CLEAN SKY 2 Impact Assessment

Final Report of the Expert Group

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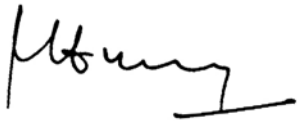

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Preliminary report of the Impact Assessment Expert Group

1 Executive summary

The document presents the conclusions and recommendations of the group of experts for the Clean Sky 2 (CS2) Impact Assessment performed in July-August 2012. These conclusions and recommendations are based on the Industry Proposal entitled “A preliminary Programme Outline for Clean Sky 2” dated 20-07-2012.

As indicated in its title, the Industry Proposal is a preliminary outline prepared for the purpose of aiding the Commission to ascertain the merits of CS2, a Joint Technology Initiative (JTI) similar to Clean Sky. The justification of CS2 has the same basis as Clean Sky, namely, mitigating the environmental impact of air traffic and improving the EU aeronautical industry competitiveness. The first declared objective of CS2 is to build upon the Clean Sky demonstrator results and integrate them into complete flying vehicles so as to give the EU aeronautical industry the confidence boost which is necessary for the market introduction of innovative technologies. These activities are to be executed within the Horizon 2020 time frame. Another CS2 objective is to mature further Clean Sky technologies and other novel technologies for future radically new aircraft concepts as will be required to meet Flightpath 2050 objectives. According to the Industry Proposal, CS2 is expected to start in 2014 and to end in 2024. This implies, therefore, a 4 years overlap from 2014 to 2017 between Clean Sky and CS2.

The Expert Group has been established by the Commission in June 2012. The terms of reference have been developed by the Directorate General for Research and Innovation and are to “Provide an expert opinion on the content and the relevance of the Industry Proposal for the establishment of the Clean Sky 2 and assess the different scenarios for the way forward of the current Clean Sky programme.”

The Expert Group fully supports the CS2 initiative.

- The Expert Group agrees that the CS2 initiative is justified and necessary for a full integration of Clean Sky demonstrators and for further technology innovation towards Flightpath 2050 goals.
- The Expert Group supports the general objectives described in the Industry Proposal as ambitious but realistic and consistent with Horizon 2020 guidelines and current technological requirements.
- The Expert Group considers that the Clean Sky type of organisation gives a project-like character to the programme. Activities are focused and awareness of objectives and deadlines is high. In view of the satisfactory operation of the Clean Sky JU, the Expert Group supports the establishment of a similar structure for CS2.

The industry proponents have clearly indicated that the CS2 proposal is a preliminary one and that, therefore, detailed technical descriptions of the demonstrators and the associated work plans are not yet available. The Expert Group understands this situation but, consequently, has not been able to carry out a detailed technical evaluation.

- Whilst the general objectives are endorsed, the Expert Group recommends quantifying the environmental targets and identifying and justifying the societal and economic objectives.
- The Expert Group considers that the detailed technical content of CS2 should be available well before the official start of CS2. This involves preparing a work plan with project milestones including decision gates, such as for launching demonstrations.
- The Expert Group stresses that CS2 should not become a broad development programme constituted by the sum of all desirable research activities. In most IADPs and ITDs, there is a need to streamline the programme and to focus on key high priority topics. High priority topics should be those required for IADP demonstrators or the most promising ones in terms of environmental and socio-economic impact. The streamlining process must be an integral and essential objective of the project definition.

The Expert Group notes the special requirements and constraints regarding the establishment of CS2, the overlap between Clean Sky and CS2 and recognizes the need for technical and managerial continuity to ensure a seamless transition of activities.

- The Expert Group considers that these requirements are best achieved by considering CS2 as an extension[1] of Clean Sky, and not just as a new project. This scheme has been used successfully in a previous Joint Undertaking. This approach would be consistent not only with the rationale and objectives of Horizon 2020 but also with the longer term objectives of Flightpath 2050.
- With regards to the governance, the Expert Group supports the Industry Proposal approach to maintain all Clean Sky instruments with a single management structure for Clean Sky and CS2 during the transition period from 2014 to 2017. This will provide technical and managerial continuity.
- In order to clarify the management and reporting chain, the Expert Group considers that Governing Board members and their alternates from industry should be selected among senior aeronautical industry technical representatives but who are not directly involved in IADP and ITD activities.
- The role and responsibilities of the JU and its management need to be strengthened.
- The Executive Team staff and budget resources should be substantially increased because of the parallel management of Clean Sky and CS2 and also because the proposed budget for CS2, 3.6b€, far exceeds the 1.6b€ of the Clean Sky budget thus implying more extended and demanding activities.

[1] The term “extension” applies to support proposals for new activities requiring new design work, new hardware and new experiments. It may also require new specialized staff, changes in the organisation and new investments. It is not applicable to cover delays or mismanagement in the activities.

The Expert Group recommends maintaining TE as an essential element within CS2, with its role being strengthened.

- TE should develop independent simulation capabilities in order to monitor results with the TE team coming from highly qualified independent research / academic institutes.
- The TE budget should be raised according to the extended scope.

Budgetary flexibility is essential for an organisation like CS2.

- This should be provided by allowing multi-annual Grant Agreements for members and empowering the JU management for certain budget reallocation.
- An overall contingency budget should be introduced to be handled by the Governing Board.

In conclusion, CS2 has the potential to play a vital role in addressing Horizon 2020 societal challenges and in moving towards the targets set by Flightpath 2050.

2 Introduction

In 2009, the Clean Sky Joint Undertaking, a Public Private Partnership between the European Commission and the Aeronautical Industry, was established by Council Regulation (EC) 71/2008 for a period up to 31 December 2017. The main objective was to develop environmental technologies impacting all flying segments of commercial aviation in order to contribute to the targets defined by the Advisory Council for Aeronautics Research in Europe (ACARE) for reduction of emissions and noise in air transport in Europe. So far, 12 industry leaders, 74 associated members and more than 400 partners, are working successfully together in a number of technology domains defined by Clean Sky to address the ACARE 2020 environmental objectives and demonstrate and validate the technology breakthroughs that are necessary to make major steps towards them.

In 2011, a new vision "Flightpath 2050" was proposed following the EUROPE 2020 and the Transport White paper, with ambitious goals for a sustainable and competitive aviation sector. Based on this vision's goals, a renewed Strategic Research and Innovation Agenda (SRIA) is currently under development. This agenda will provide the research and innovation roadmap to reach the goals highlighted in "Flightpath 2050" and guide and support future actions in public and private funding programmes towards Flightpath 2050 objectives including future Framework Programmes. Environmental impact mitigation and answering the strong international competition will be the main drivers in the aeronautics domain. In order to achieve the defined targets, applicable regulatory and financial framework need to be streamlined to accelerate the development and encourage deployment of technologies to reduce the environmental impact.

To address Horizon 2020 priorities and in response to the Flightpath 2050 targets a renewed initiative, called Clean Sky 2 (and hereafter referred to as CS2), is proposed by the aeronautical industry involved in Clean Sky. While the current Clean Sky programme is focused on demonstration and validation of technology breakthroughs, the new initiative intends to bring an additional level of integration and to focus on the aircraft as a whole. The proposers' target is to transition from the ACARE Vision

2020 to the Flightpath 2050 objectives and in difference of the current initiative, where near term objectives (2020) are targeted, the new one aims at contributing towards mid and long term goals (for 2035 and 2050).

In order to support the EU policy development, a formal procedure assessing the opportunity and relevance for the aeronautics JTI continuation within Horizon 2020 has been launched. For this purpose, the Commission has established a group of independent, external experts in order to assess the industrial proposal in terms of general, environmental, economic, and social impacts, benefits, and cost in comparison to other options which are described in the following section. The terms of reference of the expert group, which have been developed by the Directorate General for Research and Innovation, are to "Provide an expert opinion on the content and the relevance of the Industry Proposal for the establishment of the Clean Sky 2 and assess the different scenarios for the way forward of the current Clean Sky programme."

In this report, the industrial proposal is analysed in terms of advance beyond Clean Sky and its strategic relevance, the quality and relevance of the technical content, the governance organisation and the financial structure. The potential impact on the environment and on the industry competitiveness is briefly assessed. Comments related to each component of the proposal (IADPs and ITDs) are also presented. Main remarks and recommendations are shown in italics and referenced such as ***R4.2.2-1*** where "4.2.2" is the section number and "-1" is a sequential number.

A full list of remarks and recommendations is provided at the end of the report.

3 Scope of the assessment

In order to address the societal challenges evidenced by Horizon 2020 and to achieve the goals as defined in the new vision "Flightpath 2050", six different policy options with different levels of public involvement are available. While the first option, being the "no-EU" option has been already rejected within the Horizon 2020 proposal, the following five options are remaining[2]:

a. *Business as usual:* continue with the current Clean Sky initiative (as defined on the basis of the ACARE Vision 2020) and Horizon 2020 collaborative research;
b. *Zero Option:* use only the Horizon 2020 collaborative research;
c. *Horizon 2020 collaborative research and contractual PPP:* continue with an initiative in a form of a contractual Public-Private Partnership;
d. *Horizon 2020 collaborative research and Joint Technology Initiative (JTI):* new Clean Sky initiative in a form of a Public-Private Partnership with new/updated objectives;
e. *Regulatory option:* drive aviation greening of air transport by legislation.

In July 2012, a group of leading European Aeronautical companies, all of them already involved in the current Clean Sky Joint Undertaking, have prepared a

[2] EU_Roadmap_SCJU_IA_draft4.pdf issued by DG RTD – H3 in 04/2012

"Preliminary Programme Outline"[3] for a new Initiative Clean Sky 2 (CS2) with new and updated objectives. The proposal follows the policy option "d: *Horizon 2020 collaborative research and Joint Technology Initiative (JTI)*".

The proposal is centred on the continuation of Clean Sky efforts, addressing integrated technology demonstrations at large system level, and building upon Clean Sky achievements including new technologies, new configurations and new vehicle demonstrations at the integrated vehicle level.

Besides three integrated technology demonstrators (ITDs, similar to Clean Sky ITDs) on airframes, engines and systems, three innovative aircraft demonstrator platforms (IADP) are proposed targeting at a final proof of aircraft systems to validate their design and functions, on fully representative innovative aircraft configurations in an integrated environment and close to real operational conditions. The IADPs cover Large Passenger Aircraft, Regional Aircraft and Fast Rotorcraft. The Clean Sky Technology Evaluator (TE) is planned to be continued.

In order to meet in full the ACARE 2020 goals and to make important steps towards the Flightpath 2050 vision, the targets of CS2 imply an extension beyond the environmental targets of Clean Sky. Competitiveness of the European industry as well as social and economical benefits are addressed in the proposal as well.

The proposal foresees a total private and public investment of 3.6 Billion Euro over the full duration of Horizon 2020 from 2014 to 2024.

In addition, some principles of governance and management are proposed.

4 General comments on the proposal from industry

4.1 Strategic relevance

4.1.1 Critical role of the aeronautic industry for EU economy and society

The crucial role of the aeronautic industry for the EU economy and society is well illustrated in Flightpath 2050, the Report of the High Level Group on Aviation Research. This industry is characterized by a high R&D intensity (around 12%)[4] and a large positive trade balance. It is an important employer of highly skilled personnel. In 2009 its turnover reached over €100 billion.[5] It is formed by a complex supply chain, including some major companies and thousands of small and medium enterprises operating across the EU. The European aeronautics industry has been able to gain progressively a leading position in the world market over the last 50 years. Furthermore it has a critical role in fostering European integration.

[3] „A Preliminary Programme outline For Clean Sky 2", 20/07/2012
[4] The proposal notes at page 18 that 7 Billion euro per year are invested in research and development within the civil aeronautics sector.
[5] Flightpath 2050 p.5.

