https://ntrs.nasa.gov/search.jsp?R=20190000386 2020-03-10T16:36:58+00:00Z

Cluster Node Computing for Target Generation Systems in Aircraft Simulations

Spencer Monheim, Michael Feher, James Murphy
NASA Ames Research Center

Bonnie Andro-Avila
MIRACORP, Inc.

AIAA SciTech 2019 Conference
Jan 7-11, 2019

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

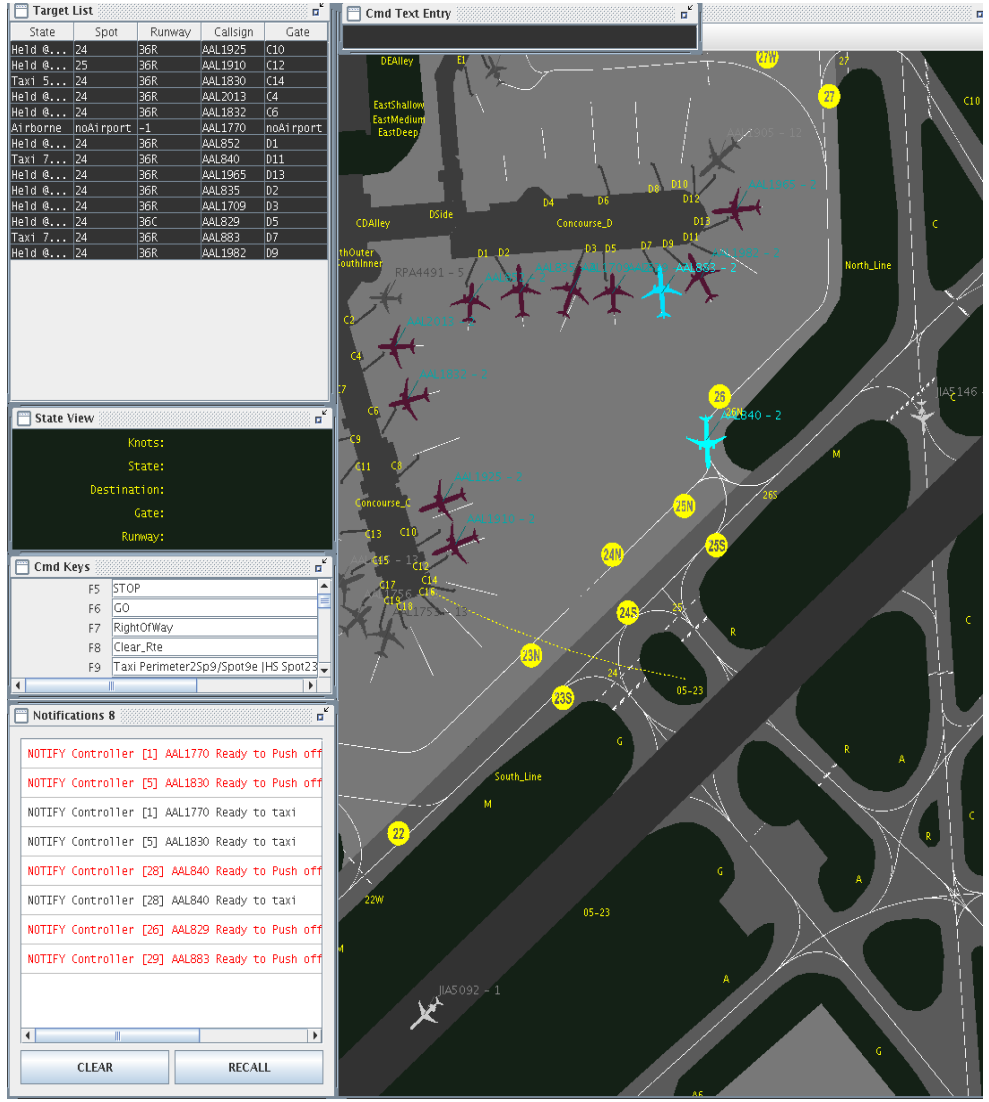
- Definition of a Target Generator

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

- Performance Results

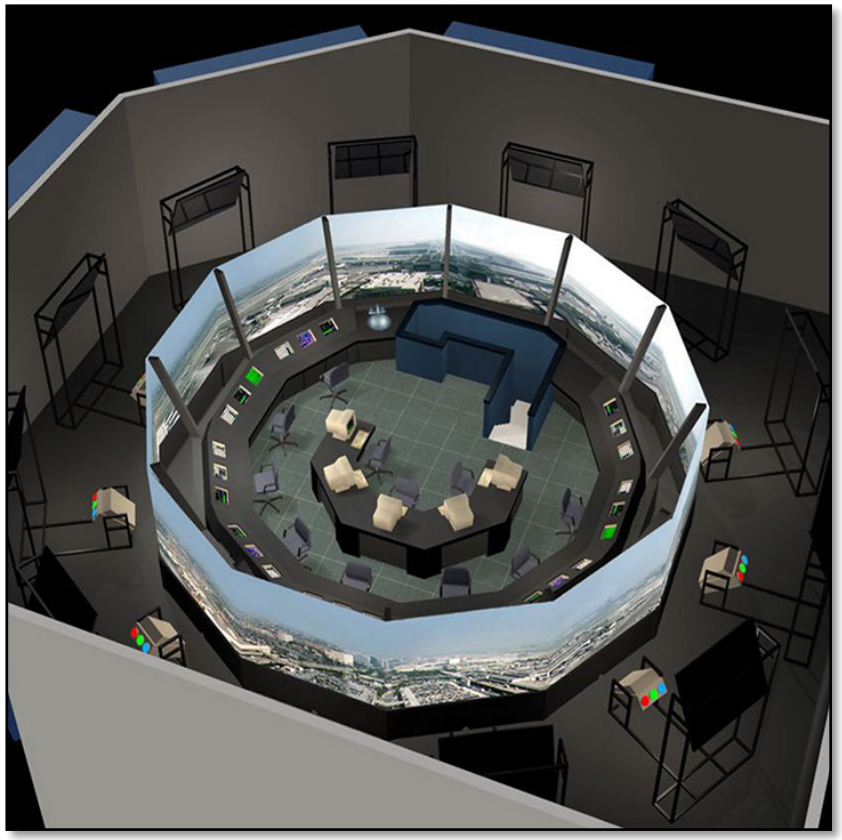
Background: What is a Target Generator?

- 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

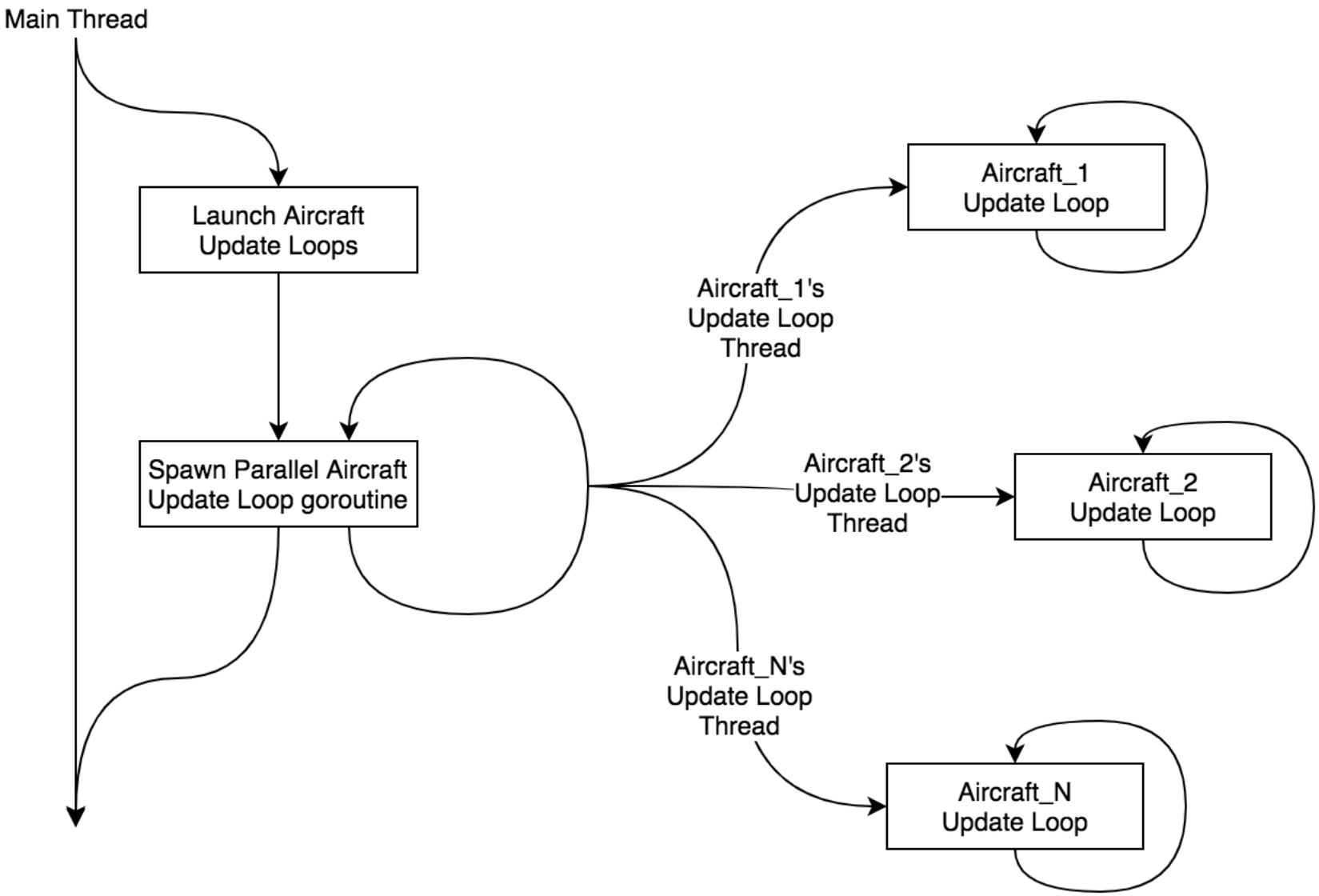
Building a Target Generator Prototype - Part 2: Language

