Carnegie Mellon
Software Engineering Institute
Pittsburgh, PA 15213-3890

TRL Corollaries for Practice-Based Technologies

Caroline Graettinger
SuZ Garcia
Jack Ferguson

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Purpose of this Presentation

To offer a draft set of TRL descriptions for use in assessing practice-based technologies (PBTs)

To outline the next steps by which these descriptions will be prototyped, piloted, and tested

What are PBTs?

Practices Processes Methods Approaches Frameworks (for the above)	Product Line Practices CMMI (framework) Acquisition practices Transition processes

Versus non-PBTs:

- Hardware
- Software
- Embedded systems
- Biomedical devices

DoD Technology Readiness Levels

A scale from 1 to 9 used to assess technology maturity*

- Basic principles observed and reported.
- Technology concept and/or application formulated.
- Analytical and experimental critical function and/or characteristic proof of concept.
- Component and/or breadboard validation in laboratory environment.
- Component and/or breadboard validation in relevant environment.
- System/subsystem model or prototype demonstration in a relevant environment.
- System prototype demonstration in an operational environment.
- Actual system completed and qualified through test and demonstration.
- Actual system proven through successful mission operations.

*DoD Interim Defense Acquisition Guidebook, October 30, 2002

Why New TRL Descriptions for PBTs?

TRL users find current description difficult to interpret for non-hardware/system technologies

e.g. software, medical, practices

Army developed TRL descriptions for software

Army Medical Research and Materiel Command developing TRL descriptions for biomedical technologies

AFRL (Bill Nolte) maturing a software tool for implementing TRLs

Study by SEI and Army CECOM in 2002 showed TRLs also not readily applied to information assurance PBTs

Why Should I Care?

Improvement of acquisition practices will require the implementation of PBTs

Knowing the “readiness” of a PBT is important to managing its implementation risks:

- “early” technologies may be suitable for some, but require additional investment (to mature) for others
- “mature” technologies may be suitable for some, but offer no competitive advantage to others (because everyone has access to it)

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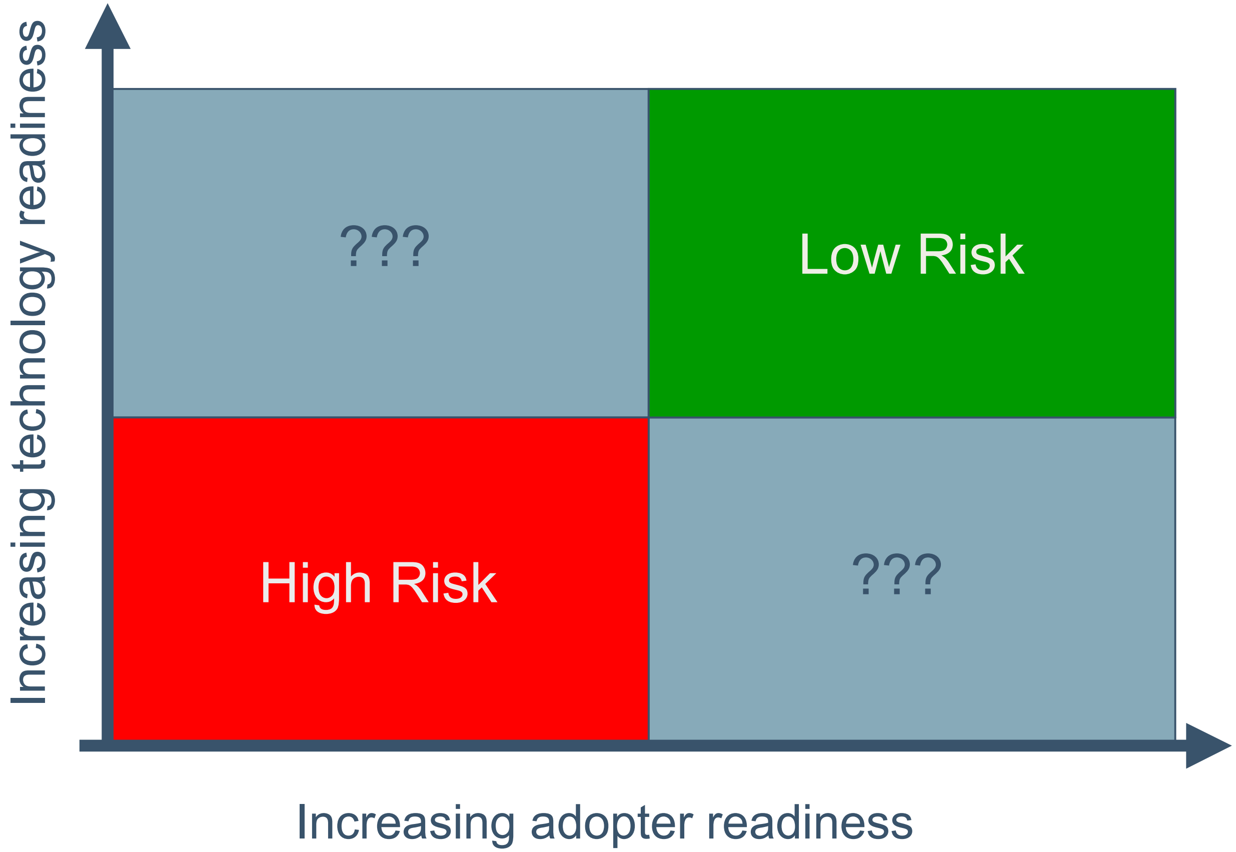
Implementation Risk