4.1.2 Challenges facing the EU aeronautic industry

Major environmental, competitiveness and regulatory challenges face the European aeronautics industry in the present context of rapid transformation of the world economy. Air traffic is expected to grow by 4% to 5% per year in the next decade leading to a near doubling in 2020.[6] To serve society's needs while mitigating the negative effects on the environment, the aeronautic sector should thus introduce substantial innovations in vehicles and engines.

In addition high oil price and the inclusion of air transport in the EU Emission Trading Scheme increase the necessity of a major leap in fuel and noise efficiency.

At the same time international competition, from traditional competitors and new producers based in emerging markets, is getting tougher. For example, the Chinese state-owned company COMAC is expected to become the strongest of all the newcomers "because they have more financial firepower than anybody else".[7] COMAC will also benefit from a large domestic market, since over the next twenty years China is expected to be the most valuable aircraft market. The increasing role of Chinese banks in aircraft financing may also strengthen COMAC position. China's ambition to become a force in the industry is clearly indicated by aerospace being targeted in the 12th Five Year Plan (2011-2015) as a Priority Industry. An important factor shaping the competitive game is that both traditional and emerging non-EU manufacturers have access to massive public support for their research activities. In this complex setting, European companies may maintain their key position only via successful research and innovation activities leading to energy efficient and cost effective products.

4.1.3 Horizon 2020 priorities and Flightpath 2050 targets

Horizon 2020, the EU new funding programme for research and innovation, identifies critical Societal Challenges to be tackled in order to promote smart, sustainable and inclusive growth, focusing more than in the past on innovation-related activities. The aeronautical industry may offer a crucial contribution to addressing these priorities, specifically to the creation of a smart green and integrated transport system.

Flightpath 2050 - in line with Horizon 2020 objectives - has set ambitious targets to tackle the challenges confronting the aeronautic sector.[8] The long term (i.e. 2050) environmental targets for aviation, relative to the 2000 situation, are: a 75% reduction in CO2 emissions per passenger-kilometre, a 90% reduction in NOx emissions, a 65% reduction in perceived noise emissions of flying aircraft. Also short term (2020)

[6] Proposal p 19 Refers to European Commission DG Transport and Mobility.
[7] Parker, A., A dogfight for the duopoly, Financial Times, August 7, 2012.
[8] Flightpath 2050 refers to aviation as a whole. It is thus expected that, besides more efficient aircrafts and engines, also better operational and flight management procedures will contribute to the fulfilment of the 2050 goals. The split between the different domains has yet to be defined. In the case of ACARE SRA-1 it was expected that the 50% reduction in CO2 by 2020 (relatively to 2000) should be due to a 40% reduction from aircraft technologies and 10% reduction from ATM and operations (see „A Preliminary Programme outline For Clean Sky 2", 20/07/2012, p.14).

and medium term (2035) targets are set.[9] If achieved, this rate of emissions abatement will mitigate the effects of traffic expansion.[10] Fulfilling these goals will also greatly enhance EU industry competitiveness, since greater energy efficiency will imply reducing operating costs.

4.1.4 Why CS2 may play a vital role in addressing Horizon 2020 Societal Challenges and in moving towards the targets set by Flightpath 2050.

Flightpath 2050 ambitious targets may be reached only through non-incremental innovations in vehicle and engines technologies. Significant performance improvements require step changes in technology and architecture. It is not possible to rely simply on market mechanisms to achieve these major non incremental innovations needed for fulfilling Horizon 2020 priorities and pursuing Flightpath 2050 targets. In fact, aeronautic programmes imply very long research and innovation cycles, they are very expensive and generally involve setbacks along the way and are thus associated to a higher level of risk than acceptable to industry or to the financial community. Returns are often delivered decades after the original investment and low profitability discourages private investment, thus making public financial intervention necessary.

Such a high-risk non-incremental research aimed at developing non-conventional aircraft concepts can take place only within a long term, co-ordinated and multidisciplinary programme such as CS2 PPP. The reasons why a PPP organisation still represents the best policy option will be briefly discussed in 4.2.3, 4.2.4. It is worth noting that the considerations which led to support the JTI (PPP) approach in the Clean Sky case have gained additional importance at the present time, since both the environmental and competitive challenges have become more severe.

The industry proposal aims to move its pre-competitive research closer to market (in line with Horizon 2020 indications) for accelerating market introduction of new technologies. CS2 is expected to demonstrate and simulate several systems jointly at the full vehicle level, while Clean Sky only matured components and systems individually. The stated CS2 environmental goals are “to *finish the job* of achieving the ACARE SRA goals as set for 2020” and to “facilitate the first important steps for the medium term (up to 2035)”.[11]

CS2 may aspire to fulfil its ambitious targets since it will build upon Clean Sky results, procedure and management. Achieving these ambitious targets however requires finalising the proposal - which is still in a preliminary phase and thus does not offer yet a fully defined technological roadmap - indicating clear and quantifiable environmental and technological targets, and focusing on few integrated demonstrators.

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[9] Detailed environmental targets for each of the three periods are presented in ACARE, June 2012, Realising Europe’s vision for aviation, volume 1, p. 79.

[10] The global reduction of the aeronautics impact envisaged by Flightpath 2050 on the environment would require other elements, such as the use of low carbon emission fuels, which are considered as being outside of the scope of this assessment.

[11] Industry proposal 20 July 2012, p. 10.

Clean Sky 2 has thus the potential to play a crucial role in addressing Horizon 2020 key Societal Challenges and in making important steps towards the Flightpath 2050 mid-term targets (2035).

4.2 Continuity and transition from Clean Sky to the proposed CS2 programme

4.2.1 Clean Sky status and expected achievements

Clean Sky was set up in 2008 and is expected to end in 2017. A 1st Interim Assessment of Clean Sky was conducted in 2010 and drew supportive conclusions on the Clean Sky Joint Undertaking. However, due to administrative delays in setting up the Joint Undertaking and in establishing the technical teams, this 1st assessment could only cover the first year of autonomous operation of the Clean Sky Joint Undertaking.

At this stage, a formal assessment of Clean Sky achievements is, therefore, not available apart from the Scientific and Technical Advisory Board (STAB) 2012 reviews. However, there are positive indications which give confidence that Clean Sky should, not fully but substantially, meet its objectives.

The Clean Sky objectives are primarily to reduce the environmental impact of air traffic and to improve the EU aeronautical industry competitiveness.

Environmental objectives are being assessed within the Clean Sky organisation by the Technology Evaluator (TE). There have been significant delays in TE progress and so far, only a preliminary and limited assessment has been carried out. The results of the preliminary assessment have not revealed unexpected issues and, at this stage, indications are that the original objectives in CO_2 and NO_x emission reductions and noise abatement seem to be within reach of the programme.

A significant effort is required to ensure that interfaces between Integrated Technical Demonstrators (ITDs) and TE become more effective so as to allow the first full assessment which is planned in 2012.

Technical progress is measured by the rate of achievement of milestones. Most tasks are on schedule and proceeding satisfactorily but in some areas there are delays due to various administrative and technical reasons. This situation is reflected in the budget execution which shows a tendency towards under spending. This can be attributed to lack of resources among ITD Leaders, lack of success with some technical developments and difficulties in getting proper replies to some Calls for Proposals (CfP). These delays are expected to impact the Technology Readiness Level (TRL) which, for some technologies, will not reach the TRL 5-6 level that was set as a target.

In spite of some delays in placing contracts, the CfP procedure is working well: topics offered for development contracts are well defined and strongly focused.

The technical definitions of demonstrators are now well established and in a number of areas, manufacturing activities are ongoing and pieces of hardware are available. It is, however, too early to attempt predicting the level of success in achieving the demonstrator programme. From its inception, Clean Sky has set to itself ambitious and challenging objectives. It is encouraging that these objectives, although still ambitious and challenging, appear to be still mostly achievable.

With regards to the EU industry competitiveness, Clean Sky is fulfilling its objectives of stimulating new research within the framework of a PPP which enables long term cooperation among European aeronautical stakeholders. Importantly, the participation of SMEs is higher than in other FP7 instruments with approx. 40% of the budget for Partners allotted to SMEs.

The Expert Group understands that in a challenging development programme such as Clean Sky some objectives may not be achieved to the full extent as defined initially. With this caveat, the Expert Group agrees that Clean Sky is progressing well and appears still capable of meeting its most essential objectives.

R4.2.1-1: *The Expert Group recommends carrying out a thorough ex post assessment of Clean Sky after its completion. It may become a powerful instrument to assess the full impact of the PPP approach.*

4.2.2 Is it justified to continue the aeronautical JTI after Clean Sky?

The current Clean Sky programme aims at building demonstrators at system level that will be tested on ground or in flight. These systems, such as laminar wings, new engines and aircraft configuration, will be tested separately but full integration of these systems into a single vehicle is not planned in Clean Sky. The CS2 initiative aims at a higher level of integration with complete aircraft demonstrators so as to understand the full impact, including risks and synergies, of the combination of innovative technologies. This will bring the development closer to market adoption and reduce the industrial risk. This higher level of integration is reflected in the CS2 proposal which indicates that achievements are to be measured through a System Readiness Level (SRL) in addition to the Technology Readiness Level (TRL) used in Clean Sky.

Following the White Paper on Transport, Flightpath 2050 has set new, more ambitious objectives for air transport regarding environmental impact and passenger mobility. Meeting these objectives requires more innovative and, in some cases, radically new aircraft technologies together with a closer integration of the whole aviation sector. CS2 encompasses, therefore, new technologies aiming at initiating the transition from Vision 2020 towards Flightpath 2050 goals.

R4.2.2-1: *The Expert Group supports the general objectives described in the Industry Proposal and agrees that the CS2 initiative is justified and necessary for a full integration of Clean Sky demonstrators and for further technology innovation towards Flightpath 2050 goals.*

The Expert Group support is, however, conditional upon

- *the definition of ambitious, but realistic quantitative environmental targets,*
- *the definition of other socio-economic benefits, and*
- *the conclusion of a detailed technical evaluation which, at the present time, is not possible in view of the preliminary nature of the proposal.*

It is further noted that technology development towards Flightpath 2050 long term objectives far exceeds the CS2 goals and implies future similar programmes after CS2.

4.2.3 What is the most effective structure for CS2?

The arguments in favour of a PPP have been well set out by the industry proponents.

The Expert Group acknowledges that the Clean Sky PPP, a JTI with a Joint Undertaking:

- Provides a stable mid to long term framework enabling long term commitment of the participants for developing innovative design solutions;
- Ensures focus of industry participants towards well-defined environmental and societal goals. This essential function is provided by the Technology Evaluator;
- Steers activities towards integration of new technologies into new aircraft configurations;
- Stimulates and enforces cooperation among major aeronautical companies;
- Enables a substantial participation of SMEs and academia through flexible and open Call for Proposal procedures.

A key objective of Clean Sky is to overcome the so-called “market failure” by using public support to reduce the development risk of non conventional technologies to a level that is considered to be financially viable by industry.

The Expert Group has no insight into industry’s judgment of what is a financially viable risk and cannot, therefore, comment on this specific point. However, the Expert Group notes that the deterioration of the economic and financial situation makes investment in technology more difficult and more necessary than when Clean Sky was established.

The Group notes further that the Clean Sky type of PPP structure has certainly been successful in attracting private investment and in stimulating and accelerating the development of “clean” aeronautical technologies.

Apart from the Clean Sky type of organisation, there are other options such as Horizon 2020 Collaborative Research or Contractual PPP as described in section 3. These options satisfy certain requirements but do not offer the combined advantages associated with the operation of a Joint Undertaking. In particular they do not provide:

- The long term commitment that is required for the long innovative cycles of aeronautical industry;
- The synergies associated with the interfaces between IADPs and ITDs and the single management structure;
- The focus on environmental goals that is enforced by the Technology Evaluator.

