

Technical Readiness Level

TAKING STEPS TOWARD IMPLEMENTATION

What steps are necessary to move an innovative idea to an implementable technology? The steps along the way were named in the 1970's when NASA developed the Technical Readiness Levels (TRLs) as the formal scale identifying a technology's maturity level. There are nine levels that identify technical steps needed for a technology to advance.

Even though TRL was originally used for space exploration technologies, the level descriptions can easily be translated to any industry. The U.S. Department of Transportation developed a TRL guidebook in 2017, using the history of the Electronic Toll Collection (ETC) System to divide the levels into four main categories: Basic Research, Applied Research, Development, and Implementation, as illustrated in Table 1. It took a several years to move ETC from basic research to final implementation. Now, ETC system. As are required in all new federally funded toll facilities.

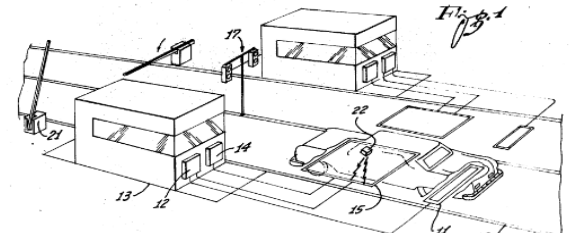


Figure 1. Automatic toll charging system, U.S. Patent 3602881

TABLE 1. Technical Readiness Level for Electronic Toll Collection (ETC)

Category	Level of Readiness	ETC History
Basic Research	1 Basic Principles Observed	Radio-frequency identification (RFID) technology was used during WWII to identify if the planes were allied or enemy. During the 1950s and 1960s, there was a search for applications to use radio transporters.
	2 Technology Concept Formulated	In 1963, economist William Vickrey saw ETC systems as a potential application.
	3 Experimental Proof of Concept	Researcher Mario Cardullo developed a passive radio transporter with memory, demonstrating the ETC concept in the 1970s.
Applied Research	4 Technology Validated in Lab	Development and validation of RFID for tracking system for the U.S. Department of Energy and the U.S. Department of Agriculture continued through the 1980s.
	5 Technology Validated in Relevant Environment	Researchers tested early ETC systems on closed courses and public roads.
Development	6 Technology Demonstrated in Relevant Environment	Researchers replaced the small installation with one featuring more readers and transporters.
	7 System Prototype Demonstration in Operational Environment	The initial pilot phase was limited to test, government, and commercial vehicles.
	8 System Complete and Qualified	ETC systems were proven to be safe and their usage was open to all road users.
Implementation	9 Actual System Proven in Operational Environment	Fully deployed systems in Texas started in 1989 and in Oklahoma in 1991.

Cutting edge technologies are being researched by Michigan Department of Transportation (MDOT) Research Administration (RAAd), the National Cooperative Research Program, other DOTs, and other industries. MDOT, working with its partners, strives to implement safe, sustainable, and cost-effective innovations. Is there an innovation that you would like to bring to MDOT? What TRL is your innovation? How could RAAd help you move it a step closer to implementation? These are critical questions worthy of consideration as you engage in bringing innovation to MDOT.

WHY IT MATTERS

- TRL can be used across MDOT's focus areas to identify what is needed for new technologies to reach implementation level.
- You can use TRL to assess the potential of a past research project and identify the next steps needed.
- You can engage in MDOT's research program at any TRL to move an innovation closer to reality.

LEARN MORE

For more information about TRL, see FHWA's [Technology Readiness Level Guidebook](#). For more information about RAAd, see the [Research and Implementation Manual](#). If you have an innovative idea or questions, contact RAAd using the links below.