

# Comparison of tracking progress frameworks: What's the difference and why should I use the AULs.

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# Why use a framework to track progress?





It can help us  
build a  
bridge and  
navigate the  
valley of  
death





A tracking framework can ensure  
*clear communication* between  
developers/researchers and users  
*about the use and current*  
*development stage* of a product.



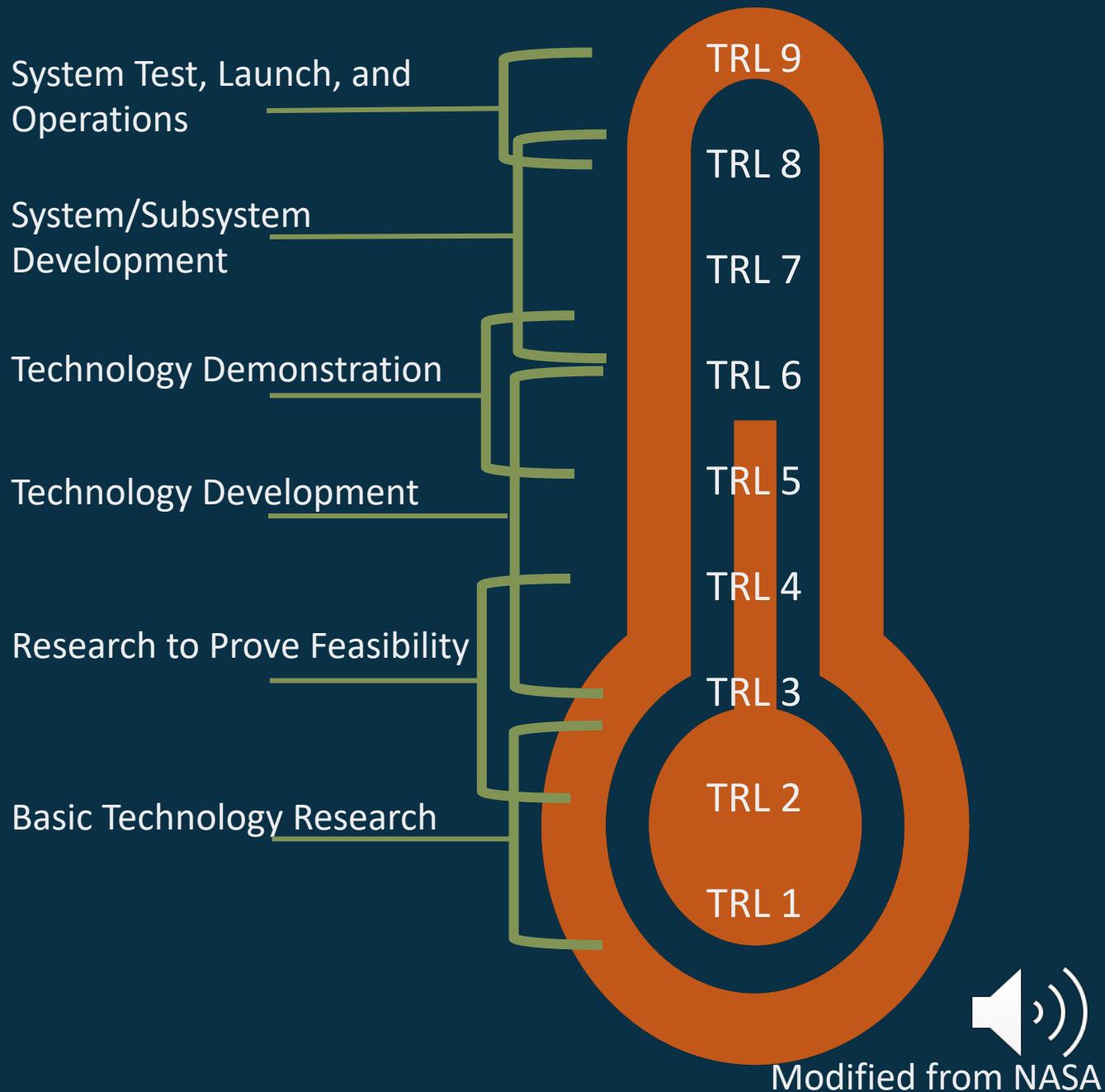
Which frameworks are out  
there? What were they  
designed to track?



# Technology Readiness Levels, TRLs

(Mankins 1995

<https://ecss.nl/home/ecss-e-hb-11a-technology-readiness-level-trl-guidelines-1-march-2017/>



# Technology Readiness Levels

A method to estimate  
the maturity of  
technology for space  
flight

Supports efforts for  
risk management

Can help at  
proposal/mission  
formulation

Can help determine  
funding

Does not require an  
identified user or to  
define user  
requirements





# Readiness Levels: RLs

(NOAA Administrative Order  
(NAO) 216-105B)

