iDEX Innovations for Defence Excellence

Guidelines

iDEX Technology & Product Management

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Your Innovation & Growth Partner

iDEX

INNOVATIONS FOR
DEFENCE EXCELLENCE

Enabling Indian Innovation to substitute
Imports and transform Indigenisation

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Executive Summary

The success of **Open Innovation** - the central tenet of iDEX, depends chiefly on the program being implemented **with a VC mindset**, which essentially is oriented around creating a framework of expectations, guidelines, and metrics to deftly foresee, mitigate, and manage risks inherent in converting novel technologies and new products into commercially viable solutions and profitable businesses. In the specific context of accelerating commercial launch of technologies and products to achieve the desired business goals, the definition of milestones in terms of specific goals and deliverables to be achieved by the startups, are influenced primarily by the desired commercial outcomes - outcomes and metrics related to time-to-market, competitive advantages of product, cost-effective exploration of multiple alternative solutions/designs, rapid iteration to continuously test and calibrate the product designs etc. matter the most. The startups are given the flexibility to operate with autonomy, as long as the decisions made by them are backed by sound implementation, indicating measurable progress towards these desired metrics and outcomes. Achieving commercial outcomes and market success through the program is given more importance than completing a predefined set of technical activities according to a statement of work within pre-approved budget for estimated costs but in effect failing to achieve the desired product outcomes that matter most in ultimately achieving the primary objectives of iDEX.

Decisions concerning sanction and disbursement of grant funds, reporting progress on pre-approved milestones, review of milestones progress, feedback, facilitating support in the form of resources and services etc. shall be based on **'success indicators'** vs '**safety indicators'**. Safety indicators being linked to: 1. conformance to the statement of work and 2. compliance to budgeted costs (indicator of safety). Success indicators linked to measurable goals or significant deliverables both interim and final, which validate the direction and progress - both speed and the quantum, towards achieving the ultimate outcomes. Therefore, to achieve real success, especially in the context of open innovation, where the Solution Seekers are collaborating with the Solution Providers, merely putting in place procedures, defining the roles, describing the activities and reporting on a periodic basis is not sufficient. Actually when seen from the point of view of realising outcomes that matter, they are entirely insignificant. Unless the Co-Creation activities are carried out under a structured **Product Management** approach, such procedures only create a misplaced sense of safety, much like being in a continued state of forward movement but actually lacking progress - a lot of distance measured on the treadmill but zero displacement.

During the co-creation process between the military and the innovators, the outcomes must be aligned to the validation of risk factors, which will serve as objective milestones in the path towards delivering defence-grade solutions ready for production and acquisition by the military.

1. Demonstrating technical feasibility of the solution to meet the functional requirements as deemed necessary by the Nodal Agency, by being compliant to the usage, deployment, operating, and integration constraints as may be critical to the end-user, operator or soldier.and acquisition by the military.

2. Completing all desired test procedures, by being ready to support all stages of unit and integration test plans, and in successful execution of end-user trials.

3. Engineering the solution to meet the exhaustive set of military standards while being duly compliant with the certification procedures as is deemed necessary by the concerned SHQ supervised by the Nodal Agency.

In summary, from the standpoint of managing the innovation grants and the co-creation of military-grade products, what matters most is key iDEX stakeholders getting real-time data and insights about the on-the-ground progress of translating nascent technologies, novel product ideas, or innovative system designs into military-grade solutions, ready for production and acquisition.

Objectives of Product Management Practices

1. Defining the Right PRODUCT

a Ensuring completeness and correctness of requirements defined to translate the needs and expectations of the military user and operator;

b Ensuring output of the Innovation project (development phase) seamlessly transitions to the commercial procurement to facilitate accelerated readiness for defence production and acquisition;

2. Building the Right PRODUCT

a Offering the Right Utility (Features, Functions)

b Designing the Right Usability (UX, Integration, Operations)

c Guaranteeing the Right Quality (Performance, Reliability, Standards)

3. Building the Product RIGHT

a Implementing best practices in the Design and Engineering of defence grade solutions;

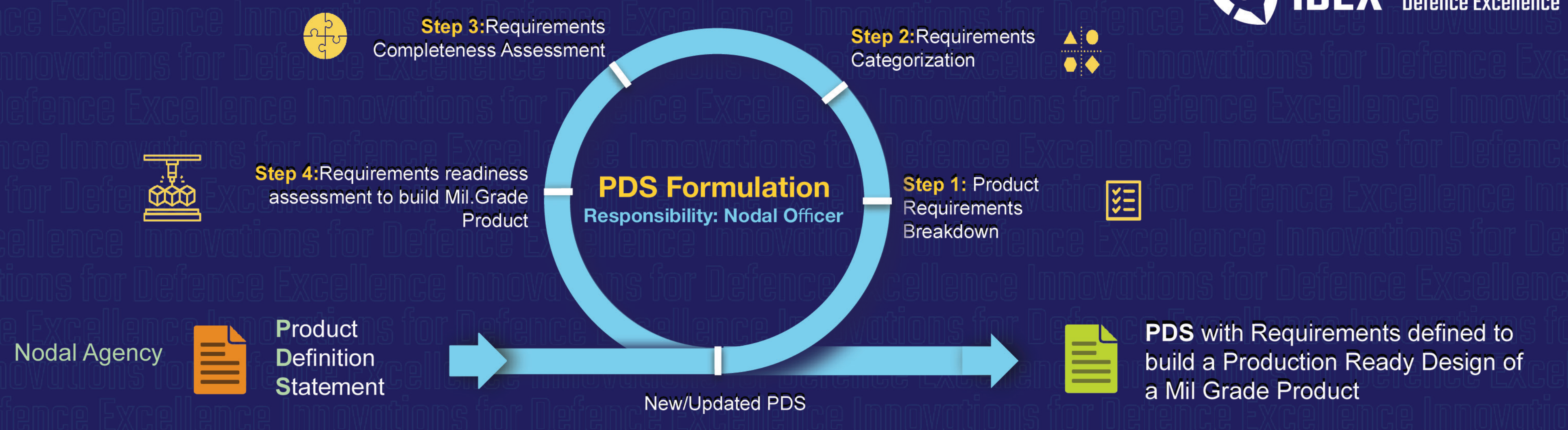
b Completing requisite procedures for integration, trials and certification iteratively and at the right intervals/stages to reduce technical debts and preempt expensive failures;

c Designing the product for being manufacturable or deployable to defence grade and standards at scale, complexity, ruggedness, reliability, and volumes commensurate with military's expectations;

d Designing the product to be highly suitable for easy extensibility, upgrade, and maintenance operations and acceptable to military procedures;

Along similar lines to Financial/Accounting MIS which play a critical role in the effective management and administration of grants, it is proposed to create a MIS for implementing Product Management practices in iDEX.

