Depot Maintenance Remote Monitoring Solutions

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Aaron J. Spak, Manager, Technology Deployment
20 July 2011

Purpose

- Present systems overview & case studies of demonstrated *remote / integrated* monitoring solutions designed to provide enterprise-wide visibility into asset utilization and enable optimized maintenance practices.

Efforts described -- Phase 3 SBIR

Agenda

- Impact Introduction – very brief!
- SBIR Roots
- Integrated Systems Approach
- Component Technology
- Case Studies
  - Portsmouth Naval Shipyard: WEMACS
  - Pearl Harbor Naval Shipyard: Dry Dock Pump Monitoring
  - Warner Robins ALC: LifeMeter

Company Background

- Founded in 1999, Privately Held
- Currently 130 employees
- Comprehensive CBM Portfolio
  - Impact: Software, Services, System Integration
  - Impact-RLW Systems: Industrial and Wireless Monitors
  - Impact Sytems UK: Fluid Monitoring for mobility market
- Offices in NY, PA, GA, Glasgow Scotland – 70% in Rochester
- 2010 revenue $22M, 2011 (projected) $25M
- Named to 2007 Inc magazine list of fastest growing U.S. private companies (#41 in Defense Contractor category)
- 30% eight-year compound annual growth rate (revenue)
- Top DOD Contractor in the U.S. for Automated Health Management technologies
  - $75M of R&D investment and growing
  - $35M directed towards Joint Strike Fighter (supporting zero scheduled maintenance initiative)

The Rochester Top 100

Inc. 5000 The Fastest Growing Private Companies in America

Impact Technologies

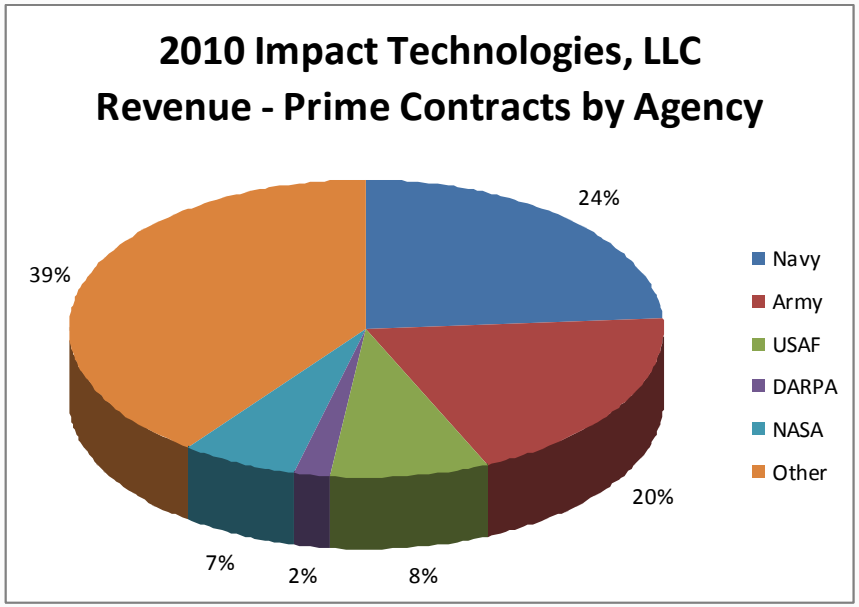
What Does Impact Do?

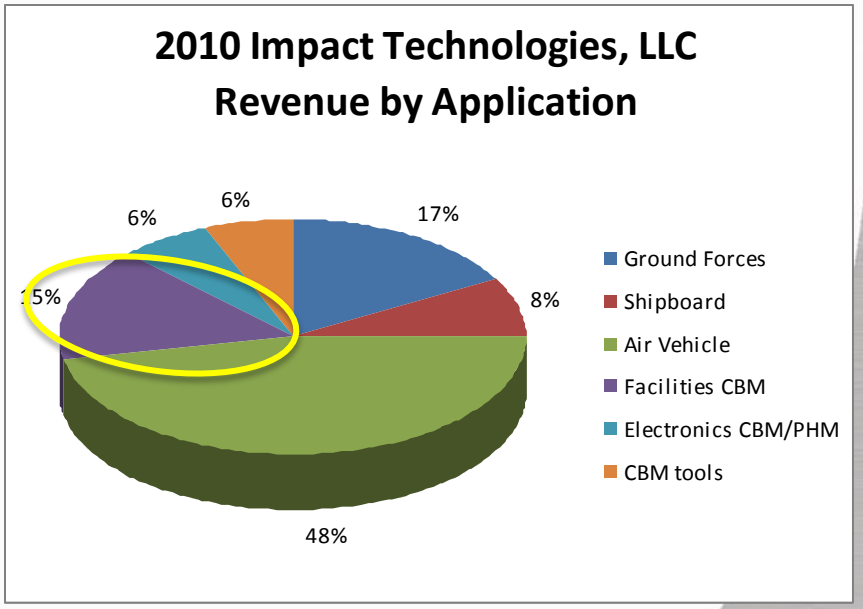
- Engineer and implement advanced health management solutions that monitor, detect, isolate, and predict equipment performance and readiness
  - Software solutions, smart sensors and hardware solutions, full system designs
  - Development, test and evaluation, integration, and deployment expertise
- Integrate with operator, maintenance, and logistics systems to minimize life cycle costs while maximizing system availability

Company Overview and History

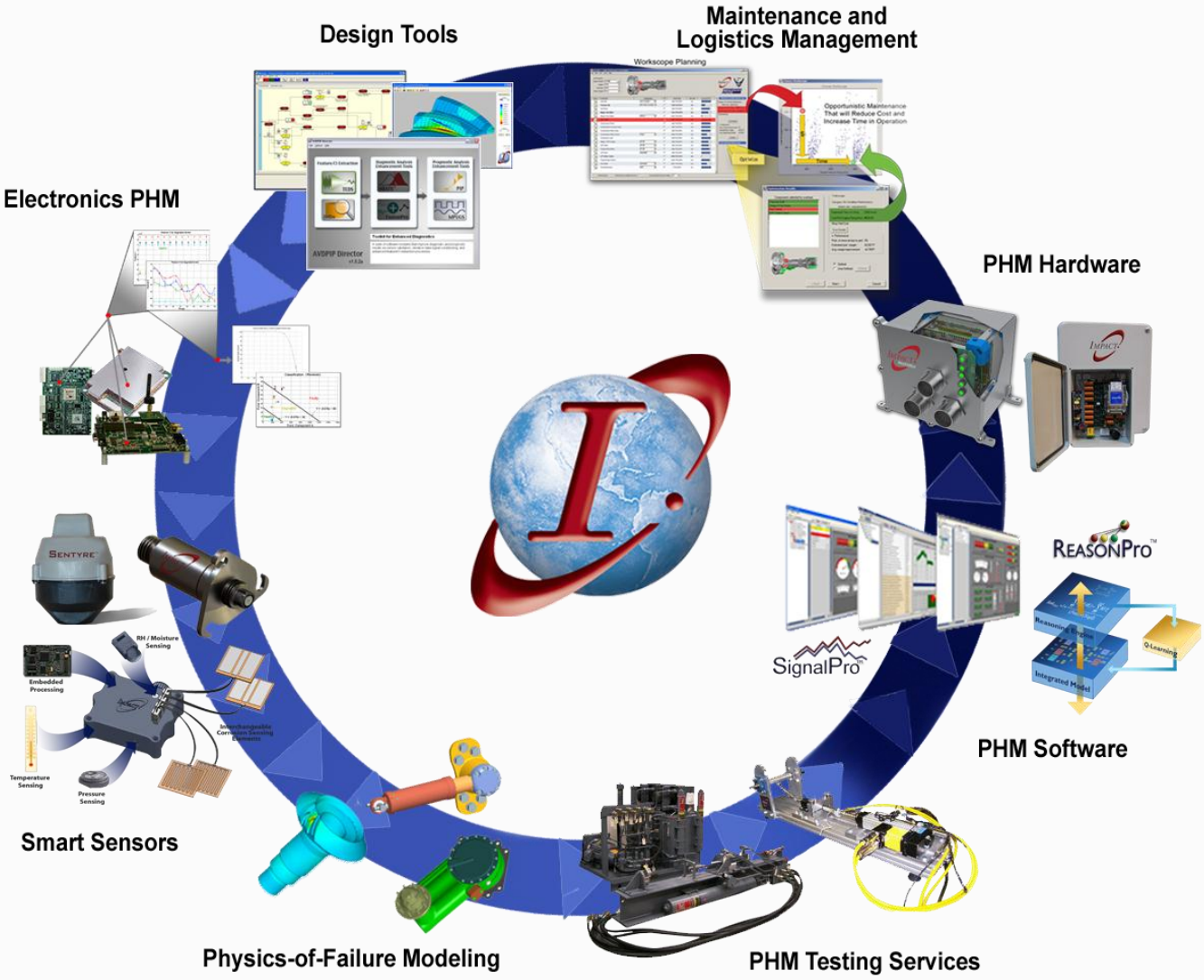
Customer and Program Diversity

- Balanced blend of Army, Navy, Air Force, NASA and Industrial Customers
- Technologies applicable across multiple vehicles, platforms and operations
- Continuously working on over 100 PHM/CBM related programs simultaneously



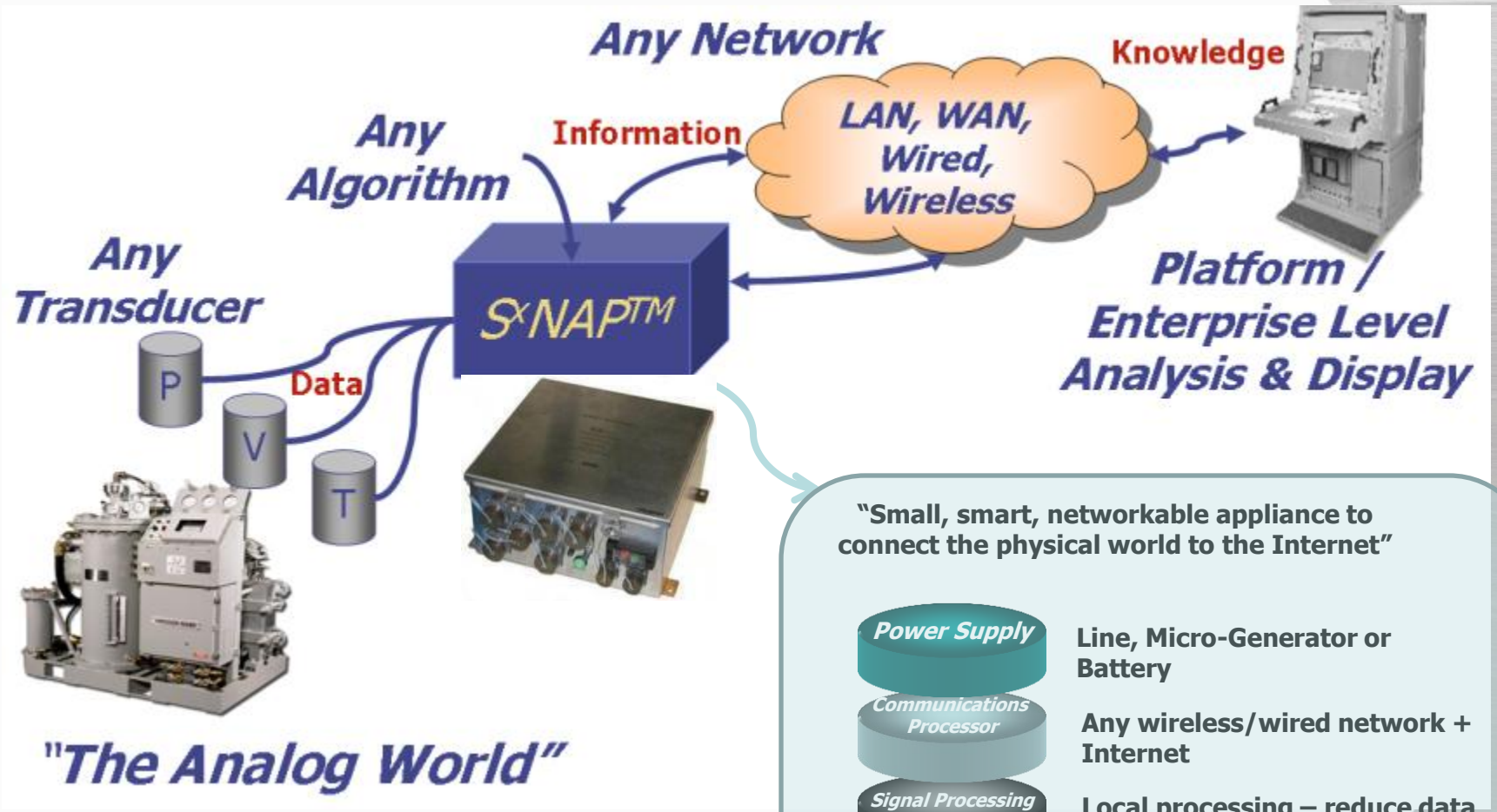


Impact Core Business Areas



Integrated Systems Approach and Component Technologies

Open Platform for Condition Monitoring



"Small, smart, networkable appliance to connect the physical world to the Internet"

