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A Candidate Functional Architecture Design
for the Detection and Monitoring Process of a
Counterdrug Joint Task Force

by

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June, 1993

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The Counterdrug Joint Task Force (JTF) represents an organizational environment that demonstrates requirements needed by most joint task forces. The nature of a JTF is that of a temporary organization established from many organizations to accomplish a specific task. Once this task is completed the different organizational elements return to their previous command structure. By designing the JTF using a systems engineering approach of top down decomposition, a format for the baseline requirements can be established. This decomposition format can be applied to generate other JTFs or re-applied to existing JTFs to verify systems requirements compliance. This thesis conducts a breadth-first examination of the Counterdrug JTF detection and Monitoring process. Systems engineering software using IDEF0 facilitates this design and is demonstrated in this thesis. A detailed analysis is then conducted for the data fusion and decision support sub-functions of the detection and monitoring process. The development of an alternative candidate architecture provides a different perspective to accomplishing top level system requirements. Designing a functional architecture using systems engineering tools enhance the performance of a JTF and can assist in the creation of future similar organizations.

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A Candidate Functional Architecture Design for the Detection and Monitoring Process of A Counterdrug Joint Task Force

by

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Submitted in partial fulfillment
of the requirements for the degree of

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from the

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ABSTRACT

The Counterdrug Joint Task Force (JTF) represents an organizational environment that demonstrates requirements needed by most joint task forces. The nature of a JTF is that of a temporary organization established from many organizations to accomplish a specific task. Once this task is completed the different organizational elements return to their previous command structure. By designing the JTF using a systems engineering approach of top down decomposition, a format for the baseline requirements can be established. This decomposition format can be applied to generate other JTFs or re-applied to existing JTFs to verify systems requirements compliance. This thesis conducts a breadth-first examination of the Counterdrug JTF detection and monitoring process. Systems engineering software using IDEF0 facilitates this design and is demonstrated in this thesis. A detailed analysis is then conducted for the data fusion and decision support sub-functions of the detection and monitoring process. The development of an alternative candidate architecture provides a different perspective to accomplishing top level system requirements. Designing a functional architecture using systems engineering tools enhance the performance of a JTF and can assist in the creation of future similar organizations.

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I. INTRODUCTION: THE ENVIRONMENT

A. BACKGROUND

Many existing Department of Defense organizations become fully operational yet fall short of meeting mission requirements because their missions were not designed from a systems perspective. Their ability to accomplish their mission is severely hampered by constant distractions generated from the necessity to refit or reorganize their operational systems. This shortfall is due to unplanned circumstances or incompatible systems that cannot interface with their environment. Systems Engineering design tools greatly enhance the performance of the system. Even for systems already functioning, a decomposition of the original requirements can enhance the performance, streamline functionality, and improve the quality of the system's output. This technique is called process re-engineering.

Disaggragating the mission of the Counterdrug Joint Task Force (JTF) (as an example of a multi-agency task force), demonstrates the complexities involved in creating and running what will be in the future a more common command and control environment. This system represents common military applications demonstrated by focusing on the detection and monitoring processes of the Counterdrug JTF. The fusing multiple source data into a useable product is a key military application exhibited by the Counterdrug JTF.

The amount of data flowing into a command center expands beyond the decision makers capability to decipher it and fuse it into working, timely information. Data fusion is defined in a military context as a process that is performed on multi-source data at several levels. Each level dealing with the detection, association, correlation, estimation and completely and timely assessments of the situation and threat . Understanding the detail of the systems necessary to fuse data from many sources and from many levels into a viable product reduces inefficiency caused by retroactive system re-building within any military organization.[Ref. 1: p. 1]

B. SCOPE

This thesis will focus on the design of a candidate architecture based on the requirements established for the Department of Defense by the Defense Appropriations Act of 1989. The interpretation of those requirements by the armed service further directs the design problem[Ref.2: p.6]. This thesis focuses on the functions integral in making decisions for intelligence collection and interdiction operations within a Counterdrug JTF. This narrow scope generates the basic requirements that initiate the design for a candidate functional architecture for detection and monitoring data fusion operations. This thesis provides an alternative architecture based on the original Department of Defense (DOD) guidelines to demonstrate compliance to requirements with a different approach. This thesis does not establish requirements for the physical systems involved in the complicated process of detection and monitoring.

C. METHODOLOGY

This thesis demonstrates a technique for designing a multi-agency JTF that has a detection and monitoring function. The systems engineering approach to designing a candidate functional architecture focuses on the ability to delineate the exact, detailed requirements necessary to accomplish the mission of the organization. These requirements are described as top-level-system-requirements (TLSRs) [Ref. 3:p. 28A]. The mission must be clearly defined and inflexible if a workable design is to be constructed. The guidelines established for the DOD by the national command authority provide the baseline requirements for the development of the TLSRs. These guidelines establish the responsibilities of the DOD and their relationship with federal Counterdrug agencies. This thesis will use a design technique variation of Structured Analysis and Design Technique (SADT) called IDEF0, which is explained in Appendix A. This approach will decompose the stated requirements and develop a candidate architecture for the data fusion function of the detection and monitoring process.

D. SYNOPSIS

This thesis begins with a review of the environment and its impact on the system in focus in Chapter I. This chapter has introduced the environment that the system-in-focus operates within and provides a perspective to conduct the functional design for a candidate architecture. Chapter II will develop the first level of decomposition, level zero. This level examines the system-in-focus from a macro level and demonstrates its interactions with the environment. The data association and correlation of these multiple agency inputs are processes that are decomposed in this thesis. The systems interoperability and the dissemination of the intelligence products developed in the decision cycle of the Counterdrug JTFs is reviewed with a breadth first examination to determine areas of decomposition. Chapter II initiates the decomposition of the system-in-focus and examines the interaction of the controls and inputs which are the crucial catalysts from the environment.

Chapter III establishes mission-scenario combinations that generate requirements for the sub-functions identified at this level of decomposition. These sub-functions in turn generate detailed sub-functions that further work to define the system-in-focus. By focusing on one sub-function at each layer of decomposition, the specific requirements of detection and monitoring established at level zero are traced to the lowest level disaggregation. At this simplified level the engineer starts to build systems that will accomplish each sub-functional requirement. Because of this simplified level, the interaction of the subfunctions and their inter-relationships are programmed into the system design, rather than having to be retroactively installed at a later time.

Chapter IV describes the level of decomposition that interacts with the human decision making cycle. The next level of decomposition will describe in greater detail the decision process involved in physically incorporating the specific track into current operations by creating a track model. This model will generate a decision cycle in the current operations.

Chapter V describes the data fusion function and the criteria for completion of a design. When it is apparent that any further decomposition will require a discussion of how the process physically accomplishes its functions, then a different level of abstraction is needed. The discussion of the use of specific types of expert systems or decision support systems to facilitate sub-functional operations and their development would breach the current abstraction level. This level of decomposition is not sufficient to design a complete functional architecture for the Counterdrug JTF. Its purpose has been to establish the framework for the continuing examination of each level of the functional architecture and initiate the examination of possible alternative functional architectures that would accomplish the TLSRs. These alternative architectures may depart from the candidate architecture at any level of decomposition. This departure must still accomplish the sub-functional requirements of any parent functions associated with the design. Chapter VI proposes an alternative architecture based on an examination of the original guidelines established to define the detection and monitoring mission for DOD. Chapter VII is the conclusion of the thesis with the recommendation for the use of the system design process to create a template for establishing joint task forces.

E. THE SYSTEM-IN-FOCUS

The system-in-focus is the entity that must be delineated from the environment. In this case the system is distinguished from its environment by the chain of command it operates within, the controls it must function with, the resources it uses to accomplish its TLSR compliant functions, and the output it produces[Ref. 4:p. 1A]. The Counterdrug JTF is the system that will be decomposed to identify the TLSR compliant functions necessary to conduct detection and monitoring operations. There are currently three counterdrug JTFs operating under the command of their respective regional specified command under the Joint Chiefs of Staff within DOD. Although no one specific JTF was modeled in this thesis, JTF 4 and JTF 5 represent the system with the decomposable detection and monitoring requirements. DOD must coordinate all counterdrug policy issues with the Office of National Drug Control Policy (ONDCP)[Ref. 5:p. 3-17]. Figure 1 illustrates the federal counterdrug community.

F. THE ENVIRONMENT OF THE SYSTEM-IN-FOCUS

1. Background: DODs Role In Counterdrug Operations

a. Defense Appropriations Act of 1989

The Defense Appropriations Act of 1989 defined the lead agencies responsibilities in the federal counterdrug community. DOD became the lead agency responsible for the detection and monitoring of drug trafficking craft attempting to enter the United States by air, sea, or ground. Coordinating issues concerning the command, control, communications and intelligence (C^3I) assets was also delineated as the responsibility of DOD. [Ref. 6: p. 65]

b. Creation of the JTFs

The Joint Chiefs of Staff directed regional specified commands to establish JCS direction of the formation of regional JTFs. These JTFs would promote regional coordination with all agencies involved in interdiction operations by providing state of the art detection and monitoring resources for counterdrug operations.

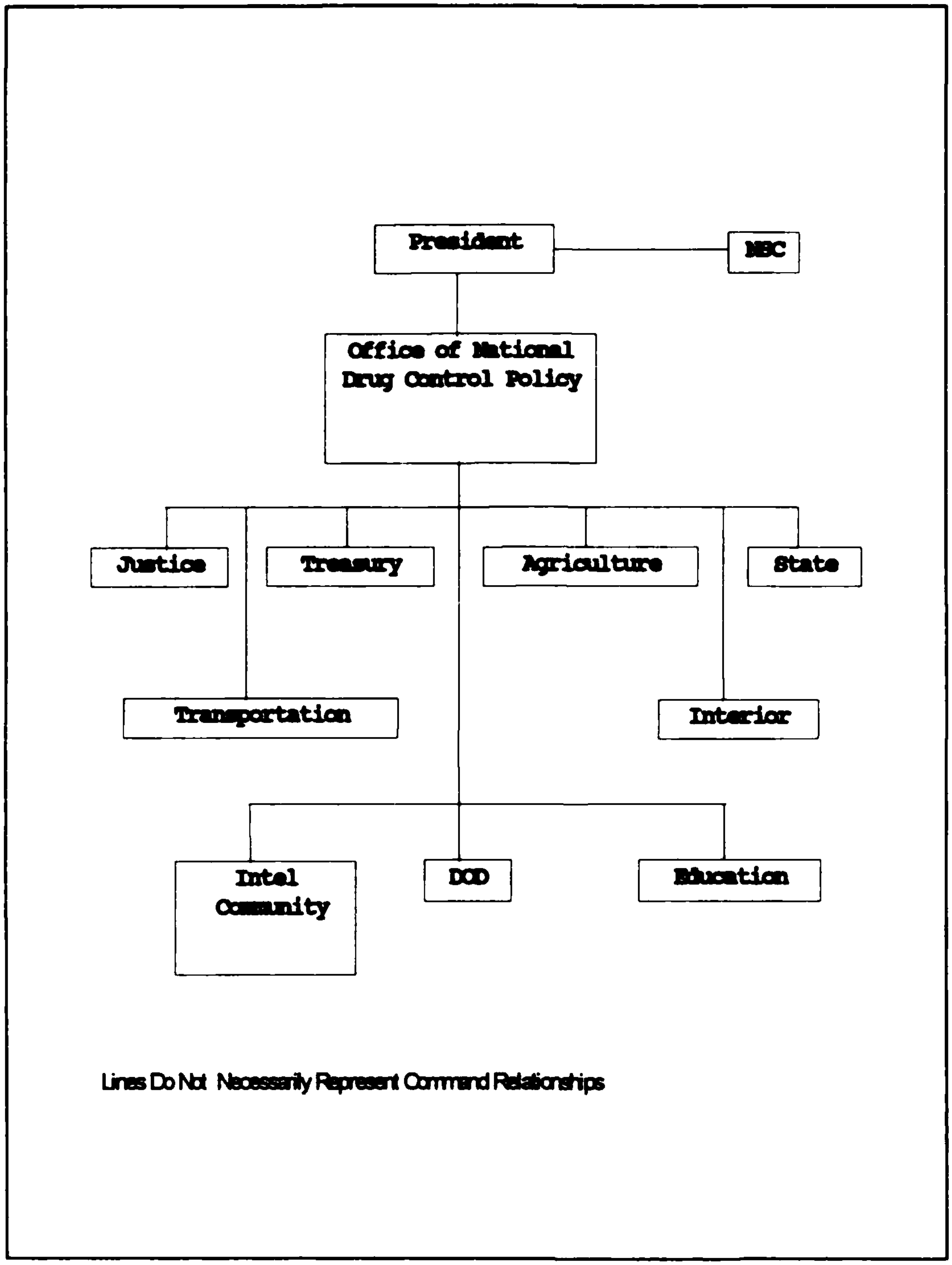

Figure 1: Federal Counterdrug Community

The JTF would also provide coordination for the exploitation of DOD C^3I assets to regional federal and local counterdrug agencies[Ref.7]. Figure 3 at the end of the chapter illustrates a typical JTF regional counterdrug agency environment.

c. *The Posse Comitatus Act*

A limiting parameter critical in the examination of the environment within which the counterdrug JTFs operate is the exclusion of any DOD personnel from conducting any law enforcement activities within the United States. Title 10 and the Posse Comitatus Act describe what actions are prohibited to the military.[1]

2. Factors Affecting Sensor Input

a. *The Enemy*

Drug trafficking is a multi-billion dollar a year profit making industry. This industry has its own infrastructure including sophisticated production, transportation and distribution systems. The elements creating the sensor input to the JTF is the transportation techniques used by drug traffickers to ensure a supply for distribution.[Ref. 8:p. 112]

b. *Smuggling Methods and Routes*

Cocaine, heroin and marijuana represent the three major types of illegal drugs that require interdiction operations. Most heroin originates in Asia and crosses the Pacific Ocean by ship. Often these large ships meet with smaller, faster craft offshore

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[1] There are specific instances where under a state of emergency federal troops can conduct these activities, see Title 10 of the U.S. Code and the Posse Comitatus.

to diversify the actual port of entries for the drugs. Cocaine travels by both ship and plane from South America. 80% of all Cocaine entering the United States is grown in Peru and manufactured into the final product in Columbia. A current trend is a shift in manufacturing sites to the Upper Amazon in Brazil, and in Ecuador. Marijuana comes by ship, plane and ground vehicle from Mexico and South America. The most used routes for transportation into the United States are shown in Figure 2.[Ref. 9:p. 36]

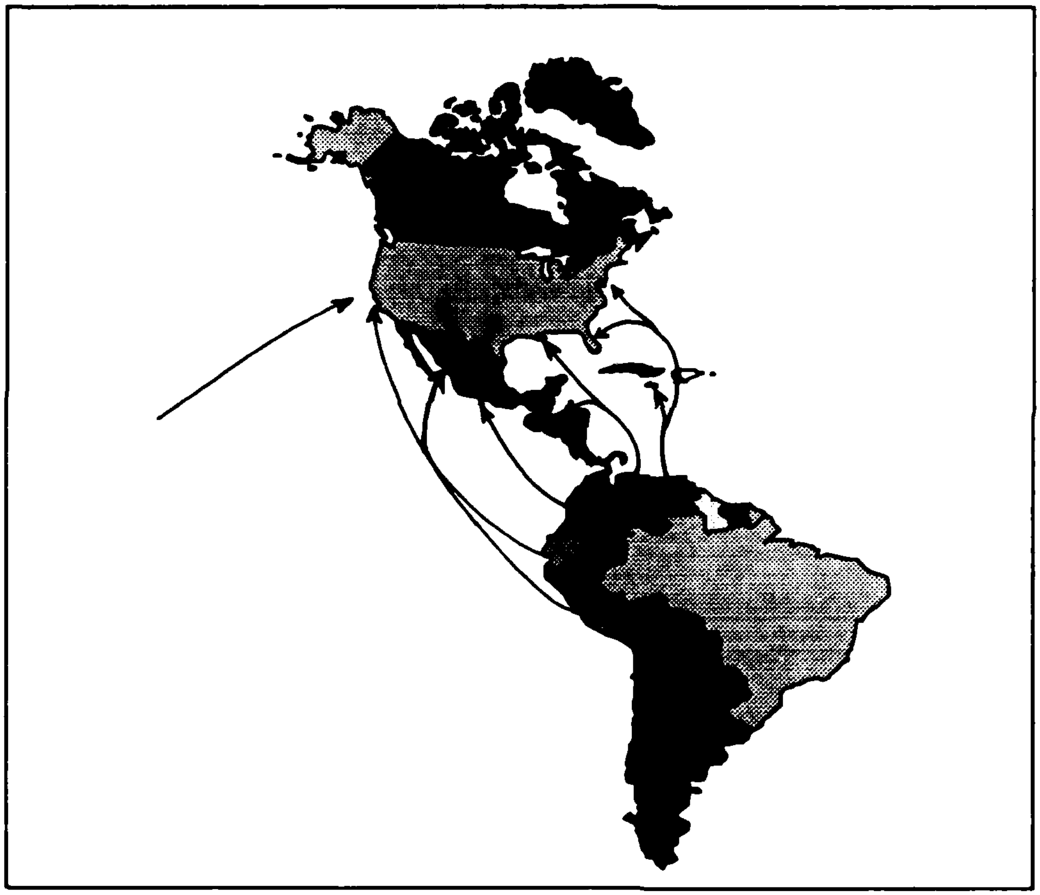

Figure 2: Major Drug Smuggling Routes

c. JTF Sensor Support Agencies

The data fusion that occurs within a Counterdrug JTF refers to both the automated systems processes and the human decision making process. The correlation of data from many different agencies into a useable intelligence product incorporates both these aspects. A summary of the agencies input provides a perspective into the scope of the fusion problem.

(1) NORAD: Target detection, identification and tracking into the Air Defense Identification Zone (ADIZ) transmitted via the Defense Data Network (DDN) and the Joint Visual Integrated Display System (JVIDS).