A reference **Product Management Dashboard** is illustrated below, and this document aims to describe the scientific principles behind the quantitative metrics and qualitative insights presented in the dashboard.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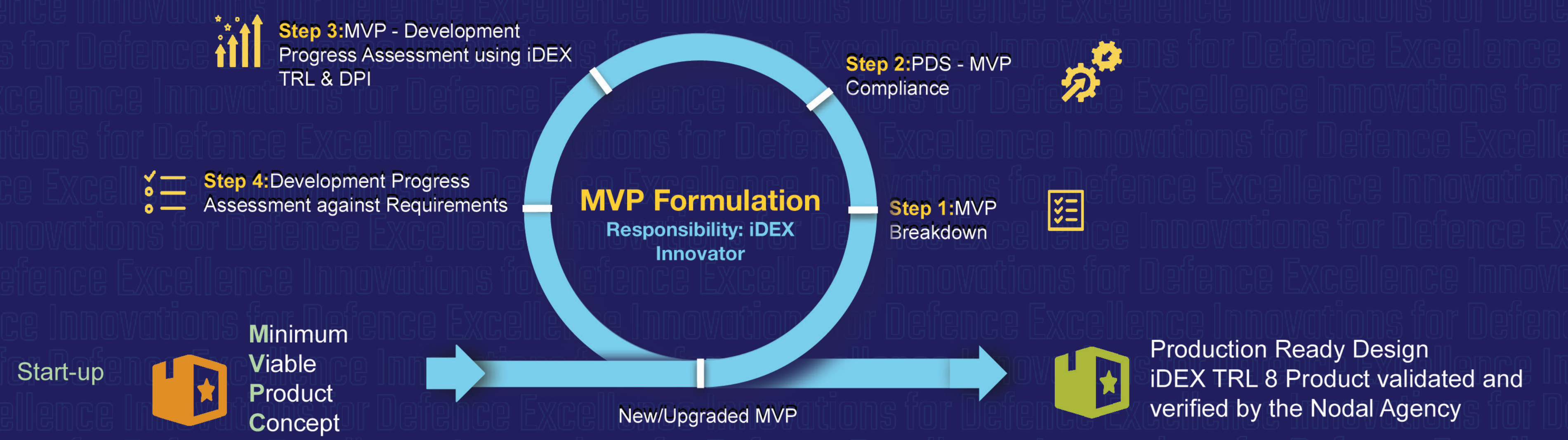
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iDEX TRL 8 Product validated and
verified by the Nodal Agency

Product Management Dashboard Snapshot

Product Management Dashboard

iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora
iDEX Innovator/Startup: Dimension NXG
Target Product Completion Date: 14 April 2021

Product Requirements Document (PDS)
Version: 1.0 **Dated:** 3 Jan 2020

MVP Design & Specification Document
Version: 1.0 **Dated:** 19 May 2020

PDS Completeness

# of Product Requirement Units (PRUs) 34 **PDS Completeness Rating** Low

Summary of PDS Breakdown & Assessment

Requirement Category	Features & Functionalities	Usage/Usability/Operational Constraints	Performance Parameters/Metrics	Integration to Target Platform	Test Plans and Procedures Relating to End-User Trials	Applicable QA/Mil Grade Standards
Level of Completeness of Requirements	High	Medium	Low	Medium	Low	Low
# of PRUs	21	6	5	1	0	1
Are PRUs mapped to TRL-8?	Yes	No	No	No	No	No

PDS-MVP Compliance

% Compliance of MVP against PDS Requirements 44%

Summary of PDS-MVP Compliance

Compliance Label	Fully Compliant	Partially Compliant	Non Compliant	Pending	Disqualified	TOTAL
# of PRUs	15	8	11	0	0	34
% Compliance	44%	24%	32%	0%	0%	

Technology & Product Readiness

TRL Summary

MVP (Current)	MVP (Target)	# of Subsystems	Subsystem	Current TRL	Target TRL
4	8	2	AjnaVU MR Headset	4	8
			360deg Vision System	4	8
			<Name of Subsystem>		
			<Name of Subsystem>		
			<Name of Subsystem>		
			<Name of Subsystem>		

# of PFUs (Product Functional Units) in MVP 31

Product (MVP) Breakdown Structure

Product Breakdown Level	Module	Component	Attributes	TOTAL
# of PFUs	6	25	0	31

Development Progress Indicators (DPIs)	% Development Progress			Development Progress Indicators (DPIs)	# PFUs
Backlog	51%	36%	0%	Backlog	12
Dev In-Progress	16%	24%	0%	Dev In-Progress	7
Verified Functional PoC	33%	40%	0%	Verified Functional PoC	0
S/SS Integration Completed	0%	0%	0%	S/SS Integration Completed	12
Trials/QA Passed	0%	0%	0%	Trials/QA Passed	0
Production Ready Design	0%	0%	0%	Production Ready Design	0
					31

Summary of Product Development Progress against PDS Requirements

Development Progress Indicator (DPI)	Backlog	Dev In-Progress	Verified Functional PoC	S/SS Integration Completed	Trials/QA Passed	Production Ready Design
# of PRUs	12	3	19	0	0	0
% Dev Progress against DPIs	35%	9%	56%	0%	0%	0%

1 Case and Context for Technology Management

The process of translating proven scientific knowledge through technology and systems development into military grade systems ready for acquisition and deployment for military applications, is generally referred to as **Technology Management.** The practice has gained global salience after NASA and then later on by DoD of USA, and their counterparts in other countries, made Technology Management a critical part of managerial capabilities especially within the Technology Planning and Capability Acquisition wings of key defence, aerospace, and space agencies/departments.

At its core, Technology Management is essentially about managing risks associated with cost, capabilities/performance, timelines, production capacity, obsolescence, and self-reliance in the process of developing technologically advanced solutions to meet the escalating demands of the military. This is significantly more complex and operationally very different from Project, Cost and Commercial Management practices conventionally adopted for managing development and procurement of systems that are low-tech, only incrementally innovative, and involve design and engineering of proven/mature systems, components etc. against well defined specifications.

Given the risk management purpose and orientation, the Technology Management process involves a set of practices, techniques, and tools, to identify, mitigate and manage risks involved in the translation of nascent technologies, novel product ideas, or innovative designs of systems, into military-grade solutions, ready for production and acquisition. In contrast to managing procurement of more conventional, low-tech and mature systems, the onus to manage risks while allowing for opportunities to emerge for technology and innovation driven strategic advantages, is solely on the principal. Generally speaking those administrative norms, operational procedures, and commercial terms, practised to safeguard acquisition budgets, operating costs, schedule, and quality, are found inadequate. In the context of iDEX, wherein the process of innovation and development is undertaken by external agencies with public funds, it is imperative that a rigorous process of Technology Management is implemented.

