Cluster Node Computing for Target Generation Systems in Aircraft Simulations

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Objective

Discuss the development of a general purpose prototype target generator for air traffic management simulations in order to accommodate future research at NASA Ames Research Center's Aviation Systems Division

Outline

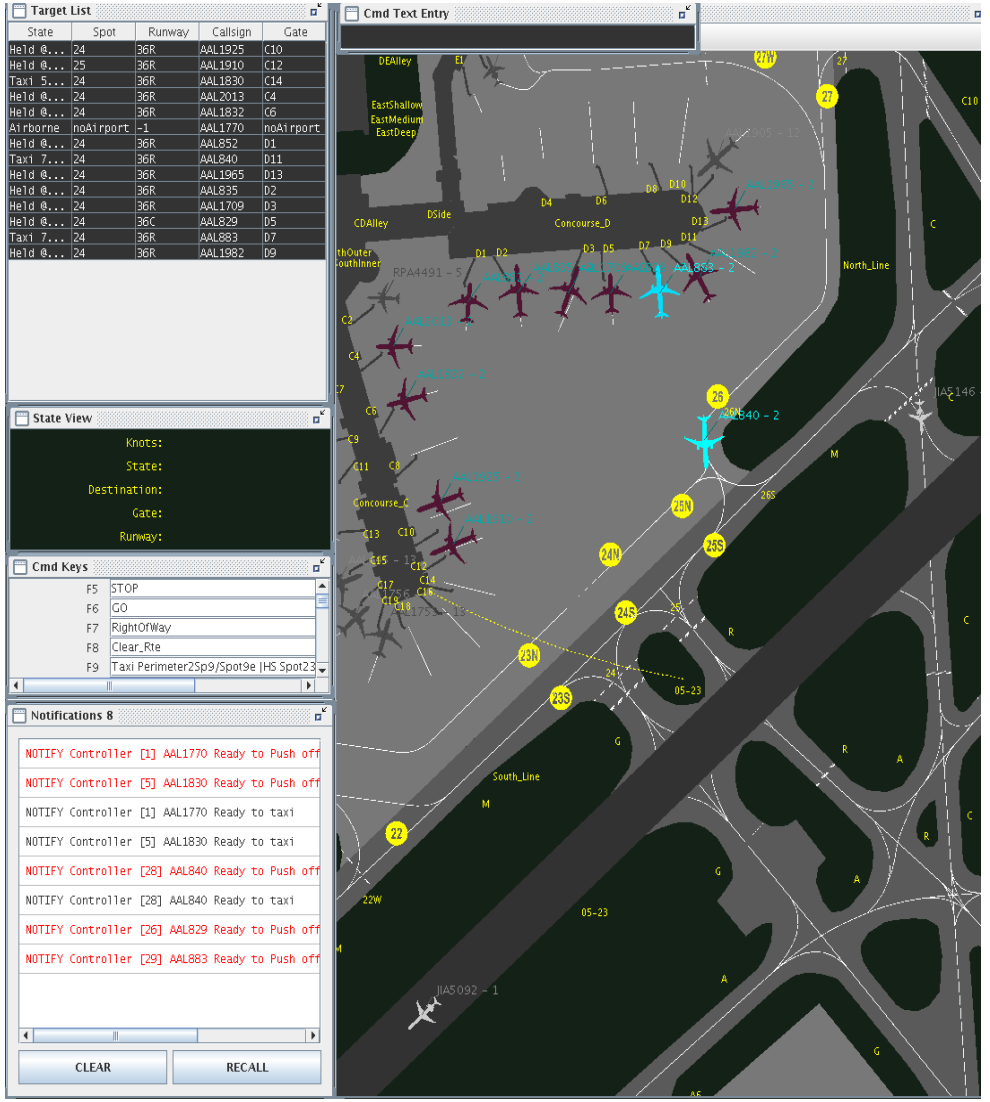
- Definition of a Target Generator

- System Design
  - System Design Philosophy
  - Rationale for Language Used
  - System Architecture
  - Rationale for Networking Protocols Used

