

NASA's Surface Deformation and Change Designated Observable Architecture Study Current Status

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EARTH SYSTEM OBSERVATORY

INTERCONNECTED CORE MISSIONS

SURFACE BIOLOGY AND GEOLOGY

Earth Surface and Ecosystems

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

CCP

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

CONSENSUS STUDY REPORT

THRIVING ON OUR CHANGING PLANET

A Decadal Strategy for Earth Observation from Space



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

AEROSOLS

Particles in the Atmosphere

MASS CHANGE

Large-scale Mass Redistribution

SBG

SDC

MC

A

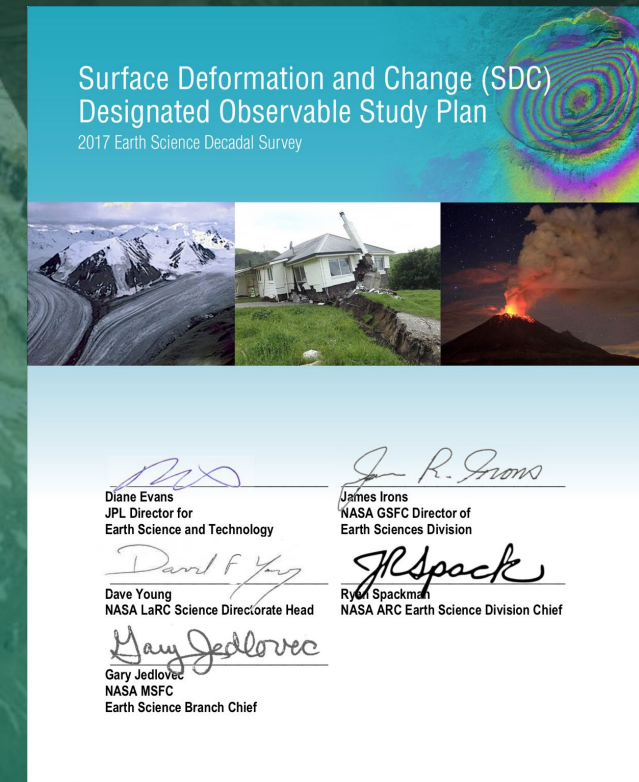
Surface Deformation and Change (SDC) Architecture Study Objectives

Determine cost-effective SAR-based architecture to implement the Decadal Survey's SDC geodetic observables

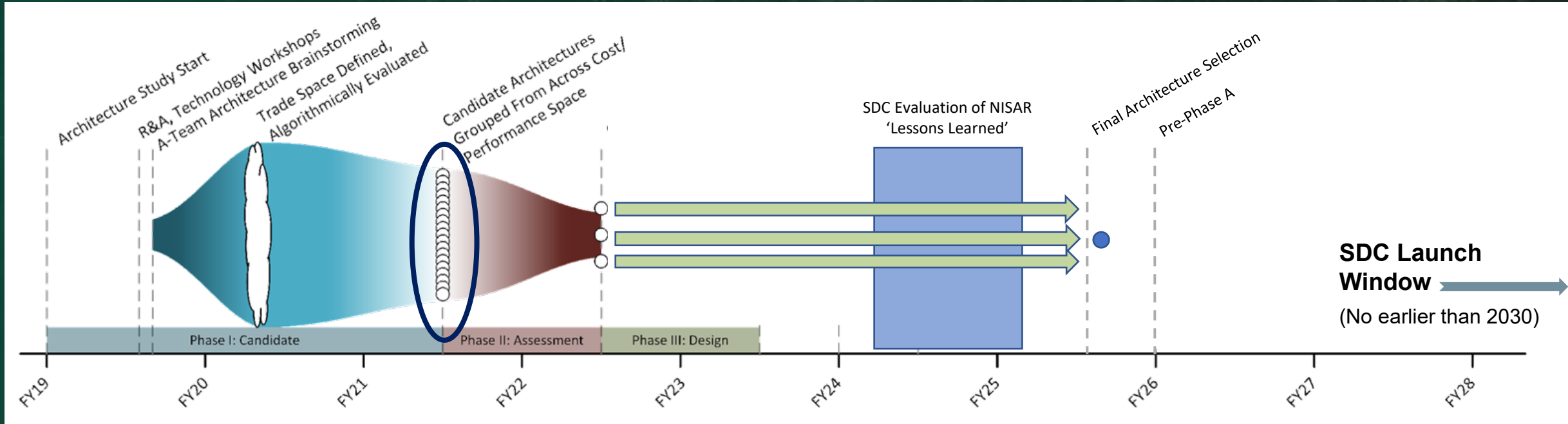
Understand the cost/benefit of other Science and Applications in the SDC trade space

Engage emerging best and new practices in industry including smallsat constellations and commercial data purchases

Explore international partnerships to leverage capability and reduce cost.



