Aviation
A Journey to 2050

31st Congress of the
International Council of the Aeronautical Sciences

Charles Champion
Belo Horizonte, September 2018

Aviation in figures

3.6billion
Passengers

51.2million
Tonnes of freight

$2.7trillion
Global GDP* annually

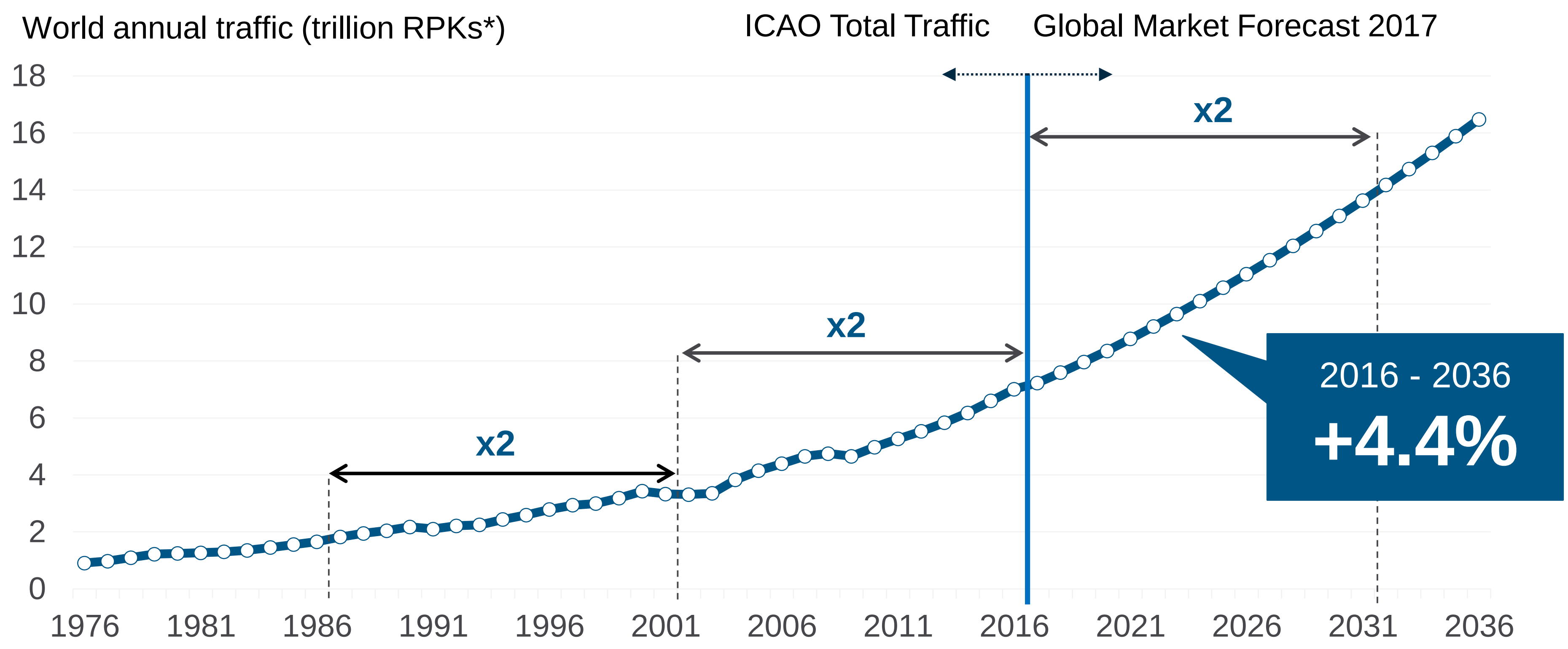
62.7million
Jobs supported

Source: ATAG 2016

***GDP:** Gross Domestic Product


AVIATION
CHALLENGES
A JOURNEY
To 2050

Air Traffic will Double in the Next 15 Years



*RPK: Revenue Passenger Kilometres

Air Transport is a Growth Market

60% over the **last 10 years**

More than double since **2001**

Source: ICAO, Airbus GMF 2017

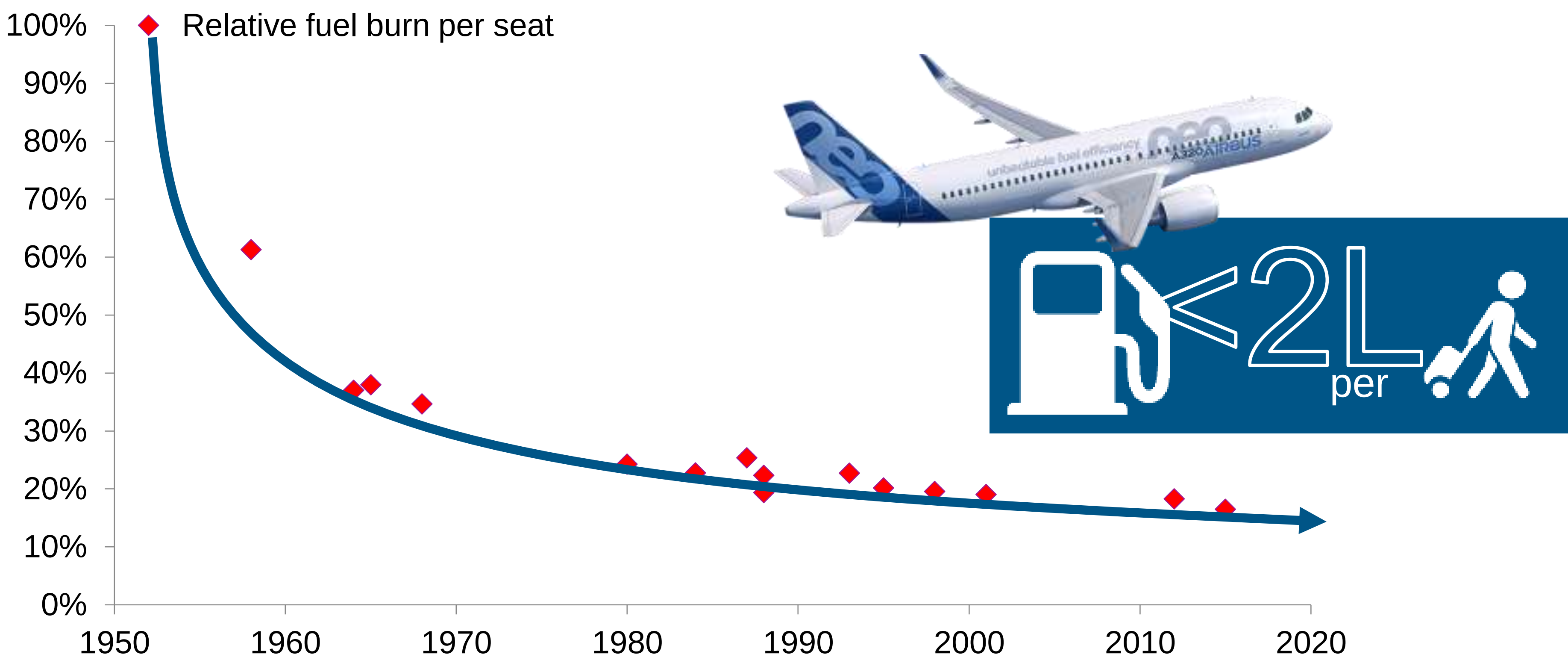
The Challenge for Aviation: Sustainable Growth

