An Actionable Framework for Transitioning Technology to the Warfighter

The Transition Maturity Framework (TMaF) Quick Start Guide

https://aida.mitre.org/tmaf

tmaf@mitre.org

MITRE developed the TMaF in partnership with, and funded by, the Operational Energy-Innovation Directorate (OE-I) within OUSW(A&S). It provides a standardized way to assess transition maturity, helping program managers make informed decisions and innovators focus resources on the activities needed to move technologies into operational use.

This work was funded using contract funds under Contract W56KGU-18-D-0004. The view, opinions, and/or findings contained in this brief are those of The MITRE Corporation and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

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From Prototype to Battlefield Impact

The Transition Maturity Framework (TMaF) is a toolkit that helps teams and programs align on what evidence is needed to move transition decisions.

Get Started

TMaF Lite

TMaF for Transition Roadmapping

Ditching The Problem

MITRE's research behind the TMaF suggests that the Innovation transition "valley of death" is more often not a single technical gap, but a series of gaps—better described as "ditches of death," related to:

- Production capability
- Acquisition program commitment
- Alignment to a funded requirement
- Warfighter training and buy-in

Barriers to transition are typically programmatic and organizational—not technical.

(see GAO-25-107003)

TMaF puts the warfighter first. It accelerates the delivery of superior technological capabilities by:

- Guiding innovators and developers around ditches of death with clear, actionable, critical activities.
- Giving program managers a structured way to select the right projects and manage their transitions effectively.

How TMaF Helps Teams Move Transition Decisions Forward

Transition happens one decision at a time. The TMaF helps teams and programs align on the next decision, the evidence required to move it, and the work needed to produce that evidence.

In reviews and planning discussions, the TMaF guides the following:

- **Where** is the bottleneck? (TRL, MRL, TCL, RRL, or WRL)
- **Who** needs to say yes? (transition stakeholders / partners)
- **What** evidence do they need? (signal vs. decision-grade evidence)
- **How** do we get it? (critical activities)
- **When** is it achieved? (milestones)

The TMaF is a practical framework that helps technology development teams and programs overcome transition barriers and move technologies into operational use.

Bottom Line

The TMaF aims to accelerate the transition of superior technological capabilities by aligning decisions, evidence, and action.

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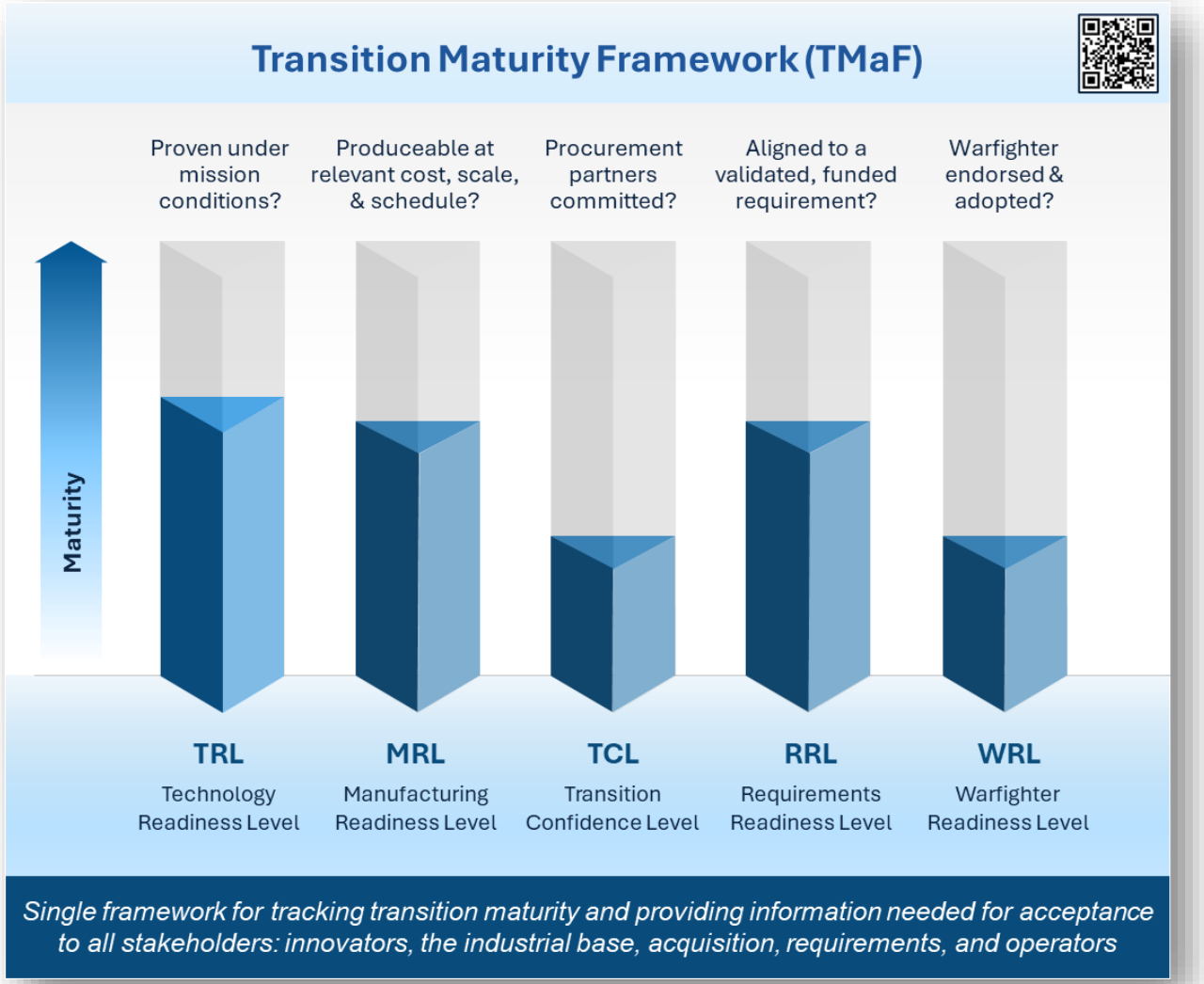

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1. Introduction to the Transition Maturity Framework (TMaF)

The Challenge

Breakthrough technologies fail to reach the field.

Common Barriers:

- Lacking clear alignment to operational problem
- System and program integration challenges
- Lacking warfighter endorsement

MITRE & the Operational Energy-Innovation Directorate (OE-I) developed the Transition Maturity Framework (TMaF) to empower programs & innovators to overcome these barriers.

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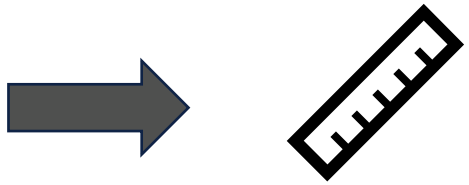
Motivation for the Transition Maturity Framework (TMaF)

- Track maturation from applied research to transition to use



standardized maturity scales

- Provide information needed by all stakeholders for technology acceptance

Aligned to transition stakeholder technology acceptance criteria

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For Program Managers:
Offers a standardized means to evaluate, balance, and monitor transition maturity

For Innovators:
Informs strategic evaluation of partnerships as well as resourcing and execution of critical activities needed to navigate past transition "ditches of death"

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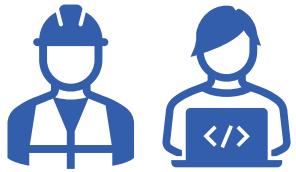
Innovation is just the first step

To achieve successful technology transition, innovators must understand / meet technology acceptance criteria of multiple stakeholders

Will you be a partner to transition this technology?