Where are we today?



- Original SDC Study Timeline

- ESO: Lessons learned from NISAR will guide the SDC architecture development and selection

- Final SDC selection will likely be mid-2025

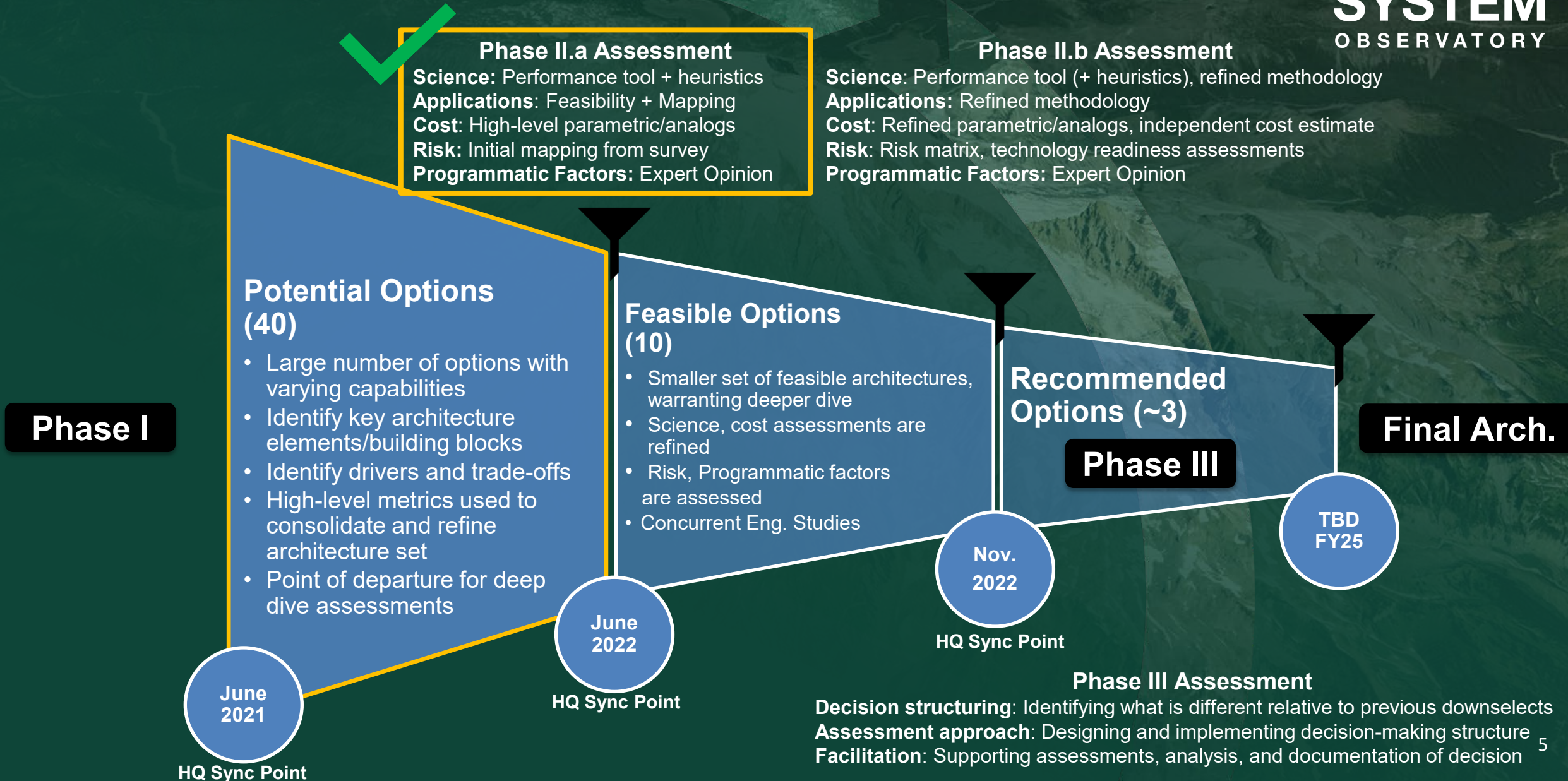
NISAR
Launch

Commissioning + 3 yrs science ops

NISAR is a “trailblazer” for the ESO

- The SDC Study Team just completed the initial downselect
- **Today we will review the SDC downselect approach and architectures that were selected.**

