DRAFT VLA/EVLA Transition Observing System Development and Re-engineering Plan

03 September, 2004

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Revision History

Date	Version	Description	Author
10-Aug-04	1.0	Initial draft	Tom Morgan
18-Aug-04	1.1	Additions/corrections after initial review	Tom Morgan
24-Aug-04	1.2	Added design tasks to most phases, added some project management tasks, added assumption 7, added milestones, did some rewording and enhancement.	Tom Morgan
03-Sep-04	1.3	Modification to milestones, integrated diagrams	Tom Morgan

Introduction

The following describes a multi-phase plan of Monitor & Control (M&C) and Operations & Management (O&M, a.k.a. e2e) hardware and software design, development and deployment to accommodate the transition from VLA to combined VLA-EVLA and then to production EVLA observing operations while minimizing interruption of service.

Hardware Delivery Schedule

The delivery of EVLA Antenna and WIDAR Correlator hardware determines the dates by which certain Monitor & Control and Operations & Management functionality will be needed. The following is a time line of major hardware delivery and testing milestones. The dates are the most recent available and are subject to change.

Milestone	Date
Antenna 14 moved to Master Pad (and 13 to the array)	Oct 2004
Antenna 14 moved to the array (16 moved to M.P.)	Dec 2004
Four EVLA antennas on the array	Dec 2005
EVLA wideband testing using VLA Correlator	Jan 2006
Begin Prototype WIDAR Correlator on-the-sky testing	Apr 2006
End Prototype WIDAR Correlator on-the-sky testing	July 2006
WIDAR Correlator CDR	July 2006
Ten EVLA antennas on the array	Dec 2006
Begin Production WIDAR Correlator board installation	Nov 2007
Production WIDAR Correlator ready for software	Dec 2007
Sixteen EVLA antennas on the array	Dec 2007
WIDAR Correlator complete enough for observing	Mar 2008
Production WIDAR Correlator fully installation	July 2008
WIDAR Correlator available for start of commissioning	July 2008
Twenty-two EVLA antennas on the array	Dec 2008
End WIDAR Correlator commissioning (if begun in 7/08)	Mar 2009
Twenty-seven EVLA antennas on the array	Q4 2008
All EVLA antenna hardware upgrades completed	Q4 2011

Planning Assumptions and Constraints

There are a number of testing and operational assumptions and constraints which must be considered when planning the delivery of specific M&C and O&M functionality.

1) Shortly after antenna 14 is moved to the Master Pad there will be a need to conduct multiple EVLA antenna tests with it and antenna 13.
2) Antenna 14 is the first EVLA antenna that will be suitable for inclusion in the VLA for regular observing. As soon as antenna 14 is available for VLA science operations there will be a strong desire to use it.
3) It will not be possible to connect VLA antennas to the WIDAR Correlator. As a result, three EVLA antennas must be available before on-the-sky testing with the prototype WIDAR Correlator can be completed.
4) It will not be possible to use the MODCOMPS to handle EVLA antenna and WIDAR Correlator based metadata and correlation output. Therefore, the equivalent functionality must be available in the EVLA systems prior to on-the-sky WIDAR Correlator testing (April, 2006 for prototype hardware).
5) There will be sufficiently many EVLA antennas (16) by the time "shared risk" observing by external users with the WIDAR Correlator is scheduled to begin (Q2 2008) to allow significant scientific observing.
6) There will be at least 22 EVLA antennas by the time WIDAR Correlator commissioning is completed in March of 2009. Demand to use the array with the WIDAR Correlator for regular scientific observing will increase rapidly from this point.
7) It will be desirable to retire the MODCOMP systems prior to the end of VLA observing. Although it will be possible to continue using them for the VLA, it is assumed that from an operational and cost standpoint it will be preferable to employ the EVLA systems for M&C of VLA antennas and the VLA correlator, even though this will require the development of temporary software that will be discarded once VLA observing ceases.

Objectives and Dependencies

Consideration of the above hardware delivery schedule and assumptions and constraints allows the identification of system functionality that must be in place to support hardware testing, test observing and science operations objectives at various points during the VLA to EVLA transition. The following presents these objectives and a brief synopsis of their functional dependencies along with target completion dates and references to corresponding planning phases used in succeeding sections of this report.

Objective	**Dependencies**	**Target Date**	**Planning Phase**
1. Single EVLA antenna standalone testing	Single EVLA antenna monitor and control	Completed	-
2. Multiple EVLA antenna combined testing	Multiple EVLA antenna monitor and control	Oct, 2004	I
3. EVLA antenna(s) integration into VLA observing operations	EVLA antenna checking and flagging, EVLA access to ANTSOL and pointing offsets, generation of EVLA antenna capable control scripts	Jan, 2005	I
4. Prototype WIDAR Correlator standalone testing	Prototype Correlator Monitor and Control System (CMCS), Prototype Correlator Backend (CBE), Prototype EVLA DCAF	Q2 2005	Correlator Group
5. MODCOMP Systems Retirement	Duplication of all needed MODCOMP functionality on EVLA systems	Q4 2005	II and III
6. Prototype WIDAR Correlator on-the-sky testing	WIDAR output feed to VLA DCAF and Archive, EVLA Executor control of WIDAR Correlator, generation of WIDAR capable control scripts	Q1 2006	IV
7. Production WIDAR Correlator on-the-sky testing	EVLA DCAF and TelCal integrated into EVLA M&C System, EVLA prototype archive, prototype observing status function	Q3 2007	V
8. Production WIDAR Correlator shared-risk observing	EVLA antenna and WIDAR Correlator capable observing script generation ready for external use	Q1 2008	VI
9. Production WIDAR Correlator regular science observing operations	EVLA Proposal Submission, Observation Preparation, Scheduling and Science Archiving	Q1 2009	VII

