A Systems Engineering Approach for Global Fleet Station Alternatives in the Gulf of Guinea

Systems Engineering Analysis (SEA-12)

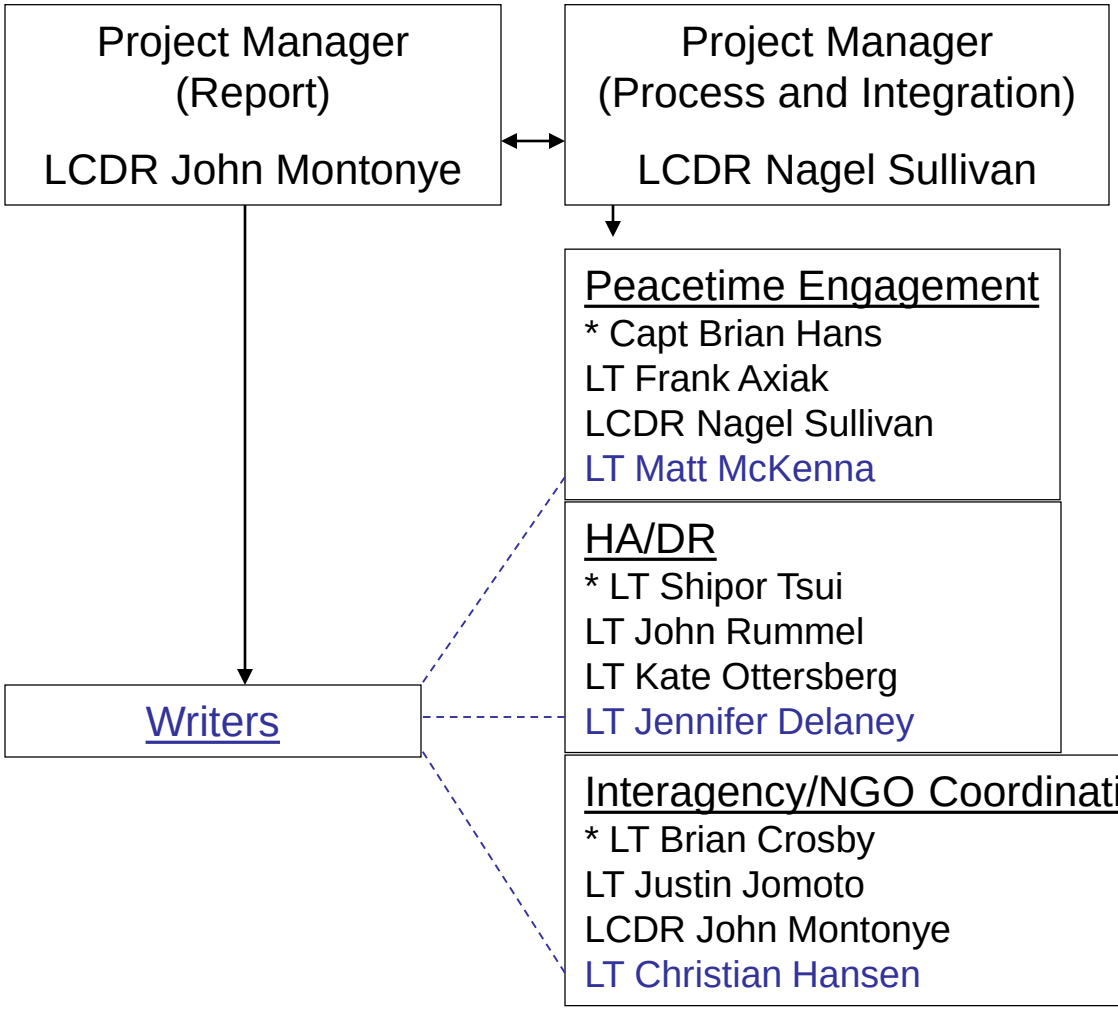
Brief to N8F

10 Dec 07

Systems Engineering Analysis Curriculum

- Navy URL focused curriculum "From Maxwell to Mahan"
- Three education skills threads with JMPE
  - Systems Engineering
  - Technology
  - Analysis
- Integrates cross campus Navy study in lieu of thesis

