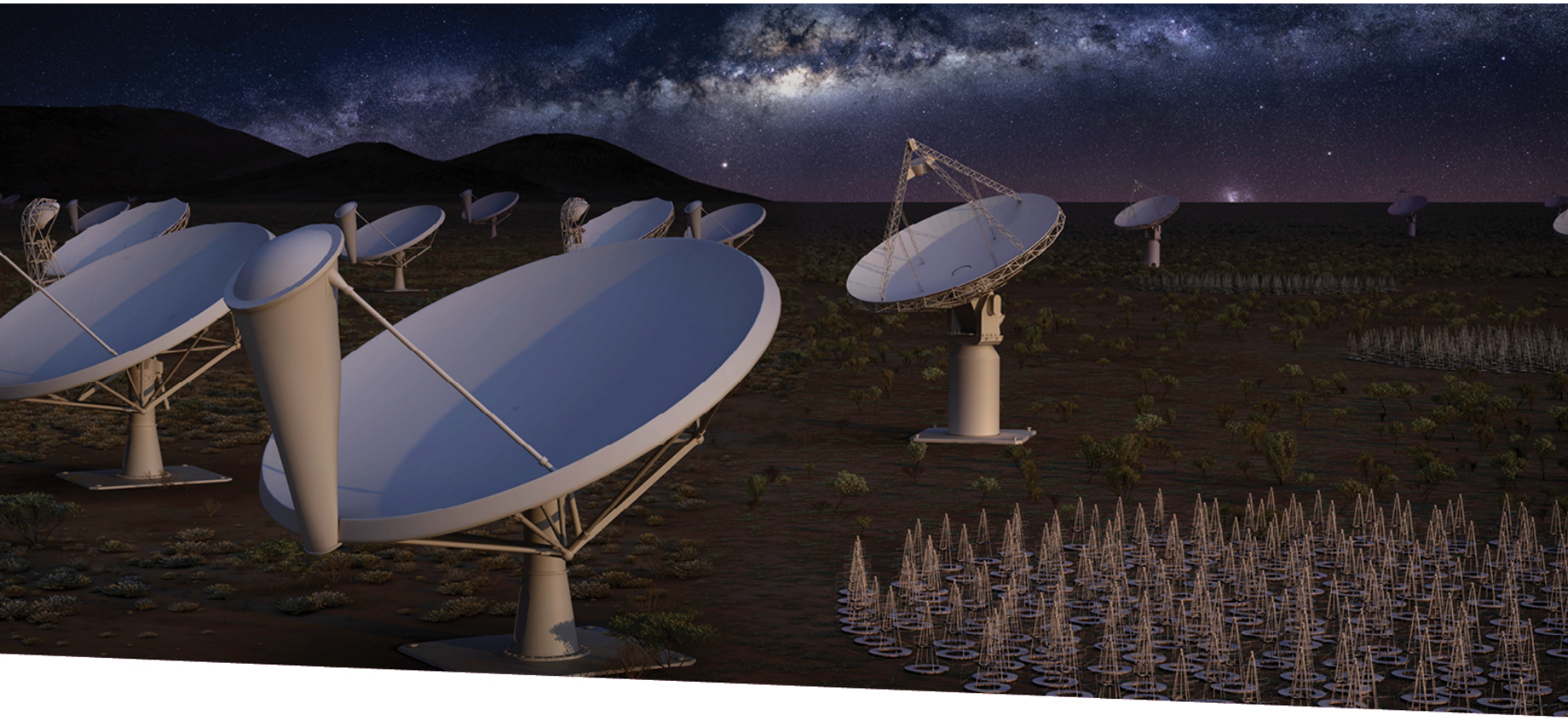
Integration Test Facilities

Proposal



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Purpose of an Integration Test Facility?

The ITF's primary purpose is design qualification, it will provide an Integration and Verification Facility for SKA MID and LOW where representative software and hardware can be integrated, tested and verified for both stand alone functionality and interoperability prior to being fielded.

