Green Regional Aircraft

Annual Implementation Plan 2011

Annex 1b

Table of content

Abbreviations and Definitions

A/C	Aircraft
AEA	All Electrical Aircraft (one of the technology domains of the GRA ITD)
CFD	Computational Fluid Dynamics
CAA	Computational Aero-Acoustics
CfPs	Call for Proposals
CSJU	Clean Sky Joint Undertaking
D&M	Design and Manufacturing
GA	Grant Agreement
GB	Governing Board
HLD	High-Lift Devices
ITD	Integrated Technology Demonstrator
JTI	Joint Technology Initiative
LE	Leading Edge
LNC	Low Noise Configuration (one of the technology domains of the GRA ITD)
LWC	Low Weight Configuration (one of the technology domains of the GRA ITD)
M	(cruise) Mach Number
MDO	Multi-Disciplinary Optimisation
MLG	Main Landing Gear
MTM	Mission &Trajectory Management (one of the technology domains of the GRA ITD)
MP	Management Plan
NC	New Configuration (one of the technology domains of the GRA ITD)
NLF	Natural Laminar Flow
NLG	Nose Landing Gear
OR	Open-Rotor
QAS	Quality Assurance System
SSE	Shared Simulation Environment
TE	Trailing Edge
TF	Turbo-Fan
TP	Turbo-Prop
WP	Work Package
WT	Wind Tunnel
WTT	Wind Tunnel Tests
2D	Two-Dimensional
3D	Three-Dimensional

Description of work for year 2011

GRA0 – ITD Management

GRA0 - Management overview

The GRA (Green Regional Aircraft) management structure aims to ensure timely achievement of high quality technical demonstrations and to provide qualified contractual and budgetary support and coordination of the projects. It also intends to ensure that knowledge management and other innovation-related activities are coordinated at GRA level.

GRA0 - Work Programme Year 2011

The management plan document aimed at defining the management rules to be applied in the frame of the ITD "Green Regional Aircraft" for a Clean Sky continues to be updated.
Essentially, it describes: the ITD organization and how it is in relationship with other ITDs and European bodies; the way to manage the configuration and the documentation; the way to choose partners and supplier and how to manage them.
Furthermore, this Plan describes the main procedures in order to create a GRA Quality Assurance System (QAS). Finally, it's the basic reference quality and management document to be known and applied by any person contributing to the research.
This plan is applicable to the ITD GRA Program and will be used, with relevant updating, for all the phases of the program. GRA coordinator is setting up a Web site with GRA members support; for some of them a contribution in kind like management instead of contributing cash to the Coordinator has been considered.
GRA Web site will be implemented to be used as secure area for submission of reports, deliverables, communication and lodging of JU documents (Steering Committee minutes, …) and as working area.
Further, the following activities will be developed:

-Coordinate ITD reporting for 2011; manage ITD interfaces to Joint Undertaking; organization and management of Steering Committees and Consortium Management Committee; administer CSJU financial contributions and maintain records and financial accounts; preparation of Annexes 1b & 2b for 2012 Annual Implementation Plan; definition in detail the description of the yearly activities for each Work Package in the Description Work; establish the 2012 budget request for each members (including the CfPs budget request for year); assist the CSJU Staff member during the CfPs negotiations for aspects related to the technical implementation of the project; prepare the Annexes 1A & 2B for 2012 Grant Agreement; co-ordinate the technical work through the presence of the highest level WP leaders; participation to the GB.

GRA0 - Calls for Proposals Year 2011

No CfPs will be launched during the year 2011

GRA1 – Low Weight Configuration (LWC) domain

GRA1 - LWC overview

The objective of the Green Regional Aircraft – Low Weight Configuration is to validate and demonstrate the technologies best fitting the environmental goals set for the regional aircraft entering the market in the following years.
Low weight aircraft configuration will develop the advanced solutions of composite structures where sensors are embedded and advanced materials and architectures are used so to obtain the load carrying capability plus the ancillary functions expected by the different elements of the structure at a weight significantly lower than using today technology.
The relevant technologies that, after the maturation obtained in the first years of the project, will be selected as the most appropriate in terms of benefits and costs for future regional aircraft, will then be demonstrated in full scale ground and flight tests. Demonstration will be performed in flight on appropriate test aircraft, preceded by ground tests, by replacement of a few panels (depending on selected technologies) .
Scope of the Flight Test is to obtain validation in flight for advanced structural technologies that require data acquired in an actual operating environment.
Scope of the Ground Test is to obtain validation for those advanced structural technologies that require static and fatigue data acquired using a test set-up simulating structural behaviour at full scale section level.

