

Depicting Interagency Information Sharing using Systems of Systems

Using Architecture to Focus Specific Data Exchanges

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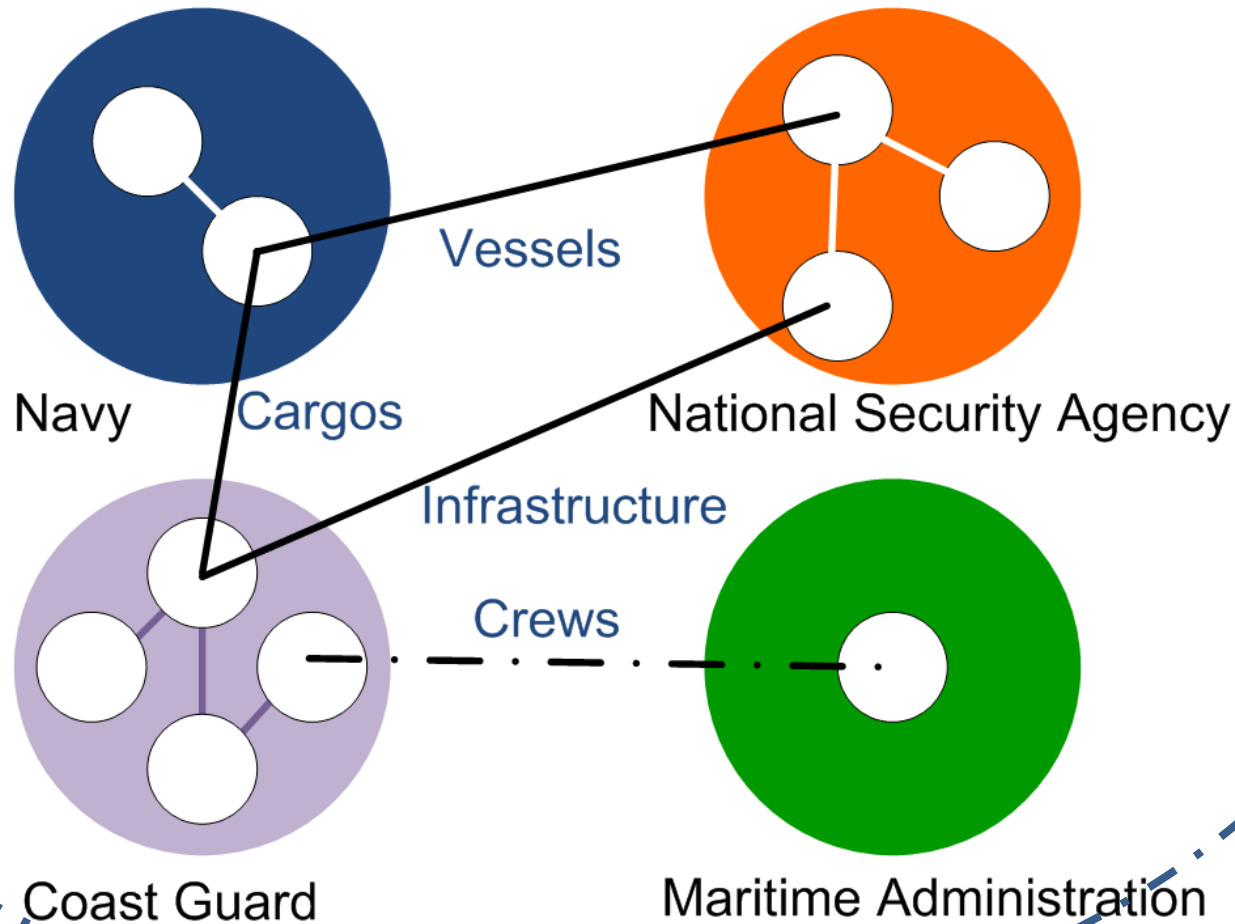
SATURN 2012 Conference – May 10, 2012

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Agenda

- Maritime Domain Awareness Context
- Systems of Systems
- Information Sharing Data Exchanges
- Isolated Data Flows
- System Node Classification
 - Producers / Consumers ; Publishers / Subscribers

MDA System of Systems Subset



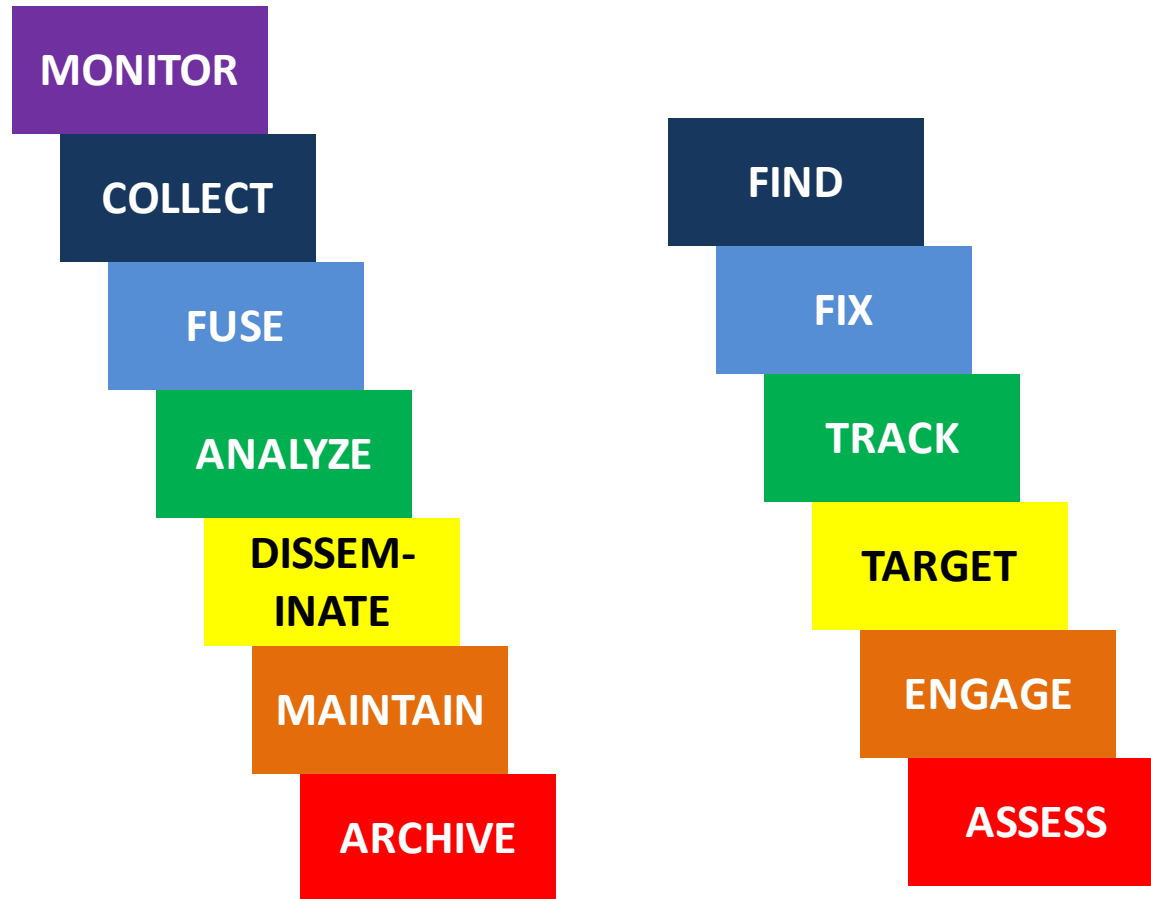
MDA Producer Responsibility Matrix

(notional subset with potential exaggeration)

