U.S. Department of Transportation

Enabling Indoor Navigation to Support Complete Trips

Purpose – Why are we Here

- **Purpose of this Webinar**
  - To share an Indoor Navigation solution (currently being developed) for the ITS4US Buffalo All Access Program, including the technology involved, features and implementation considerations, and conclude with a brief demonstration of indoor navigation in action
  - Q&A

Agenda

- **Webinar Content**
  - Webinar Presenter Introductions
  - ITS4US Program Overview
    - Deborah Curtis, FHWA-Office of Operations, Research and Development
  - Buffalo All Access Program Overview
    - Robert Jones, Niagara Frontier Transportation Authority
  - ITS4US Buffalo – Indoor Navigation Solution Deep Drive
    - CXApp Technology Overview
      - Dana Marciniak Wyse, CXApp
  - Indoor Navigation – Concepts and Technology Overview
    - John Wiens, Neaera Consulting
  - Project Specific Considerations
    - John Wiens, Neaera Consulting
  - Demonstration Video
  - Q & A

Webinar Protocol

- **Webinar Protocol**
  - Please mute your phone during the entire webinar
  - You are welcome to ask questions via chatbox at the Q&A Section
  - The webinar recording and the presentation material will be posted on the ITS4US website

Webinar - Enabling Indoor Navigation to Support Complete Trips

Darren Weibler

Solution Architect, Neaera Consulting

Introduction of Presenters

Deborah Curtis
Highway Research Engineer, FHWA-Office of Operations, Research and Development

Robert Jones, AICP
Buffalo All Access Concept Deployment Lead
Deputy Director, Public Transit, NFTA

John Wiens
Technology Engineer, Neaera Consulting

Dana Marciniak Wyse
Senior Program Manager, CXApp

Darren Weibler
Solution Architect, Neaera Consulting

Supporting Cast

Etch

Darlene Magold, GISP, CEO
John Woyame, Solution Architect
Jesse Glascock, Solution Architect

CXApp

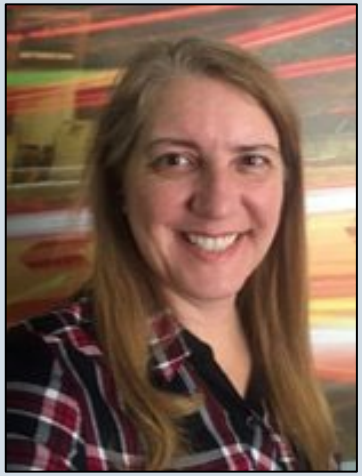
Chris Wiegand, EVP Revenue Operations
Daniel Seijas, Technical Support

ICF

Polly Okunieff, Systems Engineering Lead, Buffalo All Access Project

Nayel Serulle, Principal Engineer

ITS4US Program Overview



Deborah Curtis

Highway Research Engineer

FHWA-Office of Operations, Research, and Development

Program Overview

- A USDOT Multimodal Deployment effort, led by ITS JPO and supported by OST, FHWA and FTA
- Supports multiple large-scale replicable deployments to address the challenges of planning and executing all segments of a complete trip

Vision

Innovative and integrated complete trip deployments to support seamless travel for all users across all modes, regardless of location, income, or disability

Program Goals

Spur high-impact integrated Complete Trip deployments nationwide

Identify needs and challenges by populations

Develop and deploy mobility solutions that meet user needs

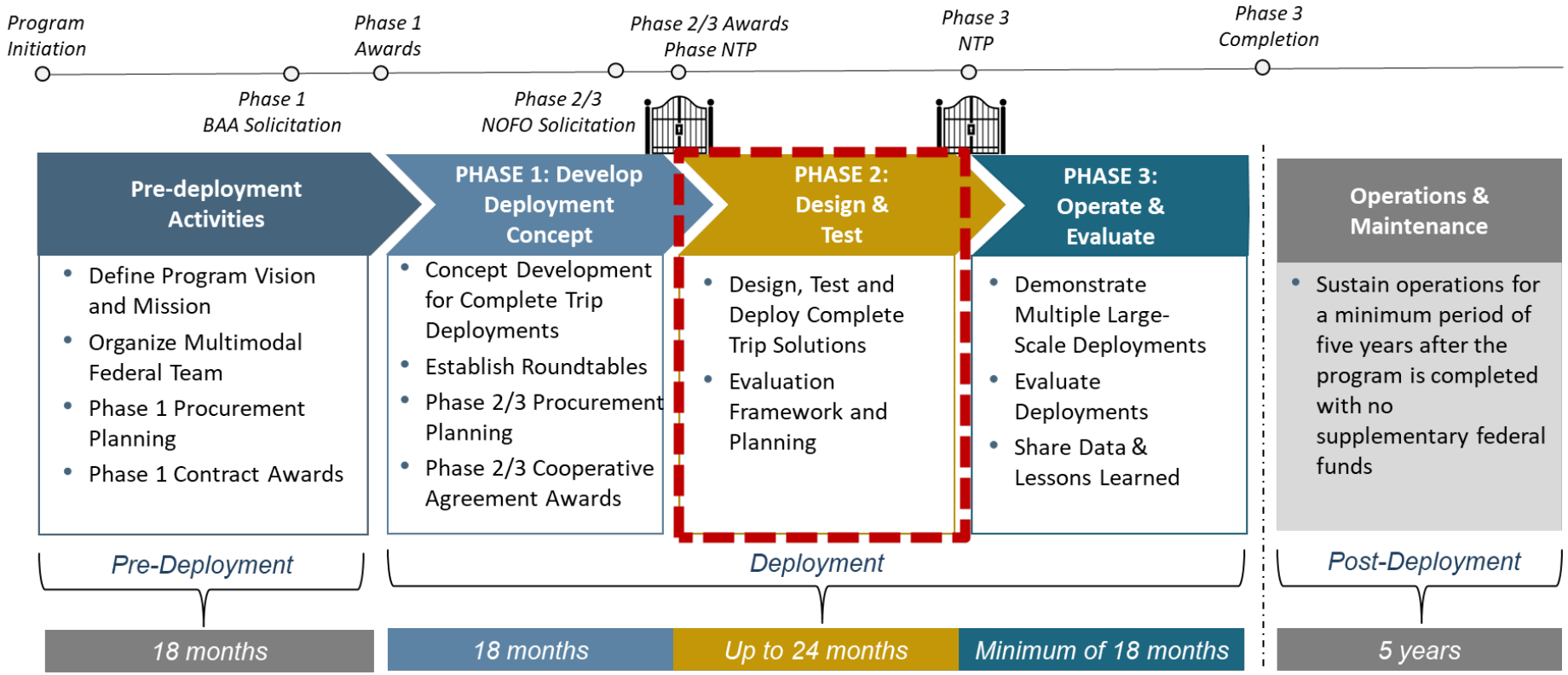
Measure impact of integrated deployments

