ACARE

STRATEGIC RESEARCH AGENDA

Advisory Council for Aeronautics Research in Europe

October 2004

VOLUME 2

Strategic Research Agenda

Volume 2

Advisory Council for Aeronautics Research in Europe

October 2004

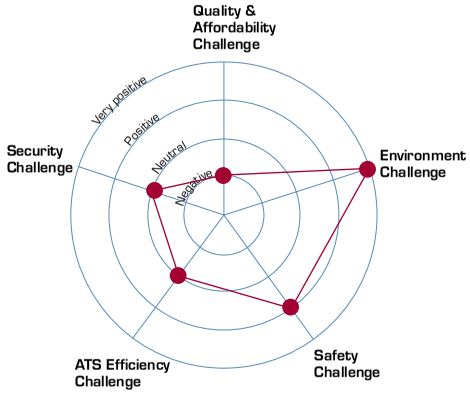
Table of contents

Volume 2

Introduction	5		
Technology area	ATM	Airport	Aircraft
Flight Physics	–	–	26
Aero-structures	–	–	28
Propulsion	–	–	31
Aircraft Avionics, Systems & Equipment	6	16	33
Flight Mechanics	7	–	39
Integrated Design & Validation (methods & tools)	7	16	39
Air Traffic Management	9	16	43
Airports	–	19	–
Human Factors	15	24	44
Innovative Concepts & Scenarios	15	25	45

Ultra Secure ATS

Ultra Green ATS



Challenge: Quality and affordability

Goals

- Reducing travel charges
- Increasing passenger choice
- Transforming air freight services
- Creating a competitive supply chain able to halve time-to-market

Challenge: Environment

Goals

- To reduce fuel consumption and CO_2 emissions by 50%
- To reduce perceived external noise by 50%
- To reduce NOx by 80%
- To make substantial progress in reducing the environmental impact of the manufacture, maintenance and disposal of aircraft and related products

Challenge: Safety

Goals

- Reduction of the accident rate by 80%.
- Reduction in human error and its consequences

Challenge: Air Transport System efficiency

Goals

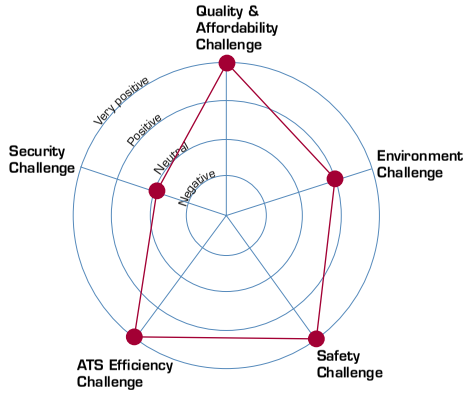
- To enable the Air Transport System to accommodate 3 times more aircraft movements by 2020 compared with 2000
- To reduce the time spent by passengers in airports to under 15 minutes for short-haul flights and to under 30 minutes for long-haul
- To enable 99% of flights to arrive and depart within 15 minutes of their advertised scheduled departure time, in all weather conditions

Challenge: Security

Goal

- Zero successful hijack.

Highly Customer Oriented ATS



Highly Time Efficient ATS

Highly Cost Efficient ATS

Figure 1

Introduction

Volume 2 is a specialist complement to Volume 1 of the 2nd edition of the ACARE Strategic Research Agenda and is mainly intended for use by the aeronautical Stakeholders as a tool for planning the implementation of the associated research programmes. As figure 1 shows, the Challenges and their related quantitative/qualitative goals which formed the focus of the first edition of the SRA, are retained in this second edition. The High Level Target Concepts collectively address all the Challenge areas and their related goals providing traceability with the first edition.

Volume 2 has been designed in tabular format as an index to the technical solutions proposed within volume 1. It has been structured on the ACARE taxonomy (a sector wide approach used for technology descriptions), by mapping the numerous technologies proposed under each HLTC against the ten broad taxonomy areas and the hierarchy of underlying domains. The analysis has been confined to the primary level of the Taxonomy to offer a consistent but informative representation of the various inputs. The applicability to the HLTC(s) of each technology solution has been recorded, together with a technology classification, its expected maturity level as a function of time, and the sector which is expected to be the leader in its development (Aircraft, ATM or Airport).

To improve the utility of the tables the technology solutions for each of the three sectors (ATM, Airport and Aircraft) have also been mapped separately against the taxonomy. This enables the reader wishing to focus on a specific sector to access the data more easily.

Definitions

The table of technology solutions contain a large amount of data and for presentation reasons, a number of abbreviations and common definitions have been used. These are briefly outlined below.

