The Challenge of Safety

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Executive Summary

Within ACARE, the objective of this report is to propose Solutions aimed to reach the Safety challenge. This challenge refers to the Group of Personalities (GoP) Vision of 80% reduction of accident rate, with particular focus on drastic diminution of human error, in the Air Transport System of the years 2020+ characterised by three fold Air Traffic increase, all weather and on time operation. Research effort will be focused to ensure that there will be no increase in number of accidents in Europe with Aircraft and operators complying with European standards / regulation.

The scope is limited, in this first phase, to commercial fixed wing aircraft.

The Air Transport scenario used to guide the work conforms to the GoP Vision, completed by some assumption: development of freight transport which could be separated from passenger' transport, larger use of regional Airports, evolution of Air Traffic Management towards more autonomy delegated to Aircraft and towards 4 Dimensions trajectory control, using space based technologies. The outlined scenario is in line with the ACARE report on the Challenge of more Efficient Air Transport.

Taking into account the result of existing initiatives on Safety, in particular the statistics of accidents, the recommended Research & Development activities are aimed to reduce **drastically**:

– the three major categories of accidents: Approach/landing, Controlled Flight into Terrain (CFIT) and Loss of Control.

– the main causes of accident, as resulted from the current statistics and reflection on their evolution in relation with the Air Transport vision: atmospheric hazards, failure to maintain safe separation between aircraft in flight, collision risk on ground …

– the occurrence of human error and its consequences

Breakthroughs are mainly based on:

– Situation awareness, enhanced flight envelope protection and assistance to recovering aircraft trajectory, trajectory prediction ;

– Air/Ground collaboration for safe and optimised A/C separation, conflict trajectory presentation and resolution ;

– Airborne traffic situation awareness, automatic spacing with gradual progress towards self separation ;

– Atmospheric hazards prevention: clear air turbulence, wake vortex, windshear, icing;

– Extensive use of precision approach/landing, more automation with clear "real world" vision systems and predictive warning means to help humans to remain “in-the-loop”; surface movement guidance and control ;

– Full modelling of human behaviour and performance in the "system of systems" ; wider use of optimised methods and tools for training ;

– Progress on methods and tools for certification, as the aircraft and its inter-relation with Air Traffic Management will be more and more complex ;

The research recommendations, regrouped into 10 Contributors, are sustained by basic enabling technologies in hardware, information and communication, human factors knowledge and system design.

A list of Technology Integration Platforms (TIP) are proposed to validate the concepts described in Contributors, in an operational context. Some of them will contribute also to the Security Challenge (see the Challenge of Security)

The future activities related to the Challenge of Safety depend on the decision of ACARE Members on future issues to be addressed for the second release of the SRA. Pending this decision, the following issues to be undertaken as next steps are envisaged:

– Extension of work to include the rotary wing aircraft ;

– Examination of potential Safety issues specific to Commuters or Business Aircraft ;

– Research for practical metrics to measure the contribution of different research topics to the goals ;

– Reflection on potential additional strategic routes necessary for Safety …

Introduction

Air travel is very safe and getting safer. The risk to an individual passenger is that making three flights every day the present average expectation of a flight related death would be one in 1000 years. The present high performance results from steady progress in every aspect of flight safety. Flight safety is recognised by all as an absolute requirement for the global air transport system and attracts sustained international attention with important initiatives such as CAST (Civil Aviation Safety Team) in the USA and JSSI (Joint Safety Strategic Initiative) in Europe.

The Challenge arises not from any failure of the past but from the needs of the future. The ambition of Vision 2020 is that increased traffic and new operational requirements to best serve citizens will not be accompanied by increased accidents. Two implications stem from this aim. Firstly that the basic relationship of accidents to traffic density will have to improve at least as fast as traffic is rising. Secondly, given the expectation that coping with much more traffic will demand new concepts for the air transport system and the new safety performance will have to be delivered in the context of those future operations.

Background

Air Transport scenario for the years 2020+

The Air Transport scenario adopted for the years 2020+, needed for the reflection on Safety, is based on the following elements:

– In macroscopic terms, Air Transport growth will conform to the GoP vision: triple traffic in Europe for the years 2020+, despite cyclical variations in annual growth. It is assumed that the 11th September event will not change the global trend ;

– Aircraft fleet: freight transport will be significantly developed during the next 20 years ; the world A/C fleet will be composed mainly by "current designed" aircraft, with a larger part of large A/C and a larger fleet for freight transportation ; passenger and freight transports will be more separed to optimise their respective costs operations;

– The second decade might see more intensive use of automatic flight control and management for freight aircraft.

– Airports will remain the scarce resource. As it is likely that the construction of new airports or new runways will be limited due to environment concerns, regional airports will be more exploited to satisfy the demand ;

– In terms of Air Traffic Management (ATM), the trends are towards Autonomous Aircraft for Free Routing with a prudent transfert of Aircraft separation task from ground to air ;

– It is also predicted that Communication, Navigation and Surveillance (CNS) means will be more and more based on satellites (GPS, Galileo ...).

The above assumptions are coherent with the outlined findings of the Challenge of more efficient air transport.