Identify replicable solutions and disseminate lessons learned

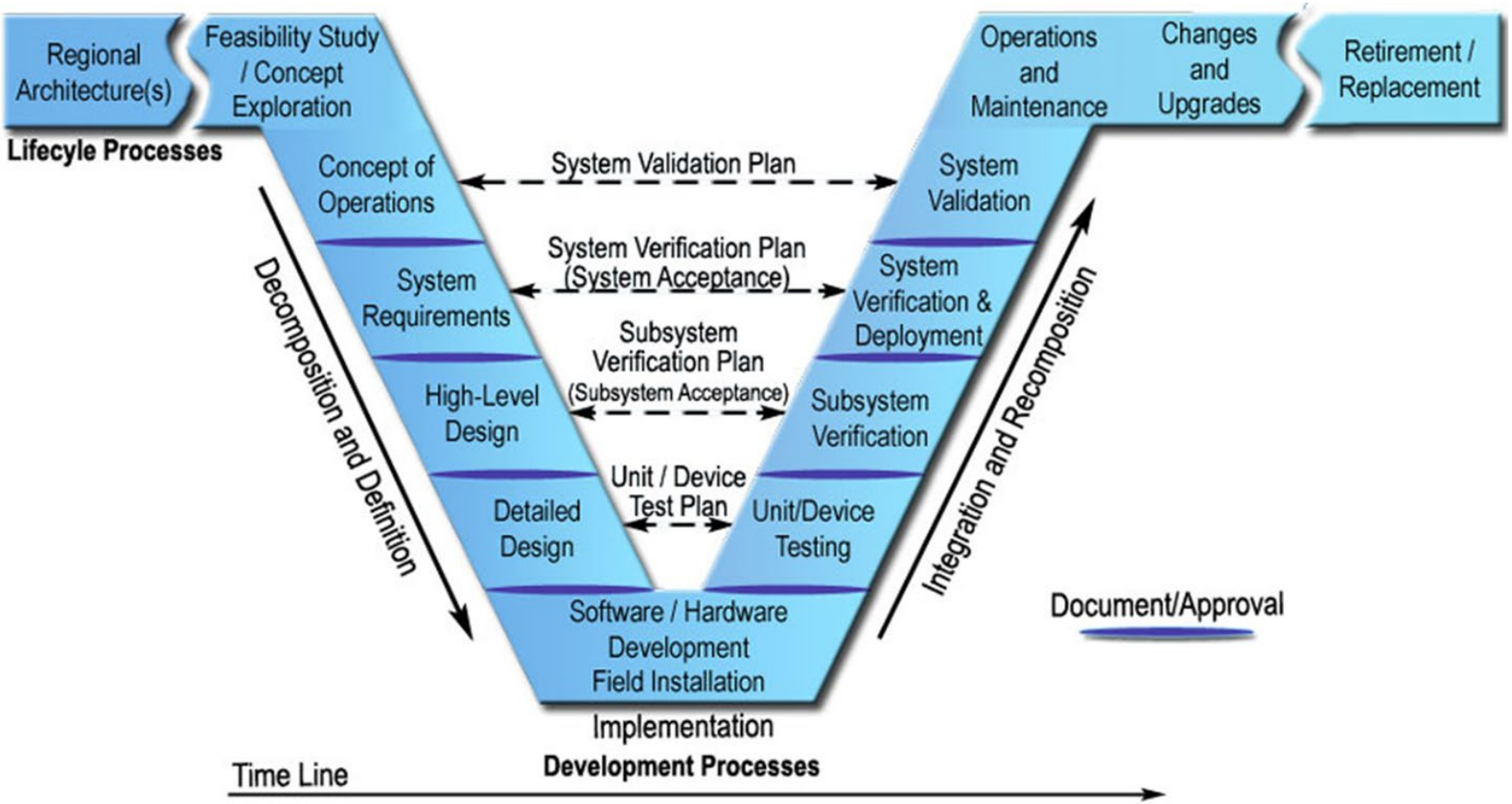
ITS4US Program Fundamental Elements

- Site deployments will be real-world environment **deployments**
- Serve as replicable models and remain in operation
- There are **multiple** site deployments
- Unique solutions to address critical, local challenges
- Deployments are expected to be both **large-scale and multi-modal**
- **Large-scale** implies deployments will have measurable impact
- Sites will deploy **multiple technologies and modes**