European Union's Flightpath 2050

-75%	-90%	-65%
CO_2	NO_x	Noise

Reference year: 2000

History of a Continuous Fuel Burn Reduction



80%

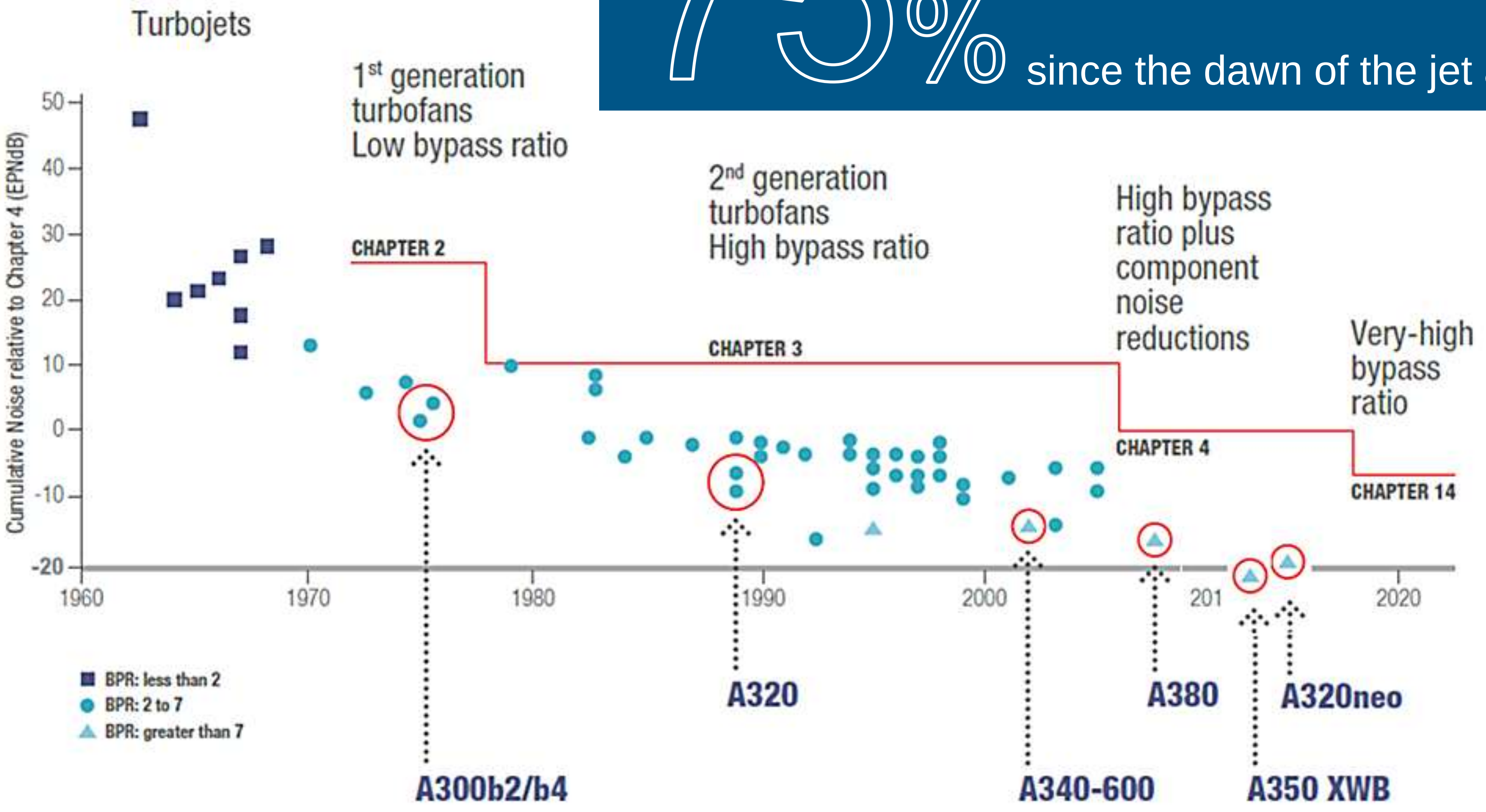
Fuel Burn & CO_2 Reduction

per seat

since the dawn of the jet age

History of a Continuous Noise Reduction

75% Noise Reduction since the dawn of the jet age



Aviation Challenges

Sustainable growth &
traffic doubling every 15 years

Commitment to the Flightpath 2050
technology targets

Safety & Security

This is what is expected from YOU !


AVIATION
CHALLENGES
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The Eco-Efficiency & Performance Levers