Taxonomy area:
one of ten high-level areas in which the aeronautical research and technology has been subdivided in the ACARE taxonomy

Domain:
one of several technical disciplines contributing to a given taxonomy area

Technology classification*:

- **B**ase: Essential to be in business, widely exploited by competitors, little competitive impact
- **K**ey: Well embodied in products and processes, high competitive impact
- **P**acing: Under experimentation by some competitors, competitive impact likely to be high
- **E**merging: At early research stage or emerging in other industries, competitive impact unknown but promising

Impact: an indication as to the level of technology maturity

- Low
- Medium
- High

* Source: "Managing Technology for Corporate Success" - Chris Floyd

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
4. Aircraft Avionics, Systems & Equipment													
Navigation/Flight Management/ Autoland	Terrain and obstacle database processing, Tracking of aircraft without transponder signal, Automatic tracking and alerting of flight path deviation	B								○	●		○
	Satellite positioning and guidance system	K								○	●		
	Safe and reliable 4D navigation system	K				○	○				●		○
	High precision IFR landings	E				○		○			●	○	○
	Data fusion and signal processing for pattern recognition	P								○	●		○
	High performance air ground datalink and communication system	E				○			○		●		○
Identification	Tracking of aircraft without transponder signal	B								○	●		○

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC: Highly Customer Oriented ATS	HLTC: Highly Time Efficient ATS	HLTC: Highly Cost Efficient ATS	HLTC: Ultra Green ATS	HLTC: Ultra Secure ATS	Sector: ATM	Sector: Airport	Sector: Aircraft
5. Flight Mechanics - Performance													
Analytical	Vertical, steep, low or high speed at high climb/descent rates with 360 deg. turning for low area impact	P					○		○		●		○
6. Integrated Design & Validation (methods & tools)													
Hazard Analysis	Security and proof of asynchronous system and software	B								○	●		○
System reliability	Security and proof of asynchronous system and software	B								○	●		○
Collaborative Decision Making	Collaborative processes and systems for decision making	K							○		●		○
Simulator environments & Virtual reality	System simulation and validation	K								○	●		○
Decision Support Systems	Decision support using artificial intelligence	K								○	●		○
	Real time flow monitoring and update of 4D contracts	E				○	○				●		
	Conflict detection solutions	E						○	○		●		

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	Decision support using artificial intelligence	K								○	●		○
Information management & Knowledge management (Methods & tools)	SWIM	P				○	○				●		
Autonomous operation	Terrain and obstacle data-base processing, Automatic tracking and alerting of flight path deviation	K								○	●		○
	Self-separation for landings and take offs	E				○					●		○
	Autonomous operations, Airborne Self Separation System. Automated Flight Information service	P				○					●		○
	Automated tower	E				○	○	○			●	○	
	Conflict detection solutions, sense and avoid systems	P				○					●		○
Development of synthetic environ-ment & virtual reality tools	Data fusion and signal processing for pattern recognition, system simulation and validation	K								○	●		○

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC: Highly Customer Oriented ATS	HLTC: Highly Time Efficient ATS	HLTC: Highly Cost Efficient ATS	HLTC: Ultra Green ATS	HLTC: Ultra Secure ATS	Sector: ATM	Sector: Airport	Sector: Aircraft
	Augmented reality tower tools	E				○	○				●	○	
	Improved human factors analysis and pilot workload prediction tools	K				○	○				●		○
	Airborne enhanced/ synthetic vision systems	E				○	○	○			●		○
Real Time Simulators	System simulation and validation	K								○	●		○
7. Air Traffic Management (Source ARDEP)													
Overall ATM	Aircraft environment signature database	K							○		●		
	Real time environment monitoring system	K							○		●		
	Required target performance oriented (low cost) system architecture	P						○			●		
	Required target performance oriented system architecture	E				○	○		○	○	●		
	SWIM	P				○	○				●		
	Overall system integration	P				○	○	○	○	○	●		
	Real time performance monitoring	E				○	○				●		

* See the introduction for details

Taxonomy Area and Domain		Technology	Classification *	Impact *			HLTC					Sector		
				2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
		Required total system performance	P	■	■	■	○	○				●	○	
		Consistent and high integrity airspace, aircraft preformance databases	P	■	■	■	○	○				●		
		Collaborative processes and systems for decision making	K	▒	▒	■				○		●		
Airspace Management		Dynamic airspace management system	K	▒	▒	■				○		●		
	Airspace typologies	**Customer oriented airspace**					○					●		
	Airspace typologies	**Time efficient airspace**						○				●		
	Airspace typologies	**Low cost airspace**							○			●		
	Airspace typologies	**Green airspace**								○		●		
	Airspace typologies	**Secure airspace**									○	●		
		Airspace modellisation	K	▒	▒	■	○	○				●		
		Dynamic and collaborative (civil and military) airspace management system, strategic and collaborative traffic allocation system	E	▒	▒	■	○	○				●		

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
Flow and Capacity Management	Real time flow monitoring and update of 4D contracts	E				●	●				●		
	4D trajectory based contract management system	K							●		●		
	Traffic allocation system taking into account capacity and demand	E						●			●		
	Dynamic traffic allocation, taking into account environmental impact	K							●		●		
	Airspace boundary infringement monitoring system	E				●	●				●		
	Integrated (air/ground) 4D processing system taking into account "economically efficient buffers"	P						●			●		
	Advanced integrated air/ground 4D trajectory management and monitoring system	E				●	●				●		
	Integrated (air/ground) 4D processing system	P							●		●		
Communication System	High bandwith datalink, Encryption and secured communication network	K								●	●		