Power Supply	Line, Micro-Generator or Battery
Communications Processor	Any wireless/wired network + Internet
Signal Processing	Local processing – reduce data to information
Transducers	Analog electrical signal proportional to physical parameter

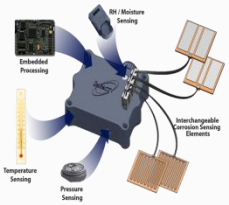
Technology & Areas of Expertise

Development & Validation Phase – *Sensing and Monitoring*

TRL 6

TRL 7

TRL 9



TRL 5

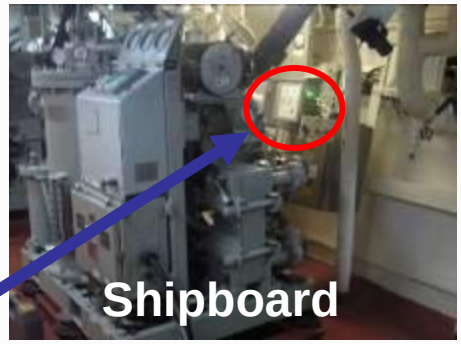
TRL 9

TRL 6

Device	Vibration Channels	Vibration Bandwidth[1]	Local Feature Extraction	Small Footprint	Low Power[2]	Flexible Input Types[3]	Desktop Class Processor	Demonstrated FIPS 140-2[4]	Cost
 **Impact Sentyre™** *Completely Wireless*	1	~10kHz		✓	✓				$
 **Impact SNAP®**	8[5]	~45kHz	✓	✓		✓		✓	$$
 **Impact HealthMax™**	64[6]	~40kHz	✓	✓		✓	✓		$$$$
 **NI Compact RIO**	32+[7]	~20kHz	✓	✓		✓			$$$

[1] Alias-free dynamic signal bandwidth with simultaneous sampling. [2] More than 2 years battery life.
[3] Variable conditioning options to handle a variety of signal types: temperature, strain, current, vibration, etc.
[4] This hardware has been demonstrated to meet the requirements of FIP 140-2 U.S. government computer security standards.
[5] There are expansion options up to 64 channels, however only two channels can be sampled simultaneously at a time.
[6] 64 single-ended, 32 differential. [7] The number of channels varies by input type. The numbers shown here are simultaneously sampled, IEPE powered vibration channels installed in a single chassis. Expansion chassis are optional; the channel limit may be determined by data bandwidth requirements.

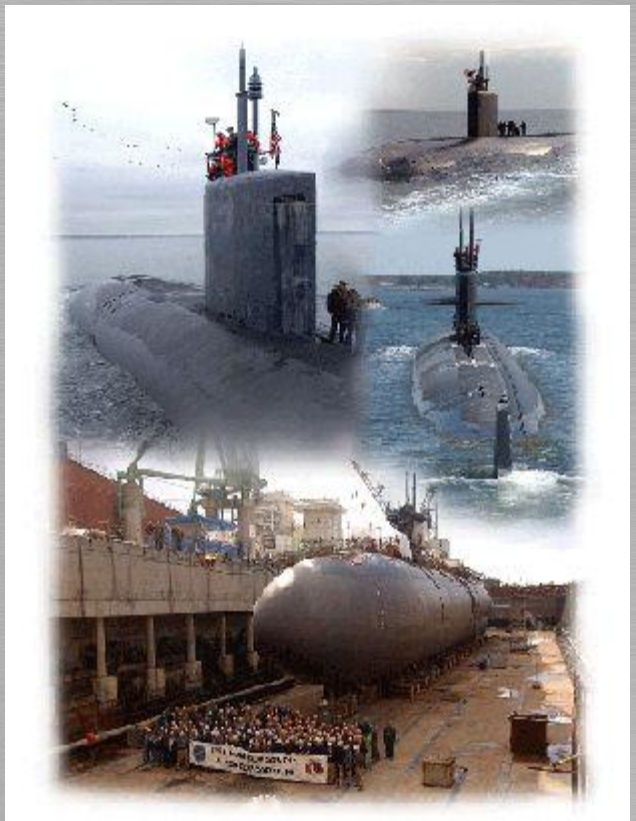
SNAP2 - Technical Basis



- XML Interfaces [S2NAP® XML Schema]
- 8 Sensor Channels
- Tachometer Input
- 2 Analog Output Channels
- 1 Relay Contact Output
- 2 EIA-232 Serial Ports. (Optional EIA 422/485)
- Dual Processor Architecture
- **Wi-Fi (IEEE 802.11b) Wireless Network – FIPS 140-2**
- Mil-Qualified

Developed under SBIR Topic OSD01-CBM02 – "Smart Spaces"

Portsmouth Naval Shipyard: WEMACS



Program Overview

- Project Initiation Portsmouth Naval Shipyard – 2006
  - Extension of prior SBIR projects – Phase 3 SBIR
- Sponsorship - transition from ONR to NAVSEA04XI (Installations & Equipment)
- Program Goals
  - Provide ability to monitor shipyard capital assets, facilities and equipment in support of performing maintenance based on ***objective evidence of need*** -- ***Condition Based Maintenance (CBM) IAW OPNAVINST 4790.16a***
  - Develop, install and accredit FIPS 140-2 secure wireless network
  - Enable shipyard business processes and applications (e.g., eFEM)

Improve Asset Availability – Decrease Maintenance Costs

Wireless Equipment Monitoring and Control System (WEMACS)

- Wireless Network
- eFEM Integration (IBM Maximo)
  - NMCI Connectivity
- Usage Monitoring
- Load Monitoring
- VFD Fault Code Alerting

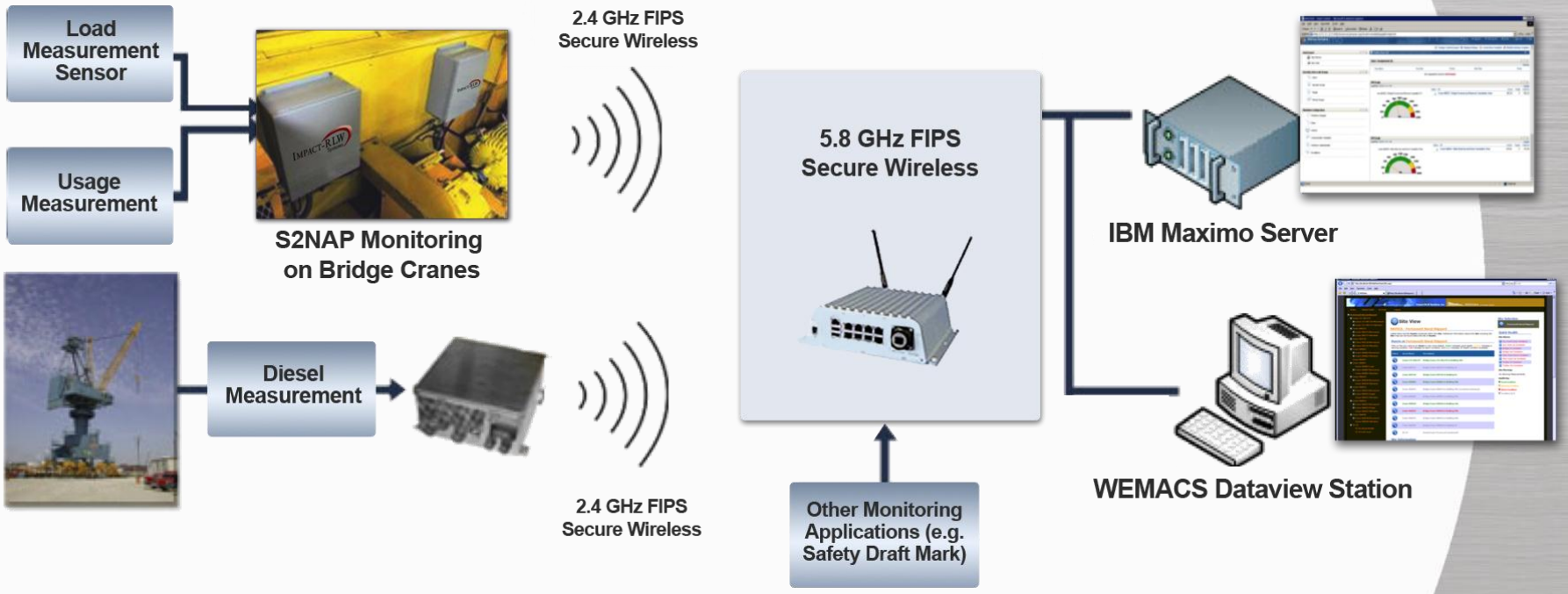
WEMACS System Overview

- WEMACS provides Shipyard wide monitoring and management capability for capital assets.

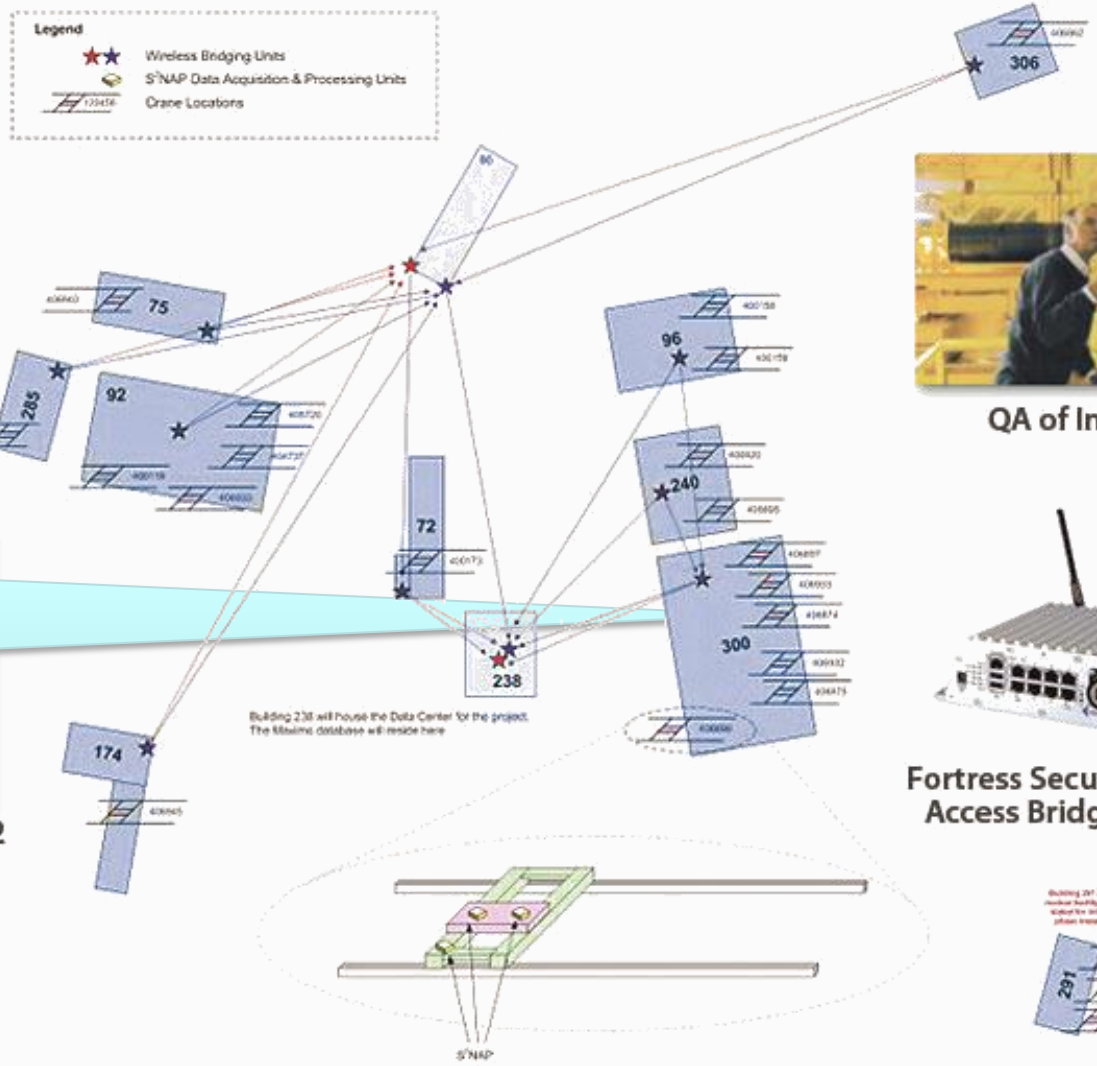
- Shipyard Wide Impact
  - Cranes, Machine Tools, Temp Services, etc.
  - Secure wireless network developed and installed throughout PNS – currently in Accreditation process.
  - Infrastructure available to support secure data transport and analysis for *any* unclassified application.