GRA1 - LWC Work Programme Year 2011

Requirements for the definition of the generic future regional aircraft and for ground and flight demonstration will be completed. Structural definition of peculiar items of advanced aircraft configurations will be performed. The test reports for all developed technologies (sensors, layer, multilayer, nanomaterials and advanced metallic structures) will be completed for the First Technologies Down Selection. The methodologies for probabilistic structural real design will be completed. For reinforced flat large panels with different technologies selected after the first down selection, the identification of properties to test, the validation of process manufacturing, test article design and manufacturing, testing activity and results analysis will be performed. The definition of technical solutions on empennage, wing, fuselage/cockpit of the future generic regional aircraft utilising the selected technologies will de developed. The definition of structure components to be tested in flight will be completed. The engineering and manufacturing data to prepare the test article will be provided for flight test. The activities for providing lay out and installation of advanced components to be tested in flight and manufacturing plan of advanced components will start. The definition of a preliminary flight test plan will start. The request for ground test and the ground test article general lay out will be completed. The manufacturing plan of ground test article and the definition of Test Rig General Lay Out will start. The Design & Manufacturing preparation of test rig and test article will start.

In details the following WPs will run during 2011:

WP 1.1 LWC Requirements :
Main objectives of 2011 are: completion of the definition of the requirements for the definition of the generic future regional aircraft and for ground and flight demonstration.

WP 1.2 LWC Architectures :
The 2011 activities concern the completion of the assessment of the effects on the airframe structures of peculiar items linked to advanced aircraft configurations.

WP1.3 GRA Enabling Technologies for LWC

In details the following WPs will run during 2011:

WP1.3.1 Enabling Sensors Technology for LWC :
Objective of 2011 is the completion of test activities for some developed sensor technologies (Acoustic emission and Optical sensors) for the First Technologies Down Selection.

WP1.3.2 LWC Enabling Technologies for Layer :
Objective of 2011 is the completion of the specimens manufacturing, basic testing activity (chemical-physical, mechanical and specific for multi-functionality) and results analysis for the First Technologies Down Selection.

WP1.3.3 LWC Enabling Technologies for Multilayer :
The 2011 activities concern the completion of the results analysis of basic testing activity (chemico-phisical, mechanical and specific for multi-functionality) for the First Technologies Down Selection.

WP1.3.4 LWC Enabling Methodologies for Design :
Main objectives of 2011 are:

- Provide a statistical model by test results, numerical simulation and processing from an onboard monitoring system
- Validate the virtual mechanical modelling to compute residual strength for compression after impact loading by residual static strength testing for stiffened panels subjected to static tests after impact.
- Provide a state space analysis together with advanced structural reliability methods and causal bond theory to evaluate critical functional paths, robustness under operational/extreme conditions and the total reliability of the complex system.

WP1.3.5 LWC Enabling Technologies for Nanomaterials :
Main objective of 2011 is the completion of the mechanical and functional tests results evaluation on the nano-reinforced coupons for the First Technologies Down Selection.

WP1.3.6 LWC Enabling Technologies for Maintenance :
This WP will address function-based-design modelling for Intelligent Structural Health Monitoring (ISHM), structural diagnostic and different issues on repair materials, processes, quality assurance. The WP will take into account the most severe airworthiness rules and innovative technologies proposed and validated in the JTI LWC with regard to the fulfilment of the repaired structures. Adhesive bonding, smart patch, riveted technologies are considered to fulfil low weight and low maintenance cost target.
The main objective of 2011 are:

- Completion of methodologies for Intelligent Structural Health Monitoring (Diagnostic) through the following CfP's:

  - JTI-CS-2009-1-GRA-01-009: "Intelligent Stress Health monitoring";
  - JTI-CS-2009-1-GRA-01-010: "Induction Heating and Health Monitoring Solutions for Smart Aircraft Maintenance using Adapted Composite Patches".

- Evaluation of the performance of bonding strength and examination of practical application aspects of bonded composite repairs using innovative materials and, potentially, modified surface preparation processes through the first part of activities of the following CfP:

  - JTI-CS-2010-1-GRA-01-029: "Definition of requirements and tests of practicability"

WP1.3.7 LWC Enabling hybrid Technologies:
Main activity of this WP is the manufacturing large panels representative of wing and fuselage structure using the different technologies selected in WP 1.4.1.