Challenges related to Aircraft lifecycles

- Software cycle: **6 to 12 months**

- Hardware cycle: **3 to 5 years**

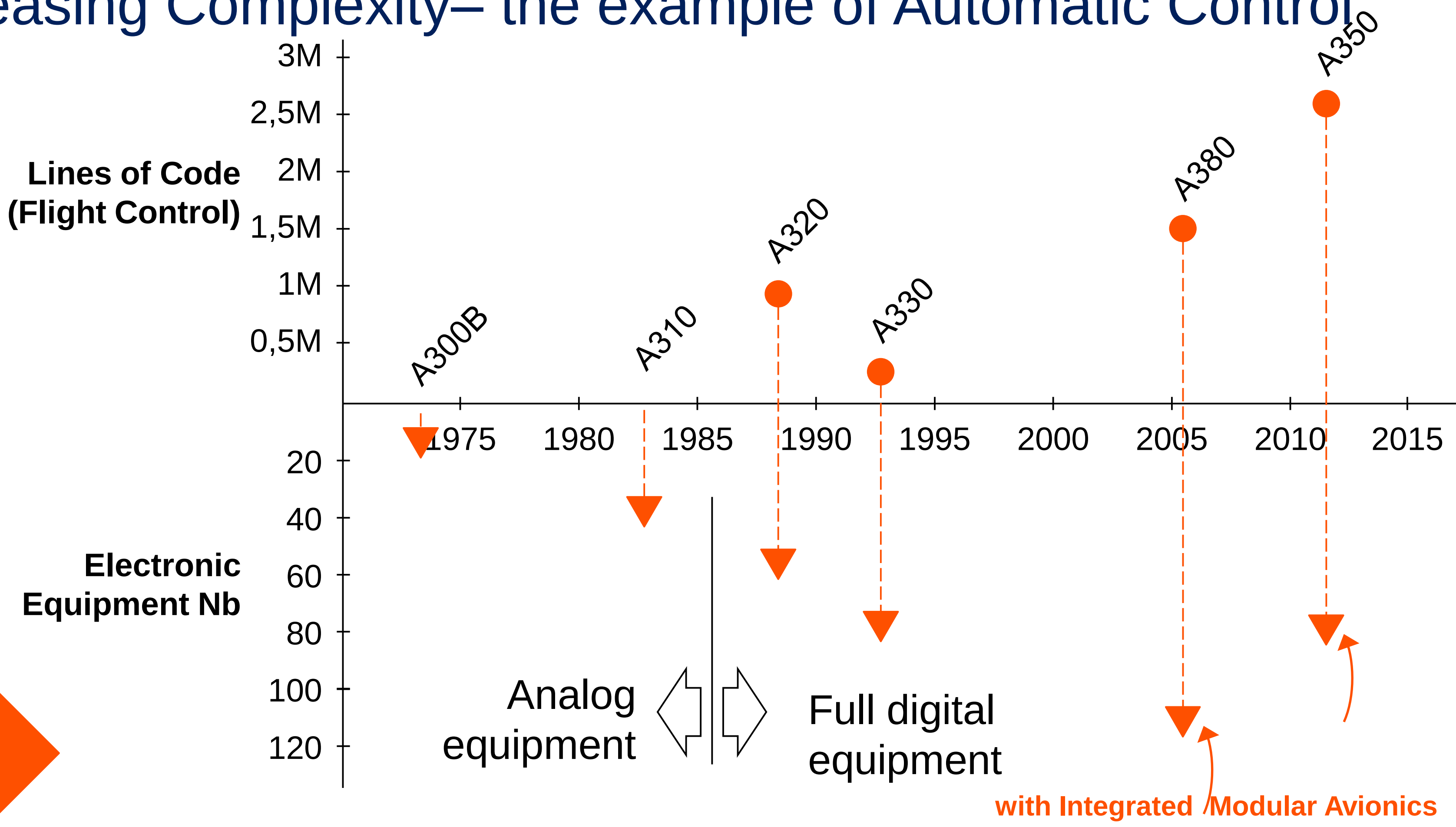
- A/C upgrades: **6 to 15 years**

- A/C production: **30 to 50 years**

32 years ago the A320 first Fly By Wire airliner still alive and kicking!

32 years from now…2050!

Challenges related to Increasing Complexity– the example of Automatic Control



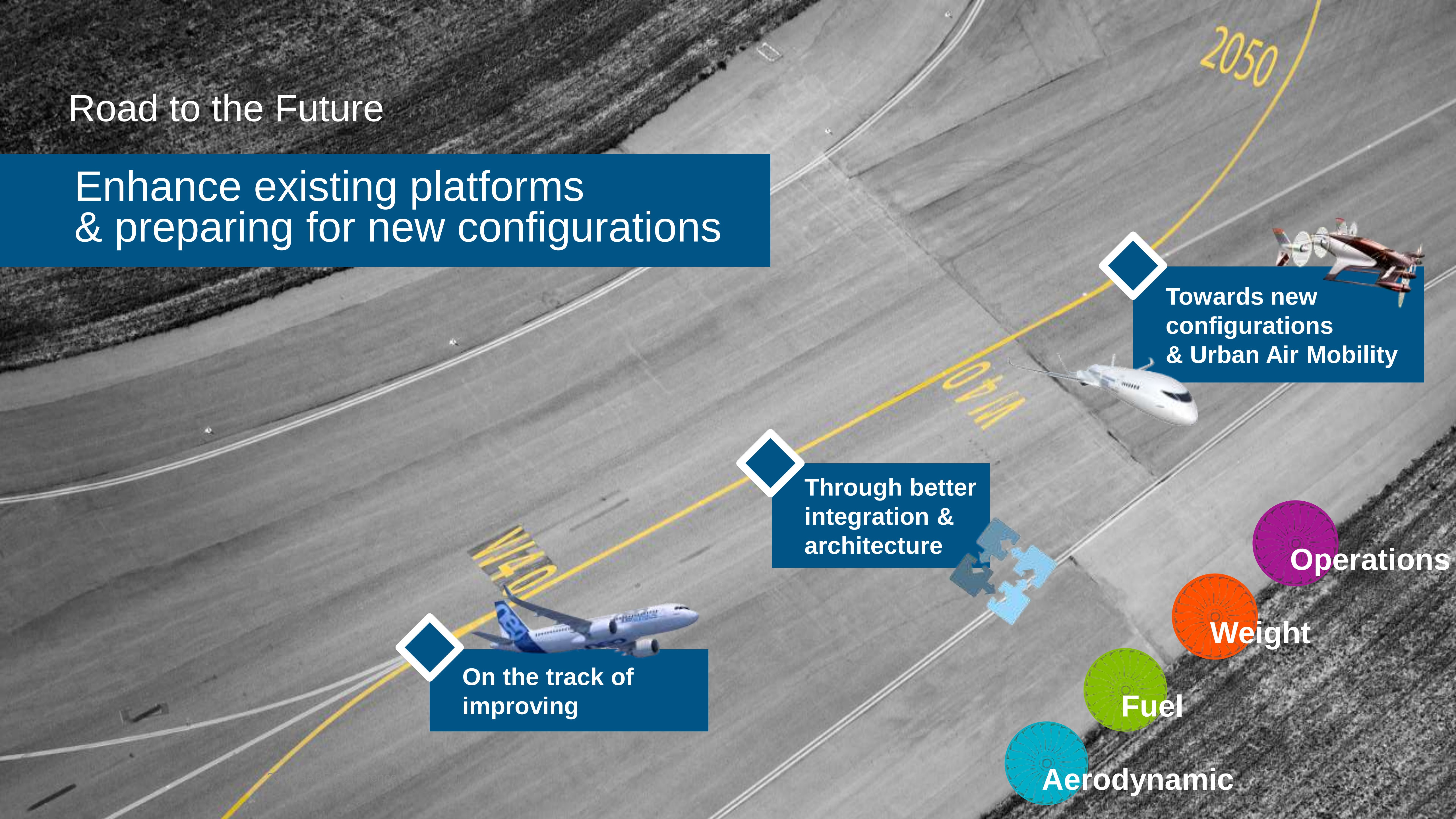
Managing Complexity needs a Paradigm Shift :

Architecture, Agile Methods, Artificial Intelligence…

and Certification rules

Road to the Future

Enhance existing platforms & preparing for new configurations

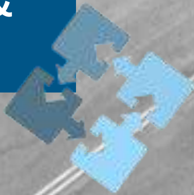


Road to the Future

Enhance existing platforms & preparing for new configurations

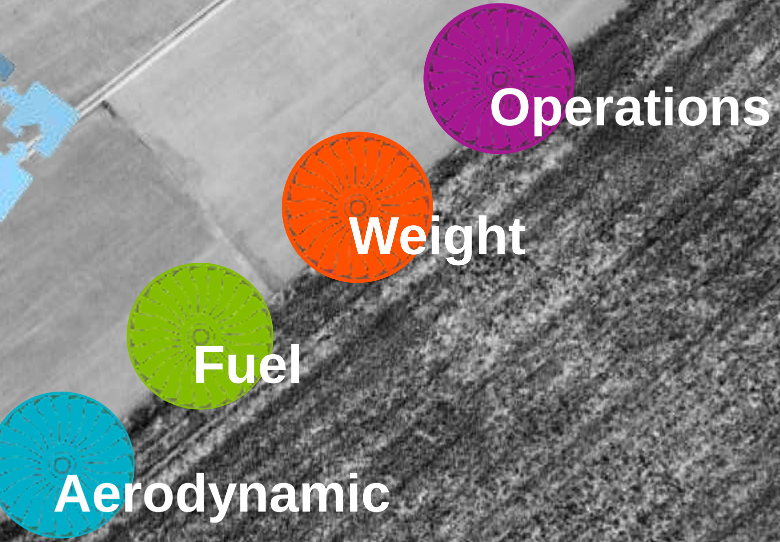
- New Engines on existing products
- Advanced composites
- Additive Layer Manufacturing
- Systems for Safety
- Predictive maintenance