SDC Downselect Process (Phase II.a)



Architecture groups

Flagship

**Distributed Repeat
Track**

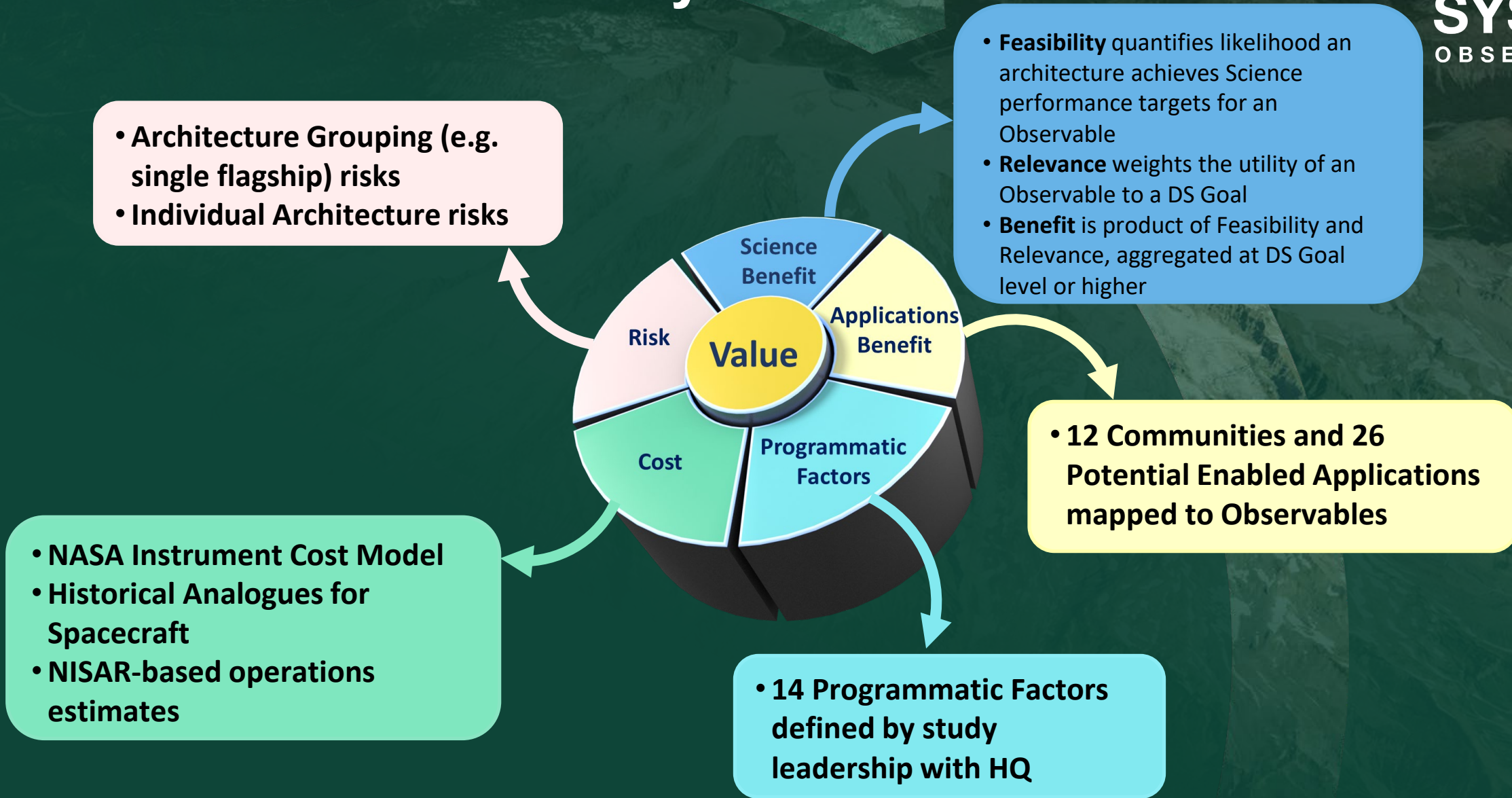
Multi-Squint Formation

Lowered Inclination

Helical Orbit Formation

**Alternative Water
Vapor Techniques**

Value in the SDC Study



Selected Architectures

Architecture	Characteristic	Orbital Phasing Groups	Pol.	Repeat Period (Days)	Per Satellite Swath (km)	Relative Cost
L1C	NISAR w/PWV inst.	1	Quad	12	240.0	2.9
L4A	2x NISAR w/ROSE-L	4	Quad	3	240.0	3.6
L5A	NISAR via 5 Smallsats	5	Dual	2/8	60.0	1.6
L6C	ROSE-L Active Multi-Squint Co-fliers	2	Single	6	80.0*	1.0
L6E	ROSE-L Passive Multi-Squint Co-fliers	2	Dual	6	80.0*	2.0
L8A	Sub-Daily Repeat	1	Dual	0.25/12	30.0	2.1
L9A	NISAR via Multi-Squint Co-fliers	3	Dual	4/12	80.0	2.4
L12B	Multi-Baseline Helical Orbit	2	Dual	6	40.0	2.3
L12C	Fast Revisit Low Cost per Sat.	12	Single	1/4	60.0	1.8
L18A	Multi-Squint Low Cost per Sat.	6	Single	2/8	60.0	2.2

*Reported swath is for the co-fliers, not ROSE-L.

Architecture Science Benefit scores per Focus Area

Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
L1A	0.74	0.82	0.57	0.70	0.56
L1B	0.74	0.82	0.57	0.70	0.56
L1C	0.73	0.82	0.57	0.75	0.57
L2A	0.76	0.84	0.59	0.79	0.59
L2B	0.74	0.82	0.57	0.77	0.57
L3A	0.69	0.76	0.55	0.73	0.62
L4A	0.78	0.85	0.60	0.80	0.63
L4B	0.69	0.74	0.54	0.73	0.65
L4C	0.26	0.77	0.56	0.61	0.56
L5A	0.71	0.78	0.57	0.78	0.72
L6A	0.69	0.76	0.54	0.69	0.70
L6B	0.69	0.76	0.55	0.76	0.60
L6C	0.69	0.74	0.54	0.76	0.56
L6D	0.69	0.79	0.53	0.69	0.56
L6F	0.26	0.79	0.57	0.67	0.60
L6E	0.69	0.74	0.54	0.76	0.56
L9A	0.69	0.74	0.54	0.76	0.62
L12B	0.71	0.80	0.54	0.78	0.59
L12C	0.63	0.50	0.51	0.75	0.79
L18A	0.62	0.50	0.50	0.74	0.58
L18B	0.62	0.50	0.50	0.74	0.58

Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
S1A	0.72	0.79	0.56	0.70	0.56
S1B	0.72	0.79	0.56	0.70	0.56
S2A	0.74	0.81	0.57	0.78	0.59
S2B	0.72	0.79	0.56	0.77	0.58
S3A	0.67	0.74	0.54	0.73	0.65
S4B	0.67	0.72	0.52	0.73	0.65
S4C	0.24	0.74	0.54	0.61	0.56
S6A	0.62	0.72	0.51	0.70	0.69
S6B	0.70	0.78	0.55	0.76	0.62
S5A	0.69	0.75	0.55	0.78	0.72
S6D	0.69	0.79	0.53	0.69	0.56
S9A	0.67	0.72	0.52	0.75	0.62
S12B	0.67	0.72	0.52	0.75	0.62
S6F	0.24	0.76	0.55	0.67	0.60
S12C	0.61	0.47	0.49	0.75	0.79
S18A	0.60	0.47	0.49	0.74	0.58
S18B	0.60	0.47	0.49	0.74	0.58
C6C	0.66	0.80	0.51	0.75	0.58
C4A	0.70	0.78	0.55	0.73	0.59

