FAST is a new way of thinking, a new approach to look at the future.

It is not revolution, but evolution that follows from what aviation professionals normally do.

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Contents

- **Work with Eurocontrol**
  - **ANS-1**
- **Value for ECAST/CAST, i.e. "why continue FAST"**
- **Why support from experts is necessary**

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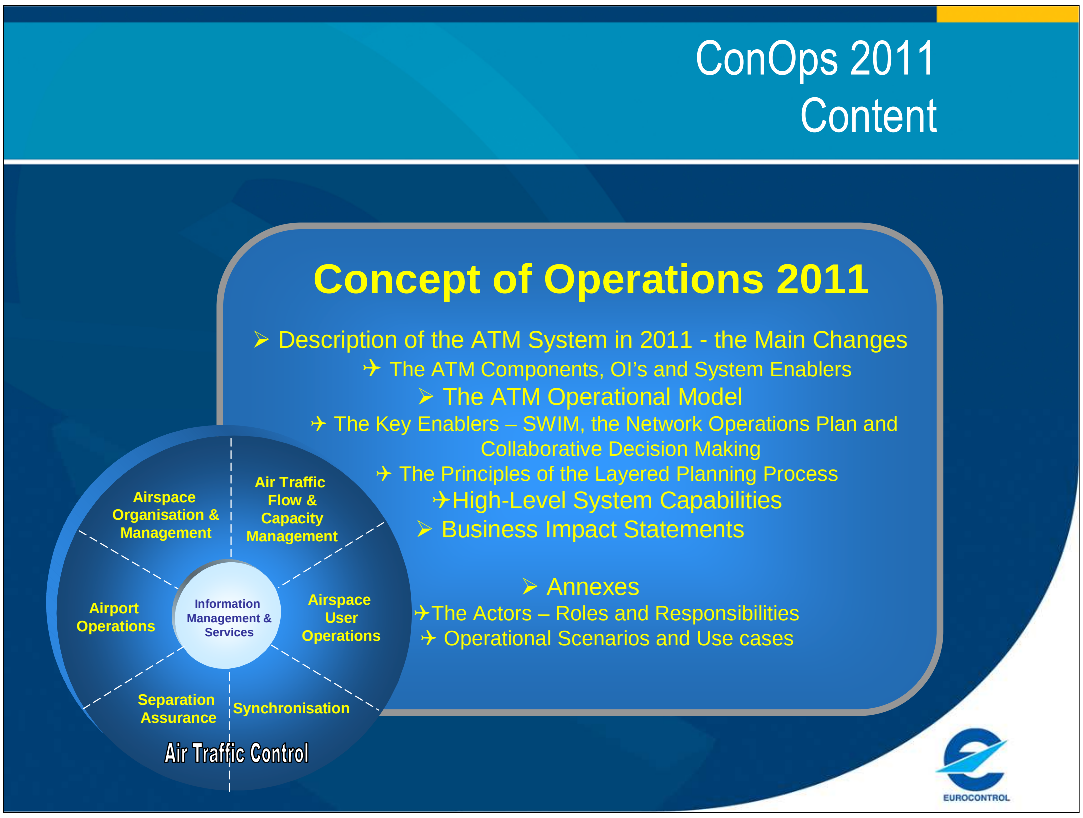
This presentation summarizes the results of the Future Aviation Safety Team effort starting with the end of AC-13 mining and other important topics such as

•Work with Eurocontrol

•Value for ECAST/CAST i.e. why continue FAST

•Why support from experts is necessary

ConOps 2011 Eurocontrol effort (ANS-1)



•Having spend some time on the assessment method, Now I would like to introduce briefly the subject of assessment.

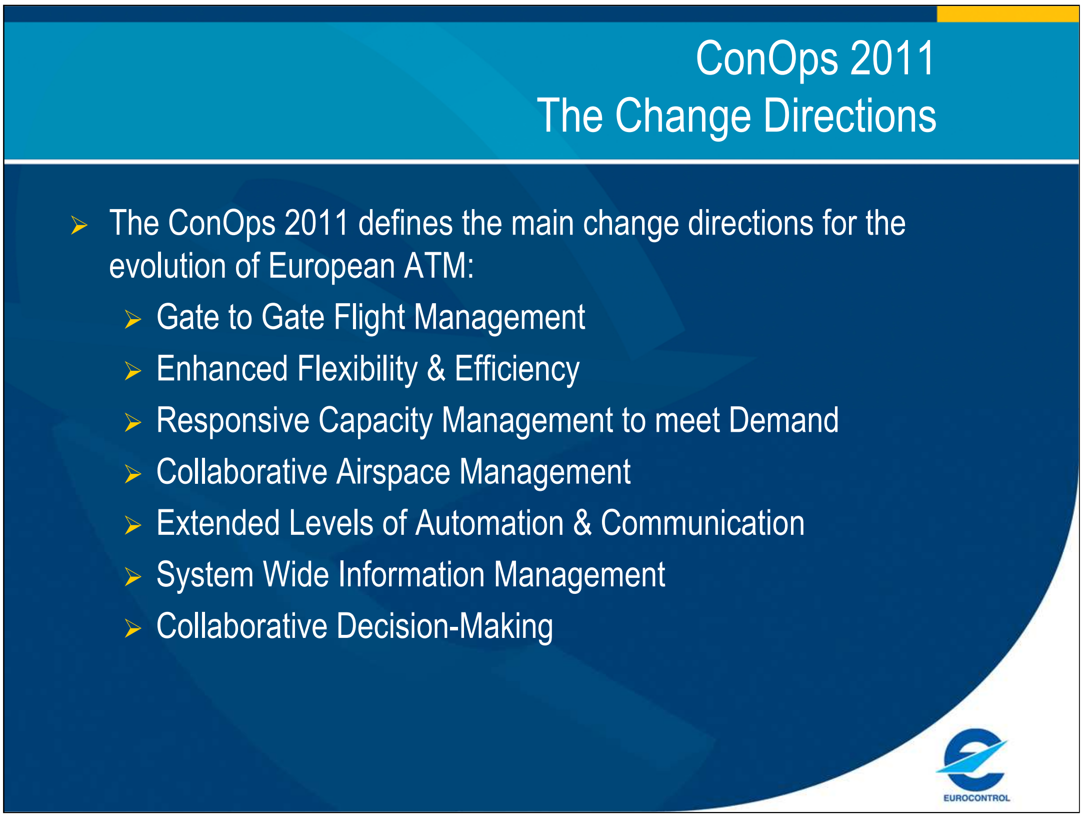
•The Eurocontrol Concept of Operations (ConOps) for 2011 represents an important step in the evolution of the European ATM system towards the target vision set out in the OCD and ATM 2000+ Strategy.

