

INTRODUCTORY PRESENTATION

DECEMBER 2021



GEOSPATIAL DATABASE MANAGEMENT SYSTEM (DBMS)

KEY TO AIRPORT DIGITAL TWIN

Objective



Enable Airport Owners



Achieve & Sustain Digital Twin



Definition: “Digital-Twin” (DT)

**Virtual
Representation
as Digital Counterpart
of Physical Object,
Facility, System,
and/or Process**

To improve:
Planning & Development
Operations & Maintenance
Safety & Security
Level of Service
Costs & Revenues
etc...





DT Data Spans:

- Future
- Present
- Past





DT Includes:

- Appearance
- Internals
- Processes

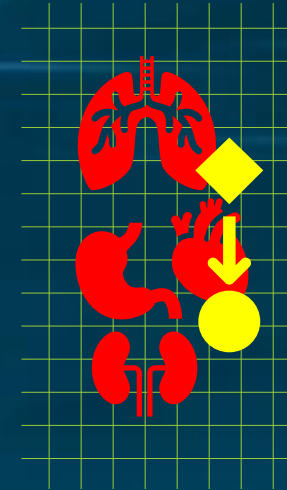




Pre-DT Airports



- Mostly Stand-Alone Systems with Few Integrated
- Some Spatial Modeling
- Few Digital Workflows
- Some Analytics





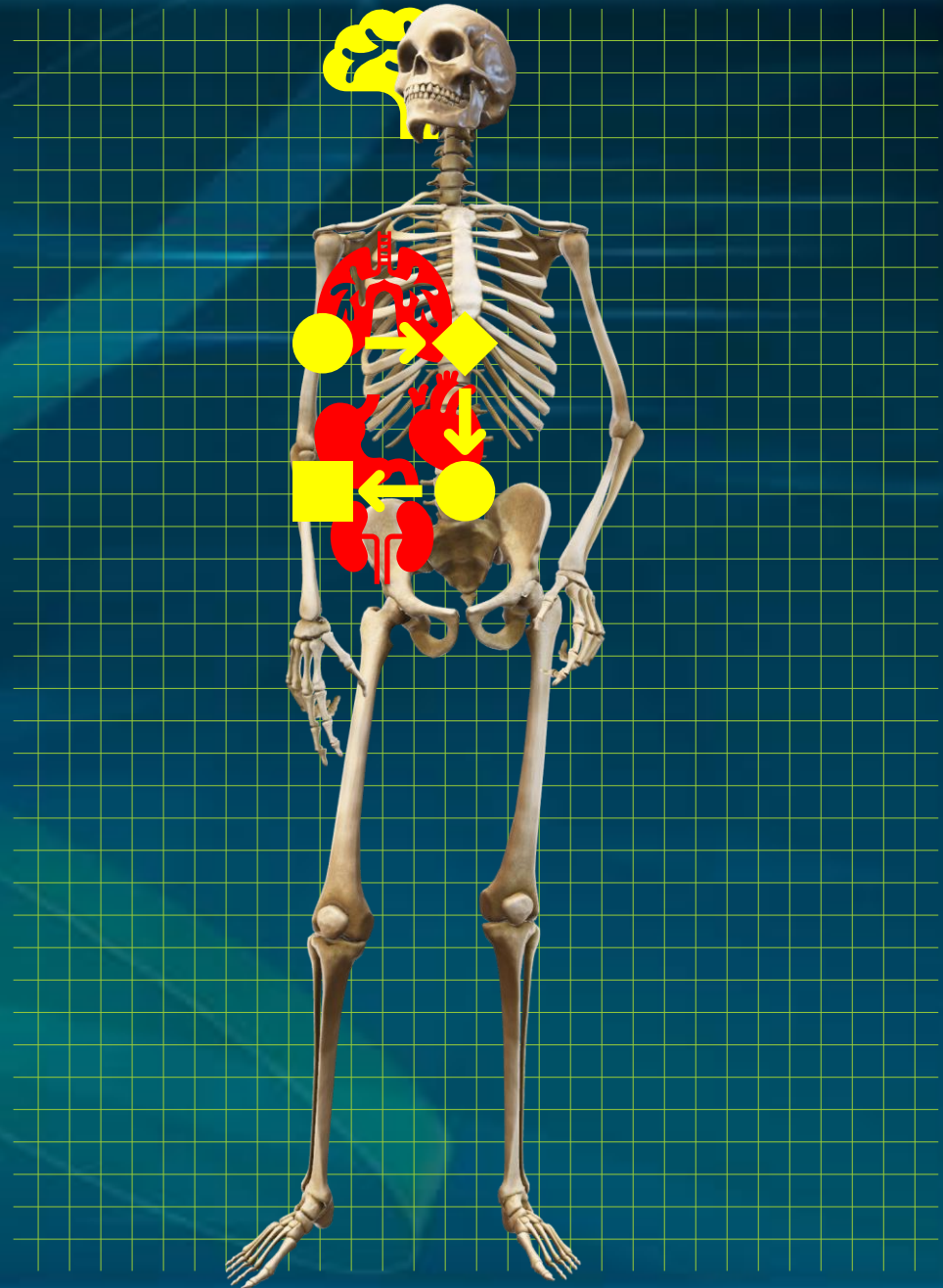
DT Foundation

“Skeleton”
correlates DT
components
together
via common
denominator

Spatial Database

key

to achieving DT

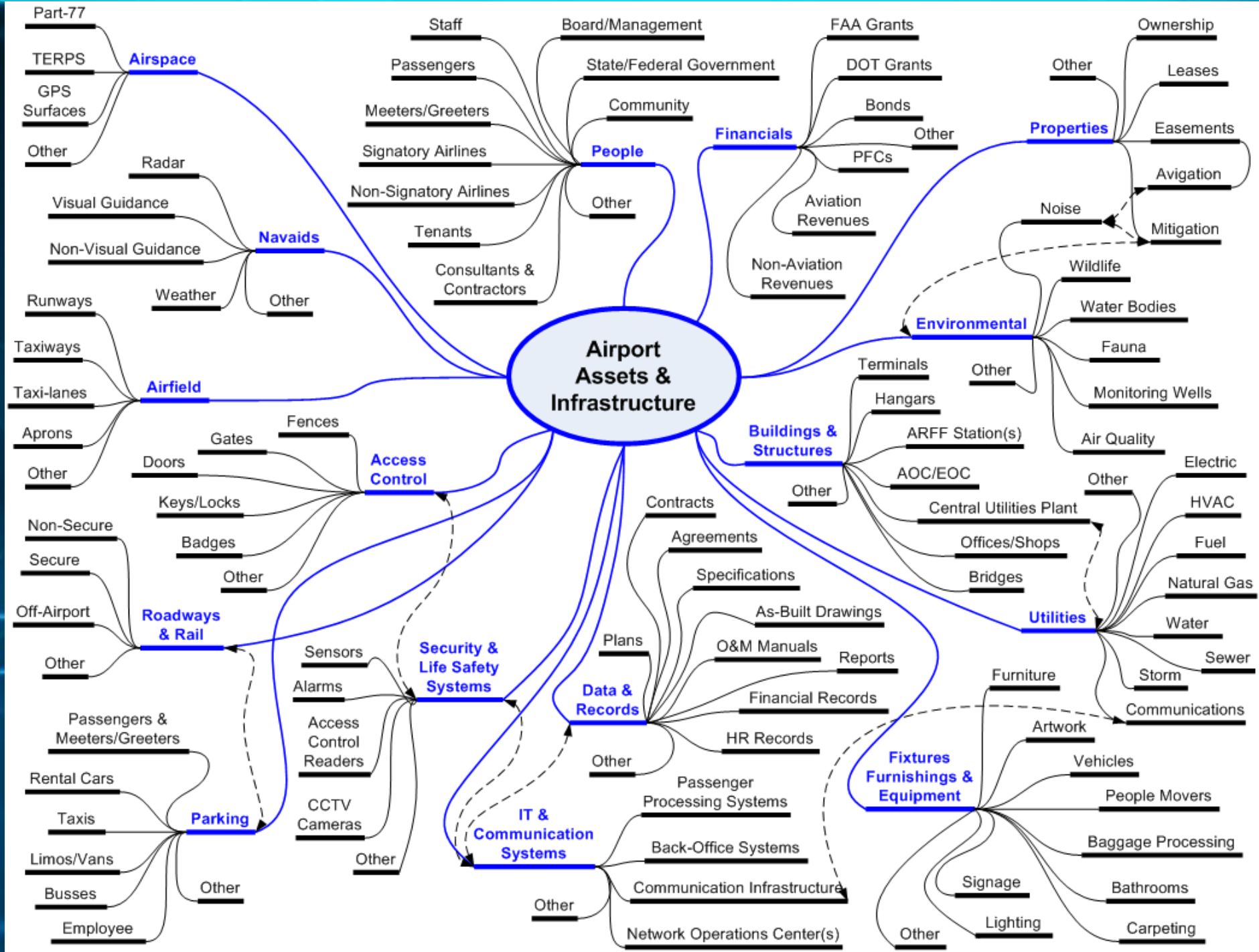
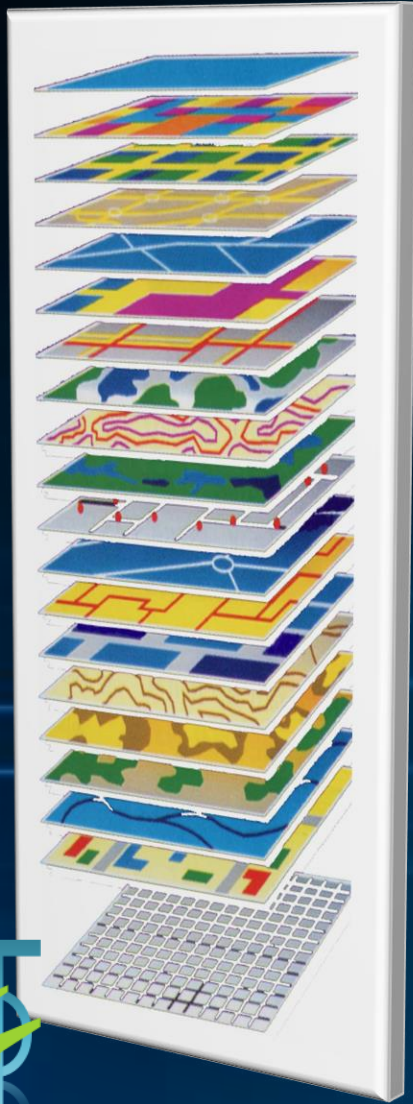


Airport DT Business Needs



- Internet of Things (IoT) with analytics have become common place (e.g., **CCTV cameras, sensors, alarms, elevators, escalators, etc.**)
- Different IoT types overlayed on disparate system maps/floorplans **need to be updated more efficiently with constant airport changes**
- **Need to correlate interdependencies** of various IoT types across large and complex airport facilities that are constantly evolving
- **Need** various IoTs with analytics **on same “page”** via shared up-to-date airport maps/floorplans

DT Fusion



Examples of DT Data Fusion



- ALP & Floor Plans
- 3D LiDAR with Draped Imagery
Outdoors & Indoors
- Airspace / AOA Traffic & NOTAMS
- Aircraft Gate Turn-Around Status
- On-Airport Roadways / Curbs
- Parking Garages / Lots Status
- People Movers Status
- Elevators / Escalators Status
- Ticket Counters Status
- Security Checkpoints Status
- PAX Congestion / Queues
- Bathrooms Status
- Alarms / Sensors / CCTV
- Incidents / Complaints
- Inspections / Issues / Weather
- Projects, Work Orders, Outages...



Airport DT Sample Use Cases

- Where are **levels of service impacted across terminal** in terms of congestion, queue lengths, wait times, elevator/escalator outage ...
- **Which CCTV cameras** cover access control alarm, smoke alarm, incident...
- When & where should work be scheduled to **minimize impacts to operations, other projects, other work orders, etc.**
- etc...



x-Spatial
is Common
Denominator

Enabling Spatial
Correlation for
Airport Digital
Twin (DT)

DT Spatial Correlation



CLT Lease... Operations Dashboard

Description: Concourse: Floor: Lease Termination:

Leases To Expire **21** This Quarter
Last update: a few seconds ago

Leases To Expire **53** Next Quarter
Last update: a few seconds ago

Lease Expiration Timeline

Total Lease Area: **230,554.4 ft²**
Last update: a few seconds ago

Total Lease Area by Tenant

Area (square feet)

Layers

- Points
- Concession
- Building Elements
- Public Services
- Floor Plan
- TSA Bag Belt
- Base Map
- Terminal Gates
- Rooms
- Actual Room Numbers
- CLMS Room Numbers
- Both Room Numbers
- Security
- Tenant Locations

Room 121C = 6415sf
 Holdroom - Gates 6 & 8
 US Airways, Inc.
 CLM# 62 16322A

IMTG Spatial Admin - CONTA Admin

Facility: Los Angeles International Airport

Facility Level: Boarding

Central Terminal Area

Floor: Level 1 - Concourse 1A/2007CA

Point height to horizontal reference plane

X	643959.844
Y	180795.543
Z	1.842
Distance	2.655 m

IMTG Spatial Admin - CONTA Admin

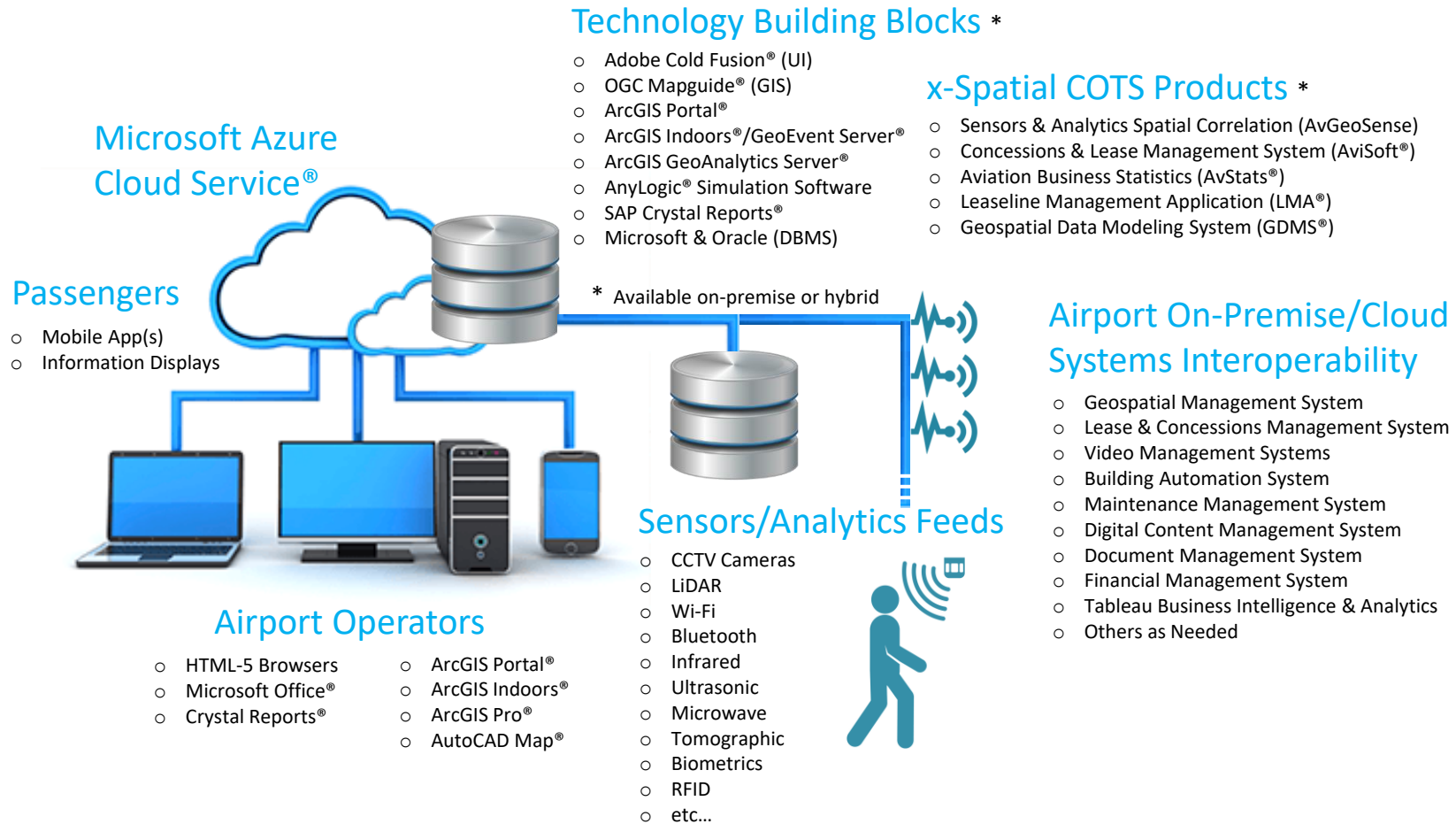
Facility: Los Angeles International Airport

Facility Level: Boarding

Data Administration View: Feature Class: buildings_safety

Primary Key Identifier	Unique Data Identifier	Name	DetailLink	Location	Date Created	Date Last
21640067	21640067	FSC-1	21640067	LAX	2016/06/27/09:34:16	2016/07/18/15:56:26
21640068	21640068		21640068	LAX	2016/06/27/09:34:16	2016/07/18/15:56:26

x-Spatial DT COTS Building Blocks



x-Spatial DT-Enabling Technology Stack

User Interfaces

- Trimble Cityworks®
- Willow Twin®
- Autodesk Forge®
- Esri Portal®
- x-Spatial GDMS®
- x-Spatial AviSoft® AvStats®

Geospatial Processing

- x-Spatial UMA/LMA®
- Solv3D®
- esri GeoAnalytics Server®
- esri GeoEvent Server®
- esri ArcGIS Indoors®
- esri ArcGIS Portal®

Sensors & Analytics

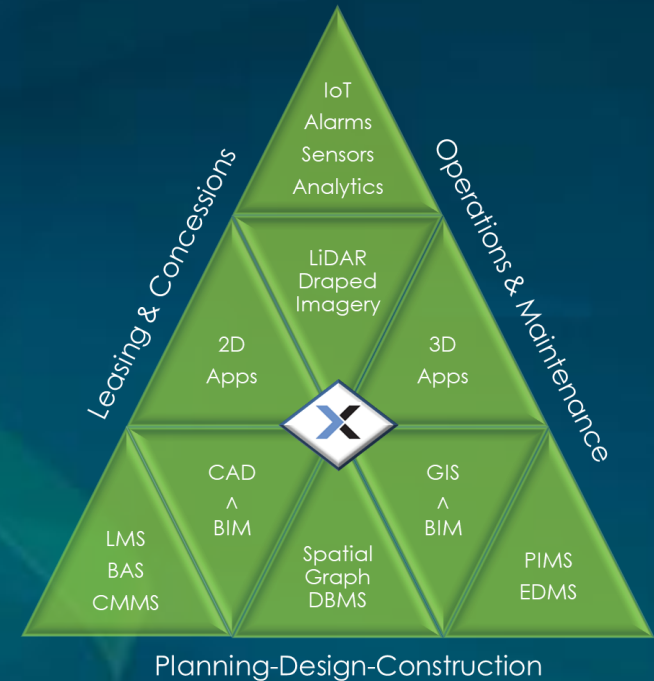
- Video Mgm't System (VMS) / Analytics
 - Cameras
 - Cameras
 - Cameras
- PAX Flux Analytics
 - Sensors
 - Sensors
 - Sensors
- Vehicle/Aircraft Analytics
 - Sensors
 - Sensors
 - Sensors

