



# ***The Application Usability Level framework***

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Assessment of Understanding and Quantifying Progress Team***

***CCMC workshop April 24 – 27 2018***



# Connections

*How best to find research ready for operations and operational needs where research can help.*

Barrier for effective applied space weather: (from the research side)

- 1) Finding and knowing best how to communicate with end users
- 2) Knowing what research will produce useful tools to aid decision making processes.
- 3) Knowing the requirements and needs of the user community
- 4) Advertising how our research could be useful

NASA COMMUNICATIONS (NASCOM)



OS/CDS-104

NASA

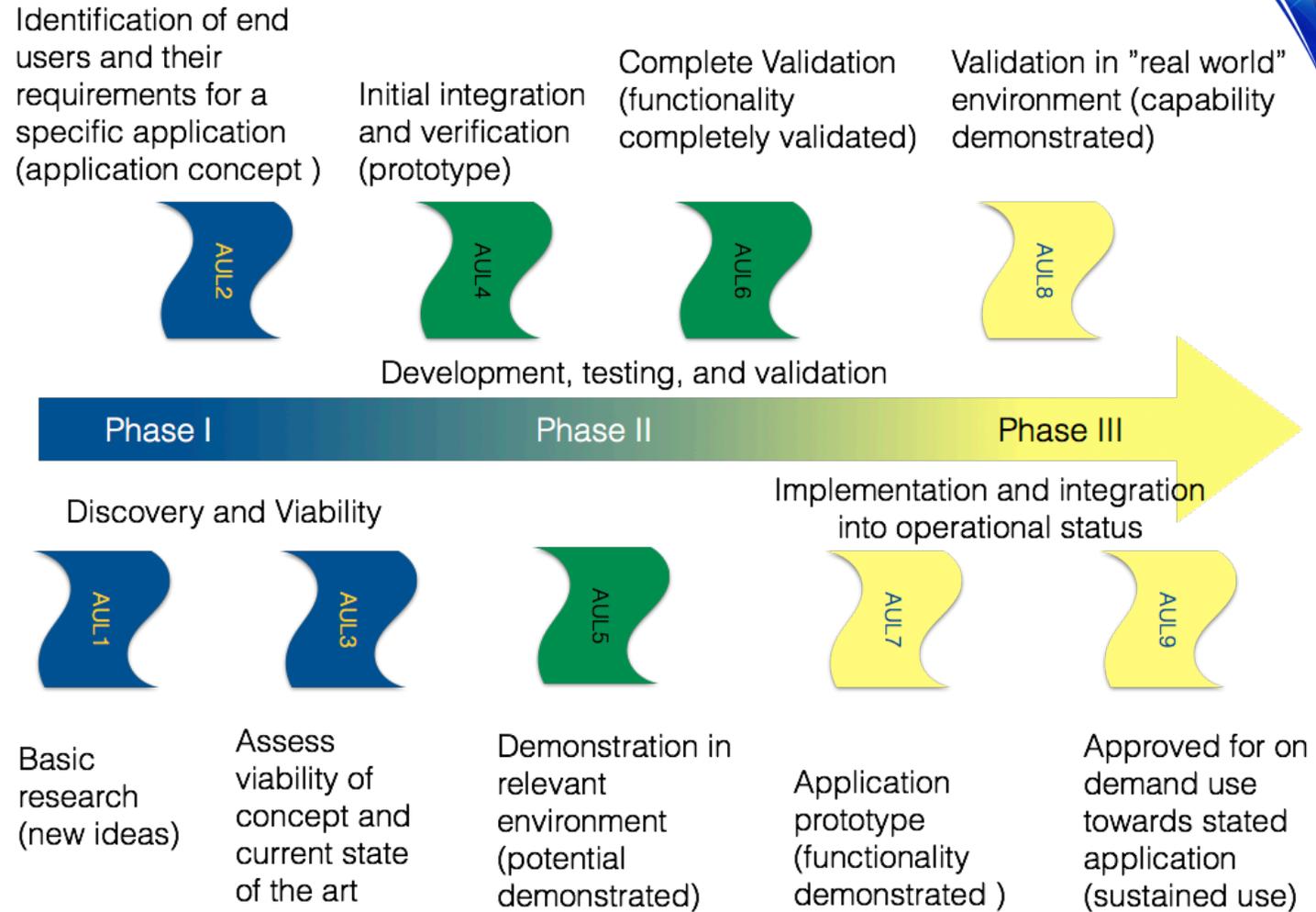


# Application Usability Levels

Proposed tracking method

## AUL: Application Usability Level

An effective framework to aid in communication, track progress of a project towards completion, and advertise user needs and research capabilities.



AULs

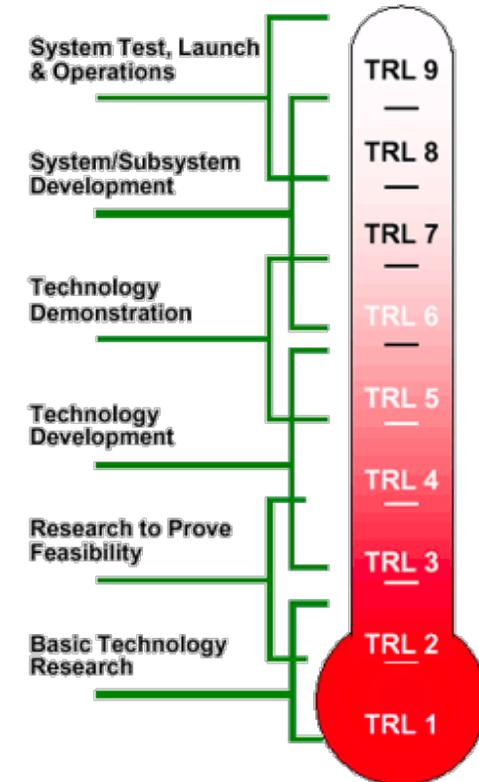
# Application Usability Levels

## Background

### Technology Readiness Levels (TRLs)

“Technology Readiness Levels (TRLs) are a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology. “

- Technology Readiness Levels  
A White Paper April 6, 1995  
John C. Mankins



NASA

# Application Usability Levels

## Background

### ARL: Applications Readiness Level

9 levels with three phases: tracks progress from research through testing and development to sustained use by an industry partner.

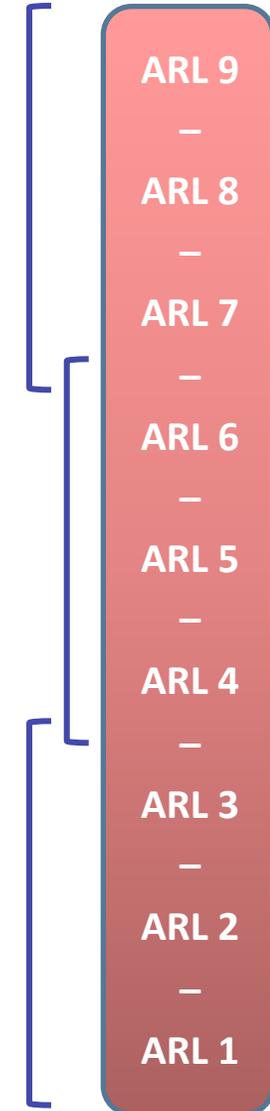
ARL as a tracking tool:

- » Communication Tool: convey progress of the project towards sustained use.
- » Analysis Tool: assess progress of a project towards completion.
- » Reporting Tool: convey performance goals and completion of goals to funding agencies.
- » Diagnostic Tool: identify roadblocks in development.

*Partner  
Demonstration  
and Transition*

*Development,  
Test, and  
Validation*

*Discovery and  
Feasibility*





# Application Usability Levels

Why a new tracking method?

