

Facilitating Operational Agility via Interoperability

A call for a common ontology to quantify multi-domain maturity in a complex environment

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Theme 8 – Communications and Interoperability

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Empowering procurement economics

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Operational Agility

- ▶ Operations are becoming increasingly complex, both in the public and private domains, increasing the need for **operational agility**

“The ability to detect and respond to (an increasing diversity of) threats in a timely and effective (and multidimensional) manner in all domains”

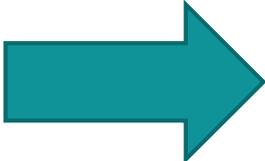
- ▶ **Operational agility...**

- ▶ ...Enables the use of resources/capabilities toward a new and larger enterprise capability
- ▶ ...Applies in coalition efforts for assistance in national disasters and warfare situations
- ▶ ...Allows for the use of capabilities independent from the entity from which the capability is provided

From Standards to Operational Agility

- Common standards
 - Interoperability at systems interfaces
 - Information exchange between coalition partners
 - Situational awareness
 - Observe-Orient-Decide-Act (OODA) loop



 Operational agility

Dealing with Complexity

- ▶ Systems can be simple, complicated, or complex
- ▶ Connecting systems enables information exchange
- ▶ Using available services serves a greater enterprise function – e.g., **internet of things** (civil) and **battlespace of capabilities** (military)
- ▶ **Complexity**: A state in which systems within systems are self-organizing or organized in an ad hoc manner
- ▶ The **butterfly effect** of modern operations – smaller capability changes in one system can significantly impact the capabilities of the whole
- ▶ The ultimate effects of connecting systems cannot be **consistently and tightly constrained**; limits of human and IT abilities

Interoperability for Operational Agility

- ▶ Exchanging information in operation requires **interoperability of system interfaces**
- ▶ Two definitions of interoperability*:
 - ▶ **Organizational**: “The ability to act together coherently, effectively, and efficiently to achieve tactical, operational, and strategic objectives.”
 - ▶ **Technical**: “The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users.”
- ▶ **Multi-domain capability** is based on both types of interoperability: integration of human resources/activities and autonomous/unmanned systems
- ▶ Improving operational agility through interoperability drives 3 outcomes:
 - ▶ **Agile system acquisition** providing **timely reaction** to emergent challenges;
 - ▶ Capability **integration by design** without constraining **national sovereignty**; and
 - ▶ **High-fidelity interoperability** between **all** capability providers.

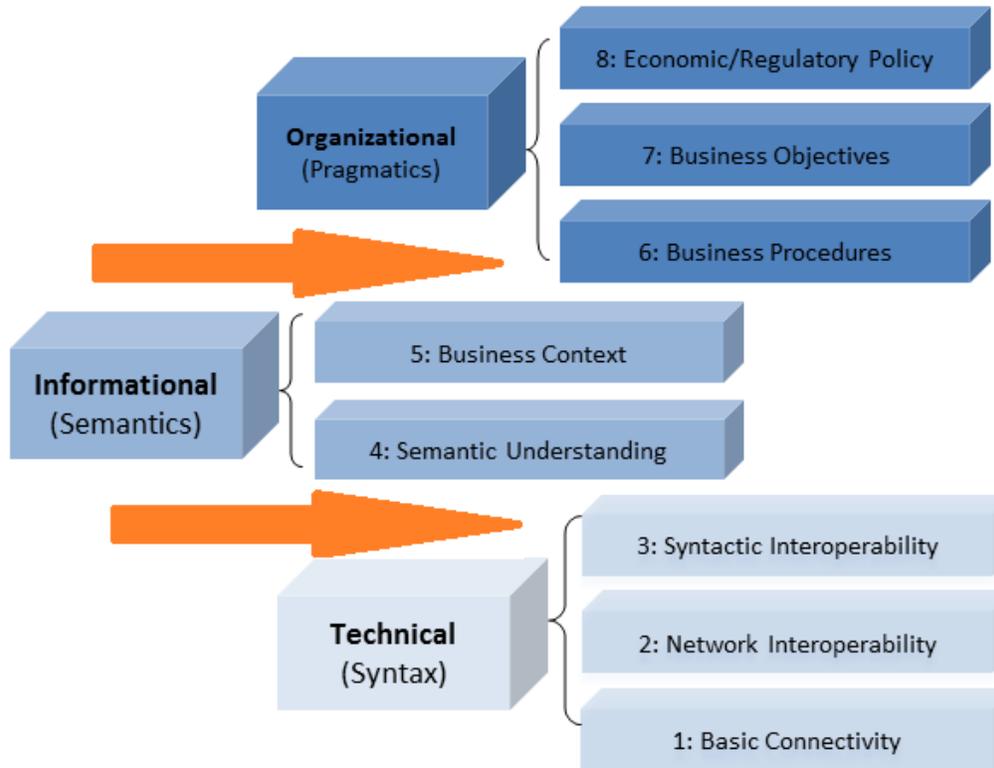
*DOD Dictionary of Military & Associated Terms, August 2017