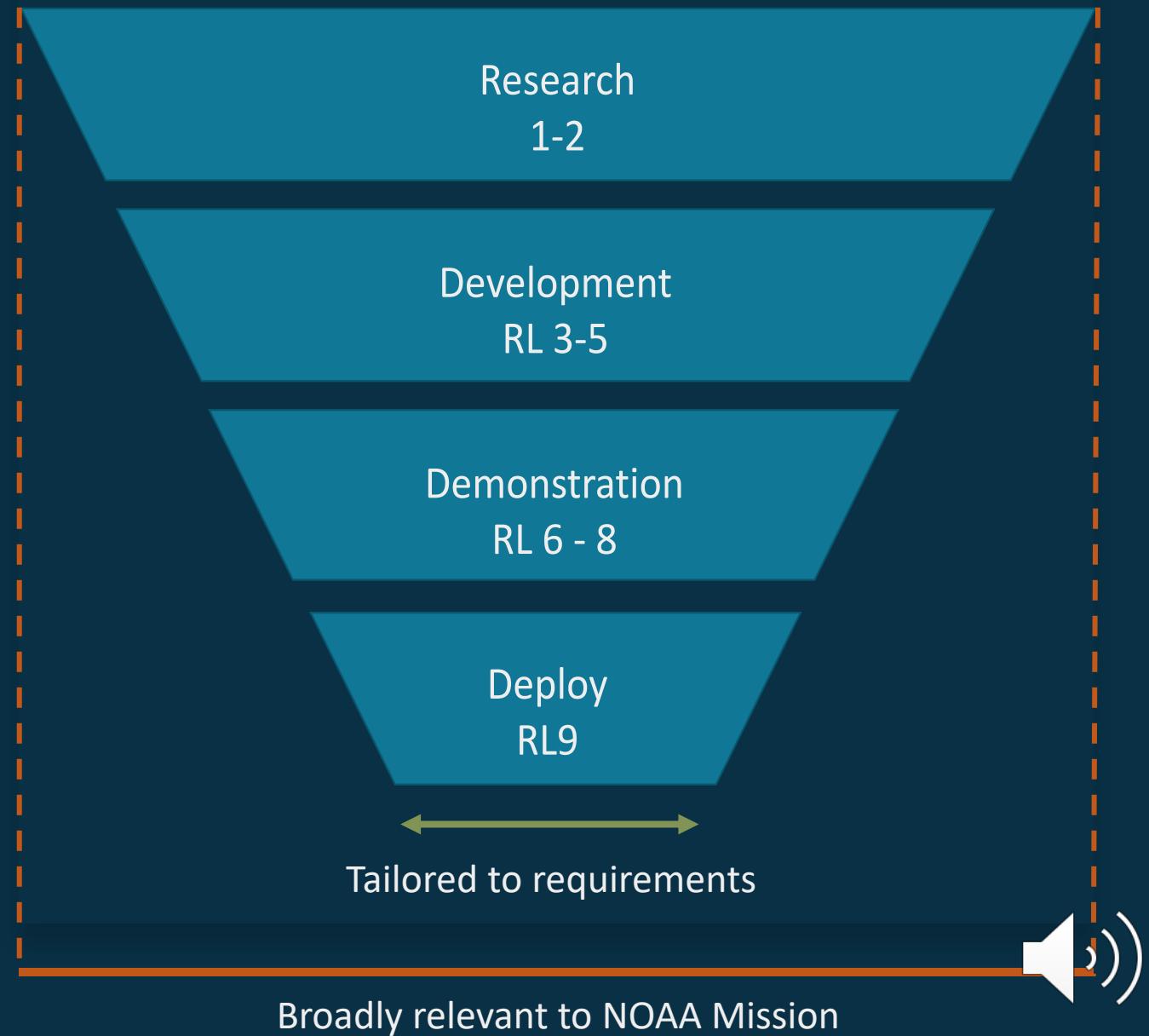


# Readiness Levels

- This Order establishes the process for identifying, transitioning, and coordinating R&D output to operations, applications, commercialization, and other uses.

