Paper based analysis to support TDLIO testing

Shaun Donnelly – ATEQ Consulting

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Introduction

Scope of the Presentation

- Need for IO Management in TDLs
- UK's Approach to IO Management
- Paper Based Testing – Key Components
  - IERs
  - Implementation Data
  - Known Limitations
- Use of Paper Based Testing Outputs

Briefer BIO

Shaun Donnelly

ATEQ Consulting

1985-1998 - RAF

- Software Engineer on the E-3D

1998 – Present

- TDL Consultant
- Specialist in TDL Testing
- Supported many national and international programs
  - Air, Surface and Land Systems
  - C2 and Non C2
- Provides IO and IO Matrix support to the TDL CaT ITS

TDL Misconceptions

Why do we need Interoperability Management?

If you implement using the STANAG, what can go wrong?

TDL = Just another radio!

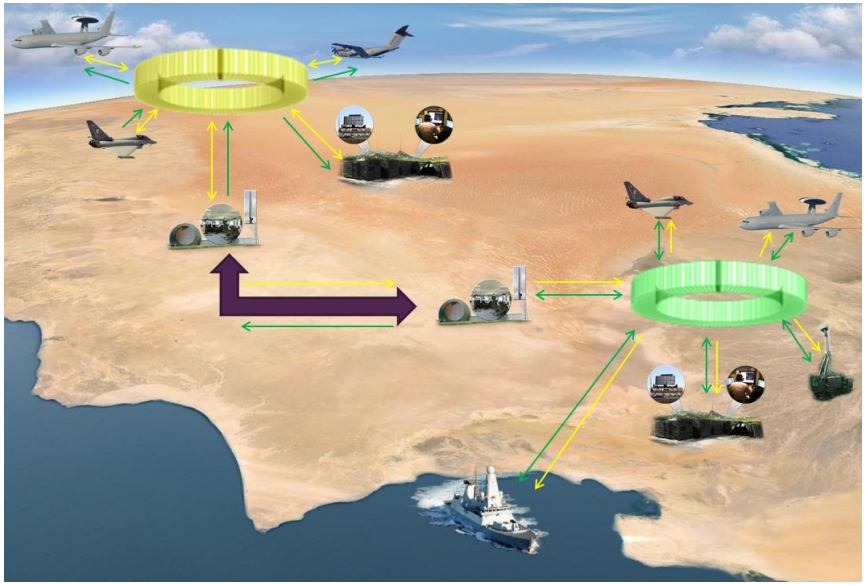
There is a Data Forwarder so we can be sure of seamless comms

He has MIDS, I have MIDS – we have Link 16

The Reality!

TDL solutions are often based on “high-level” operational requirements

- Integration of TDLs into platforms
  - is complex
  - is often led by industry
  - is often developed from a single platform perspective



TDL Standards

- Have been historically ambiguous
- Are living and (by committee action) evolving documents

Platforms are developed

- To different Standard baselines
- Using different
  - integration approaches
  - Interpretations of the standards

Illustrative Example

STANAG Draft Revise 3 **+DLCPs**
Early NRS
Circa 1995

STANAG Ed 3 **+DLCPs**
Supplier Imp Plan
Circa 2001

STANAG Ed 6 **+DLCPs**
iSMART PRS
Circa 2011

STANAG Ed 1 **+DLCPs**
Supplier Spec
Circa 1998

MIL-STD 6016C **+DLCPs**
iSMART PRS
Circa 2005

UK Approach to IO Management

Collect

Analyse

Inform

Operational Feedback

Ops/ Trg

Problems/Issues

National Issues DB

TDL CaT

DLCPs

National Stds CCB

TDL CaT ITS

IOAs

NATO IOAs

IOM Responses

NATO IOM

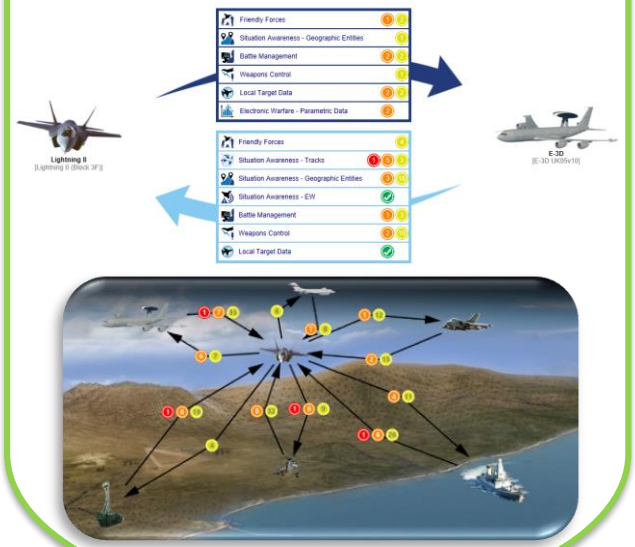
Platform Programmes

Implementation Data

iSMART Repository

IOE Reports

TDL Caps & Lims Repository



Operational Community

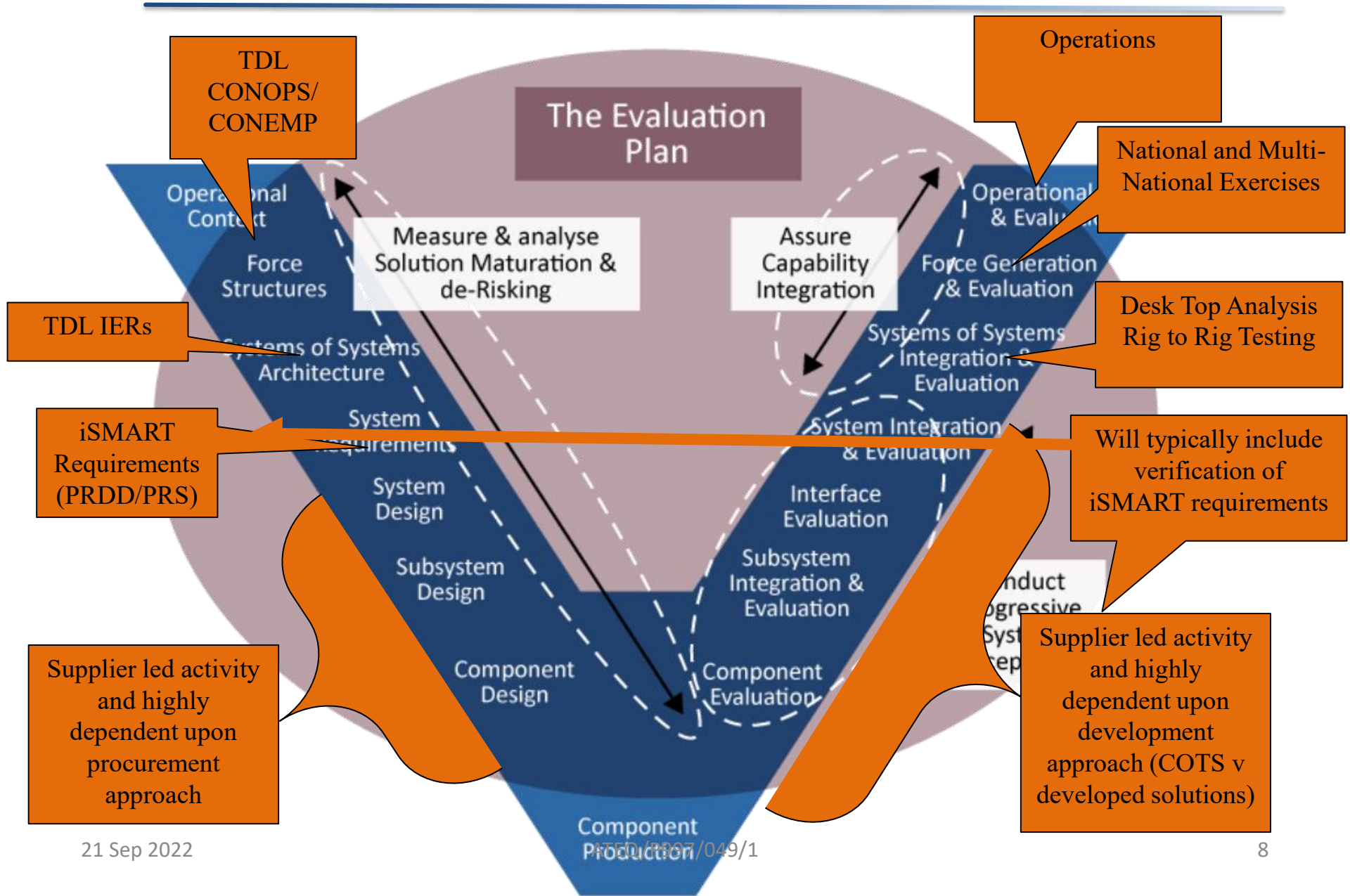
Key UK Principles

Knowledge in Defence – Best practice guidance for procurement

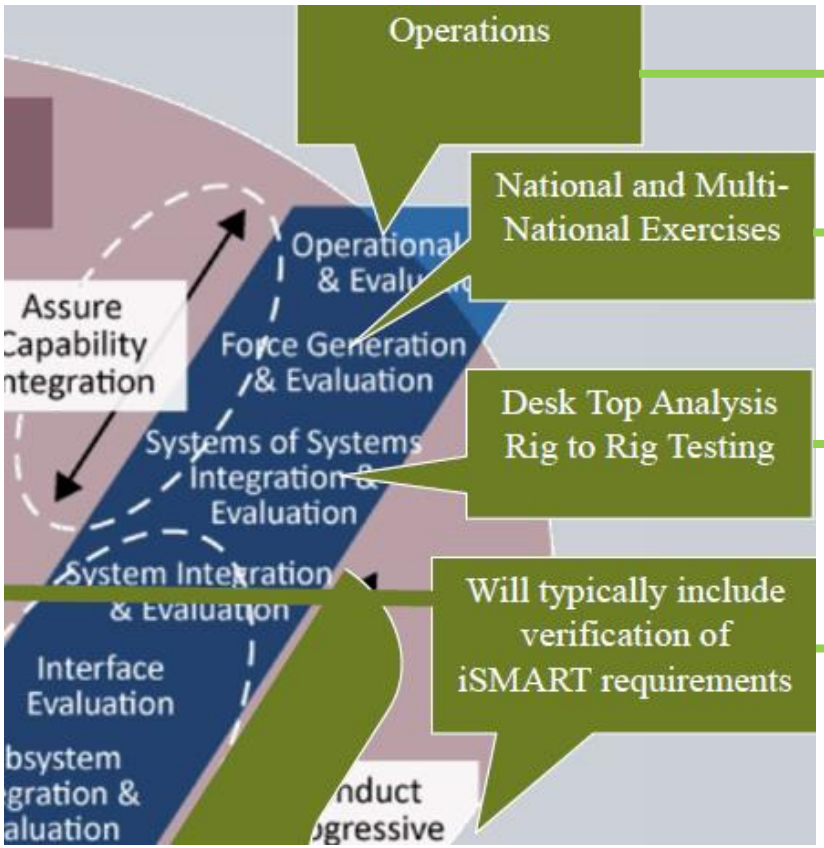
- Integrated Test, Evaluation and Acceptance
  - Use all phases of testing to gather evidence
  - Use all outputs from testing to inform operational use (Caps & Lims)

