MICHIGAN STATE UNIVERSITY

Project Plan Presentation Training Simulator Using GPS-Indexed Video

The Capstone Experience

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From Students…
…to Professionals

Project Sponsor Overview

- Second largest railway in the United States in mileage coverage
- Delivers a variety of goods to 23 different states
- Helped build the first transcontinental railway

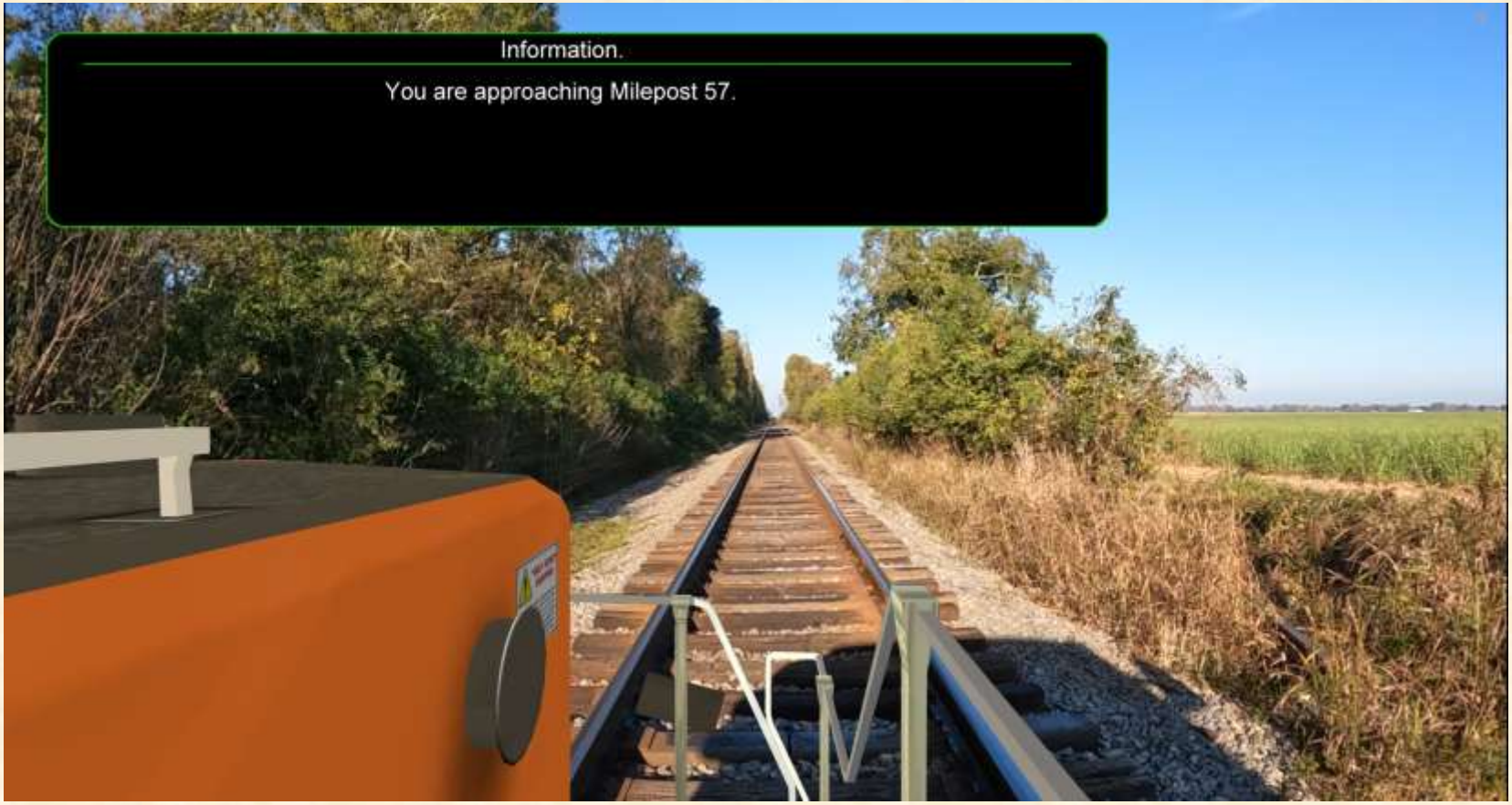
Project Functional Specifications

- Problem: Training simulators require realistic environments, but creating digital twins for 30,000+ miles of track is a major challenge
- Video footage covering the track exists but a solution to implement it into the simulation does not
- Solution: A GPS-synchronized video player that integrates real-world video footage with training simulations
- Uses GPS and velocity data to play the correct video segments while overlaying digital elements like signals and signage

