Digital System Models:

An Investigation of the Non-Technical Challenges and Research Needs

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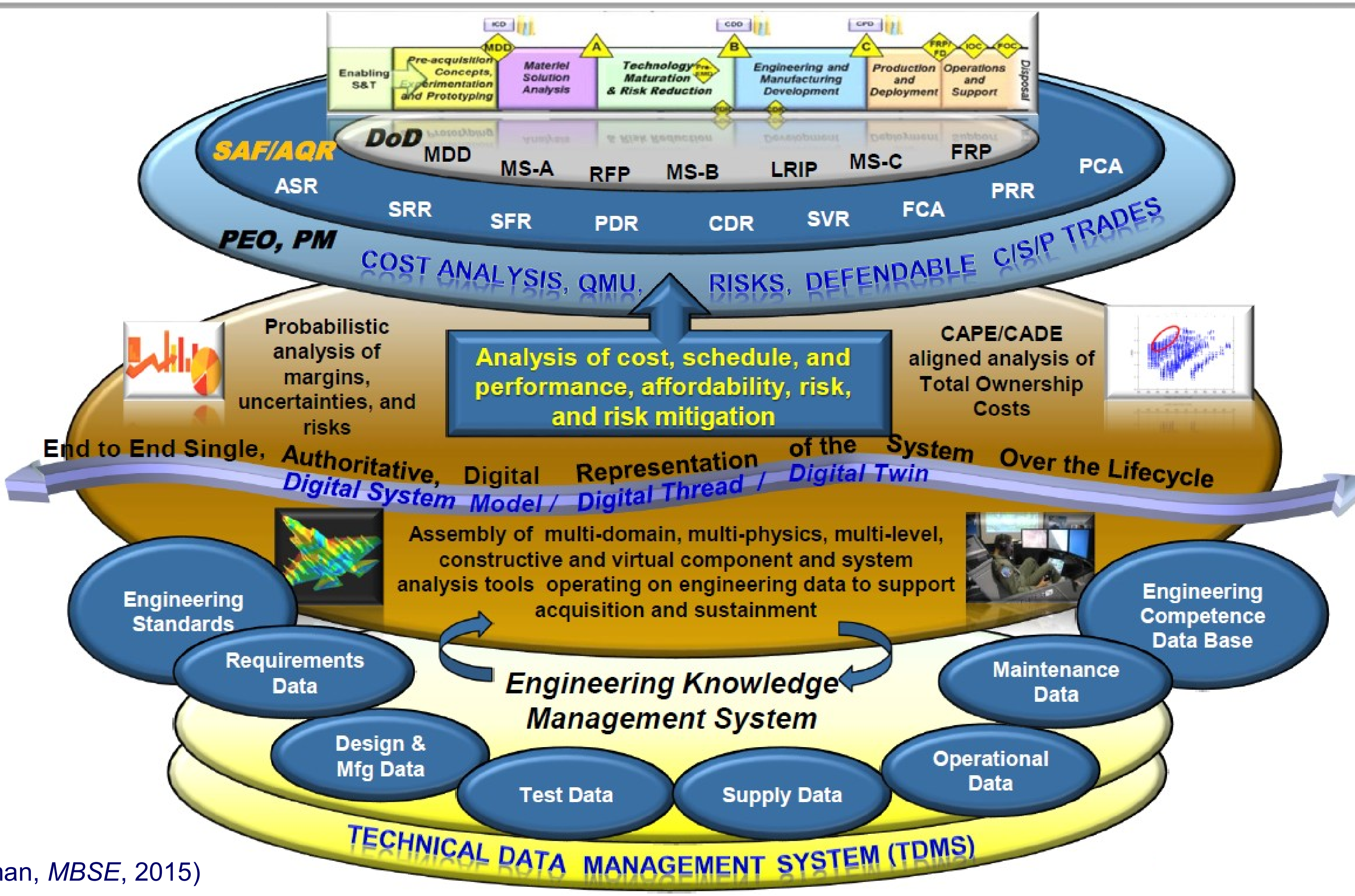
Motivation

- Non-technical challenges have not been investigated to the extent of technical ones
- Exploration of the topic intended to raise awareness of non-technical challenges
  - Focus on intellectual property and knowledge assessment
- Paper provides some illustrative examples of possible ways forward and seeks suggestions for additional ideas and research

Not to suggest that vision for digital system models is critically flawed
Not to suggest that all of the challenges are easily overcome

