This research is a condensed abstract from a larger piece of writing, please contact michael@michaelmckellar.co.uk for a link to the complete document for proper referencing.

User Perception of Real-Time Content Performance Testing

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1 Optimal Real-time Content Consumption Parameters

Referring back to the research from Schnall, Hedge and Weaver, this research knows that resolution and framerate (2012) are some of the most important factors in technical experience. The new Portal plugin implementation allowed the Soluis Portal to render at resolutions previously not thought possible, well exceed the theoretical maximum projectable space, or much smoother framerates. In various tests of the deployed plugin rendering complete 360º content with a 4096x4096 pixel fisheye was possible, framerates of 60 fps were presumed as standard.

However, ever increasing the resolution started to have detrimental effects on playback where complex real-time architectural content was required, producing a 4000x4000px output would fluctuate between 20-30PFS during playback. This raised the question of whether users perceived resolution (eg image quality) more than framerate (eg image smoothness) more highly as impacting on their overall user experience.

As such, the investigation into resolution vs framerate was one of the main empirical studies to come out of this research during its time of development with the Soluis Portal.

A special variant of the Portal plugin was created to allow multiple rendering modes. The first had the ability to render the maximum possible Portal resolution, six cube faces of 2048x2048px creating a 4096x4096 fisheye output. The second allowed refresh rates up to 60fps, facilitated by reducing the resolution the minimum visible resolution[1] of 3000x3000px.

A games engine testing environment was created where the variable plugin was implemented, it consistent of a free-movement, very high-quality model of an apartment interior. Inclusive of dynamic lighting, moving image (via video playing on a TV in the space), water simulation and high-density texturing throughout.

The environment and user's perception of their experience was measured via a blind A/B test. While they were made aware that they would be seeing two versions of the same environment, no details on the purpose or what was going to be measured via responses were disclosed.

[1] Minimum viable resolution is calculated by working out the number of possible projected pixels across the horizontal of the dome fisheye – at time of writing that was roughly 3000 pixels – and making sure each of them has a distinct pixel to project, any number lower than this would feature image aliasing.

Based on our research into PANS and the detailed interview work on user experience within an immersive dome environment, it was this research's hypotheses that:

1. users would rate the lower resolution, higher framerate scenario more favourably than the higher quality experience.
2. The effect of lag, jittering or jumping images would be much more detrimental on a user than constantly lower resolution.
3. Higher, stable framerates would have greater positive effect on a user's experience vs greater visual quality

On agreement to participate, participants were given a disclaimer outlining what they would be involved in, the rules and boundaries of the experiment and what to do it they wished to stop participation at any point.

It was explained that they were about to be shown both scenario A (high res) and B (high framerate) for equal, measured, periods of time (2 minutes per scenario). They were allowed to freely roam around and explore the environment in its entirety during both scenarios. During their participation, participants were asked to speak out loud any notes, comments or observations during their roaming time. After, they were asked to complete a short seven question response that asked them to pick either (or neither) of the scenarios in a number of experience-based criteria. With participant agreement, all studies where recorded in both video and via written host observation. Table 8 has the initial questions posed to participants after the scenarios. Appendix 11.3 has the completed participation and response documents.

TICK ONE PER QUESTION

		Scenario A	N/A or Neither	Scenario B
1	… Was the more natural feeling environment			
2	… Felt smoother to walk through			
3	… Looked cleaner			
4	… Felt more realistic			
5	… Looked better			
6	I enjoyed the experience in … the most			

	Yes	No
The experiences were the same		

Any other comments regarding the whole experience or either or the options?

Table 1: Initial A/B Testing Response Form

A total of 15 participants took part over two days of testing. Participants held a variety of skill levels in both computing, technology and experience in the dome itself. While this research has not yet reached the level of complete statistical analysis of the data, all initial responses appear to be in line with our preliminary hypothesis. We reach this opinion as the majority of recorded scenarios and written responses lean toward a conclusion with framerate being more important impactor on experience than resolution. None (zero) of the participants reported a feeling of enjoying the Scenario A (high resolution) more than the other, the majority reported no difference in the look of either scenario and nearly all reported a smoother experience within the higher framerate experience. While none could directly list the reasons that Scenario B offered a greater user experience, in comments or notes, an uncorrected 73% (11) of participants knew that the scenes were not the same. An interesting observation in the scope of PANS and the ceiling limited user experience theory.

An additional hypothesis would be that users felt less engaged in scenario A due to the number of skips and jumps, previously discussed as breaks in presence in this document, and therefor had a lower user experience and PANS response. Figure 17 shows a participant navigating inside scenario A. An overview of the participant responses can be found Table 9, the complete set of feedback in appendix 11.3.1.

