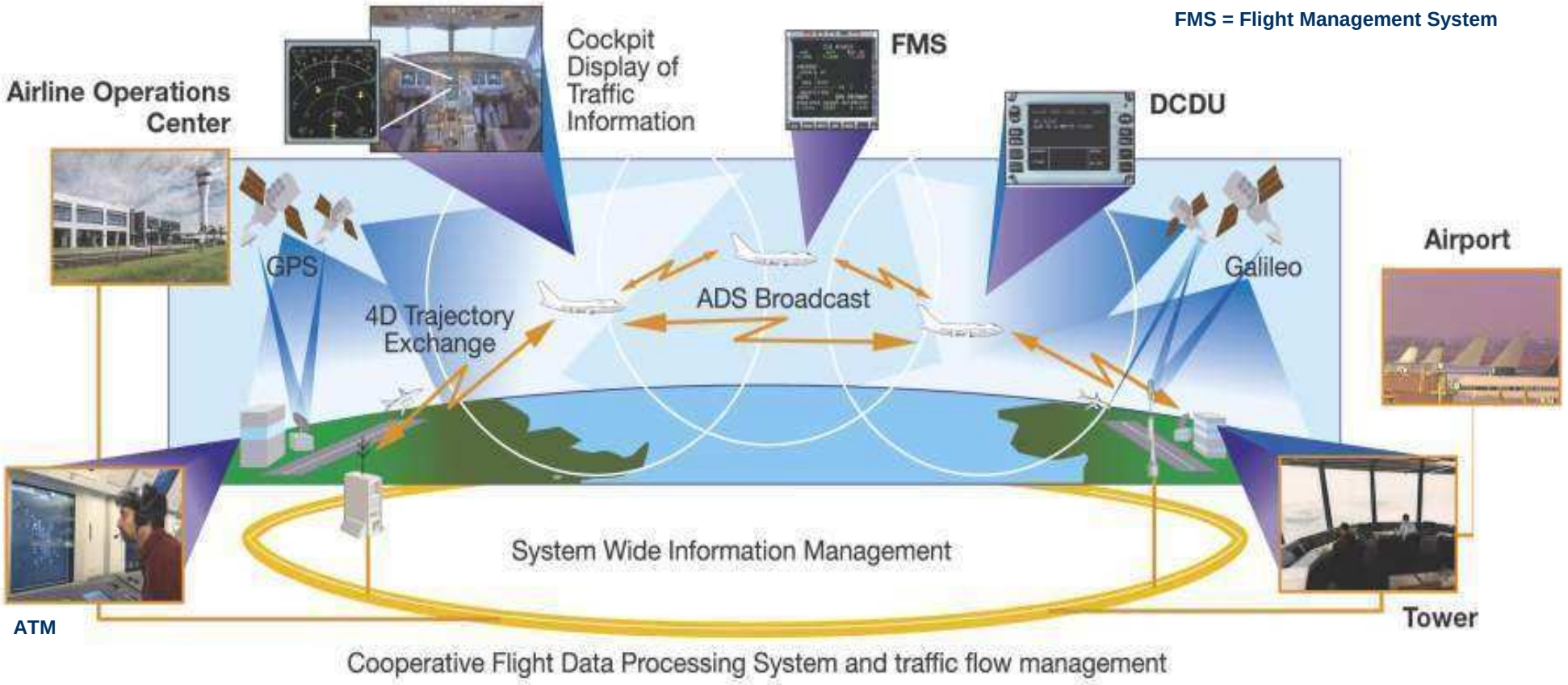
INTELLIGENT & COMMUNICATING AIRCRAFT IN 2030 : TECHNICAL AND SCIENTIFIC CHALLENGES

Pierre FOSSIER, THALES Air Operations

Intelligent & Communicating Aircraft within the Air Transport System

ATM = Air Traffic Management

FMS = Flight Management System



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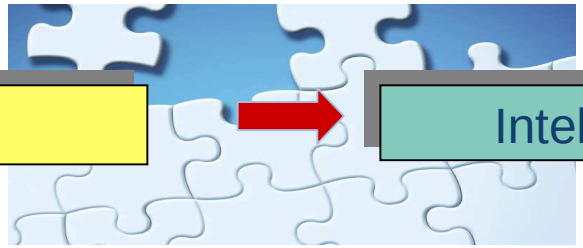
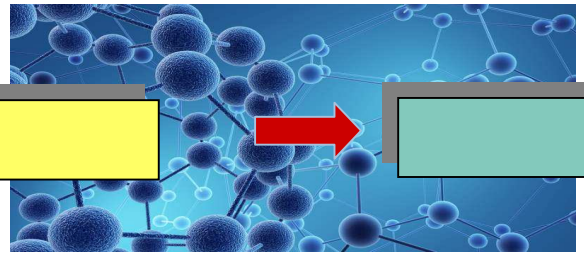
The four main avenues for innovation

