Network Centric Operations
Conceptual Framework
Air-to-Ground Case Study
Final Brief
17 June 2004
Prepared by SAIC for:
Evidence Based Research, Inc.

Overview – Air/Ground Case Study

- **Objective**
- **Operational Context**
- **Scope and Assumptions**
- **Approach**
- **Peer Reviewers**
- **Analysis**
  - Vignettes, Observations, Findings, Interpretation
- **Conclusions, Recommendations**

Objective

- ## Research Objectives:
    - Develop a case study that applies the NCO CF to Force Application within the context of Major Combat Ops
        - Based on insights gained from air-ground operations DCX I, OEF, OIF
        - Assess ability of NCO CF to explain underlying relationships
    - Improve underlying theory of NCO through feedback on the utility of the NCO CF

- ## Design and Background:
    - Leverage past studies that focused on the value of legacy forces vs. NCO forces
        - RAND Air-to-Air Case Study,
        - US Army Division Capstone Exercise Phase I (DCXI)
    - Validate relevance of NCO CF to air-ground (CAS) operations through analysis of combat operations in Enduring Freedom and Iraqi Freedom

Hypothesis

- Network Centric Operations will improve air-ground (close air support) operations through improvements in the following elements of the NCO CF:
  - Quality of Individual Information
  - Quality of Individual Sensemaking
  - Degree of Shared Information
  - Degree of Shared Awareness

Operational Context

- *Digital systems* significantly reduce the potential for miscommunication and misunderstanding that come with voice systems. Ground personnel and aviators are able to see relevant information from the same perspective at the same time, thus *improving collaboration and shared decision making*.

- *Individual confidence increases* as a result of the quality and share-ability of information, which, in turn, contributes to faster and *more accurate decisions*

- Better decision making contributes to *better combat effects* and increased speed of command.

- Better and faster combat effects contributes to greater *confidence and trust* between the air and ground components

- Greater confidence and trust between the components facilitates transformation of both components to a *lighter, more agile, and more integrated joint air/ground force*.

- A transformed air/ground force *enables changes in service doctrine, training, and organizational constructs* that allows a more efficient and more effective joint force to emerge.

Aerial view of Objective Ginger from Operation Anaconda in the Shah-i-kot Valley

al Qaeda fighting position at Objective Ginger from Operation Anaconda from which ground forces received fire

Solution Strategy: The NCO Story Line

The transition from a legacy to a networked air-ground environment incorporates all elements of the CF and pervades each domain

➡️

Network centric systems increase the quality and degree of shared mission critical information
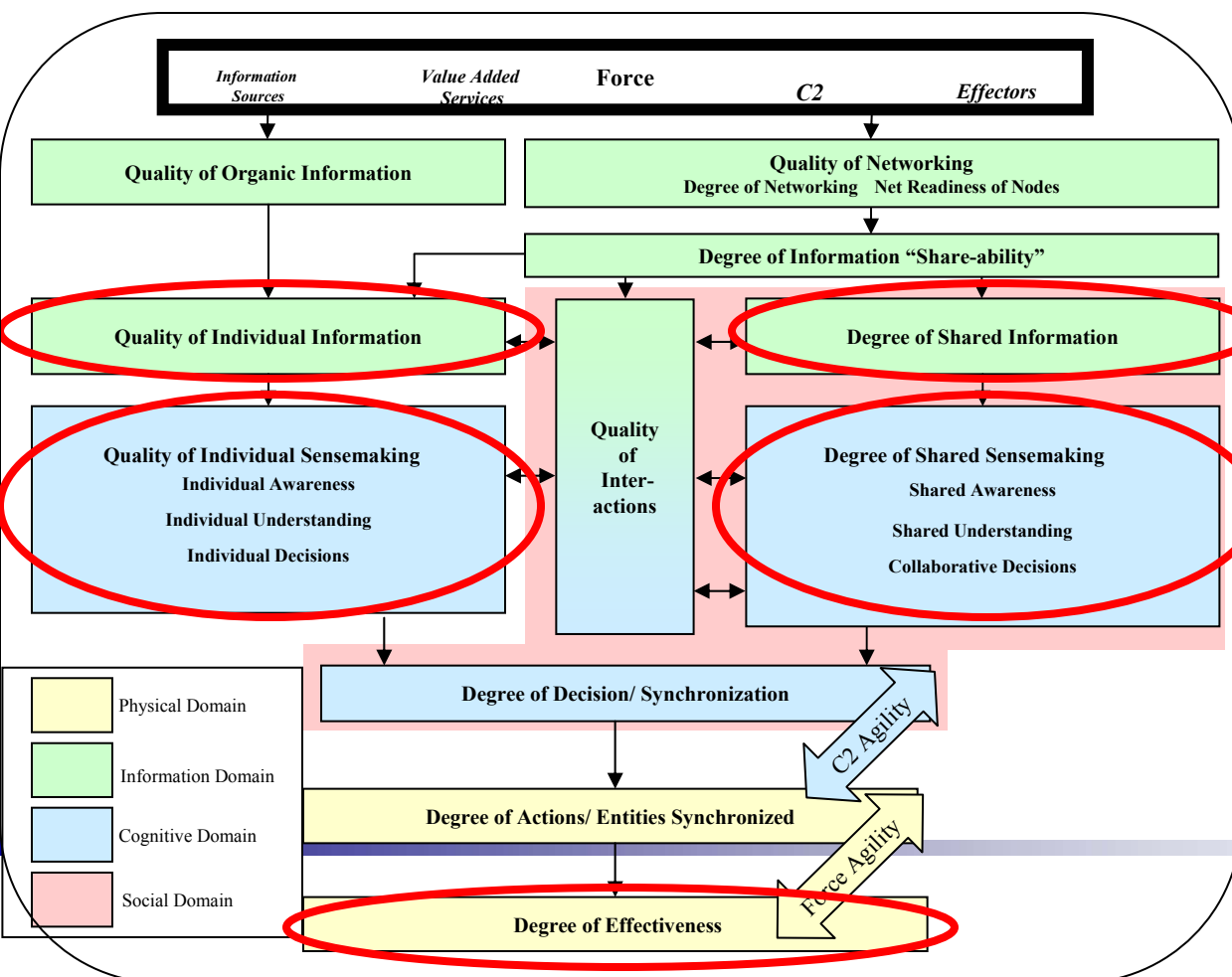
This permits a common perception of the battlespace to emerge, creating a shared awareness of the environment

This decreases the level of uncertainty, thus improving the degree of decision quality information which improves the quality and degree of sensemaking and interactions

This in turn improves a force's agility, time to execute, efficiency, and effectiveness in air-ground operations

Information Sources	Value Added Services	Force	C2	Effectors

Quality of Organic Information

Quality of Networking
Degree of Networking   Net Readiness of Nodes

Degree of Information "Share-ability"

Quality of Individual Information

Degree of Shared Information

Quality of Individual Sensemaking
Individual Awareness
Individual Understanding
Individual Decisions

Quality of Inter-actions

Degree of Shared Sensemaking
Shared Awareness
Shared Understanding
Collaborative Decisions

Degree of Decision/ Synchronization

C2 Agility

Degree of Actions/ Entities Synchronized

Force Agility

Degree of Effectiveness

Physical Domain

Information Domain

Cognitive Domain

Social Domain

Scope

Limited in Scope
- Based on small sample size
  - Began with 54 screening interviews. Added another 27 detailed, then another 6 extensive
- Focused on small sub-set of networked air and ground operations in OEF and OIF
  - CAS sub-set with interaction between ground controller and aviator
  - Based on interviewee experience in approximately 90 sorties out of 3200 total air-ground sorties
  - Only 46 sorties involved use of NCO systems
- Focused on a few components of the broader conceptual framework which drove approach
  - Cognitive
  - Social
  - Interviews to provide insights into cognitive process

Assumptions

- OEF and OIF would provide adequate unclassified data sources and instances of air-to-ground force employment interactions

- The area of greatest interest in analyzing the NCO CF cognitive and social domains is the interaction between the aviator and small maneuver force

- The interview protocol would reveal relevant information regarding the cognitive and social domains of the NCO CF from actual combat operations

- Data would be robust enough to allow analysts to draw conclusions about the hypothesis

Constraints

- Classification of operational data

- Relevant exercise results designated "For Official Use Only."

