ACORN GUI Strategy at Fermilab

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In partnership with:

Outline

- ACORN overview

- Current control system - ACNET

- Modernization strategy for ACORN

- Next steps

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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
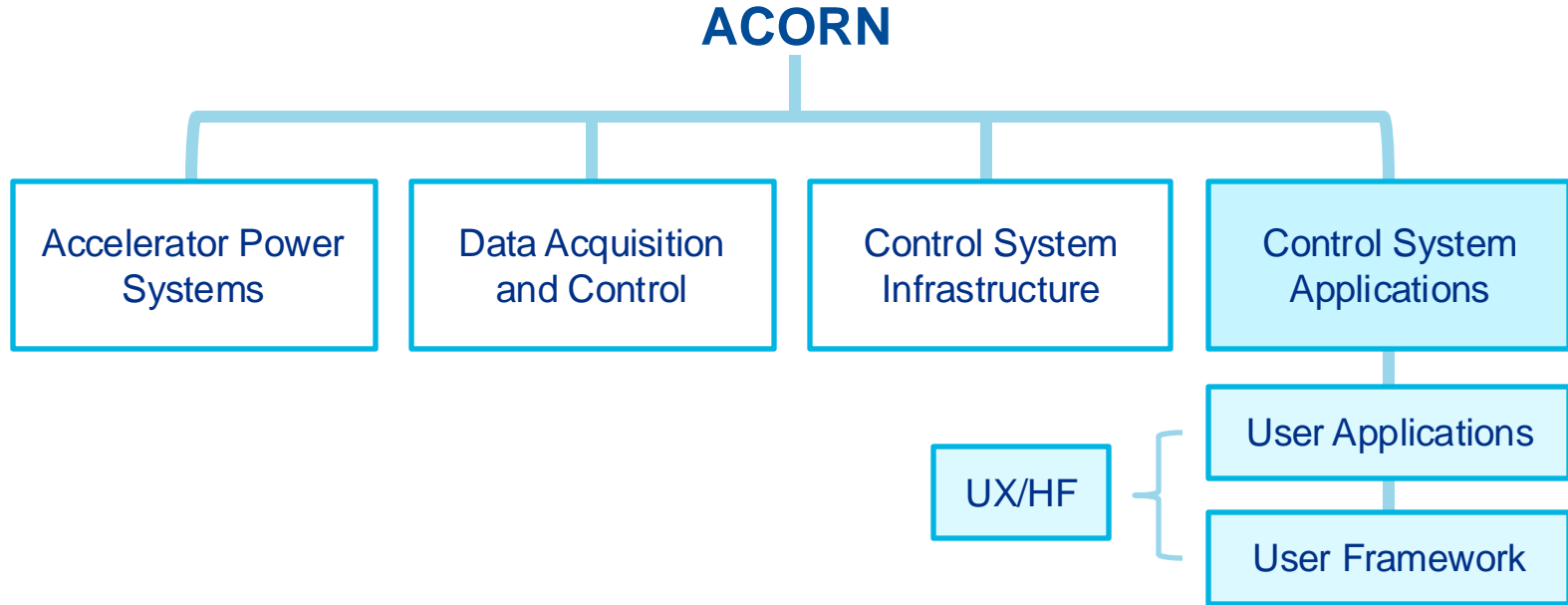
- $211M total project cost
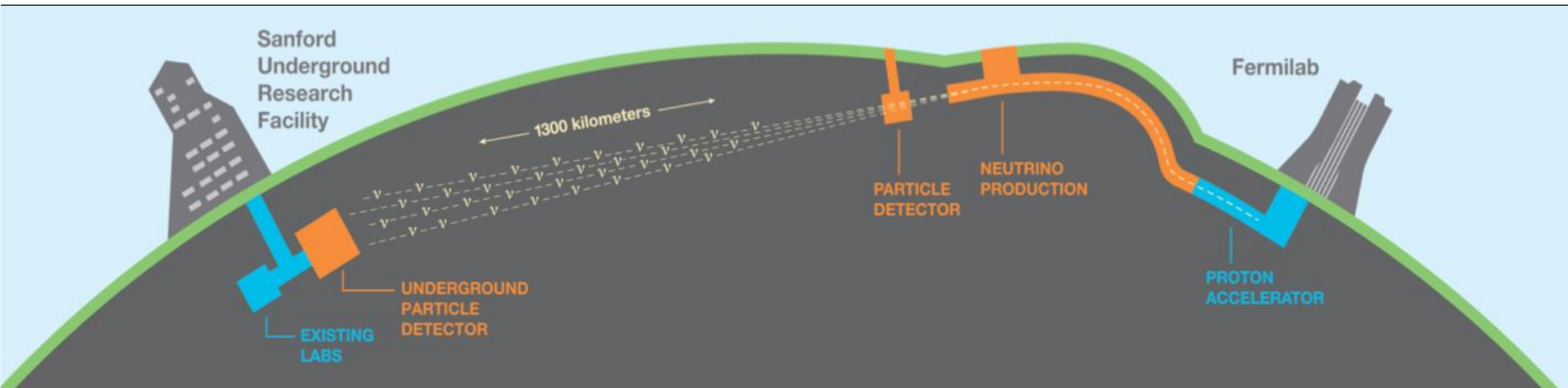
ACORN Project Goals

