Configuration Mapper

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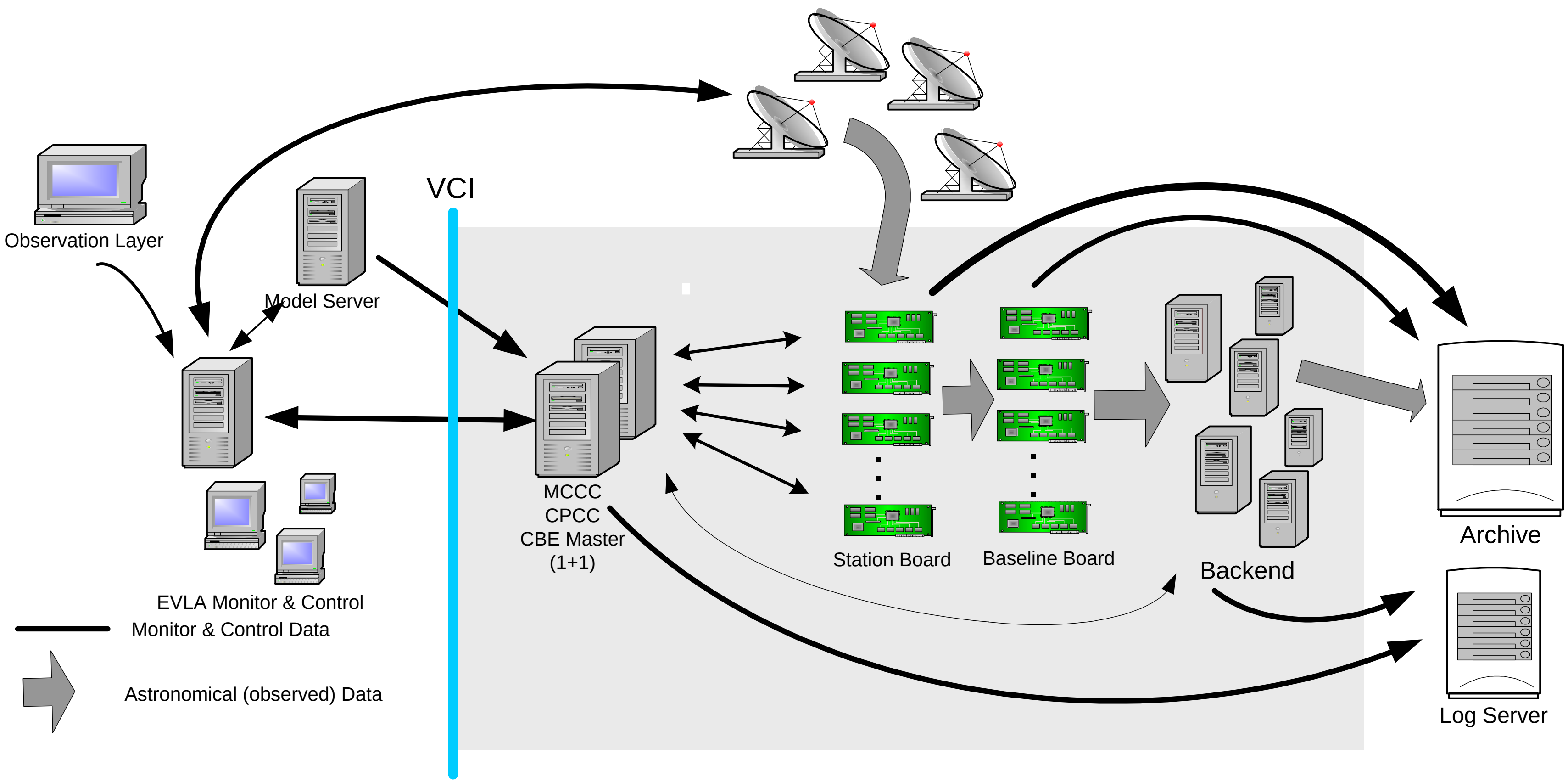
Outline

- Software package that translates received VCI configuration requests into correlator hardware configuration.

- Main application: a process running on the MCCC and handling EMCS requests in real-time.

- Additional use: as an off-line tool can be used for planning, scheduling and optimization of the observations.

Correlator



Observation Layer
Model Server
VCI
MCCC
CPCC
CBE Master
(1+1)
Station Board
Baseline Board
Backend
Archive
Log Server
EVLA Monitor & Control
Monitor & Control Data
Astronomical (observed) Data

Virtual Correlator Interface - VCI

- Interface between the correlator and the EVLA Monitor & Control System (EMCS).
- VCI shields the EVLA Monitor & Control System from the details of the correlator implementation.
- VCI is defined as a set of messages and procedures that allow the EVLA M&C System to control and monitor the correlator.
- The protocol is defined in the document:

  "VCI Protocol Specification", DRAO A25201N0000.
- VCI messages are XML documents.

VCI Messages

- VCI messages generated by the user:
  - Configuration Requests / Commands
  - Delay Models
  - Tone Extraction Models
- VCI messages generated by the MCCC:
  - Messages used to confirm receipt of a Configuration Request:
    - Ack / Nack
    - Accept / Reject messages
  - Configuration change:
    - Activated
  - Status Reports
  - Alarms / Logs

NRC · CNRC

Requirements

– User (EMCS) should be able to specify configuration for each Station Board independently, i.e. user should be able to transmit a VCI Configuration Request for a single Station Board and activate the configuration independently
  - from other boards in the same Station Board Quad and
  - from other stations in the same Subarray.

– The correlator should not have a concept of the *duration* of an observation. The configuration should be activated at specified time and remain active until overwritten by another configuration that uses the same Station Board.

Message Handling

- When running on the MCCC communicates with:
  - EVLA Monitor & Control System (the user)
  - Station Board CMIBs
  - Baseline Board CMIBs
  - Correlator Backend Master

- XML parsing and validation is performed by the VCI, CMIB and CBE Message Handlers.

- Only well-formed and valid messages (documents) are passed to Configuration Mapper.

Observation

- Configuration of an observation (or scan) is specified as a sequence of VCI Station Board Configuration Requests, followed by an Activation Trigger.
- VCI Station Board Configuration Request specifies:
  - **Board ID (rack-crate-slot)**
  - **Observation ID**
  - **Subarray ID**
  - Up to two **Basebands**
  - For each Baseband, a list of **Subbands**
  - For each Subband of each Baseband, required **output products**.
- Board ID defines the physical location of the board (and its IP address).
- Observation ID is used to identify a group of messages that should be activated at the same time.
- Subarray ID is used to determine the baselines where correlation is required.

