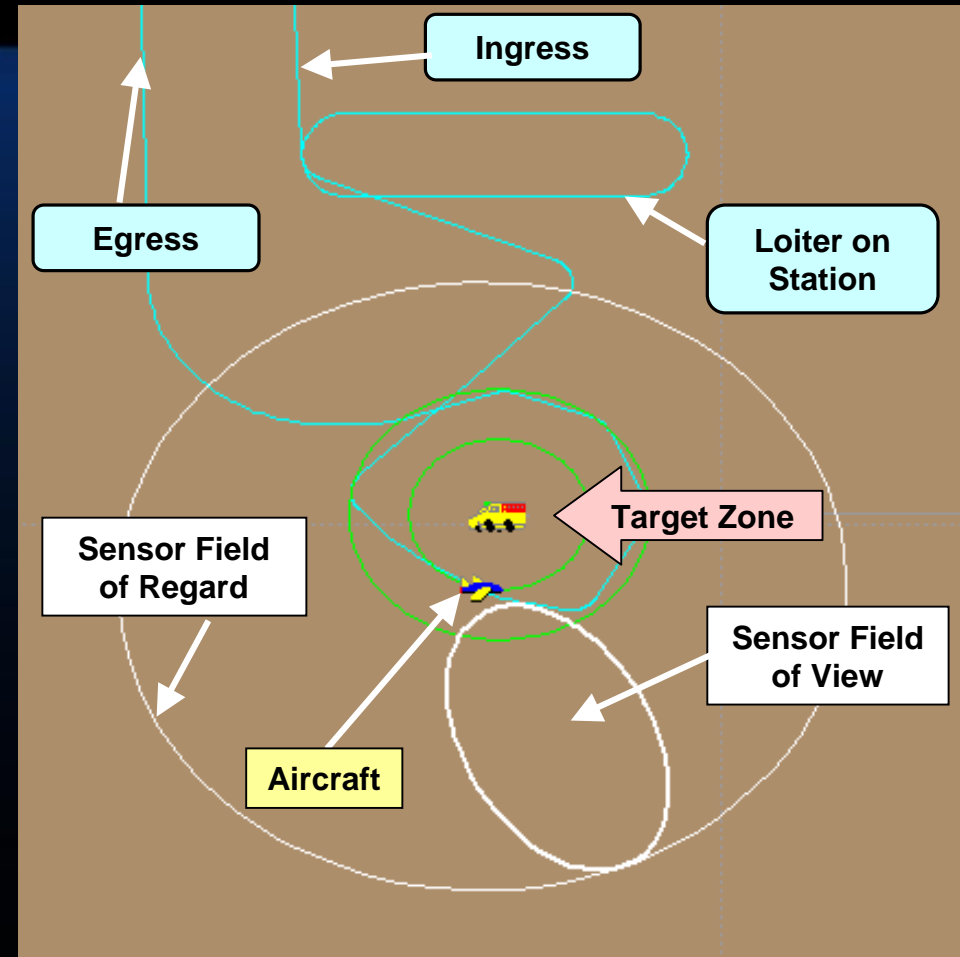
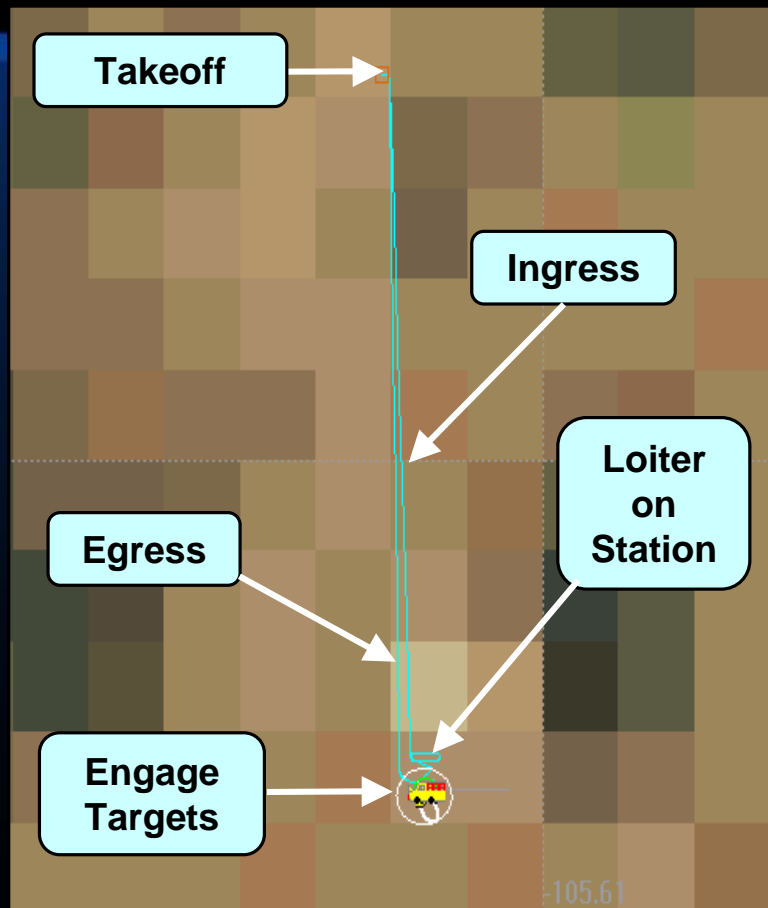
## Approach:

- Safeguard Approach – Disable Air Defense
- Prevent Alarm - Disable Com Links
- Provide Close Support - Create Distractions (fires)
- Prevent Escape - Immobilize Terrorist Vehicles
- Prevent Ingress of Reinforcements - Stop Incoming Terrorist Vehicle

**Assault Timeline Requirements Dictate Laser Engagement Sequence**



# Overall Mission Simulation



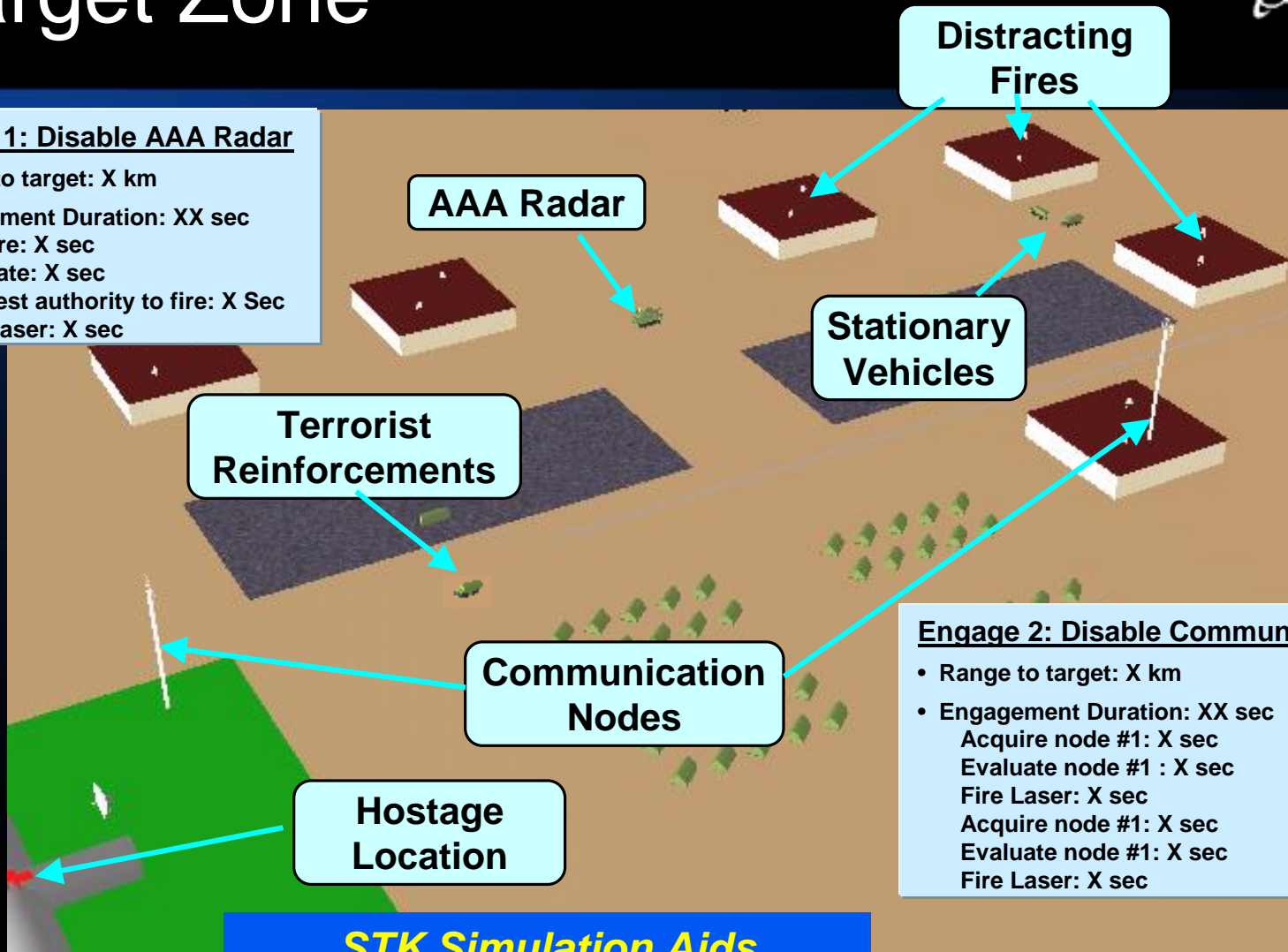
**Satellite Tool Kit (STK)  
Simulates Tactical Battlefield**