Main objective of 2011 are:

- Process manufacturing to be validated
- Large panels of fuselage and wing design for material/technology selected in WP 1.4.1 (trade off study) complying with the requirements established in WP 1.1
- Large panels manufacturing
- Testing activity
- Destructive and non-destructive inspection

WP1.3.8 LWC Enabling Technologies for Advanced Metallic Materials :
The 2011 activities concern the completion of result and the tests campaign and reports analysis of the different solutions for the advanced metallic structure for the First Technologies Down Selection.

WP1.4 Application Studies for LW

In details the following WPs will run during 2011:

WP1.4.1 LWC Enabling Ranking of applicable technologies :
Main objective of 2011 is the completion of the definition of a trade-off between the proof test article and the reference test article in order to select the structural solution to be tested in WP 1.3.7, complying with the requirements established in WP 1.1 and taking into account the test results coming from the First Technologies Down Selection.

WP1.4.2 LWC Technical solution for regional A/C :
Main activity to be performed in the present WP is the definition of the technical solutions to be used on such items as components of the future generic regional aircraft. The solutions will be identified among the technologies selected in the WP 1.3 and taking into account the inputs from WP 1.3.7.
Main objective of 2011 is the definition of technical solutions on empennage, wing, fuselage/cockpit of the future generic regional aircraft utilising the selected technologies will de developed.

WP1.5 LWC Definition of Demonstration

In details the following WPs will run during 2011:

WP1.5.1 LWC Definition of Flight demonstration :
Main activities to be performed in the present WP are the definition of the technical solutions of the structure components of the flight demonstrator and the definition of the test plan, test lay-out, test article/platform.
Main objectives of 2011 are:

- Selection of the aircraft on which to perform the flight test
- Definition of which structure components of the test aircraft will be changed with components utilising the technologies to be demonstrated in flight
- Definition of the engineering and manufacturing data required to prepare the test article and their sources
- Start with the preparation of a lay out of the advanced components to be tested and of their installation on the test aircraft and the information for aircraft refurbishing
- Start with the preparation of the manufacturing plan of the advanced components to be tested
- Start with the preparation of the test plan, including data to be obtained, the relevant instrumentation required, flight profile, data analysis requirements.

WP1.5.2 LWC Definition of Ground demonstration :
Main activities to be performed in the present WP are the definition of the technical solutions of the structure components of the ground demonstration and the definition of the test plan, test lay-out, test article/platform.

Main objectives of 2011 are:

- Definition of the experimental data to be acquired
- Definition of the general lay out of the ground demonstrators (tooling and Test article) on which to perform the foreseen ground activities
- Definition of which technologies will be included in (which ground demonstrator if there is more than one) the test article, on which structural component
- Definition of the engineering and manufacturing data required to prepare the test article and their sources
- Start with the preparation of a lay out of the advanced components to be tested.

WP1.6 LWC Demonstration Preparation & Test

In details the following WP will run during 2011:

WP1.6.2 Preparation of Ground Demonstration:
Main activity to be performed in the present WP is the preparation of the test articles on which structural tests (static, fatigue) and other types of tests will be performed.
Main objective of 2011 is start, in the last 2 months of the year, with the preliminary activities for Tooling and Test Articles design.

GRA1 - Calls for Proposals Year 2011

In addition to the work outlined in the remainder of this Annual Implementation Plan for 2011, Calls for Proposal will be launched during the year 2011.

GRA2 – Low Noise Configuration (LNC) domain

GRA2 - LNC overview

Regional aircraft typically operate over airports located in the neighbourhood of densely populated areas, with a high frequency of taking-off and landing events and, hence, they strongly contribute to the impact of air transport on environmental noise and pollution.

Furthermore, due to the typical short range of regional aircraft whose cruising flight distance is only about 50%, the climbing performance and the empty weight of the aircraft have both a strong influence on the entire mission fuel consumption and, again, on gaseous contaminants and noise emissions over airports surrounding regions.

Therefore, in order to contribute to the achievement of the environmental goals of reducing aircraft community noise as well as gaseous emissions, the "Low Noise Configuration" project within the GRA ITD will pursue a dual purpose:

- to assess technologies aimed at reducing airframe noise which during the approach flight phase (with engine power at minimum, high-lift devices deployed and undercarriage lowered) is a major contributor to the aircraft annoyance perceived by the resident population;
- to address technology innovation toward paramount functions for a next generation, green regional aircraft:
  - highly-efficient aerodynamics to reduce fuel consumption and pollution at cruise condition;
  - wing loading control to enhance aerodynamic efficiency in all flight conditions and, hence, to reduce fuel consumption and pollution over the whole mission, also allowing for steeper initial climbing, noise-abatement flight trajectories;
  - wing loading alleviation to avoid any possible loads exceeding over structural design conditions and, hence, to optimise the wing structural design for weight savings.

