Amir Bijandi

Mentor: Timothy Davis

Remote-Guided Pickup Drop Off System RGPDOS

AGENDA

- My Background
- Introduction & need
- Five-minute Video
- CONOPS (initial & final)
- How did we model the RGPDOS?
- Reports: RA, FA, TS, Conceptual design, etc.
- Risk Management
- Recommendations

TECH. BACKGROUND

U.S. MERCHANT MARINER

7+ YEARS OF MARITIME EXPERIENCE

IN BOSCO, VSC, D.C. CRUISES ….

EDUCATION:

BS, MARINE ENGINEERING

BS, NAVIGATION

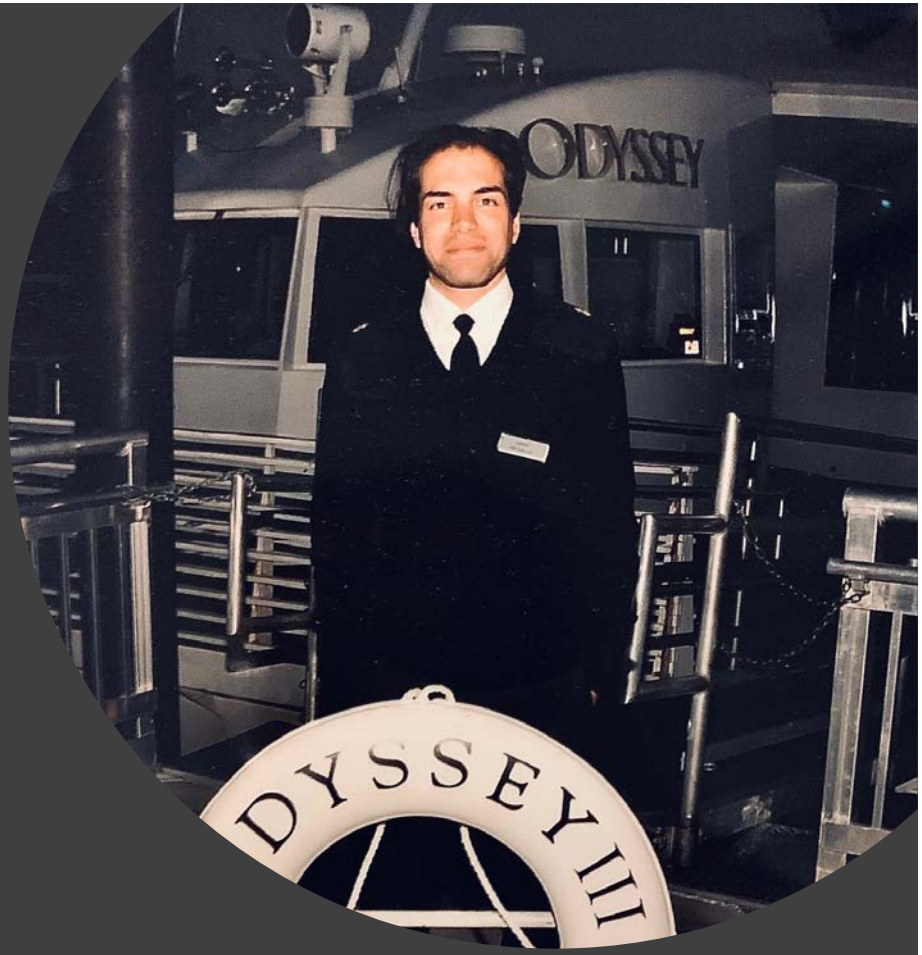
CURRENTLY STUDING M.S. SYSTEM ENGINEERIGN

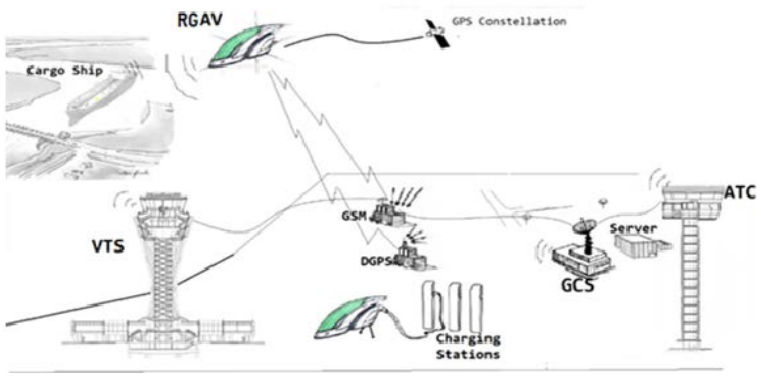
FUN FACTS;

VIOLONIST & COMPOSER

SWIM COACH

LOVE NATURE & READ BOOKS





Introduction

RGPDOS initial concept is a system that;

Improve maritime transportation implementing SE processes.

Decrease TTL cost and needs for personnel

Minimize loss of lives and property

Eliminate the deficiencies and downsides of the current system.

Stakeholders;

Marine pilots

Port Management

VTS Personnel

Ships Crew

AV pilot (System operator)

What is going on ?
What is wrong?

- **Spend a night** in the mouth of the Chesapeake Bay waiting for the inbound cargo ships

- VTS must allocate **a noticeable time to schedule** the marine pilots.

- **Delays** in-bound/ out-bound **vessels**

- **Climbing up/down the pilot ladders is risky and could jeopardize the marine pilot's life**

Launches and Rope ladders

SLOW
UNSAFE

Stakeholders Needs

FORM – 001- PILOTAGE NEED ANALYSIS QUESTIONNARIE MAR-2019

The objective of this survey is to collect valid information about port of Baltimore pilotage operation. The collected data may be used by Johns Hopkins University in order to develop cutting-edge technology to promote port safety and its operational capabilities.

Personal details

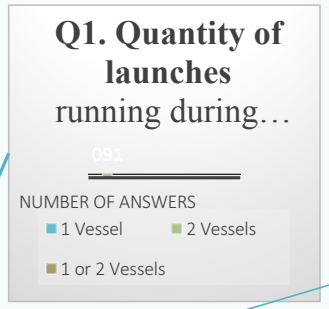
Name: **Nick Nielson** Organizational Rank/position: **President of Association of Maryland Pilots**

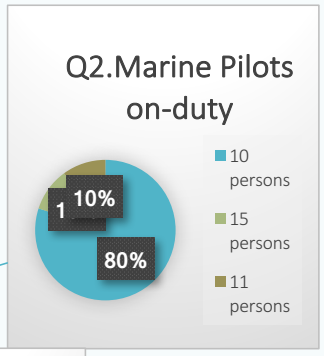
1. How many pilot vessels are operationally running during each shift work? (No matter how many hours each shift work is)
   1 or 2
2. How many marine pilots are on-call/standing by during routine operations? If you don't know the exact number, please chose one of the followings 10 to 20
3. How much fuel would be the average monthly consumption of a pilot boat? Less than 200 gallons and about ……. gallons

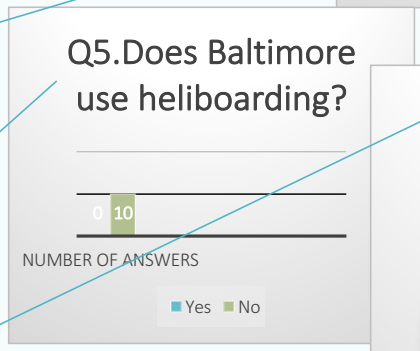
a) 200 gallons to 500 gallons ☐
b) 500 gallons to 1000 gallons ☐
c) More than 1000 gallons ☐
Not answered – sensitive data

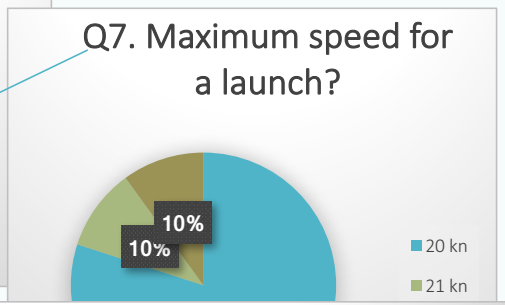
4. How much is the yearly maintenance cost for each pilot boat? Not answered – sensitive data
5. Does the port of Baltimore use heliboarding for pilot embarkation/disembarkation operations? If yes, how much does it cost each time? No, it does not
6. On average, how many pilotage operations does the port of Baltimore have per day? Not answered – sensitive data
7. What is the maximum speed of a pilot boat? The maximum speed that we operate our launches is 20 Kn.
8. As per local regulations, what is the maximum boarding speed? Not more than 8 Kn
9. How many accidents did you have reported regarding pilot embarkation/disembarkation in the past five years? Not answered – sensitive data How about near accidents? Not answered – sensitive data
10. Are the bay pilots relieved by the harbor pilots before docking operations? Yes
11. What do you believe is the "hiccup" in the port of Baltimore in terms of pilot embarkation/disembarkation? Pls mention technical incapability's.
    Unlike many industries, piloting has changed rather little over the millennium. We still climb up the side of a ship using a rope ladder, a risky task you have get used to it.