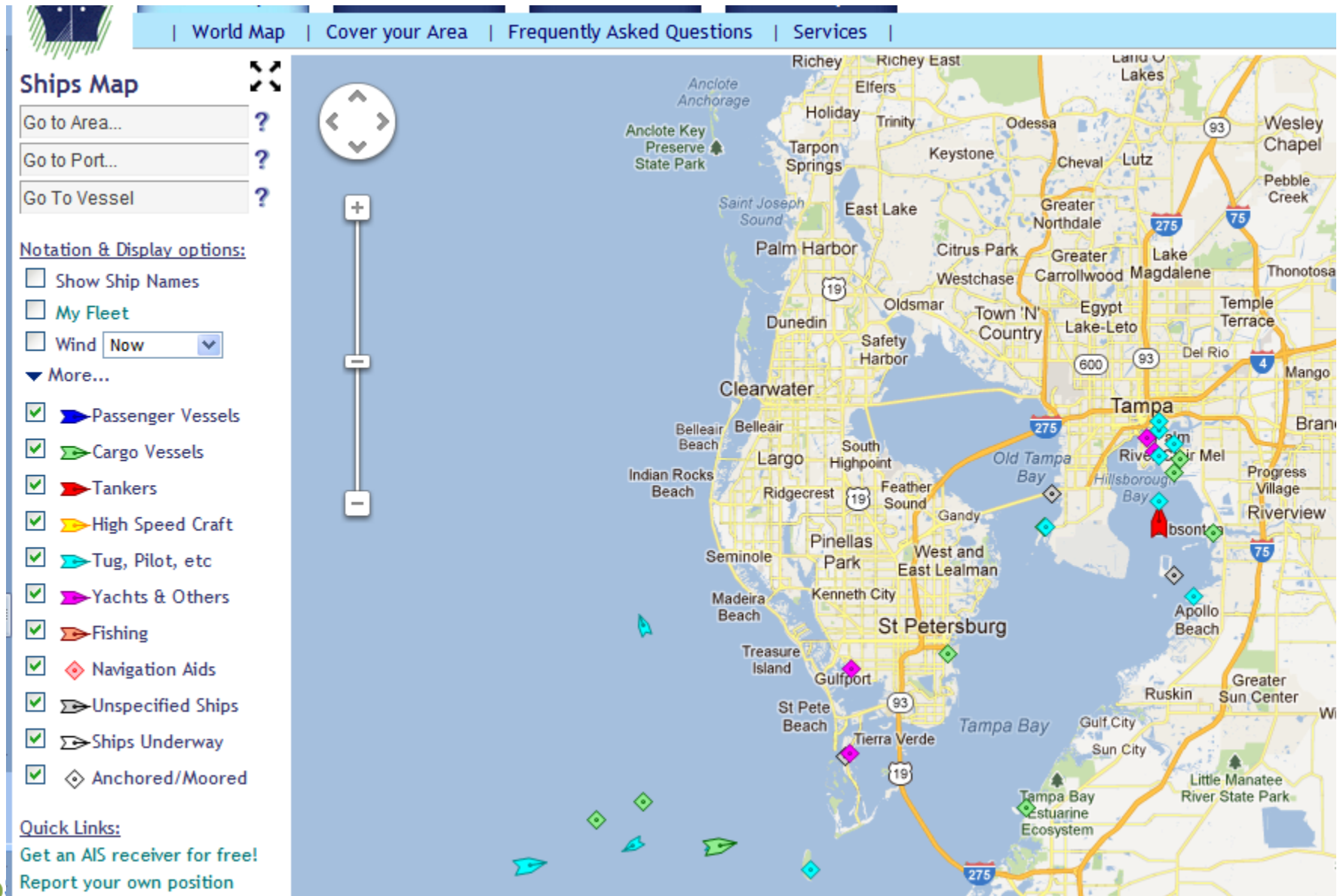
replace cells with system identification/function

	DoD	DHS				DOT	Commerce	
Org's/ Fcn's	Navy	Coast Guard	Customs & Border Protect.	Immig. And Customs Enforce.	US Citizen and Immig. Services	Mari- time Admin.	Nat'l Ocean. & Atmos. Admin.	Environ. Protect. Agency
ID and Locate								
Vessels	Yes	Yes	Yes			Yes		
Cargo	Maybe	Yes	Yes			Yes		
People	Maybe	Yes	Yes	Yes	Yes	Yes		
Infras.	Maybe	Yes	Yes			Yes		
Weather	Yes	?				Yes	Yes	Yes
Water Kinetic	Yes	?				Yes	Yes	Yes
Water Quality		?				Yes		Yes

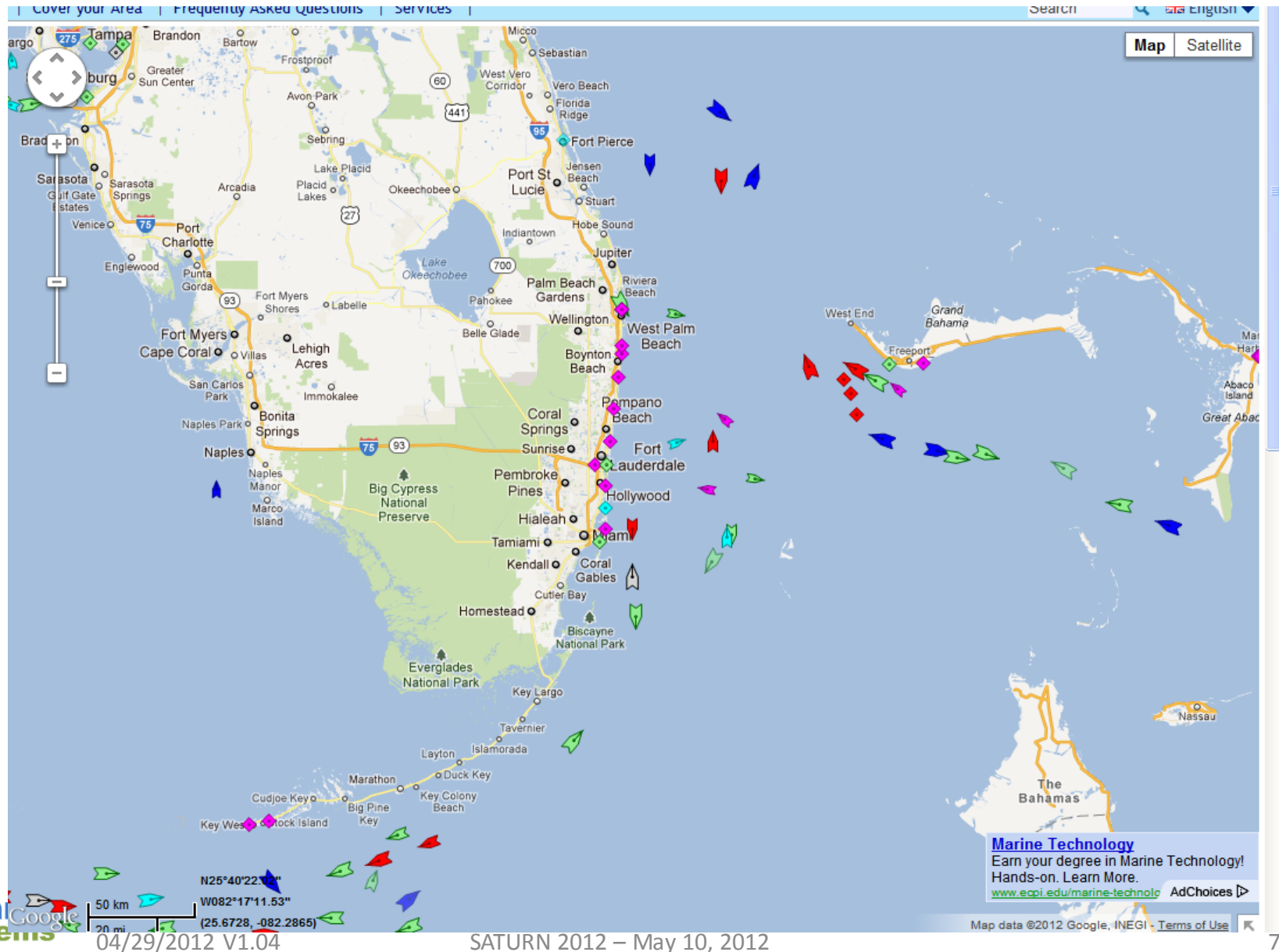
Types of Systems, Functions, and Services for Situational Awareness and Weapons



