

# Interactive Simulation on High Performance Computers (HPCs)

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# Brief History

The Department of Defense (DOD) initiated the High Performance Computing Modernization Program (HPCMP) in 1992.

Since then the Department of Defense has expressed interest in putting "the power of simulation into the hands of the warfighter".

Based on a recent U.S. Army solicitation:

“There exists a need to optimize the use of hardware and software design methods using high performance computer systems to meet the performance and real-time demands of emerging Interactive Simulation for Training (IST) applications.”

HPCs are now being considered (and used) for training and simulation purposes, yet challenges remain.

This presentation will address an innovative navigation data transfer method that Quadelta and George Mason University have developed, and are currently testing, for interactive 3-D simulations on HPCs.

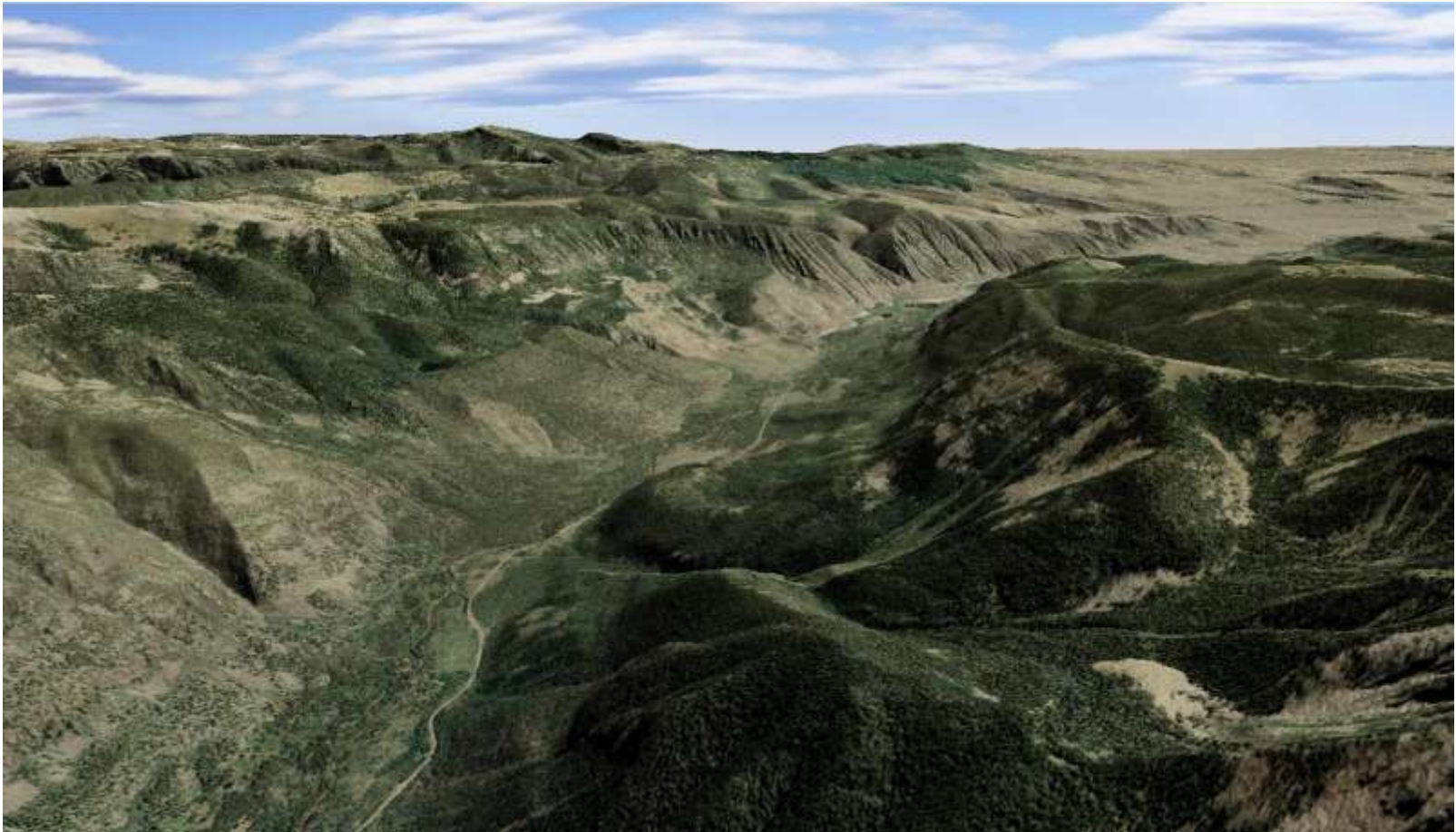
## Objective (1 of 4)

Provide a cost-effective means to communicate with an HPC for real-time, interactive 3-D training and simulation purposes.



