BOX #9

1STB_2T

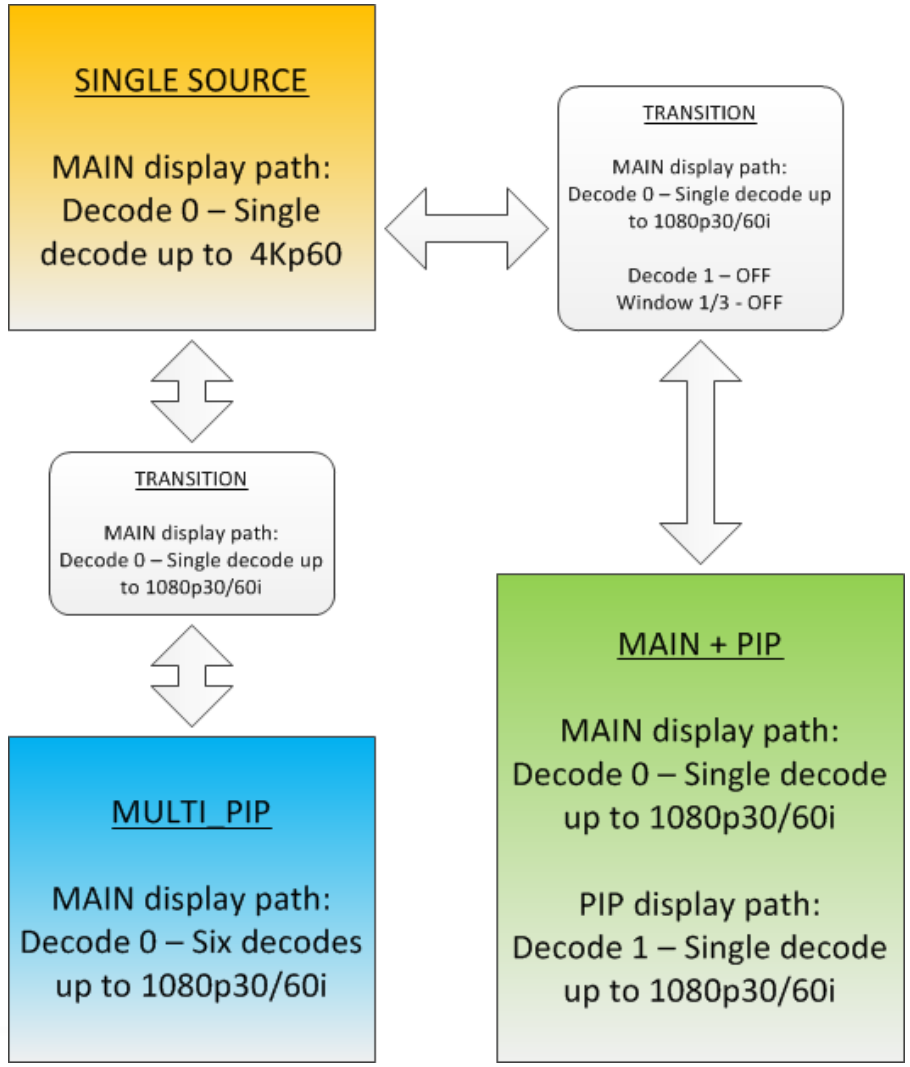
7445 Dx

BOX MODE 9 - SUMMARY

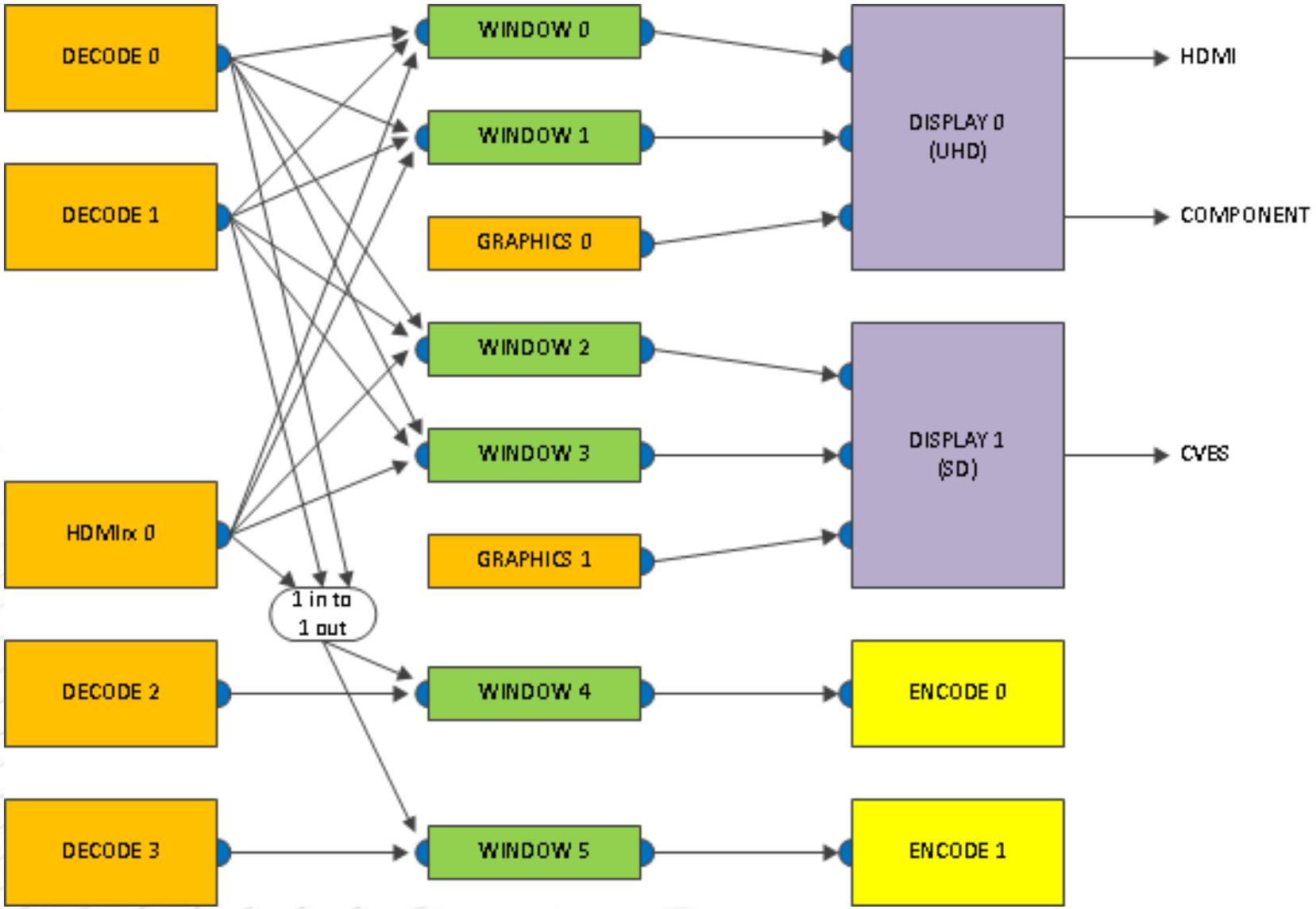
- **Memory speed 3x 32-bit DDR3-2133**
- **Supports:**
  - 4kp60 10-bit HEVC decode
  - MAIN + PIP (limited usage)
  - Multi-PIP (up to six displayed at a time)
  - UHD + SD simultaneous outputs
  - HDMI input
  - Two encodes up to 1080p30 8-bit AVC

DISPLAY MODES

- **There are three exclusive display modes available in this box mode:**
  - **Single source mode** – allows for the decode and display of a single source up to 3840x2160p60 10-bit HEVC as well as standard 1080p30/60i 8-bit AVC
  - **Multi-PIP mode** – allows for the decode and display of up to six independent 1080p30/60i sources
  - **MAIN + PIP mode** – allows for two 1080p30/60i sources to be displayed using two video paths.
- ***Each of these modes are available concurrently with two independent transcode operations***
- **Transitioning from one mode to another has specific limitations shown in the diagram**
  - You may keep one decode on the main path active.
- **You may transition directly from MAIN+PIP mode to Multi-PIP mode and back again if you meet both transition requirements.**
- **Each mode will have different display limitations and PQ limitations described later.**
  - Different de-interlacer capabilities for example
- **Transitions should be as seamless as possible**
  - On the order of a few frames at most.



