Cybersecurity TTP Workshop

January 12th – 13th, 2023

University of South Alabama – School of Computing

Dr. Debra Chapman – dchapman@southalabama.edu

Dr. Alec Yasinsac – yasinsac@southalabama.edu

TRUSTED CI
THE NSF CYBERSECURITY CENTER OF EXCELLENCE

TRL Assessment and TTP Canvas

Dr. Debra Chapman

(taken from the Trusted CI TTP Playbook
created by Ryan Kiser and Florence D. Hudson
https://trustedci.org/ttp)

TRUSTED CI
THE NSF CYBERSECURITY
CENTER OF EXCELLENCE

Trusted CI TTP Program

- Purpose – to enable researchers to transition cybersecurity research into practice.
- Established – 2018
  - NSF Grant supported (1547272, 1920430, 2241313)
  - Workshops, webinars, etc.
- Developed a set of materials to assist researchers and practitioners with TTP
  - https://trustedci.org/ttp (available under Creative Commons Attribution 3.0)
  - Designed to aid in planning and decision making for TTP
  - Technology Readiness Level (TRL) Assessment Tool
  - TTP Canvas

Technology Readiness Level (TRL) Assessment Tool

- Based on NASA and U.S. Government Accountability Office TRL Processes
- Enables the researcher to assess/identify the current state of the research
  - Allows them to identify any gaps to operational deployment readiness
  - Assists in developing a plan to progress the user environment toward operational readiness
    - Prioritize efforts necessary to further mature the technology
    - Captures the state of several difference components to identify those which are most in need of improvement

- This process can be completed iteratively - as improvements are made it is valuable to track progress and reevaluate current priorities

Technology Readiness Level (TRL) Assessment Tool

- The TRL Assessment tool can be used to:
  - Describe the overall maturity of a technology
  - Describe the maturity of each of the different subsystems and components that provide the functionality of the technology
  - Discern what components need the most attention in order to make the technology operationally viable
  - Communicate to stakeholders regarding the current state of development and future work.
- The TRL Assessment Tool allow researchers to capture the current state of different components that provided the necessary functionality
  - Allows researcher to identify where efforts need to be focused in order to mature the technology

TRL Worksheet

Product breakdown				*Implementation Approach*	
System	**Component**	**TRL**	**Justification**	**Implementation Method**	**Component Source**
Your System Name					
Target Environment =					
Your subsystem 1					
	Your component 1				
	Your component 3				
	Your component 4				
	Your component 5				

*** May have more than one key technology item per row; enter these key technology challenges only at the lowest product breakdown level at which they first arise.***

* We suggest categorizing subsystems by functionality provided and components as functional units which are needed to provide specific functionality. Other organizational structures may be appropriate depending on the technology being assessed.

* While assessing a technology you may find that a core piece of functionality is well understood, but perhipheral functionality (I/O, human interfaces, APIs, etc.) is not clearly defined.

* Comprehensive understanding of perhipheral functionality may be difficult until a much more complete understanding of the operational environment and other factors is achieved.

* If you find that you are having difficulty distinguishing between components which are parts of different subsystems consider whether these map to a distinct functionality which chould best be captured as a distinct subsystem.

TRL Definitions (1 – 7)

TRL	Definition
1	Basic Principles are observed and reported
2	Technology concept or application is formulated
3	Analytical and/or Experimental Critical function or Characteristic Proof-of-Concept
4	Research has been validated in laboratory experiment
5	Model or prototype demonstrated in a relevant environment
6	Actual system is completed and qualified through test and demonstration
7	Actual system is proven through successful operation