Digital Thread (DTh), Digital Twin (DTw), and Digital System Model (DSM)

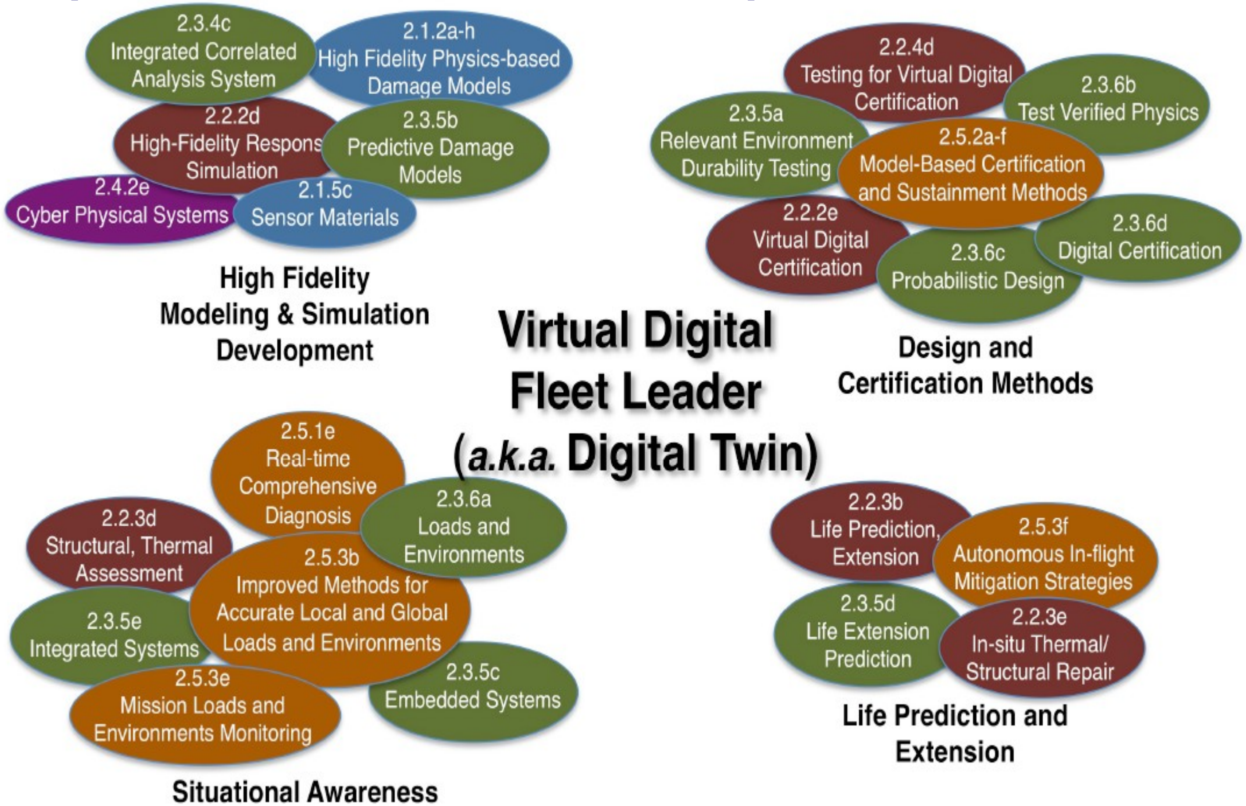
Overview of Intent



(Zimmerman, *MBSE*, 2015)

Digital Twin

- Integrated model of an as-built system
- Updated to reflect changes to system
- Used to predict performance and required maintenance



(Glaessgen, 2012)

Digital System Model and Digital Thread

Digital System Model

- Concrete, integrated model
- "A digital representation of a defense system"
  - (Zimmerman, *MBSE*, 2015)

Primary focus of this investigation

Digital Thread

- The "enterprise-level analytical framework… based on the DSM"
- Term for the general design and acquisition process that uses a DSM

Systems Engineering Advancement Research Initiative

DSM Challenges

Obstacles in a variety of fields need to be overcome

- Computational processing power (West, 2015)
- Model integration software
- Model precision & accuracy
- Change log upkeep

- Protection of intellectual property
- Cybersecurity
- Inter-model comparisons
- Acceptance by stakeholders

These challenges will not be addressed by technical solutions alone.

