Technology Readiness Levels in ARTES Technology & Product Developments

Level	TRL Technology Readiness Level (Space and Ground Segments)				SRL Service Readiness Level (System)
	Capabilities	Space Segment model	Ground Segment model	Software model	
1	Basic principles observed and reported		Idea or concept	Research results or preliminary algorithm	not applicable
2	Technology concept/ application formulated		Concept supported by paper	Individual algorithms for main functions	Application/service concept formulated, market opportunities not yet addressed
3	Analytical and experimental critical function or characteristic proof-of-concept	Mathematical models, supported e.g. by sample tests	Demonstrate feasibility	Prototype of the main functions	Concept analysis performed and target market identified
4	Functional verification of component / breadboard in laboratory environment	Breadboard	Partial prototype	Alpha version covering the main functions	Application/service verification in laboratory environment, market segment(s) and customers/users identified
5	Critical function of component / breadboard verified in a relevant environment	Scaled EM for the critical functions	Reduced scale prototype (for large pieces)	Beta version covering all functions	Application/service verified using operational elements, customers/users not involved
6	Demonstration of element critical functions in a relevant environment	Full scale EM representative for critical functions	Full prototype to demonstrate functionality	Product	Demonstration of prototype in relevant environment, price policy identified
7	Demonstration of element performance in the operational environment	QM/EQM/PFM[a]	Verified Product with final BOM, layouts, released software, full GUI	Integrated product validated in a pilot case	Trials with customers/users to validate utilisation and business models
8	Actual system completed and accepted for flight	PFM/FM	Validated Product in operation and commercial offer ready	Integrated product validated for full operation	Application/service completed and validated, commercial offer ready
9	"Flight proven" system through successful mission operations	PFM/FM	Product operationally deployed and used by paying customer	Live product validated in a mission	Application/service operationally deployed and used by paying customers

[a] A PFM may be used to achieve qualification provided that the commercial customer accepts the risk and it is demonstrated that the use of an alternative qualification model (e.g. EQM) is not viable. In this case the cost of the flight hardware is not supported by ESA.

See also (available on the ARTES web site at https://artes.esa.int/documents):
"Guidelines for the use of TRLs in ESA programmes", ESSB-HB-E-002, Issue 1, Rev 0, 21 August 2013.
"Technology readiness level (TRL) guidelines", ECSS-E-HB-11A, 1 March 2017.