Digital Transformation of Aviation

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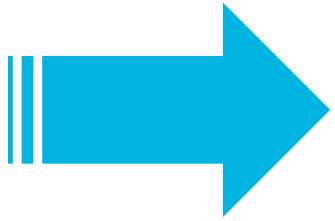
GE moved from a Burning Platform to Digital Transformation

DEFENSE

(Early 2010s)

Protecting Service Contracts



OFFENSE

(Today)

Focus on Productivity and New Offerings, Markets, & Models

Where did the journey start?

Commercial Engines | Services | Supply Chain | Military | BGA & IS

GE Aviation

Forcing functions for internal transformations

→GE90 SHROUD PROBLEM

→GENX FUEL NOZZLE PROBLEM

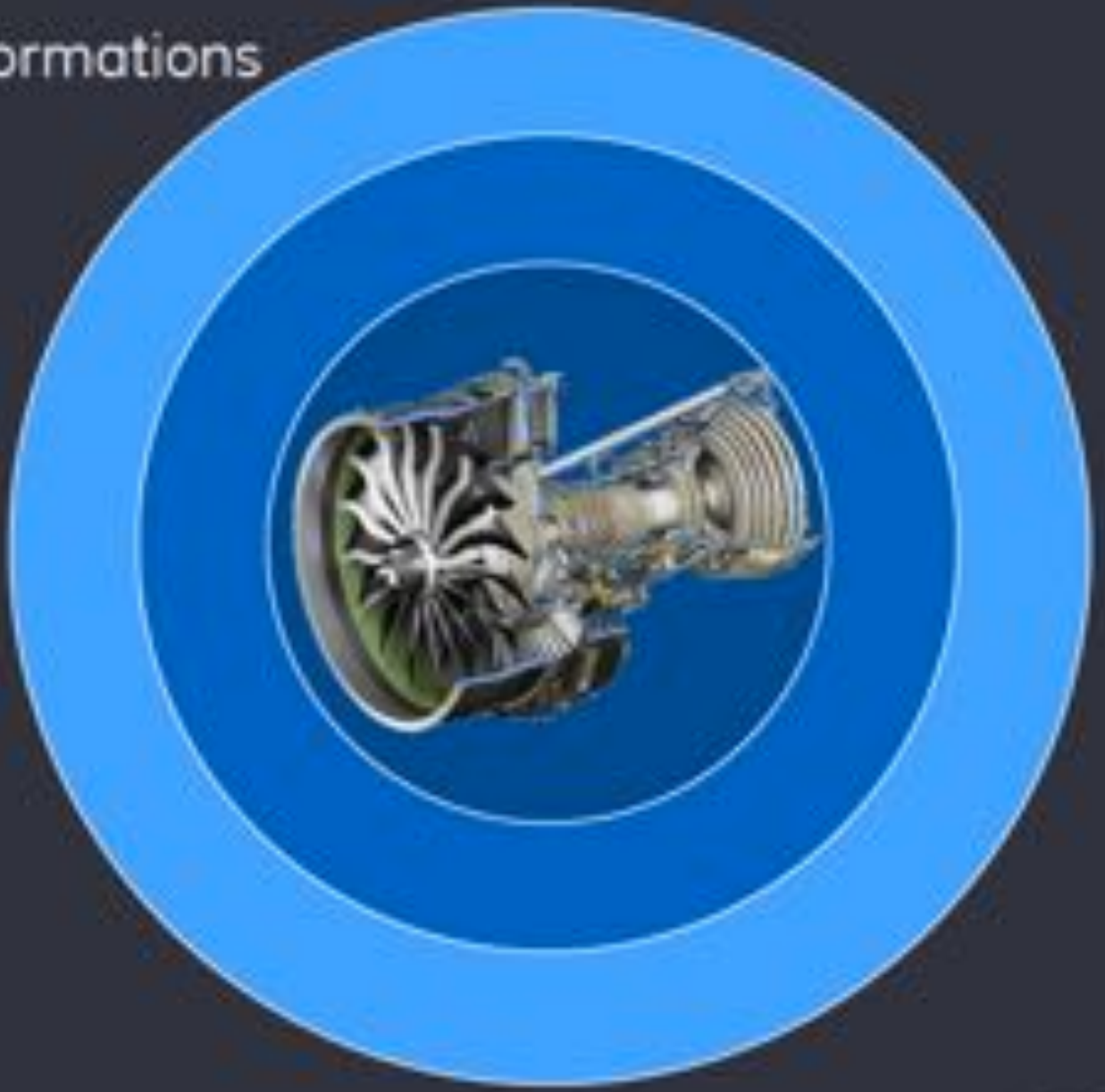
→LEAP PRODUCTION COST

→INVENTORY COSTS

→SHOP DELIVERY

→_

→____

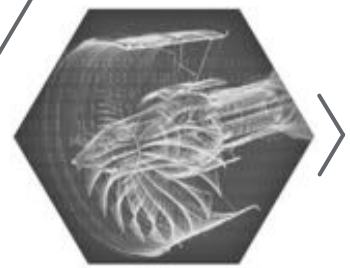


Digital Twin … 21st Century Fleet Management

Customer outcomes … reactive to proactive

SENSORS
Temperature
Pressure
Flow
etc.