Development and Re-engineering Plan

Introduction

The plan is broken-up into seven distinct phases of design, development and deployment of new software and supporting hardware systems. The phases are not meant to be conducted in a rigid serial fashion. Some, and possibly a great deal of overlap and concurrency should be anticipated. Completion dates are given based on hardware schedules. Start dates will depend on personnel availability and workload estimates that will be completed during Phase III.

The first three phases are primarily concerned with keeping the VLA operating as the new antennas are introduced. Phase IV begins the full scale effort of introducing permanent EVLA software systems.

Phases I, II and III secondarily, along with Phase IV, cover objectives leading to prototype WIDAR Correlator on-the-sky testing currently scheduled to commence in April, 2006. Prototype WIDAR Correlator on-the-sky testing will require the availability of basic EVLA M&C capabilities and the duplication of some critical MODCOMP functions in the EVLA software system. The WIDAR Correlator CDR is directly dependent upon these on-the-sky tests. Any delays in completing the tests could delay the CDR and potentially impact the delivery schedule of production WIDAR hardware.

The final three phases cover objectives leading to the commencement of regular scientific observing by external users once the WIDAR Correlator is commissioned. This part of the effort will be dominated by the completion of production worthy EVLA M&C functionality and the introduction of O&M functionality.

Diagrams detailing the deployment of functionality onto various computer systems along with data transfer and communications paths are provided for the first four phases of the plan. It should be noted that the software component boxes are meant to represent the presence of specific function. The actual design and implementation of particular functions will be worked-out by the developer responsible and may not be as a single monolithic software component. The next three phases, being further into the future, are less well determined. Deployment and other details for these and possible additional phases will be provided at some future date.

The current state of the system (as of 1 August, 2004) is shown in diagram 1. This configuration satisfies Objective 1 above and permits standalone testing of EVLA antennas while allowing for concurrent independent operation of the VLA. The only connections between VLA and EVLA systems are the attachment of EVLA antennas to the VLA D-Racks and a feed of VLA monitor data to the EVLA Archive.

Phase I

The primary objective of Phase I of the plan is to bring the EVLA and VLA software systems to the point where it will be possible to conduct multi-antenna EVLA testing (Objective 2) and use one or more EVLA antennas in the VLA (Objective 3). The array is scheduled to go into BnA configuration on 21 Jan, 2005. At this point it will be highly desirable to be able to incorporate one or more EVLA antennas into VLA observing. On 18 Feb, 2005 the array is scheduled to go into B configuration. The ability to use EVLA antennas is required at this time. Upon completion of the first task Objective 2 will be satisfied. At the end of task seven, Objective 3 will be satisfied.

A secondary objective of Phase I is to prepare for the full scale development of all EVLA software systems. Tasks 8 through 12 are directed toward this end. Phase I consists of the following tasks:

1) Introduce multiple EVLA antenna objects into script interpretation. The software now becomes an Executor prototype.

Completion date of task 1: Oct, 2004.

2) Prepare for VLBI use of antenna 13.
3) Establish an event synchronization connection between the MODCOMPS and the EVLA script interpreter and a mechanism on the MODCOMPS to deliver a signal at the start of a scan for example.
4) Build an EVLA flagger function on MCHOST and establish a connection to deliver flagging information to the MODCOMP DUMP function. This will allow the incorporation of EVLA flags into visibility data going to the VLA Archive.
5) Establish ANTSOL and pointing offsets connections from the MODCOMPS to the EVLA script interpreter. This will allow phased array observing and referenced pointing.
6) Build an EVLA antenna checker function on MCHOST. This function is needed to provide operators with a useable display of EVLA antenna status and module failure reports. Identify a set of additional operator screens and implement a starter set of functionality.
7) Provide a means of translating VLA observing scripts into an equivalent EVLA script. VLA operations using EVLA antennas will require the operators to independently submit separate scripts to the EVLA and VLA systems.

EVLA antenna incorporation into VLA observing should be possible at this point.

Diagram 2 shows the deployment of the EVLA and VLA system components at the completion of task 7. Phase I tasks 1 through 7 must be completed before EVLA antennas can be used for regular VLA operations.

8) Identify all other MODCOMP functionality needed on the EVLA systems. This must be done to assure all required components are in place by the end of Phase III.
9) Define, agree upon and formally accept (i.e., document) a code management system, a standard software build methodology, programming languages, software utilities, a set of programming standards and practices, and a documentation scheme (including the types of documents to be produced, the point at which they are required and a numbering scheme).
10) Based upon experience gained during tasks 1 to 7 above, define, agree upon and formally accept a communications method or set of methods tied to specific communications requirements to be used for all further M&C development and to serve as the starting point for O&M prototyping and development.
11) To the extent possible without interfering with the primary objective of completing tasks 1 to 7 by Jan, 2005, begin detailed design work on EVLA M&C and O&M sub-systems. By integrating this work with Phase I development it should be possible to minimize the amount of temporary code that is built. A set of milestones for the continuation of the design effort through 2005 will be established. Design documentation standards will be established at the same time.
12) Define, agree upon, and formally accept an applications deployment scheme, including server configuration-control, access policies, service-level agreements for deployed applications, and procedures for the validated transition of applications from development, through internal and external testing, to production deployment.

