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

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

FAST

Contents

- **AC-13 Recommendations**
  - **Future Medium**
  - **Future Long**
- **Process development**
- **Change in Process to more customer focus**

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

•Process development.

•Change in process to more customer focus

Future Medium

5 - 10 years

Theme I: Integrated Air Ground Space system recommendations

	Score
13. CNS/ATM: Based on previous research and rule making, use required safety targets and safety analysis to develop and design components of the air/ground/space (AGS) system and enable total system safety assessment across organisational boundaries.	23.8
18. MANUFACTURERS: Based on previous research and rule making, use required safety targets and safety analysis to develop and design components of the air/ground/space (AGS) system and enable total system safety assessment across organisational boundaries.	23.8
10. REGULATORS: Based upon previous research, adopt and implement standards for certification and operation defining safety targets and safety analysis at the total system level for present and future air/ground/space (AGS) systems and enable total system safety assessment across organisational boundaries.	19.0
11. REGULATORS: Combine ATM safety regulations and Aircraft safety regulations in order to achieve a total system approach.	19.0
14. CNS/ATM: Develop appropriate procedures for abnormal and emergency situations, in particular failure conditions involving multiple alerts from various sources (for example, one alert from ground system and one from airborne system)	15.2

Theme I: Integrated Air ground Space system recommendations

	Score
15. ALL: Work with the rest of the aviation community to develop processes that will establish and maintain historical documentation containing the requirements, design details and assumptions that were made during initial design and any subsequent changes to the system (documentation should answer Know How, Know Why, Know Where). This process should include the establishment of reporting requirements and preservation of in-service feedback.	15.2
16. RESEARCH COMMUNITY: Work with the rest of the Aviation Community (including Regulators) to establish and evaluate safety targets and safety analysis at the present and future air/ground/space (AGS) system level, e.g., interaction both normal and abnormal conditions and security infringements, etc.	15.2
12. REGULATORS: Review and if necessary improve as appropriate todays certification process to ensure adequate resolution of existing interface of the total system.	14.3

Justification

- By 2020 FAST expects Aircraft, ATC, Airline Operations centers and Satellites to be nodes
  - of an Integrated Air Ground Space System (AGS) that
  - will operate during all phases of flight and
  - communicate through data link
- Significant changes through 2020 that will change the way actors/stakeholders operate individually & globally, communicate and co-operate
  - free routing/free flight
  - new airspace classification
  - 4-D dimensional trajectories

Justification

- Progressive development of this " Distributed multi agent system" in which
  - artificial agents (e.g. a computer or network of computers)
  - automation
  - computers
  - data bases and even
  - "artificial intelligence"

  will play an important role and is the response to the following civil aerospace challenges
  - increased aerospace capacity
  - better respect of the environment ("sustainable growth" approach)
  - improved safety

Justification

- FAST recommendations have been formulated to
  - prevent
  - control or
  - manage

  the Air Ground Space system hazards in a pro active way
- There are many organizations involved in the Air Ground Space system development
  - System level safety assessment is imperative
  - Also across organizational boundaries
  - Safety standards to be open and in full view of all involved

Theme IV: Absence of human agent recommendations

	Score
17. EDUCATION AND TRAINING: Training programs should emphasize pattern recognition and skill-based procedures to cope with time critical situations, rather than relying on knowledge based analysis. (CAST Intervention 487)	8.2
19. OPERATORS: Require training/standardization programs, which teach situation awareness. (The knowledge and understanding of the relevant elements of the pilot surroundings, including aircraft systems, and the pilots intentions) (CAST Intervention 147)	8.2