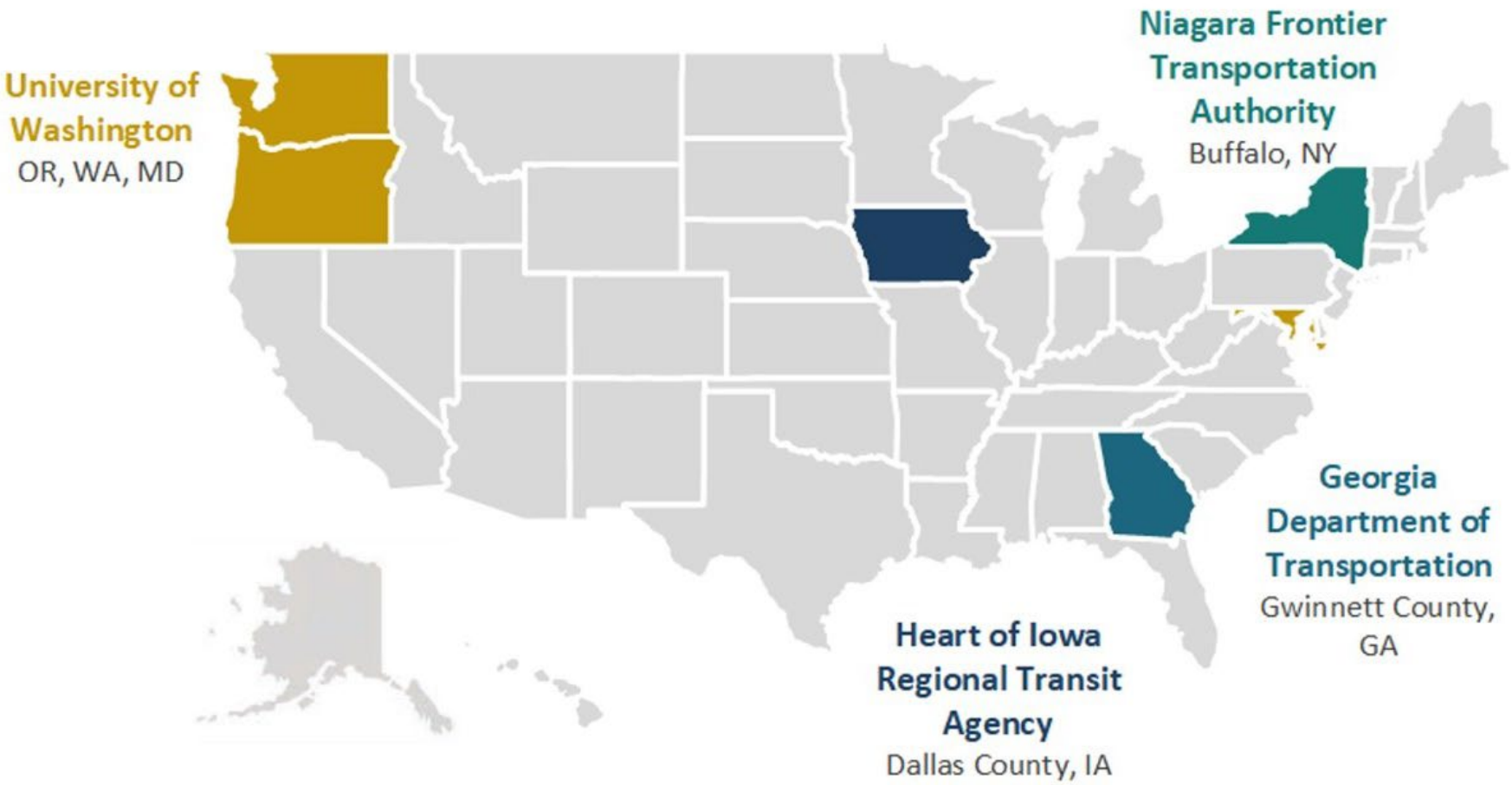
Deployment Phases



Systems Engineering "Vee" Diagram



Phases 2 and 3 Awardees



ITS4US Team Photo Collage

Source: USDOT

Buffalo All Access Program Overview

Robert Jones, AICP

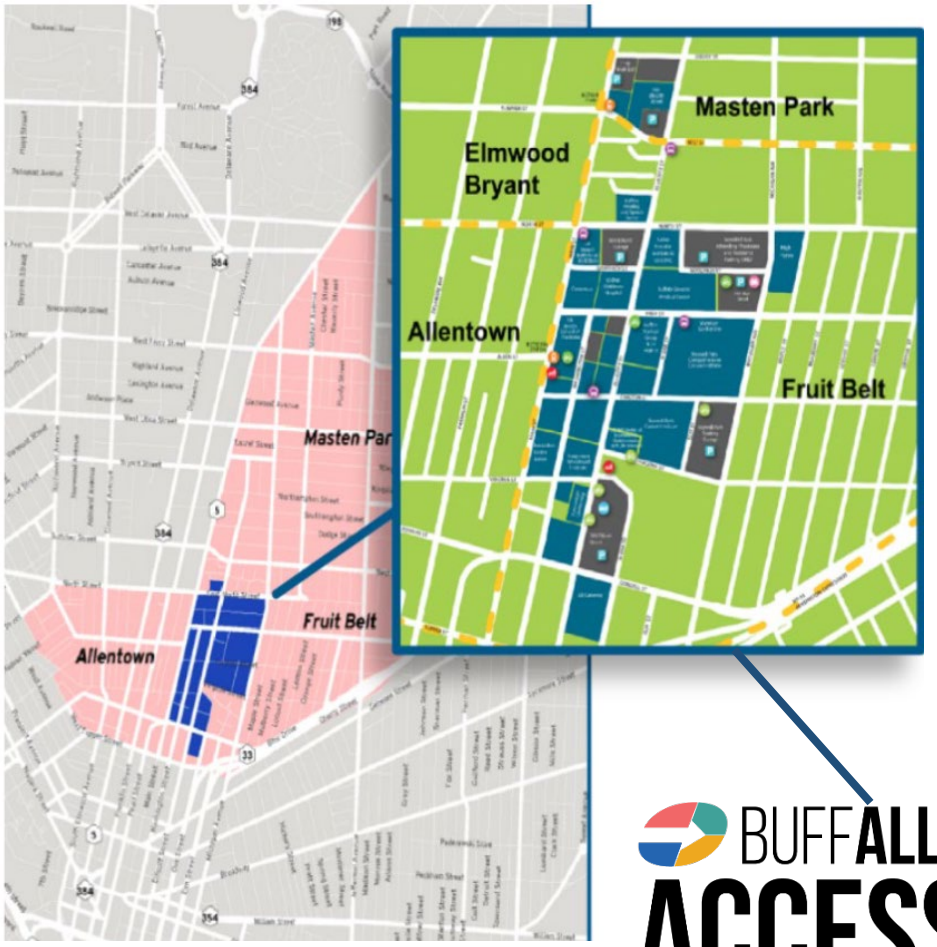
Buffalo All Access

Concept Deployment Lead

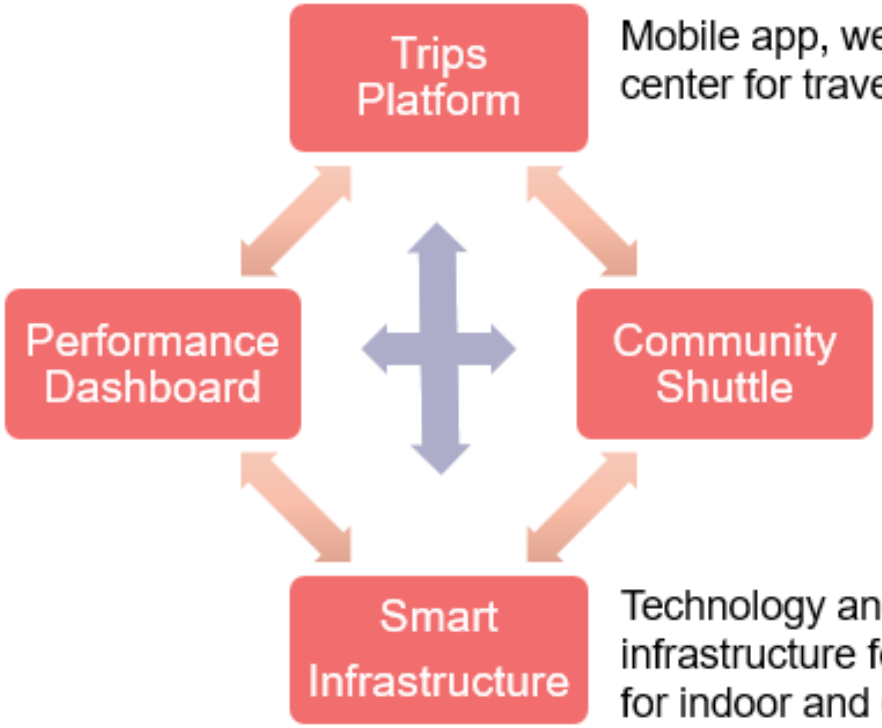
Deputy Director, Public Transit, NFTA

Buffalo All Access Factsheet

- **Where:** Deployment area in and around the Buffalo Niagara Medical Campus.
- **Why there**: 150+ companies, 16,000+ employees/students, 1.5+ million visitors per year.
- **What**: Deployment of new and advanced technologies to address existing mobility and accessibility challenges.
- **Innovation:** Factors in travelers' preferences and accessibility-related needs for comprehensive trip planning.



Buffalo All Access System Overview



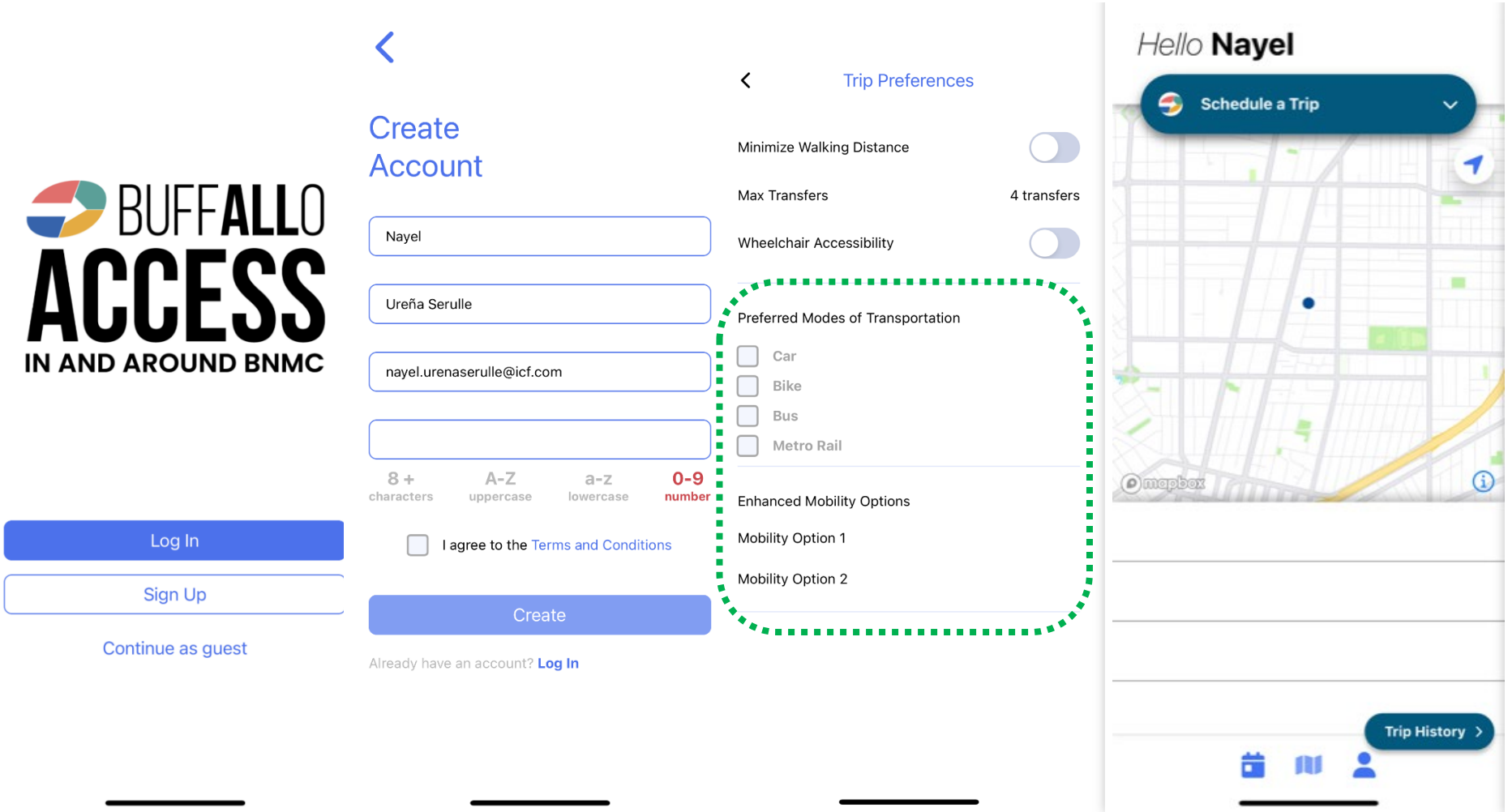
Mobile app, website, and call center for travelers to plan trips.

Measures and presents the performance of the system.

Shuttle system providing scheduled and on-demand connections to Metro Rail, BNMC, and surrounding neighborhoods.

Technology and supporting infrastructure for wayfinding for indoor and outdoor orientation, navigation and destination confirmation.

Buffalo All Access App Platform (App & Web)



Buffalo All Access – NEW Services

Source: Redyref

Source: CxApp

Source: Miovision

Source: ADASTEC and Vicinity Motors

Buffalo All Access – Fully Deployed

Participants

- 100 participants during Phase 2.
- 300-500 participants in Phase 3.

Indoor Navigation

- Around 100 beacons installed in VIA.
- Full integration with Buffalo General Hospital.

Kiosks

- 2 kiosks installed, one within the Buffalo General and another within a metro station.

Intersections

- Two intersections equipped with auto-request technology.

Vehicles

- 1 Autonomous Shuttle
- 1-2 Human Driven Shuttles

Platforms

- Fully integrated Web and Mobile App Complete Trip Planning tool.
- Outward facing Performance Dashboard.

