NORTHROP GRUMMAN

DEFINING THE FUTURE

Future Integrated Fire Control

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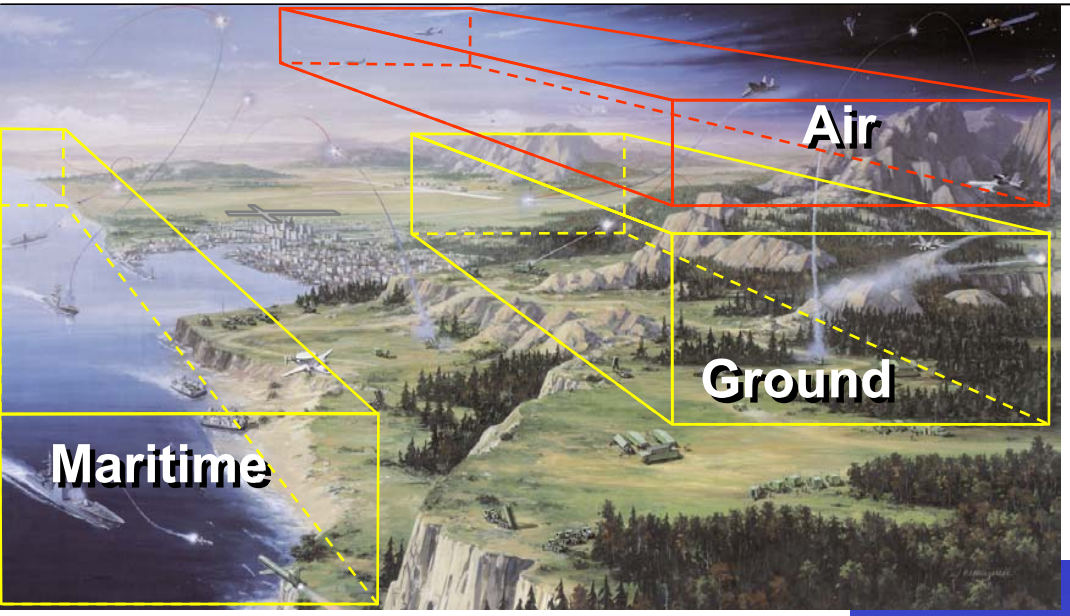
Future C2 Challenges:

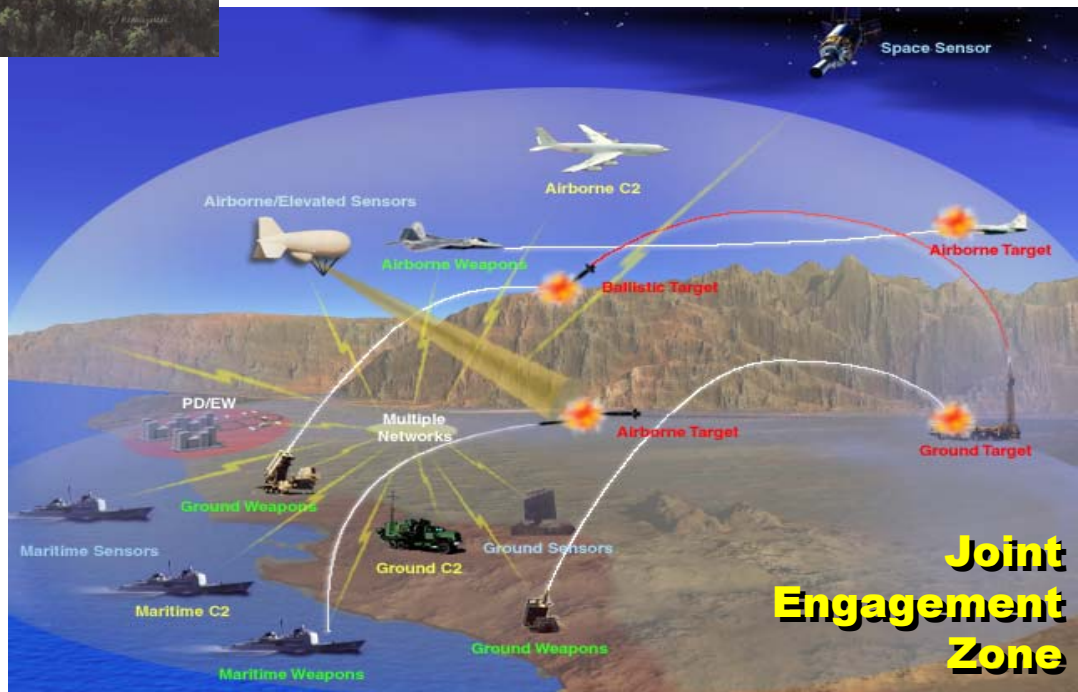
- Information Dominance
- Most Effective Use of Joint/Coalition Assets & Forces
- Dynamic Force & C2 Tailoring

C2 Challenges for Future Warfare



- Non-interoperable pictures: air, ground, maritime
- Non-interoperable units: ships, aircraft, land assets, etc.
- Uncoordinated C2/Decision-making: use of weapons & sensors is "platform-centric"

- JEZ: achieve ability for aircraft & interceptors to share airspace
- IFC: achieve ability to utilize non-collocated weapons & sensors to perform fire control
- Enhance C2 decision-making to support time-critical Joint (& Coalition) operations



The Role of C2

The role of C2 in warfare operations is to optimize the use of offensive and defensive resources to combat enemy threats.

Future advances in Joint C2 will rely on:

- Automated Decision-Making
- Advanced Data Fusion
- Enhanced Situational Awareness
- Distributed Resource Management
- Collaborative Time-Critical Missions
- Collaborative Planning & Dynamic Re-Planning
- Force-Wide Resource Optimization

Background

Research Goal:
To explore concepts and develop capabilities that achieve shared battlespace situational awareness among distributed forces and optimize the management of distributed warfare resources for Force-centric collaboration.

Sponsors:
- Joint Single Integrated Air Picture (SIAP) System Engineering Org.
- Navy's Common Command and Decision (CC&D) System
- Johns Hopkins University Masters Program

Major Participants:
- Mike Green, Naval Post Graduate School, Monterey, CA
- William Canfield, Lockheed Martin, Moorestown, NJ
- Ray Thornber, Galaxy Scientific, San Diego, CA
- Capt Jeff Wilson & JSSEO Staff, JSSEO, Arlington, VA

- **Integrated Fire Control**
- C2 Design Considerations
- Future C2 Concepts
- Key Capabilities Required
- Conclusion

IFC Definition

Integrated Fire Control (IFC) refers to the participation and coordination of multiple non-collocated warfare assets in tactical engagements of enemy targets

- IFC is the ability to develop fire control solutions from information provided by remote sensors

- IFC expands the weapon's effective kinematic range by removing dependency on range limits of the local sensors

- Future advances in aerospace warfare depend largely on IFC – the collaborative use of distributed warfare assets for time-critical aerospace engagements.

Why *Integrated* Fire Control?

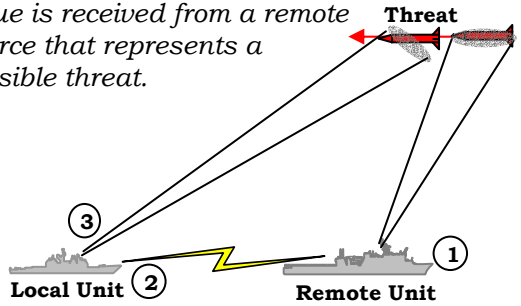
The ability to direct distributed warfare resources in a collaborative manner enables major enhancements for tactical fire control:

- Selection of the best shooter from a set of geographically distributed weapons
- Improved chance of interception (by selecting the optimal engagement geometry)
- Improved economy of weapon resources (by reducing redundant shots)
- Earlier launch decisions are possible (remote detection/precision tracking)
- Decoupling of local sensor/weapon pairing constraint
- Sharing engagement control – forward pass
- Off-board engagement support for guidance relay and target illumination
- Enhanced defense against complex threat environments (sophisticated or significant numbers of aerospace targets) – IFC may be a necessity for victory

IFC Variants

Precision Cue

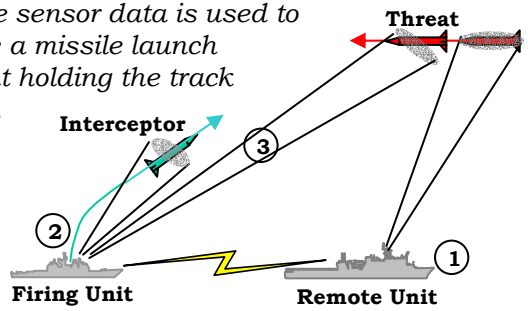
A cue is received from a remote source that represents a possible threat.



(1) Remote sensor detects threat.
(2) Local unit receives cue.
(3) Local unit tasks local sensor to detect and track threat.

Launch on Remote

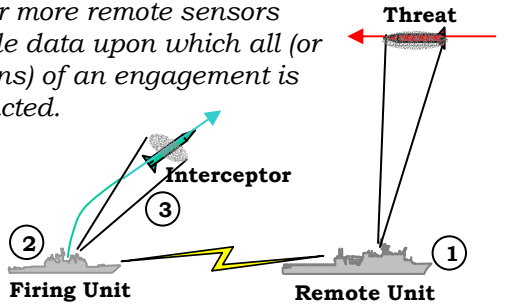
Remote sensor data is used to initiate a missile launch without holding the track locally.