Programming Language Chosen: Go

Selection Criteria:

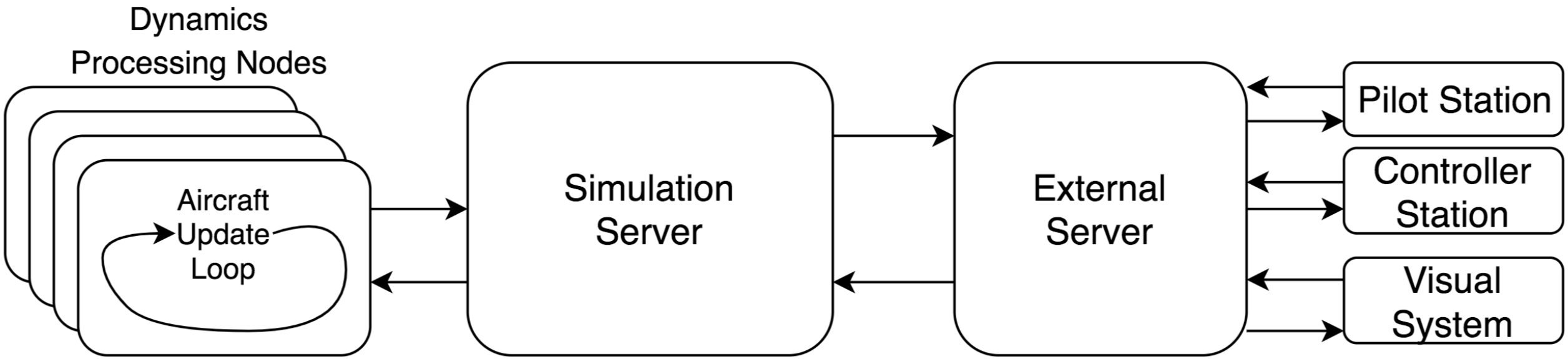
- Native support for multi-threading
- High developer velocity
- Support multiple network protocols like TCP, UDP, UNIX Domain Sockets, http, Websockets, etc.

