SYSTEMS ENGINEERING RESEARCH CENTER

Software Systems Engineering for the Development, Deployment, and Exploitation of Artificial Intelligence / Machine Learning-Based Systems at the Tactical Edge

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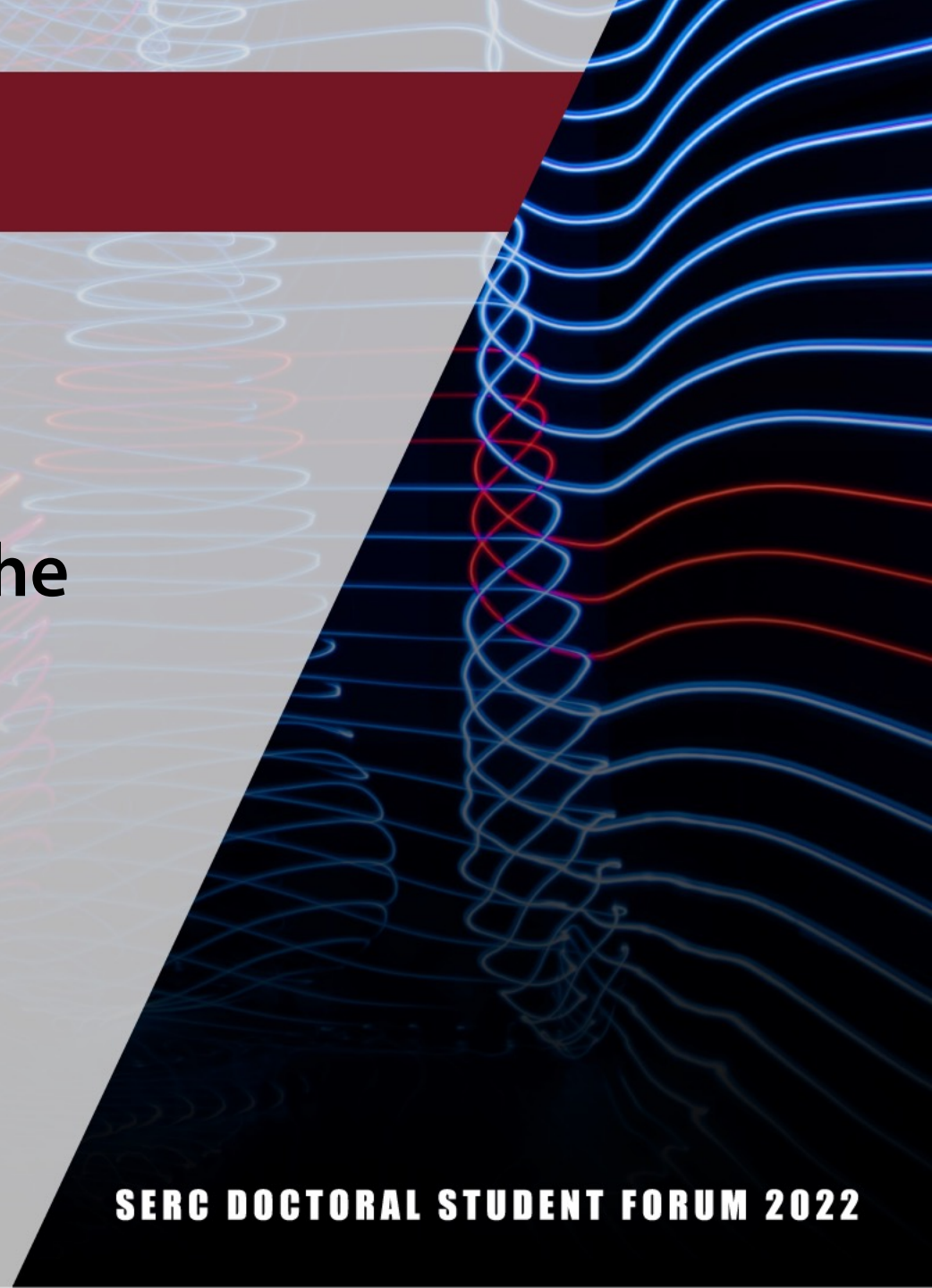
NAVAL POSTGRADUATE SCHOOL



SERC DOCTORAL STUDENT FORUM 2022

Outline

- Bottom Line Up Front
- Problem & Significance
- Department Complications
- Problem Decomposition
- Holistic Framework
  - Non-Technical Aspects
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  - Technical Aspect Tool Example
- Closing Remarks