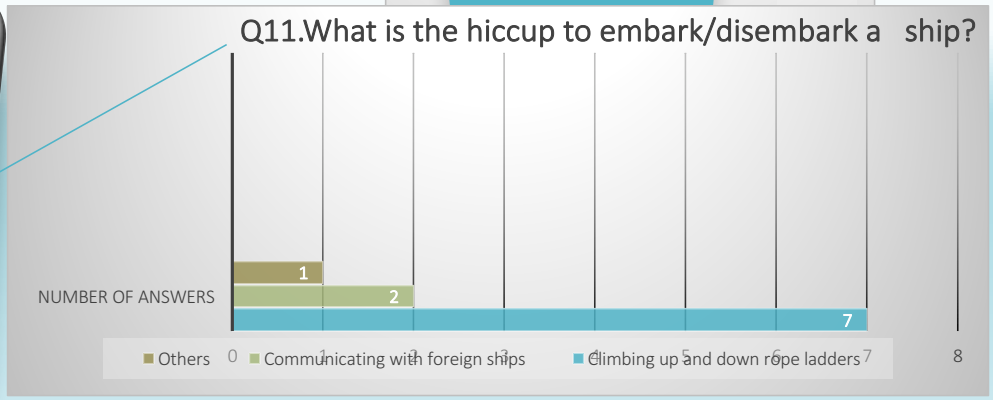
Researcher: Amir Bijandi





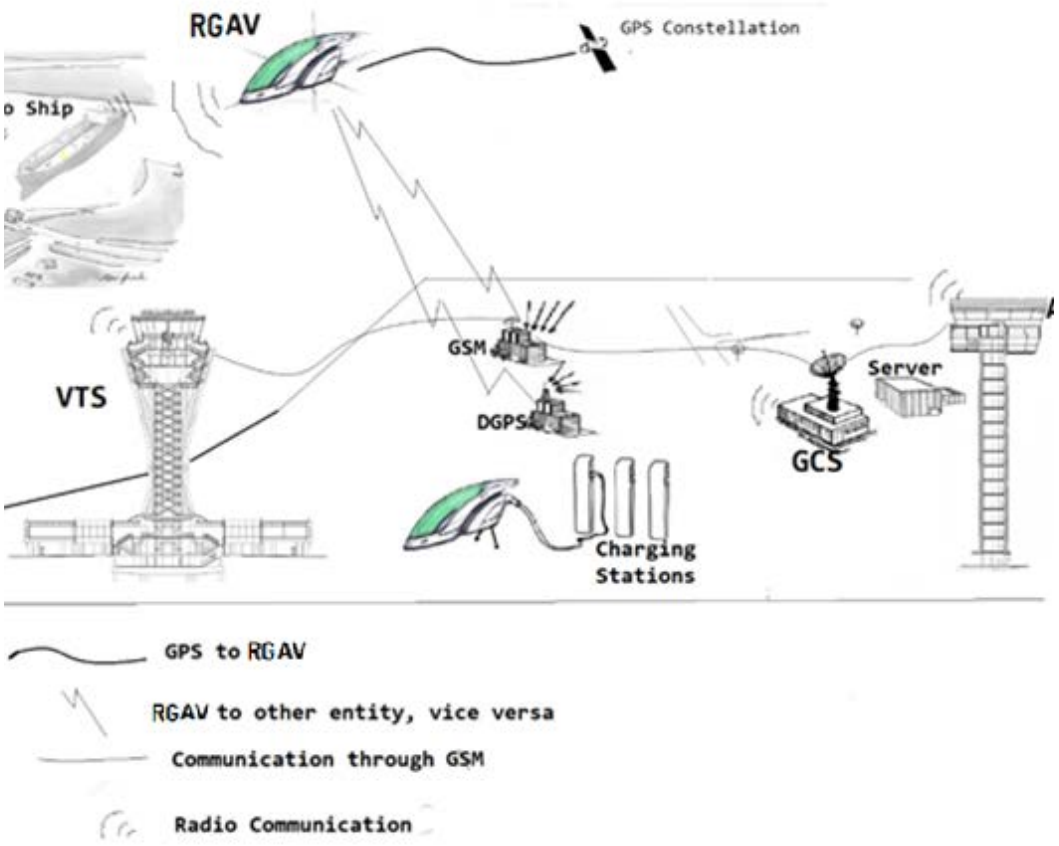






Results

Question	Discerption	Mean result	Result considered
1	Number of launches are currently used	1.9	2 Launches
2	How many marine pilots are needed	10.6	11 pilots
3	The average consumption of a pilot boat	Sensitive information	100 gph (50 gph for each launch)
4	Yearly maintenance cost of a pilot boat in the port of Baltimore	Sensitive information	$55k
5	Any alternative system is currently used	NA	NO
6	How many pilot operations per day	Sensitive information	18 operation per day
7	Maximum traveling speed of the current system	20	20kn
8	Maximum boarding speed	8	8 kn
9	Number of incidents related to the current system	Sensitive data	46% of all incidents
10	If the bay pilots relieved by the harbor pilots	Yes	Yes
11	What is the most noticeable downside with the present system	70 % mentioned, Climbing up and down rope ladders	Climbing up and down rope ladders



Initial ConOps

Utilize VTOL capabilities to transfer MPs

Autonomously Schedule MP

Autonomously picks the fastest available RGAV

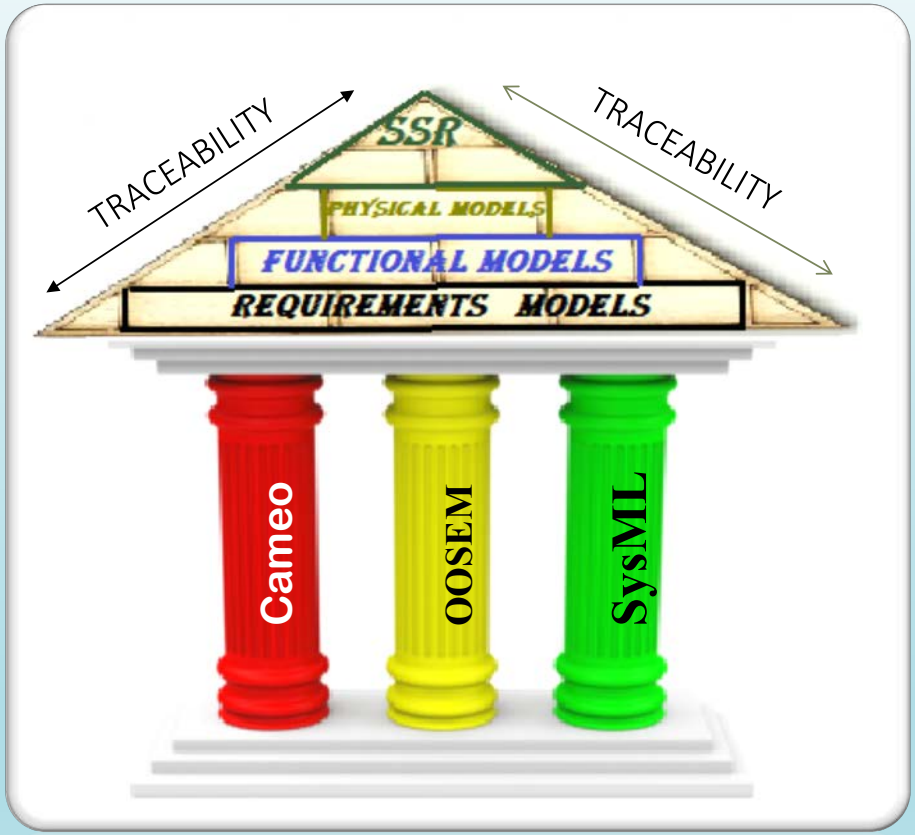
Autonomously charge/refuel RGAV

Comply with Safety/Security measures (ISPSS Code, FAA Rules, IMO Regulations,…)

Cost-effective comparing to Launches and rope ladder

Faster and Safer

LET’S WATCH THE VIDEO



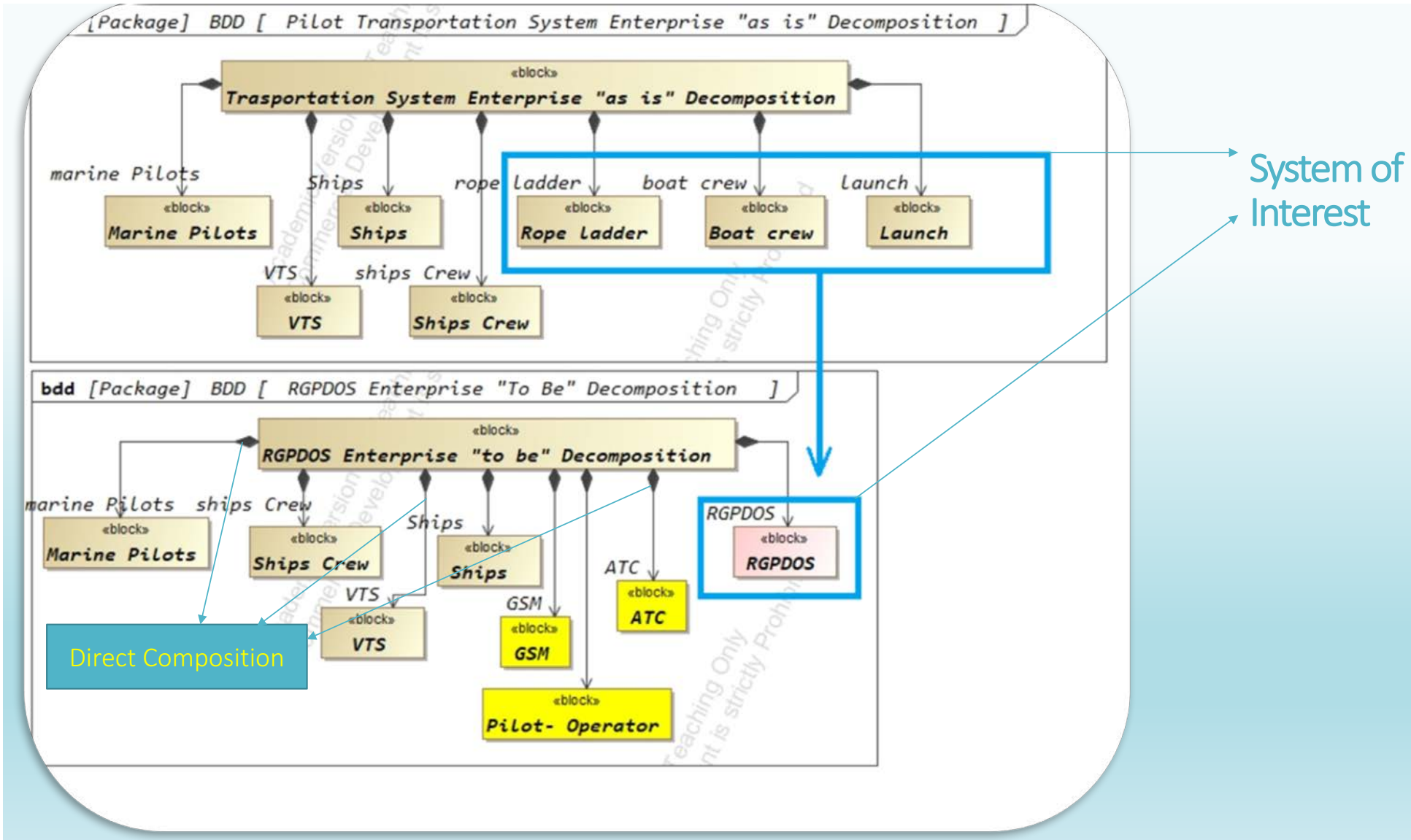
How We Modeled?