In order to meet the above objectives, consideration will go to enabling technologies investigated in the course of past European research programmes as well as to more advanced concepts. In particular:

- Natural Laminar Flow Wing design;
- High-Lift Devices highly-efficient / low-noise configurations involving: i) acoustic treatments (liners) and other passive solutions (brush-like devices, serrations, fences, etc.) to attenuate vortex flows induced noise emissions; ii) gapless leading edge architectures (drooped nose, Krueger flap); iii) enhanced aerodynamics through optimised shaping and active flow control; iv) morphing structures;
- Loads control / alleviation concepts based on active control of conventional / unconventional wing control movables and wing aero-elastic tailoring;
- Drag reduction through passive flow control devices to delay boundary layer transition (e.g. micro-roghness) and to reduce skin friction in the turbulent flow region (e.g. micro-riblets).

The above integrated concepts and relevant technical solutions will lead to the conceptual wing design, combining conventional and advanced functions, tailored to the requirements of several configurations in the overall future scenario of the Green Regional Aircraft, that is: innovative Open Rotor (rear-fuselage power plant) with a NLF wing, Turbo-Prop, Turbo-Fan.

Furthermore:

- Low-noise configurations of Main and Nose Landing Gears, based on already matured concepts (no pipes and wires installed around the strut, wheel pack fairings, etc.) and more advanced technologies (e.g. wake vortices control), tailored to a Green Turbo-Prop high-wing Regional A/C configuration.

The LNC project work programme will develop through following phases: i) definition of requirements & architectures (WP 2.1); ii) assessment of enabling technologies (WP 2.2); iii) application studies (WP 2.3); iv) final demonstrations (WP's 2.4, 2.5 and 2.6) of selected solutions.

The down-selection process of the addressed technologies will proceed in a multi-physics view through theoretical studies, supported by advanced modelling tools, and experimental validation by wind-tunnel tests and functional / mechanical testing.

Demonstrations of wing technologies are planned to be carried out through large-scale wind-tunnel tests on A/C configurations models.

Demonstrations of landing gears low-noise technologies will take place through aero-acoustic full-scale wind-tunnel tests.

The final stage of the activity plan – analysis & final reporting (WP 2.7) - will be dealing with an overall assessment of project results as well as with guidelines/recommendations toward applications of green technologies to future products.

GRA2 - LNC Work Programme Year 2011

The activities planned over the reference project period are inherent in the "Requirements & Architectures" (WP 2.1) and in the "Enabling Technologies" (WP 2.2), as outlined below.

WP 2.1 Requirements & Architectures

- Multi-disciplinary design of the baseline wing for a future regional A/C with under-wing engine nacelle installation. This activity, already assigned through CfP (JTI-CS-2010-01-GRA-02-007), will develop along the following phases:
  - CFD based wing aerodynamic optimisation to achieve the best aerodynamic efficiency at key design point(s), by considering both transonic cruise and climbing performances;
  - Aero-elastic wing design coupling CFD and static/dynamic analyses to achieve the best structural efficiency (wing box minimum weight) still preserving the aerodynamic behaviour;
  - HLD design (aerodynamic shaping and settings) to optimise lift-to-drag ratio during take-off/first climbing flight phases and to meet high-lift requirements at approach/landing flight conditions;
  - HLD kinematics design and preliminary definition of relevant actuation system.
- New tasks dealing with MLG (fuselage mounted solution) and NLG design for a TP high-wing A/C configuration, based on relevant new requirements specification. These will be the baseline architectures for subsequent LG related low-noise technology studies.

WP 2.2 Enabling Technologies

The technology development for the OR A/C (NLF wing), TP and TF wing concepts defined in WP 2.1, tailored to respective wing configurations and relevant baseline HLD architectures, will continue overall the reference project period. At the same time, LG low-noise technologies for a TP (high-wing) A/C configuration will be addressed. The activities inherent in the concerned technology fields are described hereinafter.