Station Board Quad

- A Quad consists of four adjacent boards in the Station Board rack.
- The same output on all the Station Boards in a Quad is connected to the same Baseline Board Input.
- All the boards in a Quad must belong to the same Subarray.

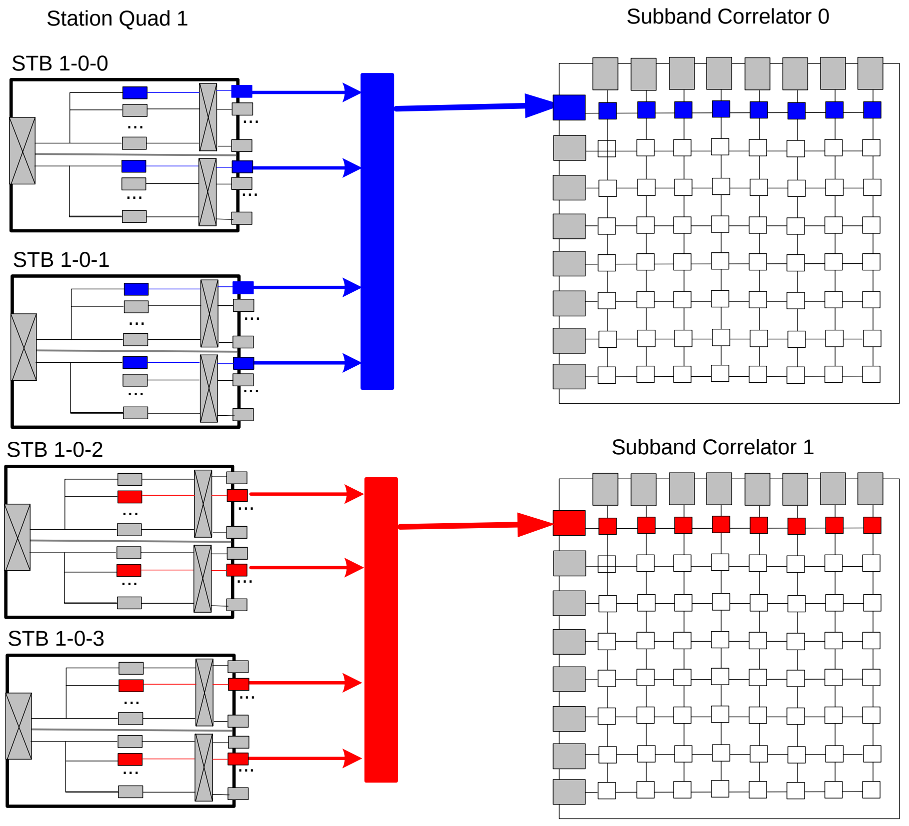
  This restriction was initially introduced due to hardware limitations. In the current architecture each Station Board can generate DUMPTRIG with different Minimum Hardware Integration Time and use different *observe time*.

  In the configuration where different Station Board forward output to different Subband Correlators, the Station Boards could belong to different Subarrays.

Requirement that all the boards in a Quad belong to the same Subarray simplifies software implementation (to some extent).

Should we keep this limitation ?

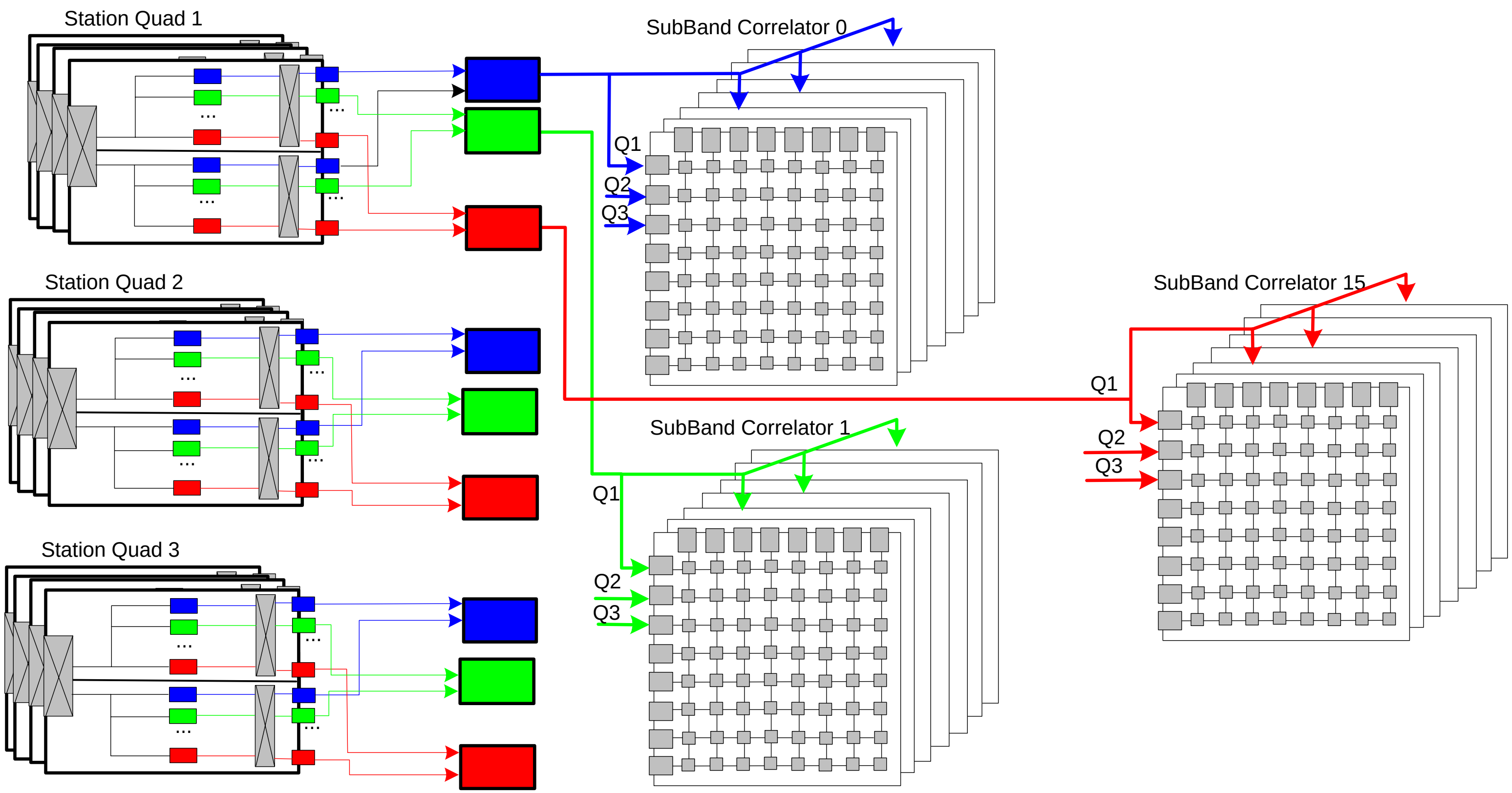
STB Quad - Two Subarrays



Subband Correlator

- The same output (port) on all the Station Boards in the WIDAR correlator is to the same group of Baseline Boards.
- A group of Baseline Boards that are connected to the same output on Station Boards is called Subband Correlator.
- There will be 16 Subband Correlators in the EVLA configuration.
- All boards that belong to one Subband Correlator will be located in the same Baseline Rack (Configuration Mapper does not make any assumptions regarding the Baseline Board location).