- Limited access to selected personnel because of ongoing combat operations and high OPTEMPO of many units.

- Data erosion: interviewees were describing events that occurred months earlier.

Approach

- Screening interviews with senior reviewers and key personnel
- Basic research of after action reports and supporting documents
- Detailed interviews with selected personnel
- Extensive recorded interviews with personnel involved in NCO CAS ops
- Analysis of interviews with focus on NCO CF elements
- Interpretation of analysis

Approach

- Analyze interview data to contrast between baseline (legacy systems) and treatment (NCO systems) in CAS operations
    - <u>Legacy System</u>: Collaboration and shared situational awareness between aviator and maneuver element achieved primarily by voice.
    - <u>Network Centric Warfare System</u>: Collaboration and shared situational awareness between aviator and maneuver element achieved using voice and digital data transfer to provide visual displays to all participants
- Display comparison in tabular and graphical form
- Interpret and report results

Peer Reviewers

- **LTG Steven Boutelle, USA**
  - Chief Information Officer/G-6
- **LTG Johnny Riggs, USA**
  - Director, Objective Force Task Force
- **Maj Gen John Bradley, USAFR**
  - Assistant to CJCS for Reserve Matters
- **Maj Gen David Deptula, USAF**
  - Director of Plans and Programs, HQ ACC
- **Maj Gen Ron Bath, USAF**
  - Director of Strategic Planning
- **BGen Robert Schmidle, USMC**
  - Director, Expeditionary Force Development Center
- **Mr. Kenneth Callicutt, USAF**
  - AF C2ISR Center

Data Collection

- **Benchmark:**
  - Division Capstone Exercise Phase I (DCX I)
    - Legacy Operations vs. Networked Operations at the tactical level
    - Documented improvement in information quality and share-ability as well as improved combat results
- **Case Study:**
  - CAS operations in Afghanistan and Iraq.
  - Comparing Legacy Operations to NCO
  - Focus on interaction between aviator and small maneuver unit (the seam in air-ground ops)

Data Collection

- Used an interview structure worksheet (on right) to compile the assessments of DCXI/OEF/OIF participants of the relevant NCO CF variables
- Developed a graphical depiction of the networked and non- networked force performance
  - Quantitative Inputs:
    - Perceived performance of voice and data link systems
    - Known outcomes of performance (time to engage, effects on target, etc.)
  - Qualitative Inputs:
    - Interviews with pilots, FACs, C2 and battle management personnel, other SMEs
    - Known exogenous factors (training, organization, doctrine, TTPs, environmental, etc.)

Quality of Individual Information

1. Cor...
2. Pre...
3. Cur...
4. Rele...

Overall...

Quality of Individual Sensemaking

1. Corr...
2. Preci...
3. Curr...
4. Relev...
5. Unce...

Overall C...

Degree of Shared Information

1. Ext...
2. Cor...
3. Pre...
4. Cu...
5. Rel...

Overall...

Degree of Shared Awareness

	Total	
1. Extent	Total	1.33
2. Correctness	Total	2.67
3. Precision and Accuracy	Total	3.00
4. Currency	Total	2.33
5. Relevance	Total	3.00
6. Uncertainty		
	Total	2.33
		2.50

Combat Effectiveness

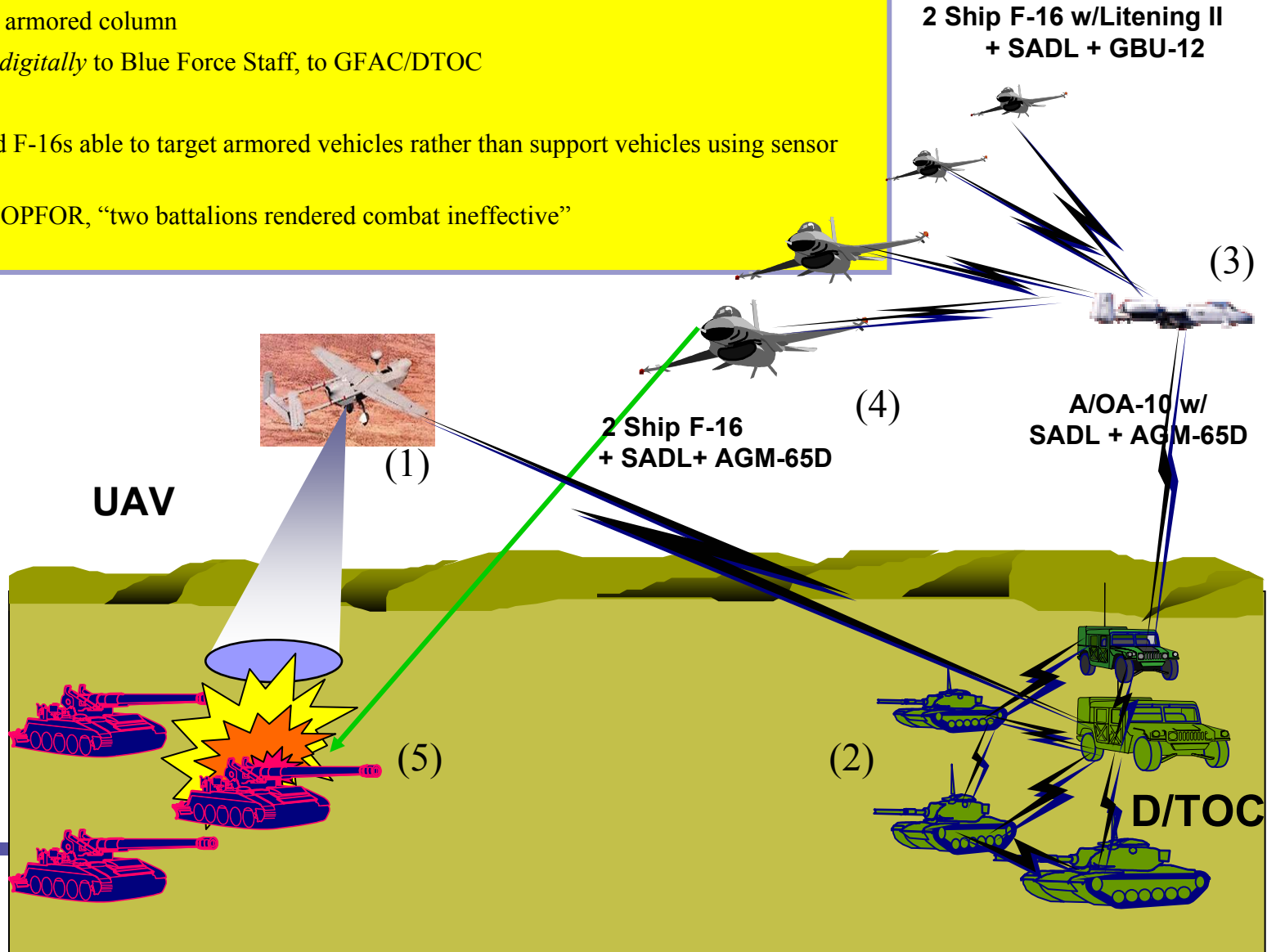|	
1. Quality of Finding the Target	2
2. Quality of Engaging the Target	3
3. Quality of Assessing the Target	2
Overall CE Score:	2.33