Our Approach

Each TRL consists of

- a Definition, meant to be technology-independent
- a more detailed, technology-dependent Description

• Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties

Our approach was to modify the Description for each level, leaving the Definition as is.

Caveats

The Definitions are not really technology-independent (e.g., the term “breadboard”) but for those who want to use TRLs to assess non-hardware/system technologies, they’ll have to live with it if they want to be compliant with the TRL scale

TRLs are not the only criteria that support technology management, they are just one of numerous criteria

Users in the SEI/CECOM study estimated the TRL scale provides them up to 30% of their decision criteria

Checkpoint

At this point, you should understand

- the importance of assessing PBT readiness as a matter of managing implementation risk
- that current TRL descriptions are difficult to apply to the PBT context

In the next few slides, we show

- A mapping between the TRLs for hardware/system context and our proposed TRLs for PBTs
- an example using SW-CMM

TRL Readiness Fundamentals in the Hardware/Systems Context

For hardware/systems, TRLs 1-9 depict the following general progression in readiness:

- The environment in which the technology can function becomes more representative of the final operational environment
  - from paper studies through laboratory setup, simulated environments, to mission operations

- The completeness of the technology increases
  - from basic properties through breadboard components, integrated components, prototype, to final form

What Does this Mean for PBTs?

The environment in which the technology can function becomes more representative of the final operational environment *(a community of users)*

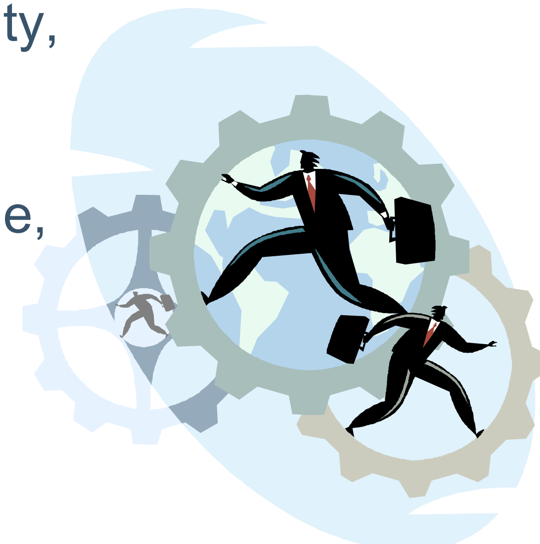
- *for PBTs this means the community of users expands from initial risk takers to more mainstream members of the community*