From a risk management perspective, Technology Management essentially aims to validate in a systematic manner these salient aspects during the course of the systems engineering process:

1. Are the capability enrichment goals and technology needs, comprehensively translated into expectations properly captured in the form of requirements?

2. Are requirements defined at the desired level of technology/ system maturity acceptable to the military as a viable design ready for defence production and induction?

3. What is the degree of compliance of the proposed technology concepts and innovative solutions against addressing the exhaustive set of requirements defined?

4. Is the rate of progress of the development project satisfactory against the expectations to deliver a viable design at the desired level of technology/product maturity in a timely manner?

1.1. Technology Readiness Levels (TRLs)

In order to objectively assess the maturity of any technology (system) under development and to quantify the inherent risk associated with functionality, system integration feasibility, operational viability, performance reliability, maintainability etc. Technology Readiness Level was developed as a universally accepted tool. It uses a 9 point scale with each higher level indicating an enhanced level of maturation and consequently every higher level on the scale corresponds to lesser overall risk of technology development. Each point is mapped to a qualitative description of the requisite criteria against which the candidate technology needs to be evaluated, and the point is accorded after due assessment of strong evidence presented in relation to the parameters and attributes of the criteria.

1.1.1. Technology Development versus Product Development

Before we proceed further, it is important to gain a consistent definition of the term **'Technology'**. Technology refers to the output of the process of translation of knowledge and principles of scientific research into a form suitable for use in real-world applications. To put it simply, that form is generally referred to as **'Solution'** at a conceptual level, or as a **'Product'** in a commercial context, or as a **'System'** in the context of in-house development within an organization.

The question of technology maturity and the notion of risk inherent to the maturity of technology, arise only if candidate technology is nascent or novel and remains to be proven in terms of its efficient translation into a Solution, Product or a System, backed with evidence of desirable performance in the target application(s). It is assumed that technologies at lower levels of maturity are inherently risky when transitioned into the downstream stages of production or manufacturing, where technologies are not mature enough for the design and engineering activities whose optimisation for cost, time, inventory, and defects will come under significant risk.

For example, say a new optical sensor technology developed from advances in material science research and translated into a core-component of a vision/imaging product intended for industrial surveillance applications. On the evidence that the final product is performing reliably, the element of risk associated with the maturity of the technology is considered least, almost zero. If the same technology, which is now embodied in the form of a core-product ready for prototype development or even for the manufacturing of production-ready designs of other products, then the risk of maturity of this vision/imaging technology is least/zero. However, what matters now is the development maturity of the product in which the proven technology is being embedded.

Traditionally TRLs were created in an era where military and space agencies held a near monopoly over technology development, so every new capability development project was engaged with nascent technologies with significant risk. In an attempt to build technology led strategic advantages over adversaries it is but natural that New Technology Capabilities developed for defence applications involve the translation of emerging scientific discoveries.

The TRL methodology works most effectively in this context. However, in the case of developing innovative solutions utilizing proven/mature technologies, risk related to technology maturity matters less, but what matters more is the maturity of the developed product (system), in being acceptable as a viable military-grade design.

Using the analogy of Ranks vs Marks to understand the limitations of the TRL Model

Students are given Ranks in competitive exams, and the Rank indicates the relative standing between students, which determines decisions concerning their admission to institutions, for instance. However, the Rank itself is a derivative of the marks/grades scored by the students in different subjects, and these Marks individually are the actual indication of the level of learning/knowledge acquired. The Rank itself is a very abstract indicator and doesn't at all serve the purpose of diagnosing the actual gaps in knowledge or skills, for coming up with improvement plans to address gaps and to enhance the student abilities.

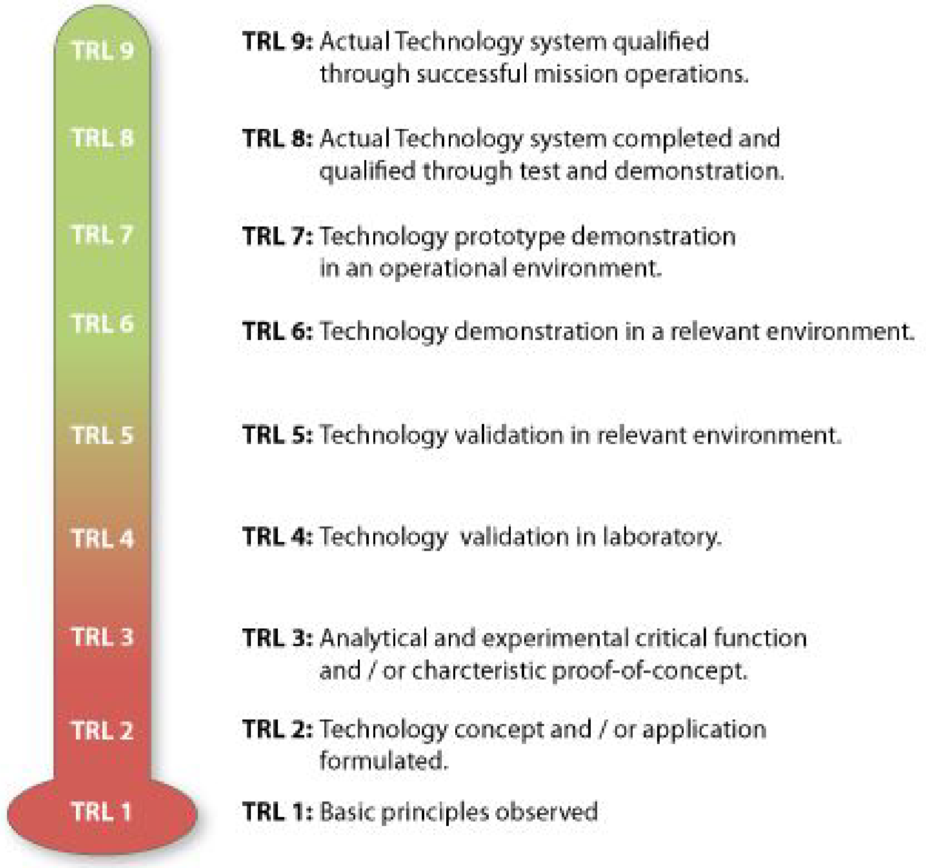
Ranks serve the limited purpose of a rubric, whereas Marks serve the purpose of a diagnostic tool. Along similar lines, TRL is much too abstract a metric to effectively serve the purpose of diagnostic, which is critical for effectively managing product/system development projects.

1.2. Adaptations and Limitations of TRL Methodology

The limitations of the TRL methodology in the specific context of funding and incubating technology and product development projects in iDEX, have been enumerated below:

1.2.1. Generic versus Program specific TRL Definitions

A generic description of TRLs broadly accepted internationally is illustrated below:



However, the terms of reference, viz. Technology Validation, Relevant Environment, Operational Environment, Qualification through Test etc. need to be defined in the specific context of the overall iDEX program or in some cases at a specific project level too.