It is envisaged that as design is qualified, most of the I&V work will migrate to site (Engineering Array used for design qualification).

It is envisaged that the function of the facility will evolve over time, initially taking shape as an ITF to support integration and verification, and verify production readiness of prototypes. The ITF(s) could evolve into Regional/ National Engineering/Development Centres, towards the end of the construction phase.

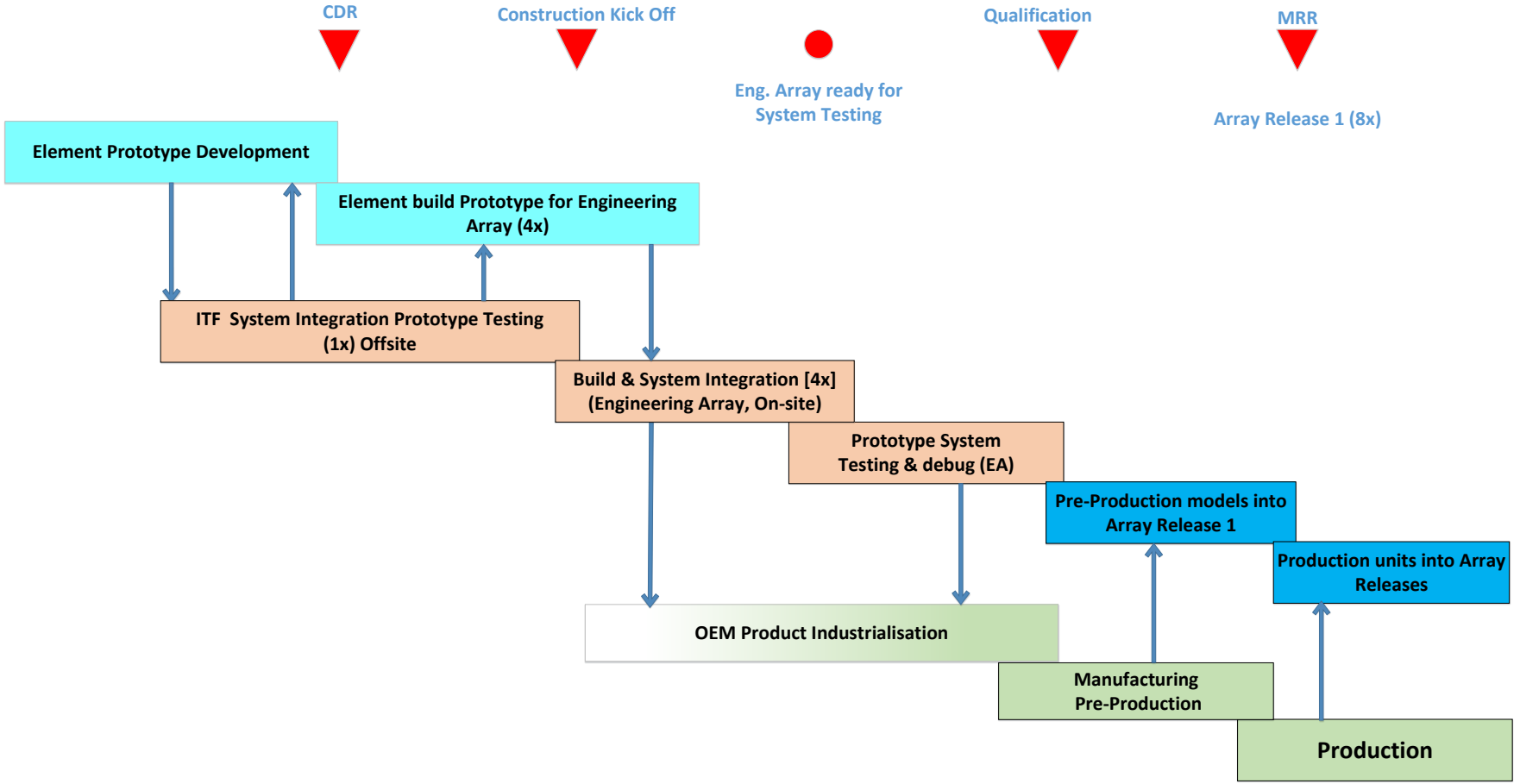
The ITF is not a maintenance facility where post-delivery integration issues are sorted out.

