Architecture Design, TI2806

Blazin and the Goons

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1 Introduction

This document describes the technical design of the application made by “Blazin and the Goons” for PolyCast to manage live musical video recordings. It provides functionality for operators to manage scripts and be in sync during the recording.

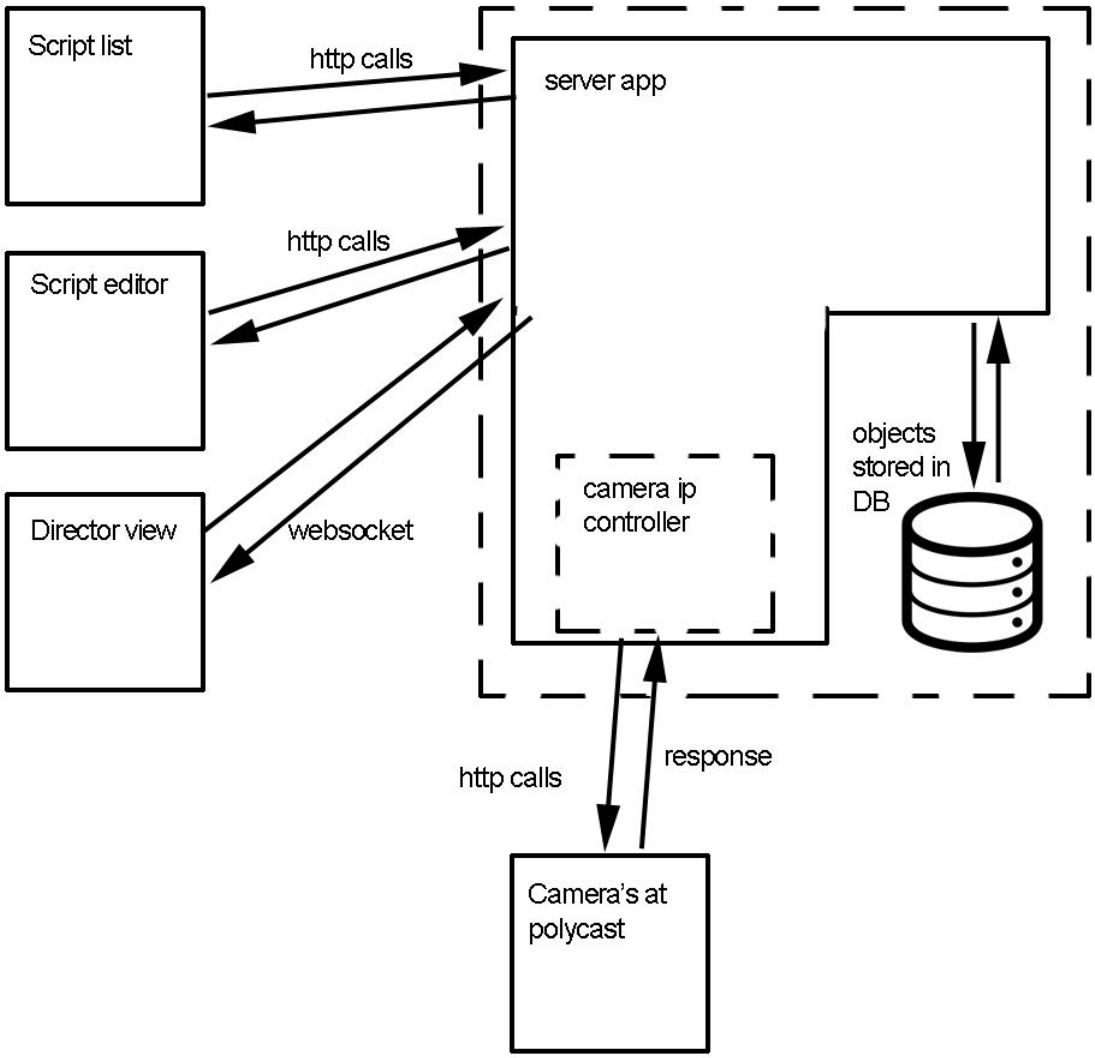
1.1 Design goals

- **Easy of use**
  The system has to be fast and easy to use for all operators, because time is limited during a recording. Operators should not have to spent time using the system that was intended to make their live easier.
- **Performance**
  Since we need to improve the workflow of the camera crew performance is of utmost importance. The system needs to work fast with as little delay as possible. Too much delay can lead to problems when cameras are not in position when they need to be. The system must therefore be realtime, there is no room for noticeable latency.
- **Reliability**
  The system is being designed to lift pressure and workload off of the camera crew. If the cameras are not in the right preset at the right time or some other malfunction happens, the crew can’t trust the system, especially not in a live environment. Especially in a live environment where multiple concurrent users are operating the system, reliability is even more important.
- **Security**
  If the server is not going to be local it should be unable for outsiders to go in the system and control the cameras or change the presets for obvious reasons.

