SKA Software Development

Scaling agile software development processes around the world

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Juande Santander-Vela on behalf of SKAO

Workshop on Open-Source SW Lifecycles, 2020-07-24

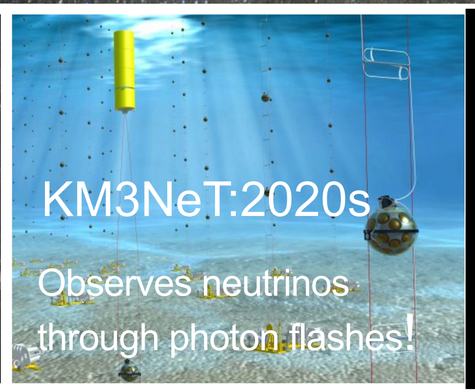
Talk Outline

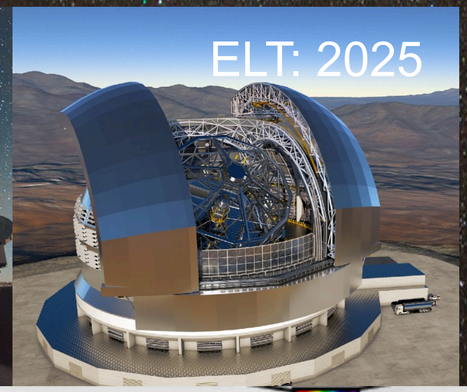
- The Square Kilometre Array Observatory
- Software at the core of the SKA Observatory
- The need for scaling software development
- Selecting and prototyping SAFe®
- Future Work!

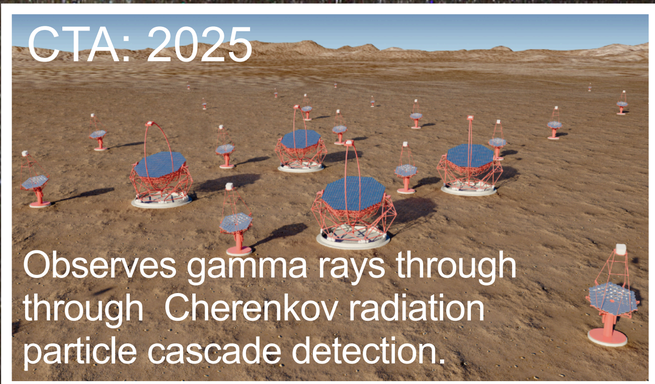
The Square Kilometre Array Telescopes & Observatory

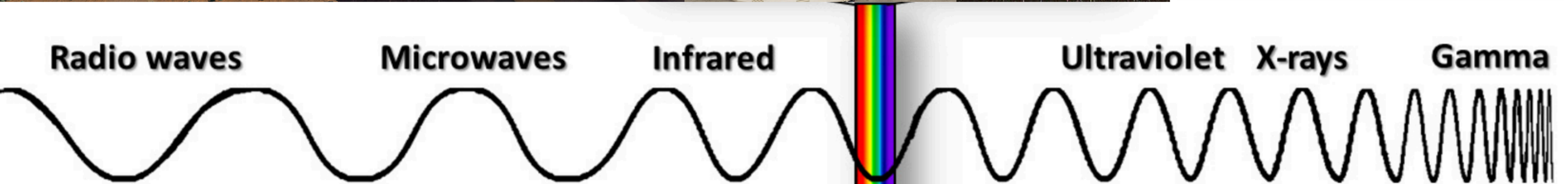
Or why and how do we get 1 km^2 of collecting area?
And can we find a (radio) quiet place for it?

21st Century Observatories

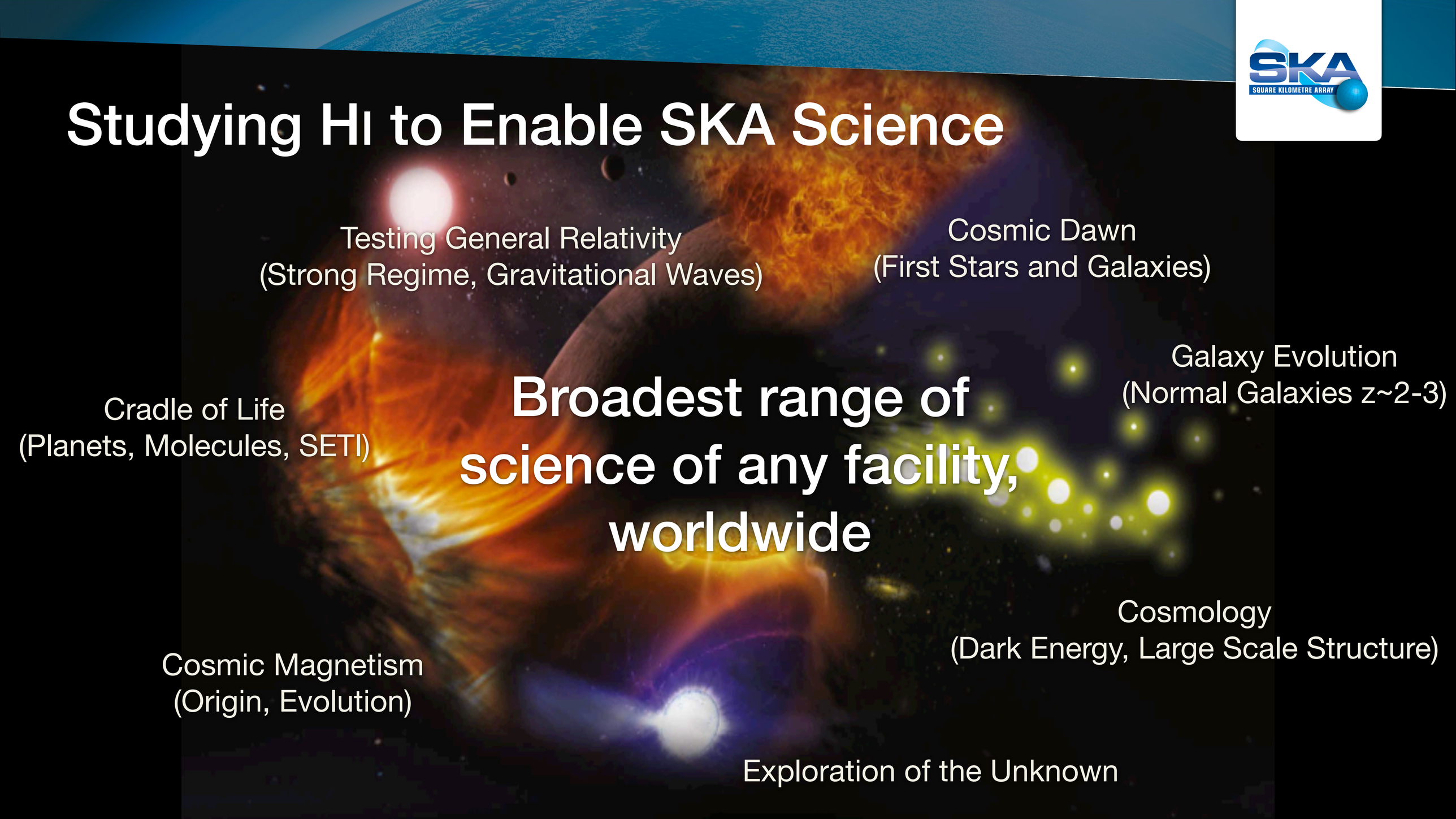








Studying HI to Enable SKA Science



Testing General Relativity
(Strong Regime, Gravitational Waves)

Cosmic Dawn
(First Stars and Galaxies)

Galaxy Evolution
(Normal Galaxies z~2-3)

Cradle of Life
(Planets, Molecules, SETI)

Broadest range of science of any facility, worldwide

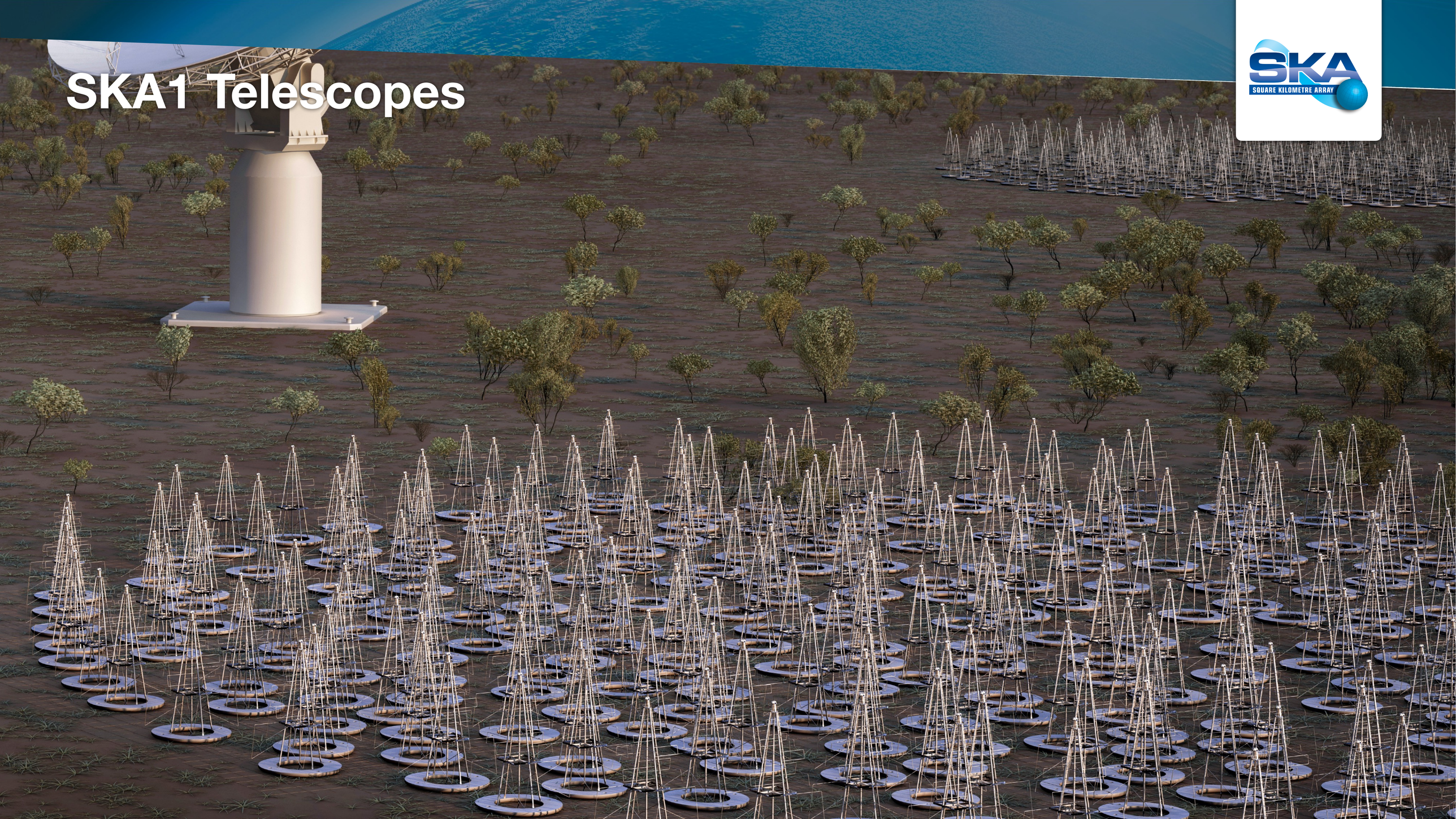
Cosmology
(Dark Energy, Large Scale Structure)

Cosmic Magnetism
(Origin, Evolution)