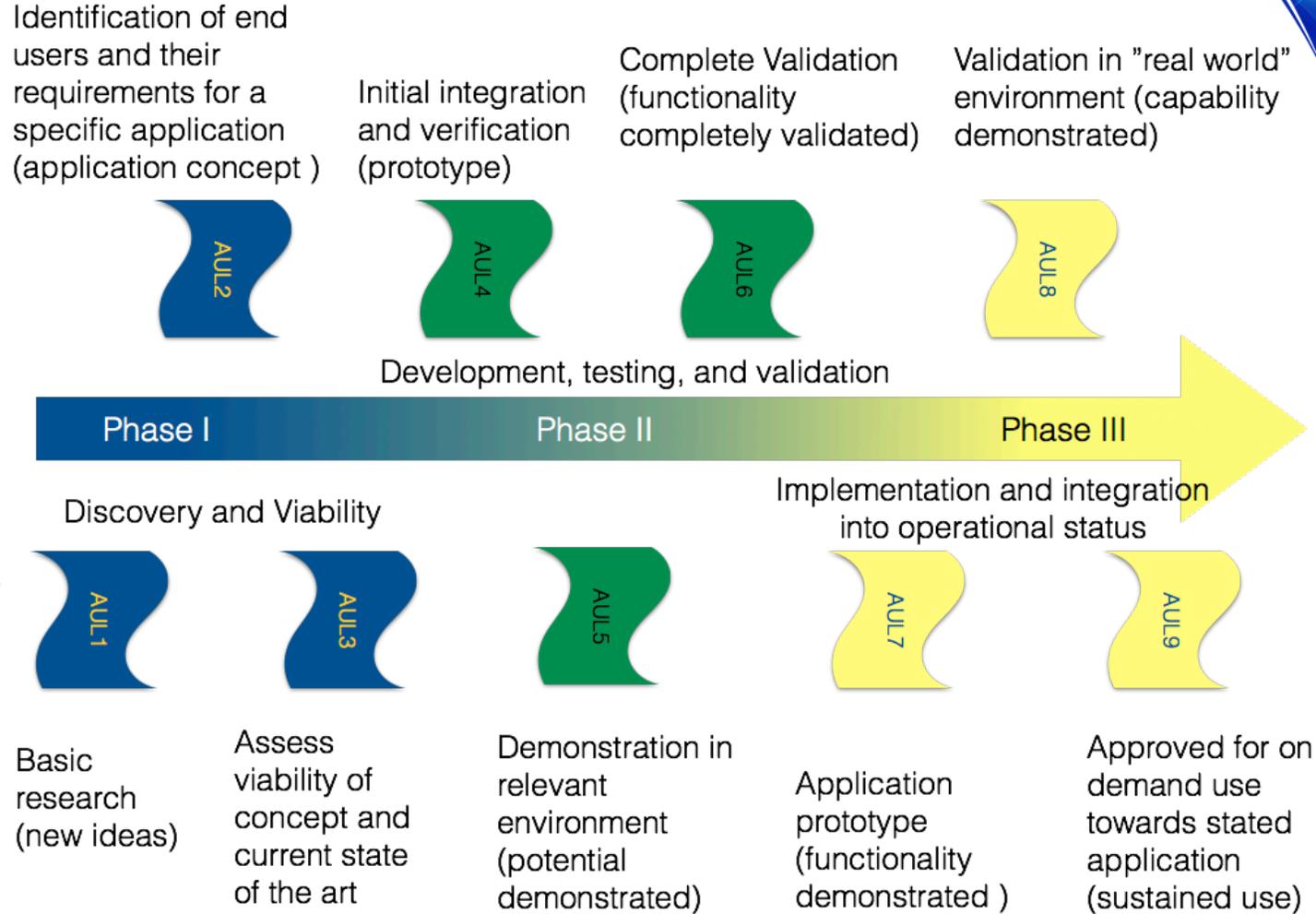
## AUL: Application Usability Level

Heliophysics and the applied Space Weather communities are not as mature as the Earth Sciences and their applied sciences.

Space Weather/Heliophysics end users are often other researchers, DoD, and other government agencies along with industry partners.

Not all of the end users are able to talk directly to researchers or to share their data. This can cause difficulty for some milestones in the ARLs.

The Heliophysics communities need to develop more efficient pathways of communication with our end user communities.



## AULs



# ***Application Usability Levels***

*The three phases*

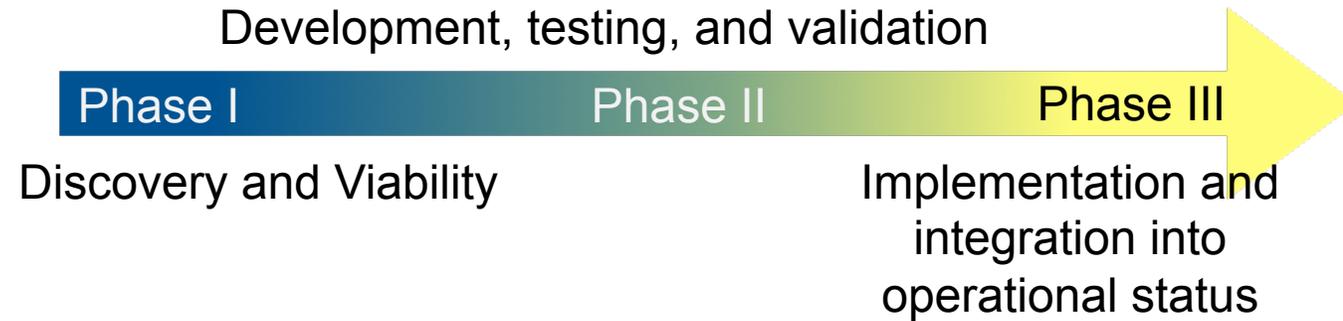
## **AUL: Application Usability Level**

### **Phases:**

Phase 1: Discovery and Viability

Phase 2: Development, Testing, and Validation

Phase 3: Implementation and integration into operational status.



# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

### Phases:

Phase 1: Where fundamental Research becomes applied. Not all research may or should progress beyond the very first AUL. However, if there is a potential user identified, whether they are a fellow researcher or an industry partner, then this phase will determine whether the project should progress to phase II.



# Application Usability Levels

*The three phases*



## AUL: Application Usability Level

AUL 1: This level is where the basic scientific concepts and projects are created and potential applications are identified. A project is considered to have an AUL 1 if the following milestones are achieved:

### Milestones:

- Ideas for how project output may enhance decision making or be applied to an end user application.
- Research is documented and disseminated for the project, so that the usability may be assessed by way of the AUL method.
- Potential interested end users are identified, but not necessarily contacted.

Phase I

Discovery and Viability



Basic  
research  
(new ideas)



**AULs**

# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

AUL 2: In this level, the application concept is formalized. An interested end user is contacted, and their needs for a specific application are identified. A project is considered to have an AUL 2 if the following milestones are achieved:

Identification of end users and their requirements for a specific application (application concept )



### Milestones:

- Formalization of the application.
- An end user is contacted and avenues of communication are established.
- Identification and formalization of the requirements and metrics necessary for successful application of the project for the end user's needs.

Phase I

Discovery and Viability





# Application Usability Levels

The three phases

## AUL: Application Usability Level

AUL 3: the feasibility and viability of achieving success for the specific application, under the requirements set out in AUL 2, should be carefully assessed by the end users and researchers.

### Milestones:

- Documentation and dissemination of the expected advancements and proposed metrics from the current state-of-the-art.
- Components of the application, model/data analysis effort are tested and validated
- Detailed characterization of the baseline performance and limitations with respect to the application are completed.
- Convincing case for the viability and feasibility of the proposed project towards improving upon the state of the art for the identified application is made.

Phase I

Discovery and Viability



Assess viability of concept and current state of the art

**AULs**



# ***Application Usability Levels***

*The three phases*

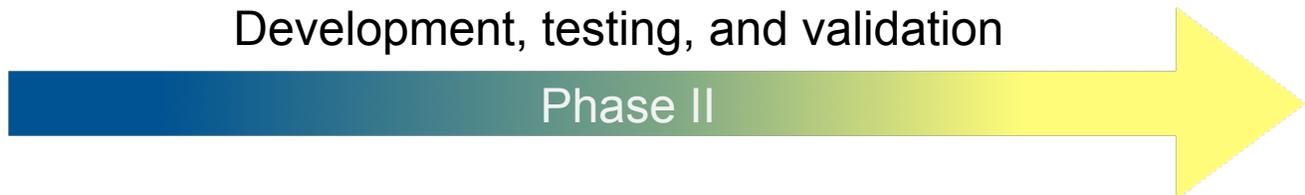
## **AUL: Application Usability Level**

### **Phases:**

Phase 2: Focus on finalizing development of the new state-of-the-art project integrating the resulting tools into the identified applications, demonstrating the feasibility of the new product and validating the new system.

