This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2020-6670C

United States
Department of Energy
National Nuclear Security Administration

International Nuclear Security

Counter-Unmanned Aircraft Systems (CUAS) Security Performance Metrics and Requirements

INS
International Nuclear Sec
Reducing Risk of Nuclear Terr

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OUTLINE

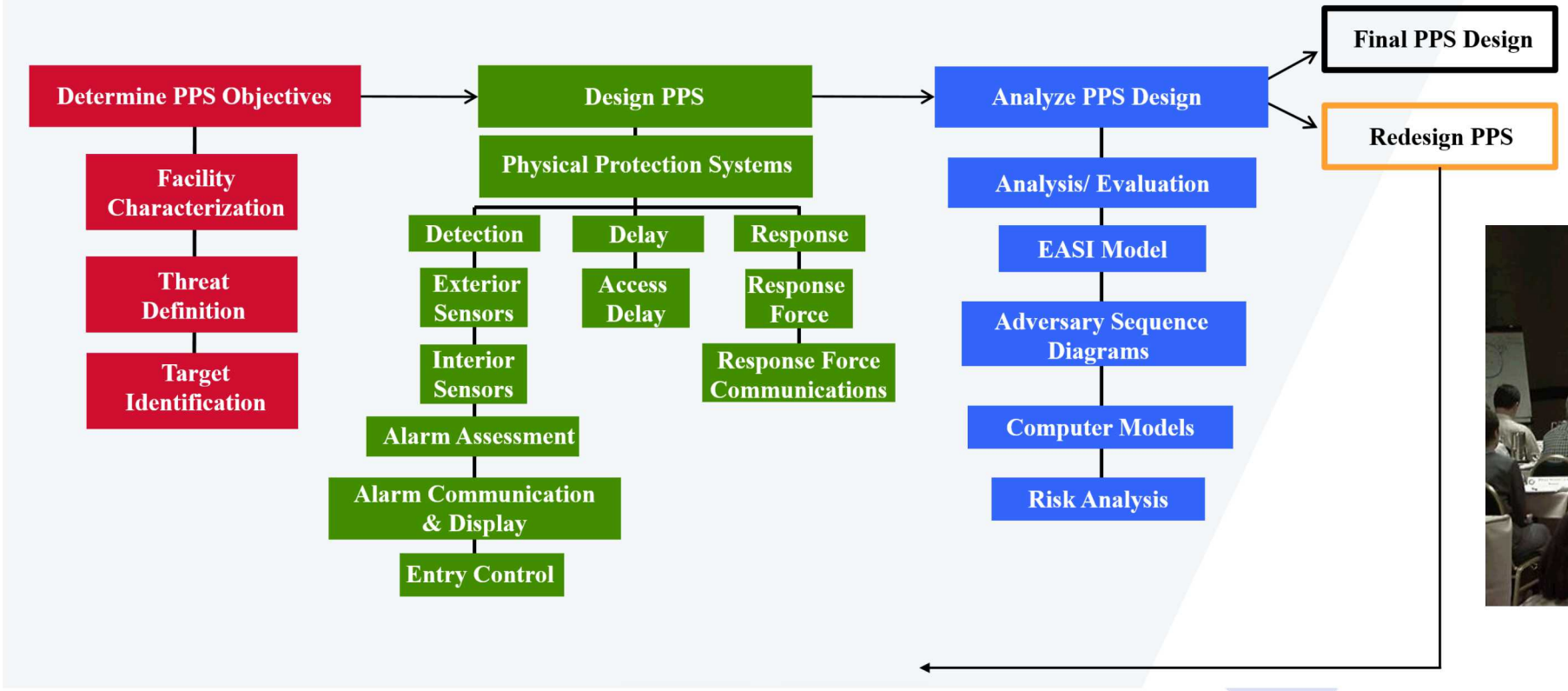
- Sandia's Mission and Background in Physical Security
- Design Evaluation Process Outline (DEPO)
- CUAS Requirements
- Security Performance Metrics – Performance Based
- Analysis of Ability to Meet Requirements

SANDIA'S MISSION AND BACKGROUND IN PHYSICAL SECURITY

Provide physical security system designs and technologies for the protection of nuclear weapons, material, and other high consequence assets.

