

# Complex Sampling and Correlation, Dual RDBE Operation, And X-Cube switches



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Atacama Large Millimeter/submillimeter Array

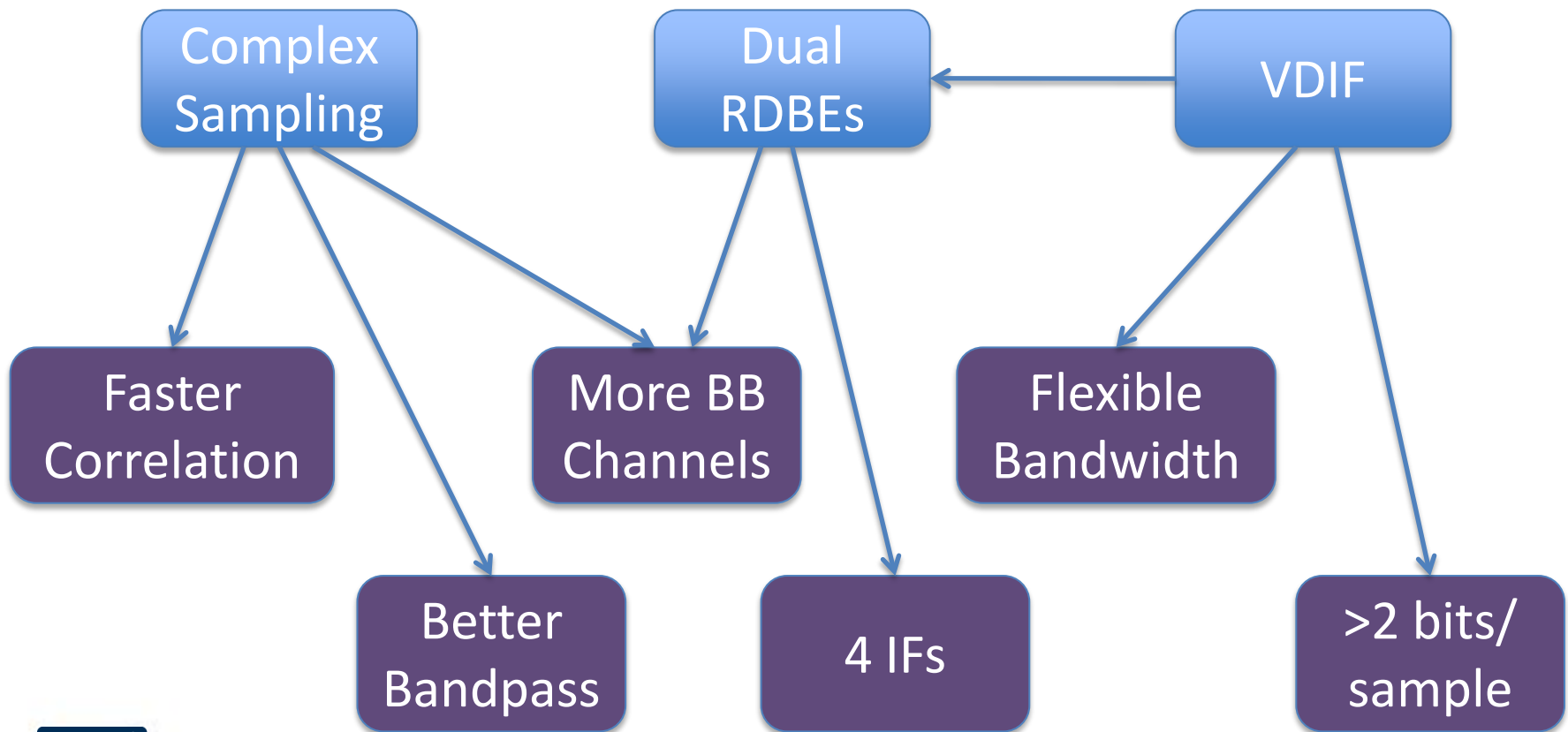
Expanded Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array



