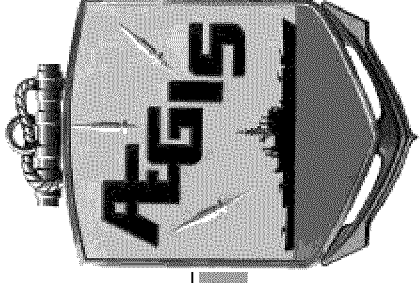


NDIA NAVAL INTEROPERABILITY WORKSHOP

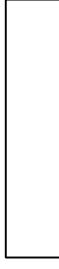


# Aegis Combat System Interoperability - Designing, Building and Testing

*Orlando Carvalho*



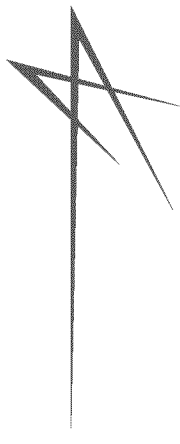
Naval Electronics & Surveillance Systems-Surface Systems  
Moorestown, New Jersey



## Report Documentation Page

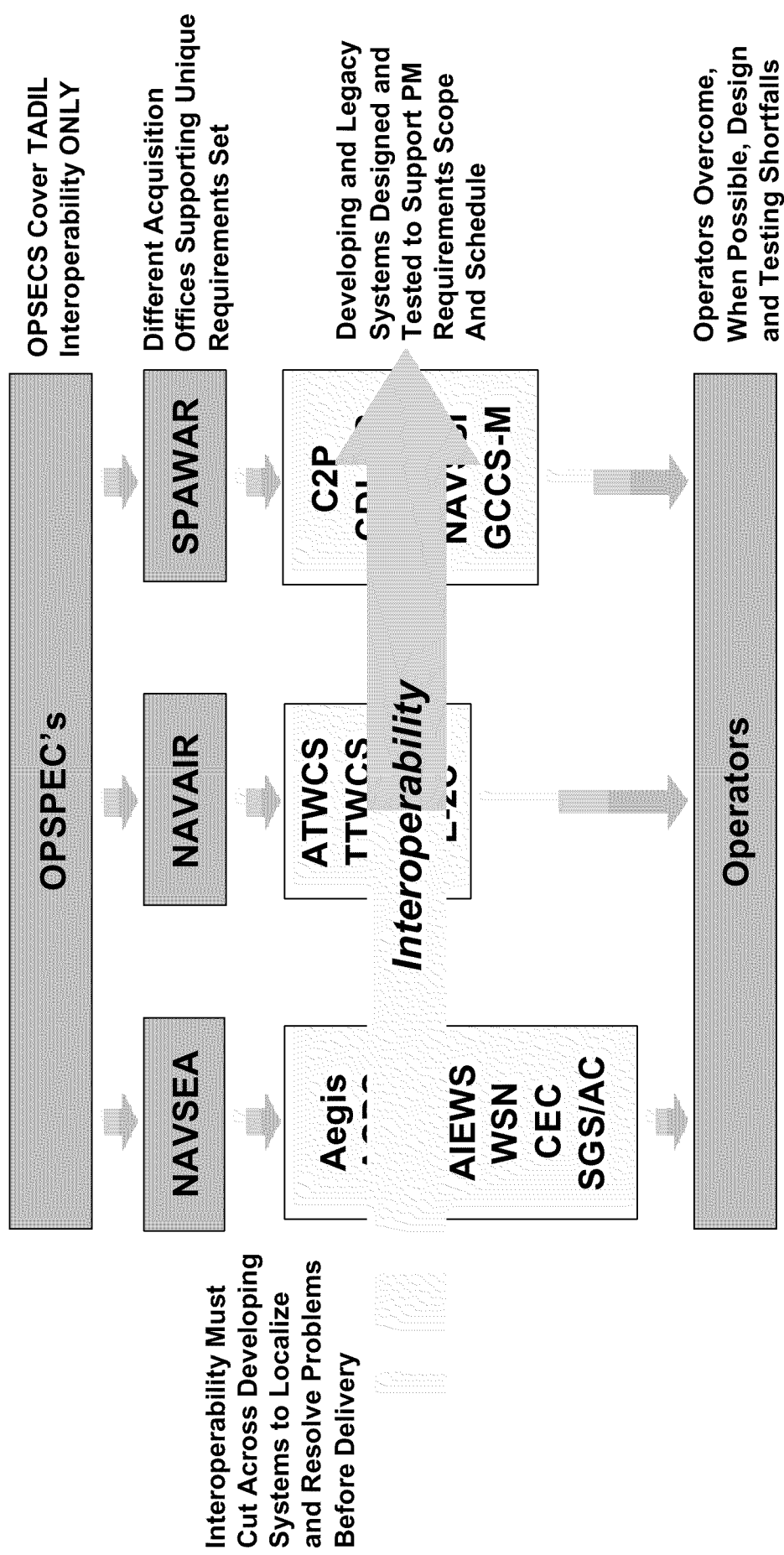
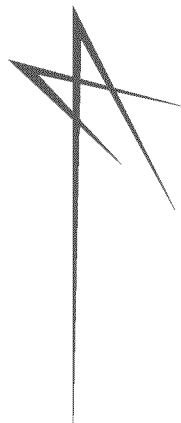
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| <b>Report Date</b><br>30052001                                                                                                                                       | <b>Report Type</b><br>N/A                          | <b>Dates Covered (from... to)</b><br>- |
| <b>Title and Subtitle</b><br>Aegis Combat System Interoperability - Designing,<br>Building and Testing                                                               | <b>Contract Number</b>                             |                                        |
|                                                                                                                                                                      | <b>Grant Number</b>                                |                                        |
|                                                                                                                                                                      | <b>Program Element Number</b>                      |                                        |
| <b>Author(s)</b><br>Carvalho, Orlando                                                                                                                                | <b>Project Number</b>                              |                                        |
|                                                                                                                                                                      | <b>Task Number</b>                                 |                                        |
|                                                                                                                                                                      | <b>Work Unit Number</b>                            |                                        |
| <b>Performing Organization Name(s) and Address(es)</b><br>Lockheed Martin                                                                                            | <b>Performing Organization Report Number</b>       |                                        |
| <b>Sponsoring/Monitoring Agency Name(s) and Address(es)</b><br>NDIA (National Defense Industrial Association 2111<br>Wilson Blvd., Ste. 400 Arlington, VA 22201-3061 | <b>Sponsor/Monitor's Acronym(s)</b>                |                                        |
|                                                                                                                                                                      | <b>Sponsor/Monitor's Report Number(s)</b>          |                                        |
| <b>Distribution/Availability Statement</b><br>Approved for public release, distribution unlimited                                                                    |                                                    |                                        |
| <b>Supplementary Notes</b><br>Proceedings from Armaments for the Navy Interoperability Workshop, 30-31 May 2001 sponsored by NDIA.                                   |                                                    |                                        |
| <b>Abstract</b>                                                                                                                                                      |                                                    |                                        |
| <b>Subject Terms</b>                                                                                                                                                 |                                                    |                                        |
| <b>Report Classification</b><br>unclassified                                                                                                                         | <b>Classification of this page</b><br>unclassified |                                        |
| <b>Classification of Abstract</b><br>unclassified                                                                                                                    | <b>Limitation of Abstract</b><br>UU                |                                        |
| <b>Number of Pages</b><br>17                                                                                                                                         |                                                    |                                        |

