Data Management

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Range

- Receive raw data from Data Acquisition
  - The raw data become DM’s when they hit site storage

- Deliver science-quality intermediate data products to the collaboration
  - “Intermediate data products” are single-frequency maps and transient alerts
  - “Science-quality” includes all documentation and ancillary data products required to analyze the data

- Deliver science-quality intermediate and final data products, and the software used to generate them, to the community

- The Data Management construction project must:
  - Support the optimization and validation of the experiment design
  - Be ready to transition to operations at first telescope commissioning
Scope

- Data registration on receipt from DAQ
- Data movement from sites to US and between US data centers
- Archival storage of raw data and derived data products
- Production of daily single-frequency maps from all telescopes
- Identification of transients in daily maps & issuing of science alerts
- Monitoring of data quality in daily maps & issuing of operational alerts
- Characterization of the experiment (instrument + observation) from design, laboratory & field data
- Production of bulk single-frequency maps, including systematics mitigation
- Characterization of bulk single-frequency maps
- Production of mock datasets for design validation & data characterization
- Delivery of science-grade intermediate data to the collaboration
- Receipt of data quality/sufficiency feedback from the collaboration
- Delivery of science-grade intermediate and final data to the community
Work Breakdown Structure

*interim

- Intentionally distributed leadership to leverage the full range of Stage 3 expertise and to interface with the collaboration as widely as possible.
## Design Drivers - Data Rates

<table>
<thead>
<tr>
<th>TELESCOPES</th>
<th>DETECTORS</th>
<th>SAMPLING FREQUENCY (Hz)</th>
<th>DATA RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RAW (Samples/Sec)</td>
<td>COMPRESSED (Gbps)</td>
</tr>
<tr>
<td>CHLAT</td>
<td>243,520</td>
<td>400</td>
<td>$9.7 \times 10^7$</td>
</tr>
<tr>
<td>SPLAT</td>
<td>114,432</td>
<td>400</td>
<td>$4.6 \times 10^7$</td>
</tr>
<tr>
<td>SAT</td>
<td>153,232</td>
<td>100</td>
<td>$1.5 \times 10^7$</td>
</tr>
</tbody>
</table>

Data rates set site bandwidth and local storage requirements.

Design: sufficient network bandwidth (1.1 Gbps) from Chile; insufficient network bandwidth (0.7 Gbps) from South Pole.

Design: 1 month backup (382 TB) in Chile; 1 year backup (5.4 PB) at South Pole.
Data volumes set US data center storage requirements

Design: 1 year of raw data + 7 years of science data (17 PB) spinning at each data center

Design: 7 years raw data (49 PB) archived at each data center

### Design Drivers - Data Volumes

<table>
<thead>
<tr>
<th>TELESCOPES</th>
<th>DAILY DATA (TB)</th>
<th>SPINNING DATA (PB)</th>
<th>ARCHIVAL DATA (PB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHLAT</td>
<td>11.8</td>
<td>4.3</td>
<td>30.1</td>
</tr>
<tr>
<td>SPLAT</td>
<td>5.5</td>
<td>2.0</td>
<td>14.2</td>
</tr>
<tr>
<td>SAT</td>
<td>1.9</td>
<td>0.7</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Data volumes set US data center storage requirements

Design: 1 year of raw data + 7 years of science data (17 PB) spinning at each data center

Design: 7 years raw data (49 PB) archived at each data center
**Design Drivers - Daily Data Processing**

<table>
<thead>
<tr>
<th>TELESCOPES</th>
<th>CYCLES (TFLOP)</th>
<th>PEAK MEMORY (TB)</th>
<th>SINGLE DAILY MAP DATA (GB)</th>
<th>TOTAL DAILY MAP DATA (TB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHLAT</td>
<td>0.84</td>
<td>11.5</td>
<td>54</td>
<td>138</td>
</tr>
<tr>
<td>SPLAT</td>
<td>0.40</td>
<td>5.7</td>
<td>4.5</td>
<td>12</td>
</tr>
<tr>
<td>SAT</td>
<td>0.13</td>
<td>1.2</td>
<td>0.02</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Daily data processing drives the fast-access computational requirements

Design: CHLAT processing in the US; SPLAT+SAT processing at South Pole
Simulating and reducing the entire dataset requires:

- Cycles: 21.9 EFLOP
- Peak memory: 11.7 PB
- Peak scratch: 2.1 PB

Design: bulk computational resources must be allocated at national computing centers

Design: balance having sufficient centers to accommodate down-times & support diverse approaches (high performance + high throughput) against the cost per center of maintaining/optimizing the software stack.
Allocated computational resources are planned, not confirmed.
PBD Software Schematic
Interfaces

All interfaces must be documented:

- Interface Control Documents with other L2 Subsystems
- Memorandum of Agreement with the Collaboration
Data Challenges

- Data Challenges are at the core of the DM construction project:
  - Experiment (Instrument + Observation) design validation
  - Data management subsystem validation
    - Including sufficiency of allocated computational resources
  - Analysis pipeline validation
- Each agency review features an enhanced/matured design to be validated.
- Each review is informed by a preceding data challenge.
- Each Data Challenge is a 6-month process.
## Data Challenge Schedule/Process

<table>
<thead>
<tr>
<th>Months Before Deadline</th>
<th>1.09.01 Subsystem Management</th>
<th>1.09.02 Data Movement</th>
<th>1.09.03 Software Infrastructure</th>
<th>1.09.04 Data Simulation</th>
<th>1.09.05 Data Reduction</th>
<th>1.09.06 Transients</th>
<th>1.09.07 Site Hardware</th>
<th>AWGs</th>
<th>TWGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
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<td>6</td>
<td></td>
<td></td>
<td>1. Define scope</td>
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<td>5</td>
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<td>2. Freeze simulation &amp; reduction modules</td>
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<td>4</td>
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<td>3. Construct and execute pipelines</td>
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<tr>
<td>2</td>
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<td></td>
<td>Execute science analyses &amp; document in design report</td>
<td>Execute technical analyses &amp; document in design report</td>
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<tr>
<td>1</td>
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<td>Provide feedback to DM</td>
<td>Provide feedback to DM</td>
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<td>0</td>
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<td>10. Director's Review</td>
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<td>11. Agency Review</td>
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</table>
Parallel Session

Presentation by each L3 team

- More detailed dive into each L3 subsystem
- Open issues and questions
- Path to CD-1/PDR

Note also the “Design Validation: Technical to Measurement” theme which will focus on Data Challenge 1 and validating the Preliminary Baseline Design.
Open Questions

- Do we have the full set of data product requirements from the collaboration?
- What is the exact boundary between project and collaboration with respect to transients?
- What is the optimal map-making approach when computational cost is included? Does it vary with science case?
- Are there other computational resources we should be looking to use?
  - FABRIC in network computing
  - Joint South Pole computational infrastructure with IceCube
- How best do we deliver data to the collaboration? Can/must we deliver computational resources too?
- Do we have the right feedback loops with TWGs and AWGs?