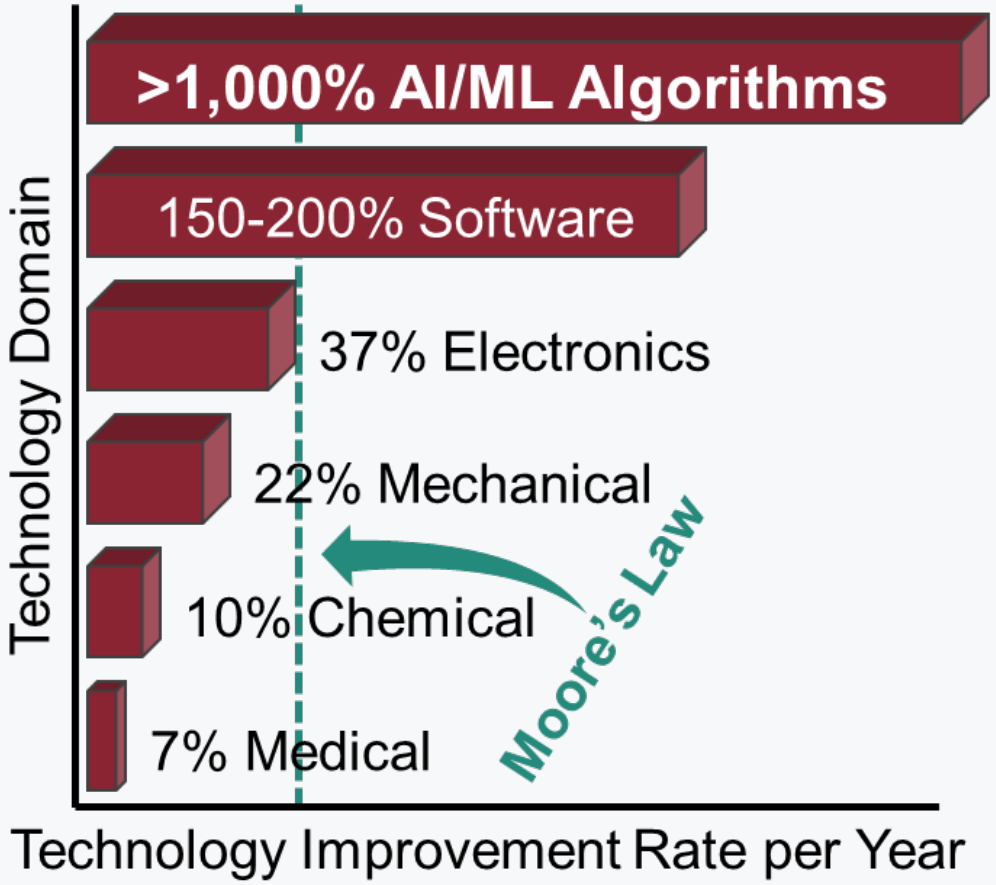
Bottom Line Up Front

- The DOD is dependent upon AI/ML to enable its future operational warfighting concepts
- To be great at AI/ML, an organization must first be fluent in modern software practices
- The DOD is not fluent in modern software practices and lacks the foundational prerequisites to enable modern software practices
- The DOD has unique AI/ML requirements beyond the commercial sector; DOD AI/ML development and delivery is more complex

This research will develop a holistic theoretical framework to successfully enable DOD AI/ML solutions at every phase of their lifecycle

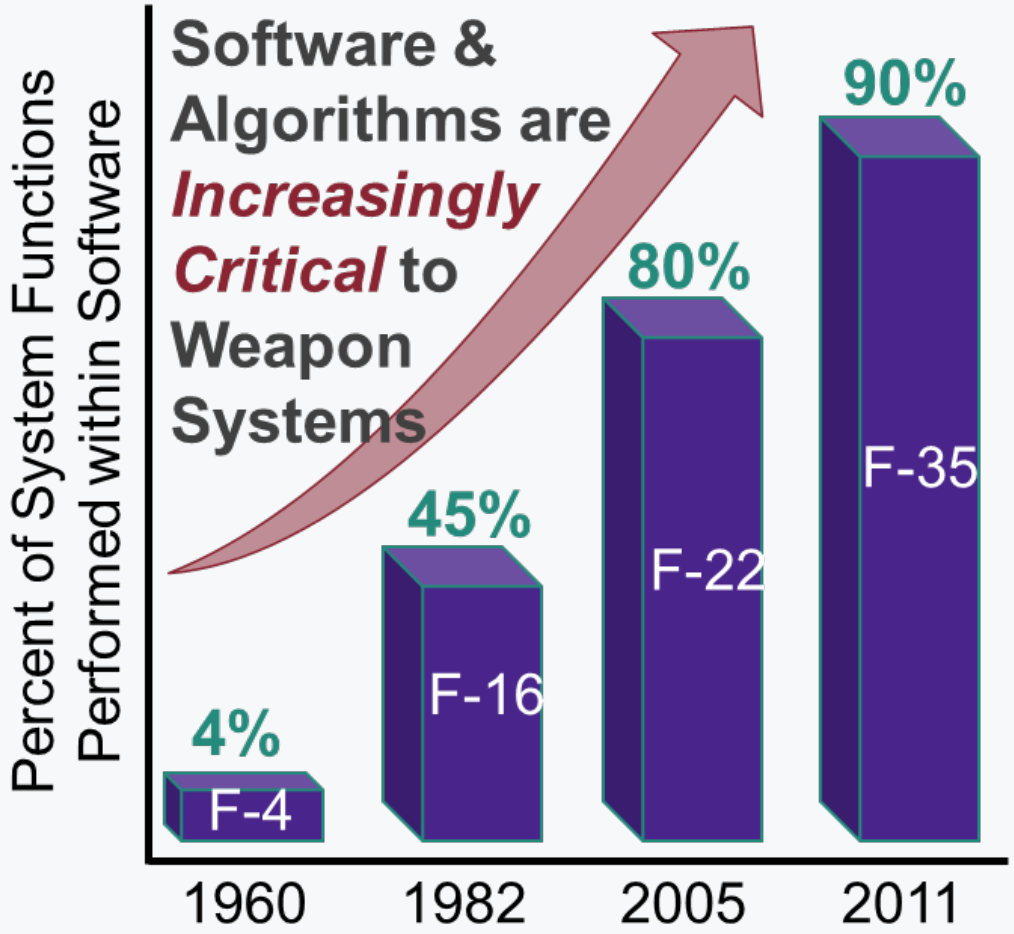
Problem & Significance

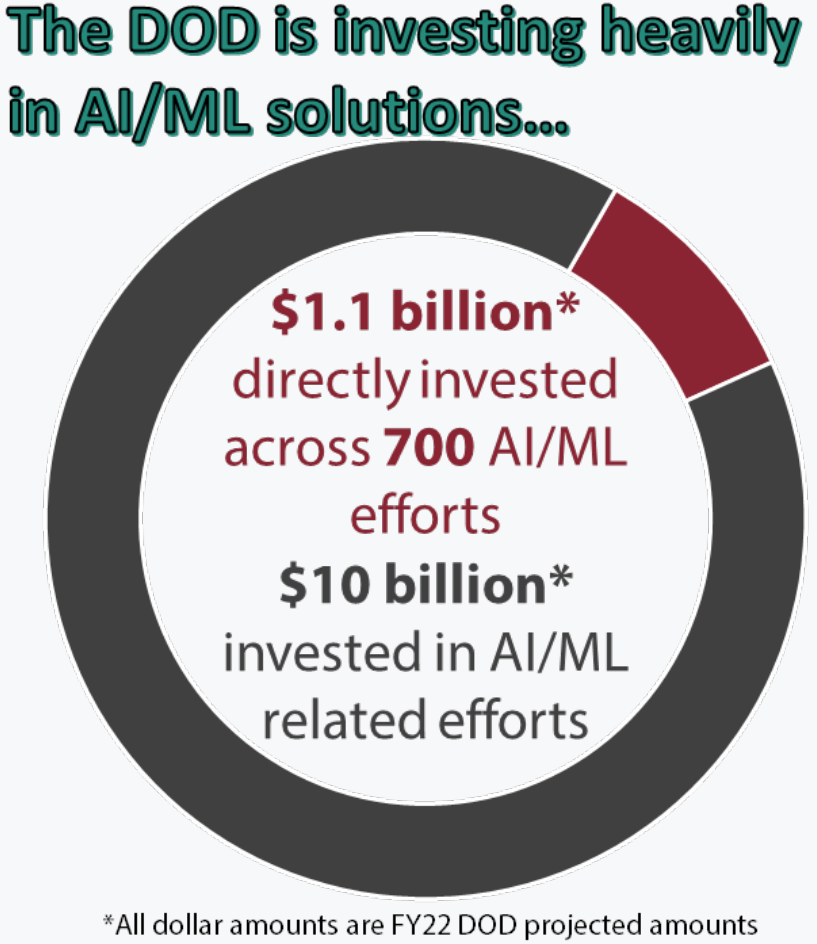
- AI/ML is ***rapidly evolving*** and ***actively transforming*** the battlespace



