

DYNAMIC DISPLAY SYSTEM AT FERMILAB

EXECUTIVE OVERVIEW

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The Dynamic Display system at Fermilab allows for customized content to be shown on dedicated high-definition TV's throughout the lab. The content that is being shown on each display can be changed quickly by an untrained person with access to a control point.

Content definitions are stored in a database. Each content instance is approved by a manager at Fermilab. Many of the functions for administering this database are available on-site at Fermilab (only) via interactive web pages.

Content is web pages. Many of the web pages used by the Fermilab experiments can be used directly as content for these displays.

The features of this system have been developed to have a robust, dynamic display system for use in the two remote operations centers in the Wilson Hall Atrium, the ROC-W (Neutrino experiments) and the ROC-E (CMS). The system has expanded to other locations.

This system is an alternative to commercial "digital signage" systems, with advantages unique to Fermilab:

1. All content is hosted web pages; no special, proprietary content system is required.
2. The decision as to what is shown on a display is given to the user; it usually takes less than one second for a touch on a control screen to be seen on a display point.
3. The system can run on Windows, Mac and Unix platforms; we have chosen Scientific Linux Fermilab for most of the systems and have demonstrated the other systems.
4. There are no licensing fees.

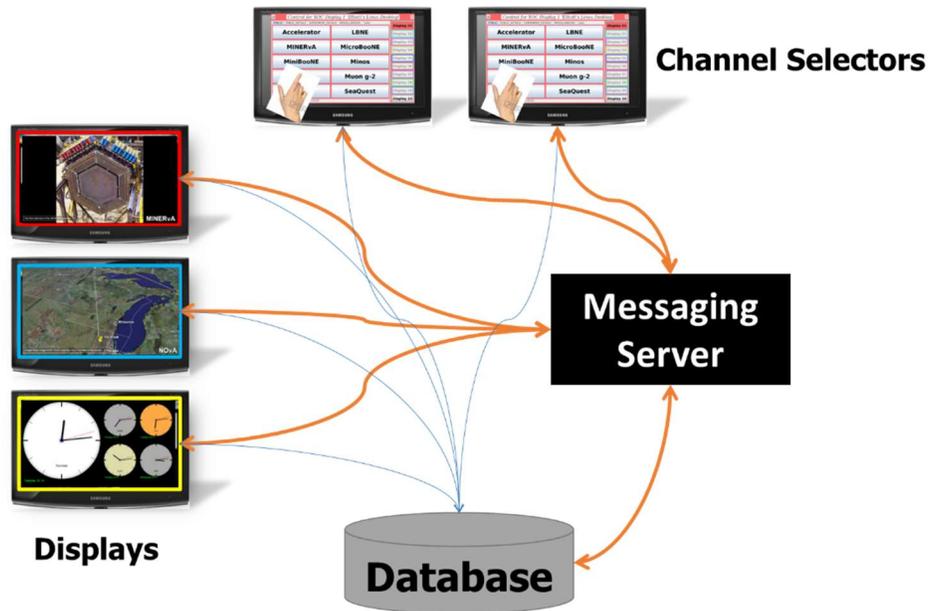
Features that this system has in common with commercial digital signage include:

1. The content is administered and approved centrally
2. The configuration of each element in the system is administered centrally
3. The status of the system is available at all times, as are local log files of activities.
4. It uses the Internet for all communications
5. Security (authorization and authentication) of these communications is designed into the system
6. Display units use commodity computers and HDTVs

OVERVIEW

TOPOLOGY

The schematic layout of the clients and the servers in the Dynamic Display system is depicted here.



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All of the lines of communication are over the Internet.

The pieces are:

- **Channel Selector** – the GUI that allows users to change the content on the displays. These can be put anywhere, and they can be configured to control any subset of the displays in the system.
- **Displays** – the HDTV and SLF PC that show the content. Each display runs Firefox, on Scientific Linux Fermilab, as the display software.
- **Messaging Server** – Receives messages from Channel Selectors and relays them to the appropriate display. The message must be correctly signed with a digital cryptographic signature to be accepted and relayed.
- **Database** – The following information is kept in the database
 - Configuration information for the displays
 - Configuration information for the channel selectors, including which displays it may control.
 - Configuration information for the messaging server
 - The list of approved content (URLs)
 - The present status of each display
 - The public decryption keys for verifying the cryptographic signatures of messages

The database is a MariaDB (<https://mariadb.org/>), and is hosted centrally by the Core Computing Division/Database Services group.

When a display is told to show content (a web page) or a list of content, it will show this content until it is told to show something else. That is, if the control point, the messaging server or the database server go down, the display will continue to show its content uninterrupted. It will try to show a list of content, but if the network is down that could interfere.