The Expert Group considers that the Clean Sky type of organisation, a PPP with a Joint Undertaking, gives a project-like character to the development programme. Activities are focused and awareness of objectives and deadlines is high.

This arrangement (PPP with Joint Undertaking) was taken onboard for Clean Sky, based on the recommendations in the “Study on the proposed Aeronautics JTI structure and rules of participation”[12].

[12] E. Bertolini, M. Huguet, June 2006

R4.2.3-1: *In view of the satisfactory operation of Clean Sky, the Expert Group supports the establishment of a similar PPP structure for CS2. Furthermore the Expert Group considers that, among the options available, the PPP with Joint Undertaking is the structure with the best potential to achieve the CS2 objectives within the proposed timescale.*

4.2.4 How to manage the transition from Clean Sky to CS2?

4.2.4.1 The overriding need for continuity

CS2 is largely building upon technologies and demonstrators developed under Clean Sky. Most Clean Sky activities will continue after the possible start of CS2 in 2014 and key results from demonstrators will become available in the 2015-2016 period. Thus, the start and ramp up of CS2 activities will be strongly impacted by the availability of Clean Sky results. Transition from Clean Sky to CS2 is, therefore, expected to be progressive depending on how and when Clean Sky results are achieved. Technical and managerial continuity between Clean Sky and CS2 are therefore essential to ensure a seamless transition of activities.

The Expert Group notes that setting up a new organisation for CS2 would be a time consuming process that would inevitably lead to delays and inefficiency during the initial running-in phase of CS2 and would also, most likely, result in some loss of know-how. It is further noted that many of the CS2 proponents are already involved in Clean Sky and the most effective way to proceed is to maintain essentially the same organisation.

The Expert Group considers that continuity can only be achieved when Clean Sky and CS2 are under a single management from 2014, i.e., a single Joint Undertaking constituted of a single Governing Board, a single Executive Team and a single industrial ITD, IADP structure.

The ITD and IADP structure will evolve during the overlap period from 2014 to 2017 so as to cover both Clean Sky and CS2 activities.

The Expert Group welcomes the industry proposal to essentially maintain the Clean Sky Joint Undertaking with all its instruments, basic structure and internal regulations (see section on governance).

R4.2.4-1: *The legal and financial bases of CS2 are not known yet but they should be aligned to existing Clean Sky regulations to ensure a broad compatibility of the two entities.*

All the above requirements can be satisfied in a logical and self-consistent manner when CS2 is considered as an extension of Clean Sky. This concept is introduced in the section on governance.

4.2.4.2 The need for a detailed CS2 development plan

The transition requires a detailed analysis of ongoing Clean Sky activities and of planned CS2 activities so as to delineate precisely, and for each task, when Clean Sky stops and when and from which basis the related CS2 task starts. Thus, CS2 tasks will start at different times depending on Clean Sky progress and achievements. This process is essential for the establishment of a proper work schedule, for the planning of resources and of course for budget control.

R4.2.4-2: *The effort and time required for planning the transition should not be underestimated and planning work should start as a matter of urgency.*

R4.2.4-3: *The first step is to designate the CS2 IADP and ITD Leaders. In the Expert Group opinion, continuity and effectiveness would dictate to maintain, as far as possible, the same responsibilities as in Clean Sky.*

R4.2.4-4: *It is recommended to identify candidates for core partners at an early stage and invite representatives to contribute to the CS2 content definition in order to allow a transparent and open process.*

R4.2.4-5: *When IADP and ITD Leaders are known, it is recommended to set up joint teams comprising Clean Sky participants, CS2 future participants and JU Executive Team participants to prepare detailed resource-loaded work schedules for CS2.*

This planning exercise will naturally lead to a precise definition of each task in CS2, it will ensure a close alignment of CS2 activities on ongoing Clean Sky activities and it will provide the basis for the determination of the required budgetary and staff resources.

R4.2.4-6: *The Expert Group considers that the detailed technical content of CS2 should be available well before the official start of CS2. This involves preparing a work plan with project milestones including decision gates, such as for launching demonstrations.*

During implementation, this work plan should be subject to reviews and modifications depending on actual progress and difficulties met.

4.3 Technical content

4.3.1 Technical definition and step beyond Clean Sky

The CS2 programme logic is built upon two pillars:

- Build upon Clean Sky results for new integrated vehicle demonstrations. This vehicle integration will be carried out by three IADPs on Large Passenger Aircraft, Regional Aircraft and Fast Rotorcraft.
- Continue Clean Sky technology demonstrations at large system level and initiate new technologies. This type of activity will be carried out by three ITDs on airframes, engines and systems and equipment.

The IADPs aim at vehicle integration, a step which is clearly beyond the Clean Sky objectives and is to be measured in terms of the SRL in addition to TRL as used for Clean Sky.

The ITDs will mature technologies to the level required for integration into the vehicles developed by the IADPs. Furthermore, ITDs will also develop technologies not selected for IADP integration but which are promising enough for future innovative designs towards Flightpath 2050 objectives.

The combination of IADPs for vehicle integration and ITDs for system technology is welcome but requires strong integration and coordination to reap the full potential benefit of synergies among IADPs and ITDs and to avoid overlap.

R4.3.1-1: *The Expert Group endorses the CS2 general objectives as ambitious but realistic and consistent with Horizon 2020 guidelines and current technological requirements.*

For each IADP and ITD, the objectives, demonstrators and potential technology streams have been identified in general terms.

R4.3.1-2: *Whilst the general objectives are endorsed, the Expert Group recommends quantifying the environmental targets while identifying and justifying the societal and economic objectives.*

For each of the CS2 projects, this quantification of objectives is necessary for a full justification of the project and to enable a sound decision to launch the project, monitor the achievements, modify the objectives or abandon the project when necessary.

The Expert Group acknowledges the preliminary nature of the proposal and notes that detailed technical descriptions of the demonstrators and the associated work plans are not yet available. This is not surprising at the present stage when CS2 projects are still largely undefined.

R4.3.1-3: *The Expert Group is unable to carry out a detailed technical evaluation in view of the current preliminary form of the proposal and recommends carrying out such a detailed technical evaluation when the full industry proposal becomes available.*

In the current assessment, the Expert Group will nevertheless highlight for each major item some of the required additional technical information and will make some recommendations to support the preparation of the final programme proposal.

4.3.2 Scope of the current proposal

The success of Clean Sky is largely due to its project-like character with a relatively small number of well focussed demonstrators in each ITD and clearly set deadlines. Clean Sky, as a European Joint Undertaking, is also about cooperation and integration among EU aeronautical industries. The management of interfaces and the enforcement of collaborations and synergies is a challenge in Clean Sky but remains a manageable task. CS2 should retain these winning features of Clean Sky.

The scope of the CS2 proposal in its current preliminary form is considered as being too broad. This is typical for a new project in the definition phase, where many options are being considered and the down selection process has not yet started. This situation must be addressed since the burden of too many demonstrators and technology streams and of a too complex interface matrix would make the management of CS2 an exceedingly difficult task.

R4.3.2-1: *The Expert Group stresses that CS2 should not become a broad development programme constituted by the sum of all desirable research activities with, as a consequence, a dilution of key objectives and limited prospect for collaboration among contributors.*

4.3.3 The need to streamline activities

In most IADPs and ITDs, there is a need to streamline the programme and to focus on key high priority topics. High priority topics should be those required for IADP demonstrators and the most promising in terms of environmental and socio-economic impact.

The lessons learnt from Clean Sky indicate that the streamlining process must be an integral and essential objective of the project definition.

R4.3.3-1: *The Expert Group recommends streamlining the CS2 programme around high priority topics. This process should be essentially completed before the start of CS2.*

Overlaps exist between IADPs and ITDs and should be minimized or eliminated where possible. This involves identifying research areas common to several IADPs and ITDs and may require transferring activities among IADPs/ITDs so that one IADP/ITD is designated as the leading body in a particular technology field. It is of course understood that integration into single vehicles of diverse technologies implies that the three IADPs will inevitably cover common technology areas. However, IADPs should concentrate on their specific issues.

R4.3.3-2: *For optimum use of resources, the Expert Group stresses the need to minimize or eliminate overlaps between IADPs and ITDs. This will also simplify the interface matrix thus enhancing management effectiveness.*

4.4 Technology Evaluator

The TE is a very important part of Clean Sky and results of the TE will contribute to the justification of investments made in Clean Sky.

With a set of simulation tools, its aim is to evaluate the environmental impact of a new technology or concept at local level (a new aircraft, an airport) or at a global level (a fleet, the world). These tools are a key to adjust objectives, to compare technologies, to monitor achievements in potential reduction of fuel burn, CO_2 emission, NO_x emissions and noise. In principle, the TE should assess all technologies developed or matured within CS2 regardless, whether they will be integrated into a IADP level demonstration or stay at ITD level. This would allow a objective assessment even of low level TRLs providing an justified rational for maturing them further in CS2.

R4.4-1: The Expert Groups recommends extending the focus of TE to lower TRLs across all ITDs and IADPs.

The complexity of the task relies in the necessary complete re-optimisation of an airframe taking into account a set of new technologies and their potential gains, but also all the other constraints on optimisation of airframe. This task is made normally by airframe manufacturers and is part of their core knowhow. No access to the sources of these optimisation tools is to be expected. In addition, results of evaluation of a technology could be in conflict with the commercial policy of communication of an airframe manufacturer.

It is important that Clean Sky be able to perform this type of optimisations by itself through TE to check the achievements of the programme. Comparable numerical tools for optimizing airframes are also developed or could be developed by specialized universities or research centres.

R4.4-2: *The Expert Group recommends maintaining TE as an essential element within CS2, with its role being strengthened as indicated below.*

- *TE should develop independent simulation tools in order to monitor results.*
- *In order to ensure the independence of TE without any constraints from industry, the TE team should be from highly qualified independent research/academic institutes.*

- *The JU executive management should chair the TE steering committee.*
- *Consequently, the associated budget for TE should be raised according to the extended scope.*

R4.4-3: *Effective interfaces between TE and the IADPs and ITDs are key to successful TE operation.*

- *The Executive Team should be given the responsibility and authority to ensure effective communication between TE and IADPs and ITDs and to ensure that deadlines are met for the transmission of necessary data to TE.*
- *Furthermore, TE should have representatives in each IADP and ITD so as to establish a close interaction between the engineers and the TE evaluators.*

R4.4-4: *The Expert Group considers that TE should progressively become the nucleus of, and enable a transition towards, a "European Aeronautical Technology Evaluator Facility"*

4.5 Governance and organisation

4.5.1 CS2 as a Clean Sky extension

The Preliminary Programme Outline for Clean Sky 2, ed. 20/07/2012 (referred to in the following as the Industry Proposal) indicates a full awareness of the intrinsic difficulties to link CS2 with Clean Sky, namely:

a) Four years of overlapping (2014-2017), which immediately generates the question of how to run two organisations in parallel while preserving the continuity between Clean Sky and CS2;
b) The evaluation of the activities performed in Clean Sky and their significance, which depends on their level of success, for the planned activities for CS2;
c) The technical relationship between the ITDs of Clean Sky and the IADPs and ITDs of CS2 and the timing for transition;
d) The use, partially or in total, of the staff of Clean Sky for the staffing of CS2;
e) The possible or necessary changes of rules for CS2 as compared to Clean Sky;
f) The closing of accounts for Clean Sky and the opening of accounts for CS2.

R4.5.1-1: *The Expert Group recommends considering CS2 as extension (with new/updated goals) to Clean Sky, and not just as a new and independent project. This would give a clearer direction to solve, in a logical and self-consistent manner, most if not all, problems associated with a transition focussed on continuity and integration as well as the launch of new activities in parallel.*

The term "extension" applies to support proposals for new activities, requiring new design work, new hardware and new tests. It may also require new specialized staff, changes in the organisation and new investments. It is not applicable to cover delays or mismanagement in the activities.