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	High performance air ground datalink and communication system	E				●	●				●		●
Navigation Systems	Satellite positionning and guidance system, Automatic tracking and alerting of flight plan deviation	P								●	●		
ATC automation/ DSS Decision Support Systems	Automation of routine tasks	P				●	●	●			●		
	Airborne Separation Assistance System	P							●		●		
	Sequencing of applications of Airborne Separation Assistance System	P				●	●				●		
	Conflict detection solutions	P					●	●	●		●		
	Integrated departure/ arrival/en route management tools	P				●					●		
	New HMI technologies and interaction modes	E				●	●				●		
Avionics	Airborne Separation Assistance System	P				●	●	●	●	●	●		
Airport Traffic Management	New runway management systems	P, E				●	●				●	●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	Airborne enhanced/ synthetic vision systems	E				●	●	●			●	●	
	Automated tower	E				●	●	●			●	●	
	Self separated take offs and landing	E				●		●			●	●	
	New operational procedures according to environmental signatures	E							●		●	●	
	Augmented reality tower tools	E				●	●				●	●	
	Airport environment dynamic monitoring system	P							●		●	●	
	Automatic detection and correction of trajectory deviations	E								●	●	●	
	Ground movement control for all weather 24h-operation (ASMGCS)	K				●	●	●			●	●	
	Overarching airport mgmt system (capacity, arrival etc,….)	K				●	●	●	●	●	●	●	
	Develop models to optimise take-off and approach profiles for all aircraft types and weather condition	K							●		●	●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	New operational concepts for Simultaneous Not Interfering Operations (SNI) to manage different kinds of vehicles (fixed wing, rotary wing and tilt rotor) with different flight profiles	P				○	○				●	○	
	Capability of a/c to predict the vortex produced by preceding a/c with consequent reduced separation	P				○	○				●	○	○
	Aircraft/VTOL simultaneous non interfering approaches and departures	E				○	○				●	○	
	Formation take-off and landing	E					○				●	○	
	Multiple/flexible threshold operations						○				●		
	All weather high precision navigation, landing and take off capability via Ground Based Augmentation System; Wake vortex and wind-shear detection and management system	P				○	○				●	○	○

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
Airline Operations	Collaborative processes and systems for decision making	K							○		●	○	○
	Traffic allocation system, taking into account capacity and demand	E					○	○			●	○	
	Dynamic and collaborative airspace management system, strategic and collaborative traffic allocation system	E				○	○				●		
Meteorological	Aeronautical and weather information management and forecasting capability, including use of aircraft downcast data	E				○	○				●		
9. Human Factors													
Human Information Processing	Human factor and behaviour modelling	K				○				○	●		○
Human Survivability, Protection and Stress Effects	Human factor and behaviour modelling	B				○				○	●	○	○
10. Innovative Concepts & Scenarios													
Breakthrough Technologies	Autocontrol	E				○	○				●		

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
4. Aircraft Avionics, Systems & Equipment													
Navigation/Flight Managment/Autoland	High precision IFR landings	E				○		○			○	●	○
6. Integrated Design & Validation (methods & tools)													
Collaborative Decision Making	Airport integrated information distribution and management system	P				○	○					●	
Autonomous Operations	Automated tower	E				○	○	○			○	●	
Development of Synthetic environment and virutal reality	Augmented reality tower tools	E				○	○				○	●	
Numerical Models (including Fast Time Simulation)	Fast time simulation for training on best practices for ATS efficiency	K				○	○		○	○		●	
7. Air Traffic Management (Source ARDEP)													
Airport Traffic Management	Required total system performance	P				○	○				○	●	
	New runway management systems	P, E				○	○				○	●	
	Airborne enhanced/ synthetic vision systems	E				○	○	○			○	●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	Automated tower	E				○	○	○			○	●	
	Self separated take offs and landing	E				○		○			○	●	
	New operational procedures according to environmental signatures	E							○		○	●	
	Augmented reality tower tools	E				○	○				○	●	
	Airport environment dynamic monitoring system	P							○		○	●	
	Automatic detection and correction of trajectory deviations	E							○		○	●	
	Ground movement control for all weather 24h-operation (ASMGCS)	K				○	○	○			○	●	
	Overarching airport managementt system (capacity, arrival, etc,….)	K				○	○	○	○	○	○	●	
	Develop models to optimise take-off and approach profiles for all aircraft types and weather condition	K							○		○	●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	New operational concepts for Simultaneous Not Interfering Operations (SNI) to manage different kinds of vehicles (fixed wing, rotary wing and tilt rotor) with different flight profiles	P				○	○				○	●	
	Capability of a/c to predict the vortex produced by preceding a/c with consequent reduced separation	P				○	○				○	●	○
	Aircraft/VTOL simultaneous non interfering approaches and departures	E				○	○				○	●	
	Formation take-off and landing	E					○				○	●	
	Multiple/flexible threshold operations	P/E					○				○	●	
	All weather high precision navigation, landing and take off capability via Ground Based Augmentation System; Wake vortex and wind-shear detection and management system	P				○	○				○	●	○

