Orleans: Virtual Actors for Programmability and Scalability of Cloud Applications

Philip A. Bernstein, Sergey Bykov, Alan Geller, Gabriel Kliot, Jorgen Thelin
Microsoft Corporation

Problem
• Building interactive, distributed services is hard
  • Challenges: scalability, reliability, concurrency, ...
• The actor model helps make it easier
  • Actors are objects that do not share state
  • E.g., game, device, phone, scoreboard, region
• But problems remain
  • Actor lifecycle management, actor failure & recovery, actor placement, distributed races, resource management

Novel Solution: Virtual Actors
• Always exist
• Cannot be created or destroyed
• Are location transparent
• Are instantiated when referenced
• Are reclaimed when not used
• Are analogous to virtual memory

How to Invoke Virtual Actor “A”

Orleans Benefits
• Helps desktop developers succeed with distributed apps
  • Ensures app is scalable, reliable, and elastic by default
• Improves productivity of distributed systems experts
  • 3-5x less code to write than on a bare VM
• Performance is near-real-time (milliseconds)

Scalability
• Near linear scaling to 100K’s requests/second
• Scalable in number of actors
• Multiplexes network connections, threads, and memory buffers for efficiency
• Location transparency simplifies scaling up or down
• Elastic – transparently adjusts to adding or removing servers

Implementation – Project Orleans
• Define .NET classes in C#, as if they run in one process
• Orleans scales out the app on a cluster of servers
• ActorID→Server mapping is stored in a distributed hash table and cached locally.
• If server S fails, actors at S are reactivated elsewhere
• Kill & reactivate actors mapped by S’s directory
• Single-threaded actors, communicating via async RPC
• Timer services, load balancing, declarative persistence, ...

Adoption
• Used extensively by Microsoft and its customers
  • For all cloud services of the Xbox game Halo 4
  • Telemetry, Internet of things, and many other games
• Microsoft Azure’s Reliable Actors is based on Orleans’ API
• Project “Orbit “ is a Java implementation of Orleans-style virtual actors by BioWare, a division of Electronic Arts
• Thriving open source community at GitHub

Orleans is open source at https://github.com/dotnet/orleans