Moreover, this "extension" approach would be consistent not only with the rationale and objectives of Horizon 2020 but also with the frequent references to Flightpath 2050 vision in the Industry Proposal. Since Flightpath 2050 is a very serious objective for Europe and the Commission, these long term ambitious objectives can be best met by subsequent extensions of the Clean Sky Programme.

The JET Joint Undertaking[13] provides a good example of such a successful extension strategy.

The duration of Clean Sky exceeds by 4 years the duration of FP7 and likewise, the duration of CS2 exceeds by 4 years the duration of Horizon 2020. This is causing some difficulties in working out an organisation which should operate and integrate two projects during the long period of overlap. Since the industry proposal addresses long term Flightpath 2050 goals which are expected to require future programmes after CS2 the issue of overlapping programmes may occur again.

R4.5.1-2: *The Expert Group recommends that future programmes after CS2 should provide clear transition procedures with a minimum overlap.*

4.5.2 Membership and governance instruments

Adopting the concept of CS2 being an extension to Clean Sky, the Expert Group welcomes the Industry Proposal to essentially maintain the Clean Sky Joint Undertaking with all its instruments and basic structure and internal regulations:

a) The Governing Board;
b) The Executive Director leading The Executive Team;
c) The Steering Committees for each IADP and ITD;
d) The National States Representatives Group (NSRG);
e) The Scientific and Technical Advisory Board (STAB);
f) The General Forum of Stakeholders (GFS).

The Expert Group notes that the proposed CS2 membership, including the Commission, Leaders and Core Partners, is similar to that of Clean Sky.

The proposed competitive selection rules for Partners are also similar to those in use for Clean Sky, while the selection process for Core Partners has been improved in terms of independence and transparency.

[13] The Joint European Torus JET is a successful example of a Joint Undertaking in the Research Programs of the European Union. It was the first time the European Commission used the scheme Joint Undertaking, back in 1978. JET came in operation (on time and substantially within costs) in mid 1983 and was to be operated until 1988. Since then, there have been a number of extensions (to 1992, to 1996 and to 1999). Each extension (which included new participating countries) was granted by the Commission and by the European Parliament, not because of delays, but in support of proposals for new experiments requiring substantial hardware upgrading both in engineering and in physics. To do this, new specialized staff was required, changes in the organisation were implemented and, of course, investments were made, with the clear commitment to maintain any change and/or addition to a minimum. The experience of JET is relevant also because the total investment, at today costing, would be about 1.5 b€.

The Expert Group supports the Industry Proposal approach and re-iterates that continuity between Clean Sky and its extension (CS2) requires a single management, i.e., a single Joint Undertaking constituted of a single Governing Board, a single Executive Team and a single industrial ITD, IADP structure. This single management will oversee the Clean Sky activities until 2017 and the new CS2 activities from 2014 until the planned termination date of CS2.

The Governing Board composition and the ITD and IADP structures will evolve during the overlap period from 2014 to 2017. This is covered in the following section.

R 4.5.2-1: *The Expert Group recommends that the selection process of core partners should be executed under the control of the JU executive team.*

4.5.3 The Governing Board

There is a management inconsistency in the Clean Sky organisation in that currently a person leading an ITD is also allowed to represent a member in the Governing Board. As such, this person sometimes is judge and party of his/her own activities.

The Expert Group considers that this management situation should be corrected for CS2.

R4.5.3-1: *The Governing Board members and their alternates from industry should be selected among senior aeronautical industry technical representatives but who are not directly involved in IADP and ITD activities. In addition, the Governing Board should focus its activities on strategic guidance.*

All aeronautical companies participating as Leaders in CS2 should have one representative in the Governing Board. Representatives of Core Partners should also be included as it is the case in Clean Sky.

The change in Governing Board membership should occur at the start date of CS2. This implies a change in the Clean Sky statutes.

With this new arrangement and during the transition period from 2014 to 2017, the Governing Board would include:

- The EC;
- Representatives from each industry Leaders in Clean Sky;
- Representatives from each new industry Leaders in CS2;
- Representatives from Associates from Clean Sky and Core Partners from CS2.

From the end of Clean Sky, the membership would be reduced to the EC and industry Leaders and Core Partners in CS2.

4.5.4 The management of the Executive Team

As mentioned already in the 1st Clean Sky interim assessment carried out 2010 and as expressed above the need for strengthening the role and responsibilities of the JU and its management has been recognized. In addition, improving the role of the JU would allow the Governing Board to focus on Strategic Guidance. These considerations are even of higher importance in light of the proposed extension of Clean Sky.

The Expert Group considered two options for the management structure of the Executive Team.

The 1st option is to support the Executive Director through strengthening and extending the second level management at the start date of CS2. In principle, the current top level management structure is recognized as being adequate and well suited to run Clean Sky as well as CS2, including the transition period. Some Expert Group members favoured this option as being efficient and demonstrated by the satisfactory operation of Clean Sky[14].

The 2nd option is to replace the Executive Director by a General Director and an Executive Director at the start date of CS2. The main functions of the two managers could be summarized as follows:

- The General Director would be the Legal Representative of the JU. He would be responsible for the evaluation of external constraints such as societal and environmental aspects. He would liaise with national programmes and industries involved in CS2. He would report to the Governing Board and be directly responsible for the Executive Team administration.
- The Executive Director would focus on the follow-up and management of technical activities in the IADPs, ITDs and TE, ensure that interfaces are properly addressed and control Grant Agreements with Members and Partners. The Executive Director would report to the General Director.

Some Expert Group members[15] considered that the transition from Clean Sky to CS2 with 4 years of overlap and the need to reinforce the role of the Executive Team would be best achieved with this 2nd option.

4.5.5 The Executive Team supervisory functions

R4.5.5-1: *The Expert Group recommends reinforcing the strategic, administrative and technical role and power of the Executive Team.*

4.5.5.1 Ensuring the programme flexibility

The JU should be able to react swiftly to technical setbacks, to problems induced by lack of resources in companies, to changes in partnership and to changes in policies or priorities. Such issues have arisen in Clean Sky.

R4.5.5-2: *The JU needs to be empowered and to carry the duty to propose stopping an activity with too much delay or too low TRL expectation, launching a new one with better prospects and modifying the budget share between / within IADPs / ITDs. Programme decisions of this kind can only be made by the Governing Board but it should be the Executive Team management's responsibility to raise issues and propose remedies.*

R4.5.5-3: *The rules of decision making should not prevent justified and important re-adjustments of the programme. For example, for budget changes a written procedure by the Executive Director including the principle of "tacit approval" with time limits (e.g. 6 weeks) should be considered as an instrument for avoiding delays.*

[14] This 1st option was supported by Francesca Sanna-Randaccio, Serge Eury and Peter Hecker.
[15] This 2nd option was supported by Enzo Bertolini and Michel Huguet.

4.5.5.2 Access to technical information

Most if not all IADPs and ITDs in Clean Sky 2 contain more than one project, leading to the creation of a new figure in the organisation of Clean Sky 2, the Project Responsible Leader (present in the ITDs of Clean Sky)

R4.5.5-4: *In order to execute properly its supervisory function, the Executive Team should have direct access to IADP and ITD Leaders and to Project Responsible Leaders within each IADP and ITD. It should have the right to request access to works and facilities where development and manufacturing activities are taking place.*

4.5.5.3 Interfaces and Synergies

Given the challenge of meeting the ambitious demonstrator objectives and deadlines, it is expected that each IADP and ITD will naturally tend to concentrate on its own internal issues. This is fact of life in all development projects and it is, therefore, the management's responsibility to enforce a proper handling of interfaces. In CS2, this managerial function must be one of the main duties of the Executive Team.

R4.5.5-5: *The Expert Group considers it necessary to reinforce the role and power of the Executive Team to identify interfaces between IADPs and ITDs, to ensure that these interfaces are handled properly and to enforce synergies. This is all the more important for high TRL and high SRL activities which are getting close to market application and for which IPR issues become critical.*

R4.5.5-6: *This role in interface coordination by the JU is to be exercised:*

- *At the work definition level: The Executive Team should verify and give its approval of the completeness of the interface matrix and specifications. The Executive Team should enforce the implementation of interfaces in the Grant Agreements and in the yearly Development Plan of each IADP and ITD.*
- *Throughout the work execution: The Executive Team should ensure that interfaces are properly addressed and should enforce joint activities and technology exchanges where required. The Executive Team should also identify overlaps and take action to minimize or remove these overlaps.*

R4.5.5-7: *For all interface and supervisory activities above, the Executive Team Management should retain the authority to request actions from IADP and ITD Leaders and the responsibility to report to the Governing Board on deficiencies in addressing interface issues.*

4.5.6 The Call for Proposal Process

R4.5.6-1: *It is recommended to empower the JU to decide if a topic is, or is not, relevant in terms of CS2 objectives in order to avoid launching topics only for fulfilling the requirement of 25% of the budget for calls, thus leading to activities without great interest and sometimes out of the scope of the main activities.*

4.5.7 The Executive Team resources

R4.5.7-1: *It is recommended to substantially increase the Executive Team staff and budget resources because of the parallel management of Clean Sky and CS2 and also because the proposed budget for CS2, 3.6b€, far exceeds the 1.6b€ of the Clean Sky budget thus implying more extended and demanding activities.*

The recommended extension approach would permit making optimum use of the existing Clean Sky Team, bringing their experience to the Project and contributing

greatly to assure continuity and a smooth transition. In addition it would be natural to execute the transition any time during the 4 years of overlapping and not abruptly at the end of 2017. In this way the necessary increase of the Team may be better contained.

4.5.8 IADP and ITD management and Steering Committees

The Expert Group recommends that, similarly to Clean Sky, each IADP and ITD is to be lead by two co-Leaders one of which being the IADP/ITD coordinator.

R4.5.8-1: *The common Leadership and coordination for all projects within an IADP or an ITD is important to promote synergies and a proper coverage of interfaces.*

The management functions involve for example:

- Preparing decisions for the projects within their IADP/ITD on technical, schedule and financial aspects (including for example reallocation of funds among IADP projects);
- Coordinating the IADP/ITD activities and chairing the IADP/ITD steering committee;
- Reporting to the JU management.

Each project within an IADP or ITD should be lead by a Project Leader and a Project co-Leader. The responsibilities include for example:

- The technical, schedule and financial management of one IADP/ITD project;
- Reporting to the IADP/ITD Leader and co-Leader;
- Providing all necessary information to the JU management.

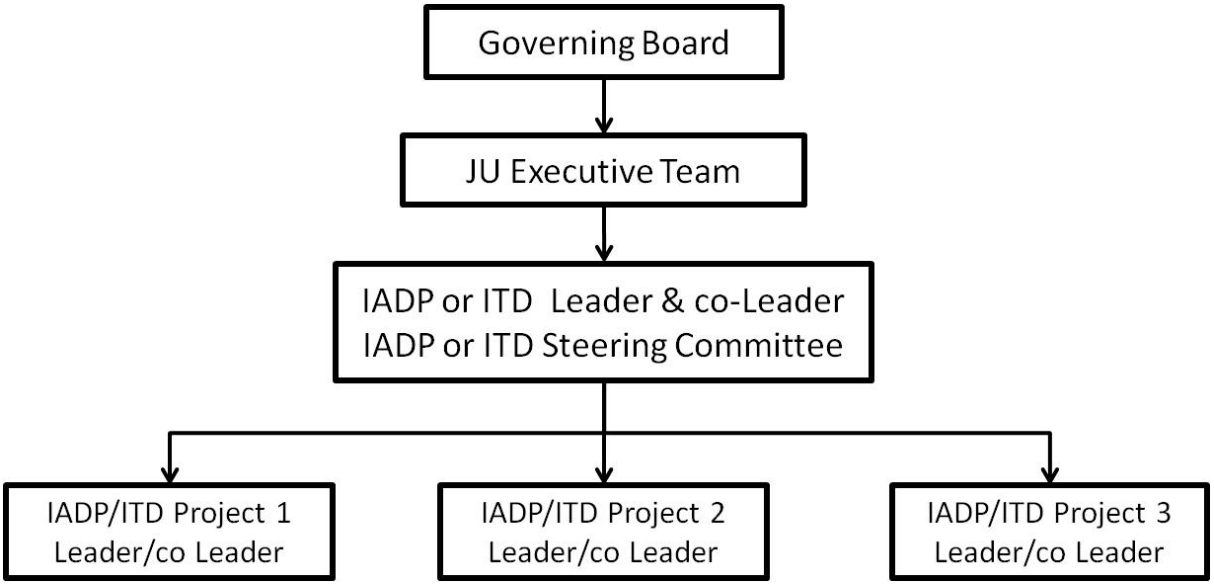

Diagram of management chain

4.5.9 IADP and ITD structure

In order to ensure and enforce continuity between Clean Sky and CS2, it seems necessary for the CS2 IADPs and ITDs to be associated to the existing Clean Sky ITDs wherever there are strong links between them. In this way, topics that pertain to both Clean Sky and CS2 could be addressed jointly by a single Steering Committee.