(2) USN Ships and Aircraft: Target detection, identification and tracking in assigned areas of responsibilities transmitted via secure satellite communications, FM radio transmission and JVIDS.

(3) United States Coast Guard Ships and Aircraft: Target detection, identification and tracking in assigned areas of responsibilities transmitted via secure satellite communications, FM radio transmission and JVIDS.

(4) United States Air Force Aircraft: Target detection, identification and tracking in assigned areas of responsibilities transmitted via secure FM radio transmission and secure digital data networks.

(5) The Drug Enforcement Administration: Intelligence reports based on the collection of information from informants, foreign country law enforcement,

special agents inside and outside the United States, and other human intelligence sources (HUMINT).

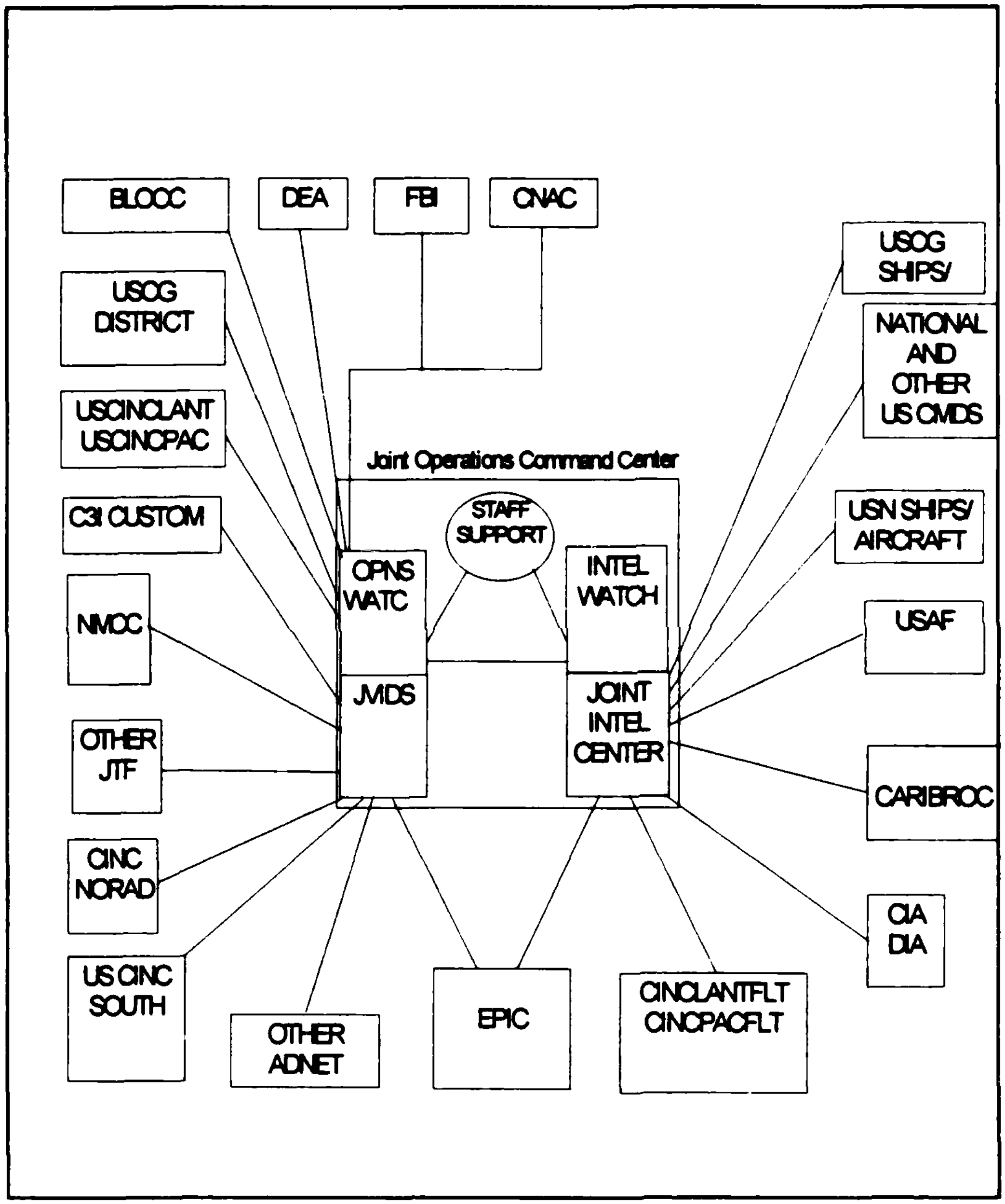

Figure 3: Regional JTF Environment

(6) Defense Intelligence Agency: Intelligence reports based on the collection of information from informants, foreign country intelligence services, attaches in U.S. embassies abroad, and other HUMINT sources.

(7) Other National Technical Means: Sophisticated systems on from spacecraft, high flying aircraft, and other national sources provide imagery intelligence (IMINT) to the JTFs. Other national agencies provide electronic (ELINT) and communication (COMINT) intelligence reports transmitted via Special Compartmented Information (SCI) networks to the JTFs.[Ref. 10: pp. 66-73]

G. SUMMARY

This chapter introduced the environment that the system-in focus operates within and provides a perspective to conduct the functional design for a candidate architecture. Chapter II will develop the first level of decomposition, level zero. This level examines the system-in-focus from a macro level and demonstrates its interactions with the environment. The data association and correlation of these multiple agency inputs are processes that are decomposed in this thesis. The systems interoperability and the dissemination of the intelligence products developed in the decision cycle of the Counterdrug JTFs is reviewed with a breadth first examination to determine areas of decomposition.

II. THE SYSTEM-IN-FOCUS

This chapter will define level zero of the Counterdrug JTF. The IDEF0 methodology will describe the system and display the structural aspects of the JTF architecture. This will allow for a visual representation of the decomposition of the elements that form the requirements for the Counterdrug JTF. Appendix A provides a detailed explanation of this top down approach that illustrates systems engineering decomposition.

The system engineering approach begins with the capturing of the system-in-focus by defining its boundary with the environment. To study one system, it is important to be able to distinguish what qualities can be attributed directly to it, rather than from some external factor. Systems engineering directs attention on the system-in-focus by bounding it with specific criteria. Whatever is within the boundary is the system, everything else is in the environment. Developing this environmental interface will produce scenarios that can be paired with specific functions. After the pairing of the scenario-requirements sets, the functions can then be reduced to a level where they appear unique in activity and have one or only a few relationships with other functions. Figure 4 shows a path through the levels of decomposition, beginning with the system-in-focus and the primary top level requirements. These requirements generate the descending level sub-functions necessary to meet the mission guidelines.

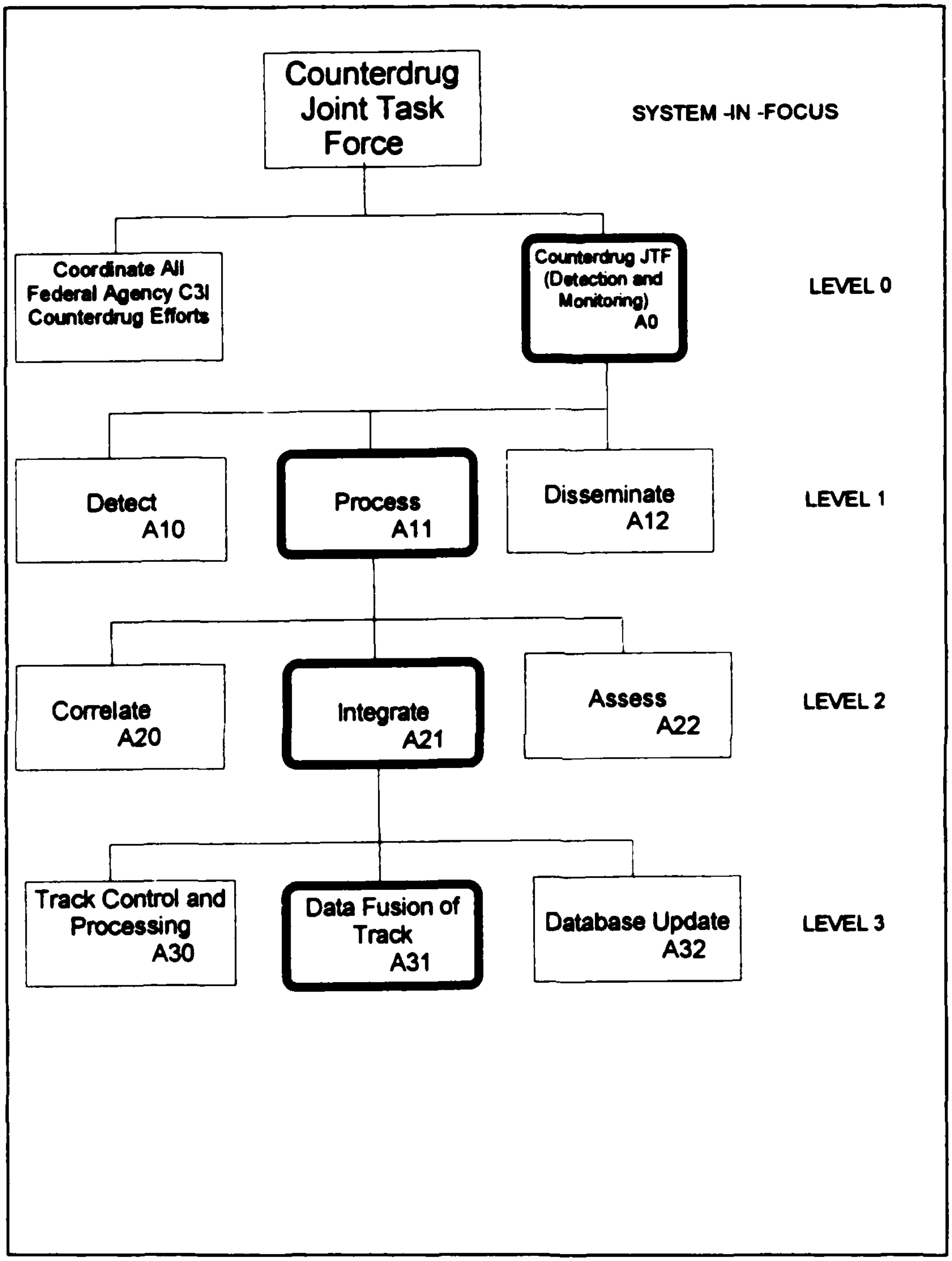

Figure 4: Decompositional Path

The scope of this thesis is focused on the intelligence analysis and operational data fusion requirements generated by the Counterdrug JTF's detection and monitoring mission. In order to maintain this scope only those elements depicted in bold in Figure 4 will be decomposed. The other elements will be described in less detail in order to relate their processes to the decomposed function. Such an approach facilitates information hiding[2] and simplifies the building of the architecture by insuring inter-operability before system construction. [Ref. 3: p. ii].

A. LEVEL ZERO

Systems engineering describes the first layer of architectural decomposition as the point where the system-in-focus reacts with its environment at the most general level [Ref. 3:p. 5]. This level is defined by four factors; controls, inputs, resources and outputs. Figure 5 illustrates the interaction of the system-in-focus with the environment. Through inputs and outputs the system receives variables. The controls and resources (mechanisms) structure the interaction of the system-in-focus with the environment. An activity report at the end of the chapter describes the separate factors as they interact with the system-in-focus. These reports are generated by the IDEF0 software and assist in tracking the flow of data through the function. Each IDEF0 design associates an activity report in subsequent levels of decomposition to its respective diagram. Following the

[2] Information hiding is the principle that modules and functions should be designed so that the variables within the module are inaccessible or hidden from other modules. Unless there is specific need for modules to share the variables, the modules are independent of each other. This promotes design simplicity and minimizes complex interactions and coordination of effort. [Ref. 3: p. 6]

activity reports from one level to the next will help the reader see the coupling of functions from level to level.

1. Controls

Controls are the driving elements that define and restrict the actions of the system-in-focus. These controls represent a command structure as well as the mission of the system-in-focus. This mission generates a set of requirements that generate TLSR compliant sub-functions. The Defense Appropriations Act of 1989 designated the first set of TLSRs for the role of DOD in the war on drugs [Ref. 5:p. 4-3]. *The National Security Strategy for the United States* produced each year by the Executive branch has further delineated the requirements in the following years [Ref. 6:p. 3]. DOD established the following additional guidelines for controlling the use of the Armed Forces. These guidelines focus on the responsibility for the detection and monitoring of aerial and maritime transit of illegal drugs into the United States:

1. Build on existing capabilities and facilities;
2. Employ DOD resources in a way which supports and enhances traditional mission capability;
3. Limit the modification or procurement of infrastructure and systems which are dedicated to unique anti-drug activities;
4. Expand upon previous DOD detection efforts;
5. Develop a comprehensive detection and monitoring plan for the borders of the United States;

6. Evaluate existing DOD systems and programs to identify opportunities for enhancing detection and monitoring capabilities;

7. Coordinate all detection and monitoring activities. [Ref. 2: p. 3]

The command structure for the DOD counterdrug mission was left to the specified commands, under the guideline of using existing capabilities and facilities. Figure 5 represents the command structure for a Counterdrug JTF.

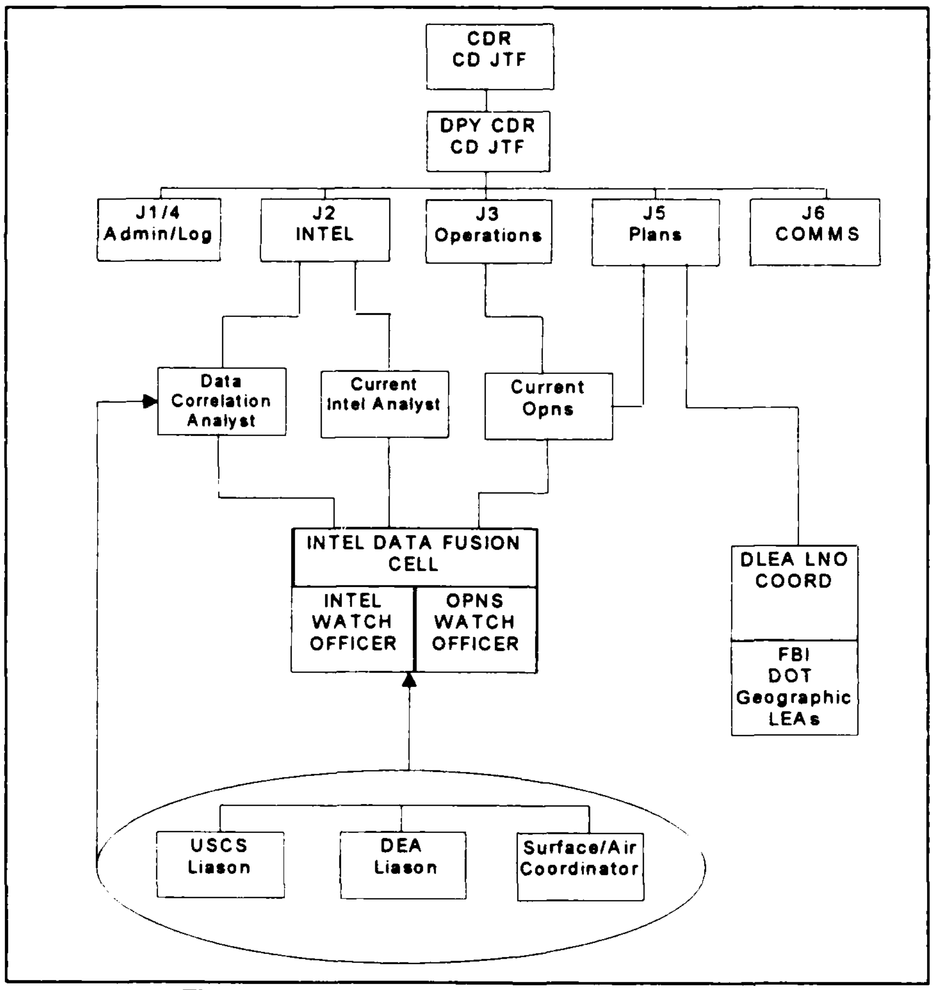

Figure 5: Typical Counterdrug Command Structure

The designated mission assigned to DOD and the structure of the chain of command frame the constraints that the Counterdrug JTF must operate within. They directly or indirectly influence the desired outputs of the system-in-focus. The DOD guidelines listed above establish the top level system requirements of detection, monitoring and coordination of all federal agency counterdrug C^3I efforts. Details of these specific characteristics are given to demonstrate their required functionality to accomplish the mission.

a. Detection

The detection of any craft that is known to be or falls within the established guidelines for suspicion of transporting illicit drugs. These guidelines include but are not limited to:

1. Known previous drug trafficker
2. Off standard sea or air routes
3. Not maintaining typical communications
4. Missing or obscured identification markings
5. Not using proper lighting at night.[Ref. 8: p. 20]

b. Monitoring

Monitoring includes the confirmation of a track as a possible drug trafficker. The JTF's specific mission is to observe the actions of the craft as it enters its area of responsibility. A further delineation of the sea is the coastal waters of the United States, internationally accepted as a 12-mile zone. The maritime commerce area protected by the United States Coast Guard (USCG) extends out to 200 miles from the coast. Detection and monitoring can occur outside the 200-mile zone depending on the sensor used. Monitoring then becomes an active function within the 200-mile area.[Ref. 8: p. 22]

c. *Coordination for all Federal Agency Counterdrug C3I Efforts*

DOD is responsible for becoming the lead agency for the development of command, control, communications and intelligence (C^3I) processes and applications for interagency counterdrug efforts [Ref. 5:p. 3-18].