•It builds upon the envisaged changes of the ATM system (e.g. Single European Sky and Dynamic Management of European Airspace Network) in order to define a logical progression path leading to the target year of 2020.

•ConOps 2011 uses a detailed ATM Process Model (represented by the circle on the slide) to show the evolution of the ATM components and their respective interactions.

•The ATM process model is based on the layered planning process, encompassing three phases: strategic, pre-tactical and tactical

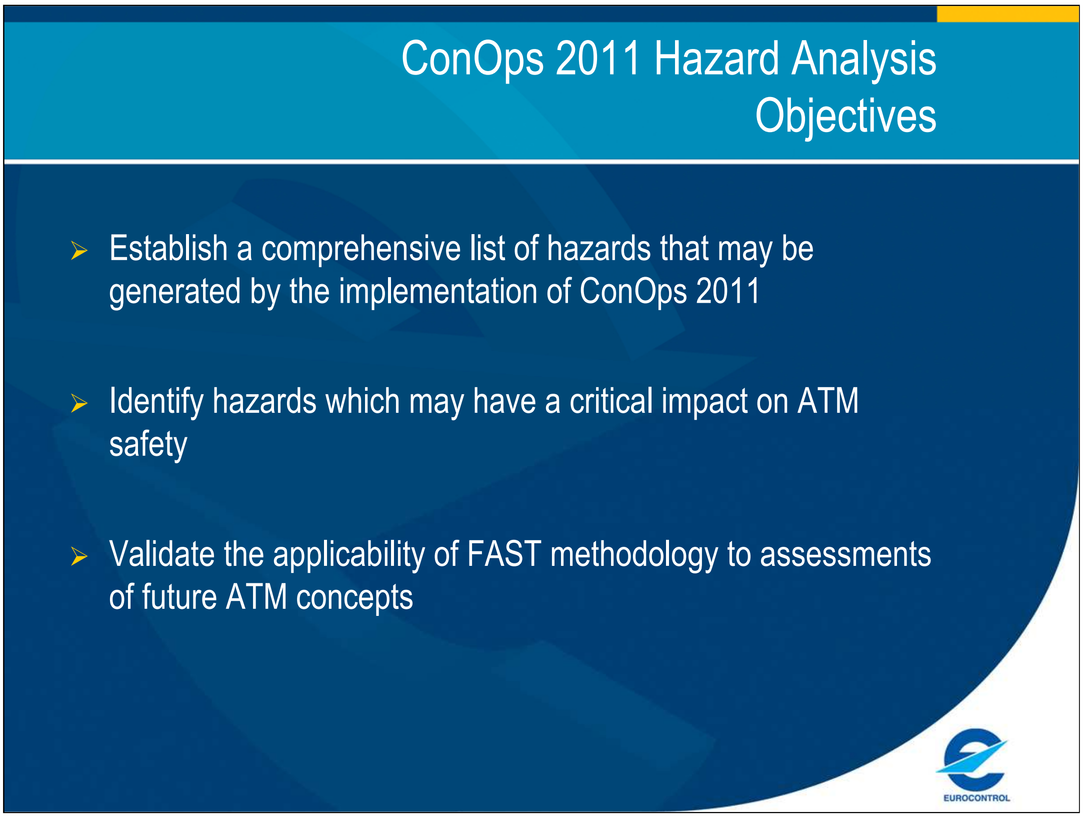
•A number of operational scenarios and use cases provided at annex to the ConOps document, describe in a structured manner and from operational perspective how the future system should work and how the actors interact and use the system.



The ConOps 2011 defines the main change directions for the evolution of European ATM, which can be summarised into the following 7 bullet points:

- Integrated Gate to Gate Flight Management, ensured through a collaborative process involving all concerned actors
- Enhanced Flexibility & Efficiency to better meet users' business objectives
- Responsive Capacity Management to meet Demand
- Collaborative Airspace Management to ensure the fair access to airspace and its most efficient utilisation
- Extended Levels of Automation in the cockpit and on the ground
- System Wide Information Management - to provide best possible integrated picture of the past, present and (planned) future state of the ATM situation.
- Collaborative Decision-Making in which the actor best able to make the decision is the one who does

•SWIM and CDM, together with the NOP, are the three key enablers for the ATM model and concept.



The ConOps 2011 preliminary hazard analysis was aimed at achieving to the extend possible the following objectives:

•Establish a comprehensive list of hazards that may be generated by the implementation of the Eurocontrol Concept of Operations for 2011

•Identify hazards which may have a critical impact on the future ATM system, the so called show stoppers.

•Validate the applicability of FAST prognostic hazard analysis method to the assessment of future ATM concepts.

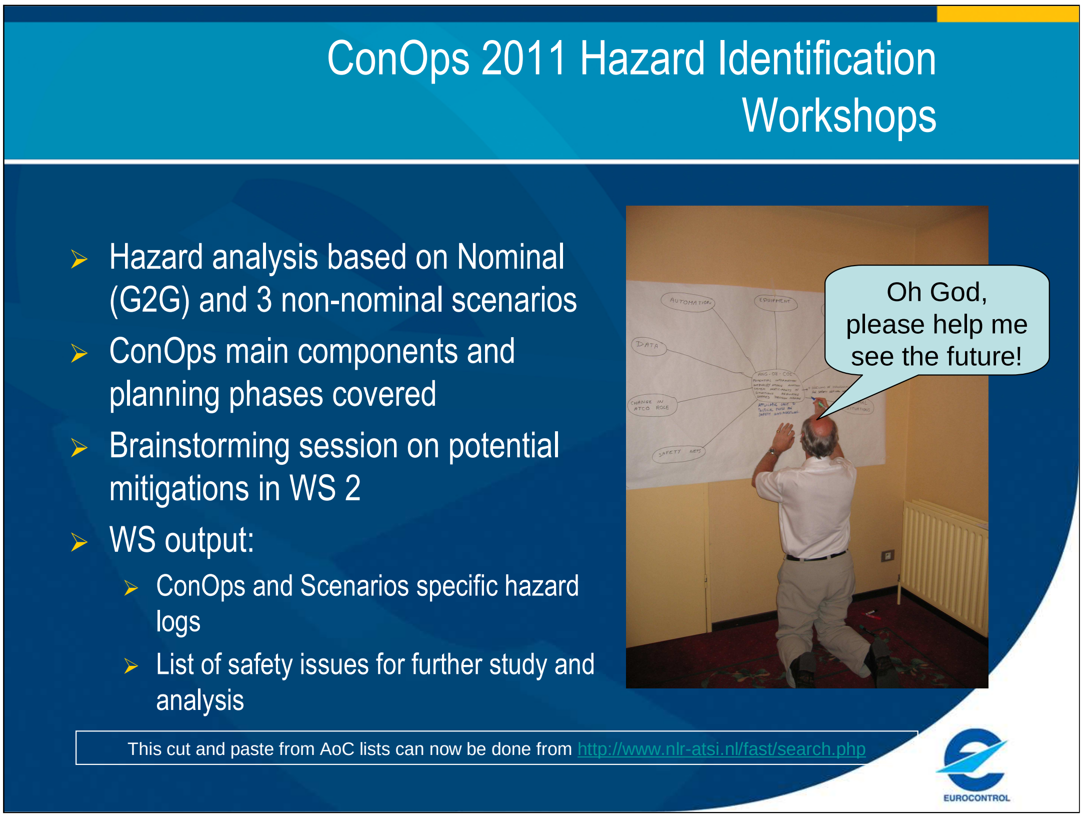
•The hazard identification included all the steps of the FAST process with the exception of step 9 “Formulate recommendations and identify Watch Items”