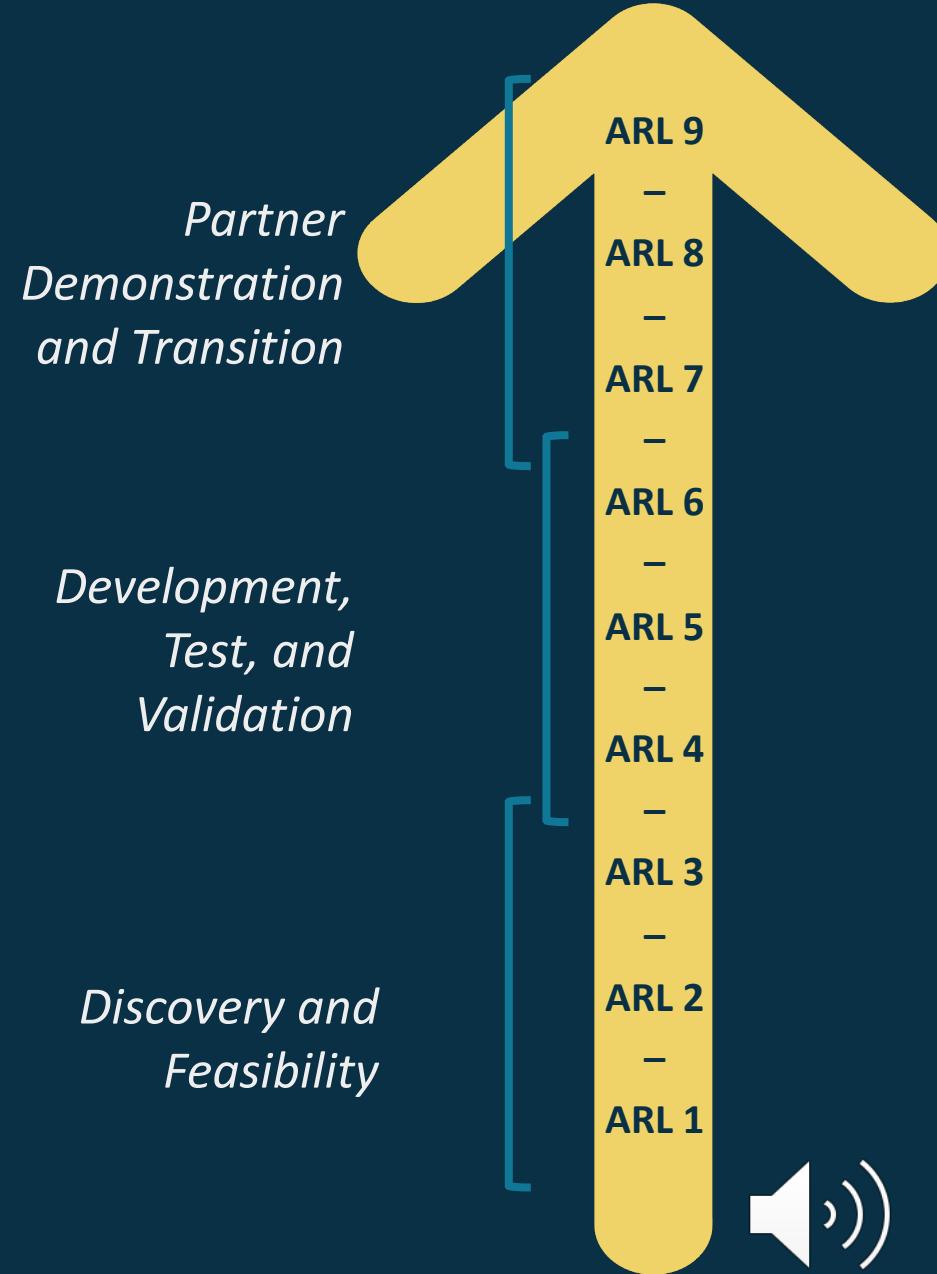


# Readiness Levels

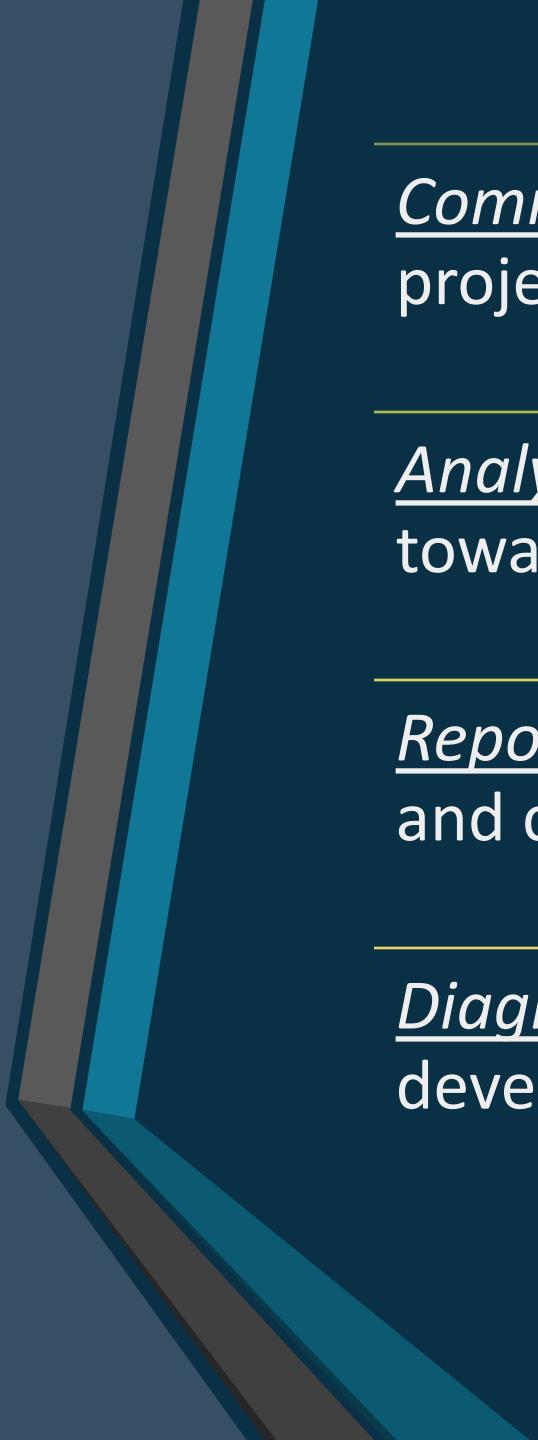


# Application Readiness Levels: ARLs (Lawrence Friedl/ NASA)

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# Application Readiness Levels



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*Communication Tool:* convey progress of the project towards sustained use.

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*Analysis Tool :* assess progress of a project towards completion.

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*Reporting Tool:* convey performance goals and completion of goals to funding agencies.

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*Diagnostic Tool :* identify roadblocks in development.

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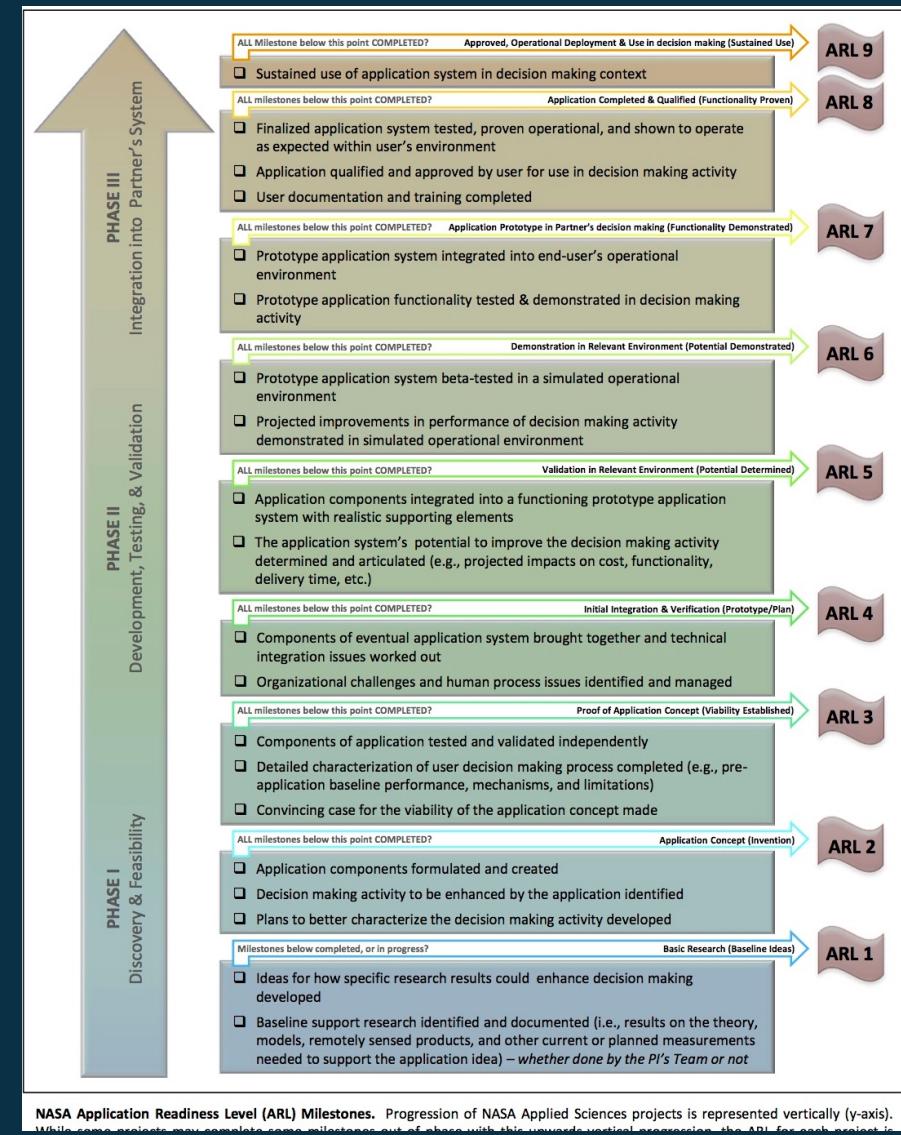