(1) Remote unit provides FCQ threat data.
(2) Firing ship launches interceptor based on remote threat data.
(3) Local unit tasks local sensor to provide FCQ threat data for remainder of post-launch engagement cycle.

Engage on Remote

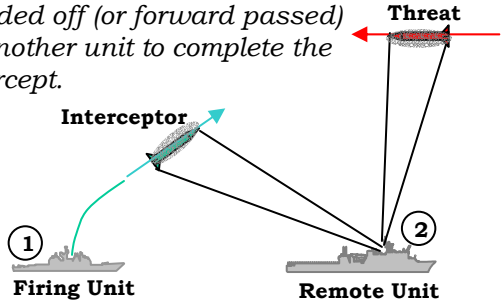
One or more remote sensors provide data upon which all (or portions) of an engagement is conducted.



(1) Remote unit provides FCQ threat data.
(2) Firing ship launches interceptor based on remote threat data.
(3) Remote unit continues to control engagement (compute & provide interceptor guidance, etc.) based on remote data.

Forward Pass

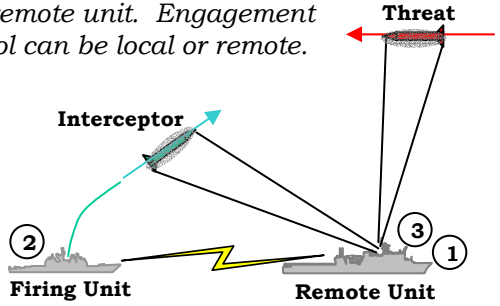
Control of the in-flight missile is handed off (or forward passed) to another unit to complete the intercept.



(1) Firing Unit launches interceptor & passes engagement control to Remote Unit
(2) Remote Unit takes over engagement control – tracks threat, passes guidance to interceptor, and illuminates threat when necessary

Remote Fire

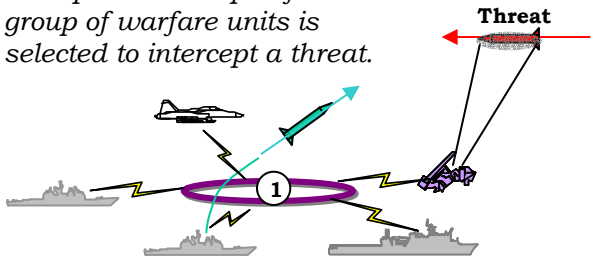
The decision to launch is made by a remote unit. Engagement Control can be local or remote.



(1) Remote unit makes decision that firing ship should launch.
(2) Firing ship launches interceptor.
(3) Remote unit (in this example) controls engagement (threat tracking, interceptor guidance, etc.).

Preferred Shooter Determination

The optimum weapon from a group of warfare units is selected to intercept a threat.



(1) The best shooter is selected based on optimum engagement geometry and engageability determination. PSD can be performed in conjunction with any of the other IFC variants. PSD is, in effect, Force-centric weapon-target pairing.

Fire Control Functions

Fire Control Function	Function Description
Object Observation	Sensor(s) observes aerospace object.
Object Tracking & Identification	Object is tracked and identified – sensor measurements are used to estimate an object's location, kinematics, identity & intent
Fire Control Quality Data Attainment	Data is obtained with enough accuracy and update rate to support engagement (launch decision, guidance calculations, and engagement control). (May involve sensor tasking or managing data path (dedicated or increased bandwidth))
Engagement Initiation	Decision is made to initiate defensive measures against an air target of interest (includes: threat evaluation, engageability determination, shooter selection, sensor support selection).
Guidance Calculation	Calculation is made of the interceptor guidance required to intercept target.
Engagement Control	Warfare resources are managed during engagement: weapon control; tasking sensors & communication resources; ensuring resource commitment; monitoring resource performance; validating FCQ data; monitoring engagement support; and negating (terminating) engagement if necessary.
Guidance Relay	Sensor or communication data path provides guidance (in-flight target updates (IFTUs) or target object maps (TOMs)) to interceptor while in flight.
Target Illumination	Sensor illuminates target to support interceptor homing to target.

- Integrated Fire Control
- **C2 Design Considerations**
- Future C2 Concepts
- Key Capabilities Required
- Conclusion

Design Considerations

The manner in which C2 functions are performed determines the degree of integration achievable and the ability to control Forces from a Force-centric perspective.

The key to achieving *integrated* C2 or fire control is the realization that common command and decision functions can be performed in a variety of manners:

[1] Locally or remotely
[2] From a Unit-centric or Force-centric perspective
[3] Using unique or common processing
[4] Centralized or De-centralized control
[5] Manually or in an Automated-fashion

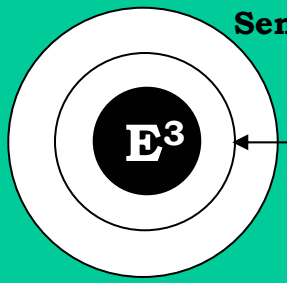
Local vs. Remote

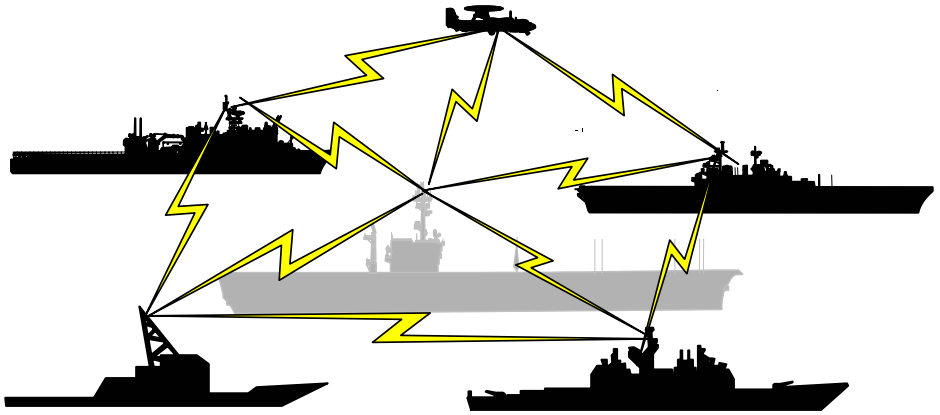
	PC Precision Cue	LoR Launch on Remote	EoR Engage on Remote	FP Forward Pass	RF Remote Fire	PSD Preferred Shooter Determination
Object Observation	R	R	R	L or R	R	L or R
Object Tracking & Identification	L & R	R	R	L or R	R	L or R
Fire Control Quality Data Attainment	L	R & L	R	L or R	R	L or R
Engagement Initiation	L	L	L	L	R	Force Perspective
Guidance Calculation	L	L	L	L or R	L or R	L or R
Engagement Control	L	L	L	L & R	L or R	L or R
Guidance Relay	L	L	L or R	L or R	L or R	L or R
Target Illumination	L	L	L or R	L or R	L or R	L or R

= Key function that, when performed remotely, distinguishes an IFC variant

Shifting to Force Level Thinking

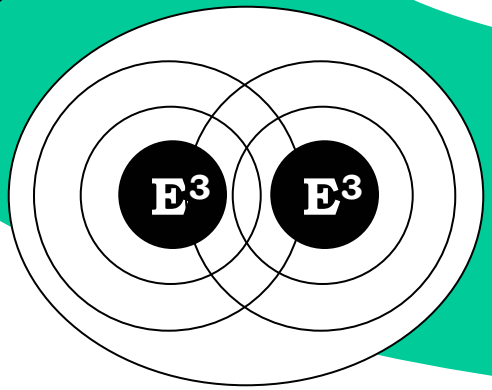
Single Unit



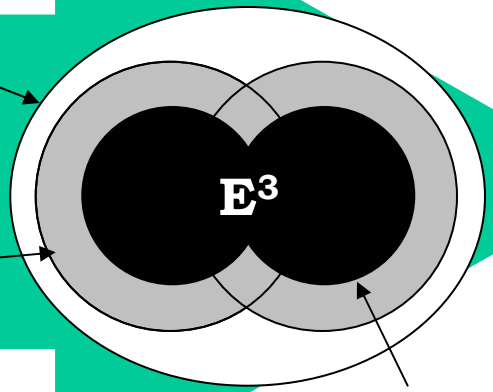


Network Centric Collaboration

Multiple Units (Non-collaborative)