•Due to the volume of information to be digested by the experts and the limited time available to develop detailed understanding, five briefing packages were prepared and distributed, covering respectively AOM and FCM, ATC, AP, UO, system support.

•Hazard analysis was performed in two workshops held in June and July 2006.

•Essential factor for the success of the WS was the achievement of an excellent mix of expertise. All major ATM stakeholders were represented. Moreover, the mix of US and European expertise supported the cross-fertilisation of experience and knowledge, and provided for a fresh look at the future Eurocontrol Concept of Operations and its global interoperability.

•For better efficiency workshop participants were grouped in 3 teams, each one led by facilitator.



•The nominal G2G scenario and 3 non-nominal scenarios were used for hazard identification:

- •The G2G scenario is a description of a typical airline flight through in the future system from planning through to postassessment.
- • Execution of a General Business Aviation Flight
- •Airport Reduced Capacity (due to closure of a runway);
- •Flight Data Processing System (FDPS) failure at major ACC

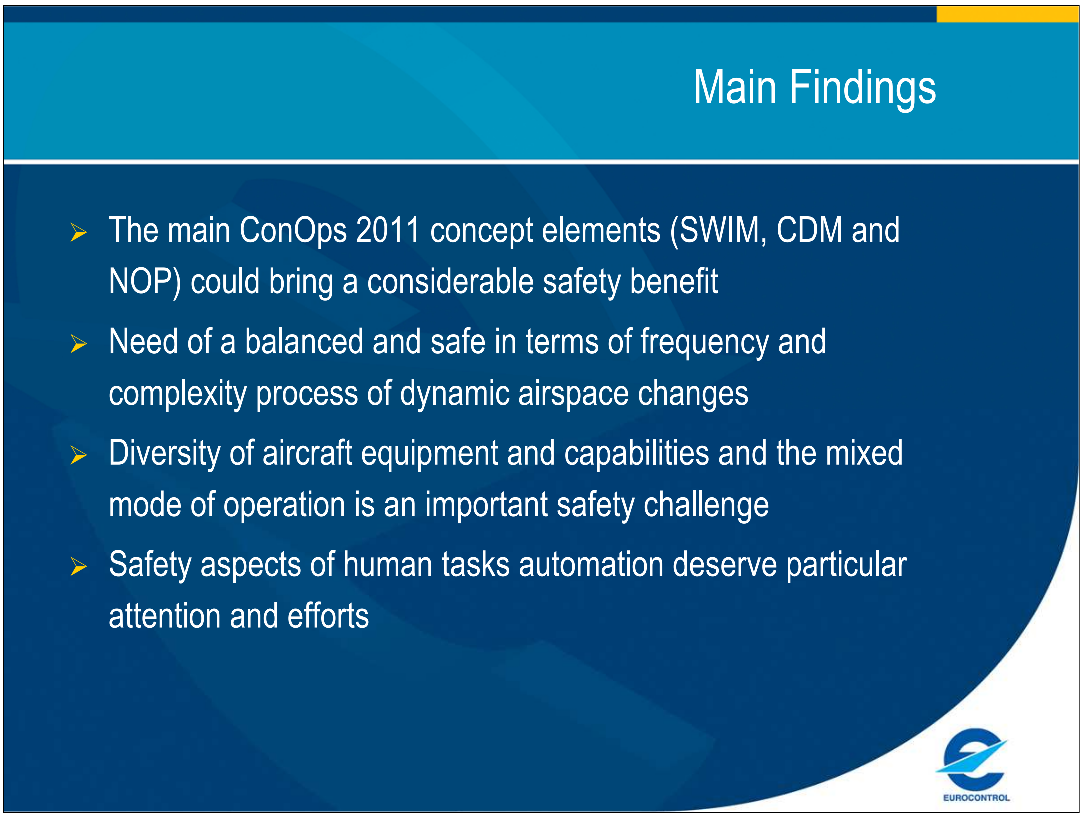
•In WS 1 participants were grouped in three teams according to the area of expertise to analyse the following ConOps components:

- •AOM / ATFCM;
- •ATC and Airport Operations;
- •Airspace Users (Aircraft) Operations.

➢the three phases of the layered planning process : strategic, pre-tactical and tactical

•A focused brainstorming session for identification of potential mitigations to the identified hazards was held in WS 2.

•Workshop output was collated in general ConOps and scenario related hazard logs and List of safety issues for further study and analysis.



•What are the main findings of the WS in brief?

•The main ConOps 2011 concept elements: Layered planning, NOP, SWIM and CDM could bring a significant safety benefit, provided that a set functional and integrity safety requirements are established and implemented in order to ensure the consistency, robustness and timeliness of the related processes, rules, procedures and products.

•The dynamic changes to the airspace should be balanced in terms of frequency and complexity and should ensure consistency between 4D trajectories, changes to airspace structures and status, and available resources in the ground based components of the ATM system

•The diversity of aircraft equipment and capabilities has been identified as an important safety challenge to be accounted of in the implementation of future operational concepts. Potential hazards may be generated by the mixed mode operations, non homogenous procedures or lack of such; use of multiple control techniques, and other.

• Expectantly, the hazard analysis revealed that safety aspects of automation of human tasks deserve particular attention and efforts. Although different levels of automation are realised in the cockpit and ground environments, pilots and controllers remain the ultimate decision makers in ConOps 2011 operational environment. And there is a need to ensure their skills and proficiency are maintained allowing for safe operations in all situations, especially in degraded modes of system operation.