PHYSICAL ENGINE



DIGITAL TWIN

Measurements

PREDIX

Cumulative Damage & Meta Models

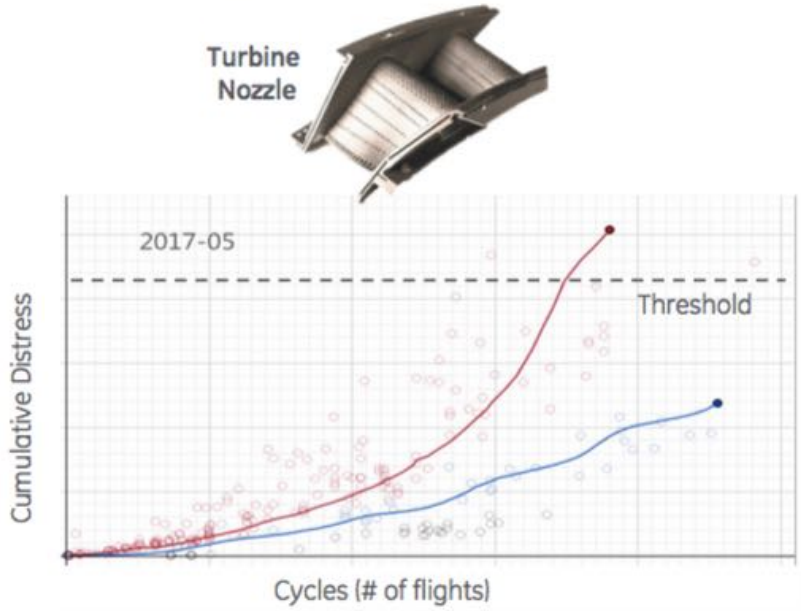
Proactive & Predictive Analytics

CUSTOMER OUTCOMES

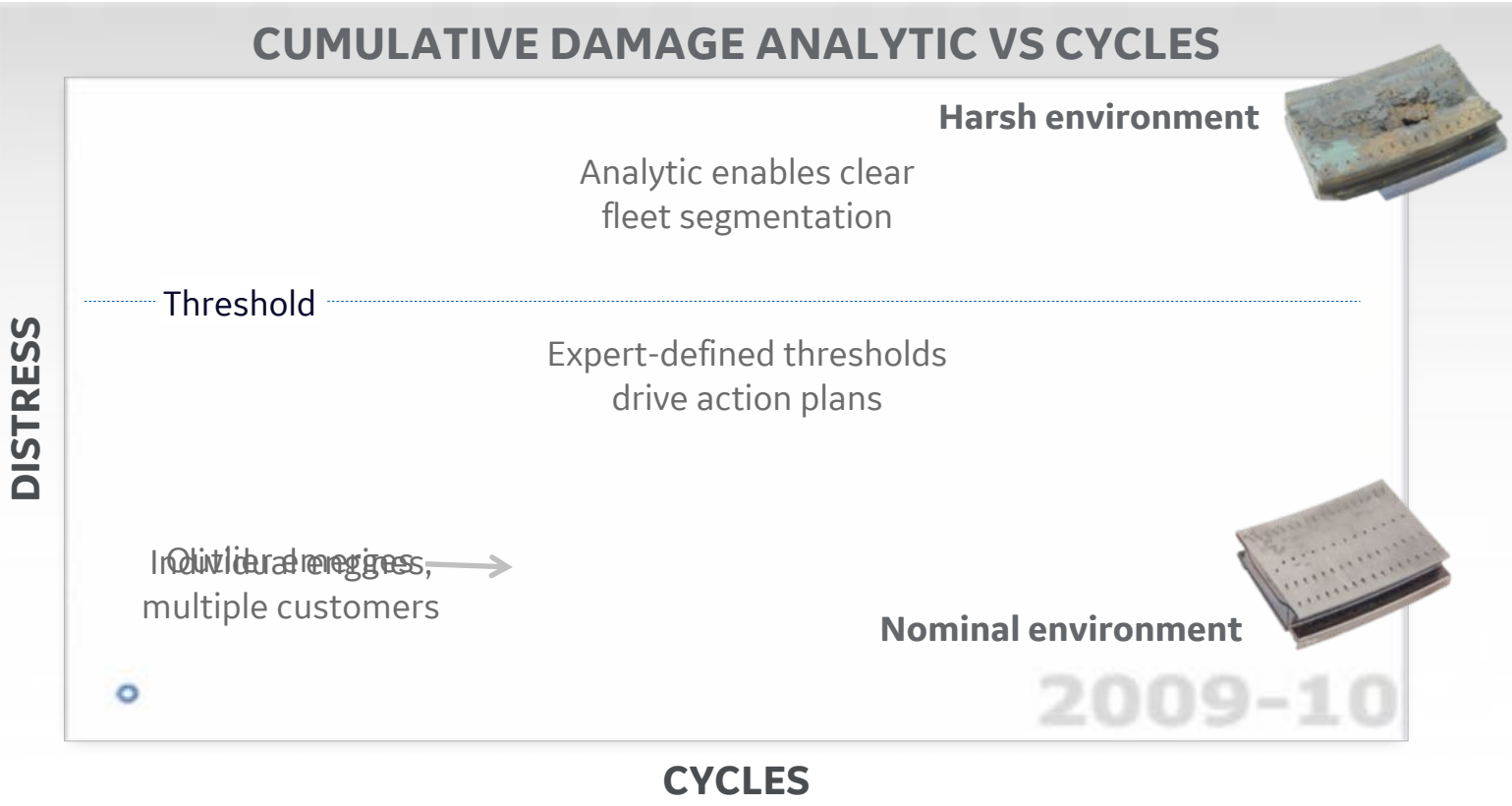
Improved Dispatch Reliability
Reduced Unplanned Engine Removals
Reduced Maintenance / Inspection Burden
Lower Cost of ownership

