

### **National Institute of Building Sciences**

**Provider Number: G168** 

Are You an AEC Game Changer? And The Built Environment

January 10, 2018

- **Designing the Future of Architecture Construction**
- Session WE2A: Using Technology to Move the Industry Forward
- Stephen Hagan, FAIA, CEO, Hagan Technologies @SHaganFAIA Kimon Onuma, FAIA, President, Onuma, Inc. @KimonOnuma





Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.







#### Course Description

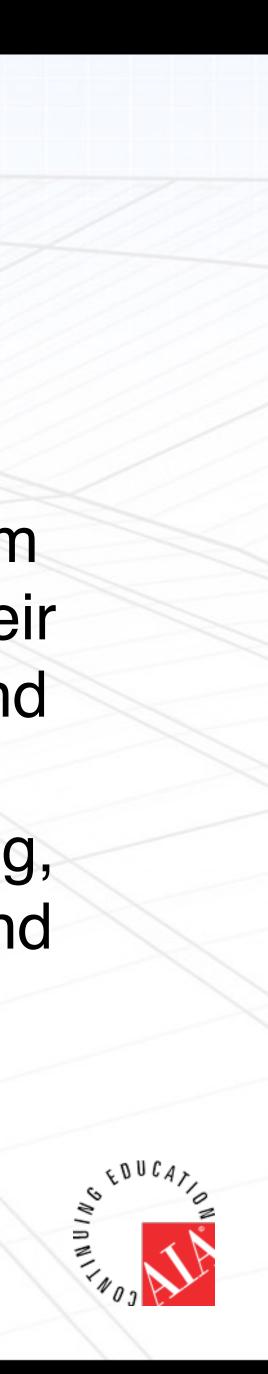
Within our lifetime, we have seen amazing advancements in technology that dramatically change how we work and live. Much of this has even occurred within the last 5 to 10 years. One of the most exciting aspects of this trend is when radical, new, disruptive approaches are invented to tackle problems and tasks that have been otherwise addressed by entrenched, traditional methodologies for decades. This presentation will explore how this trend is impacting the design and building industry and how National Institute of Building Sciences standards and projects are enabled by game changing innovations. The speakers will present case studies of how the architecture, engineering and construction (AEC) industry is using these innovations to improve project outcomes by using standards-driven technologies for design, construction and operations. These lessons learned come from a variety of owners, architects and equipment manufacturers. The success stories come from the U.S. Department of Veterans Affairs; Defense Health Agency; Sherlock, Smith & Adams Architects; Tri W-G Medical Equipment; and many more. New methods of collaborating across the industry are emerging. Sharing these game changing solutions between government agencies and the private sector is accelerating ways to solve complex problems today.





At the end of the this course, participants will be able to:

A.Upon completion, participants will be able to establish and prioritize the top 3 or 4 emerging technologies that interest them and their firms and pose great opportunities for the future of their practice. These innovative technologies enable the architect and architectural practice to increase the value of the built environment in terms of safety, occupant comfort and well-being, often using data and technology feedback for human-centric and experiential design processes.





At the end of the this course, participants will be able to:

B.Upon completion, participants will be able to understand what <u>path-breaking and leading firms</u> are doing to dramatically improve outcomes and provide innovative services to their clients and customers. These firms have transformed their practices through the immersive use of these innovative technologies and processes, thereby increasing productivity and profitability, in additioon to improving building systems, materials and methods, as well as quality and integrative of design and construction documents and follow-on construction contract administration.





At the end of the this course, participants will be able to:

C.Upon completion, participants will be able to understand how the built environment, form and function of architecture, and everything from small components to entire buildings to regions and urban scale can be dramatically improved by new emerging technologies--whether it is wearable computing, cloud computing, or big data. A special focus of the presentations and interaction with attendees will be on critical building systems, materials and methods, as well as design and construction processes (codes and standards, environmental compliance, new as well as renovation and historic preservation).





At the end of the this course, participants will be able to:

methods, pre-design and historic preservation).

D. Upon completion, participants will be able to take key ideas back to the office on Monday and create their own Innovative Technology Execution Plans for their in-house projects and firm-wide business planning. Included in the workshop is a workbook with exercises throughout the day and a process and strategy to create a personal Game-Changing Innovation Technology Execution Plan. Each attendee will select one or more of critical topic areas to address in their Execution Plan: Building systems, construction contract administration and documents, design (including urban planning), environmental and legal project constraints and opportunities, materials and





# GAME CHANGING INNOVATION Designing the Future of Architecture Construction & The Built Environment

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· Course Course

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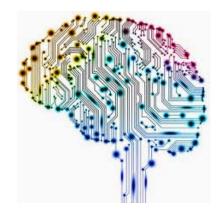
AIA Conference on Architecture 2017 April 27–29, Orlando A REAL PROPERTY AND A REAL

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## **Game-Changing Innovative Dynamic Technologies**

- 3D Printing
- 3D Reality Model
- Artificial Intelligence | Machine Learning
- Augmented Reality | Virtual Reality
- Big Data and Analytics
- BIM (Building Information Modeling)
- CAFM I CMMS
- Cloud Computing
- Cybersecurity
- Design Automation
- Digital Fabrication
- Drones
- Fog Computing
- Gamification
- Geo-Spatial | GIS | Location
- Internet of Things (IoT)
- Laser Scanning
- Messaging (email, sms, and beyond)
- Mobile
- Model Checking
- Pervasive Computing
- Reality Capture
- Sensors I Sensor Web
- Simulation
- Social Networking and Media
- Wearable Computing







• BIM



• CAFM

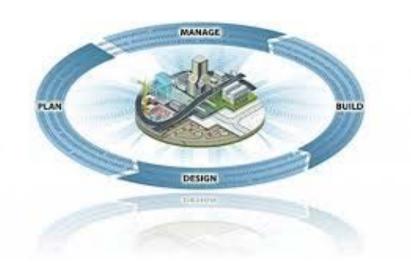


TABLE TA



Cloud Computing







# A Tsunami and a Jumble of Technologies

- 3D Printing
- 3D Reality Model
- Artificial Intelligence | Machine Learning
- Augmented Reality | Virtual Reality
- Big Data and Analytics
- BIM (Building Information Modeling)
- CAFM I CMMS
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- Simulation
- Social Networking and Media
- Wearable Computing









## **Game-Changing Innovative Dynamic Technologies**

<ul> <li>3D Printing</li> <li>3D Reality Model</li> </ul>		\ A / I
Artificial Intelligence   Machine Learning	•	What i
<ul> <li>Augmented Reality   Virtual Reality</li> <li>Big Data and Analytics</li> </ul>		
• BIM (Building Information Modeling)	•	Choos
• CAFM I CMMS		
Cloud Computing		
Cybersecurity	•	Case
Design Automation		
<ul> <li>Digital Fabrication</li> <li>Drones</li> </ul>		Indust
Fog Computing	-	muusi
Gamification		
<ul> <li>Geo-Spatial   GIS   Location</li> </ul>		YOUR
<ul> <li>Internet of Things (IoT)</li> </ul>		
Laser Scanning		
<ul> <li>Messaging (email, sms, and beyond)</li> </ul>		Conclu
Mobile     Model Checking		
<ul> <li>Model Checking</li> <li>Pervasive Computing</li> </ul>		
Reality Capture		
Sensors I Sensor Web		
<ul> <li>Simulation</li> </ul>		
<ul> <li>Social Networking and Media</li> </ul>		
Wearable Computing		

- is Game Changing Innovation?
- se 2 or 3 to Focus on!
- Studies
- try-Wide Studies
- **R** Innovation Execution Plan
- lusion and Looking Forward



## "If you don't change...you're going to perish"

"If you want to survive, you're going to change; if you don't, you're going to perish. It's as simple as that."—*Thom Mayne, FAIA, 2005 Pritzker Prize Winner* 





### **Game-Changing Innovative Dynamic Technologies**

#### Model Authoring / Checking Tools

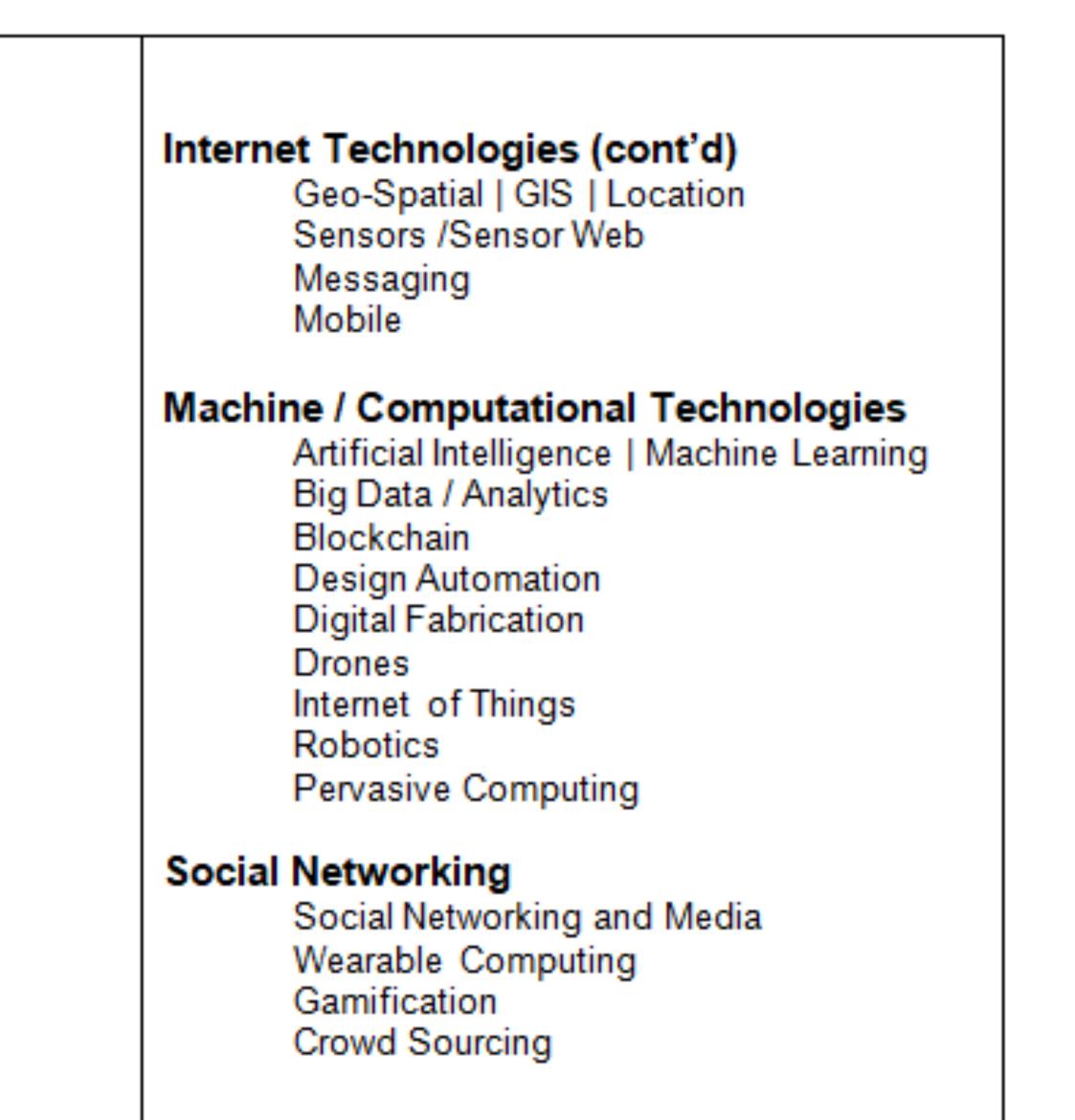
BIM CAD CAFM | CMMS / IWMS Clash Detection Model Checking Simulation

#### Immersive Technologies

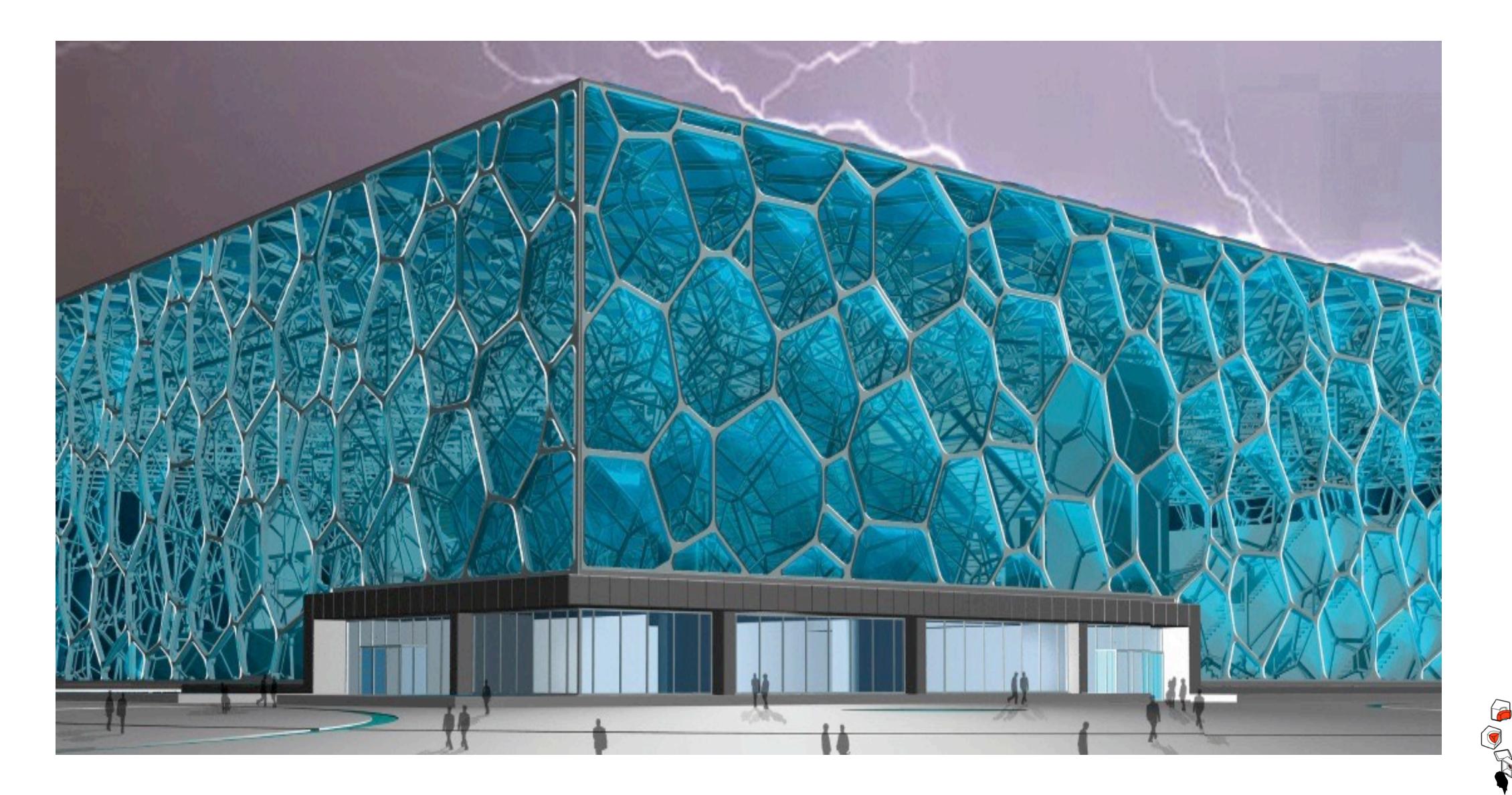
3D Printing 3D Reality Model 3D / Laser Scanning 4D Scheduling Augmented Reality | Virtual Reality Reality Capture X-Reality

#### Internet Technologies

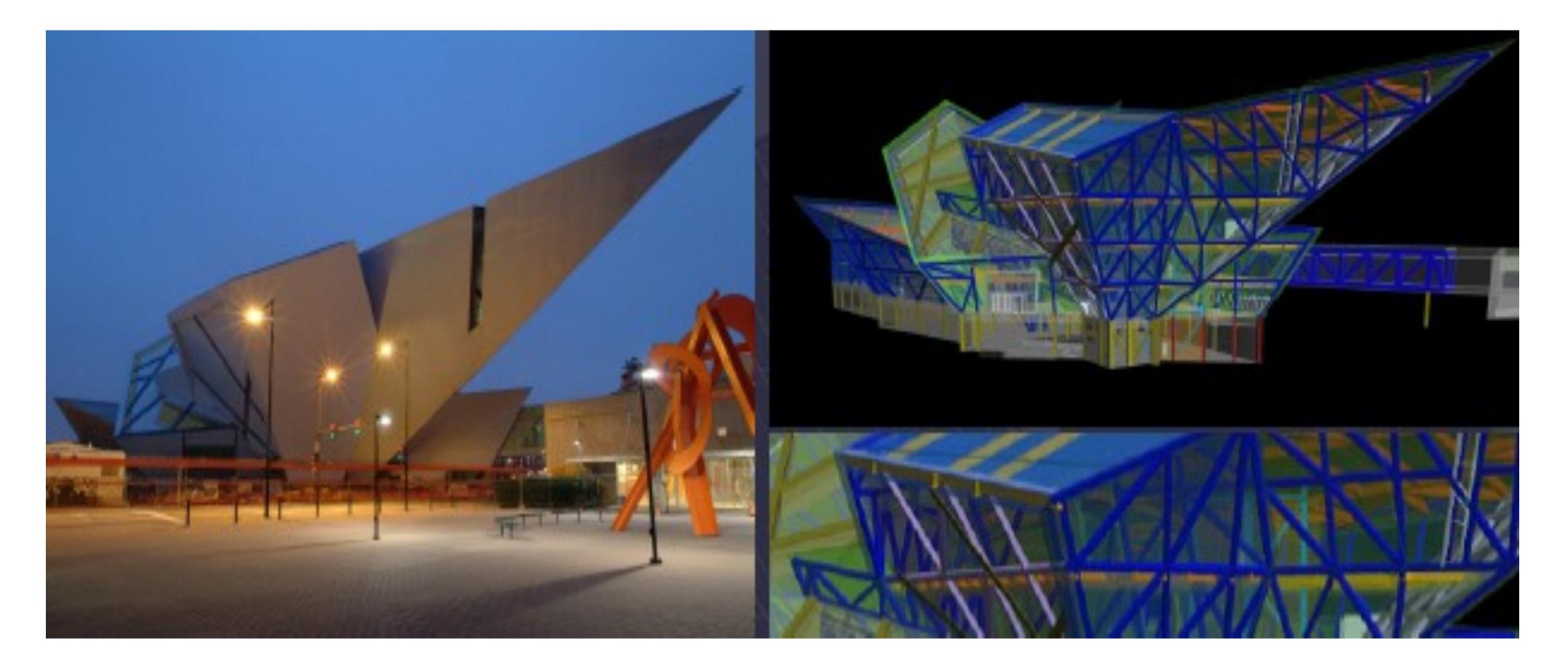
Cloud Computing Cybersecurity Fog Computer Geo-Spatial | GIS | Location







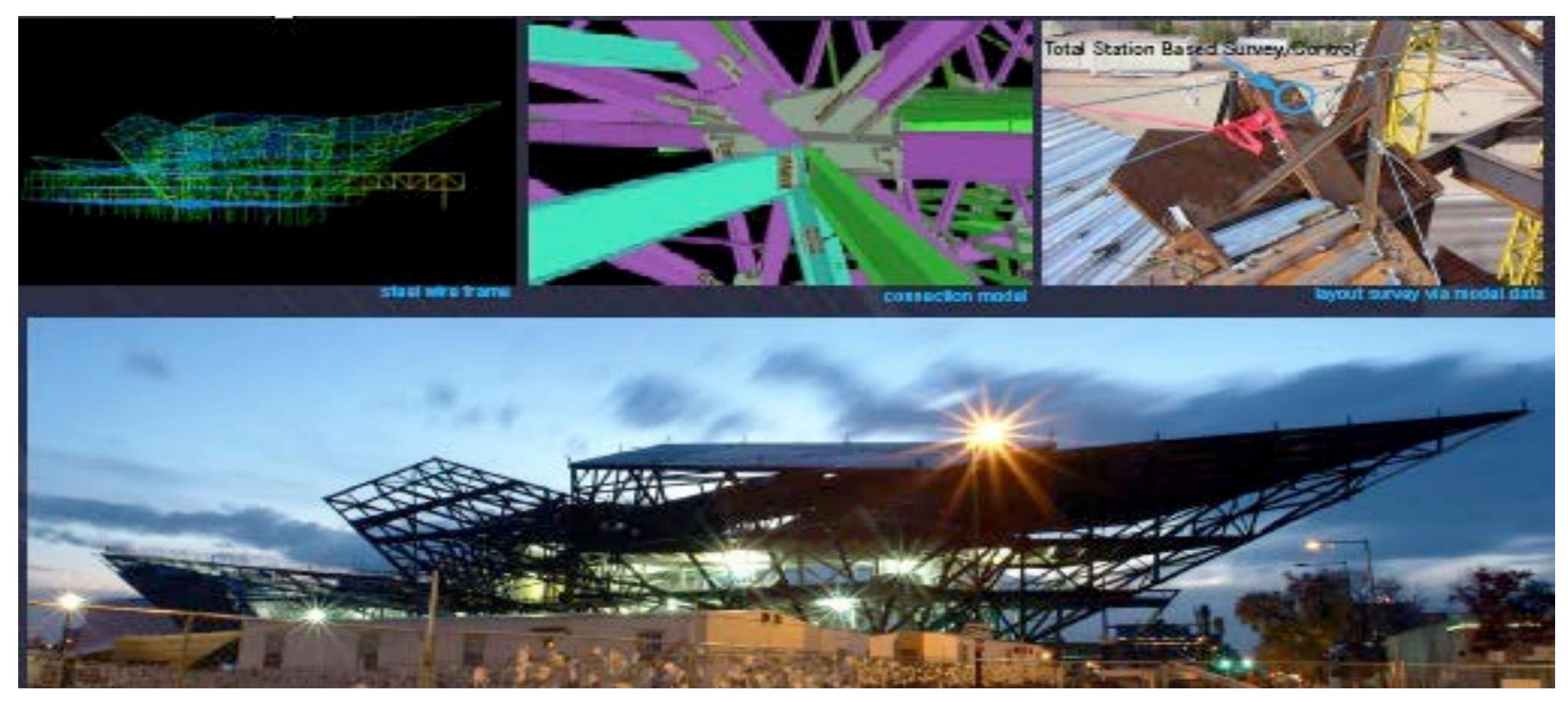




#### Fredric C Hamilton Building Denver /

uilding M.A. Mortenson Company Denver Art Museum





#### Fredric C Hamilton Building M.A. Mortenson Company Denver Art Museum







## **3D Printing**

3D printing realistic architectural models. 3D printing is often used to promote architectural projects by showcasing the final result with **3D printing** models. The SLA (Stereolithography) technology is usually the best fit, along with the Polyjet technology, or even the FDM technology. A 3D Printed Home Model.