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC: Highly Customer Oriented ATS	HLTC: Highly Time Efficient ATS	HLTC: Highly Cost Efficient ATS	HLTC: Ultra Green ATS	HLTC: Ultra Secure ATS	Sector: ATM	Sector: Airport	Sector: Aircraft
Airport Operations	Zero emissions people transporters (e.g. maglev trains, electric vehicles)	P							○			●	
	Low weight cars with hybrid transmission	P							○			●	
	Reliable/embedded intermodal links to ensure predictable home-to-gate time and reduce emissions	K					○		○			●	
Airline Operations	Collaborative processes and systems for decision making	K							○		○	●	○
	E-tickets	B				○		○				●	
	Traffic allocation system, taking into account capacity and demand	E					○	○			○	●	
8. Airports													
Security Equipment	Biometrics and corresponding identification	P								○		●	
	Real time detection of explosive, weapon, nbc products	K								○		●	

VOLUME 2 Airport

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
	Passive gamma detection (nuclear) and Active gamma detection (explosives); ultra rapid sampling and analysis for biloigocal and chemical materials - virus detection	K								○		●		
	Freight dip to encourage explosives to detonate in contained environment	B								○		●		
	Automated x-ray screening for multiple materials	K								○		●		
	Decision support systems using artificial intelligence	P								○		●		
	Training, simulation	K				○	○			○		●		
	Crew control of time optimised procedure, on-board traffic awareness system	B								○		●		
	Crisis management, standardised case studies	K				○	○			○		●		

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Ground Transport	Minimization/elimination of ground vehicles by providing automated services at the gate, e.g. fuel hydrant, electrical and air plug-in points, hydrants for waste disposal, conveyers for luggages and catering	B				●	●		●	●			●	
	Long duration batteries	K							●				●	
	Light weight vechicles powered by fuel cells	K							●				●	
Airport Buildings, infrastructure and runways	Solar energy for power generation	K							●				●	
	New airport configuration for large freighter aircraft	P				●		●					●	
	Advanced runway materials with porous characteristics preventing lying water	P				●	●						●	
	Variable gradient runways	P				●	●						●	
	Underfloor heating for runways	E				●	●						●	
	System automation	K					●	●					●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	System standardisation and flexibility of service	K					○	○				●	
	IT, planning and assistance systems	B						○				●	
	Advanced LIDAR/SODAR for detection and avoidance of turbulence, windshears and wing tip vortices	P				○	○					●	
	ASMGCS	K				○	○					●	
	Infrastructure design with flexible exit and taxiways signing	K					○					●	
	Infrastructure and operational procedures to handle multiple aircraft types	P					○		○			●	
Crisis management	Decision support systems using artificial intelligence	P								○		●	
	Simulation	B				○	○					●	
	Standardised case studies	K				○	○					●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC: Highly Customer Oriented ATS	HLTC: Highly Time Efficient ATS	HLTC: Highly Cost Efficient ATS	HLTC: Ultra Green ATS	HLTC: Ultra Secure ATS	Sector: ATM	Sector: Airport	Sector: Aircraft
Airport External Safety	Training, simulation	K				○	○					●	
	Crew control of time optimised procedure, on board traffic awareness system	K								○		●	
	Crisis management, standardised case studies	K				○	○					●	
Airport Security	Vehicle movement controls, Vehicle inspection technology	K								○		●	
	CCTV, thermal systems (IR), passive radars, spatial and behavioural recognition software and technologies	B				○				○		●	
	Airport surrounding surveillance systems, Airport fence control systems	K								○		●	
	Passenger RF tags (active) and triangulation technologies to identify passenger location within airport	K				○	○			○		●	
	RFID tag based travel management/check-in/ boarding concepts/access control	P						○				●	

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
	Biometric recognition system using smart card travel documentation linked to criminal/anti-terrorism databases	K	■	■	■	○	○	○	○	○		●		
	Databases for inventory management	B	■	■	■					○		●		
	RF tags and sensors on conveyors; cost effect-ive reading sytem linked to overarching security database; CCTV and data imaging software	K	▪	■	■					○		●		
	RF tags correlated with luggage in containers	K	■	■	■		○			○		●		
	RFID tag based passenger/luggage/cargo tracking concepts	P	▪	■	■			○				●		
9. Human Factors														
Human Survivability Protection and Stress Effects	Human factor and behaviour modelling	B	▪	■	■	○				○	○	●		○
Human Element in Security	Human factor and behaviour modelling	K	▪	■	■					○		●		○