What are the possible Benefits of an ITF?

- System level design qualification
- Early integration and verification (ITF Will help to answer the question, does the system/subsystem meet the requirements?)
- Verification of functionality and performance requirements, and SW/ FW/HW functionality upgrades before shipping products to site
- Risk and cost reduction (finding faults offsite is less costly)
- Collaborative lab environment to test and debug (off site)
- Early knowledge transfer between consortia, manufacturers and suppliers
- ITF will help to improve understanding of manufacturing and production processes (is the level of performance reproducible?)
- Help to reduce redesign work.
- Improved CM of test environment
- Good training ground for AIV team and maintenance/operations staff
- Support for new Hardware/Software releases (The lab support team would be ideal for troubleshooting lab and site issues).

How does the ITF fit into the time line?

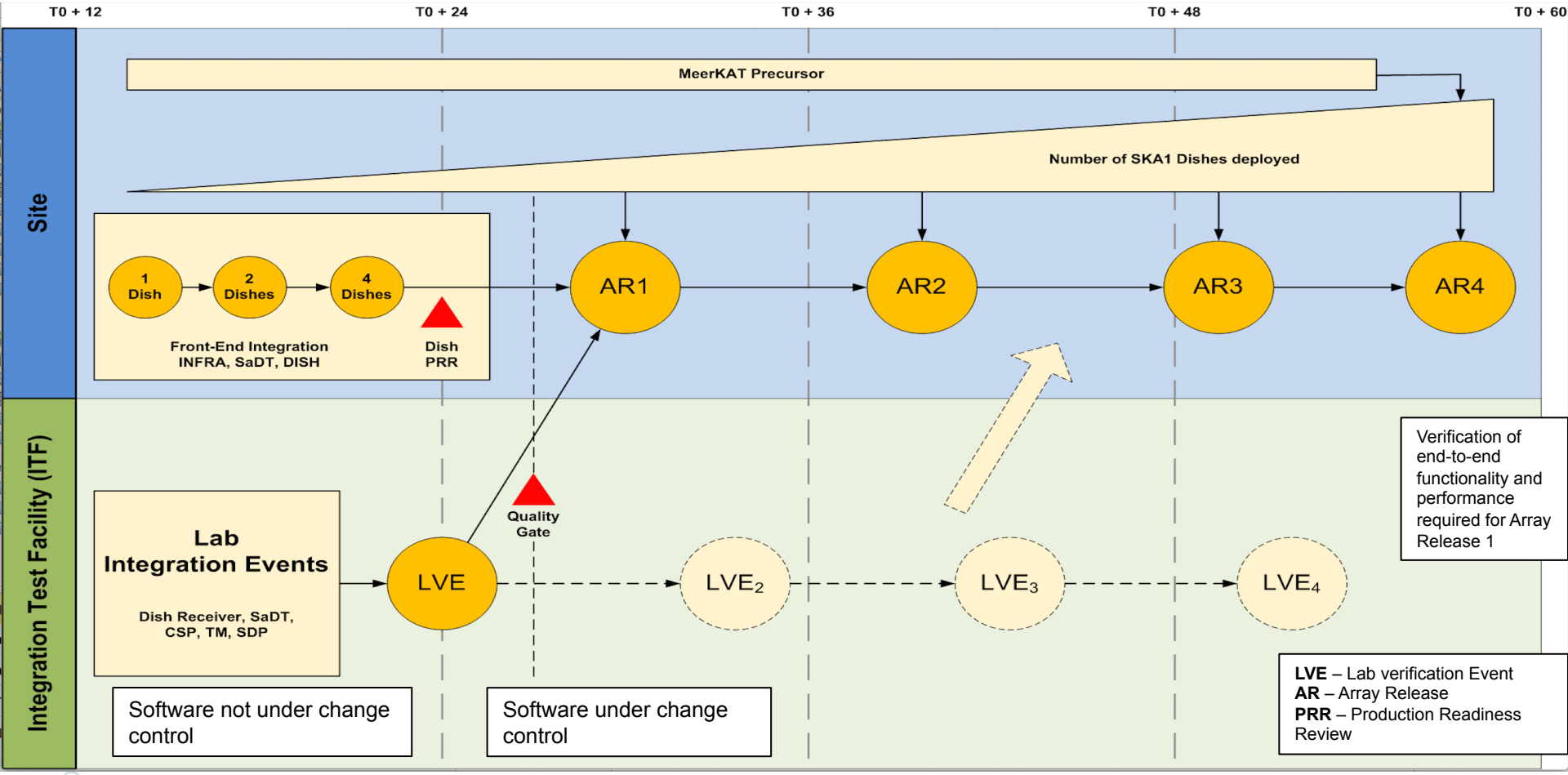
The below figure depicts how the ITF might fit into the current roll out plan for MID as an example.