TDL Policy (Joint Service Publication 604, Leaflet 2002 (TDL))

- iSMART Process
- IO Testing Requirements
- Risk based approach


TDL CONOPS/ CONEMP
Operations
The Evaluation Plan
National and Multi-National Exercises
Measure & analyse Solution Maturation & de-Risking
Assure Capability Integration
Force Structures
Force Generation & Evaluation
TDL IERs
Systems of Systems Architecture
Systems of Systems Integration & Evaluation
Desk Top Analysis Rig to Rig Testing
iSMART Requirements (PRDD/PRS)
System Design
System Integration & Evaluation
Will typically include verification of iSMART requirements
Interface Evaluation
Subsystem Design
Subsystem Integration & Evaluation
Supplier led activity and highly dependent upon procurement approach
Component Design
Component Evaluation
Supplier led activity and highly dependent upon development approach (COTS v developed solutions)
Component Production

TDL Capabilities &Limitations



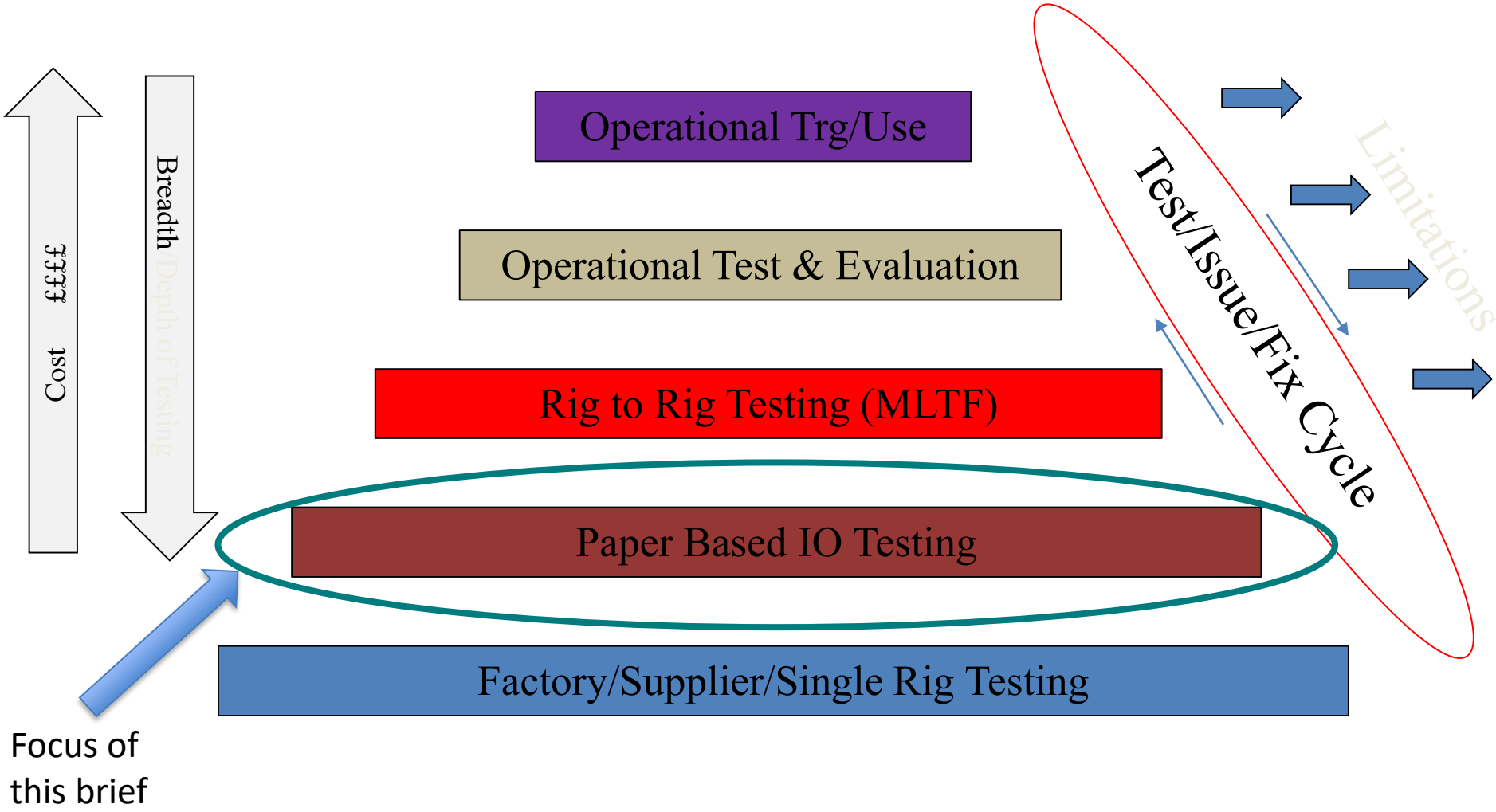
Inform

IOE Reports

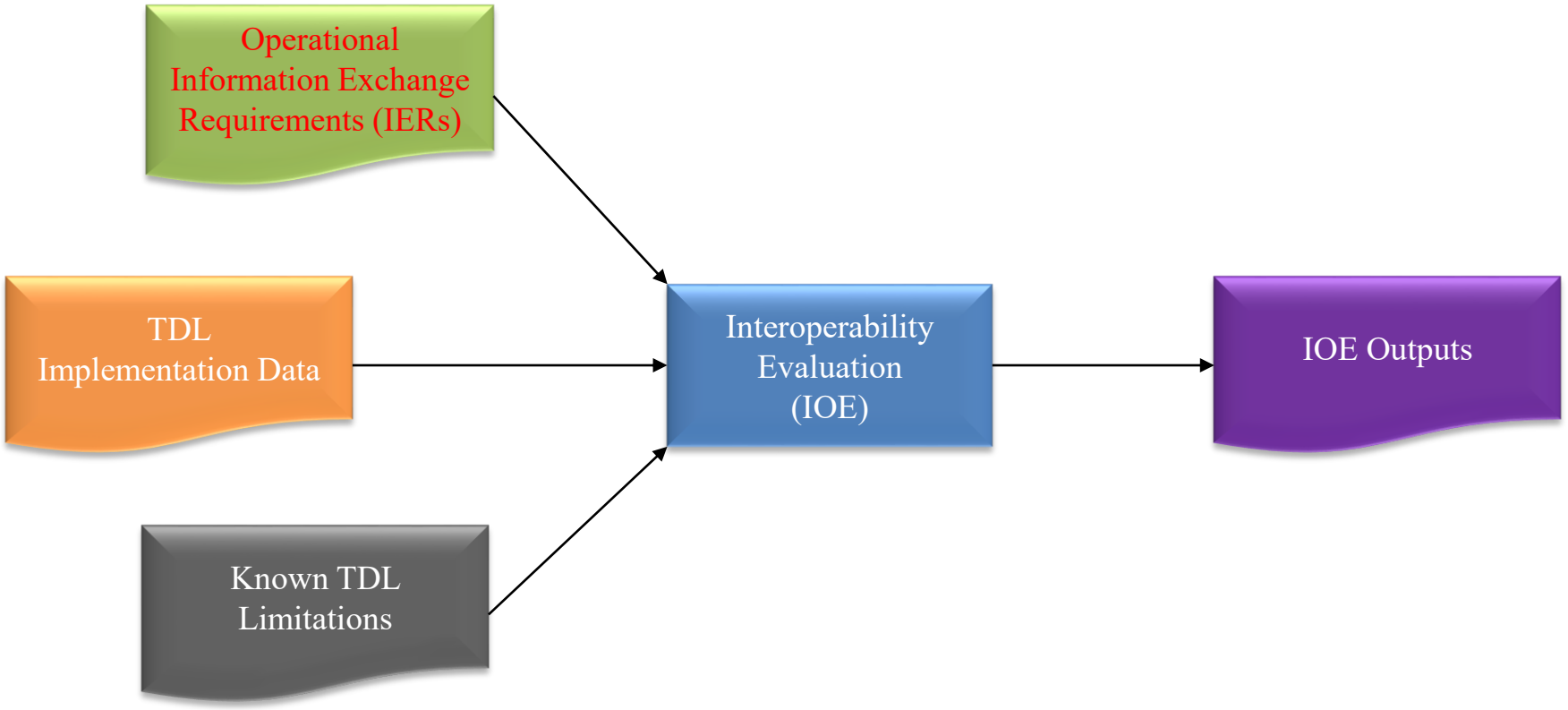
TDL Caps & Lims Repository

Operational Community

TDL Test Phases



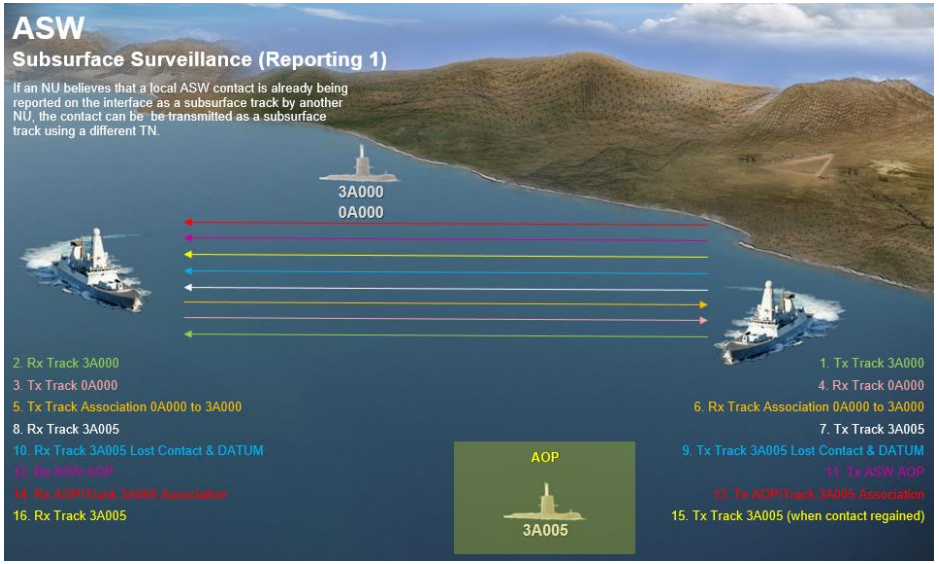
Key Components



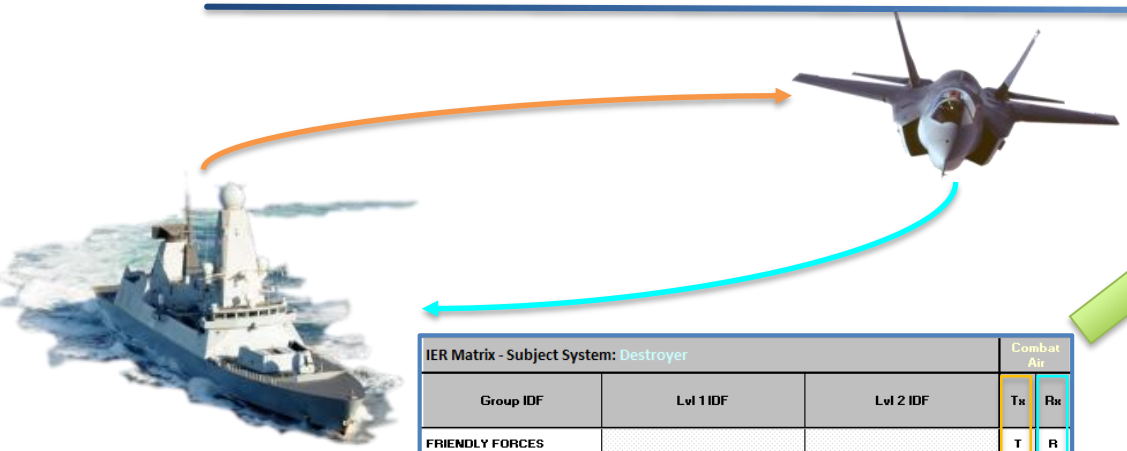
Define IERs – Operational Context

Many TDL programmes lack operational context and requirements

- Scenario/mission/role based Use Cases assist in IER Capture
- IERs need to be operationally focussed
  - TDL message agnostic
  - But mapped to TDL message structures to aid effective and efficient interoperability evaluation



IERs – Scope for IOE



IER Matrix - Subject System: Destroyer			Combat Air	
Group IDF	Lvl 1 IDF	Lvl 2 IDF	Tx	Rx
FRIENDLY FORCES			T	R
SITUATION AWARENESS - TRACKS			T	-
	Threat Warning		T	-
		Threatened Object	T	-
		Threatening Object	T	-
		Threat Type	T	-
		Additional Supporting Data	T	-
	Air Track		T	-
	Air Track - Pseudo Local		-	-
	Surface Track		-	-
	Surface Track - Pseudo Local		-	-
	Land Track		T	-
	Space Track - Basic SA		-	-
	Subsurface Track		-	-
	Track Picture Management		-	-
SITUATION AWARENESS - GEOGRAPHIC ENTITIES			T	R
SITUATION AWARENESS - EW			-	-
BATTLE MANAGEMENT			-	-
WEAPONS CONTROL			-	-