# Outline

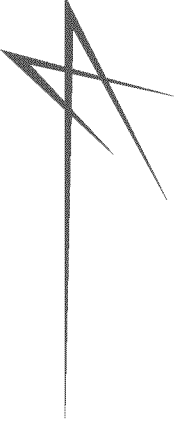


- **Aegis Combat System Engineering Agent (CSEA)  
View**
- **Aegis Baseline 6 III Interoperability Initiatives**
- **Lessons Learned and Shortfalls**
- **Summary**

# Aegis CSEA View



**System Development "Business As Usual" will Not Achieve Interoperability Improvement**

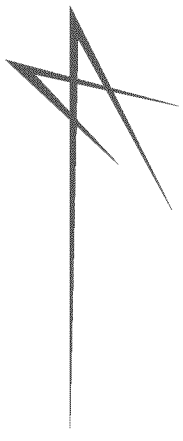


# Background

- CEC OPEVAL events led to formation of an Interoperability Task Force Senior System Engineering Council
  - Tasked to resolve System problems, point solution for CEC OPEVAL
  - ITF LinkIID/Interoperability team investigated 166 problems and corrected 38 over 17 months
- Concurrently PMS 400B asked, How can we improve interoperability during development?
- Lockheed Martin developed new test initiative to identify and correct interoperability problems during Baseline 6 Phase III development

*Interoperability Improvement Required Infrastructure and Process Changes, I.e. Not "Business As Usual"*

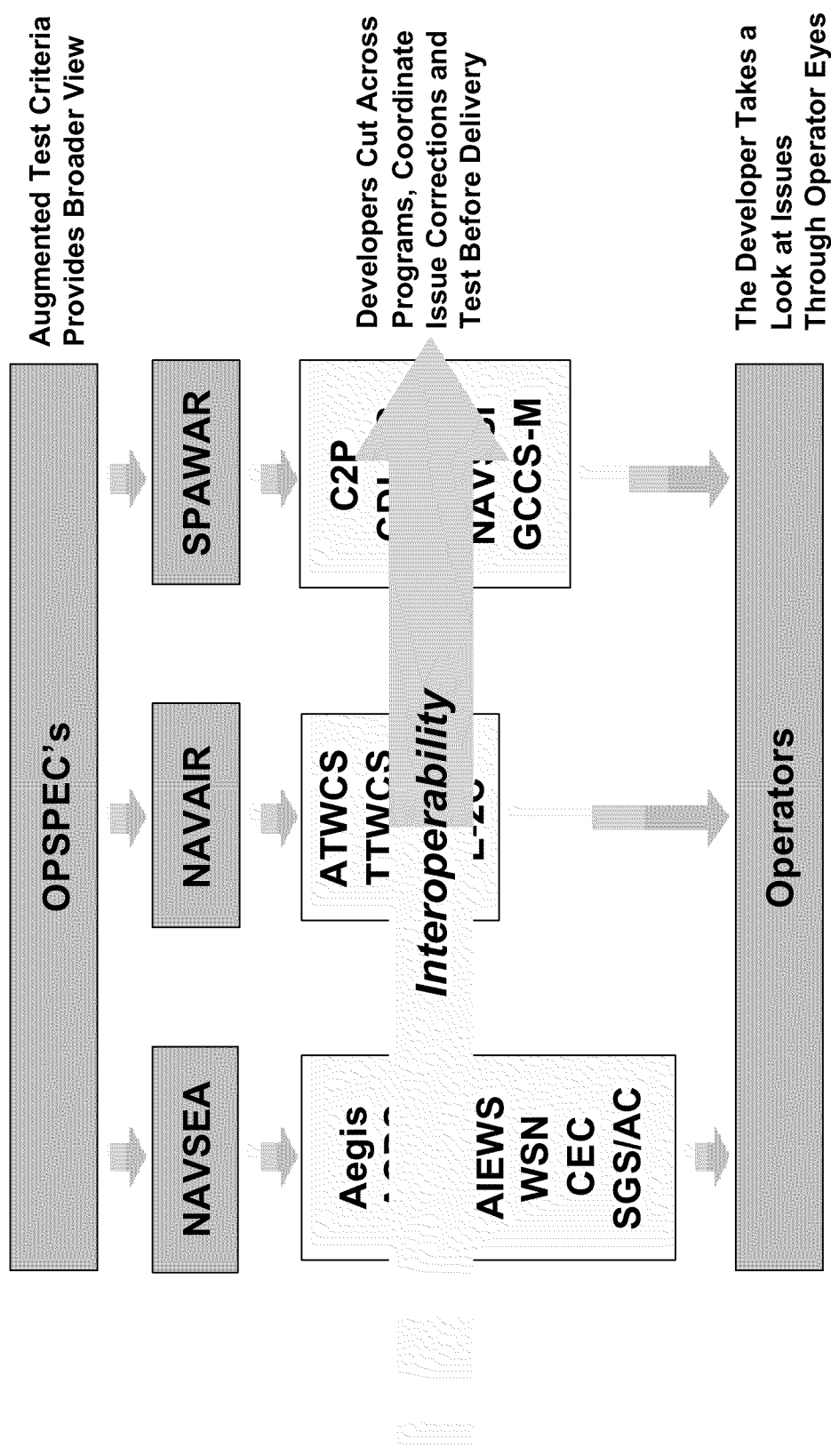
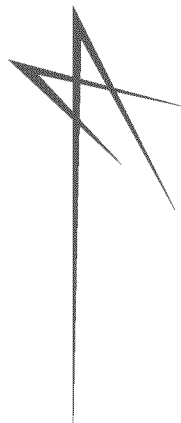
# ***New Test Initiative – What to Do?***