Spatial Updates

- Trimble
- AUTODESK
- esri

DBMS

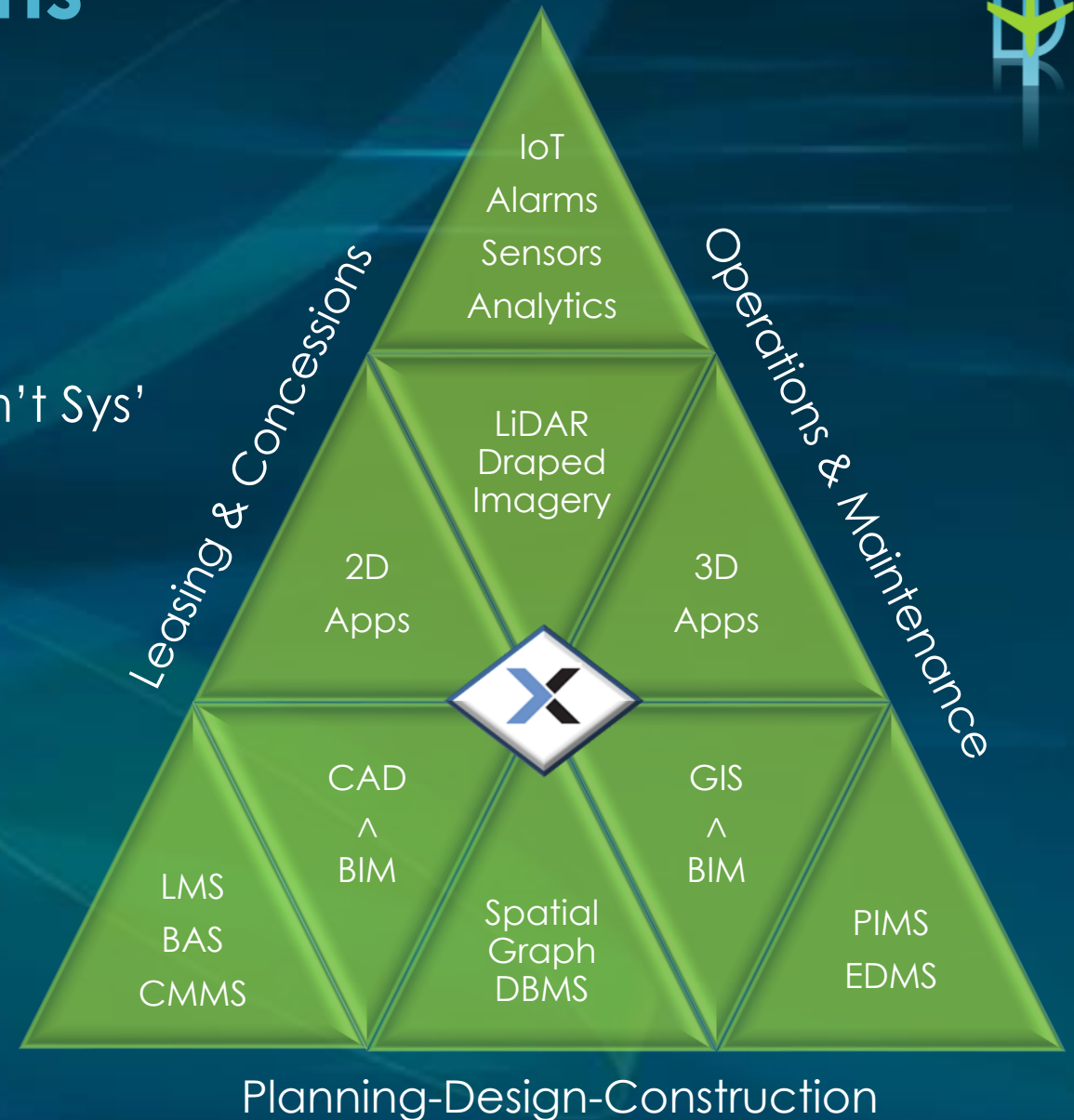
- Oracle Database®
- DDMS®
- ESRI GeoDatabase®



DT Components & Acronyms



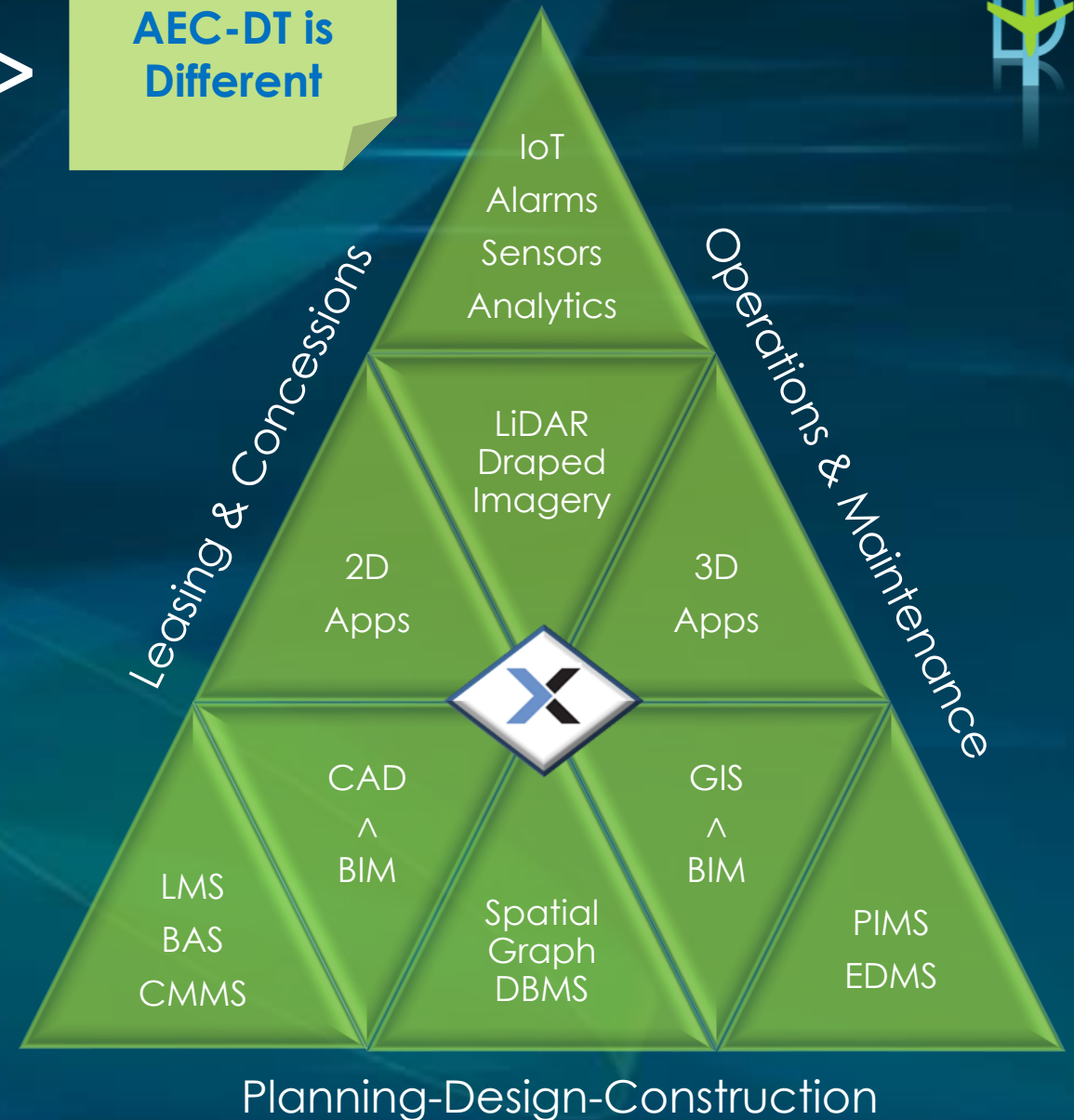
- **BAS** – Building Automation System
- **BIM** – Building Information Modeling
- **CAD** – Computer Aided Design
- **CMMS** – Computerized Maintenance Mgm't Sys'
- **DBMS** – Database Mgm't System
- **EDMS** – Electronic Doc's Mgm't System
- **GIS** – Geospatial Information System
- **IoT** – Internet of Things
- **LiDAR** – Light Detection and Ranging
- **LMS** – Lease Management System
- **PIMS** – Project Info' Mgm't System



Holistic DT Stakeholders on Airport Owner-Side ----->

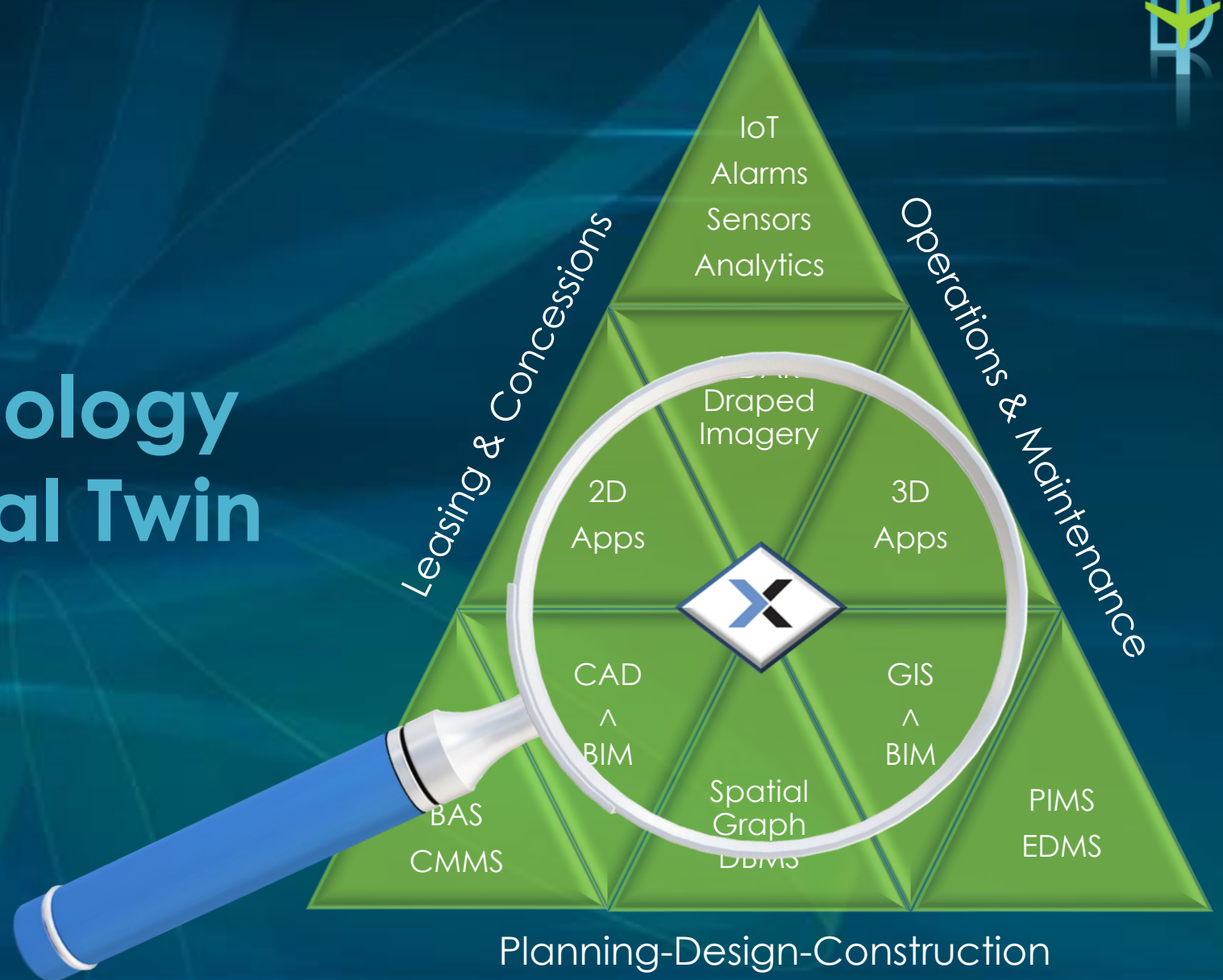
AEC-DT is Different

- Planning & Environmental
- Engineering & Construction
- Operations & Security
- Facilities Maintenance
- IT Systems & Infrastructure
- Leasing & Concessions (Revenues)
- Finance & Procurement
- Legal & Administration





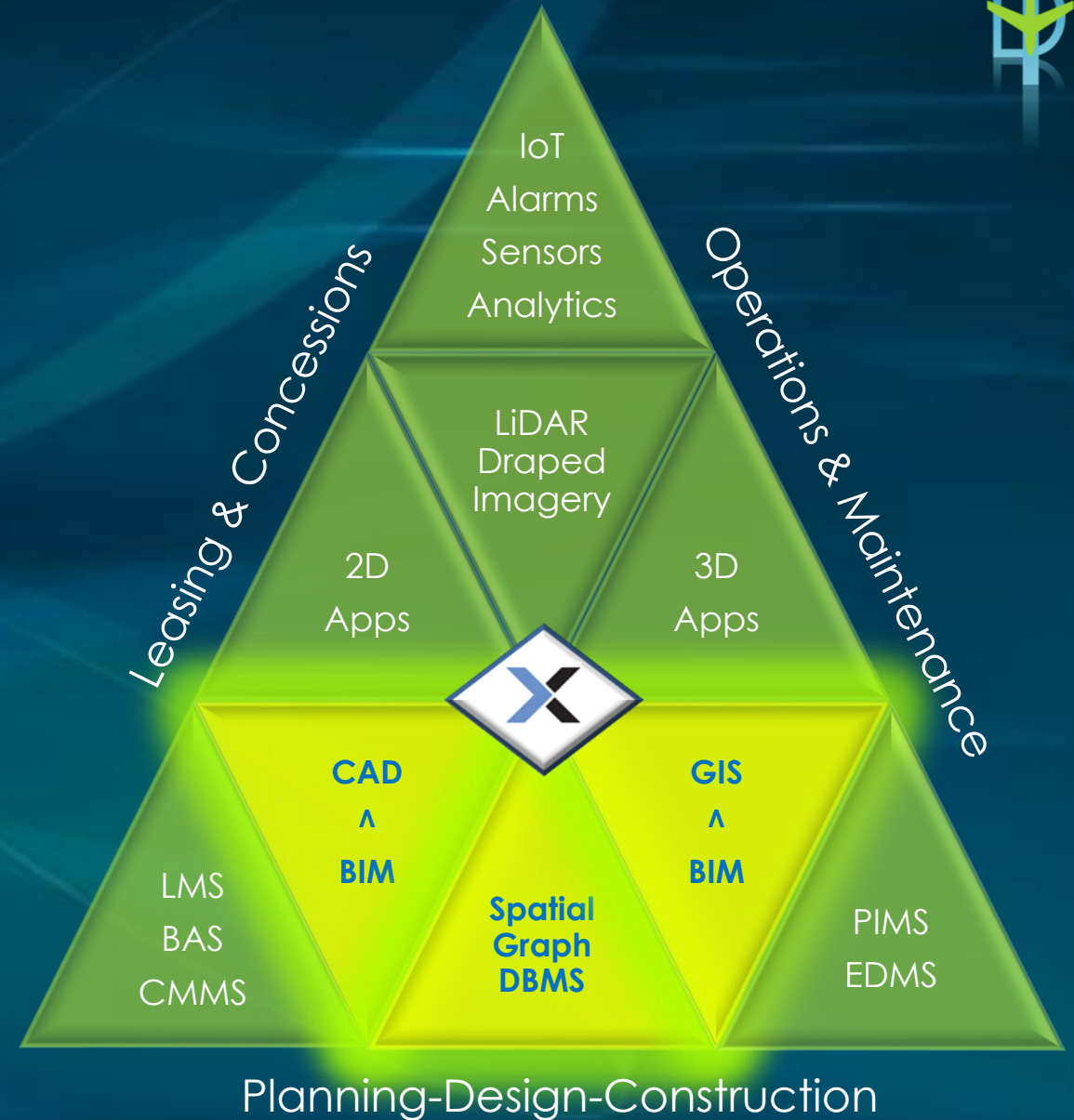
Examine x-Spatial's Enabling Technology for Airport Digital Twin



Spatial DBMS

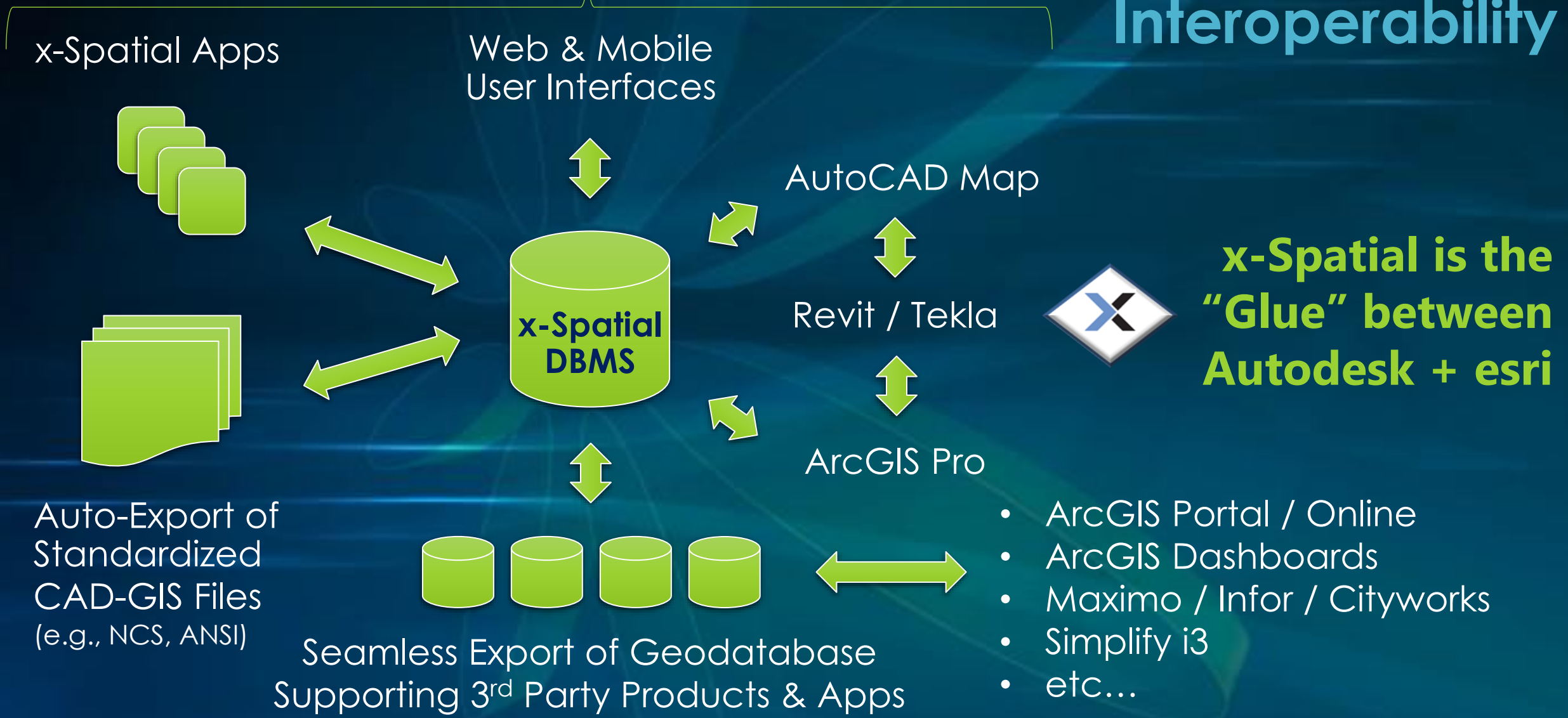


- ➔ AEC CAD Standards Export
- ➔ FAA AGIS/eALP Standards Export
- ➔ Assets Breakdown Structure (i.e., features & attributes)
- ➔ Data Processing
 - BIM ---> CAD Processing
 - CAD ---> GIS Processing
 - BIM ---> GIS Processing
 - BIM ---> BAS/CMMS Processing



Digital Twin

x-Spatial DBMS Interoperability



x-Spatial DBMS Serving Both Autodesk & ESRI



The screenshot shows the ArcMap interface with a floor plan map. The Table of Contents on the left lists the following layers:

- Mezzanine
 - LAX.MEZZANINE_FLOORPLAN
 - MLE
 - LAX.T1_MEZZANINE_TENANT
 - LAX.T1_MEZZANINE_ROOMS
 - <all other values>
 - USE
 - Boarding
 - Concessions
 - Custodial
 - Equipment
 - Maintenance
 - Miscellaneous
 - Safety
 - Security
 - Service
 - Ticketing
 - Utilities - Communications
 - Utilities - Electrical
 - Utilities - Mechanical
- Second Level
 - LAX.SECOND_LEVEL_FLOORPLAN
 - <all other values>
 - A_CADLAYER
 - A-ANNO-NOTE
 - A-ANNO-TEXT
 - A-BAGS-CONV
 - A-BAGS-CRSL
 - A-DOOR
 - A-DOOR-OVHD
 - A-DOOR-SLDG
 - A-EQPM
 - A-EQPM-FIDS
 - A-EQPM-SECU

