
NATS
Atlantic City
TITLE
r:Evolution
Systems Thinking and the
4TH Industrial Revolution
PRESENTER
MARK FLANIGAN
NATS Chief Innovation Officer


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01 **PHYSICAL**


01/01
SMART
AIRPORTS
& CITIES

WHAT IS A SMART AIRPORT?

THE PASSENGER

The SMART Airport connects the total journey, enabling passengers to personalise their journey from ‘booking to back home’, to enhance their experience through choice, flexibility and convenience.

01/01

SMART AIRPORTS & CITIES

THE OPERATION

The SMART Airport is an advanced, seamlessly connected operation where all actors and stakeholders collaborate to create and manage an optimised plan that delivers predictability and punctuality at the best price for the passenger.

THE BUSINESS

The SMART Airport delivers outstanding performance and value, enabling Airports and Airlines to satisfy their customers and shareholders through optimum use of assets, infrastructure, resources and investments.

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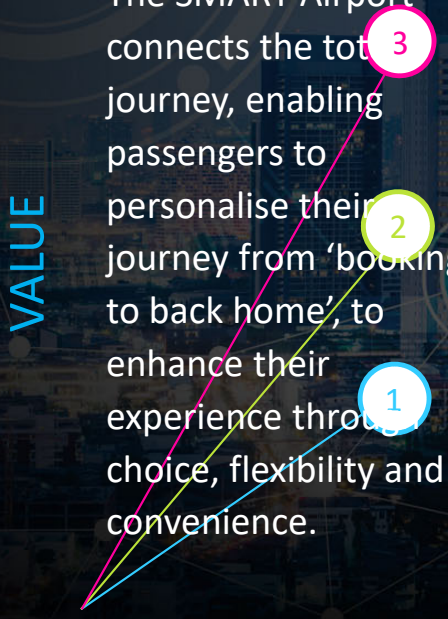
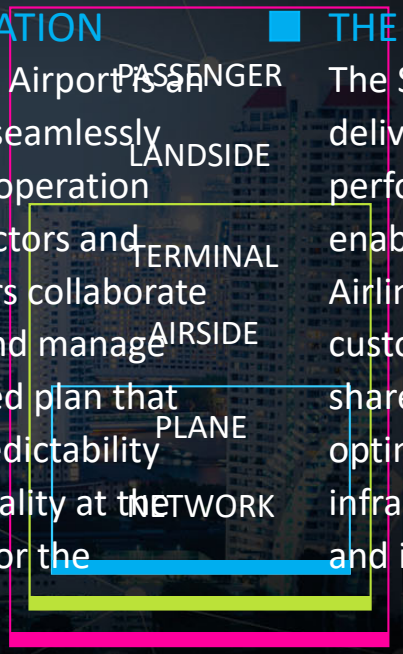
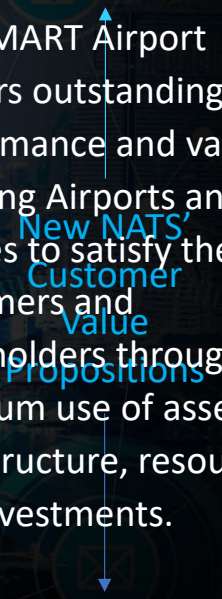
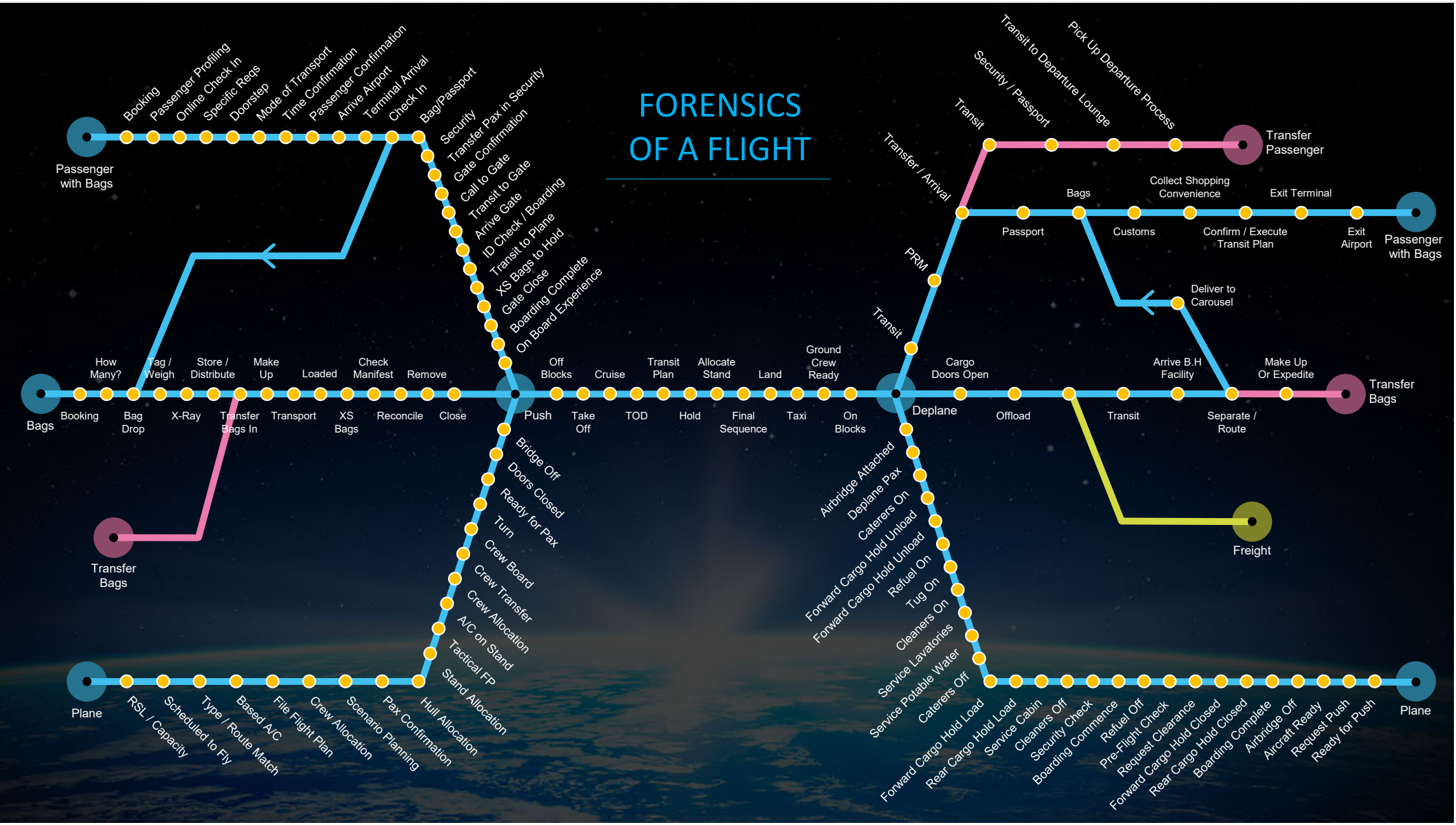
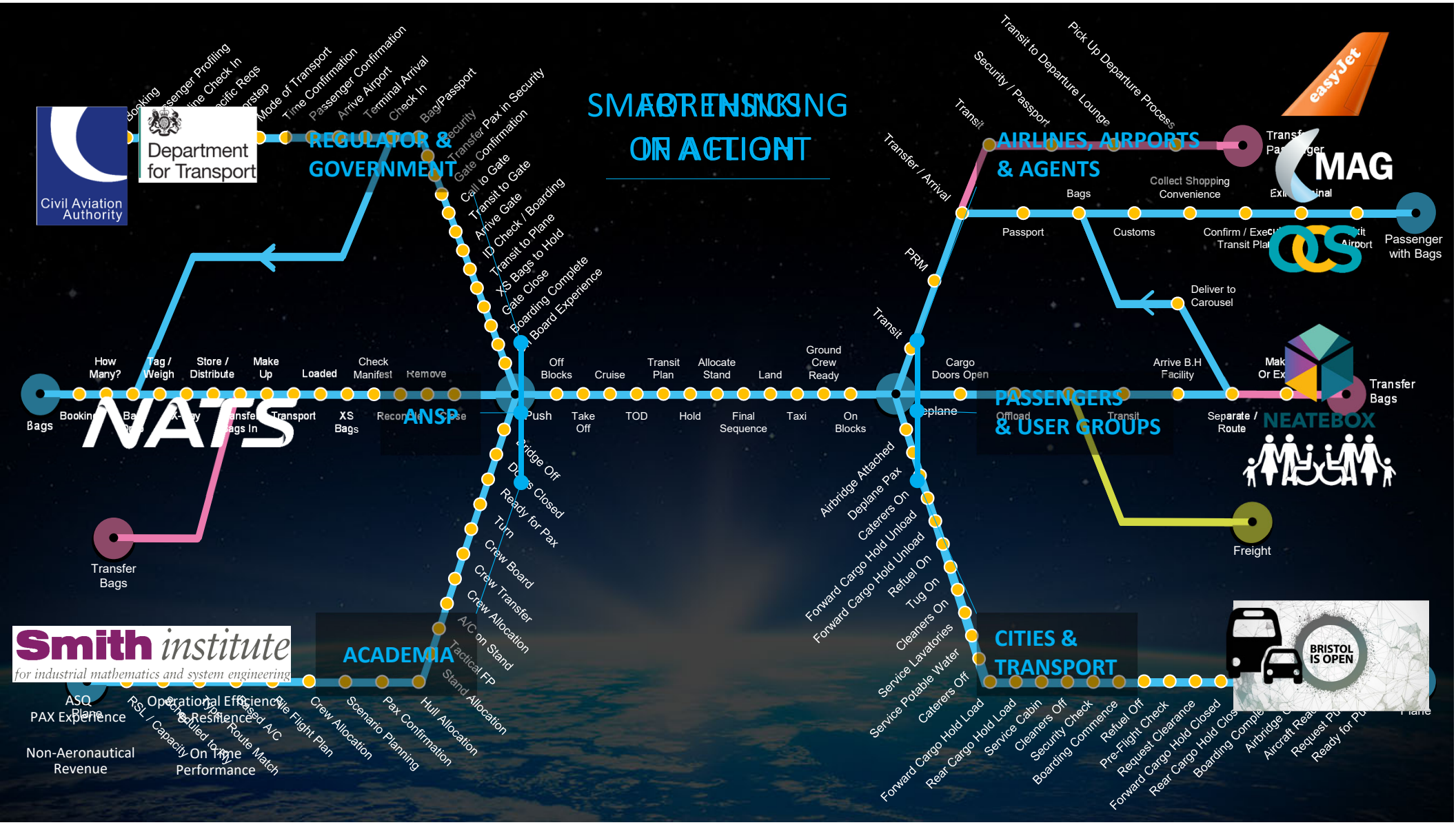
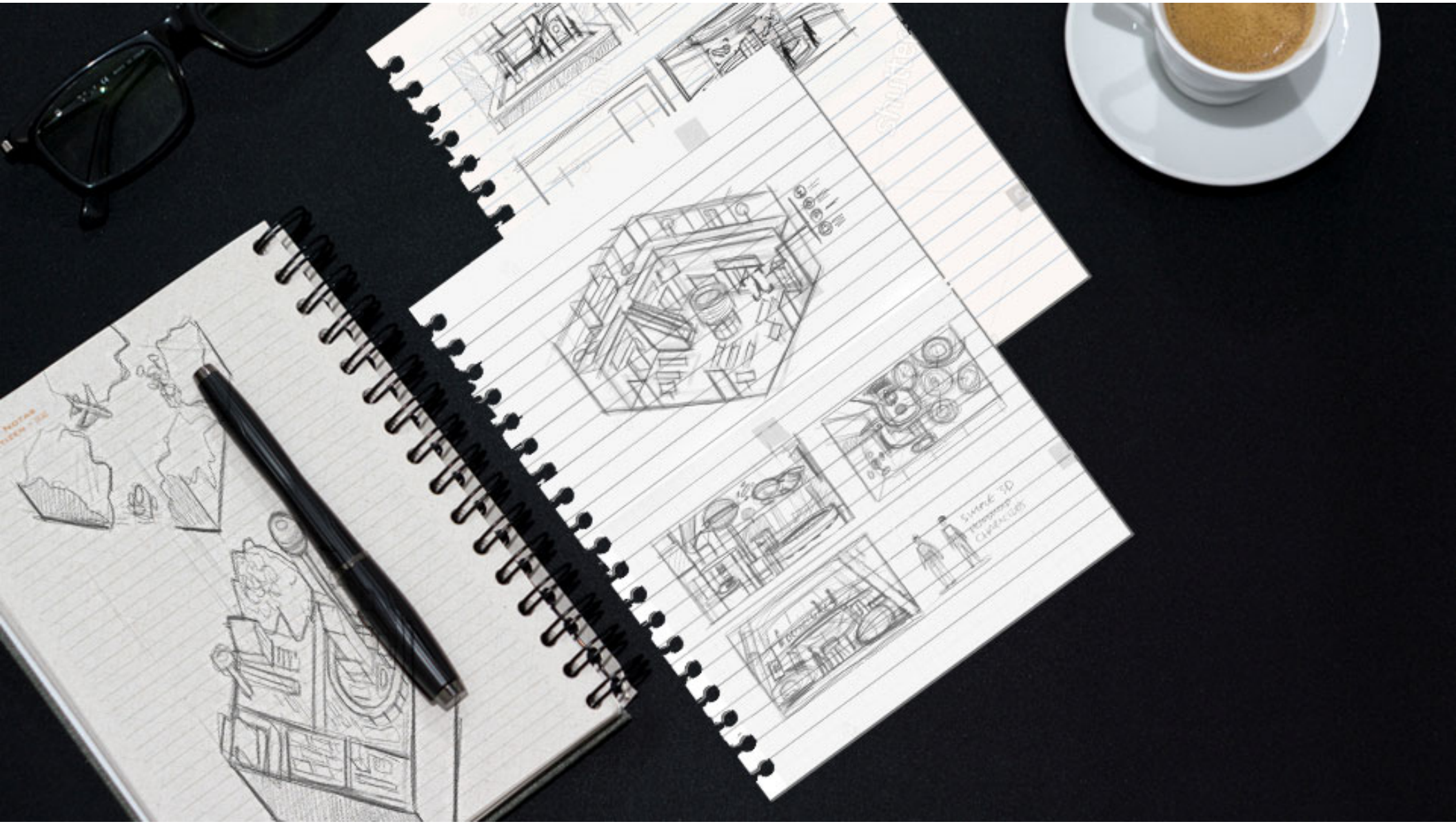