POSSIBLE VIDEO ROUTINGS



SOURCE LIMITATIONS

- **Decode 0**
  - Single source mode:
    - 3840x2160p60 10-bit HEVC (HVD0) or
    - 1080p30/60i 8-bit HEVC / AVC (HVD0 or HVD1)
  - Multi-PIP mode:
    - 1920x1080p30/60i 8-bit HEVC / AVC (3x) (HVD0) +
    - 1920x1080p30/60i 8-bit HEVC / AVC (3x) (HVD1)
  - MAIN + PIP mode (MAIN or PIP):
    - Supplies decode for either MAIN or PIP path
    - 1920x1080p30/60i 8-bit HEVC / AVC (HVD0 or HVD1)
- **Decode 1**
  - MAIN + PIP mode (PIP or MAIN):
    - Supplies decode for PIP or MAIN path
    - 1920x1080p30/60i 8-bit HEVC / AVC
  - Must be inactive for single source mode and multi-PIP mode.
- **Decode 2 (Transcode 0)**
  - 1920x1080p30/60i 8-bit HEVC / AVC
- **Decode 3 (Transcode 1)**
  - 1920x1080p30/60i 8-bit HEVC / AVC
- **Graphics 0**
  - 1080p60 32-bit ARGB
- **Graphics 1**
  - 480p60 32-bit ARGB
  - 576p50 32-bit ARGB
- **HDMIrx 0**
  - 4096x2160p60 12-bit 4:2:0
  - 4096x2160p60 12-bit 4:2:2
  - 4096x2160p60 8-bit 4:4:4

HARDWARE RESOURCE MAPPING

Decoder	MFD	Usage	Hardware
Decode 0	MFD0	Single source mode Multi-PIP mode MAIN + PIP mode (MAIN or PIP)	HVD0 HVD1
Decode 1	MFD1	MAIN + PIP mode (PIP or MAIN)	HVD1
Decode 2	MFD2	Transcode 0	HVD2
Decode 3	MFD3	Transcode 1	HVD2

WINDOW LIMITATIONS

- **Window 0 (MAIN / UHD)**
  - Single source mode:
    - Up to full-screen display (smooth scaling)
    - 10-bit support / 1080i60 10-bit de-interlacing
  - Multi-PIP mode:
    - Up to six windows where the display area of each window is up to 1/N the display size where N is the number of active multi-PIPs (example later).
    - 480i60 / 576i50 8-bit de-interlacing
  - MAIN + PIP mode (MAIN):
    - Up to full-screen display (smooth scaling)
    - 10-bit support / 1080i60 10-bit de-interlacing\
- **Window 1 (PIP / UHD)**
  - MAIN + PIP mode (PIP):
    - Up full-screen display (smooth scaling)
    - 1080i60 8-bit de-interlacing
  - Must be inactive for single source mode and multi-PIP mode.
- **Window 2 (MAIN / SD)**
  - Single source mode:
    - Up to full-screen display (smooth scaling)
  - Multi-PIP mode:
    - Up to six windows where the display area of each window is up to 1/N the display size where N is the number of active multi-PIPs (example later).
  - MAIN + PIP mode (MAIN):
    - Up to full-screen display (smooth scaling)
- **Window 3 (PIP / SD)**
  - MAIN + PIP mode (PIP):
    - Up to ½ x 1 full-screen display (smooth scaling)
  - Must be inactive for single source mode and multi-PIP mode.
- **Window 4 / 5 (Transcode 0 and 1)**
  - Full-screen display
  - 1080i60 de-interlacing