The screenshot shows the AutoCAD Map 3D interface with a floor plan map. The Properties window is open, displaying the following feature properties:

Property Name	Value
FeatId	9010718
ACTUAL_ROOMNO	<Null>
AREA	974.0000
AS_PUBLISHED	Y
A_CREATED_BY	BEHZAD
A_CREATED_DATE	2012/08/08@20:55:06
A_FLOOR_ID	1862
A_GROUPNAME	20100001A-08
A_LOC_ID	LAX000CTA00T103080021
A_PROPERTYTYPE	ROOM
A_UPDATED_BY	BEHZAD
A_UPDATE_DATE	2012/08/08@20:55:06
BEYONDSECURITY	1
CLEAN_RESPONDESC	<Null>
CLEAN_RESPONSID	<Null>
EXCLUDEDAREA	0
FLOORID	1862
FLOORTYPEDESCR	<Null>
FLOORTYPEID	<Null>
LOC_ID	LAX000CTA00T103080021
NOTES	<Null>
PROP_ORIGIN	<Null>
PROP_ORIGINDESC	<Null>
REAREA	808.0000
ROOMDESCRIPTION	Food and Beverage
ROOMID	54760
ROOMNO	21
ROOMRENTABLE	<Null>
ROOMTYPEDESCR	Concessions
ROOMTYPEID	34
STATUS	<Null>
TOOLTIP	Rm# 21 = 974sf,nConcessio...

x-Spatial Industry Unique Top 10 Features



1. “Single Source of Truth” **Spatial Database** Management System (DBMS) Serving Many Needs
2. **No DBA Required** for Spatial DBMS – User Friendly Web User Interface with Metadata
3. Rich CAD-GIS Database Structure Based on **National Standards** which can be Tailored by Owner
4. **Automation of GIS Data Creation / Updates** from AEC Deliverables (e.g., CAD to GIS conversion, asset re-numbering)
5. **Data Co-Editing** from AutoCAD Map, ArcGIS Pro, and Web Applications



x-Spatial Industry Unique Top 10 Features



6. Preserved AutoCAD Data Characteristics for Re-Use by AEC (e.g., line styles, colors, layers, etc.)



7. Preserved esri Data Characteristics for GIS Analysis (e.g., Topology, Networks, etc...)



8. Seamless Output of Geodatabase and Web Services Serving ESRI-based Products

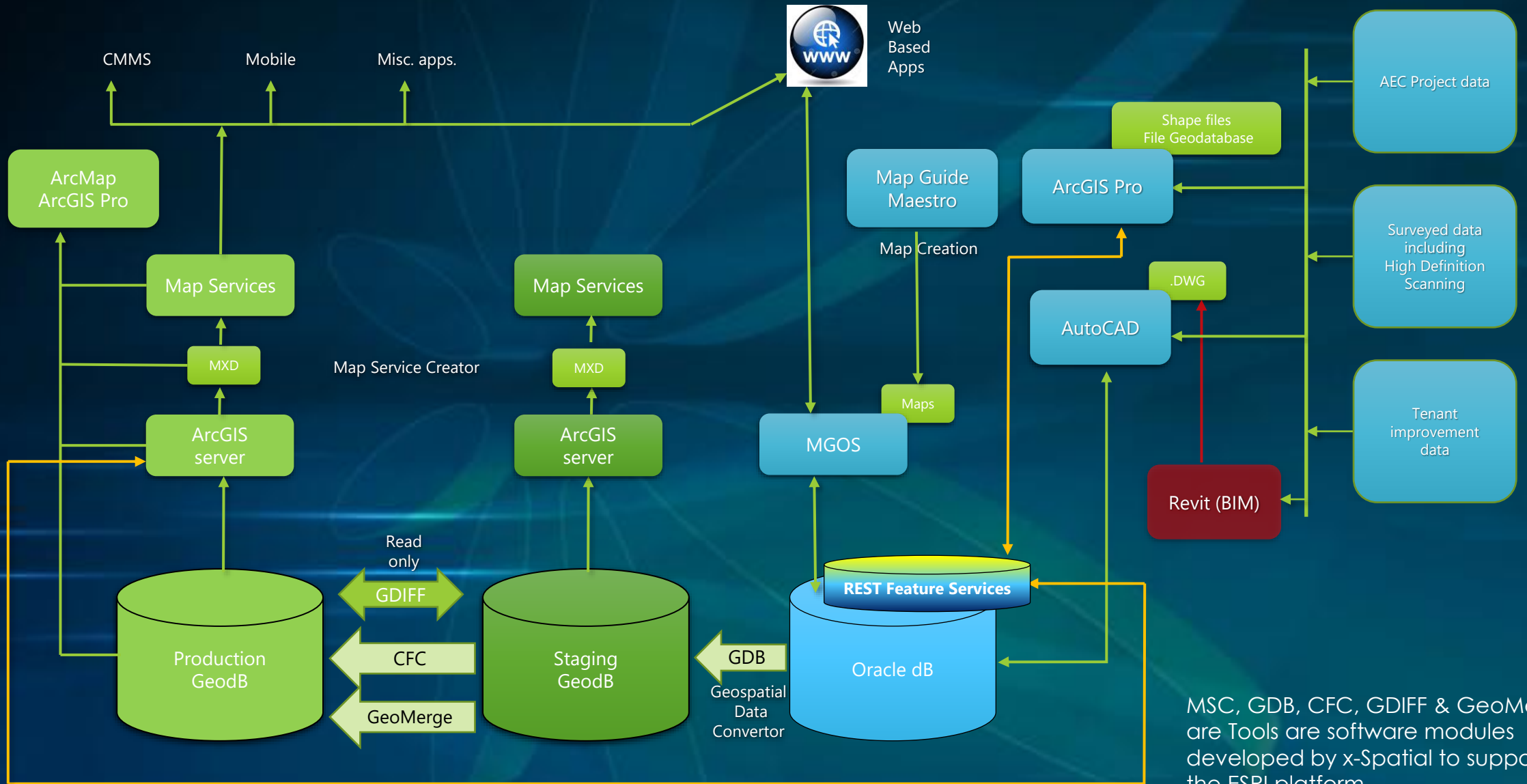


9. Automated Output of Standardized Datasets (e.g., AIA/Civil CAD, ANSI GIS, FAA, etc.)

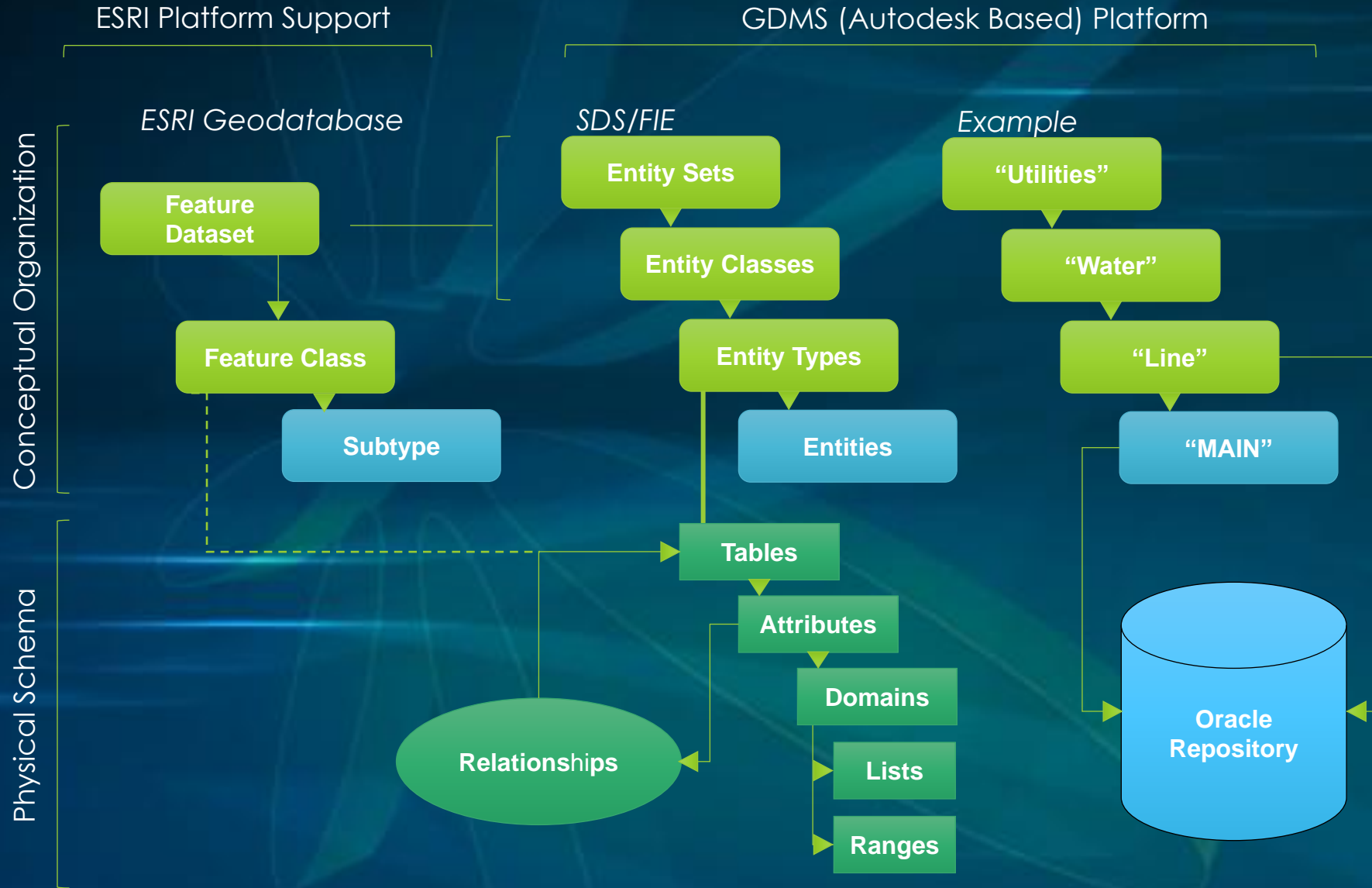


10. Integrated Web Applications (e.g., Source Drawings Mgm't, Utilities Mgm't, Pavement Mgm't, Lease Mgm't, etc.)

System Architecture



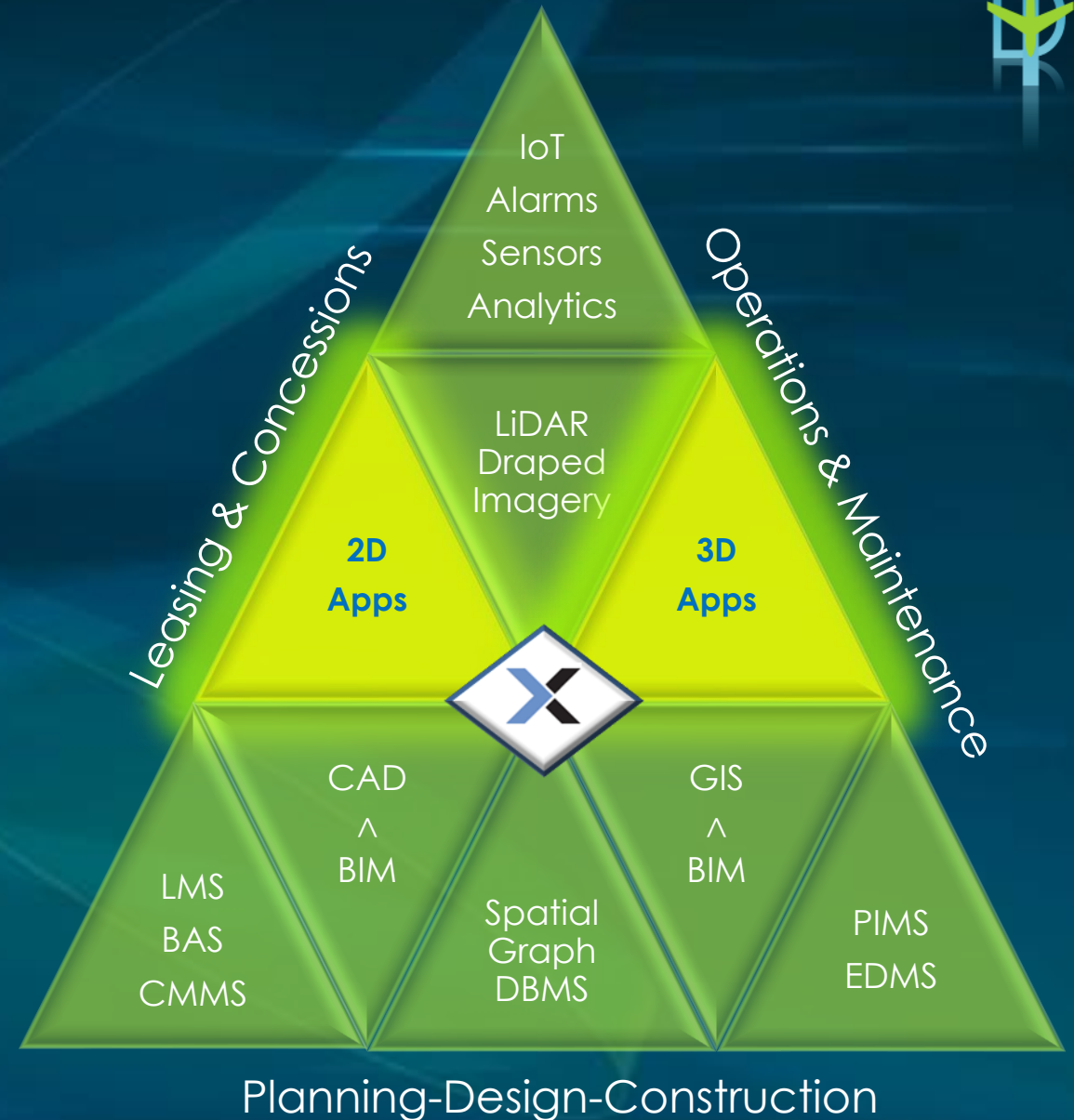
Data Structure



2D & 3D Applications



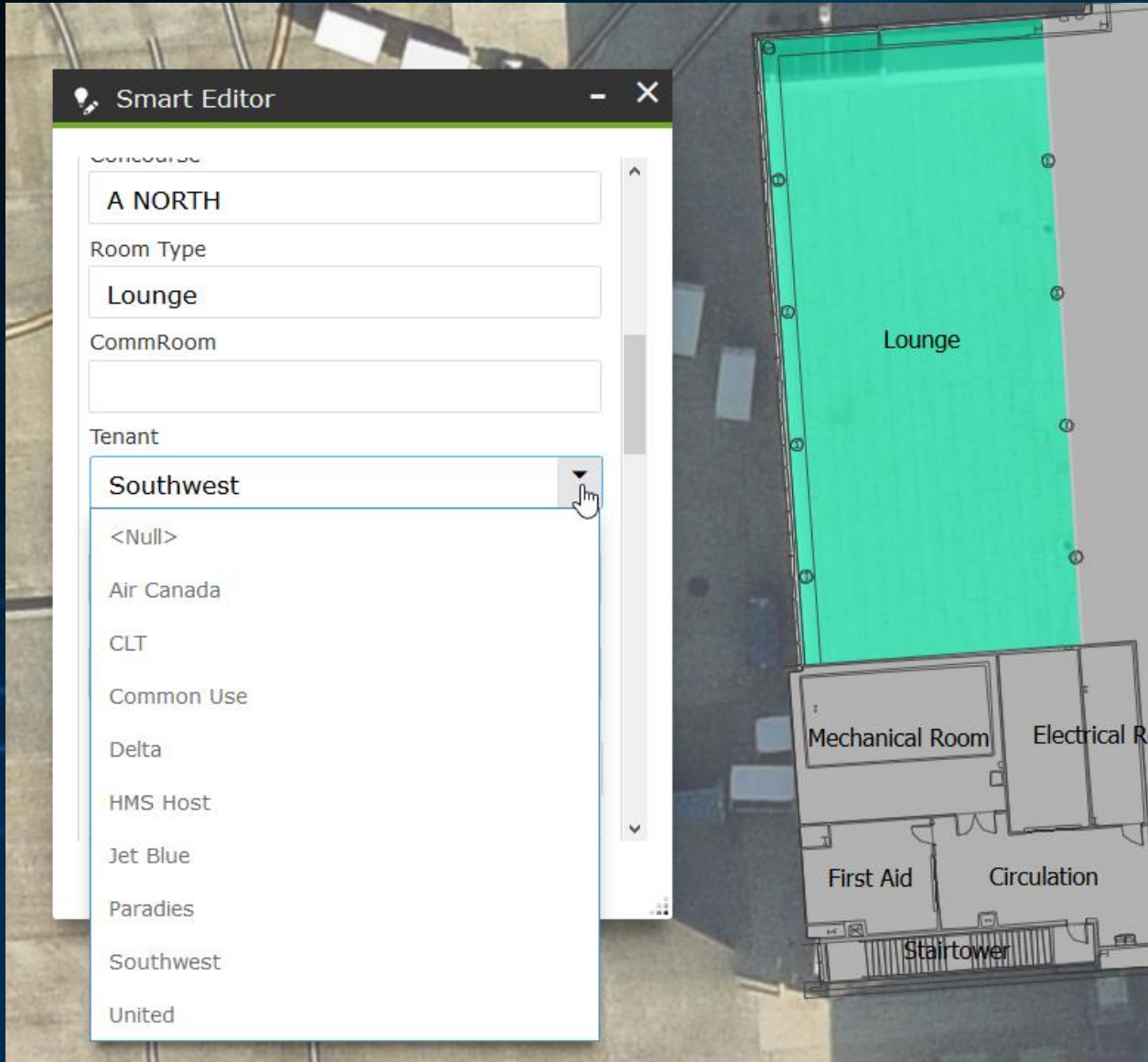
- ➔ Most map-based applications used by airport owner are 2D; easier to understand
- ➔ 3D mostly used by airport owner for:
 - Height constraints analysis related to airspace
 - Line of site analysis for ATCT and CCTV camera placement
 - Subsurface utilities depth analysis



Light User Web Applications



Light User Mobile Applications



LAWA
Spatial Admin DDMS Admin

Hello Anna X Melikyan
Logoff
Home
Open Map
Search
Data Explorer

- boundary
- buildings
 - buildings_access
 - buildings_equipment
 - buildings_general
 - buildings_roof
 - buildings_safety
 - buildings_security
 - buildings_space
 - buildings_structure
- cadastre
- communications
- environmental_hazards
- fauna
- flora
- geodetic
- geology
- improvement
- land_status
- landform
- transportation
- utilities
 - utilities_cntrl_mntr_system
 - utilities_compressed_air_sy
 - utilities_electrical_ext_light
 - utilities_electrical_system
 - utilities_fuel_system
 - utilities_general
 - utilities_heat_cool_system
 - utilities_industrial_system
 - utilities_natural_gas_syste
 - utilities_storm_system

Layers

- Buildings
- Boundaries
- Property Mgmt
- Transportation
- Aircraft
- Vehicle
- Rail
- Pedestrian
- Parking
- Utilities
 - Communications Syst
 - Electrical System
 - Fuel System
 - Natural Gas System
 - Water System
 - Sanitary Sewer System
 - Storm Drain System
- Fences Gates and Walls
- Environmental
- Survey Control
- Geology and Soils
- Grounds
- Wells
- Contours and Coastline
- Parks and Recreation
- Grids
- Planned Construction
 - Airfield
 - Transport
 - Utilities
 - Bridges
 - Structures
 - Fences/Gates/Walls
 - Parking
 - Removed

X: 6425661.707718, Y: 1799023.582801 (FOOT) | 0 features selected | 1: 22302.27 | 4.76 x 2.37 (mi) | Powered by MapGuide

Data Administration View Feature Class: utilities_electrical_system

electrical_cable_line	electrical_capacitor_point	electrical_ductbank_line	electrical_generator_point	electrical_ground_point	electrical_junction_site	electrical_meter_point	electrical_motor_point	electrical_panel_area	electrical_pedestal_point					
Material Composition Code	Group Conductor Quantity	group Conductor Size Code	Voltage Code	Narrative Text	Depth	Datalink ID	Location	Date Created	Date Last Edited	DDMS Source	Comment	Disposition	Is Published	Type Discriminator
STEEL_GALV			6	1 1/2" CONDUIT				1 1/2" CONDUIT	289164	LAX	2005/05/04@08:29:55	2016/12/23@08:30:42	0150174	EXIST 1 1/2"