Scope and methodology

Scope

In this first phase, the scope is limited to the main sector of Commercial Air Transport based on fixed wing aircraft. It is also important to note that:

The goal is to propose R&TD actions to ensure the 80% reduction of accident rate, not of the Air Transport as it is today, but of the effective and efficient Air Transport system as visioned by the GoP, which is caracterised by:

- Three fold "density", due to the triple traffic
- All weather operation
- 99 % of flights within 15 mn of schedule
- Operation at Airports 24 h per day …

As these features have a strong influence on accident risk, reflections on Safety will have to take them into the problem context.

Although know-how and technologies are key factors to reach the GoP vision, others "non research issues" might also be determinant for progress: regulations, international agreements, states policies… When possible and appropriate, these issues will be mentioned to draw attention of decision-makers.

Methodology

The methodology used to address the Challenge of Safety is based on:

– The utilisation of available results, in particular the JSSI (Joint Strategic Safety Initiative) and the US CAST (Civil Aviation Safety Team) works.

– Concentration of effort to diminish drastically the major categories of accidents, as resulted in statistics and surveys (see chart) ; they are: Approach/Landing, CFIT (Controlled Flight Into Terrain), and Loss of Control.

More over, it is clear that, without any actions, the evolution towards GoP Air Transport scenario will increase the accidents rate in these categories.

– Focus of reflection to define and propose remedies to the main causes of accidents, taken into account the future features of Air Transport as set out by the GoP. They are mainly: atmospheric hazards, failure to maintain safe separation between aircraft in flight, collision hazards during ground operations and, of course, human factors.

– Anticipation of future accident causes, linked to the evolution of techniques / technologies used: extension of automation for instance, …

– The perceived need to improve Methods and Tools for engineering and Certification, as Aircraft and its inter-relation with the evolutive ATM system will be more and more complex.

– Focus on human role in the three complementary aspects: training, understanding human behaviour and performances, minimization of human error occurrence and consequences.

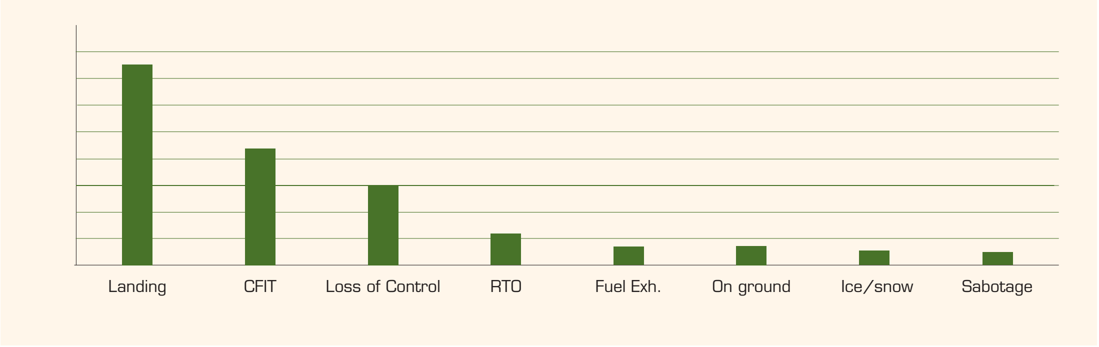


Figure 1: Statistics of worldwide airline hull loss accidents classified by type of event 1989 - 1998

Figure 2
Schematic Diagram of the Challenge of Safety

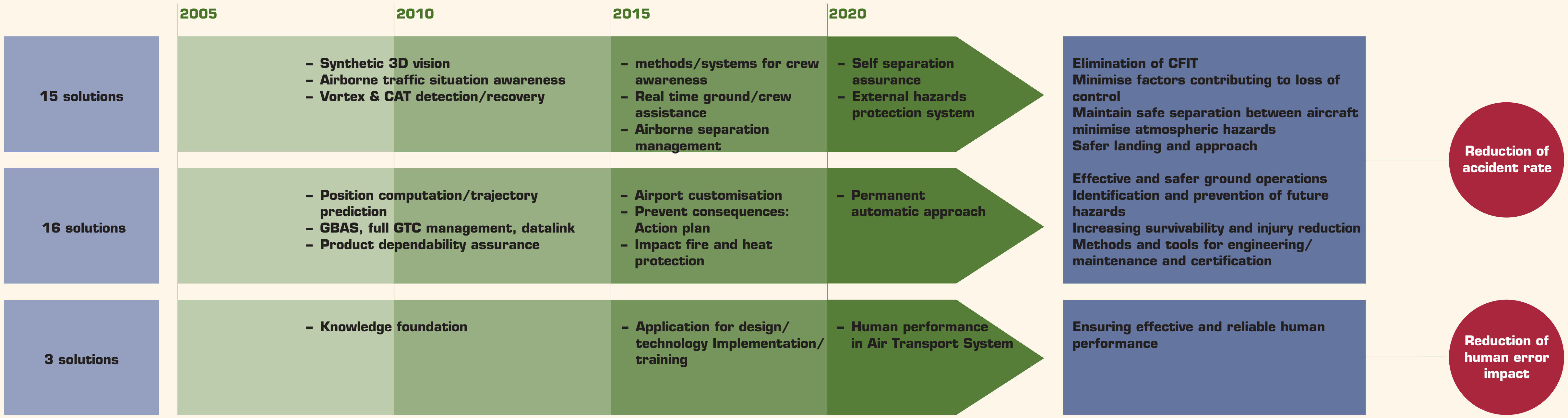


Figure 2

Challenges and Goals

Safety rests on three pillars:

– the technology, systems design and operations,

– regulation including certification and qualification, a special challenge will be presented in establishing systems of certification and qualification in the highly complex and integrated systems of the future,

– the human performance to operate the whole chain of Air Transport activities.

Two Goals were defined to meet the Safety challenge

– Goal 1: Reduction of the accident rate by 80%, addressing the first two pillars

– Goal 2: Reduction of human error and it consequences, addressing specifically the third pillar

An overview of the challenge can be found in **Figure 02**

Contributors

The main research routes to reach the Goals mentioned above are named Contributors. In **Figure 03** these Contributors are presented with milestones at 2008, 2015 and 2020, which are the dates where Research and Development should be achieved and actual implementation of proposed products/systems can begin, if the GoP vision for Air Transport in 2020 is to be realised. These milestones are referred to as short, mid and long term in the following text. The Contributors are based on the methodology outlined in the section Background.

Elimination of CFIT (Controlled Flight Into Terrain)

This Contributor was chosen because it is the second largest category of accidents (~20% of hull loss accidents). It should eliminate the majority of causes identified as primary factors of CFIT accidents. Its goal is a reduction by 90% of CFIT accident rate.

A solution proposed for the short term is **a better analysis of in-service experience data** with the development of new software tools sfor operators. Another solution for the short term is the **synthetic 3D vision capability** (see also Contributor Approach and Landing).

For the mid term, a **better provision of information to the crew** is proposed. This includes ATC instructions, weather, A/C positions, velocities, trajectories, terrain and obstacles, CFIT foreseeing capability, etc... This also means a ground elaboration of data and data link capability for digital transmission to aircraft. Furthermore, the **CFIT prevention through an improved set of warning cues** (visual and oral) for flight path intersection with terrain is proposed.

Short term recommendations of US CAST/Safer Skies and of European JSSI are not taken into account here.

Minimise factors contributing to LoC (Loss of Control)

This Contributor was chosen because LoC is the third largest category of accidents (~ 15 % of hull loss accidents) and it should eliminate the majority of identified primary factors of LoC accidents. The goal is a reduction of the LoC accident rate by 80%.

For the short term a solution proposed consists of i**mproved methods and tools for training** like training for recovering of aircraft upset situation, simulator models for post stall recovery. Another solution for the short term deals with **external hazards**.

It should provide a better knowledge of the effects of ice accretions and reliable means of A/C surface ice detection. Moreover, it should give ground and airborne means of detection of meteorological icing conditions and turbulence. For this solution, see also the Contributor "Minimizing Atmospheric Hazards".

For the mid term, a solution proposed is the **improved man-machine interface design** that implies a better knowledge of crew behaviour, the validity of assumed « normal pilot skill » as well as improved methods and systems for crew awareness of automation modes. Another solution consists of **on board systems for failure understanding and reconfiguration management**. This includes real time assistance to the crew, ground assistance capability via data link for mid term complex situation, false warning reduction,...

The short term solution **Improved Certification / Design Approval Criteria** is also proposed.
It supports as well the Contributor "Methods & Tools for Engineering & Certification".

Short term recommendations of US CAST / Safer Skies and of European JSSI are also not taken into account here.

Maintain Safe Separation Between Aircraft

This Contributor was identified to help in achieving a 80% reduction of risk in the context of tripled traffic, where the separation risk is roughly proportional to the square of the traffic. The focus of this Contributor is on preventing aircraft from flying conflict paths, better resolving the residual conflicts, and recovering from actual unresolved conflicts. The approach includes gradual introduction of Airborne Separation Assurance.

Solutions proposed for the short term are the definition of **new separation paradigms** (ground, air-ground and air based), the **definition of acceptable separation safety levels** and means to monitor safety performance.
Systems for improving airborne situation awareness are also proposed.

For the mid term, solutions proposed are the **development of gradually Airborne Spacing and Airborne Separation Assurance** applications as well as the improvement of technological and organisational support for better separation management. Furthermore, the development of an approach for **dynamic allocation of normative separation** is also considered.

The development of technology / methods for **allowing airborne self-separation assurance** are proposed as solutions for the long term.

The non research issues are the need for a global aviation approach for aircraft separation and the need for clear safety regulatory framework.

Minimizing Atmospheric Hazards

This Contributor is motivated by the fact that atmospheric hazards are a major cause of accidents. It focuses on the detection and avoidance of major causes such as Wake Vortex, Clear Air Turbulence, icing conditions as well as on the implementation of an External Hazards Prevention System for information and avoidance. The objective is to eliminate these causes of accidents. This Contributor also supports the Contributors of Effective and Safer Approach and Landing, Loss of Control and Air Transport System objectives.

