# Data Focused Naval Tactical Cloud (DF-NTC)

## ONR Information Package

**June 24, 2014**

# ONR Information Package Components

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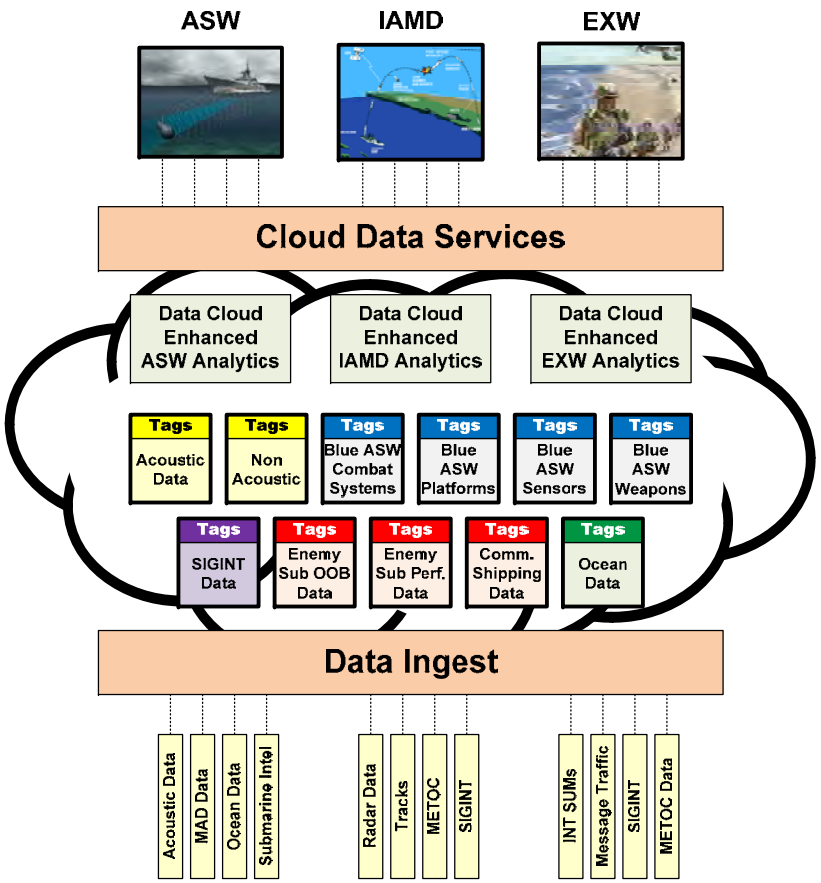
| Part #1 | DF-NTC EC Overview |
| Part #2 | NTC Overview |
| Part #3 | Developing on the NTC Platform |
| Part #4 | Data Science Thrust |
| Part #5 | Data Ingest and Indexing Thrust |
| Part #6 | Analytic Thrust / ASW |
| Part #7 | Analytic Thrust / IAMD |
| Part #8 | Security Thrust |

# Part #1

# DF-NTC EC Overview

# DF-NTC Enabling Capability




- Data-driven decision support shaped by commander's intent, historical decisions/results, COA/ECOA . . .
- Advanced analytics to support effective/rapid planning, assessment & execution
  - ASW
  - IAMD
  - EXW
- Autonomous predictive SA across warfare domains
- Adaptive fleet-wide data sharing in DIL environment
- Data protection and security mechanisms to ensure the integrity of data
- Automated data security tagging at ingest

# S&T Objectives

- **Develop efficient, effective ingestion capabilities for ASW, IAMD, & EXW data in support of broad Naval needs**
  - **NTM, acoustic, radar, EO/IR, ESM, METOC . . .**
- **Develop efficient analytic techniques & algorithms that extract critical, mission-focused, insight & present timely I&W from volumes of disparate ingested data**
- **Develop widgets & applications for cloud environment that provide enhanced C2 capabilities**
  - **Electronic representation Naval Plans**
  - **Automated assessment of operational impacts to Naval Plans**
  - **Automated planning & re-planning aligned with Commander's Intent**

**Warfighting Payoff**

- **Ability for Naval Warfare Area commanders to more effectively & rapidly plan, assess & execute operations by employing advanced analytics that leverage cross-Warfare data**

**Co-evolution of CONOPS/TTPs with Data & Analytics S&T Products**

# Part #2

# NTC Overview

# Cloud Computing Context

## IT Efficiency Clouds

**Purpose:** **Consolidate enterprise computing for cost savings**

- Located at Large Data Centers
- Supports 10,000s of customers
- Operates on high bandwidth networks

**IT Efficiency Clouds are mature and can make the Navy IT infrastructure more cost effective**

## Naval Tactical Cloud (NTC)

**Purpose:** **Improve warfighting effectiveness while operating inside adversary kill chains**

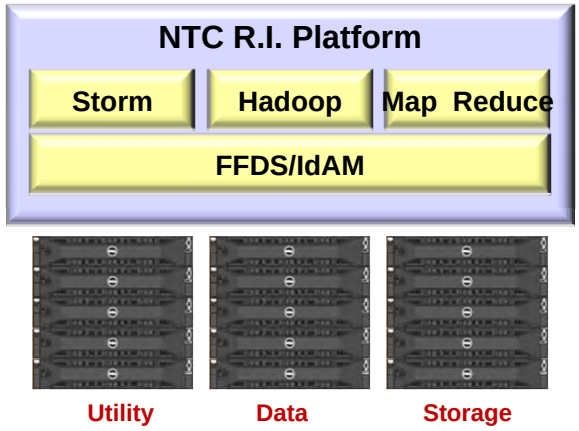
- Cloud located at the tactical edge supporting real-time mission planning and execution
- Applications automate diverse sensor and data assimilation
- Operates on tactical RF networks

**Tactical Clouds are emerging and have the potential to radically improve Navy combat effectiveness**

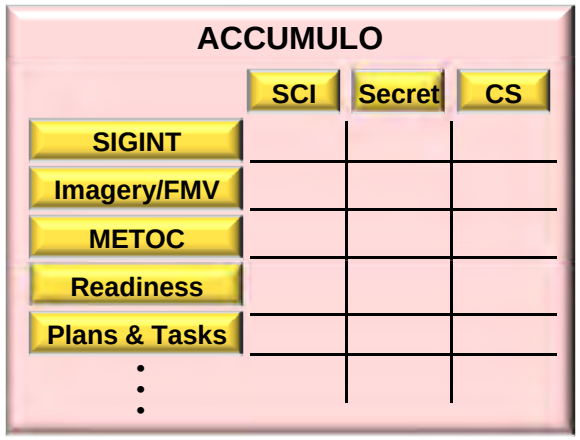
# ONR Enabling Technologies for NTC

## NTC RI Platform

**Massive Storage & Compute Platform Core & Common Services**

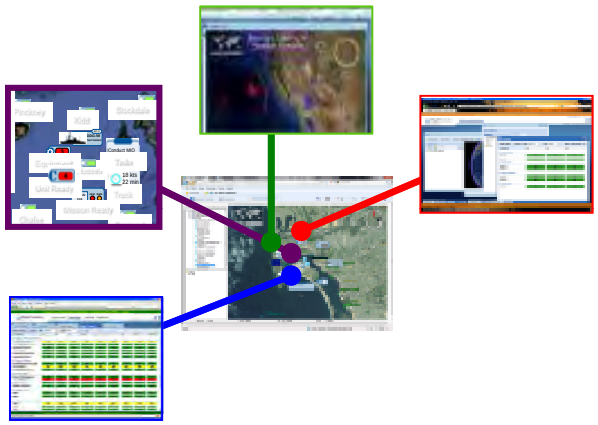



**All Source, Big Data UCD Framework**

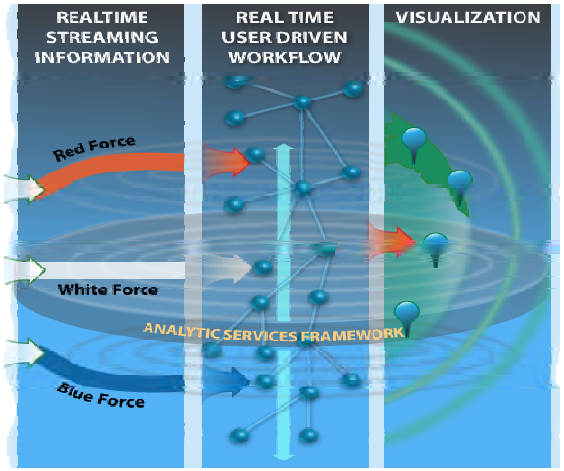



## SAVA

**Highly Tailorable, Quickly Developed Apps & Widgets**

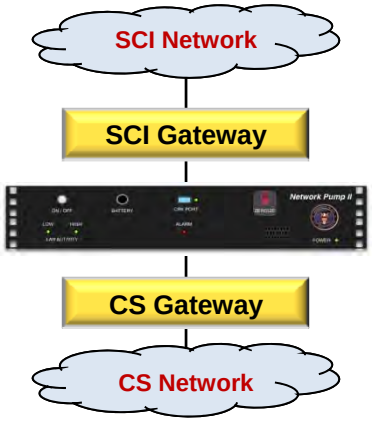


**High Performance Data Analytics/Predictive Analysis**



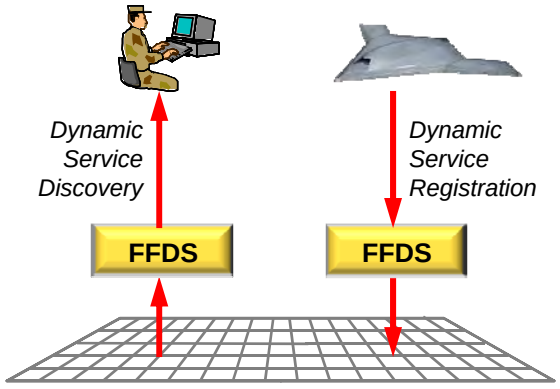

## UGW/PUMP II

**High Performance, Cross-Domain Gateways**



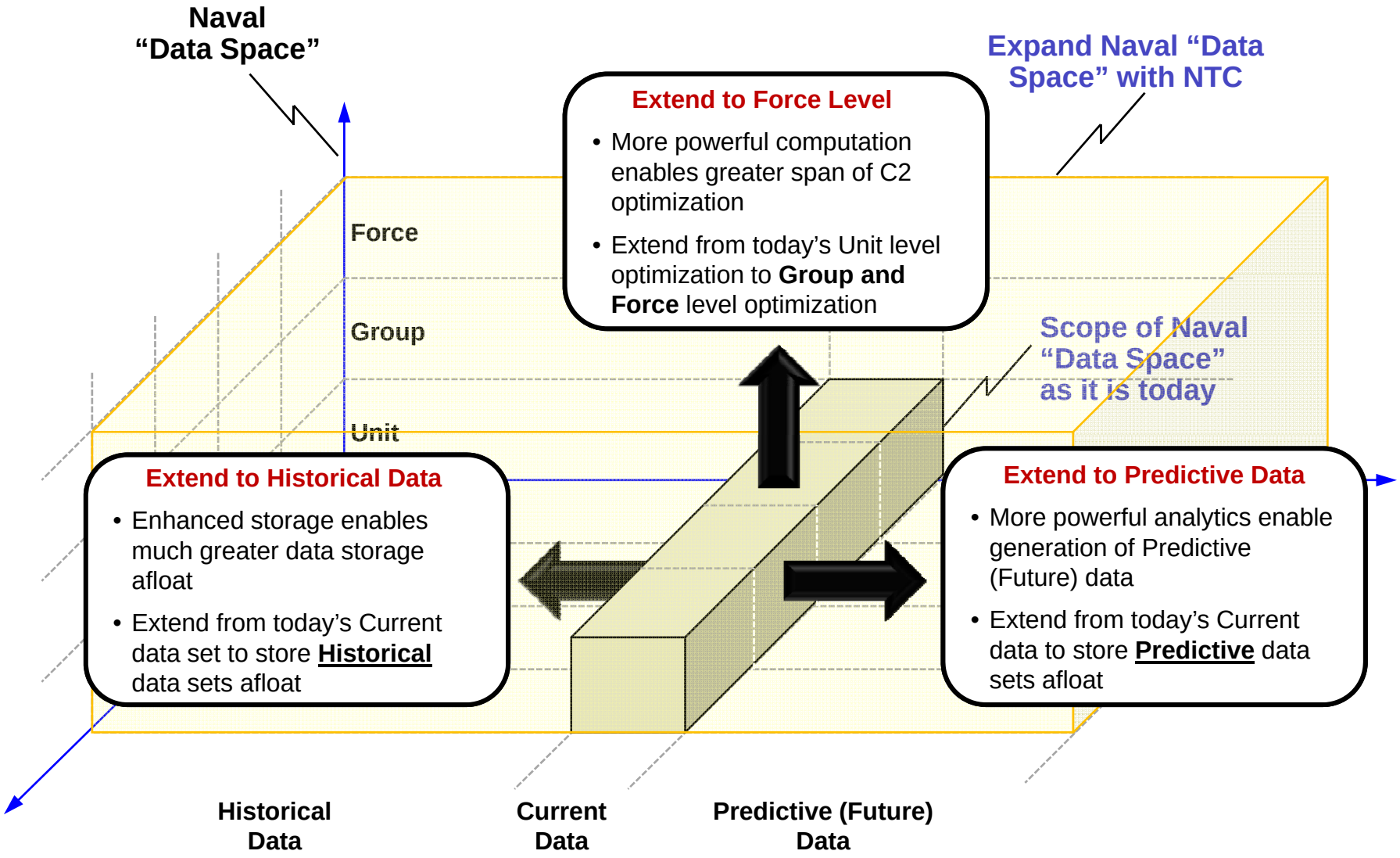

## FFDS

**Dynamic Federation & Discovery Services for D-DIL**

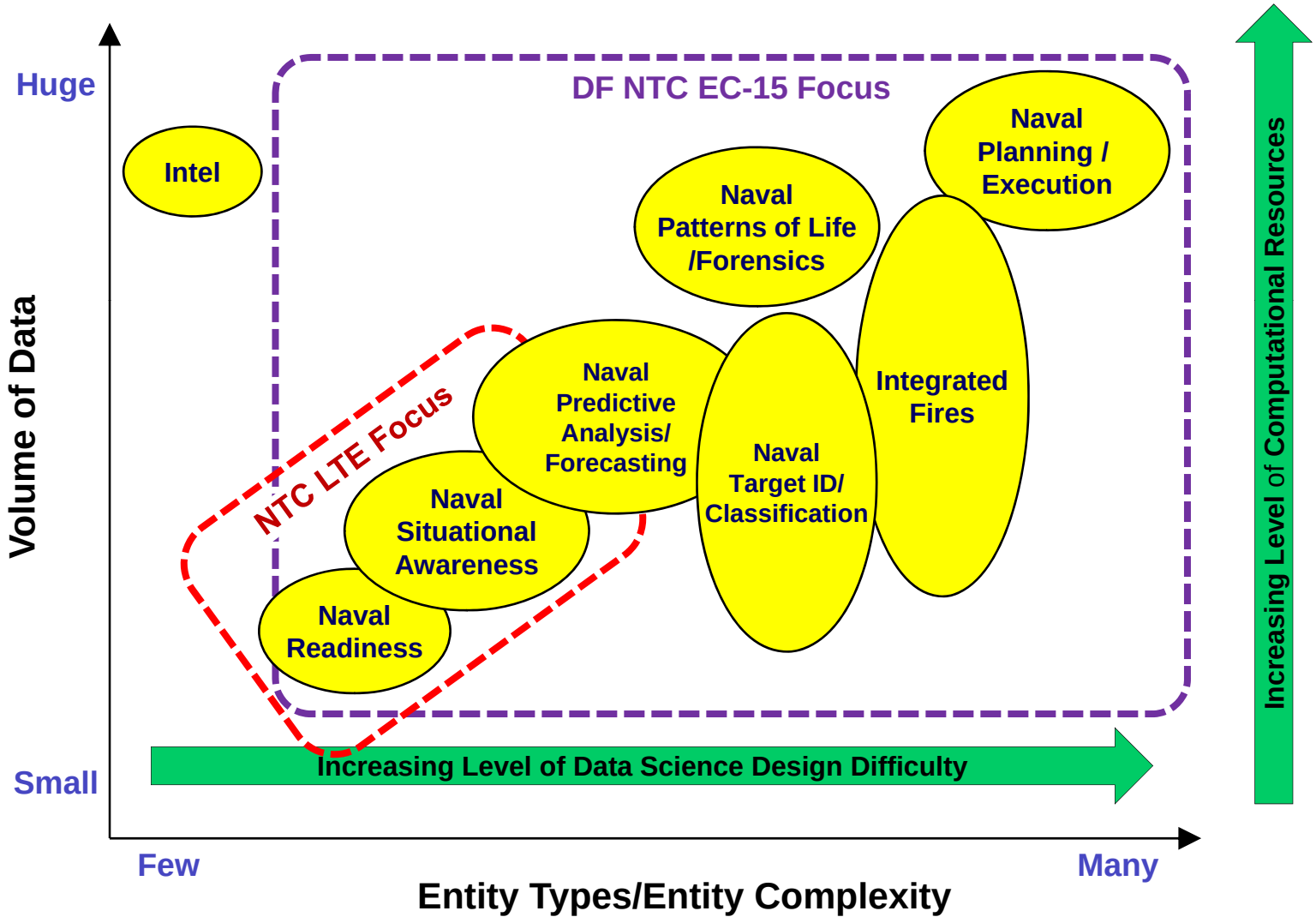



Naval Tactical Networks

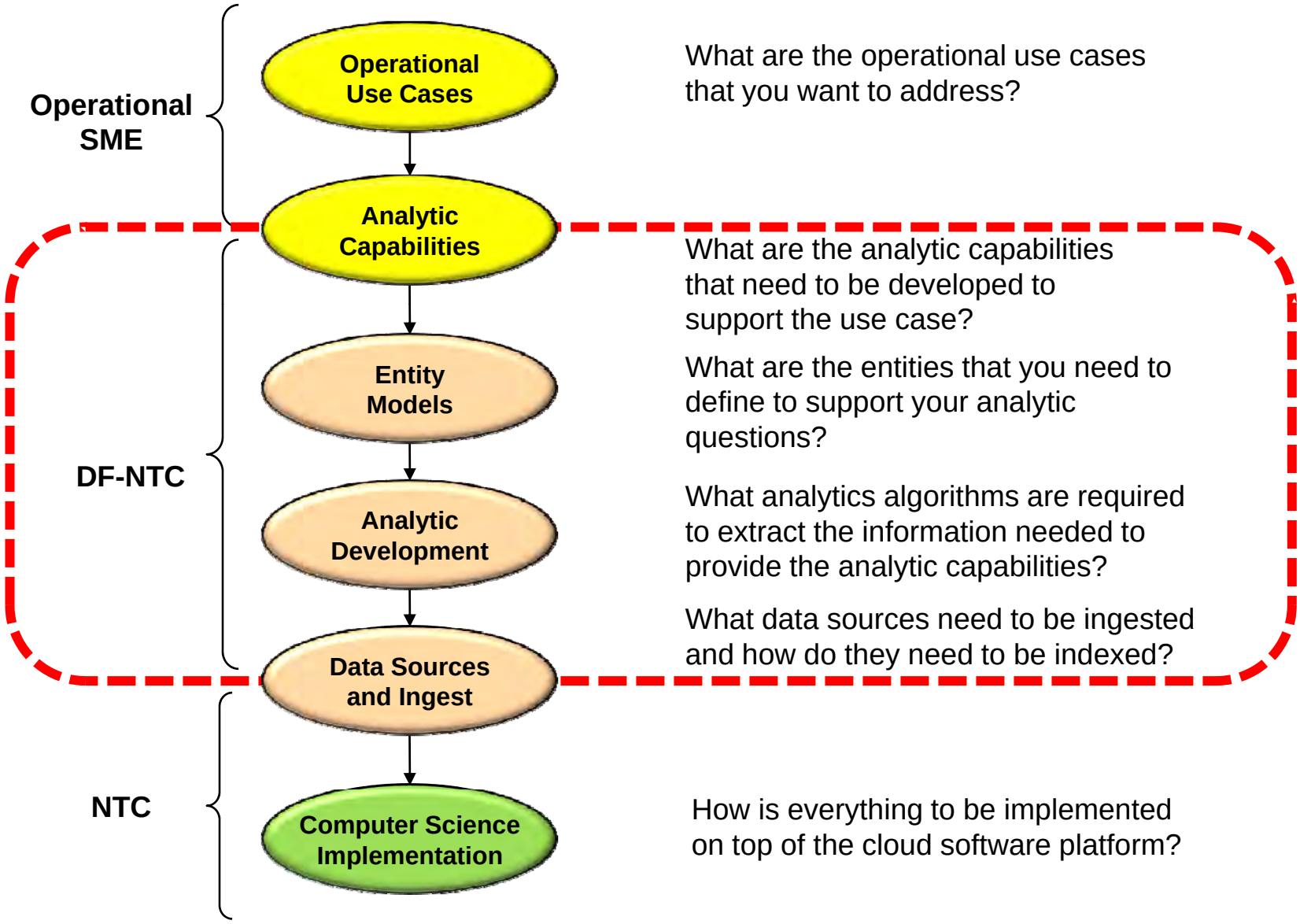
# Harnessing the Complete Naval "Data Space"



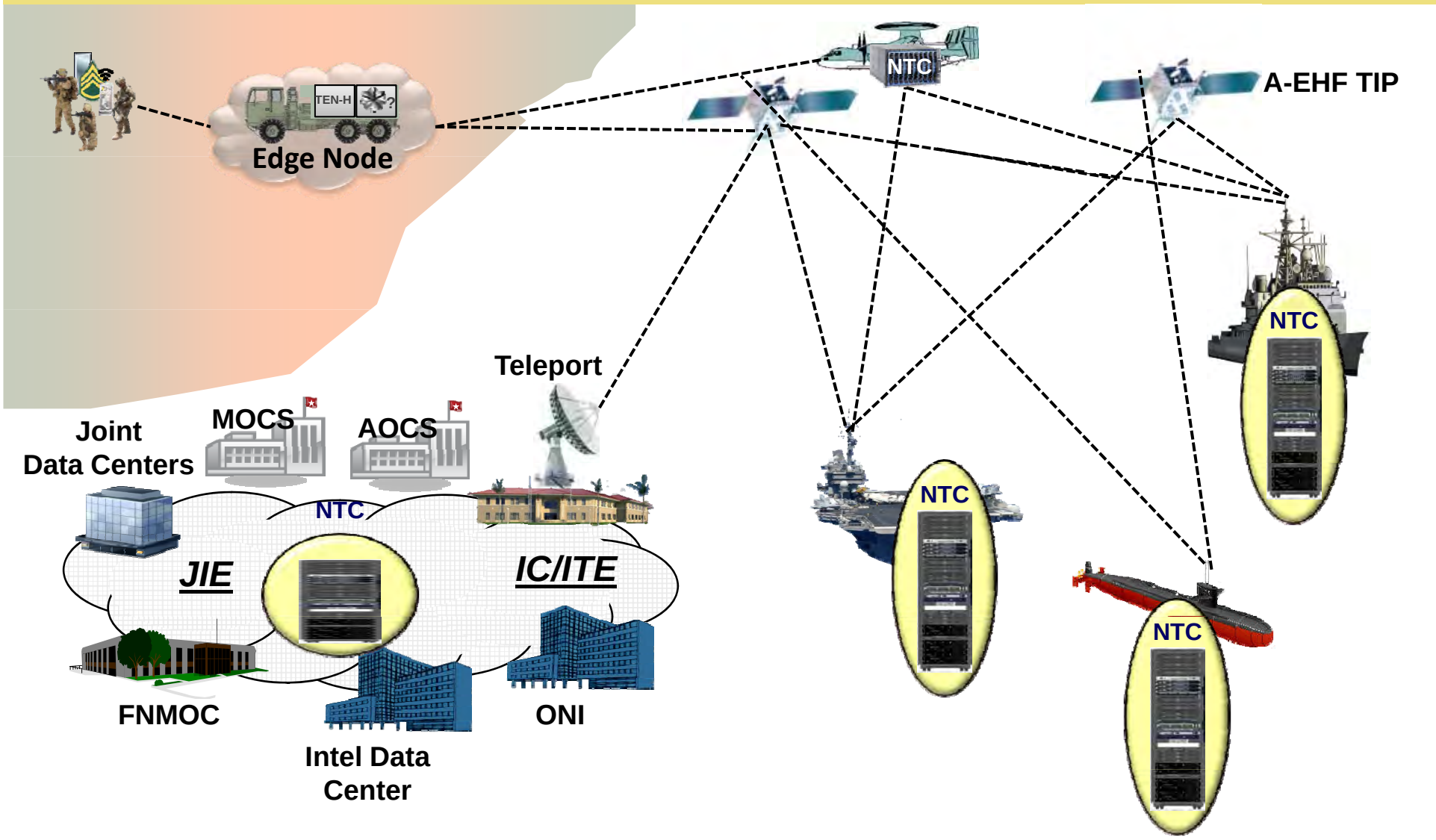
# Naval Big & Semantic Data Challenge



# Data Science Methodology



# NTC Enabling Tactical Joint Warfighting Data Interoperability




**Seamless Warfighting Data Interoperability Ashore/Afloat**

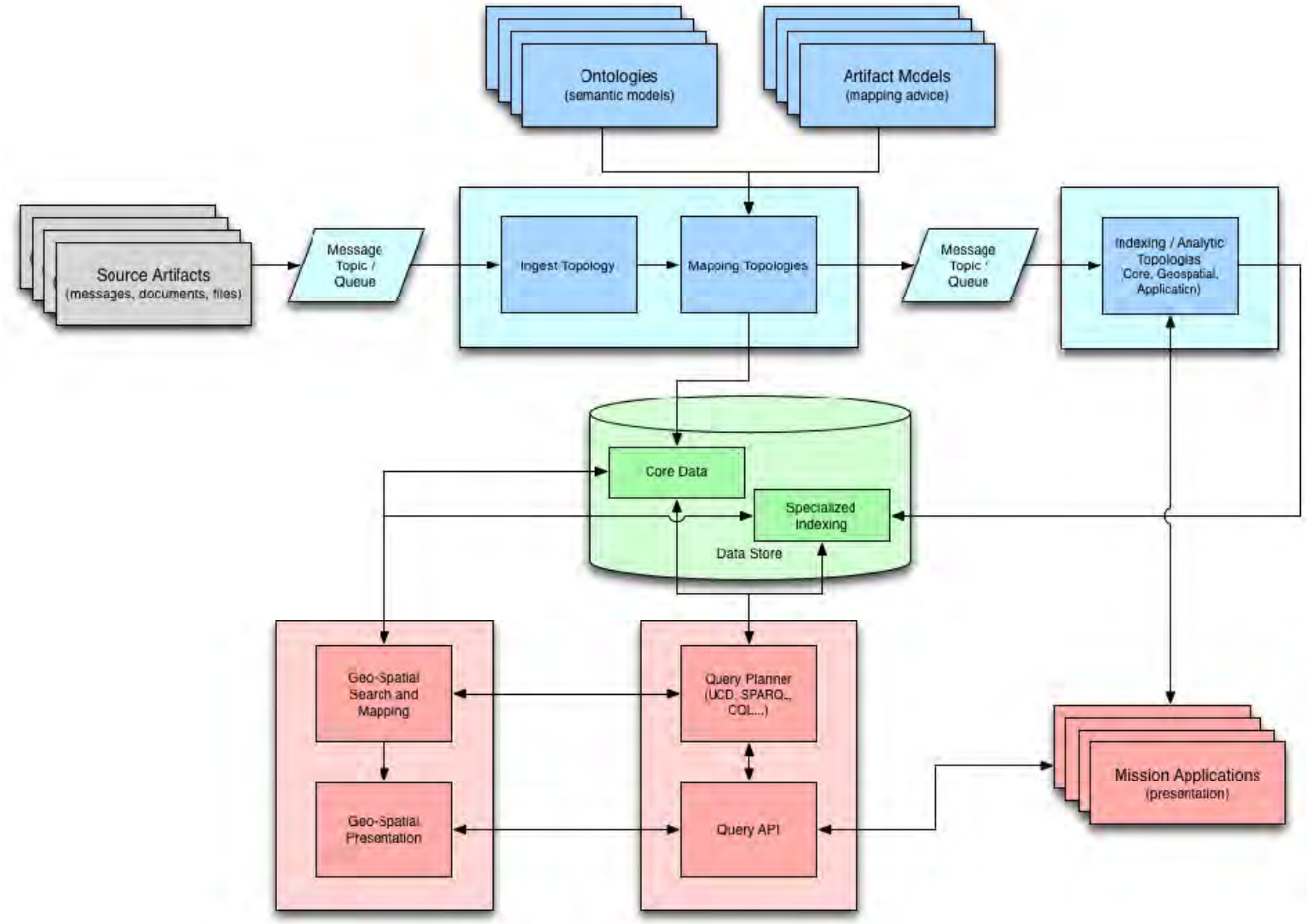
# Part #3

# Developing on the NTC Platform

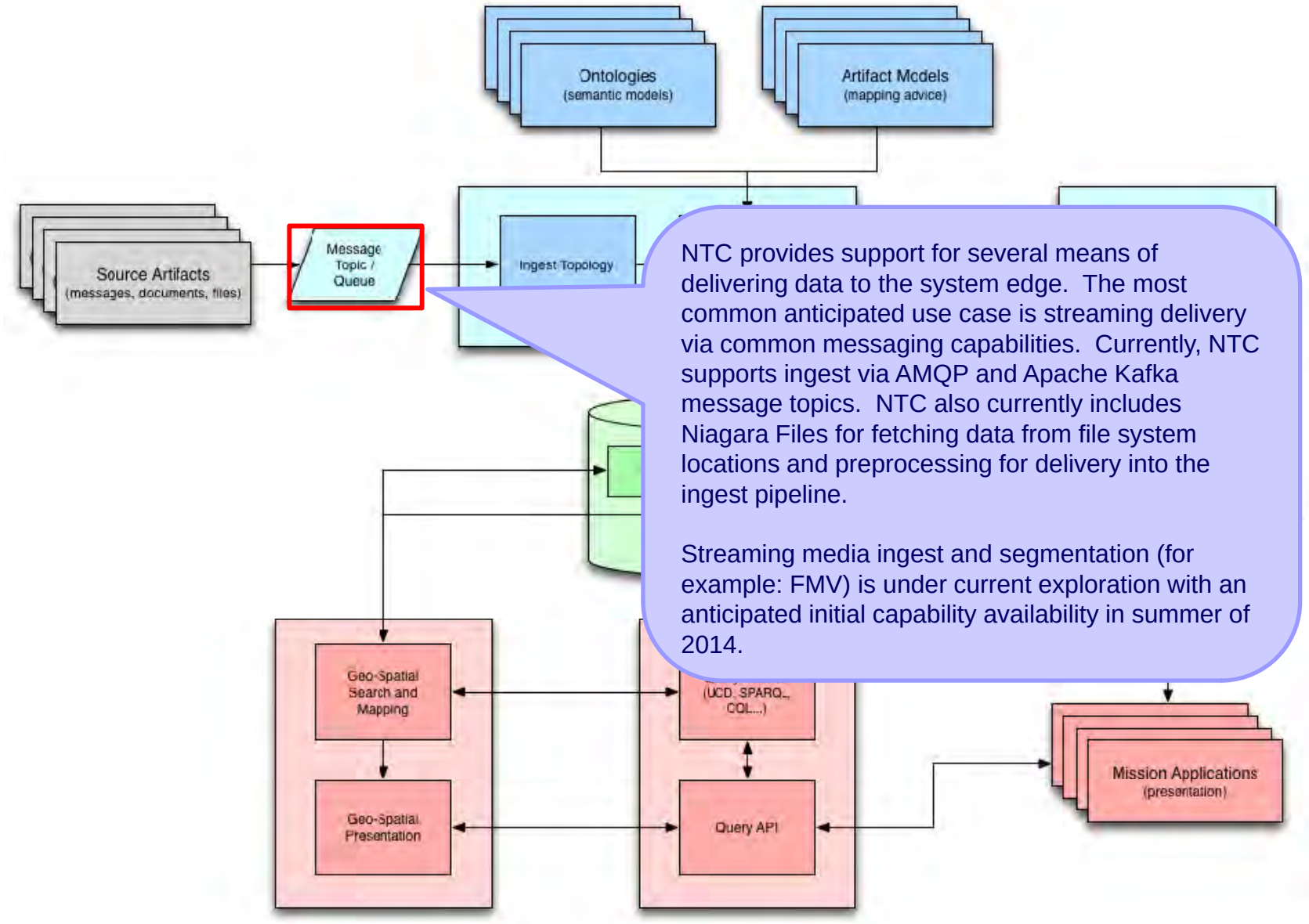
# What is NTC?

- **NTC is an implementation of a Big Data analytic cloud environment.**
  - "Cloud" is a heavily overloaded term. In this context, cloud is not about:
    - Offsite data storage, though remote storage and access to data may occur
    - Virtualization, though all or part of the architecture may be virtualized
    - Application hosting, though NTC will host and support client applications
  - "Cloud" is about:
    - Providing the means to store and access massive amounts of data
    - Providing the means to host data from multiple disparate sources in a common environment
    - Providing the tools to extract meaning from and enrich data on a massive scale, including correlation of data from multiple domains
- **NTC is designed to operate at the tactical edge.**
  - NTC is intended to provide the means to take the tools that were previously available only to shore-based operators and at the national level , and to make them available to the forward-deployed warfighter
  - NTC is designed to support data collection, analysis, and presentation capabilities, even in the absence of robust connectivity to resources ashore.
- **In Short: NTC is a set of services focused on providing an end-to-end ecosystem for ingesting, storing, processing, and accessing data from multiple and possibly disparate sources – in a package suitable for deployment to the tactical edge.**

# NTC Ecosystem



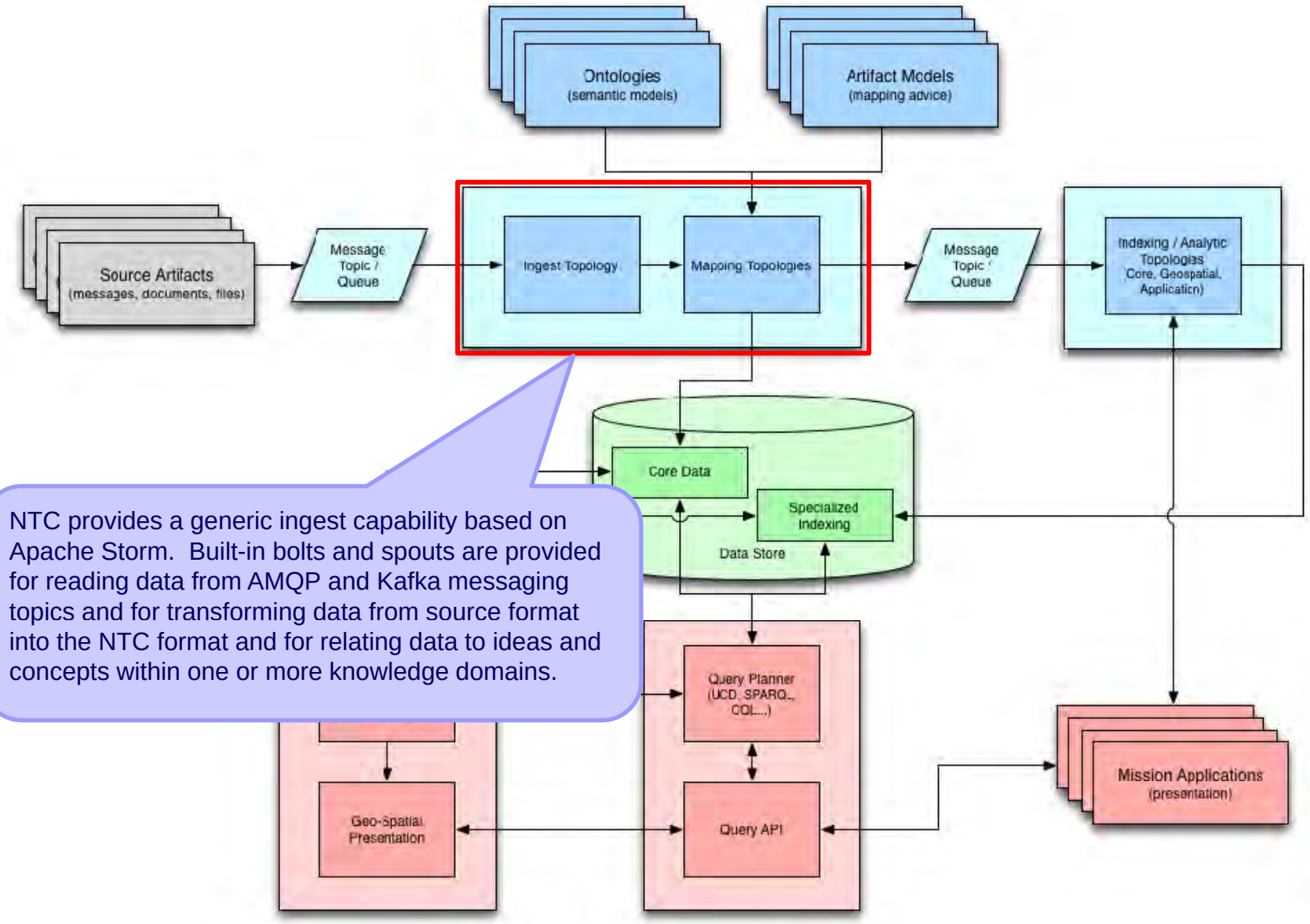
# NTC Ecosystem




NTC provides support for several means of delivering data to the system edge. The most common anticipated use case is streaming delivery via common messaging capabilities. Currently, NTC supports ingest via AMQP and Apache Kafka message topics. NTC also currently includes Niagara Files for fetching data from file system locations and preprocessing for delivery into the ingest pipeline.

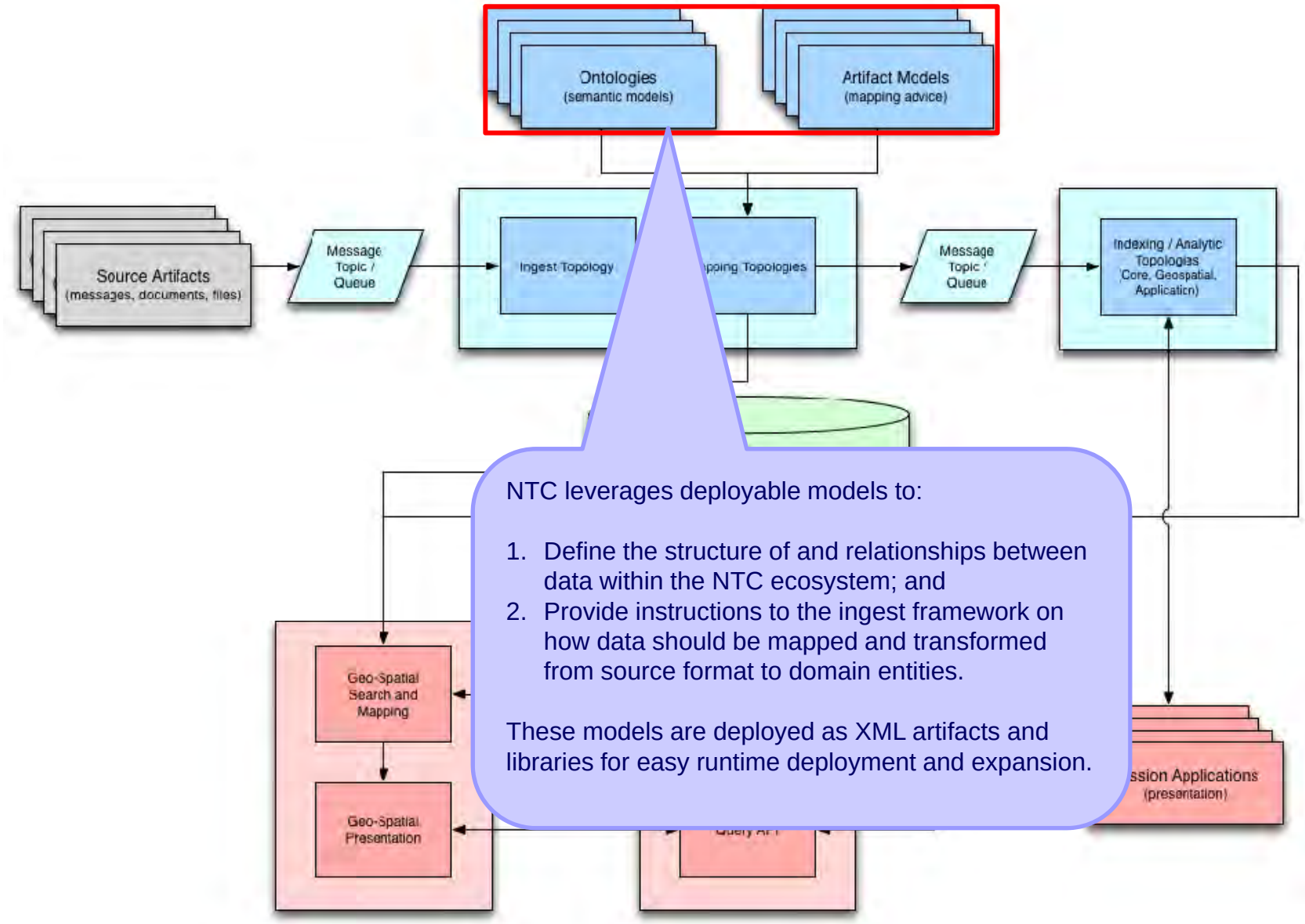
Streaming media ingest and segmentation (for example: FMV) is under current exploration with an anticipated initial capability availability in summer of 2014.

# NTC Ecosystem




NTC provides a generic ingest capability based on Apache Storm. Built-in bolts and spouts are provided for reading data from AMQP and Kafka messaging topics and for transforming data from source format into the NTC format and for relating data to ideas and concepts within one or more knowledge domains.

# NTC Ecosystem

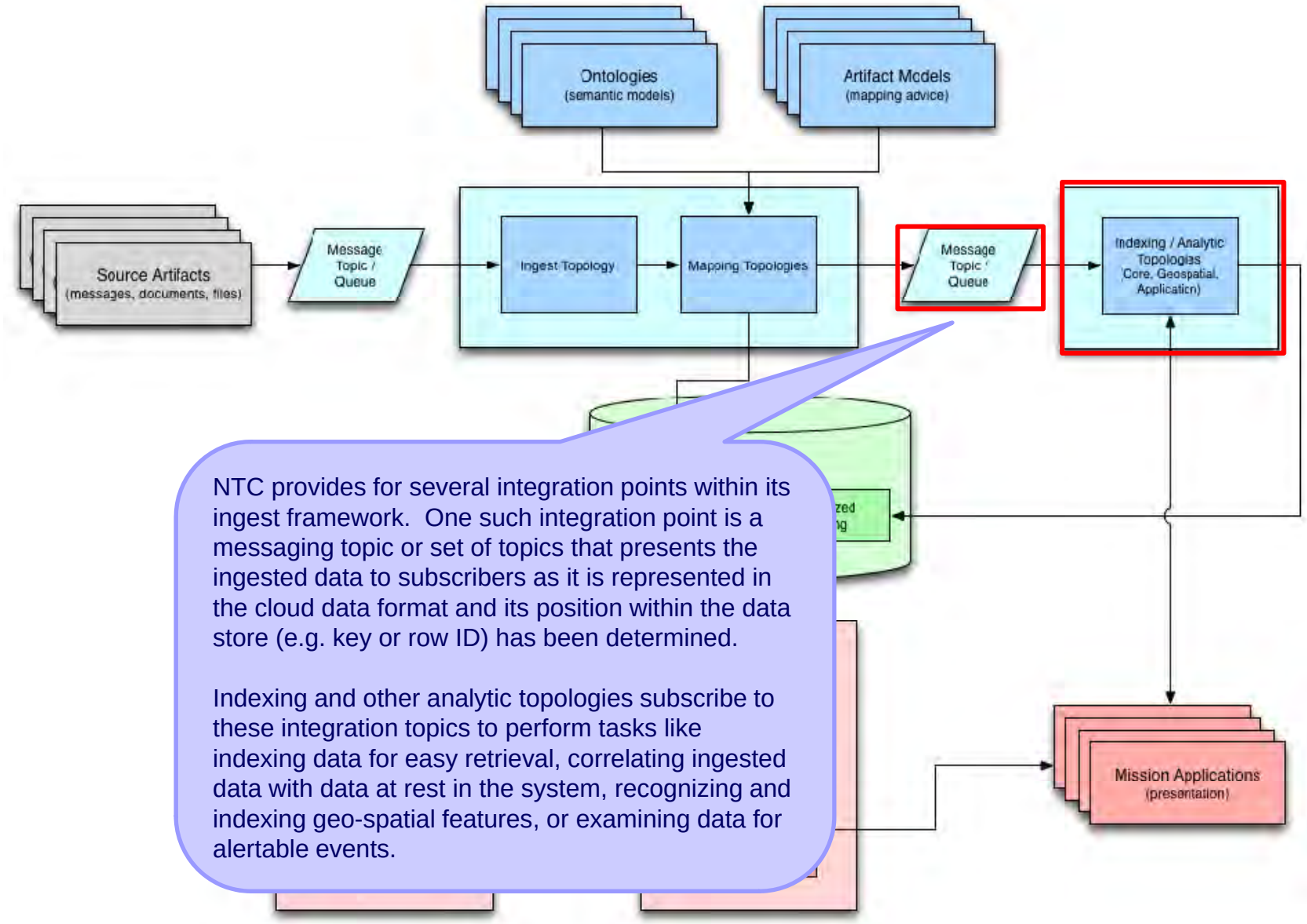



NTC leverages deployable models to:

1. Define the structure of and relationships between data within the NTC ecosystem; and
2. Provide instructions to the ingest framework on how data should be mapped and transformed from source format to domain entities.

These models are deployed as XML artifacts and libraries for easy runtime deployment and expansion.