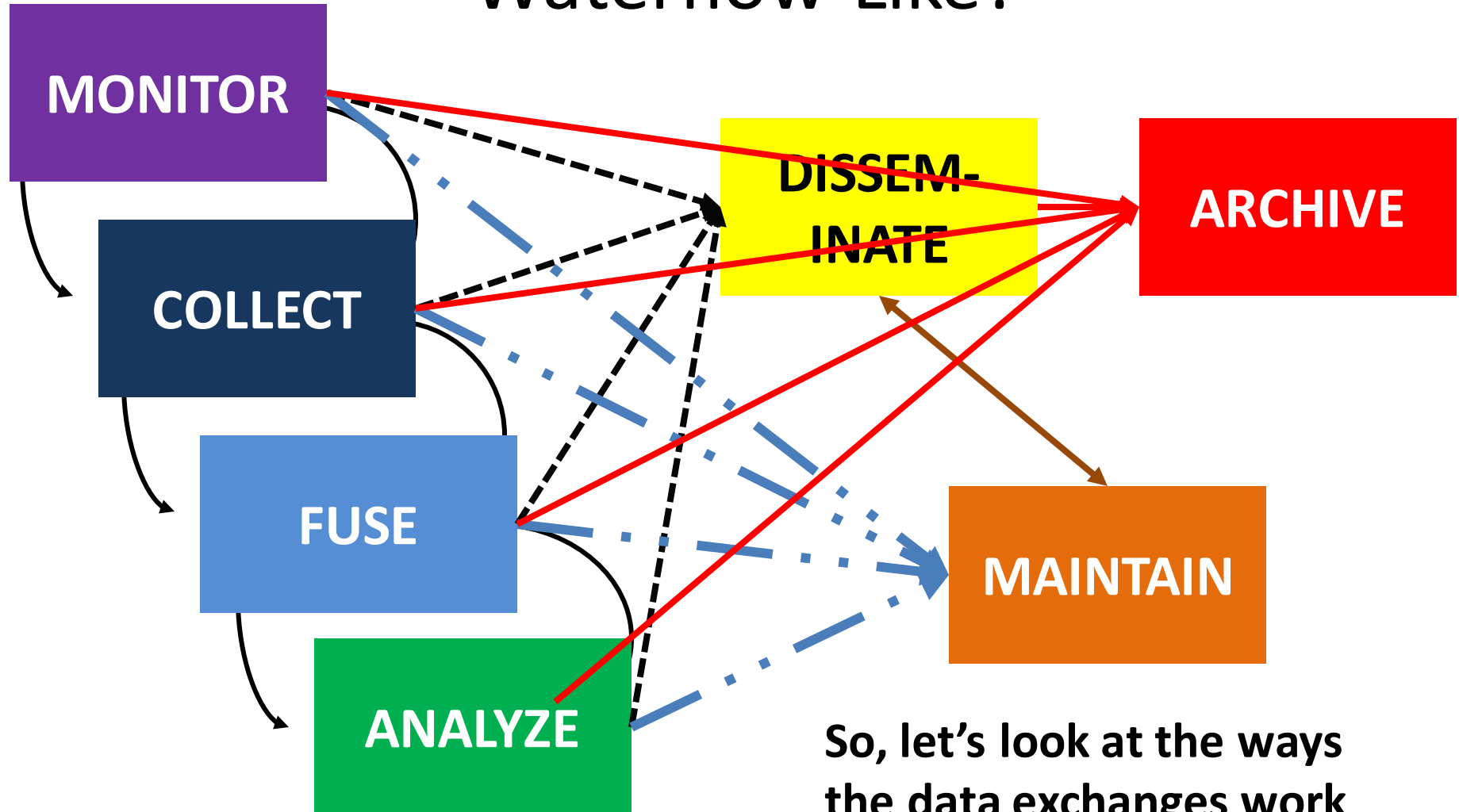
Tampa-St. Petersburg Harbor



Miami Harbor and Nearby

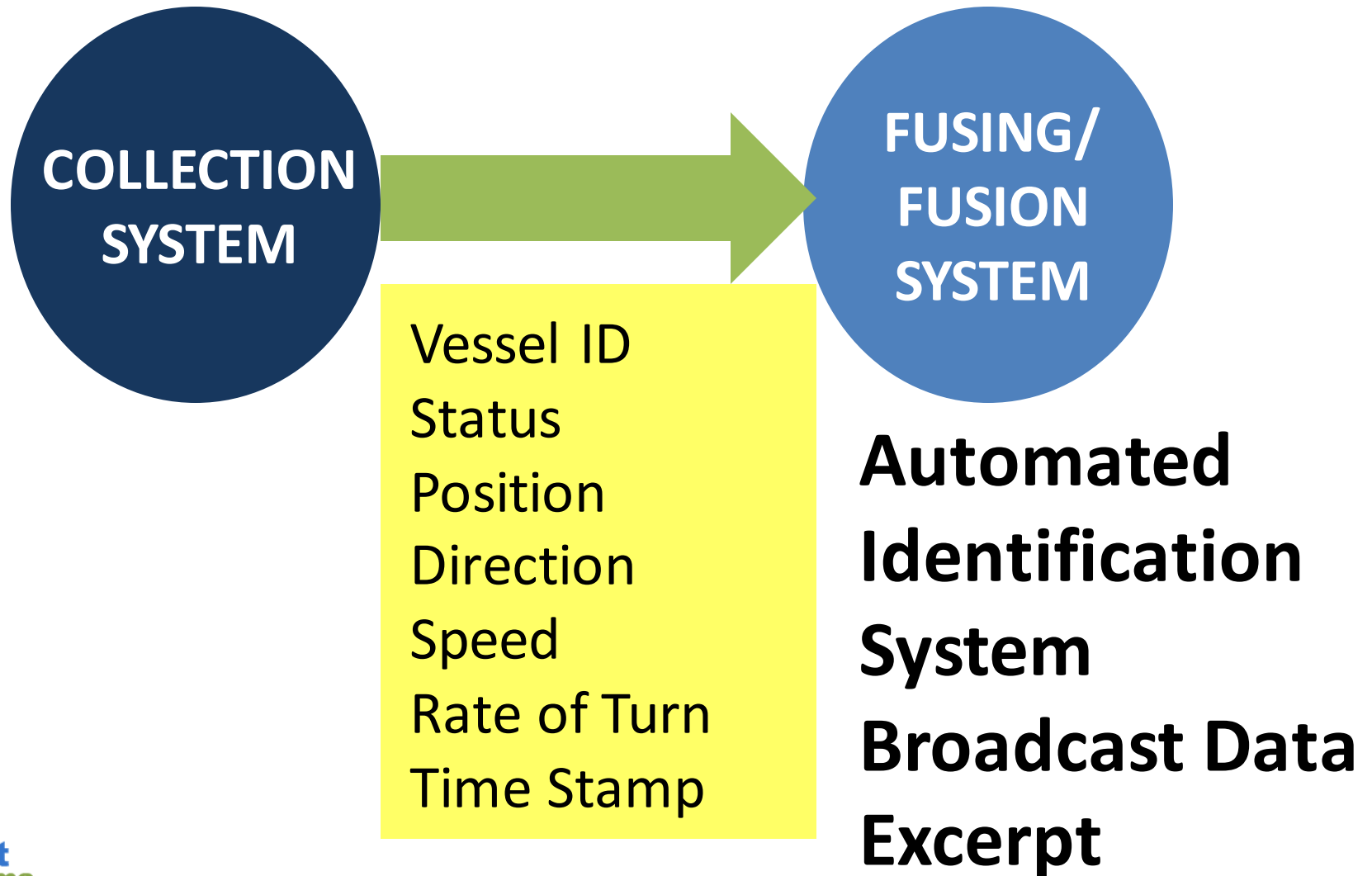


MCFADMA General Flow Waterflow Like?

