

ACORN GUI Strategy at Fermilab

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UX Engineer

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In partnership with:

Argonne
NATIONAL LABORATORY

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Idaho National Laboratory

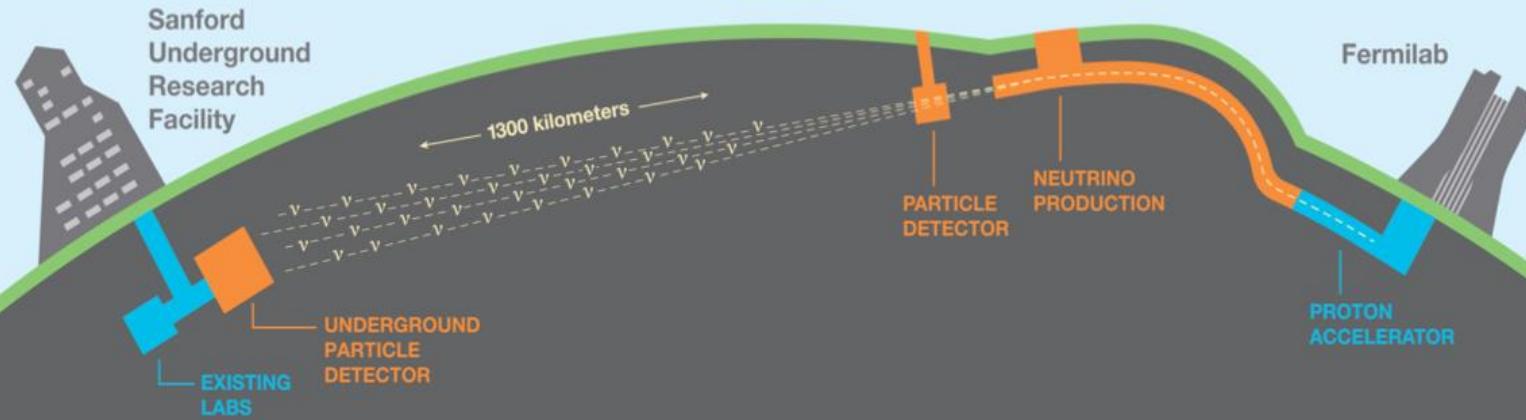
OAK RIDGE
National Laboratory

Outline

- ACORN overview
- Current control system - ACNET
- Modernization strategy for ACORN
- Next steps

Accelerator Controls Operations Research Network (ACORN)

- The ACORN Project will modernize Fermilab's accelerator control system and replace end-of-life accelerator power supplies
- ACORN Mission Need (CD-0) was approved August 28, 2020
 - Fermilab's power systems and ACNET control system need to be modernized or replaced to meet the future needs of LBNF/DUNE and PIP-II
- Project Completion (CD-4): 2031
- \$211M total project cost