- Performance Results

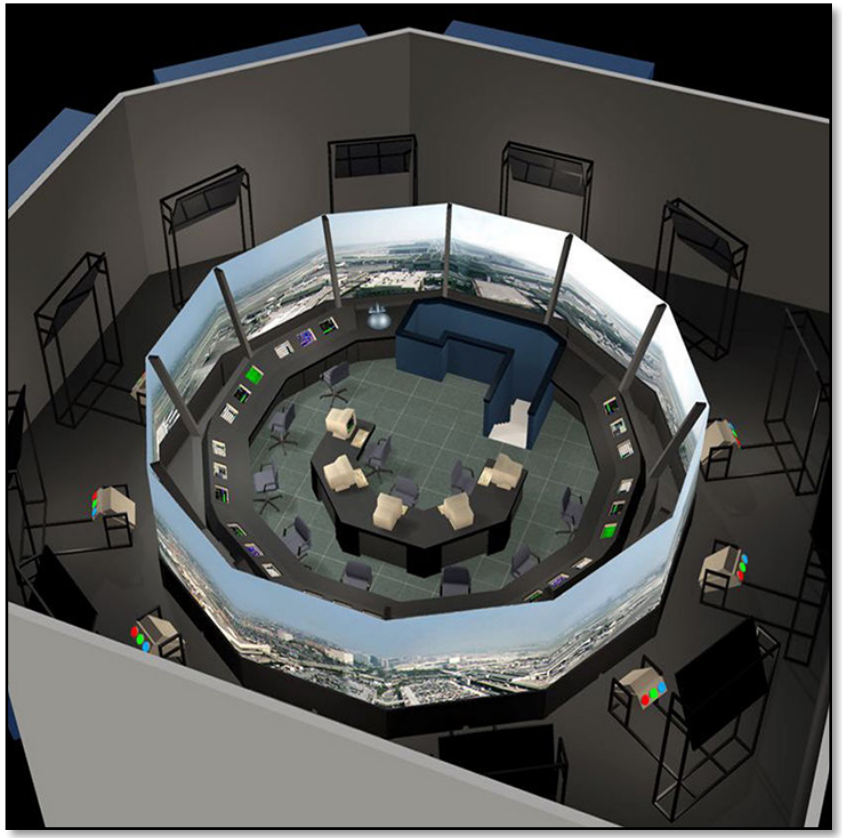
Background: What is a Target Generator?

- Simulates multiple aircraft to create an airspace simulation
  - Fly aircraft along pre-defined routes or along vectors
  - Publish the positional and attitude data to an external interface
- Provides interfaces for client software such as pseudopilot or controller interfaces
- Facilitates research simulations



FutureFlight Central

- Air traffic control simulation facility
- 360 degree visualization
- Facilitates air traffic management research simulations



Building a Target Generator Prototype - Part 1: System Design Philosophy

- Leverage the fact that newer processors are more commonly increasing the number of cores over single-core performance
- Separate the target generator entirely from client software (pilot stations, etc.) and utilize the UNIX-style approach to software
- Provide the capability for pilot and controller interfaces to be remotely accessible via a web browser

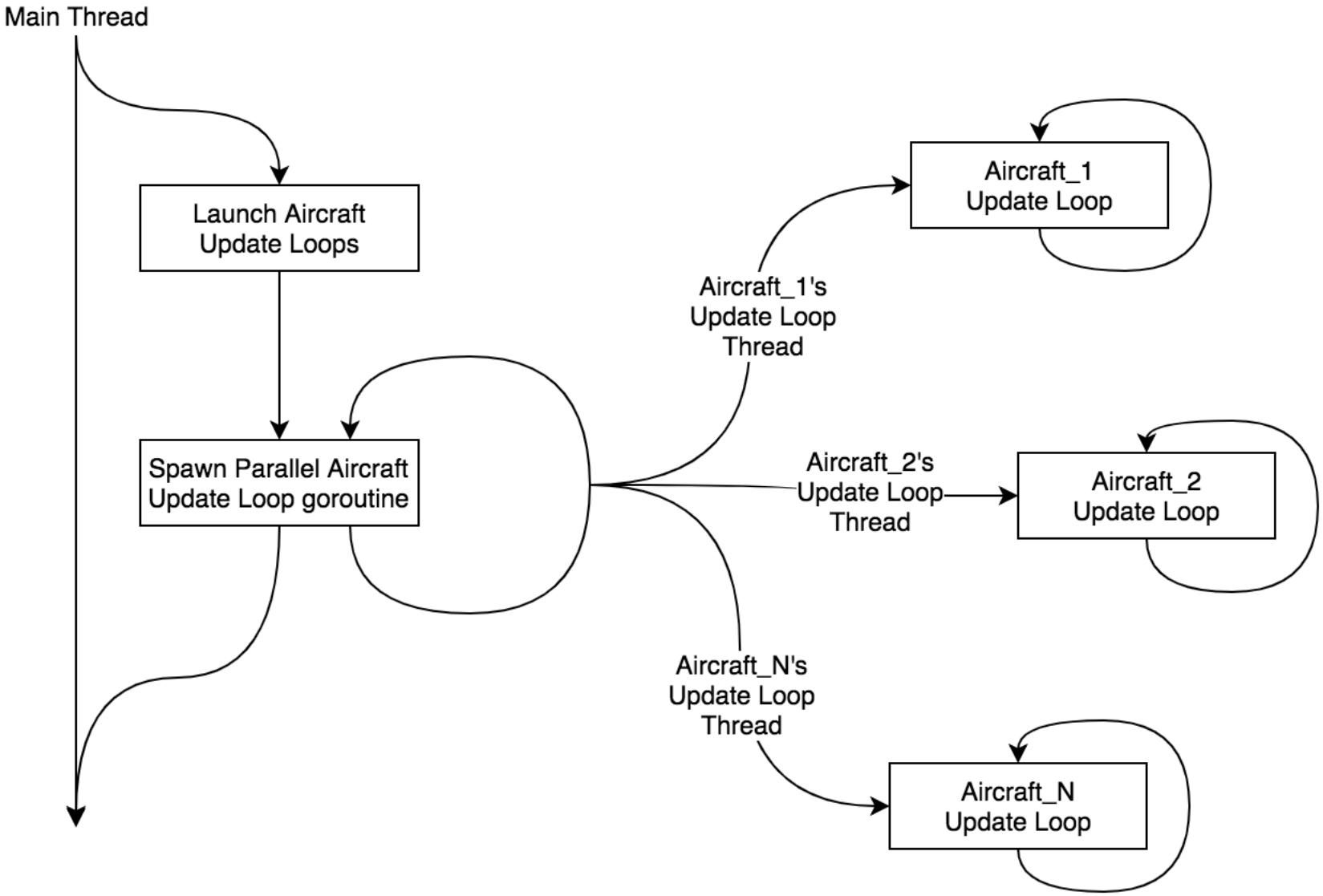
Building a Target Generator Prototype - Part 2: Language

