Network Centricity And The Flight-Line Mechanic

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Abstract

"Network Centricity and the Flight-line Mechanic" looks at the efforts of the Electronic Distribution of Technical Information via Satellites (EDTIS) Program managed by the Air Force Research Laboratory (AFRL) for the Robins Air Logistics Centers Special Operations Office (WR-ALC/LU). The EDTIS Program is being performed by the Raytheon Corporation, which brings to the project its expertise in electronically formatted technical documentation, satellite interoperability, and radar weapon system technology and documentation. EDTIS is developing the technologies necessary to provide a link between technical information repositories (such as Technical Order Libraries, vendor services, and skill pools) and flight-line personnel over a satellite network. This type of network link frees the technical person from a dependence on bulky paper technical manuals, and allows him to select what he wants, where he wants it, and when he wants it.

The EDTIS program has proven the technical feasibility of distributing timely technical information between remote sites. It is now working on improving the presentation of the technical information to the technician through improved portable maintenance aides, visualization and vocalization techniques, and data links between satellite nodes and the maintenance activity. If this type of system could be fully implemented, the requirement to transport complete sets of hard copies of technical documents for every fleet mission deployment would be eliminated, saving millions of dollars in storage, transportation, and document configuration management.

The Aerospace Command and Control and Intelligence, Surveillance, and Reconnaissance (C2ISR) Campaign Plan 2000 has a focus area called Intelligence, Surveillance, and Reconnaissance (ISR) Tasking Processing Exploitation and Dissemination (TPED): This focus area states that we must embark on a course of action for effective and dynamic tasking ISR assets, exploiting and fusing the gathered information, and providing it to the war-fighter in a timely manner and format he can use. The key element of this strategy is continuing our efforts to modernize ISR ground

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station thus improving multidiscipline TPED functions and accommodating new platforms. This effort will encompass fielding an open standard fusion architecture and new ISR battle management tools.

This high level Air Force planning document seeks to break down the barriers between information sources (the ISR community), the decision makers (command and control community), and the war-fighter. This paper shows how the EDTIS program meets part of this initiative, by servicing the flight-line mechanic (flight-line warrior), who's talents and skills help provide Global Engagement opportunities. This is done, by providing timely dissemination of technical information in an application specific format.

The power of this demonstration is that technical information, or command and control information, or any kind of mission critical information can be distributed through networks, formatted to the war-fighter application, and acted upon as a new information source in a network centric fusion.

Network Centricity

The new and evolving concept of network centricity is replacing the familiar concept of system or platform centricity. System centricity is based on a standalone system containing (or obtaining) all the information it needs to perform its tasks within its immediate control. The system centric application depends on a tightly coupled access to processors and data-stores that are part of the overall system. The system centric approach has been very popular for systems such as fighter platforms, which require a high level of autonomy to complete its mission. The downsides of system centricity is 1) the overhead associated with total resource ownership, 2) the complexity of testing peculiar systems and subsystems, and 3) the inflexibility of these systems to rapidly adapt to environmental changes.

As applications are becoming more information dependent, their need for near to real-time accurate information is driving them to obtain this information from outside reliable sources. This information might come from other nearby applications through direct data-links or from far away sources through satellite links. As the information for these types of systems becomes more organized into networks, these systems become network centric. Network centric systems can devote their resources to process and react to environmentally supplied information, making them much less complex, and much more adaptive to changing world conditions.

ISR Tasking, Processing, Exploitation And Dissemination (TPED)

An exert from the United States Air Force Aerospace Command Control Intelligence, Reconnaissance (C2ISR) Campaign Plan 2000 [1] states that TPED looks at the issue of how to effectively and dynamically task ISR assets, exploit and fuse the gathered information, and provide it to joint/combined war-fighter in a timely manner. The factors of TPED include:

- (Tasking) Redundancy and inefficient platform tasking results in inefficient platform use
- (Processing) Data and information overload difficult to analyze and correlate data to produce useable intelligence need fused intelligence
- The lack of automated ISR tools magnifies manning shortfalls and training deficiencies
- (Exploitation) Insufficient manning and training create “bottlenecks” which slows reporting and product distribution
- (Dissemination) Lack of automated classification sanitization systems and dissemination architecture restrict the timely flow of intelligence to allied/coalition forces
- Major portion of TPED is outside of AF control

The consequences of TPED are:

- Inefficient tasking increases operating costs, reduces ISR gathering capabilities, and frustrates decision-makers
- Fragmented and inadequate data fusion processes obscure high value and time sensitive information from reaching the warfighter
- “Bottle necks” in exploitation processes diminish return and waste of ISR capabilities
- Inadequate TPED results in delayed support to decision-makers; resulting in targeting errors, fratricide, etc. [1].

Electronic Distribution of Technical Information via Satellite (EDTIS)

Electronic document generation and distribution offers the opportunity to implement many worthwhile changes beyond simply increasing the speed of document distribution. A properly configured system can provide instantaneous release of an authorized document anywhere in the world. In addition, it gets the information to the user, the flight line maintenance technician. But it can do much more. It can provide multiple levels of linked graphics and text to assist in understanding how to maintain unfamiliar equipment. It can prompt additional information to help probe in unfamiliar areas, and it can stand aside when available expertise is present. In order to realize the full advantage of electronic documents, an infrastructure must be installed which provides the required capability. Figure 1 diagrams the physical architecture of an electronic distribution network from a central (national) facility to one of N flight line maintenance stations.