ITS4US Buffalo – Indoor Navigation Solution Deep Drive - CXApp

Dana Marciniak Wyse

Senior Program Manager, CXApp

Company Profile

BUFFALO ACCESS IN AND AROUND BNMC

cxapp

CXApp's **The Workplace SuperApp™**, is a platform that consolidates the services, features, and functions of the workplace tech stack into a single mobile app.

250+ Native features
100+ Workplace Integrations
486 Cities with at least one campus deployed
61 Countries Worldwide in Global Footprint

Est. 2015 as TheCXApp

CXApp Mapping Platform creates highly accurate indoor maps, and its developer tools fuel the transformation of physical spaces into interactive digital environments.

600+ Million Sq. Ft. Digitized Globally
94% CSAT Score
8 Native Map Kits Available for use
4 Native CXApp Products powered by Mapping

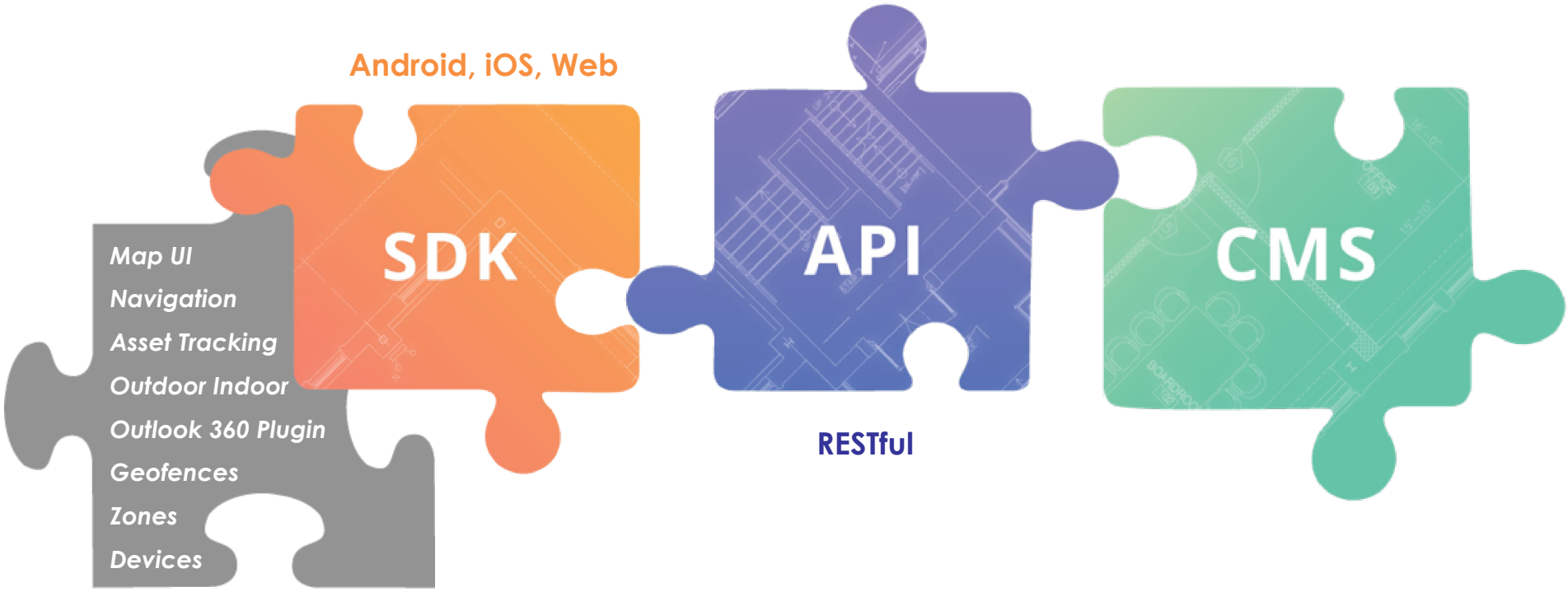
Est. 2010 as Jibestream

Financial Services	Technology	Retail	Transportation
Media & Entertainment	Healthcare	Consumer	Real Estate