Subband Correlators - Connections



Subband Identifiers

- VCI STB Configuration Request, for each Station Board output data stream (subband) specifies a unique set of identifiers:
    - Station ID (1-255)
    - Baseband ID (0-7)
    - Subband ID (0-17)

- Station ID is usually the same for all the basebands that belong to the same antenna.

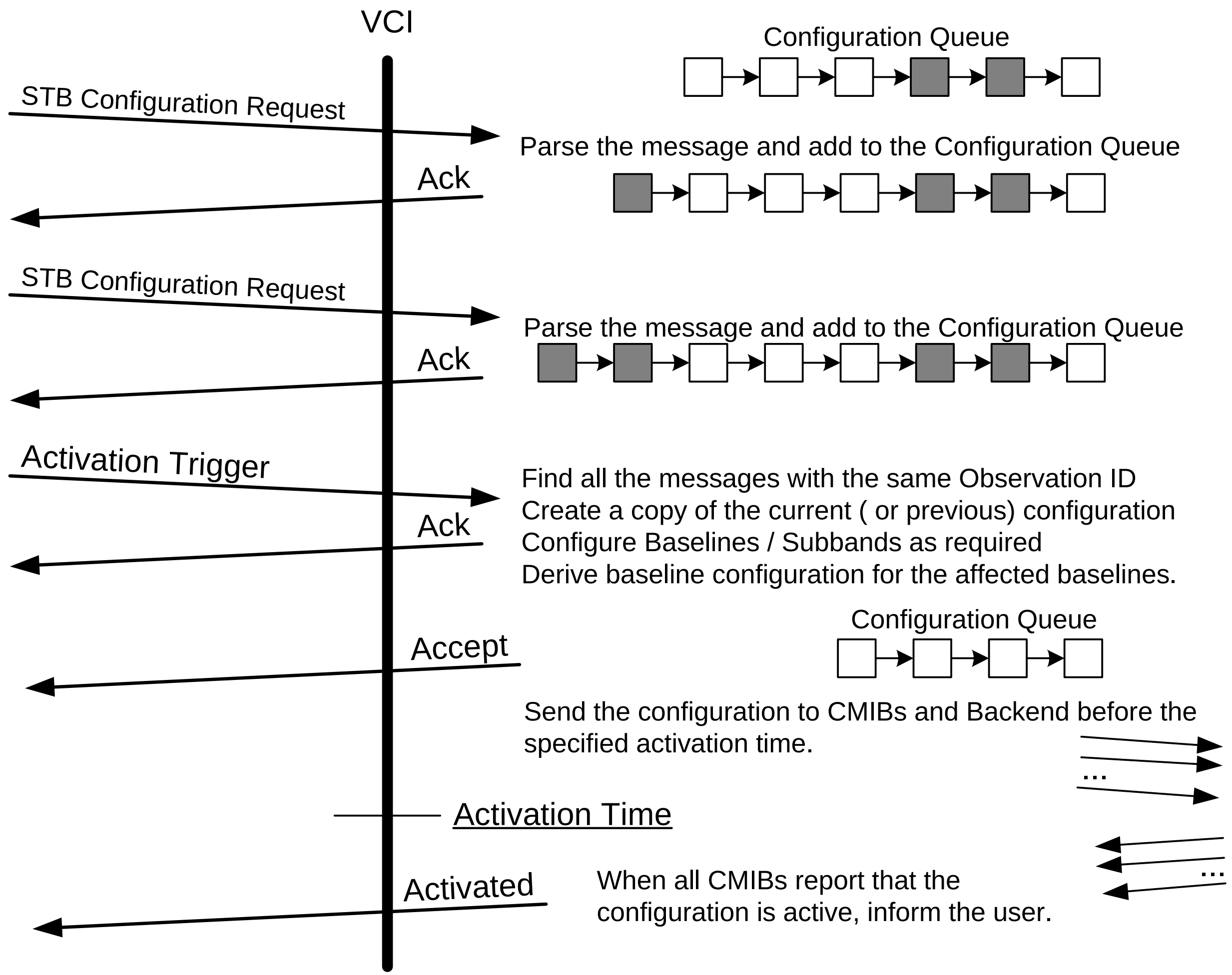
- Baseband is assigned a unique combination of Station ID and Baseband ID.

- Station/Baseband/Subband IDs are embedded into Station Board output data stream (subband).

Activation Time / Duration

- Activation Time is specified in the VCI Activation Trigger.
- Activation Time applies to the messages with the specified Observation ID.
- Once activated, the configuration remains in effect until the next configuration is activated on the same resource.
- The correlator does not have a concept of *duration* of the observation or scan – configurations are activated as requested without knowledge how long the configuration will remain in effect.

Configuration Queue



Activation Trigger

- VCI Activation Trigger specifies:
  - Activation Time
  - Observation ID

- When received, an Activation Trigger applies to all the Configuration Request messages with the specified Observation ID that are found in the Configuration Queue.

- The user (EMCS) should wait for all the VCI Configuration Requests to be acknowledged before transmitting the Activation Trigger.

- User can re-use the same set of configuration messages by simply changing the Activation Time in the Activation Trigger.

Configuration Mapper – Main Components

- Correlator Status: the current configuration and status of the correlator hardware and software components.
  - Station Boards
  - Baseline Boards
  - Connections between Station Boards and Baseline Boards (Data Streams)
  - Backend Master – address and status (and few other things…)
- Configuration Queue:
  - List of received VCI Configuration Requests
- Activation Queue:
  - List of configurations to be activated sorted by the activation time.