3D printing for architecture - Aniwaa.com www.aniwaa.com/3d-printing-for-architecture/

How 3D printing will change architecture and construction - Dezeen https://www.dezeen.com/2013/05/21/3d-printing-architecture-print-shift/ -May 21, 2013 - Existing 3D printers are only able to produce homogeneous materials that have the same properties throughout. But graded materials would be useful for printing architectural elements - such as beams or façades that mimic bone, which is hard on the outside but spongy on the inside.



About this result . Feedback



## **3D Reality Model**

#### **Bentley**

Solutions

Products

Subscriptions Services







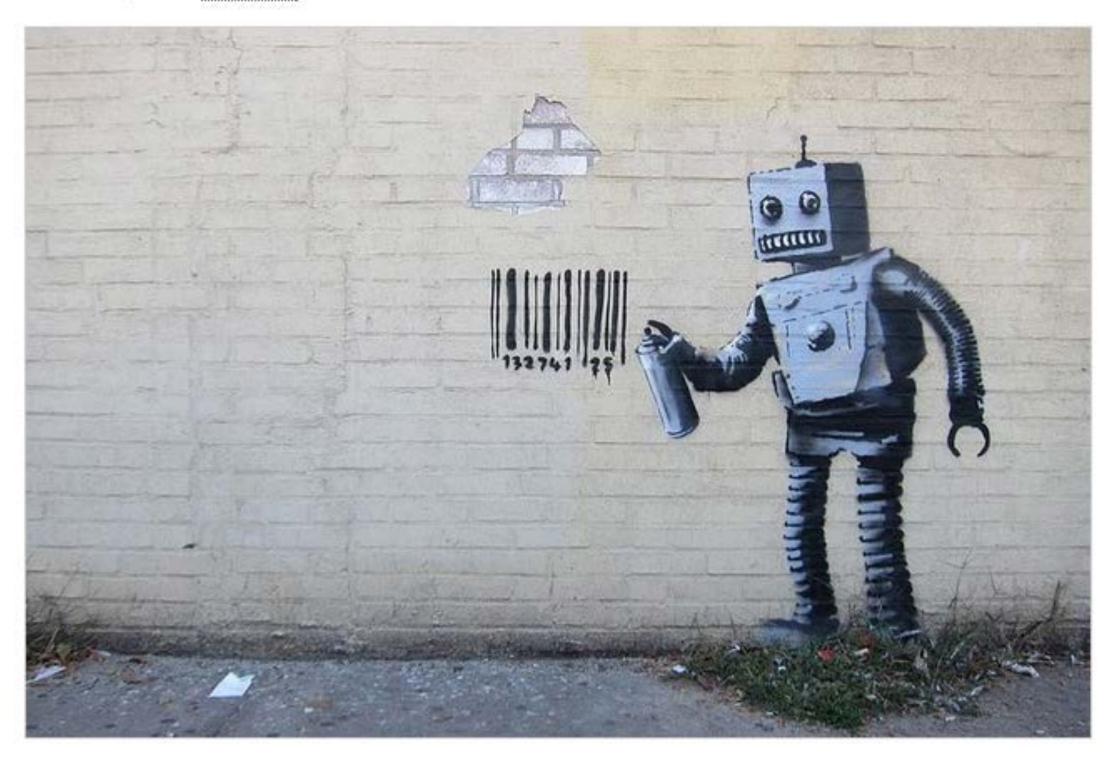
# **Artificial Intelligence**

# ARCHITECTUREAU

HOME PROJECTS AWARDS NEWS REVIEWS PRACTICE PEOPLE DISCOURSE PRC

#### Architecture in the coming age of Artificial Intelligence

Discourse | Words Rory Hyde







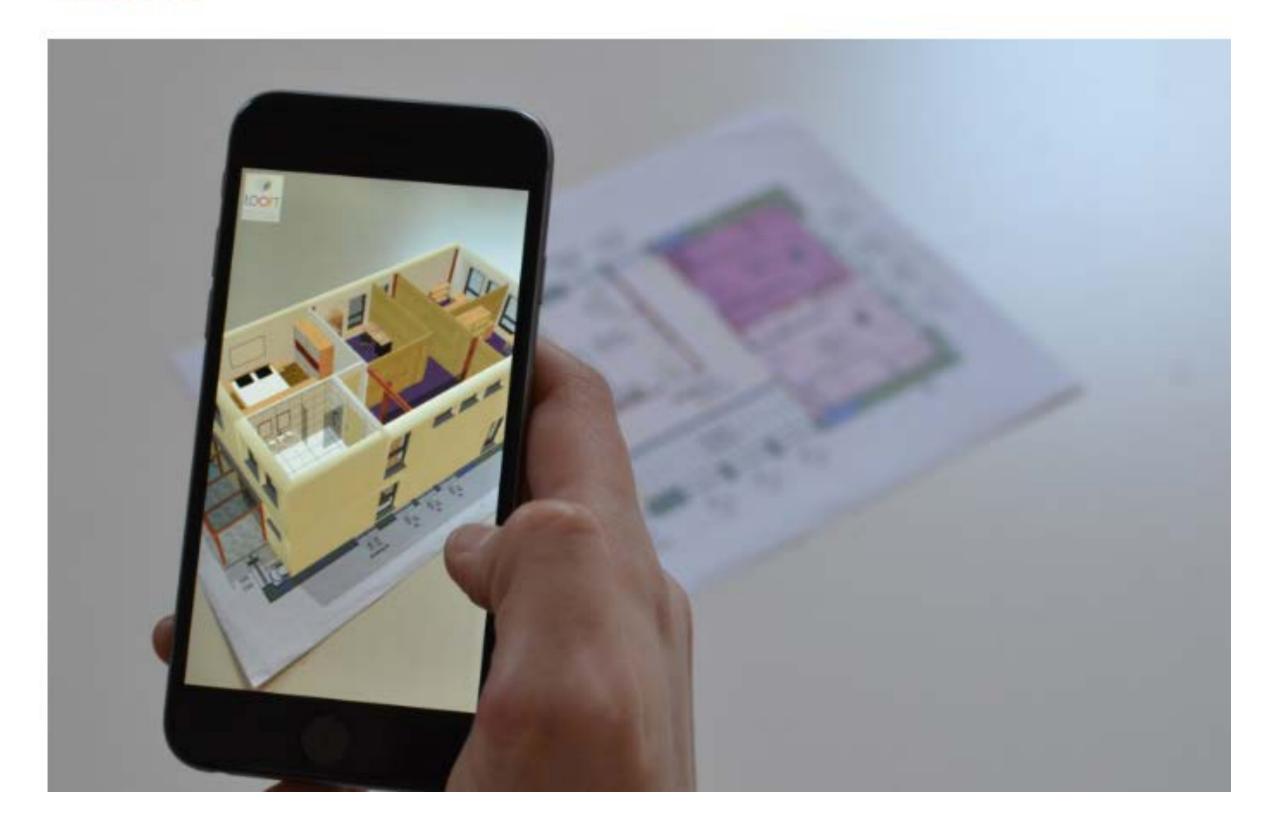
## **Augmented Reality**

PRODUCTS

#### Three Augmented and Virtual Reality Apps for Design and Construction

Step inside your CAD and BIM models with new software for mobile devices.

#### By HALLIE BUSTA





## **Big Data and Analytics**

### BUILDING DESIGN

MAGAZINE BUILDING SECTORS BUILDING TEAM GIANTS 40 UNDER 40 BIM/VDC AWARDS BD+C EVENTS

There are literally hundreds of applications for deep analytics in planning and design projects. We profile some early successful applications.

BIM AND INFORMATION TECHNOLOGY | FEBRUARY 12, 2014 | DAVID BARISTA, EDITOR-IN-CHIEF



This article is part of BD+Cs special five-part Technology Report 2014: Top tech tools and trends for AEC professionals.





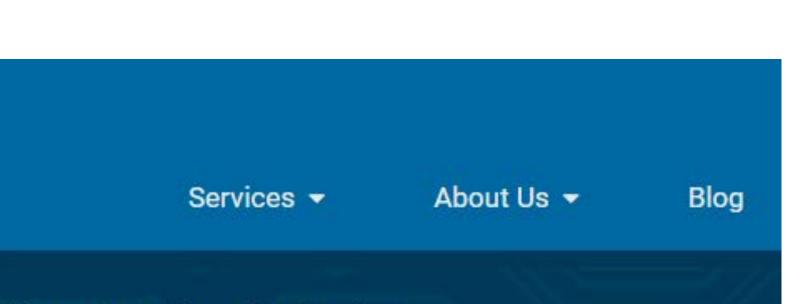
## **Cloud Computing**



#### **Benefits of Cloud Computing for the Construction Industry**

#### Fi 🈏 🗔 🚳 🔤

Most of the hubbub around cloud services is discussed in terms of those in business services. Companies working in the financial sector, in marketing, consulting, insurance, and other business services all can gain major advantages by migrating processes and storage to the cloud. However there are plenty of other industries out there that can enjoy the benefits cloud computing can provide. One such industry in particular is the construction industry. Contractors, architecture firms, and building material suppliers can all enjoy streamlined business operations (and competitive advantages) by utilizing the power of the cloud.







## Cybersecurity

Schinnerer's 55th Annual Meeting of Invited Attorneys

#### Cyber Security and Cyber Insurance for the Design and Construction Industry

by Patrick J. O'Connor, Jr., Esquire

#### Nature of the Threat

The threat is real and growing. While the most visible targets are government agencies and financial, health care, and retail organizations, no one is immune from the risk of loss or injury due to a breach of cyber security. The U.S. Department of Energy, in partnership with the U.S. Department of Homeland Security and in collaboration with private and public sector experts, has defined cyber security risk as follows:

Cyber security risk is defined as risk to organizational operations (including mission, functions, image, and reputation), resources, and other organizations due to the potential for unauthorized access, use, disclosure, disruption, modification, or destruction of information, IT [Information Technology] and/or OT [Operations Technology]. Cyber security risk is one component of the overall business risk environment and feeds into an organization's enterprise risk management strategy and program. Cyber security risk cannot be completely eliminated, but it can be managed through informed decision-making processes.<sup>1</sup>



## **Digital Fabrication**

Digital fabrication is a type of manufacturing process where the machine used is controlled by a computer. The most common forms of digital fabrication are: CNC Machining: where, typically, shapes are cut out of wooden sheets - this is the main technology used by OpenDesk products at the moment.

**Opendesk - Digital Fabrication** https://www.opendesk.cc/about/digital-fabrication

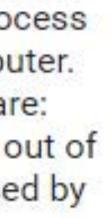
Technology

### **Digital fabrication is so much** more than 3D printing

#### By OLIVIA SOLON

Wednesday 13 March 2013

There is too much coverage in the press about the wonders of 3D printing and it's a distraction from the real revolution, argues Neil Gershenfeld, the head of MIT's Centre for Bits and Atoms. "The coverage of 3D printing is a bit like the coverage of microwave ovens in the 50s. Microwaves are useful for some things, but they 





About this result · Feedback



## **Design Automation**



Calendar Contracts Events Find an Architect Job Board About

#### Design Automation for Prefab Construction

by AIA East Bay Staff on 03/22/2017



desired design intent. In addition, manufacturing I projectfrog feel. Fortunately, there is a new way to design for p for mass-customization, enabling architects to qui designs.

Join Project Frog for a presentation on this new too and features: instant structural validation of a Typ

Tuesday, April 11, 2017 Noon-1pm Free and open to all. BYO Lunch. RSVP to events@aiaeb.org.

1 CES LU

For architects, prefab design can box



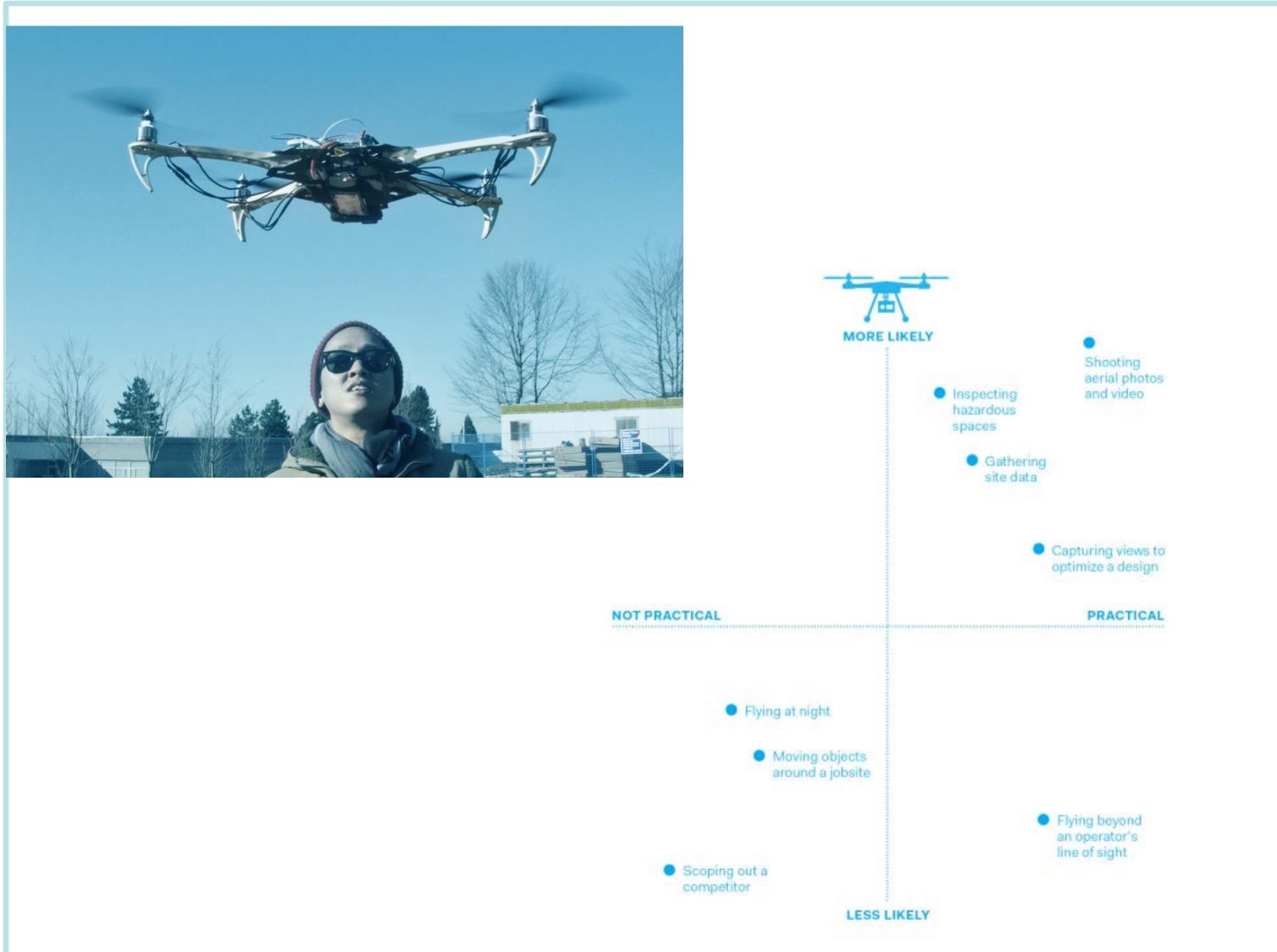
FROG	

Membership			
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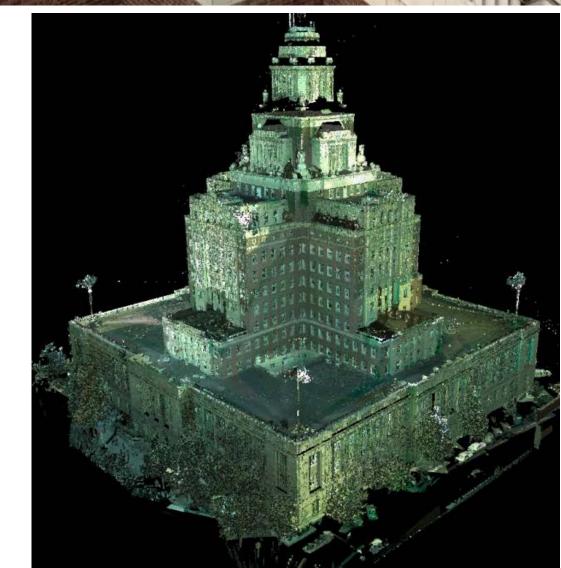




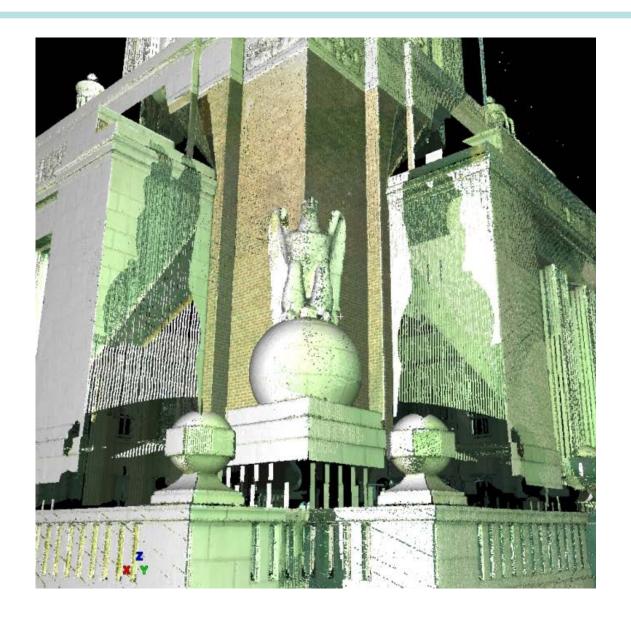


## Laser Scanning and BIM: GSA









#### **Philadelphia Custom House Envelope Repair**

- Built in 1934
- 8 Roofs
- 1050 Windows
- Documentation of window
- types to be renovated
- Provide model to design team



# Laser Scanning | Drones to Save Antiquities

#### Hope for Palmyra's Future

After Islamic State retreated last month, a plan to rebuild an ancient city





## **Apple and Augmented Reality**

### Apple's Next Big Thing: Augmented Reality

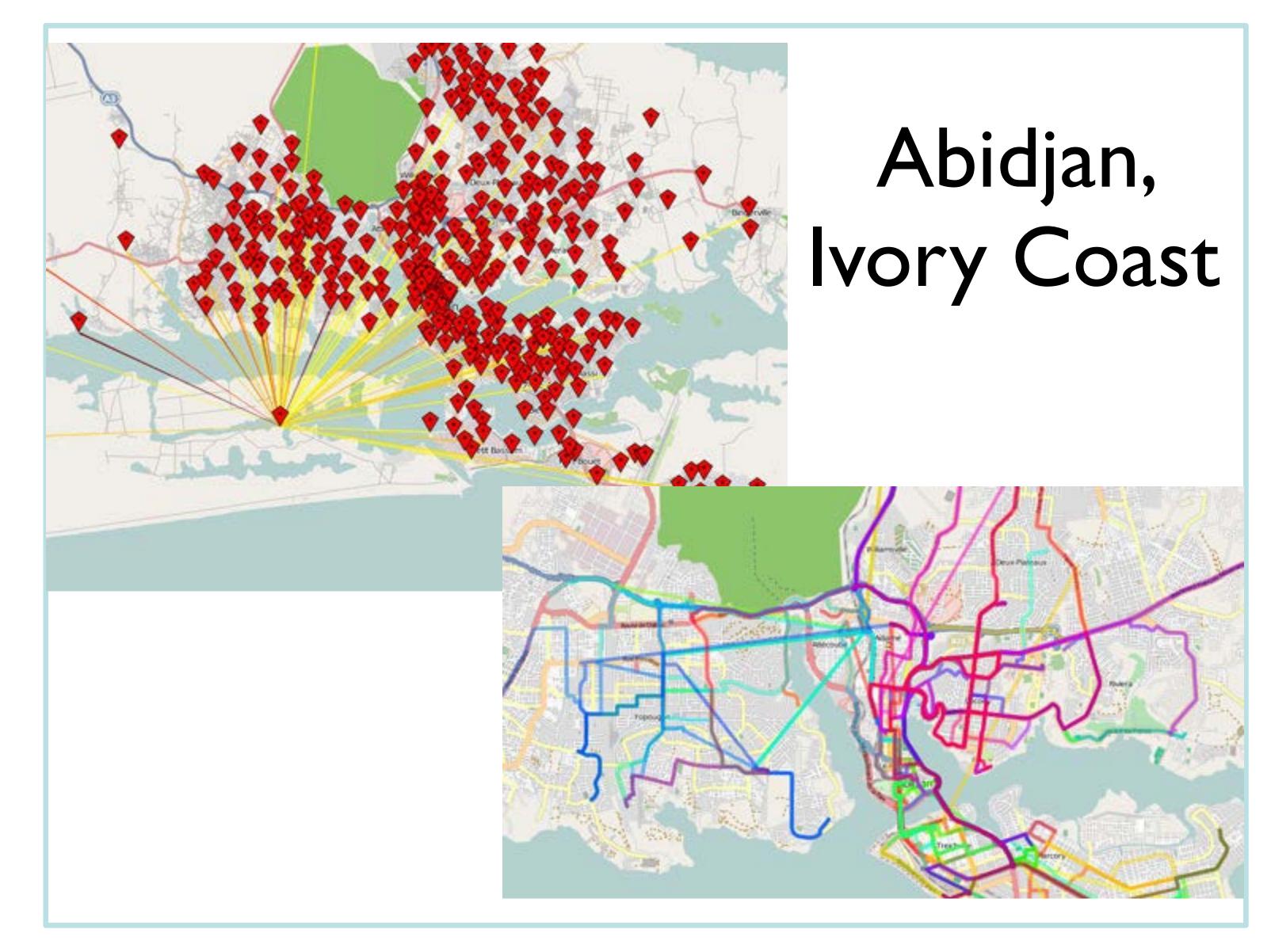
CEO Tim Cook is betting on augmented reality, a cousin of VR that he believes will keep his company on top and may even supplant the iPhone.

by Mark Gurman March 20, 2017, 6:00 AM EDT





# **Geospatial and Big Data Optimizing Transit**





# Location-Based VR to Save Shopping Malls

### Can A Location-Based VR Startup Help Revive Shopping Malls and Cinemas?

Founded by veterans of ILM, Disney, EA, and other media giants, Nomadic plans on building rich experiences that can be refreshed regularly.