MBSE

Methodology

Tool

Language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Trasportation System Enterprise "as is" Decomposition
marine Pilots
Ships
rope ladder
boat crew
launch
«block»
Marine Pilots
«block»
Ships
«block»
Rope ladder
«block»
Boat crew
«block»
Launch
VTS
ships Crew
«block»
VTS
«block»
Ships Crew
System of Interest
bdd [Package] BDD [RGPDOS Enterprise "To Be" Decomposition]
«block»
RGPDOS Enterprise "to be" Decomposition
marine Pilots
ships Crew
Ships
RGPDOS
«block»
Marine Pilots
«block»
Ships Crew
«block»
Ships
«block»
RGPDOS
ATC
VTS
GSM
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ATC
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VTS
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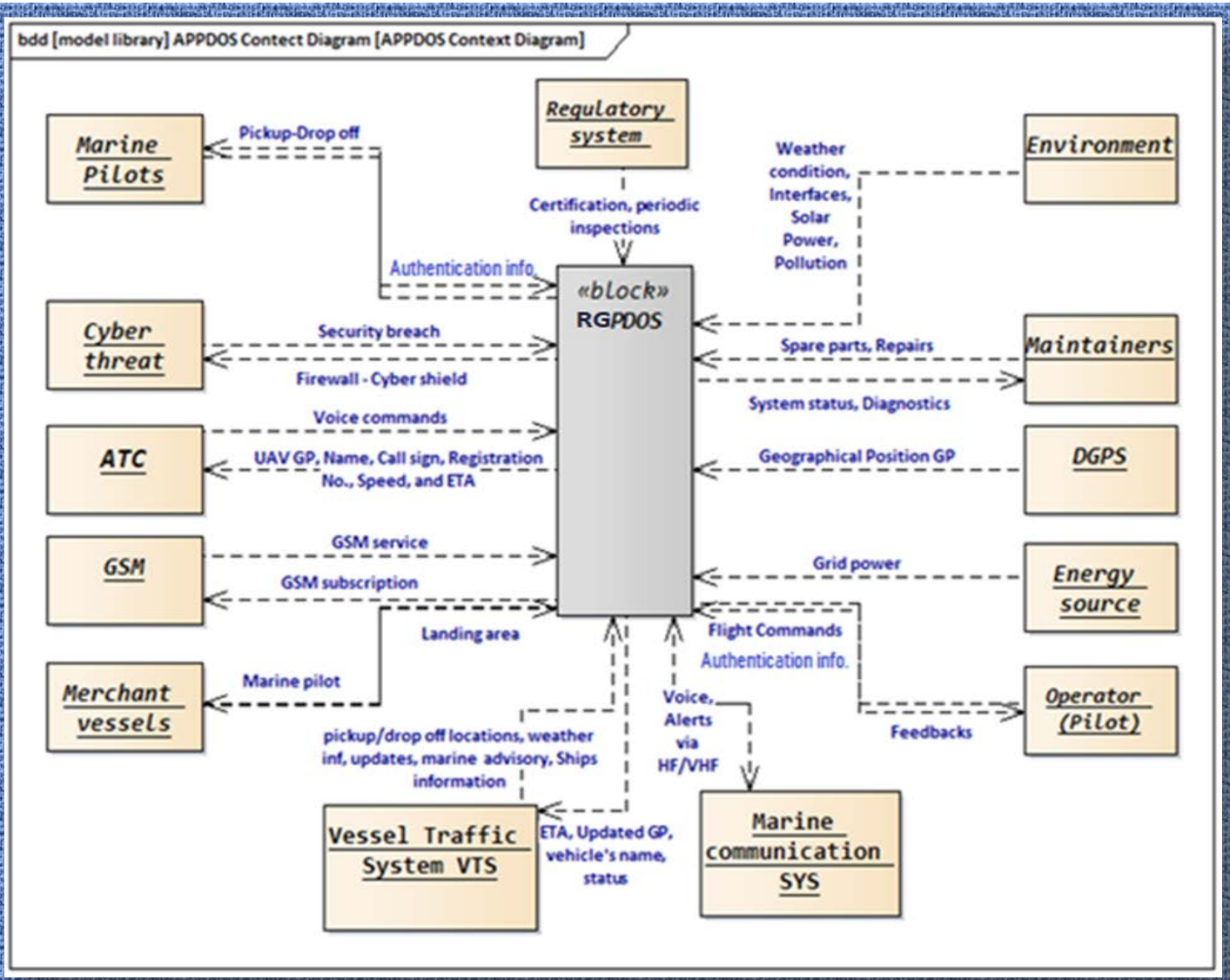
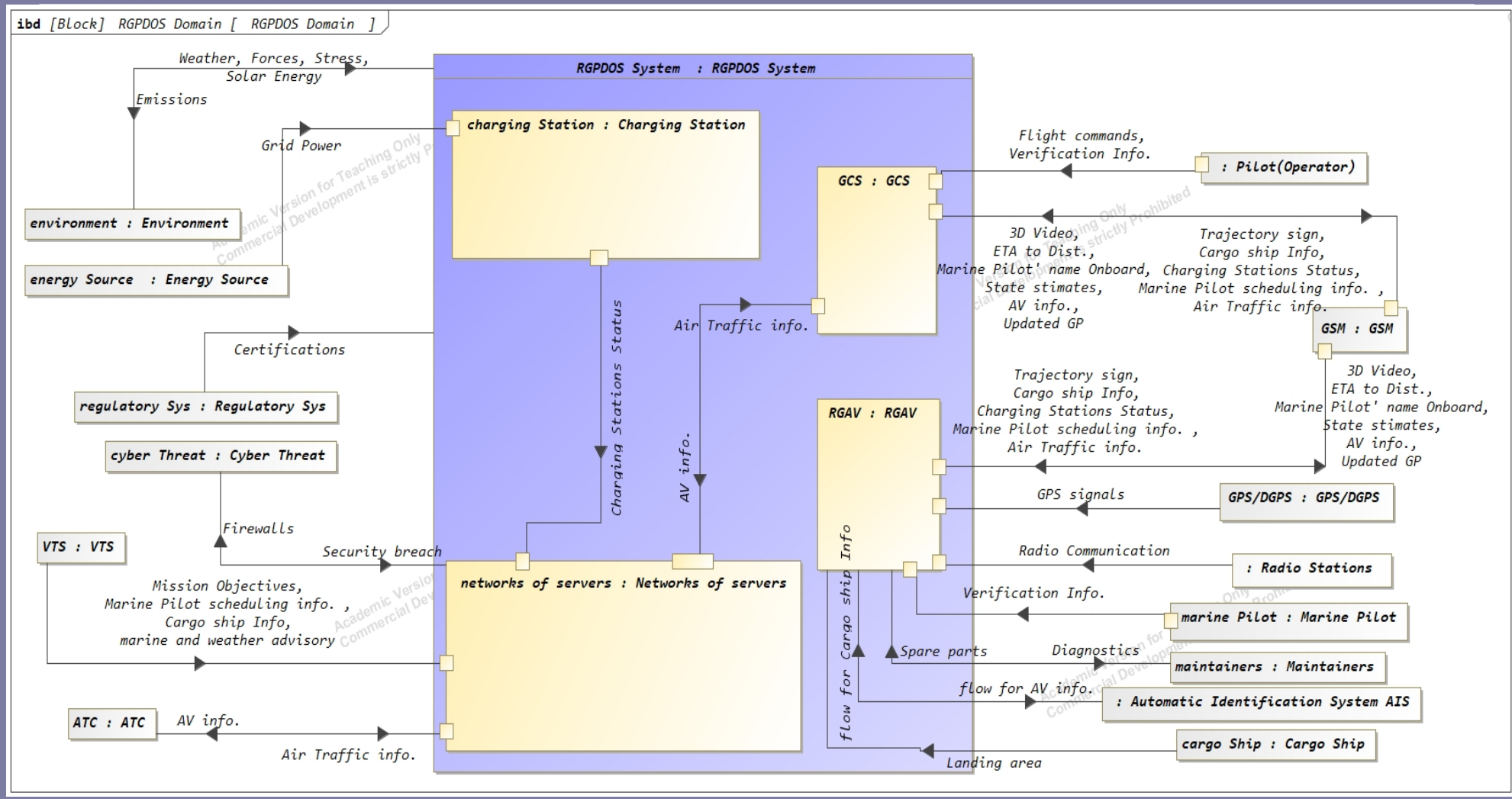
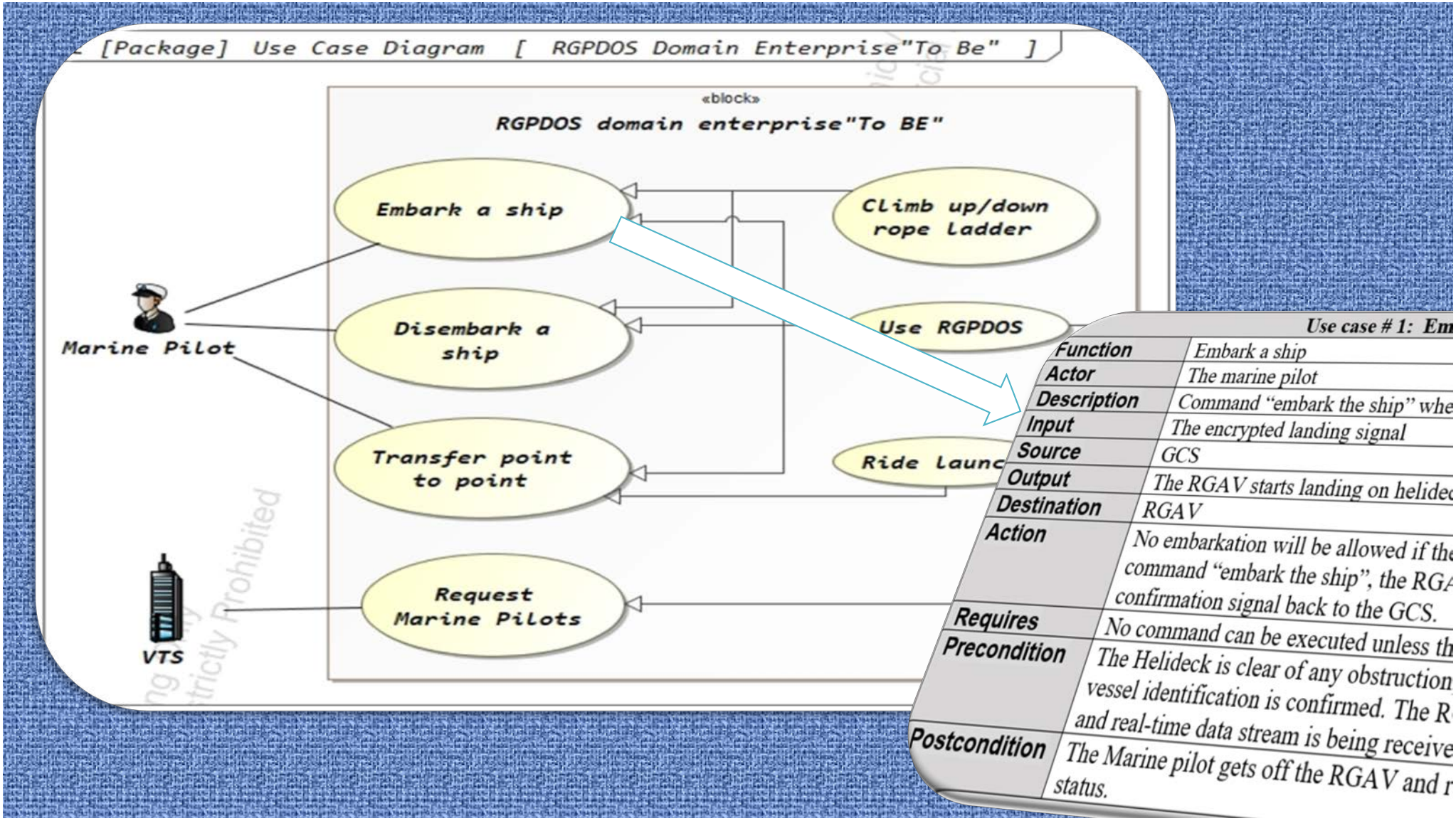
GSM
Direct Composition
«block»
Pilot- Operator



