EVLA System PDR
System Overview

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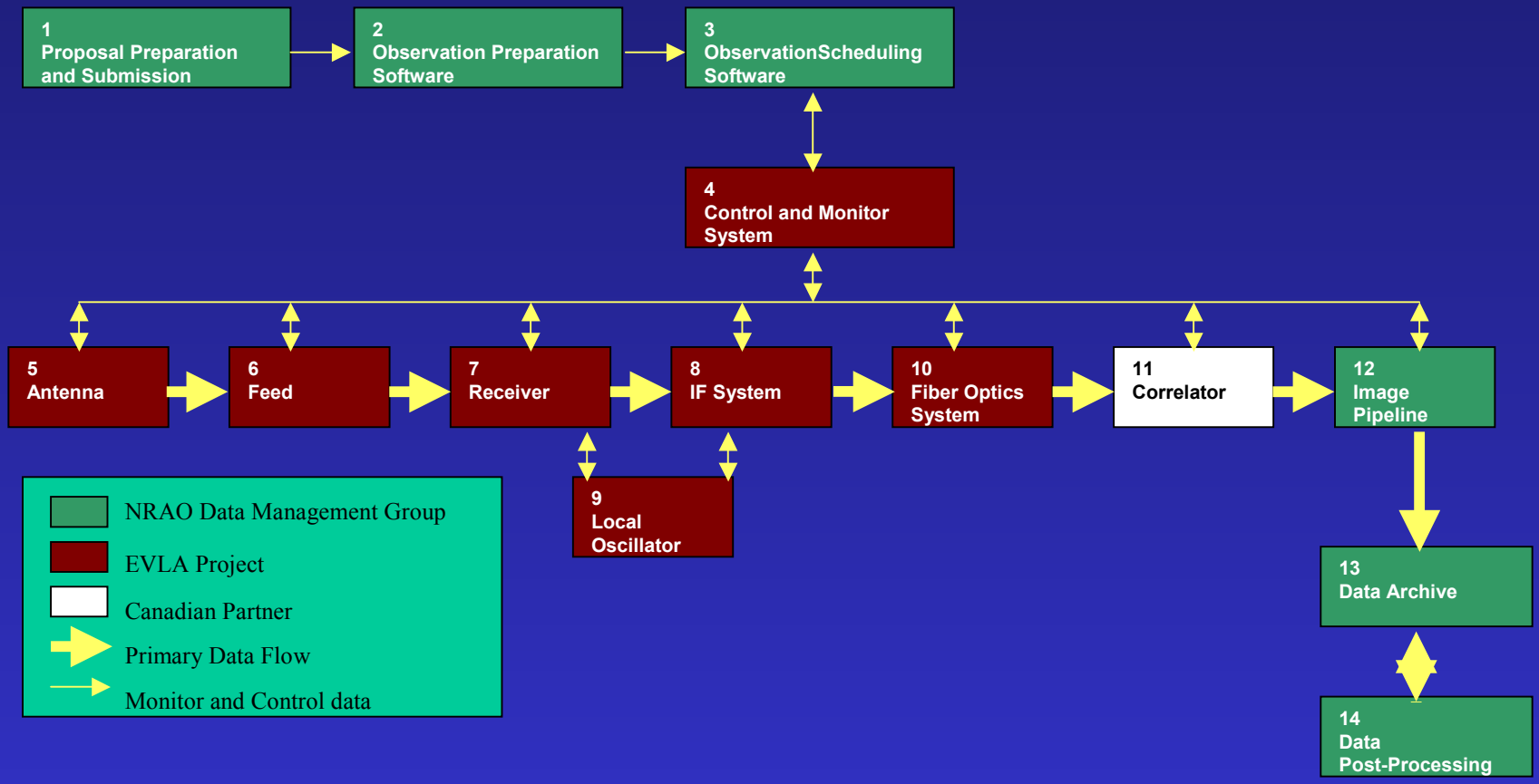
What will be Replaced?