Innovator



Yes, if it serves our business

Industrial Base

Yes, if it can work reliably under mission conditions

Defense Innovation Ecosystem (RDT&E)

Yes, if you can deliver it affordably, on time, and to specification

Defense Acquisition Portfolio

Yes, if it solves a key operational problem

Defense Requirements Authority

Yes, if it helps me do my job

Warfighter / Operational User

Inability to meet these stakeholder criteria risks the technology falling into a "ditch of death"

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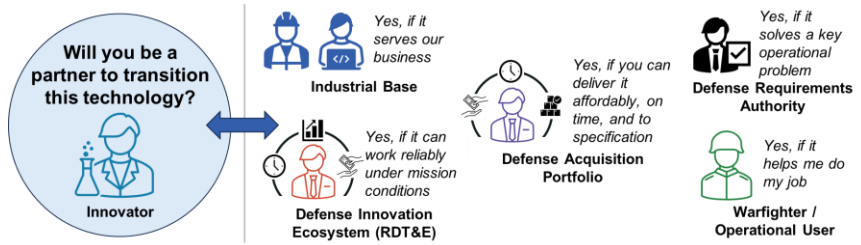
What Actually Drives Transition?



Five Key Readiness Areas:

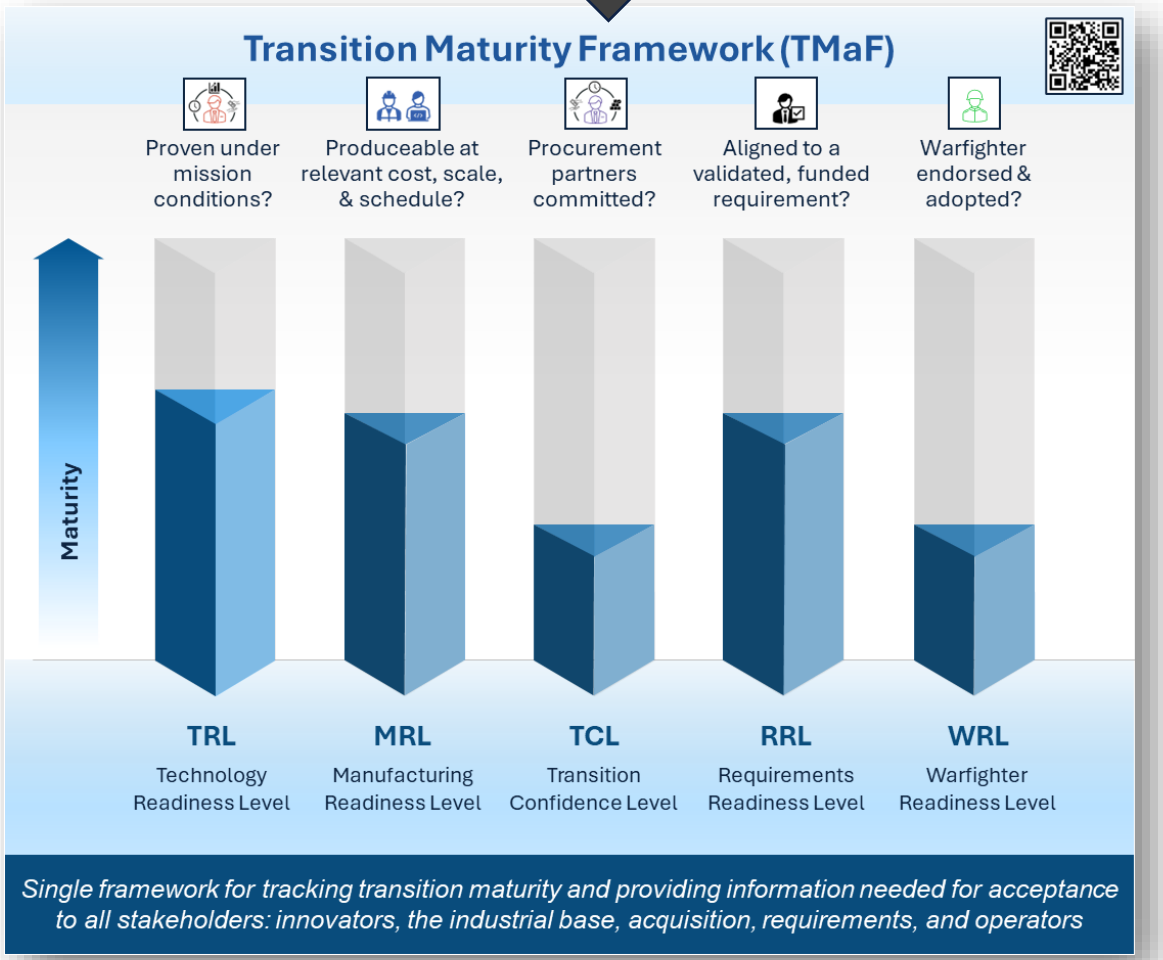
Pre-existing

1. **Technology Readiness (TRL)**
   - ✓ Proven under mission conditions?
2. **Manufacturing Readiness (MRL)**
   - ✓ Produceable at relevant cost, scale & schedule?
3. **Transition Confidence (TCL)**
   - ✓ Procurement partners committed?

Developed by MITRE & OE-I

4. **Requirements Readiness (RRL)**
   - ✓ Aligned to a validated, funded requirement?
5. **Warfighter Readiness (WRL)**
   - ✓ Warfighters willing & able to adopt (DOTMLPFP)?

- ***Note:* Software Readiness Level (SRL) Coming Soon!**



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An Actionable Framework

Example: Warfighter Readiness Level Table

		WRL – Warfighters willing & able to adopt? – Delivered ≠ *Adopted*	Critical Activities
Maturing *Eager to Adopt*	9	**Deployment and cultural integration.** The project is fielded to operational units and becomes an integral part of the military culture. Warfighters endorse its use, and it is fully embedded in Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P). This ensures the technology is fully embraced and operationally effective.	• Conduct comprehensive training sessions to ensure warfighters are fully proficient with the technology • Gather and document warfighter endorsements and testimonials to support cultural integration • Review and update DOTMLPF-P to reflect the technology's integration
	8	**Training and warfighter integration.** Training programs are developed to familiarize warfighters with the technology. Projects with a warfighter on the development team progress quicker, as they provide input from the end-user perspective during the design phase. This ensures warfighters have the necessary skills and knowledge to effectively use the technology.	• Develop training programs and workshops to familiarize warfighters with the technology • Include warfighters on the development team to provide input from the end-user perspective • Conduct simulations and exercises to explore the technology's capabilities and gather feedback
	7	**Operational trials and commitment to POM.** The technology is deployed in limited operational trials, with warfighters providing feedback on usability and effectiveness. Money is allocated to purchase the project at scale, supporting the warfighter's ability to execute the mission. This involves warfighters in the evaluation process to ensure the technology meets their needs.	• Organize limited operational trials with warfighters to gather feedback on usability, training, and effectiveness • Secure funding commitments for full-scale deployment by demonstrating value and impact • Document and analyze feedback to refine the technology, improve training TTP's and ensure it meets operational needs
Emerging *Engaged*	6	**Adoption/training development.** The technology is adopted across relevant units, with continuous adaptation and support to address emerging challenges. Project developers coordinate with educational institutions to develop and mature training packages, ranging from "on the job training" to curriculum development for new career fields. This ensures the necessary infrastructure and training are in place to support widespread use.	• Develop, mature, and distribute detailed training packages in collaboration with CCMDs, SEOs, and educational institutions • Establish a support system for continuous adaptation and troubleshooting to address emerging challenges • Ensure infrastructure is in place to support widespread use, including facilities and logistics
	5	**Policy development and field demonstration.** Policies and procedures are developed to support the technology's integration, with warfighters involved in shaping guidelines and training. This shaping includes deployment, employment, and disposition policies as well as the affiliated initial design and development of the Mission Essential Task List (METL) inputs. The project is inserted into a collective training event under operational conditions to understand its fit within doctrine and Tactics, Techniques, Procedures (TTPs). Feedback is captured for senior leaders making acquisition decisions.	• Involve warfighters in shaping policies and procedures to ensure practicality and acceptance • Conduct field demonstrations under operational conditions to validate the technology's fit within doctrine • Capture and analyze feedback from demonstrations to inform policy & training development and support acquisition decision-making in concert with CCMD and SEO POCs
	4	**Leadership, advocacy and endorsements.** Leadership and education efforts focus on building advocacy among key personnel. Leaders are trained to understand and communicate the technology's benefits. This is a critical step to transition from a science and technology project to a program of record, indicating support by end-users for adoption and purchase at scale.	• Train leaders to understand and advocate for the technology, emphasizing its benefits and applications • Secure endorsements from key leadership, CCMDs, and SEOs to support transition to a program of record • Develop communication materials to effectively convey the technology's value to users and stakeholders
Nascent *Aware*	3	**Lab/field integration.** The technology is assessed for its fit within existing organizational structures, with adjustments made to align with current processes. Tests allow developers to gather diagnostic data, with warfighter participation critical for replicating realistic conditions and offering operationally informed feedback.	• Conduct lab and field tests with warfighter participation to gather diagnostic data and feedback • Assess the technology's fit within existing organizational structures and make necessary adjustments • Begin planning with CCMD and SEO POCs for integrating the technology into existing inventory and logistics systems
	2	**Initial engagement.** Warfighter consultation and validate end user requirements. Warfighters engage in discussions about the technology's implications for Doctrine and Organization. Service labs and industry must gain support from Combatant Commands (CCMDs) and/or Service Energy Offices (SEOs), demonstrated by a letter of support. This assesses how the technology fits within existing command structures and roles.	• Engage warfighters in discussions about the technology's implications for Doctrine and Organization • Validate requirements the S&T project team has curated during RRL research activities • Secure letters of support and POCs from CCMDs and/or Service Energy Offices to demonstrate stakeholder backing • Assess how the technology fits within existing command structures and roles
	1	**Awareness and alignment with requirements.** Warfighters are introduced to the technology concept, with initial discussions and briefings raising awareness and gauging interest. DoW innovation investments are aligned with warfighter needs, ensuring the technology aligns with current and future operational concepts. This could be a "technology pull" if Warfighter has an existing requirement the technology solves or could be a "technology push" if there is not a codified, existing requirement.	• Engage Warfighters from both the CCMDs and the Services' Supporting Commands to ensure joint mission execution and Organize/Train/Equip (O/T/E) presentation of forces perspectives • Conduct initial briefings and discussions to raise awareness and gauge interest in the technology • Align technology development with DoW innovation investments and warfighter needs • Explore how the technology aligns with current and future operational concepts • Leverage this information to conduct RRL research to identify initial requirements as possible