Wireless Equipment and Control System

- *Usage data* converted to actionable information via IBM Maximo
- Asset information will be available to NAVSEA enterprise via NMCI



PNS WLAN Footprint



QA of Install

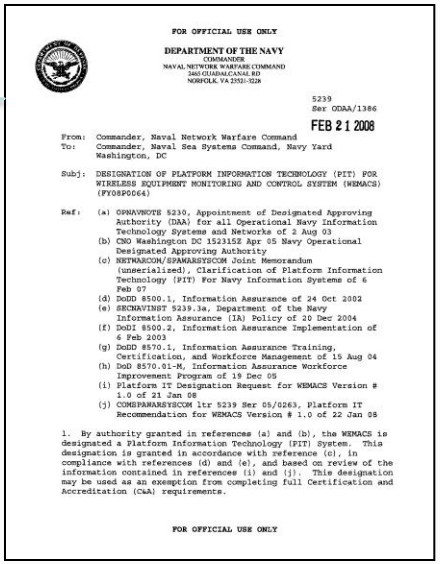
S²NAPs Aboard Crane #932

Fortress Secure Wireless Access Bridge - ES520

Secure Wireless Network

- **Features**
  - Complies with governing DoD and DoN Security Guidance
  - Uses validated COTS FIPS 140-2 equipment and secure clients (software)
  - Could support both fixed and mobile client applications

NETWARCOM Platform IT (PIT) Designation



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DEPARTMENT OF THE NAVY
COMMANDER
NAVAL NETWORK WARFARE COMMAND
2465 GUADALCANAL RD
NORFOLK, VA 23521-3228

5239
Ser ODAA/1386
FEB 21 2008

From: Commander, Naval Network Warfare Command
To: Commander, Naval Sea Systems Command, Navy Yard Washington, DC

Subj: DESIGNATION OF PLATFORM INFORMATION TECHNOLOGY (PIT) FOR WIRELESS EQUIPMENT MONITORING AND CONTROL SYSTEM (WEMACS) (FY08P0064)

Ref: (a) OPNAVNOTE 5230, Appointment of Designated Approving Authority (DAA) for all Operational Navy Information Technology Systems and Networks of 2 Aug 03
(b) CNO Washington DC 152315Z Apr 05 Navy Operational Designated Approving Authority
(c) NETWARCOM/SPAWARSYSCOM Joint Memorandum (unserialized), Clarification of Platform Information Technology (PIT) For Navy Information Systems of 6 Feb 07
(d) DoDD 8500.1, Information Assurance of 24 Oct 2002
(e) SECNAVINST 5239.3a, Department of the Navy Information Assurance (IA) Policy of 20 Dec 2004
(f) DoDI 8500.2, Information Assurance Implementation of 6 Feb 2003
(g) DoDD 8570.1, Information Assurance Training, Certification, and Workforce Management of 15 Aug 04
(h) DoD 8570.01-M, Information Assurance Workforce Improvement Program of 19 Dec 05
(i) Platform IT Designation Request for WEMACS Version # 1.0 of 21 Jan 08
(j) COMSPAWARSYSCOM ltr 5239 Ser 05/0263, Platform IT Recommendation for WEMACS Version # 1.0 of 22 Jan 08

1. By authority granted in references (a) and (b), the WEMACS is designated a Platform Information Technology (PIT) System. This designation is granted in accordance with reference (c), in compliance with references (d) and (e), and based on review of the information contained in references (i) and (j). This designation may be used as an exemption from completing full Certification and Accreditation (C&A) requirements.

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Bridge Crane "At the Hook" Load Monitoring

- Calibration sticker applied 5/27/2009 on crane 897
  - Used reference load cell in-line with test weights
- Identical system installed on crane 898 (sister crane)
- 897 and 898 located in Bldg 300 Shaft Bay

Reference Load Cell [lbs]	GL112 Hand Held Display [lbs]	Error
15,180	15,370	-1.30%
30,235	29,760	1.60%
45,307	46,050	-1.60%
60,571	60,650	-0.10%
70,614	71,450	-1.20%

Setting new industry standard for load measurement accuracy.

Portal Crane Load Monitoring

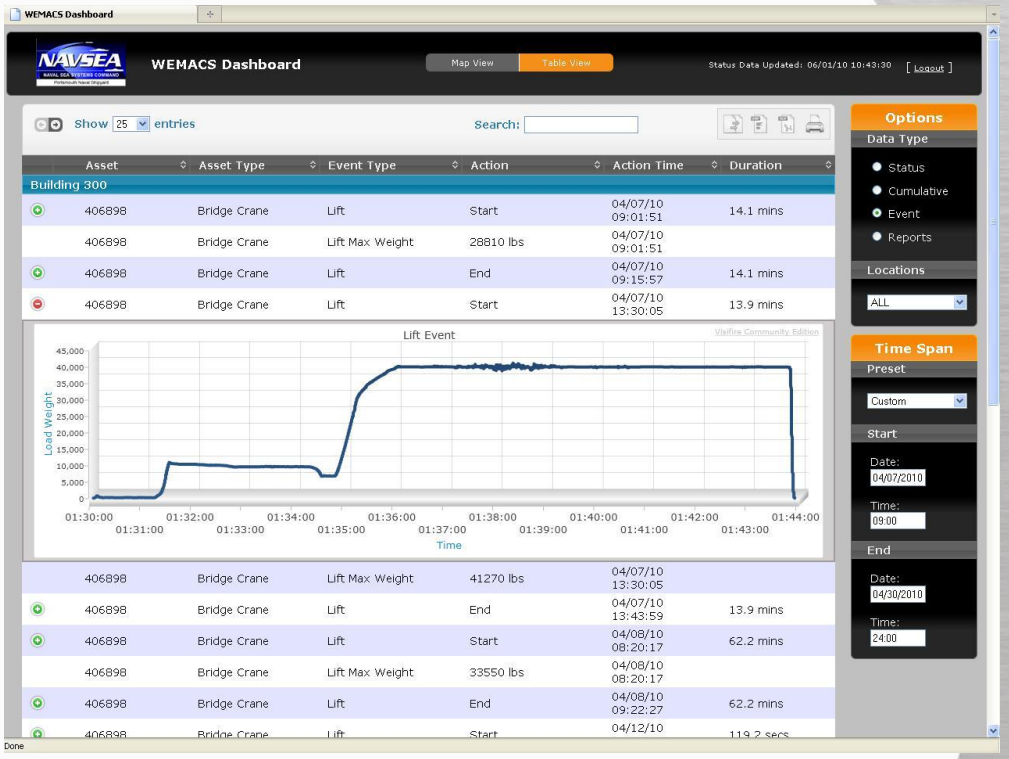
- At-the-hook load monitoring on PC31 provides high accuracy load-moment indication on whip and main hoist.
- Safe Load Indication capability
- Data supports crane life analyses
- Calibration completed – crane back in service.

Modified main hook trunion

Whip Hoist Assembly

Web-based Data Display

- Dashboard display of summary status and cumulative usage data.
- Displays each lift profile as an individual event.
- Data summarized in reports of usage over user-defined time intervals.