- Most feeds and front end electronics
- All LO/IF electronics
- IF transmission system
- All monitor & control electronics
- Correlator
- Computing systems / software

EVLA Subsystems



Antennas

- Use 28 existing VLA antennas
- No change to quadrapod or subreflector
- Modify feed cone and vertex room for new front ends and electronics
- Modify or upgrade encoders and servo system for improved pointing and tracking, especially for super-sidereal tracking modes

Frequency Coverage

VLA BAND	FREQUENCY	FREQ RANGE	POLARIZATION
4	74 MHz	73.5 – 74.5 MHz	RHCP/LHCP
P	327 MHz	300 – 340 MHz	RHCP/LHCP
L	1.5 GHz	(1.0)1.2 – 2.0 GHz	RHCP/LHCP
S	3.0 GHz	2.0 – 4.0 GHz	RHCP/LHCP
C	6.0 GHz	4.0 – 8.0 GHz	RHCP/LHCP
X	10.0 GHz	8.0 – 12.0 GHz	RHCP/LHCP
U	15.0 GHz	12.0 – 18.0 GHz	RHCP/LHCP
K	22.0 GHz	18.0 – 26.5 GHz	RHCP/LHCP
Ka	33.0 GHz	26.5 – 40.0 GHz	RHCP/LHCP
Q	43.0 GHz	40.0 – 50.0 GHz	RHCP/LHCP

Projected Receiver Temperatures

VLA BAND	FINAL T_{RX} (K)
L	8.8
S	13.8
C	18.9
X	20.7
U	21.4
K	28.0
Ka	37.7
Q	44.1

IF Frequencies

(for wideband sampling)

VLA BAND	Conv LO	Conv IF	1'st LO	1'st IF	2'nd LO	2'nd IF
4	1.024	1.098	13	11.902	14.8	2.898
P	1.024	1.351	13	11.649	14.8	3.151
L			13	11-10	14.8	2-3
S			13	10-8	14.55	2-4
C			16	12-8	14.0-14.8	2-4
X			N/A	N/A	10.8-14.8	2-4
U			24-26	12.5-7.5	10.8-14.8	2-4
K			30-36	12.5-7.5	10.8-14.8	2-4
Ka			36-48	12.5-7.5	10.8-14.8	2-4
Q			51-60	12.5-7.5	12.0-14.0	2-4

IF Frequencies

(for high resolution sampling & transition)

VLA BAND	Conv LO	Conv IF	1st LO	1st IF	2nd LO	2nd IF	3rd LO	3rd IF
4	1.024	1.098	13	11.902	14.8	2.898	4.096	1-2
P	1.024	1.351	13	11.649	14.8	3.151	4.096	1-2
L			13	11-10	14.8	2-3	4.096	1-2
S			13	10-8	14.55	2-4	4.096	1-2
C			16	12-8	14.0-14.8	2-4	4.096	1-2
X			N/A	N/A	10.8-14.8	2-4	4.096	1-2
U			24-26	12.5-7.5	10.8-14.8	2-4	4.096	1-2
K			30-36	12.5-7.5	10.8-14.8	2-4	4.096	1-2
Ka			36-48	12.5-7.5	10.8-14.8	2-4	4.096	1-2
Q			51-60	12.5-7.5	12.0-14.0	2-4	4.096	1-2

LO System

- New hydrogen MASER
- GPS timing reference
- Fiber optic distribution
- Round trip phase measurement

Wideband Digitizers

- 4.096 giga samples / second
- 3 bits / 8 level
- 2-4 GHz harmonic sampling
- 256 MHz LVDS parallel data output
- Being developed for ALMA at the University of Bordeaux in France

High Resolution Digitizers

- 2.048 giga samples / second
- 8 bits / 256 level
- 1-2 GHz harmonic sampling
- 256 MHz LVDS parallel data output
- Two Maxim MAX108 devices interleaved
- Supports high resolution observing and VLA to EVLA transition phase