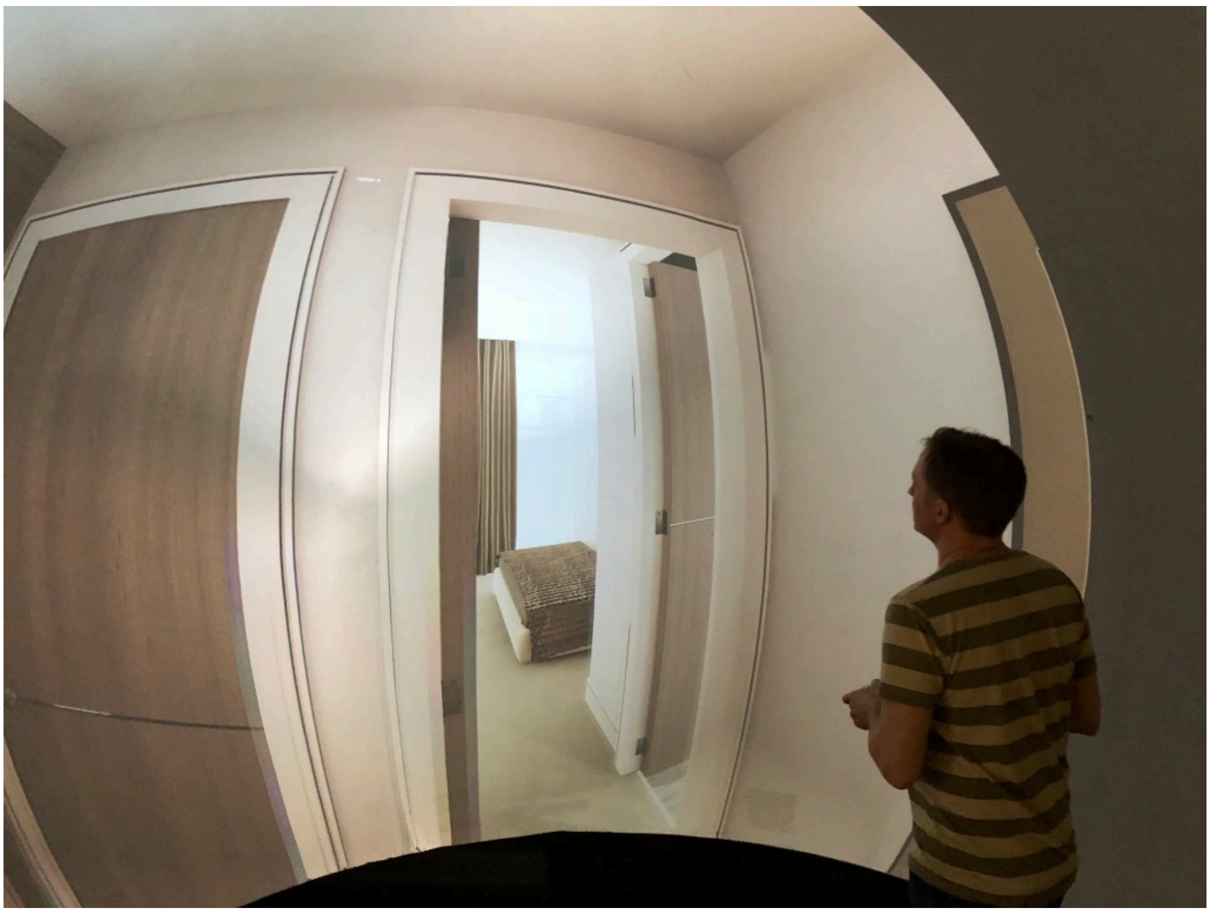

Figure 1: Participant exploring the high-resolution scenario

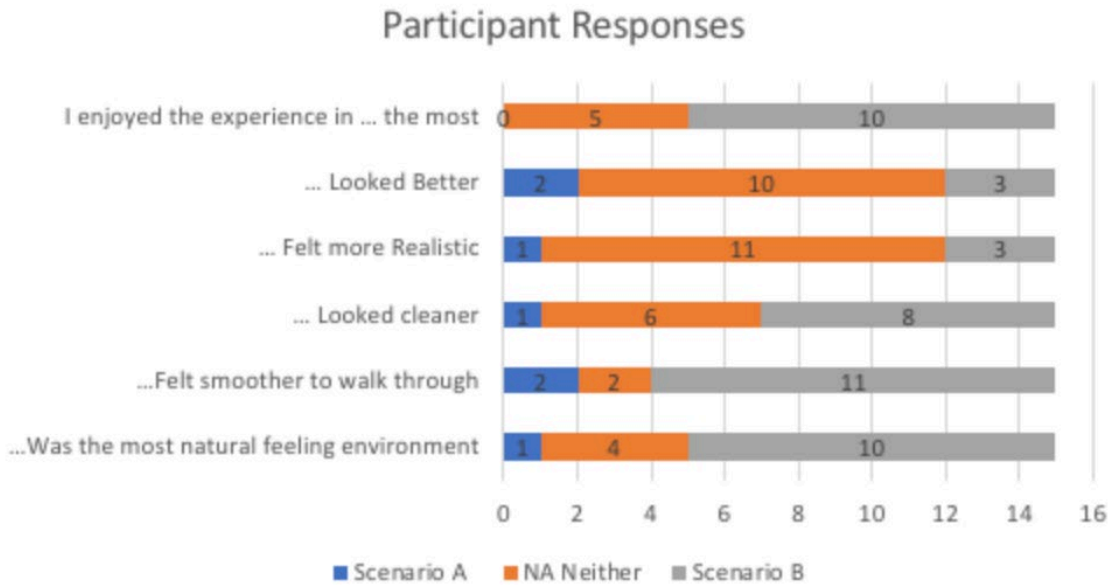

Table 2: initial user responses

It should be a focus of future work to test this theory further, specifically looking at how far quality can be sacrificed for playback improvements. In the Soluis Portal tests this research was able to confer negative experiences out of even the most amateur users with obvious breaks in presence. It is especially important for the designer of immersive dome environments to be able to understand the impact on user experience the playback of content brings. This chapter covered very specifically real-time, free roam content, but it can be hypothesized that video and animated content may be bound by the same resolution vs framerate impactors.

1.1 Content Delivery

After the initial testing and assessment of the resolution and playback requirements for the Soluis Portal, this research moved to better understanding and disseminating the requirements.

It was our understanding from the various observations, tests and workings with the Soluis portal that the majority of users neither understood the use of the space, or how to correctly operate it. Standard control over the dome content was via a standard Windows desktop environment within the Portal space, sometimes on a touchscreen UI, or directly from one of the projected images on the dome surface.

