

Final Report
on the
Long-term Scenarios II Workshop

Airport Palma de Mallorca, Spain

19 – 21 March 2001



AERONET

AERONET - II

Long-term Scenarios of Aviation and its Emissions

Is aviation on the way to sustainability?
A European networking activity

Status – Report and proposal for future work

after Workshop II on 19-20 March 2001
at the Airport in Palma de Mallorca, Spain

Ralf Berghof, Roger Gardner, Ute v. Reibnitz, Alf Schmitt

July 2001

Content	Page
Summary	
1. Background and objectives of the AERONET Long-term Scenarios Project	5
2. Concept for the Performance of the Project	6
3. Status before Workshop II	7
4. Preparation of Workshop II	7
5. Performance of Workshop II	8
5.1 Introduction	8
5.2 Expectations of the workshop participants	9
5.3 Review of the two extreme scenarios, designed at Workshop I	9
5.4 Design of two new intermediate scenarios for the environment of aviation	18
5.5 Beginning of the consequence analysis (step 6 of the scenario process)	26
5.6 First conclusions	28
6. Follow up after Workshop II	29
7. Planning of further steps	30
7.1 Proposal for a EU – Project	30
7.2 Possible work until the start of the proposed EU funded Project	30

ANNEX:

Annex 1	Agenda of Workshop II
Annex 2	Participants of Workshop II
Annex 3	Overview of Workshop I & Top level goals of Workshop II (foils)
Annex 4	Relevant external activities (foils)
Annex 5	Summary description of the two scenarios A & D developed at Workshop I (foils)
Annex 6	Storylines for the scenarios A, B, C and D, designed after the Workshop II by the moderators (Scenario clusters restricted to alternatives of dominant factors from external influencing fields)

Summary

In March 2000 AERONET responded to partner's interest in „Long-term Scenarios on Aviation and its Emissions“, initially with the concept to perform 2-3 workshops in the 2000 and 2001 to produce a set of four qualitative scenarios including 2-3 constrained scenarios (with – as far as possible – some first quantification).

The results of the workshop period should be taken forward by a European study team to develop quantification for the scenarios designed and to elaborate the details needed to achieve the objectives of the AERONET Scenario Project. The second stage could involve a pre-study, possibly financed by national sources, to firm up the outcomes of the workshops, to define concrete goals, contents and structures for the work of the study phase, and to investigate models which can be used for quantification. The objectives and tasks developed in the pre-study should then be realised through a (main) study project, funded e.g. by the European Commission. The (preliminary) results of this work should be discussed in an open European review, finished by a European workshop. Final scenarios should be available during 2003. These proposed steps towards complete scenarios will be considered further with key stakeholders and participants.

The final outcome of the AERONET Scenario Project should then be made available as information for the strategic planning of European stakeholders in aviation, as input for other European projects related to aviation and its emissions, and referred to the worldwide international community, especially to ICAO/CAEP, for further discussion.

The present Status Report describes the situation of the AERONET Scenario Project after the second workshop held on 19-20 March 2001 at the Airport Palma de Mallorca, Spain. The main objective of this workshop was the modification of the two extreme „background“/environment scenarios, developed at the first workshop in Cologne, the design of two intermediate scenarios, the identification of possible influences of the designed scenarios for the future demand in aviation, resulting air transport and related emissions, and the start of the analysis of resulting consequences and requirements for stakeholders and participants in aviation.

The participants of Workshop II were welcomed by Alvaro Middelmann, Director of Air Berlin for Spain and Portugal, who hosted - together with the Airport of Palma de Mallorca - the workshop and Winfried Dewes, AERONET. Alf Schmitt gave short overviews on the results from Workshop I as about the prime goals and the programme of Workshop II. Roger Gardner reported about relevant external activities (some background information on recent scenario work of the IPCC) and the moderator Ute Helene v. Reibnitz explained the need and use of scenarios. This first session was finished with a workshop plenary, at which point the participants described their expectations to the scenario project and Workshop II.

In the following sessions the group work, facilitated by the moderator, started with a modification of the two extreme scenarios (A and D) developed at Workshop I, followed by the definition of two intermediate scenarios (B and C). This phase started at the afternoon of the first day and was finished at lunchtime of the second day. During the second (and last) afternoon of the workshop, the consequences of the scenarios A and D on the fields „air transport demand“, „requirements for aviation“, „emissions“, and „others“ were identified and some Consequence Analysis was performed. Further „Consequence Analysis“ and last two steps („Wild Card Analysis“, „Scenario Transfer“) would be performed at a later stage. Details of the work are given in the report.