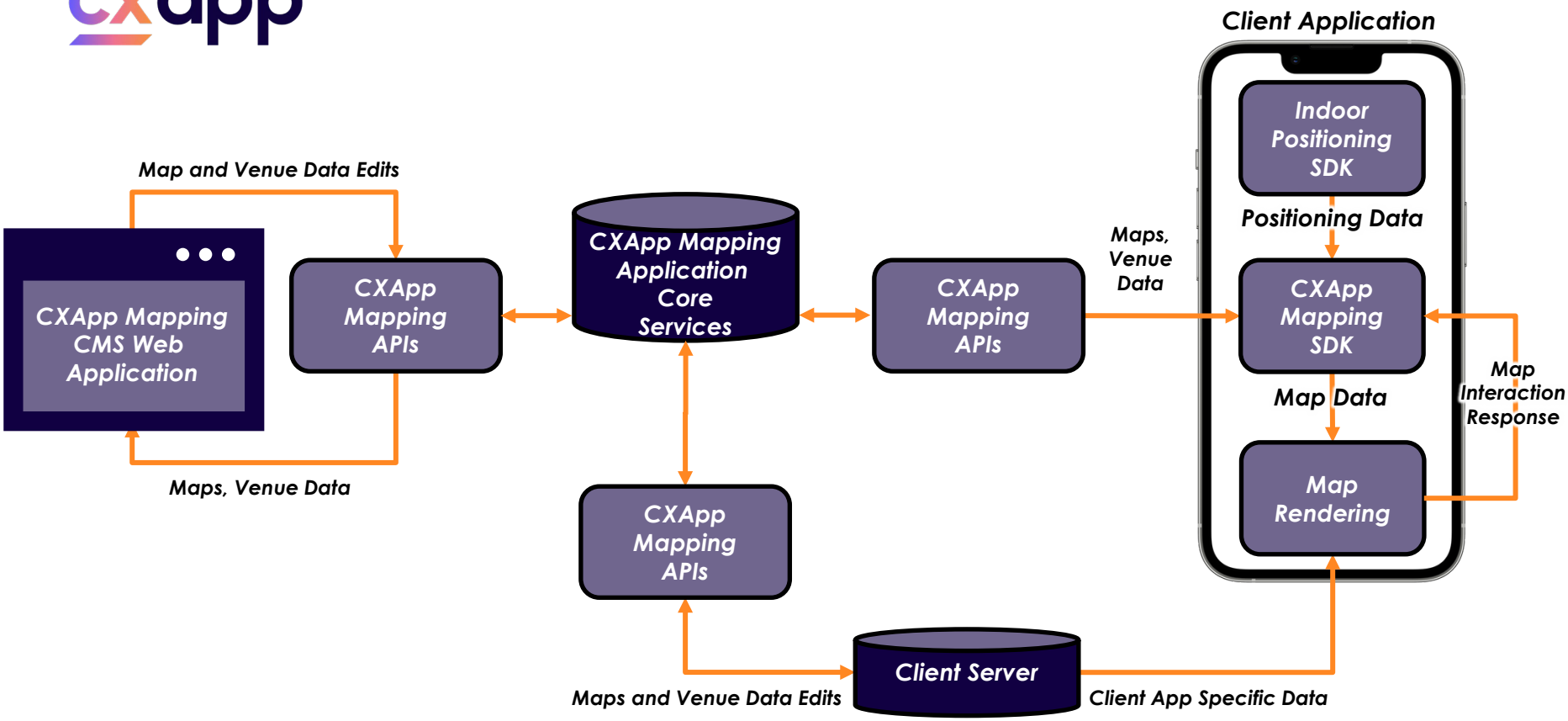
Mapping Overview

- Integrations with third party systems stream in additional static or dynamic meta-data
- The position provided by the Indoor Positioning System is used to display the Blue Dot and enable location-aware Navigation
- Points of Interest in the form of Destinations and Amenities are connected to horizontal and vertical paths for Wayfinding
- Geofences and Zones can be configured to trigger location-aware use cases and visualize categories of spaces
- The geolocated base CXApp Map contains all the addressable layers extracted from the CAD drawings to power you use cases

Mapping Product Ecosystem



Mapping High Level Architecture



One Platform, Unlimited Use Cases

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cxapp

Wayfinding

Outdoor-Indoor Wayfinding

Asset Tracking

Map Profiles

Business Intelligence

Location Sharing

Proximity Messaging

Geofencing

Security Management

Building Efficiency & Facility Management

Intelligent Parking

Tips for Successful Map Projects

BUFFALO ACCESS IN AND AROUND BNMC

cxapp

Data Ownership

Maps are living things. Identify the areas of the solution requiring ownership for great experiences long after Go-Live.

Source of Truth

Determine the initial and ongoing sources of truth for ***structural and spatial*** meta-data changes.

Nomenclature

Consider the continuity of experience of ***naming conventions*** for patients across their journey:

- Appointment Info
- App/Map Data
- Signage
- Elevator Floor Names
- Verbal / Colloquial Terms
- Acronyms

Look and Feel

Implement ***map designs*** and interactions, that are universal, or have strong commonality, regardless of the venue or the source data.

ITS4US Buffalo – Indoor Navigation Solution Concepts and Technology Overview

John Wiens

Technical Engineer, Neaera Consulting

Indoor Navigation

- Possible Indoor Navigation Solutions
  - Wi-Fi
  - RFID
  - Ultra-Wide Band
  - Bluetooth
- Localization Strategies
  - Relative Signal Strength Indication
  - Time of Flight
  - Time Difference of Arrival

Wi-Fi

- Existing Wi-Fi infrastructure can be used for indoor localization
- Operate at 2.4GHz
  - Wi-Fi operates over a relatively narrow signal band, with high broadcast power.
- Localization is done via Relative Signal Strength Indicators (RSSI)
  - Distance between beacon and device is approximated based upon received signal strength
  - Provides low resolution indoor position tracking (10m)
  - Works best when there is line of sight to beacons
  - 0 – 50 meters of range
- Available in most smart phones which possess Wi-Fi capabilities

Radio Frequency Identification (RFID)

- RFID allows for completely passive localization in an isolated area
  - Beacons broadcast radio waves to nearby devices.
  - Received signals induce a response from the device which includes some information about the device.
  - RFID readers than collect the device broadcast information and process it to generate a device location
  - RFID readers must then transmit the computed position back to the device for the device to enable on-board navigation
- A maximum range of ~ 1 meter greatly limits the applicability of RFID for indoor navigation
- Passive nature of RFID tags makes them cost-effective, durable ways of tracking objects

Ultra-wide Band (UWB)

- UWB operates at low power across a large spectrum range
  - 3.1GHz - 10.6 GHz
  - Large band range provides additional resistance to signal interference
  - Low power broadcasts reduce beacon and phone power consumption
- Localization Techniques
  - Time of Flight (ToF) – Beacons can calculate distance to a device directly by measuring the delay between when messages are transmitted and when messages are received.
  - Time Difference of Arrival (TDoA) - Beacons may work together to calculate device position by measuring the reception delay difference between multiple beacons.
- Localization accuracy (0.5m)
- Requires specialized hardware not common in most smart phones.
  - Recent generation flagship devices have dedicated chips for UWB.
- Requires Special UWB beacons

Bluetooth

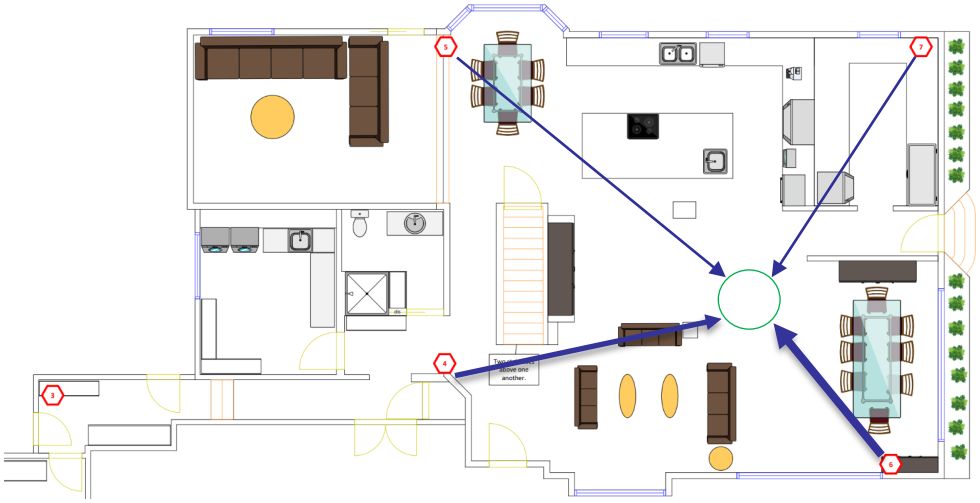
- Requires Bluetooth beacons to act as navigation anchors
  - Beacons operate on the I-Beacon or Eddystone (now obsolete) protocols
- Bluetooth operates on the 2.4 GHz band close to Wi-Fi
  - Lower Broadcast power and bandwidth than Wi-Fi
- Localization is done via Relative Signal Strength Indicators (RSSI)
  - Distance between beacon and device is approximated based upon received signal strength
  - Provides indoor position tracking around 5m of accuracy
  - Works best when configured with line of sight to beacons
  - 0 – 25 meters of range
- Works on most Bluetooth enabled smart phones