The AIV dream is to commence ITF operations during the pre-construction phase to provide input to element CDR, leading to an Engineering Array on Site.

How does it fit into the time line?

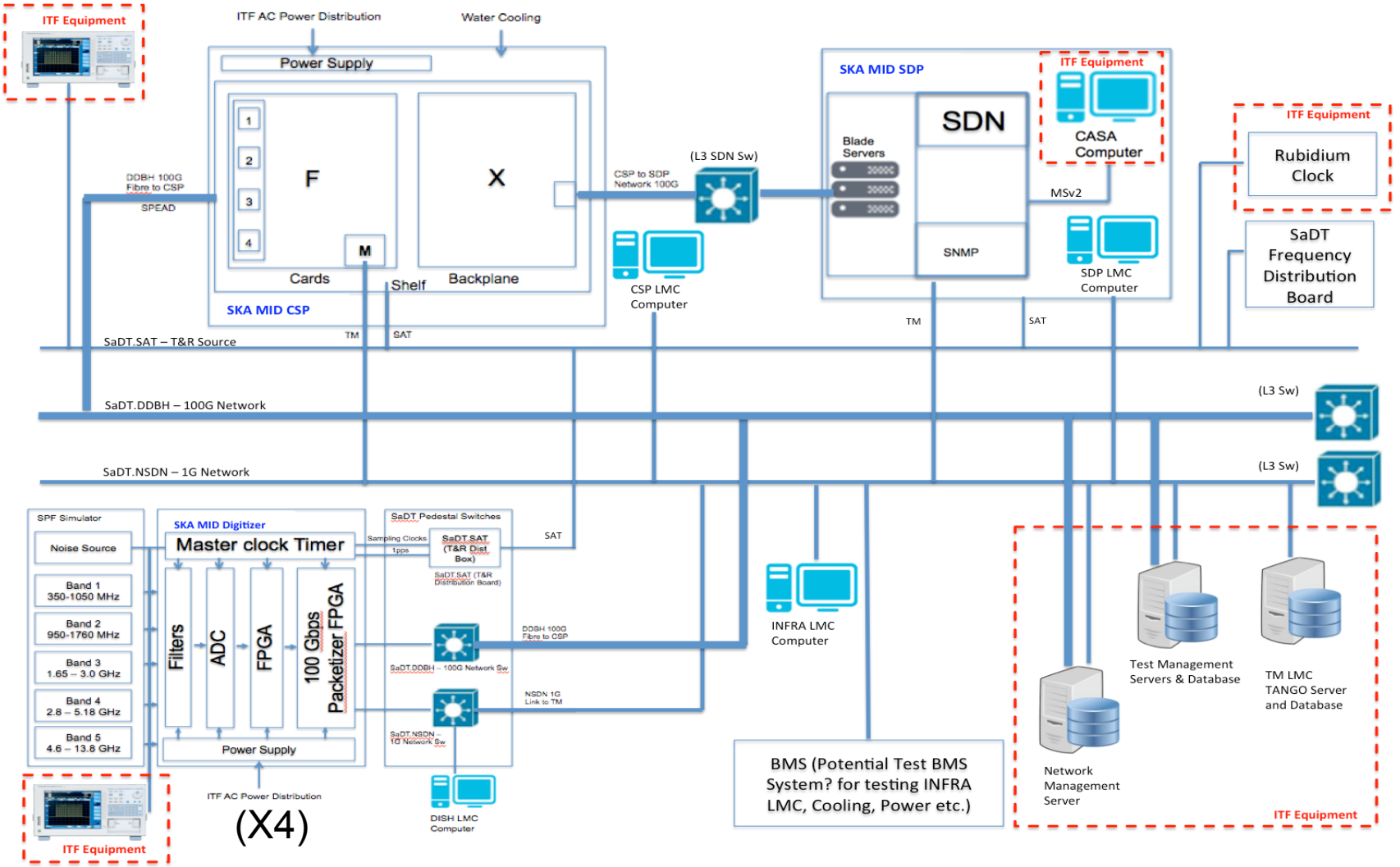
How the ITF and the Engineering Array fit into the time line could evolve as more information comes in from discussion with consortia. Recent AIV discussion suggests CSP, TM and SDP timelines do not allow for an EA. Timeline has to be realistic - what is achievable? What HW/SW/FW is available and when (more discussion required with consortia)?