> •Roles and responsibilities of the human operators are proportionate to the future system complexity and level of automation.
>
> •training needs to maintain human proficiency in all situations allowing for safe operations in degraded system modes.
>
> (e.g. false sense of safety even at very high traffic levels. Controller's and pilots skills in tools' performance monitoring, task prioritisation and management may be degraded)
>
> •increasing amount of information and the requirement to process it and take the

The ConOps hazard analysis helped us a number of safety management areas where further enhancement will be needed to meet the safety challenges of the future:

•Safety roles and responsibilities

The integration of airborne and ground based elements of the ATM system may lead to changes and possible reallocation of safety roles and responsibilities. The process should be supported by appropriate methods for advanced Human computer interaction.

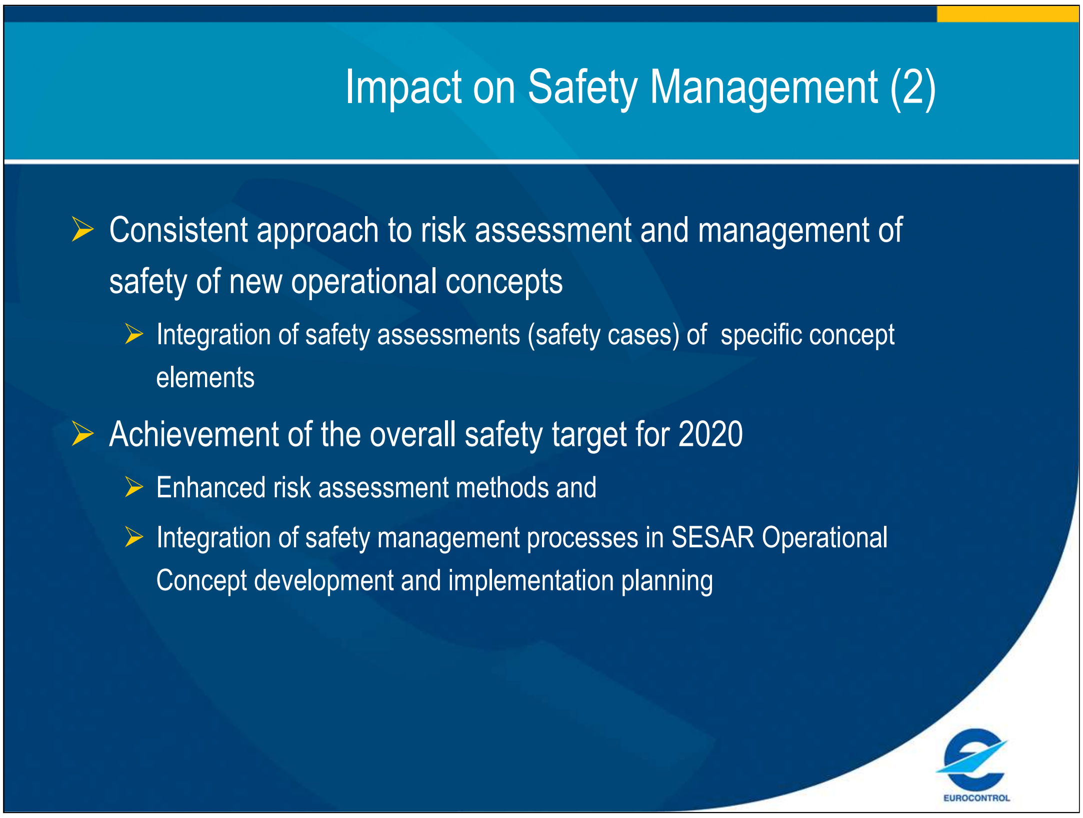
•Proactive safety management in early stages of change planning

The development and deployment of efficient mechanism for delivery of safety recommendations to the concept designers will enable the shift from technology driven to safety driven automation.

The methodologies for safety assessment of future operational concepts should be further enhanced.

•Safety in transition need to be addressed

The implementation of future operational concepts (SESAR) means an extended transition period till 2020 and beyond. Principles and requirements for safe transition planning supported by implementation guidance material will have to ensure that adequte safety targets are set and achieved throughout the transition period.

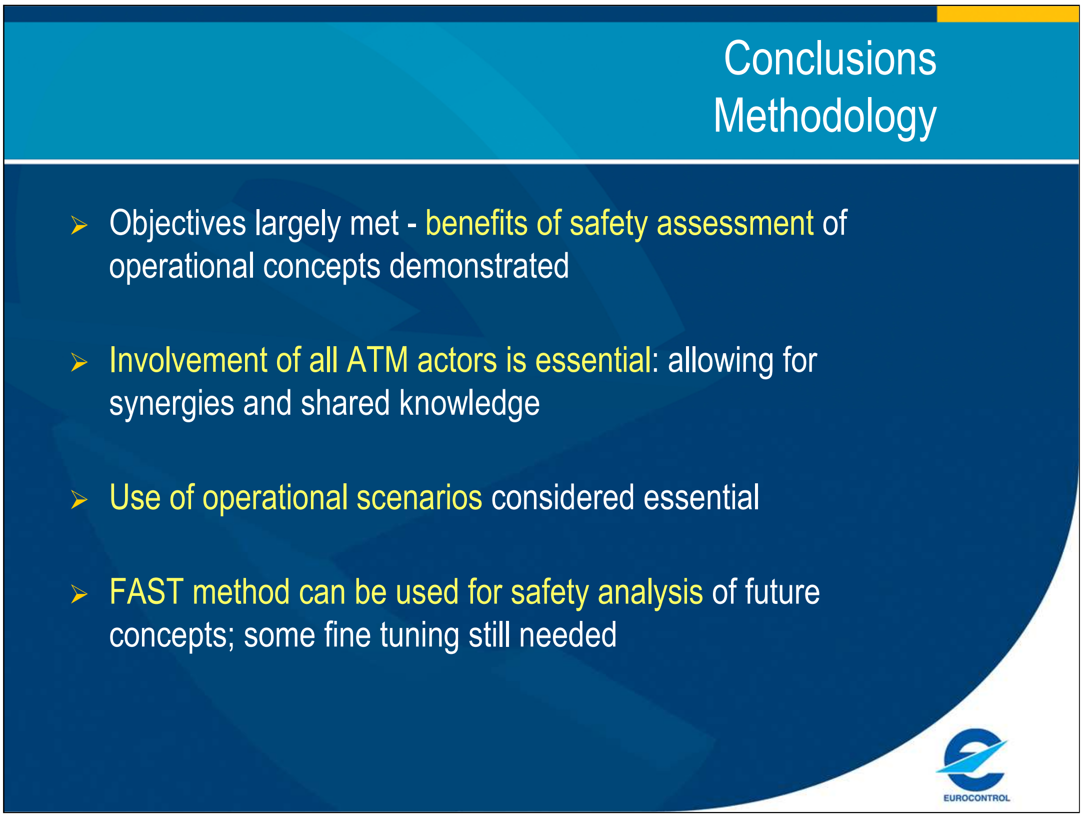


•Consistent approach to risk assessment and management of safety when implementing new operational concepts.