Correlator Status

Software representation of the correlator

Station Board:

- Current configuration:
  - configuration and status as reported by the CMIB.
  - the VCI message
  - CMIB configuration message
- Next configuration:
  - board configuration
  - CMIB configuration message
  - Activation Time
  - timers and indicators
  - the received VCI message

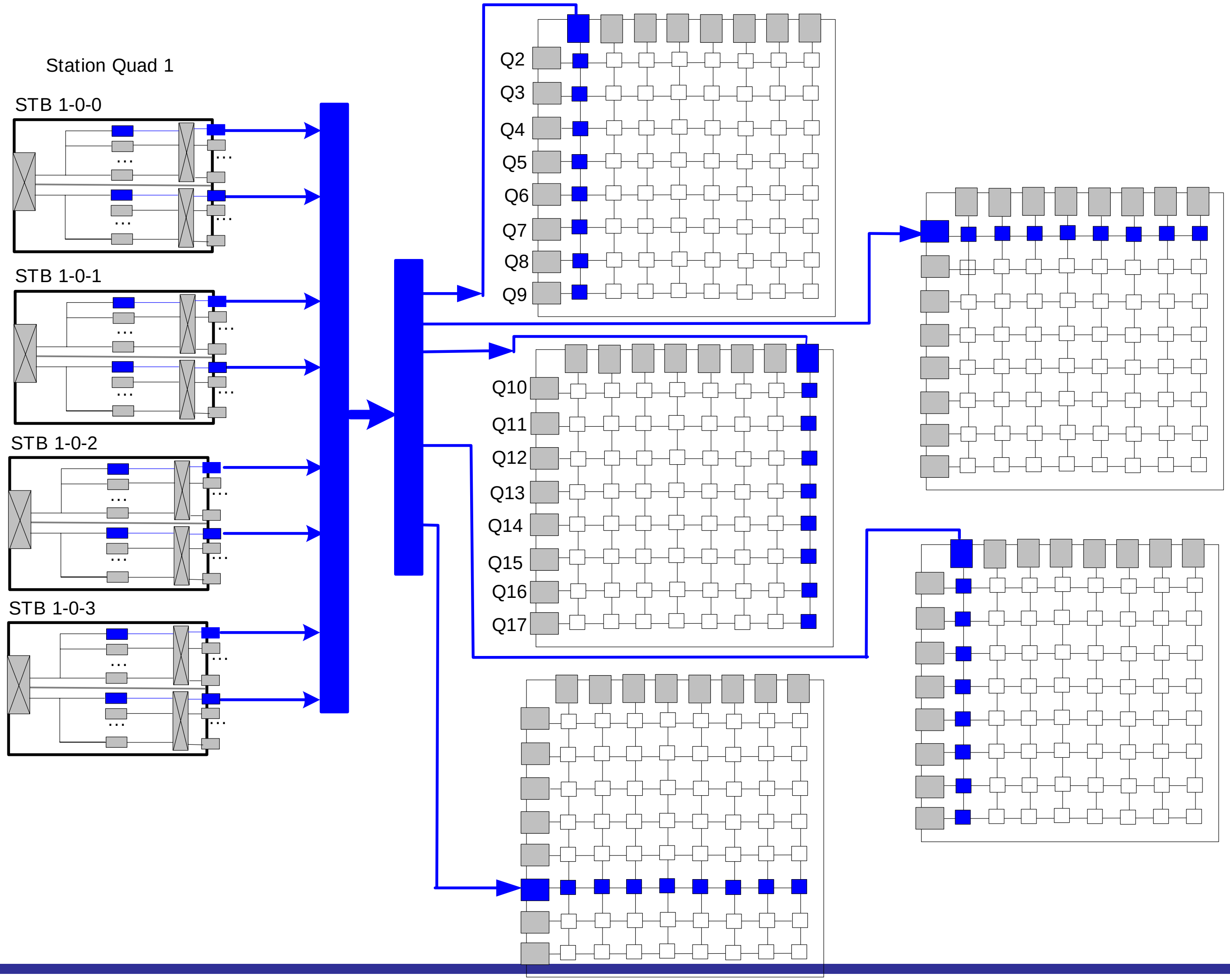
Baseline Board:

- Current configuration, for each independently configurable component:
  - configuration and status as reported by the CMIB.
  - CMIB configuration
- Next configuration for each independently configurable component (input h/w and Correlator Chip) :
  - Hardware configuration (software representation of the hardware component)
  - CMIB configuration message
  - Activation Time
  - Timers and indicators associated with the next configuration.

Correlator Model : Data Streams

- Connections between the Station Boards and Baseline Boards.
- Loaded at initialization from the Correlator Hardware Configuration file, which is created in the correlator configuration discovery mode (or manually).
- For each Baseline Board Input Data Stream file specifies the Station Board Output it is connected to.
- In EVLA correlator each Station Board Output will be connected to five Baseline Board Inputs.
- Object Correlator Status is created at initialization from this file.

Data Streams



Configuration

When an Activation Trigger is received:

- All the VCI Configuration Requests with the specified Observation ID are removed from the Configuration Queue.
- An instance of a class CorrModel is created:
  - as a copy of the CorrModel which is scheduled to be activated before the newly received configuration, or
  - based on the current Correlator Status, if the new configuration is the next configuration to be activated.
- Station Boards in the new CorrModel are configured as specified.
- Baseline configuration is derived from the configuration of Station Boards.
- The new CorrModel is added to the Activation Queue.
- For each individually configurable element (Station Board, BLB Input, Correlator Chip), Configuration Mapper checks if this is the next configuration to be activated, and sends configuration to CMIB, if it is.

Correlator Model

- Software representation of the configurable components:
  - Station Boards
  - Baseline Board Input and Correlator Chip
  - Data Streams
- When a configuration with new Activation Time is received, a new CorrModel is created.
- If when an Activation Trigger is received with the Activation Time for which a CorrModel already exists in the Activation Queue, the existing model is updated.
- A new instance of the CorrModel is created as a shallow clone, i.e. a new CorrModel "points" to the objects in the previous configuration or in the current correlator status. A new copy is created only for the components that are affected by the new configuration.

