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Autonomic Logistics Supporting Tactical Combat Vehicles in the MAGTF

Ed Crow, Penn State Applied Research Laboratory

CBM+ Working Group Meeting

Dec 12 2009

Agenda

USMC Autonomic Logistics

Embedded Platform Logistics System

Trials Supporting Autonomic Logistics

Value and Utility to Operational Availability and Combat Support

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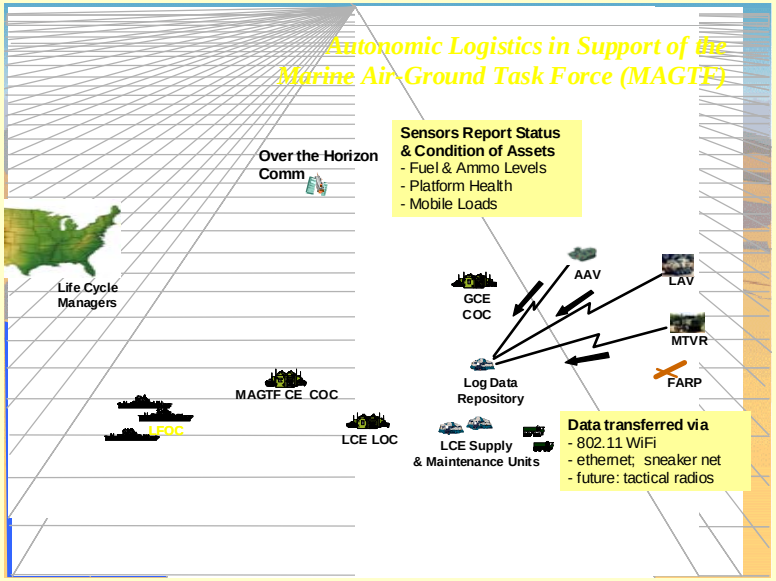
USMC Autonomic Logistics Requirement

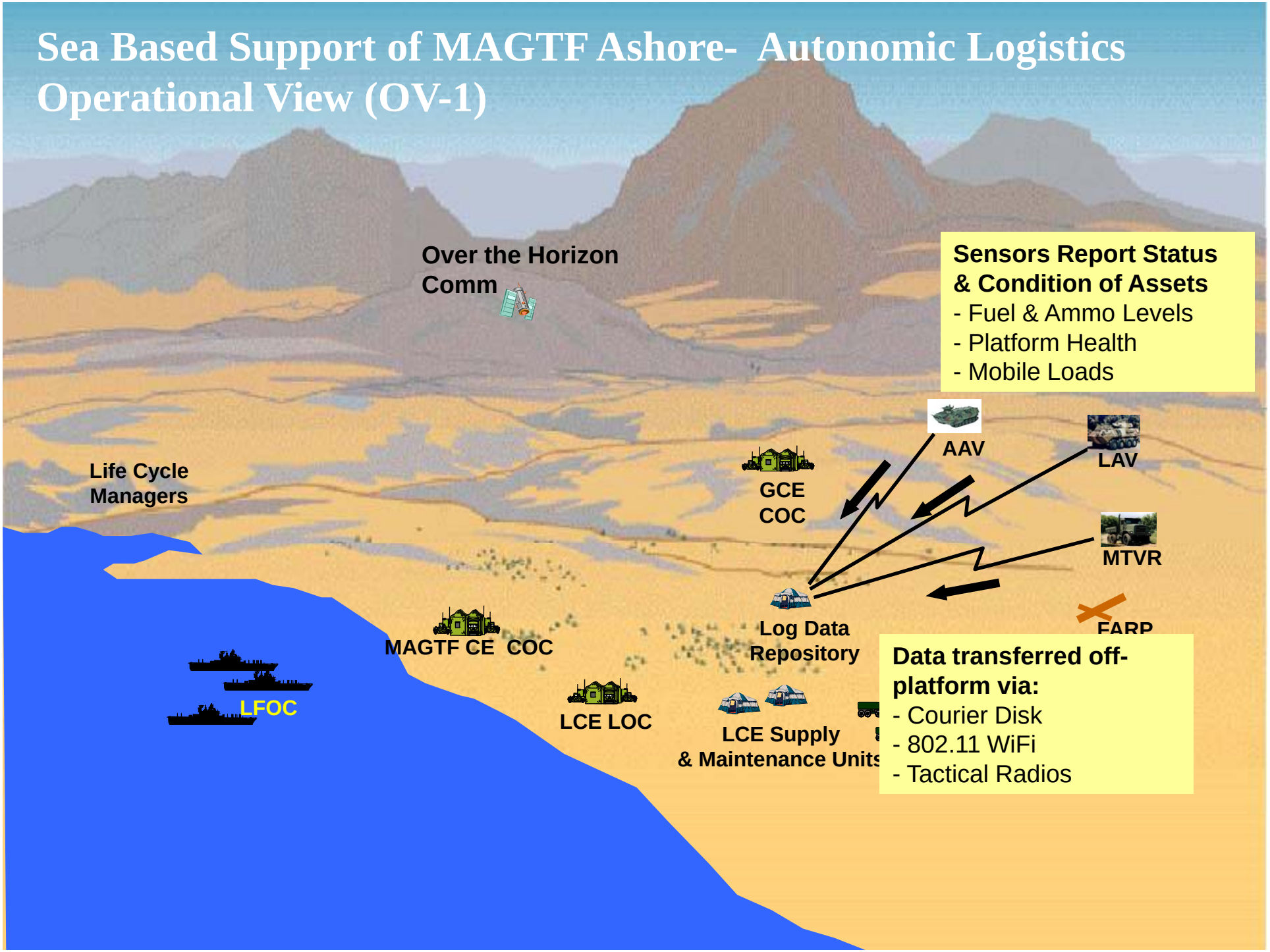
Operational Concept: Marine Corps Warfighting Concepts require the (MAGTF) has a greater capability to generate focused and tailored logistics support to the maneuver elements within the Area of Operations (AO). Operational Commanders and their staffs will require access to accurate, timely, mission critical information relating to (their equipment).



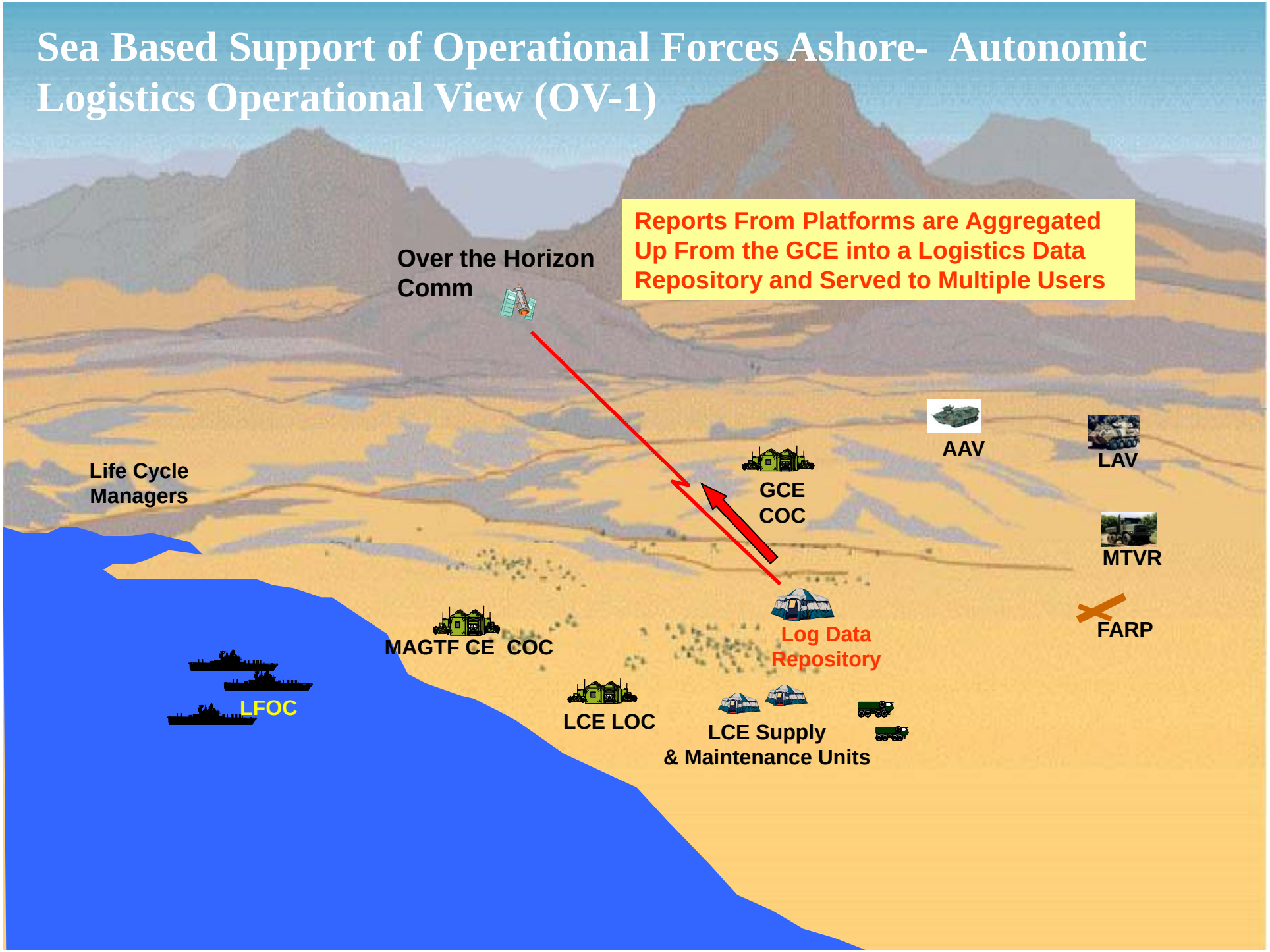
AL Mission Needs Statement: Central to this requirement is the ability to receive timely and accurate information about the operational status of tactical equipment in deployed environments under various mission scenarios and operational conditions.

AL Performance Spec: …will monitor and report: platform ID, fuel and ammunition levels, equipment health, and mobile loads to the Common Operating Picture (COP) through Global Combat Support System (GCSS).