Programming Language Chosen: Go

Selection Criteria:

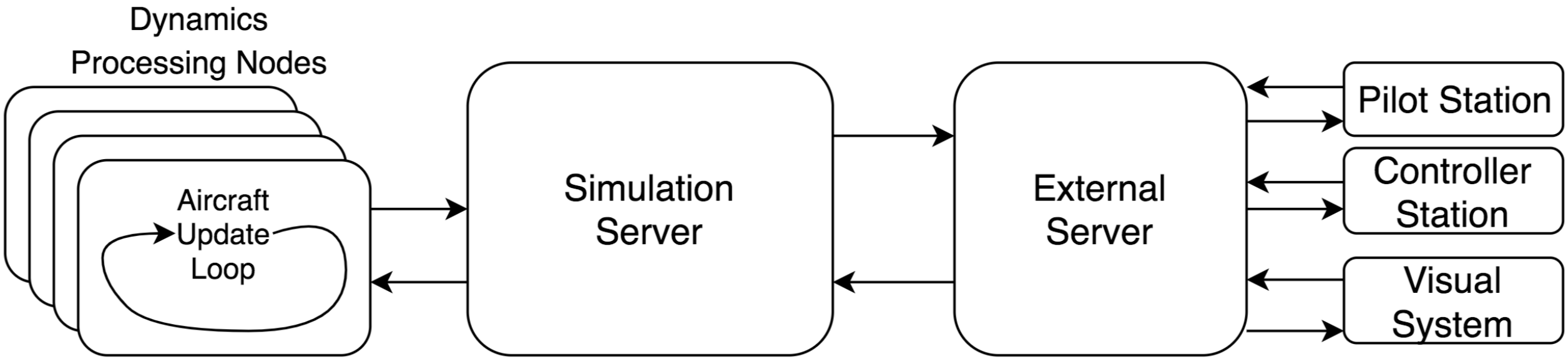
- Native support for multi-threading
- High developer velocity
- Support multiple network protocols like TCP, UDP, UNIX Domain Sockets, http, Websockets, etc.

Using Go's concurrency model to implement Parallelism



Building a Target Generator Prototype - Part 3: System Architecture

Utilize the UNIX philosophy, “Write programs that do one thing and do it well, write programs that work together.”