Justification to follow under the next time frame

Future long

> 10 years

Theme IV: Absence of human agent recommendations

	Score
20. RESEARCH COMMUNITY: Develop sensor and data management technology that detects unique and un-planned-for problems that replicates human sensory capability	19.2
21. RESEARCH COMMUNITY: Develop data sensing, data merging, data filtering, data analysis and diagnostic techniques (Artificial Intelligence, expert systems – in particular neural nets)	19.2
22 RESEARCH COMMUNITY: Develop compensation technology that replaces pilot and cabin crew reasoning and problem-solving abilities especially for those unique situations that require novel and immediate responses by ground or automatic systems	15.3
23. MANUFACTURERS: Develop data sensing, data merging, data filtering, data analysis and diagnostic techniques (Artificial Intelligence, expert systems – in particular neural nets) for supporting software and equipment	19.2
24. MANUFACTURERS: Work with the rest of the aviation community to develop processes that will establish and maintain historical documentation containing the requirements, design details and assumptions that were made during initial design and any subsequent changes to the system (documentation should answer Know How, Know Why, Know Where). This process should include the establishment of reporting requirements and preservation of in-service feedback	12.3
25. REGULATORS: Develop new regulatory measures dealing with issues of absence of human agents aboard aircraft (as well as absence of human agents in Supervisory Command and Control (SCC) facilities)	15.3
26. CNS/ATM/SCC: Devise methods to keep SCC advised of current aircraft performance capabilities that would normally be evaluated and communicated by flight crew and devise methods to intervene and correct anomalies.	12.3
27 EDUCATION AND TRAINING: Use education and training requirements as a cornerstone of the design process and use training as a source of feedback to the design process.	11.4

Justification

- Despite low probability of FAF (Fully Automatic Flight) with passengers in less than 20 years from now, FAST investigated it to:
  - highlight tendencies valid for automated manned flights, e.g. situational awareness
  - highlight that in silent cockpit crew awareness of phenomena may be poor and new detection technologies may be necessary in near future
- Detection technologies will be developed if FAF is built, but
- When NOT developed, FAF will not come, hence
  - recommendations strive to have technologies to
  - accurately detect, or solve unexpected safety related hazard on FAF

Justification

- Needed technologies for FAF
  - improved aural (hearing), olfactory (smell), tactile (feel) and visual sensors
  - nano & “smart” sensors that only broadcast information when deemed significant to provide a network of basic sensors when properly interpreted sense a problem
  - Wire-less detection and transmission to decision making computer
  - Decision making computer to ”ping” remote sensors when problems are expected and information is not coming from the sensors

Justification

- Biggest technology hurdle
  - data merging, diagnostic, interpretation, decision making & problem solving
    - crew member walks aft in cabin to observe fuel mist trailing from wing
    - FAF requires similar (at least functionally) device sensing and deduction capability for decision making and problem solving
  - Requires substantial application of
    - diagnostic, decision making, planning and action and capabilities
    - most addressed by “Artificial Intelligence”

- Burden of proof for
  - Acceptability will be "that a FAF airplane will need to be at least as good as a piloted aircraft".

Serious concern

•May lead to a regulatory overkill due to the many uncertainties around FAF,

•Regulatory overkill from the past, typical example:

automatic landing. Under autoland conditions, unrealistically harsh conditions need to be simulated, for instance under crosswind limits, leading to manual landings when crosswind exceeds the simulated limit of e.g. 25 knots.

Flight testing has shown that the automatics under these conditions would have made a perfect landing, while the manual landings in excess of 25 kts crosswind have shown in several cases to end up in significant mishaps.

Justification

- All automation topics, but especially FAF and also the integrated AGS, identify computer software safety and security issues, either as
  - inherent hazards or
  - as hazards generated by interactions.
  - Artificial Intelligence and rapid pace of software and technology development were identified as two of these interactions.
- In particular the following issues were raised:
  1) What the system learns is not predictable and may not be shared with subsequent operators;
  2) Certification issues with Artificial Intelligence (e.g. neural nets, fuzzy logic), etc.

Justification

- Increasingly autonomous military airplanes will be introduced along with long endurance communication and civil surveillance platforms for detecting fires, security threats and the like.
- Twenty years from now, it is possible that there will be
  – fairly autonomous cargo carrying airplanes flying, and
  – passenger airplanes may be being designed at that time.
- The transition to FAF will not occur at once. It will have a phased introduction,
  – starting with single pilot operated aircraft, which will necessitate substantial Human Factors research to integrate the pilot with its "semi-autonomous" aircraft.
  – This research may also have significant spin off for today's man-machine interfaces.