- ***Develop a system test infrastructure that would stimulate multiple systems during development***
  - ***An infrastructure that supported:***
    - ***an ability to generate and distribute common dynamic tracks to be processed by multiple systems.***
    - ***computer generated scenarios that would replicate operationally based experience.***
- ***Develop a robust test criteria with quantitative performance measurements***
- ***Develop test methodologies that facilitate:***
  - ***Iterative cross system problem identification***
  - ***Coordinated developer investigation***
  - ***System wide problem resolution and validation***

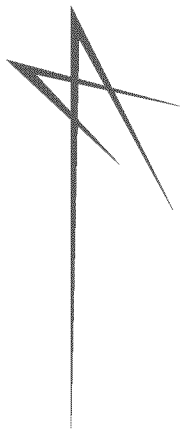
***Move Away From Sterile Single Ship Test Environments,  
Validating SIW Requirements... Move towards  
Testing The Way The Ship Fights***

# New Test Initiative – How To Do It



*Interoperability Can Be Measured and Tested by Developers*

# ***Multi-Aegis Combat System (MACS)***



- *High-fidelity interoperability testing using operationally based scenarios on a distributed network*
  - *Distribute tracks via Distribute Interface Simulator (DIS)*
  - *Connect TADILS via Aegis Broadcast Network (ABN-16)*
  - *Connect CEC via secure LAN*
- *Supplements*
  - *Navy Link Certification*
  - *Link exercises with Patriot/THAAD,E-2, ACDS*
- *Provides*
  - *Common sensor environment*
    - *Multi-aircraft , Multi-TBM*
    - *Simultaneous AAW and TBM*