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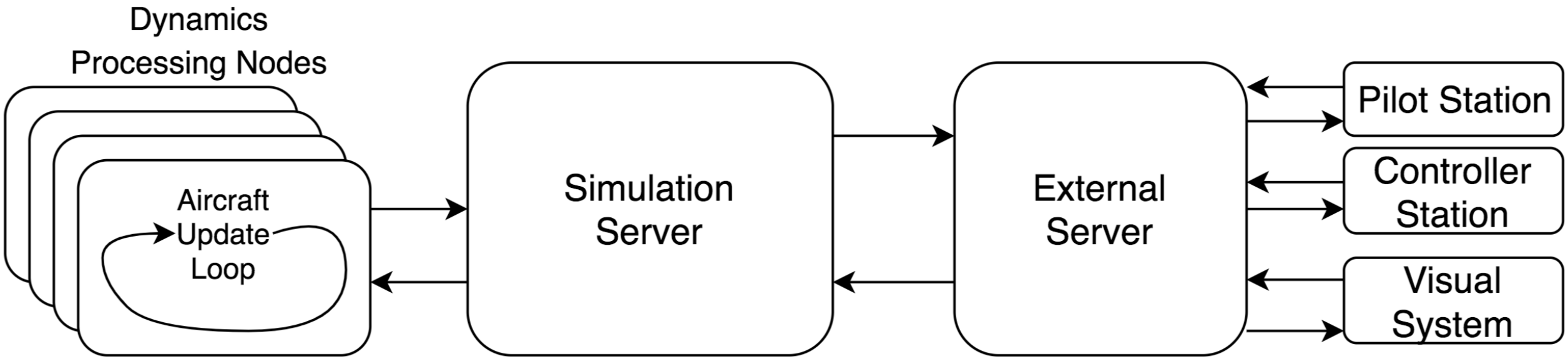

Computes Aircraft States

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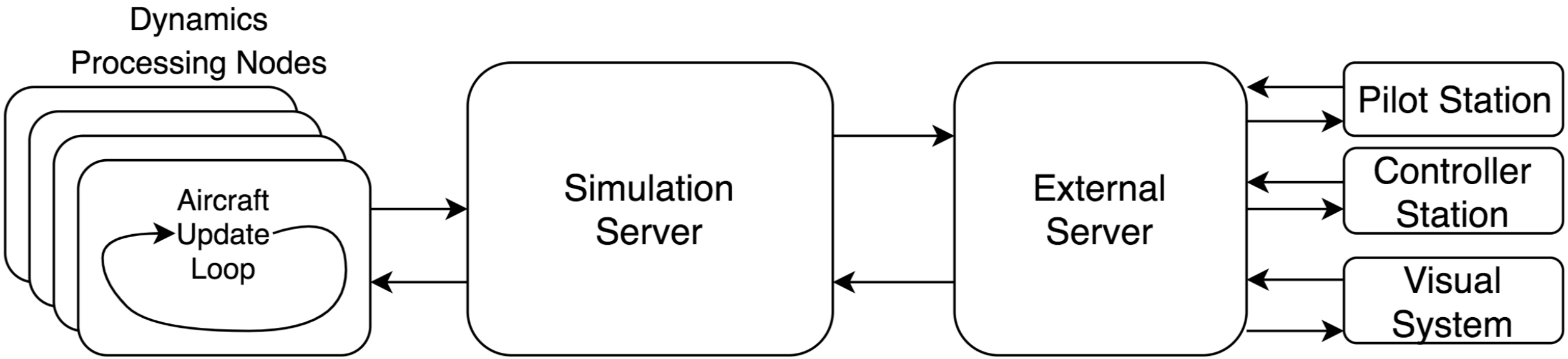

Computes Aircraft States

Broker of Messages
Simulation Manager

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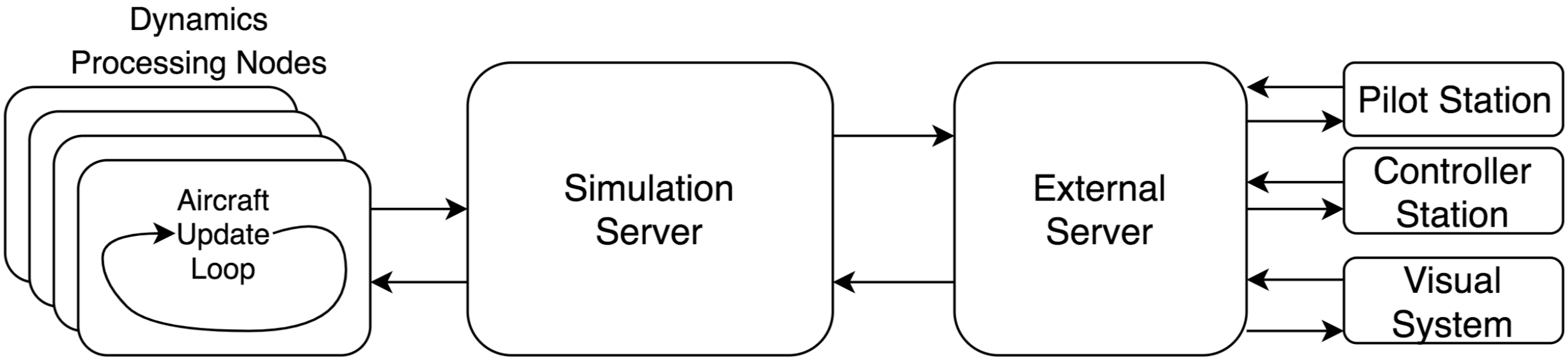