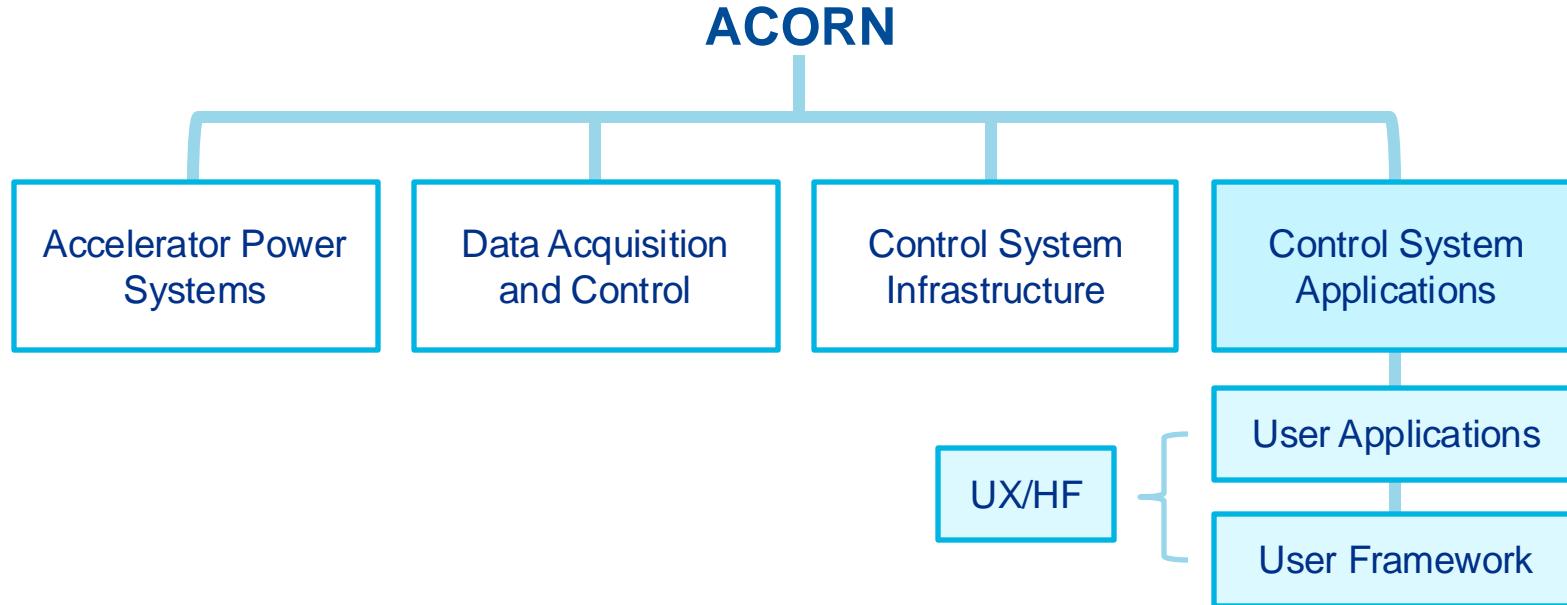


ACORN Project Goals

- Replace end-of-life Booster, Main Injector, and Muon Campus accelerator power systems
- Replace the antiquated ACNET control system with EPICS for the accelerator complex
 - Improve the human-system interfaces & software development applications of the accelerator control system
- Implement an architecture that promotes a highly reliable and resilient control system
- Support the development and deployment of AI/ML capabilities for accelerator operations

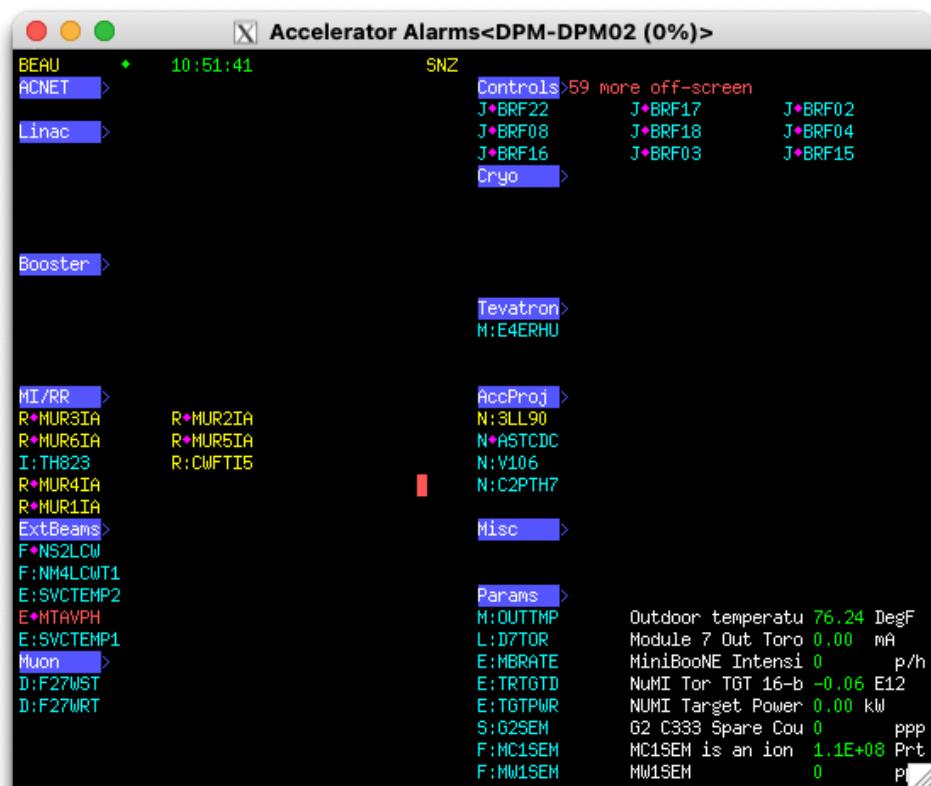


Accelerator Controls Operations Research Network (ACORN)