Design assumption documentation: a novel defense

For two recommendations appearing under Theme I & IV the justification may not be immediately clear

Design assumptions documentation

15.ALL: Work with the rest of the aviation community to develop processes that will establish and maintain historical documentation containing the requirements, design details and assumptions that were made during initial design and any subsequent changes to the system (documentation should answer Know How, Know Why, Know Where). This process should include the establishment of reporting requirements and preservation of in-service feedback.	15.2
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Justification

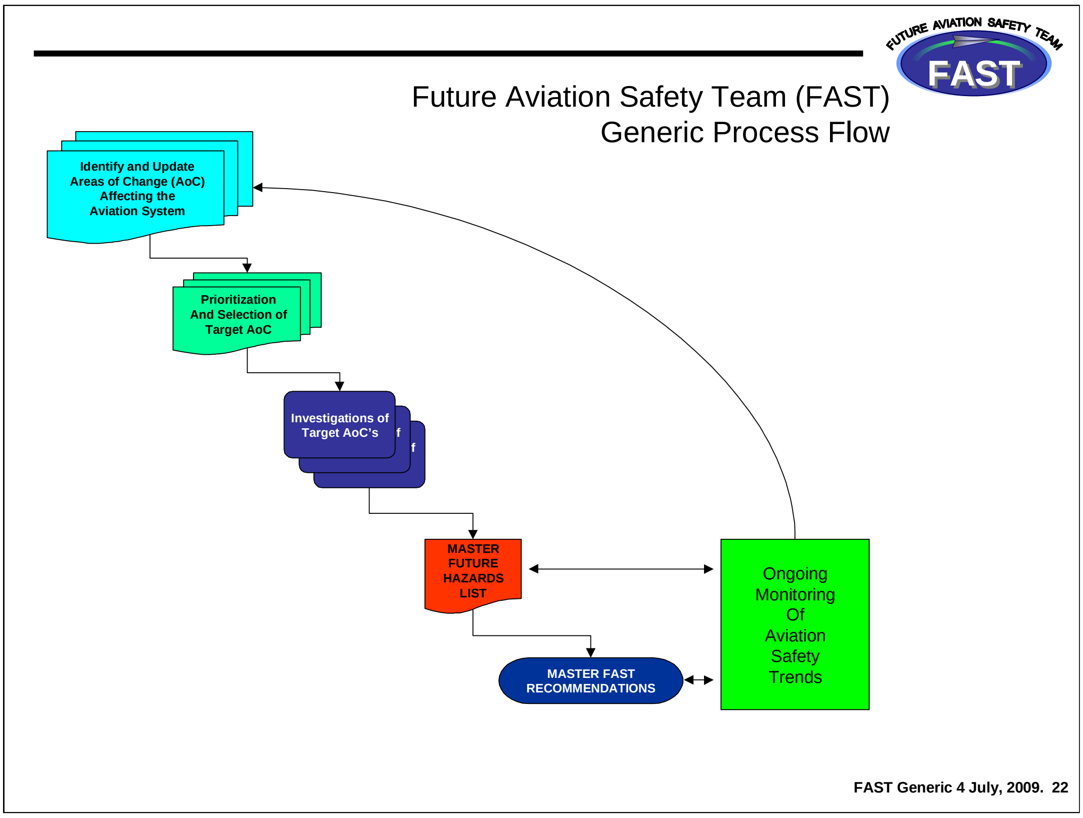
- FAST found for today's & future production systems
  - for AGS (Theme I) and FAF (Theme IV)
  - but also for many contemporary aircraft and
  - ground ATC and Space systems

  they will be longer in production & operation than ever before
- Requires a novel defense because
  - life span of type certificates [e.g. B737] longer than ever before, same for
  - FAF or any intermediate aircraft
  - due to increasing development cost
- Manufacturers will do derivatives as continuing process
  - also for ground ATC
  - space “nodes” of the future AGS system

Justification

- Result, many operators, designers, regulators, researchers
  - may have left the industry long before last derivative enters operation
  - new defense required
- “Environment” a key to many accidents
  - Boeing study suggests that in 60-70% of accidents environment was different from what was assumed during design
  - One of the origin’s of FAST
- Not only valid for flight deck automation but also for the whole aviation system

Process Development



The overall process consists of six major elements:

1. Identification of Areas of Change (AoC) affecting the aviation system either from within or from external sources

2. Prioritization and selection of highest priority AoC's for subsequent analysis

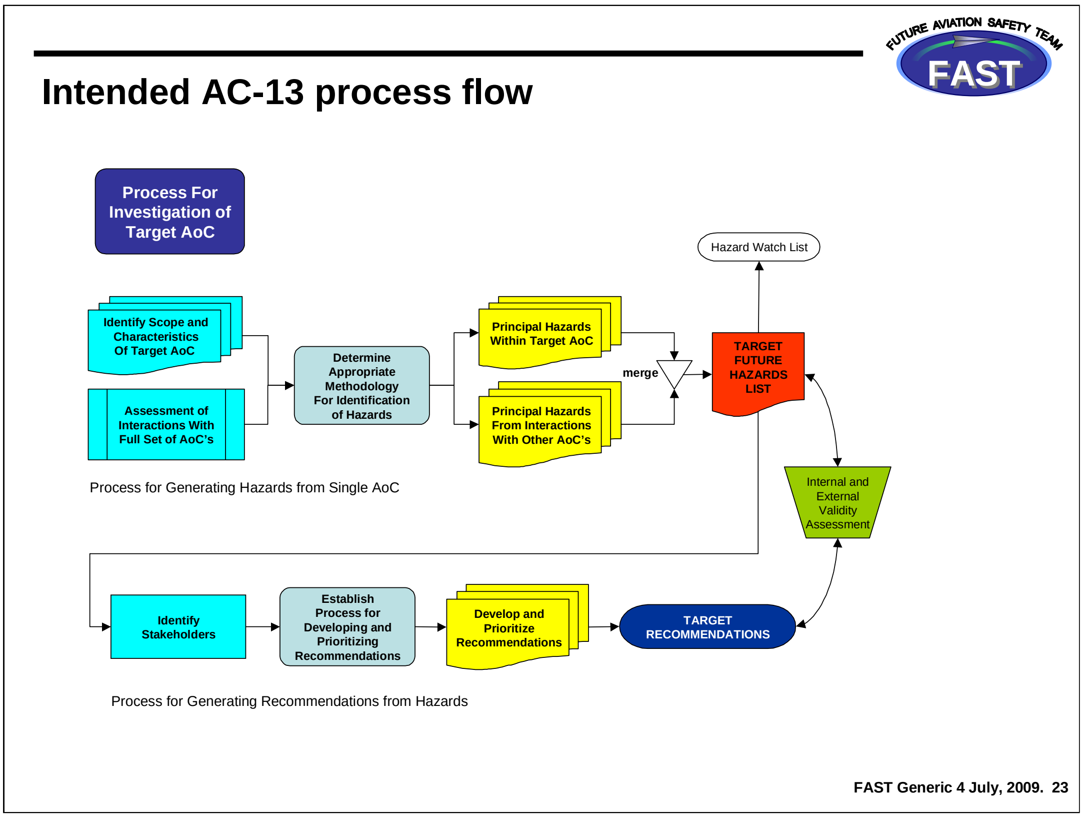
3. a) Identification of potential hazards arising from the inherent characteristics of the target AoC as well as potential hazards arising from interaction of the target AoC domain with other AoC's that may not be obvious

b) Formulation of target recommendations for action that are transmitted to cognizant safety organizations, authorities, and manufacturers

