TRL	DENOMINATION	SGA2 Definition	HARDWARE	SOFTWARE	PROCESS	SERVICE
1	**PROJECT INITIATION**	- Project owner identified - Project principles and high-level objectives defined - Use case definitions (includes target users and activities)	Basic technology processes and scientific knowledge underpinnig hardware applications are known. Technology principles and high-level objectives defined. Supporting Information includes published research or other references that identify the principles.	Basic technology processes and scientific knowledge underpinnig software applications (arquitecture, formulation) are known. Technology principles and high-level objectives defined. Supporting Information includes published research or other references that identify the principles.	Basic principles of the process are known and high-level objectives defined. Supporting information includes published research or other references that identify the principles.	Basic principles of the service are known and high-level objectives defined. Supporting information includes published research or other references that identify the principles.
2	**CONCEPTUALISATION**	- Analytic study of the problem space - Identify key functions which must be validated in Component Implementation - Prototype Epic planning - Formulate validation criteria of complete prototype system - Formulate validation criteria for critical Components	Practical applications are identified. However, applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate scientific principles, including validation criteria for critical components. PoC (proof-of-concept) being planned.	Practical applications are identified. However, applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate scientific principles, including validation criteria for critical components and basic prototypes of algorithms . PoC (proof-of-concept) being planned, starting with preliminary simulations with synthetic data.	Practical applications of the process are identified. However, applications of the process are still speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical with the emphasis on understanding the process better. Validation work is designed to corroborate principles. PoC (proof-of-concept) is only planned at this stage.	Practical applications of the service are identified. However, applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical with the emphasis on understanding the service better. Validation work is designed to corroborate principles. PoC (proof-of-concept) is being planned, starting with preliminary service simulations
3	**PROOF OF CONCEPT IMPLEMENTATION**	- Implementations of key functions - Validation of critical concepts - Identification of additional validation criteria for TRL4	This includes analytical studies and laboratory-scale studies to validate the analytical predictions of separate elements of the technology. Critical components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement experiments.	This includes analytical studies and laboratory-scale studies to validate the analytical predictions of separate components of the technology. Software components are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement experiments.	It includes analytical studies to validate the performance of separate components of the process. These components are validated, but there is no attempt to be integrated. Modelling and simulation may be used to complement validation	It includes analytical studies to validate the performance of separate elements of the service. These elements are validated, but there is no attempt to integrate them into a complete service system. Modelling and simulation may be used to complement validation
4	**PROTOTYPE COMPONENT**	- Validation of prototype Components in Lab - PoC has become prototype Components - Load testing of Components under key load criteria - System technology selection has been made - Identification of additional validation criteria for TRL5	Basic technological components are integrated to establish a load testing of elements or components. This is a "low fidelity" system to demonstrate basic functionality and critical test environments. Examples include integration of ad hoc hardware in a laboratory and testing with a range of stimulants and small scale tests on actual waste. Supporting information includes the experimental components and experimental test results differ from the expected system performance goals. This is the first step in determining whether the individual components will work together as a system.	Key software components are integrated, and functionally validated, to establish interoperability and begin architecture development. This is an alpha protoype to demonstrate basic functionality and critical test environments. Examples include integration of software modules in a laboratory and testing with a range of data sets. Supporting information includes the experimental components and experimental test results differ from the expected system performance goals. This is the first step in determining whether the individual modules will work together as a system.	Key components of the process are integrated, and functionally validated. This is an initial version of the process to demonstrate basic functionality. Supporting information includes validation of components and those results that differ from the expected process performance goals. This is the first step in determining whether the process components will work together.	Key service elements are integrated, and functionally validated, to establish interoperability. This is an initial version of the service to demonstrate basic functionality and testing critical environments. Supporting information includes validation of elements and those results that differ from the expected service performance goals. This is the first step in determining whether the service elements will work together as a system
5	**PROTOTYPE INTEGRATION**	- Validation of integrated system in a real-world environment - Tested in restricted environment with a small number of real users - Identification of additional validation criteria for TRL6 - Data formats specified	The technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a medium-fidelity, laboratory scale system to demonstrate overall performance in a simulated environment with a range of stimulants or small number of users. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment and analysis of what the experimental results mean for the eventual operating system/environment. Increased fidelity of the system and environment to the actual application.	End-to-end software elements integrated, as well as implemented and interfaced with existing systems/simulations conforming to target environment. Examples include testing a medium-fidelity, laboratory scale system to demonstrate overall performance in a relevant environment. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment and analysis of what the experimental results mean for the eventual operating system/environment. Data formats specified. Increased fidelity of the system and environment to the actual application.	Process components integrated, as well as implemented and interfaced with existing processes conforming to target environment. Examples include testing a medium-fidelity test that demonstrates overall performance of the process in a relevant environment. Supporting information includes results from the testing, analysis of the differences between the test and eventual operating system and analysis of what the tested results mean for the eventual operating environment.	End-to-end service elements integrated, as well as implemented and interfaced with existing systems conforming to target environment. Examples include testing a medium-fidelity test that demonstrates overall performance of the service in a relevant environment. Supporting information includes results from the testing, analysis of the differences between the test and eventual operating system/environment and analysis of what the tested results mean for the eventual operating system/environment.