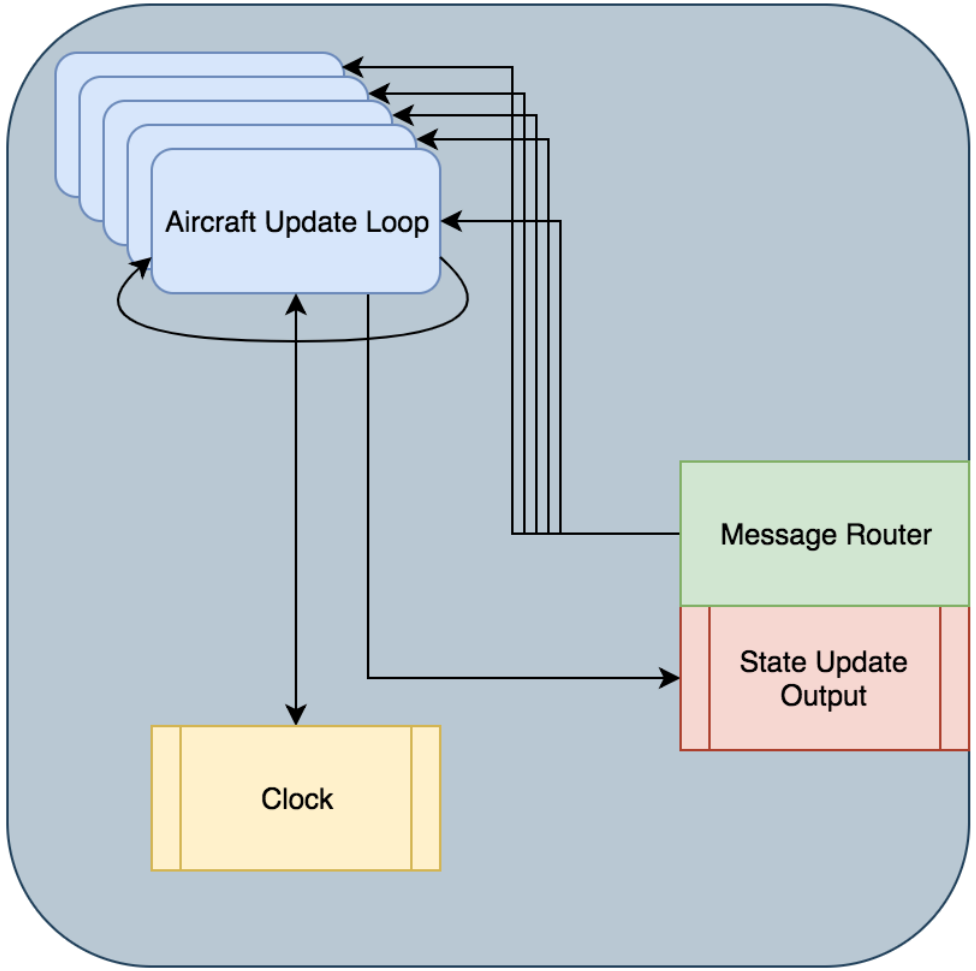
Computes Aircraft States

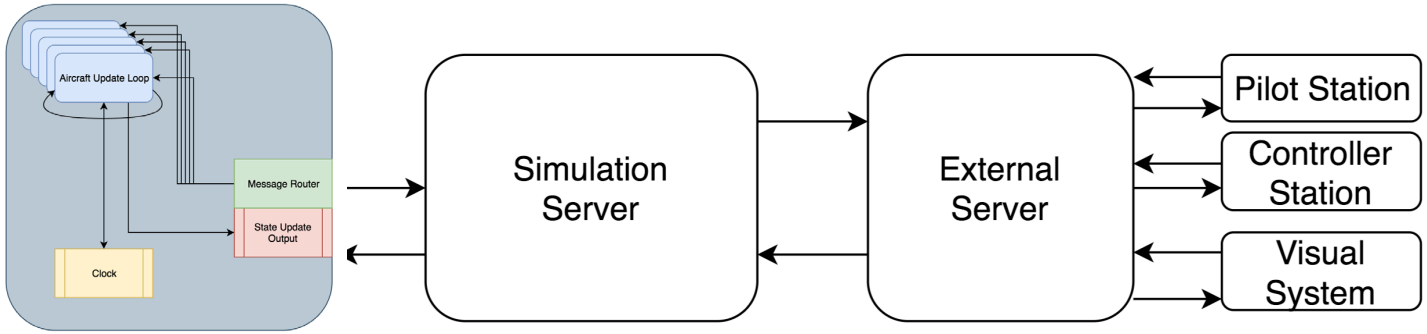
Broker of Messages
Simulation Manager

Manages Client Connections