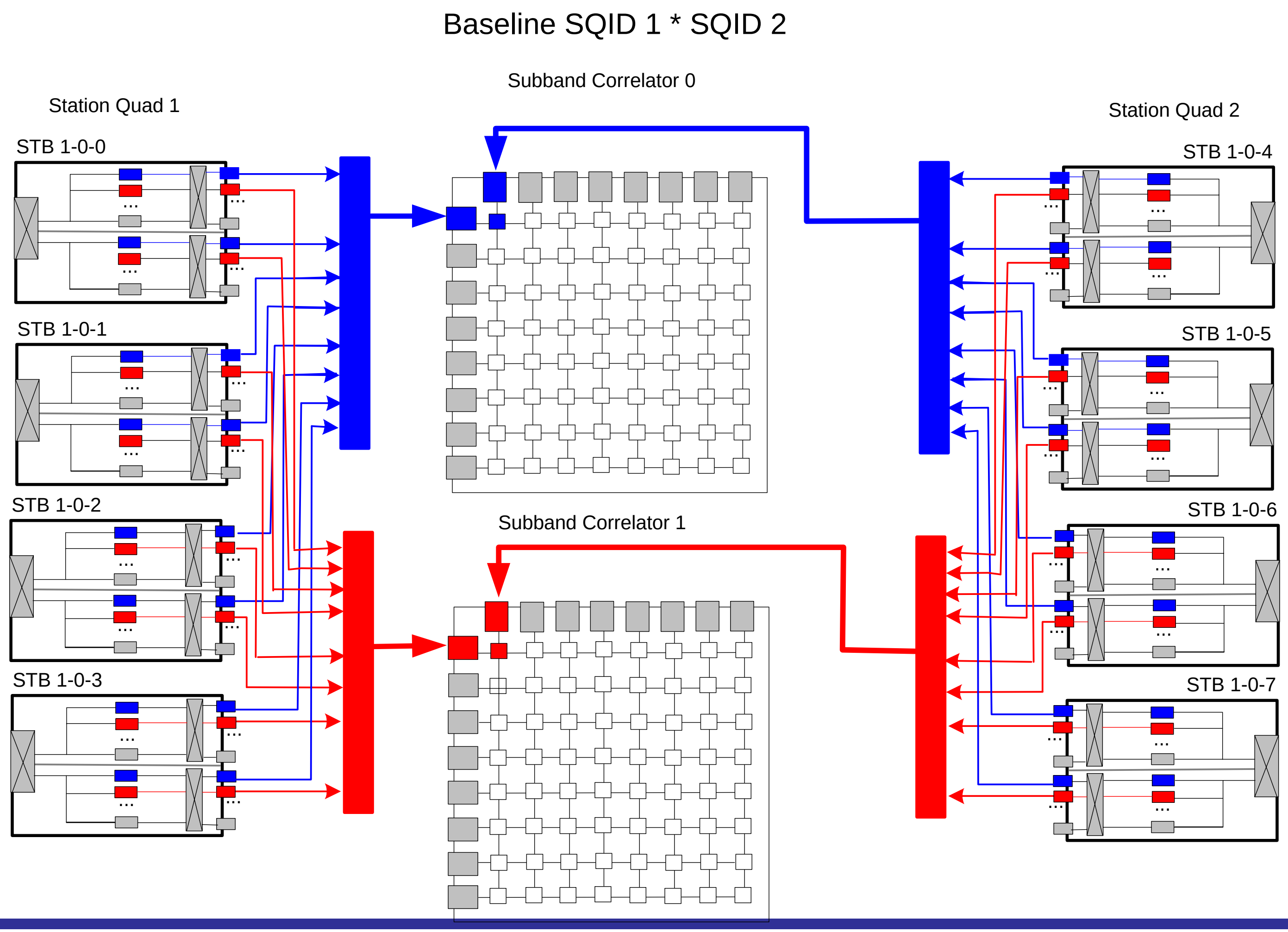
Station Board Configuration

- For each subband user must specify:
  - Subband ID
- User may specify:
  - Filter ID
  - Subband Correlator ID (STB Output)
  - When Subband Correlator ID is not specified by the user, Configuration Mapper calculates the number of Subband Correlators needed to obtain products and assigns SBC(s) starting from the subband with the lowest ID.

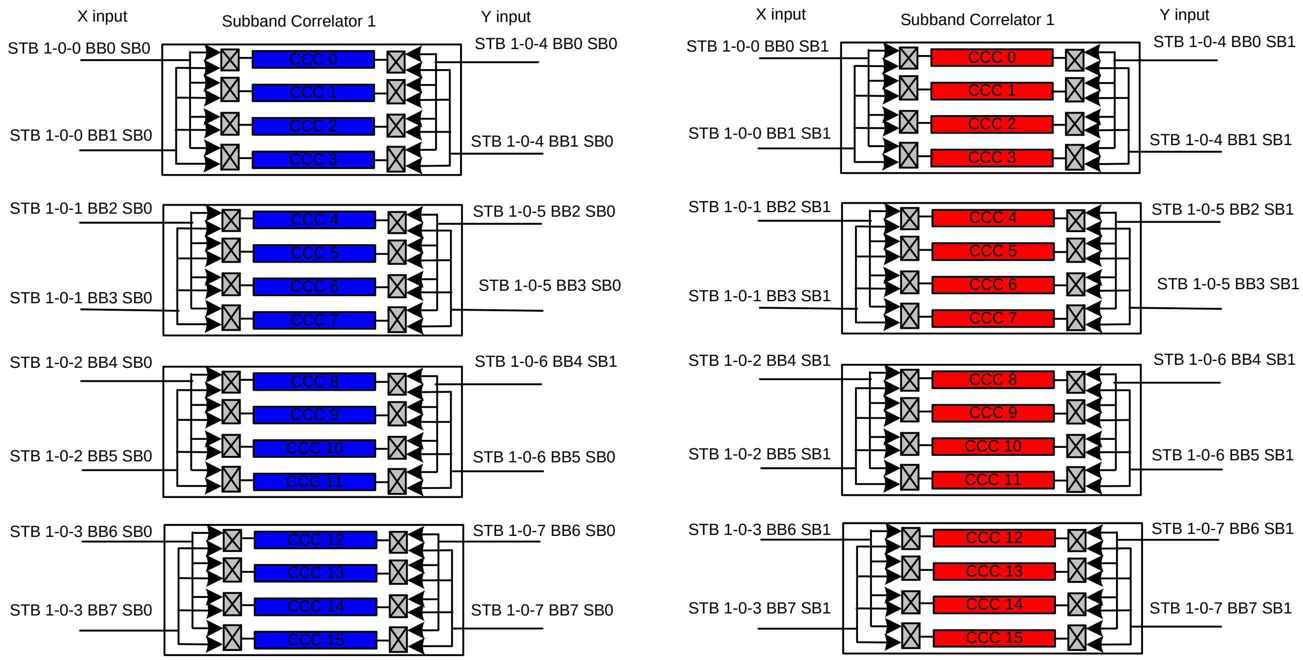
VCI Configuration Request (1)

```
<stationBoard rack=1 crate=0 slot=0 obsId=123 subarray=1 station =1>
    <baseband id=0 dataPath=0 input=FORM-0 pol=right >
       <subband id=0 prod=4 lags=128 />
       <subband id=1 prod=4 lags=128 />
    </baseband>
    <baseband id=1 dataPath=1 input=FORM-1 pol=left>
       <subband id=0 prod=4 lags=128 />
       <subband id=1 prod=4 lags=128 />
    </baseband>
</stationBoard>
```