Map View – Asset Drilldown

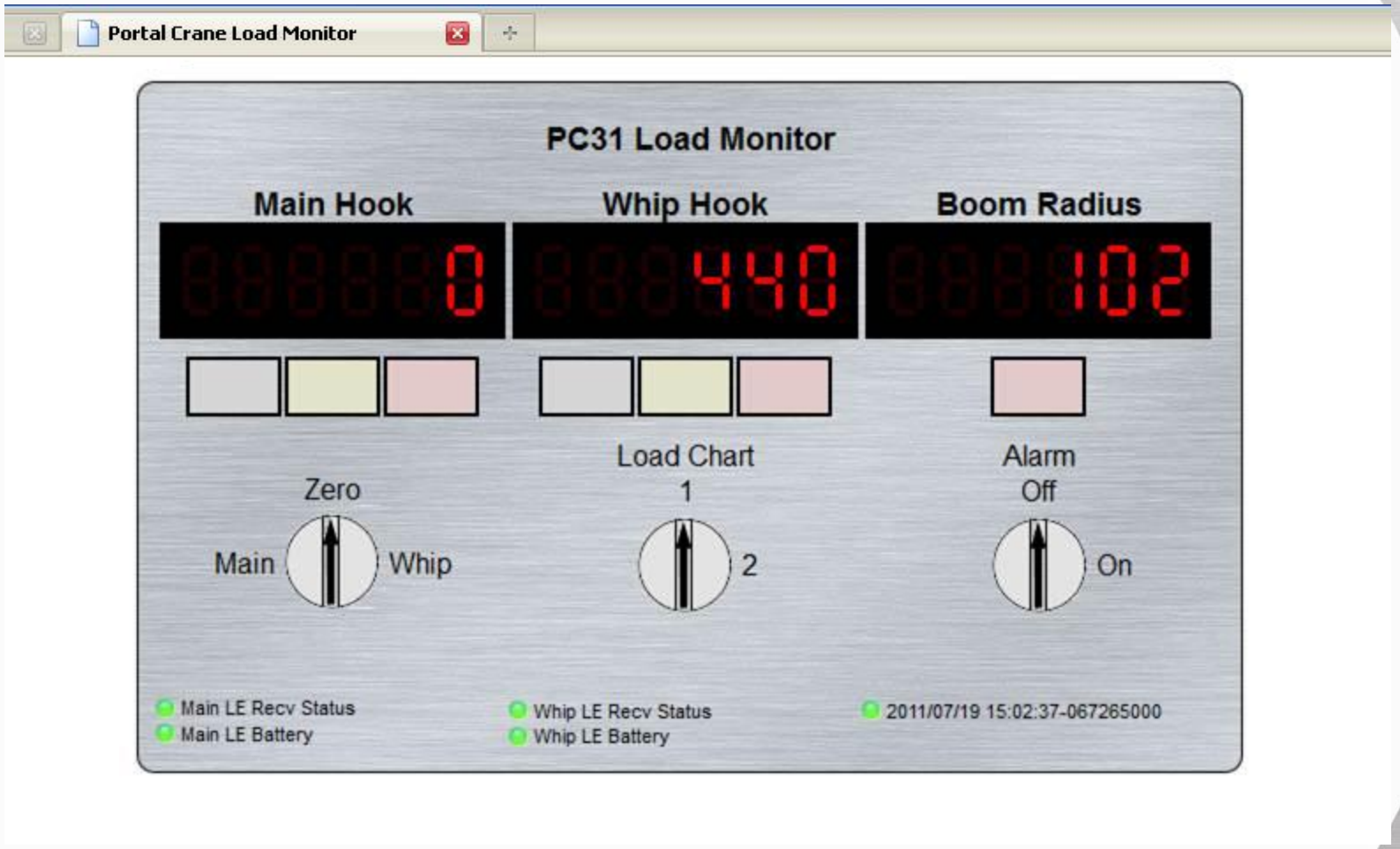
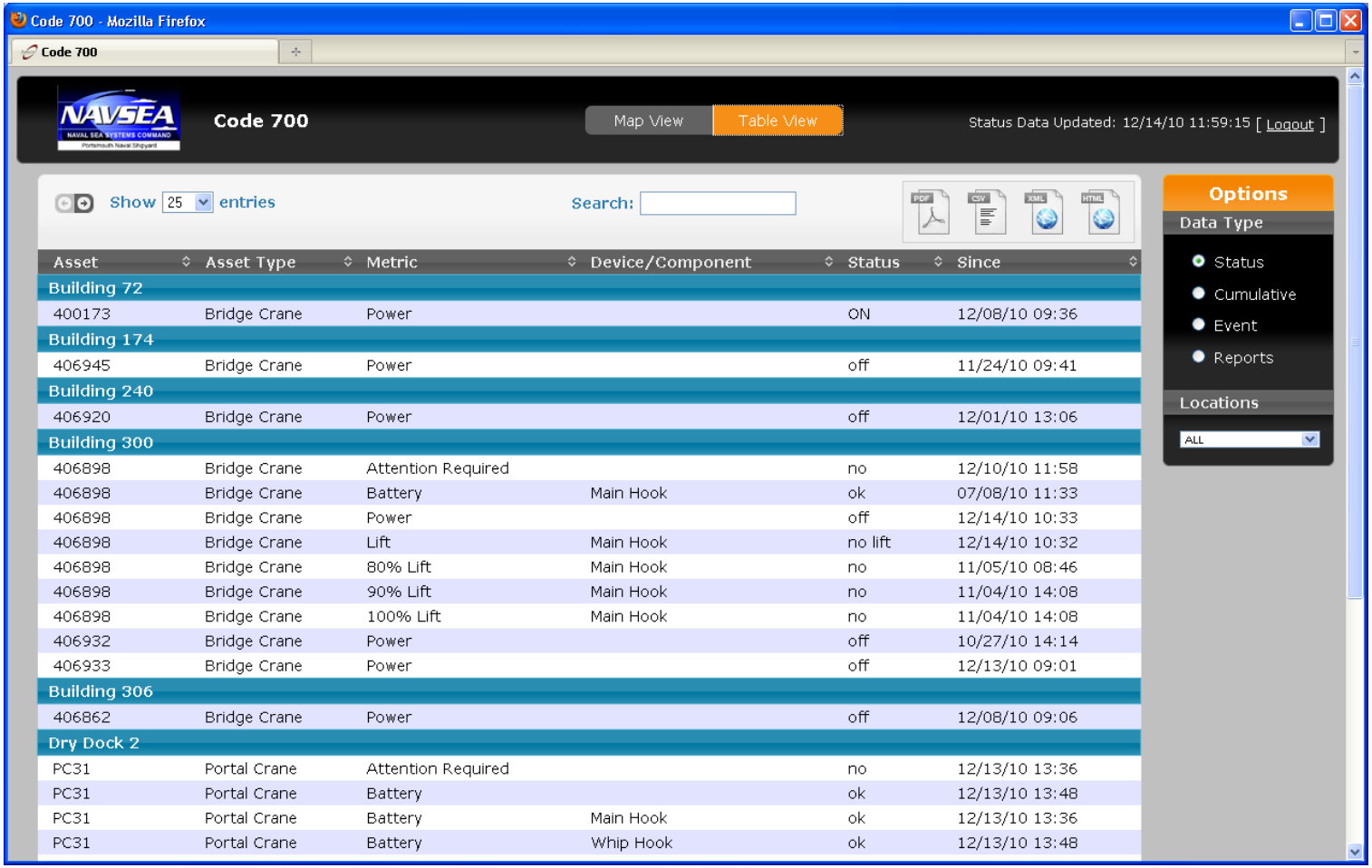


Table View – Status



Asset	Asset Type	Metric	Device/Component	Status	Since
Building 72					
400173	Bridge Crane	Power		ON	12/08/10 09:36
Building 174					
406945	Bridge Crane	Power		off	11/24/10 09:41
Building 240					
406920	Bridge Crane	Power		off	12/01/10 13:06
Building 300					
406898	Bridge Crane	Attention Required		no	12/10/10 11:58
406898	Bridge Crane	Battery	Main Hook	ok	07/08/10 11:33
406898	Bridge Crane	Power		off	12/14/10 10:33
406898	Bridge Crane	Lift	Main Hook	no lift	12/14/10 10:32
406898	Bridge Crane	80% Lift	Main Hook	no	11/05/10 08:46
406898	Bridge Crane	90% Lift	Main Hook	no	11/04/10 14:08
406898	Bridge Crane	100% Lift	Main Hook	no	11/04/10 14:08
406932	Bridge Crane	Power		off	10/27/10 14:14
406933	Bridge Crane	Power		off	12/13/10 09:01
Building 306					
406862	Bridge Crane	Power		off	12/08/10 09:06
Dry Dock 2					
PC31	Portal Crane	Attention Required		no	12/13/10 13:36
PC31	Portal Crane	Battery		ok	12/13/10 13:48
PC31	Portal Crane	Battery	Main Hook	ok	12/13/10 13:36
PC31	Portal Crane	Battery	Whip Hook	ok	12/13/10 13:48

Table View - Cumulative – Crane Movement Time (Oct. 2010)

