NATO Additive Manufacture – An industry view

Logistics Velocity
Enabled by Secure In-field
Additive Manufacturing

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TDI AdM SWG

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Topics

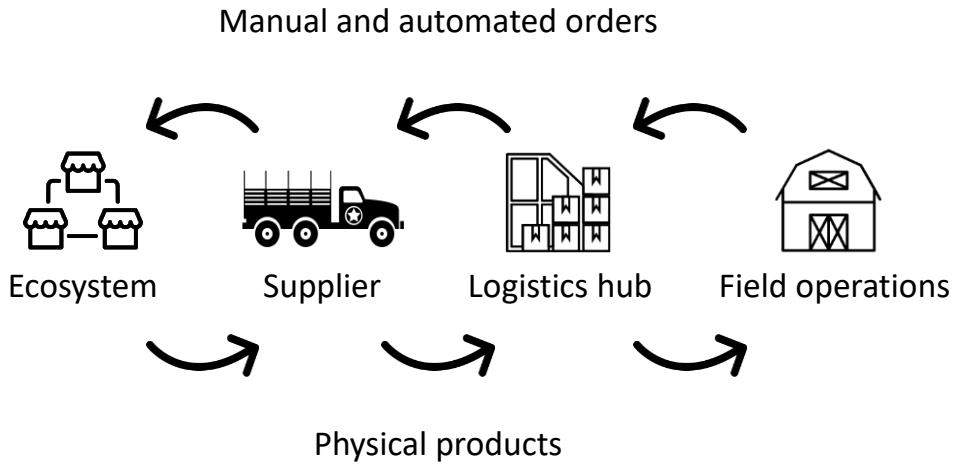
- Background
- NATO AdM Exercise
- Potential NATO AdM Study

The Logistics Challenge

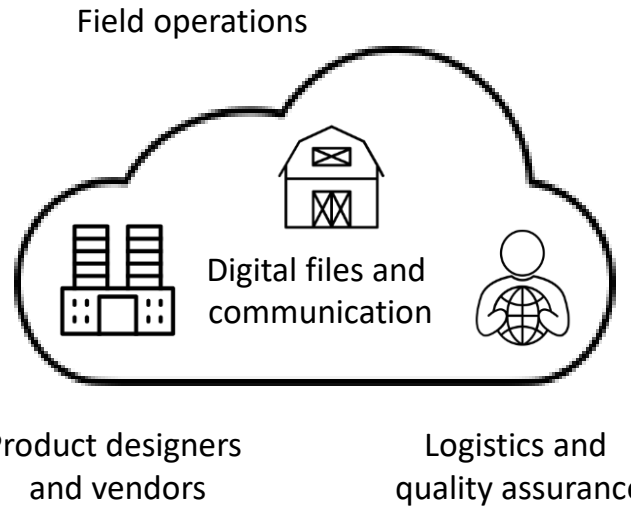
- Current conflicts require increased logistics velocity with agile and light weight support
  - Must reduce the “Iron Mountain”
  - Must reduce “Just in Case” Inventory – of each participant
  - Key to Multi-Domain Battle, Hybrid warfare, multi-national operations
- Disrupted or degraded communications in the Area of Responsibility
  - Must provide an alternate interoperable support system

Additive Manufacturing Can Turn the Physical Supply Chain Digital

Traditional supply chain



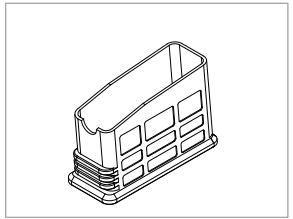
Digital supply chain



HUGE COST- AND RESOURCE INEFFICIENCIES

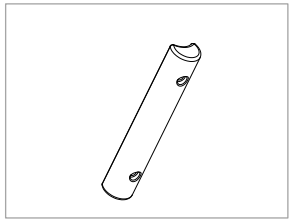
REDUCED FRICTION - POTENTIAL FOR DISRUPTION

Value Added by Implementing AdM Near the Point of Need



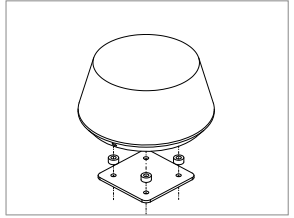
Use case #1:

Temporary Fix



Use case #2:

1:1 Spare Parts



Use case #3:

New Product Innovation

Short term benefits:

- Increased logistics agility and readiness
- Reduced response time
- Increased ability to meet unforeseen events
- Ability to produce custom products or systems in-field
- Digital interoperability instead of identical equipment

Long term benefits:

- Reduced warehousing and administration cost
- Reduced transportation cost
- Improved obsolescence management

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From the NATO Industry Forum Nov 2018

“NATO is pursuing disruptive technologies to maintain a technological edge in today’s multi-domain security environment. The process of integrating such technologies as artificial intelligence (AI), big data analytics and blockchain systems into the Alliance’s operations and mission requires steadfast collaboration with those at the forefront of technological progress.”

CWIX (Coalition Warrior Interoperability eXploration, eXperimentation, eXamination, eXercise)

- Annual Bi-SC Exercise
  - NAC Endorsed
  - Military Committee directed
  - C3 Board (C3B) guided
  - ACT directed and managed
- Bydgoszcz Poland
  - Annually in June

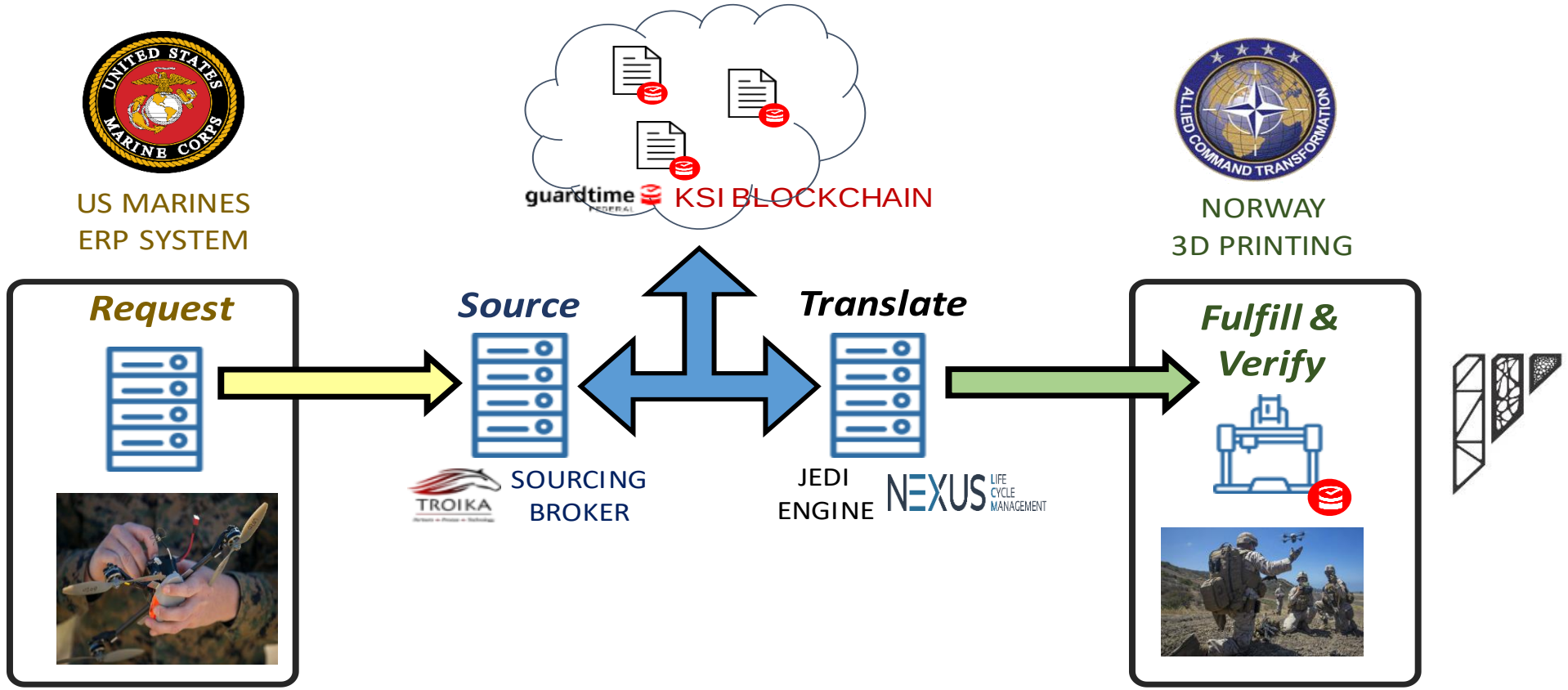
Logistics Focus Area

	Objective	Expl	Exper	Exam	Exer
1	To assess the in-field ability of national militaries to additively manufacture (3D print) polymer parts designed and specified by a third party.		X		
2	To assess the applicability of blockchain/distributed ledger technology in securing the integrity of the data exchange and process steps in the digital thread for additive manufacturing, from requirement to sourcing to data exchange to production.	X			

The Scenario

- Deployed Multinational Force executing NATO mission
- A US Marine Corps part breaks
  - Key part to a Nibbler UAV
- Request for resupply
  - Determination made that in-field additive manufacturing best solution
    - Availability of approved drawing; availability of compatible printer in the field; non-critical item
- Remote access of technical data package (part drawing)
- Drawing provided from source (in US) to field (in Poland)
  - Secured by Blockchain
- Part printed by Norwegian AdM in-field capability, installed on Nibbler
- Nibbler is mission capable