Exploration of the Unknown

SKA1 Telescopes

SKA1 Telescopes

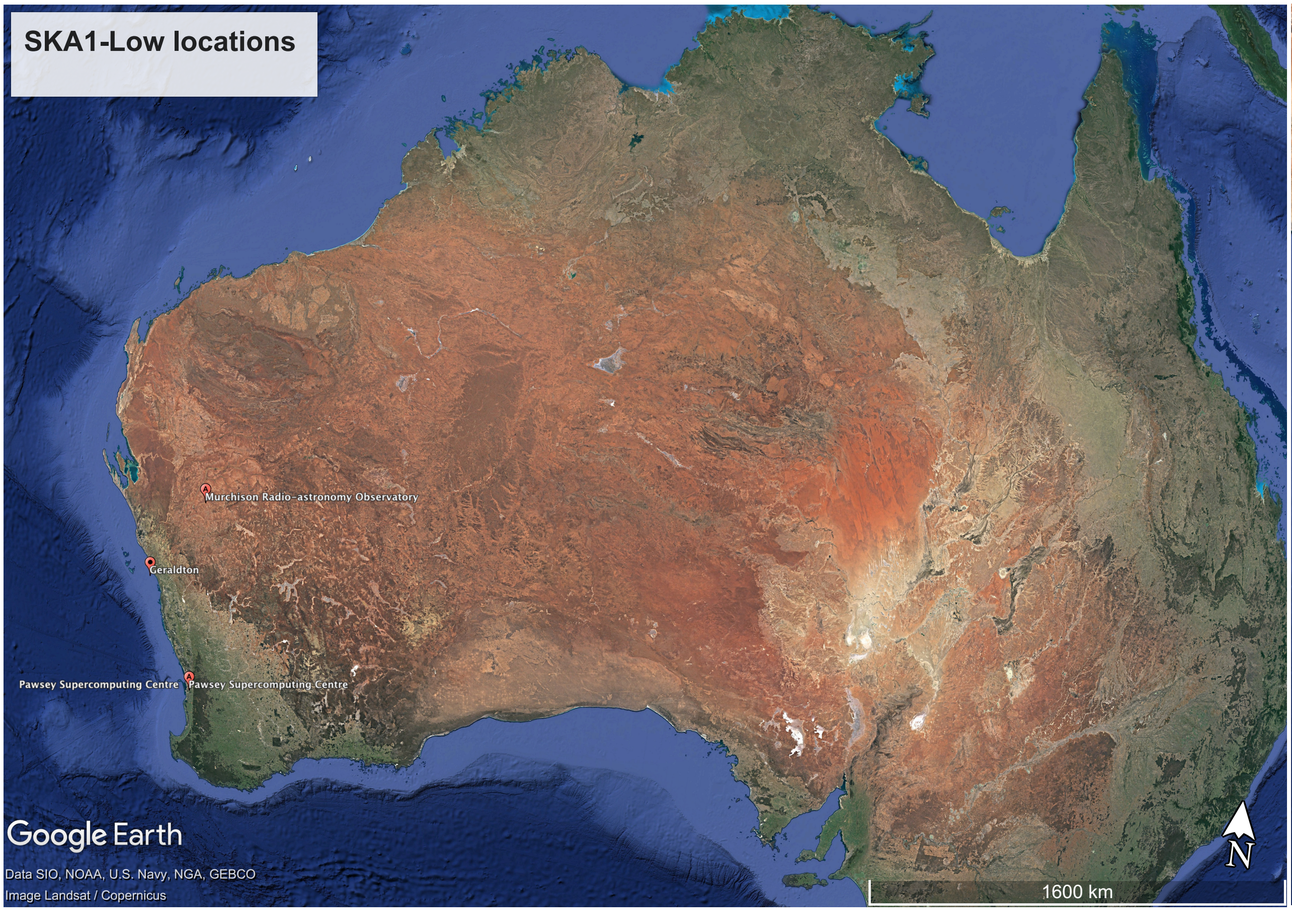


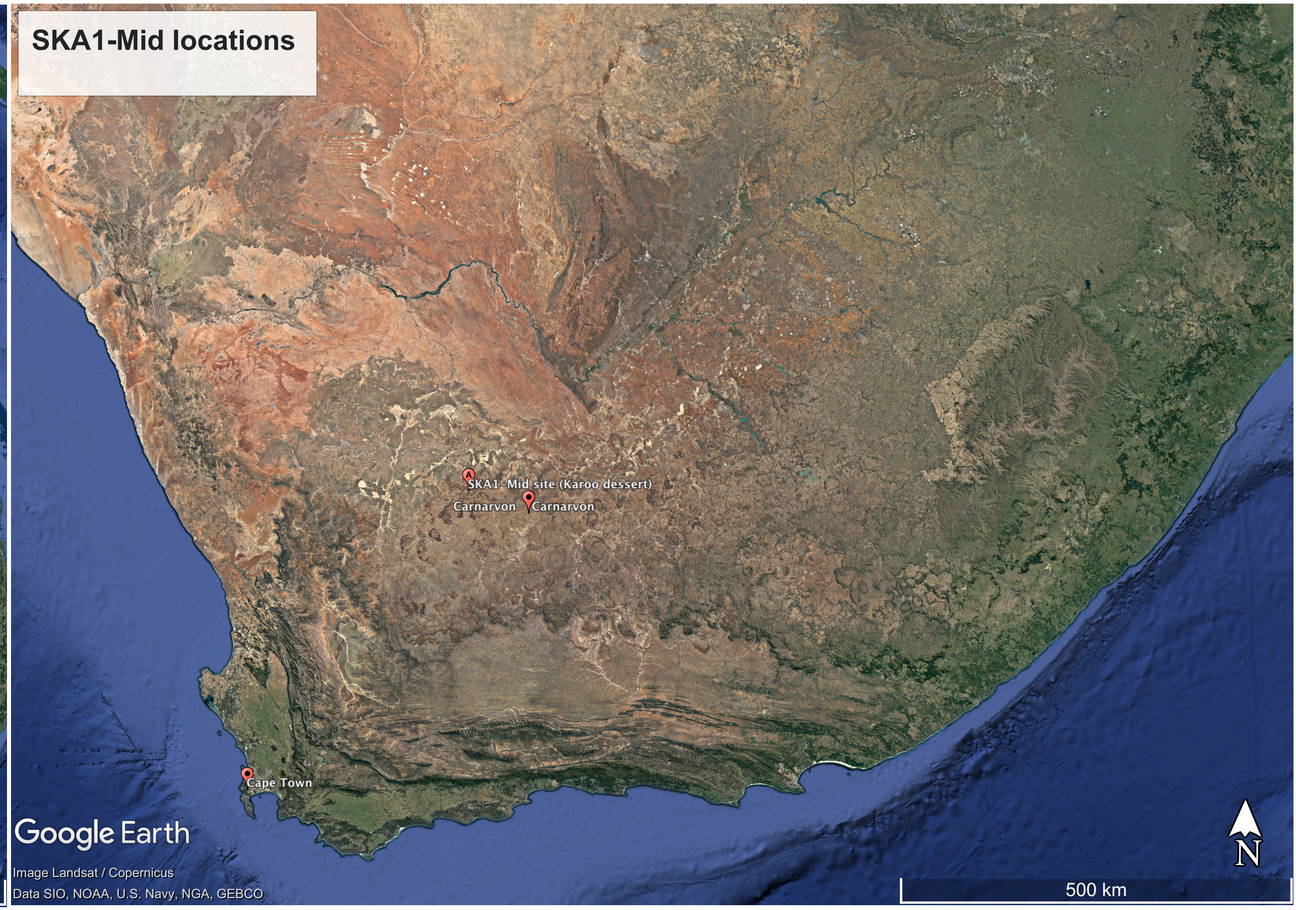
SKA1 Telescopes

Two world-leading telescopes

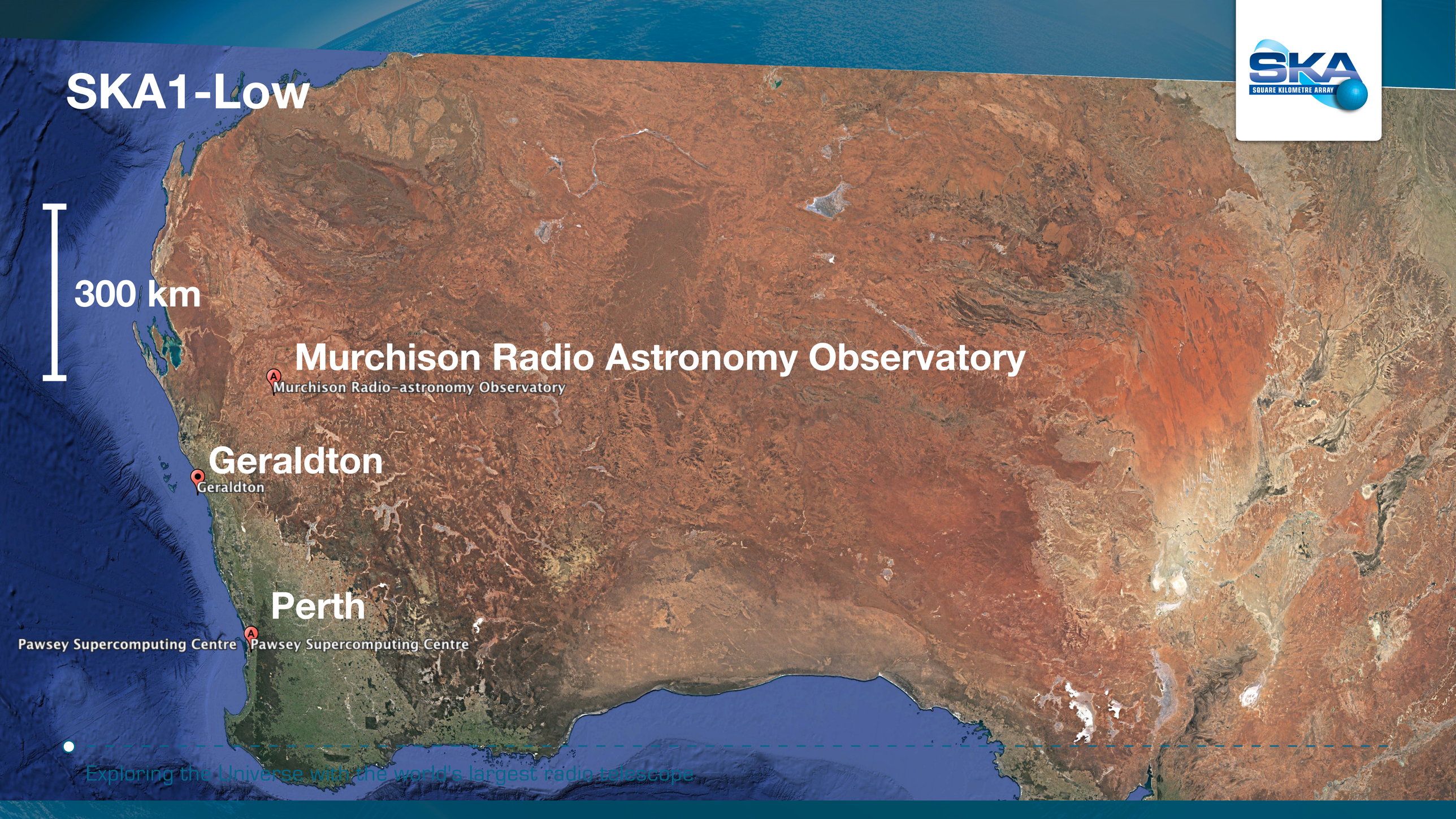
Acting as world-leading observatory

SKA1 Sites

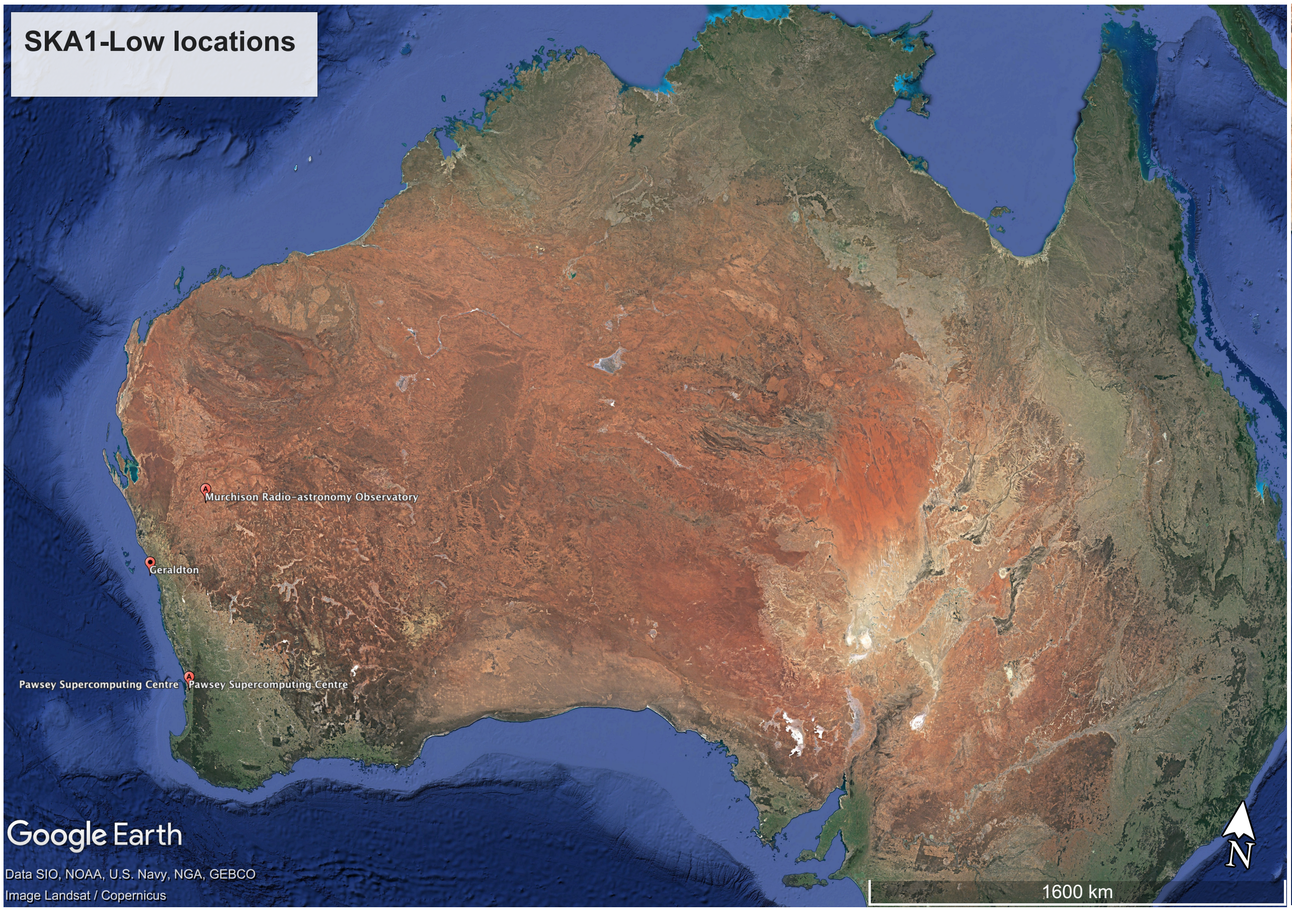


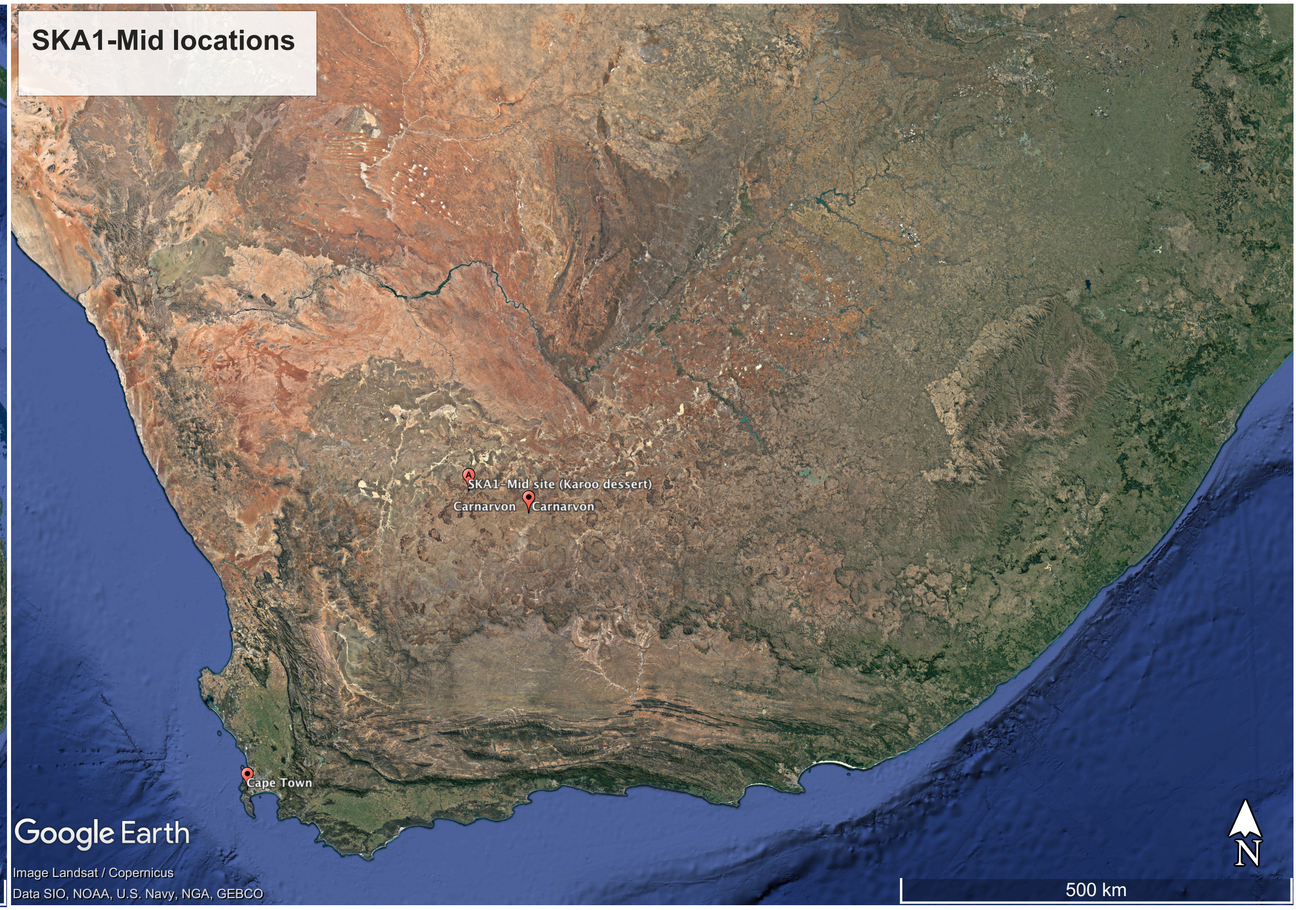


Exploring the Universe with the world's largest radio telescope

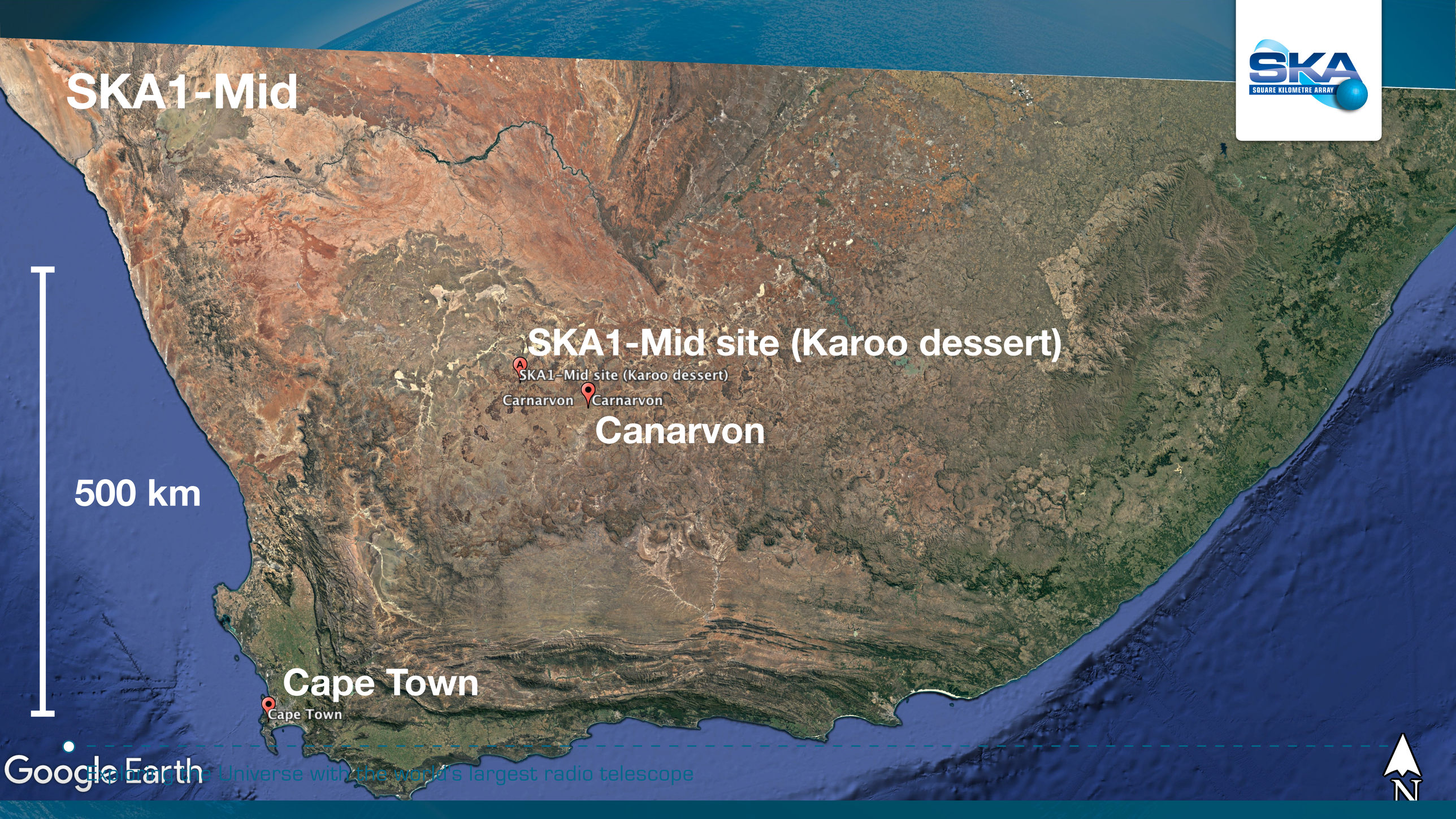

SKA1-Low
300 km
Murchison Radio Astronomy Observatory
Murchison Radio-astronomy Observatory
Geraldton
Geraldton
Perth
Pawsey Supercomputing Centre
Pawsey Supercomputing Centre
SKA
SQUARE KILOMETRE ARRAY
Exploring the Universe with the world's largest radio telescope

SKA1 Sites





Exploring the Universe with the world's largest radio telescope


SKA1-Mid
SKA1-Mid site (Karoo dessert)
SKA1-Mid site (Karoo dessert)
Carnarvon
Carnarvon
Canarvon
500 km
Cape Town
Cape Town
Google Earth
Unveiling the Universe with the world's largest radio telescope
N

Both sites have stringent Radio Quiet Zone regulations!

