A Cloud-Based GNSS Velocity and TEC Data Center: Initial Perspectives from Hazard Monitoring

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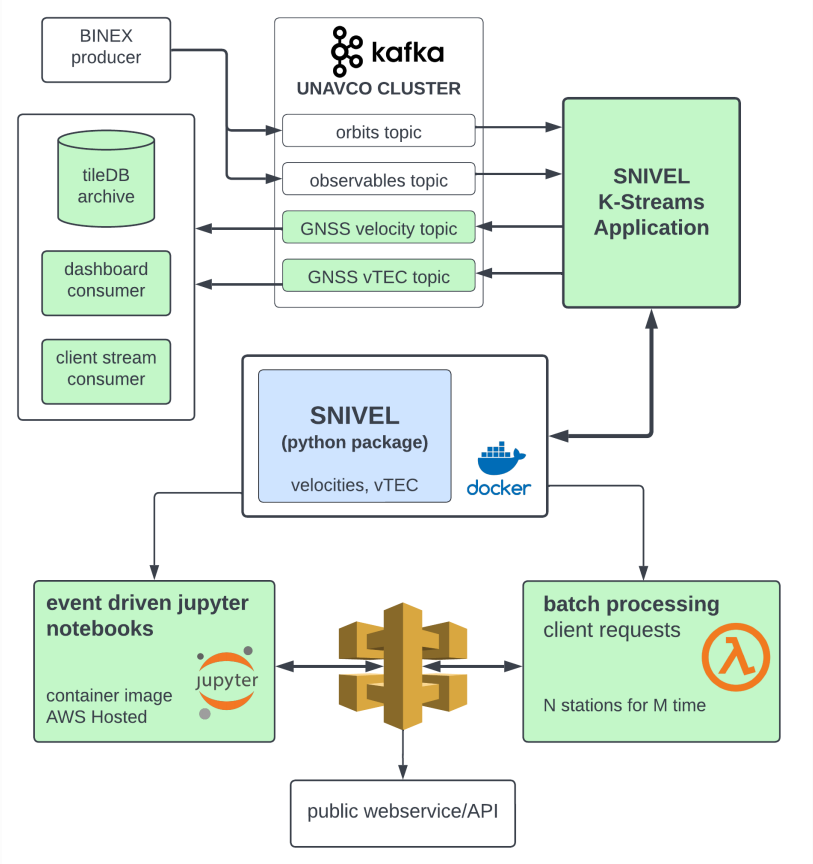
Observations of strong ground motion during large earthquakes are generally made with accelerometers. These observations have a critical role in early warning systems, seismic engineering, source physics studies, basin/site amplification, and macroseismic intensity estimation. However, inertial sensors have difficulty recording the full dynamic range of velocities and displacements, especially at low frequencies during large earthquake events, due to sensor rotations and tilts. For early warning purposes, scientists have proposed using displacements recorded at GNSS receivers to obtain the slip history of large earthquakes in real-time without saturation. However, computing GNSS displacements in real-time can be problematic due to issues with phase ambiguity fixing, cycle slips, and loss of satellite lock. One potential solution to this issue is to process the raw GNSS observations for velocities instead of displacements by taking a single difference in time between the satellite positions and the GNSS phase observables. This presentation provides an introduction to our recently funded project to create an operational real-time GNSS velocity data center. Code modifications to the SNIVEL software package, which utilizes the narrow-lane combination phase observables to compute velocities, will be made to consume raw GNSS observables from EarthScope's Kafka stream processing platform and TileDB. In addition to velocities, SNIVEL can compute ionospheric total electron content (TEC) perturbations, which we will operationalize for hazard monitoring. Incorporation of GNSS velocities to ShakeMaps will be developed and machine learning techniques will be explored for time series analysis and forecasting ground motions for earthquake early warning. Access to real-time data streams in the future will be available through a variety of means such as API calls, subscription to Kafka topics, and Jupyter notebooks. In the future, we plan to incorporate these streams into the G-FAST geodetic early warning module that is part of the ShakeAlert system.



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