A solution proposed for the short term is the **detection and avoidance of turbulence** through detection of Wake Vortex and Clear Air Turbulence using Laser Technology and through on board warning and automatic recovery. Another short term solution is to **guaranty runway capacity during bad meteorological condition**. This implies to study safety aspects of cross wind above 25 knots and the effect of buildings for turbulence. A model for each airport should also be built.

For the mid term, a solution for this contributor is **the implementation of the External Hazards Prevention System**. This requires the integration of data from on board equipment and from outside equipment (ground and satellite) for the real time dissemination of updated meteo data to all aircraft for avoidance of hazardous atmospheric zones, in relation with Air Traffic Control.

Basic technology needs for this Contributor are sensor technology at reasonable cost, meteorological modelization and data link worldwide.

Effective and Safer Approach and Landing

Approach and Landing is the main category of accident particularly in the non precision approach mode. Therefore, this Contributor addresses the development of effective and economical systems so as to make available Precision Approach/Landing and Automatic Approach to all A/C. Moreover, it addresses the development of Tactical decision tools, Vision Systems and Ground Control for awareness and monitoring. The goal is to reduce the accident rate by a factor of 90%.
This Contributor is linked to the Contributors CFIT Reduction and supports the general need for Situation Awareness.

Solutions proposed for the short term are:

– **Augmentation of usage of Precision Approach** through position computation and trajectory control with GNSS Augmentation System, predictive trajectory computation on ground and through management by Air Traffic Control

– **Development of Tactical Decision tools for the crews:** this means to provide flight monitoring and decision support within flight deck and the development of corresponding tools, shared by pilot and controller

– **Improvement of Vision System** through an Enhanced Vision System using infra red technology and a Synthetic Vision System with data fusion including terrain and obstacles data base

For the long term, a solution proposed is the **Development of full Automation with improved Awareness** with **permanent Automatic Approach and Landing** and with Synthetic Vision System and **predictive trajectory computation** on ground for monitoring

The non research issues necessary to implement this Contributor are the Development and dissemination of Augmentation Systems for localization, Data Link, Obstacles Data Base and Sensor Technologies for Vision.

Effective And Safer Ground Operation

Ground movement of aircraft and ground vehicles is a source of accidents, mainly in bad weather and poor visibility conditions, with cost and efficiency implications. Hence this Contributor focuses on improvements to ATC/GTC working conditions, through the development of aircraft database / datalink and flight management. Improvements on information display system, ground active sensoring network are also aimed at to achieve the goal of a reduction by 80% in accident rate on ground.

One solution proposed for the short term is the **improvement of ATC/GTC/aircraft datalink and communication systems** which requires the upgrading of GNSS Ground Base Augmentation System (GBAS), the full GTC management of A/C positions and routings as well as the transfer of routing and position information to A/C. Another solution for the short term is the **development of Active Ground Surveillance System (AGSS)** whereas the **Customised technology implementation in airports** is a solution for the mid term.

Non research issues to be tackled for this Contributor are certification and institutional aspects of Member States cooperation.

Identification & Prevention of Future Hazards

This Contributor reflects a proactive approach to accident prevention, anticipating expected changes in air transport. This approach is complementary to the reactive approach that is based on the analysis of past accident data. This Contributor is focused on the identification – and prevention of – hazards which have not yet generated any accident but might do so in the future (« future hazards »). The goal is to define and apply a methodology to help identifying future hazards and the setting of actions to prevent them and to monitor permanently the emergence of new hazards.

A solution for the short term is the **identification of the future hazards**. This means the determination and prioritization of areas of change and associated future hazards. Another short term solution is **monitoring emergence of new dangerous scenarios** through flight data recorder based incident analysis (this solution is complementary to the identification mentioned above). The last solution for the short term consists of **addressing already identified future hazards**. These are related to CNS/ATM security, impact of data link and co-operative management between air and ground, human performance issues. A solution for the mid term is the creation of a **research action plan** to prevent consequences of identified future hazards.

There are non research issues related to this Contributor. The basis of JSSI FAST Group should be used for the identification of areas of change / future hazards. Moreover the non research actions in action plan for prevention of future hazards have to be taken into account.

Increasing survivability and injury reduction in aircraft accidents and incidents

The increasing survivability and injury reduction is a major issue for public perception of safety and public confidence / acceptance of future air transport. It should allow a significant increase of number of survivors in many cases of accidents. This Contributor focuses on making research more efficient and creating synergies on the topics of impact protection, fire and smoke survivability and facilitation of evacuation and escape. The goal is to improve survivability and to reduce injuries for occupants.

The solution proposed include all short, mid and long term items. The solution **Impact Protection** foresees investigations on subjects like overhead bins, seat/floor strength, safety belts, air bag technologies, impact protection systems and energy absorption provisions. **Fire & Smoke Survivability** address between other things protection against smokes and fumes, outside burn through, heat and toxic fumes release, new aircraft door concepts as well as light weight breathing equipment. Effect of darkness and smokes, fire and heat protection, bed and aisles configurations, impact of new aircraft designs are tackled within the solution **Evacuation & Escape**.