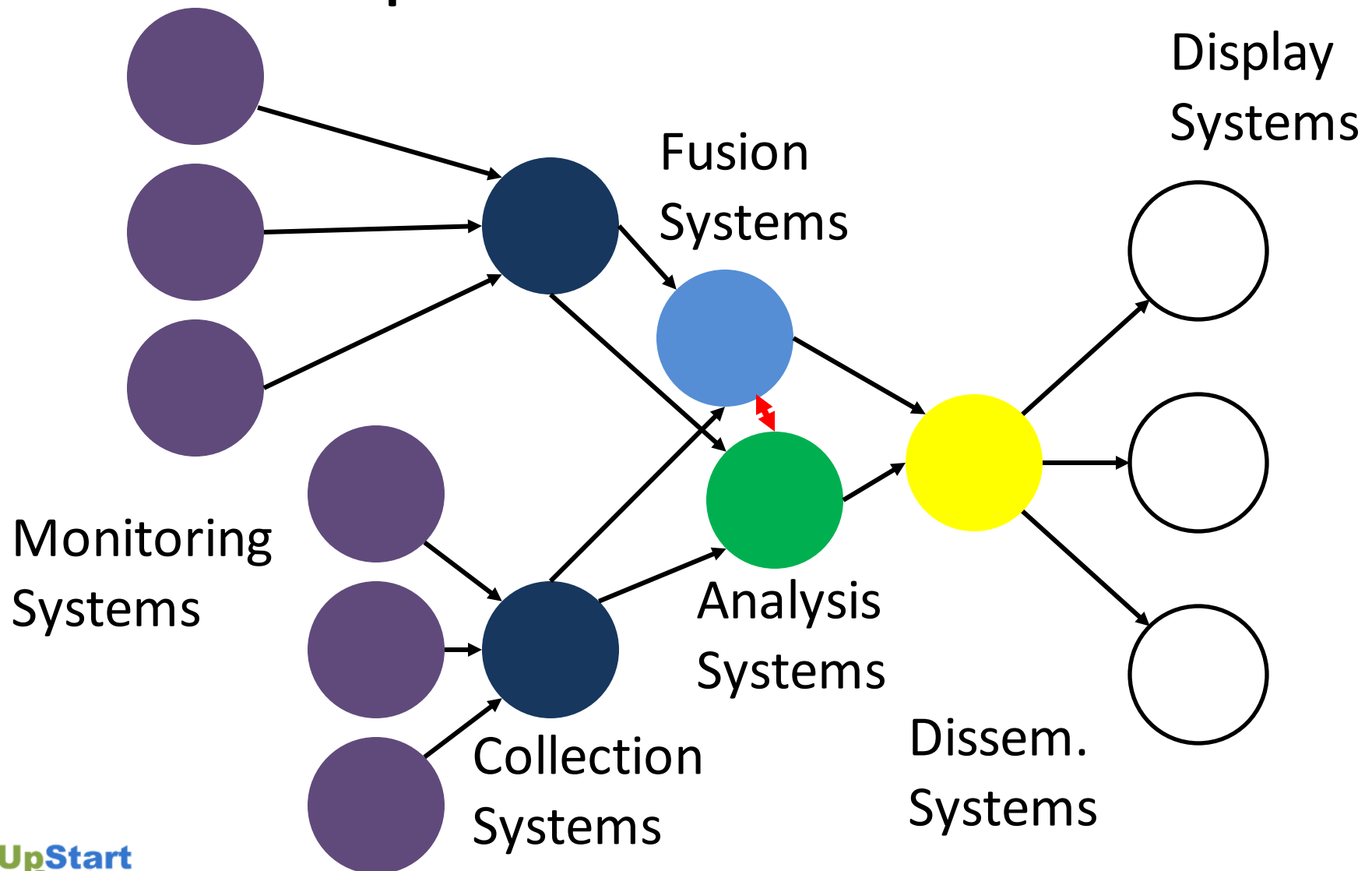


So, let's look at the ways
the data exchanges work

MDA Data Stream Example



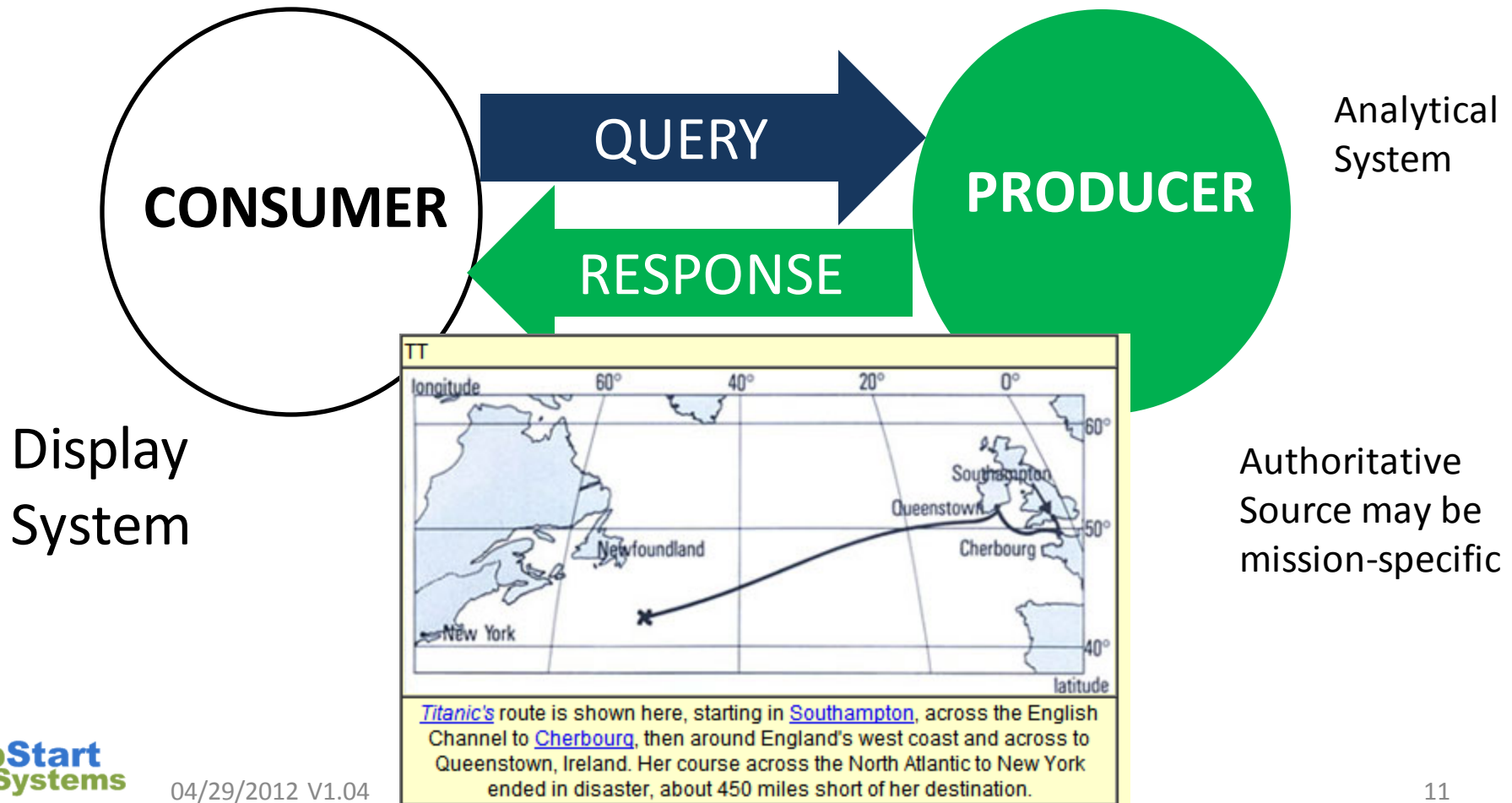