Data Collection Efforts:
Interview Breakdown
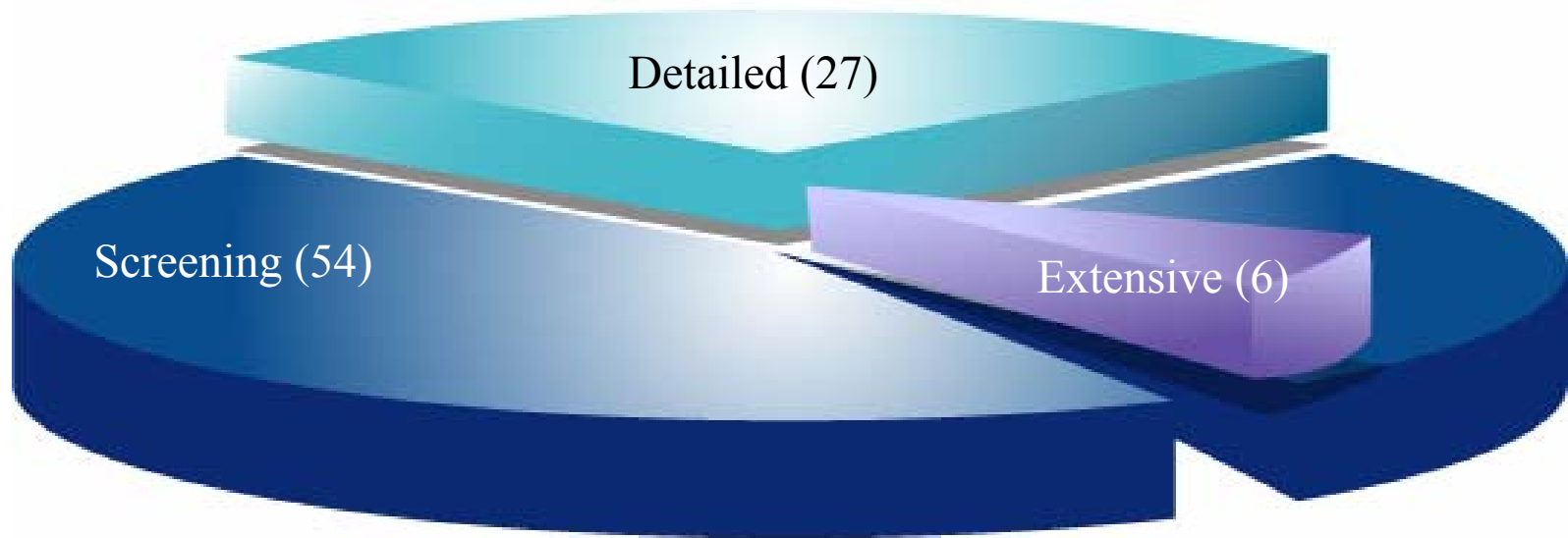
Data Analysis, Observations, Insights

- Division Capstone I
- Operation Enduring Freedom
- Operation Iraqi Freedom
- Cognitive and Social Domain Implications
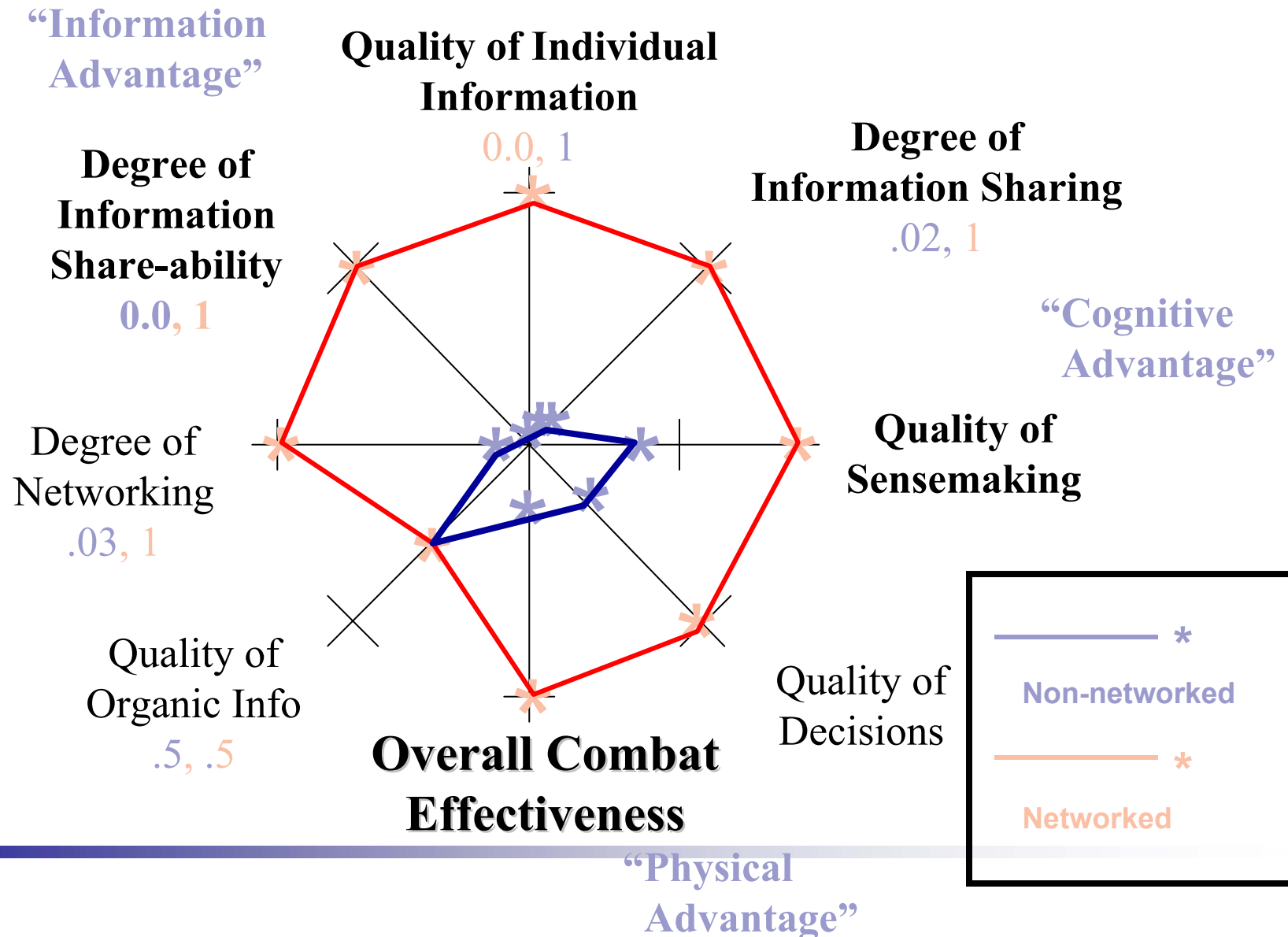
DCXI: The Nighttime CAS Scenario
(Network Centric Warfare Systems vs. Legacy Systems)

1. UAV spots OPFOR armored column
2. Information passed *digitally* to Blue Force Staff, to GFAC/DTOC
3. To AFAC
4. Litening II equipped F-16s able to target armored vehicles rather than support vehicles using sensor point of interest.
5. Decisively engages OPFOR, "two battalions rendered combat ineffective"

2 Ship F-16 w/Litening II + SADL + GBU-12

(3)

A/OA-10 w/ SADL + AGM-65D

(4)

2 Ship F-16 + SADL+ AGM-65D

(1)

UAV

Source: US Army Division Capstone Exercise - Phase I (March-April 2001)

(5)

(2)

D/TOC

- UAV spotting of the OPFOR column increased the *Quality of Individual Information*

- G-2 and G-3, armed with information could predict the OPFOR's objective and route, increasing the *Quality of Individual Sensemaking*

- Information digitally transferred via EPLRS and SADL systems to the GFAC, the AFAC, and to the F-16 pilots increased both the *Degree of Shared Information and the Degree of Shared Awareness.*

- The combination of this resulted in a measurable improvement in the *confidence and trust* the commander had to call in an nighttime air CAS mission

- The successful attack, rendering the OPFOR combat ineffective increased *combat effectiveness* when compared to the unit equipped only with Legacy Systems.