❖ **WP 2.2.1 - HLD highly-efficient / low-noise technology studies**

i. passive low-noise solutions (acoustic liners, flap side edge fence) to reduce noise sources due to flap tip vortices, cove vortical flows, vortex shedding, etc.;

ii. aerodynamic optimisation and innovative kinematics so as to achieve HLD low-noise design (smaller deflections, reduced slots and tracks) still preserving high-lift performance;

iii. advanced architectures including morphing, hinge-less wing T/E structures and smart actuation of gapless L/E devices (drooped nose, Krueger flap);

iv. active boundary layer control through synthetic jets to delay flow separation and enhance airfoil high-lift capability.

Relevant activities will be characterised by the following crucial steps:

a) Completion of the first phase of conceptual design (through MDO modelling, CFD/CAA 2D and 3D numerical analyses, multi-physics virtual studies), supported by functionality testing for some specific solutions (e.g. droop nose actuation);

b) first down-selection of the most promising HLD concepts/technologies;

c) experimental validation and assessment of aerodynamic and aero-acoustic performances of selected HLD concepts through 2D WT tests.

❖ **WP 2.2.5 - Loads control & alleviation technology studies**

i. Assessment and development of wing control movables aero-mechanical concepts including: new rapid wing tip devices; innovative seamless surfaces for lift distribution control; new rapid T/E concepts; classical control surfaces used in a non-conventional way.

ii. Assessment of concepts for loads control by means of flexible wing checked deformation (active slow shape changes of L/E and T/E to maximise wing efficiency and adaptive wing concepts).

Relevant activities focused on OR A/C wing and also tailored to TP A/C wing will be characterised, over the reference project period, in particular by:

- parametric analyses of LC&A performance versus devices sizing, settings and position;
- sensitivity analyses of LC&A devices efficiency to variation of wing geometrical and structural/aero-elastic characteristics (A/R, twist, flexibility);
- pre-design of LC&A devices structural (skin, sub-structures) and actuation system architecture.

The part of the aforementioned wing LC&A technology studies related to a future TF A/C configuration will be assigned through CfP (JTI-CS-2010-05-GRA-02-014).

❖ **<u>WP 2.2.3 & 2.2.4 - Main and Nose Landing Gears low-noise technology studies</u>**

Following concepts will be addressed:

- aero-acoustic design of MLG and NLG (strut and wheel pack) by adopting both conventional solutions (aerodynamic shaping, fairings, optimised architecture reducing wires and pipes installed) and more advanced technologies (e.g. vortex disintegrators);
- LG bay (cavity) noise suppression devices (e.g. spoilers, bulkhead ramps);
- LG bay doors optimised design to maximise noise shielding effect.

The conceptual design of LG low-noise configurations will rely, over the reference project period, on theoretical studies using semi-empirical methodologies, CFD/CAA numerical analyses, virtual

modelling of gear actuation to account for gear integration and functionality requirements/constraints (structural issues, gear equipment interfaces, etc.).

GRA2 - Calls for Proposals Year 2011

In addition to the work outlined in the remainder of this Annual Implementation Plan for 2011, Calls for Proposal will be launched during the year 2011.

GRA3 – All Electrical Aircraft (AEA) domain

GRA3 - AEA overview

This GRA3 domain is mainly focused on studies, validation and verification activities aimed at demonstrating the feasibility of All Electrical Aircraft (AEA) systems configuration for the Future Regional Aircraft. The removal of hydraulic fluid will further contribute to achieve the goal of an environmental friendly regional aircraft.
To achieve such objectives, Energy Management solutions shall be extensively investigated and demonstrated. Energy management is the control of aircraft loads – electrical in an "all electrical" frame – optimizing weight, volume and consumption, while taking care of power transients by "smoothing" non essential or non critical loads for that operative flight or operative phase. As a consequence, all on-board systems and related technologies (e.g., electrical and electronic technologies for generation, distribution and control, air conditioning and pressurization, ice protection, actuation (flight controls, landing gears, …), engine and its accessories) shall be reviewed and reconsidered. GRA AEA will demonstrate, up to flight demo, architectures and components fully representative of aircraft integration issues for next generation Regional Aircraft.