# NTC Ecosystem

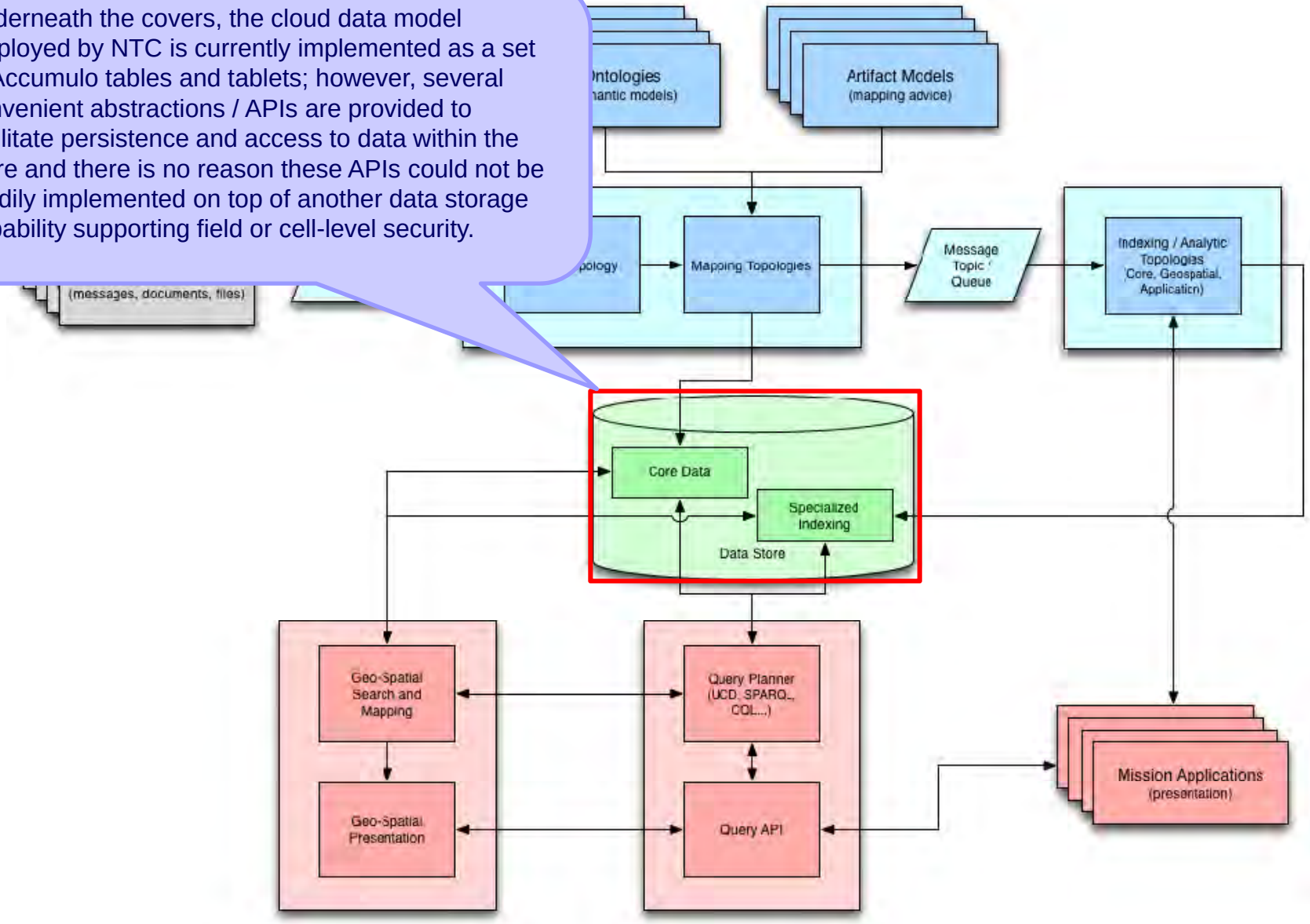



NTC provides for several integration points within its ingest framework. One such integration point is a messaging topic or set of topics that presents the ingested data to subscribers as it is represented in the cloud data format and its position within the data store (e.g. key or row ID) has been determined.

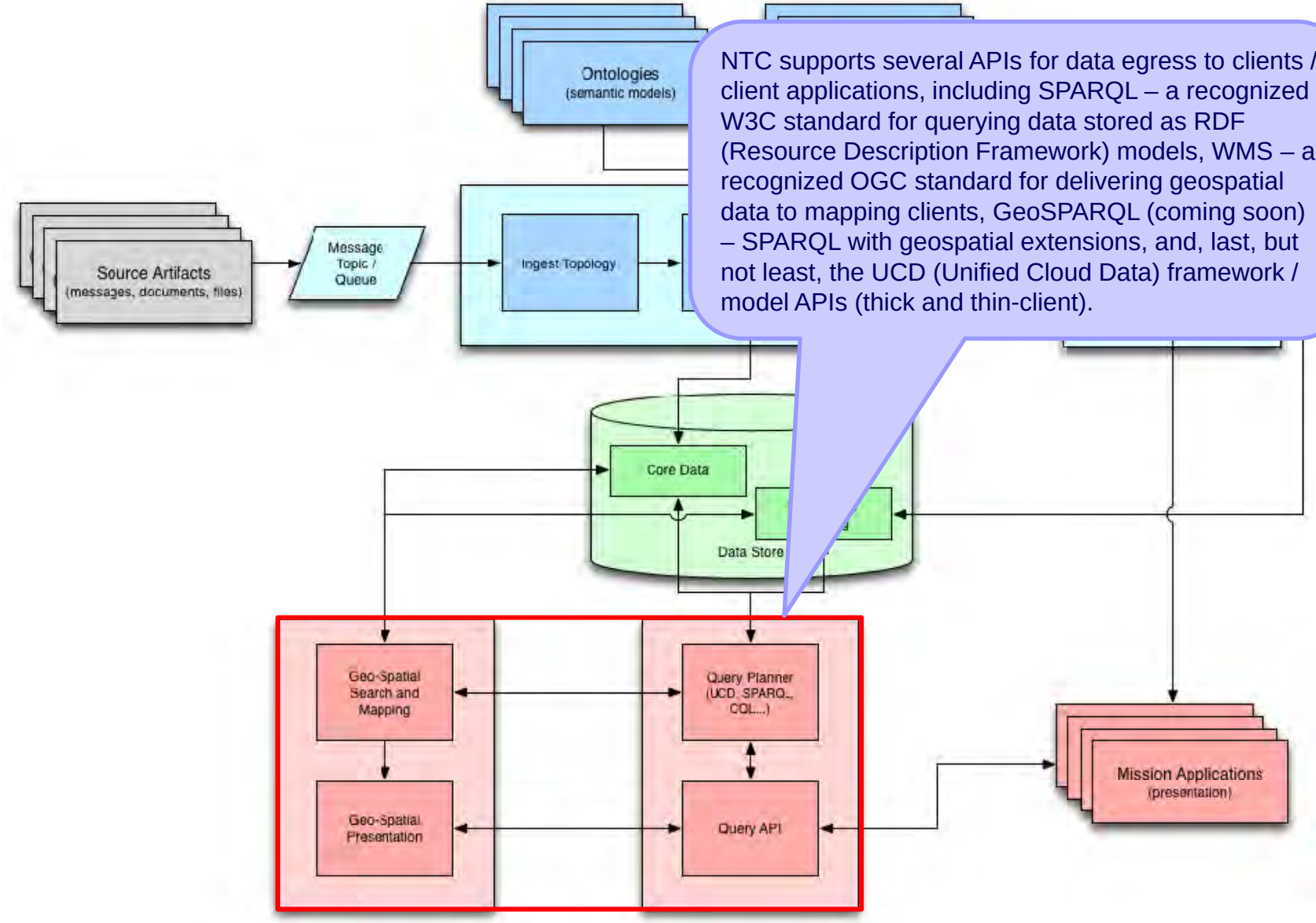
Indexing and other analytic topologies subscribe to these integration topics to perform tasks like indexing data for easy retrieval, correlating ingested data with data at rest in the system, recognizing and indexing geo-spatial features, or examining data for alertable events.

# NTC Ecosystem

Underneath the covers, the cloud data model employed by NTC is currently implemented as a set of Accumulo tables and tablets; however, several convenient abstractions / APIs are provided to facilitate persistence and access to data within the store and there is no reason these APIs could not be readily implemented on top of another data storage capability supporting field or cell-level security.

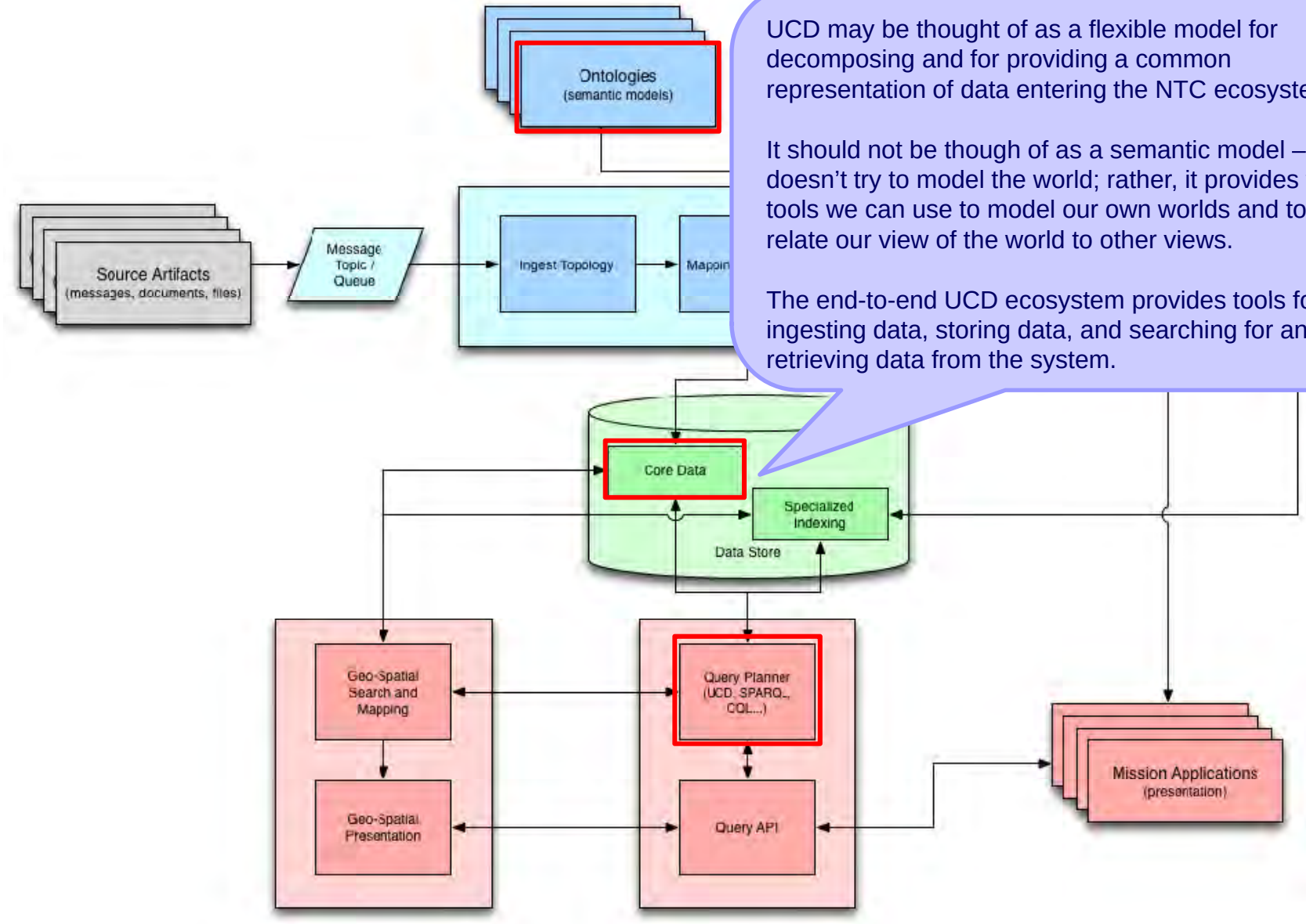


# NTC Ecosystem




NTC supports several APIs for data egress to clients / client applications, including SPARQL – a recognized W3C standard for querying data stored as RDF (Resource Description Framework) models, WMS – a recognized OGC standard for delivering geospatial data to mapping clients, GeoSPARQL (coming soon) – SPARQL with geospatial extensions, and, last, but not least, the UCD (Unified Cloud Data) framework / model APIs (thick and thin-client).

# What is UCD?
# How Does it Relate to NTC?




UCD may be thought of as a flexible model for decomposing and for providing a common representation of data entering the NTC ecosystem.

It should not be though of as a semantic model – it doesn't try to model the world; rather, it provides the tools we can use to model our own worlds and to relate our view of the world to other views.

The end-to-end UCD ecosystem provides tools for ingesting data, storing data, and searching for and retrieving data from the system.

# What is UCD?
# How Does it Relate to NTC?

**Modeling Data in UCD:**

**Semantic models are stored as data, rather than defined by structure:** In UCD, models can be thought of as relational, but they are not defined by database, table, or column structure. Several tables / types within the UCD model are dedicated to definition of semantic models for describing data. These entities include *concepts*, *predicates*, and related *associations*. Within UCD, a *concept* can be thought of as a type definition. A concept represents an abstraction that can be applied across multiple items of concrete data. Examples of concepts might include things like *person, vehicle, truck, aircraft, building*, and so forth. Predicates represent verbs that may be applied to relate one instance of a concept to another, or, in the case of a model description, to relate one concept to another. Examples of predicates might include ideas like *has*, *knows*, *buys*, and so on. Predicates are binary: they take a subject argument and an object argument. Together the subject, predicate (verb), and object form a *statement*. An example of a concrete statement might be *John [subject] knows [predicate] Karl [object]*. An abstract statement defining a model relationship might go something like *car [subject] has [predicate] engine [object]*.

**Common models and model elements promote universal understanding:** If concepts or predicate meanings are duplicated within multiple models, the capability to relate data across multiple models or analytics is adversely impacted. This can be mitigated somewhat by relating model concepts themselves with a predicate (something like: *modelA\person:modelA\sameAs:modelB\person*), but at the cost of additional indirection within the data store, complicating queries and reducing performance. What is the significance of this? Model reuse may have a significant impact on performance and correctness. Fewer models means less indirection to get to the desired data. It also means less information that must be federated in order to promote understanding across platforms.

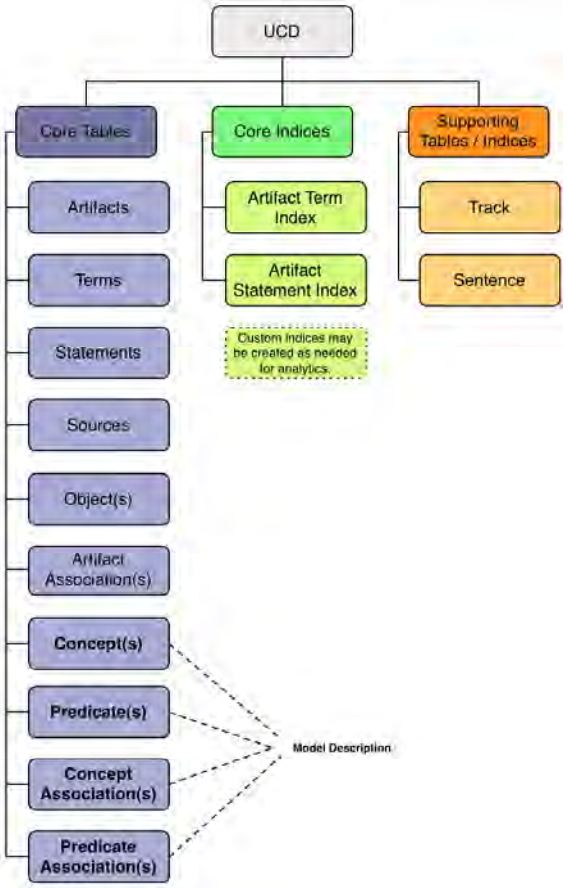
**Artifacts may be thought of as source data (even if they are derived), terms and statements represent extraction / enrichment:** What this means: Terms and statements can have meaning apart from the context of an artifact, but they may not be supportable without the source artifact. This raises the question of whether terms and statements should be federated apart from their source artifacts, or whether the source artifact should be federated whenever related extraction / enrichment products are moved. Since the meaning should be able to be derived from the extraction / enrichment products, it would make sense to federate them separately, unless the source artifact is explicitly requested, wouldn't it?

**The intent of UCD is to promote data fusion by breaking data down into its smallest common denominators to promote sharing across applications and analytics:** The concepts that serve to make the big-table big-data infrastructure useful across a broad range of applications include *extraction* and *enrichment*.

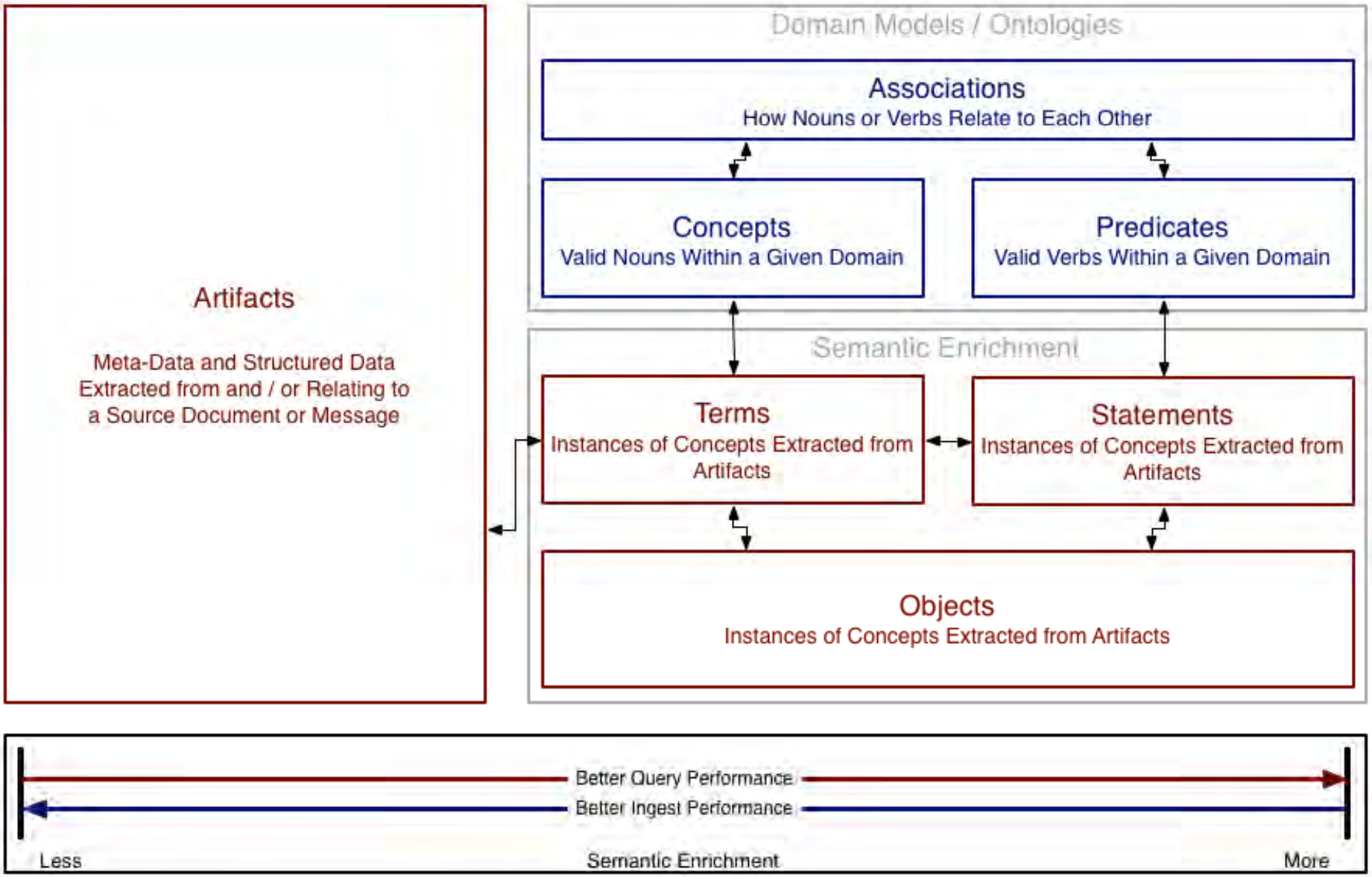
Extraction occurs when an inline or batch analytic breaks an *artifact* into its *terms*. An *artifact* represents some collection of data (typically one that has its own model outside the context of the cloud). An artifact may be a video clip (or metadata accompanying the clip), an XML message, a picture, a human-readable document, or other collection of data that is more complex than a single *term*. A *term* represents the smallest meaningful unit of data that may be extracted from an artifact. A terms is defined by its name or identification (sign) within the artifact, association with the artifact (including location), and association with a (model) concept. A term might identify Jamie as a person, mentioned in Line 6 or 36 seconds into a given artifact.

Enrichment occurs when an analytic creates assertions about data fond in artifacts. These assertions are stored as statements and may be supported by sentences. An example of a statement might be "Karl buys cocaine," where the predicate *buys* references a valid verb in some known model (for example a model describing commerce). This statement has value in and of itself - all that is needed to preserve the information in the statement is the statement itself, including the terms, and the model explaining the terms' concept labels and the predicate (verb). A sentence entry may also be created to support the statement (the sentence may refer to a section of a video clip in which Karl is seen making his purchase).

**Though Data Is Often Presented in Tabular Form, a Hierarchical View May Be a Better Approximation of Structure:** In a BigTable application, the Row ID of an entry might better be thought of as a root ID of a tree. In tabular form the same row ID would be repeated for each column, or node in the tree. Hierarchical views of the UCD tables are presented below.



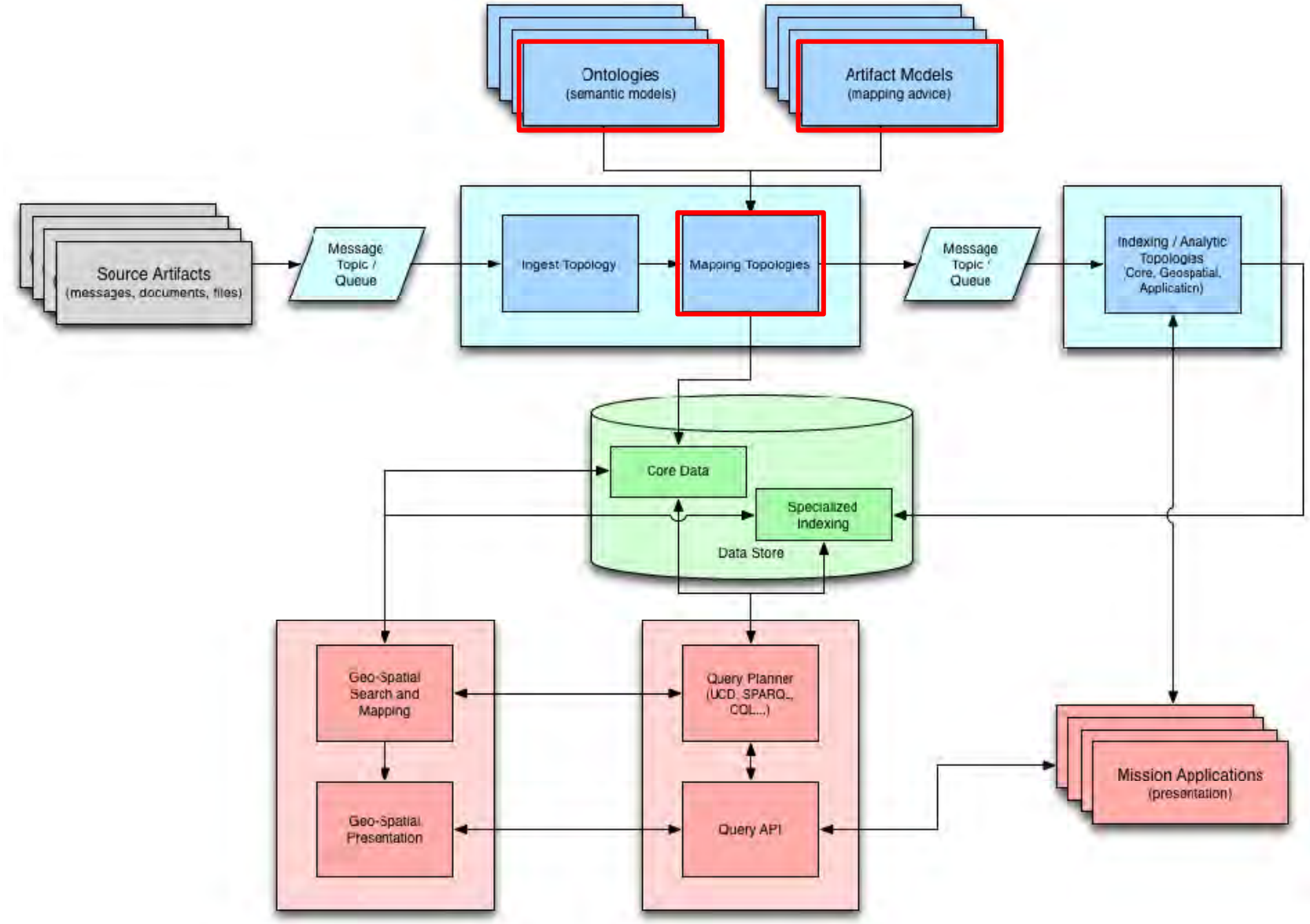
# What is UCD?
# How Does it Relate to NTC?



# Do I Have to Use the UCD APIs In Order to Use UCD?

- **No, NTC will provide several APIs to allow mission and other applications to interact with the data stored in the UCD store. In particular, the next release of NTC will provide limited support for ingest and retrieval of data in RDF formats. In particular:**
  - Ingest of TriG files
  - Retrieval of data via SPARQL / RDF query API
- **Because the underlying UCD structure provides support for representing data as SPO statements, the transition between UCD and RDF is a relatively natural one.**
- **As previously noted, NTCs geospatial components also provide support for retrieval of data by WMS-compliant clients.**

# How Do I Ingest Data Into the UCD Ecosystem?



# How Do I Map Data Into the UCD Ecosystem?

- **The DPF UCD Topology handles mapping of data from structured input documents to UCD entities**
- **The DPF UCD Topology provides a generic mediation and ingest capability for NTC**
  - The topology leverages models for instruction on mapping of data
  - New models may be added at runtime to add support for new input sources
  - Models are delivered in the form of XML documents and supporting libraries
- **There are two types of models used for ingesting data into the NTC UCD storage framework**
  - The Domain Model represents the “target” representation for the data being ingested
    - The Domain Model represents a knowledge domain and provides a standardized way of representing data from multiple sources within that domain (similar to an OWL model / ontology)
  - The Artifact Model provides the mapping instructions needed to extract and transform data from a source document or artifact and map it to concepts and structures described in one or more domain models

# How Do I Map Data Into the UCD Ecosystem?

- **Do I have to map my source data to rich entities (graph topology)?**
  - In short, no. It is possible to map a message or document type to an Artifact only. In this case:
    - Artifact meta-data (things like author, source, dates) are mapped to the Artifact meta-data fields, as normal
    - Artifact data (content) are mapped to the Unstructured Text or Structured Data section of the Artifact
  - When would I want to map data to structured Artifact data?
    - When high-speed, high-volume ingest is essential (there are tradeoffs)
    - When semantic enrichment is non-essential or can be performed after the fact

# Ingest Take-Aways

- **The Domain Model(s) represent(s) my target – how I want data represented within the system**
- **My domain models represent how I can query for and associate data within the system**
- **In order to be able to use my domain Concepts, I must register them with the system**
- **The Artifact Model represents my source to target mappings – how I get from the source representation to my domain model**
- **I can forego mapping to a domain model, but the penalty is a loss of richness in my data representation**
  - Limits the types of queries I can perform
  - Limits the types of associations I can draw

# Development Process

- **Partners are participants – no "siloed" development**
  - NTC developers share common code repositories, common collaboration resources, and common development environments
  - NTC provides a partner forums and wiki resources for documentation and collaboration
  - NTC partners participate in NTC development planning and retrospective sessions
- **NTC is leveraging an agile development approach**
  - Sprints are planned at one-month intervals
  - Goals are established for all NTC developers (core and partner)
  - Daily stand-ups are conducted for each team
  - Retrospective and goal-setting occurs at the end of each sprint
  - Tasks are prioritized according to dependency and sponsor input
- **Bottom line: NTC is One Team, One Fight!**

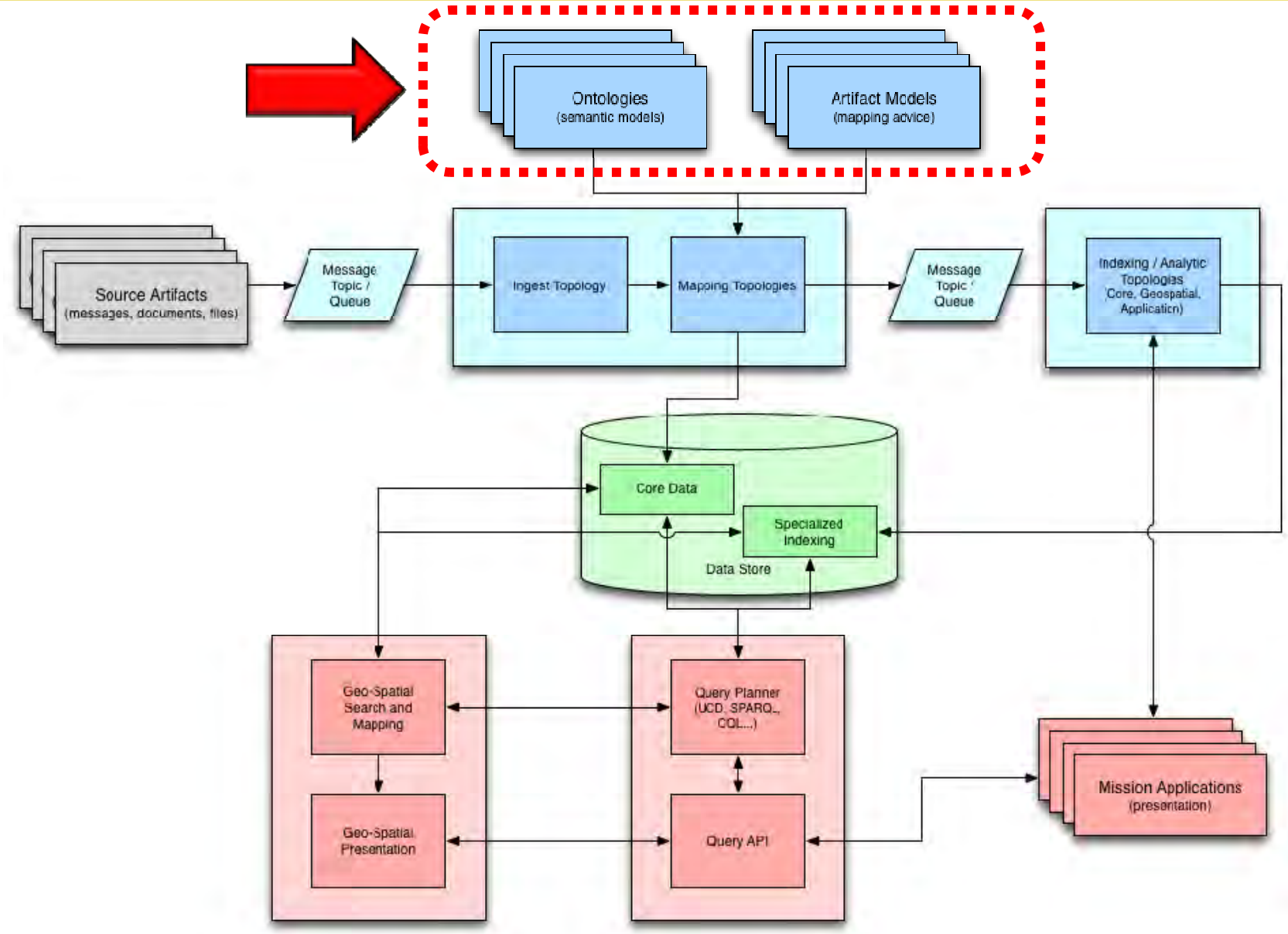
# Part #4

# Data Science Thrust

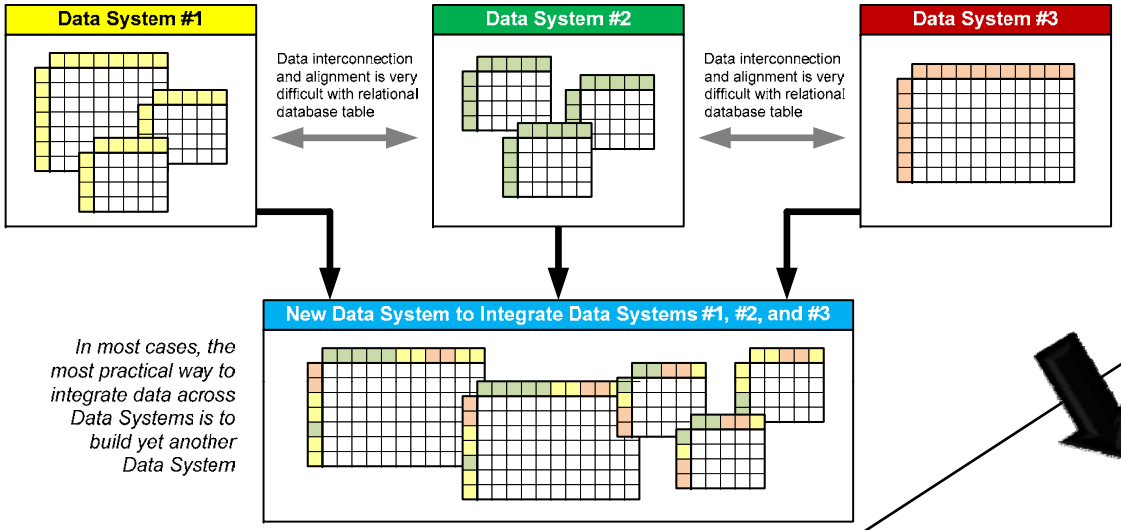
# The Data Science Thrust

- **Purpose:**
  - Develop the Data Representations and Semantics to be used within the Naval Data Ecosystem
- **Provides the foundation for the entire DF-NTC EC**
- **Warfare Areas of Interest:**
  - ASW
  - IAMD
  - EXW
- **Key Supporting Domains of Interest:**
  - Combat ID
  - Spectrum Management
  - Cyber
  - Blue and Red Force Readiness
  - Blue and Red Force Structure and Capabilities
  - Plans & Tasks
  - Meteorological and Environment

# Data Science Thrust in Context of the NTC Data Ecosystem



# From Data Systems to Data Ecosystems



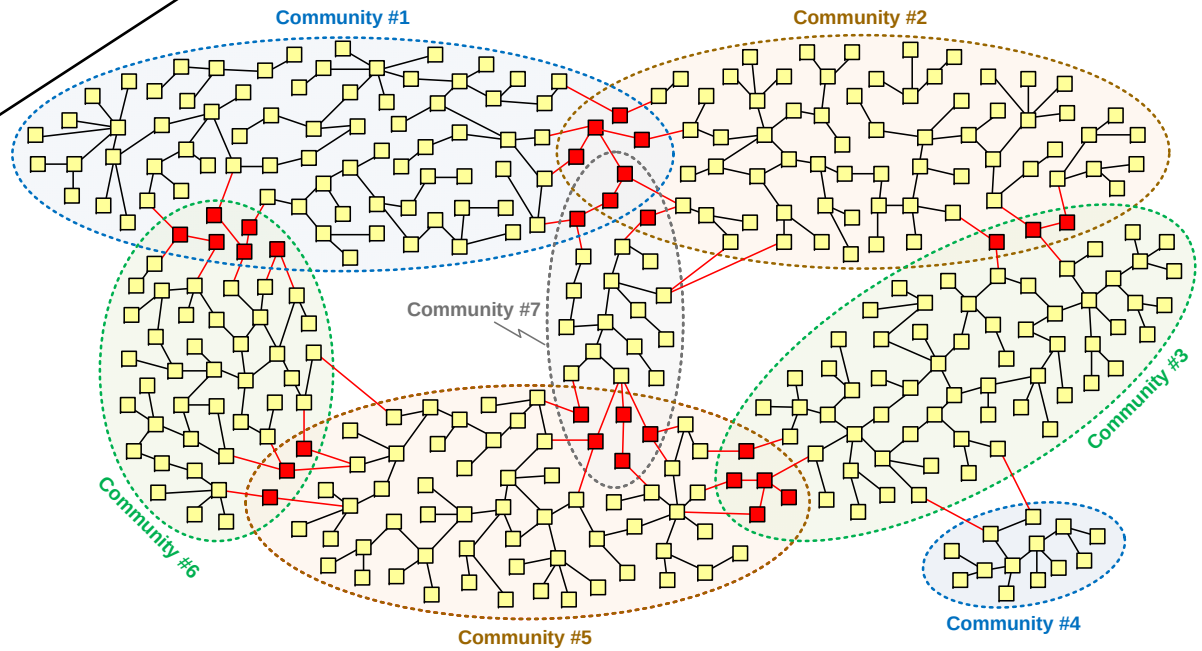

*In most cases, the most practical way to integrate data across Data Systems is to build yet another Data System*

## Data Systems:

- Optimized for performance and efficiency, over flexibility and integration
- Interconnection and alignment of data is very difficult

## Data Ecosystems:

- Optimized for flexibility and integration over performance and efficiency
- Interconnection and alignment of data is very easy



# Objectives

1. **Build Out families of Data Representations and Semantics required for modern Naval Warfare.**

2. **Advance our ability to perform Data Representation and Semantic Mapping**

3. **Develop Data Representations and Semantics that address challenges of A2AD/D-DIL Environments**

# 1. Build Out Families of Data Representations and Semantics for Naval Warfare

- **Goal is to develop a foundation that encompasses multiple Naval Mission areas**
  - Near-Term focus is on ASW, IAMD, and EXW
  - Cyber, EW, Spectrum Mgt. are considered key supporting areas
  - Long Term looking towards all Naval Mission Areas
- **Preferred Paradigm**
  - Artifacts → captured as is
  - Metadata → Graph representation (RDF)
  - Semantics → OWL/RDFS
  - Strong case must be made for other approaches
- **Leverage existing work being done by relevant COIs, don't start from scratch!!**
  - ASW COI → ASW COI Data Model
  - IAMD COI → Common Data Model
  - Others COIs → Joint, IC, Federal, Coalition (as relevant to Naval Warfare)

# 1. Build Out Families of Data Representations and Semantics for Naval Warfare (con't)

- **More interested in the actual Data Representation and Semantics, not the tools to produce and manage them**
- **Interested in techniques for generating OWL/RDFS Semantic definitions from other sources (e.g., UML)**
- **Looking for Data and Semantic Expertise relevant to the Naval Warfare domain**
  - More important to be Domain experts than to be RDF/RDFS/OWL experts
  - Compelling proposals will bring Domain expertise to the Table
- **High Productivity is Essential**
  - Current pace of building out Data Representations and Semantics is too slow
  - We are looking for proposals where more rapid progress is possible
  - Data Representations/Semantics built out in weeks/months, not in years

# 2. Advance our ability to perform Data Representation/Semantic Mapping

- **We expect the NTC Data Ecosystem to host many different Data Representations and Semantics from different Naval COIs**
  - COIs have made significant investments that can change quickly
  - COIs have unique Data Representation needs
- **For DF-NTC we want to be able to effectively map between the Data Representations and Semantics of different COIs**
  - Map Data Representations between COIs (both logical and physical)
  - Map Semantics to Data Representations
  - Map Semantics between COIs
- **Interested in Domain Expertise to Generate Mappings**
  - Need mappings between primary COIs ASW, IAMD, EXW
  - Need mappings to supporting domains: Cyber, EW, Spectrum Mgt., . . .
  - The mappings are of greater interest than tools to do mapping
- **Need to leverage commercial standards to express mappings**

# 3. Develop Data Representations and Semantics that address challenges of A2AD/D-DIL Environments

- **How to account for Data Representation and Semantic information that is distributed over a Tactical Force?**
  - How to deal with Identity
  - How to deal with Provenance
  - How to deal with Metadata generation and management
- **How do we adjust Data Representation and Semantic information to deal with resource constraints?**
  - Constraints on network bandwidth
  - Constraints on storage (onboard ship)
- **Can we use variable resolution Data Representation to mitigate A2AD/D-DIL conditions?**
  - Multiple Representations of variable size
- **How do we support real-time mapping between COI Data Representations and Semantics in A2AD/D-DIL conditions when distributed across a Battle Group?**

# Summary of Key Challenges

- How can we speed up the creation of data representation and ontology designs from taking years to taking weeks or months?
- How do we avoid the proliferation of too many specialized data representations and ontologies such that it becomes too hard to manage them and integrate them?
- How can we automate the capture and ingestion of legacy data representations and ontologies into RDF/OWL?
- How can we automate the cross-connection of different data representations and ontologies from across diverse communities?
- What are the key data representations and ontology constructs for addressing Cross Warfare Area planning and resource allocation activities

# Departing Thoughts

- **It isn't necessary to address the full breadth of all Naval Warfare Areas, but . . .**
  - Be sure to address a sufficiently substantial subset
  - Be sure and be able to fully address the scope of your selected subset
- **Recognize the Data Science Thrust will support other Thrusts**
  - Show how you can be sufficiently flexible to support needs of other Thrusts
- **Leveraging Data Representations/Semantics from other Naval Communities is essential**
  - Proposing to build from scratch will be looked at with much skepticism

Revolutionary Research . . . Relevant Results

# Part #5

# Data Ingest & Indexing Thrust

# Data Ingest & Indexing Thrust

1. **Build a rich set of data within the Naval Tactical Cloud Big Data environment that will support the development of advanced analytics for ASW and IAMD**

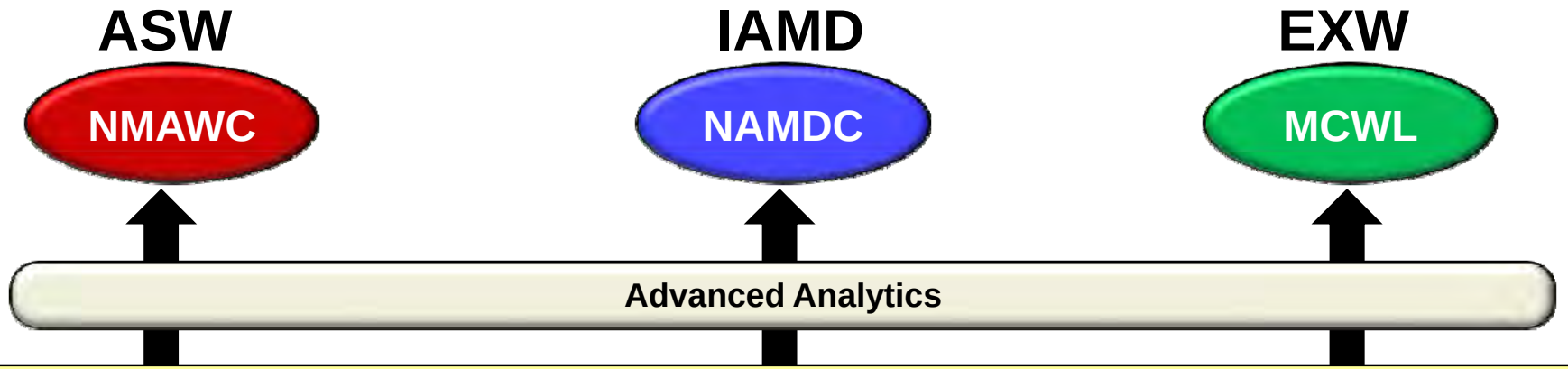
2. **Develop enhancements and augmentations to the current Naval Tactical Cloud that facilitate faster and easier data ingest and indexing**

# 1. Build a Rich Set of Data within the NTC

- **Developing comprehensive Big Data sets for Naval Warfare has been a challenge**
  - Interested in all Naval Mission Areas
  - ASW, IAMD, and EXW are the primary focus areas for the BAA
  - Cyber, EW, Spectrum Mgt. are considered key supporting areas
- **Goal is to develop robust Big Data sets for Naval Warfare**
  - Data Sets directly relevant to ASW and IAMD
  - Big Data sets that support ASW and IAMD
- **Looking for teams with Domain (e.g., Data) expertise**
  - We expect all proposers to have experience with Big Data technology
  - Need to show you understand the data, not just the technology
  - Many Naval data sets are highly classified, so must have proper clearances
- **Looking for ideas for getting up the Data Curve**
  - We are looking for 90% coverage of relevant data, not 10%
  - We are looking for how to bring in real data, from Naval Mission partners

# Data Scope

*(Examples, not Prescriptive)*




## National/Tactical Sensing

- **Radar**
  - SPY-1
  - AN/TPY-2
  - Cobra Dane
  - UEWR
  - Sea-Based X-Band
- **ESM**
  - SEWIP
  - Others (classified)
- **Space**
  - SSTS
  - DSP
  - Other (classified)
- **SIGINT**
  - ELINT
  - COMINT
  - MASINT
- **Passive Acoustic**
  - Ocean bottom acoustic arrays
  - Towed arrays
  - Variable depth sonar
  - Dipping sonar
  - Sonobouys
- **Active Acoustic**
  - Ship-mounted active sonar
  - Explosive Echo Ranging
  - Low Frequency Active
  - Dipping sonars
  - Sonobouys
- **Non-Acoustic**
  - Magnetic Anomaly Detection
  - Radar (surface detection)
  - EO (periscope/wake detection)
  - IR (diesel submarine venting detection)

## Blue Readiness

- **Blue ASW Platforms**
  - CG/DDG/FFG
  - P-3/EP-3/P-8
  - SSNs
  - UAVs (BAMS, . . .)
  - USVs/UUVs
  - SURTASS
- **Blue ASW Sensors**
  - Active Acoustic Sensors
  - Passive Acoustic Sensors
  - Non-Acoustic Sensors
  - National Sensors
- **Blue ASW Weapons**
  - ASW Torpedoes
  - ASW Standoff Missiles
  - ASW Mines
  - IO systems
- **Blue ASW Combat Systems**
  - AN/SQQ-89(V)
  - USW-DSS
- **Blue IAMD Platforms**
  - CVN
  - CG/DDG
  - P-3/EP-3/P-8
  - SSNs
- **Blue IAMD Sensors**
  - Radars
  - ESM
  - Space
- **Blue Hard Kill IAMD Weapons**
  - SM-3
  - SM-6 (ERAM)
  - Phalanx
- **Blue IAMD Combat Systems**
  - Aegis
  - SSDS

