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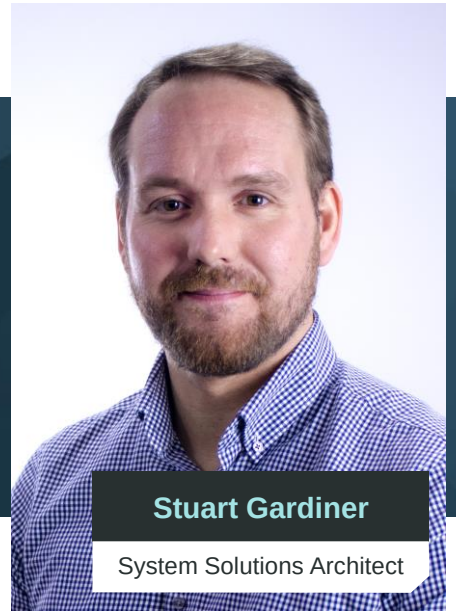
ARTIFICIAL INTELLIGENCE AS AN INTEGRATED FORCE MULTIPLIER

September 11, 2019 **MR STUART GARDINER| System Solutions Architect**

Introduction: AI as an Integrated Force Multiplier



- **Role**: Member of the CTO Office at TRL Technology, a subsidiary of L3HARRIS, specializing in Enterprise Solutions for CEMA.
- **Background**: Extensive experience across multiple domains and the capability lifecycle, focused on delivering critical mission outcomes.
- **Objective**: Identification of an approach to consider the use of Artificial Intelligence as an Integrated Force Multiplier.

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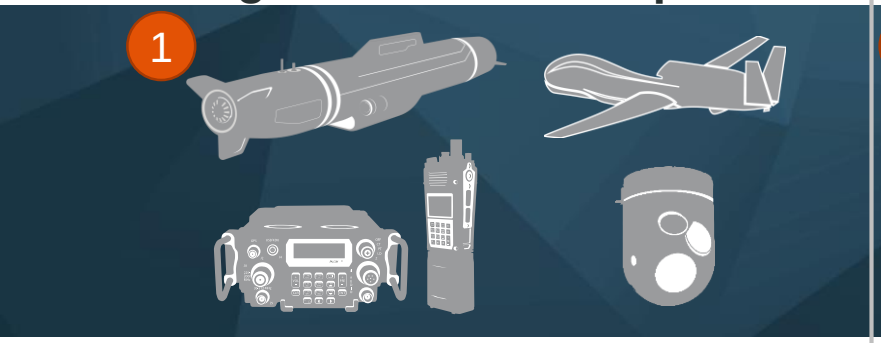
L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs.

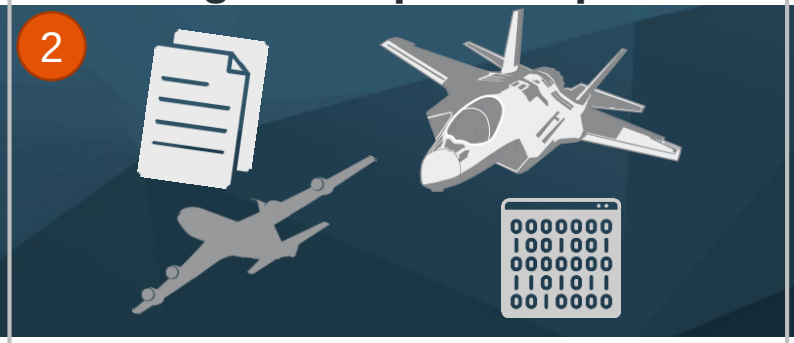
Structure

Integrated Force Multipliers



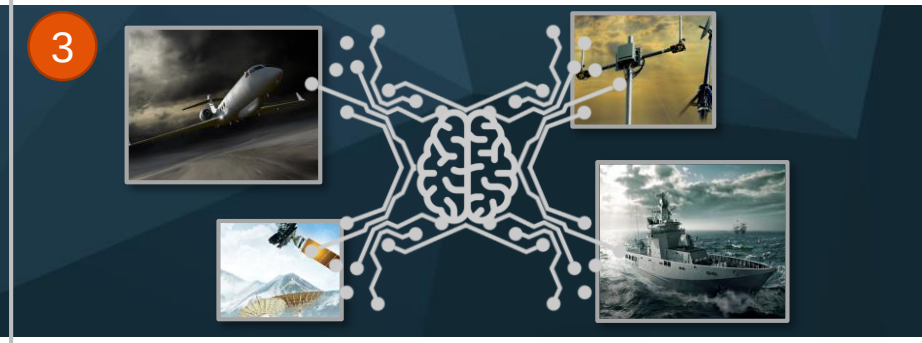
- Illustration of a general model to understand Integrated Force Multiplication (IFM).
- Convergence and divergence of Technology and Operational Understanding for IFM.
- General examples of IFM to convey evolution overtime.
- Enabling role of Data Science, Machine Learning for AI as an IFM.

Evolving Concepts of Operation



- Identification of the driving factors behind the evolution of data and information.
- Assessment of the impact of evolving and dynamic information dependent CONOPs.
- Key elements of the advancement of information driven CONOPs.
- Identification of key components and characteristic of information CONOPs

AI Candidate Scenarios



- Overview of the resulting operational environment established from information CONOPs.
- Identification of prevalent Edge and Enterprise technologies present in the environment.
- Discussion of candidate AI IFM scenarios for Edge technologies.
- Discussion of candidate AI IFM scenarios for Enterprise technologies.

Force Multiplication: Core Components

Force Multiplication Impact

- Illustrative concept to show the impact of IFM
- Impact of IFM should be considered from multiple perspectives
- Convergence of operational understating and S&T
- Difference between Force multiplication and IFM

Science and Technology

- Underpinning enabler to any integrated force multiplier
- Research, academia and enduring drive IFM convergence
- Science and Technology threads exist for multiple IFM themes
- Genuine scientific and technological breakthroughs are a catalyst

Operational Exploitation

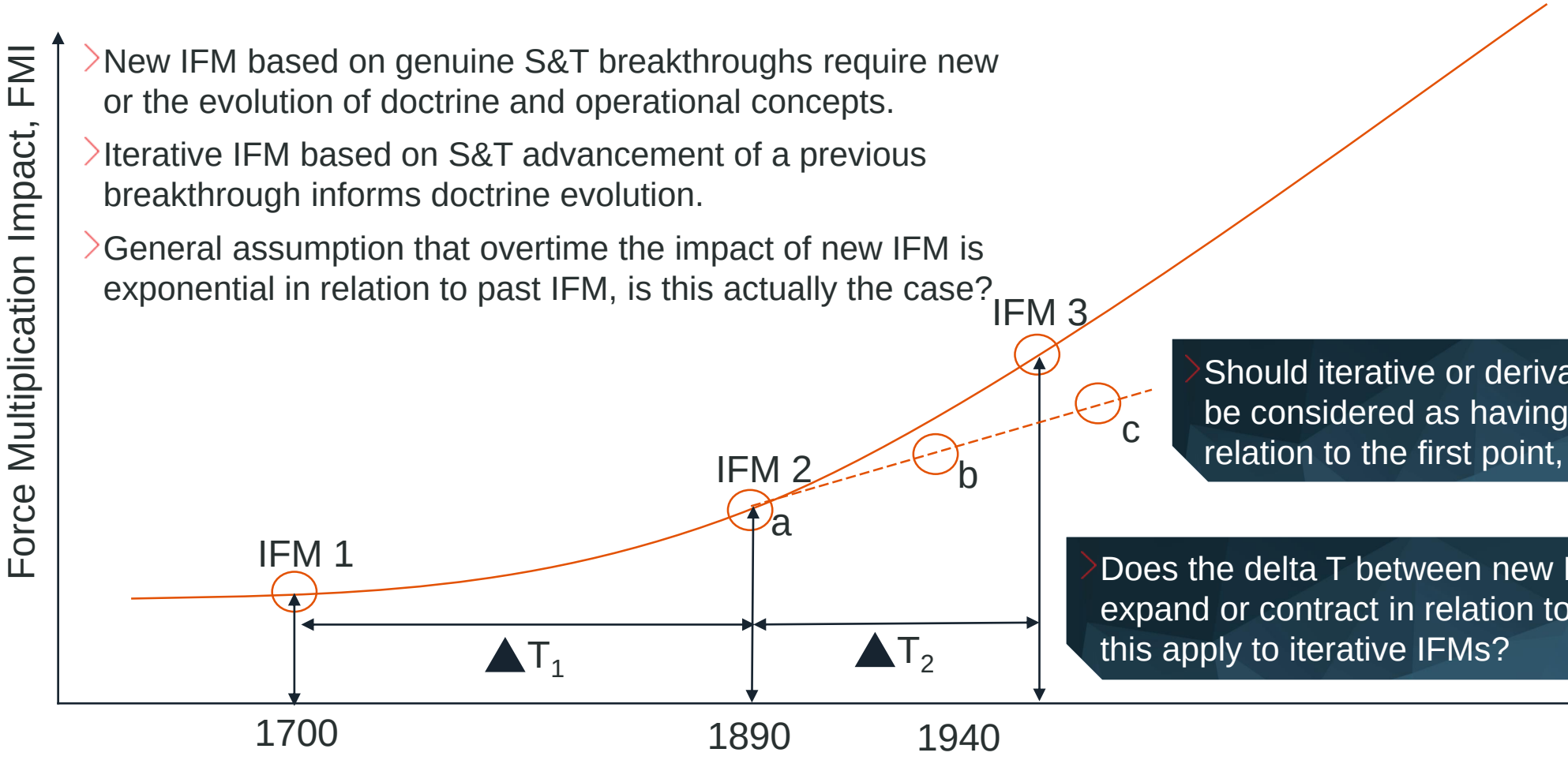
- New doctrine and Concepts of Operation may be required
- Impact assessment on training and expertise to maximise benefit
- OODA loops applied pre and post convergence of initial IFM
- OODA loops for operational employment and adaptive evolution