And we have a 50 years operational lifetime!

SKA Organisation

- Australia (DoI&S)
- Canada (NRC-HIA)
- China (MOST)
- France (CNRS)
- Germany (MPI)
- India (DAE)
- Italy (INAF)
- Netherlands (NWO)
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- Portugal
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- Spain (MICINN)
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- UK (BEIS/STFC)

In discussions with:

- Switzerland
- Japan
- South Korea

SKA Members
*SKA Observatory founding members

African Partner Countries

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In the process of becoming an Inter-Governmental Organisation

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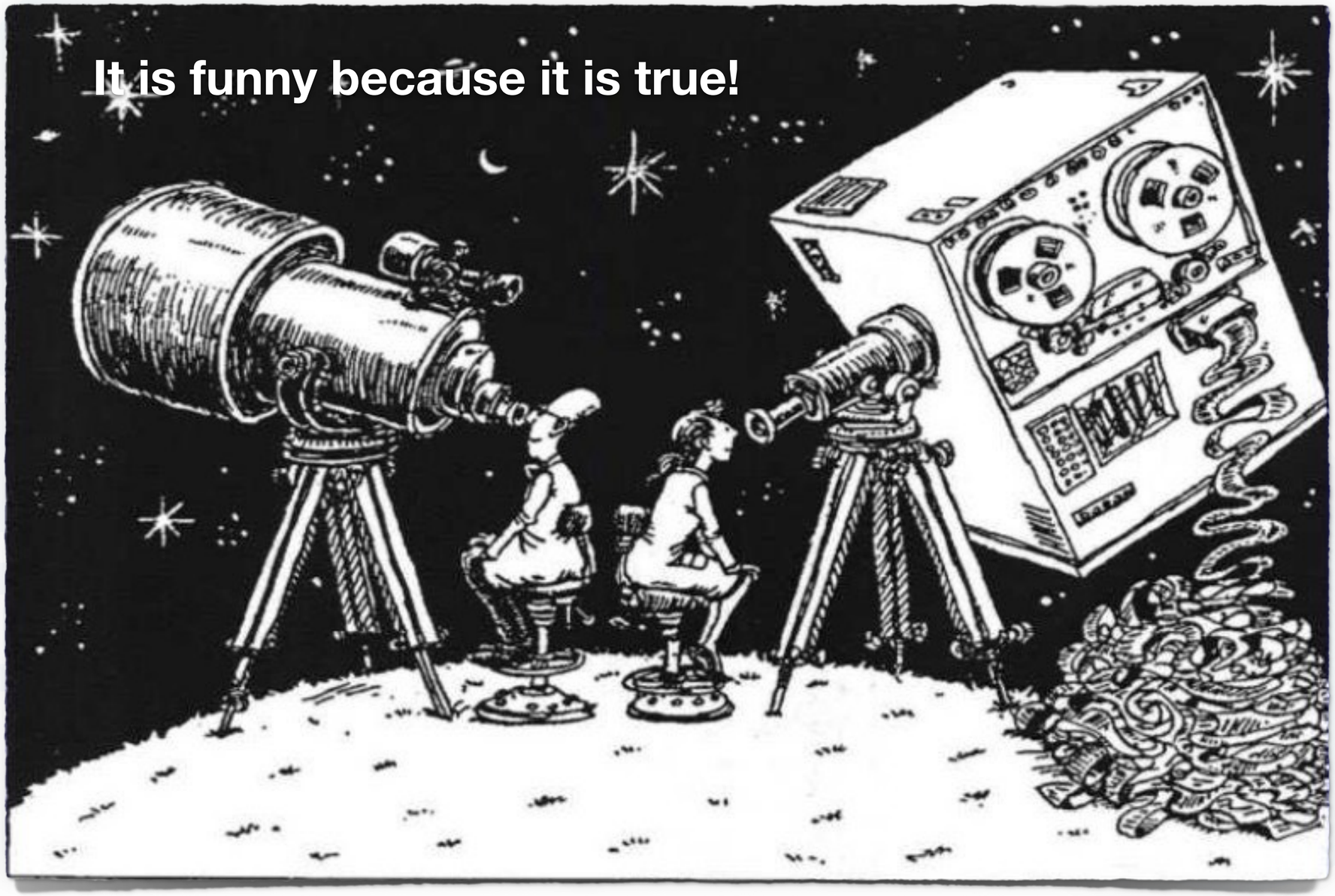
Treaty signed: Rome, 12 March 2019

And we passed System CDR in Dec 2019!

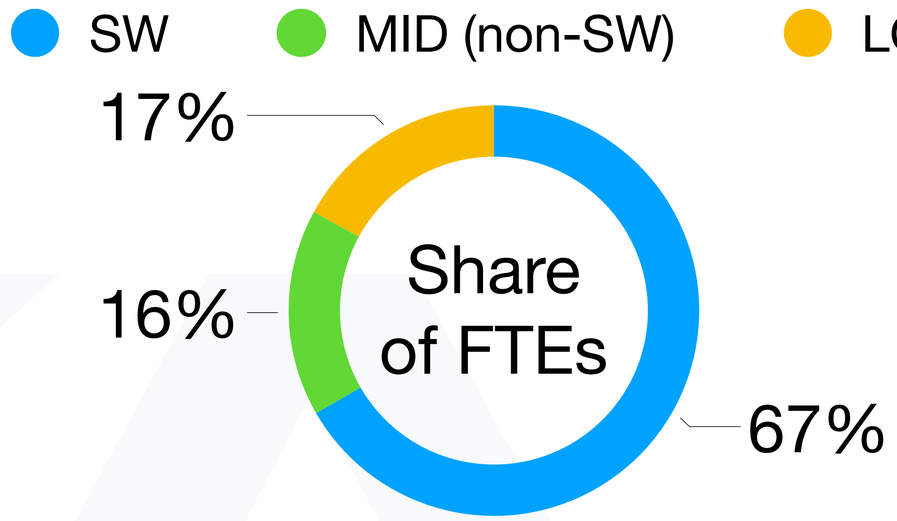
Software at the core of the SKA Observatory

Or how do we massage radio photons with software?


It is funny because it is true!