(1) Hardware and Software Support: As the lead agency for counterdrug C^3I, DOD is responsible for assisting in the development of hardware that will support the drug war. This is manifested in the supply of leading edge technology currently in use by DOD to drug law enforcement agencies (DLEAs). An example of this is Operation Mountain Pass, the overhaul of the El Paso Intelligence Center (EPIC) by the Defense Information Systems Agency (DISA). Existing hardware, software (government and civilian off-the-shelf) and continuing support contracts were purchased by the DOD agency in direct coordination with the Drug Enforcement Administration, the lead agency for the Intelligence Center. DISA provides guidelines for the purchase of software and hardware to their geographic counterparts in the DLEAS to ensure compatibility of systems and to provide the most advanced equipment. JTFs can provide equipment when tasked for the conduct of an operation.[Ref. 2: p.2]

(2) Coordination: The Counterdrug JTF provides direct interface with equipment and personnel to requesting agencies for DOD support. DLEAs requesting DOD resources do so through the regional Counterdrug JTF. DOD provides training for equipment to DLEAs. DOD provides personnel to work with planning and the execution of command and control activities for interdiction and eradication operations outside the United States. Advanced communication networks such as the Defense Systems Network (DSN) provide connectivity for databases and on-line message traffic to federal agencies on a dedicated network called the anti-drug network or ADNET.[3][Ref. 11]

2. Inputs

Correlated data received from various sources supply the inputs to the counterdrug JTF at level zero. These sources include but are not limited to HUMINT resources from federal agencies such as the Drug Enforcement Administration (DEA), Customs, the Federal Bureau of Investigation, and foreign diplomatic channels.[4] Communications, electronics and imagery intelligence (COMINT, ELINT, and IMINT) are supplied from DOD resources directly tasked and operating on counterdrug missions. [Ref. 9:p. 177]. The variety and quantity of the data received create the requirement for a specific filtering process that will be examined at a further decomposition level. The

[3]A comprehensive examination of this top level requirement is beyond the scope of this thesis. This subject justifies a thesis topic of its own due to the complex arrangement of law, working procedures and unique requirements each agency has in working in the counterdrug environment.

[4] Any further examination of HUMINT intelligence sources is beyond the classification level of this thesis. See references 8,9 and 10 for more information.

data received at the JTF passes through external sensor data processing and is not received in a raw sensor format. The JTF must conduct operations using existing DOD resources and cannot become sensor processing facilities. This creates the first time lag for the JTF in its intelligence analysis process. It also implies that the data have been subjected to a level of filtering has occurred to the data before its arrival to the JTF. These two factors will be examined at the third decomposition level.

3. Resources

Resources are the mechanisms available to the JTF to process the inputs and create outputs that meet the TLSRs. These mechanisms are the personnel, hardware and software organic to the JTF. Personnel organic to the counterdrug JTF includes permanently stationed representatives from the DLEAs and other federal agencies. Their responsibilities are to coordinate intelligence gathering efforts, assist in the consolidation of intelligence from other agencies, and assist in the processing of the gathered intelligence. These liaison personnel also assist in the dissemination of the intelligence product to the appropriate interdiction force.[Ref. 7]

Hardware and software resources are database intensive, and have the ability to draw upon external databases in near real time to verify and assimilate data to make a coherent intelligence product. This is assimilation will be described in the Correlation and Process functions. Resources including personnel and equipment used by the JTF must derive from previously existing DOD programs and from other federal agencies that can provide real time interface access.

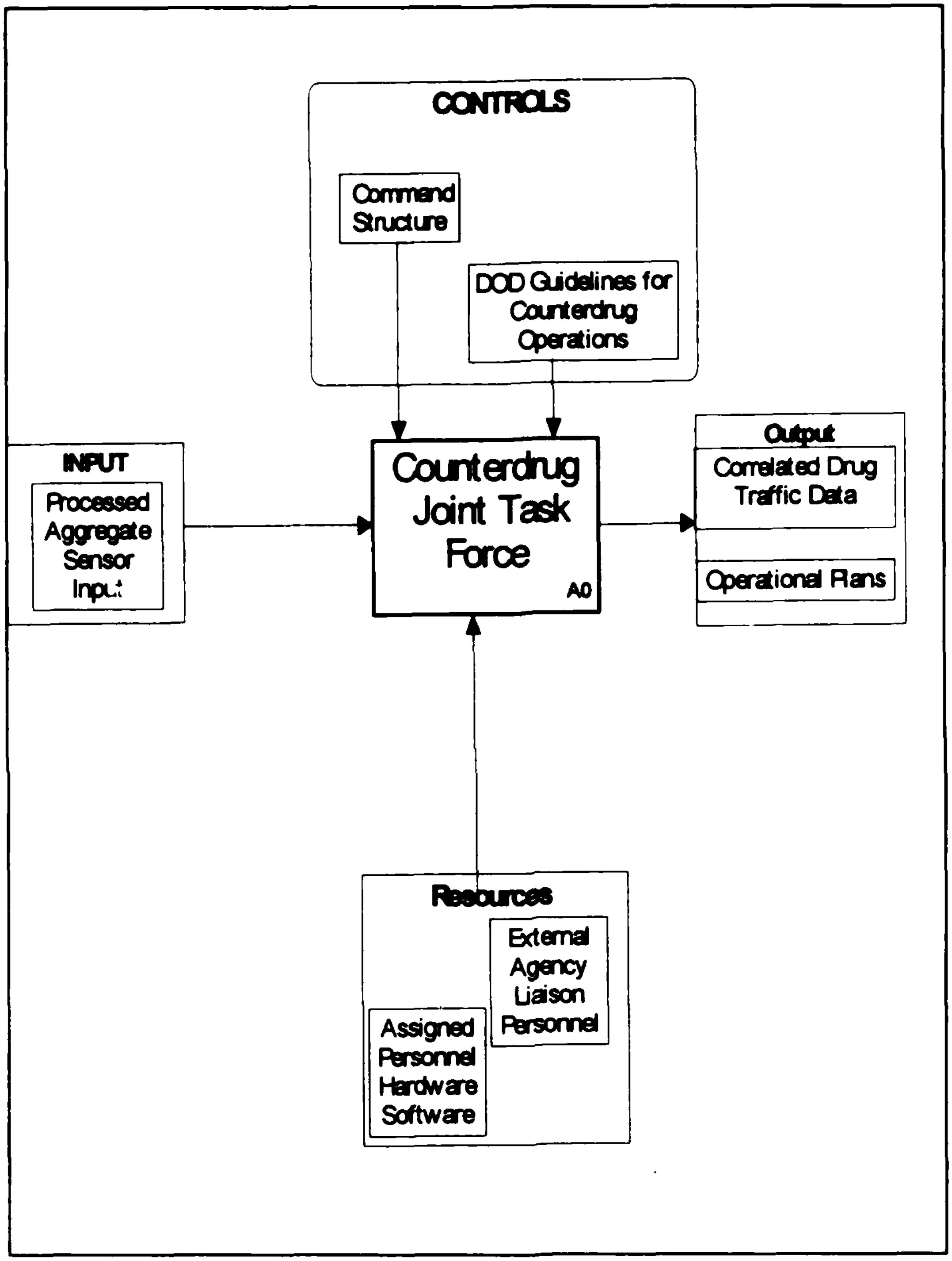

Figure 6: Level Zero IDEF

4. Outputs

The outputs of the counterdrug JTF are those products of the functions designed to meet its top level requirements. At this level of decomposition where the JTF is at its closest to the environment, the form of this output is specific data on drug traffickers. They fit either the detection or monitoring criteria defined earlier. This output can include analytical factors that denote vessel or aircraft type, probable contraband cargo, and probable port and probable route into U.S. coastal waters. The data in this form would be assigned to the appropriate agency for interdiction operations. Currently within U.S. coastal waters U.S. Navy vessels carrying Coast Guard Law Enforcement Detachments (LEDETs) can board suspicious craft with specific probable cause and seize the vessel and cargo.[2] This is the only action where the JTF functions in an operational sense, with control over those forces through its specified command and in some instances, direct control through an operational control (OPCON) arrangement. Not all specified commands delegate this authority. Forces Command operates JTF 6 in the southwest border region of the United States as an intelligence processing and coordination entity with no operational forces assigned for interdiction operations.[Ref. 5:p. 4-16]

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[2]The specific requirements for boarding and seizing cargo and craft, and the LEDET functioning aboard U.S. Navy ships is examined in detail in reference 10.

B. SUMMARY

This chapter defined the system-in-focus and its macro level interaction with the environment. The next chapter will examine the Process function as it relates to the detection and monitoring system requirements of the Counterdrug JTF. The Detect, Process and Disseminate functions are macro level elements detailing the level zero decomposition. The Process function will be decomposed for further detailing of the system-in-focus. This function maintains the flow of information processing and the decision making requirements that are the focus of this thesis. The first decomposition of the system-in-focus defines the environment within which the system operates and describes the two interactions between the environment and the system-in-focus. The counterdrug JTF as the system-in-focus interacts by receiving inputs from the environment. Based on the controls it must operate under and with the available resources it has, the JTF produces outputs that to meet its mission requirements.

C. ACTIVITY REPORT FOR: LEVEL ZERO DECOMPOSITION

[A0] Counterdrug Joint Task Force

Inputs: Processed Aggregate Sensor Input

Outputs: Operational Plans and Intelligence Reports on Identified drug Trafficking Tracks

Controls: Command Structures, DOD Guideline for Counterdrug Operations

Mechanisms: Resources, Human, Equipment, Information Processing Systems

III. THE DISAGGREGATION OF LEVEL ZERO: LEVEL ONE

The first specific decomposition of the detection and monitoring top level requirement develops the IDEF0 design relationships to examine their related decomposed elements. This decomposition illustrates the interaction of the system-in-focus with the environment. The decomposition will create scenarios that will generate output from the system-in-focus. The scenario described in the decomposition is the physical environment and the system structures that are unique to a specific requirement.

The interaction with the environment at the first level of decomposition is the input to the Detect Sub-function. The interaction at this first sub-function receives processed data and sends it through both human, hardware and software resources. These resources then disseminate the processed sensor data as an intelligence product to interdiction forces in the form of reports and orders.

Level one describes the entire system through the three elements: the Detect sub-function, the Process sub-function, and the Disseminate sub-function. This first decomposition level will be the last where the entire flow of data can be seen from input to output. At subsequent levels of decomposition, the level of detail increases. The internal functional architecture within a sub-function is hidden from previous levels of decomposition. This is crucial to tracing requirements facilitation.

Systems engineering extracts the specific requirements from the goals provided by higher authority. The first objective is to extract a mission that will accomplish the system's goals. These missions in the context of systems engineering must be within a frame of reference and the situational and geographical environment of the specific system. Systems engineering describes this situational and geographical environment as the scenario. The scenario description is meant to encompass aspects of the environment external to the system-in-focus that directly affect the system's desired outputs. The majority of these catalysts affect the system through controls and inputs. [Ref. 12:p. 15]

A. INTERACTION WITH THE ENVIRONMENT

1. Controls

The controls define the quality and the type of input that the system can process. The two controls addressed in this thesis at the level zero decomposition are mission guidance and the command structure. These controls generate specific requirements and limitations for the inputs. The mission guidance detailed in the level zero decomposition creates the specific environment within which the requirements must be accomplished. It also establishes the command structure of the counterdrug JTF.

Examining each guideline the DOD established to meet top level requirements generated in Chapter I creates a mission-scenario combination that will generate a sub-function. After an explanation of each specific guideline a table will provide a summary for each mission-scenario combination.

The first DOD guideline, building on existing capabilities and facilities, states that no new ground breaking is authorized either for doctrine or for location. DOD forces must continue operating in the same locations use established methodologies for detection, processing and disseminating intelligence products. These methodologies frame the scenario within which the Counterdrug JTF must operate, and delineate the requirements of sub-functions related to each decomposed element. Guideline 1 represents the Mission-Scenario combination generated by the existing capabilities guideline.

Guideline 1

Mission: Build on existing capabilities to conduct counterdrug operation within DOD capabilities.

Scenario: Under current operational contingencies, plan, coordinate and conduct counterdrug operations with existing forces and equipment while continuing wartime readiness training.

Guideline 2 illustrates employing DOD resources in away which supports and enhances traditional mission capability emphasizes the need to maintain the standards for war-fighting. Retraining personnel in roles that degrades their performance in the execution of a typical national defense mission to perform a counterdrug mission must be avoided.

Guideline 2

Mission: Maintain current levels of readiness while executing counterdrug operations.

Scenario: Conduct counterdrug operations so that they enhance the tasks in traditional national defense missions.

The modification and procurement of infrastructure and systems that are dedicated to unique anti-drug activities narrows the scope of the JTFs' mission. Guideline 3 ensures the development of systems in a counterdrug operation do not detract from any traditional missions the personnel and equipment are required to perform.

Guideline 3

Mission: Conduct counterdrug operations with current chain of command relationships.

Scenario: Within the established unified commands, conduct counterdrug operations under established command structures.

Guideline 4 expands upon previous DOD detection and monitoring efforts enhances the development of all systems previously involved in counterdrug operations to be evaluated and used. Implied is the use of systems from traditional national defense missions to enhance war fighting skills.

Guideline 4

Mission: Review existing detection and monitoring systems and develop those that enhance the counterdrug mission.

Scenario: Using assets previously employed in counterdrug operations, promote their use to enhance all detection and monitoring related DOD missions.

Guideline 5 develops a comprehensive detection and monitoring plan for the borders of the United States and is a direct mission guideline. This requirement is restricted by the previous guidelines.

Guideline 5

Mission: Establish a detection and monitoring plan for counterdrug operations for the border of the United States.

Scenario: Using current capabilities and infrastructure, detect drug trafficking operations along the border of the United States and disseminate targets to interdiction forces.

Guideline 6 evaluates existing DOD systems and programs to identify opportunities for enhancing detection and monitoring capabilities. This focuses on enhancing current traditional methodologies and systems through the efforts undertaken in counterdrug operations.

Guideline 6

Mission: Evaluate current detection and monitoring systems for benefits to the national defense missions and counterdrug operations.

Scenario: Review all detection and monitoring operations within the regional command areas and evaluate their benefits for countedrug operations.

The coordination of all detection and monitoring activities places the burden on DOD to maintain communications networks necessary to ensure connectivity between DOD and DLEAs. What is implied is a degree of control by DOD resources over other agencies in the execution of coordinating operations, which does not exist. This guideline cannot be developed into a mission-scenario combination because of its dysfunctional premise.

These guidelines have generated mission-scenario combinations that define the functional requirements of the system-in-focus. These are the specific controls on the detection and monitoring process.

2. Inputs

a. Multiple Source Processed Sensor Data.

The Counterdrug JTF receives data at a level of processing that relieves the JTF of the necessity to have direct sensor data processors and control the operations of the sensors. The types of data, HUMINT, COMINT, ELINT, and IMINT, as well as open source information (newspapers, books, CNN, etc.) are filtered by the agencies operating with the JTF. These agencies process data which their JTF liaisons assist in correlating and assessing to determine current operational value. These liaisons and their relationships will be discussed in detail under resource input to the subsystem. The cyclic request process for information and the access to DLEA databases is a function of the liaison as they request data based on ongoing operations.

b. Specific Data Requirement Inputs.

Specific data requirements to access JTF databases and on-line systems represent specifications necessary for system input. The systems engineer attempts to identify the layers of detail necessary to develop these specific requirements. The following sub-functional requirements generate the investigation of each as required functions and activities that must be accomplished to facilitate their previous level of decomposition. This ensures that each activity does not overlap into another sub-function in the system-in-focus.

c. Key Word Search and Recognition Requirements.

Incoming message traffic from multiple agencies in a multi-level-security environment generates the need to rapidly distinguish data of importance to the specific JTF. To start the process of collating related data a key word search and recognition requirement is required. This requirement begins to identify data that has been designated by the JTF as related to ongoing operations. A further level of detail is presented to identify areas of requirements necessary to facilitate decomposition.

(1) Related Sub-requirements:

1. Incoming maximum data traffic capability;
2. Speed of Hardware processing systems;
3. Maximum number of keyword recognition triggers;
4. Multiple Level Secure channels for input and output of information.

(2) Database Requirements

1. Relational Database and database management system that allows multiple input and multiple output based on sensitivity of data.

2. Data analysis tools and expert systems that collate related data to a predetermined level of accuracy based on the operational requirements of each data package.

d. Imagery Directly Related to Second Sources

The requirement to cross cue incoming imagery with a local database to verify and update the JTF database with relates to the Correlate and Process sub-functions. This requirement combined with the textual data received on the key word recognition system combine to focus and collate the data into operational and intelligence data packages.

e. Security and Sanitization for Further Processing

Law enforcement agencies do not have the required facilities to process special compartmented information (SCI) DOD classification level data received from DOD intelligence sources. The JTF must protect the source of its intelligence gathering systems by sanitizing data received from sensitive sources. The DLEAs also consider their sources of intelligence perishable and must guard against unnecessary exposure to other agencies not directly related to the specific data package being developed.

f. Communications and Network Requirements

Requirements for a multiple level internal secure network for internal transmission of data, and for the dissemination of classified material to external agencies and interdiction forces is generated to facilitate information processing.

(1) Wide Area Network requirements established with DOD through the Defense Data Network (DDN). The Defense Secure Network (DSNET) 1 operates on the General Service (GENSER) level for transmitting data at this classification. ADNET is the specific network in DSNET 1 that the DLEAs use for voice and data traffic for counterdrug data Ref. 13:p. 27]. The JTF operates at the secret and higher levels of classification with other DOD agencies for voice and data traffic on DSNET 2 and DSNET 3[Ref.1 3:p. 17].

(2) Resource Requirements: The resources act to accomplish the desired activity internal to the subfunction being decomposed. These resources can be considered the mechanisms that do the work on the inputs. These mechanisms can be both equipment and personnel. Together these mechanisms sort data and merge it into useable information that will assist in ongoing operations. These data packages are crucial for further operations that require decision making based on analysis of the inputs. The input requirements arrange the data into cohesive groups of information that must be matched to present activities and previously collected and processed data.

3. Resources

The automated information processing systems employed by the personnel that process the data and the liaison personnel are the primary resources of the system. The detailed decomposition of the tasks of the personnel and the functions of the equipment is the basis for the third level of decomposition discussed in Chapter V.