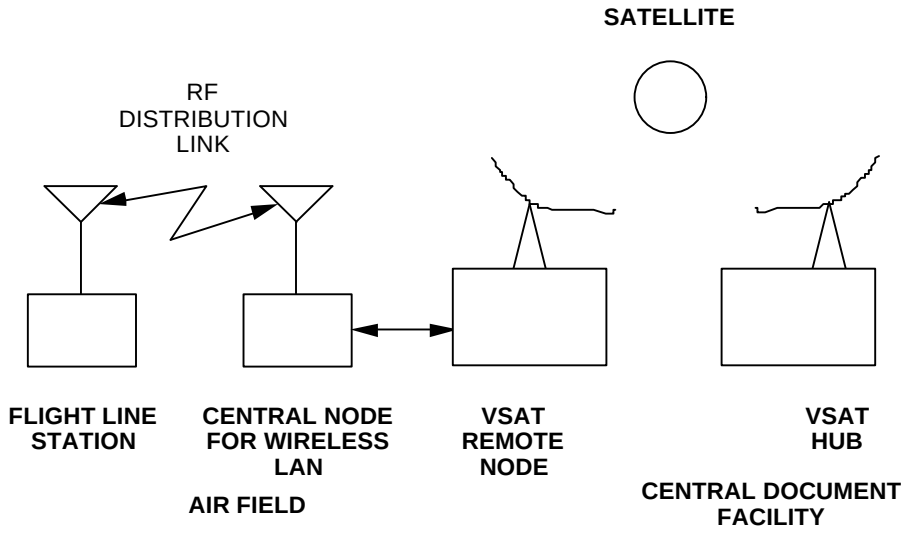

Figure 1 - Physical Architecture of an Electronic Distribution Network

This network allows the transmission of data from the Very Small Aperture Terminal (VSAT) hub to the remote VSATs at very high rates to service multiple users. The VSAT remote node parses this high rate data stream and passes a relatively small amount of the data over the wireless LAN to the flight line stations. A flight line system with a wireless modem connection to a central data base storage system on the air field could be configured using a small commercial computer, such as a hand-held personal maintenance assistant (PMA) with cordless technology.

System 2000 Demonstration Program

This effort demonstrated several necessary steps for achieving the goal of the elimination of the printing and distribution difficulties. These difficulties are associated with weapon system Technical Orders (TOs). This is accomplished through the paperless electronic delivery of these documents directly to the maintainer at any location on the globe equipped with a simple, inexpensive VSAT. The on-line distribution of maintenance related support data is a feature of the Raytheon System 2000 Precision Maintenance System.

In the System 2000 architecture, the documents are maintained in a central CONUS (Continental United States) repository and are delivered in the latest revision appropriate to the aircraft configuration specified by the maintainer. The electronic Technical Orders are in the form of Class IV Interactive Electronic Technical Manuals (IETMs) with electronic enhancements to greatly reduce the time required by the maintainer in performing his function. The Technical Orders are delivered directly to the maintainer at the flight line via a small hand held wireless Portable Maintenance Aid linked directly to the local VSAT receiver/transmitter.

The initial phase of this project was sponsored by the Warner Robins Air Logistic Center (WR-ALC/LUE) and funded by USAF Productivity, Reliability, Availability and

Maintainability (PRAM) Office of Wright-Patterson AFB (WPAFB). The project provided a demonstration of commercial satellite applicability in the Department of Defense environment for real-time on-line access and distribution of Technical Orders in IETM format to field users using transportable VSATs.

A VSAT Terminal and user PC console was installed at Hurlburt Field, as well as two loaned VSAT Terminals, one each to the second field site at Warner Robins ALC, Robins AFB, and the central data repository site at the Raytheon office. The equipment at each of the three sites was configured to meet the requirements of each site. A two-way communications link via contractor-operated satellite was also provided. When the satellite communications network was placed into service, the three sites were put into their "permanent" configuration, enabling communication among the sites. In establishing satellite network operation, many parameters were analyzed, such as projected bandwidth requirements, frequency availability, pointing angles, etc. The satellite network was then made available 24 hours per day, 7 days per week, on an as-desired basis, between the three sites noted above, for the designated period of performance.

A central repository of Electronic Technical Orders was established at the Raytheon Warner Robins office. Data installed at the central repository included a limited number of Technical Orders in IETM format for the AC-130U Gunship, as developed by the Technical and Management Services Corporation (TAMSCO) for the sponsor organization. It was successfully demonstrated that IETMs could be transferred between locations via the satellite communications network. The System 2000 user interface provided the basic capability to access IETMs, initiate their transfer to and from the central database, and access the Advanced Integrated Maintenance Support System (AIMSS) tool to view and utilize the IETMs.

The IETMs selected for use in the demo were thought to be Class II, fully functioning, and complete. Unfortunately, several of the documents were actually supplements, and the main documents had to be retrieved. In addition, many of the diagrams included were not of the quality required to be brought up to Class IV. Therefore, more work was required than anticipated, in converting the documents to Class IV. In retrospect, it may have been better to start with the paper documents, at least for consistency expectations. Once the IETMs were converted to Class IV, they functioned well as part of the System 2000 demonstration.

By using interactive, electronic documentation, the user is able to find the information needed quickly. Hot spots on the diagram link to sources detailed information, as seen in Figure 2. The next snapshot (Figure 3) demonstrates how safety warnings have greater impact in interactive electronic documentation. From the perspective of the IETM user, there were not enough IETMs provided to allow them to evaluate the quality of the IETMs themselves. Although the main concept of the demo was to demonstrate IETM distribution via the satellite network, it is important to provide enough data samples to all of the users throughout the demonstration system to facilitate a system-wide evaluation. The user community has identified several IETMs, and these are being retrieved.