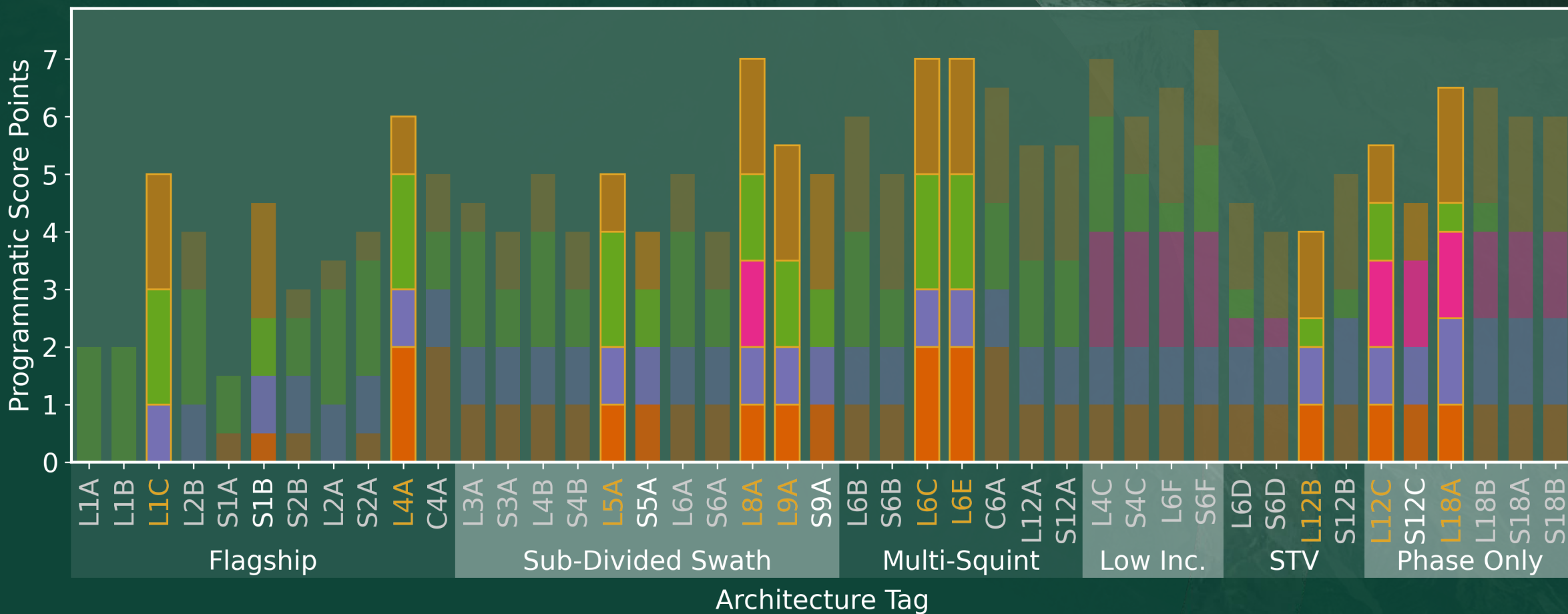
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L18B	0.62	0.50	0.50	0.74	0.58