Sea Based Support of MAGTF Ashore- Autonomic Logistics Operational View (OV-1)



Sea Based Support of Operational Forces Ashore- Autonomic Logistics Operational View (OV-1)



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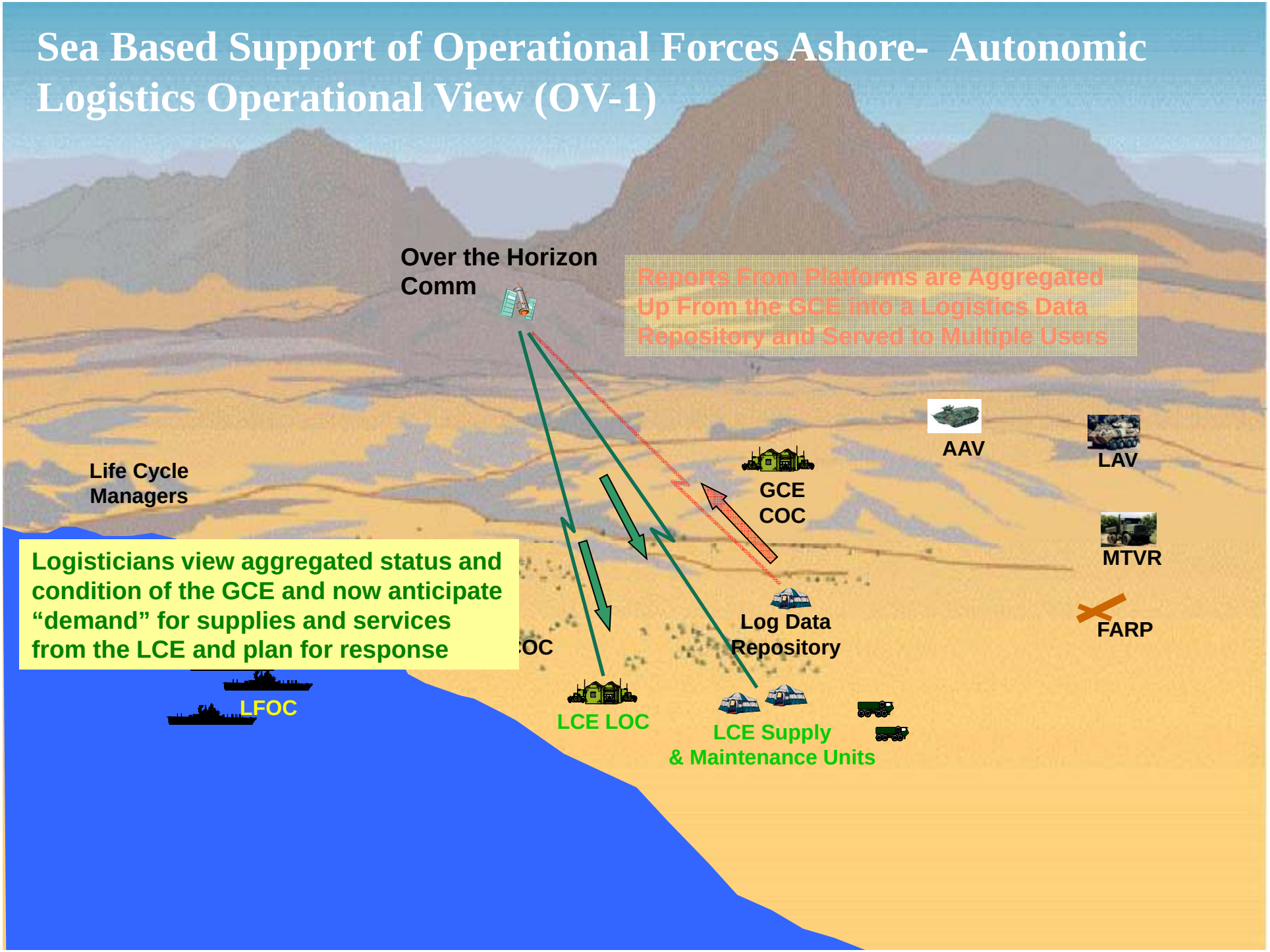

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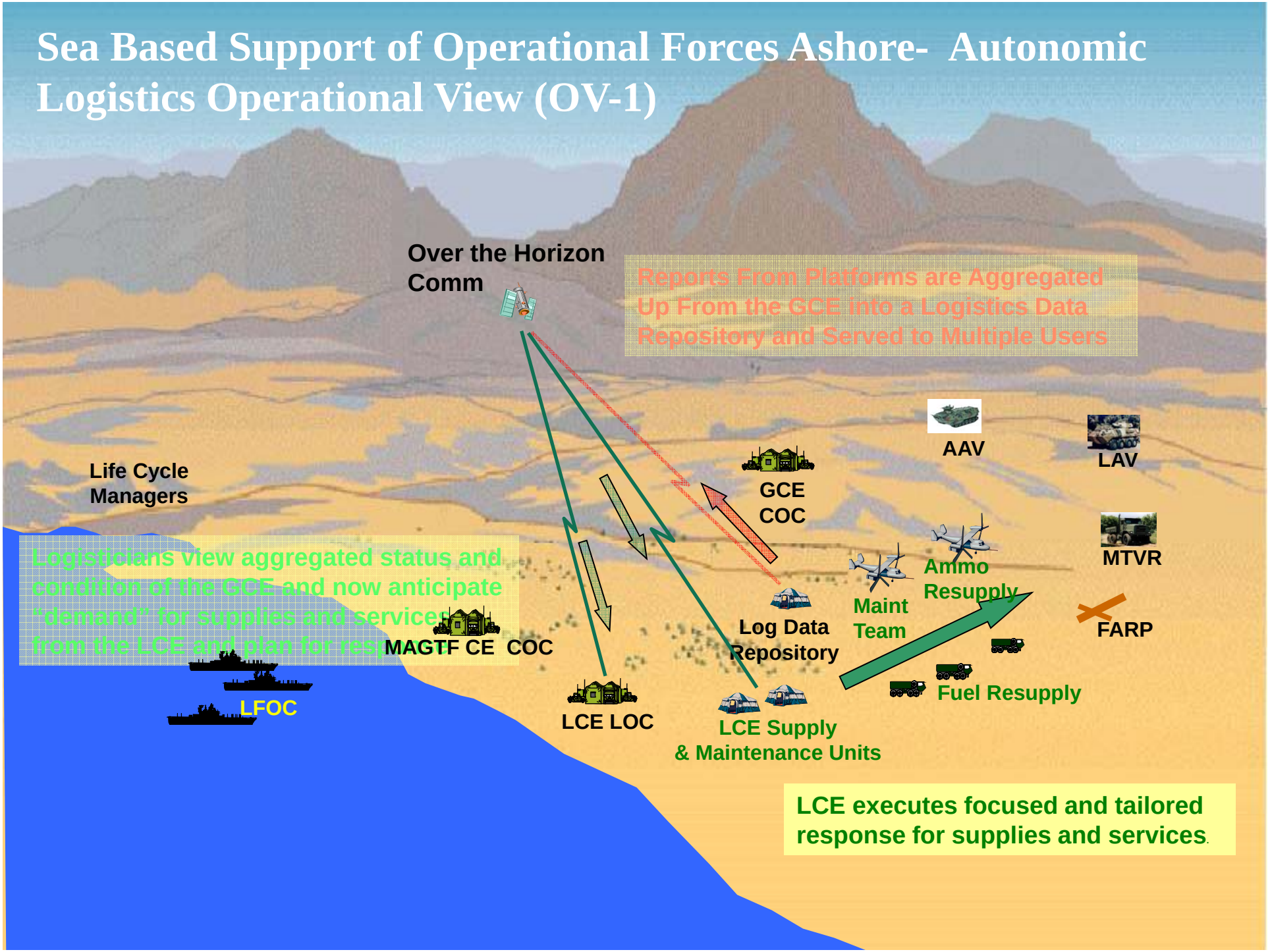