(1-25 of 7,123 Records) First Previous Next→ Show ALL Records

Power User Interface

Utilities: Courtesy of LAX & x-Spatial



LAWA
Spatial Admin **DDMS Admin**

Jello Anna X Melikyan
 ogoff

Home
 Open Map
 Search
 Data Explorer

- boundary
- buildings
- cadastre
- communications
- environmental_hazards
- fauna
- flora
- geodetic
- geology
- improvement
- land_status
- landform
- transportation
 - trans_pavement_distress
 - trans_pavement_inventory
 - transportation_air
 - transportation_airfield_facili
 - transportation_general
 - transportation_pedestrian
 - transportation_railroad
 - transportation_vehicle
- utilities

Pavement Management
 ELSEE
 Mobile Data
 Reports

Layers

- Buildings
- Boundaries
- City - County Boundaries
- Property Mgmt
- Transportation
 - Aircraft
 - NavAid
 - RWY End Poir
 - Centerlines
 - Airfield
 - Runway
 - Taxiway
 - Taxilane
 - Apron
 - Airfield Names
 - Infield
 - Dustcap
 - Airport Safety Are
 - Object Fre
 - Obstructio
 - Runway P
 - Runway S
 - Taxiway S
 - All Areas
 - Vehicle
 - Pedestrian
 - Parking

Map Position
 Create Point Data
 Add Point(s)
 Multi-Point Mode
 Point Classification
 buildings
 buildings_access
 bldgs_door_point
 DOOR_EXTERIOR

Auto-Generate Attributes
 Auto-Gen Suffix
 Delete Point(s)
 Move Point(s)

Quickview
 Admin East
 Admin West
 CTA
 Century East
 ConRac Area
 FBO
 Imperial Cargo Complex
 Imperial East

GoTo Update Add Remove
 Private quickview
 (+) Admin. quickview

Layer Set
Map Tools
 Zoom Scale

X: 6445926.113201, Y: 1799673.757519 (FOOT) | 0 features selected | 1: 30281.66 | 3.56 x 2.52 (mi) | Powered by MapGuide

Data Administration View **Feature Class: transportation_air**

airfield_infield_site | airfield_safety_area | airfield_surface_centerline | airfield_surface_marking_area | **airfield_surface_site** | navigational_aid_point | rwy_disp_thresh

	Unique Data Identifier	Use Code	Feature Name	FM Name	FM Type	FM Name - OLD	Datalink ID	Location	Date Created	Date Last Edited	DDMS Source	Comment	Dispo
<input type="checkbox"/>	19555002	Dustcap		DCPE08	DCP		19555002	LAX	2016/01/28@13:52:14	2021/02/25@09:10:37			
<input type="checkbox"/>	19555003	Dustcap		DCPC01	DCP		19555003	LAX	2016/01/28@13:52:14	2021/02/25@09:10:37			

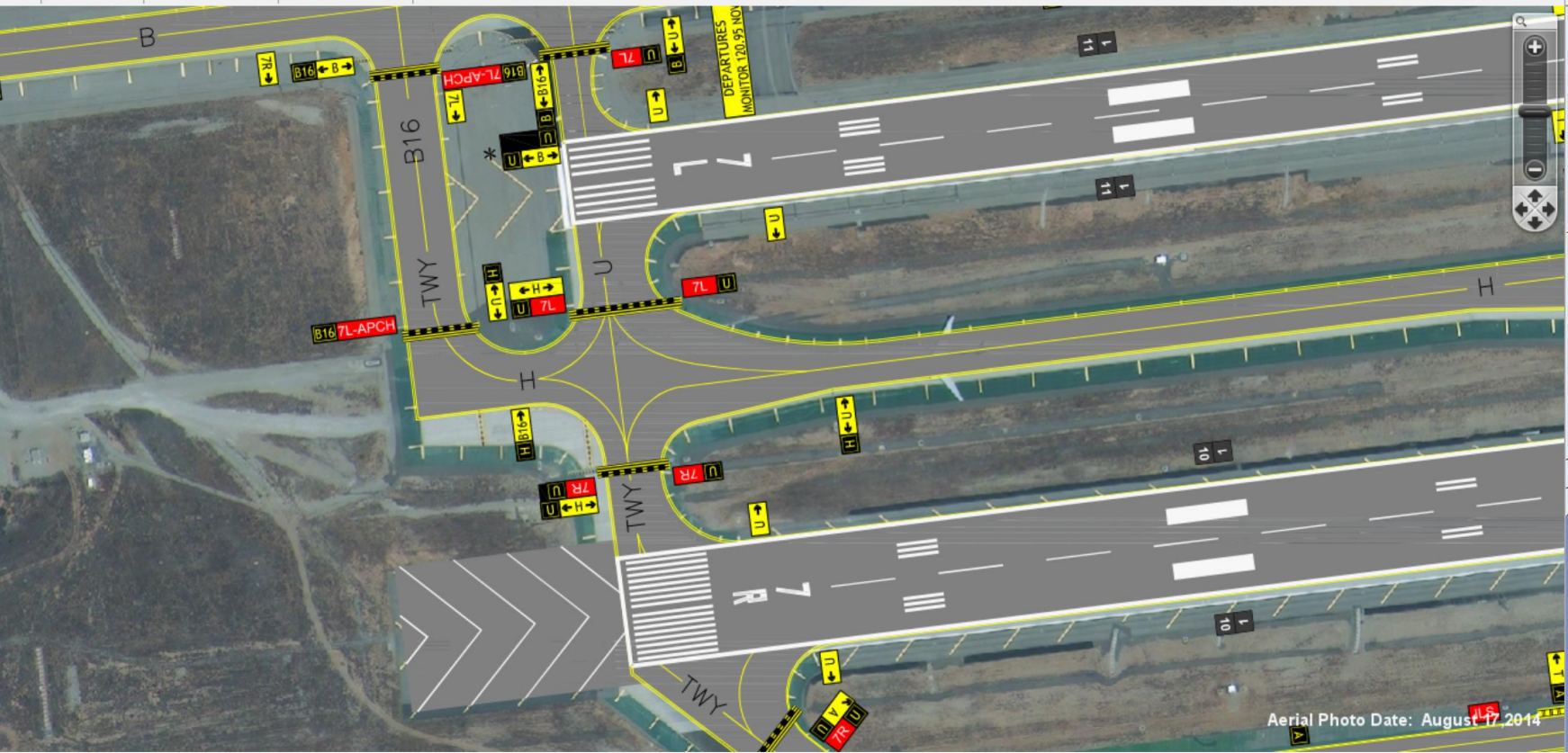
(1-25 of 663 Records) | First | Previous | Next → | Show ALL Records | Show 25 Rows per

Airfield: Courtesy of LAX & x-Spatial



Layers

- Buildings
- Transportation
- Airside
 - Airfield Light Point
 - Navigational Aid F
 - Aircraft Parking S
 - Part 139 Day Insp
 - Service Road
 - Airfield Marking
 - Facility Maintenar
 - Runway
 - Taxiway
 - Taxilane
 - Apron
 - Infield
 - Airfield Surface
 - Airfield Surface P
 - Signage
 - signage_ed
- Landside
- Thomas Brothers
- Aerial
- Base Map
- Building



Aerial Photo Date: August 17, 2014

X: 6433551.715925, Y: 1798251.134426 (FOOT)

0 features selected

1: 2422.70

2887.47 x 1377.49 (ft)

Kelar Microwizard

Quickview

- (+)2nd Level Roadway As-B
- (+)Admin East
- (+)Admin West
- (+)Butterfly Zone
- (+)Central Terminal Area - C
- (+)Century Blvd
- (+)Century Cargo Area
- (+)FBO

GoTo Update Add Remove

(*) Private quickview

(+) Admin. quickview

Layer Set

(*Jeds lazer
86026-80-01-R02

Re-Load Update Add Remove

(*) Private layer set

(+) Admin. layer set

Parcels															Printer Friendly Version
	Location Code	Parcel No.	Parcel Name	Zoning	Actual Area	Datalink ID	Type Discriminator	Location	Date Created	Date Last Edited	Owner Operator	Leaseholder Name	Comment	Disposition	Is Published
<input type="checkbox"/>	LAX000CTA	CTA	CTA	TERMINAL	23,223,120.00	11565485	PARCEL	LAX	2013/07/25@18:59:51	2013/08/28@15:53:51					Y
<input type="checkbox"/>	LAX000RAC	RAC	RAC	SERVICE	7,264,021.00	11565498	PARCEL	LAX	2013/07/25@18:59:51	2013/08/28@00:28:34					Y
<input type="checkbox"/>	LAX00AQBF	AQBF	ACQUISITION AREA - BELFORD	ACQUISITION AREA	880,216.00	11565491	PARCEL	LAX	2013/07/25@18:59:51	2013/08/28@00:28:34					Y
<input type="checkbox"/>	LAX00AQMS	AQMS	ACQUISITION AREA - MANCHESTER SQUARE	ACQUISITION AREA	5,322,053.00	11565492	PARCEL	LAX	2013/07/25@18:59:51	2013/08/28@00:28:34					Y
<input type="checkbox"/>	LAX00BADL	BADL	BADLANDS	OPEN	5,209,899.00	11565488	PARCEL	LAX	2013/07/25@18:59:51	2013/08/28@00:28:34					Y

Power User Interface

Signage & Markings:
Courtesy of LAX & x-Spatial



File Edit View Favorites Tools Help
 x-Spatial - Home LAWA DDMS MPA DDMS MGP CLMS Login AviSoft AEGIS Login

IMTG

Spatial Admin DDMS Admin

Hello Ahmad Maghboul

Home

Open Map

Facility

Van Nuys Airport

VNY_APMS

Parcel

Select a Parcel

Building

Select a Building

Floor

Select a Floor

--Select a Map--

Search

Data Explorer

Pavement Management

Inventory Tree

Inspections/Export

Maintenance Report

ELSEE

Mobile Data

Reports

Document Administration

Spatial Data Administration

Geodatabase Administration

System Administration

Layers

- Aerial
- Airfield
- Buildings
- Pavement
 - Inspection
 - Asphalt Distress
 - Concrete Distress
 - Inventory
 - Sub-sample
 - Sample
 - Section
 - Branch
 - Surface Type
 - Use
 - Maintenance
 - Asphalt Distress
 - Concrete Distress

Quickview

Layer Set

Map Tools

Zoom Scale

Zoom Selection

Zoom to Initial View

Zoom to Previous View

Zoom to Next View

Buffer

Select within

Clear Selection

Measure Dist

Measure Area

Get Length

Get Area

Get Coordinates

Printable Page

Dwf Plot

Markup Tools

ID: 9202017
 Type: distress_point_pcc_insp
 SubType: POINT
 Comment: 12/10/2013 8:35:04 AM
 Distress Type: 74 - Joint Spalling [SLABS]

Edit 9202010, transportation, trans_pavement_distress, distress_point_pcc_insp, POINT, trpvinspcc

Location VNY

Created By behzad

Date Created 2013/12/10@08:42:34

Last Edited By behzad

Date Last Edited 2013/12/10@08:42:34

Reason Code

Quality Level D - DERIVED

Ddms Source

Qa Status 1 - GEOMETRY ONLY

Owner Operator LOW

Leaseholder Name

Comment 12/10/2013 8:42:34 AM

Disposition

Is Published N

Attributes Documents (0)

Primary Key Identifier 9202010

Distress Type 62 - Corner Break [SLABS]

Distress Severity L

Distress Comments

Aerial Photo Date: May 2nd, 2013

1 Concrete Distress selected 1: 287.52 342.68 x 163.48 (ft) Kelar Microwizard

Printer Friendly Version

Sample Date From	Sample Date To	Last Updated by	Last Updated on
12/10/2013	12/31/2013	behzad	01/17/2014
12/10/2013	02/01/2014	behzad	01/03/2014

Power User Interface



LAWA

Spatial Admin DDMS Admin

Hello Anna X Melikyan

Logoff

Home

Open Map

Search

Data Explorer

- + boundary
- buildings
 - buildings_access
 - buildings_equipment
 - buildings_general
 - buildings_roof
 - buildings_safety
 - buildings_security
 - buildings_space
 - buildings_structure
- + cadastre
- + communications
- + environmental_hazards
- + fauna
- + flora
- + geodetic
- + geology
- + improvement
- + land_status
- + landform
- + transportation
- utilities
 - utilities_cntrl_mntr_system
 - utilities_compressed_air_sy
 - utilities_electrical_ext_light
 - utilities_electrical_system

Layers

- Safety
 - APD HQ
 - Fire Stations
 - Security Posts
 - Patrol Areas
 - Dispatch Points
 - Exterior Dispa
 - Common Name
 - Dispatch Doors
 - Duress/Cover
 - Phone
 - AED
 - Fire Ext
 - TBD
 - All Dispatch P
 - Common Name
 - Dispatch Doors
 - Duress/Cover
 - E Phone
 - VOIP Location
 - AED
 - Fire Ext
 - TBD
 - All Points by F
 - Common Nam
 - 207 Doors by I
 - AED and First



Map Position

Create Point Data

Add Point(s)

Multi-Point Mode

Point Classification

buildings

buildings_access

blbgs_door_point

DOOR_EXTERIOR

Auto-Generate Attributes

Auto-Gen Suffix

Delete Point(s)

Move Point(s)

Quickview

Admin East

Admin West

CTA

Century East

ConRac Area

FBO

Imperial Cargo Complex

Imperial East

GoTo Update Add Remove

Private quickview

(+) Admin. quickview

Layer Set

Map Tools

Zoom Scale

X: 6440853.299056, Y: 1801676.428155 (FOOT) 0 features selected 1: 11708.59 7277.21 x 5142.84 (ft) Powered by MapGuide

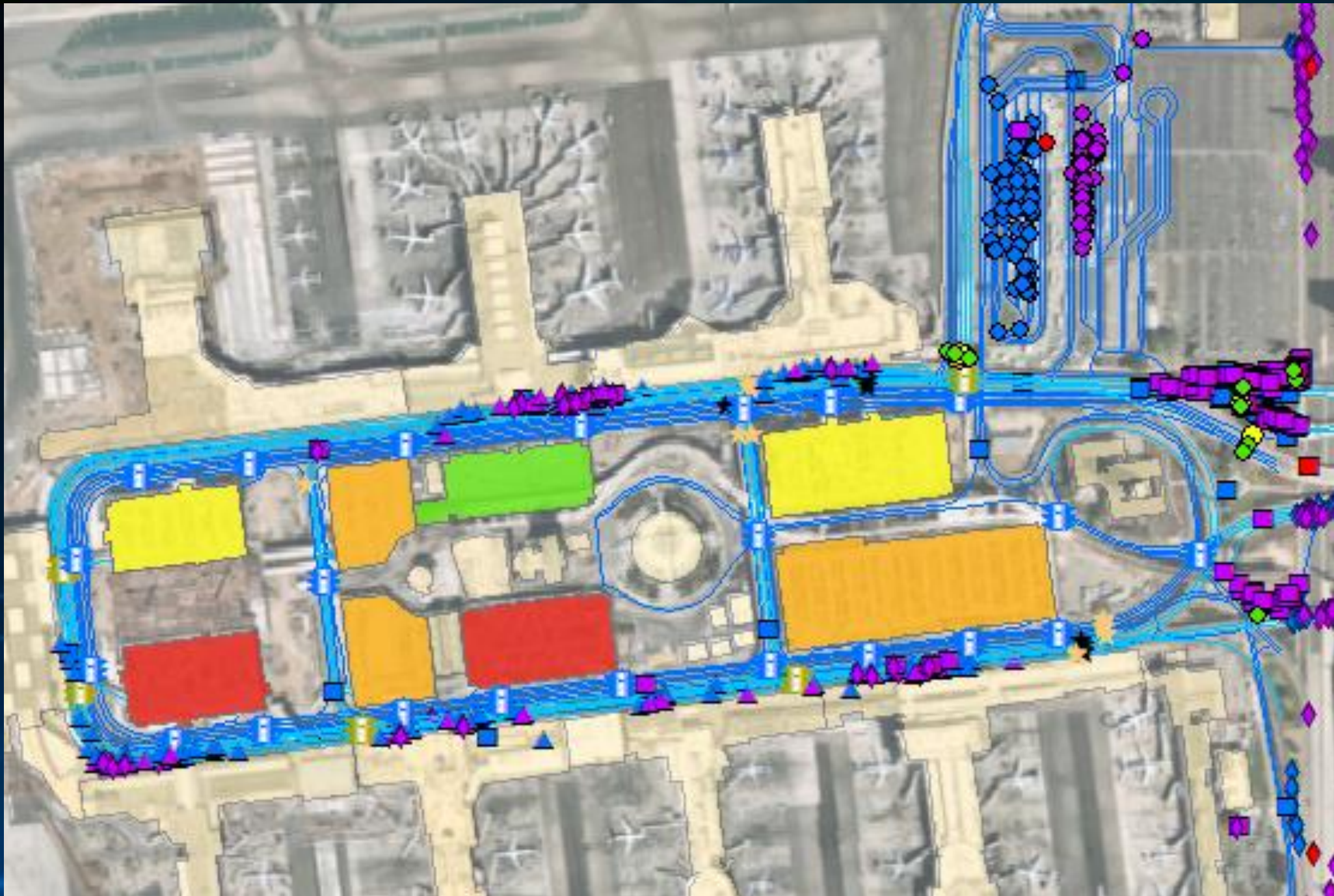
Tasks

Data Administration View Feature Class: buildings_general

slab_area	structure_existing_point	structure_existing_site	structure_foundation_line	structure_future_site	structure_modification_site																					
Unique Data Identifier	Location Code	Parcel ID	Building Name	Legacy Name	Building No.	FM - Name	FM Name - OLD	FM - Type	Use Code	Type Code	Status Code	Condition Code	Security Access Level	Address 1	Address 2											
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	14488166	14488166	LAWA	Centra Cargo		D0501	CGRC41	CRG	Cargo	PERMANENT		10326	Aviation

(1-25 of 696 Records) First Previous Next → Show ALL Records





Courtesy of LAX
Central Terminal
Area Near Real
Time Traffic

GIS Data

- Traffic signals
- Parking structures
- Transponder readers
- Traffic count loops
- Centerline per lane

Non-Spatial
Real-Time Data

- TNC data
- Traffic count loop data
- Transponder data
- Parking occupancy

The screenshot displays a GIS application interface. On the left, there are navigation and search panels. The top-left corner shows the 'LAWA' logo and user information for 'Hello Anna X Melikyan'. Below this are panels for 'Spatial Admin', 'DDMS Admin', and 'Home'. The 'Open Map' panel includes dropdowns for 'Facility' (Los Angeles International Airport), 'Facility Level' (Level 01), 'Sector' (Central Terminal Area), 'Building' (Tom Bradley International Termin), and 'Floor' (Arrival - LAX000CATBIT01). A 'Data Explorer' panel on the left lists various data layers like 'boundary', 'buildings', 'cadastre', etc. The main map area shows a detailed floor plan of a terminal building with various colored zones and points. A 'Layers' panel on the left lists categories like 'Emergency Info', 'Equipment', 'Interior Features', and 'Base Map'. On the right, there are panels for 'Map Position', 'Create Point Data', 'Quickview', and 'Map Tools'. The bottom status bar shows coordinates and map scale.

