GLOBAL PERSISTENT ATTACK
ARCHITECTURE, PROCESS,
AND RISK ANALYSIS

This Briefing is: UNCLASSIFIED
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Shape the future of systems engineering in the AF and DoD to improve our ability to deliver war-fighting capabilities. We will accomplish this by conceptualizing new processes, practices, tools, and resources for the systems engineering workforce through research, education, and consultation.
GRP Methodology

1) Strategy and Doctrine Review
   GPA CONOPS
   • Determine operational activities & relationships

2) Develop Architecture Products
   OV-2
   • Identify critical nodes and info exchanges
   OV-5
   • Resolve activities & interactions
   PSM
   • Present logic and sequence

3) Execute Risk Analysis
   1) Develop component PDF
   2) Create overall probability function
   3) Run Monte Carlo simulation
   4) Evaluate results

Apply Constraints
Strategy and Doctrine Review

GPA CONOPS

Strategy and Doctrine Review

GPA-BA-1.0 Command and Control

MCL-2.0-Joint Command and Control

GPA-BA-2.0 Intelligence

MCL-1.0-Battlespace Awareness

GPA-BA-3.0 Surveillance and Reconnaissance

MCL-1.0-Battlespace Awareness

Battlespace Awareness Dominance (GPA)
Operational Activity Hierarchy

Battlespace Awareness Dominance

Information / Cyberspace Dominance

Air & Space Dominance

Surface Dominance

Enabling Capabilities

1) Strategy and Doctrine Review
   - Determine operational activities & relationships
   - Apply Constraints

2) Develop Architecture Products
   - Identify critical nodes and info exchanges
   - OV-5
   - Solve activities & interactions
   - PSM
   - Present logic and sequence

3) Execute Risk Analysis
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   - Run Monte Carlo Simulation
   - Evaluate results

4) Develop GPA CONOPS
   - Interact with other branches and agencies
   - Engage MOCs
   - Use MFs
GPA A0 Diagram
(OV-5)
Battlespace Awareness

Command and Control
Command and Control JFC

Intelligence
Joint Pub 2-01

Surveillance and Reconnaissance
AF C4ISR CONOPS

Provides Traceability from Strategic Concepts to Architectural Products
Methodology - PSM

- Apply Sequencing Logic for Risk Quantification
- Based on “Global Power” PSM
  - Uses F2T2EA Framework
  - Adaptable!
**OV-5 to PSM Mapping**

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**Detailed binary accounting of OV-5 operational activities mapped to**

- Find, Fix, Track, Target Engage, Assess (F2T2EA) process sequence model developed and available by request.

**Result:** Requirements Traceability!
What needs to happen is mapped to when and how it will happen.
PDF Development

- **P(s) PDF** – Probability of successfully completing activity
- Based upon available data, SME input, and/or modeling and simulation results
- Reflects both capability and sufficiency
- Research used Triangular PDFs

一件事情的PDF，即完成活动的概率

**Triangular Distribution:**
- Minimum: 0.99
- Likeliest: 0.995
- Maximum: 1.00
PSM Structure Function

Methodology - PSM

GPA P(s) = P.01

Plan

Is BA Adequate?

Find

Fix

Track

Generate Mission

D.08

D.17

P.03

P.04

P.05

P.06

P.07

P.08

P.09

D.07

Additional Assessment Required?

Assess

Engage

Deliver

Target

Battlespace Awareness

Force Application

Information Dominance

Enabling

Is Track Required?

End

Generate Mission

True

False

P.01

P.02

P.03

P.04

P.05

P.06

P.07

P.08

Target

P.06

P.07

P.08

D.07

Assess

Engage

Deliver

False

P.09

Assess

Engage

Deliver

True

GPA P(s) = P.01

Plan

Is BA Adequate?

Find

Fix

Track

Generate Mission

D.08

D.17

P.03

P.04

P.05

P.06

P.07

P.08

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D.07

Additional Assessment Required?

Assess

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Battlespace Awareness

Force Application

Information Dominance

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Is Track Required?

