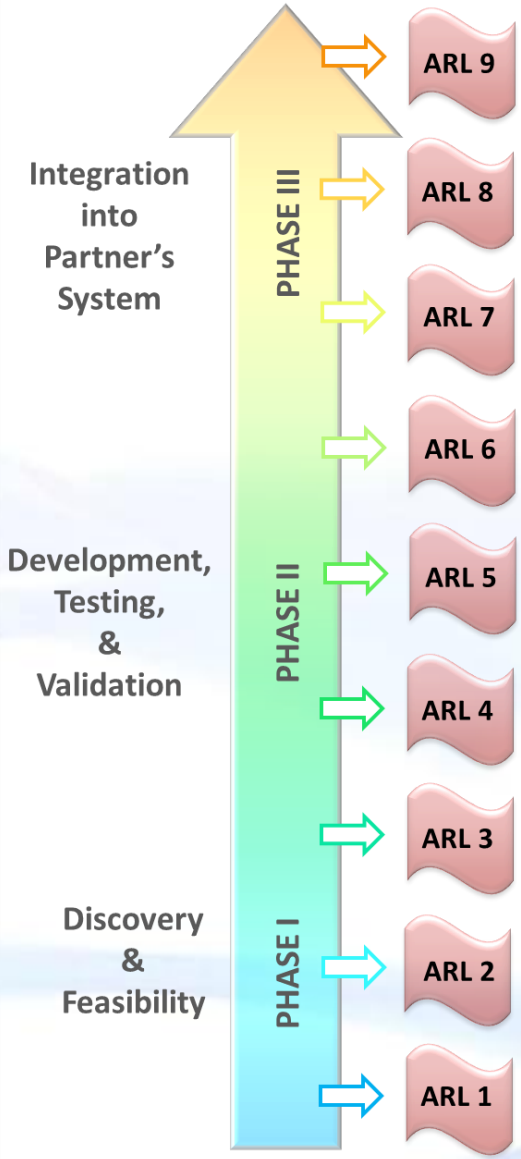
The Application Readiness Level Metric



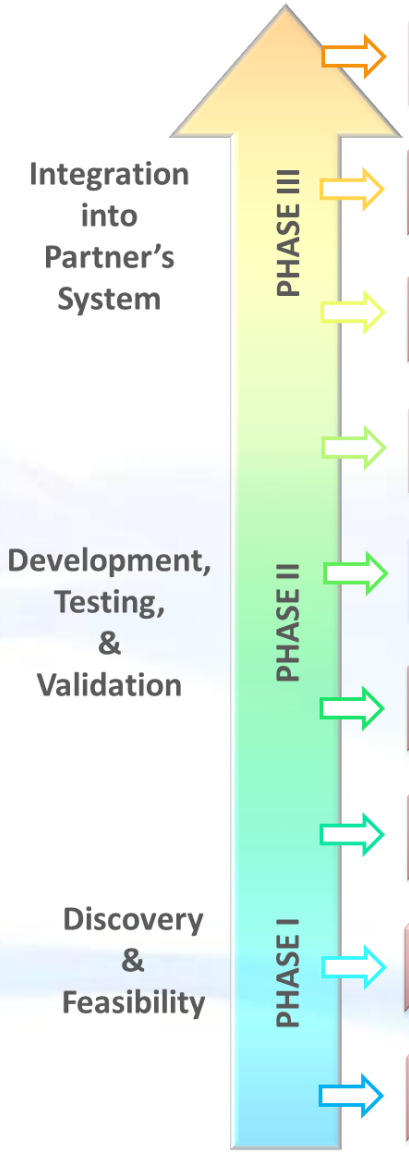
NASA Application Readiness Levels (ARLs)

The NASA Applied Sciences Program has instituted a nine-step Application Readiness Level (ARL) index to track and manage the progression and distribution of funded projects. This index is an adaptation of a scale used by NASA for managing technology development and risk (Technology Readiness Levels, TRLs), and reflects three main tiers of project research, development, and deployment. In general, ARLs 1-3 encompass discovery and feasibility; ARLs 4-6 address development, testing, and validation; and, ARLs 7-9 focus on integration of the "application" into an end-user's decision-making activity. Using this scale, project teams are being asked to assess the "maturity" of their Applied Sciences project on a regular basis, starting with the project proposal.

At the beginning of each project, project teams are asked to assess which ARL the project is starting at (**Start-of-Project ARL**) and also to project what level the project will reach upon completion (**Goal ARL**). Throughout the duration of most projects, teams are expected to re-assess their project's ARL on periodic basis (**LifeCycle ARL**), every August for a federal "**Fiscal Year ARL**" measure, and at the close-out of their award **(End-of-Project ARL).** It is not expected that all projects will start at ARL 1 and end at ARL 9, so please carefully read through the milestones that need to be met to achieve each ARL, and choose appropriately. In addition, while some projects may complete a few milestones out of phase with this generalized progression from ARL 1 to ARL 9 or may have project components at different levels, **a project's ARL is determined at any given time by the highest level for which all milestones preceding it have been completed in full.**

Definitions for each level and its associated milestones follow.