Manage Complexity, optimise



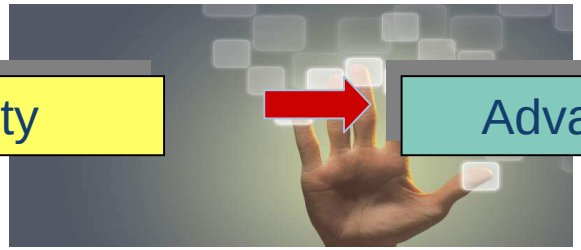
Intelligent Mission Management

Access relevant information



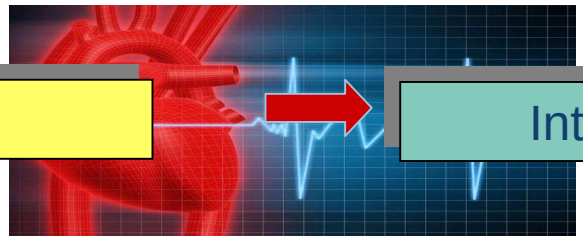
Aircraft Connectivity

Help User to Handle Complexity



Advanced Man-System-Interface

Supervise and monitor



Integrated Health Monitoring


Mission Management

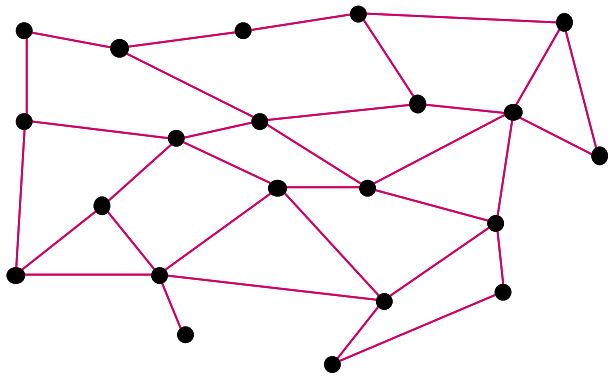
From Flight… to Mission

Sextant

Radio-aided

- Congested airports
- Satisfy passengers' expectations
- Manage complexity

Complexity management



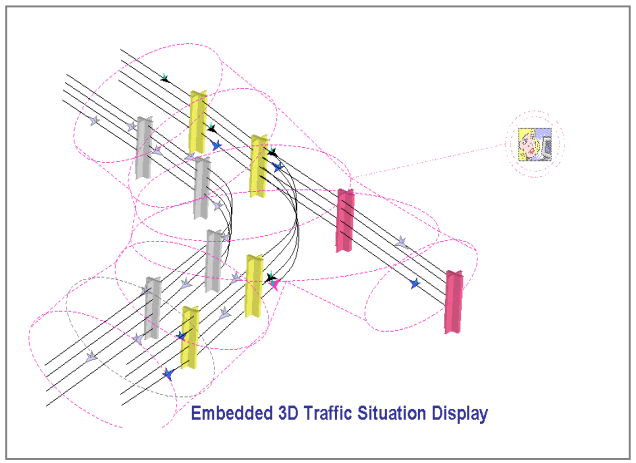
Lean journey

Fly safely and on time in increasing traffic …

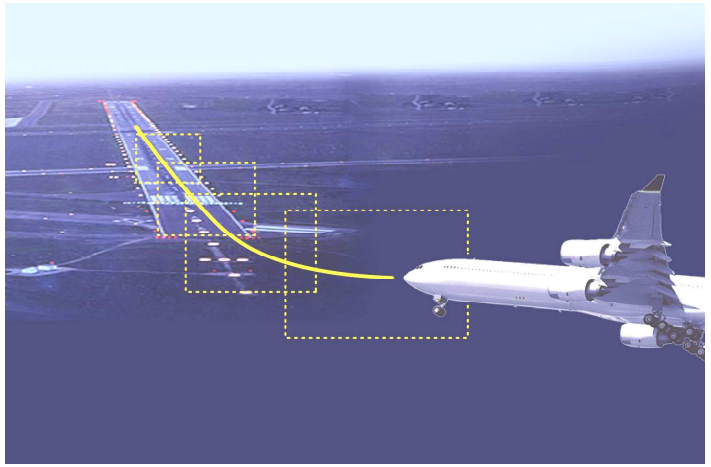
… manage the interactions into a single concept: The Mission

The Mission Benefits

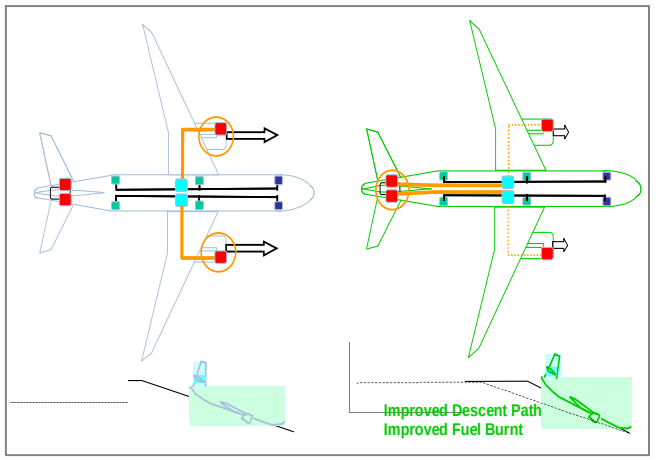
Operations ↗	Increased Air Traffic capacity	Performance
efficiency ↗		
€ $ ↘	Mission efficiency (economical)	Lean
green ↗		
CO_2 ↘	Environmental footprint	Clean