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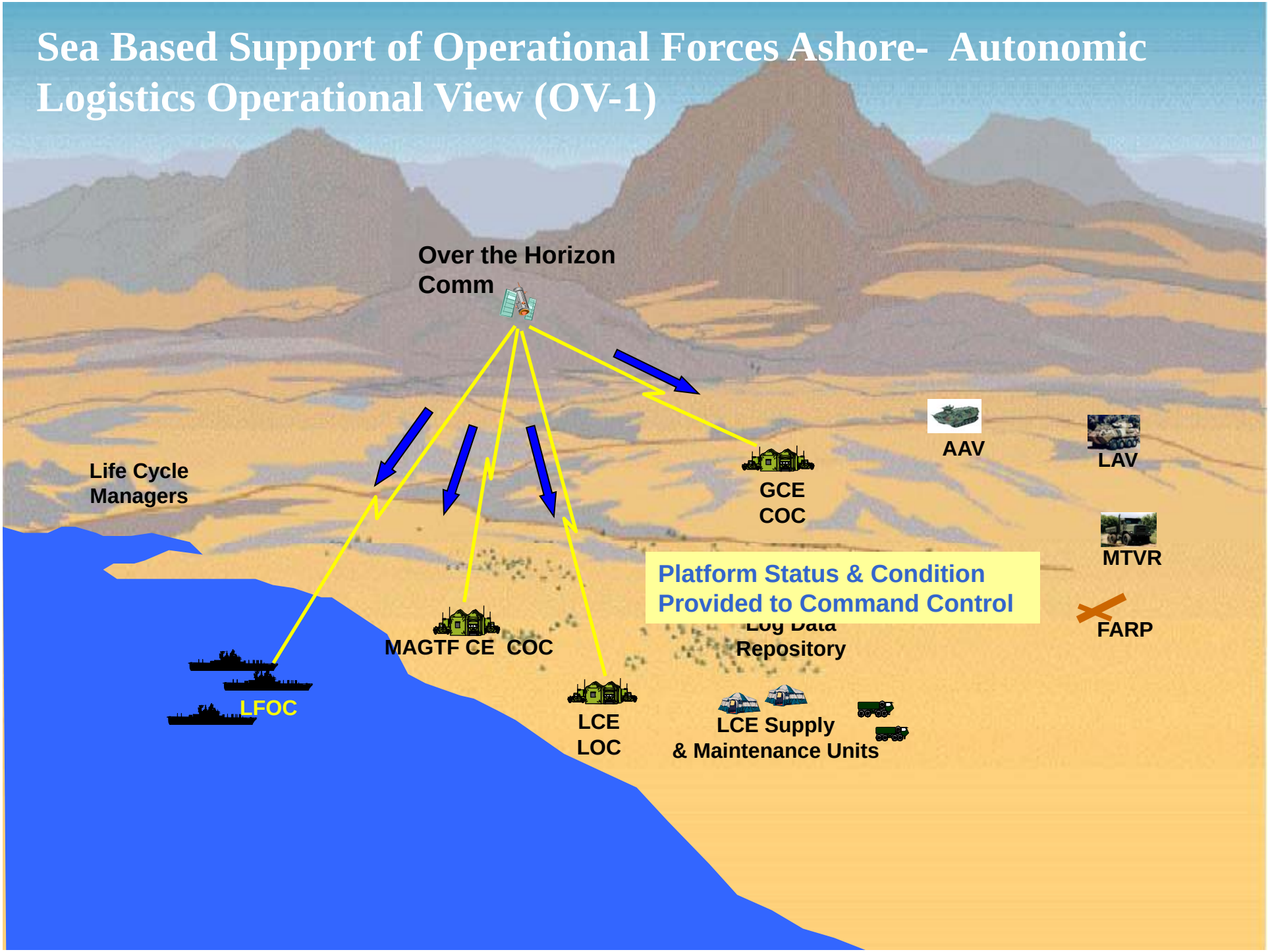
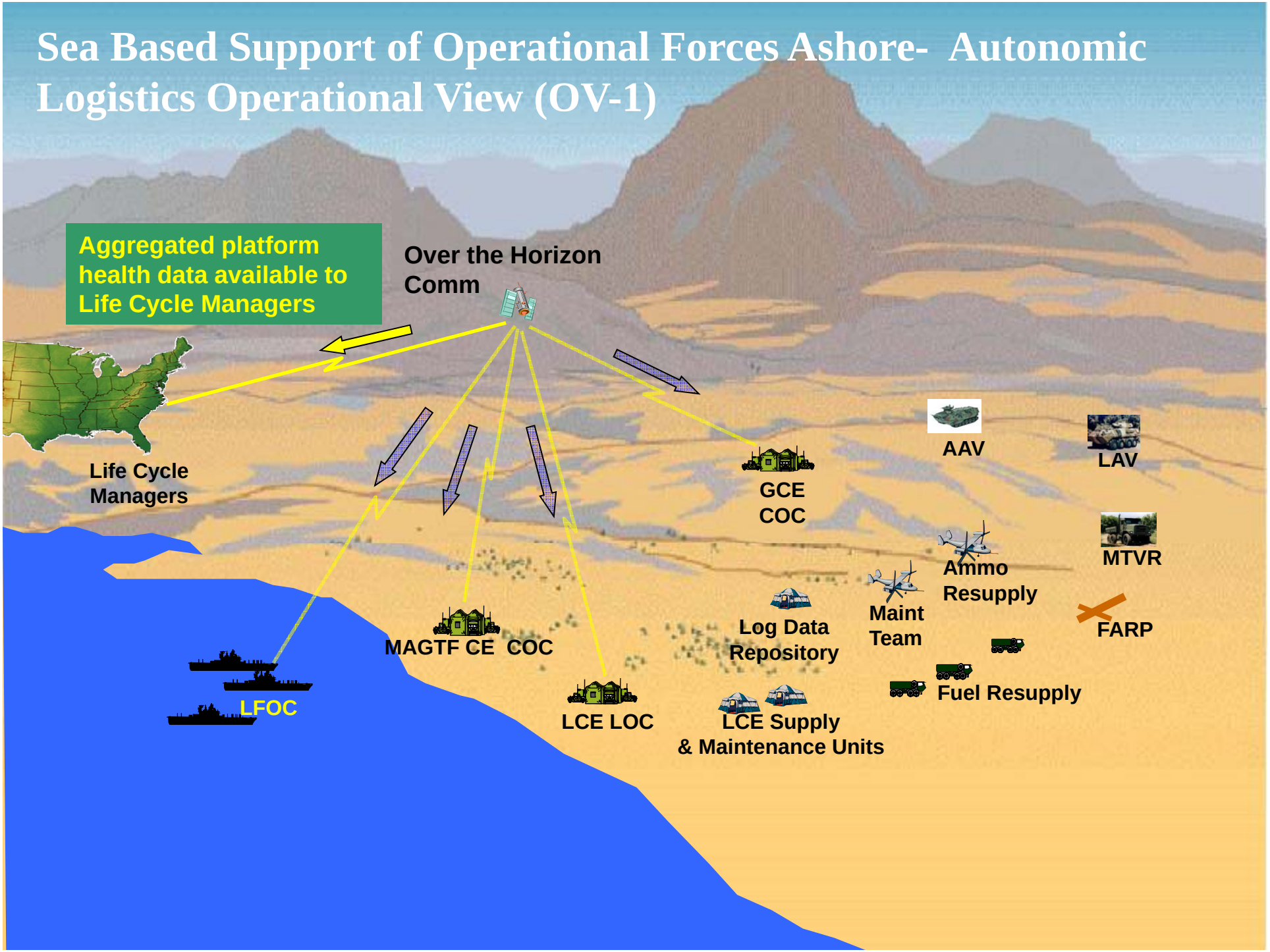


Sea Based Support of Operational Forces Ashore- Autonomic Logistics Operational View (OV-1)



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USMC Autonomic Logistics Program of Record

Enables Condition Based Maintenance (CBM+)

- Autonomically collects and reports platform health data to operators and maintainers

→

- Reduces manual analysis and provides more accuracy to diagnostics
- Supports development of prognostics
- Improves life-cycle affordability

→

- Reduces maintenance cost and down time, and increases operational readiness

Enhances Visibility for the Joint Logistician

- Communicates requests for service and other logistics requirements data in a time relevant manner

→

- Supports matching of resources against anticipated logistics requirements
- Enhances monitoring of joint logistics performance

→

- Enables establishment of responsive demand and support networks that bring speed and quality to the logistics process in the operating environment

Supports Quicker, Better Informed C2 Decisions

- Transmits operational health/ readiness data off platform which is made available to C2 users

→

- Accelerates information to decision-makers
- Informs supportability assessments to the Joint Force Commander

→

- Allows commanders to leverage resources to maximize warfighting

Informing and enabling more efficient maintenance, logistics, and C2

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POR Autonomic Logistics-Programs

The AL family of programs consist of:

- **Electronic Maintenance Support System (EMSS)** - provides the technical conduit to enable a net-centric data environment for platform performance data and ability to quickly diagnosis and repair essential equipment
- **Embedded Platform Logistics System (EPLS) –** delivers the "on-platform" system/ infrastructure to acquire operationally relevant data
- **AL-MC Service (ALS) –** provides the "off-platform" data/information sharing (networking, data management, and applications) and integration (communications, information assurance, and interface) for the Logistics and C2 enterprises.

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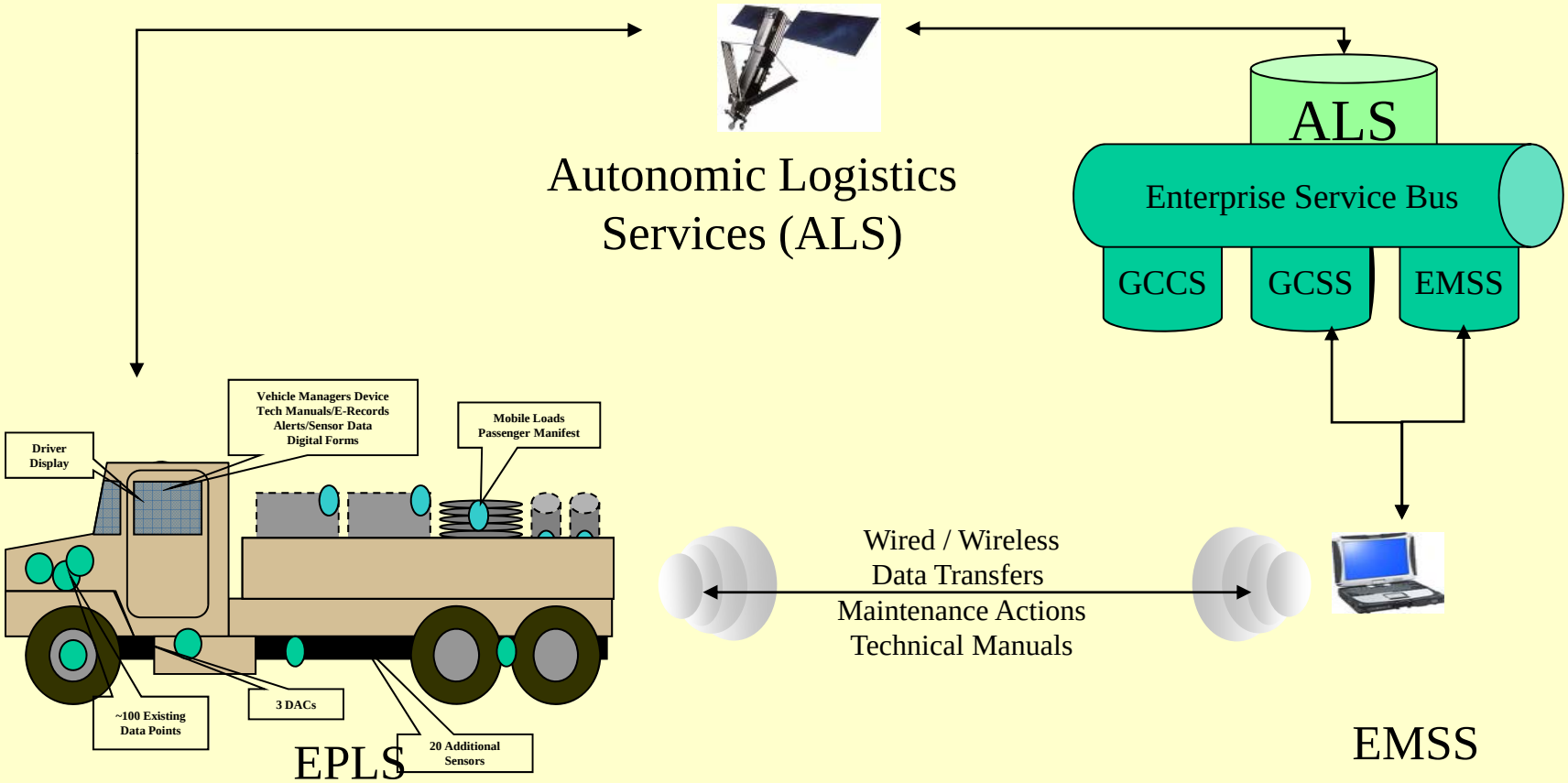
How They Fit