Time

- Trends and influences over hundreds of years
- Impact of rapid technological shifts over tens of years
- Evolution of generational warfare, first, second, third and fourth
- Time deltas between IFM convergence and divergence

Force Multiplication: General Model

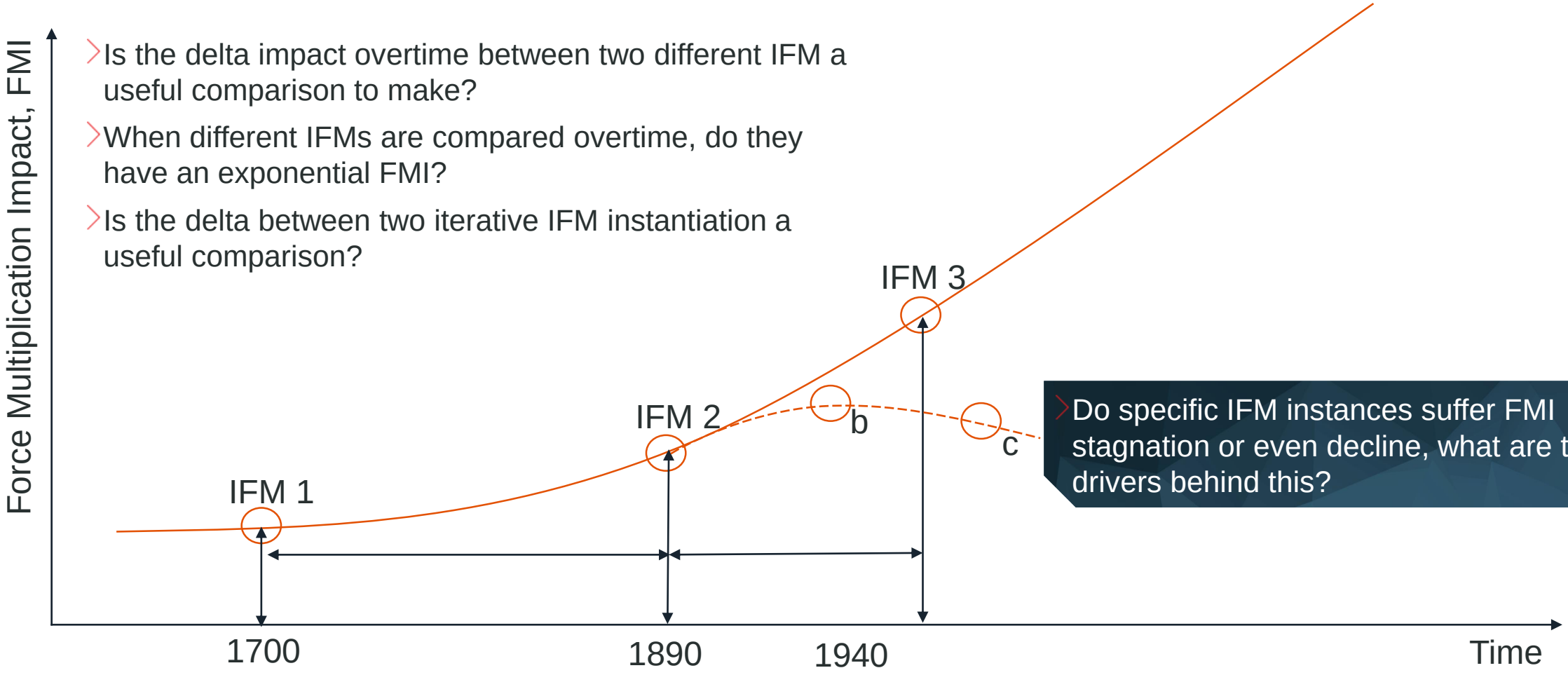
- New IFM based on genuine S&T breakthroughs require new or the evolution of doctrine and operational concepts.
- Iterative IFM based on S&T advancement of a previous breakthrough informs doctrine evolution.
- General assumption that overtime the impact of new IFM is exponential in relation to past IFM, is this actually the case?



- Should iterative or derivatives of initial IFM be considered as having a linear impact in relation to the first point, not exponential?
- Does the delta T between new IFM instances expand or contract in relation to FMI overtime, does this apply to iterative IFMs?

Force Multiplication: General Model

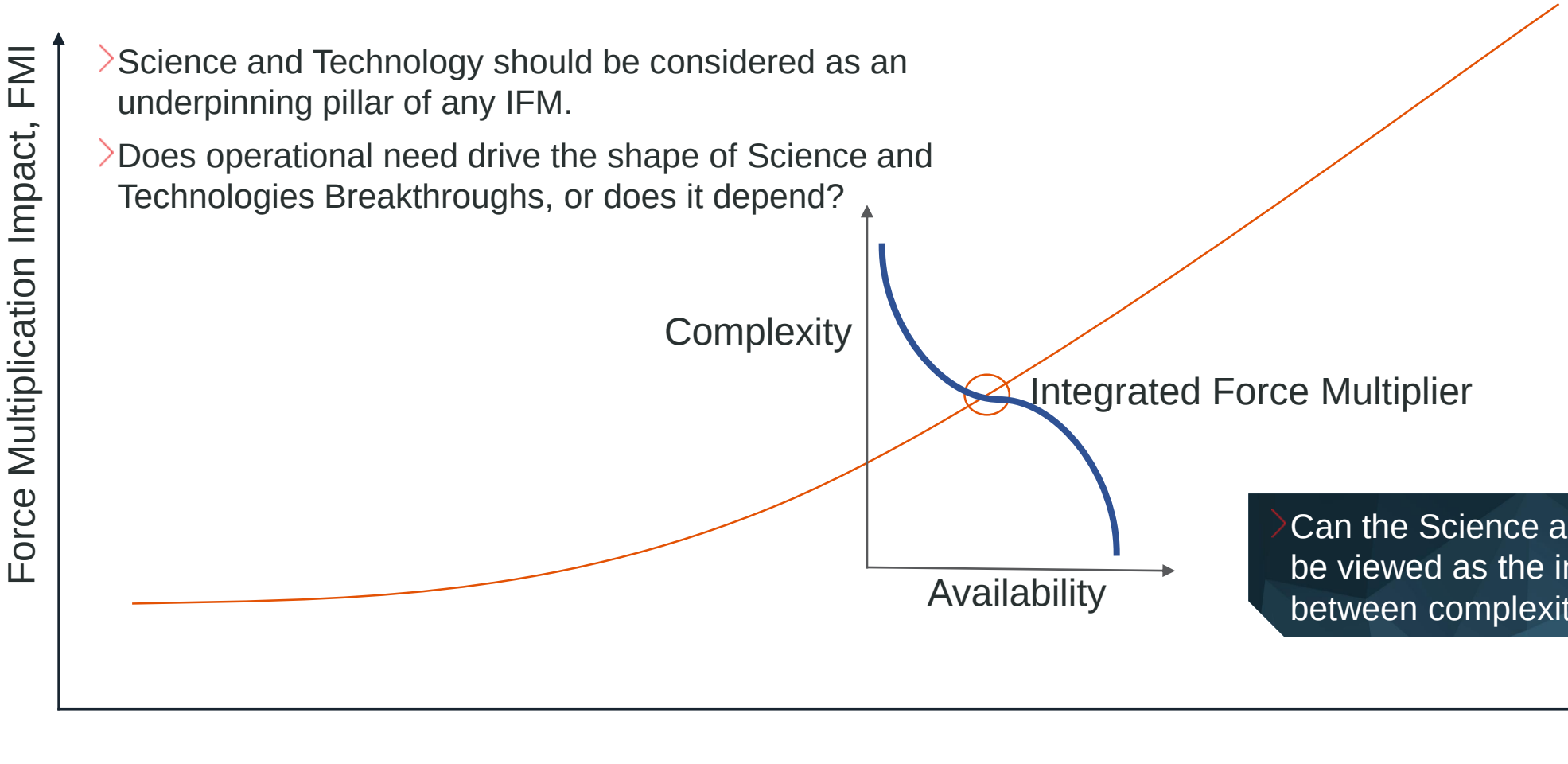
- Is the delta impact overtime between two different IFM a useful comparison to make?
- When different IFMs are compared overtime, do they have an exponential FMI?
- Is the delta between two iterative IFM instantiation a useful comparison?



- Do specific IFM instances suffer FMI stagnation or even decline, what are the drivers behind this?

