
AIRFIELD 4.0
technologies that will revolutionize airfield operations
IESALC
ILLUMINATING ENGINEERING SOCIETY
AVIATION LIGHTING COMMITTEE
ADB SAFEGATE

Airfield 4.0

Digital Transformation

AIRFIELD 1.0

1910

Kerosene flares, Beacons and floodlights

Goosenecks kerosene flares lighting small airfield landing strips. Airway navigational beacons

AIRFIELD 2.0

1940

Incandescent, Halogen, CCRs, transformers, control panels

Incandescent airfield lighting advanced to halogen lights and lighting systems with touchdown zones and centerline visual aids

AIRFIELD 3.0

1980

Computerized airfield control, Powerline carrier, LED

Airfield lighting computer systems, A-SMGCS leveraging powerline carrier technology and LED airfield lights

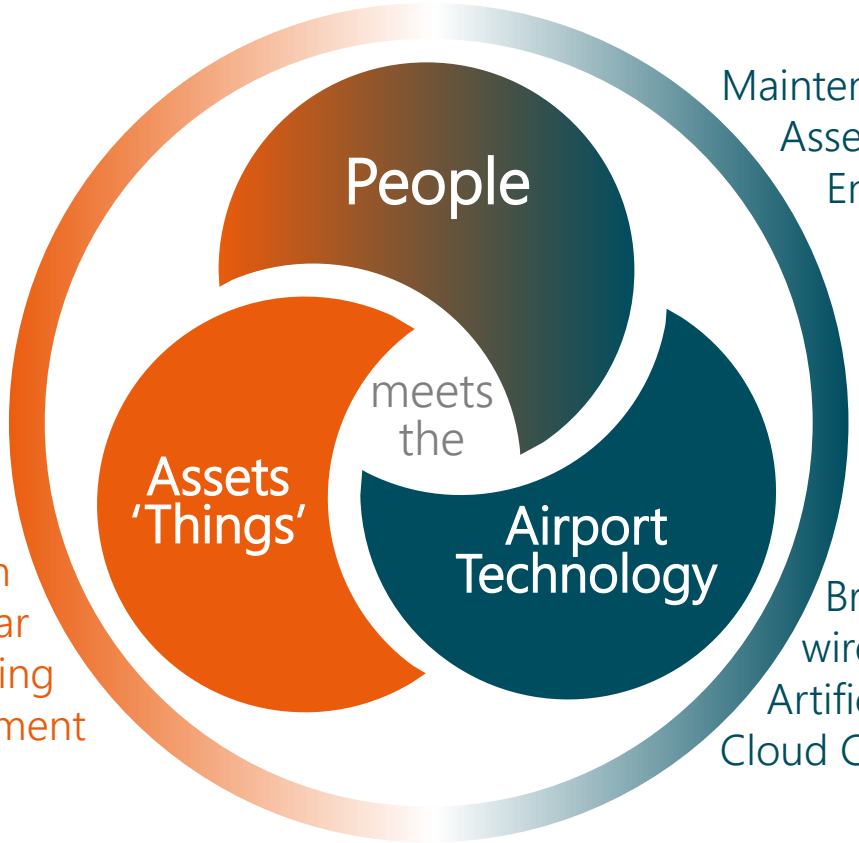
AIRFIELD 4.0

TODAY

Broadband airfield wireless networks, Remote Asset Monitoring, Internet of Things

IoT airfield lighting, wireless connectivity, AI analytics, remote monitoring and operational dashboards

AIRFIELD 4.0



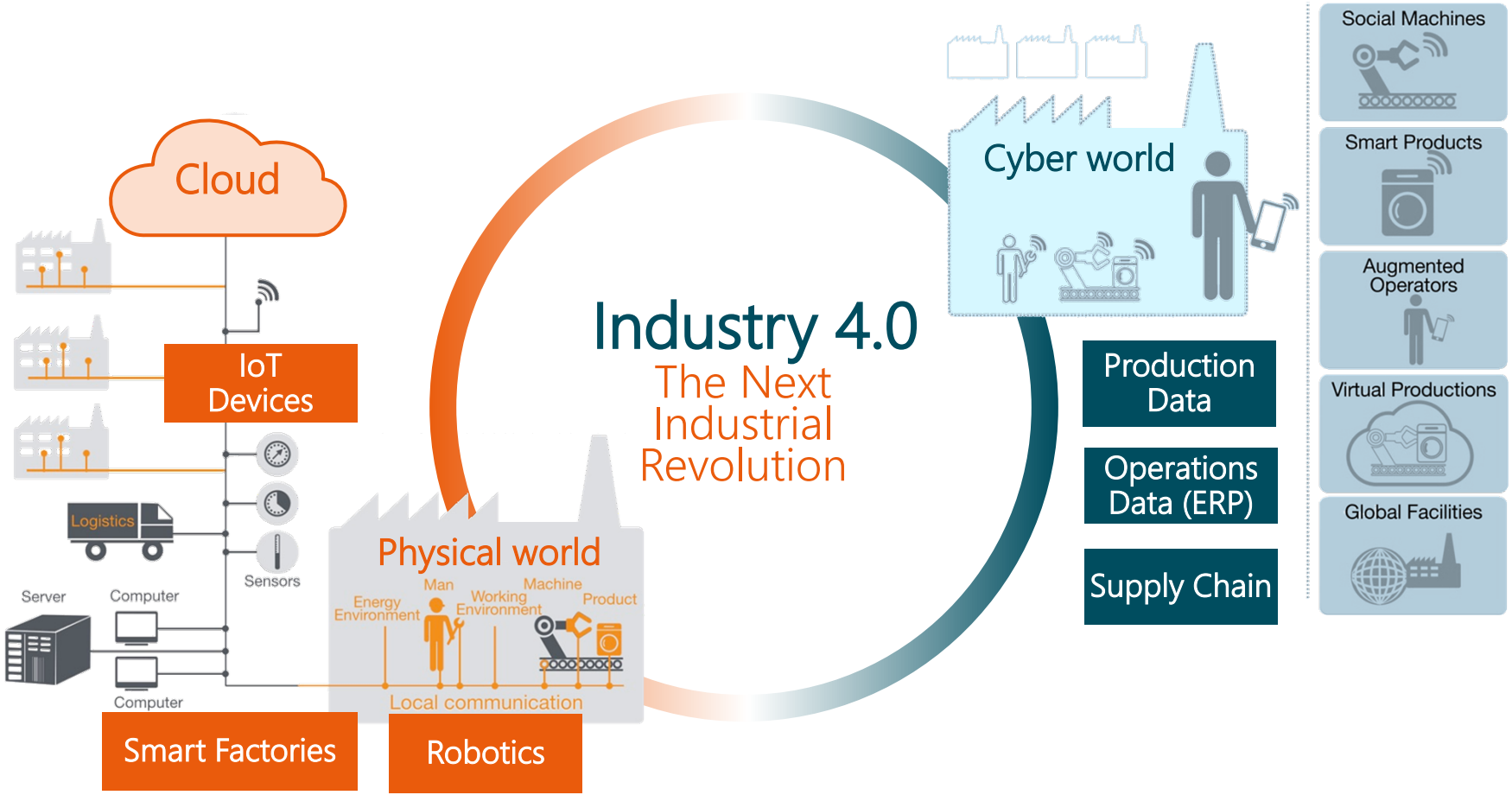
Maintenance • Operations
Asset Managers
Engineers • Contractors

Physical Airfield

Lights • Approach
CCRs • Switchgear
Signs • Cabling
Pavement

Cyber Airfield

Broadband network
wireless • 4G/5G •
Artificial Intelligence
Cloud Computing


Cloud
IoT Devices
Logistics
Sensors
Server
Computer
Computer
Smart Factories
Physical world
Energy Environment
Man
Working Environment
Machine
Product
Local communication
Robotics
Industry 4.0
The Next Industrial Revolution
Cyber world
Production Data
Operations Data (ERP)
Supply Chain
Social Machines
Smart Products
Augmented Operators
Virtual Productions
Global Facilities

zippin Checkout-free Concession Store

RESULTS

66% speed increase (3.5m versus 10m wait)
45% concessions growth compared to 2021

System also designed to reorder inventory and optimize the logistics

Overhead cameras follow customer movements in the store

On leaving the store, shoppers get a receipt for purchased goods

Smart-shelf sensors identify products picked up or put back to create a 'virtual shopping cart'