WRL 5 Definition

5 **Policy development and field demonstration.**
Policies and procedures are developed to support the technology's integration, with warfighters involved in shaping guidelines and training. This shaping includes deployment, employment, and disposition policies as well as the affiliated initial design and development of the Mission Essential Task List (METL) inputs. The project is inserted into a collective training event under operational conditions to understand its fit within doctrine and Tactics, Techniques, Procedures (TTPs). Feedback is captured for senior leaders making acquisition decisions.

WRL 5 Critical Activities

- Involve warfighters in shaping policies and procedures to ensure practicality and acceptance
- Conduct field demonstrations under operational conditions to validate the technology's fit within doctrine
- Capture and analyze feedback from demonstrations to inform policy & training development and support acquisition decision-making in concert with CCMD and SEO POCs

The TMaF levels provide project teams with a set of transition milestones.

Critical activities offer them a starting point to develop a plan to strategically address transition challenges as they move through those milestones.

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Transition Maturity Framework in Practice

FY25, the Operational Energy—Innovation Directorate (OUSW(A&S)), fully integrated TMaF into its proposal solicitation, selection, and execution management processes

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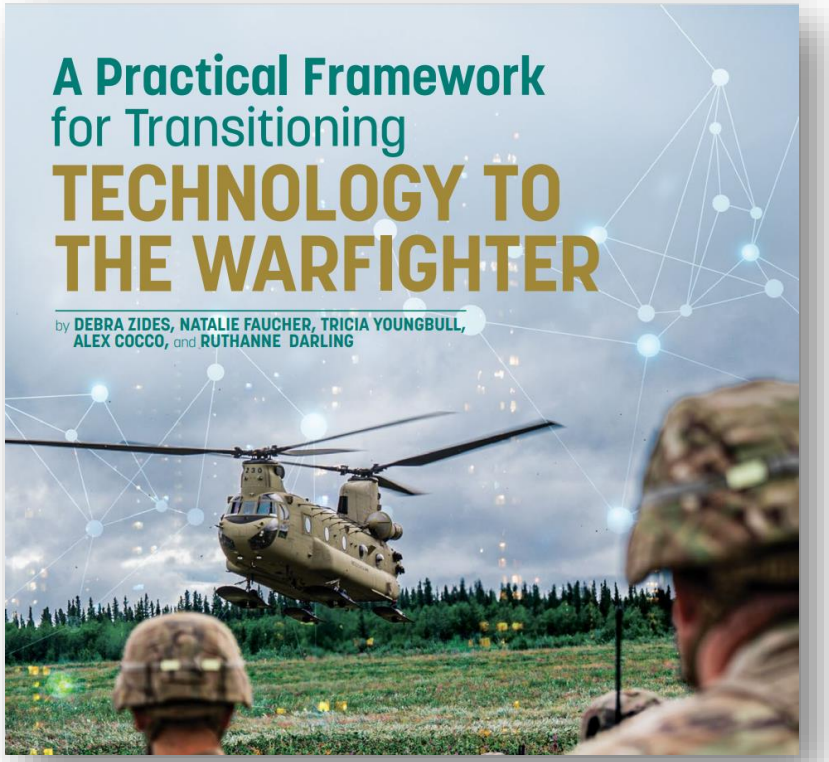
"It takes a team effort to succeed and the TMaF provides a consistent and actionable way to move forward. It puts the power of DoW, its people and processes, not only on the same page, but the right page and allows everyone to coordinate and move projects forward successfully… ***The TMaF clarifies and simplifies the processes and moves everyone collaboratively toward the common objective*** *– state of the art, fielded technology that assists the warfighter in achieving deterrence and battlefield overmatch."*
– Ms. RuthAnne Darling, OE-I Director



Sept.-Oct. 2025 Defense Acquisition Magazine
https://www.dau.edu/library/damag/september-october2025/practical-framework

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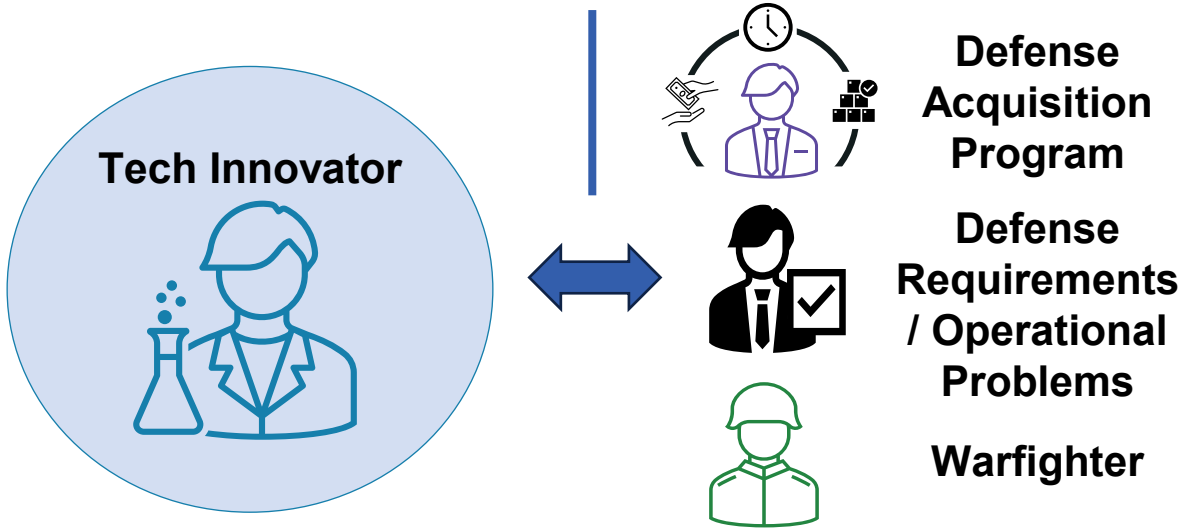
Complementary Tools to Remove Transition Barriers

