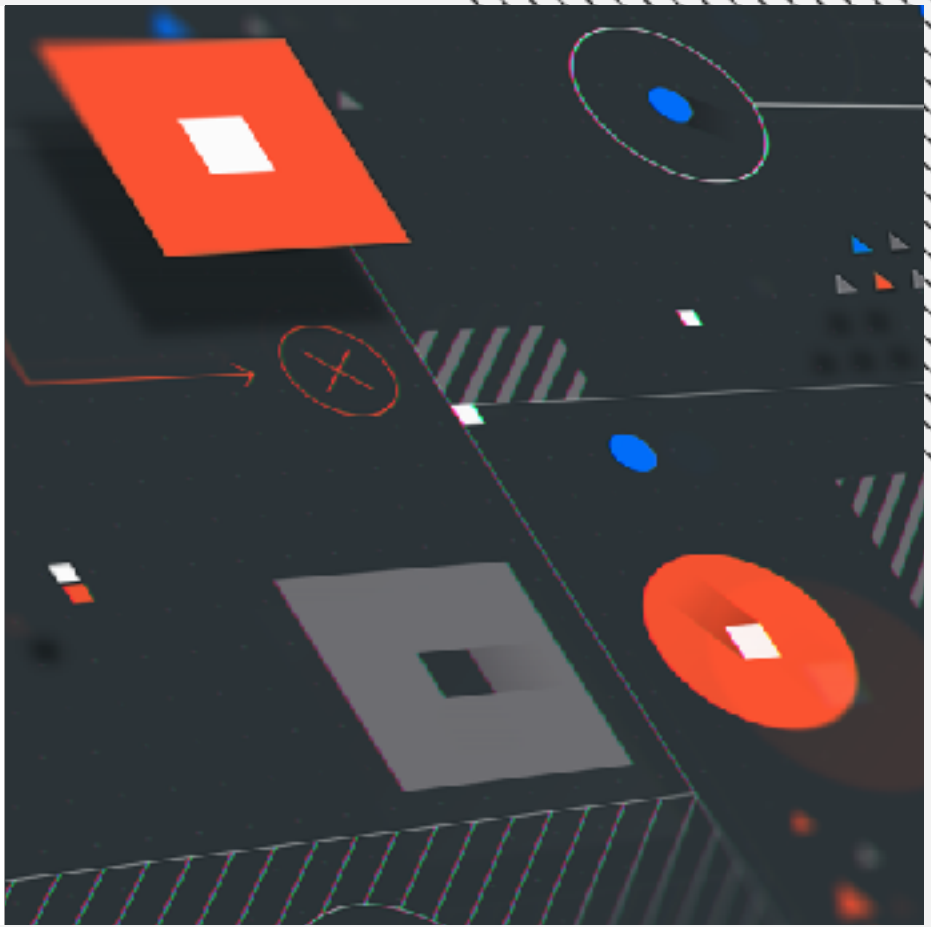
SpatialOS for Military Simulation and Training



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26/September/19

SpatialOS

A SpatialOS Primer

SpatialOS

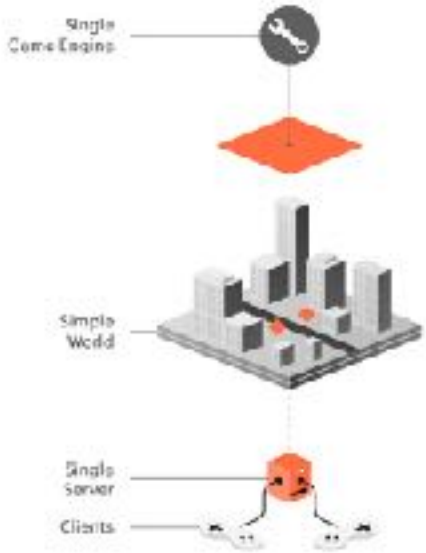
SpatialOS

SpatialOS is a simulation interoperability platform, developed by Improbable.

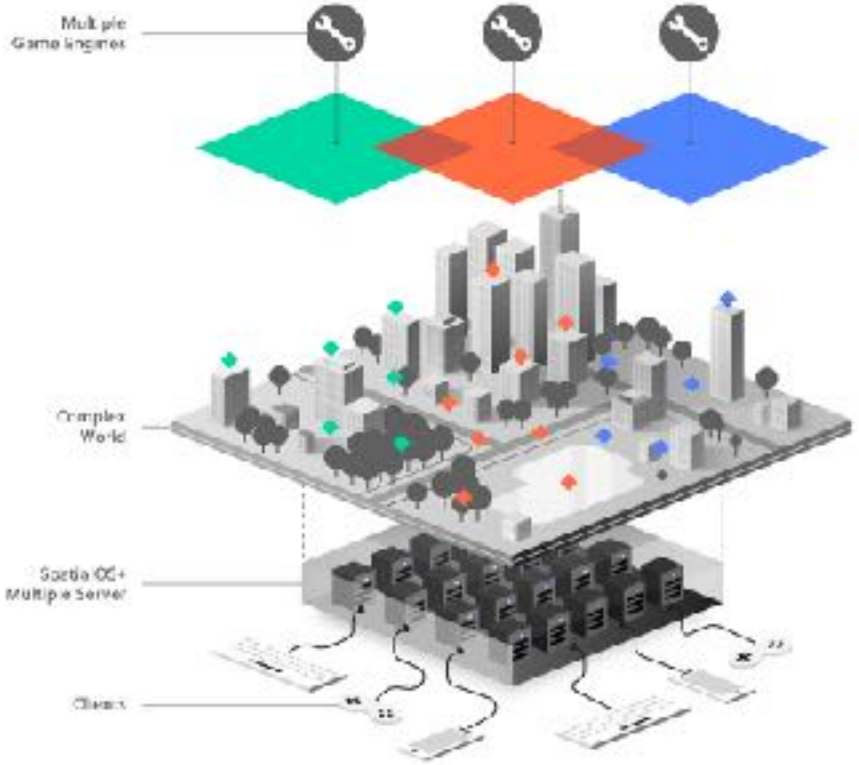
Initially built for the commercial gaming sector, it is being extended for applications in military modelling and simulation.