What does an ITF consist of?

- It will consist of buildings, rack space, lab space, storage, facilities, workshop, test support equipment/systems/team
- Multi-disciplinary engineering team with domain knowledge of the various HW/SW/FW products
- It must have good transport/cargo links nearby
- A System under test (comprising of representative hardware/software)
- A test environment and supporting equipment
- High bandwidth connection to the outside world
- Optional – High band width connection to site.

Example System Under Test (MID)



Mixture of Simulators & real HW/SW

System Under Test – Comprised of?

The system under test may comprise of the following:

- Simulators/emulators (RF input signals, LMC's etc)
- Prototype 4 channel correlator
- Prototype Receivers (digitizers)
- Prototype beam former
- Prototype Frequency Distribution Board
- Rubidium clock
- Bespoke Racking
- Prototype LMC/LMC Simulators
- Representative SaDT network
- Instance of CASA and SDP data product in MSv2 format
- Test support systems, test equipment, services and tooling
- Optional – fibre connectivity to on-site

Type of Testing

The test environment would facilitate sub-system testing and verification (white box), and system level integration testing and verification (black box), leading to design qualification.

Some examples of testing, that may take place at the ITF:

White Box Testing

- Component and code coverage testing
- Interface Testing

Black Box Testing

- Boundary Value Testing
- Decision Table Testing
- Finite State Machine Testing
- Human, machine interface Testing

Black Box – High Volume Testing

- Automatic random Testing
- Performance Testing
- Recovery Testing
- Stress Testing

