NCAR Earth Observing Laboratory
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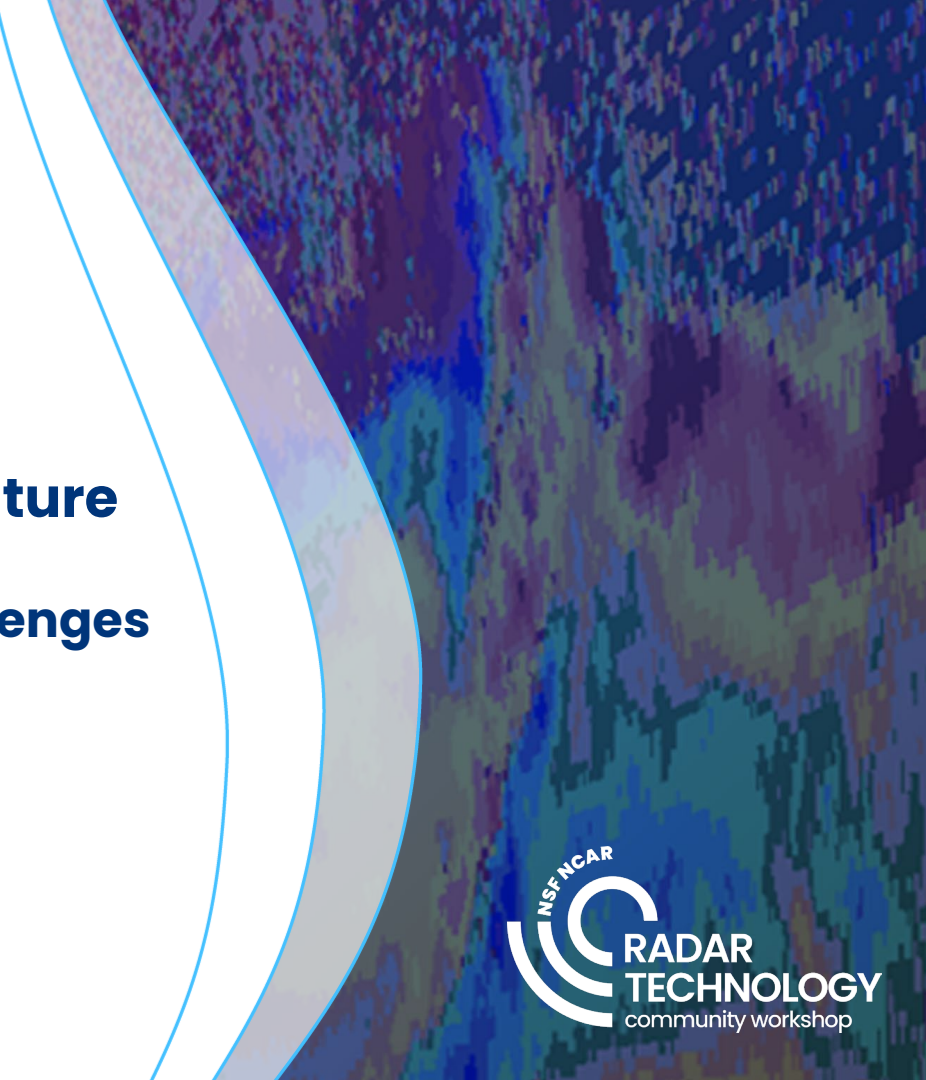
Feasibility Considerations for Future Airborne and Shipborne Radar: Cost, Design and Deployment Challenges