Expanded Data Stream



Query – Response

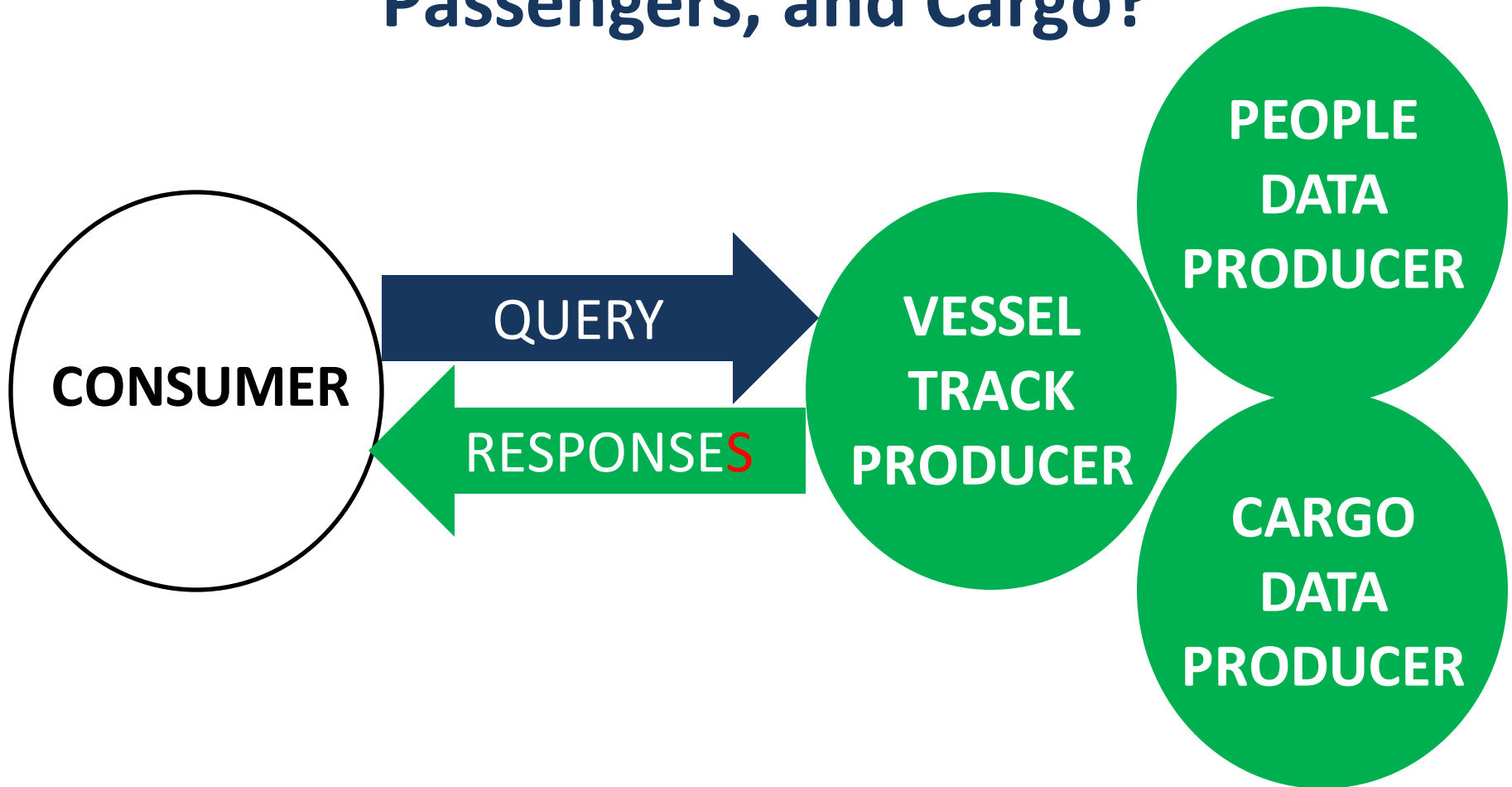
Consumer – Producer

What is the track of the Titanic?