This can be achieved since there is continuity between the Clean Sky ITDs and the CS2 IADPs and ITDs as illustrated on the table below.

Continuity between Clean Sky and CS2

Clean Sky ITDs	CS2
SFWA	Large passenger aircraft IADP & Airframe ITD
GRA	Regional aircraft IADP & Airframe ITD
GRC	Fast rotorcraft IADP & Airframe ITD
SAGE	Engines ITD
SGO	Systems & equipment ITD
ECO	

At the start date of CS2, initiation of CS2 IADP and ITD activities could take place within the corresponding Clean Sky structures. Initially, the CS2 activities would simply be additional projects within the existing Clean Sky ITD.

The change-over from the Clean Sky structure to the CS2 structure should be made at a date to be defined for each IADP and ITD depending on Clean Sky demonstrator progress and the development of the specific CS2 activities.

The CS2 Airframe ITD has no direct equivalent in Clean Sky and should be started when found useful depending on results from SFWA, GRA and GRC demonstrators.

R4.5.9-1: *The ECO ITD has no direct equivalent in CS2 and no continuation of ECO activities has been recognized by the Expert Group. It is recommended to consider the continuation of ECO activities in relevant fields like systems, airframes and engines.*

4.5.10 Management of Level 2 projects

The possibility of assigning Level 2 projects to CS2 is mentioned in the industry proposal.

With regards to this option, the expert Group can make the following remarks:

- As pointed out in the Industry Proposal, management of Level 2 projects by the Executive Team of CS2 should help towards a better integration of Level 2 projects towards CS2 objectives.
- The additional work load on the Executive Team would be substantial and would require additional resources.
- Since Level 2 projects are funded 100% by the Commission and CS2 members may apply to these projects, the Level 2 project management (calls for proposal, adjudication and supervision) should be independent from the Governing Board and be solely under the responsibility of the Executive Team. It follows that the Executive Team management would report to two different bodies: the Governing Board for CS2 and the Commission for level 2 projects. This may generate some difficulties in the reporting chain and in controlling the workload of the Executive Team.

R4.5.10-1: *Considering the advantages and drawbacks and in view of the heavy workload of the Executive Team which is requested to become more pro-active in*

managing CS2, the Expert Group suggests keeping Level 2 projects separate from CS2.

***R4.5.10-2:** However, should a decision be made to assign Level 2 projects to CS2, the Expert Group considers that the assignment should be strictly restricted to Level 2 projects directly related to the technological objectives of CS2.*

4.5.11 Involvement of Airspace Users, Air Navigation Service Providers and airports

The Expert Group believes that the consortium should foresee measures and instruments avoiding potential hurdles in a later implementation and deployment of technologies developed and matured in the context of CS2.

On one hand the level of success in introducing CS2 technologies into the market depends on how far air space users, i.e. the airlines, identify economical benefits or can be driven through incentive mechanisms. In addition, the compatibility with procedures and technologies developed and deployed under the strategic guidance of SESAR and other related programmes within the domains of airports and Air Navigation Service Providers is of importance.

***R4.5.11-1:** The Expert group recommends introducing an instrument of involving the major stakeholders of the Air Transport Systems in the strategic guidance of CS2 in order to ensure awareness and to support implementation and deployment.*

4.6 Financial organisation and proposed budget

Little information on the financial organisation of CS2 is provided, as should be expected since the legal basis for a new Financial Framework Regulation is not yet fully known.

Preliminary budget figures at IADPs/ITDs level are presented but due to the lack of detailed technical definition of demonstrators, the Expert Group is unable to comment on whether the proposed total budget of 3.6 B€ and the budget breakdown are justified.

However, a few preliminary remarks can be made and are presented below.

1) Some illustration of the criteria for resource allocation would be useful.
2) As the CS2 budget breakdown is rather different as compared to Clean Sky (for instance Engines is expected to receive 16.6% of the budget in CS2 while in Clean Sky SAGE had 26.5% of the total), it will be important to know which major difference between the technological programmes of the two JTIs has led to this major budget reallocation.
3) Furthermore the Experts may also note that the amount of resources allocated to the Technology Evaluator (TE) is lower in CS2 as compared to Clean Sky, both as % and as absolute amount. TE was allocated 31 MEuro (1.9% of the total) in Clean Sky while it is expected to receive only 20 MEuro (0.5%) in CS2. This is in contrast with the suggestions arising from several

relevant bodies (e.g. NSRG, STAB, 1st Interim Evaluation Report), which stressed that the TE is an essential tool "for industrial and public accountability"[16] and that its role should be strengthened. That would require raising the TE share to at least the percentage received in Clean Sky (1.9%) (see section 4.4).

4) The proposed breakdown by nature of participant should be more fully presented, clarifying whether in the case of participations to calls from other IADPs/ITDs the share of Leaders may rise over their initial allocation.

5) It is mentioned that CS2 Financial Organisation will build on Clean Sky experience, based on well structured financial procedures. The guiding principle in the new JTI is that "the changes in the rules and procedures will be limited to those stemming from the lessons learnt".[17] Therefore it might be useful to recall some of the lessons on Clean Sky financial matters offered by the different assessment exercises undertaken on the first JTI. Two points deserve particular attention:

   a) It is important to keep the possibility to negotiate multi-annual Grant Agreements with Members (GAMs) to provide the financial flexibility necessary for research.

   b) It is necessary to strengthen the role of the JU executive management in the possible reallocation of funds, defining the level and type of GAMs-related decision which could be delegated to her/him.

6) CS2, unlike Clean Sky, should have a clearly defined Contingency Budget. This is considered necessary to ensure programme flexibility, to compensate for technical setbacks or changes in participants and to account for changes of conditions which may lead to new objectives or new policies during the many years of CS2 operation. This is one of the lessons learnt from Clean Sky where the initial technical choices have, in some cases, changed substantially. In view of the programme size, challenges and duration, a contingency budget amounting to 10 to 20% of the total budget seems reasonable.

7) This overall contingency budget implies a reduction of the budget allocated to each IADP and ITD (see chapter 6). It should be under the control of the Governing Board.

8) Flexibility is necessary to adjust budget allocation during the long duration of CS taking into account changes in aeronautic environment, priorities from companies, results achieved, technical difficulties, delays or underspending in some projects.

   In Clean Sky, even if the JU could make a proposal for budget reallocation, the rule of unanimity for the Governing Board decisions tends to prevent such

[16] Continuity of the JTI instrument under Horizon 2020 for Aeronautics and Air Transport, Initial View of the member States and Associated States (Third Draft v1, 30-7-2012).
[17] A Preliminary Programme Outline for Clean Sky 2 (20/07/2012, p. 70)

budget re-allocation. This problem is of particular relevance during the transition phase between Clean Sky and CS2.

In summary, the main comments and recommendations are to:

R4.6-1: *Review and justify the criteria for resource allocation between different IADPs/ITDs;*

R4.6-2: *Reconsider and raise the TE budget share;*

R4.6-3: *Provide an overall contingency budget (10 to 20%) to be handled by the Governing Board;*

R4.6-4: *Allow negotiating multi-annual Grant Agreements with Members (GAMs);*

R4.6-5: *Strengthen the role of the JU management in budget reallocation. In particular, review the level and type of GAM-related decisions which could be delegated to the JU Executive Director;*

R4.6-6: *Consider legal financial solutions allowing the JU to make the best use of resources and in particular ensuring full budgetary flexibility during the entire period of the execution of the research activities. It is recommended to foresee in CS2 the necessary budget flexibility.*

5 Potential impact

5.1 Will CS2 contribute substantially to environmental and societal challenges ahead?

The proposed activities bear the potential to significantly contribute to the environmental and societal challenges. A clear path of continuation on technologies for reducing emissions of noise and gases (NOx/CO_2) from Clean Sky is recognized. Through increasing the maturity levels of these technologies up to TRL 6 and raising them to a higher level of integration the expected achievements of the proposed IADPs and ITDs may enable substantial environmental savings in the next generation of a/c platforms. In addition, the investigation of new and promising technologies in lower TRL domains appears as being promising in identifying further enabling technologies.

R5.1-1: *A quantification of expected environmental benefits in total and per technology with reference to ACARE 2020 aeronautics goals needs to be elaborated with the full technical work plan.*

In addition, a roadmap is required identifying the CS2 contribution towards the envisaged goals in "Flightpath 2050" allowing the identification of remaining gaps.

5.2 Will CS2 provide a boost to EU industry competitiveness?

On one hand the development of technologies addressing environmental goals will also greatly enhance EU industry competitiveness, since greater energy efficiency will imply reducing operating costs.

On the other hand, a substantial amount of activities improving the EU industry competitiveness directly are included in the proposal. The most promising major domains of a/c technology development are addressed. Clear links to previous upstream research performed in former or current EU Framework Programmes are

highlighted. A clear indication is provided, that these technologies have reached sufficient TRLs and are key enablers for improving future airborne segments in terms of environmental savings, efficiency or safety and providing competitive advantages. A clear and sound strategy of increasing the levels of system integration is provided.

6 Specific comments on the CS2 IADPs and ITDs

R6-1: *The Expert group recommends that for each of the IADPs and ITDs analysed below:*

- *Precise environmental, social and economic objectives have to be specified;*
- *A detailed technical content should be available well before the start of CS2.*

6.1 Large passenger aircraft IADP

Proposed total budget (requested funding plus in-kind contribution): 1150 M€

Review of objectives

Large passenger aircraft (LPA) IATD objectives are focused on the next generation of European short/medium range aircraft (today Europe has 40 % of the market share in this category with an objective of 75% of the fleet needing replacement from 2025 onwards). It is wise to concentrate resources on this specific kind of aircraft which represents more or less 50% of the global aeronautical market and 50% of the global fuel burn. Consequently if the objectives are achieved, it will have a great impact:

- On environment;
- On European industry competitiveness and European Leadership;
- On the social objective of mobility.

Description of programme and demonstrators

The proposal is based on 3 types of activities:

- Large scale integrated demonstrator platforms;
- Large demonstrators on ground and in flight;
- Tools and numerical simulation means.

These activities are shared between 3 platforms:

- Platform 1: “Advanced Engine and Aircraft Configurations”;
- Platform 2 : “Innovative Physical Integration Cabin - System - Structure”;
- Platform 3: “Next Generation Electrical Aircraft Systems, Cockpit Systems and Avionics”.

General comments

The proposal is focused on the 3 main topics which qualify the efficiency of an aircraft:

- Propulsive efficiency through a flying demonstration of a new propulsion system (CROR or HBPTF)
- Lift/drag ratio through a hybrid laminar flow wing demonstration
- Weight through new materials for the cabin

The experts consider this selection as being logical and appropriate.