Download the App, scan the QR code store key

Allegiant Stadium (Home of Raiders), August 2022

Cloud

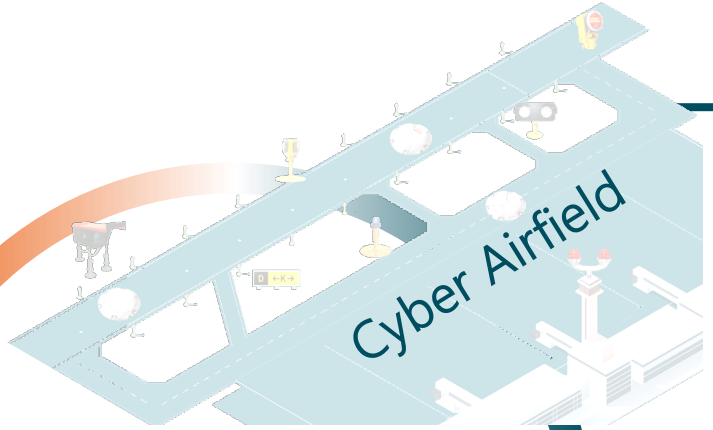
Lighting Vault

Lighting Vault

IoT Lights and Devices with Sensors

Photometric Data

ALCMS

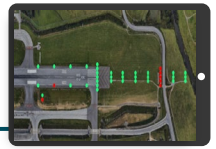


Cyber Airfield

AIRFIELD 4.0

The Next Airfield Revolution

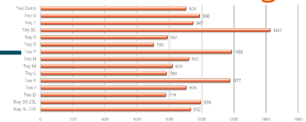
Physical Airfield



Virtual Digital Airfield

Responsive Remote Maintenance

Data-driven Insights

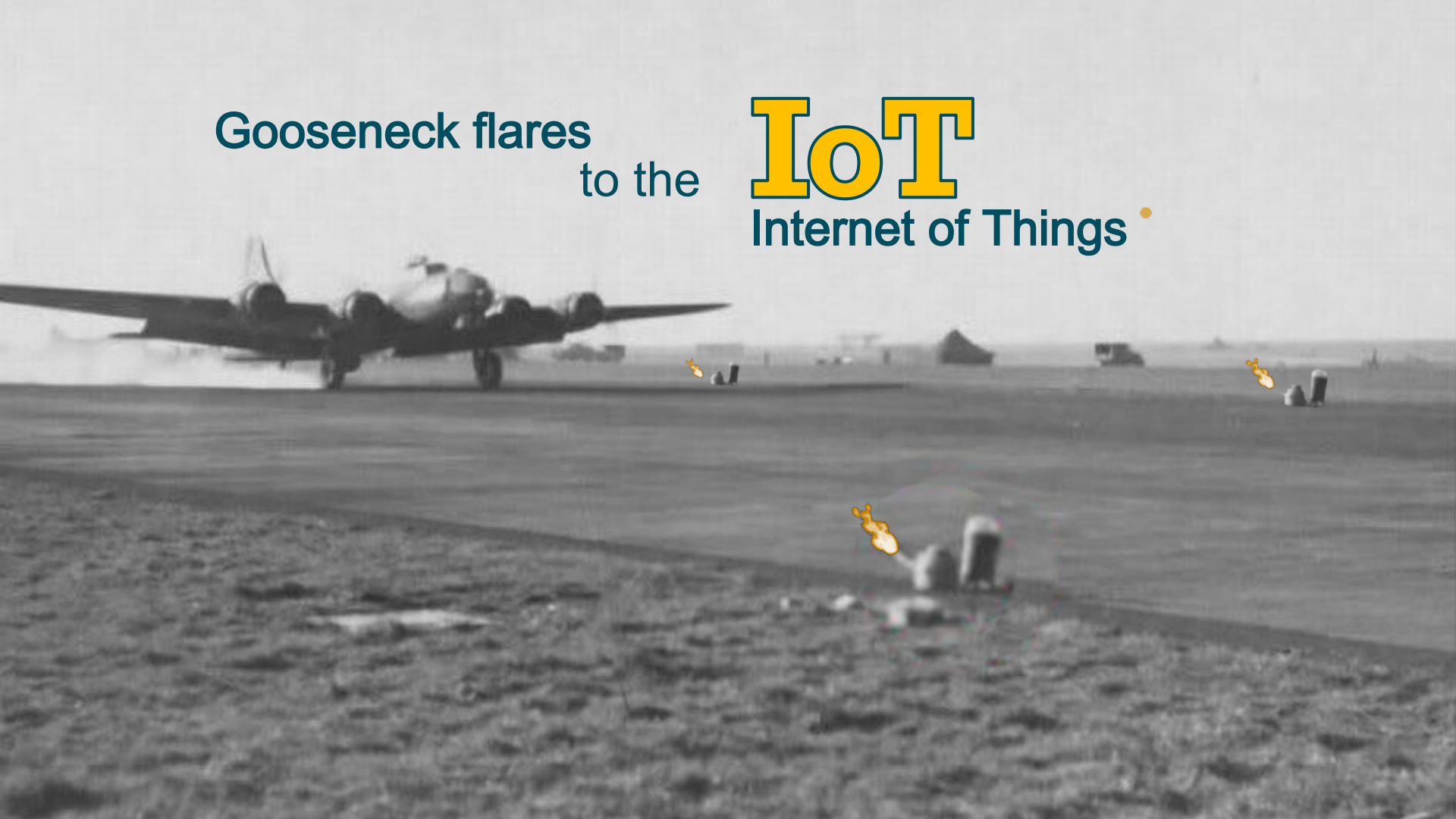


Digitized Processes

AIRFIELD SAFETY

Cloud

ADB SAFEGATE


Gooseneck flares
to the
IoT
Internet of Things

Internet of Things IoT 5 Main Components

Cloud

Microsoft Azure for example

Secured Data Storage

Analytics

Cloud Computing

Cloud Processes the data

User Interface

Web Application

Mobile Application

Private VPN Link

Analytics

Edge Computing

Processor processes the data

Gateway

ATCT

Maintenance

Airfield Lighting Control and Monitoring System

Field Electrical Center

Local Network

Things or Devices

Airfield Lighting Fixtures

Powerline Carrier Devices

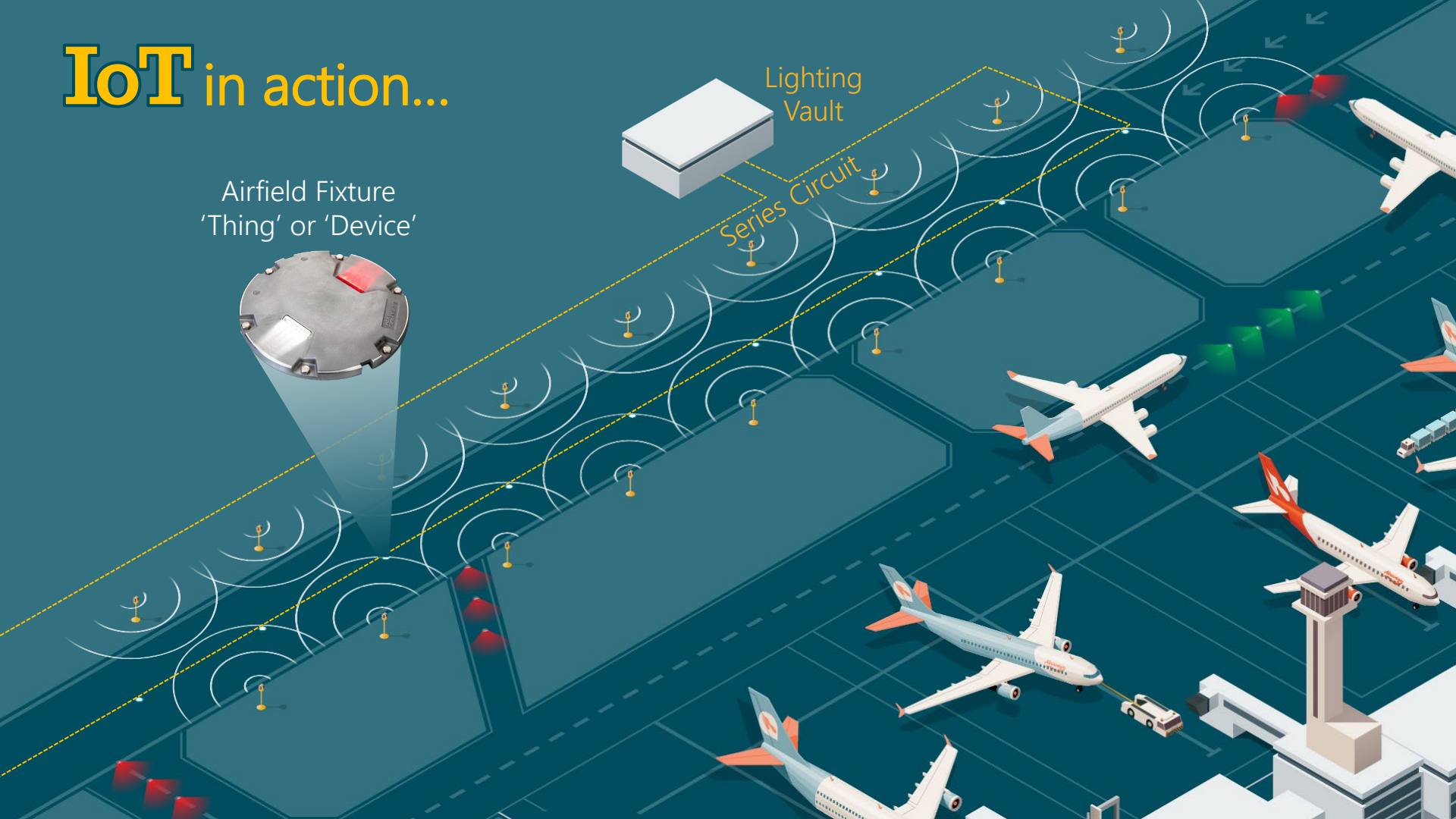
CCR

Powerline Controller

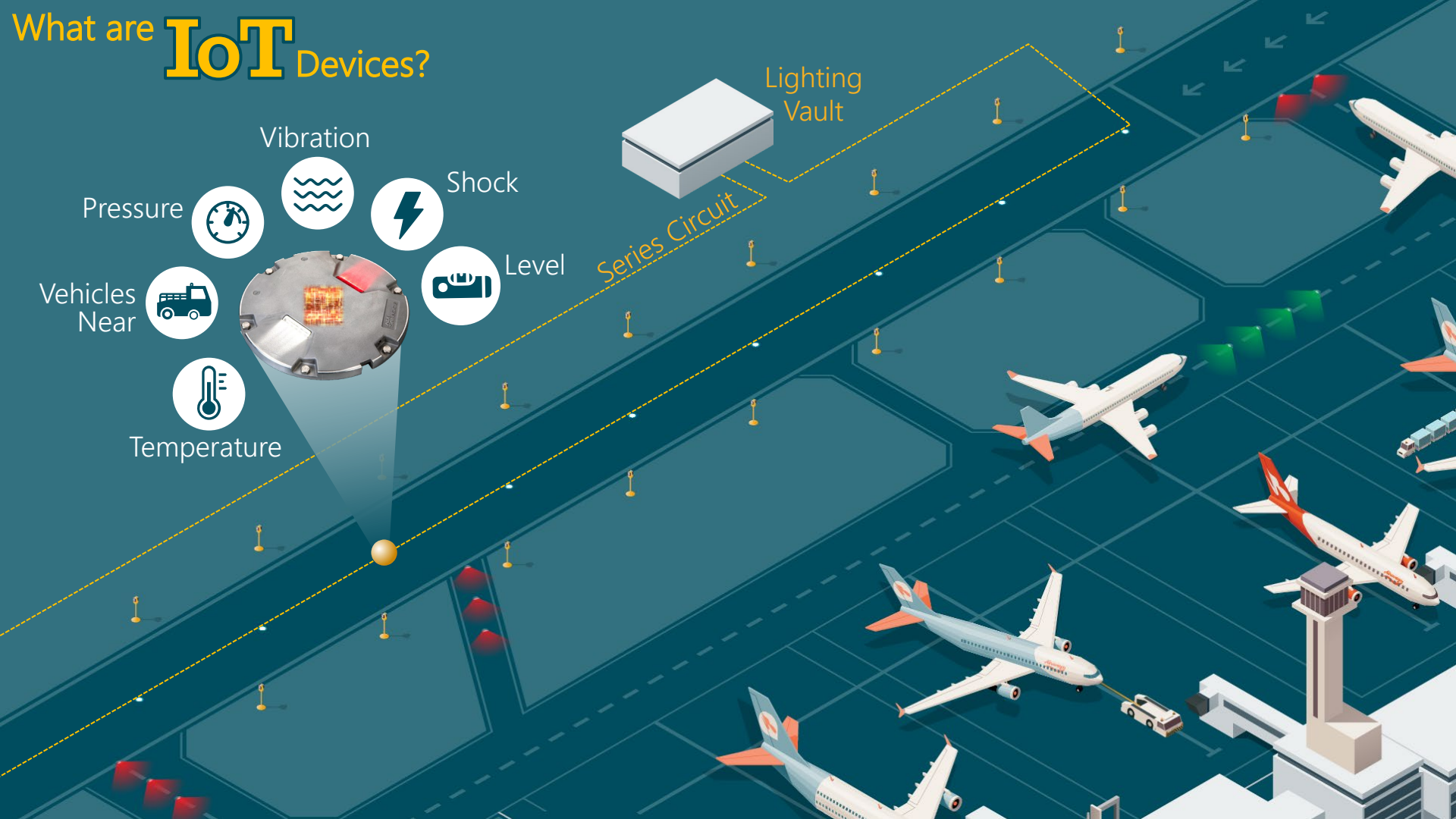
Series Circuit

PAPI Wireless Devices

IoT in action...



What are IoT Devices?