On the track of improving



Through better integration & architecture

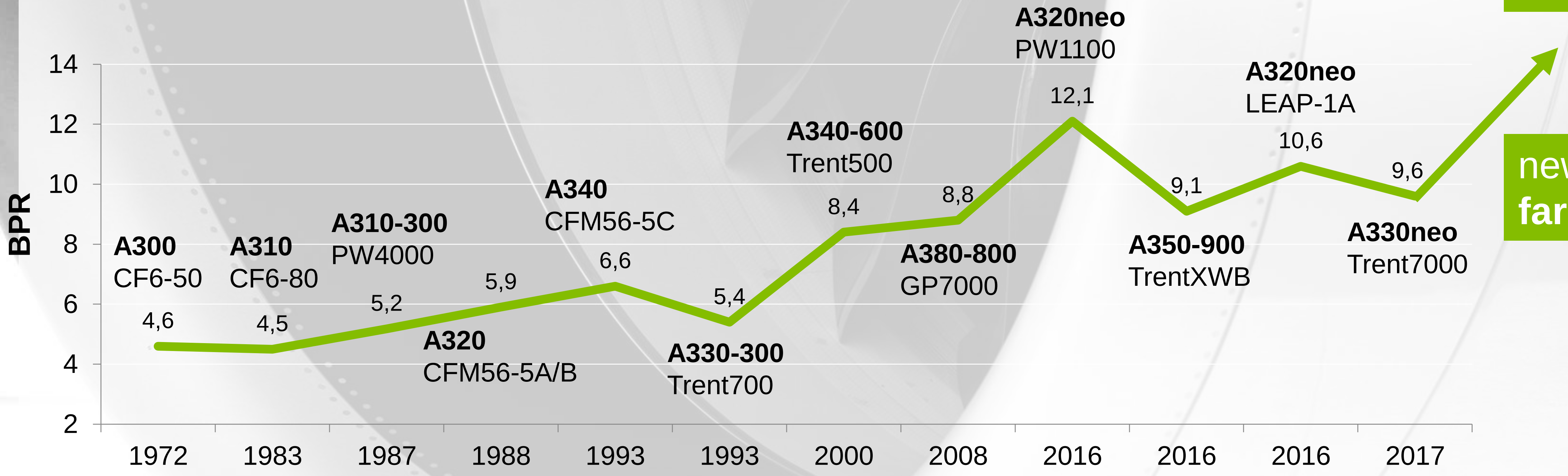
Towards new configurations & Urban Air Mobility



Fuel

New engines on existing products

Benefits from the continuous technology progress allow engine configuration changes
Improving aircraft platform capabilities



R&D target
BPR > 15

&

new technos
far beyond

BPR: Bypass ratio

Constantly enhance performance of our flying platforms
Build future & disruptive technologies

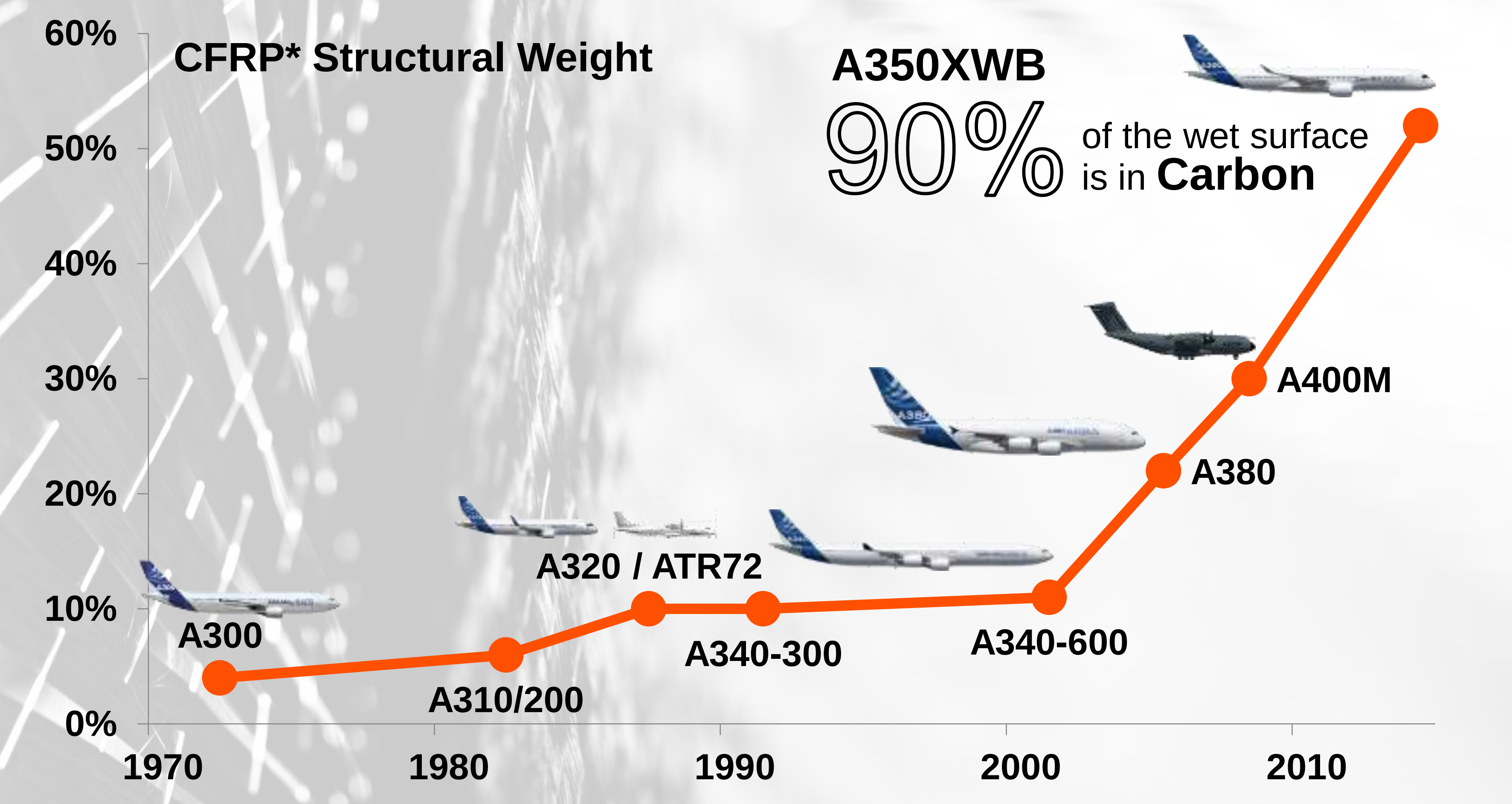

Success
The neo story
Aircraft changes mainly contained at engine level
-20%
fuel burn per seat
A320, a commercial success!
60%
NEO market share
13,000
orders from 300 customers
A321
high demand
-50%
Noise & NOx emissions
source AIRBUS