The Process



2019 NATO Communications and Information Agency (NCIA) Innovation Challenge winner

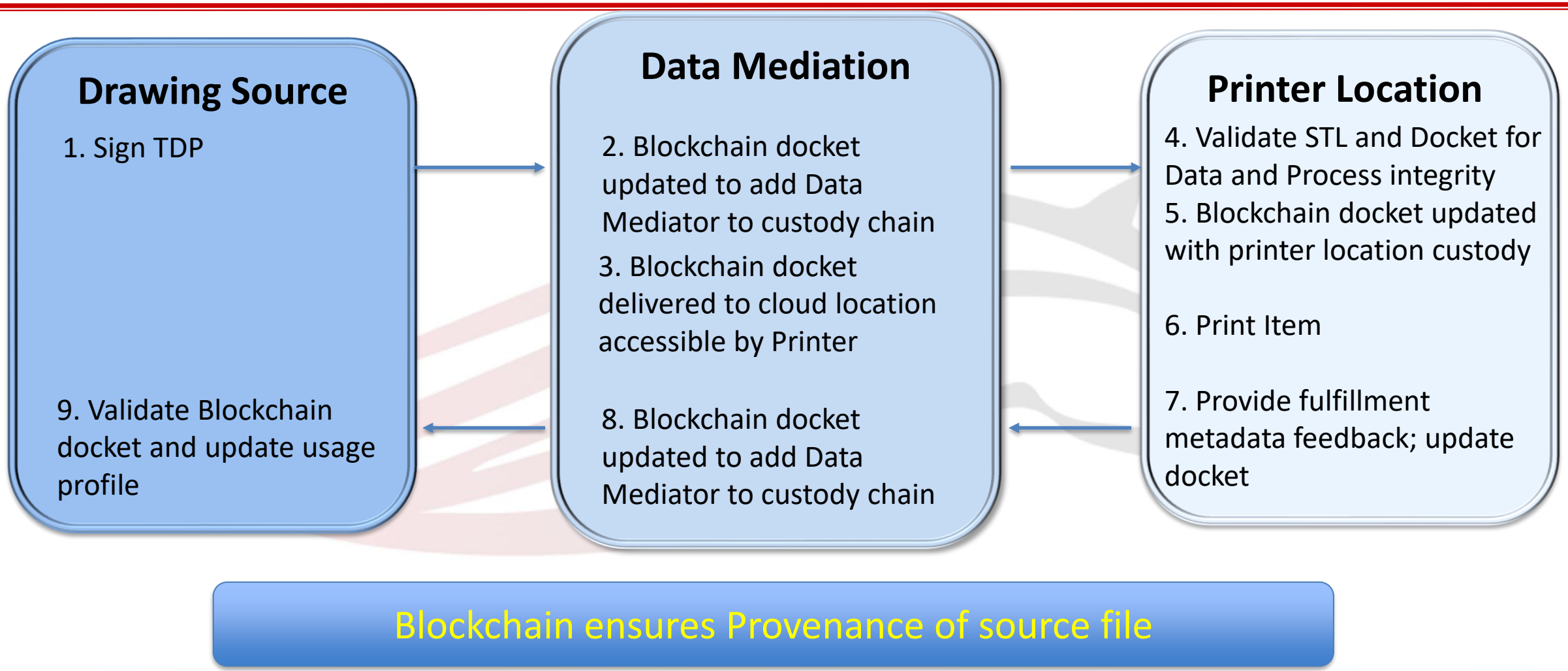
The Contributing Technologies - What

- Data Interoperability
  - Sourcing Broker
    - Supports selection of logistic support to deployed forces, including external support
    - Based on rules that consider location, priority, and available sources
  - Joint Enterprise Data Interoperability
    - Data Mediation for data and system level interoperability
    - US Marine Corps and Joint Staff J4 sponsored
- Data Integrity
  - Digital Authenticity for Military Support (DAMS)
  - Proof of concept of Keyless Signature Infrastructure (DSI) Blockchain
  - Operated by Guardtime Federal (US branch of Estonian Guardtime)
- In-Field Additive Manufacturing
  - Norwegian capability from Fieldmade (Fieldmade.no)
  - 20 Foot ISO container, self-contained, transportable, software and hardware
  - Design, 3D printing, post processing, and QA of polymer and carbon-infused polymer parts

The Contributing Technologies - Why

- Data Interoperability
  - Multinational operations require collaborative planning and operational data sharing
  - Exploit international data standards
  - Discover and transmit print files
- Data Integrity
  - Positive assurance provided by Blockchain technology that print file is authentic
    - At rest and in transit; chain of custody
    - Track print events; enables IP protection and payment
- In-Field Additive Manufacturing
  - Field level production reduces logistics tail and increases operational tempo
  - Manufacturing, post-processing, and quality testing in a standard military container for rapid deployment