Just as Ranks are derived from Scores, which are computed on the basis of well defined criteria and measurable parameters, so too TRLs for a specific program. The TRLs are mapped to parameters that independently measure different risk factors of technology maturity. In addition, for each of the parameters/criteria corresponding to the risk factors, the description of the requisite evidence to qualify the criteria must be defined too.

The risk factors include:

Functional Compliance
Performance
Design Readiness
Level of Integration

An integrated matrix for evaluating Technology Readiness along with the parameters relating to risk factors, recommended for iDEX products (innovations) is presented below:

TRL #	Description of Readiness Level	Functional Compliance	Integration Readiness	Design Readiness	System Performance
Level 9	Product ready for military acquisition/induction				
Level 8	Production Design validated in Field/End-User Trials and verified for QA/Standards				
Level 7	Prototype validated in Field/ End-User Trials				
Level 6	Prototype demonstrated in target platform after system integration				
Level 5	Prototype validated for system integration to target platform		<To be defined>		
Level 4	Functional prototype for lab validation				
Level 3	PoC to demonstrate functions of critical subsystems /modules				
Level 2	Product concept formulated				
Level 1	Basic scientific principles				

1.2.2. Guidelines for implementation of TRL Methodology in iDEX

The TRL matrix defined in the form of a framework has to be customised for each Challenge, so as to avoid a generic one-size-fits-all format being used merely for the sake of formality. In doing so one doesn't really benefit from the application of the TRL methodology, since the data about the TRL levels across different projects and their corresponding insights fail to present the real element of risk inherent in each development project. It is therefore recommended that the reference TRL framework is suitably adapted to the specific context and is completed at the time of sanctioning grants and before the issuance of a substantially complete PDS. It is also suggested that the TRL framework may be defined uniquely for a certain **category of innovative/technologically advanced solutions (products)** as opposed to being defined for each individual Challenge or Project.

1.2.2.1. iDEX Product Categories

Broadly speaking the following categories of products may be considered as the reference to arrive at decisions relating to the definition of unique TRL framework:

1. Products for end-use operations typically by soldier, airman or seaman.
2. Products integrated to Land platforms operated in tactical warfare
3. Products integrated to Naval platforms operated in tactical warfare
4. Products integrated to Air platforms operated in tactical warfare
5. Products integrated into platforms/systems not operated in tactical warfare
6. Software ONLY Products/Systems integrated into field operated platforms
7. Software ONLY Products/Systems integrated into existing IT systems

1.2.2.2. Reference TRL Framework for a particular Category of Products - #1

iDEX Challenge: See Through Armour

Product Category: #2 Products integrated to Land platforms operated in tactical warfare

TRL #	Description of Readiness Level	Functional Compliance	Integration Readiness	Design Readiness	System Performance
Level 9	Product ready for military acquisition/induction				
Level 8	Production Design validated in Field/End-User Trials and verified for QA/Standards				
Level 7	Prototype validated in Field/ End-User Trials				
Level 6	Prototype demonstrated in target platform after system integration				
Level 5	Prototype validated for system integration to target platform	**<To be defined>**			
Level 4	Functional prototype for lab validation				
Level 3	PoC to demonstrate functions of critical subsystems /modules				
Level 2	Product concept formulated				
Level 1	Basic scientific principles				

1.2.2.3. Reference TRL framework for a particular Category of Products - #2

iDEX Challenge: AI in SCM & Logistics

Product Category: #7 Software ONLY Products/Systems integrated into existing IT systems

TRL #	Description of Readiness Level	Functional Compliance	Integration Readiness	Design Readiness	System Performance
Level 9	Actual system proven through successful mission-proven operational capabilities.	<To be defined>			
Level 8	Actual system completed and mission qualified through test and demonstration in an operational environment.				
Level 7	System prototype demonstration in an operational, high-fidelity environment.				
Level 6	Module and/or subsystem validation in a relevant end-to-end environment.				
Level 5	Module and/or subsystem validation in a relevant environment.				
Level 4	Module and/or subsystem validation in a laboratory environment (i.e., software prototype development environment).				
Level 3	Analytical and experimental critical function and/or characteristic proof of concept.				
Level 2	Technology concept and/or application formulated.				
Level 1	Basic principles observed and reported.				

1.2.3. Monitoring of development progress for sub-systems/ modules at interim project milestones is not effective using TRL Assessment

Although TRLs are extremely effective in managing risks at an overall system level, especially in the context of those development projects with a higher degree of nascent/unproven technology subsystems or components, there are limitations in the application of TRL methodology, which have been extensively documented within guidelines notified by NASA, DARPA etc. In iDEX where development is undertaken by an external agency against a product development grant, in addition to managing risk it is equally critical to monitor and measure the progress of the development activity and its status at interim milestones where additional funds under the grant are approved to the innovator agencies.

In projects that involve relatively less complex technology, and fewer number of subsystems/modules, the need for a Product Management approach becomes more pertinent, than purely Technology Management. That is akin to using a complex tool for a simplistic purpose, and would become more a burden than a real value addition.

Essentially, the orientation of Product Management is towards continuous assessment of the readiness of the product in terms of: being put for trials, validated for end-user acceptance, proven for reliable performance, designed for manufacturing etc.

1. Is there a clear and complete definition of what the Right Product is?

Assessment of the completeness of the PDS, and ensuring a rigorous approach is followed by adopting the popular industry practices of creating Product Requirements Document (PRD).

Refer to section 'Completeness of Product Requirements Definition' further below.

2. **Is the product developed meeting the complete requirements of the expected Right Product?**

   Assessment of the compliance of the proposed solution against the requirements defined to deliver a production ready design verified and validated.

   Refer to section 'Compliance of MVP Design and Specifications against Product Requirements' further below.

3. **What is the status/progress of building the Right Product?**
   How much of the Right Product has been built now?
   Are there risks in terms of uncertainties about cost, schedule, and meeting the requirements?

   Assessment of the progress of product development in terms of quantum of completion achieved and the pace of progress against milestone specific expectations, so as to manage risks through timely decisions and suitable interventions.

   Refer to section 'Assessment of Progress of Product Development' further below.

To an extent this Product Management orientation to monitoring the progress of the development projects funded through iDEX has already been integrated into the definition of milestones for the Product Dev/QA track of the milestones framework for SPARK Grants, included as Anx: X in the contracts.

However, unless activities and deliverables defined in the WBS milestones are aligned with the stage-wise maturation of product readiness consistent with standard product development process/methodologies, and unless evidence to support maturation of product readiness is rigorously validated at the completion of these milestones, the translation from intent to implementation will be deficient.