BENEFITS

Per Asset Model
Continuously Tuned
Scalable & Adaptable



With proven results



Outcomes

Major Middle East customer in harsh environment … better predictability

56% decrease in disruptions[-a)]

15% decrease in overhauls[-b)]

12 additional days of utilization[-c)]

(a- Unscheduled engine removals 1H2016
(b- Forecasted reduction in performance shop visits FY17-18
(c- Customer estimate

Reduced maintenance burden = removals ↓ disruptions ↓ inspections ↓


H14

Social

Industrial

Age

Relationship

Income

Likes

Relationship

Digital Twin

Equipment type

Parts numbers

Material properties

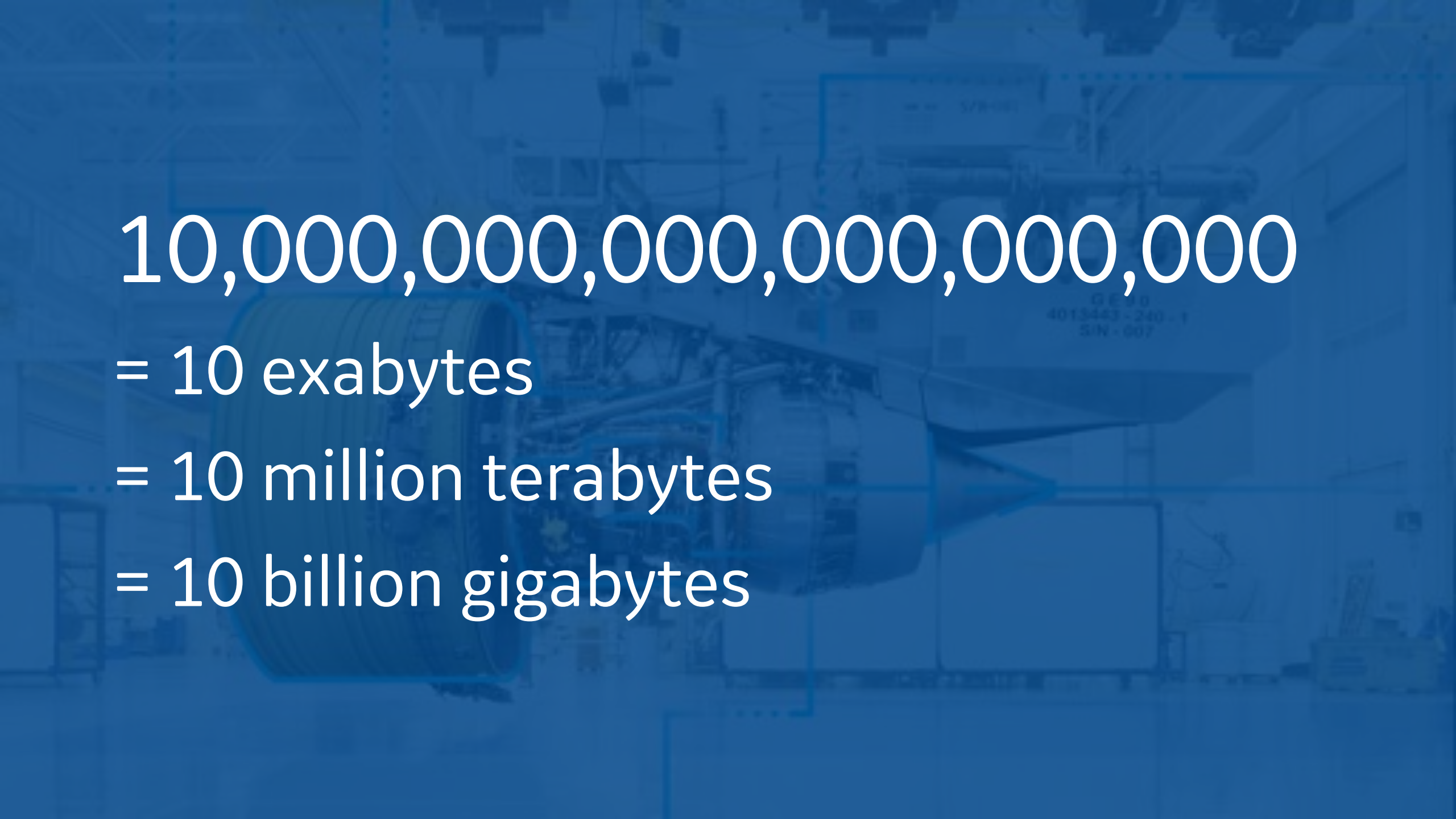
Maintenance history

Operational conditions

Sensor data

Better ads

More uptime ▶ **Safer operations** ▶ **Fuller automation**



10,000,000,000,000,000,000

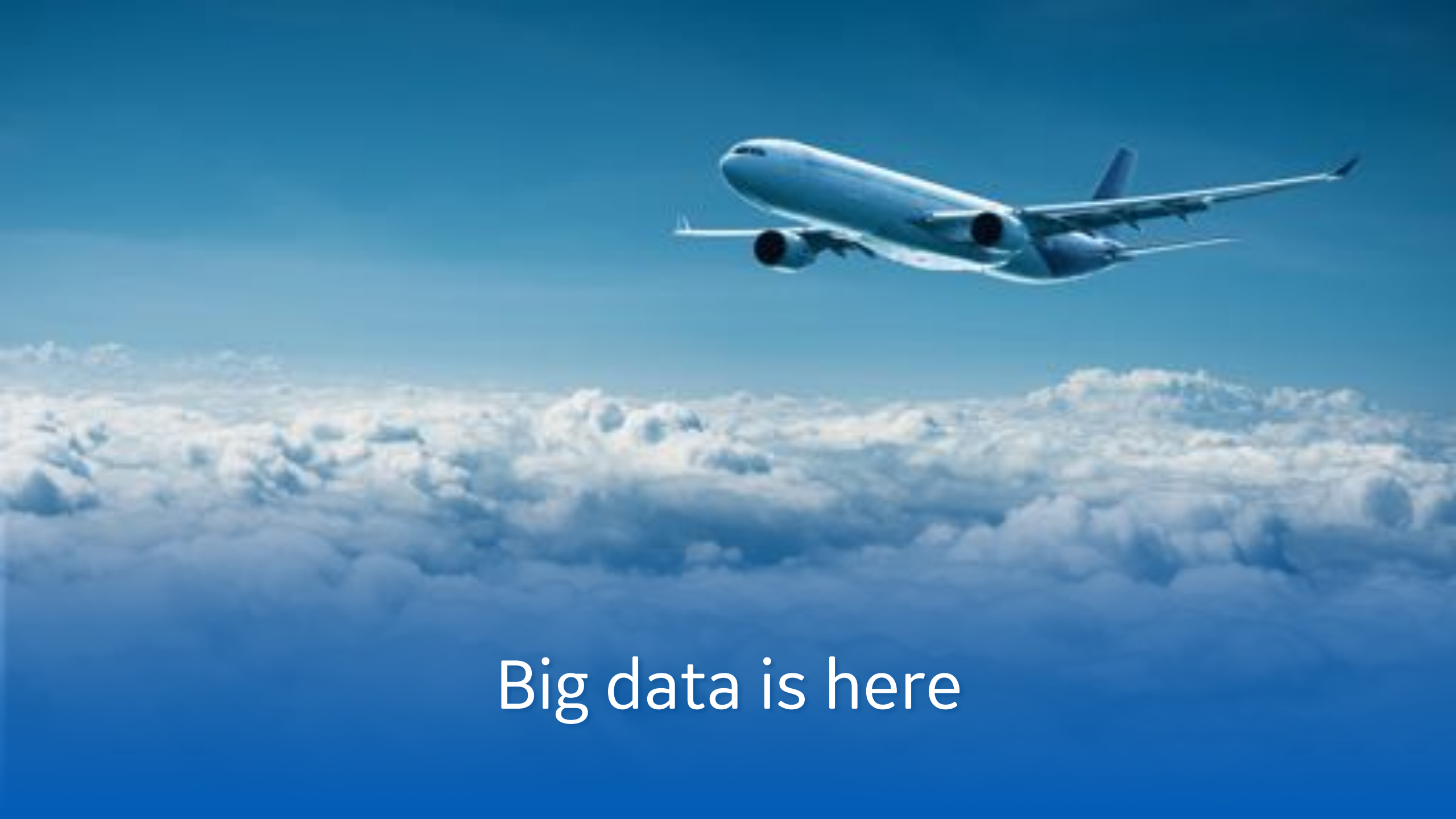
= 10 exabytes