IF Data Transmission

- Fiber optic based system
  - Twelve 10 gigabit per second links per antenna
  - Based on SONET/OC-192 technology
  - Using hardware designed for ALMA
    - Slightly modified for longer baselines / VLBI
    - Receiver uses different physical packaging

Transition Interface

- Use digital FIR filters and D/A converters to regenerate 64MHz analog IF signals
- Feed to VLA digitizers via existing baseband filter and driver modules
- FIR's and D/A converters may be combined with EVLA data transmission system receiver modules

WIDAR Correlator

- Being developed by HIA/DRAO in Canada

Number of Stations	32 (installed racks for 40; architecture supports up to 256).
Max spectral channels/baseline @ max bandwidth	16,384 (more with "wideband recirculation" and sensitivity losses).
Max spectral channels/cross-correlation with recirculation	262,144
Polarization products	1, 2 or 4
No. of basebands/antenna	8 x 2 GHz each (more with narrower bandwidths)
Quantization	1, 2, 3, 4, or 8-bit initial quantization; 4 or 7-bit re-quantization after sub-band filter.

WIDAR Correlator

Correlator efficiency	~95% (4-bit initial quantization, 4-bit re-quantization, 5-level fringe rotation)
Sub-band bandwidth	128 MHz, 64 MHz, 32 MHz, …, 31.25 kHz (2-stage radar-mode). Each sub-band's width and position can be set independently of any other sub-band.
Sub-band tuning	Each sub-band should remain within an appropriate integer slot to minimize band edge SNR loss. E.g. a 128 MHz sub-band should be within 1 of 16 equally spaced slots in a 2.048 GHz band.
Spectral dynamic range	(Initial quantization) 3-bit: ~44dB; 4-bit: ~50dB; 8-bit: ~58dB.
Auto-correlations	Wideband (4x2 GHz pairs): 4 products of 1024 spectral channels each, SNR loss of 4. Sub-band: 16,384 total spectral channels per station (widest sub-band), no SNR Loss.

Monitor & Control

- Ethernet based system
- 100 megabit fiber in antennas
- 1 gigabit fiber CEB to antennas
- 100 Mbps and 1Gbps fiber and TP in CEB
- Standard interface circuit(s) being developed for modules and correlator

Power Supplies

- 48 VDC in antennas and correlator
  - Lower current distribution
  - Components widely used in telecom industry
- Combination of linear and switching regulators
- Backup power on critical subsystems

Racks/Bins/Modules

- Use a modified version of existing designs
  - Improved RFI characteristics
    - More high speed digital circuits in antennas and CEB
    - Wider bandwidth front ends
  - Improved Thermal characteristics
    - Heat generated by high speed digital electronics
    - RFI sealed modules/racks present greater challenge
    - Greater thermal stability for LO/IF electronics

System Availability

- Equal or better system availability statistics as existing VLA system
- Purchase and maintain adequate spares
- Purchase and maintain all tooling required to support the system over its lifetime
  - Software & programmable logic tools
  - Surface mount rework tools

RFI Considerations

- External RFI
  - More RFI sources
    - Ground and space based
    - Cell phones / PCS
    - Satellite radio / television broadcasting
    - DME / military & civilian radar / super doppler weather radar
  - More sensitive front ends
  - Environmental Monitoring System (EMS)
    - Located at VLA site
    - Collecting data for use in system design

RFI Considerations

- Internal (VLA site generated) RFI
  - High speed digital electronics
    - Digitizers, data transmission system, correlator
  - More and faster computers on site
  - Comb generators in 6 synthesizers per antenna
  - Wider IF bandwidths
  - Switching regulators
  - Alma test interferometer on site

RFI Considerations

- Solutions:
  - WIDAR correlator design
  - High resolution digitizers at antenna
  - High dynamic range IF system
  - New shielded room for correlator
  - Improved rack/bin/module designs
  - Flexible system design
    - Fast total power measurement, variable gain, test points, etc…
  - Low emission electronic design techniques

Solar Observation

- Solar Calibration
- Solar Attenuators
- Rapid T_{SYS} Measurement

Questions?