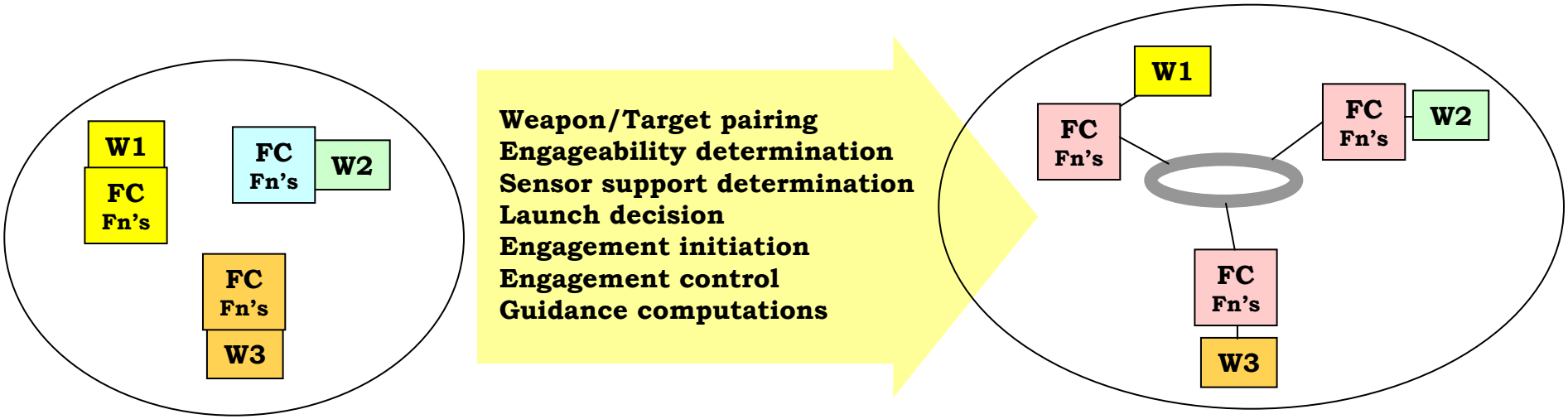


Multiple Units (Collaborative)



Unique vs. Common Processing

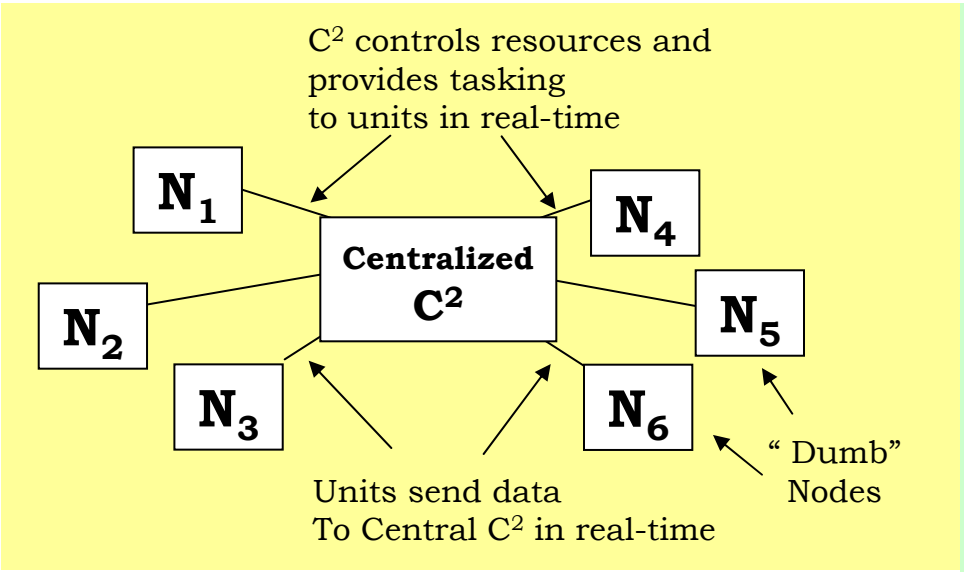
Another challenge lies in the necessary paradigm shift to performing C2 functions in an identical manner at each node. This difficult, yet necessary, shift is key to enabling more advanced forms of C2.

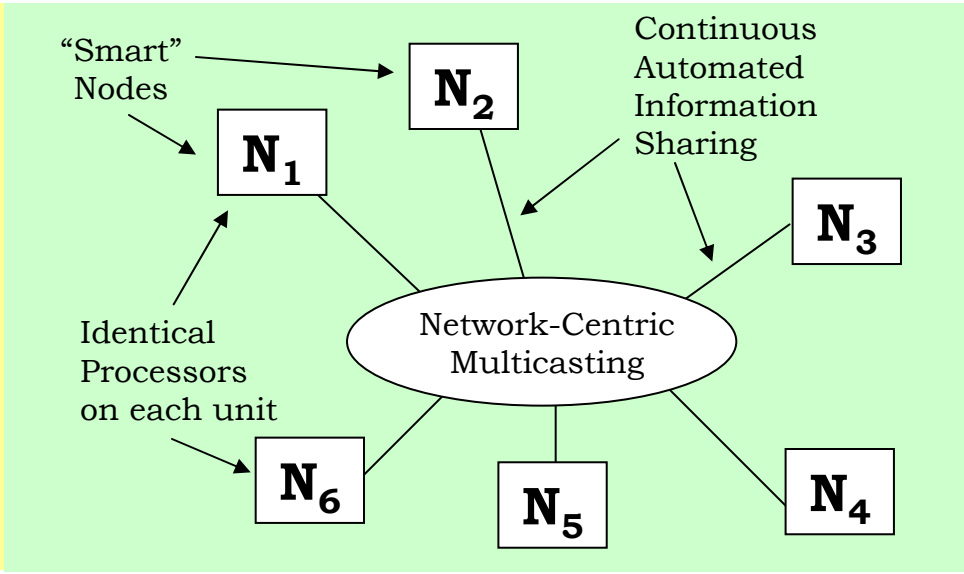


- The fire control focus is unit-centric
- Each weapon system is focused on it's own engageability—whether it's weapon will intercept the target
- Each weapon system cannot determine if it is the best shooter in the Force; and each will only consider local sensor support
- Forward Pass would be cumbersome if not impossible

- Fire control focus is Force-centric
- Requires access to information concerning all the relevant warfare resources within the Force
- Preferred shooter determination among Force's weapons is enabled
- Advanced forms of IFC requiring automation such as LoR and EoR are more effectively performed
- Performing fire control functions in an identical manner on each unit enables control of engagement to be more easily passed between units

Centralized vs. De-centralized





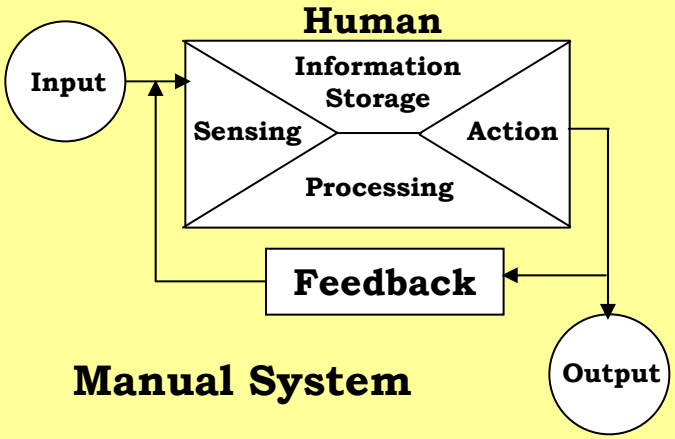
C2 can be performed using a centralized decision node approach; however there are major advantages to adopting a decentralized approach:

• The biggest factor is the latency involved in centralized C2. Aerospace warfare places high demands on rapid decision-making and responses - waiting for a launch decision to be made at a remote central decision node may not be an option.

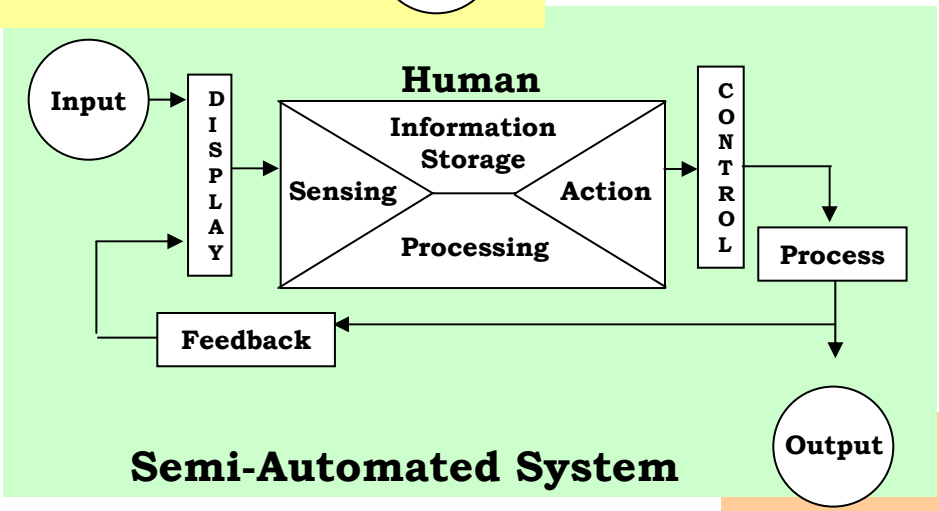
• Distributing command authority for interceptor launch decisions to the unit level is a long-standing tradition and has its obvious merits.