Common acquisition barriers:

1. Connecting to programs:
   - **Tech2PEO/PAE (live):** input tech details, outputs curated list of programs with contacts
2. Identifying requirements:
   - **Tech2Req (MVP live):** input tech details, outputs list of relevant DoW requirements
3. Communicating mission impact:
   - **M&S (in progress):** low barrier-to-entry, flexible mission-level modeling

Tech2PEO/PAE, Tech2Req, M&S



Complementary tools are designed to support effective engagement with transition stakeholders to support strategic transition management

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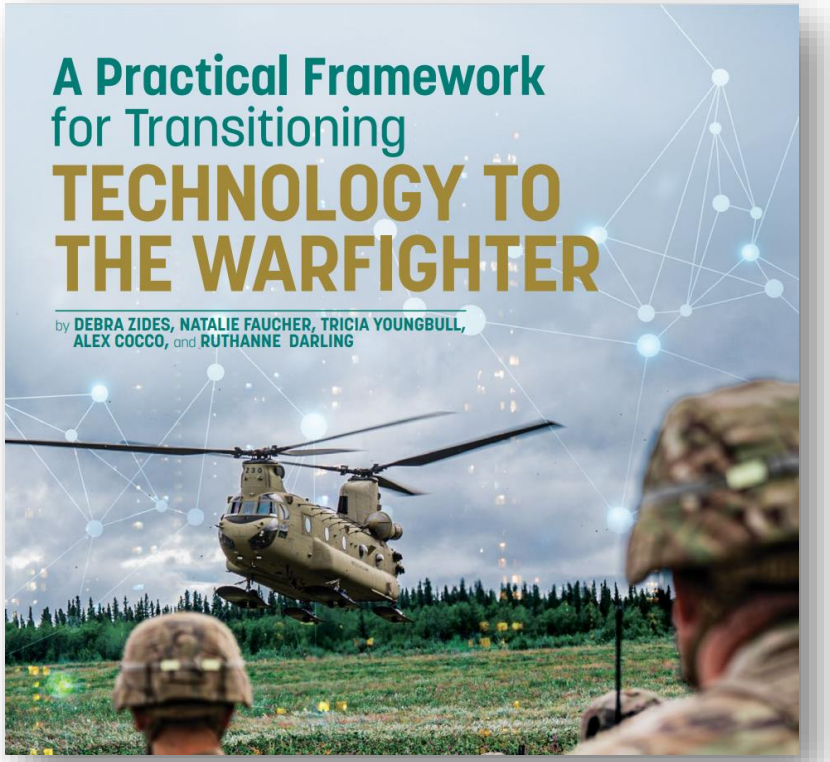
Engage with the Transition Maturity Framework

- **Access** TMaF and Tech2PEO/PAE through MITRE's Acquisition in the Digital Age (AiDA) website:
  - https://aida.mitre.org/tmaf & https://aida.mitre.org/the-mitre-tech2peo-tool
- **Listen** to MITRE MNS SVP & GM, Keoki Jackson, discuss TMaF on the Federal News Network's Federal Drive podcast:
  - A new framework aims to build a bridge across the defense acquisition valley of death
- **Read** our Defense Acquisition Magazine article:
  - A Practical Framework for Transitioning Technology to the Warfighter | www.dau.edu
- **Connect** with the TMaF and Tech2PEO/PAE teams via email:
  - tmaf@mitre.org & tech2peo@mitre.org



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Scan for link:
https://aida.mitre.org/tmaf

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2. Getting Started: TMaF Lite

TMaF Lite distills the framework into a concise set of stakeholder-focused principles designed to help innovators engage defense stakeholders effectively, guide technology development, and maintain alignment with warfighter needs.

Recommended Actions

1. **Establish mission alignment**
   - Review the TMaF guiding principles to ensure development remains aligned to warfighter needs and operational relevance.
2. **Assess maturity across key dimensions**
   - Innovators: Evaluate your project against each TMaF Lite dimension as nascent, emerging, or maturing.
   - Programs: Evaluate the portfolio's maturity across each dimension from nascent through maturing.
   - Conduct the same assessment with partners and key stakeholders.
3. **Validate alignment and identify gaps**
   - Determine whether there is consensus across the team and stakeholder base.
   - Identify capability gaps, development risks, and areas of opportunity revealed by the assessment.
   - For programs: Confirm the portfolio's maturity profile is aligned to the funding and transition strategy.
4. **Determine the next action**
   - Review the TMaF "Next Move" Cheat Sheet.
   - Confirm the team has the personnel and mission partners required to engage the appropriate stakeholders.
   - Estimate the cost to generate the evidence needed to secure stakeholder buy-in and support transition decisions.

Consider building a transition roadmap: TMaF for Roadmapping

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TMaF guiding principles for developing technology that serves the warfighter:

Think beyond TRL.

Technical maturity alone does not guarantee a successful transition. It marks the *start* of the transition conversation.

Know the defense customer.

Transition involves various stakeholders, each requiring different forms of evidence to satisfy acceptance criteria. Early, informed, and sustained engagement with transition stakeholders is critical.

Make strategic tradeoffs informed by stakeholders.

Strategically invest in activities that balance addressing technology acceptance criteria across stakeholders.

Start with TMaF Lite (next slide)

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Transition Maturity Framework (TMaF) Lite

Develop technology… ***…that serves the warfighter.***

	TRL	MRL	TCL*	RRL	WRL**
Transition Partner	Defense Innovation Ecosystem (RDT&E)	Industrial Base	Defense Acquisition Portfolio	Defense Requirements Authority	Warfighter / Operational User
Guiding Question	Proven under mission conditions?	Produceable at relevant cost, scale & schedule?	Procurement partners committed?	Aligned to a validated, funded requirement?	Warfighters willing & able to adopt?
Operating Principle	Demo-able ≠ *Deployable*	Prototype ≠ *Product*	Interested ≠ *Committed*	Prioritized Long-term ≠ *Funded Now*	Delivered ≠ *Adopted*
Maturing	Proven Reliable (operational test & evaluation)	Delivering (pilot to low-rate initial/full-rate, production release)	Committed (formal transition/transfer agreement, funding)	Specific & Funded (funded Capability or Urgent/Emergent Need)	Ready to Employ (fielded & fully embedded in DOTMLPF-P)
Emerging	Demonstrated (component / prototype demo)	Tuned & Tested (prototype production, min. viable product)	Interested (regular meetings, collaborative planning)	Focused & Prioritized (key operational problem, integrated priority list)	Involved (leaders/warfighters involved in shaping training & policy)
Nascent	Researched (proof-of-concept)	Planned (feasibility studies, pre-alpha)	Acquainted (target programs identified, initial engagement)	Broad & Prospective (strategy, warfighting concept)	Aware (initial warfighter testing & feedback collection)

*Identify and prepare to connect with relevant programs using the Tech2PEO/PAE tool and associated resources here: https://aida.mitre.org/the-mitre-tech2peo-tool/

**Consider leveraging OSW the Warfighter Touchpoint Tool for collecting warfighter feedback at demos/experiments/exercises here: https://cristlgov.com/auth/signup

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TMaF “Next Move” Cheat Sheet

If your bottleneck is…	The stakeholder is…	They need evidence of…			Your next move is…
		Early Signal	*Moderate Evidence*	*Strong Evidence*	
TRL (doesn’t work yet)	Defense Innovation Ecosystem	Prototype demo in laboratory	Relevant environment testing	Operational testing & evaluation	Run testing in a relevant environment
MRL (can’t scale)	Acquisition / Industrial Base	Production feasibility analysis	Pilot-scale production	Delivery at relevant scale, cost & schedule	Pilot production / scale plan
TCL (no commitment)	Acquisition	Informal PM interest	Regular engagement with program	Collaborative program integration planning	Engage PM, develop integration plan
RRL (no requirement)	Requirements Authority	Capability linked to operating concept	Draft CONOPS / stakeholder alignment	Validated, funded requirement	Build CONOPS, align to requirement
WRL (no trust)	Operator	Positive operator feedback	Training or use in exercise	Operational unit endorsement	Run training / exercises

Identify your bottleneck & coordinate with relevant stakeholders to move forward

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3. TMaF for Transition Roadmapping

TMaF levels provide project teams with a structured set of transition milestones.