Problem & Significance

- Software & algorithms are ***increasingly critical*** to weapon systems





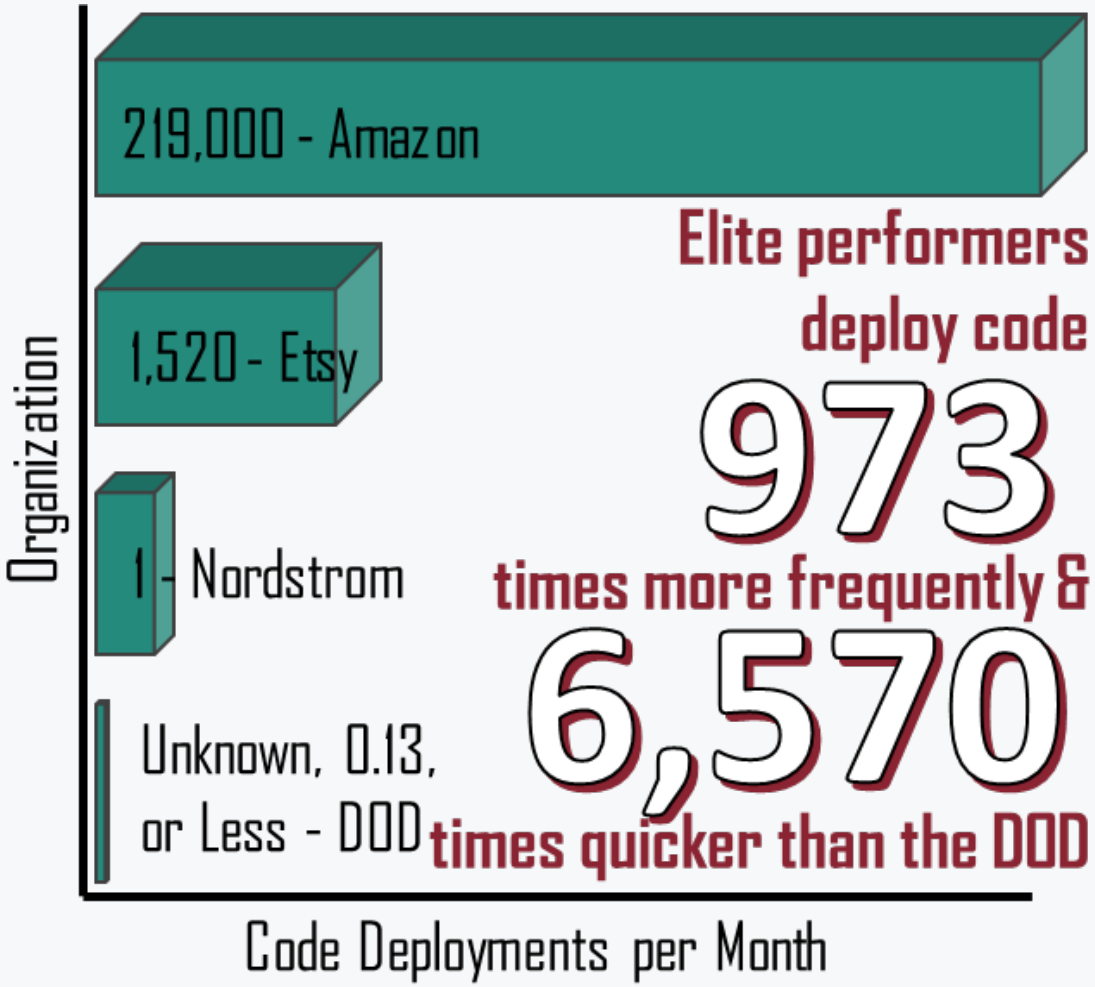
*All dollar amounts are FY22 DOD projected amounts