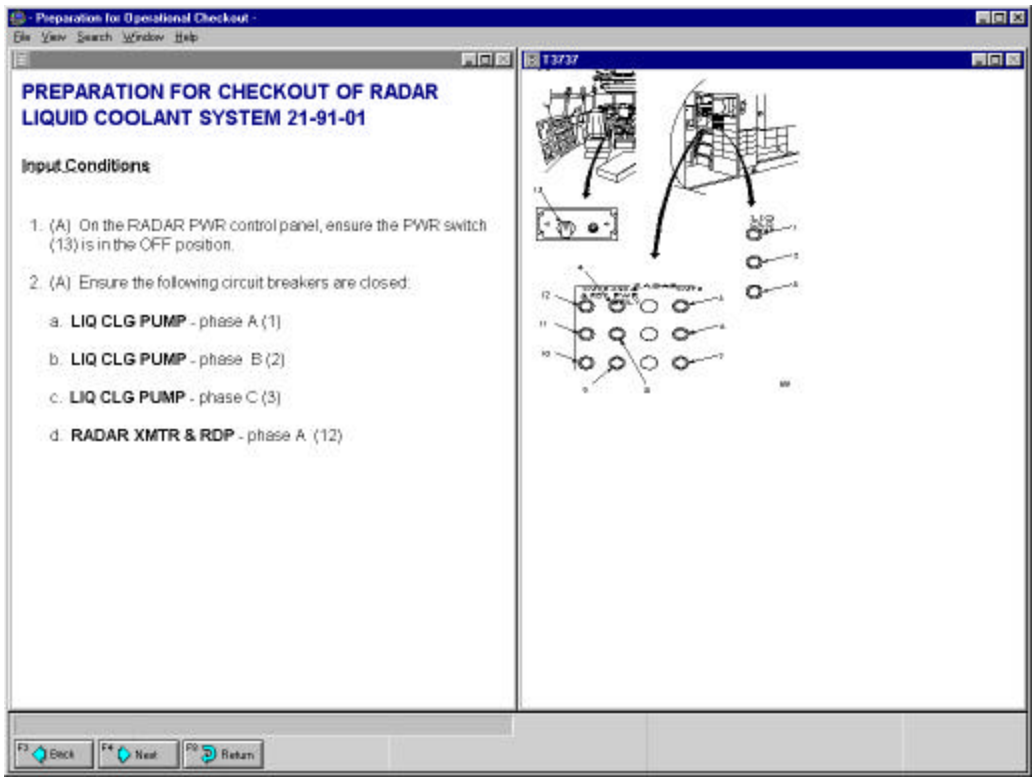

Figure 2

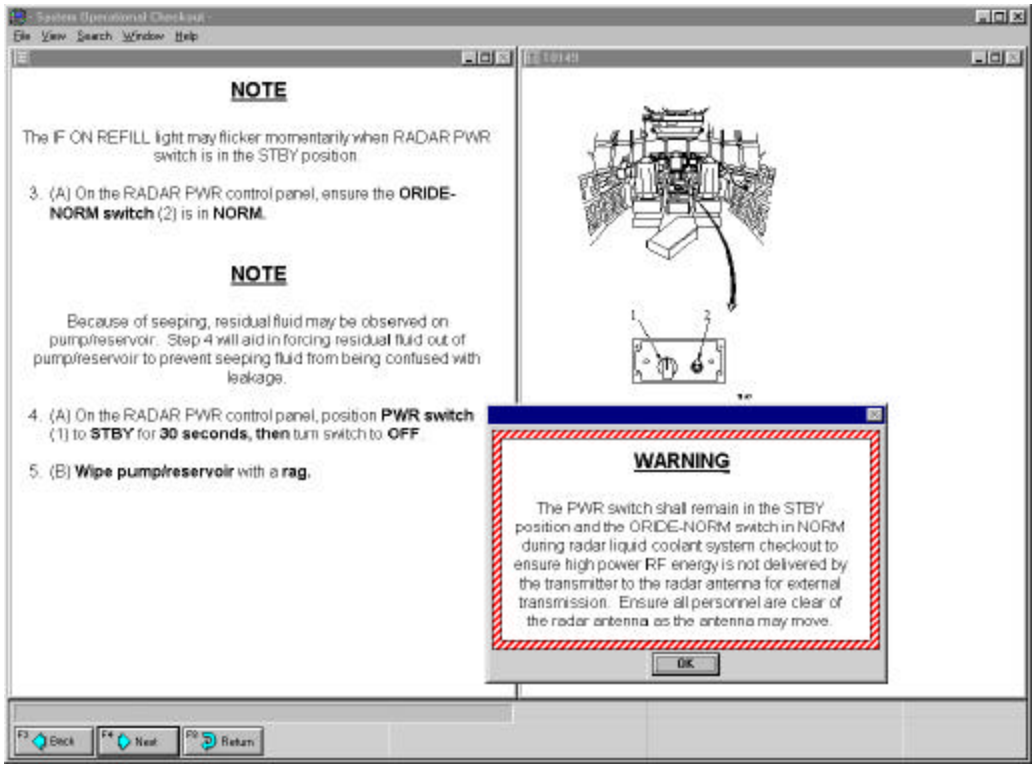

Figure 3

They are in paper format. This will provide a good indication of the end-to-end processing needed to replace existing paper Technical Orders with Class IV/V IETMs. This task demonstrated many aspects of how the System 2000 Precision Maintenance System is a viable and practical approach to the urgent need to reduce the cost of Operations and Maintenance of USAF aircraft.

Remote Access Through Satellite

The use of satellite technology to provide the infrastructure to use electronic documents provides significant capability, several of which are not available through other means, including:

- Virtually instantaneous worldwide data delivery and collection
- Assessment of system damage incurred during battle
- Visibility into asset management and system configurations
- Integration of remote sites into a cohesive system
- Databases kept current and available
- Central configuration management

Portable Maintenance Aides

In order to receive the benefits of electronic documents, they must be viewed on some form of an electronic display. For the aircraft maintainer, a Portable Maintenance Aide (PMA) is used. The PMA is linked to a local server, either by radio link or through a disk-docking system. The particulars of each installation determine which method of linking is used. The PMA can also be designed with the capability of interfacing with a bus of the system under test for even more powerful diagnostic capability. The Electronic Distribution of Technical Information via Satellite (EDTIS) analyzed various commercially available devices for suitability. Several ruggedized laptop computers ere evaluated for various features, including screen size and quality, reaction to heat, cold, and sunlight, battery life, processing power, cost, and other features important to users.

Portable Maintenance Aid (PMA) Notebook Computer Trade Study

Maintaining operability of the aircraft is vital to its mission. Having the most up to date technical manuals available during maintenance, inspection and checkout of the aircraft is essential to performing these tasks. Storing these various maintenance publications in electronic format reduces the shear volume and logistics associated with hard copy manuals. This study was conducted to select a notebook computer that can provide the solution to accessing electronic media.

A notebook computer, used as a portable maintenance aide (PMA), reduces storage space and transportation costs associated with alternative hard copy of technical manuals. In that respect, IETMs can be centrally located and have the latest change orders incorporated. Thus, IETMs can increase the efficiency within the maintenance library to updated releases in a timely manner and assure that the aircraft maintenance crews are using the latest revisions.

The study provided recommendations to support the transmission and use of IETMs at the aircraft maintenance flight line. This study was conducted by selecting various notebook computers that are ruggedly constructed, which can survive in the flight line maintenance environment, from a field of over 100 manufacturer's models. Palm top devices were eliminated from this study because of the relative small size of the display, which is difficult to read while scrolling through text and drawings.