  - Initial implementations executed at NATO exercises

Blockchain Assurance Concept for In-Field AdM



Outcomes of CWIX

- The design and print specifications of US parts were printed by a Norwegian printer in the field
  - 70 non-electrical parts printed in 61 hours
  - Main body took 19 hours
- The digital thread secured using Blockchain
  - Authenticated provenance of drawings
  - Ensured integrity of digital data during transport
  - Captured chain of custody

Benefits of In-field Additive Manufacturing

- Agile parts replacement in-field as needed
  - Reduces the transportation, storage, and retrograde cost of “iron mountain”
  - **One AM capability can print parts for equipment unique to a contributor in a multinational force increasing interoperability without requiring homogenous equipment**
- Issues found during operation can be identified and an engineering change designed quickly, disseminated and printed immediately
- Obsolete or out-of-stock items can be recreated
- Failures that impact mission can be addressed by stop-gap 3D printed parts

Multinational Implementation Challenges

- Harmonization between drawing specifications and printer capabilities
  - Printer manufactures can employ proprietary software to prepare designs for printing
  - Item pedigree - Certification, Identification, Print condition capture requirements
- Management of AM digital materials at rest
  - Discoverability of drawings and compatible printers
  - Ensuring proper accounting for use of intellectual property
- Visibility of common NATO Blockchain implementations to establish similar approaches
  - Ensure interoperability among Blockchain provider implementations