# Application Readiness Levels

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

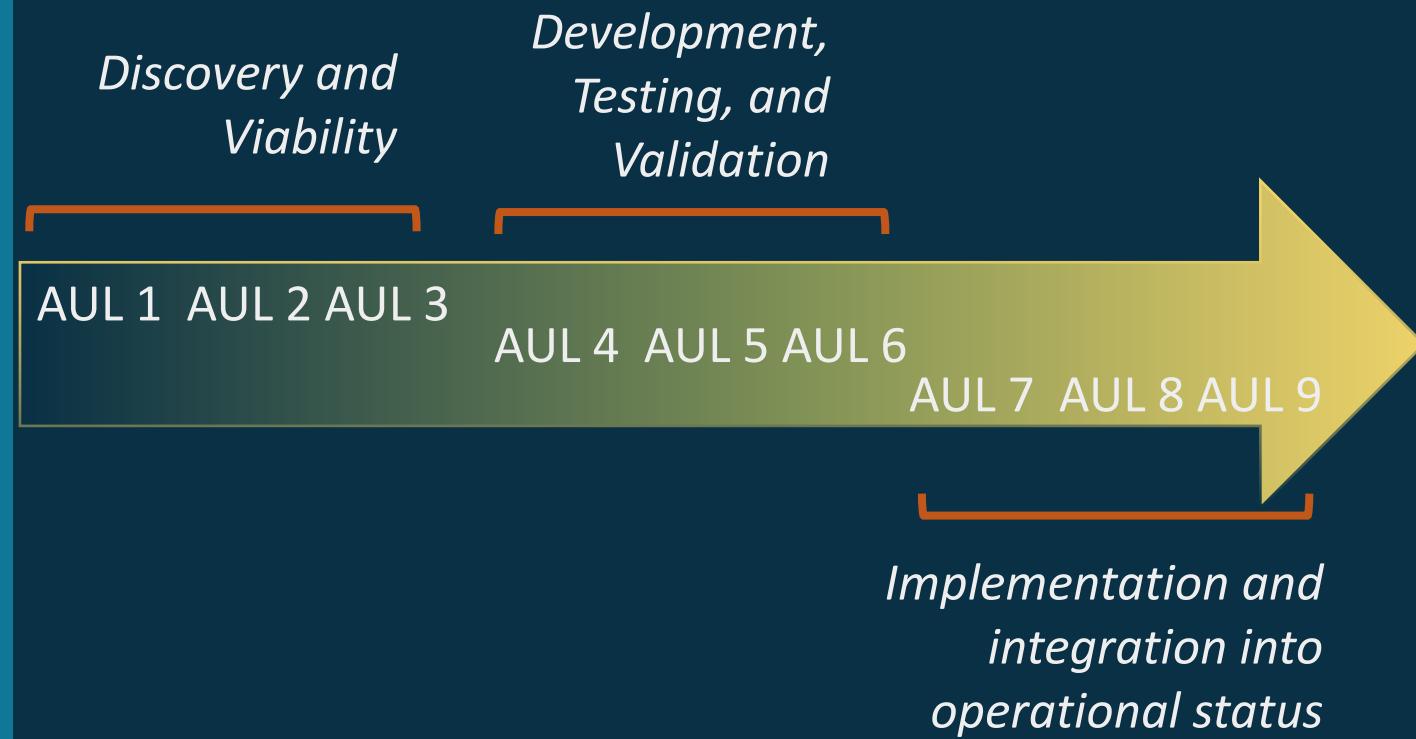
During a grant cycle, teams are asked to state what the current ARL of the application is, what the goal ARL is, and to update these numbers each fiscal year.

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



# Application Usability Levels (AULs) (Halford et al 2019)

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# Application Usability Levels

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

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



# Application Usability Levels



Communication Tool: convey progress of an agreed upon project/product with an identified user towards sustained use.



Reporting Tool: convey user requirements and metrics as well as operational environment



Analysis Tool : assess progress of a project towards usability and meeting of the users agreed upon requirements.



Diagnostic Tool : identify roadblocks in development. Can also be used to identify new applications and new users