Significant improvements related to this Contributor could be achieved without additional research through the use of already available technologies (if integrated into mature and economically feasible packages). The report to EC on survivability factors analysis of January 1995 should also be taken into account.

Methods and Tools for engineering and certification

This Contributor reflects the need to cope with changes in technologies, aviation system architecture, concepts, organisations and operations. It should contribute to improve the built-in dependability performance of aeronautical products (safety, reliability, survivability and vulnerability) for ground and airborne segments. The objective is to enable industry to design, produce and operate the civil aviation system with a built-in dependability level that meets the GoP standards.

For the short term, the solution proposed is to **Increase depth of product's dependability assessment**. This should help to facilitate design of dependable systems and to evaluate potential faults in all phases (design, operation, maintenance). Furthermore, methods to cover all potential factors to avoid problems associated with complex industrial organizations should be developed. Finally, affordable methods and tools to check systems robustness against experience gained should be looked for.

A solution for the mid term is to **Enlarge the scope of dependability assessments to the global Air Transport System** (ground segment, airborne / ground segment integration, training organizations…). This requires the allocation of safety objectives to individual products derived from requirements on overall civil aviation safety performance. This also implies the development of new methods and tools to demonstrate performance of each segment and of the global system. Furthermore, the necessity for increased efficiency to keep design, certification, maintenance and operation affordable for Industry has be considered.

The regulatory system (requirements and advisory materials) is a non research issue that has to be taken into account for this Contributor. The objectives could not be reached without the creation or revision of the regulations.

Ensuring effective and reliable human performance

Human performance is currently a major Contributor to accident, and developments in air sector technology and context are likely to make this worse. Therefore, the priority of this Contributor is to identify key human variables and to create an extensive database relating human performance to safety. This will require further development and validation of measurement tools and models. This will then allow philosophies, guidelines, and evaluations to be developed for system design and implementation. In the longer term the ability to analyse the human as part of a complex air 'system-of-systems' will enable a holistic approach to be taken to improve error tolerance and recovery, as well as reliability and safety. The goal is to create 100% capability to either avoid or to fully recover from accidents caused by human performance

The solution proposed for the short term is to **build up a knowledge foundation** (tools, databases, models) of human performance and shaping factors in the air transport sector context. For the mid term this **knowledge foundation** should **be applied** to develop robust / valid design, to assess and implement technologies, working practices and training. The solution for the long term is to **integrate models and data** of human performance with other air sector component models to enable an holistic approach to safety management.

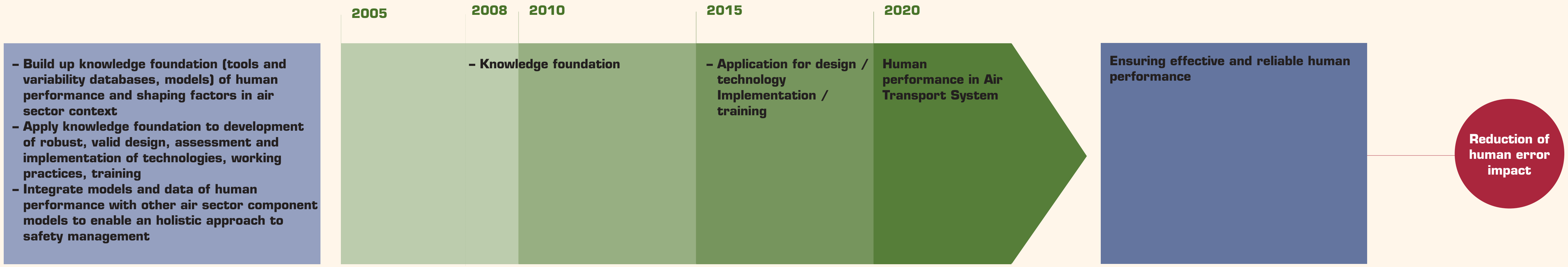
Legal developments in apportioning responsibility for accidents are non research issues that also have to be considered.

Figure 3
Synthesis of Contributors for the Challenge of Safety (1/2)