After the workshop the facilitator, Mrs. von Reibnitz, has elaborated comprehensive storylines for all scenarios A, B, C and D, which are given in Annex 6 of this Status Report.

The workshop was closed with a discussion on first conclusions on the outcomes of the workshop and appropriate next steps. The participants agreed that a third workshop appeared to be needed once the pre-study or main study work was advanced to the point that detailed scenarios needed to be reviewed by a broader circle of European expertise. The Core Team took the responsibility to prepare the final report. Finally, thanks and much applause were given to the two facilitators for their professional work.

The result of the workshop period should be taken forward through a European study team to develop quantification for the scenarios designed by the workshop and to elaborate the details needed to achieve the objectives of the AERONET Scenario activity. So far, DERA, DLR, EADS/Airbus, Lufthansa, NLR have expressed an interest to discuss the scope, content and participation in an EU funded project.

Until mid September all activities will now be concentrated on discussion and preparation of an appropriate proposal for such a project. If accepted, the EU funded project would probably start in early 2002. The time until the start of the project should be used to broaden as far as possible the knowledge and expertise needed for its performance.

1. Background and Objectives of the AERONET Long-term Scenario Project

At the second meeting of the Steering Group on 2 March 2000 AERONET, a Thematic Network Project initiated and supported by the European Commission, it was decided to follow a joint proposal of the two AERONET Groups EDI and OTD and the German Scenario Circle to take up the topic „Long-term Scenarios on Aviation and its Emissions“ and to deal with this subject through a European AERONET scenario workshop project.

Long-term scenarios on aviation and its emissions are important as input for long-term assessment of the impacts of these emissions on climate change, and on local (airport) air quality, and as basic information for long-term strategic planning in the field of air transport. There is an identified need for robust 2050 scenarios, especially reflecting the European perspective.

Published in the year 1999, various scenario approaches for the possible development of global air traffic and related emissions until 2050 were developed and described in the report of the Intergovernmental Panel on Climate Change (IPCC) on „Aviation and the Global Atmosphere“. The key set of scenarios was developed for IPCC by FESG, an ICAO/CAEP working group, as a quantitative input – in form of emission inventories – for the calculation of the global impact of aircraft emissions on the atmosphere.

Common to all scenarios considered in the 1999 IPCC Special Report was the assumption of an unconstrained development of air traffic. With that, the whole range of constrained scenarios was excluded from further consideration.

Moreover, the ICAO/FESG scenarios are based on the GDP figures of the IPCC „background“ scenarios on the development of economy, population, energy, generated in 1992. However, recently (in the year 2000) the IPCC has published new background scenarios developed for its Special Report on „Emissions (ed.: of all anthropogenic sources) Scenarios“ with new assumptions for developments in economic and population features. Before using the ICAO/FESG scenarios once again (e.g. as part of a complete set of scenarios), it would be appropriate to modify them to refer to the newest set of IPCC background scenarios.

Considering this situation, it seems to be obvious that if a sound base for the long-term strategic planning in aviation and the long-term assessment of its emissions is required, it will be necessary to undertake a new effort to design a full set of long-term scenarios based on the best

information presently available. With its European Long-term Scenario Project AERONET has initiated such work to be developed through a formal EC project.

The main objective of AERONET scenarios activities is the „design“ of a set of four scenarios of the long-term development of aviation and its emissions until the year 2050,

- for which the „no-restriction“ assumption of the scenarios available will no longer be a principal hypothesis, although it will be necessary to have as well one (or more) unconstrained „control“ scenario(s).
- which take into account the new „background“ scenarios from the IPCC on economy, population (and others), developed for the IPCC „Third Assessment Report“, and other recent information and results especially from ICAO/CAEP, industry, economic and air transport sources and various AERONET workshops in years 1999 and 2000,
- which can be used as basic input for atmospheric assessments, and in addition explicitly addresses topics which are critical for the long-term strategic planning in the field of air transport and can be applied as well to policy development work.