# DDC Personality: Future features and capabilities



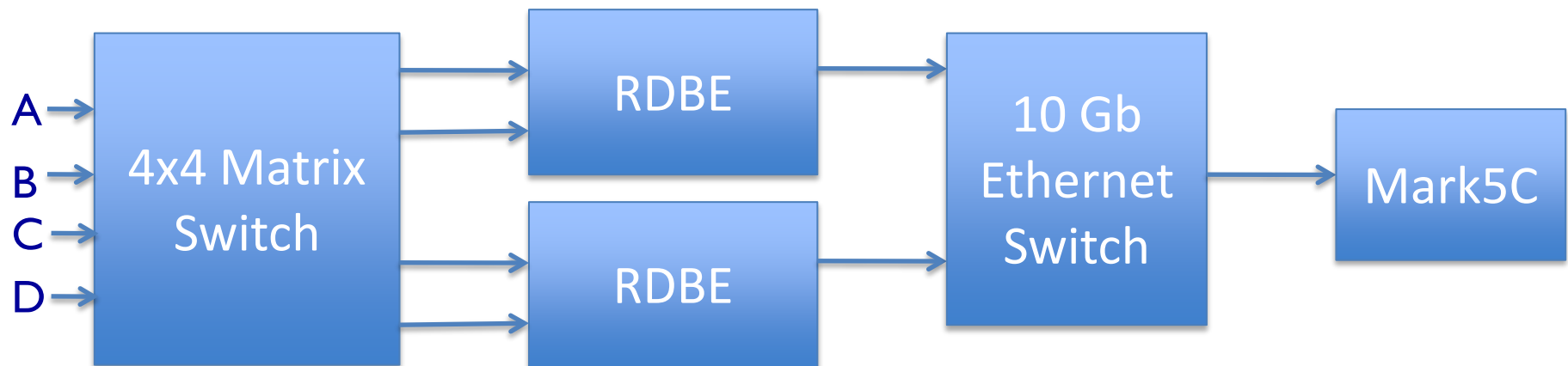
# Complex sampling

- Meaning of
  - Instead of one real value every  $1/2bw$ , one complex value every  $1/bw$
  - Even real values equal real part of complex values
  - Odd real values are Hilbert transform of imaginary parts
- Equal information content in both representations
  - Except: quantization and Hilbert transform are commuted
- Why use complex sampling?
  - FPGA internal representation is already complex
  - Resources required to make real output
    - **Complex will likely will double number of DDC channels**
  - Real output conversion degrades signal
  - FX correlation intrinsically complex; efficiency to be gained

# Complex Sampling (continued)

- Potential pitfalls
  - Some correlators may not accept complex data as input
  - Complex samples are still rather foreign to us
  - Nomenclature still not standardized within VLBI
    - Notion of sidebands  $\Leftrightarrow$  sign of imaginary component
    - Band edge vs. center for reference
- Status
  - NRAO FPGA engineers already investigating the concept
    - Initially with Mark5B format
  - DiFX has capability to correlate complex data (but not tested here)
  - New fake data simulator mode in DiFX will allow some early testing
  - NRAO internal proposal submitted; hope to proceed earlier

# Dual RDBE configuration



# Dual RDBE Operation

- Always has been a part of the VLBA Sensitivity Upgrade Project
- Required to simultaneously record >2 IFs
  - Useful for dual pol S/X and dual IF-pair C-band observing
- Allows double number of baseband channels to be produced
- Ultimately may allow double bandwidth (to 4 or 8 Gbps depending on data source and recorder) with existing IF configuration
- Status
  - NRAO engineers beginning VDIF data format generation
    - A new VDIF extension will be proposed
  - X-cube soft-switch installed at LA for upcoming testing of merged data
  - EVLA is giving initial testing opportunities for merged VDIF streams
  - Correlation of VDIF: most infrastructure is complete but untested
  - Channel mapping scheme established:

<https://science.nrao.edu/facilities/vlba/publications/memos/sensitivity-upgrade/sensimemo39memo.pdf>



# Mark5C and multiple data sources

- Mark5C at EVLA being fed by multiple baseline boards through 10g switch
  - Adam Deller to give more details later
  - Proving to be a good test system for us
    - Switch emits RARP packets
    - Two simultaneously emitted packets (length = 1032 bytes) result in only one packet being recorded
- X-cube “Ethernet Soft-Switch Recorder” being studied for use at VLBA
  - Acts as packet forwarder, duplicator
  - Switching based initially on source/dest ethernet ports
  - Internal memory used to smooth bursty traffic
    - Could function eventually as a burst mode processor
  - CPU sees data: could be used for real-time data inspection
    - Pulse cal extraction
    - Spectra