Completion date of Phase I: Jan, 2005.

Phase II

Phase II of the plan is an intermediate point along the way to shifting all needed MODCOMP systems functionality to EVLA based M&C systems. It consists of the following tasks:

1) Install the new controller unit on the existing correlator. This will remove the need to control the VLA correlator with a MODCOMP. Spectre and the array processor can be retired.
2) Migrate ANTSOL, pointing offsets and part of the DUMP function from the MODCOMPS to a separate LINUX computer. This task creates a VLA DCAF component. At initial deployment it will simply combine pre-built headers supplied by the DUMP function on the MODCOMPS with the correlator output. It will forward the results to ANTSOL and directly to the VLA Archive, thus removing the need for MODCOMP support of the VLA Archive.

Diagram 3 shows the deployment of the EVLA and VLA system components at the completion of Phase II tasks 1 and 2. These should be completed by the middle of 2005 in order to keep on track to support on-the-sky testing of WIDAR Correlator prototype hardware.

3) Design efforts begun in Phase I will be expanded to include all sub-systems not yet addressed and the prototyping of major M&C and O&M components in a combined system.
4) Evaluation of O&M communication methods will commence.
5) At the beginning of the phase, tracking of milestones defined during Phase I will commence.
6) A progress review will be held at the end of the Phase. (This may be an appropriate point to hold an M&C PDR.)

Completion date of Phase II: Q2 2005.

Phase III

Phase III completes the effort of offloading all MODCOMP based functionality and allows their retirement (Objective 5). It consists of the following tasks:

1) Build functionality that consumes VLA monitor data and produces EVLA type alerts. Route the output to the EVLA checker function. At this point it should be possible for operators to receive status (Checker) information from both EVLA and VLA antennas with the EVLA system.
2) Build functionality that consumes VLA monitor data and produces flags. Route the flags to the EVLA flagger function where they will be combined with EVLA flags and sent on to the DCAF function. At this point the VLA Archive will still be in use, so all flags are still VLA style.
3) Build a VLA antenna object to allow control by the EVLA Executor. VLA antenna commands will be derived from EVLA observe script input.
4) Build a VLA correlator object to allow control by the EVLA Executor. VLA correlator commands will be derived from EVLA observe script input.
5) Integrate the VLA system parameter data base into the EVLA system parameter data base. This will be needed by the Executor for controlling VLA hardware.
6) Move VLA header data construction (in DUMP) from the MODCOMPS to VLA DCAF. The VLA DCAF will now be supplied with all metadata input.
7) Implement as needed on the EVLA systems, other MODCOMP functionality identified during Phase I task 8.

At this point it should be possible to control VLA, EVLA antennas and the existing correlator without the MODCOMPS. Diagram 4 shows this state. Diagram 5 shows the systems after the MODCOMPS have been removed. The current target date for retiring the MODCOMPS is 31 Dec, 2005.

8) An O&M communications method or set of methods tied to specific communications requirements will be agreed upon and formally accepted.
9) All EVLA software design work will be completed by the end of Phase III. Development tasks will be derived from the detail subsystem designs and level of effort estimates will be made for each task. From this a project plan and schedule

(that either enhances or supercedes this document) including at a minimum a tracking system, development, test and integration milestones, development dependencies and identification of responsible parties will be created.

10) A final review of all detailed subsystem designs will be held by year end 2005. The project plan and schedule will be presented at the final review. (This may be an appropriate point to hold an M&C CDR, and an O&M PDR.)

Completion date of Phase III: Q4 2005.

Phase IV

Objective 4, standalone WIDAR Prototype testing will be satisfied by the separate (already ongoing) design, development and deployment of prototype CMCS, CBE and EVLA (FITS) DCAF facilities by the Correlator development group. The initial phase of prototype WIDAR testing will be done in a standalone mode with direct configuration of the correlator and backend from test interfaces. The EVLA DCAF component attached to the Backend will be needed, but connection to ANTSOL will not be necessary. This work must be completed by mid 2005.

Phase IV prepares the EVLA systems to handle on-the-sky testing of prototype WIDAR Correlator hardware (Objective 6). From this point on the subsystem designs and project plan produced in Phase II will apply (and therefore may enhance or supercede the remaining parts of this plan). The following tasks are involved:

1) Integrate the Correlator Monitor and Control System (CMCS) with EVLA M&C. At a minimum it should be able to configure the WIDAR Correlator and capture a meaningful set of monitor data. It should also be possible to forward configuration information to the Correlator Backend (CBE).
2) Integrate the CBE and EVLA prototype DCAF with EVLA M&C and Archive. The base functionality of the CBE system should be present along with a meaningful amount of monitoring capability.
3) Metadata from the system Executor must be delivered to the EVLA DCAF. This will be needed to produce output in a form suitable for external analysis.
4) Provide a prototype direct EVLA observing script builder.
5) Add WIDAR configuration capabilities to the EVLA observing script builder.
6) Add a WIDAR Correlator object to the Executor.
7) Provide a prototype EVLA archive.