The completeness of the technology increases

- *For PBTs this means the technology progresses from defined basic properties through defined core practices, implementation mechanisms, best practices, to a body of knowledge*

Key Differences

The operating environment for PBTs is people/organizations/community, not hardware/systems



PBT environment is more mutable, malleable, in flux

PBT Corollaries - draft

TRL	HW/System	PBT
1	Scientific research, paper studies	Scientific, behavioral, and market research, paper studies
2	Practical, speculative applications invented	Practical, speculative applications invented, potential user communities identified
3	Active R&D initiated, analytical and lab studies of components	Active R&D initiated, critical elements identified and demonstrated with innovative users
4	Basic components integrated, lab environment	Basic elements integrated to form core PBT, visionary leaders used to demonstrate value and transitionability
5	Integrated components demonstrated in simulated environment	Prototypes of implementation mechanisms established, demonstrated with core PBT for pragmatic users in simulated environments, such as role-based workshops
6	Prototype tested in relevant environment	Implementation mechanisms refined and integrated with core PBT, demonstrated in relevant environments, e.g., pilot settings
7	Actual system prototype in operational environment	Implementation needs of mainstream users identified and integrated into the prototype, operational use by relevant users demonstrated across the community
8	Final form proven to work in operational environment	Technology picked-up for wide-spread rollout across the community
9	Actual application running under mission conditions	PBT use is considered routine within community, best practices and body of knowledge in place

Example: SW-CMM -1

TRL #	Key Characteristics	SW-CMM based Improvement Example	Nominal Timeframe
1	Scientific, behavioral, and market research, paper studies	IBM software framework research, Crosby research, Humphrey proposal of 5-level maturity framework	1985-1987
2	Practical, speculative applications invented, potential user communities identified	Initial questionnaire developed/published (87-TR-13), DoD and its sw-intensive system suppliers identified	1986-1987
3	Active R&D initiated, critical elements identified and demonstrated with innovative users	SPA, 87-TR-13 used with large DoD organizations and contractors; *Managing the SW Process* book published	1987-1989

Example: SW-CMM -2

4	Basic elements integrated to form core PBT, visionary leaders used to demonstrate value and transitionability	SW-CMM initial design prototyped/tested	1989-1991
5	Prototypes of implementation mechanisms established, demonstrated with core PBT for pragmatic users in simulated environments, such as role-based workshops	SW-CMM v1.0 published; piloted with wider user base; SPA and SCE used to feed back info to CMM dev team; SEPG workshop becomes SEPG conference	1991-1993
6	Implementation mechanisms refined and integrated with core PBT, demonstrated in relevant environments, e.g., pilot settings	SW-CMM v1.1 published; Intro training, CBA-IPI and lead appraiser program developed; ROI case studies published	1993-1995

Example: SW-CMM -3

7	Implementation needs of mainstream users identified and integrated into the prototype, operational use by relevant users demonstrated across the community	Transition Partner, CBA-IPI, SCE 3.0, Intro TTT established; SW measurement books published; process support (proc defn, MPI) courses developed; SW-CMM v2.0 drafted	1993-1997
8	Technology picked-up for wide-spread rollout across the community	"YAMMs" phenomenon; high maturity workshops established; principles for CMM established; SW-CMM v2.0 chosen as basis for CMMI framework	1995-1997
9	PBT use is considered routine within community, best practices and body of knowledge are in place, may involve incorporation of the technology into community guidance and policy	Incorporation of CMM concepts into ISO 15504; over 60 orgns invited to 2001 high maturity workshop; noticeable improvement in maturity profile for intended community; SW-CMM subsumed into CMMI (broadening overall community)	1997-2001

Summary and Next Steps

Initial draft of TRL Descriptions for PBTs provided

Community feedback and participation welcome

Next steps – pilot and test these descriptions with SEI's and other's PBTs