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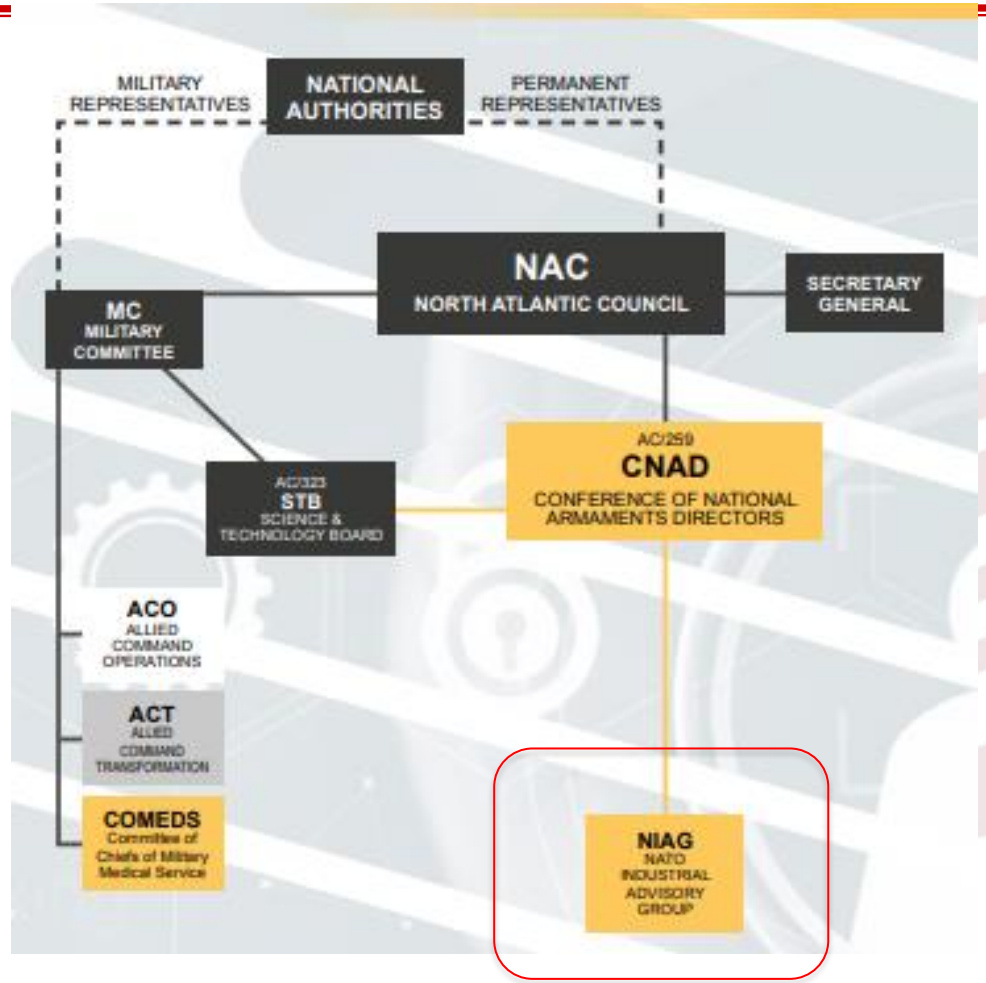
Potential NATO Study

- Conducted by industry via the NATO Industrial Advisory Group (NIAG)
- Possible NATO Sponsors
  - Allied Command Transformation
  - Alliance Committee 327 Life Cycle Management Group
- Intent: Provide Industry's view on key topics for coordinated and collaborative multi-national exploitation of AdM to support NATO operations
  - Standards – materials, print file formats, codification
  - Data sharing – discoverability, security environment
  - Legal framework – certification, IP

NATO Industrial Advisory Group



TECNICAL ADVICE TO INFORM:

- Standardisation
- Capability + Requirements Development

STRATEGIC ADVICE ON INVESTMENT IN:

- Production capabilities
- Skills and human capital needs
- Industry partnering for cooperation and consolidation
- Technology Roadmaps

The link to Life Cycle Management

- Acquisition of rights to drawings and specifications
  - Controlling and accounting for usage
  - IP infringement due to reverse engineering
- Impact to Integrated Logistic Support
  - Considerations for ALP-10 rewrite
- Implications for maintenance schedules
  - Sensor enabled part can direct resupply via printing just prior to failure

Disruptive technologies have the potential to change Life Cycle Management doctrine;
Standards will be important

Discussion