Data Administration View Feature Class: buildings_safety

		bg_safe_asset_point	em_access_point													
		Primary Key Identifier	Unique Data Identifier	Name	Phone Number	Serial Number	Narrative Text	Datalink ID	Location	Date Created	Date Last Edited	DDMS Source	Comment	Disposition	Is Published	Type Discriminator
<input type="checkbox"/>		29871981	29871981		2000017130		Family Restroom	29871981	LAX	2017/10/13@10:07:48	2020/05/22@09:24:30				Y	EMERGENCY_PHONE
<input type="checkbox"/>		29871983	29871983					29871983	LAX	2017/10/13@10:01:59	2018/04/25@12:18:28				Y	FIRE_EXTING
<input type="checkbox"/>		29871984	29871984		2000017128		Women's Restroom	29871984	LAX	2017/10/13@10:01:06	2020/05/22@09:25:07				Y	EMERGENCY_PHONE

(1-25 of 63 Records) First Previous Next→ Show ALL Records Show 25 Rows per page

Power User Interface

Emergency Assets:
Courtesy of LAX & x-Spatial



Airport Assets Symbolized in 2D



IMTG

Spatial Admin DDMS Admin

Hello Behzad Mohammadi

Logoff Show System Variables

Home

Open Map

Facility

Los Angeles International Airport

LAX

Facility Level

Basement

Default Facility Map

Sector

Central Terminal Area

Building

Tom Bradley International Termi

Floor

Level 4 - Departures - LAX000C

[Admin_Only] Security Equipmer

Search

Data Explorer

- + boundary
- buildings
 - buildings_access
 - buildings_equipment
 - buildings_general
 - buildings_roof
 - buildings_safety
 - buildings_security
 - buildings_space
 - buildings_structure
- + cadastre
- + communications
- + environmental_hazards
- + fauna
- + flora
- + geodetic
- + geology
- + improvement

Layers

- Layer Group
 - acams_point_by_I
- CCTV
 - Camera
 - PTZ Camera
- Emergency Info
 - Emergency Stair
 - Defib, Fire Ex., En
 - Defib / Bleed Kit
 - Fire Extinguisher
 - Emergency Phone
 - Unknown
- Equipment
 - Interior Features
 - Floorplan Informaton
 - Building Zones
 - Door / Access Points
 - Ladders
 - Interior Doors
 - Emergency
 - Entry Access
 - Stair Access
 - Interior Access
 - Unclassified

X: 6437459.792370, Y: 1801776.020809 (FOOT)

0 features selected

Map Position

Create Point Data

Add Point(s)

Multi-Point Mode

Point Classification

transportation

transportation_airfield_facility

airfield_facility_surface_site

N/A

Auto-Generate Attributes

Auto-Gen Suffix

Delete Point(s)

Move Point(s)

Quickview

Layer Set

Map Tools

Markup Tools

Entity Attribute - Internet Explorer

http://agis.x-spatial.com/UMS/cfscrips/Forms/EntityType_View.cfm?RecordID=21640067

Location	LAX
Created By	SP028139541053\lawadefault
Date Created	2016/06/27@09:34:16
Last Edited By	avidovic
Date Last Edited	2016/07/18@15:56:26
Reason Code	
Quality Level	D
DDMS Source	
QA Status	1 - GEOMETRY ONLY
Owner Operator	
Leaseholder Name	
Comment	
Disposition	
Is Published	Y
Type Discriminator	AED

Attributes Documents (0)

Primary Key Identifier	21640067
Name	T4S

	Primary Key Identifier	Unique Data Identifier	Name	Datalink ID	Location	Date Created	Date Last			
<input type="checkbox"/>	21640067	21640067	T4SC-1	21640067	LAX	2016/06/27@09:34:16	2016/07/18@15:56:26			Y
<input type="checkbox"/>	21640068	21640068		21640068	LAX	2016/06/27@09:34:10	2016/07/18@15:56:26			FIRE_EXTING

(1-19 of 19 Records) First Show 25 Rows per page

Los Angeles World Airports Example

- Airport Enterprise GIS (AEGIS) system by x-Spatial
- Hierarchically structured spatial database
- Interior & exterior data for three facilities
 - LAX
 - VNY
 - PMD
- Project deliverables repository
- Standards & specs
- Enterprise Services
 - Police CAD
 - Facility Maintenance (Maximo)
 - Lease Management (Propworks)
- **Current challenges**
 - **Keeping up with data updates**
 - **Dynamic / quickly changing terminal layouts**
 - **Ongoing Capital construction**
 - **By time as-built received, it's obsolete, as tenants constantly do modifications**
 - **No true integration with Police CAD & Maximo**

INTERIOR DATA

- **169 buildings** with floors for LAX & VNY airports
- **475 floors** containing floor plans, room, lease, and other info
- Total number of **rooms – 30,059**
- Total **room square footage – 34,276,866**
- Existing **Terminal square footage – 9,130,786**

OVERALL LEASE DATA

- Total number of **lease spaces – 28,973**
- Total **lease square footage – 36,357,501**

EXTERIOR DATA

- **424,858 features of 239 types**

SPATIALLY REFERENCED DOCUMENTS

- **~180,000 drawings & reports**

DT spatial visualization in 2D vs 3D



Airport Spatial Assets	Both 2D & 3D	2D	3D
FAA AGIS (Outdoors)	Sustainable via GIS & LiDAR		
Airfield (e.g., runway, taxiway, apron, areas, lights, signs, markings)		Yes	Maybe
Airspace (e.g., surfaces, obstructions, protection area)		Yes	Yes
Cadastral (e.g., boundary, parcel, zoning, easement, land use, trade zones)		+Yes	No
Environmental (e.g., HAZMAT, fauna, flora, flood zones, wetland, noise)		Yes	Yes
Geospatial (i.e., airport control points, PACS/SACS, coordinate grid, contours)		Yes	Yes
Man Made Structures (e.g., building, construction area, roof, fence, gate, tower)		Yes	Yes
NAVAIDs (i.e., equipment and protection zones)		Yes	Yes
Security (e.g., areas, perimeter lines)		Yes	Maybe

Which is more practical for which applications?

Which is more sustainable?

DT spatial visualization in 2D vs 3D (cont')



Airport Spatial Assets		2D	3D
Surface Transportation (e.g., bridge, road, parking, rail, tunnel, sidewalk)		Yes	Yes
Utilities (i.e., above ground & subsurface)		Yes	Yes
Airfield Pavement Sections & Conditions (i.e., for PCI)		Yes	No
Project Boundaries (Historic-Current-Future)		Yes	No
Lease Boundaries (outside)		Yes	No
Lease Boundaries (inside)	<p>Both 2D & 3D Sustainable via GIS & LiDAR</p>	Yes	No
Terminal Floor Plans		Yes	Maybe
Non-Terminal Floor Plans		Yes	No
Cameras-Sensors-Alarms		Yes	Maybe

Which is more practical for which applications?

Which is more sustainable?

DT spatial visualization in 2D vs 3D (cont')



Airport Spatial Assets		2D	3D
High Priority FF&E (e.g., escalators, elevators, conveyors, displays, AEDs, etc...)		Yes	No
Lower Priority FF&E (e.g., light fixtures, furnishings, artwork, etc...)		Yes	No
Indoor Utilities		Yes	Maybe
IT/Communication Infrastructure	Both 2D & 3D	Yes	Maybe
Publications (map production)	Sustainable via		
ALP	GIS & LiDAR	Yes	No
Exhibit-A (Property Acquisition Map)		Yes	No
Composite Lease Exhibit		Yes	No
Signage & Markings Plan (Part of Airport Certification Manual)		Yes	No
Security Plan		Yes	No
Emergency Grid / Map Book		Yes	No

Which is more practical for which applications?

Which is more sustainable?



ArcGIS Pro Reads Directly Revit (.rvt) & Publishes to 3D Web Scene with Attributes

Courtesy of ATL &





ArcGIS Pro Reads Directly Revit (.rvt) & Publishes to 3D Web Scene with Attributes

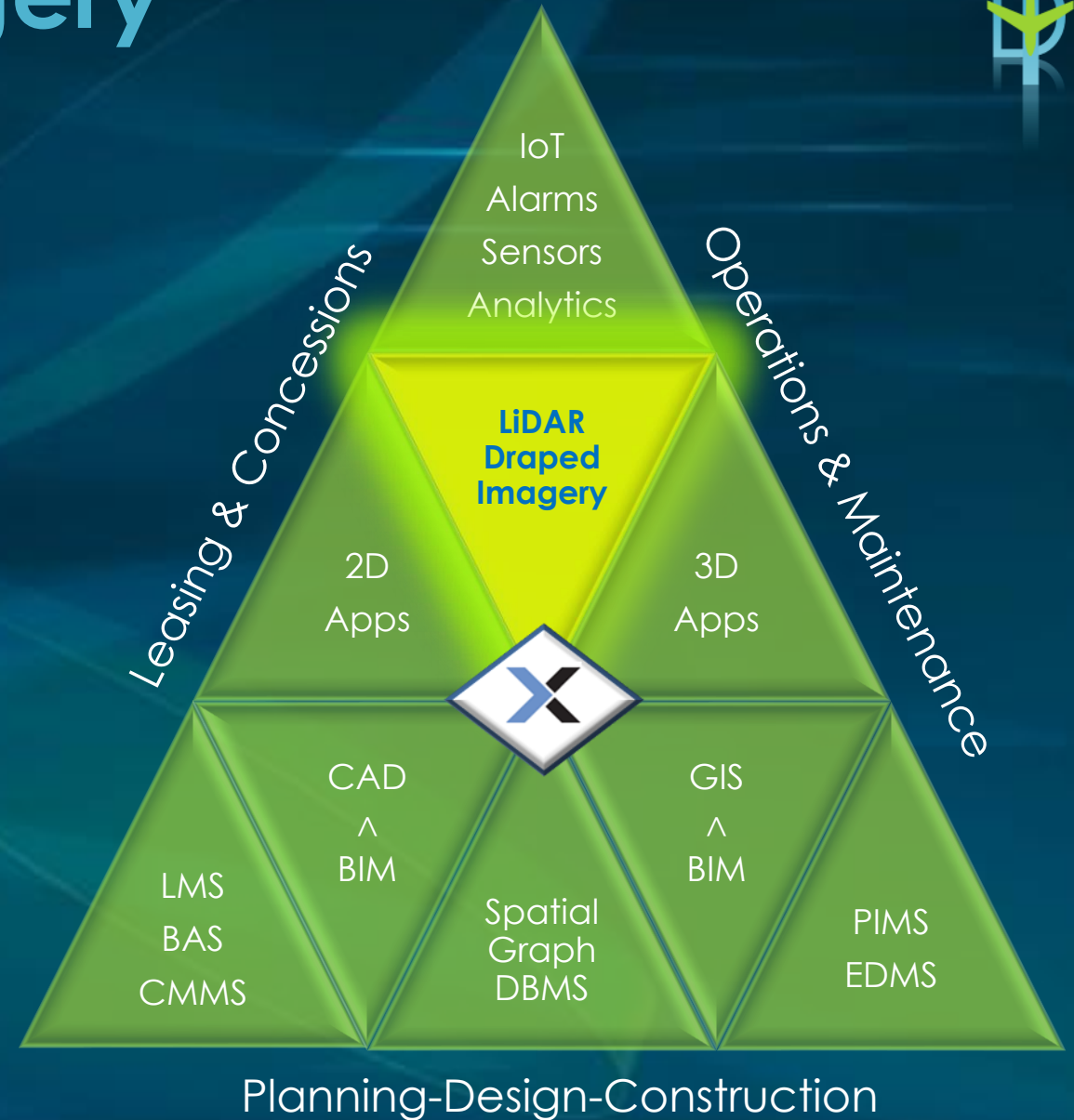
Courtesy of ATL &



LiDAR with Draped Imagery



- Survey Automation Tools
- Ground Control Points (GCP)s
Enable On-Going Updates Splicing
 - Outdoor
 - Indoor
- GIS Integration
 - 2D/3D Linked Views
 - 2D/3D Linked Assets
- 3D Measurement Tools
- Improved Situational Awareness



IMTG Spatial Admin

Layers:

- AED, Fire Ex
 - bg_safe_asset_point
 - Defibrillator
 - Fire Extinguisher
 - Unknown
- Equipment
- Interior Features
 - Access Points
 - Room Information
 - Leasehold Information
 - Cleaning Respons
 - Leaseholder
 - Space Class
 - Space Description
 - Space Numbers
- Base Map
- Aerial

Map Position: Pop-up, Docked

Create Point Data

Add Point(s)

Multi-Point Mode

Point Classification

- buildings_access_point
- pasngr_board_point
- BOARDING_CHECK

Auto-Generate Attributes

Auto-Gen Suffix

Delete Point(s)

Move Point(s)

Quickview

Layer Set

Map Tools

Markup Tools

0 features selected | 1: 1502.42 | 1776.10 x 677.20 (ft) | Powered by Infrastructure Map Server

Point height to horizontal reference plane

Point	X	6438160.844
Distance	Y	1802759.563
Line	Z	-1.847
Catenary	Distance	2.655 m

Copy to Clipboard | Clear

Copy to Feature

Measure Preferences

Indoor Imagery Draped over LiDAR Supporting 3D Measurements & Situational Awareness

Courtesy of LAX & x-Spatial



Entity Attribute - Google Chrome

airports.x-spatial.com/UMSCLT/cfscripts/forms/EntityType_view.cfm?RecordID=877953...

877953, buildings, buildings_safety, bg_fire_extinguishers, bgutfirext

Location CLT
Created By ed
Date Created 2021/10/13@11:08:06
Last Edited By ed
Date Last Edited 2021/10/13@11:10:35
Asset ID
Quality Level A
DDMS Source
Comment Data collected via 360d Imagery
Disposition
Is Published N
Type Discriminator FIRE_EXTING

Attributes Documents (0)

Room 0085
Building Concourse A North
Floor 2
ID
Status
Type
Description Enclosed Fire Extinguisher
Comments Data collected via 360d Imagery
Serves
Address
StreetNum
StreetName
StreetType
City
Zipcode
CollectedBy Ed. M.
DateCollected 10/13/2021
Duplicates?
RoomNumber_Old

X-SPATIAL

leaders in airport information management

Conc_A_North_Ticket_Mission_7

ed.maghboul@x-spatial.com

Measurements
Layers
Folders
Bookmarks
Data Export
Print Screen
Jump to Location
Management
Settings

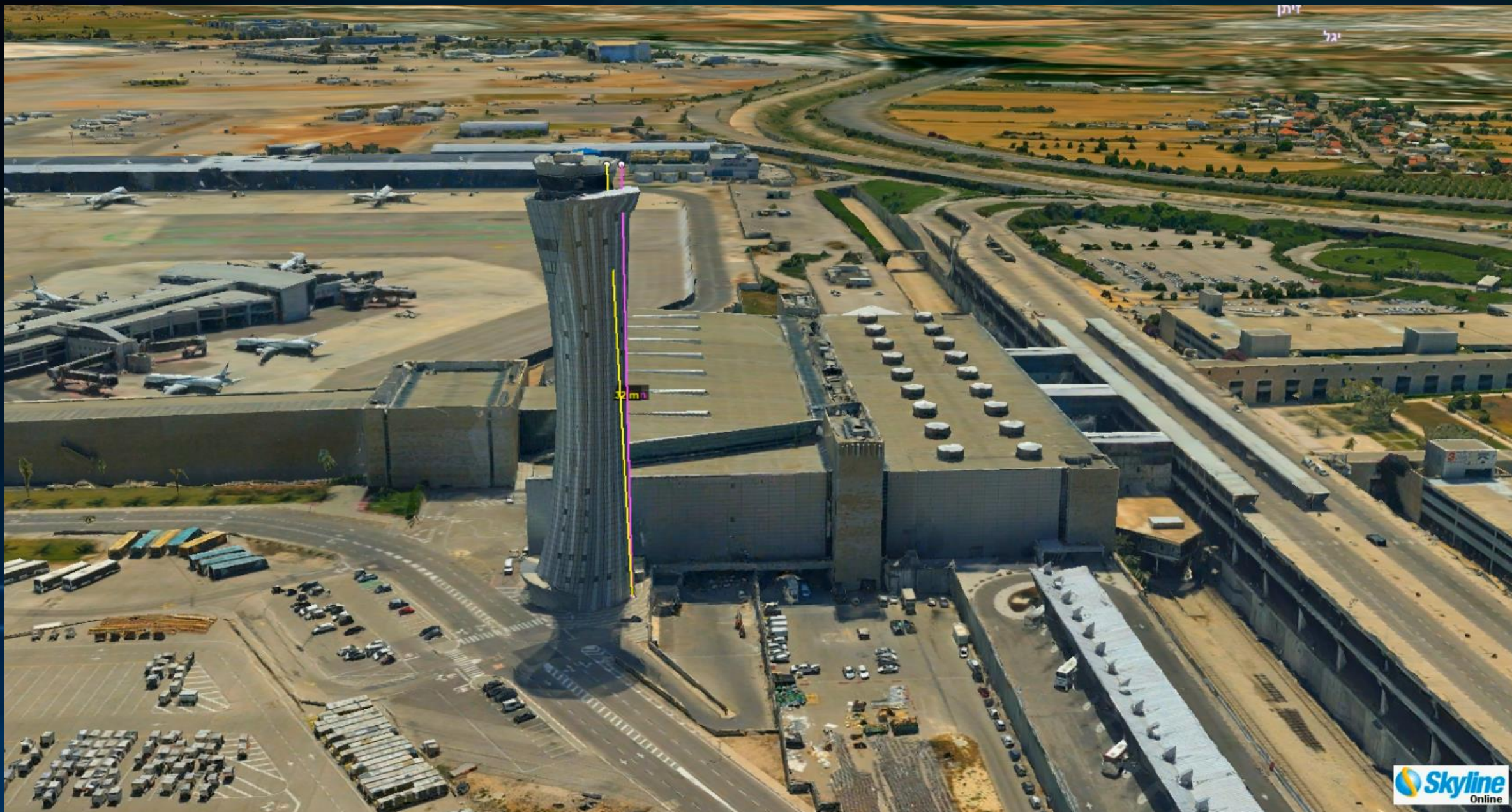
Title: Fire Extinguisher
Color: [red square]
Collection: Bldg_safety

Powered by SOLV3D Inc. © 2021 | v2.2.2375
2021-08-10 | NAD83 / North Carolina (ftUS)

Indoor Imagery
Draped over LiDAR
Integrated with GIS

Courtesy of CLT & x-Spatial





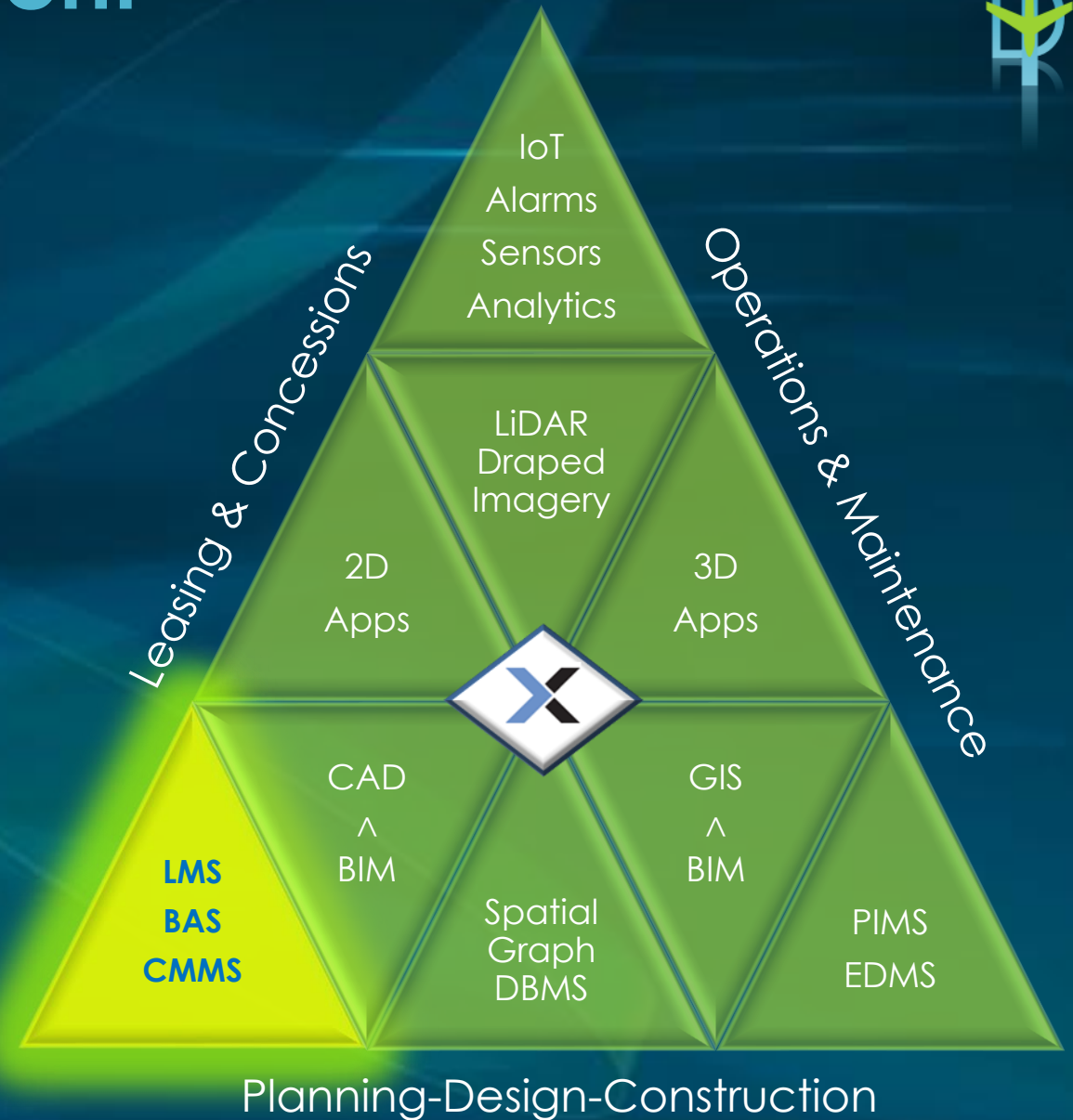
3D Aerial Imagery Leveraging LiDAR & PhotoMesh