The achievement of this objective will be supported in particular by the establishment of a method for integration of safety assessments (safety cases) performed on specific concept elements and supporting technologies, or other planned changes, e.g. data link, ASAS applications, etc.

•Ensure the achievement of the overall safety target for 2020

Enhanced risk assessment methods (especially to have a reliable assessment of human contribution to risk), as well as integration of safety management processes in SESAR Operational Concept development and implementation planning activities.



•As promised at the start, a few observations to conclude my presentation.

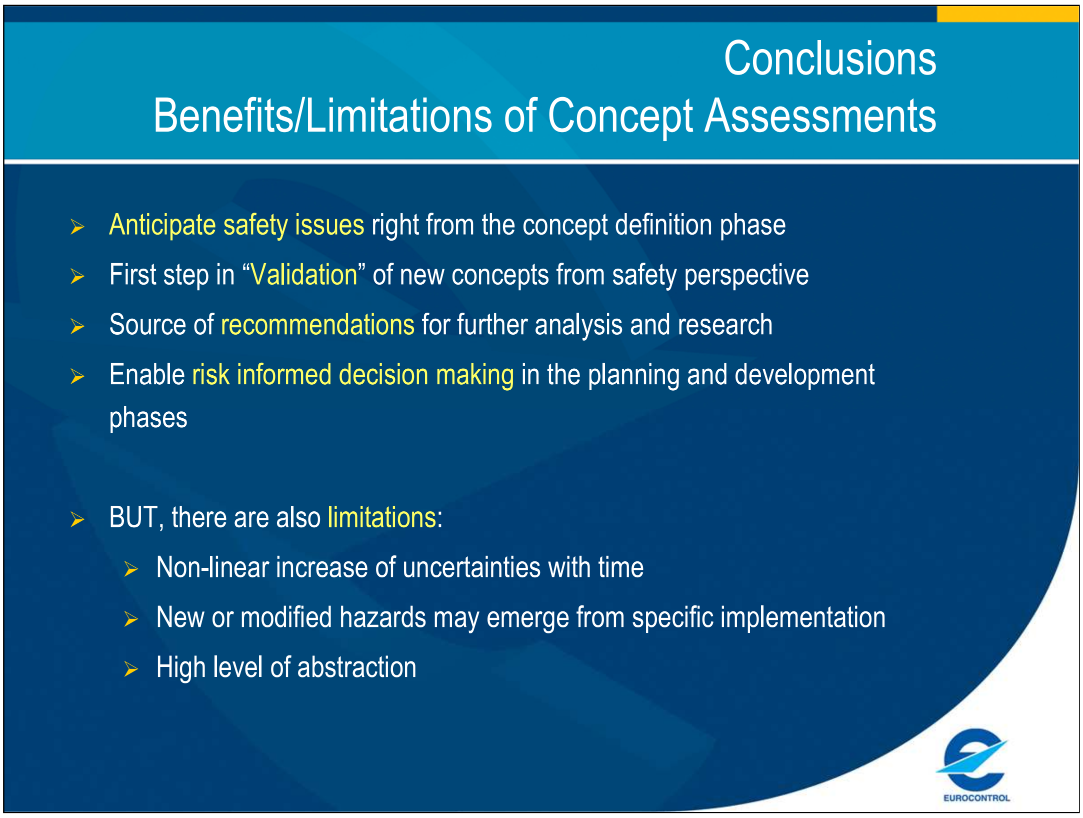
•The study objectives were largely met – the benefits of safety assessment of operational concepts have been demonstrated by the results from the two workshops. Hazards that may have critical impact on the ConOps implementation (showstoppers) have not been identified.

•A repository of potential hazards and safety issues has been established that will be taken into account in the further concept development work.

➢Involvement of all ATM actors is instrumental in achieving assessment objectives, allowing for synergy and shared knowledge among the aviation partners.

•The use of operational scenarios has proven to be essential in all steps of the assessment process. It enables the deep understanding of the future changes and their impact on operations, as well as improves process efficiency.

•FAST method can be used for safety analysis of future concepts, but some fine tuning is still needed. FAST has also identified this need and work is ongoing.



The proactive approach to safety of future ATM implemented through safety assessment of future concepts, has a number of important benefits. It enables us to:

•Anticipate safety issues right from the concept definition phase

•Enables us to make the first step in the "Validation" of the new concepts from safety perspective;

•The assessment results are clearly indicate the areas for further analysis and research of specific concept elements and implementation solutions;

•Furthermore, it enables the implementation of a risk informed decision making process already in the early planning and development phase.

There are also inherent limitations of the concept safety assessments associated to the extended planning horizon of future concepts. A few of them are the:

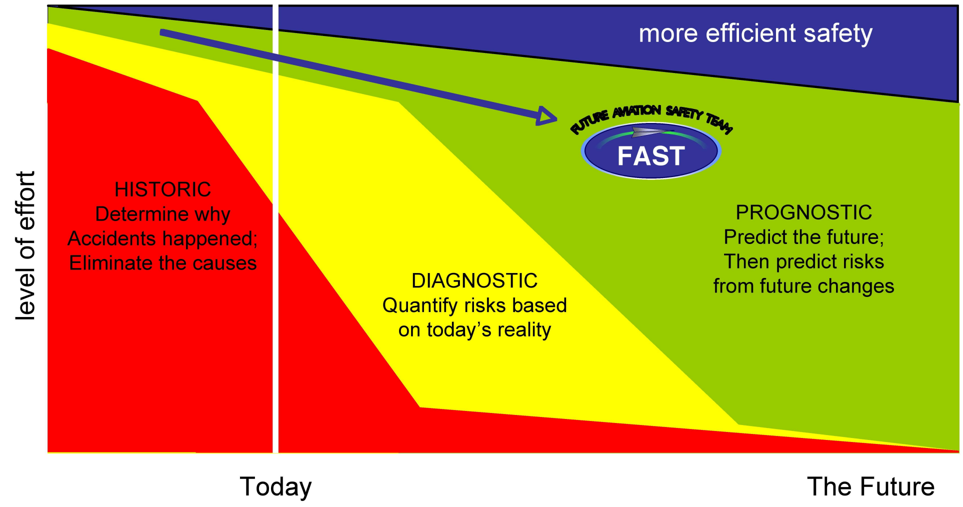
•Non-linear increase of uncertainties with time and related on hazard analysis

•New or modified hazards may emerge from specific implementation;

•Also, the high level of abstraction of concept descriptions, does not facilitate the safety analysis.