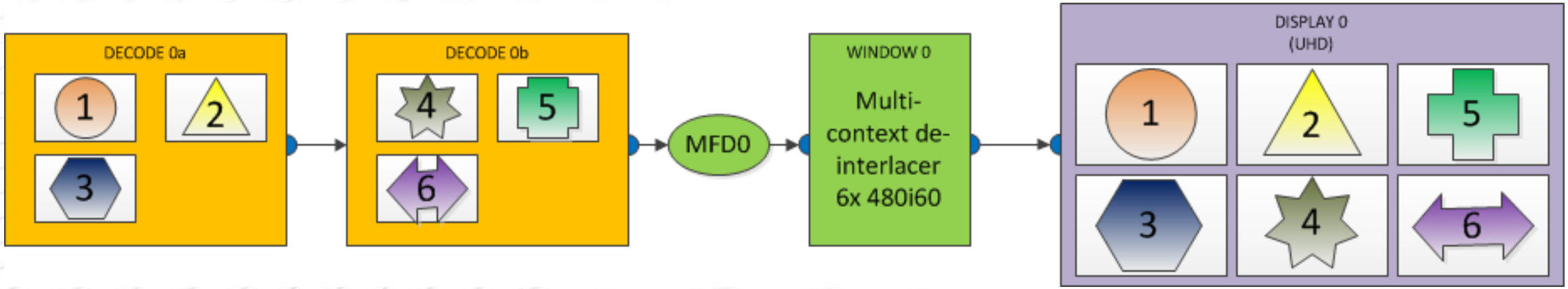
DISPLAY AND ENCODE LIMITATIONS

- **Display 0 (UHD)**
  - 3840x2160p60 12-bit 4:2:0 (HDMI)
  - 3840x2160p60 12-bit 4:2:2 (HDMI)
  - 3840x2160p60 8-bit 4:4:4 (HDMI)
  - 1920x1080p60 (component)
  - Only one display format at a time
    - If you want 1080p60 component, HDMI also needs to be 1080p60.
- **Display 1 (SD)**
  - 480i60 (CVBS)
  - 576i50 (CVBS)

- **Encode 0 / 1**
  - 1080p30 8-bit AVC

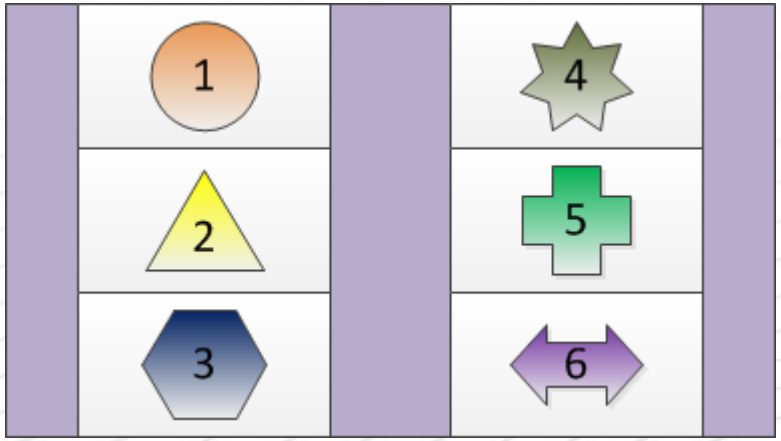
MULTI-PIP USAGE

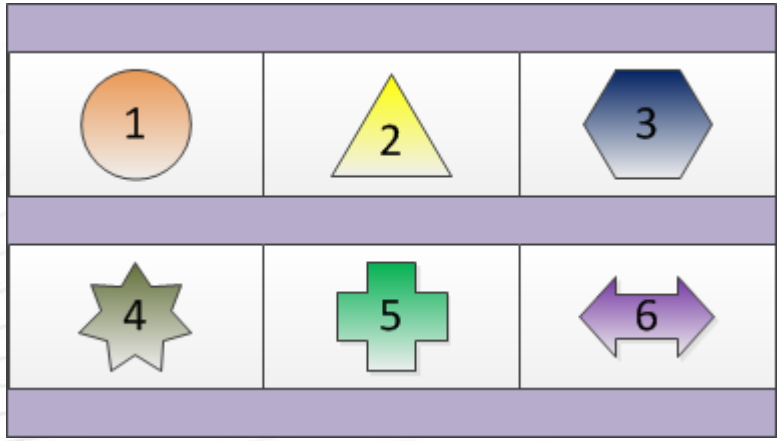
- **Multi-PIP is when a single decoder is capable of handling multiple full-resolution and a single display path can send them to the display.**
  - Here a “multi-PIP decode” is a 1080p30/60i 8-bit AVC or HEVC channel.
- **These channels can be decoded, displayed and composited into a single display.**
  - In this box mode, the final display can provide six independent multi-PIP decodes when HVD0 and HVD1 are used in tandem.
  - The display can be up to 3840x2160p60.
- **For improved quality, each multi-PIP also has a 480i60 capable de-interlacer.**

