European aviation noise research network (X-NOISE)

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ABSTRACT

The X-NOISE Coordination Action, through its network structure and comprehensive workplan involving experts groups, scientific workshops, international cooperation seminars and a common information system, addresses the noise challenges faced by Aviation. As such, the project scope significantly contributes to the objective of reducing Aircraft Noise by 10 dB per operation as set by the ACARE 2020 Vision, while addressing key factors associated with Airport Noise issues. A dedicated Aviation Noise Research Network has then been established, developing its activities along a 3-Pillar approach. (1) Definition, coordination and assessment of a European research strategy aimed at meeting the ACARE noise targets. (2) Dissemination and communication of the European research effort scientific and technological achievements as well as issues and priorities for the future. (3) Improved integration of European research community activities in the field of air transport related noise research.

Keywords: Aircraft Noise, Airport Noise, Aeroacoustics, Noise Impacts
I-INCE Classification of Subjects Number(s): 13.1, 52.2

1. INTRODUCTION

To successfully address the objectives set for European research, a dedicated Aviation Noise Research Network (X-NOISE) has been established. It has developed its activities along a “3-Pillar” approach as described below:

- Definition, coordination and assessment of research strategies aimed at meeting the 2020 ACARE noise target (average reduction of 10 dB per operation relative to the 2000 situation).
- Dissemination and communication of the research effort scientific and technological achievements as well as issues and priorities for the future.
- Improved integration of European research community activities in the field of air transport related noise research.

2. NETWORK OBJECTIVES AND ACTIVITIES

2.1 Implementing a European aircraft noise research strategy

The ACARE Strategic Research Agenda (SRA) (1) has established in 2002 a general framework for European Aviation related research, including the definition of quantified targets for 2020. A key step for the X-NOISE network has been the elaboration of a detailed research strategy supported by complementary tools such as state-of-the-art assessment, gap analysis, as well as mechanisms to gather of novel ideas and concepts. As part of this strategy, four main contributors were identified which would allow to achieve the -10dB/operation target through a phased approach. As described in Figure 1, schematically the four contributors can be summarized as follows:

- Generation 1 Noise Reduction Technologies: improved / novel passive techniques,
- Noise Abatement Procedures: continuous descent approach, optimized takeoff procedures,
- Novel Architectures: advanced aircraft / engine concepts, optimized powerplant installation,
- Generation 2 Noise Reduction Technologies: multidisciplinary aeroacoustic design, active techniques

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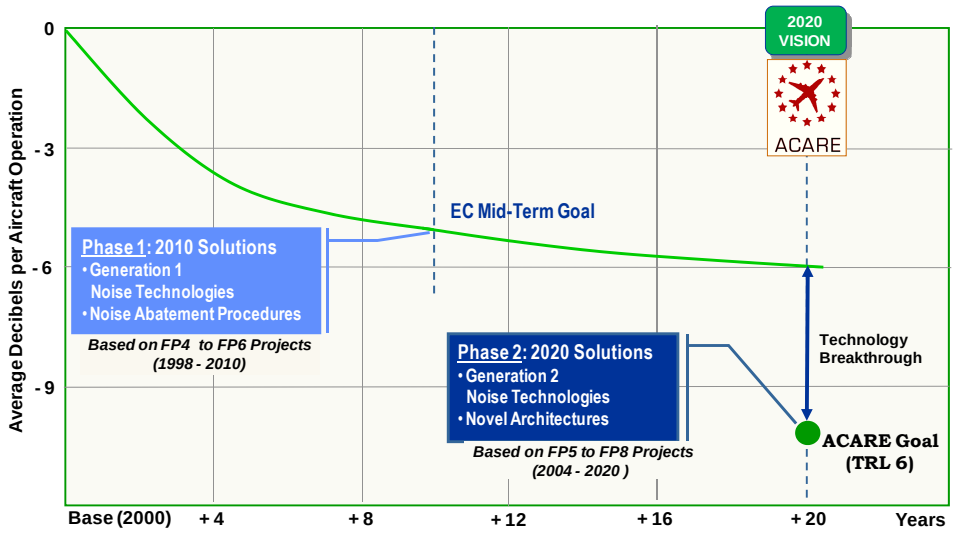