SEA-12: Who We Are



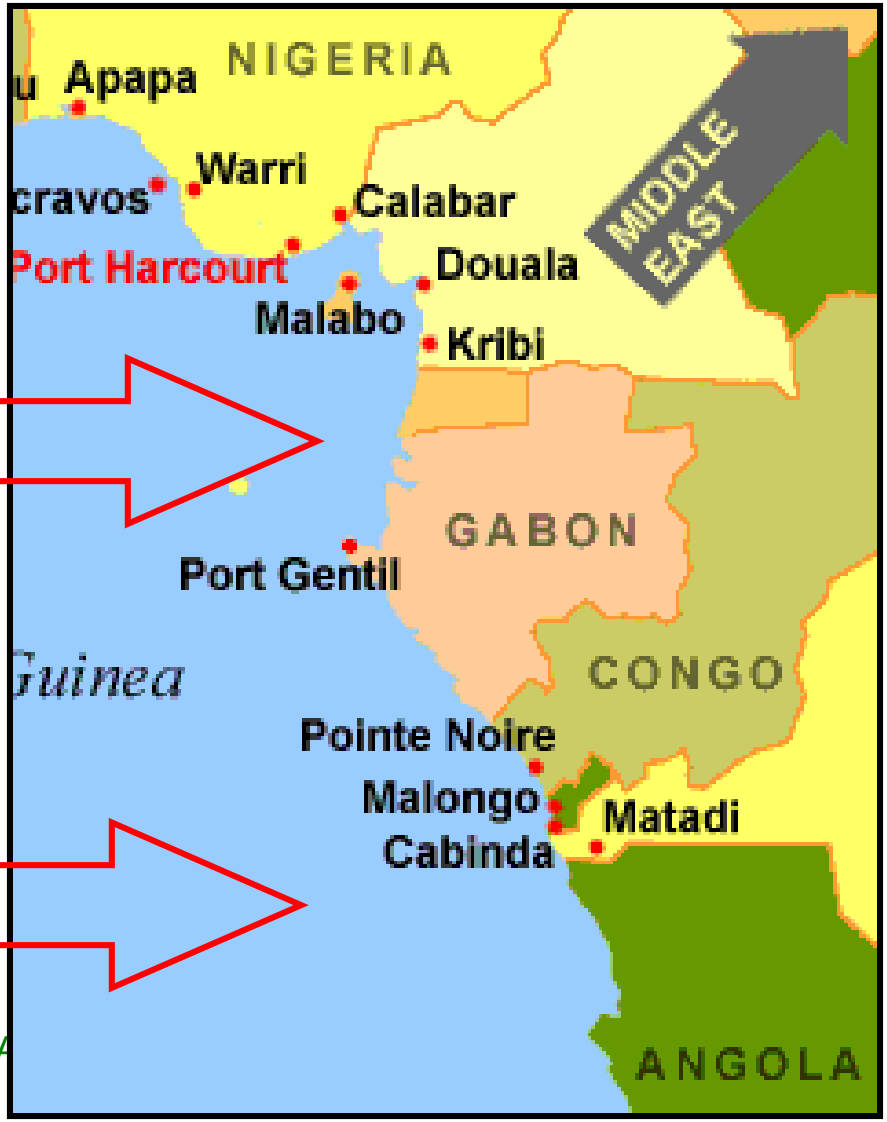
* Team Leads

Interactions

Bottom Line Up Front

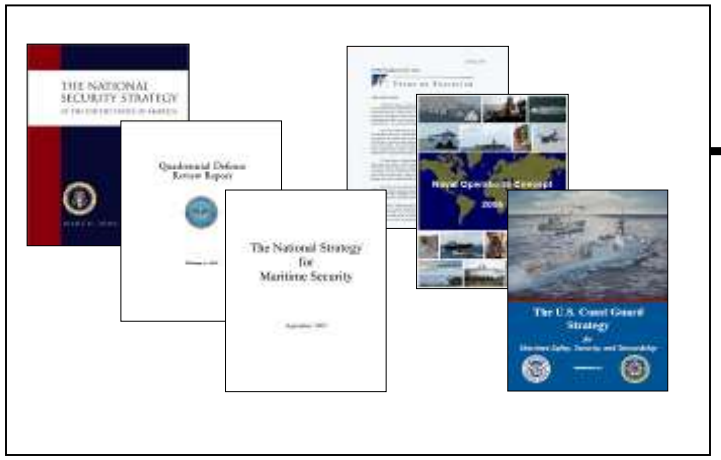
Top Solution Alternatives

or

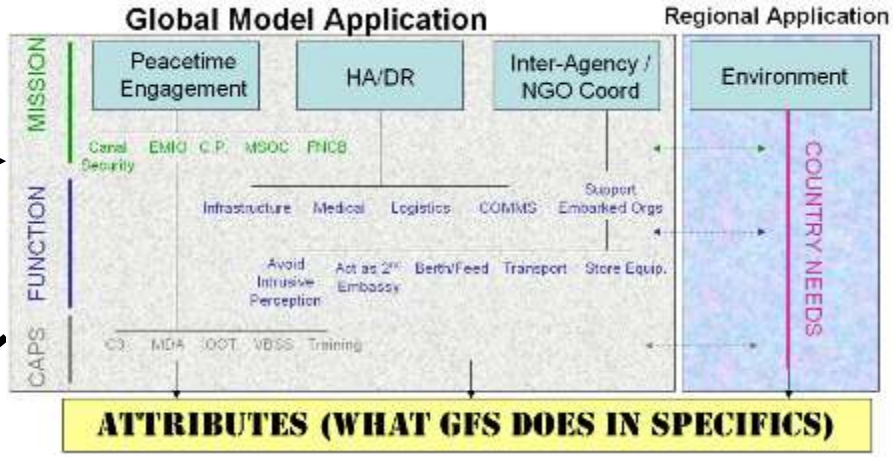


Research Process Model: Modified JCIDS

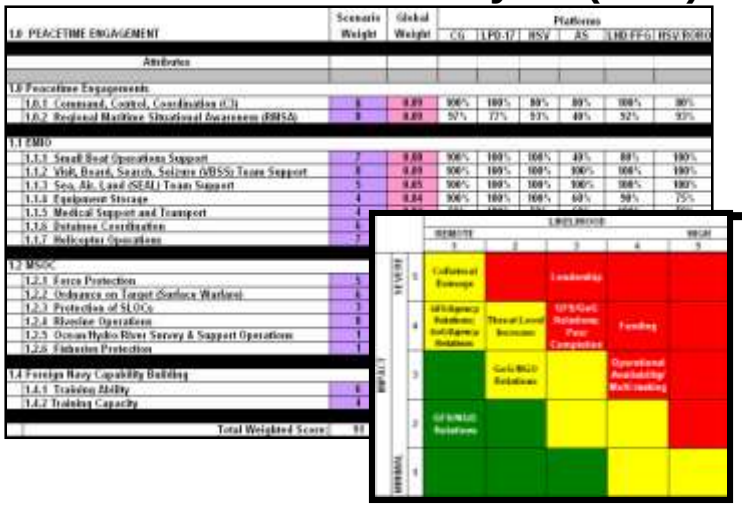
Strategic Guidance



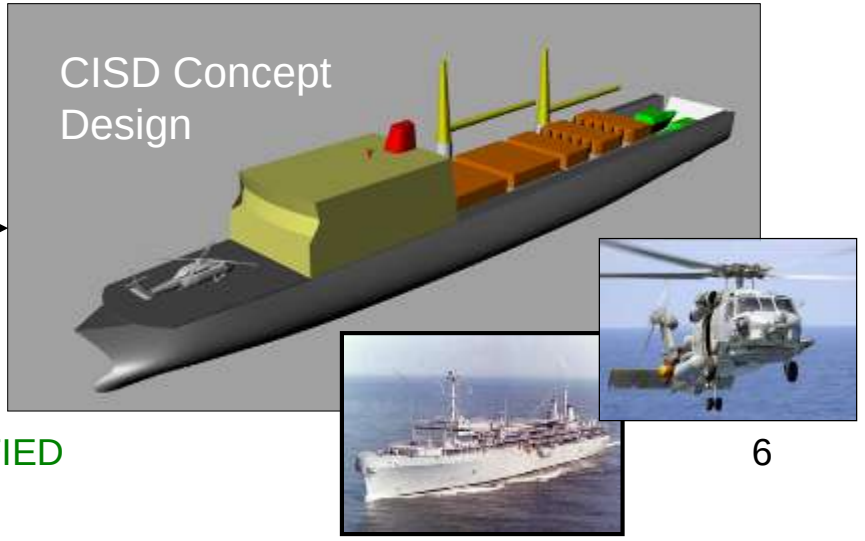
Functional Area Analysis (FAA)



Functional Needs Analysis (FNA)



Functional Solutions Analysis (FSA)



Our JCIDS process: Project Evolution

- **Strategic Guidance**
- Functional Area Analysis (FAA)
- Functional Needs Analysis (FNA)
  - Scenarios and Key Attributes
  - Results/Decision Theory Analysis
  - Cost Benefit Analysis
  - Risk Analysis
- Functional Solutions Analysis

Defining GFS: Different Perspectives

"A hub where all manner of joint, interagency, international organizations, navies, coast guards and non-governmental organizations could partner together as a force for good."