Therefore, it was hypothesized that a clearer, more understandable control and access system within the Soluis Portal would increase a user's agency within the space. As the Soluis Portal had no direct control system (Control/Content Management System [CMS]) after implementation, the evaluation of its benefits was outside the scope of this research. This research will instead overview its implementation and purpose for usability.

Due to the very manual and exposed method of loading and operating content in the inherited Portal the implementation of a CMS had two goals:

- Provide a single collection, distribution and management platform for all possible dome content
- Remove direct access to the control server and backend systems, increasing security and streamlining the user understanding of the Portal operation

As outlined, the original portal design required a connected monitor within the dome user interaction space to allow for the selection, control and manipulation of content. Figure 18 shows the original user journey of experiencing multiple different pieces of content.

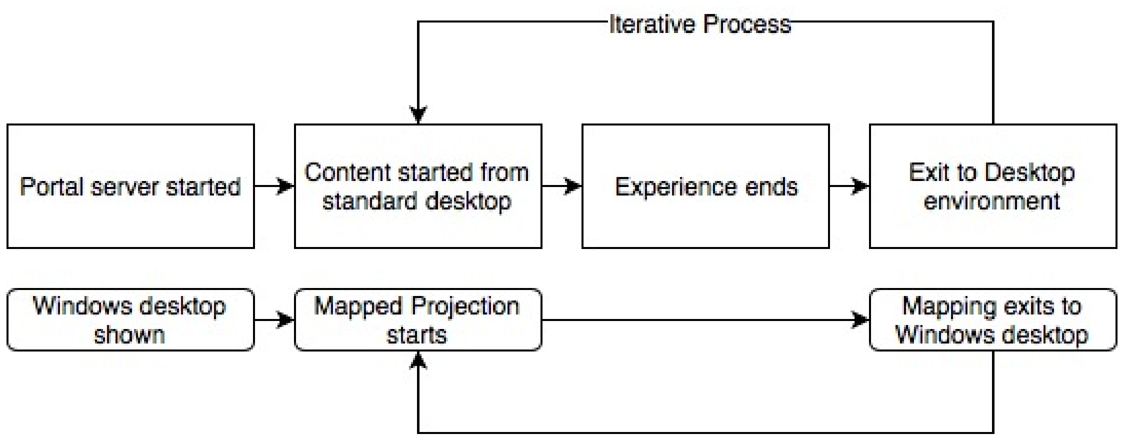

Figure 2: Original Content Experience

There were very obvious breaks in the user journey where both the experience in the dome exited to display an unmapped, blank desktop environment as well as requiring the user to open the next desired content experience from a standard Windows folder. During the prototyping and development stages of the Soluis immersive dome this was okay. However, the entry point for non-experts meant that nearly everyone that used the IDE required an expert on site to both run and support any experience full time.