FORENSICS
OF A FLIGHT
Passenger with Bags
Booking
Passenger Profiling
Online Check In
Specific Reqs
Doorstep
Mode of Transport
Time Confirmation
Passenger Confirmation
Arrive Airport
Terminal Arrival
Check In
Bag/Passport
Security
Transfer Pax in Security
Gate Confirmation
Call to Gate
Transit to Gate
Arrive Gate
ID Check / Boarding
Transit to Plane
XS Bags to Hold
Gate Close
Boarding Complete
On Board Experience
Bags
How Many?
Tag / Weigh
Store / Distribute
Make Up
Loaded
Check Manifest
Remove
Booking
Bag Drop
X-Ray
Transfer Bags In
Transport
XS Bags
Reconcile
Close
Transfer Bags
Push
Off Blocks
Cruise
Transit Plan
Allocate Stand
Land
Ground Crew Ready
Take Off
TOD
Hold
Final Sequence
Taxi
On Blocks
Bridge Off
Doors Closed
Ready for Pax
Turn
Crew Board
Crew Transfer
Crew Allocation
A/C on Stand
Tactical FP
Stand Allocation
Hull Allocation
Pax Confirmation
Scenario Planning
Crew Allocation
File Flight Plan
Based A/C
Type / Route Match
Scheduled to Fly
RSL / Capacity
Plane
Transit
Security / Passport
Transit to Departure Lounge
Pick Up Departure Process
Transfer Passenger
Transfer / Arrival
PRM
Transit
Bags
Passport
Customs
Collect Shopping Convenience
Confirm / Execute Transit Plan
Exit Terminal
Exit Airport
Passenger with Bags
Deliver to Carousel
Deplane
Cargo Doors Open
Offload
Transit
Arrive B.H Facility
Separate / Route
Make Up Or Expedite
Transfer Bags
Freight
Airbridge Attached
Deplane Pax
Caterers On
Forward Cargo Hold Unload
Forward Cargo Hold Unload
Refuel On
Tug On
Cleaners On
Service Lavatories
Service Potable Water
Caterers Off
Forward Cargo Hold Load
Rear Cargo Hold Load
Service Cabin
Cleaners Off
Security Check
Boarding Commence
Refuel Off
Pre-Flight Check
Request Clearance
Forward Cargo Hold Closed
Rear Cargo Hold Closed
Boarding Complete
Airbridge Off
Aircraft Ready
Request Push
Ready for Push
Plane


SMART SOLVING
ON ACTION
REGULATOR & GOVERNMENT
Civil Aviation Authority
Department for Transport
AIRLINES, AIRPORTS & AGENTS
easyJet
MAG
PASSENGERS & USER GROUPS
NEATEBOX
NATS
ANSP
ACADEMIA
Smith institute
for industrial mathematics and system engineering
CITIES & TRANSPORT
BRISTOL IS OPEN
Booking
Passenger Profiling
Online Check In
Specific Reqs
Bag Drop
Mode of Transport
Time Confirmation
Passenger Confirmation
Arrive Airport
Terminal Arrival
Check In
Bag/Passport Security
Transfer Pax in Security
Gate Confirmation
Call to Gate
Transit to Gate
Arrive Gate
ID Check / Boarding
Transit to Plane
XS Bags to Hold
Gate Close
Boarding Complete
Board Experience
How Many?
Tag / Weigh
Store / Distribute
Make Up
Loaded
Check Manifest
Remove
Bags
Booking
Transfer Bags In
Transport
XS Bags
Off Blocks
Cruise
Transit Plan
Allocate Stand
Land
Ground Crew Ready
Push
Take Off
TOD
Hold
Final Sequence
Taxi
On Blocks
Bridge Off
Doors Closed
Ready for Pax
Turn
Crew Board
Crew Transfer
Crew Allocation
A/C on Stand
Tactical FP
Stand Allocation
Hull Allocation
Pax Confirmation
Scenario Planning
Crew Allocation
File Flight Plan
Route Match
Delayed A/C
Operational Efficiency & Resilience
Scheduled to Time
RSL / Capacity On Time Performance
ASQ
PAX Experience
Non-Aeronautical Revenue
Transfer Bags
Transfer / Arrival
Transit
Security / Passport
Transit to Departure Lounge
Pick Up Departure Process
PRM
Transit
Passport
Bags
Customs
Collect Shopping Convenience
Confirm / Execute Transit Plan
Exit Airport
Passenger with Bags
Deliver to Carousel
Freight
Transfer Bags
Arrive B.H Facility
Separate / Route
Cargo Doors Open
Offload
Transit
Deplane
Airbridge Attached
Deplane Pax
Caterers On
Forward Cargo Hold Unload
Forward Cargo Hold Unload
Refuel On
Tug On
Cleaners On
Service Lavatories
Service Potable Water
Caterers Off
Forward Cargo Hold Load
Rear Cargo Hold Load
Service Cabin
Cleaners Off
Security Check
Boarding Commence
Refuel Off
Pre-Flight Check
Request Clearance
Forward Cargo Hold Closed
Rear Cargo Hold Closed
Boarding Complete
Airbridge
Aircraft Ready
Request Pu
Ready for Pu
Plane