- 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

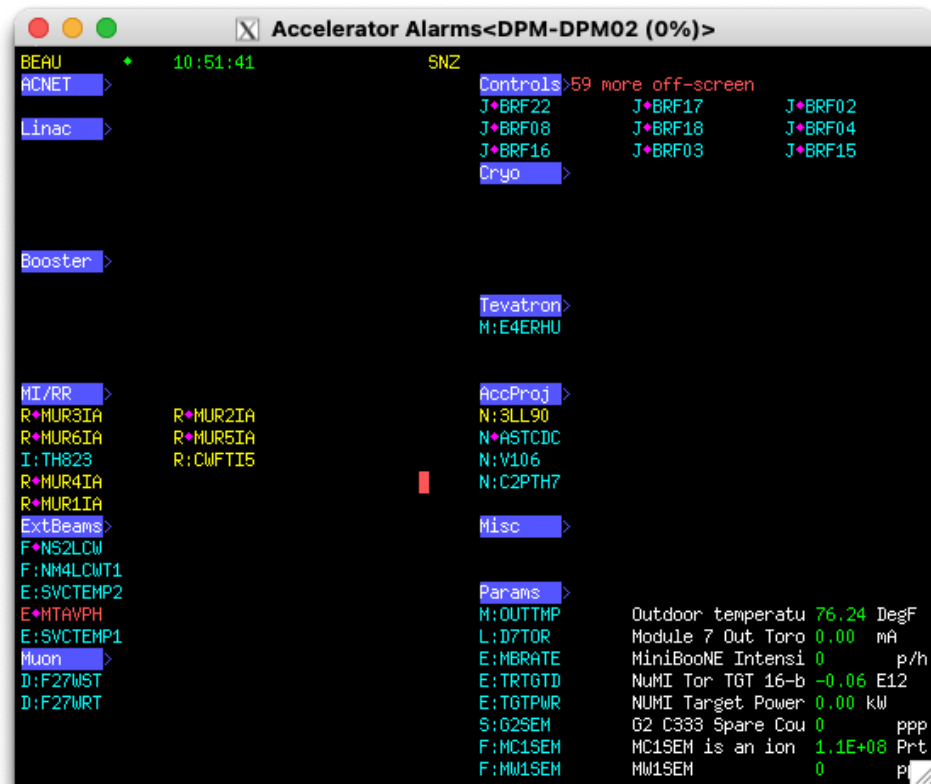- Support the development and deployment of AI/ML capabilities for accelerator operations

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Accelerator Controls Operations Research Network (ACORN)

ACORN

- Accelerator Power Systems
- Data Acquisition and Control
- Control System Infrastructure
- Control System Applications
  - User Applications
  - User Framework
  - UX/HF

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# 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

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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