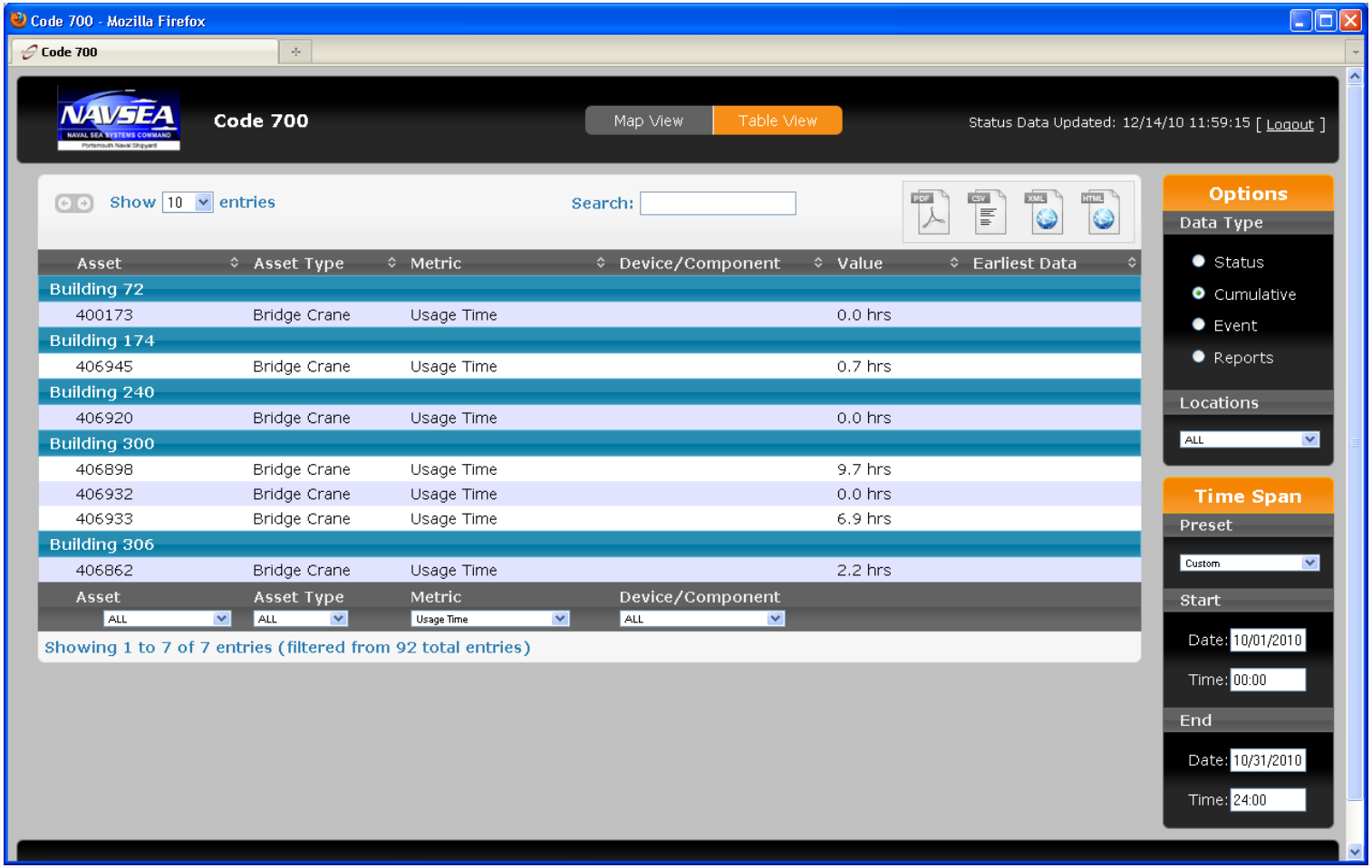


Table View – Event – Bridge Crane Lift Events

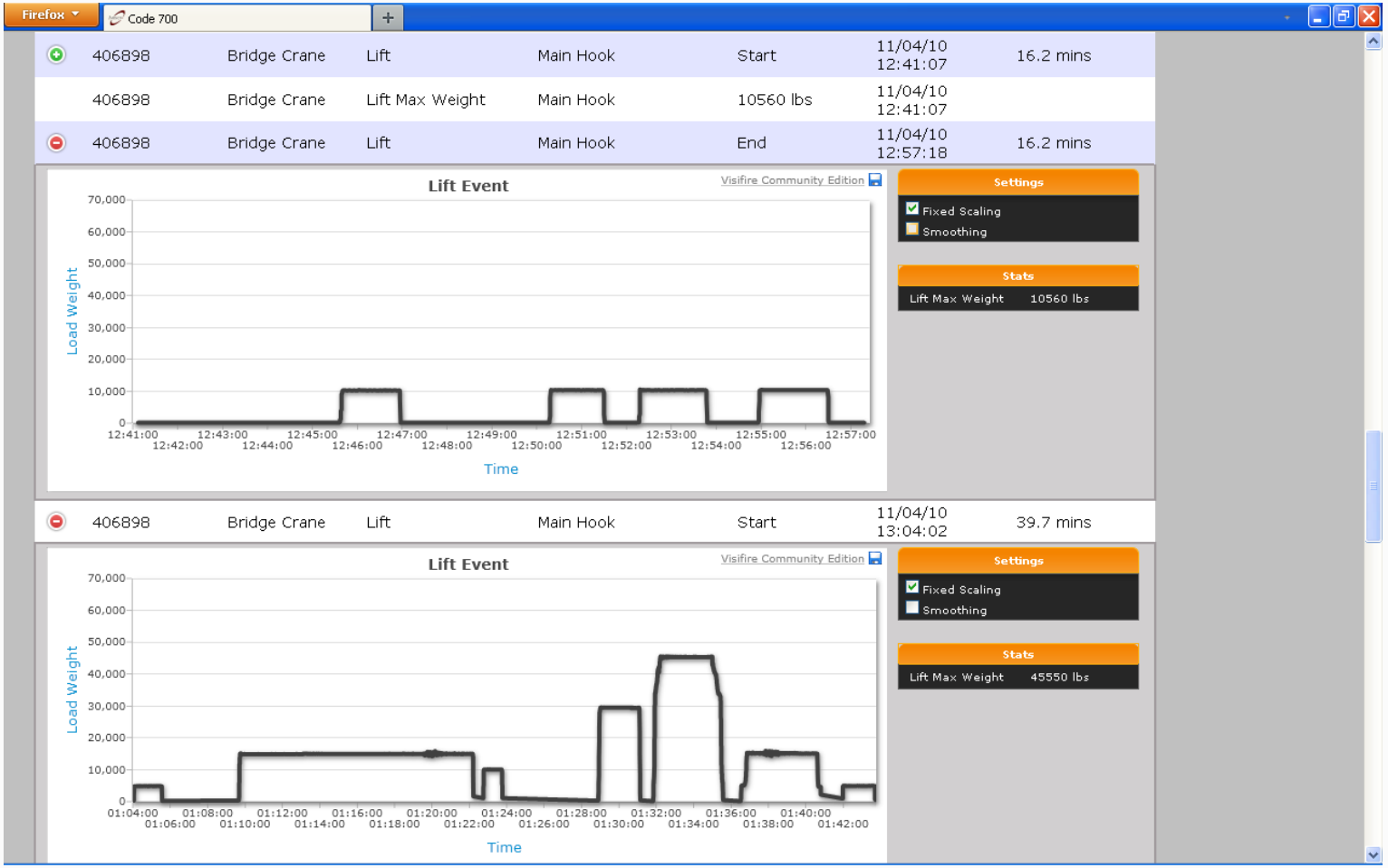
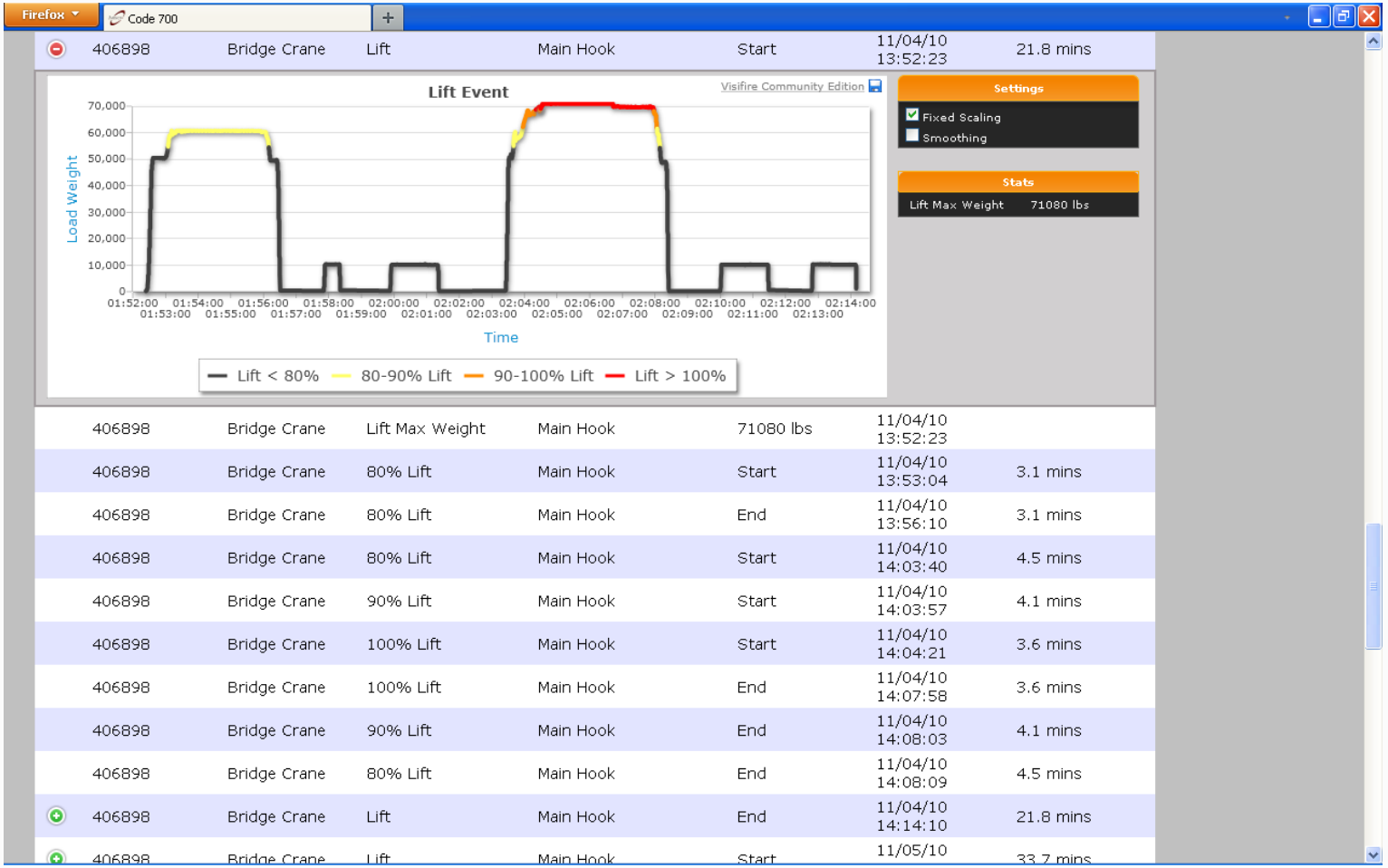


Table View – Event – Bridge Crane Lift Event > 100% Capacity



	406898	Bridge Crane	Lift	Main Hook	Start	11/04/10 13:52:23	21.8 mins
	406898	Bridge Crane	Lift Max Weight	Main Hook	71080 lbs	11/04/10 13:52:23	
	406898	Bridge Crane	80% Lift	Main Hook	Start	11/04/10 13:53:04	3.1 mins
	406898	Bridge Crane	80% Lift	Main Hook	End	11/04/10 13:56:10	3.1 mins
	406898	Bridge Crane	80% Lift	Main Hook	Start	11/04/10 14:03:40	4.5 mins
	406898	Bridge Crane	90% Lift	Main Hook	Start	11/04/10 14:03:57	4.1 mins
	406898	Bridge Crane	100% Lift	Main Hook	Start	11/04/10 14:04:21	3.6 mins
	406898	Bridge Crane	100% Lift	Main Hook	End	11/04/10 14:07:58	3.6 mins
	406898	Bridge Crane	90% Lift	Main Hook	End	11/04/10 14:08:03	4.1 mins
	406898	Bridge Crane	80% Lift	Main Hook	End	11/04/10 14:08:09	4.5 mins
	406898	Bridge Crane	Lift	Main Hook	End	11/04/10 14:14:10	21.8 mins
	406898	Bridge Crane	Lift	Main Hook	Start	11/05/10	33.7 mins

Lifting and Handling Benefits

Management, Engineering, and Maintenance

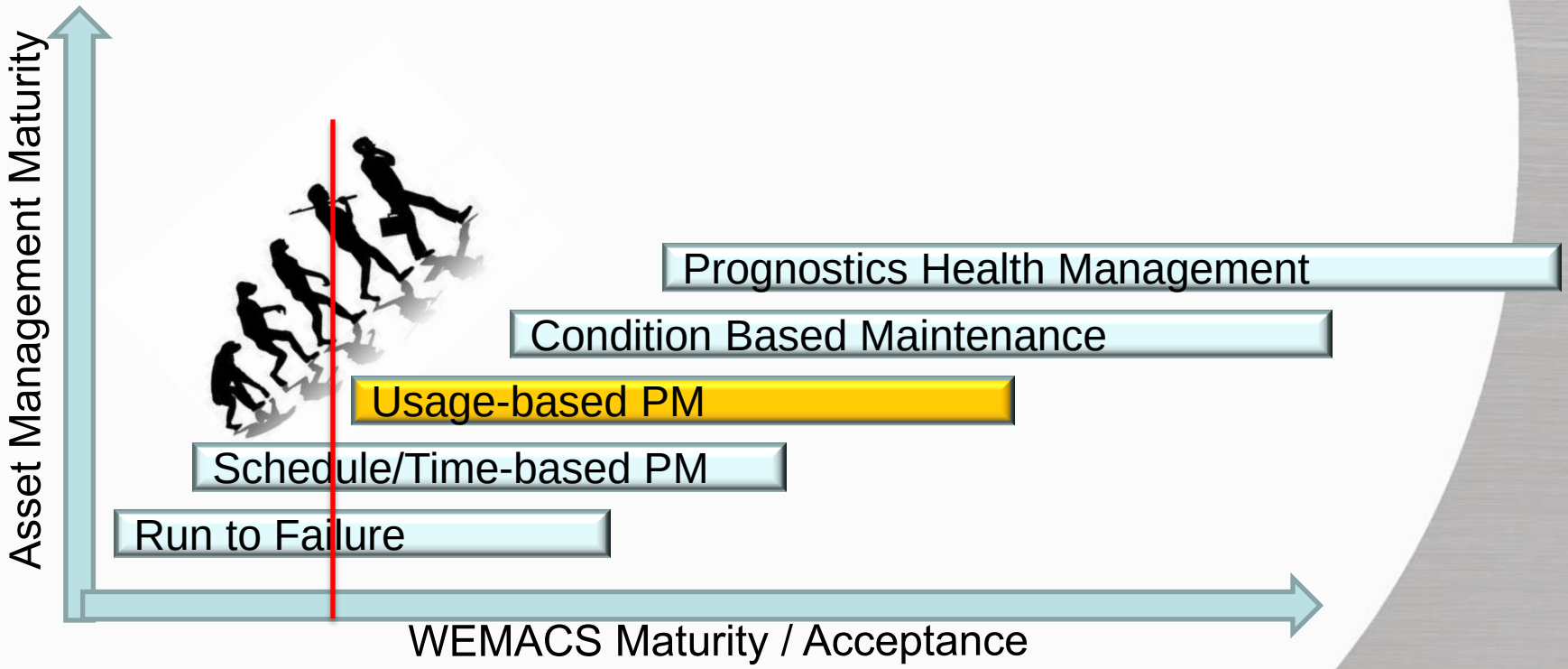
Feature	Benefit
In-line measurement	Eliminates idler arm deficiency
High-accuracy	Eliminates dyno
eMail Alerts	Faster incident/breakdown response
eFEM Connectivity	OQE Generation to enable CBM
	Automatic work order generation
Expandability	Low-cost integration of additional monitoring (e.g. oil sensing)
Cab Display	Fast operator response – overload avoidance
Stored Data	Incident reconstruction/resolution

Data Analysis

- Usage Data = How much has the crane been used?
  - Foundation for CBM – baseline capability
  - Resource planning
- Load Data = How hard has the crane been used?
  - Operational aid to improve safety case
  - Rapid response with OQE to crane incidents
- “How Much” + “How Hard” can be used for Structural Life Benchmarking

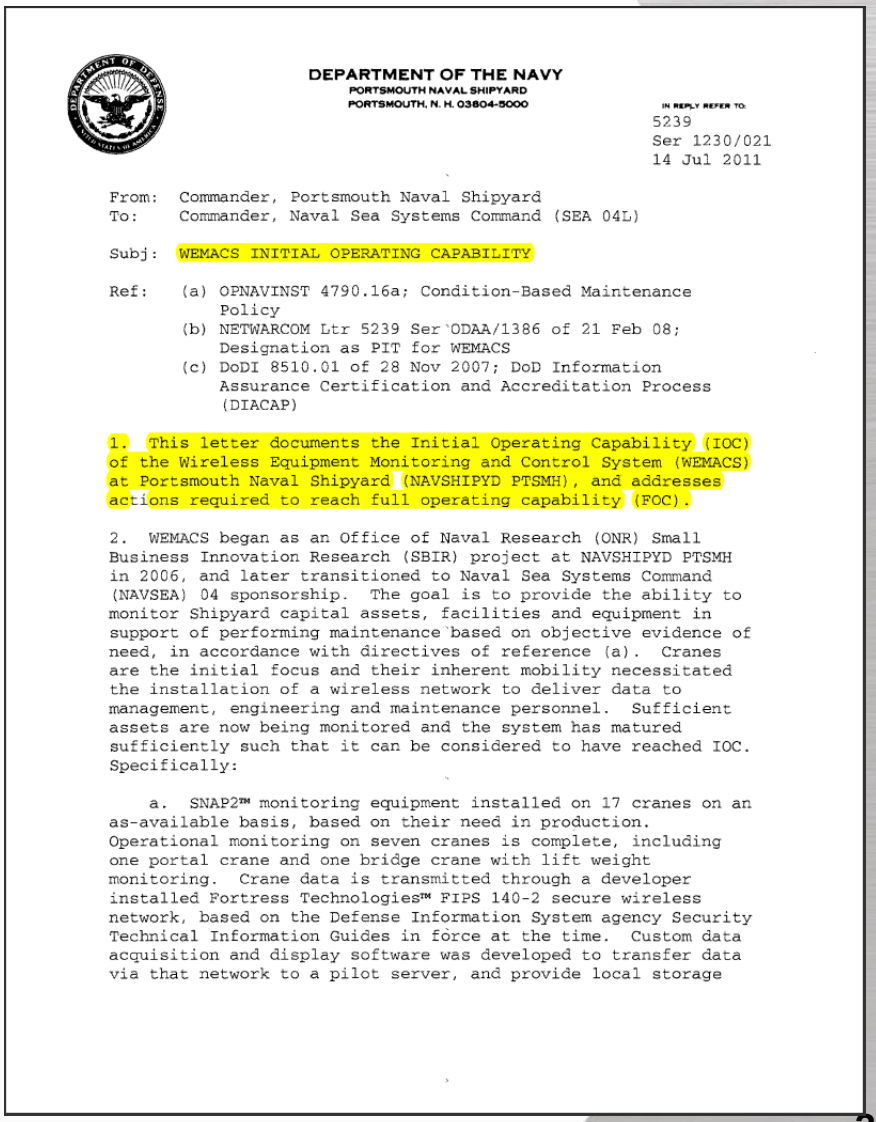
WEMACS Benefit

- Optimize maintenance based on objective evidence (CBM+)
- Real-time visibility into asset operations/utilization
- Facilitates long-range re-capitalization planning (PPBS)



WEMACS IOC Designation

- IOC Designation 14 July 2011
- Documents current status and recommended future actions.
- Establishes a technical basis for both monitoring applications and associated IT infrastructure.