SMART SUMMARY

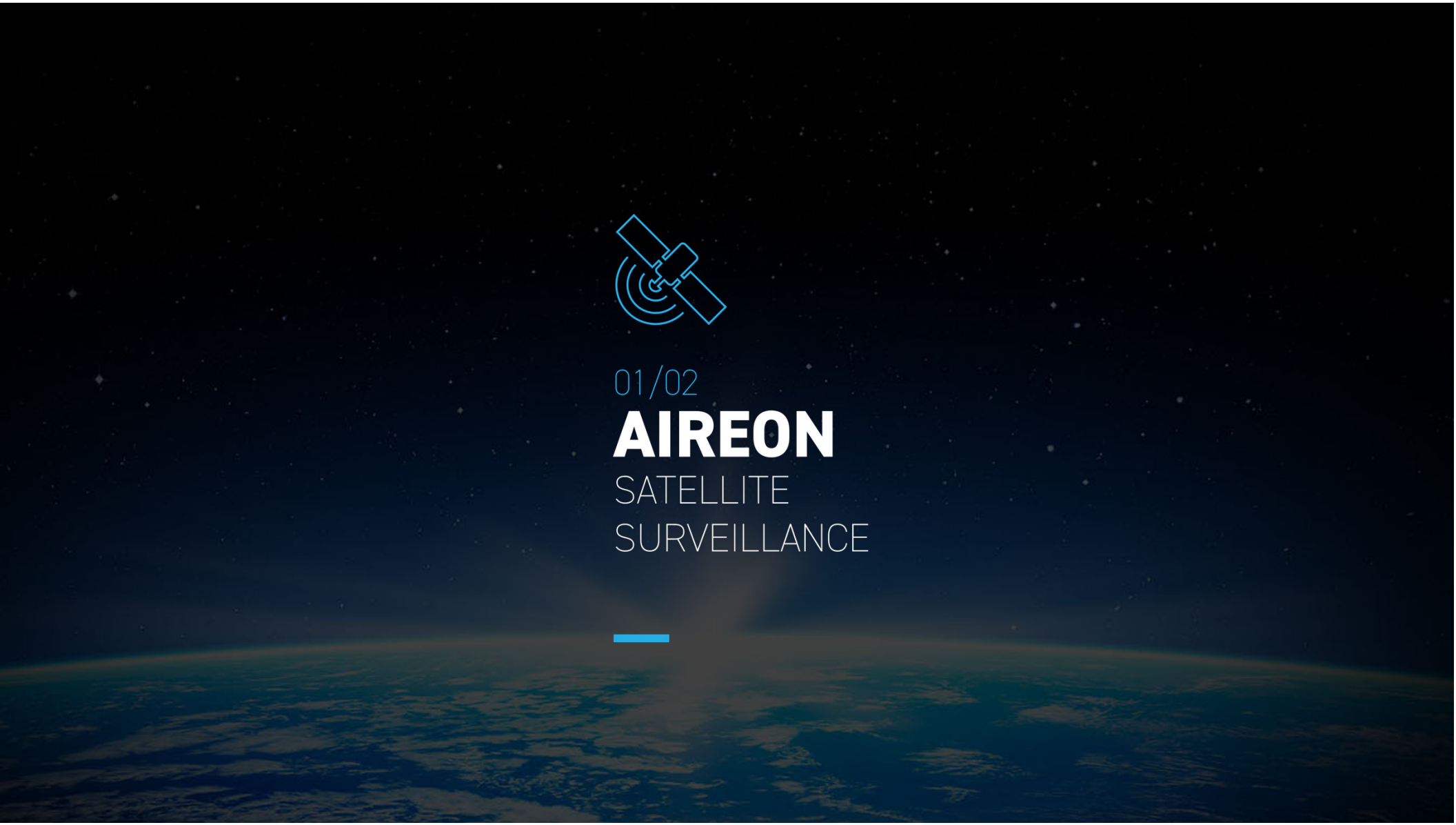
ON TIME PERFORMANCE
Passengers, Bag and Planes – together, to schedule!

NON-AERO REVENUE
Airports are huge retail and car parking business

EFFICIENCY & RESILIENCE
Streamlined operations with rapid recovery from disruption

PAX EXPERIENCE
Happy passengers spend more money – fact!

CONNECTED COMMUNITY
Airport, Airlines, ATC and Cities - working together for a seamless travel experience


01/02
AIREON
SATELLITE
SURVEILLANCE

01/02

AIREON

SATELLITE SURVEILLANCE

SEEING FURTHER

- $69m investment in disruptive technology
- Combination of LEO & Airborne positioning & prediction will prevail
- Industrial Maths and Intelligent Systems will drive new possibilities in Flight and Network Optimisation
- Emergence of global, on-demand Trajectory Services from new players
- Builds on Free Route, Business User Trajectories