LOCAL TARGET DATA			-	-
ELECTRONIC WARFARE - PARAMETRIC DATA			-	-
BALLISTIC MISSILE DEFENCE			-	-
ANTI SUBMARINE WARFARE			-	-
IMAGERY			-	-

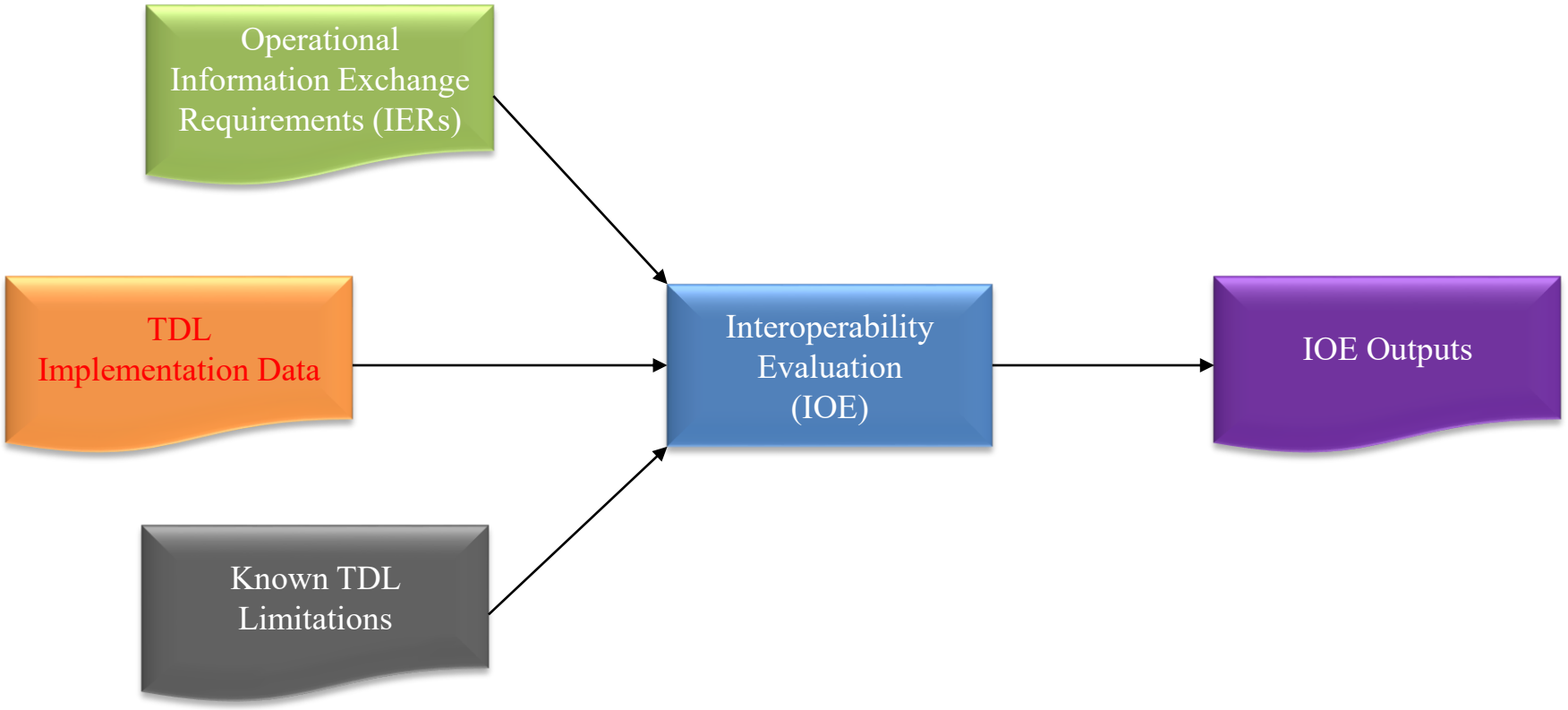
Table 2-1 – IERs – Air Surveillance System and Combat Air

Functional Area	IERs
Friendly Forces	Location and Identification data Basic Status information Text Messages
Situation Awareness – Track Data	Air Tracks (Air Surveillance System to Combat Air) Land Tracks (Air Surveillance System to Combat Air) Threat Warnings (Air Surveillance System to Combat Air)
Situation Awareness – Geographic Entities	Geographic Reference Points, Lines and Areas (Air Surveillance System to Combat Air) Land Objects (Points) (Air Surveillance System to Combat Air) Emergency Points (Air Surveillance System to Combat Air) Data Update Request for Reference Point data (Combat Air to Air Surveillance System)

Table 2-2 – Information Exchanges Discounted from IOE – Air Surveillance System and Combat Air

Functional Area	Discounted IERs
Situation Awareness – Track Data	Surface Tracks Space Tracks Subsurface Tracks Data Update Requests (Air Surveillance System to Combat Air) Force ID Change instructions (Air Surveillance System to Combat Air)
Situation Awareness – Geographic Entities	Data Update Request for Reference Point data (Air Surveillance System to Combat Air) Emergency Points Pointers
Battle Management	No requirement to exchange
Weapons Control	No requirement to exchange
Local Target Data	No requirement to exchange
Situation Awareness - EW	No requirement to exchange
EW – Parametric Data	No requirement to exchange
Ballistic Missile Defence	No requirement to exchange
Anti-Submarine Warfare	No requirement to exchange
Imagery	No requirement to exchange

Key Components



TDL Implementation Data

Often “Project Owned”

- Key issue for central TDL “authority”

Available in several forms

- Full iSMART Products
- Supplier specific documents
- Implementation Plan
  - Excel
  - Tool set “specific”
  - PDF
- IOM Data
- HMI Specifications/Operator Handbooks
  - Data may be passed over the TDL but is it displayed to the operator
    - In a clear and logical manner