Using Go's concurrency model to implement Parallelism



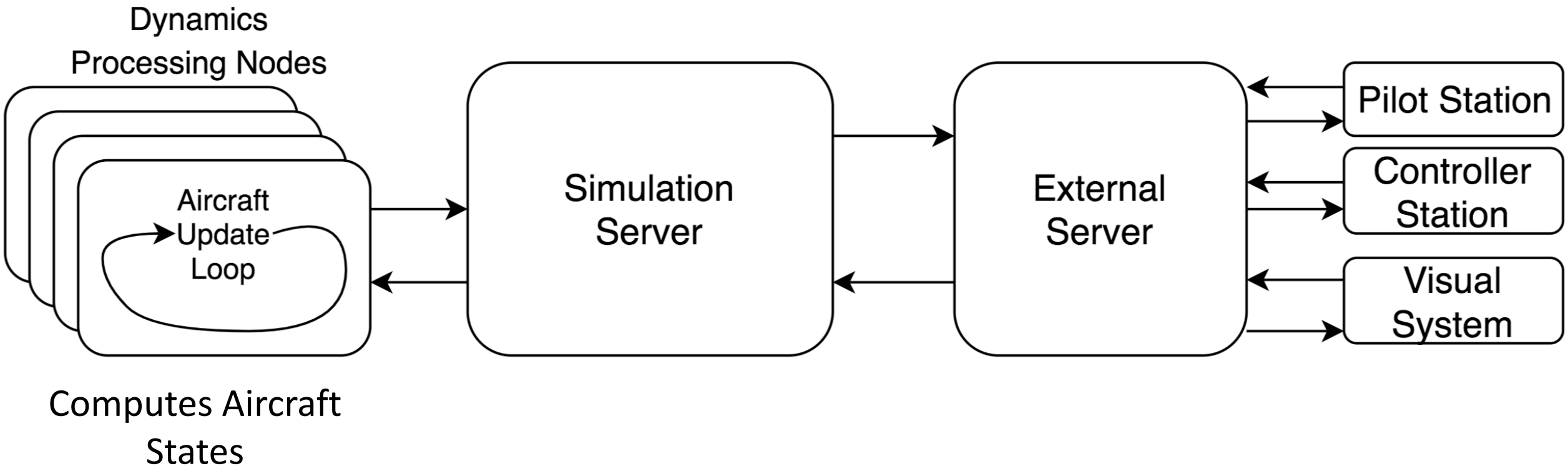
Building a Target Generator Prototype - Part 3: System Architecture

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



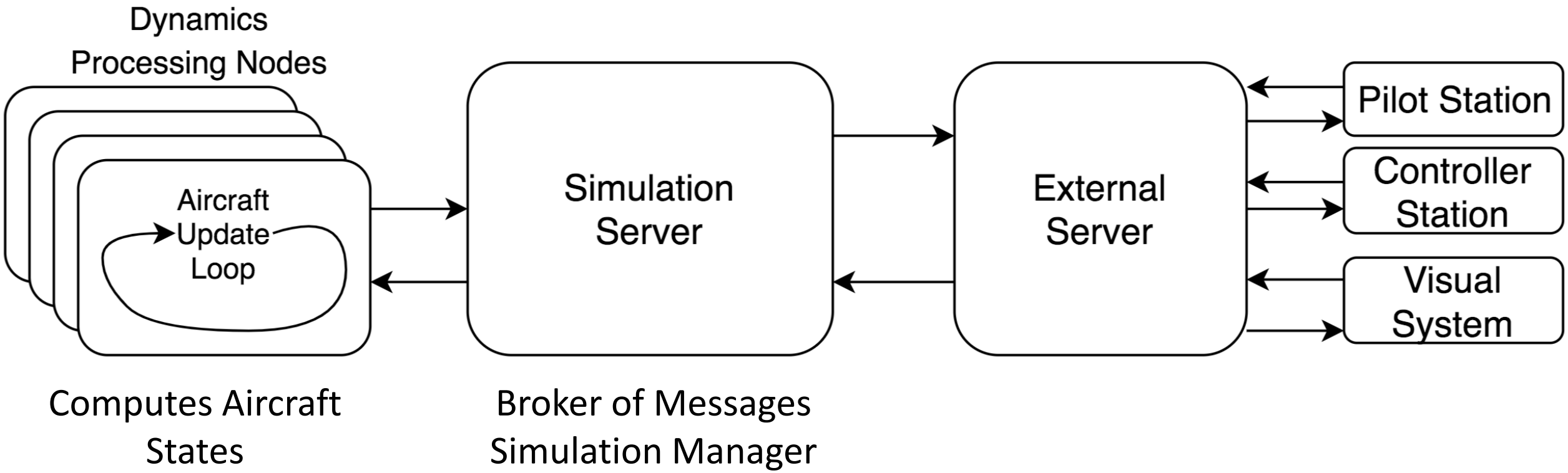
Building a Target Generator Prototype - Part 3: System Architecture

