Introduction

Spatial simulations (e.g., Massively Multiplayer Online Games, or MMOGs) allow entities (i.e., players) to send or receive messages from an area.

Described as Spatial Publish Subscribe (SPS):
- Subscribe an area
- Publish messages to an area
- Get publications if pub/sub areas overlap
- Move a subscribed area

To scale up spatial simulations, partitioning of the space is needed, but with fixed partitioning:
- Entities may overload a partition
- Lack of entities may underload a partition

Design of VSO

Voronoi Self-organizing Overlay (VSO)
- Client: an entity (e.g., a user) in the system
- Matcher: a manager of a region that matches publications with subscribers
- Matchers partition & manage the entire space into regions

Basic procedure:
- A client connects to a matcher
- The client sends pub/sub requests to matcher (in the form of center + radius)
- Subscription requests recorded at the owner matcher (who covers sub centers)
- Matchers check if a publication should be delivered to a subscriber

Key design elements:
- Matchers form a fully-distributed Voronoi-based Overlay Network (VON), (Fig. 3.)
- If a pub/sub request lies outside of region, it is forwarded via VoroCast, (Fig. 4.)
- Scalable as matchers can be added/removed, fault-tolerant as fully-distributed.

Self-organization of VSO

Advantages of Voronoi partitioning:
- produces fewer regions for same load per region (Fig. 5)
- can be adjusted easily for load balancing

Adjustment rules for matcher overload:
- shrink region sizes by asking neighbors to come closer
- request matcher insertion (from a gateway), if overload persists
- a matcher continuously moves its site (center) to center of entities

Summary

- SPS is a basic primitive for spatial simulations
- Voronoi diagrams provides self-organizing spatial partitioning
- VSO supports scalable & fault-tolerant SPS operations

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