Many of the PMA COTS products surveyed have high-resolution displays that are readable in direct sunlight, and are environmentally compatible to resist rain, oil, grease, dust and extreme temperatures. This is typical of the environments that combat aircraft flight maintenance crews experience on the flight line. For a PMA to be an effective tool at the flight line, it must be reliable and flexible to adapt easily into the work environment. Figure x represents a composite configuration of the desirable features of a Notebook Computer.

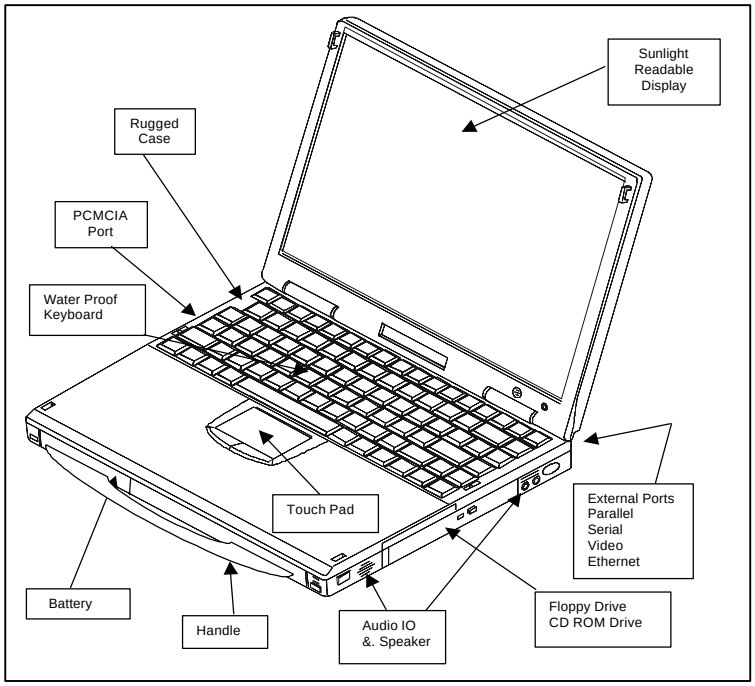

Figure 4 – Notebook Computer PMA Features

Evaluation And Weighting Criteria

Table 1 lists the important factors and consideration criterion for selecting a notebook computer as a PMA. These seven criterion influence overall performance and provide the basis for the Quality Functional Deployment (QFD) ratings.

Number	Type
1	Battery Life
2	Weight
3	Size of unit
4	Screen for viewing
5	Ruggedness
6	Environmental
7	Performance

Table 1 - PMA Criterion

Relative Weighting Of Evaluation Criteria

In the process chosen to evaluate the various notebooks, a list of characteristics, features and specifications were collected and sorted into the major PMA Criterion. Each model was then evaluated against the Criterion by applying relative weight values on a scale of "1 to 4" where "4" being best. The evaluation grade scale is defined in Table 2.

Weight	Definition
1	Not a feature or characteristic of the product.
2	Average, minimum needs; but lacks performance.
3	Good feature meets requirements.
4	Exceed expectations, best in class.

Table 2 - QFD Weighted Values

The characteristics provided by the manufacturers, or derived during the evaluation, were assessed with the relative weight values applied to the listed criterion, and summarized in each of the seven Criterion categories. For all categories, compatibility with the mission objectives was the essential focus in the assessment; i.e., speed in which to handle physically large documents and diagrams, use of a docking station or remote terminal and wireless local area network (WLAN) were kept in mind while rating the products performance.

Battery Life

The category "Battery Life" contains many variables that determine the operating life of a notebook. Ideally, a PMA should have extended battery life and the longer the battery charge lasts, the more suitable it will be. Some models support dual batteries, which can extend the operating life to 4 hours of continuous operation. Others incorporate a “hot swap” feature that enables the user to exchange the main battery while running on the second battery. Another feature to extend the operating life of the battery is the Power Management feature that can idle down the hard disk and suspend the display while in a non-use state, but remain powered on. The last item in this category for consideration was the type of battery installed. A Lithium Ion battery outperforms a Nickel Metal Hydride by as much as 50%. This single factor alone can extend the operating life from 2 hours to 3 hours, and combined with the dual battery configuration, makes the unit desirable for use at the flight line. However, one must consider giving up a Floppy or CD-ROM drive for using a Dual Battery configuration. This would have the least impact on the performance issue if the technical manuals are downloaded across a Wireless LAN verses using a CD-ROM containing the publications. However, the alternative is always open to use CD-ROM publications, provided that the unit is configured with the swap option.

Screen For Viewing, And The User Interface

These are the most important consideration features, the user interface, consisting of the Keyboard/Touchpad (mouse) and the Display. The more hostile the environment is, the more important it is to have a good visible display, one that is readable in direct sunlight. Likewise, at night, a back lit keyboard would be desirable. Within this category for consideration in the notebook ergonomics, is the Touchpad. The Trackball or the Pointing Stick is another common device required in manipulating the application windows and pull-down menus. But they all have limitations and/or user’s preferences. The most common among the various types of "cursor" controls used in the notebook is the Touchpad, and preferred by manufacturers. Most of the notebooks endorsed for evaluation were configured with a Touchpad, although some rugged notebooks also support touch screen[1] or bezel keys in their specifications and listed options such as the Panasonic CF-27.

Ruggedness

Mobility of the notebook computer is another deciding factor. Rugged notebooks have a tendency to be heavy, i.e., 10 to 15 lbs. Thus, the needs for a carry handle. Not all the notebooks had handles, but included a carrying case, which may restrict the maintenance operator or become a hazard around the aircraft. It is evident that the more rugged the notebook construction is the higher probability that it will survive rough handling. These factors were determined through product specification and hands-on use of the products.
Many of the PMA COTS products surveyed in this trade study are of ruggedized construction, capable of withstanding a drop to concrete surface and keep running. Many

[1] Phoenix Group, Inc. Nightingale

products are compliant with various Military Standards and Specification, and the most predominate specification was Mil-810E. Although this item is listed in the QFD Matrix, the relative weight factor was diminished in the final tally. It was felt that the specifications provided would provide sufficient detail in determining the ruggedness of a given unit.