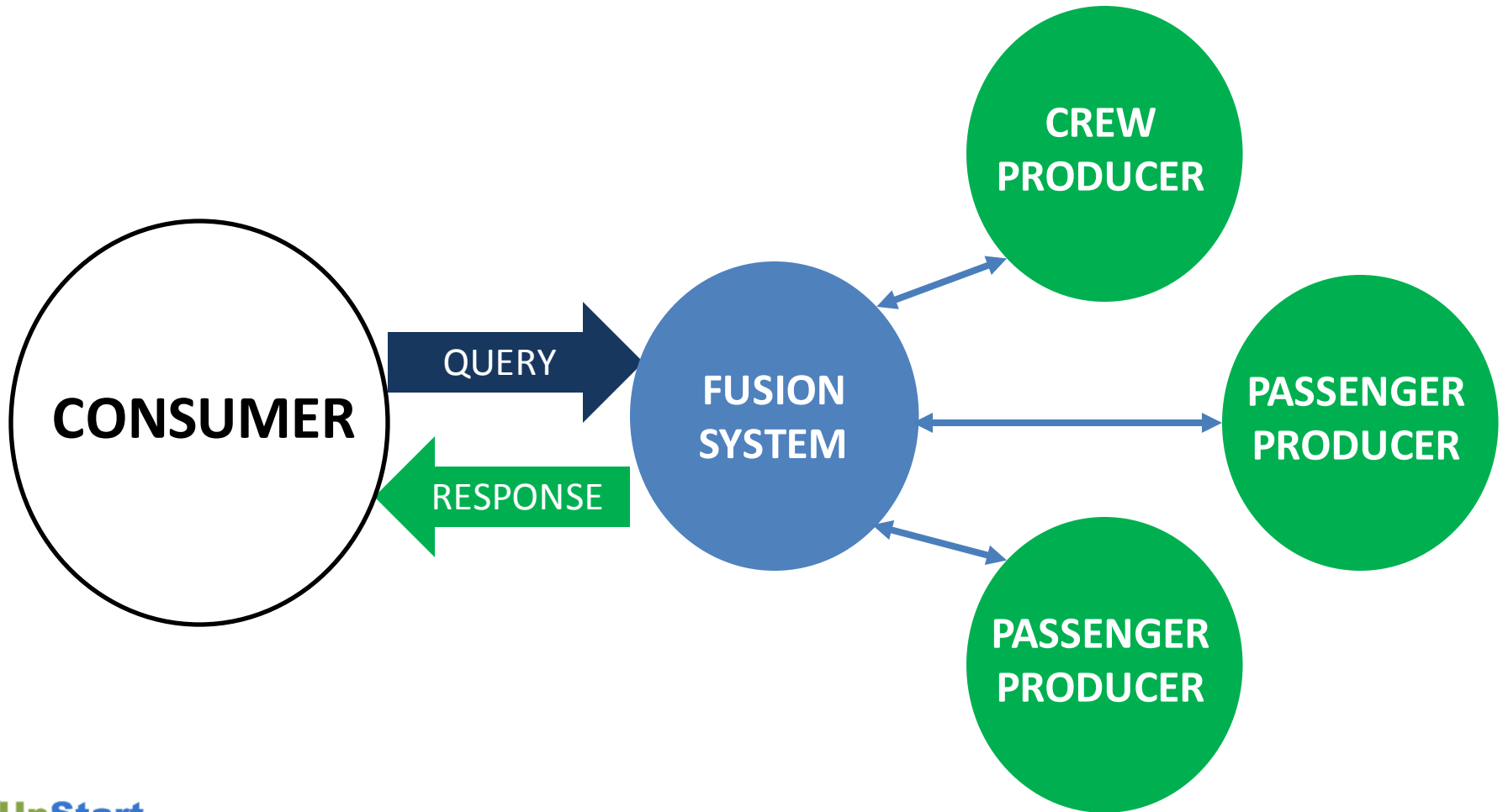
Complex Query for Multiple Sources

What are the Titanic's Track, Crew, Passengers, and Cargo?



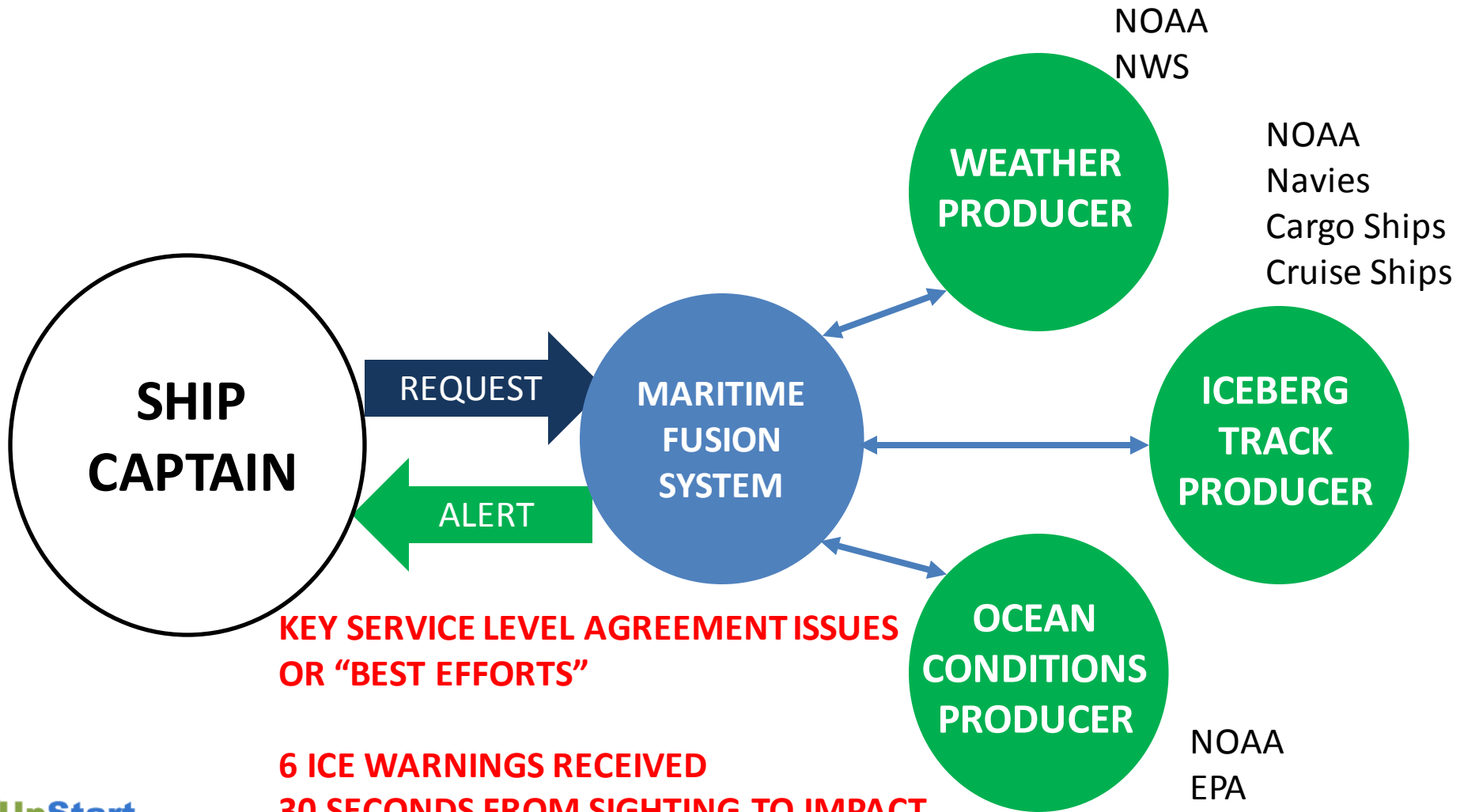
Introduce Fusing System

Who are the Titanic's crew and passengers?