Collaborative Traffic Management



Seamless flight – networked lean ops



Power Optimisation

The Mission Management concept is a key enabler for breakthrough visions

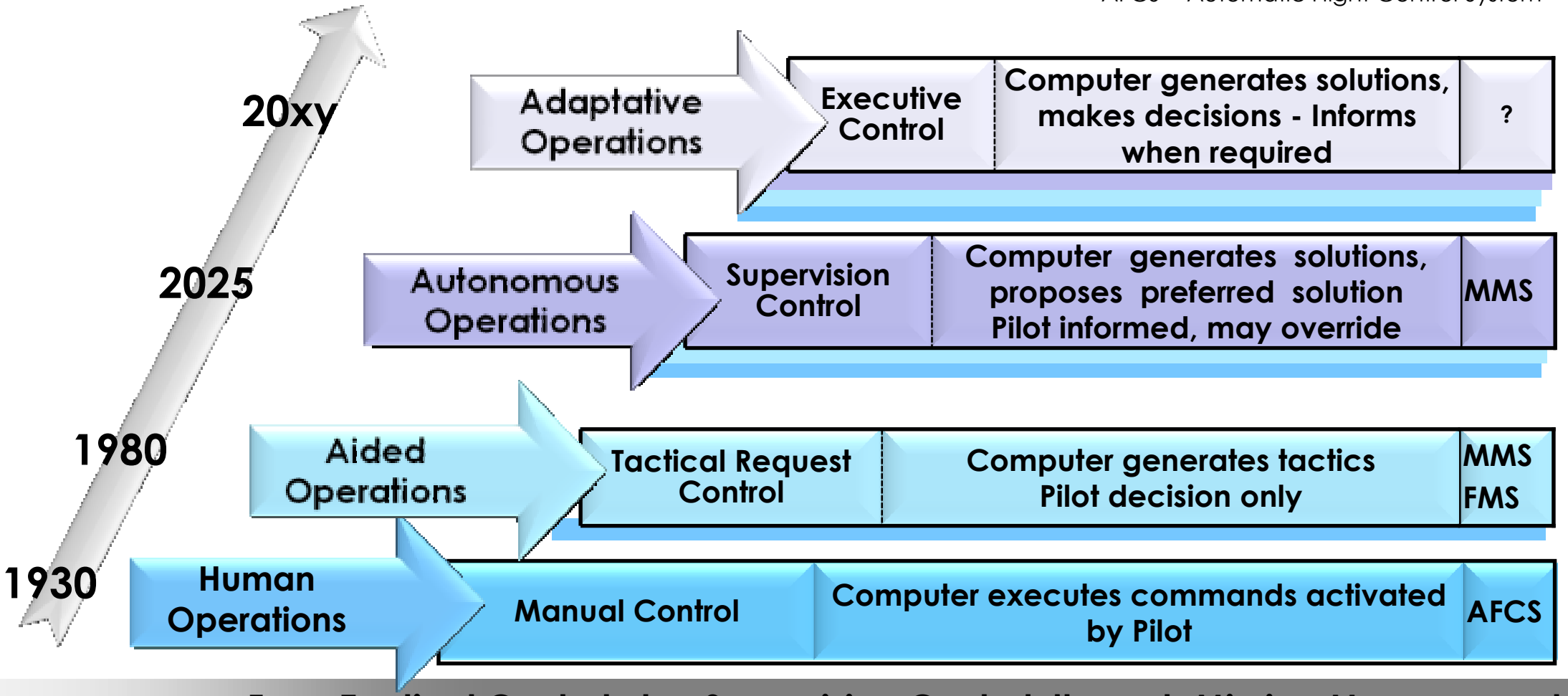
Aerospace rules, constraints & reality

Other Transport domains are paving the way

Set up a roadmap to demonstrate feasibility with regard to all aspects

Technical stakes: Autonomy Level in Operations

MMS = Mission Management System
FMS = Flight Management System
AFCS = Automatic Flight Control System



From Tactical Control to Supervision Control through Mission Management

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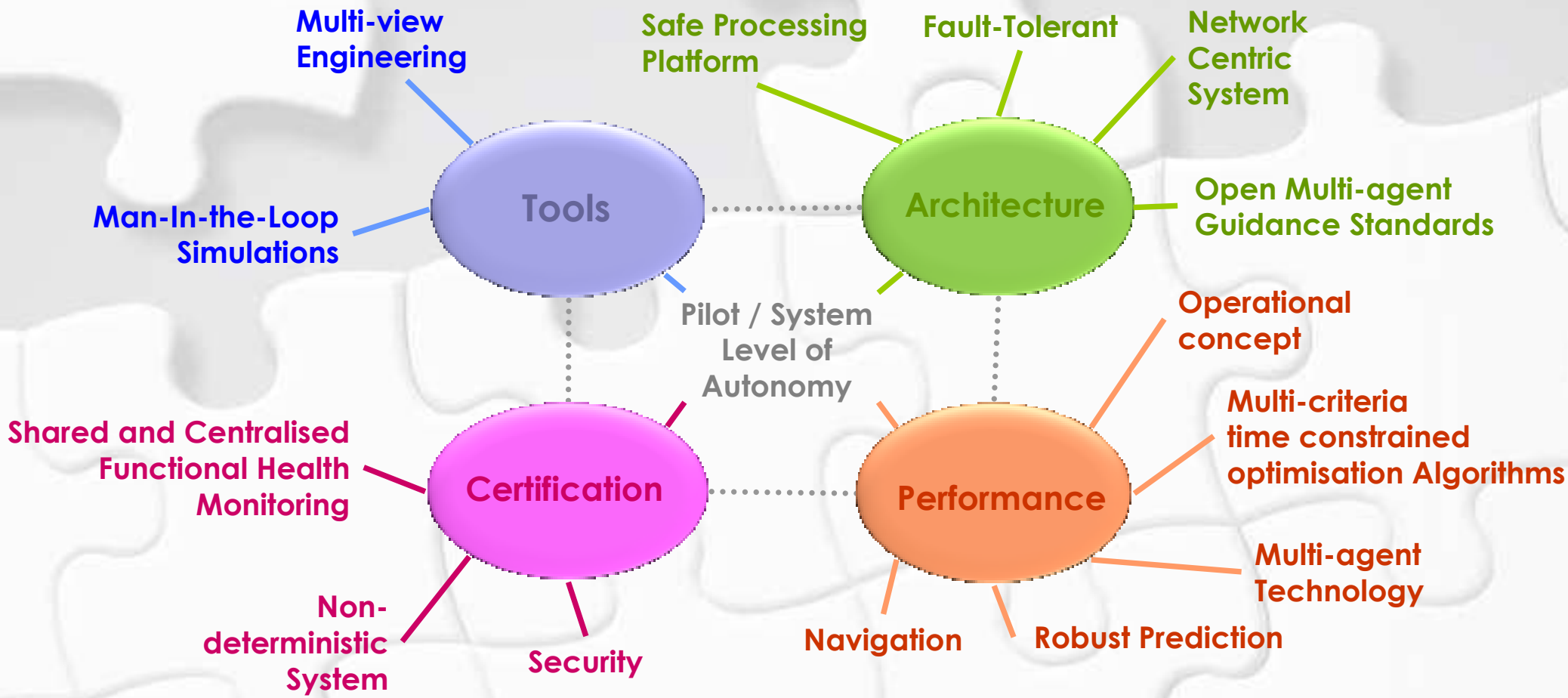
The 2030 Mission Management System: our vision



