VLBA Status

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Outline

- Current issues
- Infrastructure activities
- Ongoing development activities

Current issues: COVID-19

- VLBA continues to operate
  - Operations and site staff are reporting to work
  - Most others working from home
  - Upcoming call for proposals unlikely to be affected
  - All antennas still functioning
- Maintenance is more difficult
  - Inter-site travel suspended
  - Major maint visits are on hold (usually 2-3 per year)
  - Saint Croix repairs nearly completed, but on hold
- Development work slowed
  - Software largely locked-down but development continues
- NRAO will begin ramping up return-to-office in early June

Current issues: cold weather operation

- Parts in the Focus/Rotation subreflector mount suffer high failure rates in cold temperature (below 10F)
- A study is underway to determine best way to proceed
  - Different lubricants?
  - Stronger, less brittle, materials for key parts?
  - Heaters on key mechanisms?
- Goal: robust operation down to at least 0F
  - Much less than 1% of observing time

Ongoing infrastructure activities

- Geodetic-grade GPS receivers at all VLBA sites
  - Used by geodesists and astronomers
  - 5 sites have receivers now
    - UNAVCO had these units deployed
    - Data made available to public
  - NGS expressed interest in funding deployment
    - Timescale uncertain
- New weather stations
- New "E"-rack in VLBA antenna receiver cabin
  - Room for new equipment, including new samplers
  - Designed to prevent EMI from digital equipment from entering receivers
  - Will implement modern power supplies and diagnostic capabilities

E-rack at Pie Town

Ongoing development activities

- High-speed network to VLBA sites
  - Improved diagnostics
  - New low-latency capabilities
  - Improved inter-operability with IVS, EVN
- New synthesizers
  - Antenna maintainability
  - Improved tuning flexibility (inter-operability, RFI avoidance)
- VLBA New Digital Architecture
  - Expansion of capabilities / increase in flexibility
  - Antenna maintainability
  - RFI immunity
  - External user opportunities
- Mark5 units to be retired in June 2020

High speed networks

- NSF-funded initiative
- All 10 VLBA sites to reach 200 Mbps network service
  - Operation of links funded for 2-3 years
- All 10 VLBA sites internally ready for 10 Gbps
- 1 VLBA site to achieve 5+ Gbps service (if opportunity allows)
  - Would serve as experiment to move data recorder to Socorro

- Progress
  - 8 sites have >=200 Mbps service
    - MK, PT, KP operating at 1 Gbps
  - LA and HN under contract
    - Completion delayed; expected by September

L404B synthesizer modules

- Old (L104) synthesizers have limited capabilities
  - Very coarse tuning at alternating 200 and 300 MHz steps
  - Concern about long term maintenance
- New units arbitrarily tunable
  - Any frequency between 2 and 16 GHz
    - More tuning range than L104, anticipating need by Ka-band receiver
  - Uses an NRAO-patented phase-locked direct digital synthesizer in combination with comb generator
- Progress
  - One unit deployed
  - Remainder of units to be deployed by approx. summer 2021

VLBA New Digital Architecture (VNDA)

- Existing sampler / digital channelizers (RDBEs) are becoming difficult to maintain with obsolete components
- Replacement system developed to following philosophies
  - Use commercial off-the-shelf (COTS) hardware where possible
  - Use standard interfaces and data formats where possible
  - Self diagnostic capabilities designed in from start
  - MTBF-informed design
  - Consider downstream obsolescence
  - Digitize as close to receivers as possible
  - Use multicast, to allow flexible re-use of signals

VLBA New Digital Architecture (VNDA)