Why continue FAST

Level of Effort for Safety Practitioners versus Time



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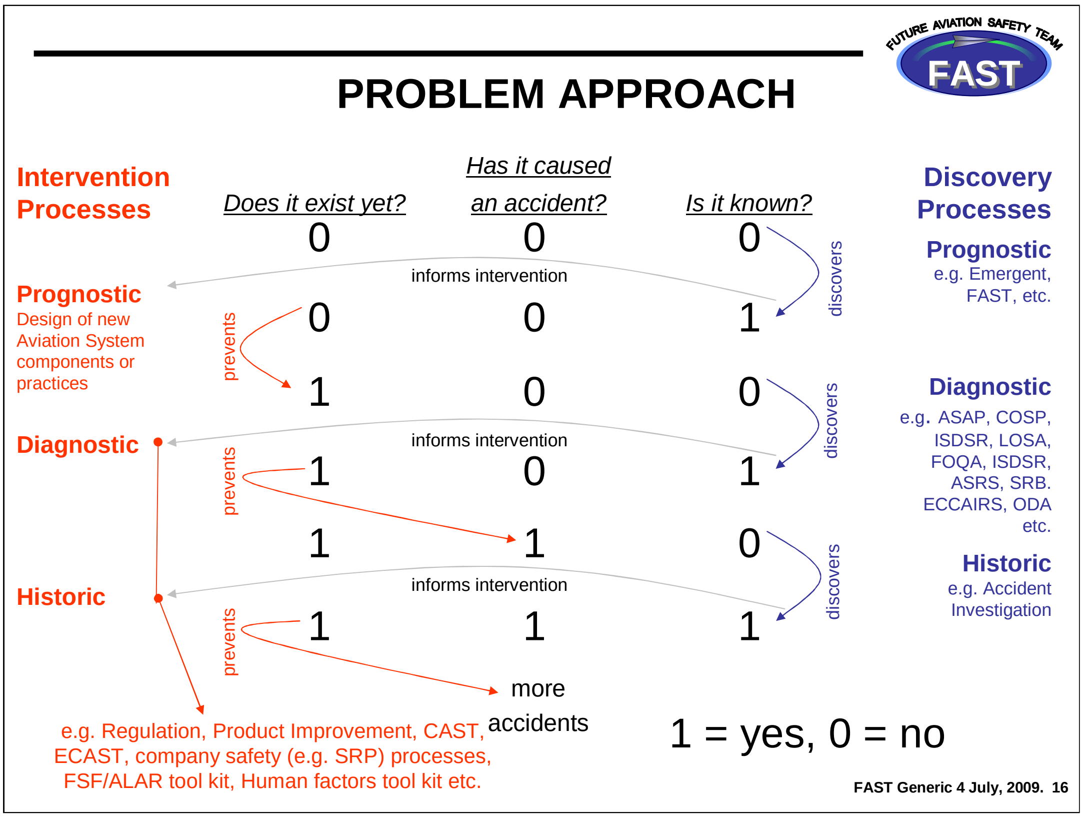
The single most important reason for the existence of the Future Aviation Safety Team (FAST) is to complete the Historic > Diagnostic > Prognostic safety-analysis cycle.

Without FAST Prognostic work, the aviation community runs the risk of over-emphasizing the Diagnostic problems of today or preoccupation with the Historic problems of the past. FAST provides the balance.

If future safety trends are ignored – or not systematically analyzed by a FAST-like process – the aviation system will again find itself in a reactive mode when future problems arrive.



Where FAST fits: A Hazard in the Aviation System…………………

Raises 3 important questions: Does the Hazard exist, has it caused an accident [or incident] and is it known.

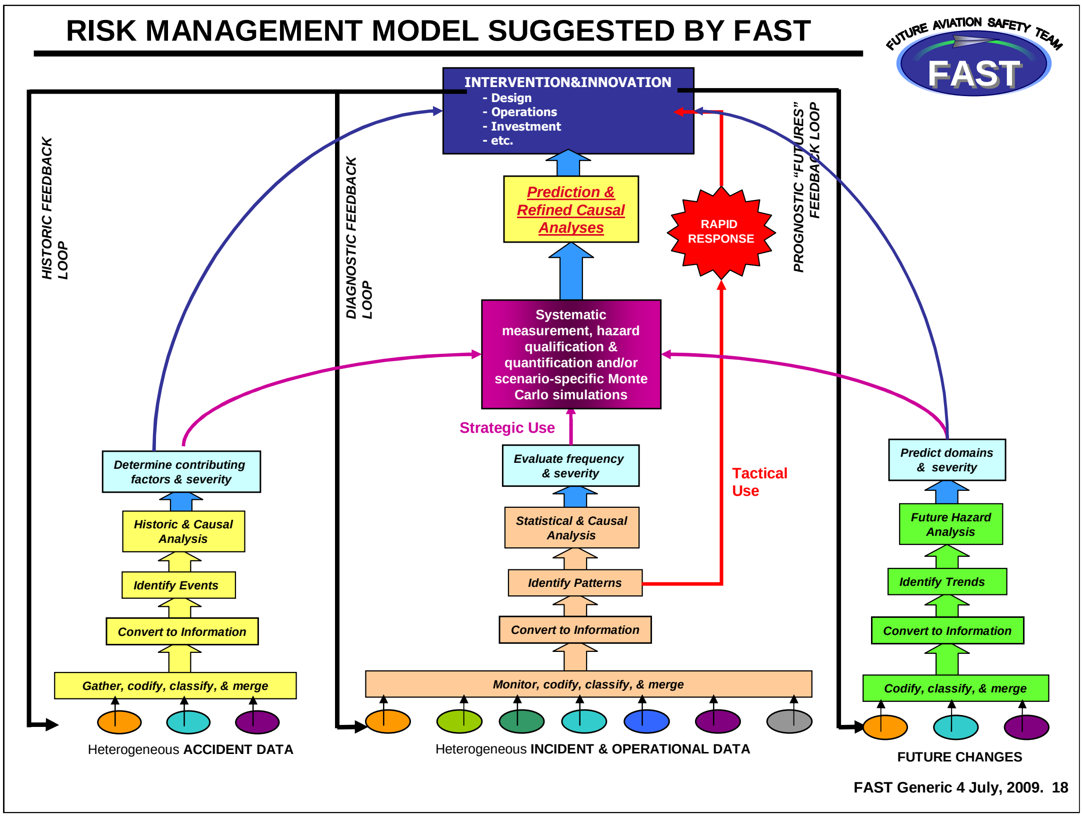
When investigating historic hazards, two things are clear, the hazard exists and it has already caused an accident. It may still be that the hazard as such may still be unknown. Knowing it exactly, provided the right intervention are implemented then helps to prevent more accidents from happening. Examples are regulations, product improvements, CAST interventions, FSF ALAR toolkit, Human factors toolkit, etc

The diagnostic route is different: the hazard may exist, but has not yet caused an accident and the hazard may still be unknown. However, knowing the hazard, e.g. from an incident or a stream of incidents or accident pre-cursors, may help to implement interventions before an accident happens. Examples are revised training, revised regulations, product improvements, etc.

