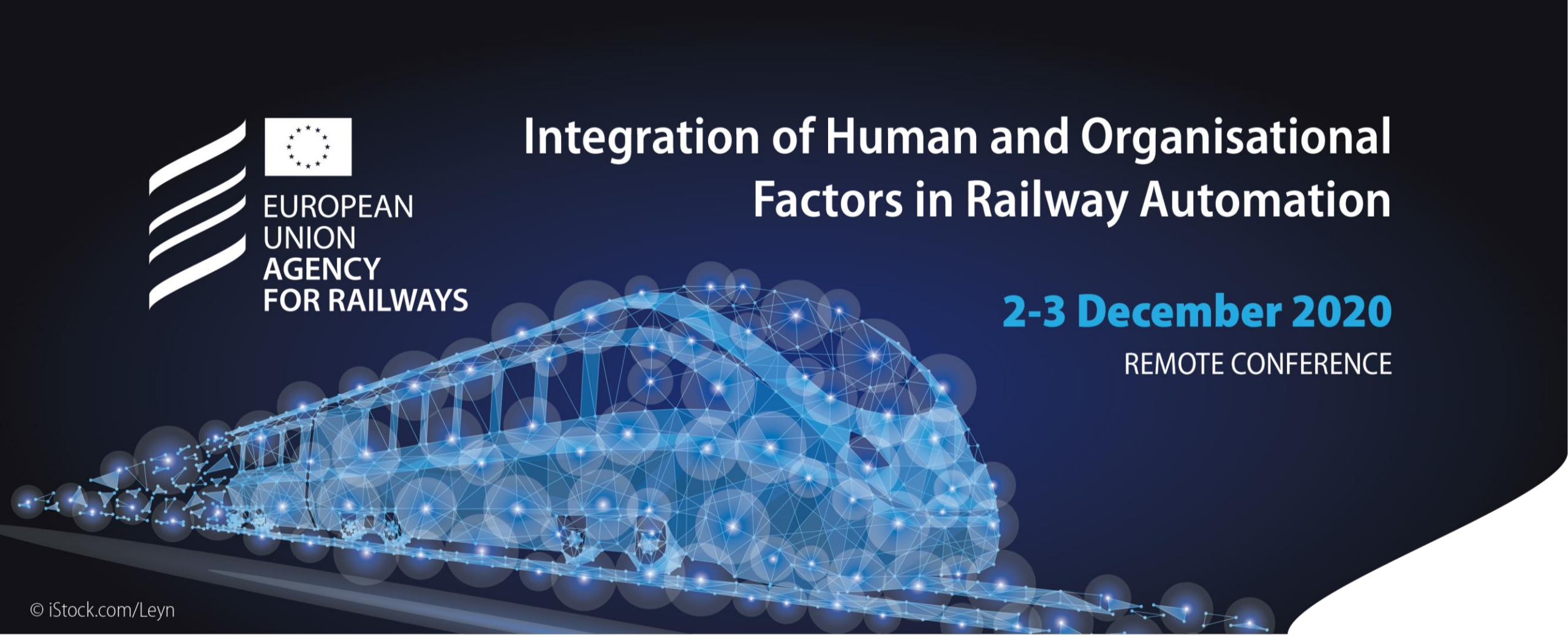

HOW ARE HOF INTEGRATED IN AUTOMATION IN AVIATION?

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[redacted]

Jean Pariès Scientific Director

EUROPEAN UNION AGENCY FOR RAILWAYS

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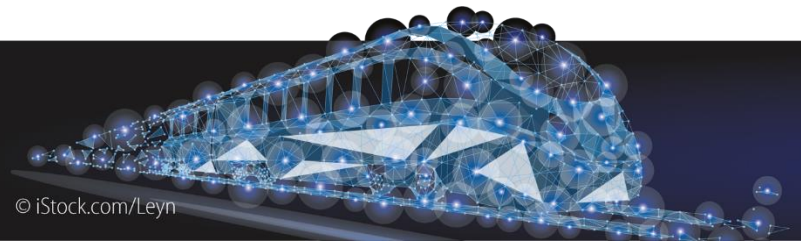
HOW ARE HOF INTEGRATED IN AUTOMATION IN AVIATION?