DEPARTMENT OF THE NAVY
PORTSMOUTH NAVAL SHIPYARD
PORTSMOUTH, N. H. 03804-5000

IN REPLY REFER TO:
5239
Ser 1230/021
14 Jul 2011

From: Commander, Portsmouth Naval Shipyard
To: Commander, Naval Sea Systems Command (SEA 04L)

Subj: WEMACS INITIAL OPERATING CAPABILITY

Ref: (a) OPNAVINST 4790.16a; Condition-Based Maintenance Policy
(b) NETWARCOM Ltr 5239 Ser ODAA/1386 of 21 Feb 08; Designation as PIT for WEMACS
(c) DoDI 8510.01 of 28 Nov 2007; DoD Information Assurance Certification and Accreditation Process (DIACAP)

1. This letter documents the Initial Operating Capability (IOC) of the Wireless Equipment Monitoring and Control System (WEMACS) at Portsmouth Naval Shipyard (NAVSHIPYD PTSMH), and addresses actions required to reach full operating capability (FOC).

2. WEMACS began as an Office of Naval Research (ONR) Small Business Innovation Research (SBIR) project at NAVSHIPYD PTSMH in 2006, and later transitioned to Naval Sea Systems Command (NAVSEA) 04 sponsorship. The goal is to provide the ability to monitor Shipyard capital assets, facilities and equipment in support of performing maintenance based on objective evidence of need, in accordance with directives of reference (a). Cranes are the initial focus and their inherent mobility necessitated the installation of a wireless network to deliver data to management, engineering and maintenance personnel. Sufficient assets are now being monitored and the system has matured sufficiently such that it can be considered to have reached IOC. Specifically:

a. SNAP2™ monitoring equipment installed on 17 cranes on an as-available basis, based on their need in production. Operational monitoring on seven cranes is complete, including one portal crane and one bridge crane with lift weight monitoring. Crane data is transmitted through a developer installed Fortress Technologies™ FIPS 140-2 secure wireless network, based on the Defense Information System agency Security Technical Information Guides in force at the time. Custom data acquisition and display software was developed to transfer data via that network to a pilot server, and provide local storage

Certification & Accreditation Status

- WEMACS registered and approved in:
  - DITPR-DON # 22278
  - DADMS # 78840
- NMCI Interconnect provisioned – expected ?QFY11
- Certification & Accreditation by NETWARCOM
  - Initial set of C&A Documentation submitted
  - Working with shipyard Code 1230 (IT) to standup system in Building 170 and formal security scanning and testing (April 2011) to complete C&A Documentation and submit to NETWARCOM

C&A is the 'long pole in the tent'

Pearl Harbor Naval Shipyard & IMF: Dry Dock Pump Monitoring

Pearl Harbor Naval Shipyard

4 Dry Docks
12 Main Pumps
9 Drain Pumps

Focus: Main Pumps and Drain Pumps

Code 980 (Dry Dock Engineering) needs objective evidence of the need for an overhaul.

Main pump motor – from 1943

System concept design and baseline data collection performed early 2010

Code 980 featured initiative at NAVSEA dry dock conference in April 2010

~$3M for Main Pump overhaul – *COST AVOIDANCE* is the driver…

Scope of Work

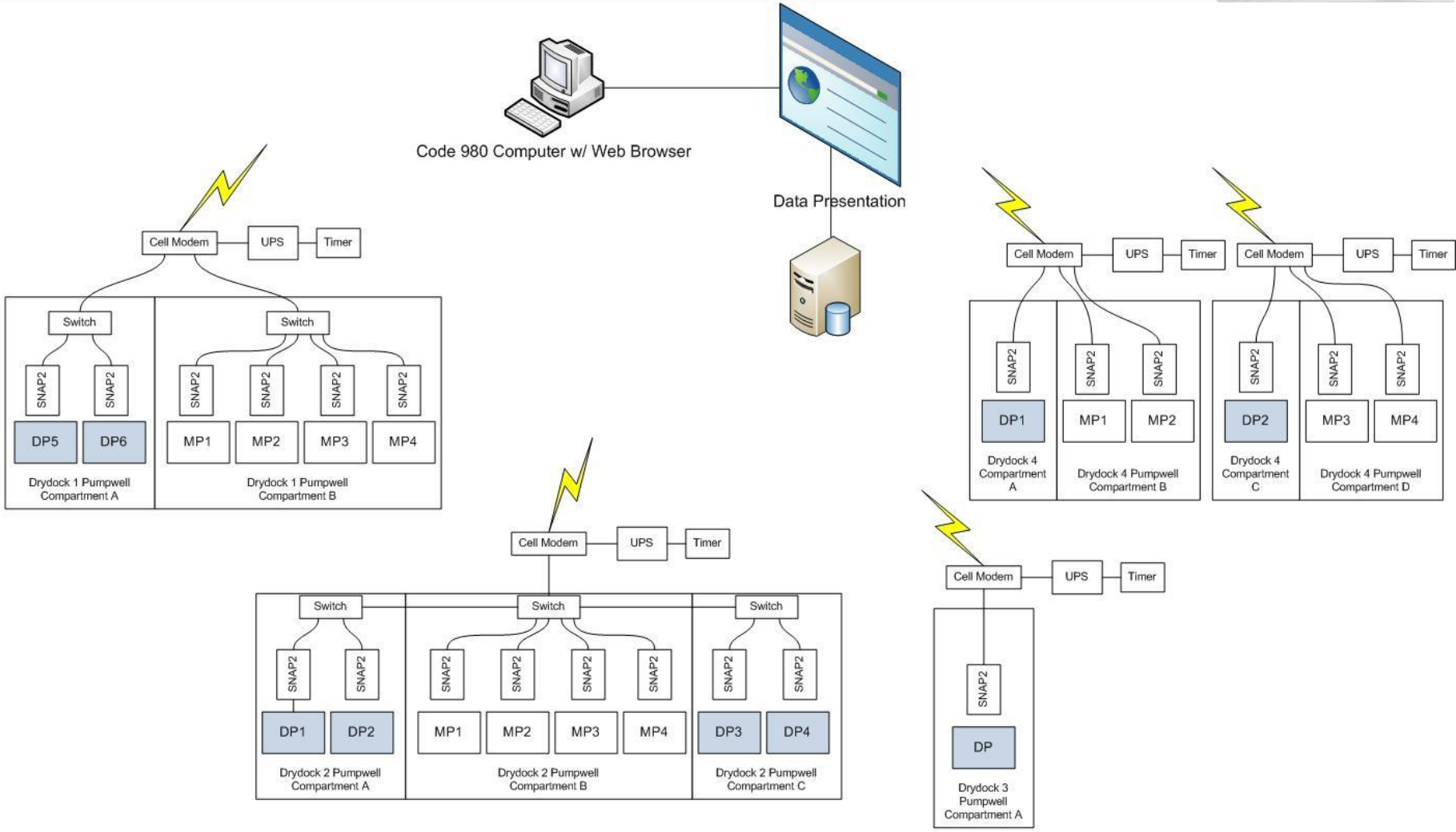
OBJECTIVE: *"I want to ability to predict, w/i the next 5 years, that I need an overhaul. In the next 2 years, I expect to see indicators start to move towards telling us when we need an overhaul."* PHNS&IMF Code 980

- Provide monitoring infrastructure to enable CBM and permit future expandability/enhancement by using a modular architecture.

PHNSY Shipyard-wide System

- Embedded monitors applied to each pump
- Communicate via cellular modem (interim) to central location
  - Coordinated w/ C1230 (CIO)
  - Future compatibility with in-process secure wireless network native to S2NAP
- Web-enabled “Dashboard” for data visualization
- Status, alarms, and historical reports of vibration/temperature profiles