Courtesy of Skyline Software Systems

Enterprise Asset Management



- ➔ Leases & Concessions
- ➔ Building Automation
 - ➔ SCADA (HVAC/Electrical)
 - ➔ HVAC
 - ➔ Electrical & Lighting
 - ➔ People Movers
 - ➔ Escalators
 - ➔ Elevators
 - ➔ Moving Sidewalks
 - ➔ APMS
 - ➔ Jet Bridges
- ➔ Work Orders
- ➔ Condition Assessments



Lease Management

CLT Lease... Operations Dashboard

Description: Concourse: Floor: Lease Termination:

Leases To Expire
21
This Quarter

Leases To Expire
53
Next Quarter

Total Lease Area:
230,554.4 ft²

Total Lease Area Pie Chart:

- CLT: 51.96%
- Delta: 9.80%
- Jet Blue: 5.47%
- Southwest: 6.97%
- United: 10.61%
- Common Use: 1.73%
- Null: 0.17%
- MHS/Am: 8.14%
- Other: 0.88%

Map Viewer - Windows Internet Explorer

https://gis2x-spatial.com/mapserver2014/clmsmapviewer/FacilityMap.asp

Layers

- Points
- Concession
- Building Elements
- Public Services
- Floor Plan
 - TSA Bag Belt
 - Floor Plan
 - Base Map
- Terminal Gates
- Rooms
 - Actual Room Numbers
 - CLMS Room Numbers
 - Both Room Numbers
 - Security
 - Tenant Locations
- 'Airmail Boston, Inc.'
- 'Airport Mallers, Inc.'
- 'Building Chases'
- 'GSA - TSA'
- 'Non-Public'
- 'Public'
- 'United Air Lines, Inc.'
- 'US Airways, Inc.'
- 'Vacant'
- Room Needs to be Coded
- Cleaning Responsibility
- Building Additions
- Rentable Rooms
- Fly Over Photo
- Utilities
 - Water Hydrant
 - Water Valve
 - Water Line

Rm# 121C = 6415sf
Holdroom - Gates 6 & 8
US Airways, Inc.
CLMS# 1632/31

CLMS Common Lease Management System

Facility: Logan International Airport
Company: Delta Air Lines, Inc.

Monday, September 23, 2011
FARS Customer No: 101

Agreements (113)
20351 - L-8639
21461 - L-8639(4) (Continental Airlines, Inc.)
21773 - L-8639(5) LL-6964 (Alaska Airlines, Inc.)
21165 - LL-4572

Rate Schedules (11) Vacancy Fee
Spaces (72) 31T1
Concepts (0)

Logoff
User Guide
Feedback

Search
Company GO

Home
Company
Agreement
Revenue Forecast
Recap
Billing
Facility
Alerts
Reports
Concession
Data Admin.
System Admin.

Show Map

Agreement Financial Information

CLMS No. 20351
Legal Ref. No. L-8639
Agreement Type Lease
Agreement Term 10 Years
Agreement Date 07/01/2006
Commencement Date 07/01/2006
Board Vote Required? Yes
Administrative Group ABO-Leasing
Administrator Name Greg Zanni
DBE Percentage 0.00
D.B.O. Used No
Chapter 91? No
Contract Manager Jill Cleary
Description Terminal A Restated Lease
Notes

Current Termination Date 06/30/2016
Federal Ref. No.
Agreement Sub Type Active
Agreement Status Active
Rent Commencement Date 07/01/2006
Original Termination Date 06/15/2016
Board Vote Date
Assignable No
Admin Ext.
Holdover Provisions No
D.B.O. No
Cancelable No

Edit Prime Contract Change Company Duplicate

Record No. 20351 was last updated on 04/01/2015 at 09:44:02AM by Laura

Recap Amendments Options Deposits SubLease Spaces Review Documents (39) Notes (0)

Space No	Property Type	Description	Space Function / Permitted Use	Rent Commencement Date	Commencement Date	Termination Date	Billing Quantity	Percent Billable	Bill?	Space Status
01	Billing	Holdroom Areas 1 thru 11	Holdroom	07/01/2006	07/01/2006	06/15/2016	11.00	100.00	Yes	Active
02	Billing	Holdroom Areas 13 thru 17	Holdroom	07/01/2006	07/01/2006	06/15/2016	5.00	100.00	Yes	Active
3101	Room	Main Terminal, 1st Floor	Office	07/01/2006	07/01/2006		1,311.00	100.00	Yes	Active

Schedule Type Rent Support Premise Rent

Commission - Sales Commission - Volume

MAG Plus Commission Fee

Greater of MAG and Commission Fee

MAG Plus Percentage of Revenue in excess of MAG

MAG Based on Passenger Volume (% applied)

Description

Next Escalation Factor Next Escalation Period Annually

Escalation Type % of Actuals Next Escalation Date

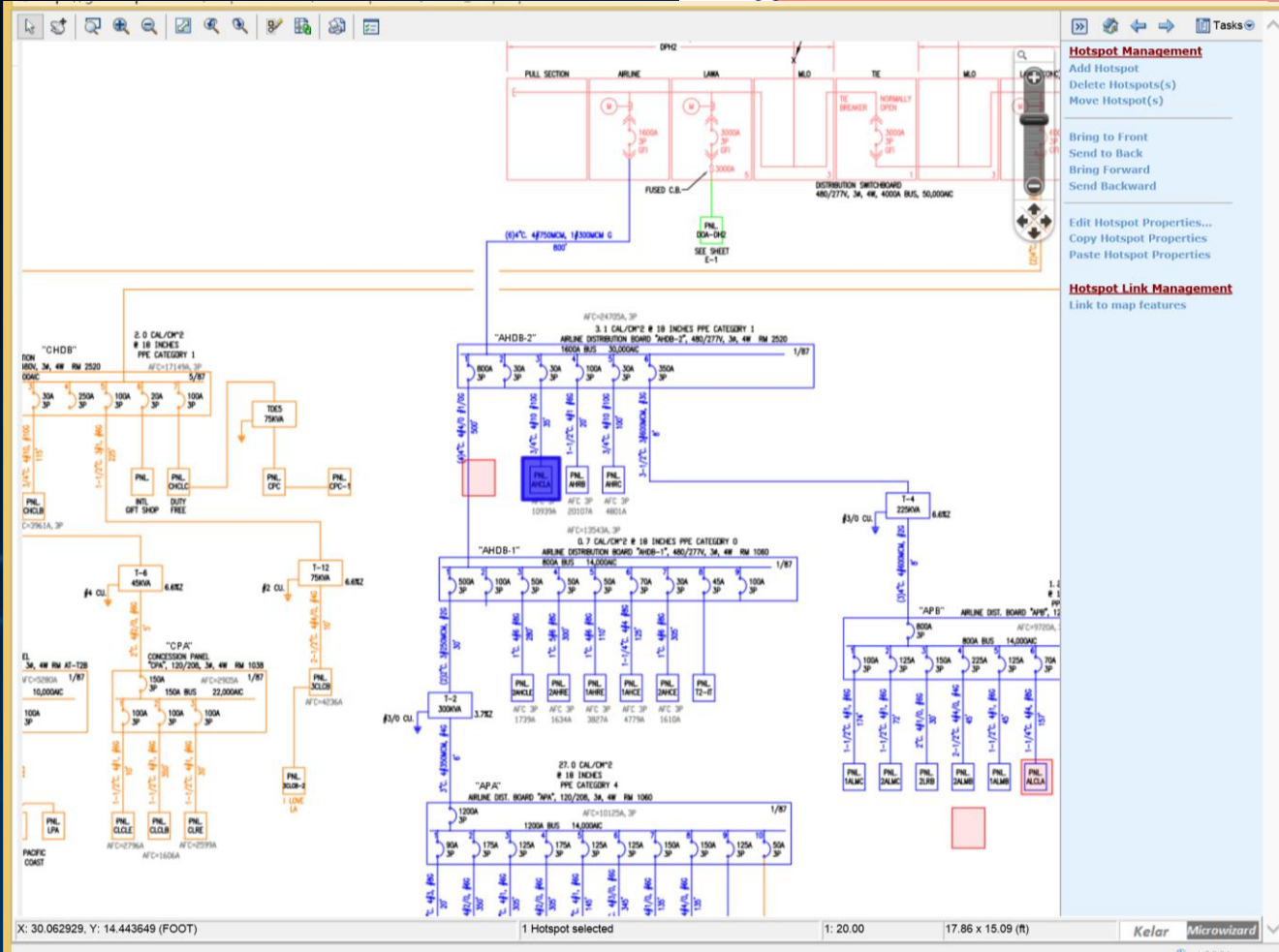
Reminder Date

Notes

OK Cancel

Electrical Panel Management

1



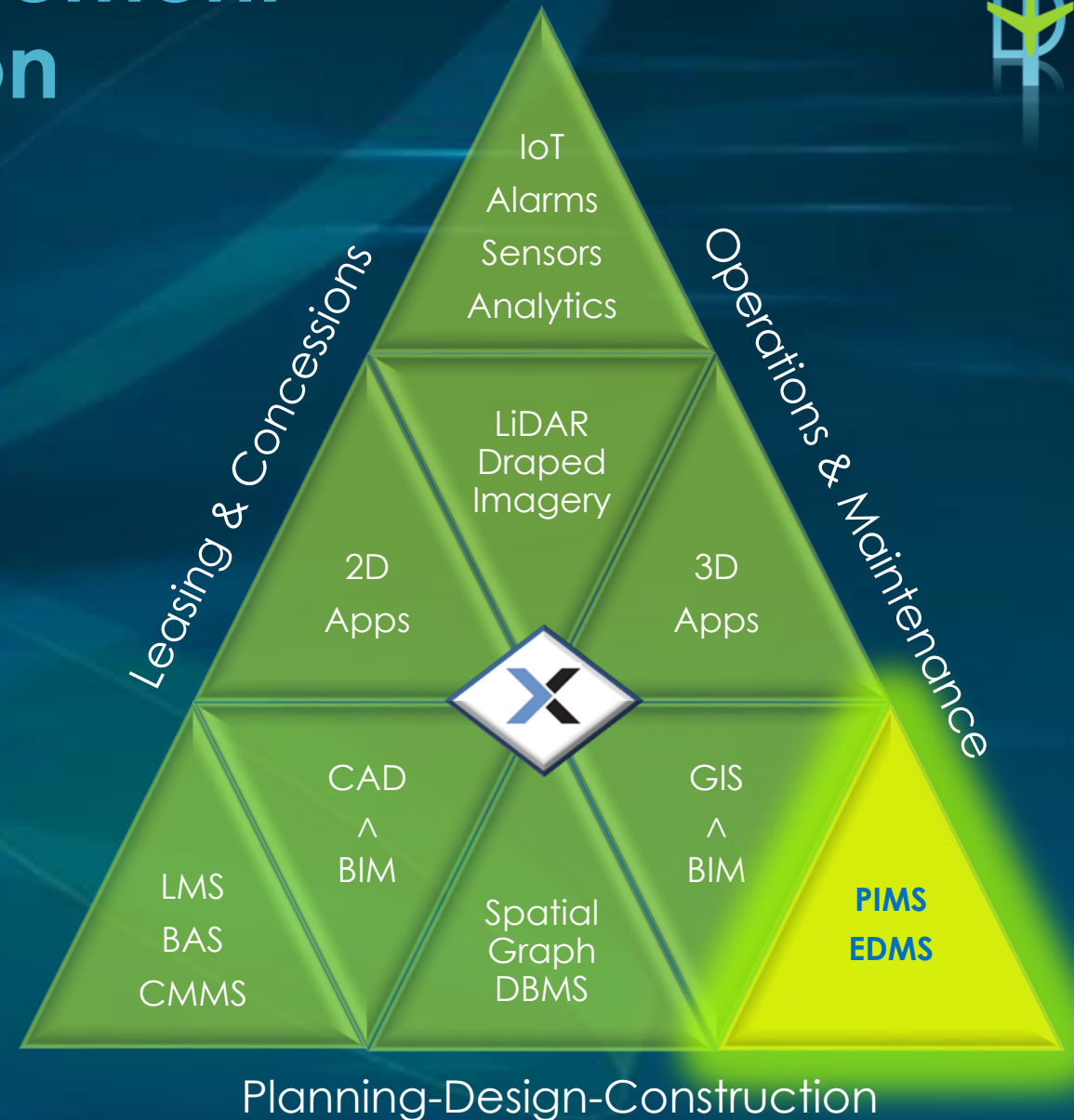
Datalink ID: 11954082
Entity Type Name: electrical_panel_area
Type Discriminator: NORMAL_PWR
DDMS Source: 2021515
Comment: AHCLA
Panel Name: AHCLA
Related Documents (first 20):
: 2021511_AHCLA_1_T2 Equip Assessment Report 2009-11-01 342.pdf
Hyperlinked Drawings:
20060029A-11-E03 - Panel AHCLA (4)
20060029A-12-E04 - Panel Sch AHDB - AHCLA (3)

2

Project Information Management & Electronic Documentation



- ALP Change Requests / 7460s
- Construction/O&M Logistics
Outage Coordination
- Construction Photos
- LiDAR Scans & Survey Data
- ORAT
- As-Builts / O&M Manuals
- etc...



Drawing & Document Mgm't System (DDMS)

IMTG
 Spatial Admin DDMS Admin
 Hello Ahmad Maghboul
 Logoff

Home
 Open Map

Facility
 Los Angeles International Airport
 LAX_DDMS

Parcel
 Select a Parcel

Building
 Select a Building

Floor
 Select a Floor
 --Select a Map--

Search
 Documents

List All Documents
 Advanced Document Search

Document Set
 (+)Eds
 (+)ELSEE Eqp. Report
 (*)Test -1
 Address Map
 Airfield Driving Routes
 Airport Boundary
 Airport Certification Manual Maps
 ALP - Airport Layout Plan

Load Update Add Remove
 (*) Private document set
 (+) Admin. document set

Data Explorer
 Pavement Management
 ELSEE
 Mobile Data
 Reports
 Document Administration
 Spatial Data Administration
 Geodatabase Administration

https://gis2.x-spatial.com/UMS/cfscripts/logoff.cfm

x·SPATIAL

Aerial Photo Date: August 17, 2014

X: 6437289.551905, Y: 1796866.166101 (FOOT) 1 Grid selected 1: 17307.07 5.03 x 1.86 (mi) Kelar Microwizard

Data Administration View

	Bar Code No.	Airport Code	Drawing No.	Project Title	Discipline Code	Sheet No	Sheet Title	Document Date	Rev No	Rev Date	Drawing Set	Media Sub Loc	Util Dwg	
<input type="checkbox"/>	0001021	LAX		TERMINAL BUILDING MODIFICATIONS/SECOND LEVEL ROADWAY PROJECT	ARCH	4 A-4	TERMINAL 4 SECOND FLOOR PLAN - WEST	11/30/1981	25	02/10/1983	0000827	F001C	NO	Canopy Removal Phase
<input type="checkbox"/>	0001501	LAX		AMERICAN AIRLINES - SECOND LEVEL EXPANSION - LAX 170	CIVIL	001A	LIST OF DRAWINGS	02/25/1983			0000962	F001D	NO	DISCIPLINE CODES (A - ARCHIT)
<input type="checkbox"/>	0001502	LAX		AMERICAN AIRLINES - SECOND LEVEL EXPANSION - LAX 170	PLUM	P-101	FIRST LEVEL EAST PLUMBING	12/20/1982	3	04/22/1985	0000962	F001D	NO	DISCIPLINE CODES (A - ARCHIT)
<input type="checkbox"/>	0001503	LAX		AMERICAN AIRLINES - SECOND LEVEL EXPANSION - LAX 170	PLUM	P-102	FIRST LEVEL CENTER PLUMBING	12/20/1982	3	04/22/1985	0000962	F001D	NO	DISCIPLINE CODES (A - ARCHIT)
<input type="checkbox"/>	0001504	LAX		AMERICAN AIRLINES - SECOND LEVEL EXPANSION - LAX 170	PLUM	P-103	FIRST LEVEL WEST PLUMBING	12/20/1982	2	04/22/1985	0000962	F001D	NO	DISCIPLINE CODES (A - ARCHIT)

Integrated Project Mangm't via Simplify i3



Project Status: Active x Completed x Inactive x [Filter Icon]

[Map Controls: +, -] Find address or place [Search Icon]

Select Area Layers Tools

Layers [Save Icon] [Refresh Icon] [Close Icon]

All Filtered

- Calgary International Airport
 - Projects
 - APO - Airport OPS Project
 - CIP - Tenant Project
 - FAC - Facilities Project
 - GLC - Capital Project
 - GWO - Groundside Maintenance Pr
 - IOC Project
 - MWO - Airside Maintenance Projec
 - Work Orders
 - BaseLayer

2021 Pavement Restoration

Project ID: GLC - Capital Project-0019
Status: Planned
Start Date: 04/13/2021
Estimated Completion Date: 11/30/2021
Zoom to

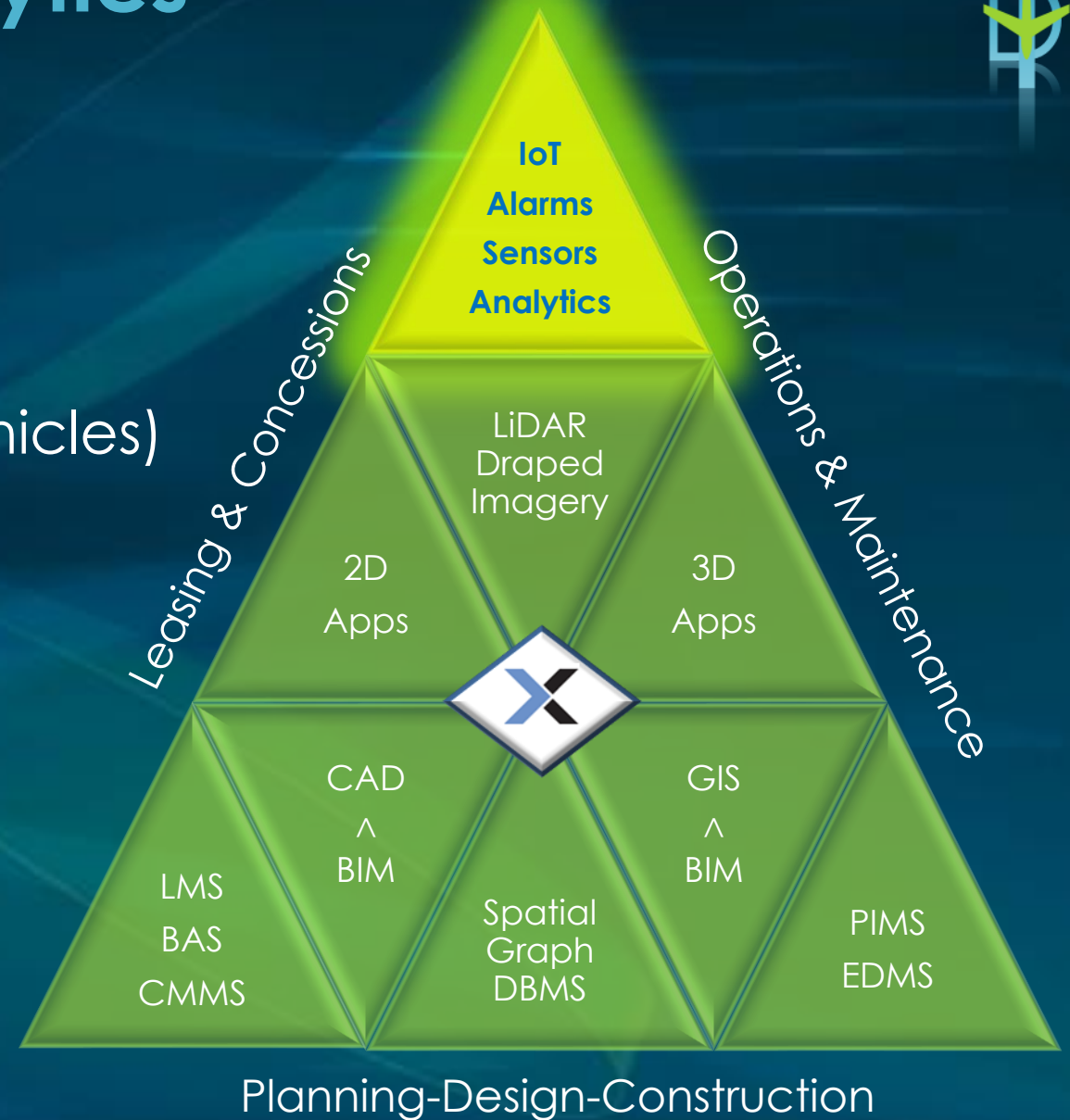
[Map Controls: Full Screen, Print, Measure, Home]