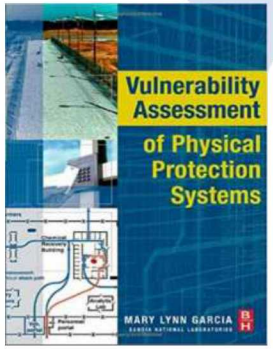
- 50+ years of Department of Defense and Department of Energy support
- Over 1 Billion executed for DOE and DoD over the last decade

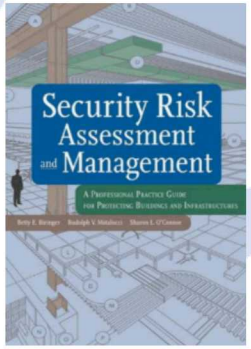
DESIGN AND EVALUATION PROCESS OUTLINE (DEPO)

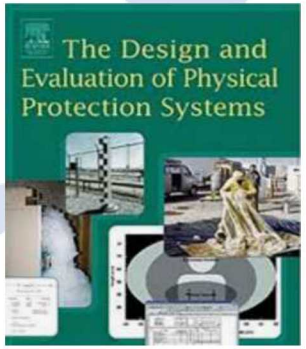


PPS = Physical Protection System

CUAS design process, will follow the same methodology used for Physical Security.





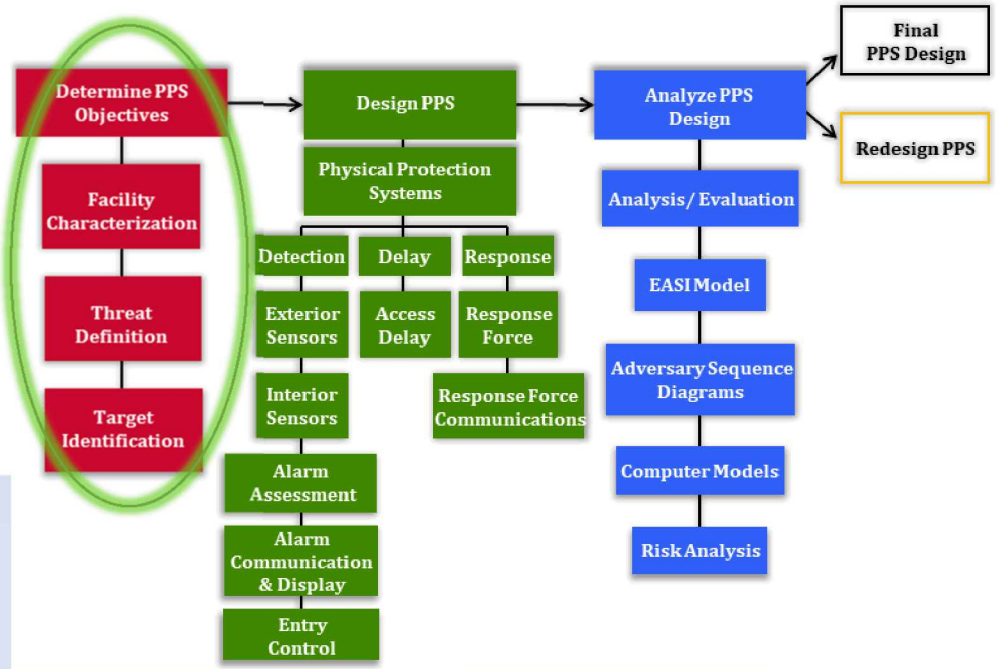


ESTABLISH SECURITY REQUIREMENTS

QUESTIONS, QUESTIONS, QUESTIONS

What are you trying to protect?

- Facility?
- People?
- Mission?
- Materials?
- Reputation/Image?