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
10. Innovative Concepts & Scenarios														
Unconventional Configuration and New Aircraft Concepts	Dedicated Freigther a/c	P				●		●		●			●	●
	Mission adaptive cabin/ cargo configuration with fixed change times	P				●		●		●			●	●
	Optimised configuration for specialised freighter a/c	P						●					●	●
	Revolutionary concept removable cabin	E					●						●	●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
1. Flight physics														
Computational Fluid Dynamics	Optimised airframe design for high L/D cruise and low thrust approach	P							○					●
Unsteady Aerodynamics	Optimised airframe design for high L/D cruise and low thrust approach	P							○					●
	Electro-magnetic technologies for drag reduction in cruise	E							○					●
	Flow control	P							○					●
	Low noise drag generation for approach	K							○					●
Aeronautical Propulsion Integration	Ingegrated nacelle/wing design for UHBR engines	K							○					●
	High-Lift engine airframe integration (e.g. blown flaps with propeller or UHBR-engine)	P							○					●
	Electro-magnetic technologies for drag reduction in cruise	E							○					●
	Flow control	P							○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Airflow control	Flow control	P							●					●
	Electro-magnetic technologies for drag reduction in cruise	E							●					●
	Hybrid laminar flow	P							●					●
	Morphing airframes	E							●					●
	Adaptive winglets	K							●					●
	High-Lift engine airframe integration (e.g. blown flaps with propeller or UHBR-engine)	P							●					●
High Lift Devices	Specific low-noise aircraft configuration (high wing with high area, slatless high-lift system, etc.)	K							●					●
	High lift system design for High climb number design for High-lift system forand steep take-off	K							●					●
Wing Design	Electro-magnetic technologies for drag reduction in cruise	E							●					●
	Adaptive winglets	K							●					●
	"Tool set/digital environ-ment for simultaneous multi-disciplinary optimisation"	K						●						●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
	Morphing airframes	E							○					●
Computational Acoustics	Active noise suppression in cabin	K				○			○					●
External Noise prediction	Specific low noise rotorcraft	P							○					●
	Landing gear noise reduction technologies (fairings…)	K							○					●
2. Aerostructures														
Metallic Materials & basic processes	Use of lightweight materials and processes for airframe	B							○					●
	New materials for weight reduction/reduced fuel consumption	K						○						●
	Friction-reducing surface coatings (nanotechnology)	P							○					●
	Paintless a/c	P							○					●
Non-Metallic Materials & basic processes	New materials for weight reduction/reduced fuel consumption	K						○						●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Composite Materials & basic processes	Use of lightweight materials and processes for airframe	B							○					●
	New materials for weight reduction/reduced fuel consumption	K						○						●
Manufacturing and Assembling Technologies	Low environmental impact materials and manufacturing (airframe, engine, equipment)	B							○					●
	Use of non toxic materials (inflammability, cabling)	B							○					●
	Flexible machining equipment for multiple process integration at low production rates	K						○						●
	Highly automated manufacturing, assembly and quality assurance	B						○						●
	Green coolants for machining	K							○					●
	Enhanced (prediction) accuracy for extended modelling and simulation application/coverage	P						○						●
Structural Analysis and Design	Tool set/digital environment for simultaneous multidisciplinary optimisation	K						○	○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Smart Materials and Structures	Morphing airframes	E							○					●
	Flow control	P							○					●
Helicopter Aero-acoustics	Specific low noise rotorcraft	P							○					●
Noise Reduction	Innovative active control devices for noise with the possible use of MEMS	P							○					●
	Specific low noise rotorcraft								○					●
	Noise shielding through aircraft configuration	K							○					●
	Acoustic panels	B							○					●
Acoustic Measurements and Test Technology	Active noise suppression in cabin	B				○								●
Aircraft Security	Bomb proof cargo containers, Cargo screening and sensor system	K								○				●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
3. Propulsion														
Performance	High temperature materials and coatings for compressors, combustors and turbine	K							○					●
	Increased turbomachinery efficiencies and stall margins	K							○					●
	Variable pitch for fan blades to achieve high thrust at low speeds	P							○					●
	High rpm/no-thrust conditions for approach	P							○					●
	More efficient cooling technologies	K							○					●
	Lightweight architecture and materials for engine rotors and structures	B							○					●
	Nacelle/thrust reverser/nozzle design (scarfed inlets, liners, chevrons…)	K							○					●
	Components with reduced thermo-mechanical distortions and more efficient sealing technology	K							○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Turbomachinery/ Propulsion Aerodynamics	Components with reduced thermo-mechanical distortions and more efficient sealing technology	K	■	■	■				○					●
Combustion	Combustor operability	K	■	■	■				○					●
	Combustion technologies for reducing emissions produced by conventional engine configurations	B	□	■	■				○					●
	Enhanced mixing design/ technologies for lean combustion	K	■	■	■				○					●
	Multi-point fuel injection	K	■	■	■				○					●
Air-breathing propulsion	Nacelles technologies for weight reduction	K	□	■	■				○					●
	Geared fan engine	P	□	■	■				○					●
	Ingegrated nacelle/wing design for UHBR engines	K	□	■	■				○					●
	Ultra High By-Pass Ratio engine	P	□	■	■			○					●	
	Contra-rotating fan engine	P	□	■	■				○					●