It is understandable that before the end of Clean Sky and before the results of main demonstrations like the Laminar Flow of SFWAC or the CROR of SAGE become available, it is too early to fix precisely the next steps of demonstration. Consequently, the technical content of the IADP is more or less only a list of technologies which could be matured in this IADP.

Platform 1 "Advanced Engine and Aircraft Configurations"

- Development and deployment of a new methodology to validate "disruptive" new aircraft configurations.
- Development, qualification and calibration of related new simulation tools through wind tunnel tests, simulation.
- Adaption of virtual testing tools to prepare and accompany large scale integrated testing.
- Full size demonstration and testing of next generation engines/propulsion systems partially or fully integrated into the aircraft architecture with complementary rig or ground demonstration of specific features. Flight test preparation, clearance and testing of new engine configurations and the associated integration.
- Validation of active flow control systems integrated into major aircraft components for a high efficient low drag configuration of next generation aircraft.
- Modelling and multi-functional integration at full system level.
- Complementary technology validation at virtual and physical full-scale.

The objective of an IADP in complement to an ITD is to check the behaviour of different technologies merged together in demonstrators.

R6.1-1: *To stay with the objective of merging technologies in demonstrators, it is recommended to concentrate Platform 1 resources on main flying demonstrations in order to implement high SRL level of new integrated technologies.*

R6.1-2: *The proposers should clarify if the integration and demonstration of a new propulsive system together with a new laminar flow wing is foreseen in CS2.*

R6.1-3: *Individual technologies or tools should be essentially developed inside ITDs of CS2.*

Platform 2 "Innovative Physical Integration Cabin – System - Structure"

The platform will provide the frame for large-scale complex demonstration airframe structures using advanced materials in conjunction with the introduction of a "more" or even "all electric" aircraft architecture which has major consequences for fuselage design, cabin system and physical arrangement.

- New overall airframe architecture and new integration approaches.
- Integration of cabin/systems/structure functions, weight savings and reduced production costs.
- Modelling and multi-functional integration of breakthrough systems.
- New system architectures for more electric aircraft, integration of fuel cells, alternative energy generation, storage and management systems.
- Technology validation at virtual and physical full scale.

- Validation of breakthrough technologies by simulation and physical test beds.

R6.1-4: *It is recommended to concentrate Platform 2 resources on a single ground demonstration integrating all work streams of cabin – system – structure technologies.*

Platform 3 "Next Generation Electrical Aircraft System, Cockpit and Avionics"

A huge potential for improvement for the next generation aircraft is provided by the enormous progress in computer technology, miniaturization of electronics, improvements in power electronics and electrical and data network capability.

In the area of cockpit technology and avionics, the advancements have to be put in combination with the new capabilities and functionalities of future ATM operational procedures, as well in combination with the requirements for a next generation cockpit, taking a gradually changing pilot work profile into account.

- Simulation and in flight demonstration of partial and full suite new operational cockpit technology (linked to the ATM environment).
- Integrated avionics, increased flight safety, reduction of cockpit workload.
- New avionics validation platform for integration of novel functions in a realistic environment.
- Verification and validation (by simulation, virtual reality, mock-ups) of new avionics functions.
- Integrated all electric systems with power and thermal management.
- Reduction of electric energy, reduced power requirements, thus less fuel consumption.

R6.1-5: *It is recommended to combine Platform 3 work packages in order to achieve integrated demonstration.*

Interfaces & synergies with other platforms and ITDs

R6.1-6: *Possible duplication of activities with Airframe ITD and with System ITD has to be checked and avoided.*

Relevance, quality and risks of program

At this stage of the preparation of the program, there is still little technical information on each demonstration. If the program is successful, this will accelerate the introduction of these new integrated technologies and will give to European industry a competitive advantage.

Demonstrations, especially flying demonstrations with completely new technologies or concepts are technically challenging and is a risk taking action, but this is the reason of such public/private partnership like Clean Sky.

6.2 Regional aircraft IADP

Proposed total budget (requested funding plus in-kind contribution): 230 M€

Introduction and objectives

This section of the industry proposal describes well, but in general terms, the activities and the challenges of Regional aircraft (RA) IADP.

It starts by recalling the Clean Sky GRA (Green Regional Aircraft) success factors, i.e. low weight structural solutions, low external noise solutions, all electric solutions for the aircraft services and mission and trajectory management. The key technologies of Clean Sky GRA will be tested on ground and/or on flight, however as an alone technology or with limited integration. Moreover TRL will never (or seldom) reach level 6.

Therefore the mission of RA IADP is very clear: reach level 6 for TRL, by means of the three ITDs of CS2, and integrate most (if not all) these technologies by means of the RA IADP, with in flight tests or ground tests.

Description of demonstrators

There are three integrated demonstrations for RA IADP:

(a) Flight demonstration of innovative wing, tail planes and flight control technologies;
(b) Flight demonstration of wing related systems and power plant technologies;
(c) Ground demonstration of a full scale innovative fuselage and passenger cabin technologies.

General comments

The proposal is clearly oriented toward the needs of the market although, even at the end of CS2 in 2024, there is not yet integration at vehicle level of the three demonstrations described above.

However, the Industry Proposal indicates that the new Regional Aircraft should enter into service from 2025. Since the summary table “Estimated Timeline and Resources” shows the IADP test evaluation in 2022, it seems there will not be enough time for an entry into service in 2025.

R6.2-1: *The proposal should include a description of the plans between the test evaluation in 2022 and bringing the regional aircraft into service.*

Air travelling within Europe door to door in 4 hours is one of the many goals of Flightpath 2050 (page 11 reads): 90% of the travellers within Europe are able to complete their journey, door to door within 4 hours.

This is one of the few Flightpath 2050 goals mentioned in the Industry proposal on page 35. It is recognised that this is an important objective for air transport, facing the competition of fast trains up to journeys of 1000-1500 km.

However, it is obvious that the implementation of this goal requires changes that involve not only aircraft and airport logistics but also changes which do not pertain to aviation such as ground transport infrastructure to improve access to airports and what is today a major issue, i.e., security checks.

R6.2-2: *The Expert Group recommends analysing and quantifying the contribution of the Regional Aircraft, and more generally CS2, to the long term goal of air travelling within Europe door to door in 4 hours.*

6.3 Fast rotorcraft IADP

Proposed total budget (requested funding plus in-kind contribution): 420 M€

Review of Objectives

The overall objective of the Fast Rotorcraft IADP is satisfying a steadily growing demand for highly flexible and efficient transport and social services (e.g. addressing life protection and citizen safety), while at the same time reducing further the environmental impact of rotorcraft transport in terms of both noise and emission. These objectives are in line with the strategic priorities of Horizon 2020, Flightpath 2050 and the Transport White paper 2011.

The vision behind this IADP is that fast rotorcraft configurations, by combining the vertical capabilities of an helicopter with the speed, range and altitude capabilities of a fixed wing aircraft, may satisfy some of the society needs better than conventional helicopters.

An equally important objective is to confront international competition, which is intensifying in the civil rotorcraft sector. Due to the expected contraction of the military helicopter market, several producers of military rotorcrafts (such as Bell and Sikorsky) are looking to increase their sales in the civil market, and are also heavily investing on non-conventional rotorcrafts.[18] At the same time, production in emerging markets is expanding. In addition, both traditional and emerging non-EU manufacturers have access to massive public support, primarily aimed at military programmes but with important fallouts in the civil segment.

In such a competitive context, non-incremental research aimed at developing non-conventional rotorcraft concepts is particularly important. Such a high risk research is only possible as part of a long term, co-ordinated and multidisciplinary programme such as CS2.

Description of Programme and Demonstrators

In this IADP, research and technological development will concern two non conventional rotorcraft configurations: the tilt-rotor and the compound helicopter. These research programmes will build on previous activities undertaken by the two major EU helicopter groups: the AW609 by Augusta-Westland, and the X3 project by Eurocopter. A large or full scale demonstrator will be designed for each of the two fast rotorcraft concepts and flight demonstration will be performed.

The programme encompasses a wide range of activities which are expected to be validated in the two demonstrators (such as adding a tiltable portion of the wing itself thus building on the previous EU ERICA programme, developing an engine with the power level required to permit operation in a tilted attitude, implementing composite

[18] Jaworowski R., Royce,D., 2012, The World Rotorcraft market 2012-2021, Vertiflite March/April; Nelms D., 2012, Speed Streak, Aviation Week &Space Technology, July 9; Warwick, G., et al., 2012, Spooling up, Aviation Week &Space Technology, July 16; Wall, R., 2012, 2012, Family Planning, Aviation Week &Space Technology, February 13.

structures, developing blade active control, etc.). Although collaboration with organisations working within the airframe, engine and systems sectors is foreseen, only a clear interaction with the airframe ITD emerges, while no real interaction with the engine ITD is indicated.

As the programme concerns highly innovative technologies, the risks are higher than for incremental innovations. Technical risks are high since fast rotorcraft are considerably more complex technologically than traditional rotorcrafts and commercial risk is high because opposition by the public due to noise emission may hamper the possibility of creating vertiports in/within cities.

General Comments

This programme presents several positive aspects. It addresses a new market segment, it builds on knowledge already acquired between two major European rotorcraft manufacturers and may have an important role in integrating the supply chain across EU. On the other hand, the synergies with other IADPs/ITDs are not well defined.

R6.3-1: *Since this IADP includes two separate and potentially competitive projects, the Expert Group recommends spelling out the interactions and level of cooperation between the two projects within the IADP. This clarification should be an important part of the work definition programme taking into account IPR issues. Furthermore, synergies with other IADPs/ITDs should be specified.*

In the CS2 rotorcraft proposal there is a less clear continuity with the current GRC Clean Sky activities than in other IADPs and ITDs and the proposal makes only limited reference to technologies developed in GRC.

R6.3-2: *The Expert Group recommends clarifying the possible use in the Fast Rotorcraft IADP of technologies developed in GRC of Clean Sky.*

6.4 Airframe ITD

Proposed total budget (requested funding plus in-kind contribution): 700 M€

Review of objectives

The global aim of the ITD is to demonstrate innovative airframe concepts and architectures up to the integrated system level, and enable their introduction into the next generation of aircraft.

Description of programme and demonstrators

This ITD complements the technology portfolio, in two batches with different time of availability.

With respect to this objective, each technology stream leads to a major demonstration, with the following demonstration options under consideration:

- Ground demonstration at a representative scale of the airframe component;
- Flight demonstration of a modified platform, incorporating the new system for demonstration in representative flight condition;
- Sub-scale flying demonstrator.

The key technology streams which are described in too general terms in the proposal are the following:

- Innovative aircraft architecture;

- Innovative fuselage;
- Advanced passenger-friendly cabin;
- Next generation cost efficient wing;
- Advanced control of flexible aircraft;
- Extended laminarity for major airframe components for wider flight conditions;
- Next generation nacelles;
- Advanced rotorcraft airframe.

Activities are focused on innovative wing concepts and unconventional fuselage configurations including novel propulsion integration solutions concepts (buried engines) and product definition and demonstrations, but also manufacturing and assembly techniques, modelling and other enabling capabilities.

Laminar Flow is the aerodynamics technology with the highest drag reduction potential; within Clean Sky (natural laminarity for Mach number M=0.75 aircrafts will be brought to TRL=6). The next step is the increase of applicability (up to M=0.85 for long range applications) and more extensive applicability on the wing (e.g. inner wing).

General comments

This ITD includes eight technology streams which all seem important but are only described in general terms and without clearly specified applications for IADP integrated demonstrators.

R6.4-1: *The Expert Group recommends that each of these technology streams should be related to IADP activities: for each technology stream, there should be a specific IADP application and the time scale of development should be compatible with the IADP demonstrator requirements.*

Establishing these correlations between the Airframe ITD and the IADPs should allow streamlining the ITD activities and should avoid duplication of activities between the IADPs and the airframe ITD.

