Modular Digital Infrastructure for Radio Telescope Arrays

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Outline

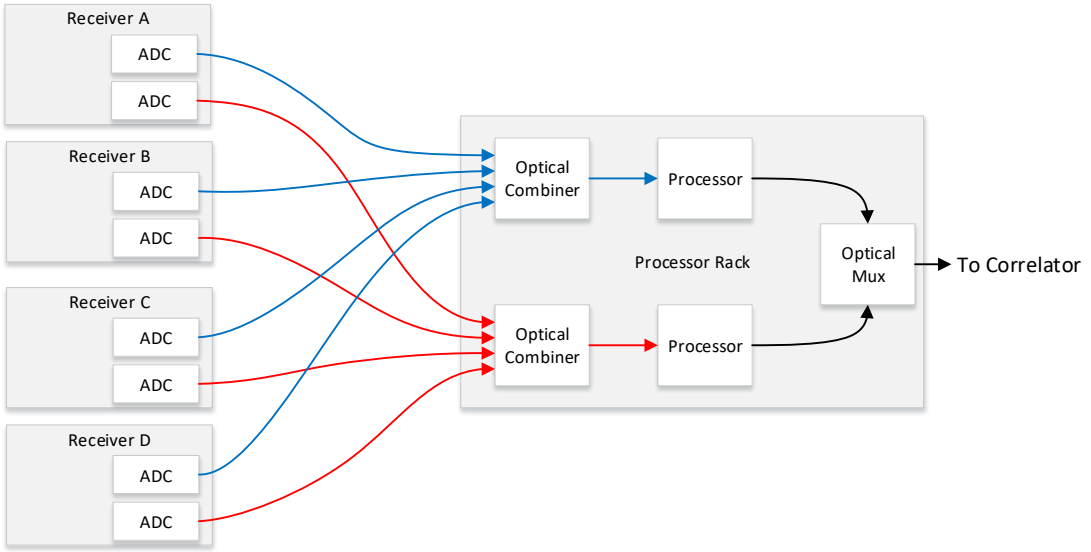
- ADCs
- Local Data Multiplexing
- Local Processing
- Long Haul Data Transmission
- Network Based Crossbar for Correlator
- Modular Correlator
- Timing, Monitor and Control

ADCs

- Many ADCs Per FE receiver
- Each ADC is dedicated to a single receiver
- Simultaneous operation
- Split or couple FE signals
- LO, Filter, ADC
- Optical output
  - Commercial JESD204B
  - Unformatted Data