Figure 1- Phased Approach to ACARE Noise Target

This phased approach has been elaborated through a process involving consultation of the scientific community as well as the major industrial stakeholders. It has now led to the effective implementation of a number of complementary projects. All through FP4 and FP5, an initial Phase 1 effort targeting the EC short/mid term improvement goal of 5dB was aimed at bringing a number of noise reduction technologies (Generation 1 solutions) to validation status (Technology Readiness Level 6). This effort was completed at the end of the SILENCE(R) project in 2007.

As can be seen on Figure 2, a significant and sustained Phase 2 effort has been subsequently initiated to achieve the technology breakthroughs needed for full achievement of the ACARE goals. Such breakthroughs encompass a wider range of areas (examples: aircraft and engine « low noise » architectures, individual component aeroacoustic design associated with low weight technologies, innovative noise reduction techniques such as active / adaptive systems), each providing technology building blocks along the multidisciplinary path leading to an aircraft design optimized for minimal environmental impact.

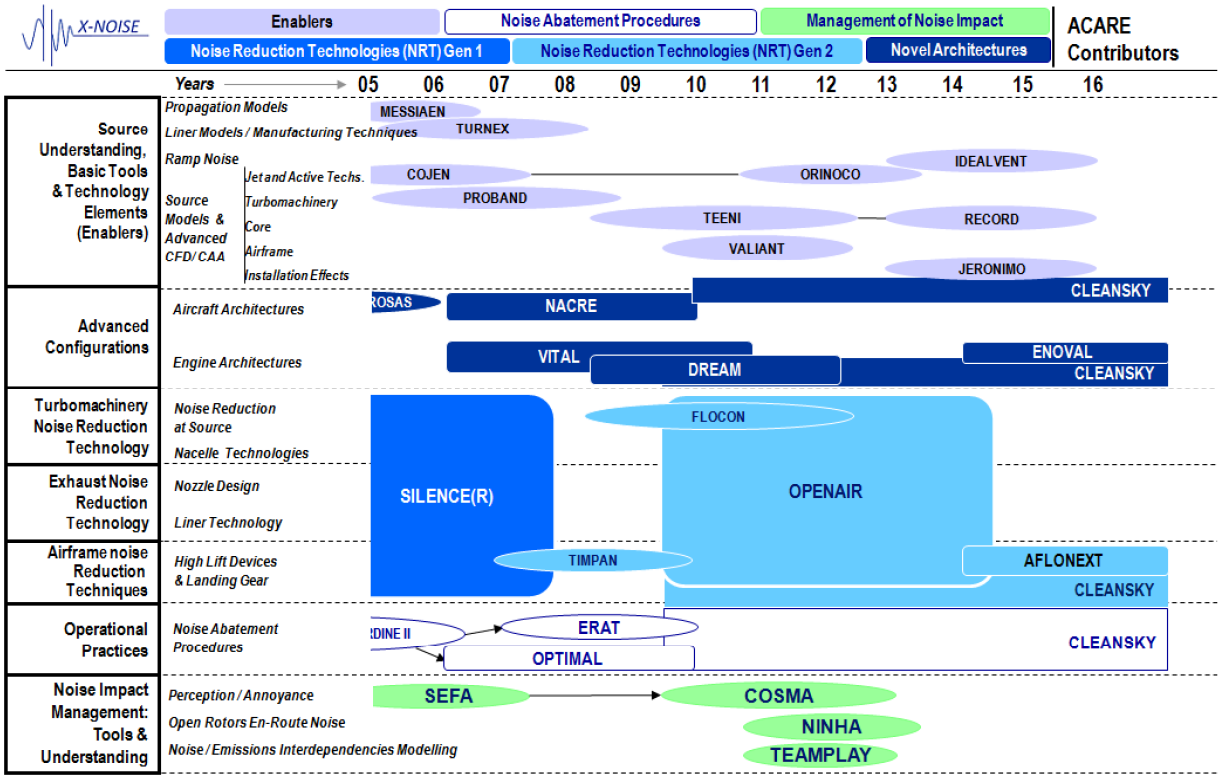

Figure 2 –Roadmap of Aircraft Noise Projects supported by EC DG Research – Phase 2

