# CubIT: Large-scale Multi-user Presentation and Collaboration

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## Abstract

CubIT is a multi-user, large-scale presentation and collaboration framework installed at the Queensland University of Technology's (QUT) Cube facility, an interactive facility made up 48 multi-touch screens and very large projected display screens. CubIT was built to make the Cube facility accessible to QUT's academic and student population. The system allows users to upload, interact with and share media content on the Cube's very large display surfaces. CubIT implements a unique combination of features including RFID authentication, content management through multiple interfaces, multi-user shared workspace support, drag and drop upload and sharing, dynamic state control between different parts of the system and execution and synchronisation of the system across multiple computing nodes.

## Author Keywords

Multi-touch; Very large displays; Interactive wall displays; User-centered design; RFID

## ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: Graphical user interfaces (GUI), User-centered design

**Figure 1:** Cube display walls
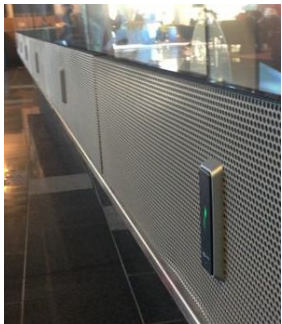


**Figure 3:** CubIT on a Cube wall



**Figure 2:** RFID readers

## Introduction

Recent advances in multi-touch display technology have led to a surge in the availability and use of very large interactive screen surfaces. The availability of these surfaces has made it possible to built systems that allow multiple users to simultaneously interact on massive shared workspaces [e.g. 1, 2, 4].

The Queensland University of Technology (QUT) recently opened an interactive exhibition and learning facility, named "The Cube" [3]. The Cube features several very large interactive multi-panel wall displays, each consisting of up to twelve large 55-inch LCD multi-touch screens. The area above these screens consists of very-large scale projected display area (see Figures 1 & 2). The Cube is publicly accessible and used by large numbers of public visitors, students, academic and professional staff.

In this paper we describe CubIT, a multi-user, presentation and collaboration framework that was specifically designed to make use of the Cube's very large interactive surfaces. The system's primary purpose is to enable QUT's staff and student population to upload, interact with and share their own media content on the Cube's display surfaces using a shared workspace approach. Due to its' public nature and broad user-base the system's design faced a broad range of technical and user interaction challenges. The system had to be very easily accessible and usable, support the upload use and sharing of media content and support multiple simultaneous users. Because of the size of the canvas and the number of multi-touch displays involved, the applications had to be built to run distributed across multiple display and computation nodes as well as sync the application's state across

these different nodes to create a seamless user experience. We briefly describe the system and how these design challenges were addressed.

## CubIT system overview

*System components*

CubIT consists of three interface components to support different types of interaction, a *multi-touch interface*, a *web-based content platform* and a *mobile interface*. The web-based interface (Ruby on Rails) allows users to upload and manage content and further supports system administrators in the moderation of content and the administration of user accounts. CubIT supports the upload and display of a wide range of image and video formats. The multi-touch interface (Python / Kivy) enables users to interact with content on the multi-touch displays of the Cube. It focuses on drag and drop interaction allowing users to display content on different parts of the shared canvas as well as share content between users. The mobile interface (iOs) presents an alternative mechanism to upload and create content on the fly. It was specifically designed to allow users to "flick" content to one of the Cube walls without using cumbersome upload procedures. Both the web and mobile interfaces support textual input and allow users to name content and create text notes.

*RFID login*

Each second multi-touch screen in the Cube is equipped with an RFID reader (see Figure 3). Users log in to CubIT by swiping their RFID-enabled staff or student cards on one of the readers. Once a user logs in their user workspace handle (see below) appears on screen. The application is location-sensitive, the workspace handle appears on the screen closest to the RFID reader. This feature allows users to log out and move
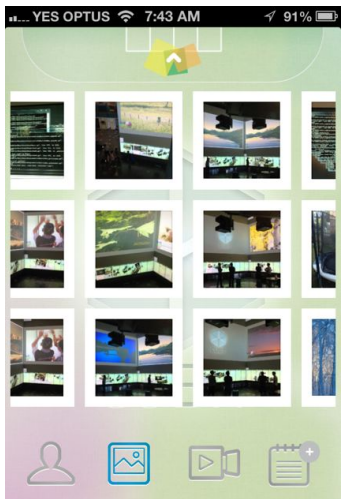
**Figure 4**: CubIT mobile interface



**Figure 5**: Workspace handle & top dock

to a different part of the screen (or a different wall altogether) to log in again, effectively moving their content to different locations.