Implementation Data

D.1.2 C² TRACK TRANSMISSION

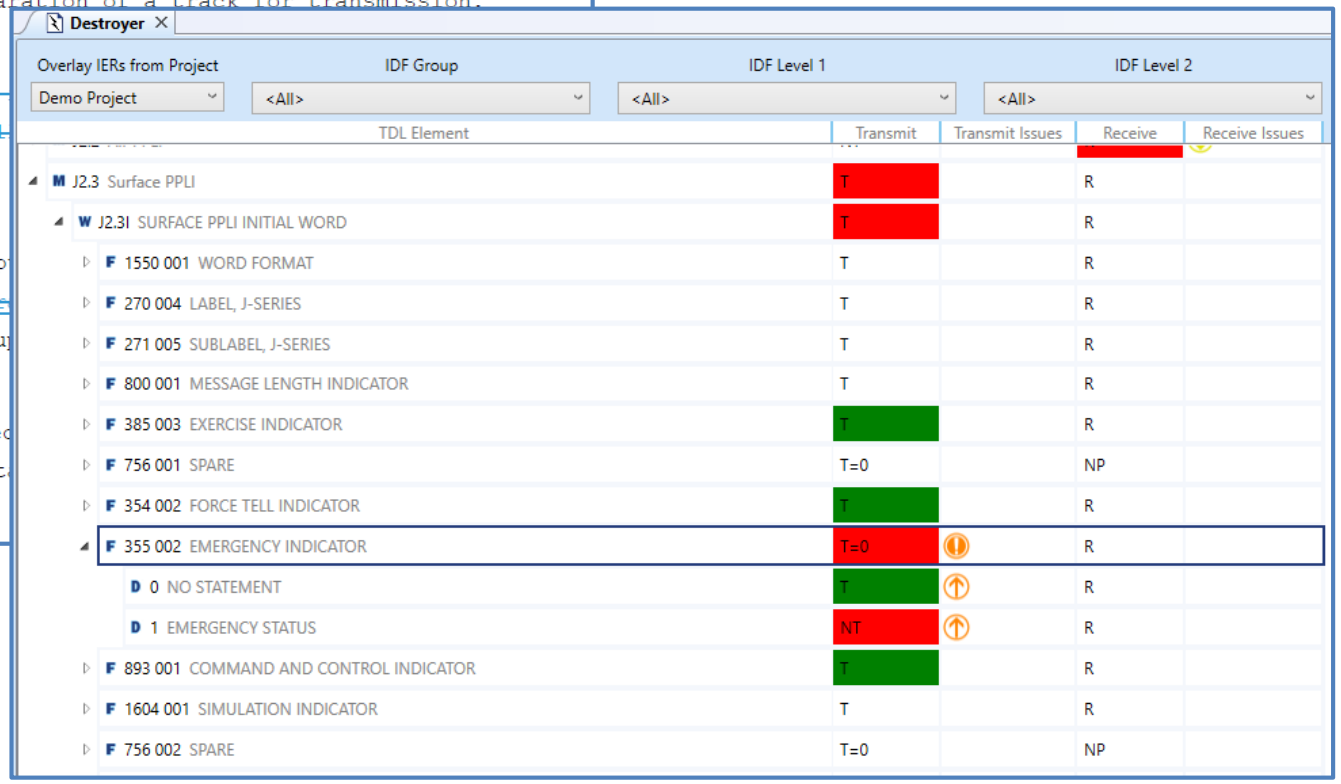
D.1.2.1 C² Track Transmission Stimulus

D.1.2.1.1 Transaction D.1.1, C² Preparation for Track Transmission (Paragraph D.1.1.3.6.1), upon preparation of a track for transmission.

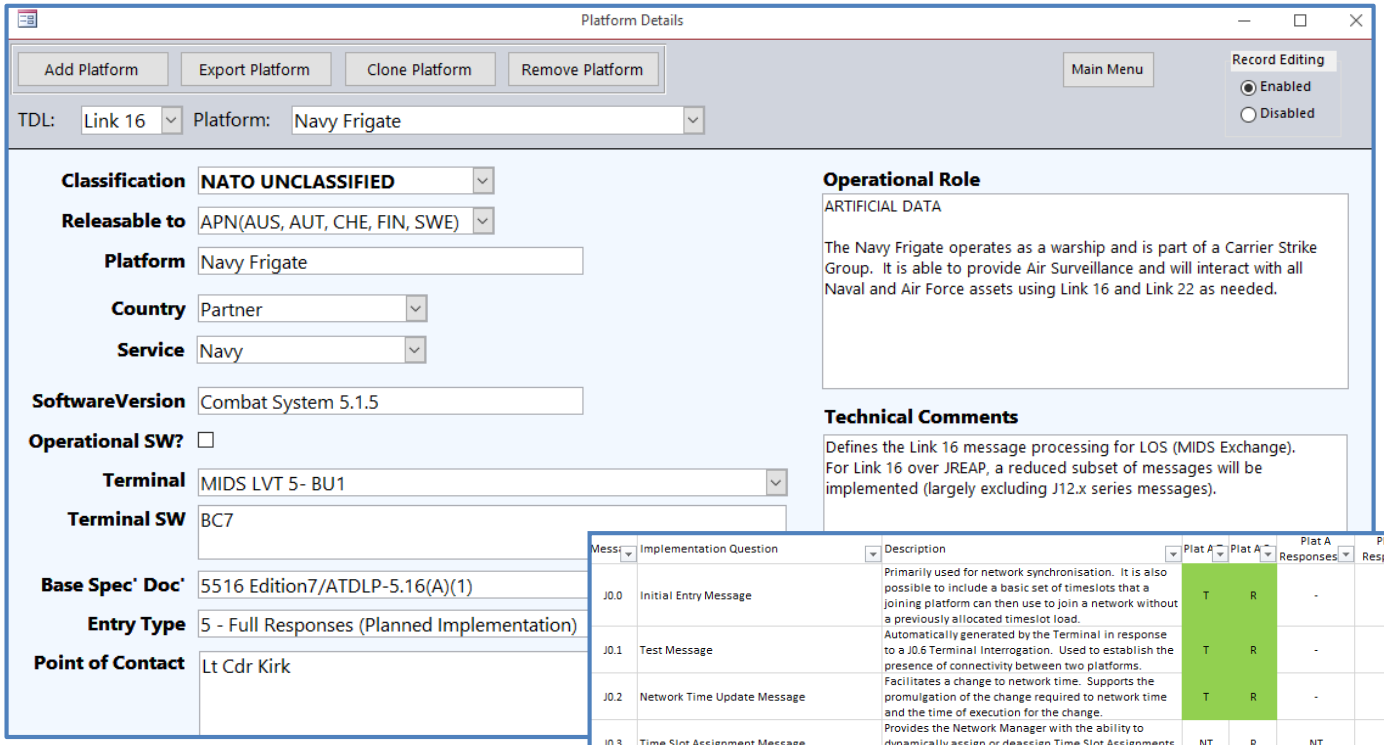
D.1.2.1.2 ~~Periodically as defined Paragraph D.1.2.3.3.12.e, for a Bal repeated transmission.~~ Not Used

D.1.2.1.3 Transaction E.1.3, Recep Number (Paragraph E.1.3.3.1, ~~Paragr E.1.3.3.14~~), on receipt of a data u

D.1.2.1.4 Transaction P.3.3, C² Rec P.3.3.3.5.a), upon automatic accept for which R² is held.



IOM Data



Mess	Implementation Question	Description	Plat A	Plat A	Plat A Responses	Plat A Response	Plat B	Plat B	Plat A Response	Plat A Responses	Plat A Comme	Plat B Comme
J0.0	Initial Entry Message	Primarily used for network synchronisation. It is also possible to include a basic set of timeslots that a joining platform can then use to join a network without a previously allocated timeslot load.	T	R	-	-	T	R	-	-	No Comment	No Comment
J0.1	Test Message	Automatically generated by the Terminal in response to a J0.6 Terminal Interrogation. Used to establish the presence of connectivity between two platforms.	T	R	-	-	T	R	-	-	No Comment	No Comment
J0.2	Network Time Update Message	Facilitates a change to network time. Supports the promulgation of the change required to network time and the time of execution for the change.	T	R	-	-	T	R	-	-	No Comment	No Comment
J0.3	Time Slot Assignment Message	Provides the Network Manager with the ability to dynamically assign or deassign Time Slot Assignments being used within the Network.	NT	R	NT	NP	NT	R	NT	NP	No Comment	No Comment
J0.4	Radio Relay Control Message	Provides the Network Manager with the ability to dynamically assign or deassign Relay Functions being used within the Network in order to ensure effective data propagation within the network.	NT	R	NT	NP	NT	R	NT	NP	No Comment	No Comment
J0.5	Repromulgation Relay Message	Used to identify particular messages within a specific timeslot that are to be relayed as part of the repromulgation relay function. A unit can either originate repromulgation relay or simply repromulgate messages that were originated by others.	NT	R	-	-	T	R	-	-	No Comment	No Comment
J0.6	Communications Control Message	See Below	NT	R	NT	NP	T	R	NT	NP	No Comment	No Comment
J0.6	Action, Communication Control = 0 (Terminal Interrogation)	Request that a remote unit responds with either a J0.1 (Test Message) or J2.x (PPLI Message). Used to establish connectivity.	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	No Comment	No Comment
J0.6	Action, Communication Control = 3 (Control Request)	Request from a unit to the Network Manager to request more/less Timeslots be assigned on a specified NPG. Used by systems that can automatically detect over or under utilisation of timeslots.	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	No Comment	No Comment
J0.6	Action, Communication Control = 3 (Control Request)	Allows the appropriate authorised unit to effect a change of CVLL within a remote unit.	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	No Comment	No Comment
J0.7	Time Slot Reallocation Message	Provides the capability for a JU to request a percentage of time slots from a shared Time Slot Reallocation (TSR) pool and disseminate the requests of other JUs.	T	R	-	-	NT	NP	-	-	No Comment	No Comment

HMI Specs/Operator Handbook

An often overlooked valuable source of information, especially valuable if working with just a message implementation

- Describes how the operator interacts with the TDL
  - Can reveal aspects of the implementation not expressed in the message implementation