IoT Devices you might be using

amazon echo

Request songs, place phone calls, set timers, ask questions and get information

fitbit

Smartwatch tracks your fitness activity, sleep, heart rate and more

august

Smart Lock

Manage doors from any location hassle-free

amazon dash BUTTON

Quickly order household essential items you've set up on Amazon.

belkin wemo

Smart Light Switch

Manage your home lights from the wall, your mobile or by using your voice

Microsoft HoloLens

Augmented reality with see-through holographic lenses

Data Ingestion

- IoT enabled devices (sensors) collect data
- Data is **ingested by the devices and sensors**

Data Transmission

- Data is **transmitted to the cloud via Gateways**
- Gateway is a method of transmission that connects to the Internet
- Wi-Fi, Cellular, Satellite

Data Analysis and Prediction

- Uses historical data collected over time
- Provides actionable insights that help in predicting future events

Data Visualization

- Real time information visualized in applications for the end user
- Tables, meters, alarms, notifications

Data Processing

- Taking the IoT devices raw input data and outputting it as information people can view, understand and react to


IoT Device
Airfield Lighting Fixture
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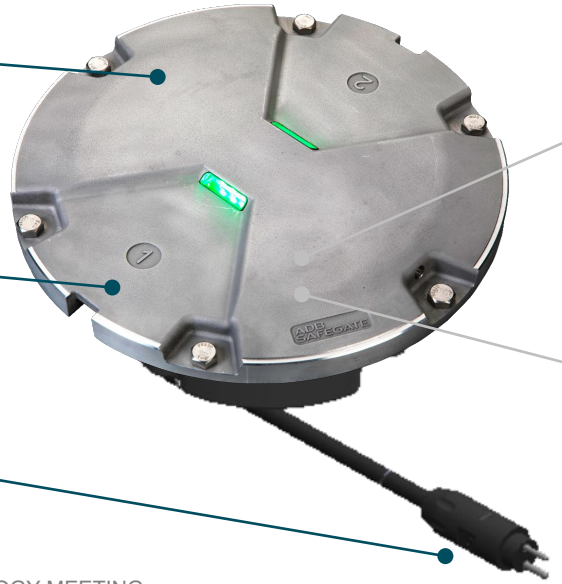
IoT Airfield Lighting Fixture

1 **Top Cover**
Uni-directional and
Bi-directional

2 **Prism**
Replacement
prism windows

3 **LED Light Engine**
Replaceable
lighting engines



4 **Bottom Pan**
with encapsulated
electronics

5 **Cord Set**
Replaceable
secondary cord set

6 **Sensors**
Integrated into
the circuit board

7 **Powerline Carrier Communications**
integrated in circuit
board

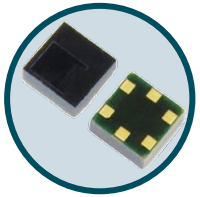
Types of Sensors

Live Demo

3D Accelerometer & Gyroscope

with embedded pedometer

2.5 X 3mm

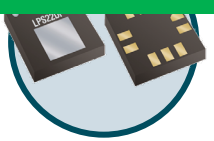


Temperature & Humidity

-40°C to 120 ° C

2 X 2mm

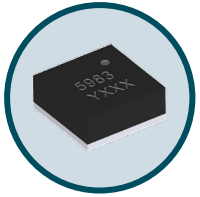
Live Demo



Pressure

260 to 1260 hPA

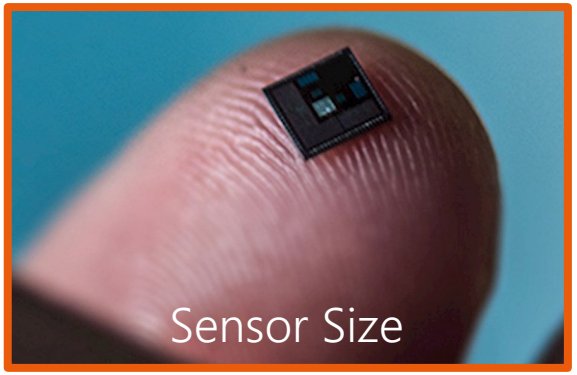
2 X 2mm

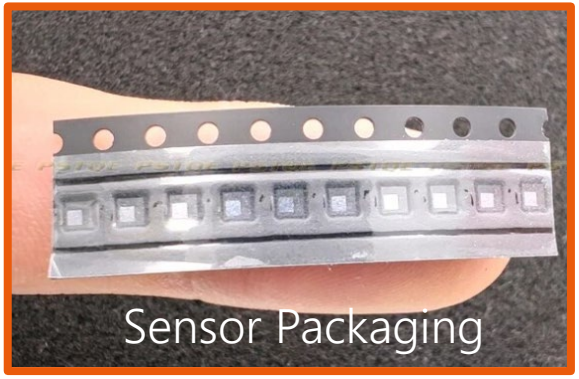


3-axis Magnetic Field

Digital Compass

3 X 4mm





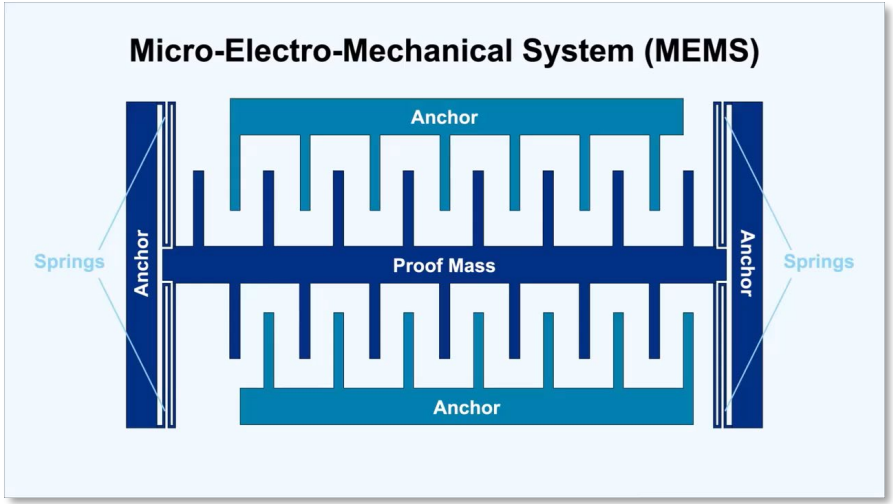
3D Accelerometer & Gyroscope

Sensor Overview

What is an Accelerometer?

- MEMS or micro-electro-mechanical system
- Measures the **vibration, or acceleration** of motion of a device (light fixture)
- The gyroscope can measure and maintain the **tilt and lateral orientation** of the light

How does it work?



Applications

- Vehicle airbags
- Drone auto-leveling
- Camera stabilizer
- Machinery vibration / stability
- Smartphones to wake up or auto rotate images

3D Accelerometer Sensor
Demonstration #1

Vibration Simulation

- Fixture is installed in a base can
- Hit the light fixture with a rubber mallet
  - Simulated roll over vibrations from planes or vehicles
- Light will **flash for 2 seconds** indicating the detection of the vibration

Simulation Only


Demonstration #1
Airfield Lighting Fixture
shock and vibration detection
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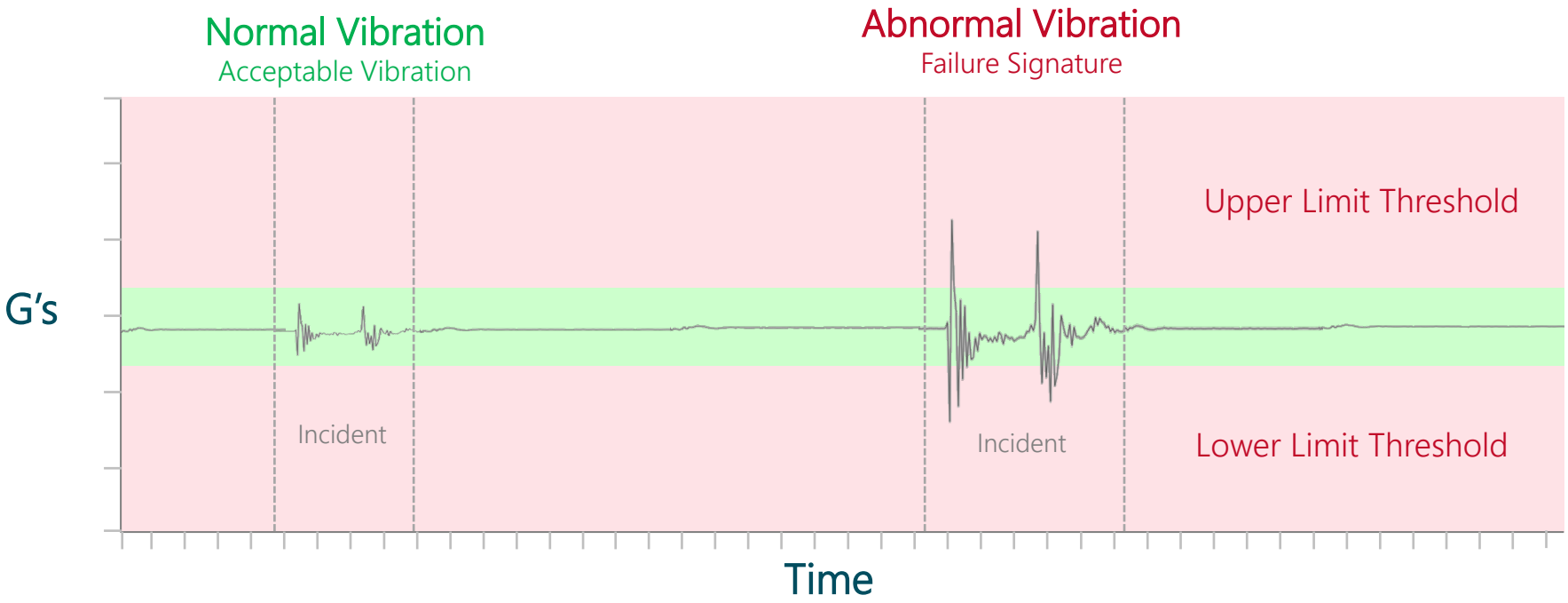
3D Accelerometer Sensor
Demonstration #1
Accelerometer Sensor Data



3D Accelerometer Sensor Demonstration #1

Accelerometer Sensor Data

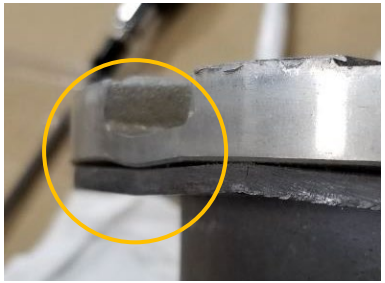
How could this be used?

Loose Fixture

Fixture not completely torqued or clamping force not sufficient

Loose Bolt(s)

Thread marks on the fixture thru holes is a good indication of fixture movement



Over-Torquing

Deformed bottom pan loosens fixture mounting

Fixture Installation Issues

Not per FAA AC 150/5340-30 +0 and -1/16”

Base Can Installation

Flange Ring, Concrete, P-606 Epoxy

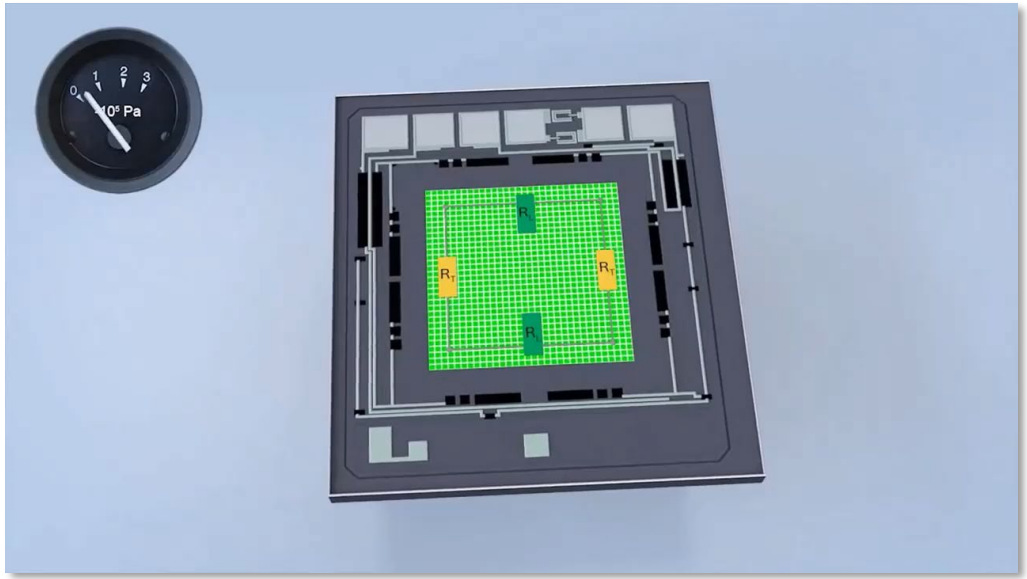
Piezoresistive Pressure Sensor

Sensor Overview

What is a Pressure Sensor?