Weight

Advanced Composites

Lighter & **Stronger** by Design

Maximise **weight reduction** & **fuel efficiency**



*CFRP: Carbon Fiber Reinforced Polymere

Weight

Design for Additive Layer Manufacturing

3D-printing: a strong asset for the future

only 5% waste material

up to 50% potential weight saving

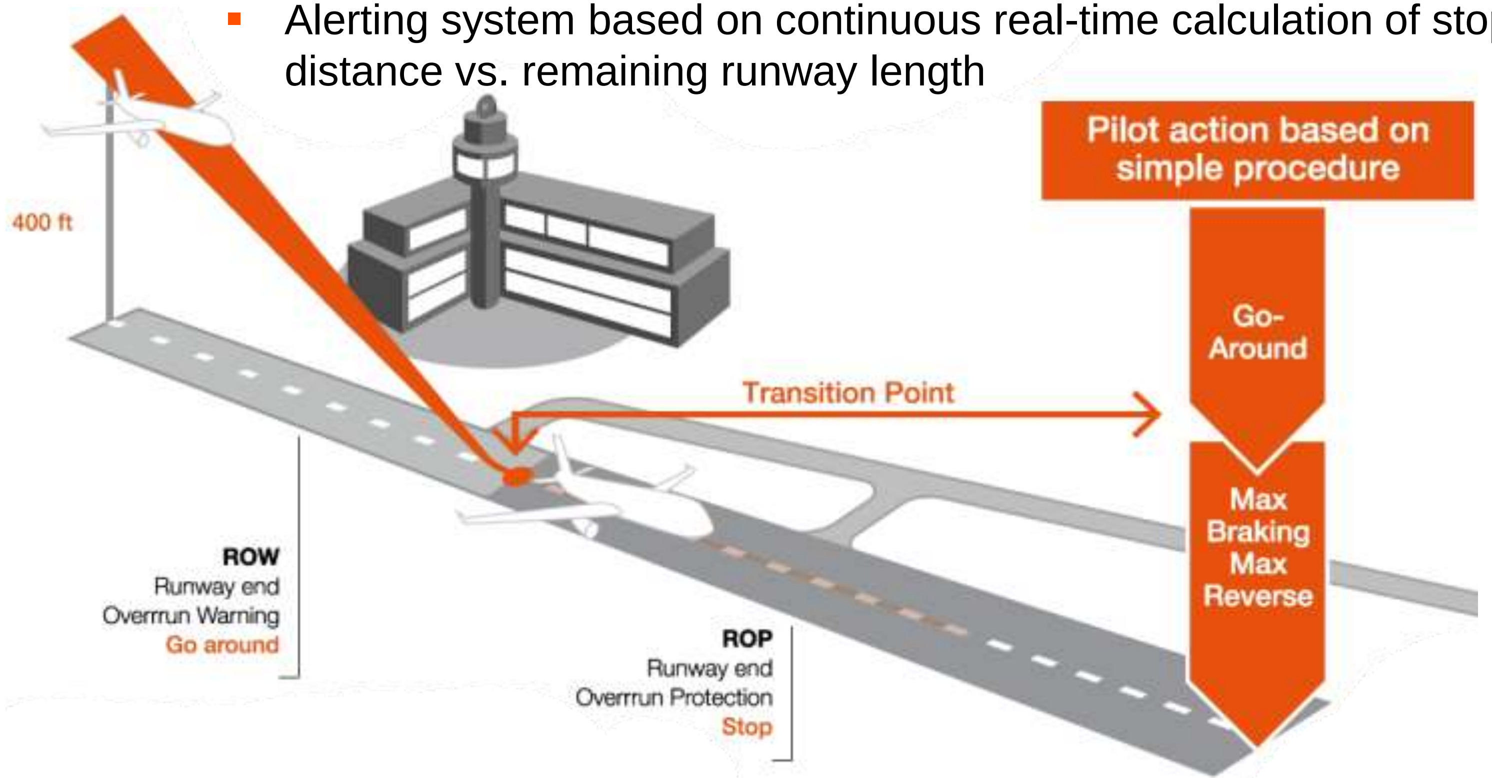
Safety – the Runway Overrun Protection System as an example

Enhance Safety

by preventing runway overrun at landing

Principle

- Alerting system based on continuous real-time calculation of stopping distance vs. remaining runway length



Operations

Predictive Maintenance

skywise

An Open Digital platform for the aviation industry

Give prior indication of a component/system failure

Thanks to systematic transmission of massive data & data analytics

Allow anticipation & planning of the maintenance

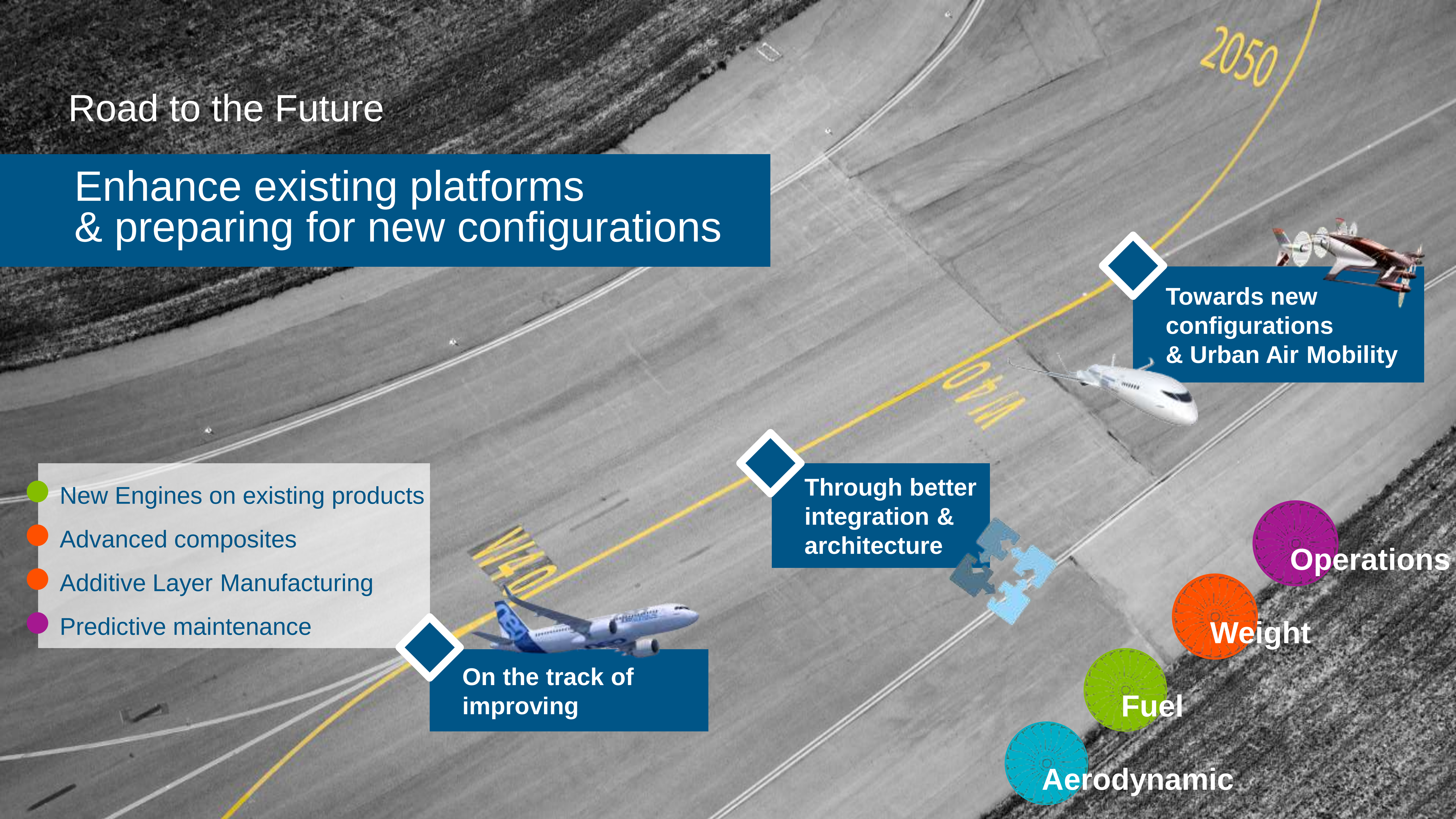
Prevent unexpected failures & operational interruptions