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



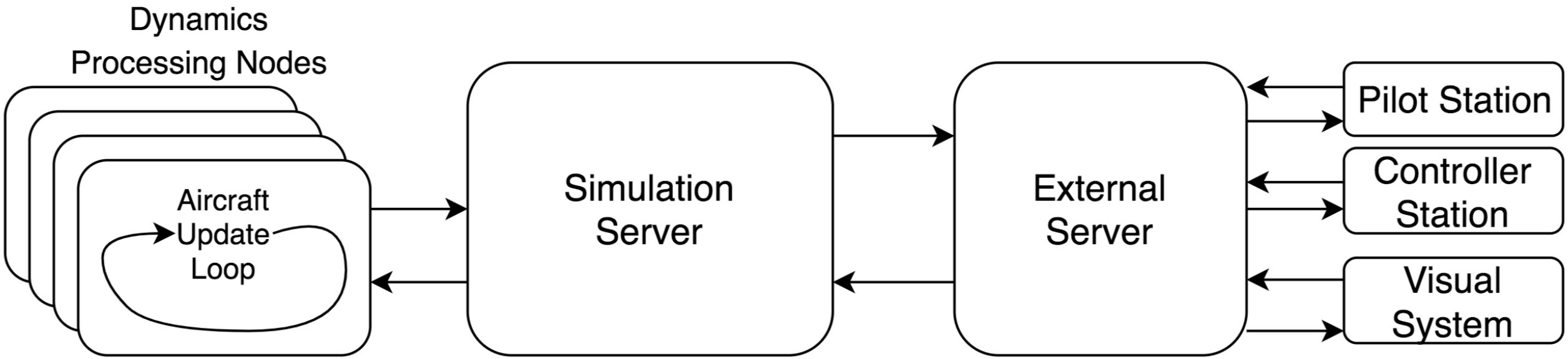
Building a Target Generator Prototype - Part 3: System Architecture

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



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.”