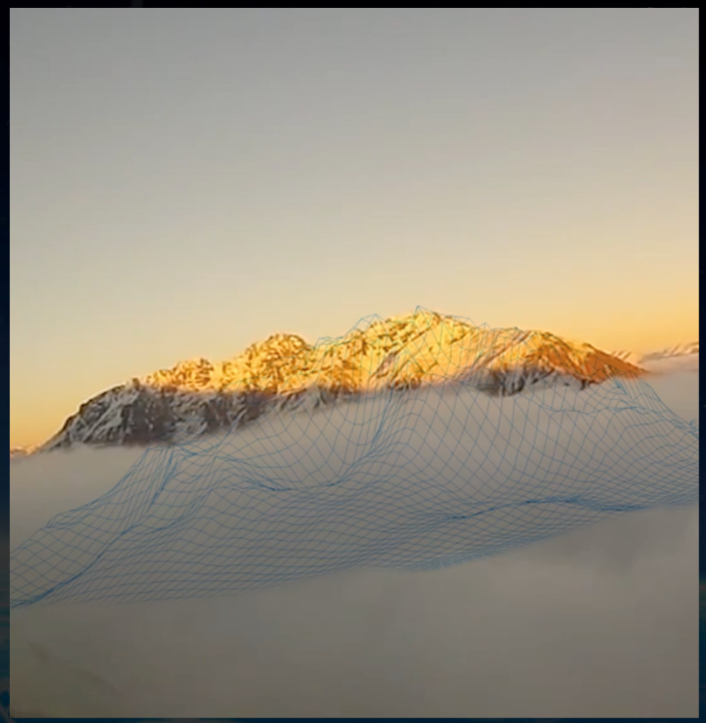
01/02

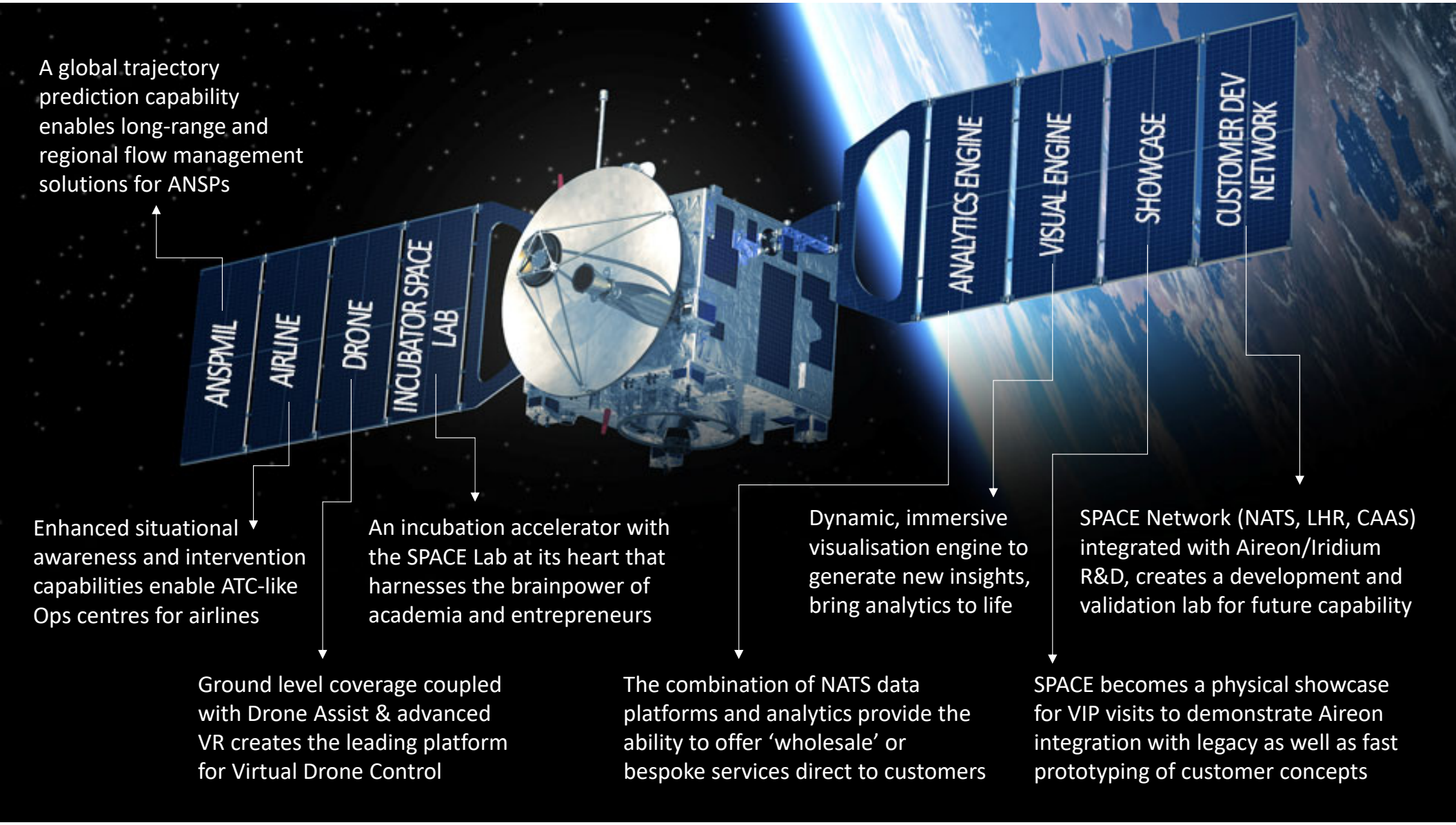
AIREON

SATELLITE SURVEILLANCE

SEEING FURTHER

- Add in Self Separation, RNP-AR and TMA Systemisation
- Greater ability for airlines to demand lower costs, and develop assured separation capabilities in Airline Ops
- As we assure Aireon coverage to ground -and for drones- and with automated airspace design and digital towers…
- The 70yr old system has just changed…better get thinking!




A global trajectory prediction capability enables long-range and regional flow management solutions for ANSPs
ANSP/MIL
AIRLINE
DRONE
INCUBATOR SPACE LAB
ANALYTICS ENGINE
VISUAL ENGINE
SHOWCASE
CUSTOMER DEV NETWORK
Enhanced situational awareness and intervention capabilities enable ATC-like Ops centres for airlines
An incubation accelerator with the SPACE Lab at its heart that harnesses the brainpower of academia and entrepreneurs
Dynamic, immersive visualisation engine to generate new insights, bring analytics to life
SPACE Network (NATS, LHR, CAAS) integrated with Aireon/Iridium R&D, creates a development and validation lab for future capability
Ground level coverage coupled with Drone Assist & advanced VR creates the leading platform for Virtual Drone Control
The combination of NATS data platforms and analytics provide the ability to offer 'wholesale' or bespoke services direct to customers
SPACE becomes a physical showcase for VIP visits to demonstrate Aireon integration with legacy as well as fast prototyping of customer concepts

01/03

URBAN TRAFFIC

DRONES AND MOBILITY

01/03

URBAN TRAFFIC

DRONES AND MOBILITY

DRONE SAFE
dronesafe.uk

NATS

UNIFIED TRAFFIC MANAGEMENT (UTM)

- Already flown/proven (Military) Drones in controlled airspace
- Issued Operating Guidance with CAA to advance awareness across the UK for commercial and leisure users
- Deliver accredited commercial Pilot training
- Have launched an App to manage registration, and build a data platform
- Now demonstrating BVLOS for Medical, Emergency, Security, Construction and Community in 5 major UK cities
- Conducting Industry Demonstration event at Manchester Airport
- Establishing UK-wide, integrated approach to Unified Traffic Management
- This is a commercial space to play in the UK; NATS has no right to the licence!