Introduce Services

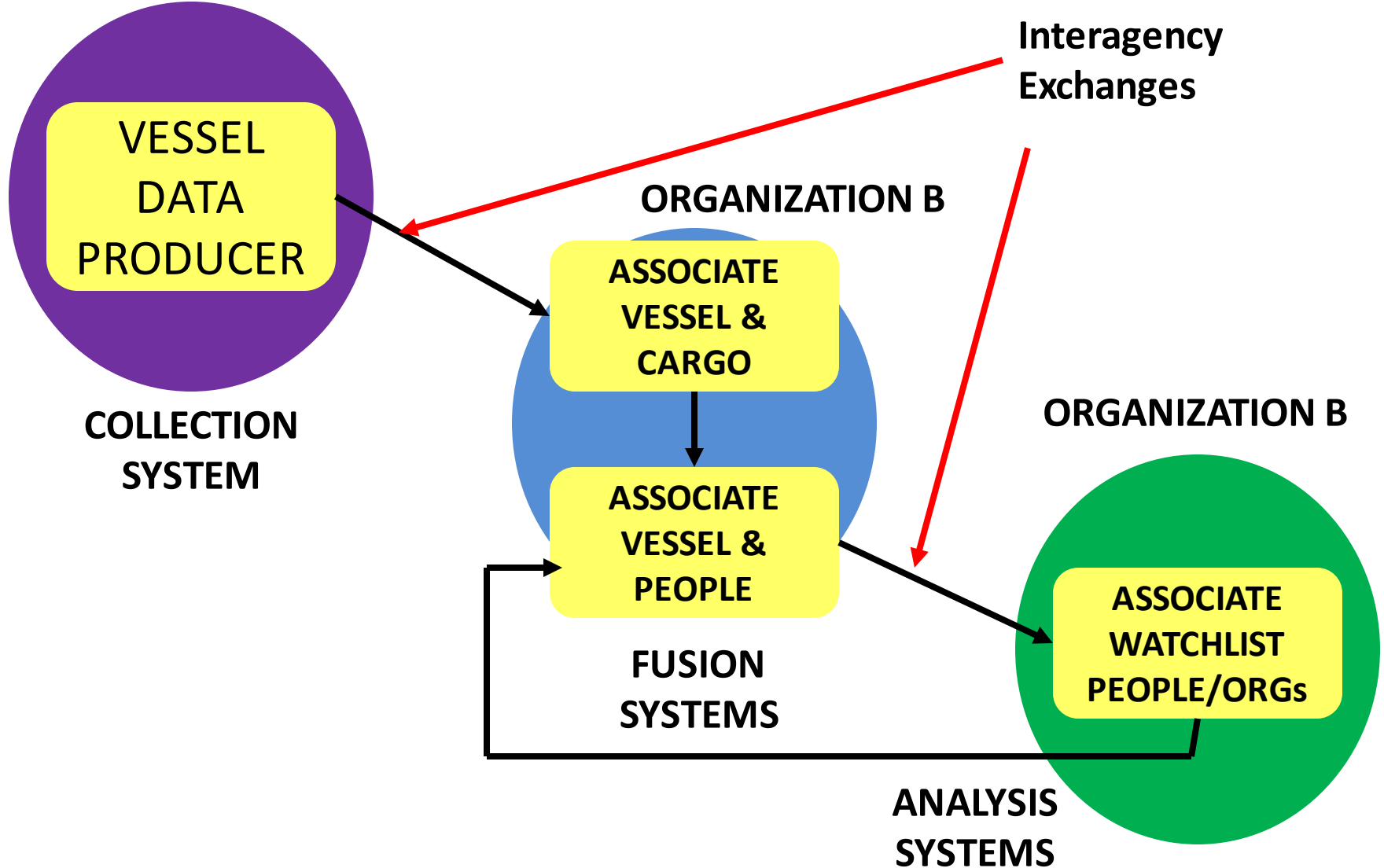
Let me know if Titanic is near an danger!



Iceberg View from Carpathia Rescue Cruise Ship



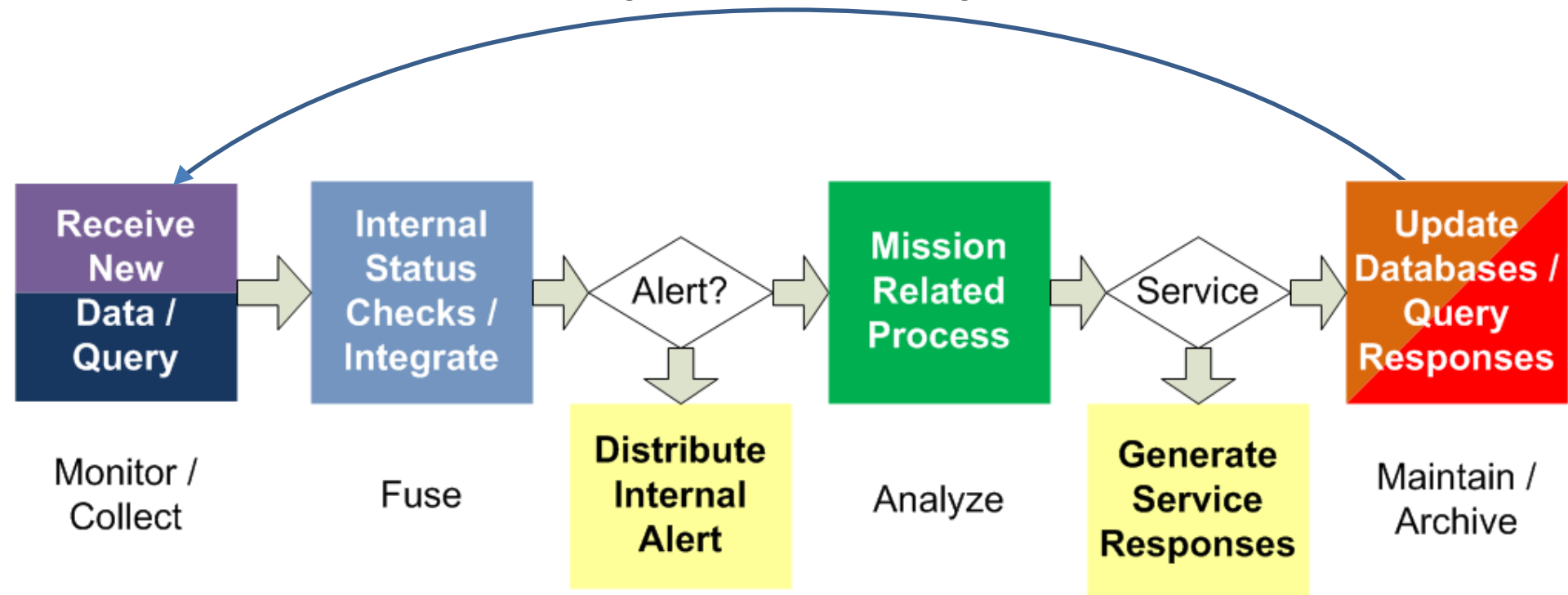
Simple Organizational Producers - Consumers