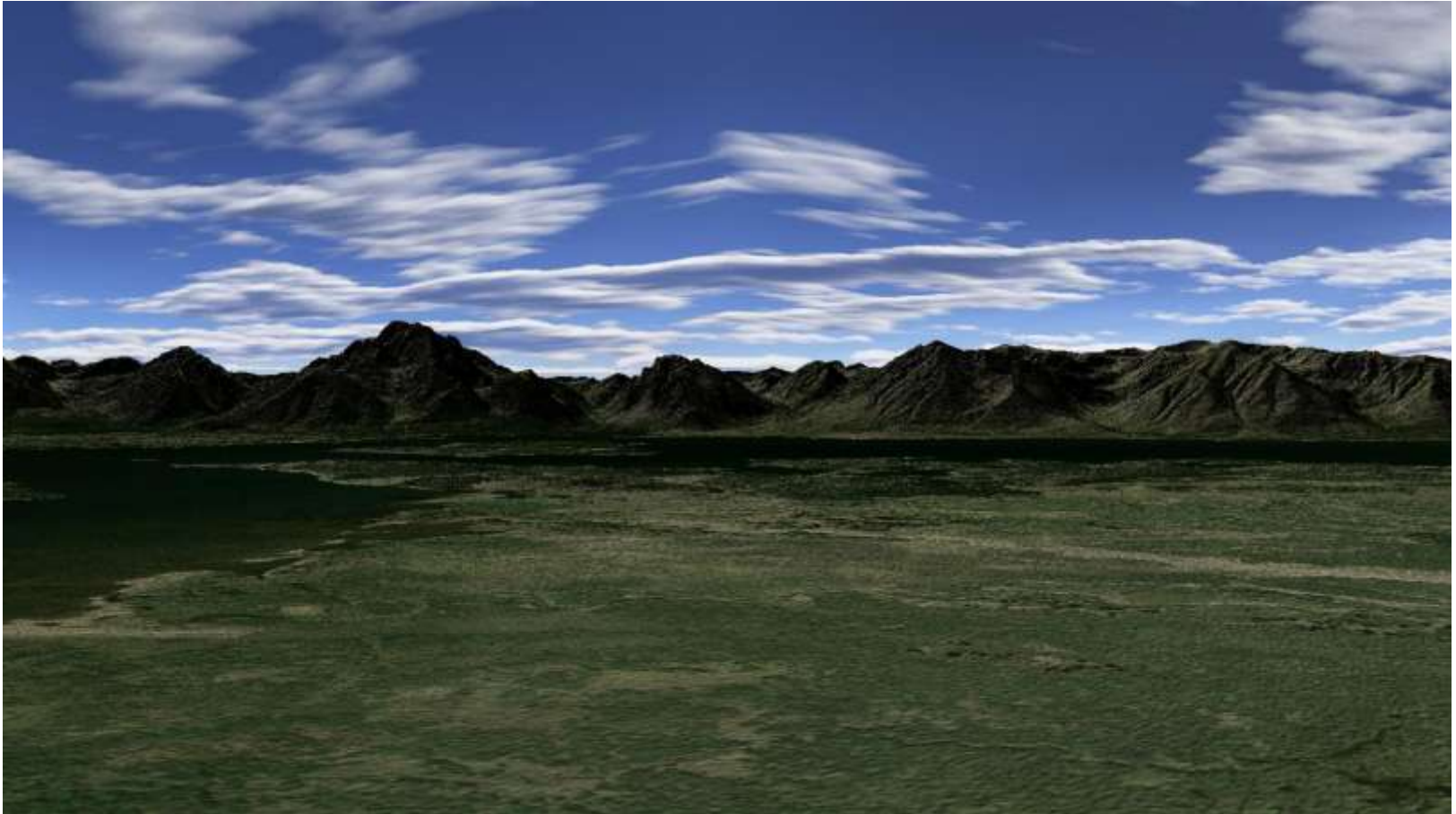
## Objective (2 of 4)

Provide high-resolution urban and rural synthetic environments that are as realistic as possible.