High-level context diagram (Black box)

Conceptual Block Diagram




[Package] Use Case Diagram [RGPDOS Domain Enterprise"To Be"]
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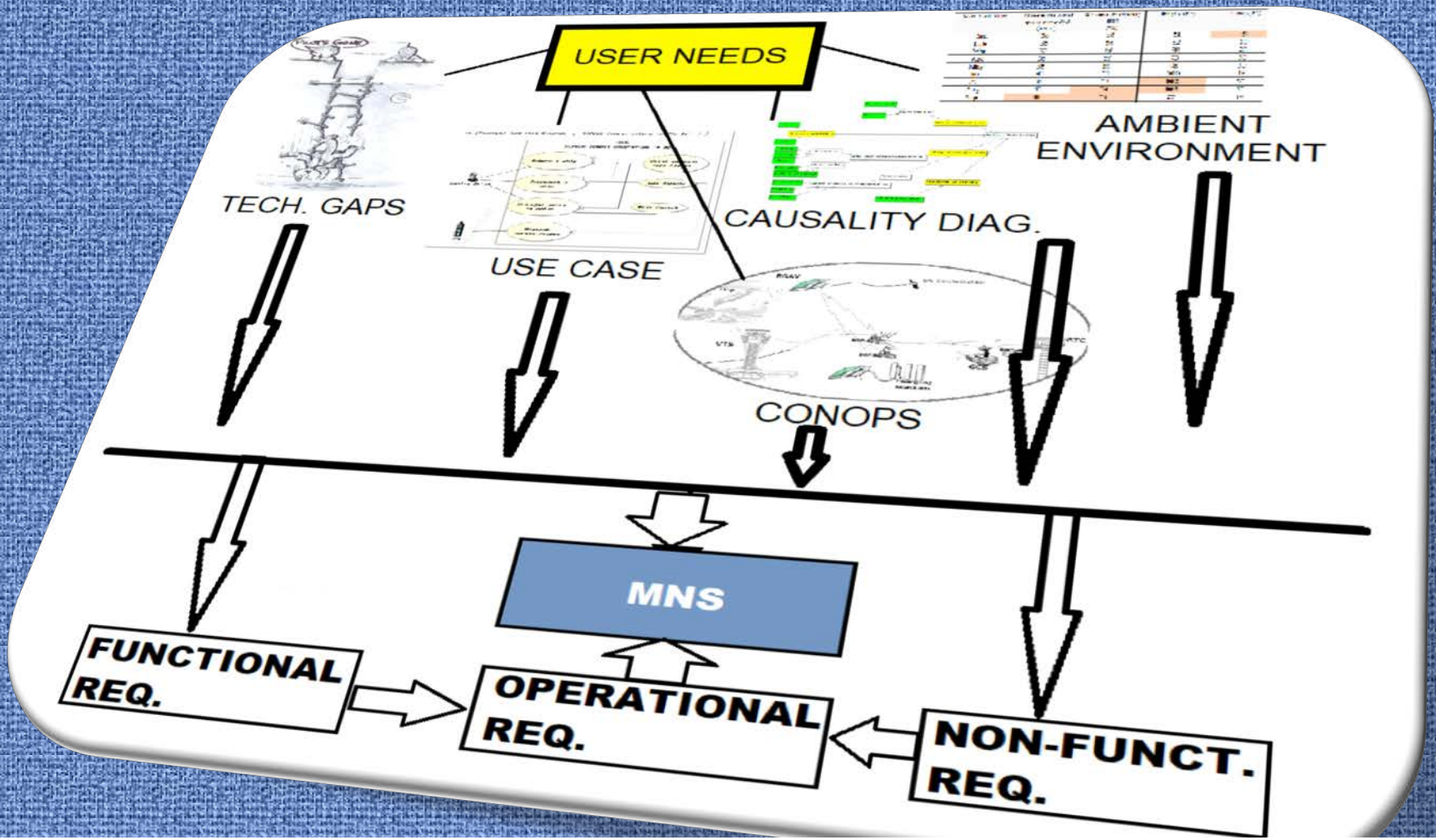
RGPDOS domain enterprise"To BE"
Embark a ship
Climb up/down rope ladder
Disembark a ship
Use RGPDOS
Transfer point to point
Ride launc
Request Marine Pilots
Marine Pilot
VTS
Use case # 1: Em
Function
Embark a ship
Actor
The marine pilot
Description
Command "embark the ship" whe
Input
The encrypted landing signal
Source
GCS
Output
The RGAV starts landing on helide
Destination
RGAV
Action
No embarkation will be allowed if the command "embark the ship", the RGA confirmation signal back to the GCS.
Requires
No command can be executed unless th
Precondition
The Helideck is clear of any obstruction vessel identification is confirmed. The R and real-time data stream is being receive
Postcondition
The Marine pilot gets off the RGAV and r status.

Requirement Development



KPP

NOT NEGOTIABLE

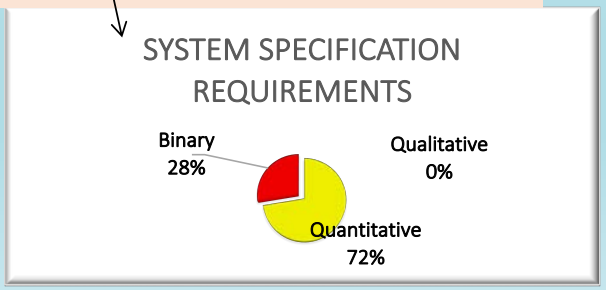
Key Performance Parameters KPP				
Req. ID	Requirements Title	Requirement Text	Threshold	Objective
1.1	System availability	The RGPDOS shall have a system availability ≥99.8 %.	System availability of 99.8%	System availability of 100%
1.2.1	Fast transportation Harbor to PBA	The RGPGOS shall transfer marine pilots from harbor to PBA in less than 2 h(T)	2h	1h
1.2.2	Fast transportation PBA to Harbor	The RGPGOS shall transfer marine pilots from PBA to harbor in less than 2 h.(T)	2h	1h
1.2.3	Fast transportation	The RGPGOS shall transfer marine pilots from a ship to a ship in the PBA in less than 0.5h(T)	30 min	15min
1.27	Retrieval of information	The system shall enable retrieval of information about marine pilot transportations as needed by the port administration.	Data available for ≥ 6 months	Data available since system inception
3.22	Clean source of energy	The RGPDOS shall use a clean source of energy in order to comply with 40 CFR-part 87, CONTROL OF AIR POLLUTION FROM AIRCRAFT AND AIRCRAFT ENGINES.	comply with 40 CFR-part 87, CONTROL OF AIR POLLUTION FROM AIRCRAFT AND AIRCRAFT ENGINES.	Zero emission and no air pollutant.

Requirements Sample

ID	Row #	Requirement Name	Requirement Statement R	Type	Traceability	KPP	Verification Method	Function ID	Function Name F	Pa P
1.0 OPERATIONAL REQUIREMENTS										
1.1	1.	System availability	The RGPDOS shall have a system availability of ≥99.80 %.	NO	0.7	X	A	7.0 7.8.3 7.8.4	Support maintenance Switch to EP Switch back to main power	4.0 RGAV Subsystem 3.0 EP 4.8 Flight Computer 4.19 RGAV Diagnostics 3.5 EP Diagnostics 2.4 GCS Diagnostics 5.5 NWS Diagnostics
1.2	Fast Transportation									
1.2.1	2.	Fast transportation Harbor to PBA	The RGPGOS shall transfer marine pilots from harbor to PBA in less than 2 h(T)	NO	0.1 0.4 UCS01	X	T	5.0	Transfer MP	4.0 RGAV Subsystem 2.0 GCS
1.2.2	3.	Fast transportation PBA to Harbor	The RGPGOS shall transfer marine pilots from PBA to harbor in less than 2 h.(T)	NO	0.1 04 UCS02	X	T	5.0	Transfer MP	4.0 RGAV Subsystem 2.0 GCS
1.26	28.	Encrypted communication	The internal communication of the system with mobilized component(s) used to transport the marine pilot shall be encrypted by 128 bit(T)/ 256bit(O)	NO	0.5	X	A	5.1.3.2	Encrypt real-time codes	4.4 OBSS On-Board Security Sys
1.27	29.	Retrieval of information	The system shall enable retrieval of information about marine pilot transportations and access to the system pertaining to the last 180 days as needed by the port administration.	NO	0.9	X	T	12.0 12.6 12.6.1 12.6.2 12.6.3	Archive data Store data Compress data Format data Save data	4.20.5 Flight data recorder 5.2 Server CPU 5.2.1 Network operating software 5.6 Cache memory
2.0 Functional Requirements										
2.11.2	12.	Flight range	The system shall be able to accomplish a flight range ≥ 150(O) nm/145nm(T) Flight range is the maximum distance that the RGAV can fly without stopping while at maximum carrying capacity.	BI	1.5		T	5.4.2.5	Fly a required flight path while carrying a payload	4.8.1 AV software 4.8 Flight Computer 4.15 Steering systems

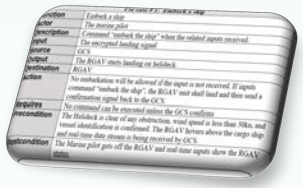
Requirement Development

Project Stage	Total	Quantitative	%	Binary	Qualitative
Requirements Analysis Report	144	**61**	42	28	55
Functional Analysis Report	184	83	45	35	67
Trade Study	190	87	46	36	67
Conceptual Design Report	195	90	46	37	68
System Specifications	239	173	72	66	0
Risk Management	240	174	73	66	0
Test Plan	245	179	73	66	0
Final	**245**	**179**	**73**	**66**	**0**



