



U.S. AIR FORCE



# AFRL

## Leveraging Game Engines and Data Interchange Formats to Revolutionize Distributed Training

711 HPW/RHWM

Air Force Research Laboratory



## GRILL<sup>®</sup> Mission

- Leverage commercial and government off-the-shelf gaming hardware and software to find solutions for Air Force training and simulation needs.
- STEM (Science Technology Engineering Mathematics) outreach that supports White House and SECAF STEM initiatives to encourage pursuit of STEM disciplines in students of all ages.





# What's a Game Engine

- Software framework
- Simplify game development
- Suite of tools
  - Physics engine
  - Lighting/Rendering engine
  - Audio/Video engines
  - World builder tools
  - Developer tools
    - C++, C#
- Numerous benefits/deficits





## Benefits – Cost/Licensing

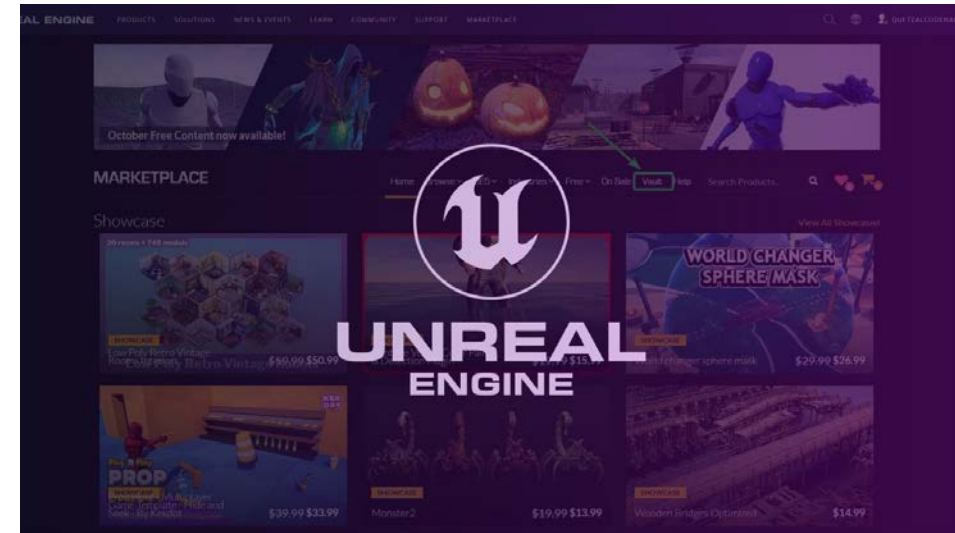
- Low barrier to entry
  - Free
- Unreal Engine
  - Royalties
    - 5% of revenue after first \$1,000,000 USD made
  - Licenses
    - Private training sessions
    - Perforce depot
- Unity
  - Licenses
    - Extra engine content



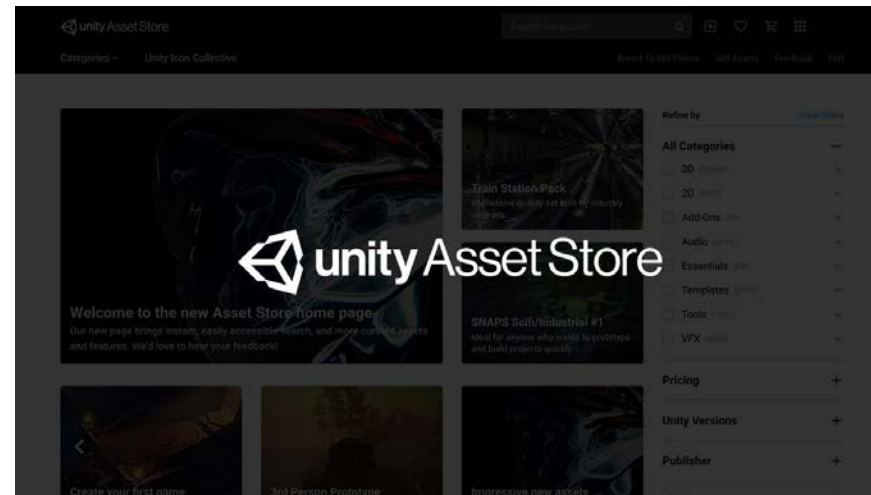
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# Benefits – Ecosystem