Jean Pariès

Scientific Director



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The extension of the automated domain

- Flight control: attitude (pitch, roll, yaw) then flight path (heading, speed, vertical speed, FP angle)
- Navigation: track, position, altitude,
- Flight plan: way points, 3D trajectory, 4D trajectory
- Flight management: flight plan, fuel management, ATM communication , pressurization & A/C,
- A/C monitoring: systems

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Positive Features of Automation

- Enhanced performance:
  - Two-member flight-crews.
  - Navigation & guidance accuracy, flight time, fuel efficiency, overall flight operation and maintenance performance and cost/benefit ratio .
  - Fly-by-wire increases flight efficiency and makes manual flying easier.
- Increased reliability:
  - Technical reliability, redundancy of the processing chains
  - Computing power, lots of sensors and parameters, flexibility of reconfigurations
- Dramatic evolution of instrument panels:
  - Giant advances in flight, navigation, and systems displays
  - Accurate and reliable representation of the outside and inside world

Expected benefits	Real effects
Components roles substitutions within the same system	The system is changed, roles of people change. Activities are transformed. Monitoring rather than acting
Decreased workload	Low workload decreased (routine situations) and high workload increased (abnormal situations)
Simplified cognitive tasks	Creates new kinds of cognitive tasks, often at the wrong time. With programming, consequences of errors shift into the future.
Focuses user's attention on the right issues	Makes it harder for users to remain "in the loop" and aware of the situation. Reliability induces complacency . Decrease in non-verbal communication Increase in standardized verbal communication
Less knowledge and skills required	New knowledge and skills demands.
Same kind of skills acquisition and maintenance trough experience	Ironies of automation: basic skills are lost, but even more needed when things get really wrong
Better accuracy, reliability, efficiency, safety	… but "automation surprises"

Adapted from Dekker & Woods, 1999

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Automation accidents

- The history of aviation accidents related to automation clearly shows that automation rises serious HOF safety issues , including
  - Management of automation failures
  - Loss of situation awareness
  - Automation surprises
  - Ironies of automation

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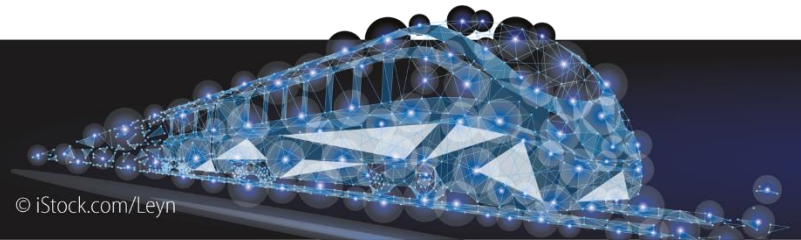

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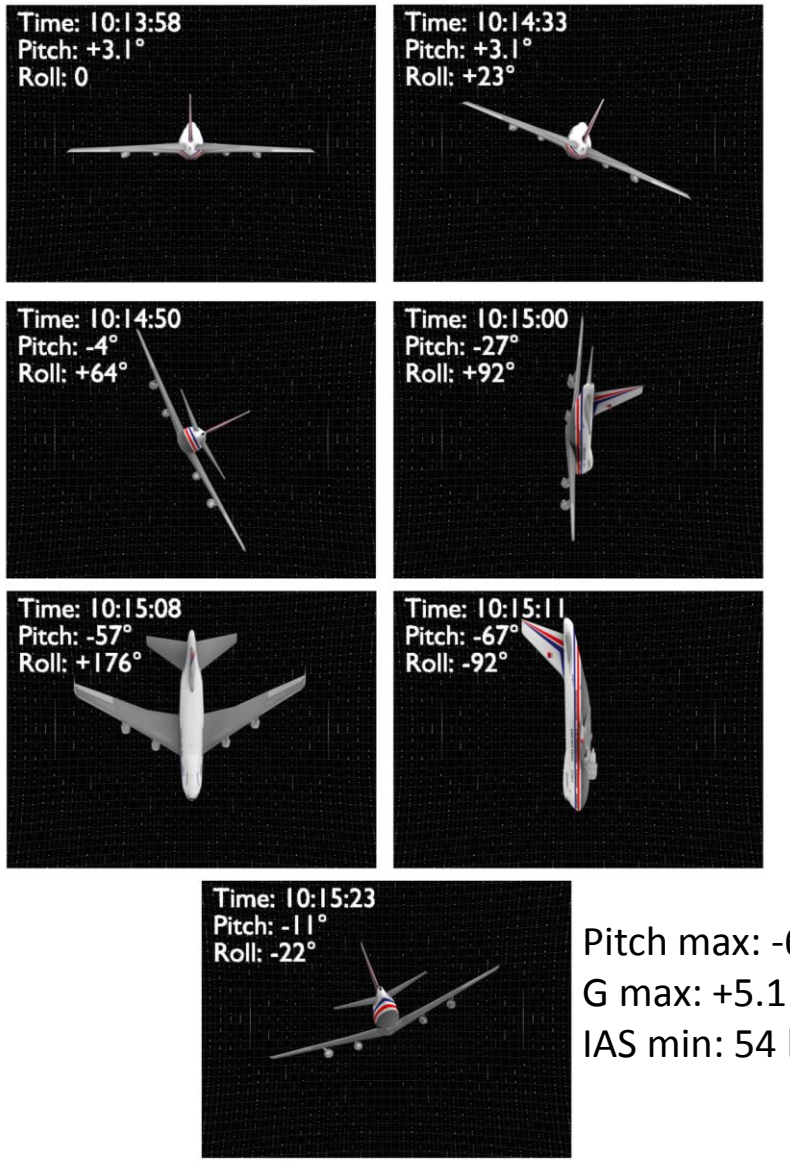
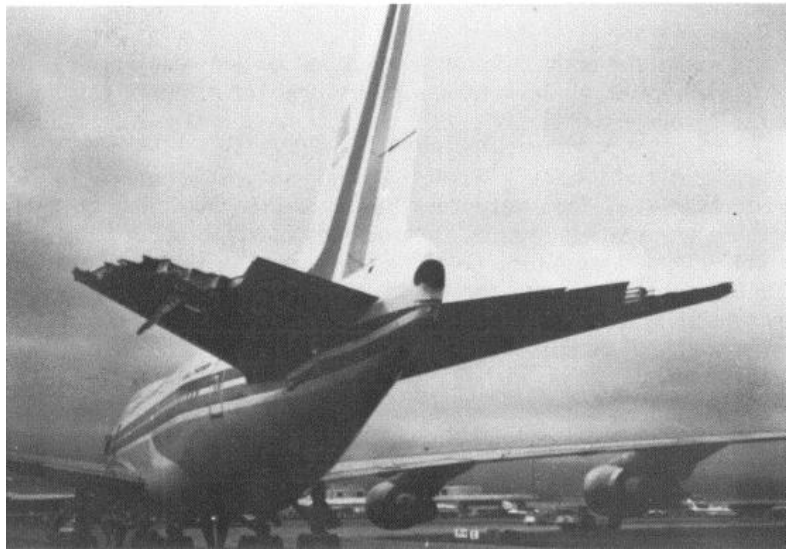
China Airlines Flight from Taipei to LA on 19 February 1985, (Boeing 747SP)