Force Multiplication: Science and Technology

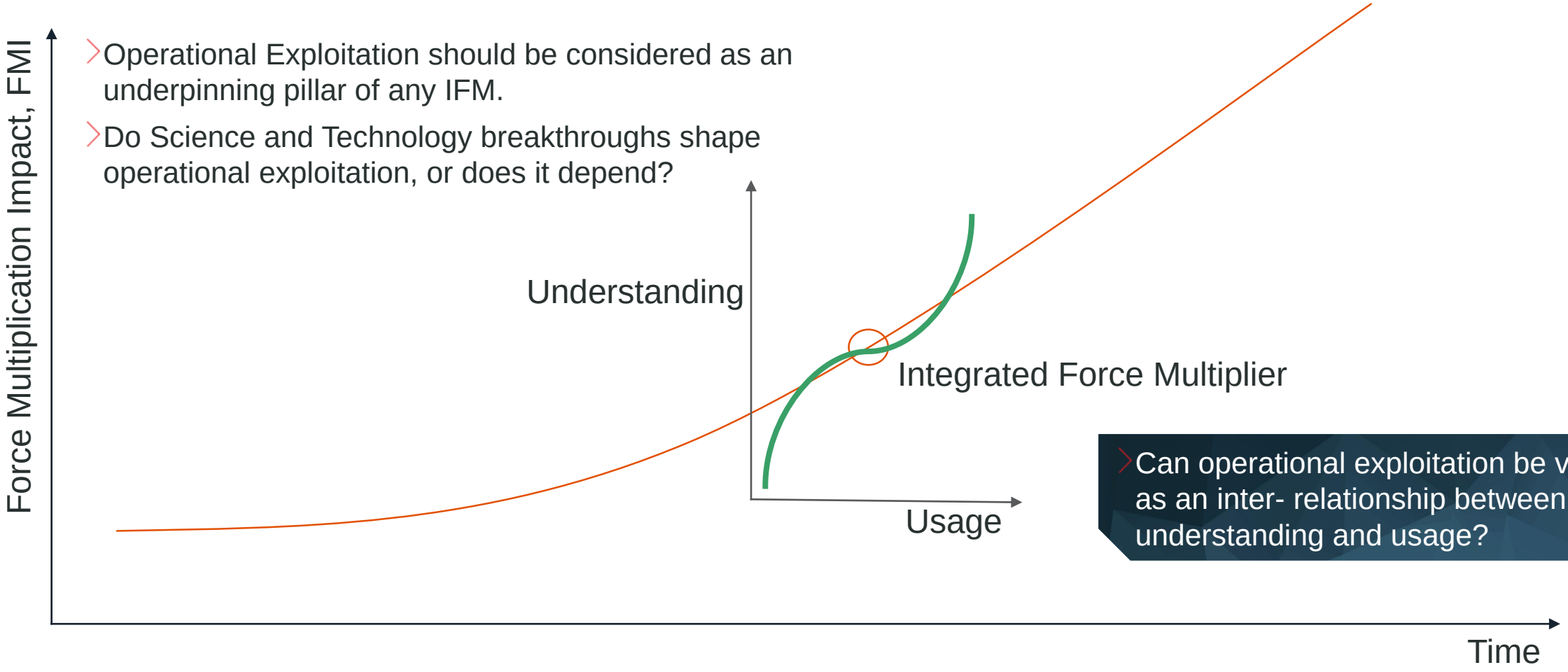
- Science and Technology should be considered as an underpinning pillar of any IFM.
- Does operational need drive the shape of Science and Technologies Breakthroughs, or does it depend?



- Can the Science and Technology thread be viewed as the inter-relationship between complexity and availability?

Force Multiplication: Operational Exploitation

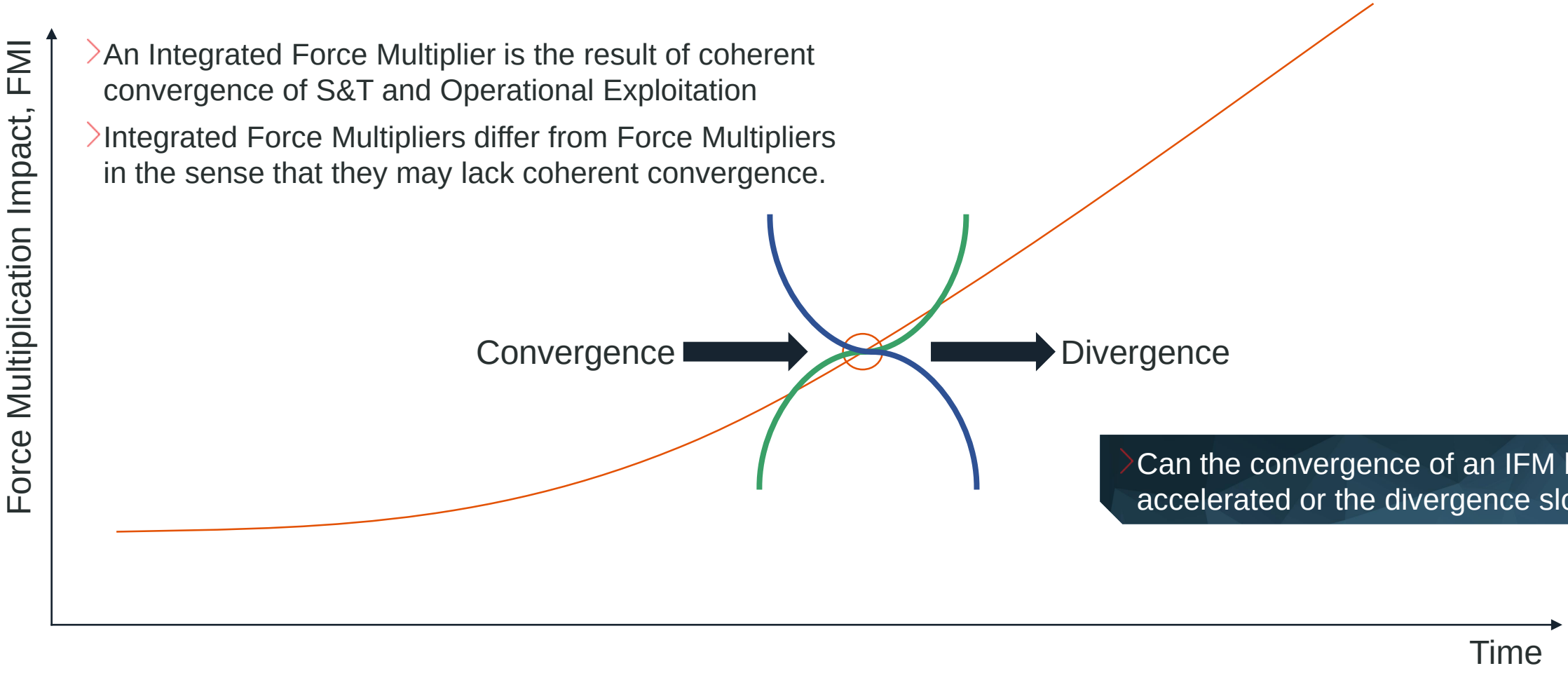
- Operational Exploitation should be considered as an underpinning pillar of any IFM.
- Do Science and Technology breakthroughs shape operational exploitation, or does it depend?



- Can operational exploitation be viewed as an inter- relationship between understanding and usage?

Force Multiplication: Pillar Inter-relationships

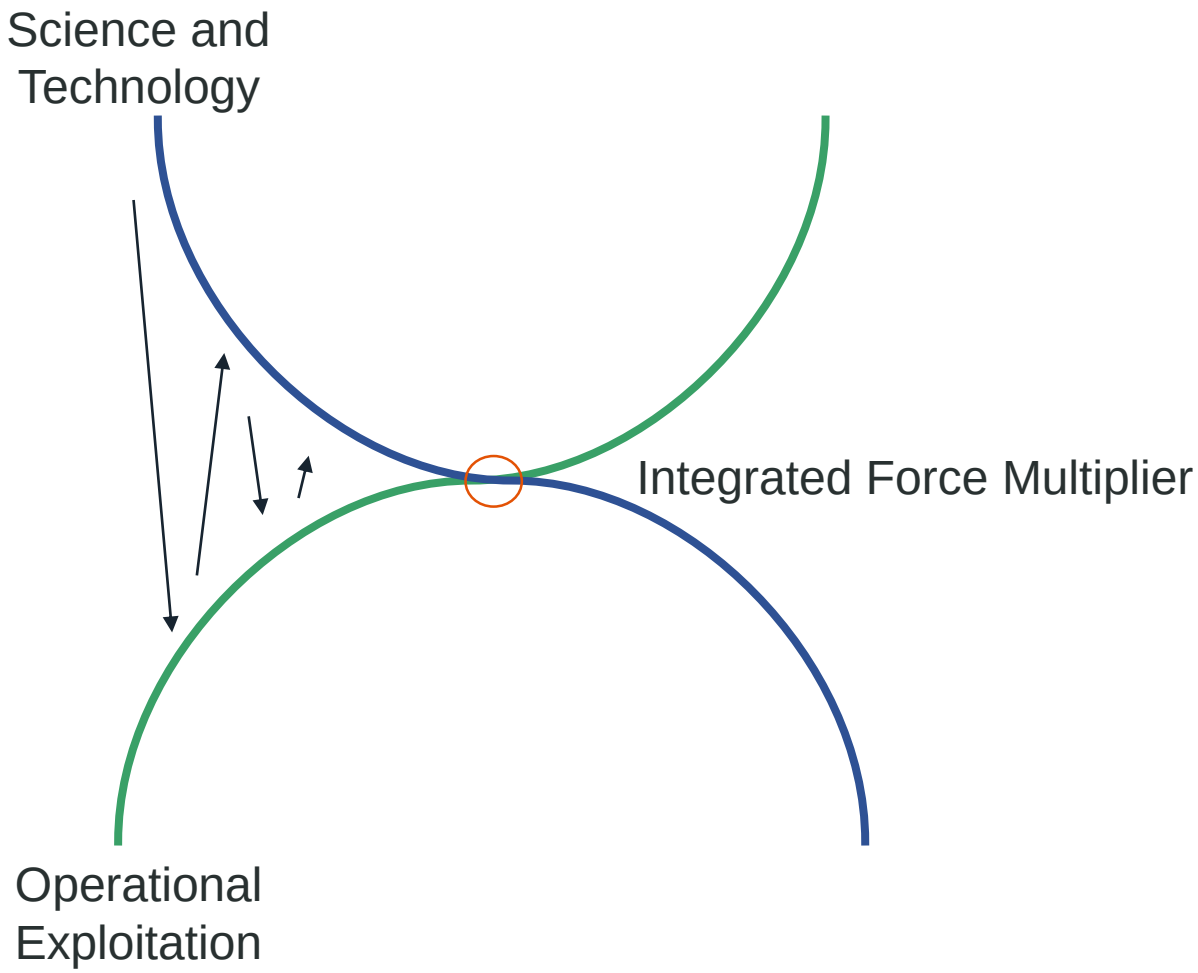
- An Integrated Force Multiplier is the result of coherent convergence of S&T and Operational Exploitation
- Integrated Force Multipliers differ from Force Multipliers in the sense that they may lack coherent convergence.