EPLS FIELDING PLAN 2010 & Beyond: 5204 MTVRs; 878 LAVs & 1057 AAVs

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How They Work Together

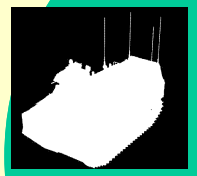
Acquire system/subsystem performance/health data, perform diagnostics and analysis at unit, battalion, enterprise (C2 and Logistics) levels

Acquire Data, Assess

Assess, Analyze, Diagnostics,

Assess, Analyze, Diagnostics, Prognostics Forecast, Share

System/sub system health, ammo, fuel and mobile load status



AAV with EPLS Sensors

MTVR with EPLS Sensors

LAV with EPLS Sensing

Collect, monitor and report platform health to maintenance techs

EPLS

Communication
Messaging

Company, Deployable, Regional levels

Database
Replication

Provides IETMs and maintenance support

EMSS

SOA Environment
Transfer
Cross Domain Guard

CBM+ Application

GIG

Logistics and C2 Enterprise Applications

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Experimentation to Buy Down Risk to MCSC POR's

- *What is the impact of having an Autonomic Logistics systems capability on logistics support operations? Metrics?*
- *What's the necessary capability and how does that mesh with Marines and their process?*
- *What's practical and affordable to implement?*

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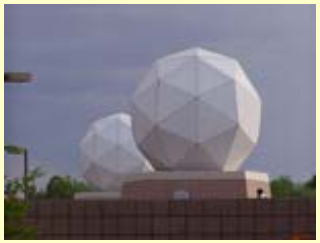
Autonomic Logistics Field Trials

-III MEF Okinawa, Japan



Iridium ground station receives data burst and sends it through gateway into internet .

IRIDIUM

Satellites receive data burst

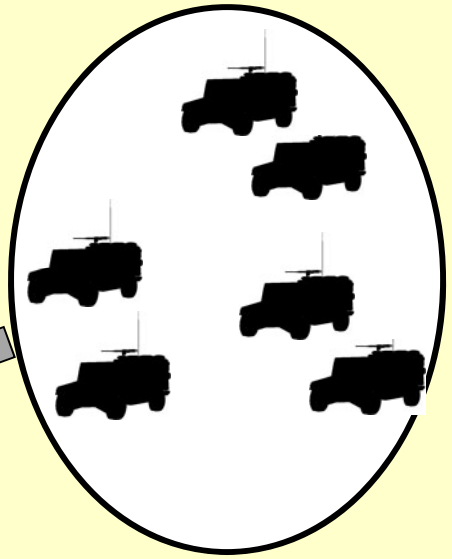
IRIDIUM

Low Bandwidth Data Path

Gateway Server

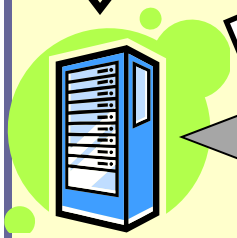
Existing Web Site

Command Control



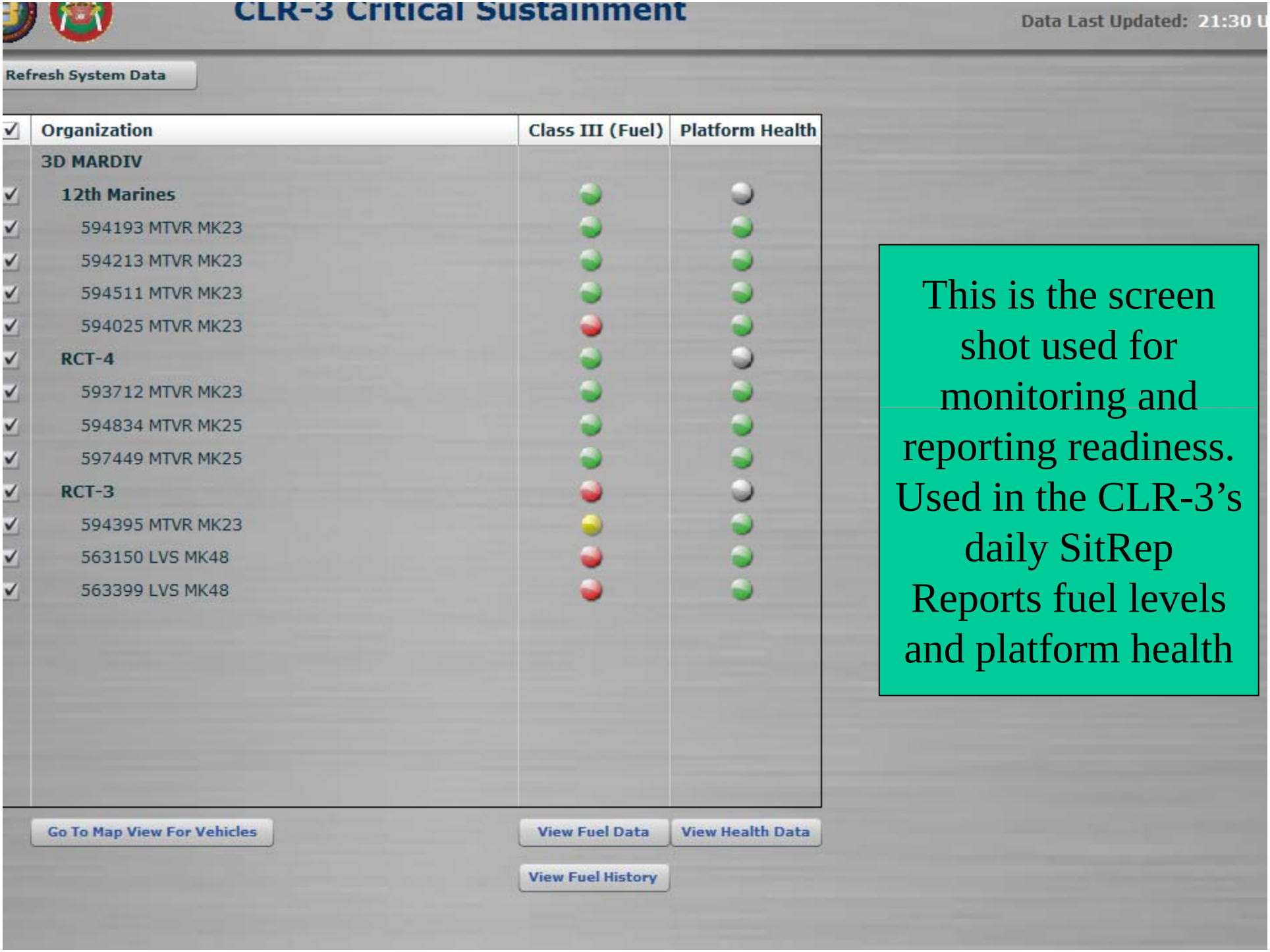
High Bandwidth Data Path

SECURE FTP or HAND CARRY

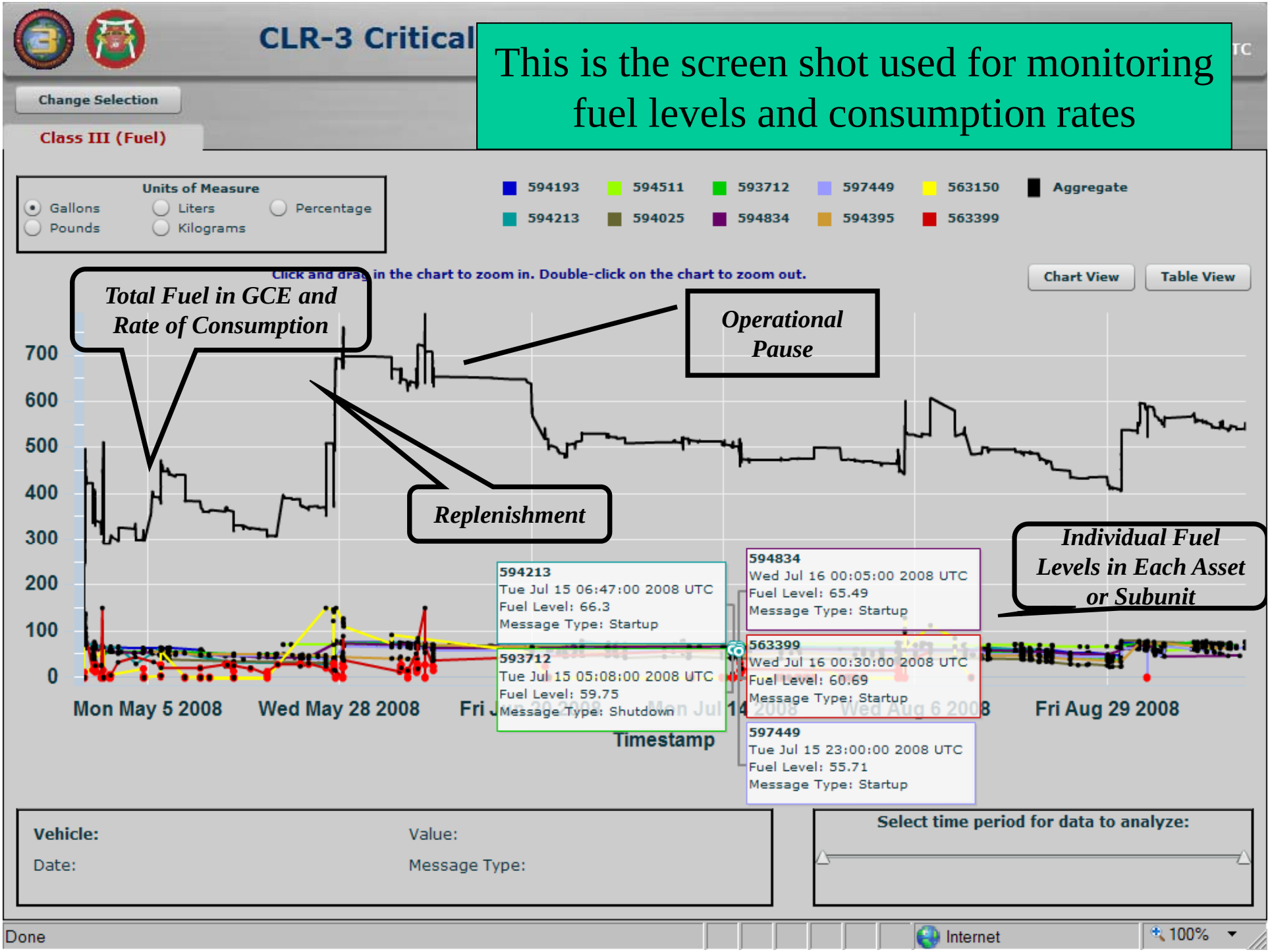


Database

SECURE FTP or HAND CARRY



This is the screen shot used for monitoring and reporting readiness. Used in the CLR-3's daily SitRep Reports fuel levels and platform health