TRL Definitions

TRL	Definition	Hardware Activities Description	Software Activities Description	Exit Criteria
1	Basic principles observed and reported	Scientific knowledge generated underpinning hardware technology concepts/applications.	Scientific knowledge generated underpinning basic properties of software architecture and mathematical formulation.	Public dissemination of research underlying the proposed concept/application
2	Technology concept or application formulated	Invention begins, practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture.	Practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations & concepts defined. Basic principles coded. Experiments performed with synthetic data.	Public dissemination of the application/concept that addresses feasibility and benefit
3	Analytical and/or experimental critical function or characteristic proof-of-concept	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using non-integrated software components	Demonstrated analytical/experimental results with a proof-of-concept model validating predicitions of key parameters
4	Research validation in laboratory environment	A low fidelity prototype is built and operated to demonstrate basic functionality and critical test environments and associated performance predicitions are defined relative to the final operating environment.	Key, functionally critical, software components are integrated, and functionally validated, to establish interoperability and begin architecture development. Relevant Environments defined and performance in this environment predicted.	Test performance of low-fidelity prototype demonstrating agreement with analytical predictions. Documented definition of relevant environment.
5	Model or prototype demonstration in a relevant environment	A high-fidelity prototype that adequately addresses critical issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale realistic problems. Partially integrate with existing hardware/software systems. Limited documentation produced. Engineering feasibility fully demonstrated.	Test performance of a fully functional prototype demonstrating agreement with analytical predictions
6	Actual system completed and qualified through test and demonstration	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios.	Documented test performance verifying analytical predictions
7	Actual system proven through successful operations	The final product is successfully operated in its actual target operational environment.	All software has been thoroughly debugged and fully integrated with all operational hardware/software systems. All documentation has been completed. Sustaining software engineering support is in place. System has been successfully operated in the operational environment.	Documented operational results

TRL Worksheet Example (page 1)

Product breakdown				***Implementation Approach***	
System		TRL	Justification	Implementation Method	Source
TTP TRL Assessment Example Web Application		**4**	**Core functionality tested.**	**Deployed on service provider VM**	
Subsystem	**Component**				
User interface	Apache httpd	7+	This is widely used open source web server software. The installation is managed and supported by the hosting provider for the web server.	Provided by service provider	Preinstalled by service provider.
	REST API endpoint	4	Basic API calls have been tested. Additional functionality is being developed and further testing is planned.	Custom httpd module written in c to provide REST API	Internally developed
	Web GUI	5	Web UI prototype is functionally complete and has been fully tested across two out of three target browsers. Ready to begin usability and accessibility testing.	Custom javascript UI built using open source library XYZ.	Internally developed, library xyz is developed and supported by the zyx project.
	mod_dbd database module	7+	This is a widely used open source plugin to enable apache httpd to interact with SQL databases. The installation is managed and supported by the hosting provider for the web server.	Provided by service provider	Preinstalled by service provider.
Data management	MySQL database	7+	This is widely used open source database software. The installation is managed and supported by the hosting provider for the web server.	Provided by service provider.	Preinstalled by service provider.
	Database interface	4	SQL queries in the script function as intended with MySQL when run with test data. Some test and data sanitization code is complete and ready for testing.	Python script with preformed SQL queries, API interaction functions, data test functions, and data sanitization functions.	Internally developed

TRL Worksheet Example (page 2)

Product breakdown				*Implementation Approach*	
System		TRL	Justification	Implementation Method	Source
TTP TRL Assessment Example Web Application		4	Core functionality tested.	Deployed on service provider VM	
Subsystem	Component				
Core software	Data analysis engine	5	Methodology validated using test data. Key functionality completed and provided through intended software interfaces. Intended behavior documented.	Core software built in Java	Internally developed
	Software interfaces	5	All intended functionality has been tested and works as expected both when used directly and when using database interface shim and REST API calls. Created engineering documentation formally describing intended behavior of system interactions with the data analysis engine.	Core software built in Java	Internally developed
Development Process	Build system	5	Automated tests and alerting integrated and used in all build processes for core components.	Build automation and testing developed using both custom and pre-built Jenkins plugins.	Internally developed using JenkinsCI, an open source build automation system supported by CD Foundation and the Linux Foundation.
	Development procedures	6	Software development practices including coding standards, commit guidelines, and contributor expectationshave been documented and implemented by the core development team. Public documentation describing these practices has been provided to community contributors and is in final review stages.	Open documentation hosted on github describing expectations for contributors to the project.	Internally developed

*** May have more than one key technology item per row; enter these key technology challenges only at the lowest product breakdown level at which they first arise.**

* We suggest categorizing subsystems by functionality provided and components as functional units which are needed to provide specific functionality. Other organizational structures may be appropriate depending on the technology being assessed.

* While assessing a technology you may find that a core piece of functionality is well understood, but perhipheral functionality (I/O, human interfaces, APIs, etc.) is not clearly defined.