SpatialOS

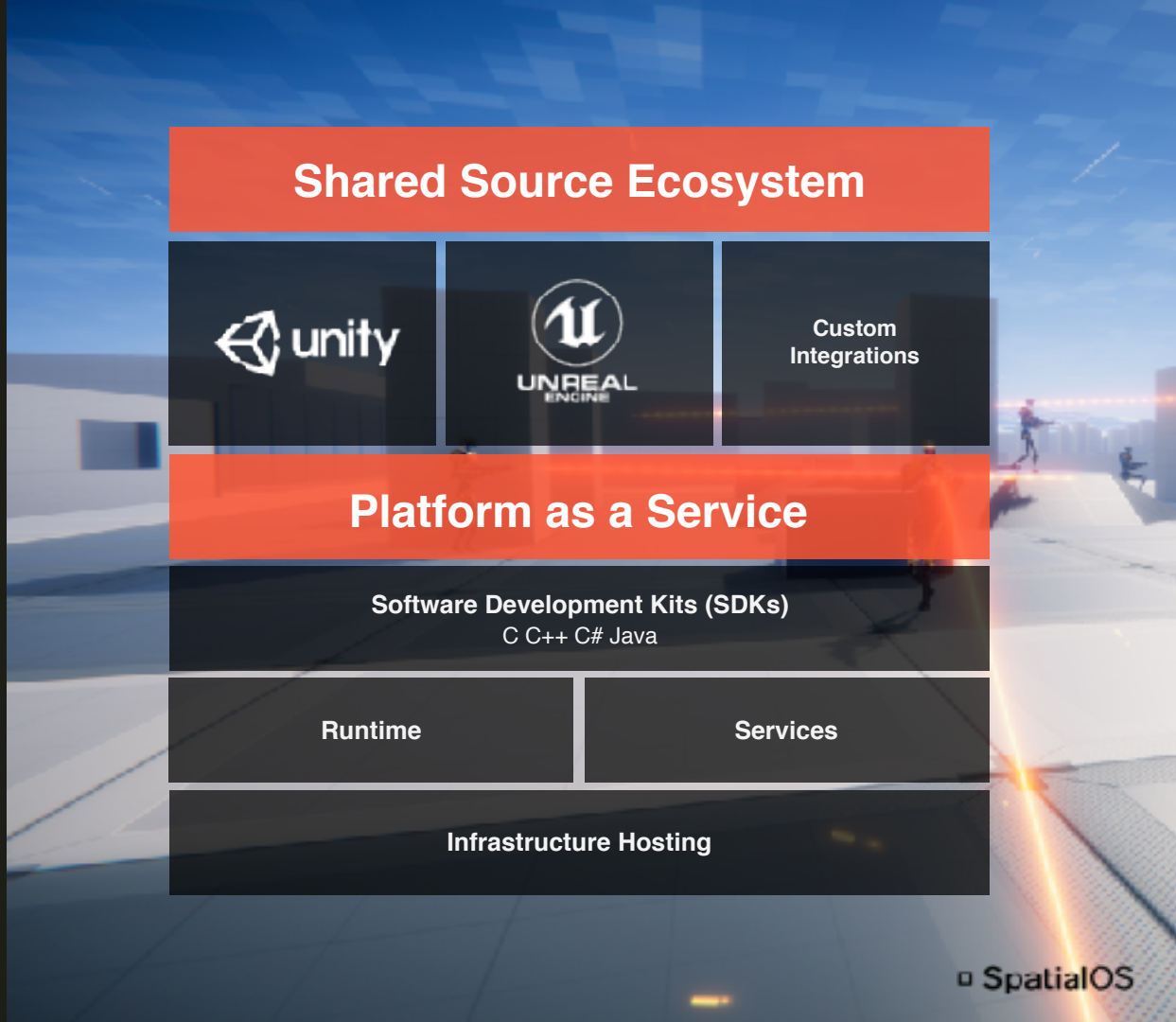
Single Server Architecture



SpatialOS Architecture



The SpatialOS Platform




SEED
Always on complex systems (physics, gathering, political, economic) at a huge scale involving 1000s of players.
Rich simulation
Meaningful persistence
Cross-platform
SpatialOS

MIDWINTER ENTERTAINMENT

Description

Scavengers puts players in the role of survivors fighting in a not-so-distant future, where cataclysmic events have triggered a new ice age.

Genre

Multiplayer shooter, rich PvE/ PvP mix, survival elements.

Dev stack

Unreal, SpatialOS.

Entities

64 Players
150 intelligent AI creatures

Team

Built by a team of 32+.
Pre-alpha.

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VAKI GAMES

Description

Two teams of five players (attackers and defenders) battle for control within the map. Each match is surrounded by similar games, with players able to view and participate in adjacent battles.

Genre

MOBA, eSports, Tower-Defence.

Dev stack

Unreal, SpatialOS.

Team

Built by a team of 12.
Pre-alpha.