In the following sections, a set of methodologies and related tools and techniques to implement the desired Product Management practices in a structured and consistent manner are described. These practices are expected to complement the TRL methodology and form an integral part of the overarching Technology Management process to be institutionalised within iDEX.

2

Product Management Practices for iDEX

2.1. Focus Area #1 - Completeness of Product Requirements Definition

To ensure that the requirements are defined such that a product design fully compliant to these requirements is automatically deemed to be acceptable as a viable product for defence production and acquisition, it is recommended that the Problem Definition Statement (PDS) document issued by the anchor SHQ, DPSU or OFB covers exhaustively the following types of requirements:

1. Features & Functionalities
2. Usage/Usability/Operational constraints
3. Performance parameters/metrics
4. Integration/Verification to target platform
5. Test plans and procedures for End-User Trials
6. Applicable QA/Mil Grade standards

For each of these categories of requirements, it is mandatory to define and describe all those granular requirements as may be applicable, at a level commensurate with the expectations for developing a product at TRL-8.

2.1.1. Correctness of Requirements Definition

The biggest risk in innovation arises from the innovator building a solution that the user doesn't find useful/usable and/or the buyer doesn't find valuable enough to be willing to pay the price for. Open Innovation framework brings the Innovator to co-create with the User or Buyer, facilitating an efficient discovery of the real needs of the **Beneficiary** free from the biased perspectives on either side of the innovation transaction. The biases at the innovator's end are caused by the influence of their strong conviction in the capabilities of their technologies and innovative ideas. While those on the user's end arise from perceiving their own problems statements through the lens of their own solutions concepts, coming under a strong influence of their technical knowledge and competencies. Beyond merely bringing the innovator and the beneficiary together, a structured process of problem curation including rigorous definition and detailed documentation of the various facets of the User's Requirements is essential to realise the ultimate benefits of open innovation. So, it's not merely the completeness of the requirements definition but also the correctness that matters, because **'Defining the Right PRODUCT'** shall serve as the basis for **'Building the Right PRODUCT'** and **'Building the Product RIGHT'**.

Defining Requirements the CORRECT way

To ensure that the Problem Definition Statement is able to achieve the desired level of Correctness, it is recommended that the definition and description of requirements be oriented around the following:

- **Functional requirements of the user/operator** describing their needs to be fulfilled, gaps to be addressed, or challenges to be overcome etc. or basically the description of the 'Job to be Done';

- **Functional capabilities or Features** describing the desired functionalities of the solution

- **Operational constraints** relating to the broader context or environment in which the desired solution must be used, deployed or operated;

- **Expectations on intangible benefits or tangible/measurable gains** to be realised by the user from adopting and operating the solution to address the needs or to overcome their challenges;

- **Performance metrics or outcomes** to be used as benchmarks in evaluating the effectiveness of the solution;

- **Quality standards** to be complied with in order to qualify as a military grade solution;

Defining Requirements the INCORRECT way

The following orientation of defining requirements must be avoided:

- **Technical Specifications** describing the intricacies of the design and engineering aspects of the solution, its constituent subsystems and components etc.

2.1.1.1. Test Criteria for Requirements versus Specifications

In certain cases, the definition of the problem statements may require the inclusion of certain 'Technical Specifications' relating to various aspects of the desired military-grade product including functionality, performance metrics, system integration, operating/system parameters etc., which may at face-value go against the expectation that PRUs shouldn't be defined as technical specifications. However, the inclusion of these may be valid from the point of view of stating those minimum requirements or expectations crucial to delivering the desired/viable product. In such cases, should the innovator(s) find any of these PRUs invalidating the core idea, concept or design of the proposed innovative solution, and thereby limiting the value/ potential of their core innovation, then those PRUs may either be removed from the PDS or tagged as Disqualified for the challenge as a whole or selectively for any/some innovators.

An assessment matrix as has been illustrated below is recommended to be duly implemented for every iDEX Challenge to effectively manage the process of defining product requirements:

#	Requirements Category	Level of Completeness	Are requirements mapped to TRL-8?
1	Features & Functionalities	Very High High Medium Low Very Low	Yes No Not Applicable
2	Usage/Usability/Operational constraints	Very High High Medium Low Very Low	Yes No Not Applicable
3	Performance parameters/ metrics	Very High High Medium Low Very Low	Yes No Not Applicable
4	Integration/Verification to target platform	Very High High Medium Low Very Low	Yes No Not Applicable
5	Test plans and procedures for End-User Trials	Very High High Medium Low Very Low	Yes No Not Applicable
6	Applicable QA/Mil Grade standards	Very High High Medium Low Very Low	Yes No Not Applicable

2.1.2. Product Requirements Breakdown

To facilitate effective assessment of the completeness of requirements but more so to streamline the subsequent assessment of compliance of MVP against these requirements, and to prepare for better monitoring and reporting throughout the product development cycle, it is recommended that a **Requirements Breakdown Structure (RBS)** is practised. In such a structure, the qualitative and descriptive contents of the overall scope of requirements are translated into indivisible (unique or independent) **Product Requirement Units (PRUs)**, which are each numbered and shall each have to be individually complied to and duly addressed by the MVP.

Please refer to Table-A below for a recommended format for documenting the Requirements Breakdown Structure along with an enumerated list of unique or independent requirement units.

Note: It is to be mandated that a fully complete product requirements document is delivered for each iDEX Challenge by the respective SHQ/ DPSU Nodal Agency and duly reported to key stakeholders, no later than 3 months from the date of issuance of the first version of PDS.

Table-A: Reference Requirements Breakdown Structure (RBS)

Requirements Breakdown Structure for iDEX Challenges

iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora

PRU #	#	Requirement Unit
	1	**Functionality & Integration**
	A	**Camera/Sensors**
1		1. Uncooled TI Camera with suitable frame rate and delay
2		2. Human detection range 300m
3		3. Tank detection range 500m
4		4. Resolution on par with human eye
5		5. Position above free board level to stream above water level feed during amphibious ops
6		6. Day and night vision
	B	**Video feed**
7		1. 360° coverage around the ICV BMP-2 to the operators
8		2. Preferably coloured video in night
9		3. View choosable between Normal, Infrared and thermal modes
	C	**Head Display Units**
10		1. Head or Helmet mounted
11		2. Separate for Commander and Driver Head Display Units
12		3. Head motion tracking
13		4. Bioccular, High resolution HD view
14		5. Terrain/tactical situational update
15		6. Transparent screen or display
16		7. No interruption to existing BMP-2 head gear functionalities
	D	**Head Display Units (Data Display)**