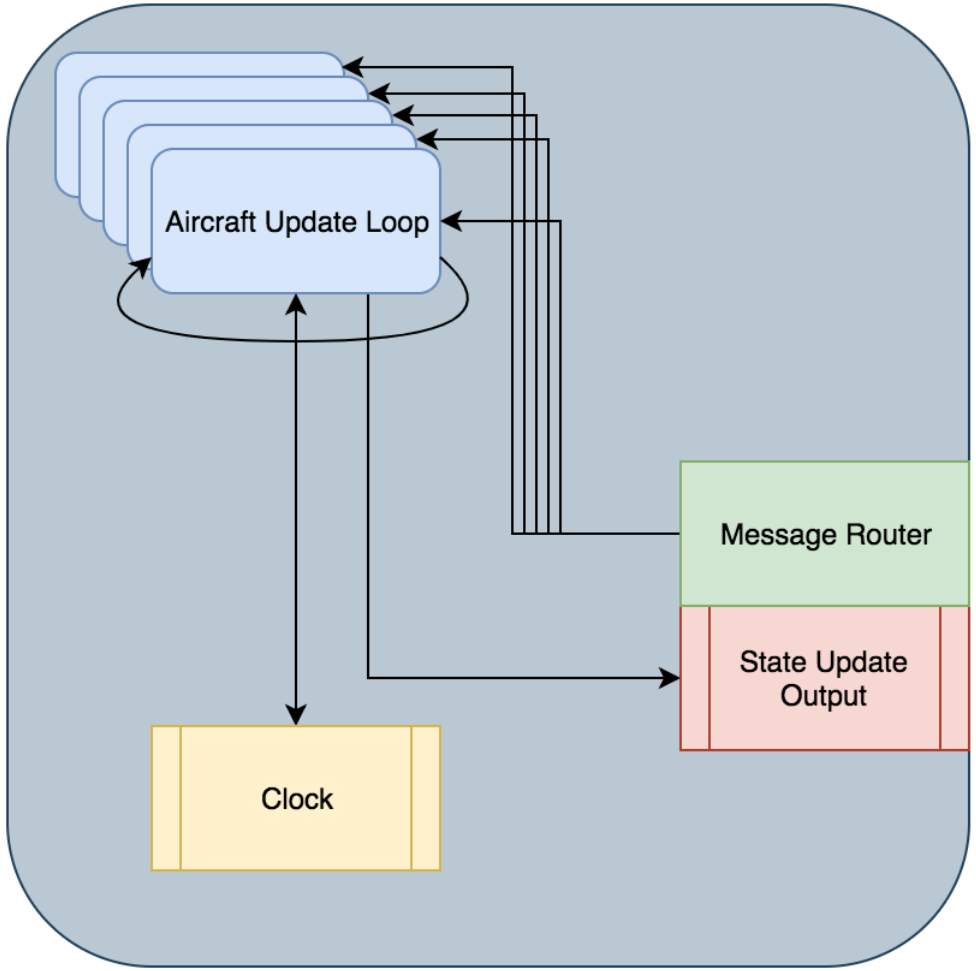
Computes Aircraft States

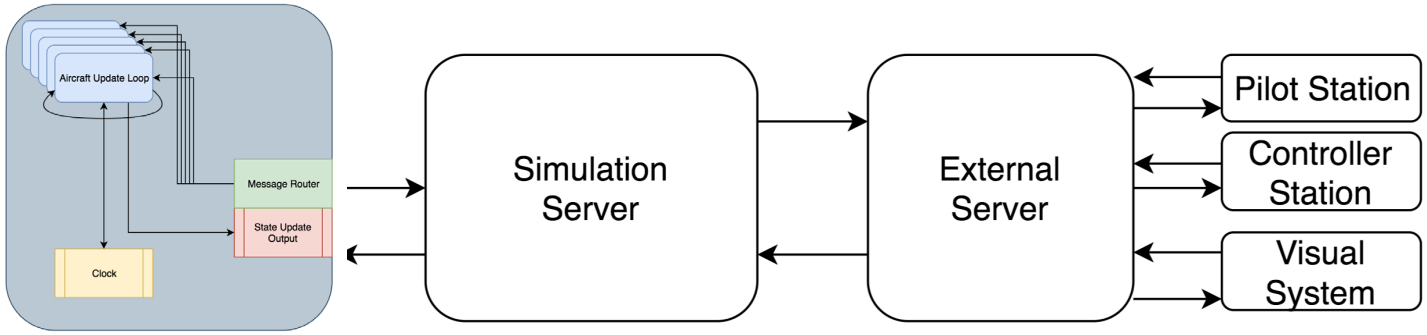
Broker of Messages
Simulation Manager

Manages Client Connections
Provides Interface to Simulation

Dynamics Processing Node

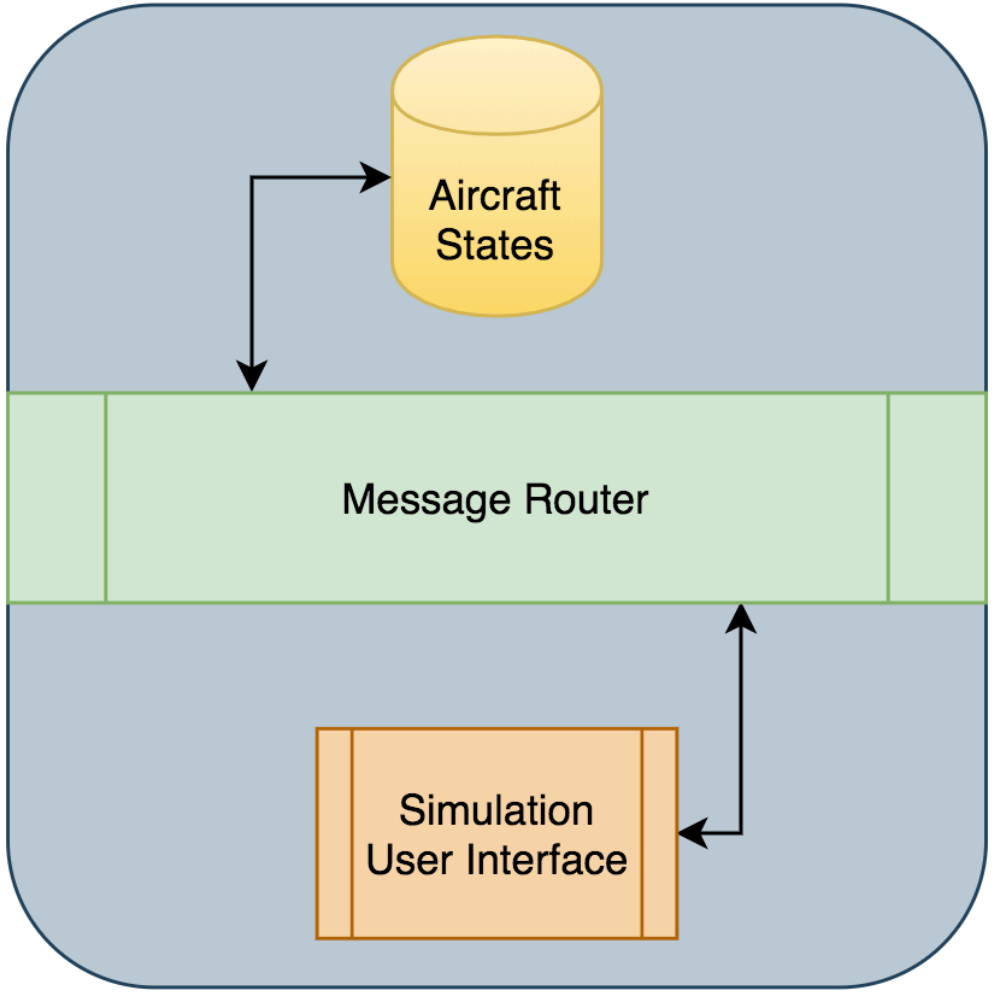
- Clock
- Aircraft Update Loop
- Message Router
- State Update Output