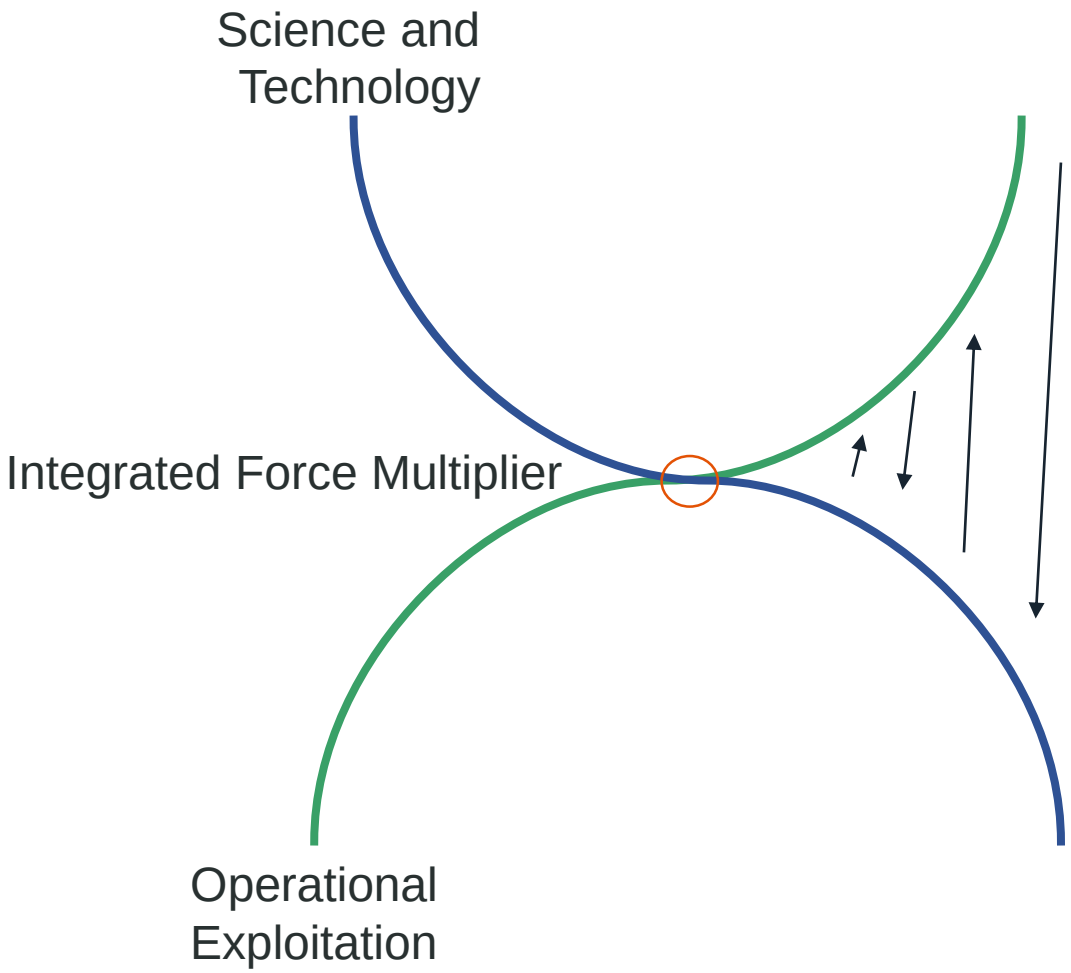
- Can the convergence of an IFM be accelerated or the divergence slowed?

Force Multiplication: Convergence

- The convergence of Science and Technology with Operational Exploitation are fundamental to an IFM
- Convergence is driven by the collaboration of the two pillars;
  - Does Scientific and Technology Breakthroughs feed the development of Doctrine?
  - Does the constant evolution of Doctrine inform the direction of effort to generate S&T breakthroughs?
- Continued iterative engagements are used to align S&T with operational exploitation this includes;
  - Doctrine, CONOP, CONEMP, DLODs,
  - Experiments, Concept & Field Demonstrators, IOC ETC
- The convergence of these pillars is the differentiating factors between a Force Multiplier and an Integrated Force Multipliers



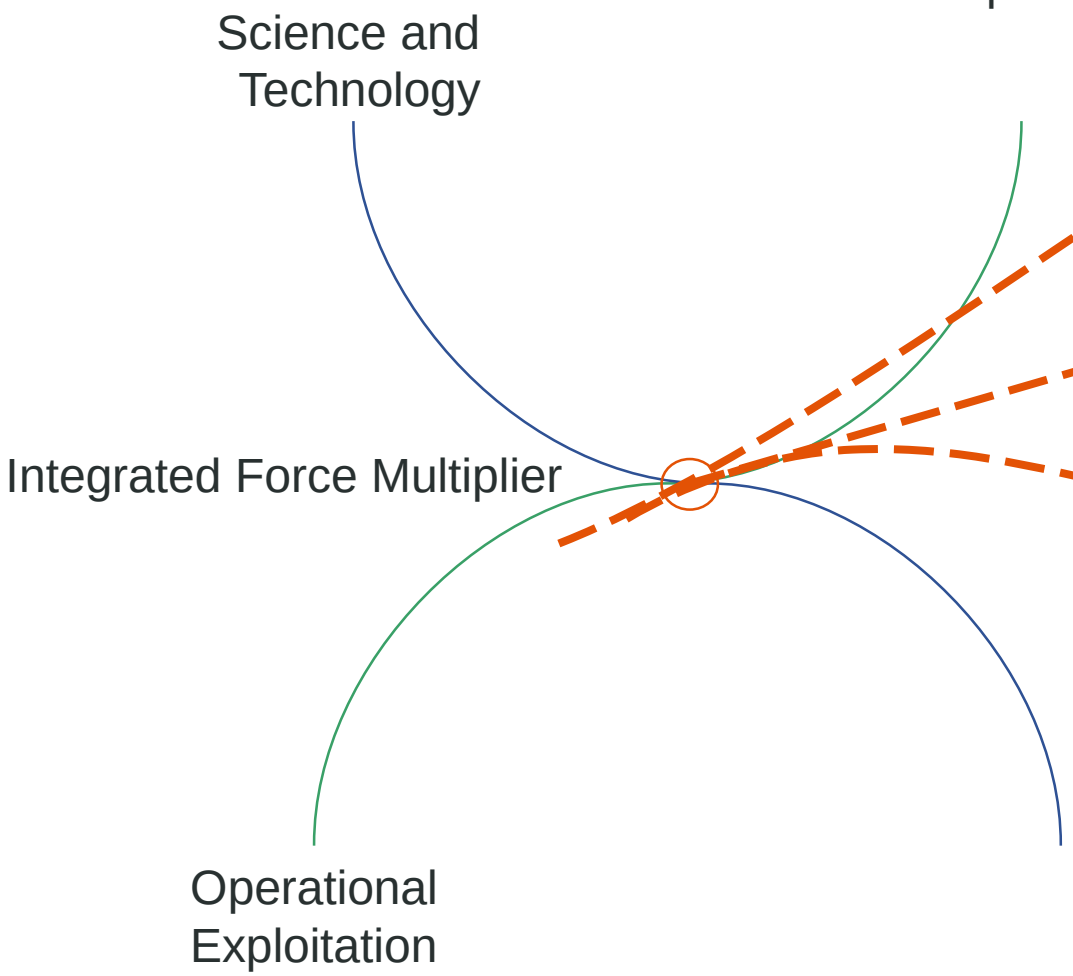
Force Multiplication: Divergence



- The divergence of Science and Technology with Operational Exploitation is key phenomenon to understand
- Divergence is driven by the inherent nature of the two pillars;
  - Does availability of a specific IFM to others and adversaries have a non-recoverable negative impact
  - Can the negative impact of S&T be counter acted by operational exploitation in new and innovative ways?
  - Operational exploitation will decline overtime, either in relation to new related IFM iterations of new IFMs