Operation Enduring Freedom

- Air/Ground engagements used both Legacy and NCO systems
  - NCO systems were available to air component forces and were effective in information sharing among aircraft in support of ground operations
  - Ground component forces used systems such as GPS and laser designation
  - Close air support collaboration between aviators and maneuver forces used Legacy Systems
- Interviews based on aviator experience using both legacy systems and NCO systems during OEF

Degree of Effectiveness—OEF

OEF NCO Systems vs. Legacy Systems
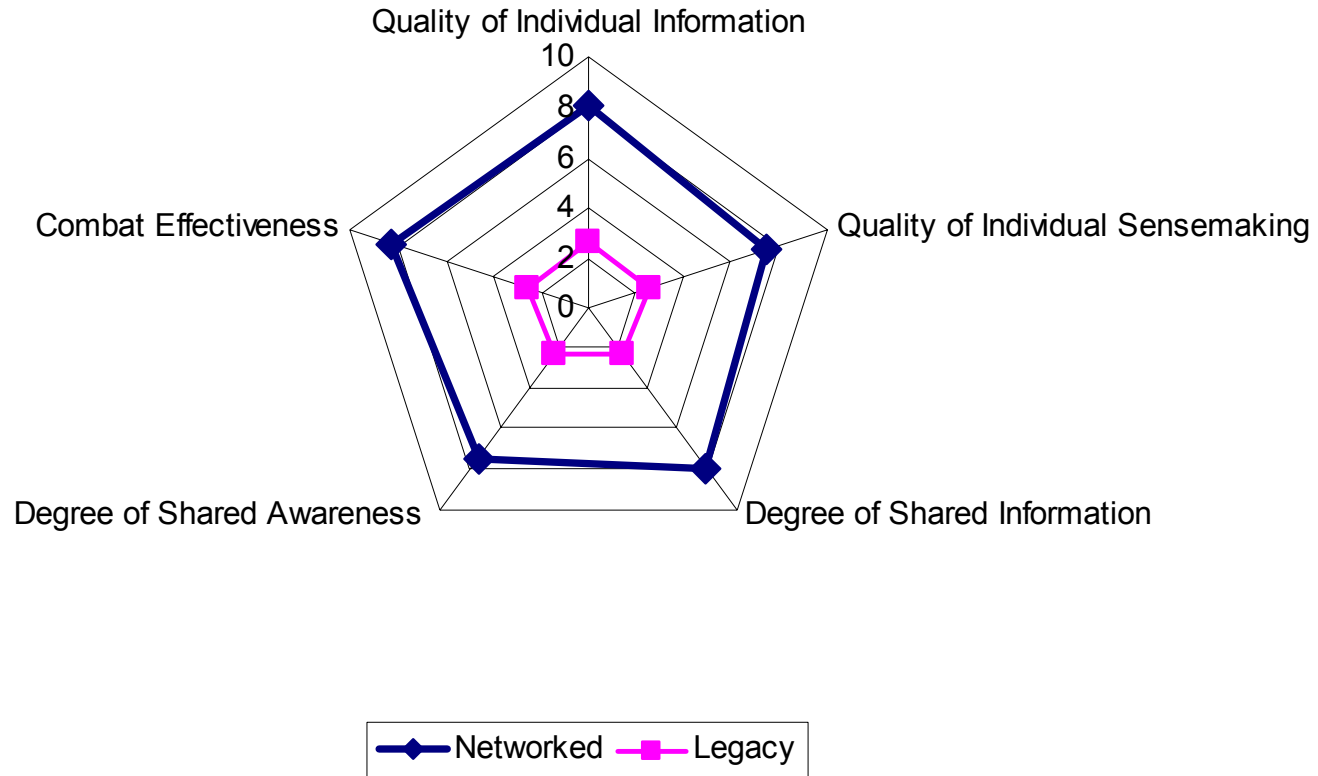
- The use of data link systems in aircraft increased the elements of the NCO CF for the pilots

  - *"In regards to the (F-16 Block) 30, they always had position, location, altitude, heading, fuel, ordinance, and a look into what the pilot was doing with his airplane—a look into his mind."*

- However, a link to the tactical ground forces was not available.
- CAS missions were called in using legacy communication systems

Operation Iraqi Freedom

- NCO systems used extensively between components at operational level and within component chains at all levels
- Multiple systems supported networking between staffs
  - AOC, ASOC, TOCs linked with UAVs and aircraft
  - Western Iraq ops highly networked but force application opportunities limited
- Most CAS missions dependent primarily on legacy systems at the aviator-ground maneuver element level
  - Marine LAV Bn Commander believed voice was the fastest way accomplish the mission
  - Army units called for CAS usually when close contact with enemy forces and guided air power onto target by voice
- NCO Systems facilitated "groundbreaking" collaboration between the Army's V Corps and the 4th Air Support Operations Group
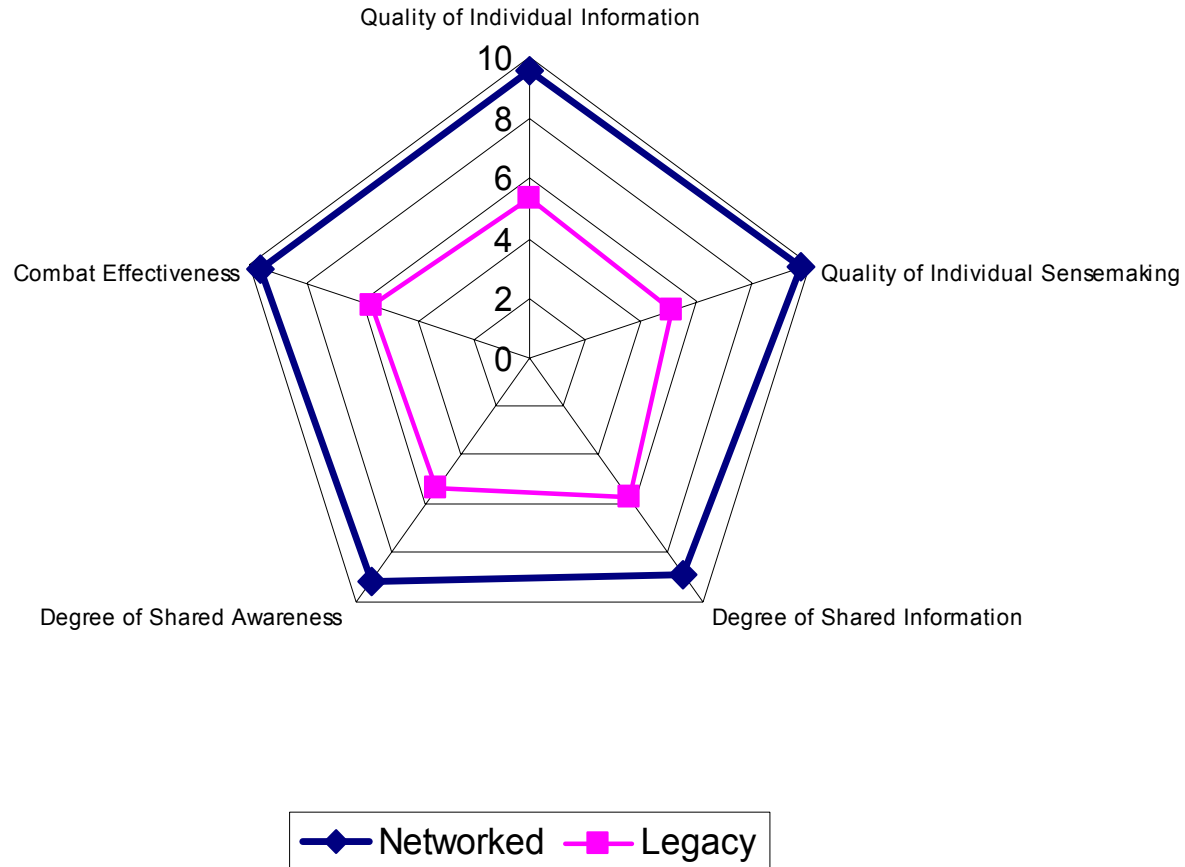
Operation Iraqi Freedom

- Illustrative example comparing legacy vs NCO at the tactical level: Litening II Targeting Pod combined with Pioneer UAV live video feed

- Mission: Attack building/bunker complex in urban area

  - <u>Legacy systems</u>: Harriers equipped with Litening Pod and voice communications system
    - Unable to positively identify the target
    - Two Separate sections of Harriers sent home
    - <u>0% mission success</u>

Litening II Pod + Pioneer

- **Network Centric systems:**
  - ☐ Harrier equipped with:
    - Litening II Targeting Pods
    - Pioneer video feed
  - ☐ FAC equipped with
    - Pioneer Mobile Receiving Station
  - ☐ Able to reconcile differing air and ground perspectives with video
  - ☐ Precision Guided Munitions on target in under 9 minutes
  - ☐ 100% mission success

OIF: Evaluating Elements of the Cognitive and Social Domains of the NCO CF: Network Centric v. Legacy Systems

Network Centric Systems vs. Legacy Systems

Quality of Individual Information

10

8

6

4

2

0

Quality of Individual Sensemaking

Combat Effectiveness

Degree of Shared Awareness

Degree of Shared Information

Networked — Legacy

- Simultaneous viewing of the target by the pilot and the FAC *increased situational awareness*, improved confidence and trust, and *increased combat effectiveness*

  1) bombs on the target

  2) decreased "talk on" time

- In spite of the small sample size, this case tells a good story in relating cognitive elements of NCO CF to comparison between baseline and treatment

  - System only used for 4 total CAS missions and one ISR mission.
  - Interviews show strong correlation between NCO, shared situational awareness, and confidence

- Marines and USAF are now testing Litening II Targeting Pod + Predator video feed.

