HLA 4 in the Cloud: Modernizing Distributed Simulation

As simulation programs increasingly shift toward cloud-based infrastructure, the need for standards that align with these environments becomes critical. HLA 4—the latest evolution of the High Level Architecture (HLA) standard—introduces features specifically designed to meet the demands of modern deployment models. This blog explores how HLA 4 helps simulation developers take full advantage of cloud based technologies, without sacrificing the performance, interoperability, and robustness that HLA is known for.

From supporting scalable architectures and edge-connected clients to enabling more flexible, secure communication, HLA 4 is designed to bridge the gap between traditional simulation systems and today's cloud-based infrastructure. Whether you're planning persistent training environments or seeking to simplify simulator deployment across global networks, HLA 4 brings the capabilities needed to future-proof your solution.

The Federate Protocol

The HLA 4 Federate Protocol is a standardized, message-based communication protocol that defines how simulators interact with the RTI. It specifies the structure, encoding, and sequencing of messages exchanged between a simulator and the RTI, independent of programming language or RTI implementation. The protocol uses a single TCP connection between the simulator and the RTI with a Protobuf-based serialization format to ensure efficient and consistent data exchange.

Client-Server Architecture

The new Federate Protocol standardizes the client-server communication model, making simulators easier to containerize and deploy using modern

infrastructure tools. The simulator acts as a client, similar to how web browsers work, communicating with a central RTI server.

Resumable Connections

Federate Protocol supports intermittent connectivity, clients can drop and reconnect without requiring a restart. This is useful for users on the edge of connectivity with unreliable connections or mobile systems.

Thin Clients and Offloading

With the simulator acting as a client, it's easier to offload work to cloud resources. This allows local systems to run lighter-weight clients while offloading heavier processing or data workloads to the cloud.

Secure WebSockets

Communication can use secure WebSockets, which are widely supported and can be routed, monitored, and secured like any other web service. This fits well with DevOps and cloud security practices.

Secure communication and Certificates

All communication can be encrypted using TLS 1.3, with support for both server and client (mTLS) authentication. This is the same technology used for banking and other secure web applications, and makes sure to only connect trusted simulators and RTIs.

Global Reach via CDN

RTI servers can leverage cloud content delivery networks (CDNs) to reduce latency and improve performance to support globally distributed simulators and users.

Modern Language Support

With the protocol specified independently of a particular RTI implementation, simulators can be built using popular languages in cloud stacks like Go, Rust, and JavaScript, without falling back to C++ or proprietary libraries.

No RTI Vendor Dependency

The Federate Protocol can be implemented independently of a specific RTI. An open-source reference library is already available and can be embedded into any simulator, enabling greater portability and flexibility across vendor solutions.

Scalability Improvements

Interest Management

Interest Management is an essential tool to minimize unnecessary network traffic. HLA 4 improves how interest management information can be expressed in the FOM. It's now easier to define, extend, and combine this information using modular FOMs, making it more practical to build scalable systems that only send relevant data to each participant.

Directed Interactions

With directed interactions, simulators no longer need to broadcast messages system-wide. Instead, they can target messages to specific recipients, reducing the load on both the network and on federates that don't need the data.

Better Reusability

Flexible Object Model Merging

Cloud deployments often reuse existing simulators in new contexts. HLA 4 extends the flexibility of object model merging, allowing developers to combine and extend object model and data types more easily. This reduces friction when reusing cloud-based components across different use-cases.

Access Control

Federate Authentication

Access control is more important in multi-tenant and shared environments. HLA 4 allows RTIs to authenticate federates using passwords or certificates. There is also support for custom authentication plugins to add support for Single Sign-On, OAuth2, or cloud-native identity providers.

HLA 4 is Cloud-Ready. Are you?

HLA 4 introduces a host of features that bring simulation interoperability in line with cloud-native principles. These enhancements help organizations build systems that are:

- Optimized for cloud or hybrid deployment
- More resilient to connectivity disruptions
- Easier to scale and maintain
- Compatible with modern languages and security practices
- Less tied to specific RTI implementations

By embracing modern communication models and improving modularity, scalability, and security, HLA 4 makes distributed simulation more accessible and future-ready. If you're planning your next move into the cloud, now is the right time to explore HLA