Intellectual Property

Intellectual Property (IP) Concerns

DSM seeks to integrate all “authoritative data and associated artifacts”

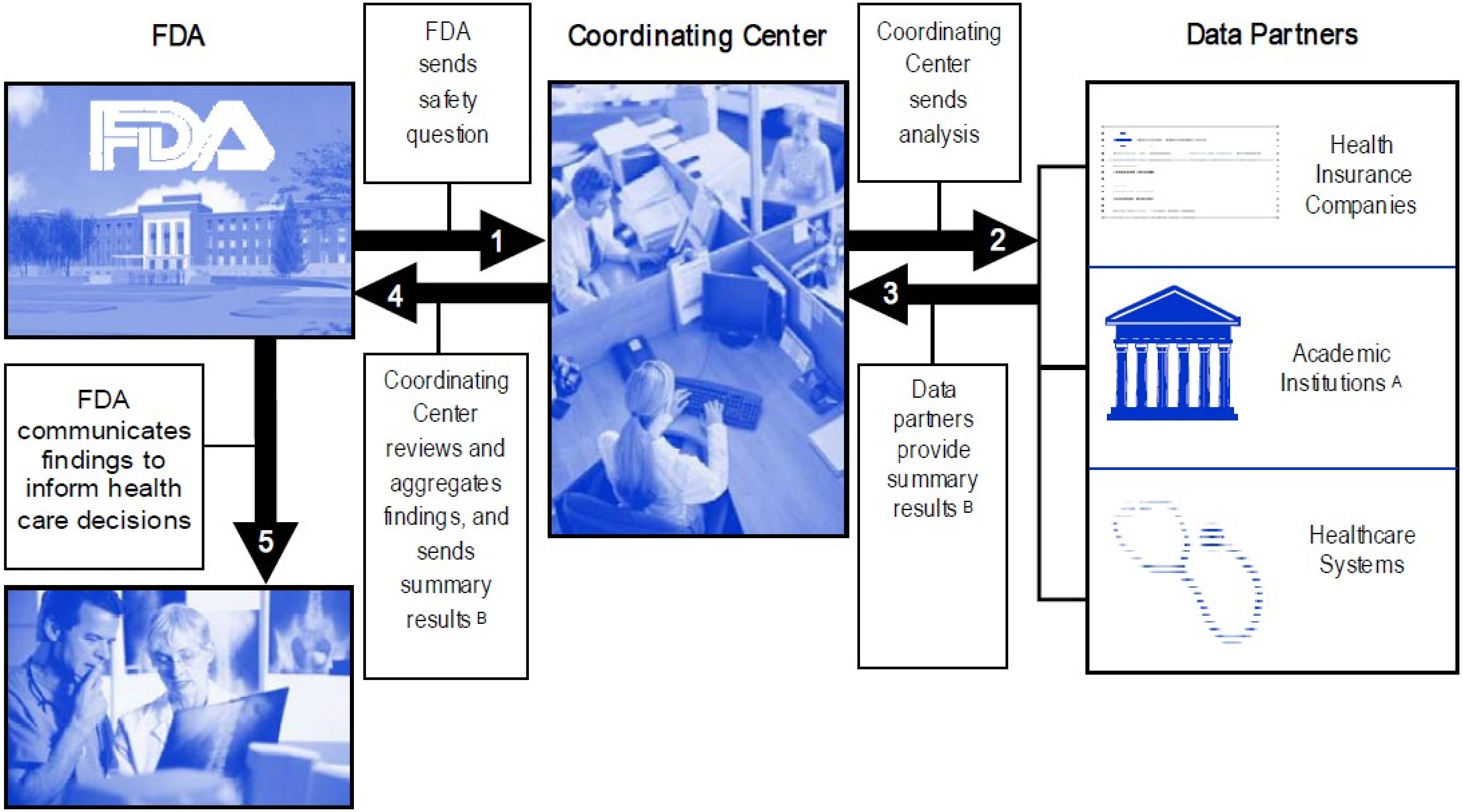
- IP is valuable
  - Would firms share?
  - Who owns IP and at what stages?
- Cybersecurity
  - The better the DSM is, the more enticing a target
  - The more locked down, the harder to use

IP Protection Tools

Patents	Copyright	Trade Secrets

• Could protect jointly developed technologies
• Requires publication (contrary to classification requirements)
• Primarily useful for protecting structure of DSM (modeling packages, data exchange methods, computational devices)
• Not as useful for specific designs, experimental data, etc.
	• Limited application to DSM
	• Can protect specific software packages
	• Cannot protect technical underpinnings of software packages
	• Cannot protect experimental data
		• DSM will require sharing between firms (unless DoD is sole holder of DSM)
		• NDAs are commonly used tool
		    • Time-consumptive
		    • Limitations on enforceability
		• Excessive NDA use could limit reusability of project materials