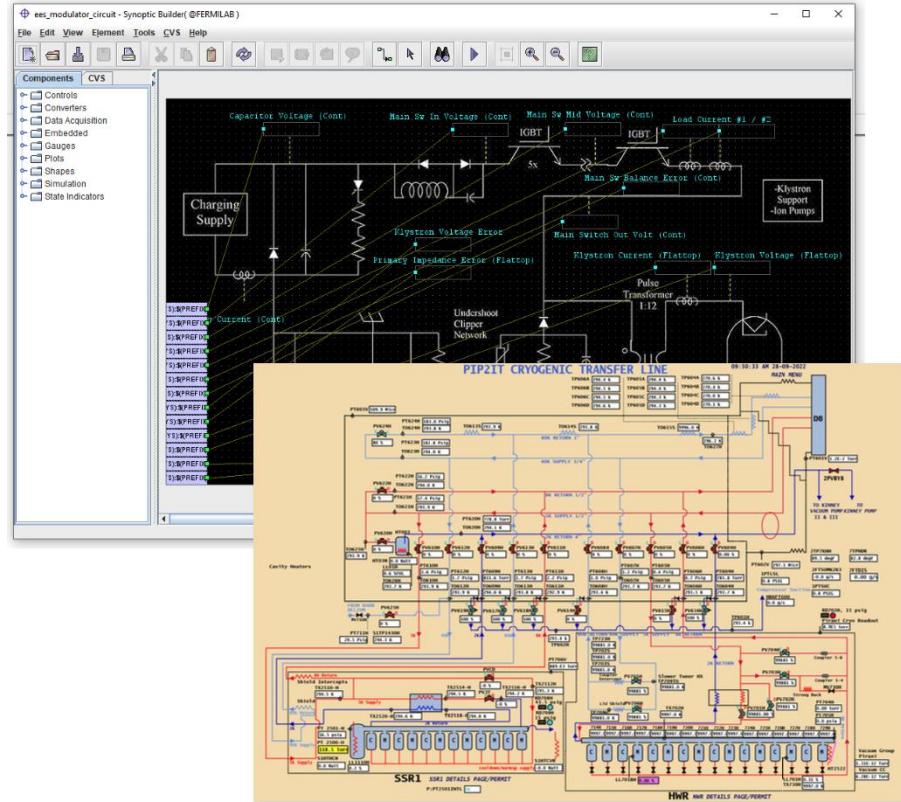
Fermilab's Control System

- ACNET
 - 40+ year history at Fermilab
 - Unified system for the entire complex
 - All accelerators, all machine and technical equipment
 - Common console manager can launch any application
 - Users connect to a LinuxVM via SSH
 - Applications are served to desktop via X11
 - Most applications written in C/C++
 - FORTRAN still exists
 - Handful of applications written in Java



Fermilab's Control System - Synoptic

- Built with Java APIs
- “No-code” Display Builder
- SVG for rendering displays
- Displays can be launched in a dedicated viewer or browser
- Still supported but development has stalled
- 1,600 Synoptic displays
- Synoptic → Phoebus



ACORN Applications Modernization

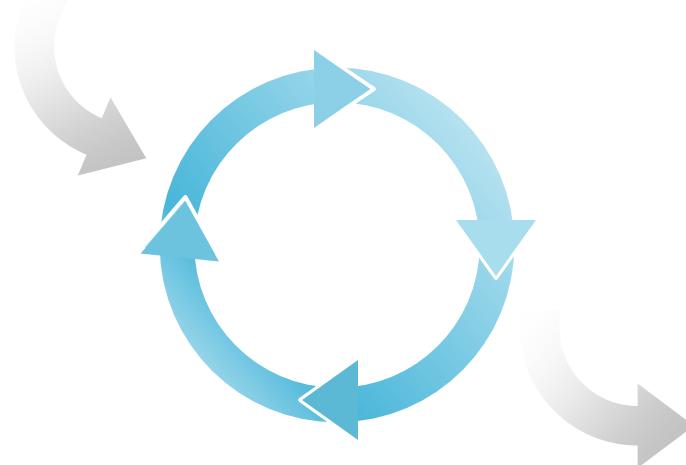
- Our GUI strategy is to embrace web and cloud computing technologies as the future for control system applications and services
 - Move from mostly text-based applications to modern graphical web applications
- Currently in the alternatives analysis phase that will develop the next generation platform for control system GUIs at Fermilab
- Incorporating User Experience and Human Factors into the development of our applications from the beginning