Mission Management : a Mission Critical Information System

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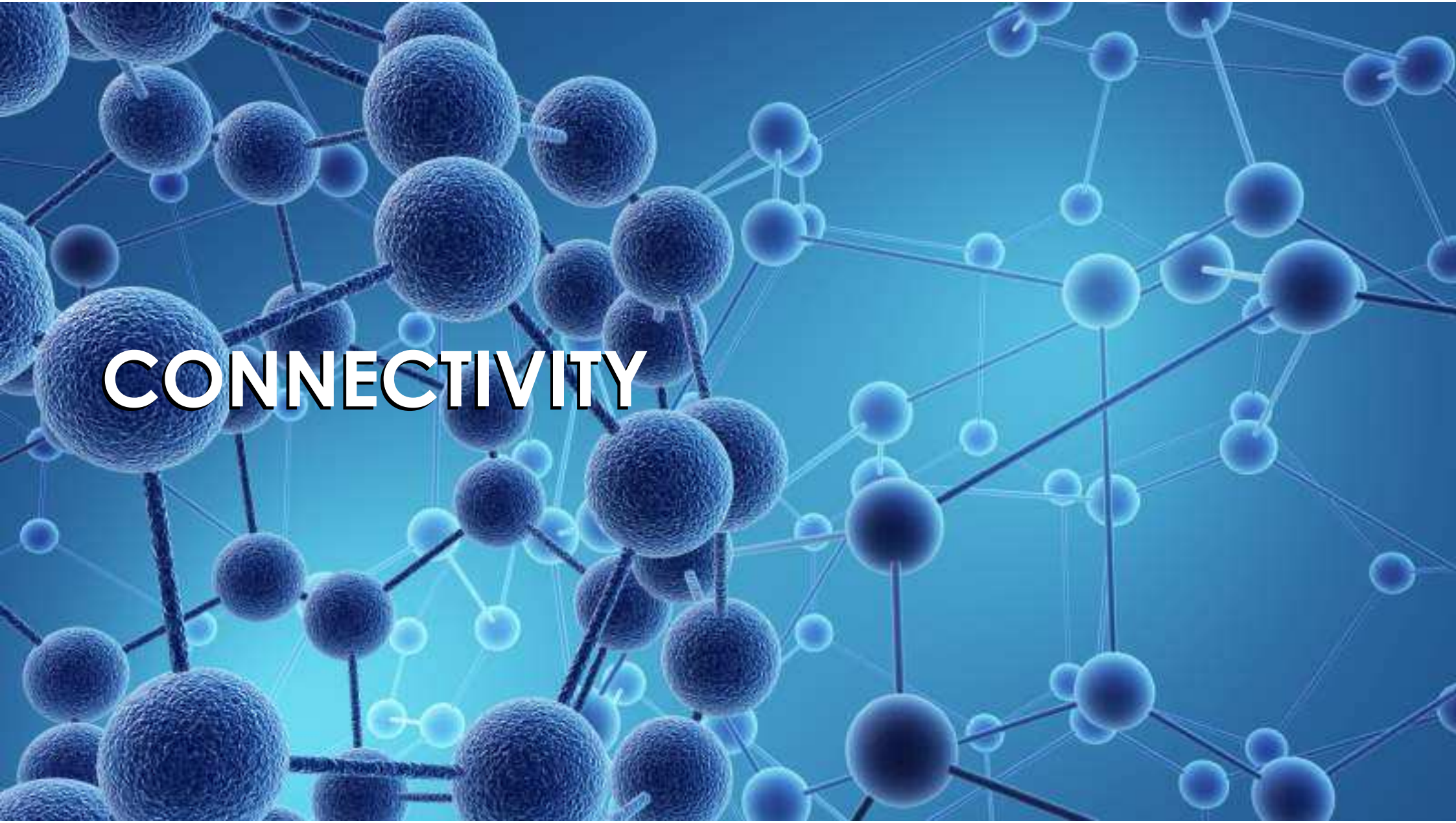