- ADM Mike Mullen (CNO)

"GFS is a persistent sea base of operations from which to coordinate and employ adaptive force packages within a regional area of interest."

- SOUTHCOM Website

"The Global Fleet Stations (GFS) pilot program will serve as a regional cornerstone for phase "0", Shaping and Stability Operations. GFS supplies an adaptive force package that supports the 1,000-ship Navy with a persistent presence."

- Dept of Navy Office of Information (CHINFO)

Scoping the Project by Region: Gulf of Guinea

- Vast expanse of ocean
- Navies and Coast Guards span a wide range of capabilities and needs
- Varied political/cultural/socio-economic environments and situations per country, offering a broad spectrum of government, non-government, and military assistance opportunities.
- Past and future pilot/HADR programs
- Opportunities for cross-campus integration

Output of Strategic Guidance: Definition and Problem Statement

Definition

A sea base of operations from which to coordinate and launch a variety of missions within a regional area of interest, focusing primarily on Phase 0/Shaping and Stability operations, to include Theater Security Cooperation, Maritime Domain Awareness, and tasks associated with the war on terror.

Problem Statement

Evaluate Global Fleet Station system alternatives to provide the most effective solution to execute Maritime Security and Influence Operations in the Gulf of Guinea, projected to 2012.

Project Evolution

- Background
- **Functional Area Analysis (FAA)**
- Functional Needs Analysis (FNA)
  - Scenarios and Key Attributes
  - Results/Decision Theory Analysis
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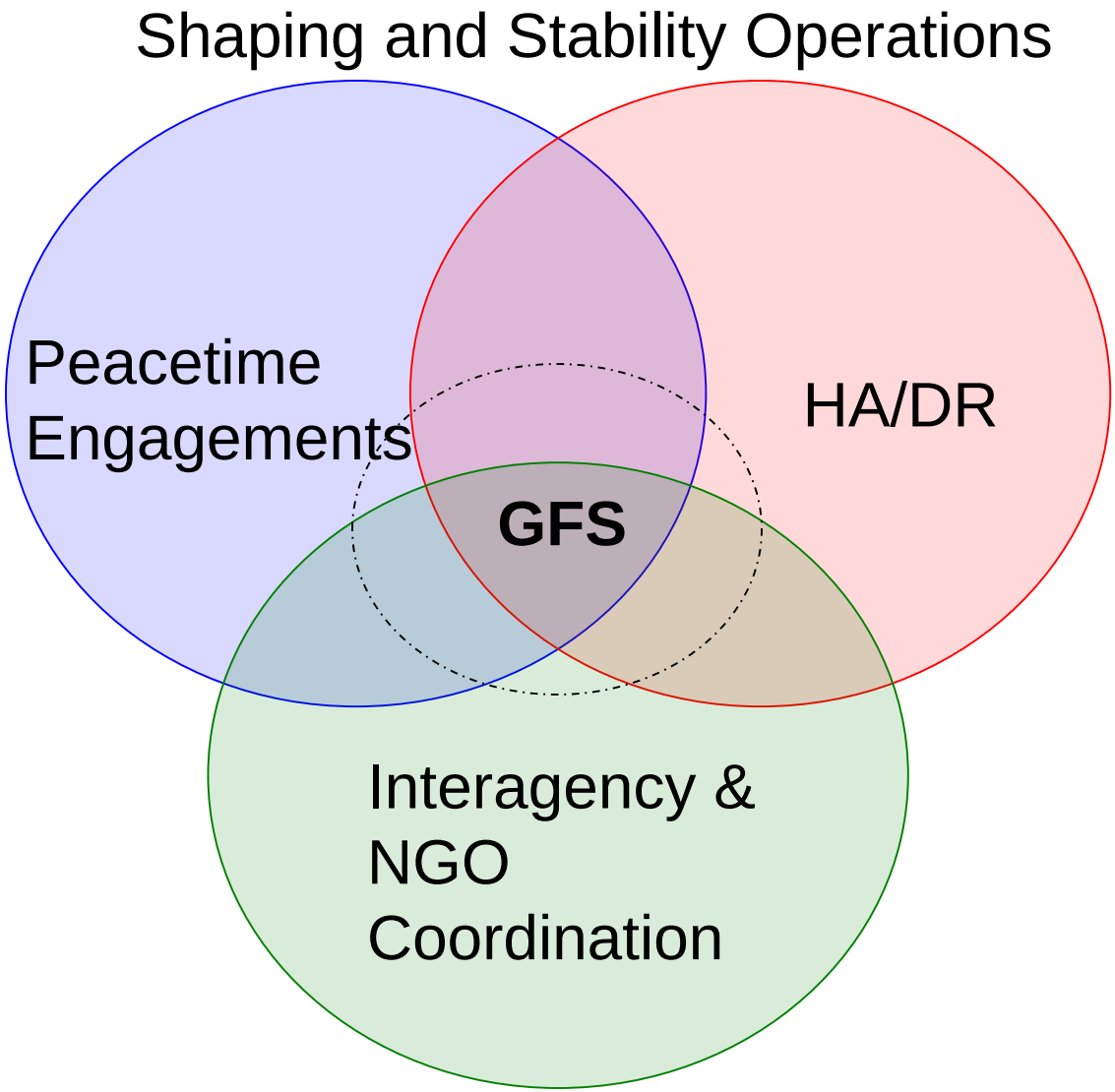
  - Risk Analysis
- Functional Solutions Analysis

FAA: Breaking Into Teams to Develop Attributes

Determine Capabilities and Requirements for GFS Based on Strategic Guidance via Mission Areas

- Peacetime Engagement
  - Military to Military
- Humanitarian Assistance / Disaster Relief
  - Crisis Response: Short Term Solutions to Regional Issues
- Interagency & NGO Coordination
  - Long Term Influence/Solutions to Regional Issues