- Large labor pool
  - Not proprietary
  - Developers readily available
- Marketplaces/Open-source content
  - Plugins
  - Third-party content
  - Varying cost/quality
- Community forum websites



[Image Source](#)



[Image Source](#)



# Benefits – Out of Box Capabilities

- Jack of all trades
- Suite of tools
  - Physics engine
  - Lighting/Rendering engine
  - Audio/Video engines
  - World Builder tools
  - Developer tools
    - C++, C#
    - Easy to add libraries
- High visual quality
  - Realistic digital twins
- Extended Reality (XR) support



[Image Source](#)



# Benefits – Extended Reality (XR) Support

- Ease of development
  - Virtual Reality (VR)
  - Augmented Reality (AR)
  - Mixed Reality (MR)
- Provides development tools
  - Can import additional tools
- Provides starter projects

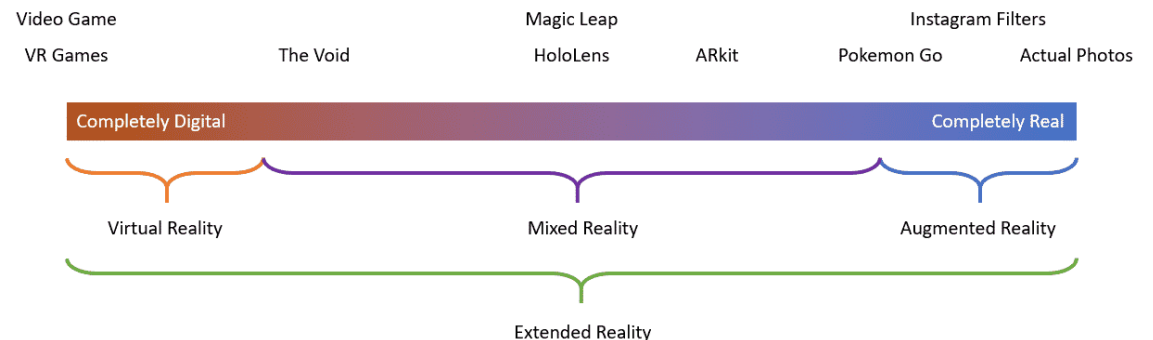


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## Reality – Virtuality Spectrum



[Image Source](#)



# Benefits – Cross Platform Support

- Develop for multiple platforms/devices
  - Windows, iOS, Linux
  - Wearables
  - Handheld
  - Consoles
- Quick development
  - Supplies build tools
  - User Interface (UI) flexibility
  - Supports multiple input modalities

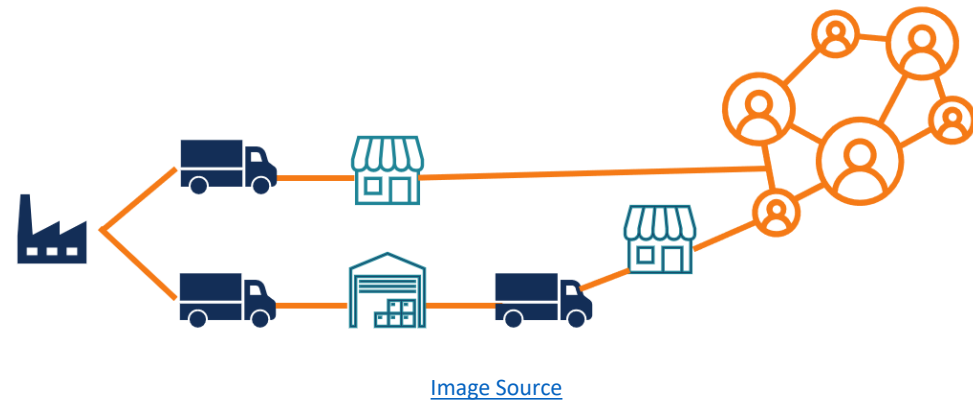


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## Deficits – Distribution

- Easy for commercial services
- Tough in military context
  - Various distribution methods
    - Ex: Army MilGaming, DoD Safe
    - Access walls
    - Content restrictions
  - Tech support
    - Project setup/installation
    - Edge machine restrictions
    - Interfacing with external systems
- Mitigation
  - ???