Furthermore, as an indication of the wider range of expertise now mobilized through the network, a significant and coordinated effort has been launched to improve the understanding of psychoacoustic factors as well as provide aviation stakeholders and policy makers with better tools and knowledge to help manage the environmental impact of air transport operations.

2.2 Assessing the current achievements and supporting the definition of longer-term research priorities

In 2012/2013 the OPTI project (2) was tasked to assess the present achievements across the board of all ACARE SRA expressed targets. X-NOISE supported this effort, taking this opportunity to consolidate a comprehensive assessment methodology. This methodology, established for the evaluation of progress relative to the fixed wing aircraft noise subset of the SRA, is based:

- first on the internationally recognized Technology Readiness Level (TRL) scale, that allows keeping track of the situation of individual technologies identified in the SRA as key elements of the ACARE technology oriented solutions for noise reduction.
- second on a dedicated process, called Aircraft Noise Technology Evaluator (ANTE), involving a predictive model with capability to roll up the benefits of individual technologies at contributor level.

The TRL situation was then used to support the qualitative analysis in terms of assessing the implementation of the initial SRA strategy, evaluating the size of the associated effort and identifying potential gaps emerging from either technical difficulties, insufficient funding support or new priorities and technological avenues.

In parallel, the existing Technology Evaluator exercise carried out combining Silence(R), Sourdine and Optimal results supported the quantitative analysis of achievement relative to the ACARE goals.

X-Noise further in-depth analysis of the current achievements relative to Technology Readiness Level 6 prospects allowed to consider that the mid-term interim objective of –5dB per operation were met by 2010.

However, a number of breakthrough achievements still require consolidation to higher TRL status within the remaining time period to 2020. As a consequence to maximize chances of meeting the 10dB noise reduction goal, the following recommendations have been expressed:

- Maintain significant effort in support of Noise Reduction Technologies Generation 2 to reach TRL6, including active techniques and addressing integration issues such as weight, performance and durability.
- Re-energize support to activities on Novel Architectures, with a particular focus on Low Noise Aircraft configurations.
- Ensure successful implementation of Low Noise Operational Procedures as investigated in FP5 and FP6

It has also been pointed out that these conclusions did not take into account the specific situation created by the emergence of open rotor engine configuration as a serious contender when dealing with low carbon technology options. Offsetting the anticipated noise source impact associated with novel open rotor engine architectures will necessitate an aggressive approach, through dedicated research aimed at rotor blade aeroacoutic design, engine / airframe installation and flow control techniques in particular.

In parallel, looking further into the future, X-NOISE has contributed to the development of the new ACARE Strategic Research and Innovation Agenda (SRIA) aimed at the 2050 timeframe.

As stated in the Flightpath 2050 document (3), the ACARE 2050 objective is to reduce the perceived noise emission of flying aircraft by 65% relative to the 2000 situation. In line with ICAO’s Balanced Approach concept, this reduction should be achieved through a significant research programme aimed at novel technology and enhanced low noise operational procedures,

complemented by a coordinated effort providing industry, airports and authorities with better knowledge and impact assessment tools to ensure that the benefits are effectively perceived by the communities exposed to noise from air transport activities.