17		1. Different Data to different users (Commander/Driver) aligning to their view and need (with azimuth 200° and vertical ±50° field of view)
18		2. Selective ON/OFF of displays / data
19		3. Vehicle performance data
20		4. Digital Zoom-in capabilities
21		5. Gunners sight
22		6. With relevant symbols through advanced image processing and distortion correction
23		7. AI based tactical insights
	E	Software (to inject below data into HDUs)
24		1. GPS data: Vehicle location coordinates, heading, route to destination, ETA
25		2. Ballistic data : Ammunition status, Type and direction of cannon should be sent to display unit
26		3. Radio data : Channel/frequency set and radio set in use
27		4. Process inputs like Battlefield Management System (BMS)
	F	Ruggedness
28		1. Internal systems: Ergonomic, Unbreakable/Hardened, Water proof
29		2. External modules: Military grade, water proof, protection from small arms fire, Should not change silhouette of BMP-2
30		3. Redundancy: Sufficient number of extra cameras to be incorporated for usage in case of break in primary devices
	G	System Operation
31		1. Minimum 8 hours of continuous operation (Development Candidate)
	H	Miscellaneous
32		1. Self sufficient in power supply requirements
33		2. No compromise in amphibious and anti CBRN capability

2.2. Focus Area #2 - Compliance of MVP Design and Specifications against Product Requirements

2.2.1. Definition of Minimum Viable Product (MVP)

The term **Minimum Viable Product (MVP)**, in this context of product development towards delivering military-grade solutions, refers to the **production-ready design of the proposed technology/solution** that is found **acceptable by the military as a viable product for defence production and acquisition**. To achieve the status of MVP is considered the ultimate goal of the product development project, and the final outcome is achieved after going through various stages of development, system integration, and different types of validation, verification and certification activities. To be designated as MVP implies that the developed solution has achieved full compliance against the exhaustive set of product requirements and has been certified to be ready in terms of functionality, performance, reliability, QA, and compliance to standards, for being taken from product development into commercial procurement, production, and acquisition.

For the sake of consistent usage and interpretation of the term **'MVP'**, the following guidelines are recommended:

1. The term MVP implies that the minimum expected outcome (final technical output) of every product development project supported under iDEX is the 'production ready design' of the respective technology/solution proposed by the Innovator Agency;

2. All development projects irrespective of the nature of challenges, technology domain areas, design/architecture of the proposed solution, use-cases or application scenarios, standardised solution or not, type of product etc. are expected to deliver a MVP, unless approved under exceptional cases;

3. MVP implies that all aspects of technical activities relating to design, development, system integration, verification, trials, certification and other areas as may be relevant have been completed, and that the MVP is ready for any or all activities relating to procurement, production, transfer of technology, technology licensing etc. which may be independently undertaken without the direct involvement of the Innovator agency;

2.2.2. Assessment of Compliance of MVP

Typically, in systems engineering process, a distinction is made between **Validation** and **Verification**. **Validation is generally a managerial activity** involving qualitative assessment of data against a set of benchmarks whereas **Verification is a specifically defined technical activity** involving implementation of test procedures to evaluate the candidate system against an exhaustive set of benchmarks, expectations, and predefined test results/outcomes.

To aid the effective implementation of the desired assessment of MVP compliance, the following guidelines are to be adhered to:

1. A **Validation approach** is recommended to assess the **Functional Compliance** of the candidate product using data and specifications about its concept, design, and architecture against the exhaustive set of product requirements defined for the desired target product.

2. Although at every stage of the product development cycle, necessary Verification procedures are performed to assess the MVP under development against expected technical and operational results in functionality, usability, system integration, performance, reliability, manufacturability, compliance to standards etc. the impact of technical measures taken to address gaps identified during these verification steps is severe on the costs, timelines, and the very viability of the current design and architecture of the proposed product concept. **It is therefore considered most critical to rigorously validate whether the design, architecture, and all aspects of technical decisions are aligned with developing a MVP that will address the product requirements exhaustively at maturity/readiness commensurate with TRL-8**.

3. A rigorous validation exercise is recommended in the upstream stages of the product development cycle and to make this as effective as possible, there needs to stringent measures taken to ensure that the product requirements and the technical data/details relating to the concept, design, and architecture of the proposed MVP are properly documented.

4. This is not a one-off assessment but a continuous process requiring an assessment at every milestone of the product development cycle or whenever there is a substantive change in either the definition of requirements or extension in the scope. At every such assessment point only the most recent document describing the technical details, data and specifications of the proposed MVP must be used as the basis to evaluate compliance.

5. As a general practice it is recommended that proper version control mechanisms be practised to track the lifecycle of the product requirements document and the MVP design and specifications document.

6. It is to be mandated that a comprehensive assessment of the MVP compliance against product requirements is completed and duly reported to key stakeholders within 15 days from the issuance of each progressively updated version of the PDS.

It is recommended that the assessment of the compliance of the MVP against the corresponding product requirements be implemented along the lines of a Conceptual Validation exercise. The actual nature of the assessment recommended for each of the categories of requirements have been presented in the table below, and a suitable **Compliance Label** be used to indicate the status of the compliance selected from one among these:

1. Fully Compliant
2. Partially Compliant
3. Noncompliant
4. Pending

The statement/definition of requirements are absent or insufficient.

5. Disqualified

Not feasible toa ssess compliance objectively, given the incomplete/ irrelevant nature of the requirement as defined/described in the current version of the requirements document.

#	Requirements Category	Nature of Assessment of MVP Compliance	Compliance Label
1	Features & Functionalities	1. Is the proposed concept, design and architecture of the MVP addressing the desired functional utility and capability as per the definition and description of the requirements? 2. Is the MVP at subsystem, module or component levels collectively able to cater to each unique or independent requirement related to features or functionality?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified
2	Usage, Usability & Operational constraints	Is the proposed concept, design and architecture of the MVP offering the desired functional utility/ capability while being fully compliant with the necessary constraints?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified
3	Performance parameters & metrics	Is the proposed concept, design and architecture of the MVP capable of offering the desired functional utility/capability while performing at the desired levels as characterised by the parameters/metrics stipulated in the requirements document?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified
4	Integration & Verification to target platform	Is the proposed concept, design and architecture of the MVP capable of offering the desired functional utility/capability when deployed or integrated to the target platform as is prescribed in the requirements document?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified
5	Test plans and procedures for End-User Trials	1. Is the proposed concept, design and architecture of the MVP capable of supporting the implementation of necessary technical and operational procedures to verify the compliance against end-user trials as is prescribed in the requirements document? 2. Is the Innovator agency able to guarantee the form, fit, and functional aspects of the necessary technical deliverables in order to undertake desired end-user trials independently?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified
6	Applicable QA & Mil Grade standards	Are the applicable standards and specifications as is prescribed in the requirements document given due consideration in the proposed concept, design and architecture of the MVP?	Fully Compliant Partially Compliant Noncompliant Pending Disqualified