Cognition and Combat Effectiveness in CAS

- **More advanced network communications systems (especially video) increase speed and accuracy of collaboration between air and ground units**
  - Conclusions based on subjective views of participants
  - No external metrics against which to judge the accuracy of the conclusion
- **Digital data displays supported cognition**
  - Accelerated the emergence of common *pattern recognition*
  - Strengthened connections between attention and short term memory
  - Helped maintain the consistency of *short term memory*, and
  - Compensated for omission, inaccurate transference, and errors in voice communications.

Interaction with the Social Domain

- Historical cultural differences exist among the principal actors in CAS missions which inhibit confidence and self synchronization

  - NCO systems and visualization tend to mitigate the differences

  - Imagery contributes to Shared Awareness and to Self synchronization

Conclusions and Recommendations

- Case Study Conclusions
- Implications for Force Transformation
- Evaluation of NCO CF
- Recommendations

Conclusions

- The use of relatively robust Network Centric Warfare Systems exhibits improvements in the elements of the NCO CF; providing a measurable improvement in the confidence and trust of the warfighters and ultimately, improved combat effectiveness

- Network centric systems enhance CAS engagements
    - Reduce Kill-Chain timeline
    - Increase trust and confidence
    - Contribute to improved Responsiveness and Flexibility

- Network Centric Systems allow air controllers to see more at a higher level. This is beginning to change the traditional definitions of "tactical" and "operational"

Conclusions

- Most CAS collaboration between aviators and ground maneuver forces depended heavily on voice communications (legacy systems), but...

- NCO is robust at operational level and services are pursuing equipment, concepts, and experiments that leverage NCO at the tactical level
  - JCAS Mini-Test
  - Controlled testing of Litening video data link system
  - JEFX 04 experimentation with Army Close Air Support, Situational Awareness
  - Recent operations in Iraq

Implications for Defense Transformation

- Ground maneuver forces can reduce or eliminate heavy organic indirect fire systems, facilitating a chain of desirable outcomes
  - Lighter maneuver forces with greater destructive power
  - Reduced logistics footprint and support tail
  - Distributed maneuver operations
  - Faster deployment, employment, and redeployment of maneuver forces
  - Changes in maneuver organization structures
  - Changes in concepts, tactics, doctrine

Evaluation of NCO CF

- NCO CF is highly relevant to air-ground operations, but to influence strategy, policy, doctrine, and concepts, war fighter needs to:
  - ☐ Be able to relate to it
  - ☐ Be able to apply it
- NCO CF should relate to terms war fighters use
  - ☐ Reduce complexity
  - ☐ Adjust vocabulary
- NCO CF should emphasize outputs in two main categories
  - ☐ Combat Effects: trust, self synchronization, cycle time, agility, fratricide, collateral damage
  - ☐ Transformational Capabilities: distributed ops, new organizations, new concepts, speed of command, demassification

Recommendations

- ## Believe CAS is viable area of study for NCO CF

  - Develop NCO-oriented surveys for selected units rotating out of Iraq and Afghanistan as CAS procedures and equipment could be much different than what they were over a year ago
    - This type of data is not routinely captured in lessons learned data bases today
  - Integrate NCO CF measures of merit into Joint experiments to document examples of digital data transfer and improved combat effectiveness
  - Consider a study at the classified level

BACKUP SLIDES

DCXI Night CAS Scenario—Results (NCO Systems)

- Blue force equipped with Network Centric Warfare System
  - UAV's
  - Airborne Forward Air Controller in O/A-10's with Situation Awareness Data Link
  - Two Flights of F-16s equipped with SADL and Litening II targeting pods
  - Ground Forward Air Controller digitally communicating with AFAC
- UAV spots OPFOR armored column after it leaves the assembly area
- Information passed *digitally* to Blue Force Staff, to GFAC, to AFAC, and to F-16s.
- Litening II equipped F-16s able to target armored vehicles rather than support vehicles using sensor point of interest.
- Decisively engages OPFOR, "two battalions rendered combat ineffective"

Example of Information Processing Model

- A US infantry squad is fired upon by Taliban in Afghanistan
  - Infantrymen found cover/fix enemy's general location **(Perception).**
  - Recognized sounds as hostile attack (**Pattern recognition**).
  - Individuals looked for attackers precise location **(Attention).**
  - Both **Short Term Memory (STM)/ Long Term Memory (LTM)** facilitated the reaction
    - STM remembered sound of gunfire
    - LTM retrieved training responses for incoming fire
  - Individual's training generated a mental image depicting their relative location to the attacker and to other members of the squad **(Imagery).**
  - The squad leader organized the squad's response using verbal commands and hand signals (**Verbal and sign language**)
- The squad destroyed the attackers with organic firepower

Data Collection Efforts

- **Strategies**
  - Open source literature
  - Official after action reports, lessons learned, and other documents
  - Determined potential instances of NCO air-ground engagements through a review of previous OFT work
  - Peer reviewers
  - Air-ground subject matter experts
- **Objectives**
  - Collected data on the nature (degree of networking) of air-ground missions during OEF/OIF
  - Collected data on US Army air-ground engagements
  - Collected data on US Air Force air-ground engagements
  - Collected data on US Marine Corps air-ground engagements

Data Collection Efforts: Interview Structure

- **General Background**
  - ☐ Mission specifics
  - ☐ Networking systems available
    - ■ Experience with networked systems
  - ☐ Planning and preparation
- **Quality of information**
  - ☐ Quality of Individual Information
  - ☐ Quality of Individual Sensemaking
- **Collaboration and Information Sharing**
  - ☐ Degree of Shared Information
  - ☐ Degree of Shared Awareness
- **Combat Effectiveness**
  - ☐ Finding the Target
  - ☐ Engaging the Target
  - ☐ Assessing the Target

Data Collection Efforts

Current selected NCO systems

- Litening II Targeting Pod and the Mobile Receiver Station (MRS)
  - Pioneer video data link
- Airborne EPLRS in F-16 and A/O-10
- Situational Awareness Data Link (SADL) and SADL Ground Forward Air Controller (GFAC) Equipment
- Tactical Data Link Handoff System (TDLHS)
- Data Link Gateways
- JCAS Sensor Point of Interest

Litening II Targeting Pod and the Mobile Receiver Station (MRS)

Variable gain setting

Sensor mode

Target

RADAR altimeter

Polarity

LSS code

Track mode

Range

- Third Generation Forward Looking Infrared
- Charge Coupled Device (CCD) Sensor
- Laser Spot Searcher/Tracker (LSS/T)
- IR Marker
- 40K+ Laser Ranger/Designator

- Pod is modified using off the shelf Pioneer UAV transmitter module & power supply module

- MRS consists of a receiving and processing unit (RPU), a display unit, a tripod, and a backpack
- can also receive video from the Hunter, Pioneer, and Shadow UAVs
- Allows pilot and GFAC share the same common view of the battlespace