HMI Specs/Operator Handbook

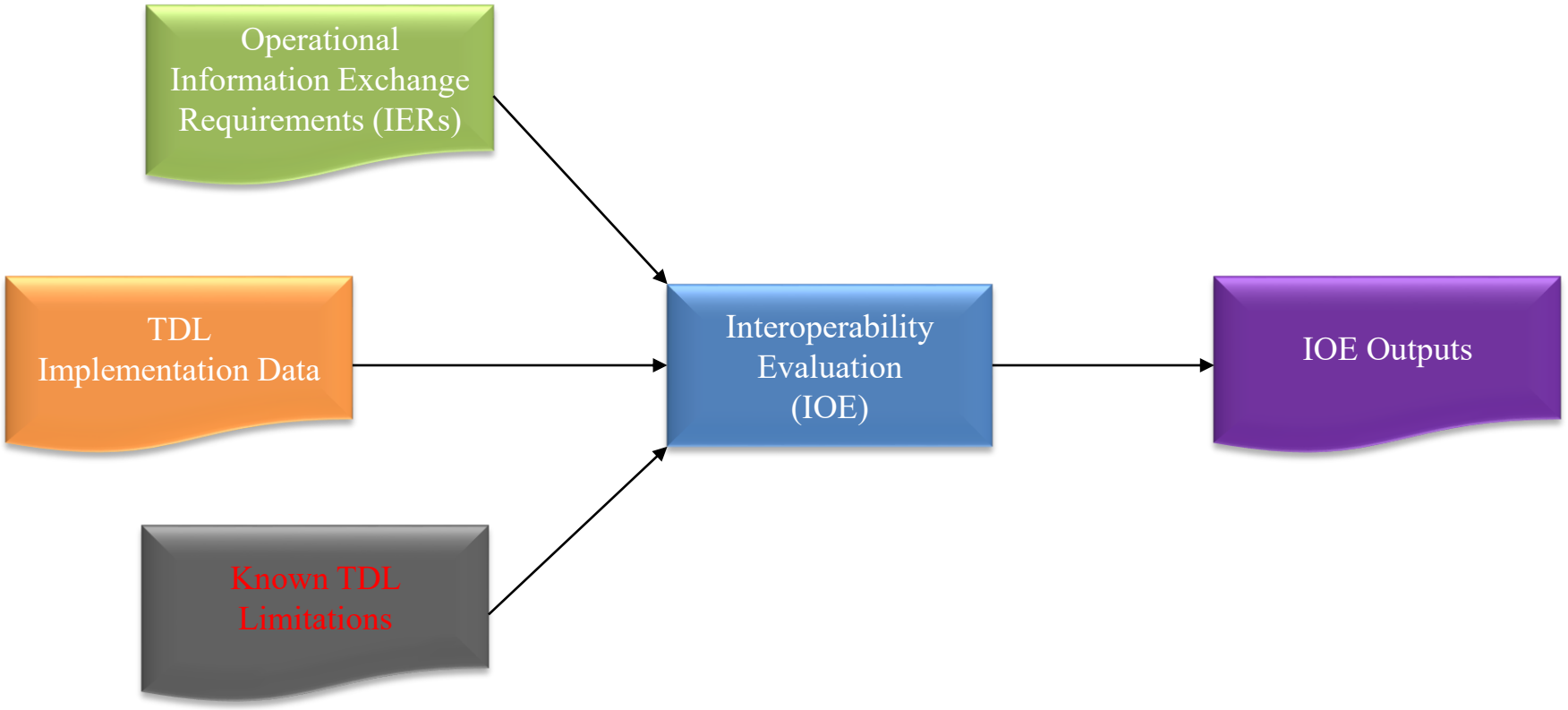
L16 Geographical Pointers are used to highlight a geographic area to Flight Members.

Pointers are created on the Point page using existing Mark Points and the **Pointer** (R5) button.

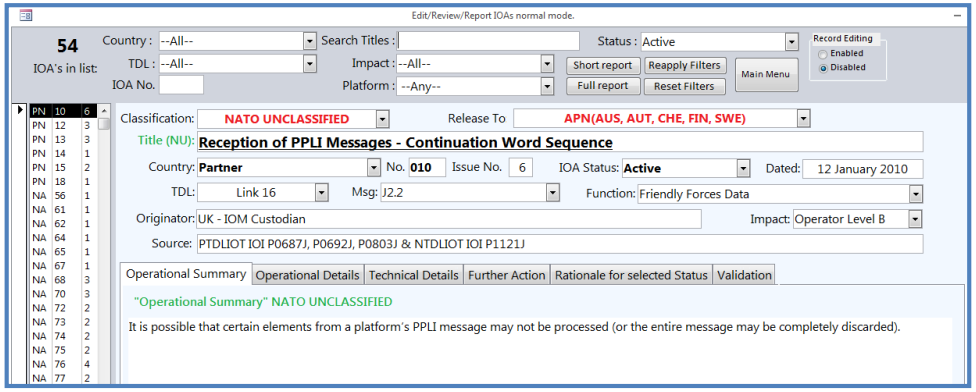
- The POINTER button is only displayed when a Mark Point is selected for review. When selected, the following occurs:
  - A Pointer is created at the Mark Point's location.
  - The Pointer is transmitted to all flight members.
  - Selects the newly created point as the point being reviewed.

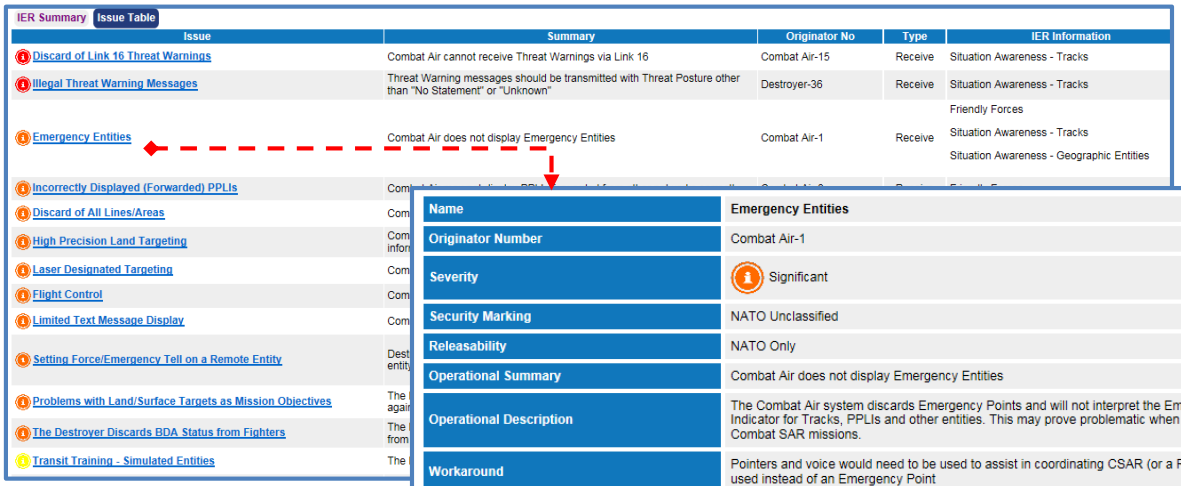
Note: If there are no Flight members in the database the POINTER button isbarriered.

Key Components



Known TDL Limitations



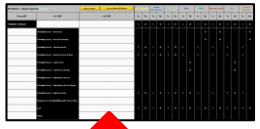


Name	**Emergency Entities**
Originator Number	Combat Air-1
Severity	Significant
Security Marking	NATO Unclassified
Releasability	NATO Only
Operational Summary	Combat Air does not display Emergency Entities
Operational Description	The Combat Air system discards Emergency Points and will not interpret the Emergency Indicator for Tracks, PPLIs and other entities. This may prove problematic when undertaking Combat SAR missions.
Workaround	Pointers and voice would need to be used to assist in coordinating CSAR (or a Reference Point used instead of an Emergency Point
Technical Description	J3.1 Emergency Point message is discarded on reception. The Emergency Indicator in all other J-Series messages is not interpreted.
Further Action	Future upgrade
IOA Number	
IOI Numbers	
National Issue Numbers	
Issue Status	InvestigationComplete
Issue Applies To	[Op Flt Prog 12.0] J2.3 Surface PPLI J2.3I SURFACE PPLI INITIAL WORD 355 002 EMERGENCY INDICATOR