## Deficits – Approval/Clearance

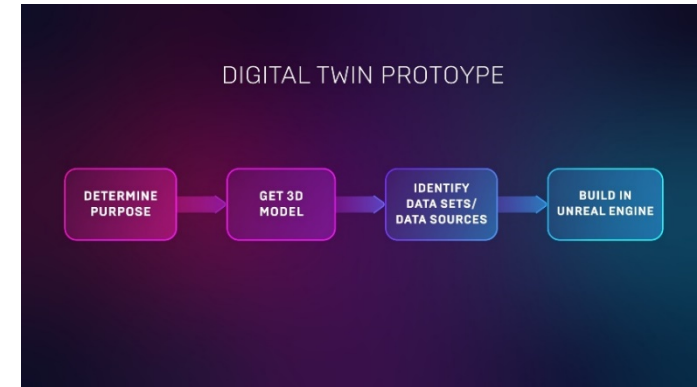
- Frequently updated
  - New features
  - Bug fixes
- Marketplace content
  - Unknown third-party developers
- Plugins
  - Potential reliance on connectivity
    - Bluetooth, Internet
  - Limitless combinations
- Mitigations
  - Start approval process as soon as feasible



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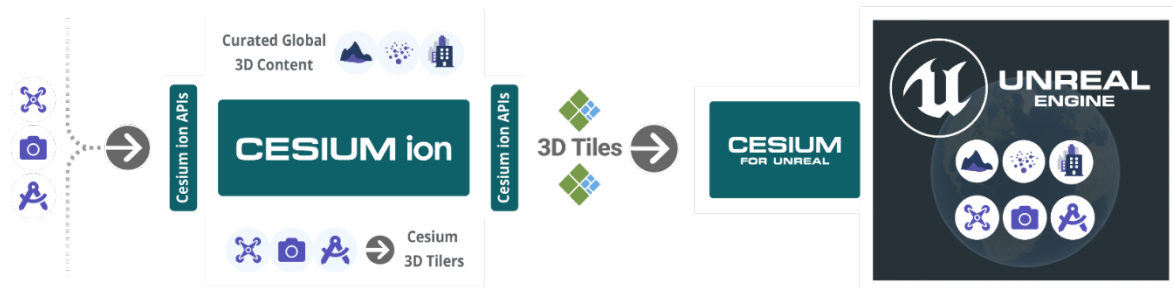
# Deficits – Geospatial/Round Earth Support

- Geospatial
  - Ground up creation
    - Rare on marketplace
    - Manual process
  - Reconcile coordinate systems



[Image Source](#)

- Mitigation
  - New game engine geospatial solutions
    - Cesium
    - ArcGIS

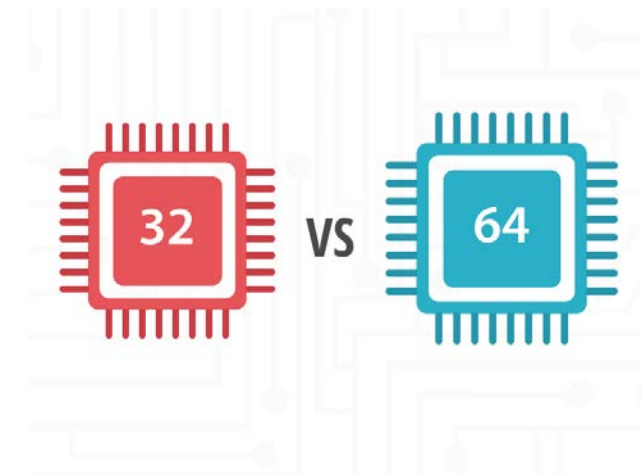


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## Deficits – 32 vs 64 Bit

- Code backend – 64-bit
  - C++, C#
- Engine specific entities – 32-bit
  - Graphics pipeline – 32-bit
  - Lose location precision far from origin
- Mitigation
  - Unity
    - High Precision Framework Plugin
      - Supplies 64-bit
  - Unreal Engine
    - Supports 64-bit in Unreal Engine 5



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### Unity-Technologies/ **com.unity.gis.high-...**