4. Outputs

Requirements for processed, analyzed intelligence on a track that can be used for current operations and disseminated to DLEA for database update and further analysis represent the output of the process subfunction. Using the networks currently in place for dissemination, the capacity for exporting information must be to a level capable of being received by the DLEAs. Transmission of imagery related products is necessary to accomplish this subfunction requirement.

A standard format across all agencies transmitting counterdrug data must be implemented for the transmission of information. This reduces errors from incorrect information processing and redundant requests for information because of incompatible or unknown data formats.

Established guidelines for all DOD and DLEAs for timeliness of dissemination and priority of dissemination based on threat analysis, is key to ensuring rapid transmission of critical intelligence for interdiction purposes. This is accomplished by a transmission priority and labeling format that automatically designates and orders data traffic based on its level of precedence.

Figure 7 illustrates the level one decomposition and its interactions with the environment. Figure 8 is a detailed decomposition of level one to demonstrate the interaction of the resources and the generated output of the system. Figure 9 previews the next level of decomposition and illustrates the relationship between the different levels.

B. SUMMARY

This chapter establishes mission-scenario combinations that generates requirements for the sub-functions identified at this level of decomposition. These sub-functions in turn generate detailed sub-functions that further work to define the system-in-focus. Each level of decomposition focuses on a specific aspect, rather than trying to show the entire system and all its related sub-functions. By focusing on one sub-function at each layer of decomposition, the specific requirements of detection and monitoring established at level zero are traced to the lowest level disaggregation. At this simplified level the engineer starts to build systems that will accomplish each sub-functional requirement. Because of this simplified level, the interaction of the subfunctions and their inter-relationships are programmed into the system design, rather than having to be retroactively installed at a later time.

C. ACTIVITY REPORT FOR: LEVEL ONE DECOMPOSITION

[A0] Counterdrug Joint Task Force

Inputs: Processed Aggregate Sensor Input

Outputs: Operational Plans and Intelligence Reports on Identified drug Trafficking Tracks

Controls: Command Structures, DOD Guideline for Counterdrug Operations

Mechanisms: Resources, Human, Equipment, Information Processing Systems

[A10] Detect

Inputs: Multiple Processed Sensor and Data Input

Outputs: Established Track Identification

Controls: Specified Command, Top Level Warfare Requirements

Mechanisms: Multi Agency Sensors, Data Collection Access

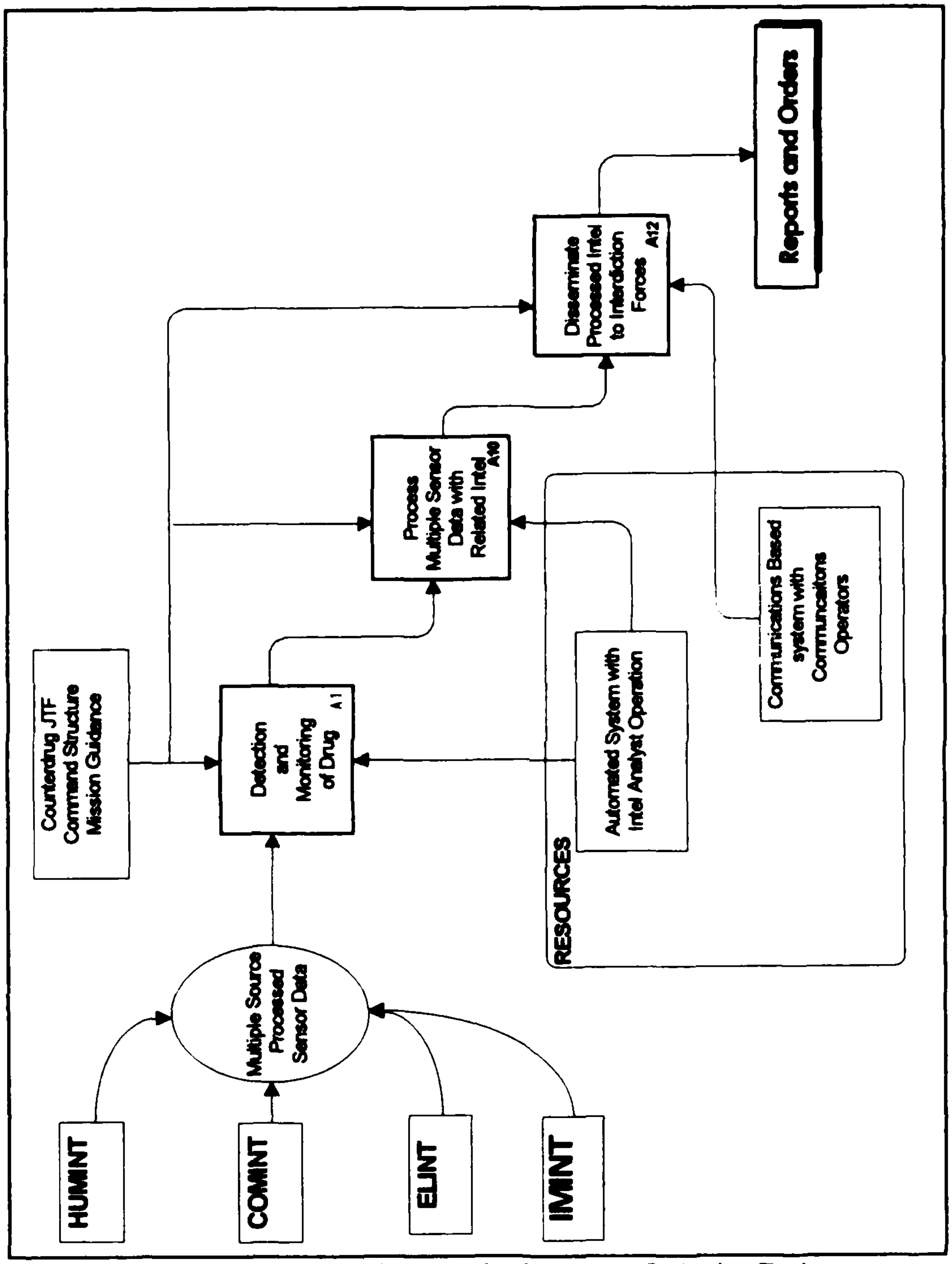

Figure 7: Level One Interaction with the CD Sensor Collection Environment

[A11] Process

Inputs: Established Track Identification Established

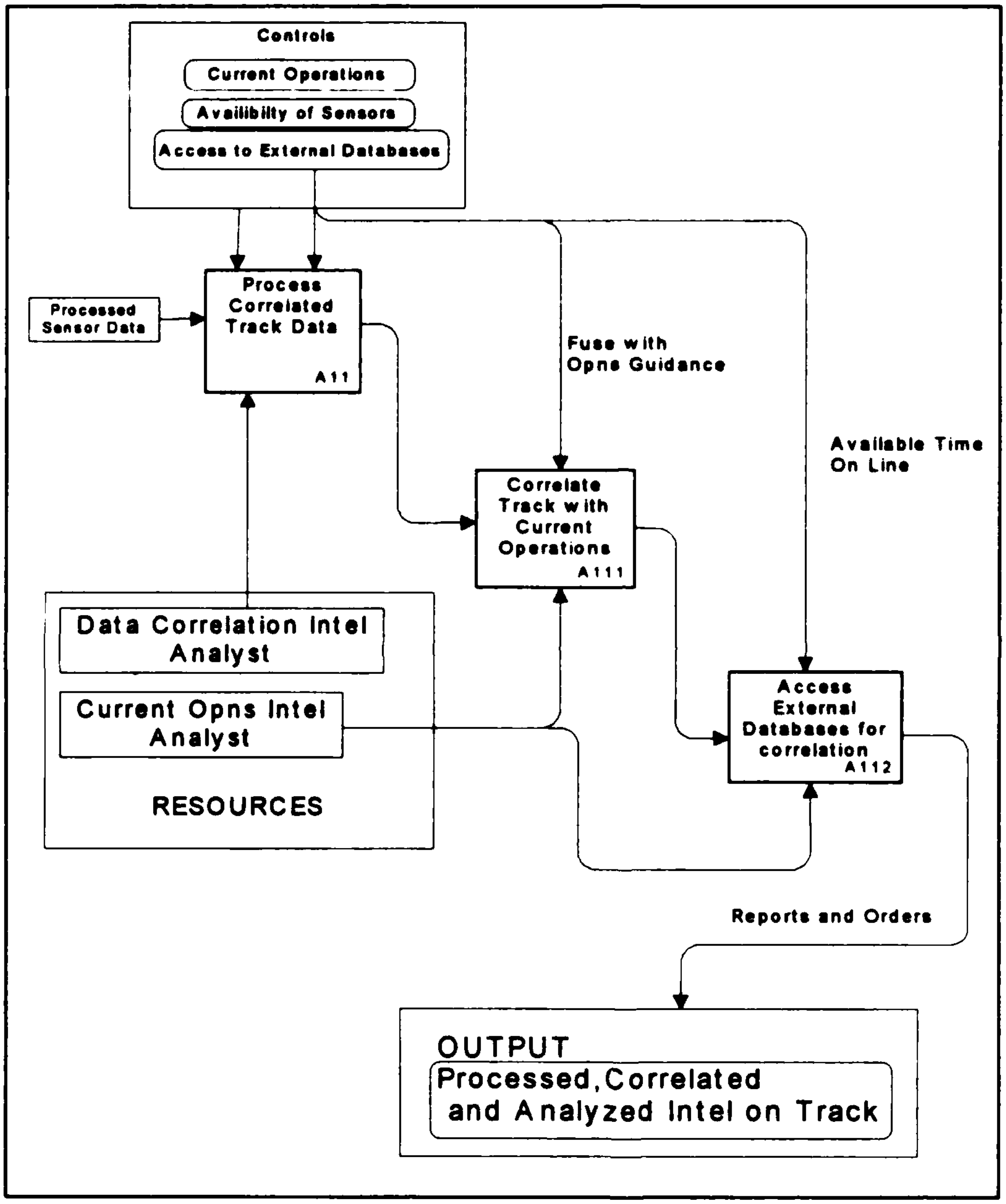

Figure 8:Level One Detail

Outputs: Correlated Track Information with Ongoing Interdiction Operations

Controls: Mission Guidance and Current Operational guidelines

Mechanisms: Information processing systems and Decision Support Systems resources internal to the Counterdrug JTF

[A12] Disseminate

Inputs: Correlated Track Information with Ongoing Interdiction Operations

Outputs: C3I Information and Action in the form of Intelligence Reports and Interdiction Orders

Controls: Levels of Security and Ability to Establish Multi-Agency Sensor Data Report Formats.

Mechanisms: Dedicated Communications Systems to support the reception and transmission of voice and data traffic

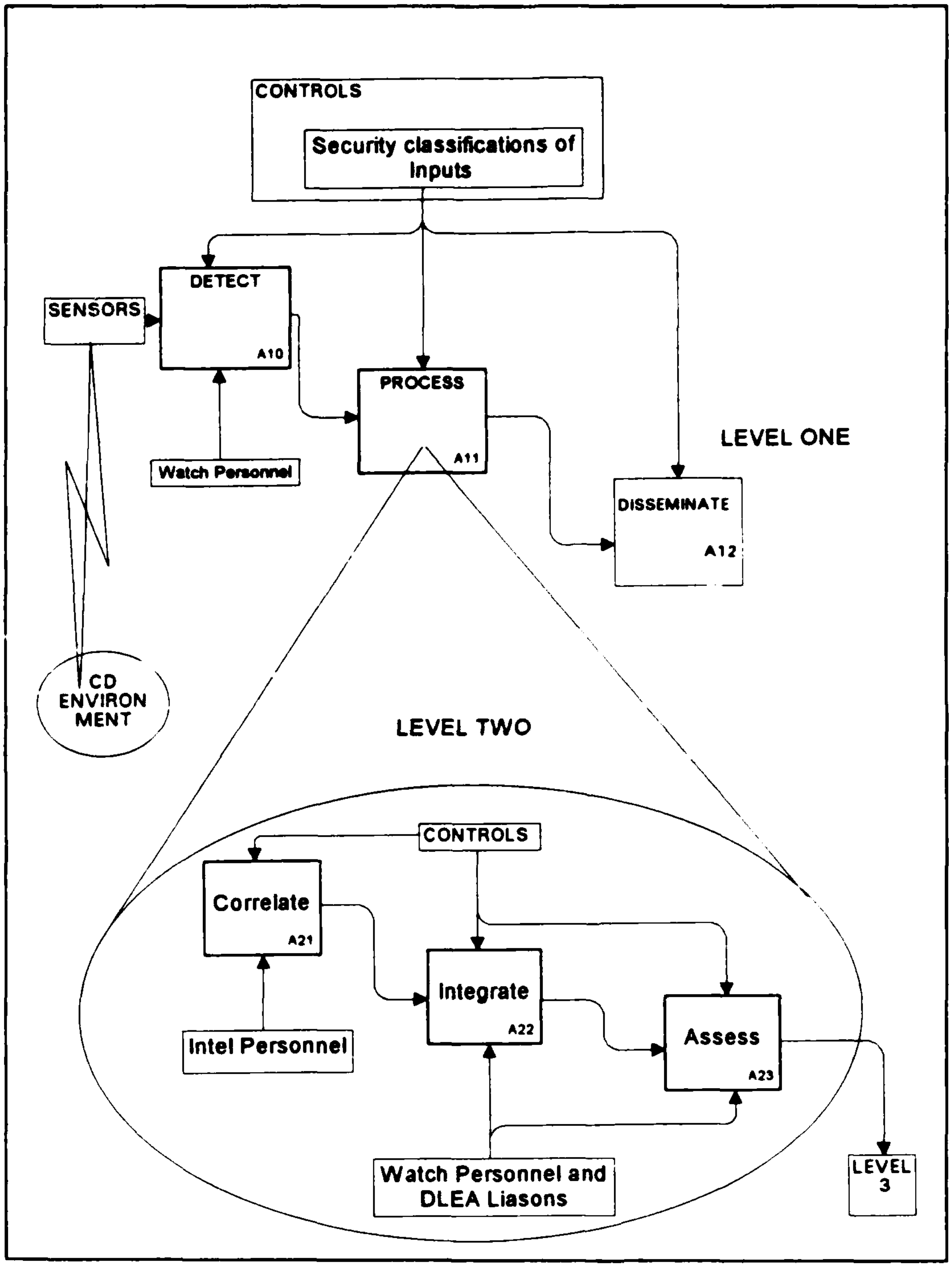

Figure 9: Level Two Preview

IV. SECOND LEVEL DECOMPOSITION: INTEGRATION OF PROCESSED DATA INTO CURRENT OPERATIONS

Integration of the processed data at this level in the functional architecture incorporates the human decision making process and the interaction of this process with a physical environment. The mechanisms internal to the system-in-focus operate in this environment to accomplish their functional requirements. The previous two levels of decomposition, level zero and level one, were more abstract in nature due to their wider scope. Their purpose was to show the context and broad functioning of the Counterdrug JTF as a system-in-focus and how the JTF interacts with its environment.

The requirement to develop intelligence products and operational orders are the substantive output of detection and monitoring for the counterdrug JTF. The generation of this output meets the requirements established in the DOD guidelines to support the interdiction forces. The Correlate Sub-function is responsible for establishing threads of continuity from the incoming data. This continuity ensures effective correlation with other relevant data specific to a targeted vessel, area of concern, specific drug trafficker or any pre-defined subject of analysis. The resources of this sub-function generate the requirement for hardware and software that accomplishes the Correlate sub-function. The Integrate sub-function defines the parameters for the Correlate sub-function by determining the amount of data that can be integrated into the system. The data leaves the Correlate sub-function formatted in such a way that can be manipulated by the Integrate sub-function to pair it to ongoing operations. The Integrate sub-function also combines the current database for intelligence gathering missions and to generate a request for further related data. The output of the Integrate sub-function is compartmentalized data and the request for further related data. The Assess sub-function takes this data and establishes its sensitivity to current operations. If the data meets the established criteria it is time-tagged and forwarded to interdiction forces. This data is also prioritized based on threat analysis characteristics as it is stored in the database.

These three sub-functions exist within the process function that sends intelligence products and orders to interdiction forces via the Disseminate function. A key to understanding functional architectures is to maintain the link with the parent-child relationship within functions. In IDEF0 terminology, the child sub-function retains all the characteristics of its parent as well as having unique characteristics of *its own*. These unique characteristics accomplish specific sub-requirements generated by the parent function. This design characteristic ensures that no child sub-function operates in an independent environment, exclusive of its parent. This enhances information hiding and promotes low levels of functional coupling. Figure 10 shows the IDEF0 diagram of the two sub-functions.

A. THE CORRELATE SUB-FUNCTION

1. Controls

Addressing the sub-functional requirements to accomplish the Correlate sub-function demonstrates the level of detail needed in the processing of incoming data to achieve an output that will support the process of detection and monitoring.

2. Inputs

The sources of data as seen from Figure 5 in Chapter III must be sent in a format that can be readily absorbed into the decision making process. The correlation subfunction must be able to associate the incoming data to a dynamic track model or be associated with a profile to fit into the database at a certain priority level. The controls for the correlation subfunction are generated by the mission guidance that determine the ongoing interdiction operations. These mission parameters design the filters for the key word search and imagery identification systems to screen the information processing systems. Although specific sensor management is conducted by the sensor's controlling agency, the JTF requests additional data to build the track model. Once the track model fits the interdiction criteria it is placed in a queue. The queue constantly feeds the data association portion of the correlation subfunction, identifying incoming data that will be added to the track model. If additional data enhances the model, it advances in the queue.

3. Resources

The incoming message handling capability of the JTF processes the messages from their baseline format and sends it through data association. The incoming imagery capability of the JTF is also a function of the data association process. These two systems within data association merge to build the track's specific drug trafficking characteristics. Once the model reaches a state that it can be determined to be within the interdiction criteria, the track is sent into the queue.