Table-A: Reference Requirements Breakdown Structure (RBS)

Statement of MVP Compliance against Product Requirements & Status of Development Progress

iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora

PRU #	#	Requirement Unit	MVP Compliance	Product Dev. Progress
		Functionality & Integration		
	A	**Camera/Sensors**		
1		1. Uncooled TI Camera with suitable frame rate and delay	Partially Compliant	Dev In-Progress
2		2. Human detection range 300m	Noncompliant	Backlog
3		3. Tank detection range 500m	Noncompliant	Backlog
4		4. Resolution on par with human eye	Noncompliant	Backlog
5		5. Position above free board level to stream above water level feed during amphibious ops	Noncompliant	Backlog
6		6. Day and night vision	Fully Compliant	Dev In-Progress
	B	**Video feed**		
7		1. 360° coverage around the ICV BMP-2 to the operators	Fully Compliant	Dev In-Progress
8		2. Preferably coloured video in night	Noncompliant	Backlog
9		3. View choosable between Normal, Infrared and thermal modes	Fully Compliant	Verified Functional PoC
	C	**Head Display Units**		
10		1. Head or Helmet mounted	Partially Compliant	Verified Functional PoC
11		2. Separate for Commander and Driver Head Display Units	Fully Compliant	Verified Functional PoC
12		3. Head motion tracking	Fully Compliant	Verified Functional PoC
13		4. Bioccular, High resolution HD view	Fully Compliant	Verified Functional PoC
14		5. Terrain/tactical situational update	Partially Compliant	Verified Functional PoC
15		6. Transparent screen or display	Fully Compliant	Verified Functional PoC
16		7. No interruption to existing BMP-2 head gear functionalities	Fully Compliant	Verified Functional PoC
	D	**Head Display Units (Data Display)**		
17		1. Different Data to different users (Commander/Driver) aligning to their view and need (with azimuth 200° and vertical ±50° field of view)	Fully Compliant	Verified Functional PoC
18		2. Selective ON/OFF of displays / data	Fully Compliant	Verified Functional PoC
19		3. Vehicle performance data	Noncompliant	Backlog
20		4. Digital Zoom-in capabilities	Fully Compliant	Verified Functional PoC
21		5. Gunners sight	Fully Compliant	Verified Functional PoC
22		6. With relevant symbols through advanced image processing and distortion correction	Fully Compliant	Verified Functional PoC
23		7. AI based tactical insights	Noncompliant	Verified Functional PoC

	E	**Software (to inject below data into HDUs)**		
24		1. GPS data : Vehicle location coordinates, heading, route to destination, ETA	Noncompliant	Backlog
25		2. Ballistic data : Ammunition status, Type and direction of cannon should be sent to display unit	Noncompliant	Backlog
26		3. Radio data : Channel/frequency set and radio set in use	Noncompliant	Backlog
27		4. Process inputs like Battlefield Management System (BMS)	Noncompliant	Backlog
	F	**Ruggedness**		
28		1. **Internal systems :** Ergonomic, Unbreakable/Hardened, Water proof	Noncompliant	Backlog
29		2. **External modules :** Military grade, water proof, protection from small arms fire, Should not change silhouette of BMP-2	Noncompliant	Backlog
30		3. **Redundancy :** Sufficient number of extra cameras to be incorporated for usage in case of break in primary devices	Fully Compliant	Verified Functional PoC
	G	**System Operation**		
31		1. Minimum 8 hours of continuous operation (Development Candidate)	Partially Compliant	Verified Functional PoC
	H	**Miscellaneous**		
32		1. Self sufficient in power supply requirements	Partially Compliant	Verified Functional PoC
33		2. No compromise in amphibious and anti CBRN capability	Noncompliant	Backlog

2.3. Focus Area #3 - Assessment of Progress of MVP (Product) Development

2.3.1. Product Breakdown Structure

In the system engineering process, to bring a degree of objectivity to the assessment of the pace and quantum of progress of the development projects there arises the need to define quantifiable data points, which can be measured in a standardised manner across different stages of the development cycle. One commonly adopted method is to break down the product (system) being developed into an enumerated list of independent parts. But to avoid an unstructured assortment of parts, the product design and architecture is represented as a hierarchical structure by disaggregating the whole product into granular levels namely, subsystems, modules, components, and functional attributes.

A reference framework for modeling the hierarchical Product Breakdown Structure is suggested below:

Product Breakdown Level		**Description**
Level-1	Product	Overall whole product, referred to as the MVP.
Level-2	Subsystem	Every significant part of the whole product that is fully autonomous and capable of independent functioning with explicit interfaces with their counterparts.
Level-3	Module	Key functional units that are functionally interdependent with other peer units under a specific subsystem.
Level-4	Component	Uni-functional elements that combine with other similar units to implement the desired functionality at the module level.
Level-5	Attribute	Atomic level functional elements, which may be added to the enumerated list of PFUs only if there is a reasonable merit to do.

From the very upstream stages in the product development cycle it is to be mandated that the proposed MVP concept, design and architecture may be represented in the form of a hierarchical structure with enumerated list of independent parts, referred to as the **Product Breakdown Structure** and **Product Functional Units (PFUs)** respectively, as illustrated in the example below in Table:C.

Table-C: Reference Product Breakdown Structure

Product Breakdown Structure

iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora

PFU #	Product - See Through Armor			
	1	MR Headset		
1		1.1	Glasses	
2			1.1.1	
3			1.1.2	
4			1.1.3	
5			1.1.4	
6		1.2	Computing Unit	
7			1.2.1	
8			1.2.2	
9			1.2.3	
10			1.2.4	
11			1.2.5	
12			1.2.6	
	2		360deg Vision System	
13		2.1	Camera Modules	
14			2.1.1	
15			2.1.2	
16			2.1.3	
17			2.1.4	
18			2.1.5	
19			2.1.6	
20		2.2	Image Feed Aggregation Hub	
21			2.2.1	
22			2.2.2	
23		2.3	High Performance Compute Unit	
24			2.3.1	
25			2.3.2	
26			2.3.3	
27			2.3.4	
28			2.3.5	
29		2.4	Interface/Integration	
30			2.4.1	
31			2.4.2	

2.3.2. Development Progress Indicators

In order to effectively monitor and report the progress of product development it is imperative to track the pace and quantum of progress at frequent intervals. In the context of this assessment, it is important to focus more specifically around the set of technical activities concerning the actual development of the various parts of the proposed MVP and their integration at subsystem and later at the final system level. Typically development activities are undertaken at the level of subsystem, modular, component and functional attributes, followed by target platform integration, verification and certification procedures carried out at the holistic system level. The TRL methodology adequately serves the purpose of tracking the current status and measure of progress of the latter set of system level procedures and the effectiveness of their output/outcomes.