PHNSY Shipyard-wide System

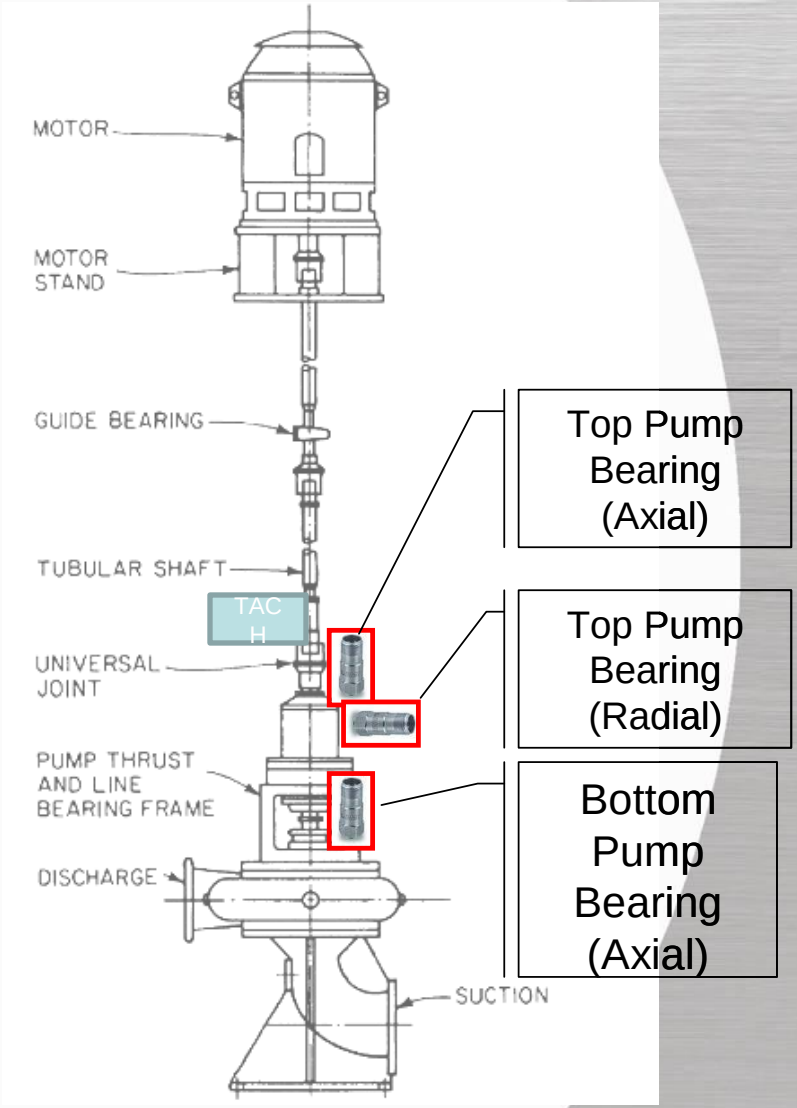


Scenario 2: Wired SNAPs to Switches

DP = Drain Pump
MP = Main Pump

Baseline Data Collection – MP4

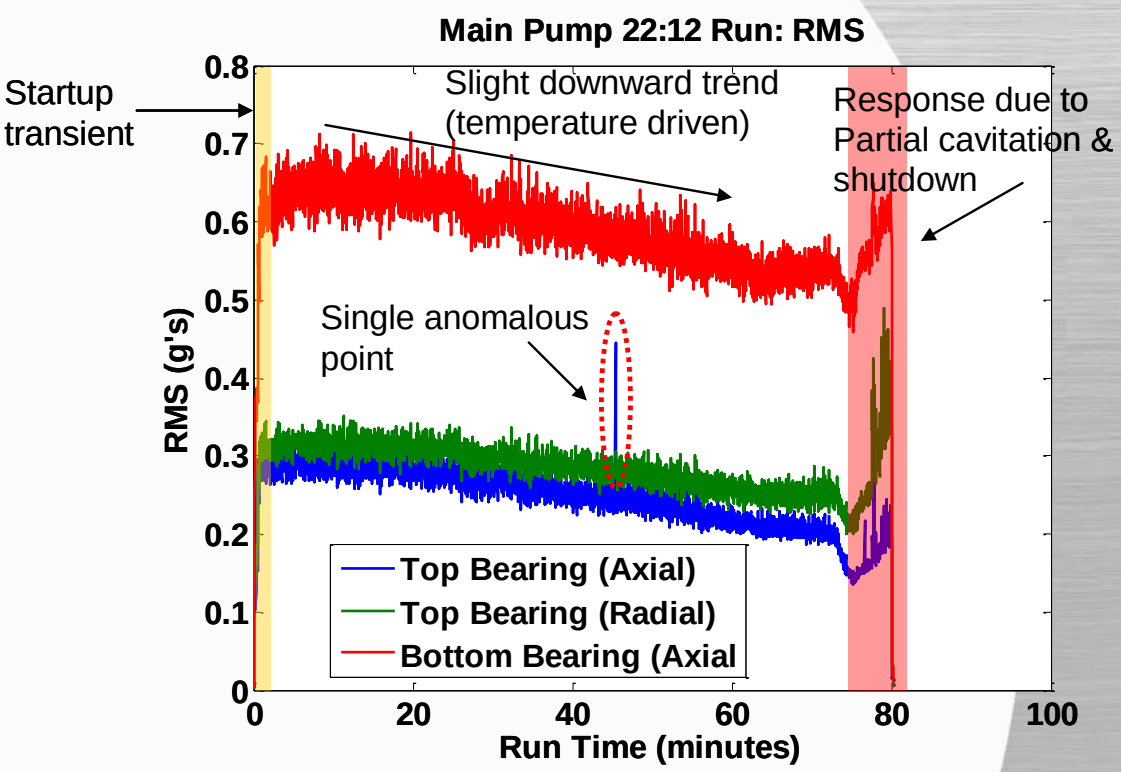
- PHNSY DD2, MP 4 and DP 1
- 3 Accels and 1 Tach on MP4 during docking evolution



Main Pump Sensor Configuration

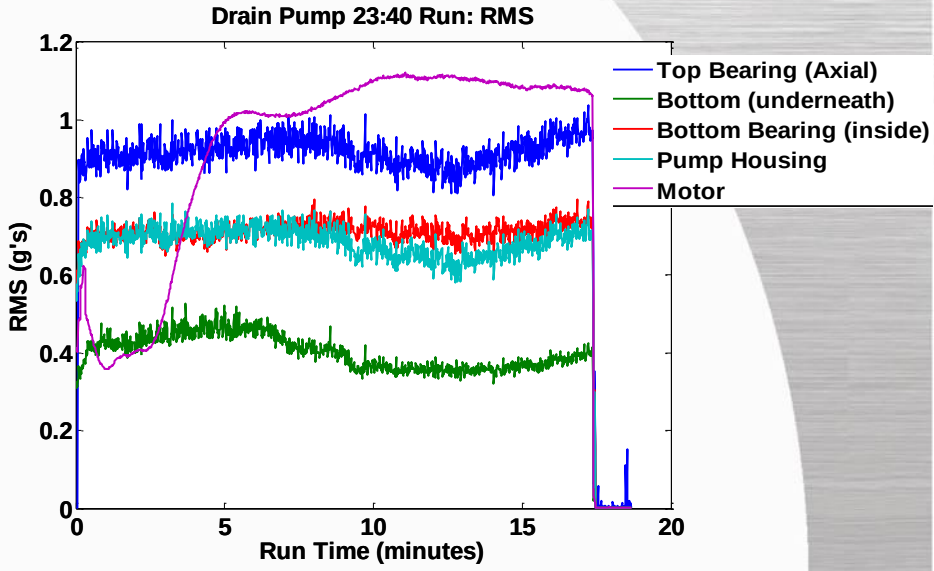
Main Pump Data

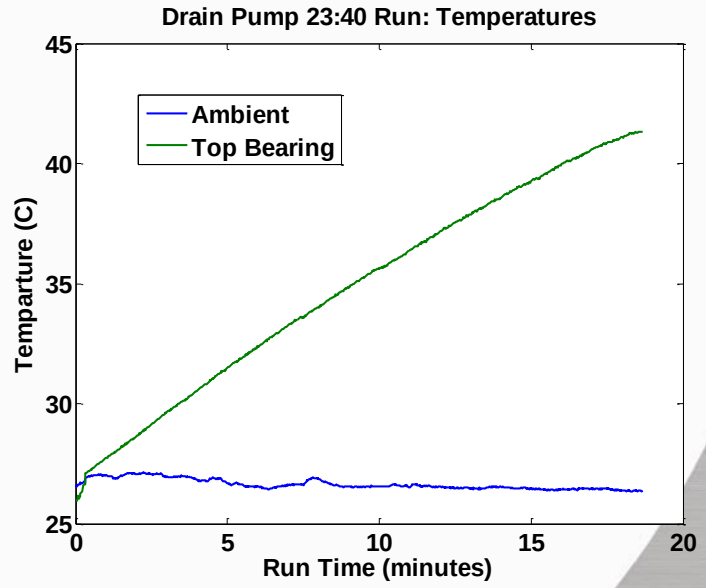
- 100 mV/g accels appropriate (industry standard)
- Steady vibration levels – ideal for reduction of false alarms
- Cavitation detection possible



Drain Pump Data

- Temperature significantly more important
- Provides a baseline of data for a ‘degraded’ pumps – valuable for comparison w/ new pumps.
- Data to be compared with replacement pumps planned for 2010





Dry Docks 1, 3, 4 Ready To Ship

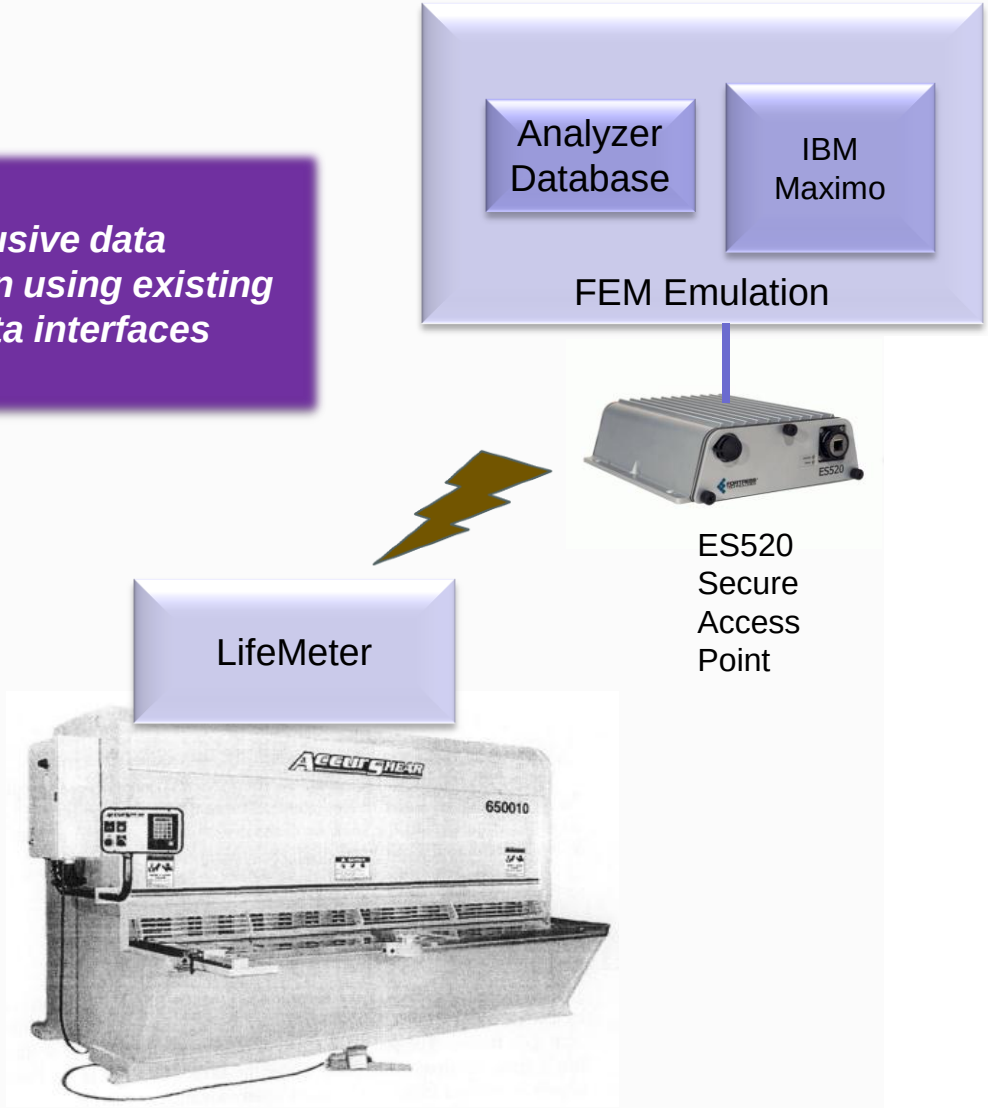
Warner Robins ALC: LifeMeter

Program Objectives

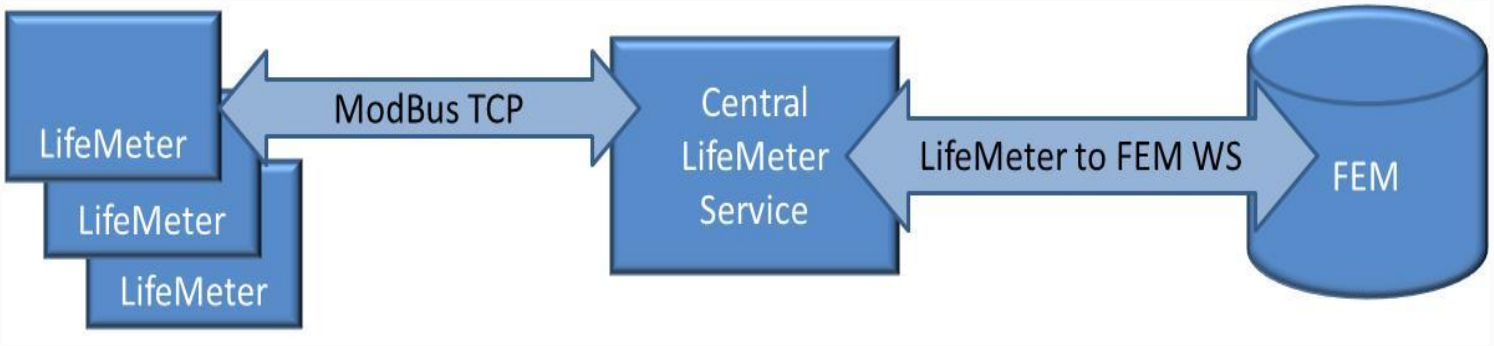
- Automatically and objectively collect usage history of machine tools
- Integrate data with FEM for workflow automation

Demonstration Concept

Non-intrusive data collection using existing wired data interfaces



LifeMeter Software Block Diagram High Level



LifeMeter Software Details

- ModBus Monitor
  - Central Service for reading 1-N modbus/serial/WS devices
  - Single configuration item – straightforward management and control
- LM Data Store and Analyzer
  - Short term data store for LM history
  - Preliminary data reduction and analysis functions
  - Reduces data set transferred to EAM
- MXInterface Web Service (WS)
  - Web Service interface to the Maximo MBO for data insertion
  - Resides on same platform as FEM
  - Utilizes published IBM methods for interacting with Maximo

Current C&A status

- The software system is based on a software system currently undergoing Navy C&A
  - WRALC is able to leverage the work already done to reduce costs
  - Completed work is used as risk-reducer for WRALC
  - Using standard documented IBM Maximo interfaces allows for easier management and updates

Key Accomplishments

- Transitioned demonstration objectives from sensor data demonstration to non-intrusive data collection via existing resources.
- Implemented software interfaces to Altair controller.
- Implemented FEM emulation for demonstration.
- Reduced prototype LifeMeter physical size/complexity.
- Integrated prototype LifeMeter with FEM using MODBUS simulator.