Software is at the core of the SKA1 Observatory and telescopes

100 FTEs/year during bridging

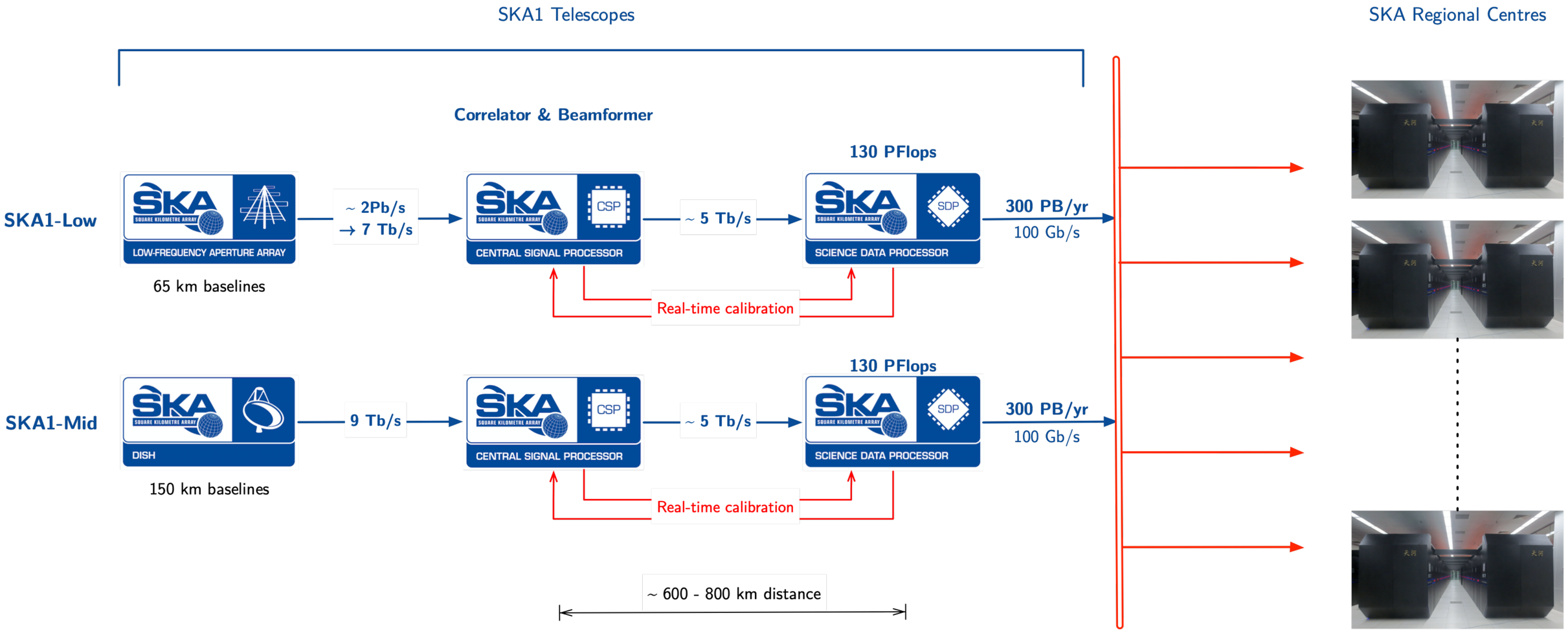


Software is at the core of the SKA1 Observatory and telescopes

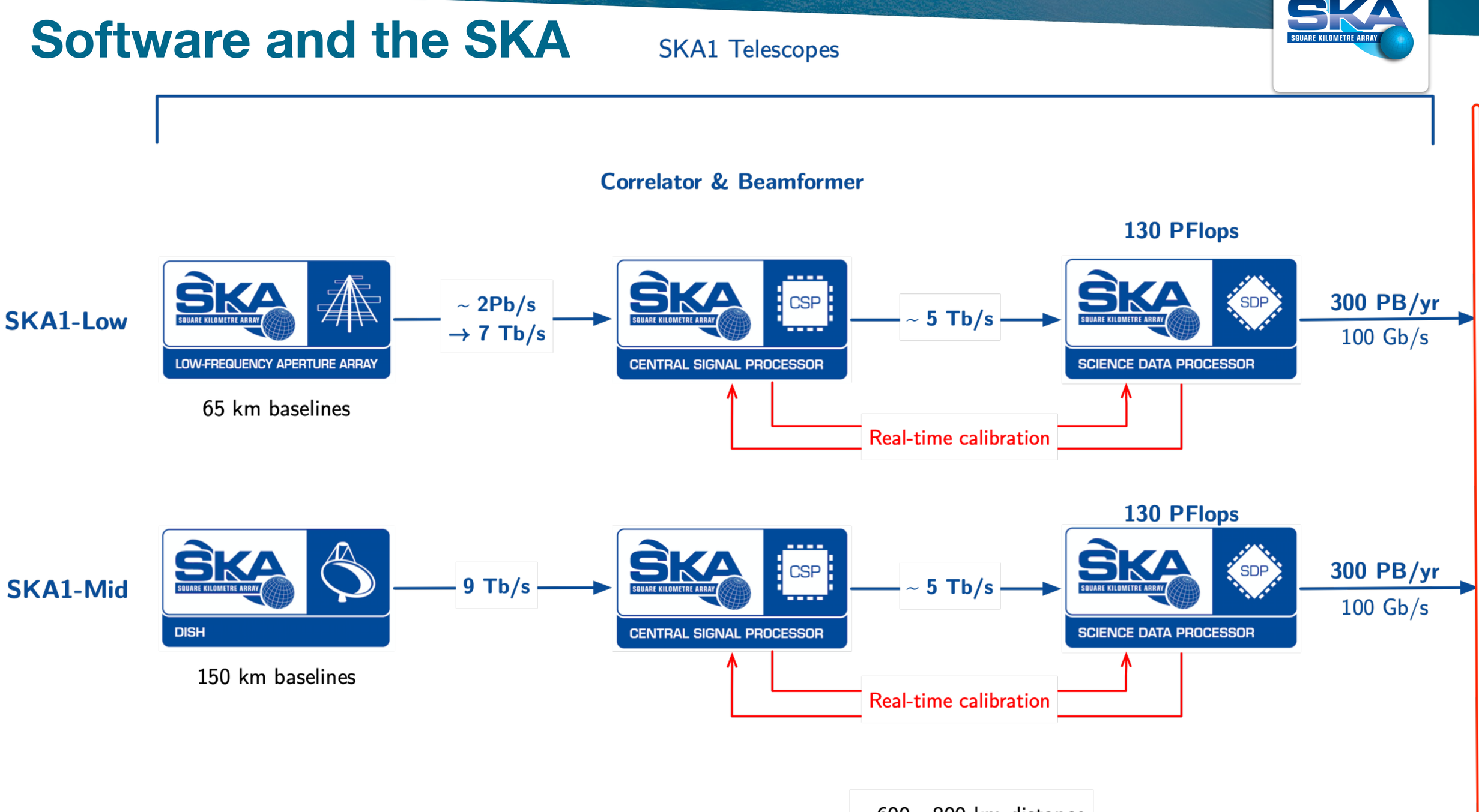
100 FTEs/year for Data Processing

~50% total construction budget for SW

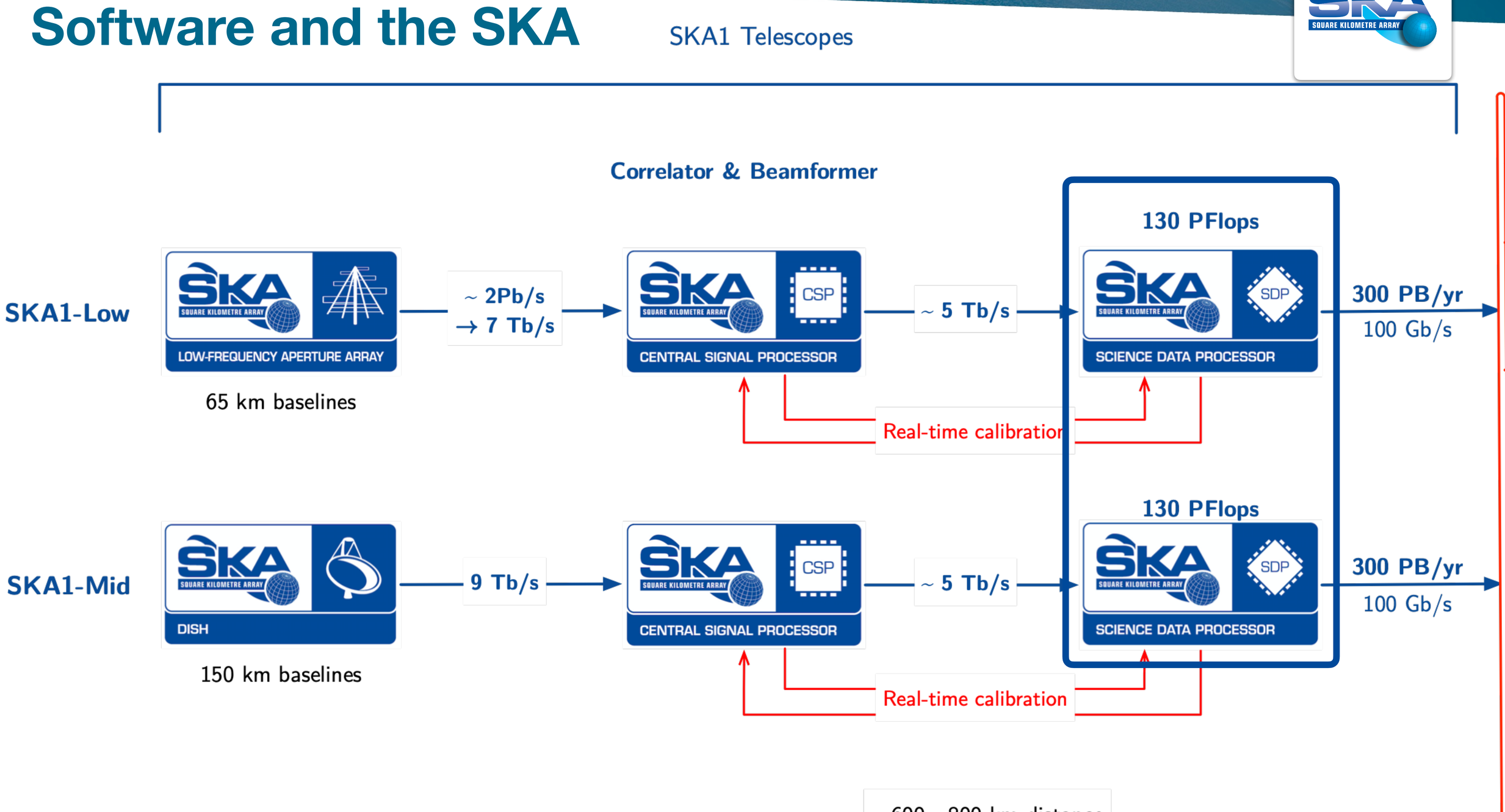
Software and the SKA



Software and the SKA

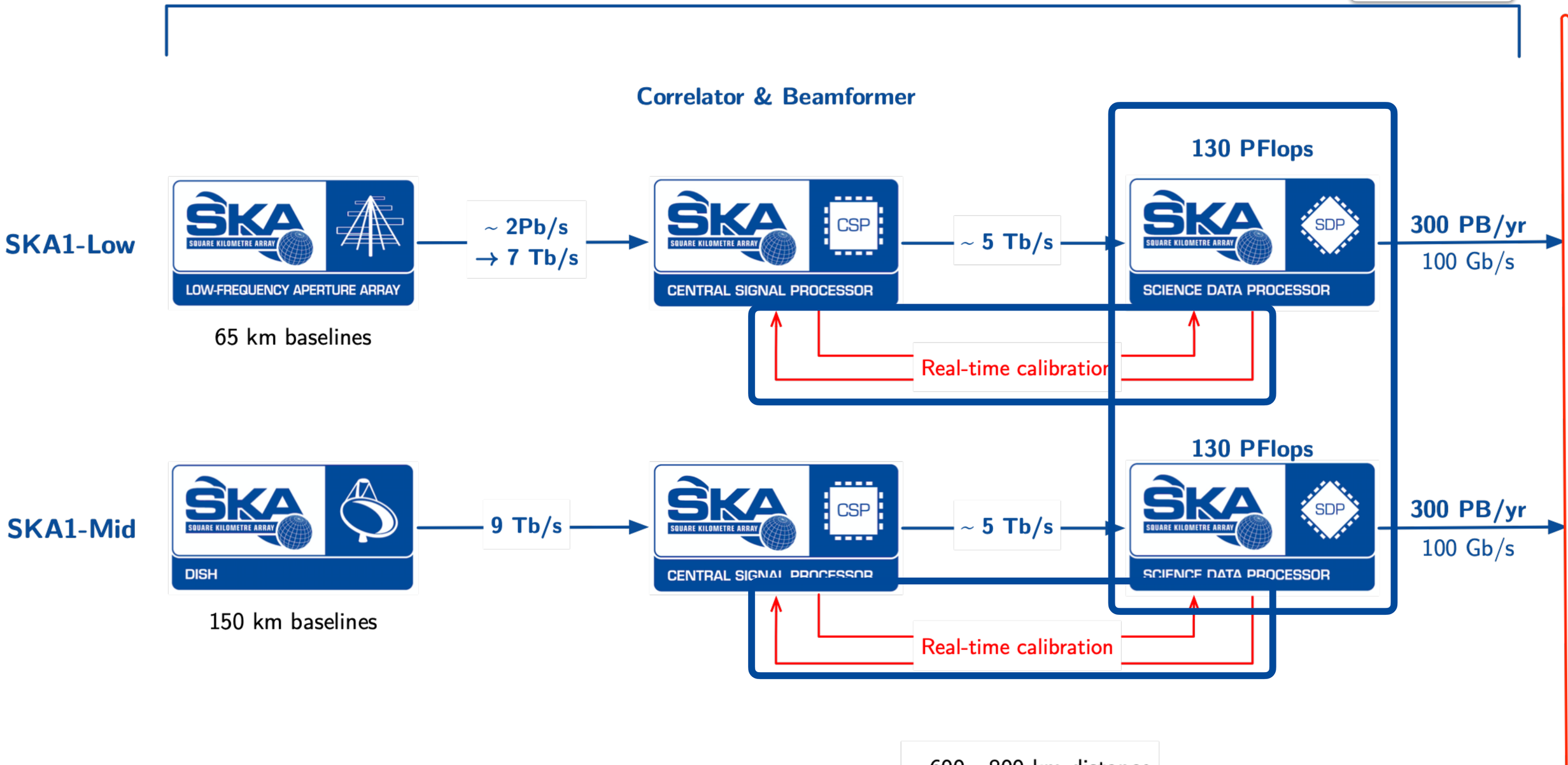


Software and the SKA

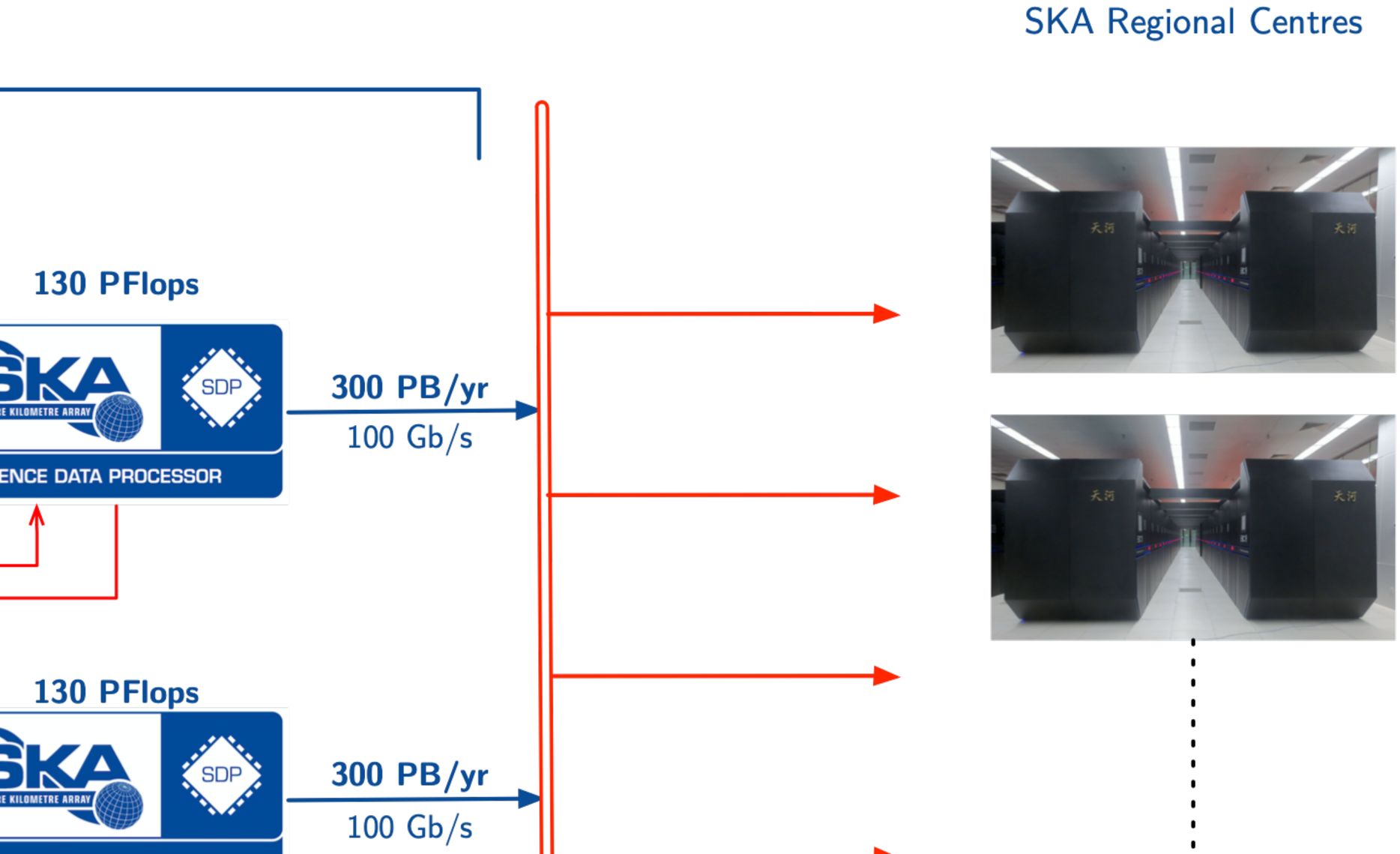


Software and the SKA

SKA1 Telescopes



Software and the SKA



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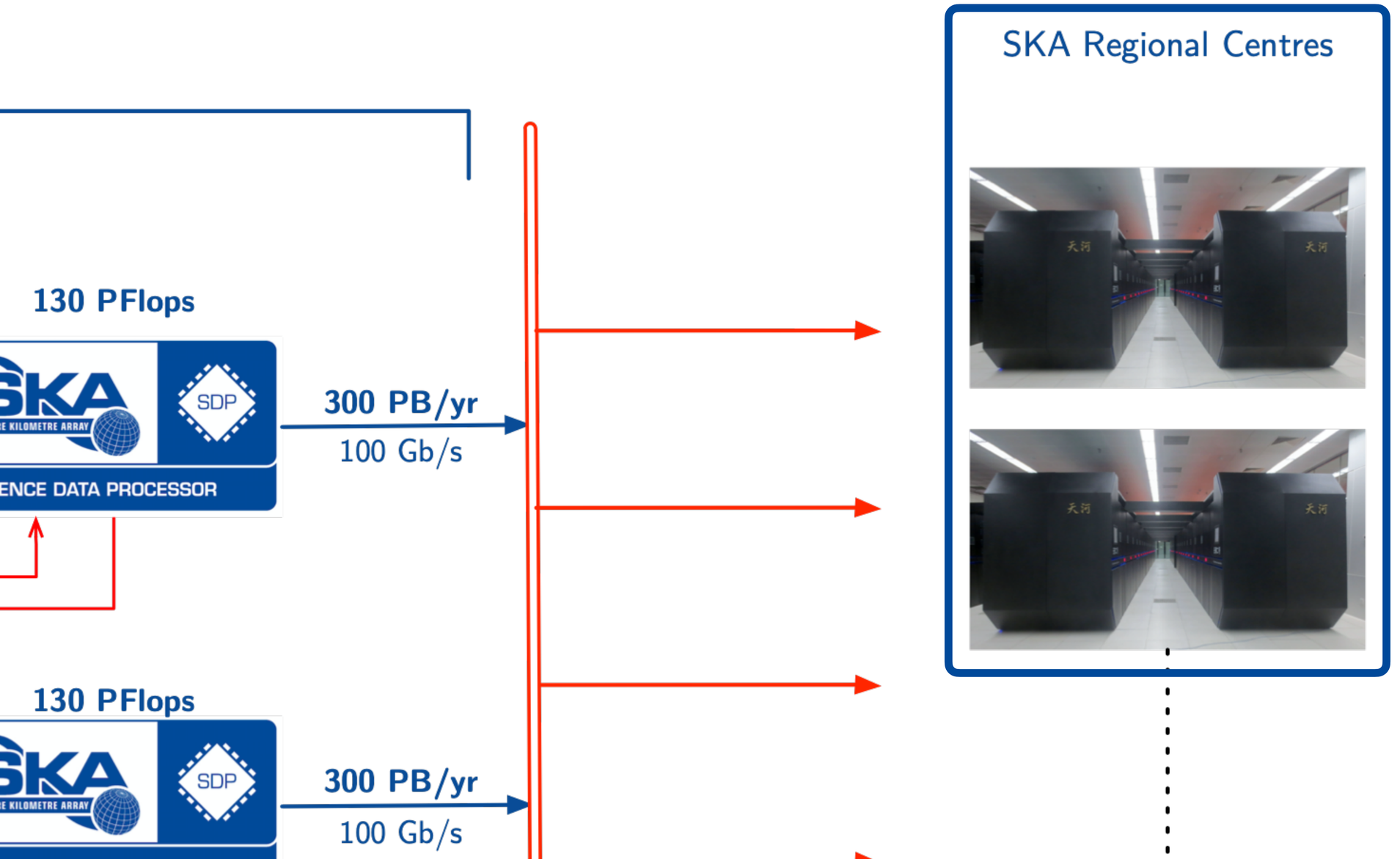

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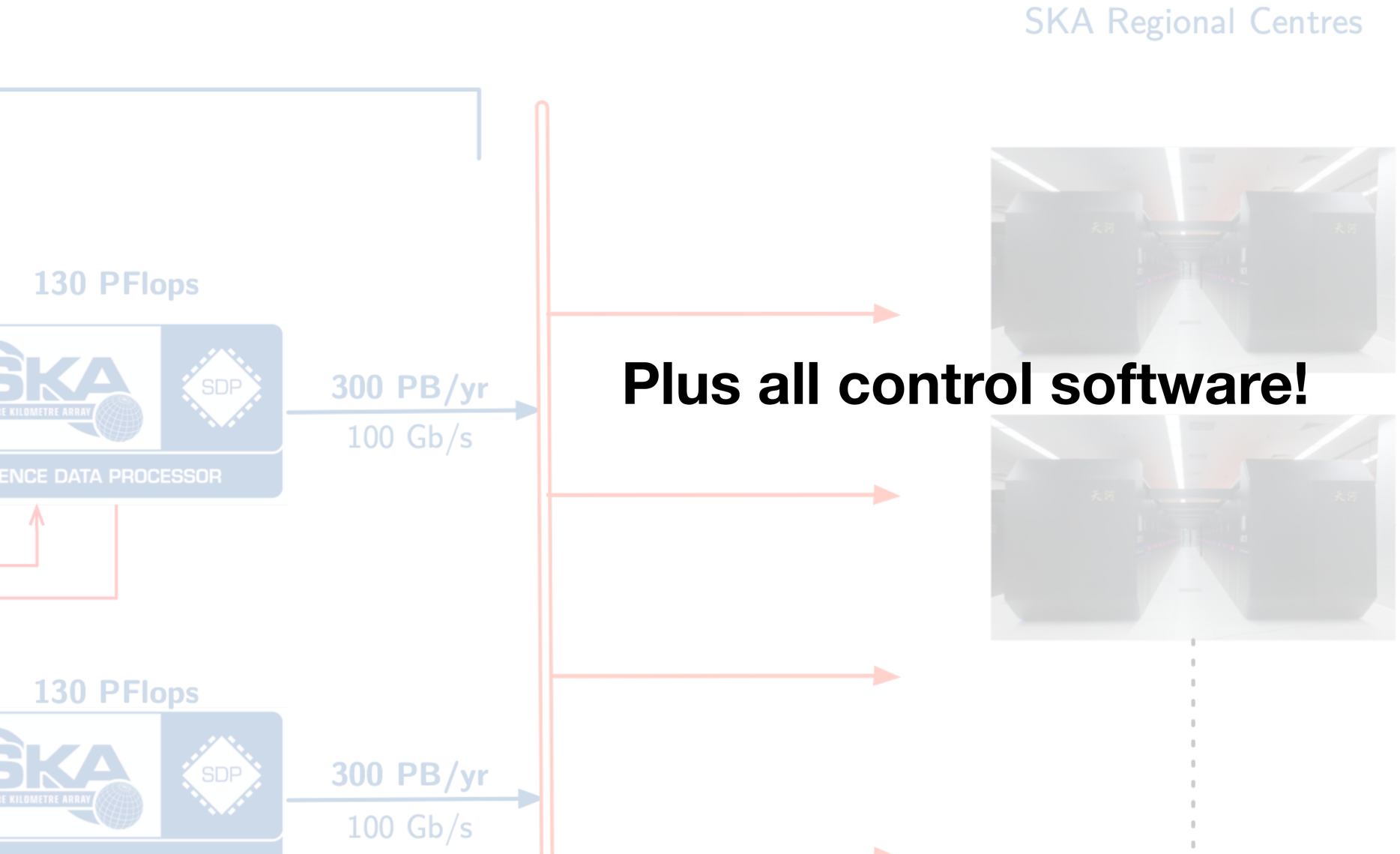

Plus all control software!

All of this with Open Source and Open Development!

The need for scaling software development

Or how to bring autonomy and alignment to hundreds of people.

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*SKA Observatory founding members

African Partner Countries

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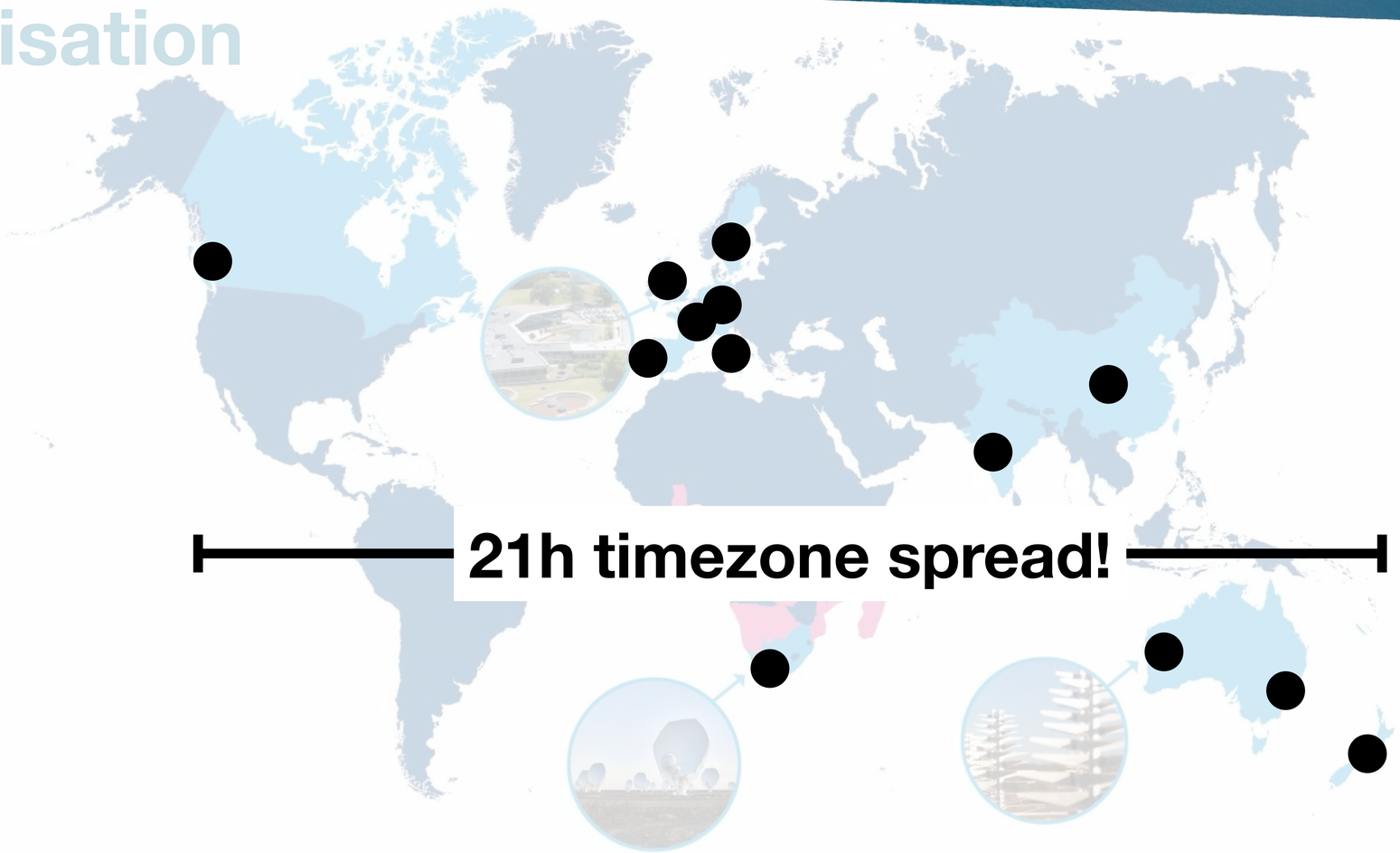

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Zeroth Rule of Scaling:

Zeroth Rule of Scaling: Don’t!

