Quick Reminder on the LHCb Upgrade Timeline

- Main Upgrade of the experiment happening in Run 3 (2021)
  - Full and final real-time data reconstruction at online resources
  - Trigger output bandwidth increases by several factors

- Run 4 upgrade (HL-LHC) in computing will see minor changes compared to Run3
LHCb Upgrade Distributed Computing in a Nutshell

• LHCbDIRAC will continue to operate distributed computing resources in upgrade era
  • Architecture allows re-engineering, scaling of individual components as needed

• Full exploit of “Turbo” paradigm
  • Final detector alignment and calibration during trigger processing
    • Already successfully exercised for 1/3 or the trigger rate in Run 2
    • → final physics objects out of the trigger → no offline data processing
    • → 90 % of distributed computing resources needed for MC simulation

• Factor 5 increase of luminosity (Run3) & removal of L0 hw trigger & reduction of event size via Turbo
  • → increase of trigger rate by one order of magnitude
  • → LHCb needs for simulated events scales with the above
    • → aiming for 60 to 80 % of fast and full parametrized simulated events
    • Re-decay, tracker-only, RICHless in production, more planned (shower libs, delphes, …)

• → Despite optimizations, offline data storage needs increase by factors
Distributed Workload Management – User Analysis

• User analysis with input data
  • Input data split and grouped according to storage sites
  • Jobs sent to data storage site location (T0, T1, T2D)
  • Fallback mechanism (Gaudi federation)
    • In case the local replica is not accessible → WAN fallback onto possible 2nd replica
  • Push from individual user analysis towards “working group productions”

• User analysis without input data
  • Runs on all WLCG resources
Distributed Workload Management – MC Simulation

• MC Simulation – Step 1, generator and detector response
  • 95% of CPU used in this step.
  • Output upload of (intermediate) file to “buffer storage” (usually T0 & T1)
  • Runs on all computing resources (WLCG, Boinc, HPC, Cloud, …)
  • No input data needed for this step (start from random seed)

• MC Simulation – Step 2
  • Processed at disk storage site
  • Process remaining workflow (digitization, trigger, (reco), stripping (aka slimming, streaming, skimming)
  • Output upload to disk storage site (T0, T1, T2D)
LHCb Distributed Data Management

- Small number of disk storage sites
  - T0 + (8) T1 sites, 13 T2 sites with storage (>> 300 TB each)
  - User and buffer space on T0/1 sites
  - Data & MC replicated twice on all storage sites

- Mostly ”democratic” data replication policy based on free space
  - Both data and MC

- Launch of data management workflows done manually (takes O(\text{Min}))
  - Replication managed by Dirac, offloaded to FTS3 (including staging)
  - Remove replica, delete file done by Dirac
  - Transfer P8 (pit) to CERN done by Dirac
Data Management Catalogs & Data Access

- Dirac File Catalog (~ 20 Mio LFNs)
  - Information on centrally produced data replicas
  - Provides access to logical SEs (can be on same hardware SE)

- Bookkeeping
  - Contains data provenance information (~ 1 Billion files)
    - Origin (LHCb or MC), Conditions (Beam energy), Processing pass (reco, stripping, …), Event Type (mostly for simulation), File type (RAW, RDST, BHADRON.MDST, EW.DST, …)
  - Stores information on all files ever created and data quality information
    - Including location, worker node, cpu time, wall time, …)
  - Defines “data sets” used by physicists for selection of their input files
Space Tokens & Data Access

• Space tokens in use
  • LHCb-Tape (T1D0)
  • LHCb-Disk (T0D1)
  • LHCb-User (T0D1)

• Moving from srm to direct xroot access
  • Reading shall be possible soon for all sites
  • Writing possible on sites where tape and disk are not in the same namespace
Outlook

• Run 3 upgrade step is major for LHCb
  • Offline distributed computing needs increase by several factors

• WLCG developments aiming to reduce resource needs are welcome
  • NB: Different timeline of upgrade program to GPDs

• LHCb volunteers to try especially storage need optimizations early on