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## A Comprehensive Bandwidth Testing Framework for the LHCb Upgrade Trigger System

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The LHCb experiment at CERN has undergone a comprehensive upgrade. In particular, its trigger system has been completely redesigned into a hybrid-architecture, software-only system that delivers ten times more interesting signals per unit time than its predecessor. This increased efficiency - as well as the growing diversity of signals physicists want to analyse - makes conforming to crucial operational targets on bandwidth and storage capacity ever more challenging. To address this, a comprehensive, automated testing framework has been developed that emulates the entire LHCb trigger and offline-processing software stack on simulated and real collision data. Scheduled both nightly and on-demand by software testers during development, these tests measure the online- and offline-processing's key operational performance metrics (such as rate and bandwidth), for each of the system's 3500 distinct physics selection algorithms, and their cumulative totals. The results are automatically delivered via concise summaries - to GitLab merge requests and instant messaging channels - that further link to an extensive dashboard of per-algorithm information. The dashboard and pages therein (categorised by physics working group) facilitate exploratory data analysis and test-driven trigger development by 100s of physicists, whilst the concise summaries enable efficient, data-driven decision-making by management and software maintainers. Altogether, this novel and performant bandwidth testing framework has been helping LHCb build an operationally-viable trigger and data-processing system whilst maintaining the efficiency to satisfy its physics goals.

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