Development of an Extension of GeoServer for Handling 3D Spatial Data

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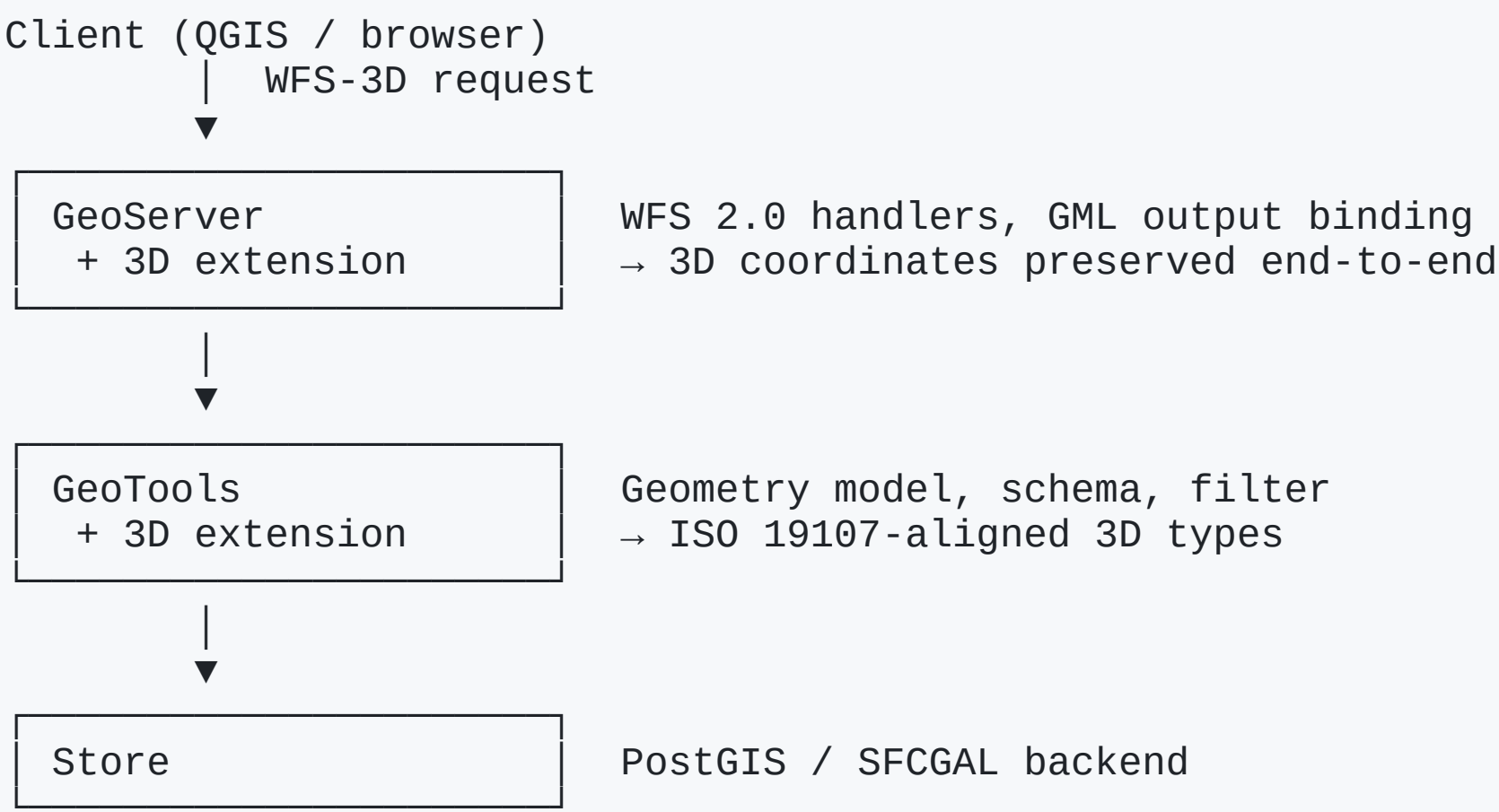
Why a 3D extension?

- OGC's spatial type system in `Simple Features for SQL` (SFS) is fundamentally **2D**.
- Mainstream open-source GIS — GeoServer / GeoTools / JTS — inherits that 2D world.
- 3D city models, indoor maps, building footprints with elevation, geological data — all force a workaround (`Z` carried as attribute, not as geometry).
- **Goal:** make 3D a first-class concept across the WFS → GeoTools → store stack, not a side channel.

The stack we touched



What changed in GeoTools

- **Geometry model.** Add `Solid`, `CompositeSurface`, `Triangle`, `TIN` — ISO 19107 SF-aware shapes that JTS doesn't carry.
- **Schema / SRS.** Track CRS dimensionality (2D / 2.5D / 3D) so the binding layer doesn't silently drop `Z`.
- **Filter functions.** Lift `intersects`, `within`, `distance` to 3D — delegate to an SFCGAL backend when the geometry is solid.

What changed in GeoServer

- **WFS request handlers.** Recognize 3D-typed feature types and route them to the 3D-aware GeoTools path.
- **GML output binding.** Emit `gml:Solid`, `gml:TriangulatedSurface`, etc. for 3D geometries instead of degrading to 2D.
- **Store hookup.** Surface a SFCGAL-backed PostGIS store as a regular GeoServer data store.

Limitations & future work

- **Renderer client.** Browsers and most GIS desktops were not 3D-rendering WFS responses in 2017 — QGIS was the most reliable testbed.
- **Spec gap.** OGC's WFS-3D / GML-3D pieces were in flux; we tracked the strictest reading of GML 3.2 SF-1.
- **Performance.** SFCGAL is correct but slow; large 3D feature collections need streaming + spatial indexing tuned for `BBox3D`.

Resources

- **Source — GeoTools 3D extension:** https://github.com/STEMLab/geotools-3d-extension
- **Source — GeoServer 3D extension:** https://github.com/STEMLab/geoserver-3d-extension
- **Original slides:** https://www.slideshare.net/hyunggyuryoo/slideshelf
- **Lab:** STEMLab @ Pusan National University

Thanks!