2 Software architecture views

This chapter will explain the architecture of the system. The first paragraph will show the system as a set of subsystems and how they interact with each other. The second paragraph will explain the relation between the hardware and the software of the system. The third paragraph shows how the system manages its data. Lastly, the fourth paragraph explains how the system stays concurrent and prevents unwanted interactions.

2.1 Subsystem decomposition



The system is divided in four sections.

- **Reactive AngularJS 2 front-end**
  The client-side framework that supports responsive updating of the DOM after a data change. All views are based upon this framework.
- **Server**
  - **Controllers**
    The server uses the Play Framework as HTTP framework. It follows the MVC-pattern. Controllers parse the incoming HTTP requests, serve content or return errors. They provide the gateway from HTTP to the rest of the system.
  - **Models**
    Models store the script data and other operational information. They provide an interface to save the models in a database.
  - **Utilities**
    Component that provides functionality to socket management and camera management. The management of sockets is important for the real time updating of the clients. The camera management component provides a Java interface to talk with the connected cameras and perform commands on the cameras.
  - **Views**
    There are three main views as of now. The script list view shows the available scripts to run. The script editor is the view responsible for creating and editing scripts before actually running them. The main view is the director view, which contains all aspects that are important during the recording of an event. This view is divided in a couple of subviews, namely the running script, the available presets, the livestream with scheduled next camera's and a dock that contains action buttons and a script timeline.
  - **Database**
    The database is used to store the scripts, cameras, actions and presets. Currently it consists of tables to represent the following objects
    - Scripts
    - Actions - actions in a script
    - Presets - presets for cameras
    - ActiveScript - the current active script together with its position and running time.
    - Location - Representing a recording location
    - Cameras - Objects representing cameras residing at a location

2.1.2 Socket management

In environments where real-time communication is important both client to server and server to client, the system relies on communication via WebSockets. WebSockets provide a way to keep a connection open between a browser (client) and server. Client and server can communicate state changes instantly by writing on the socket. Unlike traditional HTTP calls, the server can push data to the client too.

Data that is transmitted via the websocket is always encoded in JSON format. This makes it easy to structure data. Three types of messages are currently supported

1. Start message
   A control message. The start message is used when no script is currently active and a recording session has to be started. The message indicates which script should start
2. Stop message
   Similar to #1, this control message stops a running script.
3. State message
   Only works when a script is active. This is an encoding of the current active script object. State changes are saved to the model and transmitted over the socket. This is the most simple way to communicate the state of the current active script to all clients.

When a server receives any message from any client, it retransmits the current state to all connected clients.

When a client loses connection to the server, it tries to reconnect after a certain time interval. This time interval starts at 5 seconds and continually grows with 5 extra seconds after each failed attempt. The sequence of intervals is as follows: 5 - 10 - 15 - 20 - 25 - 30 - … seconds.

2.1.2 Front-end structure and reactive programming

The client side relies on websocket updates to get the new state. This updated model state is then reflected into the user interface. This is facilitated by programming the user interface in a reactive manner.

Reactive programming is re-evaluates calculations after a change of data[1]. For instance, in imperative programming, in the calculation *a := b + c*, *a* stores the sum the value of *b* and *c* at runtime. After a change of *b* or *c* the value of *a* stays the same. However, in reactive programming, when *b* and *c* change, the value of *a* will be re-evaluated.

We can see that this kind of programming can be useful in some situations. In the application this is used in the front-end: Any data change re-evaluates the logic of the user-interface automatically.

The user-interface is defined in the html together with components. The framework that facilitates the reactive programming and does most of the heavy lifting is AngularJS 2, which in turn relies on ReactiveX[2]. AngularJS 2 is still in beta but provides enough functionality to use it reliably.