Environmental

Operating and storage temperature varied widely between units, while all of the units included in this study were resistant to water, dust, dirt and spills, thus, part of the definition of "ruggedness". They also have high-resolution displays that are readable in direct sunlight, and are environmentally compatible to resist rain, oil, grease, dust and extreme temperatures. This is typical of the environments that combat aircraft flight maintenance crews experience on the flight line. However, extreme low temperatures can affect the display, and some have been known to crack below –20° C[2]. This parameter alone may prevent purchasing one product line to meet the needs as a PMA. Therefore, considerations need to be made for extreme conditions like Alaska. Xenocom's Rough Rider model was rated highest in this category with a storage (non-operating) temperature range from -40° C to +70° C, and an operating temperature range of –20° C to +50° C with installed option.

Performance

Performance characteristics varied widely with the models reviewed. They ranged from an Intel 486 DX[3] system to the Pentium 266[4] supporting MMX technology, with on board memory from 8 MB to 64 MB. For the application of the PMA, memory configuration is an important feature. Most notebooks have a limited number of memory slots (2), and it can be cost effective to equip the PMA with at least 64 MB or more. One factor to consider is the type of memory modules, either EDO RAM (which must be installed in pairs) or SO-DIMMS (SDRAM) which can be installed in singular modules. Upgrading memory can always be done later, but in the case of EDO RAM, both modules need to be of the same type and speed. Therefore, SDRAM would be the preferred choice, and only the Panasonic ToughBook CF-27 had SO-DIMMS options.

Support for the Operating System is also critical decision. Many of the systems support Windows NT, and thus a need for a CD-ROM or Ethernet to facilitate system load. Only one system in the hands on evaluation would not support Windows NT[1]. The Litton model, although only equipped with an Intel 486 DX processor, was noted to be compliant with Windows NT. However, it should be noted here that a notebook running Windows NT 4.0 Operating System on a 486 DX processor would be extremely slow, and as such, rated poorly in the performance criteria.

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[2] Ref: Military & Aerospace Electronics, October 1998
[3] Litton Industries, Model 3486
[4] Panasonic®, Model CF-27

In summary, Figure 5 is a composite comparison of the configuration alternatives and evaluation criterion, and includes all the models from this Trade Study.

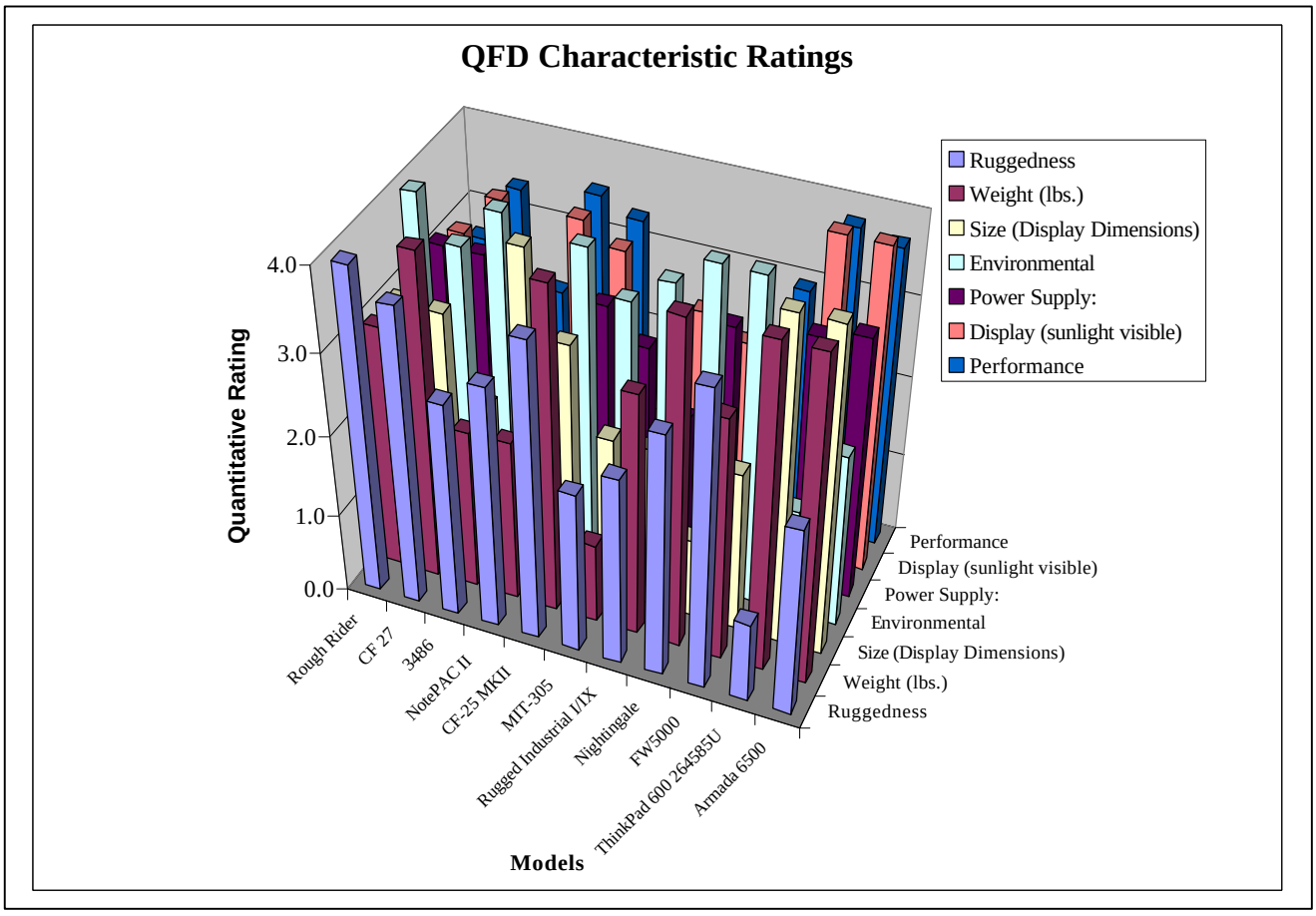

Figure 5 - QFD Summary Rating

Quantification Of Evaluation Criteria

Table 3 is a summary of the quantified scores from the Quality Functional Deployment Matrix. The parameters listed under each of the primary class categories were evaluated using two methods, i.e. Hands-on, or Review. The manufacturer or their product sales representative supplied the Hand-on units. Reviews were conducted strictly from product literature and specifications of the products listed. The goal was to make the "best choice" among the products available at the time of this study.