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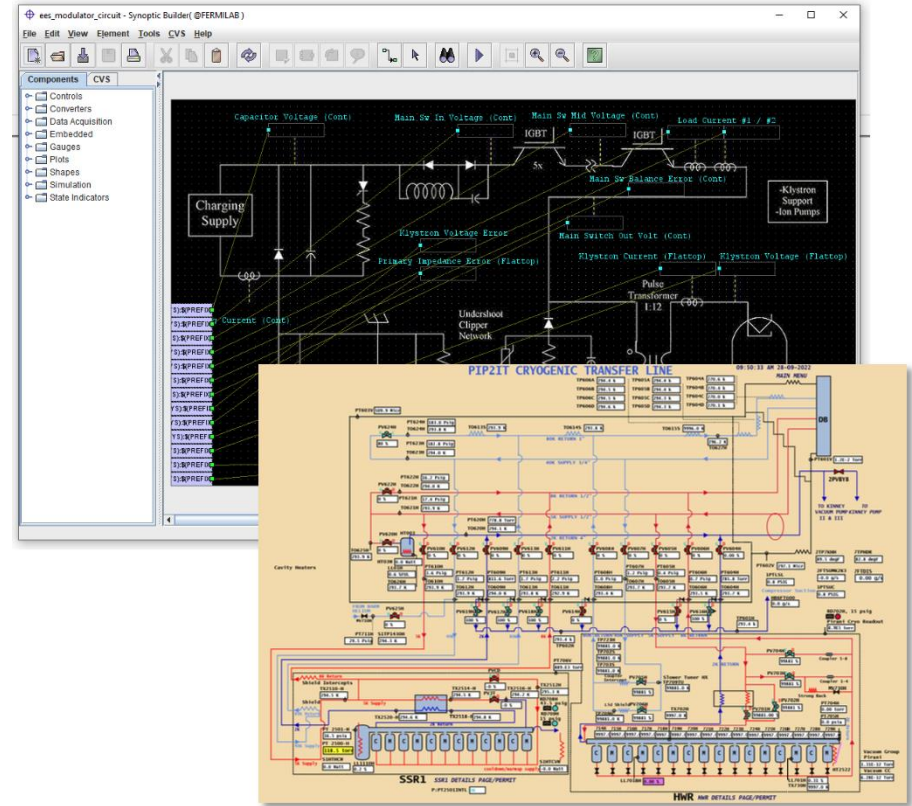
ACORN Applications Modernization

- 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

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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
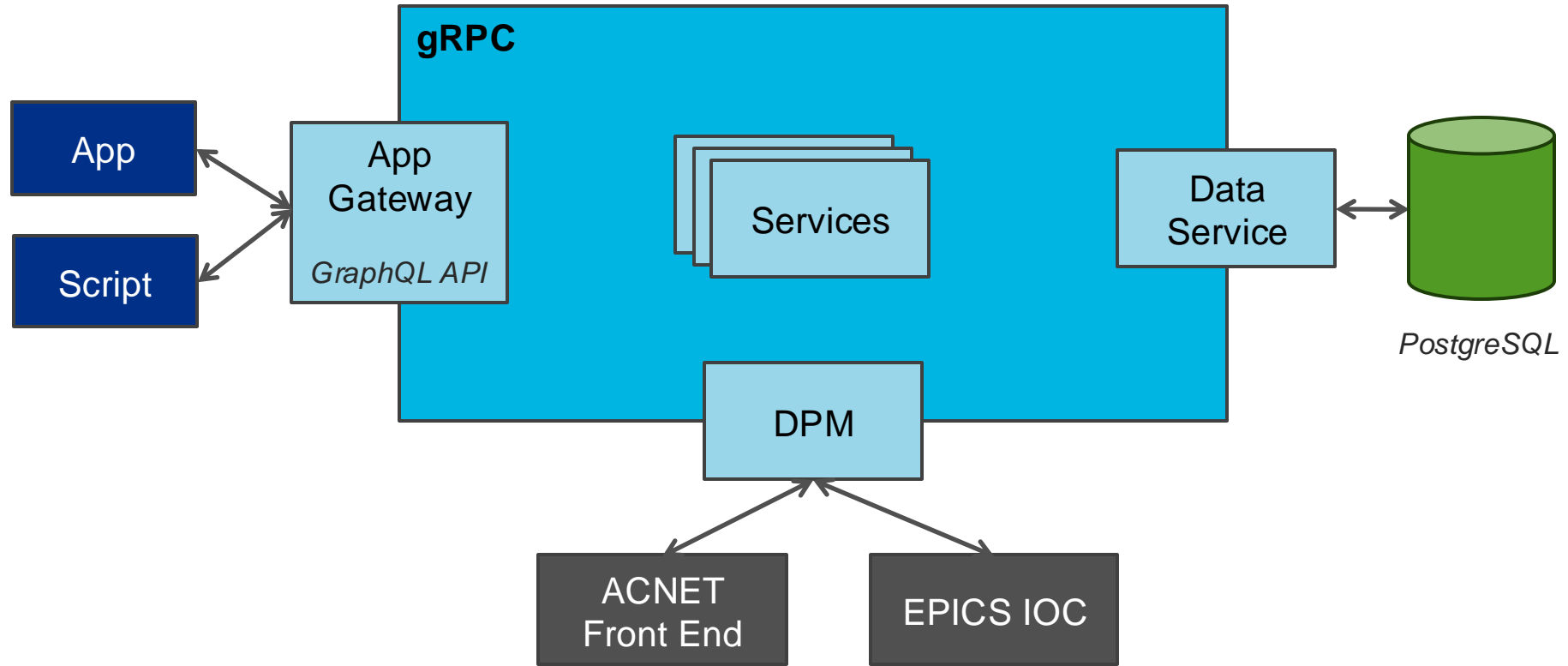
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ACORN Applications Modernization