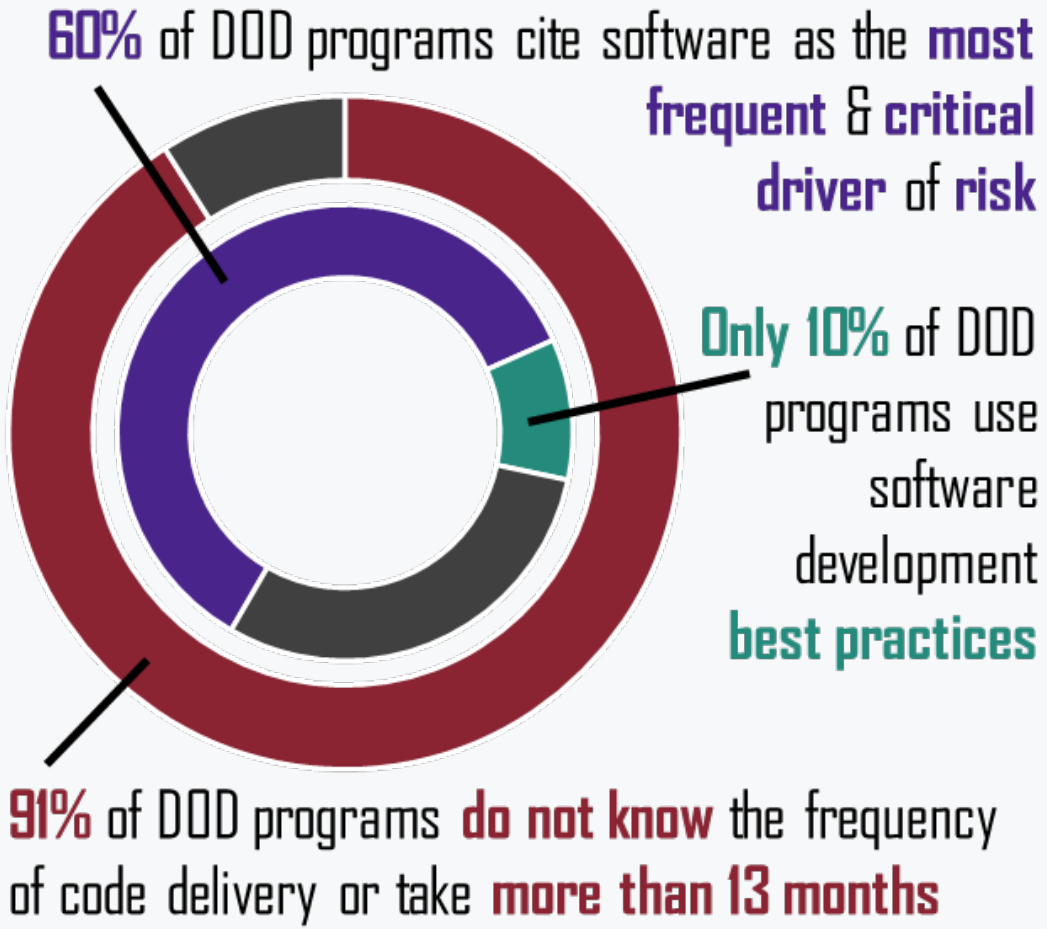
Problem & Significance

- To be ***great*** at AI/ML, an organization must first be ***fluent in modern software practices***
- For organizations considered ***"digitally native"*** with ***years*** of experience in modern software development and deployment, successful AI/ML implementation is ***difficult***

- ***30%*** of application deployments ***fail***
- ***29%*** of IT project implementations are ***unsuccessful; 20%*** are ***unrecoverable***
- ***75%*** of customers rate their app. as ***failing***
- ***87%*** of AI/ML models are ***never deployed***

How Does the Department Compare? (Hint: Not Well)





Additional Department Complications

- ***Unique*** and ***stringent*** AI/ML requirements ***beyond*** the commercial sector
  - Acquisition methodology of "lift-and-shift" or "rip-off and deploy" will ***fail***
- The Department's operating model for acquisition ***barely works*** for hardware-centric systems & ***currently fails*** for software centric systems
  - Programs are, on-average, ***30 months behind schedule***
  - Capability delivery takes, on-average, ***130.6 months or almost 11 years***
- AI/ML solutions ***must*** make use of legacy platforms
  - Average platform age: ***17 years old***

Department Complications Summary

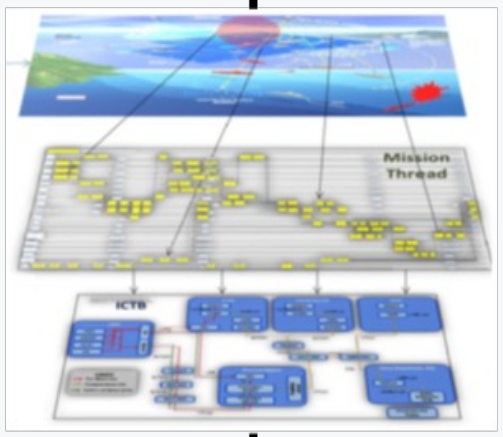
"The current approach to software development is ***broken*** and is a ***leading source of risk*** to DoD: it takes ***too long***, is ***too expensive***, and exposes warfighters to ***unacceptable risk*** by delaying their access to tools they need to ensure mission success" (DIB, 2019, pp. i).

Now what?