## Intelligence

- **Enemy Air/Missile Order of Battle**
  - Enemy A/M Basing
  - Enemy A/M performance characteristics
  - Enemy A/M readiness
  - Enemy A/M capabilities
- **Enemy Air/Missile Operations**
  - Enemy A/M Doctrine
  - Enemy A/M TTPs
  - Historical transit patterns
  - Historical operating areas
- **Enemy Sub. OOB**
  - Enemy Sub. Basing
  - Enemy Sub performance characteristics
  - Enemy Sub readiness
  - Enemy Sub capabilities
- **Enemy Sub. Ops**
  - Enemy Sub Doctrine
  - Enemy Sub TTPs
  - Historical transit patterns
  - Historical operating areas
- **Commercial Shipping**
  - Ship Position Data
  - Shipping lanes
  - Historical Traffic Patterns
  - Ship Noise Characteristics

**Fully Integrated Big Data Env**

## Environment

- **Atmospheric**
  - Winds
  - Temperature
  - Pressure
  - Density
  - Precipitation
- **Geography**
  - Terrain
  - Roads
  - Features
  - Vegetation
  - Soil
- **Oceanography**
  - Bathymetry
  - Sea Temperature
  - Sea Density
  - Sea Salinity
  - Currents
  - Convergence Zones
  - Bottom Characteristics
  - Bottom Features

## 2. Develop enhancements and augmentations to the current Naval Tactical Cloud that facilitate faster and easier data ingest and indexing

- **Goal is to ingest and index faster and more effectively**
  - Interested to enhancements to existing NTC ingest and indexing processes
  - Must show how enhancements will result in actual data getting into NTC
- **For Data Ingest**
  - Primary goal is bringing content into the Naval Data Ecosystem
  - Interested Data Sets directly relevant to ASW and IAMD
  - Interested in relevant supporting data sets (Cyber, EW, Spectrum Mgt.)
  - Interested in enhancements that result in more data ingest production
- **For Data Indexing**
  - Most interested in ideas for general indexing (i.e., indexing for unanticipated use cases, not specific use cases)
  - Interested in indexing for distributed, federated environments (e.g., a Battle Group)
  - Interested in indexing that is robust in A2AD/D-DIL conditions
  - Interested in indexing under constrained storage conditions

# Other Considerations

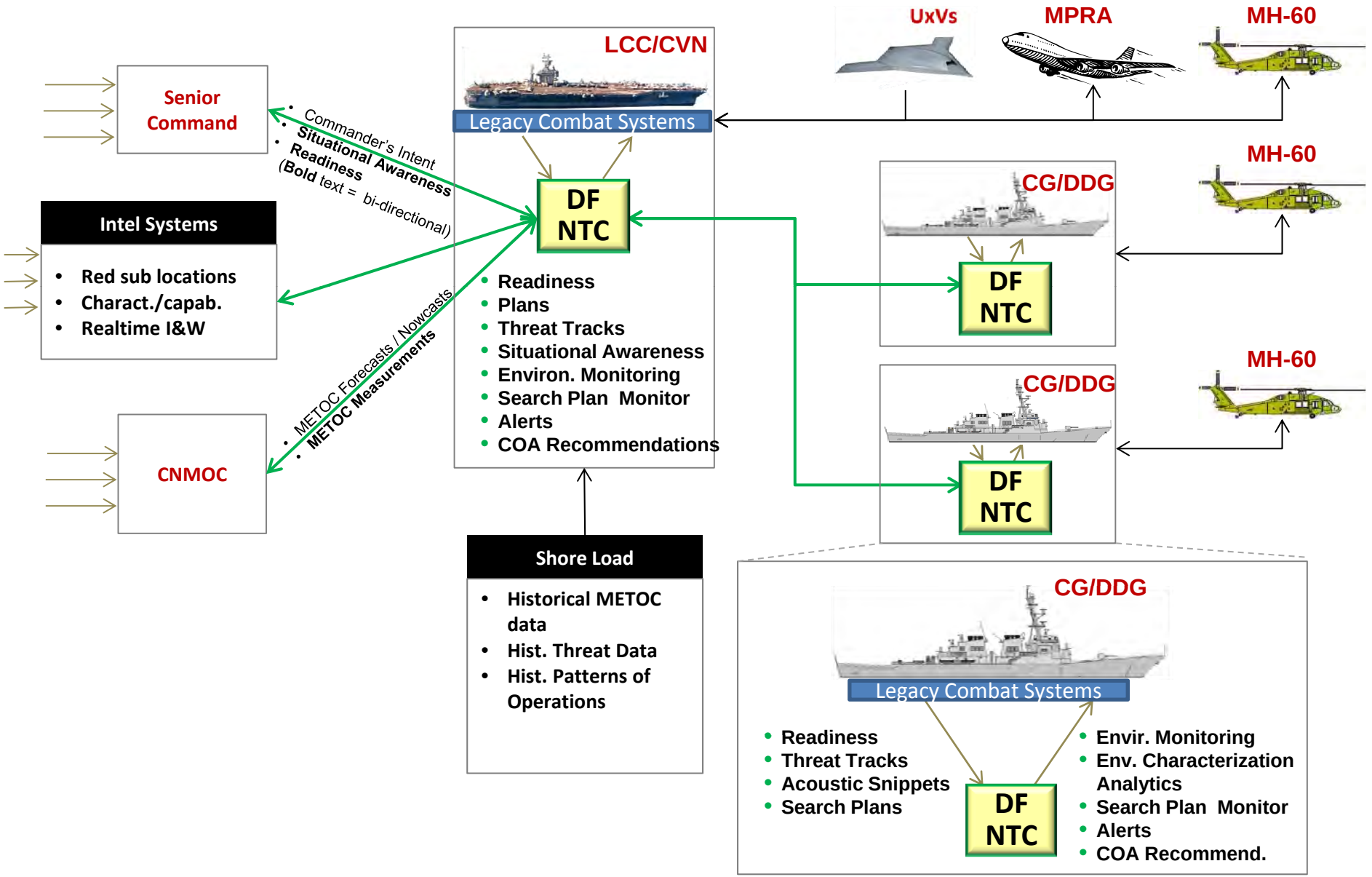
- Experience with NTC-like Big Data platform is important
- Domain Expertise (e.g., understanding the data) is essential
- Key emphasis is ability to ingest and index real data

# Part #6

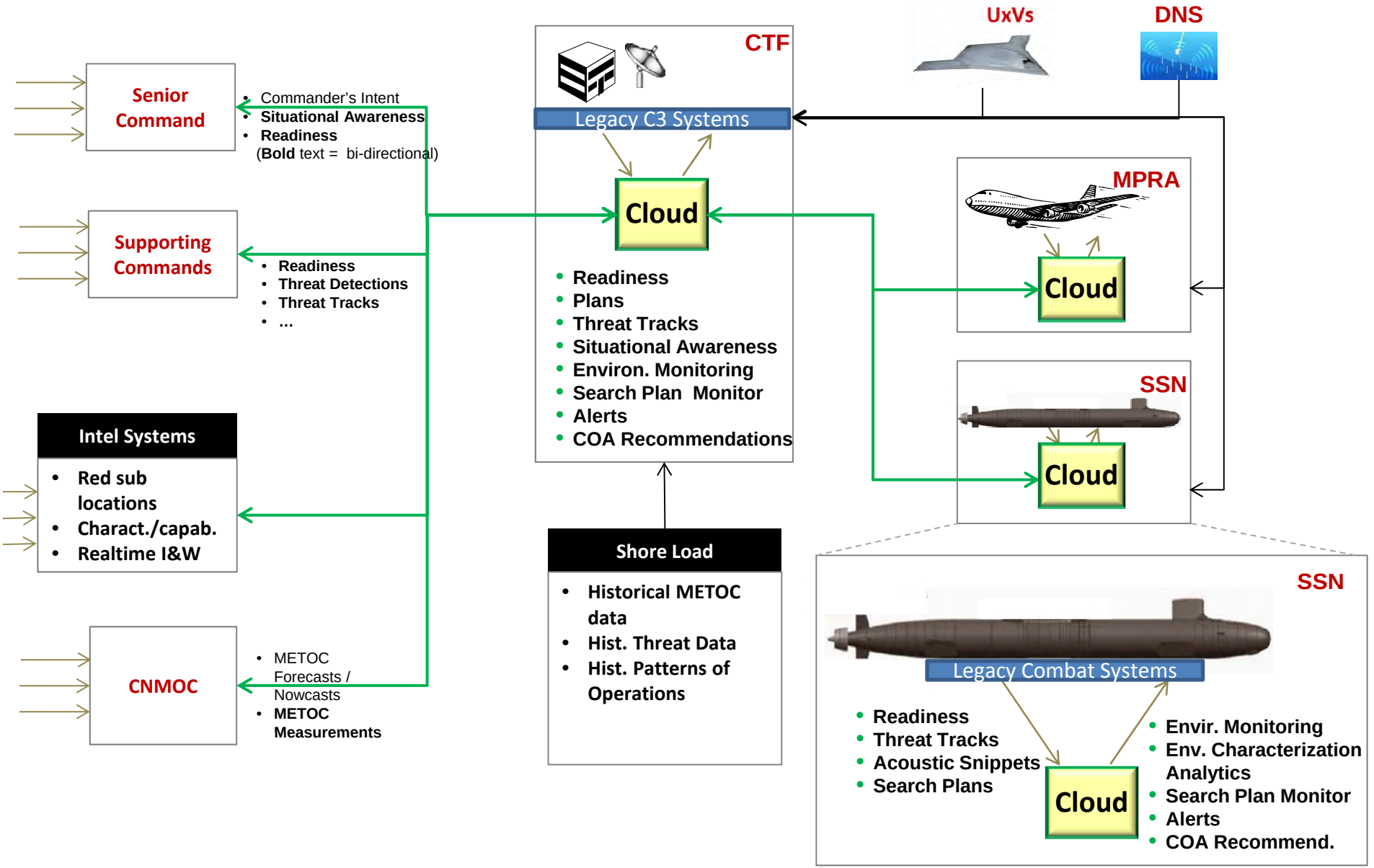
# Analytic Thrust / ASW

- **Two ASW scenarios cases will be introduced to offer context.**
- **Three exemplars will briefed:**
  - "Mundane" – Ambient Noise
    - Monitoring
    - Analyzing
    - Data sharing
    - Forecasting
    - Alarm triggers
  - "Intermediate" – Acoustic snippet fusion
    - Analyzing
    - Discovery
    - Fusion
    - Bell-ringing
  - "Reach" – Multi-domain info-fusion
    - Prioritized Discovery
    - Multi-domain fusion
    - Situational Awareness / Commanders Intent
    - Decision-making

# ASW Scenario – Strike Group Use Case



# ASW Scenario – Theater ASW Use Case



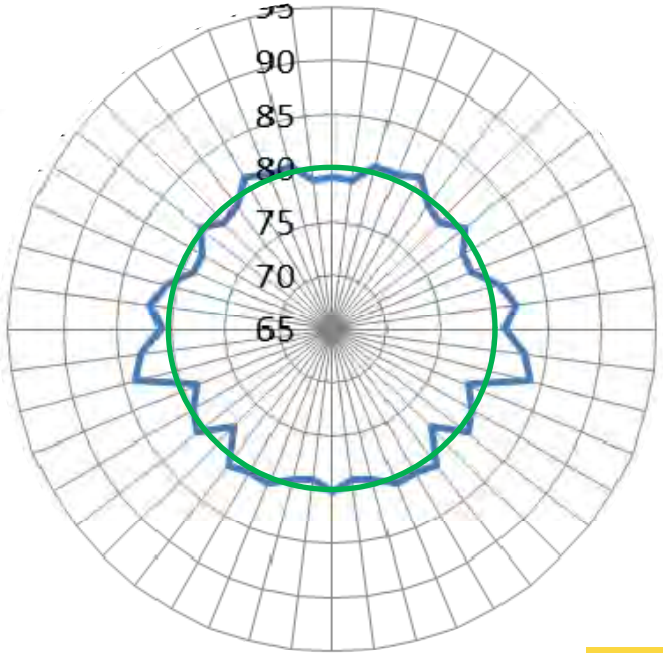
# Mundane Exemplar of Cloud Analytic in Support of ASW

# Ambient Noise Monitoring Analytic

- **A series of 5-minute ambient noise measurement have been modeled.**
  - Temporal variability
  - Beam-to-beam variability
- **A four hour sequence of "measured" noise is depicted.**
  - In our exemplar, 80 dB is assumed to be the historical omni-directional (isotropic) noise field.
    - This is what the platform and the ASW Commander would use in planning.
  - For ease of understanding, representations of ambient noise are based on omni-directional noise, such that noise level in the beam is adjusted to reflect what an isotropic noise field would have produced it.
- **The last slide:**
  - Shows 24 hours of simulated data.
  - Shows what a noise monitoring analytic might do.
  - Suggests additional mundane cloud analytics that might be brought to bear

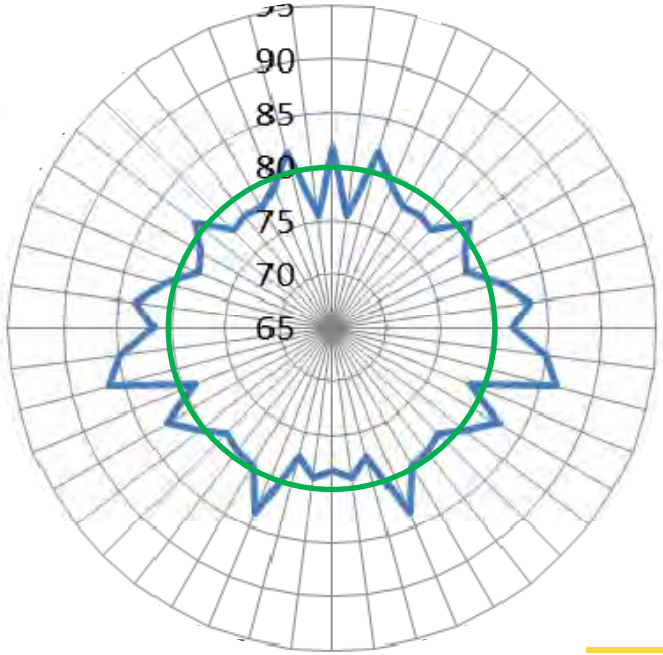
Today, there is a lot of reliance on historical data for planning and then Situational Awareness