ESTABLISH SECURITY REQUIREMENTS

QUESTIONS, QUESTIONS, QUESTIONS

What is the threat?

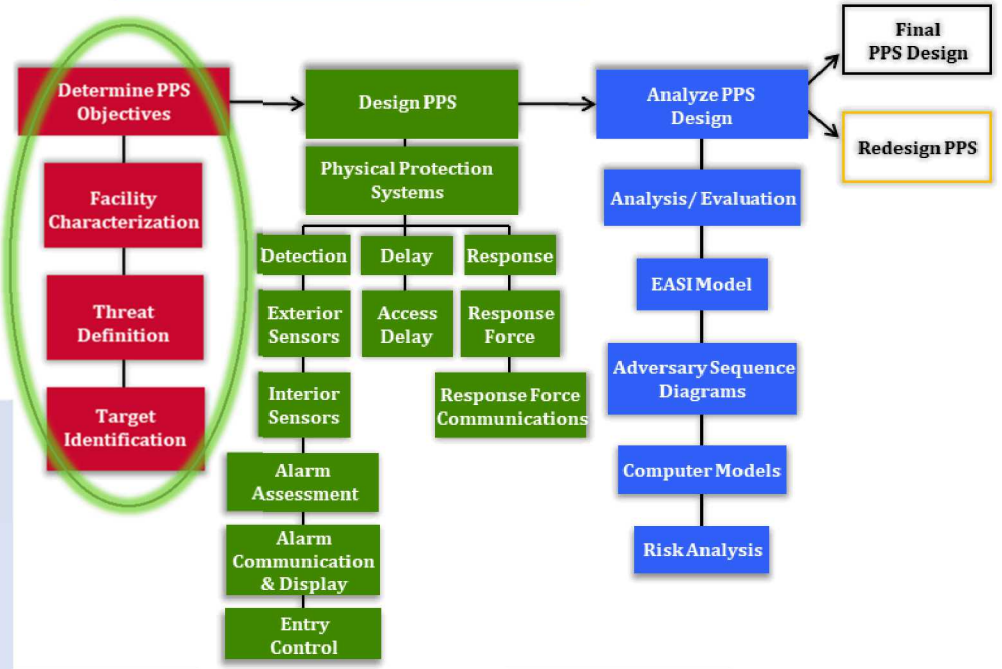
Unmanned Aerial System (UAS)

- What types?
- How big?
- How fast?
- How high/low?
- How many?
- Type of navigation?

What can they do/carry?

- Imagers
- Explosives
- Chem/Bio
- People?