CLR-3 Critical
This is the screen shot used for monitoring fuel levels and consumption rates
Change Selection
Class III (Fuel)
Units of Measure
Gallons
Liters
Percentage
Pounds
Kilograms
594193
594511
593712
597449
563150
Aggregate
594213
594025
594834
594395
563399
Click and drag in the chart to zoom in. Double-click on the chart to zoom out.
Chart View
Table View
Total Fuel in GCE and Rate of Consumption
Operational Pause
Replenishment
Individual Fuel Levels in Each Asset or Subunit
700
600
500
400
300
200
100
0
Mon May 5 2008
Wed May 28 2008
Fri Aug 29 2008
Timestamp
594213
Tue Jul 15 06:47:00 2008 UTC
Fuel Level: 66.3
Message Type: Startup
593712
Tue Jul 15 05:08:00 2008 UTC
Fuel Level: 59.75
Message Type: Shutdown
594834
Wed Jul 16 00:05:00 2008 UTC
Fuel Level: 65.49
Message Type: Startup
563399
Wed Jul 16 00:30:00 2008 UTC
Fuel Level: 60.69
Message Type: Startup
597449
Tue Jul 15 23:00:00 2008 UTC
Fuel Level: 55.71
Message Type: Startup
Vehicle:
Value:
Date:
Message Type:
Select time period for data to analyze:
Done
Internet
100%

CLR-3 Critical Sustainment

Data Last Updated: 21:30 UTC

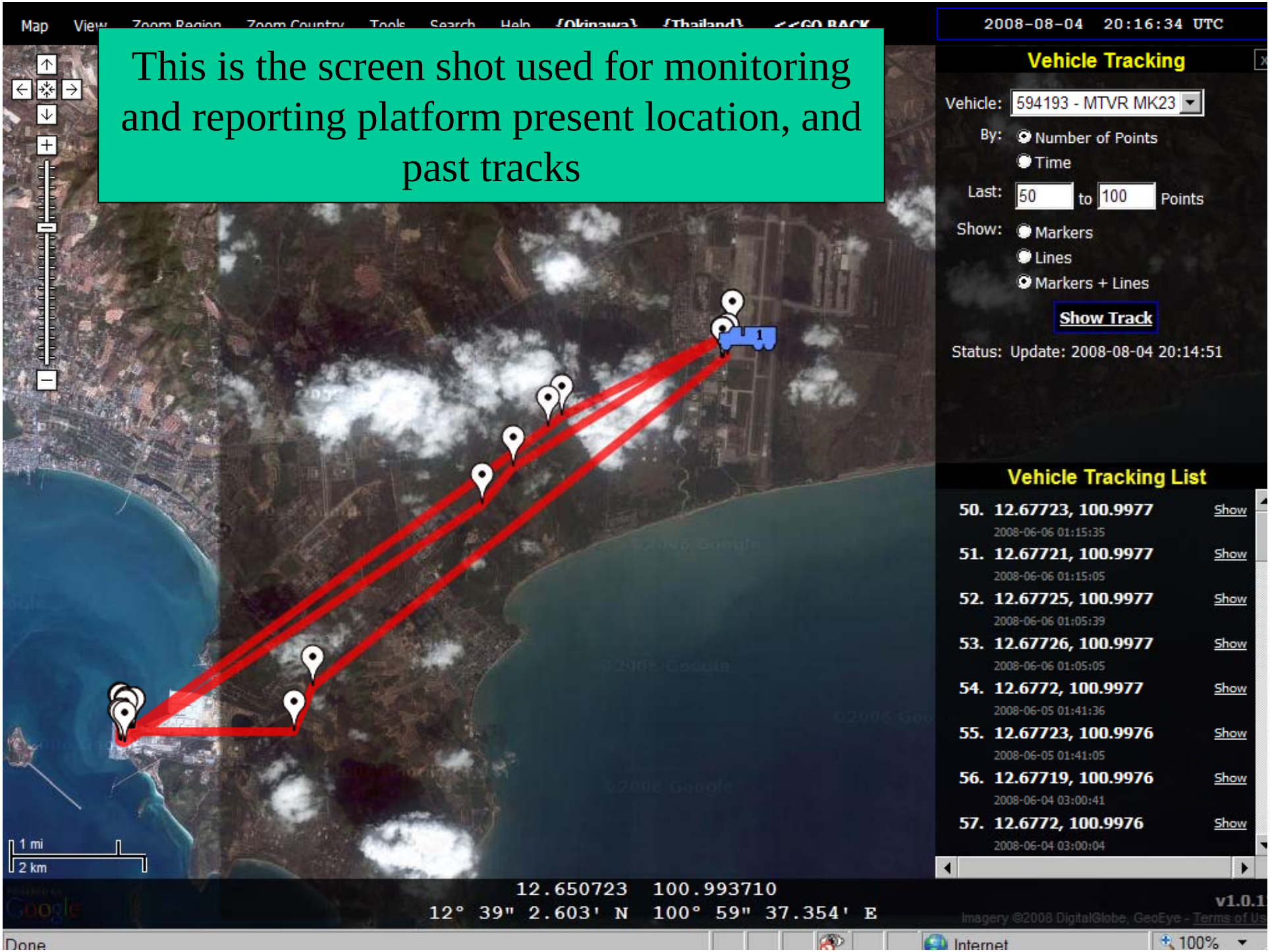
<< Go Back

Organization	Hlth	Engine Hrs	Odometer	Detected Faults	Report Time
3D MARDIV					
12th Marines					
594193 MTVR MK23		836.05	8157	All systems report operational	23:15:00 (6/24/08)
594213 MTVR MK23		534.55	3903	All systems report operational	06:06:00 (8/4/08)
594511 MTVR MK23		1244.8	12193	All systems report operational	07:25:00 (8/4/08)
594025 MTVR MK23		302.43	2001	All systems report operational	07:52:00 (8/4/08)
RCT-4					
593712 MTVR MK23		679.9	6299	All systems report operational	08:22:00 (8/4/08)
594834 MTVR MK25		948.55	9930	All systems report operational	08:10:00 (8/4/08)
597449 MTVR MK25		-	-	-	-
RCT-3					
594395 MTVR MK23		767.45	5635	All systems report operational	09:06:00 (8/4/08)
563150 LVS MK48		-	-	-	-
563399 LVS MK48		-	-	-	-

This is the screen shot used for monitoring and reporting equipment usage (miles/hrs) and faults/failures

Done Internet 100%

This is the screen shot used for monitoring and reporting platform present location, and past tracks



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This is the screen shot used for estimating combat range and reach

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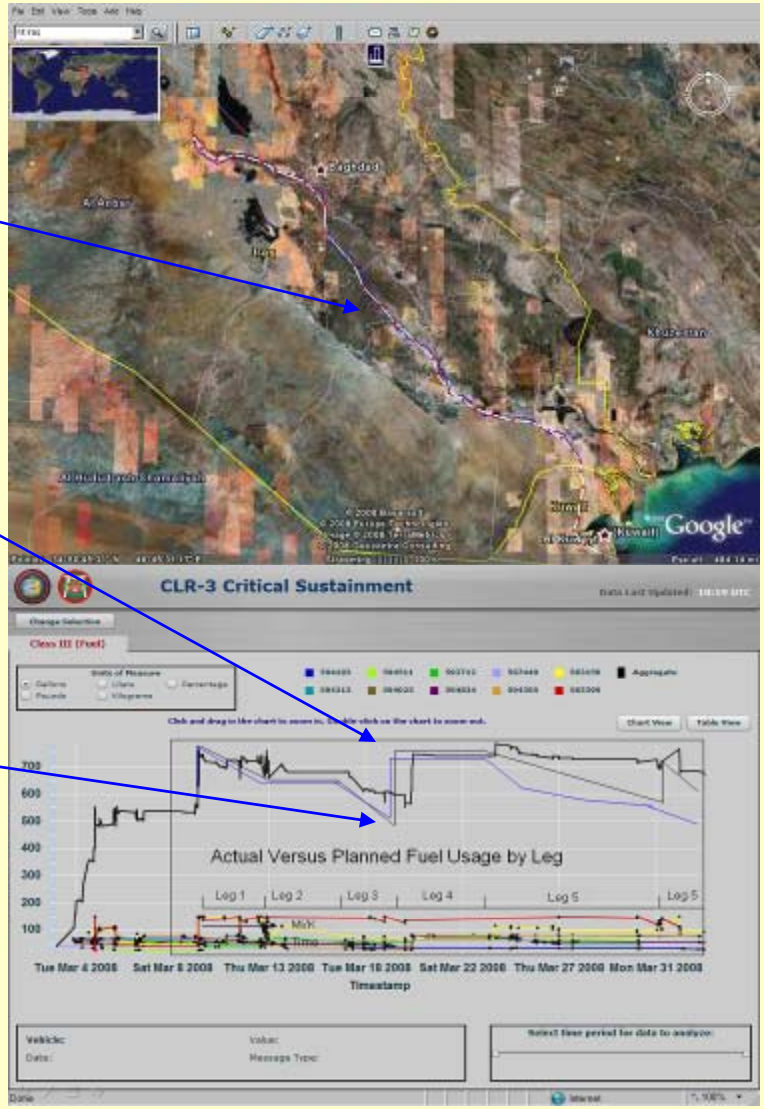
Fuel Consumption Prediction Tool