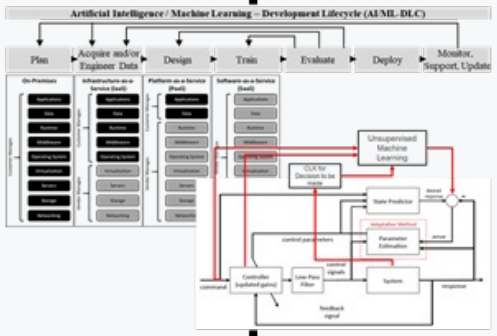
Decomposing the Problem

Analysis & Extraction of Shortcomings

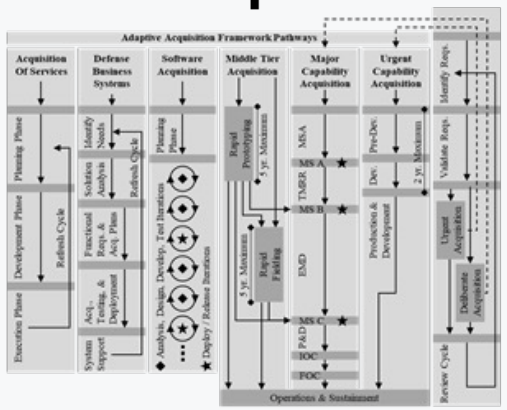
Future Warfighting Concepts



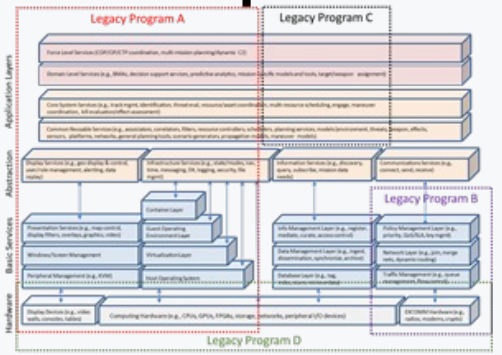
Unique DOD AI/ML Requirements



Current DOD Operating Model



Force Composition, Capability Dev. & Delivery



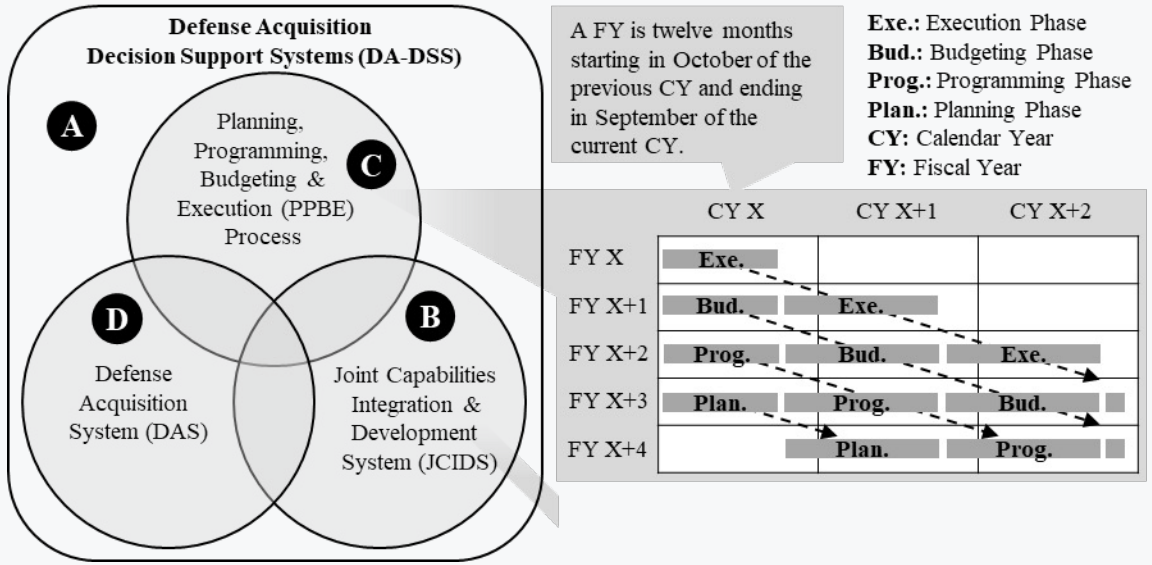
Instantiation & Mapping to Future Operating Model & Architecture

Framework to Address…

- Develop a ***holistic*** theoretical framework to successfully enable DOD AI/ML solutions at every phase of their lifecycle
  - Develop DOD ***acquisition guidelines*** to address management, contracting and resourcing ***shortcomings*** of AI/ML solutions
  - Develop a ***flexible*** and ***scalable*** AI/ML delivery platform architecture along with ***legacy platform*** integration and modernization methods
  - Create ***reusable*** artifacts for ***model training, design*** and ***architecture discovery***

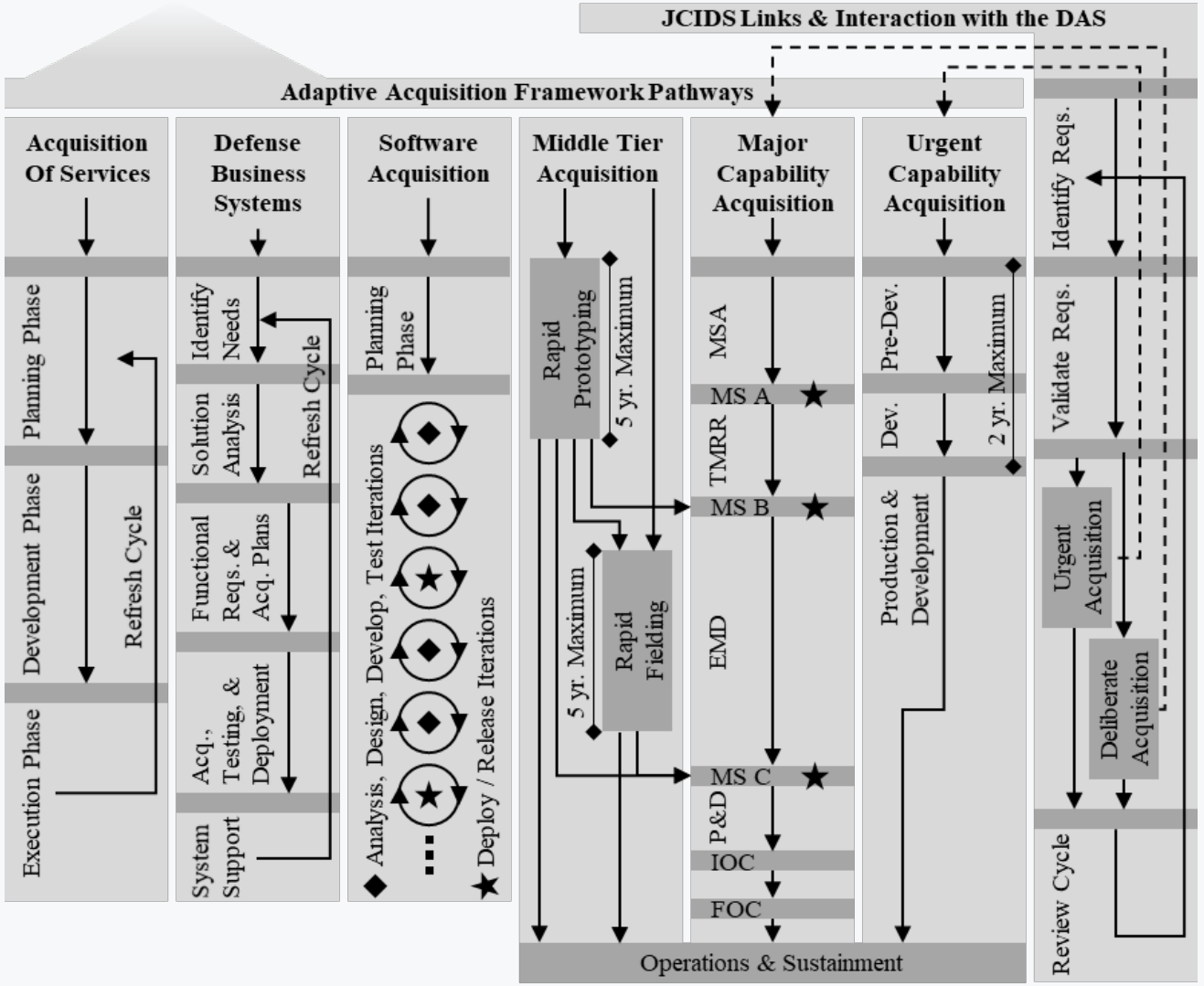
Non-Technical Aspects

- Addressing acquisition management mapped to the AI/ML lifecycle
- Addressing resourcing