= 10 million terabytes

= 10 billion gigabytes

10,000,000,000,000,000,000,000

... the amount of OT data generated by the global commercial airline fleet

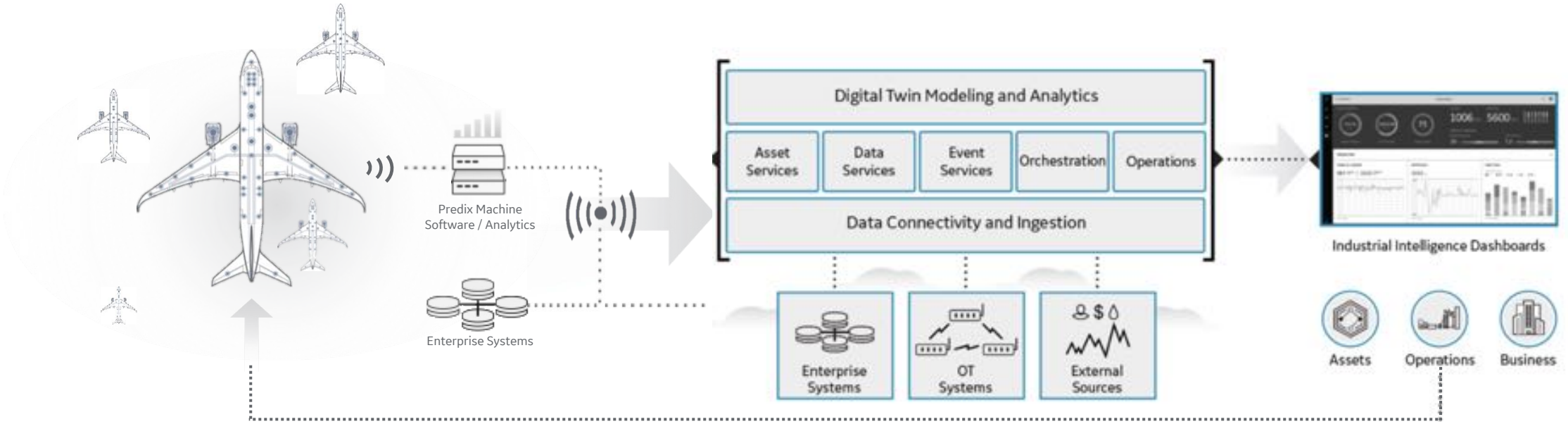

Big data is here

Edge-to-Cloud … platform-as-a-service

EDGE Connected assets. Edge appliances. Edge Analytics.

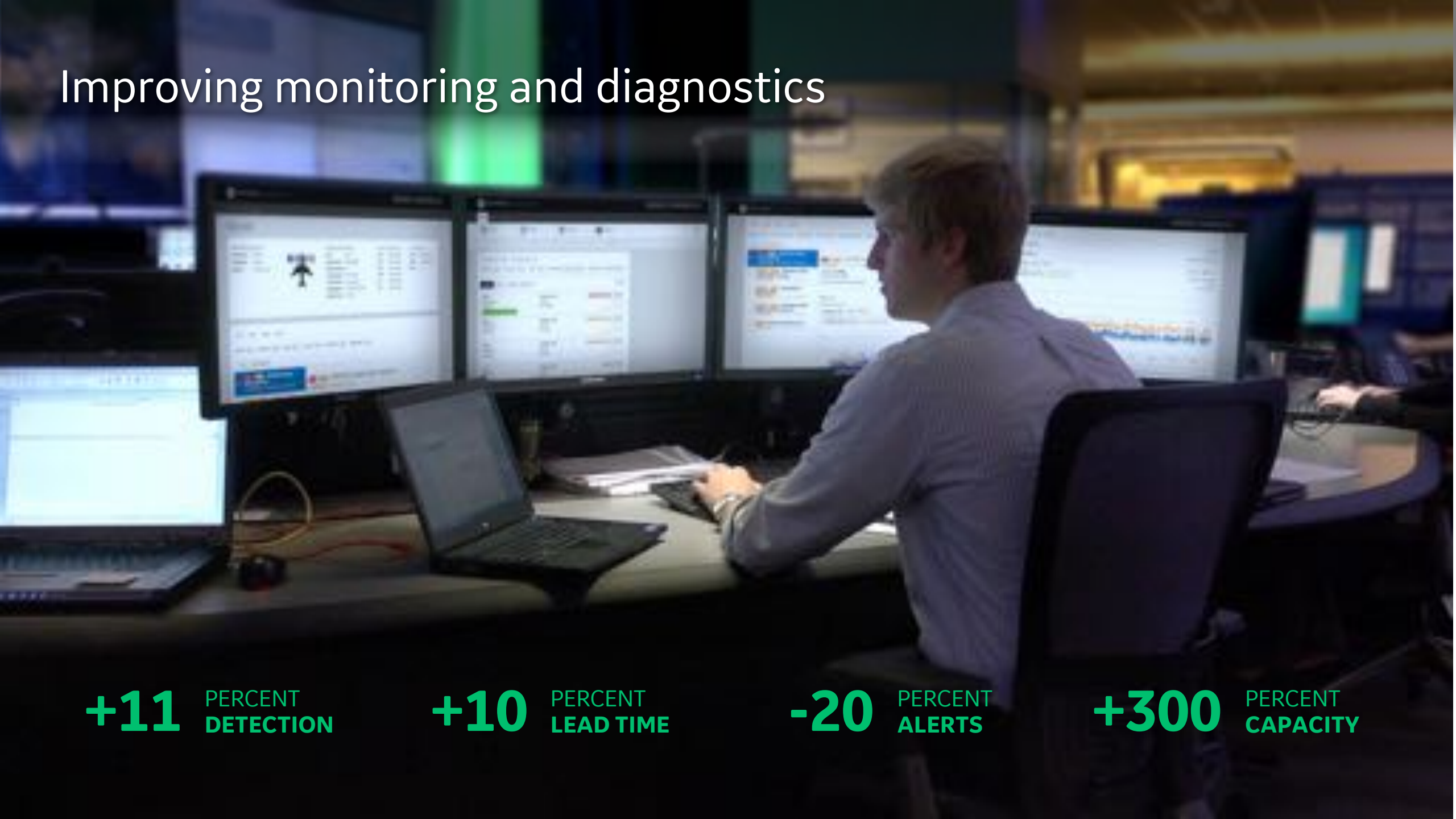
CLOUD Connect industrial assets with people through data and analytics.