Completion date of Phase IV: Q2 2006.

Upon completion, support for on-the-sky WIDAR Correlator testing will be present. Diagram 6 shows system deployment at the end of Phase IV. (This may be an appropriate point to hold an O&M CDR.)

Phase V

At the end of Phase V Objective 7, Production WIDAR Correlator on-the-sky testing will be supported. Two Tasks are involved:

1) Complete the production EVLA DCAF and integrate it into the EVLA M&C systems.
2) Complete the production EVLA TelCal and integrate it into the EVLA M&C systems.

Completion date of Phase V: Q3 2007.

Phase VI

At the end of Phase VI Objective 8, Production WIDAR "shared risk" observing by external users will be supported. Two tasks are involved:

1) Complete and deploy a combined EVLA antenna and WIDAR Correlator capable observing script generation capability that is ready for external use.
2) Introduce the use of a prototype observing status tool. The functionality of this software will be defined during the design work in Phases II and III.

Completion date of Phase VI: Q1 2008.

Phase VII

At the end of Phase VII Objective 9, Production WIDAR Correlator regular science observing will be supported. Four tasks are involved:

1) Complete and deploy a production EVLA Proposal Submission facility. It is expected that this will be based upon the GBT facility currently under development.
2) Complete and integrate a production scheduling mechanism into the EVLA M&C systems. The scheduler at this point should be able to produce a schedule of observations covering periods of a day to a month and be capable of employing atmospheric, environmental and equipment state information. Standalone operation will be acceptable.
3) Complete and deploy a production EVLA Science Archive.
4) Complete and deploy a production observing status tool.

Completion date of Phase VII: Q1 2009.

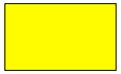
KEY

SYSTEM COMPONENTS

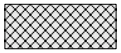
Hardware System or Component

Software Function

Data Source or Sink



Control Script



Redundant Component or Data Flow Path

DATA PATHS

Control Information Flow

VLA Monitor Data Flow

EVLA Monitor Data Flow

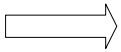
Combined VLA, EVLA Monitor Data Flow

Flags

Delays and Offsets Data Flow

Metadata (Headers)