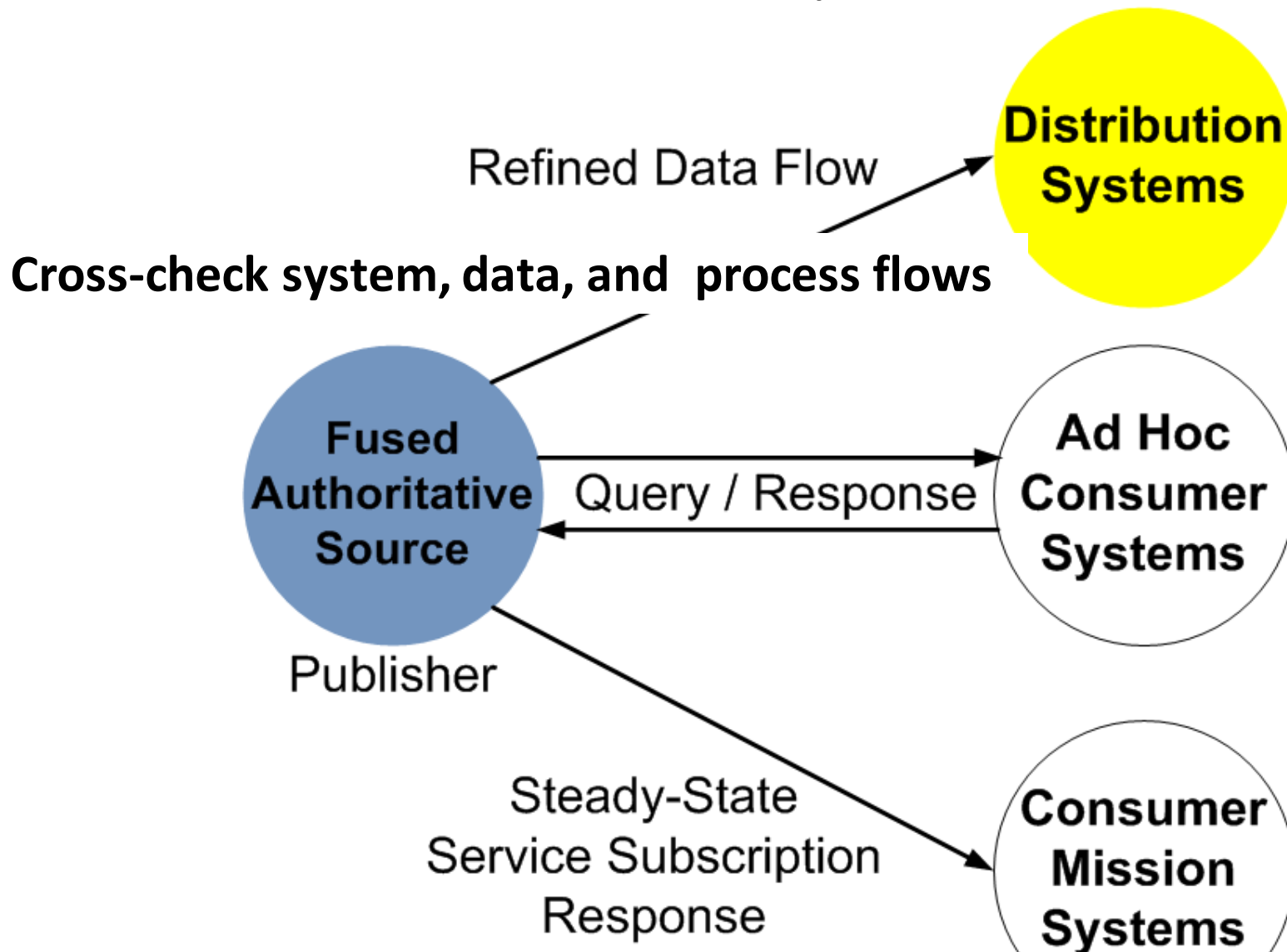
System Category Refactoring

Sensor	<ul style="list-style-type: none">• Raw data instruments, extend SoS boundary
Monitoring	<ul style="list-style-type: none">• Sample sensors and produce digital data
Collection / Source	<ul style="list-style-type: none">• Aggregate monitoring systems, uniform data type
Verified / Trusted Source	<ul style="list-style-type: none">• Cross-checked source, archive, data mart, data warehouse
Fusion	<ul style="list-style-type: none">• Aggregate different data types, consistency check
Discovery, Analysis, & Dissemination of Alerts	<ul style="list-style-type: none">• Identify interesting / important data, applying business rules (e.g., vessels of interest)
First Responder Notification	<ul style="list-style-type: none">• Consumer of messages, indications, warnings, and alerts for automatic or manual processing
Responder Action	<ul style="list-style-type: none">• Dispatching systems – mission oriented action initiation

Process Template – Systems Flow



Authoritative Publishers / Trusted Consumers



Each of these systems has multiple sources and also acts as a source for others

Next Steps and Q&A

- Additional Perspectives to Include:
 - Cybersecurity
 - Multiple Networks at Different Security Levels with automated guard filters
 - Multiple SOAs and Enterprise Service Buses (ESBs)
 - More formal architecture patterns
 - Identification of trusted authoritative sources and services
- Q&A

Backup Materials

Maritime Domain Awareness Context

- National Maritime Domain Awareness (MDA) Enterprise Architecture
 - April 2009 to March 2011
- Focus on Federal Agency information sharing
 - Vessels, Cargo, People, Infrastructure
- Authoritative Data Sources difficult to identify
- Independently evolving systems of systems
- Focused on System Views & Data Exchanges

“Derived and interpreted from”

[Lane's] System of Systems (S-o-S)

- Very large system using an architecture to integrate constituent systems
- Exhibits emergent behavior not otherwise achievable by its constituent systems
- Constituent Systems
 - Independently developed, managed, and operated
 - New and existing systems in various life-cycle stages
 - May include Commercial Off-the-Shelf products
 - Have their own, independent missions, purposes, uses, etc.
 - Can dynamically enter and leave a System of Systems
 - May not have effective Service Level Agreement guarantees for other constituent systems within the same System of Systems

Lane's System-of-Systems Object Models (Abstracted)

(based on Jo Ann Lane,
System of Systems Capability-to-Requirements Engineering, 2012)

- Each constituent system modeled as an object
- Constituent system functions are object attributes
- Interfaces of constituent system relationships
- Protocols describe interface objects
- Data objects describe data elements traversing interfaces and can be used to identify interoperability issues related to security, format, precision, resolution, etc.

[Sheard's] Specific S-o-S Issues

- Component systems built for other purposes
- Rapid evolution precludes stable requirements
- Stakeholders have conflicting needs and lack of incentives for collaboration in S-o-S
- Component systems have (geographically and temporally) distributed development, leading to communications problems
- High dependence on integrated computing infrastructure

[Sheard's] Complex Systems

- Complex systems have no central authority
- Large number of potential arrangements
- Components are heterogeneous
- System boundary may be hard to “pin down”
- Structure and behavior is not deducible, nor inferred, from the component systems

Logical, Tactical, Analytical Sequences

- MCFADMA – Monitor, Collect, Fuse, Analyze, Disseminate, Maintain, and Archive
- F2T2EA – Find, Fix, Track, Target, Engage, and Assess
- Locate, Identify, Track, and Engage
- Find, Fix, Finish, Follow-through
- Many more, with overlapping and conflicting terms and definitions

References

- [Author] citations indicate “interpreted and derived from” the cited document
- Lane, Jo Ann “System of Systems Capability-to-Requirements Engineering,” presentation, 2012
- Sheard, Sarah A. “Principles of Complex Systems for Systems Engineering,” Draft not published, 2006
- Weiland, Dr. Peter L. “Increasing ROWS Lethality with Optical Weapon Detection Systems,” presentation, May 2011