Manufacturer & Model	Evaluation Method	Total Score
Xenocom, Rough Rider	Hands-on	3.26
Panasonic, CF 27	Hands-on	3.45
Litton Industries, 3486	Review	2.54
Dolch Computer Systems, NotePAC II	Hands-on	2.79
Kontron Elektronik, CF-25 MKII	Review	3.42
Raytheon TI Systems, MIT-305	Review	2.06
CYTEC, Rugged Industrial I/IX	Review	2.53
Phoenix Group, Nightingal	Hands-on	2.83
Fieldworks Inc., FW5000	Review	3.02
IBM, ThinkPad 6000	Compare	3.04
Compaq, Armada 6500	Comapre	3.35

Table 3- QFD Summary

Wireless Network and Heads-Up Wearable Portable Maintenance Aid (PMA)

The Wireless Network and a Heads-up Wearable Portable Maintenance Aid (PMA) Computer Trade Study will present recommendations to support the transmission and use of IETMs at the aircraft maintenance flight line. This study is being conducted by selecting the top six (6) wireless manufacturers or suppliers and evaluating their wireless hardware in the EDTIS lab at the Raytheon facility in Fullerton, California. Various PCMCIA cards, access points, bridges, switches, routers, ATMs, antennas, etc. were borrowed from state-of-the-art Commercial-Off-The-Shelf (COTS) wireless manufacturers or suppliers, and the wireless hardware was evaluated. The trade study will summarize the various COTS wireless products that meet the EDTIS requirements to support data, voice, and video over IP on the aircraft maintenance flight line, and will perform efficiently in the flight line maintenance environment. The trade study is based on the evaluation of six wireless manufacturers or supplier products. The objective of this trade study is to emulate the transfer of IETMs over a wireless LAN and to evaluate the performance of each of the COTS wireless manufacturers or suppliers:

1. Lucent Technologies (FHSS and DSSS)
2. Nortel Networks (FHSS and DSSS)
3. Proxim (FHSS and DSSS)
4. Symbol Technologies (FHSS and DSSS)
5. Breezecom (FHSS and DSSS)
6. Wi-LAN (DSSS only)

Six proof of concept demonstration scenarios will provide an indication of the flexibility of the laboratory capabilities at Fullerton, California. Each of the COTS wireless manufacturers or supplier's hardware that meets the basic EDTIS requirements will be evaluated in each of the six proof of concept demonstration scenarios. Extensive laboratory testing will be performed to provide a recommendation for the best wireless solution for maximum performance and reliability for users of the technology developed under EDTIS. The Fullerton lab environment also has the capabilities to act as a Ground Entry Point (GEP) to validate all interfaces and software, as well as ensuring that the EDTIS software is DII-COE compliant by testing on internal Local Area Networks (LANs) with Raytheon's CII-COE laboratory.

Two (2) voice recognition packages are being evaluated:

1. IBM Via Voice
2. Dragon Speak using the Parrot headset

Evaluation Criteria

The performance and reliability characteristics provided by the manufacturers, or derived during the evaluation, will be assessed for each of the six Proof of Concept Demo Scenarios. For all scenarios, compatibility with the requirement objectives was the essential focus in this assessment, i.e., signal strength, data throughput (speed in which to handle physically large documents and diagrams), range, use of a docking station or remote terminal, wireless local area network (WLAN) performance, voice and video performance, and latencies will be noted while rating the products performance.

All the quantified data collection, distances, data transfer reliability (number of packets lost), network interaction, speed of service, and the seamless functionality of the wireless network will be considered in recommending the best wireless solution for the EDTIS Program.

Heads-Up Wearable Wireless PMA

Xybernaut is the one of the leading state-of-the-art manufacturer of a wearable wireless PMA. Xybernaut is providing their heads-up wearable PMA to support the proof of concept demonstration scenarios. The voice over IP scenarios will be tested using the Xybernaut heads-up unit.

Peer-to-Peer Wireless Configuration in Lab

Figure 6 shows the peer-to-peer wireless configuration that will be used in the lab to evaluate the six COTS wireless manufacturers and suppliers.