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Role of Informational Interoperability



Adapted from: GridWise Architecture Council. 2008. GridWise Interoperability Context-setting Framework, v1.1 pp.52

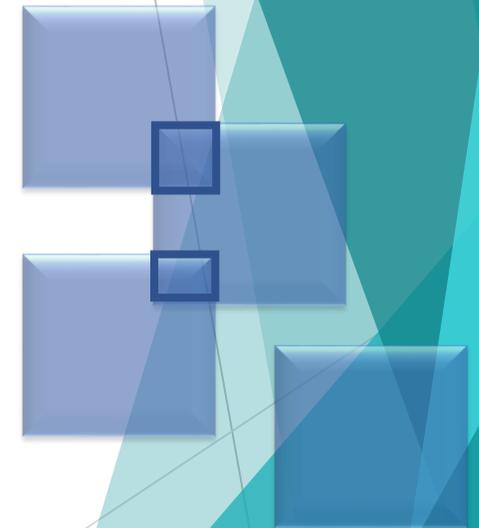
Research Outline

- ▶ **Challenge:** Current approaches to support interoperability are not comprehensive enough to improve organizational and technical interoperability in operational contexts
- ▶ **Task:** Highlight the need for a conceptual framework and methods (**Interoperability Readiness Level model**) to drive interoperability, to enhance operational agility in the military and non-military domains
- ▶ **Approach:**
 - ▶ **Framework:** Organization of concepts to provide a common **ontology** of interoperability metrics to be developed by stakeholders
 - ▶ **Ontology:** A set of concepts and categories in a subject area/domain that shows their properties and relationships
 - ▶ **Method:** Application of the ontology to connect different layers of interoperability based upon **open standards**
 - ▶ **Tools:** Implementation of the method to provide interoperability solutions

Methods for Measuring Readiness

- ▶ Methods currently exist for identifying the maturity or readiness of a technology or system
- ▶ Widely adopted (Europe and the United States)
- ▶ **Technology Readiness**: Quantifies system technical maturity
 - ▶ Measure of system functionality
 - ▶ The technology works
- ▶ **Integration Readiness**: Quantifies system integration maturity
 - ▶ Measure of (pre-planned) mission capability
 - ▶ The system works in the particular context
- ▶ *But* – none focus on operational agility, which requires more!

System Interoperability Sphere



TRL

- TRL 1 Basic principles observed
- TRL 2 Technology concept formulated
- TRL 3 Experimental proof of concept
- TRL 4 Technology validated in lab
- TRL 5 Technology validated in relevant environment
- TRL 6 Technology demonstrated in relevant environment
- TRL 7 System prototype demonstration in operational environment
- TRL 8 System complete and qualified
- TRL 9 Actual system proven in operational environment

Fundamental Research

Industrial Research

Experimental Development

Typical Product Innovation Life Cycle

Product Idea

Solution Design

Prototype

First Test Products

Commercial End Products

Curiosity Driven Research

Solution Exploration

Prototyping

Original development of a limited volume of first products/services in the form of a test series

Commercialisation of products/services (may include commercial development activities: e.g. quantity production, customisation, integration, etc)