Development, testing, and validation

Phase II



# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

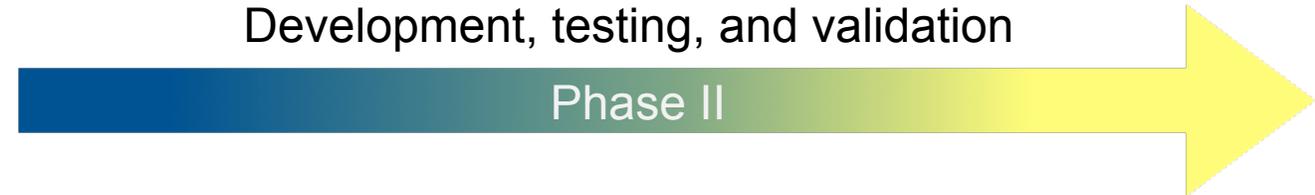
AUL 4: the basic prototype is completed and initial integration into the end user application is started. To achieve AUL 4, it must be verified that all components work together.

Initial integration  
and verification  
(prototype)



Development, testing, and validation

Phase II



### Milestones:

- Integration of the system into the application.
- Organizational challenges and human process issues (if applicable) are identified and managed.

**AULs**



# Application Usability Levels

*The three phases*

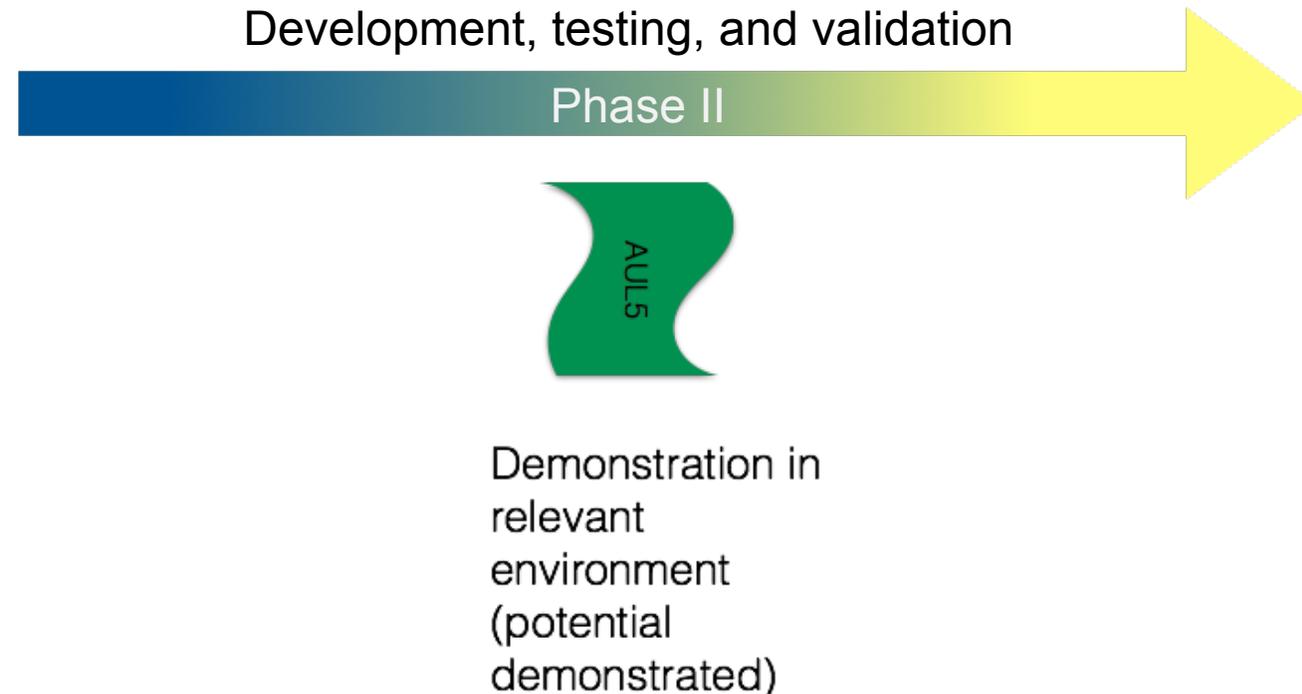
## AUL: Application Usability Level

AUL 5: In this level the potential of the new model/data analysis efforts are determined for the specified relevant environment (e.g. storm, substorm, or quiet time conditions).

### Milestones:

- The project team must articulate and disseminate the potential for the improvement upon the state of the art.
- Application components integrated into a functioning application system for use during the given relevant environmental parameters.

### AULs



# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

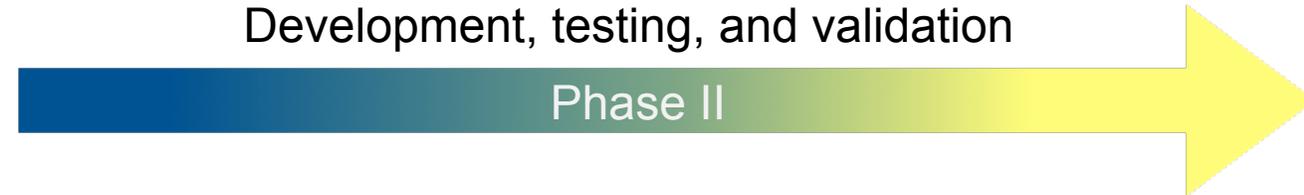
AUL 6: the potential is fully demonstrated, and this is stated as a major increase in the applications usability and ability to become the new standard used for the end user. Any application components already deployed in the end user's operational environment are tested in their operational and/or decision making context.

Complete Validation  
(functionality  
completely validated)



Development, testing, and validation

Phase II



### Milestones:

- Prototype application system beta-tested in a simulated operational environment.
- Projected improvements in performance of the state-of-the-art and/or decision making activity demonstrated in simulated operational environment.
- Publication of the specific application and associated metrics and the projects progress towards this application.

**AULs**



# ***Application Usability Levels***

*The three phases*

## **AUL: Application Usability Level**

### **Phases:**

Phase 3: Where the project is handed off and fully integrated into the end user's application. This also includes new validation efforts to determine how well the new application performs in a "real world" setting. Validation and continued use in an operational environment drives discovery of new science questions, problems, and of course new applications.