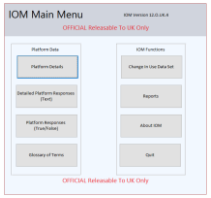
Performing the IOE

HMI Specs

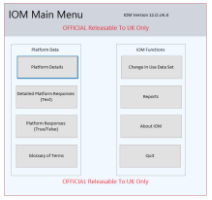
HMI Specs


IERs

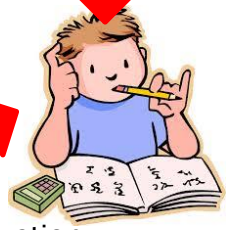
Known IOAs



IOM entry



IOM entry

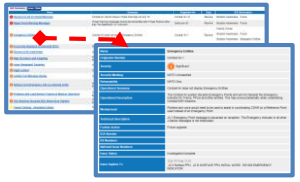

Evaluation

IO Issues

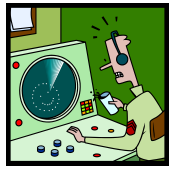
Test Reports

Change Candidates

Change Candidates


Known Caps and Lims

IO Test Candidates



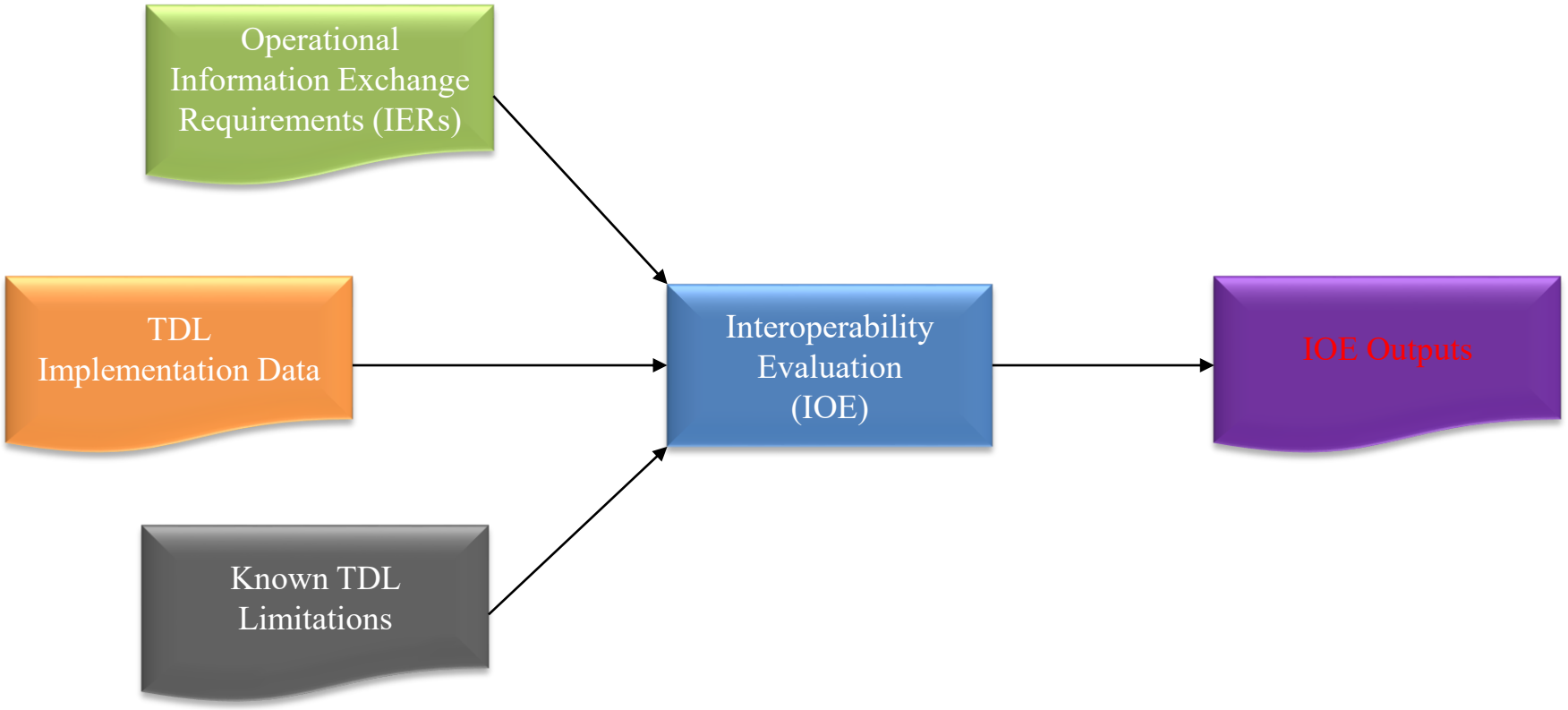
Improves operations

IOE Challenges

Lack of detailed platform information

- Increasingly, platforms are only providing Message Implementation Plans (MIPs)
- A lot can be determined from MIPs, but the nuances in the implementation are not obvious
  - Message NPGs
  - Features such as flight member processing not obvious
    - Have make assumptions based upon the declared underlying Link 16 message standard, e.g. ATDLP-5.16 or MIL STD 6016
- Documentation releasability
  - Platform and National authorities restricting the release of platform TDL documentation
- Quality of Documentation available directly relates to the accuracy of the IOE
  - More assumptions have to made Vs definitive statements

Key Components – IO Management



IOE Outputs - Key Issues

IOEs reports historically developed from a technical standpoint

- Overly focussed on technically derived issues
  - Little or no operational significance
    - Impacts not well identified
- As a consequence, front line were not benefiting
- IOE Reports:
  - "Bulky"
  - Static
  - Required SME knowledge to interpret
- A more operationally focussed output was needed
  - And more dynamic

IOE Outputs

Key Components of IOE Output

- Detailed Analysis
- Operational View
  - Representation of IERs
  - Capabilities & Limitations
- Identification of priority candidates for physical testing
  - Lack of information at the IOE stage on certain capabilities
  - IO issues raised by the IOE can be validated and assessed
  - Allows precious testing time to be used more efficiently
    - Focus on areas of operational importance
    - More testing on areas that have problems Vs areas that appear sound
    - Don’t test areas that will not work

Outputs – MOD Sharepoint

UK TDL Capabilities & Limitations Repository

Platform Focussed Caps & Lims

A400M - Summary A400M IOEs	Apache Summary Apache IOEs	Crowsnest Summary IOEs (FOC) IOEs (SRP11.1 - CSG21)	E-3D Summary E-3D IOEs	F-15 Summary F-15 IOEs
F/A-18 Summary F/A-18 C/D IOEs	LEAPP Summary LEAPP IOEs	Lightning Summary Lightning IOEs	Network Management Issues	Poseidon P-8A Summary P-8A IOEs
QNLZ Summary QNLZ IOEs	Sky Sabre Summary Sky Sabre IOEs	Type 45 Summary IOEs (MML) IOEs (Pre MML)	Typhoon Summary P3Ea IOEs Tranche 1 IOEs	UCCS Summary UK CSI Summary UCCS/CSI IOEs

Outputs – MOD Sharepoint

Strategic Command
Defence Digital

ISS Home | ISS Strategy | UK Link (LTD) | EDIT LINKS

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- Home
- UK TDL Caps & Lims Repository
- UK IOM Database
- IOE Reports
- UK Platform - TDL Data Summary
  - Link 16
  - JREAP-C/Link 11/22/VMF
  - ISR Data Links
  - Stakeholder Information
- Documents
- Site contents
- Recent
- Recycle Bin
- EDIT LINKS

A400M - OFFICIAL

A400M

Operational Description	The A400M, which is a collaborative venture involving the governments and industries of six European countries, will support the deployment of the Joint Rapid Reaction Force and will give the RAF a tactical and strategic-airlift aircraft capable of supporting all three services.
Platform Configuration Notes	
Platform I&D	01/04/2017
Platform O&D	01/04/2050

TDL Employment

	Link 16	Link 22	JREAP	Link 11A	Link 11B	VMF(Messages)	VMF(Header)	VMF(Bearer)	IDL	Link 1
Employed?	Yes	No	No	No	No	No	No	No	No	No
Baseline Standard	5516 Edition 3	-	-	-	-	-	-	-		
Notes										

TDL Forwarding

	Link 11 - 16	Link 11 - 22	Link 16 - 22	Link 16 MIDS - JREAP
Data Forwarder	No	No	No	No
Conourrent Interface Unit	No	No	No	No
Baseline Standard	-	-	-	-
Notes				

TDL Baseline Details

> [Link16] IDS Issue 3

TerminalType	MIDS LVT 1- BU1
Terminal Notes	

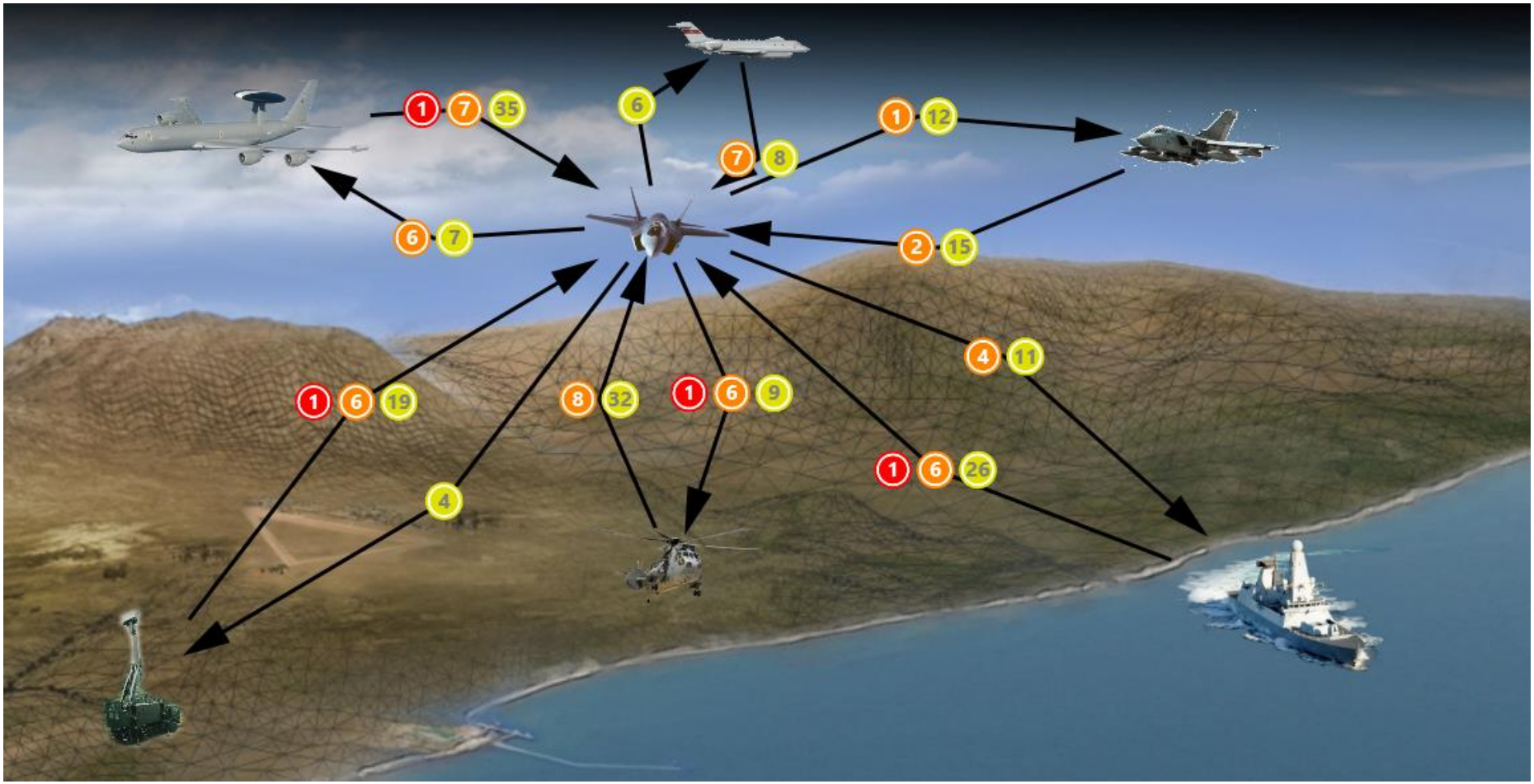
Network Participant Groups (NPGs)