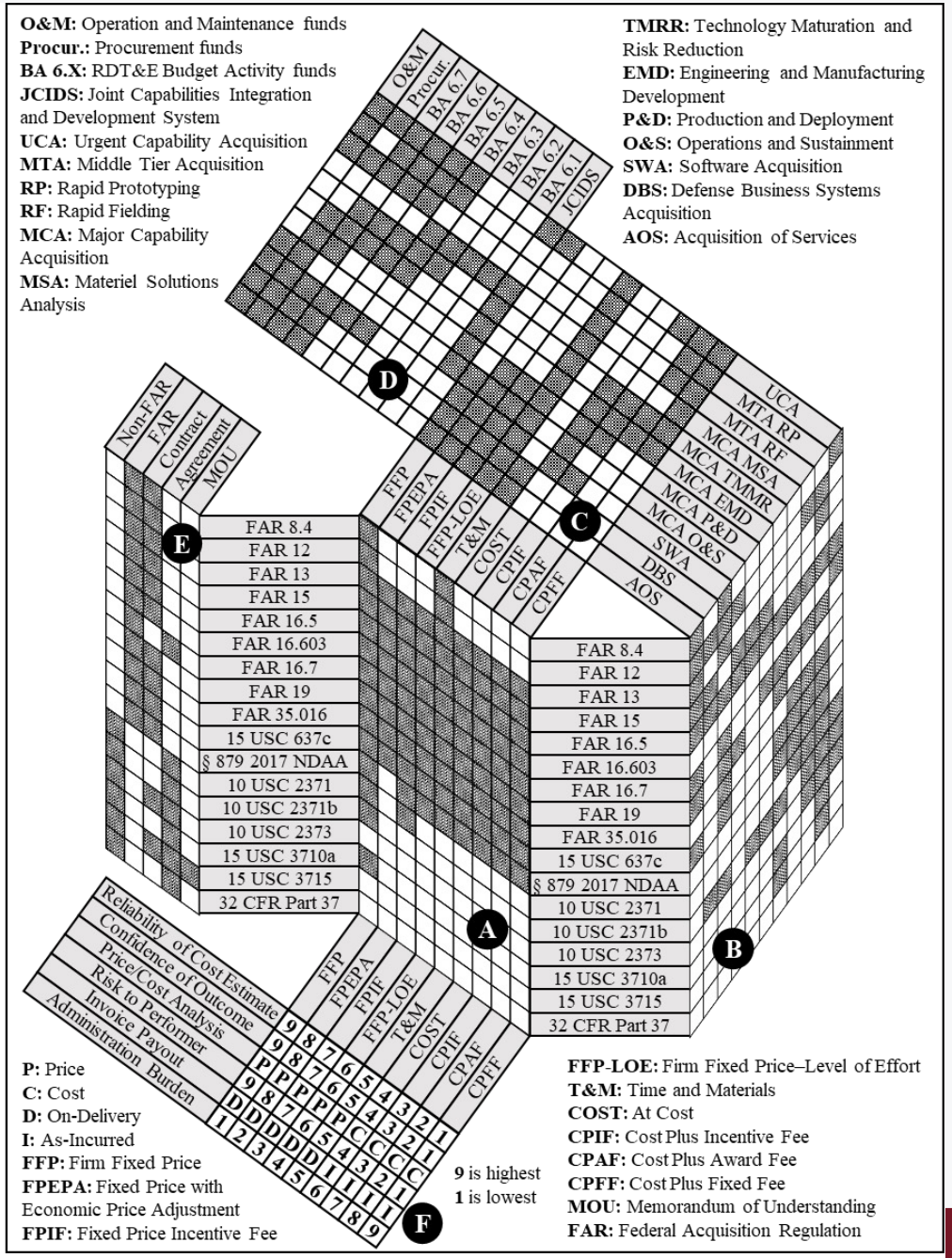
A FY is twelve months starting in October of the previous CY and ending in September of the current CY.

Exe.: Execution Phase
Bud.: Budgeting Phase
Prog.: Programming Phase
Plan.: Planning Phase
CY: Calendar Year
FY: Fiscal Year