FAA: GFS is a Complex System



FAA: Attribute Definition and Example

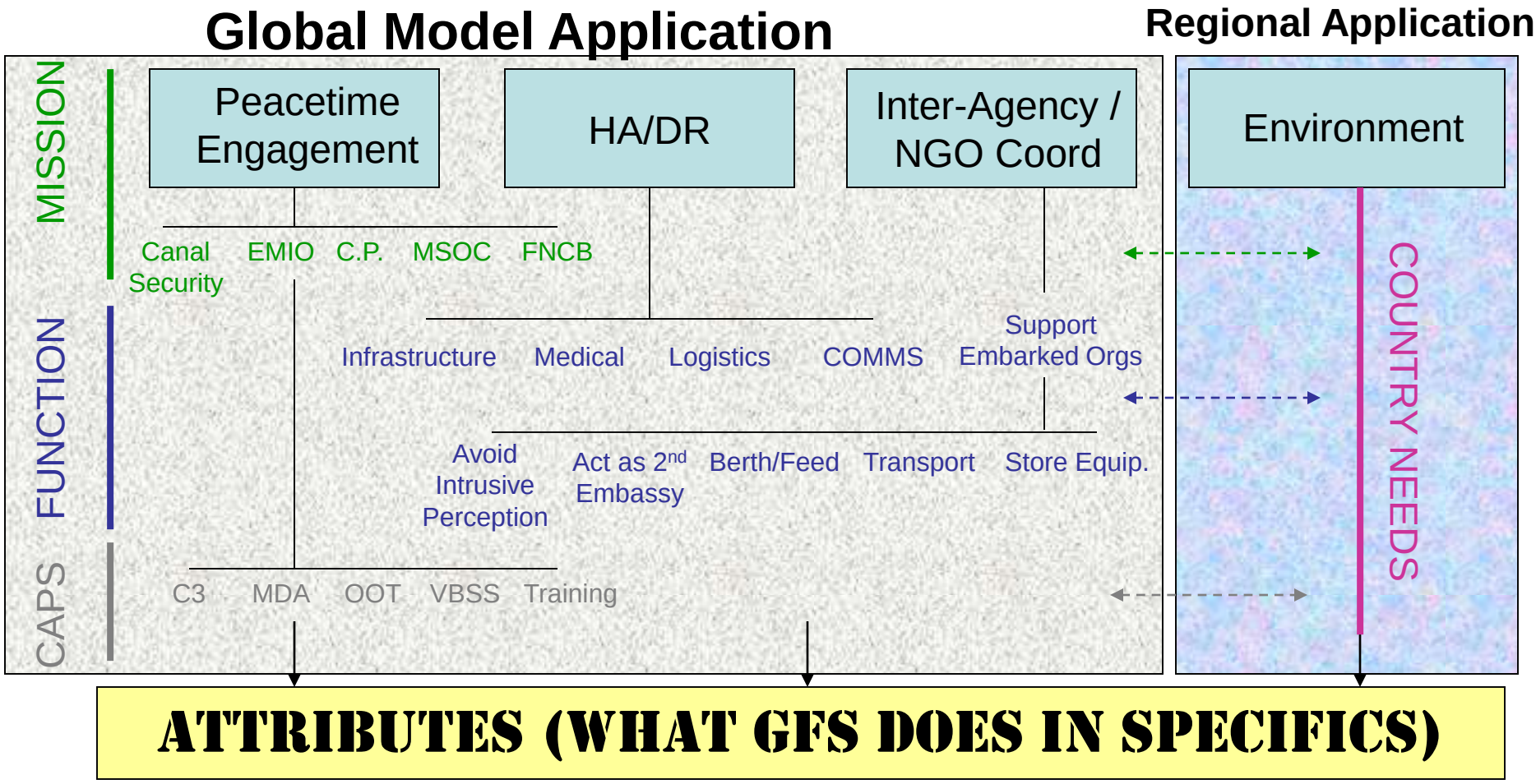
Definition

- Attribute:
  - A Quantitative or Qualitative Characteristic of an Element or its Actions *(CJCSM 3170.01C)*
  - Specific Capabilities
  - What GFS Does

Example

Mission	**1.0** Peacetime Engagement (all sub-missions)
Capability/ Function/ Mission	**1.0.1** Command, Control, Coordination (C3) - The ability to exercise authority and direction by a properly designated commander…
Attribute	**1.0.1.2 C3 Integration**. GFS shall have computing capabilities that integrate sensors, communications, and self-protection weapon systems into a single command and control system.

… a Possible Global Process with Regional Application



Project Evolution

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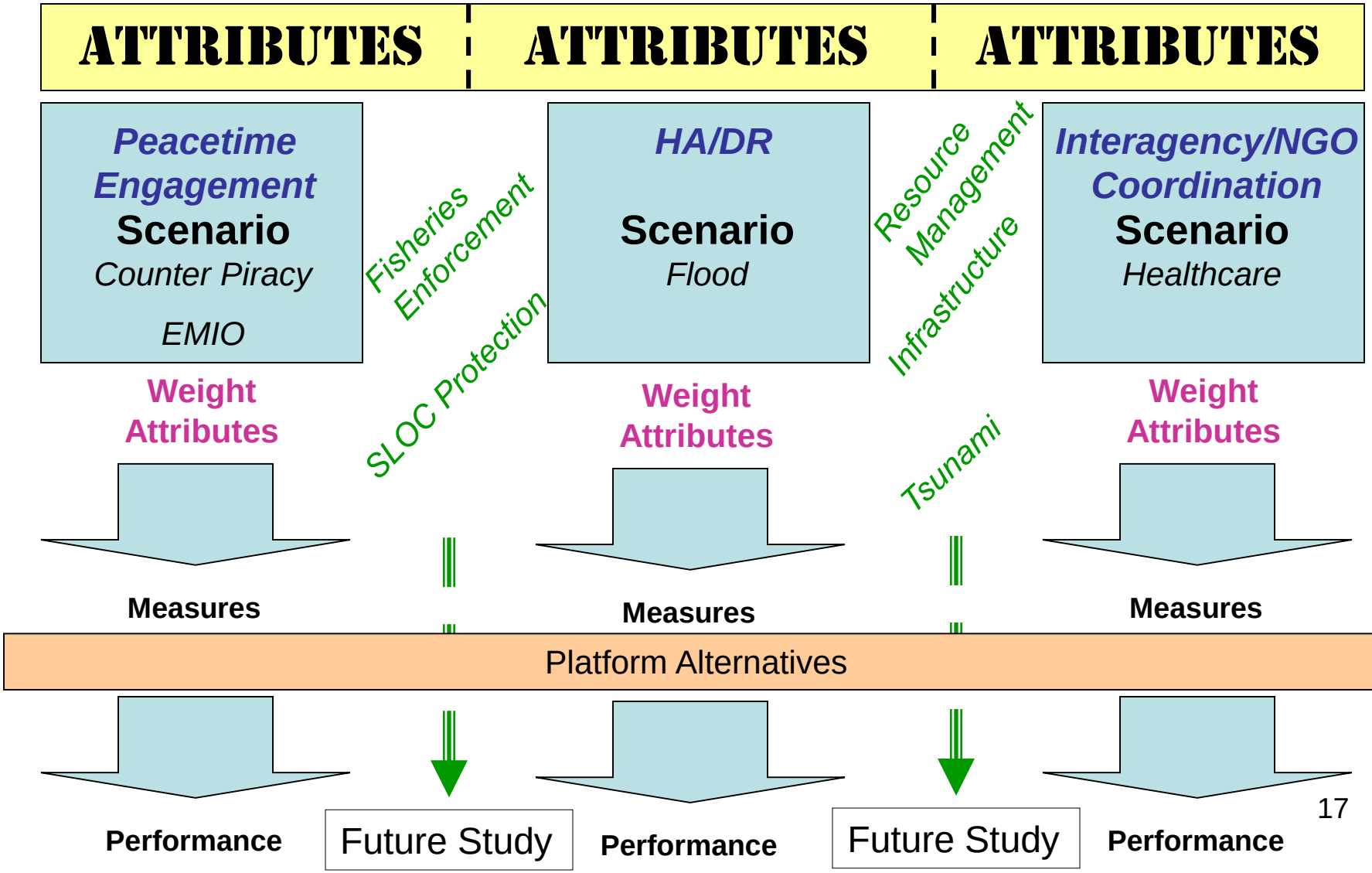
FNA: Scenarios by Mission