NPG No	1	2	3	4	5	6	7	8	9	10	11	12	13	18
NPG Name	Initial Entry	RTT - A	RTT - B	Network Management	PPLI and Status Group A	PPLI and Status Group B	Surveillance	Mission Management / Weapons Coordination and Management	Control	Electronic Warfare	Image Transfer	Voice Group A	Voice Group B	Network El Weapons(
Transmit	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	No
Receive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No

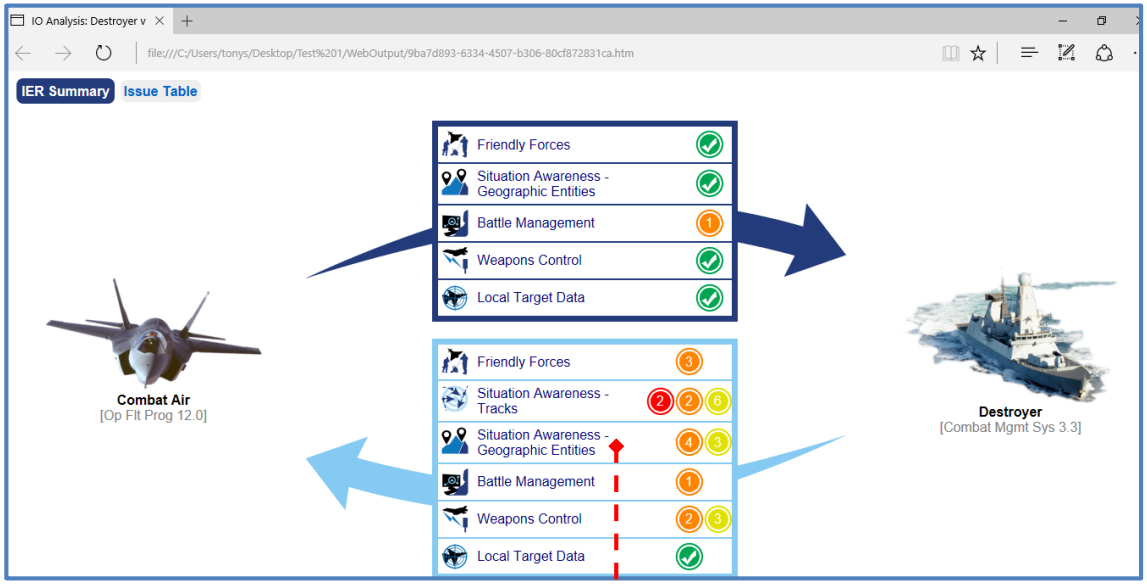
Conourrent Multi-Netting

CMN-2	No
CMN-3	No
CMN-4	No

Outputs – MOD Sharepoint



Outputs – MOD Sharepoint



Situation Awareness - Geographic Entities

Geographic entities that are exchanged to provide additional SA or to report entities for which direct sensor support is not available.

Reference Point - Hazard

A geographic reference point that reports an entity that is a potential Hazard to friendly forces

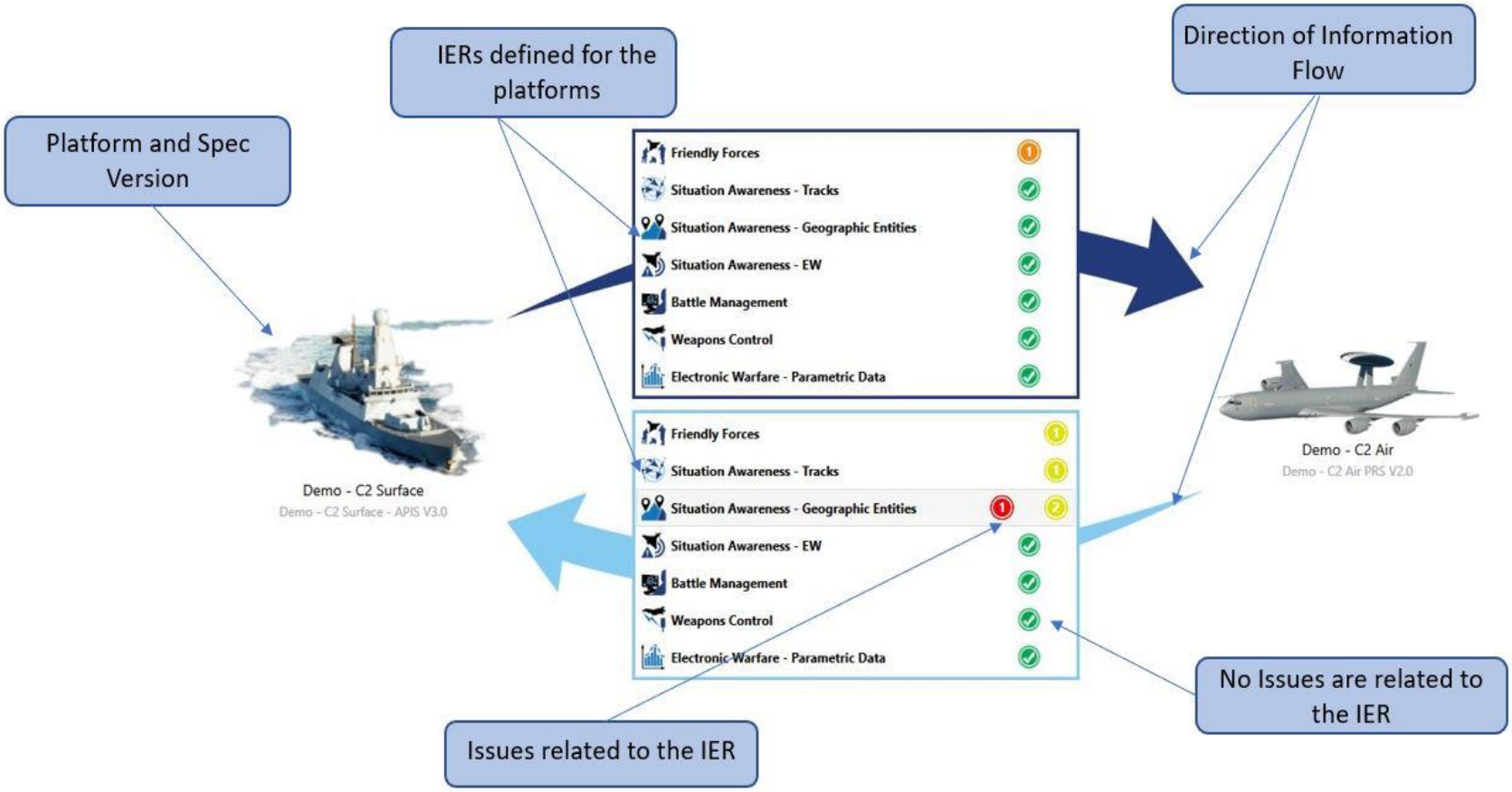
Information Type	Issue	Operational Summary
Hazard Description	No Known Issues	
Location	Combat Air Discards All Slaved Reference Points	The Combat Air system discards any Reference Point which is slaved to another track or PPLI

Land Object

A geographic object in the Land domain that has been derived from other than sensors

Information Type	Issue	Operational Summary
Location	High Precision Land Targeting	Combat Air does not interpret Land Objects with High Precision positional information correctly
Identification	Exercise Objects - Displayed as Real	Combat Air displays all exercise tracks/points as if real
Enhanced Point Characteristics	Setting Force/Emergency Tell on a Remote Entity	Destroyer may not be able to set Force Tell or Emergency Status on a remote entity.
	Limited Supporting Information - Land Points	Destroyer reports limited information for Land Points.