CURRENT STATUS

A wide variety of content has already been created or captured. Examples are:

- YouTube Videos and Playlists
- CERN videos
- Dynamic slide shows of Fermilab photographs
- Experiment event displays
- Radar maps
- Weather information
- PowerPoint and PDF slide shows
- Analog clocks from around the world
- Performance charts from the Accelerator Division

Content can be created by anyone with experience creating web pages.

Displays have been deployed to

- ROC-West
- ROC-East
- WH2E
- WH12E (Neutrino Division HQ)
- MINOS Assembly building
- Site 38 (FESS Operations)
- AD Computer Room
- WH8W/PPD
- Fermilab Test Beam Facility (FTBF)
- WH11/LPC

The servers are:

- Messaging server: fess-fm38-display-01-02.fnal.gov
 - For the Displays at Site 38
- Messaging server: roc-w-11.fnal.gov
 - For everything else
- Vip-mariadb-prd.fnal.gov
 - The database server for everything
- Web server for newly-developed, custom content: <https://dynamicdisplays.fnal.gov>

The Dynamic Display system has an approved Fermilab Risk Assessment.

SPECIFICATIONS

PRIMARY SPECIFICATIONS

1. Content is created by anyone
2. The content to be displayed is determined at local control points
3. Changing the content on a display is quick (always less than 10 seconds, usually less than 1)
4. Docents may use designated local control points to select content on selected displays
5. Content instances are web pages

Limiting content to web pages is not, in our opinion, any limit at all. Anything that can be shown on a PC screen can be shown in a browser. Moreover, the number of people who can write web pages is vast.

SECONDARY SPECIFICATIONS

1. Content specifications (URL's) are stored in a database
2. Content is approved prior to use
3. Adding a new web page for approval takes less than a minute
4. Specific control points can only change pre-defined displays' content
5. A display instance learns its configuration from the database
6. A control point instance learns its configuration from the database

HARDWARE SPECIFICATIONS

1. Only commodity hardware is used
2. The system has been deployed on Windows, on Macs and on Scientific Linux PC's
3. Displays continue to show their assigned content if the servers go down

SECURITY SPECIFICATIONS

1. Messages to change the content on a display are cryptographically signed.
2. These signatures cannot be spoofed
3. The computers that are allowed to change the content on any individual display is restricted, and is specified in the central database
4. All messages are logged

CONTENT SPECIFICATIONS

The following sorts of content are supported

1. Web pages
2. PowerPoint presentation (through Office Online)
3. Single images
4. YouTube videos and playlists

Furthermore

1. Content will auto-refresh
2. Lists of content can be displayed in sequence

IN CONTRAST TO COMMERCIAL DIGITAL SIGNAGE

Each commercial digital signage system has its own content creation environment. Some of these are very sophisticated. Each of them is unique. To learn how to create content on one of these systems is, in our opinion, difficult. This is one reason for the development of the Dynamic Displays system: All content is shown on a browser—they are all web pages.

Commercial digital signage systems do not do on-demand, unplanned content changes easily. This limitation is a major reason why we invented the Dynamic Displays system.

The Dynamic Display system has no direct implementation costs other than the cost of the hardware.

This Dynamic Display system is hardware and operating system agnostic.

CURRENT HARDWARE AND SOFTWARE DEPENDENCIES

There are no hardware dependencies.

We have chosen a specific set of hardware at this time that satisfies what needs to be done.

- For the displays
 - Commodity computers running Scientific Linux 7.x
 - Commodity HDTV or 4KTV
- For the Channel Selector
 - Commodity computer running Windows 10
 - Commodity 21-inch touch-screen monitor

The software dependencies are:

- Java 1.8.x.
 - All of the software has been developed with this version of Java.
 - The software can run under Java 1.7.x, but it *will not run* on Java 1.6.
- Firefox
 - Version 52 with these two plugins
 - Remote Control (<https://github.com/pmorch/FF-Remote-Control>)
 - R-Kiosk (<https://addons.mozilla.org/en-US/firefox/addon/r-kiosk/?src=api>)
 - Version 60 and beyond with Selenium (<https://www.seleniumhq.org/>)

The software is all stored in a GIT repository in Fermilab's Redmine, <https://cdcv.s.fnal.gov/projects/roc-dynamicdisplays>

CONCLUSIONS

The Dynamic Display system has been installed at various locations at Fermilab to allow for customized content to be shown on dedicated high-definition TV's. Docents and other minimally-trained people change the content that is being displayed.

Content is web pages. Many of the web pages used by the Fermilab experiments can be used directly as content for these displays. The definitions of these "Channels" are URL's and these are stored in a database.

The messages that cause a display to change its content are cryptographically signed to help assure that inappropriate content is not displayed.