01/03

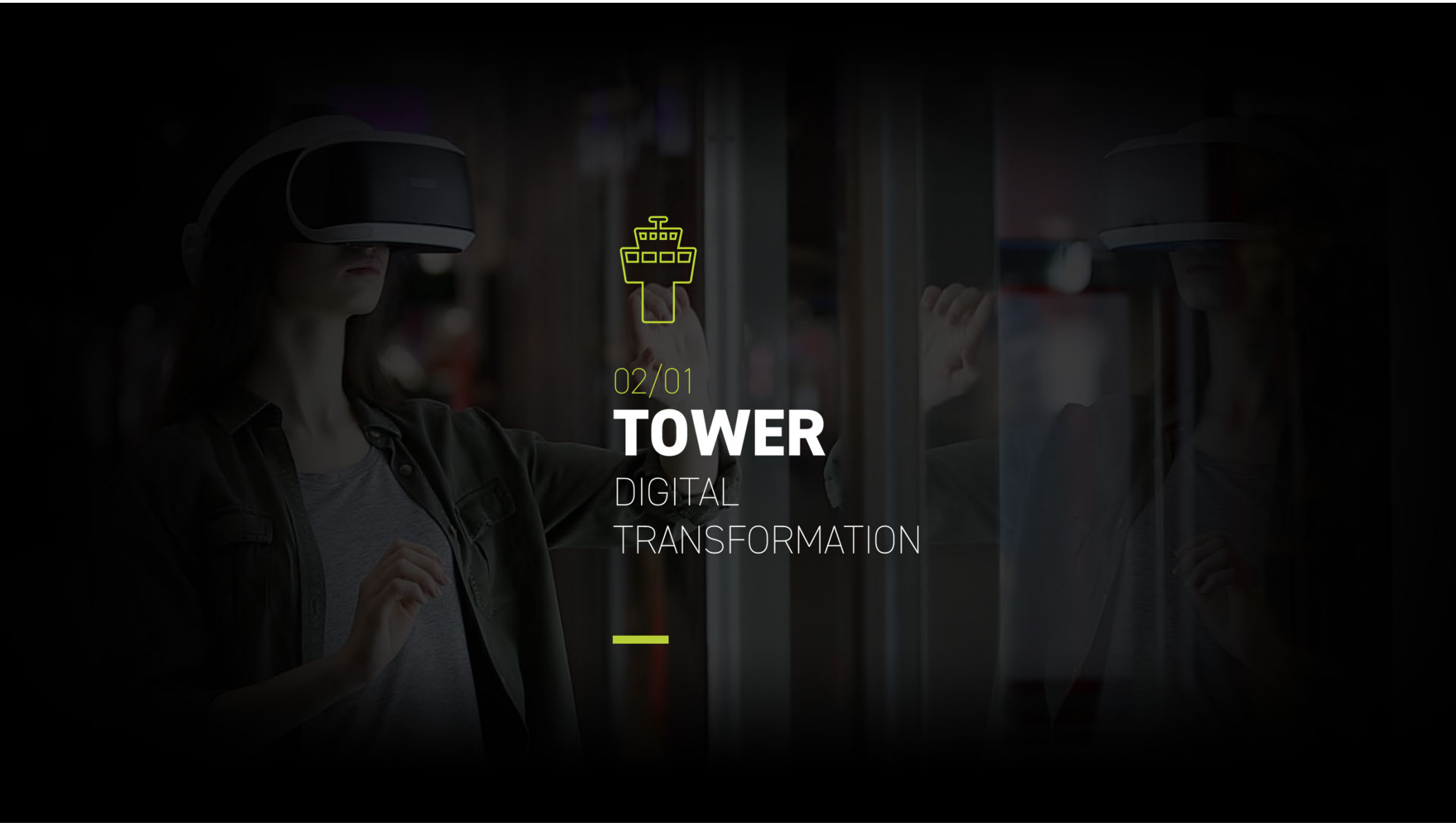
URBAN TRAFFIC

DRONES AND MOBILITY

URBAN AIR MOBILITY (UAM)

- Newer focus on Urban Mobility, Electric Engines, Personal Air Vehicles and Taxis
- And how to evolve our system thinking to stay in control
- Some Cities want to ‘control’ their own airspace in the future as part of an extended connected transport network
- We must always have a bigger picture, a smarter way of decongesting and deconflicting
- And better ways of delivering value for corporates and citizens
- Or the combined challenge of evolving airborne and urban technology
- And new player capability…
- Could signal the start of the end of traditional air traffic control!


02 DIGITAL



02/01

TOWER

DIGITAL
TRANSFORMATION

02/01

TOWER

DIGITAL TRANSFORMATION

DAWN OF A NEW ERA IN TOWERS

- Roadmap will quickly deploy new thinking based on Computer Vision
- But will quickly drive towards assured executive control for routine ops
- Our digital tower lab network will accelerate new dev and validation
- Creating ability to reduce workload, costs and evolve tower ATCO roles

Today's Tasks

AUGMENT

Ultra HD VCR
Enhanced situational awareness through application of computer vision and analytics

AGGREGATE

Smart Tower
Smart Tower with fully connected airside-landside Operation; replaces 50% of Tower OR/Workload

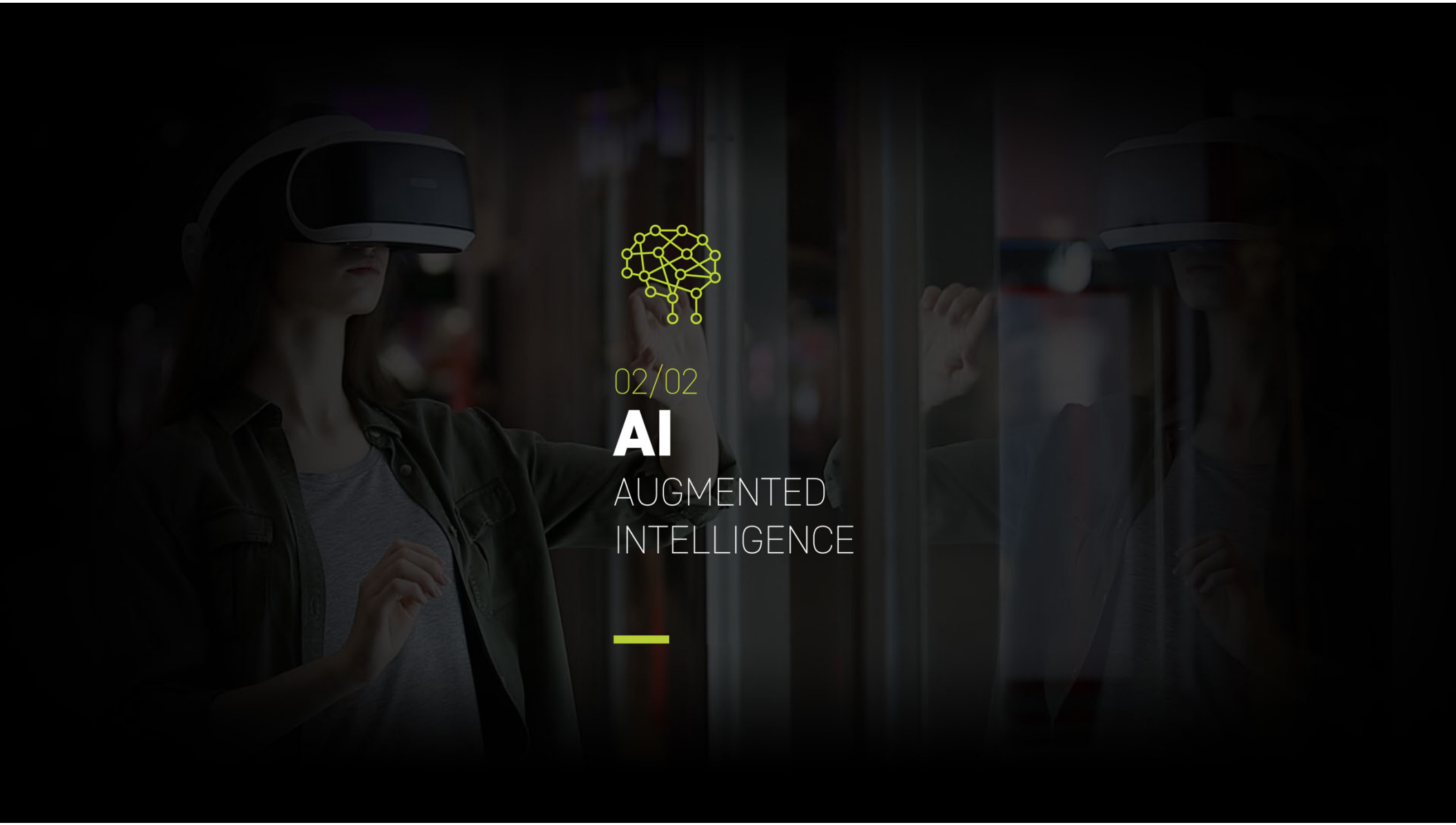
ASSIST

Executive Assistant
Executive 'Digital' Assistant replaces 75% of Tower OR/Workload, and performs ATC for all routine Ops