The UI monitor within the dome also raised the issue of becoming a barrier to experience to users within the dome. Figure 19 shows a user holding both an Xbox controller (used to drive various real-time environments) and looking directly at the control UI while doing so. The impact of the Xbox controller and other similar interactive technologies on immersive experience is well documented in other literature. (Barrera, Takahashi, & Nakajima, 2004a, 2004b; Krogh, Ludvigsen, & Lykke-Olesen, 2004; Rogers & Lindley, 2004).

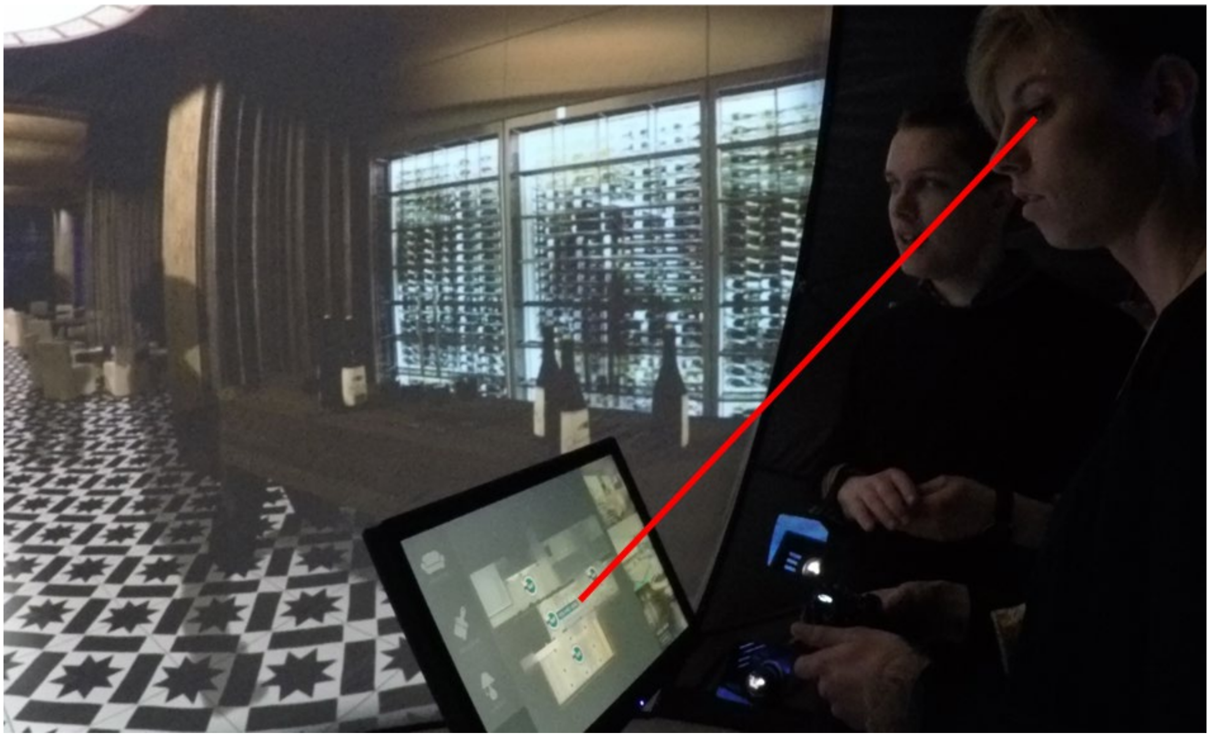

Figure 3: User interacting with UI monitor

As our investigation into the literature showed, users will have a negative experience where control and input are dictated in an obtrusive manner and the methods of use are unobvious. As is the case represented in Figure 19, where the user is looking at the monitor, therefore completely disconnecting and removing from the experience within the dome. Figure 20 represents another example where the interaction with the existing control system did not represent a good experience for the user. By incorrectly holding the Xbox controller, their potential interaction ability was limited.

Figure 4: Lowered user experience by inaccuracies in control

To attempt to solve a number of these user confusing, distracting and ultimately experience lowering elements of the existing Soluis control system we moved to implement a wireless, indirect CMS, delivered in a BOYD (Bring your own device) manner.