# Application Usability Levels

*The three phases*

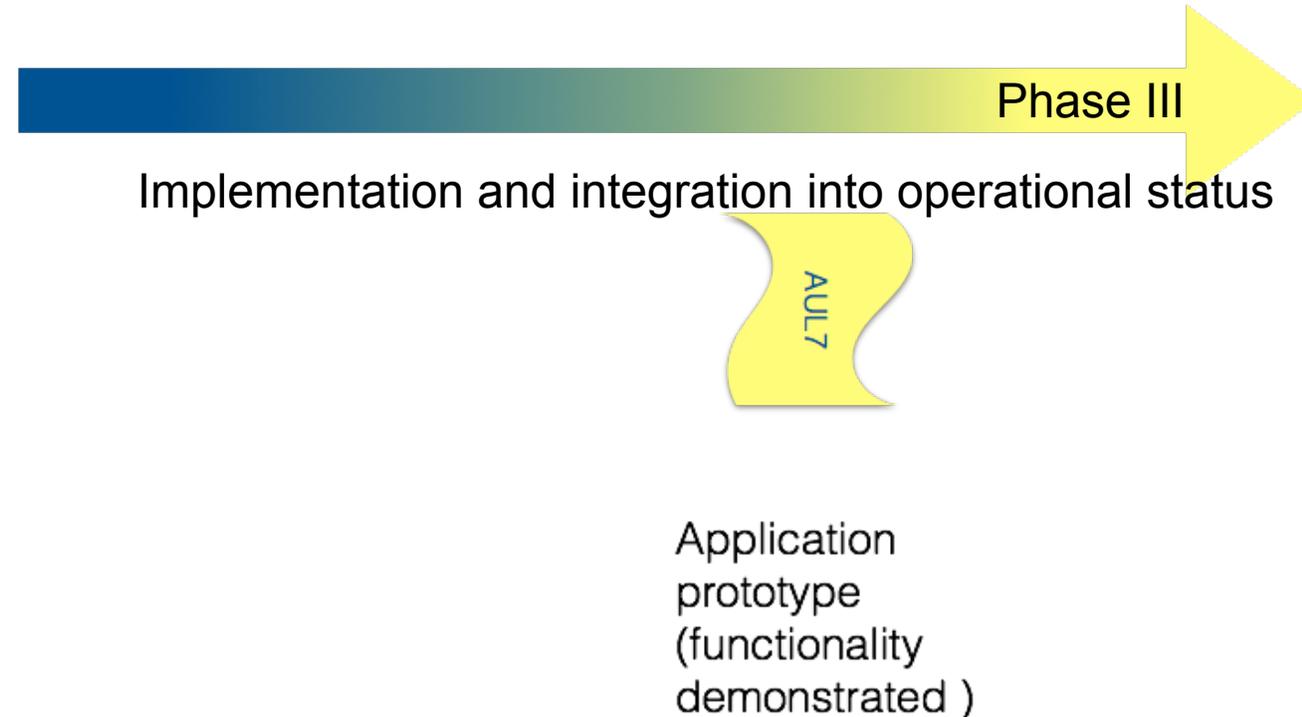
## AUL: Application Usability Level

AUL 7: All portions of the new project are integrated into the end user's application and the functionality has been established.

### Milestones:

- The system must be fully integrated into the operational environment specified by the end user.
- The system's functionality is tested and demonstrated in the end user's specified relevant environment.
- Project team must demonstrate the functionality of the new system for the end user's application and disseminate the results.

### AULs



# Application Usability Levels

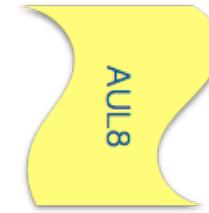
*The three phases*



## AUL: Application Usability Level

AUL 8: the new project is fully integrated into the end user application system and is validated by the end user. The application is proven to work in its final form under the expected condition either meeting or surpassing the initially identified requirements and metrics. In addition, user documentation, training documentation, and maintenance documentation are completed.

Validation in "real world" environment (capability demonstrated)



### Milestones:

- The end user must approve the addition of the new project to their application for their operational use.
- Finalized application system tested, proven operational, and shown to operate within the specified requirements and metrics.
- Applications qualified and approved by the end user for their use.
- User documentation and training completed.

### AULs

# Application Usability Levels

*The three phases*



## AUL: Application Usability Level

AUL 9: the project is the new state of the art and has been proven to work in a sustained manner. Continued validation efforts are performed for the project's sustained use in the operational environment.

### Milestones:

- Sustained and repeated use of the application by the specified end users.
- The continued validation of the project in the operational environment.
- Publication of the validation efforts, metrics, and new state of the art project to the community for the specific application.

### AULs



Approved for on demand use towards stated application (sustained use)

# Application Usability Levels

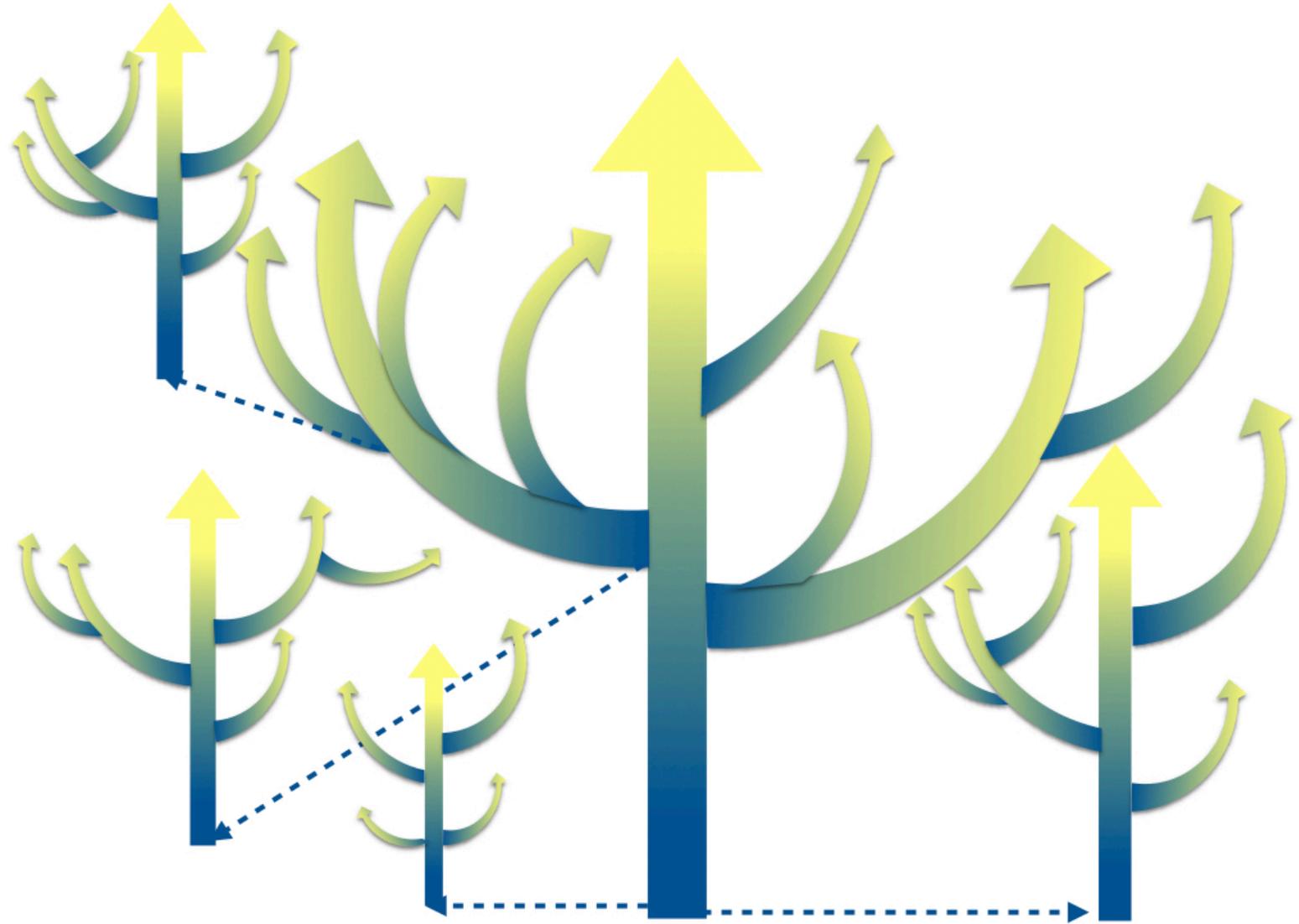
*The three phases*

## AUL: Application Usability Level

Beyond AUL 9: During this process, it is likely that you have found other projects or applications. In this framework it all feels like there is a clear start and stop, but this is far from the truth.

New end users, new applications, and altogether new projects are identified. Just like any good research project, there is always more to do and more to learn and improvements to be made.

**AULs**





# Application Usability Levels

Examples

## AUL1: Project

Jeff has a new cubesat mission and believes that their data will be useful to modelers. They have just written their instrument paper and have started considering the temporal and types of data products which will be useful as an input for modelers.

### Milestones:

- ✓ AUL1 - Ideas for how project output may enhance decision making or be applied to an end user application.
- ✓ AUL1 - Research is documented and disseminated for the project, so that the usability may be assessed by way of the AUL method.
- ✓ AUL1 - Potential interested end users are identified, but not necessarily contacted.

Phase I

Discovery and Viability



Basic  
research  
(new ideas)

**AULs**



# Application Usability Levels

Examples

## AUL1: Project

Jeff has a new cubesat mission and believes that their data will be useful to modelers. They have just written their instrument paper and have started considering the temporal and types of data products which will be useful as an input for modelers.

Identification of end users and their requirements for a specific application (application concept)



Discovery and Viability



research (new ideas)

### Milestones:

- ✓ AUL2 - Formalization of the application.
- ✓ AUL2 - An end user is contacted and avenues of communication are established.
- AUL2 - Identification and formalization of the requirements and metrics necessary for successful application of the project for the end user's needs.

