Bifrost: A Viable Replacement for Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) for Simulation Interoperability.

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Robert (Bob) Uhl, Riptide Software – A Phoenix Defense Company, USA
David Acevedo, US Army PEO STRI, USA
DoD Modeling and Simulation Timeline

Significant changes have occurred since development of standing M&S architectures

40 Year Timeline of M&S, Technology, and World Events

1968 - Arpanet
1970 - NPT
1974 - EtherNet
1975 - MicroSoft / ABQ
1975 - Vietnam War ends

1985-1990
- HTML
- Berners-Lee
- Berlin Wall falls
- 4.8Bn Pop. (World)

1990-1995
- STOW '90
- 1278 (1993)
- DIS
- Fielding
- RESTful Ph.D.
- 1995-2000
- HLA
- Proven
- STOW '97 (1997)
- CTIA
- HLA
- CTIA
- TNIA
- Human Genome
- Google
- 1st Multi-Core Processor
- DSEF
- Wow 10M Subscribers
- Illustri*
- Army
- STE
- 1in3 jobs: SW or robots (Gartner)
- 1 M commercial UAVs (Gartner)
- 8.1Bn Pop (World Pop.)

2000-2005
- Amazon EC2
- iPhone
- PV6
- Higgs
- Watson
- Facebook
- 1.4Bn Devices on IoT (Gartner)
- Snowden
- ISIL
- New START treaty expires (2011)

2005-2010
- NoSQL "re-introduced"
- HTML 5 Spec
- Finalized
- 26bn Devices on IoT (Gartner)
- US $17.6T PPP
- China $17.4T PPP

2010-2015
- 2015-2020
- 2020-2025
- New START treaty expires (2011)
- 1 M commercial UAVs (Gartner)
- 8.1Bn Pop (World Pop.)

DoD Modeling and Simulation Innovation Workshop (SIW)
Bifrost Highlights

• Bifrost is a next generation Service Oriented Architecture connecting simulations to share state using modern commercial approaches and technology.
• Bifrost is scalable to more than 4 million entities over a global environment.
• Bifrost’s web user interface can control multiple sources of simulated entities – single user interface across multiple simulations
Bifrost Highlights

• Bifrost utilizes modern technology pioneered in the commercial sector to improve Modeling & Simulation capabilities.
  ▪ Takes advantage of multi-core processors to support large scale and a large number of clients
  ▪ Works naturally in the cloud environment
  ▪ Efficient over the network and simple to route across multiple networks
  ▪ Natively supports mobile devices, desktops, and servers
Bifrost Highlights

- Bifrost optimizes network bandwidth to work efficiently across DoD networks, cloud deployments and long-haul exercises.
  - Does not rely on multicast, which simplifies shared deployment in commercial or private cloud environments
  - Demonstrated connection to over 200,000 simulated entities in Orlando, to virtual simulators in Ft. Riley and Ft. Carson over VPN on a cell phone hotspot
  - Demonstrated connection to over 1 million entities from Ft. Moore to seven sites across the Battle Lab Simulation Collaborative Environment
  - Demonstrated connection to over 1.1 million entities over a 1.5 Mbps Wi-Fi connection at the 2019 Interservice/Industry Training, Simulation and Education Conference (I/ITSEC)
Benefits of Bifrost

- Provides collaborative capability – supports distributed exercises between geographically separate sites
  - Already demonstrated connections on DoD networks between various distributed sites
  - Natively support cloud or on premises deployment
- Uses little bandwidth
  - Uses less than 1/20th of the network bandwidth of the equivalent HLA exercise
- Does Not Require a coordinated Federation Object Model (FOM) agreement.
  - Data model is discoverable at runtime via API
  - Data model can be extended during runtime without requiring restart
Bifrost Architecture
Bifrost Tools
Bifrost – Control
Bifrost Interoperability
Bifrost Interoperability - control