AUTOMATE

Auto Tower
A Strategist/Orchestrator oversees Autonomous Control of Airside Ops; 90% of OR/Workload replaced

New Tasks


02/02
AI
AUGMENTED
INTELLIGENCE

02/02

AI

AUGMENTED INTELLIGENCE

AI – ASSURING THE THINKING MACHINE

> “Classical decision theory in a modern-day machine learning environment, with applied mathematics and optimisation theory”

BIG CHALLENGE: Making the safety case for executive control

STEPS

- Design an ATCO Agent
- Input the NATS college curriculum
- Train it in the AI Lab using our game data
- Inject human-centred design and values
- Assess it as you would a typical NATS Trainee
- Evidence and assure its behaviours

KEY COMPONENTS OF THE EXPERIMENT

We are going to train an AI agent in our LAB to separate aircraft and assess and score it as we would a current trainee

THE COLLABORATION
UK Centre of Excellence for AI with world class track record

THE AI LABORATORY
Delivering a new research platform, customisable to the AI experiment

GLOBAL COLLABORATION
A 14 month engagement convening worldwide experts in AI

THE AI ATCO
Training an agent to make good decisions

CONTINUATION
Where we go next and the new opportunities we will have

THE AI ATCO

SENSING

Computer Vision

Using cameras to find the objects and actions of interest at the airfield
Has tremendous value as a standalone capability e.g. blind spot alerts, drone detection, debris spotter, push-back, wheels-up, runway incursion…
Other sensors are radar, ADS-B and in the future, biometrics.

Sensor Fusion

Merge the data from the sensors to build a total picture of the airport, the airspace the ops room

MODELS OF THE REAL WORLD

Logical and Analytical

Driverless cars have already created models for objects: cyclists, cars, buses etc. We need to build models for objects in our system, e.g. aircraft, tugs, Driverless cars already understand actions: a cyclists arm being extended = turn. We need to build model that understand significant events e.g. manoeuvre start
Better model = better decisions, better decision means more automation

THINKING AND ACTING

Localisation and Path Planning

Where we are relative to other objects, and their intent

Acting

Choosing the right tasks to automate for the ATCO and executing.

Decision Making

Classical Decision Theory with uncertainty.
We are coordinating multiple objects so special treatment of decision theory is required. What is optimal for the aircraft, for the ATCO, for the system?

THE AI LABORATORY

TRAINING DATA

EXAM DATA

HEATHROW FOR ATCO TRAINEES WEEK 0 - 4

TRAINEE AGENT ASSESSMENT
AI ASSESSMENT TRAINING PERFORMANCE

ACADEMIC NETWORK

THE PROPOSAL ARC

We can monitor the AI field or we can activate our approach to design and train an AI ATCO

02/03

MIXED REALITY

GOING BEYOND GAMING

02/03

MIXED REALITY

GOING BEYOND GAMING

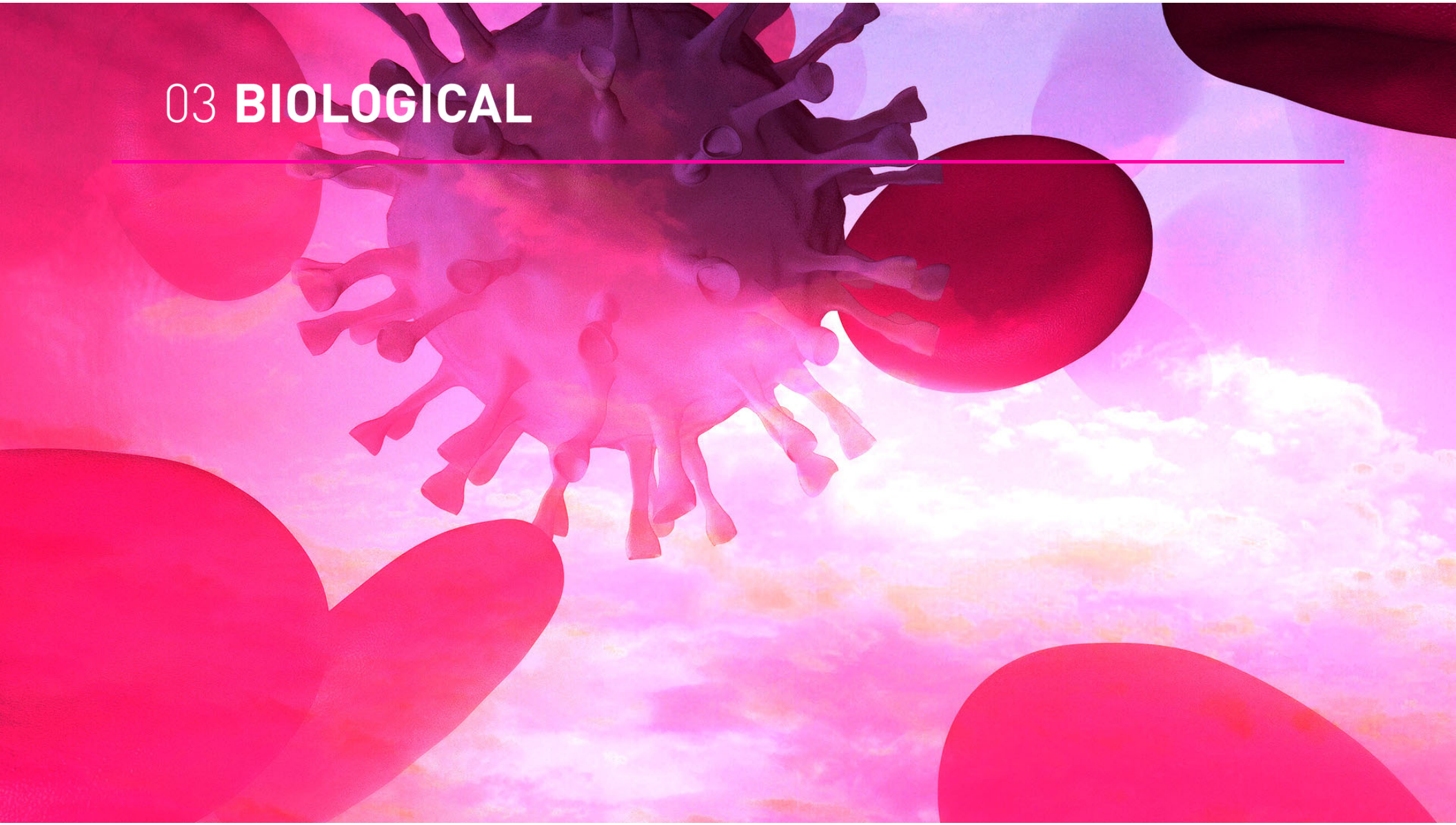
AUGMENTED AND VIRTUAL – OUR REALITY

Can we take this beyond a cool way to train or engage users and customers..?