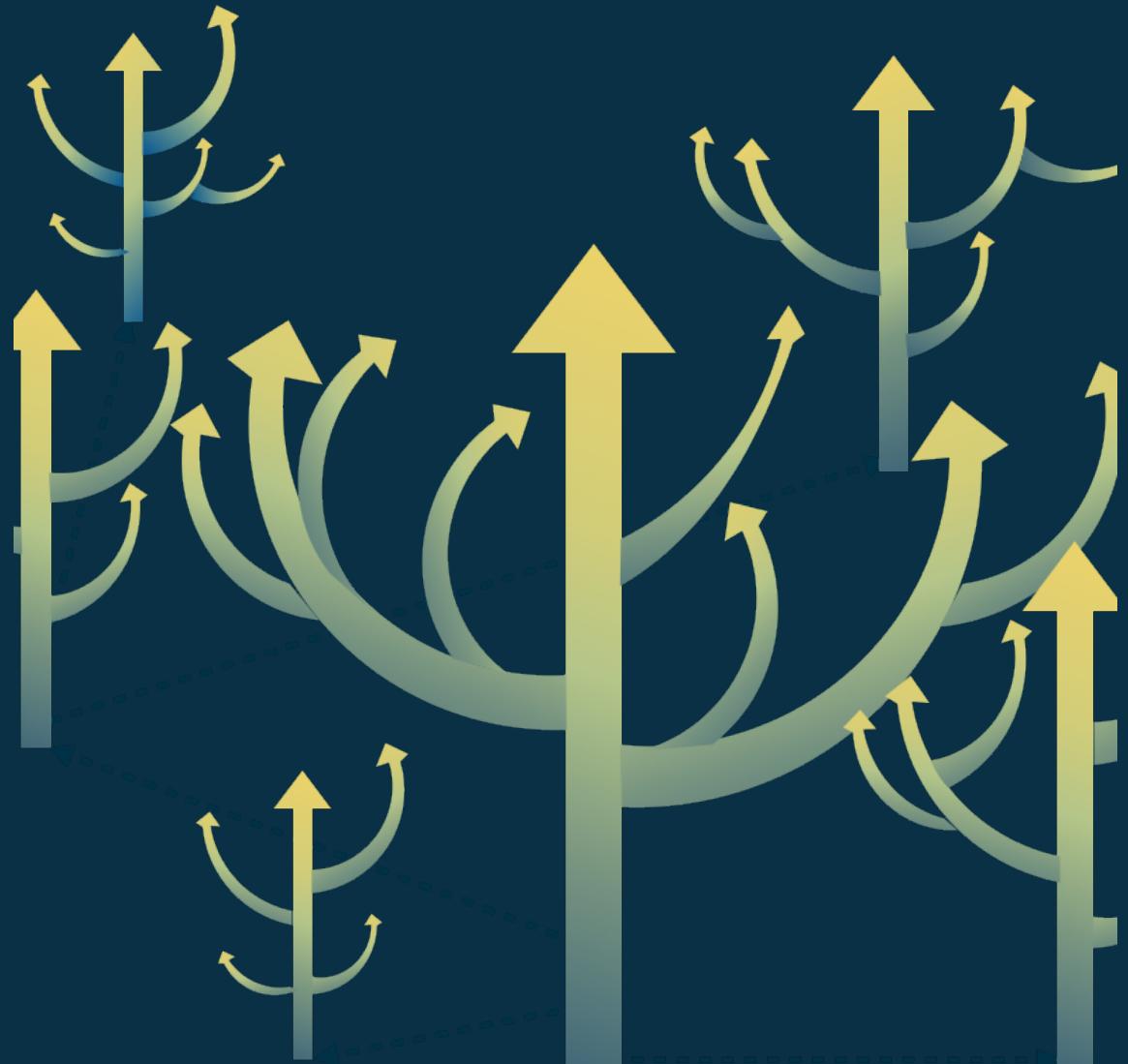


# Application Usability Levels

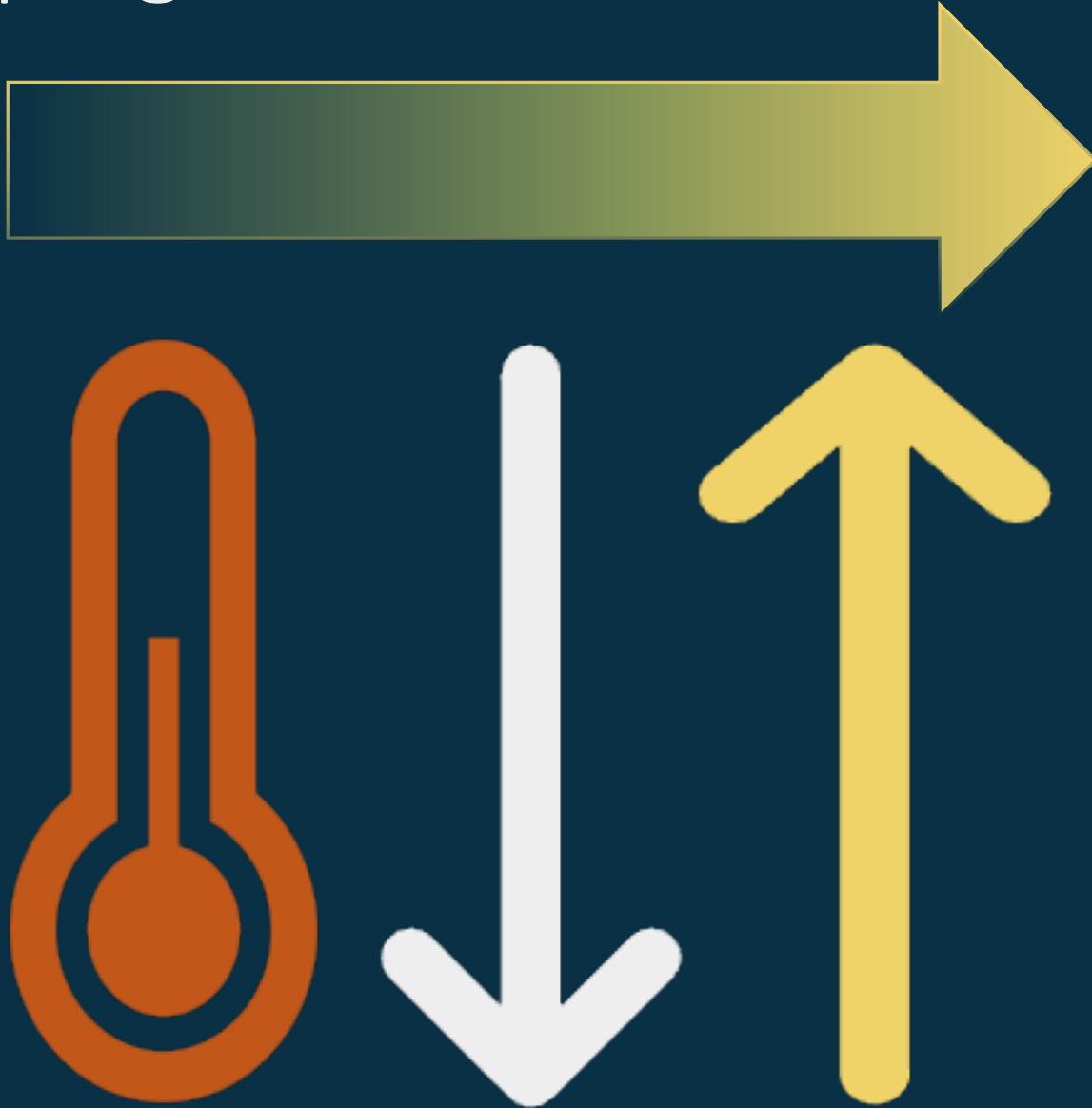
Each level has clear milestones which must be met for an application to advance to the next level. Both the user and researcher must agree that the level has been attained.