DAREWISE
ENTERTAINMENT

Description

Project C is a unique massively multiplayer action adventure set on the exotic planet of Cov-5, where alien races compete to survive in a harsh desert.

Genre

Survival,
Open World, PvP + PvE

Dev stack

Unreal, SpatialOS.

Team

Built by a team of 30+.
Pre-alpha.

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NetEase Games

Description

Sandbox multiplayer in VR. Players team up to explore, build and fight in a post-apocalyptic world.

Games span weeks, with sessions resuming from prior state when players log in.

Genre

Session-based Shooter RPG, VR, Survival

Dev stack

Unity, Lua, C#, SpatialOS.

Team

Built by a team of 40+. Gamescom demo, August 2018.

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Screenshot: Nostos by NetEase games (pre-Alpha, built on SpatialOS)

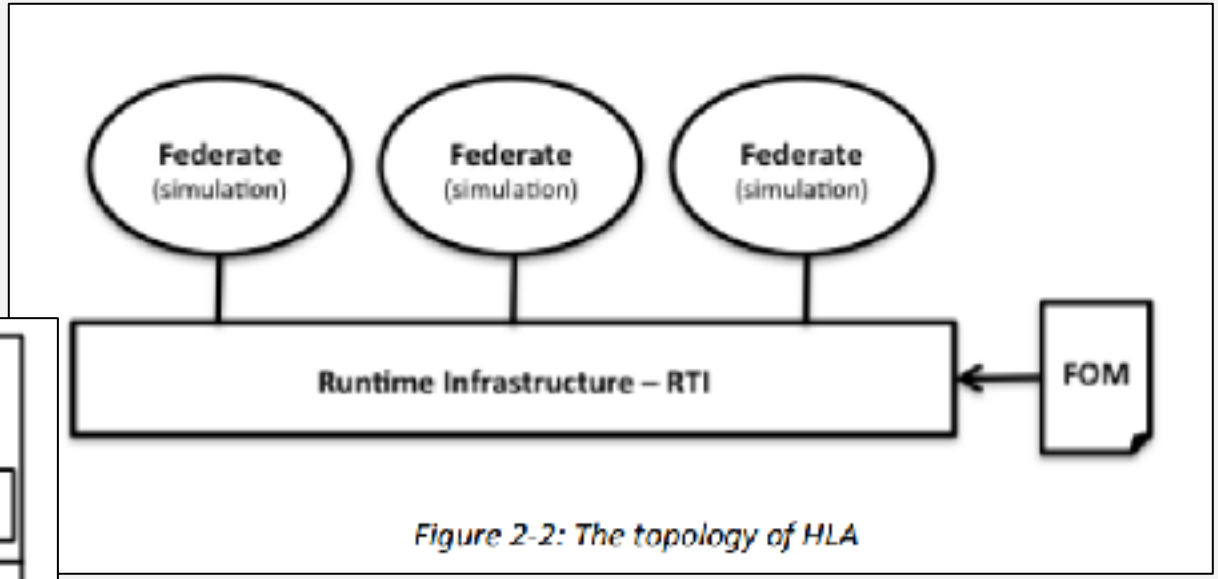

Figure 2-2: The topology of HLA

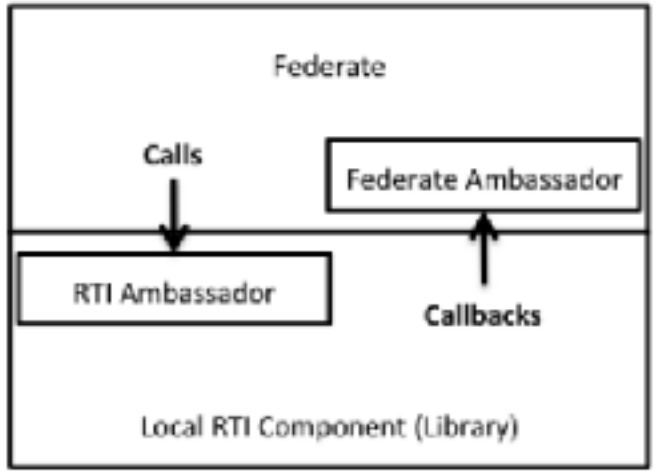