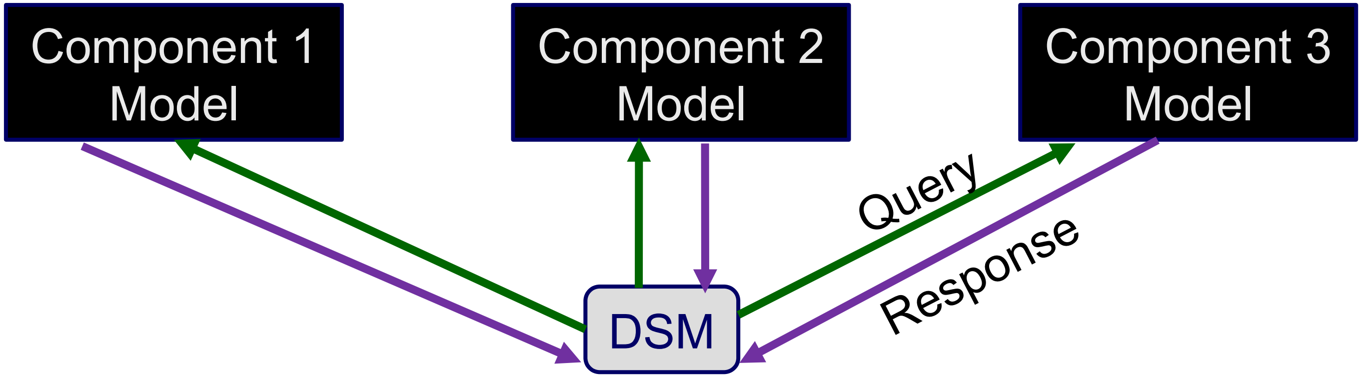
Comparison: FDA Sentinel Initiative



(OMP, 2010)

Comparison: FDA Sentinel Initiative

- HIPAA restrictions on sharing similar to firms wanting to protect IP
- Decentralized system
  - Treat modeling software and models generated as black boxes
  - Could protect IP of firms involved with DSM



Knowledge Assessment

Knowledge assessment (KA) is defined in this context as the assignment of validity to any particular piece of information or expertise.

Generating Digital Model Buy-In

- Trust and Willingness
- Access to examples, assumptions, methods, proof
  - DoD Metadata Registry
  - DoD Modeling & Simulation Catalog
- Visualization: *Not just aesthetics*
  - Can affect risk aversion, ability to negotiate, willingness to use a tool, etc. (Park, 2007)
  - If no standard exists, differences can cause misinterpretations of data

Potential DSM Structures

Model Package Development

	Pros	Cons
DoD Developed	Reduces IP disputes Can maintain access Eliminates inter-model comparisons Based on CREATE (Kraft, 2015)	Does not utilize industry expertise Requires DoD to maintain and update
Heterogeneous, Privately-Developed	Fully leverages competitive industry Minimizes DoD effort	Does not resolve IP disputes directly Requires inter-model comparison Potential lack of continued access
Homogenous, Privately-Developed	Reduces IP disputes Partially leverages industry Reduces DoD effort Eliminates inter-model comparisons	Introduces miniature monopolies Potential lack of continued access Does not minimize DoD effort

Model Use

	Pros	Cons
Centralized – Single Copy	Reduces security risk	Difficulty in updating Hampers iterative design
Centralized – Multiple Copies	Allows for iterative design	Few firms can host full DSM Increases security risk Does not address IP disputes Requires syncing
Distributed	Reduces IP disputes Allows for iterative design	Requires transition to centralized during hand-off to DoD Potentially technically difficult Increases simulation-run times Increases security risk

Discussion

Some of the decisions made regarding these non-technical issues can profoundly impact the technical aspects of DSM

- Additional investigation and consideration of non-technical challenges is important
- New technological tools may give us additional ways of addressing these non-technical issues
- DoD has to play multiple roles in the development of DSM
  1. Customer: Financial incentive
  2. Standards Enforcer: Regulatory incentive
  3. Neutral Mediator: A non-competing party with whom information can be shared
- Other potential DSM structures need to be explored and compared

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Questions?

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