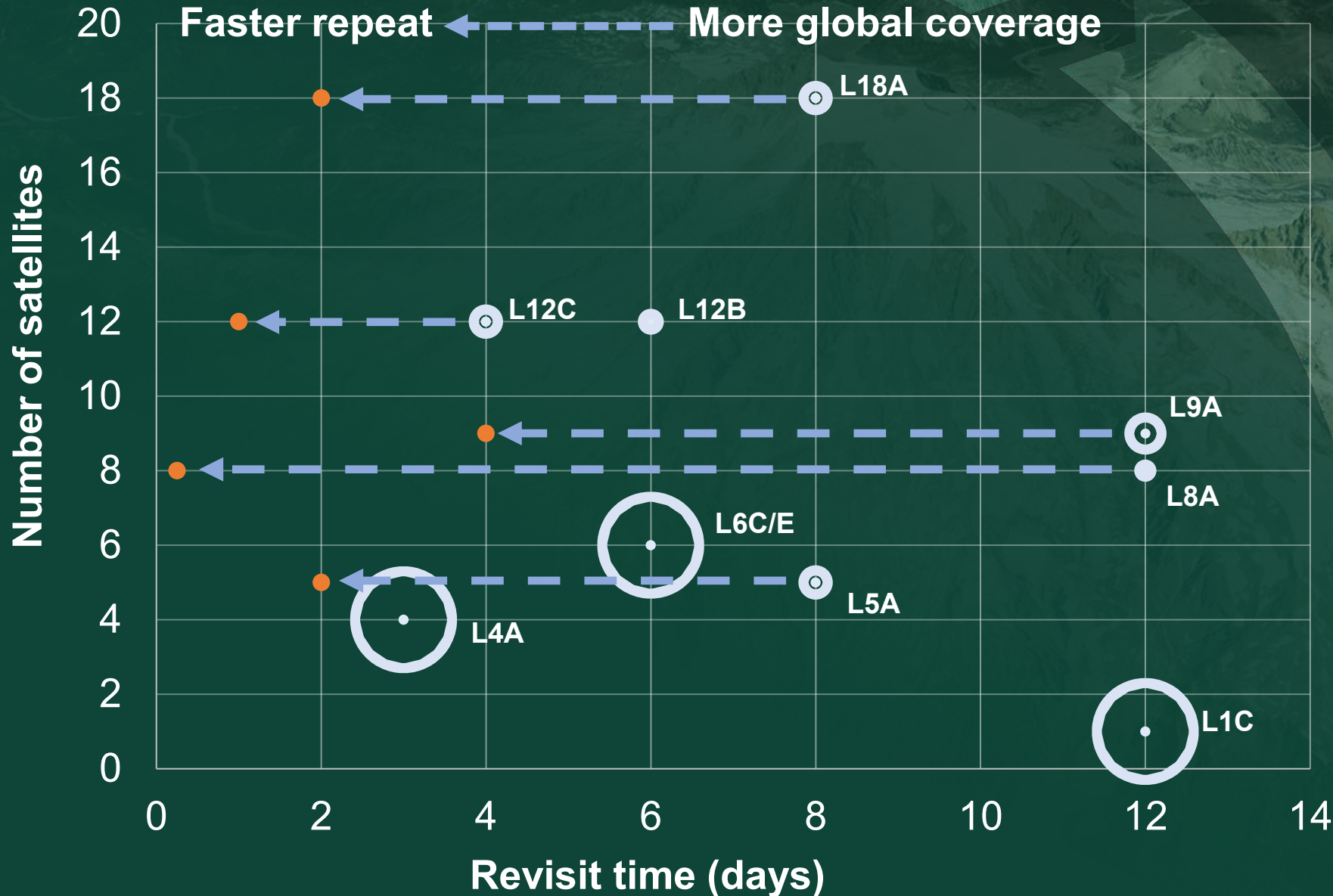
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S5A	0.69	0.75	0.55	0.78	0.72
S6D	0.69	0.79	0.53	0.69	0.56
S9A	0.67	0.72	0.52	0.75	0.62
S12B	0.67	0.72	0.52	0.75	0.62
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C6C	0.66	0.80	0.51	0.75	0.58