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Dutch Ministry of Defense: PCP for an ICT Solution on mobile radio interoperability



Ministerie van Defensie

- ▶ Two main challenges:
 - ▶ **Lock-in** to particular providers - Full interoperability between radios only possible between the same providers
 - ▶ Current solution to carry multiple radios is physically limiting and **compromises the effectiveness** of military operations
- ▶ Approach: engage with the market through a **Pre-Commercial Procurement** (purchase of R&D services) for an interoperability solution
- ▶ Selected for eafip (European Assistance for Innovation Procurement) assistance
- ▶ Current open market consultation: TED Notice at <http://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:129741-2018:TEXT:EN:HTML&src=0>



(Source: <http://eafip.eu/assistance/procurers-receiving-assistance/ministerie-van-defensie/>)

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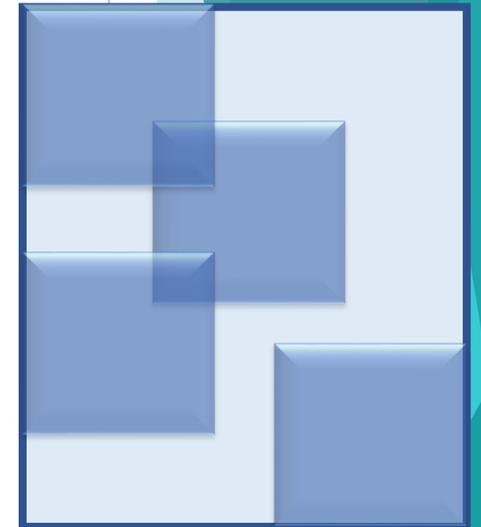
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Interoperability Readiness Level Model

- ▶ A conceptual framework and methods which focus on operational agility, for ad-hoc (“on-the-fly”) composability of capabilities
 - ▶ From a **complexity science** standpoint
- ▶ **Interoperability Readiness Level (IRL)**: Quantifies system multi-domain maturity
 - ▶ Readiness to support operational agility through enterprise readiness
 - ▶ The system works in an enterprise
 - ▶ Modern operations are happening in a *complex environment* – the IRL must reflect this!
- ▶ The IRL could be applied as an assessment tool to
 - ▶ Enable consistent, uniform **discussions** of interoperability across different capabilities
 - ▶ Facilitate **synchronized capabilities** and provide a visualization of the interoperability of systems in planning and executing activities

Enterprise Interoperability Sphere



Benefits of Open Standards for Interoperability

- ▶ Well-developed and well-defined **interfaces** are central to easing system adaptation
- ▶ For highest interoperability, interfaces should be based on standards which are **open** (vs de facto), **high-fidelity**, **reliable**, and **coalition-wide**
- ▶ **Referencing standards** in the public procurement best practices across alliances enables collaboration, innovation and nation-specific solutions
- ▶ Defines a **solution space** that invites products based on existing standards infrastructure – where the innovation and existing systems are clearly connected