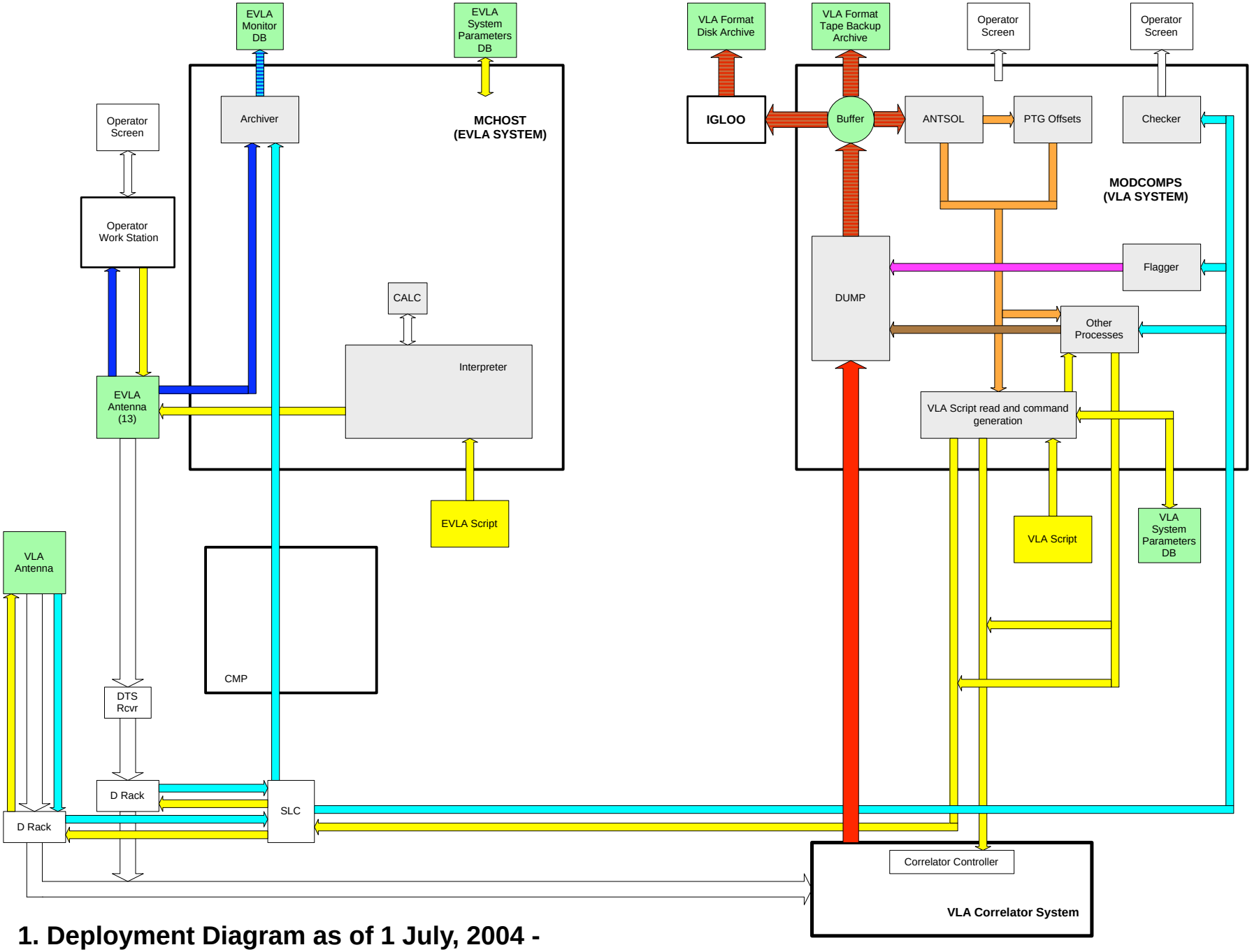
Display Data Flow



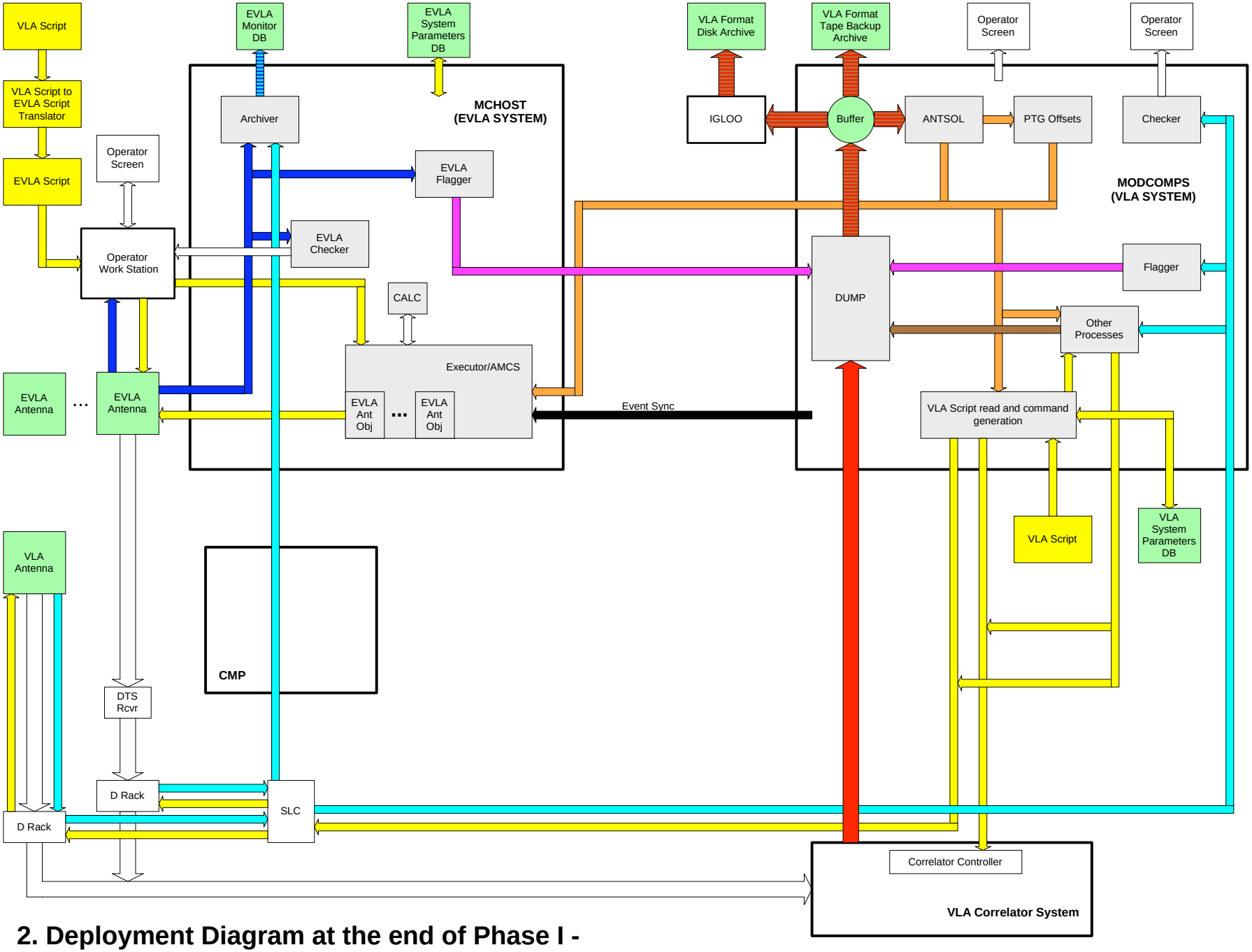
Raw Antenna Signal

Correlator Output Data