Brad Klotz, NSF NCAR EOL



NSF NCAR RADAR TECHNOLOGY community workshop

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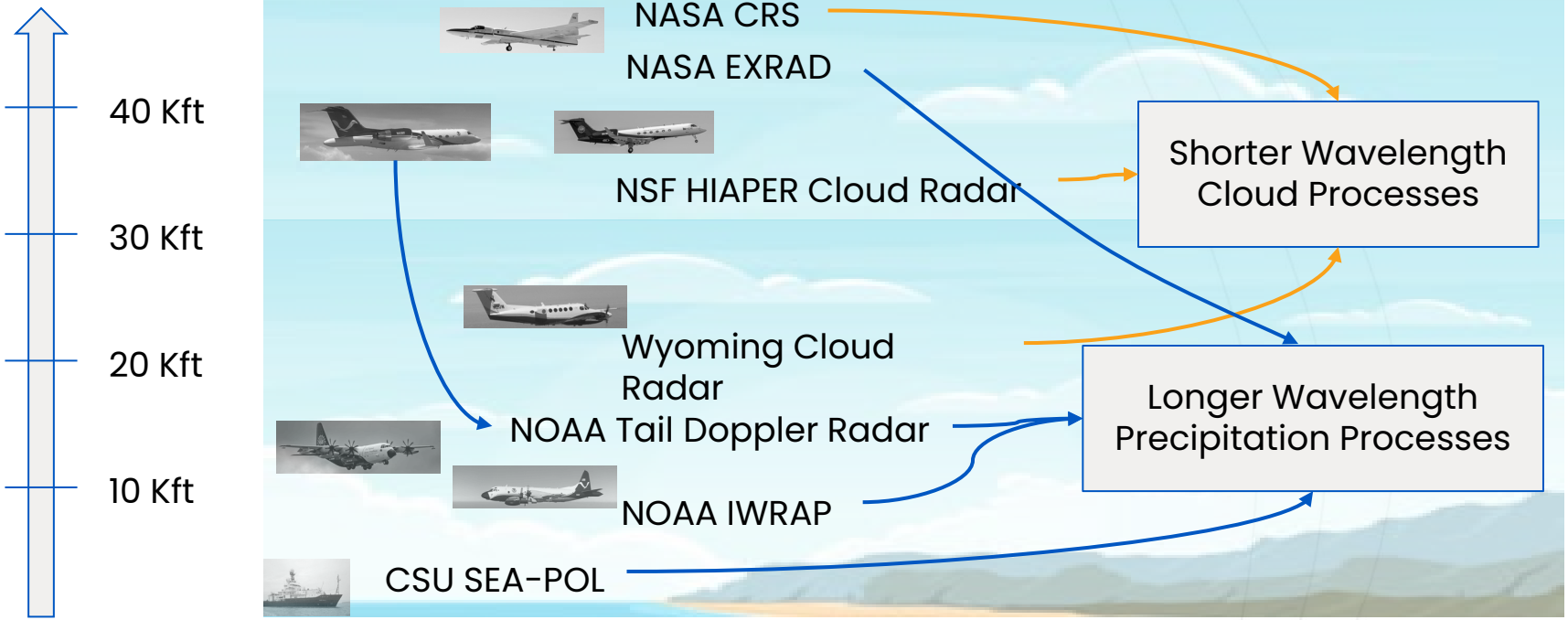
Importance of Airborne and Shipborne Radars

- Airborne and Shipborne radars provide important observations in remote and difficult-to-reach locations
- They are often paired with other instrumentation to promote inter-connected atmospheric studies
- They can provide an immense impact to fundamental research where physical and thermodynamic processes are not well-understood
- They are shown to improve forecasting capability across different scales and types of atmospheric phenomena