Photo: UlrichHeither https://creativecommons.org/licenses/by-sa/3.0/legalcode

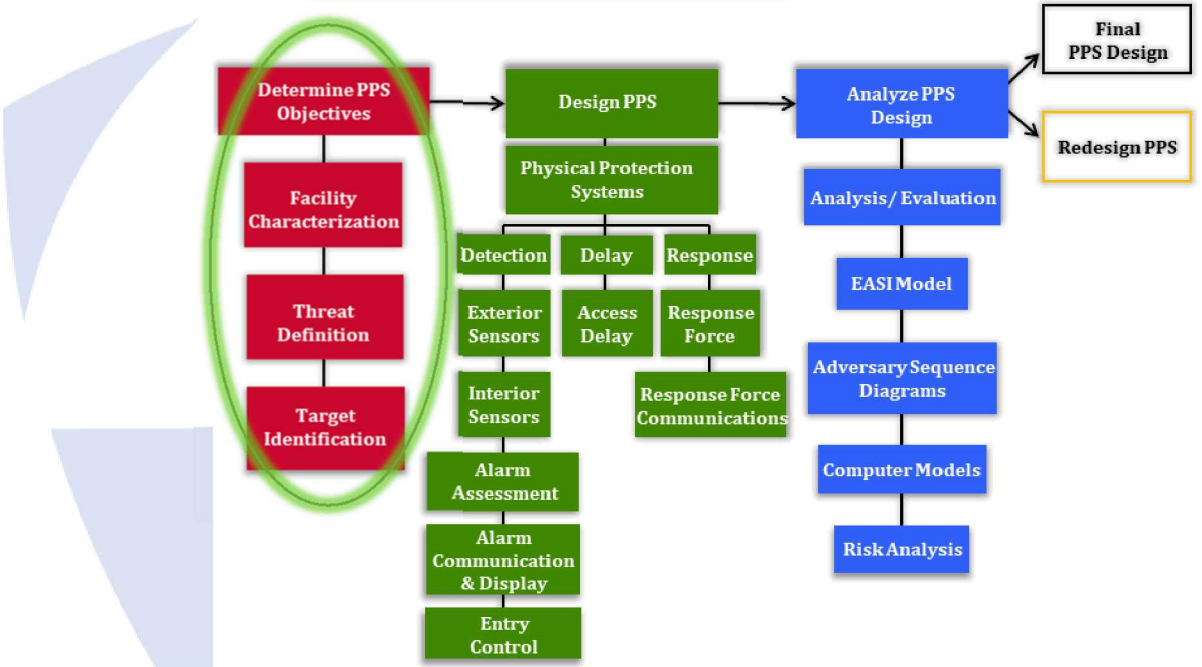


ESTABLISH SECURITY REQUIREMENTS

QUESTIONS, QUESTIONS, QUESTIONS

What are the physics-based constraints?

- Line of Sight – Terrain/Buildings/Foliage
- Sensor Phenomenology
- Assessment Phenomenology
- Neutralization Phenomenology
- Environmental –
  Weather (fog/snow), Wildlife, RF Environment

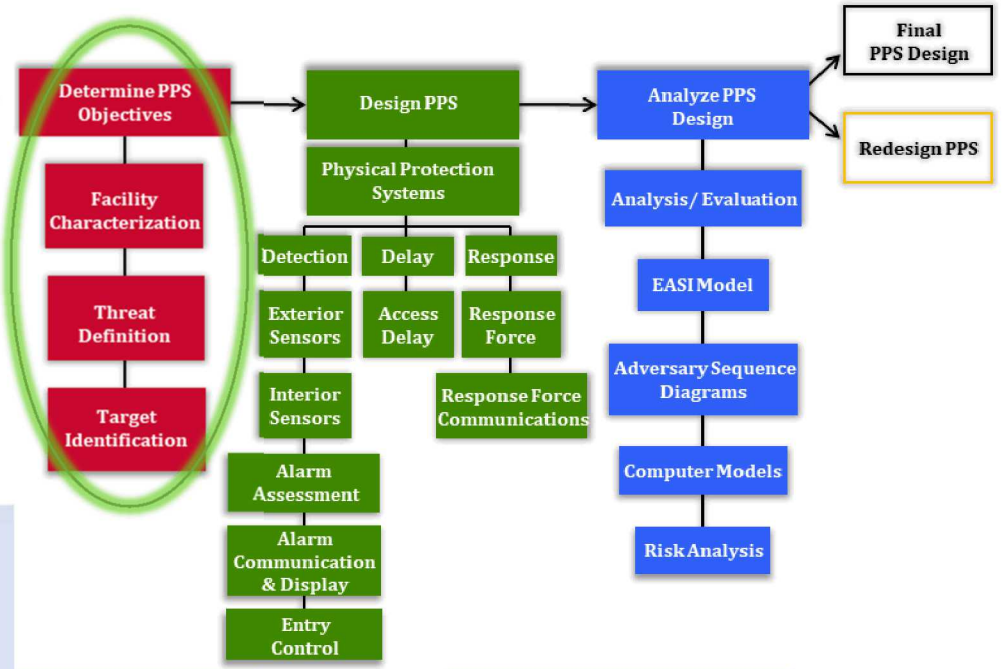


ESTABLISH SECURITY REQUIREMENTS

QUESTIONS, QUESTIONS

What are the non-physics based constraints?