Critical activities offer a starting point for building a transition roadmap and addressing key transition risks as projects advance through each milestone.

This section supports transition roadmap development by providing tables summarizing TMaF levels, critical activities & guidance on levels of evidence needed to demonstrate progress.

Recommended Actions

1. **Review TMaF Lite**
   - Review TMaF Lite to establish a common framework for assessing maturity, planning progression, and aligning with stakeholder expectations.
2. **Assess current maturity**
   - Innovators: Assess your project's current maturity across each dimension using the TMaF milestone table.
   - Programs: Assess the portfolio's current maturity across each dimension using the same table.
   - Repeat the assessment with partners and key stakeholders.
3. **Set target maturity levels**
   - Use the TMaF milestone table to define target maturity levels across dimensions.
   - Establish targets collaboratively with partners and stakeholders.
4. **Identify required activities**
   - Use the TMaF dimension activity tables to identify representative activities needed to move from current to target maturity.
5. **Define evidence requirements**
   - Review the "Tracking Progress" section.
   - Work with partners and stakeholders to identify the evidence required to demonstrate progress and satisfy technology acceptance criteria.
6. **Estimate resourcing needs and prioritize**
   - Estimate the time and resources required to achieve target maturity.
   - Refine activities, set priorities, and align resources with partners and stakeholders.
7. **Review and adjust during execution**
   - Regularly review the roadmap with partners and stakeholders.
   - Confirm priorities, assess progress, and adapt to changing conditions.

3. a) TMaF Milestone Table

Transition Maturity Framework (TMaF): Milestone Table

Develop technology… ***…that serves the warfighter.***

		TRL	MRL	TCL	RRL	WRL
Guiding Question		Proven under mission conditions?	Produceable at relevant cost, scale & schedule?	Procurement partners committed?	Aligned to a validated, funded requirement?	Warfighters willing & able to adopt?
Operating Principle		Demo-able ≠ *Deployable*	Prototype ≠ *Product*	Interested ≠ *Committed*	Prioritized Long-term ≠ *Funded Now*	Delivered ≠ *Adopted*
Maturing	**9**	Actual system proven through successful mission operations	(Level 10) FRP demonstrated and lean production practices in place LRIP demonstrated; capability in-place to begin Full-rate production (FRP)	Transition to acquisition program office complete	Funded, approved joint or service requirement	Deployment and cultural integration
	8	Actual system completed and qualified through test and demonstration	Pilot line capability demonstrated; Ready to begin Low-Rate Initial Production (LRIP)	Formal transition agreement & transition funding committed	Validated, unfunded joint or service requirement	Training and warfighter integration
	7	System prototype demonstration in an operational environment	Capability to produce systems, subsystems, or components in a production representative environment	Integration strategy & resourcing defined	Pre-validated (draft) joint or service requirement	Operational trials and commitment to POM (Program Objective Memorandum)
Emerging	**6**	System/subsystem model or prototype demonstration in a relevant environment	Capability to produce a prototype system or subsystem in a production relevant environment	Pre-transition planning aligned with Program Manager	Senior-level capability assessment / joint problem endorsement	Adoption/training development
	5	Component and/or breadboard validation in relevant environment	Capability to produce prototype components in a production relevant environment	Program office interest formalized	Combatant command priority alignment	Policy development and field demonstration
	4	Component and/or breadboard validation in laboratory environment	Capability to produce the technology in a laboratory environment	Stakeholder engagement & target acquisition program(s) identified	Strategy / force design / capability framework alignment	Leadership, advocacy, and endorsement
Nascent	**3**	Analytical and experimental critical function and/or characteristic proof of concept	Manufacturing proof of concept developed	Transition concept & technical goals established	Operational concept alignment	Lab/field integration
	2	Technology concept and/or application formulated	Manufacturing concepts identified	Project initiated & TRL baseline set	Demos, experiments, exercises, or warfighter feedback	Initial engagement
	1	Basic principles observed and reported	Basic manufacturing implications identified	Gap recognized & technology discovery underway	Exploratory or emerging need	Awareness and alignment with requirements

3. b) TMaF Dimension Activity Tables

		TRL – Proven under mission conditions? – Demo-able ≠ *Deployable*	Critical Activities
Maturing *Proven Reliable*	**9**	**Actual system proven through successful mission operations.** Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.	• Final refinement of the mission and system performance criteria • Execute final design refinements if necessary • Plan the relevant operational test and evaluation
	8	**Actual system completed and qualified through test and demonstration.** Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.	• Final refinement of the mission and system performance criteria • Execute final design refinements if necessary • Plan the relevant operational test and evaluation
	7	**System prototype demonstration in an operational environment.** Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.	• Define the mission and system performance criteria • Plan the relevant environment validation experiment/test/demonstration (consider integration into operational experiment or exercise - e.g., Arctic Edge) • Enhance capability to create prototype close to the operational system concept • Execute relevant lab environment high fidelity breadboard validation
Emerging *Demonstrated*	**6**	**System/subsystem model or prototype demonstration in a relevant environment.** Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.	• Define the mission and system prototype performance criteria • Plan the relevant environment validation experiment/test/demonstration (consider integration into operational simulation - e.g., AFSIM) • Enhance capability to incorporate realistic supporting elements • Execute relevant lab environment high fidelity breadboard validation
	5	**Component and/or breadboard validation in relevant environment.** Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include high-fidelity laboratory integration of components.	• Define the mission and system/subsystem model or prototype performance criteria • Plan the relevant environment validation experiment/test/demonstration • Enhance system fidelity capability to incorporate realistic supporting elements • Execute relevant lab environment high fidelity breadboard validation
	4	**Component and/or breadboard validation in laboratory environment.** Basic technological components are integrated to establish that they will work together. This is relatively low-fidelity compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.	• Define the mission and component and/or breadboard performance criteria • Plan the validation experiment/test/demonstration • Integrate low fidelity version of system components in lab • Execute lab environment breadboard validation
Nascent *Researched*	**3**	**Analytical and experimental critical function and/or characteristic proof of concept.** Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	• Integrate basic components and verify that they execute the critical function as intended
	2	**Technology concept and/or application formulated.** Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.	• Design analytical and laboratory studies to validate expected performance of separate elements of the technology
	1	**Basic principles observed and reported.** Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.	• Compile speculative set of applications for observed basic principles

For additional guidance, see the 2025 Technology Readiness Assessment Guidebook.