IMAGES: COURTESY OF NOMADIC

#### FAST @MPANY



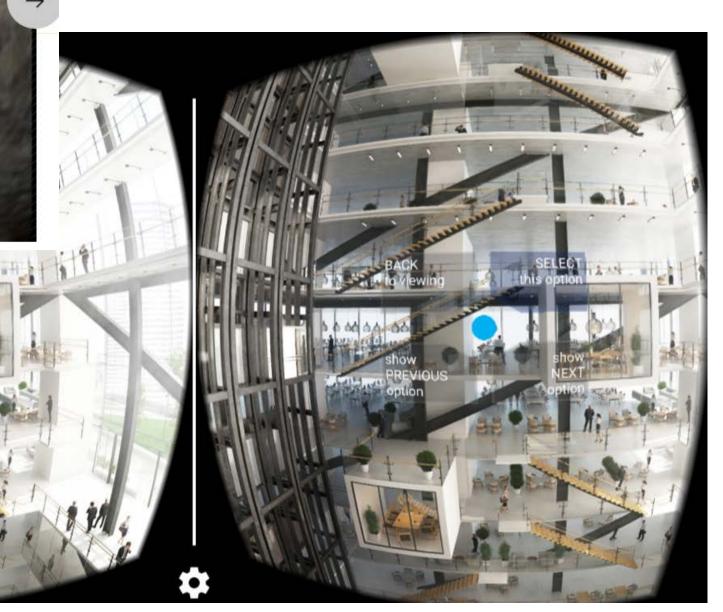
# Harnessing Innovative Technologies: NBBJ

#### This Architecture Firm Is Turning VR Into The Next Great Productivity Tool

NBBJ is the first major architecture firm jumping headlong into VR—by incubating its own platform.









# Harnessing Innovative Technologies: Skanska



**Tie virtual and** augmented tools together on the site

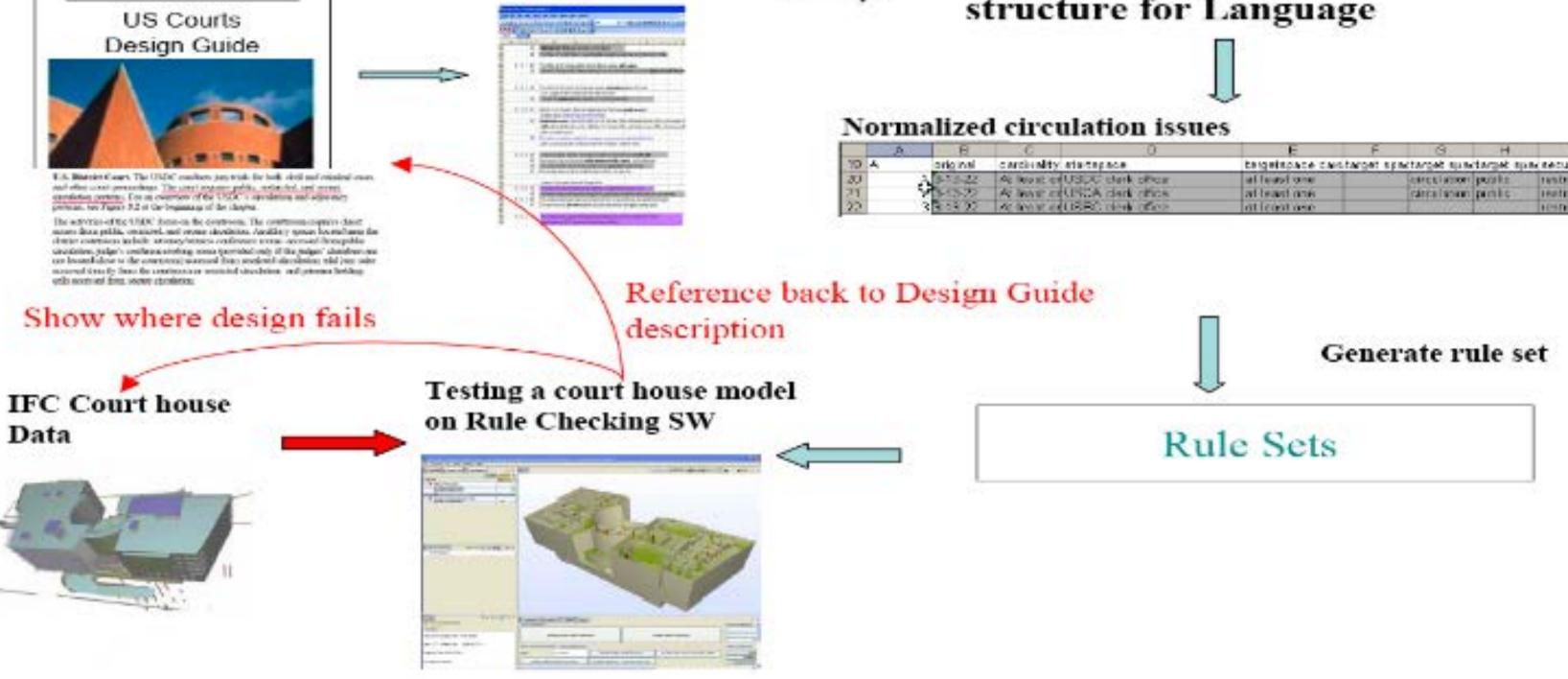
V> DAQRI

Courtesy Skanska

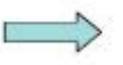


## **Model Checking**





### Automated Circulation Validation Using BIM

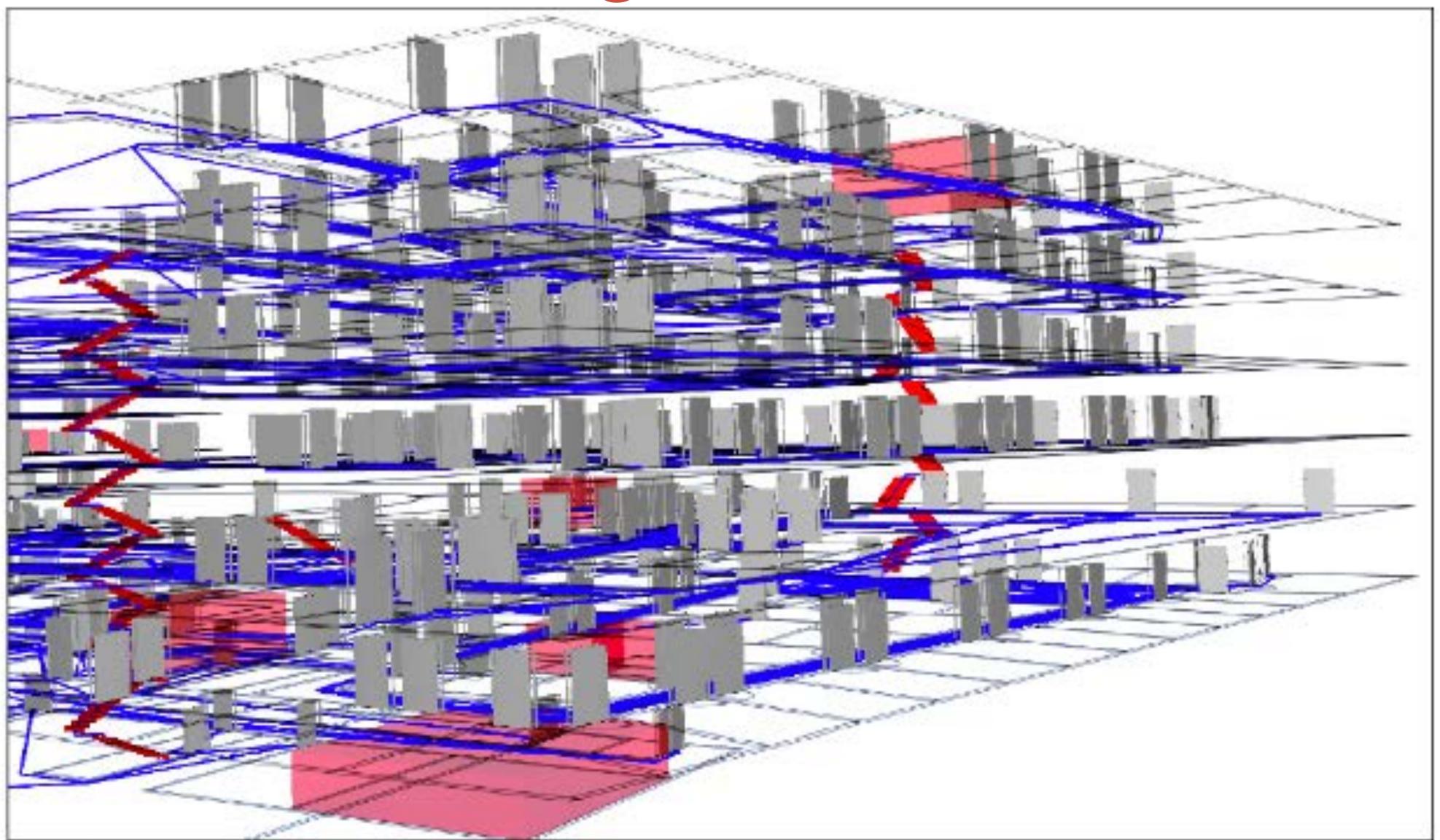


Define standard syntax and structure for Language

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22		3 8 4 8 22	ACTION AND BE	Coler office	at least as	0		10000	restriction.	Circulation (D



## **Model Checking**



#### 27,000 routes were tested using 302 circulation rules in approximately 20 seconds.

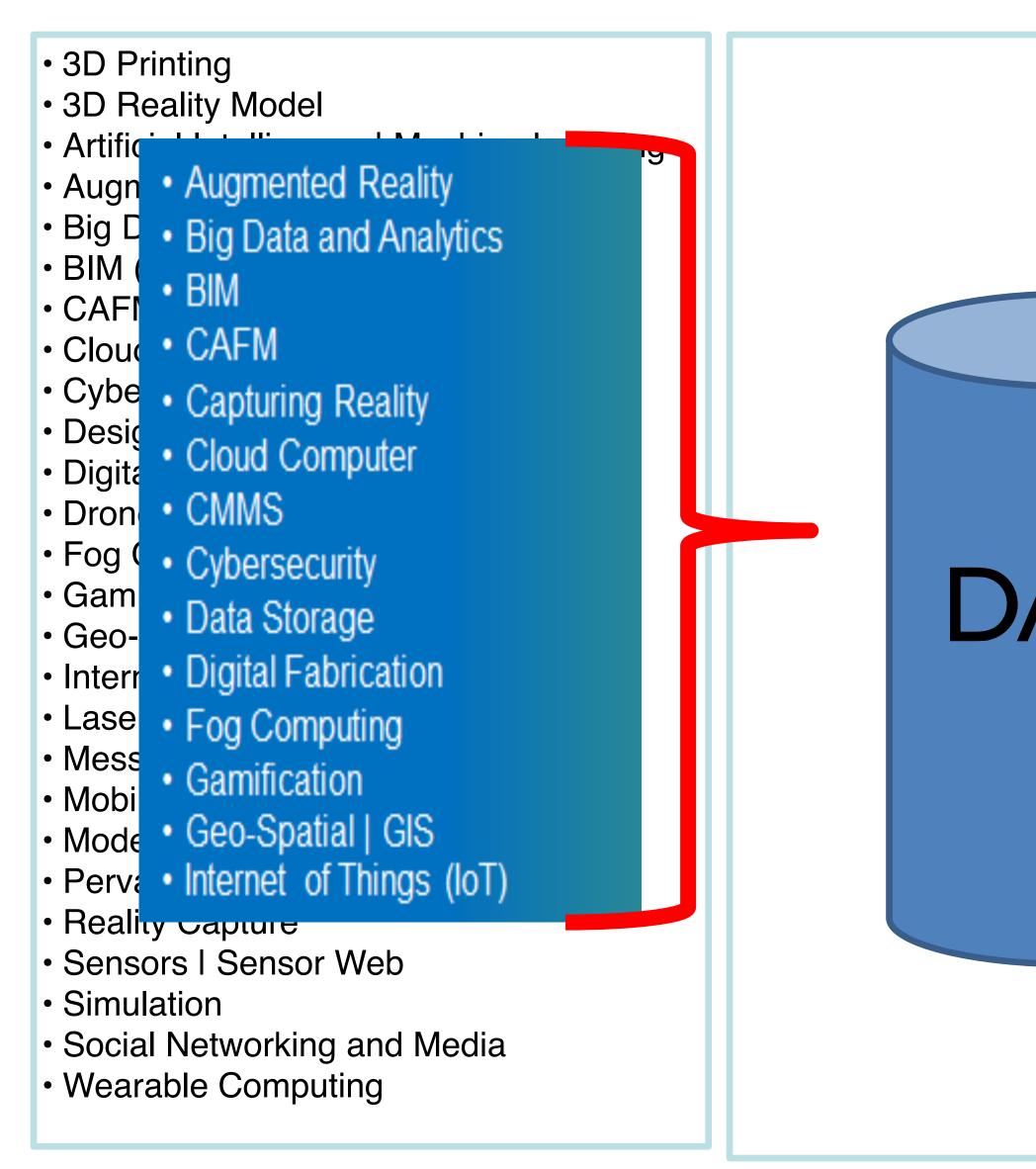


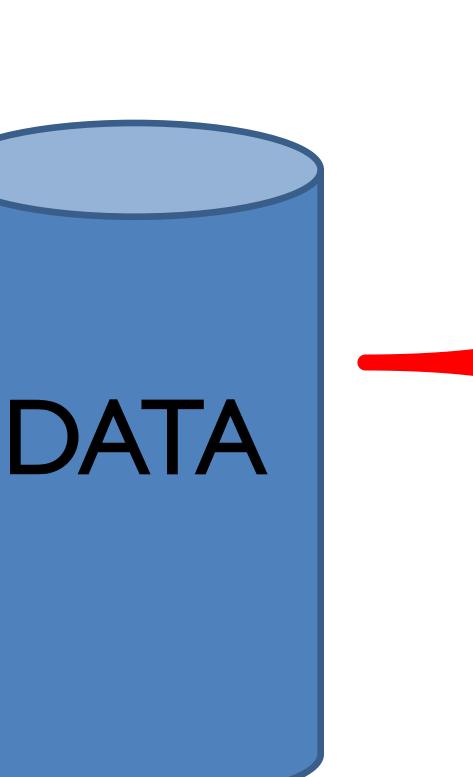


The master information delivery plan is the primary plan for the preparation of the project information (from the supplier's perspective) required by the employer's information requirements. It lists information deliverables, and sets out when project information is to be prepared, by whom, and using what protocols and procedures for each stage of the project.



## Ultimately it is all about Data





- Laser Scanning
- Messaging (email, sms, and beyond)
- Mobile
- Model Checking
- Pervasive Computing
- Sensors
- Simulation
- Social Networking and Media
- Specification Authoring
- Synchronization
- Virtual Reality
- Wearable Computing

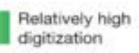


## 2015 McKinsey Global Institute Study

CBINSIGHTS	#constructiontech		ERED
	McKinsey Global Institute industry digitization index; 2015 or latest available data	Relatively le digitizati Digital le	
	Assets	Usage	Labo
			Anathet making
	Sector	G¥ 33 €	5 And
	ICT <sup>2</sup>		
	Media		
	Professional services		
	Finance and insurance		
	Wholesale trade		
	Advanced manufacturing		
	Oil and gas		
	Utilities		
	Chemicals and pharmaceuticals		
	Basic goods manufacturing		
	Mining		
	Real estate		
	Transportation and warehousing		
	Education		
	Retail trade		
	Entertainment and recreation		
	Personal and local services		
	Government		
	Healthcare		
	Hospitality		
	Construction		
	Agriculture and hunting		
<b>CBINSIGHTS</b>	#constructiontech		McKinse

www.cbinsights.com

10



atively undigitized sectors



#### CONSTRUCTION IS ONE OF THE LEAST DIGITIZED SECTORS

Construction is towards the bottom when it comes to digitization, with only agriculture and hunting falling beneath it. Many of these areas are less complex and could reduce the cost of services if automated (eg., transactions, business processes, etc.).

11



#### A lot of back and forth between field and desk - Total per Work Order 70 Minutes

Calculated as 8 hour days

10 Minutes Each × 783,917 WO= 16,332 Days

8



DoD Wide 783,917 Work Request in 2012

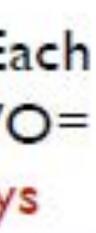
20 Minutes Each to travel back to Desk and enter data x 783,917 WO= 32,663 Days



Go back to Workstation Enter into DMLSS FM

Send Field Tech to Respond

Close out Work Order

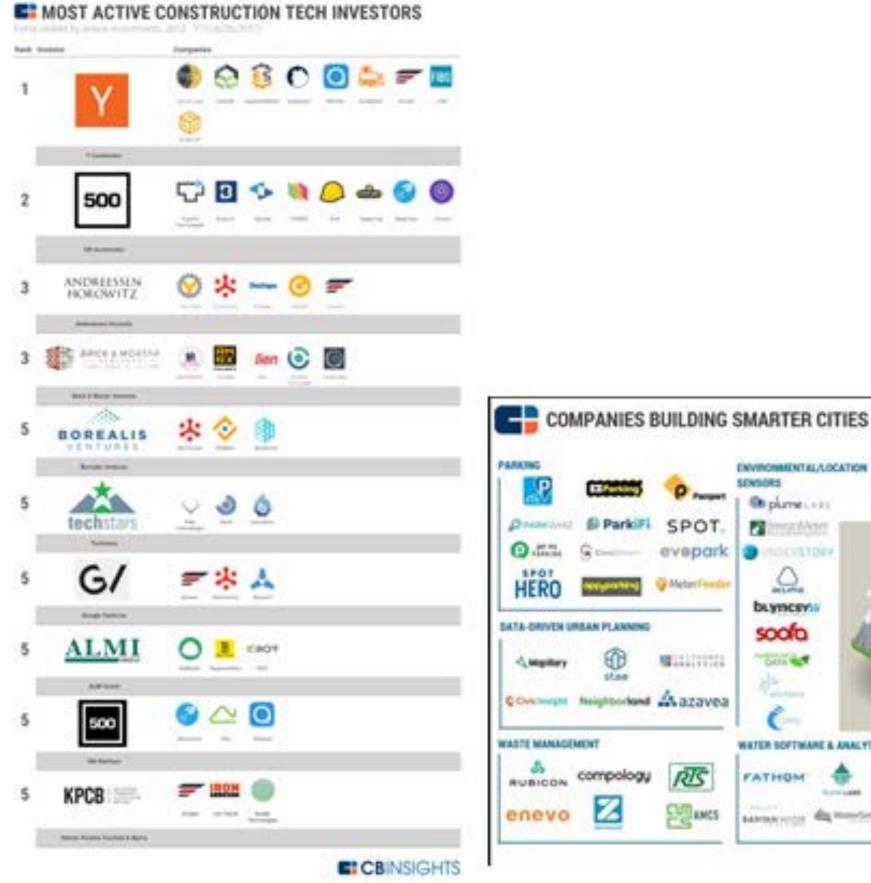






## Huge Investment is Happening NOW

#### Construction Tech | Smart Cities Tech | Cyber Tech



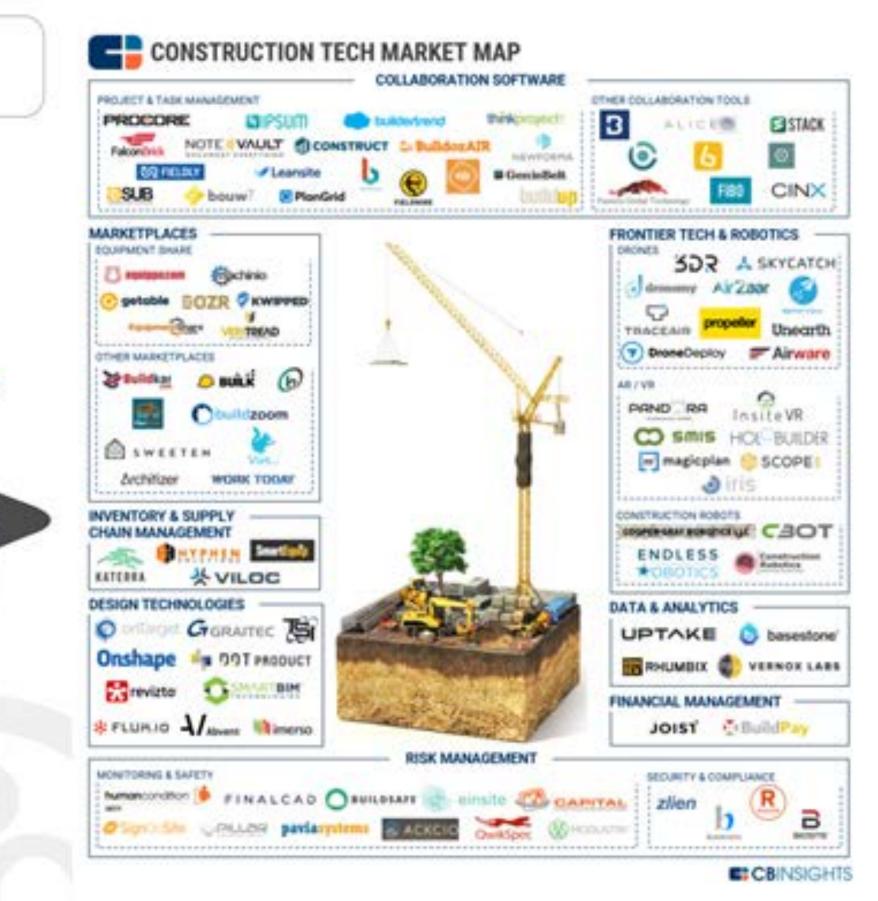


	ENVIRONMENTAL/LOCATION	DISASTOR MANAGEMENT	SMART TRANSPORT (SHUTTLE/BIRE)
Peopert	Ob plume	ICONCORN ZENYSIS	Zogster SOOT MOOIKO
POT. apark	a innadoten	Transit App	CONNECTIVITY VENTAM SVINTUE VISION purplewith PRANENT
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			CONDIGHTS