4. Assemble and update a Master Hazards List

5. Assemble and update a Master Recommendations List

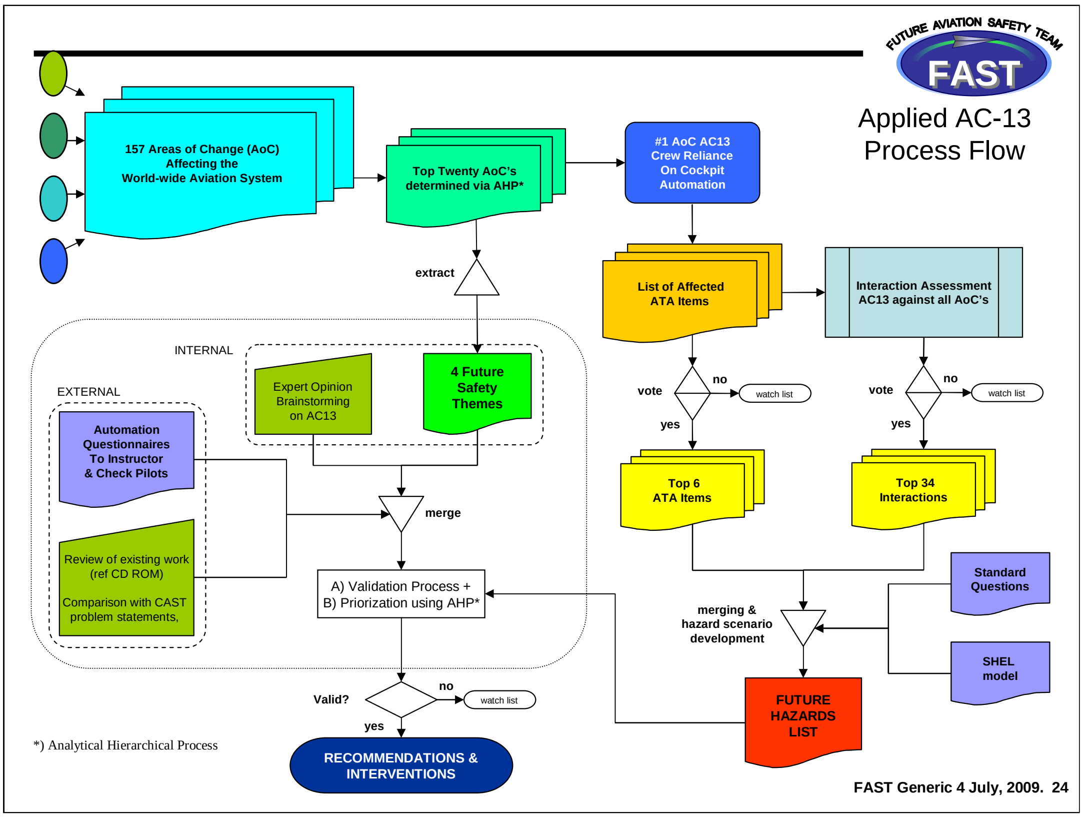
6. Continuous monitoring of the aviation system for purposes of updating the AoC's, hazards list, and recommendations via an appropriate feedback mechanism.



After the selection of an Area of Change to study is made, an appropriate methodology for the identification of hazards must be determined. In this case, since cockpit automation can be linked to ATA airplane classification codes, the ATA codes were uses to select the significant interactions. The following areas were selected

1. CRM issues arising from "automation"
2. Flight management systems
3. Situational awareness display
4. CNS-ATM (Free Flight)
5. Fully automated flight
6. Navigation using terrain following recognition

An important aspect of the generic FAST methodology is to look at all the interactions of the selected Area of Change (AoC) with the other areas of change.



The process flow used to analyze AC13 differs slightly from the Generic process. Lessons learned

1. The importance of clearly defining the scope; trends; scenarios and technology road maps for the Area of Change that is being studied.

2. The importance to build a Team where the main disciplines in relation with the area of Change under review are represented.

3. For Areas of Change that have a broad scope, the need to focus on selected aspects and mine the corresponding hazards that they would create.

4. The need to comprehensively identify the interactions arising from the target AoC with other areas of change and the need to focus on the most important ones.

5. When analyzing hazards resulting from interactions, the importance of addressing only those truly generated by the interactions and not those that would result from the other area of change

6. When it has been necessary to focus on selected facets of an area of change, the synthesis of hazards at the level of the whole area of change is a critical exercise.

