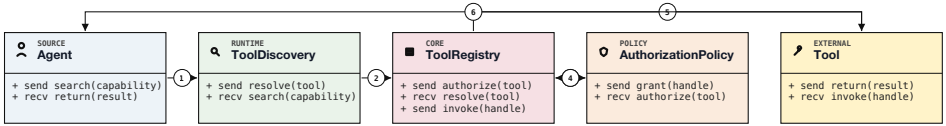
P09 Deferred tool loading

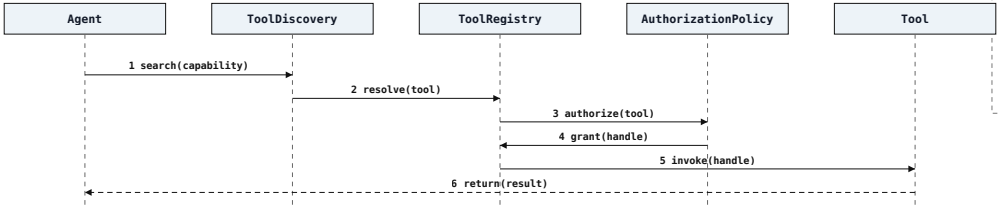
Primitive · A² A1 · registry role collaboration

Discover capabilities only when needed.

STRUCTURE · PARTICIPANT COLLABORATION



INTERACTION



MESSAGE TRACE `1 search(capability) → 2 resolve(tool) → 3 authorize(tool) → 4 grant(handle) → 5 invoke(handle) → 6 return(result)`

Evidence: 35/41 repositories, 32/36 families; 35 trajectories (16 multi-checkpoint); exact audit: not sampled.

Variation: Search tool, registry, namespace, loading scope, and cache policy.

Negative control: A large static tool list does not satisfy deferred loading.

PATTERN INTERFACE

context
Available tools are too numerous or expensive to expose eagerly.

trigger
The agent searches, discovers, or lazily resolves a tool.

structure
Discovery descriptor, registry, authorization check, and invocation handle.

effect
Tool schema is loaded on demand and authority is checked before execution.

CONTRACT ANNOTATIONS

requires	Tools have discoverable metadata and a stable invocation identity.
ensures	A discovered tool can be invoked once with its own schema and current permissions.
invariant	Lazy loading does not cache a stale authorization decision.
violation	Unknown, stale, or unauthorized tools fail explicitly before side effects.