## From Smart Buildings to Smart Cities

## **Smart Buildings Smart Tech**





## **BIM (and Technologies**

#### INTRODUCTION

PENNSTATE

1855

ANNOUNCEMENTS

EVENTS

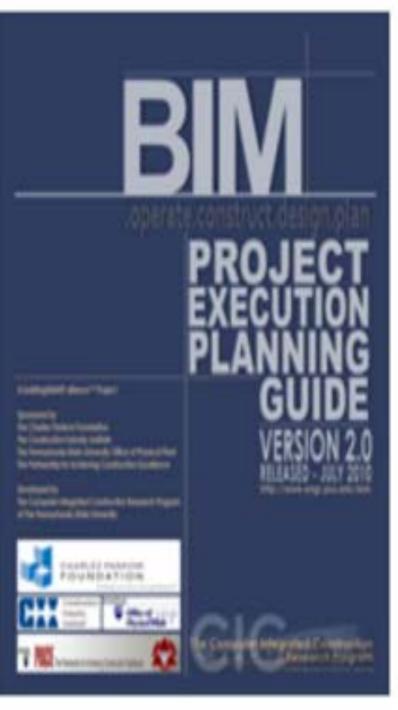
RESOURCES

FEEDBACK

CIC Home

AE Home

Penn State OPP



Click to DOWNLOAD

s) Execut	tion Planning
NING	PENN STATE COMPUTER INTEGRATED CONSTRUCTION
Introduction	Project Owner BIM Uses
<text></text>	Announcements: New Uses of BIM Document Released! The Uses of BIM document is designed to communicate the BIM Uses classification system and BIM Use Purposes.
FINA STATI MARINA	Version 2.0 of the BIM Planning Guide for Facility Owners Released June 2013.
Click to DOWNLOAD	Subscribe to BIM Planning's to recieve a



## 2004 – 2018 AIA TAP Building Connections Congress– Future of Design

#### **Building Connections Congress 2018**

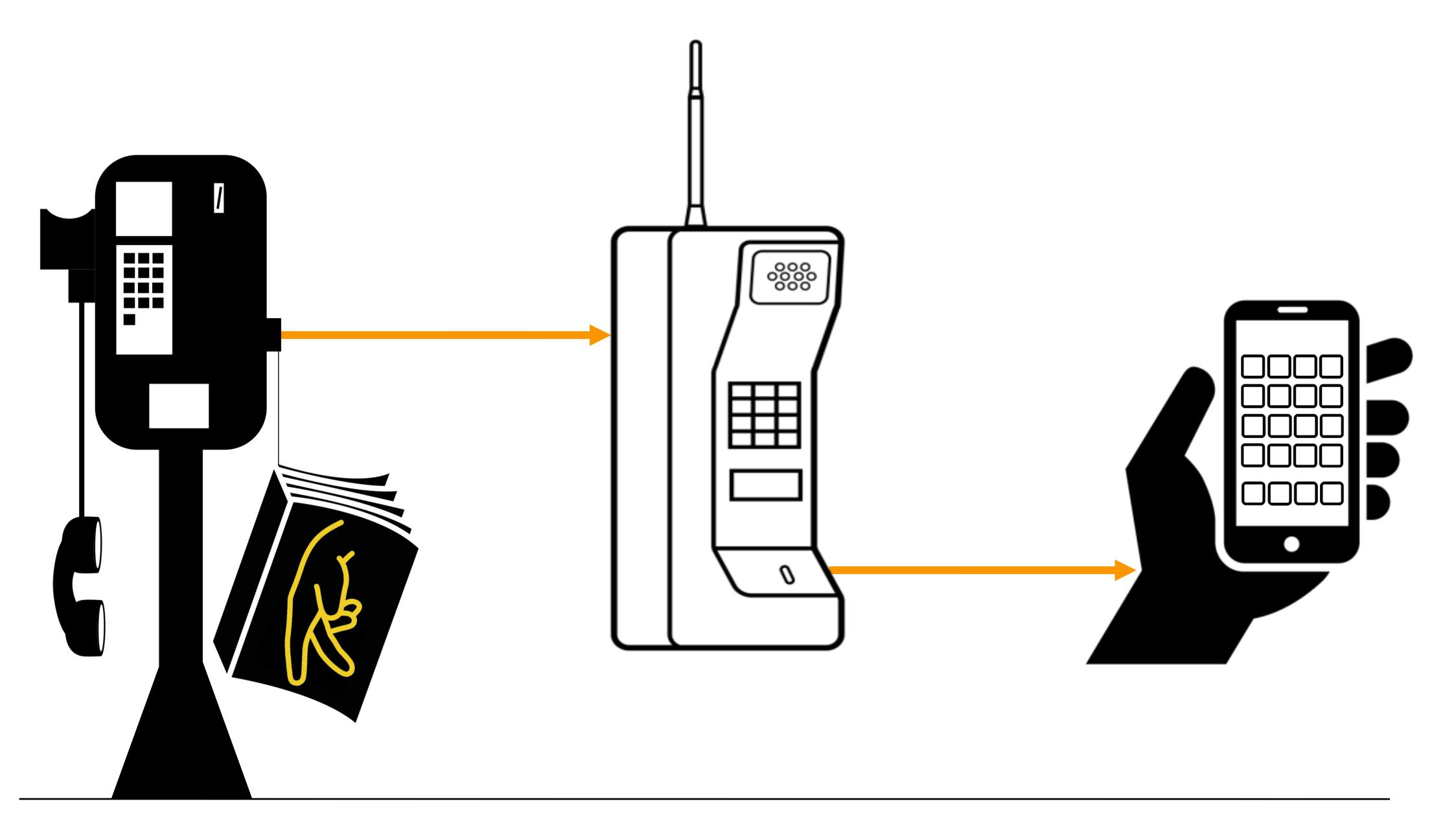
#### Register Now

When: Jan 8, 2018 from 8:30 AM to 5:00 PM (ET) Associated with Technology in Architectural Practice