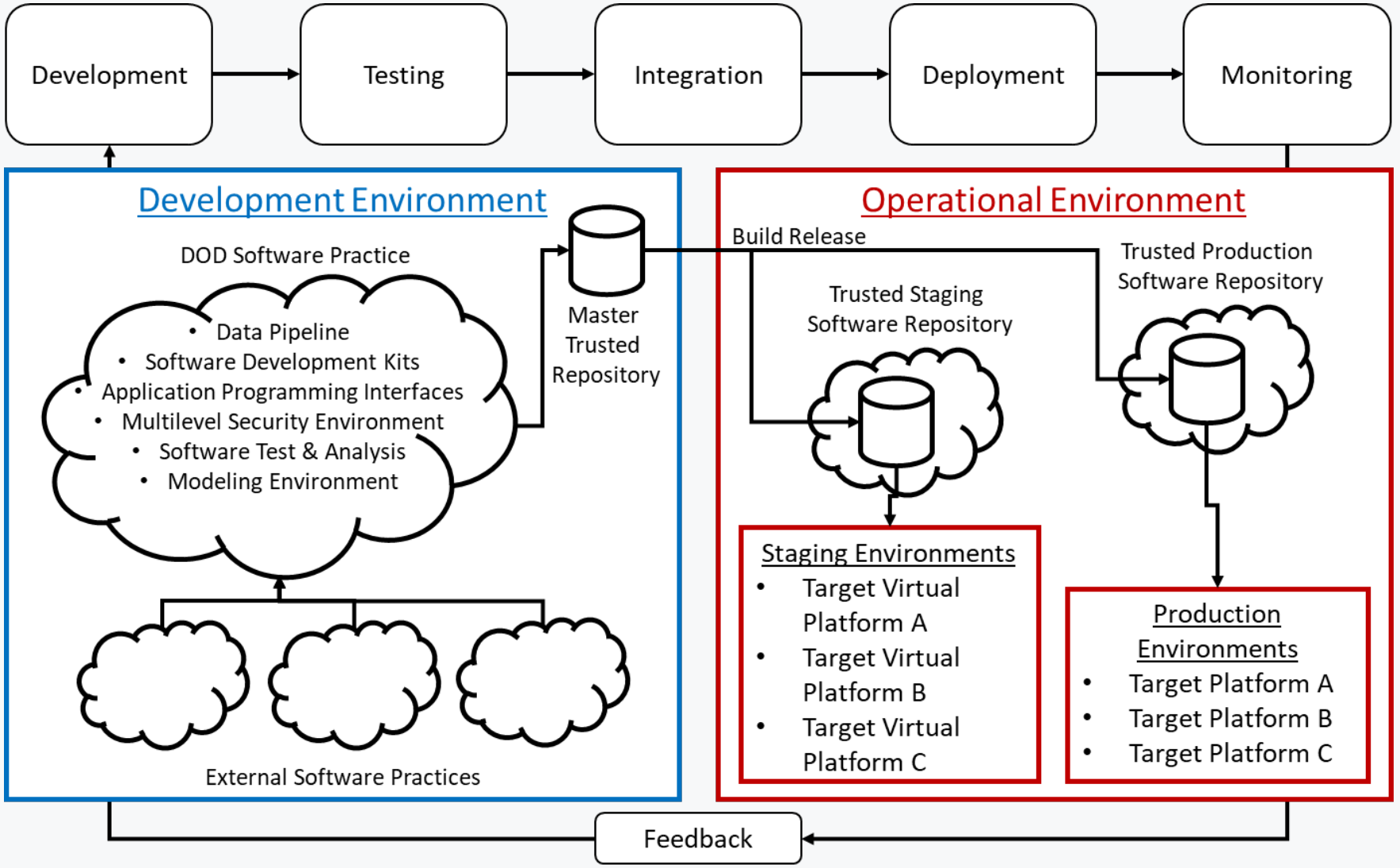


Non-Technical Aspects

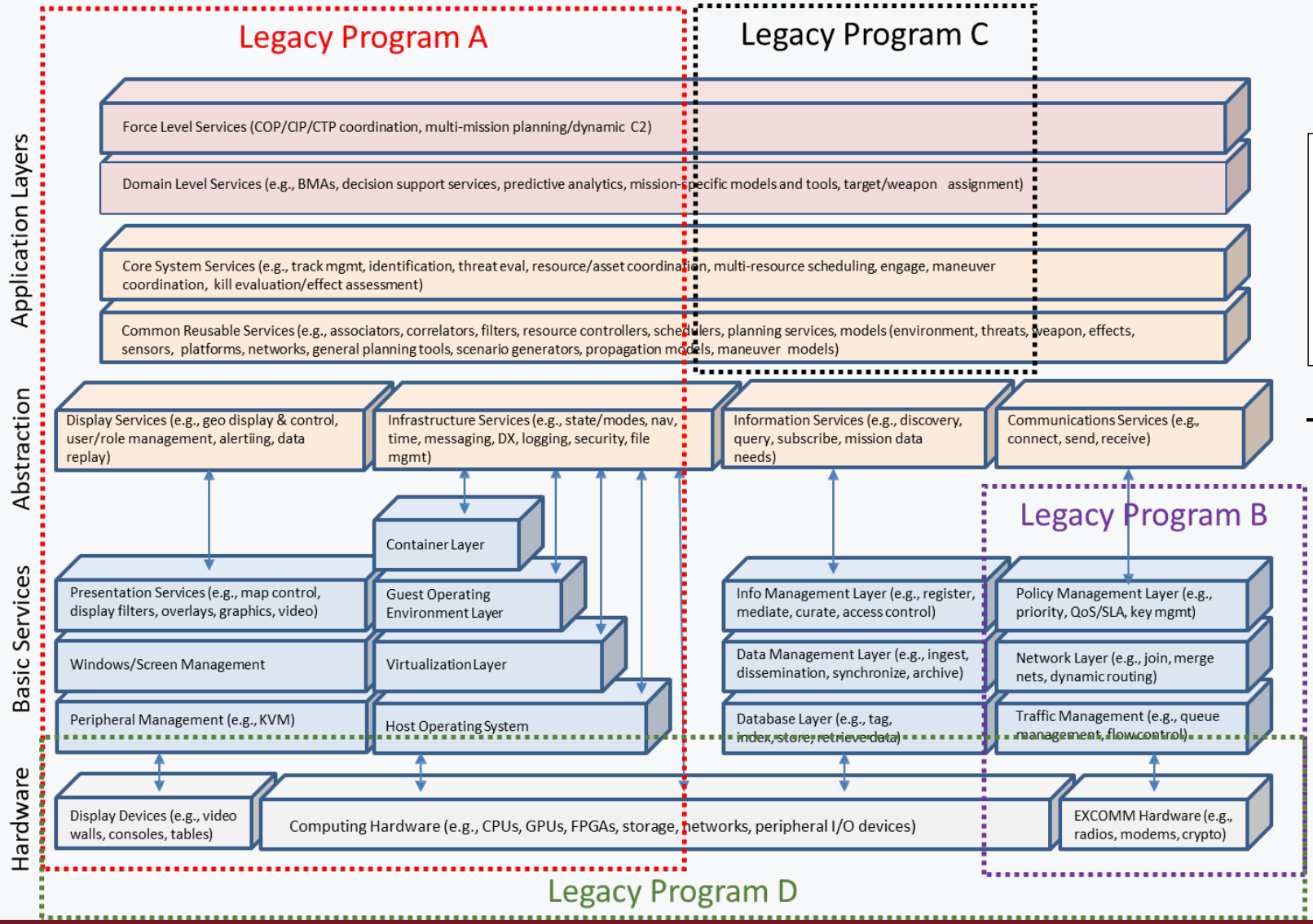
- Addressing contracting:
  - Types
  - DIDs
  - CDRLs
  - PSCs
  - DD254
  - Data Rights