- Ultra compact piezoresistive sensor
- Functions as a digital output barometer

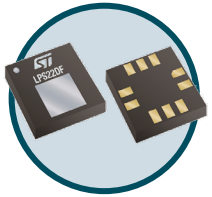
How does it work?



Applications

- Altimeters and barometers for portable devices
- GPS applications
- Weather station equipment
- Fitness watches

improves accuracy of wearable fitness devices, particularly with respect to calories spent, walking on inclines versus climbing stairs



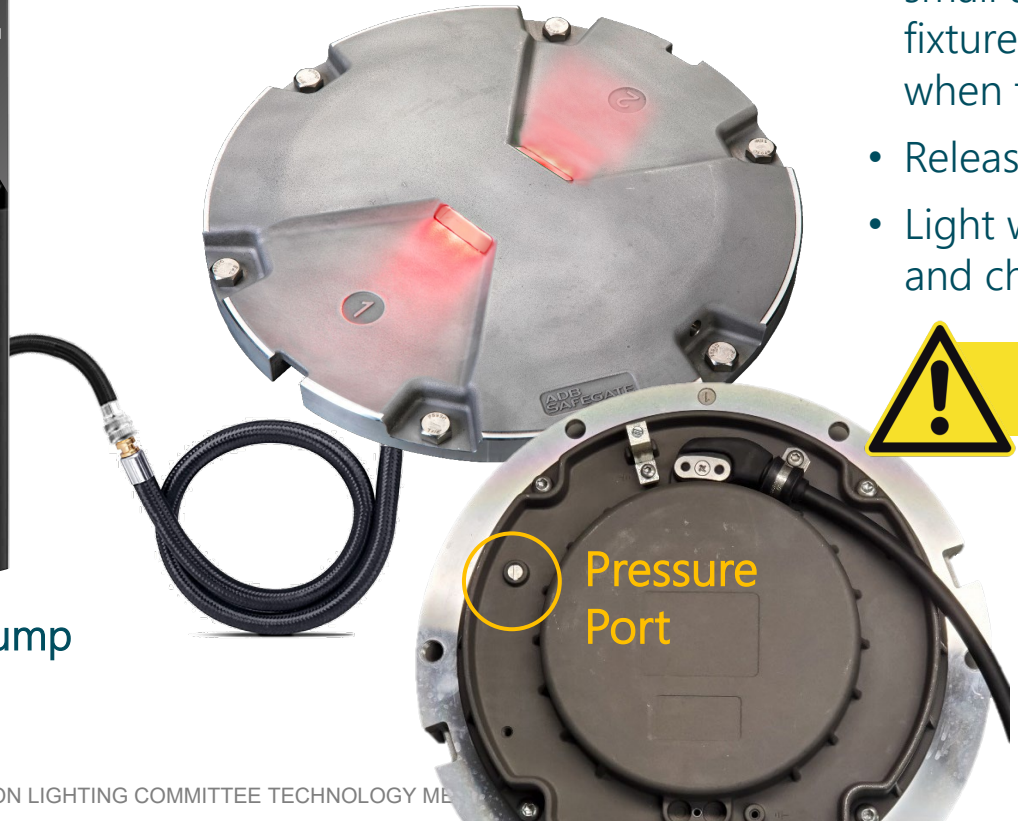
Pressure Sensor Demonstration #2

Loss of Pressure Simulation

- Ball pump is used to simulate the small amount of pressure within a fixture as it heats up internally when turned ON
- Release pressure from the fixture
- Light will detect the pressure loss and change to RED

Simulation Only

Digital Ball Pump




Demonstration #2
Airfield Lighting Fixture
pressure loss detection
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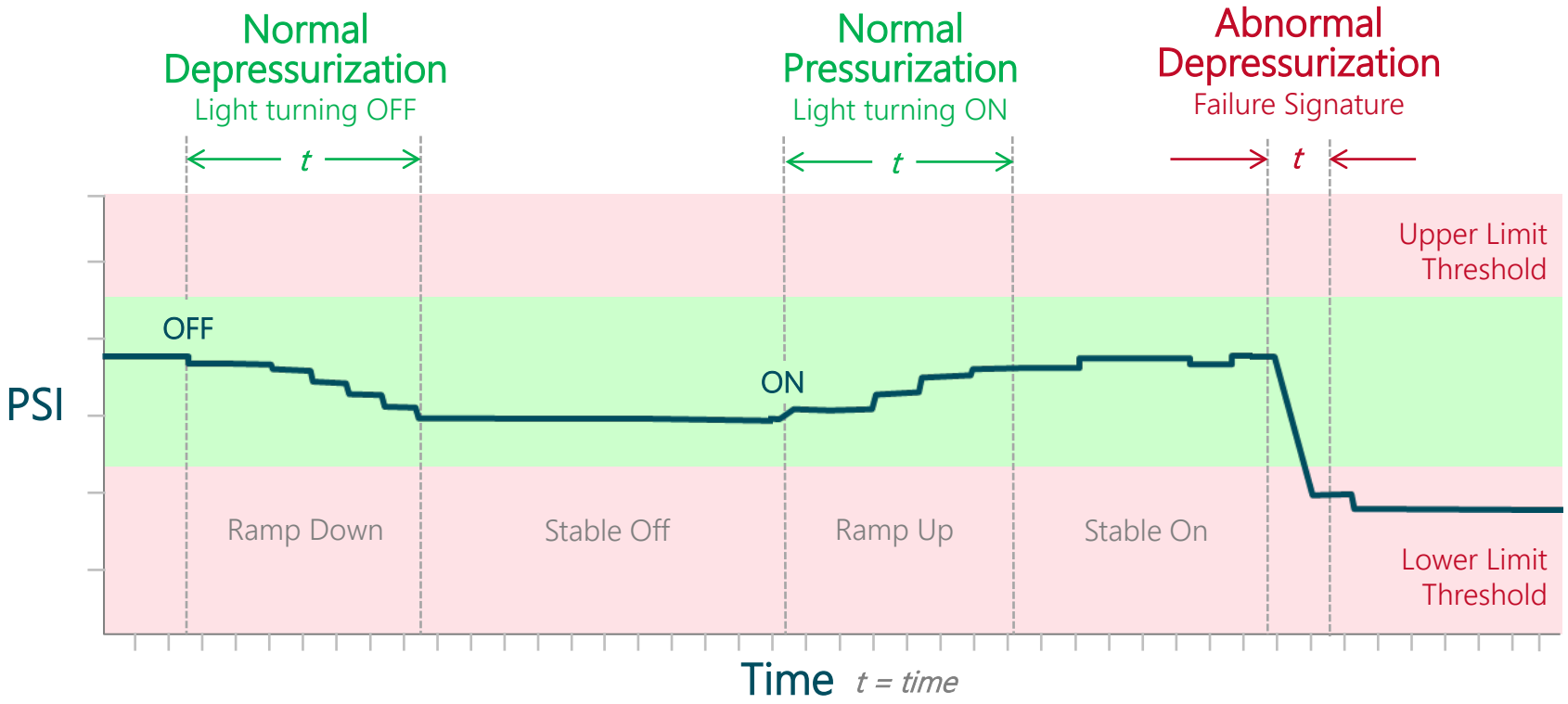
3D Accelerometer Sensor
Demonstration #1
Pressure Sensor Data



3D Accelerometer Sensor
Demonstration #1
Pressure Sensor Data

How could this be used?

Cracked Fixture Top Cover

Cracked Prism Window

Prism sock seal failure

Damaged Prism

O-ring failure or not seated correctly

Damaged cordset

Revolutionizing

Airfield Operations

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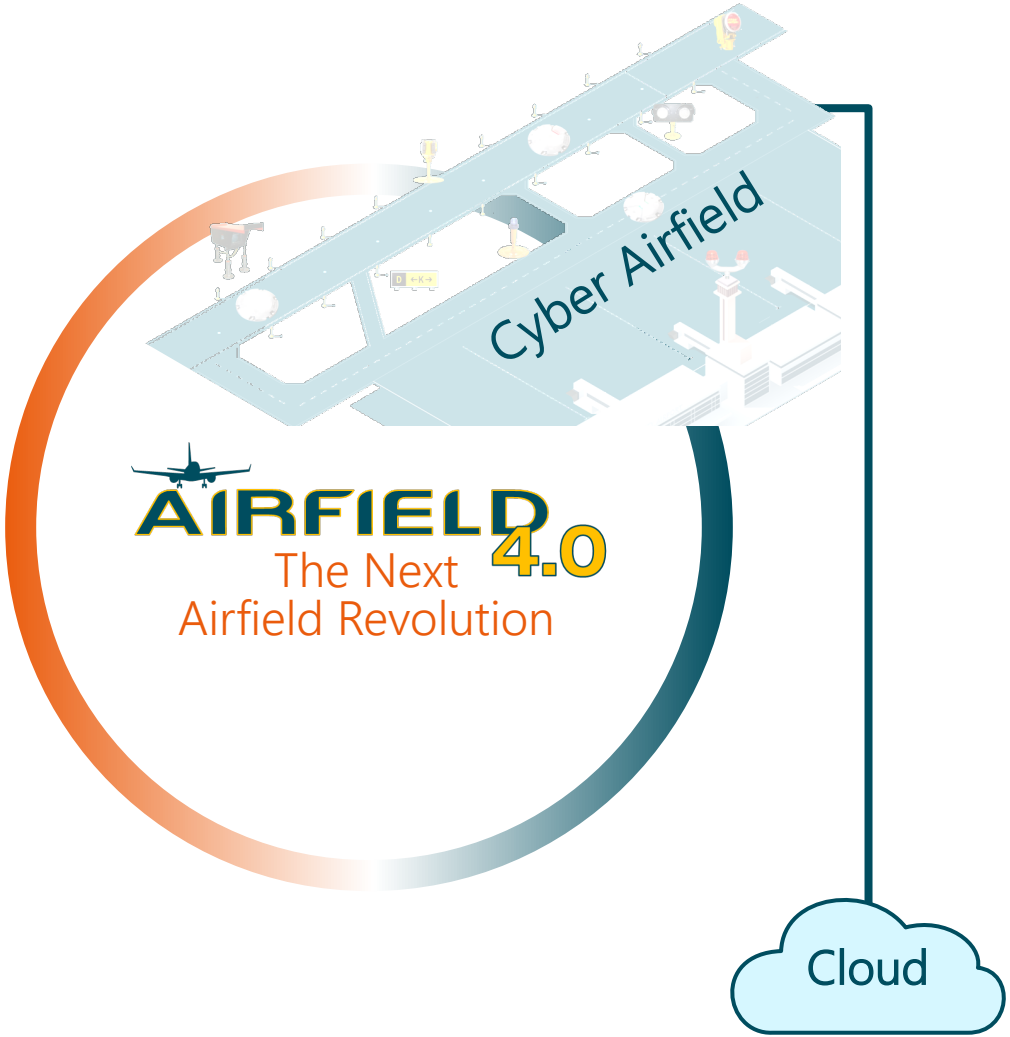
2022 IES AVIATION LIGHTING COMMITTEE TECHNOLOGY MEETING