End

Generate Mission

True

False

P.01

P.02

P.03

P.04

P.05

P.06

P.07

P.08

Target

P.06

P.07

P.08

D.07

Assess

Engage

Deliver

False

P.09

Assess

Engage

Deliver

True
Methodology - PSM

PSM Structure Function

First Section

D2.01
P2.01
P2.02

D2.06
P2.06
P2.05

D2.01 = True then
P1.02 first section = P2.05 P2.05a

D2.01 = False then
P1.02 first section = P2.02 P2.03 P2.04 P2.05 P2.05a

Second Section

If D2.06 = True then
P1.02 first section = P2.06 P2.05a

If D2.06 = False then
P1.02 first section = P2.02 P2.03 P2.04 P2.05 P2.05a

Methodology - PSM

PSM Structure Function

1) Strategy and Doctrine Review
   GPA
   CONOPS
   • Determine
   • Determine
   operational
   activities &
   relationships

2) Develop Architecture
   OV-5
   • Identify
   critical
   nodes &
   info
   exchanges
   • Resolve activities &
   interactions
   PSM
   • Present
   logic &
   sequence

3) Execute Risk Analysis
   1) Develop component PDF
   2) Create overall probability function
   3) Run Monte Carlo simulation
   4) Evaluate results

Deliver

Assess

Evaluate

Enabling

Information Dominance

1.02 Generate the Mission

First Section

1.02 Generate the Mission

Second Section

Fix

Track

If D2.06 = True then
P1.02 first section = P2.06 P2.05a

If D2.06 = False then
P1.02 first section = P2.02 P2.03 P2.04 P2.05 P2.05a
Analysis & Results

Fiscally Constrained Force Assumptions

- Slipping C2ISR Modernization Program
- Closing F-22 Line After Lot 9
- Cutting or Slipping F-35 Program
- Cutting or Slipping New Tanker Development
- Failing to Develop New Long Range Bomber

Assumptions for Proof of Concept Only
Analysis & Results

C2ISR Affected Nodes

Plan Generate Mission Find Fix Track

Target Engage Deliver

Battlespace Awareness
Force Application
Information Dominance
Enabling
Analysis & Results

F-22 Affected Nodes

1) Develop component PDF
2) Create overall probability function
3) Run Monte Carlo simulation
4) Evaluate results

OV-2
• Identify critical nodes and info exchanges

OV-5
• Resolve activities & interactions

PSM
• Present logic and sequence

1) Strategy and Doctrine Review
   GPA
   CONOPS
• Determine operational activities & relationships

Apply Constraints
Analysis & Results

F-35 Affected Nodes

1) Strategy and Doctrine Review
   GPA
   CONOPS
   • Determine operational activities & relationships
   • Apply Constraints

2) Develop Architecture Products
   • Identify critical nodes and information exchanges
   • Solve activities & interactions

3) Execute Risk Analysis
   I) Develop component PDF
   II) Create overall probability function
   III) Run Monte Carlo simulation
   IV) Evaluate results

4) Present logic and sequence
Analysis & Results

Tanker Affected Nodes

1) Plan
2) Generate Mission
3) Find
4) Fix
5) Track
6) Target
7) Engage
8) Deliver
9) Assess

Battlespace Awareness
Force Application
Information Dominance
Enabling
Analysis & Results

Bomber Affected Nodes

1) Strategy and Doctrine Review
   GPA
   CONOPS
   • Determine operational activities & relationships

2) Develop Architecture Products
   OV-2
   • Identify critical nodes and info exchanges
   OV-5
   • Solve activities & interactions
   PSM
   • Present logic and sequence

3) Execute Risk Analysis
   1) Develop component PDF
   2) Create overall probability function
   3) Run Monte Carlo simulation
   4) Evaluate results

4) Apply Constraints

Battlespace Awareness
Force Application
Information Dominance
Enabling

Assess
Deliver
Engage
Find
Fix
Track
Plan
Generate Mission
Target
Analysis & Results

FCF Affected Nodes

1) Develop component PDF
2) Create overall probability function
3) Run Monte Carlo simulation
4) Evaluate results

2) Develop Architecture Products
   - OV-2: Identify critical nodes and info exchanges
   - OV-5: Solve activities & interactions

1) Strategy and Doctrine Review
   - GPA, CONOPS
   - Determine operational activities & relationships

Apply Constraints

Battlespace Awareness
Force Application
Information Dominance
Enabling
Analysis & Results

Fiscally Constrained Force

“Ability to Avoid/Defeat Detection?” Decision Node – The probability that the platform, even if detected by any available means, will not have to take evasive maneuvers to self protect.

Air Refueling GM Activity Nodes – The probability that the A/C successfully and sufficiently receives air refueling.
Analysis & Results

FCF Critical Nodes

“Is BA Adequate?”

“Sufficient Fuel?” & Air Refueling

“Avoid/Defeat Detection?”