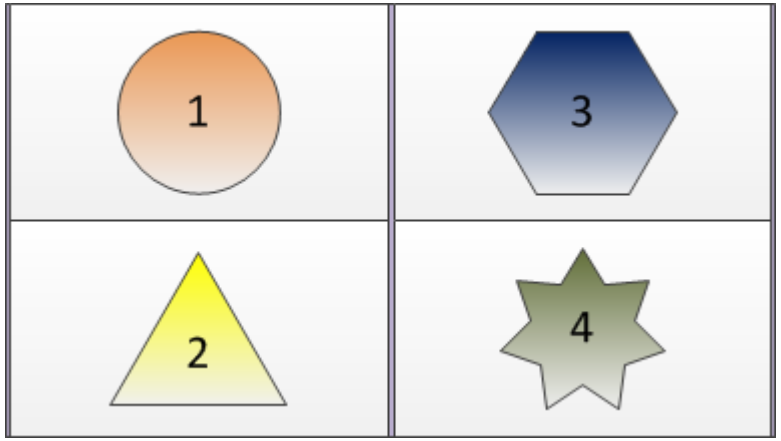


SAMPLE MOSAIC DISPLAY CONFIGURATIONS

- **The display limitation is based on the number of multi-PIPs**
  - When you have six windows, each multi-PIP window may take up to 12.5% of the display canvas. When you have four windows, each may take up to 20% of the display canvas.
    - Need more clarification from hardware and updated examples below.
- **Examples:**
  - If you have six multi-PIPs, each window may take up to 1/6th of the display canvas
  - If you have four multi-PIPs, each window may take up to 1/4th of the display canvas
  - If you have one multi-PIP, the single window may take up the entire canvas







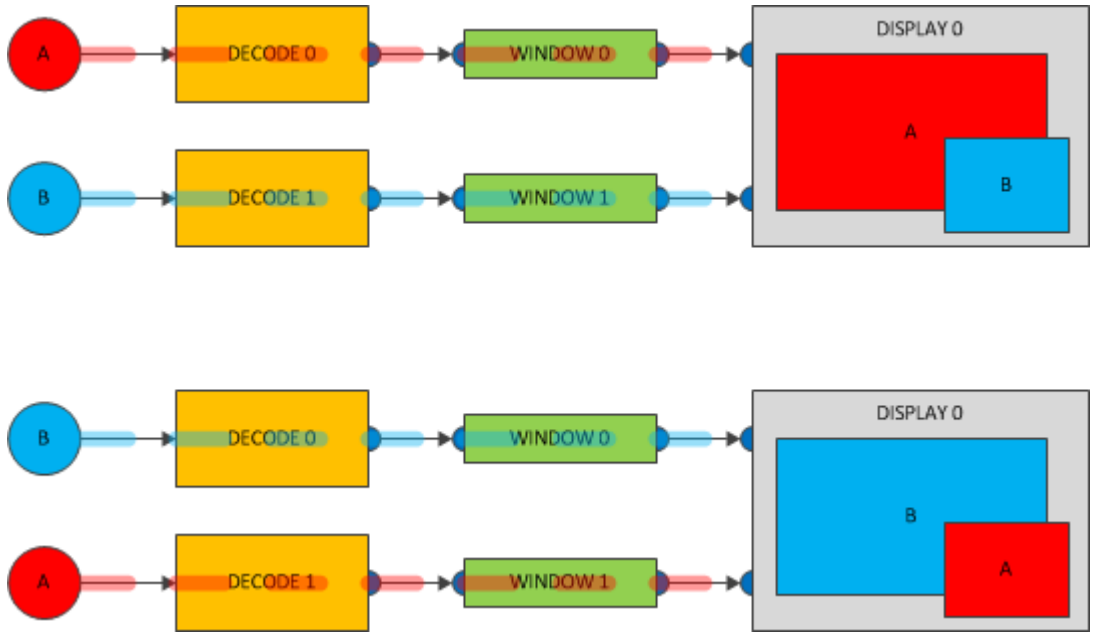
MAIN/PIP swap

MAIN + PIP SWAP

- **Only applicable in MAIN+PIP mode**
- **In this mode we have two equivalent decoders: Decode 0 and Decode 1**
- **However, the two window paths are not equivalent**
  - Window 0 has 10-bit quality, 10-bit de-interlacing, better picture quality (sharpness, noise reduction)
  - Window 0 has 8-bit quality, 8-bit de-interlacing limited to 480i (improve?), size limitations (improve?)
- **With that in mind there are several techniques that can be used to implement MAIN+PIP swap - each one with advantages / disadvantages**
- **Techniques:**
  - Decoder swap – Swap occurs by changing the decoders
  - Window swap – Swap occurs by changing the windows
  - Smooth swap – Swap occurs by resizing the windows
- **The following slides go into more details on each of these modes**