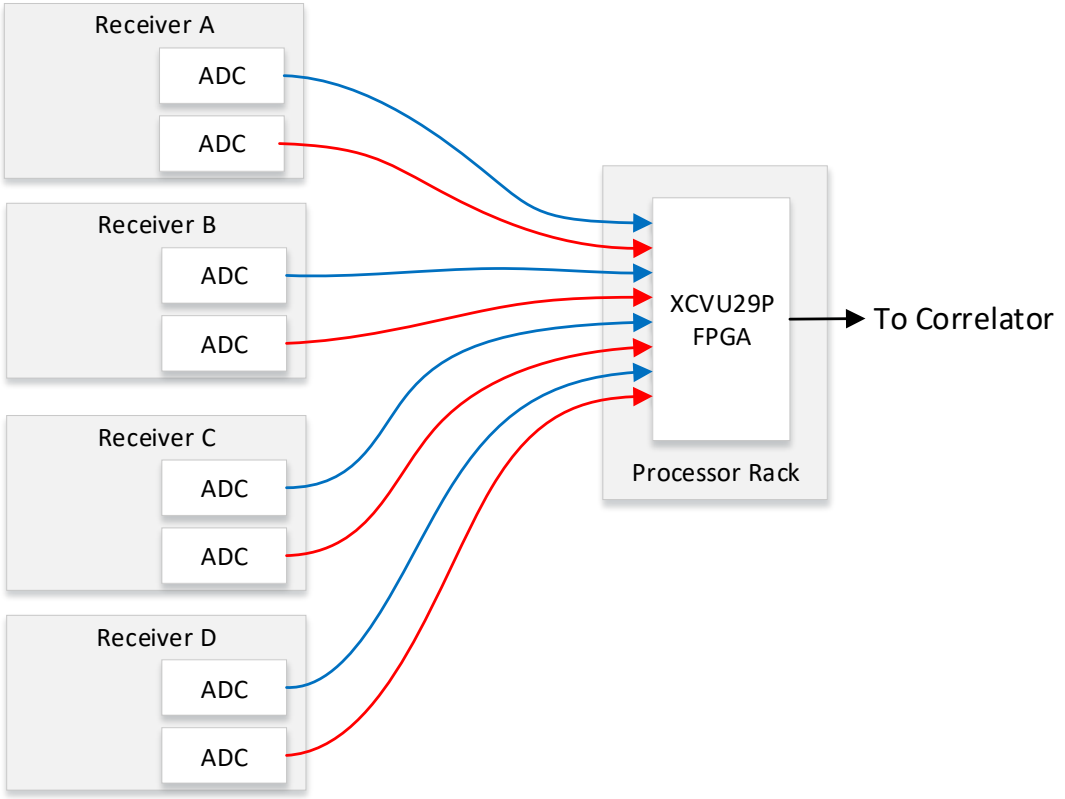
Local Data Multiplexing

- Optical Multiplexing to local processor
- Only ADCs from one receiver are on



Local Data Multiplexing

- 400Gb/s transceivers
  - 8 colors
  - 56Gb/s per color
  - 8 ADCs per transceiver
- New FPGAs!
  - 56Gb/s SerDes x48
  - 12,288 DSP



Single Dish Processing

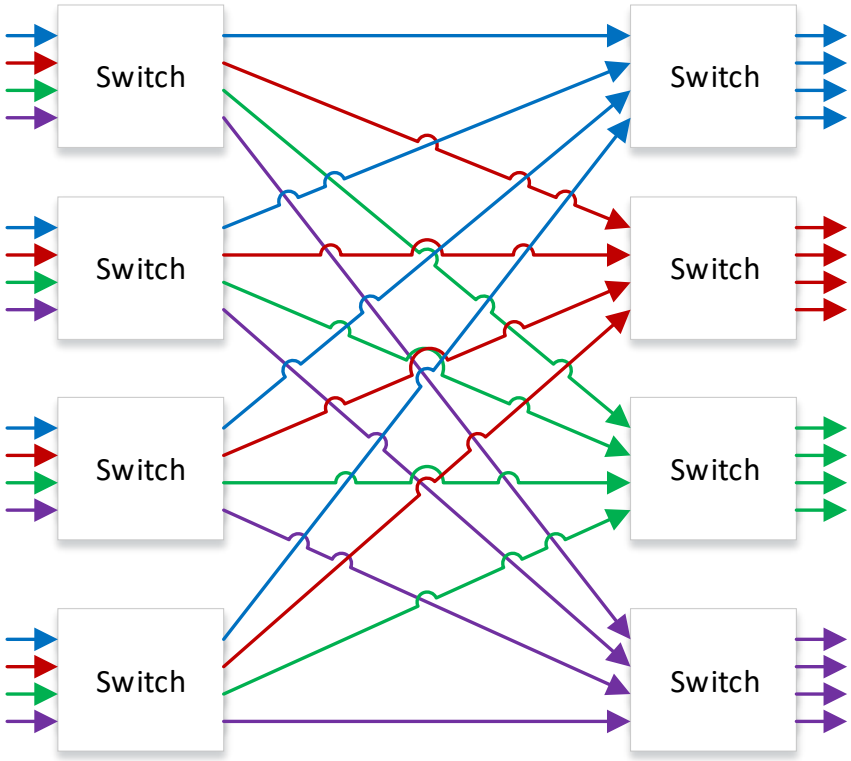
- Frequency slicing/channelizing
- Sideband separation
- Sub-band selection
- RFI flagging and excision
- Gain equalization
- Sample re-quantization
- Ethernet formatting with timestamps
- ngVLA short and mid baselines might be near correlator