FNA: Analysis of Current Alternatives

Six Platform Alternatives

CG

LPD-17

HSV

AS

RO-RO/HSV

FFG/LHD

Performance, Cost, and Risk

Best System Alternatives

Project Evolution

- Strategic Guidance
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Scenario Weights

- **Weight:** How Important an Attribute is
  - The Same for All Ships
  - Develops an Attribute Hierarchy and Global Weight (GW)
  - GW = Individual Weight/Sum of all Weights
  - Means of Quantifying Attributes, via Weights

	0	N/A
Little to no impact on mission accomplishment	1	Minimal importance
	2	
	3	Moderately important
	4	
Without attribute there is small degradation to mission	5	Important
	6	
	7	Very Important
	8	
	9	Absolutely Essential
Cannot perform mission without	10	Mission Critical

Value Scores

- **Value Score:** How Well a "Current Capability" Platform Fulfills an Attribute.
  - Some Scores are Quantitative
  - Some Scores are Qualitative
  - All are Objective
  - Used Utility Theory
  - Measured in Percentages

Peacetime Engagement: Scenario

Context: GFS conducting training with the Nigerian Navy for maintenance, security of petroleum infrastructure, boarding operations, fisheries protection, border dispute resolution.

Threat: Movement for the Emancipation of the Niger Delta (MEND) militia boards a Nigerian Shell Oil platform near Bonny Island (littoral), steals 100s of barrels of petroleum with a small coastal tanker (200-300 ft) and a swarm of 5 fast boats with small arms/RPGs; 3 Shell hostages taken.

In cooperation with the Nigerian Government, GFS is tasked by AFRICOM to lead the ensuing operation in support of the Nigerian Navy's constitutional role.

Why:

- International training and exercises are fundamental parts of GMP and GFS mission
- Similar attacks are a recurring threat
- Bonny River and littoral waters are representative of critical traffic ways
- Negligible offshore capability is endemic to the region

Peacetime Engagement: Key Attributes Results

1.0 PEACETIME ENGAGEMENT	Weight	Global Weight	Platforms					
			CG	LPD-17	HSV	AS	LHD/FFG	HSV/RORO
Attributes								
1.0 Peacetime Engagements								
1.0.1 Command, Control, Coordination (C3)	8	0.09	100%	100%	80%	80%	100%	80%
1.0.2 Regional Maritime Situational Awareness (RMSA)	8	0.09	97%	77%	93%	40%	92%	93%
1.1 EMIO								
1.1.1 Small Boat Operations Support	7	0.08	100%	100%	100%	40%	80%	100%
1.1.2 Visit, Board, Search, Seizure (VBSS) Team Support	8	0.09	100%	100%	100%	100%	100%	100%
1.1.3 Sea, Air, Land (SEAL) Team Support	5	0.05	100%	100%	100%	100%	100%	100%
1.1.4 Equipment Storage	4	0.04	100%	100%	100%	60%	90%	75%
1.1.5 Medical Support and Transport	4	0.04	50%	100%	50%	60%	100%	50%
1.1.6 Detainee Coordination	6	0.07	100%	100%	100%	100%	100%	100%
1.1.7 Helicopter Operations	7	0.08	100%	80%	80%	0%	100%	80%
1.2 MSOC								
1.2.1 Force Protection	5	0.05	100%	100%	90%	80%	100%	65%
1.2.2 Ordnance on Target (Surface Warfare)	6	0.07	100%	95%	90%	80%	95%	50%
1.2.3 Protection of SLOCs	3	0.03	100%	100%	100%	70%	100%	70%
1.2.4 Riverine Operations	8	0.09	100%	100%	80%	80%	100%	80%
1.2.5 Ocean/Hydro/River Survey & Support Operations	1	0.01	100%	100%	100%	100%	100%	100%
1.2.6 Fisheries Protection	1	0.01	100%	100%	100%	100%	100%	100%
1.4 Foreign Navy Capability Building								
1.4.1 Training Ability	6	0.07	100%	100%	100%	100%	100%	100%
1.4.2 Training Capacity	4	0.04	80%	100%	100%	100%	100%	100%
			CG	LPD-17	HSV	AS	LHD/FFG	HSV/RORO
Total Weighted Score:	91	1.00	97%	96%	91%	72%	97%	85%