Outputs – MOD Sharepoint



Outputs - MOD Sharepoint

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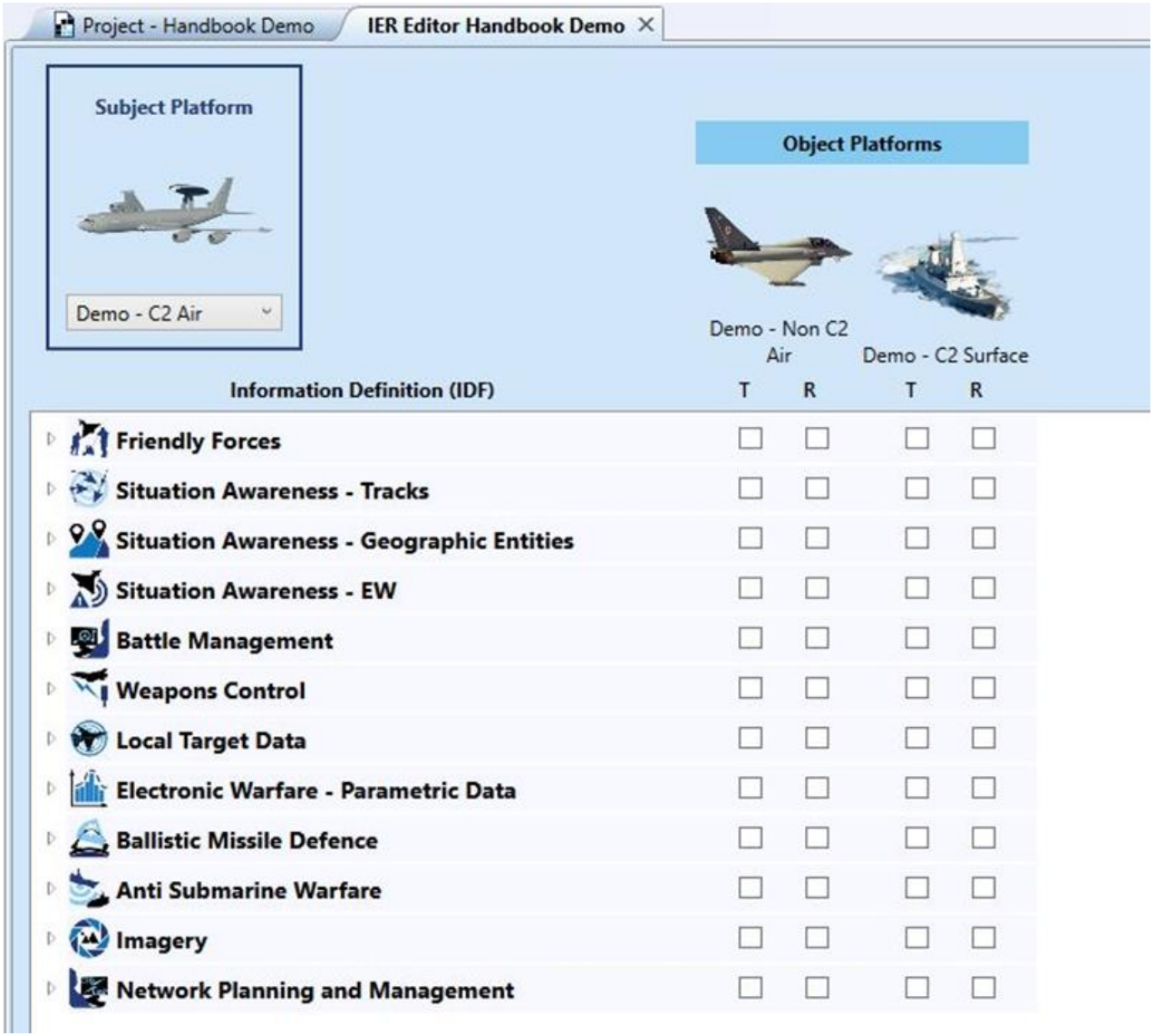
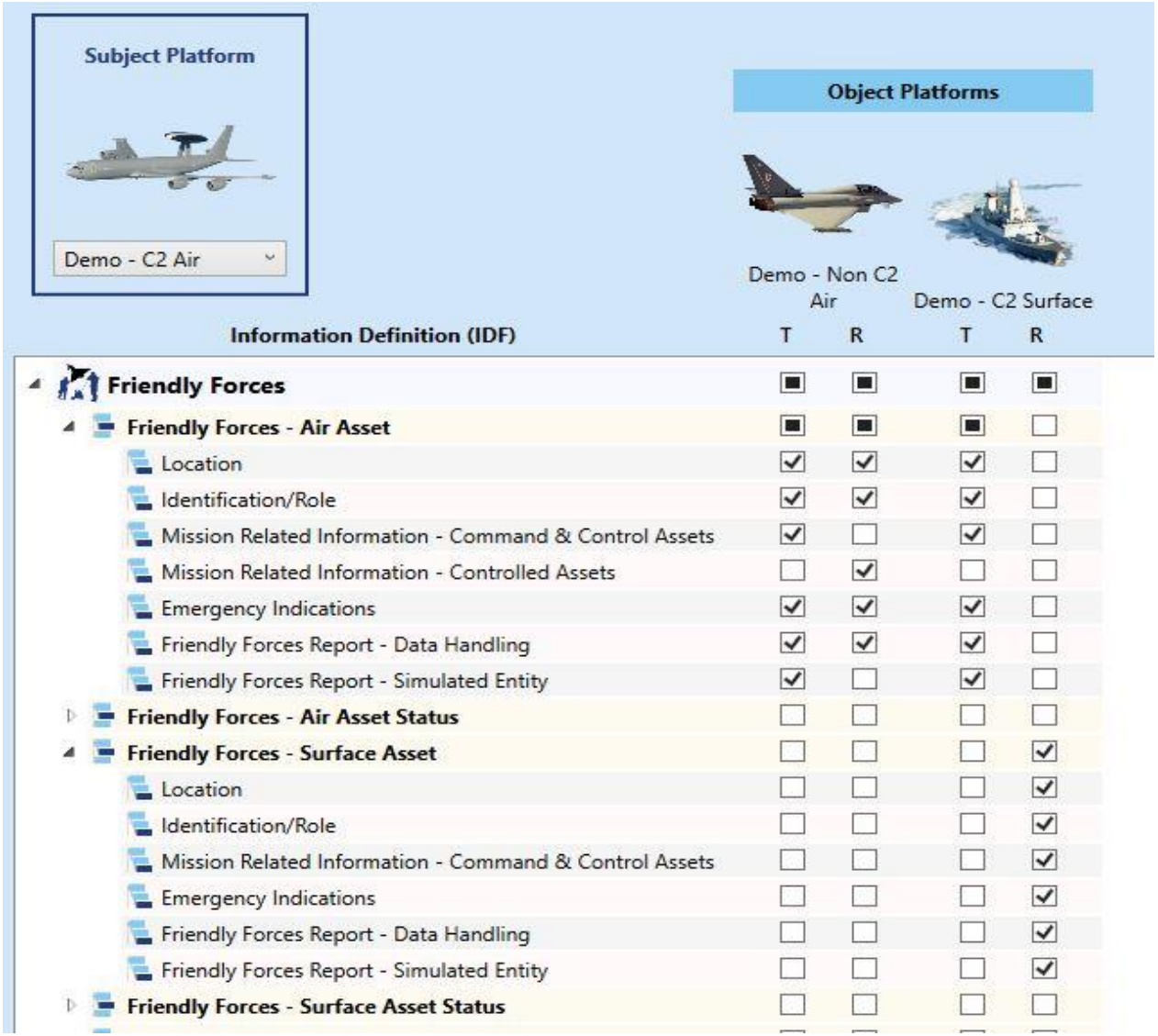


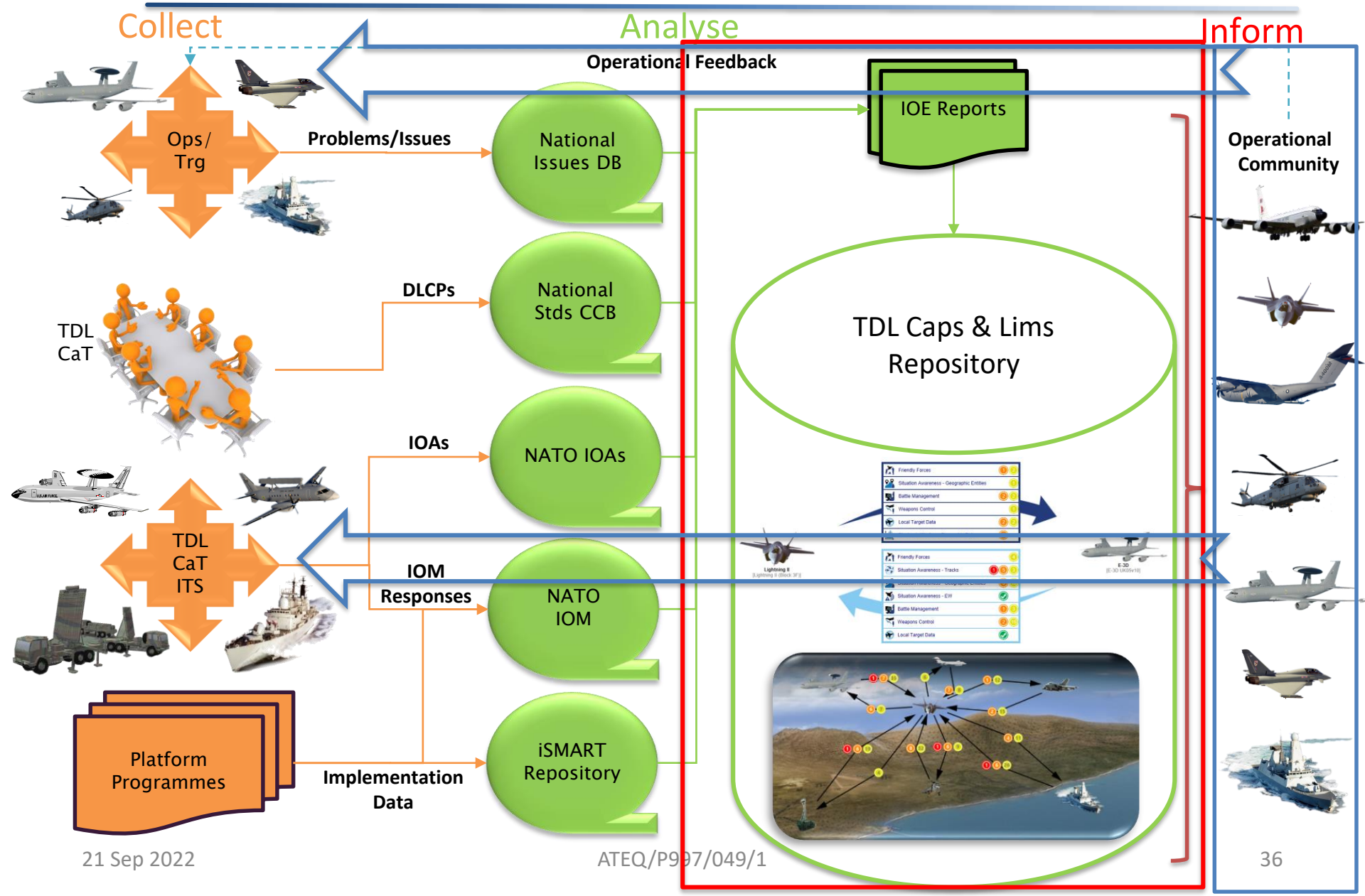
Outputs – MOD Sharepoint



Information Definition (IDF)	Demo - Non C2 Air T	Demo - Non C2 Air R	Demo - C2 Surface T	Demo - C2 Surface R
Friendly Forces	■	■	■	■
Friendly Forces - Air Asset	■	■	■	☐
Location	☑	☑	☑	☐
Identification/Role	☑	☑	☑	☐
Mission Related Information - Command & Control Assets	☑	☐	☑	☐
Mission Related Information - Controlled Assets	☐	☑	☐	☐
Emergency Indications	☑	☑	☑	☐
Friendly Forces Report - Data Handling	☑	☑	☑	☐
Friendly Forces Report - Simulated Entity	☑	☐	☑	☐
Friendly Forces - Air Asset Status	☐	☐	☐	☐
Friendly Forces - Surface Asset	☐	☐	☐	☑
Location	☐	☐	☐	☑
Identification/Role	☐	☐	☐	☑
Mission Related Information - Command & Control Assets	☐	☐	☐	☑
Emergency Indications	☐	☐	☐	☑
Friendly Forces Report - Data Handling	☐	☐	☐	☑
Friendly Forces Report - Simulated Entity	☐	☐	☐	☑
Friendly Forces - Surface Asset Status	☐	☐	☐	☐

Outputs – MOD Sharepoint

UK Approach to IO Manangement



Physical IO Testing

Physical IO Testing

Questions?