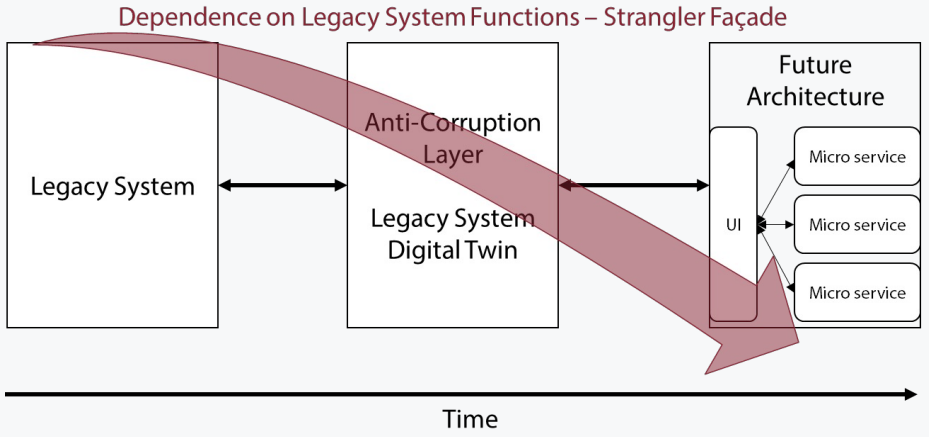


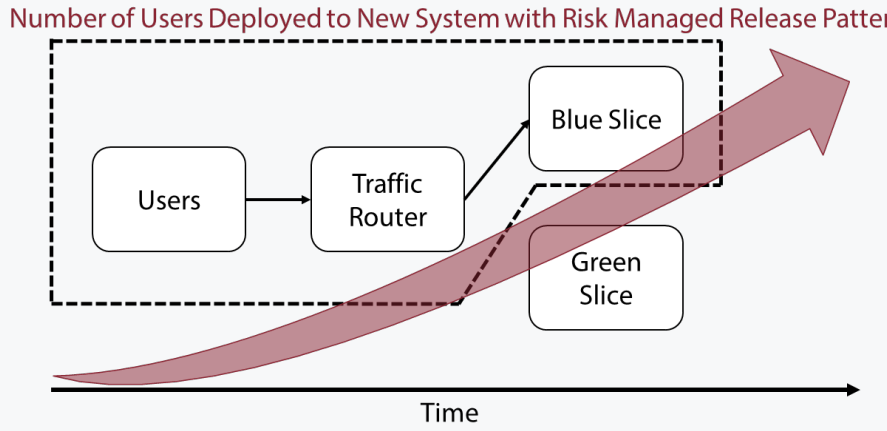
Technical Aspects



Technical Aspects

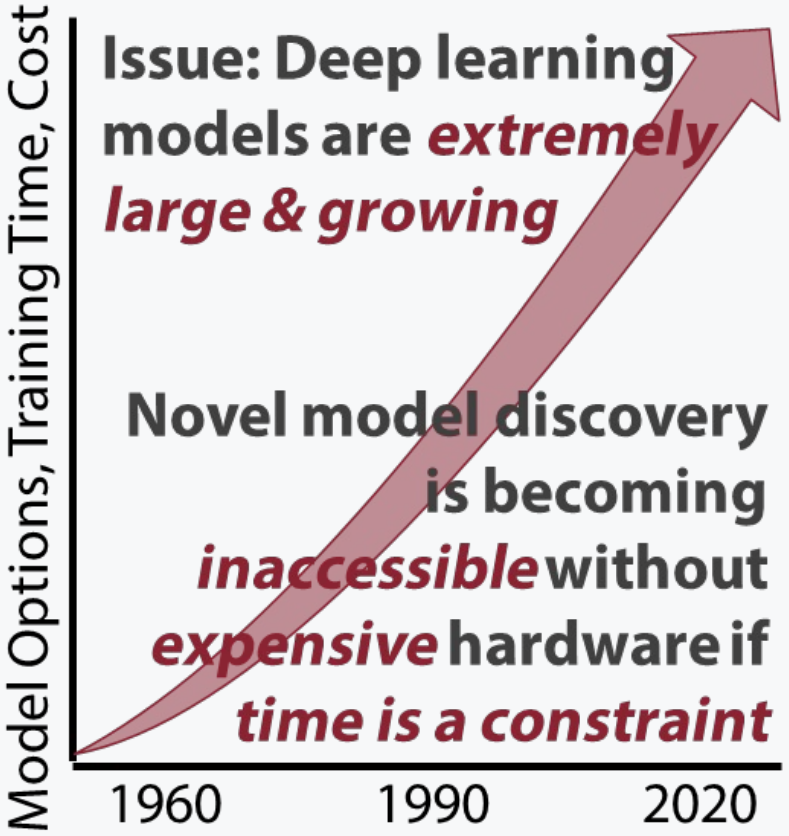


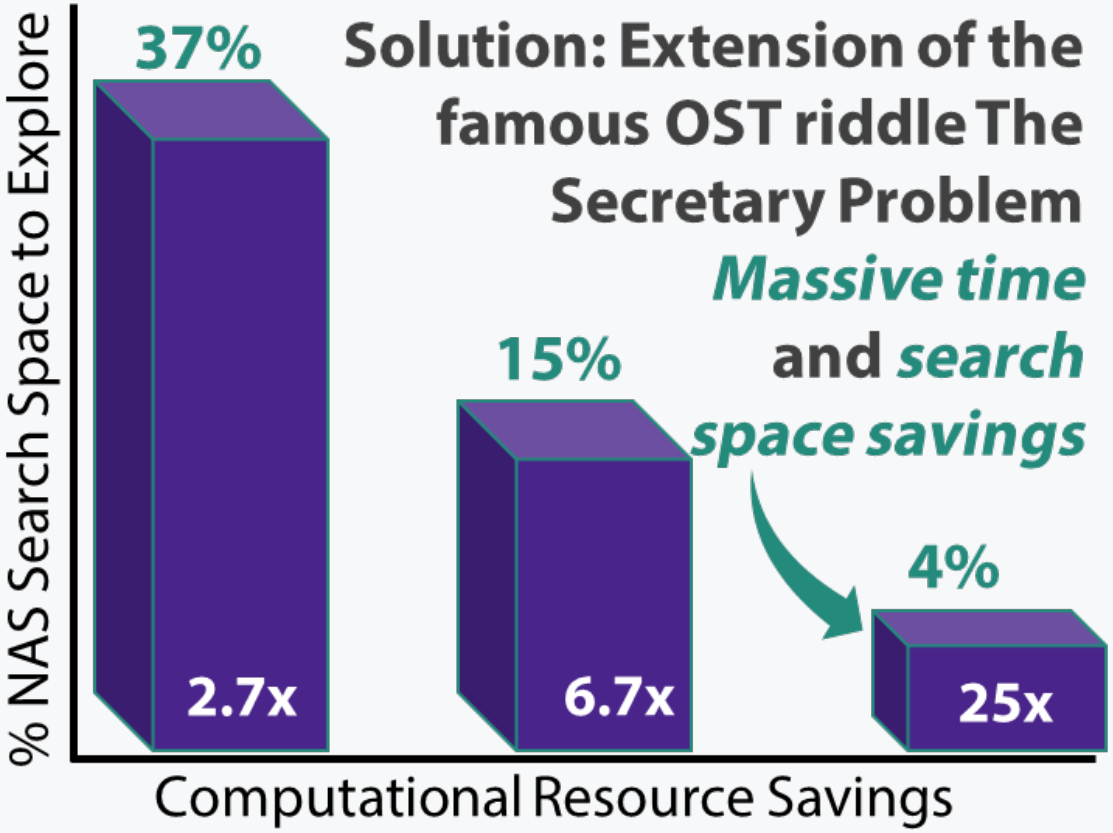




Technical Aspect Tool Example

- ***Reusable*** artifact example: Efficient neural architecture search (NAS) method developed by applying optimal stopping theory (OST)





Closing Remarks

- This research will develop a holistic theoretical framework to successfully enable DOD AI/ML solutions at every phase of their lifecycle

- Will provide reusable engineering artifacts to programs charged with AI/ML development, procurement, and deployment

- Approved Department execution plan

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THANK YOU

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