Force Multiplication: Divergence

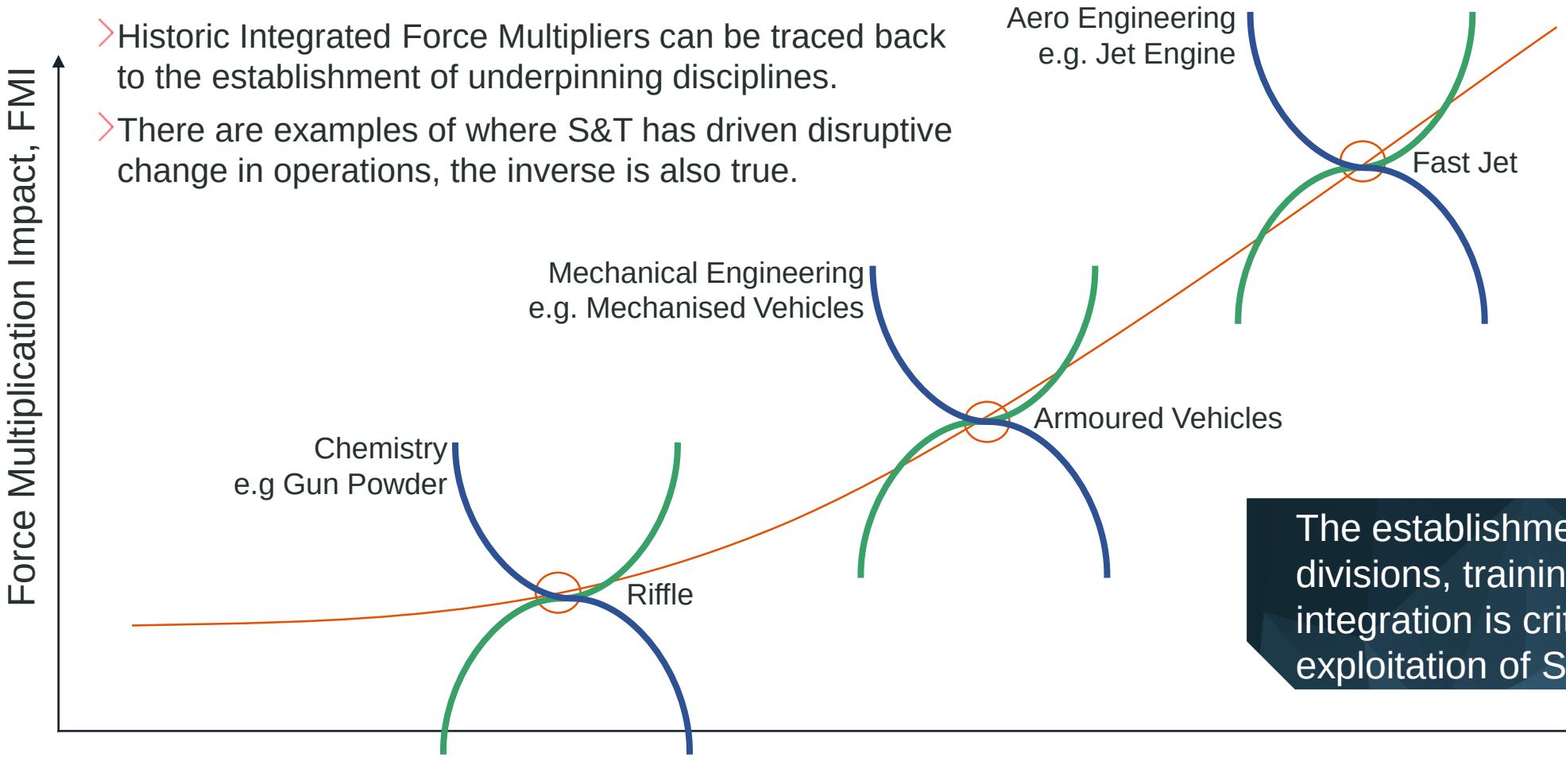
Can the impact of an IFM when in divergence can be viewed as the resultant vector of S&T and operational exploitation?



- In relation to future unrelated IFM
- Continued IFM impact due to increased exploitation through innovation
- Stagnation and then decline of IFM due to
  - Obsolesce
  - Adversary counter measures
  - Availability to others
  - Different operational need
  - New Integrated Force Multipliers
- IFM can either become linear, stagnate or decline.

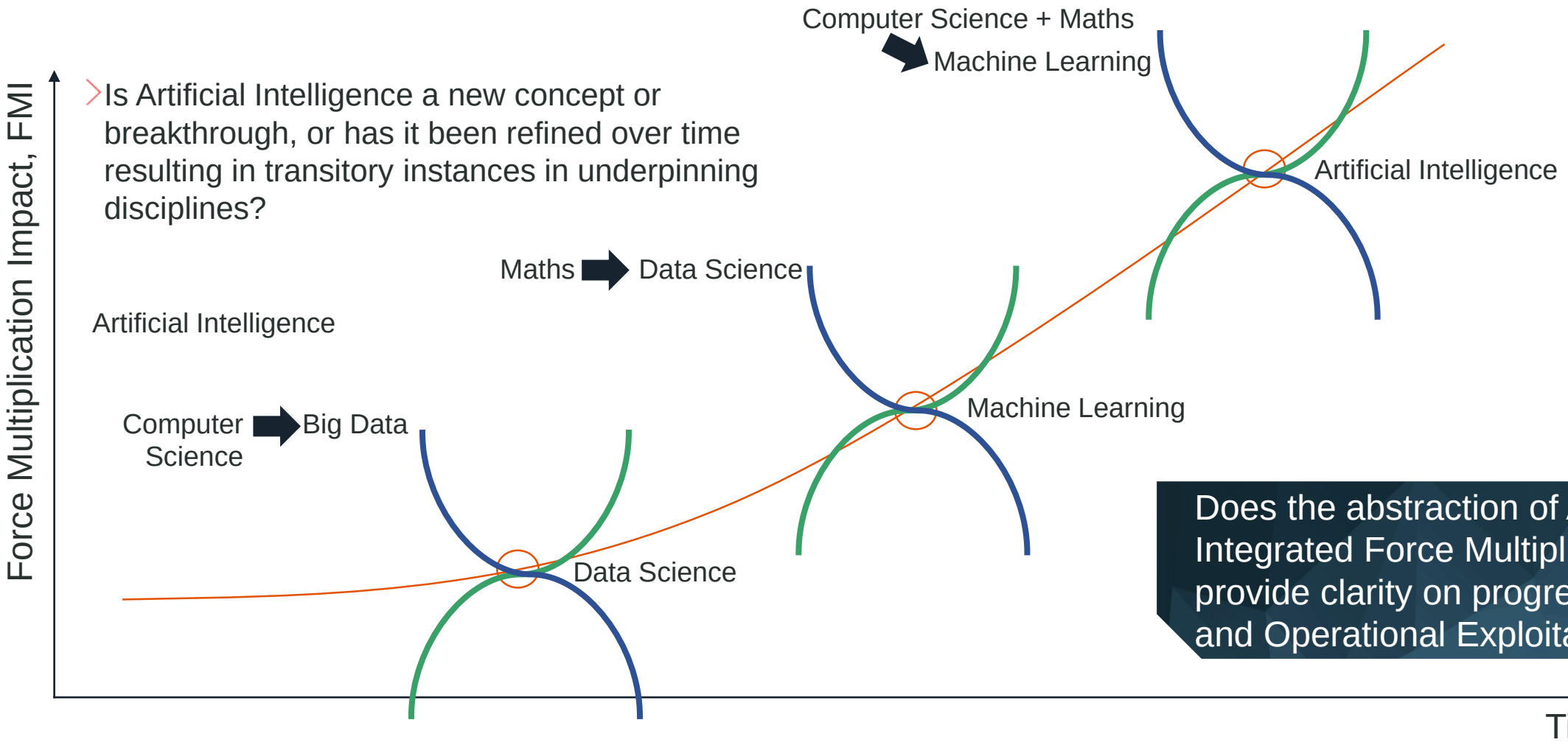
Force Multiplication: Early IFM

- Historic Integrated Force Multipliers can be traced back to the establishment of underpinning disciplines.
- There are examples of where S&T has driven disruptive change in operations, the inverse is also true.