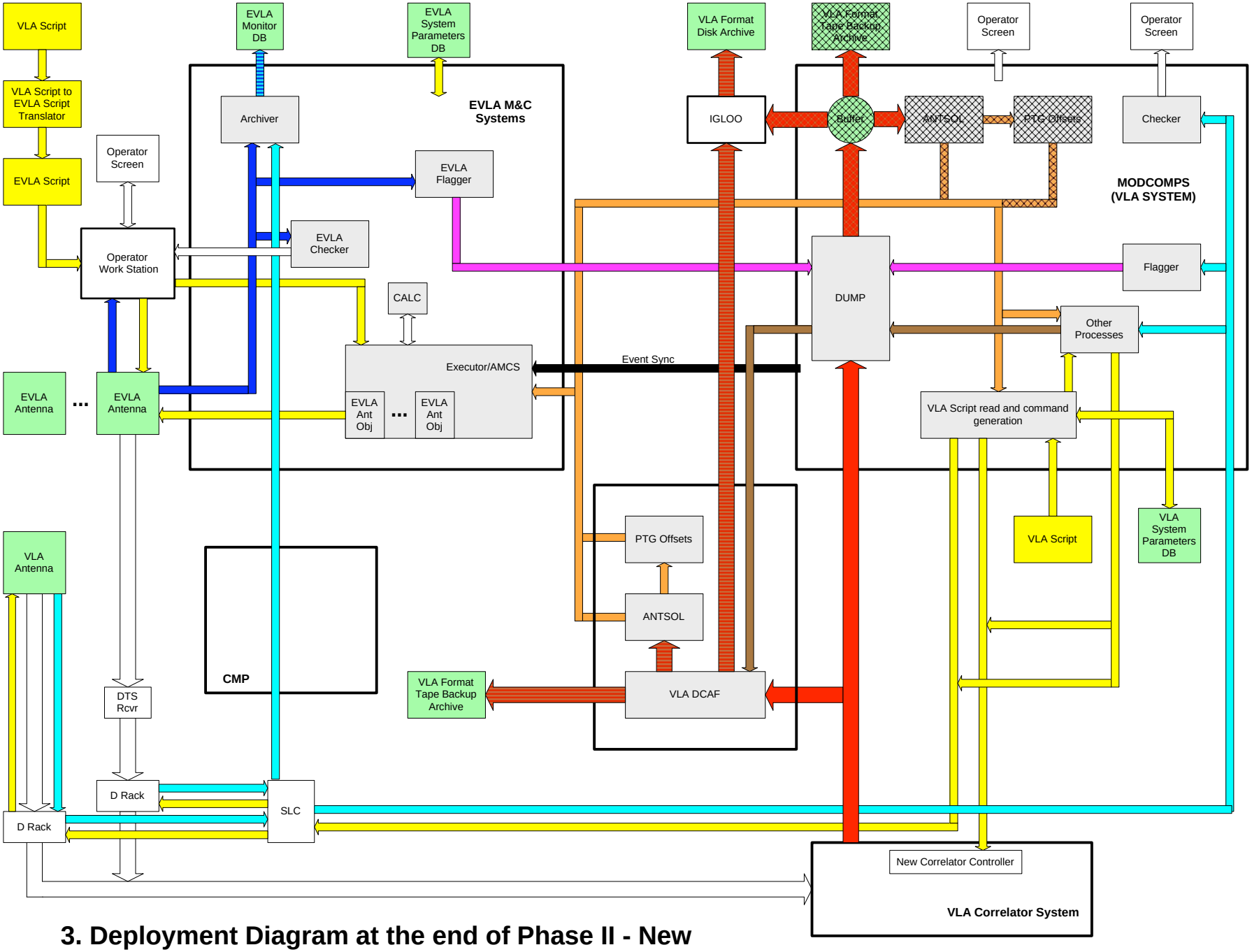
Combined Correlator and Metadata Output



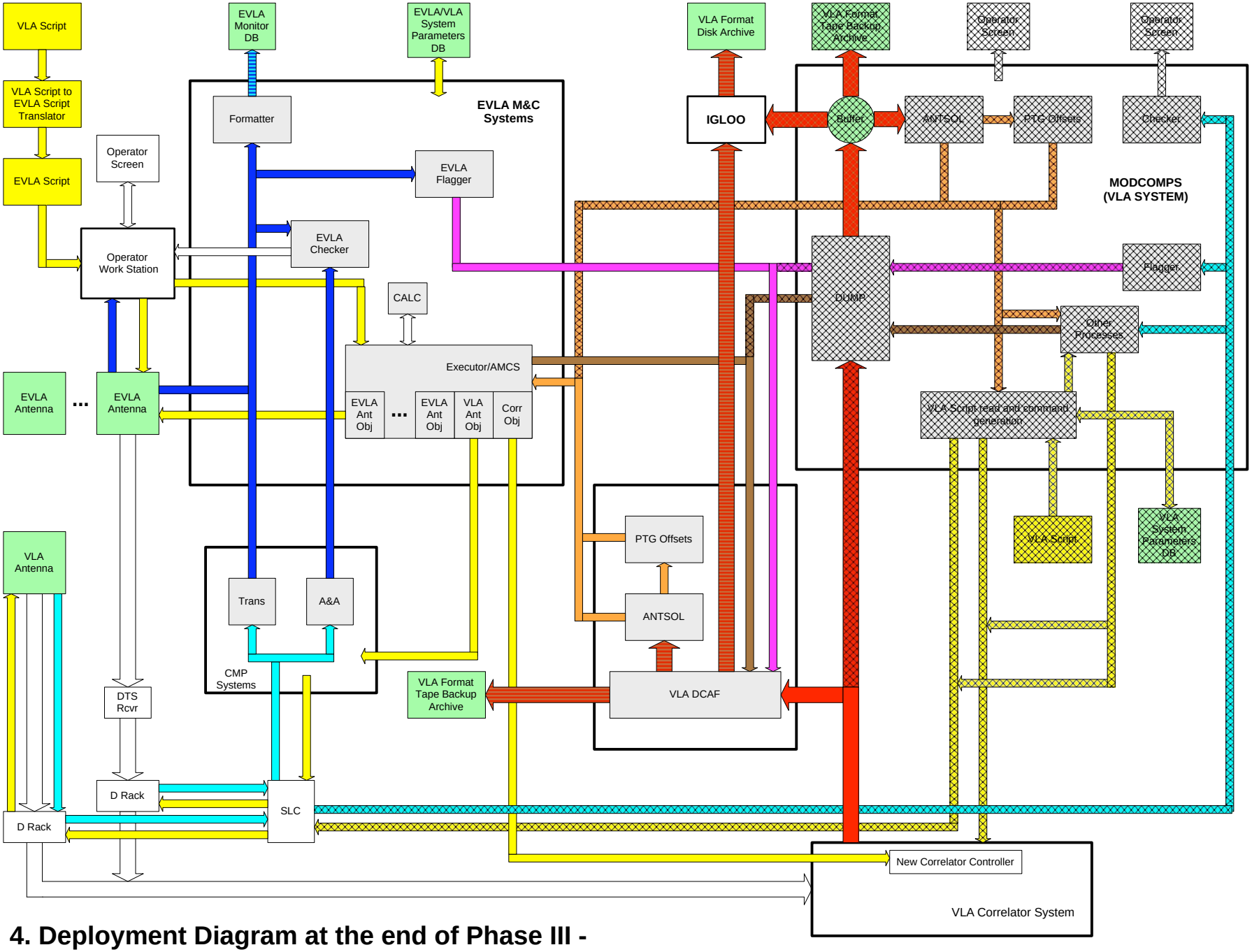
1. Deployment Diagram as of 1 July, 2004 - Standalone EVLA Antenna Testing



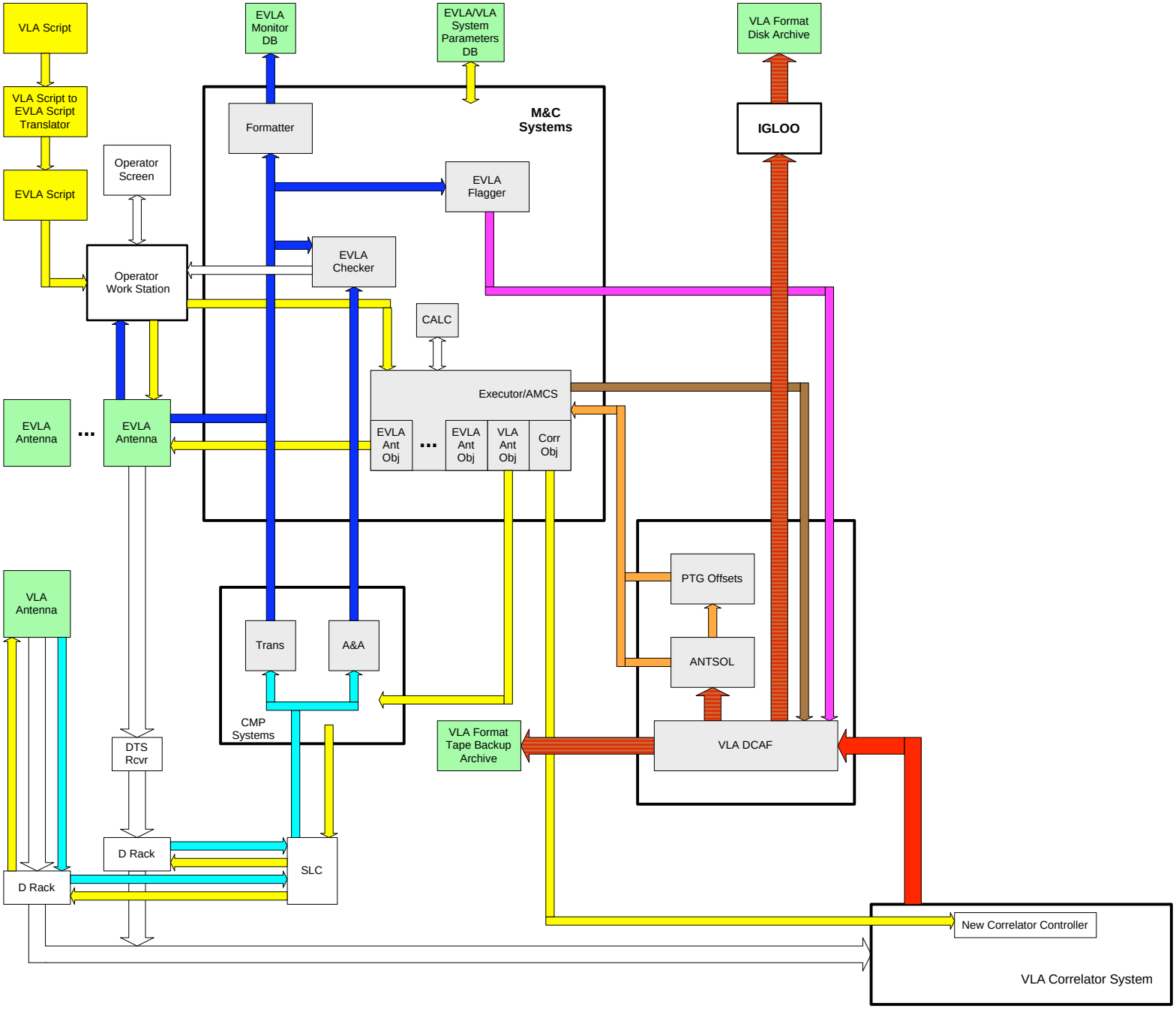
2. Deployment Diagram at the end of Phase I - Integrated VLA/EVLA Antenna Observing