6	**PILOT-SCALE PROTOTYPE TO REAL-WOLD INTEGRATION**	- Validation of integrated system in a real-world environment - Load testing of integrated system under expected load - Identification of additional validation criteria for TRL7 - System monitoring points specified (for services) - Initial User documentation - Initial System documentation - Tested in a real-world environment with a small number of real users	Integrated systems or engineering-scale prototypes are tested in a relevant environment. Examples include testing an a high fidelity system/component prototype under expected load or with a small number of real users. This is a step up from laboratory scale to operational real-world scale and the determination of scaling factors that will enable design of the operating system. The operating environment for the testing should closely represent the actual operating environment.This includes initial system documentation and inital user documentation.	Integrated systems or prototype implementations of the software are tested in a relevant environment being demonstrated on full-scale realistic problems. Examples includes testing an a high fidelity prototype under expected load. Partially integrate with existing hardware/software systems. This is a step up from laboratory scale to operational real-world scale and the determination of scaling factors that will enable design of the operating system. The operating environment for the testing should closely represent the actual operating environment.This includes initial system documentation and inital user documentation.	Integrated process is tested in a relevant environment being demonstrated on full-scale realistic problems. Examples includes high fidelity testing under expected load. This is a step up from tests to operational real-world scale and the determination of scaling factors that will enable design of the process. The operating environment for the testing should closely represent the actual operating environment. This includes initial process documentation.	Integrated service is tested in a relevant environment being demonstrated on full-scale realistic problems. Examples includes high fidelity testing under expected load. This is a step up from tests to operational real-world scale and the determination of scaling factors that will enable design of the service system. The operating environment for the testing should closely represent the actual operating environment. This includes initial service documentation and initial user documentation.

7	**OPERATIONAL INTEGRATION**	- Validation of integrated system in a real-world environment - Tested in a real-world environment with a small number of real users (canary testing for SoA) - No expected data format or API changes (for services or software Components) - System monitoring implemented (for services)	Validation of a full-scale, integrated system in a relevant real-world environment. Examples include testing a high fidelity full-scale prototype in the field in order to address all critical scaling issues. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment. Final design is virtually complete.	Validation of a prototype software with all key functionality available in a relevant real-world environment. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment. No expected data format or application programming interfaces changes. Final design is virtually complete.	Validation of the process with all key functionality available in a relevant real-world environment. Well integrated with other processes demonstrating operational feasibility. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment. No expected changes of the process. Final design is virtually complete.	Validation of the service with all key functionality available in a relevant real-world environment. Well integrated with other systems and services demonstrating operational feasibility. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment. No expected service changes. Final design is virtually complete.
8	**DEPLOYMENT**	- Validation of integrated system in a real-world environment - Tested in a real-world environment with a small number of real users - SLA (service Level Agreement) enforced (for services)	Integrated system has been proven to work in its final form and under expected conditions. Examples include developmental testing and evaluation of the system in fully loaded testing. The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment.	Full software system has been proven to work in its final form and under expected conditions. All functionality successfully demonstrated in simulated operational scenarios. Tested in a real-world environment with a small number of real users. Software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed.	The process has been proven to work in its final form and under expected conditions. All functionality successfully demonstrated in simulated operational scenarios. Tested in a real-world environment with a small number of real users. The process has been fully integrated with all operational systems. All user and following-up documentation are completed.	Full service has been proven to work in its final form and under expected conditions. All functionality successfully demonstrated in simulated operational scenarios. Tested in a real-world environment with a small number of real users. The service has been fully integrated with all operational systems. All user documentation, training documentation, and following-up documentation completed.
9	**PRODUCTION**	- Validation of integrated system in a real-world environment - Tested in a real-world environment with a target number of real users	System is in its final form and operated under the full range of operating conditions. Examples include testing in a real-world environment with a target number of real users. Final product operates over the full range of expected conditions	System is in its final form and operated under the full range of operating conditions. All software has been thoroughly debugged and fully integrated with all operational hardware/software systems. Tested in a real-world environment with a target number of real users. All documentation has been completed. Sustaining software engineering support is in place. Final product operates over the full range of expected conditions	The process is in its final form and running under the full range of operating conditions. It has been thoroughly depurated and fully integrated with all operational systems. Tested in a real-world environment with a target number of real users. All documentation has been completed. Process engineering and following-up support is in place. Final process operates over the full range of expected conditions	Service is in its final form and running under the full range of operating conditions. It has been thoroughly depurated and fully integrated with all operational systems. Tested in a real-world environment with a target number of real users. All documentation has been completed. Service engineering and following-up support is in place. Final service operates over the full range of expected conditions