Black Box – Special Testing

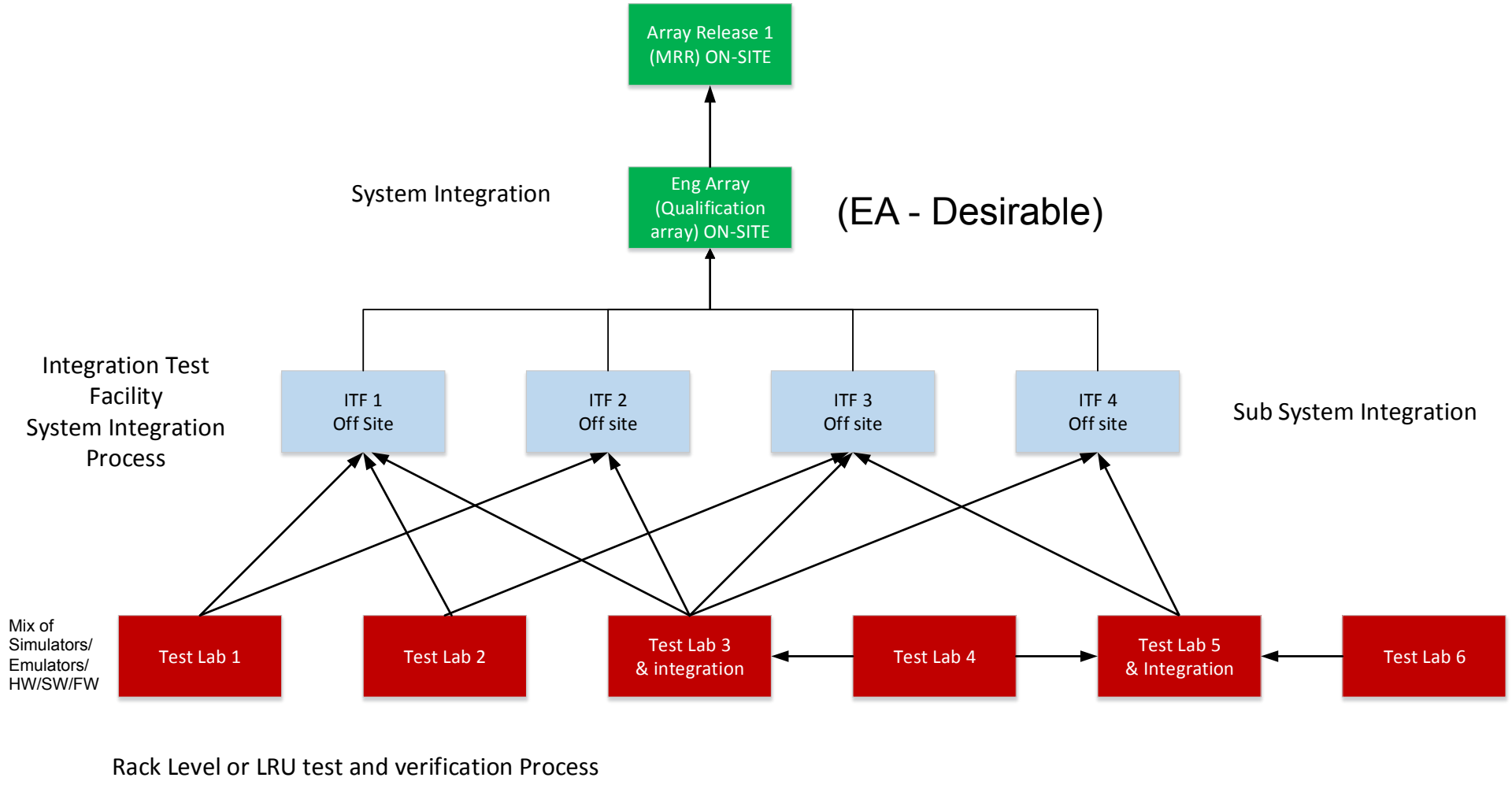
- Usability Testing
- Security Vulnerability Testing
- Reliability Testing
- Search-based Testing
- Mutation Testing

Black Box – Environmental Testing

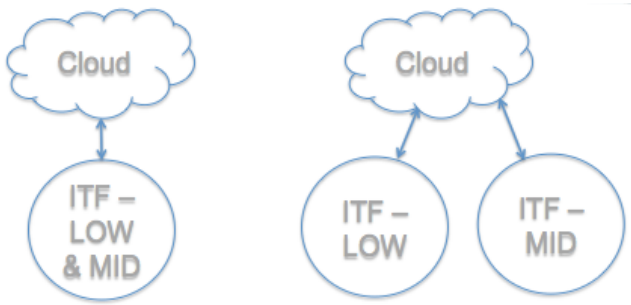
- Environmental Stress Screen Testing
- EMI/EMC Testing
- Destructive Testing
- Reactive Testing
- Temporal Testing