The first set of recommendations considered solutions capable by 2050 of reducing noise at departure and arrival by 15dB per operation relative to Year 2000 aircraft. On top of expected 2020 achievements, anticipated solutions will involve:

- the use of multi-disciplinary optimization to develop and improve engine/nacelle design and installation, airframe design and noise abatement procedures capabilities.
- the development of a 3rd Generation of Noise Reduction Technologies (NRT), relying in particular on active and/or adaptive techniques to reduce the noise of engines, landing gears and high-lift devices.

Such mid and Long-term solutions will also require a shift in aircraft configuration, such as the use of tube and wing with engine noise sources shielding and ultimately blended-wing body aircraft. This type of aircraft can benefit from engines mounted on top of the fuselage or embedded inside the airframe.

Moreover, in order to exploit new technology / low noise operations developments and to enable integrated impact mitigation solutions, it will be of utmost importance to:

- improve and continuously update the understanding of how noise from air transport operations implemented through new Air Traffic Management solutions affects people.
- provide the technical support to successful implementation of planning policies for the long term benefit of the communities compatible with traffic growth.

In line with this comprehensive strategy, a number of “Enabling Factors” foreseen as key contributors to the 2050 noise goal achievement were also pointed out, namely:

- Improved numerical simulation capabilities, together with test facilities incorporating advanced measurement techniques, in order to support further noise reduction at source level as well as the implementation of multi-disciplinary optimization techniques and aircraft/engine integrated design practices contributing to lower noise through efficient integration of noise reduction solutions, reduced weight, decreased drag, improved powerplant efficiency and flight path design,
- Stimulated advances in related technology areas, such as materials and electronics, to allow the introduction of novel low noise technologies, including active/adaptive techniques,
- Updated, internationally recognized, Annoyance and Sleep Disturbance models, taking into account the evolution of aircraft noise signatures and traffic conditions (multiple events), also considering airport specificities,
- Tools supporting transparent communication policies covering relevant indices, flight path / operations on-line forecast and tracking as well as comprehensive assessment of environmental interdependencies and monetization of impacts.

It was also recommended that wider international cooperation be sought, in particular in areas where knowledge development is not concerned with competitive and industrial property issues.

In view of the opportunities provided through the new European research framework program (Horizon 2020), it is firmly believed that industry led programs will allow appropriate maturation of Generation 2 technology solutions for 2020.

At this stage, it is also considered as extremely important that a dedicated and coordinated effort of the research community is now initiated and supported to address the enabling factors emphasized above and provide excellent foundations for the longer term solutions identified within the context of the ACARE SRIA.

2.3 Developing the research network

In parallel, improved integration of the research community at European level has been pursued. Through the various individual projects and the networking efforts carried out over the last ten years, the European aircraft noise research community has now reached a critical mass. As of 2014, close to 200 different organizations have participated in at least one project proposal over the last four EC framework programs. Three priorities have driven the network efforts in the community building area:

- better coordination of expertise at national level around a common set of well disseminated European priorities and objectives, also leading to a better exploitation of national funding around similar priorities,
- better identification and exploitation of national upstream research into larger European technology validation projects,
- structured development of local networks in order to foster participation in future projects.

To this end, a network of national Focal Points has been established to favor efficient coordination of expertise at national level. Representatives of CIS, South America and Mediterranean regions have also joined in the network to foster further international cooperation.

The current network development phase launched in 2010 through the X-NOISE EV Coordination Action then addressed the scope represented in Figure 3