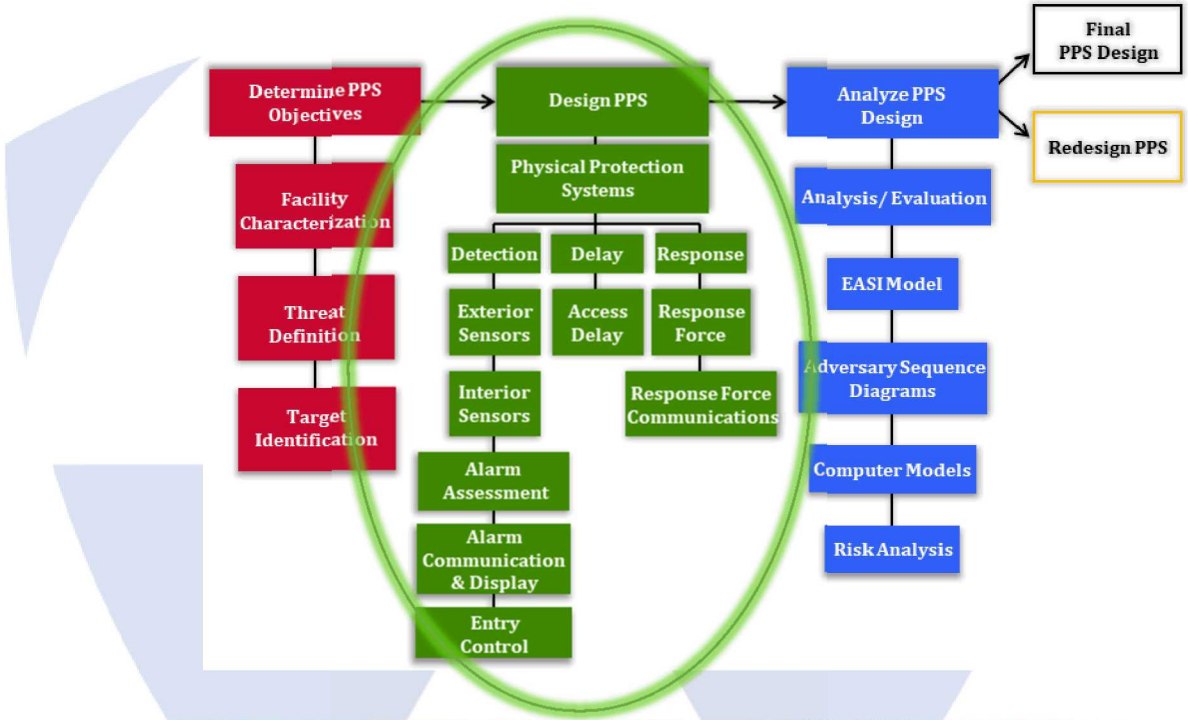
- Policy/Legal – when/where are you allowed to neutralize a UAS?
- What kind of legal risk (liability) are you willing to accept?
- What kind of security risks are you willing to accept?
  - Loss of life
  - Loss of mission
  - Loss of materials
- What consequences are you willing to accept?
- Technology Maturity
- Cost / Resources