*Syncing*
CubIT uses an object store and pubsub notification service to dynamically maintain the state of the application across different interfaces. Changes to content on each of the interfaces are dynamically represented on all of the other interfaces (e.g. changes to the user name in the web interface are dynamically applied to a user's workspace on the multi-touch wall). The multi-touch interface itself is implemented using a peer-to-peer architecture, syncing content, state and touch information across neighbouring nodes.

## CubIT interface elements

*User workspace handle*
The user workspace handle represents a user's content on the shared canvas (see Figure 5). It consists of an avatar, username label, scrollable workspace containing the media content and two function buttons, "pin / unpin content" and "minimise / maximise".

The scrollable workspace displays the media content in the form of thumbnails representing images, videos, text and presentations. Thumbnails can be clicked to be opened on the workspace, as well as dragged around the workspace handle to be reordered or deleted. The z-order for user handles is set to be higher than any other content on the screen ensuring that the user workspace is always accessible, and not obscured.

The pinning and minimize/maximise functions allow users to control the content on the screen and prevent clutter. When a handle is "pinned" all of a user's

content displayed on screen moves in sync with the workspace handle when dragged, allowing users to move all their open content to a different part of the workspace. The minimise/maximise function allows users to save the state of their workspace and the way content is arranged. The state persists across sessions and instances of CubIT allowing users to replicate their content layout every time the log in.

*Media items*
Media items (images & videos) as well as text notes appear as zoomable, rotateable and translatable widgets on the screen. The zoom factor is limited to allow images to scale up to no more than the width of three portrait panels (3240 pixels) to prevent individual content items from obscuring the whole canvas. Videos have a standard set of video controls (pause, play, seek, volume). When tapped each item reveals an overlay menu that allows users to set the item to *standard rotation* and *close* the widget. When opened from the workspace, each media item can be opened multiple times, spawning multiple instances on the canvas. If items get permanently deleted from the workspace (or the system via the web interface) all of the item's currently open instances on the canvas are closed.

*Collaboration and sharing*
CubIT has been designed to make it easy to share content between users. In order to copy content items between accounts users drag thumbnail representations of images, videos, notes or presentations into another user's workspace. This creates a new instance of the copied object which is independent of the original. This function applies to user workspaces as well as presentation workspaces (see below).
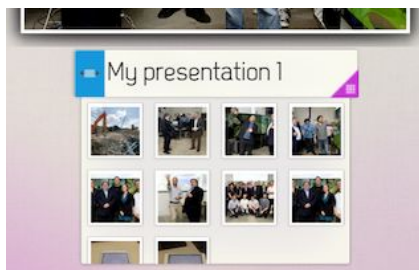
**Figure 6**: Presentation in scale mode



**Figure 7**: Presentation in slideshow mode with open workspace

*Presentations*
CubIT implements a custom presentation widget to display stacks of images, videos and notes in a more convenient manner. The widget consists of several functional components (see Figures 6 & 7). The display section allows content items to be displayed, scaled and swiped like a slideshow. A handle similar to the workspace handle identifies the presentation. A selection box underneath the handle allows easy access to the surrounding slides and can be used to scroll through and navigate the presentation. Presentations can be edited dynamically using the multi-touch interface. In order to edit a presentation users can press the presentation workspace button (bottom right of the presentation handle) and open the presentation's workspace. A presentation workspace provides the same functionality as a user workspace and allows users to reorder, delete and add content on the fly.

Presentations provide a modal interface that lets users switch between scaling and slideshow mode. In scaling mode a presentation behaves generally like a media item. The media item above the handle can be scaled and moved. When switched to slideshow mode users can swipe backwards and forwards through the presentation, while scaling and translation are disabled.

*Top dock & Top dock view*
The Cube facility includes large projection screens on top of walls of interactive panels. CubIT enables users to "throw" individual media item up to the projection screen to be displayed at full resolution. The rationale for this design option was to allow users to interact with content closely on the touch panels, while using the projection surfaces for presentations to larger groups. To control the content on the top projection screen

CubIT implements a docking area (top dock) stretching along the top border of the multi-touch panels (see Figure 5). Media items that are dragged into the dock are represented by thumbnails and displayed in full resolution on the top screen (see Figure 2).

## Conclusions
CubIT has been in use for the last 7 months and has seen a wide range of applications including lectures, conferences, student presentations and collaborative design sessions. Central to the design of CubIT was the goal of making the process of uploading and accessing content as easy as possible. We have achieved this by engaging potential users through a user-centred design process and developing a technical infrastructure (RFID readers, multi-touch walls), services (content management, syncing) and interfaces (multi-touch, mobile and web-interfaces) that addresses the inherent interface and technical challenges of the Cube facility.

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