Contributors	2005	2008 / 2010	2015	2020	Objective
– Analysis of in-service data – Synthetic 3D vision capability – Better provision of information to the crew – Improved set of warning cues (visual and oral)		– New Software tools – Synthetic 3D vision	– Enhanced information / datalink – Improved warning		Elimination of CFIT
– Improved training methods and tools – Improved man-machine interface design – Reduction of vulnerability to external hazards – On board systems for failure understanding and reconfiguration management		– Stall recovery – Efficient ice detection	– Methods / systems for crew awareness – Real time ground / crew assistance		Minimise factors contributing to loss of control
– Definition of new separation paradigms – Improved airborne traffic situation awareness – Airborne Spacing and Airborne Separation Assurance applications – Develop technology / methods for allowing airborne self-separation assurance		– New separation paradigm – Airborne traffic situation awareness	– Airborne separation management	– Self separation assurance	Maintain safe separation between aircraft
– Detection and Avoidance of Turbulence – Guarantee runway capacity during bad meteorological conditions – Implementation of the External hazards prevention System		– Vortex & CAT detection / recovery – High cross wind effects		– External hazards protection system	Minimize atmospheric hazards
– Augmentation of usage of Precision Approach – Development of Tactical decision tools for the crews – Improvement of Vision System – Development of full Automation with improved Awareness		– Position computation / trajectory prediction – Flight monitoring and decision support on flight deck – Infra-red / synthetic vision		– Permanent automatic approach	Safer approach and landing
- Improvement of ATC/GTC/aircraft datalink and communication systems - Develop Active Ground Surveillance System - Customised technology implementation in airports		– GBAS, full GTC management, datalink – AGSS	– Airport Customisation		Effective and safer ground operation
– Identification of the future hazards – Monitoring emergence of new dangerous scenarios – Addressing already identified future hazards – Research action plan for mitigating future hazards		– Areas of change – FDR analysis – CNS, ATM, datalink	– Action plan for hazard prevention		Identification & prevention of future hazards
– Impact Protection – Fire & Smoke Survivability – Evacuation & Escape			– Impact, fire and heat protection		Increasing survivability and injury reduction
– Increase depth of product's dependability assessment; design, certification, maintenance – Enlarge the scope of dependability assessments to the global Air Transport System		– Product dependability assurance	– Dependability of Air Transport System		Methods and tools for engineering / Maintenance and certification

Reduction of accident rate by 80 %

Figure 3
Synthesis of Contributors for the Challenge of Safety (2/2)



Activities for implementation of Contributors

General presentation

The basic findings to reach the vision on Safety are the Contributors; they are the backbone of propositions for R&T planning.

Three activities are proposed for their implementation:

- Research topics are described in the previous section 'Contributors'. They are, in general terms **"system research"** complemented by development of specific mock-ups, for test and validation, of small / medium sizes.

- This system research will have to be supported by basic research for **enabling technologies** progress. Basic technologies research are, in general terms, closer to fundamental research and might be applied to other domains than Aeronautics.

- **Technology Integration Platforms** (TIP), which are in general of large size and aimed to validate the concepts proposed in different Contributors. They might be ground validation benches or specific A/C equipped for flight validation and test in operational context. Although the simple solution could be to propose a specific platform for each Contributor, economical consideration have led to propose a lesser number of TIP than Contributors. This approach is confirmed by the technical analysis that has shown that the proposed TIP can be reasonably designed to validate technically several concepts proposed in different Contributors.

The general presentation of activities for implementation of Contributors is summarised in **Figure 04**. The Solutions for Contributors are described in the previous chapter. The following paragraphs present the basic enabling technology needs and the Technology Integration Platforms.

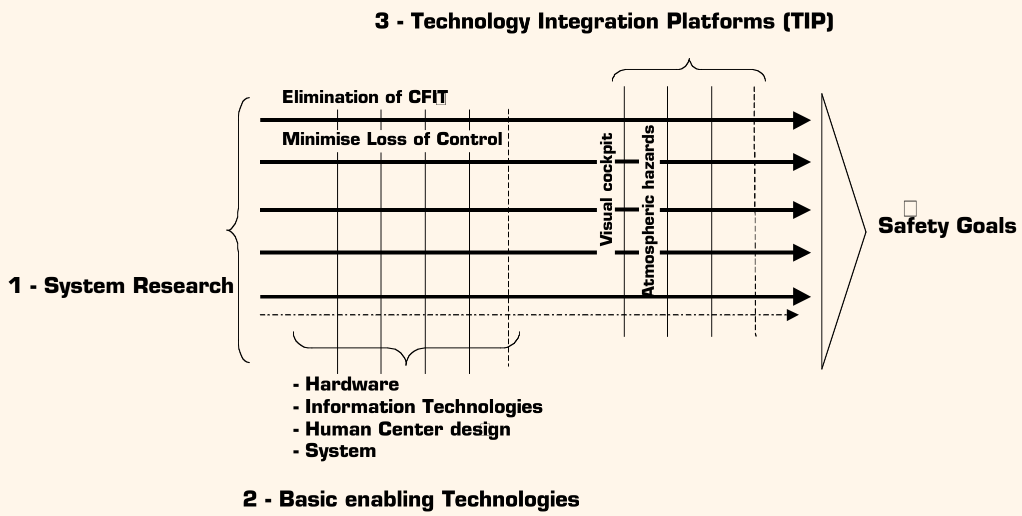


Figure 04: The three Activities for the implementation of the Contributors

Basic enabling technologies

The synthesis list of basic enabling technologies for all Contributors proposed, grouped in four headings, is shown in **Figure 05**. A more detailed description of the technology needs related to the different contributors is given in Annex 1.