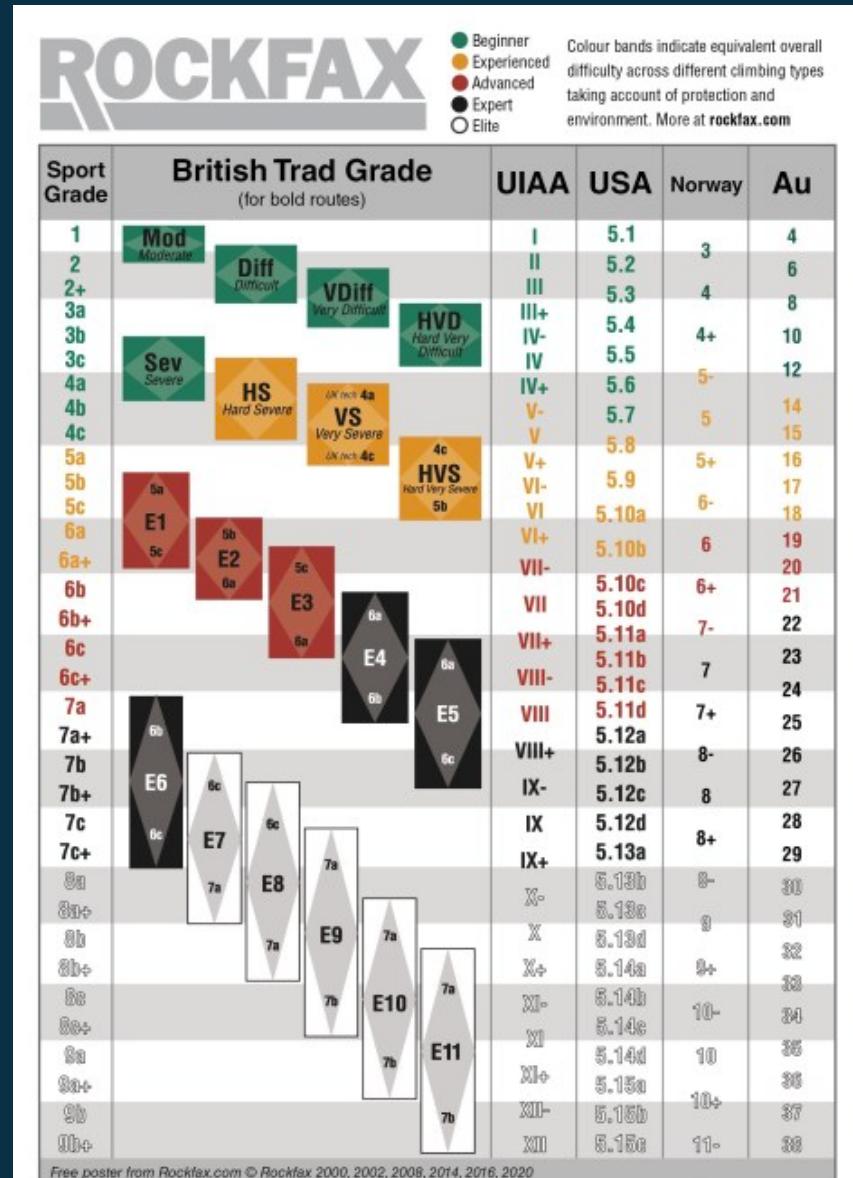
The AULs allow for progress to be shown without necessarily completing science closure.

If the user requirements change, then a new branch is generated. This allows for continued development with the original requirements and clear reporting on the new product AUL path.



# Mapping between the frameworks





When comparing different frameworks we can look to how others have done this. Here is an example for international scales of rock climbing.