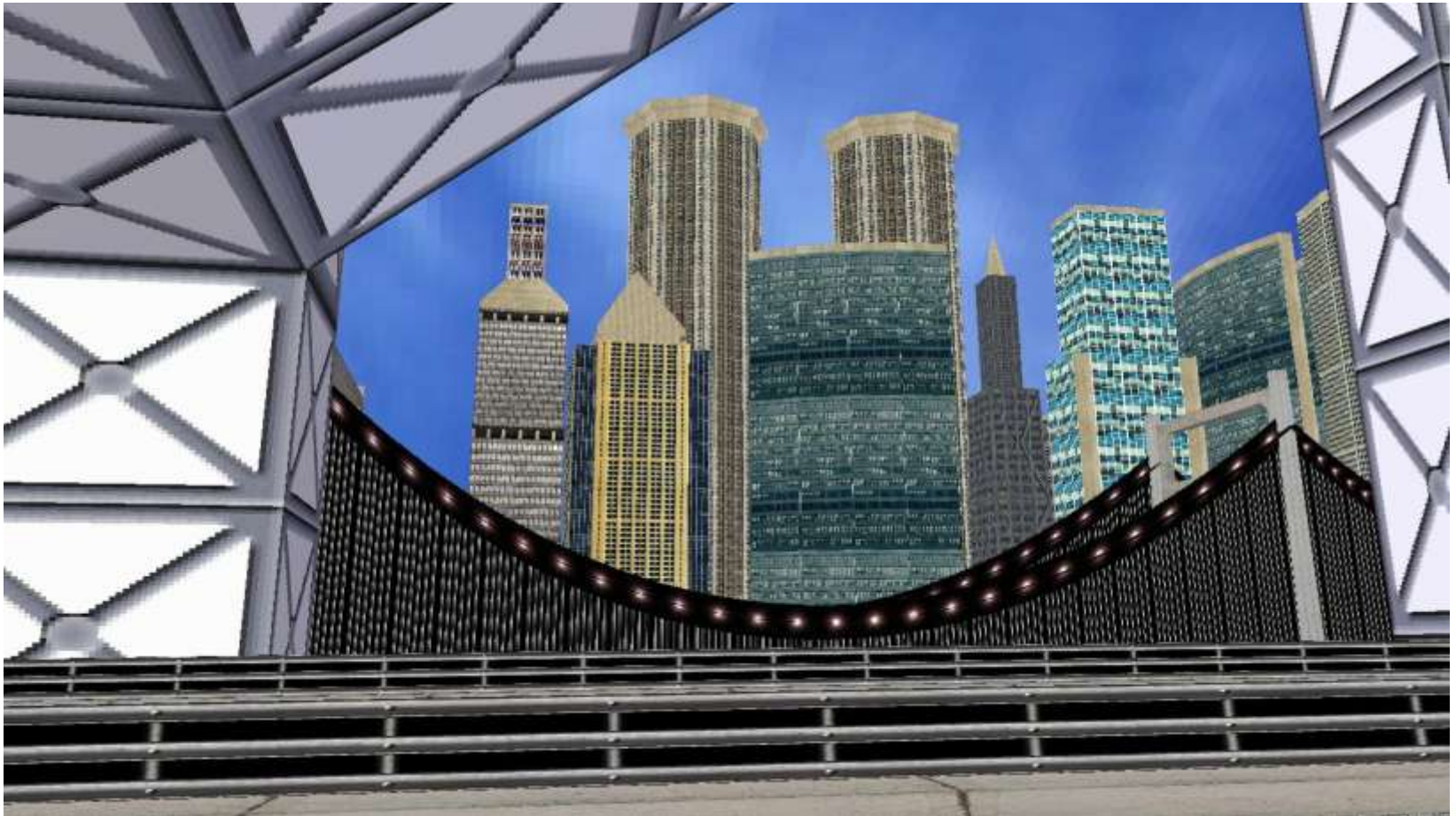
## Objective (3 of 4)

Provide a means to connect to an HPC from any location, from most desktops or laptops.



# Objective (4 of 4)

Reduce latency and dropped packets as much as possible.