• Equipping distributed units with common algorithms to produce identical engagement recommendations enables a decentralized, yet Force-centric approach and eliminates a single point of failure

Manual vs. Automated

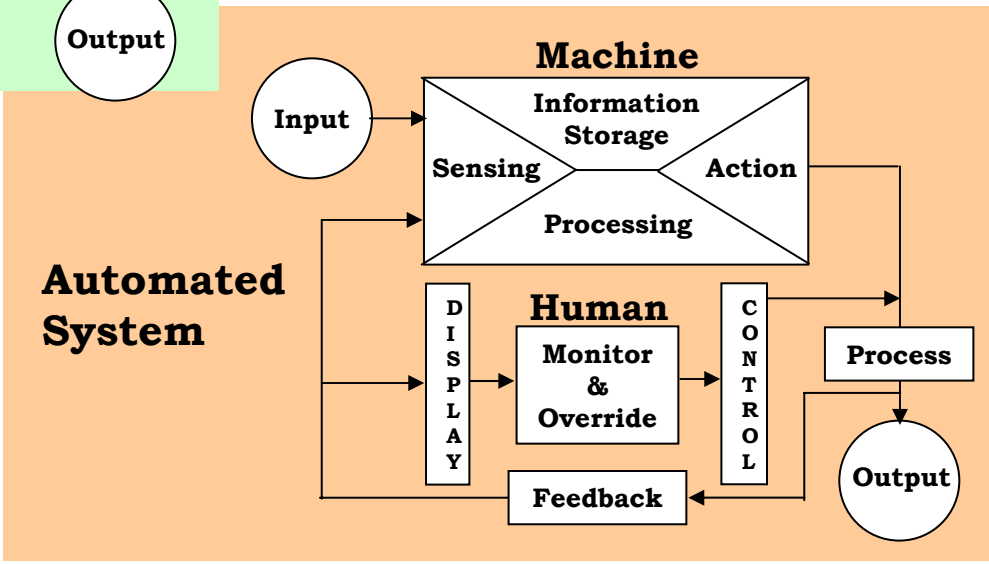


Manual Decision-making
- Humans make distributed collaboration decisions
- Humans communicate over voice communications or "intranet chat" to commit resources for IFC



Semi-Automated Decision-making
-Humans make distributed collaboration decisions with aid of machine-fused & shared picture
- Resource control, tasking, and commitment performed using automated feedback and control processes

Automated Decision-making
- Machines perform decision-making capabilities as well as feedback processing, information display, and control.
- Machine-generated decision options are presented to human for monitoring and command by negation (overriding automated decisions).



Command Authority

C2 must be designed to permit local control of warfare assets, thus maintaining organic command authority, while enabling Force-level optimized asset utilization, control, and collaboration across distributed warfighting units or hosts.

- Perform launch decision locally
- Use common decision aids that recommend resource usage (e.g., weapon-target pairing) with Force-wide perspective
- Ensure local operators always have ability to override local resource taskings generated in an automated fashion
- Maintain operator ability to manage resources manually

C2 Design Principles

The following design principles are key to advancing future C2 capabilities:

[1] Enable fire control functions to be performed locally or remotely
[2] Utilize warfare resources from a Force-centric perspective
[3] Shift common command and decision functions from unique methods to common processes
[4] Design C2 into a decentralized architecture
[4] Enable C2 decision-making to be performed in an automated-fashion
[5] Perform IFC while enabling local Command Authority

- Introduction to IFC
- IFC Design Considerations
- **Future C2 Concepts**
- Key Capabilities Required
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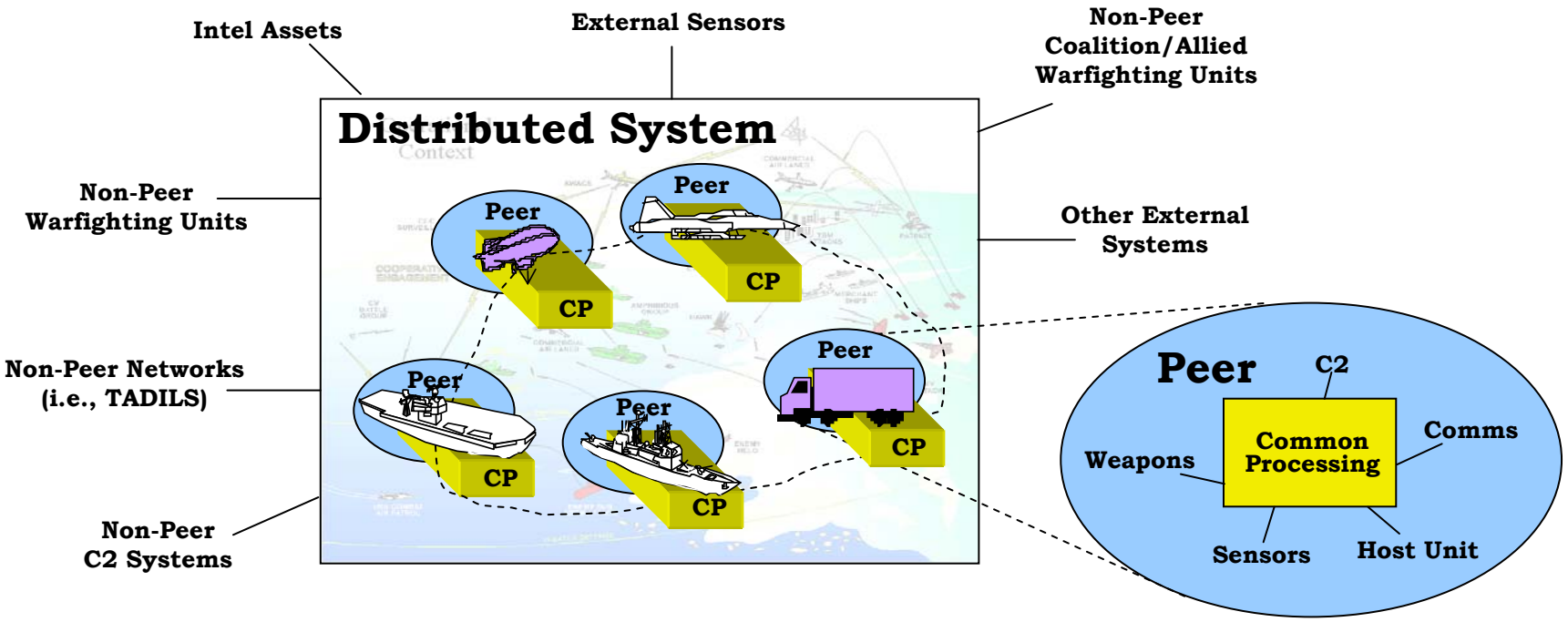
Future C2 Concepts

[1] Implement an architecture that combines a network centric paradigm with automated intelligent management of sensors, weapons, and links to overcome individual system limitations and enable collaborative engagements; and
[2] Provide automated engagement decision aids that use "common" algorithms and shared tactical data to simultaneously produce identical engagement recommendations at each distributed unit

Characteristics:
- **Dynamically updateable doctrine**
- **Decentralized architecture**
- **Synchronized information, doctrine, decision aids**

Each smart node determines optimum force-level resource management option & gains nodal agreement prior to tasking resources