CUAS KEY PERFORMANCE METRICS

TEST RESULTS USED TO DESIGN THE SYSTEM

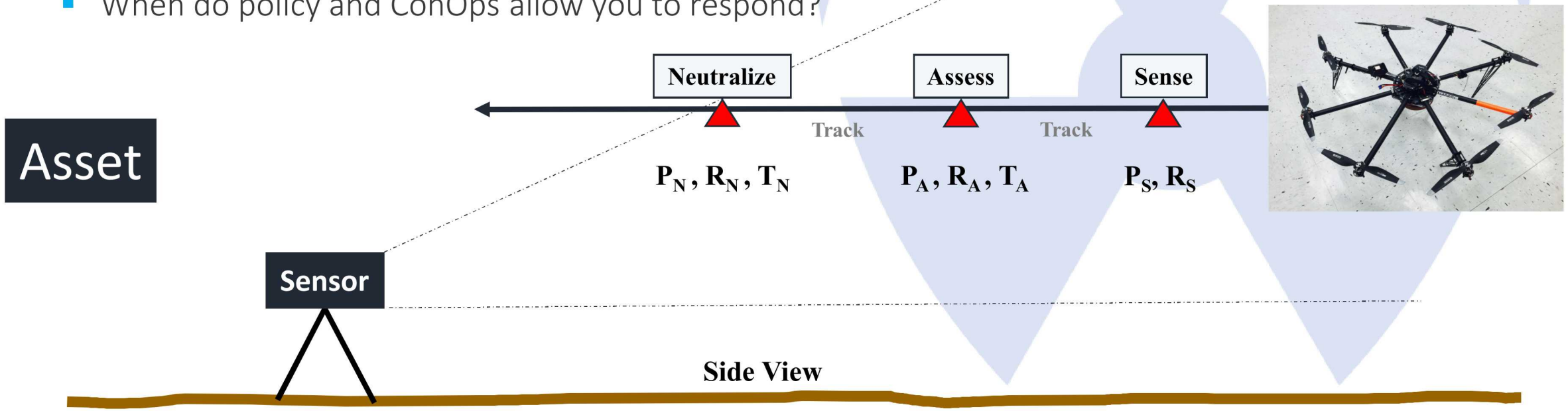
- Sensing a Potential Intruder/UAV
  - Sensing Range (R_S)
  - Probability of Sense (P_S)
  - Nuisance Alarm Rate (NAR)
- Assessing Cause of Alarm
  - Assessment Range (R_A)
  - Assessment Time -- (T_A)
  - Probability of Assessment (P_A)
- Neutralizing Intruder
  - Neutralization Range (R_N)
  - Neutralization Time (T_N)
  - Probability of Neutralization (P_N)



Very similar to metrics used for Perimeter Security and Extended Detection

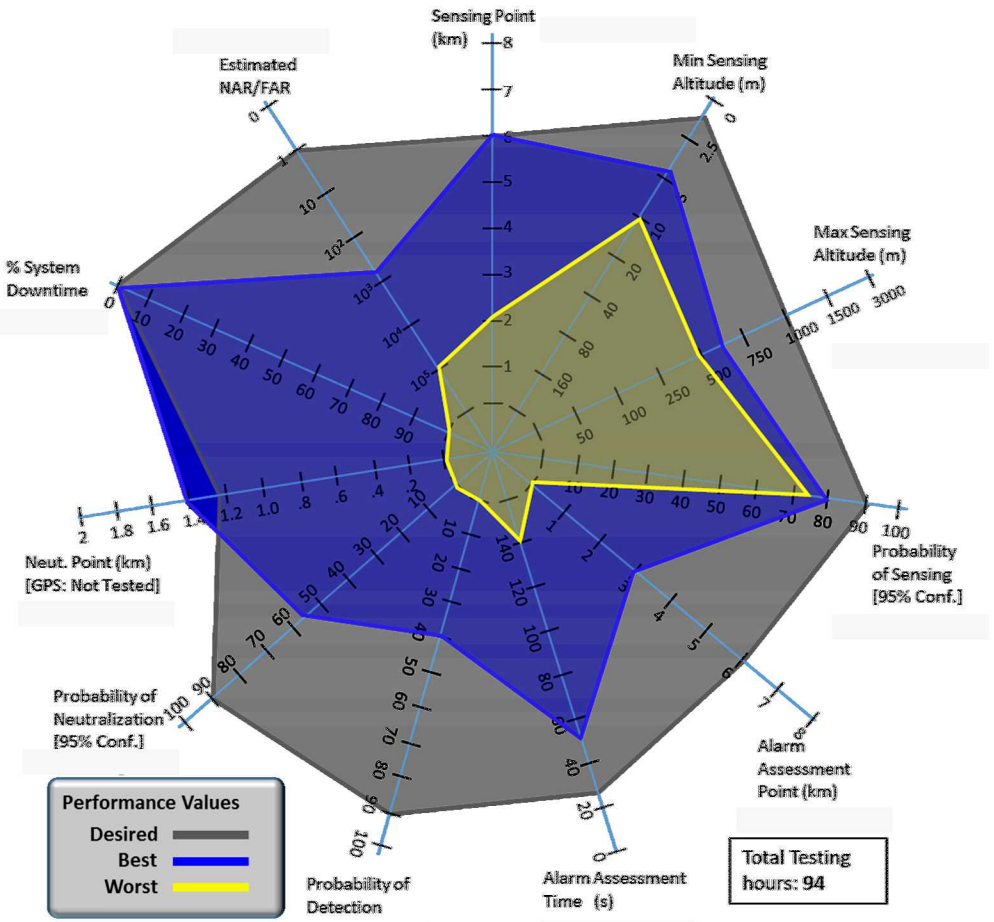
NOTIONAL EXAMPLE OF CUAS SCENARIO AND TEST METRICS