CONNECTIVITY

Connectivity

Enterprise Requirements

Aviate Connectivity for flight

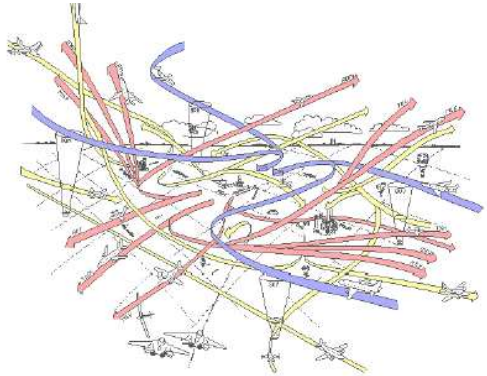
Aircraft Connectivity for Operations

User / Cabin Connectivity

Innovation

Simplicity of cabin experience to satisfy customer demand

Management of complex environment to enable competitive operation



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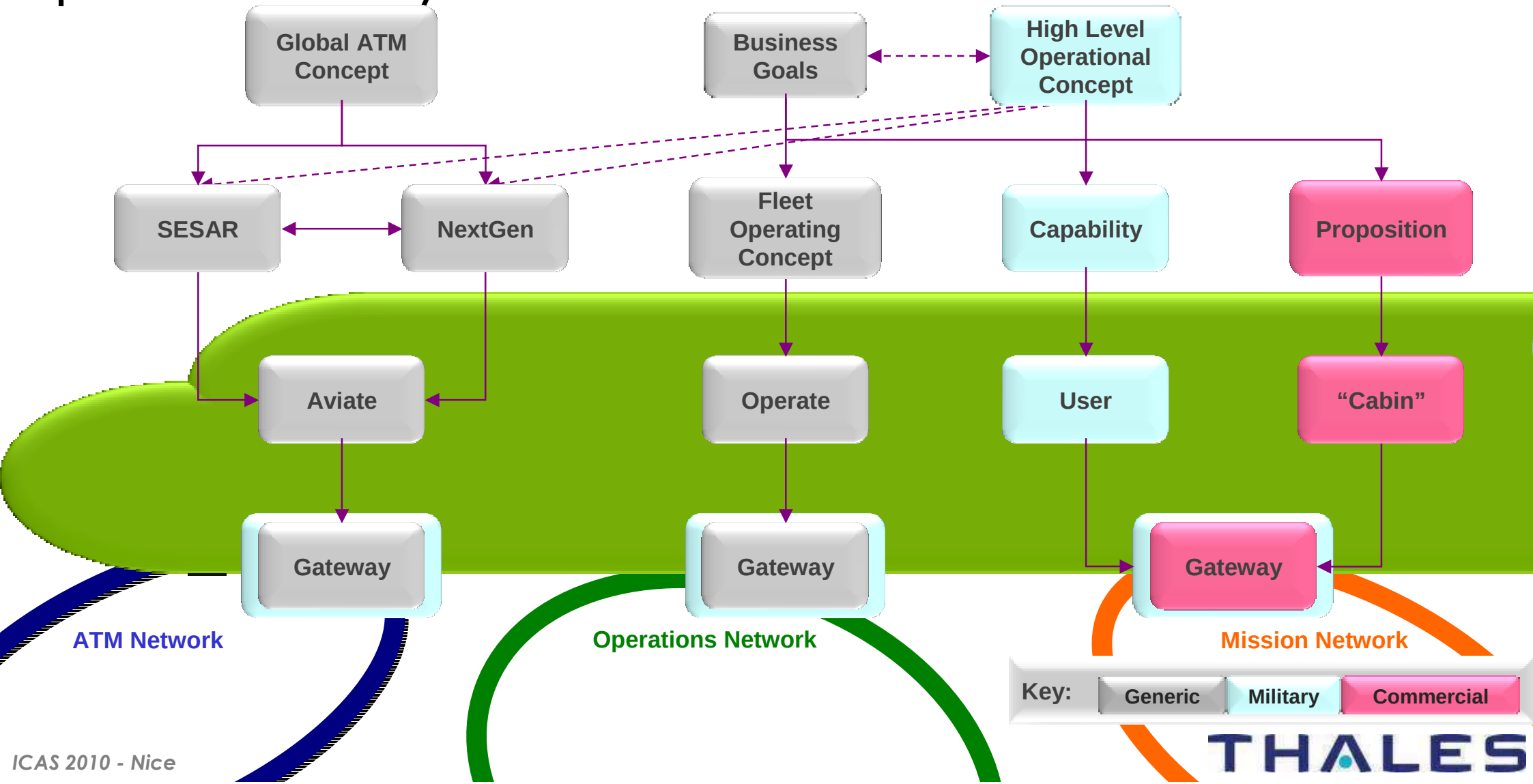
Aspects of Connectivity



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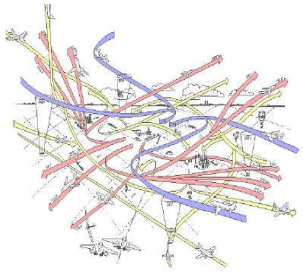
Connectivity - The 2030 vision

Aviate



Connected Information System

situation awareness and rapid controlled reaction in an increasingly complex environment

Operational

Optimised, Adaptable, Efficient, Connected Air Transport

Integrating Connectivity Enables Competitive Service

User

Virtual Presence Technology

Personal / Business Experience

Unimpeded by travel

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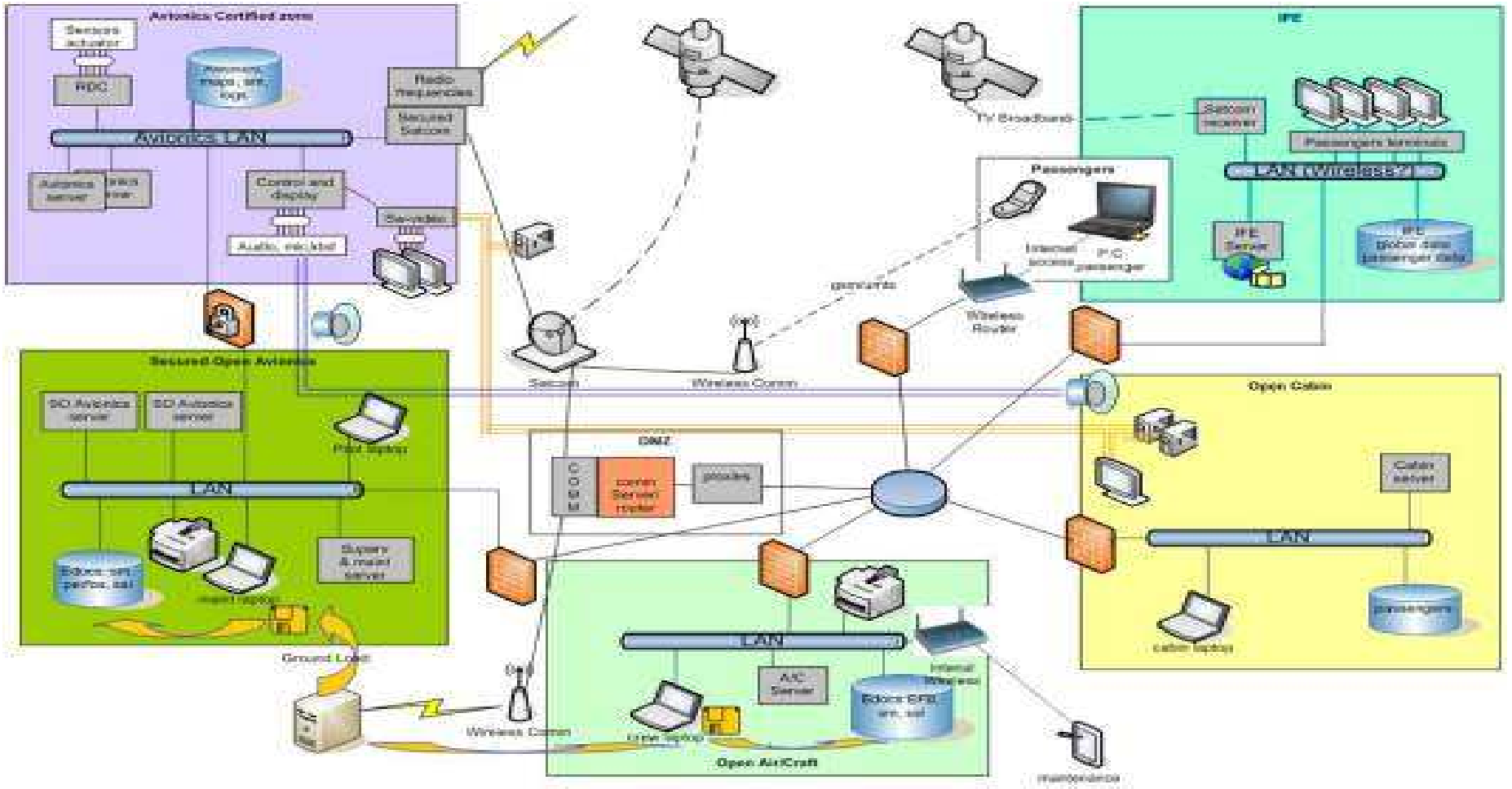
Unified Connectivity Architecture