ARL Schema – The Levels



- **ARL 9** Approved, Operational Deployment and Use in Decision Making (Sustained Use)
- **ARL 8** Application Completed and Qualified (Functionality Proven)
- **ARL 7** Application Prototype in Partner's Decision Making (Functionality Demonstrated)
- **ARL 6** Demonstration in Relevant Environment (Potential Demonstrated)
- **ARL 5** Validation in Relevant Environment (Potential Determined)
- **ARL 4** Initial Integration and Verification (Prototype/Plan)
- **ARL 3** Proof of Application Concept (Viability Established)
- **ARL 2** Application Concept (Invention)
- **ARL 1** Basic Research (Baseline Ideas)

ARL 1

Basic Research
(Baseline Ideas)

This level is the foundation upon which application concepts are developed. At this level, basic scientific concepts, connections, and insights and are observed and reported, and research produces results that provide the **basis for applications ideas**.

Milestones:

- ❑ Ideas for how specific research results could enhance decision making developed
- ❑ Baseline support research identified and documented (i.e., results on the theory, models, remotely sensed products, and other current or planned measurements needed to support the application idea) – *whether done by the PI's Team or not*

ARL 2

Application Concept
(Invention)

Application invention and formulation of concept begins here. Initial understanding and characterization of the decision making activity are articulated. At this level, the full **application system is still speculative** and there is no proof or detailed analysis to support the assumption.

Milestones:

- ❑ Independent application components formulated and created
- ❑ Decision making activity to be enhanced by the application identified
- ❑ Plans to better characterize the decision making activity developed

ARL 3

Proof of Application Concept
(Viability Established)

Feasibility studies to assess the potential viability of and provide a proof-of-concept for the application are conducted. In addition, a more complete characterization of the decision making process is completed. Different components of the application system are **not yet integrated**.

Milestones:

- ❑ Components of application tested and validated independently
- ❑ Detailed characterization of user decision making process completed (e.g., pre-application baseline performance, mechanisms, and limitations)
- ❑ Convincing case for the viability of the application concept made

ARL 4

Initial Integration & Verification
(Prototype/Plan)

Basic components of Earth science products and the decision making activity (decision support system, tool, etc.) are integrated together into a prototype "application system" to establish that they will work together. At this level, the technical, organizational, and human process issues related to the decision support activities are also worked out. Project team must **verify that components will work together** to achieve this ARL.

Milestones:

- ❑ Components of eventual application system brought together and technical integration issues worked out
- ❑ Organizational challenges and human process issues identified and managed

ARL 5

Validation in Relevant Environment
(Potential Determined)

Basic components are integrated with reasonably realistic supporting elements so application can be tested in a simulated decision making environment. Prototype implementations conform to the end-user's target environment and standard interfaces. Validation that the decision making activity both functions with the Earth science products and is projected to improve performance is achieved. Project team must **articulate the potential** for performance improvement in decision making to achieve this ARL.

Milestones:

- ❑ Application components integrated into a functioning prototype application system with realistic supporting elements
- ❑ The application system's potential to improve the decision making activity determined and articulated (e.g., projected impacts on cost, functionality, delivery time, etc.)

ARL 6

Demonstration in Relevant Environment
(Potential Demonstrated)

Achieving this level represents a major increase in the application's demonstrated readiness. The prototype application system is demonstrated in a relevant environment or in a simulated operational decision making environment. Any application component(s) already deployed in the end-user's environment are tested in operational decision making context. Project team must **demonstrate the potential** for performance improvement in decision making to achieve this ARL.

Milestones:

- ❑ Prototype application system beta-tested in a simulated operational environment
- ❑ Projected improvements in performance of decision making activity demonstrated in simulated operational environment

ARL 7

Application Prototype in Partner's Decision Making
(Functionality Demonstrated)

Prototype application system and all pre-deployed components are fully integrated into the end-user's operational environment, such as the partner's decision making activity. At this level of application system maturity, functionality is demonstrated to win the confidence of the partner. Project team must **demonstrate the functionality** of the integrated components in the decision making activity to achieve this ARL.

Milestones:

- ❑ Prototype application system integrated into end-user's operational environment
- ❑ Prototype application functionality tested & demonstrated in decision making activity

ARL 8

Application Completed & Qualified
(Functionality Proven)

Actual application system is completed and 'qualified' by the partner through testing and demonstration in the targeted decision making activity. The application is proven to work in its final form and under expected conditions. In addition, most user documentation, training documentation, and maintenance documentation are completed. **Partner must approve** the application system for use in their decision making activity to achieve this ARL.

