TRL Definitions, Descriptions and Supporting Evidence

TRL	Definition	SYSTEM			
		Description		Supporting Evidence	
9	Actual technology system qualified through successful mission operations.	Actual application of the technology in its final form and under operational conditions. Technology proven in-service. Successful operational experience.		ISRM reports, User validation. May be linked to FOC.	
8	Actual technology 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 technology and integration development. Examples include developmental test and evaluation of the system in its intended platform to determine if it meets design specifications. All functionality tested in simulated and operational scenarios.		Results of testing the system in its final configuration under the expected range of environmental conditions in which it will be expected to operate. Assessment of whether it will meet its operational requirements. What problems, if any, were encountered? What are/ were the plans, options, or actions to resolve problems in-service? Usually linked to ISD.	
		HARDWARE		SOFTWARE	
		Description	Supporting Evidence	Description	Supporting Evidence
7	Technology prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or platform in the field). The operational environment may be defined as that which exposes the technology to the physical, electrical, environmental and security interfaces that will be experienced in service.	Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are the plans, options, or actions to address the delta of where the technology is now and that required for ISD (the next level)?	Level at which the program feasibility of a software technology is demonstrated. This level extends to operational environment prototype implementations where critical technical risk functionality is available for demonstration and a test in which the software technology is well integrated with operational hardware/software systems.	Critical technological properties are measured against requirements in a simulated operational environment. Full integration.
6	Technology system / sub-system 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 field testing a prototype in a high fidelity laboratory environment or in a simulated operational environment operating under proposed protocols.	Results from field testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are the plans, options, or actions to resolve problems before moving to the next level?	Level at which the engineering feasibility of a software technology is demonstrated. This level extends to laboratory prototype implementations on full-scale realistic problems in which the software technology is partially integrated with existing hardware/ software systems.	Results from laboratory testing of a prototype package that is near the desired configuration in terms of performance, including physical, logical, data, and security interfaces. Comparisons between tested environment and operational environment analytically understood. Analysis and test measurements quantifying contribution to system-wide requirements such as throughput, scalability, and reliability. Integration of

					basic components.
5	Technology component and/or basic technology subsystem validation in relevant environment.	Fidelity of technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include high fidelity laboratory integration of components, and basic field trials to prove capability concepts.	Results from testing a laboratory based system are integrated with other supporting elements in a simulated operational environment. How does the “relevant environment” differ from the expected operational environment? How do the test results compare with expectations? What problems, if any, were encountered?	Level at which software technology is ready to start integration with existing systems. The prototype implementations conform to target environment/ interfaces. Experiments with realistic problems. Simulated interfaces to existing systems. System software architecture established. Algorithms run on a processor(s) with characteristics expected in the operational environment.	System architecture diagram around technology element with critical performance requirements defined. Processor selection analysis, Simulation/ Stimulation (Sim/Stim) Laboratory build-up plan. Software placed under configuration management. COTS in the system software architecture is identified. Integration plan.
4	Technology component and/or basic technology subsystem validation in laboratory environment.	Basic technological components are integrated as sub-systems to establish that they will work together. This is relatively low fidelity compared with the eventual system. Examples include integration of ad-hoc hardware in the laboratory.	System concepts that have been considered and results from testing laboratory scale models. References to who did this work and when. Provide an estimate of how hardware and test results differ from the expected system goals and (re)assess the way forward.	Basic software components are integrated to establish that they will work together. They are relatively primitive with regard to efficiency and robustness compared with the eventual system. Architecture development initiated to include interoperability, reliability, maintainability, extensibility, and scalability issues. Emulation with current/ legacy elements as appropriate. Prototypes developed to demonstrate different aspects of eventual system.	Advanced technology development, stand-alone prototype solving a synthetic full-scale problem, or standalone prototype processing fully representative data sets. Assessment of architecture and how it will be integrated.
3	Analytical and experimental critical function and/or characteristic proof-of-concept.	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	Results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. References to who, where, and when these tests and comparisons were performed. What are the plans to address the delta of where the technology is now and that required for ISD – are they viable?	Active R&D is initiated. The level at which scientific feasibility is demonstrated through analytical and laboratory studies. This level extends to the development of limited functionality environments to validate critical properties and analytical predictions using non integrated software components and partially representative data.	Algorithms (or software components) run on a surrogate processor in a laboratory environment, instrumented components operating in laboratory environment, laboratory results showing validation of critical properties.
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.		Publications or other references that outline the application being considered and that provide analysis to support the concept. Applied research activities, analytic studies, small code units, and papers comparing competing technologies.	
1	Basic principles observed and reported.	Lowest level of technology readiness. Blue skies scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology’s basic properties. .		Published research that identifies the principles that underlie this technology. References to who, where, when. Early lab model of basic concept may be useful for substantiating the TRL level	

Term	Definition
Component	A single element of technology. The lowest sub-system that provides sufficient granularity to identify technical risks and opportunities.
High Fidelity	Addresses form, fit and function. A high fidelity laboratory environment involves testing with equipment that can simulate and validate all system specifications within a laboratory setting.
Integration	The systematic, structured and progressive activity of testing, validating and verifying the interactions between sub-systems up to the overall system.
Low Fidelity	A representative of the component or system that has limited ability to provide anything but initial information about the end product. Low fidelity assessments are used to provide trend analysis.
(Mathematical) Model	A functional form of a system, that begins to demonstrate the interaction of the (sub) system with the wider environment.
Operational Environment	An environment that addresses all the (UK) operational requirements and (UK) specifications required of the final system to include platform, packaging and personnel. This should be as close to mission operation conditions as circumstances allow.
Prototype	A physical or virtual model used to evaluate the technical feasibility or military utility of a particular technology, process or concept.
Relevant Environment	A testing environment that simulates the key aspects of the (UK) operational environment.
Simulated (Operational) Environment	Either: (a) a real environment that can simulate all the (UK) operational requirements and specifications required of the final system but not necessarily concurrently; or (b) a simulated environment that allows for testing of a virtual prototype. Used in either case to determine whether a developmental system meets the (UK) operational requirements and specifications of the final system.
Sub-System	A sub element of an overall system that can be bounded/ defined in terms of functionality.
System	All technical elements that comprise the project operating as a single system to deliver a defined capability.