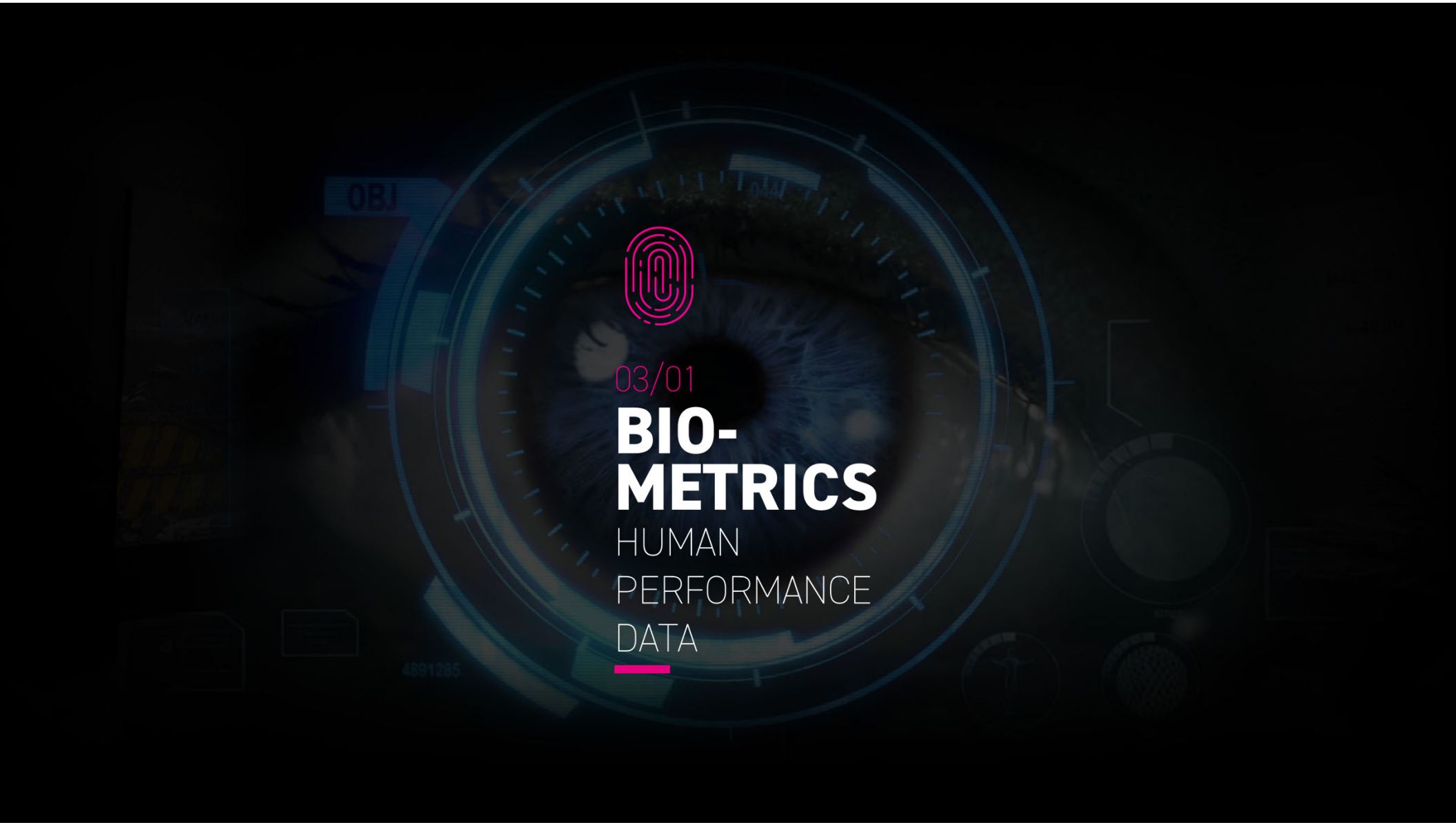
What will be the application of immersive technology in our future system..?

Will consumer demand for new experiences change how we need to think about travel..?

- Built a multi-user Outer-SPACE VR lab for global collaboration
- Built an AR Heathrow
- Built a VR City for Smart City Ops Room applications, eg, traffic, crowd and disruption management
- Looking at more real time, and interactive visual analytics applications as part of a value platform…
- To find where, and if, we can deploy it to augment human intelligence



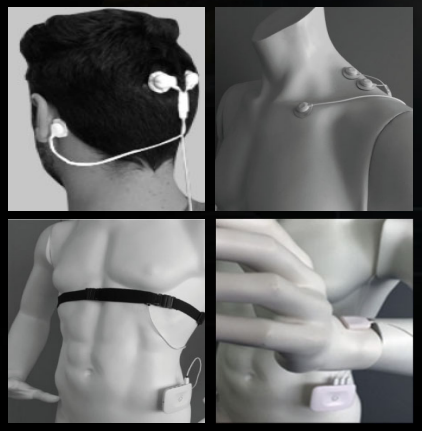
03 BIOLOGICAL


03/01
BIO-
METRICS
HUMAN
PERFORMANCE
DATA

03/01

BIO-METRICS

HUMAN PERFORMANCE DATA



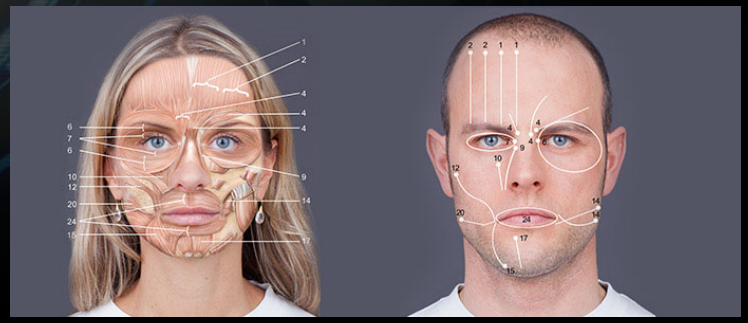
HUMAN PERFORMANCE - BIOMETRICS

GOAL 1: Establish the scientific correlation between biometric data and human performance

GOAL 2: Understand and manage real time fatigue and workload

GOAL 3: Evidence the case for assured automation

- Conducted live operational trials
- Run hackathons on data
- Focus now on two main areas to develop fast algorithms for video based applications
- Essential we have a human data thread for AI deep learning
- To get the right balance and assurance in our thinking systems of the future.



SYSTEMS THINKING. SYSTEMS LEADERSHIP

- 4th. Industrial Revolution could catalyse a new cultural renaissance and create a truly global society
- But has potential to robotize humanity, and challenge our traditional sources of value – Work, Community, Family, Identity
- It presents a great challenge of externalities and unintended consequences, and uncertainty of long term impacts on complex social and environmental systems
- Have to think Systems not Technologies – systems that deliver well-being
- Design Systems to give people more choice, opportunity, freedom and control over their lives
- Employ human-centred design alongside System Thinking to encode technologies with societal values
- It's Systems Leadership -Governments, Businesses and You-that will shape and protect a more inclusive, sustainable, and prosperous world
- Be alive to the opportunity!


NATS

NATS

Making Moving Marvellous

THANK YOU