Buffering Transients
Basic use cases

- Buffer stores a rolling N seconds of “raw” data.
- Buffer can be frozen, dumped to storage, and processed offline.
- Scenario 1: triggered by a real-time SKA transients search pipeline (internal trigger).
- Scenario 2: triggered by an external alert.
- Scenario 3: triggered randomly for other science purposes (e.g. very high-time-res imaging offline).
- Scenario 4: triggered for testing, commissioning, regular system monitoring.
Buffering Transients
Why?

- Localization to 1-2 arcsec of short, impulsive, non-repeating transients.
- Full polarimetry.
- Full time resolution.
- Possibly coherent dedispersion.
- Low-level signal verification.
Buffering Transients
Where?

- Station/antenna raw voltages.
- and/or non-accumulated visibilities
- and/or tied-array voltage beam
Buffering Transients

What?

• Storing 10s of data will take ~256GB of memory per buffer element (could trade for bandwidth).
• Buffer size dictated by event duration, system latency and dispersive sweep across the band.
• SKA-Low: 350-250MHz is a 33s delay for a DM = 1000pc/cc.
• Readout and offline processing should be shorter than time between triggers.
• Expect order 10s of triggers per day.
Operations per second required to process real-time incoherent beam

\[ N_{\text{ops}} = N_{\text{DM}} \times N_{\text{pol}} \times N_{\text{beams}} \times BW \times N_{\text{ant}} \]

\[ N_{\text{pol}} = 2 \]
\[ BW = 300/N_{\text{beams}} \text{ MHz} \]
\[ N_{\text{ant}} = 1024 \text{ (full array), 768 (core), 512 (inner core)} \]
\[ N_{\text{DM}} = DM_{\text{max, TBB}} / \Delta DM \]

\[ DM_{\text{max, TBB}} = T_s \nu_{\text{GHz}}^3 / 8.3 \times 10^{-6} / \Delta \nu_{\text{MHz}} \]
where \( T_s \) is the size of buffer (seconds)

\[ \Delta DM \approx 506 \frac{W_{\text{ms}} \nu_{\text{GHz}}^3}{\Delta \nu_{\text{MHz}}} \]

Cordes+ (2003)

\[ A_{\text{eff}} / T_{\text{sys}} = 1070 \text{ m}^2 / \text{K} \]
\[ \nu = 200 \text{ MHz} \]
Example: Operations per second required to process real-time incoherent beam

\[ N_{\text{ops}} = N_{\text{DM}} \times N_{\text{pol}} \times N_{\text{beams}} \times \text{BW} \times N_{\text{ant}} \]

<table>
<thead>
<tr>
<th>N_{\text{ant}}</th>
<th>BW/beam</th>
<th>N_{\text{beams}}</th>
<th>T_s</th>
<th>DM_{\text{max,TBB}}</th>
<th>\Delta DM</th>
<th>N_{\text{DM}}</th>
<th>N_{\text{ops}}</th>
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</thead>
<tbody>
<tr>
<td>1024</td>
<td>300MHz</td>
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<td>300s</td>
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<td>0,01</td>
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