R6.4-2: *Possible duplication of activities with LPA IADP has to be checked and avoided.*

R6.4-3: *The ITD aims also at developing technologies not selected for IADP integration but which are for future innovative designs towards Flightpath 2050 objectives. These lower TRL, longer term technologies should be clearly identified and potential applications described in order to facilitate prioritization.*

6.5 Engines ITD

Proposed total budget (requested funding plus in-kind contribution): 600 M€.

Review of objectives

The general CS2 objectives are:

- To fully validate the novel configurations for new narrow body aircraft to reach the full 20% CO_2 reduction targeted for 2020.
- To validate innovative engine technologies across the whole market (from turbo shaft to large commercial aircraft) to achieve the full 20% CO_2 reduction.
- To validate new technologies to enable the development of a new generation of turboprop engines to enhance European competitiveness.

Description of Programme and Demonstrators

The programme is based on demonstration of technologies in either flight demonstration or representative tests at a high system level, mostly at the level of an engine.

Engine demonstrators foreseen include:

- Continuation of the CROR validation of Clean Sky;
- Geared Turbofan (GTF) engine for new civil aircraft**;**
- New, Ultra-High Bypass Ratio (UHBR) engine demonstration;
- Demonstration of a new high performance gas generator, capable of integration in a hybrid electrical-thermal engine;
- Propulsion systems for radical design options will also be considered, such as the hybrid wing body, distributed propulsion, etc.

General comments

The programme provides continuity with respect to Clean Sky with some demonstrations such as the CROR and provides also new configurations such as the UHBR.

R6.5-1: *Interfaces between the engine ITD of CS2 and SAGE of Clean Sky have to be clarified with a clear determination of the steps beyond Clean Sky.*

The Geared Turbofan described in the proposal cannot be considered as a new step when taking into account that this configuration is already going through the certification process. However, the Expert Group acknowledge the importance to develop the relevant technology in the EU.

There are also new demonstrators such as UHBR engine and the gas generator for turbo-shaft engine. The concepts are relevant but there is too little information for the Expert Group to express opinions on these new activities.

At this stage of the preparation of the program there is still little technical information on each demonstration. But each of the demonstrations in concept is relevant. If the program is successful, this will accelerate the introduction of these kinds of engine with big improvement in efficiency (fuel burn, noise and NOx reduction) and will give to European industry a competitive advantage.

Each of the demonstration is technically challenging and is a risk taking action, but this is the reason of such public/private partnership like Clean Sky with a sharing of risk.

6.6 Systems & equipment ITD

Proposed total budget (requested funding plus in-kind contribution): 500 M€

Review of objectives

The aircraft systems and equipment ITD addresses the development and validation of technologies, functions and systems in order to gain either environmental benefits or to achieve industrial leadership through improving operating cost.

Environmental benefits are expected mainly in the domains of aircraft mission optimisation, aircraft energy and thermal management, the more electric aircraft, mass reduction, perceived noise reduction, improved aerodynamic and flight mechanical performance through aircraft systems and reduced use of scarce or

hazardous materials. The environmental targets per technology domain are not yet quantified.

In addition, all these as well as further areas like new internal aircraft configurations are expected to provide competitive advantages.

While the majority of activities will be focused on demonstration, high TRL and integration to deliver a significant part of the ACARE 2020 objectives, new technologies, step-changes for future systems, and assessment of alternative technologies in some areas are proposed. These activities are planned for the last years of CS2 with a view to address the medium term goals (2030/2035) of the new ACARE SRIA.

Description of programme and demonstrators

A variety of technology streams to be further developed and to be matured has been identified by the proposers. Most of these technology streams are a continuation of Clean Sky activities primarily addressing environmental benefits. These include:

- As a continuation of SGO activities: Electric and energy management, electrical air systems and thermal management, mission management and ATS level functions, all electric landing gear and autonomous electrical taxiing;
- As a continuation of SFWA activities: Innovative wing/control surface actuation systems.

There are also new streams from research programmes external to Clean Sky targeting at other societal or economic improvements. These cover innovative cockpit, avionics platforms and networks, advanced cabin systems.

Not all technologies are foreseen to enter into flight demonstration. The consortium is presenting a three staged approach in developing, assessing and demonstrating the achievements:

- In the “Technology Level” all technologies are planned to be developed and assessed individually and to be demonstrated standalone in a dedicated environment for evaluating environmental, societal or economic benefits.
- In the “Integrated Demonstrator Level” an integrated evaluation of related technologies from one or several technology streams will be carried out. The consortium proposes an energy management demonstrator (assessing electrical load management and thermal management at aircraft level), a full cockpit demonstrator (assessing crew workload or reduced crew operations) and further integrated demonstrations in the Cockpit and Avionics domain.
- In the “Ready-to-fly Level” development and supply of “ready-to-fly” parts or subsystems for full integration in IADP-level tests and assessments is foreseen on a case-by-case basis. “Ready-to-fly” systems shall be originating either from Clean Sky, already demonstrated at TRL 4 to 6, or shall be new systems developed in CS2. The consortium identifies as first candidates electrical subsystems, actuation, landing systems, avionics platform and cockpit devices (screens, HUDs, etc.), specific systems such as positioning systems, sensors, communication/data link equipment or functions, advanced mission management functions (data fusion, advanced FMS, etc.).

General comments

Regarding technologies originating from Clean Sky (in particular covering the “more electric aircraft” and “management of trajectory and mission”) an initial reference to the respective Clean Sky activities and achievements is provided. The new streams implicitly build well on ongoing national or EC funded activities like current FP7 level 2 projects in the systems domain, although those links are not outlined in detail.

However, the translation of the underlying strategy into a technological roadmap linking technological achievements to either environmental savings or societal or economical benefits remains unclear. The table provided at the end of the proposal description does not answer these questions sufficiently. In addition, the envisaged targets are not sufficiently set in relation to the expected achievements in terms of European strategies, nor are furthers steps of required research elaborated to achieve those visions.

The proposers foresee activities on three different levels: technology level, integrated demonstrator level and ready to fly level. A development, integration and evaluation process is described, targeting at those three different levels of integration. All three levels target at TRLs between 5 and 6. The group of experts believes that this stepwise approach is well suited to serve the specific needs of a “horizontal” technology domain as aircraft systems appear to be. In addition the target TRLs are considered as being fully appropriate.

The proposers address primarily the ACARE 2020 targets. In addition, they foresee to investigate new technologies and step changes for future systems in the final period of CS2 to address the medium term goals of the ACARE SRIA.

R6.6-1: *The Expert Group considers it being necessary to categorize each activity according to the target level, i.e., technology level, integrated demonstrator level and ready to fly level.*
In the case of the ready to fly level, the application to a specific IADP demonstrator should be described.

R6.6-2: *Likewise, lower TRL activities falling into the demonstrator and the technology levels should be identified and the target achievements described.*
This categorization of activities should allow streamlining the ITD activities, highlighting priorities and should avoid duplication of activities between the ITD and IADPs and other ITDs.

R6.6-3: *In addition, the Expert group advises to present a clear strategy on how to handle research related to low TRLs and to clarify*

- *Under which EC funding instrument should it be elaborated,*
- *Which TRL should be targeted, and*
- *How the interface processes between the different instruments should be organised.*

Comments on research streams

The following recommendations apply for the different research streams as being proposed:

- Energy management systems, electrical systems, electrical air systems and thermal management systems:

The proposed activities build upon the ongoing activities of Clean Sky. The technological domains of development are sufficiently specified.

R6.6-4: *An overall implementation roadmap from today's a/c via a more electrical a/c towards the full electrical a/c and the related penalties and savings in the different stages in terms of weight and fuel needs to be presented.*

- Mission management and ATS level functions:
  This stream foresees demonstrators in "management of the air network" and "management of operations". In principle it is recognized, that these two concepts are of high priority and importance in order to develop an efficient, safe and environmentally friendly air transport system. In addition, the proposers recognize the need for close institutional links to another research programme (SESAR 2), which will focus on Air Traffic Management. Two sub-domains of research are proposed: "flight and mission management" and "cockpit and interaction".

  R6.6-5: *The experts believe that the development of a/c technologies supporting future concepts of operation is of highest importance. However, the proposers need to specify in much more detail the interfaces to external programmes (e.g. SESAR).*

  R6.6-6: *For the domain of cockpit and interaction the differentiation between the research streams "Mission management and ATS level functions" and "Avionics and Cockpit" research stream remains unclear. Some overlap is identified.*

- Avionics & Cockpit
  The proposers address a broad variety of technologies within the domains of "innovative cockpit environment" and "avionics platform and networks".

  R6.6-7: *The Expert Groups recommends sharpening the profile of avionics and cockpit and setting the proposed activities in relation to ongoing or previous projects external to Clean Sky (e.g. current FP7 level 2 projects).*

- Advanced cabin systems and functions
  R6.6-8: *The experts recommend justifying and further substantiating advanced cabin systems and functions activities.*

- Innovative wing/control surface actuation system
  R6.6-9: *The interface of Innovative wing/control surface actuation system to the airframe ITD as well as to programmes external to Clean Sky (current FP7 level 2 projects) remains unclear.*

- All electric landing gear system and autonomous taxiing
  The proposed activities build well upon Clean Sky and some justification in terms of environmental targets is provided. However, considering the current status of Clean Sky the benefit of electrical taxiing in terms of weight and fuel savings on a mission and an ATS level is not elaborated sufficiently (see R6.6-4).

7 Remarks and recommendations

This section contains the full list of remarks and recommendations. Numbering is according to the chapter where remarks and recommendations have been raised.

Number	Remark or recommendation
R4.2.1-1	*The Expert Group recommends carrying out a thorough ex post assessment of Clean Sky after its completion. It may become a powerful instrument to assess the full impact of the PPP approach.*
R4.2.2-1	*The Expert Group supports the general objectives described in the Industry Proposal and agrees that the CS2 initiative is justified and necessary for a full integration of Clean Sky demonstrators and for further technology innovation towards Flightpath 2050 goals.* *The Expert Group support is, however, conditional upon* – *the definition of ambitious, but realistic quantitative environmental targets,* – *the definition of other socio-economic benefits, and* – *the conclusion of a detailed technical evaluation which, at the present time, is not possible in view of the preliminary nature of the proposal.*
R4.2.3-1	*In view of the satisfactory operation of Clean Sky, the Expert Group supports the establishment of a similar PPP structure for CS2. Furthermore the Expert Group considers that, among the options available, the PPP with Joint Undertaking is the structure with the best potential to achieve the CS2 objectives within the proposed timescale.*
R4.2.4-1	*The legal and financial bases of CS2 are not known yet but they should be aligned to existing Clean Sky regulations to ensure a broad compatibility of the two entities*
R4.2.4-2	*The effort and time required for planning the transition should not be underestimated and planning work should start as a matter of urgency.*
R4.2.4-3	*The first step is to designate the CS2 IADP and ITD Leaders. In the Expert Group opinion, continuity and effectiveness would dictate to maintain, as far as possible, the same responsibilities as in Clean Sky.*
R4.2.4-4	*It is recommended to identify candidates for core partners at an early stage and invite representatives to contribute to the CS2 content definition in order to allow a transparent and open process.*
R4.2.4-5	*When IADP and ITD Leaders are known, it is recommended to set up joint teams comprising Clean Sky participants, CS2 future participants and JU Executive Team participants to prepare detailed resource-loaded work schedules for CS2.*
R4.2.4-6	*The Expert Group considers that the detailed technical content of CS2 should be available well before the official start of CS2. This involves preparing a work plan with project milestones including decision gates, such as for launching demonstrations.*
R4.3.1-1	*The Expert Group endorses the CS2 general objectives as ambitious but realistic and consistent with Horizon 2020 guidelines and current technological requirements.*
R4.3.1-2	*Whilst the general objectives are endorsed, the Expert Group recommends quantifying the environmental targets while identifying*