To serve the purpose of tracking current status and progress at the level of subsystem, module and component/functional attribute, a simplified model of Development Progress Indicators (DPIs) aligned with the technical stages in product development has been defined as presented below.

1. Backlog
2. Dev In-Progress
3. Verified Functional PoC
4. S/SS Integration Completed
5. Trials/QA Passed
6. Production Ready Design

2.3.3. DPIs used to track progress against the enumerated list of requirements in the Requirements Breakdown Structure

To enhance the effectiveness of the overall assessment of product readiness from a risk management point and of the progress of product development, it is recommended that the DPIs be used to indicate the current status of development for each requirement unit in the requirements breakdown structure. This cross correlation further amplifies the insights drawn and reported about the status of product development.

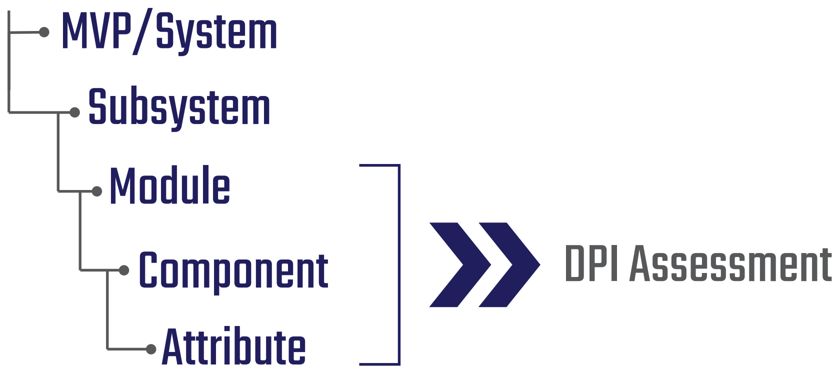
An example for reference purposes is presented in Table:B for a specific iDEX Challenge with the details of the specific Innovator agency left anonymous.

2.3.4. Integrating TRLs & DPIs for holistic assessment of Maturation/Readiness Risk and Development Progress

To avoid complicating the assessment process, and to ensure that the implementation of TRLs and DPIs complement each other and don't compete, it is recommended that a hierarchical structure be followed to realise a seamless mix of the two assessment techniques. The following guidelines are to be followed in order to achieve this core purpose:

1. **TRL assessment** is performed only at the level of the **System** (meaning the whole product or MVP) and at the level of the most significant **Subsystems**, which are each autonomous parts of the system capable of independent functioning with explicit interfaces with their counterparts.

2. **DPI assessment** is to be undertaken exhaustively at the level of the **Modules, Components,** and for those few specific **Attributes** too, which have sufficient merit in evaluating the status of development progress.



A reference implementation of the unified TRL and DPI assessment is illustrated in Table-D below:

Table-D: Reference TRL and DPI Assessment for Product Breakdown Structure

See Through Armor
iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora

			TRL										DPI						
			Ideation	Concept	PoC	Prototype (Lab Validated)	Prototype (Validated for SI)	Prototype (Field Demo)	Prototype (Field Trials)	Production Design (Field Trials/Certification)	Product Ready for Induction		Backlog	Dev In-Progress	Verified Functional PoC	S/SS Integration Completed	Trials/QA Passed	Production Ready Design	
			1	2	3	4	5	6	7	8	9	Target	1	2	3	4	5	6	Target
PFU #		Product - See Through Armor				x						8							
	1	AjnaVU MR Headset				x						7							
1	1.1	AjnaVU Glasses														x			6
2		1.1.1														x			6
3		1.1.2														x			6
4		1.1.3														x			6
5		1.1.4														x			6
6	1.2	AjnaPack Computing Unit														x			6
7		1.2.1														x			6
8		1.2.2														x			6
9		1.2.3														x			6
10		1.2.4														x			6
11		1.2.5														x			6
12		1.2.6														x			6
	2	360deg Vision System				x						7							
13	2.1	Camera Modules												x					6
14		2.1.1												x					6
15		2.1.2												x					6
16		2.1.3												x					6
17		2.1.4												x					6
18		2.1.5												x					6
19		2.1.6												x					6
20	2.2	Image Feed Aggregation Hub											x						6
21		2.2.1											x						6
22		2.2.2											x						6
23	2.3	High Performance Compute Unit											x						6
24		2.3.1											x						6
25		2.3.2											x						6
26		2.3.3											x						6
27		2.3.4											x						6
28		2.3.5											x						6
29	2.4	Interface/Integration											x						6
30		2.4.1											x						6
31		2.4.2											x						6

2.4. Focus Area #4 - Milestones Formulation using iDEX Product Management Metrics

In order to create an effective and holistic Grant Management Process based on Product Management Principles,Technical Deliverables/Progress for each milestone is planned against the MVP Breakdown using relevant metrics which are TRL, DPI and MVP Compliance. Subsequently, the same metrics are used during assessment of product development progress at the end of each milestone.

A reference formulation for milestones using TRL, DPI and MVP Compliance is presented in the Table-E

Table-E: Reference Milestones Formulation using TRL and DPI

See Through Armor
iDEX Challenge: See Through Armor
SHQ: Indian Army & OFB
Nodal Officer: Col Rishi Deora

PFU #		Product - See Through Armor	Milestone #0	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Milestone #5
		Milestonewise Product Development Prorgess/Deliverables	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design	1 Backlog, 2 Dev In-Progress, 3 Verified Functional PoC, 4 SRS Integration Completed, 5 Trials/QA Passed, 6 Production Ready Design
		PDS-MVP Compliance %	75	75	85	100	100	100
	1	AjnaVU MR Headset	Target TRL -	Target TRL -	Target TRL -	Target TRL -	Target TRL -	Target TRL -
1	1.1	AjnaVU Glasses						
2	1.1.1							
3	1.1.2							
4	1.1.3							
5	1.1.4							
6	1.2	AjnaPack Computing Unit						
7	1.2.1							
8	1.2.2							
9	1.2.3							
10	1.2.4							
11	1.2.5							
12	1.2.6							
	2	360deg Vision System	Target TRL -	Target TRL -	Target TRL -	Target TRL -	Target TRL -	Target TRL -
13	2.1	Camera Modules						
14	2.1.1							
15	2.1.2							
16	2.1.3							
17	2.1.4							
18	2.1.5							
19	2.1.6							
20	2.2	Image Feed Aggregation Hub						
21	2.2.1							
22	2.2.2							
23	2.3	High Performance Compute Unit						
24	2.3.1							
25	2.3.2							
26	2.3.3							
27	2.3.4							
28	2.3.5							
29	2.4	Interface/Integration						
30	2.4.1							
31	2.4.2							
		Ramarks						

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FORGE
Your Innovation
& Growth Partner

iDEX

INNOVATIONS FOR DEFENCE EXCELLENCE