- Process (iterative)

  - Design

  - Test

  - Implement

  - Deploy

- User inclusion throughout

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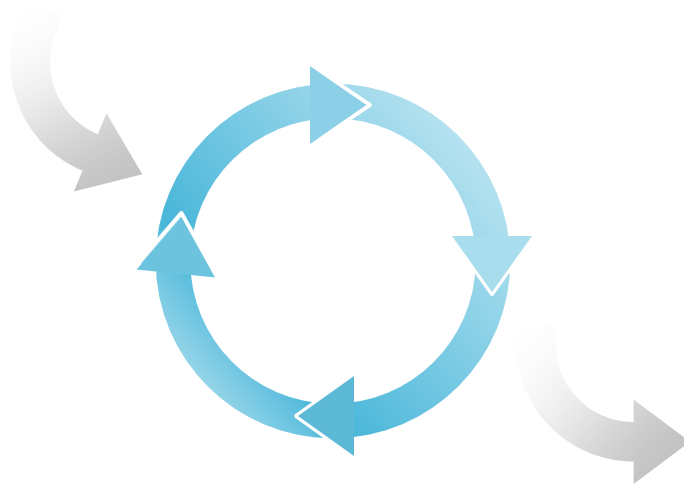
ACORN Applications Modernization

- 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

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Architecture (Simplified)

gRPC

App

Script

App Gateway

GraphQL API

Services

Data Service

PostgreSQL

DPM

ACNET Front End

EPICS IOC

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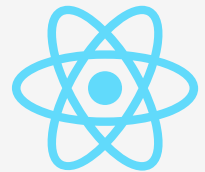🎇 **Fermilab**

Application Framework

- Flutter for framework (Dart)