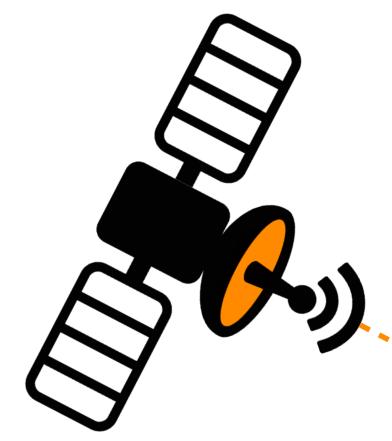




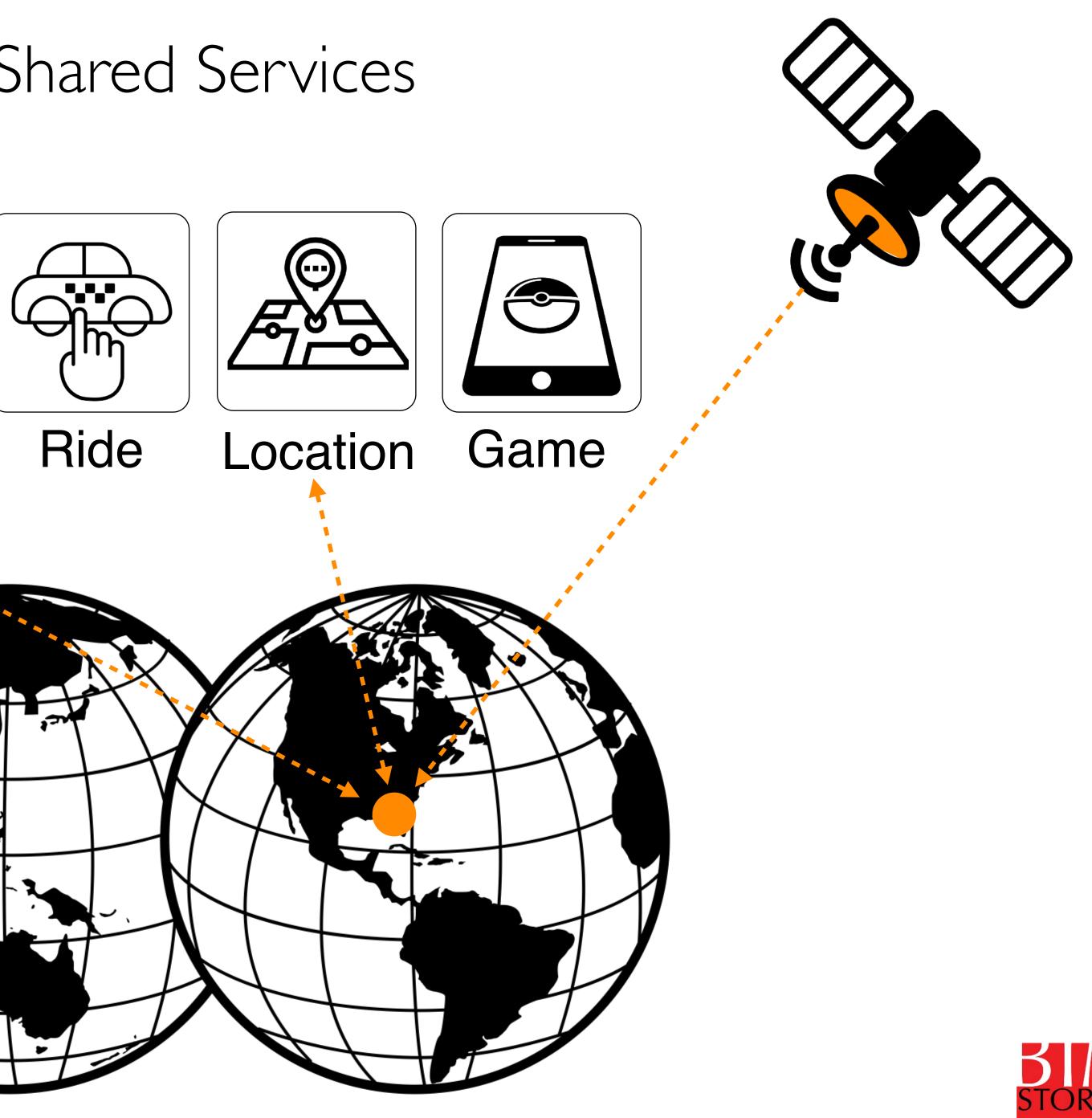


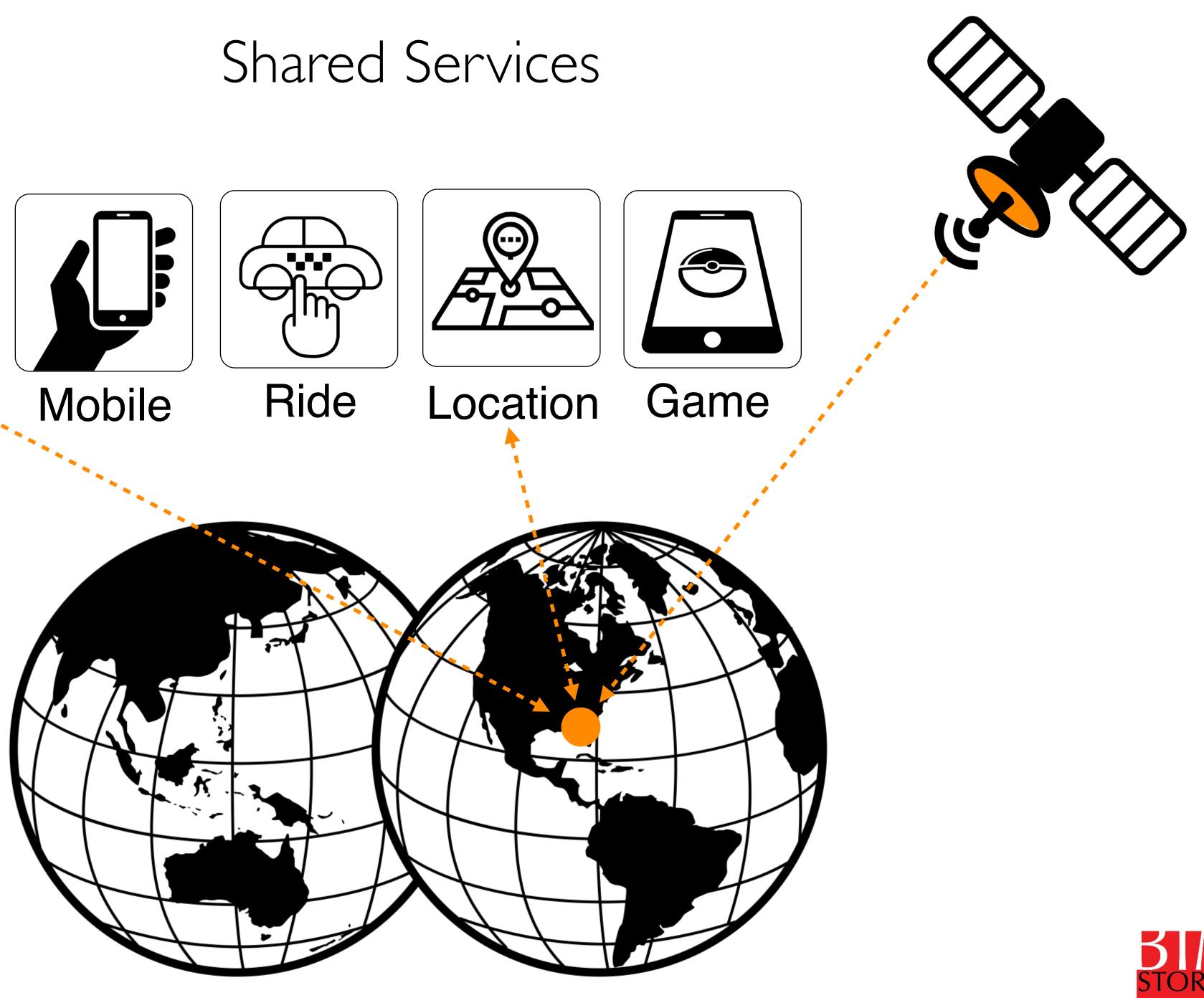






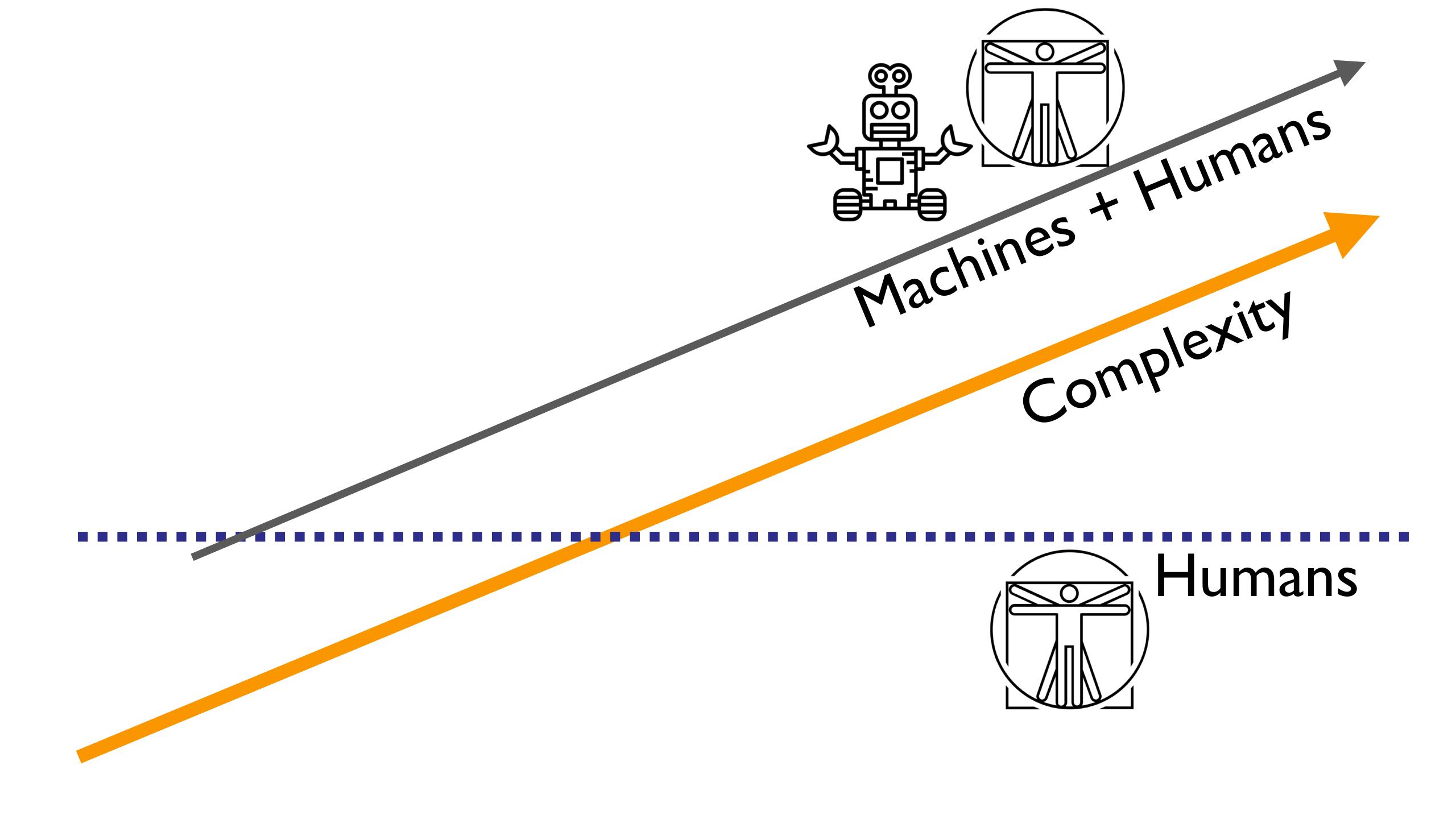




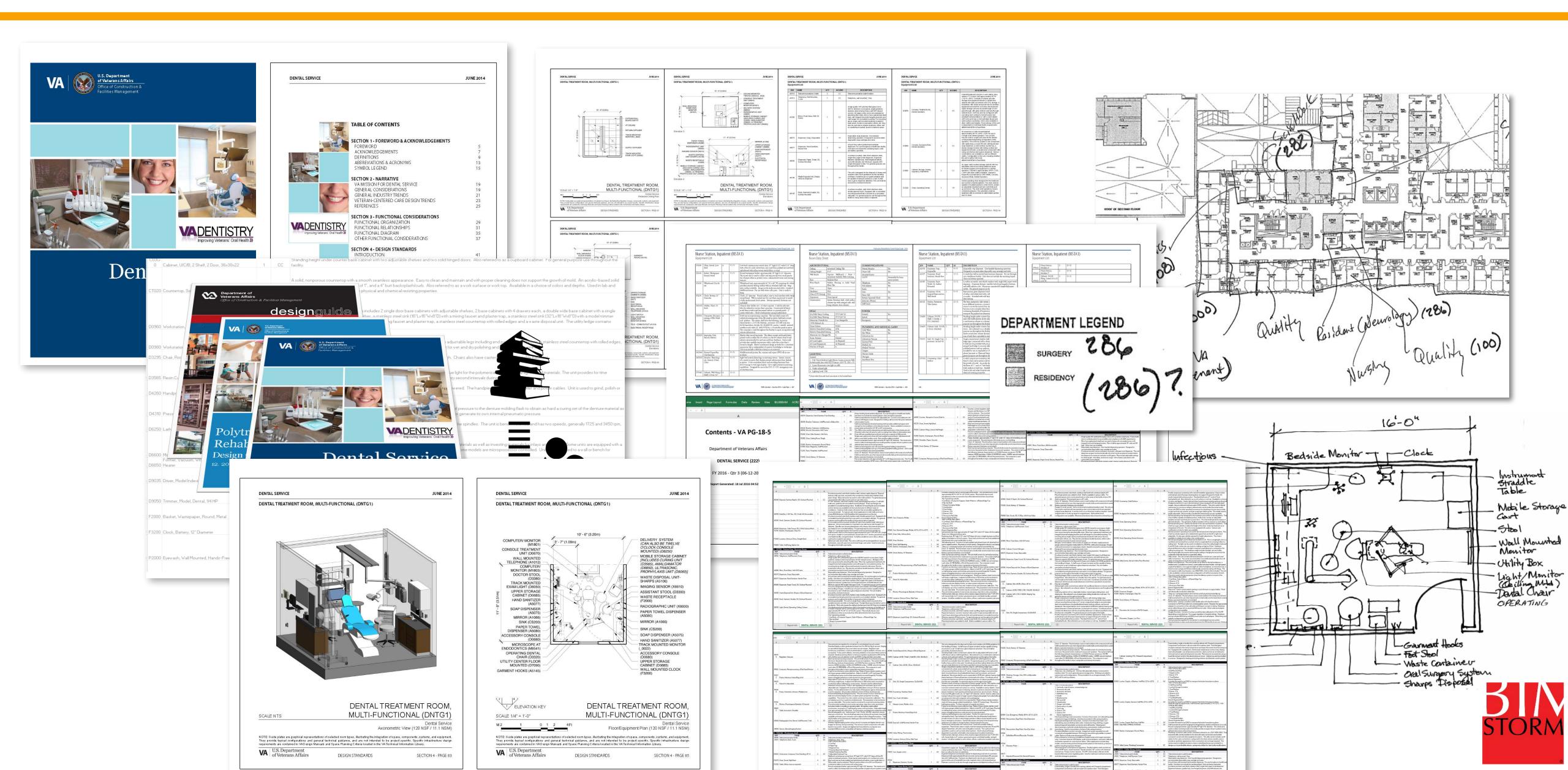








## How We Process Info









Space



# Owners are Changing



Department of Defense Defense Health Agency

# Equipment





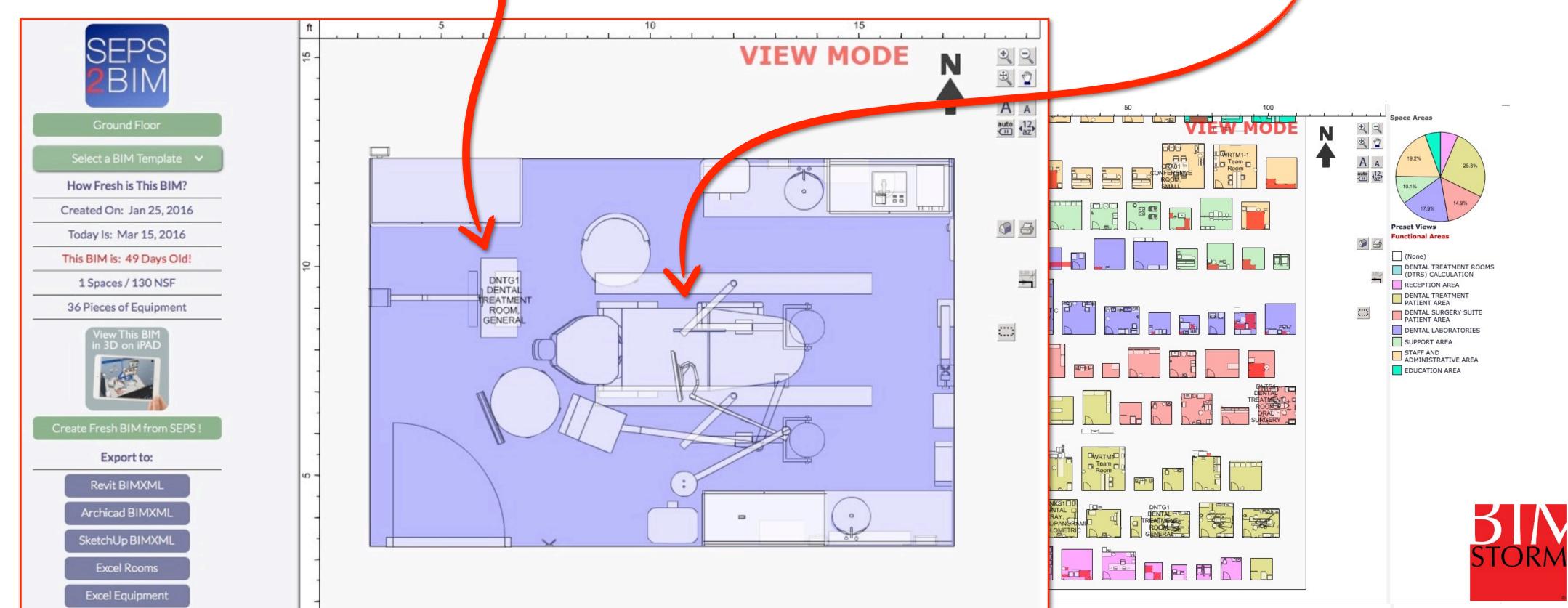




# DIGITAL DATA INTO BIM

#### **ROOMS and DEPARTMENTS**

1	Project Room GUID	1	1	2	2	Content is located in this room	1	Project Room GUID	1	1	2	2	Content is located in this room
2	Project Content GUID	4	5	6	11	Unique ID Per Content	2	Project Content GUID	4	5	6	11	Unique ID Per Content
4	JSN	F0230	workstation_2pc_c	F0205	Mail-18-openings		4	JSN	F0230	workstation_2pc_c	F0205	Mail-18-openings	
6	QTY	1	1	6	1		6	QTY	1	1	6	1	
13	Content Name	Ergonomic Task Chair	U-Shaped Admin workstation	Guest Chair	Mail Distribution Center		13	Content Name	Ergonomic Task Chair	U-Shaped Admin workstation	Guest Chair	Mail Distribution Center	



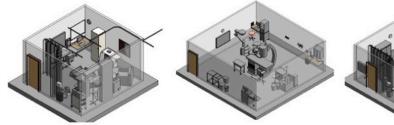
#### EQUIPMENT

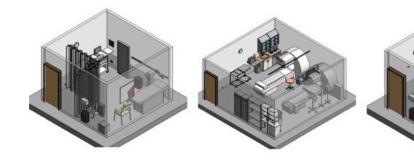


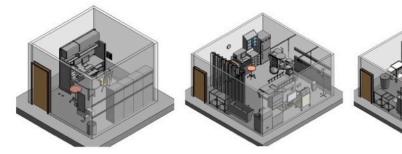
## SEPS2BIM.org Available Online

## Owner's Data to BIM

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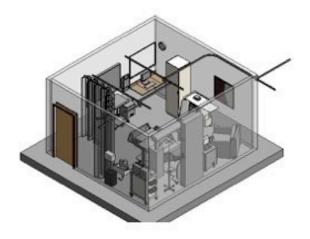