Revisiting Current Facilities

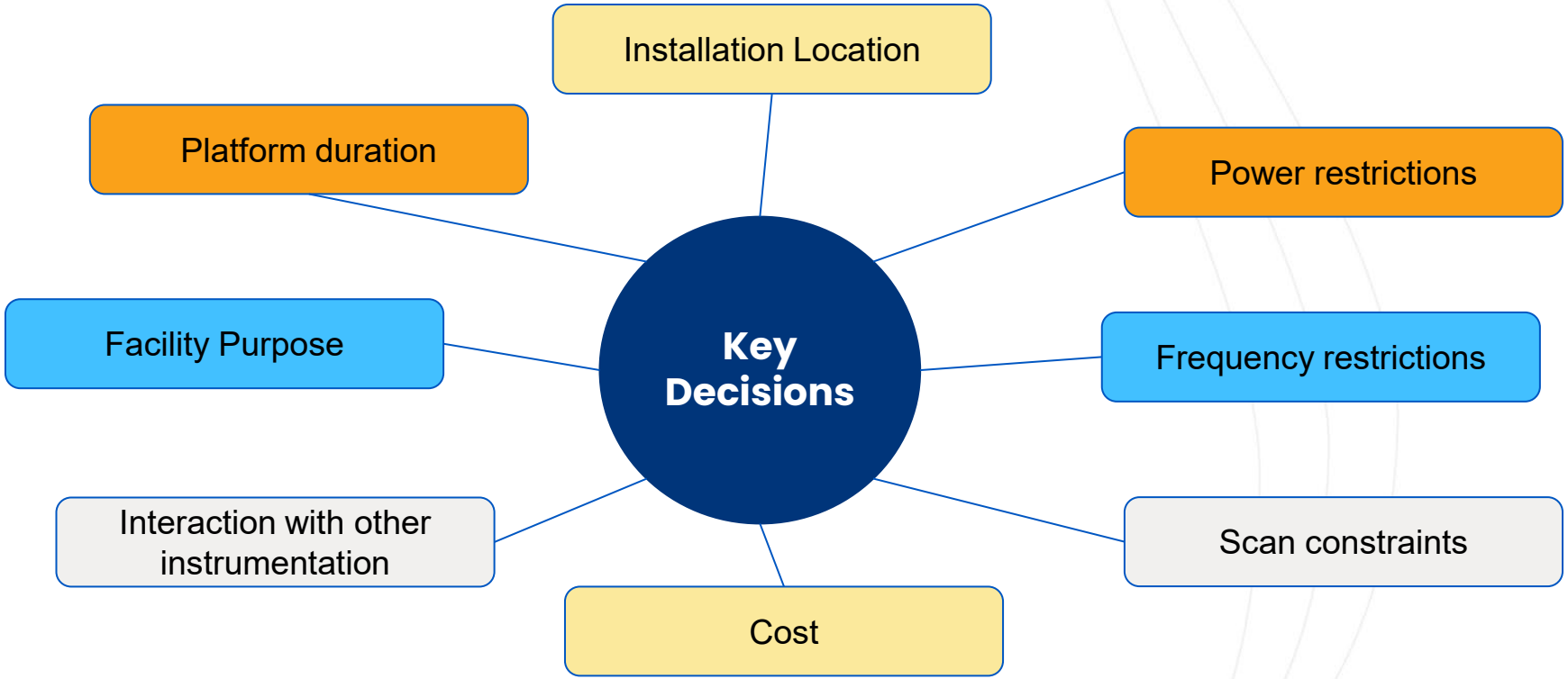


Observational Needs for Future Systems

- **Monitoring high-impact weather conditions remains a critical need for research and operations**
  - Tropical Cyclones and Tropical Convection
  - Mesoscale Convective Systems and Convection
  - Atmospheric Rivers
  - Mid-Latitude Cyclones and Winter Storms

- **Cloud level dynamics and microphysics help define processes and interactions with the environment**
  - Cloud-aerosol interactions
  - Wildfire and smoke monitoring
  - Fundamental processes in wave generation and propagation
  - Orographic induced clouds and high winds

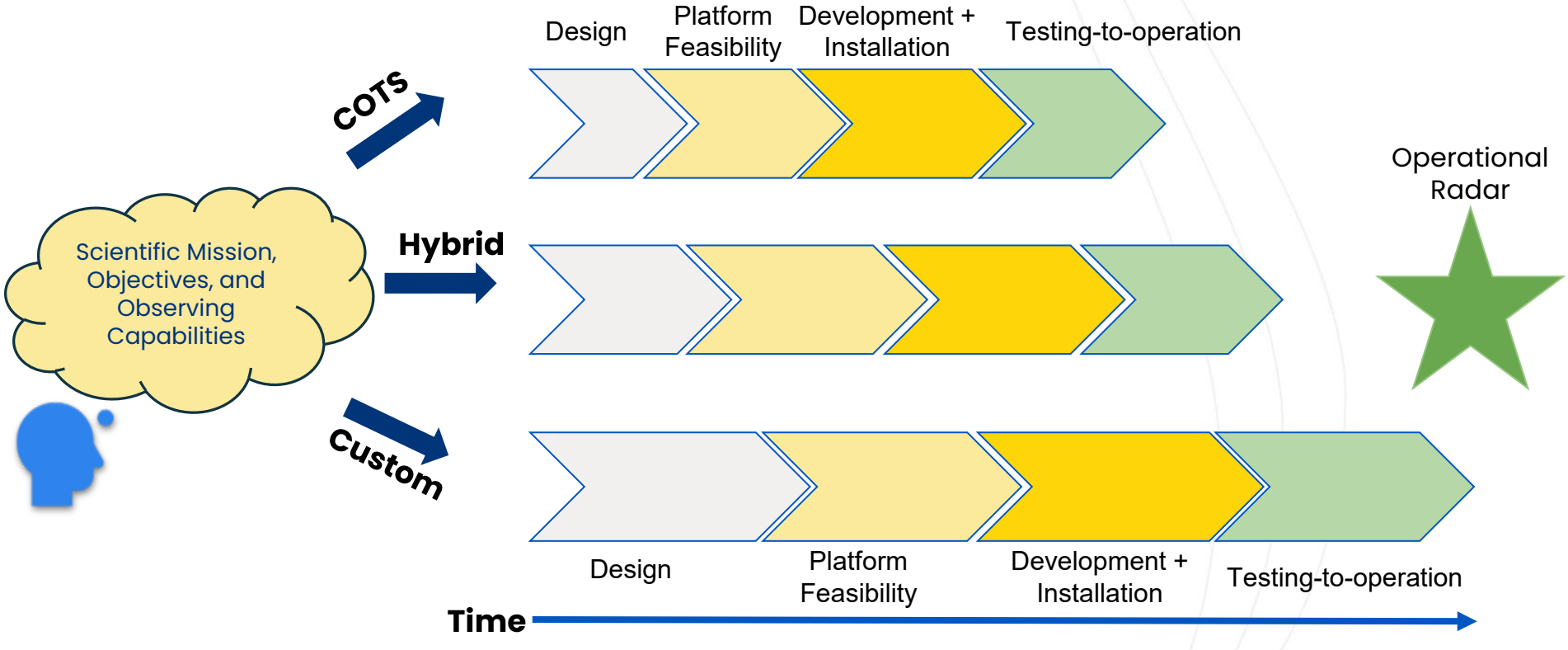
Platform Limitations and Decision Points