60m [Scale Bar]

IoT Alarms - Sensors - Analytics



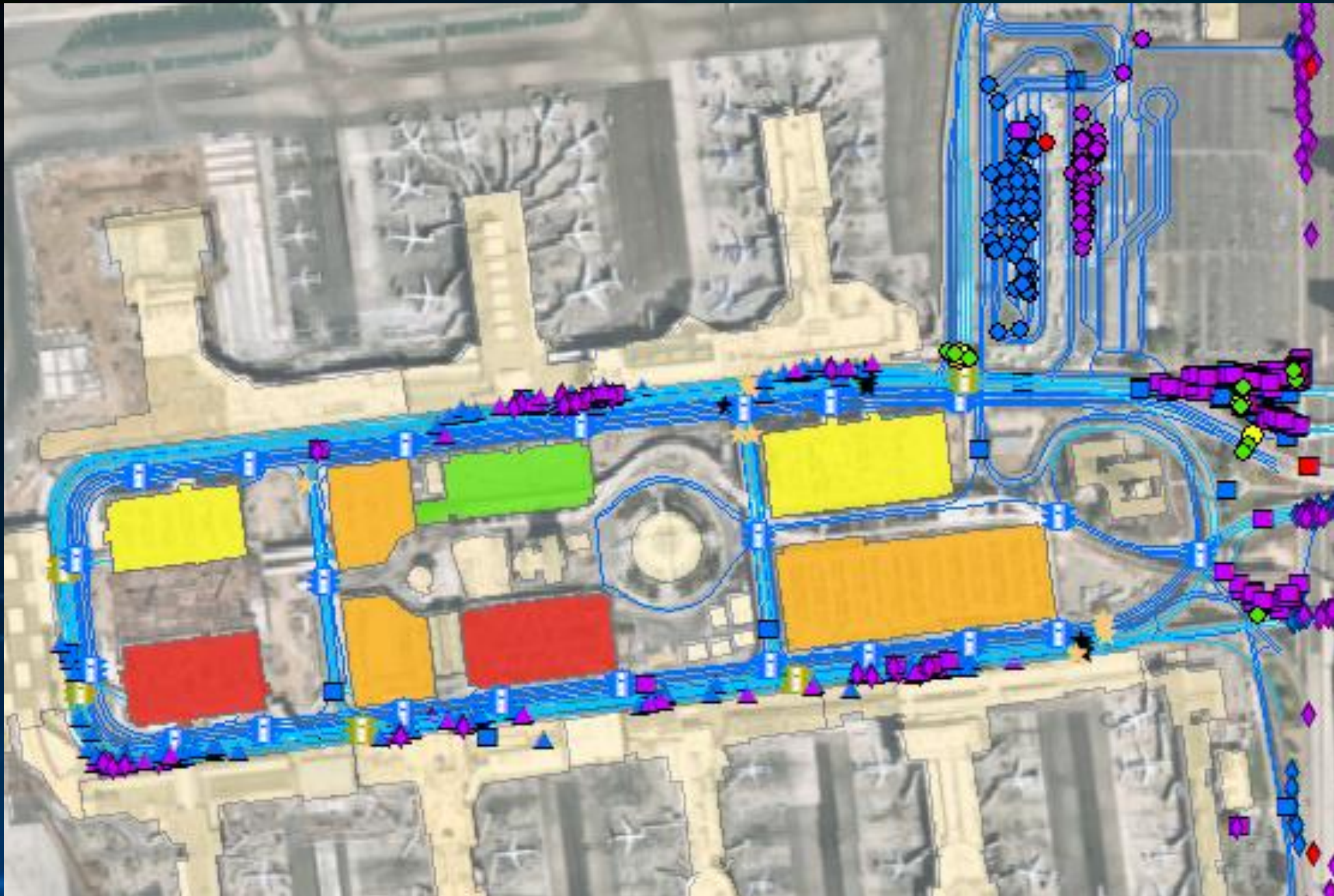
- Roadway Traffic
- Curb to Gate PAX Flux
- Security Checkpoint Wait Times
- AOA Movements (e.g., aircraft, vehicles)
- Aircraft Gate Turnaround
- Access Control Alarms
- Fire Alarms
- Restrooms Level of Service
- Trash-bins capacity
- etc...



Integrating Real-Time IoT Sensor Feeds via APIs



- **Internet of Things (IoT)** provides a common communication medium for sharing sensor data (given security credentials in place)
- **Application Programming Interfaces (API)s** published by sensor system enables sensor data to be “understood” and leveraged by other systems
- **ESRI’s ArcGIS GeoEvent Server** facilitates processing real-time sensor data and displaying it contextually on a map



Courtesy of LAX
Central Terminal
Area Near Real
Time Traffic

GIS Data

- Traffic signals
- Parking structures
- Transponder readers
- Traffic count loops
- Centerline per lane

Non-Spatial
Real-Time Data

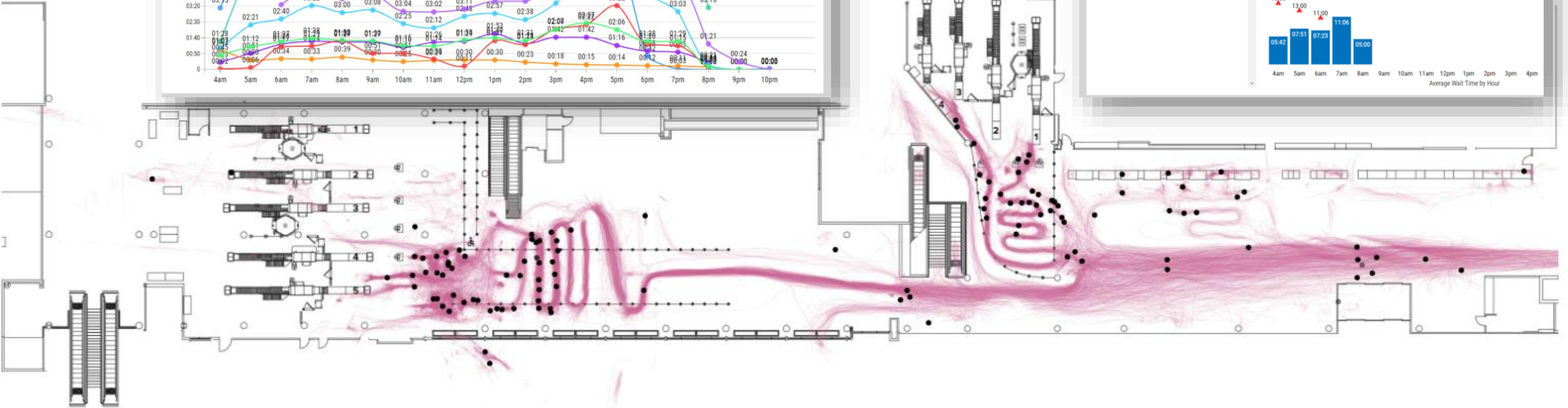
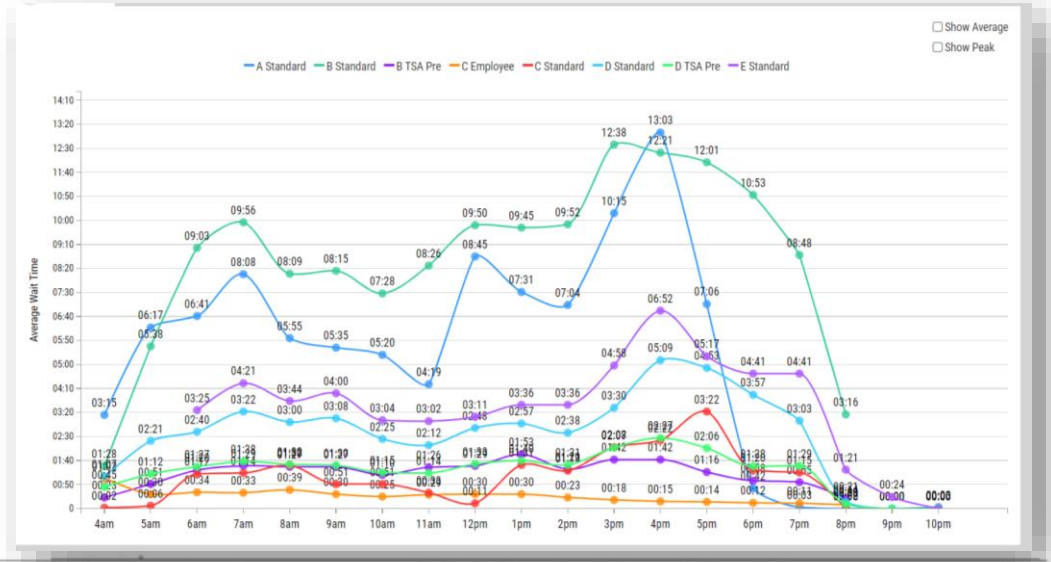
- TNC data
- Traffic count loop data
- Transponder data
- Parking occupancy



Live Map

- Our system can follow the path of individuals over a long period of time
- Multiple sensors work together to follow passengers over multiple touchpoints, like check in and security
- Live maps enable airport operators a view into their airport any time, anywhere





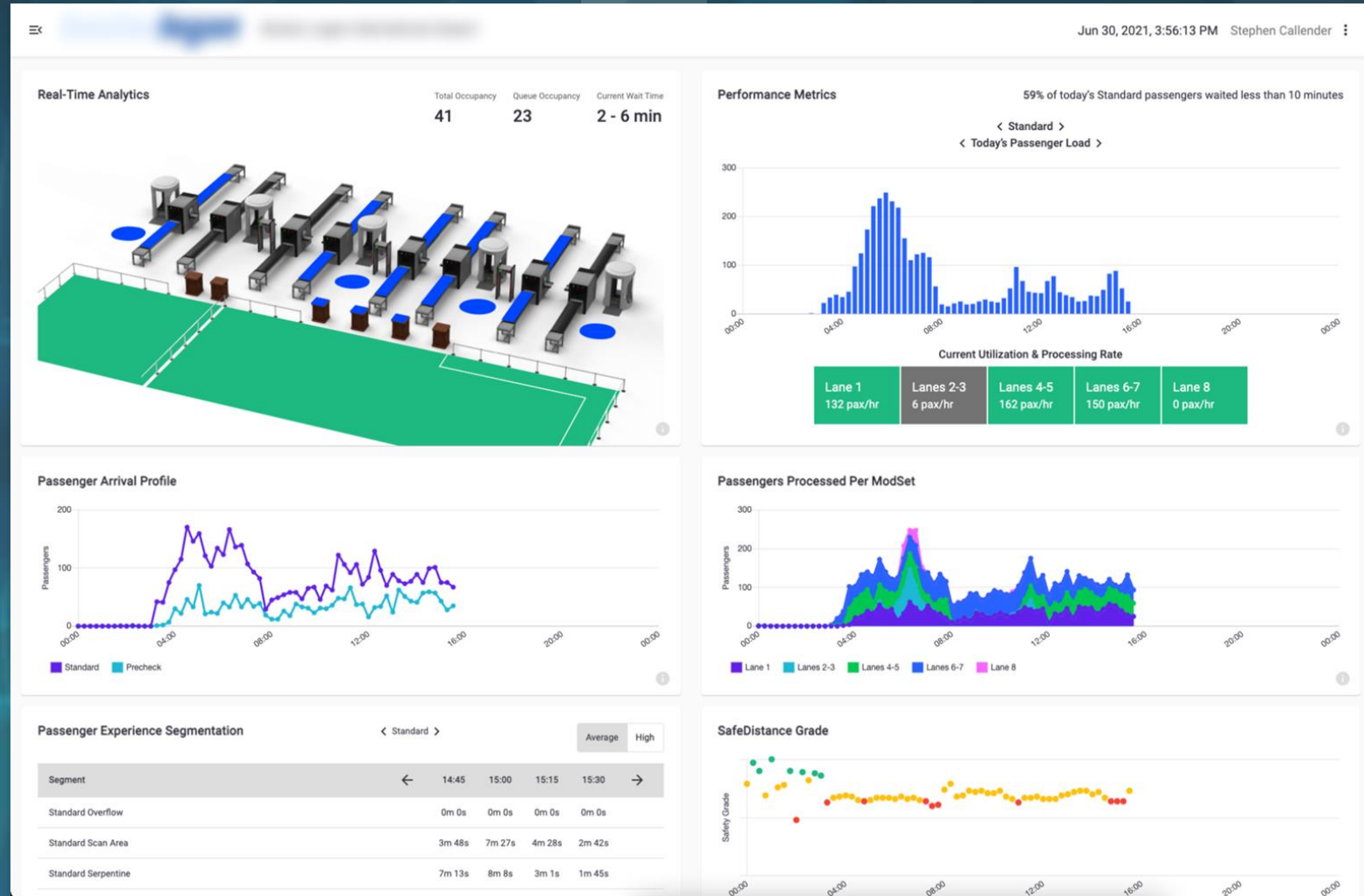
A Checkpoint Standard Open Override

<p>A 2-6 Standard +</p> <p>B 11-15 Standard 1-3 TSA Pre +</p> <p>C 1-3 Standard 1-3 Employee +</p> <p>D 5-9 Standard 1-3 TSA Pre +</p> <p>E 4-8 Standard +</p>	<p>Current Wait Time: 2-6 m Dwell Time: 5-9 m</p> <p>Avg Population: 34 pax Throughput: 336 pax/hr</p> <p>Population per Hour: 164, 259, 372, 259, 214</p> <p>Today's PAX Sum: 1268</p> <p>Average Wait Time by Hour: 05:42, 07:51, 07:23, 11:06, 05:00</p>
---	---



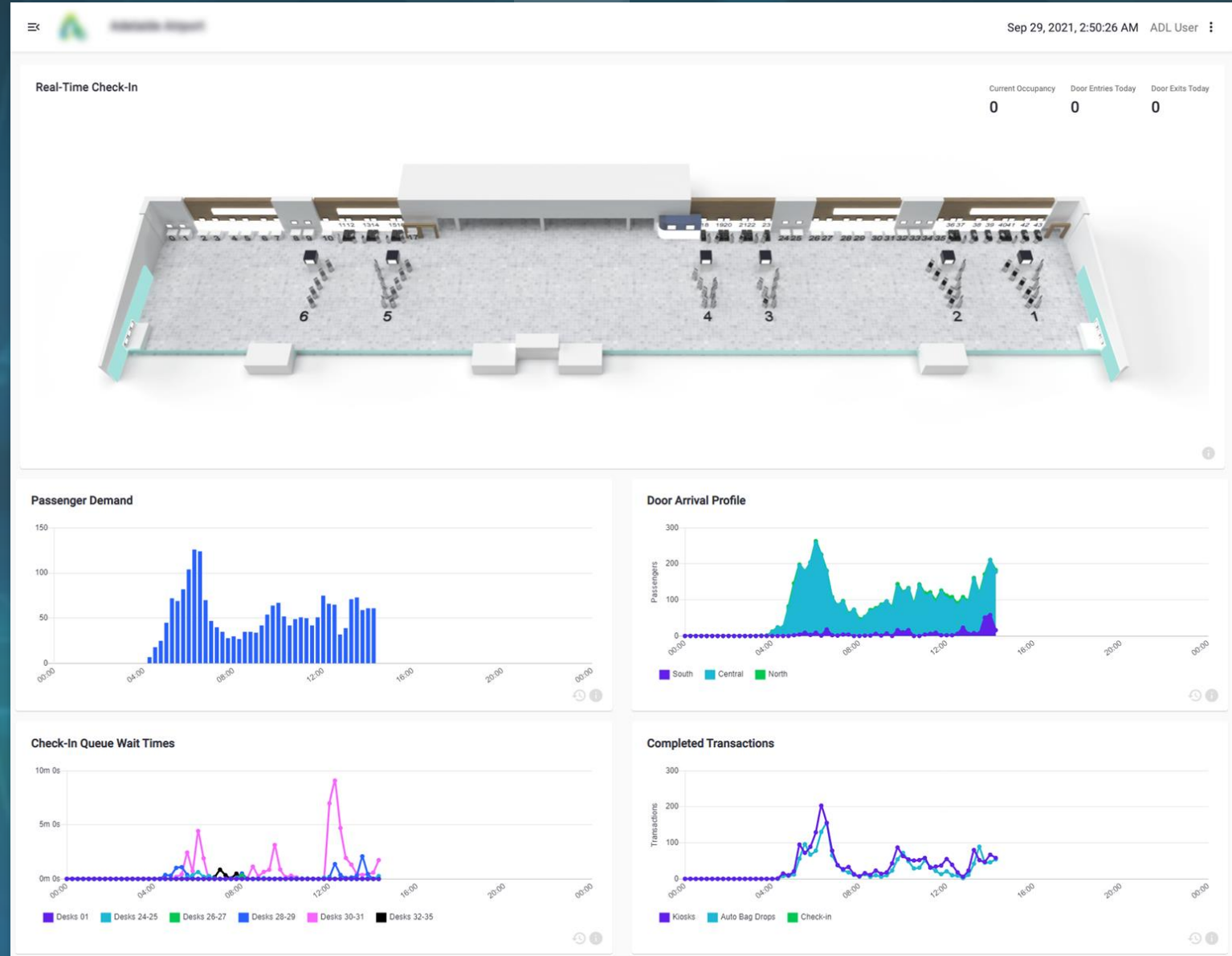
Real-Time Analytics

- Interactive 3D maps
- Passenger demand and wait time analytics
- Passenger arrival and throughput counts report
- Passenger experience segmentation
- SafeDistance Grade