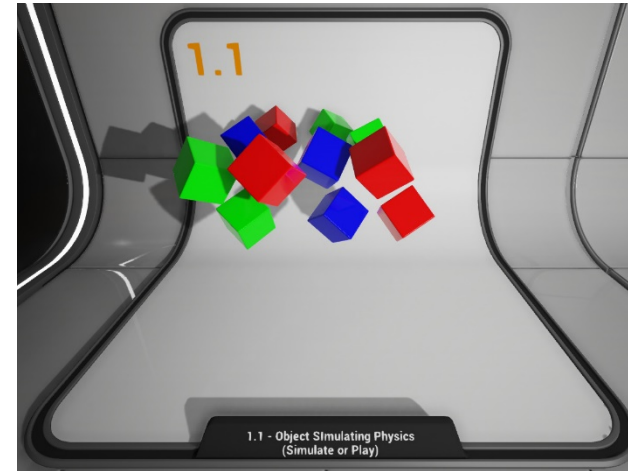
This high precision framework is a package which allows for the easy creation of large-scale visualizations. It has the ambition...

2 Contributors   0 Issues   87 Stars   13 Forks

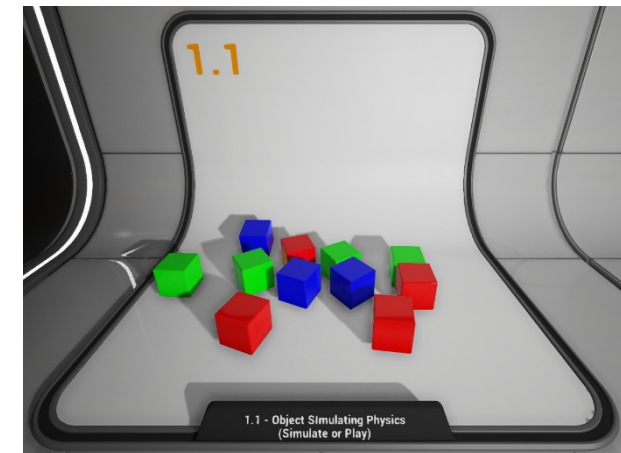
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# Deficits – Physics Fidelity

- Basic controls/algorithms
  - Simulate gravity
  - Simple projectile arcs
  - Simple collision physics
  - Impulses, momentum, movement
- Average quality
  - Balance realism and performance
- Mitigation
  - Utilize external physics tool
    - Higher fidelity



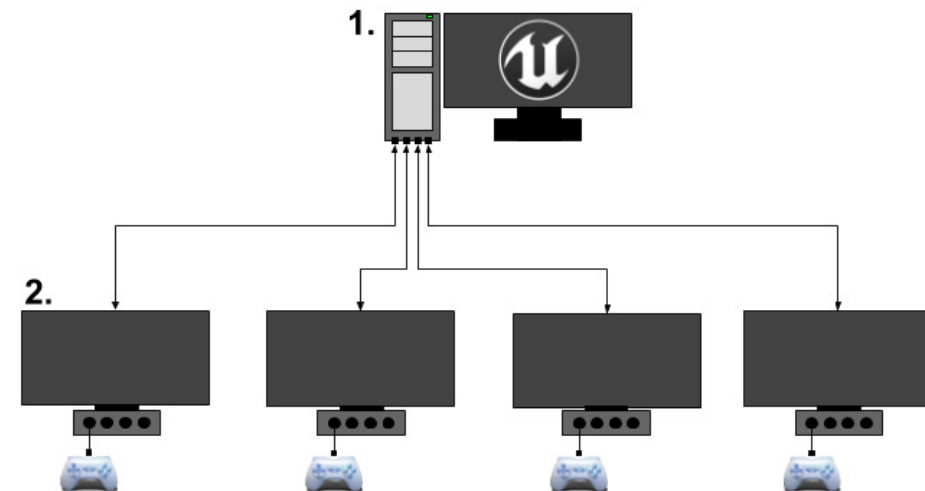
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# Deficits – Network Communications

- Server-client architecture
  - One sim, multiple instances
- Tough communicating with third-party software
  - No built-in tools
- TCP/UDP plugins
  - Typically socket level
  - Custom packet parsing
- Mitigation
  - Data interchange formats