APPLICATIONS Visibility and insights for better business outcomes.



GET CONNECTED | **GET INSIGHTS** | **GET OPTIMIZED**

Improving monitoring and diagnostics



+11 PERCENT **DETECTION**

+10 PERCENT **LEAD TIME**

-20 PERCENT **ALERTS**

+300 PERCENT **CAPACITY**

Revenue

the most powerful driver of airline profitability

1% revenue increase

More flights

More payload

=

5% LOWER fuel cost

or

10% LOWER aircraft price

or

25% LOWER maint. cost

How does GE Aviation define Digital Industrial?

Create a Digital Twin

Connecting the physical and digital worlds to improve operations

Enable the Digital Thread

Using the Digital Thread to connect people, software-defined machines and assets across an organization's ecosystem and through its lifecycle

Business Model Innovation Runs Through Network Operations

Create the OT and IT capabilities that enable innovation

The Path to Transformation

Visualize

Improve operational visibility including passenger, crew, and aircraft

- Track true cost of operations and maintenance
- Optimize aircraft and crew scheduling
- Develop real-time visibility into asset performance on any device
- Reduce foreseeable delays
- Plan maintenance processes accurately
- Understand quality of passenger experience
- Reduce cost of fuel
- Improve in-service maintenance productivity
- Reduce unnecessary spare parts inventory

Optimize

Increase efficiency with predictive operations and maintenance

- Reduce adverse passenger experience
- Reduce frequency of irregular operations
- Decrease service time and rework
- Design new equipment models for reliability
- Improve predictive maintenance capabilities
- Improve availability forecast accuracy
- Identify maintenance bottlenecks early
- Improve service productivity
- Automate traceability within the maintenance

Innovate

Dynamically sense demand and respond to maximize revenue

- Achieve exceptional passenger satisfaction
- No unexpected disruptions
- Improve demand forecasting
- Improve and accelerate network changers
- Bring real-time usage into planning cycle
- Reduce cost to serve
- Reduce human error by automating processes
- Improve revenue per seat mile
- Operations driven by Margin

TIME

Airlines have many **sources of data** surrounding flight operations.

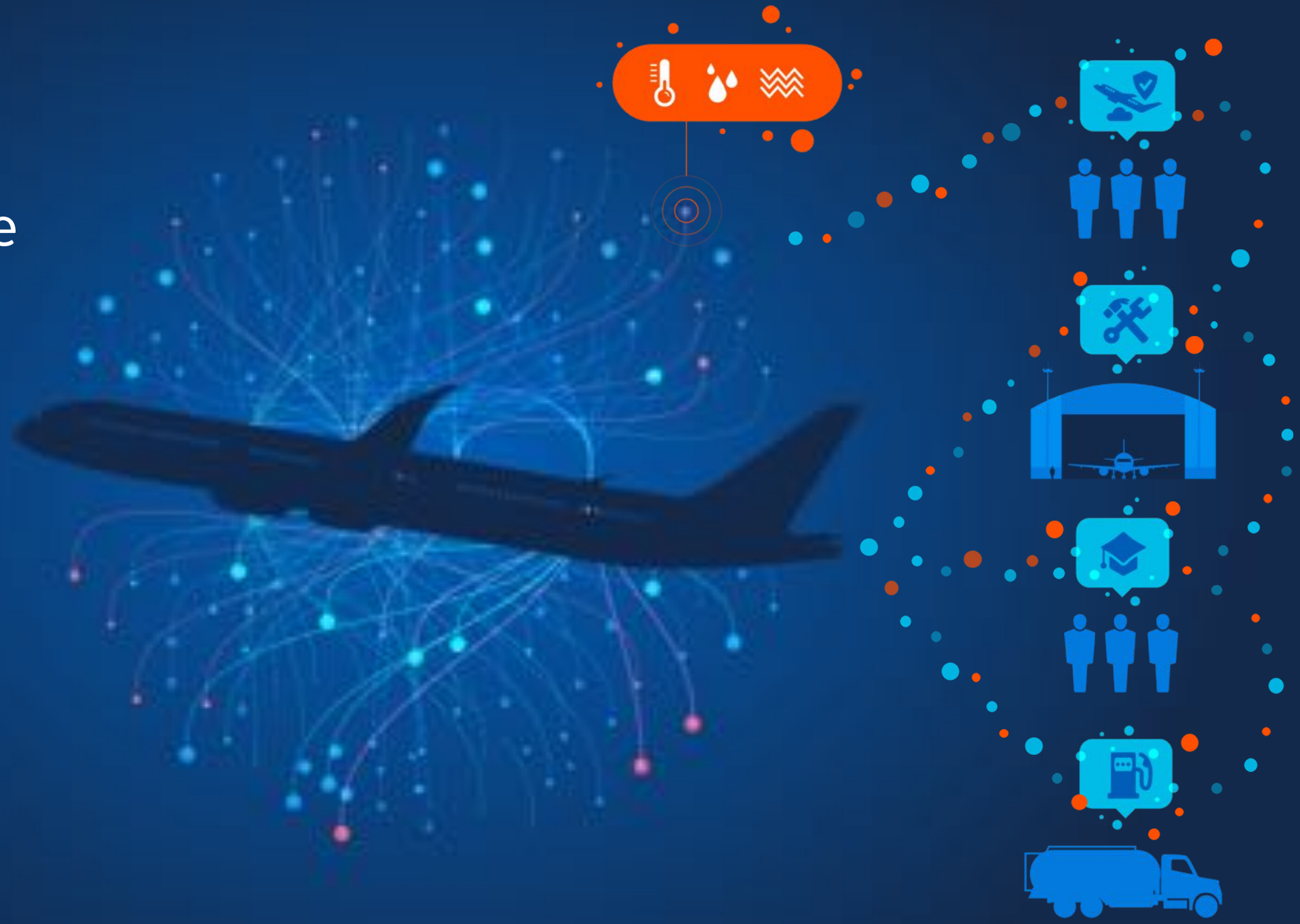
The **richest data** comes from the airline's fleet of airborne sensors, with hundreds or thousands of data points created every second.