Airborne EPLRS:
Heads Up Display in SADL-Equipped F-16
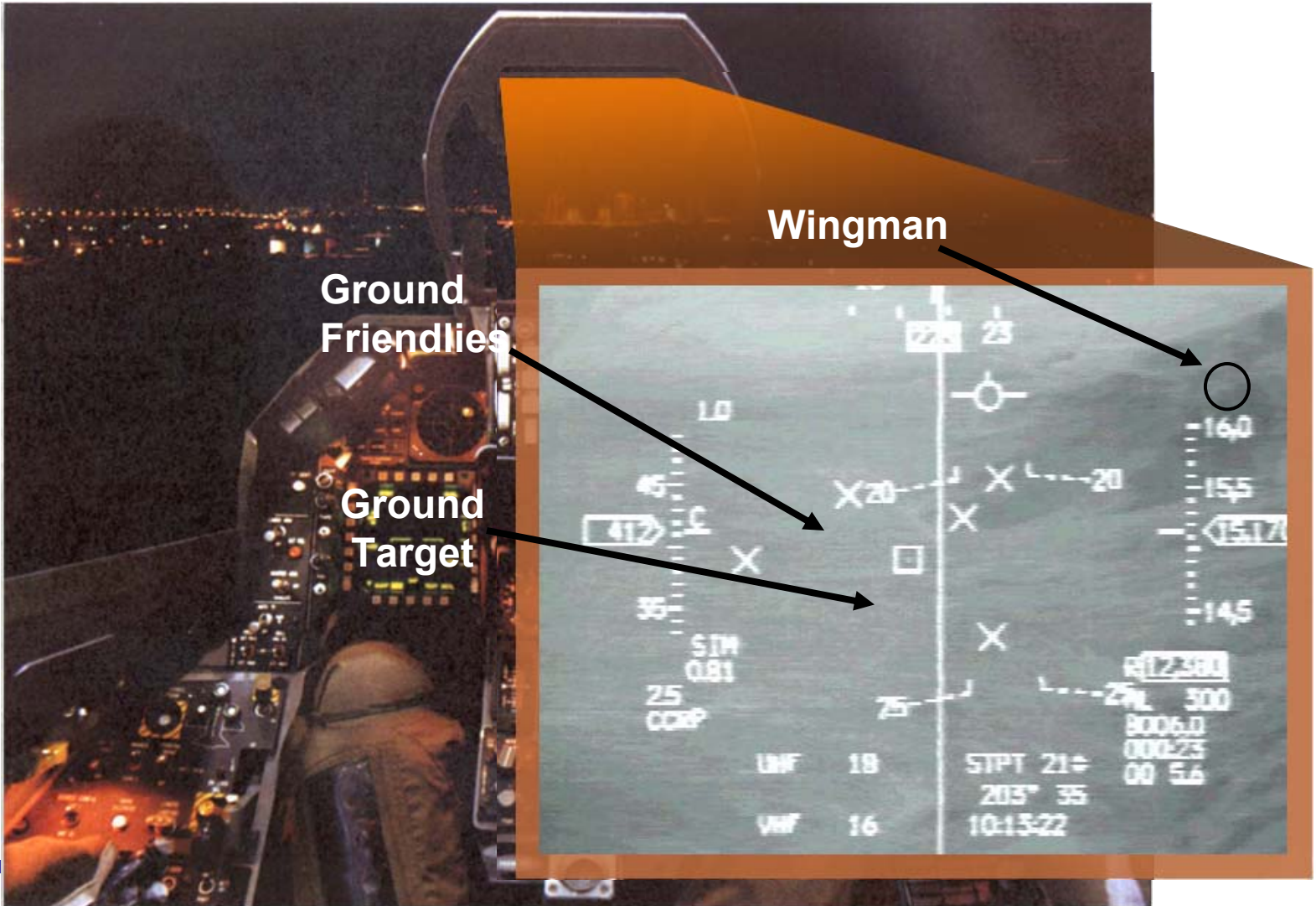
Airborne EPLRS: Tactical Awareness
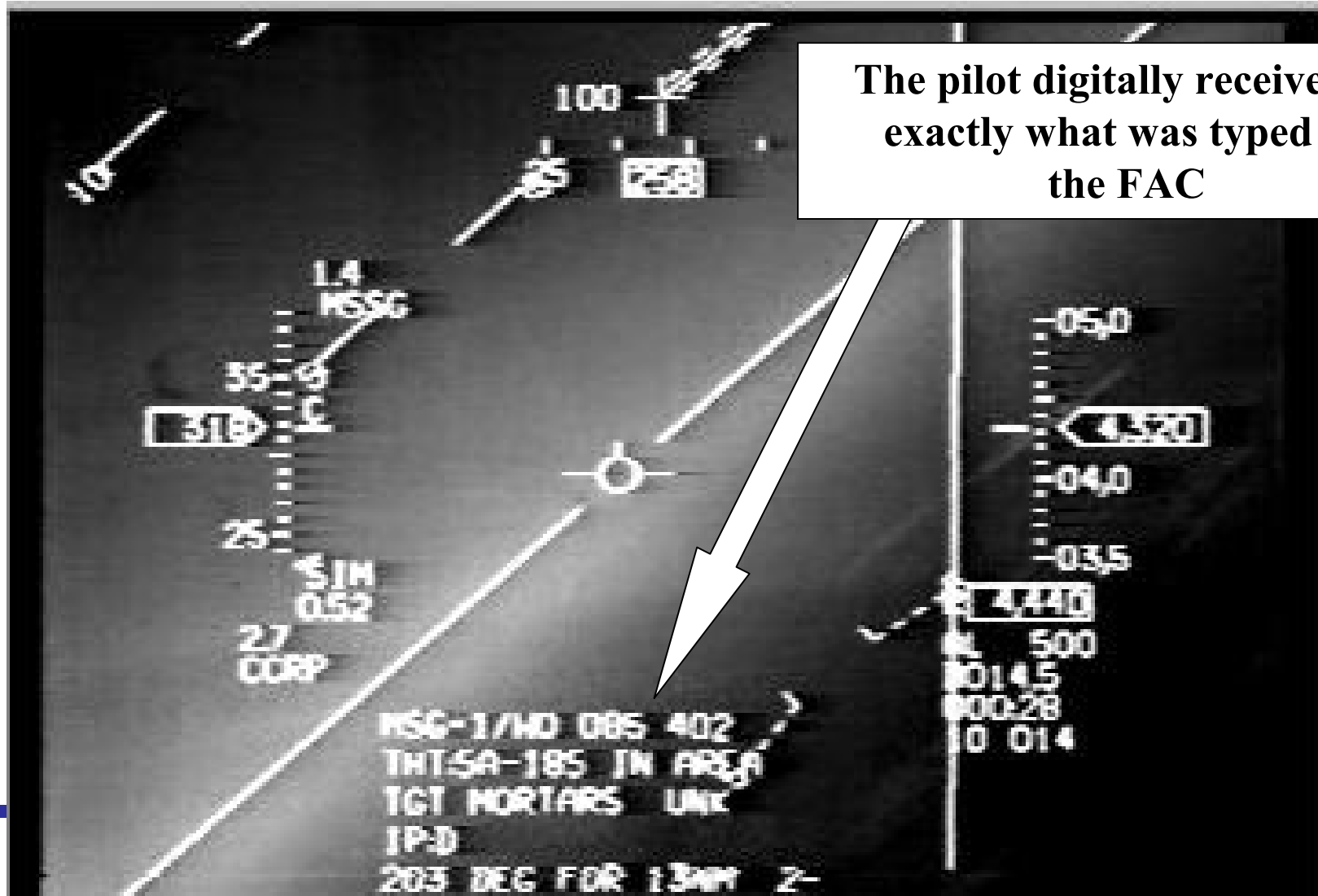## Data Display (TAD)
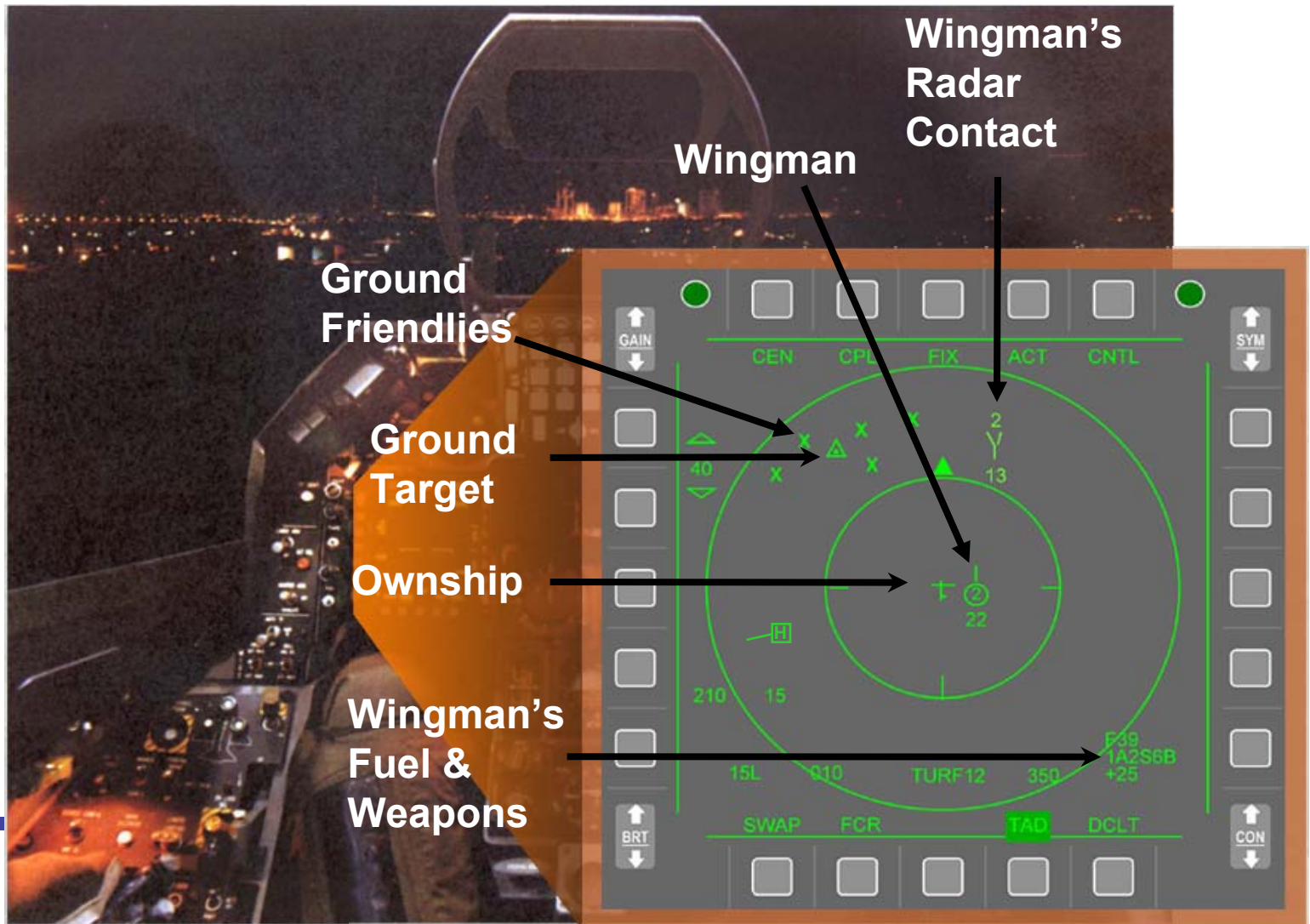
SADL GFAC Equipment