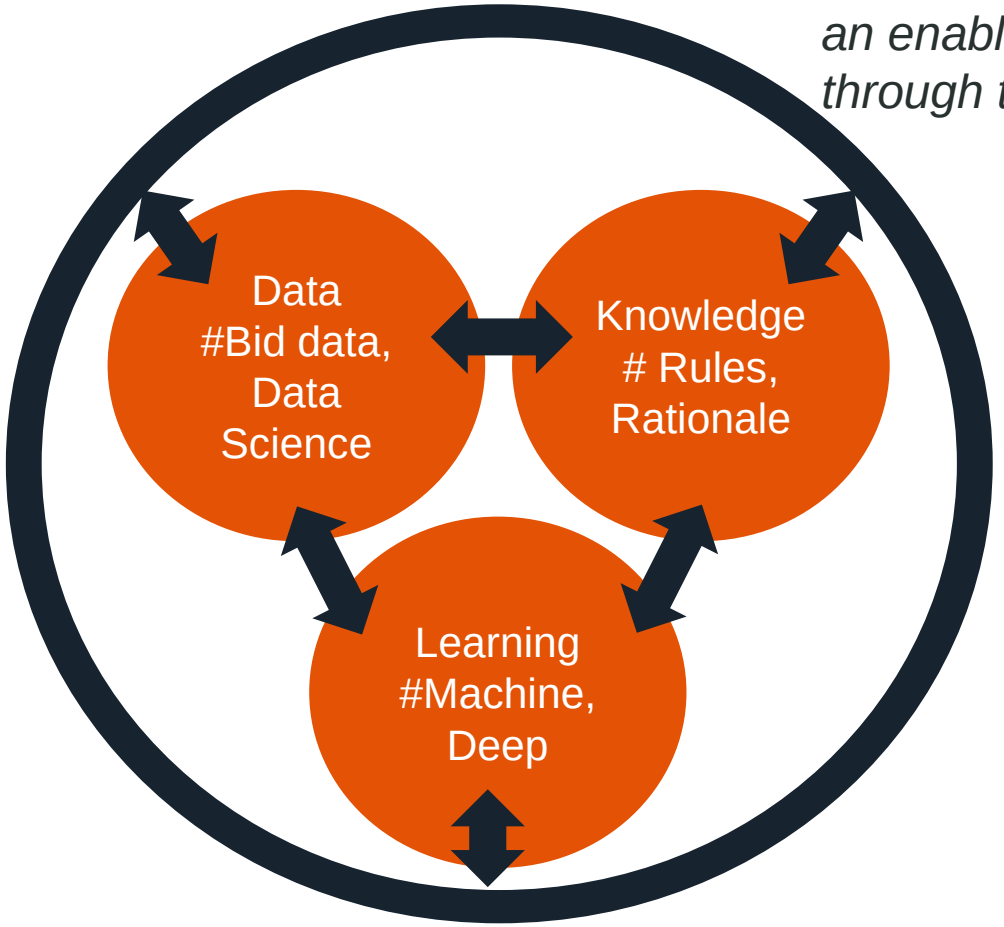
The establishment of operational divisions, training and pan DLOD integration is critical to effective exploitation of S&T.

Force Multiplication: Early IFM



Force Multiplication: Artificial Intelligence

***Artificial Intelligence**, In the context of and Integrated Force Multiplier, AI is an enabling technology that allows effective delegation of intent , achieved through the coherent exploitation of a number of underpinning disciplines.*



Super: Perceived as a threat to humanity and capable of complex large scale manipulations, conscious, self preservation, understand and have emotions.

General: Enables the delegation of intent for classes of scenarios and can adapted and learn new approaches for previously unknown scenarios.

Narrow: Enables the delegation of intent for tightly constrained scenarios, different AI implementation per scenario.

Terminology for Artificial Intelligence, Machine Learning and Deep Learning are commonly interchanged, there are multiple competing definitions and taxonomies.

Structure

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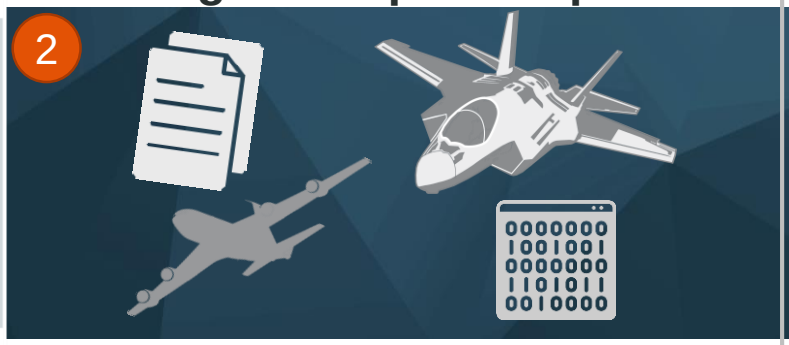
Evolving Concepts of Operation



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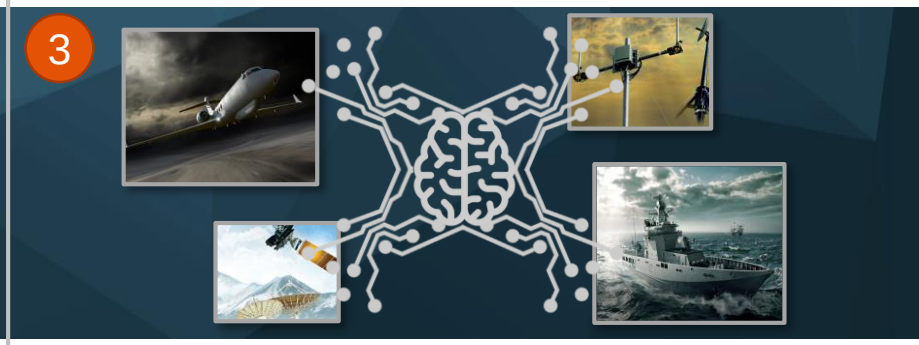

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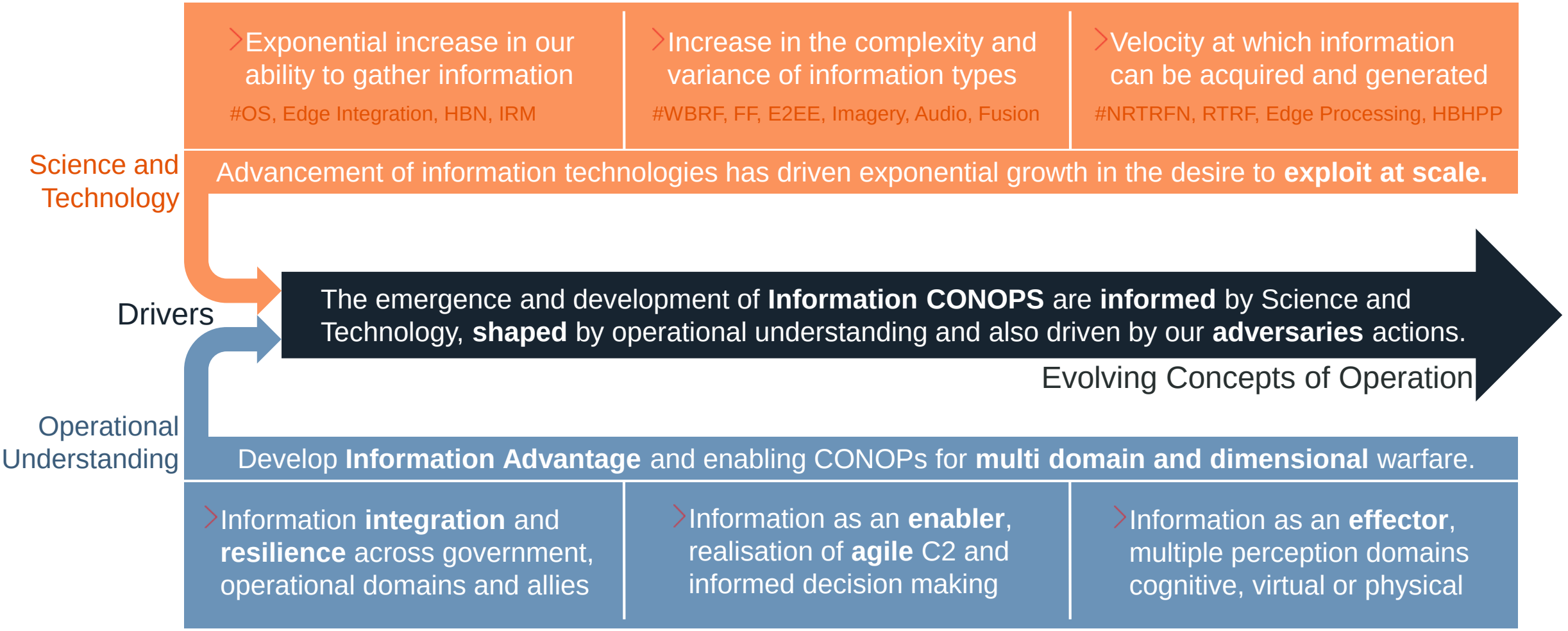
Evolving Concepts of Operation: Drivers



Evolving Concepts of Operation: Impact

The evolution of the Information domain impacts both S&T and OU

Impacting Information Characteristics

- Collection
- Complexity
- Velocity

Environment	Technical	Cognitive
Information Storm	Obsolete Solutions	Overloaded Users
#Cross Domain, Dynamic Inter-relationships, Traded as a commodity, Used as a Resource, Facilitates Attack Vector for Adversaries, Open Source, Constantly Changing	*#Tactical and strategic Networks Links, Storage, Inter-Relationships, Pattern of Life and Behaviour, Edge and Enterprise, Real Time, Legal , Labelling, Security, X Domain.*	*#What Information is Relevant?, What skills are needed?, Training, Distraction, dispirit approaches, Multi Dimensional, Time dependant, Information Gap, Gather*

Bi-directional Impact

Bi-directional Impact

Denied, disrupted and or degraded ability to make informed tactical and strategic decisions.

Machine Learning on the Battlefield,
by Dr Paul Brittan, Today at 1430-1500, Global Theatre

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Evolving Concepts of Operation: Advancement

#Consumers of raw data, partial processed data, decision makers, local, strategic

Users

Swivel chair collaboration between user operating or using different sensors and platforms.

Dependent on the user to rationalise, analyse, understand and exploit the information in a timely manner.