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# Data Interchange Formats

- DIS/HLA
  - IEEE standard network communication
- Overcome game engine deficits
  - Communicate with third-party software
  - Use external physics engine
    - Game engine as image generator
    - Keeps high visual fidelity

Field size (bits)	Field name	Data type
8	Protocol Version	8-bit enumeration
8	Exercise Identifier	8-bit unsigned integer
8	PDU Type	8-bit enumeration
8	Protocol Family	8-bit enumeration
32	Timestamp	32-bit unsigned integer
16	Length	16-bit unsigned integer
8	PDU Status	8-bit record of enumerations
8	Padding	8 bits unused

Total PDU Header record size = 96 bits

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Field size (bits)	Field name	Data type
8	Entity Kind	8-bit enumeration
8	Domain	8-bit enumeration
16	Country	16-bit enumeration
8	Category	8-bit enumeration
8	Subcategory	8-bit enumeration
8	Specific	8-bit enumeration
8	Extra	8-bit enumeration

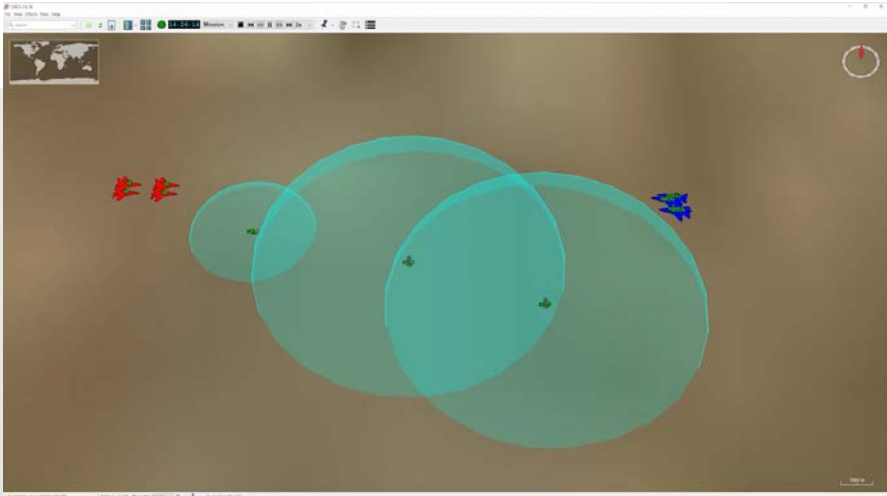
Total Entity Type record size = 64 bits

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# GRILL<sup>®</sup> DIS Plugin



## PROJECT

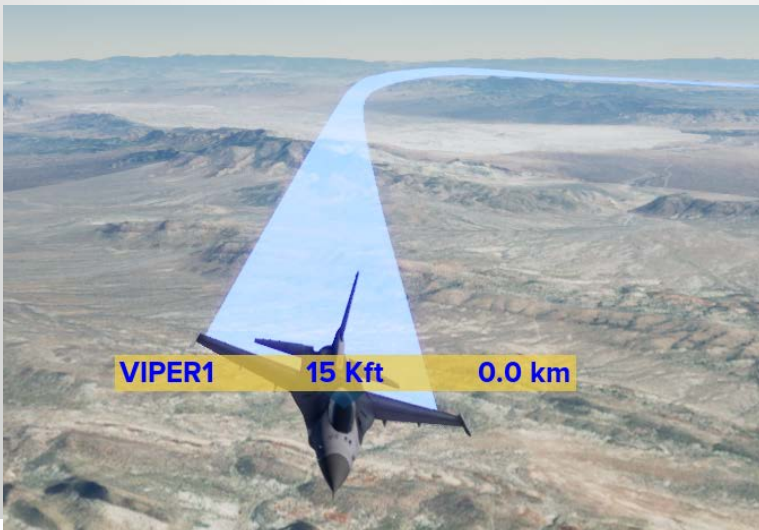
- Developed for Unreal Engine and Unity
- Utilizes NPS Open-DIS Libraries

## FEATURES

- Receiving DIS PDUs
- Sending DIS PDUs
- Dead Reckoning
- Creation of user specified DIS entities
- Custom DIS Enumeration mappings
- UDP Socket Support

## OPEN SOURCE

- Broader community support
- Implement additional PDUs



Screen captures by the GRILL





# Questions?