- Is this *far enough*?
- Is the CUAS *fast enough*?
- When do policy and ConOps allow you to respond?

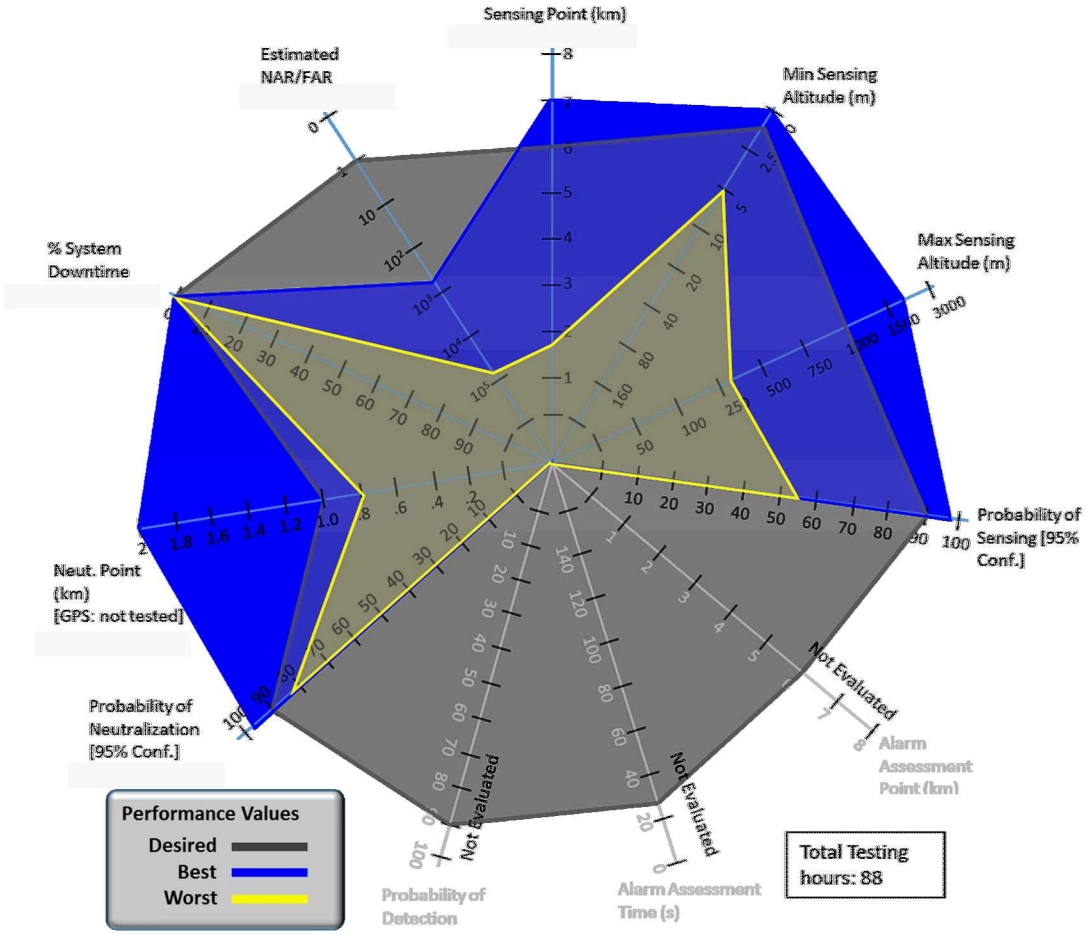


HYPOTHETICAL EXAMPLE – COMPARISON ACROSS TECHNOLOGIES

CUAS #1:



CUAS #2:



CUAS SECURITY EFFECTIVENESS

HYPOTHETICAL EXAMPLE

Probability of Detection (P_D)

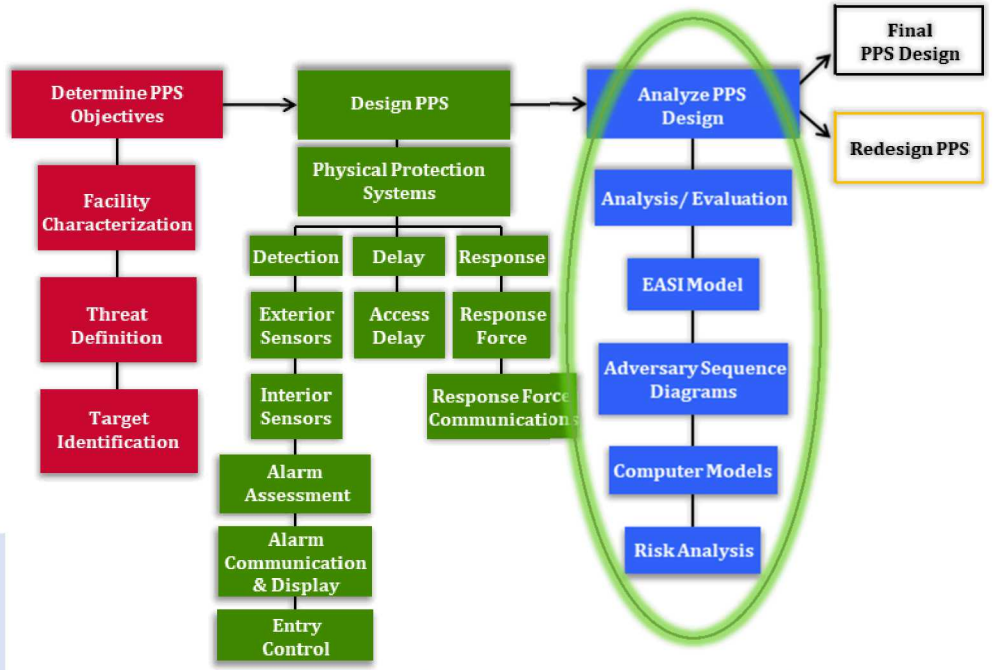
$P_D \cong P_S * P_A$

Security Systems Effectiveness (P_e)

$P_e \cong P_D * P_N$

Results from test data

- P_S = 0.9 at a range of 1000m: threat, daylight, good weather
- P_A = 0.8 at a range of 500m: threat, daylight, good weather
- P_N = 0.9 at a range of 300m: threat, daylight, good weather
  T_N = 60 seconds



$P_D \cong (0.9)(0.8) \cong 0.7$

$P_e \cong (0.7)(0.9) \cong 0.6$

60% probability of neutralizing the threat at 300 m,
It took 60 seconds to mitigate 1 UAS
how resilient is your design?

Is this good enough?

INTERNATIONAL NUCLEAR SECURITY CUAS PROGRAM

within the NNSA INS program

- Focus on technical engagements and outreach to address:
  - Needs across partner countries
  - Future scope
  - Materials / resources
- Develop content to support partner engagements
- Provide subject-matter experts to support growing program

INS
International Nuclear Security
Reducing Risk of Nuclear Terrorism

NNSA
National Nuclear Security Administration

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QUESTIONS?