For each scenario development, it is proposed that consideration should be given to consistency with other EC supported work to describe 2025 scenarios and - as far as possible – some consideration should be given to the need for information out to the 2100 time horizon.

The aim is to develop new state-of-the-art scenario information, which can be:

- used by European stakeholders in the aviation system, including airports, ATM/ATC, aviation industry, policy makers, and other relevant European organisations for a better understanding of critical aspects of the challenge to obtain sustainability for the aviation system and for a definition of possible amelioration options to avoid „unwanted“ and support „acceptable“ future developments,
- referred to the worldwide international community, especially to ICAO/CAEP for further discussion, and
- used as basic information for the calculation of a new modified set of global emission inventories applying a new approach for inventory generation in conjunction with work being developed by the European Project AERO2K and for other actual and upcoming projects considering the projection of aviation.

These objectives were agreed on by the participants in Workshop I and are only slightly modified for Workshop II to account for the development of separate 2025 scenarios work being supported by EC DGRES.

2. Concept for the Performance of the Project

Due to the present understanding, at least two workshops will be necessary to achieve the qualitative objectives of the Scenario Project in an adequate manner. After Workshop II an additional roundtable discussion with experts/stakeholders may be required to build upon the qualitative information and plan the more detailed quantitative work.

The workshops have three phases

- (A) Preparation:
Actions preceding the workshop, preparing useful and necessary inputs;
- (B) Performing the workshop:
Addressing the special objectives of each workshop
- (C) Follow up after the workshop:
Working out a more detailed description of the results achieved during the workshop, and producing a final report for each of the workshops.

As a follow-up it is proposed that a European study team (e.g. financed by the EU Commission) should develop - as far as reasonable - quantitative features for the qualitative scenarios, designed during the workshop phase, and elaborate the full details needed to achieve the objectives of the Scenario Project.

3. Status before Workshop II

The first workshop was held on 17-18 October 2000 in Cologne/Germany. At this workshop the participants:

- agreed, that the subject of the scenarios is Aviation and its Emissions and the time horizon of the scenarios is the year 2050;
- performed an Influence Analysis, in which for external fields and internal areas about 40 most important drivers and key factors were identified;
- designed two extreme „background“/environment scenarios for those fields and sectors which are known to influence the development of air transport demand and related emissions.

Details of the workshop, the follow up work and ideas for the planned further steps were described in the first Status Report of the AERONET Scenario Project, distributed in January 2001.

Meanwhile the importance of the subject, studied in the AERONET Scenario Project, is again underlined by the fact that other European groups started independently investigations in which long-term scenarios for the development in aviation are regarded (for a overview see chapter 5.1).

It will be important that these European activities will be performed in a way that they all contribute – without unnecessary duplication - to the development of a valid common European understanding on the subject.

4. Preparation of Workshop II

An Organisation Team (Core Group) was formed to prepare the workshop. Some further experts supported the Core Group. During some meetings and e-mail discussion in February the most of the details for the concept and content of the Workshop II were fixed. In early March last modifications for the agenda and details for the performance of the workshop were agreed.

Date, duration and emphasis of Workshop II

The invitation from Mr. Alvaro Middelmann (Air Berlin), a participant of the Workshop I was accepted (second) to hold Workshop II at the airport of Palma de Mallorca, Spain. The 19/20 March 2001 was agreed on as the date for the two-day-event. During the discussions on the possible agenda of the second workshop it became obvious that it would be impossible to completely finish the design of a set of qualitative scenarios within this workshop. Therefore Steps 7 and 8 of the scenario process, “Wild Card Analysis” and “Scenario Transfer” were shifted to further work. In addition it was decided that Step 6 (Consequence Analysis) should be started, but not completed, (for time reasons but as well because this task has to be performed to a large extent by the stakeholders and participants themselves).

Whereas the first workshop concentrated on the *design* of a set of two extreme (boundary) scenarios it was decided that the second should focus on

- the further review and possible modification of these extreme scenarios
- defining two more intermediate scenarios
- analysing the influence of the designed background scenarios on air transport demand / air transport aviation and related emission
- starting the *analysis of consequences* for the scenarios.

(Necessary completion of the analysis of consequences will be one of the tasks of the further work.)

Additionally it was agreed that as a starting point for the workshop the opportunity should be given to the participants to describe their expectations to the workshops and to the total AERONET Scenario Project.