PERFORMANCE

RELIABILITY

SYSTEM INTEGRITY

source AIRBUS



Road to the Future

Enhance existing platforms & preparing for new configurations

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- Predictive maintenance

On the track of improving

Through better integration & architecture

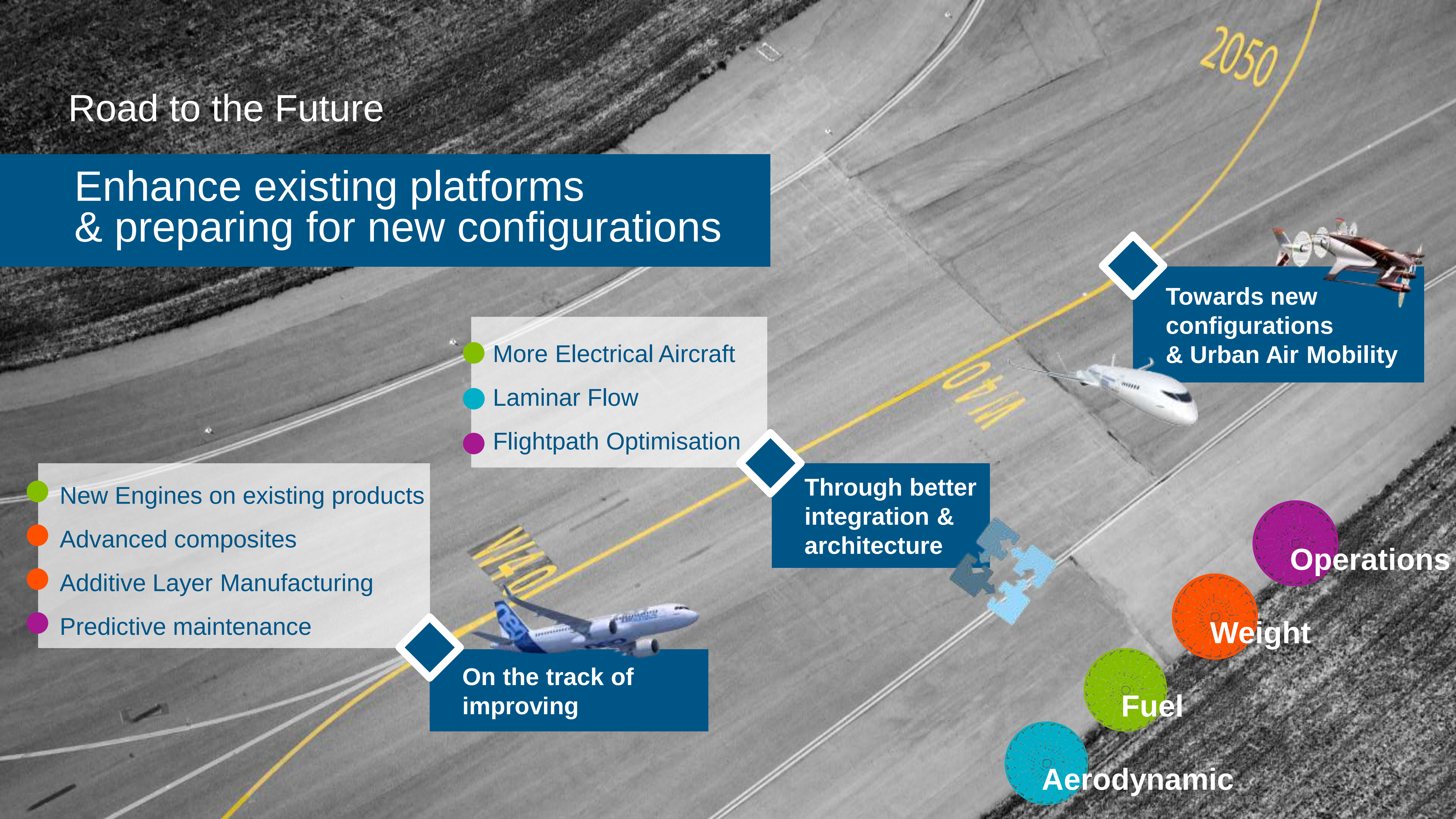
Towards new configurations & Urban Air Mobility

Operations

Weight

Fuel

Aerodynamic



Road to the Future
Enhance existing platforms
& preparing for new configurations
More Electrical Aircraft
Laminar Flow
Flightpath Optimisation
New Engines on existing products
Advanced composites
Additive Layer Manufacturing
Predictive maintenance
On the track of improving
Through better integration & architecture
Towards new configurations & Urban Air Mobility
2050
Operations
Weight
Fuel
Aerodynamic

Energy

More Electrical Aircraft

Electrical technologies have to be further explored

Move from technology bricks development

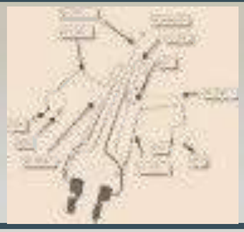
to aircraft architecture & integration

Architecture & Integration challenges

E-ECS

Propulsion Offtake & Starting

Ice Protection



Electrical Network

E-ECS: Electrical - Environmental Cabin System

Aerodynamic

Breakthrough Laminar Aircraft Demonstrator in Europe (BLADE)