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Connectivity

Simple ⟷ complex

Flight in a complex environement

Highly adaptive business

Optimum user experience

Unified Connectivity Architecture

Integrated modular radio

High bandwidth technologies

Security /accredidation

Quality of service

Content management

Integration technologies

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Human System Interactions

Safety
(system safety, performance, environmental constraints, certification, …)

Human Factors
(teamwork, stress, confidence, workload, training, multi-culturality, …)

Life cycle cost
(reliability, availability, maintenability, testability…)


1970


1990


2010

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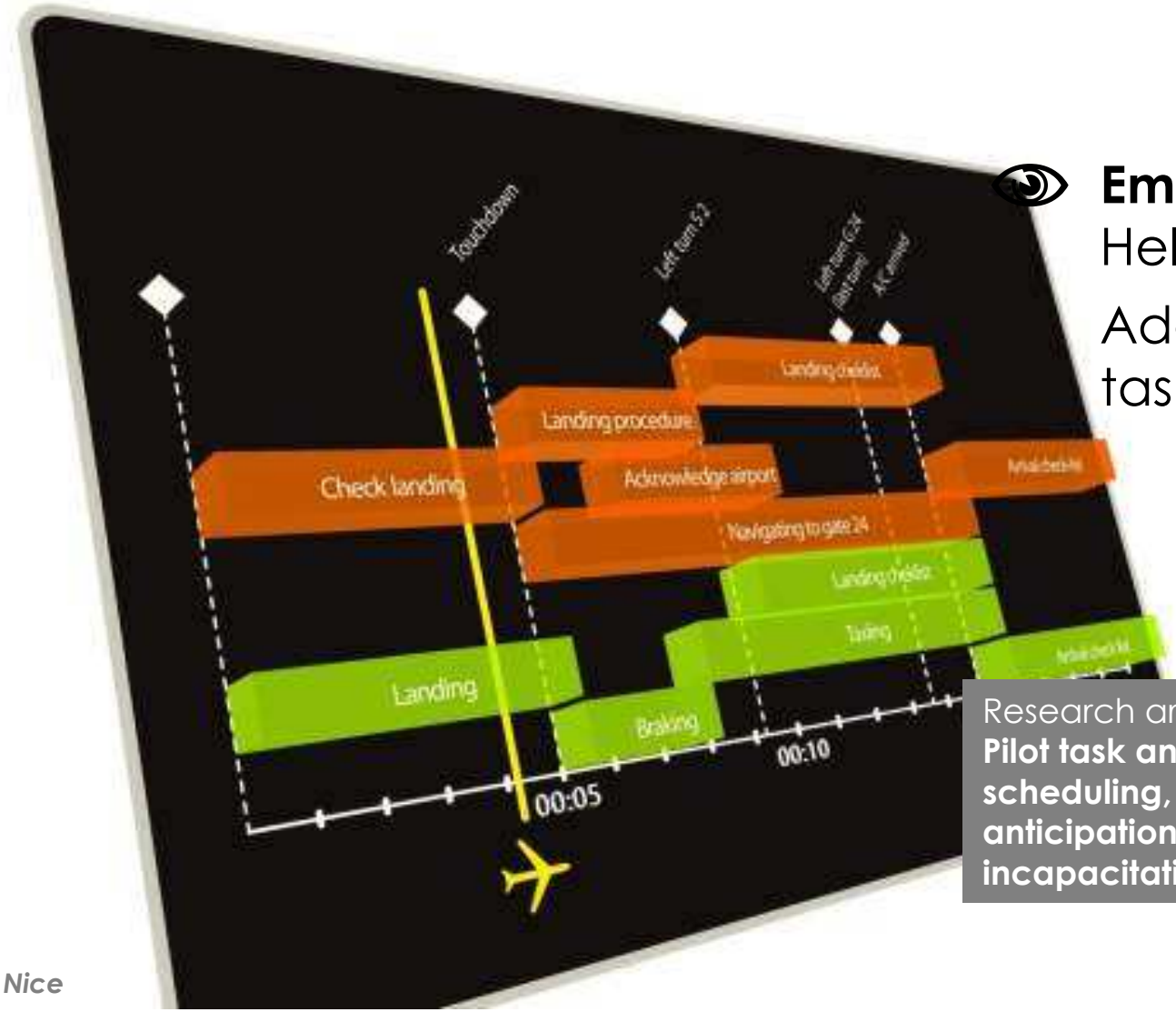
The 2030 cockpit: **filling the gap between user(s) and system(s)**



Empathic systems

Helping to anticipate

Adapting the cockpit to crew tasks, intentions and abilities

Research areas:
Pilot task analysis, intention detection, workload scheduling, cognitive resource management, anticipation of user errors, adaptive interfaces, incapacitation monitoring, biosensors…

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The 2030 cockpit: **filling the gap between user(s) and system(s)**

Personalisation
Cockpit that takes crew and companies into account…

Research areas:
Multi-culturality (social & organizational), skill & training evolution, pilot sociological evolution, companies procedures & culture, personalisation vs. cross-crew qualification,…