* Comprehensive understanding of perhipheral functionality may be difficult until a much more complete understanding of the operational environment and other factors is achieved.

* If you find that you are having difficulty distinguishing between components which are parts of different subsystems consider whether these map to a distinct functionality which chould best be captured as a distinct subsystem.

TRL Assessment Tool

- Reminder - This is an iterative process
- As improvements are made it is valuable to track progress and reevaluate current priorities
  - Assess Readiness Level of the technology again
  - Identify updated list of components that may need improvement
- The results of the TRL Assessment can be used:
  - Identify the set(s) of components that need to most work in order to move the technology toward transition to practice
  - Communication tool to describe the current state of the technology's development
    - This can be used to convey why a specific development effort is requested/necessary

TTP Canvas

- A business model canvas-based approach that is similar to (and modeled after) what is used in iCorps (NSF Innovation Corps) – Business Model Canvas
  - Modified for when the goal of TTP is not necessarily establishing a business
- A tool researchers can use to clarify:
  - The purpose and/or value of their research
  - Their target clients
  - Activities to move the research toward operational deployment (Transition to Practice)
  - Development of a sustainability model
- The TTP Canvas enables the researcher to brainstorm and develop a model to explore ideas for transitioning research into practice
- This is also an iterative tool that can be continuously updated
  - New insights about key elements including potential clients, value propositions, solutions, costs, and resources
  - Elements of the TTP Canvas can be used in presentations, papers and discussions during the TTP Process and communicate with stakeholders

TTP Canvas

1. Research problem

2. Technology innovations

3. Target users / customers

4. User operational challenges

5. Value delivered

6. Activities to deliver value

- Customer discovery
- Customer challenge discovery
- Solution development – hardware, firmware, software, services
- Develop prototype
- Develop pilot with user
- Delivery model - on site, cloud, mobile, both
- Partnerships for development or delivery
- Identify resources for coding, prototype, pilot, delivery
- Identify and develop channels for marketing, delivery

7. Resources required

- Researchers
- Students
- Infrastructure / cloud

8. Funding model ($ and sources)

- Grants
- Research partners
- Development partners
- Customers

TTP Canvas - Template v3 - 8.10.2020

Planning Activities

- When filling out a Canvas (or planning for future efforts), examples can be helpful to provide a starting point.
- 9 example activities have been provided by the Trusted CI TTP team that include things a researcher should expect to carry out in order to successfully Transition their Research to Practice
  - Each of these should be considered when developing a TTP Canvas to see if they are necessary activities for the specific research

Examples of Planning Activities

1. Customer Discovery – identify potential users who would gain value from your research
   - Who are your Customers
2. Customer Challenge Discover – Identify operational challenges of your potential users
   - What are their operational challenges
   - Test your hypothesis about what value your research can provide them
     - why would they try/use your research
     - Have you identified a solution to a problem that they actually have
3. Solution Development – Envision and Develop the solutions to the customer challenges (hardware, firmware, software, or services)

Examples of Planning Activities

4. Develop a Prototype – advance the research to develop a prototype (with documentation) that can be deployed in a user environment
5. Develop a Pilot with the User – TTP TRL 5 – Complete the prototype testing in a relevant environment to prove the viability and value of the research
6. Deliver the Model – The model should be delivered (on site, cloud, mobile) – the delivery model should be determined and clearly communicated to the user as part of the solution

Examples of Planning Activities

7. Partnerships for Development or Delivery – As you develop your solution and/or delivery model you may figure out that your need strategic partners to develop or deliver elements of the solution
   - You may not have the resources, time or skill to complete all elements
8. Identify Resources needed to Assist with Coding, Prototype, Pilot, Delivery
   - Can be students, interns, partners, other collaborators, investors, or other researchers
9. Identify and Develop Support Channels for Marketing and Delivery – if you intend to expand beyond a single client

- This is not a comprehensive list of everything that need to be considered

TRL Assessment and TTP Canvas

- Tools to assist researchers who are interested in Transitioning their research into Practice (TTP)
  - TRL Assessment helps the researcher to identify the current state of the research and develop a plan to progress into practice
  - TTP Canvas helps the researcher to clarify the value of their research, the target clients, activities to progress into practice, and a sustainability model.
- Publicly available through the Trusted CI TTP Team
  - https://trustedci.org/ttp