Long Haul Data Transmission

- Ethernet UDP Multicasts
  - VDIF
  - Video Streaming Formats
- Internet vs Dedicated Fiber (ngVLA)
  - ~10x bandwidth of largest Internet Exchange
  - 100Gb/s transceivers x4 per antenna
  - Dedicated fiber for antennas <300km from core
  - Internet carriers for longer baselines
- Limited Dedicated Fiber (ALMA)
  - 4 fibers at 400Gb/s per fiber
  - ~Same total bandwidth as ngVLA

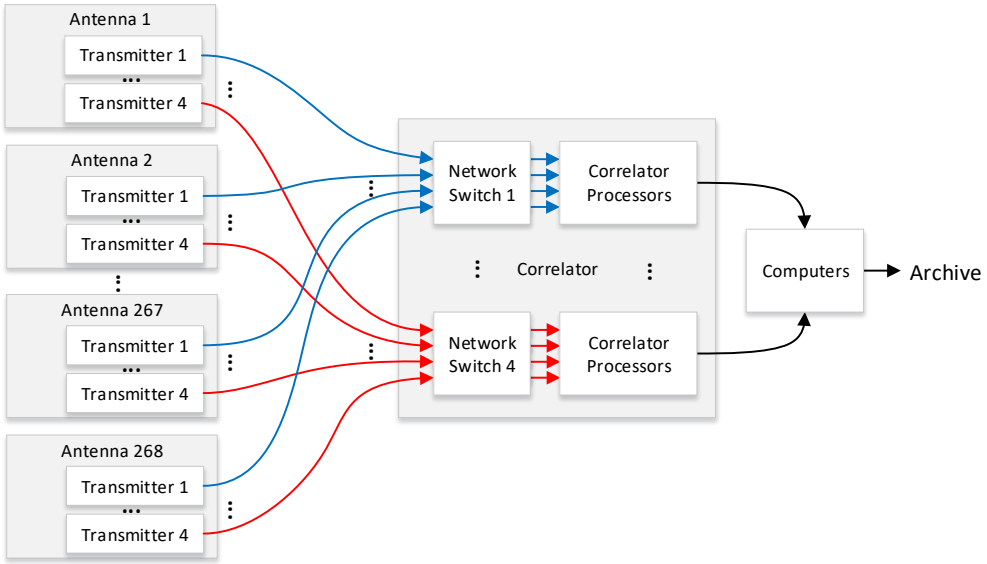
Network Crossbar for Correlator

- ~90Tb/s
- Multi-stage switching
- 48 port switches
  - 57.6Tb/s
  - 576 100Gb/s inputs
- 96 port switches
  - 230.4 Tb/s
  - 2304 100Gb/s inputs