***Built Battle Force Rancocas***



# Battle Force Rancocas

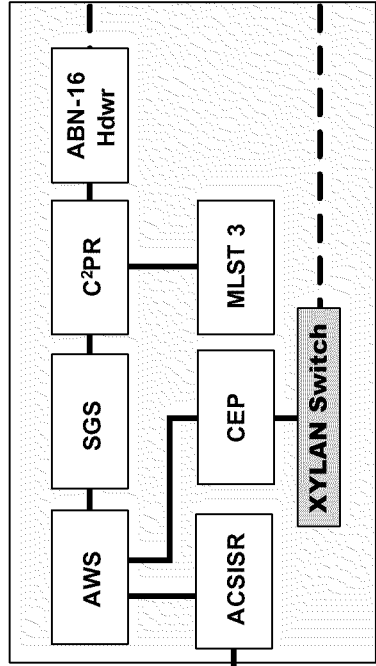


**PTC-2**



ACSIS DIS Network .47

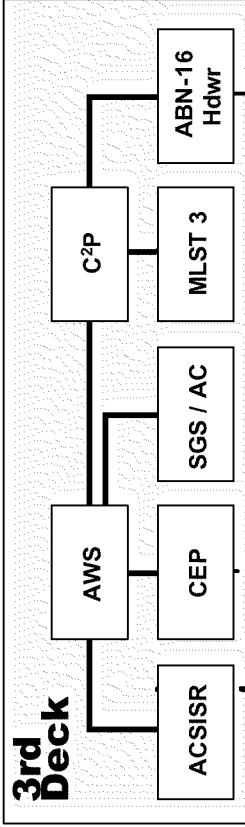
XYLAN Switch



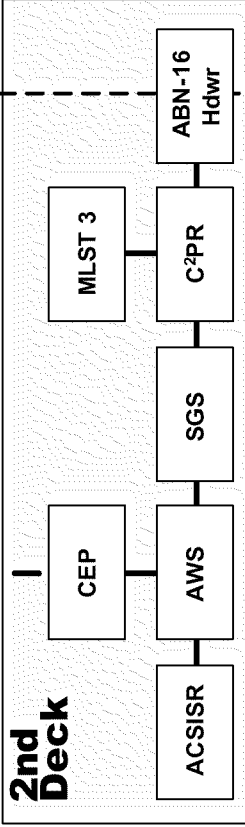
**CSEDS**



**3rd Deck**



**2nd Deck**

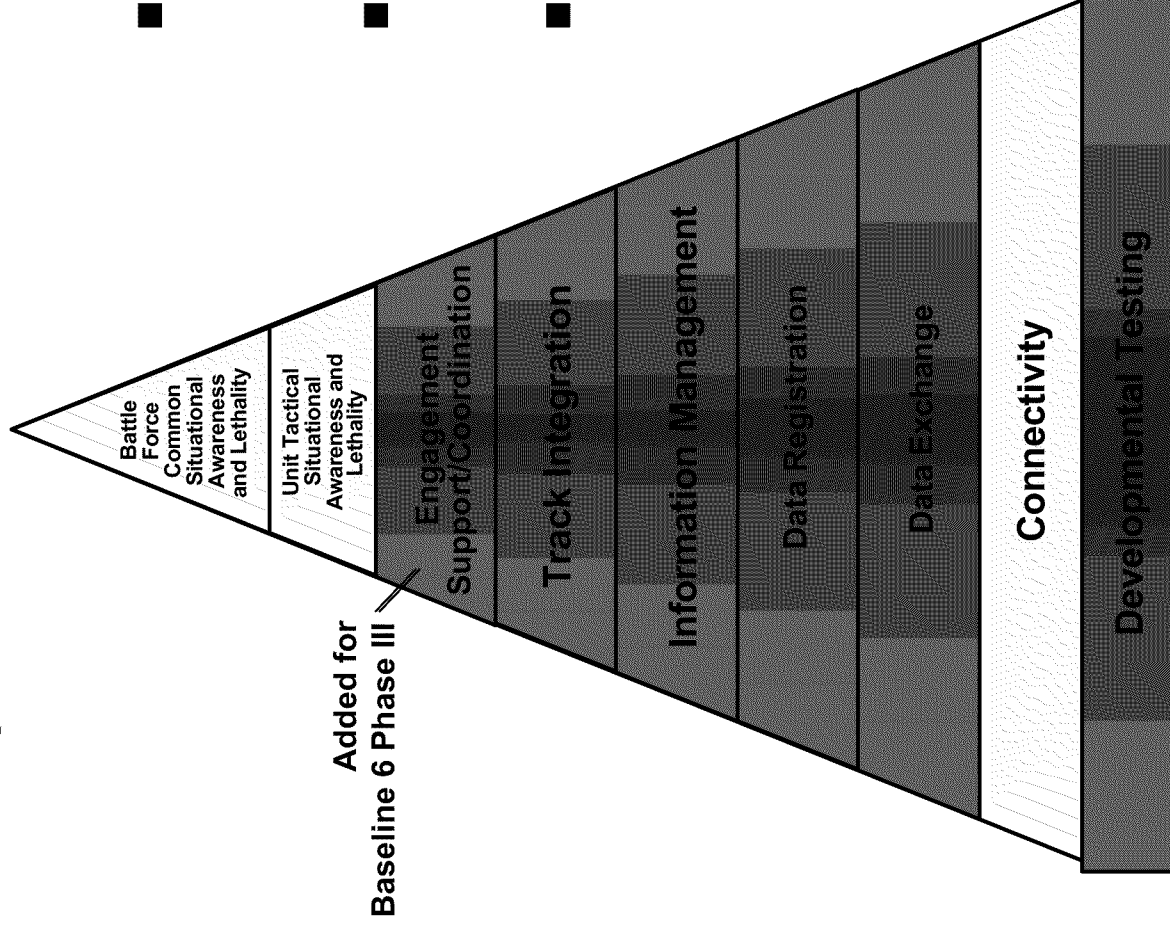
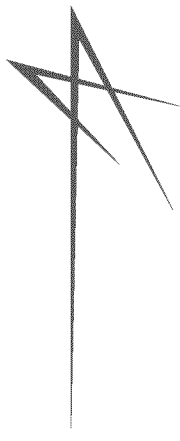