Bluetooth Beacons

- Bluetooth beacons provide a cost-effective low power way to install indoor navigation in a facility
  - Good balance of broadcast range and power performance
    - Nominal range 0-25m max 100m
    - Beacons can operate on 4-AA batteries for 2-3 years
- Compatible with previous beacon array in Buffalo General Hospital
- Accessible for a wide range of system users, doesn't require uncommon phone hardware
  - Bluetooth Low Energy (BLE) helps to keep user battery usage to a minimum.

RSSI Localization

- RSSI works by comparing the magnitude of received signals to one another
- Measurements are then compared to one another to calculate likely user location
  - Far away beacons have weak signals, while closer beacons have strong signals
- Phone IMU and other sensors are also incorporate to help stabilize and improve position accuracy



ITS4US Buffalo – Indoor Navigation Solution Concepts and Technology Overview - Project

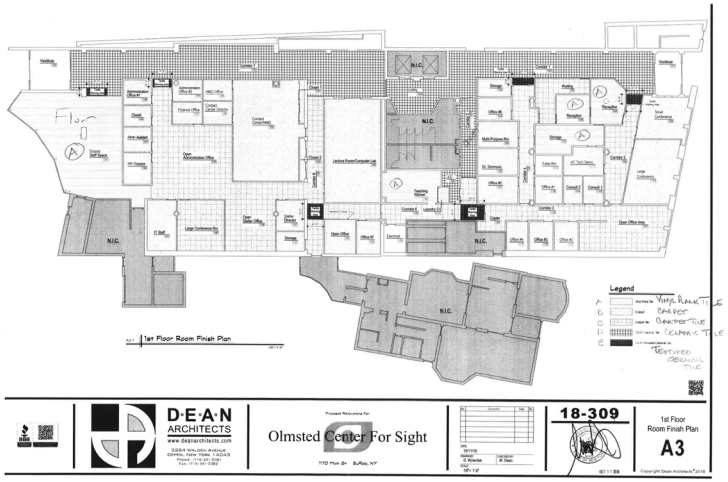
- **Topic: ITS4US Buffalo - Project Specific Considerations**

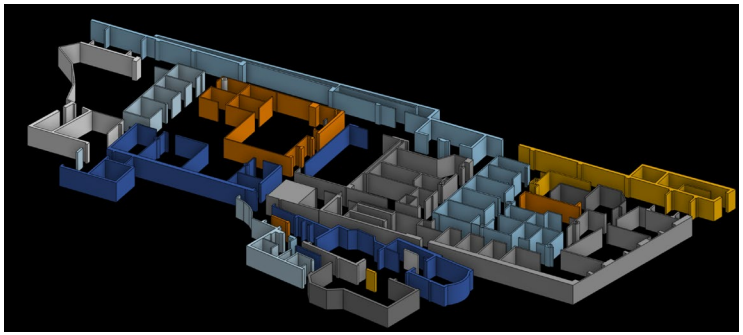
ITS4US Buffalo - General Configuration

- Building Facility maps
  - Drawing
  - CAD Model
  - Map Annotation
  - Jibestream Map
- Selecting Beacons
  - Overview of Ascent System beacons
  - Setting up beacons
- Adapting CX SDK for use with Buffalo All Access app
  - Creating React Native Package for CXApp API

Building Facility Maps

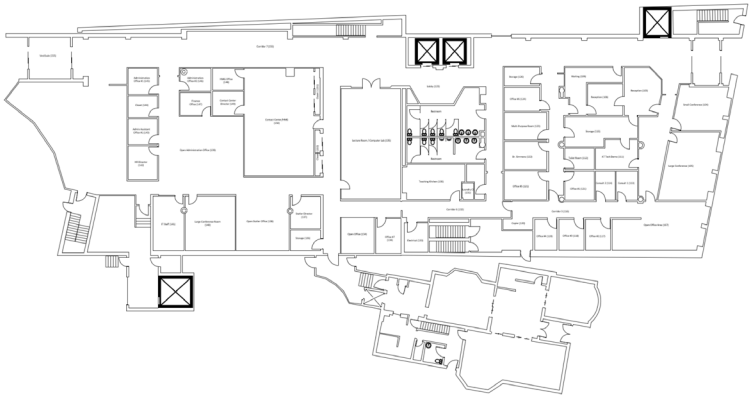
- Modelling Facility in Parametric software
  - Floor plans traced into onshape CAD tool
  - Generated to-scale building floor plans
- Output 2D dwg files to be imported in further steps





Adding Amenities

- Visio was used to quickly add amenities and labels to the map.
- Included Amenities
  - Elevators
  - Stairs
  - Doors
  - Sinks
  - Toilets

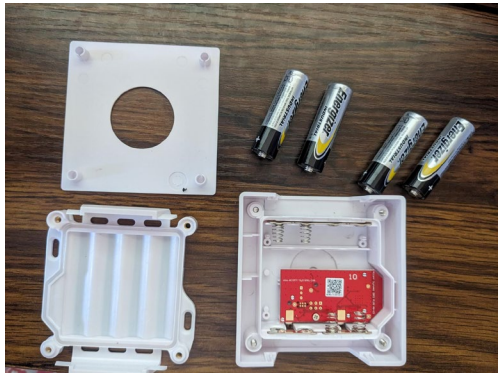


Adding Waypoints

- The created maps are then imported into the Jibestream map tool.
- Waypoints, Destinations and Points of Interest are added to the map.
- Connections on this map define how users can be routed from one location to another
- Live updates can be made to this map and will propagate to users
  - Updating waypoints
  - Changing connections
  - Adding amenities