ACORN Applications Modernization

- 629 active applications
- Scope
 - Core Applications (13)
 - Essential for day-to-day Main Control Room Operations
 - Discussions with Operations Department
 - Critical Applications (58)
 - Essential for mission-critical operations
 - Discussions with the Accelerator Directorate on how they use the control system to accomplish their responsibilities

ACORN Applications Modernization

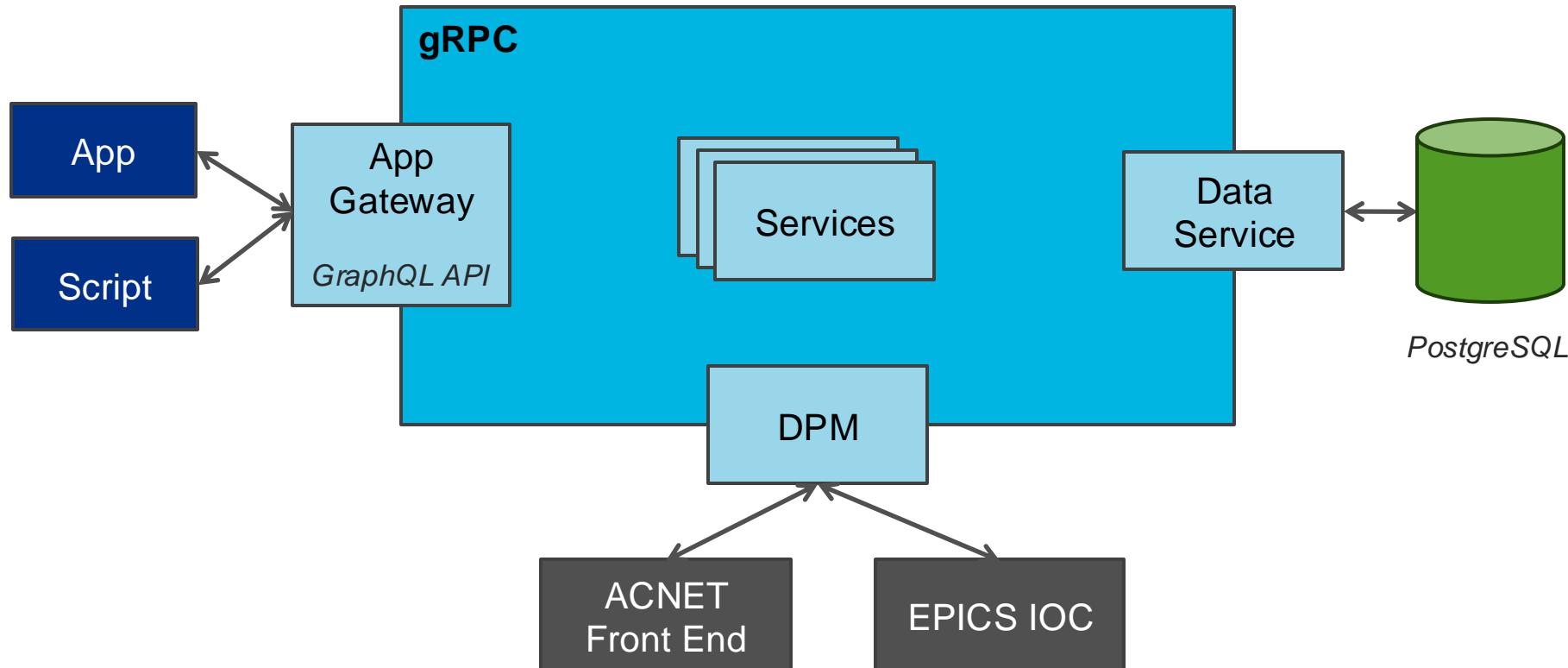
- Process (iterative)
 - Design
 - Test
 - Implement
 - Deploy
- User inclusion throughout