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Programmatic Comparison

- Leveraging Int'l Participation
- Leveraging US Agencies
- Opportunities for Leveraging Commercial Data
- Continuity with Program of Record
- Enhanced Science Return

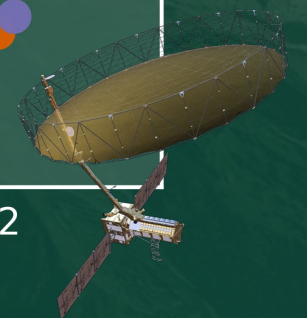
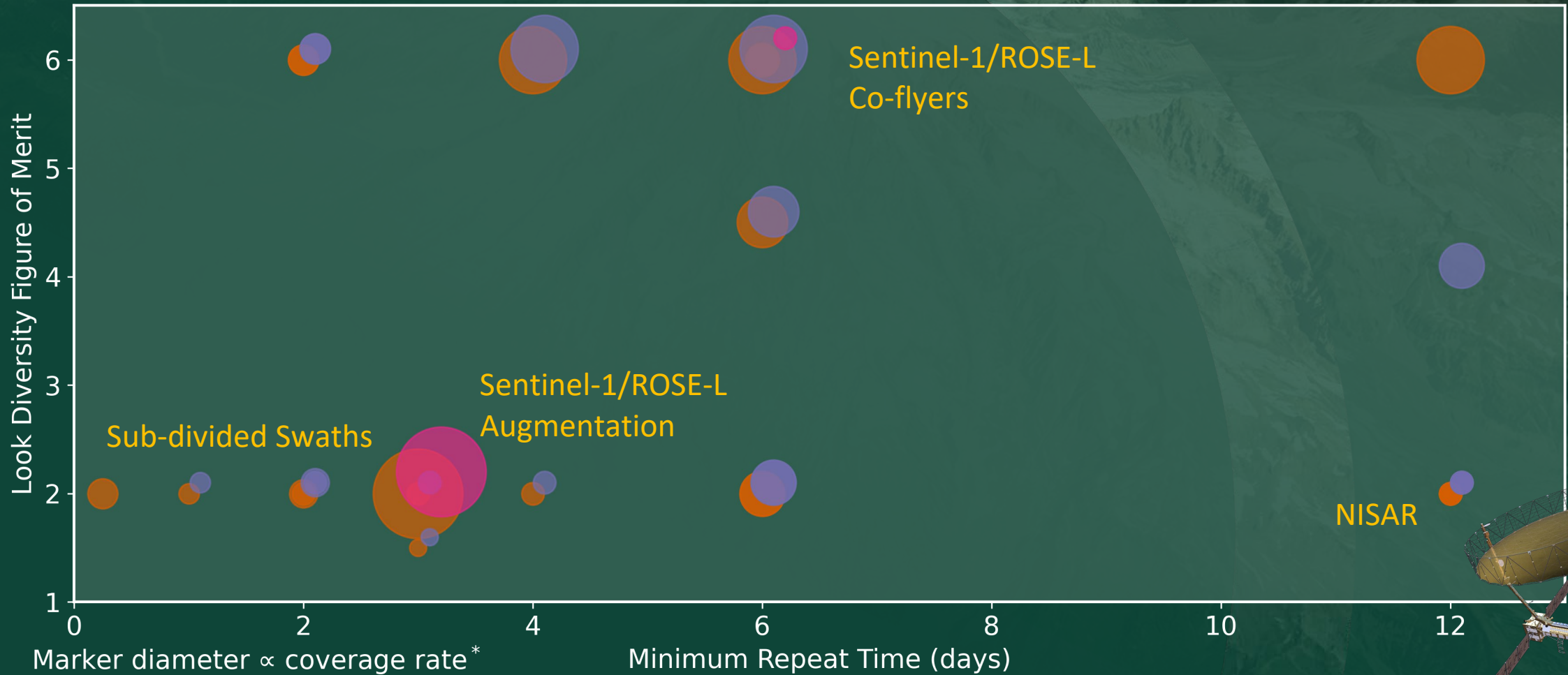