Zeroth Rule of Scaling: Don’t!

But we are way past that possibility…

Already 16 teams from 17 institutions!

Work in progress																	
		HQ	IT-Aveiro	INAF	NCRA	NZA	Swinburne	CSIRO	CRAR/UWA	NRC	UMAN	Oxford	RAL	UK ATC	SARAO	Cambridge	ASTRON	INRIA
	Total Effort	*15.3*	*2.8*	*3.5*	*9.9*	*1.6*	*0.85*	*6.5*	*3.05*	*9.45*	*6.3*	*3.5*	*3.7*	*2.4*	*14.3*	*5.2*	*3.85*	*1*
CIPA	9.45									9.45								
NCRA	7.5				7.5													
Buttons	4.4				1								1	2.4				
Cream	3.35		0.75	2.6														
KAROO	5.5														5.5			
Perentie	5.4						0.85	3									1.55	
MCCS	4.6	0.5						1.5			2.6							
OMC Product Team	4.1	1.8			1.4										0.9			
ESCAPEES	4.2	4.2																
NZAPP	1.6					1.6												
PSS	6.5			0.3		0					3.7	2.5						
SCHAAP	2																2	
SIM	7	0.4										1	2.7			2.9		
SPAZA	5														5			
Yanda	5.05							2	3.05									
DP Product Team	5	1.4													2.1	1.5		
System	5.45	2	2.05	0.6											0.8			
Platform	2.9	0.8														0.8	0.3	1
Solution Team	4.2	4.2																

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- **16 Agile Teams** in **2 Trains** including **System and Platform teams**
- ~5 FTE Average team size from 16 Consultants + SKAO
- ~160 people involved - ~60% average time commitment

Already 16 teams from 17 institutions!

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SIM	7	0.4										1	2.7			2.9		
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System	5.45	2	2.05	0.6											0.8			
Platform	2.9	0.8														0.8	0.3	1
Solution Team	4.2	4.2																

And this is ~50% of the effort that we will have to lead… just on software!

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Autonomy versus Alignment

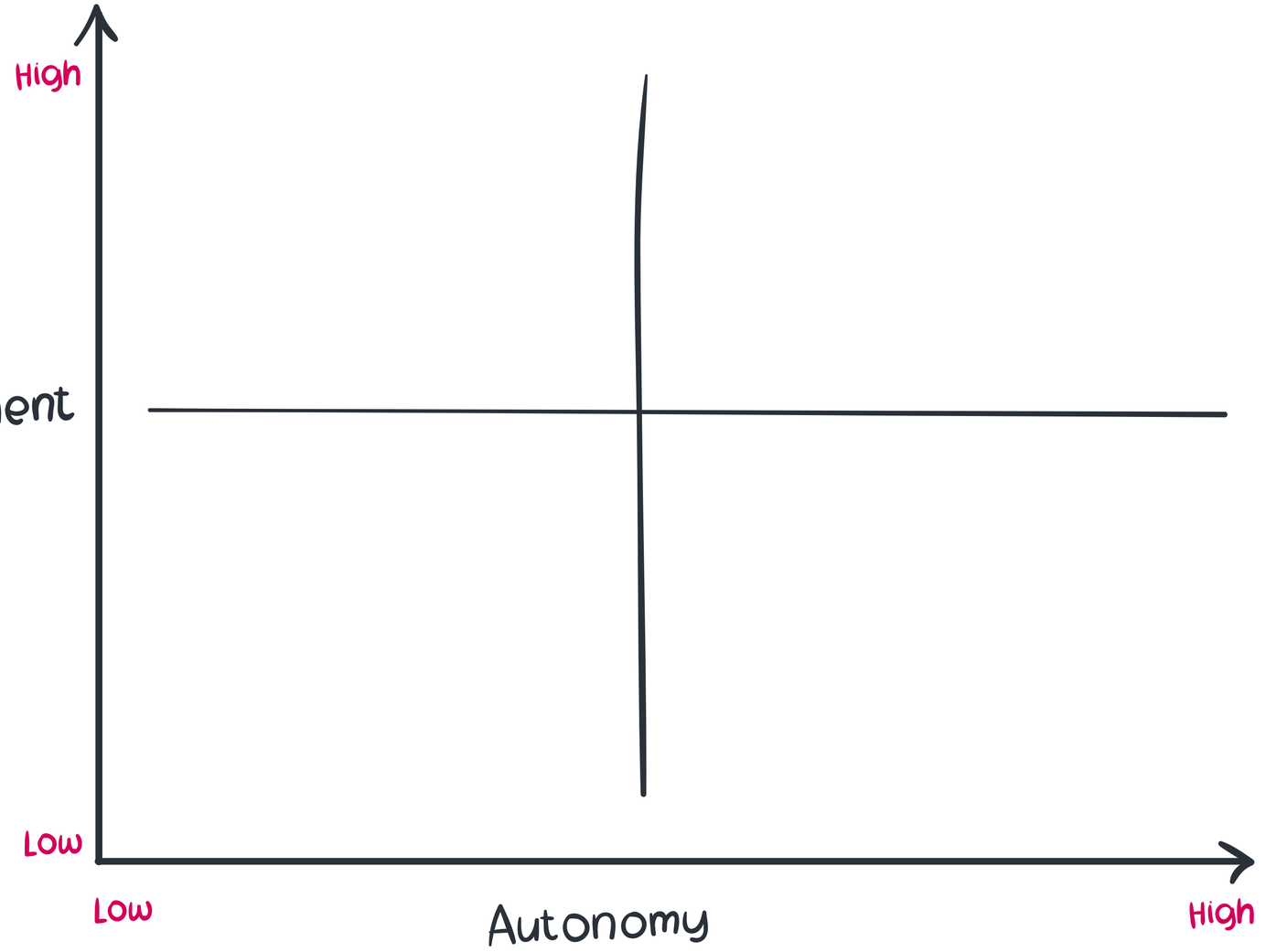

Image from DevOpsGroup

Inspired by Spotify's Engineering Culture

Autonomy versus Alignment

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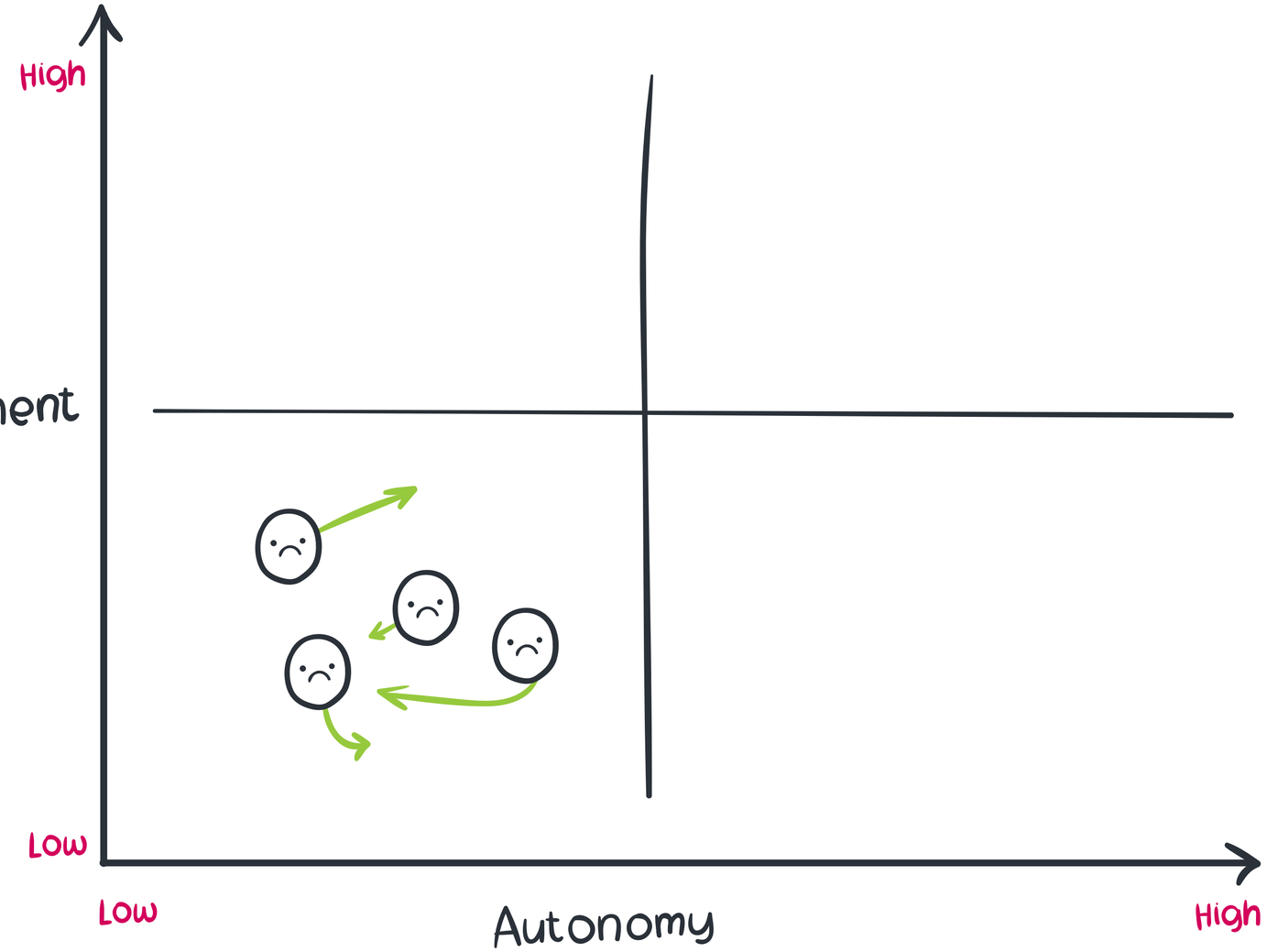

Autonomy versus Alignment

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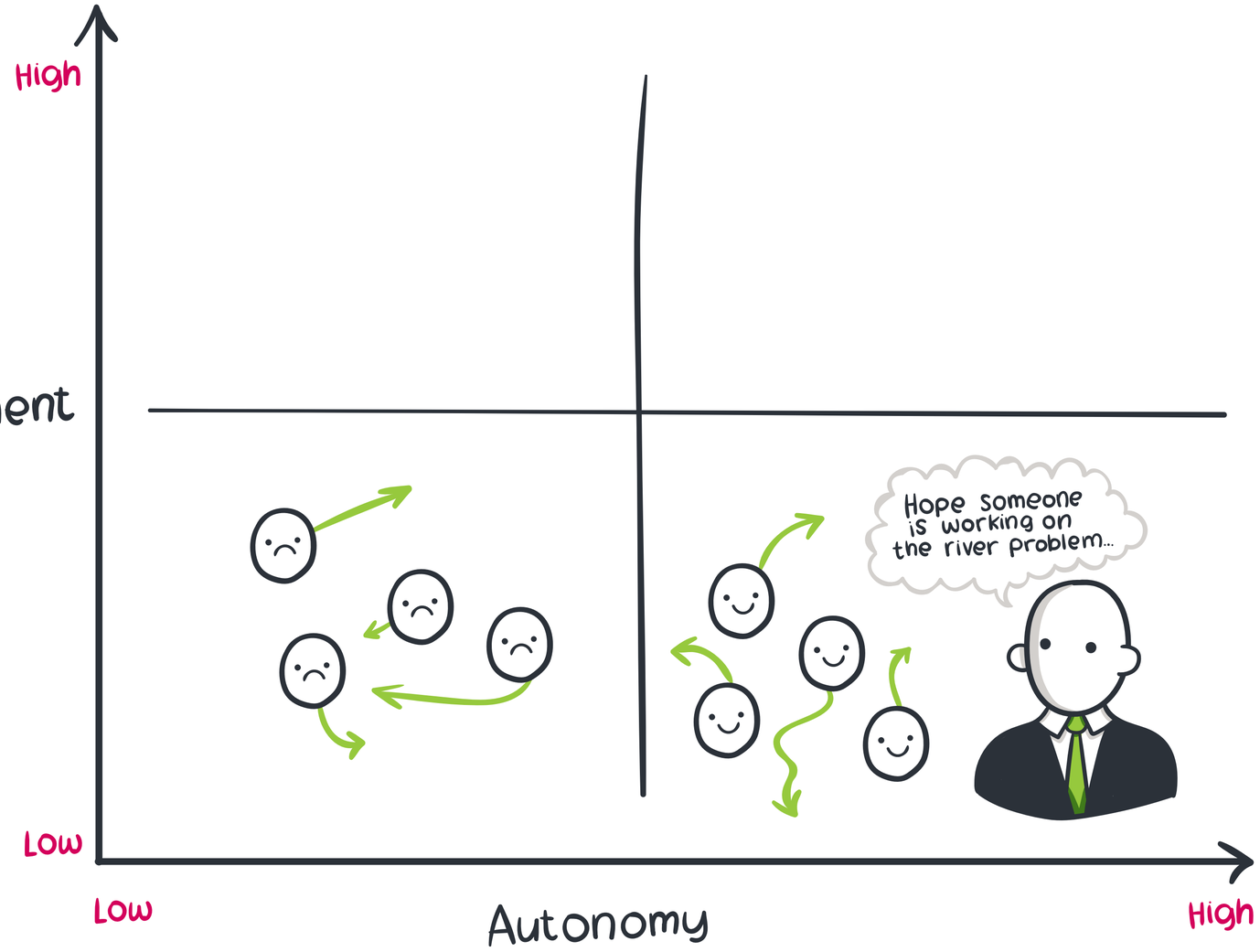

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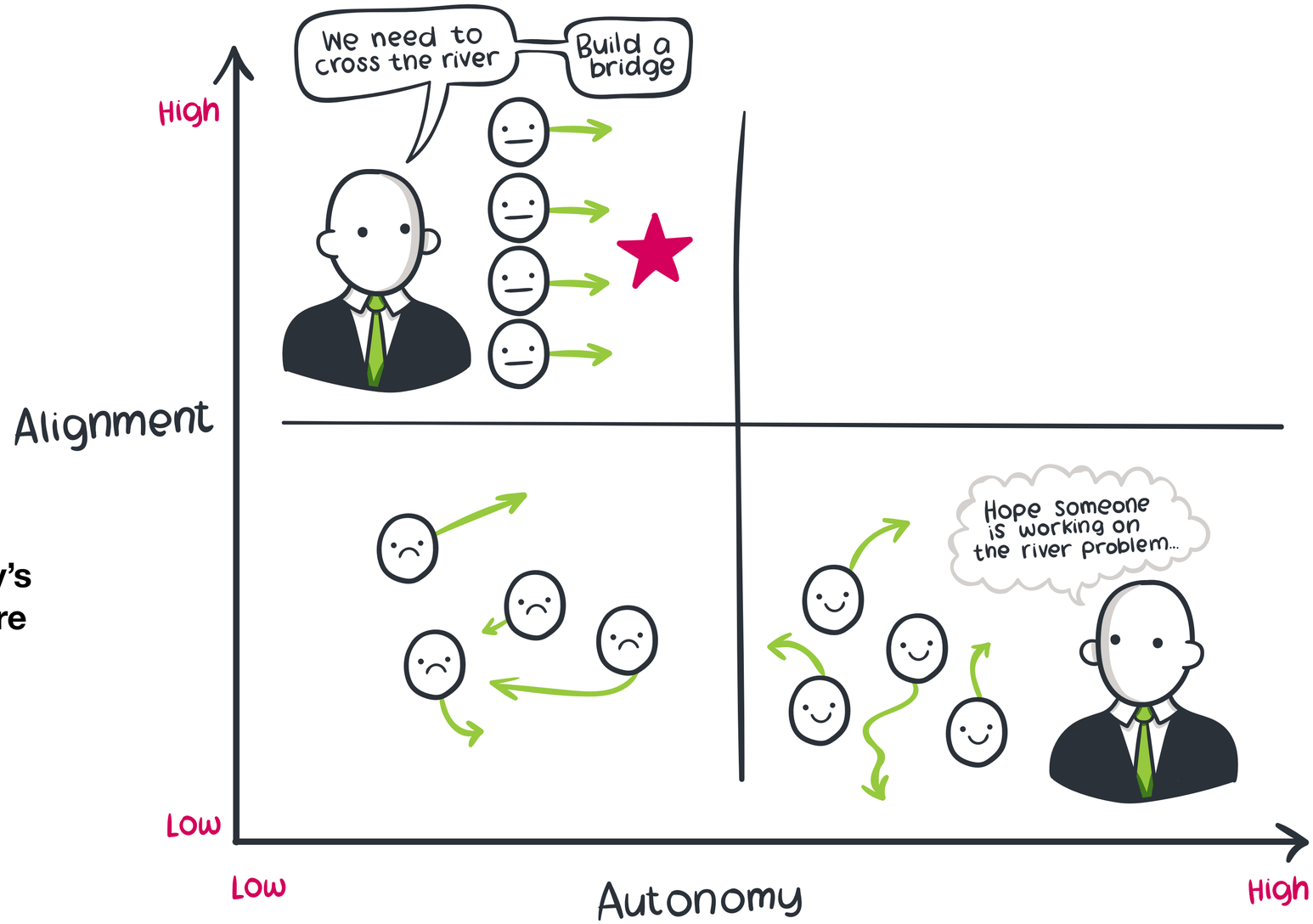