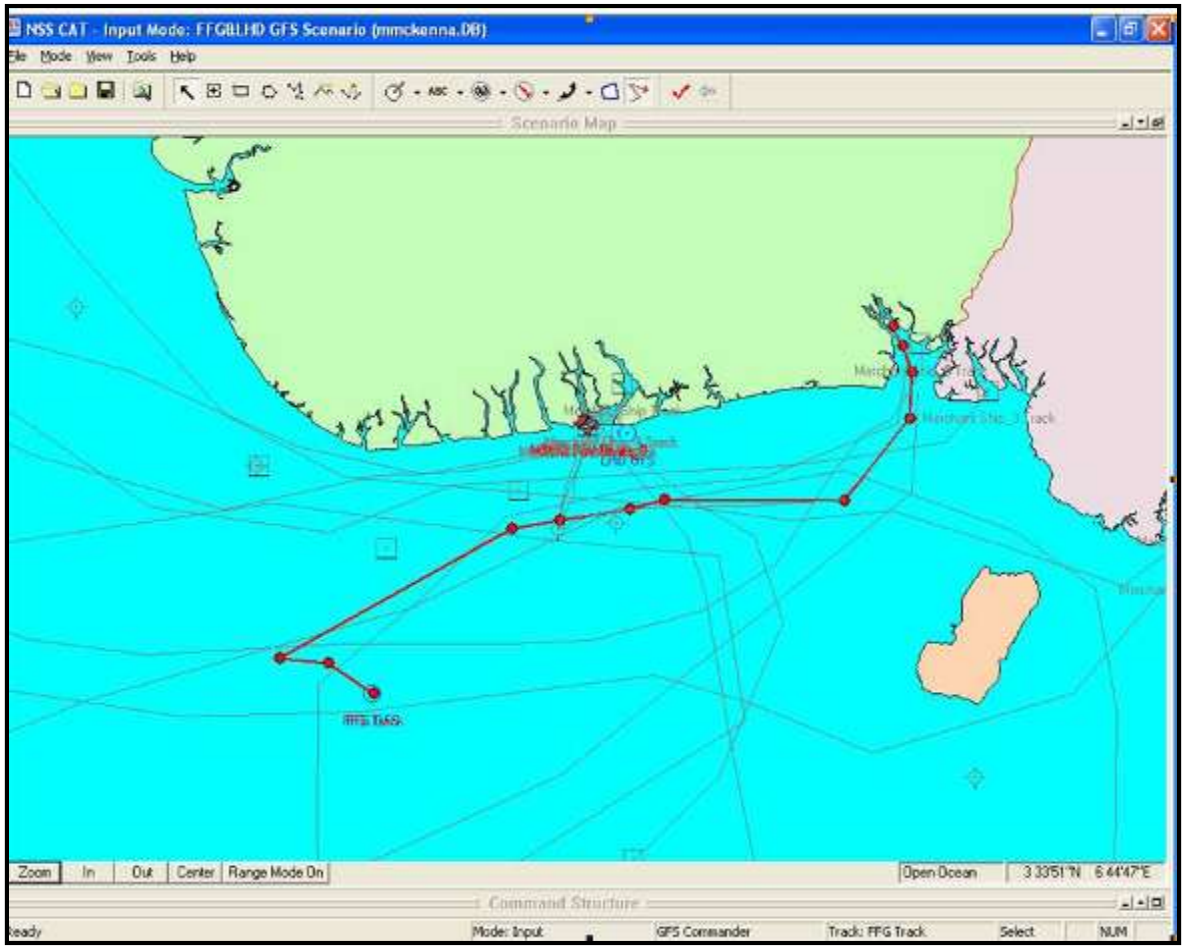
Peacetime Engagement: NSS Simulation

- Regional Situational Maritime Awareness Attribute Derived from Naval Simulation System (NSS)
- Inputs: Small Fast Craft, HSV, RORO, AS, LPD-17, Oil Platform, RPG, 50 cal, Snake Eyes, MK-96, P_k Tables, P_{hit}/P_{kill} Tables, Tracks, Helicopter Flight Plans, MOE's, Tactics Tables
- Measures:
  - Time to Detection (Ship/Helo)
  - Range to detection (Ship/Helo)

Peacetime Engagement: NSS

- Simulation run 70 times
- Ensured <5% STD Dev.
- RMSA Calculation
- Score=(2/3) Ship Score + (1/3) Helo Score

Scenario MOE's			
Platform	Distance	Time	Score
CG	21.70	4.52	95
LPD	21.70	5.63	80
HSV	19.25	3.80	100
AS	21.60	6.24	60
FFG/LHD	19.25	4.60	90
HSV/RORO	19.25	3.80	100
CG Helo	29.85	3.10	100
LPD Helo	15.00	6.30	70
HSV Helo	18.80	4.70	80
FFG/LHD Helo	18.07	2.00	95
HSV/RORO Helo	18.70	4.70	80



HA/DR: Scenario

Description:

- Northern Ghana and Ashanti have experienced unusually vast amounts of rainfall resulting in severe flooding throughout the region. The ramifications of this flooding have left 250,000 Ashanti people affected, 250 killed and 45,000 homeless.
- GFS is operating IVO the Gulf of Guinea and has been tasked to support HA/DR operations.
- Why:
  - Historical trends
  - Flex all key attributes

Natural Disaster Type	Occurrences
Coastal Flood/Lake Flood	1
Earthquake	1
Epidemic	66
Flash Floods	0
Flood	33
Insect Infestation	1
Landslide	1
Valley Flood	1
Volcano	1
Wind Storm	4
Wind Storm, Tornado	1

2002-2007

Ghana

HA/DR: Key Attributes Results

2.0 HA/DR Attributes	Weight	Weight	Global Weight	Platforms					
				CG	LPD-17	AS	HSV	LHD/FFG	HSV/RoRo
2.1 INFRASTRUCTURE	6								
2.1.1 Resource Network		4	0.09	80%	85%	75%	90%	95%	90%
2.1.2 Physical Network		7	0.16	40%	85%	60%	90%	95%	95%
2.2 MEDICAL ASSISTANCE	5								
2.2.1 Health Services		6	0.07	30%	75%	80%	30%	90%	30%
2.2.2 Plans and Operations		5	0.06	10%	80%	80%	10%	90%	10%
2.2.3 Medical Logistics		6	0.07	15%	70%	65%	30%	85%	50%
2.2.4 Administrative Services		1	0.01	100%	100%	100%	100%	100%	100%
2.3 LOGISTICS	6								
2.3.1 SUPPLY		6	0.06	30%	90%	95%	85%	90%	100%
2.3.2 MAINTENANCE		4	0.04	85%	85%	95%	85%	90%	95%
2.3.3 TRANSPORTATION		8	0.07	30%	85%	85%	85%	90%	95%
2.3.4 CIVIL ENGINEERING		4	0.04	40%	85%	60%	90%	95%	95%
2.3.5 OTHER SERVICES		5	0.05	80%	80%	90%	85%	80%	85%
2.4 COMMUNICATIONS	7								
2.4.1 Access Services		9	0.05	100%	100%	75%	100%	100%	100%
2.4.2 Voice Services		7	0.04	100%	100%	80%	100%	100%	100%
2.4.3 Data Services		7	0.04	100%	100%	80%	100%	100%	100%
2.4.4 Applications		7	0.04	100%	100%	100%	100%	100%	100%
2.4.5 Video Services		6	0.04	100%	100%	30%	100%	100%	100%
2.4.6 Satellite Communication Services		8	0.05	90%	85%	45%	80%	100%	80%
2.4.7 Communication Security		5	0.03	100%	100%	100%	100%	100%	100%
				CG	LPD-17	AS	HSV	LHD/FFG	HSV/RoRo
Total Weighted Score:			1.00	59%	87%	75%	78%	94%	82%

Interagency/NGO Coordination: Scenario

Description:

- Healthcare Scenario Selected, with Particular Focus on HIV/AIDS Epidemic
- Why:
  - Information Readily Available (AIDS Rates)
  - Pertinence to Shaping and Stability in Region
  - Project Hope Representative Cooperative
  - Flex the Ability of GFS to Support a NGO

Interagency/NGO Coordination: Scenario

Context. GFS is commencing her maiden deployment to the GoG Area of Operations (AO). One of the primary mission areas of GFS, Interagency/NGO integration, is being conducted by a NGO, Project Hope. GFS is supporting Project Hope in combating the HIV/AIDS epidemic through prevention, care, treatment, and support in three countries; Liberia, Cameroon, Angola. GFS' unique capabilities enable her to deliver, house, store, and support Project Hope in their mission.