- Using Mission Plan/ OpO
- Decompose into mission legs from Sync Matrix
- Estimate COS using updated fuel planning factors
- Plot actuals reported from continuous monitoring over top of plan
- Observe its effect, benefit



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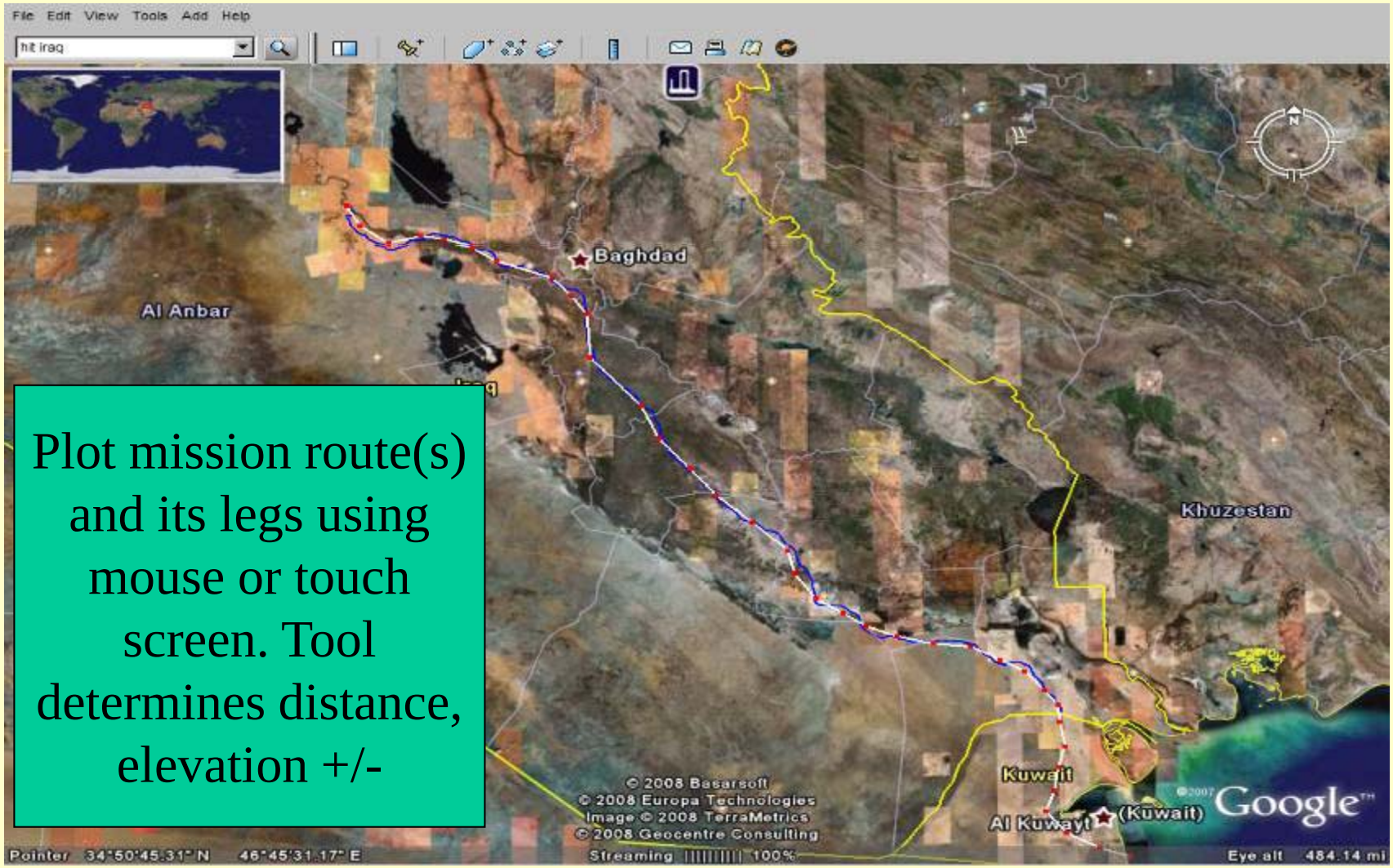
Route Planning By Mission Leg to Determine Course(s) of Support



Plot mission route(s) and its legs using mouse or touch screen. Tool determines distance, elevation +/-

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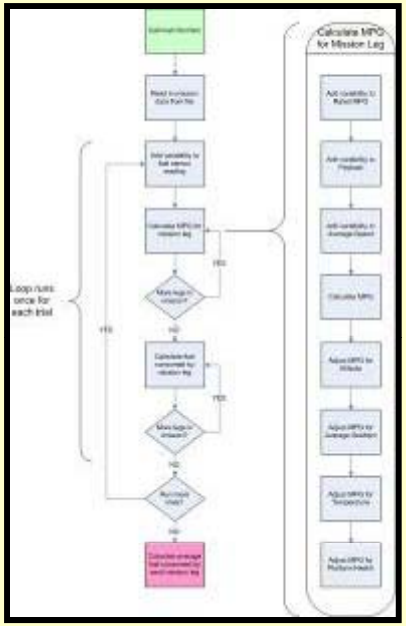
Inputs and Factors Used in Estimating Fuel Usage

Mission Leg Parameters

Platforms
Activity Type
Average Speed
Distance
Surface Type
Average Altitude
Average Gradient
Average Temperature
Idle Time
Payload



Fuel Consumed by Mission Leg

Gallons

Model contains fuel consumption characteristics for multiple platform types

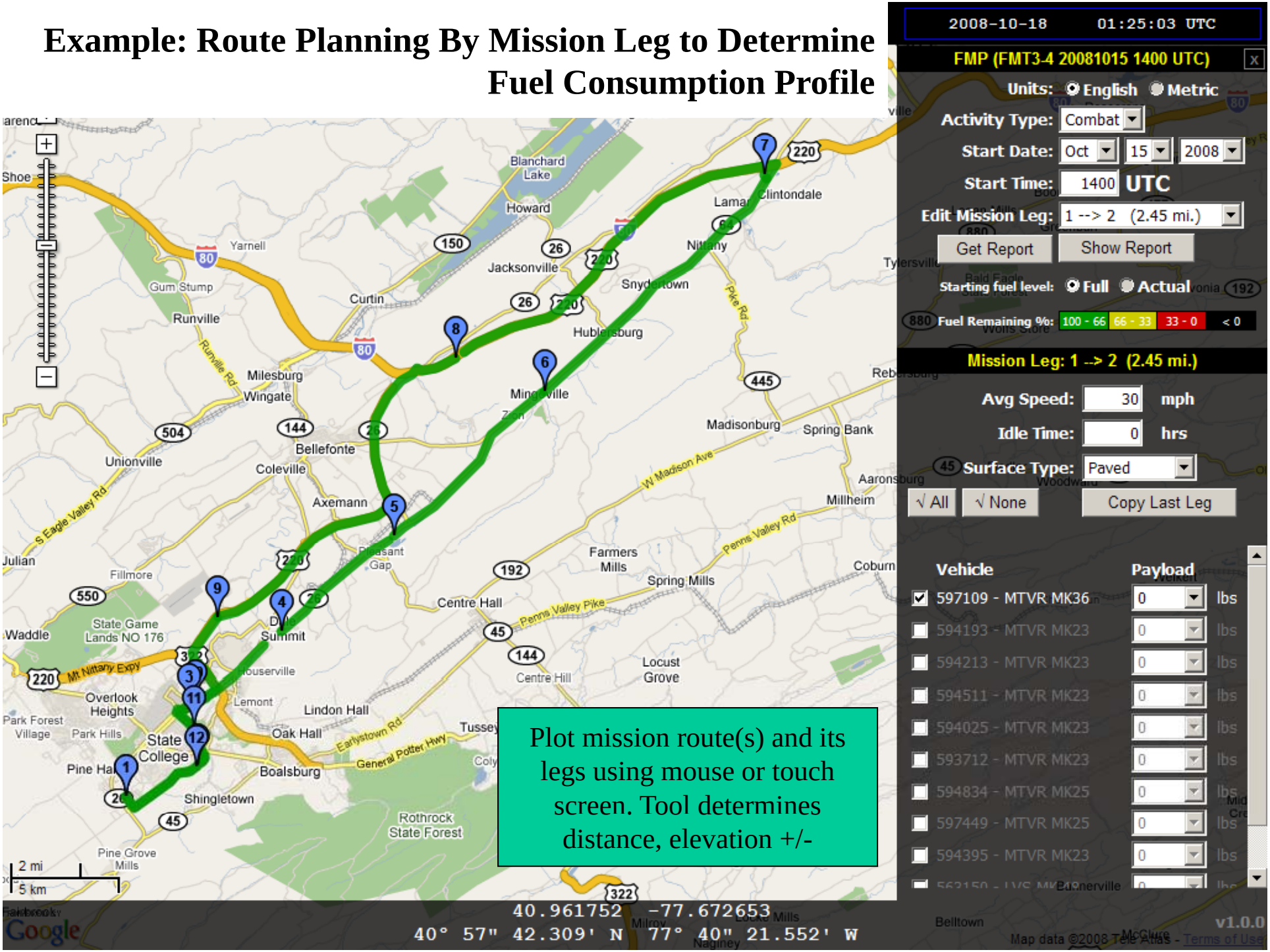
Platform Health Parameters

Cylinder Blowby
Intake Air Temperature Sensor Failure
Transmission Failure (Loss of High Gear)
Engine Over-temperature
Run-Flat Tire(s)
Fuel Type

Driver Behavior Parameters (future)

Accelerator Position Variability
Smart Operation
Momentum Advantage; Shift Points
Convey Effects

Example: Route Planning By Mission Leg to Determine Fuel Consumption Profile



CLR-3 Fuel Mission Tracking

Data Last Updated: 01:27 UTC

Refresh System Data

Missions

Mission Name	Platform	Class III (Fuel)	Health
FMT3-4 20081015 1400 UTC			
	597109		