# T=0 Hours



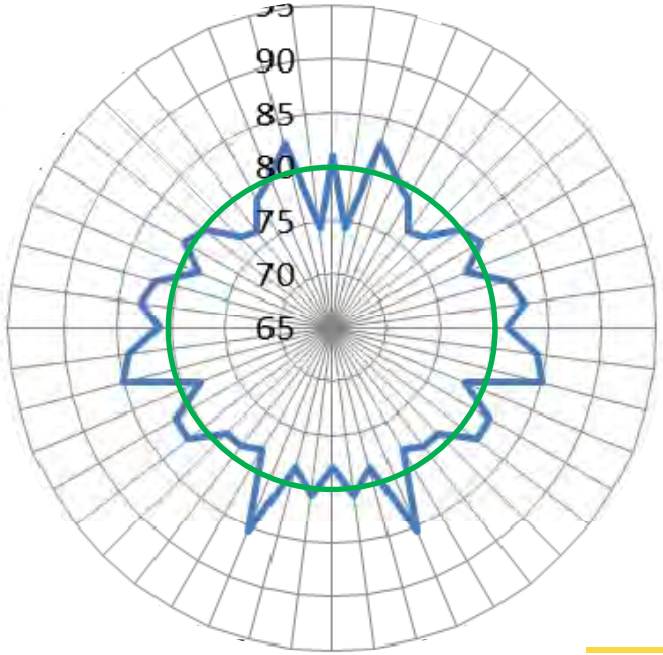

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.0833 Hours



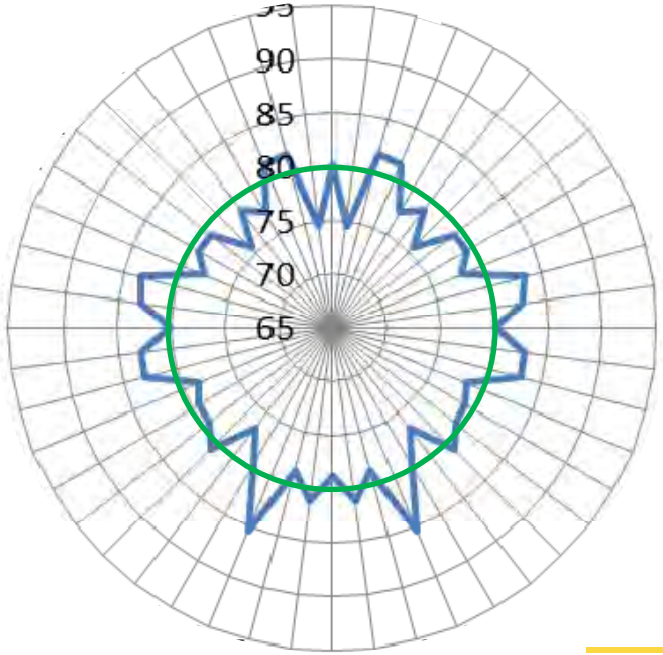

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.1666 Hours



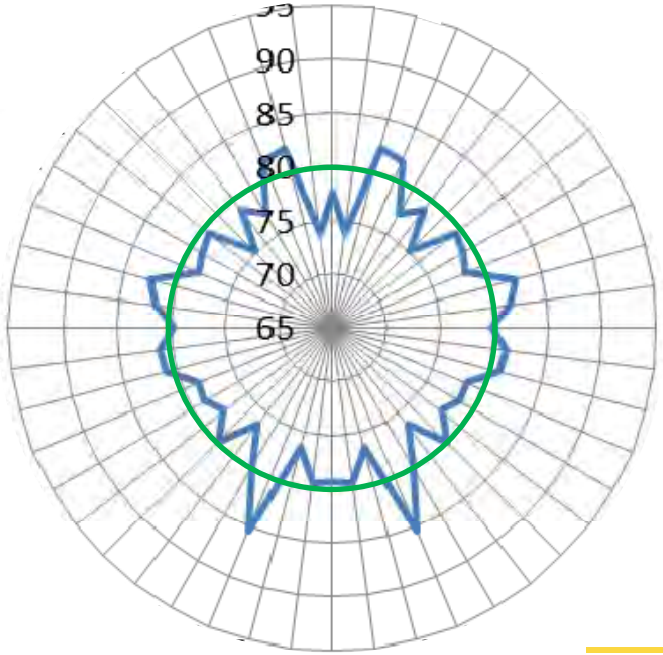

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.2499 Hours



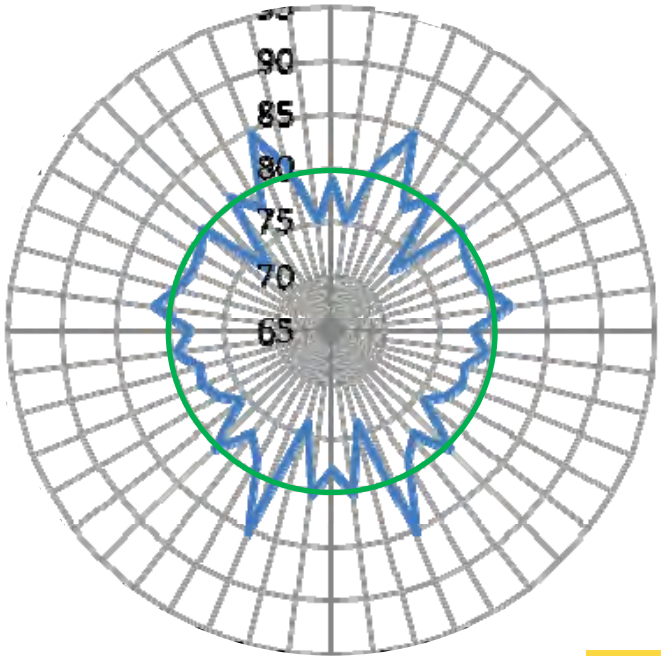

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.3332 Hours



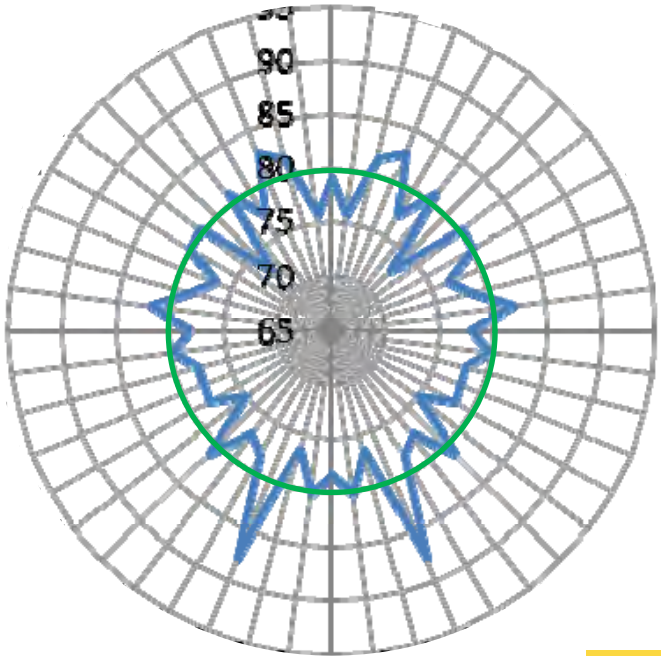

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.4165 Hours



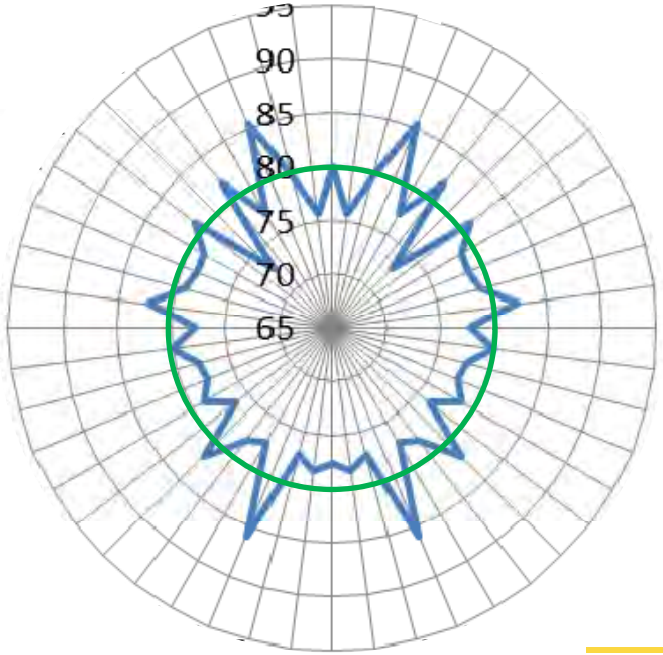

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.4998 Hours



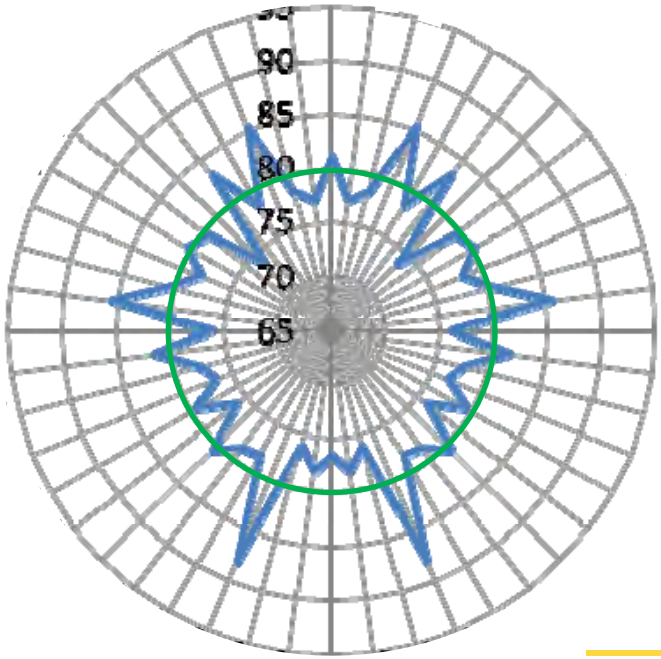

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.5831 Hours



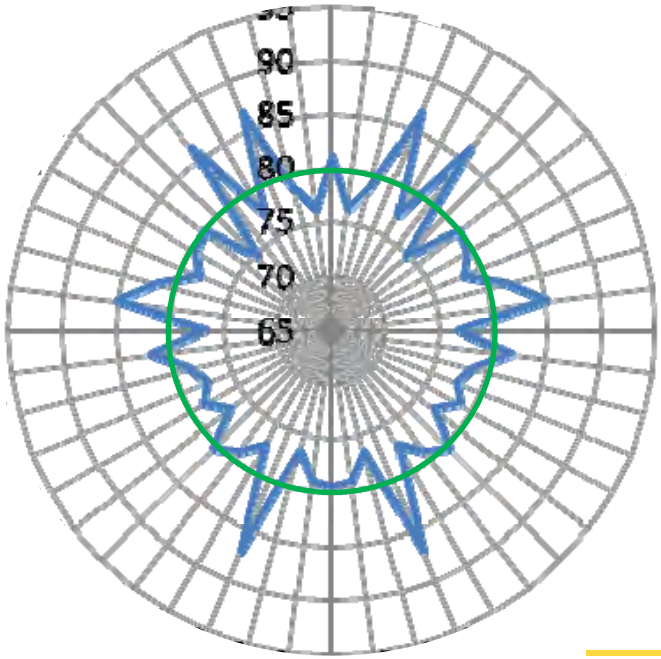

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.6664 Hours



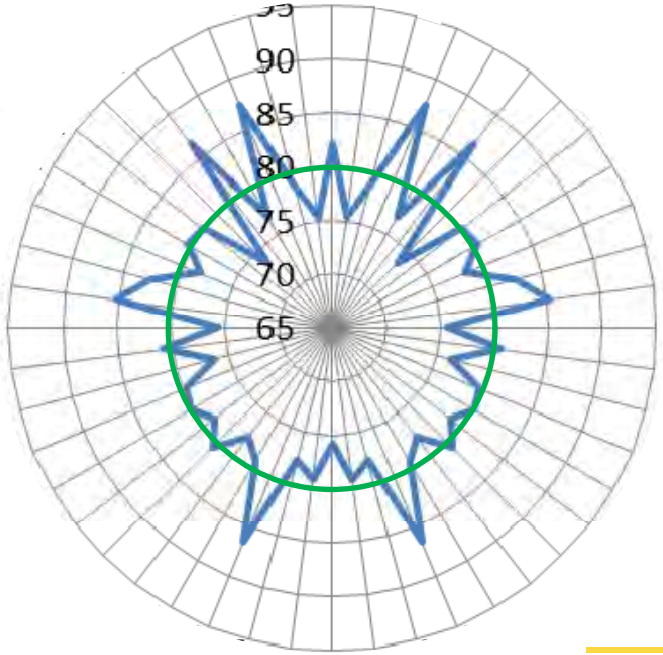

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.7497 Hours



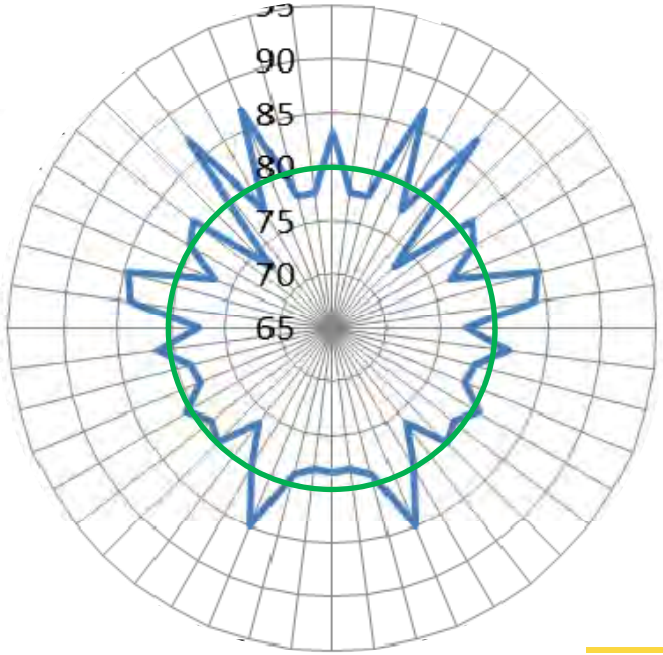

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.833 Hours



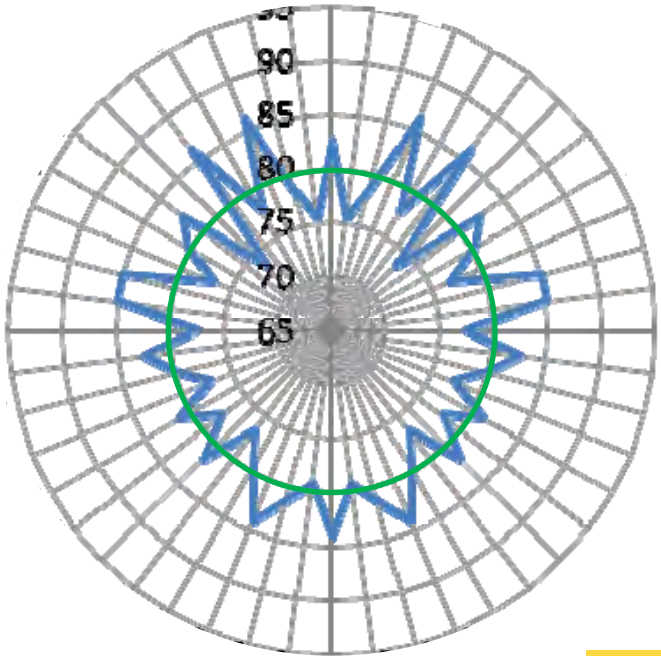

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.9163 Hours



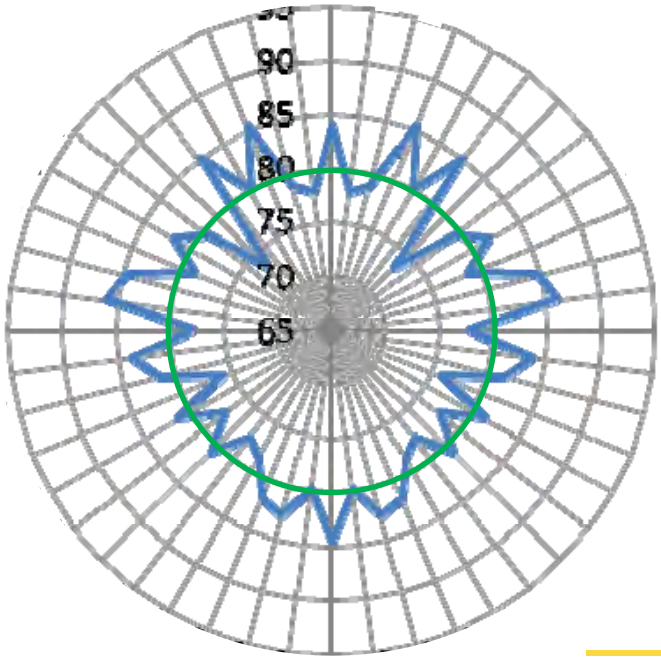

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=0.9996 Hours



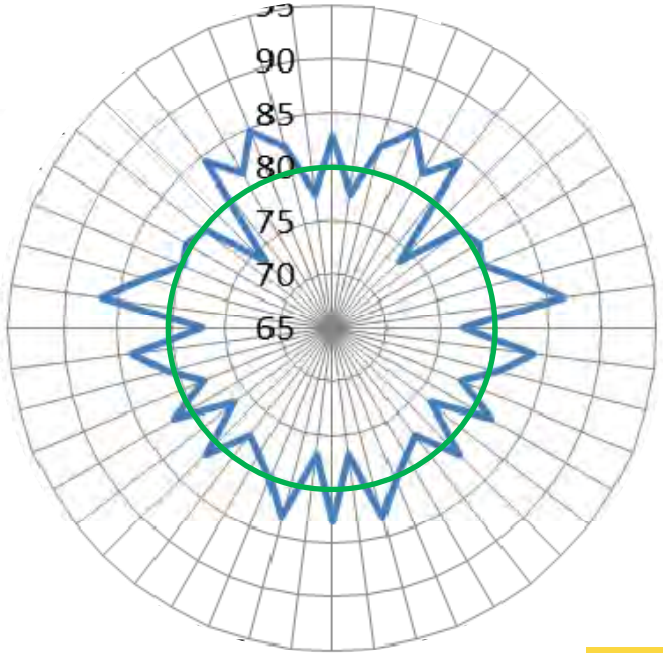

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.0829 Hours



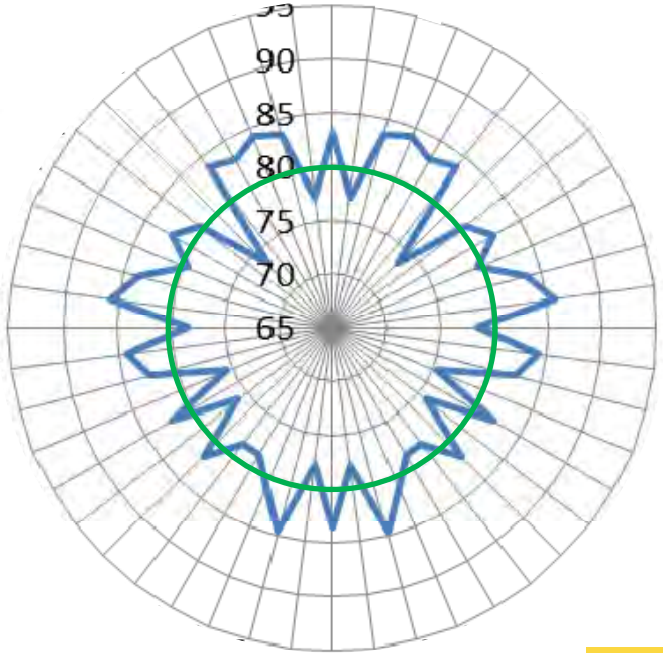

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.1662 Hours



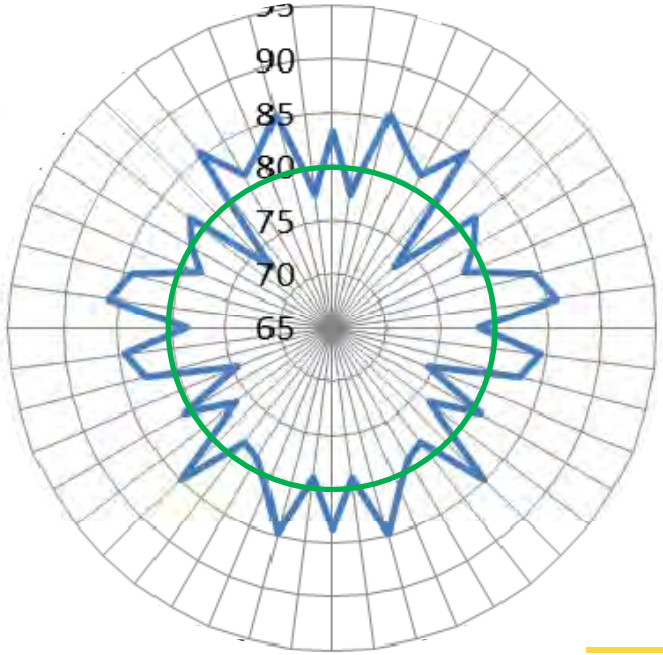

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.2495 Hours



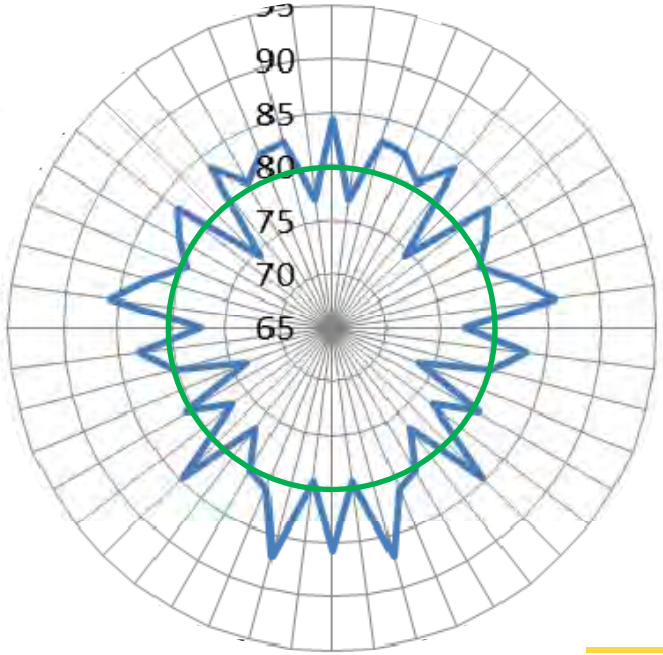

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.3328 Hours



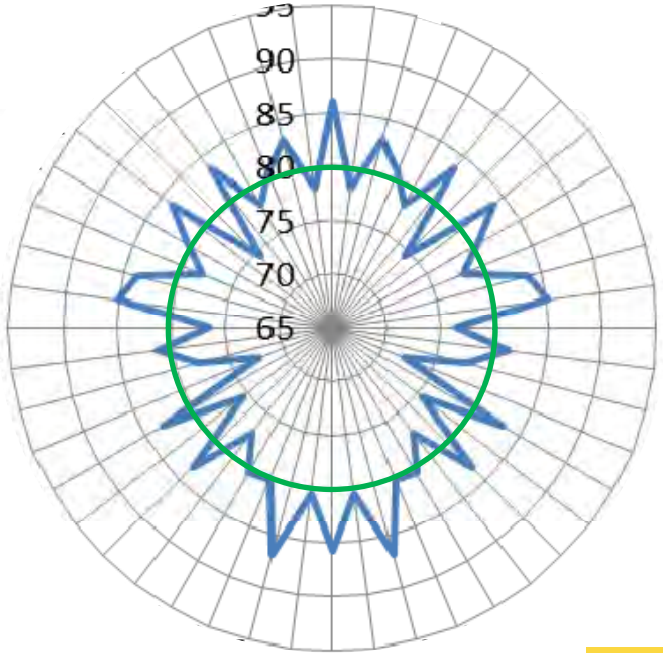

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.4161 Hours



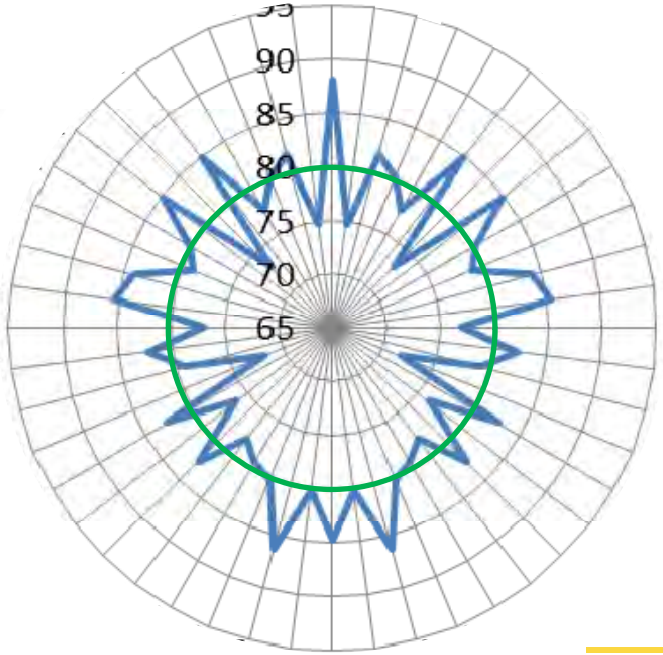

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.4994 Hours



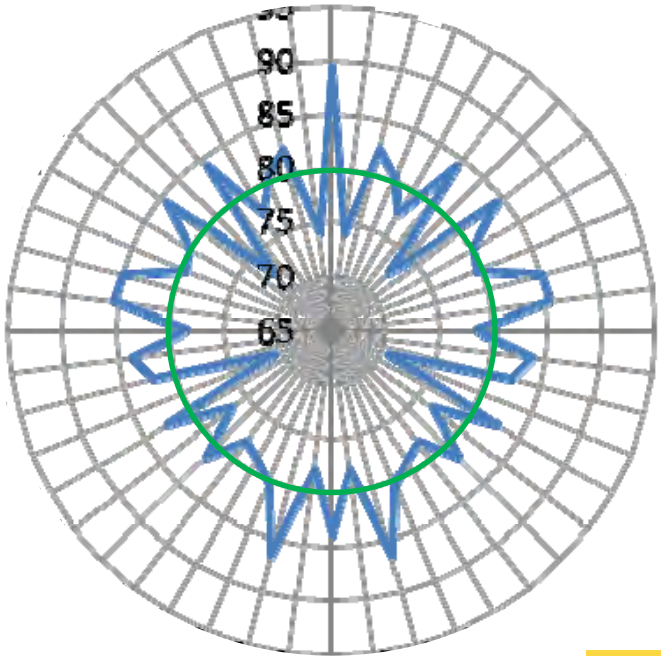

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.5827 Hours



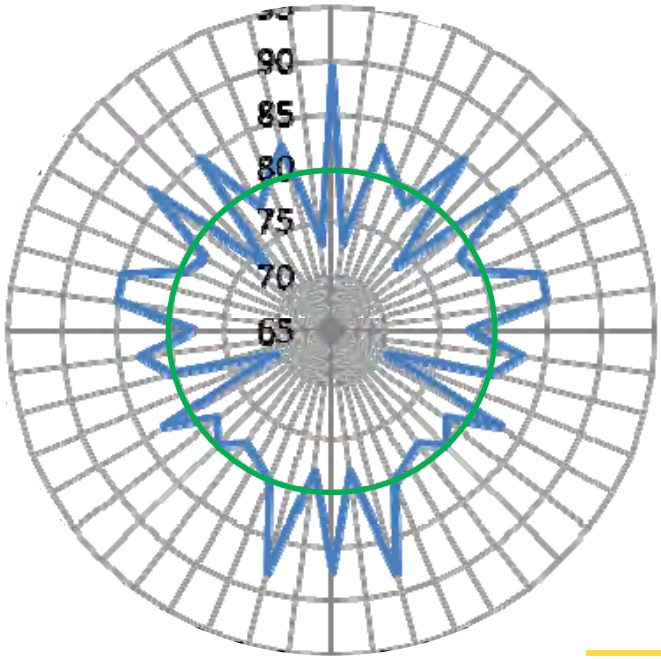

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.666 Hours



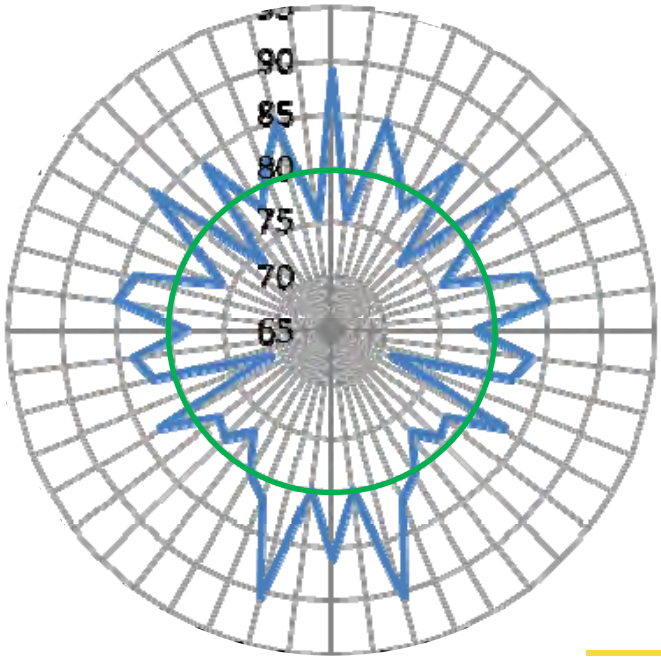

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.7493 Hours



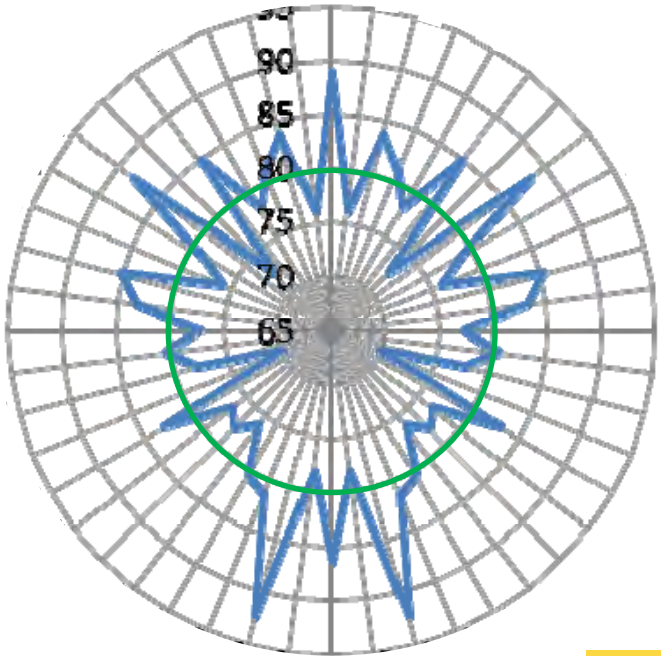

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.8326 Hours



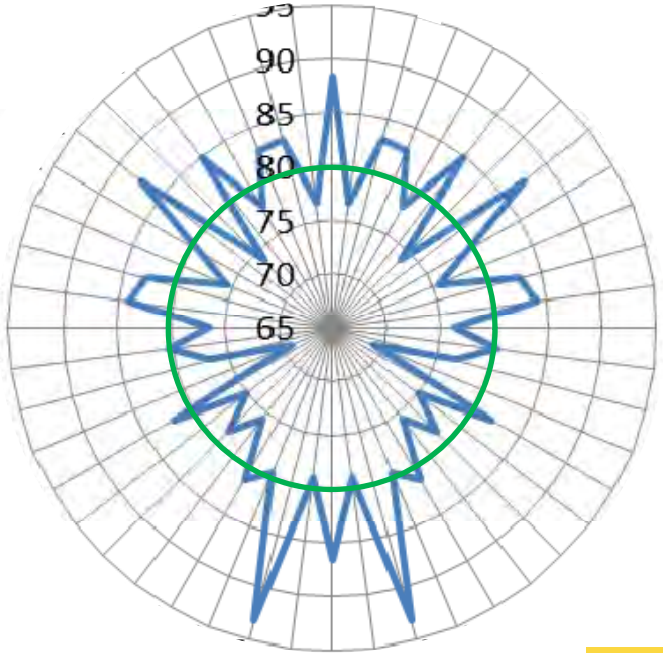

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.9159 Hours



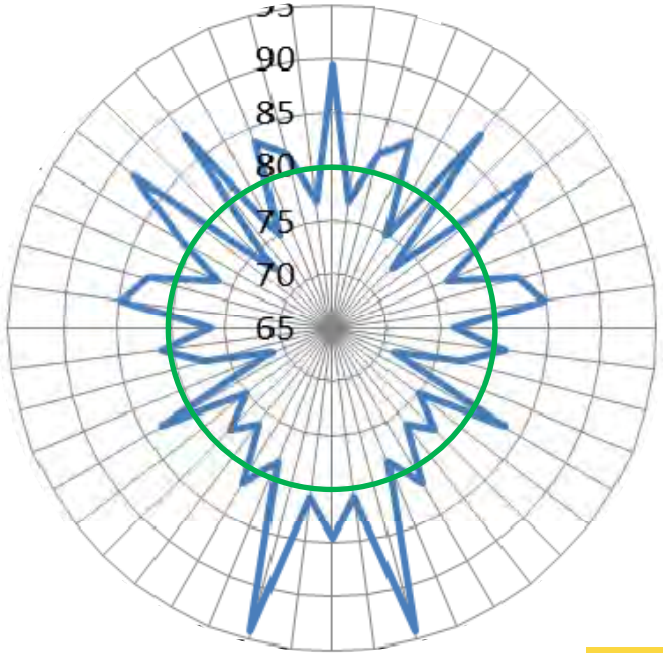

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=1.9992 Hours



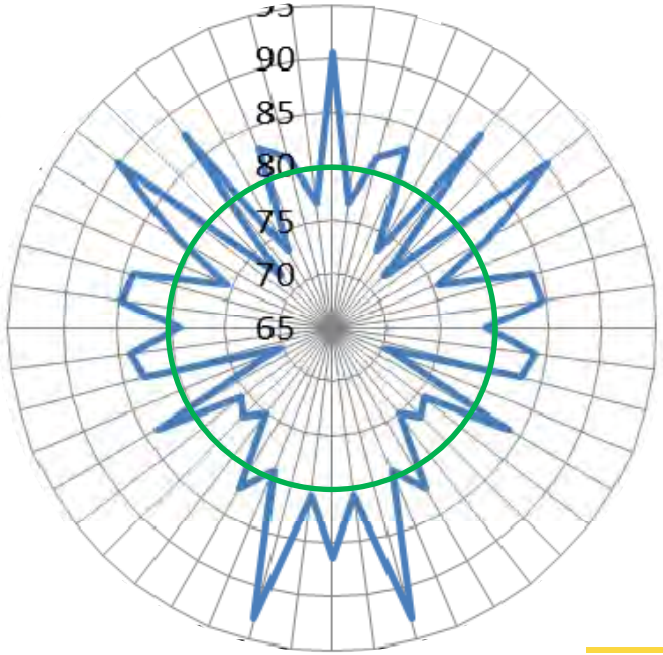

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.0825 Hours



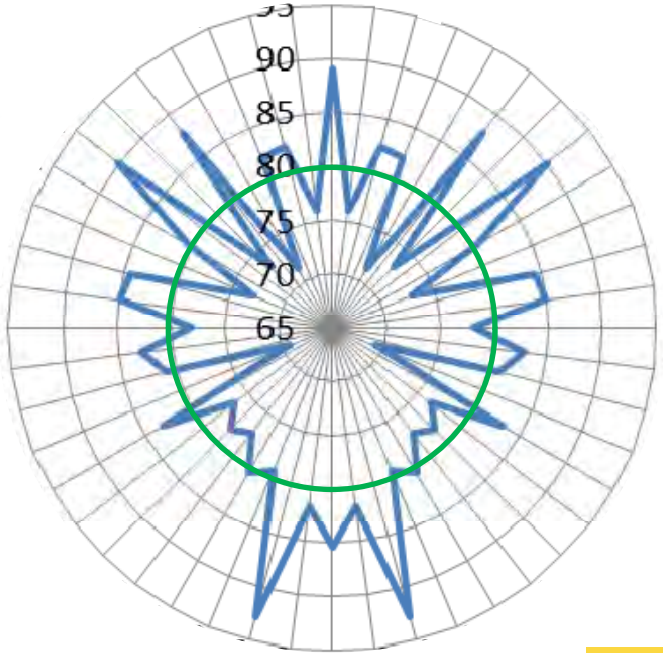

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.1658 Hours



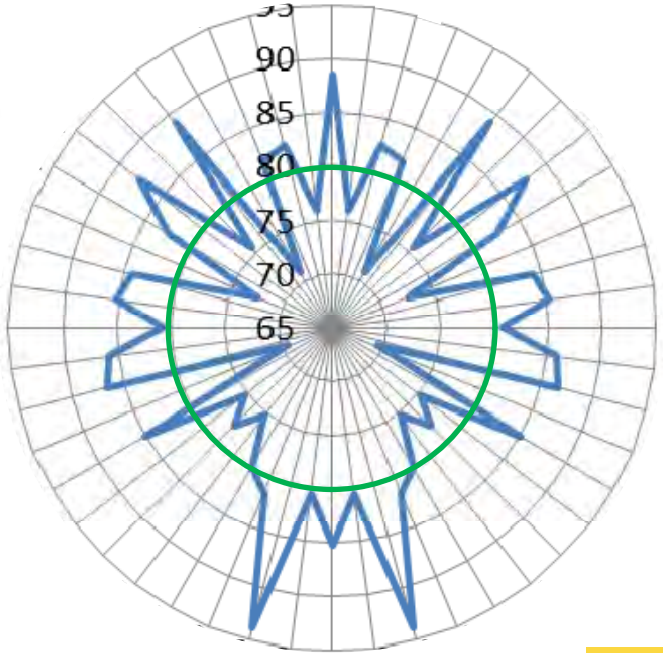

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.2491 Hours



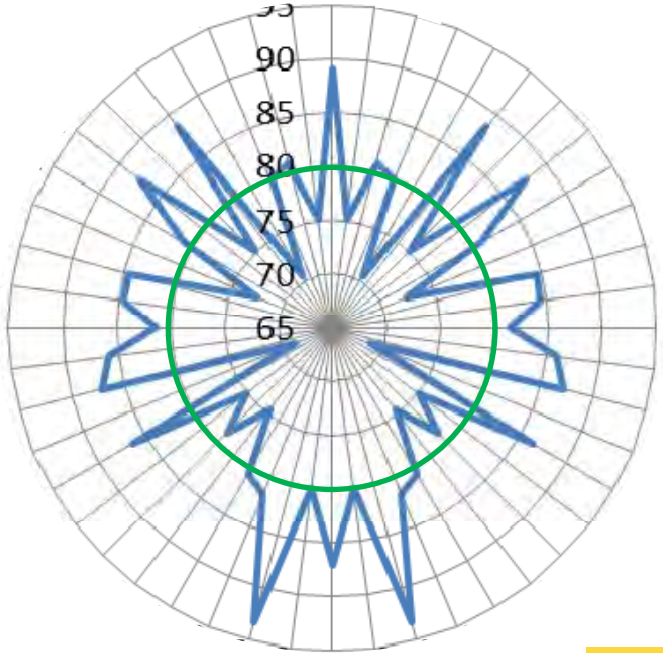

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.3324 Hours



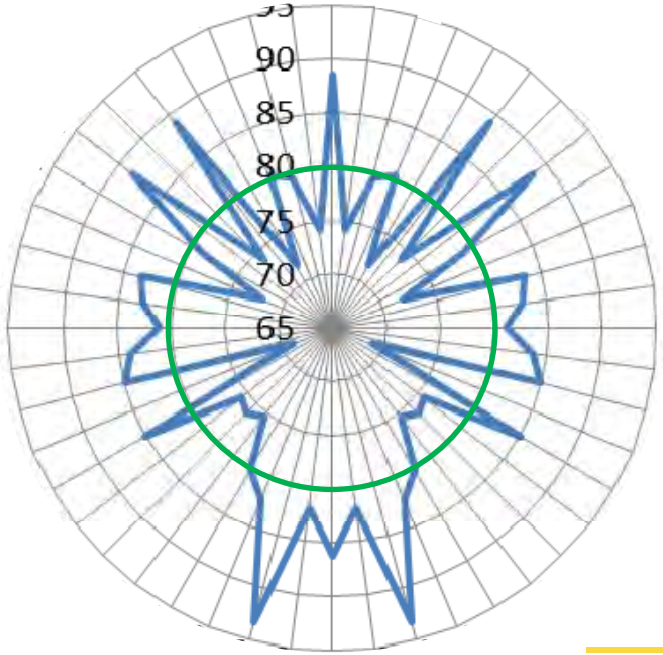

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.4157 Hours



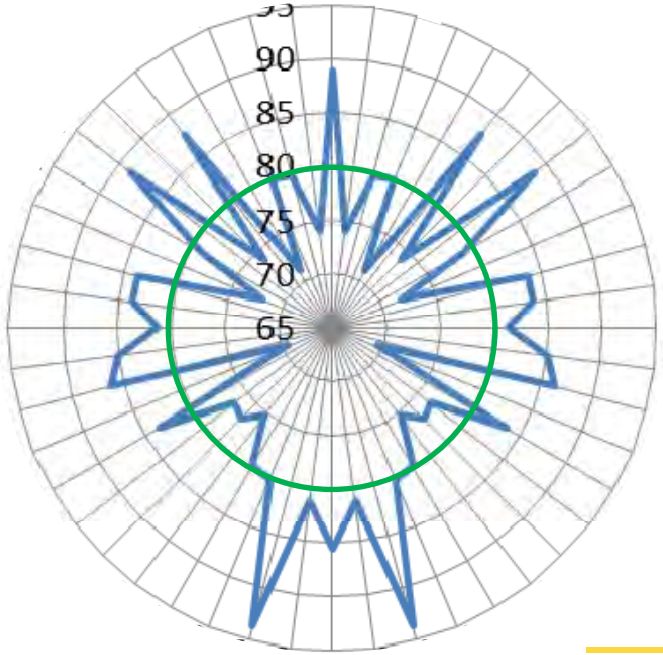

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.499 Hours



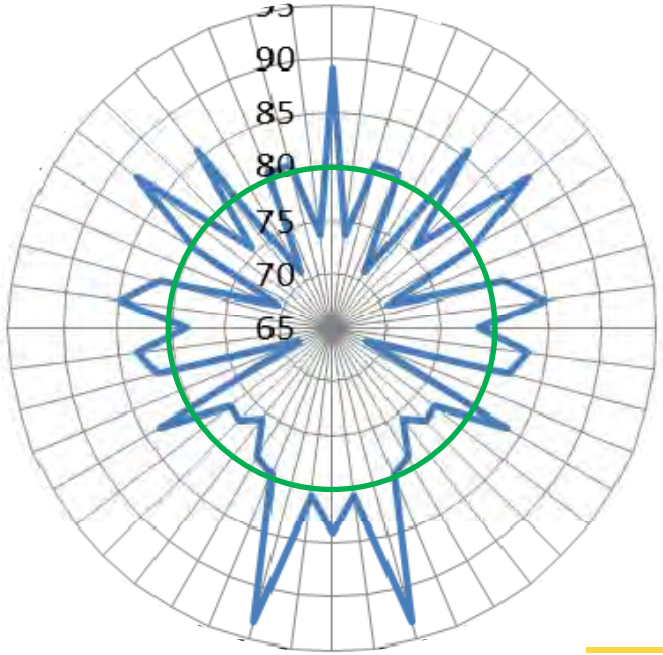

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.5823 Hours



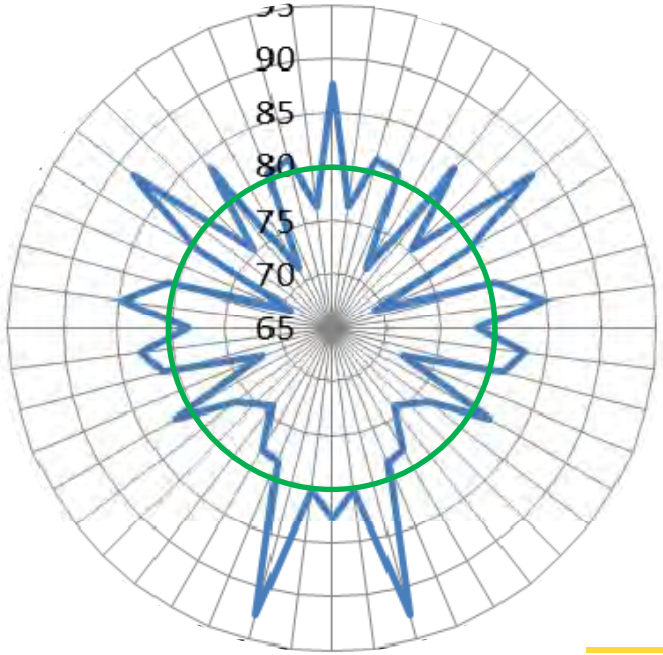

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.6656 Hours



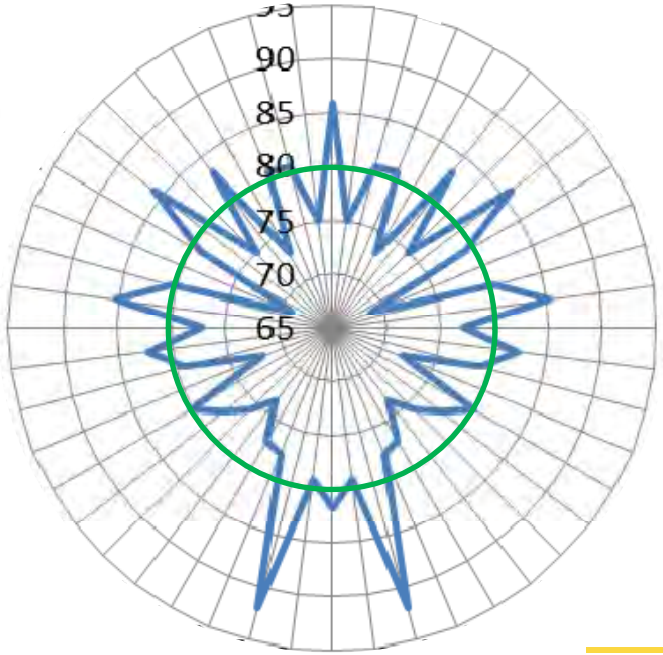

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.7489 Hours



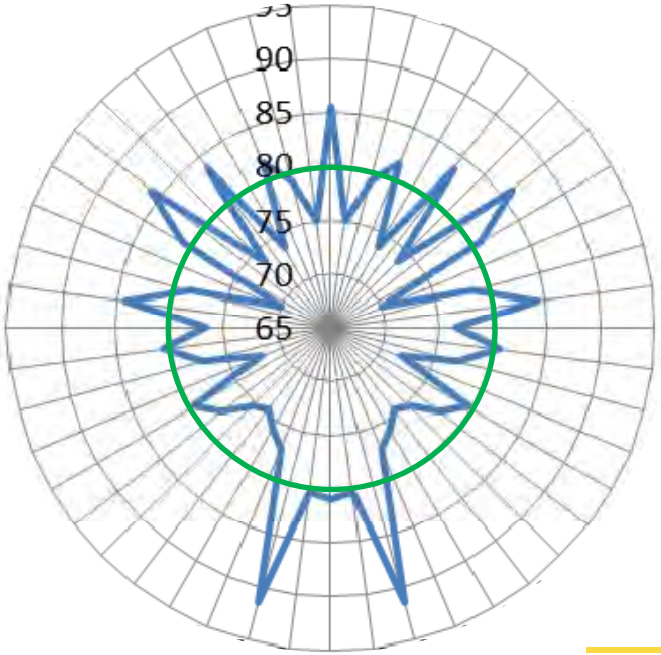

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.8322 Hours



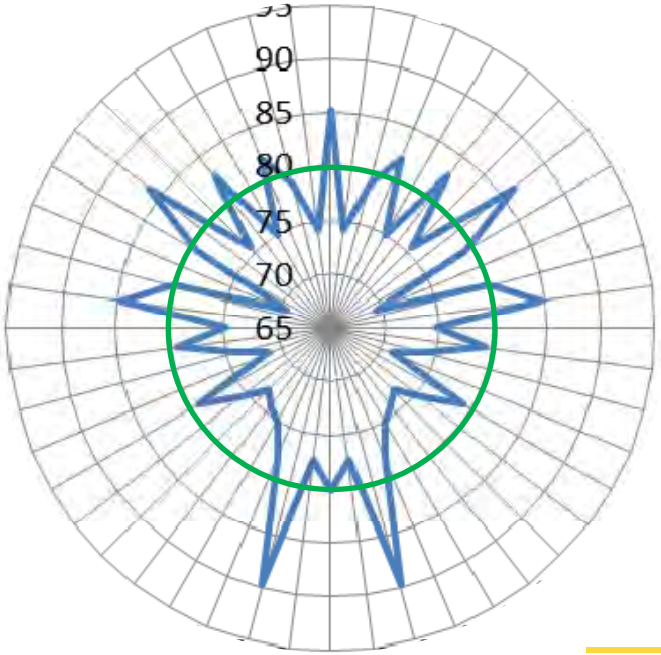

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.9155 Hours



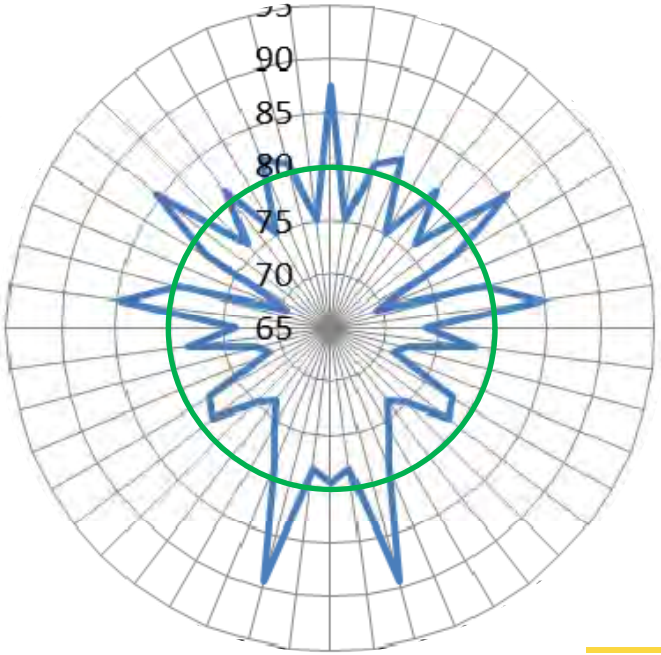

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=2.988 Hours



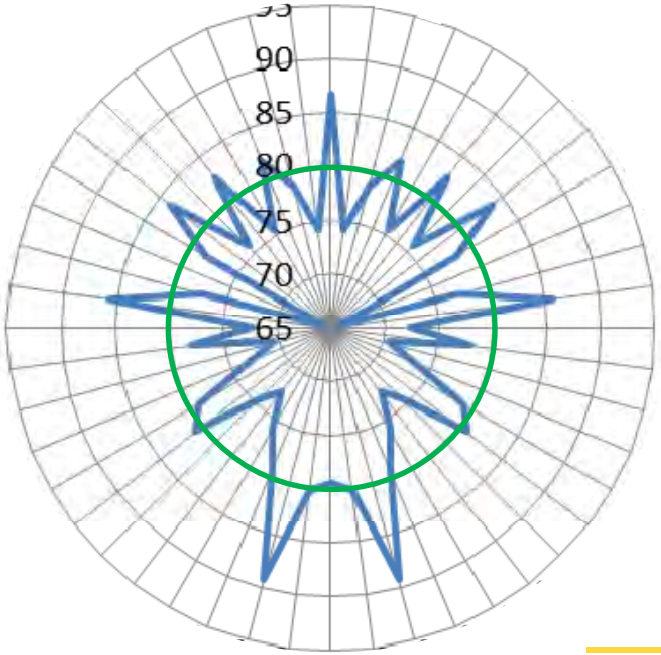

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.0821 Hours



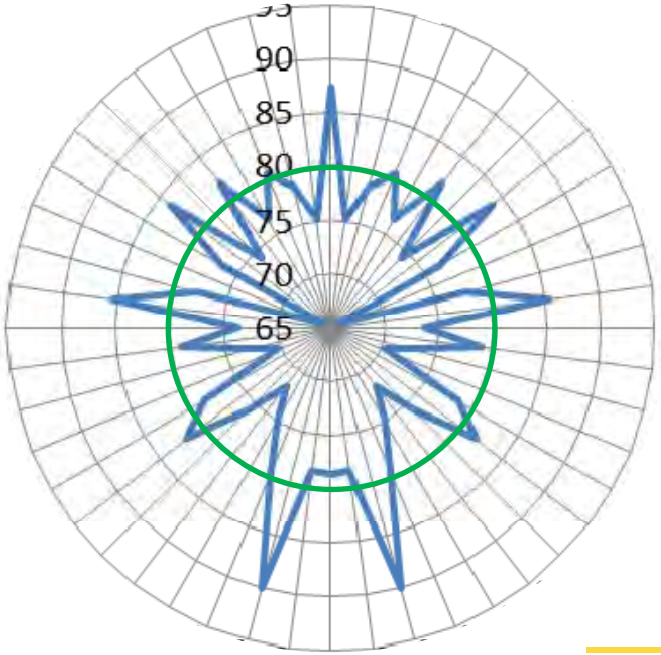

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.1654 Hours



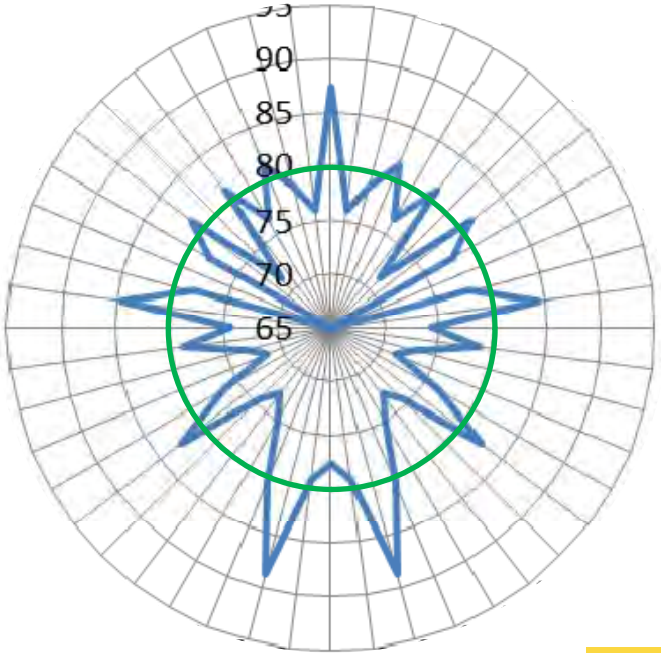

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.2487 Hours



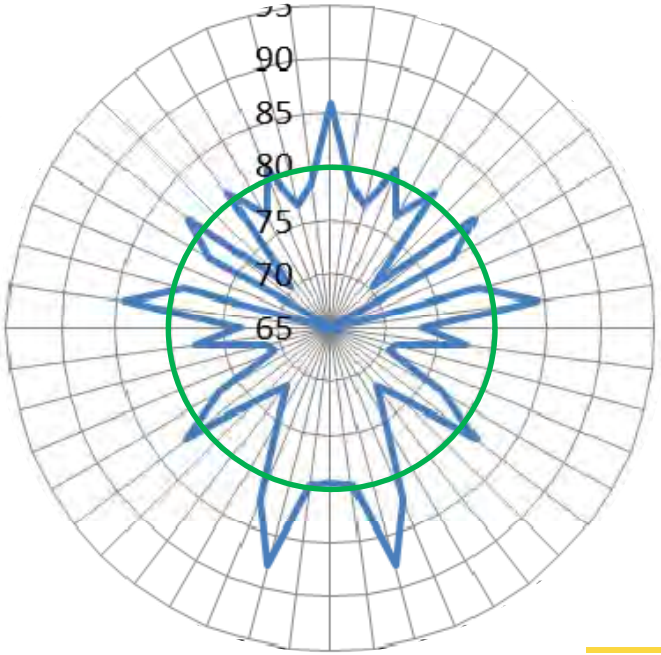

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.332 Hours



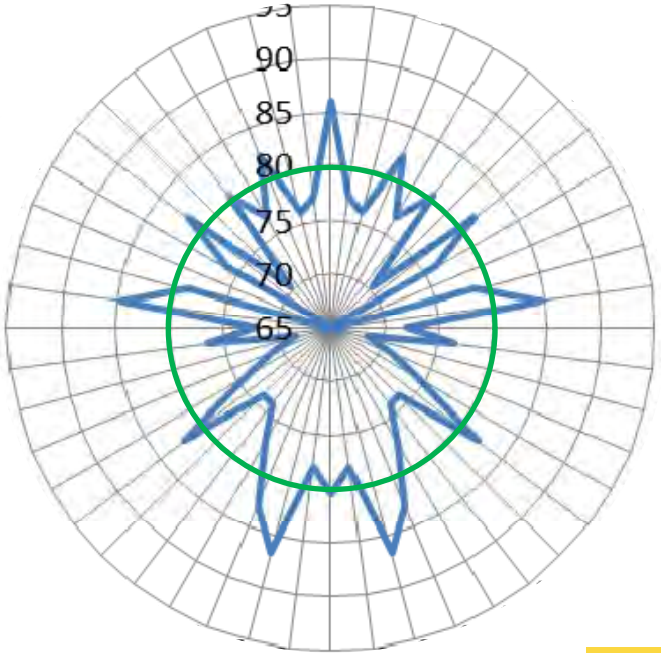

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.4152 Hours



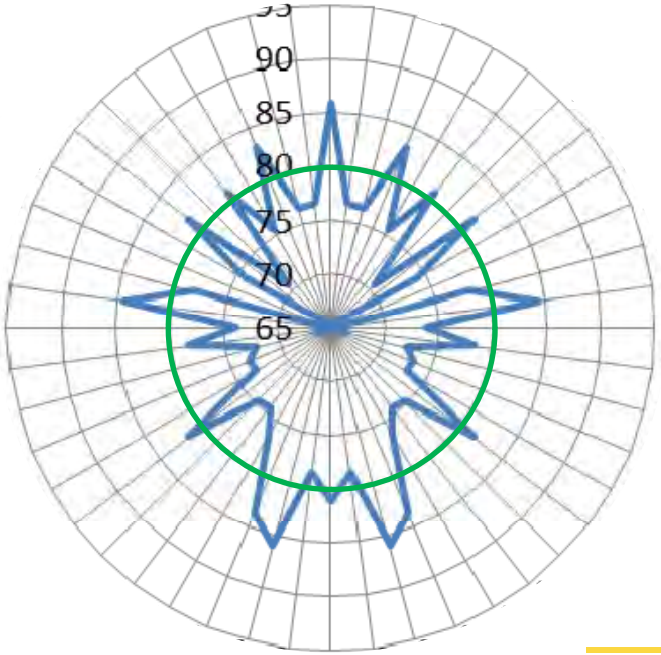

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.4986 Hours



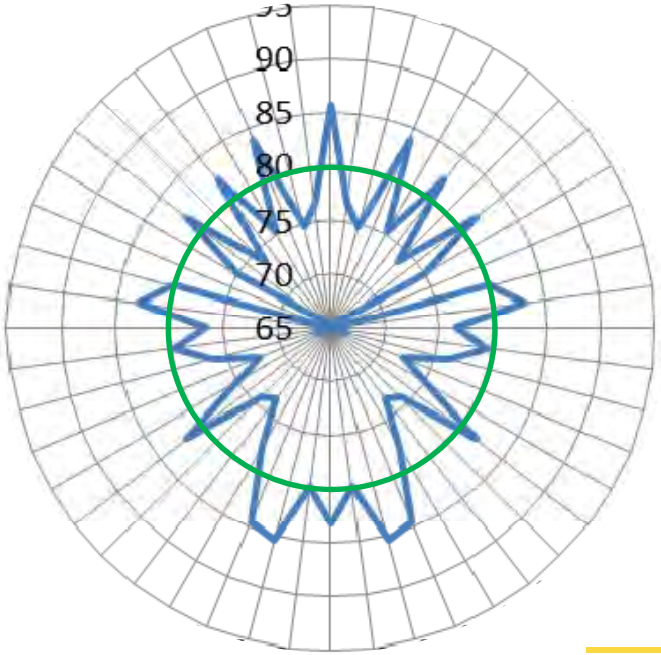

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.5819 Hours



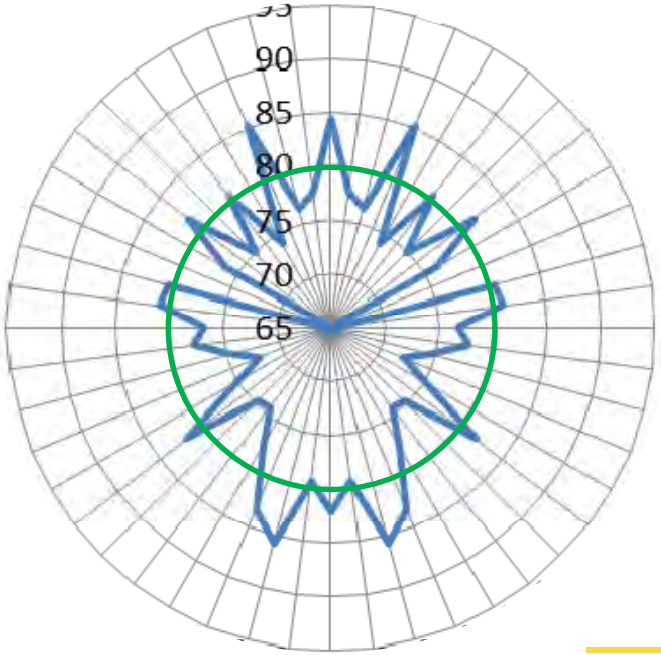

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.9151 Hours



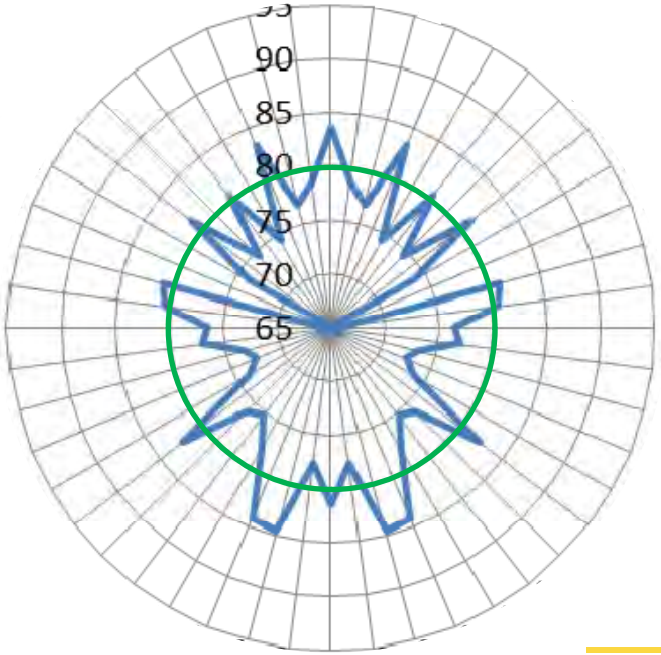

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=3.9984 Hours



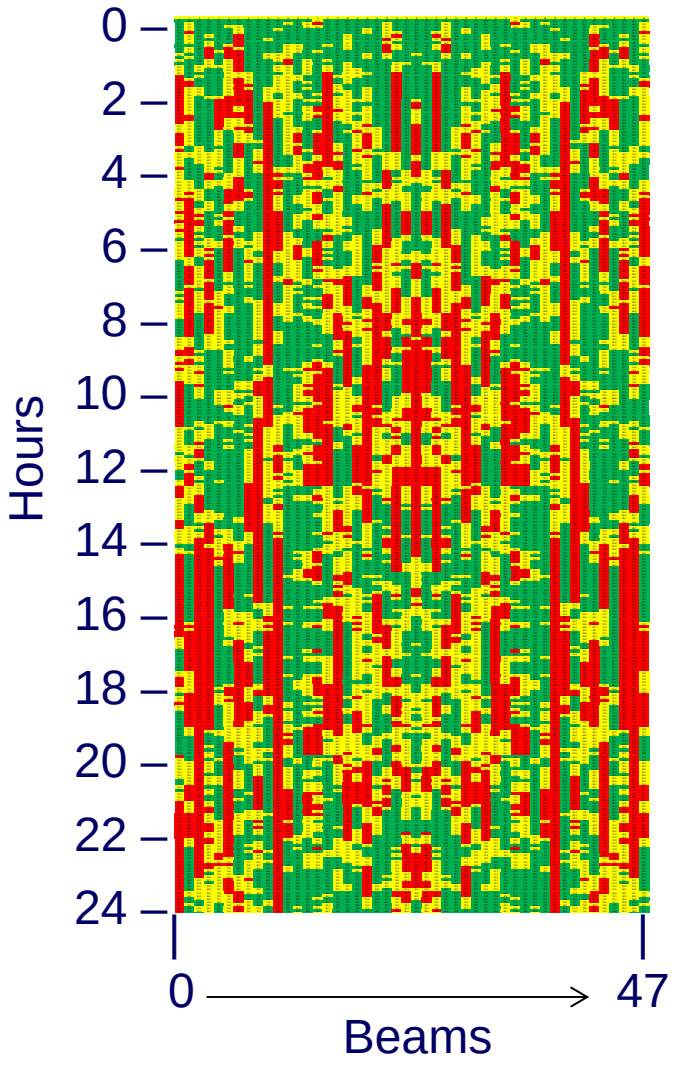

Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# T=4.0817 Hours




Omni-noise as measured in the beam
Historical omni-noise @ 80 dB

# 24 Hours of Beam Noise




- Ambient Noise within 3 dB of Historical Ave.
- Ambient Noise within 6 dB of Historical Ave.
- Ambient Noise not within 6 dB of Historical Ave.

**Analytic** might describe this data as:

- Mean of 84.3 dB
- Gauss-Markov process
  - Time constant of 12 hours
  - Correlated beam-to-beam

The above description is easily shared across low bandwidth networks and can be used to understand statistical performance of the described sensor.

Other **Analytics** might be applied.

- Alert that ave. ambient noise 4 dB above expected
- Calculate impact on search plan
  - Make recommendations to mitigate
- Identify persistent azimuthal noise field
- …

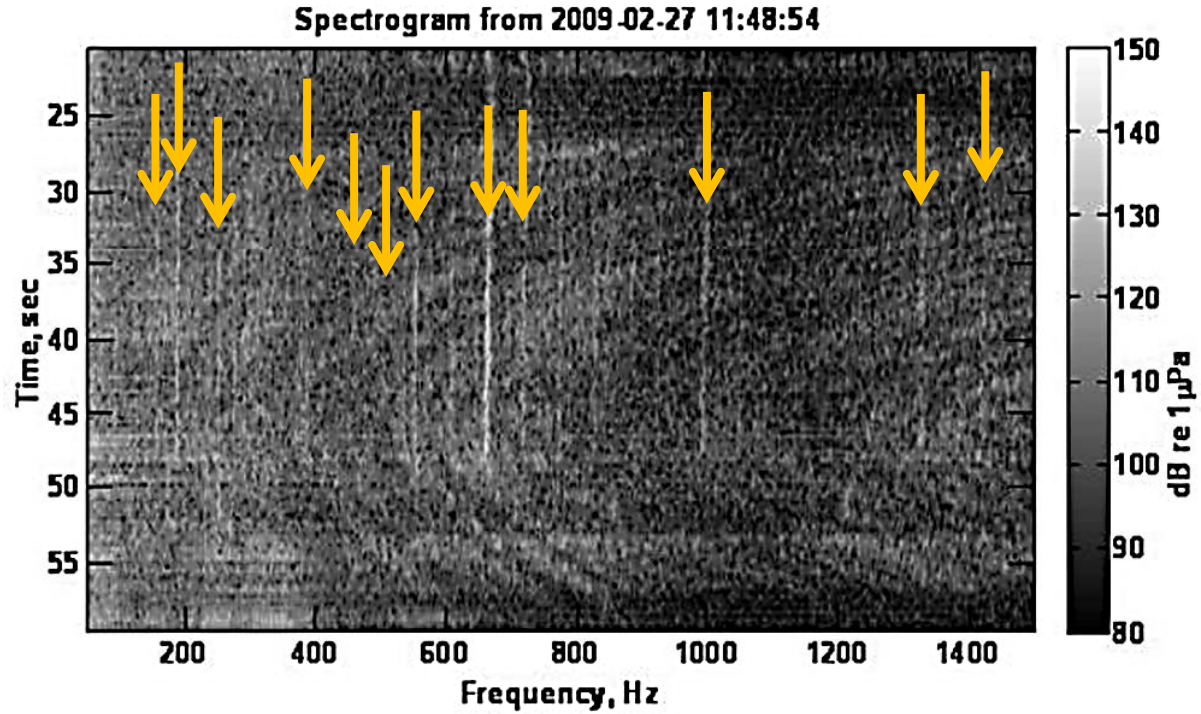
**Statistical characterization is invaluable in re-planning and developing Situational Awareness**

# Intermediate Exemplar of Cloud Analytic in Support of ASW

# Acoustic Snippet Aggregation

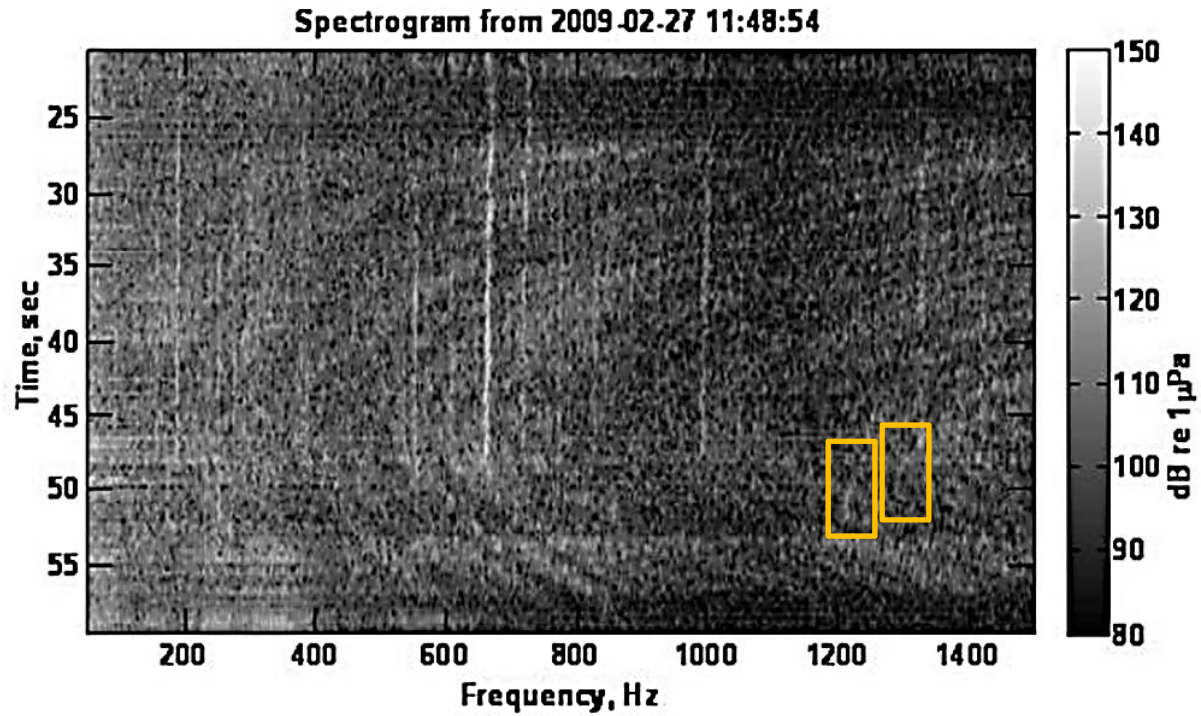
- **Typical framework for identifying contacts of interest and classifying rely on real-time / near real-time activities.**
  - Cueing theory applies and data “customers” are either just served once or not at all.
  - At any one time, the target may not provide sufficient evidence for Blue Force decision-making and action.
- **Through the cloud there is the opportunity to aggregate evidence of the target**
  - Longitudinally with data from the same sensor over time
  - Multiple sensors (including longitudinally) within the same platform
  - Multiple geographically dispersed sensors (including longitudinally)

# Exemplar Acoustic Spectrogram




- Spectrogram of a contact
- Many passive narrow band lines are displayed
- Operator classifies target as benign (not a submarine and not a target of interest)

# Exemplar Acoustic Spectrogram (Cont.)




- Automated Track Followers had been assigned by sonar system to the boxed signals.
- They were below “threshold” and no alert was generated.
- ATF snippets are recorded in the local cloud.

# Candidate Cloud ASW Analytics

1. **Analytic may be able to generate an alert based on combination of the two snippets if they are related and/or map to the best available ONI data.**
2. **Analytic may be able to combine these snippets with <u>previous</u> instantiations (snippets) recorded from the same or other sensors on that platform.**
3. **Analytic queries other clouds to look for snippets that may be correlated.**
   - Acoustic content
   - Satisfies kinematic tests
4. **Local cloud makes the snippet discoverable to other clouds.**

Cloud promotes early detection through system-of-system acoustic data fusion

# Reach Exemplar of Cloud Application and Analytics in Support of ASW

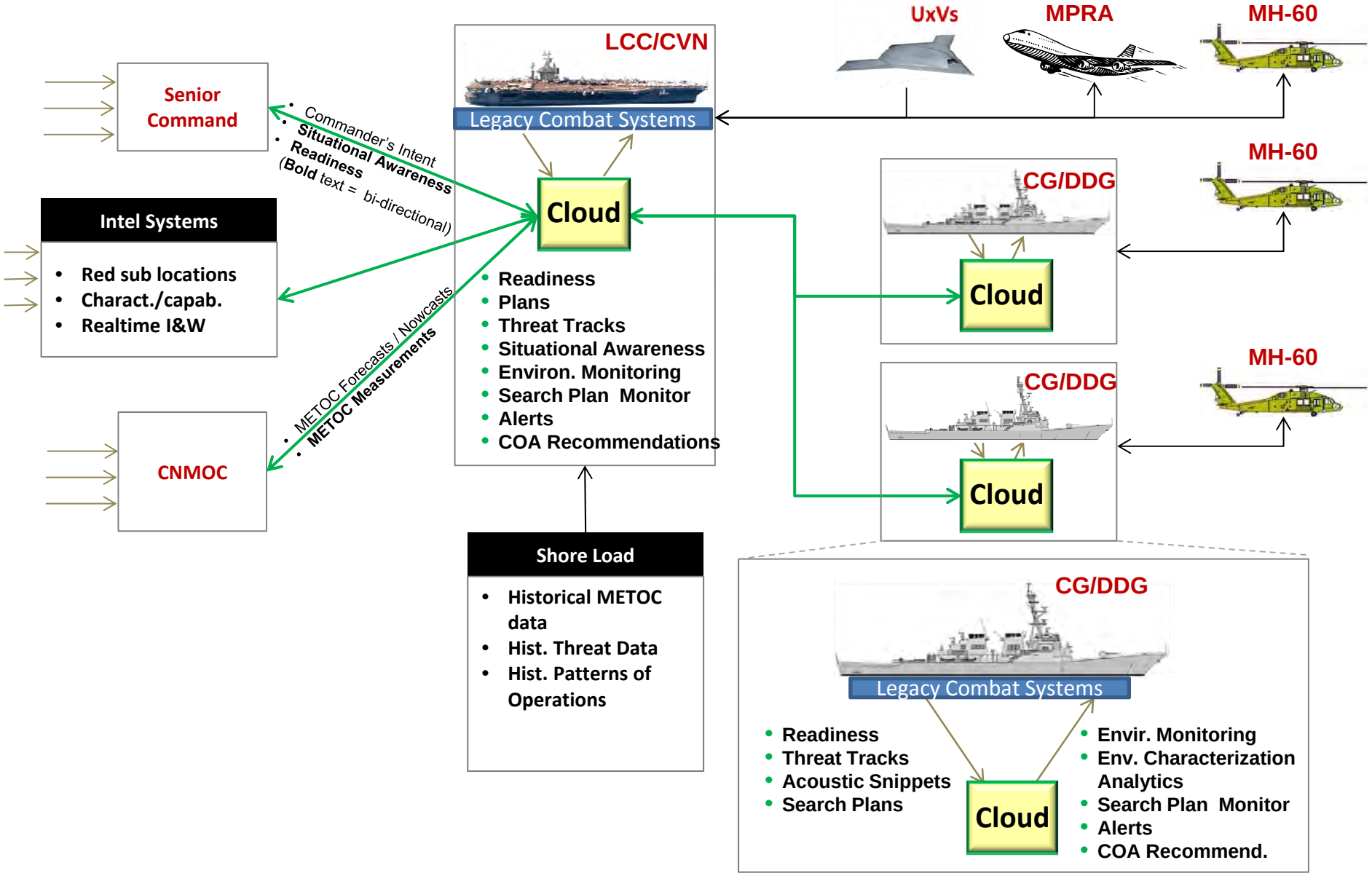
# Hypothesis of Opportunity

## It is hypothesized that:

- decisions based on better data (and better understood data) will generally promote more effective warfighting decisions.
  - All source data fusion
  - Age and quality of data understood
- analytics that search on meta-data will expose new understanding and promote greater situational awareness.
- that the cloud will make data available for more rapid discovery.
  - Tempo of Blue Force decision-making improved.