October 16-20, 2022

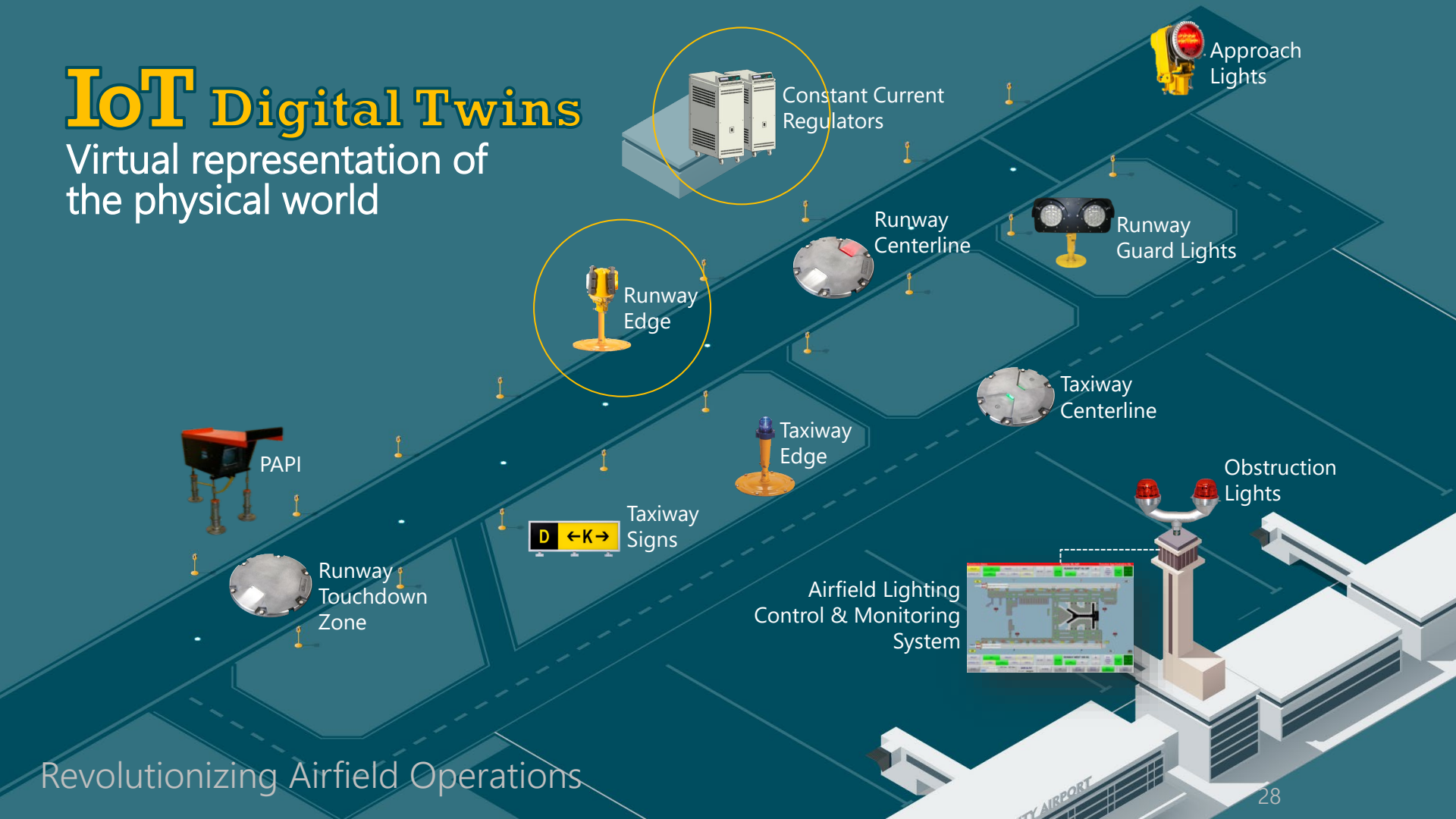
DETROIT, MICHIGAN

Virtual Digital Airfield & Digital Twins



IoT Digital Twins

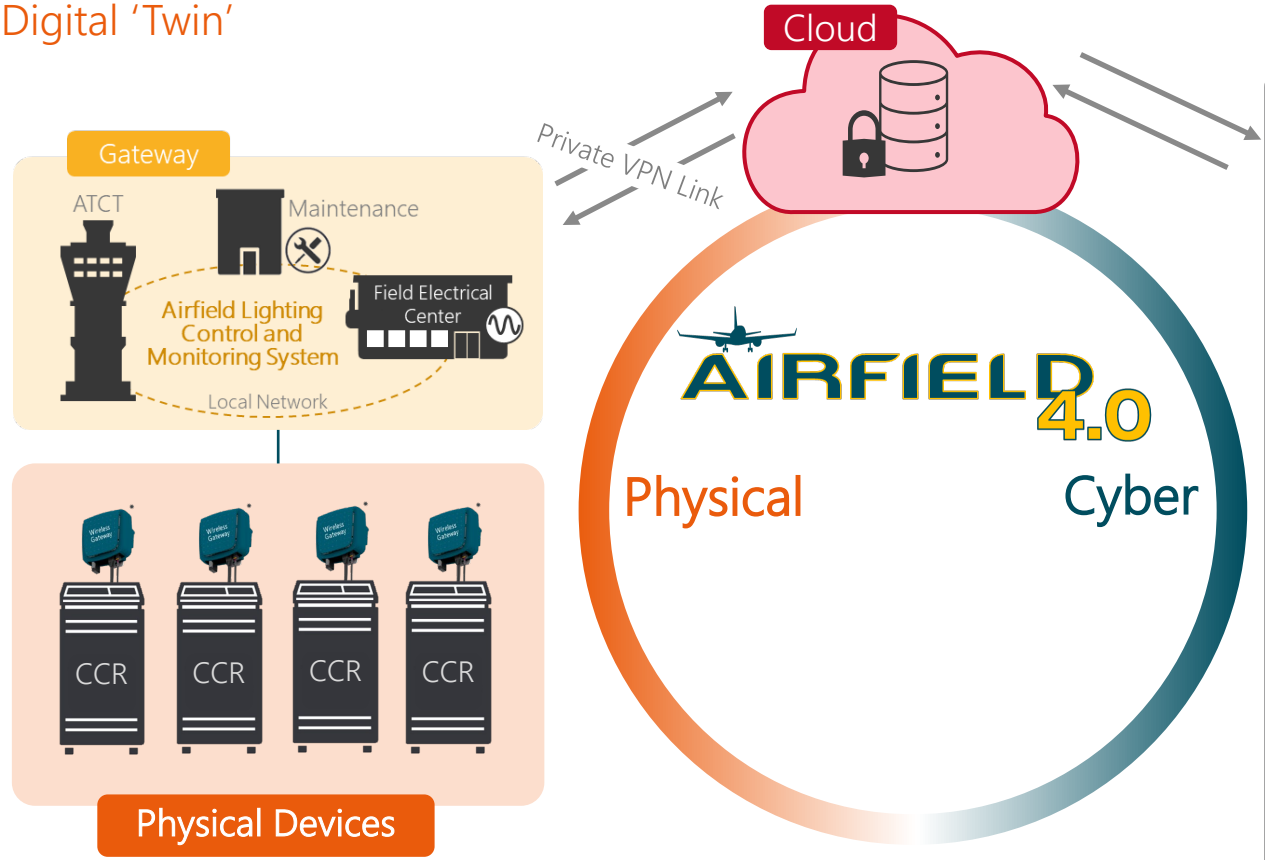
Virtual representation of the physical world



Revolutionizing Airfield Operations

Revolutionizing Airport Operations

Digital 'Twin'



Digital 'Twin'

Constant Current Regulator
Type: VIS-CRE
Size: 20kW
Input: 240VAC
Output: 6.6A

28R Rwy Edge
Circuit: 112

PERFORMANCE

Input Voltage	235	VAC
Brightness Step	3	of 5
Output	4.15	Amps
Load	17,457	VA
Insulation Resistance	5	M Ohm
Lights Out	3	

ALARM SETTINGS

Input Voltage	5%
Incorrect Current	5%
Load	10%
Insulation Resistance	Warning: 50M Alarm: 10M
Lights Out	Warning: 5% Alarm: 10%

Revolutionizing Airport Operations

Digital 'Twin'

Runway Edge Light

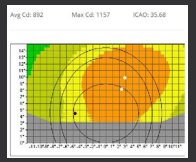
- Detect head rotating on column
- Detect light out of alignment

Physical Device

Digital 'Twin'

Runway Edge Light
Type: L-862 (L)
Color: White-Yellow
Option: without Artic Kit

Photometrics



Candela
95%

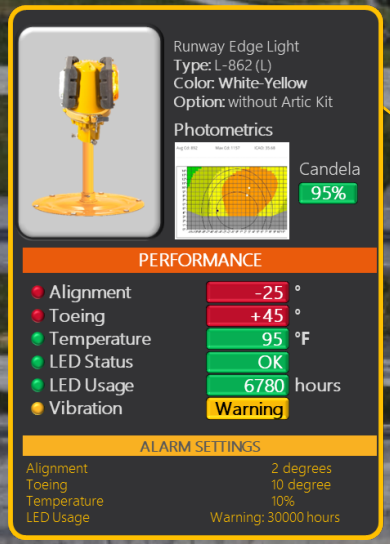
PERFORMANCE

Alignment	-25	°
Toeing	+45	°
Temperature	95	°F
LED Status	OK	
LED Usage	6780	hours
Vibration	Warning	

ALARM SETTINGS

Alignment	2 degrees
Toeing	10 degree
Temperature	10%
LED Usage	Warning: 30000 hours

Revolutionizing Airport Operations

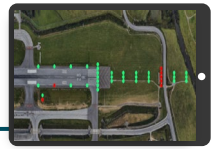


Virtual Digital Airfield

Responsive Remote Monitoring

AIRFIELD 4.0

The Next
Airfield Revolution



Virtual
Digital
Airfield

Cloud

ADB SAFEGATE

Remote Monitoring

Revolutionizing Airport Operations

Remote Monitoring

IoT Enabled

LED Steady-burner Approach

Complete Steady-burner Bar

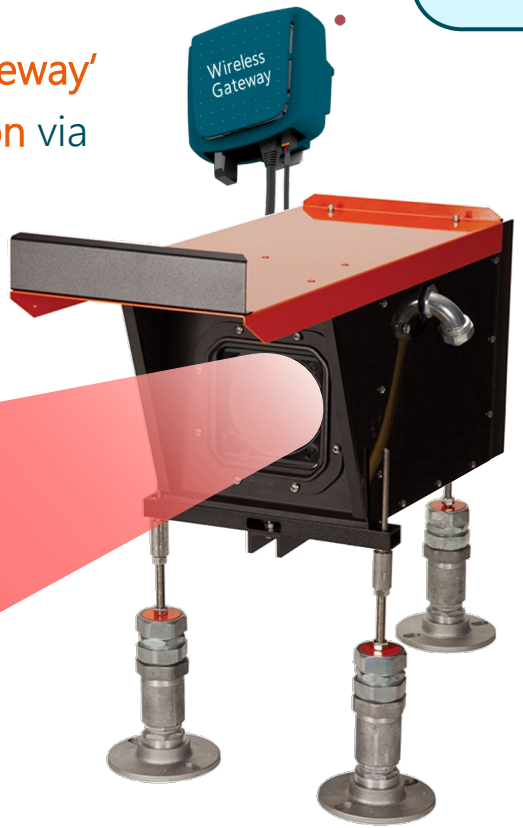
Revolutionizing Airport Operations

Remote Monitoring

Cloud
Secured data storage

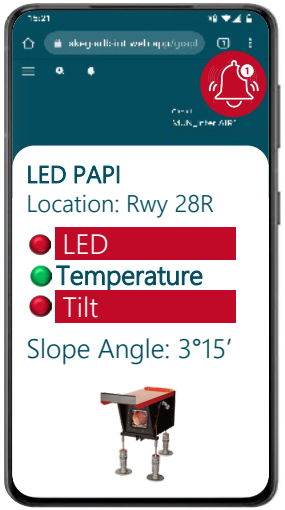
IoT Enabled Device

- Connect a **wireless 'Gateway'**
- Establish **communication** via Wi-Fi, Cellular (5G/4G)
- 'Gateway' will stream **operational data to the cloud**