AULs

# Application Usability Levels

Examples

## AUL6: Project

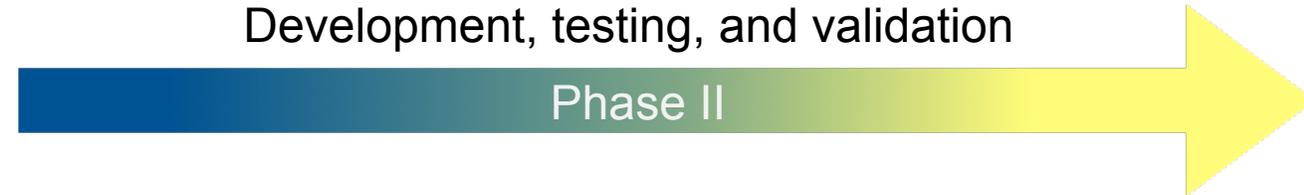
Brett has a new real-time forecasting model of plasma bubbles for the Australian Bureau of Meteorology. Together they have determined specific metrics and requirements. The new model has been validated and working for the relevant environments in a simulated operational environment at RMIT and shown to be better than the current state of the art. The results were just published in Space Weather.

Complete Validation  
(functionality  
completely validated)



Development, testing, and validation

Phase II



### Milestones:

- ✓ AUL6 - Prototype application system beta-tested in a simulated operational environment.
- ✓ AUL6 - Projected improvements in performance of the state-of-the-art and/or decision making activity demonstrated in simulated operational environment.
- ✓ AUL6 - Publication of the specific application and associated metrics and the projects progress towards this application.

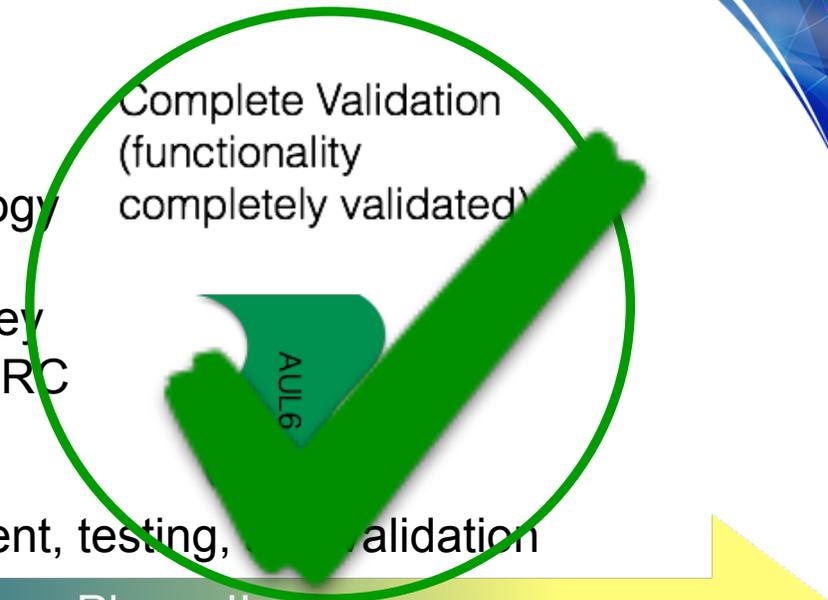
**AULs**

# Application Usability Levels

Examples

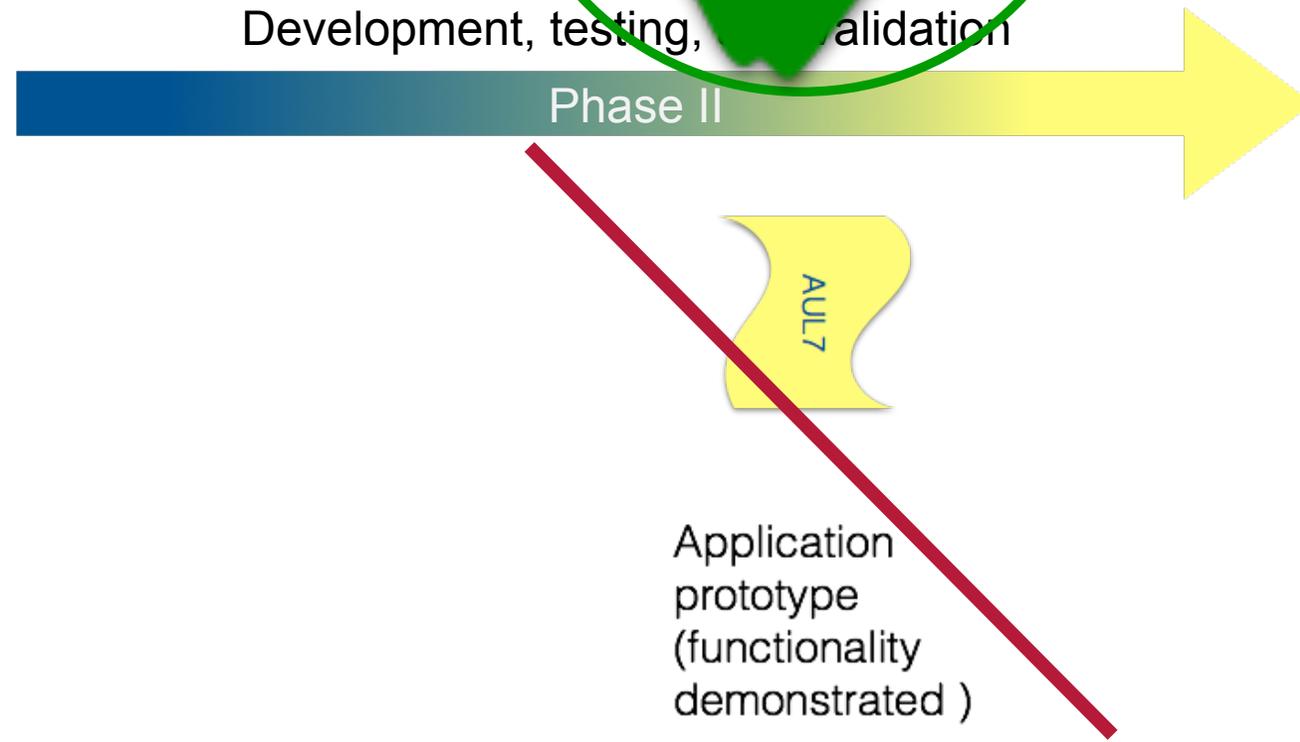
## AUL6: Project

Currently they are transferring the model to the Australian Bureau of Meteorology along with the code to test and validate it on the new system. Along with the publication of the new metrics and requirements for the specific application, they also demonstrate the functionality of the new system, and show it off at the ASRC workshop to potential new users.



### Milestones:

- AUL7 - The system must be fully integrated into the operational environment specified by the end user.
- AUL7 - The system's functionality is tested and demonstrated in the end user's specified relevant environment.
- ✓ AUL7 - Project team must demonstrate the functionality of the new system for the end user's application and disseminate the results.



**AULs**

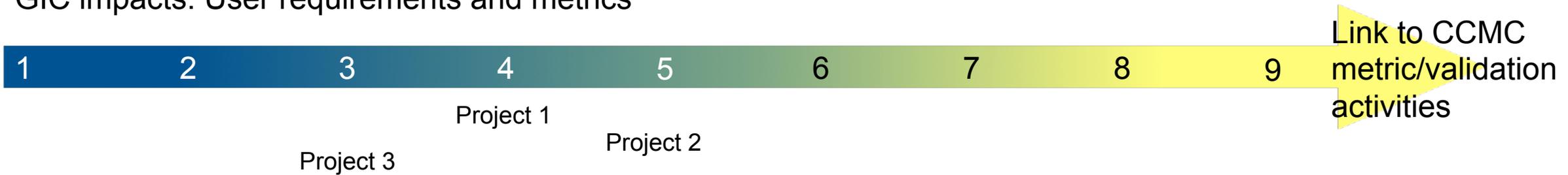


# Tracking AULs

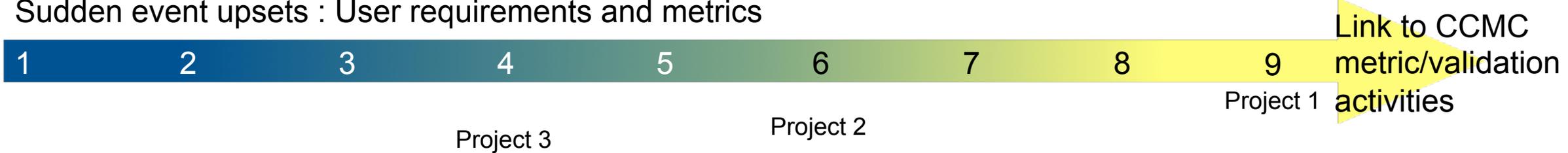
Website framework development in progress: Landing page?