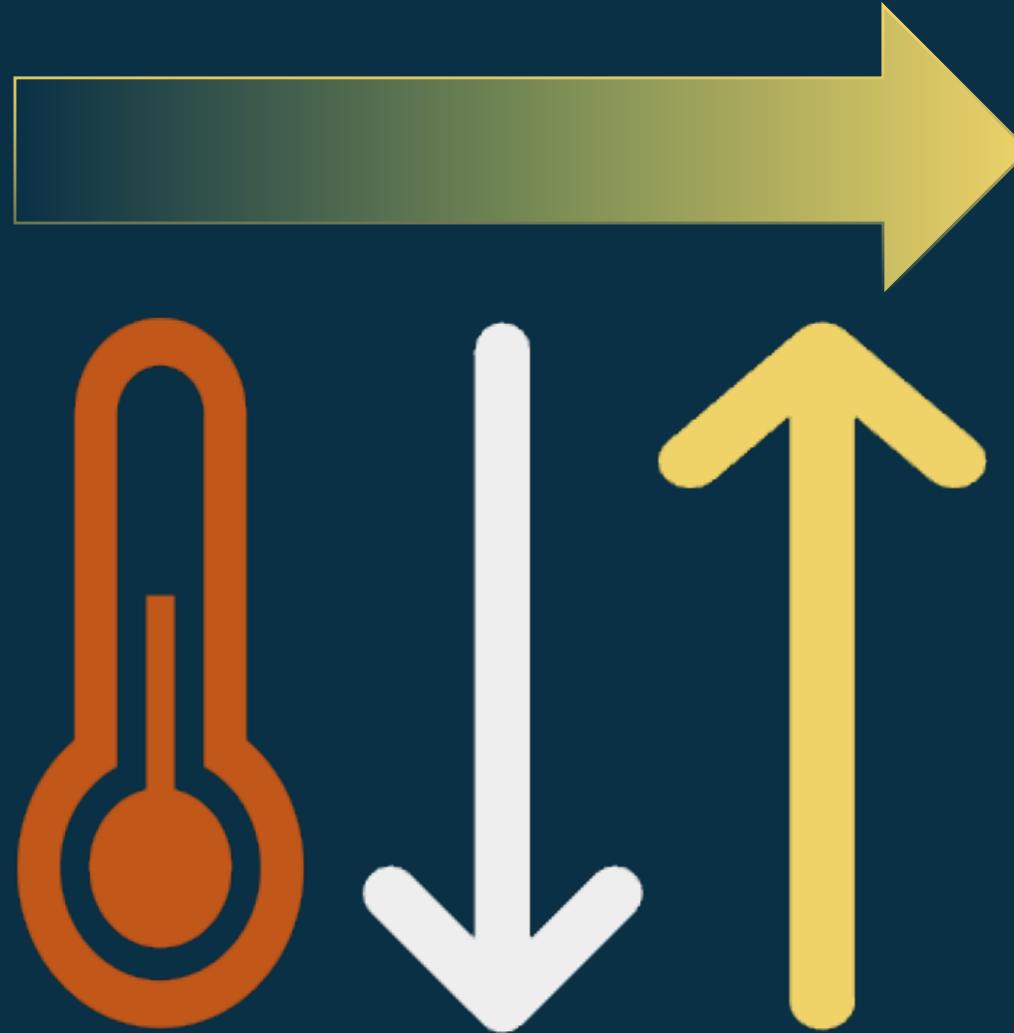
Level	TRL	RL	ARL	AUL
1	Basic principles observed and reported	Basic Research	Basic Research	Basic research
2	Technology concept or application formulated	Applied Research	Application concept (invention)	Establishment of users and their requirements
3	Proven through analysis and experimentation	Proof of concept for system, subsystem, process, product, service or tool in a laboratory or other experimental environment	Proof of Application concept (viability established)	Assess viability and current state of the art
4	Basic prototype validated in laboratory environment	Successful evaluation in a laboratory or other experimental environment	Initial integration and verification (prototype/plan)	Initial integration and verification
5	Basic prototype validated in relevant environment	Successful evaluation in relevant environment	Validation in relevant environment (potential determined)	Demonstration in the relevant context
6	(Sub)system model or prototype demonstrated in relevant environment	Demonstration of prototype in relevant or test environment (potential demonstrated)	Demonstration in relevant environment (potential demonstrated)	Completed validation
7	System prototype demonstrated in relevant environment	Prototype demonstrated in an operational or other relevant environment	Application prototype in partner's decision making (functionality demonstrated)	Application prototype
8	Actual system completed and qualified for flight	Finalize & show to work as expected within user environment & provide all documentation. User approval given.	Application completed and qualified (Functionality proven)	Validation in relevant context
9	Actual system proven through successful operation	System, process, product, service or tool deployed and used routinely	Approved, operation deployment and use in decision making	Approved for on-demand use

We can attempt to do a similar mapping – however there are areas without one-to-one correlation.

For example, no user is identified in the TRLs or RLs. The ARLs and AULs do not require operation in the space environment or a business case to be made.

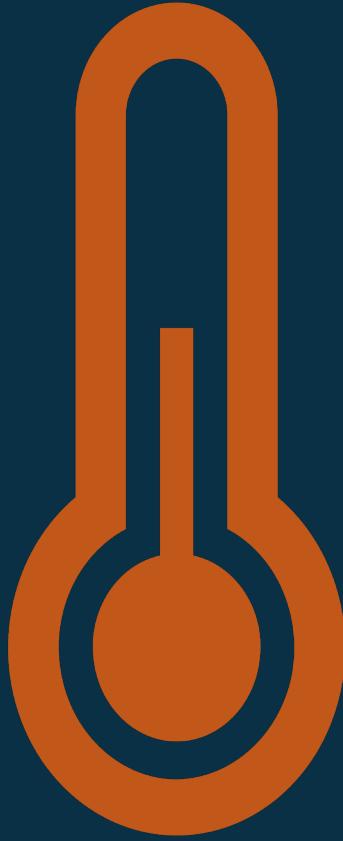


Pick the right framework: Where there is overlap and where they differ



What is each  
frameworks  
motivation?

What is the framework tracking towards?



## Technology Readiness Levels:

- Will this tool, be it software or hardware, work in the space environment?





## Readiness Levels:

- What is the maturity of a product and where is it in the transition process to addressing a NOAA mission need