	and justifying the societal and economic objectives.
R4.3.1-3	*The Expert Group is unable to carry out a detailed technical evaluation in view of the current preliminary form of the proposal and recommends carrying out such a detailed technical evaluation when the full industry proposal becomes available.*
R4.3.2-1	*The Expert Group stresses that CS2 should not become a broad development programme constituted by the sum of all desirable research activities with, as a consequence, a dilution of key objectives and limited prospect for collaboration among contributors.*
R4.3.3-1	*The Expert Group recommends streamlining the CS2 programme around high priority topics. This process should be essentially completed before the start of CS2.*
R4.3.3-2	*For optimum use of resources, the Expert Group stresses the need to minimize or eliminate overlaps between IADPs and ITDs. This will also simplify the interface matrix thus enhancing management effectiveness.*
R4.4-1	*The Expert Groups recommends extending the focus of TE to lower TRLs across all ITDs and IADPs.*
R4.4-2	*The Expert Group recommends maintaining TE as an essential element within CS2, with its role being strengthened as indicated below.* • *TE should develop independent simulation tools in order to monitor results.* • *In order to ensure the independence of TE without any constraints from industry, the TE team should be from highly qualified independent research / academic institutes.* • *The JU executive management should chair the TE steering committee.* • *Consequently, the associated budget for TE should be raised according to the extended scope.*
R4.4-3	*Effective interfaces between TE and the IADPs and ITDs are key to successful TE operation.* • *The Executive Team should be given the responsibility and authority to ensure effective communication between TE and IADPs and ITDs and to ensure that deadlines are met for the transmission of necessary data to TE.* • *Furthermore, TE should have representatives in each IADP and ITD so as to establish a close interaction between the engineers and the TE evaluators.*
R4.4-4	*The Expert Group considers that TE should progressively become the nucleus of, and enable a transition towards, a "European Aeronautical*

	Technology Evaluator Facility".
R4.5.1-1	*The Expert Group recommends considering CS2 as extension[19] to Clean Sky, and not just as a new and independent project. This would give a clearer direction to solve, in a logical and self-consistent manner, most if not all, problems associated with a transition focussed on continuity and integration as well as the launch of new activities in parallel.*
R4.5.1-2	*The Expert Group recommends that future programmes after CS2 should provide clear transition procedures with a minimum overlap.*
R4.5.2-1	*The Expert Group recommends that the selection process of core partners should be executed under the control of the JU executive team.*
R4.5.3-1	*The Governing Board members and their alternates from industry should be selected among senior aeronautical industry technical representatives but who are not directly involved in IADP and ITD activities. In addition, the Governing Board should focus its activities on strategic guidance.*
R4.5.5-1	*The Expert Group recommends reinforcing the strategic, administrative and technical role and power of the Executive Team.*
R4.5.5-2	*The JU needs to be empowered and to carry the duty to propose stopping an activity with too much delay or too low TRL expectation, launching a new one with better prospects and modifying the budget share between / within IADPs / ITDs. Programme decisions of this kind can only be made by the Governing Board but it should be the Executive Team management's responsibility to raise issues and propose remedies.*
R4.5.5-3	*The rules of decision making should not prevent justified and important re-adjustments of the programme. For example for budget changes a written procedure by the Executive Director including the principle of "tacit approval" with time limits (e.g. 6 weeks) should be considered as an instrument for avoiding delays.*
R4.5.5-4	*In order to execute properly its supervisory function, the Executive Team should have direct access to IADP and ITD Leaders and to Project Responsible Leaders within each IADP and ITD. It should have the right to request access to works and facilities where development and manufacturing activities are taking place.*
R4.5.5-5	*The Expert Group considers it necessary to reinforce the role and power of the Executive Team to identify interfaces between IADPs and ITDs, to ensure that these interfaces are handled properly and to enforce synergies. This is all the more important for high TRL and high SRL activities which are getting close to market application and for which IPR issues become critical.*

[19] The term "extension" applies to support proposals for new activities requiring new design work, new hardware and new experiments. It may also require new specialized staff, changes in the organisation and new investments. It is not applicable to cover delays or mismanagement in the activities.

R4.5.5-6	*This role in interface coordination role of interfaces by the JU is to be exercised:* • *At the work definition level: The Executive Team should verify and give its approval of the completeness of the interface matrix and specifications. The Executive Team should enforce the implementation of interfaces in the Grant Agreements and in the yearly Development Plan of each IADP and ITD.* • *Throughout the work execution: The Executive Team should ensure that interfaces are properly addressed and should enforce joint activities and technology exchanges where required. The Executive Team should also identify overlaps and take action to minimize or remove these overlaps.*
R4.5.5-7	*For all interface and supervisory activities above, the Executive Team Management should retain the authority to request actions from IADP and ITD Leaders and the responsibility to report to the Governing Board on deficiencies in addressing interface issues.*
R4.5.6-1	*It is recommended to empower the JU to decide if a topic is relevant in terms of CS2 objectives or not in order to avoid launching topics only for fulfilling the requirement of 25% of the budget for calls and leading to activities without great interest, sometimes out of the scope of the main activities.*
R4.5.7-1	*It is recommended to substantially increase the Executive Team staff and budget resources because of the parallel management of Clean Sky and CS2 and also because the proposed budget for CS2, 3.6b€, far exceeds the 1.6b€ of the Clean Sky budget thus implying more extended and demanding activities.*
R4.5.8-1	*The common Leadership and coordination for all projects within an IADP or an ITD is important to promote synergies and a proper coverage of interfaces.*
R4.5.9-1	*The ECO ITD has no direct equivalent in CS2 and no continuation of ECO activities has been recognized by the Expert Group. It is recommended to consider the continuation of ECO activities in relevant fields like systems, airframes and engines.*
R4.5.10-1	*Considering the advantages and drawbacks and in view of the heavy workload of the Executive Team which is requested to become more pro-active in managing CS2, the Expert group suggest keeping Level 2 projects separate from CS2.*
R4.5.10-2	*However, should a decision be made to assign Level 2 projects to CS2, the Expert Group considers that the assignment should be strictly restricted to Level 2 projects directly related to the technological objectives of CS2.*
R4.5.11-1	*The Group of Experts recommends introducing an instrument of involving the major stakeholders of the Air Transport Systems in the strategic guidance of CS2 in order to ensure awareness and to support implementation and deployment.*
R4.6-1	*Review and justify the criteria for resource allocation between different IADPs/ITDs*
R4.6-2	*Reconsider and raise the TE budget share;*
R4.6-3	*Provide an overall contingency budget (10 to 20%) to be handled by the Governing Board;*

R4.6-4	*Allow negotiating multi-annual Grant Agreements with Members (GAMs);*
R4.6-5	*Strengthen the role of the JU management in budget reallocation. In particular, review the level and type of GAM-related decisions which could be delegated to the JU Executive Director;*
R4.6-6	*The Expert Group recommends considering legal financial solutions allowing the JU to make the best use of resources and in particular ensuring full budgetary flexibility during the entire period of the execution of the research activities. It is recommended to foresee in CS2 the necessary budget flexibility.*
R5.1-1	*A quantification of expected environmental benefits in total and per technology with reference to ACARE 2020 aeronautics goals needs to be elaborated with the full technical work plan.* *In addition, a roadmap is required identifying the CS2 contribution towards the envisaged goals in "Flightpath 2050" allowing the identification of remaining gaps.*
R6-1	*The Expert group recommends that for each of the IADPs and ITDs analysed below:* • *Precise environmental, social and economic objectives have to be specified;* • *A detailed technical content should be available well before the start of CS2.*
	Large Aircraft IADP
R6.1-1	*To stay with the objective of merging technologies in demonstrators objective, it is recommended to concentrate Platform 1 of the Large Aircraft IADP resources on main flying demonstrations in order to implement high SRL level of new integrated technologies.*
R6.1-2	*The proposers should clarify if the integration and demonstration of a new propulsive system together with a new laminar flow wing is foreseen in CS2.*
R6.1-3	*Individual technologies or tools should be essentially developed inside ITDs of CS2.*
R6.1-4	*It is recommended to concentrate Platform 2 resources on a single ground demonstration integrating all work streams of cabin – system – structure technologies.*
R6.1-5	*It is recommended to combine Platform 3 work packages in order to achieve integrated demonstration.*
	Regional Aircraft IADP
R6.2-1	*The proposal should include a description of the plans between the test evaluation in 2022 and bringing the regional aircraft into service.*
R6.2-2:	*The Expert Group recommends analysing and quantifying the contribution of the Regional Aircraft, and more generally CS2, to the long term goal of air travelling within Europe door to door in 4 hours.*
	Fast Rotorcraft
R6.3-1	*Since this IADP includes two separate and potentially competitive projects, the Expert Group recommends spelling out the interactions and level of cooperation between the two projects within the IADP. This clarification should be an important part of the work definition programme taking into account IPR issues. Furthermore, synergies*

	with other IADPs/ITDs should be specified.
R6.3-2	*The Expert Group recommends clarifying the possible use in the Fast Rotorcraft IADP of technologies developed in GRC of Clean Sky.*
	Airframe ITD
R6.4-1	*The Expert Group recommends that each of these technology streams should be related to IADP activities: for each technology stream, there should be a specific IADP application and the time scale of development should be compatible with the IADP demonstrator requirements.*
R6.4-2	*Possible duplication of activities with LPA IADP has to be checked and avoided.*
R6.4-3	*The ITD aims also at developing technologies not selected for IADP integration but which are for future innovative designs towards Flightpath 2050 objectives. These lower TRL, longer term technologies should be clearly identified and potential applications described in order to facilitate prioritization.*
	Engines ITD
R6.5-1	*Interfaces between the engine ITD of CS2 and SAGE of Clean Sky have to be clarified with a clear determination of the steps beyond Clean Sky.*
	Systems and equipment ITD
R6.6-1	*The Expert Group considers it necessary, to categorize each activity according to the target level, i.e., technology level, integrated demonstrator level and ready to fly level.* *In the case of the ready to fly level, the application to a specific IADP demonstrator should be described.*
R6.6-2	*Likewise, lower TRL activities falling into the demonstrator and the technology levels should be identified and the target achievements described.* *This categorization of activities should allow streamlining the ITD activities, highlighting priorities and should avoid duplication of activities between the ITD and IADPs and other ITDs.*
R6.6-3	*In addition, the Expert group advises to present a clear strategy on how to handle research related to low TRLs and to clarify* • *Under which EC funding instrument should it be elaborated,* • *Which TRL should be targeted, and* • *How the interface processes between the different instruments should be organised*
R6.6-4:	*An overall implementation roadmap from today's a/c via a more electrical a/c towards the full electrical a/c and the related penalties and savings in the different stages in terms of weight and fuel needs to be presented.*
R6.6-5:	*The experts believe that the development of a/c technologies supporting future concepts of operation is of highest importance. However, the proposers need to specify in much more detail the interfaces to external programmes (e.g. SESAR).*
R6.6-6:	*For the domain of cockpit and interaction the differentiation between the research streams "Mission management and ATS level functions" and "Avionics and Cockpit" research stream remains unclear. Some*

	overlap is identified.
R6.6-7:	*The Expert Groups recommends sharpening the profile of avionics and cockpit and setting the proposed activities in relation to ongoing or previous projects external to Clean Sky (e.g. current FP7 level 2 projects).*
R6.6-8:	*The experts recommend justifying and further substantiating Advanced cabin systems and functions activities.*
R6.6-9:	*The interface of Innovative wing/control surface actuation system to the airframe ITD as well as to programmes external to Clean Sky (current FP7 level 2 projects) remains unclear.*