Finally, there is prognostic safety where the hazards may not exist, have not yet caused an accident or even an incident and are not known.This is were FAST comes in. It should be noted that e.g. OEM’s of aircraft and equipment have structured approaches to look into the future when designing new stuff. However, FAST provides one structured method to look into the future using the concept of area’s of change.

Major FAST Products (2)

- The Historic [Forensic], Diagnostic, and Prognostic approach to thinking about aviation safety originated within the FAST Core Team as a result of FAST discussions on how to differentiate major safety domains.
- Both government and industry leaders have embraced these time-domain descriptors and have adopted this conceptual vocabulary.
- These three pillars now form the philosophical foundation of many current Safety Management Systems



This sheet is an original NASA overview of pro active management of Aviation risk from a past, present and future perspective.

In this sheet, the left-hand "Historic" side of this scheme is primarily the domain of CAST [Commercial Aviation Safety Team], whereas the right-hand "Prognostic/Future changes" side is that of FAST. The middle route, that is Heterogeneous INCIDENT & OPERATIONAL DATA, now under development, should bridge the gap between CAST & FAST. Important domain players are:

- Airline reporting and analysis of incidents. The JSSI-ODAS team has looked at this, including accident pre-cursors. This is to enhance the ECCAIRS system for the mandatory EU occurrence reporting.

- FAA, JAA and EASA and other authorities.

- JSSI as it provides a forum for discussion to stimulate and provide focus for RAPID (safety) ALERTS. Recent discussions on Total loss of radio communication over Europe, Altitude Level busts, Potential Loss of control through asphalt damage on tail surfaces are good examples.

- CAST's JIMDAT is a similar breeding place for new ideas, security alerts and is also looking to co-ordinate safety matters across the industry.

- Regional Safety Team Leaders like in South America, Asia

- EUROCONTROL, IATA, ICAO

FAST considers it vital that better co-ordination is provided to integrate the 3 streams and that RAPID ALERTS, e.g. like fuel leak procedures for all aircraft are mandated earlier than the step by step introduction as happened over the last 5 years.

Major FAST Products

- Inventory of over 210 major Areas of Change affecting the aviation system either from within or without.
  - As far as is known, this is the only such repository being actively maintained and updated on a periodic basis.
  - It covers eleven major aviation categories and time periods from 5 to 25 years into the future.
  - This list of change phenomena represents a systematic "check list" that must be considered by designers of future components systems, and operational concepts.

- The FAST prioritized these Areas of Change and developed a list of "Top Twenty" change phenomena affecting aviation that were provided to the JPDO, SESAR, Fly-Safe, Boeing, Airbus, and avionics manufacturers among others.

- From this list, in 2004 the FAST identified 4 major aviation safety themes of the future that have found resonance with industry and government experts, see next page and FAST Generic 2 - page 17.

SYNTHESIS FROM TOP 20 AREAS OF CHANGE

1. Introduction of new air, ground, and satellite-based automated systems
2. Increased heterogeneity of: aircraft types & flight capabilities, equipage & software, airspace utilization approaches, and development directions & timelines for airborne, ground, and space-based aviation support systems
3. Increase in absolute numbers of aviation operations and corresponding reduction in safety margins as a result of: increased demand, decreased separation and more frequent operation in or near adverse weather conditions
4. Ensuring adequate maintenance of air- and ground-based systems in an environment of increased outsourcing of work, increased complexity of hardware, firmware & software, and a shortage of qualified maintenance personnel

Common threads as they appeared within the 2001 top 20 AoC synthesis.

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FAST identified 157 Area's of Change [AoC] up till 2001.

The four Safety themes as indicated above are a synthesis from the top 20 AoC's out of the total list.

One use of this synthesis has been to provide a very compact look into the future.

FAST Summary of Results

- A structured methodology incorporated into a formal handbook.

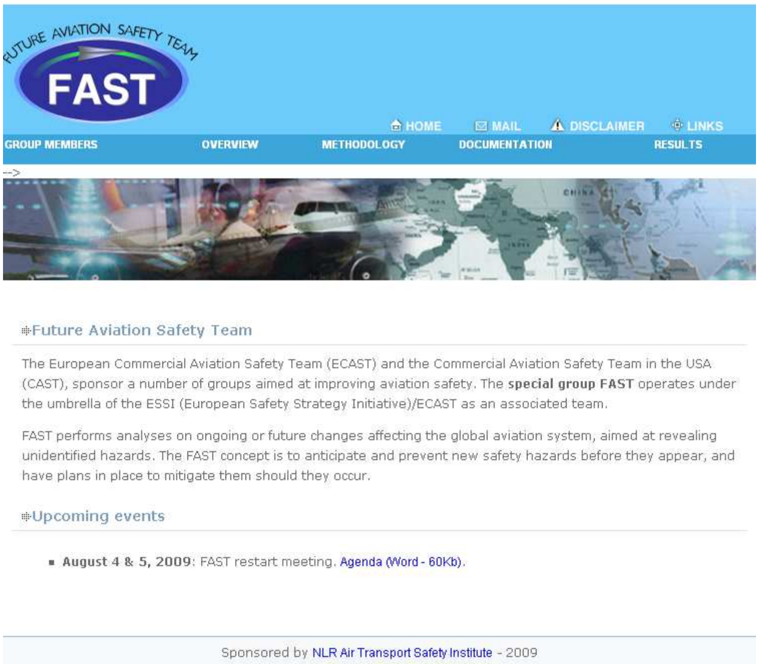
- A prioritized list of Areas of Change [AoC].

- Two applications/tests of the methodology:
  - Recommendations resulting from the study of the AOC “Increasing Crew Reliance on Cockpit Automation”, e.g. related to the Air Ground Space System [AGS]
  - Results from the study of future hazards generated by the concept of operations for 2011developed by EUROCONTROL.