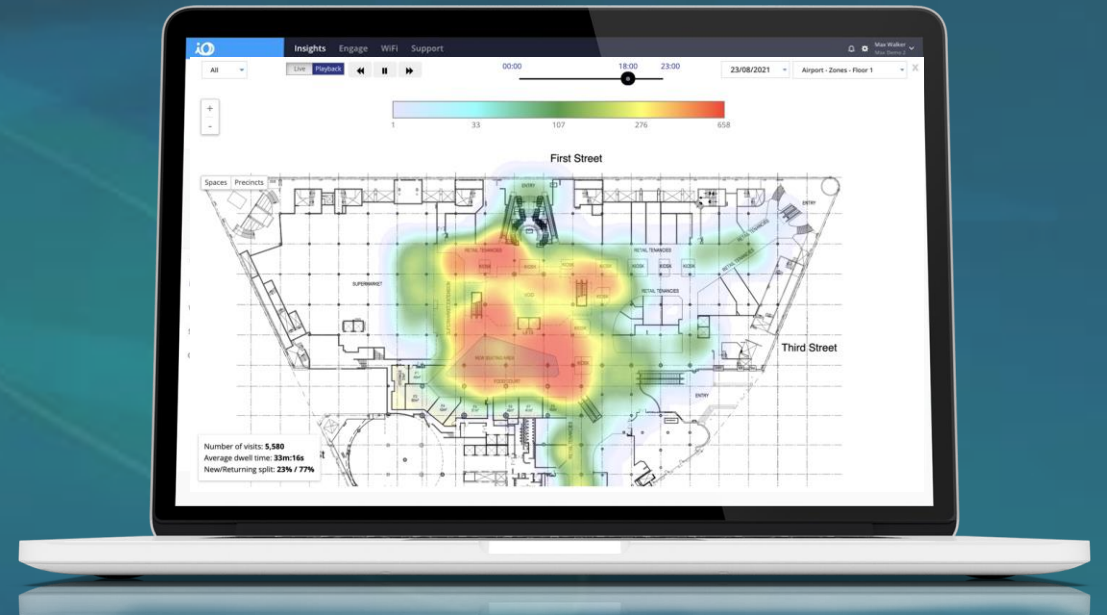
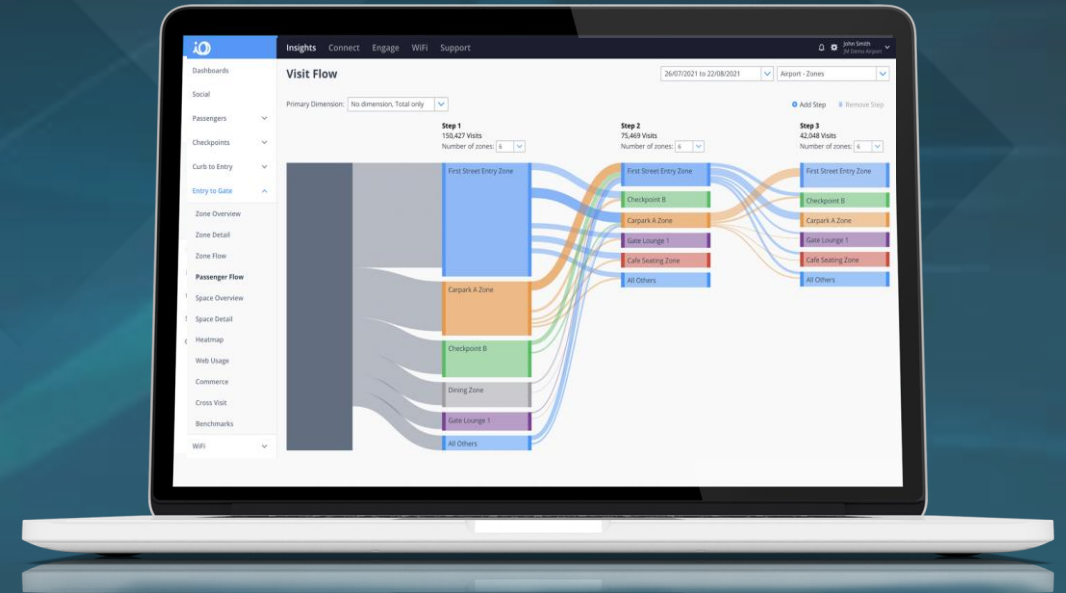
Airline Check In Analytics

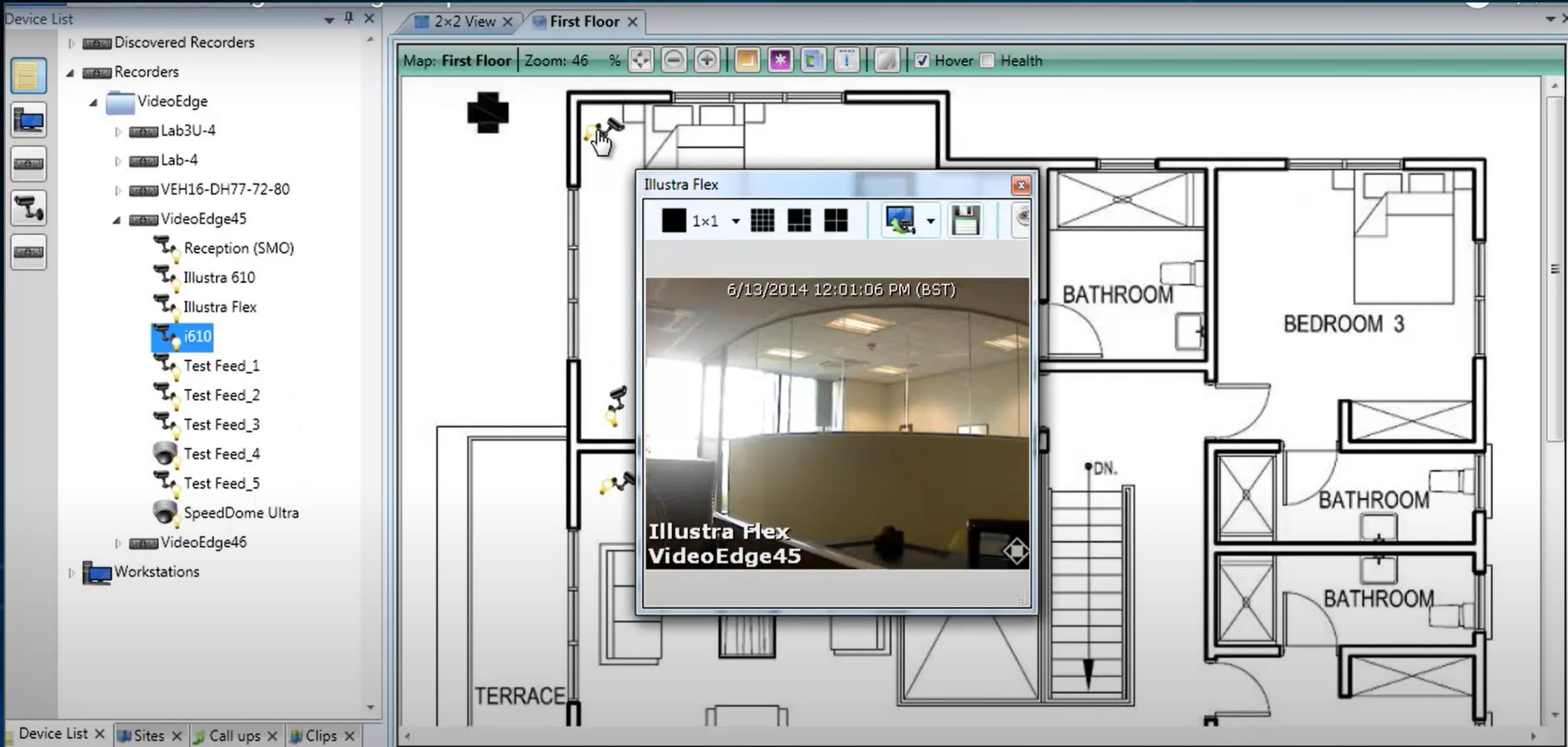
- At a glance analysis of check in lobby operations and passenger experiences
- Real-time and historical analysis of...
 - Queues
 - Check in counters
 - Kiosks
 - Bag drop
 - Customer service
 - Terminal entrances



WiFi Analytics

- Minimal to no additional infrastructure required
- Existing relationships with Boingo, Aruba, Cisco, Meraki, Ruckus and many other WiFi service and infrastructure providers
- Some of the information that WiFi analytics provide:
 - Dwell time
 - Heatmaps
 - Curb to gate / passenger journey
 - Gate departure lead time
 - Accurate visit / count trend





CCTV Video Management System (VMS)

GRAPHICS



Building Automation System (BAS)

Courtesy of CLT & Johnson Controls (Metasys)

Prioritized Gradual Implementation

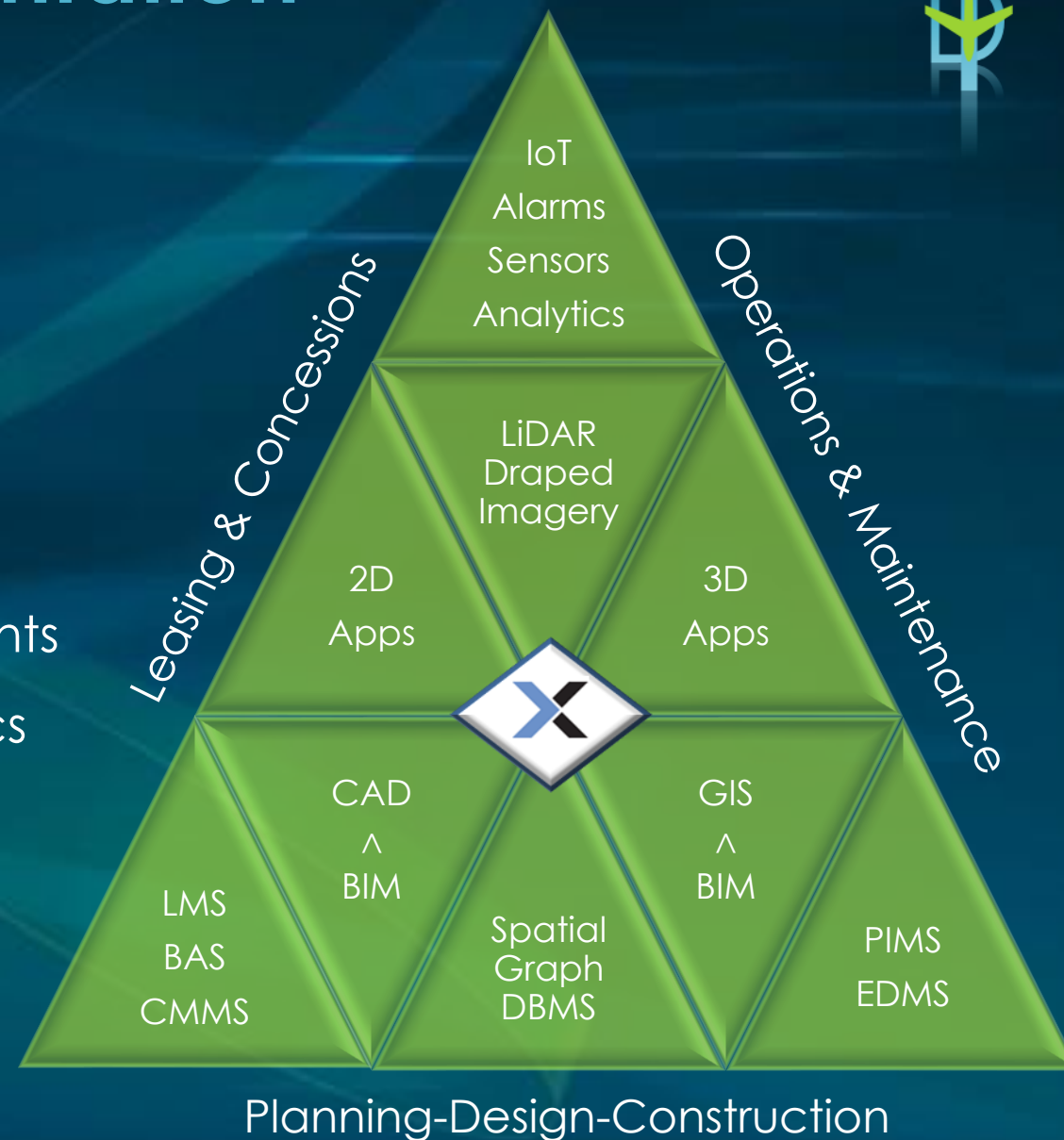


→ Simple DT

- Up-to-date eALP & Floor Plans
- 3D LiDAR with Draped Imagery
- Overlay Assets with Data

→ Ultimate DT

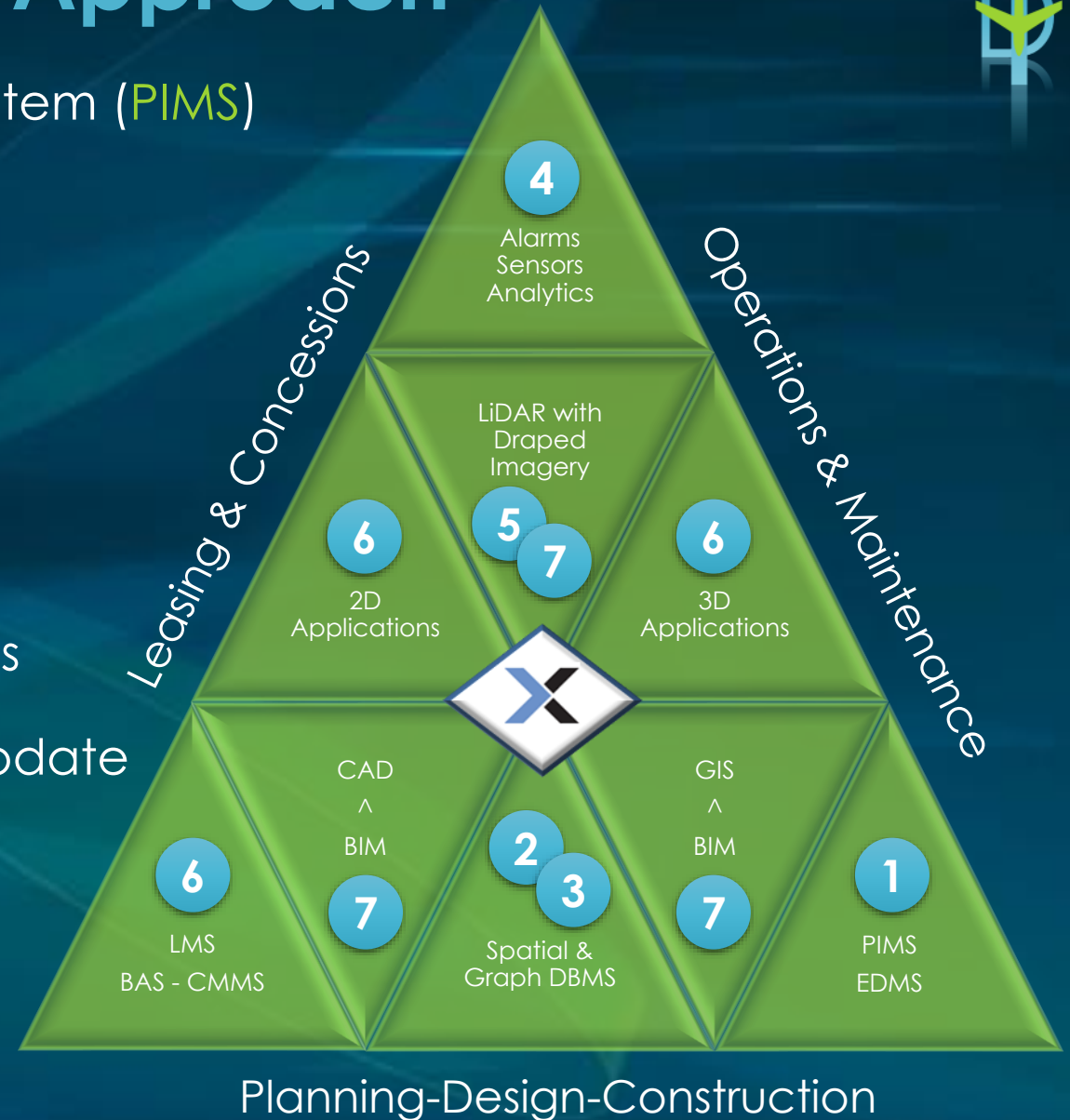
- Overlay WOs, Projects, Inspections, Incidents
- Overlay Real-time Sensor Feeds & Analytics
 - PAX Flux Curb-to-Gate
 - Vehicle Flux (e.g., AOA, Roads, Parking, Rail)
 - Baggage & Cargo Flux



Recommended DT Phased Approach



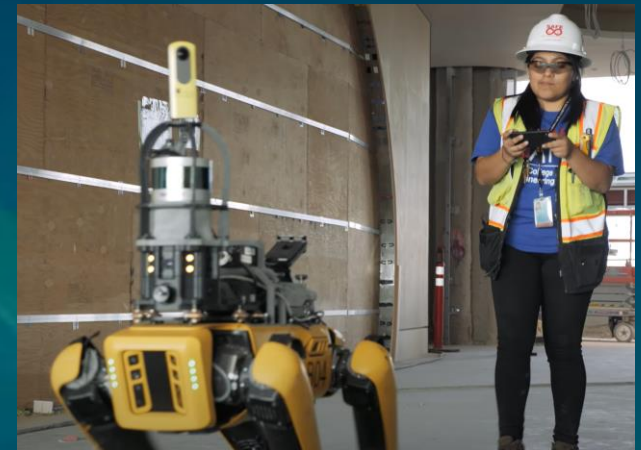
1. Setup **Project Information Management System (PIMS)** including electronic documentation
2. Setup **spatial DBMS** with data processing automation tools
3. **Populate spatial DBMS** with available data and metadata
4. **Add sensors** with real-time data feeds and analytics integrated to spatial DBMS via APIs
5. Setup **indoor/outdoor LiDAR** spatial data update process with GCPs; may be parallel to #3
6. Improve/add **applications**
7. **Sustain & enhance** as-needed



Keys to Sustaining Airport Digital Twin



- Keep it Simple & Sustainable **(KISS) Principle**
- Leverage **IoT sensors with APIs to automate overlay** of real-time (and historical) data
- **Update spatial “skeleton”** with new and/or relocated IoT sensors, assets, etc...; **leverage simple GIS symbolized point features in 2D/3D**
- Leverage **LiDAR draped imagery** with **semi-automated/robotic scanning platforms**



x-Spatial Advantages for DT



1. Reduced Data Workload

- Eliminating Duplicate Datasets
- Automating CAD to GIS Data Conversion
- Mobile Field Data Updates

2. Increased Data Reliability

- “Single Source of Truth”
- Rich Metadata Including Data Qualities
- Hyperlinks to Source Drawings/Documents
- Standardized Data

3. Flexible Data Services

- Supporting Seamlessly both Indoor and Outdoor Spatial Data
- Seamless Output to esri Geodatabase Serving 3rd Party Applications
- Seamless Output of Web Map Services for Web Application
- Automated Output of Standardized CAD-GIS Files

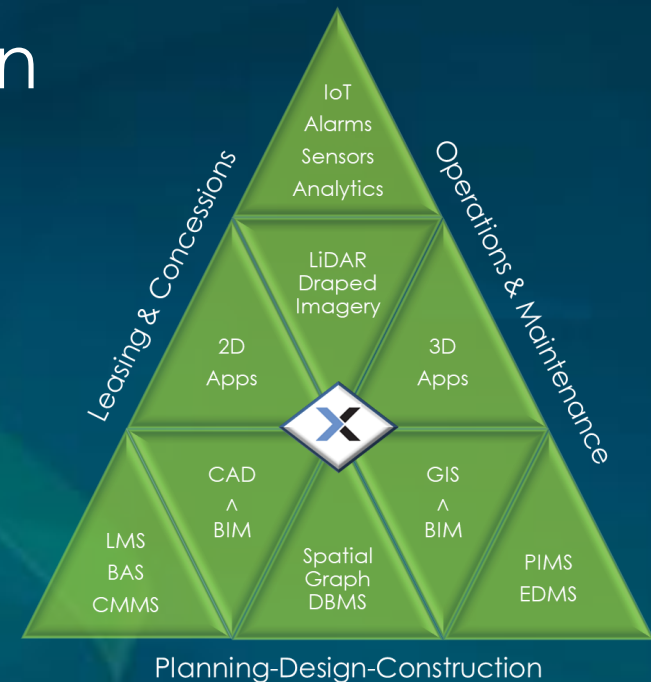
**Example: CLT's Main
Terminal Ticketing Level
Floor Plan (491 rooms)**

**Reduce CAD to GIS
Conversion Time
from 94 hrs. to 15 sec.**

Takeaways



- ➔ Airport Owner's Digital Twin (DT) is not a single software solution; it's an **integration of systems, data, and processes**
- ➔ DT is **not replacing existing airport systems**, but rather expand their utility via DT integration
- ➔ DT **requires sustainable geospatial framework**
- ➔ Airport **CIP builds and renovates** assets physically and should **also virtually via DT**



Ed Maghboul, President
Office: +1 (310) 862-1305
Mobile: +1 (310) 293-8268
ed.maghboul@x-spatial.com

David Tamir
Office: +1 (321) 473-4533
Mobile: +1 (805) 236-3286
david.tamir@x-spatial.com



GEOSPATIAL DATABASE MANAGEMENT SYSTEM (DBMS)

KEY TO AIRPORT DIGITAL TWIN