



# ForgeGIS™

## GPU-Accelerated Geospatial Primitives, Native to MCP

As of May 2026, the only commercially-supported GPU-accelerated geospatial library we have been able to identify that exposes its full operation catalog to AI agents through a native Model Context Protocol server. 220 operations · 218 MCP-accessible · 62 MCP tools across two complementary surfaces. Operations run GPU-resident where the algorithm parallelizes on the device, with CPU fallbacks for the four sequential-by-nature ops (sink fill, flow accumulation, cost distance, nibble); every operation is numerically deterministic and reachable from any MCP-capable agent — agents reach professional-grade GIS analysis through MCP without needing to know geospatial internals.

**218** / 220

**operations**  
**MCP-accessible**

*two Java-only ops by design*

**62**

**MCP tools**  
**across two surfaces**

*54 intent + 5 primitive + 3 escape*

**~800** ms

**warm-restart cold start**  
**to first tools/list**

*~3s on first-deploy, no OS cache*

### Two surfaces, one core

The MCP server exposes the catalog through two complementary access patterns. A *pipeline DSL* lets agents compose any of 133 operations into multi-step workflows the server executes GPU-resident, with intermediate results staying on the device. *54 curated intent tools* wrap common analytic tasks as typed single-call endpoints with strict input schemas. Same operations underneath — different access patterns for different agent workflows.

### Deterministic by construction

The MCP layer is a parameter-marshaling shim over the same compute implementations the direct Java API exposes — not a parallel implementation. Numerical outputs depend on the operation and its parameters, not the invocation surface. Two operations involve randomness (*KMeans-Classify*, *RandomForest*) and use a fixed deterministic default seed under MCP invocation, so agent runs are reproducible without per-call seed configuration.

### Built to be embedded

Pure-Java Maven distribution with no first-party native code. The shaded MCP server jar drops into any host environment with a JDK and a GPU driver — no separate native install step, no CUDA-only runtime requirement, no system-level GDAL install, no platform-specific binaries to coordinate. GPU dispatch goes through the JOCL OpenCL bindings (JNI bridge bundled inside the JOCL jar, extracted at runtime). Communicates over JSON-RPC on stdio per the MCP specification. Agents that spawn MCP servers per session see approximately 800 ms median to first response on warm restart.

## WHO THIS IS FOR

### LLM agent platforms grounding spatial reasoning in real geometry

Agents that need to reason about where things are, what overlaps what, how far apart features sit, what a flood envelope looks like, or what's visible from a vantage point — and need the answer in milliseconds, not seconds. ForgeGIS exposes 218 operations through MCP without requiring the agent itself to understand projections, predicates, or pipeline composition.

### Workflow and orchestration platforms

LangChain, AutoGen, MCP-native runners, and the broader class of platforms that compose tool calls into agent workflows. The dual-surface API — DSL for novel composition, intent tools for typed call shapes — lets the same library serve both "let the agent figure out the chain" and "give the agent a stable typed endpoint" workflows from one server install.

### AI-native geospatial product builders

Founders and teams building product categories that didn't exist when the GIS stack was designed for human analysts at desktops — conversational geospatial intelligence, agent-driven site selection, AI-mediated remote sensing, autonomous mission planning. ForgeGIS is the compute substrate built for that thesis from the first commit.

## PERFORMANCE HIGHLIGHTS

**~800 ms**

warm-restart cold-start to first tools/list response  
returning all 62 MCP tools, list cached on first build

**14.46x-  
39.75x**

multi-stage GPU-resident pipelines vs. GDAL CLI  
measured warm at 2048<sup>2</sup>-4096<sup>2</sup> rasters

**6.88x**

geomean across 143 catalog comparison records with GDAL CLI equivalent  
May 2026 validation run, 127 wins of 143 (op × scale measurements)

### Raw DE-9IM matrix for agent-encoded topology

Beyond the 8 OGC SFS named predicates (*Intersects, Disjoint, Within, Contains, Equals, Touches, Crosses, Overlaps*) and the 3 JTS extensions (*Covers, CoveredBy, ContainsProperly*), ForgeGIS exposes the raw 9-character DE-9IM intersection matrix per geometry-type pair through six matrix-computing operations. Agents reasoning about novel spatial relationships can encode topological queries that don't have named predicates — useful when an agent needs to express a relationship that the OGC vocabulary doesn't have a word for.

## Build with ForgeGIS

A 21-page Technical Brief with the complete 220-operation catalog, MCP surface breakdown, validation methodology, and architectural deep-dive is available on request. Docker image and Maven coordinates available on request for evaluation.

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