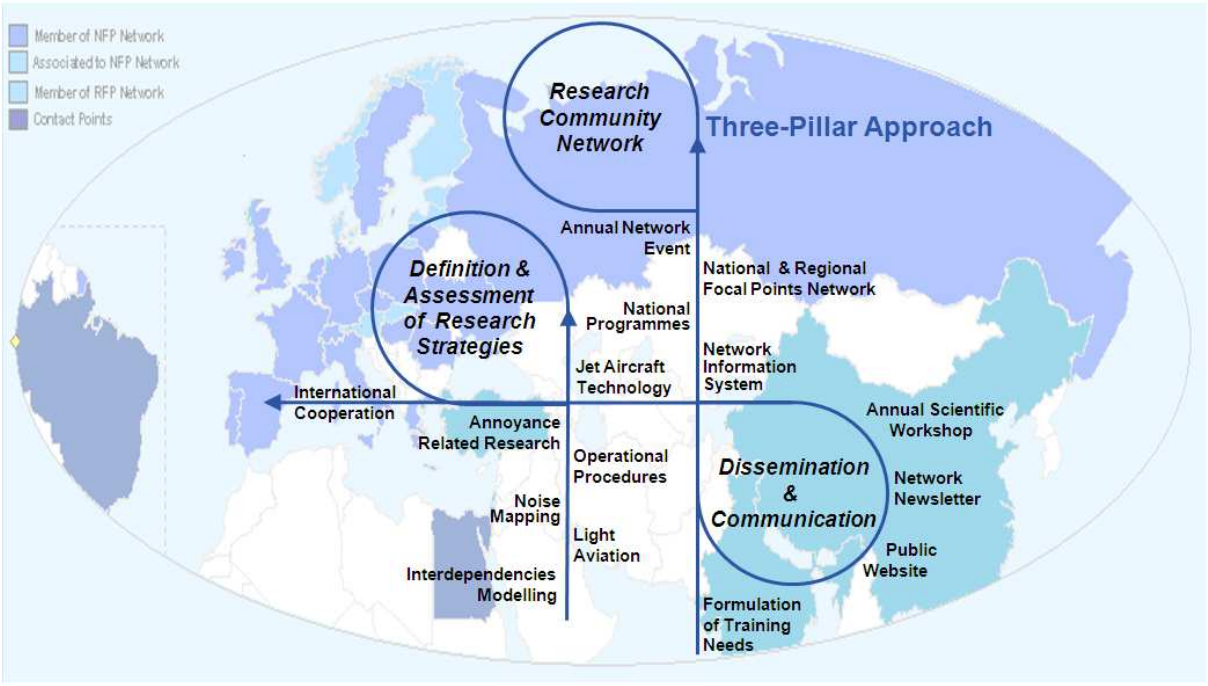

Figure 3 – Scope of X-NOISE EV Activities

Beyond the countries involved in its formal partnership, the network has been extremely active in exploring international cooperation opportunities with USA and Canada in support of EC initiatives in this direction. The ground work performed at this occasion is expected to lead to concrete collaboration projects within the next couple of years

3. CONCLUDING REMARKS

The X-NOISE Network (and supporting X-NOISE EV Coordination Action) contributes to the objective of reducing Aircraft Noise by 10 dB per operation as set by the ACARE 2020 Vision, while addressing key factors associated with Airport Noise issues thanks to its comprehensive workplan involving experts groups, scientific workshops, international cooperation seminars and a common information system (www.xnoise.eu).

To this end, it more specifically:

- evaluates EU-funded projects results and assess their contribution to the state-of-the-art,
- formulates, through development of common strategies and complementarity with national activities, priorities and key topics for future projects aimed at noise reduction at source, low noise operations, and improved understanding and modelling of the impact of aircraft noise in the community, including environmental interdependencies,
- ensures dissemination and exploitation of research findings, including technical information aimed at Regulatory Bodies and Policymaking Agencies,
- contributes to an improved integration of the European Aircraft Noise Research Community through a network of National Focal Points covering all countries with a technical interest in Aviation noise, identifies potential reinforcement of future projects partnership through extended international networking and dedicated processes to foster new collaborations and promote novel ideas.

More generally, as lasting organizations beyond the limited timeframe of individual projects, research networks ensure a much needed structural continuity aimed at longer term strategies. In linking together, they also play a key role in addressing wider issues such as the development of a concerted research approach for transport noise as whole, improved knowledge of noise-emissions interdependencies and the development of international cooperation opportunities.

ACKNOWLEDGEMENTS

The author acknowledges the support of the European Commission to the X-Noise network activities.

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