	Low powered de-icing devices	K	■	■	■				○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Nozzles, Vectored Thrust, Reheat	Thrust reverser, technologies for weight reduction	K							○					●
	Provide Low noise thrust reversal capability	P							○					●
Engine Controls	Optimised engine controls for reducing fuel burn	K							○					●
	Innovative active control devices with the possible use of MEMS	P							○					●
	Optimised engine controls for reducing noise	K							○					●
Computational methods	Enhanced (prediction) accuracy for extended modelling and simulation application/coverage	P						○						●
4. Aircraft Avionics, Systems & Equipment														
Cockpit Systems, Visualisation & Display Systems	Data fusion and signal processing for pattern recognition	B								○				●
	Common core cockpit and flight control systems with programmable functionality for standardisation, flight deck/handling commonality	K						○						●
	Airborne display of routing and traffic	E				○	○							●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
	Increased system operation automation and automated reconfiguration/ one man cockpit for passenger transport	E						○		○				●
Navigation/Flight Management/ Autoland	Terrain and obstacle database processing, Tracking of aircraft without transponder signal, Automatic tracking and alerting of flight path deviation	B								○		○		●
	Safe and reliable 4D navigation system	K				○	○					○		●
	High precision IFR landings	E				○		○				○	○	●
	Flight Management System based landing	E				○								●
	Airborne enhanced/ synthetic vision	E						○						●
	Data fusion and signal processing for pattern recognition	P								○		○		●
	Ground and flight obstacle detection and avoidance system	P				○	○							●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Warning Systems	Missile attacks sensors, Missile defence systems	B								○				●
Electronics & Microelectronics for on-board systems	Security and proof of asynchronous system and software	K								○				●
	Innovative active control devices for noise with the possible use of MEMS	P							○					●
Sensors integration	Sensor technology for detection (laser, light, radar, infrared)	B								○				●
Communications Systems	High bandwith datalink, Encryption and secured communication network, Encryption and secured navigation and landing signal network	K								○				●
	High performance air ground datalink and communication system	E				○			○			○		●
Identification	Tracking of aircraft without transponder signal	B								○		○		●
Avionics Integration	Security and proof of asynchronous system and software	B								○				●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Optics - Optronics - Lasers - Image processing and data fusion	Camera sensor technology, Sensor technology for detection, Data fusion and signal processing for pattern recognition	B								○				●
	Data fusion and signal processing for pattern recognition	K								○				●
Smart maintenance systems	Condition monitoring/ increased service intervals	P						○						●
	Lifetime increasing technologies (coatings, improved sealing)	K						○	○					●
	Environmentally friendly processes	B							○					●
	Increased re-use of systems/components and new repair technologies	E						○	○					●
	New materials for maintenance free systems	P						○						●
	Fuzzy logic/neural network BITE with negligible false alarm rates for fault tolerant/extended maintenance designs	P						○						●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Aircraft Security	Systems and procedures for identification and access of personnel to the flight deck	B	■	■	■					○				●
	On-board explosives detection systems	B	■	■	■					○				●
	Alarm systems	B	■	■	■					○				●
	Cockpit security monitoring systems	B	■	■	■					○				●
	Passenger cabin security monitoring systems	B	■	■	■					○				●
	Tamper-proof and transponder systems	B	■	■	■					○				●
	Collision and terrain-avoidance systems	B	■	■	■					○				●
	Automatic landing systems to enable forced landing of aircraft from the ground	B	■	■	■					○				●
Electrical Power Generation & Distribution	All electric aircraft	P	■	■	■			○	○					●
	High power density electric motors	P	■	■	■			○						●
	Common core cockpit and flight control systems with programmable functionality for standardisation, flight deck/handling commonality	K	■	■	■			○						●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	Fuel cells for on-board energy supply (during cruise and on-ground)	E						○	○				●
Hydraulic power generation & distribution	Oil free systems	P							○				●
	Replacement of polluting hydraulic fluid with more electrical technologies (braking system)	P							○				●
Passenger and freight systems	Active noise suppression system	K				○							●
	Automated flight information services	E				○		○					●
	Mission adaptive cabin/ cargo configuration, easy lower deck compratment adaptation/reconfiguration for flexible passenger and cargo utilisation	K				○		○					●
	Multiple access cabin architecture, Autonomous loads handling freighter	P				○	○	○					●
	Simulateneous multiple entry boarding/loading concepts	P				○	○	○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC Highly Customer Oriented ATS	HLTC Highly Time Efficient ATS	HLTC Highly Cost Efficient ATS	HLTC Ultra Green ATS	HLTC Ultra Secure ATS	Sector ATM	Sector Airport	Sector Aircraft
	Optimised configuration for specialised freighter a/c	P						○					●
	Automated catering/ cabin service	E						○					●
Environmental control System	Personalized passenger climate control	K				○							●
Fire protection systems	Fire protection systems	K								○			●
5. Flight Mechanics - Performance													
Analytical	Vertical, steep, low or high speed at high climb/ descent rates with 360 deg. turning for low area impact	P					○		○		○		●
6. Integrated Design & Validation (methods & tools)													
Methods and IT tools for Collaborative Product & Process Engineering	Digital integration of the supply chain/virtual companies	K						○					●