Pitch max: -68°
G max: +5.1
IAS min: 54 kt

- **Turbulences occurred while the AP was engaged in a « speed » mode. #4 engine failed**
- **The plane lost speed. The captain disengaged the speed mode, this switched the AP to pitch mode. He then rotated the pitch control wheel to begin a descent as he intended to restart the engine**
- **AP still engaged in a lateral mode tried to compensate for the asymetrical thrust**
- **When the captain finally disengaged the AP, the plane was out of trim and he lost control at once**

- **China Airlines Flight** from Taipei to LA on 19 February 1985, (Boeing 747SP)



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1/6/2009 AF 447 Rio de Janeiro-Paris

ECAM à 02:10:08	
AUTO FLT AP OFF	
F/CTL ALTN LAW	
(PROT LOST)	
-MAX SPEED.....330/.82	
AUTO FLT	
REAC W/S DET FAULT	

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1/6/2009 AF 447 Rio de Janeiro-Paris

+1':30''
35000 ft
-10'000 ft/mn

Stall warning

38'000ft

AP+ATHR disengaged
Loss of airspeed info
Alternate 2 flight control law

+20''
36'000ft

Stall

35'000ft

02:10:04

Pitch down (and up) inputs

Pitch up (and down) inputs

+4':24''
crash

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4th November 2010 Qantas 32

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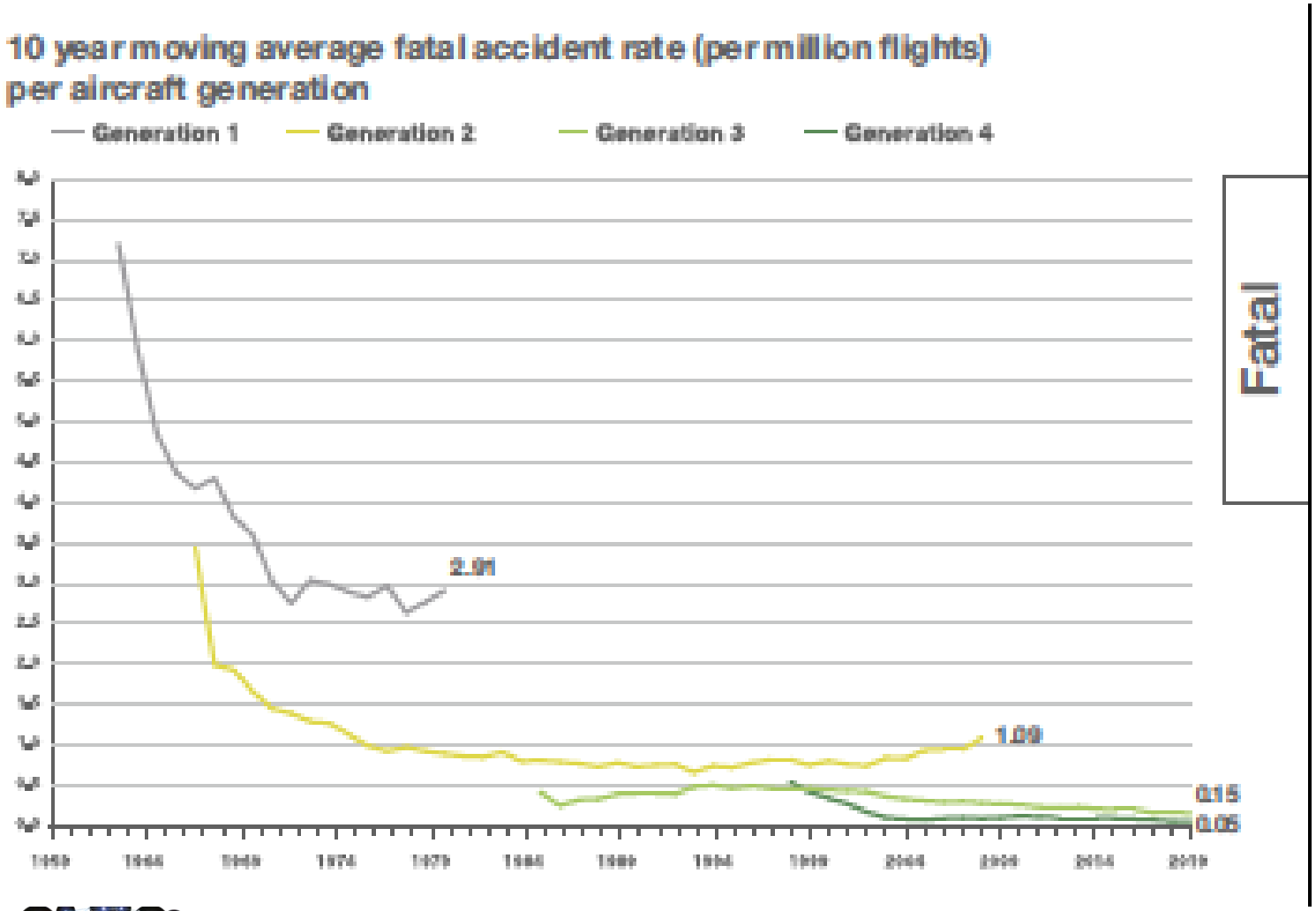
Accident rates and aircraft generations