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3) Execute Risk Analysis
   • Apply Constraints

4) Create overall probability function
   • Run Monte Carlo simulation
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5) Present logic and sequence
## FCF Independent Analysis of Constraints

<table>
<thead>
<tr>
<th></th>
<th>SRF</th>
<th>C2ISR</th>
<th>F-22</th>
<th>F-35</th>
<th>Tanker</th>
<th>Bomber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Results</td>
<td>0.8683</td>
<td>0.7937</td>
<td>0.7562</td>
<td>0.8784</td>
<td>0.8754</td>
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<tr>
<td>Is BA Adequate? = Yes</td>
<td>0.8831</td>
<td>0.8081</td>
<td>0.8672</td>
<td>0.8672</td>
<td>0.8721</td>
<td></td>
</tr>
<tr>
<td>Is BA Adequate? = No</td>
<td>0.8341</td>
<td>0.8081</td>
<td>0.8074</td>
<td>0.8081</td>
<td>0.8721</td>
<td></td>
</tr>
</tbody>
</table>

**1. Tanker**
- Overall Results: ± 0.0115
- Is BA Adequate? = Yes: ± 0.0175
- Is BA Adequate? = No: ± 0.0137

**2. C2ISR**
- Overall Results: ± 0.0204
- Is BA Adequate? = Yes: ± 0.0204
- Is BA Adequate? = No: ± 0.0208

**3. F-22**
- Overall Results: ± 0.0208
- Is BA Adequate? = Yes: ± 0.0208
- Is BA Adequate? = No: ± 0.0083

**4. F-35**
- Overall Results: ± 0.0385
- Is BA Adequate? = Yes: ± 0.0208
- Is BA Adequate? = No: ± 0.0385

**5. Bomber**
- Overall Results: ± 0.0164
- Is BA Adequate? = Yes: ± 0.0385
- Is BA Adequate? = No: ± 0.0164

### Decrease/Increase
- **Tanker**: 8.9% Decrease
- **C2ISR**: 11.8% Decrease
- **F-22**: 1.6% Decrease
- **F-35**: 2.6% Decrease
- **Bomber**: 0.8% Decrease

### Comparison
- **Tanker vs. C2ISR**: ± 1.5 times Greater
- **Tanker vs. F-22**: ± 1.5 times Greater
- **Tanker vs. F-35**: ± Same
- **Tanker vs. Bomber**: ± Same
Analysis & Results

FCF Sensitivity by Capability

Impact on Overall P(s) Distribution for FCF with Multiple Constraints

Rank Order of Individual Analysis:
1. Tanker
2. C2ISR
3. F-22
4. F-35
5. Bomber
Analysis & Results

Analysis Conclusions

Analysis of individual constraints independently highlighted Tanker constraint as having greatest impact

but

Combined effects of all constraints resulted in C2ISR modernization constraint as most important to overall success!

Based Upon Research Assumptions
**Recommendations**

**Phase I**
- Research Strategic Environment
  - NSS, NDS, NMS, SPG, QDR, Senior Leadership & SME Input
- Define Desired Operational Effects
  - JOPs, AF CONOPS, Doctrine, DoDD 5100.1, UJTL, IPL PLANS, LL
- Identify Required Operational Capabilities
  - AF CONOPS, CRRA, MCL, UJTL, IPL, APPG
- Validate Force Presentation Construct
  - Entering Assumptions & Force Construct Documents

**GPA Operational Activity Diagram (OV-5)**
- Identify Required Capabilities

**GPA PSM Sensitivity Analysis**
- Identify Critical Capabilities

**Quantified Increased Risk of FCF vs SRF**

**Phase II**
- Define Force Structure Framework
  - APPG, TPG, AFCIS, QDR, BRAC, Transformation Guidance

**Responsive Force**
- CARRA, AF CONOPS, AEF Construct, Analysis of Capability, Sufficiency, Cost & Risk

**GPA FCF Risk Analysis**
- Based Upon FCF Capabilities

**Build Fiscally Constrained Force**
- PB, DOTMLPF Impacts, Senior Leadership & SME Input

**GPA SRF Risk Analysis**
- Based Upon SRF Capabilities

**GPA SRF Sensitivity Analysis**
- Identify Capability Tradeoff Possibilities

**Allocation of Mechanisms to OV-5 Operational Activities**
Summary

- Use Risk Analysis Methodology to Identify Key SoS Interdependencies to Quantifies Risk and Identify Critical Capabilities
  - Methodology Requires Multiple Iterations!

- Architecture and PSM for GPA SoS

- Risk Analysis of GPA SoS
  - Quantify Risk for Each Force Construct
  - Identify Critical Capabilities
  - Notional Analysis Identified C2ISR as Most Critical

- Integrate Into Force Construct