	Programmable system functionality, data exchange/inter-subsystem communication technology, energy management technologies for cost effective upgrades during the life cycle (open system architectures)	P						○					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Flight/Ground Tests	Increased re-use of systems/components and new repair technologies	K						○	○					●
	Verification, Validation and Certification technologies for products based on pre-certified subsystems/ module/components/ COTS, DOTS, TOTS	K				○		○						●
Life-cycle Integration	Programmable system functionality, data exchange/inter-subsystem communication technology, energy management technologies for cost effective upgrades during the life cycle (open system architectures)	P						○						●
Fault Tolerant Systems	Security and proof of asynchronous system and software	B				○	○							●
	Fault tolerant systems, auto reconfiguration systems	K				○	○							●
Hazard Analysis	Security and proof of asynchronous system and software	B								○	○			●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
System reliability	Security and proof of asynchronous system and software	B								○	○			●
Collaborative Decision Making	Collaborative processes and systems for decision making	K							○		○			●
Simulator environments & Virtual reality	System simulation and validation	K								○	○			●
Decision Support Systems	Decision support using artificial intelligence	K								○	○			●
	Decision support using artificial intelligence	K								○	○			●
Autonomous operation	Terrain and obstacle database processing, Automatic tracking and alerting of flight path deviation	K								○	○			●
	Self-separation for landings and take offs	E				○					○			●
	Autonomous operations, Airborne Self Separation System. Automated Flight Information service	P				○					○			●
	Conflict detection solutions, sense and avoid systems	P				○					○			●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
Development of synthetic environment & virtual reality tools	Data fusion and signal processing for pattern recognition, system simulation and validation	K								○	○			●
	Improved human factors analysis and pilot workload prediction tools	K				○	○				○			●
	Airborne enhanced/ synthetic vision systems	E				○	○	○			○			●
Aircraft Performance Assessment	Technical solutions for infrastructure independent operation (stairs, towing trucks, taxiing, guidance, freighter: autonomous cargo handling) e.g. powered gear for self push back capability, electrical drive system for engine independent taxiing, etc.	K					○	○						●
	Mission adaptive cabin/ cargo configuration, easy lower deck compratment adaptation/reconfiguration for flexible passenger and cargo utilisation	K				○								●
Real Time Simulators	System simulation and validation	K								○	○			●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC Highly Customer Oriented ATS	HLTC Highly Time Efficient ATS	HLTC Highly Cost Efficient ATS	HLTC Ultra Green ATS	HLTC Ultra Secure ATS	Sector ATM	Sector Airport	Sector Aircraft
Large scale validation Platforms	Tool set/digital environment for simultaneous multidisciplinary optimisation	K						○					●
7. Air Traffic Management (Source ARDEP)													
Flow and Capacity Management	4D trajectory based contract management system	K					○						●
Communication System	High performance air ground datalink and communication system	E				○	○				○		●
Navigation System	High precision navigation using high Required Navigation Performance and Area navigation	K				○	○						●
Avionics	Crew control of time optimised procedure, on board traffic awareness system	P				○	○						●
	4D trajectory based contract management system	K					○						●
	High precision navigation using high Required Navigation Performance and Area navigation	K				○	○						●
	Airborne display of routing and traffic	E				○	○						●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
Airport Traffic Management	Capability of a/c to predict the vortex produced by preceding a/c with consequent reduced separation	P				●	●				●	●	●
	All weather high precision navigation, landing and take off capability via Ground Based Augmentation System; Wake vortex and windshear detection and management system	P				●	●				●	●	●
Airline Operations	Collaborative processes and systems for decision making	K							●		●	●	●
	Health/Integrity monitoring system for airline/type independent M&R base operation	P						●					●
9. Human Factors													
Human Factors Integration, Man-machine Interface	Improved human factors analysis and pilot workload prediction tools	K				●							●
	Human factor and behaviour modelling	K								●			●
Human Information Processing	Human factor and behaviour modelling	K				●				●	●		●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact* 2010	Impact* 2015	Impact* 2020	HLTC: Highly Customer Oriented ATS	HLTC: Highly Time Efficient ATS	HLTC: Highly Cost Efficient ATS	HLTC: Ultra Green ATS	HLTC: Ultra Secure ATS	Sector: ATM	Sector: Airport	Sector: Aircraft
	Improved human factors analysis and pilot workload prediction tools	K				○				○			●
Human Performance Modelling & Enhancement	Improved human factors analysis and pilot workload prediction tools	K				○		○		○			●
	Human factor and behaviour modelling	K								○			●
Human Survivability, Protection and Stress Effects	Highly automated cabin and cargo logistics system to support efficient a/c operation (in-flight medical support, etc.) (ST4)	K				○							●
	Human factor and behaviour modelling	B				○				○	○	○	●
Human Element in Security	Human factor and behaviour modelling	K								○		○	●
10. Innovative Concepts & Scenarios													
Unconventional configurations and new aircraft concepts	High aspect ratio/low sweep configuration ('green glider')	P							○				●
	Inter-Cooler Recuperator engine (ICR)	E							○				●
	Novel propulsion solutions (e.g. pulse detonation engine, electrical propulsion, distributed thrust…)	E							○				●