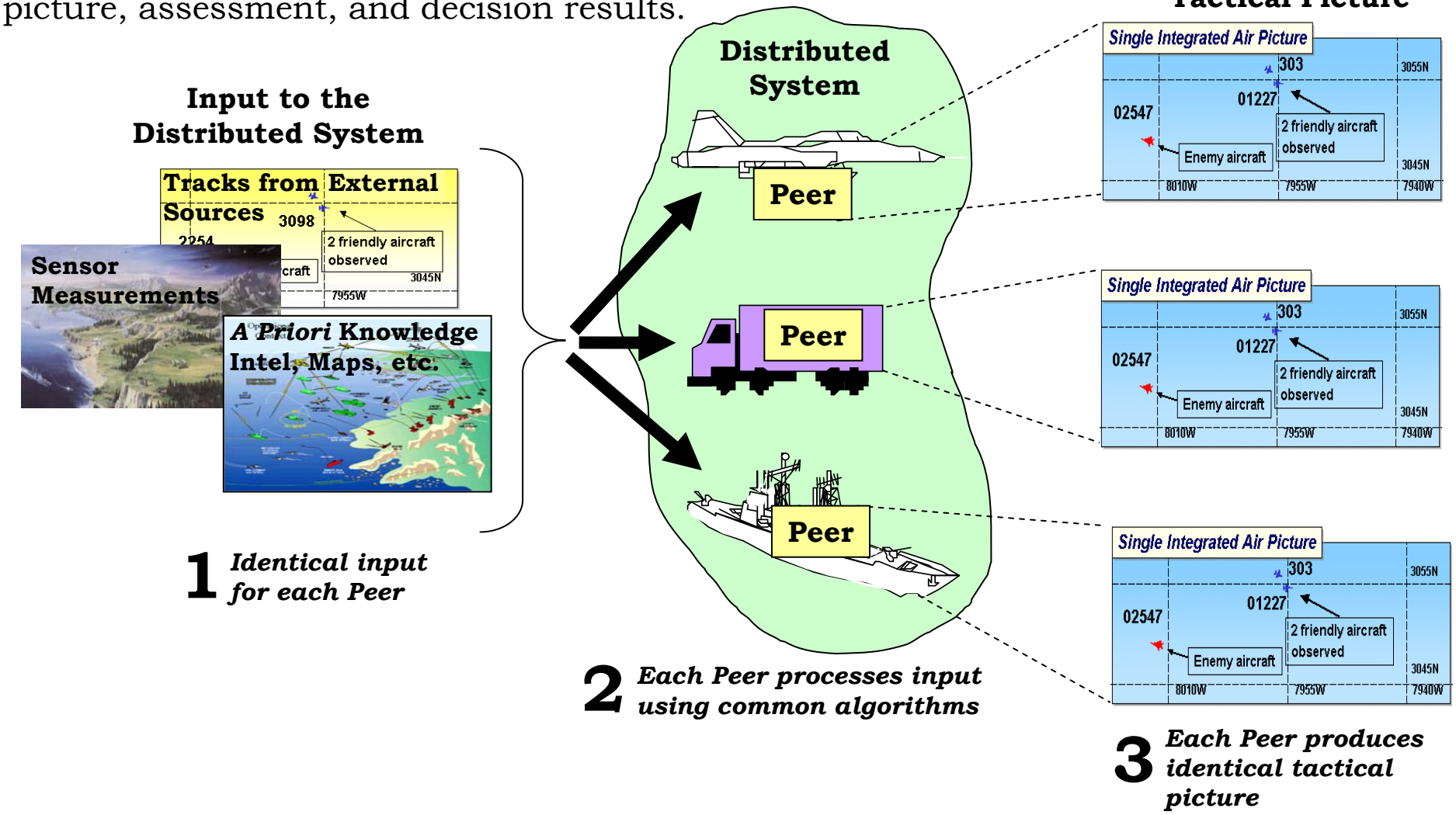
Distributed System of Peers



- Each warfighting unit implements common processing algorithms to perform Joint tactical BMC2 functionality.
- A peer is defined as the common C2 processing integrated with a unit's warfare resources.
- A "system" of distributed peers interacts or collaborates by sharing information over a Peer-to-Peer (P2P) network.

Common Processing Philosophy

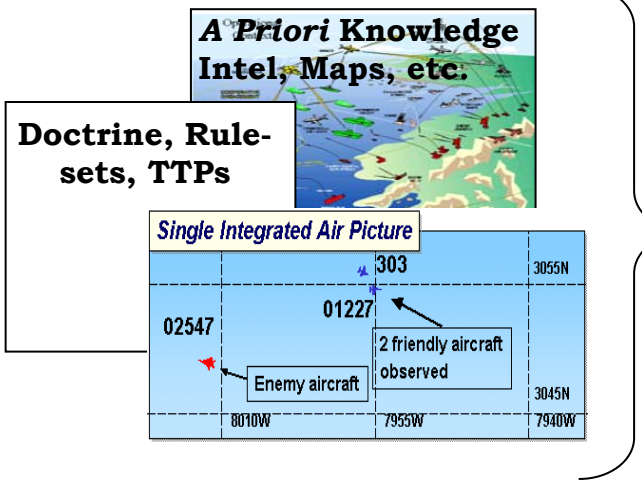
The philosophy, simply stated, is that common processing algorithms provided with identical data & information input will produce identical picture, assessment, and decision results.



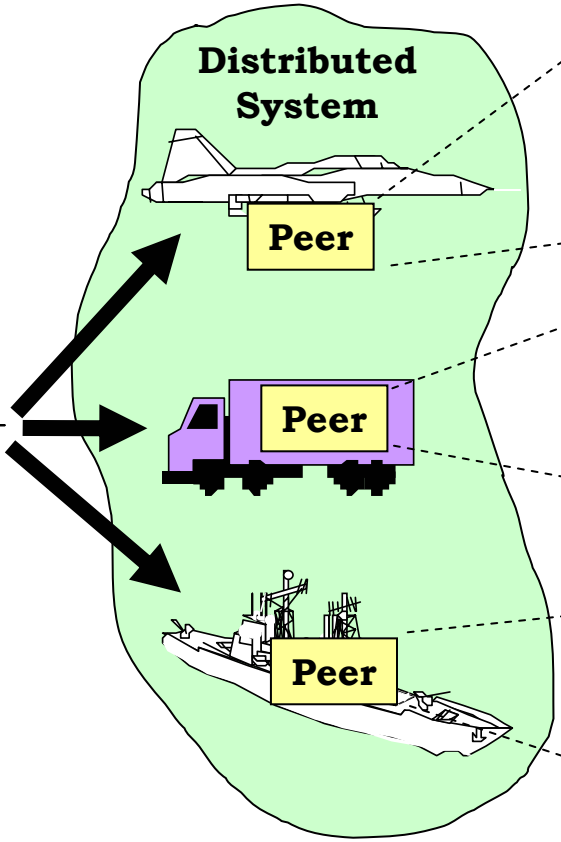
Common Processing for C2

Take the "Common Processing" Philosophy One Step Further:
Equip each IABM with common decision-making and advanced data fusion algorithms, which when fed identical track pictures (or data sets), allows each to produce identical resource tasking recommendations.