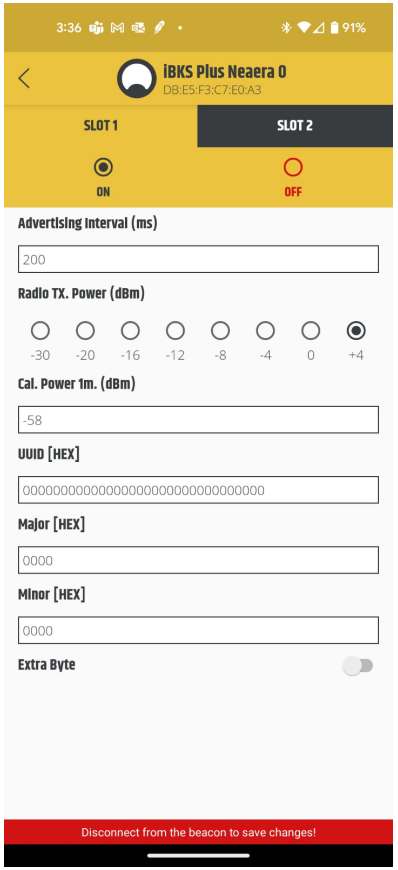
Accent System Beacons

- The new beacon installation at the Via center will use beacons provided by accent systems.
- Beacons are configured via Bluetooth from a manufactured supplied mobile application.
- Beacons allow for configurable broadcast power level and pulse frequency
- Beacons don't require AC power. Can run for 2-3 years on 4 AA batteries.
- Support both Eddystone and I Beacon protocols (I Beacon protocol used here)



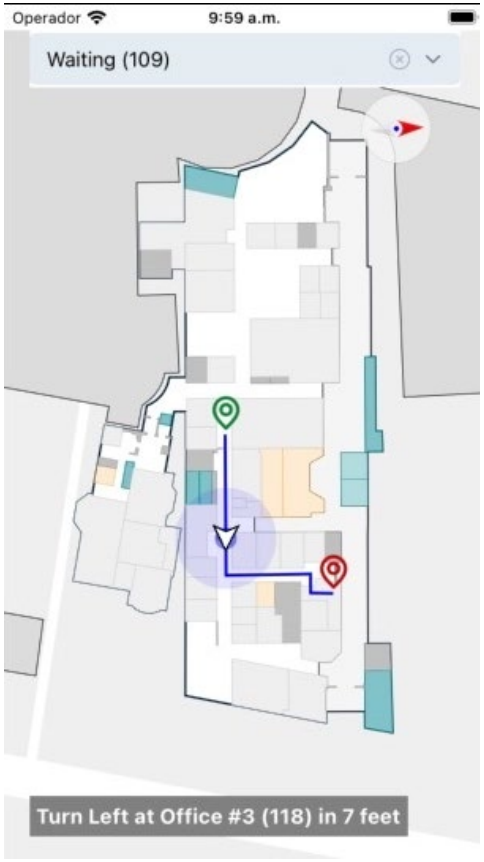
Setting up Beacons

- Beacons are configured over Bluetooth via the manufactured supplied config application
- Each beacon must be configured with the following
  - Advertising Interval
  - Radio Transmit Power
  - UUID
  - Unique Major / Minor ID pair
- Additionally, beacons can be configured with unique names to help identify them.
- Beacons should also be password locked to prevent future tampering during deployment



Adding Maps to App

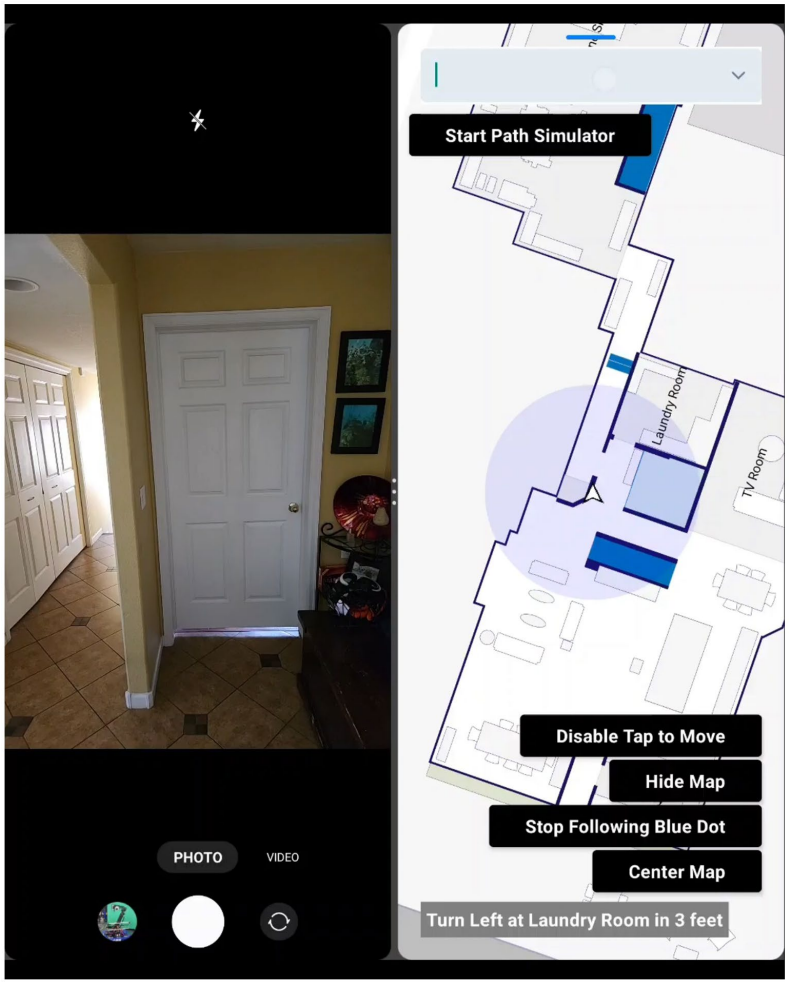
- CXApp provides SDK's for working with Maps for both Android and iOS.
- Neaera built out a react-native library wrapping the CXApp SDKs for integration into the Complete Trip Planner application.
- Maps are pulled from the online Jibestream API
- Maps include waypoints, KeyPoints, destinations, and Points of Interest, which can be used for navigating around the facility



ITS4US Buffalo – Demonstration - a Work in Progress

- **Topic: Demonstration Video**

ITS4US Buffalo – Demonstration – a Work in Progress



Q&A

- Facilitator: Carlos Alban, ITS America

References

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