GRA3 - AEA Work Programme Year 2011

During 2011 the GRA3 will perform analysis and application studies for on-board systems affected by All Electric approach either for Future Regional Aircraft and for the In-Flight Demonstrato including implementation analysis and integration of Energy Management Functional logics.
Studies will be conducted for the development of the Electromechanical Actuation for a Fly-by-Wire advanced Flight Control System with preparation and launch of CfP for designing and manufacturing of Advanced EMAs and relevant Test Rig.
Studies will continue for the specification of an innovative aircraft motion system based upon advanced electrical machines fully integrated inside the wheels of a future regional aircraft main landing gear.
It will be supported and assessed the results of 2010 CfP activities concerning the "feasibility studies of power controller for different types of electrical motors within an Energy Management architecture"
Finally several Call for Proposals will be prepared and launched aiming to design, develop and manufactur innovative FTI, equipment and parts for the "preparation of Flight Demonstration"

In details the following WPs will run during 2011:

WP3.1.2 AEA Integration requirements for systems:
This WP performed in 2010 the definition of architecture, performance, installation, functional, qualification and certification requirements for most of on-board systems relevant to the All Electrical Aircraft (AEA) for the Future Regional Aircraft affected by All Electric approach for a Future Regional Aircraft. The WP activities are expected to end by January 2011 due to updating of final integration requirements for the Wing Ice protection System.

WP3.1.3 AEA demo requirements and architectures:
This WP performed in 2010 the definition of "requirements for the on board systems and sub-systems relevant to the All Electrical Aircraft (AEA) for the Future Regional Aircraft systems affected by Energy Management when actually tested in the demonstration either on ground and in flight, as well as the definition of the "Verification and Validation Plan for Energy management demonstration into GRA". The WP activities are expected to end by January 2011 to complete the updating of the Deliverables.

WP 3.2 AEA technologies for systems (methods & tools):
The WP aims at the selection and adaptation of tools and methods suitable to the Energy Management design and simulation. The main objective is to develop a Shared Simulation Environment (SSE) to be used for the assessment and the optimisation of the Energy Management logics.
The activities for the year 2011 will continue the ones carried out during the year 2010, mainly addressing the following points:

- SSE development
  - Implementation of SSE according to the requirements developed in 2010
  - Integration of Level 1 *(Architectural Level)* and Level 2 *(Functional Level)* models into the SSE
  - Starting the development of Level 3 *(Behavioural Level)* SSE architecture and systems interfaces
- Development of systems models of regional aircraft
  - Complete implementation of Level 1 and Level 2 simulation models
  - Starting the development of Level 3 simulation models
  - Management of 2010 CfP (development of LG and FCS models)
- Development of Thermal Architecture Model of regional aircraft
  - Completion of implementation of Level 1 and Level 2 Cabin thermal model
  - Starting the development of Level 3 simulation Cabin thermal model

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WP3.3.1 Future Aircraft Configuration for AEA :
The activities for the year 2011 will continue the ones carried out during the year 2010, mainly addressing the following points:

- Analysis of function and performance of on board systems for an All Electrical future regional A/C. Activities based on the input coming from the WP 3.1.1 and WP 3.1.2 as well as data from GRA New Configuration Domain concerning A/C configuration definition.
- Monitoring and supporting of the activities concerning “feasibility studies of power controller for different types of electrical motors within an Energy Management architecture”. Activity launched with issuing of dedicated CfP and expected to start in March 2011.

In the 2011, WP3.3.1 will also start activities concerning:

- Implementation, analysis and Integration of Energy Management Functional logics for Future Regional Aircraft
- Studies on Fly by Wire Advanced flight Control Systems with definition of FCS Architectures based on Electromechanical Actuation (EMA).

WP3.3.2 Demonstrator Configuration for AEA:
In 2011 the activity of analysis of functions and performance of on-board systems interested to the ground and in-flight demonstration will start as well as implementation analysis and integration of Energy Management Functional logics for demo.
For the purpose, the activity will based on the input coming from the WP 3.1.3 - AEA demo requirements and architectures

3.5.1 Preparation of Flight demonstrator for AEA:
The WP will effectively start in 2012, but activities are needed in order to prepare and launch, in 2011, several CfPs aiming to design, develop and manufactur innovative FTI, equipment and parts for the preparation of Flight Demonstration, like:

- Control Consolle and Electrical Power Center per Flight Demo
- Development of simulated loads for Flight Demo
- Innovative instrumentation for in-flight demonstration
- Development and manufacturing of systems parts for Flight Demo

GRA3 - Calls for Proposals Year 2011

In addition to the work outlined in the remainder of this Annual Implementation Plan for 2011, Calls for Proposal will be launched during the year 2011.