Minimised drag with **laminar flow**

-5% fuel burn expected

2014 – 2015
Wind tunnel tests
Laminar wing & Krueger flap demonstrator

2016
First aircraft parts

2017
Flight tests on Airbus A340

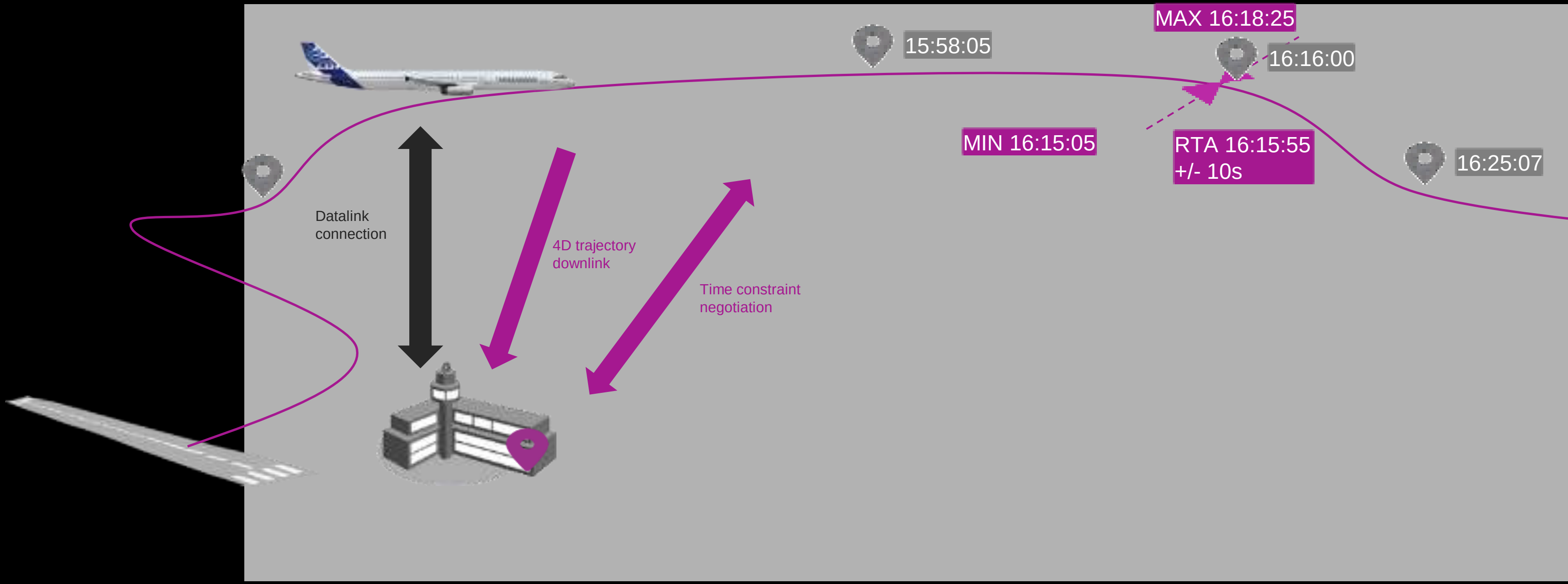
A Cleansky program

Optimized Operations: 4D trajectory exchange

Enhance ground trajectory prediction

Solve conflicting trajectories upfront

& Reduce traffic congestion



Road to the Future

Enhance existing platforms & preparing for new configurations

On the track of improving

- New Engines on existing products
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Through better integration & architecture

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Towards new configurations & Urban Air Mobility

2050

Operations

Weight

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Towards new configurations & Urban Air Mobility

- Boundary Layer Ingestion
- Open Rotor
- Distributed propulsion
- Hybrid propulsion
- Formation Flight

2050

Operations

Weight

Fuel

Aerodynamic

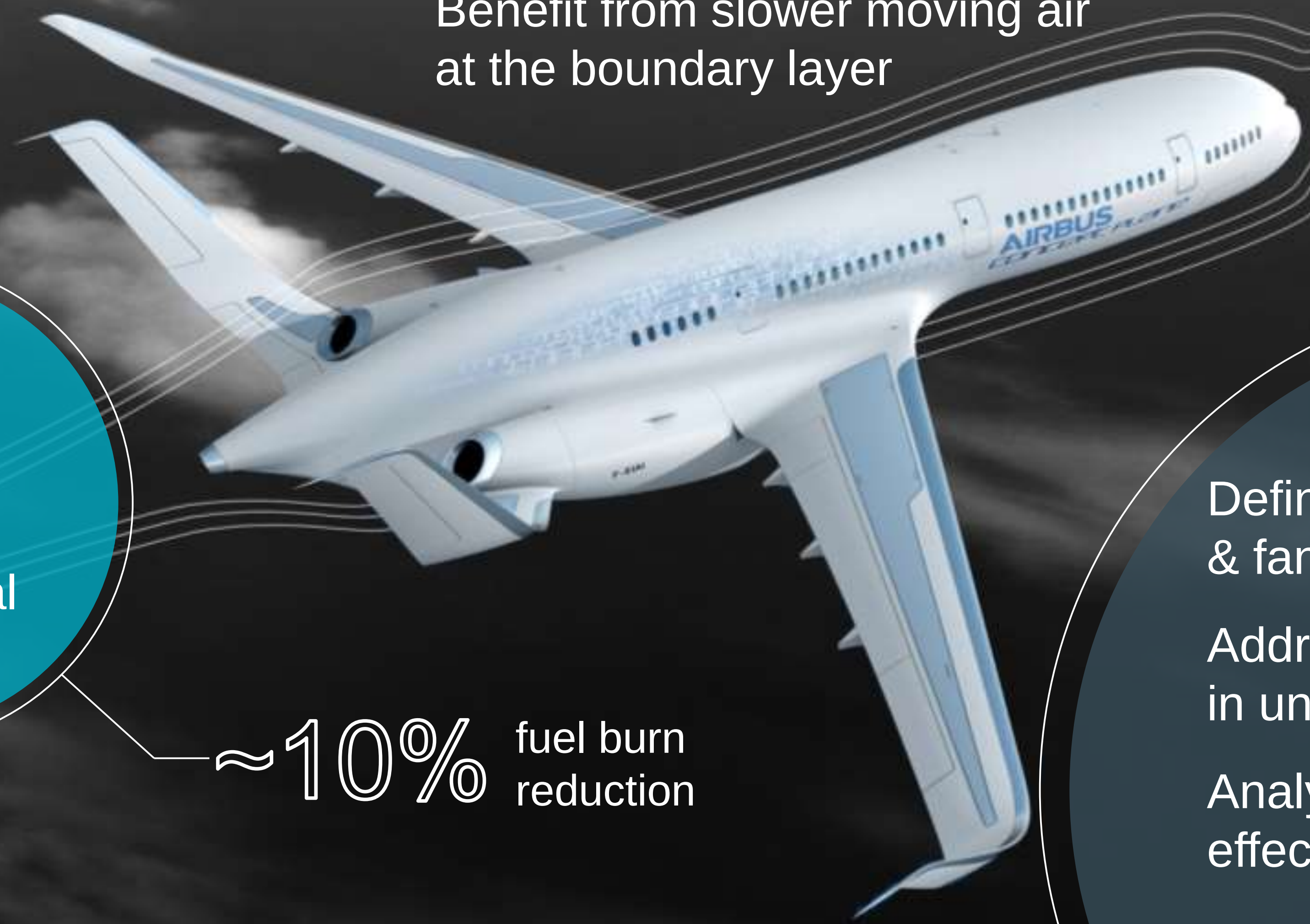
Aerodynamic

Towards new aircraft configurations

Boundary Layer Ingestion

Minimises propulsor **effort** & reduce total **drag**

Benefit from slower moving air at the boundary layer



~10% fuel burn reduction

Define optimum inlet distortion & fan reinforcement

Address propulsion integration in unusual location

Analyse & solve integration effects

Fuel

Open Rotor

Push propulsive efficiency to the limit

~6% Fuel burn saving vs. advanced UHBR

- Lower cruise speed
- Position propulsion system for safety and comfort
- Noise challenge