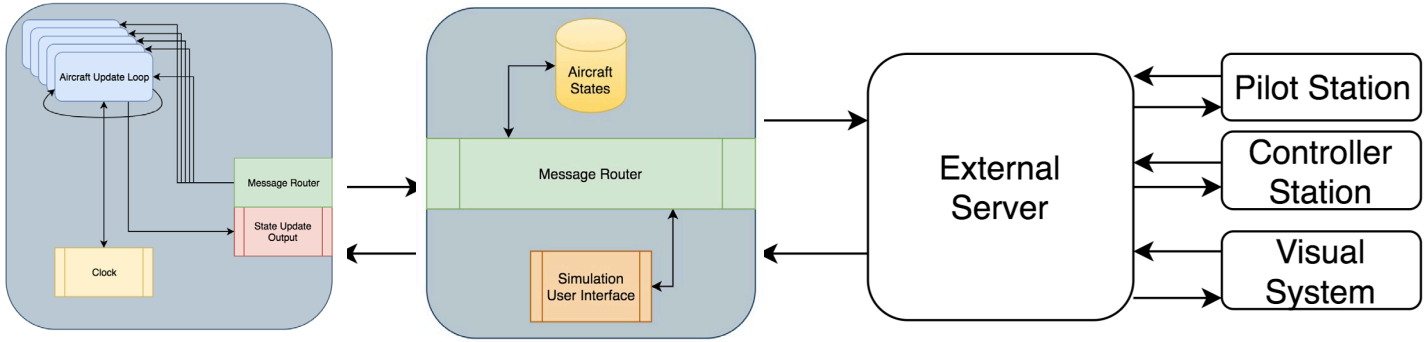




Simulation Server

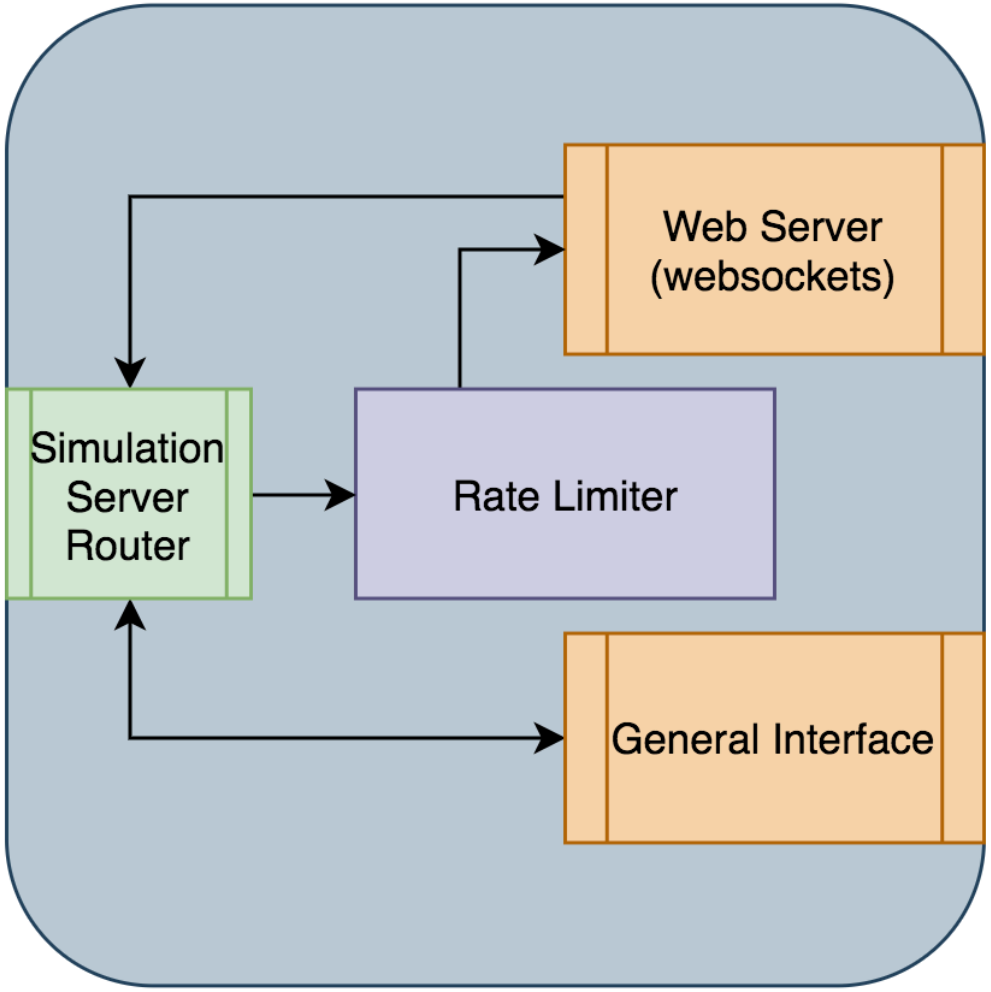
- Message Router
- Aircraft States
- Simulation User Interface