Provides Interface to Simulation

Dynamics Processing Node

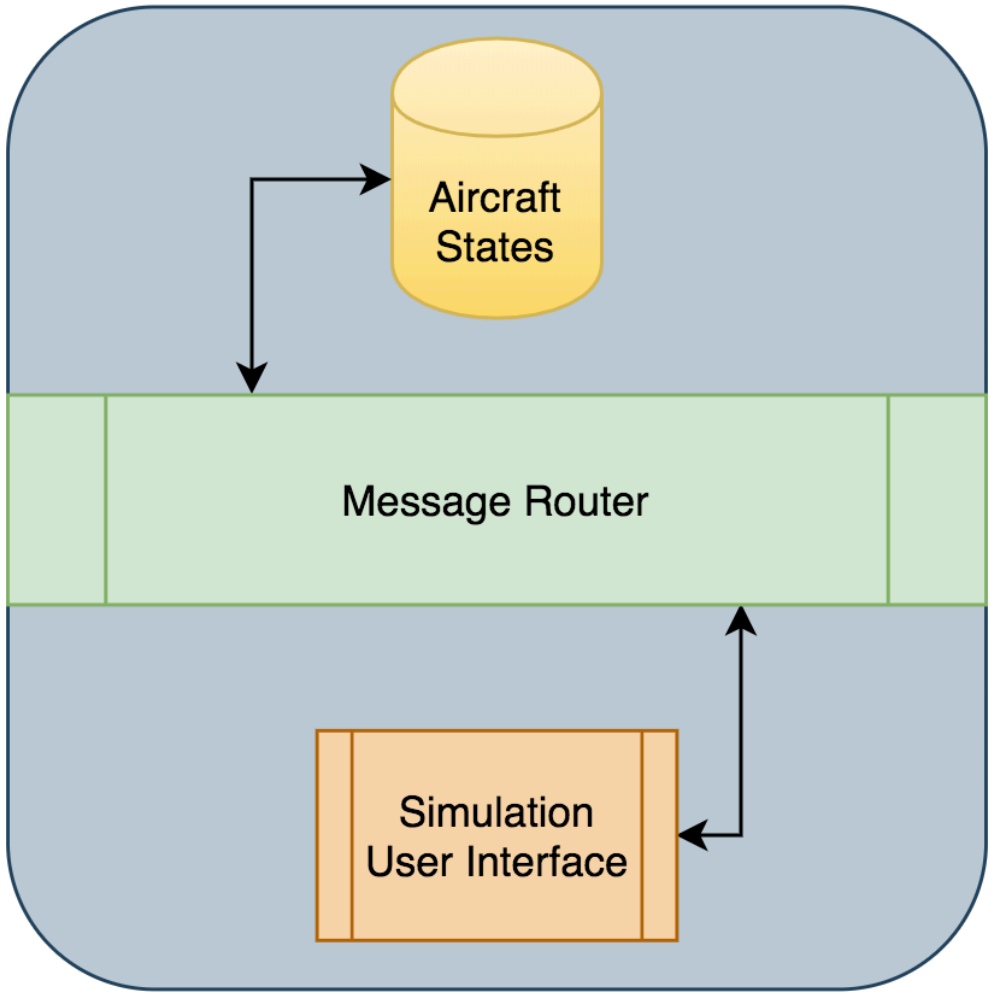
- Clock
- Aircraft Update Loop
- Message Router
- State Update Output