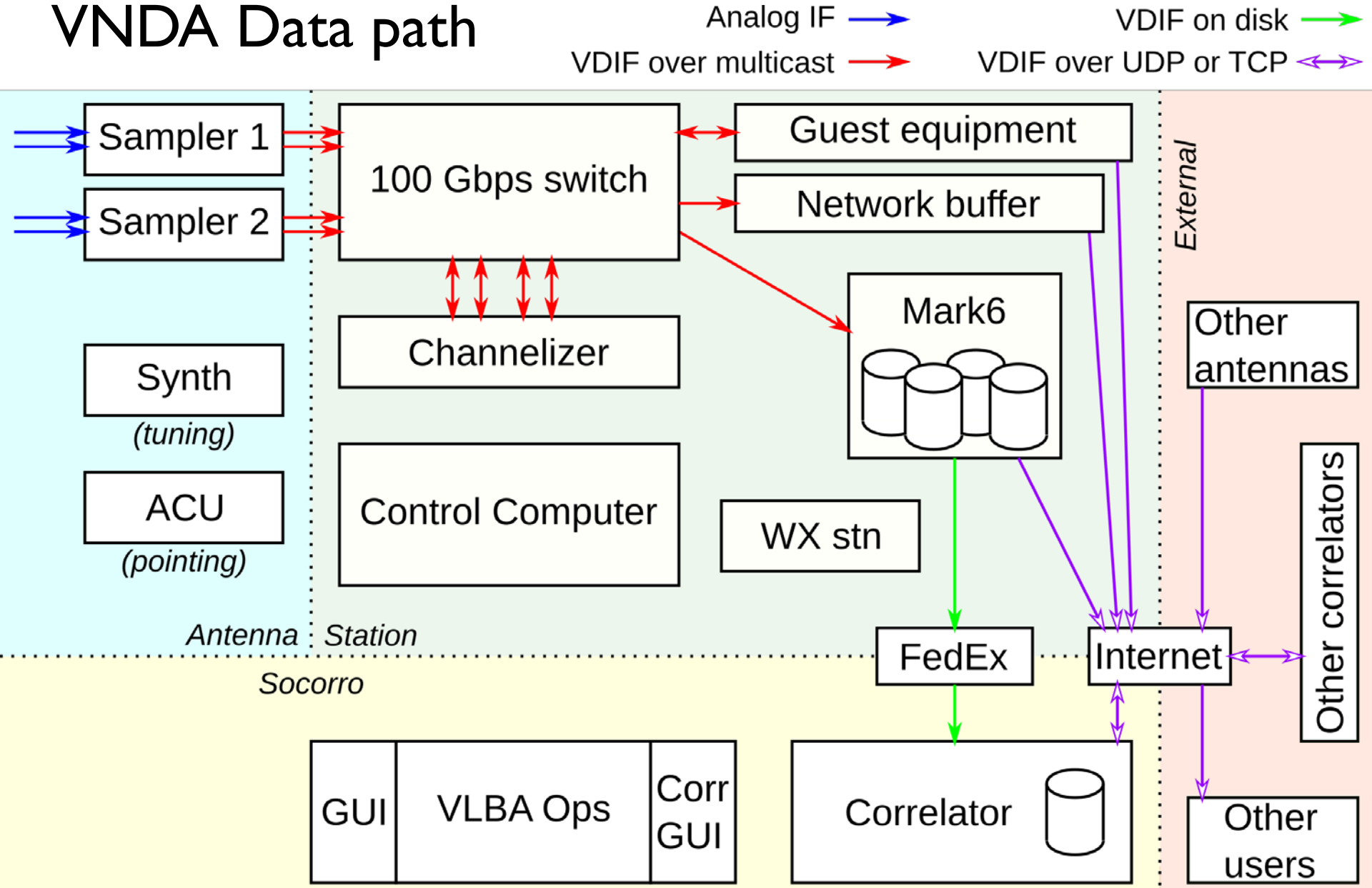
- Requirements
  - Backwards compatible with existing VLBA capabilities
  - Support for 2, 4, 8 (and maybe 12) bits per sample
  - Absolute timing stability at sample level
  - Support for non-VLBI use
    - E.g., pulsars, spectroscopy, radar
    - Some use cases may require user-supplied hardware
    - Some use cases may require user-supplied software
  - Sustainability
    - Improved in RFI tolerance and avoidance
    - Improved compatibility with other VLBI systems
    - Reduced operations footprint
    - Increased maintainability

VLBA New Digital Architecture (VNDA)

Internally called "Oryx"

- Major new components
  - Sampler modules, in receiver cabin
    - Creates 4 "digital IFs", 1024 MHz bandwidth, in VDIF format
  - 100 Gbps network switch
    - Fabric that connects all signal processing and recording components
  - Channelizer module
    - Creates digital baseband channels
    - Requantizes to 2 (or other) bits per sample
    - Computes calibration metadata (switched power)
  - Timing module
    - Need repeatable 1 PPS tick and clock signals in receiver cabin

VNDA Data path



VLBA New Digital Architecture (VNDA)

- Status and timeframe
  - Prototype hardware purchased
  - Risk reduction / prototyping phase near completion
    - CoDR on May 14
  - Summer 2022: target for array-wide deployment (funding permitting)
- External stakeholder requirements
  - We are open to developing toward external requirements
  - The sooner, the better
  - The more specific, the better
  - We would request supplements for requirements that dramatically raise cost or effort

Desired upgrades

- Analog IF system upgrade
  - Essentially plumbing; needed to significantly upgrade bandwidth
- New or upgraded receivers
  - Ka-band (approx. 28-36 GHz)
  - Wide-band X-band: 8-12 GHz
  - X-, Ku-, Q-band receivers would benefit from new amplifiers
- Full-bandwidth (8+ Gbps) network to each site
  - Requires 80+ Gbps to aggregate at correlator
  - Real-time correlator to be placed at major network hub?
- Water vapor radiometers
  - For atmospheric calibration
  - Being explored by ngVLA project

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