Figure 4-4: Calls, callbacks and ambassadors

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SpatialOS Architecture

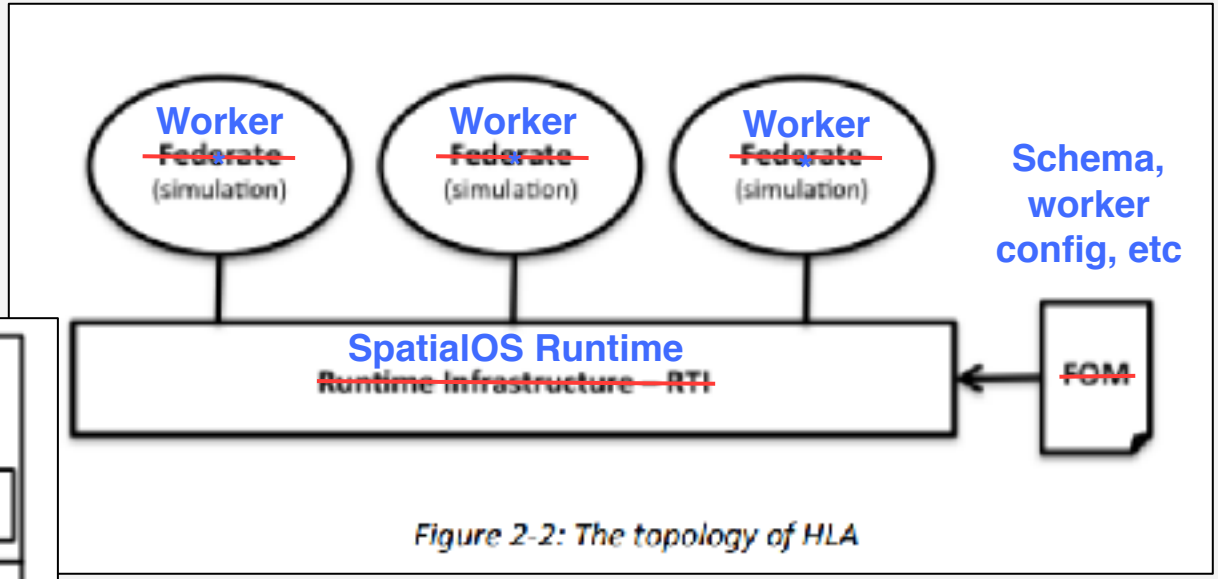


Figure 2-2: The topology of HLA

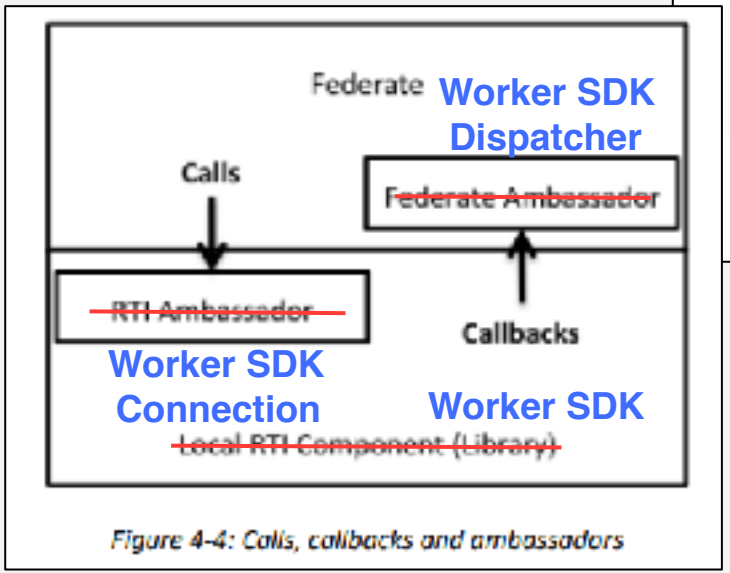


Figure 4-4: Calls, callbacks and ambassadors

SpatialOS

Entity-Components

SpatialOS uses an **Entity-Component** paradigm

Everything is an entity
Entities are **composed of components**
Components data model is **defined by schema**

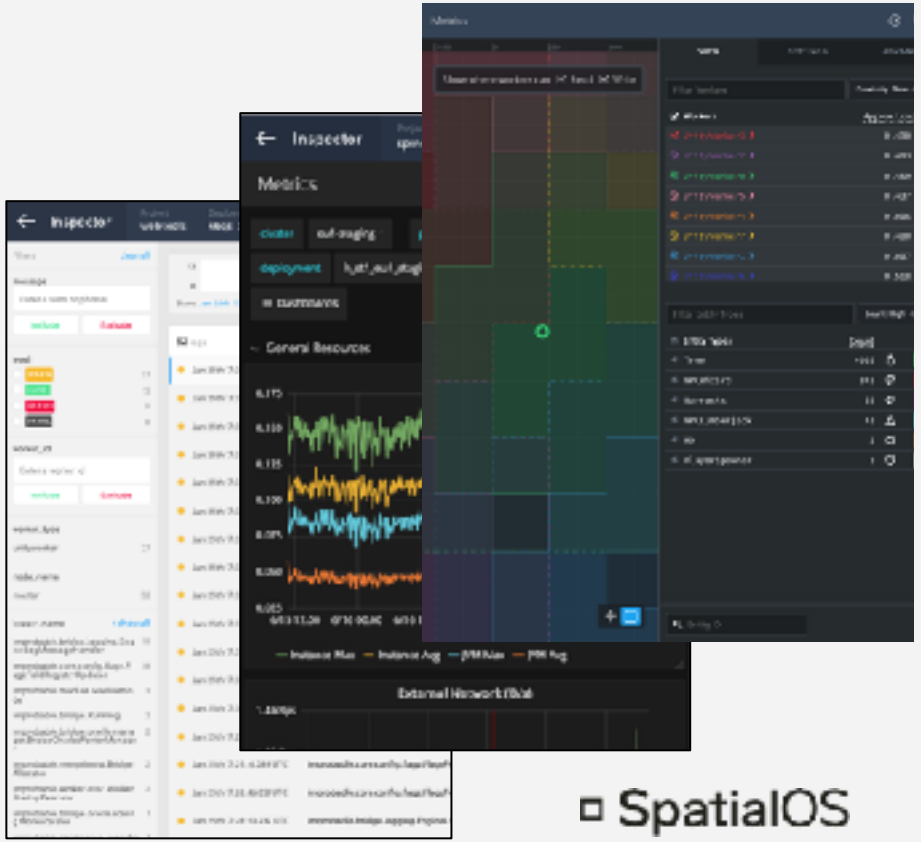
- Component Updates
  - [?] modify entity state
- Component Events
  - [?] for ephemeral updates
- Component Commands
  - [?] enable unicast messaging

```
package improbable.example;

type DamageRequest {
  uint32 amount = 1;
}
type DamageResponse {}

type DamageEvent {}

component Health {
  id = 1234;
  uint32 health = 1;
  event DamageEvent taken_damage;
  command DamageResponse

damage(DamageRequest);
}
```