ACORN Applications Modernization

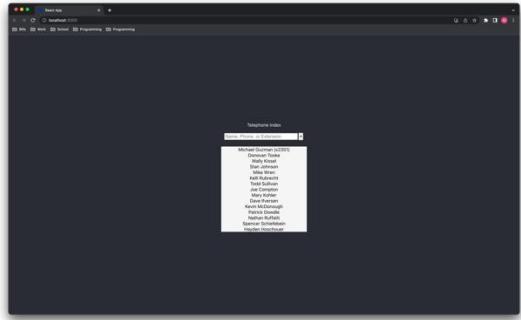
- Applications to work with ACNET and EPICS while giving the user the same experience
- Web Applications
 - Widely available and understood
 - Cross-platform
 - Accessible
 - Widget oriented
- Moving business logic from applications
 - Using existing APIs gives us flexibility for our GUI framework
 - Decoupling and moving into backend services tier
 - Web applications become thin clients that interact with the service tier

Architecture (Simplified)



Application Framework

- Flutter for framework (Dart)
 - Investigated various popular application frameworks – Flutter was preferred
 - Flutter allows for progressive web applications that can be adaptive to screen sizes



Phone Index

Name	Phone Number
Adams, Alyssa	x5652
Adams, Anthony	x5929
Adams, Jacob	x7242
Baker, Matthew	x6509
Baker, Taylor	x4555
Carter, Alexis	x5033
Carter, Alexis	x3444
Carter, Jonathan	x1140
Carter, Madison	x8781
Carter, Matthew	x9644
Carter, Ryan	x2942
Communication Center EOC-100	x3414, x3131
Davis, Emily	x6626
Davis, Emily	x1739
Davis, Jordan	x7093
Davis, Nicholas	x5607
Evans, Anthony	x9204
Evans, Jacob	x5997

Phone Index

Edit Entry

Person

First Name: Matthew

Last Name: Carter

Ext 1: 9644

Ext 2:

Ext 3:

Home number: (708) 248-2168

All numbers: (708) 992-2642

Pager: (847) 536-9808

Communication Center EOC-100

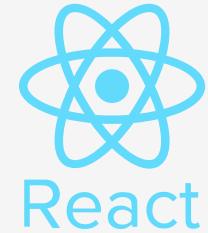
Interesting facts about Matthew Carter.

Cancel Save

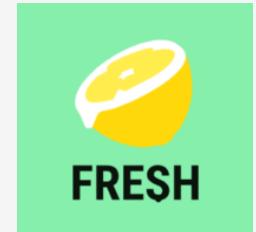
Telephone Index Application using React and Flutter



Flutter



React



ACORN User Experience and Human Factors

- Identifying end-user tasks and objectives
- Identify functional objectives of the system
- User research and usability testing
- UX design
 - Design philosophy - UX/HF principles and standards
 - Design style guide
 - Application GUI design
- Lab tour
 - Valuable to learn from others as we modernize our control system
 - Collaborative efforts & fostering an exchange of knowledge



HUMAN-SYSTEM INTERFACE STYLE GUIDE FOR ACORN DIGITAL CONTROL SYSTEM

[Accelerator Controls Operations Research Network](#)

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Prototyping and Design

- Figma
 - Design tool used to create, share, and test designs for websites, mobile apps, and other digital products and experiences
 - Rapid prototyping to workshop designs
 - Not heavy UI design upfront
 - Iterative process
 - Opportunity for user input
 - Widget and style library
 - Ability to generate code in Figma



Widget and Style Library

- Library of common components to streamline the development process
- Material Design 3 (Google) as a starting point
 - Application “scaffolds” (title bars, navigation bars, etc.)
 - Graphing and chart elements
- Library includes fonts, colors, etc. styles

Colors

Soft Black <code>#262626</code> General text, process lines, delineate objects	Yellow <code>#FFF905</code> Alert, Acknowledge signal	Grey I <code>#969696</code> Static elements
Red <code>#E53823</code> Alarm, danger signal	Magenta <code>#DE288A</code> Historical Data	Grey II <code>#EBEBEB</code> Inactive
Orange <code>#F8C443</code> Alert, caution signal	Green <code>#52A85A</code> Live value output	

Light Theme Specific

Hyperlink-Blue <code>#0000EE</code> Dynamic, clickable elements	Hyperlink-Purple <code>#551A8B</code> Accessed, dynamic element	Background-Grey <code>#D9D9D9</code> Background
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Typography

H1	Verdana, 20pt, Regular
H2	Verdana, 18pt, Regular
H3	Verdana, 16pt, Regular
H4	Verdana, 14pt, Regular
Body	Verdana, 10pt, Regular

Next Steps

- Requirements for core and critical applications
- Prototyping and UI design development
 - Templates
 - Widget & style library
- Continued user input/interaction throughout our development process
- Synoptic to Phoebus conversion

Thank you! Questions?

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