		MRL – Produceable at relevant cost, scale & schedule? – Prototype ≠ *Product*	Critical Activities
Maturing *Delivering*	9	**(Level 10) FRP demonstrated and lean production practices in place.** This is the highest level of manufacturing maturity, typically reached during the Production & Deployment or Operations & Support phases of the acquisition life cycle. At this stage, design changes are minimal and usually limited to continuous improvement or obsolescence. Systems, components, and items are in FRP and meet all engineering, performance, quality, and reliability requirements. Manufacturing processes, materials, tooling, test equipment, facilities, and workforce are fully in place and meet FRP needs. STE/SIE validation is maintained as needed, production unit costs meet targets, funding supports required rates, and continuous process improvement is ongoing. **(Level 9) LRIP demonstrated; capability in-place to begin Full-Rate Production (FRP).** At this level, the system, component, or item is in production, or has successfully achieved LRIP. This level of maturity is normally associated with readiness for entry into FRP. All At this level, the system, component, or item is in production or has successfully completed LRIP and is ready for entry into FRP. Design requirements have been met, system changes are minimal, and major design features are stable and proven through operational test and evaluation. Materials, parts, manpower, tooling, test equipment, and facilities are in place to support planned production rates. STE/SIE validation is maintained as needed, manufacturing processes in LRIP meet quality and KC tolerance requirements, risks are actively monitored, LRIP cost targets have been achieved, and the FRP cost model has been updated to reflect continuous improvement.	• Monitor and manage production line performance relative to cost and quality targets • Establish systems for continuous improvement • Plan for obsolescence management
	8	**Pilot line capability demonstrated; Ready to begin Low-Rate Initial Production (LRIP).** This level reflects manufacturing readiness for Milestone C and entry into LRIP. The system design is stable, and materials, workforce, tooling, test equipment, and facilities have been proven on the pilot line and are ready for the LRIP schedule. STE/SIE, manufacturing, and quality processes have been validated and are under control. Producibility risks are manageable, cost and production analyses have been updated with pilot line data, supplier qualification and First Article Inspections are complete, and the industrial base is ready to support LRIP.	• Complete LRIP and validate quality/cost requirements • Prove design stability through operational test and evaluation • Prepare for FRP with updated cost model and integrate lessons learned from LRIP
	7	**Capability to produce systems, subsystems, or components in a production-representative environment.** This level typically marks the end of detailed system design in EMD leading to CDR. Design is nearing completion, material specifications are approved, and materials are available for the planned pilot line build. Manufacturing processes have been demonstrated in a production-representative environment, producibility studies are complete, and risk reduction is underway. Cost, yield, and rate analyses have been updated with representative data and tracked to targets. Unit cost reduction efforts are in progress, the supply chain has been assessed, long-lead procurement plans are in place, manufacturing and quality plans are established, and tooling, test equipment, and STE/SIE validation planning are underway.	• Plan and execute production representative environment demonstration • Finalize system design • Materials specs and availability
Emerging *Tuned & Tested*	6	**Capability to produce a prototype system or subsystem in a production-relevant environment.** This level reflects readiness for Milestone B and entry into EMD, indicating acceptance of a preliminary system design. An initial manufacturing approach is in place, most manufacturing processes have been defined and characterized, and preliminary design, producibility assessments, and key trade studies are complete. Manufacturing processes, technologies, materials, tooling, test equipment, and workforce skills have been demonstrated in a production-relevant environment. Cost, yield, and rate analyses have been performed, risk reduction strategies are in place, producibility has informed system development plans, industrial capabilities have been assessed, and key long-lead and supply chain elements have been identified.	• Conduct prototype production relevant environment demonstration • Work with program office to define manufacturing requirements to support Milestone B decision • Identify system engineering/design changes
	5	**Capability to produce prototype components in a production-relevant environment.** This level is typical of the midpoint of TMRR. The industrial base assessment has begun, the Milestone A manufacturing strategy has been refined and integrated into the RMP, and enabling CTs and components have been identified. Product data for prototype component manufacturing have been released, evaluation of Key Characteristics has started, and prototype materials have been demonstrated in a production-relevant environment. However, many manufacturing processes remain in development, and manufacturing technology development and producibility assessments are underway.	• Conduct technology production relevant environment demonstration • Develop Manufacturing Strategy • Identify enabling/critical technologies and components • Identify and document key design performance parameters • Identify special tooling/facilities/material handling/skills
	4	**Capability to produce the technology in a laboratory environment.** This level is an exit criterion for MSA approaching Milestone A. Manufacturing and quality risks have been identified in the AoA, with prototype plans and mitigation strategies in place. Required investments, key process and material cost drivers, and cost uncertainties have been identified. Initial producibility assessments of the preferred solution are complete, along with initial KPPs and requirements for special tooling, handling, workforce skills, and facilities.	• Demonstrate ability to produce technology in a lab environment • Develop producibility assessments of design concepts • Identify and document key design performance parameters • Identify special tooling/facilities/material handling/skills
Nascent *Planned*	3	**Manufacturing Proof of Concept Developed.** This level begins with assessing the producibility and manufacturability of proposed system concepts through modeling, simulation, or laboratory experiments. Comparative cost models, analyses, and budgets are identified, along with manufacturing and quality requirements, initial risks, facility capacity, and materials planning. Typical of Applied Research and ATD, this stage may include limited-function experimental hardware developed in a lab environment.	• Design experimental hardware models • Plan and execute lab-level manufacturing experiments • Prototype component production in relevant environment demonstration
	2	**Manufacturing Concepts Identified.** This level of manufacturing maturity focuses on identifying manufacturing concepts. It includes broad studies of materials, processes, supply chains, workforce skills, future investment needs, and potential manufacturing and quality requirements. At this stage, an initial understanding of manufacturing feasibility and risk is emerging.	• Identify and document new manufacturing concepts of project's scientific principles
	1	**Basic Manufacturing Implications Identified.** This is the initial level of manufacturing maturity assessment, focused on manufacturing capability through early studies of global industrial and supply base trends, manufacturing science, material availability, supply chains, and metrology.	• Analyze manufacturing implications of project's scientific principles and incorporate into reports/studies

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Level descriptions were simplified for concision. For full descriptions and additional guidance, see the 2025 Manufacturing Readiness Level Deskbook.

		TCL – Procurement partners committed? – Interested ≠ *Committed*	Critical Activities
Maturing *Committed*	9	**Transition to acquisition program complete.** Transition to PAE funding and acquisition strategy completed.	• Program office has been established and resourced • The program office is executing and reporting • CCMD or Service coordination mechanisms (e.g., warfighter liaison officer) are aligned/tasked • Any transition agreements contingencies have, or are being, executed
	8	**Formal transition agreement and transition funding committed.** Signed transition agreement between PM and technology developer. Transition funding committed.	• Finalize and sign transition agreement • CCMD or Service coordination mechanisms identified • Verify funding commitment with program office
	7	**Integration strategy & resourcing defined.** Integration strategy defined. Transition cost estimate complete. Potential funding sources identified.	• Co-develop integration strategy with program office • Complete transition cost estimate and work with program office to secure funding commitment • Identify potential funding sources
Emerging *Interested*	6	**Pre-transition planning aligned with PM.** Transition technical goals approved by acquisition PM and technology developer. Transition schedule estimate developed. Project included in PM plans as a potential source.	• Finalize transition technical goals with program office and secure approval • Co-develop transition schedule estimate with program office • Verify with program office PM that the project is being considered for integration into the program baseline as a potential source
	5	**Program office interest formalized.** Expressed interest from PM office. Active communication with named PM contact.	• Onboard the program office PM • Conduct discussions with potential program offices to determine if their portfolios have performance requirements/gaps/opportunities to leverage the advanced technology • Conduct deep dive discussions with program office PM to determine transition technical goals • Initiate cost estimate planning
	4	**Stakeholder engagement & target acquisition program(s) identified.** Target PMs briefed and provided progress updates. Key transition stakeholders named. Relevant programs named.	• Set up recurring engagements with program office PM POC • Create and maintain a transition stakeholder tracker • Potential transition stakeholders identified—set up a communication plan to engage stakeholders
Nascent *Acquainted*	3	**Transition concept & technical goals established.** Specific project technical goals established. Target acquisition programs identified. Potential transition stakeholders identified.	• Verify TRL goals are established (baseline) from TRL 2 • Establish specific project technical goals • Review potential transition pathways and identify potential program offices • Reach out to acquisition program offices/portfolios to present project and request a Program Manager (PM) POC to help with transition; add the PM to project team • Identify transition stakeholders (S&T, acquisitions, requirements communities)
	2	**Project initiated & TRL baseline set.** Project initiated. TRL goals established (baseline).	• CCMD or Service reviews and validates TRL baseline goals
	1	**Gap recognized & technology discovery underway.** Working Group interest expressed. Active tech discovery. Acknowledged gap.	• Combatant Command (CCMD) interest in supporting a working group • CCMD or Service identifies the capability gap

Identify and prepare to connect with relevant programs using the Tech2PEO/PAE tool and associated resources here: https://aida.mitre.org/the-mitre-tech2peo-tool/