Managed Cloud Deployment

SpatialOS is developed as a cloud-native capability, exploiting on-demand compute resources

- Configuration-based deployment
- Shareable Game Launcher
- Reusable ‘Satellite’ Services
- API- and Web-based Tooling
- **Managed worker orchestration**

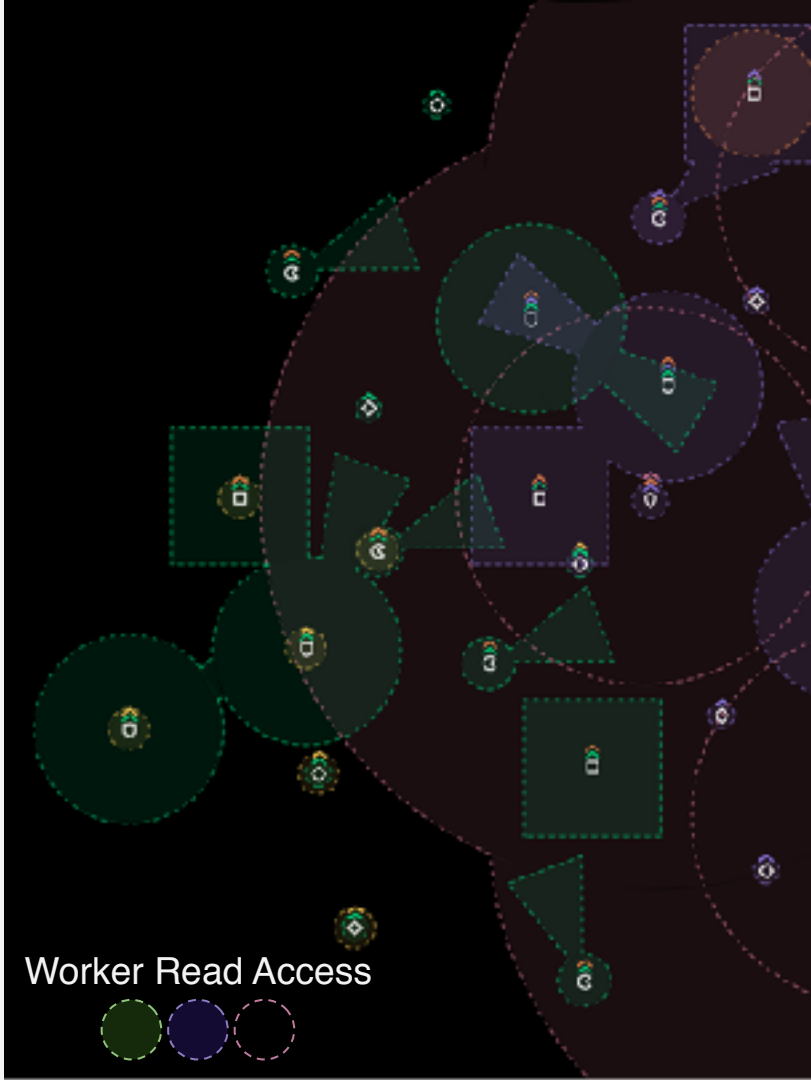


Load Balancing

Workers are **orchestrated** in the cloud to simulate entity-components they have **Authority*** over according to worker configuration and permissions

- At most one worker can be authoritative over an entity-component at a time
- Workers gain **Interest** around their authoritative entities