Input to the Distributed System

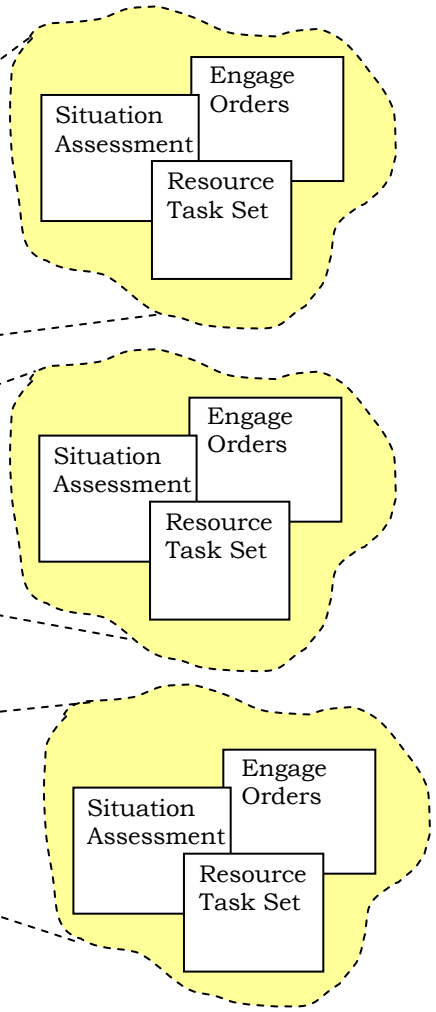


1 ***Identical input for each Peer***

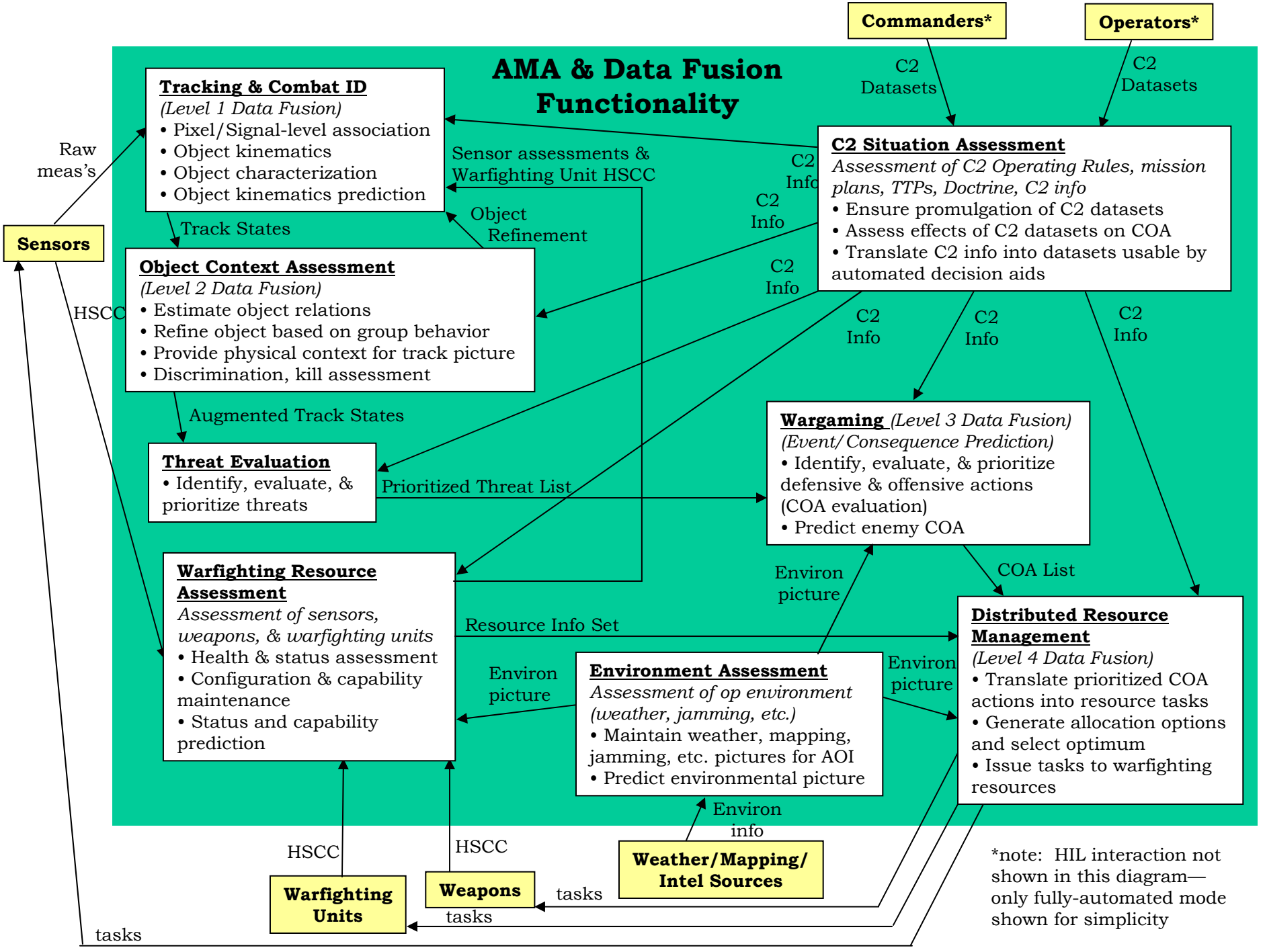


2 ***Each Peer processes input using common algorithms***

Peer Products



3 ***Each Peer produces identical results***


AMA & Data Fusion Functionality
Commanders*
Operators*
C2 Datasets
C2 Datasets
Tracking & Combat ID
(Level 1 Data Fusion)
• Pixel/Signal-level association
• Object kinematics
• Object characterization
• Object kinematics prediction
C2 Situation Assessment
Assessment of C2 Operating Rules, mission plans, TTPs, Doctrine, C2 info
• Ensure promulgation of C2 datasets
• Assess effects of C2 datasets on COA
• Translate C2 info into datasets usable by automated decision aids
Raw meas's
Sensors
Sensor assessments & Warfighting Unit HSCC
Object Refinement
Track States
C2 Info
C2 Info
C2 Info
C2 Info
C2 Info
C2 Info
HSCC
Object Context Assessment
(Level 2 Data Fusion)
• Estimate object relations
• Refine object based on group behavior
• Provide physical context for track picture
• Discrimination, kill assessment
Augmented Track States
Threat Evaluation
• Identify, evaluate, & prioritize threats
Prioritized Threat List
Wargaming (Level 3 Data Fusion)
(Event/Consequence Prediction)
• Identify, evaluate, & prioritize defensive & offensive actions (COA evaluation)
• Predict enemy COA
Environ picture
COA List
Warfighting Resource Assessment
Assessment of sensors, weapons, & warfighting units
• Health & status assessment
• Configuration & capability maintenance
• Status and capability prediction
Resource Info Set
Distributed Resource Management
(Level 4 Data Fusion)
• Translate prioritized COA actions into resource tasks
• Generate allocation options and select optimum
• Issue tasks to warfighting resources
Environ picture
Environment Assessment
Assessment of op environment (weather, jamming, etc.)
• Maintain weather, mapping, jamming, etc. pictures for AOI
• Predict environmental picture
Environ picture
Environ info
HSCC
HSCC
Weather/Mapping/ Intel Sources
Warfighting Units
Weapons
tasks
tasks
tasks
*note: HIL interaction not shown in this diagram—only fully-automated mode shown for simplicity

Common C2 Processing Products

Products of AMA and Data Fusion Process:
- Preferred shooter determination
- Weapon-Target Pairing
- Sensor Support for Engagements
- Engagement Control Strategy (i.e., forward pass)
- Engagement Preferences (intercept geometry)

Example: each distributed unit uses "common" algorithms to produce identical Force-level engagement recommendations. Therefore, each unit arrives at the same conclusion that a particular weapon has the best shot and that a particular sensor (not necessarily collocated with the weapon) can best track and/or illuminate the target.

- Integrated Fire Control
- C2 Design Considerations
- Future C2 Concepts
- **Key Capabilities Required**
- Conclusion

Key Capabilities Required

Collaborating units need to determine:

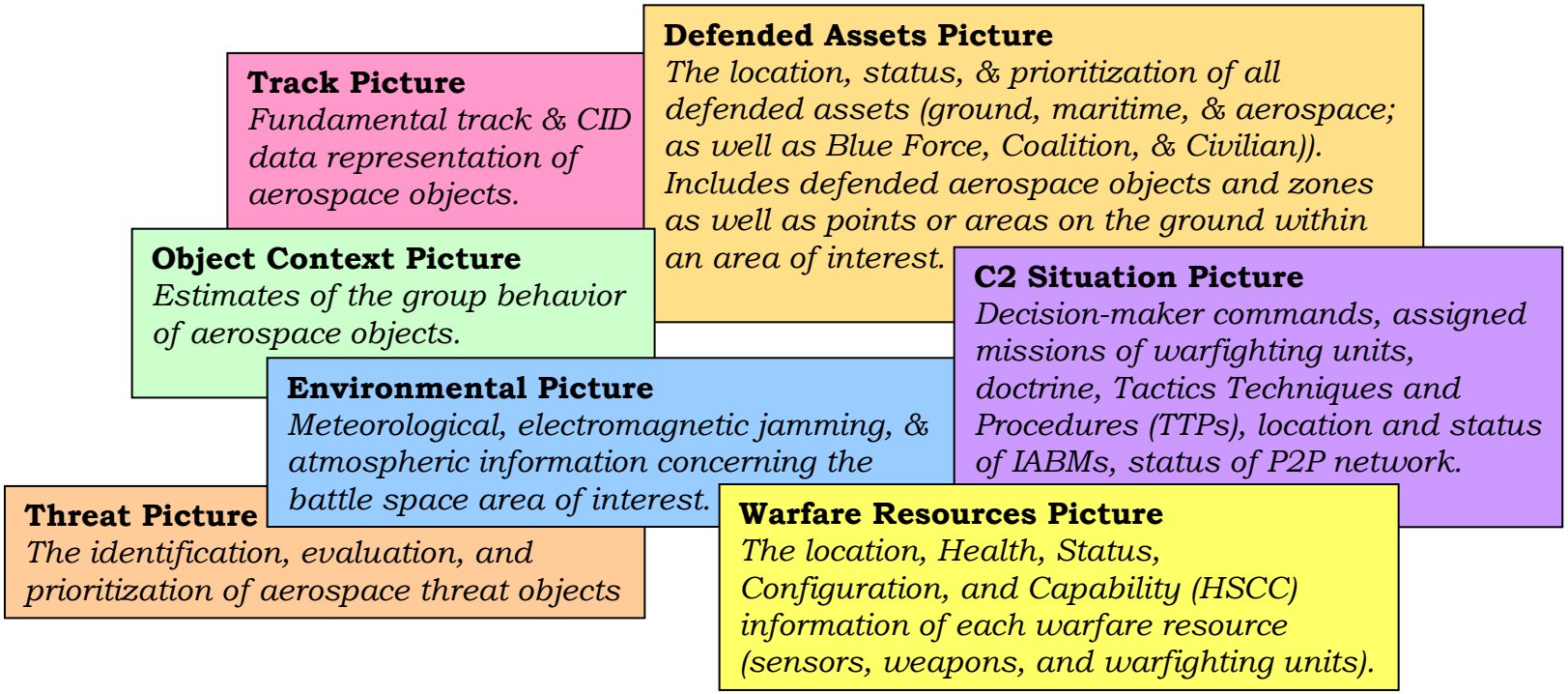
- Preferred shooter
- Weapon-Target Pairing
- Sensor Engagement Support Strategy
- Engagement Control Strategy (i.e., forward pass)
- Engagement Preferences (i.e., forward pass)

What capabilities are needed?

- Shared Situation Awareness
- Determination of Best Course of Action
- Distributed Resource Management
- Embedded C2 Planning

Shared Situation Awareness…

… is key because each unit needs identical, complete, accurate, & timely awareness (knowledge) of the operational situation.



Shared Situation Awareness (SA) is the ability of distributed units to gain an understanding of the totality of the tactical situation, including the threat, the defended assets, the readiness of warfighting resources, and command and control constraints within which the systems must operate.

Data Processing & Fusion

Shared SA relies on:
Data processing and data fusion algorithms to assess and develop a representation of the real situation

Situation Assessment Capabilities

Tracking & Combat ID
- Pixel/Signal-level association
- Object kinematics
- Object characterization
- Object kinematics prediction

C2 Situation Assessment
Assessment & Adoption of Blue Force C2 inputs
- Ensure peer promulgation of commands
- Translate C2 inputs into system operating rules, constraints, & parameters

SA Certification
- Assessment of track quality
- Assessment of track ID confidence
- Certification of fire control quality SA

Object Context Assessment
- Estimate object relations
- Refine object ID & typing based on group behavior
- Provide physical context for track picture
- Discrimination, kill assessment
- Maintain defended assets picture

Warfighting Resource Assessment
Assessment of sensors, weapons, & warfighting units
- Health & status assessment
- Configuration & capability maintenance

Environment Assessment
- Develop & maintain environmental picture (weather, mapping, jamming, etc.) for AOI

Peer Evaluation
- Assessment of Peer processing performance
- Peer health & status assessment

Threat Evaluation
- Identify, evaluate, & prioritize threats

Force Readiness Assessment
Fusion of assessments
- Determination of overall readiness of warfighting forces

Information Architecture

Shared SA relies on:
An appropriate information architecture to enable data sharing among distributed units.