Baseline Configuration (1)



Correlator Chip Configuration (1)

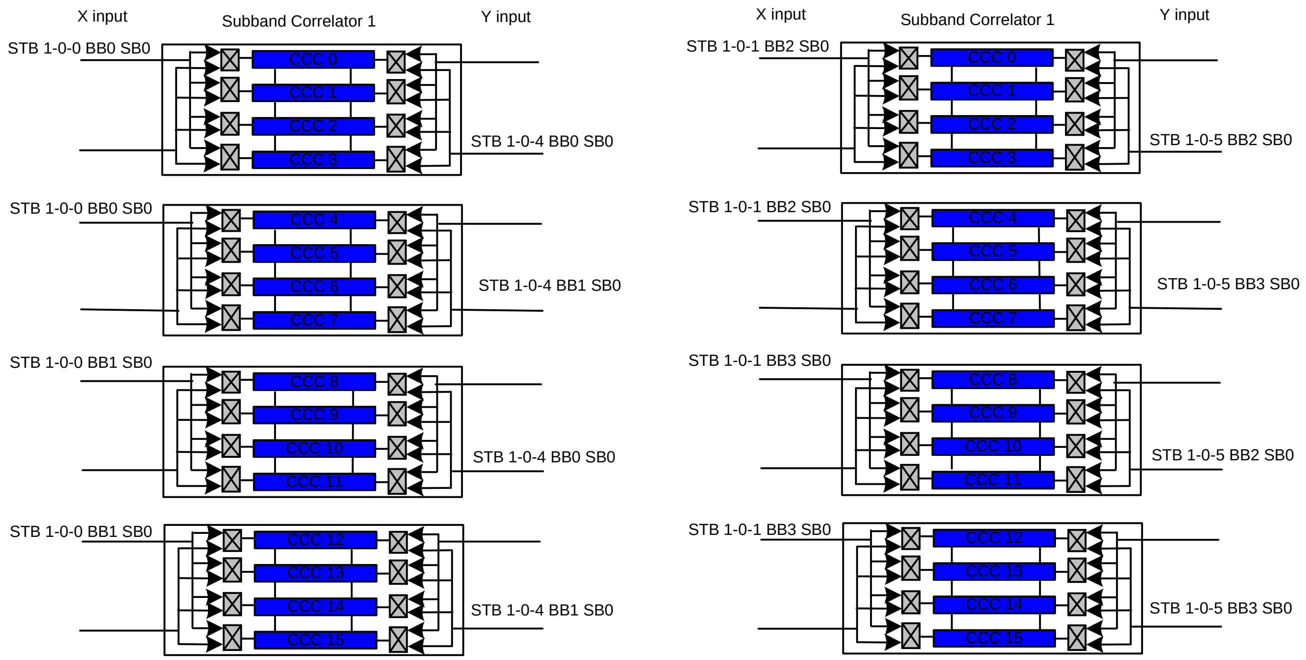


VCI Configuration Request (2)

```
<stationBoard rack=1 crate=0 slot=0 obsId=124 subarray=2 station =1>
    <baseband id=0 dataPath=0 input=FORM-0 pol=right >
        <subband id=0 prod=4 lags=512 recirculationFactor=0 />
        <subband id=1 prod=4 lags=128 recirculationFactor=0 />
    </baseband>
    <baseband id=1 dataPath=1 input=FORM-1 pol=left>
        <subband id=0 prod=4 lags=512 recirculationFactor=0 />
        <subband id=1 prod=4 lags=128 recirculationFactor=0 />
    </baseband>
</stationBoard>
```

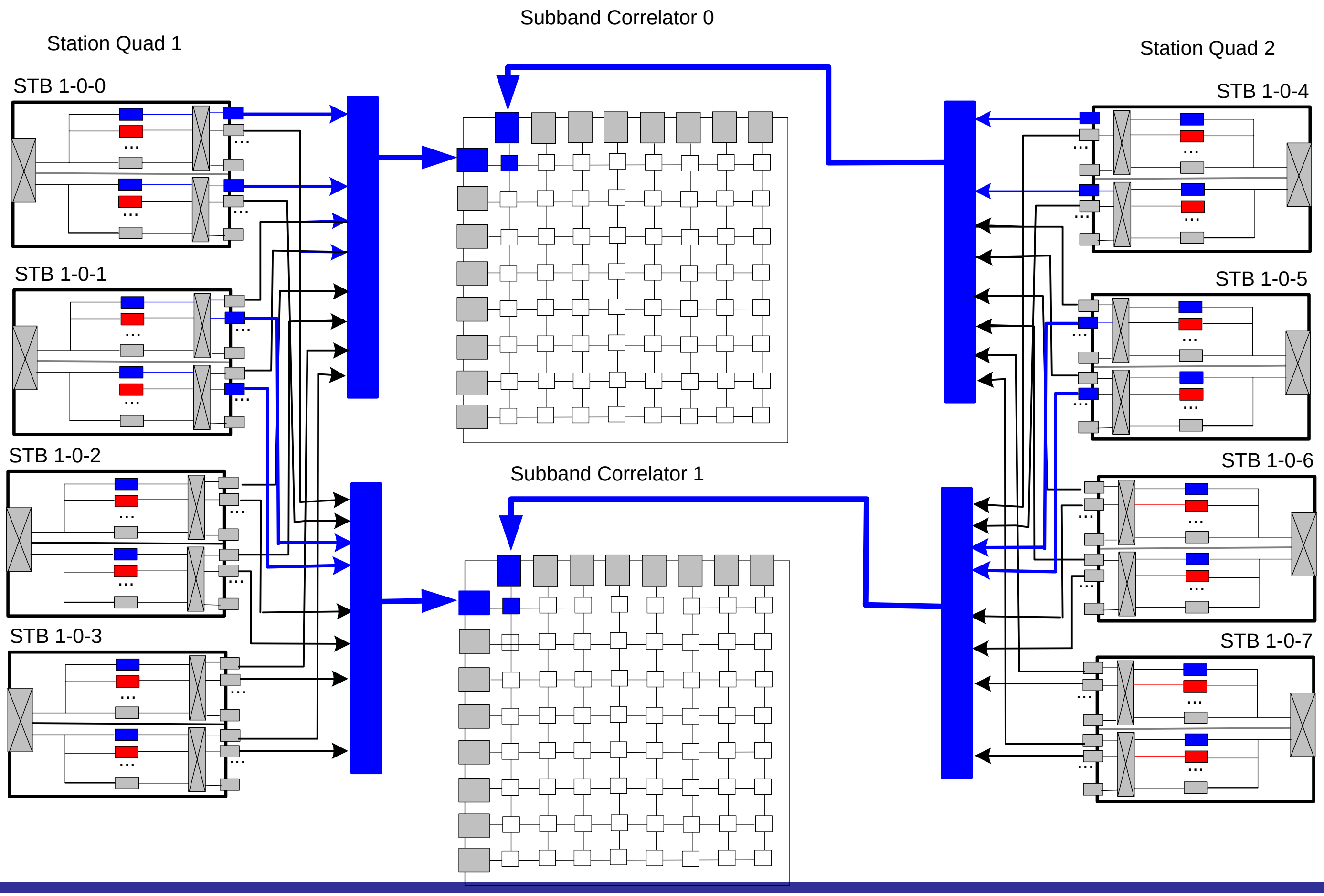
- **Entire Correlator Chip is used to obtain products for one subband pair.**
- **Starting from the subband with the lowest Subband ID, Configuration Mapper calculates number of CCS/CCQs needed to obtain the products and assigns Subband Correlator(s) for all the basebands in a Quad.**