*akin to HLA Ownership Management, but directed, not negotiated



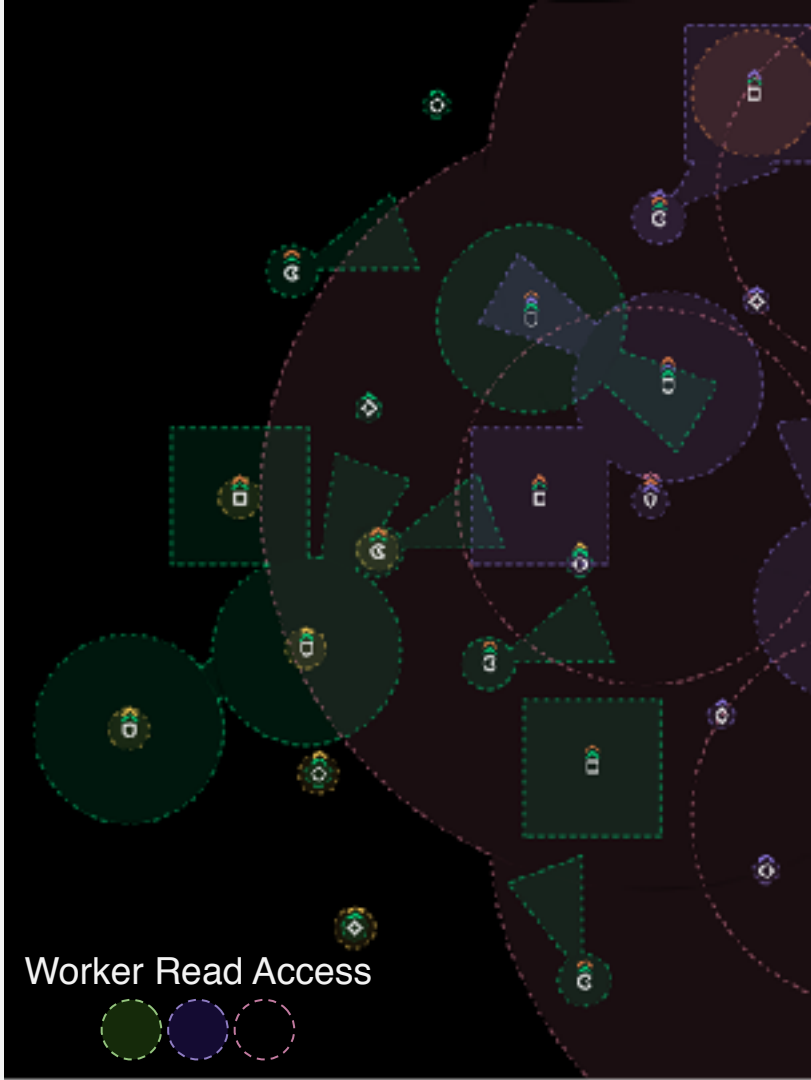
Load Balancing

Interest ‘queries’ are predominantly based on **spatial locality***
Other constraints are also supported
e.g specific-area, specific-entity

As entities ‘move’, workers gain and lose authority and read access over their constituent entity-components

- Authority and Interest are granular at the **Component** level

*akin to HLA DDM, but provided out-of-the-box by the SpatialOS Runtime, rather than optionally by workers



Data Distribution