Applications:

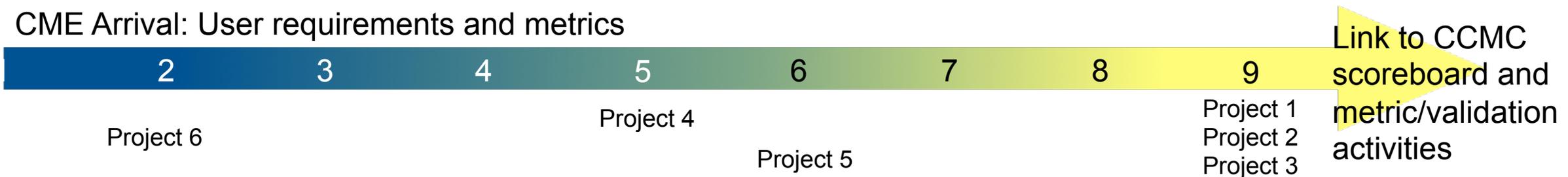
GIC impacts: User requirements and metrics



Sudden event upsets : User requirements and metrics



CME Arrival: User requirements and metrics



## Tracking AULs



# Tracking AULs

Website framework development in progress: Project specific page?

Applications: GIC impacts - User requirements and metrics

Project 1. – Brief description



Team: Lead by X  
Website: (if available)  
Contact info: (if available)

Publications/talks:  
Links ect.

If available -> example of the output



# Get involved

## Assessment of Understanding and Quantifying Progress

### International Forum for Space Weather Capabilities Assessment

[https://ccmc.gsfc.nasa.gov/assessment/  
forum-topics.php](https://ccmc.gsfc.nasa.gov/assessment/forum-topics.php)

### Assessment of Understanding and Quantifying Progress:

[https://ccmc.gsfc.nasa.gov/assessment/  
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[http://spacewx.weebly.com/tracking-  
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# Application Usability Levels

Why a new tracking method?

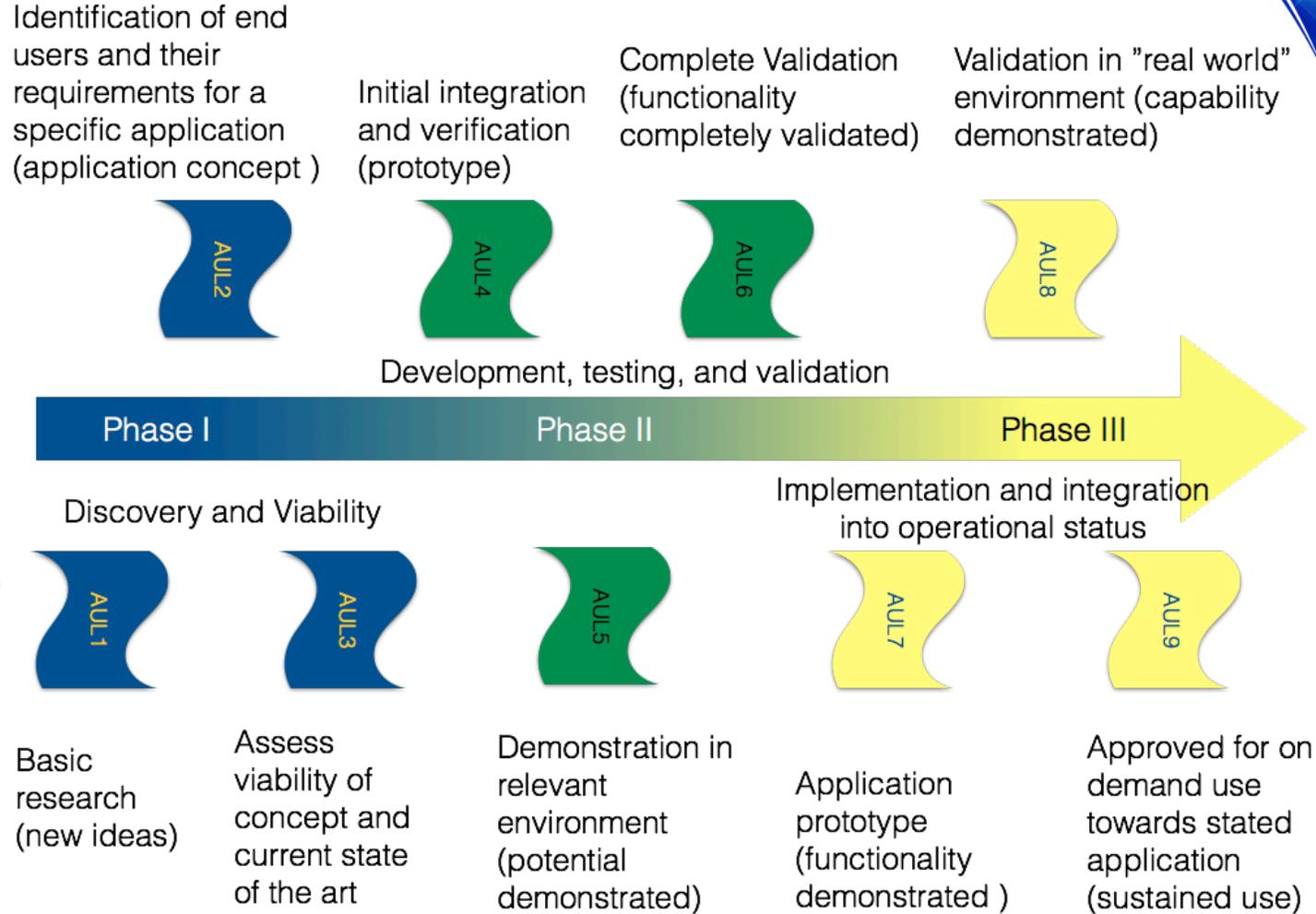
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The Heliophysics communities need to develop more efficient pathways of communication with our end user communities.



## AULs

# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

### Phases:

Phase 1: Where fundamental Research becomes applied. Not all research may or should progress beyond the very first AUL. However, if there is a potential user identified, whether they are a fellow researcher or an industry partner, then this phase will determine whether the project should progress to phase II.



Phase I

Discovery and Viability

# Application Usability Levels

*The three phases*



## AUL: Application Usability Level

AUL 1: This level is where the basic scientific concepts and projects are created and potential applications are identified. A project is considered to have an AUL 1 if the following milestones are achieved:

### Milestones:

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Phase I

Discovery and Viability



Basic  
research  
(new ideas)



# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

AUL 2: In this level, the application concept is formalized. An interested end user is contacted, and their needs for a specific application are identified. A project is considered to have an AUL 2 if the following milestones are achieved:

### Milestones:

- Formalization of the application.
- An end user is contacted and avenues of communication are established.
- Identification and formalization of the requirements and metrics necessary for successful application of the project for the end user's needs.

**AULs**

Identification of end users and their requirements for a specific application (application concept )



Phase I

Discovery and Viability





# Application Usability Levels

The three phases

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AUL 3: the feasibility and viability of achieving success for the specific application, under the requirements set out in AUL 2, should be carefully assessed by the end users and researchers.