PAPI Remote Monitoring

- Real-time data can be viewed from **any web device**
- **Alarm events** trigger notifications to essential personnel
  - Lamp Failure
  - Out of Alignment



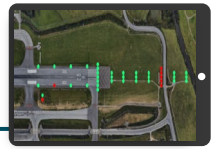
Maintenance Smartphone

Data-driven Insights

Optimizing Asset Management and Maintenance

AIRFIELD 4.0

The Next Airfield Revolution



Virtual Digital Airfield

Responsive Remote Maintenance

Cloud

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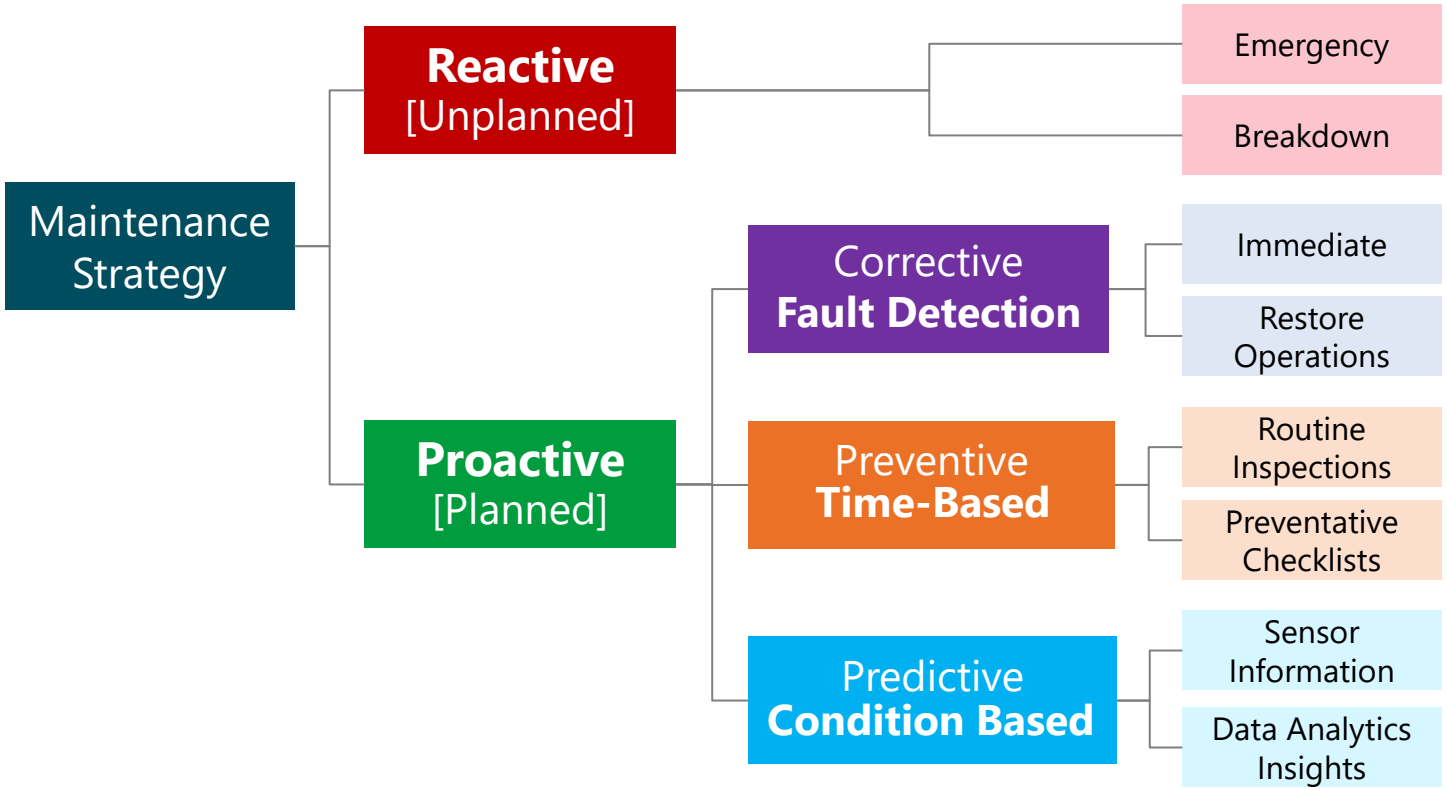
Data Analytics will Revolutionize Maintenance Strategies

from Preventive to Predictive



AIRFIELD 4.0

From Preventive to Predictive
Advanced Bolt Torquing

Angle of Rotation
of the Bolt

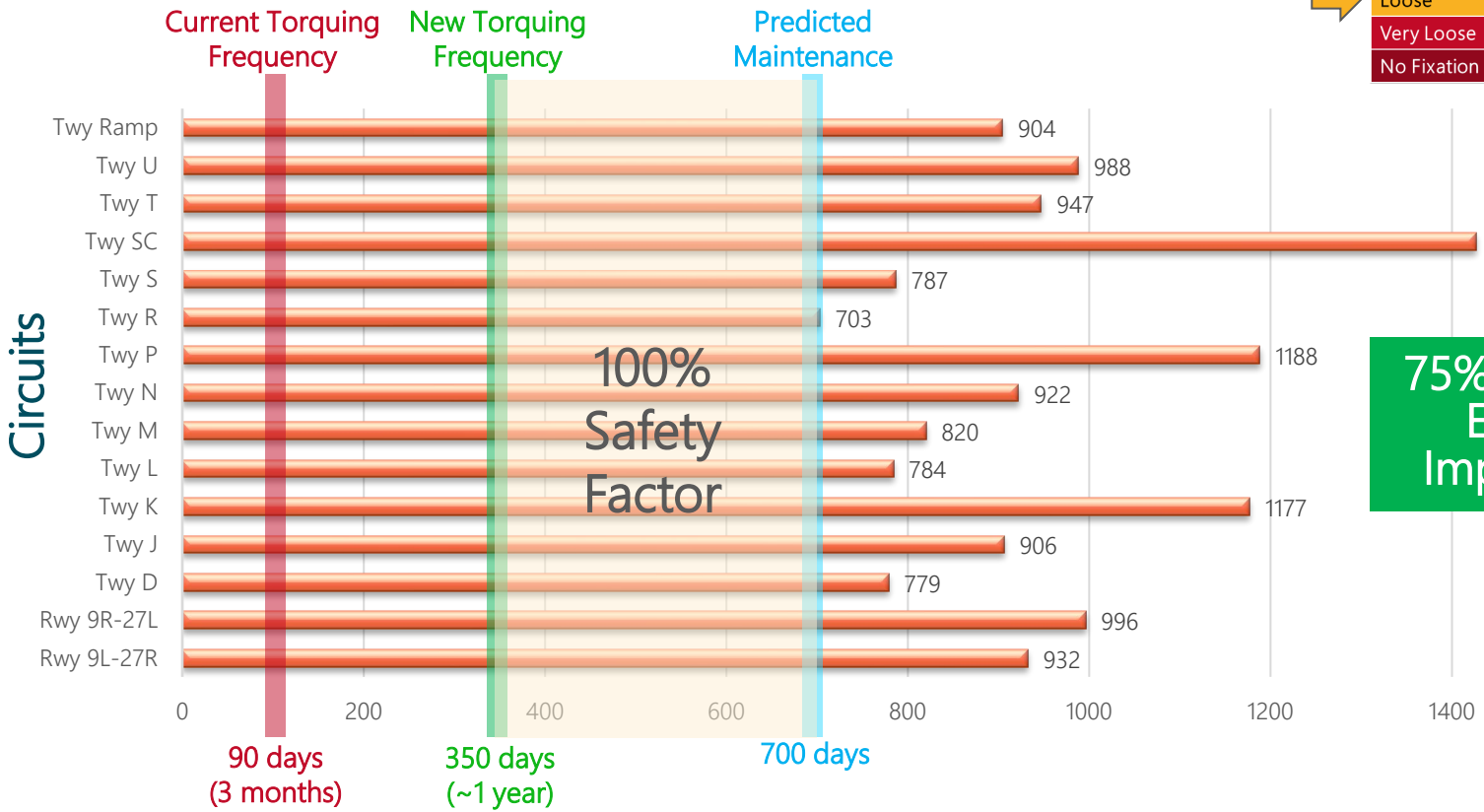
Torque Management System
Programmable Wrenches

- Measure & records bolt movement
- Torque bolt to set value

Days before bolts are 'Loose'

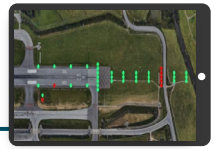
(>35% angle of rotation)

Bolt Fixation Categorization	Lower Limit	Upper Limit
Very Tight	0°	<9°
Tight	9°	<35°
Loose	35°	<75°
Very Loose	75°	<125°
No Fixation	125°	∞



75% Workforce Efficiency Improvement

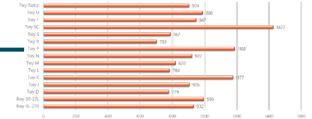
Digitized Processes
& Improved Automation