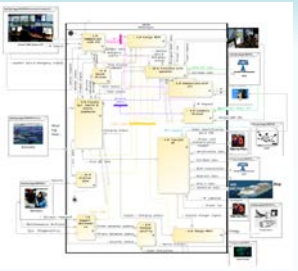
Functional Development

Use Case

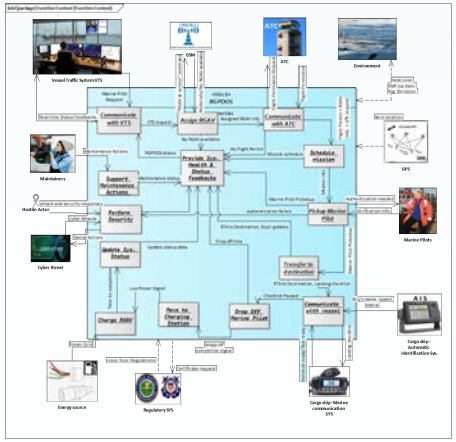


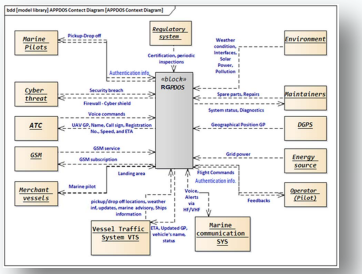
ConOps

Zero-Level Functional flow

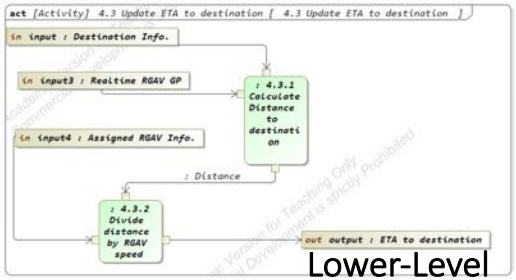


Functional Context

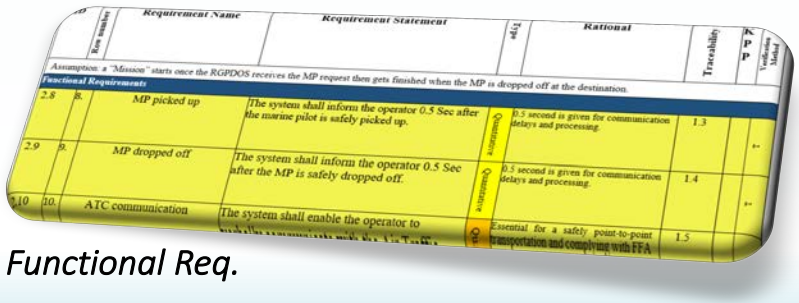




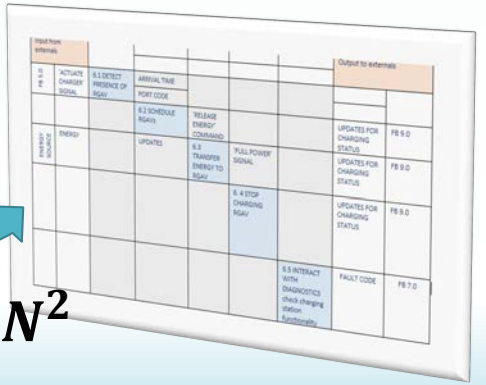
Black Box



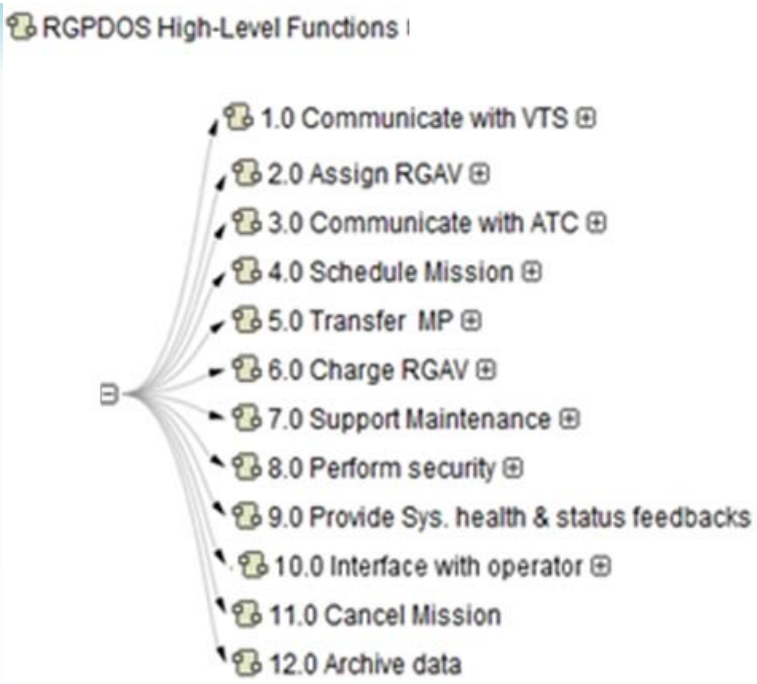
Lower-Level Functional flow



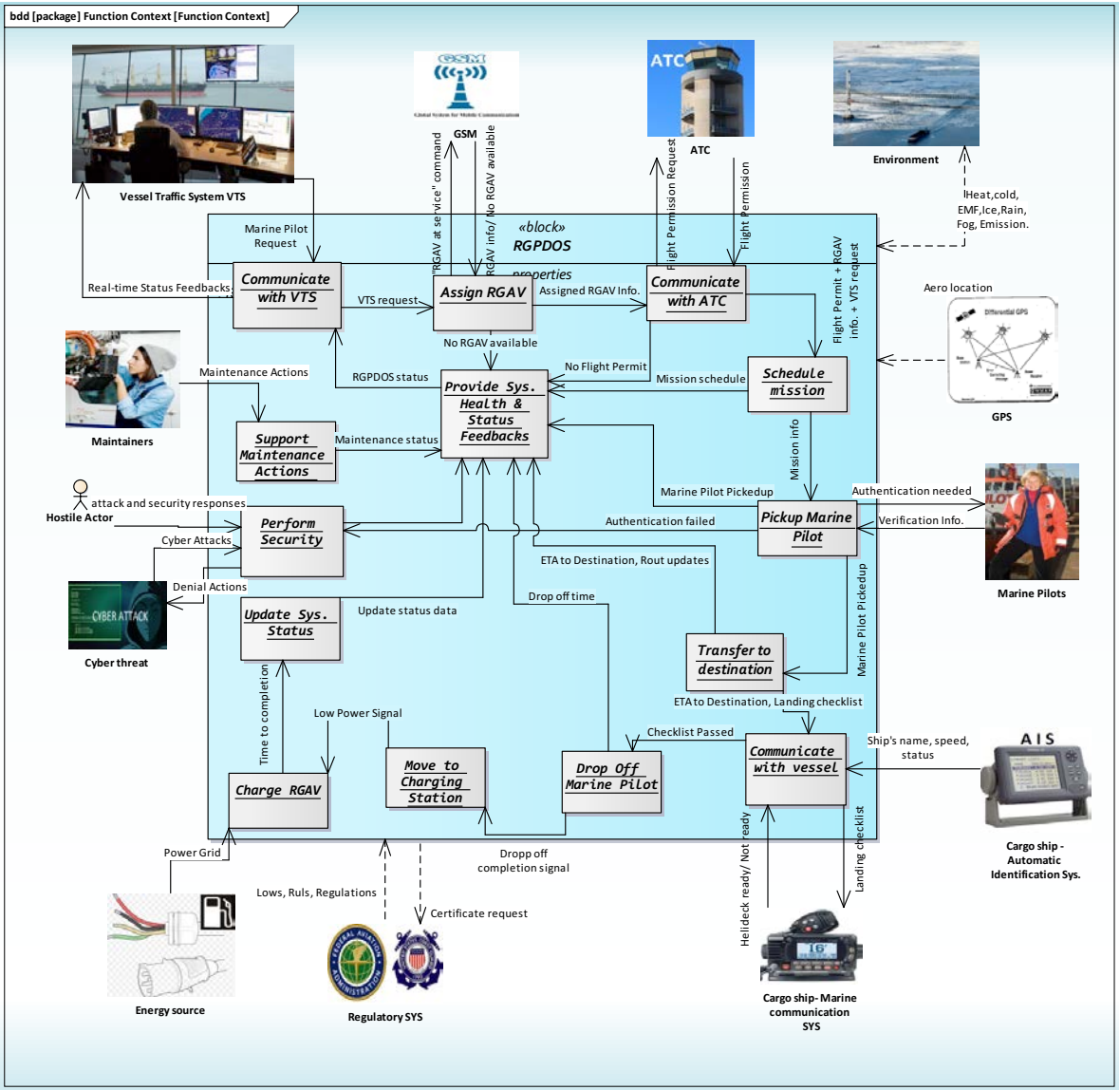
Functional Req.