7. The importance of formulating concise and correct hazards statements

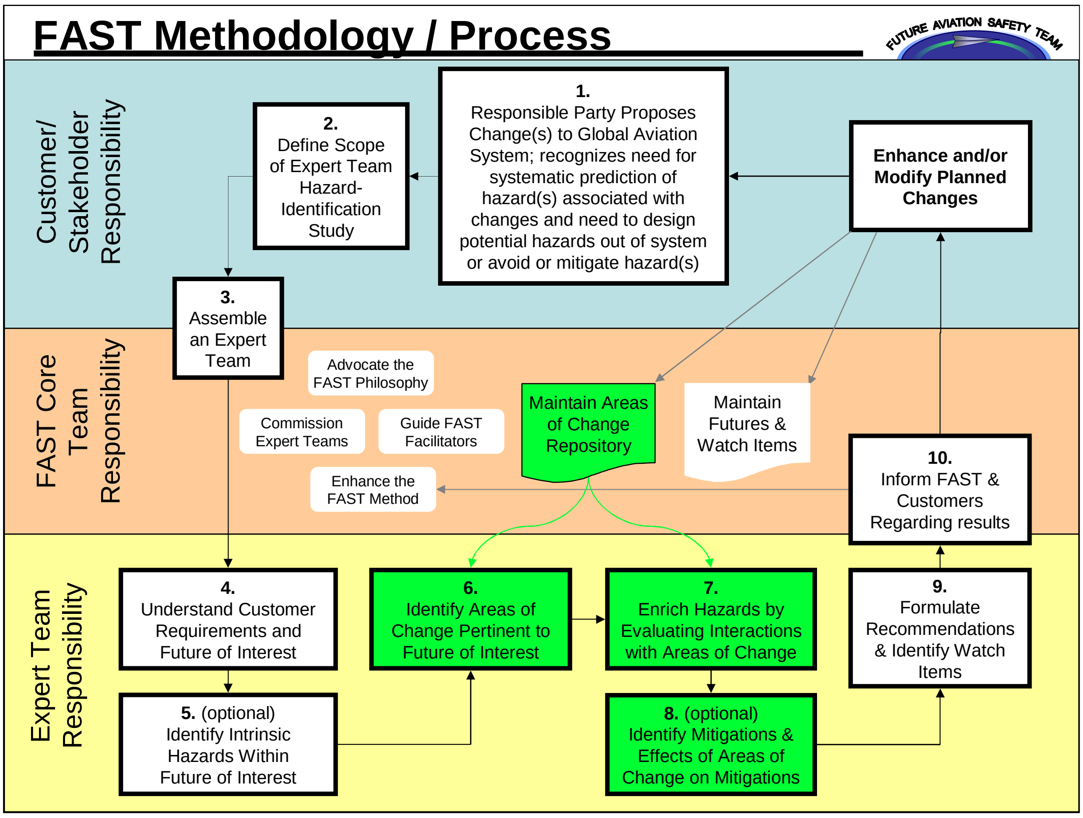
8. Necessary time should be devoted to the development of proposals for future work (perspective; discussion; amplified hazard statement; Future technology watch items)

9. Other tools than the Analytical Hierarchy Process were used to do prioritization. For example, an ordinal ranking scheme was used whereby members were given a fixed amount of votes to distribute among possible selections (usually between one third and one half of the possible options to be voted upon) that they were entitled to use as they wish (e.g. put all votes on only one option; spread their amount of votes on several options)

10. The step 5 of the methodology was not performed because we worked only on one area of change

Change in process to more customer focus

- Towards the end of AC-13 recommendation generating process, it was felt that the FAST methodology could gain in significance by making it available for any organization, not just JSSI or CAST
- The resulting process flow can be found on the next sheet



Step 1: Recognize your need for systematic prediction of hazards associated with changes and to design those hazards out of the system or avoid or mitigate the hazard.

Step 2: Clearly define the scope of the Expert Team study, incl your vision of the future,deliverables, schedule, resources, FAST facilitator(s).

Step 3: Assemble an Expert Team, 8-10 individuals, diverse perspectives are best, combine visionary and operational experience,one person of each customer and each stakeholder.

Step 4: Communicate with the Customer and FAST to understand the complete task, incl approximate "vision of the future" in question, desired deliverables, schedule & resources.

Step 5: (Optional, e.g. when a preliminary hazard analysis has already been done) Identify intrinsic hazards within future of interest, I.e. identify what could possibly go wrong..

Step 6: Identify areas of change – use the full list - pertinent to future of interest.

Step 7: Enrich hazards by evaluating interactions with Areas of Change; these maybe the most likely catalysts for revealing and understanding future hazards.

Step 8: (Optional, e.g. only when the customer sees substantial value in this activity). Identify mitigations & effects of areas of change on mitigations.

Step 9 & 10: formulate recommendations, identify watch items and inform customer and FAST regarding results. Refer to FAST handbook for detailed information

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