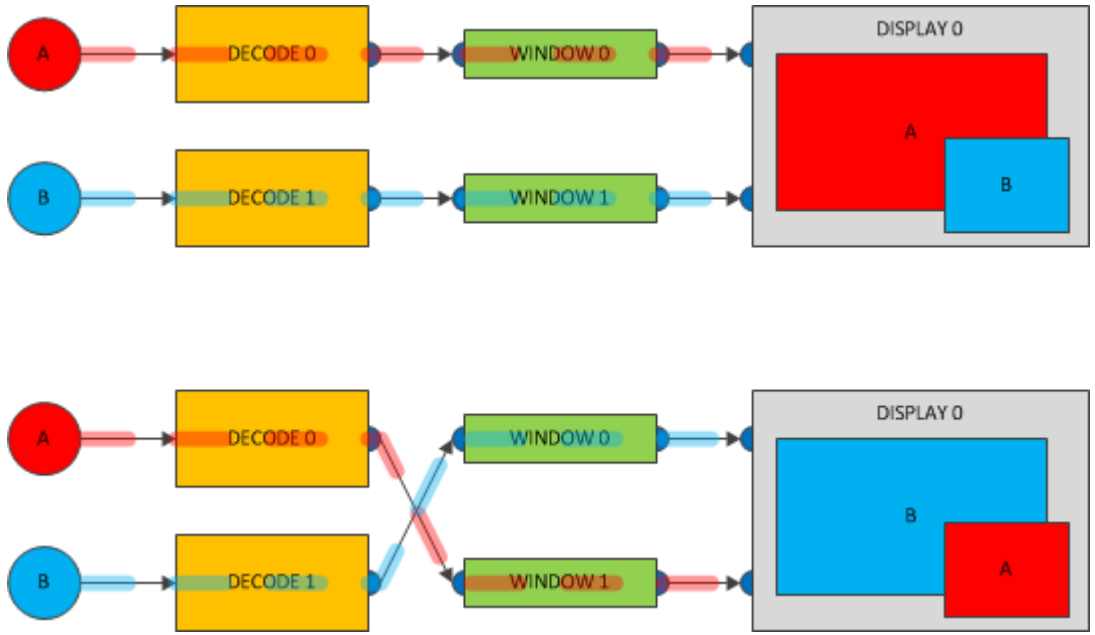
DECODER SWAP

- **To perform a swap, the decoders are shut down and restarted with the streams swapped at the input to the decoders**
- **Advantages:**
  - Decoder 0 is always feeding the main path and allows for quick transitions back to single source mode
  - Window 0 is always the main path and has the best picture quality capabilities.
- **Disadvantages:**
  - While the tuners may remain active, the decoders need to be restarted resulting in extended time during the swap operation.



WINDOW SWAP

- **To perform a swap, the windows are shut down and restarted with new decoder inputs**
- **Advantages:**
  - Window 0 is always the main path and has the best picture quality capabilities.
  - Transition time is minimal and only requires a few frame times to complete.
- **Disadvantages:**
  - Decoder 1 may be servicing the main path and would need to be shut down before transitioning into single source mode.



SMOOTH SWAP

- **To perform a swap, the existing windows are simply re-sized to become the larger main display and the smaller PIP display.**
- **Advantages:**
  - There is no transition time. This effect occurs seamlessly.
- **Disadvantages:**
  - Window 1 may be scaled to be the main path and does not have the higher quality PQ components.
    - May not be a big problem when both sources are 8-bit.
  - Decoder 1 may be servicing the main path and would need to be shut down before transitioning into single source mode.
- **ACTION:**
  - Need to determine if the RTS supports a full-screen PIP and 1080i60 de-interlacing otherwise this option is not as beneficial.