Ruggedized Laptop Creates "Digital CAS" Tasking Messages

SADL Radio transmits "Digital CAS" Messages To SADL-equipped Fighters

SADL GFAC Equipment:
FAC to Fighter Attack Brief

The pilot digitally receives exactly what was typed by the FAC

Airborne EPLRS in F-16 and A/O-10

F-16

Situation Awareness Data Link

1553B Radio

1553B Radio

Forward Air Controller

A/OA-10

Tactical Data Link Handoff System (TDLHS)

Lightweight Laser Designator Range Finder
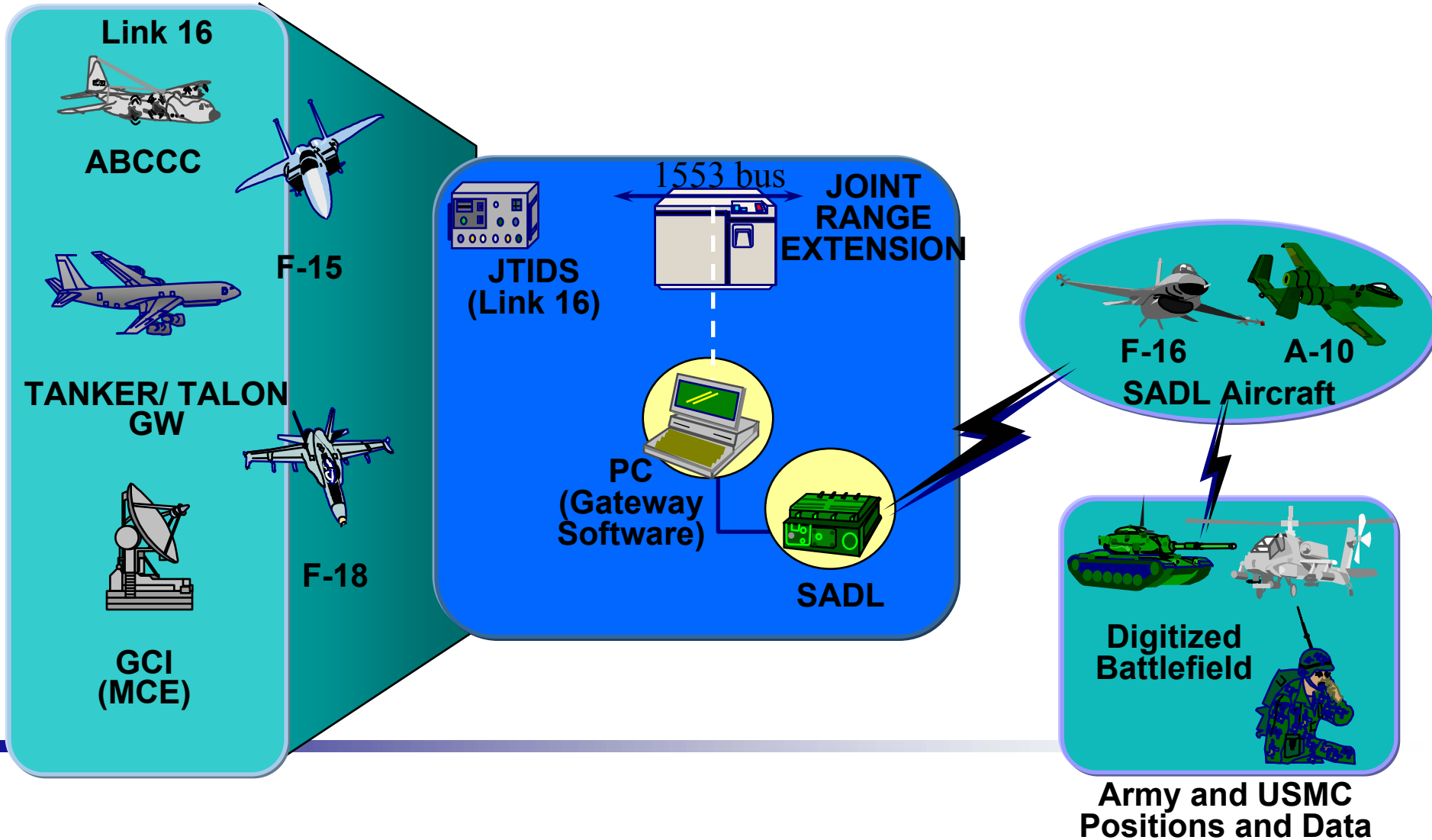
Ruggedized Handheld Computer
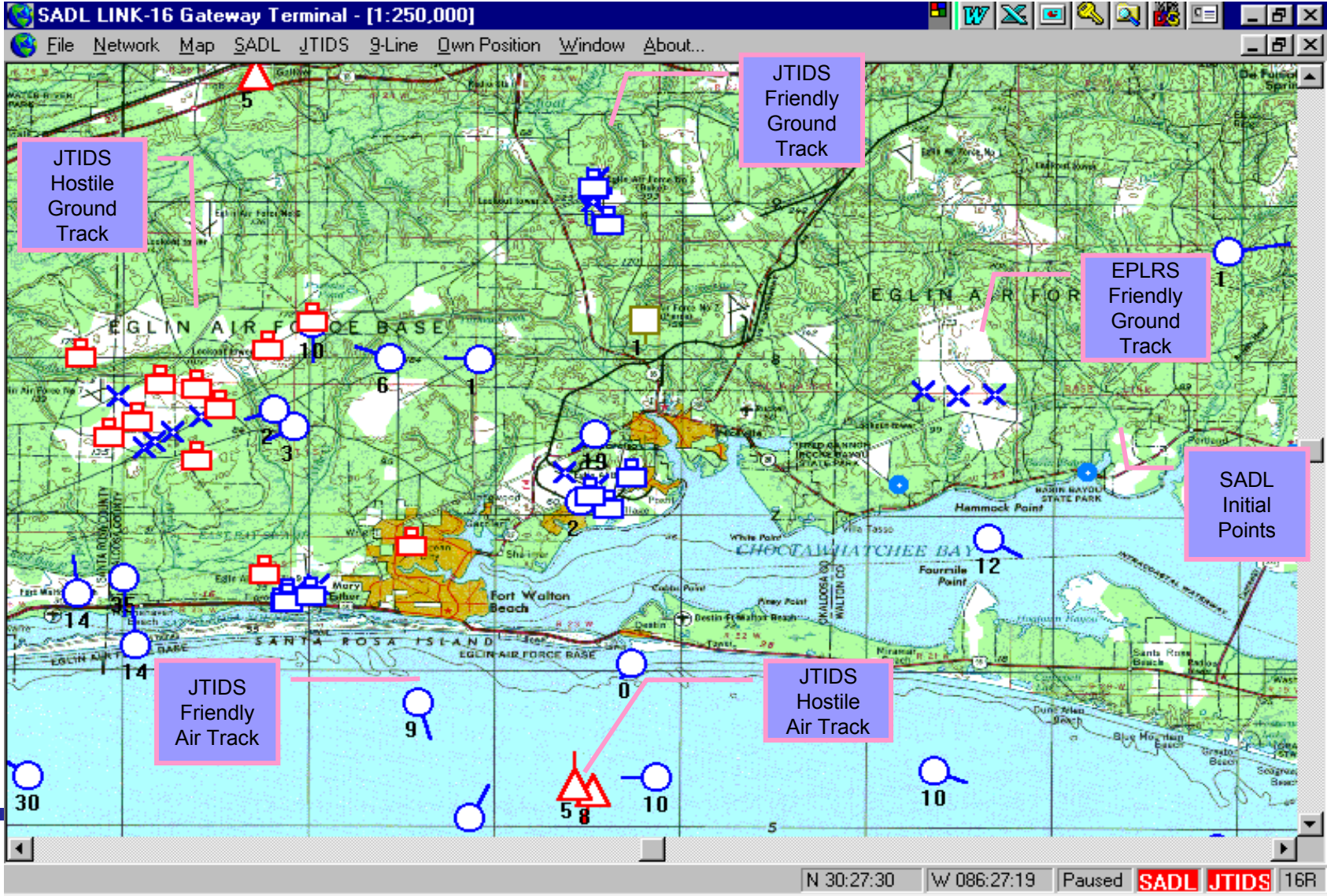
PRC-117