Revisit time vs # of satellites and swath width



Look Diversity vs. Coverage

● L-band ● S-band ● C-band



Selected Architectures - Deformation Science Perspective

Architecture	Characteristic	Continuity	Improved accuracy	Rapid repeat sampling	Level of Improvement
L1C	<i>NISAR w/PWV inst.</i>	Large	Medium	Medium	Large
L4A	<i>2x NISAR w/ROSE-L</i>	Large	Small	Medium	Medium
L5A	<i>NISAR via 5 Small Sats.</i>	Large	Medium	Medium	Medium
L6C	<i>ROSE-L Active Multi-Squint Co-fliers</i>	Large	Large	Medium	Medium
L6E	<i>ROSE-L Passive Multi-Squint Co-fliers</i>	Large	Large	Medium	Small
L8A	<i>Sub-Daily Repeat</i>	Large	Medium	Small	Large
L9A	<i>NISAR via Multi-Squint Co-fliers</i>	Large	Large	Medium	Small
L12B	<i>Multi-Baseline Helical Orbit</i>	Medium	Small	Medium	Medium
L12C	<i>Fast Revisit Low Cost per Sat.</i>	Large	Medium	Small	Small
L18A	<i>Multi-Squint Low Cost per Sat.</i>	Large	Medium	Medium	Small