UHBR: Ultra High Bypass Ratio

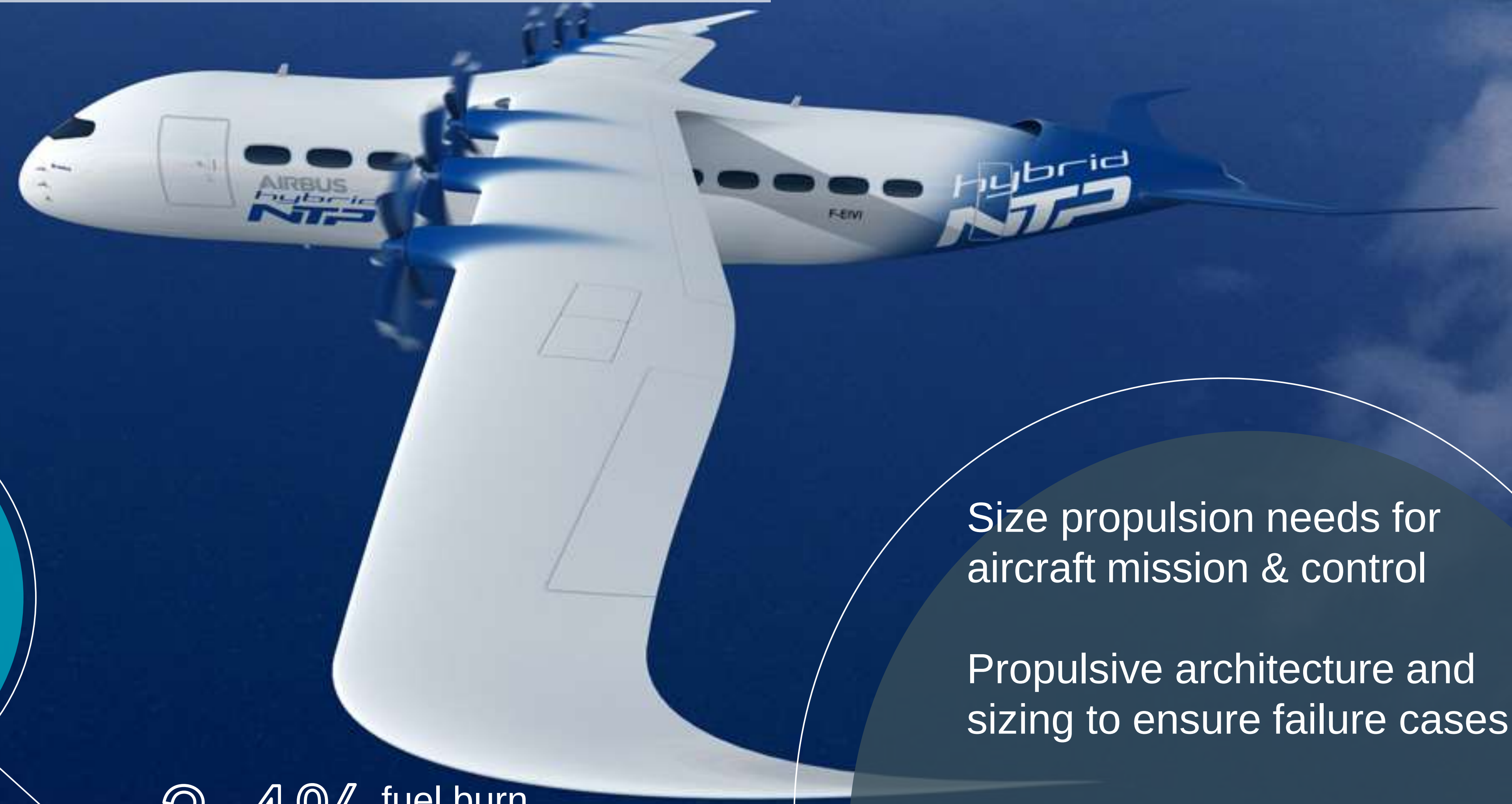
Aerodynamic

Towards new aircraft configurations

Distributed Propulsion

Reduce control surface **needs** & reduce total **drag**

~3-4% fuel burn reduction



Size propulsion needs for aircraft mission & control

Propulsive architecture and sizing to ensure failure cases

Propulsion integration for Low speed benefits and minimum drag penalty in cruise

Energy

Hybrid Electric Propulsion

Explore new configurations

From electrical power boost

To full electrical power

Develop technology bricks to investigate higher levels of hybridation & distributed propulsion

Develop integration technologies and operational solutions

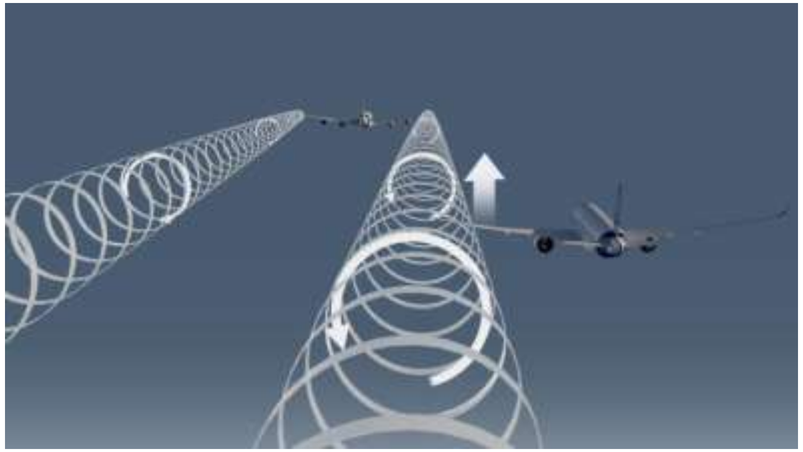
Define certification basis with authorities

Formation Flight

Reduce CO_2 emission and fuel burn by 7 up to 12%

Principle

- The leading Aircraft creates two vortices
- Following aircraft can ‘surf’ those vortices & benefits from extra lift, reduce engine setting whilst flying at the same speed



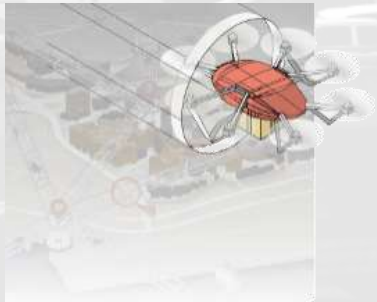
- New specific & automated control laws & sensors to optimize and maintain the position within the vortex

Towards Urban Air Mobility

Airbus is taking a pioneering role in opening the market, while developing and exploring new vehicle concepts, systems and business models

VOOM

SKYWAYS



CITYAIRBUS

VAHANA

POP.UP

source AIRBUS

Time to conclude our Journey….

Yes we will fly even more in 2050...
But only if we meet our Environmental Challenges
while improving even further Safety and Security

Advanced Materials, Aerodynamics, Systems…
…are a Must!
But only more integration within the Aircraft, between the Aircraft and the Engine and within the overall Air Traffic system will allow reaching our Goals

Will we still need air breathing engines in 2050? **Definitely more Electricity!**

Time to conclude our Journey….

Advances from other areas will accelerate our evolution even faster

- Batteries and Sensors from mass production
- Low cost very high bandwidth connectivity
- Data Analysis and Artificial Intelligence…

Increasing complexity requires a Paradigm Shift in the way we introduce technology…

- Agile methods, Fast Iterations
- Digital end to end continuity
- Open Innovation, “Coopetition”

…and address Certification Rules

2050… A world of Opportunities…

Are you Ready?

Thank You

Q&A