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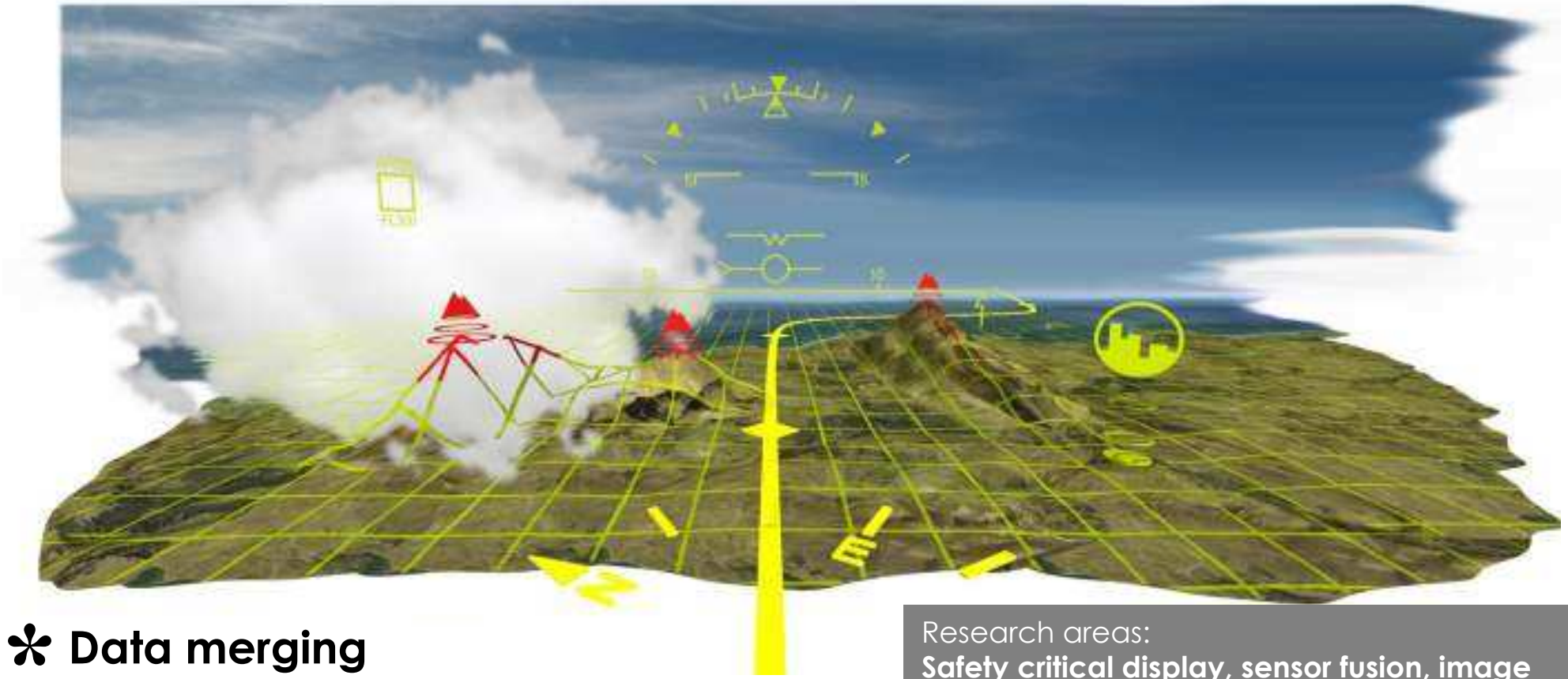
The 2030 cockpit: **helping users to handle complexity**



- **Data merging**
  A safe synthetic view to pilot, navigate and manage the mission

Research areas:
Safety critical display, sensor fusion, image processing, certified database, confidence, immersion, distributed situation awareness, 3D augmented reality, graphic data merging, sensors,…

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The 2030 cockpit: **helping users to handle complexity**

Automation

User-centric system management for pilots who are not engineers

Research areas:
Cognitive resource management, decision making models, decision aids, consistency between crew mental representation & system behaviour, evolution of aircraft systems…u

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The 2030 cockpit: **supporting new interaction languages**

Direct interactions
Using natural human interaction skills (touch, feel, …)

Research areas:
Touch interaction patterns, haptic feedback, 3D view & interactions, personal viewers (in glasses), 3D sound, active noise reduction, gesture recognition, integrated biosensors …

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The 2030 cockpit: **supporting new interaction languages**

Dematerialization
Reducing device footprint and increasing display area

Research areas:
Flat projection, OLED display, pico-projectors, ePaper, flexible screens, high-performance/high integrity GPU, wide eye-box HUD, compact optics, …

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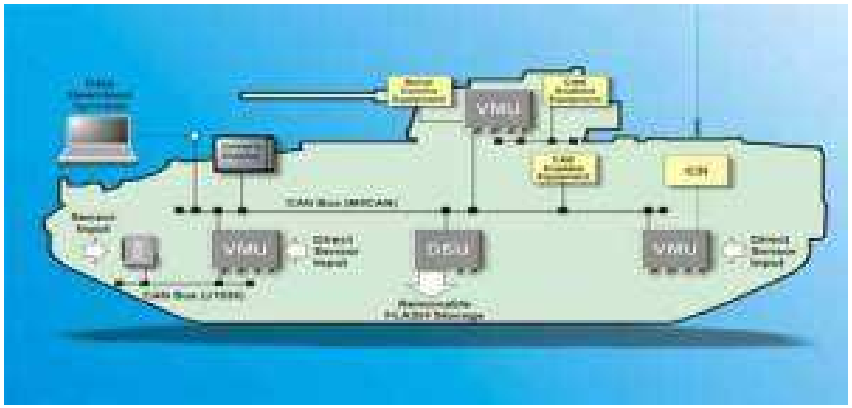
Aircraft Health Management
in 2030

Health Management Foundations : **Definitions**

Diagnostics	detect & localise failure	**- reactive**
Prognostics	measures and trends defined parameters	**- predictive**
Reconfiguration	control intelligence managing redundancy for failures	**- deferral / safety**

Human

Vehicular



Structural

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Definition: **Generically what is Aircraft Health Management System?**

System (Aircraft) Health Management:

1. A network system of Diagnostics, Prognostics and Reconfiguration functions

2. On Aircraft and Ground Based Connectivity infrastructure

3. A system for minimizing non-forecast disruptive operational events

4. A Strategic decision making tool to achieve fleet & cost optimisation

Technologies & usages: **Diagnostics to Prognostics - Today**

Diagnostic providing a centralized view of symptoms

Prognostic sub-system of key parameters measured to predict
- aircraft health status evolution
- Trends Analysis, Statistics – off-aircraft

Types of Systems Monitoring

Infrastructure

Physical Health Monitoring

Function

Functional Health Monitoring

Structure, engine

Electronics

Complex software

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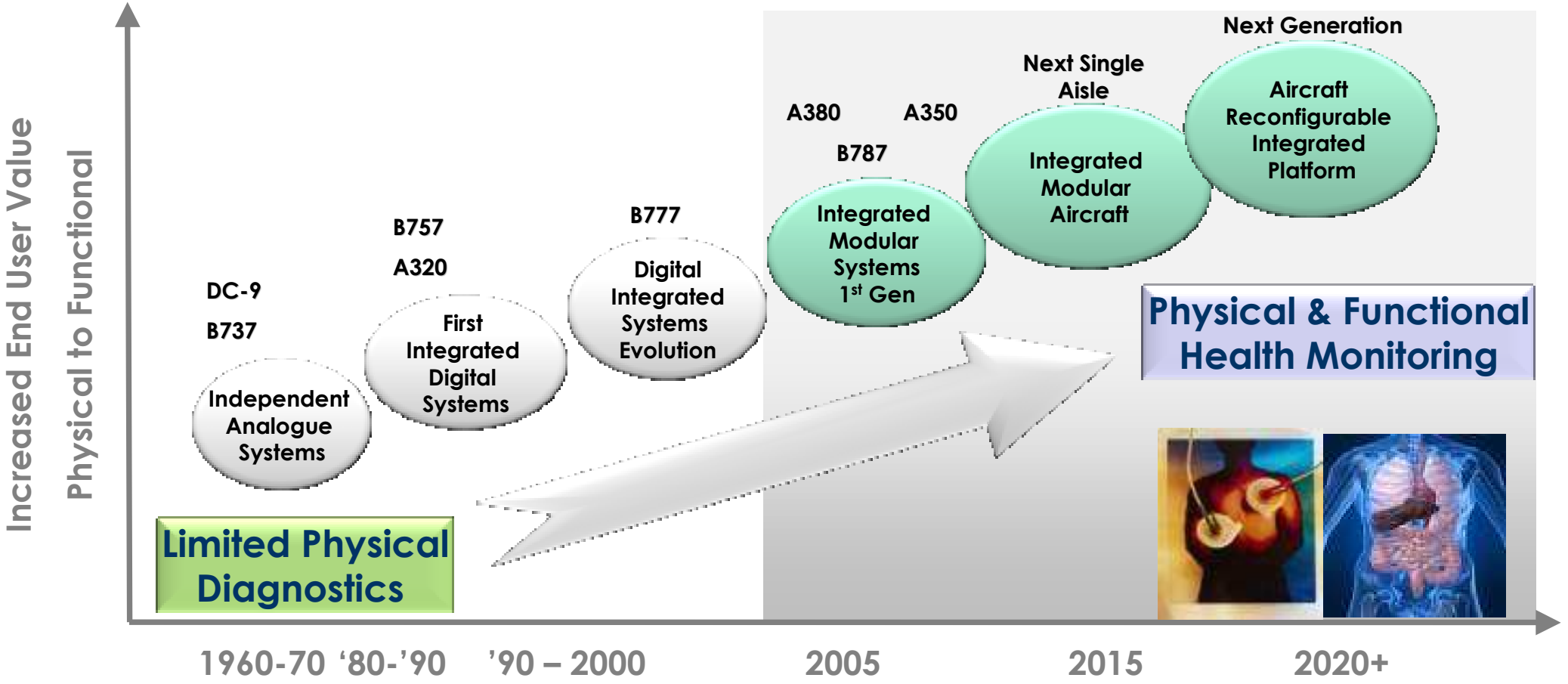
Recent History: **Aircraft Evolutionary Drivers – Physical to Functional**



Technology and Systems integration

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Operational Ambitions Today : **Maintenance Free Concept**

Reconfiguration – Deferral	continued operations with visibility of non-critical issues
Vision of Existing Health	proactive monitoring of aircraft trends
Future Health Status	decisions based on Prognostics Trends and Mission Management requirements

In future supported by : **Distributed Health Management Architecture**

Systems	on board/off board task sharing
Connected aircraft	limited level of system transmission – critical total connectivity on ground - bandwidth
Information technology	improving collaboration between operations within an airline operational environment

Today's Limitations - a Dissociated System in terms of process and connectivity

Integrated Health Management System concept

Infrastructure

Physical Health Monitoring

Structure, engine

Electronics

Function

Functional Health Monitoring

Complex software

Net-Centric

Continuous Monitoring

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Health management 2030: **Building the Vision….The Challenge!**

Engines
Structure
Systems
Avionics
Sensors
Data acquisition
Data processing

Prognostic

Diagnostic

Model based algorithms
Global architecture

Diag/Prog data fusion algorithms
IHM
Health Modelling
Flight crew reporti,ng data base

Health status

In Flight

Enhanced conf management
reconfiguration
Situation builder and A/C conf

Config

Comm

Data link security
Low cost bandwidth

Security
Gate Link

Connectivity

On Aircraft

Contextual documentation

IHM

Head mounted displays
Camera/ speech recognition
Flexible maintenance report
3D display
E logbook

On Ground

Dispatch decision aid
Optimized maintenance planning

Services

Servicing

Diagnostic

Data history
Model based diag remote

Fleet Management

Data history

Prognostic

Flexible report
Predictive models

Fleet magament service

Services

Dispatch service
Health management service
E-applications
Configuration service

Maintenance free
Operating period
Non disruptive maintenance
Embedded training
Reduced maintenance crew

Maintenance Concept

Operational concepts

Information Technology interoperable
Open architecture (SOA)
Standardization

Connecting actors

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