  - Investigated various popular application frameworks – Flutter was preferred

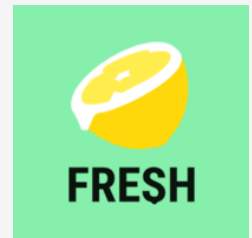 - Flutter allows for progressive web applications that can be adaptive to screen sizes
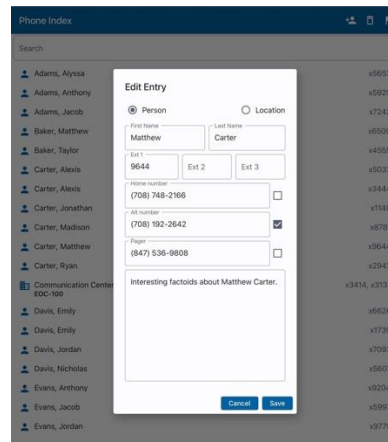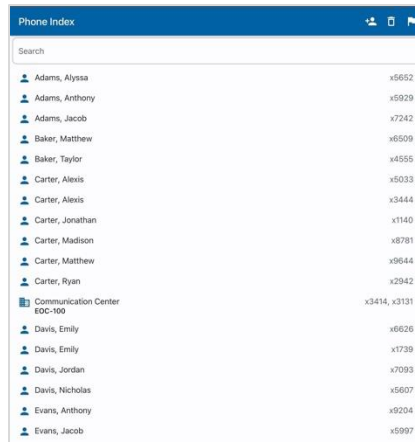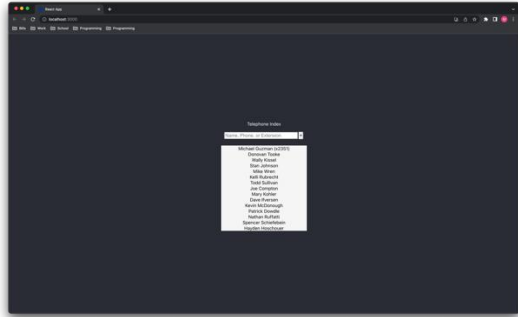

Telephone Index Application using React and Flutter

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
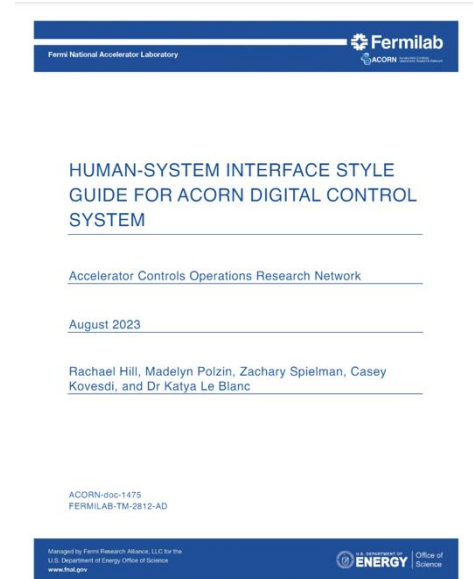
Prototyping and Design

- 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

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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
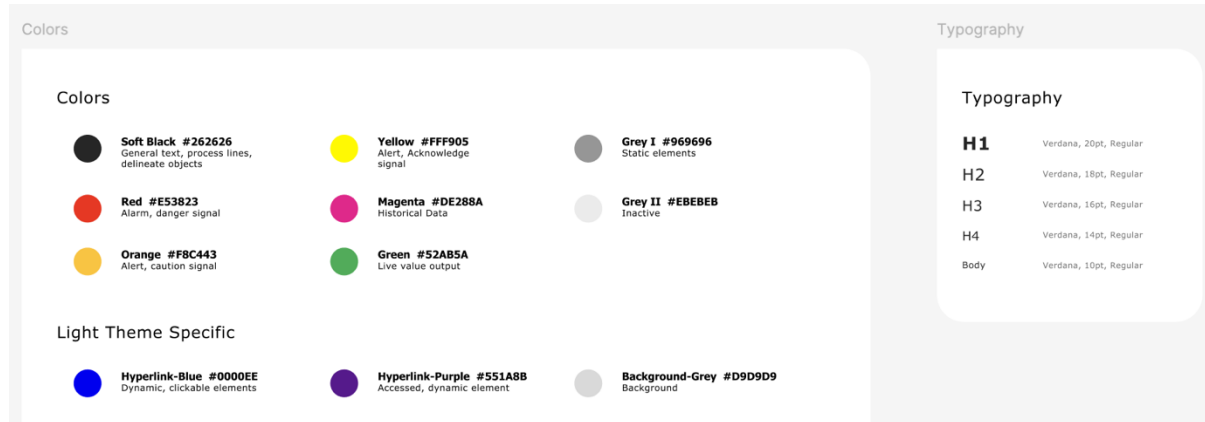
Next Steps

- 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

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Thank you! Questions?

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