Correlator Chip Configuration (2)



Subband Correlator Configuration (2)

Baseline SQID 1 * SQID 2



Baseline Configuration

1) Starting from the subband with the lowest ID, Configuration Mapper assigns Subband Correlators (STB Outputs) for all the Basebands in a Quad 1:

BB0&BB1 SB0: SBC 0

BB2&BB3 SB0: SBC 1

BB4&BB5 SB0 SBC 2

BB5&BB6 SB0 SBC 3

BB0&BB1 SB1: SBC 4

BB2&BB3 SB1: SBC 5

BB4&BB5 SB1: SBC 6

BB5&BB6 SB1: SBC 7

2) Subband Correlators are assigned for the first subband of all the Quads (Station Boards) where configuration changed.
If all the Quads are configured in the same way, the same subband will end on the same Baseline Boards.

3) Configuration Mapper then identifies baselines and configures Baseline Board Input switches and Correlator Chip for each baseline.

4) Configuration Mapper repeats the same steps for the next subband (until all subbands are configured).

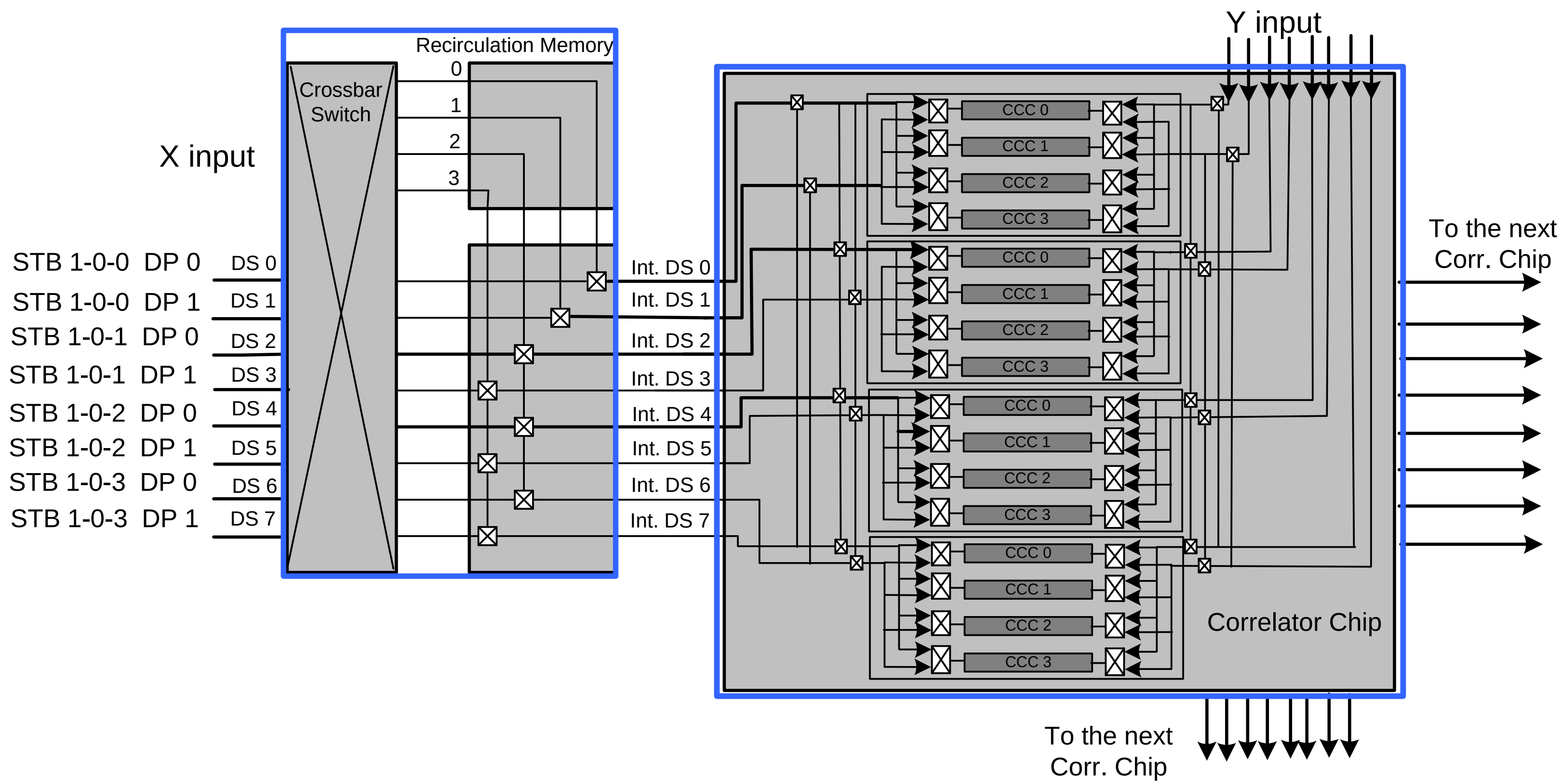
Class CorrModel

- Class CorrModel has:
  - List of Station Boards
  - List of Baseline Boards
  - List of Data Streams (i.e. STB to BLB connections)
  - List of Quads
  - List of Baselines
- All the elements are created at initialization, based on the Correlator Hardware Configuration file.
- A new instance of the CorrModel is always a copy (shallow clone) of a previously created model.
- Object that represents Quad has:
  - Subarray ID
  - Configuration change flag
  - Four Station Boards
  - List of Baselines