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		RRL – Aligned to a validated, funded requirement? – Prioritized Long-term ≠ *Funded Now*	Critical Activities
Maturing *Specific & Funded*	**9**	**Funded, approved joint or service requirement.** Technology aligns to a funded, approved requirement validated by a Service, Office of the Secretary of War (OSW) Component, Joint body, or Combatant Command (CCMD), authorized for execution (i.e., funded Capability Needs Statement (CNS), CCMD requirements, Joint Urgent Operational Need (JUON)/Joint Emergent Operational Need (JEON), Service Urgent/Emergent Operational Need (UON/EON), active delivery).	• Identify funding source(s)
	8	**Validated, unfunded joint or service requirement.** Technology aligns to a validated, unfunded requirement (i.e., approved CNS, Unfunded Requirement (UFR), JUON/JEON, UON/EON without funding).	• Verify and document project meets a validated Requirement or service/OSW policy goal
	7	**Pre-validated (draft) joint or service requirement.** Technology aligns to a pre-validated (draft) requirement or solution pathway (i.e., draft CNS/Service capability documents, draft JUON/JEON, draft Joint Operational Problem (JOP)/Key Operational Problem (KOP)-derived solutions, requirements artifacts in the Knowledge Management/Decision Support (KM/DS) system).	• Validate need for a materiel/non-materiel approach to meet an OSW, Joint, CCMD, and/or Service defined capability need or service/OSW policy goal
Emerging *Focused & Prioritized*	**6**	**Senior-level capability assessment / joint problem endorsement.** Technology aligns to senior-level or Joint problem assessment or study (i.e., JOPs, Chairman's Risk Assessment, capability gap assessments, GO/FO-endorsed CONOPS).	• Validate the project's initial capabilities align to concepts of operation (CONOPS) to meet (1) an OSW, Joint, CCMD, and/or Service defined capability need with documented buy-in from Service or CCMD staff at GO/FO level (Example: IPL or Capability Development Document (CDD)) and/or (2) a documented service/OSW policy goal
	5	**CCMD priority alignment.** Technology aligns to CCMD priority needs or problems (i.e., Integrated Priority List (IPL), CCMD-sponsored KOPs, formal CCMD memoranda).	• Validate the project's initial capabilities align to concepts of operation (CONOPS) to meet needs for (1) an OSW, Joint, Combatant Command (CCMD), and/or Service defined capability with documented buy-in from service or CCMD staff at working level (Example: an Initial Capabilities Document) and/or (2) a documented Service/OSW policy goal
	4	**Strategy / force design / capability framework alignment.** Technology aligns to DoW/Joint/Service strategies, force design, or capability frameworks (i.e., strategies, capability roadmaps, Service-level KOPs, approved CONOPS).	• Conduct research that connects the project's basic technologies to concepts of operation (CONOPS) for (1) a defined capability need mission and/or (2) a documented Service/OSW policy goal
Nascent *Broad & Prospective*	**3**	**Operational concept alignment.** Technology aligns to Joint/Service operational or warfighting concepts (i.e., operational concepts, warfighting concepts, mission threads).	• Conduct research that connects the project's basic technologies to concepts of operation (CONOPS) for a mission and/or OSD/Service policy goal
	2	**Demos, experiments, exercises, or warfighter feedback.** Technology aligns to lessons learned, experiments, exercises, or warfighter feedback (i.e., Joint Lessons Learned Information System (JLLIS) entries, After Action Reports (AARs), documented experimentation outcomes).	• Conduct research in support of studies that connect basic technologies to combatant command, OSW, Joint or Service needs
	1	**Exploratory or emerging need.** Technology aligns to early-stage, exploratory needs or informal warfighter ideas (i.e., studies/analysis, informal feedback, field reports, user stories, early concepts).	• Conduct initial research in support of studies that connect basic technologies to DoW-related needs

Note: In accordance with CJCSM 5123.01 (15 January 2026), the Capability Production Document (CPD) is rescinded, and the three active requirements documents are the Initial Capabilities Document (ICD), Capability Development Document (CDD), and Capability Needs Statement (CNS). Additionally, alignment now relies on Key Operational Problems (KOPs), Joint Operational Problems (JOPs), Service-validated requirements, Requirements and Resourcing Alignment Boards (RRABs), and Mission Engineering & Integration Activity (MEIA) outputs. Legacy JCIDS artifacts may still be used when they clearly show alignment to a capability need and are supported by current evidence.

		WRL – Warfighters willing & able to adopt? – Delivered ≠ *Adopted*	Critical Activities
Maturing *Ready to Employ*	**9**	**Deployment and cultural integration.** The project is fielded to operational units and becomes an integral part of the military culture. Warfighters endorse its use, and it is fully embedded in Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P). This ensures the technology is fully embraced and operationally effective.	• Conduct comprehensive training sessions to ensure warfighters are fully proficient with the technology • Gather and document warfighter endorsements and testimonials to support cultural integration • Review and update DOTMLPF-P to reflect the technology's integration
	8	**Training and warfighter integration.** Training programs are developed to familiarize warfighters with the technology. Projects with a warfighter on the development team progress quicker, as they provide input from the end-user perspective during the design phase. This ensures warfighters have the necessary skills and knowledge to effectively use the technology.	• Develop training programs and workshops to familiarize warfighters with the technology • Include warfighters on the development team to provide input from the end-user perspective • Conduct simulations and exercises to explore the technology's capabilities and gather feedback
	7	**Operational trials and commitment to POM.** The technology is deployed in limited operational trials, with warfighters providing feedback on usability and effectiveness. Money is allocated to purchase the project at scale, supporting the warfighter's ability to execute the mission. This involves warfighters in the evaluation process to ensure the technology meets their needs.	• Organize limited operational trials with warfighters to gather feedback on usability, training, and effectiveness • Secure funding commitments for full-scale deployment by demonstrating value and impact • Document and analyze feedback to refine the technology, improve training TTP's and ensure it meets operational needs
Emerging *Involved*	**6**	**Adoption/training development.** The technology is adopted across relevant units, with continuous adaptation and support to address emerging challenges. Project developers coordinate with educational institutions to develop and mature training packages, ranging from "on the job training" to curriculum development for new career fields. This ensures the necessary infrastructure and training are in place to support widespread use.	• Develop, mature, and distribute detailed training packages in collaboration with CCMDs, SEOs, and educational institutions • Establish a support system for continuous adaptation and troubleshooting to address emerging challenges • Ensure infrastructure is in place to support widespread use, including facilities and logistics
	5	**Policy development and field demonstration.** Policies and procedures are developed to support the technology's integration, with warfighters involved in shaping guidelines and training. This shaping includes deployment, employment, and disposition policies as well as the affiliated initial design and development of the Mission Essential Task List (METL) inputs. The project is inserted into a collective training event under operational conditions to understand its fit within doctrine and Tactics, Techniques, Procedures (TTPs). Feedback is captured for senior leaders making acquisition decisions.	• Involve warfighters in shaping policies and procedures to ensure practicality and acceptance • Conduct field demonstrations under operational conditions to validate the technology's fit within doctrine • Capture and analyze feedback from demonstrations to inform policy & training development and support acquisition decision-making in concert with CCMD and SEO POCs
	4	**Leadership, advocacy, and endorsement.** Leadership and education efforts focus on building advocacy among key personnel. Leaders are trained to understand and communicate the technology's benefits. This is a critical step to transition from a science and technology project to a program of record, indicating support by end-users for adoption and purchase at scale.	• Train leaders to understand and advocate for the technology, emphasizing its benefits and applications • Secure endorsements from key leadership, CCMDs, and SEOs to support transition to a program of record • Develop communication materials to effectively convey the technology's value to users and stakeholders
Nascent *Aware*	**3**	**Lab/field integration.** The technology is assessed for its fit within existing organizational structures, with adjustments made to align with current processes. Tests allow developers to gather diagnostic data, with warfighter participation critical for replicating realistic conditions and offering operationally informed feedback.	• Conduct lab and field tests with warfighter participation to gather diagnostic data and feedback • Assess the technology's fit within existing organizational structures and make necessary adjustments • Begin planning with CCMD and SEO POCs for integrating the technology into existing inventory and logistics systems
	2	**Initial engagement.** Warfighter consultation and validate end user requirements. Warfighters engage in discussions about the technology's implications for Doctrine and Organization. Service labs and industry must gain support from Combatant Commands (CCMDs) and/or Service Energy Offices (SEOs), demonstrated by a letter of support. This assesses how the technology fits within existing command structures and roles.	• Engage warfighters in discussions about the technology's implications for Doctrine and Organization • Validate requirements the S&T project team has curated during RRL research activities • Secure letters of support and POCs from CCMDs and/or Service Energy Offices to demonstrate stakeholder backing • Assess how the technology fits within existing command structures and roles
	1	**Awareness and alignment with requirements.** Warfighters are introduced to the technology concept, with initial discussions and briefings raising awareness and gauging interest. DoW innovation investments are aligned with warfighter needs, ensuring the technology aligns with current and future operational concepts. This could be a "technology pull" if Warfighter has an existing requirement the technology solves or could be a "technology push" if there is not a codified, existing requirement.	• Engage Warfighters from both the CCMDs and the Services' Supporting Commands to ensure joint mission execution and Organize/Train/Equip (O/T/E) presentation of forces perspectives • Conduct initial briefings and discussions to raise awareness and gauge interest in the technology • Align technology development with DoW innovation investments and warfighter needs • Explore how the technology aligns with current and future operational concepts • Leverage this information to conduct RRL research to identify initial requirements as possible