# Application Readiness Levels:



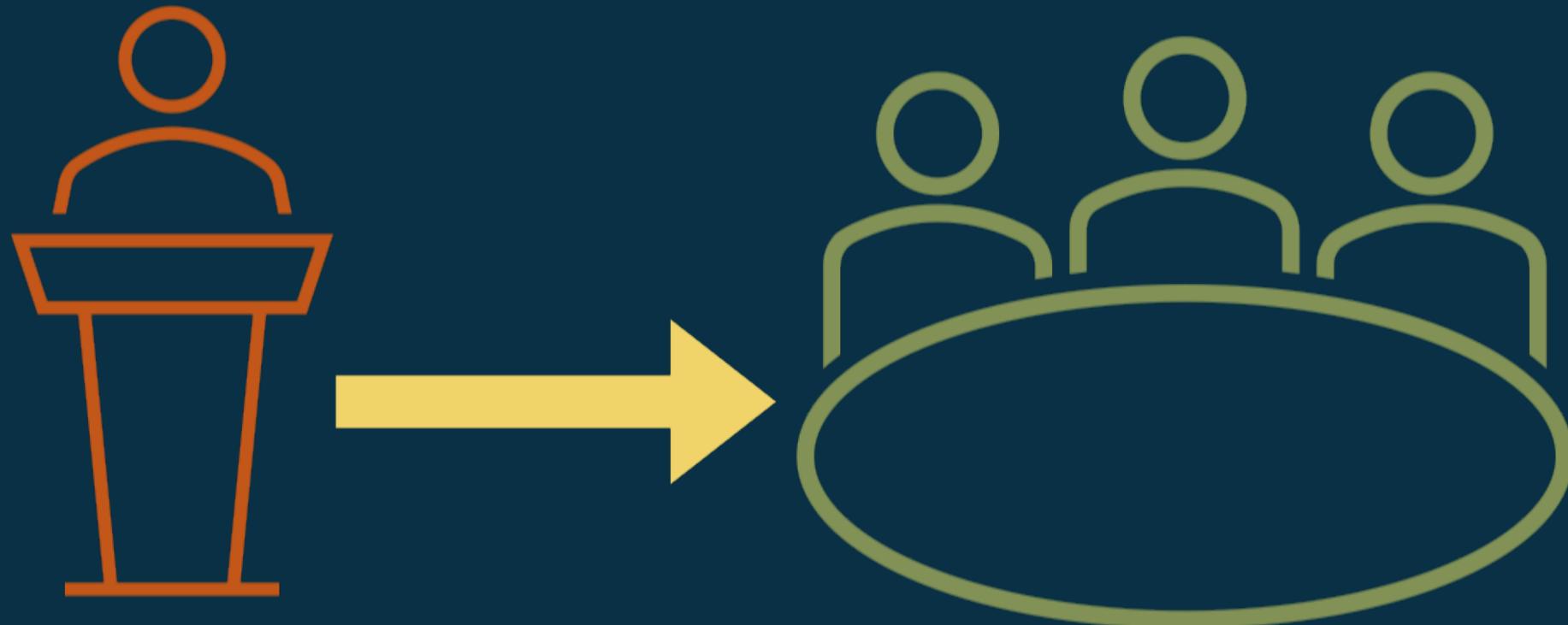
- Will this tool, be it software or hardware, work in the user specified environment and aid in a decision-making context.



# Application Usability Levels:

- Will the output of this project, be it software, hardware, data, or something else be able to provide a specific use and aid the identified user.







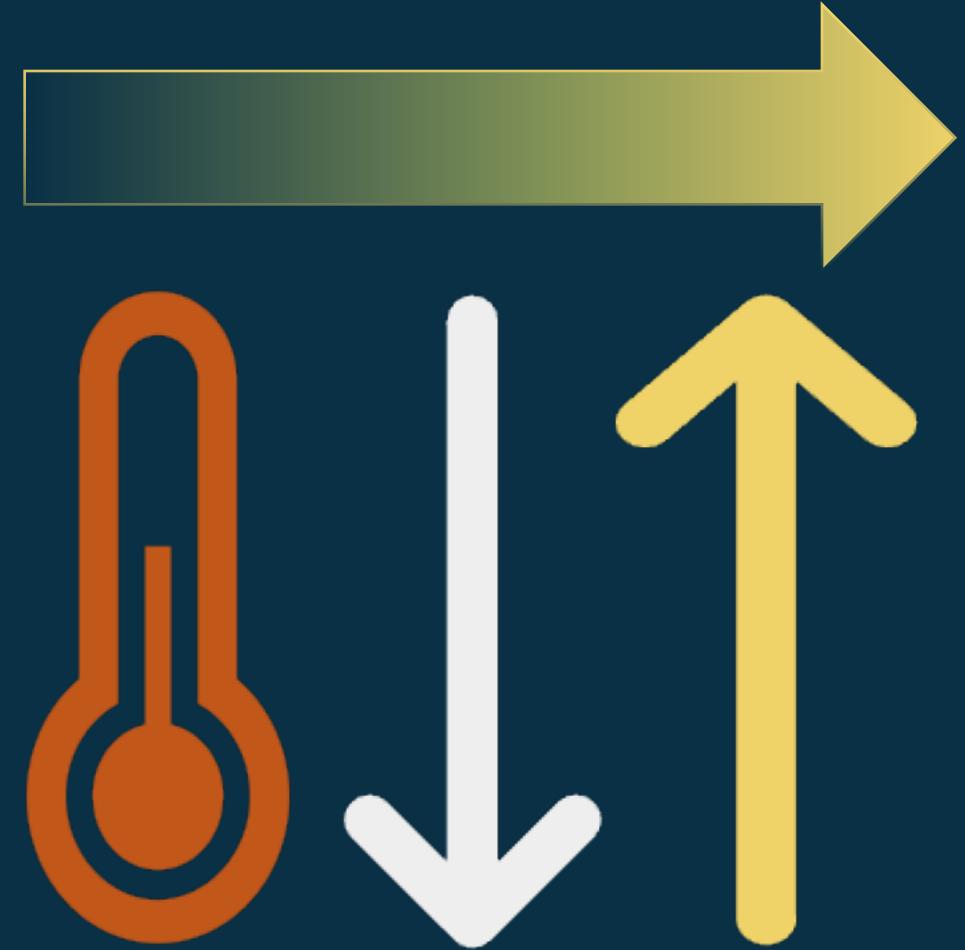
Each framework can ensure *clear communication* between developers/researchers and users *about the use and current development stage* of a product.

If flying in space is the goal –use TRLs

If transitioning a product for use at NOAA – use RLs

If ensuring readiness for use in industry – use ARLs

If ensuring usability by someone else – use AULs



# Thank you for listening

Join our ISWAT Working Group at <https://www.iswat-cospar.org/O1-01>

You can find more from our group including AUL resources at  
<https://github.com/AJHalford/AUL>

Bit of fun on Twitter mapping AULs and TRLs together  
<https://tinyurl.com/AUL2TRL>