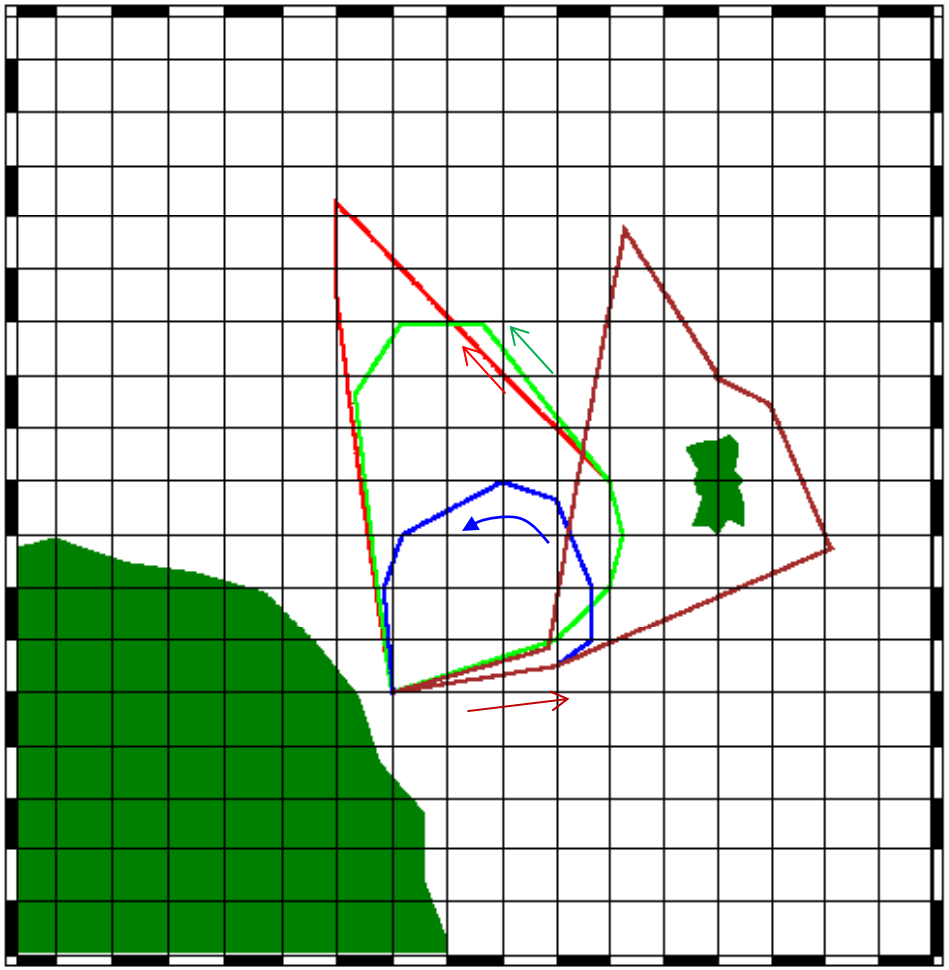
Exploiting the right data at the right place in a timely manner will improve warfighting outcomes

# Notional Cloud Opportunity



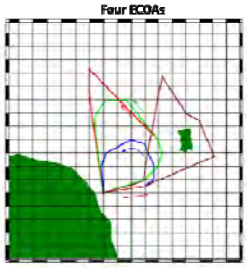
# Notional Cloud Opportunity (cont.)

**Four ECOAs**



Initially, four enemy courses of action are hypothesized for the target of interest.

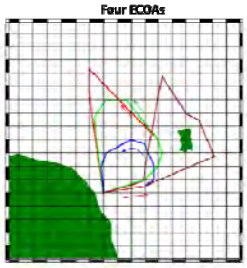
# Notional Cloud Opportunity (cont.)




**Threat Characterization Data**

| Best Available Characterization of Threat (by Hull if Avalable) | | | | |
|---|---|---|---|---|
| Acoustic Data | Signals | Levels | Prob. | Conditions |
| Weapons Data | Types | #'s | Capab. | TTP |
| ECOAs | Missions | Operate Profile | TTP | |
| … | | | | |

# Notional Cloud Opportunity (cont.)

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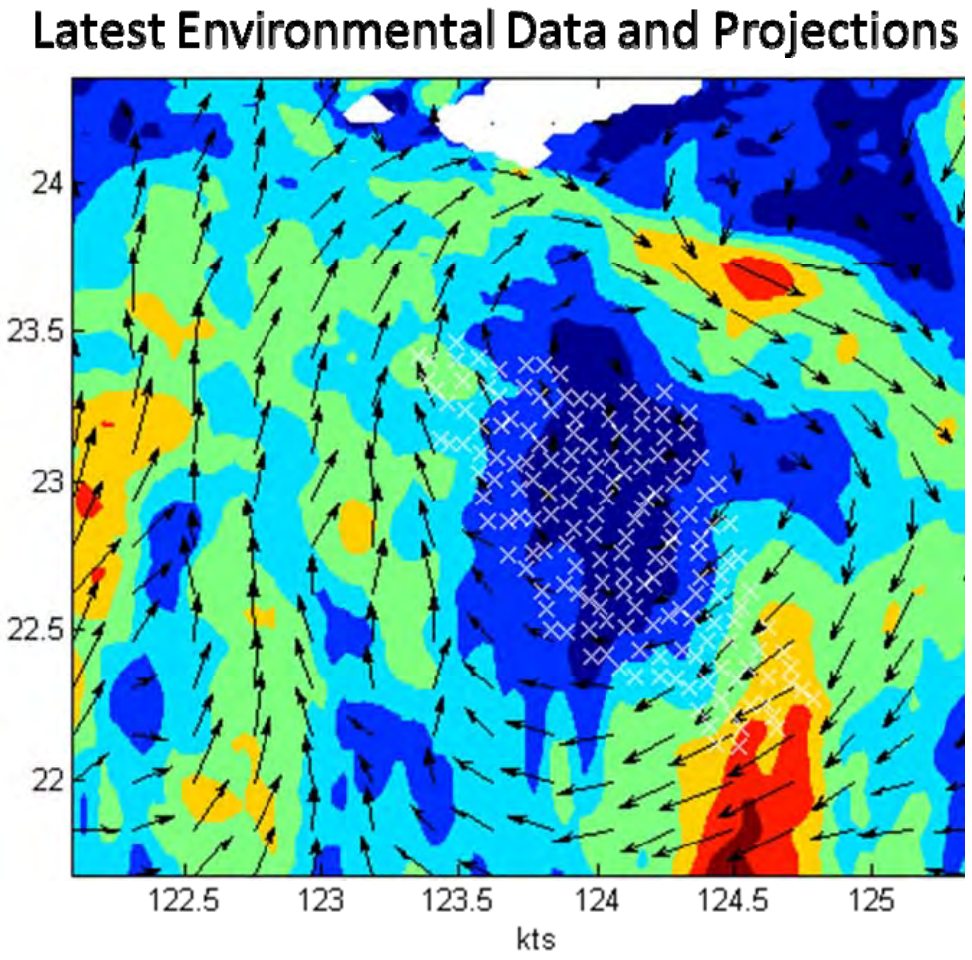
| ECOAs | Missions | Operator Profiles | TTP | |
| | | | | |



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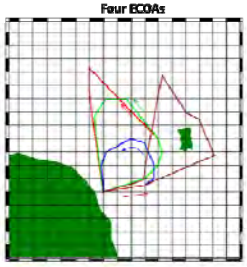
Four ECOAs



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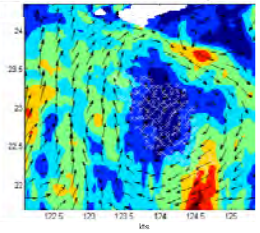
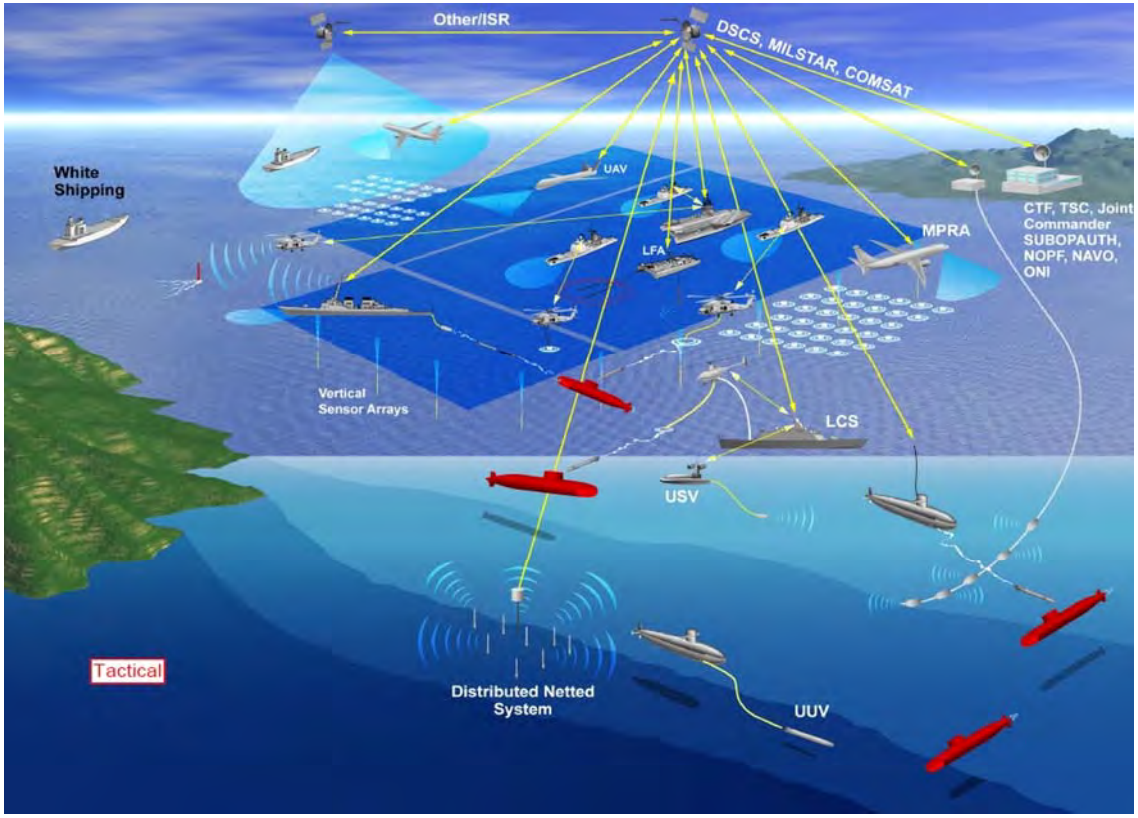
| | | | | |

Latest Environmental Data and Projections

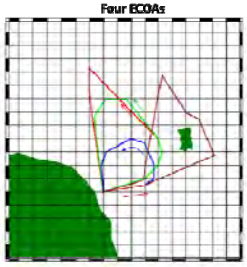


## Logistics & Readiness Common Operational Picture (COP)



# Notional Cloud Opportunity (cont.)

Four ECOAs



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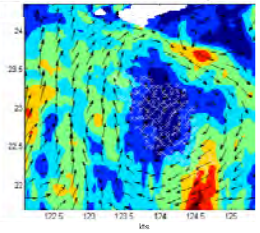
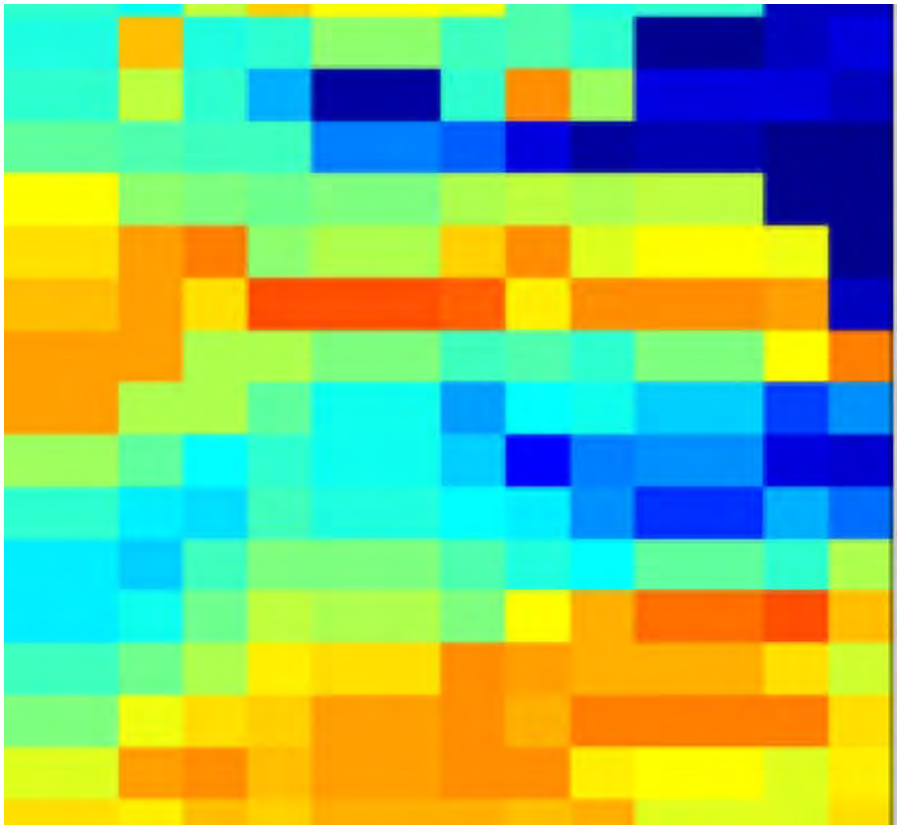


Opportunity Plot



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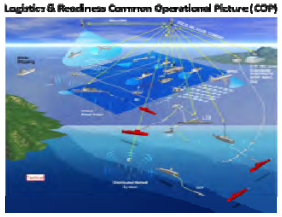
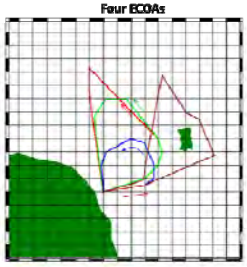


# Notional Cloud Opportunity (cont.)

Four ECOAs



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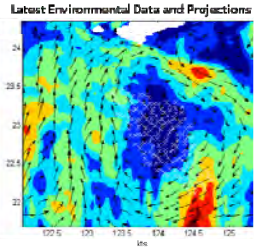
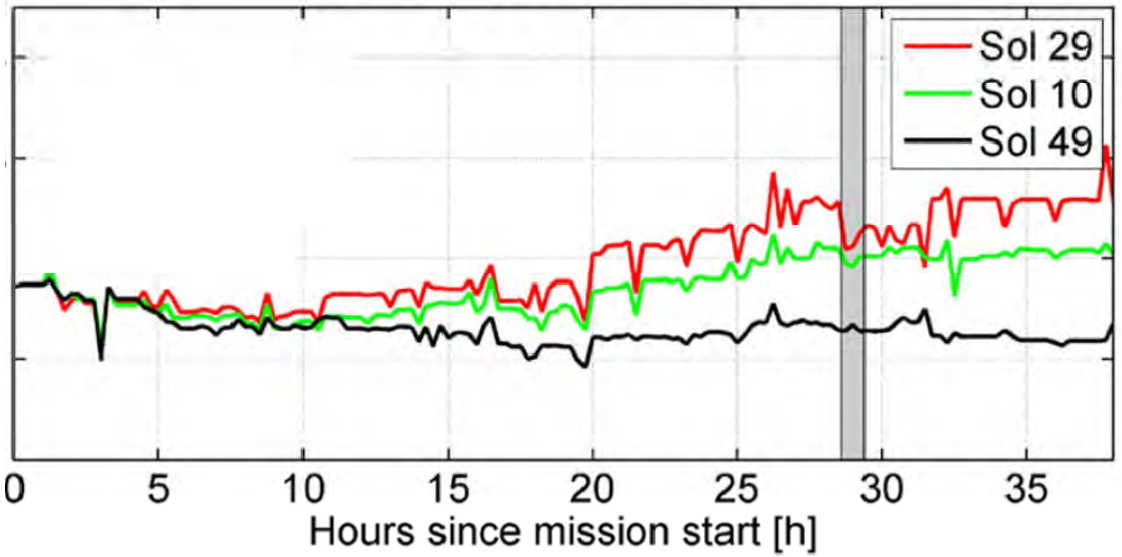


Solution Evaluations

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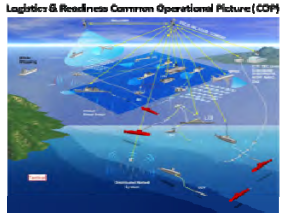
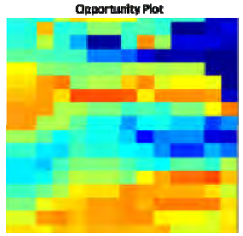
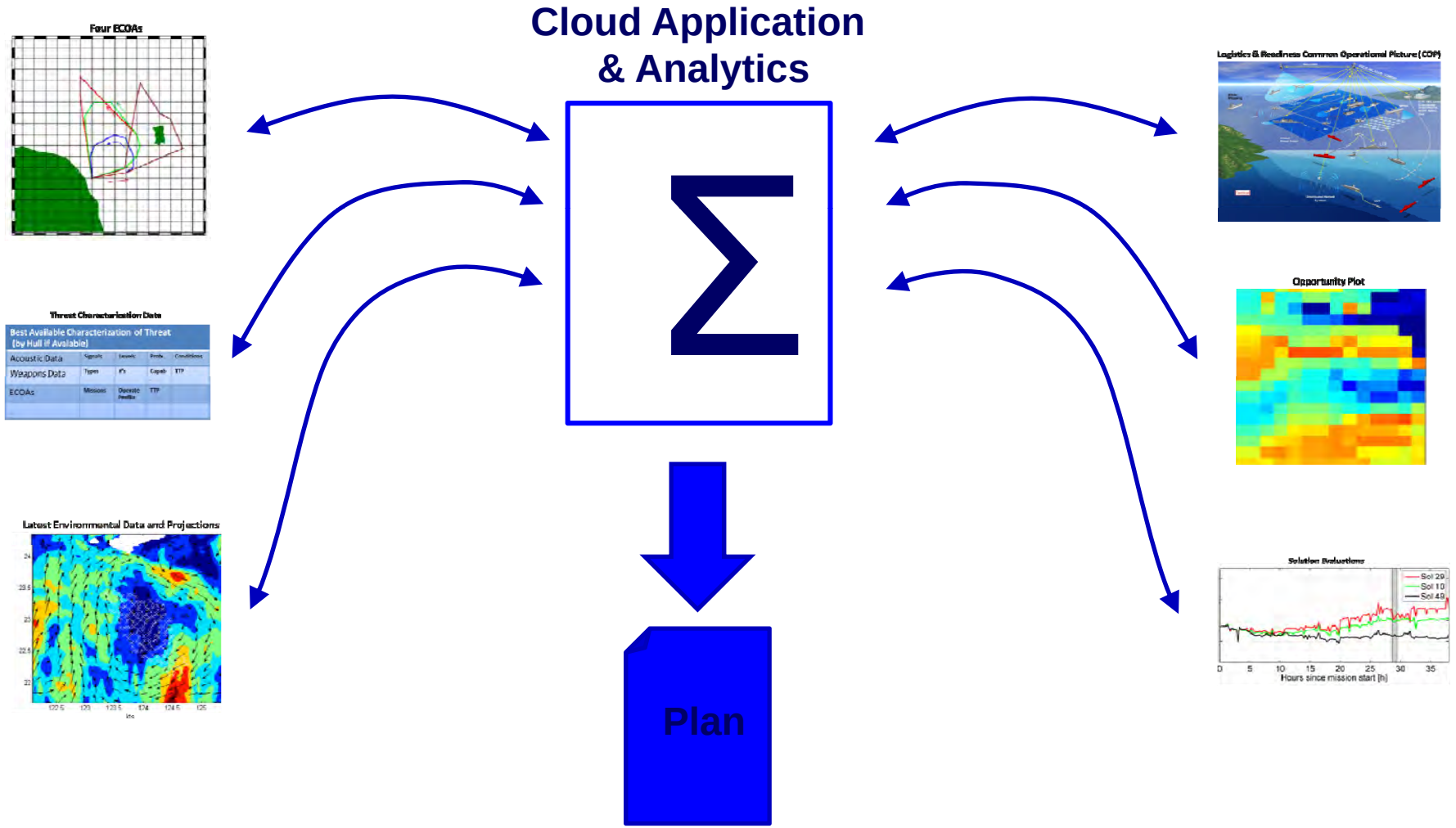


Opportunity Plot



# Notional Cloud Opportunity (cont.)

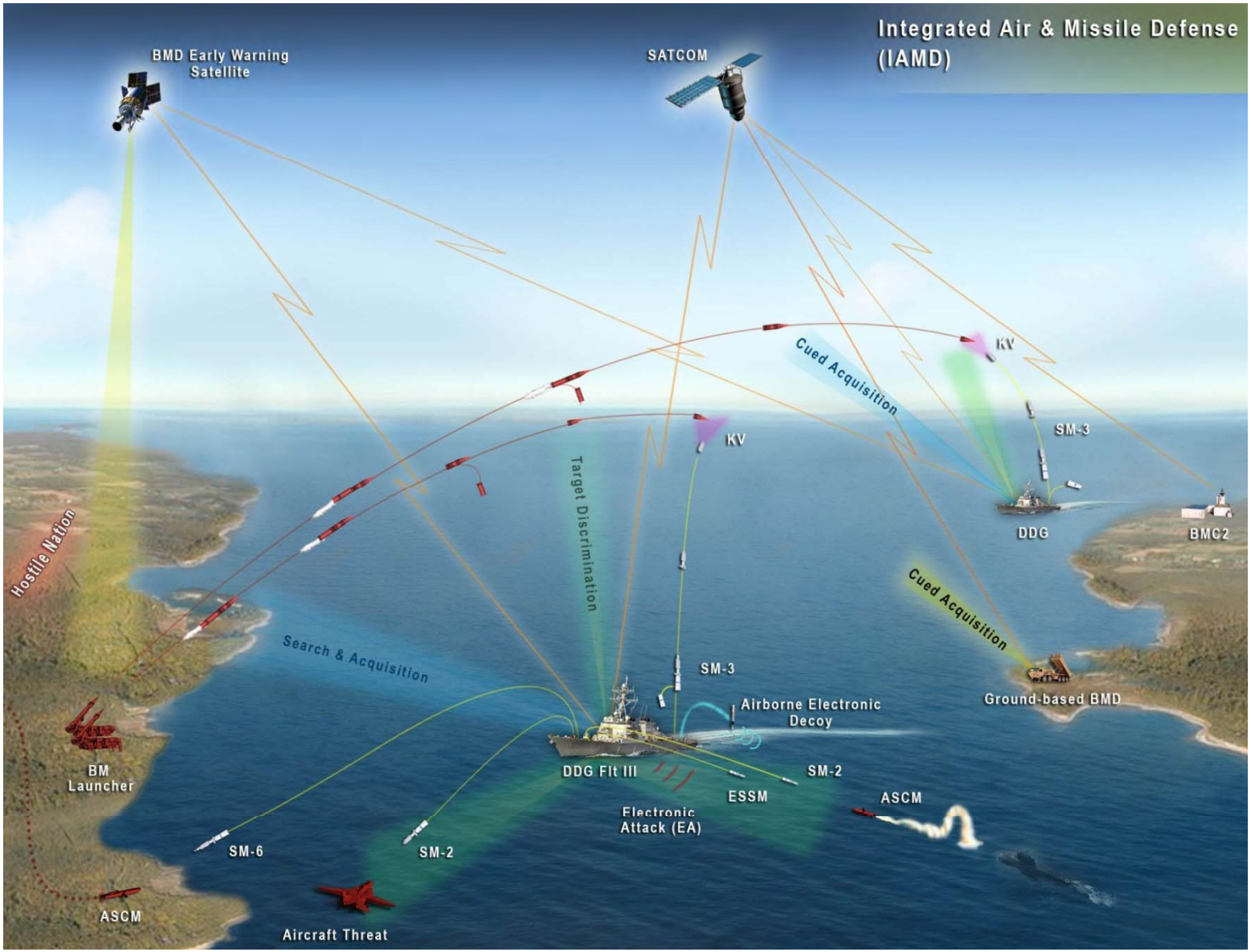


Revolutionary Research . . . Relevant Results

# Part #7

# Analytic Thrust / IAMD

# IAMD Environment



# Key Naval Tactical Cloud Enablers for IAMD

- **Combining traditionally stove-piped information into a single repository**
  - Some data can be used directly
  - New analytics can be developed that work across data sets
- **Ability to store a large volume of information**
  - Saves normally discarded data
  - Long-term pattern extraction
  - Understand state at a given time in the past
- **Ability to efficiently run big data analytics**
  - Previously infeasible questions can now be answered
- **Ability to share information among platforms**
  - Status and readiness information

# Example IAMD Analytic Areas

- **Planning**
  - Moving assets
  - Positioning assets
  - Sensor configuration and coverage
- **Situational Awareness**
  - Understanding the environment and changes to it
  - Examples:
    - Indications and warnings (I&W)
    - Alerts
    - Cueing
- **Identification and Classification**
  - Enriched set of attributes from nontraditional data sources
  - Example:
    - Recommending ID for an unknown combat system track based on data associated from Command and Control System and/or national technical means

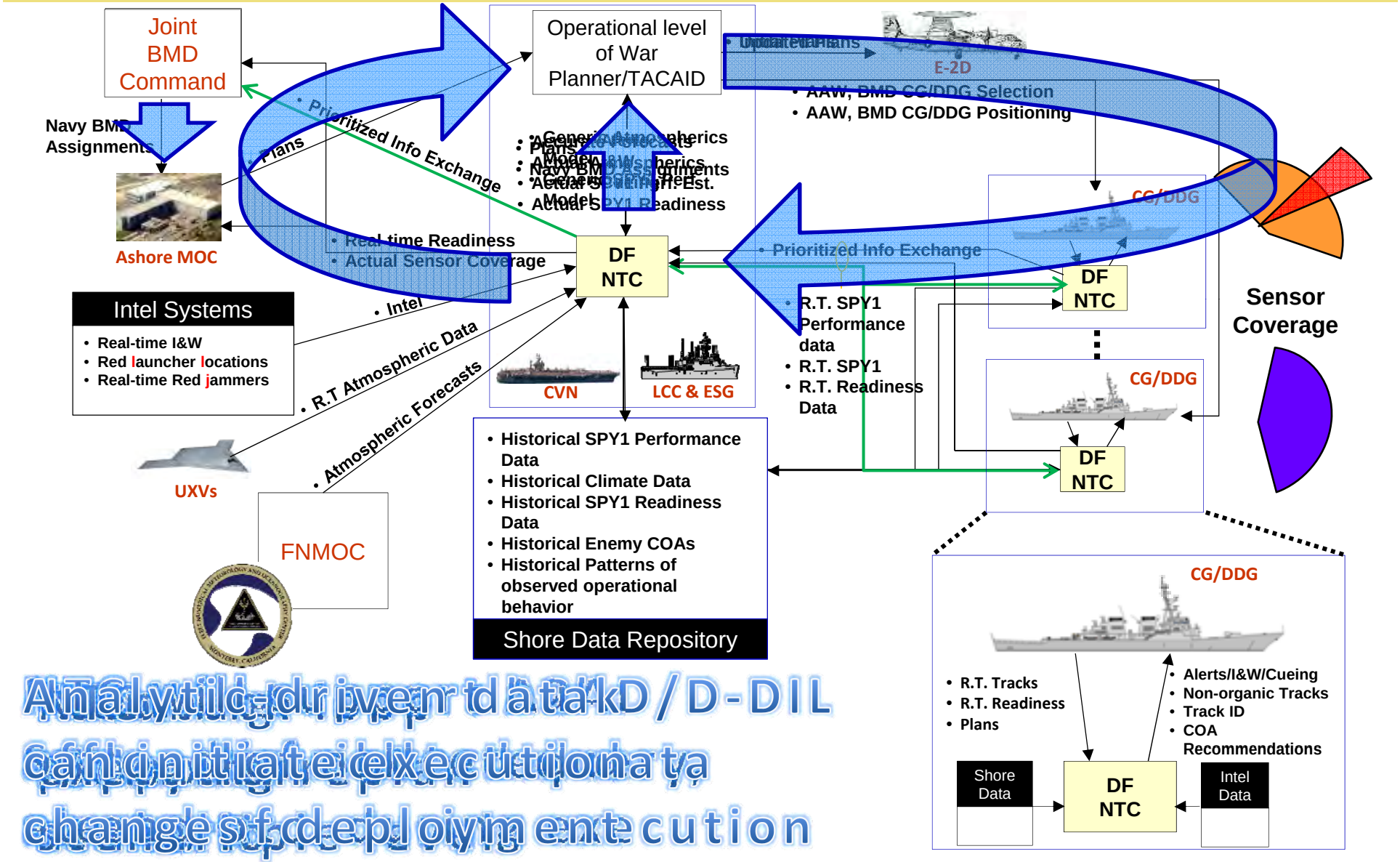
# Example IAMD Analytic Areas (cont'd)

- **Resource Allocation**
  - Spectrum allocation
  - Weapon usage optimization
- **Course of Action (COA) Recommendation**
  - Recommend COA based on observed behavior and rich set of historical behavior
- **Anomaly Detection**
  - Intent and future movement prediction
  - Indications of malicious cyber activity
  - Detection of enemy war reserve capabilities

# Example IAMD Use Cases from BAA

- Improved identity classification, intent and future movement prediction, and track association
- Optimizing sensor configuration
- Identifying unexpected Red air and missile capabilities, behaviors, and operational patterns
- Improved planning of asset movement and tactical utilization
- Weapon usage optimization
- Improved spectrum operations
- Improved situational awareness
- Cyber awareness

# IAMD Scenario
# Use Case Examples




Analytic-driven data
can initiate execution
changes of deployment

# IAMD Scenario
# Use Case Examples

Joint
BMD
Command

Ashore MOC

Operational level
of War
Planner/TACAID

CVN

LCC & ESG

CG/DDG

CG/DDG

Planning
today

# IAMD Scenario
# Use Case Examples

Joint
BMD
Command

**Navy BMD Assignments**

**Ashore MOC**

Operational level
of War
Planner/TACAID

**CVN**

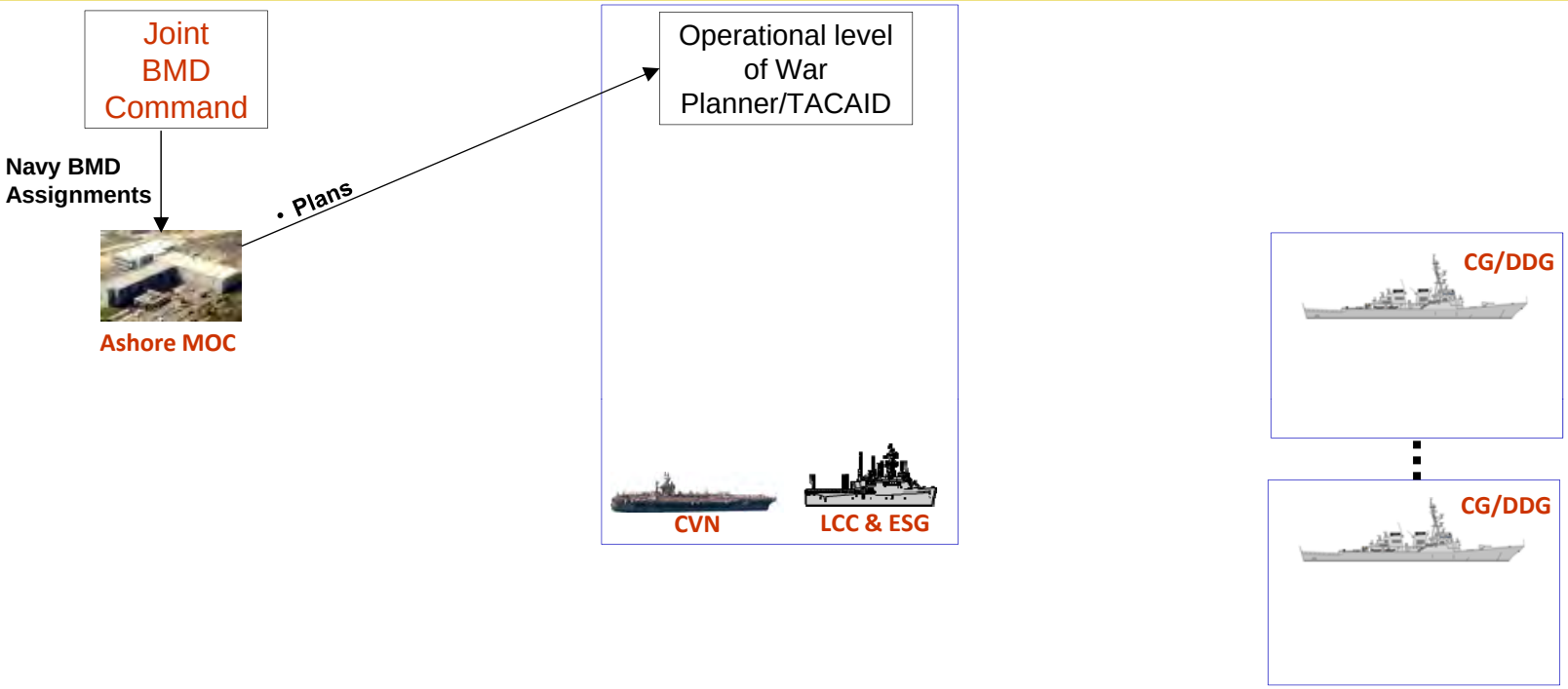
**LCC & ESG**

**CG/DDG**

**CG/DDG**

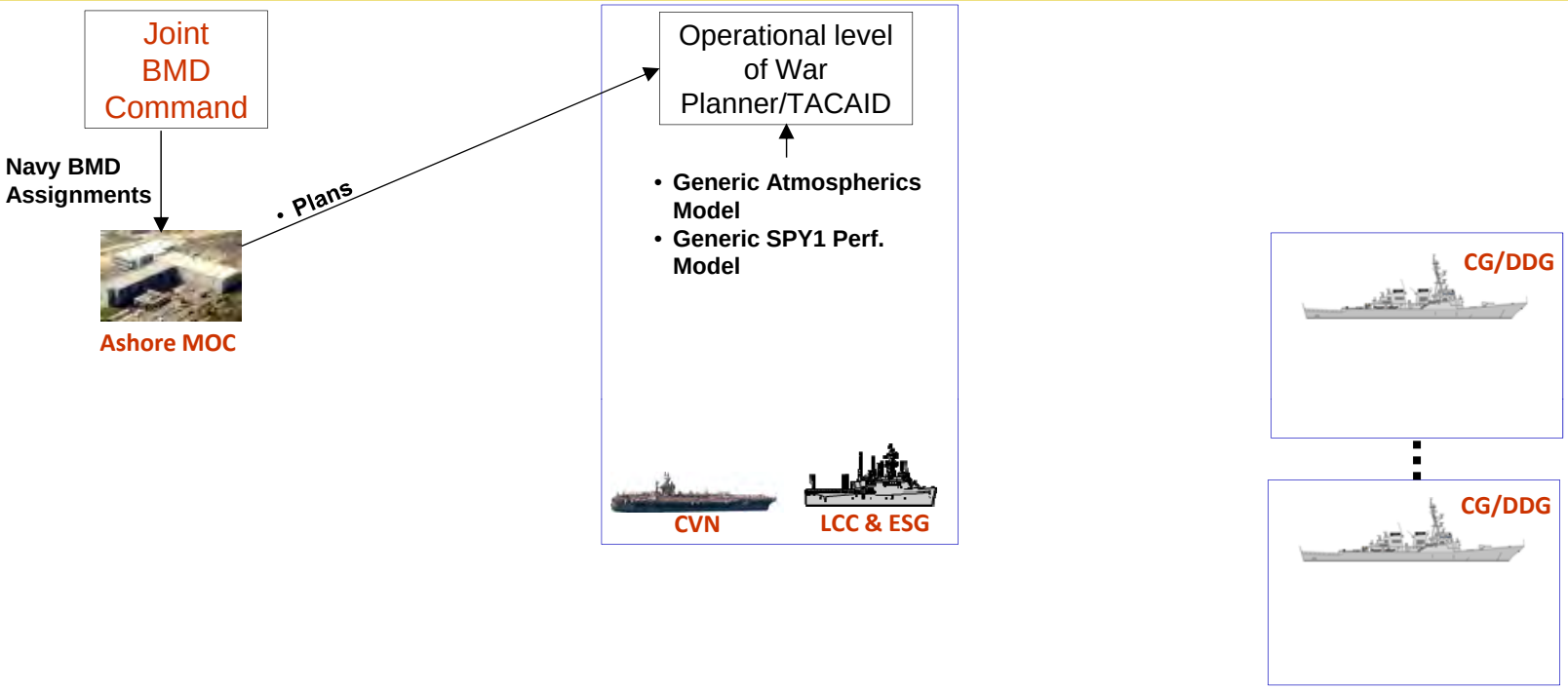
Planning
today

# IAMD Scenario
# Use Case Examples



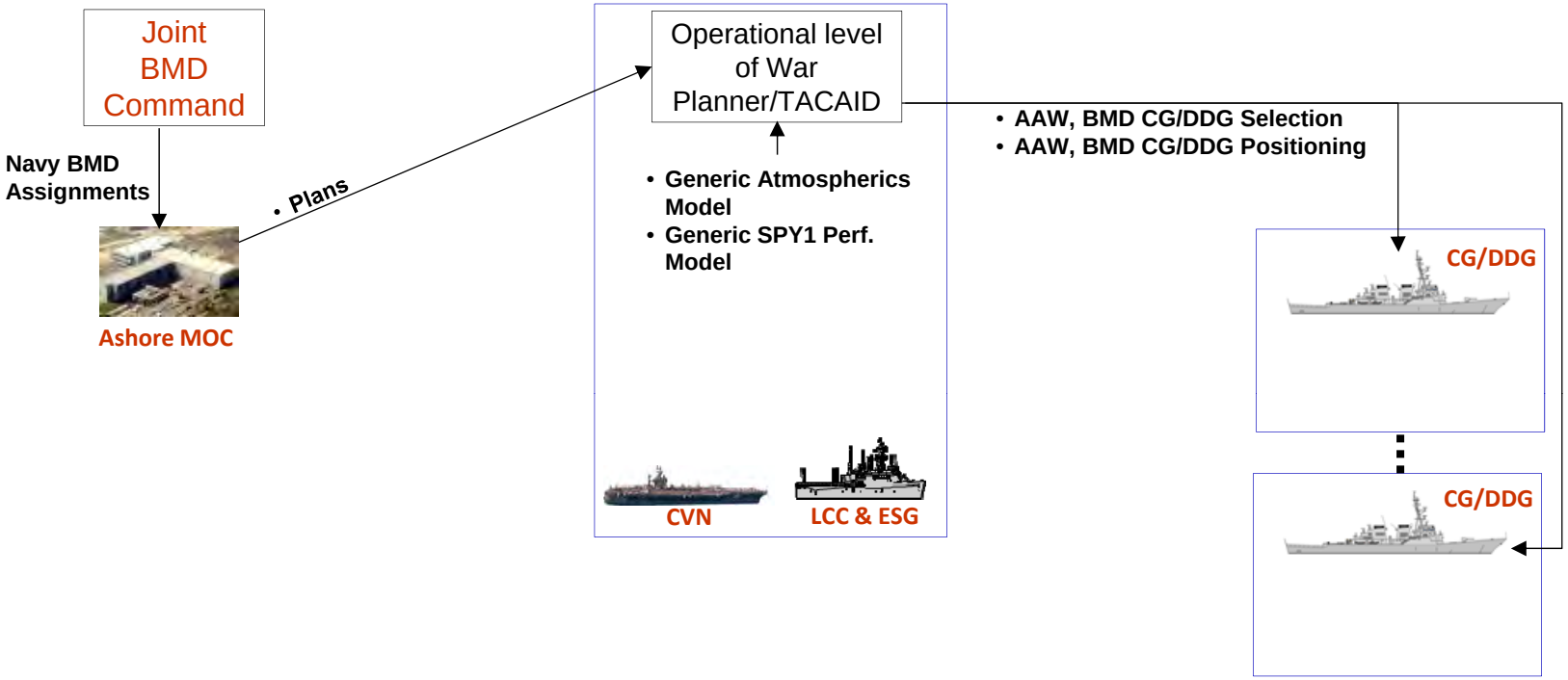

Planning
today

# IAMD Scenario
# Use Case Examples



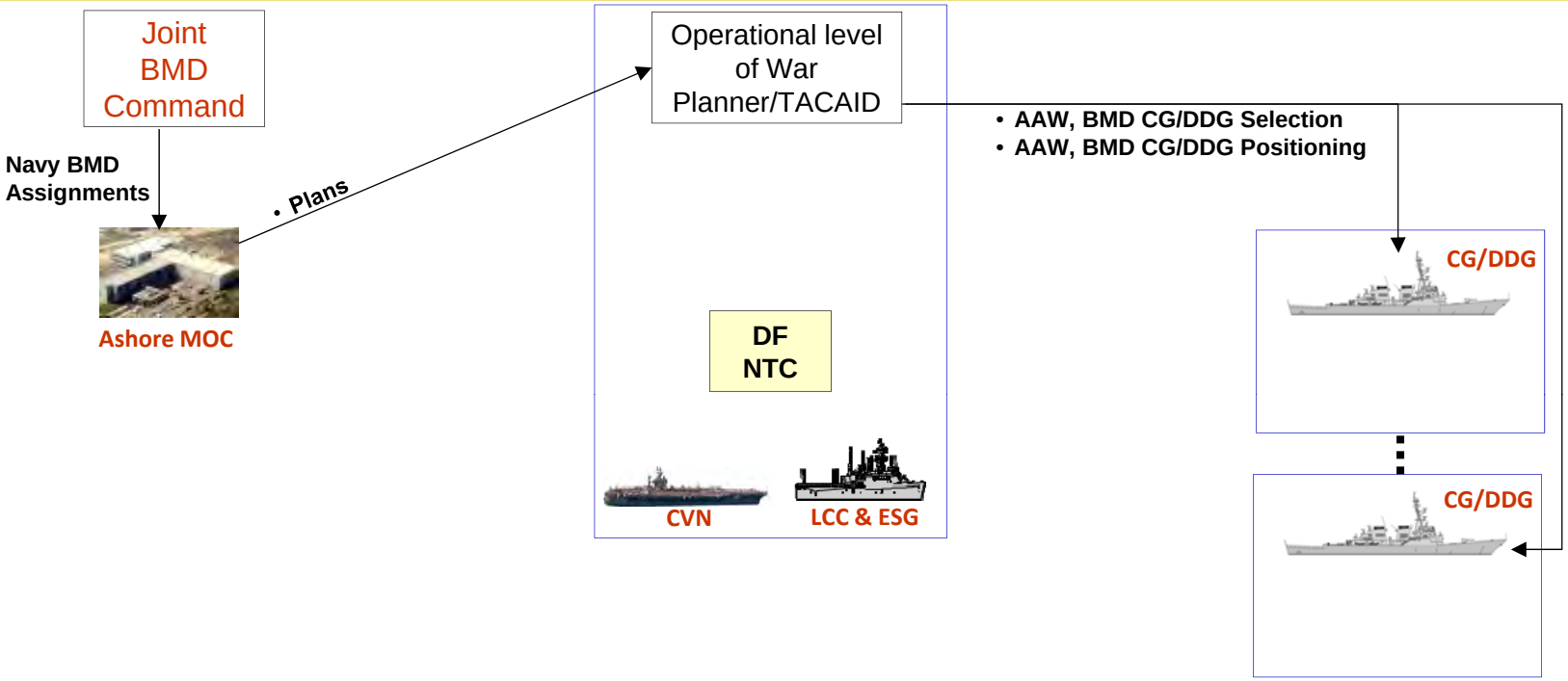

Planning
today

# IAMD Scenario
# Use Case Examples



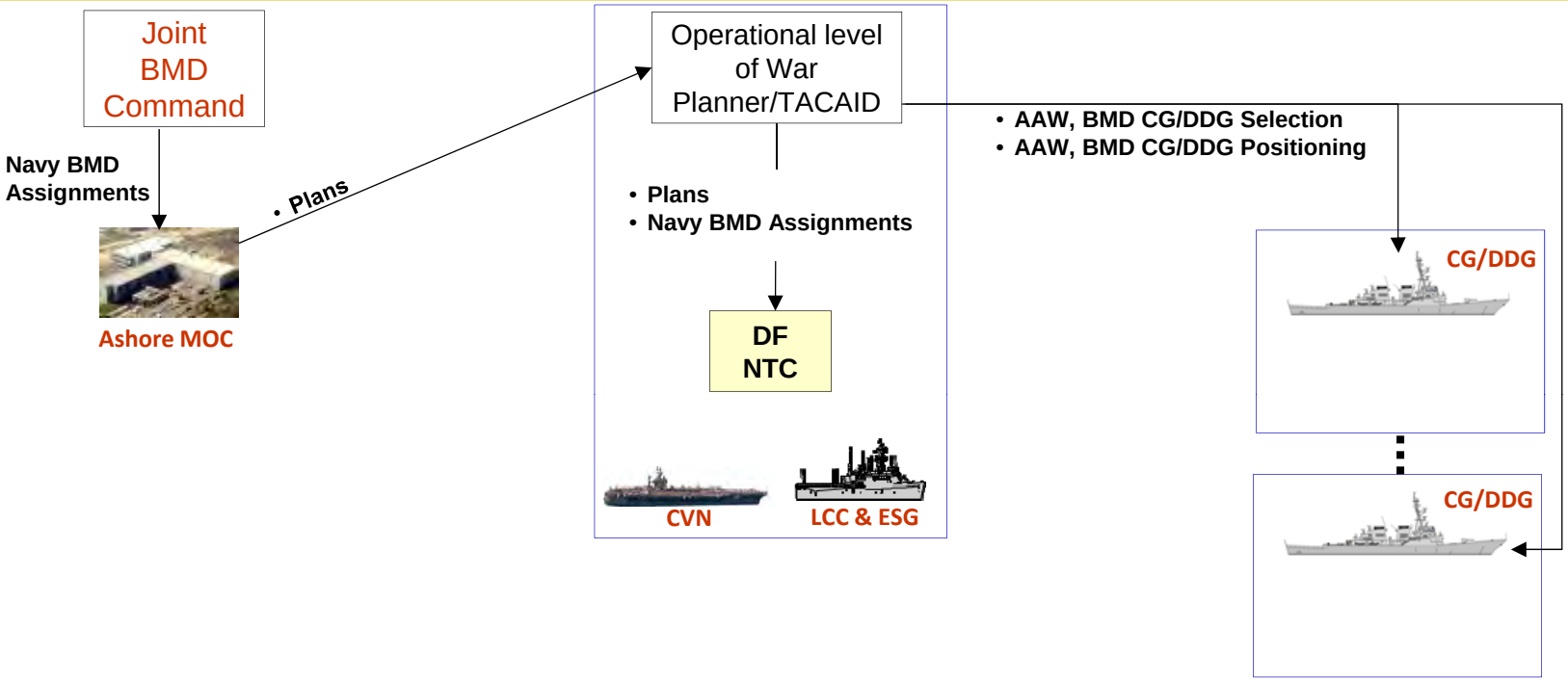

Planning today

# IAMD Scenario
# Use Case Examples




NTC planning scenario

# IAMD Scenario
# Use Case Examples

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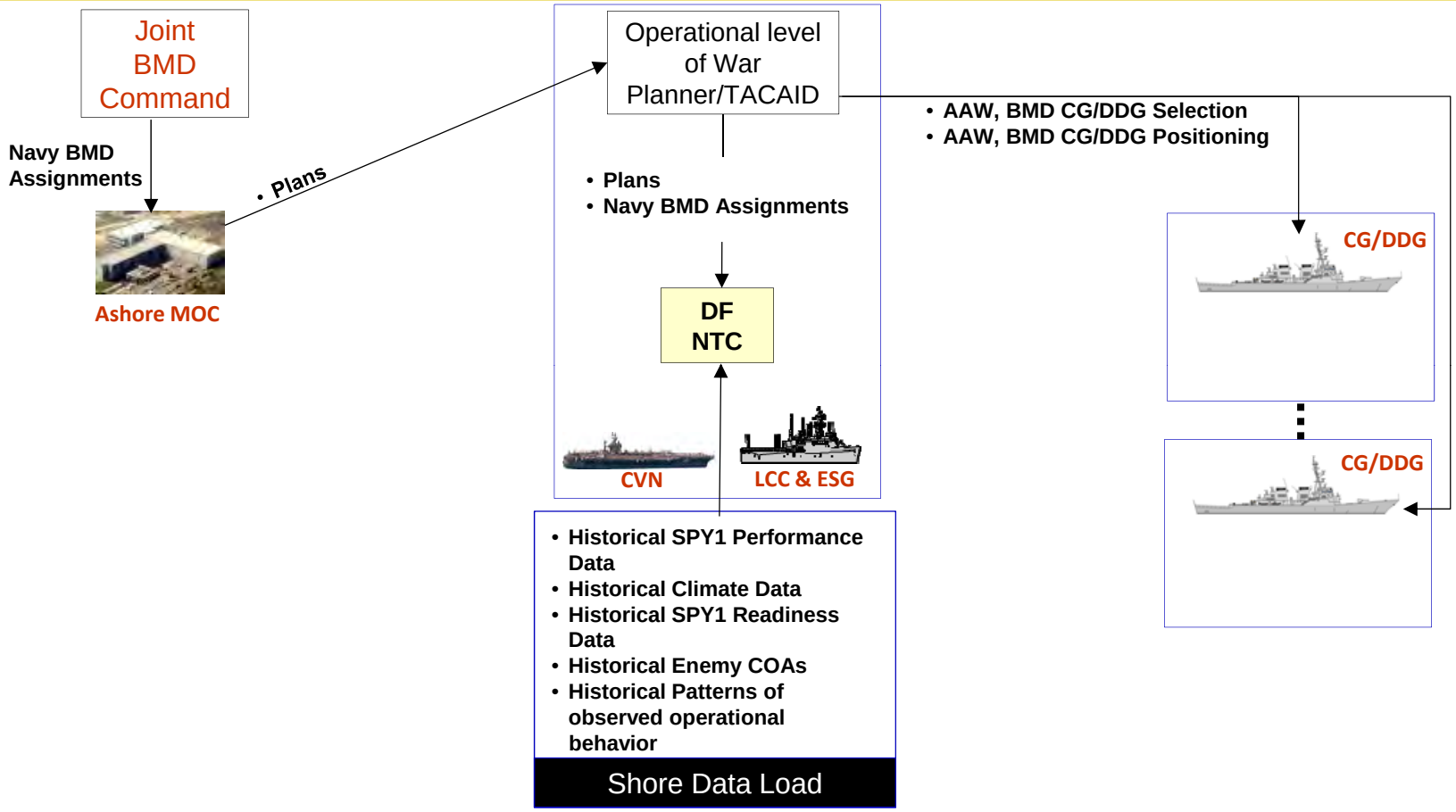