SpatialOS distributes data efficiently to workers, making use of worker **Interest** - including data requirements

The SpatialOS Runtime maintains all entity state, so it can optimise delivery to workers

- Saving bandwidth / reducing latency
- Resilience to unreliable networks
- Cater to variable fidelity clients

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Applying to Military Modelling and Simulation

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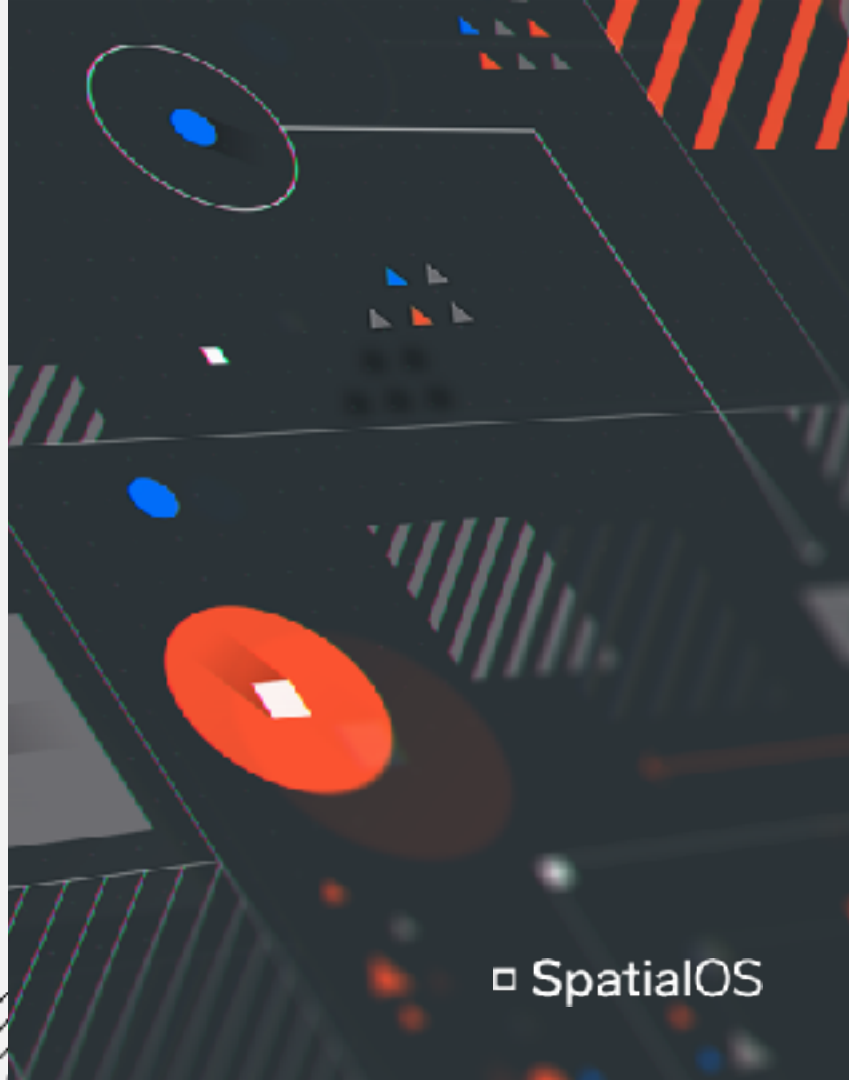
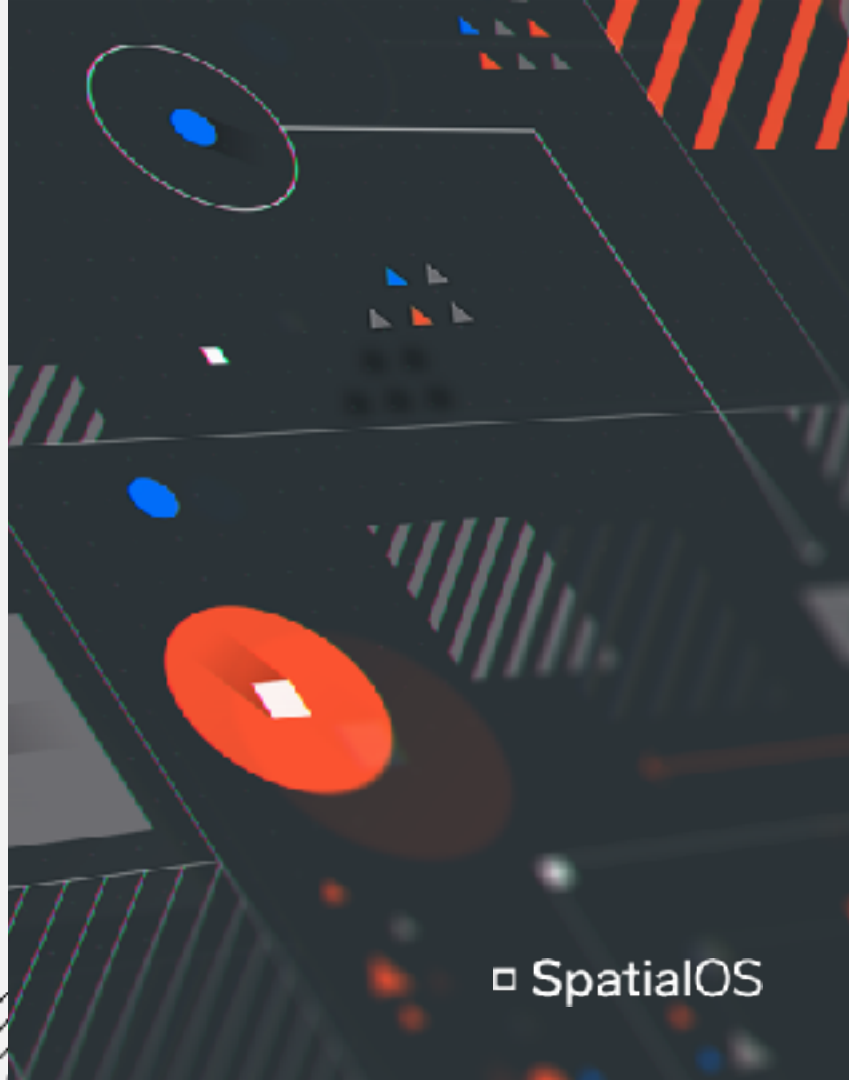
So what?