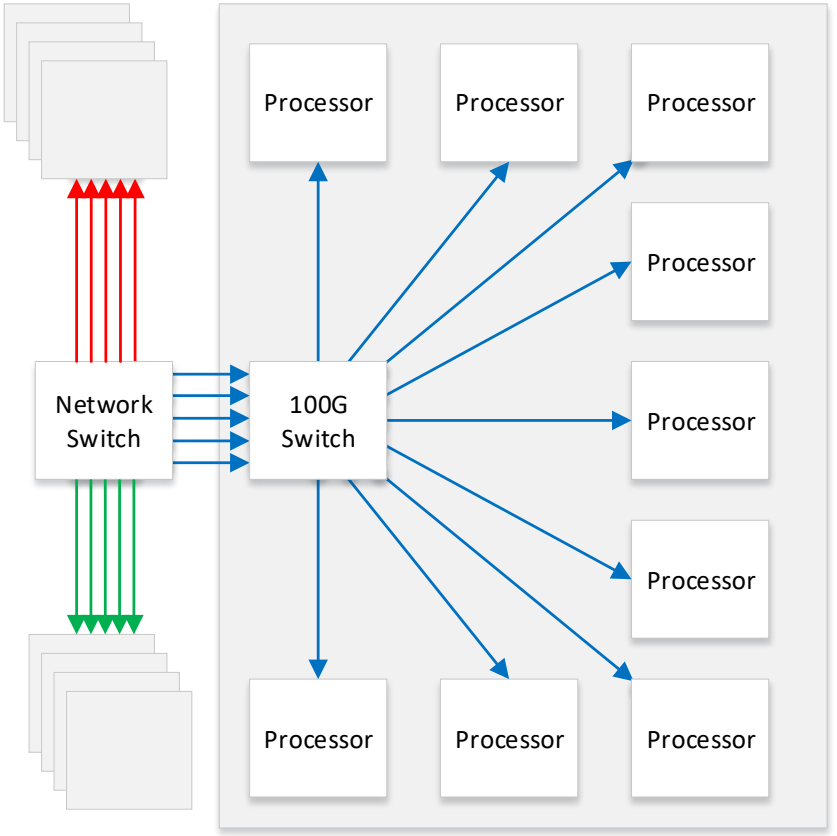
Network Crossbar for Correlator

- Nexus 9500 Modular Switch
  - 576 100Gb/s ports
  - Up to 172.8Tb/s
  - 4 needed for ngVLA – IO limited
- Metamako
  - 500 ports
  - 400Gb/s ports this FY
- Split data by channel
  - 1/4 data to each Modular Switch
  - 4x 100Gb/s fibers from antennas



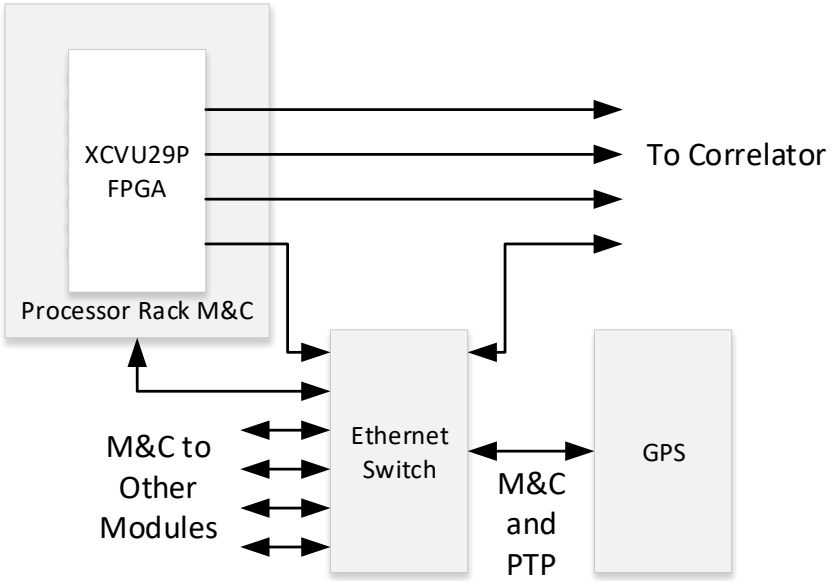
Modular Correlator

- UDP multicast subscribers
  - Network Filters Data
- ngVLA FSP
  - 450MS/s subband
  - 263 antennas <500Gb/s
  - 26 identical processors
- ALMA 2030
  - 8 F-engine processors
  - 5 Beamformer/X-engine processors
  - 8 ADC Simulators



Timing, Monitor and Control

- M&C uses extra DTS bandwidth
  - 1Gb/s is 1% of one fiber
- Precision Time Protocol
  - Ethernet
  - ~1us accuracy
  - FPGA Ethernet MAC IP



Conclusion

- COTS Ethernet Switches
- Cross-bar at ngVLA and ALMA 2030 Scales
- Allows for Modular Digitizer and Correlator Designs
- M&C transport included


ngvla
Next Generation Very Large Array