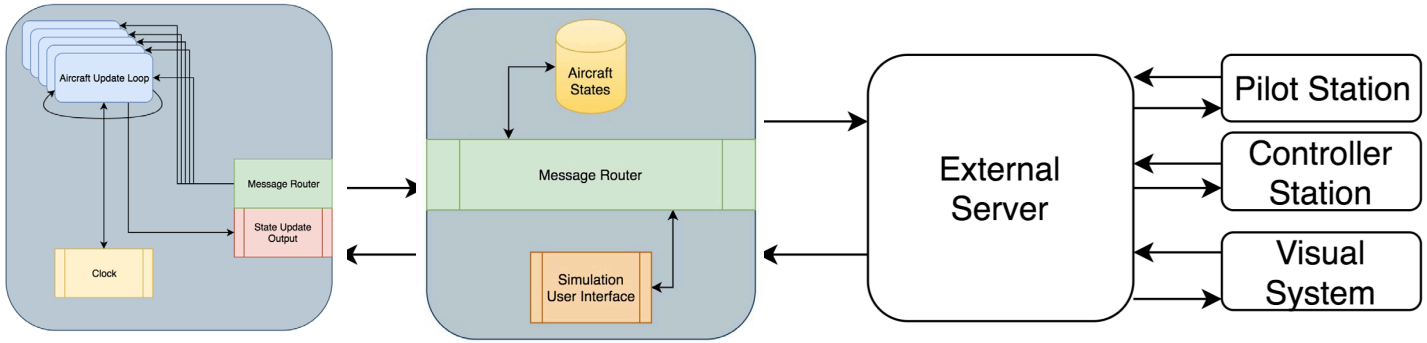




Simulation Server

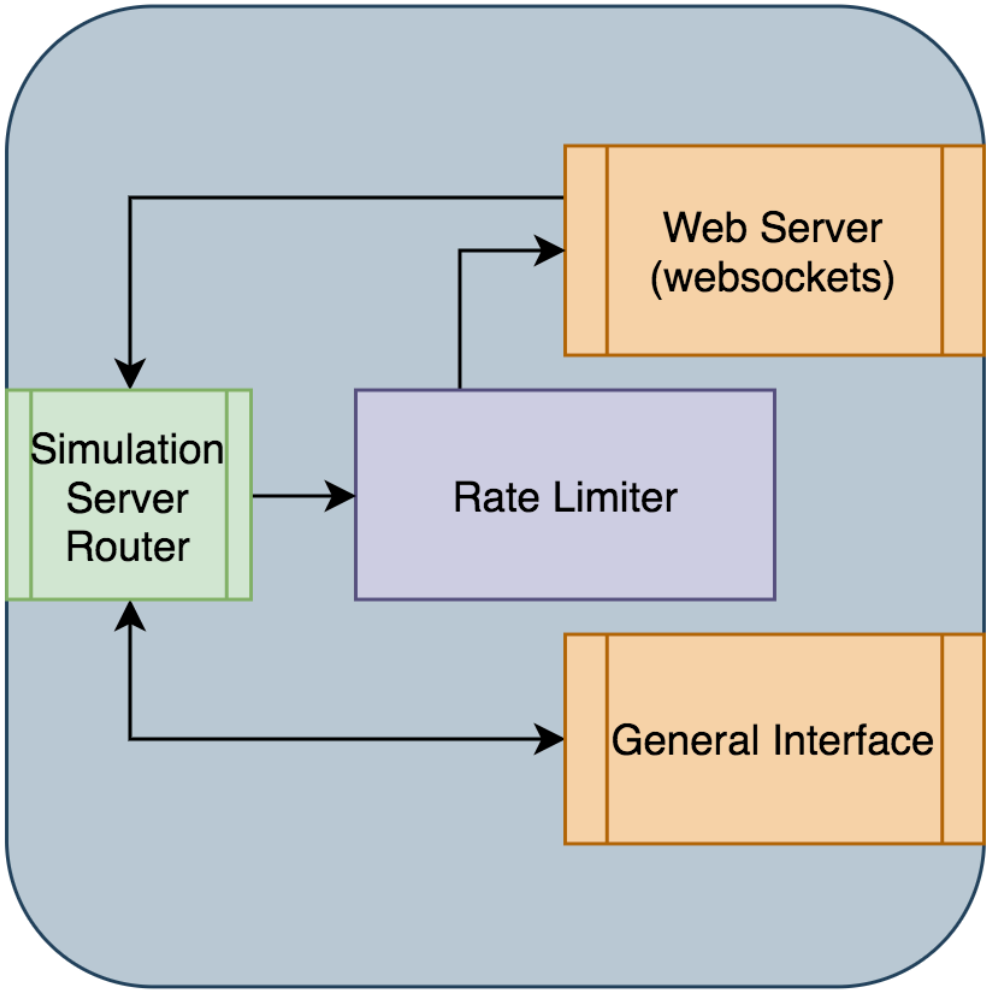
- Message Router
- Aircraft States
- Simulation User Interface