- Developers can build and compose virtual environments at **scale**
- Users can quickly deploy simulations in the cloud
- Support thousands of players using heterogeneous clients, across the internet



So what?

- Leverage trends and capabilities in commercial gaming
- Share investment in innovation and quality
- Harness commercial user base
- People and talent



Simulation Time and Determinism

SpatialOS is perfectly suited for experiential, human in the loop experiences.
Simulation complexity and immersion can lead to emergent behaviour and deeper training value.

For use cases needing determinism, SpatialOS must be augmented with a first-class concept of simulation time, and support for determinism.

Work in progress on current projects

SpatialOS

Simulation Interoperability

Militaries and governments have a wealth of existing models, simulators and trainers.

The SpatialOS Worker Protocol used to communicate between the Runtime and Workers is not wire-compatible with existing simulation interoperability standards - notably DIS, HLA.

Work in progress on current projects

SpatialOS

Deployability

Militaries and governments have stringent security, hosting and availability requirements - typified by the ‘Point of Need’.

SpatialOS **Enterprise Hosting** enables simulations to be executed using different cloud providers and secure environments, on-premise compute, and bare metal servers.

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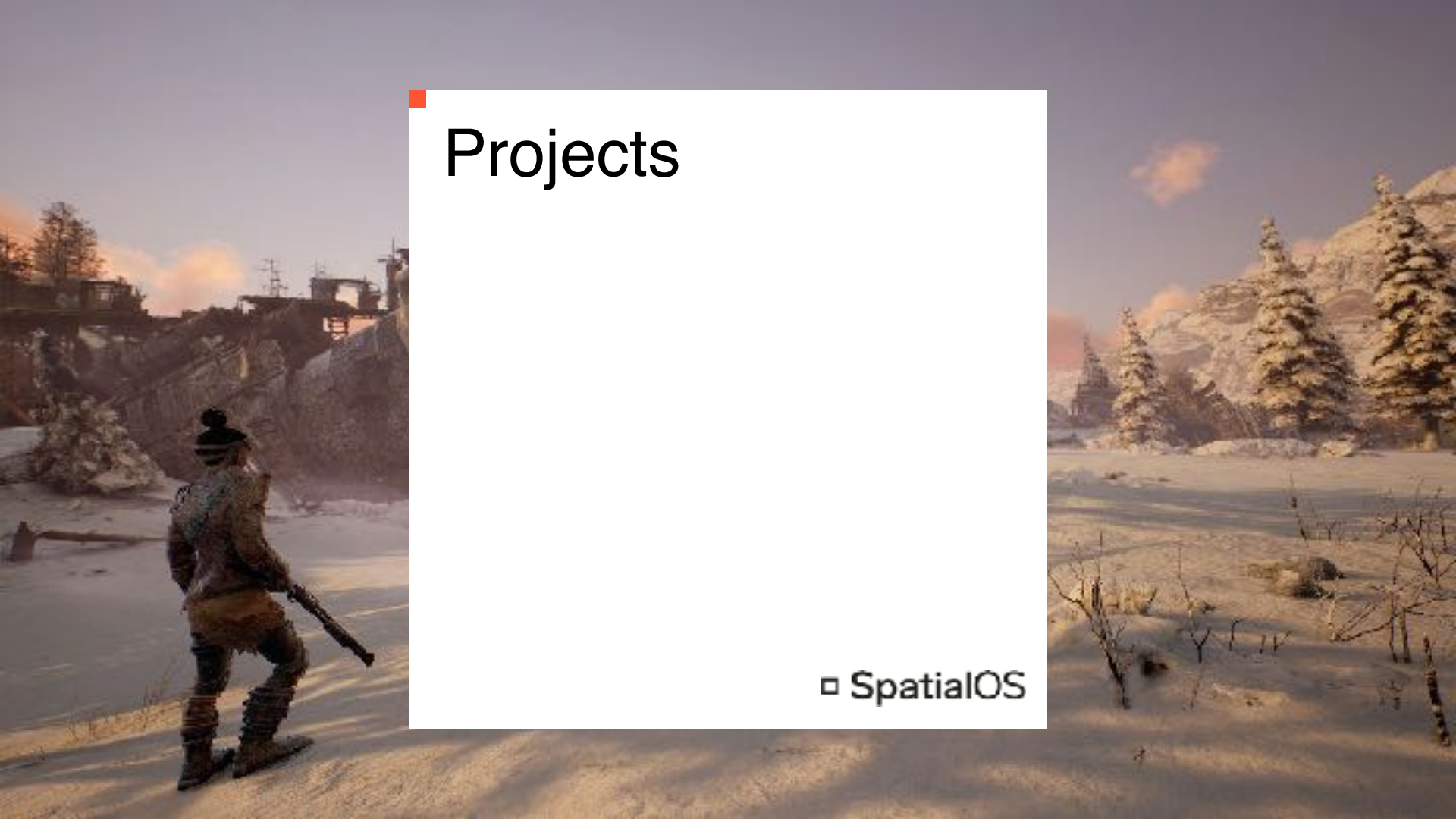
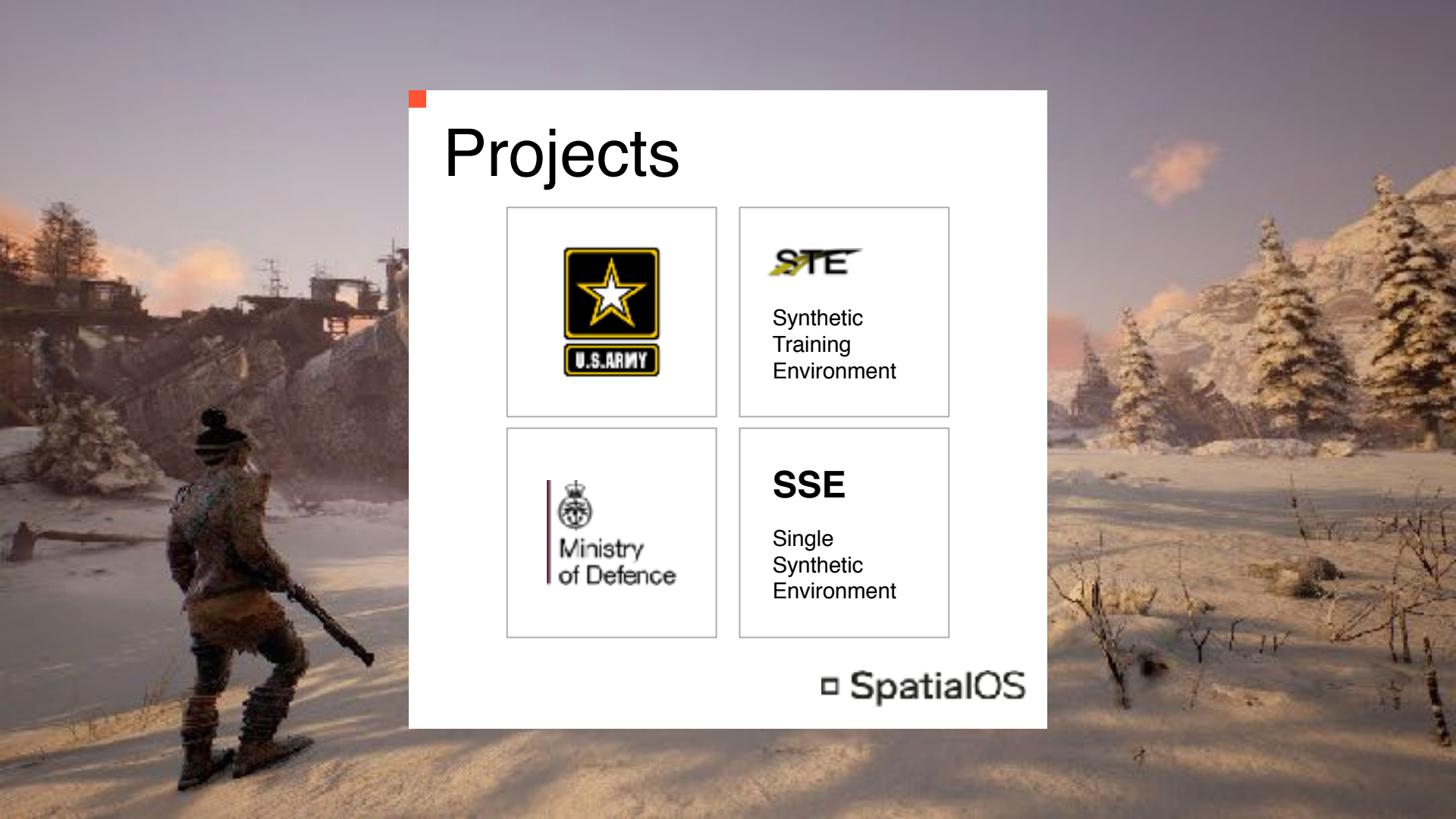

Projects
SpatialOS



Projects

U.S.ARMY

STE

Synthetic
Training
Environment

Ministry
of Defence

SSE

Single
Synthetic
Environment

SpatialOS

Questions?