View Mission Data »

Fuel Mission Planner »

Change Thresholds »

Historical Missions »

Units/Vehicles

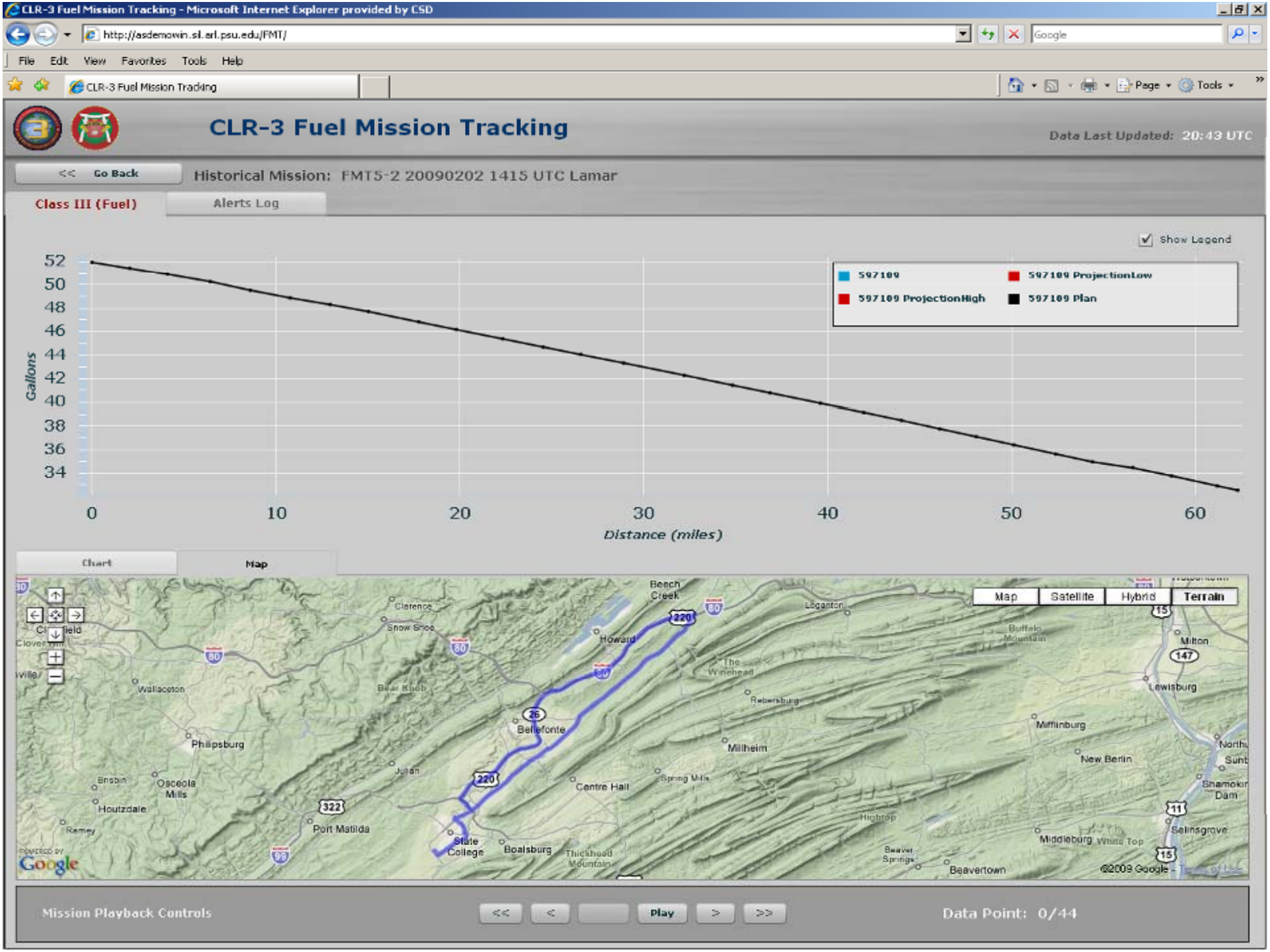
☑	Organization	Class III (Fuel)	Platform Health
	3D MARDIV		
☑	12th Marines		
☑	594193 MTVR MK23		
☑	594213 MTVR MK23		
☑	594511 MTVR MK23		
☑	594025 MTVR MK23		
☑	RCT-4		
☑	593712 MTVR MK23		
☑	594834 MTVR MK25		
☑	597449 MTVR MK25		
☑	RCT-3		
☑	594395 MTVR MK23		

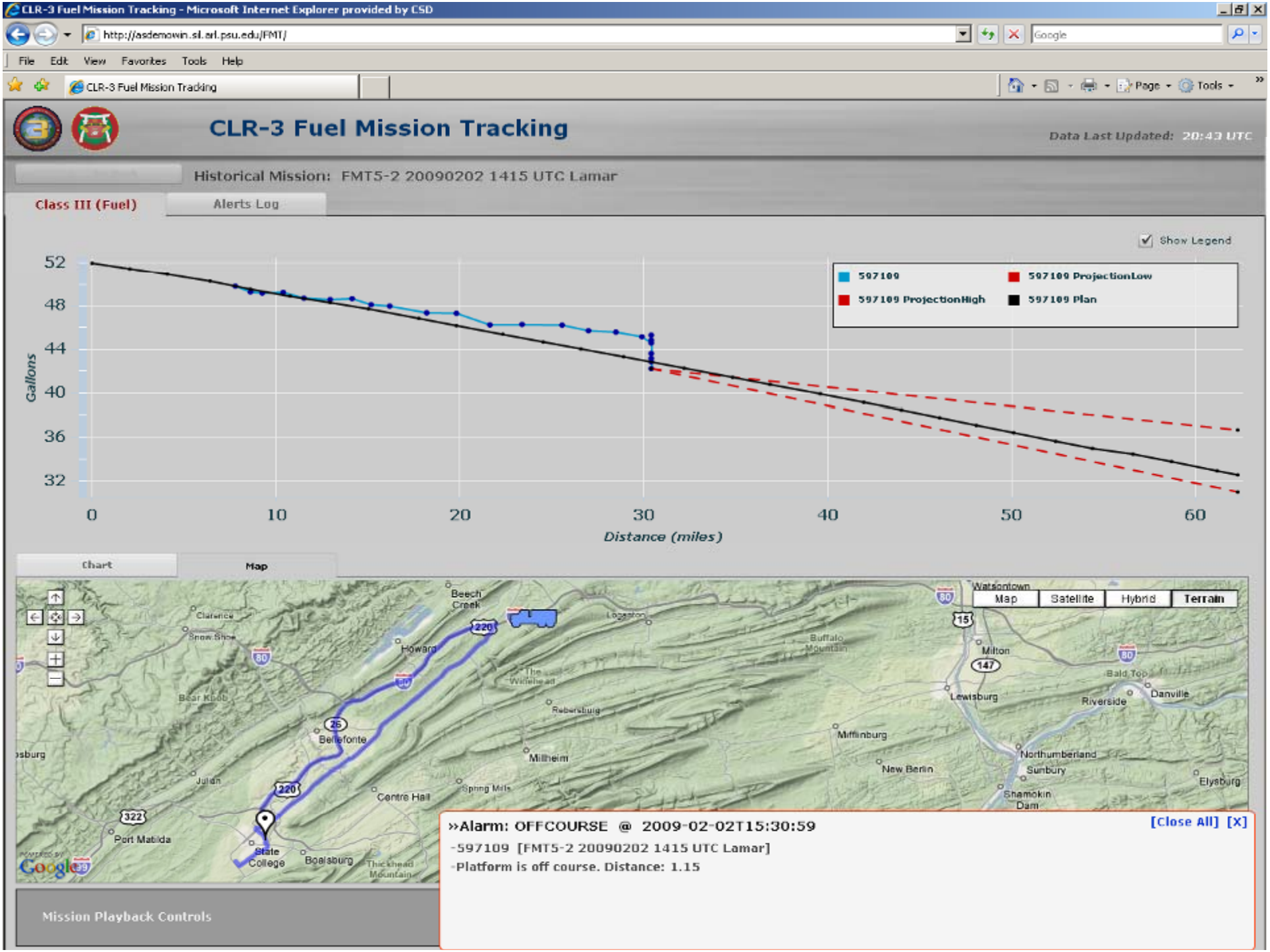
View Fuel Data »

View Fuel History »

View Health Data »

Go To Map View »


CLR-3 Fuel Mission Tracking - Microsoft Internet Explorer provided by CSD
http://asdemowin.sl.arl.psu.edu/FMT/
File Edit View Favorites Tools Help
CLR-3 Fuel Mission Tracking
Page Tools
CLR-3 Fuel Mission Tracking
Data Last Updated: 20:43 UTC
<< Go Back
Historical Mission: FMT5-2 20090202 1415 UTC Lamar
Class III (Fuel)
Alerts Log
Show Legend
597109
597109 ProjectionLow
597109 ProjectionHigh
597109 Plan
Gallons
52
50
48
46
44
42
40
38
36
34
0
10
20
30
40
50
60
Distance (miles)
Chart
Map
Map
Satellite
Hybrid
Terrain
Beech Creek
Clarence
Snow Shoe
Howard
Logan
Milton
Lewisburg
Wallaceton
Philipsburg
Bellefonte
Millheim
Mifflinburg
New Berlin
Osceola Mills
Houtzdale
Port Matilda
State College
Boalsburg
Centre Hall
Spring Mills
Selinsgrove
Middleburg
Beavertown
©2009 Google
Mission Playback Controls
<< < Play > >>
Data Point: 0/44