Assumptions:

- GFS will not provide security to personnel associated to the NGO while ashore.
- The duration of logistical support to the NGO is 6-months.
- There is no direct threat to the security of NGO personnel and equipment during the initial deployment of Project Hope personnel in country.

Interagency/NGO Coordination: Key Attributes Results

3.0 Inter-Agency / NGO Coordination	Weight	Weight	Weight	Global Weight	Platforms					
					CG	HSV	LPD	AS	LHD/FFG	HSV/RoRo
3.1 2nd Embassy:	2									
3.1.1 Coordination Center:		5		0.03	90%	90%	95%	80%	100%	90%
3.1.2 Communicate Information:		7		0.04	100%	80%	85%	75%	100%	80%
3.2 Storage of US Agency/NGO equipment:	9									
3.2.1 Storage:		10			0%	40%	53%	19%	94%	100%
3.2.1.1 Cargo:			9	0.19	0%	11%	27%	30%	100%	100%
3.2.1.2 Vehicles:			5	0.10	0%	92%	100%	0%	83%	100%
3.3 Sustaining US Agency/NGO personnel (150):	5									
3.3.1 Messing:		10		0.09	100%	100%	100%	100%	100%	100%
3.3.2 Berthing:		7		0.07	10%	50%	100%	75%	100%	100%
3.4 Logistic support for US Agency/NGO personnel	10									
3.4.1 Transportation:		10			50%	100%	100%	67%	100%	82%
3.4.1.1 Conduct LCAC Operations:			5	0.11	N/A	N/A	N/A	N/A	N/A	N/A
3.4.1.2 Provide Vertical Replenishment:			3	0.06	50%	N/A	N/A	N/A	N/A	40%
3.4.1.3 Provide Inport Replenishment:			7	0.15	N/A	100%	100%	67%	100%	100%
3.5 Minimize militaristic perception:	5									
3.5.1 Force Posture:		2		0.04	0%	50%	50%	50%	50%	50%
3.5.2 Appearance		6			28%	66%	33%	66%	17%	66%
3.5.2.1 Ship (Higher = less militaristic)			6	0.05	N/A	66%	33%	66%	17%	66%
3.5.2.2 Helo			5	0.04	28%	N/A	N/A	N/A	N/A	N/A
3.5.2.3 LCAC			5	0.04	N/A	N/A	N/A	N/A	N/A	N/A
					CG	HSV	LPD	AS	LHD/FFG	HSV/RoRo
Total Weighted Score				1.00	36%	72%	76%	57%	86%	87%

Project Evolution

- Background
- Functional Area Analysis (FAA)
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  - Scenarios and Key Attributes
  - **Results/Decision Theory Analysis**
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Summary of Platform Performance

	PE	HA/DR	NGO Coord	* Expected Value	** Cost ($mil)
CG	.97	.59	.36	**0.71**	**23**
HSV	.91	.78	.72	**0.83**	**14**
LPD	.96	.87	.76	**0.88**	**22**
AS	.72	.75	.57	**0.68**	**48**
LHD/FFG	.97	.94	.86	**0.93**	**102**
HSV/RORO	.85	.82	.87	**0.85**	**29**

*** Mission weighted: PE- .5, HA/DR- .2, NGO- .3 (example (.5*.97)+(.2*.59)+(.3*.36))= .71**

**** Cost used VAMOSC and MSC O&S costs for a 6 month on-station time**

Project Evolution

- Strategic Guidance
- Functional Area Analysis (FAA)
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  - **Cost Benefit Analysis**
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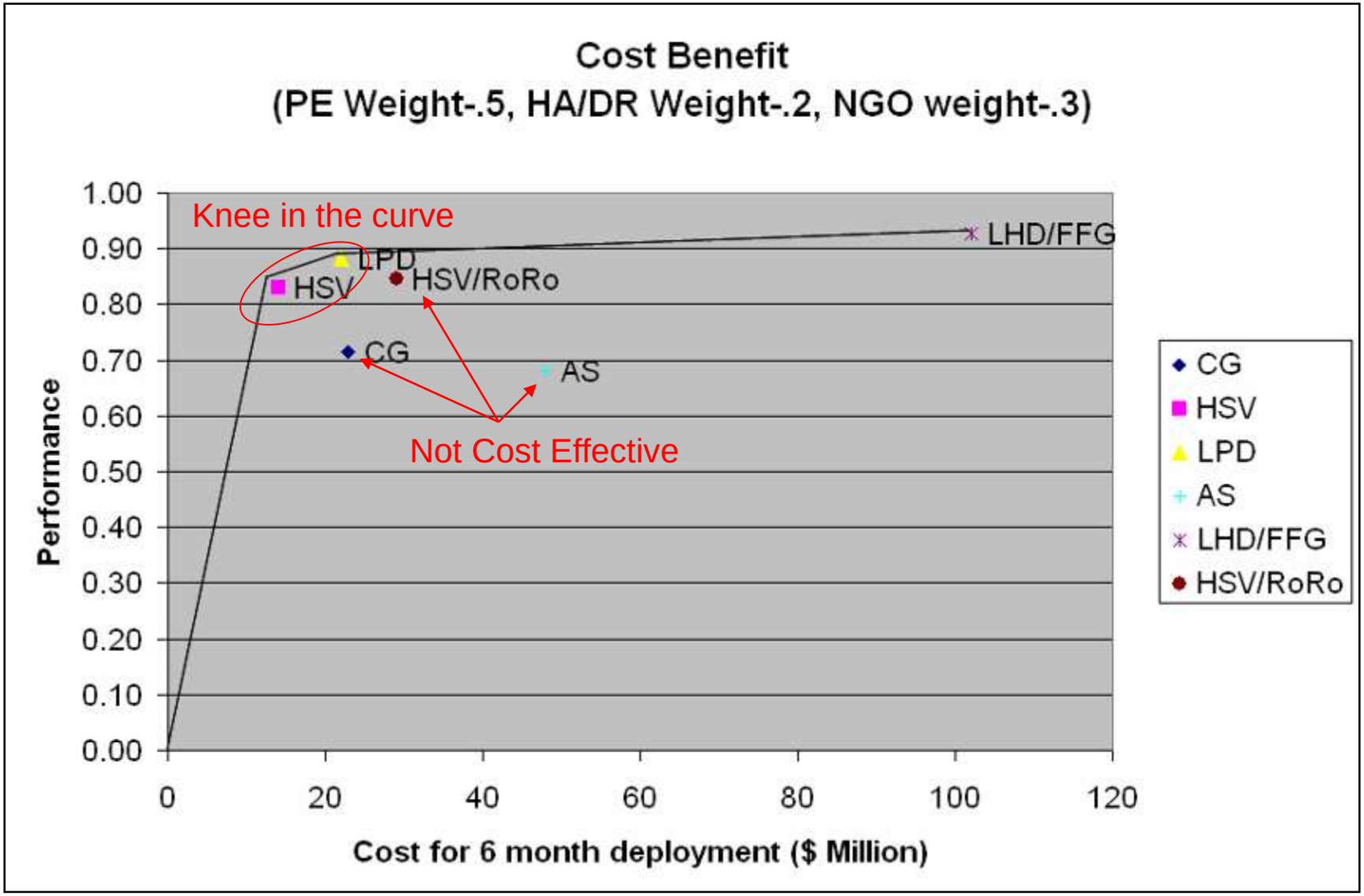
Cost Benefit Curve: Missions Weighted