Level of Improvement

Large

Medium

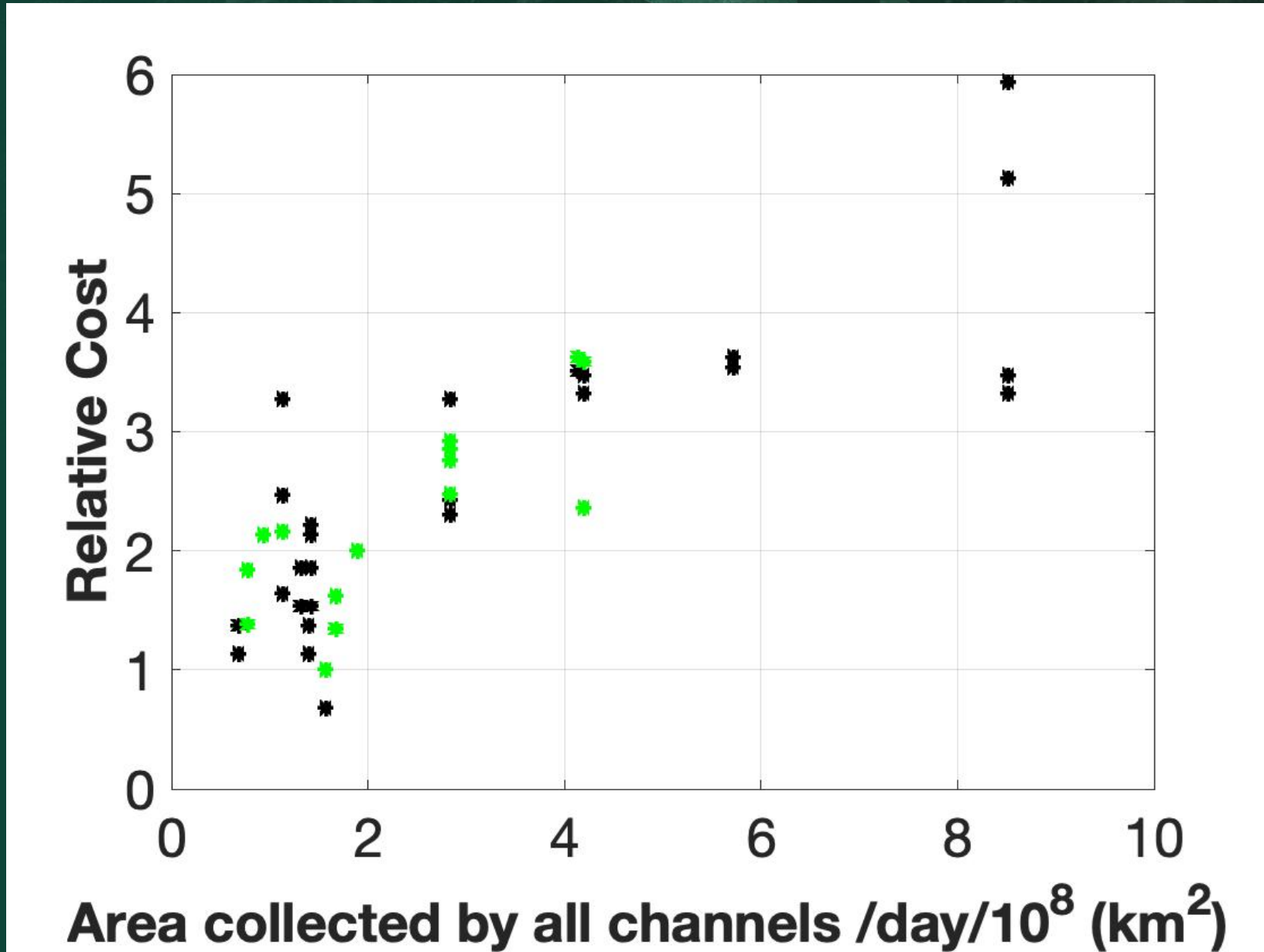
Small

NISAR-like

Selected Architectures – Radiometric-based Science Perspective

Architecture	Characteristic	Continuity	Improved accuracy	Rapid repeat sampling	Level of Improvement
L1C	<i>NISAR w/PWV inst.</i>	Large	No	No	Large
L4A	<i>2x NISAR w/ROSE-L</i>	Large	Small	Medium	Large
L5A	<i>NISAR via 5 Small Sats.</i>	Large	No	Medium	Medium
L6C	<i>ROSE-L Active Multi-Squint Co-fliers</i>	Large	Small	No	Small
L6E	<i>ROSE-L Passive Multi-Squint Co-fliers</i>	Large	Small	No	Small
L8A	<i>Sub-Daily Repeat</i>	Large	Medium	Medium	Small
L9A	<i>NISAR via Multi-Squint Co-fliers</i>	Large	Small	Medium	NISAR-like
L12B	<i>Multi-Baseline Helical Orbit</i>	Medium	Medium	No	No
L12C	<i>Fast Revisit Low Cost per Sat.</i>	No	No	No	No Polarimetry
L18A	<i>Multi-Squint Low Cost per Sat.</i>	No	No	No	No Polarimetry

Relative cost vs. area collected



Summary

- We have completed a value framework to quantitatively assess system architectures against a variety of science, applications and programmatic requirements.
- Applied the framework to 40 architectures and selected 10 L-band architectures for further study.
 - We eliminated low-inclination orbits.
 - Remaining architectures span from small satellites to flagships
- Partnerships add significant value to the SDC mission.
- Exploring the specifics of partnerships is becoming important at this point of the study.
 - Engaging with industry in co-development possibilities
 - We are open to dialogue for all options.

Thank you!

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