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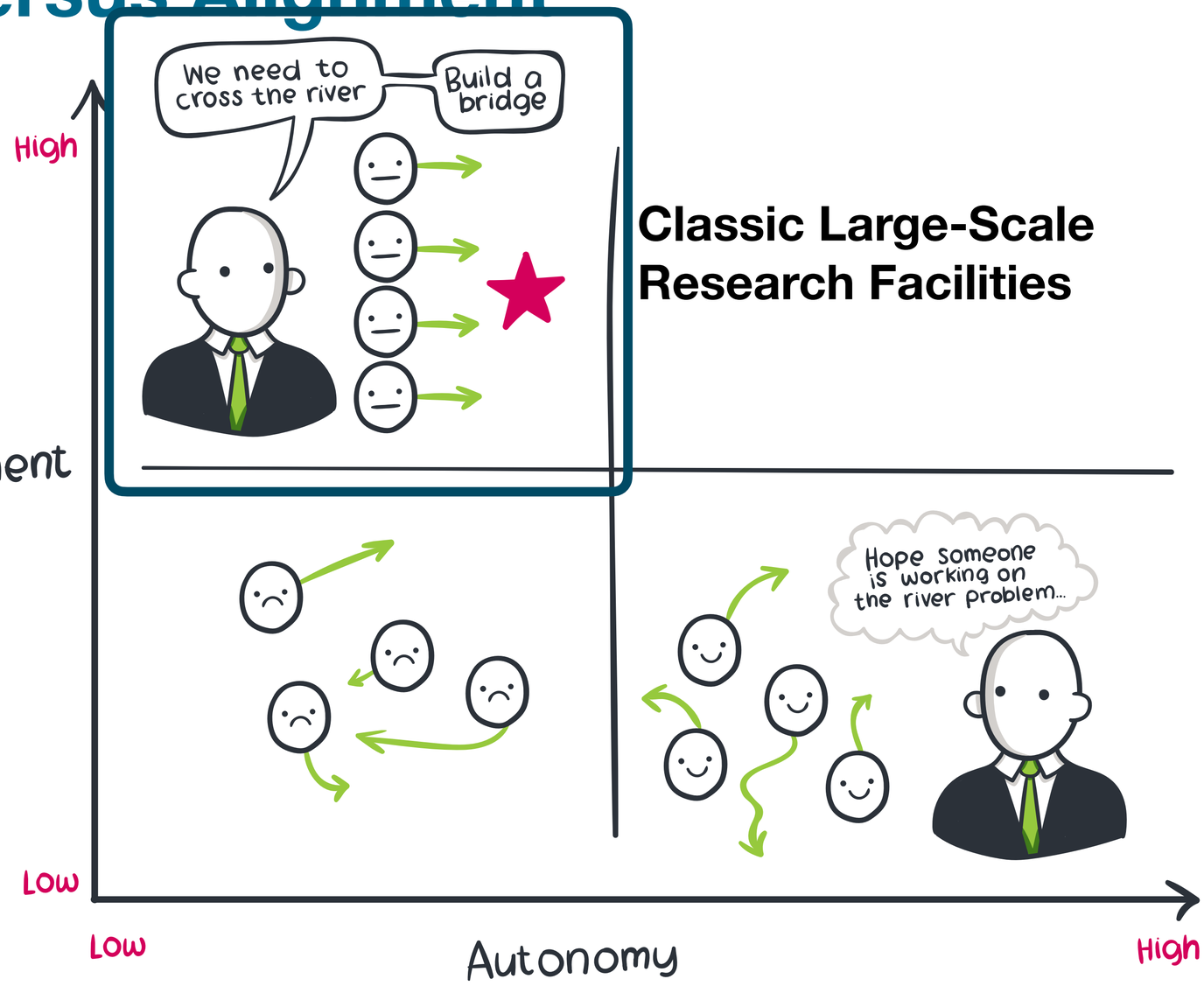


Classic Large-Scale Research Facilities

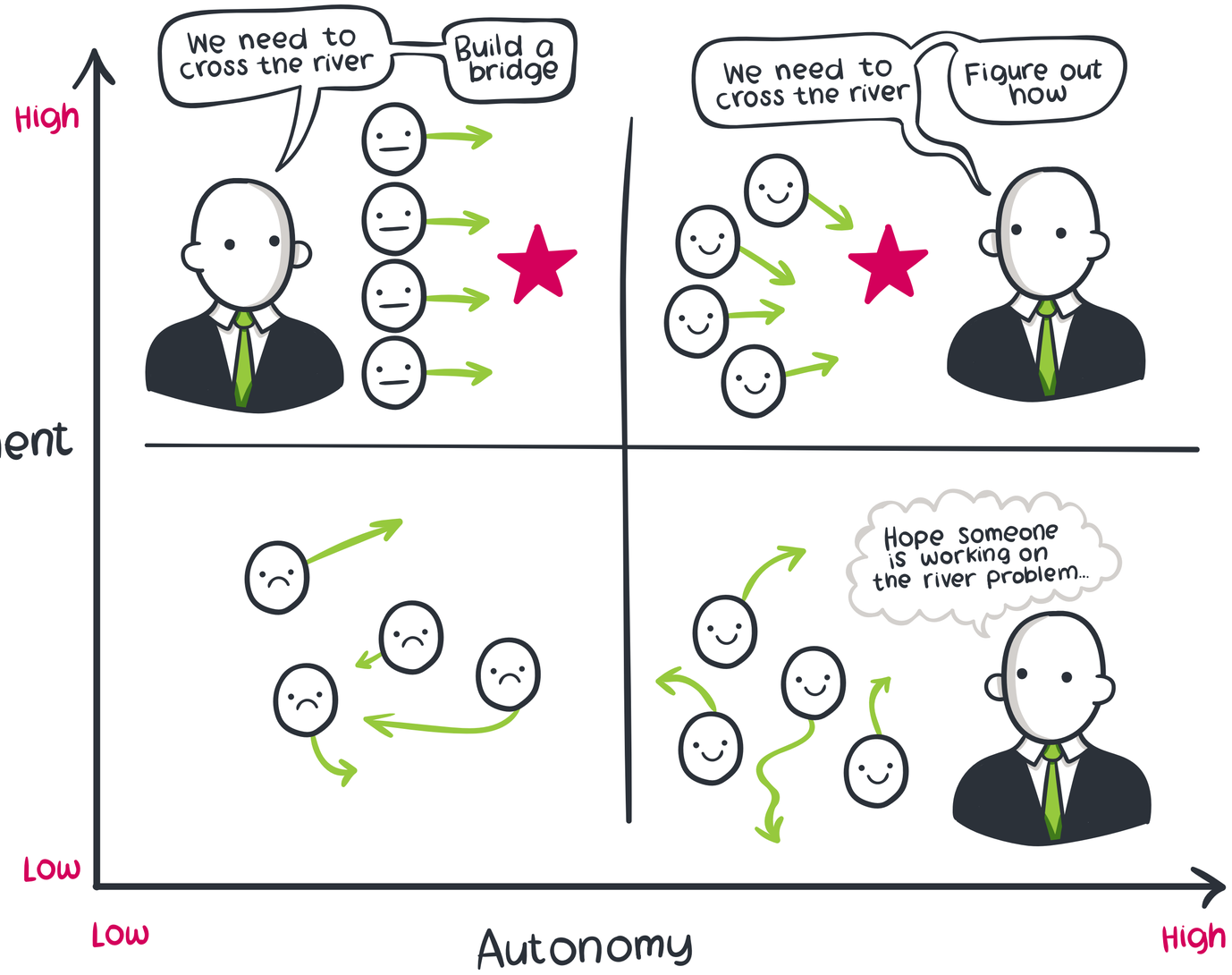
Image from DevOpsGroup

Inspired by Spotify's Engineering Culture

Autonomy versus Alignment

Image from DevOpsGroup

Inspired by Spotify's Engineering Culture



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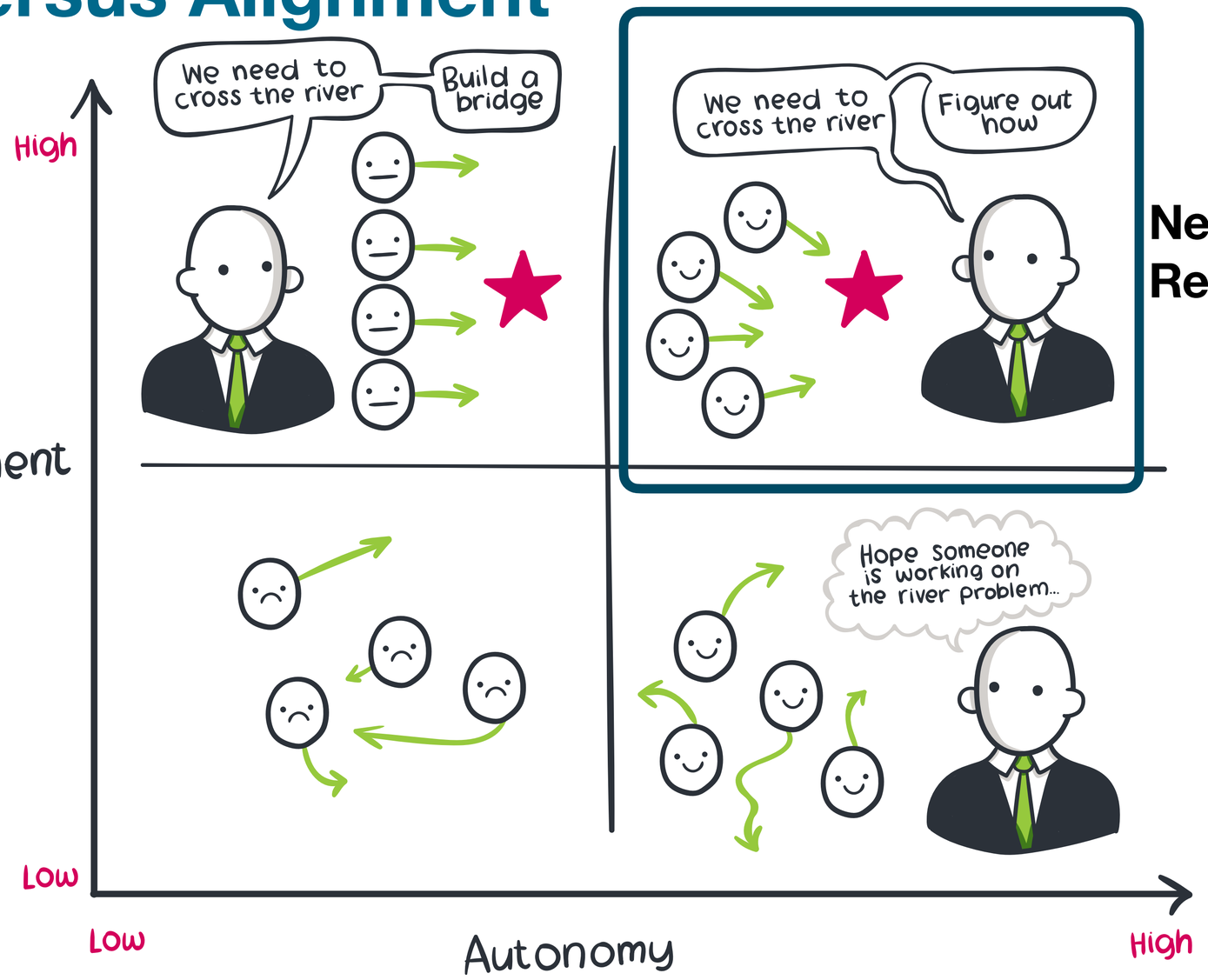


New Agile Large-Scale Research Facilities

That's us!

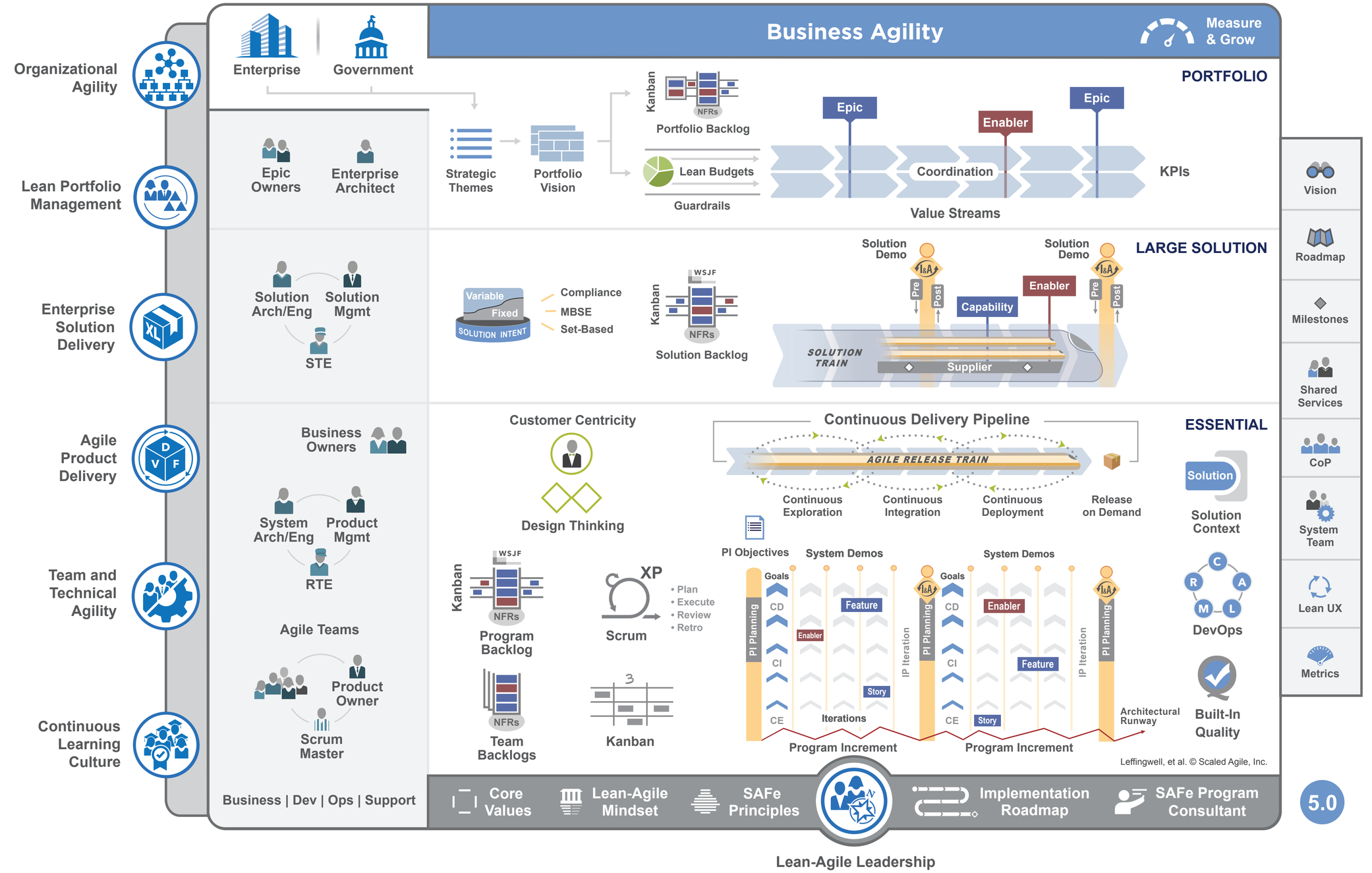
Image from DevOpsGroup

Inspired by Spotify's Engineering Culture

Selecting and Prototyping SAFe®

Or how the Scaled Agile Framework ticks all the boxes for the SKA, and how well are we doing with it.