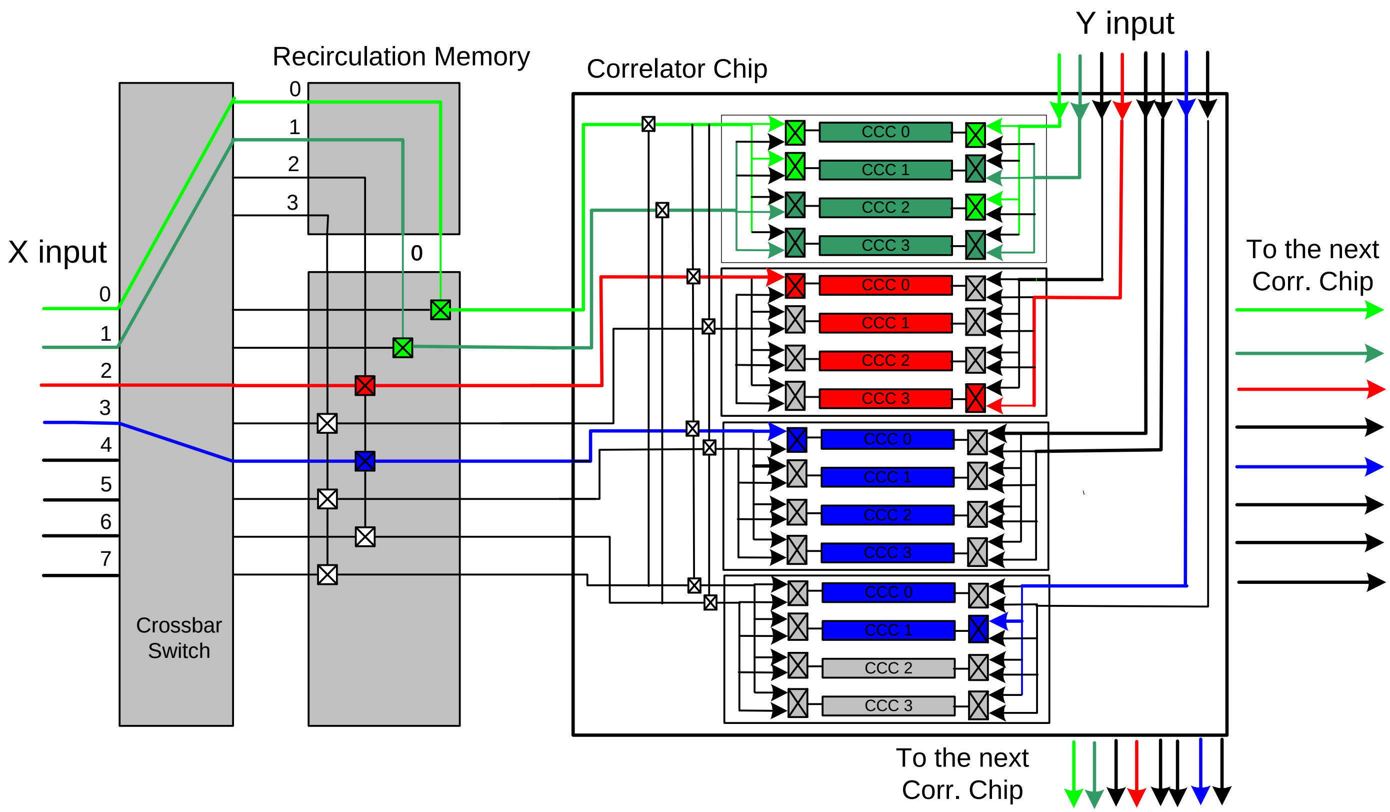
Baseline

- Class Baseline has:
  - Quad A ID
  - Quad B ID
  - For each Subband Correlator :
    - Baseline Board ID
    - Quad A Input ID (e.g. X-1)
    - Quad B Input ID (e.g. Y-3)
- In EVLA correlator there will be one Correlator Chip per Subband Correlator per baseline. Is there a need to provide support for more than one Correlator Chip per Subband Correlator? Instead of a single entry, we could have a list of Baseline Board IDs.
- In EVLA correlator all Subband Correlators will be configured in the same way, I.e. Input IDs will be same for all, but Configuration Mapper should be able to handle configuration where this is not the case.

Baseline Board Input Switches, Recirculation Controller And Correlator Chip



Baseline Board Input Switches, Recirculation Controller And Correlator Chip Example



Documents

- The functionality of the Configuration Mapper (mapping of the VCI Configuration Request into h/w configuration) is defined in the DRAO EVLA Memo 18.
- XML Schema for the VCI messages is available on the Web. Design and development are in progress.
- Design Document will be published next week.

The End

Station Board Configuration Request


```
<VciStbConfigReq msgId="10">
<ActivationTime dateTime="2005-05-13 16:17:25-0700" millis="1116026245592" />
  <BoardId rack="2" crate="1" slot="0" />
  <MinHwIntegTime microSec="15" />
  <NoiseDiode status="Off" refEpoch="0" frequency="0" timeOffset="0" />
  <Baseband id="0" dataPath="0" input="FO_0" bw="2048000000" bitsInInpStream="3">
    <Subarray id="2" />
    <Station id=“10" antenna="Antenna_10" antType="EVLA" />
    <Polarization pair="1" id="Right" />
    <Models lo="1024000000" freqOffset="0" singlePhCentar="Yes" fringeRotation="On“ />
    <Subband id="0" >
     <Filter bw="128000000" centralFreq="64000000" useMixer="Yes“ flipSideband="No"/>
     <Products q="4" bitsToCorr="4" spectCh="64" recFactor="1" sensLossAllowed="No" />
     <IntegTime stbIndex="0" hw="1" lta="1" bce="1" />
    </Subband>
  </Baseband>
</VciStbConfigReq>
```

Baseline Board Configuration

- The Recirculation Controller in the Baseline Board input may be used to re-arrange and modify input data streams as follows:
  - The order of the Data Streams may be altered.
  - 7-bit input Data Stream is divided into two internal Data Streams (MSN and LSN).
  - Input Data Stream may be delayed (to emulate delay caused by the preceding lags in the lag chain).
  - Input data may be recalculated, i.e. sent through the same Correlator Chips more than once (thus emulating a lag chain produced by several Correlator Chips).
- Based on the number of bits in the input stream (4 or 7) and on the required products, the Configuration Mapper determines the configuration of the Recirculation Controller.
- All the Correlator Chips (baselines) in the same row / column receive the same input.

Subband Correlator Configuration (2b)