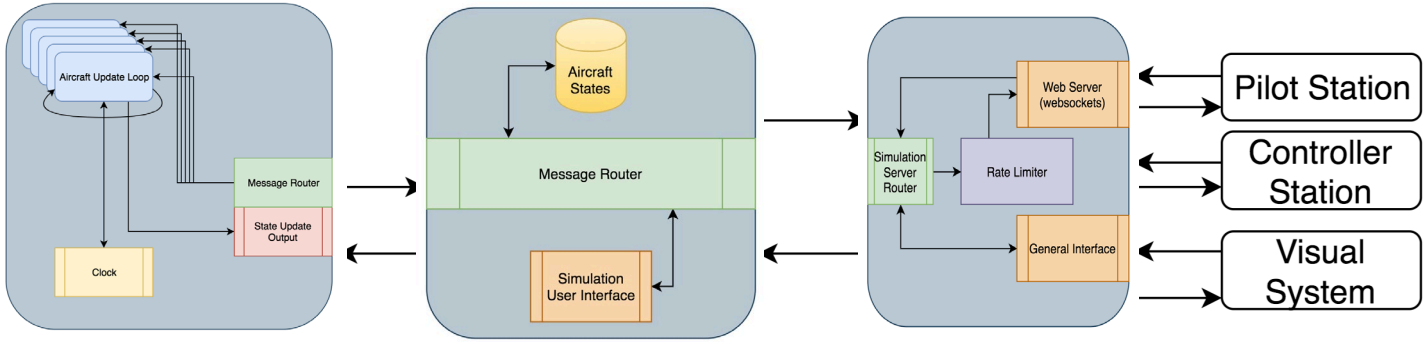




External Server

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



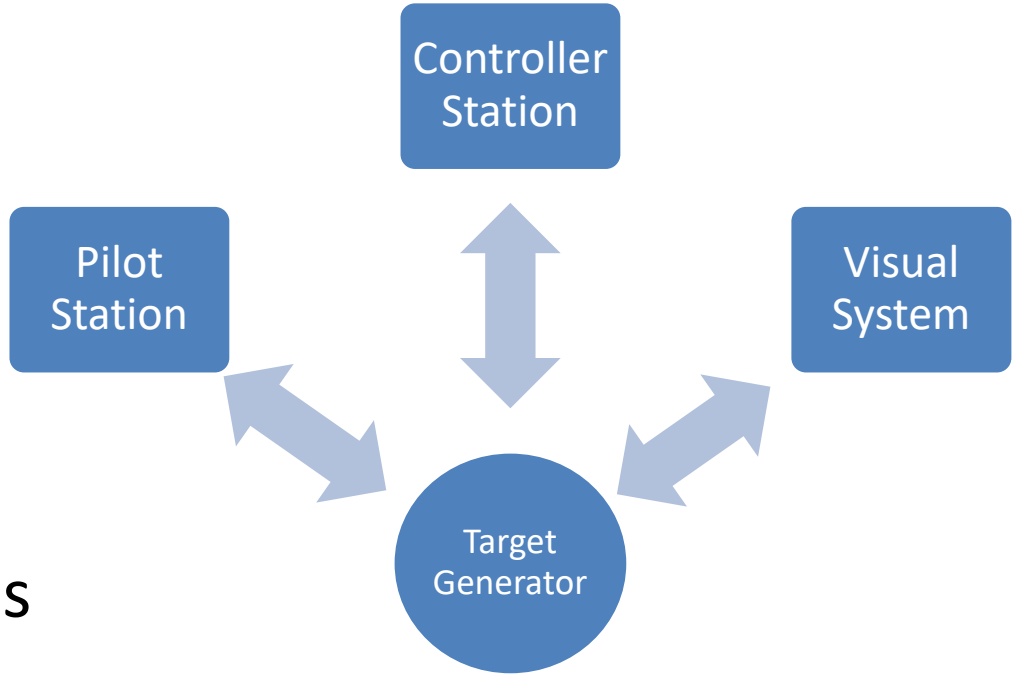


Building a Target Generator Prototype - Part 3: Network Protocols

	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