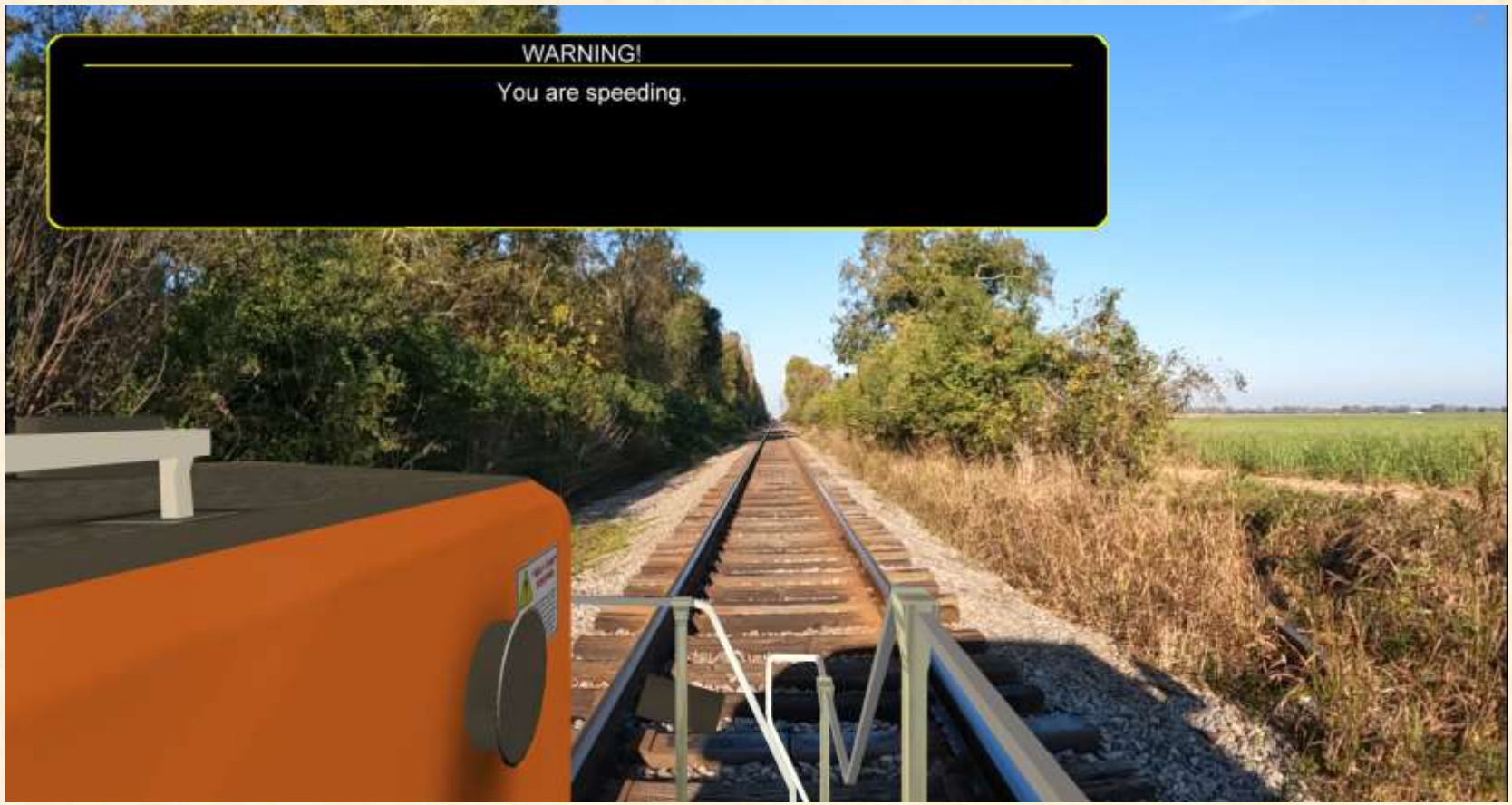
Project Design Specifications

- Real-world video with GPS over a training simulation
- Seamless transitions between video files
- Super impose the model of a train to mimic the view of the cabin
- Change the weather in the video to mimic different scenarios
- Display messages, warnings, and errors