Project Evolution

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  - **Risk Analysis**
- Functional Solutions Analysis

Risk Analysis

			LIKELIHOOD				
			REMOTE				HIGH
			1	2	3	4	5
IMPACT	SEVERE	5	Collateral Damage		Leadership		
		4	GFS/Agency Relations; GoG/Agency Relations	Threat Level Increase	GFS/GoG Relations; Peer Comptetion	Funding	
		3		GoG/NGO Relations		Operational Availability/ Multi-tasking	
		2	GFS/NGO Relations				
	MINIMAL	1					

High Risk
Medium Risk
Low Risk

Highest Risks: Assume, Control, or Transfer

		Probability	Impact
What could go wrong?	What are the consequences?	5 = High	5 = Severe
LEADERSHIP		3	5
U.S. Government leadership and/or U.S. Navy does not support GFS concept or deployment of GFS platform to troubled parts of the globe.	**GFS cancelled or scope of GFS deployment reduced. (The current sea basing concept may be used instead.)**		
RELATIONS (GFS - GoG)		3	4
Fluctuating relationships with GoG countries. Not all the countries in the GoG region are willing to participate in GFS due to an unfavorable relationship with the United States or the goals of GFS are not inline with host countries goals.	**Should GoG nations not participate in GFS, the overall effectiveness of executing GFS missions will be diminished. The amount of effectiveness diminishment is dependent on which countries that do not wish to participate in GFS; ie Nigeria would have more of an impact vs. Ghana.**		
PEER COMPETITION		3	4
A peer competitor's influence in the region surpasses that of the U.S. Peer competitor's priorities are counter to those of the U.S.	**GFS effectiveness and value in the region diminish. It will hamper efforts to accomplish it's mission because cooperation with host countries as well as being able to influence them is vital to shaping and stability operations.**		
OPERATIONAL AVAILABILITY		4	3
Operational requirements limit the availability of USN and USNS assets to support GFS missions.	**Accept less than ideal platforms; delay or cancel GFS deployments.**		
FUNDING		4	4
Congressional and Department of Defense funding may limit the ability of GFS to perform the missions set forth.	**Issues of this nature will lead to limited mission effectiveness, delays in platform deployment or possible program cancellation.**		
MULTI-TASKING		4	3
Risk of more than one simultaneous mission. GFS is in port, thus can not perform sea based missions.	**Platforms will be unable to perform all the missions. Some missions will not be accomplished.**		

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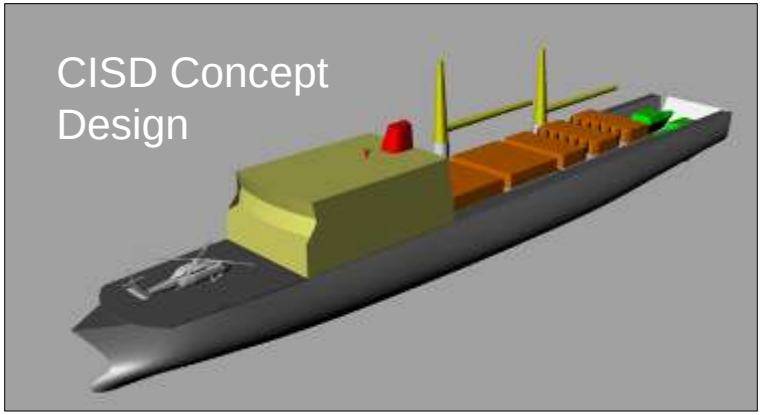
  - Cost Benefit Analysis
  - Risk Analysis
- **Functional Solutions Analysis**
- Conclusion

FSA: Notional NAVSEA "Station Ship"

Applied all three mission area attributes to NAVSEA 05D1 concept platform designed specifically for GFS.

- Using same weights, NAVSEA ship scored an 85% (tied with HSV/RORO combination for third highest)
- Outperformed one of the cost-effective platforms (the HSV)
- Pros: Small size, cargo carrying capacity, aviation and small boat capability
- Cons: Speed and communication/C2 equipment

	P.E.	HA/DR	NGO
NAVSEA	84%	85%	88%



DOTMLPF

Focusing on Doctrine, Materiel, Personnel

- If Changes Were Made, New Expected Value Performance (EVP)
- No Costs Considered
- Key Attributes

  - Communication/C2 Equipment Key Attribute for All Three Missions Areas

  - Aviation Capability: Helo Adds a Multitude of Services; from EMIO to Transporting Personnel/Supplies

  - For HA/DR and NGO: Cargo Carrying Capacity and Ability to Off-Load/On-Load Equipment/Supplies in Austere Environment

	Old EVP	Change	New EVP
CG	.71	0	0.71
HSV	.83	↑ .08	0.91
LPD	.88	↑ .03	0.91
AS	.68	↑ .16	0.84
LHD/FFG	.93	0	0.93
HSV/RoRo	.85	↑ .06	0.91

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Conclusions of Our Study

- The Best Option to Perform GFS Mission is the HSV or LPD-17
- Process is a Result
  - Sound, Objective Process Methods
  - "Global Process Model" has Regional Applications
  - DMP Applications
- Revealed Complexities of Shaping and Stability, Allowing for Better Decisions

Questions?