Milestones:

- ❑ Finalized application system tested, proven operational, and shown to operate as expected within user's environment
- ❑ Application qualified and approved by user for use in decision making activity
- ❑ User documentation and training completed

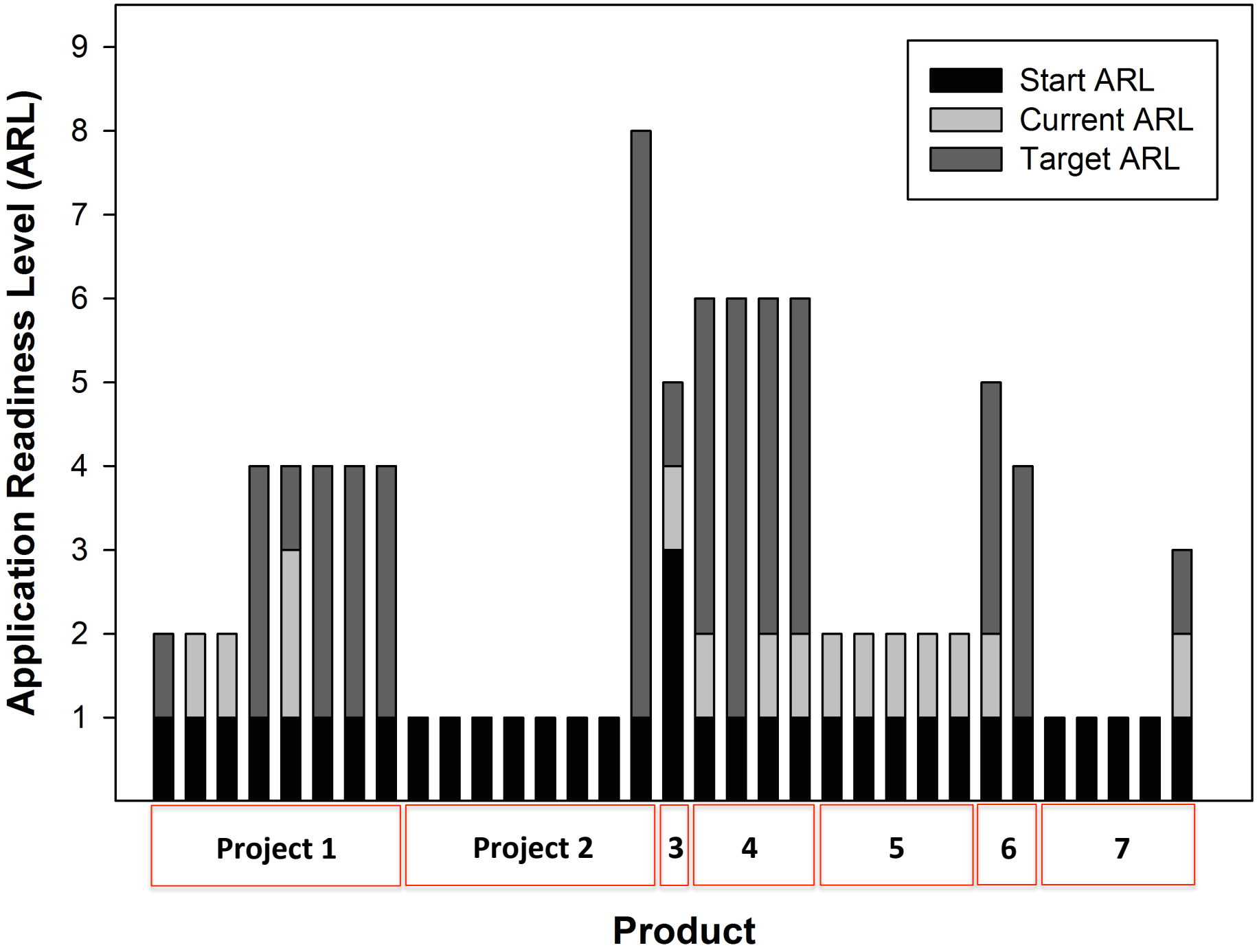
ARL 9

Approved, Operational Deployment & Use in Decision Making
(Sustained Use)

Actual operational, successful use of application by users in their decision making activities. To reach ARL 9, full integration and **repeated use** in the decision making organization's operations has been achieved.

Milestone:

- ❑ Sustained use of application system in decision making context


Application Readiness Level (ARL)
9
8
7
6
5
4
3
2
1
Start ARL
Current ARL
Target ARL
Project 1
Project 2
3
4
5
6
7
Product