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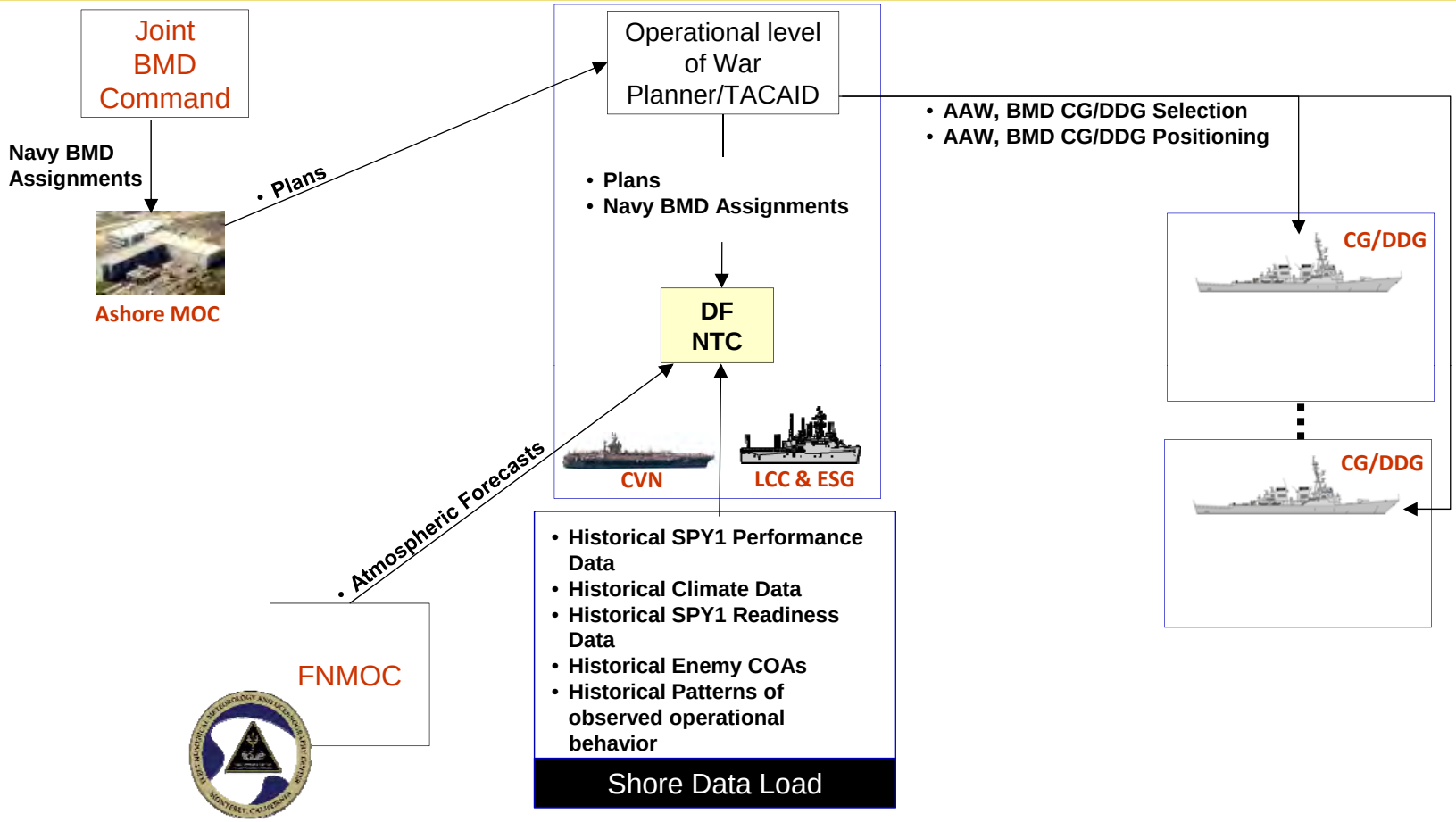


NTC planning scenario

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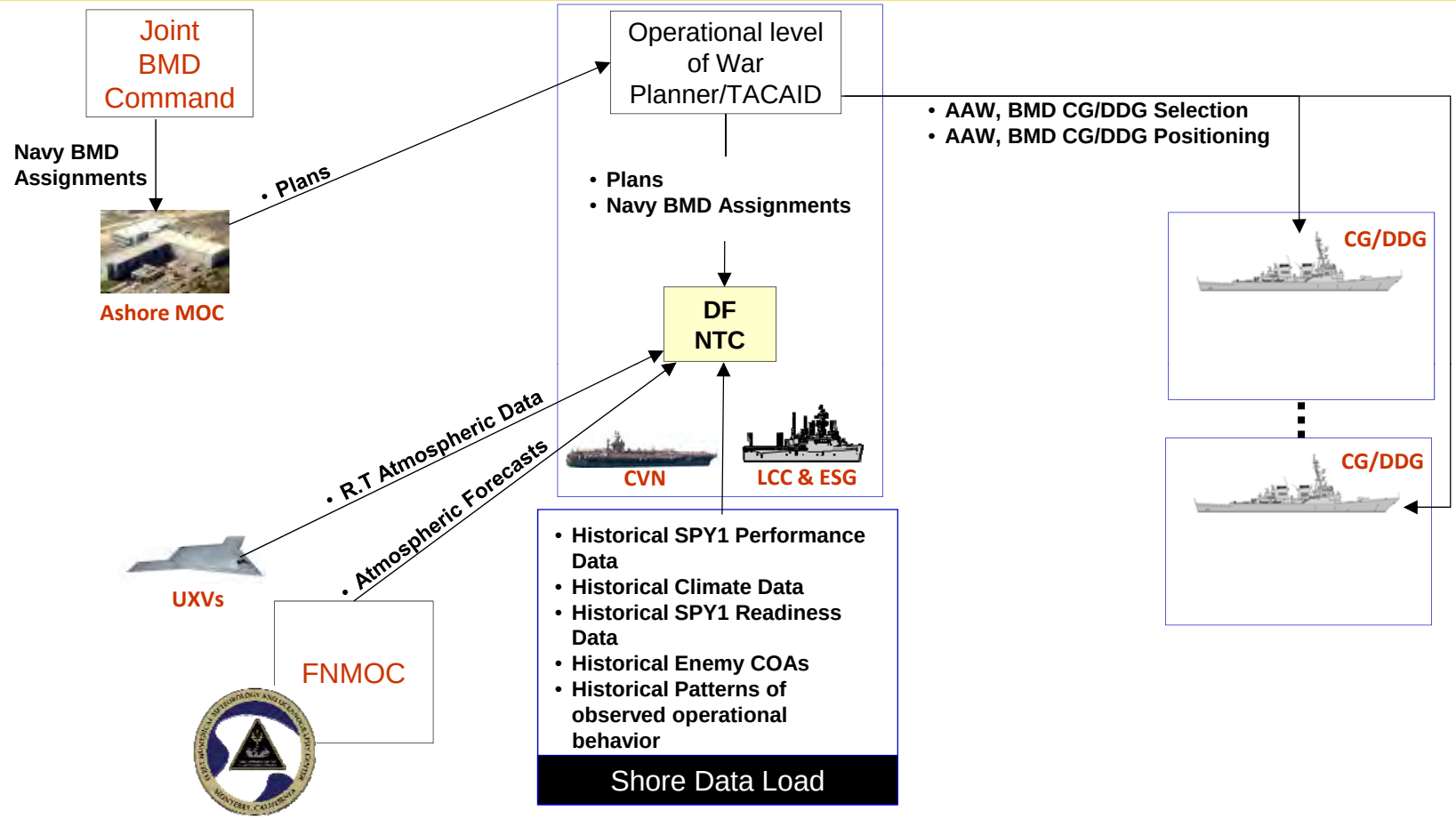


NTC planning scenario

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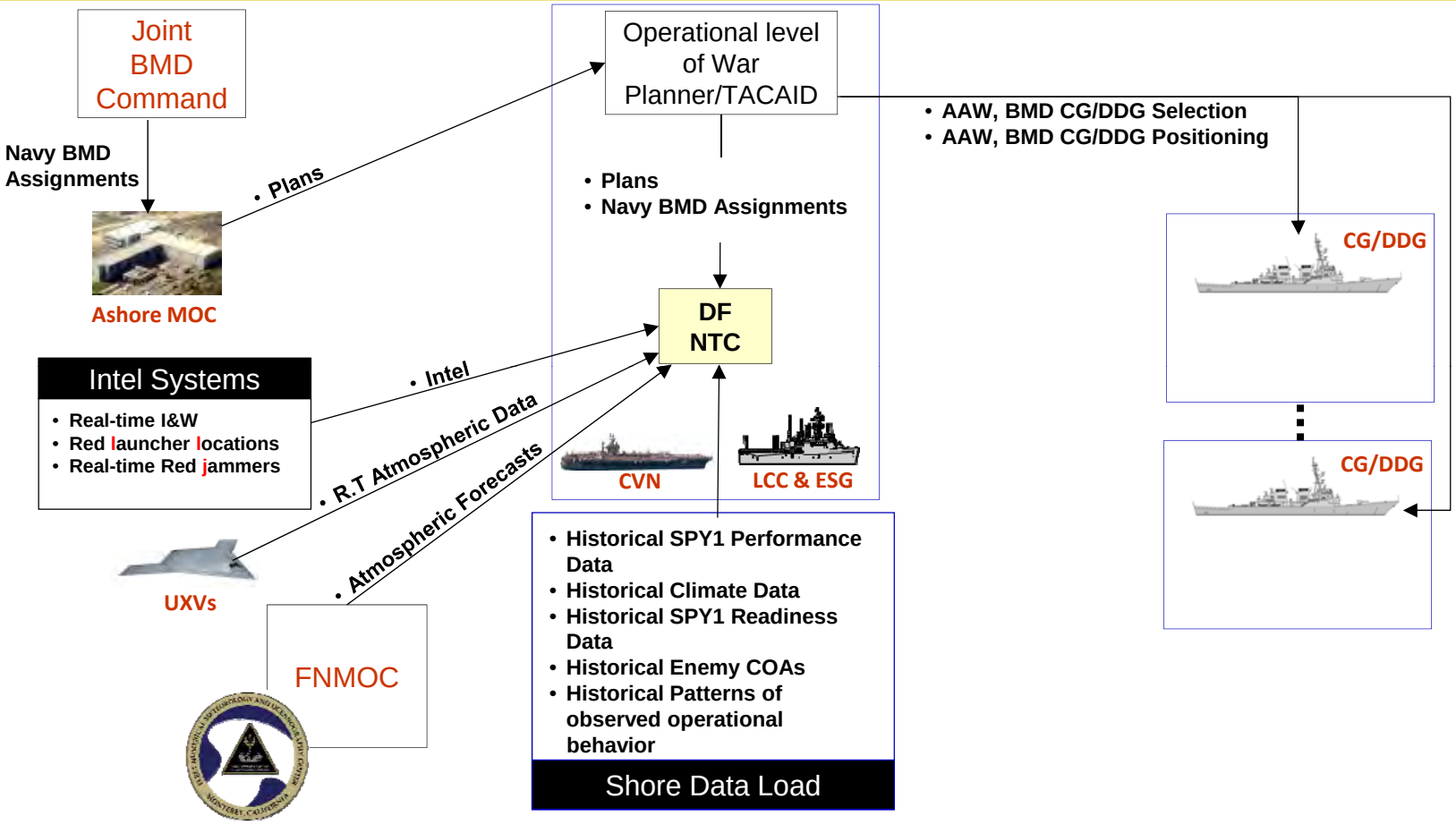


NTC planning scenario

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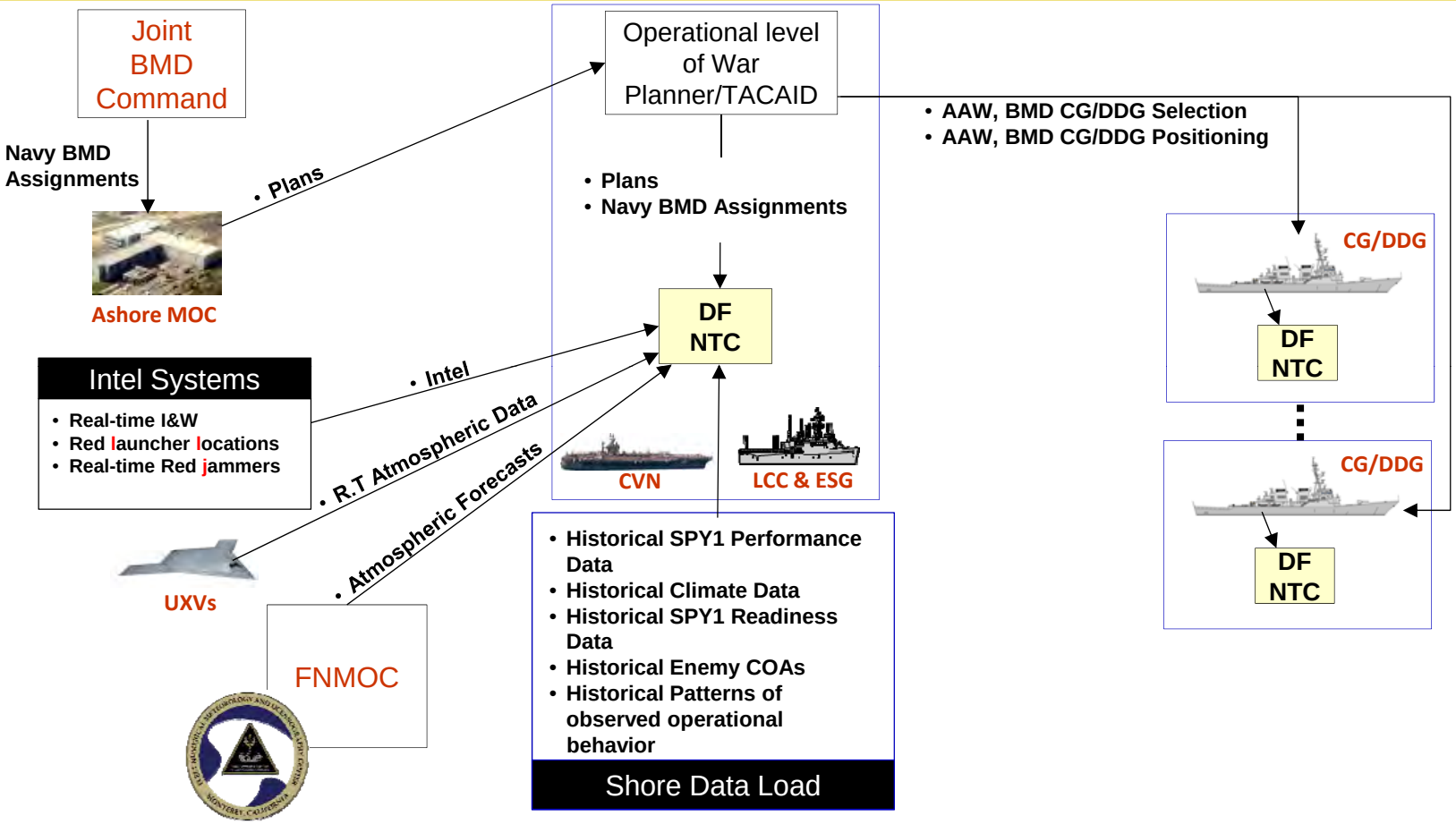
# Use Case Examples




NTC planning scenario

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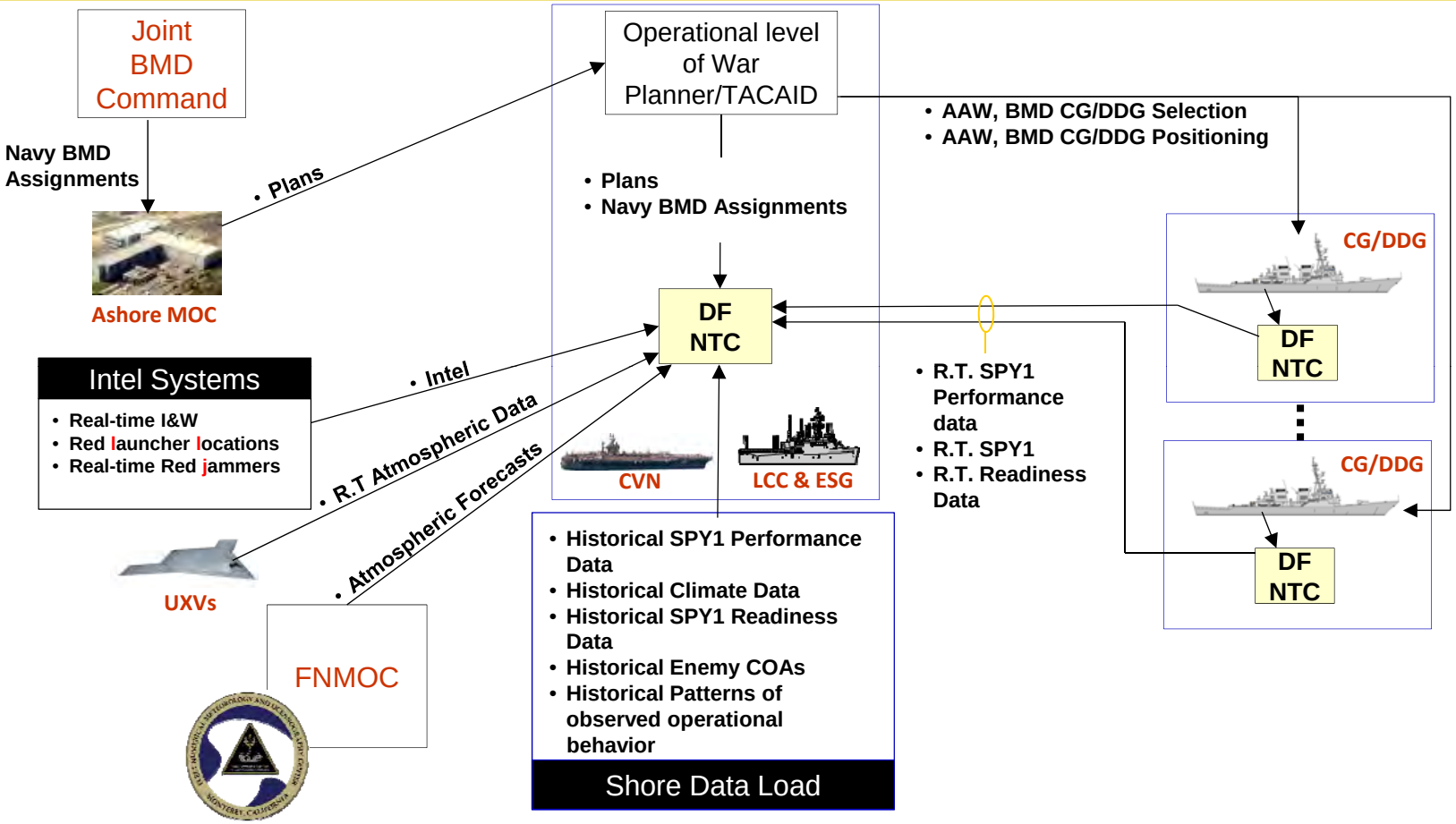


NTC planning scenario

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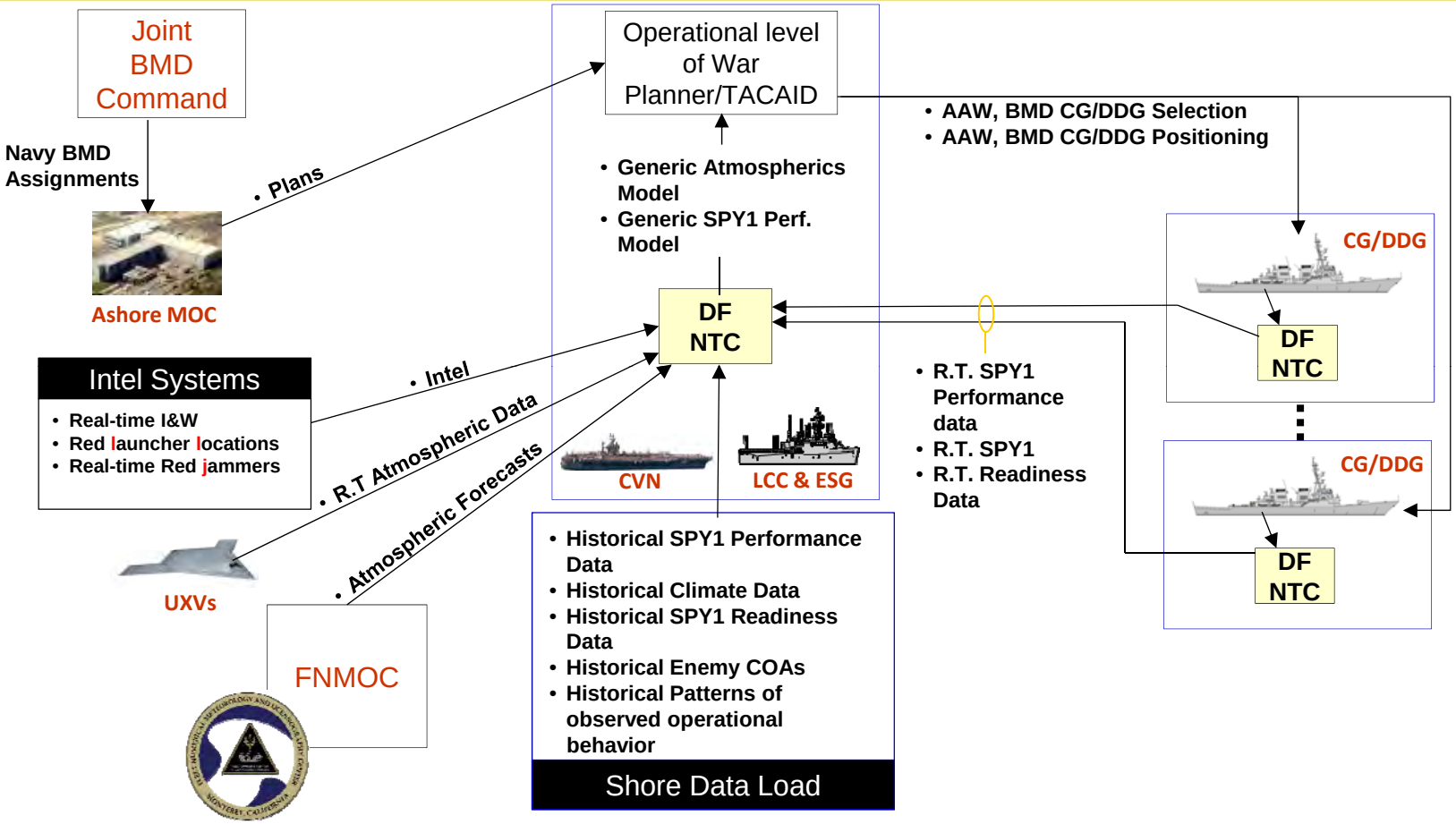
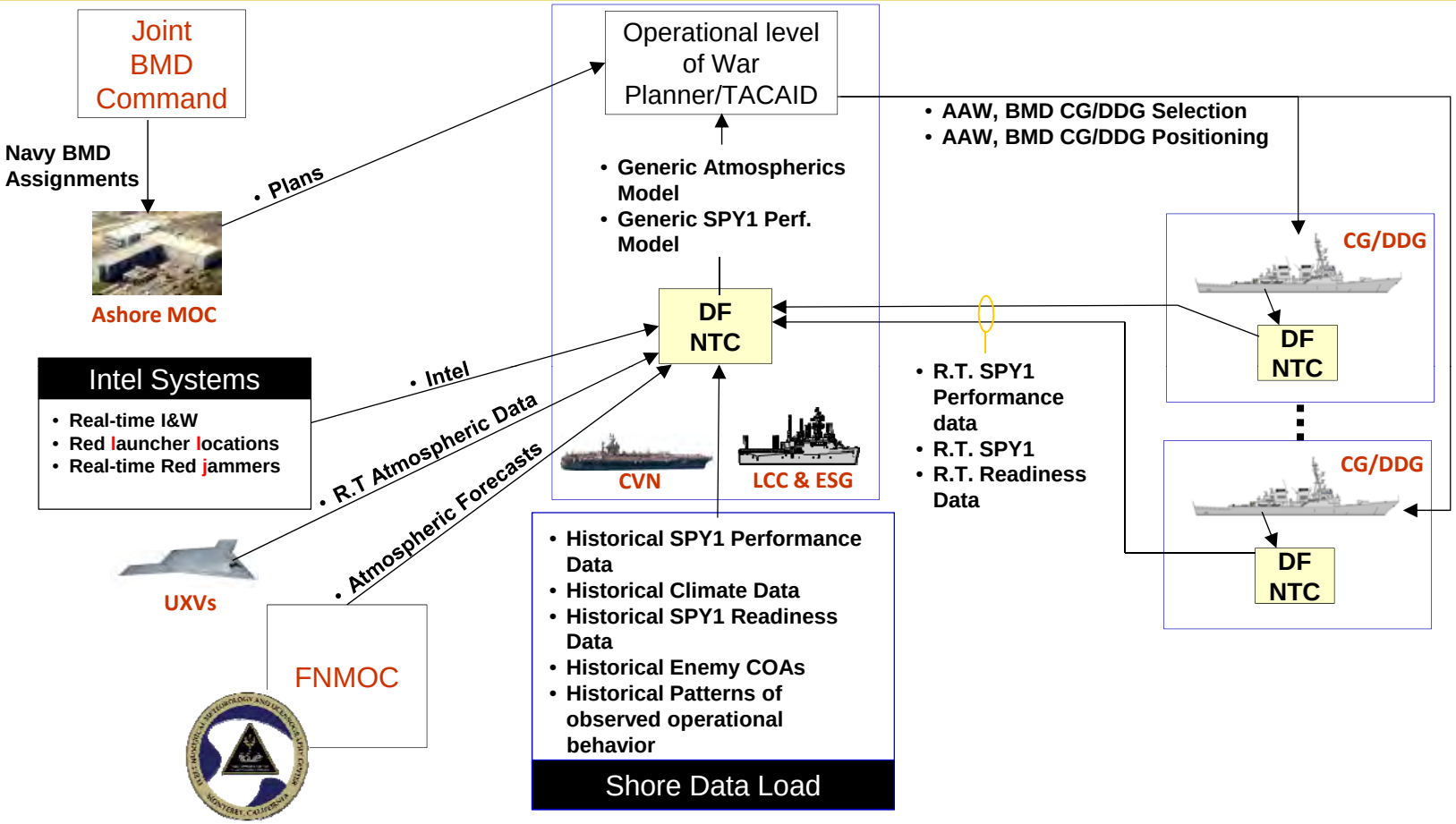


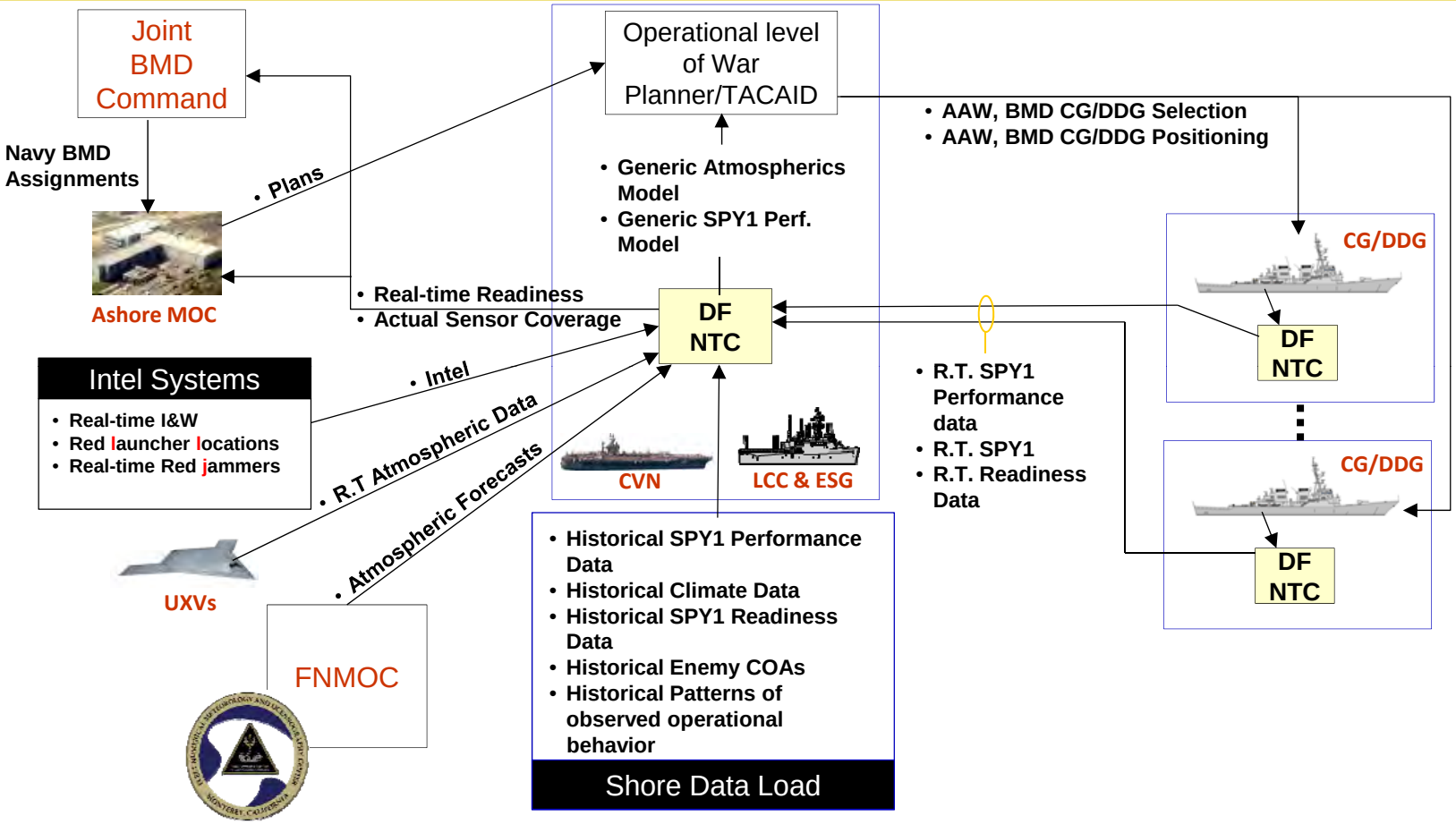

NTC planning scenario

# IAMD Scenario
# Use Case Examples




Feedback loop supports replan at multiple levels

# IAMD Scenario
# Use Case Examples

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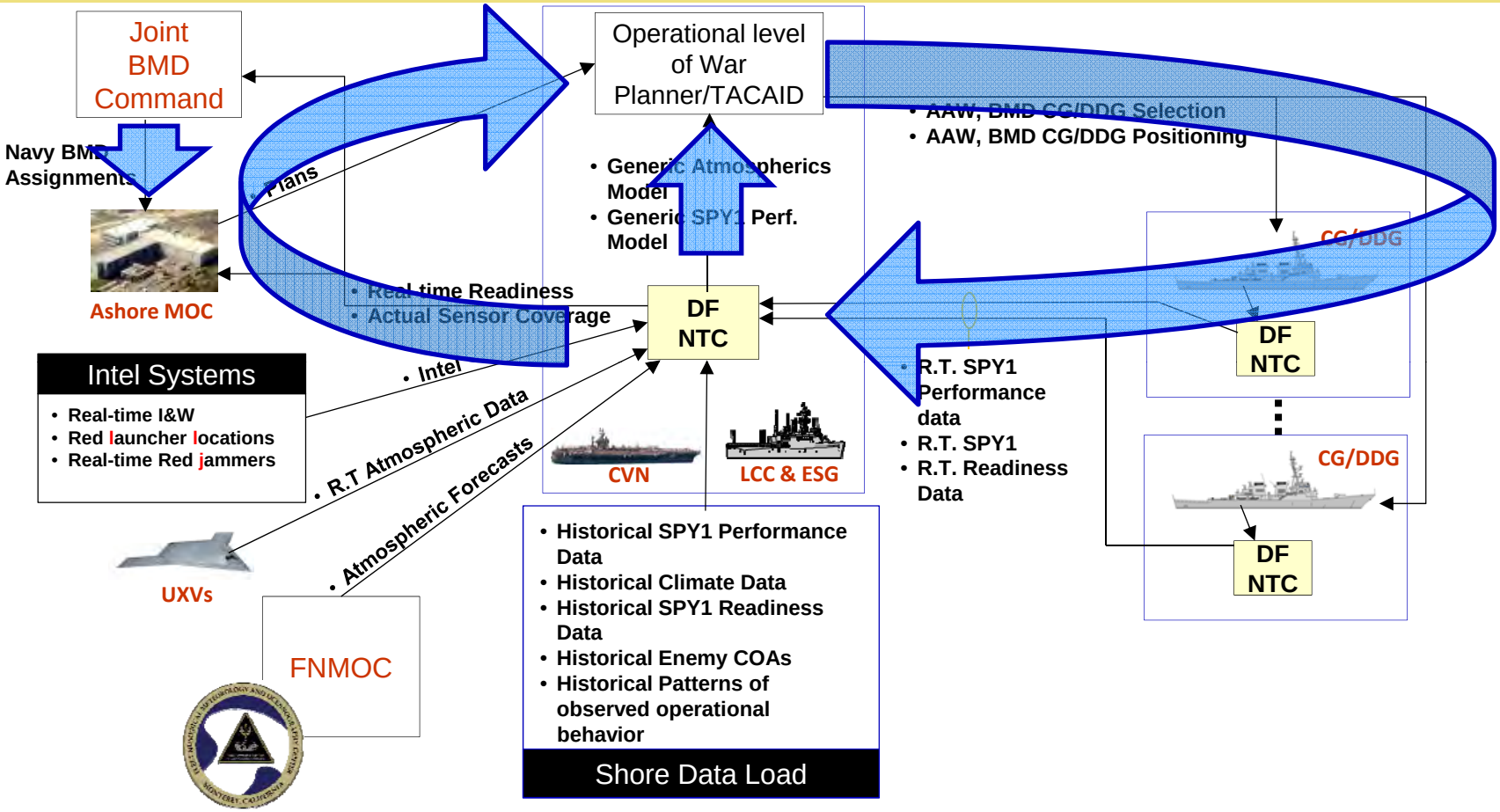


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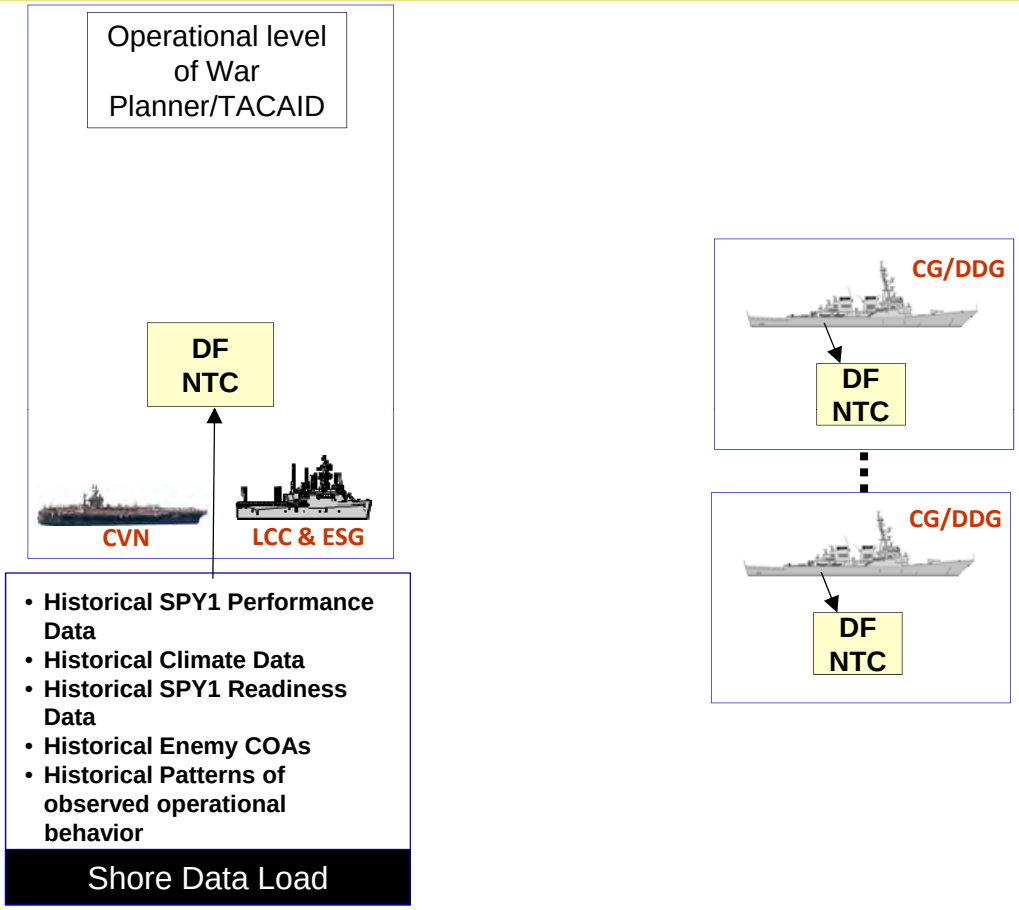
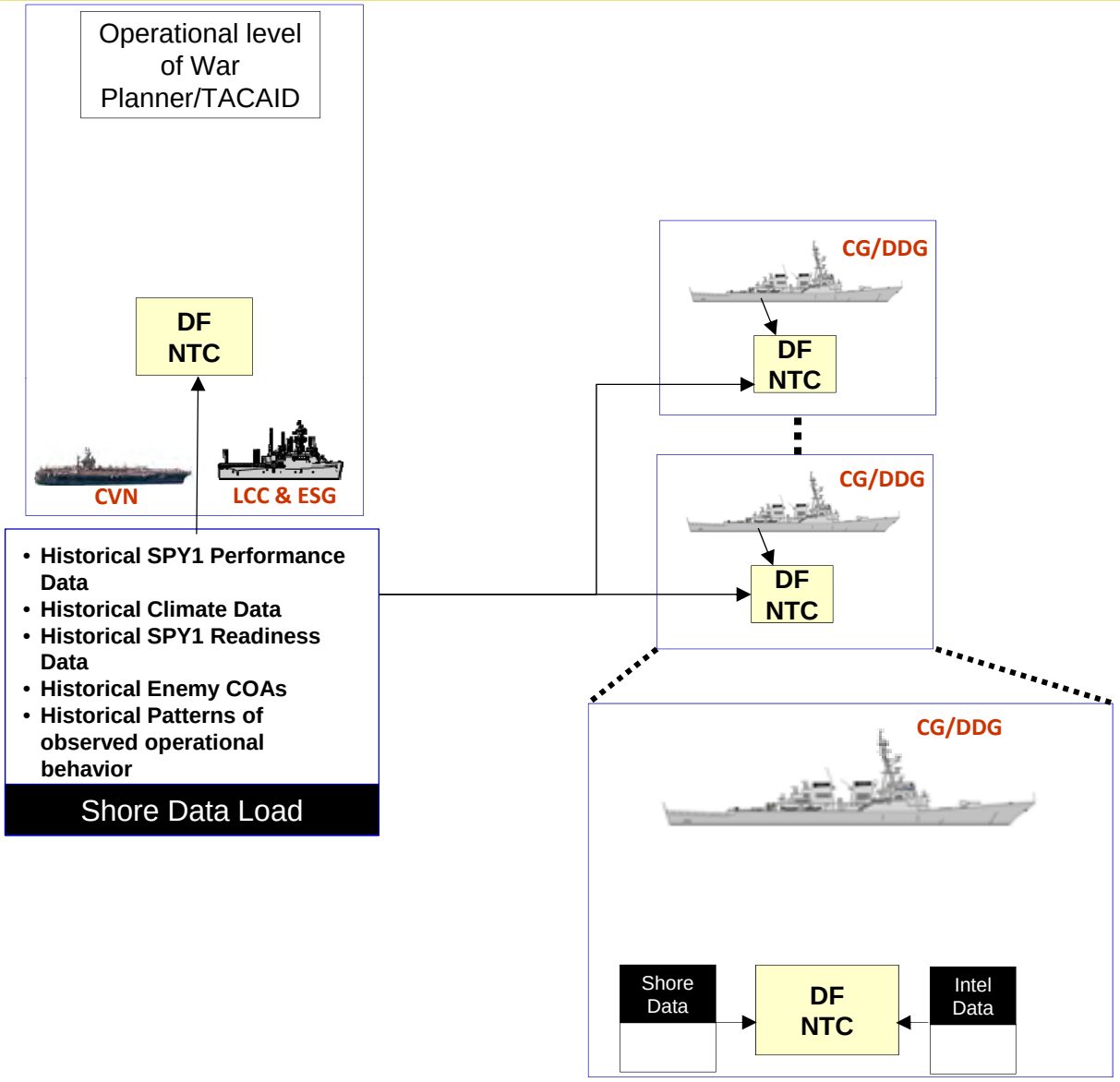