Direct Connect  
via  
NSCC F/O LAN

ABN-16

# MACS Interoperability Test Goals

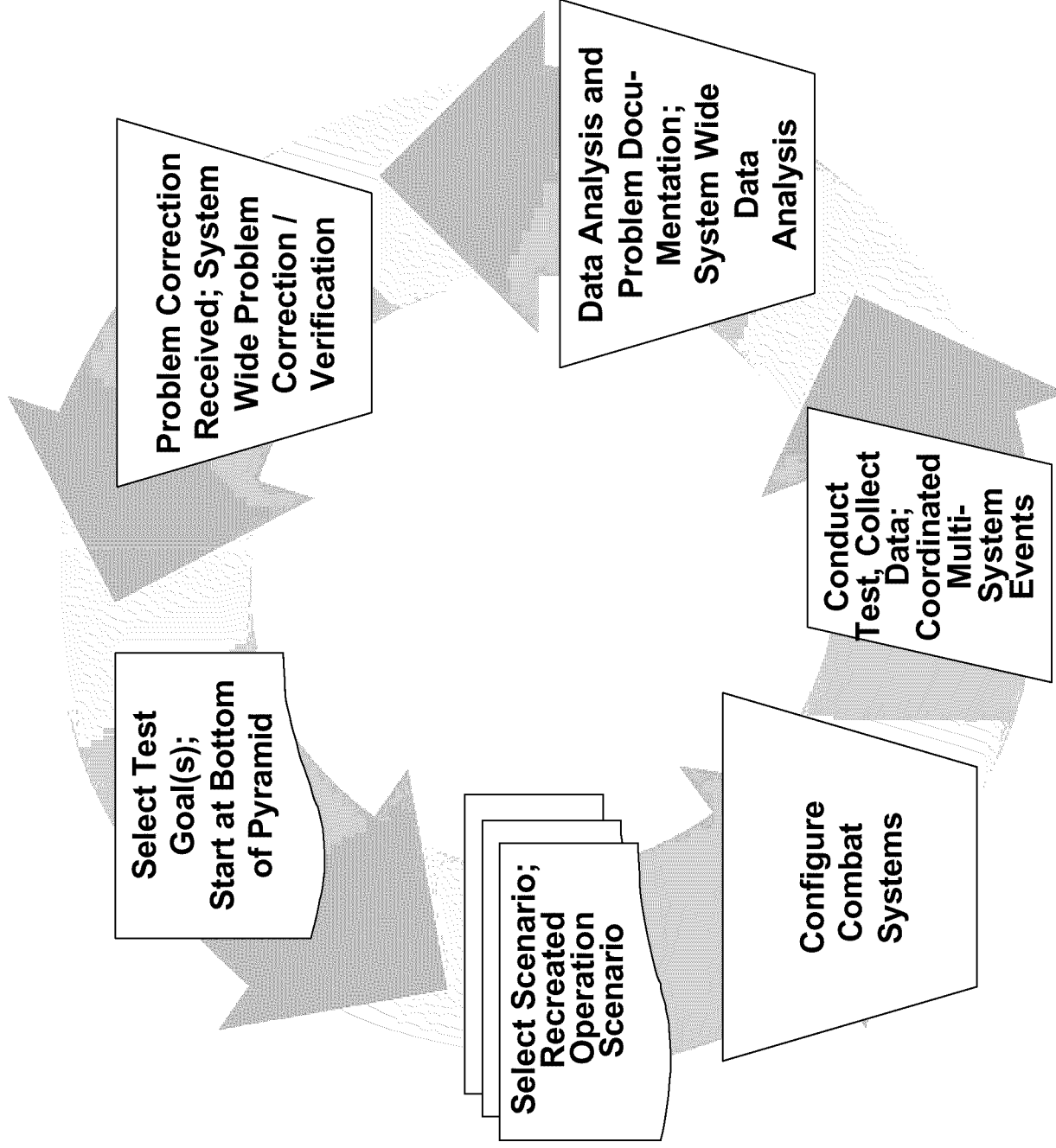
## Temp 801 Based Criteria



### Level Definition (Abridged)

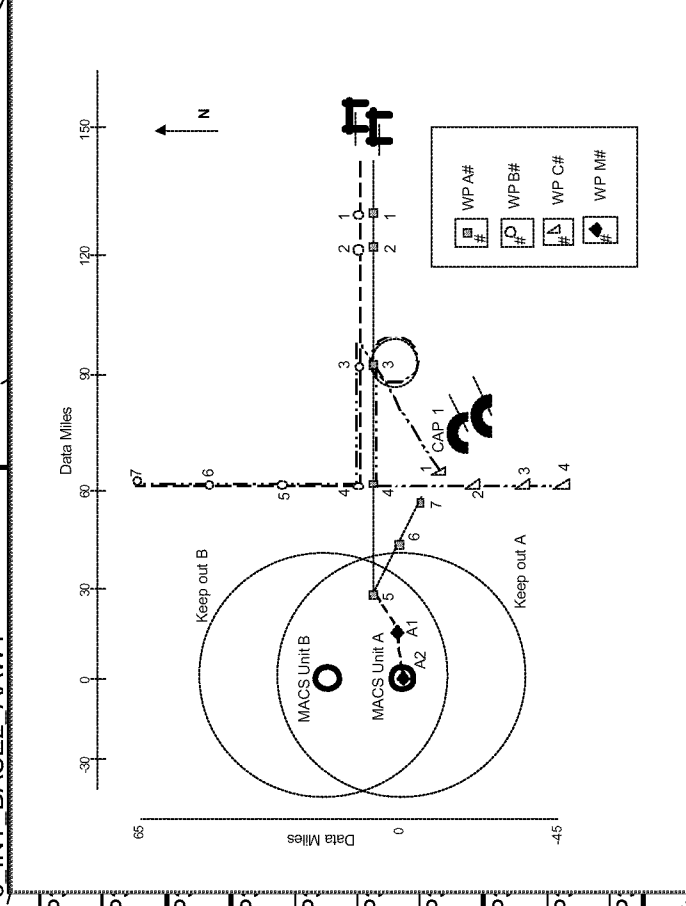
- **Engagement Support / Coordination:** Exploitation of integrated tack data and connectivity to support and coordinate air/TBM engagements
- **Track Integration:** The fusion of local and remote sensor data and track parameters (correlation, decorrelation, mutual tracking)
- **Information Management:** The storage and management of local and remote track parameter data (ID, IFF, etc.)
  - **Data Registration:** The corrective alignment of local and remote track position and kinematic data
  - **Data Exchange:** The sharing of data at the element and unit level
  - **Developmental Testing:** Verification of MACS test architecture and procedures