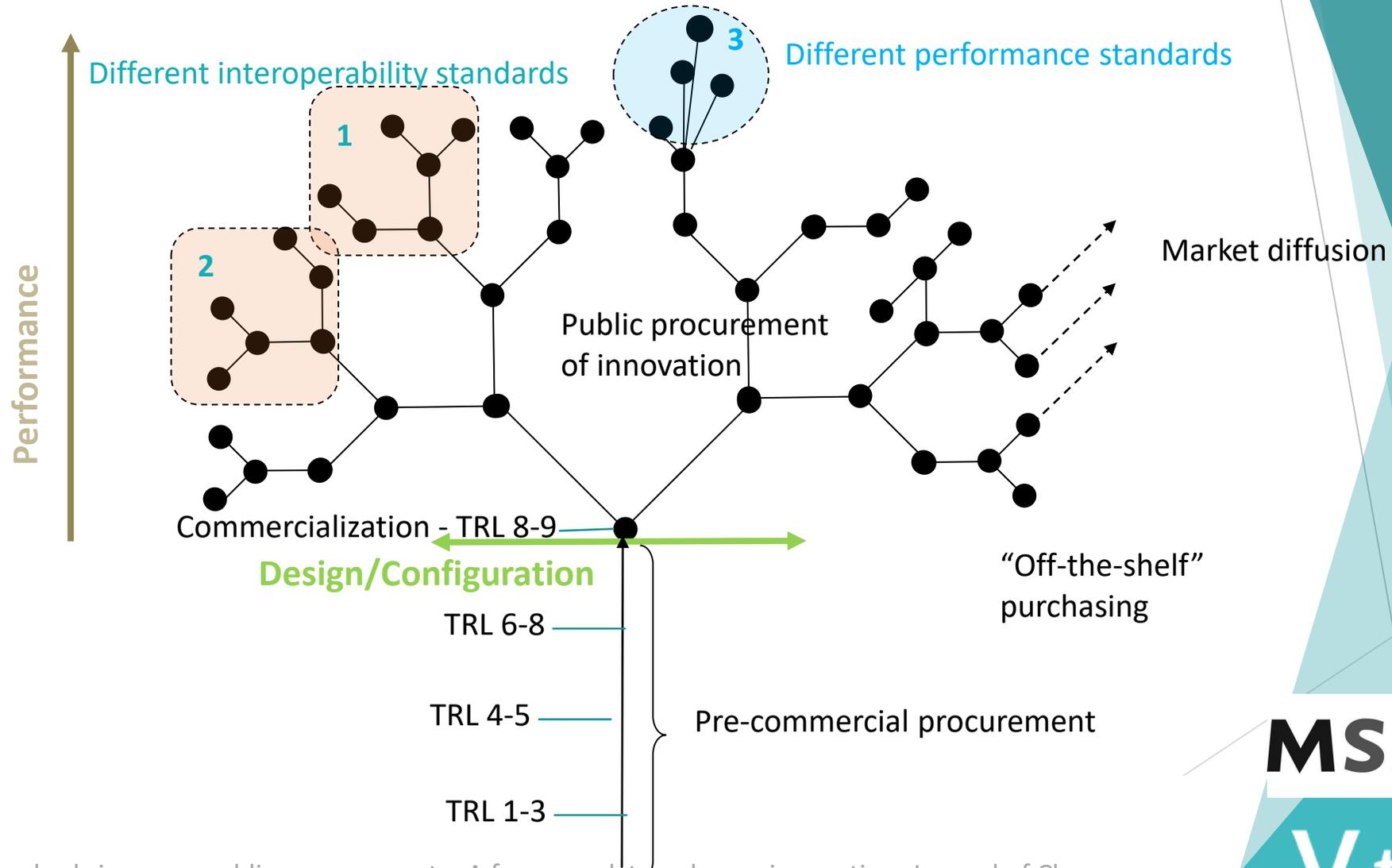
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Characteristics Space for Innovation with Standards



Rainville (2017). Standards in green public procurement – A framework to enhance innovation. Journal of Cleaner Production, Volume 167, pp. 1029-1037, <https://doi.org/10.1016/j.jclepro.2016.10.088>.

Conclusions & Recommendations

- ▶ New approaches to enabling **multi-domain capabilities** for operational agility are needed
- ▶ **Information (semantic) interoperability** can drive technical and organizational interoperability improvements
- ▶ We call for a **common ontology** of interoperability metrics, to apply based upon open (interface) standards, to provide interoperability solutions
- ▶ An Interoperability Readiness Level Model would supplement existing methods, enabling **ad-hoc composability** of capabilities in coalition efforts
- ▶ Must enable for **innovation** and “integration by design” while protecting national sovereignty

This presentation sources materials which have already been released for unlimited distribution:

- ▶ J. E. Bruzdziński, J. Selby, and A. Tolk: Challenges to Modern Allied Force Acquisition, Integration, and Interoperability; MITRE Report, 2018, Released for unlimited distribution(Case-No. 18-1151)
- ▶ J. Selby, and A. Tolk: Interoperability Readiness Levels in Support of Operational Agility; MITRE Presentation, 2018, Released for unlimited distribution(Case-No. 17-3081-11)

Thank You!

On behalf of...

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