But this data is also the most complex to work with and the most susceptible to **data quality issues.**

The data from aircraft (**Flight Data**) has traditionally been siloed for use only in the safety analysis process.

Removing this silo unlocks **great value** to the rest of the enterprise.

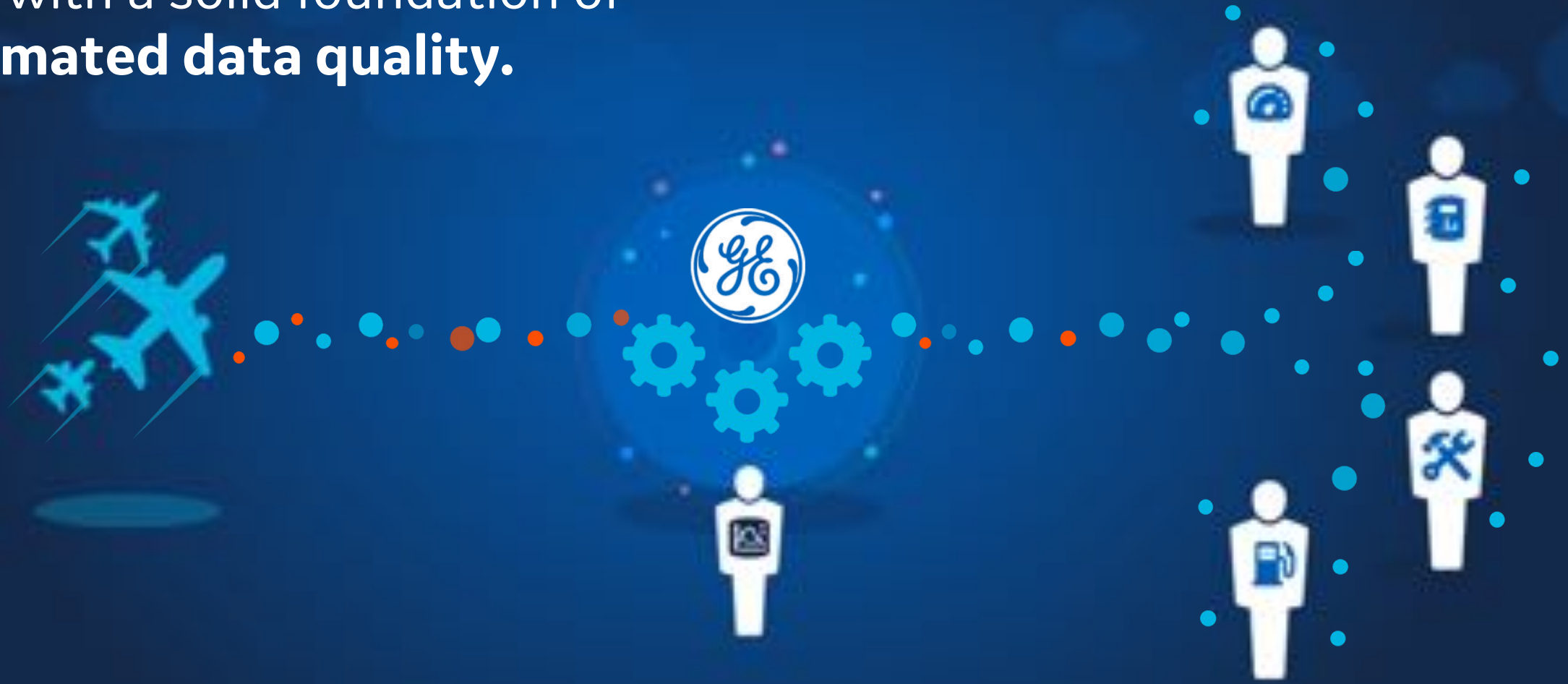
This is easier said than done, because pushing **bad data** out to a bigger audience is worse than no data at all.