Black Box – Phase Testing

ITF Location – Proposed Model

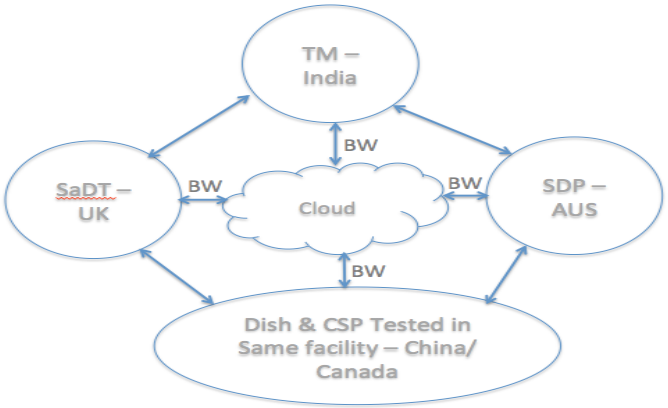


Centralised or Distributed? Middle Tier ITF



Local ITF and multiple Access

1. Requires reduced Bandwidth requirements and can be used ad-hoc
2. Promotes Face to face co-operation and testing
3. Less investment in Test Equipment and simulators



Distributed ITF and multiple access

- Possibly large amounts of permanent bandwidth
- Supports working in Silo's during System Integration
- Requires configuration management and harmonisation of multiple facilities and test environments
- Vastly increased costs (N -1 times) in terms of staff, facilities, test equipment, bandwidth for multiple connections
- Timing, synchronisation, calibration problems
- Still need to bring all equipment under one roof to complete integration testing, before being deployed to site
- All facilities may need dual capability to test LOW and MID

Some Assumptions Made

- The consortia/contractors will bring proto-type equipment, simulators or real equipment to gather data as input for the SKA1 system CDR
- The Consortia supports the concept using an ITF for (sub) system testing of their equipment or software.
- The consortia understands the need for a central Lab facility to test their equipment interacting with the rest of the system
- If actual HW or SW is not available for pre CDR, simulators are made available, usable to test interfaces and Control and monitoring.
- The ITF management will support the System test and the Consortia to deliver parts and conduct the tests.
- The output from an ITF (hardware or software) is expected to work as individual products and work as a system. The products represent the final product, but may have prototype HW and SW.
- The consortia are expected to support the Integration efforts with local and/or remote support during System Integration testing & verification.
- The consortia will develop test programs in cooperation with the ITF support team.
- The consortia would provide working hardware to the ITF
- The ITF will run from the NSEC budget and providing the framework and supporting the system integration process, but the consortia is responsible for delivering the products, setting up and maintaining the *system under test* and the test programs.
- Simulation models required in the ITF must be included in the supply contract deliverables list.
- The system must be testable in Real Time.
- The AIV work package is awarded much earlier and AIV team key staff is in place at the point the ITF becomes operational (prior to CDR). Ideally providing good transfer of existing knowledge and experience.

Possible Constraints

- The availability of real prototype hardware and software through out the *system under test*
- The ITF will integrate and test a sub set of equipment, it will not find full system level 1 problems. High-level system problems shall be debugged in the Engineering Array/Autonomous Array.
- The potential of a distributed model would introduce Bandwidth and potentially cost constraints
- Time and cost (ITF not funded within the 650 million)
- Duplicate HW for the ITF is currently not budgeted for
- Transport and logistics
- Who is going to write the test software, test and qualification program?
- Currently no Level 1 system qualification requirements exist (measures of performance for system).

AIV Next Steps

- Agree funding for ITF(s)
- Agree locations of the Middle tier ITF(s)
- Obtain commitment from consortia to plan the release of HW/SW/FW to the ITF
- Agree ITF timeline, taking individual element lab verification (already planned) into consideration
- Progress ITF requirements document(s) and qualification requirements document
- Talk to consortia to identify early integration events in the lab (e.g testing of interfaces between SDP and Correlator/Telescope Model)
- Flesh out the requirements for each element for AR1 (this is the functionality required/achievable for the Lab Verification Event)

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