1.1.1 Implementing the CMS

By adding a single point of access, that the user was familiar with, we could address our hypothesis: increased understanding and ease of use allowing for higher agency and, potentially, increased narrative ability as users engage with content more.

The implemented CMS took the form of a webserver running through native Windows services included within the operating system. This is an important feature as it allowed for backdating and updating older technologies without a lot of input. The Touchdesigner system used to control mapping of the Portal surface was expanded to accept messages via a messaging protocol called

OSC (open sound control) (Wright, 2005). Rather than the process loading with content baked[2] into it, it would now dynamically be able to search and retrieve content or spout feeds from specific locations as dictated by the OSC message and Webserver.

In turn, the developed webserver was set to scan a specific location on the dome server for any and all content that followed a specific layout. Figure 21 showcases the initial development document diagram, outlining the folder hierarchy for automatic reading of content.

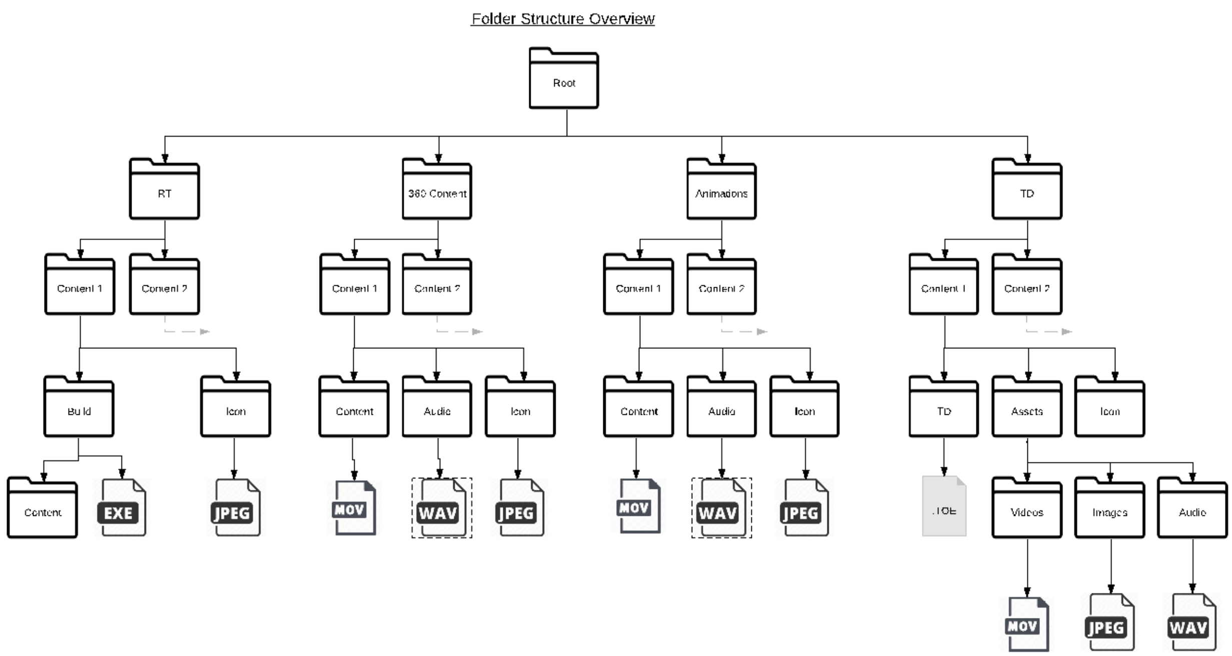

Figure 5: Overview of CMS content folder hierarchy

The first iterations of the CMS were able to simply scan the folder as above and populate a simple text list with content options to select. As shown in Figure 22, future developments were able to populate with different icon images, as found in the folders. As the system developed over the course of 18 months, up to September 2017, numerous iterations added in multiple control methods and optional extras.

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[2] The process of 'baking in' content refers to the hard coding the movie, animation or accepting the spout feed from real-time content. This can be best imagined as each piece of content (whatever it may be) having its own unique app to open that fulfils the whole end-end delivery into the dome.