Hardware

– Sensor (laser, light intensifier, radar infrared)
– Solid state laser
– Flat panel displays
– Micro displays
– Micro optic-electro-mechanical system (MOEMS)
– Audio
– Radio Frequency
– Signal processing
– High bandwidth datalink
– Material
– Textile
– Water guns
– Fire, smoke detection and recognition

Information Technologies

– Data fusion
– Pattern recognition
– Terrain and obstacle database processing
– Voice recognition
– Satellite positioning
– Guidance system
– Synthetic environment
– Visualisation including 3D

Human Centered design

– Human factors/behaviour/modelling
– Ergonomy/cognitive sciences
– Physiology perception
– Data, model, method for:
  - Organisation and culture
  - Automation
  - Information management
  - Cross cultural issues
  - Human Safety performance
  - Training effectiveness
  - Job design
  - Human behaviour under stress

System

– Prototyping tools
– Digital mock-up
– Simulation
– Integration
– System validation
– Software development tools
– Socio-technical knowledge
– System of systems

Figure 05: Basic technology needs for the Challenge of Safety

Technology Integration Platforms (TIP)

TIPs are proposed to validate the main concepts / systems or operational procedures proposed in Contributors.

It is to be noted that TIPs MAT, VAT and TPR are also proposed for the Security Challenge.

The Visual Cockpit – VC –

The function of the Visual Cockpit is to provide, through flight decks mock-ups, to pilots with validated and uninterrupted visual access to information relevant to their tasks for safe and increased operational capacity in all weather operation. It will use up to date vision systems technologies and multispectral data bases.

Atmospheric Hazards Prevention – AHP –

Composed of Ground and Airborne interlinked equipment, the TIP is designed to validate the detection and data exchange concerning Clear Air Turbulence, Wake Vortex, Windshear, Storms, icing … It will be used for flight test to validate the model and algorithms used for detection and warning. It will be based upon multi sensors data fusion to realise a reliable (no false detection) and effective detection (real-time, long range …)

Manager of Aircraft Trajectory – MAT –

This TIP will provide for a distributed management of aircraft trajectory, ensuring complementary and interoperability of the Airborne, Ground and Media segments. It encompasses the functions of preventing A/C from flying/taxiing conflicting trajectories, resolving residual conflicts and recovering from actual unresolved conflicts. Composed of interlinked Ground and Airborne segments, the system will provide dynamical re-allocation of responsibilities of crew and ATC on A/C separation in accordance with criteria for optimisation

Enhanced Navigation, Guidance & Control System for A/C Trajectory Protection and Recovery - TPR-

This TIP will be used to validate the functions:

- monitoring A/C trajectory for non abnormal deviation,
- protecting A/C manoeuvring by enhanced flight envelop,
- recovering and return of the A/C to safe situation / trajectory,
- automatic control and safe navigation / landing of A/C at predetermined Airfield.

All these functionalities are designed to ensure the Safety / Security of A/C with regard to human errors or suicidal behaviour in case of terrorist attacks.

The Vision Airport Tower – VAT –

This TIP will be centered on the development of a comprehensive airport control tower display and communication system as a focal point for all relevant information. It will use all available and innovative technologies to enhance the access to information and the sharing of information among all persons involved in the ground movement at Airport

The objective is the enhancement of Airport operations capacity and safety.

Humand centered Analysis and Demonstration for Integrated Air Transport – HCAD –

This TIP will be a focus for the assessment, development and integration of human -in-the-loop systems across the Air Transport sector

It will be based on a distributed network of simulators and models and will allow either the use of real equipment or its software models. Similarly human in the loop could be represented either by real humans, or in longer terms, by computational models of human behaviour

The overall goal is to maximise the efficiency and reliability of human performance in Air Transport through design and integration of technologies, working practices, organisation and training.

Integrated platform for system Development, Safety analysis & Certification – PSAC

Focused on A/C systems and ATM development, this platform will provide:

– system development / simulation methods & tools (with a specific focus on modelling, verification, validation and testing).

– safety analysis & certification methods and tools

In addition to standard software/hardware modelling, the platform should allow modelling and verification / validation of procedures and of normal / abnormal human behaviours

The objective is to improve the existing tools covering all development phases and integrate them into a common platform for more effectiveness

Knowledge Management System for Human Factors Integration – KMSH –

This TIP will be a proof of concept for a socio-technical network which captures and develops the participation of all air sector activities in the development and use of human factors knowledge. It should facilitate harmonised capability across CADMID (Concept, Assessment, Development, Manufacturing, Implementation, Disposal) cycle.

The network will collect and manage data, information and human expertise to create knowledge, which will be distributed in the right form, place and time to support effective practice.

It will overcome current lack of understanding and access to Human Factors, its fragmentation and the lack of visibility of its benefits.

Training Technologies and Concepts (TTaC)

The realisation of the GoP vision will require substantial training of the workforce in order to comply with both increased demands and the introduction of advanced technologies and working methods.

This TIP will bring together series of enabling technologies with advanced teaching and training methods that speed up training and enhance its effectiveness and consistency of output.

The TIP will comprise a number of experimental training facilities that pursue integrated solutions for issues related to both *topics* (automation training, ATM familiarisation, recovery from loss of control, CFIT prevention etc.) as well as *location* (on site, at home, at station, with networks or embedded) and air transport work force (flight crew, ATC, cabin, maintenance, security staff)

The transition to the vision will be facilitated by early availability of effective and pre proven training and re-training means.