# Target Zone

**Engage 1: Disable AAA Radar**

- Range to target: X km
- Engagement Duration: XX sec  
acquire: X sec  
evaluate: X sec  
Request authority to fire: X Sec  
Fire Laser: X sec



**Engage 2: Disable Communications**

- Range to target: X km
- Engagement Duration: XX sec  
Acquire node #1: X sec  
Evaluate node #1 : X sec  
Fire Laser: X sec  
Acquire node #1: X sec  
Evaluate node #1: X sec  
Fire Laser: X sec

**STK Simulation Aids Engagement Planning**

# Animation of Operational Mission



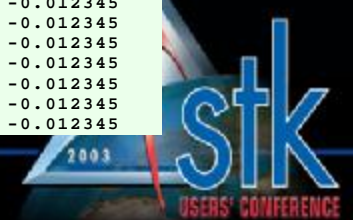
## **Hostage Rescue Mission Animation**



# Simulation Provides Quantitative Engagement Data



Target-CellPhone1-To-Aircraft-C130					
Time (EpSec)	Range Limits (acquisition to lasing)		Min: x.xxx km	Max: xx.xxx km	
2222.00	Slew Rate		Min: x.xxx rad/s	Max: x.xxx rad/s	
2222.00	Min AC-to-Target Elevation		Az: x.xxx°	El: x.xxx°	
2222.00	Max AC-to-Target Elevation		Az: x.xxx°	El: x.xxx°	
2222.00	Sensor Field Of Regard		Az: xxxx°	El: xx° to xx°	
2222.00	Time to Engage Comm Nodes		xx sec. (initial acquisition thru lasing)		
2222.00	Time to Engage AAA Radar		xx sec. (initial acquisition thru lasing)		
2222.00	Time for Close Air Support		xx sec.		
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
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2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345
2222.00	0.001234	0.001234	0.001234	0.001234	-0.012345



# Simulation Addressed Operational Issues



- STK Simulation Allowed Rapid Definition of Engagement Geometry & Timing
  - Impact of target range, airspeed, banking angle on sensor FOR
    - Example - Initial proposed engagement pattern put targets outside sensor Field Of Regard
  - Impact of different sensor and laser mounting locations & sensor rotation rate on engagement windows & mission effectiveness
- Computer Simulations Validate System Performance
  - Mission Effectiveness - How Many Kills? Do Kills Occur On-Time? Able to Prevent Alarm? Provide Enough Close Air Support?
  - Robustness - Variations in Aircraft/Weapon Design, Variations in Weather, Variations In Threat Response