Dependent on the user to rationalise, sensor placement, usage and de-confliction with partners

Near impossible for a single user to compile a coherent of information, non-optimised data fusion across dispirit sensors

Technical Enablers

- Large amounts of data heavily segregated and stove piped information from dispirit Sensors.
- Impractical network requirements and dependencies that limit scalability.
- Impractical storage and access requirements impact by security and legal process.

Sensors

#Source of raw data, dependent on users, diverse, different interfaces

RF	Spectral intelligence, geo-location, wideband, narrow band, device identification.
Audio	Acoustic intelligence, device originating geo location, non RF emitting, ID confirmation
Imagery	Image intelligence, support to ground forces, real time, strategic, pattern of life, ID confirmation
Network	Endpoint identification, On wire networks, ad-hoc, defensive, performance optimisations

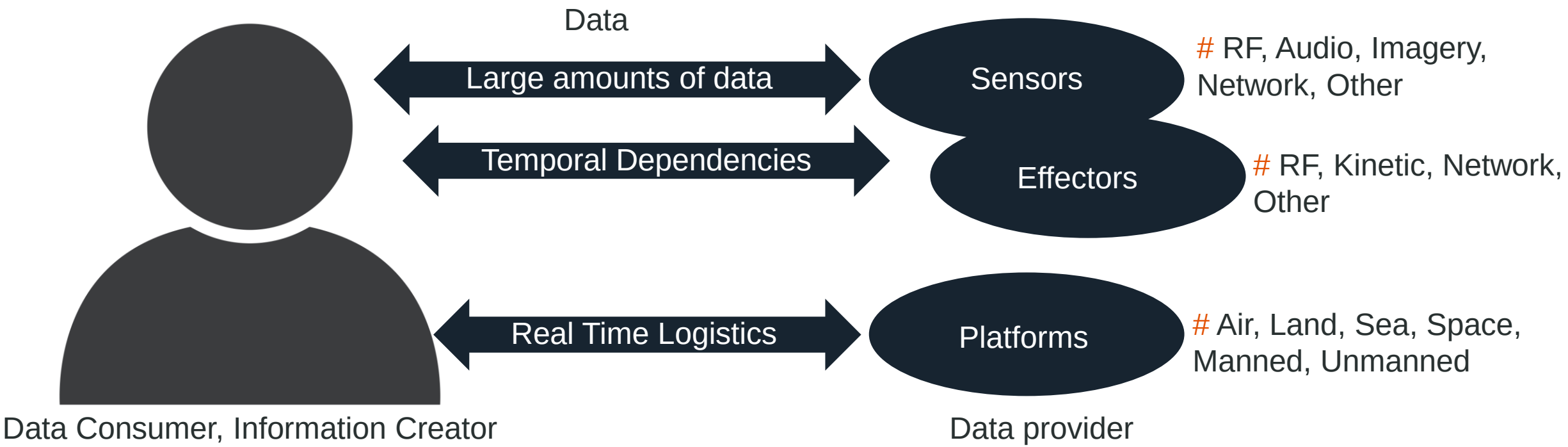
Huge burden placed on both tactical and strategic users to rationalise and exploit information

Legacy networks, approaches, processes and skills baseline are not optimised to enable information CONOPs

Dispirit sensors are focused on data acquisition and propagation for wider exploitation

Evolving Concepts of Operation: Advancement

Data driven, Cognitively Intensive, Stove Piped, Barrier to Agility, Impedes Technical Delegation of Intent



Evolving Concepts of Operation: Advancement

The issues identified amplify when cross domain scenarios are considered.
#Land, Air Sea, Space, Cyber, Joint

#Consumers of raw data, partial processed data, decision makers, local, strategic

Users

Collaboration and coordination in a cross domain environment requires significant re-examination of approaches and process.

Technical Enablers

Interconnection and access cross domains is a significant challenge to overcome.

Sensors

#Source of raw data, dependent on users,

- RF
- Audio
- Imagery
- Network

Cross domain rationalisation of sensors usage is crucial to the optimisation of resources available and specific sensors of opportunity

The desire to collaborate will impact operational agility

Information at this scale currently has the inverse effect of a force multiplier.

Effectors within this construct will result in further disruption

Evolving Concepts of Operation: Characteristics

Information CONOPs are dependant of the establishment of a coherent enterprise comprised of core and edge elements.

Core

#User, Strategic, Fusion, Proactive, Value Adding Activities, Cross Domain,

Rationalisation and fusion of information prior to user interpretation.

Proactive provision of edge assets to support ongoing and information need.

Additional layer of decision making and analysis conducted by users

The reduction of cognitive burden for low value adding task enables user to focused on value adding activities.

Services

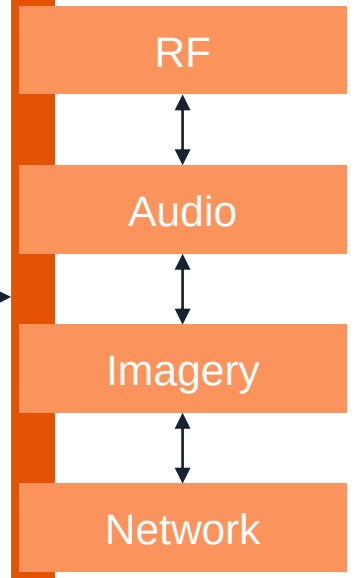
Reduce impact and dependency on networking for tactical activities

Enable rationalised cross domain solution to facilitate

Develop Information Advantage and enabling CONOPs for multi domain and dimensional warfare.

Edge

#Sensors, Rationalisation, Exploitation, Collaboration, Coordination, Autonomous, Tactical



Move rationalisation and exploitation of information to the edge

Delegate tactical decision making to the edge

Delegate coordination and collaboration edge sensors

The advancement of autonomous platforms that can host adaptable sensor payloads is a key enabler.

Structure

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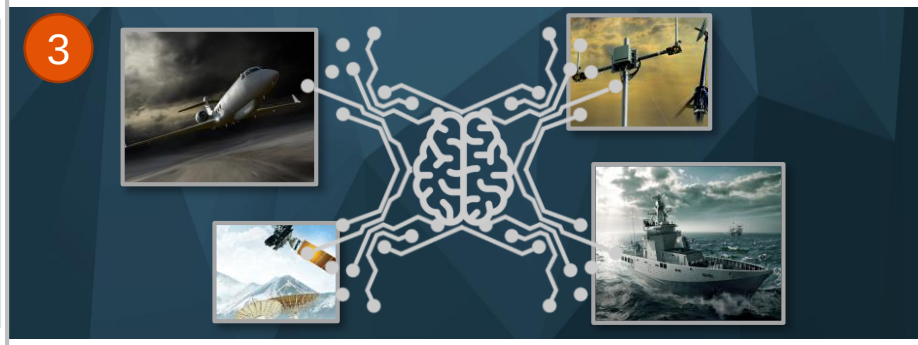
AI Candidate Scenarios

3



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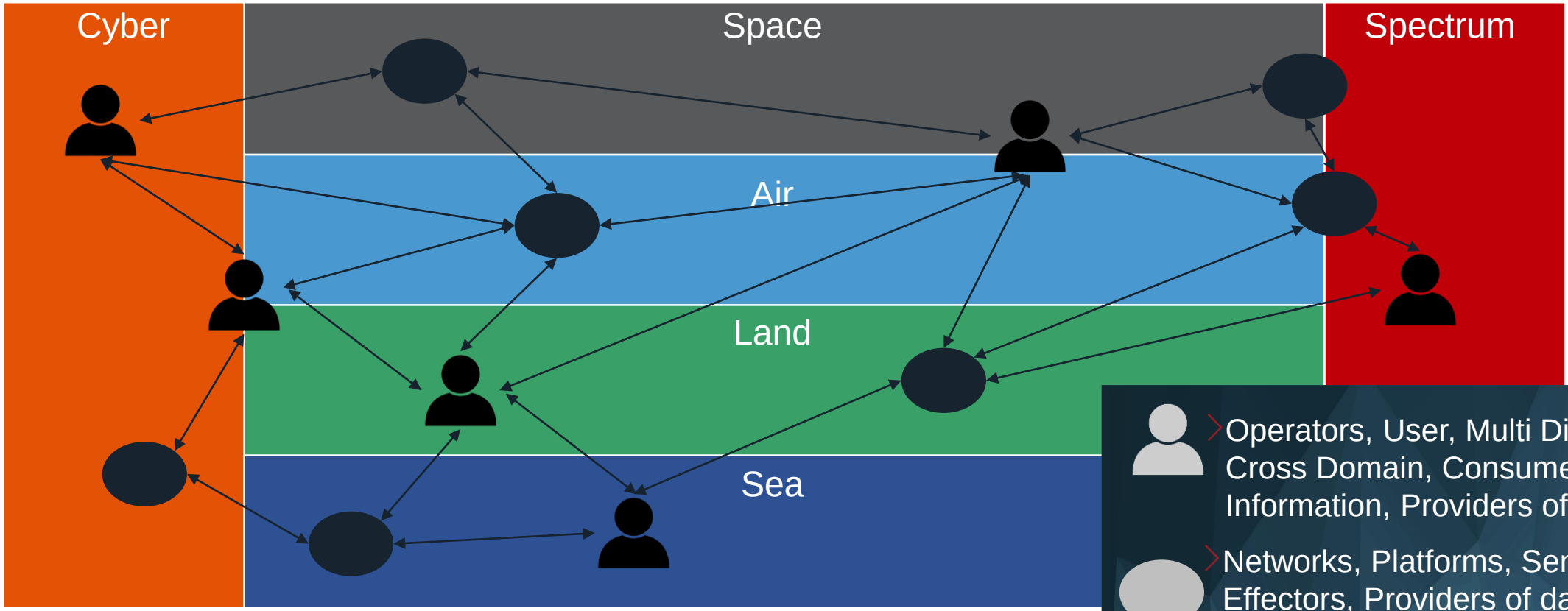
Candidate Scenarios, Operating Environment