Virtual
Digital
Airfield

Responsive
Remote
Maintenance

Data-driven Insights

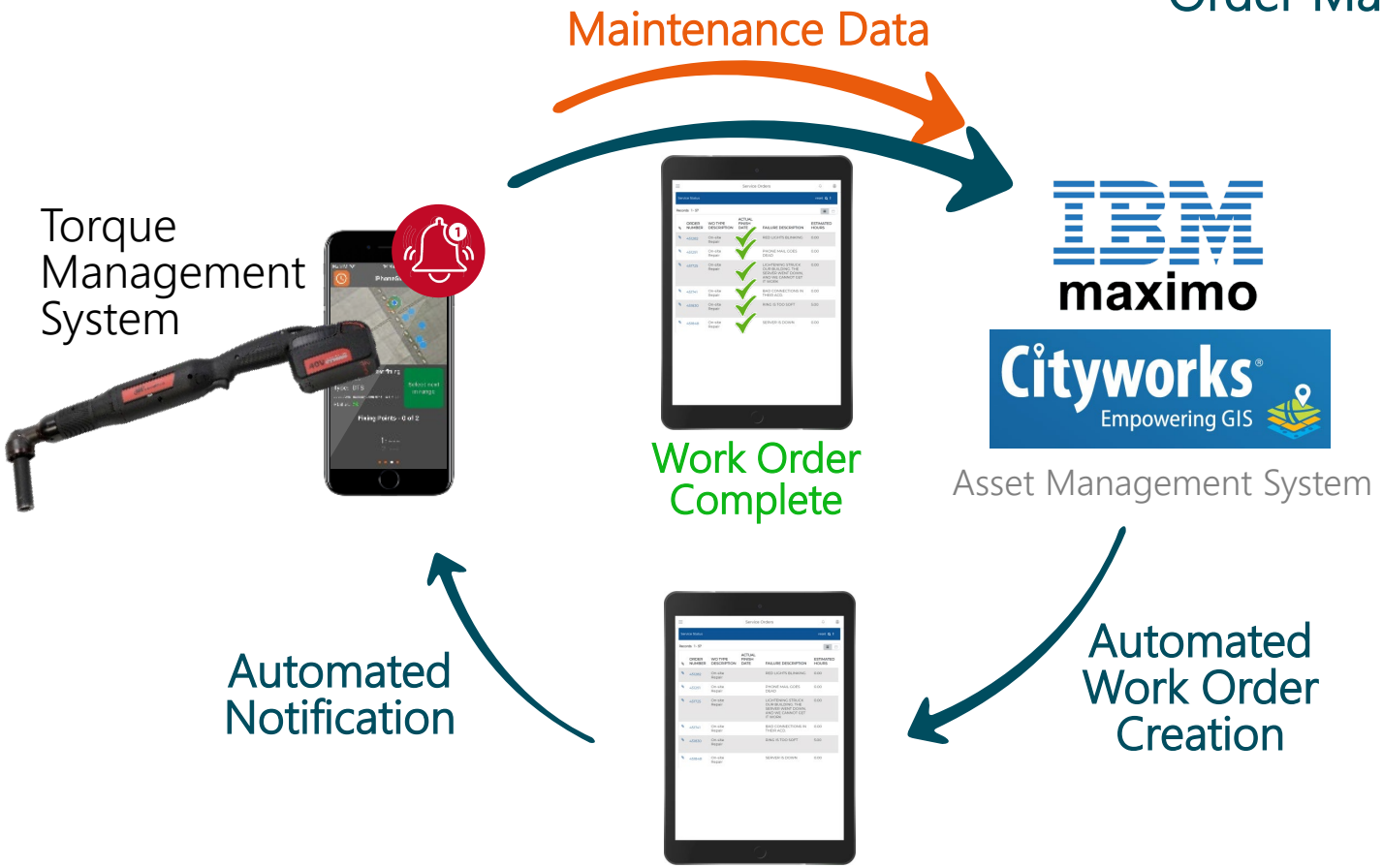


Cloud

Revolutionizing Airport Operations

Digitized Processes

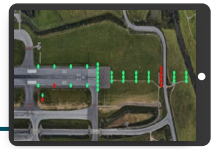
Automated Work Order Management



Airfield Safety

AIRFIELD 4.0

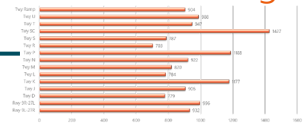
The Next
Airfield Revolution



Virtual
Digital
Airfield

Responsive
Remote
Maintenance

Data-driven Insights



Digitized Processes

Cloud

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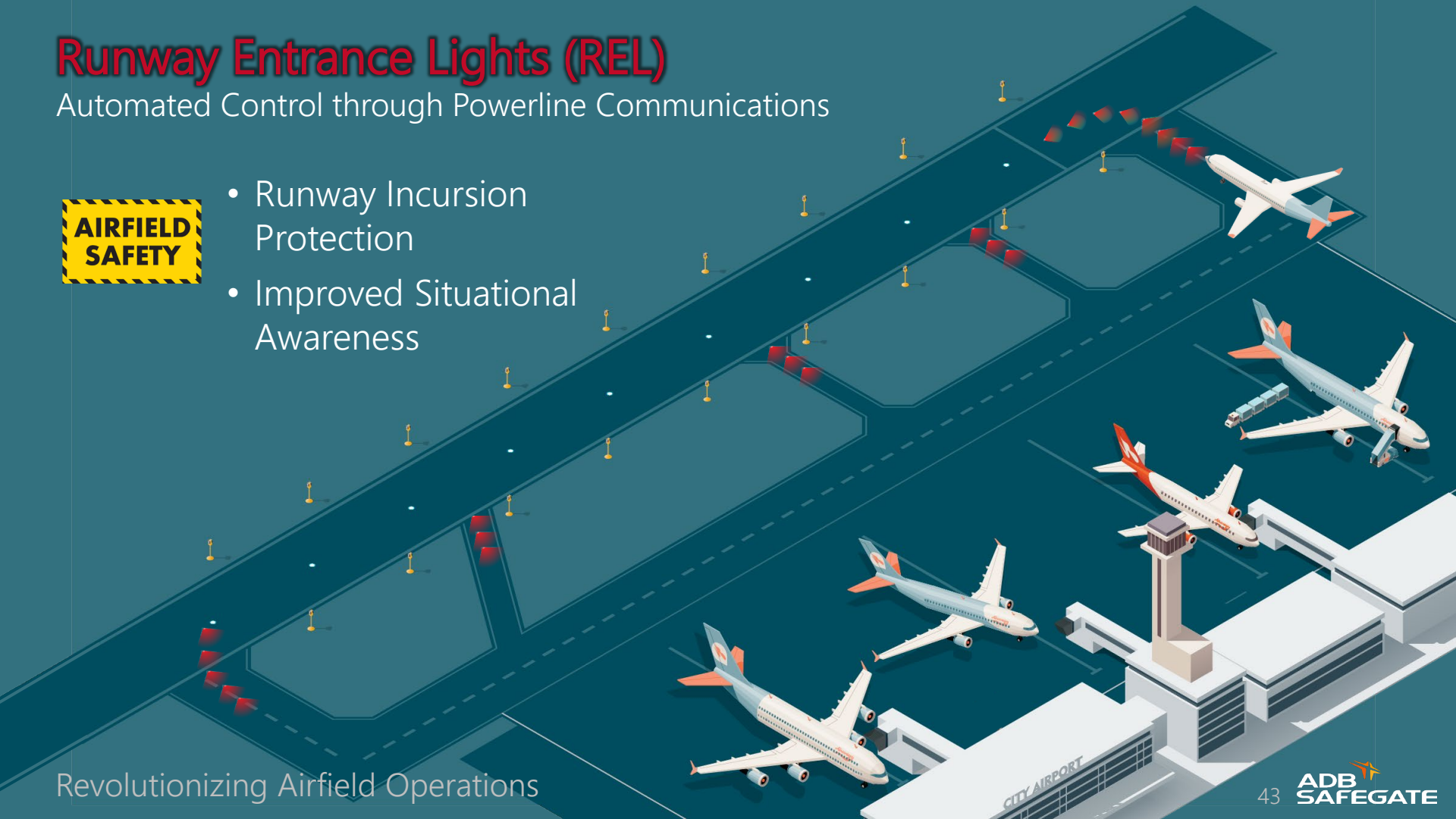
Runway Entrance Lights (REL)