➡️ **CAS/Artillery**

Data Link Gateways

Link 16

ABCCC

F-15

TANKER/ TALON GW

F-18

GCI (MCE)

JTIDS (Link 16)

1553 bus

JOINT RANGE EXTENSION

PC (Gateway Software)

SADL

F-16   A-10

SADL Aircraft

Digitized Battlefield

Army and USMC Positions and Data

Data Link Gateways:

Composite Link 16/SADL FAC Display

is a system for use on the Air Force's premier fighter aircraft -- the F-15E Eagle and F-16C/D Fighting Falcon, as well as the Navy's F-14 Tomcat. LANTIRN significantly increases the combat effectiveness of these aircraft, allowing them to fly at low altitudes, at night and under-the-weather to attack ground targets with a variety of precision-guided and unguided weapons.

- LANTIRN consists of a navigation pod and a targeting pod integrated and mounted externally beneath the aircraft.
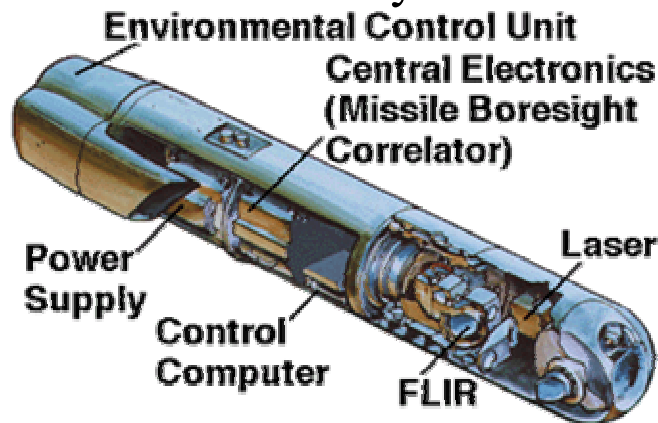
Targeting Pod AN/AAQ-14
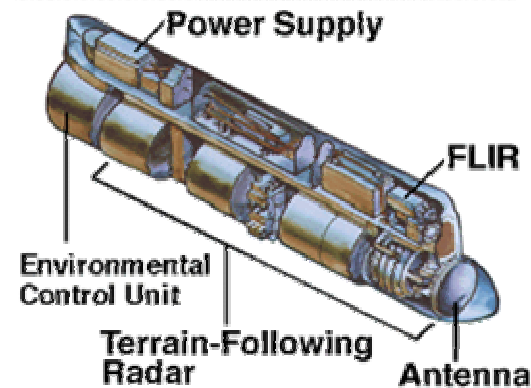
Navigation Pod AN/AAQ-13

- **General Background**
  - ☐ Mission specifics
    - ■ Timeframe, units involved, location
  - ☐ Friendly and enemy strengths, activities, capabilities
  - ☐ Terrain and weather effects
  - ☐ Individual and unit training and experience
  - ☐ Cultural differences between air and ground forces
    - ■ May be service-specific or medium (air/ground)-specific
    - ■ May involve the social domain of the CF
  - ☐ Networking systems available
    - ■ Experience with networked systems
  - ☐ Planning and preparation

Click here when finished

- **Quality of information**
  - ☐ Quality of Individual Information
    - The overall quality of information gathered from the network or from organic sources
    - Attributes: Correctness, Precision and Accuracy, Currency, Relevance
  - ☐ Quality of Individual Sensemaking
    - Ability to ascertain decision quality information out of the situation presented
    - Attributes: Correctness, Precision and Accuracy, Currency, Relevance, Uncertainty

Click here when finished

- **Collaboration and Information Sharing**
  - ☐ **Degree of Shared Information**
    - The degree to which information was shared among force entities
    - Attributes: Extent, Correctness, Precision and Accuracy, Currency, Relevance
  - ☐ **Degree of Shared Awareness**
    - Aspects of individual views of the battlespace that were shared across ground and air participants
    - Attributes: Extent, Correctness, Precision and Accuracy, Currency, Relevance, Uncertainty

Click here when finished

- Combat Effectiveness

  - **Finding the Target**: This involves making an accurate determination of the target's location and gaining a positive identification of the target that is shared among both the ground and air participants in the engagement.

  - **Engaging the Target**: This involves making the determination to "clear hot" (*Ground Participants*) or deciding to release ordinance (*Air Participants*) as well as the actual act of launching weapons against a hostile target.

  - **Assessing the Target**: This involves observing and critiquing the results of the engagement, performing a battle damage assessment (BDA), and gaining feedback to update target databases or to coordinate a re-attack.

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Fleshing out Sensemaking

- Cognitive psychology information-processing model used to assess the processes involved in the Cognitive Domain of NCO CF

- Model breaks Cognition into different stages

  - Perception
  - Pattern Recognition
  - Attention

  - Memory
  - Imagery
  - Language