4. Outputs

The track queue is the first track management process. The first detailed examination of track management occurs at this level of decomposition, but is developed in the level three decomposition of the data fusion sub-function. Internal data flow requirements establish specific routing of the track model through the physical environment. The path for textual data and the path for imagery data merge in the Correlate sub-function. Security requirements for correlating data from different levels into one intelligence package complicate the data association. Data at the highest level of security limits its distribution due to restricted transmission requirements. SCI sanitized to GENSER level for DLEA distribution may omit the source of data, inhibiting the request for additional related data. To promote direct (and subsequently minimizing) coupling of functions the mechanisms developing the track model review and generate additional requests for data based on its position in the queue.

Data sources and requests for data requirements generated by the mechanism operating on the incoming data access DOD and DLEA databases while building the

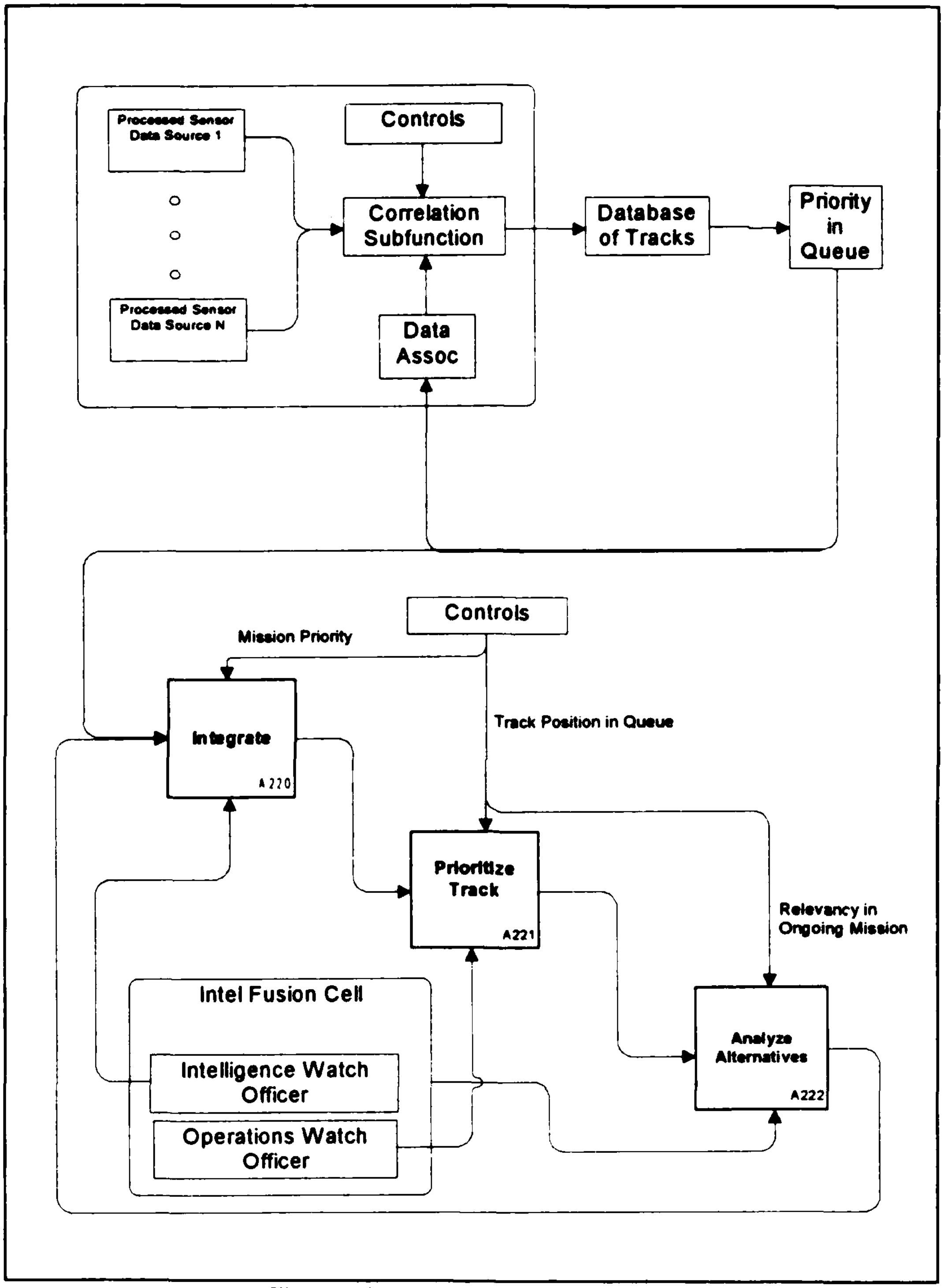

Figure 10: Level Two Decomposition

track model. These databases have been established to allow for the exchange of information within the Counterdrug environment. The El Paso Intelligence Center (EPIC) has the capability to allow a current operations request to access its national archives for counterdrug operations. EPIC can also access eight other federal agency databases for cross referencing of material via on-line file sharing systems.[Ref.11]

Other ADNET Counterdrug databases are regionally focused, containing information collected in specific geographic areas under DLEA control. Examples of these regional databases are the Rocky Mountain Information Network (RMIN), the Western States Information Network (WSIN), and Operation Alliance, a large DLEA intelligence and operations effort of the southwest border states. The Regional Intelligence Sharing System (RISS), consists of seven law enforcement intelligence programs operating in all fifty states. Six of these programs are specifically focused on obtaining and distributing criminal intelligence.[Ref. 5:p. 3-5]

B. DATA INTEGRATION

1. Controls

The size (capacity) of the transmission (receive and send) is based upon the command relationships external to the JTF. The command relationship influences the ability to request the generation of specific sensor data. Flow of information also is a function of the command relationships internal and external to the JTF. Internal to the JTF is the infrastructure of the intelligence fusion cell. The interaction between the intelligence watch officer and the operations watch officer in the physical environment

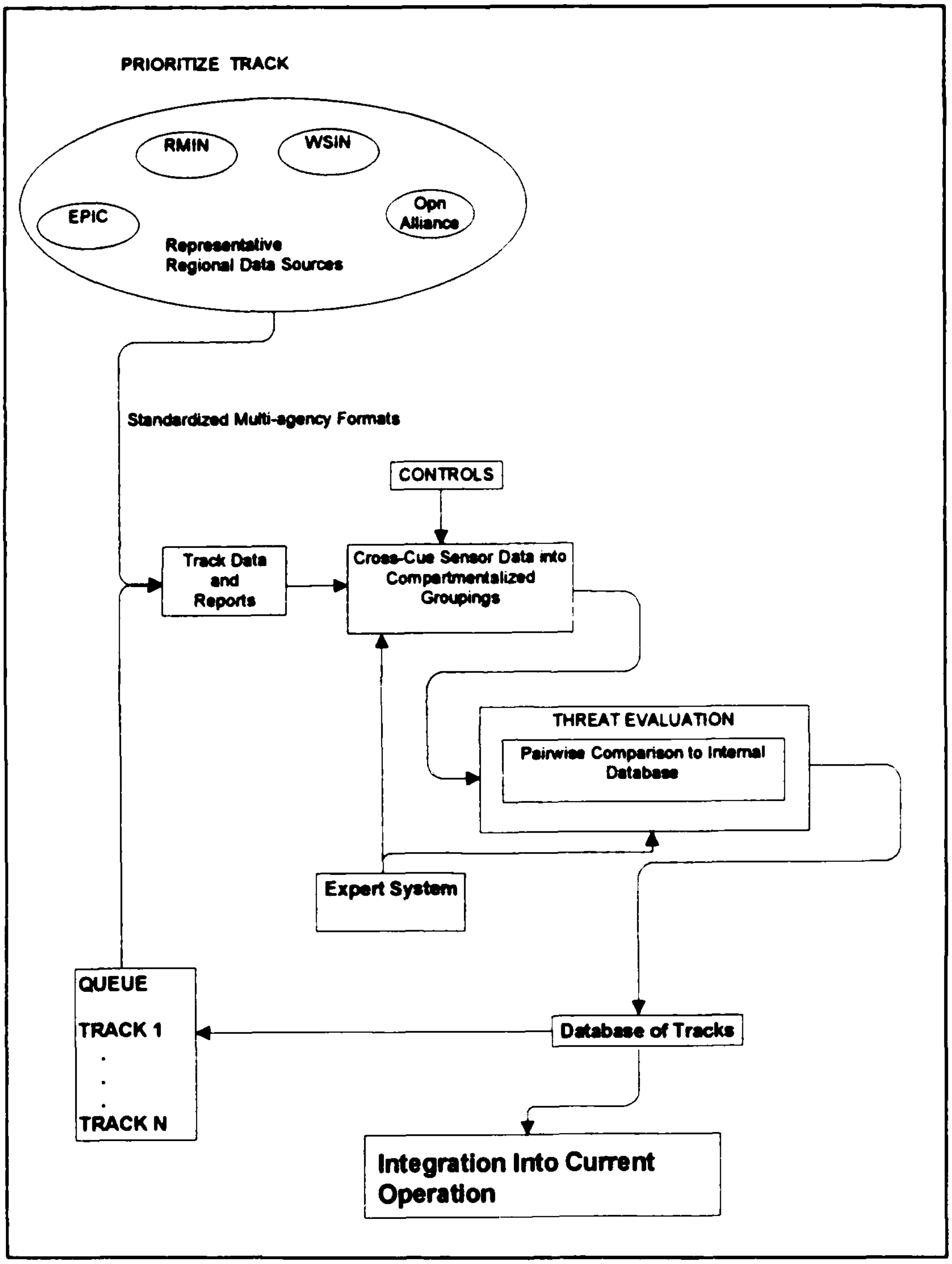

Figure 11: Level Two Detailed IDEF of Track Priority Sub-function

of the data fusion cell controls the mechanisms that integrate the track model into the current interdiction operations.

The ability to visually cross reference both message text and imagery data simultaneously is a sub-requirement generated from the controls placed upon the Integrate sub-function. Mission guidance and the chain of command structure create a physical control on the geographic area of focus. This mission guidance directs operational planning and the request for sensor data. Generation of unique or additional data collection is not authorized based on DOD guidance. Access to systems available must be timely, with an abbreviated chain of command involvement. Request access must be generated from the intelligence fusion cell and the J2 Intelligence Processing Staff.

2. Input from Correlation

The Prioritize track sub-function takes the track data and reports received in *standardized multi-agency format*. The Dynamic Track Model contains all current information on specific track with the most updated by current sensor data as it returns from the queue. This data is cross-cued and then set into compartmentalized groupings. The threat evaluation is accomplished through a pair-wise comparison of the track model's data with the interdiction criteria. The queue orders and returns data based on time received, as well as the characteristics of the specific track.

3. Resources

The cross-cuing and threat evaluation of data is accomplished using an expert system. The purpose of an expert system is to make decisions about a large amount of data over a narrow scope of knowledge.[Ref. 14:p. 432] An expert system is an automated problem solver working in a narrow field of human-based knowledge referred to as a domain. The expert system must be designed using a human expert in this narrow field. Techniques for developing the expert system to be used for data association and threat evaluation can be found in Turban's text, *Decision Support and Expert Systems*[Ref.14]. An expert system pairs incoming data with the established model framework, decides if it fits the interdiction guidelines, and then prioritizes the track by its threat status. The key to using an expert system rather than a simple information processing device is the need to be able to make a value judgement on the level of threat. This judgement is based on the timeliness, source, and repetition of the data. Repetition refers to how many times the track characteristic has been reported to the system from one or more sources.[3]

The mechanisms that perform the function of prioritizing the track also initiate the integration of the specific track into an ongoing interdiction operation. This is the result of the mission guidance and the pairing of the data to establish a track. This track changes as it is updated by sensor input.

4. Output

Integration into current operation establish an intelligence and operational overlay for export to the interdiction forces. These overlays are the output of the

[3] A basic discussion of the operation of the expert system involved is needed to define tasks between the mechanisms that support the specific sub-functional requirement. It is beyond the scope of this thesis to develop the knowledge acquisition subsystem and knowledge base for a counterdrug data association expert system.

Integrate sub-function. Analyze alternatives combines the expert system output with a human decision maker to begin a decision cycle based on the controls to the sub-function. Making an assessment, (Assess sub-function) of track bearing on current operations determines the route of the track. This track is part of an overlay that supports the current operation.

C. SUMMARY

This chapter describes the level of decomposition that interacts with the human decision making cycle. The next level of decomposition will describe in greater detail the decision process involved in physically incorporating the specific track into a current operational. This overlay will generate a decision cycle in the current operation concerning analyzing mission alternatives. Figure 12 previews the decomposition of the Integrate sub-function to demonstrate the internal sub-function of data fusion, the core requirement of detection and monitoring.

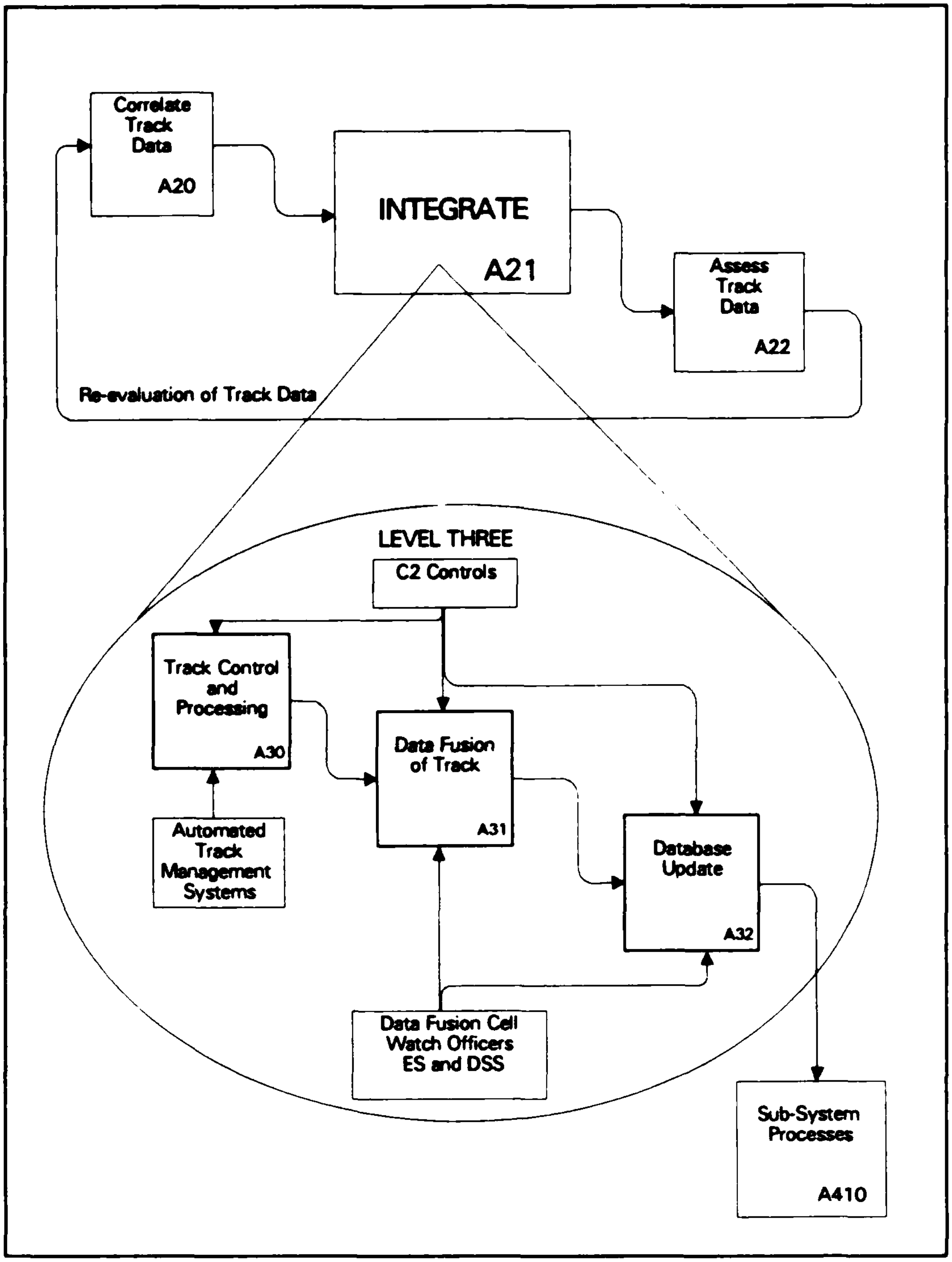

Figure 12: Level Three Preview

D. ACTIVITY REPORT FOR: LEVEL TWO DECOMPOSITION

[A11] Process Track with Current Operations

Inputs: Established Track Identification and Current Interdiction Operations Profile

Outputs: Track Relayed to Interdiction Forces in the Form of an Intelligence report, or Sent to Intelligence Database

Controls: Mission Guidance Fuzed Intelligence Data

Mechanisms: J2 Staff Intelligence Analyst, Supported by DLEA Liaison input

[A20] Correlate Track with Current Operations

Inputs: Established Track Identification and Current Interdiction Operations Profile

Outputs: Track Relayed to Interdiction Forces in the Form of an Intelligence report, or Sent to Intelligence Database

Controls: Mission Guidance Fuzed Intelligence Data

Mechanisms: J2 Staff Intelligence Analyst, Supported by DLEA Liaison input

[A21] Integrate External Databases for Correlation

Inputs: Correlated Track Information with Ongoing Interdiction Operations and Intelligence Report for Database

Outputs: Processed, Correlated and Analyzed Intelligence on Track delivered to interdiction forces or Stored in Internal JTF Database

Controls: Mission Priority Established By Higher Authority

Mechanisms: Information processing systems and Decision Support Systems resources internal to the Counterdrug JTF

[A22] Assess Track Characteristics with Current Operations

Inputs: Established Track Identification and Current Interdiction Operations Profile

Outputs: Track Relayed to Interdiction Forces in the Form of an Intelligence report, or Sent to Intelligence Database

Controls: Mission Guidance Fuzed Intelligence Data

Mechanisms: Watch Intelligence Officer

Activity Report for: Level Two Detailed Decomposition

[A21] Integrate External Databases for Correlation

Inputs: Correlated Track Information with Ongoing Interdiction Operations and Intelligence Report for Database

Outputs: Processed, Correlated and Analyzed Intelligence on Track delivered to interdiction forces or Stored in Internal JTF Database

Controls: Mission Priority Established By Higher Authority

Mechanisms: Information processing systems and Decision Support Systems resources internal to the Counterdrug JTF

[A221] Prioritize Track

Inputs: Multiple Sensor Data Correlated to Related Track Established to be Involved in Current Interdiction Operations

Outputs: Place In Hierarchy for Analysis of Alternatives

Controls: Track Position in Queue and dynamic Track Model Status

Mechanisms: Hardware Resources Internal to the Intelligence Fusion Cell Based on Established Decision Rules (Interdiction Criteria) for Ordering Track In Queue

[A222] Analyze Alternatives

Inputs: Position In Intelligence Fusion Cell Hierarchy for Decision Analysis

Outputs: Chosen Course of Action for Track Data (Transmission to Interdiction Force, Request for Additional data from External Sources, or Database storage)

Controls: Relevancy in Ongoing Mission

Mechanisms: Operations Watch Officer Analysis and Repositioning Based on Decision Making Process Using Expert System and Decision Support Systems

V. THIRD LEVEL DECOMPOSITION: DATA FUSION

This chapter completes the design of the functional architecture of the Counterdrug JTF Detection and Monitoring mission by describing the data fusion process. This process is described by Waltz and Buede as :

> The core function of data fusion is the process of combining collected sensor data on a single target to infer its identity and even higher attributes (e.g., intent, future behavior, and threat capability).[Ref 15: p. 403]

The fusion of the data in the decision support cycle captures the specific tasks of the data fusion cell. The interaction between man and machine defines the tasks necessary for both to meet the TLSRs. This interaction also delineates specific requirements accomplished in an Expert System and Decision Support environment.