# Test Process



# ACSIS Scenario Used for Data Registration Testing

| Scenario                         | Permutation                   | Section  | Recommended script name |
|----------------------------------|-------------------------------|----------|-------------------------|
| 1. Baseline AAW                  | 1. Single threat (bandit A)   | A2.1.1.1 | 6P3_INT_BASE_AAW1       |
| 1. Baseline AAW                  | 2. Single threat (bandit B)   | A2.1.3.1 | 6P3_INT_BASE_AAW2       |
| 1. Baseline AAW                  | 3. Dual threat (bandit A & B) | A2.1.3.2 | 6P3_INT_BASE_AAW3       |
| 2. Baseline AAW mode swap        | 1. Single threat (bandit A)   | A2.2.1.1 | 6P3_INT_BASE2_AAW1      |
| 2. Baseline AAW mode swap        | 2. Single threat (bandit B)   | A2.2.3.1 | 6P                      |
| 2. Baseline AAW mode swap        | 3. Dual threat (bandit A & B) | A2.2.3.2 | 6P                      |
| 3. Dual-Axis AAW threat          | N/A                           | A2.3     | 6P                      |
| 4. Modified Dual-Axis AAW threat | 1. Single ASCM salvos         | A2.4     | 6P                      |
| 4. Modified Dual-Axis AAW threat | 2. Two ASCM salvos            | A2.4     | 6P                      |
| 4. Modified Dual-Axis AAW threat | 3. Three ASCM salvos          | A2.4     | 6P                      |
| 4. Modified Dual-Axis AAW threat | 4. Four ASCM salvos           | A2.4     | 6P                      |
| 5. Baseline HVA AAW              | 1. Two ASCM salvos            | A2.5     | 6P                      |
| 5. Baseline HVA AAW              | 2. Four ASCM salvos           | A2.5     | 6P                      |
| 5. Baseline HVA AAW              | 3. Six ASCM salvos            | A2.5     | 6P                      |



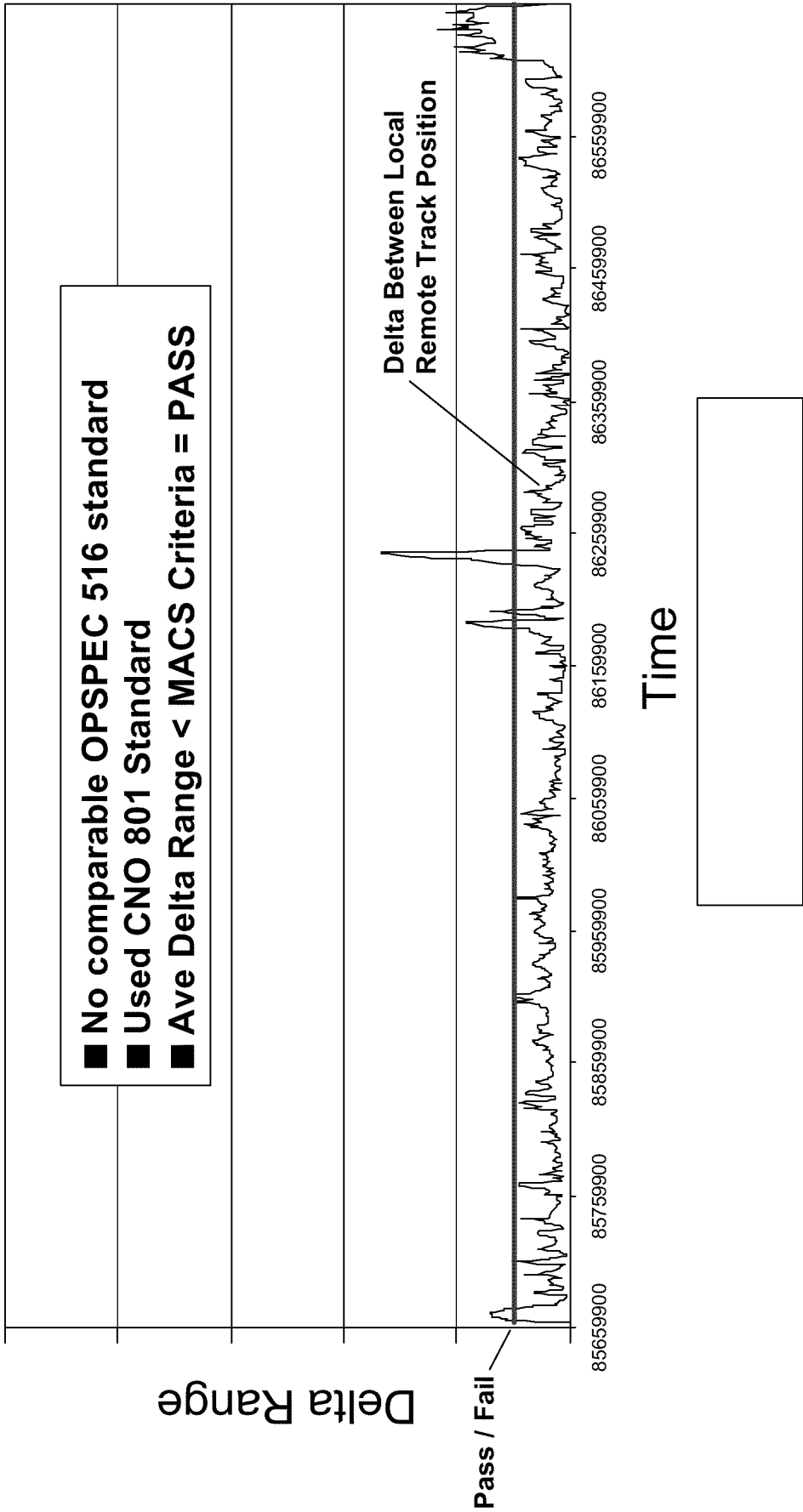
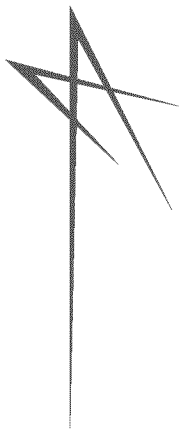
# ***Data Registration Testing:***