Peer-to-Peer (P2P) Network Capabilities

Objectives for Information Sharing:
Based on Force-centric de-centralized architecture
• Allows warfare resources to be managed according to Force-level needs (rather than unit-centric needs)
• Manages network to enable special data distribution needs during engagements. (higher data rate or throughput)

Information Dissemination Capabilities:
• Determines needs of information-recipient users or decision nodes (data advertisements/ subscriptions)
• Tracks data availability
• Establishes routing paths & maintains connectivity
• Optimizes bandwidth usage
• Determines feasibility of transmission/checks link status
• Sends and receives commands to/from remote link managers to control, manage, & synchronize transmission
• Transmits data/information according to local/remote synchronized commands

Information Exchange Required:
• Associated Measurement Reports
• Resource information: HSCC
• C2 Datasets (Doctrine, TTPs, plans, manual commands)
• Resource Tasking Requests
• Resource Commitment "Handshakes"

Data Exchange Characteristics:
• Supports real-time P2P exchange of sensor measurement data
• Broadcast/Multicast/Point-to-Point
• Non-real-time traffic for operations control
• Link monitoring
• Quality of Service delivery
• Data integrity and confidentiality
• Bandwidth allocation/monitoring
• Data dissemination prioritization (for time-sensitive data or bandwidth constraints)
• Ad hoc nodal topology (nodes can easily join or leave network)
•Interfaces with Tactical Data Links (TDLs)

Determination of Best COA…

… is key for determining that a threat requires defensive measures—taking into account possible ramifications (Effects Based Operations)

Situation Prediction

Environment Prediction
- Predict weather for AOI
- Predict possible jamming/clutter

Resource Projection
Prediction of sensors, weapons, & unit performance
- Availability & capability prediction

Wargaming – Event/Consequence Prediction
Prediction of sensors, weapons, & unit performance
- Predict threat
- Predict & evaluate enemy COA & intent
- Identify, evaluate & prioritize blue force COA
- Evaluate effects of C2 inputs on blue force COA
- Analyze historical trends

Force Projection
Prediction of Force Readiness
- Prediction of overall force readiness & capabilities

- Projects the current situation into the future to estimate the enemy COA and potential impact of the blue force's planned actions.
- Develops and assesses alternative futures or hypotheses concerning the current situation and possible COAs.
- Assigns quantitative confidence values to potential COAs
- Enables collaborative planning, effective resource management, and dynamic replanning

Distributed Resource Management...

... is key to enabling and optimizing the use of distributed resources for collaborative and integrated fire control

Distributed Resource Management

Engagement support strategy after launch
- Forward pass (preferred eng control option)
- Remote guidance relay (preferred sensor arrangement)
- Remote target illumination (preferred sensor support)

Selective engagement
- Selection of best option if multiple engagement options along the threat trajectory exist

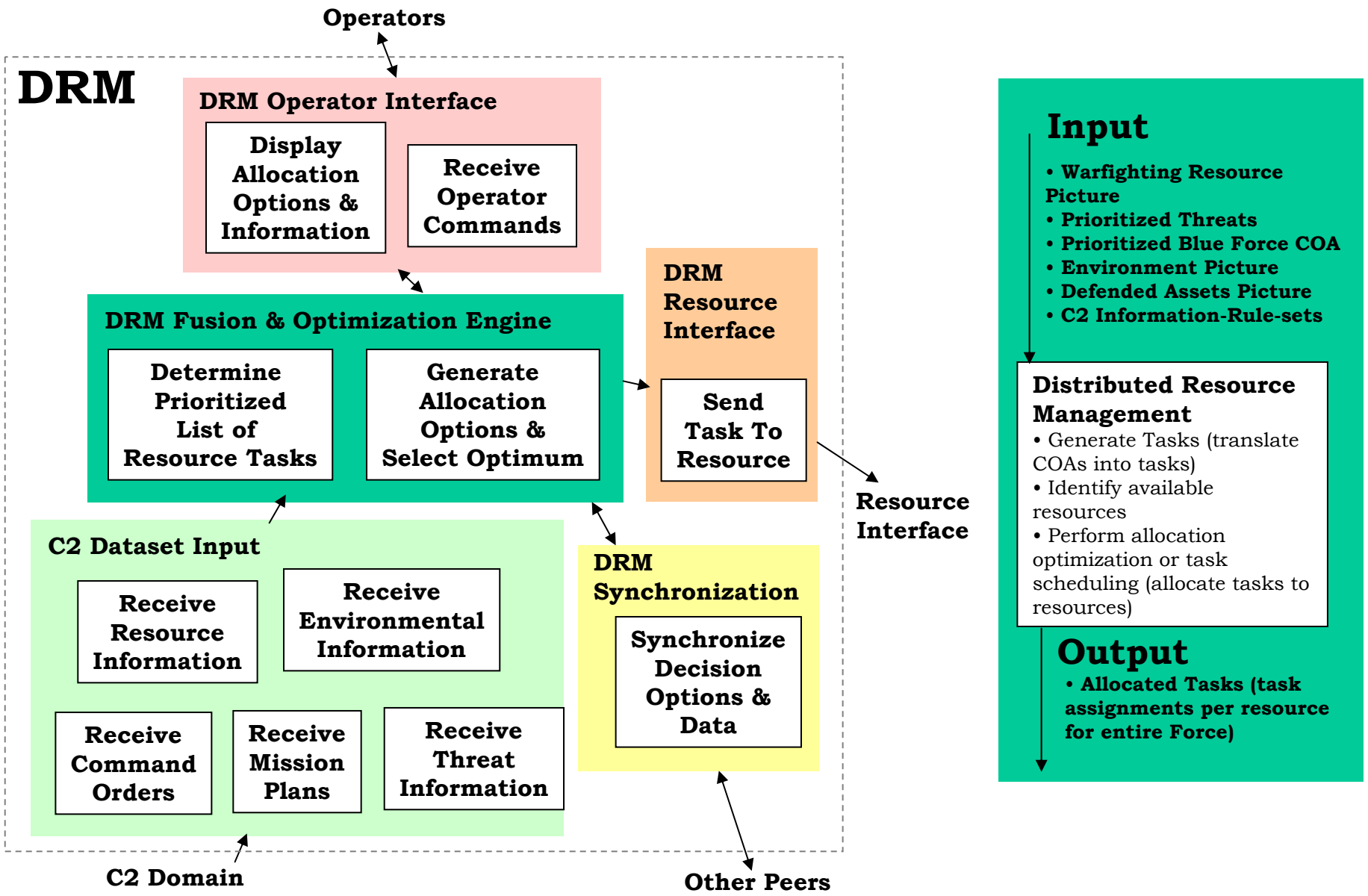
Launch determination
- Receive threat & COA determination
- Assess engageability of weapon options
- Determine intercept probability
- Decide to launch (or not)

Engagement support strategies
- Threat detection/cue
- FCQ data availability
- Sensor tasking/commitment
- Preferred sensor arrangement

Weapon-target pairing
- Preferred shooter determination
- Engageability of weapon options

- Based on the use of automated management (or decision) aids to determine and recommend optimum uses of warfare resources
- Using identical AMAs on distributed units enables decisions to be made in a timely manner to support time-critical engagement operations.
- Each distributed unit uses distributed resource management AMAs to determine tasks for all resources within the community of interest (COI)
- Resident operators always have ability to override resource tasking recommendations for local resources; thus command authority is upheld.

DRM Capability



Embedded IFC Planning…

… is key to the automated orchestration of IFC operations

Built-in planning prior to operations is a key enabler of AMAs:
- Predicting operational situations that require collaborative fire control
- Establishing prioritization schemes for missions, threats, defended areas, weapons, tactics
- Establishing rule sets to guide resource behavior for IFC operations
- Establishing parameters to control engageability calculations, target-weapon pairing, target identification/threat evaluation, & sensor tasking
- Establishing decision logic

Deliberate Planning is the predetermination of resource utilization.

Defense Planning - "Macro" Planning
- Assigning resources to missions
- Allocating areas/zones within theater
- CINC priorities
- Identifying critical assets

Defense Design – "Micro" Planning
- Specific TTPs
- Rule sets
- Initialization parameters
- Correlation Track Quality Values

Dynamic Planning is the modification of plans during operations

Dynamic Planning Functions:
- Replanning – dynamic creation of new plan
- Refinement of plan
- Reassignment of resources
- Ad hoc operations
- Alteration of rule sets
- Reset of parameters
- Reestablishing prioritization

Why Dynamic Planning is Useful:
- Plan implementation needs to reflect reality
- Resources change (things break, resources become unavailable)
- Enemy prediction never 100% accurate (unexpected events, enemy COAs, & threats)

- Integrated Fire Control
- C2 Design Considerations
- Future C2 Concepts
- Key Capabilities Required
- **Conclusion**

Conclusion

- Using distributed resources in an integrated and collaborative manner takes advantage of network-centric advances and is the key to future air warfare and missile defense advances

- Design principles guiding advanced C2 solutions include a de-centralized architecture, automating processes, using common fire control functions across the force, and using a force-wide perspective in managing resources

- The proposed strategy distributes C2 “power” to the edge: missile defense systems maintain self-contained command authority while also becoming full participants in force-centric family of systems

- Key capabilities required include: shared SA, determination of best COA, DRM, and embedded IFC planning.