Small errors can be manually filtered by humans in the limited scope of safety analysis. They become **big problems** when delivered to the masses.

Unlike the analyst, these other users need **clean data** because they don't have knowledge of the limitations of data like the analyst does.

At GE, we believe the only way to unlock the value of this data is to start with a solid foundation of **automated data quality.**



140 million
flights processed

590 TB
of data

20,000
fights per day

35+
major airlines

250+
biz jet operators

ASIAS
platform

Our analysis system was architected and evolved through over **20 years of experience** in supporting the world's largest operations, with the goal of supporting the 1 million+ flights per year customer

It provides up to 3X faster upload + up to 12X faster processing + ~20% less false positives than typical systems = up to **5X more productivity**

All of this enables a solid foundation for automated, high quality analytics to deliver data value **across the airline**

This high quality, automated analytics engine can then fuse flight data with other sources with **high confidence.**

Harmonizing connected data

Business Operations data to understand key business drivers impacting performance, profitability and improving efficiencies

Customer Experience solutions to understand customer insights, improve marketing efforts and to manage customer relationships

Asset performance management to increase reliability & productivity

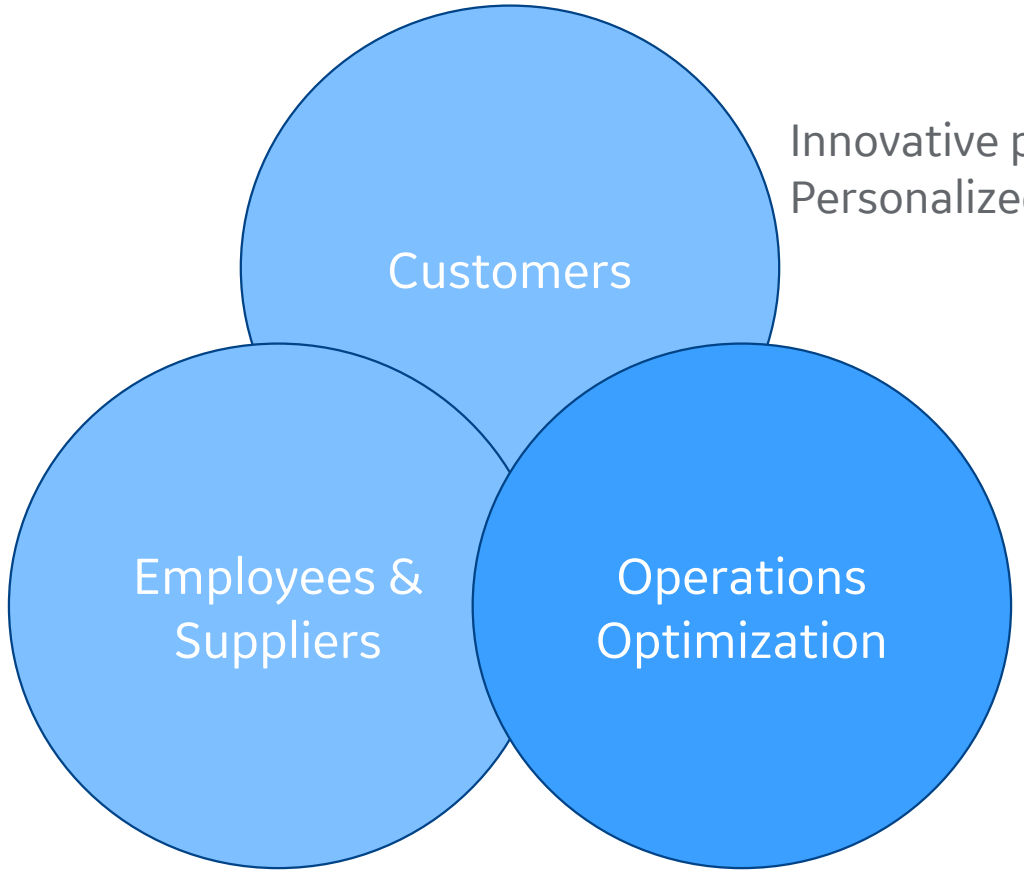
Flight analytics and expertise to improve flight operations

Fleet data management to drive fleet productivity and maintenance efficiencies

Network data sources & analytics to optimize operations recovery and crew operations

Operations serve a changing world…
driving cost, margin and delivery of passenger experience

73% of airline cost is in operations*



Innovative products
Personalized experiences

Empowered to serve

Dynamic operational fulfilment
Improve outcomes
Deliver value

*US Airline cost, Source: ICAO Airline Operating Costs and Productivity 2017

Intelligent Network Product Suite Capability

AIRPORT CLOSED 6 HOURS
200 flights impacted
30,000 passengers

OPERATIONS INSIGHTS
Operations Control

Constraints:
Aircraft, Passengers, Airport Maintenance, Crew, Cost

DETECT PROBLEM

RECOVERY OPTIMIZATION
Operations Control

OPTIMIZATION

PASSENGER PROTECTION
Reservations Support

Constraints:
Passenger Itinerary, Passenger Value, Revenue

REBOOK

PASSENGER NOTIFICATION
Call Center
Airport Agent
Self Service

OPERATIONS RECOVERY TIME

PASSENGER REBOOKING TIME