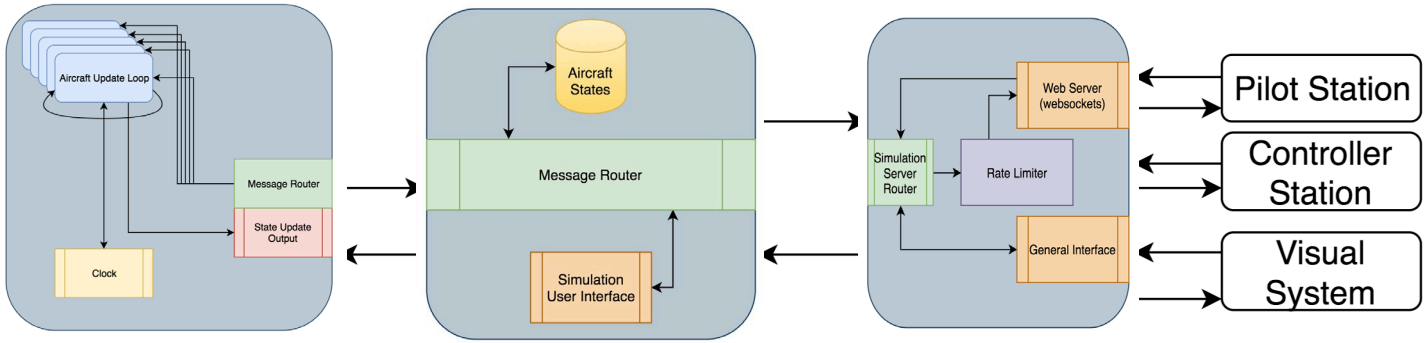




External Server

- Simulation Server Router
- Rate Limiter
- Web Server
- General Interface



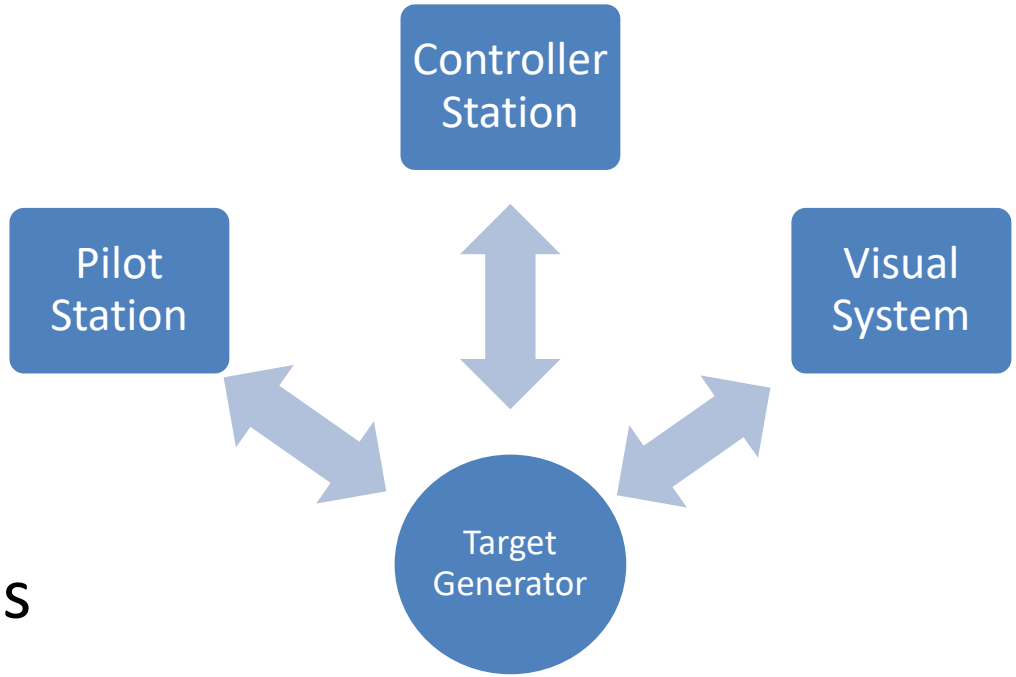


Building a Target Generator Prototype - Part 3: Network Protocols

	Internal Simulation Communication	Low Bandwidth Clients	High Bandwidth Clients
Local Communication	UNIX Sockets	N/A (Only Distributed)	N/A (Only Distributed)
Distributed Communication	TCP	HTTP/Websockets	TCP

Why WebSockets and HTTP for Pilot and Controller Stations?

- Browser Web Applications allow for ease-of-access from any on-site location or VPN'd client
- WebSockets provide streaming data to support a real-time connection to simulation
- HTTP enables upgrading to websockets, as well as a strong interface for request-response communication



Results

- Current day target generators offer 1 - 4Hz, up to 200 Active Aircraft

Prototype Tests:

- Two system configurations
  - one all-local simulation
  - one distributed system
- Two loads of traffic
  - one 400 aircraft
  - one 1000 aircraft

	400 Aircraft	1000 Aircraft
One Node	125.4Hz	48.9Hz
Two Node	79.7Hz	32.0Hz

Next Steps

- One Node Configurations outperformed Two Node Configurations:
  - Need to optimize messaging system for TCP
- Develop Clients
  - Pilot Station
  - Controller Station
- Interface with Visual Systems

Summary

- Prototype demonstrates update rates of 30Hz+ outperforming current day target generators
- Provides smooth out-the-window visuals
- Supports higher aircraft density
- Expands flexibility for client software
- Improves capabilities for future simulations research