#Cross domain, decentralised, delegated intent, reduction in cognitive burden, outcome focused, dynamic, collaborative, coordinated, information focused



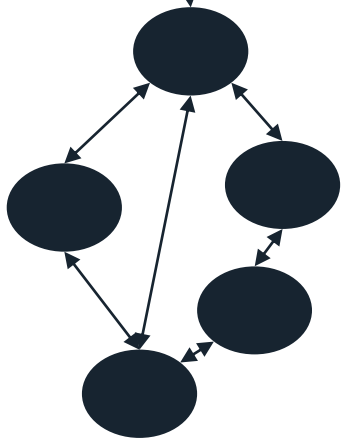
Scenario Scope

Find and report locations of device type A in Area of Interest B

#Period of Time, Priority, Accuracy, Assurance, Confidence

Rationalised Operator Interface to the Cross-Domain Enterprise, Single Information Environment

#Information, Outcomes, Delegation of Intent, Reduced Cognitive Burden, Rationalised Skill-base



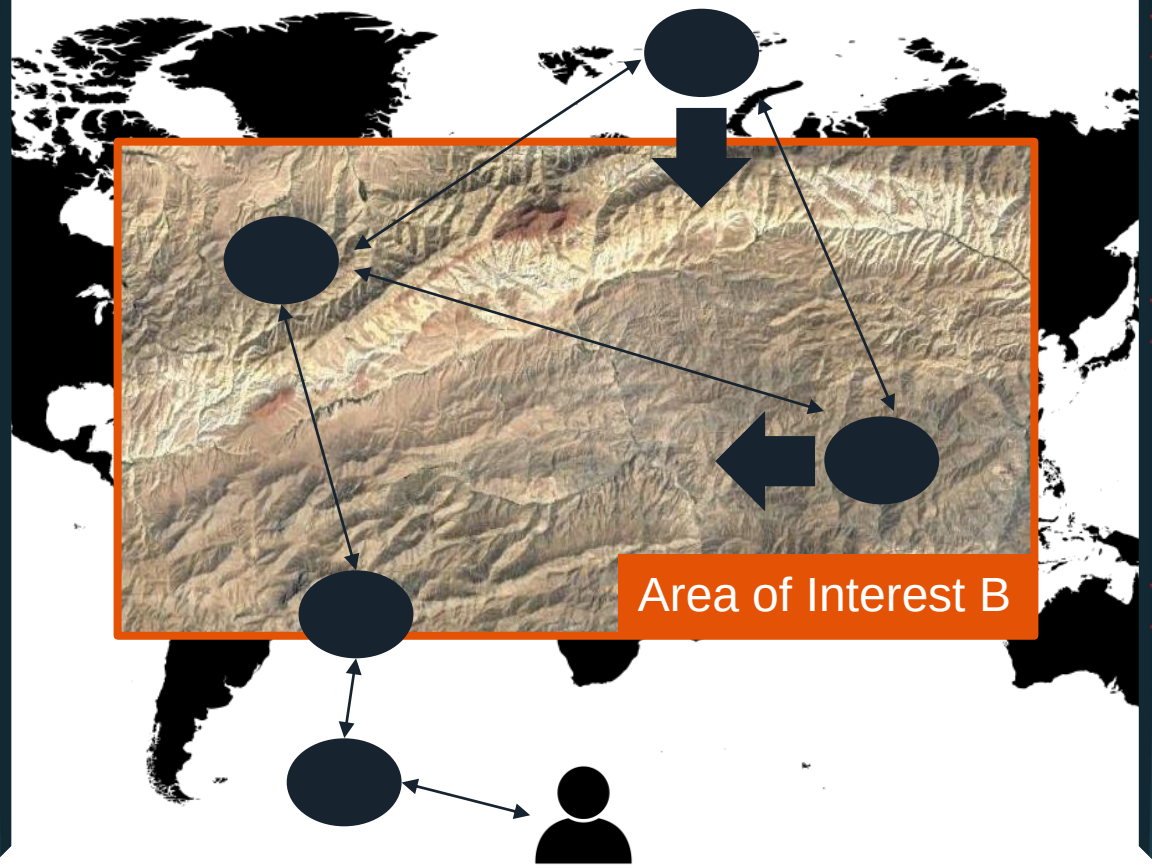
Opportunities for AI as an IFM

Artificial Intelligence is a key enabler to allow effective delegation of intent to Technology

Enterprise

Core Opportunities for AI as an IFM

- **Logistics** #Asset provision, Asset Planning, Resource Allocation, Strategic and Tactical Platform Positioning, Tasking, Demand Anticipation
- **Orchestration** #Coordination, Collaboration, De-confliction, Optimisation, Complete Force Utilisation, Coherent Operational Picture, Delegation, Fusion
- **Networks** #Wired, Wireless, Mesh, Self Healing, Cognitive Radio, Common Services, Single Information Environment, Security, Adaptive BW

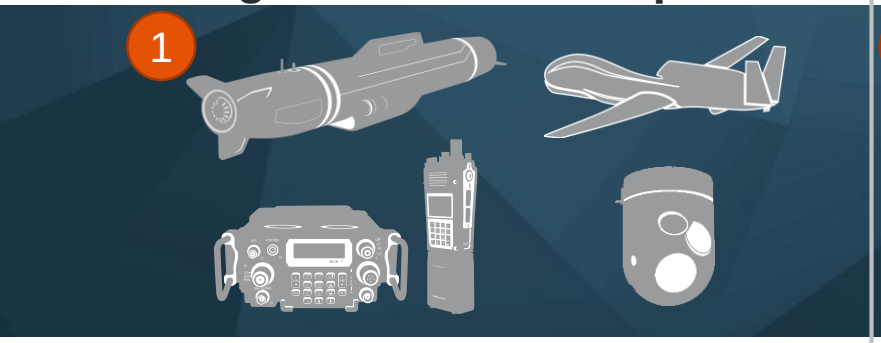


Edge Opportunities for AI as an IFM

- **Sensors** #Multi-role, Distributed Digital Signal Processing, Data -> Information, Events Reporting, Signals From Noise, Adaptable to Outliers
- **Platforms** #Unmanned, Autonomous, Air, Land, Sea Space, Augmented by Operators, Hybrid Fleet, Re-Configurable, Data and Information Fusion
- **Orchestration** #Tactical De-confliction, Optimisation, Re-use, Adaptive Multi Point Asset Utilisation, Mesh Resolution, Real Time Issue Resolution, Events

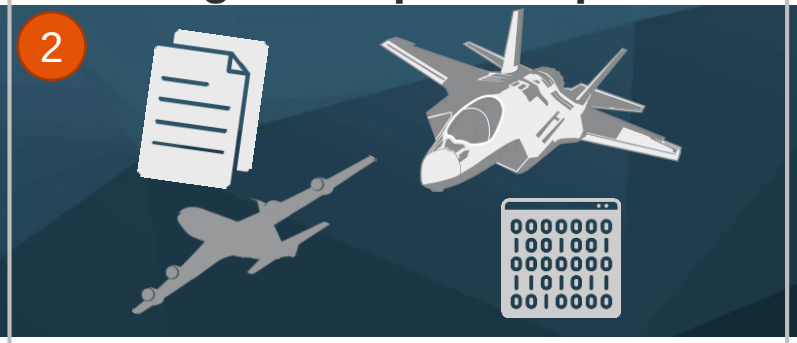
Summary of Questions

Integrated Force Multipliers



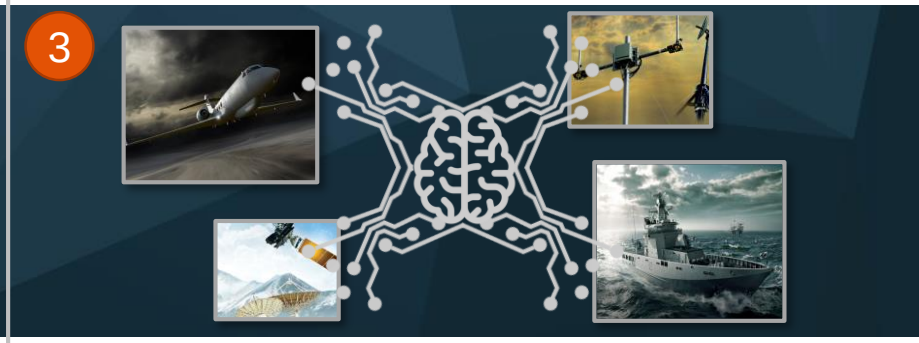
- Can the benefits of Artificial Intelligence be truly delivered without convergence with Operational Exploitation?

Evolving Concepts of Operation



- Does the advancement of Information Concepts of Operation act as the catalyst for the Operational Exploitation of Artificial Intelligence?

AI Candidate Scenarios



- Does our current operating environment prohibit the adoption of Artificial Intelligence or drive the need?

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