Future Development

- Comprehensive Machine Survey
  - Identify all data acquisition interfaces (controller types or sensor front end) of all candidate machines.
- Update Device Requirements based on lessons learned
- Demo Network I&T and Robins 2K Network Integration Planning
- FEM Integration Planning
- Expanded Demonstration
- Data Analysis and Estimated ROI

Questions/Comments?

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Mr. Aaron Spak Program Manager, Impact-RLW Systems	814-574-3750

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Backup Slides

Failure Prognosis Using Existing Data
AF093-207

IMPACT-RLW Systems

Project Description

Phase I SBIR (complete 3/2011). Demonstrated a proof of concept decision support framework to predict Remaining Useful Life (RUL) of critical assets based on maintenance history data, equipment usage, and OEM equipment information in the absence of on-line time series failure data. Phase II proposal submitted. Technologies under development include:

- Software tools for extracting failure rates and generating prognostic models from existing data sources
- Decision support engines that leverage prognostic models to predict RUL using CBM/PHM algorithms
- System health performance metrics to quantify existing and future operating conditions

Key Process Relationships/Impacts

- Knowledge of pending failures reduces time to diagnose and repair
- Ensure remaining useful life is sufficient to meet production run time requirements
- Visibility of possible future equipment failures provides opportunity to preemptively schedule maintenance actions, reduce equipment downtime, and improve maintenance resource utilization

Current State

- ***TIME BASED PM:*** Performed on a time basis for MRO production equipment
- ***RUN TO FAILURE:*** Equipment receives maintenance attention only after it has failed
- ***UNPLANNED DOWNTIME:*** Equipment failures interrupt MRO production processes and increase cost of ownership
- ***KNOWLEDGE LOSS:*** Failure and maintenance history knowledge is lost due to attrition and transient workforce

Future State

- ***USAGE/CONDITION BASED PM:*** Prognostic tools will employ available usage and condition information to accurately predict failures
- ***OPTIMIZE MAINTENANCE SCHEDULING:*** Schedule appropriate maintenance actions to prevent failures and optimize maintenance resource utilization to reduce cost of ownership
- ***OPPORTUNISTIC MAINTENANCE:*** Optimize planned downtime by performing opportunistic maintenance actions based on predicted RUL
- ***KNOWLEDGE RETENTION:*** Historical failure and maintenance information will be retained in the system

POC(s), champion(s), customer(s), and stakeholder(s)

Project Sponsor

- Frank Zahiri, WR-ALC/ENSN, Technology Insertion Branch

Technical Point of Contact

- Carlos Ortiz, USAF WR-ALC/ENRB

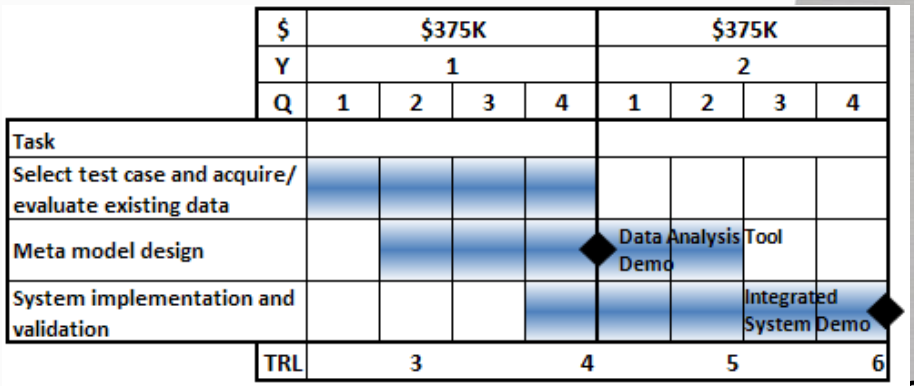
Customers

- Plant Services
  - Maintenance Manager
  - Maintenance Engineering
  - Maintenance Technicians

Technology Stakeholders

- Air Force Research Laboratory (AFRL)

Initial Effort Roadmap ROM (cost, schedule, performance)



Failure Prognosis Using Existing Data
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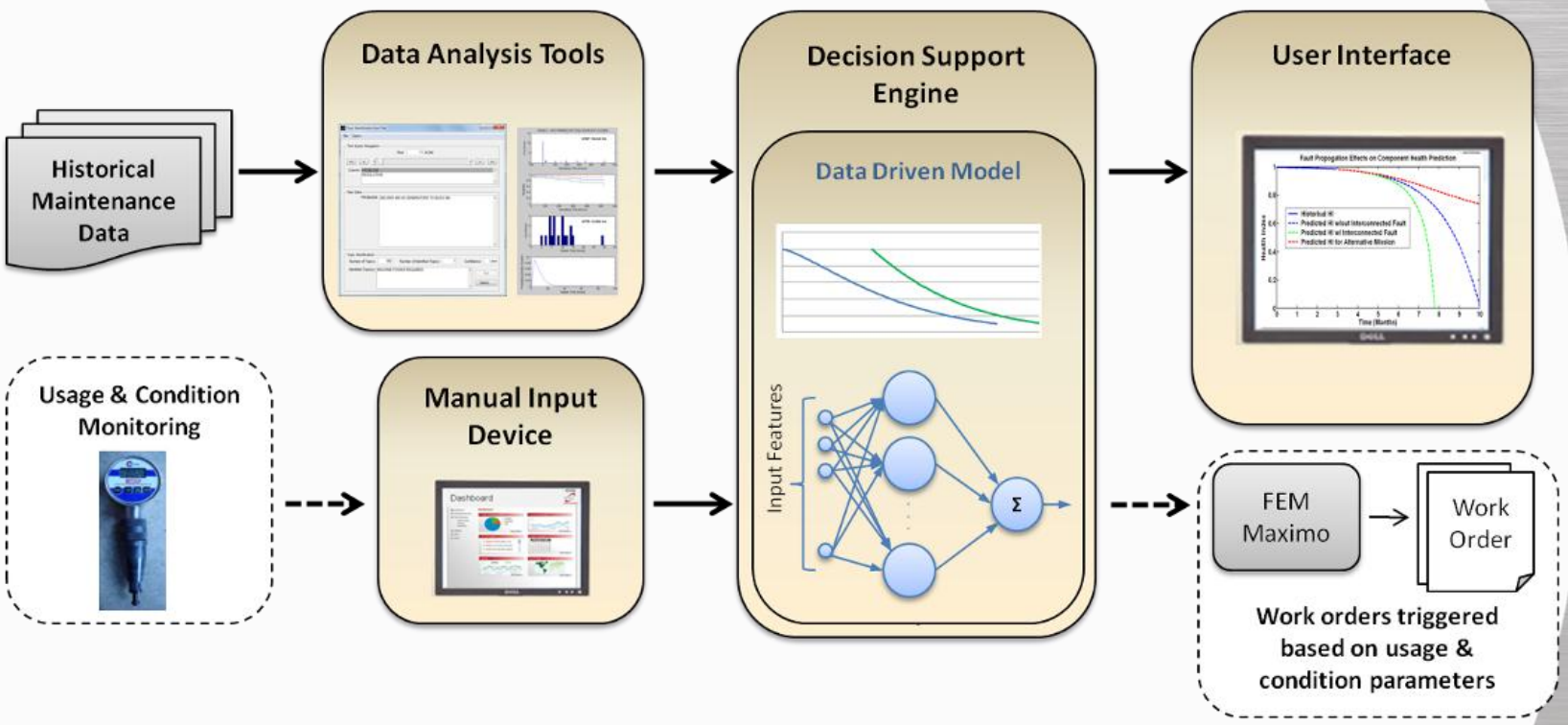

Maintainers Automated Troubleshooting Expert (MATE)
AF093-208

IMPACT-RLW Systems

Project Description

Phase I SBIR (complete 3/2011). Demonstrated proof of concept for an intelligent maintainer decision support tool that provides dynamic reasoning and machine learning algorithms for improved troubleshooting accuracy and reduced cost of operation. Phase II proposal submitted.

MATE technology:

- Dynamic Reasoning technologies to correlate observed evidence to Probable Cause of Failure (PCOF) and corrective actions
- Automatically captures maintainer experience to dynamically update the knowledge base and promote the most effective tasks (machine learning)
- Modular architecture and standardized interfaces to support multiple reasoning technologies based on operational context

Key Process Relationships/Impacts

- Automated troubleshooting guidance and feedback
- Knowledge capture and reporting features to review existing troubleshooting sessions and create new troubleshooting models
- Session tracking and reporting on frequency and efficiency of troubleshooting processes to aid in management of maintenance resources

Current State

- ***LONG REPAIR TIMES:*** Technician observes the faulty system and determines the root cause through trial and error
- ***ENGINEERING RESOURCES:*** Most difficult troubleshooting tasks are elevated to engineering support
- ***STATIC REFERENCE MATERIAL:*** Troubleshooting references such as interactive electronic technical manuals (IETM) provide static test and action sequences / do not consider customized equipment
- ***DISPARATE MAINTAINER EXPERIENCE:*** Heterogeneous distribution of knowledge and experience across workforce
- ***KNOWLEDGE LOSS:*** Expert knowledge is lost due to attrition and a transient workforce

Future State

- ***FASTER RESPONSE:*** MATE provides most effective course of action based on acquired evidence and provides required information to perform
- ***LOWER MANPOWER REQS:*** Engineering receives less field calls
- ***DYNAMIC REFERENCES:*** MATE provides dynamic access to required information based on context
- ***IMPROVED SUPPORT:*** Best practices are immediately available to all maintenance personnel
- ***KNOWLEDGE RETENTION:*** Maintenance expertise is retained in the system

POC(s), champion(s), customer(s), and stakeholder(s)

Project Sponsor

- Frank Zahiri, WR-ALC/ENSN, Technology Insertion Branch

Technical Point of Contact

- Carlos Ortiz, USAF WR-ALC/ENRB

Customers

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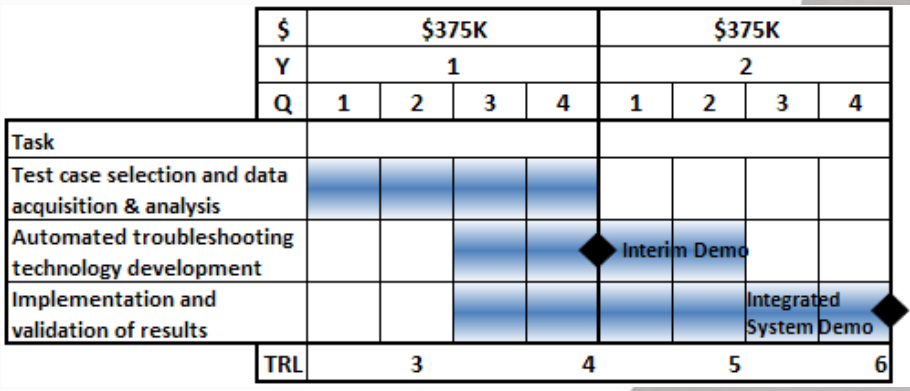
Technology Stakeholders

- Air Force Research Laboratory (AFRL)

Initial Effort Roadmap ROM (cost, schedule, performance)



Maintainers Automated Troubleshooting Expert (MATE) AF093-208

- Decoupled user interface
- Automated data acquisition
- Automated guidance through troubleshooting process
- Automated reasoning
- Self-evolving reasoners based on feedback
- IEEE 1232 Standard architecture