Source Airbus

Addressing HF

- Design:
  - Automation philosophy
  - User centered design
  - Airworthiness specifications
  - Complexity assessment
- Procedures
  - Automation usage policy
  - Automation levels
  - Automation modes
  - Crew coordination, tasks and roles definition
  - Terminology and language

Addressing HF

- Training
  - High fidelity simulation
  - Unexpected situations
  - Career management, aircraft family
  - CRM, Team work
  - Crew pairing
- Monitoring
  - Feed-back from operational experience
    - QARs
  - Feed-back from training
  - Real life observation (LOSA)

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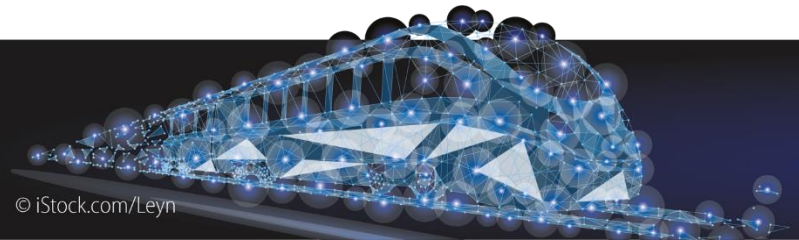
Drones

- More than 400 large U.S. military drones have crashed in major accidents around the world since 2001, (Washington Post investigation).
  - A limited ability to detect and avoid trouble.
  - Pilot error
  - Persistent mechanical defects
  - Unreliable communications links.



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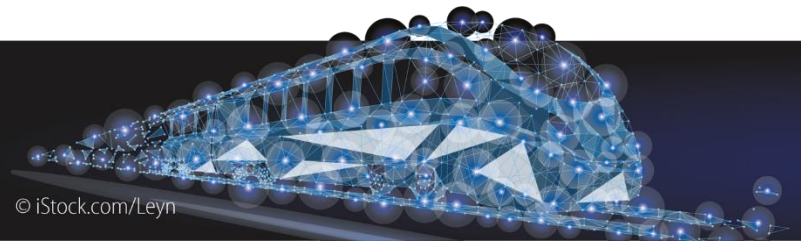
Q & A

In the next 20 minutes Mr. Jean Pariès will reply live to your questions.

- You may wish to write your question in the Teams Live chat, or
- Receive a detailed reply after this conference: use the link provided on the event webpage.



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