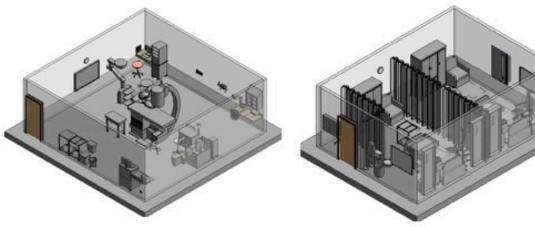


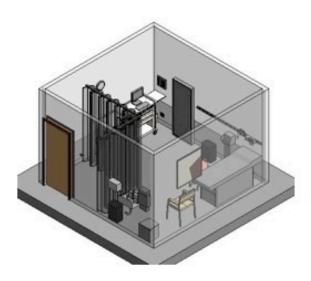


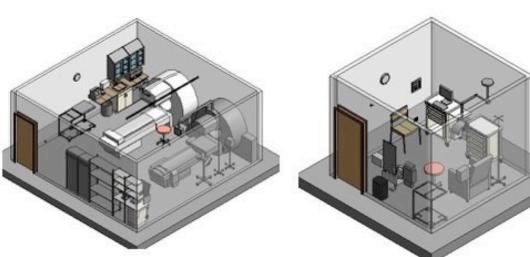


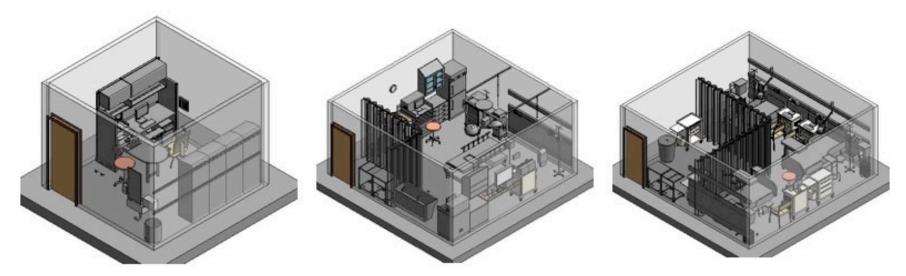


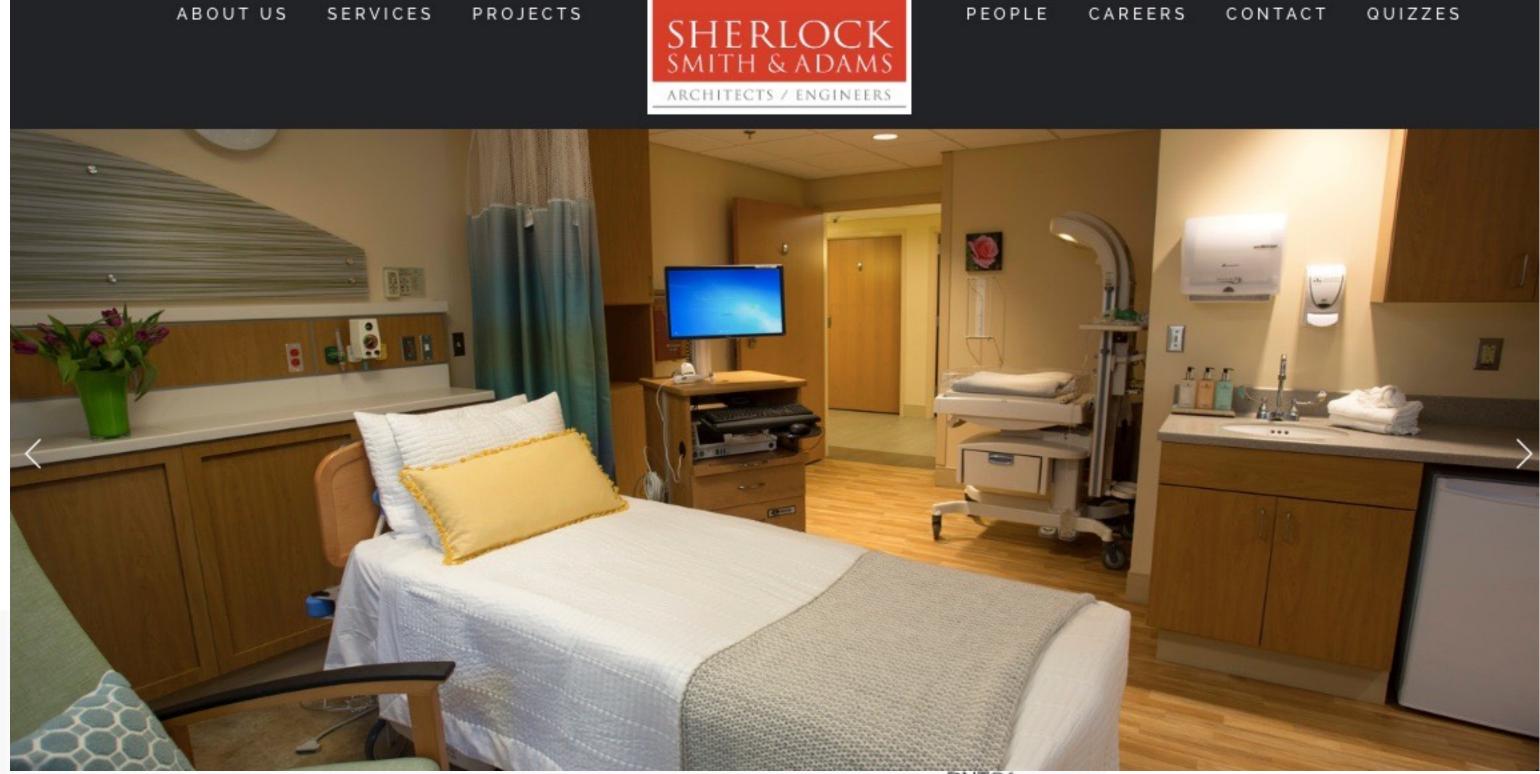




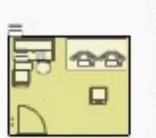


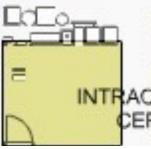
















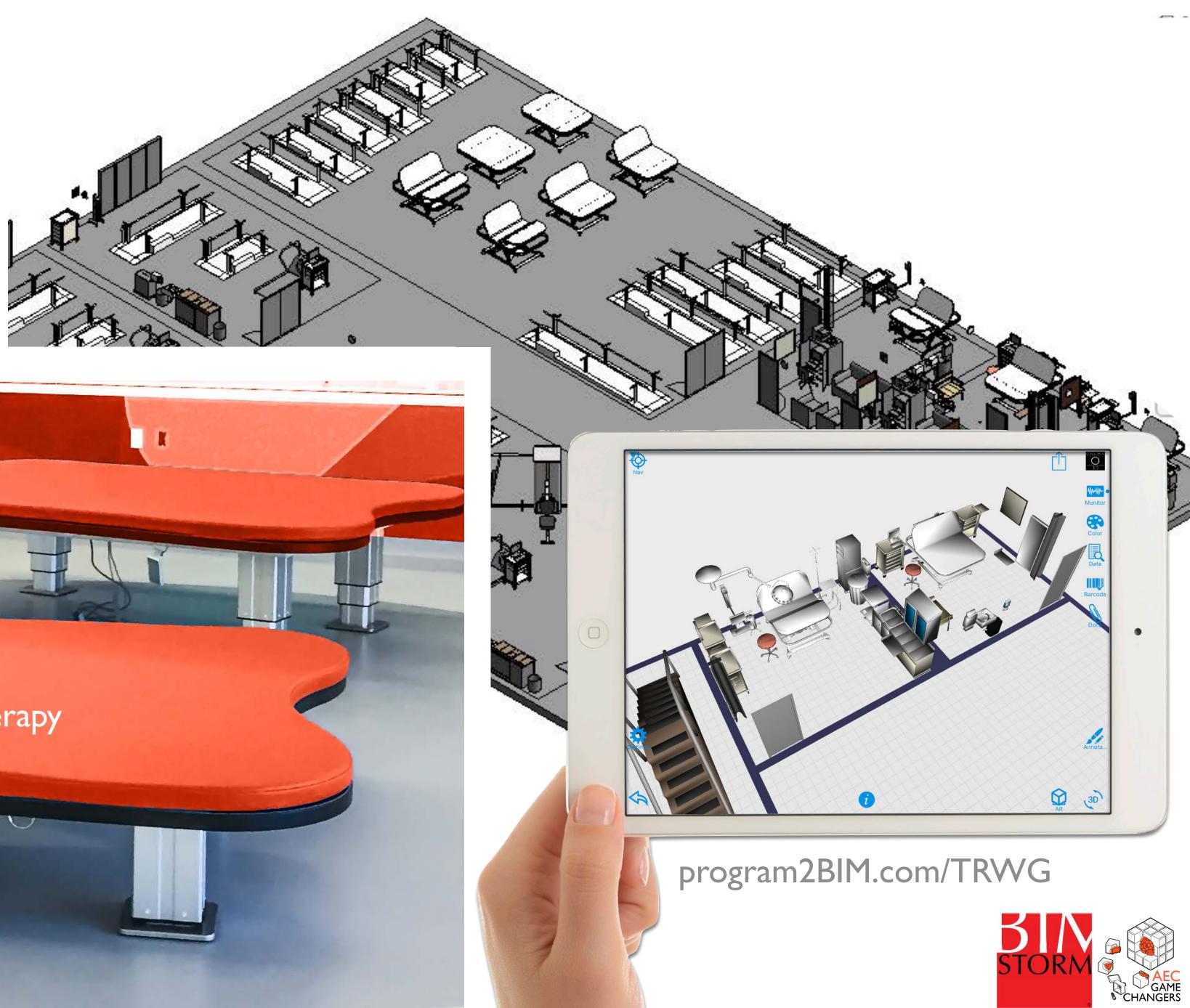






### TWG1000.SD SERIES Motorized

-



#### JSN M8315 Table, Traction, Physical Therapy

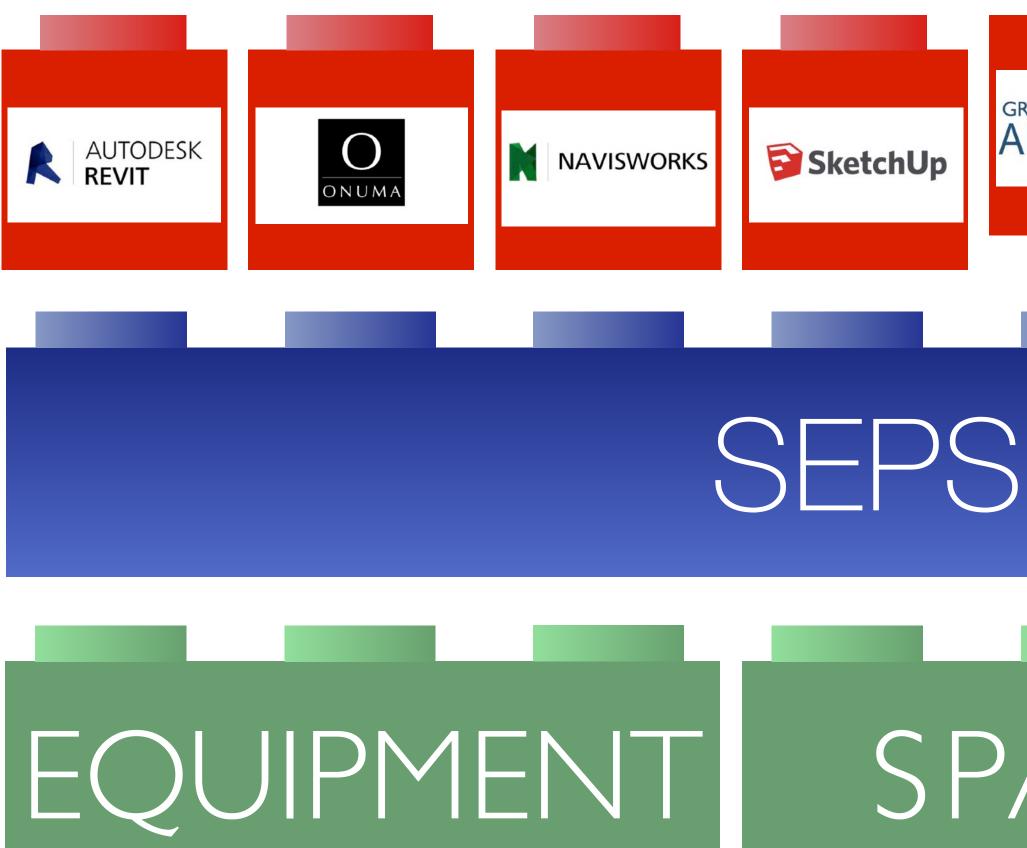


## Owner's Platform

Architects Engineers Consultants



### Decoupled Data - Modular Apps





## SEPS2BIM.org

## SPACES PROJECTS

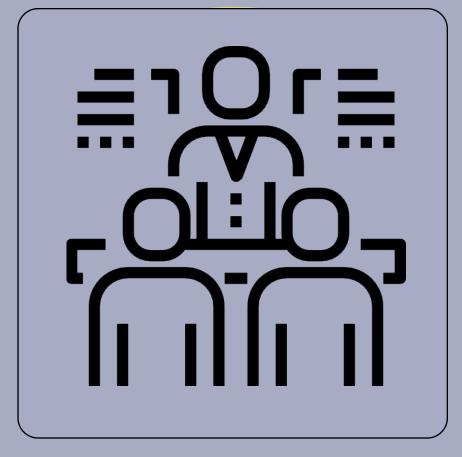




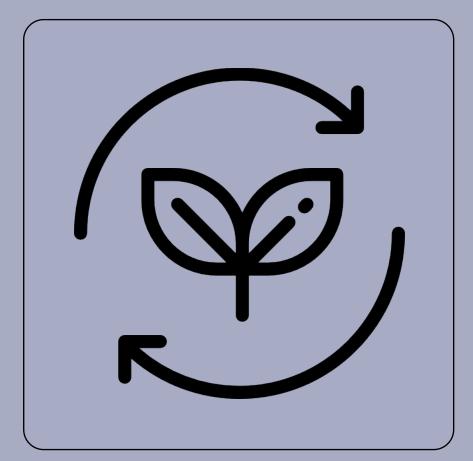




U.S. Department of State Bureau of Overseas Buildings Operations



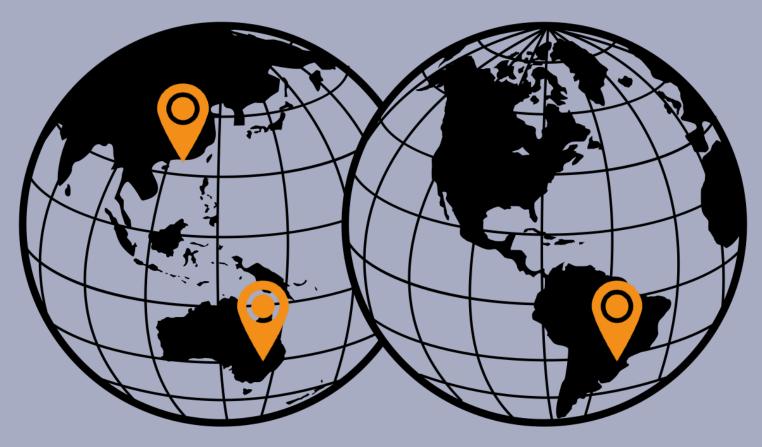
#### Improved Coordination



#### **Shared Data For Lifecycle**



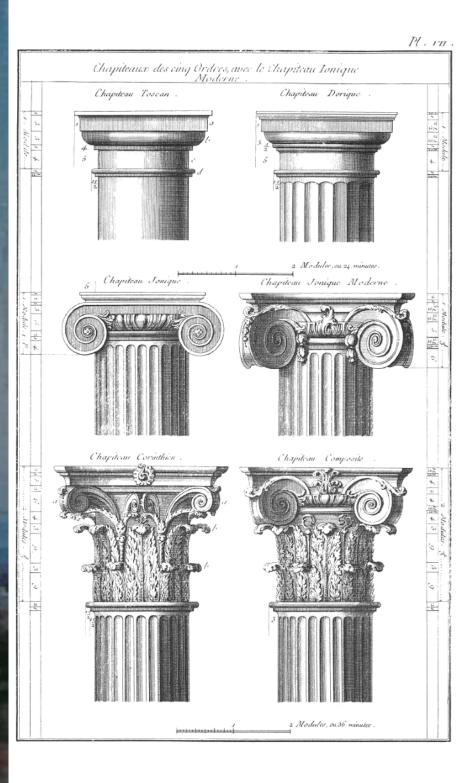




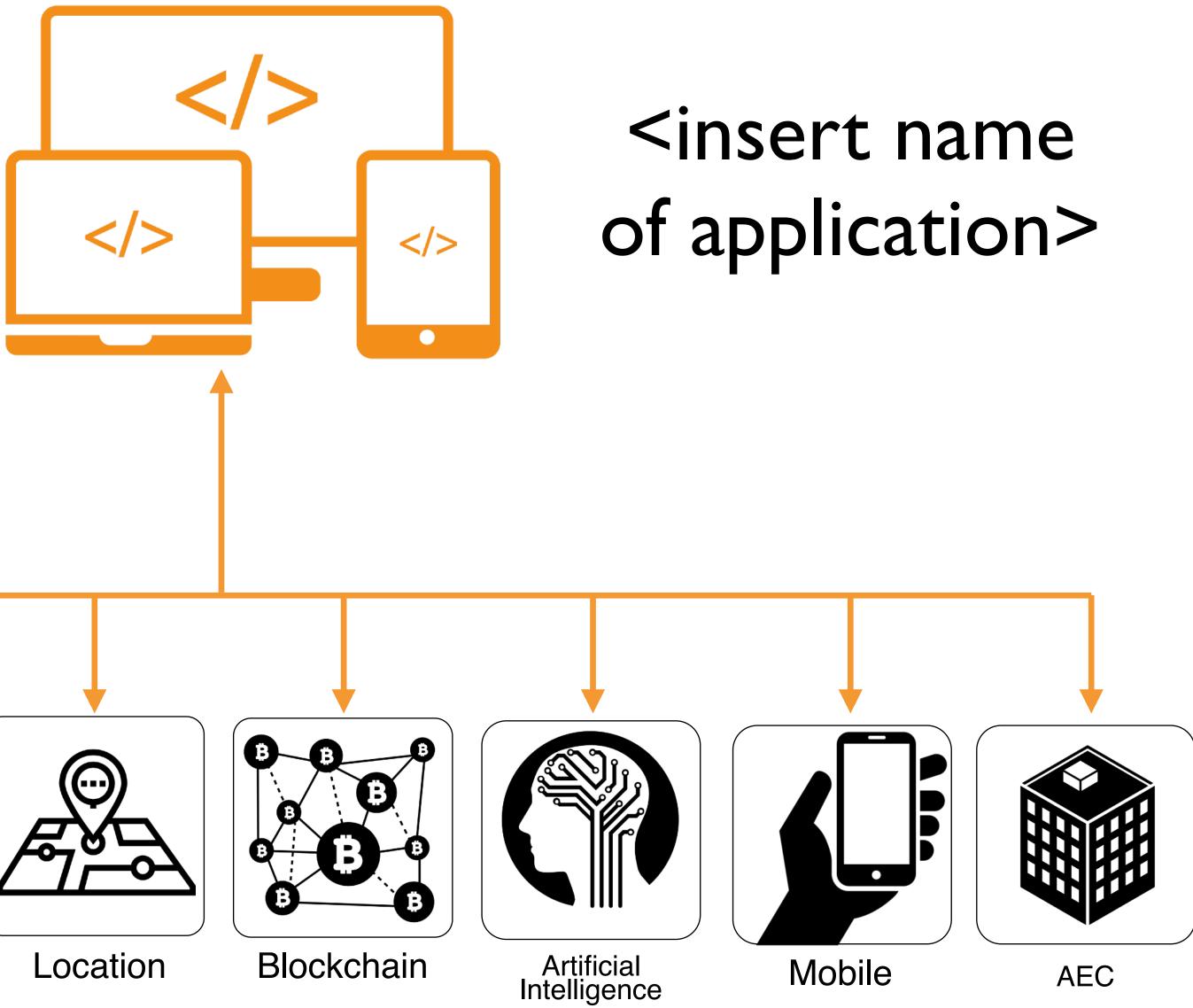
#### Improved Efficiencies

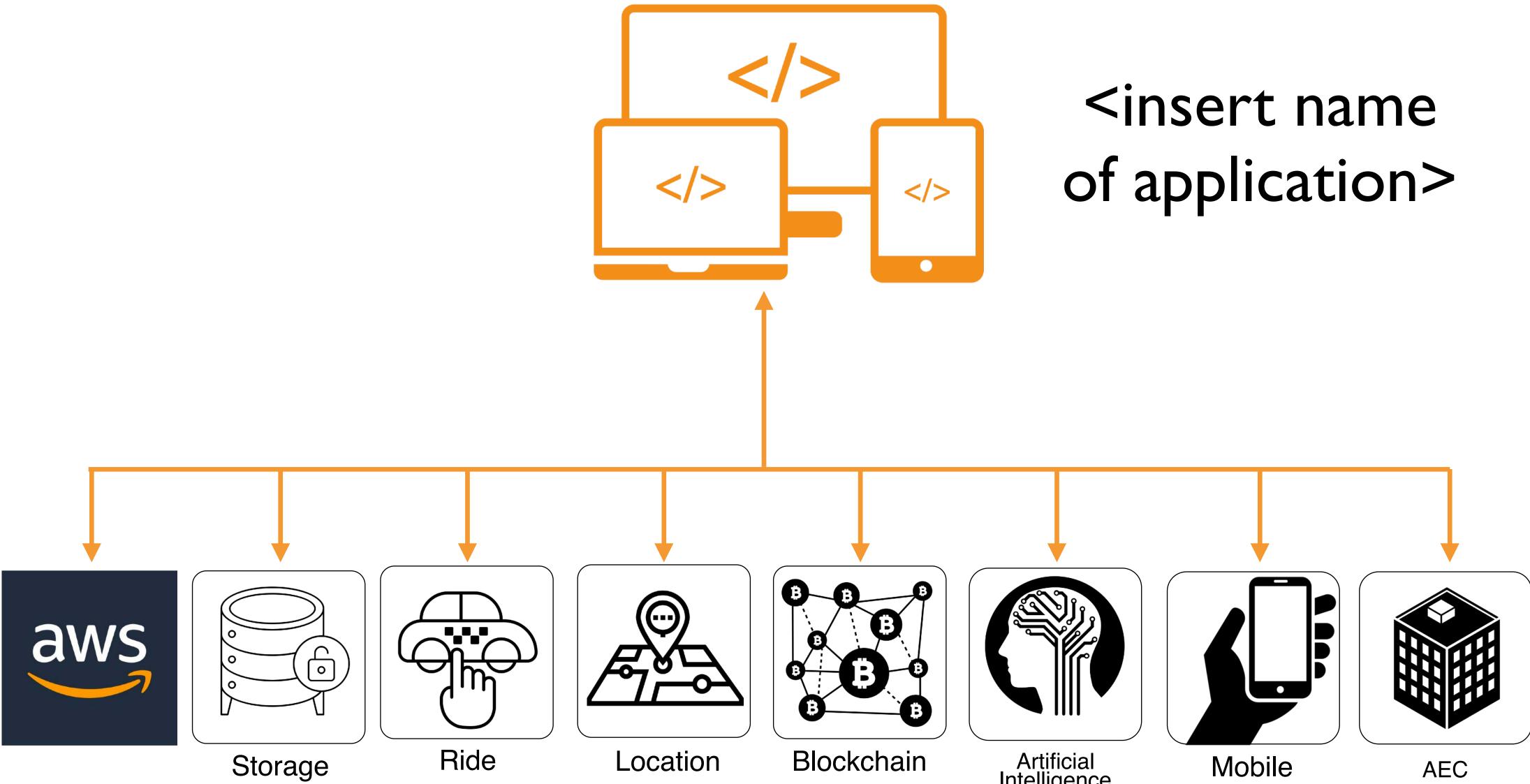
#### **Supporting Projects & Portfolio**

# Architecture as a Platform



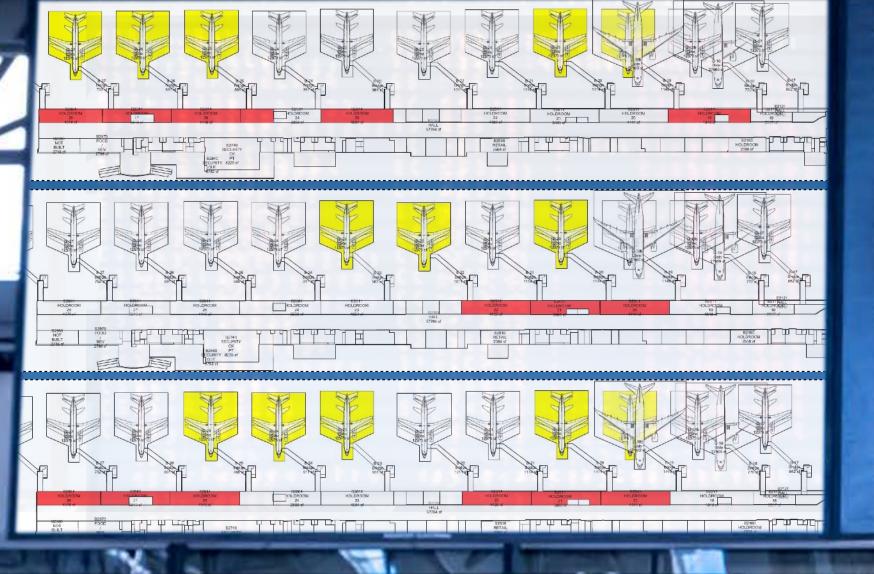






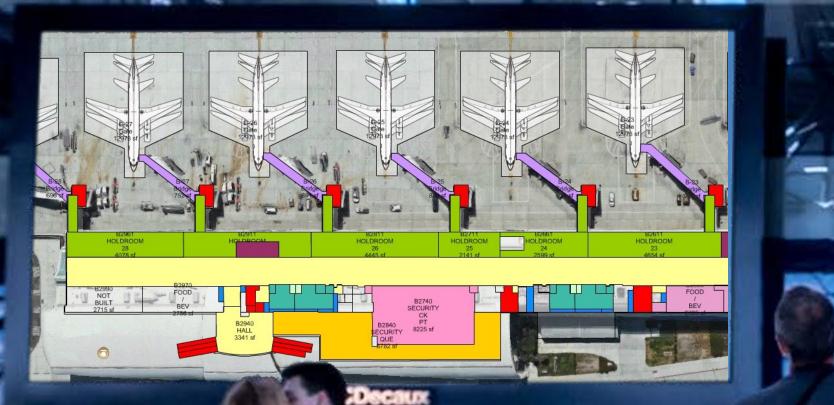
Many Databases, Many Standards, A lot of Data

### Platforms





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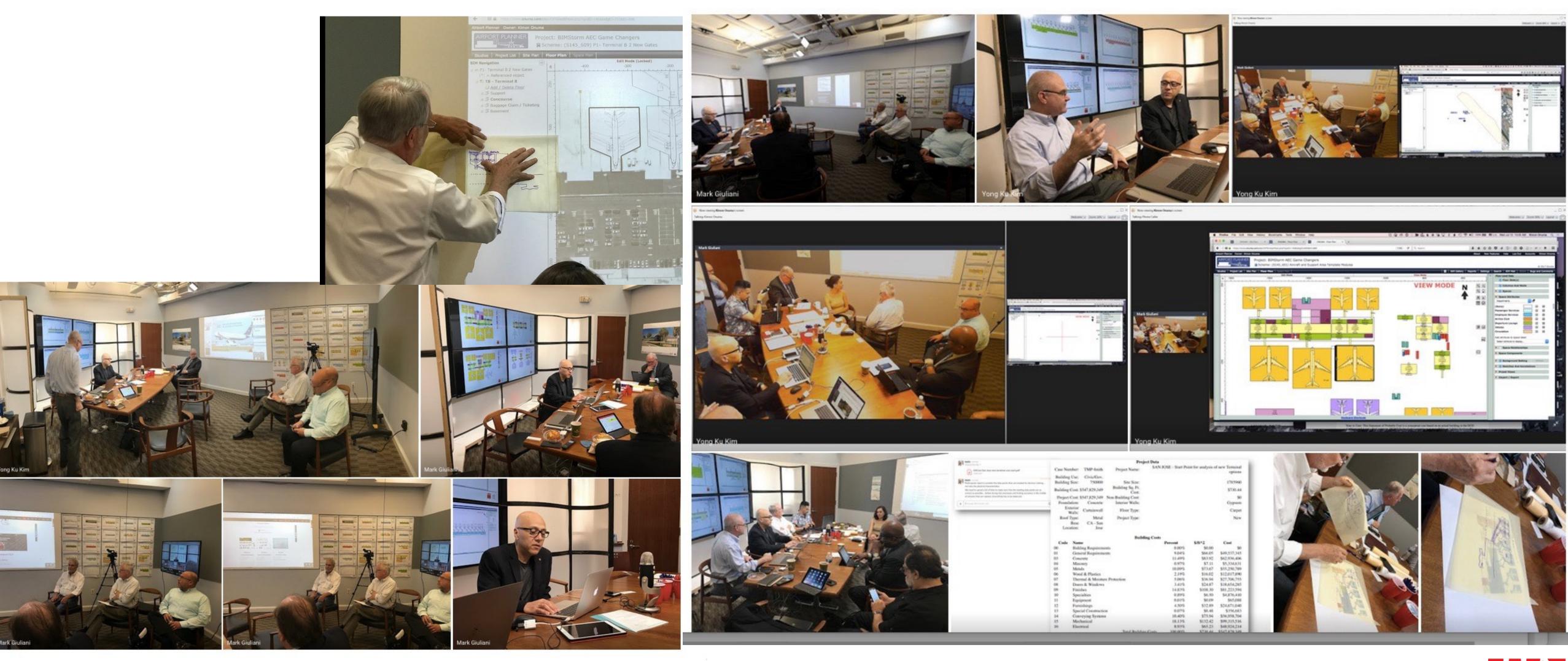
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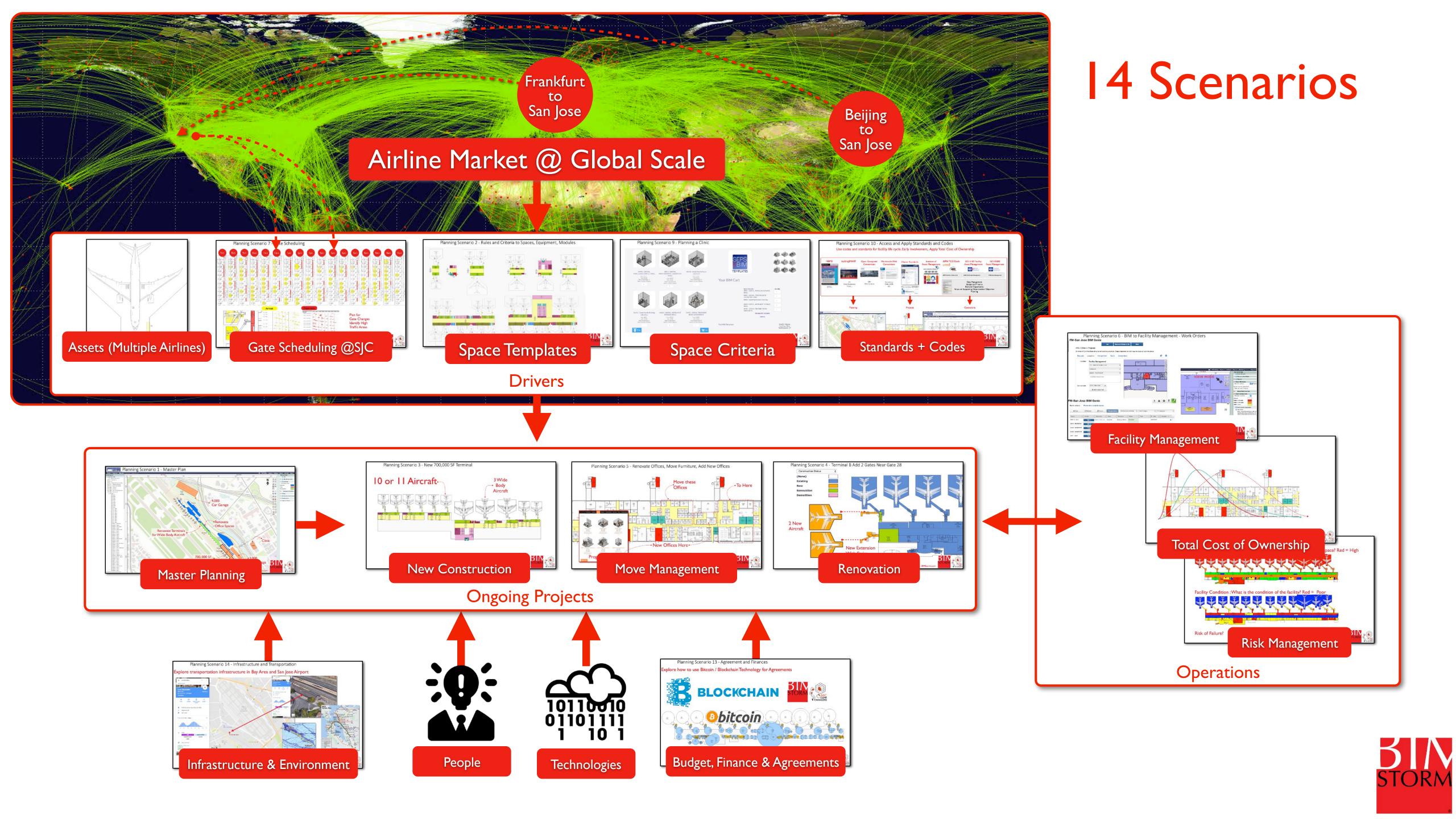
SCENARIOS 1 - MASTER PLAN 2 - TERMINAL RENOVATIONS 3 - NEW 700,000 SF TERMINAL 4 - TERMINAL B NEW GATES 5 - RENOVATE OFFICES 6 - BIM TO FACILITY MANAGEMENT 7 - GATE SCHEDULING ASSETS 8 - TOTAL COST OF OWNERSHIP
ST TRACK