Bottom Line Up Front

- Future radars and associated facilities must be guided by both scientific goals and technical feasibility
- Trade-offs are unavoidable and need to be considered as a key factor
  - Define non-negotiables vs. “nice to have”
- Cost will be a significant driver in any design and implementation plan
  - This includes access to appropriate testing and calibration facilities
- For any airborne or shipborne platform, important to understand benefits and limitations of “COTS” vs. “Custom” solutions

Multiple Pathways to Future Radars



Evaluating Radar Cost Feasibility

	COTS	Hybrid	Custom
Radar Design	$ - $$	$$ - $$$	$$$ - $$$$
Platform Feasibility	$ - $$	$ - $$$	$$$
Supporting Development	$ - $$	$ - $$	$$$ - $$$$
Platform Installation	$$ - $$$	$$ - $$$	$$$$
Testing + Operation	$$ - $$$	$$ - $$$	$$$ - $$$$
Overall	$ - $$$	$$ - $$$	$$$ - $$$$

- COTS and Hybrid solutions are typically lower cost due to less design and development needs
- Custom solutions tend to be more expensive across the board - custom radars also typical require custom installation and associated development
- Note: These are cost range estimates based on past experience and do not reflect actual vendor quotes

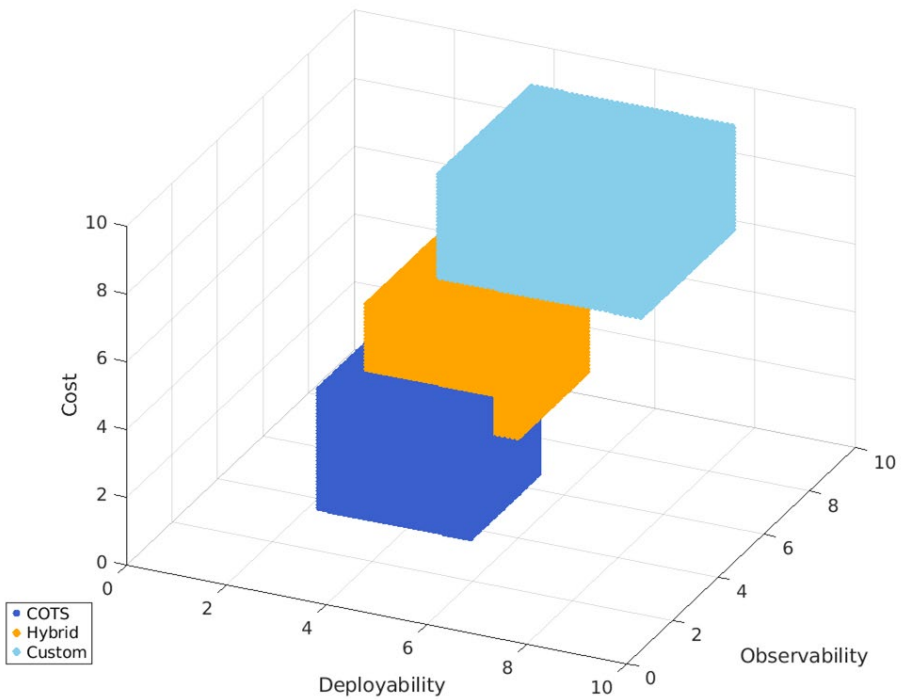
Evaluating Radar Design Feasibility

	Benefits	Consolations
COTS	• Ready to use with some provided training • Readily available parts and support and high TRL	• Little flexibility with performance requirements • May not work across all platforms
Hybrid	• Selectable options gives some control over radar capabilities • Existing interfaces could be modified to support different platforms	• Not all “nice-to-have” features will be met • Longer development time to get increased functionality operational
Custom	• High control over radar requirements and performance • Direct involvement in user and product interfaces	• Custom radars require custom infrastructure and software • Requires a significant amount of time from design to operations • Platform requirements may not allow certain design choices