SAFe® for Lean Enterprises



er Centricity

n Thinking

XP

- Plan
- Execute
- Review
- Retro

Scrum

3

Kanban

Continuous Delivery Pipeline

AGILE RELEASE TRAIN

Continuous Exploration

Continuous Integration

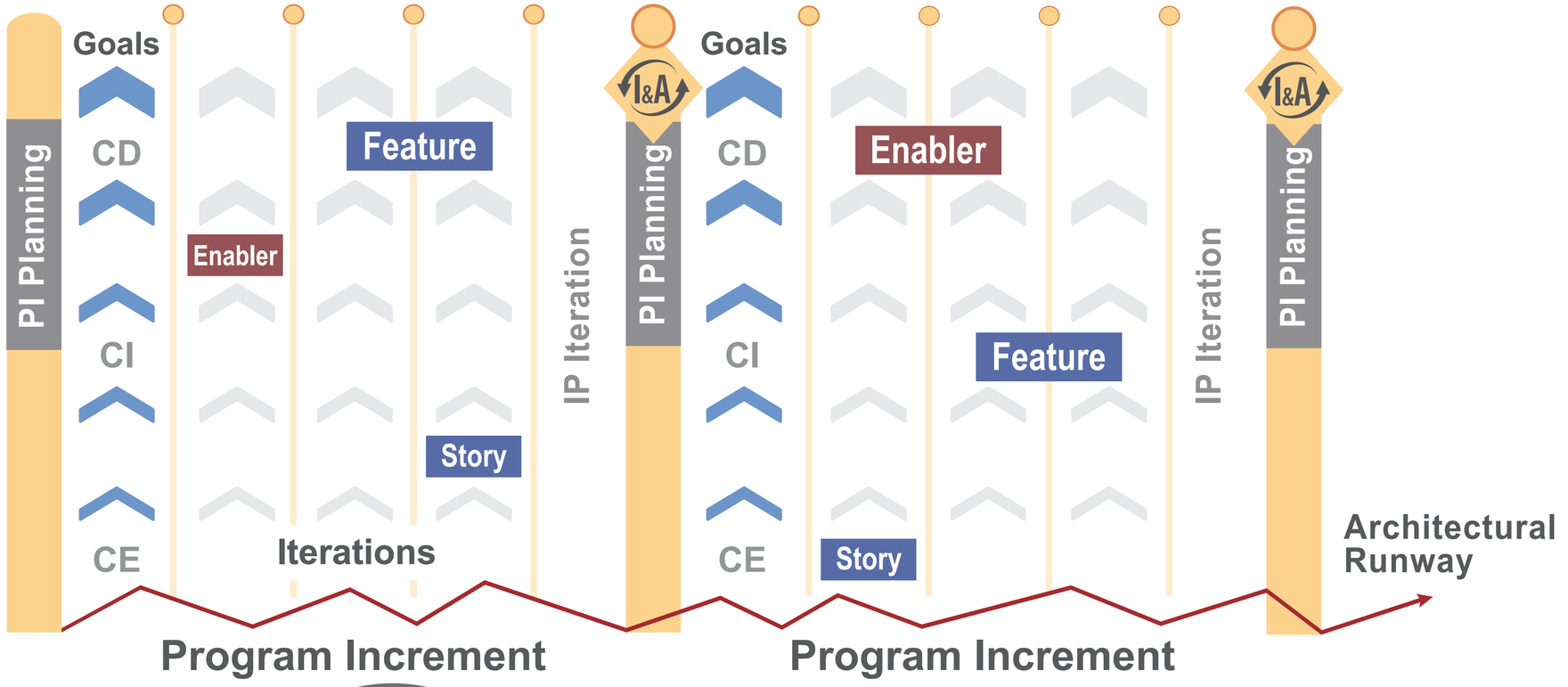
Continuous Deployment

Release on Demand

PI Objectives

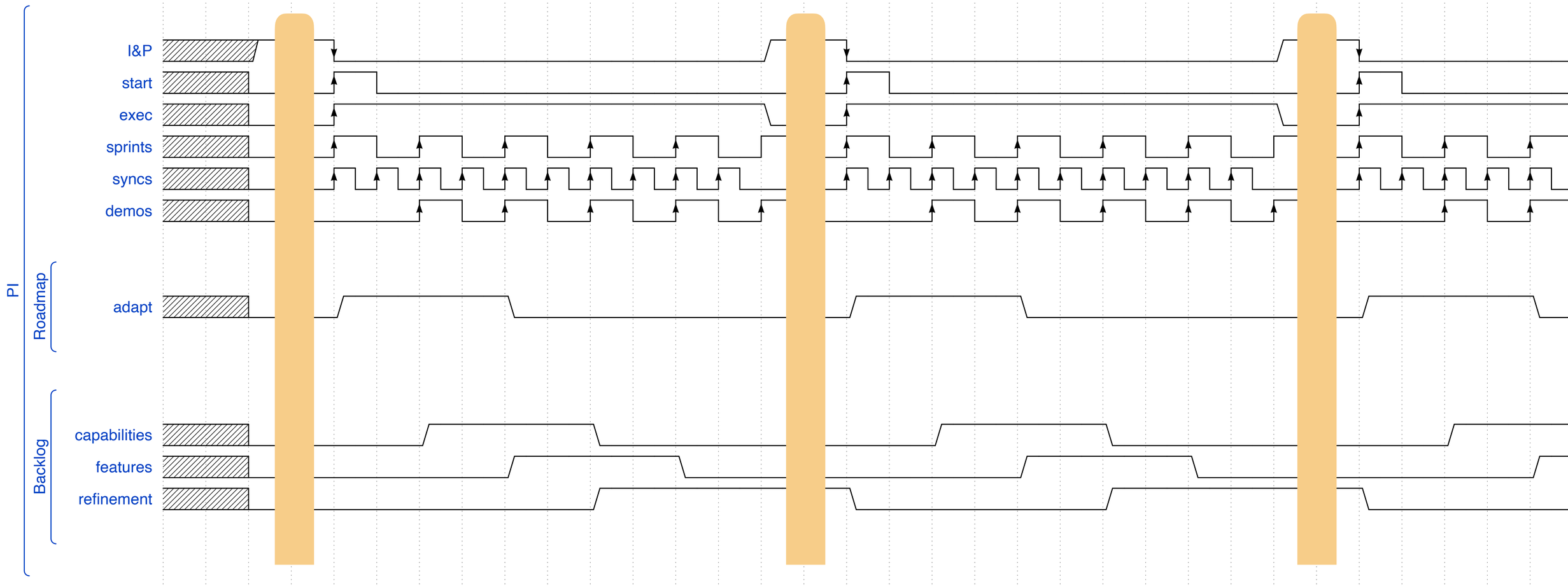
System Demos

System Demos



Leffingwell, et al. © S

The PI, Sprint, and Sync Cadence



Why the Scaled Agile Framework?

- Needed to choose a framework which is available world-wide.
- SAFe is Based on LeSS, inspired by Lean Engineering, and focused on Customer Centricity/Design Thinking.
- SAFe has a freely accessible Glossary so that people can share a common vocabulary.
- Team-level practices are just Scrum, high autonomy.
- PI Planning helps with overall alignment every 13 weeks.

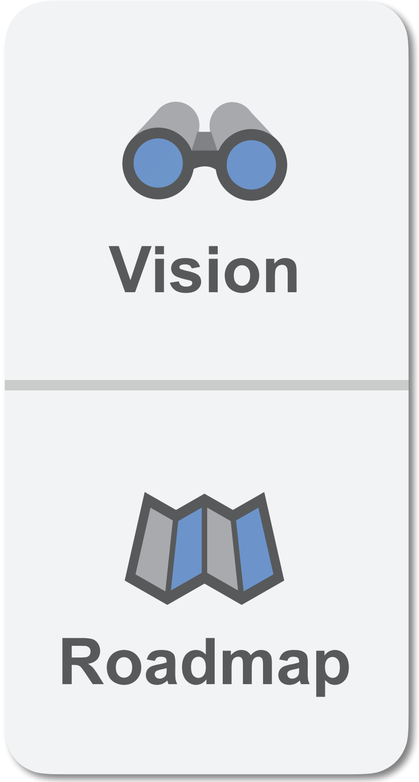
There is no magic in SAFe…

…except perhaps for PI Planning.

Exploring the Universe with the world's lar

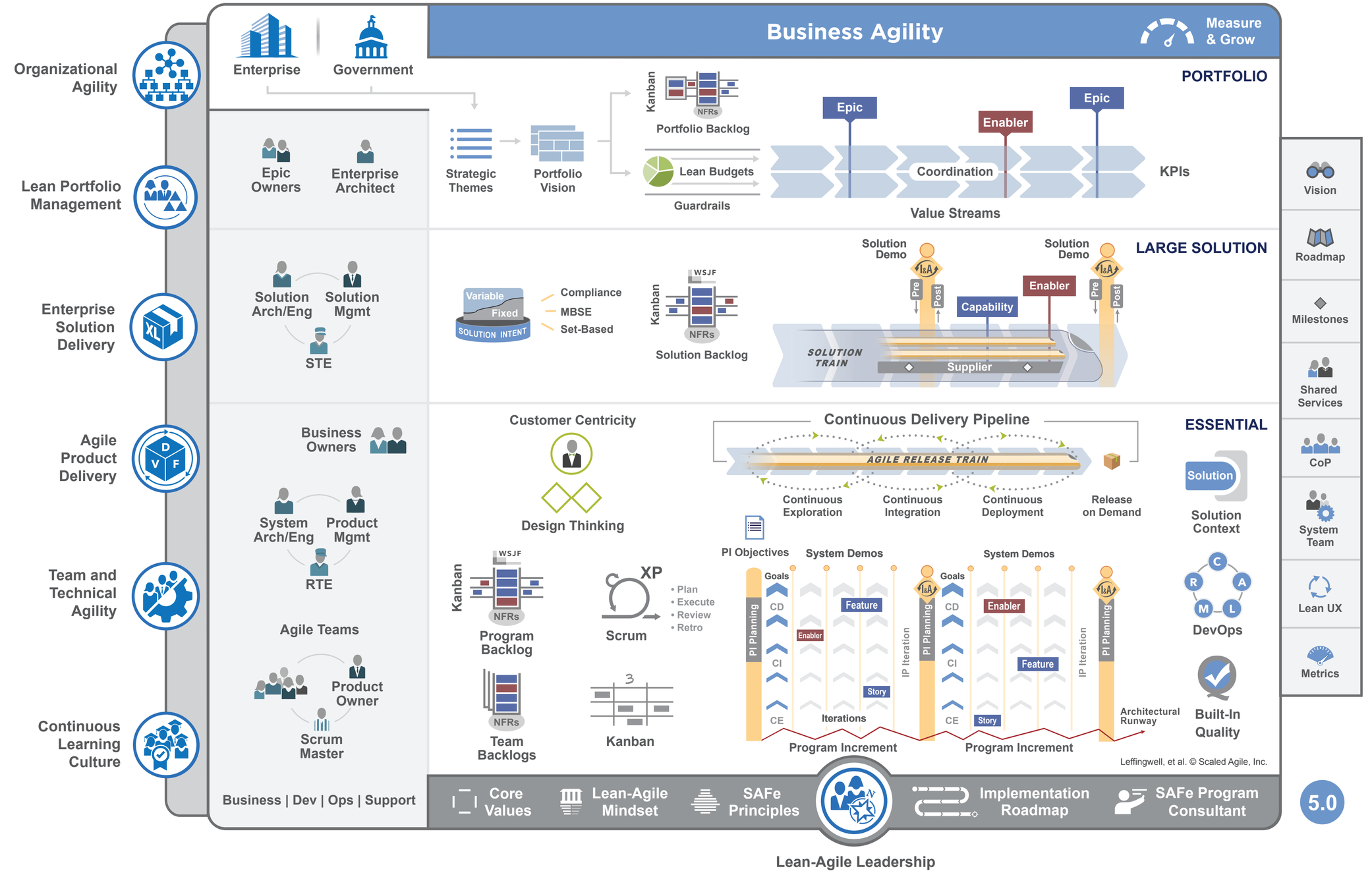
Our guidance: Vision and Roadmap

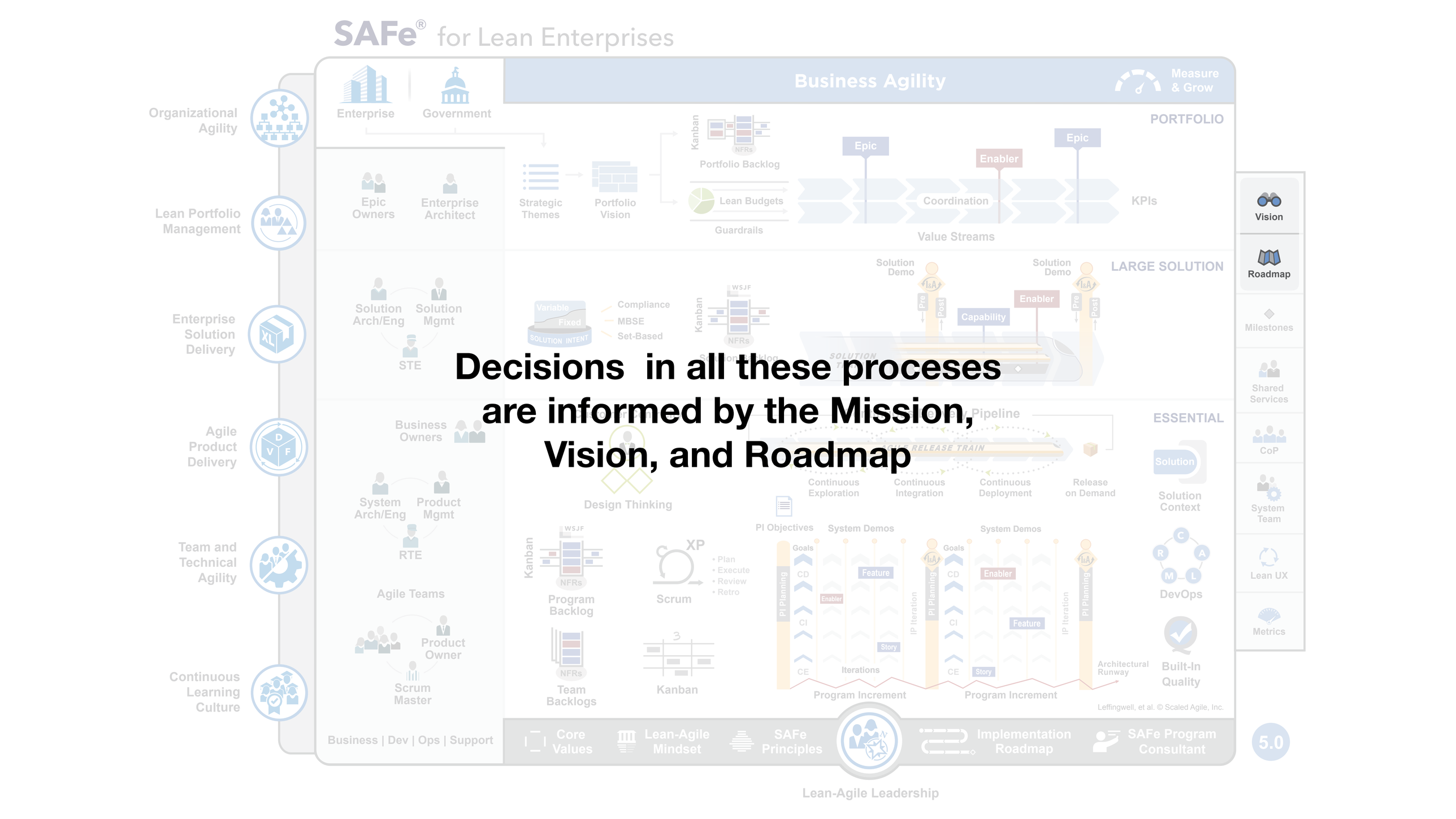
Where do we want to go?



How do we get there?