GRA4 - Mission and Trajectory Management (MTM) domain

GRA4 - MTM overview

The activities regarding Mission and Trajectory Management (MTM) are performed in GRA ITD in tight cooperation with Systems for Green Operations (SGO) ITD.
The over-all idea is that GRA ITD define Regional aircraft high level requirements and MTM peculiar functionalities. These inputs are provided to SGO ITD in order to be taken into account during technology studies. The candidate technologies will be assessed and down-selected in SGO ITD and further development for the regional applications in GRA ITD. When ready the technologies will be integrated in a Regional aircraft flight simulator. Finally, the simulator will run tests in order to assess the environmental benefits deriving from new green technologies.
In Clean Sky time-frame Alenia will participate to SGO activities such as regional a/c trajectory definition, support to optimisation tool development and technology studies. During trajectory studies inputs coming from SESAR will be taken into account.

GRA4 - MTM Work Programme Year 2011

The activities planned for 2011 are:

- A/C high level requirements for MTM (WP 4.1.1) – started in 2008
- Requirements for MTM demonstration (WP 4.1.2) – started in 2009
- Avionics Architecture (WP 4.2.1) – planned late 2009, started in 2010
- Basic prototyping tool preparation (WP 4.2.2) – started in 2008
- Prototyping Tool for MTM functions (WP 4.3)

WP4.1.1 A/C high level requirements for MTM:

- MTM functional requirements (2nd phase)
- Operational scenario (2nd phase)
- Safety requirements (2nd phase)

The first release of the above documents was produced in 2010.

As far as MTM functional requirements and operational scenarios is concerned the documents produced in 2010 (1st phase) will be updated taking into input coming from SESAR Research.

As far as safety requirements is concerned the analysis produced during 2010 (1st phase) will be deepened taking into account avionic architecture solutions.

WP4.1.2 Requirements for MTM demonstration:
The aim of this WP is to define the requirements for MTM demonstration, in terms of demonstration scenarios. The output of these tasks will be used during test cases elaboration (GRA 4.4).

In 2011 the following activities will be done:

- Scenarios analysis (2nd phase)

The above document is a revision, to be issued to take into consideration input coming from SESAR.

WP4.2.1 Avionics architectures:
The aim of this WP is to define an avionics architecture. In 2011 the activity of avionics architecture definition, started in 2010, will be finalized.

WP4.2.2 Basic prototyping tool :
The aim of this WP is the preparation of the basic version of GRA flight simulator.
In 2011 the following activities will be finalized:

- Flight Simulator components technical specification, acquisition and/or implementation
- Development of the real-time environment and of the basic A/C models
- Development of the essential A/C systems basic models
- Basic ATM scenario modelling
- Peculiar GRA HMI modelling (excluding FMS)
- Overall system integration (excluding FMS) and test
- FMS model integration in the GRA simulator and test

WP4.3 Prototyping Tool for MTM functions:
The aim of this WP is to start the upgrade of the basic version of GRA flight simulator in order to integrate a new version of FMS including green functions.

In 2011 the following activities will be started:

- Development of upgraded FMS

GRA4 - Calls for Proposals Year 2011

No CfPs are currently planned for year 2011.

GRA5 – New Configuration (NC) domain

GRA5 - NC overview

Regional aircraft high level requirements, including power-plant, will be defined for two different seats class.
Two aircrafts reference have been identified; scope of the activities is the development of two green aircrafts base on advanced Turboprop and Open Rotor or Advanced Turbofan propulsion systems.
The technology development results obtained in the other GRA domains (from 1 to 4) will be integrated in the green aircraft in order to evaluate the potential benefits for the environment. NC effort's will be concentrate, in particular, on the classification of all possible architectures matched with all compatible and innovative power-plants enabling the integration.
Activities on power-plant integration issues will be performed, largely addressed to Open Rotor aerodynamic and noise. Trade-off studies will be performed for the assessment of the aircraft general architectures and performance that are the "best fit" with respect to the GRA environmental targets and the technologies developed in others GRA technology domain.
The final demonstration will consist of a large scale wind tunnel test campaign that will assess the performance of the aircraft configuration selected and will demonstrate the achievement of the environmental targets w.r.t. reference A/C in terms of noise and aerodynamic characteristics, the last required for fuel consumption and related emission evaluation at the end of the process.

GRA5 - NC Work Programme Year 2011

NC domain activities will be focused on Loop 2 of Green Aircraft Preliminary Sizing. Several configurations (Turboprop, Turbofan and Open Rotor) will be developed. Subsequently the Loop 3 of Green Aircraft Preliminary Sizing activities focused only on the best and technically feasible two Green A/C configurations will start: the first one belonging to a Turboprop, the second one to a Turbofan and/or Open Rotor.