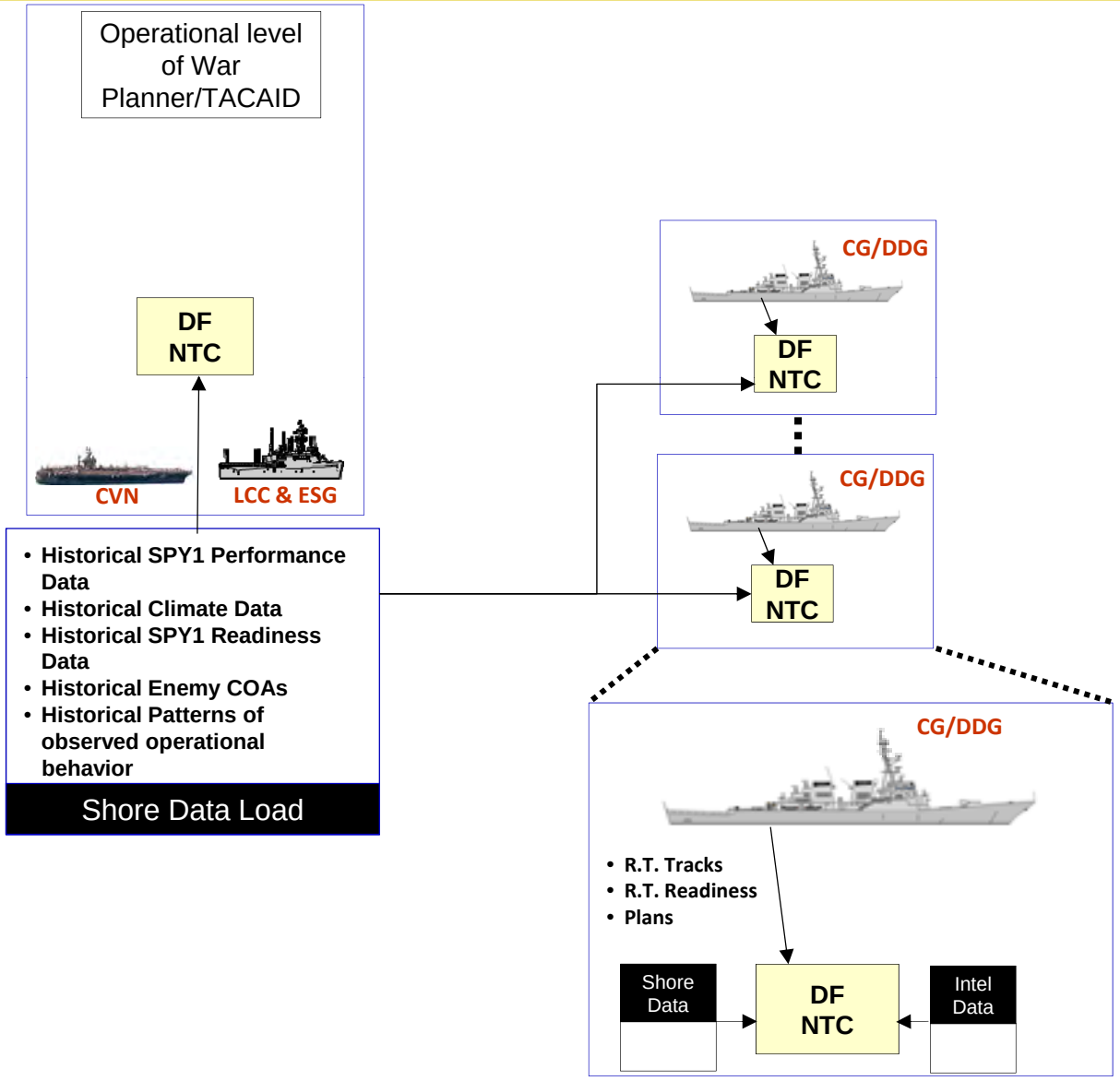

NTC execution scenario

# IAMD Scenario
# Use Case Examples



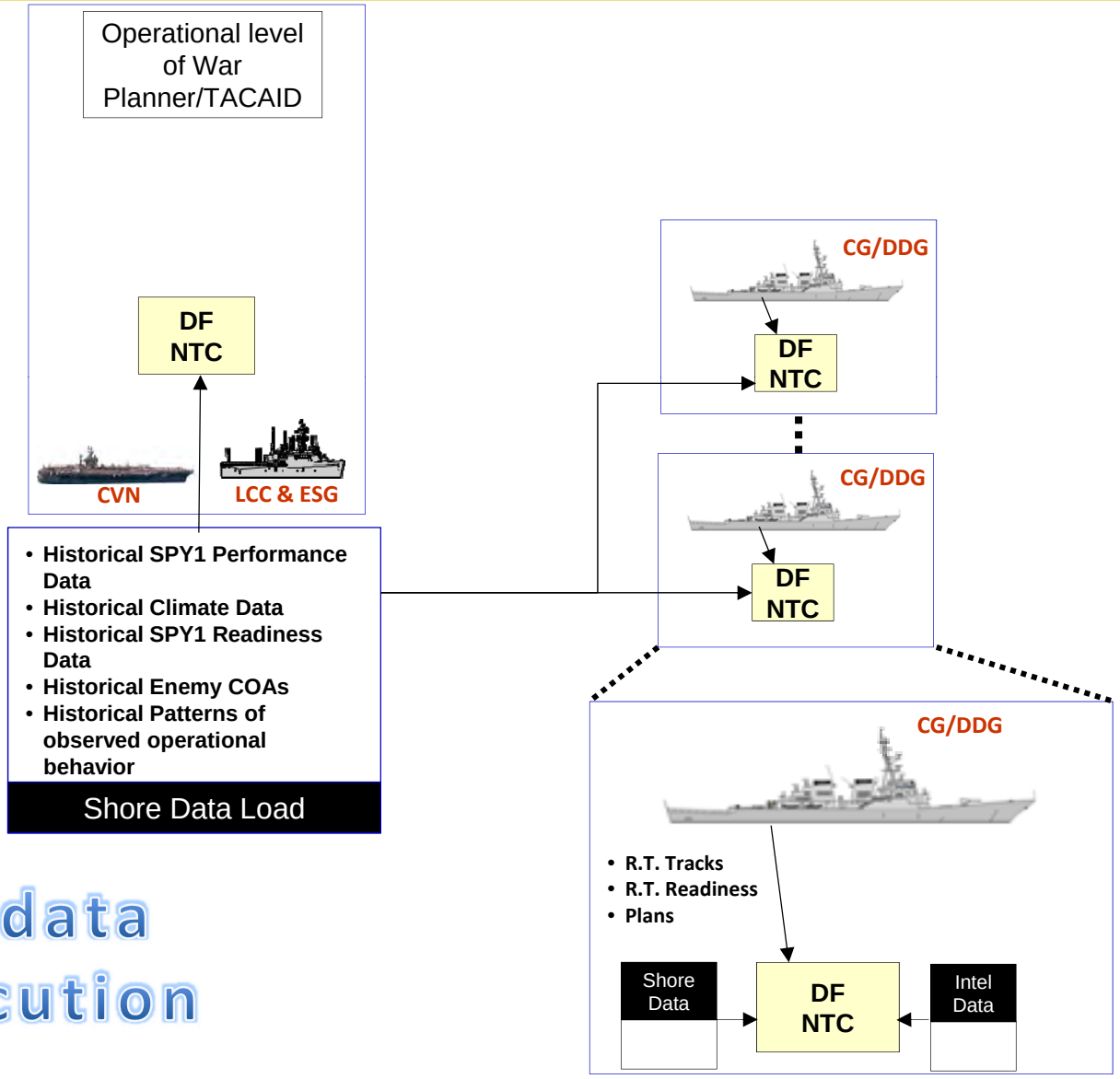

NTC execution scenario

# IAMD Scenario
# Use Case Examples



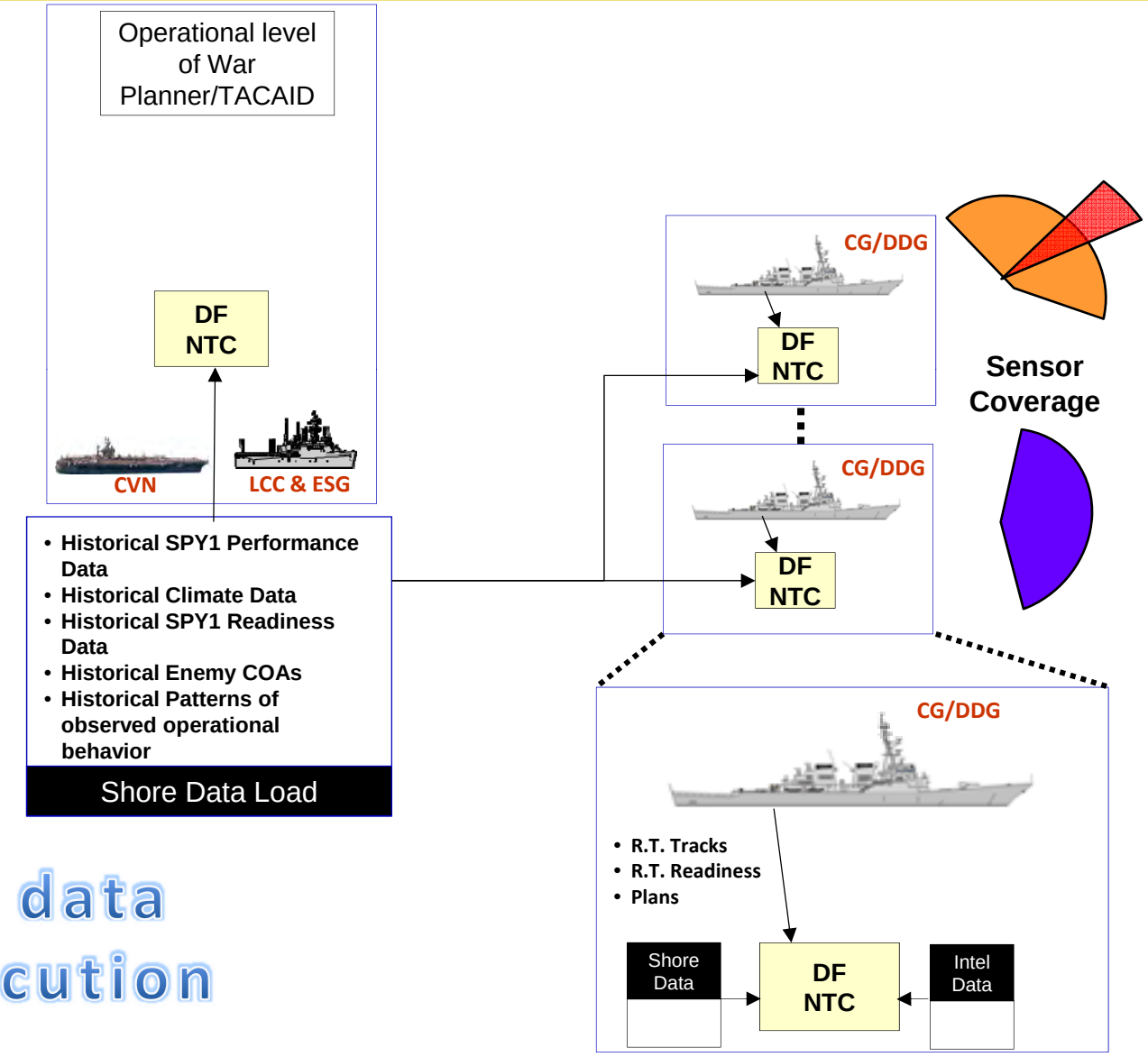

NTC execution scenario

# IAMD Scenario
# Use Case Examples




Analytic-driven data can initiate execution changes

# IAMD Scenario
# Use Case Examples

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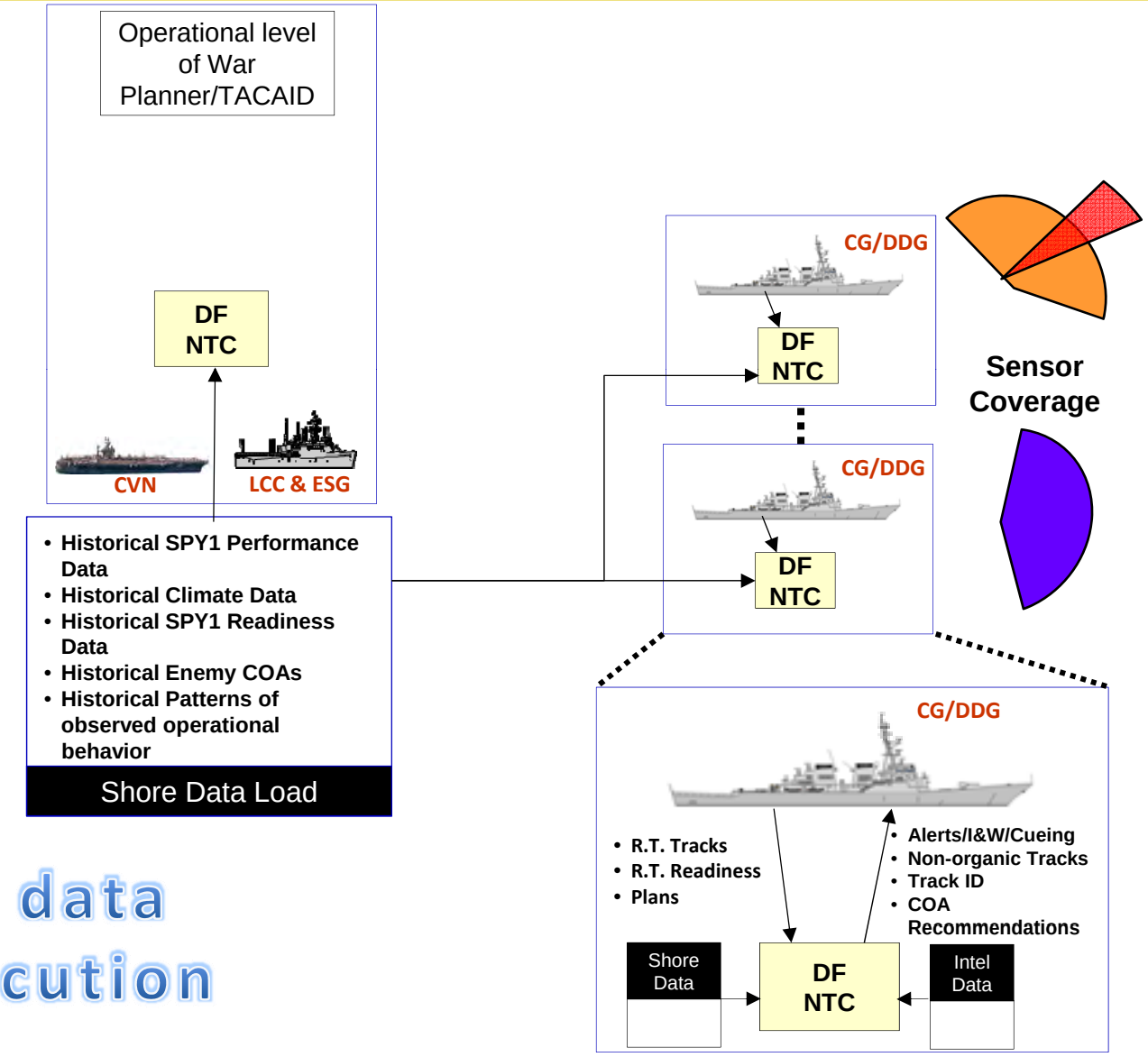


Analytic-driven data can initiate execution changes

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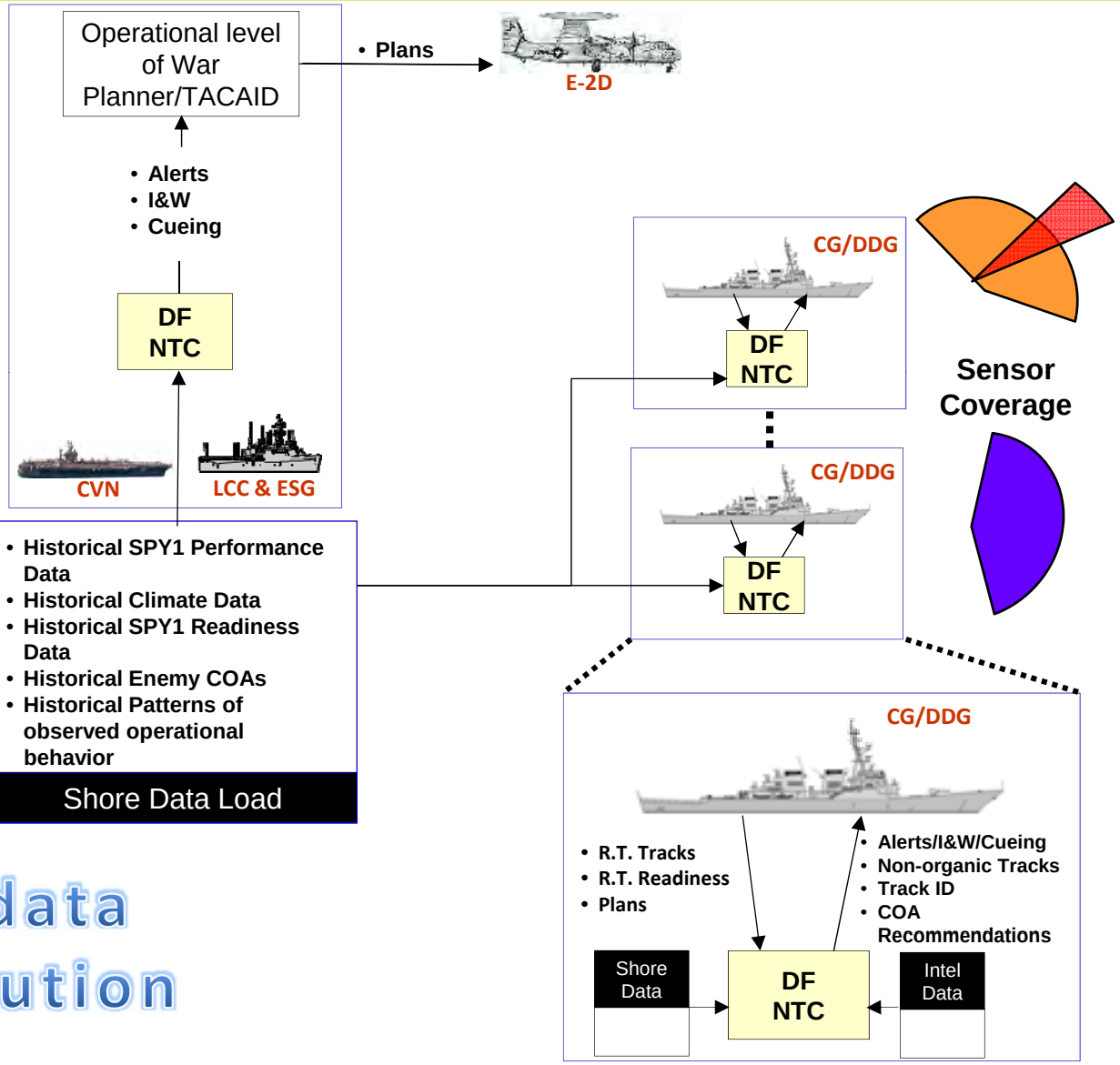


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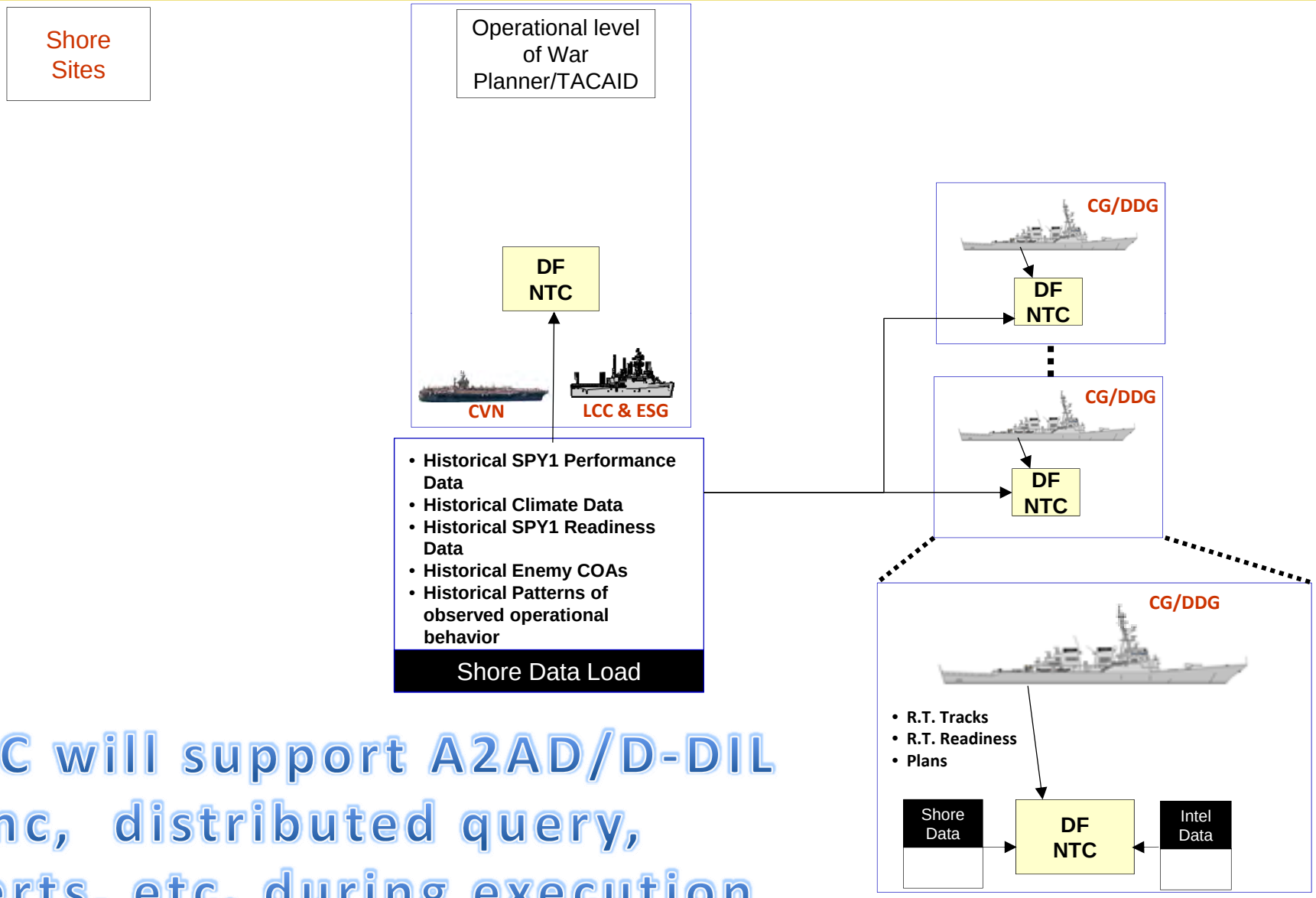
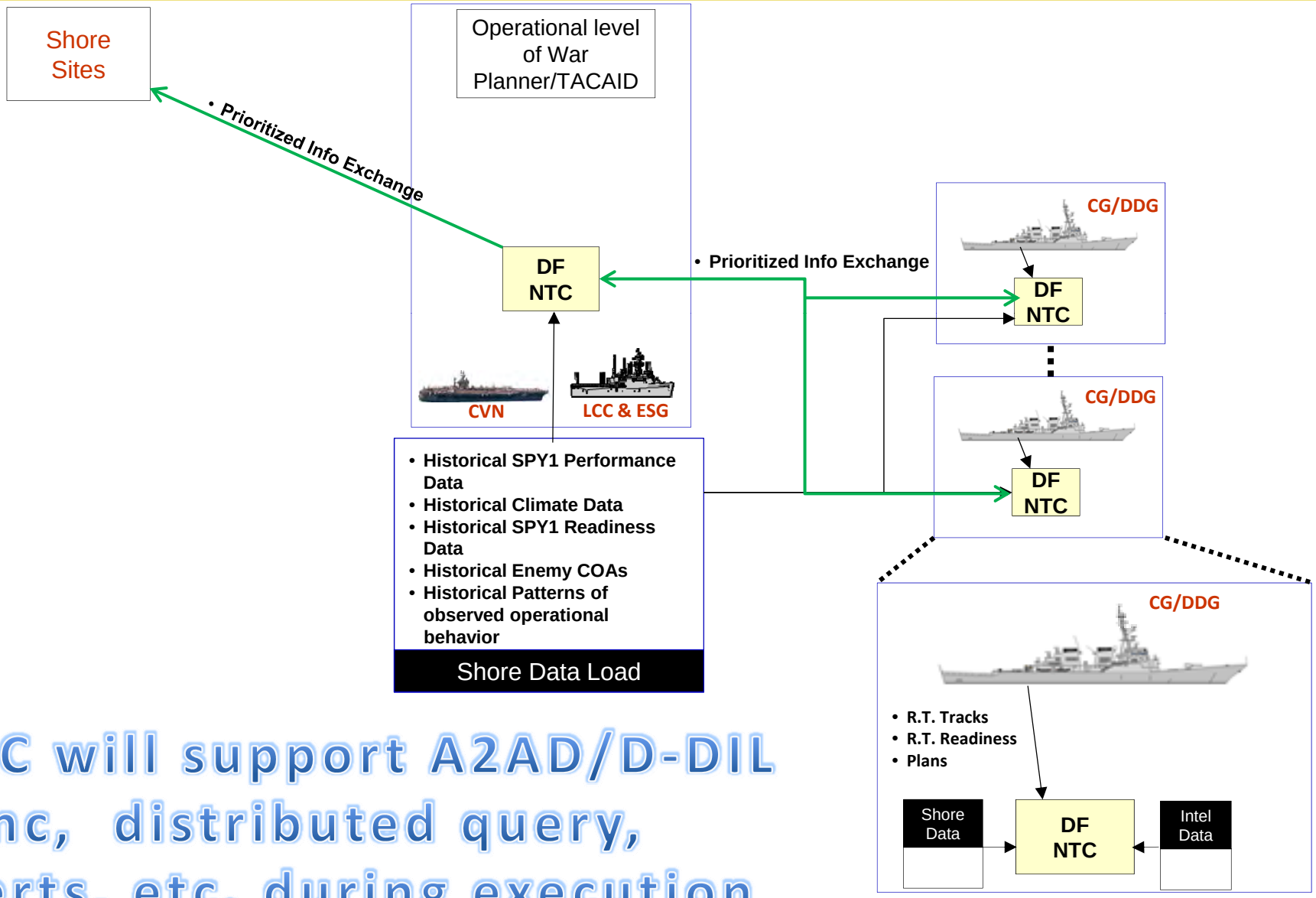



NTC will support A2AD/D-DIL Sync, distributed query, alerts, etc. during execution

# IAMD Scenario
# Use Case Examples

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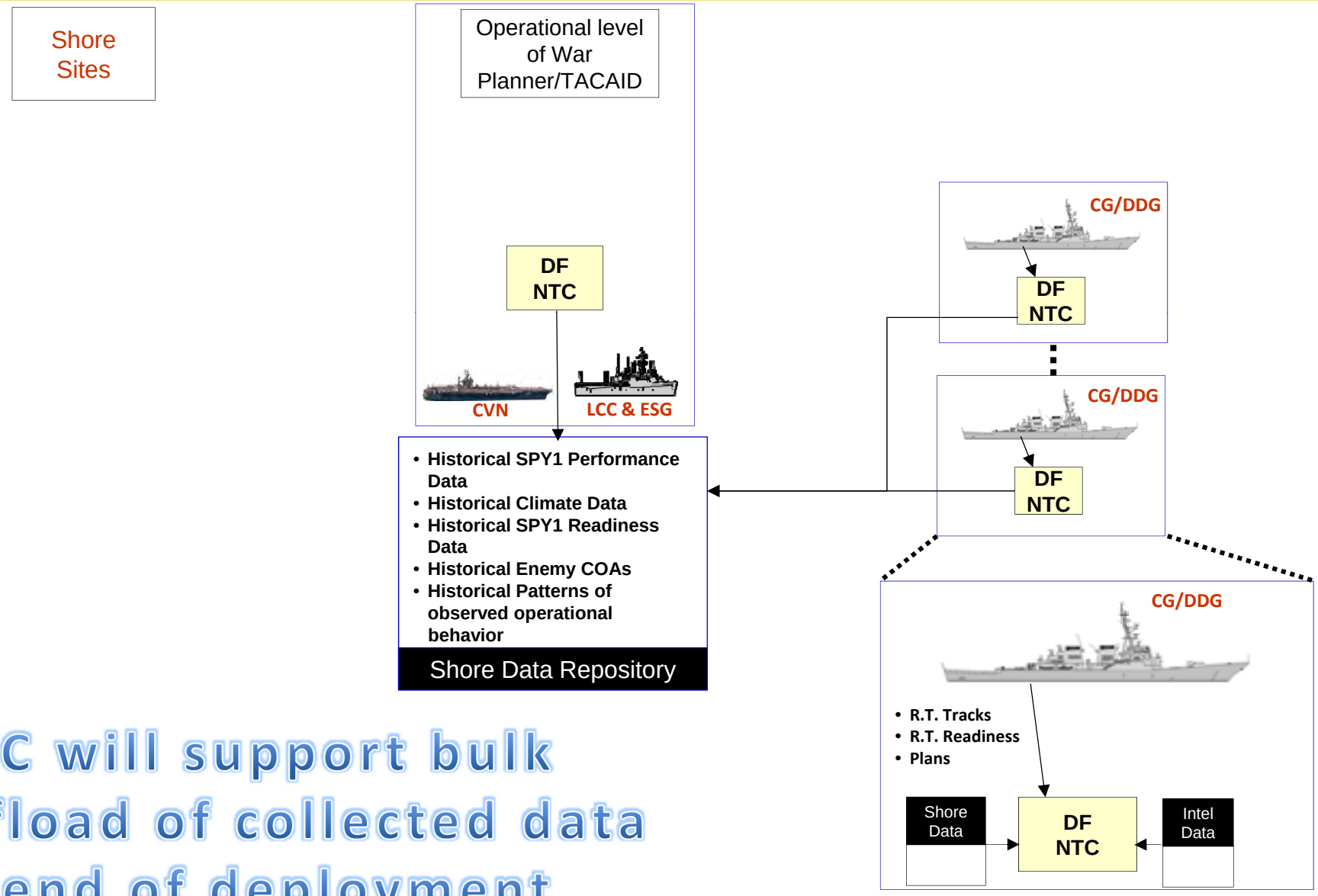



NTC will support bulk offload of collected data at end of deployment

# IAMD Data Science Challenges

- **IAMD systems produce large volumes of data**
  - What should be ingested?
  - Where should filtering occur?
  - What processing is needed inside combat system?
  - How should the data should be indexed?
  - How should data be retained and for how long?
  - How will data be shared in an Anti-Access Area Denial (A2AD)/Disrupted, Disconnected, Intermittent and Limited bandwidth (D-DIL) environment?
- **IAMD will require diverse analytics and data sets**
  - Weather and sensor performance prediction versus track anomaly prediction
  - Track example: Update rates range from very fast to very slow
    - Many times per second for sensor data
    - 10s of times per minute for tracked entities
    - Minutes, hours, or days for untracked entities
  - Cross-warfare area data sharing: What data is available? Where else can IAMD data be used?
- **Real-time Analytics**
  - Analytics may need to respond within seconds (or less) upon updates to entity data
    - Indications and warnings
  - How are analytics prioritized (e.g., I&W higher priority than planning?)?

# Part #8

# Security Thrust

# Data Cloud Security and Integrity: Challenges

- Adapt/improve technologies or techniques to protect the NTC by identifying, isolating, and/or removing adversary cyber actors from this infrastructure
- Develop analogous capabilities or new approaches for the Naval Big Data Ecosystem to assure the integrity and accuracy of the underlying data (which consists of many different types / formats) used to make decisions
- Integrate these capabilities into advanced cyber analytics / applications that leverage the NTC analytic environment while being simple enough for a sailor to operate

**The migration to the NTC provides an opportunity to give the warfighter the flexibility to fight through an adversary's attempts to use cyber to degrade or deny the decision making capabilities of naval commanders**


# *Combat System Objective Architecture and DF-NTC Perspective*

***Kathy Emery***
***PEO IWS D1***
***kathy.emery@navy.mil***

# Program Executive Office Integrated Warfare Systems

Aegis Combat Systems Integration into DDG 51 and CG 47 class ships

BFTT

CPS

CDS

AMIIP Integration

AMDR Integration

DDG

CG

NIFC-CA

SFSE

FTAMD

Open Architecture

MIPS III

CEC

ECIDIS-M

MK 34 GWS: Countries

SQQ-89: 2 Countries

• Radars: 1 Country
• Ammunition: 17 Countries

• WSN-7/9: 4 Countries
• NFCS: 1 Country

CEC: 1 Country

BFTT: 1 Country

SM-1/SM-2: 15 Countries

CIWS: 9 Countries

MK 41 VLS: 8 Countries

Aegis/ AWS: 5 Countries

LCS 1 & LCS 2 Combat Systems Variant Integration

LCS 2

LCS 1

DDG 1000 Combat Systems (TSCE) Integration

DGG 1000

SSDS Combat Systems Integration in the following classes:

CVN

LHD

LSD

LHA

LPD

IWS 1.0

IWS 2.0

IWS 3.0

IWS 4.0

IWS 5.0

IWS 6.0

IWS 7.0

IWS 8.0

IWS 9.0

IWS 10.0

PROGRAM EXECUTIVE OFFICE INTEGRATED WARFARE SYSTEMS

PEO IWS

Sub Arctic Warfare Dev.

ASW Advanced Dev.

MK-32

LCS Mission Modules

CADRT

USW DSS

SQQ-89

CV-TSC

SDRW/SRD /SCD

WQC-2A/6

Surface ASW Systems Imp.

SQS-56

UQN-4A

SEARAM

SM-2 Blk IIIB/ BLK IV

RIM-7/ MK57 NSSMS

SM-6

ESSM

Griffin

MK 45

MK 75 76mm

MK 57 VLS

NFCS

LRLAP

MK 38

AGS

CIWS

RAM BLK 1/2

MK 46 33mm

MMSP

AMDR

AN/SLQ-32

SPY-1A/B/D

AN/SPQ-9B

SPY-3

SPS-40

SPS-49

SPS-55

SPS-64

SPS-67/73

SEWIP

SSQ-82

NULKA

AUSPAR

AOEW DDE

WLR-1

SPQ-14/15

SPA-25

BPS-15

146 – Program & Projects
3 – ACAT I
5 – ACAT II
2 – ACAT III
4 – ACAT IV
9 – R&D
39 – Inactive
84 – Non ACAT

Integrated Combat Systems Major Program Manager

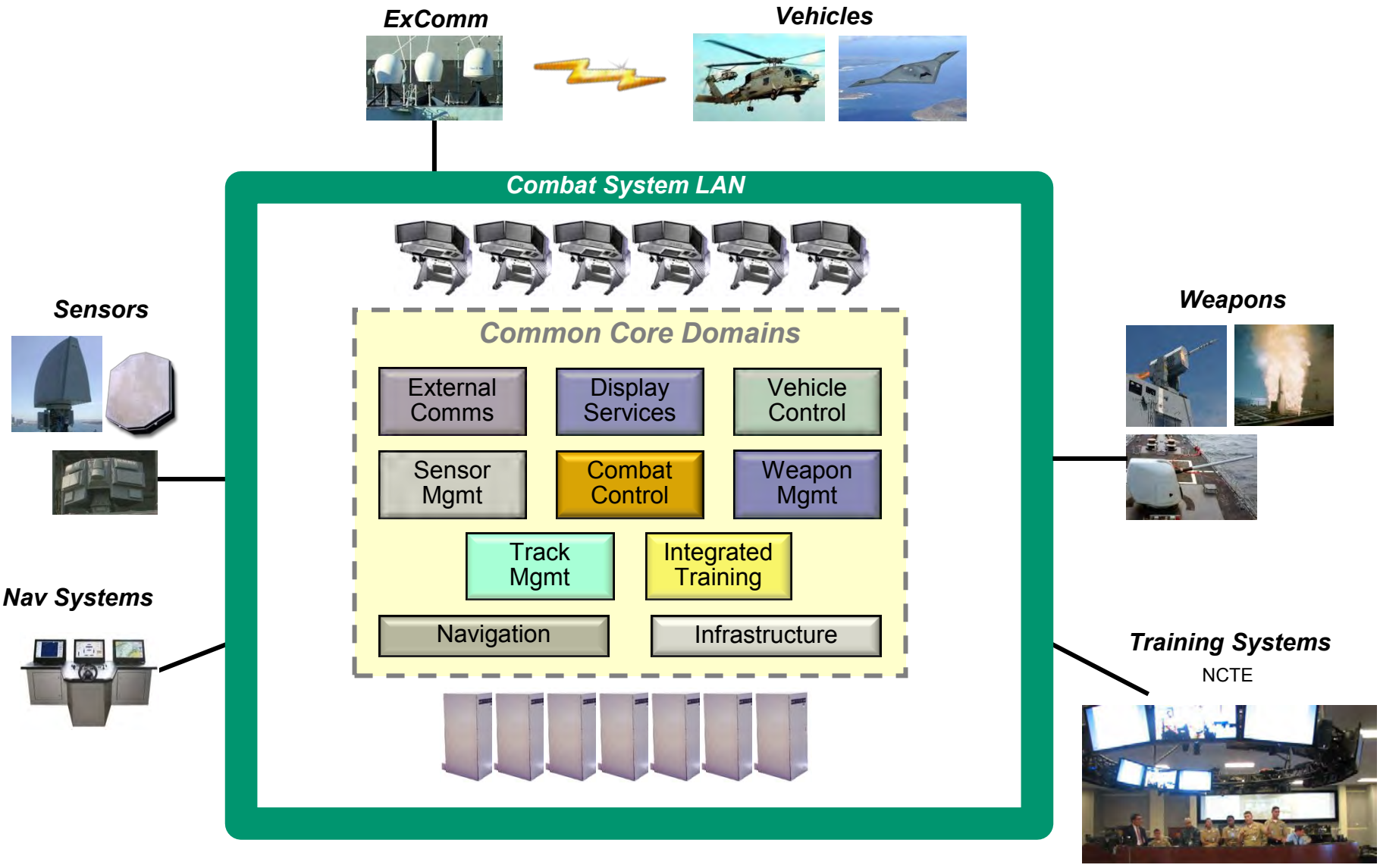
Product Major Program Managers

**PEO IWS develops, procures and delivers Integrated Warfighting Solutions for Surface Ships**

# PEO IWS Combat System Strategy

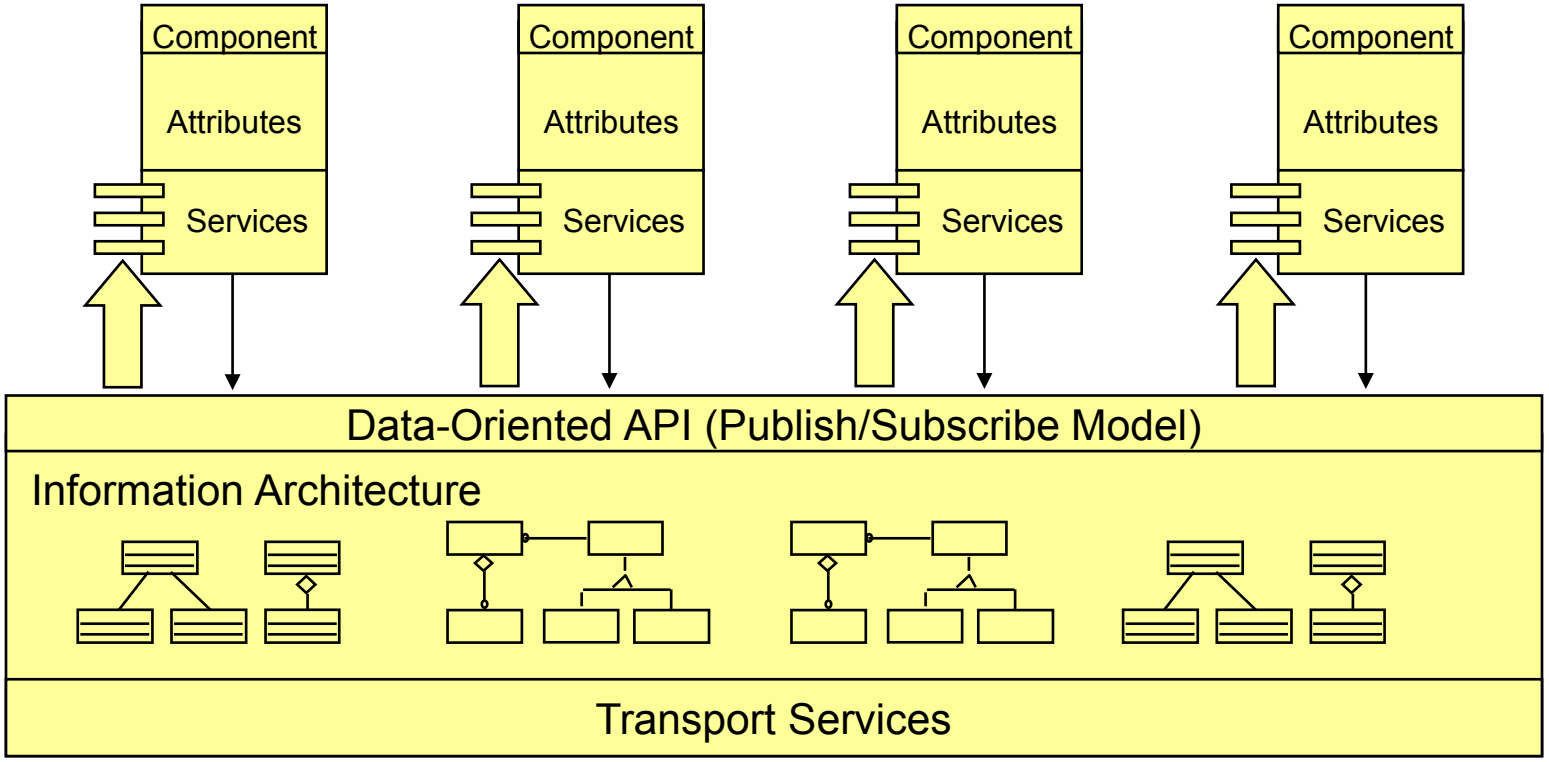
- Enhance mission capability across Surface Fleet with faster and more affordable upgrades that are interoperable and pace the threat
  - Decouple combat system acquisition from ship programs
  - Install combat system-wide network-based COTS computing environment (hardware and software)
  - Define a common objective combat system architecture and associated network-based information exchange standards
    - Standardized interfaces support commonality across ship classes
    - Flexible “information bus” simplifies integration of new CS capability
  - Reduce combat system variants and apply a product line approach for new development that aligns with objective architecture
  - Focus on fielding end-to-end capabilities vs. systems

# Combat System Objective Architecture

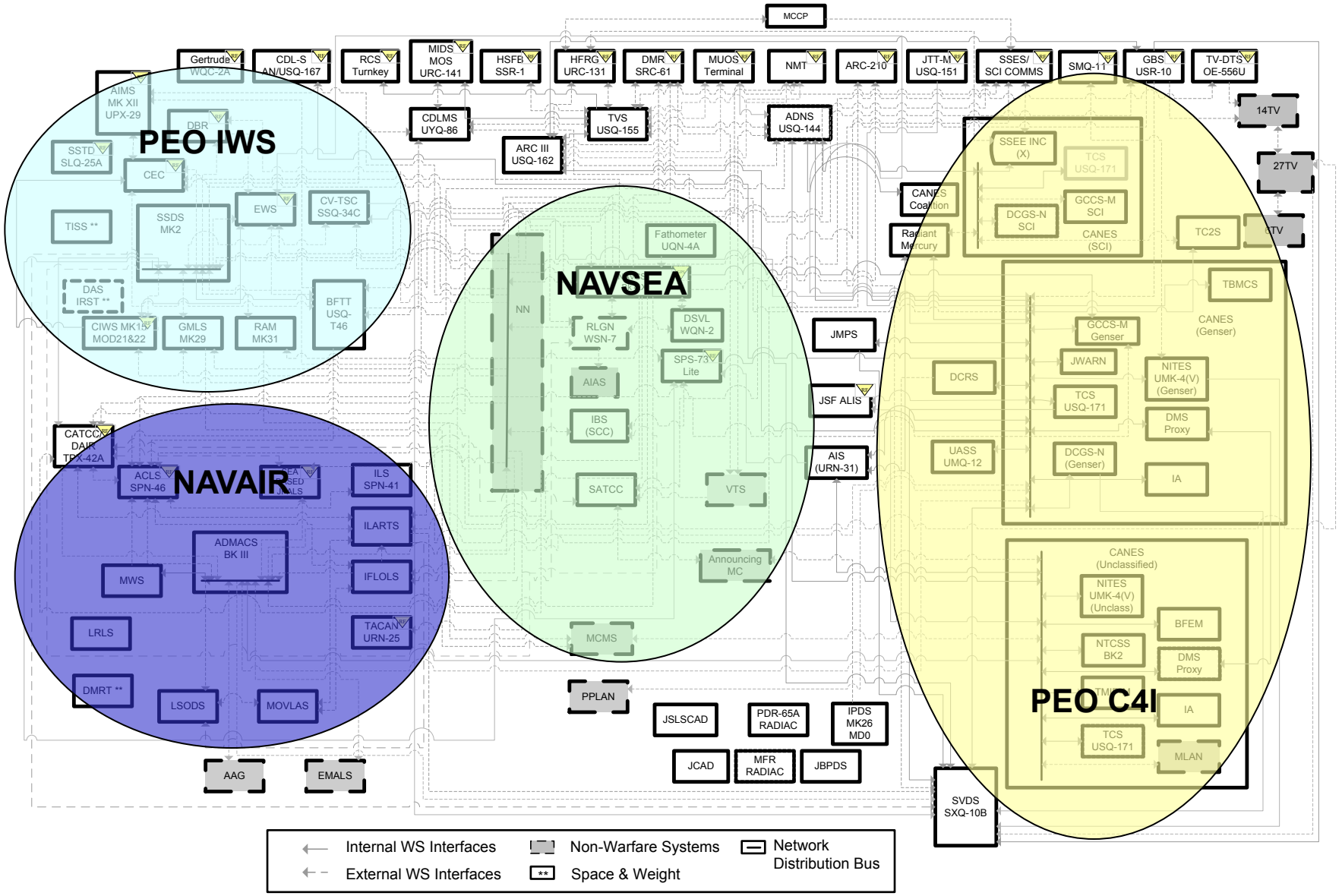


# Information-Oriented Architecture Is Key to Defining Reusable, Extensible Components

- Define a common data model and information standard
- Component-to-network interfaces, not component-to-component
- Publish information for any authorized subscriber to access
- Producers of information don't have to be aware of consumers
- Objective architecture defines interfaces for extensibility and reuse