# Hardware Interface Challenges

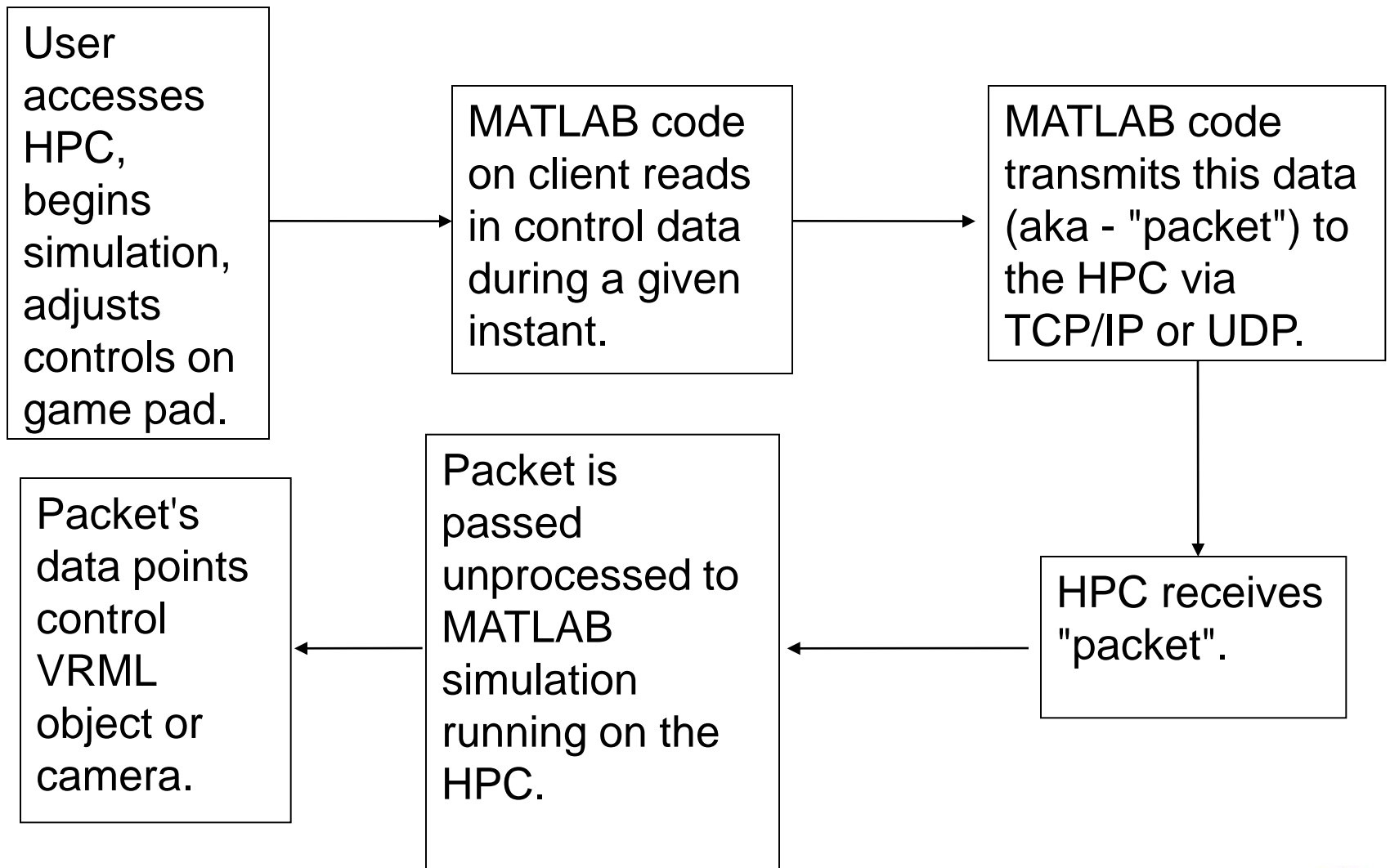
One of the greatest challenges of this project was to select the best user interface that would keep the packets as small as possible (to decrease transfer time), yet provide enough data for fluid navigation.

# Hardware Interface Options

Using the Quadelta and GMU data transfer method, each packet of data transferred over the network represents the current control settings of either a Logitech Dual Action Game Pad or Saitek's Flight Control System plugged into a USB port.



# The Flow Diagram (Using Game Pad)



# Establishing the Connection

The user must enter in the IP address of the HPC and the port that has been cleared for this purpose. A GUI is provided to establish the connection. Additional security measures are also possible.



# Quick Definitions

- Server: HPC with a program that listens for client connections
- Client: The program that has the joystick and connects to the server
- TCP – Transmission Control Protocol
- UDP – Universal Datagram Protocol
- IP – Internet Protocol

Footnote – According to Wikipedia, “In March 1982, the US Department of Defense declared TCP/IP as the standard for all military computer networking.”