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Phase I

Discovery and Viability



Assess  
viability of  
concept and  
current state  
of the art

**AULs**



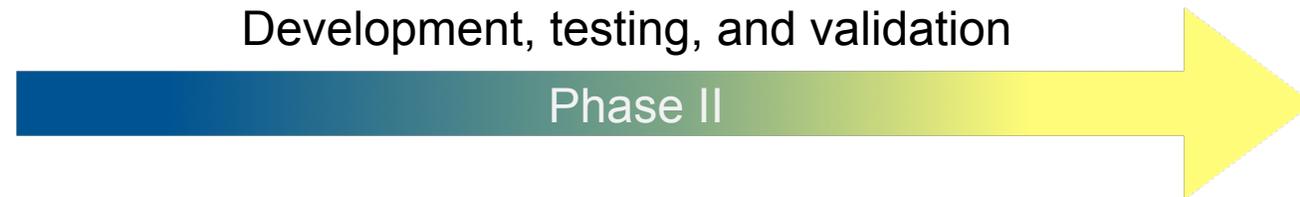
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*The three phases*

## **AUL: Application Usability Level**

### **Phases:**

Phase 2: Focus on finalizing development of the new state-of-the-art project integrating the resulting tools into the identified applications, demonstrating the feasibility of the new product and validating the new system.



# Application Usability Levels

*The three phases*

## AUL: Application Usability Level

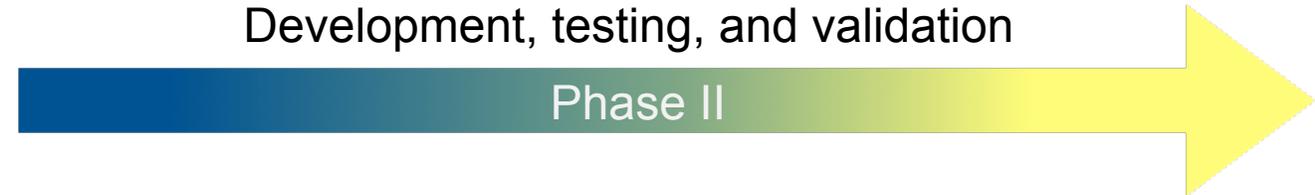
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Initial integration  
and verification  
(prototype)



Development, testing, and validation

Phase II



### Milestones:

- Integration of the system into the application.
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**AULs**

# Application Usability Levels

*The three phases*

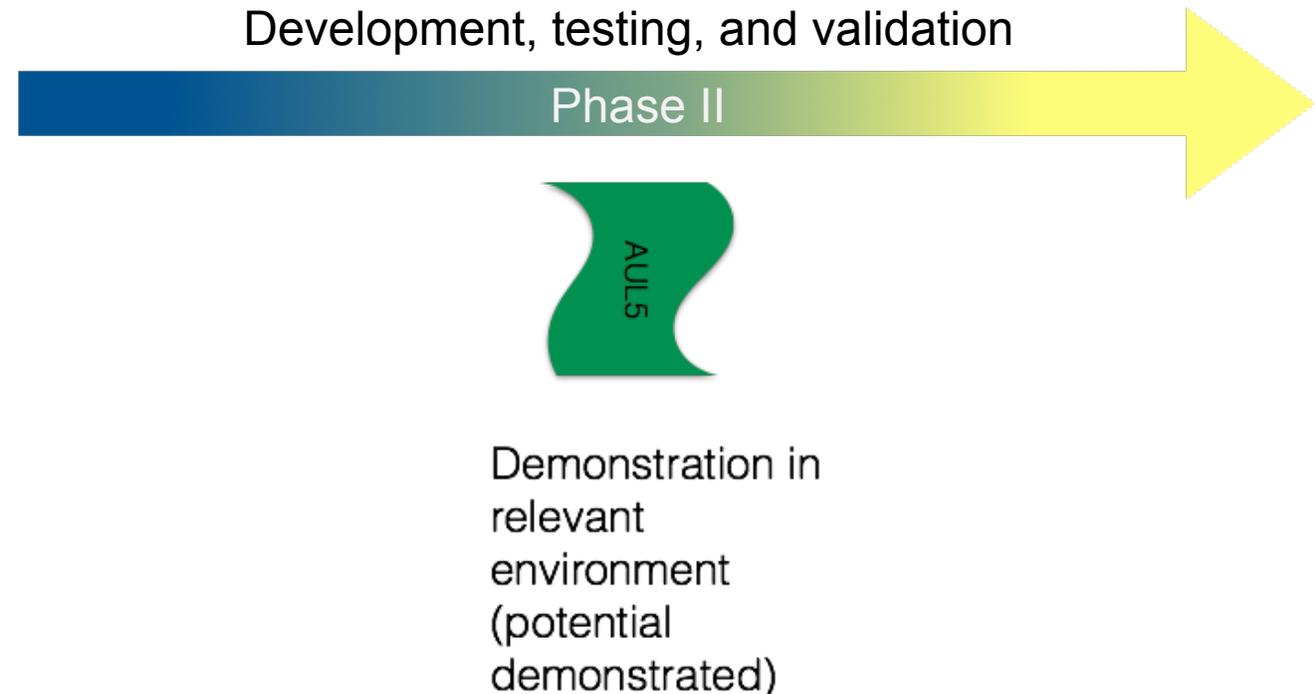
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### AULs



# Application Usability Levels

*The three phases*

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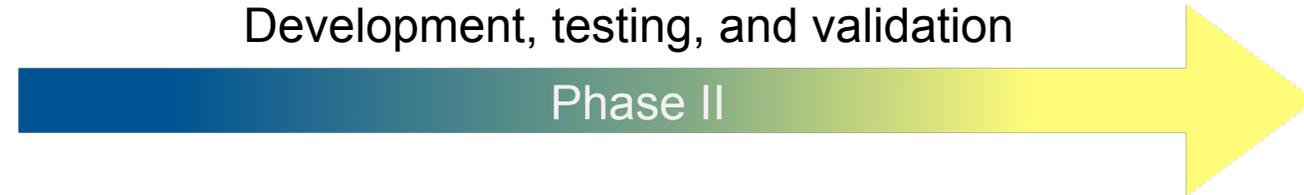
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Complete Validation  
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Development, testing, and validation

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### Milestones:

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*The three phases*

## **AUL: Application Usability Level**

### **Phases:**

Phase 3: Where the project is handed off and fully integrated into the end user's application. This also includes new validation efforts to determine how well the new application performs in a "real world" setting. Validation and continued use in an operational environment drives discovery of new science questions, problems, and of course new applications.



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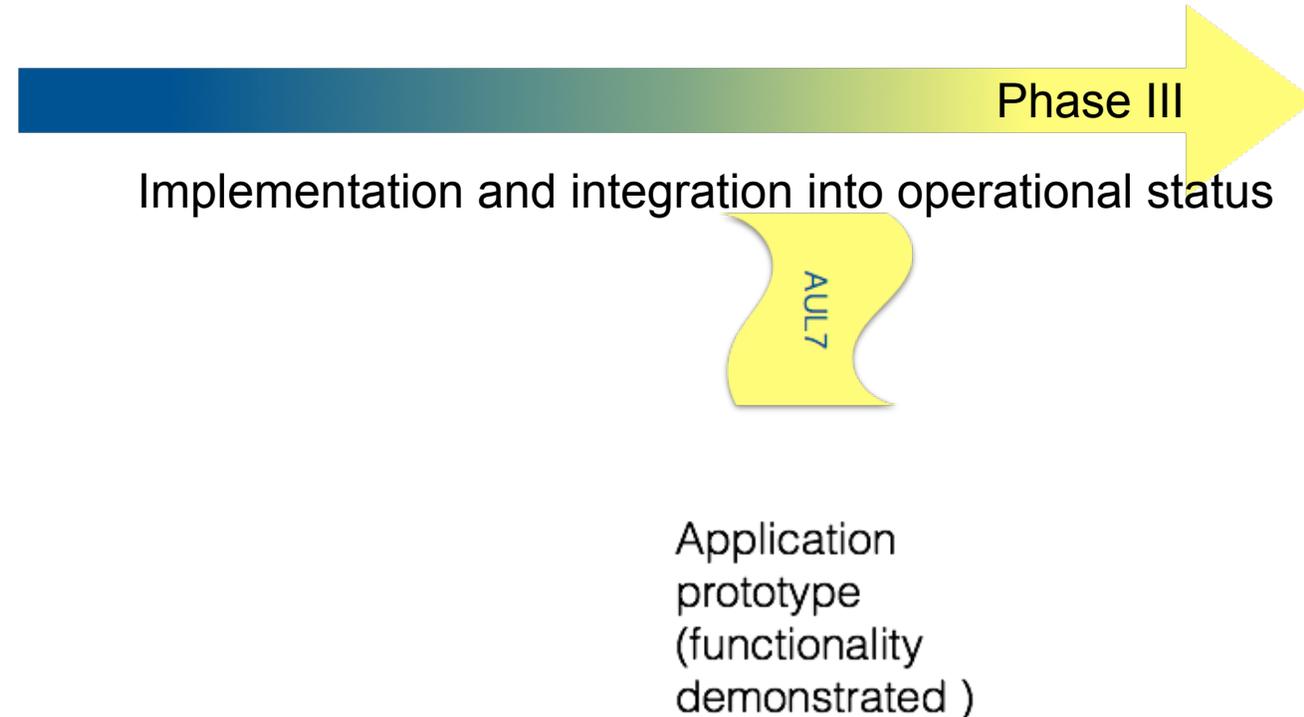
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AUL 7: All portions of the new project are integrated into the end user's application and the functionality has been established.