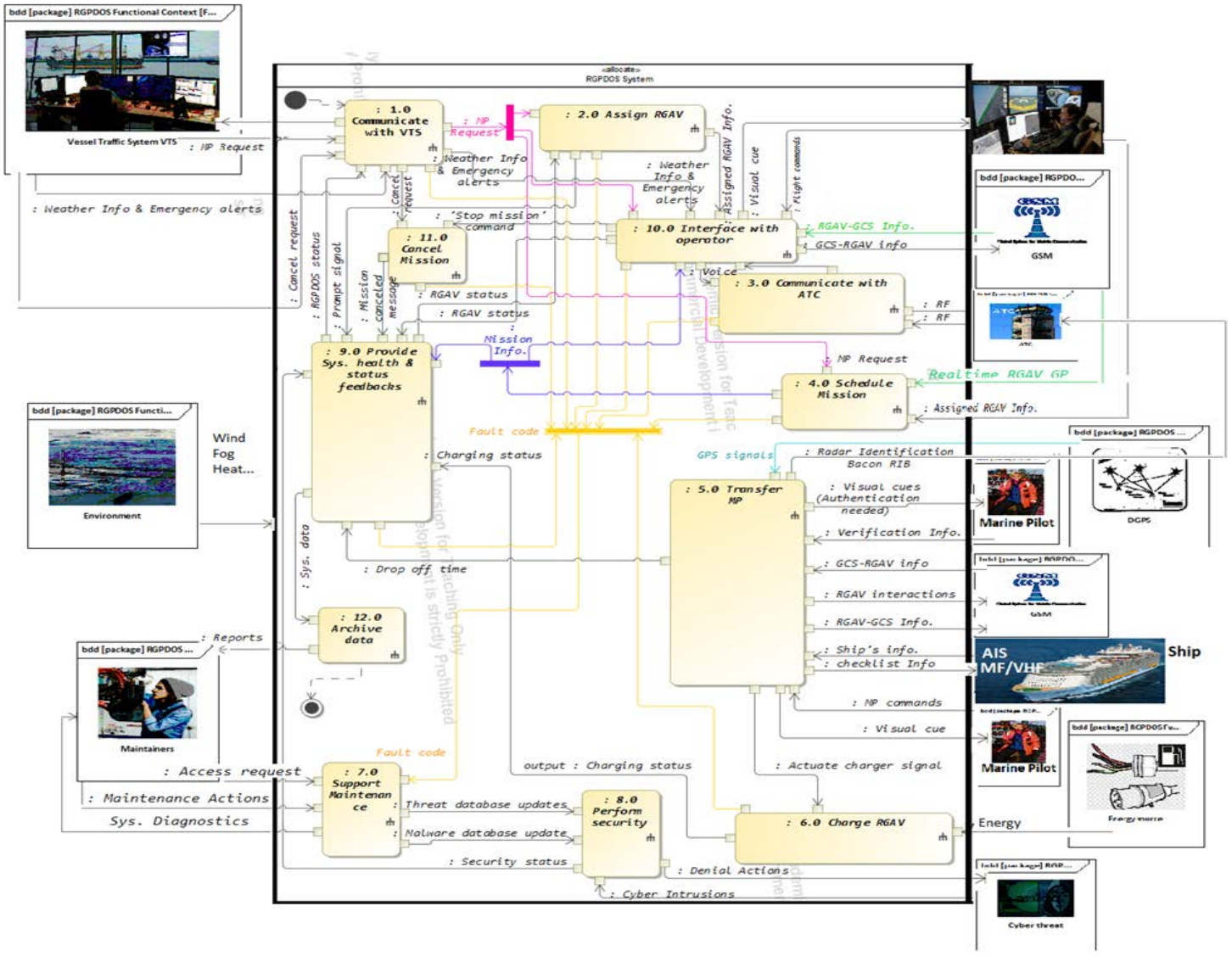
N^2

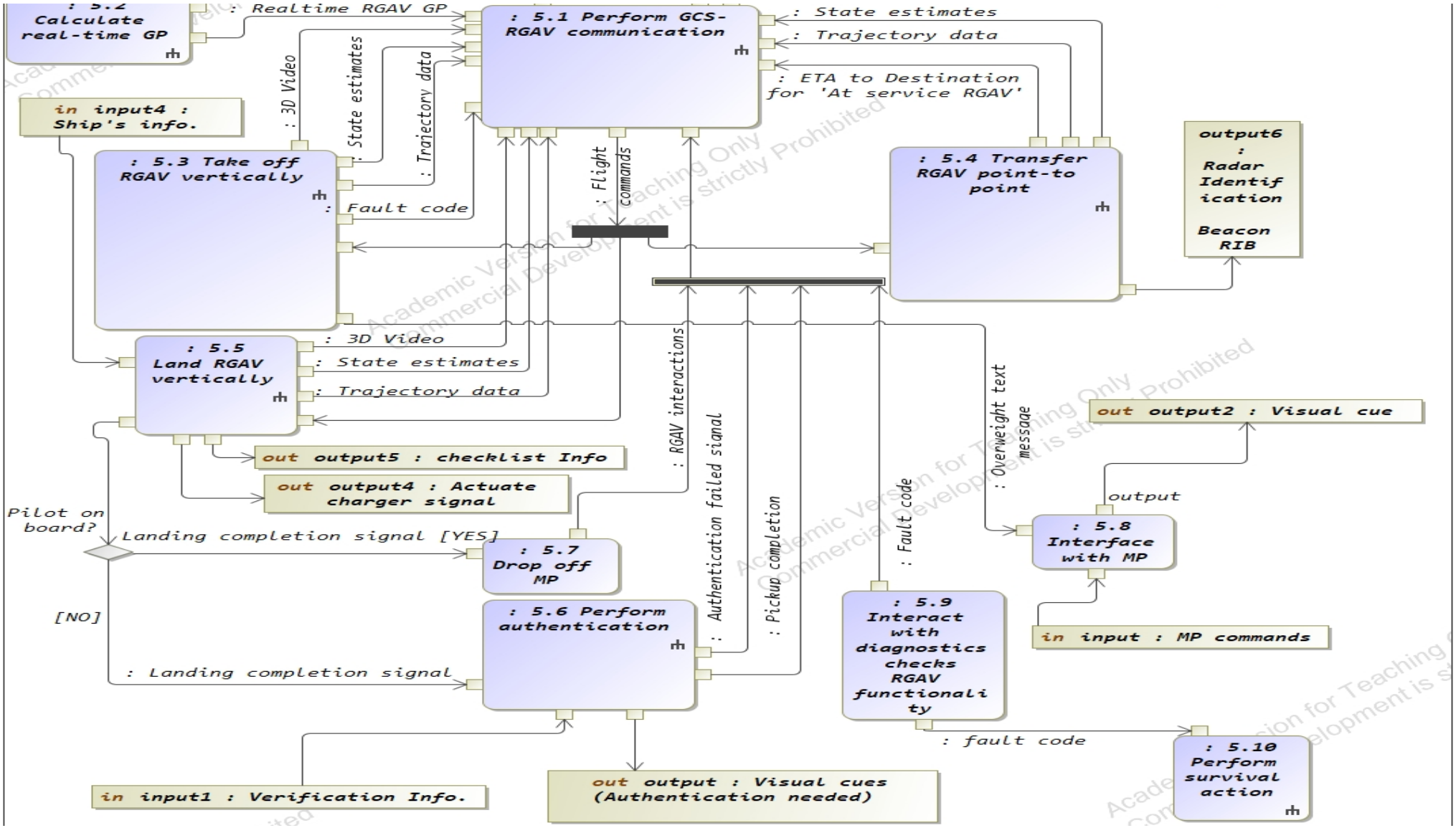


Functional Context Diagram



Functional flow Diagram (Level Zero)




: 5.2 Calculate real-time GP
: Realtime RGAV GP
: 5.1 Perform GCS-RGAV communication
: State estimates
: Trajectory data
: ETA to Destination for 'At service RGAV'
in input4 : Ship's info.
: 3D Video
: State estimates
: Trajectory data
: 5.3 Take off RGAV vertically
: Fault code
: Flight commands
: 5.4 Transfer RGAV point-to point
output6 : Radar Identification Beacon RIB
: 5.5 Land RGAV vertically
: 3D Video
: State estimates
: Trajectory data
: RGAV interactions
: Overweight text message
out output2 : Visual cue
out output5 : checklist Info
out output4 : Actuate charger signal
output
Pilot on board?
Landing completion signal [YES]
: 5.7 Drop off MP
: 5.8 Interface with MP
[NO]
: 5.6 Perform authentication
: Authentication failed signal
: Pickup completion
: Fault code
: 5.9 Interact with diagnostics checks RGAV functionality
in input : MP commands
: Landing completion signal
: fault code
: 5.10 Perform survival action
in input1 : Verification Info.
out output : Visual cues (Authentication needed)

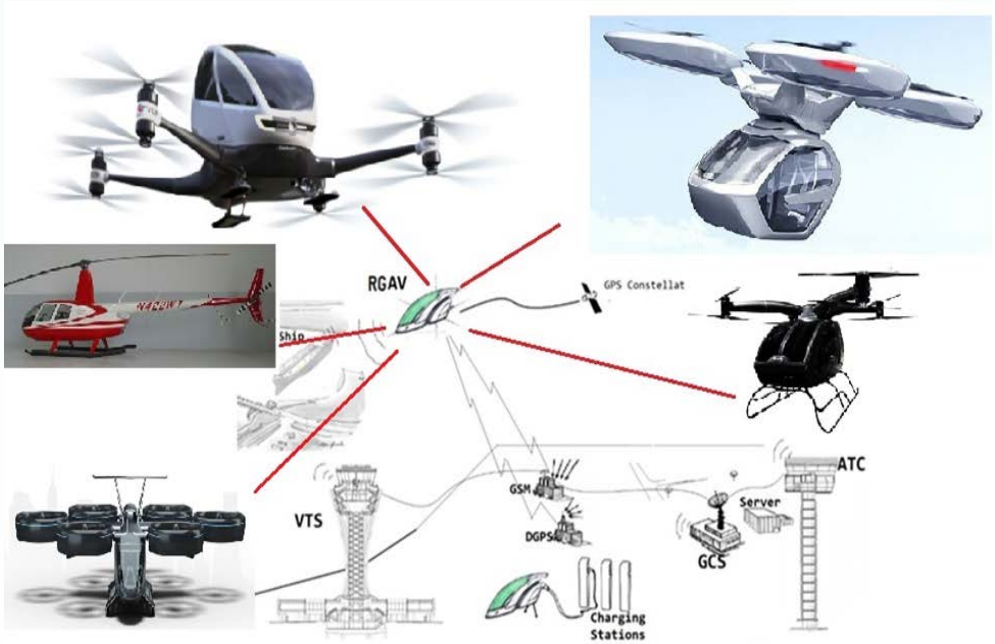
Trade Study

Formal :

What technology can be the best ???
VTOL capability & point-to-point transport

Informal:

- Cost-effective Energy source
- Charging stations functionalities.
- High-range wireless communication

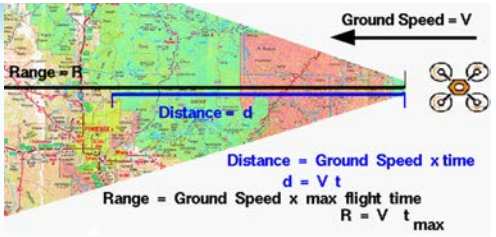


CRITERIA

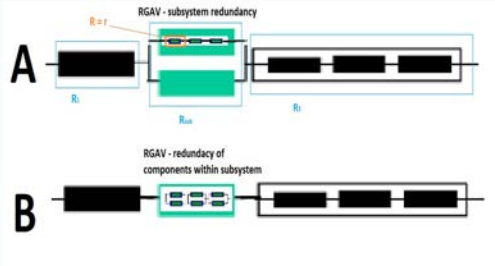
SELECTION CRITERIA TO SYSTEM REQUIREMENTS TRACEABILTY MATRIX

REQ. ID	Requirement Name	Requirement Statement	Type	Rational	Category	KPP
Revisions: N= New	R= Revisions	E= Existing				
Maximum Flight Range						
0.4	Cost-effective system of transportation	Provide a system to reduce the need for personnel and cut down the total cost in order to increase the system cost-efficiency.	QL	Higher ranges reduce the need for numbers of charging stations and RGAV units.	E	
1.2.1	Fast transportation Harbor to PBA	The RGPGOS shall transfer marine pilots from harbor to PBA in less than 2 h(T)	QN	Enable continuously fly along the path without unnecessary landings for refuel/recharge. Enable to increase average speed.	E	X
1.2.2	Fast transportation PBA to Harbor	The RGPGOS shall transfer marine pilots from PBA to harbor in less than 2 h.(T)	QN	Enable continuously fly along the path without unnecessary landings for refuel/recharge. Enable to increase average speed.	E	X
1.2.3	Fast transportation STS	The RGPGOS shall transfer marine pilots from a ship to a ship in the PBA in less than 0.5h(T)	QN	Enable continuously fly along the path without unnecessary landings for refuel/recharge. Enable to increase average speed.	E	X
1.5	Safe point-to- point transportation	The RGPDOS shall safely transport the marine pilot from harbor to the Pilot Boarding Area PBA and vice versa	QL	High ranges enable to accomplish this mission.	E	X
2.1	Number of missions per day	The system shall be capable of accomplishing 40 missions per 24h.	QN	More numbers of missions can be accomplished with high ranges	E	
2.11.2	Flight range	The system shall be able to accomplish a flight range greater than 145 nm	BI	Enable to satisfy this requirement. (minimum acceptable range)	N	
Maximum takeoff weight						
0.3	Safe means of transportation	Provide a safe transportation system in order to comply with the regulatory system, Coast Guard and FAA Rules, and improve the safety of pilotage operations.	BI	Essential for a safe flight	E	
5.5	Demographic constraints	The system shall be able to safely transport a marine pilot and their accessories weigh up to 250lb with height of 7.0 ft or less	QN	Enable to satisfy this requirement. Minimum acceptable payload	E	