## ***An Example***

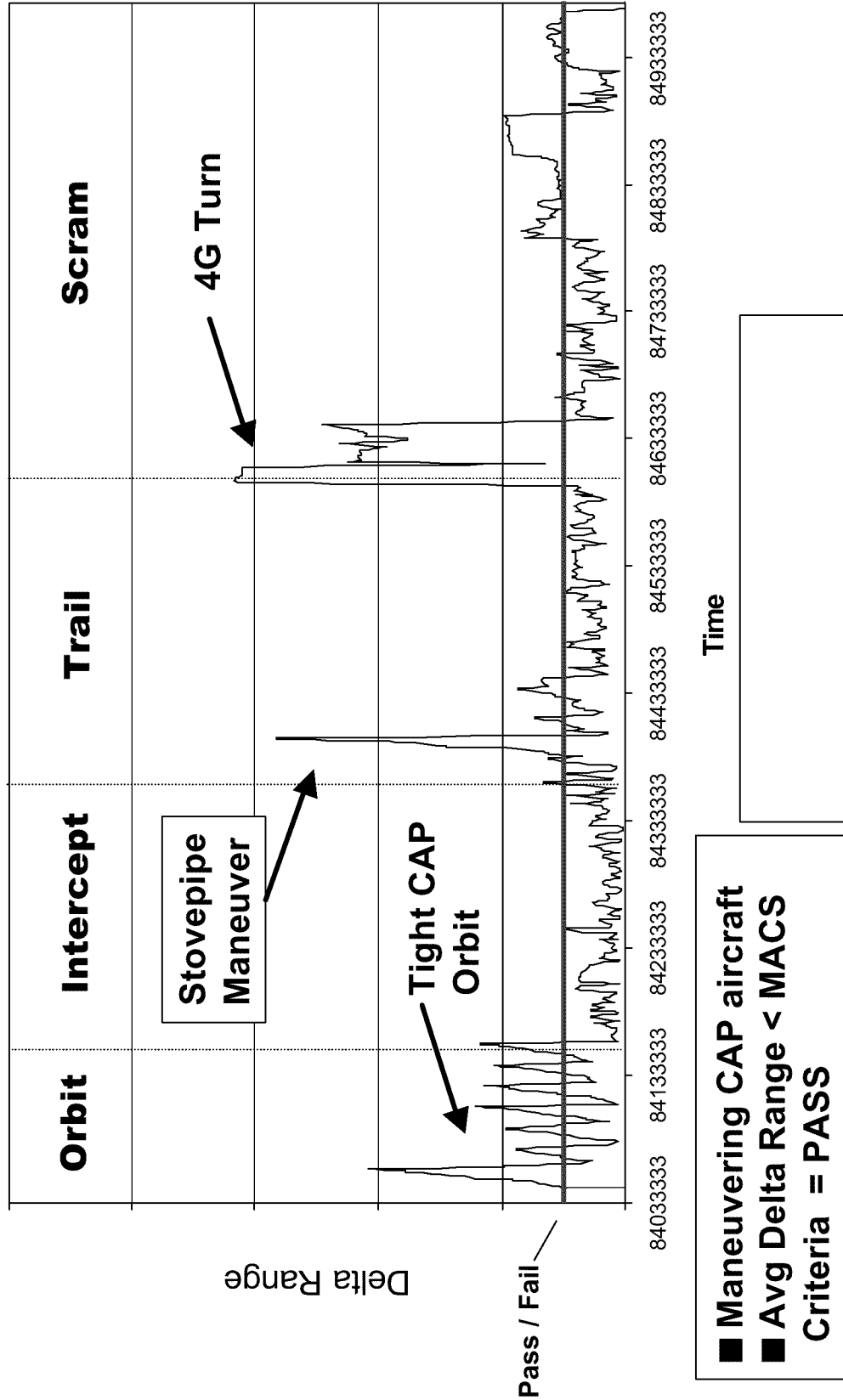
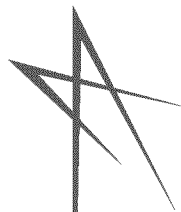
- ***MACS test matrix identifies 11 priority link specific data registration test goals and pass / fail criteria for:***
  - ***Relative Gridlock***
  - ***IU Registration***
  - ***Sensor Registration***
  - ***Developed ACSIS DIS scenario to inject sensor error that requires compensation using data registration***
- ***Initial results***
  - ***Failed on visual inspection: Tracks jumped wildly while conducting relative gridlock throughout scenario***
  - ***Data analysis identified C2PR N-1-3033, SGS / AC Sensor Registration application and C&D program problems***
  - ***All fixes verified***
  - ***Basic Relative Gridlock, IU Registration, and Sensor Registration functionality passed***