- A FAST website http://www.nlr-atsi.nl/fast

FAST Website

http://www.nlr-atsi.nl/fast



Why support from experts is necessary

There are several reasons why experts are necessary

- When looking into the future, few data exist
  - Aerospace and non aerospace experts are involved in the future
  - It therefore makes sense to poll and synthesize their ideas
  - The more experts participate, the better the results
- FAST wants, like any other safety team be data driven
  - The experts contributing to FAST are considered “the data”
  - State of the art aggregation and ranking techniques (AHP) were used
- To assist in forward looking, FAST has developed the so called “Technology Watch Items”

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Preventative Safety initiative generates a significant amount of orientations (Hazards) based on expert judgment. Further investigations are needed to strengthen validity and to keep only the best for further processing.

FAST phase 3 has dedicated much energy and got skills in Rating, ranking techniques and applications. Acquired know-how how is fundamental for further development of any Safety process in particular for FAST.

With respect to expert judgment FAST has found that:

•Knowledge of the domain – FAST could have benefited from the contribution of more domain specialists, or from a better attendance

•Aggregation and ranking techniques

- State-of- the art techniques like AHP were used

- Furthermore, techniques were adapted to the resources and time available, e.g. use of the 10 vote system instead of AHP

All of these techniques are ready for use, and are essential to arrive at manageable sets of hazards and recommendations.

Technology watch items

- This section is a key section, because it describes the technology drivers that enable the
  - turns,
  - curves and
  - intersections of the technology roadmap.
- It provides the reader with a set of items to watch. Not just technical items, but “social science” items and business/affordability perspectives.
- Each Hazard Statement may have its own Future Technology Watch Items statement.
- Alternatively, the Future Technology Watch Items statement may apply to a focus area or an AOC.
- The following sheets show TWI’s divided over 5 areas
  - Aircraft and CNS/ATM technologies
  - Aircraft design and certification and circulation of safety information
  - Software and data bases certification processes
  - Security technologies
  - Scientific and Technological advances

Aircraft and CNS/ATM technology watch items:

- Systemic use of satellite for communication, navigation and surveillance and development of associated technologies and services
- Introduction of Free flight / free-routing plans. These concepts will introduce new automations modes.
- Emergence of 4D trajectories and their consequences of crew interface.
- Decommission plans of ground navigation aids.
- Emergence of FMS Systems designed and certified for sole means of navigation.
- Introduction of new warning systems and alerting techniques, and consolidation/integration of warnings and alerts involving problems with internal vehicle systems with those from external traffic, terrain, and weather avoidance/alerting systems.
- Development of “intelligent” aircraft

Aircraft design and certification and circulation of safety information

- R&D and Industry work to ensure that the lessons learned from specific experience is permanently captured and made readily available to the aviation industry.
- Appearance, development & implementation of more robust approach to design and a process that challenges the assumptions made in the safety analysis of flight critical functions.
- Manufacturers, trainers and regulators increasingly sharing applicable experience and lessons learned.
- Airlines & training institutions insisting that crews be made aware of manufacturers' design assumptions and regulators' requirements in execution of company operating procedures.
- Active awareness programs.

Software and data bases certification processes

- Tools to speed uploads including proper certification,
- Changes to Software Certification rules that would speed up the process.
- Regulators allowing red label S/W use during revenue flights.
- Pressure from manufacturers to self certify or reduce certification time /effort, in order to reduce cost and or reduce time to market of upgrades!
- Appearance of more RISC processors in system applications.
- Increased use of flight critical S/W and increased use of ARINC specs for data link applications.

Security technology watch items

- Increases in jamming technology capability.
- Identification of change/modify/delete existing code attack plans on the Internet.
- Increase in cyber threat level directed at aviation.
- Availability of devices on the Internet.
- Appearance of movies and or books on the subject that would inspire terrorists.

Scientific and Technological advances

Artificial Intelligence

- Development of system using Artificial Intelligence (e.g. neural nets, fuzzy logic) and their consequences on crew automation interaction.
- Assuming that "decision making computers" will have a learning capability, track appearance of solutions to share/exchange the individual learning between decision making computers [via " learning ground nodes/hubs"?].
- Artificial Intelligence technology advancements enabling inexpensive replication or substitution of human sensing and reasoning to an extent that a machine can successfully interpret a situation that it has never encountered, diagnose the problem with at least human reliability, and instigate system changes to address the problem
- Monitoring of general and applied research in these areas should be made to identify scientific breakthroughs.

Scientific and Technological advances - continued

- *Micro and Nanotechnologies*
  - Nanotechnologies, new computing techniques such as molecular computing and intelligent materials.
  - Monitoring of general and applied research should be made in these areas to identify scientific breakthroughs

- *Computer-aided decision-making and cognitive engineering*:
  - Collaborative decision-making (CDM); Computer Support to Cooperative Work (CSCW), Computer-based operating aids and management systems, Groupware, Monitoring and Supervisory Control, Industrial, Human, and Cognitive Engineering.

Scientific and Technological advances - continued

Network Technologies:

- Information and Communications Networks based upon all-optical technologies and new Internet protocols,
- Advanced Middleware,
- global networking and distributed architectures, Multimodal Interfaces, Semantic-based knowledge systems,
- Networked audio-visual systems, technology-enhanced learning, advanced displays, optical, opto-electronic, photonic functional components,
- Open development platforms for software and services, cognitive systems, GRID-based Systems for solving complex problems, risk management. (Supported in particular by the EC in the 6th FWP)

Other fields technologies:

  – Track advances in the medical field such as remote surgery and automated implanted medical devices. eHealth
  – eSafety of road and air transport.
  – Track technology progress and public-acceptance of other safety sensitive domains.

Any Questions?

Acronyms

- ADREP ICAO Accident/Incident Data Reporting System
- AoC Area of Change developed by FAST
- AGS Air Ground Space System
- ANSP Air Navigation Service Provider
- ATC Air Traffic Control
- AWOS Automatic Weather Observation System
- CAST Commercial Aviation Safety Team (North America)
- CICTT CAST/ICAO Common Taxonomy Team
- ConOps In FAST context: Eurocontrol's Concept of Operations for 2011
- ConOps General: air traffic providers concept of operations
- ESSI European Safety Strategy Initiative
- ECAST European Commercial Aviation Safety Team (EuroCAST)
- ECCAIRS European Co-ordination Centre for Aviation Incident Reporting Systems

Acronyms - continued

- FAST Future Aviation Safety Team
- GTG Gate-to-Gate
- ICAO International Civil Aviation Organization
- JAA Joint Aviation Authorities (Europe)
- JSSI JAA Safety Strategy Initiative
- JSAT Joint Safety Analysis Team (CAST)
- JSIT Joint Safety Implementation Team (CAST)
- JPDO Joint Planning and Development Office (part of NGATS in USA)
- NGATS Next Generation Air Transportation System (USA)
- SESAR Single European Sky ATM Research Programme
- TCAS Traffic Collision Avoidance System
- TAWS Terrain Avoidance Warning System