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### AULs



# Application Usability Levels

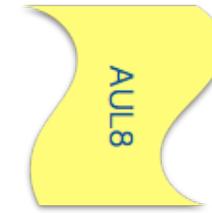
*The three phases*



## AUL: Application Usability Level

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Validation in "real world" environment (capability demonstrated)



### Milestones:

- The end user must approve the addition of the new project to their application for their operational use.
- Finalized application system tested, proven operational, and shown to operate within the specified requirements and metrics.
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**AULs**

# Application Usability Levels

## Background

### ARL: Applications Readiness Level

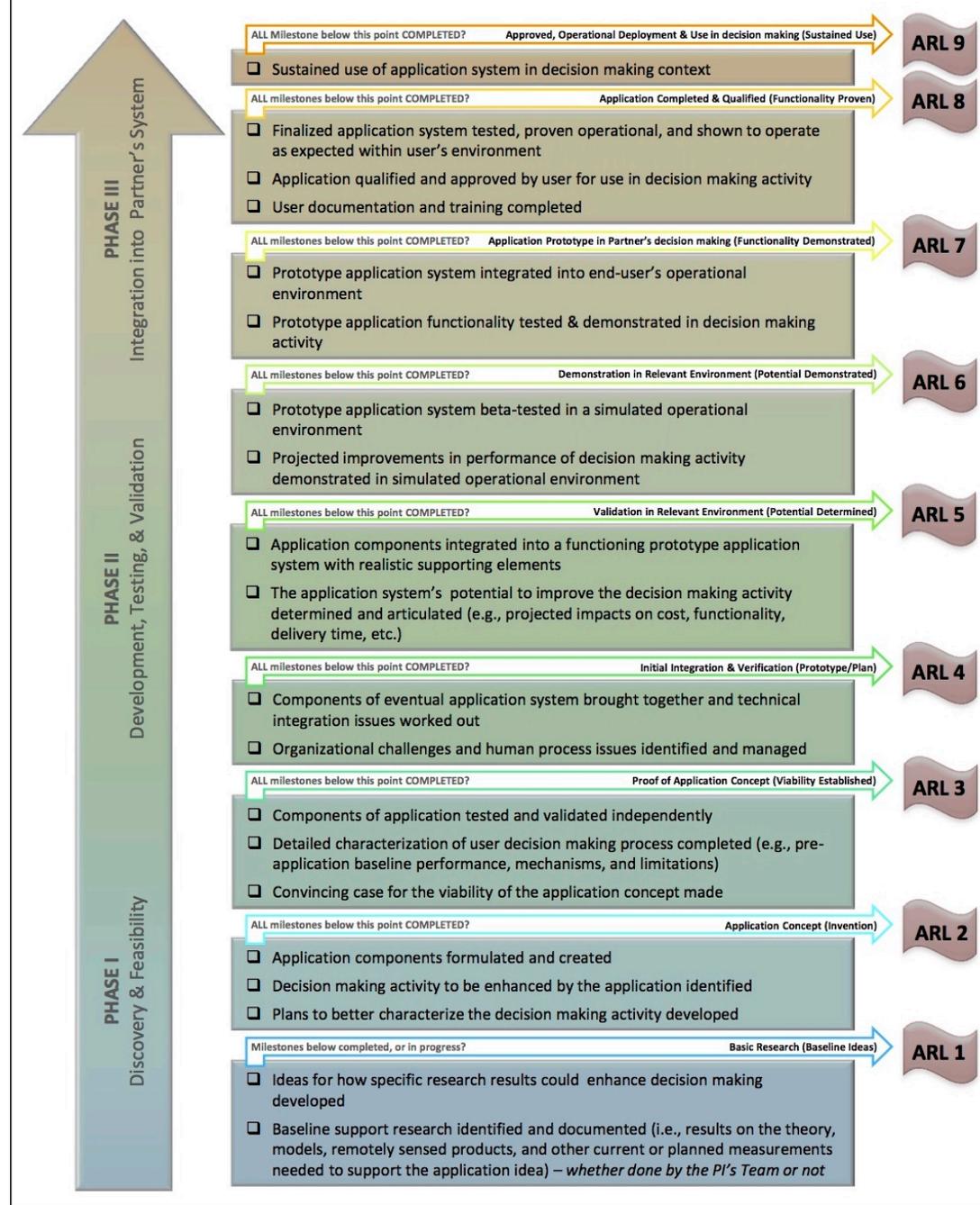
Each level has clear milestones which must be met for an application to advance to the next level.

During the course of a grant cycle, teams are asked to state what the current ARL of the application is, what the goal ARL is, and to update these numbers each fiscal year.

It is not expected that a project will advance from ARL 1 to ARL 9 during the course of one grant cycle (3 – 5 years).

<https://www.nasa.gov/sites/default/files/files/ARLMilestonesFigure10712.pdf>

### ARLs



**NASA Application Readiness Level (ARL) Milestones.** Progression of NASA Applied Sciences projects is represented vertically (y-axis). While some projects may complete some milestones out of phase with this upwards vertical progression, the ARL for each project is determined at any given time by completion of all milestones that come below it in this illustration.



# Application Usability Levels

*The three phases*

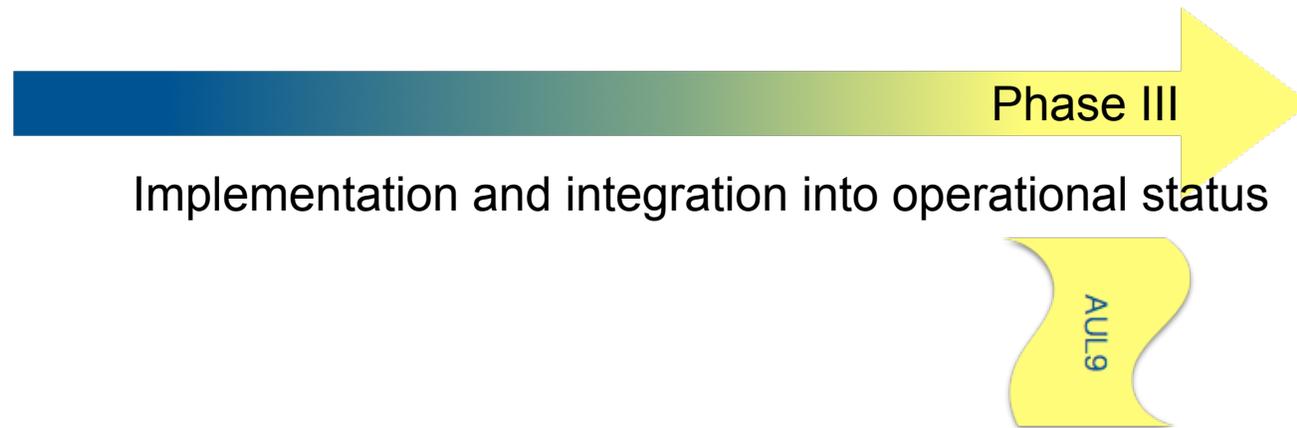
## AUL: Application Usability Level

AUL 9: the project is the new state of the art and has been proven to work in a sustained manner. Continued validation efforts are performed for the project's sustained use in the operational environment.

### Milestones:

- Sustained and repeated use of the application by the specified end users.
- The continued validation of the project in the operational environment.
- Publication of the validation efforts, metrics, and new state of the art project to the community for the specific application.

### AULs



Approved for on demand use towards stated application (sustained use)