Max. Range



Reliability



Max. Takeoff Weight

Cruise Speed

Efficiency

Max. Capacity

R ID: 2.11.1
KPP: YES
Requirement Name: Flight Range
Statement : The system shall be able to accomplish
a flight Range $\geq 145\ nm$ when the reported wind is no greater than 5Kn

e VTOL BARTINI wins

N^{th} root

Trade Space

Alternatives

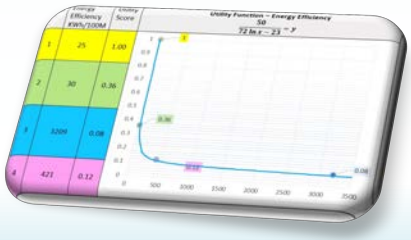
1.Lilium jet

2. Bartini

3.City hawk

4.helicopter R-22

Sensitivity Analysis

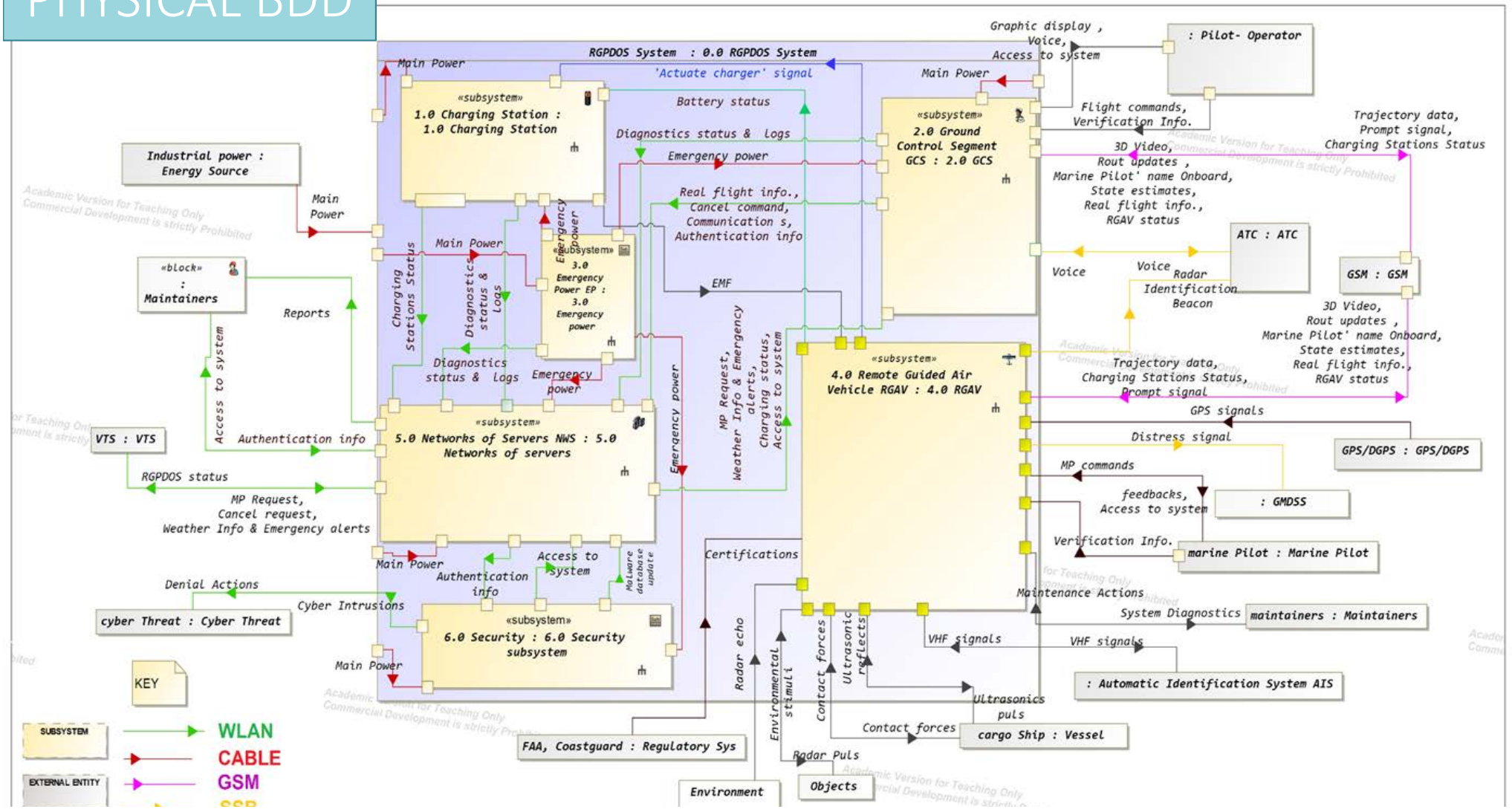


Utility Scores

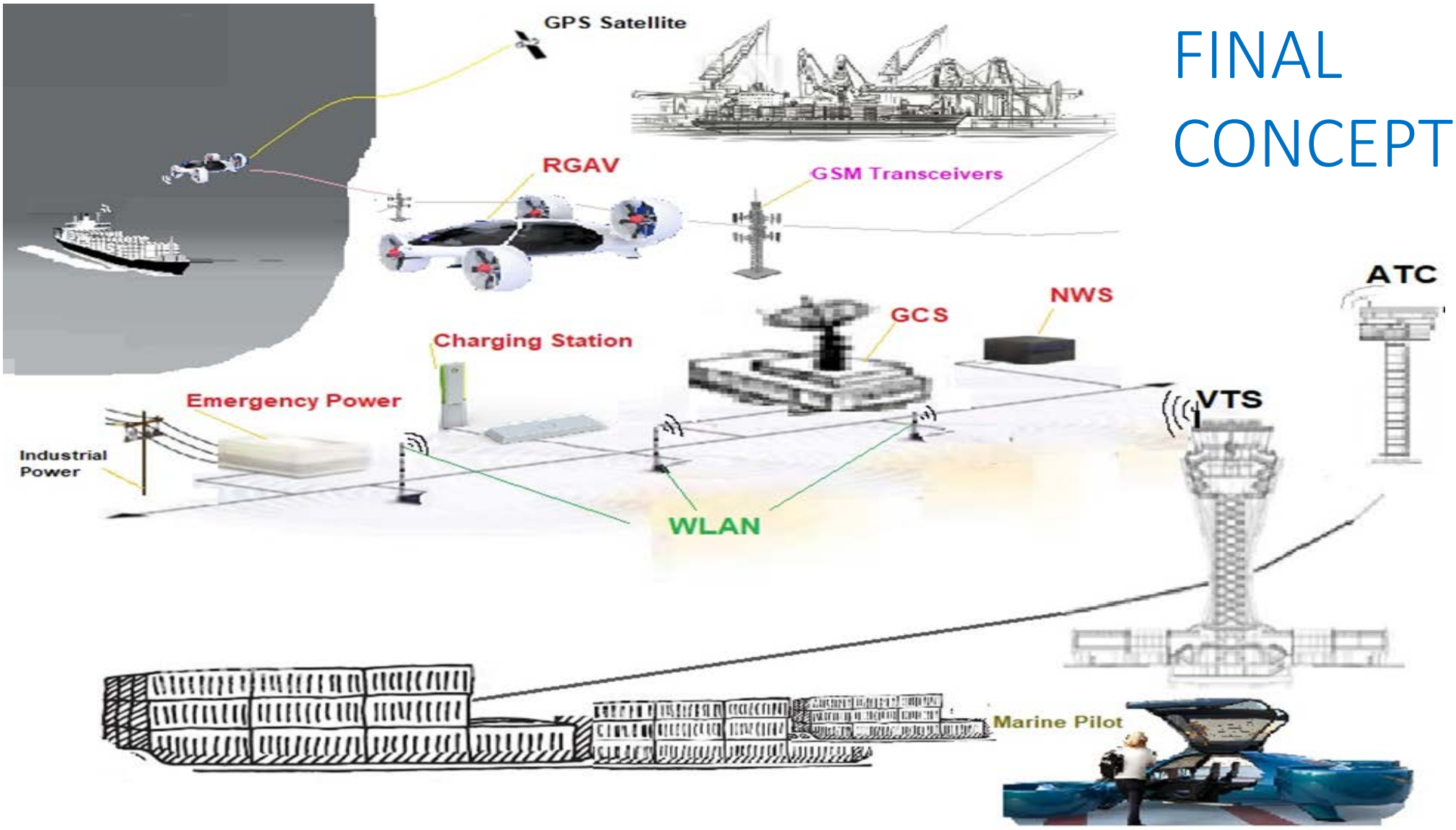
TTL Cost

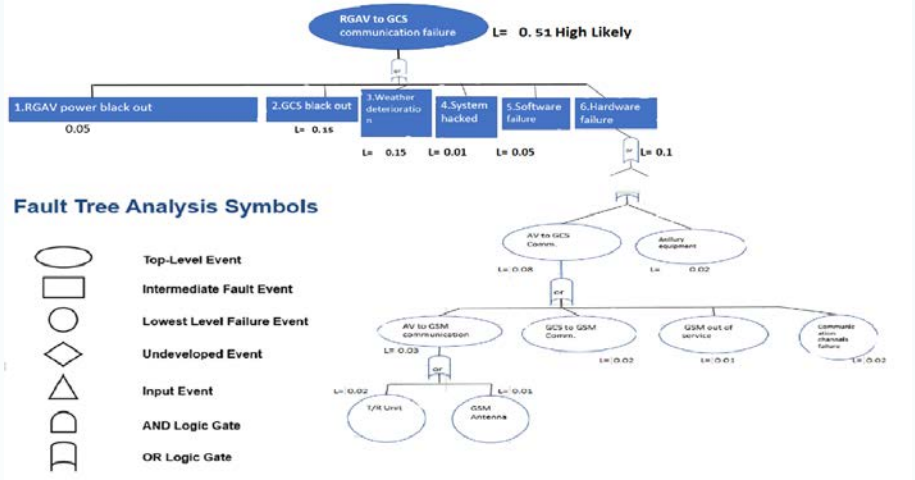
Combined Scores

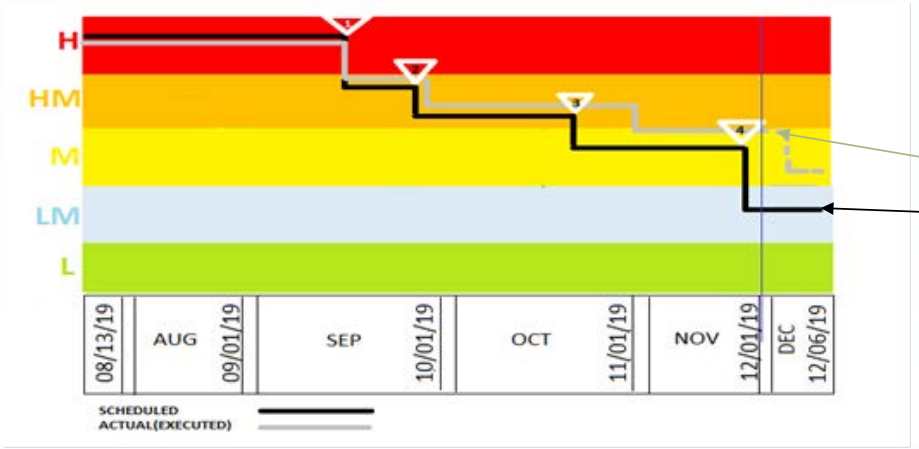
PHYSICAL BDD



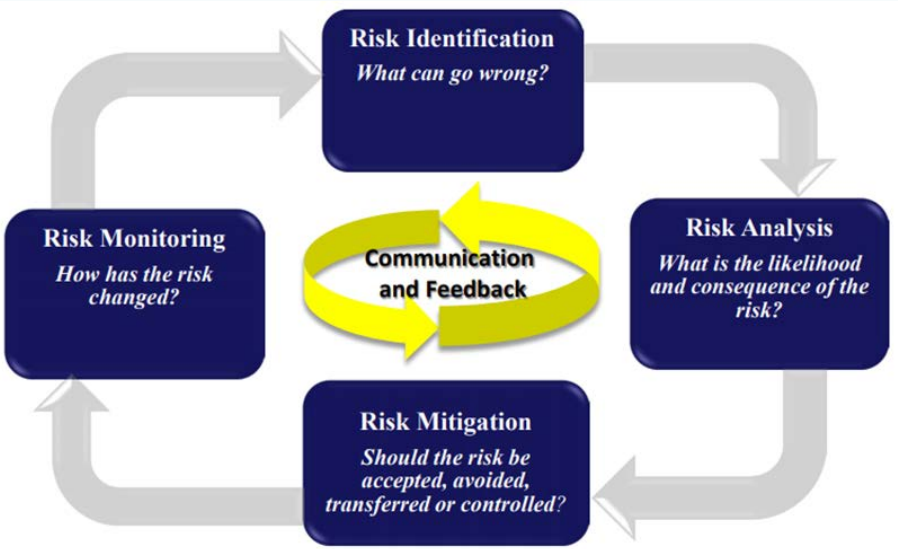
FINAL CONCEPT



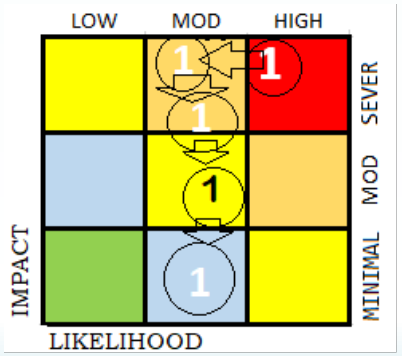




DOD RISK MANAGEMENT GUIDLINE



Risk Reduction Plan (Risk Control)					
Corrective Action	Description	Date		Risk Level If Successful	
		Execution	Scheduled	Likelihood	Impact
1	Risk identified and system requirement analyzed.	09/20/19	09/23/19	MOD	SEVER
2	Define and analyze system functional flows to determine input and outputs of remote guided functionality.	09/30/19	09/24/19	MOD	SEVER
3	Define redundancy based on RA & FA. Allocate a secondary means of communication to remotely guide the RGAV in Conceptual design phase.	11/01/19	10/25/19	MOD	MOD
4	Develop and execute the test plan.	12/03/19	11/29/19	MOD	MIN
Last Update: 12/01/19					



Final risk manifest			
Risk ID	**Title**	**Description**	**Type**
R001	GCS to RGAV Communication loss	If GCS lose communication with RGAV, The AV will not be remotely guided any longer.	Technical
R002	RGAV start-up failure on the cargo ship	If RGAV fails to start up for any reason when it is already landed on the cargo ship, the marine pilot will not be able to disembark, and the out-band vessel will take it away.	Technical
R003	RGAV subsystem failure	If RGAV technically fails, the Air Vehicle will crash.	Technical
R004	The VTS Communication loss	If the RGPDOS cannot communicate with VTS, the pilotage operation will be stopped.	Technical
R005	Charging station malfunction	If malfunction with the charging stations (out of power etc.), RGVA will not be charging.	Technical