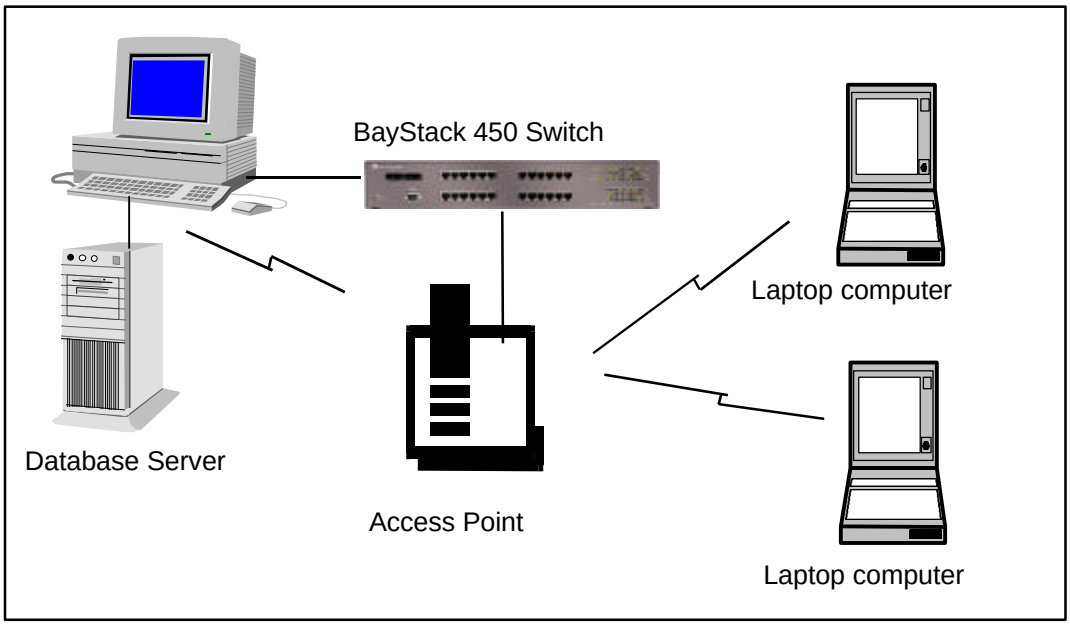

Figure 6 Peer-to-Peer Wireless Configuration

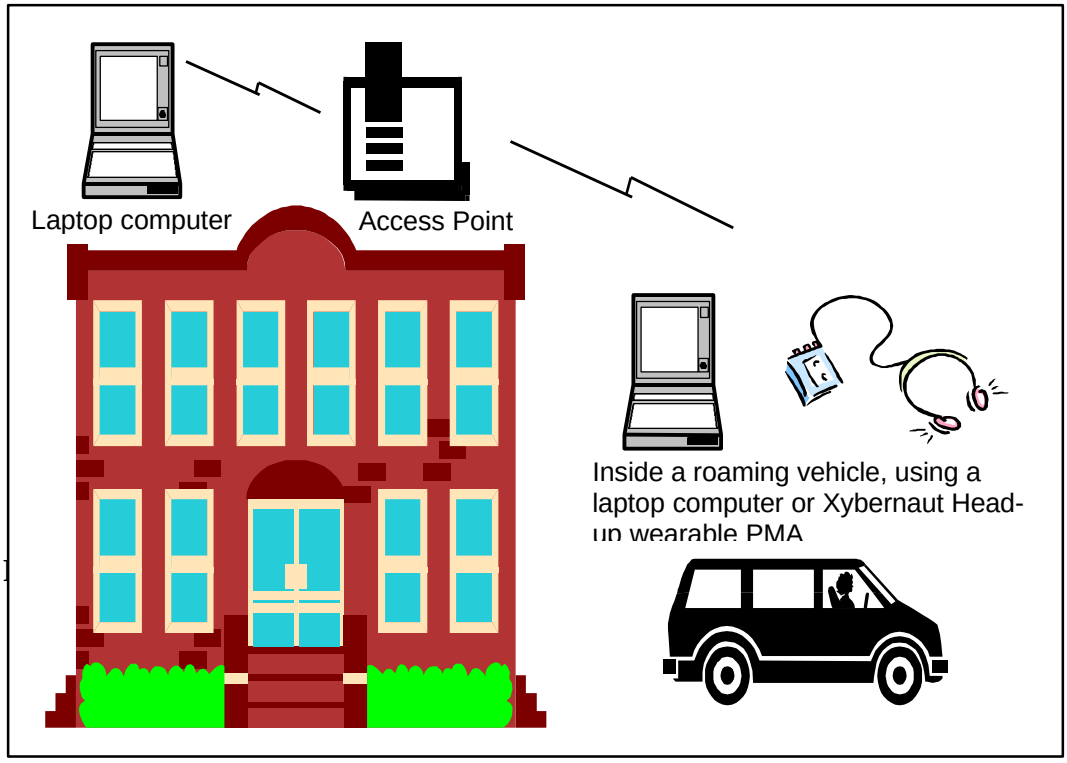

Figure 7 - Peer-To-Peer Wireless Configuration That Will Be Used Outdoors

Figure 7 shows the peer-to-peer wireless configuration that will be used outdoors to evaluate the six COTS wireless manufacturers and suppliers. A laptop and a COTS manufacturer's access point will be set up on the roof of Raytheon's building 617 in Fullerton, California. A laptop or the Xybernaut heads-up wearable PMA unit will be used in a vehicle which moves slowly, collecting data (signal strength, range, and average times to transmit packets of data). The Nortel FHSS and the Symbol FHSS wireless hardware will be tested from the rooftop.

Figure 8 – A Grateful EDTIS User

EDTIS Potential Impact of TPED

TPED looks at the issue of how to effectively and dynamically task ISR assets, exploit and fuse the gathered information, and provide it to joint/combined war-fighter in a timely manner.

EDTIS has the potential of providing war-fighters with a combat friendly PMA, which they can wear, while they receive and send real-time combat information. The land, sea, air, and support war-fighters become effective nodes in the Global Information Grid and the Joint Battlespace Infosphere (JBI).

The Joint Battlespace Infosphere (JBI)

The executive summary of the United States Air Force Scientific Advisory Board Report on "Building the Joint Battlespace Infosphere" (1) defines the Joint Battlespace Infosphere (JBI) is a combat information management system that provides individual users with the specific information required for their functional responsibilities during crisis or conflict. The JBI integrates data from a wide variety of sources, aggregates this information, and distributes the information in the appropriate form and level of detail to

users at all echelons. The JBI was originally described in the 1998 USAF Scientific Advisory Board (SAB) report *Information Management to Support the Warrior*. At the joint task force (JTF) commander's level, the JBI is a powerful command and control (C^2) system that combines inputs from a variety of sources, including existing C^2 systems, reconnaissance data, satellite data, unit capability data, logistics data, and real-time battlefield conditions. The JBI builds an aggregated picture from these combined inputs, giving unparalleled situational awareness accessed as easily as a web page. The JBI also provides for speedy downward flow of information, so when commanders order an action, the action is received and implemented at the subordinate level almost immediately. The commander in chief (CINC) or JTF commander creates a JBI for a specific purpose, usually in response to a crisis or conflict. The JBI enables the commander to focus information support for a specific operational purpose, ensure or limit access to critical information, and provide an information management system that can respond to natural or enemy actions that disrupt communications capabilities. As units are assigned to the mission, their information needs are electronically identified, and available information is automatically accessed. Thus, deployed units are ready to fight immediately upon being deployed or assigned (1).