# TCP/IP versus UDP/IP

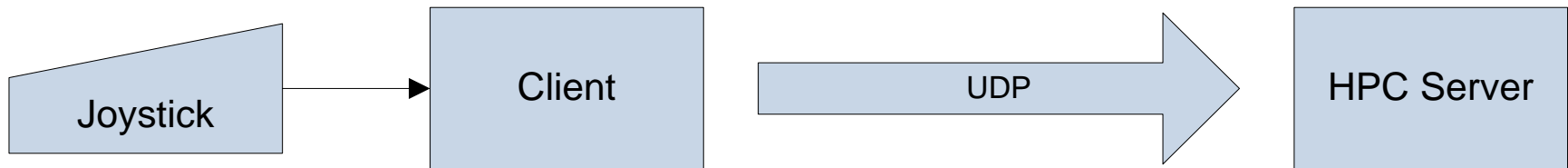
- TCP/IP
  - Reliable: Detects problems and requests retransmission of lost packets
  - Ordered
  - Heavy: Higher latency due to robustness
  - \*\* The MathWork's Instrument Control Toolbox only contains TCP/IP client
- UDP/IP
  - Less reliable: Not inherently known whether packet reaches destination
  - Not ordered or necessarily preserved
  - Light: Low Latency due to simplicity

# Original Motivations

- GMU – Needed distributed parallel processing to attain real-time sensor management simulation
  - Need for inter-process communication
- Quadelta – Interactive simulation with HPC to run simulation and training remotely in real-time
  - Need for remote resources

- Direct Model

- Constant stream of data pushed at client.



- Pros: Lowest Theoretical Latency

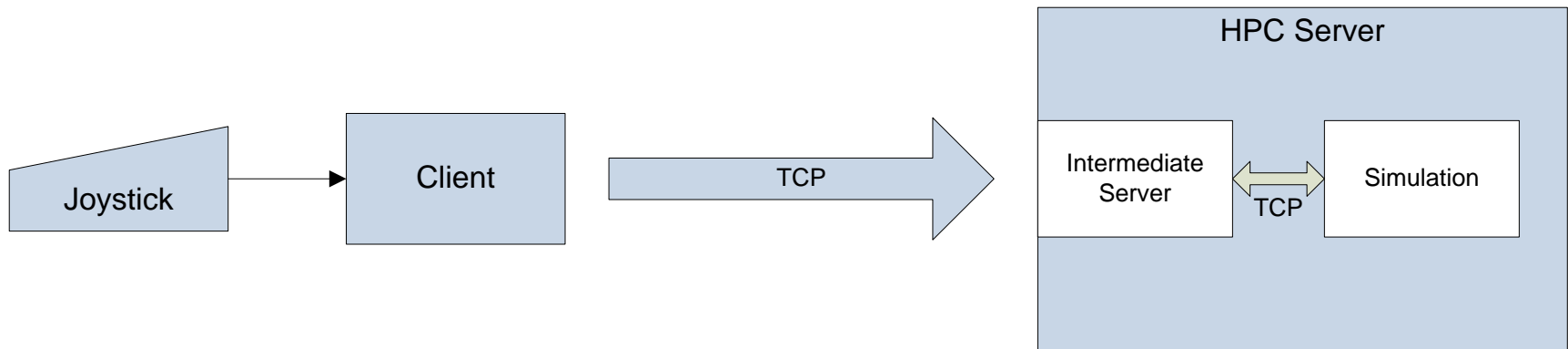
- Cons:

- Problems with rate synchronization
- Harder to route

- Conclusion: More sophisticated design or different model required

- Indirect Model

- Clients pull and Joysticks push state information asynchronously with intermediate server



- TCP is optimized for accurate delivery rather than timely delivery
- Conclusion: Good enough

- Test Results (Indirect):
  - Sending joystick data only: 28Hz
  - Getting joystick data: 13Hz (requires bidirectional traffic, so we would expect this to take longer)
  - Both simultaneously: Same ( $\sigma=8\%$ )
- Test Results (direct)
  - Streaming: 30 Hz
- Further Work: Smarter UDP based design to take advantage of lower latency

The MathWorks products used to meet these objectives include the following:

- MATLAB
- Aerospace Toolbox
- Instrument Control Toolbox
- Image Processing Toolbox
- Mapping Toolbox
- Simulink 3D Animation (formerly the Virtual Reality Toolbox)

## Benefits / Features

- Cost-Effective
- Real-time (30Hz-60Hz) is possible, limited only by available bandwidth and selected protocol.
- The capability to reduce the resolutions of terrain texture maps to render scenes adequately on standard computers.
- Clients could be located anywhere.
- Synthetic environments representing 100s of square miles are possible.

# Contact Information

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