EVLA BACKEND SYSTEM REQUIREMENTS (PRELIMINARY)

Thomas R. Morgan 31 January 2002

I. Outline

A. Performance

1. Hardware
2. Software

B. Data Processing

1. Math / Science Processes
2. Data Manipulation
3. Data Integrity

C. Communications

D. Monitor and Control

E. Scalability

F. Reliability / Availability

G. Serviceability

H. Maintainability

II. Performance

A. Hardware

1. Capable of accepting an aggregate data input stream from the correlator of a minimum of 1.6 Gbytes / sec without loss or delay.
2. Capable of delivering an output data stream to the e2e System of a minimum of 25 Mbytes / sec without loss or delay.
3. Requirements 1. and 2. above must be satisfied simultaneously, but not necessarily over the same interfaces.
4. Sufficient CPU capability and storage resources to accomplish all data processing tasks while avoiding loss or delay on the input and output data streams.
5. Sufficient excess processing and storage resources to meet short duration correlator bursting output demands. (Bursting demands TBD.)
6. Sufficient excess processing resources to provide for standby capability to meet reliability demands.
7. Sufficient excess storage resources to handle temporary overflows required to meet outage survivability demands.

8. Sufficient storage reserves to cache a defined amount (TBD) of data in the event of loss of connection to the e2e System, and sufficient spare I/O resources to download cached data to the e2e System without impacting regular operations once the connection has been restored.
9. Sufficient computational reserves to operate on excess cached input data in catch-up mode in the event of an input data build-up due to loss of availability of critical ancillary data (e.g., Station Data).

B. Software

1. FFT and other math/science application software must take optimal advantage of all system computational resources to reduce run times to the minimum practical level.
2. All I/O and storage operations must take optimal advantage of all system resources to reduce overhead and latency to the minimum practical level.

III. Data Processing

A. Math / Science Processes

1. Power-of-two complex-complex Fast Fourier Transform with retention of all output positive and negative frequencies.
2. Data windowing (with tapers ?).
3. Interference excision.
4. Interference cancellation.
5. Other functions (TBD).
6. Functions should be chainable (inputs matched to outputs) in cases where this makes computational sense.
7. Functions should be repeatable in the chain in cases where this makes computational sense.

B. Data Manipulation

1. Ordering of incoming correlator lag frames into continuous time series appropriate for processing.
2. Queuing of input data for processing.
3. Queuing of output data for transfer to the e2e System.

4. Matching of input data with configuration, station and other data and organization into an as yet to be specified output format (FITS ?) suitable for use by the e2e System.
5. Integration of math/science processes generated metadata into the output format of 4. above.

C. Data Integrity

1. Maintain input data fidelity and dynamic range across all processing, manipulation and I/O functions.
2. Capable of flagging and marking corrupted data segments and proceeding without interruption or effect on other data. This includes but is not limited to partial data, zero data, underflows, overflows, and NaNQ's whether obtained on input or arising during processing.

IV. Communications

A. Request and obtain any necessary parameters and system states for the correlator and the e2e System.

B. Obtain and acknowledge receipt of data from the correlator.

C. Obtain and acknowledge receipt of configuration data.

D. Obtain and acknowledge receipt of station data.

E. Deliver and receive acknowledgement of data to the e2e System.

F. Obtain and acknowledge receipt of correlator mode changes.

G. Deliver (without being probed) and receive acknowledgement of internal Backend System state changes as they occur. (These changes could be due to hardware failure, software hangs or crashes, and resultant swapping-in of new resources.)

H. Deliver (without being probed) and receive acknowledgement of external interface operations below specification as they are detected.

V. Monitor and Control

A. The Backend System must be testable from the outside. It must be able to accept and deliver upon requests made to determine its run state.

B. The Backend System must be self monitoring and able to detect, report on (without being probed) and take action to remedy the following abnormal conditions:
   1. Processor hardware failure.
   2. Processor operating system hangs or crashes.
   3. Software application hangs or crashes.
   4. Computational performance below minimum specifications.
   5. Computational error rate (e.g., underflows, overflows, NaNQ's) above maximum specification.
   6. Internal communications disruption or performance below minimum specifications.
   7. External communications disruption.

C. The Backend System must be able to detect and report on the following abnormal conditions:
   1. External communications performance below minimum specifications.
   2. Loss of internal storage resources.
   3. Loss of internal communications resources.
   4. Loss of internal compute resources.

VI. Scalability

A. I/O and communications hardware must be easily expanded, reconfigured, augmented or replaced to meet increasing data transfer demands imposed by EVLA science, correlator changes, and new technologies.

B. Processing and storage must be augmentable or replaceable to meet increasing demands and take advantage of new technologies.

C. A. and B. above must be accomplishable in a manner that is transparent to processing and I/O functions with the possible exception of recompilation/rebuilding of software executables.

D. A. and B. above must be accomplishable in a manner that is seamless, in that it does not affect hardware modules or software functionality that it meets at its interfaced.

E. Performance must ultimately be scaleable to up to 2 Gbytes (?) per second per correlator output channel.

VII. Reliability / Availability

A. The software part of the Backend System should be able to ultimately perform without reboot due to internal failure for a minimum of 30 days. (Generally the current period between array maintenance slots.)

B. The hardware part of the Backend System should be able to ultimately perform indefinitely without complete loss of service, except in the event of a total failure of primary and backup power.

C. The hardware and software systems must be capable of responding in a loss-less manner to changes in the input and output data rates and correlator mode changes.

D. The Backend System should continue to operate in the event of a temporary loss of connection to the e2e System.

E. In the event of a loss of connection to the correlator, the Backend System should be able to complete processing of all onboard data, deliver the results to the e2e System and maintain availability for immediate resumption of operations once the lost connection(s) are restored.

F. Continue normal operations, although not necessarily at full capacity, on all unaffected resources during partial shutdowns for maintenance, repair and/or upgrade.

G. Continue to operate in the absence of the external M/C System until the first encounter of unavailable critical data.

H. Be able to cache a predetermined amount (TDB) of correlator data after the first encounter of unavailable critical data (see G. above) and complete all requested operations on the cached data once the unavailable critical data is obtained.

I. Be able to sit at idle and restart operations with minimal delay (amount TBD).

J. Be able to handle non-real-time operations in a transparent fashion (i.e., as if real-time).

K. Act on correlator mode changes without loss of any old mode data and no loss of new mode data (except for a reasonable start-up delay).

VIII. Serviceability

A. All system processing and interconnect hardware must be readily accessible for maintenance, repair, replacement, and/or reconfiguration.

B. Maximal practical use of available “hot-swappable” devices and components should be made.

C. All system and data processing source code should be available to or on the systems that execute it.

D. Software application modules must be debuggable.

E. Software processes must be killable, restartable and testable without affecting normal operations.

IX. Maintainability

A. Complete and easily comprehendible hardware systems specifications and configuration information should be readily available.

B. Software system and application code should be well documented and written in a generally familiar language or languages (preferably not more the two).

C. Software should be written in a style that is easily readable and using practices that allow for minimal confusion.

D. Software tools and pre-built applications that do not have source code available must come with a complete diagnostic package and customer support.

E. Operating systems should either have source code available or come with sufficient diagnostics and customer support.