The decomposition of the data fusion function initiates with a description of the track control process and the track management sub-function (See Figure 13). The data fusion process will be decomposed by demonstrating the subsystems inherent to the process. The command and control sub-system, the production work flow sub-system, and the maintenance sub-system each perform specific task to process the track (See Appendix B). These sub-systems are integral to the data fusion process and must perform their specific functions for the parent function to meet its top-level-systems-requirements.

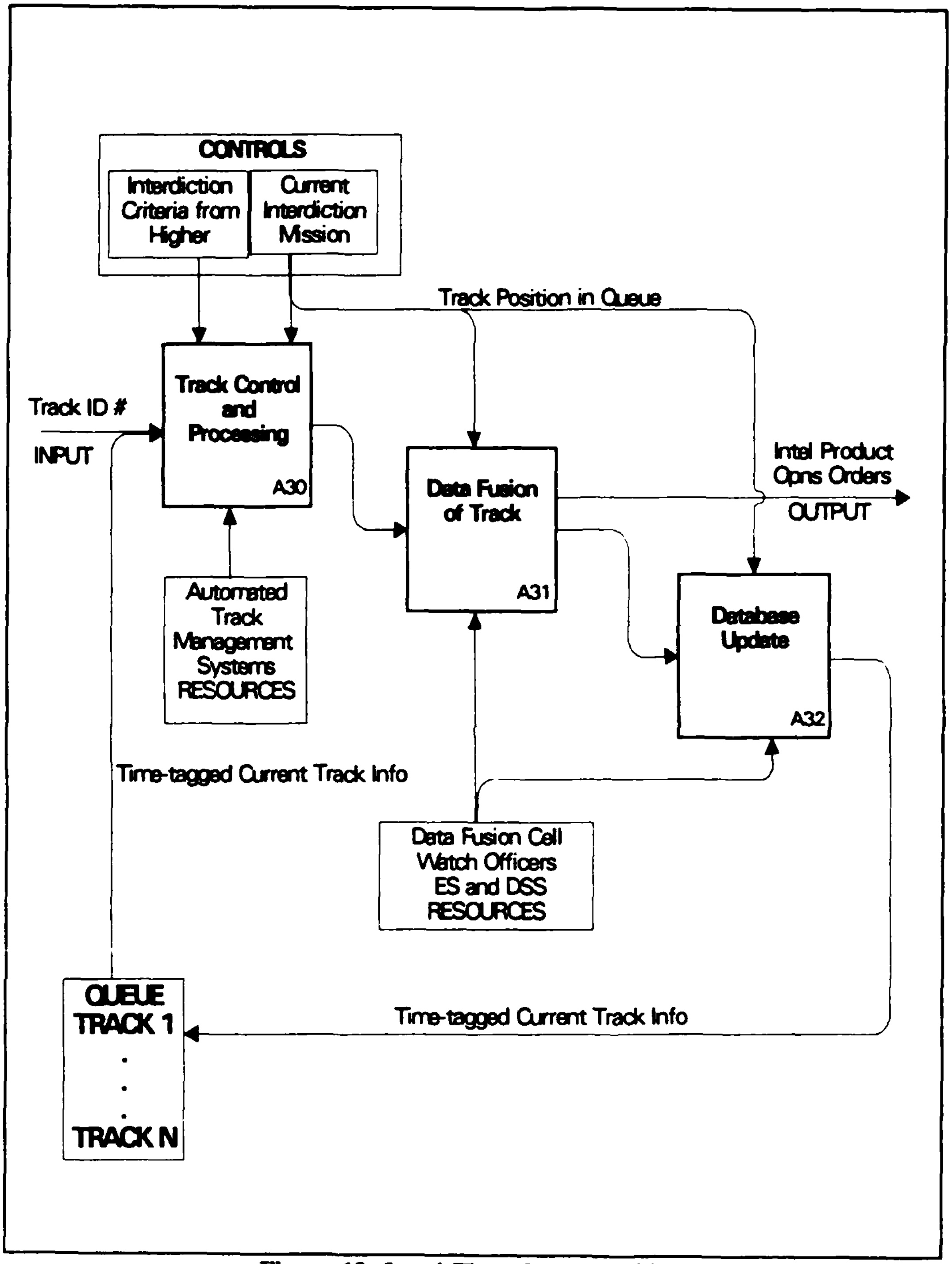

Figure 13: Level Three Decomposition

By distinguishing the three sub-systems the systems engineer demonstrates inter-relationships of the system and how they work together to accomplish the specified tasks of the system.

A. CONTROLS

The fusion of the track takes place based on its relative position in the queue. This position is a function of its threat level derived from the data association activity of the Correlation sub-function. The interdiction criteria and guidance from higher is imperative to restate because it is a variable that directly effects the unique track's position in the queue. Specific mission parameters generate requests to supply interdiction forces with timely information. A degradation of timeliness will occur based on the processing of the sensor data by the sensor's host. A standard from DOD guidelines established to define the priority of incoming sensor data will allow a time-tagging system to prioritize incoming data traffic.

B. INPUTS TO DATA FUSION

The automated track management system is the mechanism for processing the track identification with the internal database. This mechanism provides the input to the data fusion process. The track control and processing system monitors the cyclic decision process to incorporate new information from the Correlation sub-function. The data fusion process receives updated track information associated with the track.

C. RESOURCES: THE USE OF AN EXPERT SYSTEM

1. The Amount of Information

The amount of information available and ability to process it remains a difficult task at all levels of decision making. Within the Counterdrug JTF the process is complicated by the technologies that allow for more data to be brought into the JTF that can be processed efficiently by personnel. The nature of the information, coming from different sources and having no specific triggers that separate more important data from routine are two more factors that lead to the use of an expert system. A brief discussion of expert systems (ES) and decision support systems (DSS) and their functions within the data fusion process is necessary. A complete examination of the definitions, requirements and building of specific ES and DSS can be found in references eight and nine. An ES replaces human judgement in a narrow domain of information by using a well-defined and thoroughly established knowledge base. This knowledge base generates the decisions in lieu of human judgement. This ES does not simply forward messages based on certain words or phrases in received text. It has the ability to assess the value of the information, weigh it against pre-established criteria in its knowledge base, and come to a conclusion about the data. This conclusion leads to the decision. The ES also retains the ability to explain the reasons for its conclusions about the data. This function of the ES allows human decision makers to review and revise the ES as necessary. Non-expert personnel working in the data fusion cell can learn from the ES by examining this reason function.

2. What an ES Cannot Do

The shortfalls of the ES are based on the expertise and knowledge transfer to the machine within the narrow domain. The narrow domain for the counterdrug JTF for data fusion would be international laws and treaties between the United States and other countries concerning laws of interdiction. The domain would also include specific interdiction guidelines used by federal agencies. The knowledge domain will also include the DOD guidelines for detection and monitoring operations. These requirements in the knowledge base would not be to decide on interdiction, but to insure the incoming data meets all the requirements for that decision to be made. This level of decomposition focuses on the fusion of incoming data from multiple sources into a useable intelligence product that can be disseminated to interdiction forces. This information once collated into a useable product will be the basis for the chain of command and the operations personnel to make the decision. [Ref. 14:pp. 437-441]

3. The Use of a Decision Support System

The difference between a Decision Support System (DSS) and an ES is the DSS provides the decision maker alternative courses of action given the parameters it was established to interpret. The ES makes decisions based on a narrowly defined knowledge base while the DSS is designed to assist the decision maker by simplifying or reducing procedures to make decisions. The DSS performs as a tool to streamline the decision making process. Andrew P. Sage describes a DSS as:

> ...a system that supports technological and managerial decision making by assisting in the organization of knowledge about ill-structured, semi-structured or unstructured issues [Ref. 16:p. 1].

A structured problem is one regularly occurring,or has a well-defined framework for solving based on previous information. The environment the Counterdrug JTF operates within facilitates the use of a DSS.

The primary components of a DSS are the database management system (DBMS), the model base management system (MBMS) and the dialog generation and management system (DGMS). The DBMS primarily controls all manipulations on the database, insuring that any action does not disrupt or change any data. It manages large quantities of data in physical storage and works to reduce physical redundancy within the database. The MBMS functions to transform the data from the DBMS into information that is useful for decision making [Ref. 14:p. 81]. The DGMS is the facilitator between system user and the MBMS. Its purpose is to provide physical sensory interface to the user of the data processed [Ref. 14:P. 131]. This interface can occur in a variety of ways commonly termed interaction language. The focus for this thesis will be the graphical and textual display between the system user (the data fusion cell watch personnel) and the DSS. This system must provide the user with a graphical display of a geographic area of responsibility unique to the specific JTF, the track identification number, and the ability to access the track history. This track history in the database can be used to develop courses of action in the DSS to establish possible future behavior and intent of the track[4].

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[4] The complete development of ES and DSS requirements to facilitate the data fusion process is beyond the scope of this thesis and warrants a thesis for each.

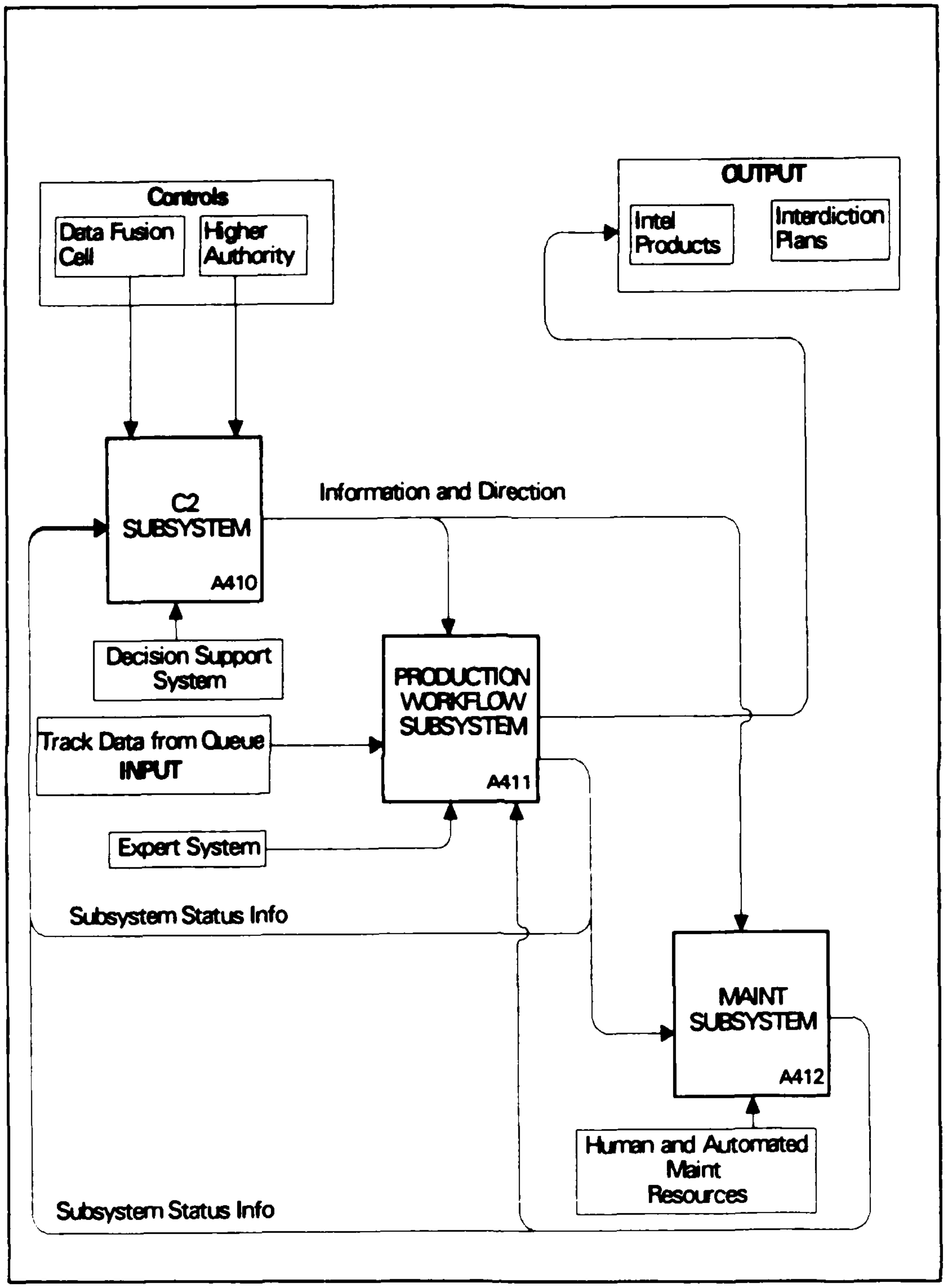

Figure 14: Data Fusion Sub-System Operations

D. OUTPUTS

The output of the data fusion process is the product of the Intelligence watch officer, the operations watch officer and the systems they use. These outputs are summarized in Table VII. This matrix describes the tasks to be performed along the horizontal axis and the personnel or equipment that performs it along the vertical axis.

E. DATA FUSION SUB-SYSTEM OPERATIONS.

At this level of decomposition an analysis of the interaction of the systems within the Data Fusion function demonstrates the necessary coupling of systems to accomplish the functional requirements. Command and Control, Production-Work Flow and Maintenance Sub-systems all work internally to the function to accomplish its requirements. Figure 14 demonstrates the interaction of these sub-systems within the Data Fusion Function. The Activity Report generated by the IDEF0 design defines in detail the inputs, outputs, controls and mechanisms acting on each system.

1. The Command and Control Sub-System

Figure 15 illustrates the command and control (C^2) sub-system within the data fusion function. The purpose of the C^2 sub-system is to provide direction and guidance to the production work flow sub system and the maintenance sub-system. This direction and guidance is framed by the controls on the function. The direction and guidance applies to actions within the system. Examples would be to direct the production-work flow sub-system to focus on a particular track for data fusion.

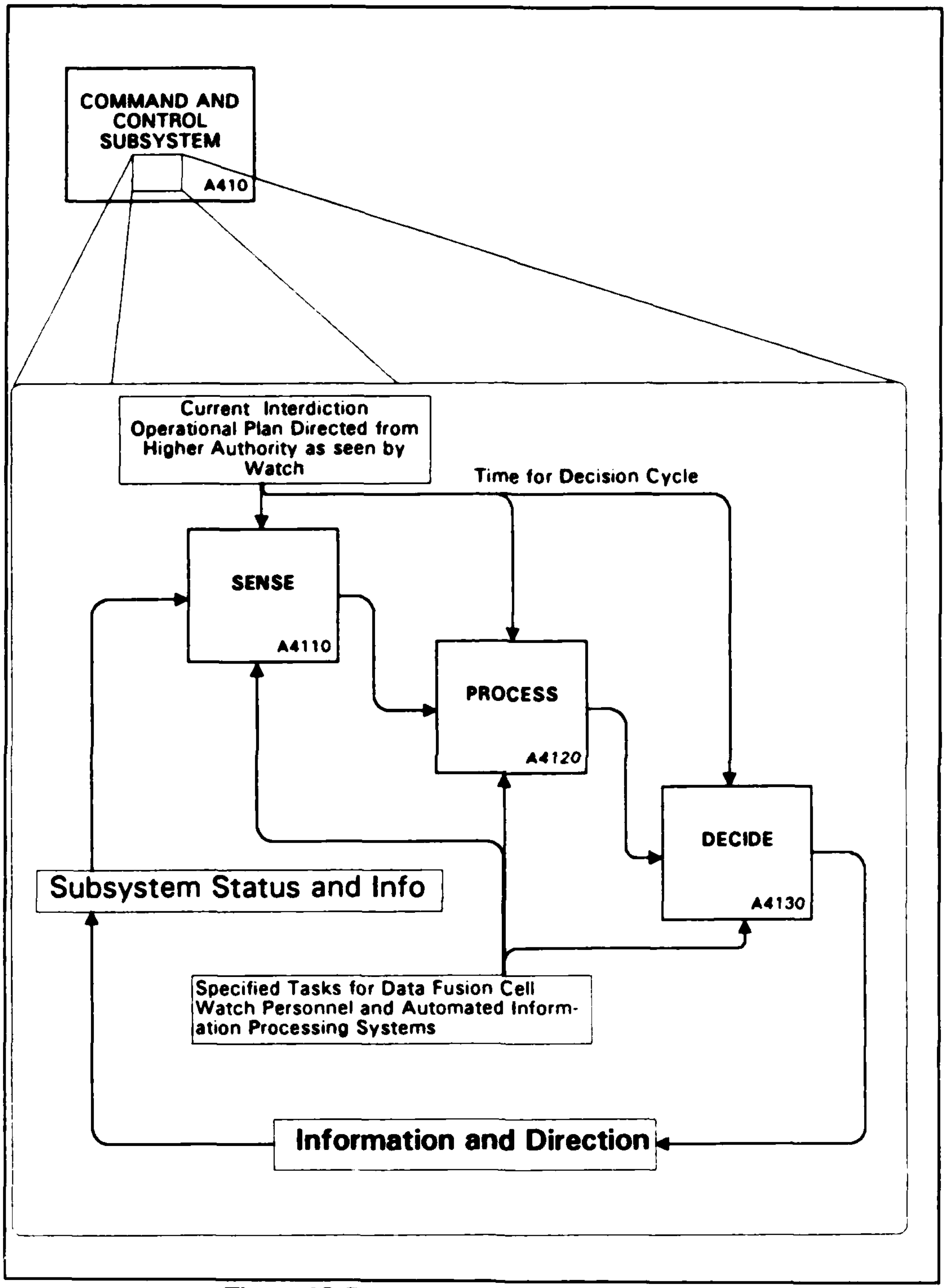

Figure 15: Command and Control Sub-System

The C^2 sub-system receives sub-system status and information from the other sub-systems and monitors changes in the environment that would effect the system.

a. The C^2 sub-system senses the change from the information received as inputs from the sub-systems.

b. The C^2 sub-system processes this change framed by its controls, using the mechanisms of the data fusion cell.

c. The C^2 sub-system decides on how it will redirect the production work flow and updates its data base with this information.