* See the introduction for details

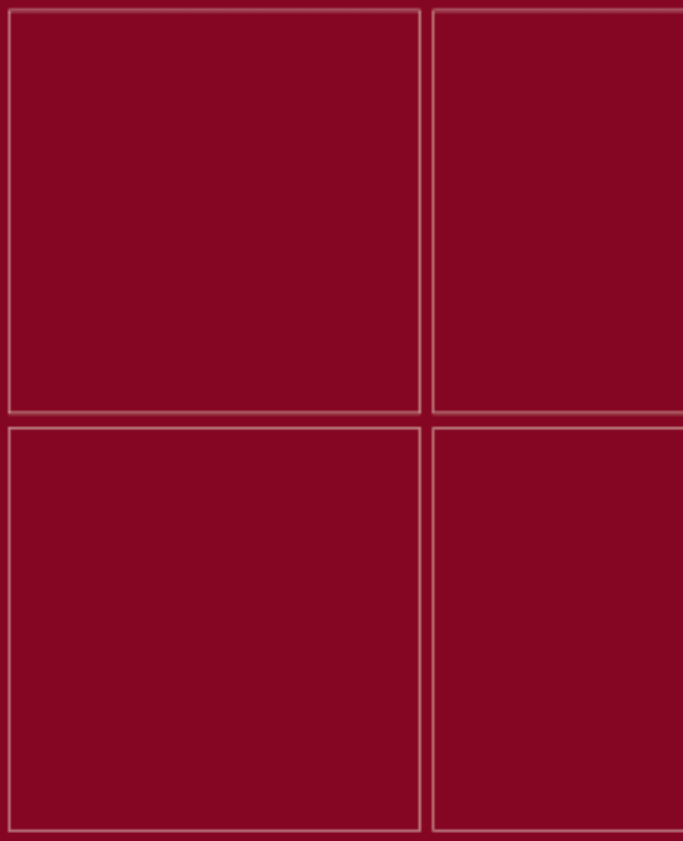
Taxonomy Area and Domain	Technology	Classification *	Impact *			HLTC					Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS	ATM	Airport	Aircraft
	Blended Wing Body configuration (BWB)	E				●		●	●				●
	Adaptive (e.g. variable cycle) engine	E					●						●
	Dedicated Freighter a/c	P				●		●				●	●
	VSTOL vehicle technologies	E				●	●						●
	Exploit specific capability for vertical landing (rotorcraft or tilt)	B				●	●						●
	VTOL capable of independent procedure	E				●	●						●
	Cabin design, quick change concepts	K					●	●					●
	Mission adaptive cabin/ cargo configuration with fixed change times	P				●		●				●	●
	Optimised configuration for specialised freighter a/c	P						●				●	●
	Revolutionary concept removable cabin	E					●					●	●
Breakthrough Technologies	Morphing airframes	E						●					●

* See the introduction for details

Taxonomy Area and Domain	Technology	Classification *	Impact*			HLTC						Sector		
			2010	2015	2020	Highly Customer Oriented ATS	Highly Time Efficient ATS	Highly Cost Efficient ATS	Ultra Green ATS	Ultra Secure ATS		ATM	Airport	Aircraft
	Friction-reducing surface coatings (nanotechnology)	P							●					●
	Designer materials tailored for multifunctional applications	E						●	●					●
	Hydrogen-based engine concepts, a/c concepts with hydrogen-based propulsion	E							●					●
	Autonomous flight control systems for freighter aircraft	E					●	●						●

List of members

CHAIRMAN	BENGT HALSE	SAAB A.B.
VICE CHAIRMEN	FRANCOIS QUENTIN	THALES
	JOACHIM SZODRUCH	DLR
Austria	Birgit Blasch	Fed. Ministry of Transport, Innovation and Technology
Belgium	Peter Van Geloven	OSTC
Denmark	Peter Worsøe	Terma Industries A/S
Germany	Wolf W. Günther	Bundesministerium für Wirtschaft und Technologie (BMWi)
Finland	Pauli Stigell	National Technology Agency
France	René Gaudin	Direction des Programmes Aéronatiques Civils
Greece	Theodoros Spathopoulos	Hellenic Aerospace Industry
Ireland	Jim Lawler	Enterprise Ireland
Italy	Maurizio Pandolfi	DIASP, Politecnico di Torino
Luxembourg	Thomas Welter	Luxembourg Aerospace Industries (LAI) Asbl
Netherlands	Ad G.M. Driedonks	NIVR Netherlands Agency for Aerospace Programmes
Portugal	José Carlos Pereira	Instituto Superior Técnico Dep. De Engenharia Mecânica
Spain	Ramón Herrero	Ministerio de Industria, Turismo y Comercio
Sweden	Hans Christer Olson	Ministry of Industry, Employment and Communications
United Kingdom	David Way	Department of Trade and Industry
European Commission	Jack Metthey	DG/RTD
	Enrico Grillo Pasquarelli	DG/TREN
Research establishments	Joachim Szodruch	DLR
	Denis Maugars	ONERA
	Jan Van Houwelingen	NLR
Manufacturing industry	Frieder Beyer	Liebherr-Aerospace Lindenberg GmbH
	Christian Mari	SNECMA
	Jerry Haller	Smiths Aerospace
	Terry Knibb	BAE SYSTEMS
	François Quentin	THALES
	Mario Pellerei	Agusta Westland S.p.A.
	Raymond Pellichero	SABCA
	Philip Ruffles	Rolls-Royce plc
	Dieter Schmitt	AIRBUS S.A.S.
	Jean-Marc Thomas	EADS
Airlines	Jouko Malen	AEA (Association of European Airlines)
	Cees Gresnigt	IATA (International Air Transport Association)
Airports	Philippe Joppart	ACI Europe
Regulators	Klaus Koplin	JAA (Joint Aviation Authorities)
EUROCONTROL	Jean-Marc Garot	EUROCONTROL
Academia	Billy Fredriksson	Linköping University



For further information

www.acare4europe.org