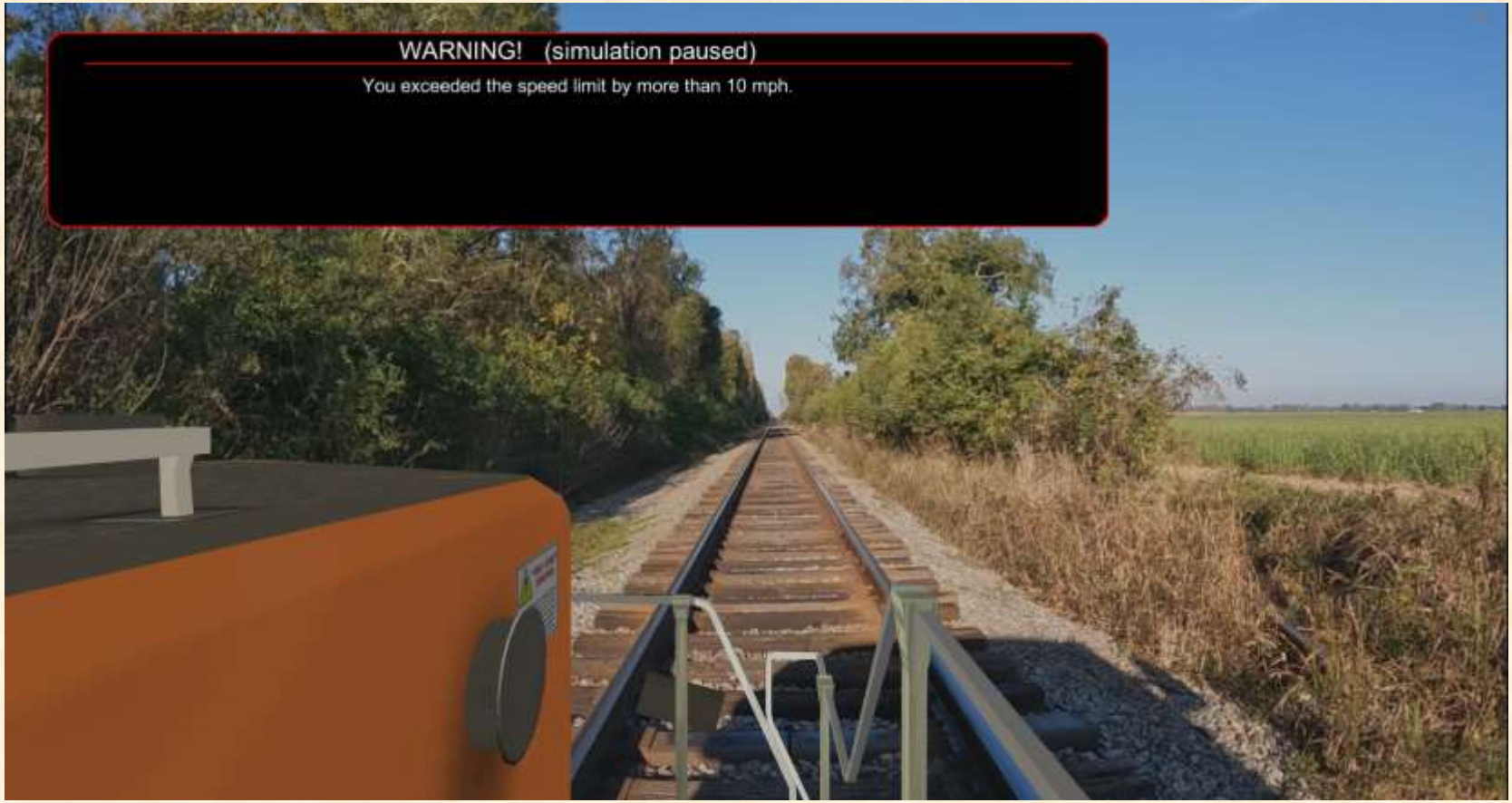
Screen Mockup: General Message



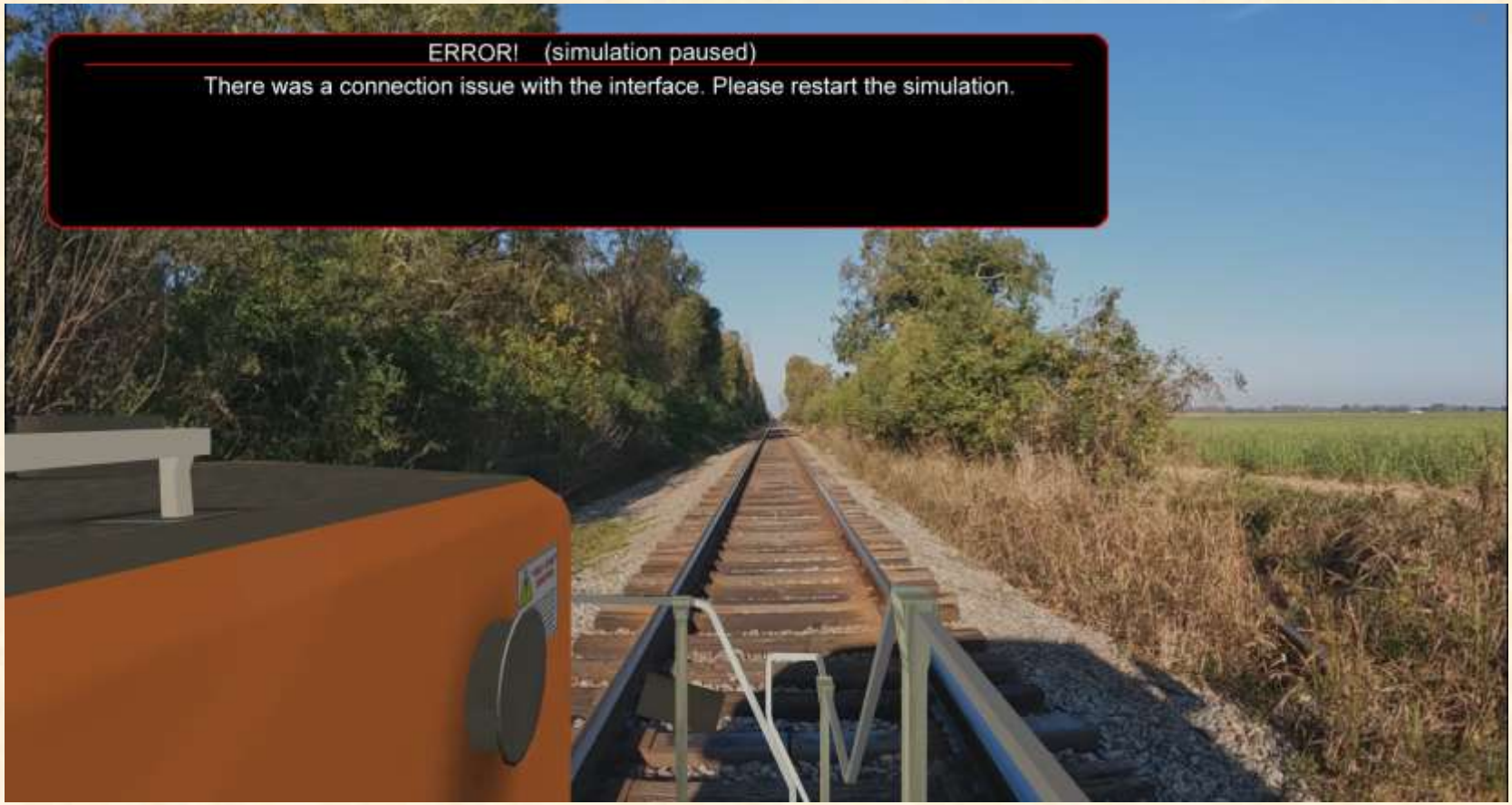
Screen Mockup: Lesser Warning



Screen Mockup: Serious Warning



Screen Mockup: Simulation Error Message

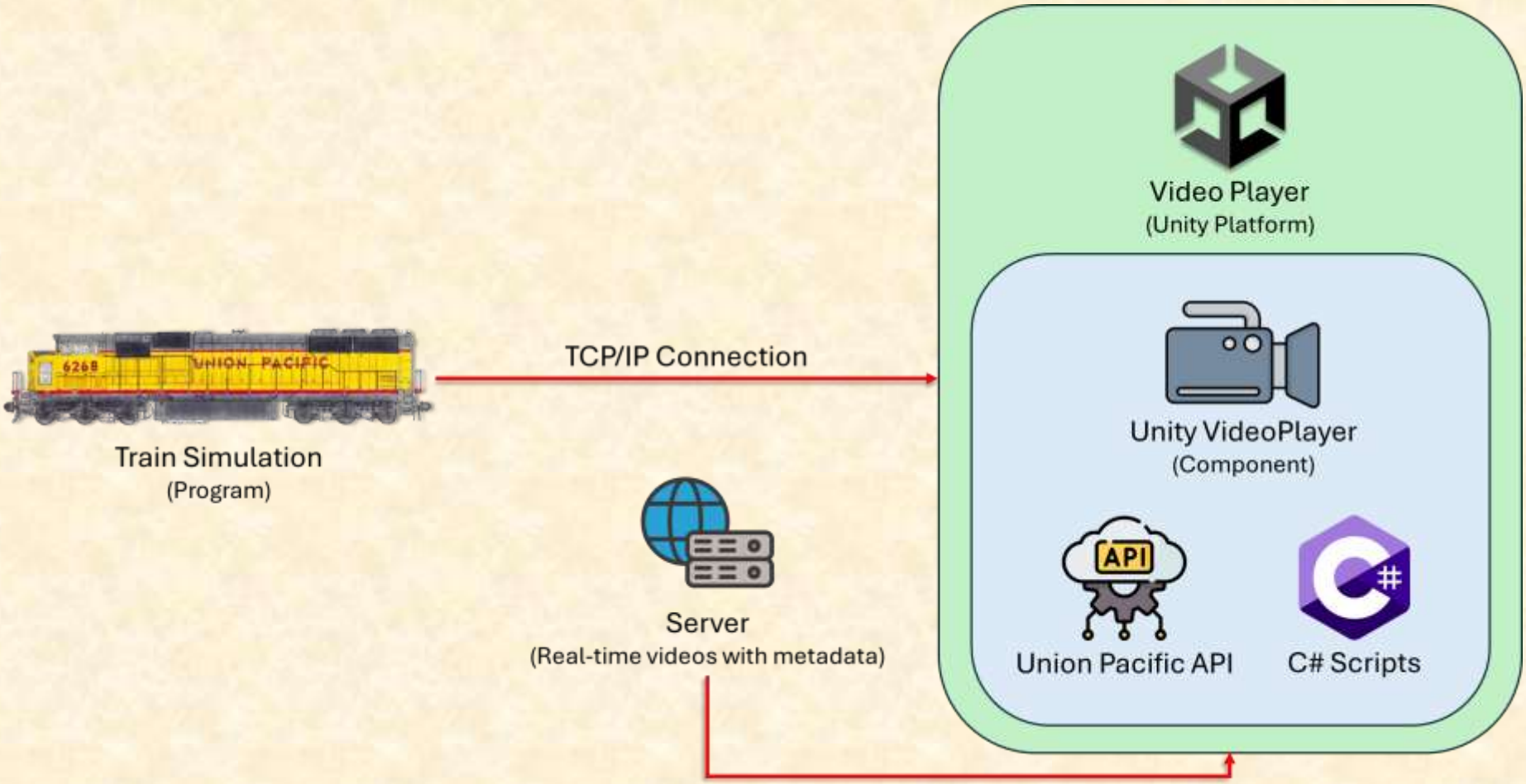


Screen Mockup: Weather Overlay

Project Technical Specifications

- Syncs video playback with real-time simulation data for locomotive training
- Uses:
  - Unity (front end) for displaying videos and messages
  - Union Pacific API, Video Player component in Unity, and C# scripts (back end) for synchronization
- Union Pacific API transmits Key simulation data (parsed in XML):
  - GPS coordinates (latitude & longitude)
  - Speed & acceleration
  - Event notifications (road crossings, stations mileposts, and simulation status)
  - Switch & signal states