Supporting these capabilities and forming a foundation of the JBI is a platform of protocols, processes, and common core functions that permit participating applications and organizations to share and exchange critical mission information in a timely manner. It provides uniform rules for publishing new and updated objects into the JBI and promptly alerts any JBI clients that have subscribed to such objects. These properties enable dynamic information flows among client programs of the JBI, serving to integrate the clients to conduct a single mission. The JBI platform integrates many individual information systems that currently support operational forces. Each existing system has been developed in a stove-piped fashion; few interoperate with each other. The JBI acts as an intermediary between these systems, converting information from one representation to another to enable interoperability. In addition to acting as middleman between disparate systems, the JBI interprets the information flowing between applications, using it to build its own, more complete, picture of the current situation. Furthermore, the JBI tailors this picture for individual users: the commander gets a high-level view of the campaign, while the soldier in the field gets a detailed description of a nearby hostile base. The JBI provides an architecture for the incorporation of future data capture technologies that exploit better sensors, databases, fusion engines, automated analysis tools, collaborative planning and execution aides, and distribution controls. It is also a disciplined process that guides the activities of people responsible for obtaining, verifying, fusing, presenting, analyzing, and controlling the information necessary for success in any operation (1).

The JBI is connected to, and interoperable with, a variety of existing and planned C^2 and combat support information systems. The JBI is not intended to replace C^2 systems, but to be the substrate for integrating them. The JBI subscribes to pertinent information published by supporting systems and, when necessary, pulls specific information from other networks. In addition, the JBI connects to fusion engines and may perform fusion on its own, thereby ensuring that the most complete and coherent picture of the battlefield

situation resides within the JBI itself. The JBI concept recognizes that display technology is constantly advancing and that new displays must be tailored for users from flight leader to JTF commander. The JBI provides services through a federation of multiple servers. The Global Information Grid connects these servers to each other and to the many systems that support the JBI. Many of the servers provide services from the rear via reachback, thereby limiting the forward footprint of the JBI (1).

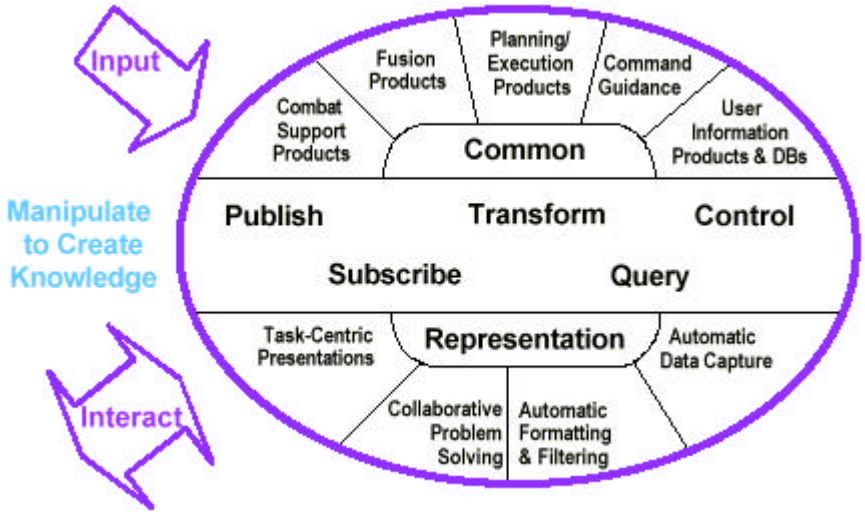

Figure 9 – JBI Functions

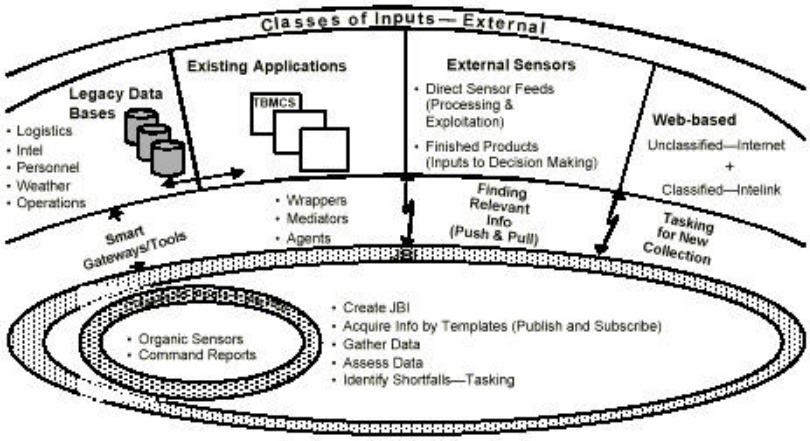

Figure 10 – JBI Architecture

Summary and Conclusions

The C2I SR Campaign Plan 2000 has a focus area called Intelligence, Surveillance, and Reconnaissance (ISR) Tasking Processing Exploitation and Dissemination (TPED). As stated earlier the consequences of TPED are:

- Inefficient tasking increases operating costs, reduces ISR gathering capabilities, and frustrates decision-makers
- Fragmented and inadequate data fusion processes obscure high value and time sensitive information from reaching the war-fighter
- "Bottle necks" in exploitation processes diminish return and waste of ISR capabilities
- Inadequate TPED results in delayed support to decision-makers; resulting in targeting errors, fratricide, etc. [1].

In order to provide efficient tasking, technologies and techniques need to be developed which link the C2ISR players. The war-fighter player needs to be a key element in gathering real-time information, and receiving the specific information he needs to accomplish his mission.

Integration and prioritization of sensitive information can be managed at centralized command posts, when it can be disseminated expeditiously through a JBI network.

The most valuable information often comes from those closest to the conflict. Bottlenecks are often caused by a misunderstanding of the task to be accomplished. Technologies must be made available which bridge bottlenecks with immediate and proximate information.

Adequate solution sets are found in expanded information searches. Connecting decision makers, mission performers, and JBI supporters with additional layers of source information improves all aspects of armed and peaceful engagements.

The move from platform centric, tightly controlled C2ISR, is being replaced with network centric, opened (but assured) C2ISR. New Commanders have in their toolbox the JBI, which makes all under their command users in an network centric operation. The commander still controls who gets what, and what he gets from the JBI. It is to this commanders benefit to enable his war-fighters (front-line and support) as information gatherers. It also pays to provide these war-fighters with the most accurate specific information they need for their jobs.

The EDTIS program enables many of the features of TPED, the JBI, and the Global Information Grid by providing a dynamic interface between war-fighters, decision makers, and all of the support staff.

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