BACK UP CHARTS

Development Strategy

Objective Capability Levels:

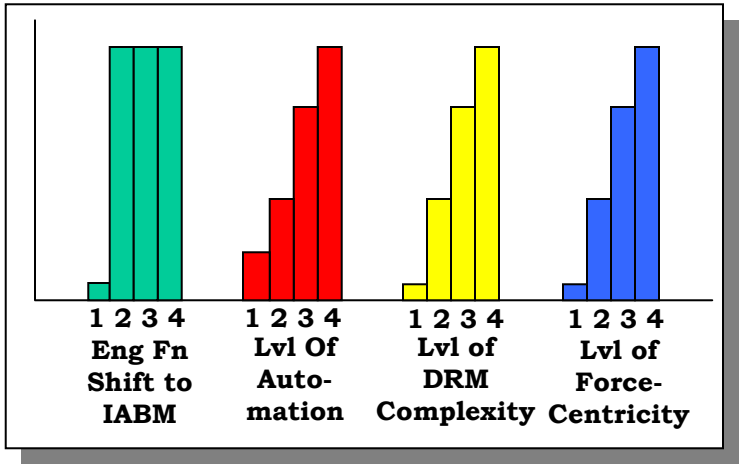
[1] Enhanced Air Picture: cleaner/better/common
[2] AMA for weapon/target & sensor/target pairing ("best" weapon, "best" target, "best" kill location, "best" tactics)
[3] Full AMA/DRM: IFC competes with other mission areas for resources

Development Strategy:

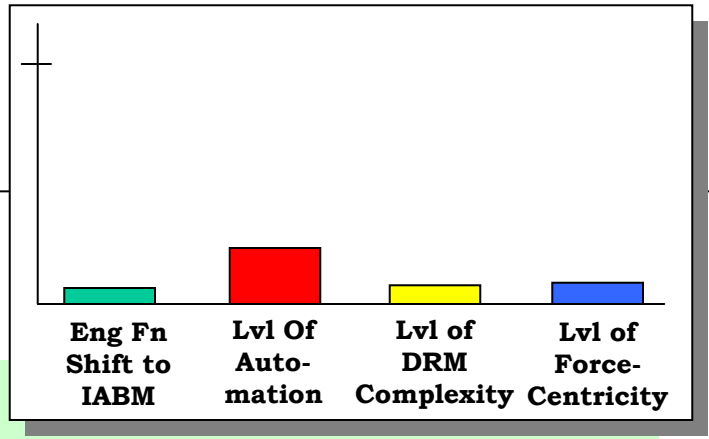
- Develop system capabilities to reach at least level [2] objective
- Build in increments or spirals that afford intermediate IFC capabilities

Spirals:

[1] NCW Foundation: Sharing high quality data for fire control
[2] Request-based IFC & common engagement functionality
[3] Basic semi-automated & force-centric IFC
[4] Fully Automated & Optimized IFC



1st IFC Development Spiral



➢ **NCW Foundation: Sharing high quality data for fire control**

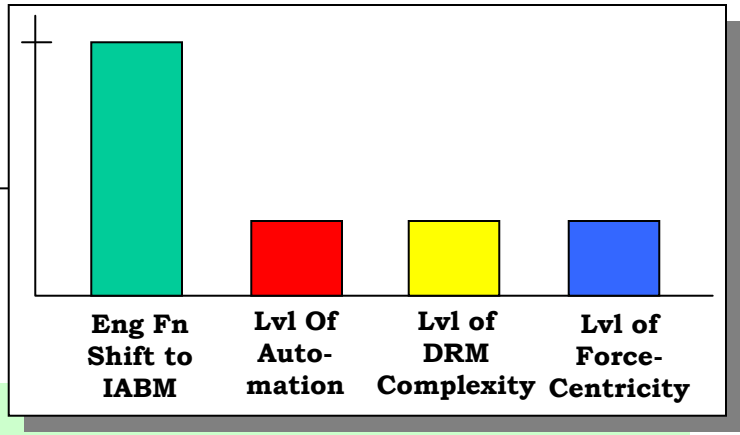
System Capabilities Required:

- Track certification
- Enhanced networks for sharing measurement data with high rates and throughput
- Automated sensor task requests broadcast within COI
- Basic sensor request prioritization scheme (for when multiple requests are received)
- Engagement notification broadcast within COI

IFC Capabilities Achieved:

- **Precision Cue** – receipt of a remote "cue" or alert of a potential threat target
- **Engagement Notification** – notification to COI when a weapon fired
- **Request for Off-board Sensor Support** – request broadcast within COI for remote sensor data to provide precision cue (surveillance) or higher track accuracy.
- **Positive Interceptor Identification** – absolute (100% confidence level) identification of aerospace object within track picture that represents interceptor
- **Basic Launch on Remote or Composite** - engagement is prosecuted on the available filtered track state. However, the weapon system performs engagement functions and the local sensor must be capable of supporting the engagement after launch as a back up if the composite track state is not sufficient.
- **Semi-automated EoR** - Use of remote FCQ data to support EoR; however, remote sensor support tasking and commitment requires Operator (or manual) in the loop

2nd IFC Development Spiral



➢ **Request-based IFC & common engagement functionality**

System Capabilities Required:

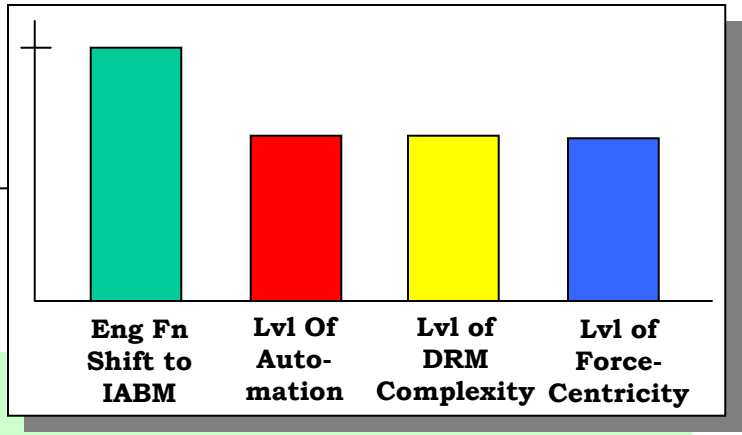
- Networks share sensor resource information (HSCC) among distributed units
- Automated sensor resource scheduling/prioritization schemes
- Self-monitoring (to determine incomplete picture or low quality track data)
- Automated weapon task requests broadcast within COI
- Intelligent application of best data fusion algorithms and best available data to produce most accurate target track
- Launch decision (engageability) functionality shifts from weapon system to IABM

IFC Capabilities Achieved:

- **Request-based EoR** – request broadcast within COI for remote sensor to provide FCQ data on threat throughout duration of engagement
- **Request-based Shooter Selection** - request broadcast within COI for remote weapons to intercept a particular threat
- **Automated LoR (or composite)** – IABM computes launch decision for local weapon based on composite track picture or best available data & data fusion processes

3rd IFC Development Spiral

- **Basic semi-automated & force-centric IFC**



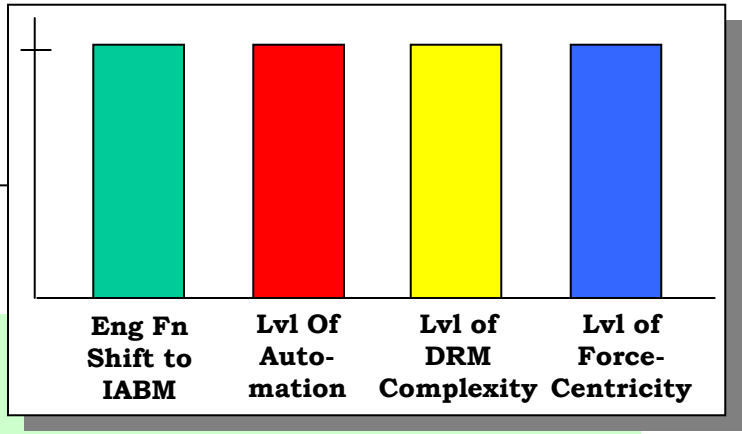
System Capabilities Required:

- Enhanced automated sensor scheduling techniques
- Request-based distributed resource management
- Basic automated management aids
- Basic deliberate planning

IFC Capabilities Achieved:

- **Enhanced Request-Based IFC** - All request-based IFC capabilities (such as EoR, selecting the best shooter, tasking sensors to enhance the picture) are enhanced because each distributed unit manages local sensors and weapons using automated common IABM processes (rather than having to interact with Operators or local sensor/weapon systems).
- **Basic Preferred Shooter Determination** - Distributed units simultaneously determine the optimum shooter for each threat based on their situation awareness of battlespace and weapon HSCC.

4th IFC Development Spiral



➢ **Fully Automated & Optimized IFC**

System Capabilities Required:

- Advanced data fusion and situation assessment
- Advanced COA determination (effects based operations)
- Fully automated DRM
- Deliberate and dynamic planning

IFC Capabilities Achieved:

- **Automated IFC** – distributed units simultaneously determine the optimum distributed resource engagement strategies involving the best use of distributed sensors, weapons, and C2 resources; and then task local resources based on the Force-level determinations. Advanced IFC strategies achieved include:
  - **Distributed sensor management**
  - **Preferred shooter determination**
  - **Automated EoR**
  - **Forward pass**
  - **Remote fire**