R006	Course completion in two semesters	Due to taking another course simultaneously, and a full-time job, there is a potential that the completion of the project in two semesters may not be possible.	Project
R007	ATC communication loss	Loss of communication between the system and ATC makes the operator unable to ask for flight permit.	Technical
R008	Complexity of the system	If the complexity of RGPDOS is underestimated, the project might not be doable within budget and schedule.	Technical
R009	Security breach	Unknown trojans and hacker attacks may cause system down.	Technical
R010	Fatal crash	If the RGAV for any reason crashes the Marine pilots risk their lives.	Technical
R011	Unknown unknown	Unknown changes, threats, regulations are not identified in the preliminary risk assessment might urge along the path of project.	Technical Project
R012	Local power outage	If any residential power outage, system power shut down.	Technical

Project Management

Nov 3rd
BCWB-BCWS=
4860 – 5520 =
- 660
Behind Schedule

Dec 1st
Behind schedule
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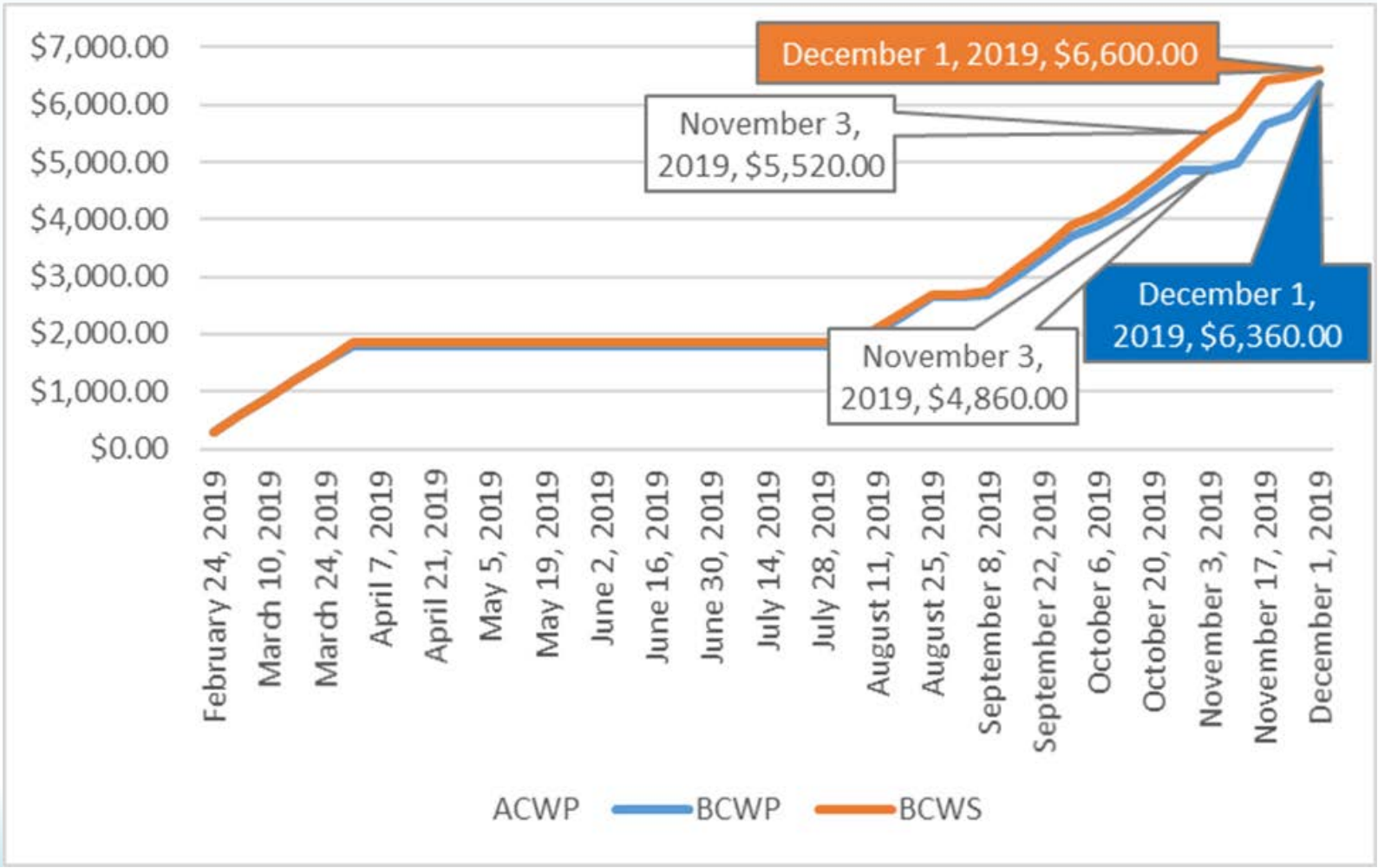


LESSONS LEARNED

1. Trade space is larger during early SE phase.
2. Information gathering in the need analysis stage is a risky task in terms of the schedule
3. Coupling and cohesions to cope with possibly unknown changes
4. Trade Study processes are not only used for simple market decisions
5. Magic Draw NOT support N^2 diagrams.
6. Error#400 with magic draw means that the modeling tools does not have enough memory allocated to work property.
7. so at the early stage of the SE process, we do not want to unnecessarily constrain our design.
8. Everything is linked to cost.

Recommendations

-**Include coding** in both M.S. SE program and **capstone project**

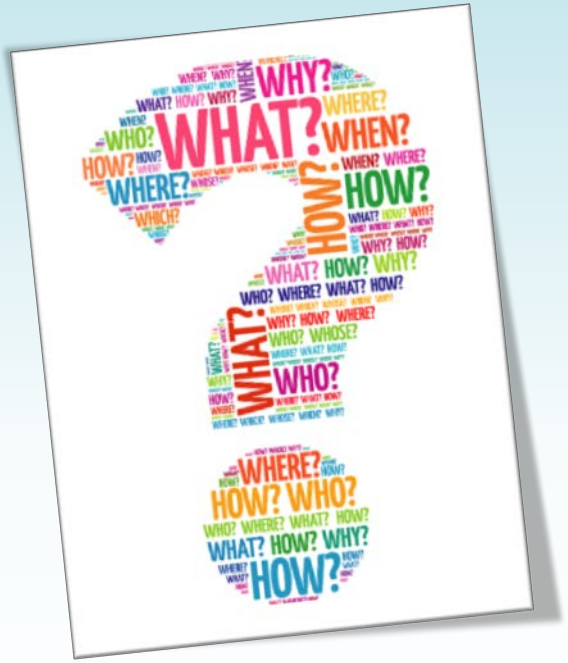
-**Establish correspondence** with agencies and **incorporations**

-**Require** SE student to use the Lab facility to conduct **at least one test case scenario**

-**Include MBSE** course in the core courses.

-**Award the best** project of each semester

-**Individual project** propelled me to apply SE processes **from NA to SSR for the first** time.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