2. The Production Work-Flow Sub-System

Figure 16 illustrates the interactions of the production work flow sub-system. In the data fusion function, it is the production work flow sub-system that acts on the collected sensor data. Using the resources organic to the function, the production work flow increases or decreases its activity level to accomplish its system requirements.

a. The production work flow sub-system senses the change by receiving the track data from the queue and framing it in terms of the C^2 sub-systems direction and guidance.

b. The production work flow sub-system processes the track data using the knowledge base of the expert system, updates the data, confirms the interdiction criteria or changes the priority of the track based on this new sensor data.

c. The production work flow sub-system <u>decides</u> if the change to the priority facilities a change in the tracks status in the queue. This decision is passed to the DSS that updates the graphical display to the user.

The data fusion cell performs all these functions nearly simultaneously. The tasks of the personnel and equipment requiring a high level of synchronization and coordination. Synchronization of functions and the coordination of the entails a complete development of hardware and software requirements. The focus of this thesis is to demonstrate these detailed requirements and any examination of these requirements would be beyond the scope of this thesis.

3. The Maintenance Sub-System

The purpose of the maintenance sub-system is to monitor the physical aspects of the system and provide a sub-system status report to the Command and Control sub-system. The expert system, in processing the data in production work flow monitors these mechanisms and determines the system's responsiveness to ongoing operations. The maintenance sub-system only reports on those physical attributes of the system and does not process any external data.

The design of the data fusion process demonstrating its internal functions completes the functional decomposition of the detection and monitoring requirements of the Counterdrug JTF. David Marca in his text *SADT, Structural Analysis and Design Technique*, states the following six criteria for stopping a structural decomposition [Ref. 12: p. 112] *a. The process contains sufficient detail.*

b. A change in abstraction level is required to continue.

c. A change in viewpoint is required to continue.

d. The process is very similar to a process in another level of decomposition.

e. The process is very similar to a process in the same level of decomposition.

f. The process is a trivial function.

The model is completed at this point because any further decomposition of the JTF would have to use a different view point or level of abstraction. The viewpoint of the system engineer detailing the purpose of the Counterdrug JTF by decomposing the functional requirement of the Detection and Monitoring TLSR would have to change in scope to a technical requirements view. The purpose of this thesis was to decompose the detection and monitoring process of the JTF to assist in establishing a functional architecture based on the sub-functional requirements generated by the decomposition. Any further decomposition would start to incorporate physical technical requirements for the environment, hardware and software associated with the detection and monitoring process. The scope of this thesis was to demonstrate the framework for the functional architecture and stimulate the decomposition from other viewpoints, such as the environmental,software and hardware requirements.

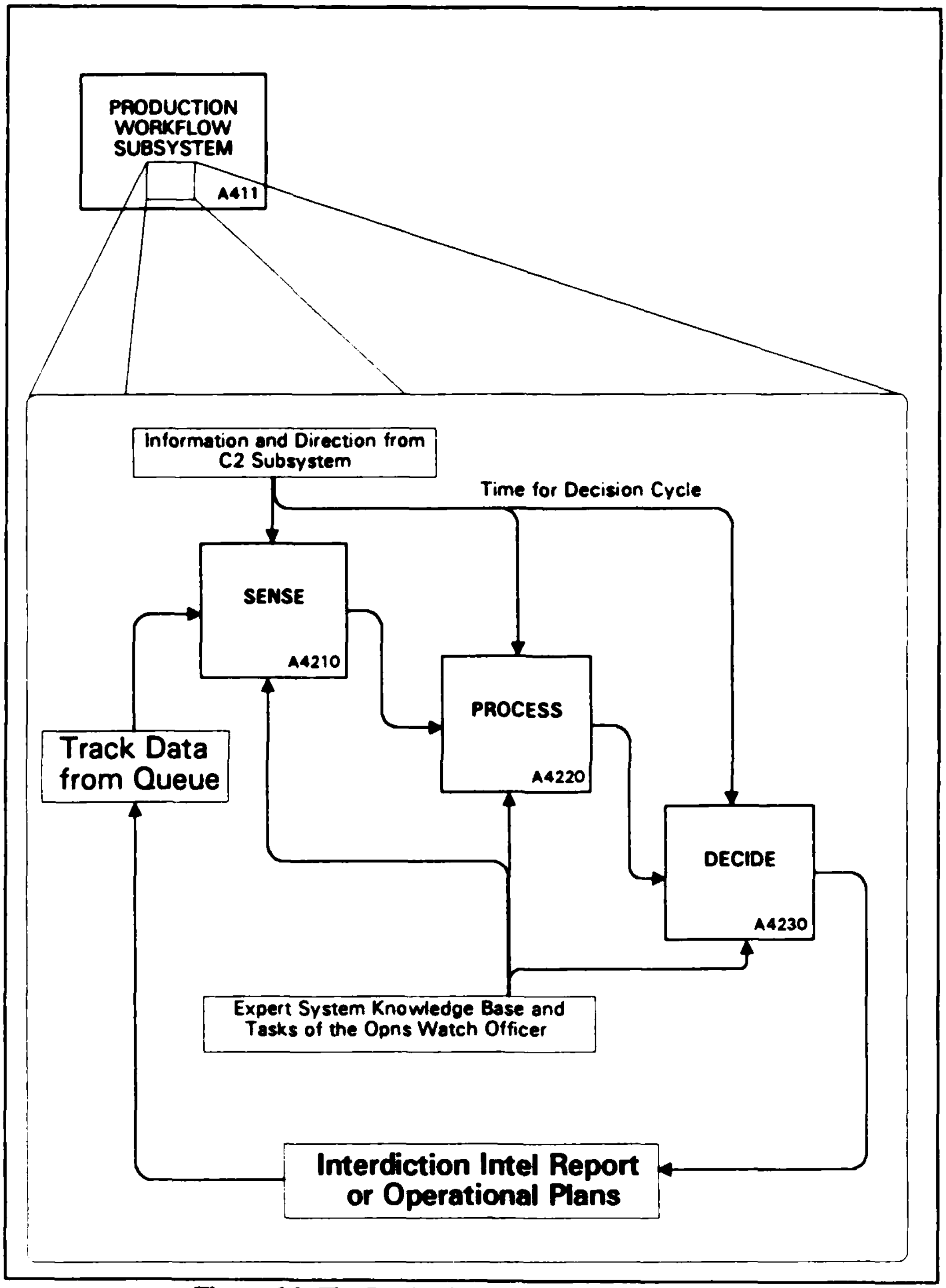

Figure 16: The Production Work-Flow Sub-System

F. SUMMARY

When it is apparent that any further decomposition will require a discussion of how the process physically accomplishes its functions, then a different level of abstraction is needed [Ref. 11:p. 113]. The discussion of the use of specific types of ES or DSS to facilitate sub-functional operations and their development would breach the current abstraction level.

This level of decomposition is not sufficient to design a complete functional architecture for the Counterdrug JTF. Its purpose has been to establish the framework for the continuing examination of each level of the functional architecture and initiate the examination of possible alternative functional architectures that would accomplish the top-level system-requirements. These alternative architectures may depart from the candidate architecture at any level of decomposition. This departure must still accomplish the sub-functional requirements of any parent functions associated with the design. The conclusion of this thesis will propose an alternative architecture based on an examination of the original guidelines established to define the detection and monitoring mission for DOD.

G. ACTIVITY REPORT FOR: LEVEL THREE DECOMPOSITION

[A21] Integrate Track Data

Inputs: Correlated Track Information with Ongoing Interdiction Operations and Intelligence Report for Database

Outputs: Processed, Correlated and Analyzed Intelligence on Track delivered to interdiction forces or Stored in Internal JTF Database

Controls: Mission Priority Established By Higher Authority

Mechanisms: Information processing systems and Decision Support Systems resources internal to the Counterdrug JTF

[A30] Track Control and Processing

Inputs: Position of Track in Queue,

Outputs:Track Paired with Current Mission, Updated Position of Track in Queue, Time-tagged for Sensitivity

Controls: Interdiction Criteria from Higher, Current Interdiction Mission

Mechanisms: Automated Track Management Systems and Databases

[A31] Data Fusion of Track

Inputs: Track Paired with Current Mission, Updated Position of Track in Queue, Time-tagged for Sensitivity

Outputs: Intel Product for use by Intelligence Personnel in External Agencies and Interdiction Operational Orders

Controls: Current Interdiction Mission

Mechanisms: Data Fusion Cell Watch Officers ES and DSS Resources

[A32] Database Update

Inputs: Intel Product for use by Intelligence Personnel in External Agencies that have access to Database that maintains track Queue

Outputs: Track Paired with Current Mission, Updated Position of Track in Queue, Time-tagged for Sensitivity,

Controls: Current Interdiction Mission

Mechanisms: Database Management System and Communication Networks

Activity Report for: Detailed Level Three Decomposition

[A31] Data Fusion of Track

Inputs: Track Paired with Current Mission, Updated Position of Track in Queue, Time-tagged for Sensitivity

Outputs: Intel Product for use by Intelligence Personnel in External Agencies and Interdiction Operational Orders

Controls: Current Interdiction Mission

Mechanisms: Data Fusion Cell Watch Officers ES and DSS Resources

[A410] Command and Control Sub-System

Inputs: Sub-System Status Info Ability to process track data from Production Work Flow and Maintenance Sub-systems

Outputs: Information and Direction, Higher Guidance Directed Interdiction Criteria for Track Data Maintenance Update

Controls: Data Fusion Cell Watch Officer Direction, Higher Authority

Mechanisms: Decision Support System Operated by Data Fusion Cell Watch Personnel

[A411] Production Work-flow Sub-System

Inputs: Updated Track Data from Queue,

Outputs: Intelligence Products to Interdiction Forces and Operational Plans

Controls: Information and Direction from the C2 Sub-System, Focuses Decision- Making Cycle in Production Work Flow on Current Operations Generated from Higher Guidance

Mechanisms: Expert System Used in Conjunction with Watch Personnel To Produce Track Threat Priority and Create Intelligence Product Maintenance Sub-System

Inputs: Rate of Operation and Status of Equipment and Personnel Operating Automated Systems

Outputs: Sub-System Status of Production Work-Flow, Ability of System to Meet System Requirements to Fulfill mission parameters

Controls: Information and Direction from the C2 Sub-System

Mechanisms: Human and Automated Maintenance Resources

[A412] Maintenance Sub-System

Inputs: Rate of Operation and status of equipment and personnel operating systems

Outputs Sub-system status of Production Work Flow, Ability of System to meet system requirements to meet and fulfill mission parameters

Controls: Information and Direction from the C2 sub-system

Mechanisms: Human and Automated Maintenance resources

Activity Report for: Command and Control Sub-System Decomposition

[A410] C2 Sub-System

Inputs: Sub-system Status and Information Received from Production Work-Flow and Maintenance Sub-System

Outputs: Information and Direction, Decision Criteria for Production Work-Flow

Controls: Data Fusion Cell Watch Officer Direction, Higher Authority

Mechanisms: Decision Support System, DLEA Liaison in Data Fusion Cell

[A4110] Sense

Inputs: Sub-system Status and Information Received from Process and Decide sub-systems

Outputs: Identification of Track Model Variable Change that requires system to increase, decrease or change current cperating variables

Controls: Current Interdiction Operational Plan Directed from Higher Authority as seen by Watch

Mechanisms: Specified Tasks for Data Fusion Cell Watch, Personnel and Automated Information Processing Systems

[A4120] Process

Inputs: Identification of Track Model Variable Change that requires Updating from the Sense sub-system

Outputs: Matching Data from Sense to Track Model in Queue to adapt system to respond to variable changes

Controls: Time for Decision Cycle, Current Interdiction Operational Plan Directed from Higher Authority as seen by Watch

Mechanisms: Expert System that Compares Data while Matching to Specified Tasks for Data Fusion Cell Watch

Personnel and Automated Information Processing Systems

[A4130] Decide

Inputs:Matching Data from *Sense to* Track Model in Queue to adapt system to respond to variable changes received from Process function

Outputs: Information and Direction for system adaptation to variable change to Sense sub-system

Controls: Time for Decision Cycle, Current Interdiction Operational Plan Directed from Higher Authority as seen by Watch

Mechanisms: Specified Tasks for Data Fusion Cell Watch Personnel and Automated Information Processing Systems

Activity Report for: Production Work-Flow Sub-System Decomposition

[A411] Production Work-Flow Sub-System

Inputs: Track Data from Queue

Outputs: Interdiction Intel Report or Operational Plans, Sub-System Status Report on Ability to Produce Functional Requirements

Controls: Information and Direction from C2 Sub-System

Mechanisms: Expert System Used by Operations Watch Personnel

[A4210] Sense

Inputs: Track Data from Queue

Outputs: Verified Sensor Data Associated to Track

Controls: Information and Direction from C2 Sub-system

Mechanisms: Expert System Knowledge Base and Tasks of the Operations Watch Officer

[A4220] Process

Inputs: Verified Sensor Data Associated to Track

Outputs: Grouped Data Information that Fits Criteria from mission guidance and is Paired to Ongoing Operations,

Controls: Information and Direction from C2 Subsystem

Mechanisms: Expert System Knowledge Base and Tasks of the Opns Watch Officer

[A4230] Decide

Inputs: Grouped Data Information that Fits Criteria from mission guidance and is Paired to Ongoing Operations

Outputs: Decision to update Track data in Queue and send Grouped data to Interdiction Forces or to Store on Internal Database, Interdiction Intel Report or Operational Plans

Controls: Information and Direction from C2 Subsystem, Time in Decision Cycle

Mechanisms: Expert System Knowledge Base and Tasks of the Opns Watch Officer

VI. AN ALTERNATIVE CANDIDATE ARCHITECTURE

A. THE COUNTERDRUG DATA FLOW AND DECISION CYCLE

This thesis began with a description of the environment that the counterdrug JTF operations within. It then decomposes the mission requirements that had been established for the Department of Defense by the National Command Authority. This process from environment to third decomposition level is illustrated in Figure 18 .