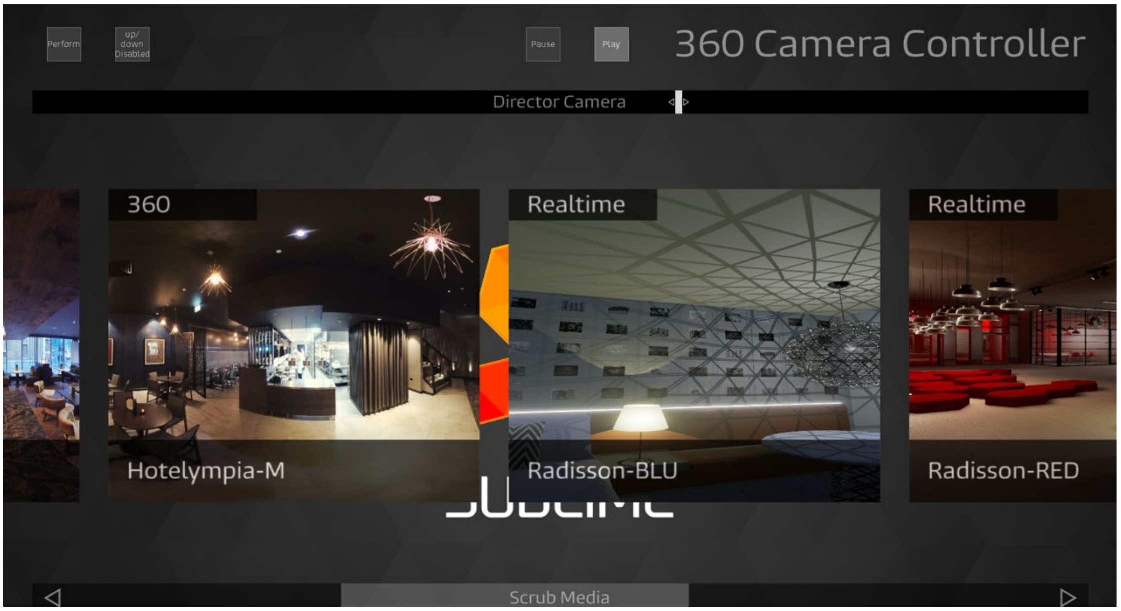
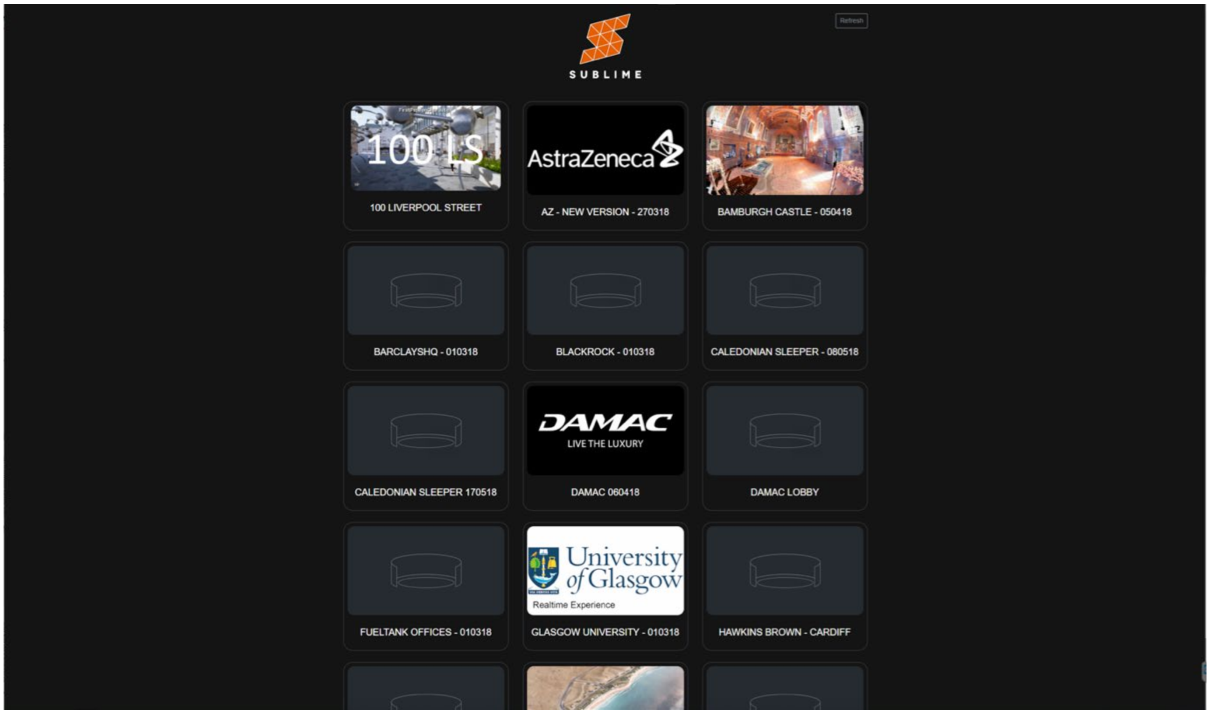