3. c) Tracking Progress: Signal to Decision-Grade Evidence

What evidence moves decisions

Early indicators, such as prototype demonstrations or initial warfighter feedback, can show a ***signal***, but they do not always drive decisions.

Decision-grade evidence gives a stakeholder what they need to act, such as committing funding or advocating for a technology's integration into an acquisition program.

Evidence should be sufficient for the next decision, not exhaustive. The evidence required depends on who is making the decision, the level of risk involved, and where the project is in the transition pathway.

Some pathways are focused on proof of concept and integration confidence building, such as BA-3-funded advanced technology development, while others require stronger evidence to support funding and transition decisions, such as BA-4-funded advanced component development and prototyping.

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Levels 1 to 9: How Maturity Shows Up in TMaF

Level 1……..Level 9

- Transition maturity is the strength of evidence behind the decision.
- TMaF describes this progression using levels (1 – 9).
- Progress is not about a score—it's more about strengthening evidence for the next decision.

Evidence Strength Across All Readiness Levels

	Typical Artifact	Early Signal	Moderate Evidence	Strong Evidence	Make the Claim
TRL	Test Results / Demo Data	Prototype demo in laboratory	Relevant environment testing	Operational testing & evaluation	“I have a technology that operate reliably under mission conditions.”
MRL	Production / Supply Chain Plan	Production feasibility analysis	Pilot-scale production	Delivery at relevant scale, cost & schedule	"I can make this many, this fast, at this cost."
TCL	Integration Memo / Transition Plan	Informal PM interest	Regular engagement with program	Collaborative program integration planning & funding	"I have someone who is ready to buy it."
RRL	CONOPS / Mission Alignment	Capability linked to operating concept	Draft CONOPS / stakeholder alignment	Validated, funded requirement	“They have buying authority, and I have a user who wants it.”
WRL	Operator Feedback Summary	Positive operator feedback	Training or use in exercise	Operational unit endorsement	"I am endorsed by the Warfighter."

Evidence is decision-grade when it lowers the approver’s risk

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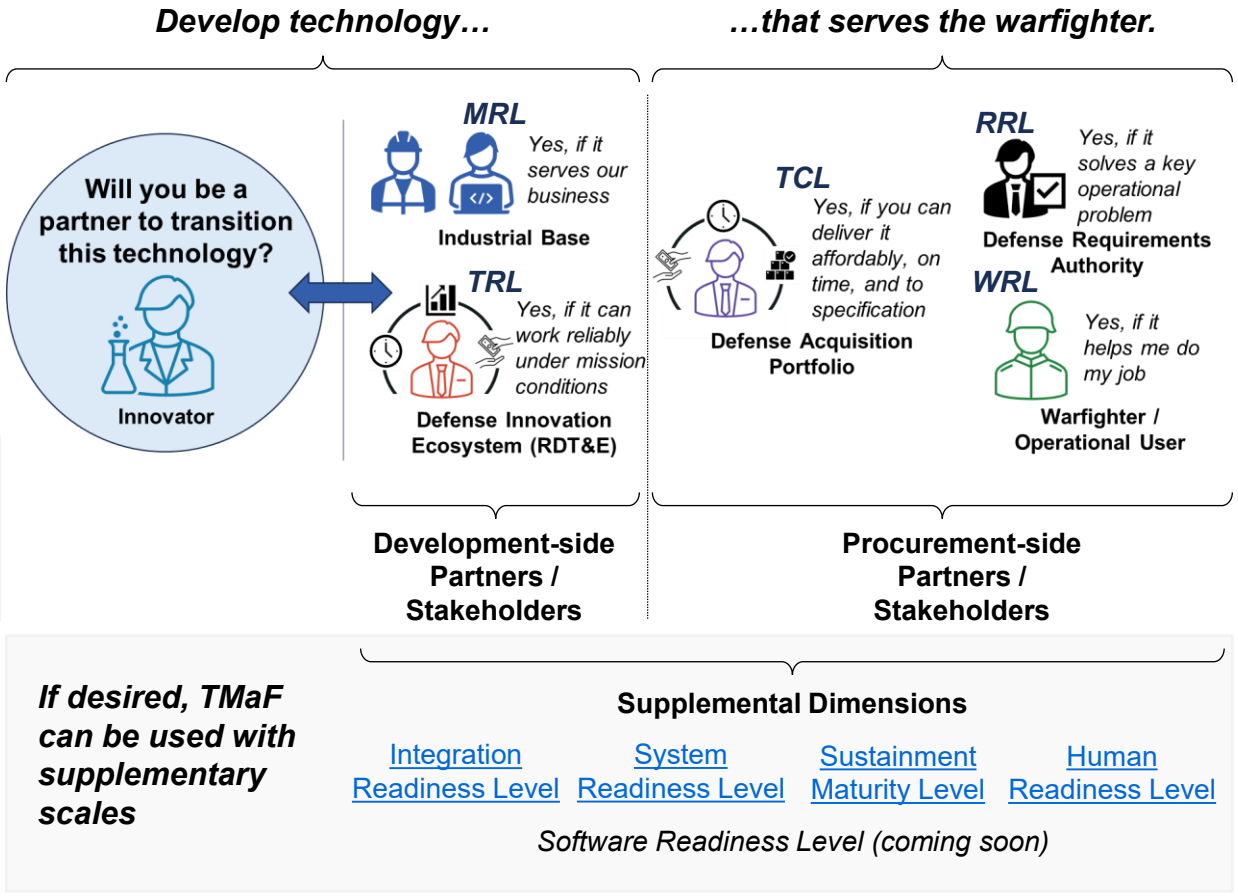
4. FAQs

Why 5 TMaF dimensions? Not fewer? Not more?

- TMaF helps innovators overcome the complexity of defense transition by **focusing on engagement with five critical stakeholders** to ensure the technology:
  - Works reliably (TRL)
  - Can be produced and delivered (MRL)
  - Meets program requirements (TCL)
  - Addresses a funded, operational problem (RRL)
  - Can be employed effectively by warfighters (WRL)
- TMaF's stakeholder-focused approach is consistent with leading entrepreneurial practice: get concepts and prototypes in front of customers early. Early customer discovery accelerates transition, reduces inefficiency, and improves outcomes for the warfighter.
- Dual-use startups and non-traditional contractors may find TMaF Lite sufficient in the early stages, shifting to full TMaF as they pursue transition into a program of record. As technologies mature, teams may also apply additional readiness frameworks to guide development and integration. For example, once a capability transitions to a program office, a program manager may direct the team to use of the Integration Readiness Level to support system integration and to manage cross-team coordination.



The 5 TMaF dimensions align to the essential partners / stakeholders needed to understanding & productively engaging the defense customer

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