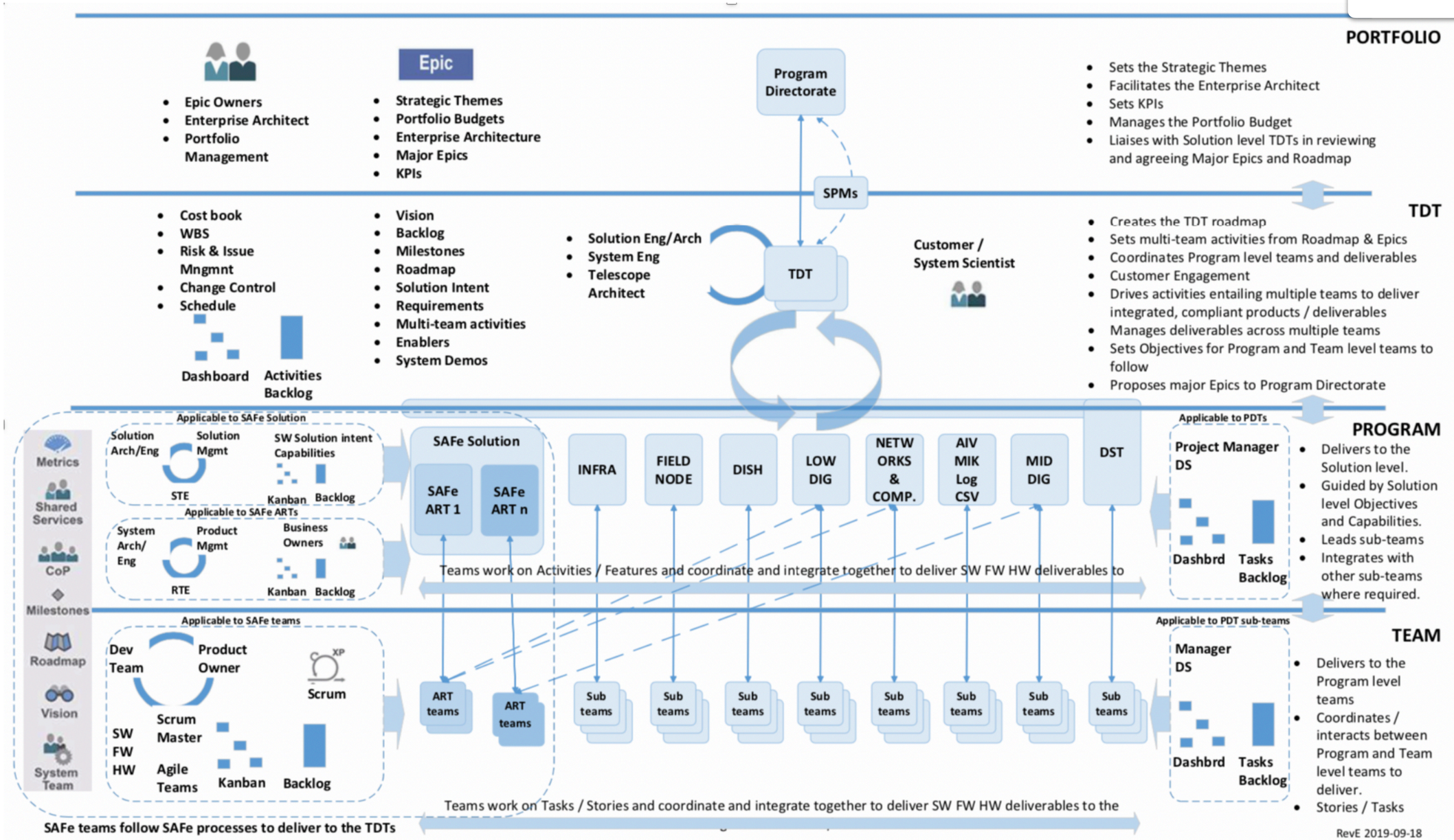
SAFe® for Lean Enterprises





Decisions in all these processes are informed by the Mission, Vision, and Roadmap

Coordinated with the Telescope Delivery Teams



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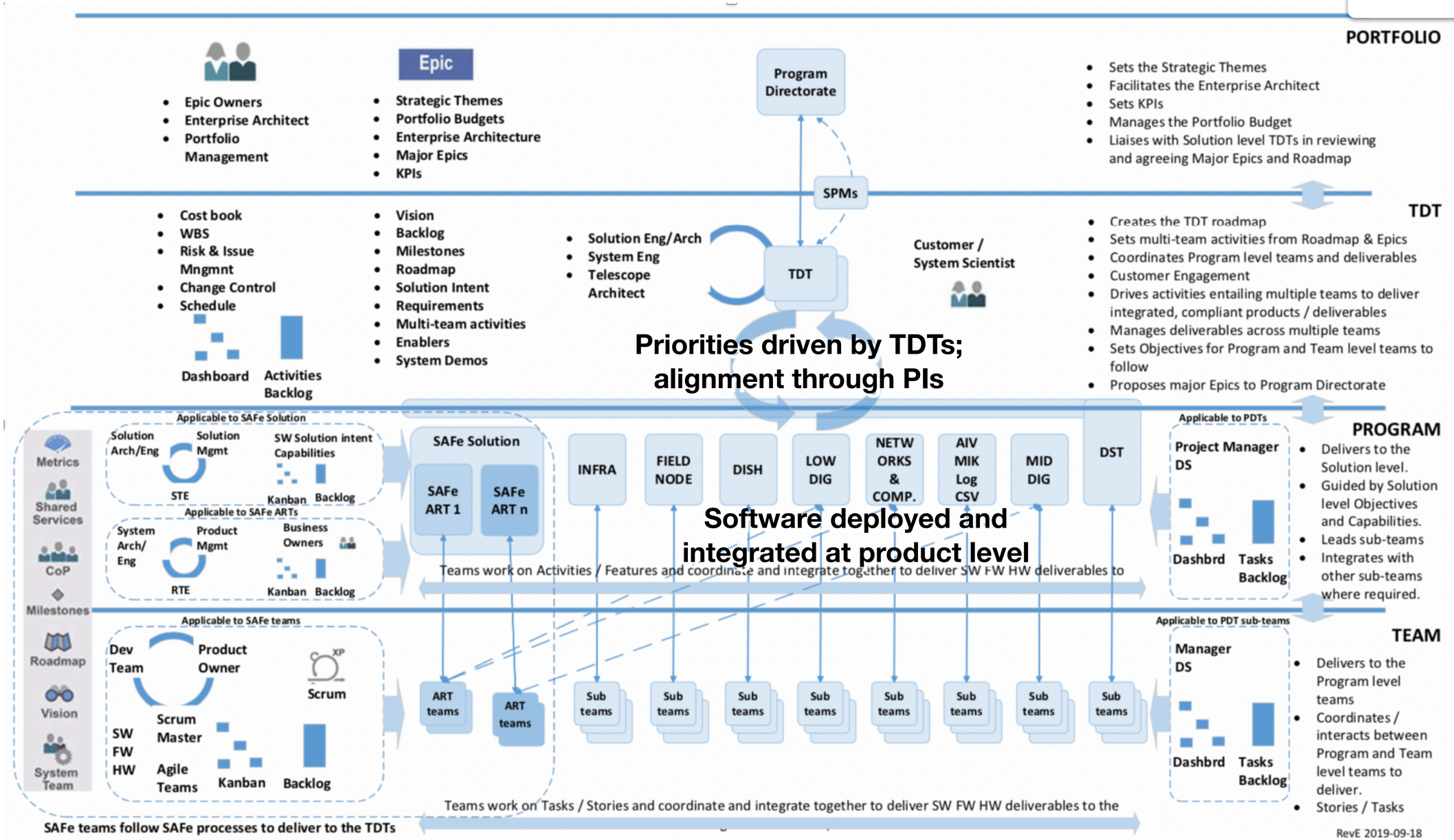

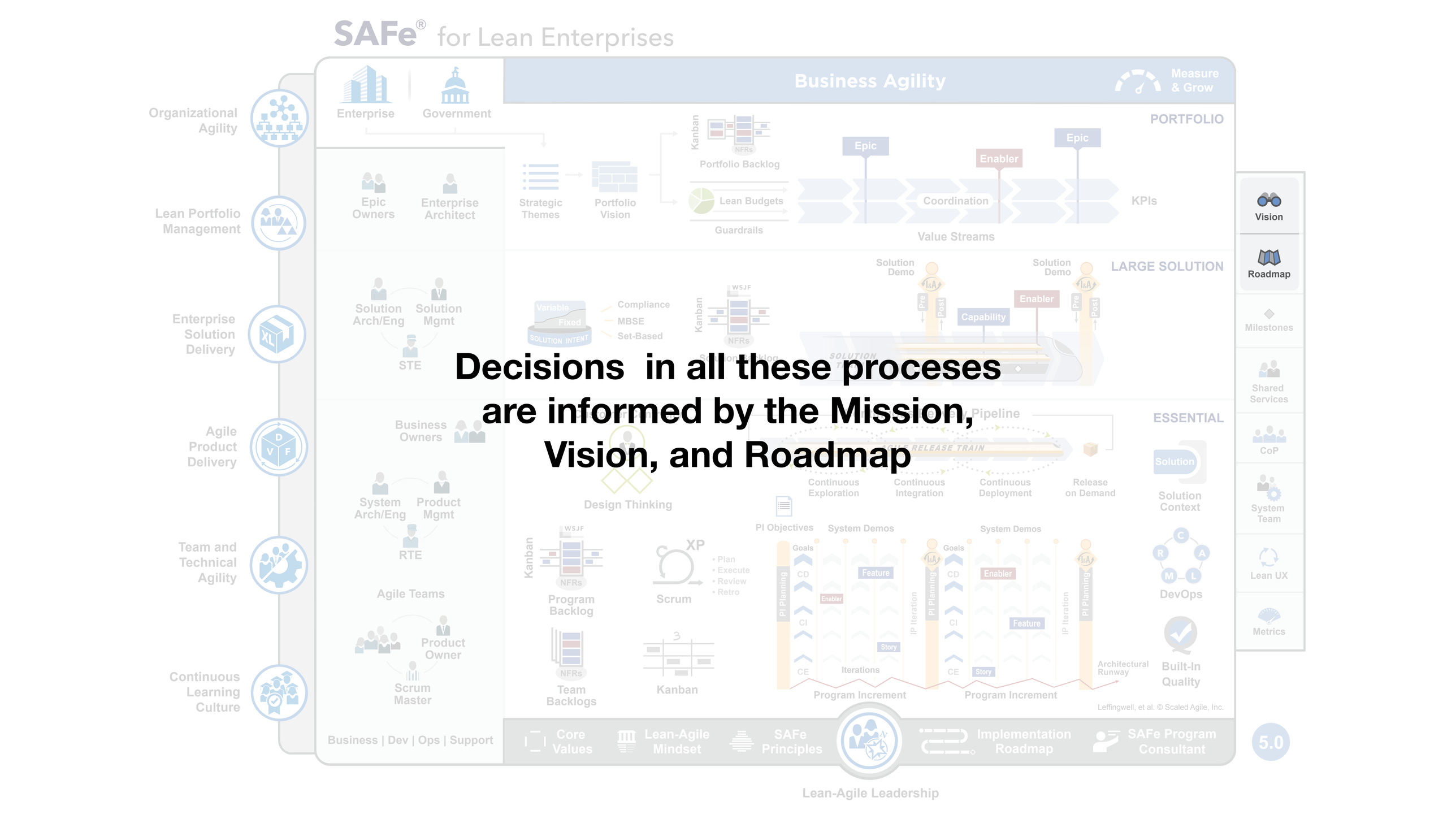

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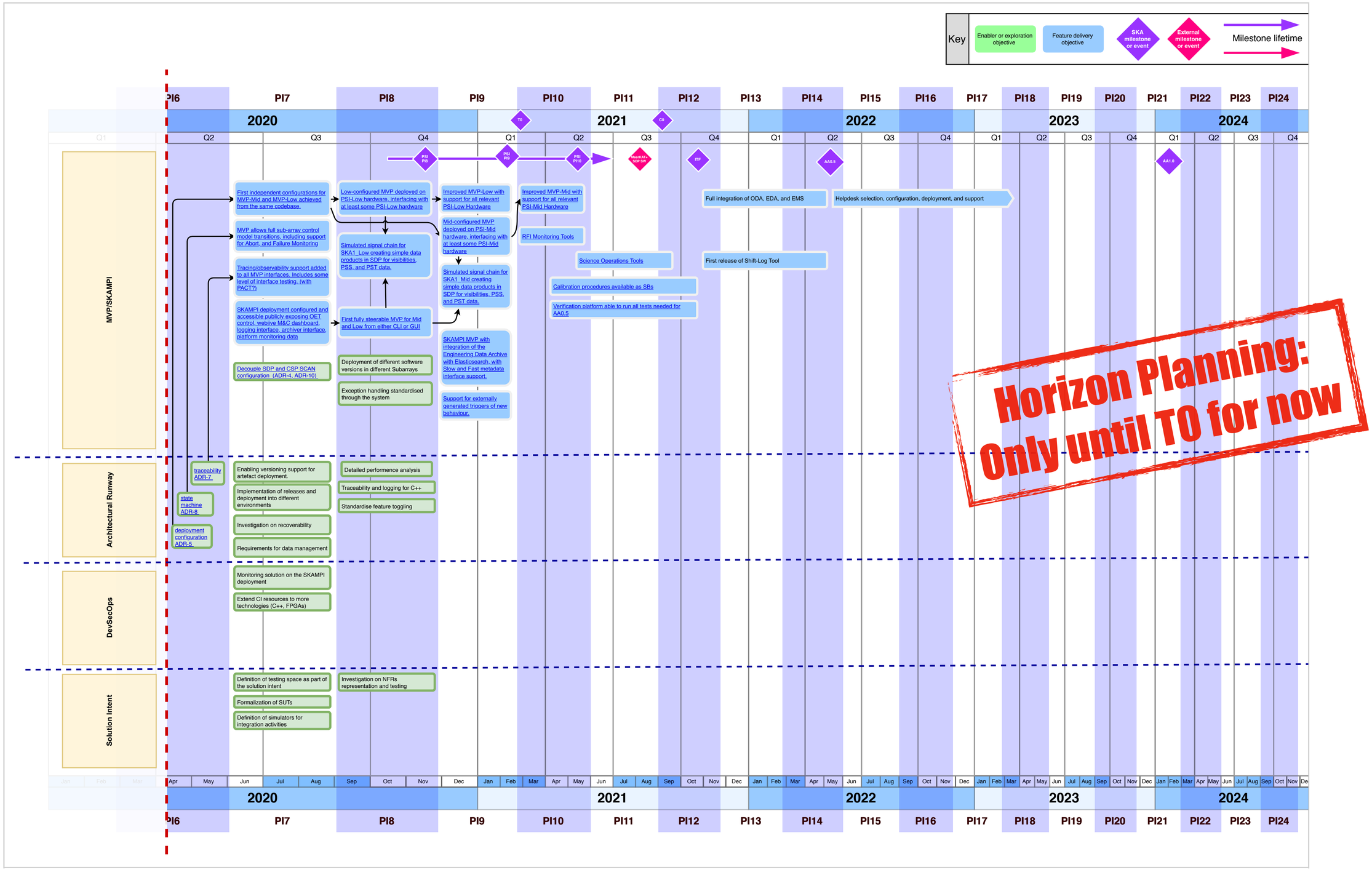
Key
Enabler or exploration objective
Feature delivery objective
SKA milestone or event
External milestone or event
Milestone lifetime
PI6
PI7
PI8
PI9
PI10
PI11
PI12
PI13
PI14
PI15
PI16
PI17
PI18
PI19
PI20
PI21
PI22
PI23
PI24
2020
2021
2022
2023
2024
TO
CO
Q1
Q2
Q3
Q4
PSI PI8
PSI PI9
PSI PI10
MeerKAT+ SDP SW
ITF
AA0.5
AA1.0
MVP/SKAMPI
Architectural Runway
DevSecOps
Solution Intent
First independent configurations for MVP-Mid and MVP-Low achieved from the same codebase.
MVP allows full sub-array control model transitions, including support for Abort, and Failure Monitoring
Tracing/observability support added to all MVP interfaces. Includes some level of interface testing. (with PACT?)
SKAMPI deployment configured and accessible publicly exposing OET control, webjive M&C dashboard, logging interface, archiver interface, platform monitoring data
Decouple SDP and CSP SCAN configuration. (ADR-4, ADR-10).
Low-configured MVP deployed on PSI-Low hardware, interfacing with at least some PSI-Low hardware
Simulated signal chain for SKA1_Low creating simple data products in SDP for visibilities, PSS, and PST data.
First fully steerable MVP for Mid and Low from either CLI or GUI
Deployment of different software versions in different Subarrays
Exception handling standardised through the system
Improved MVP-Low with support for all relevant PSI-Low Hardware
Mid-configured MVP deployed on PSI-Mid hardware, interfacing with at least some PSI-Mid hardware
Simulated signal chain for SKA1_Mid creating simple data products in SDP for visibilities, PSS, and PST data.
SKAMPI MVP with integration of the Engineering Data Archive with Elasticsearch, with Slow and Fast metadata interface support.
Support for externally generated triggers of new behaviour.
Improved MVP-Mid with support for all relevant PSI-Mid Hardware
RFI Monitoring Tools
Science Operations Tools
Calibration procedures available as SBs
Verification platform able to run all tests needed for AA0.5
Full integration of ODA, EDA, and EMS
First release of Shift-Log Tool
Helpdesk selection, configuration, deployment, and support
traceability ADR-7
state machine ADR-8
deployment configuration ADR-5
Enabling versioning support for artefact deployment.
Implementation of releases and deployment into different environments
Investigation on recoverability
Requirements for data management
Detailed performence analysis
Traceability and logging for C++
Standardise feature toggling
Monitoring solution on the SKAMPI deployment
Extend CI resources to more technologies (C++, FPGAs)
Definition of testing space as part of the solution intent
Formalization of SUTs
Definition of simulators for integration activities
Investigation on NFRs representation and testing
Horizon Planning:
Only until TO for now

Other normal DevSecOps stuff that we do…

- SKA Developer Portal with ReadTheDocs.

BSD 3-clause license for code; Creative Commons International Attribution license for documentation

- Distributed Version Control
  - Git hosted on Gitlab with Merge Requests workflow.
- Continuous Integration

See Marco Bartolini's talk on Tuesday 28th!

  - Gitlab Runners running on dedicated hardware on ENGAGE-SKA's platform.
  - Behaviour Driven Development testing, using Gerkin, part of acceptance.
- Containers (Docker, Kubernetes) and Deployment
  - Hosted on Nexus on ENGAGE-SKA's platform. Deployed using Helm.

Future Work!

Or how do we all get to keep our jobs 😉

Construction is coming!

- Construction Proposal going out in early September!
- Milestones at Array Assembly level (number of antennas/system capabilities)
  - Software roadmap needs to adapt to those capabilities, but also potential changes in priorities.
  - Release policy still TBD, but we are working on it. Happy to learn from others!
- Software work to be conducted through NEC4 Professional Services Contracts
  - We will keep doing PI plannings.
- Potential changes to team numbers, team compositions, trying to keep moving away from silos.

Earned Value Management is coming!

- Linking of Business Value towards Earned Value, versus Planned Value.
- Still need to estimate the effort for the full Roadmap!
- Using example of LSST, but again we are happy to learn from others.

DevSecOps still needs to evolve

- Lots of automations to do!
- Onboarding improvements
- Ability to deploy to multiple environments:
  - Testing
  - Online Production environment
  - **Prototype System Integration** facilities
  - System **Integration and Test Facilities**

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And the Telescopes and Observatory!

With signal-chain integration with hardware!

Conclusions

Or here is where I run out of ideas for the subtitle.

Conclusions

- We have yet lots to do!
- Agile practices with the SAFe Framework are giving a structure to software development even before construction
- Cadence and Planning gives teams autonomy AND predictability
- Prototyping it before construction makes a lot of sense!

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Thank you!

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Questions?