The path from the drug trafficking environment through the external agency sensor systems to the Watch Officers that create the intelligence reports begins to demonstrate the complexity of creating a functional architecture for the system-in -focus. One significant point that is demonstrated in this thesis is the incorporation of operational directives (planning interdiction missions) and the participation of DOD agencies in actual interdiction operations. The specific guidelines in chapter II do not address these operations. They are derived from the mission scenario combinations to maintain the force's combat readiness and utilize personnel and equipment for detection and monitoring operations that enhance war fighting skills. The development of these actions that the DOD agencies participate in can be the point of departure for an alternative candidate architecture. The Alternative Candidate Command Structure is developed from the same decomposition path discussed in Chapter I. The point of departure from the candidate architecture developed in the previous chapters evolves from the current JTF configurations. All the references and the National Strategy for Drug Control reference

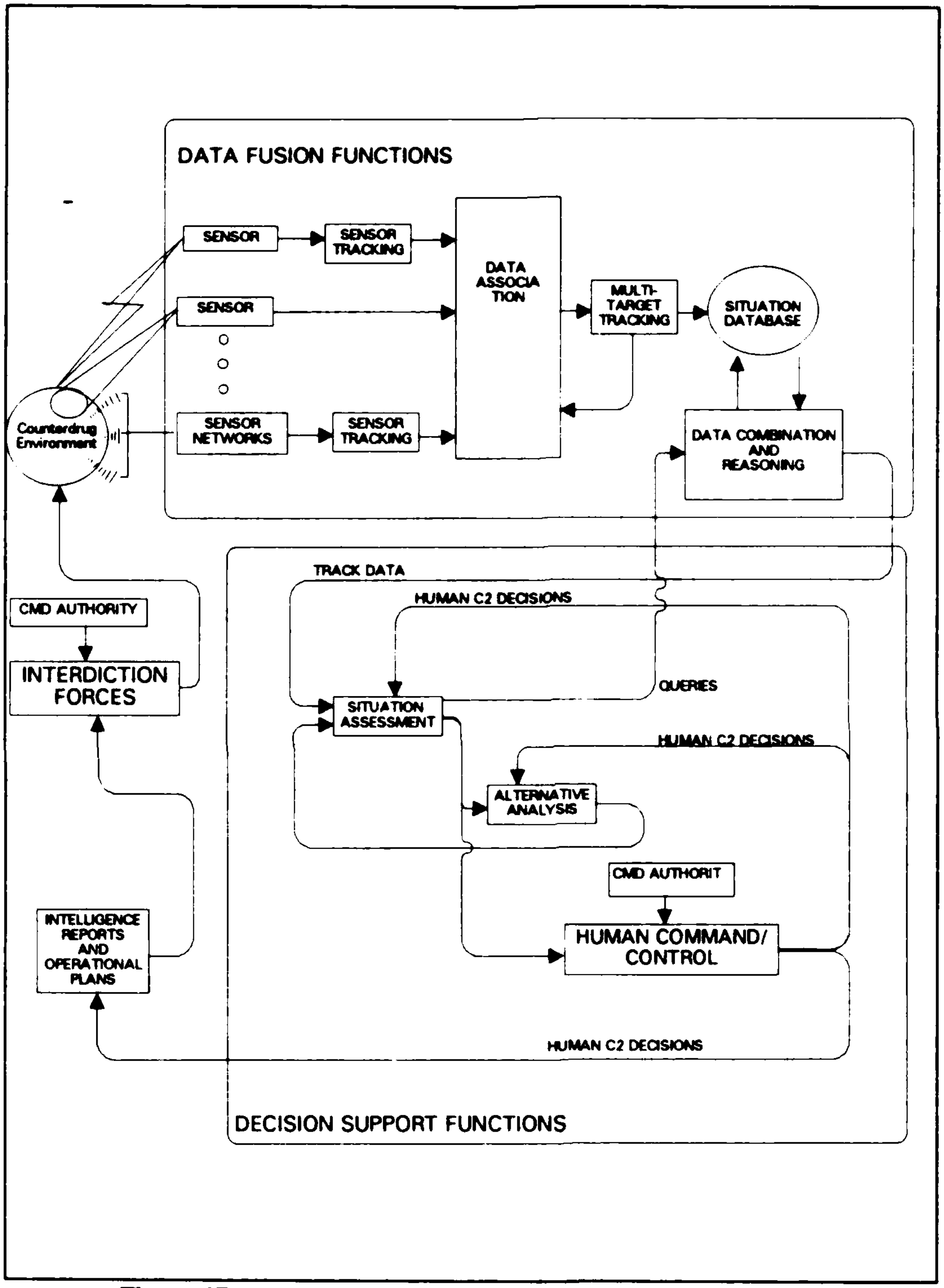

Figure 17: Data Fusion and Decision Support System Integration

the current operations that include the planning and execution of interdiction operations in the J3 and J5 staff of the JTFs. The change in architecture would be with the current operational planning for interdiction operations. This function would become an external function to be executed by personnel on the staffs of the agencies that conduct the actual interdiction operations. The primary agency responsible interdiction of maritime drug smuggling targets is the United States Coast Guard (USCG). An alternative architecture would be to have the planning for interdiction operations conducted by USCG personnel external to the JTF. The JTF Data Fusion Cell would be unchanged in function. The focus of the JTF would solely be an intelligence product to be used by the USCG planners. Currently the JTFs are commanded and staffed with USCG personnel. But the Counterdrug JTF have few or no organic assets to employ for immediate interdiction operations. The USN and USCG ships are tasked to support the JTFs for interdiction operations. These ships are under the operational control of the JTF for specific operations then return to their home stations[Ref.7]. This violates the military principles of unity of command and economy of force. The JTFs can only plan operations based around these assets, rather than based on the indications and warnings presented by the current threat. Economy of force is violated because one geographical region may have Navy, Coast Guard and Customs conducting similar interdiction operations with no unity of effort. The Coast Guard is the only federal agency that has a peacetime law enforcement mission and a wartime responsibility under the Department of Defense. The operational planning function already has an existing structure to fall within. The Maritime Defense Zones (MARDEZ) were established in 1984 by a joint Navy and Coast

Guard board to establish war time tasking for the USCG. The mission of the MARDEZ is to:

> ...conduct coordinate and control operations in the area designated as the Marine Defense Zone, as required, in order to ensure the integrated defense of the area, to protect coastal sea lines of communication, and to establish and maintain necessary control of the vital coastal sea areas, including ports, harbors,navigable waters, and offshore assets of the United states, exercising both statutory and naval command capability.[Ref.9: p.196]

The key difference would be the functioning of the Counterdrug JTFs and their output. By producing intelligence reports and maintaining their cyclic data fusion functioning, the JTFs would completely fulfill their top level system requirement, to disseminate the detection and monitoring of suspected drug traffickers to the appropriate interdiction agency. Figure 18 indicates the possible structure in the Counterdrug environment adapted from its current role as seen in Figure 17.

The personnel and functions matrix presented in the presented in the previous chapter is not significantly altered changing tasks of personnel and equipment. The J3 and J5 functions internal to the JTF remain to plan and coordinate the actions of the Counterdrug JTF. These two staff functions would no longer be required to plan, coordinate, request the resources and then execute interdiction operations with forces external to their command. The data fusion product from the JTF would be the J2 functioning of the MARDEZ in the execution of their interdiction operations.

The purpose of an alternative architecture is to provide the decision maker a different perspective to solving the specific mission the candidate architecture has been designed to accomplish. Alternative architectures do not have to be great departures from the original candidate. Alternatives should be developed in parallel and then presented to the decision maker. Alternative architectures must accomplish the system requirements of the system, or they cannot be considered a viable candidate. Deciding on the architecture to develop becomes a function of buildability. Buildability is the step in systems engineering that determines if the architecture designed is feasible to construct based on such factors as cost, resource availability, technology limitations and physical environment constraints. The system engineer examines these factors only after constructing the candidate architectures.

B. SUMMARY

The purpose of this chapter was to examine a viable alternative to the functional architecture developed in the previous chapters. The alternative has no functional deviations in the decomposition of the detection and monitoring processes and their TLSR compliant sub-functions. Its difference is in the planning, coordination and execution of operational interdiction plans to an external agency.

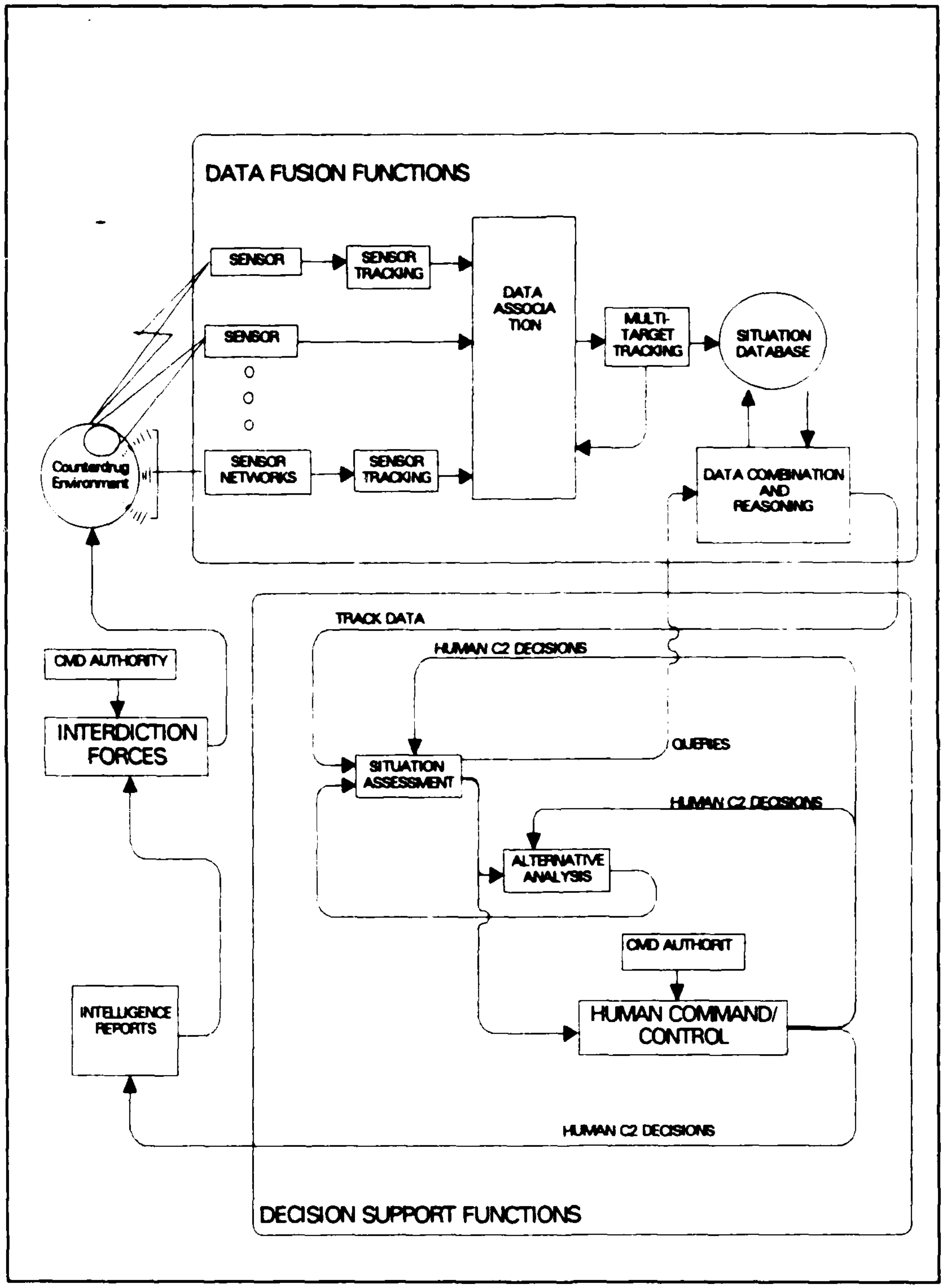

Figure 18: Alternative Architecture Output

VII. CONCLUSION

The purpose of this thesis was to develop a candidate functional architecture for the Counterdrug JTF Detection and Monitoring process using a systems engineering approach. This thesis introduces the environment of the counterdrug JTF, discusses the controls that effect the ability of the JTF to produce TLSR compliant outputs and the resources of the JTF that process the input and make it into a viable product. This was done by a process of decomposing a function to reduce its complexity. Each level was decomposed and using the principle of information hiding, a further level of detail was exposed. The disaggregation continued until the basic core functioning of data fusion was explored. The sub-systems that are integral to the functioning of data fusion allow an inspection of the requirements necessary to control the sub-function, monitor its performance, and maintain its productivity.

This thesis did not attempt to delineate all the requirements necessary to construct a counterdrug JTF. Its purpose was to provide a tool to examining current operations and procedures in a JTF to verify and confirm their compliance to their mission objectives. This thesis also provides a departure from the design with an alternative candidate architecture derived from the original baseline guidance that generated the creation of the Counterdrug JTFs.

The Joint Task Force that must interpret multiple agency data input must be able to conduct situation assessment concerning the data as it arrives for processing. This assessment occurs at many levels within the architecture. The decomposing of the function ensures that no unintentional redundancy or procedural gap that could occur during the information processing.

A. AREAS FOR FURTHER STUDY

1. Physical Requirements Determination for a Counterdrug JTF

The actual physical requirements necessary to facilitate the core data fusion process were beyond the scope of this thesis. The breadth level examination of this thesis demonstrates the need to conduct a systematic decomposition of the physical correlation of data. The data association and correlation sub-functions hardware and software requirements and the interoperability with external sensor inputs should be the subject of further study.

2. Interoperability Requirements Determination for Multi-Agency Sensor Fusion.

The ability for agencies to transmit data via multiple secure routes with the ability to discriminate receivers of the information on a network is a key area for further research. Current stovepipes exist that limit the ability of agencies to transfer data across the current ADNET system. One major shortfall is the inconsistency across federal agencies for the standardization of classification levels. Now that DOD is the lead agency for development of C^3I issues in the war on drugs, this issue should be the domain of the DOD to remedy. The issue would then be the ability to have other federal agencies equipped to handle current DOD security levels.

B. RECOMMENDATION

The use of a systems engineering approach in establishing a multiple agency task force provides the benefits of giving a template for the design of the functional architecture. This functional architecture design using a breadth first examination details specific areas for further detailed decomposition. This process is recommended at the beginning of the formation for a Task Force. While previous task force creation has been ad hoc based on the temporary nature of task forces, the permanence of these organizations and the continuing development of JTFs across the spectrum of federal agencies requires the use of systems engineering.

APPENDIX A SYSTEMS ENGINEERING AND DESIGN/IDEF®

A. SYSTEMS ENGINEERING

Two definitions of systems engineering and the methodology of functional architecture are presented to illustrate the focus of the systems used in the presentation of developing a candidate architecture for a counterdrug joint task force. The first is from the published military standard on systems engineering, as of the sixth of May, 1992, replacing the previous edition published in 1974. MIL-STD-499B defines systems engineering as:

> An interdisciplinary approach to evolve and verify an integrated and life-cycle balanced set of system product and process solutions that satisfy customer needs. Systems Engineering: (a) encompasses the scientific and engineering efforts related to the development, manufacturing, verification, deployment, operations, support, and disposal of the system products and processes, (b) develops needed user training equipments, procedures, and data (c) establishes and maintains configuration management of the system, (d) develops work breakdown structures and statements of work, and (e) provides information for management decision making.[Ref. 17:p. 5]

In his book *Decision Support Systems Engineering*, Andrew P. Sage describes systems engineering as:

> ...a focus on the tools and methods that support the application of the principals of the physical and material sciences for the betterment of humankind, . . . that enable design for more efficient and effective human interaction.[Ref. 16:p. 10]

Sage further describes systems design engineering as the methodology of decomposing large design issues into smaller component subsystems, and build the complete system as a collection of these then-integrated subsystems. This thesis attempts to use these principles in the design of a candidate architecture for a counterdrug joint task force.

Functional architecture is a methodology associated with systems engineering. Functional Architectures are descriptions of the detailed processes or functions that must occur if the desired systematic performance is to be obtained and the locational and environmental constraints are to be satisfied[Ref. 3:p. 6]. The process is developed to ensure the engineer can physically design hardware and software without constant reliance and consultation with the designers of the system. The engineer works with the most detailed function in a functional architecture to ensure there are no unforeseen redundancies or incompatible systems. The intent is to reduce the likelihood of misinterpretation of the systems and the processes that make them function so that no retroactive work must be done.

B. DESIGN/IDEF®

Design/IDEF® is a software application used to graphically demonstrate the reduction of the major system into its subsystems, and illustrate the relationships and connectivity between different subsystems and between different levels. Developed by Meta Software Corporation in Boston, Massachusetts, this software is a diagramming tool and data dictionary designed to decompose a problem graphically. IDEF stands for

ICAM (Integrated Computer Assisted Manufacturing) and IDEF0 is similar to SADT, Structured Analysis and Design Technique developed by Softech Corporation in the 1970s. SADT and IDEF0 have become a common tool for requirements definition by military and industry.[Ref. 12:p. xv] This taking apart of a system represented by boxes and arrows, allows each piece to be analyzed on its own. Arrows in IDEF represent information or data necessary to carry out the activities of the system and the information and information or products produced by the activity to accomplish the overall purpose of the system. The system is acted upon by inputs from the environment and controls from higher authority. Resources organic to the system perform the functions necessary to produce the output of the system. This output must conform to the specific requirements that created the system.

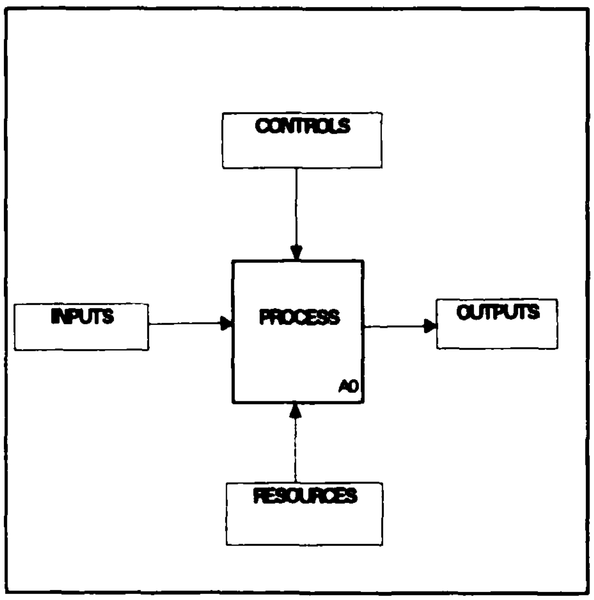

Figure 19: SADT Process Box

Using a top down approach, each IDEF diagram goes from the more general to the specific, from a single diagram that represents a whole system to a detailed diagram that explains how a specific subfunction works and relates to the other sub-functions. [Ref. 18: p. 4]

IDEF0 creates a controlled and structured environment to examine a complex system one piece at time. The meaning for each piece of the system is grasped without having to be exposed to the entire system at once. This is done in an effort to increase the engineer's understanding of each specific requirement in the design, and to understand the cohesion necessary from one subfunction to the next. The decomposition of the total system and then the development of the coupling between sub-system reduces inefficient redundancies or incompatibilities during construction of the system.

APPENDIX B TASKS MATRIX

	Higher Authority Guidance	Mission Guidance	Corellate Incoming Sensor Data	Determine Current Operations	Provide Agency Input	Transmit Intel Product	Provide Comms to JTF
CDR CD JTF	•	•					
DPTY CDR CD JTF	••	••					
J1/4 Staff Officer							
J2 Staff Officer		•••					
Data Fusion Cell							
Intelligence Watch Officer			•			•	
Operations Watch Officer				•••		•	
Decision Support System				••	••	••	••
Expert System			••				
Data Correlation Analyst			•				
Current Intel analyst				•			
J3 Staff Officer				•			
Current Operations Officer				••			
DLEA LNO		•••			•		
USCS Liaison		•••			•		
DEA Liaison		•••			•		
Surface/Air Coordinator							
J5 Plans Staff Officer							
J6 Comms Staff Officer							•
•First Level Function							
•• Second Level Function							
••• Third Level Function							

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