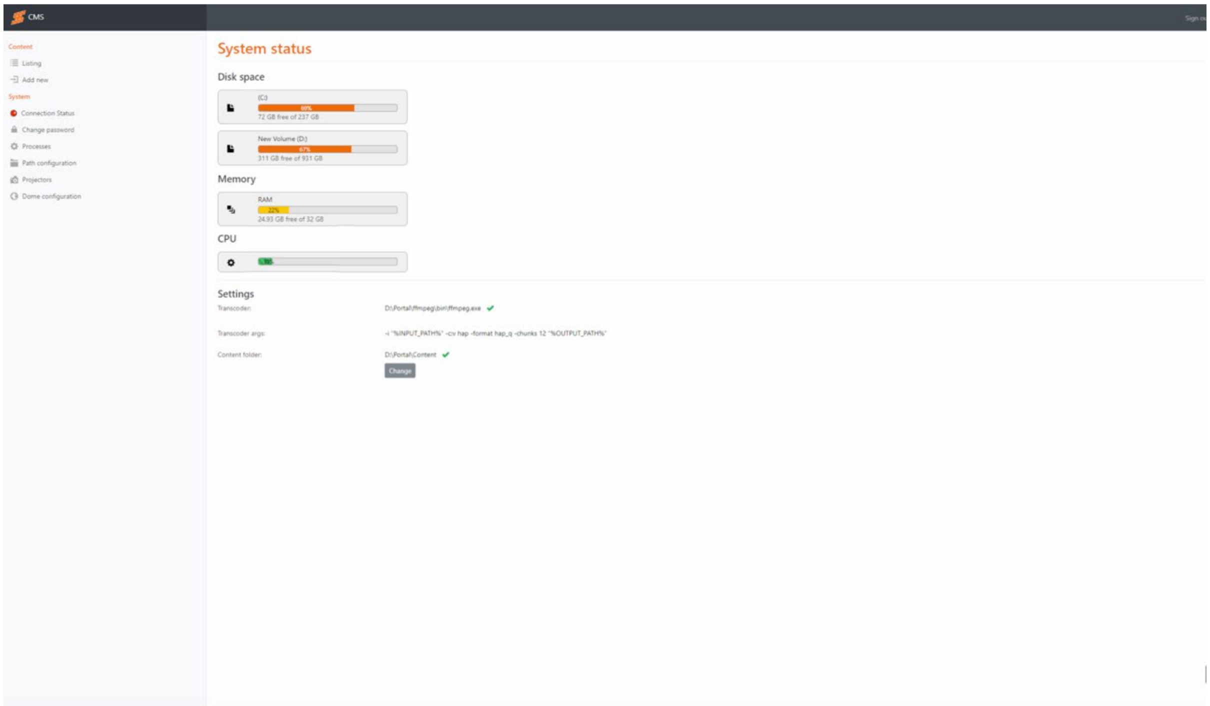
Figure 6: Early CMS able to load icon options

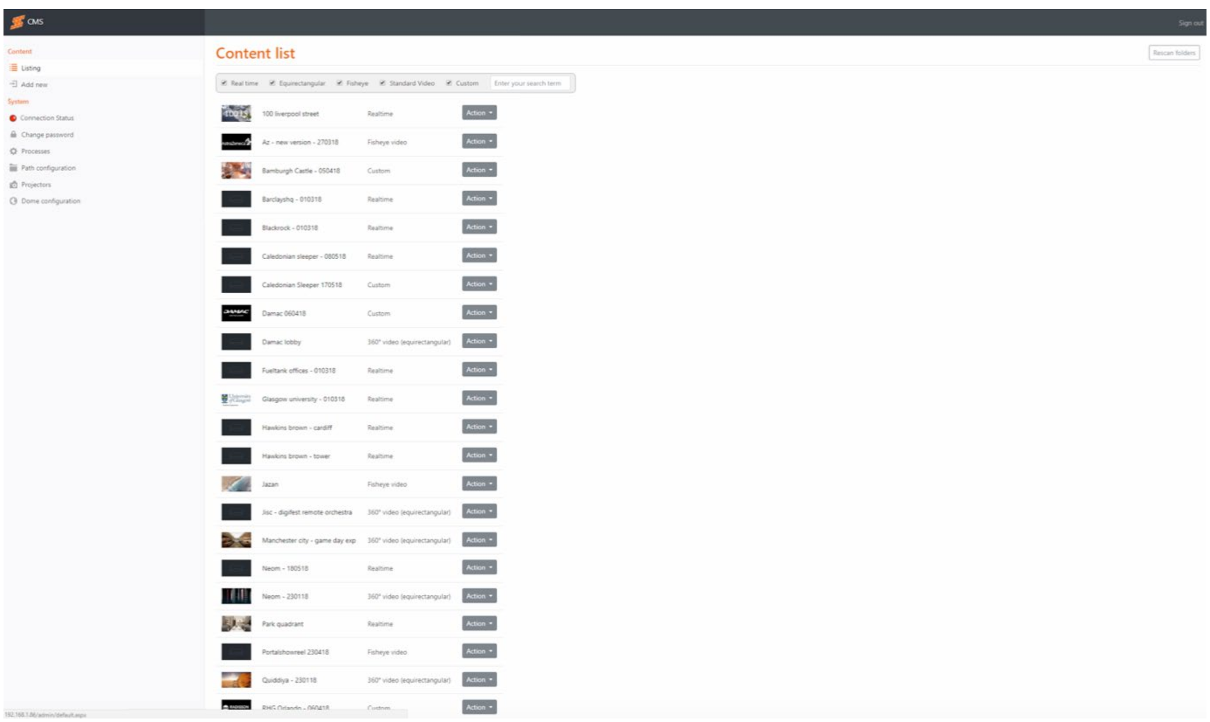
The deployed CMS is able to both upload, update and remove content dynamically without the user having to leave, refresh or otherwise interact with the server. The system can detect the different content types without input and displays specific options and screens to maximise the users experience and engagement with the content.