Main activities are:

- Update the green aircraft/powerplant requirements;
- Perform new aircraft/powerplant sizing activities;
- Optimize the Powerplant/Airframe integration for all Green A/C configurations studied;
- Perform trade-off studies in order to compare different Green A/C configurations available from architecture/integration studies;

In details the following WPs will run during 2011:

WP5.1 NC A/C High Level Requirement

- **WP 5.1.1 High level requirements for aircraft:** This WP concerns the Top Level Aircraft Requirements and environmental targets definition for future Green Regional Aircraft (Turboprop, Turbofan and Open Rotor). Main goals are:
  - Provide High Level Aircraft Requirement (Loop 3) for general architecture and, considering also design and certification aspects, about only two classes of Regional A/C studies: the first one belonging to Turboprop, the second one to Turbofan and Open Rotor.

- Update and finalize the strategy and the plan for the Validation & Verification (Loop 3) of the benefits at A/C level resulting from the integration of the new technologies (coming from other domains) and requirement for plan implementation..

- **WP 5.1.2 High level requirements for power-plants:**
  This WP concerns the specifications for the engine power-plant employing the general Top level Aircrafts Requirements released from the previous WP5.1.1. The main objective is to update/redefine (Loop 3) green high level powerplant requirements (thrust requirement on specifications point, power extraction, emissions and acoustic requirements, mass and geometry limiters) only for the best and technically feasible two Green A/C classes. At end of 2011 the Loop 3 will finish and the final requirements for Powerplant to install on the future Green Regional Aircraft configuration will be specified.

WP 5.2 NC A/C Level Architectures

- **WP 5.2.1 Aircraft general architectures and performance:** This WP concerns the preliminary green aircraft general architecture and performance configuration studies. For each Green aircraft, the best layout configuration will be selected accomplishing the requirements defined in WP 5.1.1 & 5.1.2. Main system and structure architectures will be defined for such configurations.
  Green Aircraft Preliminary Sizing activities of the Loop 2 will be completed in the middle of 2011. Then, the activities of the Loop 3 will start; only the best two configurations will be analyze.
  Another task is devoted to the development of a few Aircraft Models that will be supplied the Technology Evaluator (TE) for the global assessment of green features of such A/C's.

  Other activities will be focused on innovative Preliminary design of Regional A/C rear Fuselage (integration of Fuselage, Empennages and power-plant) in order to minimize weight, to maximize aerodynamic efficiency and the best engine noise shielding.

  Another task will be oriented to investigate advanced prop fan (CROR) propeller characteristics and its associated local impact on aerodynamic, acoustic and vibration environments of A/C configuration.

  Specific wind tunnel tests with a modular test article will be performed in order to acquire aero acoustical data of open rotor configuration. In particular these tests will be useful also to calibrate and finalize specific software dedicated to Open Rotor aero acoustic evaluation. During this test campaign different engine installation will be tested (rear fuselage and under wing).

- **WP 5.2.2 GRA Powerplant architectures:** This WP concerns the definition of architectures, performances, main characteristics and relevant systems of three different green engines (T/P, T/F and O/R) in order to size the Green aircrafts configurations. In the first months of 2011 year, the activities will be focused on Loop 2 finalization. During the loop 3 activities only the best two propulsion systems, preliminary design studies will be performed, followed by parametric studies in order to select the best compromise between performances, noise, integration constraints. These studies will integrate new technologies benefits and new energy systems impacts (more electrical A/C, high mechanical power extraction, thermal management).

WP 5.3 Powerplant airframe integration for NC

This WP is devoted to optimize the Powerplant/Airframe integration for all Green aircrafts configurations studied. The optimization aims to improve green features (noise and emissions) taking into consideration aerodynamics and structures constraints. Within 2011 the second assessment (into Loop 2) for Green Turboprop, Turbofan and Open Rotor versus its dedicated A/C architecture integration will be completed.

WP 5.4 Definition of demonstration for NC

- **WP 5.4.1 NC technologies selection for the demonstrations:** This WP is devoted to select technologies coming from other GRA domains and available from the NC studies, to calibrate the trade off studies in order to single out the most promising configuration and to compare different Green A/C configurations available from architecture/integration studies. Emphasis will be given to green features (emission and noise). Starting from main results of Loop 1 of Preliminary Sizing and subsequently of Loop 2 one, 2011 year activities will be characterized by trade-off studies, highlighting pros and cons in terms of green features.

GRA5 - Calls for Proposals Year 2011:

In addition to the work outlined in the remainder of this Annual Implementation Plan for 2011, Calls for Proposal will be launched during the year 2011.