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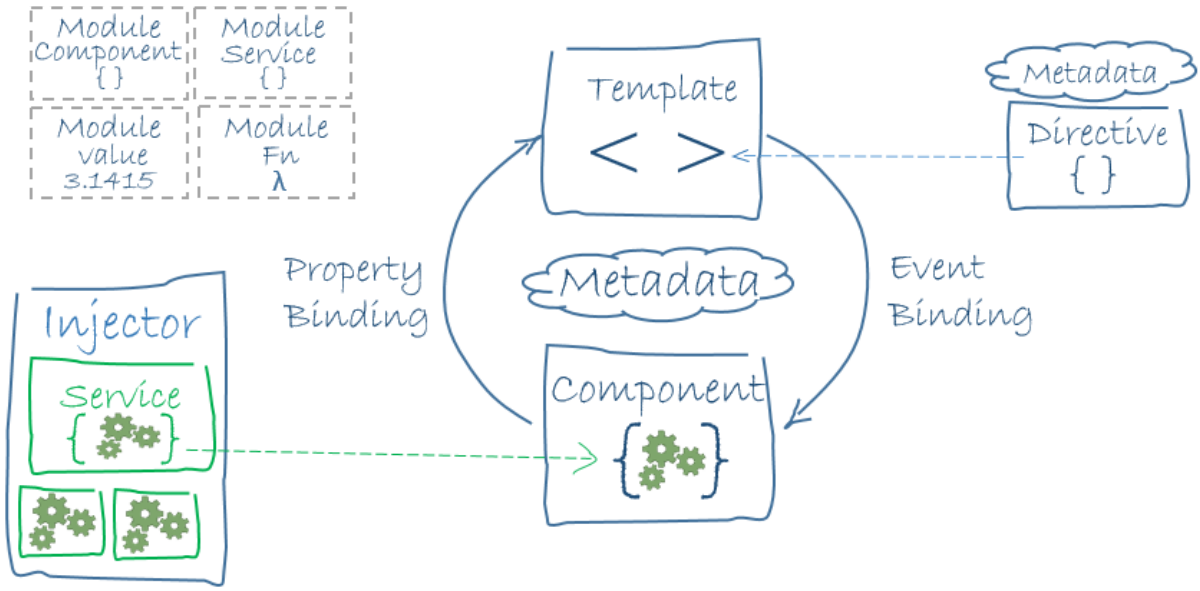
[1] Burchett, Kimberley; Cooper, Gregory H; Krishnamurthi, Shriram, "Lowering: a static optimization technique for transparent functional reactivity", *Proceedings of the 2007 ACM SIGPLAN symposium on Partial evaluation and semantics-based program manipulation* (PDF), pp. 71–80.
[2] reactivex.io

We define our interface using HTML 5 with special data and event binding attributes. Property bindings are bound to variables in the components and even bindings trigger functions in the components. The following visual describes the structure of the front-end, an AngularJS 2 application.



[3]

The HTML 5 template is connected to the component via bindings, using describing directives in the template. Moreover, services that provide general functionality such as client-server HTTP communication. These services can be used by multiple components.

2.2 Hardware/software mapping

The software can be run on a server that is accessible over the internet. Moveover, the server should have access to the cameras involved in the recording. The server can be set up in a local network with the cameras connected. Alternatively, the cameras can be accessed using a Virtual Private Network (VPN) remotely. This way, the server does not have to physically reside at the recording location which improves flexibility.

However, one should note that the bigger the physical space between server and users, the higher the latency on operation. While this is usually manageable, especially when residing in the same country, certain low-latency dependent operations should be taken into consideration when deciding on a location.

2.3 Persistent data management

Data of scripts, presets, actions and states is stored in a relational database system. Currently the Postgres DBMS is used, but it is very easy to switch systems as the data storage is implemented using an abstract DBMS driver together with the Ebean Object Relational Mapper. This, way POJO (Plain Old Java Objects) can be easily stored into the DBMS.

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[3] https://angular.io/docs/ts/latest/guide/architecture.html

For local development, an in-memory database is used. This provides good flexibility and makes sure no bugs occur that arise from the (lack of the) state in the database, because every new run the database is refreshed.

2.4 Concurrency

The application is designed to work with multiple clients operating concurrently. The concurrent clients consist of multiple operators interacting with the cameras and script.

Clients communicate with the server using asynchronous AJAX messages and asynchronous socket calls. This way the UI never blocks due to network latency.
The server communicates with the camera's over asynchronous commands to the cameras. While waiting for a response, HTTP requests may block while waiting for a response, but clients won't block due to the asynchronous client call.

Multiple clients can interact with the server in a very short time which creates an opportunity for race conditions. Elaborate tests have been developed to simulate the interaction of clients with the server. Included with this are tests that verify the right behaviour when multiple users are interacting together.

3 Glossary

Client - A remote browser that runs the app and is connected to the server.
Heroku - Service to deploy application online.
Postgres - Database system.
Server - Mainly the brain of the structure, the server synchronizes the views on every client.
View - A way the program represents itself through a user interface/web page.
VPN - Short for Virtual Private Network which can be used for secure communication between parties.