Evaluating Radar Deployment Feasibility

	Benefits	Consolations
COTS	• More time available to develop platform installation and deployment procedures • Can address specific objectives within existing requirements	• Will require additional field testing when used outside the original installation intent • Customizable user interfaces may not be available in the field without further development
Hybrid	• Higher functionality in operations • Wider operational bounds given some control over performance	• Added features may complicate processing or operation and require additional development • Longer lead time for deployment
Custom	• Deployable across multiple scenarios based upon design choices • Installation considerations could be part of design process	• May require long lead time for deployment with custom parts and operation • Platform limitations could negate upgraded capabilities

Big Picture Evaluation Process



Cost:

Serves a metric to understand constraints due to financial responsibility and risk across multiple design and development stages

Deployability:

Serves as a metric for the level of difficulty for deploying the asset in the field (including installation and testing)

Observability:

Serves as a metric the nature of the observing capabilities on a platform and the level of met science requirements

Radar Development Pathways Summary

COTS

- ✅ Lower cost
- ✅ Readily available
- ✅ Quicker turnaround to deployment
- ⚠ Low requirements flexibility
- ⚠ Installation and operation require more time when working with alternate platforms

Hybrid

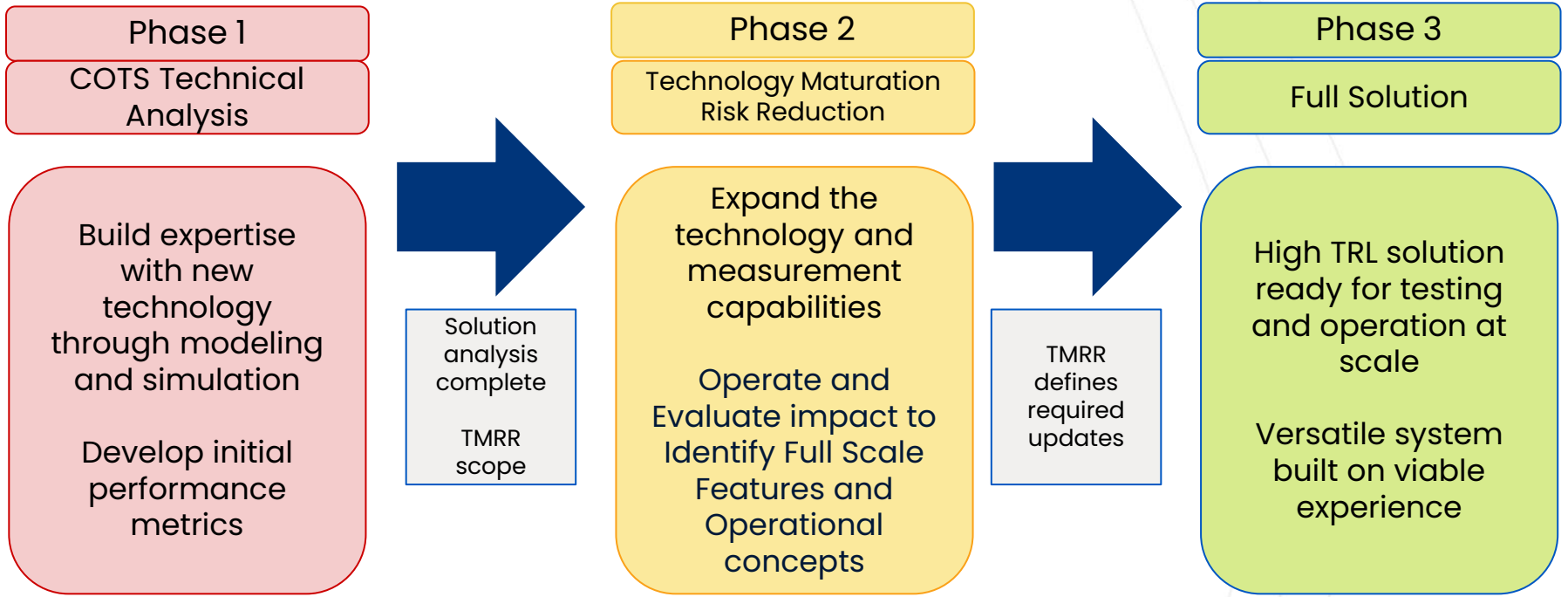
- ✅ Moderate cost
- ✅ Readily available (additional time for custom choices)
- ⚠ Deployments may change based on options
- ✅ Moderate requirements flexibility
- ⚠ Longer testing time when working with new platforms