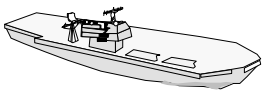


# Today's Shipboard Environment
## (Direct interfaces, weak inter-enclave integration)



# Future Shipboard Environment

## (Network interfaces, significant cross-enclave integration, IA defense in depth)



PLATFORM

External Comms Systems

MIDS, CDL-S, Gertrude, JTT-M, MCCP, SMQ-11, MUOS, NMT, GBS, ARC 210, ARC III, HFRG, DMR, HSFB, TVS, TV-DTS, ADNS

Functional Enclave

Ship Network

Aviation Systems

CATCC DAIR, ILS, ILARTS, ACLS, TACAN, JPALS, LRLS, ADMACS Blk III, MOVLAS, DMRT, IFLOLS, MWS, LSODS

Functional Enclave

C4I Systems

GCCS-M SCI, DCGS-N SCI, CANES (SCI), SSEE INC F, GCCS-M, DCGS-N, TC2S, Cross Domain, NITES, TBMCS, CANES (Genser), JWARN, TCS, DCRS, UASS, JMPS, IA, Cross Domain, NTCSS, TMIP-M, TCS, CANES (Unclassified), BFEM, NITES, MLAN, IA

Functional Enclave

Combat Systems

IRST, SGS/AC, CV-TSC, TISS, EWS, CIWS, CST, IFF, GMLS, CEC, RAM, DBR, SSTD, SSDS

Functional Enclave

Nav and HM&E Systems

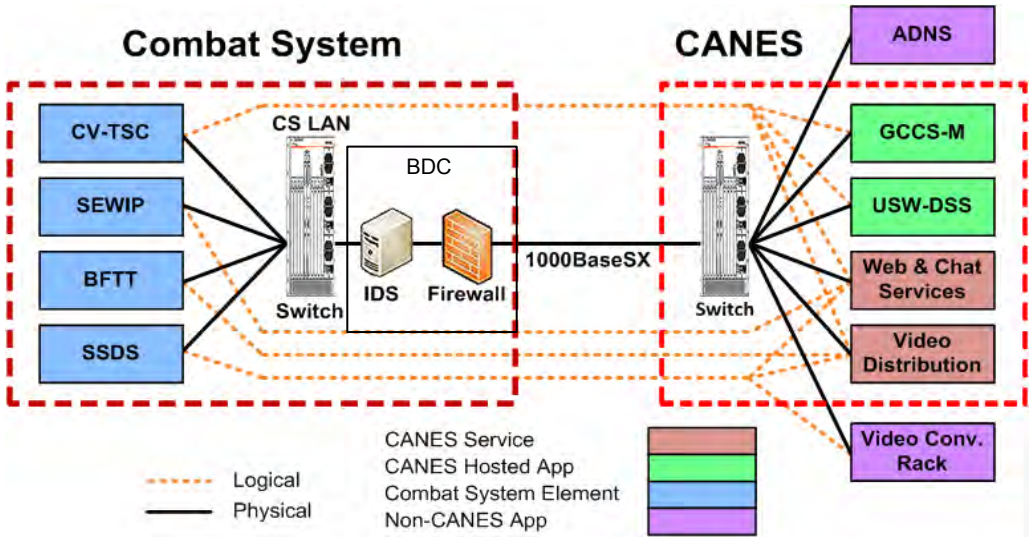
SPS-73, AIAS, RLGN, NAV, IBS, DSVL, VTS, AIS, Fathometer, NAVSSI

Functional Enclave

Interface Control

Network Management

# Gateway and Boundary Defense Capability (BDC)




Common portal that can serve as single point for data exchange between CS and C2 and provide IA protection for each domain

- Enable CS operators/applications to obtain required C2 and off-board data via network connection instead of using “sneaker net”
- Expose existing CS data in a controlled manner to C2 users
- Automatically label data with ICISM tags
- Automatic virus scan and verify bulk data
- Verify data before installing within CS
- Better access control to external web sites
- Don’t need to rely on ship’s crew establishing and removing temporary connections for distance support

Data Exchanges

- GCCS-M / CV-TSC (Tracks and Overlays)
- CV-TSC / USW-DSS / JMPS (ASW & Planning Data)
- CV-TSC / SIPR (Chat, Web Browsing)
- SEWIP / GCCS-M (COP Virtual Terminal)
- SEWIP / SIPR (Parametric Library)
- SSDS / SIPR (BG Chat)
- BFTT / NCTE (Fleet Synthetic Training)
- CDL-S / CV-TSC (MH-60 Data)
- CV-TSC / NITES (Weather)
- SSDS / Video Displays ( ASTAB Data)
- *SSDS / GCCS-M (Track Data Manager) (Future)*
- *DBR / NITES (Weather) (Future)*

# Gateway Supports Speed to Fielding Objectives

- Combat system performance is stringently engineered and CS changes go through a rigorous test & cert process
- Gateway decouples CS and C2 applications to allow C2 applications to evolve rapidly without triggering a CS recertification
  - CS side of gateway will be engineered to expose useful CS data and to appropriately tag data to allow access by authorized users without impacting CS performance
  - C2 side of gateway will react to user-defined rule sets to transfer operationally relevant data to client applications
- CS will evolve more slowly through a series of Advanced Capability Builds to exploit additional data available from C4ISR systems via the gateway/BDC

# MH-60R / Ship Integration Architecture for CVNs

Ownship-controlled Vehicles
Persistent ISR Assets

CDL

Sensor data &
controls, video

Voice
Radar Video
Ship-wide Video
Distribution System

Many consoles
& displays

Radar Video,
FLIR/ISAR

Link 16

Vehicular Tracks,
Special Points,
ASW/EW LOBs

GIG

NITES

Gateway
w/ BDC

ADNS

Track Data,
FLIR, Radar

SSDS

ASTAC
Operator

Acoustic
Helo Data

USW
Plans

CANES

CS LAN

GCCS-M/
MTC2

USW DSS
(USW C2)

SUW/USW
TOC

EW System
(SEWIP)

EW
Operator

SCC
Watchstanders

# S&T Challenges With Particular CS Relevance

- Improved coordination across operational and tactical mission planning activities, shared analytics, access to real-time readiness data
- Proactive ship stationing and sensor setup for potential adversary actions
- Environmental data to improve sensor laydown, search plans, and processing in adverse environmental conditions
- Improved ASW contact following from shared pre-contact data and analytics
- Improved situational awareness due to increased coverage from long-range sensors and persistent ISR assets
- Indications and Warnings to focus CS sensor assets on critical sectors
- Improved association of sensor data under ambiguous conditions
- Additional sensor attribute data to improve threat assessment, classification and identification
- Improved prediction of future target movement and corresponding system responses
- Ability to rapidly change response to new unexpected threat behavior in a deterministic and verifiable manner

# Program Executive Office Command, Control, Communications, Computers and Intelligence (PEO C4I)

# Battlespace Awareness and Information Operations Program Office (PMW 120)

# Distributed Common Ground System – Navy (DCGS-N) Increment 2 Overview for the ONR Data Focused Naval Tactical Cloud Industry Day

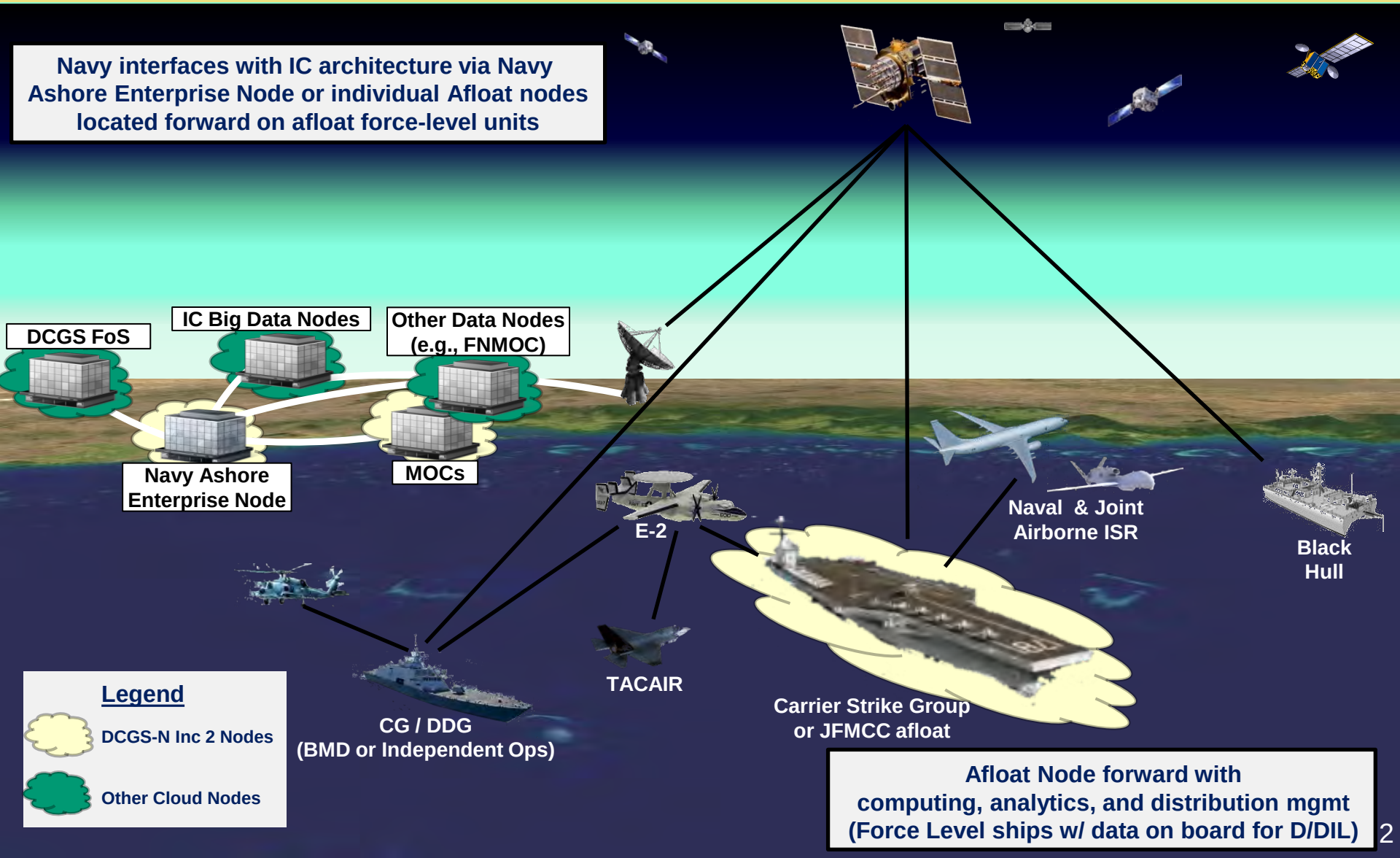

**24 June 2014**
**Jerry M. Almazan**
**Technical Director**
**(619)524-7889**
**jerry.almazan@navy.mil**

# Briefing Agenda

- DCGS-N Inc 2 Operational View
- DCGS-N PORs & Prototyping Efforts
  - Inc 1, Inc 2, & NITROS (Naval Integrated Tactical – Cloud Reference for Operational Superiority)
- Migration to Automated Workflows
- Program Structure
- DF NTC Research Opportunities for DCGS-N Inc 2
- Other Industry Collaboration Areas

# DCGS-N Increment 2
## *Operational View*

***- Pre-Baseline-***



# DCGS-N Increment 1
## *Where We've Been…* *- Pre-Baseline-*

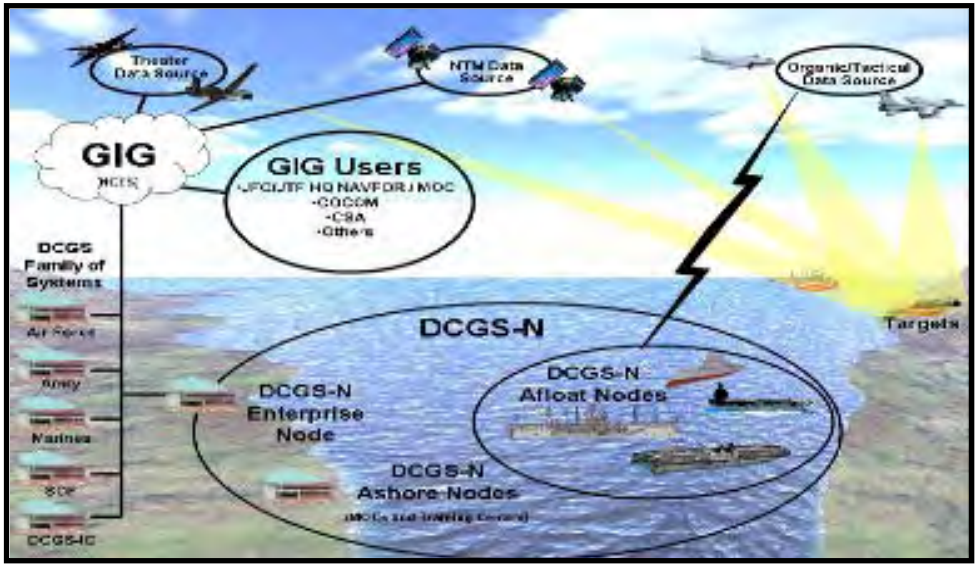
NFN → Original DCGS-N → *Inc 1 Reset* → Blk 1 EDM USS HST → MS C → FDDR → EA ECP USS BHR → Inc 1 Block 2 SIT → Inc 1 FD → **Inc 2**

**Inc 1 was about consolidating capability…**

- Merged delivery of ISR&T tools *and* integrated priority SIGINT & IMINT capabilities
- Delivered an 80% solution / Milestone C in 2 years from program reset
- More than 29 Fleet Installations

**… and taking the first steps towards a hosted environment**

- Phased migration to CANES (Inc 1 Block 2)
- Get out of the hardware business and ultimately focus on the ISR&T support tools




*3 racks, peripherals, and up to 30 workstations procured by DCGS-N*

**While Inc 1 continues to meet C/S/P, its lack of "bottom-up" design resulted …**

- Hard to use …
- Challenging to train …
- Difficult to maintain, and …
- Simply not a satisfying experience for the sailor!

**DCGS-N Inc 2 will fundamentally change this paradigm to resolve current readiness challenges and provide a system that is easier to operate, train, and maintain**

# DCGS-N Increment 2
## *Where We're Going…* - Pre-Baseline-

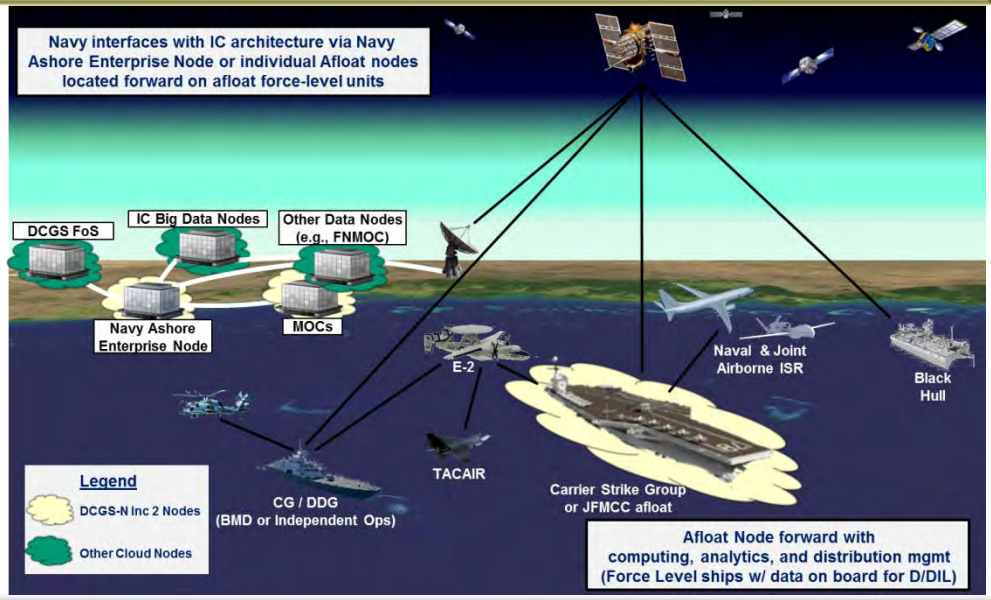
**Inc 2**

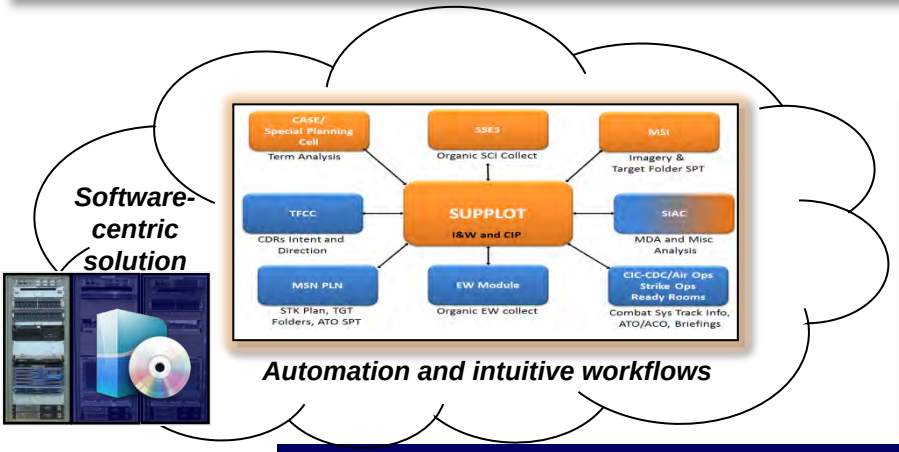
| FY x | FY x+3 | FY x+4 | FY x+5 | FY x+6 | FY x+7 | FY x+8 |
|---|---|---|---|---|---|---|
| AoA | FCR-0 (PEO C4I Prototype) | FCR-1 | FCR-2 | FCR-3 | FCR-4 | FCR-5 |

**Inc 2 will rapidly field ISR&T support capabilities …**

- Annual Fleet Capability Releases that leverage COTS/GOTS tools/services
- Agile System Engineering incorporates Requirements Governance Board priorities and user feedback into development

**… and complete the migration to a hosted environment …**




**With the time to build on, fix and streamline Information Dominance Corps' tools …**

- Familiar tools and processes, refactored to the Cloud …
- Intuitive workflow-centric design …
- Anomaly detection, exploitation and automatic fusion …
- … to combat increased data loads brought on by the sensor "tipping point" and optimize sailor capabilities!

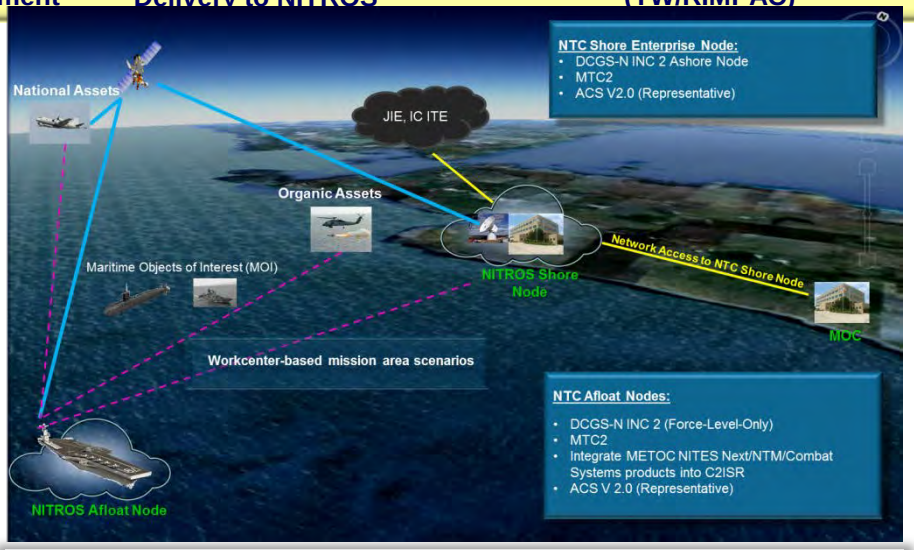
**DCGS-N Inc 2 will simplify the sailors' experience and improve Fleet Readiness**

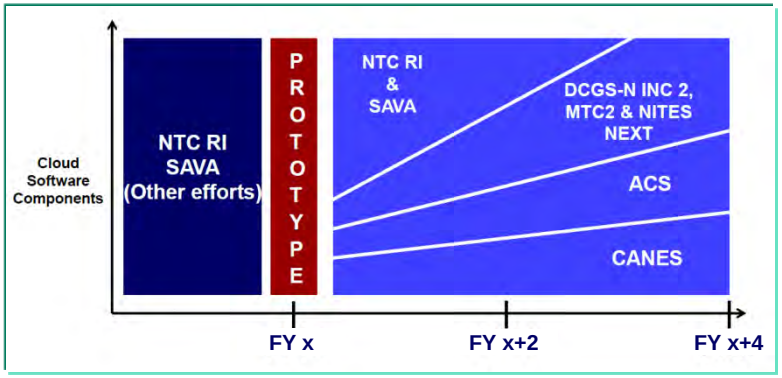
# PEO C4I's NITROS Prototype *Helps Us Get There…* - Pre-Baseline-

NITROS → NITROS Guidance → FCR-0 Demo RGB → FCR-0 Demo BTR → FCR-0 Integration & Development → FCR-0 Delivery to NITROS → NITROS SIT → NITROS Demo (TW/RIMPAC) → FCR-1

**DCGS-N Inc 2's FCR-0 will deliver an early look at our capabilities to NITROS …**

- 4 IDC KPPs
  - Automatic Fusion
  - Automated Exploitation & Detection
  - Visualization
  - Collection Management & Awareness
- Core legacy apps co-existing with large-data store
  - GALE (SIGINT), SOCET (IMINT / Targeting), CMMA (Collection Management)




***… PEO C4I's NITROS Prototype directly impacts more than just DCGS-N Inc 2 … other PORs and projects too!***

**… and wring out our agile processes …**

- Requirements
- Contracting
- Integration & Development
- Cyber Security
- T&E
- Fielding

… via continuous involvement with our Fleet, POR, and S&T partners!

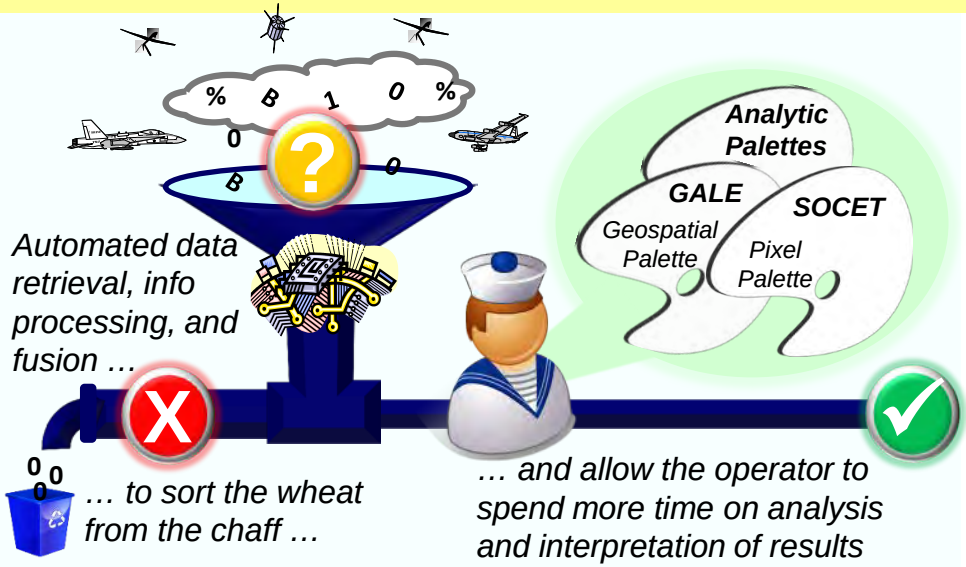
**FCR-0/NITROS will provide lessons learned to DCGS-N Inc 2, other PORs and projects, and Fleet IDC Partners in prep for Inc 2 FCR-1 and beyond**

# Complementary Role of Legacy Apps in a Workflow World

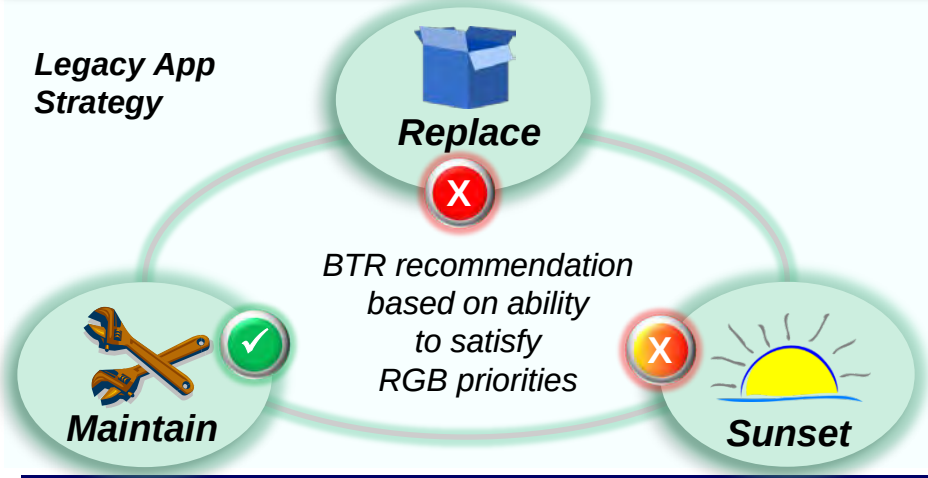
***It's hard to ask the questions today, that we need to answer tomorrow …***

**Intuitive workflows & automated fusion are based on anticipating questions and …**

- Generating an encyclopedic grasp of the environment …
- Reducing the need for situational awareness (SA) *maintenance* …
- Optimizing the analysts' time, to focus on anomalies, issues, and uncertainties




***Legacy App Strategy***

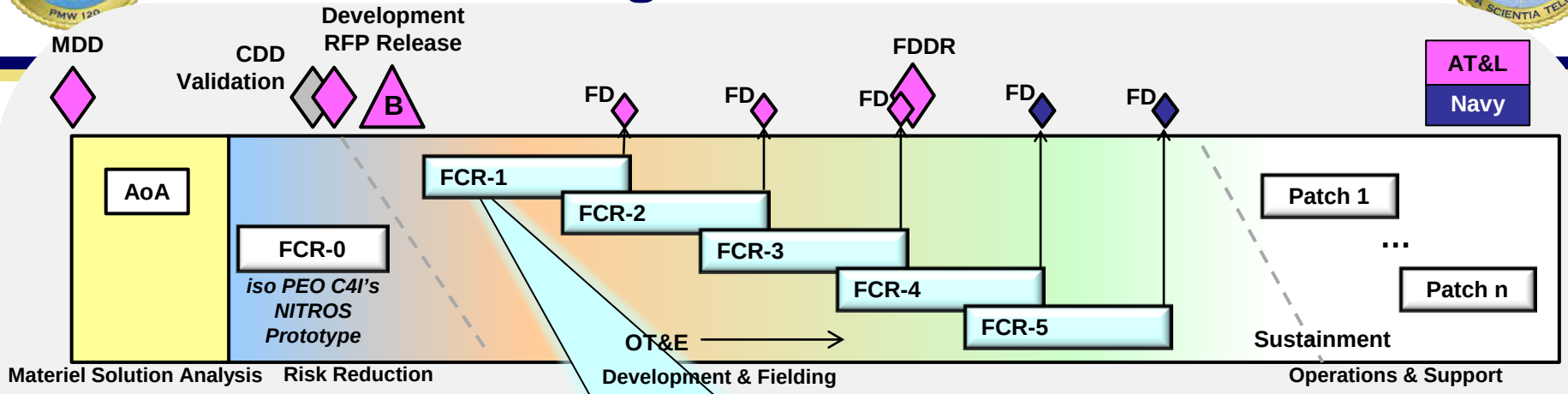



**… while relevant legacy apps (i.e., outside the automated workflow) help answer the unanticipated question …**

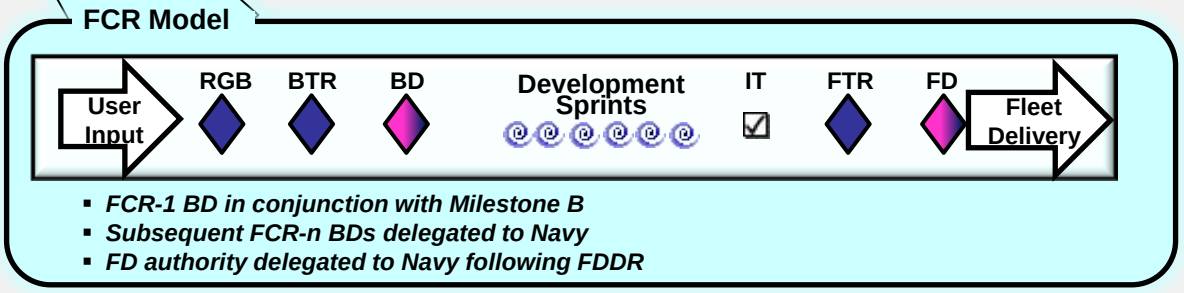
- Providing forensic, recursive analysis …
- Answering new questions about old data …
- Ensuring survivable decision support that avoids the historian's fallacy

**Together, DCGS-N Inc 2 will provide the tools *and time* to answer tomorrow's questions – supporting timely, accurate SA and enhanced speed to decision**

# DCGS-N Inc 2
## *Program Structure* *- Pre-Baseline-*




| | |
|---|---|
| AoA | Analysis of Alternatives |
| BD | Build Decision |
| BTR | Build Technical Review |
| FCR | Fleet Capability Release |
| FD | Fielding Decision |
| FDDR | Full Deployment Decision Review |
| FTR | Fielding Technical Review |
| IT | Integrated Test |
| KPP | Key Performance Parameter |
| MDD | Materiel Development Decision |
| OT&E | Operational Test & Evaluation |
| RFP | Request for Proposal |
| RGB | Requirements Governance Board |




***Illustrates the program structure and sequence of decision events only; not intended to reflect time***

***Preliminary FCR Objectives – subject to trade-off analysis/feasibility assessment and RGB approval***

| FCR-1 | FCR-2 | FCR-3 | FCR-4 | FCR-5 |
|---|---|---|---|---|
| ▪ Refactor DCGS-N Inc 1 to the cloud<br>▪ SIGINT/Tracks Workflows<br>▪ KPP initial minimums | ▪ GEOINT Workflow updates and targeting support<br>▪ FCR-1 backlog/deferred requirements | ▪ Current readiness updates<br>▪ FCR-2 backlog/deferred requirements | ▪ Current readiness updates<br>▪ FCR-3 backlog/deferred requirements | ▪ Current readiness updates<br>▪ FCR-4 backlog/deferred requirements |

**IT Box supports Evolutionary Acquisition and Agile Development based on rapidly changing Fleet priorities. Each FCR builds on the prior FCR.**

# DF NTC Research Opportunities for DCGS-N Inc 2

**(not limited to the examples below)**

- Anti-Submarine Warfare (ASW) Area
  - Enemy Course of Action Data
    - Use of Historical Pattern of Life Data
  - Organic/Non-Organic Environmental Data to Support Mission Planning (including optimal sensor deployment) and Dynamic Execution
    - Monitor differences between expected & actual conditions
  - National Technical Means

# DF NTC Research Opportunities for DCGS-N Inc 2 (cont'd)

**(not limited to the examples below)**

- Integrated Air/Missile Defense (IAMD) Area
  - Improved Identity Classification, Intent & Future Movement Prediction, & Association
    - Fuse Organic & Non-Organic, Multi-INT to ID Maritime Objects of Interest (MOI's)
    - Predict Intent & Future Movement
    - Association with other MOI's
  - Threat Evaluation and Weapon Assignment (TEWA)
    - Improved Situational Awareness
    - ID Adversary Capabilities, Behaviors, & Operational Patterns
    - Improved Planning of Asset Movement and Optimized Weapon Usage
  - Battle Damage Assessment (BDA)
    - Multi-INT/Multi-Source (including Cyber)
  - Improved Spectrum Operations
  - Cyber Awareness

# Other Industry Collaboration Areas
## *Where We Need Your Help*

- CLOUD Challenges
  - CLOUD sync in challenged bandwidth environments
  - CLOUD related "dashboards" that provide system status (HW & SW) and self healing/help
- Data Science & Management
  - Identify Data Sources, Define the Metadata and Objects, Develop Ingestion, & Indexing strategies in support of Alerting & Multi-Int Fusion
  - Move disparate data from multiple sources and security domains into a common maritime-defined schema (Subject, Predicate, and Object) in real-time
  - Development of non-proprietary interoperable technology standards. Example standards for virtualization technology.
- Automated Correlation & Fusion to Maritime Objects
  - Correlate & Fuse to the correct vessel
- Full Motion Video (FMV) Automated Object Recognition (AOR) in a Maritime Environment
  - Automatically detect & recognize Maritime Objects of Interest (MOIs) from FMV
  - Extract Geospatial Intelligence from sensor metadata
- Fusion-Based Anomaly Detection
  - Correctly detect anomalous behavior of objects that deviates from normal historical patterns
  - Heuristic/Rule-based analytics & machine-learning algorithms using all-source data to be considered
- Automated Deceptive or Non-emitting Vessel Tracking
  - Automatically recognize and track vessels that are not broadcasting correct AIS data
- Automated Alerting
  - Automatically alert correctly on user-defined Vessel of Interest criteria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Program Executive Office
Command, Control, Communications,
Computers and Intelligence (PEO C4I)

# MTC2 Industry Day Brief

24 June 2014
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PMW150 Technical Director
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# Agenda

- BLUF
- Development Strategy and Schedule
- Requirements Development
- Integration with Naval Integrated Tactical-Cloud Reference for Operational Superiority (NITROS)/NTC-RI
- C2 S&T Challenges

# BLUF

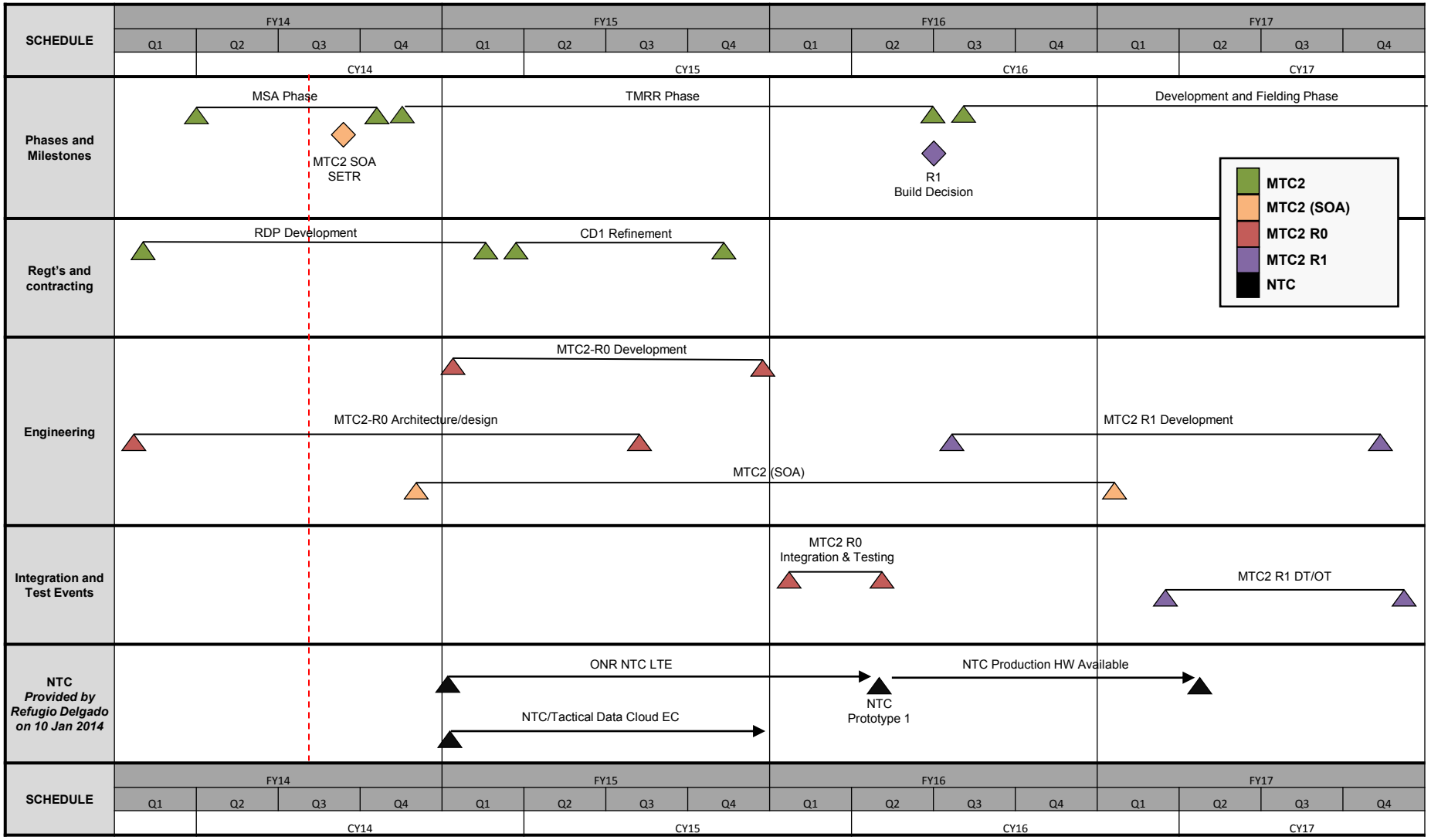
- Current Focus
  - Requirement maturation
  - Evaluation of materiel solutions against those requirements
- MTC2 Design Concept
  - Provide core functions while in an austere data environment
  - Provide enhanced functionality in a rich data environment
  - Per OPNAV, leverage the rich data that cloud-enabled environments may provide
- MTC2 Capabilities
  - Move beyond current C2 designs (historically focused on only SA)
  - Leverage additional data from a spectrum of resources when available

# MTC2 Development Strategy

## There will be 4 main efforts for MTC2

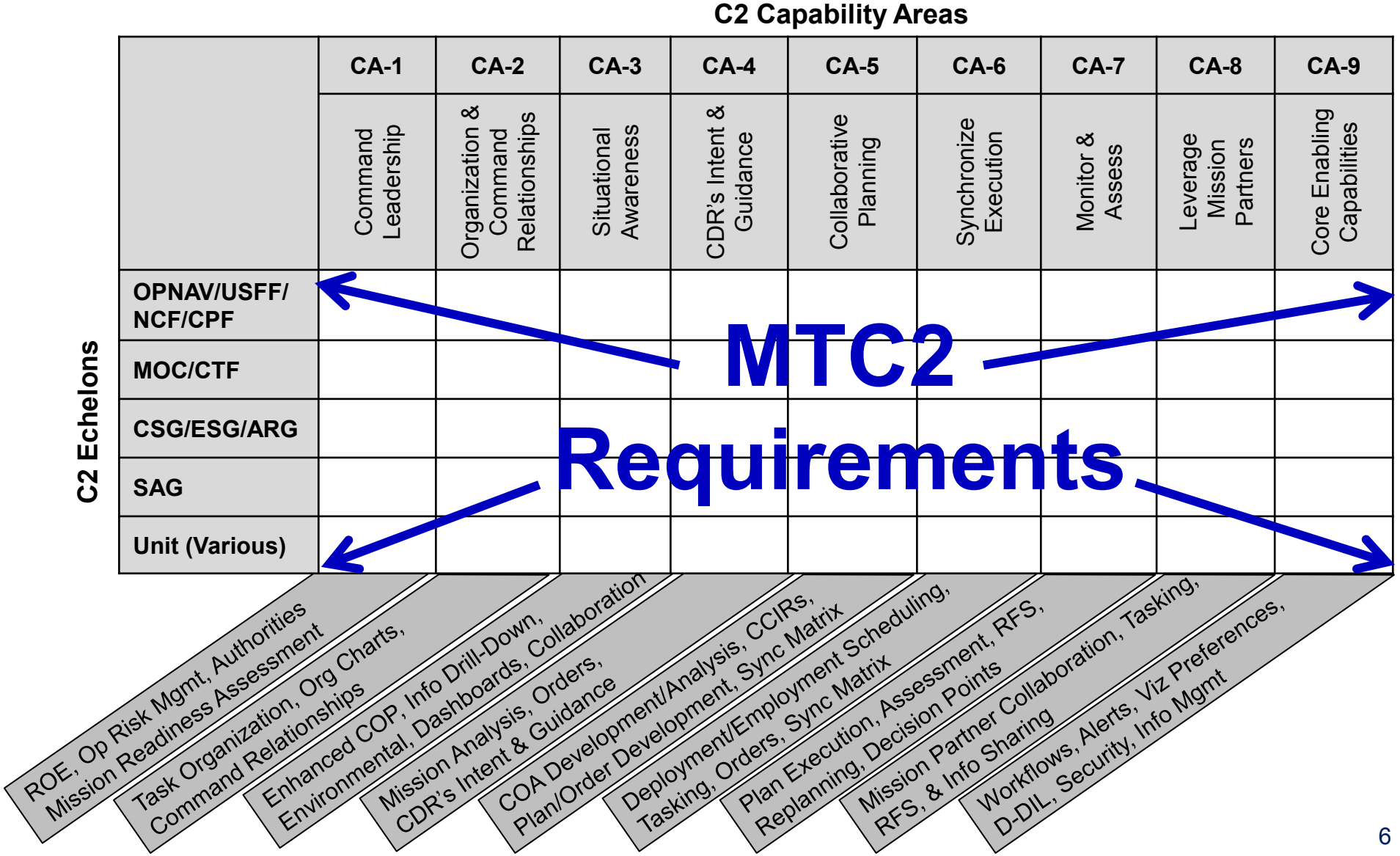
| MTC2 Variant | Fielding Sites | Fielding Date | Notes |
|---|---|---|---|
| MTC2 (SOA) | 2 sites running C2RPC UCB II | 4QFY14 | Updated & Accredited version of C2RPC UCB II |
| MTC2 R0 | 2 Sites (1 afloat and 1 ashore) | Operational Prototype – 2QFY16 | Prototype fielding to support requirements validation and R1 activities |
| MTC2 R1 | All sites (afloat and ashore) | Initial Fielding – 1QFY18 | GCCS-M Replacement. Initial PoR fielding |
| MTC2 R2 (TBD) | All sites (afloat and ashore) | Initial Fielding – 1QFY19 | MTC2 leveraging enhanced data services and availability |

# MTC2 Schedule
## *Alignment with NTC*




*As of 14 Mar 14*

# MTC2 R1/R2 Capability Areas and Echelons



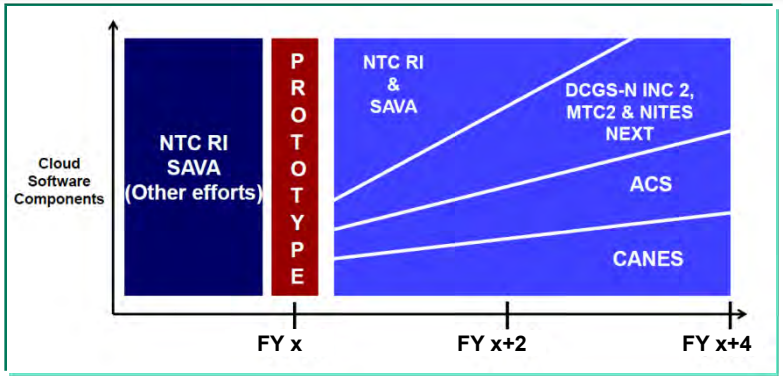
# PEO C4I NITROS Prototype

## *Helps Us Get There…* *- Pre-Baseline-*

NITROS → NITROS Guidance → R0 Development → R0 Integration → R0 Test → R0 Delivery to NITROS → NITROS SIT → NITROS Demo (TW/RIMPAC) → R1

**MTC2 R0 will deliver an early look at our capabilities to NITROS …**

- Track and Overlay Management
- CCIR/PIR
- Common Map API
- Focus on deploy-ability, supportability, maintainability and scale-ability
- Consolidated Data Store
- Establish Normalized Data Layer
- Reduce IA vulnerabilities

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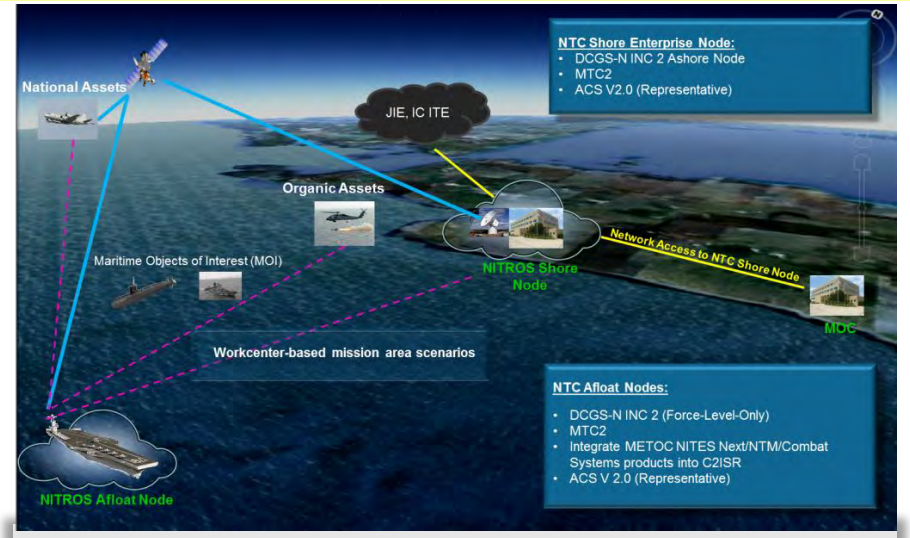


**… and wring out our agile processes …**

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… via continuous involvement with our Fleet, POR, and S&T partners!

***NITROS will provide lessons learned to MTC2, other PORs and projects in preparation for MTC2 R1 and beyond***

# S&T C2 Challenges

- Provide the Commander with timely, continuous and automated IAMD and ASW:
  - Overall Mission Assessment
  - Course Of Actions (COAs) recommendations
  - “What If” warfighter options


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