- Playback & Synchronization:
  - C# scripts control Unity Video Player and smooth transitions
  - Adapts dynamically to simulation changes
  - Support videos stored locally or on a server

Project System Architecture



Project System Components

- Hardware Platforms
  - Standard Windows PC for development and simulation playback (Windows 10 or 11)
  - High resolution monitors for video and UI display
  - Optional hardware for advanced simulation (locomotive control replica)
- Software Platforms / Technologies
  - **Windows OS:** Primary operating system for development and deployment
  - **Unity:** Core framework for UI overlays and advanced 3D model integration
  - **C#:** Primary programming language for the simulation interface (API) and video player
  - **TCP/IP:** Protocol for communication between the video player and simulation software, API establishes connection

Project Risks

- Connecting the Video Player and the Simulation
  - Communication between the Video Player and Simulation must be fast, accurate, and secure
  - Add hardcoded test cases to test the connection, then use real simulation data
- Inconsistent GPS data between the simulation and video file
  - Prevent erroneous video playback
  - Implement a threshold range to handle sudden movements
- Aligning video playback with simulation speed
  - Sync the video to the simulation GPS and adjust the speed
  - Convert GPS coordinates with the provided script and calculate the acceleration rate
- Smooth transitions between videos
  - Linking videos together seamlessly when going back a set amount of miles
  - Use easing between frames to make the two videos appear as one

Questions?