Custom

- ⚠ High cost
- ⚠ Longer Design and Development time
- ⚠ Longer platform feasibility and deployment testing
- ✅ Requirements control
- ✅ Interface control
- ⚠ Platform implementation limited by custom design

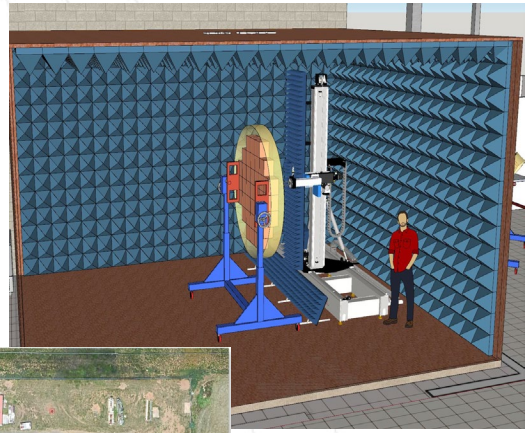
The Option of Using a Phased Approach

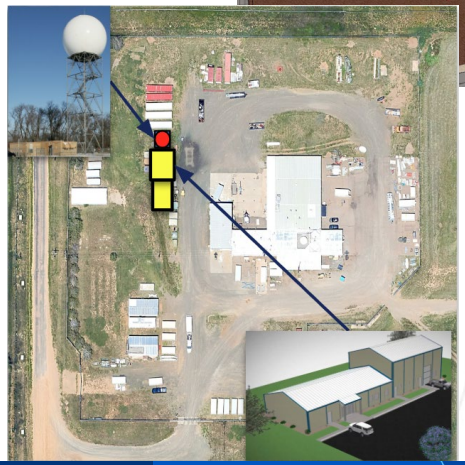
- In a phased approach, we can take advantage of COTS benefits while building expertise for a future, more versatile radar system



Radar Supporting Infrastructure

- With any radar system, periodic testing and calibration at group facilities and on the operational platform are necessary
- Costs to build test chambers or other facilities can be expensive
  - Collaboration across the community will be key
- On platform testing is also important for these radars
  - Are appropriate resources in place to handle the operational testing?





Outlook for Future Facilities

- Precipitation radars
  - New aircraft provide the opportunity to explore updated observing techniques and new technologies (Phased Array Radar)
  - Shipborne radars could benefit from use of PAR technology to monitor widespread weather systems
- Cloud radars
  - Identify new ways to utilize existing cloud radar
  - Begin testing new, high-frequency radars for more adaptive scanning
  - Determine if current aircraft or ships are appropriate for installing new high-frequency radars
- Collaboration across industries is important to diagnose needs for future radars

Discussion Topics

Here are a few ideas for us to consider as we discuss

- What are some ways the community can adapt and develop radar facilities for long-term success in a changing radar landscape?
- How can we find appropriate applications that combine the capabilities of new or existing technology with scientific needs?
- How can we better utilize or implement different weather or cloud radars on airborne or shipborne platforms in a way that addresses important science gaps?
- What is the vision for building current operations into more advanced CONOPS?
- How might we work with funding agencies to continue to support these important radar platforms?