CLR-3 Fuel Mission Tracking - Microsoft Internet Explorer provided by CSD
http://asdemowin.sl.arl.psu.edu/FMT/
File Edit View Favorites Tools Help
CLR-3 Fuel Mission Tracking
Page Tools
CLR-3 Fuel Mission Tracking
Data Last Updated: 20:43 UTC
Historical Mission: FMT5-2 20090202 1415 UTC Lamar
Class III (Fuel)
Alerts Log
Show Legend
597109
597109 ProjectionLow
597109 ProjectionHigh
597109 Plan
Gallons
52
48
44
40
36
32
0
10
20
30
40
50
60
Distance (miles)
Chart
Map
Map
Satellite
Hybrid
Terrain
Beech Creek
Clarence
Snow Shoe
Howard
Bellefonte
Milheim
Centre Hall
Spring Mills
Julian
Port Matilda
State College
Boalsburg
Lewisburg
Milton
Watsontown
Riverside
Danville
Northumberland
Sunbury
Shamokin Dam
Elysburg
New Berlin
Mifflinburg
»Alarm: OFFCOURSE @ 2009-02-02T15:30:59
[Close All] [X]
-597109 [FMT5-2 20090202 1415 UTC Lamar]
-Platform is off course. Distance: 1.15
Mission Playback Controls

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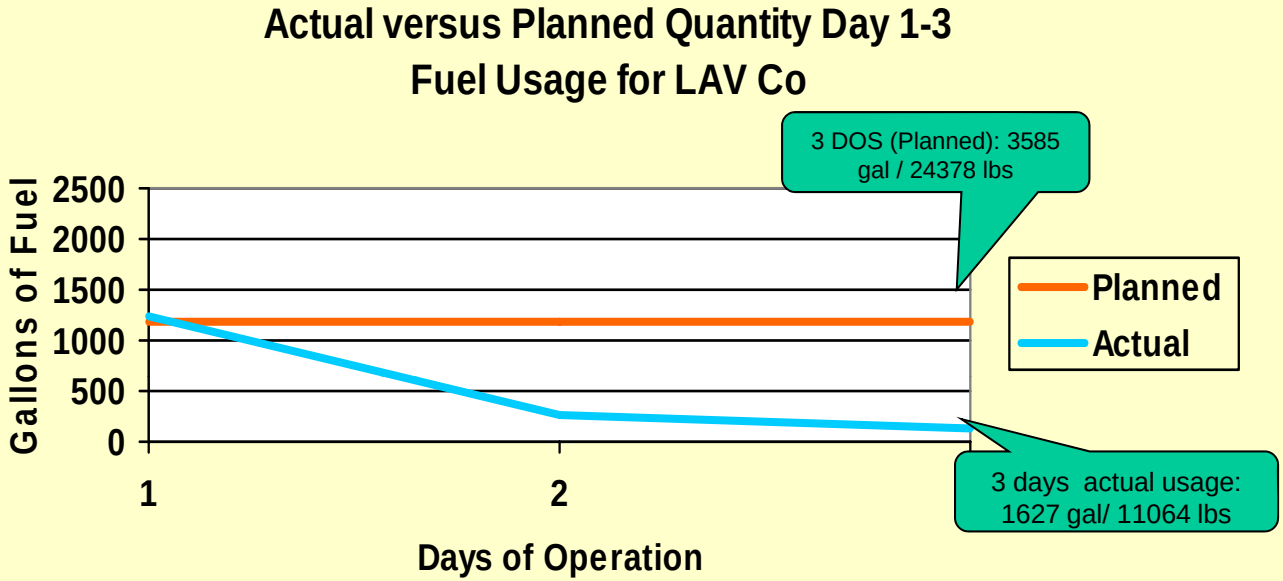
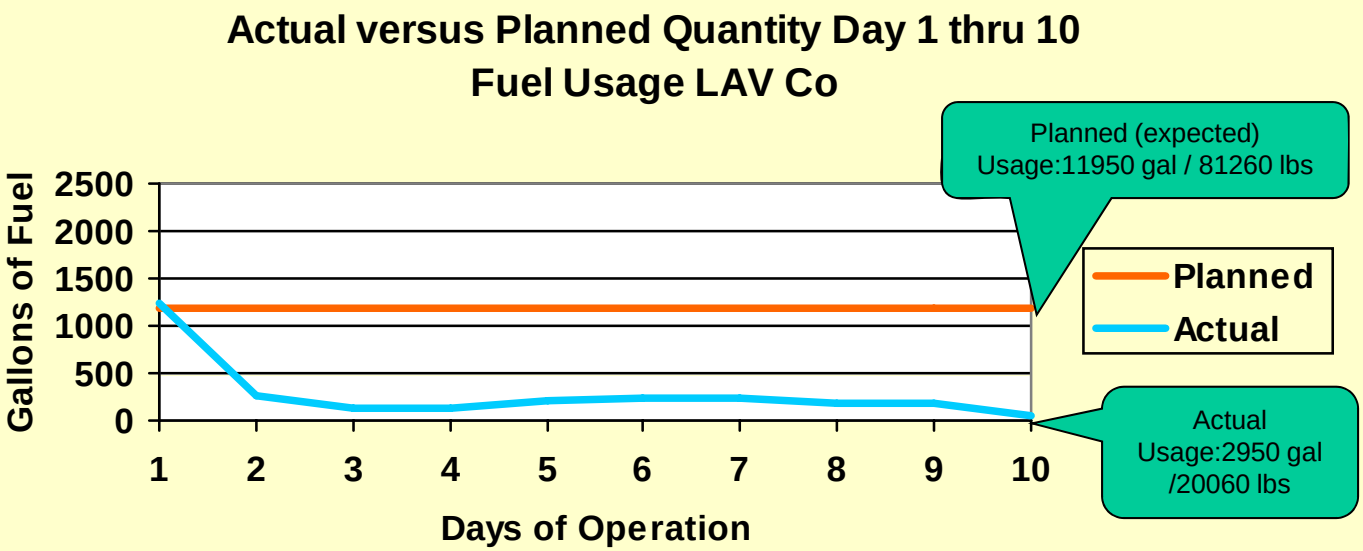
Autonomic Logistics Fuel Monitoring & Reporting Impact to MAGTF



Fuel DOS rules of thumb result in 47 – 74% unnecessary fuel replenishment. AL monitoring and reporting of fuel status results



Ref: USMC LOGISTICS MODERNIZATION (LOGMOD) SENSE AND RESPONSE LOGISTICS (S&RL): AUTONOMIC LOGISTICS STUDY ON FUEL QUANTITY MONITORING ON THE BATTLEFIELD,
Col. Charles G. Chiarotti; Penn State USMC Fellow, June 2007

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Considering the Impacts… Tactical Fuel Management

From Col Chiarotti's Fellowship Study:

Days 1-3:

-1928 gallons oversupply

-2 sixcons; 1 truck supplied not needed, or

-two sorties of H53-E (10,000lbs) from Sea Base not necessary

-Days 3-10

-9000 gals saved

-10 sixcons; 5 truck supplied not needed, or

-nine sorties of H53-E from Sea Base not necessary

LAV Co has 24 vehicles; MEB has about 1290 vehicles

A back of the envelope calculation suggests the leverage across the MEB could be about **54 times more that the benefits shown above.**

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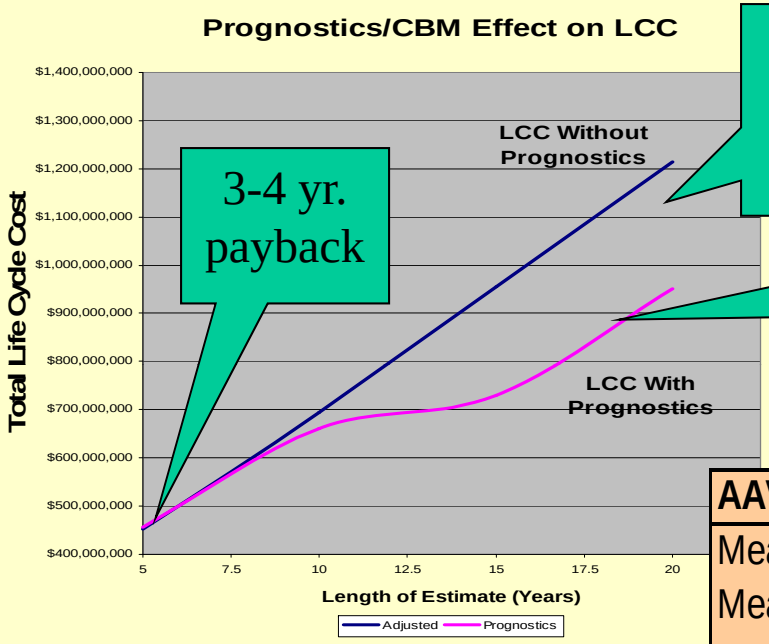
Considering the Impacts- LCC and Ao



3-4 yr. payback

Benefits increase as service life is extended

"s" shape effect due to deferred depot overhauls

AAV RAM/RS Data (Hours)	W/O Prog	W/Prog
Mean Time Between Failures	64	73.6
Mean Time To Repair	0.87	0.87
Mean Logistics Delay Time	5.4	2.7675

AAV RAM/RS Calculations	W/O Prog	W/Prog
Forecasted Op Availability	91.08%	95.29%
Increase in Op Avail w/Prog		4.21%
Increased AAVs Mission Capable w/Prog		29
Total LCC Costs per AAV w/Prog		$973,504
Operational Availability		
Opportunity Benefit of Prognostics		$27,890,754

Benefits can either be:
increased Ao;
decreased life cycle cost
or reduced number of assets for same total operational availability

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Autonomic Logistics Leverage into Combat Capability

MAGTF	LOG CMDR'S
COP	DASH BOARD
JTCW	GCSS

Log Injectors:

- Amount of "fight" left in platform / unit

Log Services:

- ITV & Supply Pt Status

Ref: USMC HQ LPV

Common Log Picture

Assessments within GCSS-MC

Info Exchange iot enable:

- Operational Planning
- Log COA Development
- Estimates of Supportability

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Advance Logistics Operational Concepts into Reality Through Demonstrations

Logistics Modernization Needs:

Keep operational tempo's and equipment availability high

Minimize logistics footprint

Adapt and Respond to Battlefield Dynamics

Key Technologies:

Monitor, collect, aggregate & report status/condition of tactical assets (sensors and communications)

Watch and act on "demand" based upon real-time awareness (IT systems and Decision Support Tools)

Our Impact:

Allows early user exposure & experience and evaluation to impact DOTMLPF

Informs the requirements process and acquisition strategy by SysCom

Facilitates tech transfer to industry

Our Role:

Build functional prototypes from high level concepts

Conduct field testing to show what it is, how it would be used and answer the "so what" question

Champion cross-agency, open standards to bust stovepipes