The current CMS also added a complete user back end accessible “admin” control panel, that still reserves ultimate control over the server and the implementation of the experience but allows users to operate more advanced features of the Portal such as; system overview and monitoring tools; projector control; mapping and blending options. All managed in a complete user focused manner to facilitate the best possible experience. The goal being that even when in use, the users focus is almost entirely on the physical dome screen. Appendix 11.4 contains a complete CMS user experience flow diagram. Figures 22 – 26 showcase the key CMS elements as they currently operate. Users are able to access the CMS via a dedicated Wi-Fi network created by each Portal system. Accessing the network allows access to the control system for anyone, and admin settings are controlled via a dedicated password gate system. Therefore, any internet enabled device is able to both access and control the Portal in-situ, creating a more connected feeling with the experience and, when via their own device, a hypothesized more engaging experience.


Refresh
SUBLIME
100 LS
100 LIVERPOOL STREET
AstraZeneca
AZ - NEW VERSION - 270318
BAMBURGH CASTLE - 050418
BARCLAYSHQ - 010318
BLACKROCK - 010318
CALEDONIAN SLEEPER - 080518
CALEDONIAN SLEEPER 170518
DAMAC
LIVE THE LUXURY
DAMAC 060418
DAMAC LOBBY
FUELTANK OFFICES - 010318
University of Glasgow
Realtime Experience
GLASGOW UNIVERSITY - 010318
HAWKINS BROWN - CARDIFF


Y
X
B
A
PICK UP THE PHYSICAL CONTROLLER TO MOVE AROUND THE ENVIRONMENT
RETURN TO MENU





Figures 7-26: Pages from the current Portal CMS

While the CMS is still a developmental feature is now solely controls all portal experiences for Soluis. It has the undiscussed benefit of allowing a permanent brand to appear during non-use times (a splash screen logo) where previous experiences would have exited to desktop.

1.1.2 Managing Control Mechanisms

1.1.3 Future of the CMS

A future focus for this research will be on the measurable impact of the control system and its features on user's experience. Nearly all existing Portal deployments still make use of an expert technician on site, but the CMS is a presumed step closer to the Soluis IDE being an autonomously running product that anyone could theoretically use. Understanding into how users perceive the control system from their own devices, the impact on their agency of the space and its potential narrative improved, should be the focus of a study. Not versus the previous control method but in general to validate its use for all complete productising of the dome.

Developmentally, the CMS still needs to expand to completely encompass all tasks that a user may need to action while using, operating or managing a Portal on their site. Further analysis and observation of a non-technician driven dome experience will aid this work.

1.2 Future position of technical development

While this research made many positive changes in both the technical infrastructure, technically delivered experience and reduction in potential impactors on experience. Technical developments have not been measured accurately, and their changes not quantified.

The impact and changes made via the above developments have made profound and lasting changes to the state of the Soluis immersive dome environment. Given the nature of the work, consideration of the outlined hypothesis should be deliberated during any implementation of future immersive, interactive spaces of this nature. However, these claims and perceived effects of changes need to be validated.

It should be proposed that future research should cover exactly this area and aim to analyse and quantify the difference in experience passed on to users via the improvements to technical facilitation alone.

The next chapter will expand and explore the perceived relationship between the current state of the technical development of the IDE in this research and the PANS framework outlined earlier.

2 Bibliography

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