Automated Control through Powerline Communications

AIRFIELD SAFETY

- Runway Incursion Protection
- Improved Situational Awareness



Revolutionizing Airfield Operations

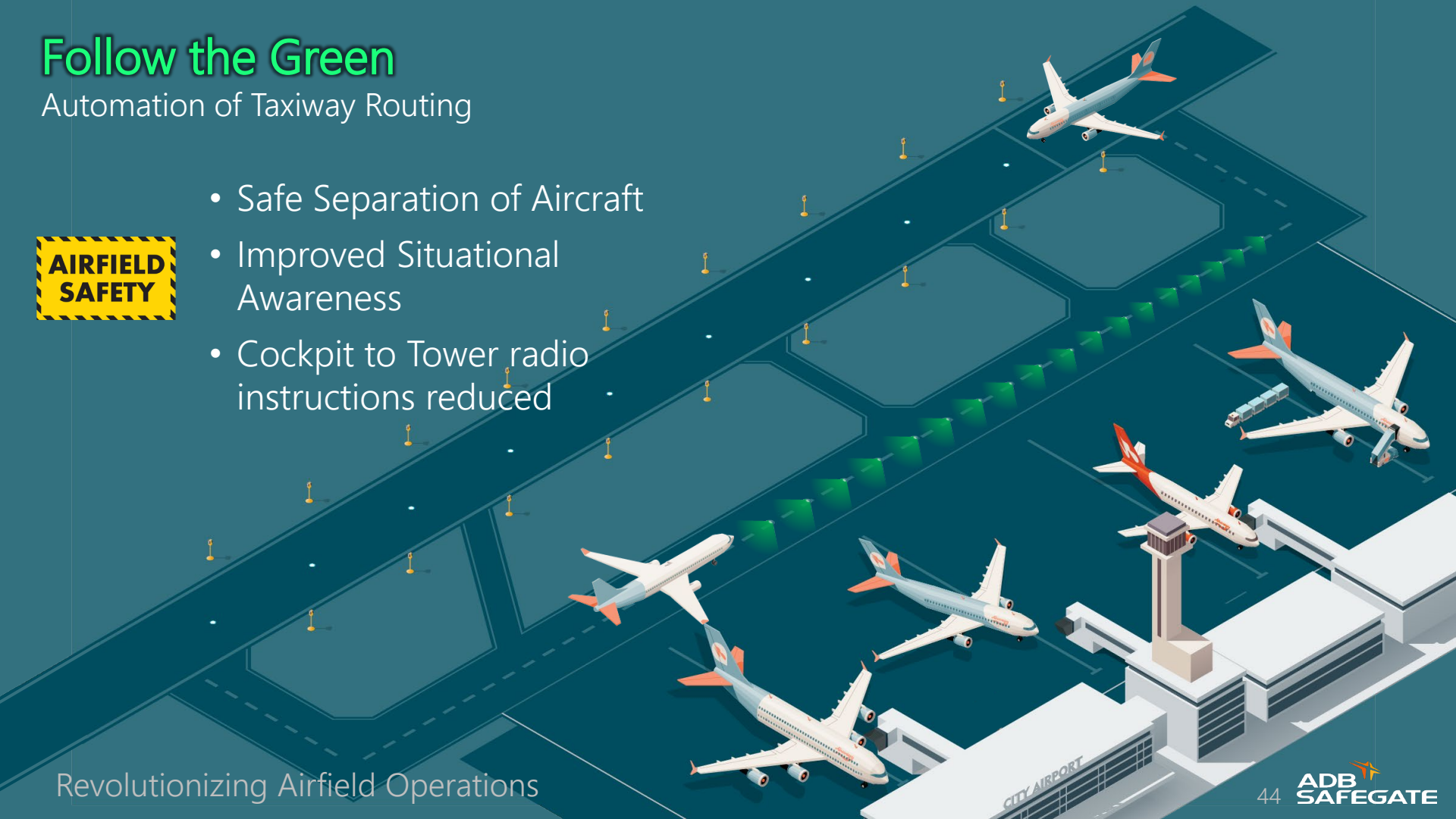
ADB SAFEGATE

Follow the Green

Automation of Taxiway Routing

AIRFIELD SAFETY

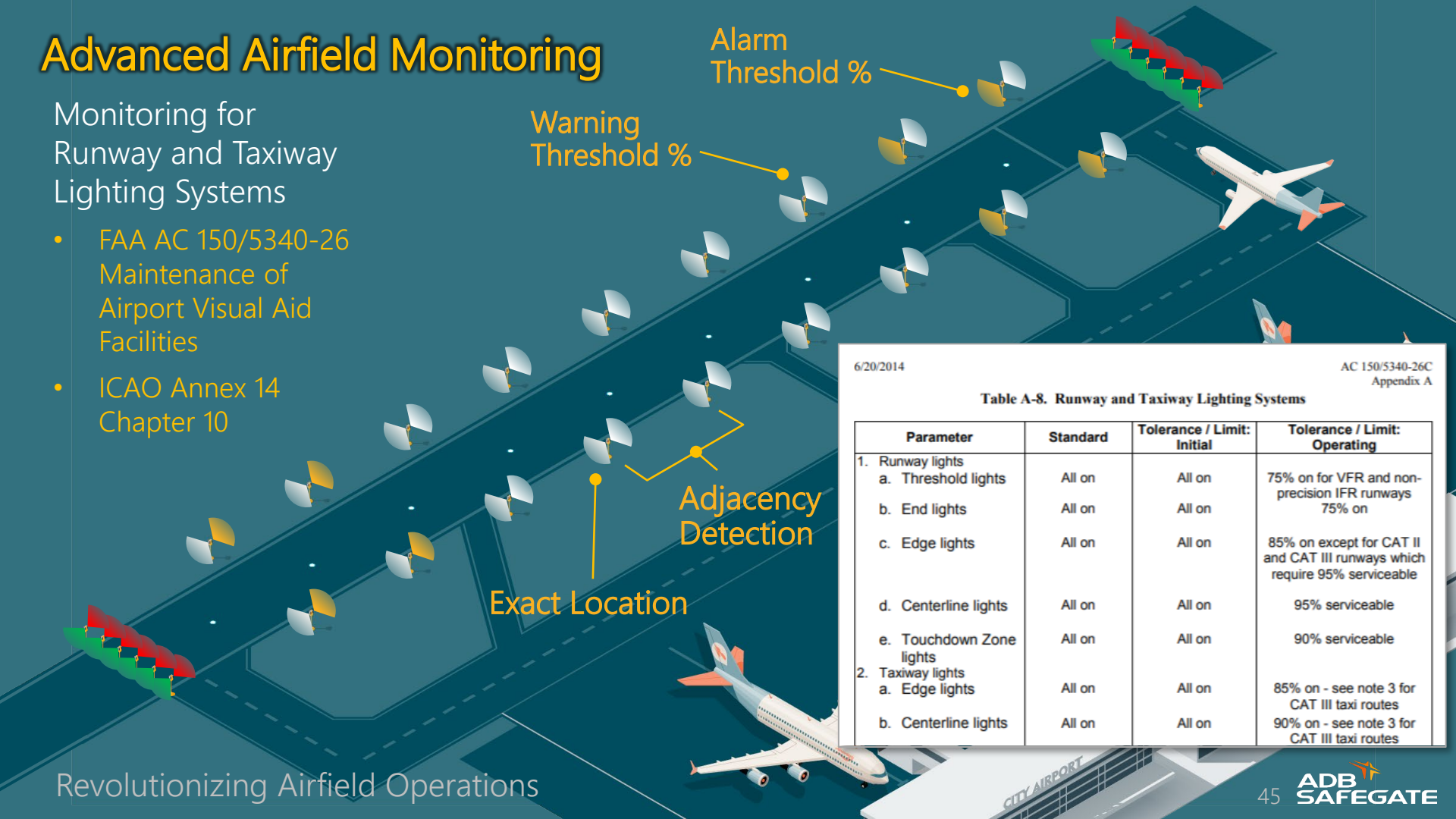
- Safe Separation of Aircraft
- Improved Situational Awareness
- Cockpit to Tower radio instructions reduced



Advanced Airfield Monitoring

Monitoring for Runway and Taxiway Lighting Systems

- FAA AC 150/5340-26 Maintenance of Airport Visual Aid Facilities
- ICAO Annex 14 Chapter 10



6/20/2014 AC 150/5340-26C Appendix A

Table A-8. Runway and Taxiway Lighting Systems

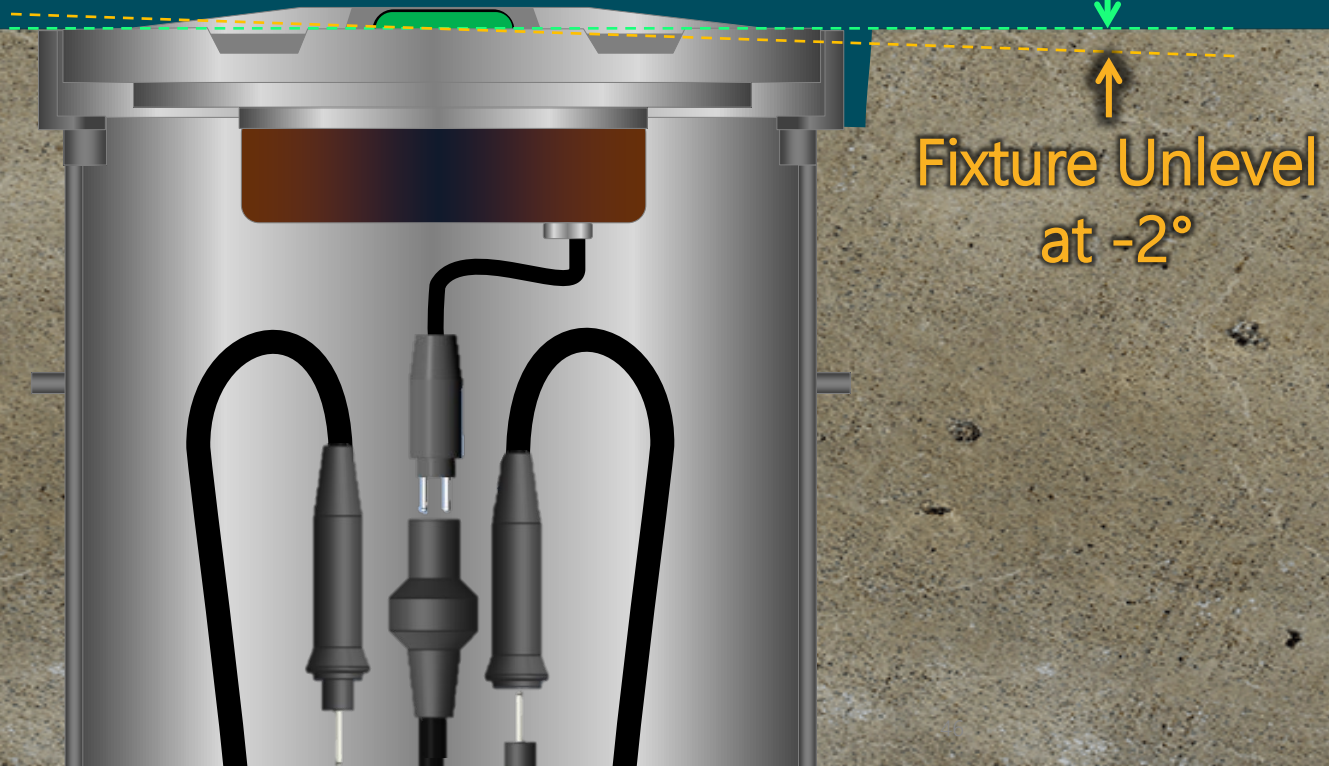
Parameter	Standard	Tolerance / Limit: Initial	Tolerance / Limit: Operating
1. Runway lights			
a. Threshold lights	All on	All on	75% on for VFR and non-precision IFR runways 75% on
b. End lights	All on	All on	
c. Edge lights	All on	All on	85% on except for CAT II and CAT III runways which require 95% serviceable
d. Centerline lights	All on	All on	95% serviceable
e. Touchdown Zone lights	All on	All on	90% serviceable
2. Taxiway lights			
a. Edge lights	All on	All on	85% on - see note 3 for CAT III taxi routes
b. Centerline lights	All on	All on	90% on - see note 3 for CAT III taxi routes

Fixture Installation Check

FAA AC 150/5340-30 Chapter 11

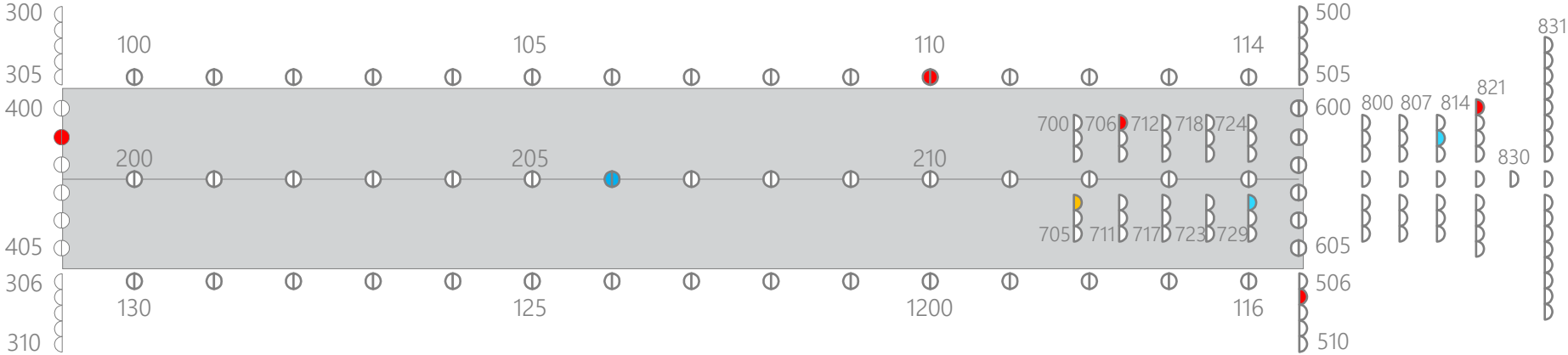
The light beam must be aligned with a tolerance of **± 1 degree**

Taxiway B Centerline	
Fixture ID	**Alignment Check**
100	0.3°
101	0.5°
102	0.5°
103	0.1°
104	0.0°
105	1.0°
106	0.3°
107	1.5°
108	0.5°
109	0.5°
110	2.2°
111	0.3°
112	0.3°



Runway Lighting Validation Check

Automated Asset Validation



IoT Lights with Sensors

3D Accelerometer & Gyroscope

Alignment & Level

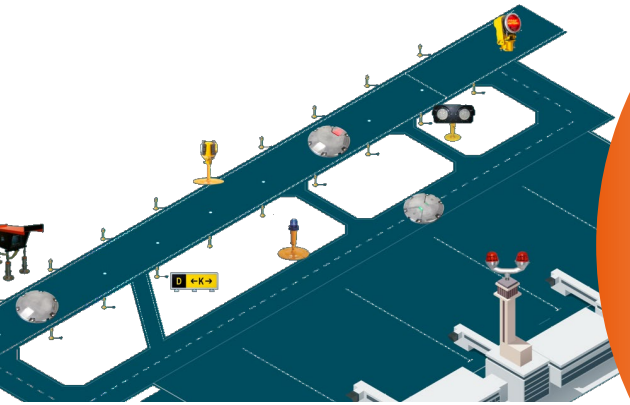
3-axis Magnetic Field

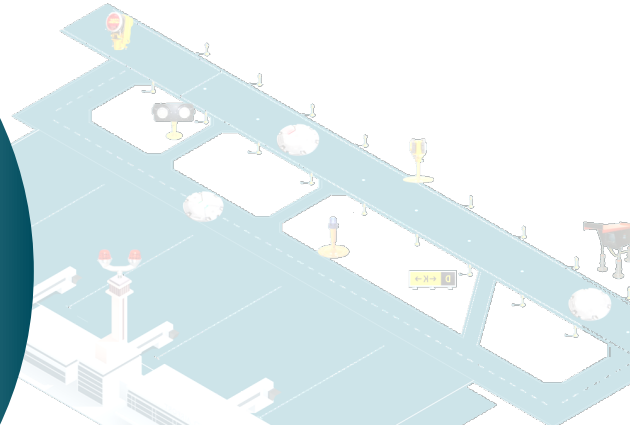
Toeing & Direction

Runway 10L-28R Lighting Validation Report

ID	Circuit	Error
110	Runway Edge	Toeing
206	Runway Centerline	Alignment
401	Runway Threshold	Toeing
703	Touchdown Zone	Level
706	Touchdown Zone	Toeing
727	Touchdown Zone	Alignment
815	ALSF II Approach	Alignment
821	ALSF II Approach	Toeing

The Pace of Innovation is Accelerating





Physical Airfield

Cyber Airfield

Thank You for your attention

ADB SAFEGATE