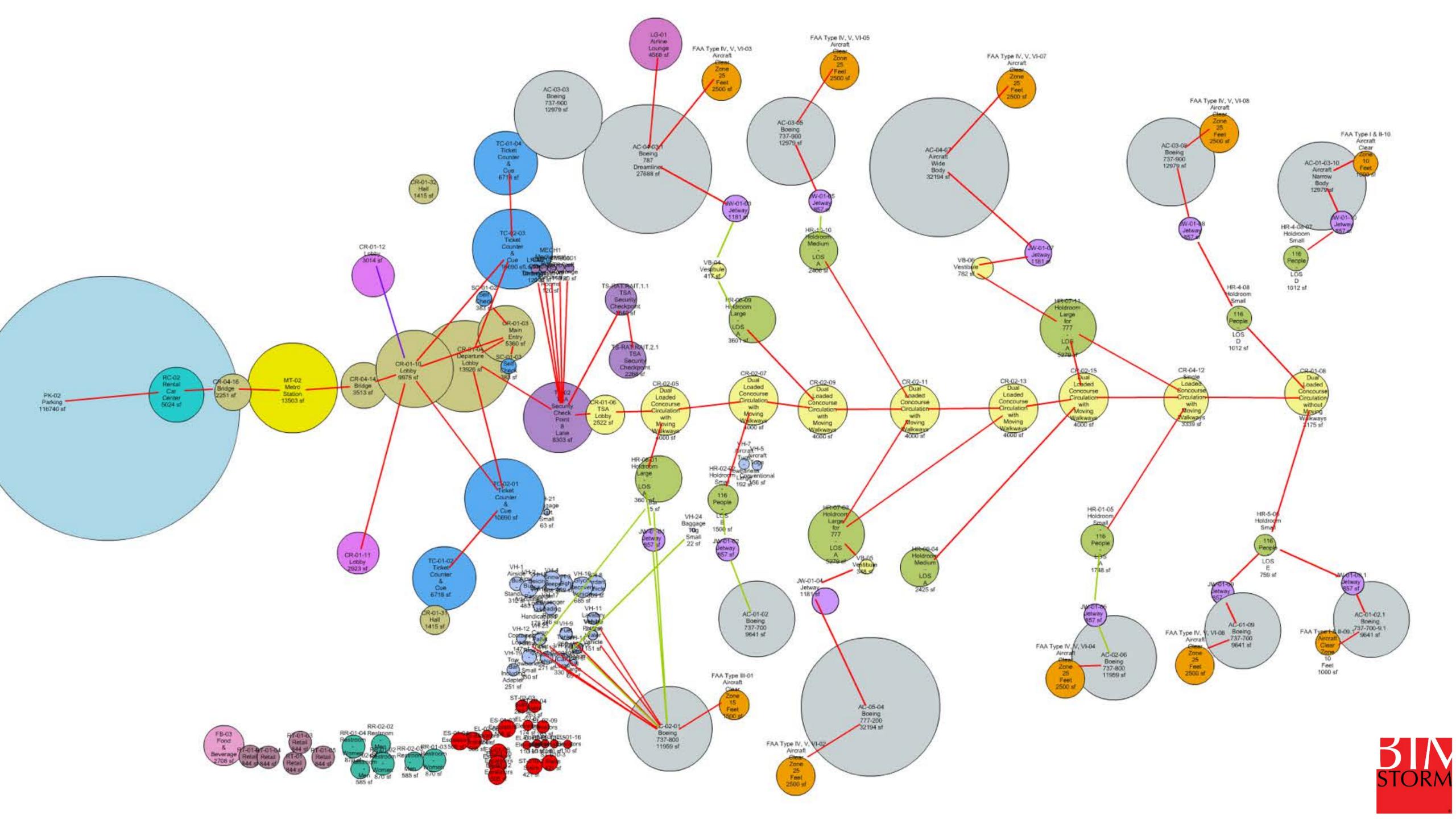


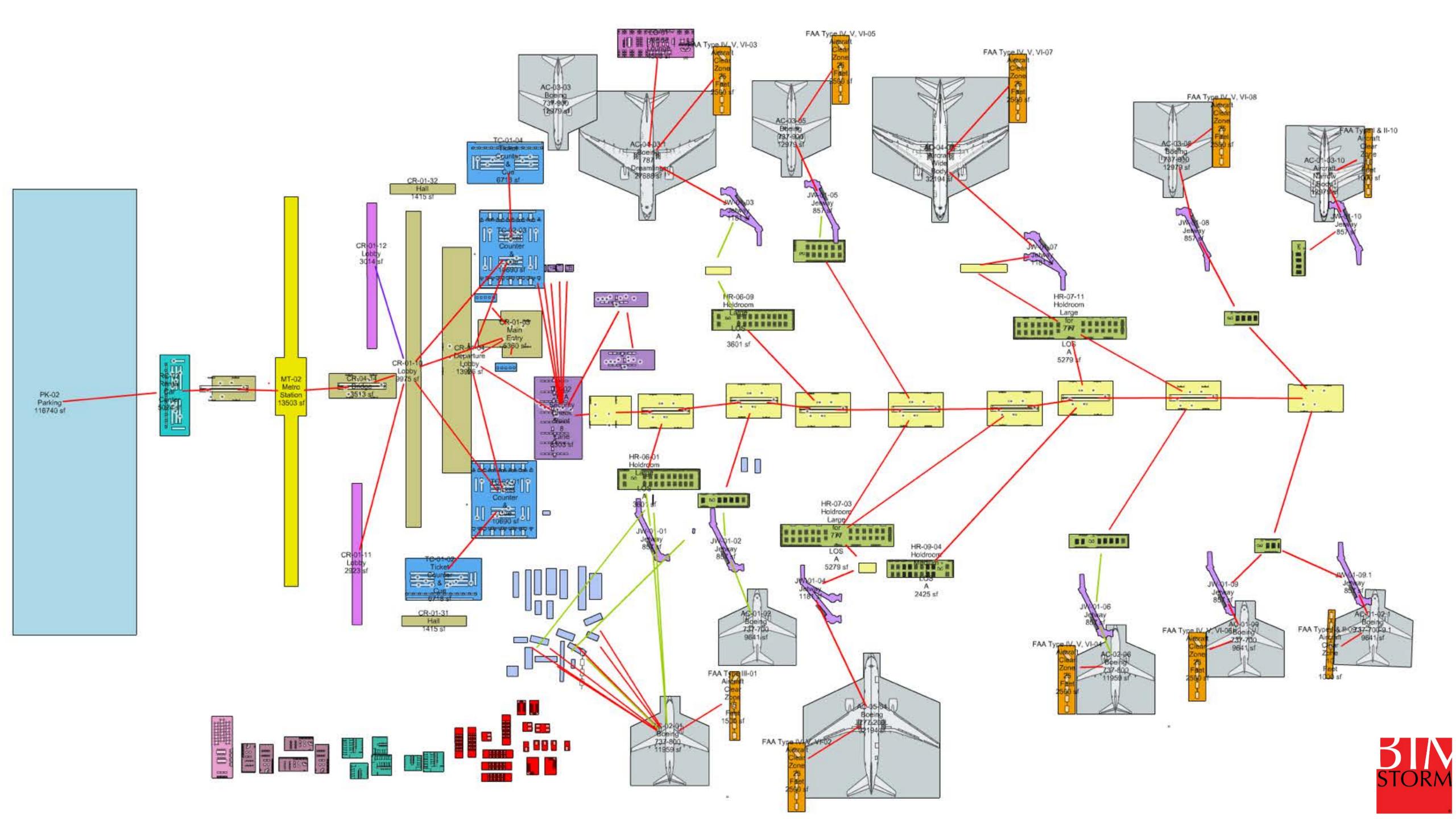
## Real Time Collaboration

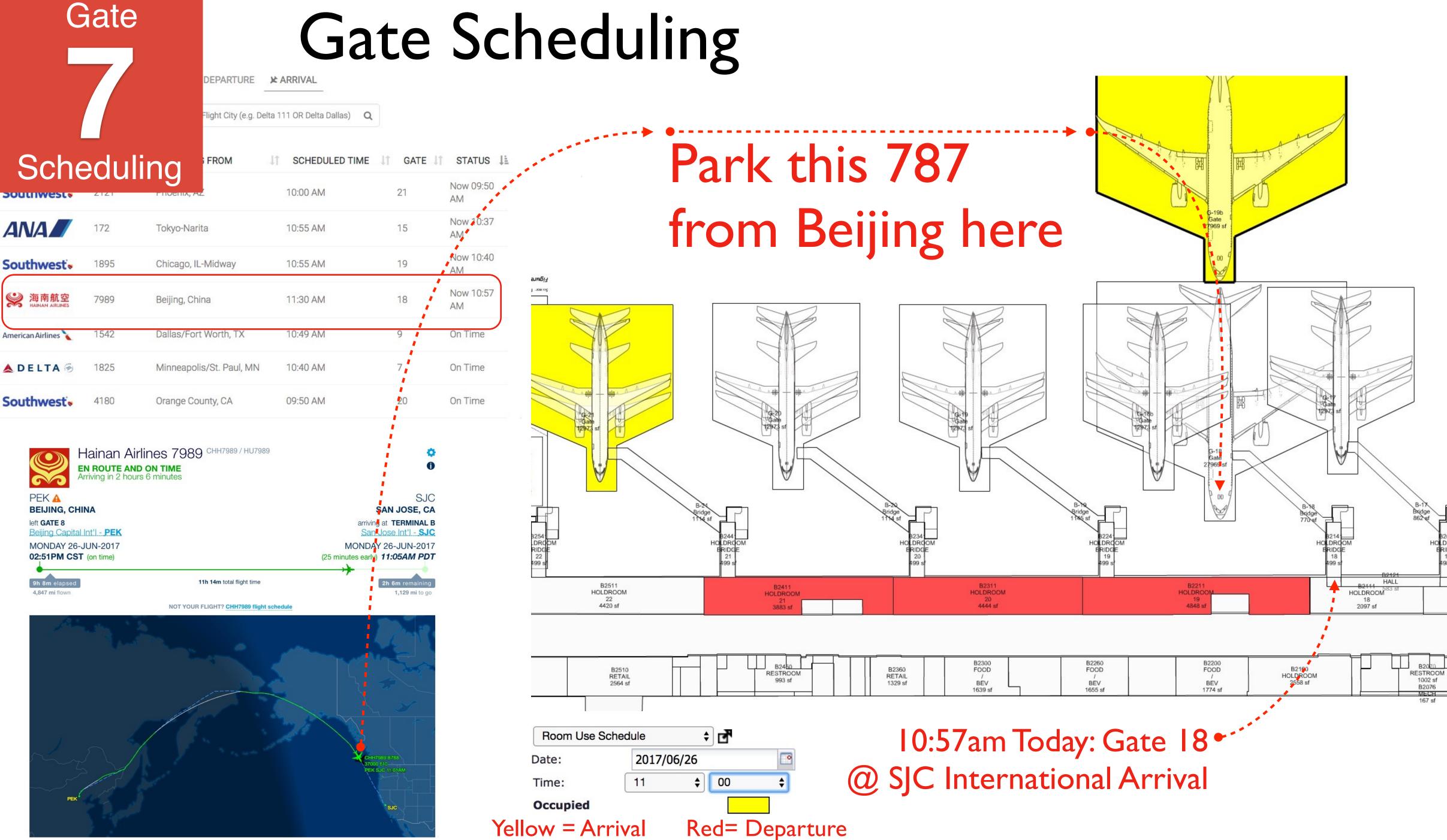




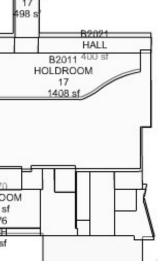






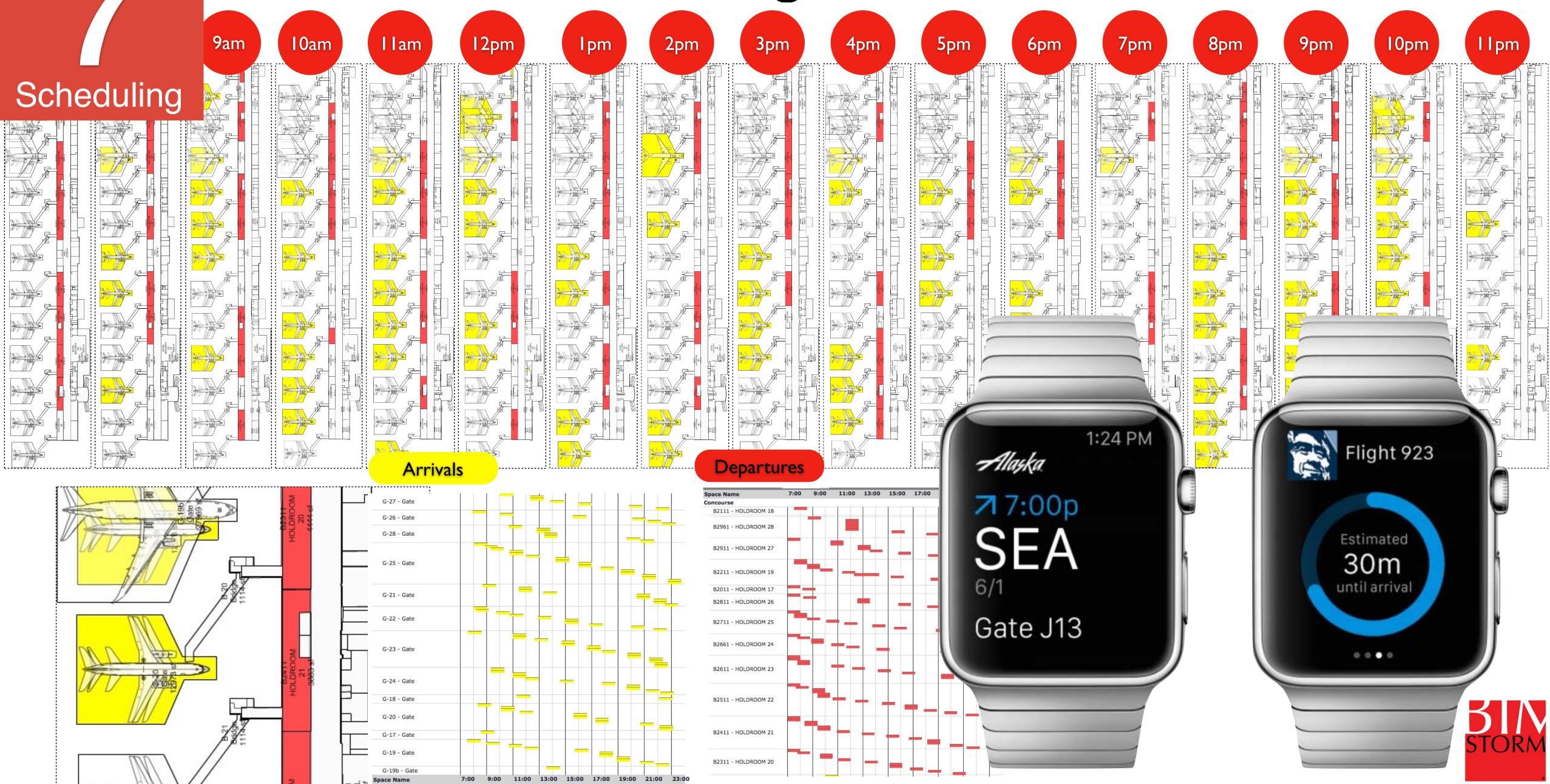






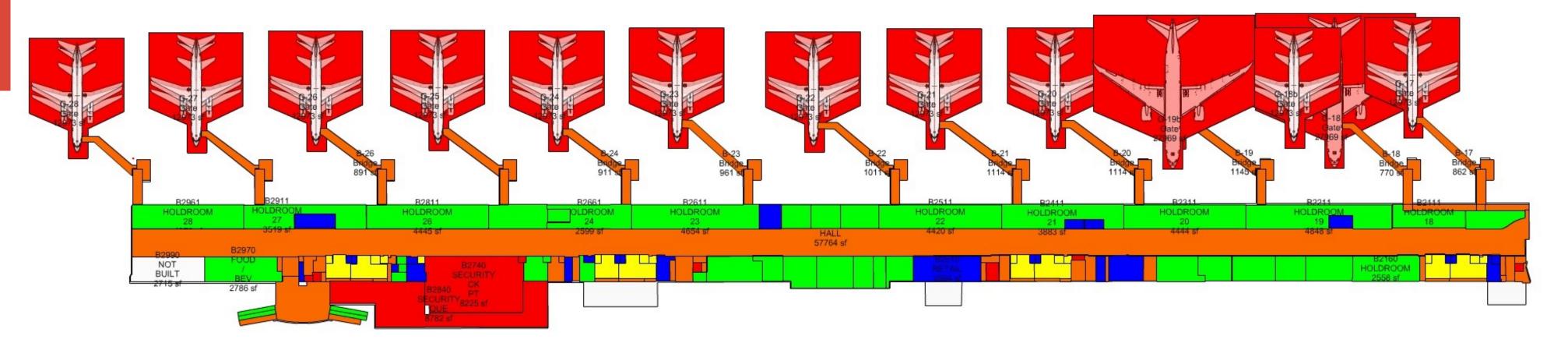
## Gate Scheduling

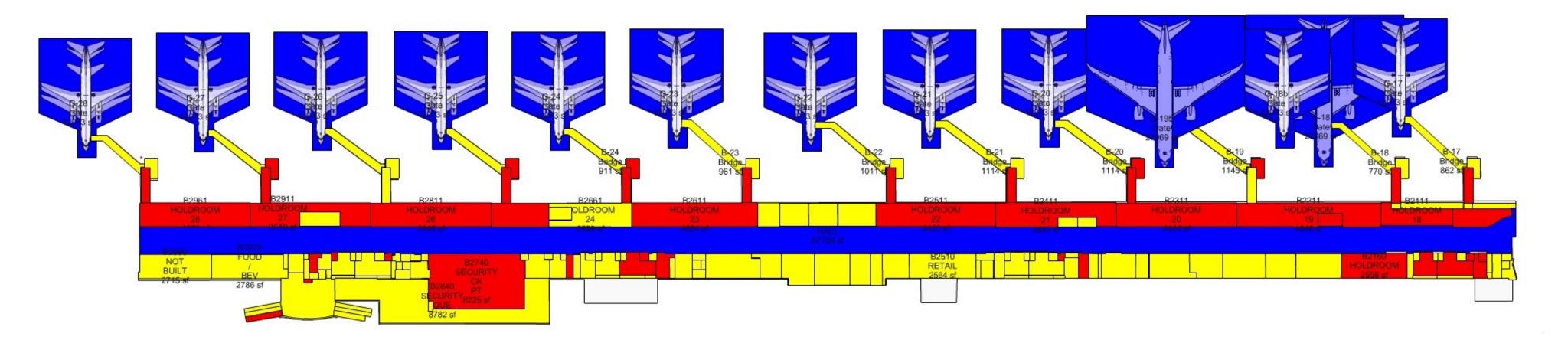
Gate



# Assets, Risk

## Assets, Risks, Mission Dependency, Cybersecurity



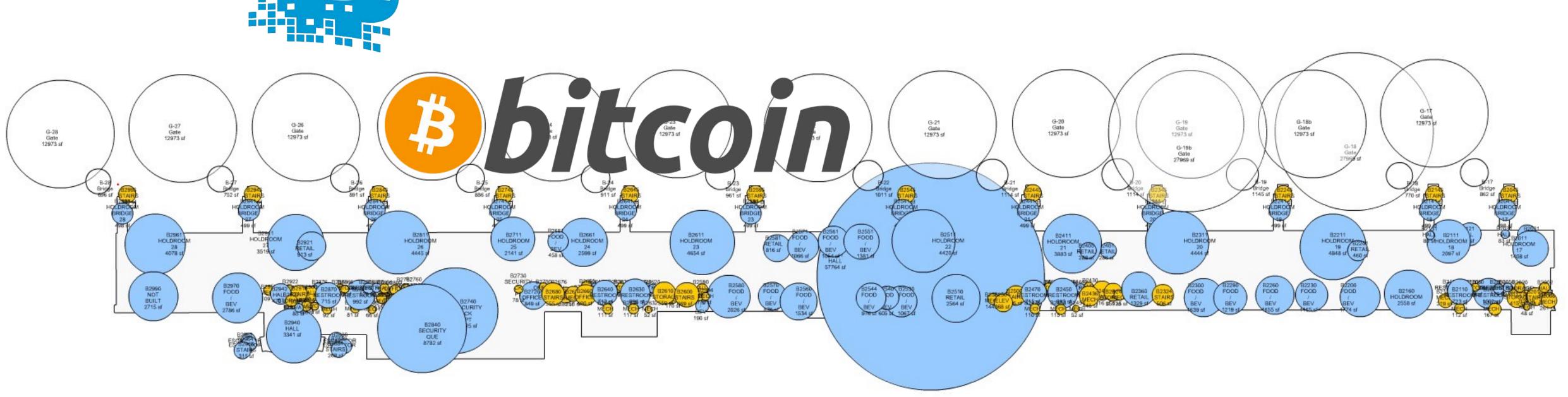


## Risk of Failure?



# Agreement and Finances

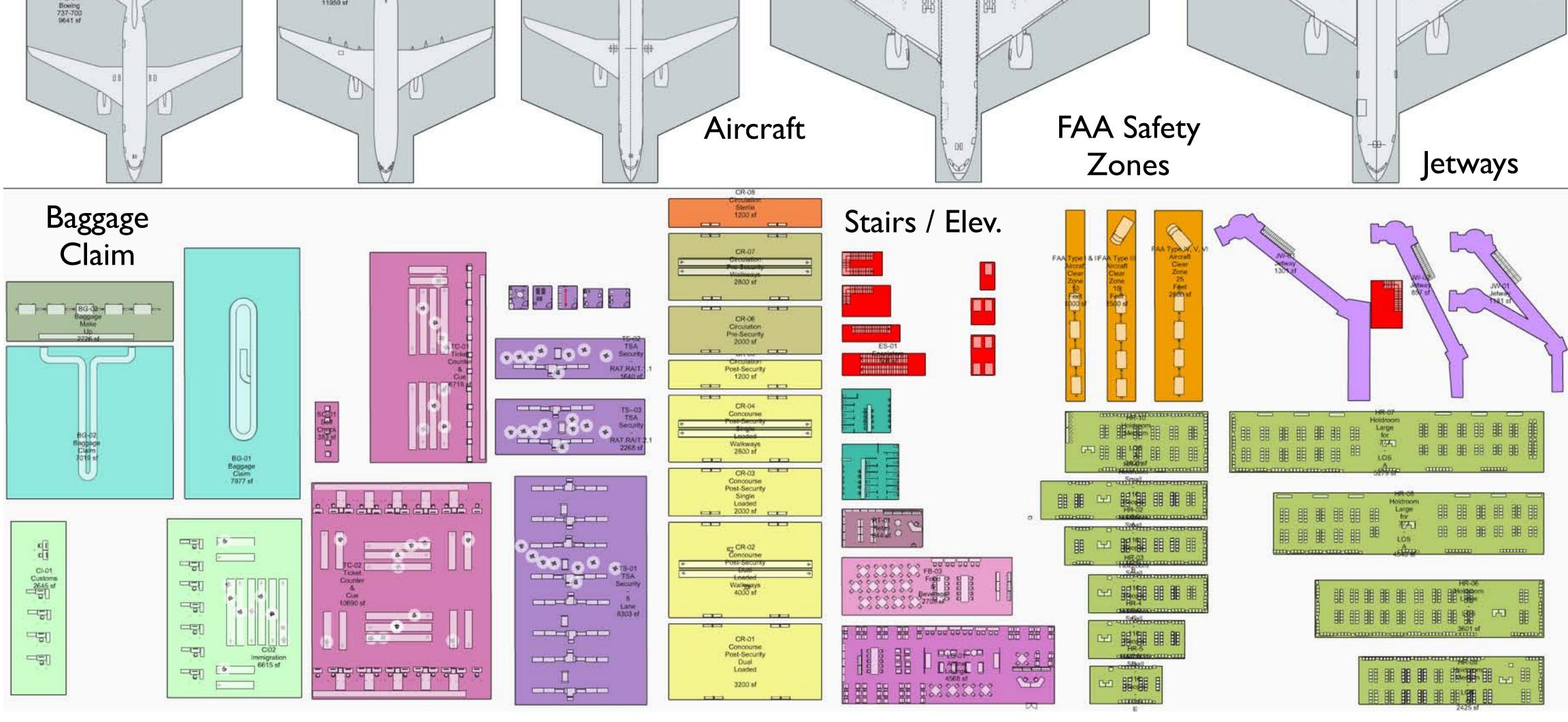
# Agreement Finances



# Transparency, Collaboration, Agility

## BLOCKCHAIN





Customs & Immigration

Ticketing

TSA C

#### Circulation

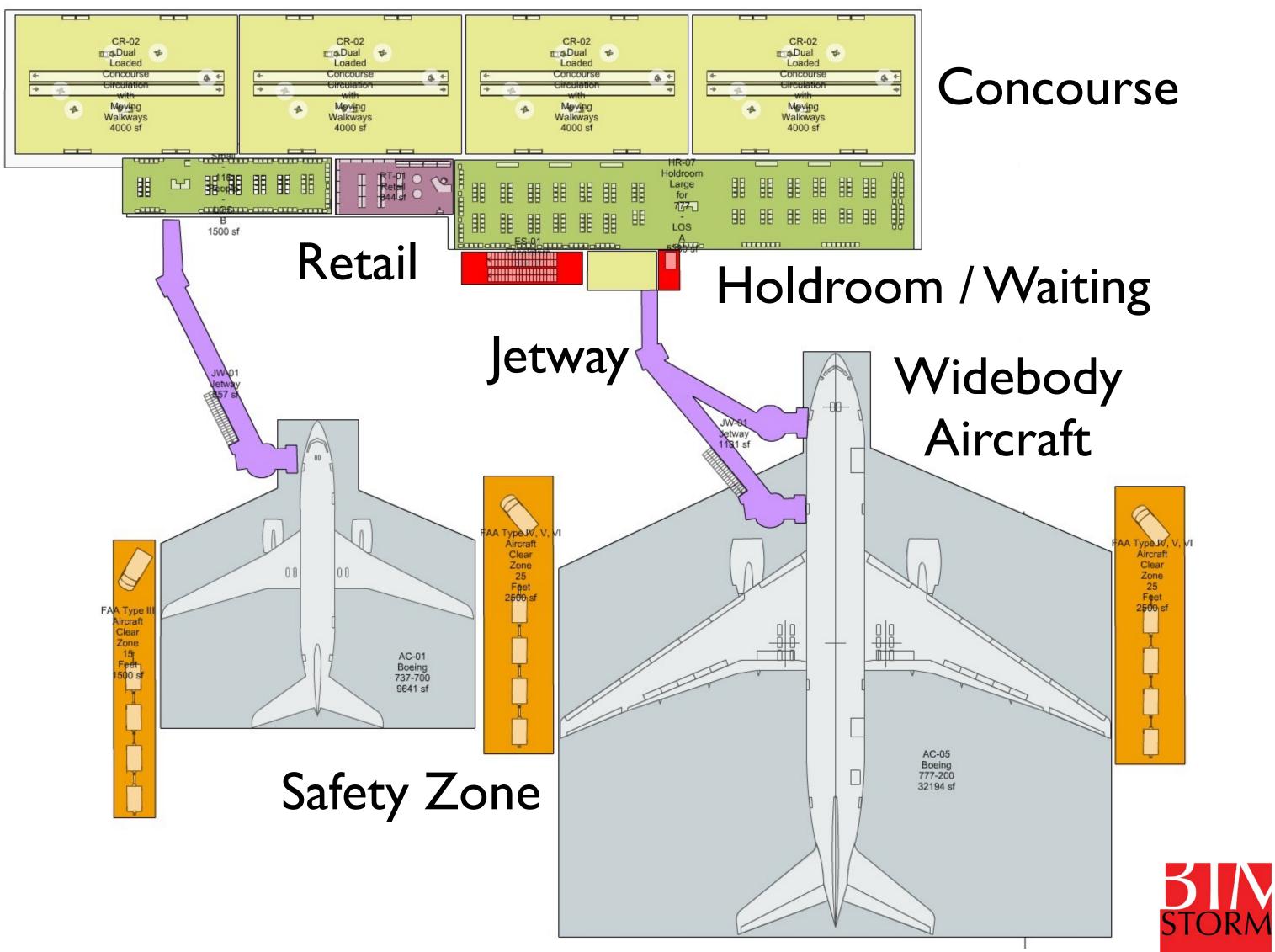
Food / Beverage Airline Lounge

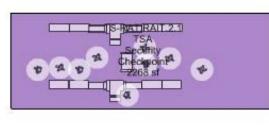
Holding Rooms Level of Service 1-5



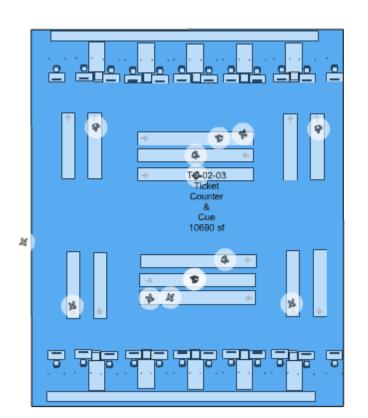


## PROGRAM2BIM.com

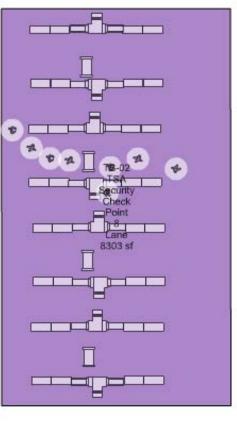








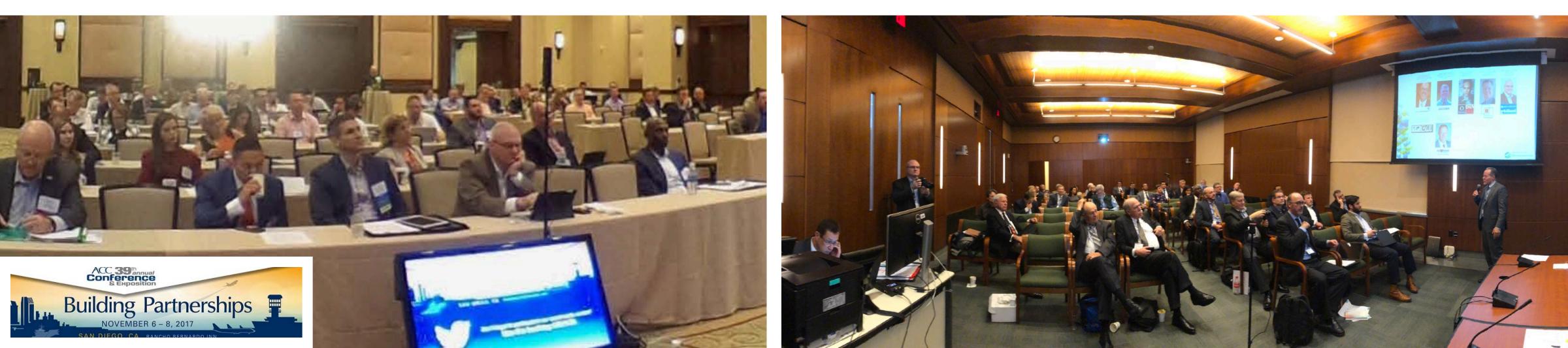
Ticket Counter

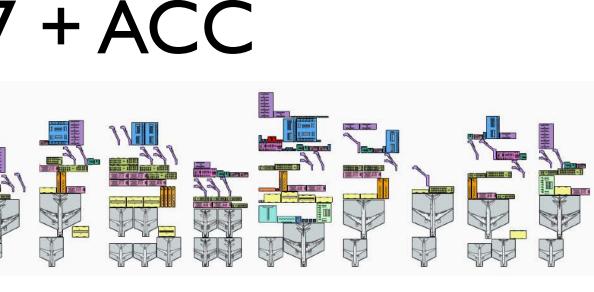


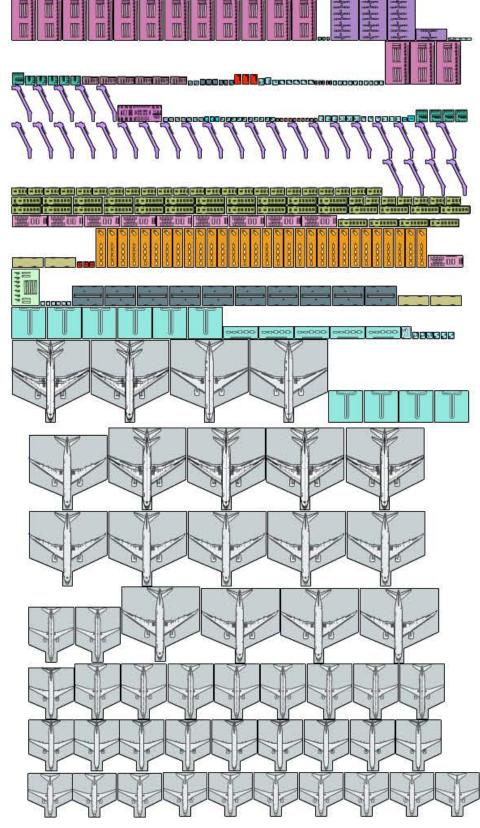
TSA

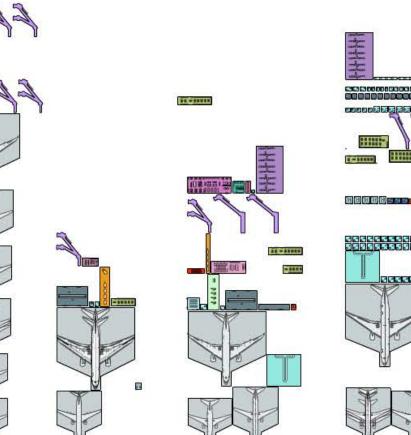


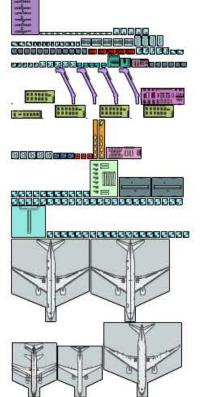
Federal Asset Leadership Week 2017 + ACC Conference 42 Projects 10 Minute Exercise 2,373,306 SF 126 Aircraft 81 Jetways / Gates 93 Holdrooms 1,459 Spaces 38,953 FFE Assets



















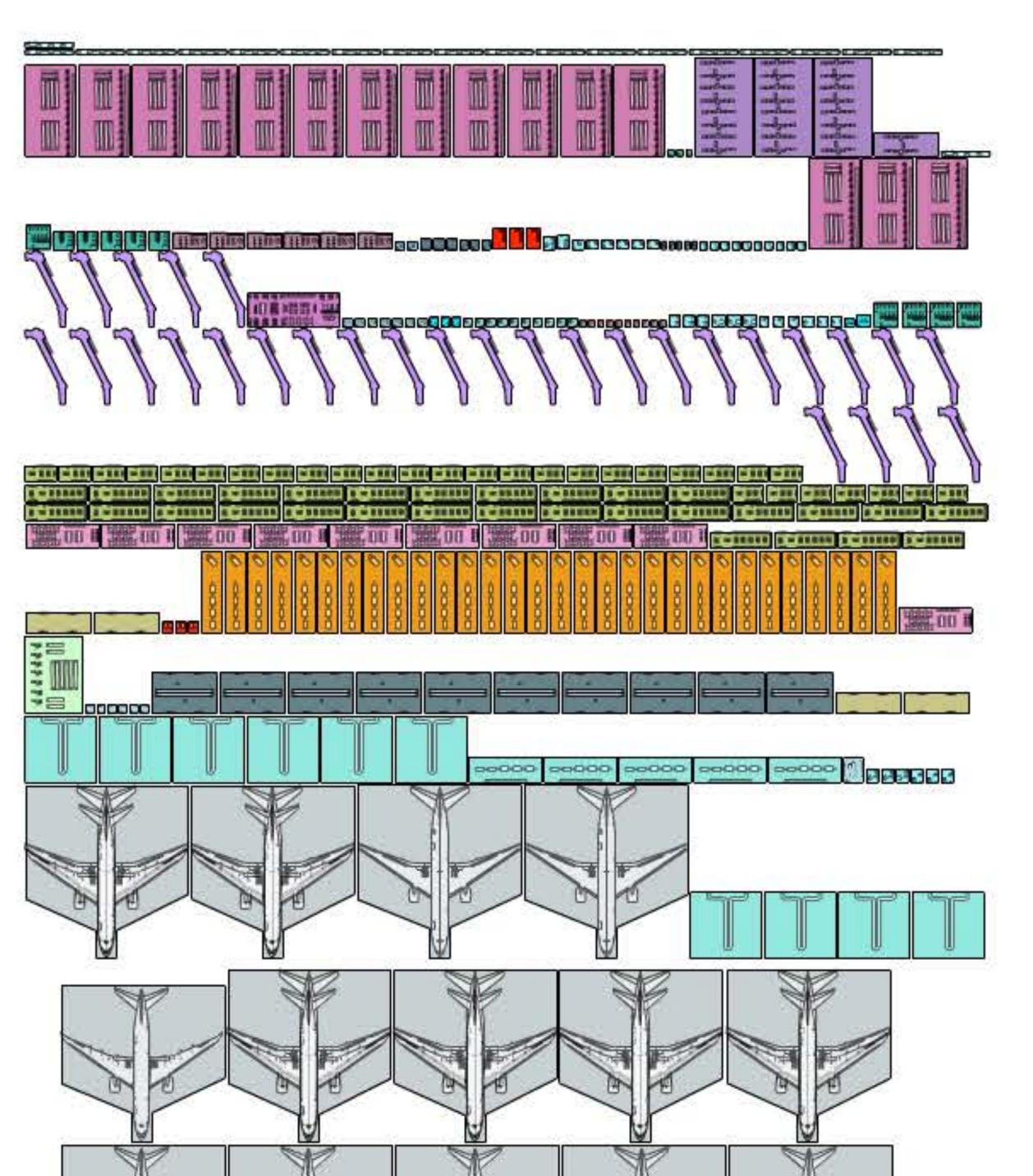
	Back
Site Informati	on
Name	ACC Conference Live BIMStorm 13 - ALN Live Planning 11.14 from Audience Layout
Scheme ID	(S177_554)
Gallery Link	BIM Gallery
Site Area	101.69 Acres
Building Infor	mation
Building ID	(B177_867)
Building Name	Building 1
Image	Browse No file selected.
Live Link	Building in Onuma System
Building Number	TBD
Total Estimated Building Cost	\$1,028,448,523
Building Area # of Floors	
# of Floors	1
Calculated (=modelled spaces)	1,044,924 sqf
Gross Calculated	1,462,893 sqf
Building Occi	upopov
Capacity	
(aggregated from space attributes)	247
Occupancy (aggregated from space	191
attributes)	
attributes)	nary
Utilities Sumr	nary
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Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year)	
Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year)	27,648,681 131,660,384 29,258
Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Natural Gas (CUFT/Year)	27,648,681 131,660,384 29,258 29,257,863
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Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Water (Gal/Year) Waste Water (Gal/Year) Solid Waste	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397
Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Natural Gas (CUFT/Year) Waste Water (Gal/Year)	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397 131,660
Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Water (Gal/Year) Waste Water (Gal/Year) Solid Waste (Lbs/Year)	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397 131,660 ummary
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Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Water (Gal/Year) Waste Water (Gal/Year) Waste Water (Gal/Year) Solid Waste (Lbs/Year) O & M Cost S Custodial Energy Grounds	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397 131,660 ummary \$3,613,346 \$4,169,245 \$365,723
Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Waste Water (Gal/Year) Waste Water (Gal/Year) Solid Waste (Lbs/Year) O & M Cost S Custodial Energy Grounds M&R	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397 131,660 ummary \$3,613,346 \$4,169,245 \$365,723 \$4,154,617
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Utilities Sumr Electricity Use(kWh / Year) Energy Use (kBTU/Year) Steam (MLB/Year) Water (Gal/Year) Waste Water (Gal/Year) Waste Water (Gal/Year) Solid Waste (Lbs/Year) O & M Cost S Custodial Energy	27,648,681 131,660,384 29,258 29,257,863 731,447 21,943,397 131,660



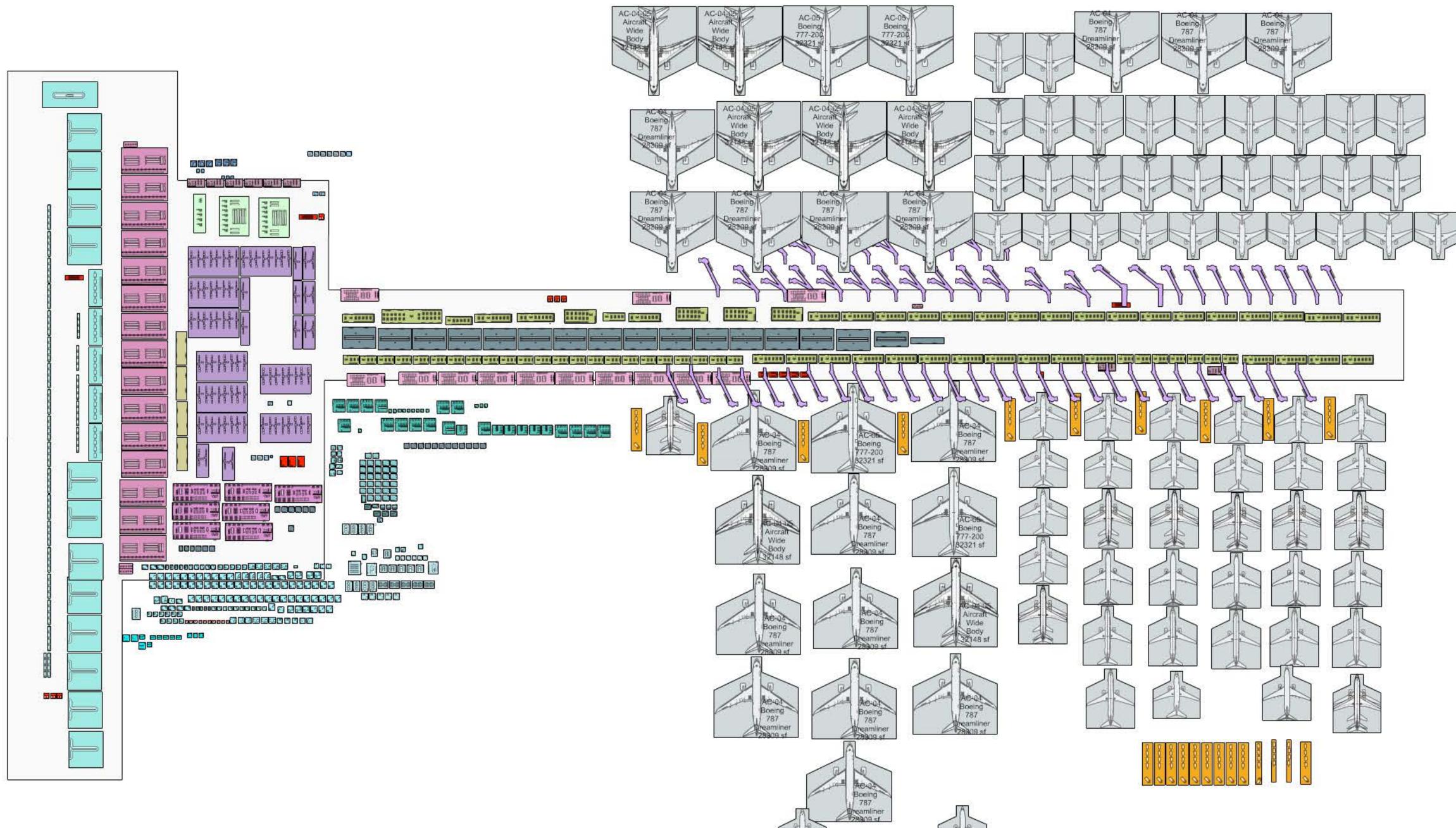
## \$1,028,448,523

Electricity Use(kWh / Year) 27,648,681 Energy Use (kBTU/Year) 131,660,384 Steam (MLB/Year) 29,258 Water (Gal/Year) 29,257,863 Natural Gas (CUFT/Year) 731,447 Waste Water (Gal/Year) 21,943,397 Solid Waste (Lbs/Year) 131,660





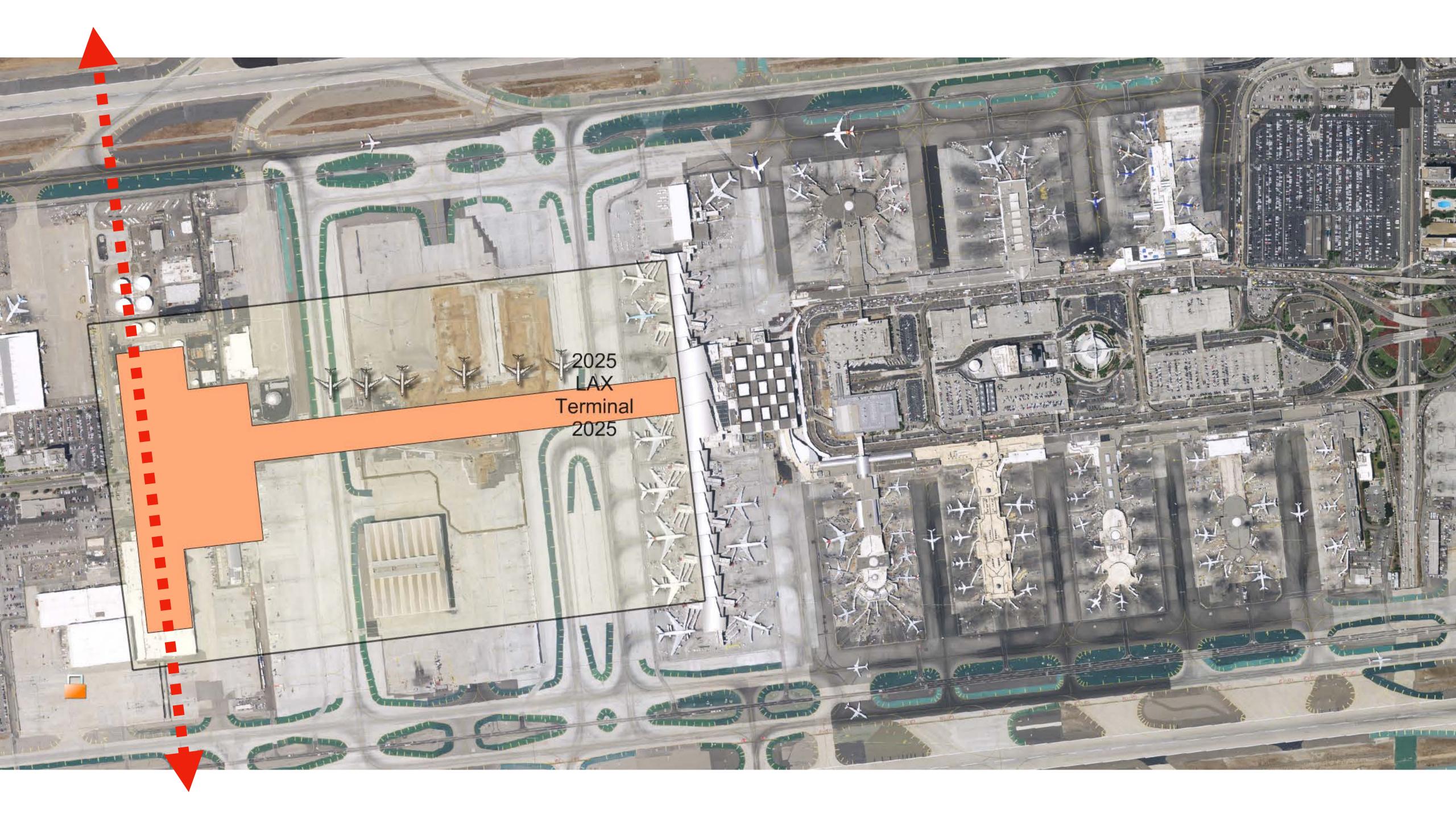
















Risk

Assets

Time

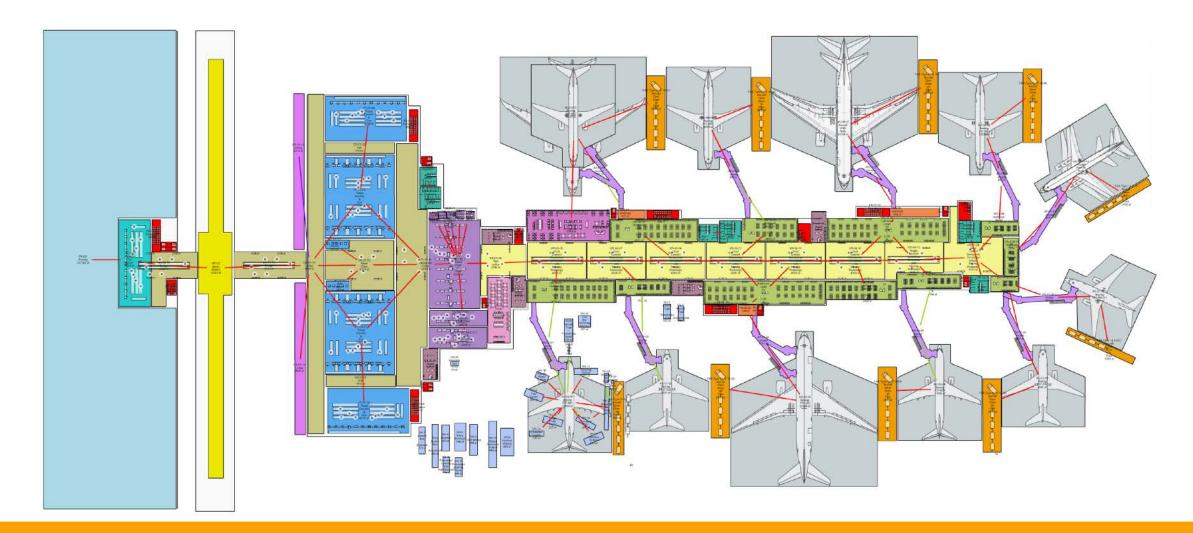
Strategy

Powered by BIMStorm



















Performance

Budget

Rules

Arrivals

Departures





## Aviation Platform



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