Conclusions and recommendations

The proposition to meet the GoP Vision on Safety is based on the expectation of a three fold Air traffic increase and a more efficient and effective air transport system to best serve citizens' need.

Main research subjects are identified with indication of milestones. Safety is related to the definition of the Air Transport system as it will evolve, up to the common agreement of all stakeholders. Therefore, the implementation of Safety measures in terms of system/equipment to be fitted to the Aircraft and to the ground infrastructure will be defined according to the general context.

In any case, the proposed research contributors will have to be undertaken to produce results which are determinant for the definition of aircraft operation to reach the GoP vision.

The future work on the challenge of safety depends on the decision of ACARE Members on issues to be addressed for the second release of the SRA. Pending this decision, the following points could be undertaken as next steps:

- Extension of work to include the rotary wing aircraft ;
- Examination of potential Safety issues specific to Commuters or Business Aircraft ;
- Research for practical metrics to measure the contribution of different Solutions to the goals ;
- Reflection on potential additional Contributors necessary for Safety

Glossary

A/C	Aircraft
AGSS	Active Ground System Surveillance
ATC	Air Traffic Control
ATM	Air Traffic Management
CAST	Civil Aviation Safety Team
CAT	Clear Air Turbulence
CFIT	Controlled Flight Into Terrain
CNS	Communication, Navigation and Surveillance
FAST	Future Aviation Safety Team
FDR	Failure Detection Review
GBAS	Ground Base Augmentation System
GNSS	Global Navigation Satellite System
GoP	Group of Personalities
GTC	Ground Traffic Control
JSSI	Joint Safety Strategic Initiative
LoC	Loss of Control
R&T	Research and Technology refers to developing new technologies – more specifically it covers basic research, concepts, technology development and technology integration & validation
RTO	Run and Take Off
TIP	Technology Integration Platforms

Annex 1:
Basic Technology needs

BASIC TECHNOLOGIES NEEDS 1/2

Contributor	Hardware	IT Technologies	Human Centered	Systems
- Elimination of CFIT	- High bandwith datalink - Audio - Signal processing	- Data fusion - Terrain and obstacle database processing/ management	- Human factors behaviour/ modelisation	- Software development tools - Simulation - Integration
- Loss of Control	- Sensor (laser, radar, infrared) - Signal processing - High bandwith datalink	- Data fusion	- Human factors behaviour/ modelisation - Ergonomy/ cognitive science	- Software development tools - Simulation - Prototyping tool - Integration
- Safe separation	- High bandwith datalink - Satellite positionning	- Data fusion - Pattern recognition - Voice recognition - Terrain and obstacle database processing/ management - Guidance system - 3D Vizualization	- Ergonomy/ cognitive science - Human factors behaviour/ modelisation - Physiology perception	- Prototyping tools - Simulation Integration - System validation - Software development tools
- Atmospheric hazards	- Sensor (laser, radar, infrared) - Solid state laser - Signal processing - High bandwith datalink	- Data fusion	- Not applicable	- Simulation - System validation
- Approach and landing	- Sensor (laser, light intensifier, radar, infrared) - High bandwith datalink	- Data fusion - Pattern recognition - Terrain and obstacle database processing/ management	- Human factors behaviour/ modelisation	- Simulation - Integration - System validation

(1/2)

BASIC TECHNOLOGIES NEEDS 2/2

Contributor	Hardware	IT Technologies	Human Centered	Systems
- Ground operation	- Signal processing - High bandwith datalink - Sensor (laser, light intensifier, radar, infrared) - Flat panel display - MOEMS - Radio frequency - Solid state laser - High bandwith datalink	- Pattern recognition - Terrain and obstacle database processing/ management - Visualization	- Human factors behaviour/ modelisation - Ergonomy/ cognitive science	- Integration - System validation - Software developmesnt tools
- Future hazards	- Not applicable	- Not applicable	- Human factord/ behaviour/ modelisation - Ergonomy/ cognitive science	- Simulation - System validation - Socio-technical knowledge - Systems of systems
- Survivability	- Strong and tighter materials - Airbag technology - Fireproof textile - Energy absorbing construction - Self repairing materials - Fire suppressed systems - Water guns or liquid drive systems - Breathy protection - Fire, smoke detection	- Visual recognition of smoke and fire - Public address systems - Fire management systems	- Human behaviour patterns under stress - Behaviour effects of smoke, and darkness - Benefits of tactical cues - Spatial arrangements and cabin awareness	- Cabin mock-up with motion and lighting devices - After accidents demonstrators/ simulator - Digital mock-up - Intelligent testing demonstrators for accident research
- Engineering and certification	- Not applicable	- Not applicable	- Ergonomy/ cognitive science	- Prototyping tools - Simulation - System validation - Software development tools
- Human performance		- Synthetic environment	- Data, model, method for: - organisation and culture - automation - information management presentation - cross cultural issues - human safety performance - training effectiveness - job design	- Integration - System validation platform tool - Socio-technical knowledge

(2/2)