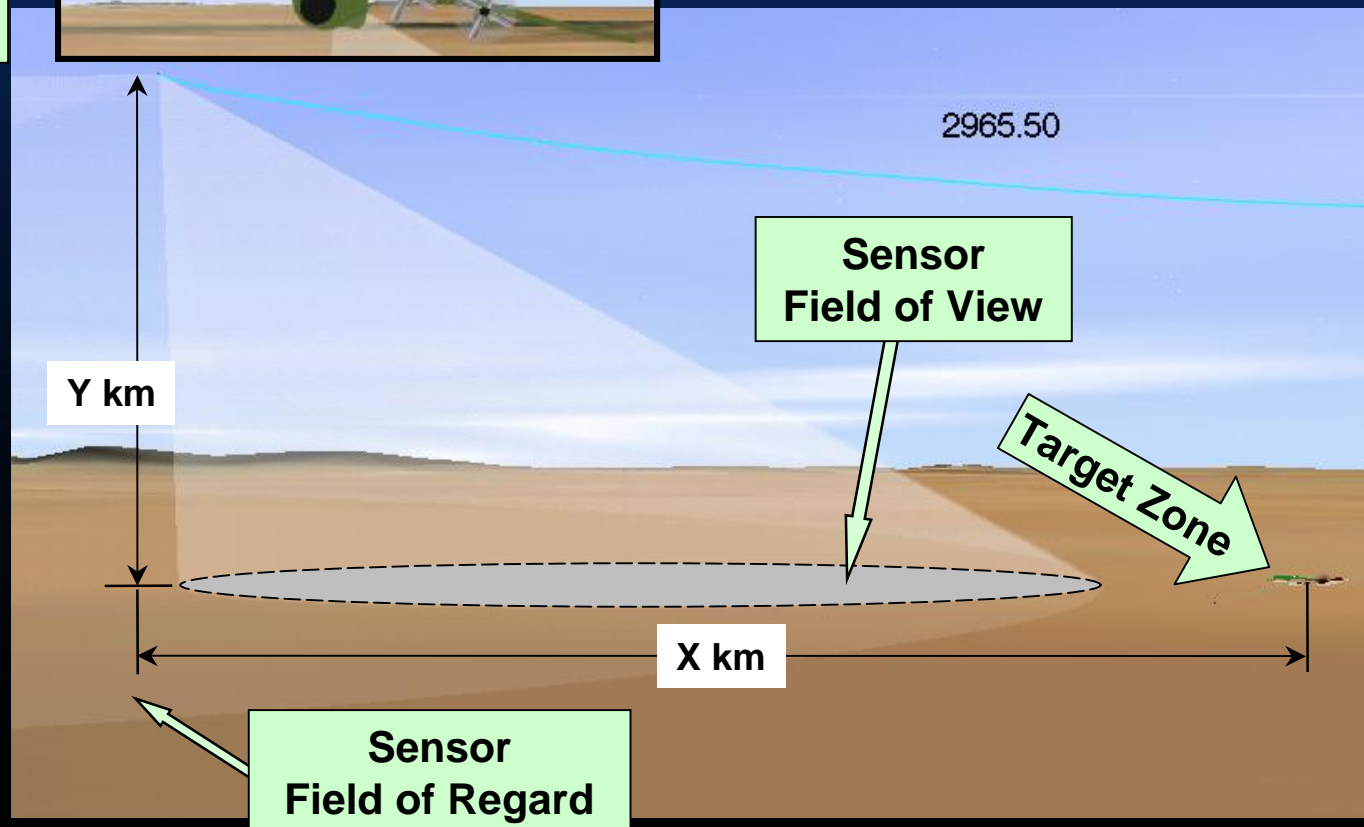


# Impact of Platform Banking on FOR

Aircraft  
 $XX^\circ$   
bank



*STK Provides True-to-Scale  
Engagement Geometry*



# Constant Bank Engagement Problem



Initial engagement scenario put targets outside sensor field of regard at specified engagement range



Remodeled engagement geometry provides better target windows



# Summary



- Developed Design Reference Mission for Potential Operational System
  - Functional Flow Block Diagrams
  - Modes & States for Aircraft Platform & HEL Weapon
  - Mission Timeline & Engagement Geometry
  - STK Simulation & Animation
    - Quick turn around: study & simulation < 1 month
- Simulation Provided Key System Design and Mission Planning Data
  - Predict & Validate System Performance
    - Exercise evolving system in intended environment to assess how well system requirements and mission goals are met
    - Rapidly assess impact of changes in sensor and weapon mounting locations on mission effectiveness
  - Generate Realistic Mission Requirements & ConOps
    - More realistic mission timeline and engagement geometries
  - Provide Flexibility & Growth for Changing Customer Missions
    - More “what-if” mission gaming while design is still fluid
    - Assess cost of system redesign for expanded mission roles



# Bibliography



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# Questions & Answers