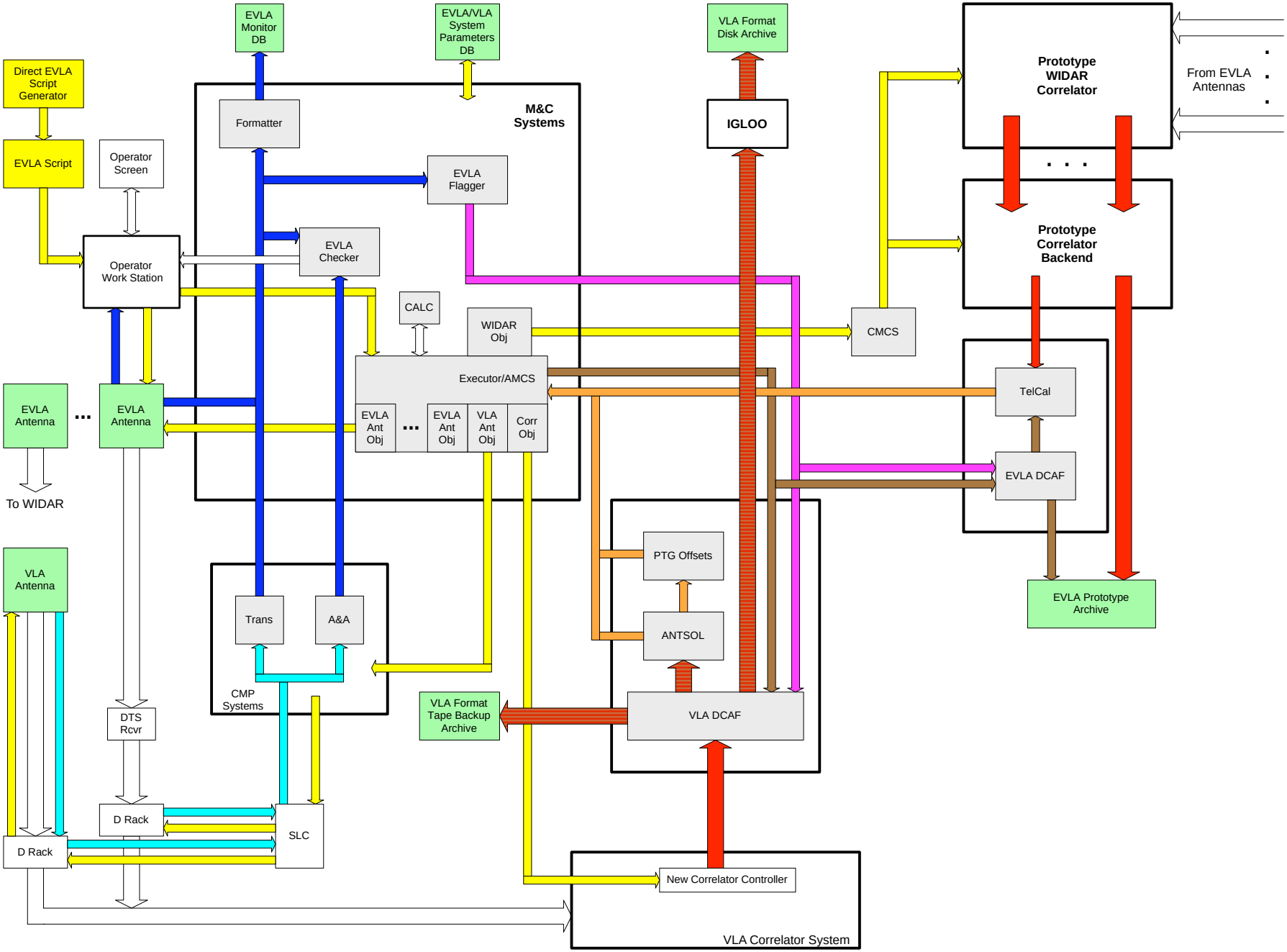
3. Deployment Diagram at the end of Phase II - New Correlator Controller, Partial MODCOMP Function Offload



4. Deployment Diagram at the end of Phase III - Complete MODCOMP Function Offload



5. Deployment Diagram with MODCOMPS Retired



6. Deployment Diagram at the end of Phase IV - Ready for On-the-Sky WIDAR Testing