***Success Story, But Required Five Month Iterative Process***

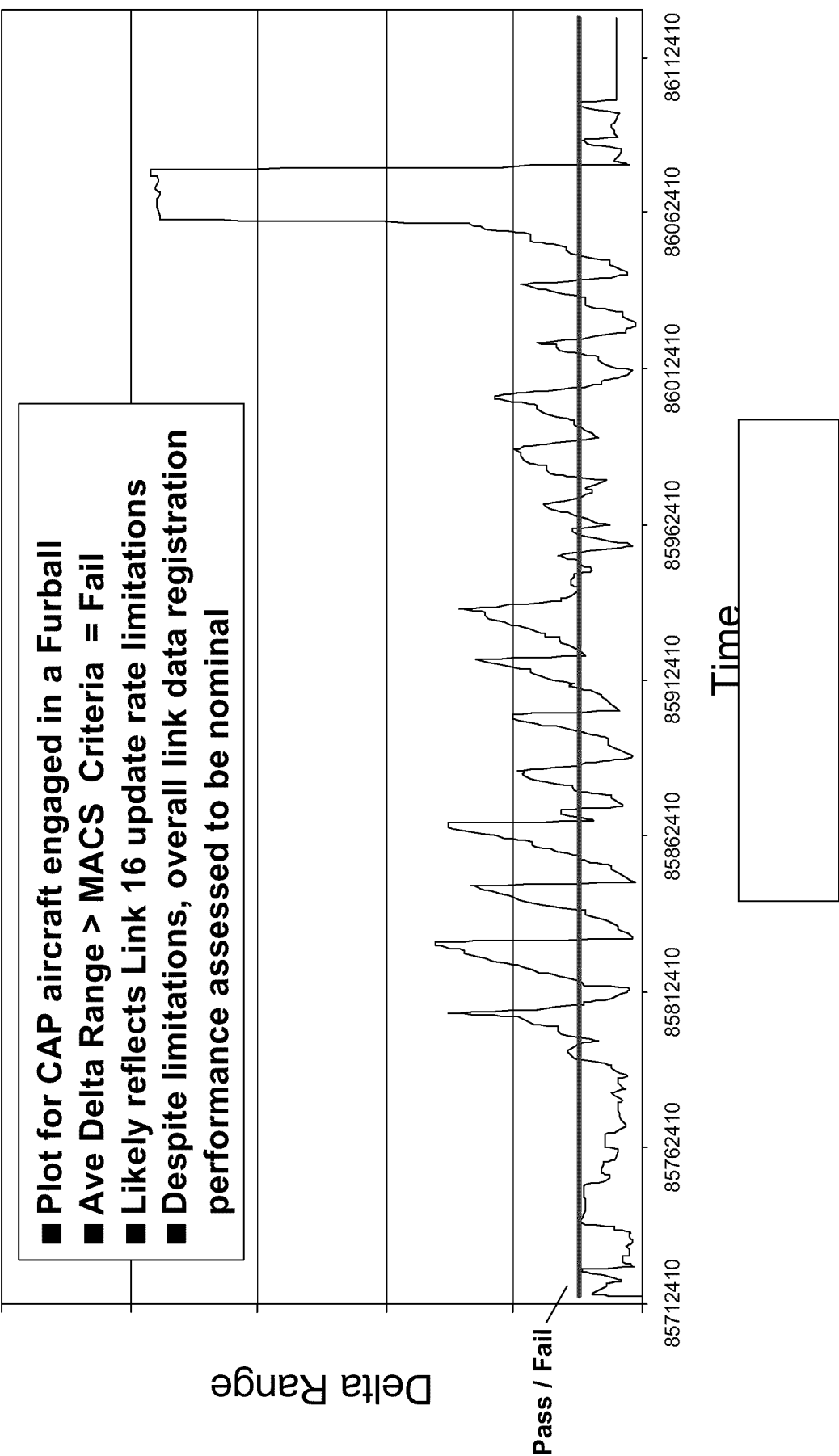
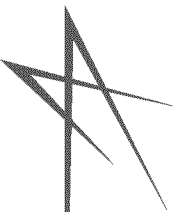
# Relative Gridlock Test Result: Aegis-Aegis Mutual Track



# Sensor and IU Registration Results

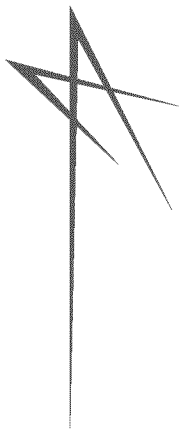


# Sensor and IU Registration Limitations



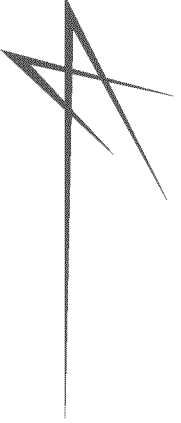


# MACS Lessons Learned



- *Developmental testing should be conducted in small doses with limited objectives*
- *Test configuration very challenging*
  - *Most resource intensive test configuration we employ*
  - *Developmental testing demands large test time investment per test objective*
- *Test architecture needed thorough testing and debugging*
- *Testing generates heavy data analysis demands*
- *DIS essential for TBMD interoperability testing*

*Finding and Fixing Interoperability Problems  
is an Iterative Time Consuming Process*



# Summary

- Lockheed Martin NE&SS-Surface Systems initiated MACS testing in response to PMS 400B direction to “improve interoperability”
- Infrastructure developed and testing in progress
- Experienced growing pains
- Testing has exposed problems that otherwise would be difficult to find or collect data on
- The use of DIS architecture has proven a necessity for TBMD interoperability testing
- Test shortfalls that affect ability to find and quickly resolve problems
  - Architecture / equipment
  - Analysis tools
  - Availability / participation of all elements developers

*Interoperability is Not a Goal, It's a Process*