Agenda for Workshop II

Including proposals from the facilitator, an Agenda was developed for Workshop II, which was a compromise between the wish to come as close as possible to a fulfilment of the extensive list of objectives of the Scenario Project and the necessity to accept the limitations for a two day activity. (See Annex 1)

Facilitator for Workshop II

It was decided to use again the help of a professional facilitator. As for the first workshop the „Scenarios + Vision“ team, Lence, France was selected to act as a neutral moderator for the complex organisation of the workshop discussions.

Distribution of further information relevant for the workshop

Besides the report of the first workshop, including the interpretation (storylines) of the two extreme scenarios designed at the first workshop and written by the facilitator/moderator, information on a new relevant external activity from the EC forward look initiative, the “Group of Personalities” (GoP) were distributed together with the draft agenda among the possible participants in the workshop.

Funding, Support and Acknowledgement

The principal funding came from AERONET. Air Berlin (Alvaro Middelmann) hosted the workshop and gave organisational support. The Airport of Palma de Mallorca made infrastructure and services available. DFS (German Air Navigation Services) provided the two co-moderators. The provision of support to help run the second workshop of this scenario activity is gratefully acknowledged.

Participation in Workshop II

Selected experts from stakeholders and actors in aviation were invited. Finally, 31 persons (including facilitators, service people) enrolled for participation in Workshop II (see Annex 2).

5. Performance of Workshop II

5.1 Introduction

Alvaro Middelmann, Director of Air Berlin for Spain and Portugal , Winfried Dewes, AERONET, DLR and Roger Gardner, AERONET, DERA welcomed the workshop participants.

Alf Schmitt, DLR gave an overview on Workshop I and on the prime goals and the programme of the Workshop II (see Annex 3).

Roger Gardner gave a short presentation on external activities relevant to the scenario project (see Annex 4).

Then the moderator, Ute von Reibnitz welcomed the participants of the workshop and explained the main features of the proposed Scenario Techniques or Process and how they work. The hallmark of the Scenario Process is to create alternatives in case of uncertainty and to assemble them into highly consistent scenarios. Because nobody knows what the exact outcome of the future will be, contrasting future situations have to be taken into account. Scenario Techniques link these scenarios to the present situation of the community taking into account existing goals, strategies and questions to be solved. The aim is to facilitate the eventual design strategies to seize future opportunities and to reduce or even turn possible threats into opportunities.

The moderator reminded the participants of the main features of the proposed Scenario Techniques or Process, the steps, which were already done at the first workshop (Step 1-5: Task Analysis, External Influence Analysis, Projections, Clustering Alternatives, Scenario Interpretation) and the one, which still have to be done.

5.2 Expectations of the workshop participants

At the end of the first morning of Workshop II the participants were asked to describe their expectations of the workshop and of the AERONET scenario activity.

The answers addressing the expectations for the workshop showed, that the participants paid the most attention to a clear, realistic and consistent definition of a set of four scenarios, which should be not incompatible to the IPCC Emissions Scenarios, which should take into account the human factors, specify the AT-characteristics resulting from the scenarios and identify positive and negative effects for aviation. Finally a broad agreement on future aviation development and its limiting factors was expected to support solution strategies for stakeholders.

The formulated expectations to the AERONET project showed a quite small range of opinions, though the background and interests of the participants were wide-ranging. The final result of the project should be creative, complementary and quantified scenarios. Most of the participants expected, that the project should broaden their view on external influences and lead to a *common* European understanding and agreement on the future, resulting e.g. in harmonisation necessary for ATM, safety, etc. Another expectation was to investigate *constraints* for the development in aviation as a basic information for European strategic planning. Depending on the role of the participants they expected support for the development of future aircraft design as well as for airport technologies and infrastructure planning. Last but not least it was expected to enhance the scientific basis for political decisions or policies in the aviation sector. Furthermore, the participants expressed the expectation, that the findings of the AERONET project will be an important support to improve European competitiveness in aviation industry, by getting a clearer picture of possible and unpredictable developments in aviation and thus supporting necessary technological and political preparation for the future.

The main reason for this collection of opinions was to offer the participants in the workshop a possibility to check, whether the progress of the project is in line with their expectations. But, in addition the results can be used to compare these statements with the outlined objectives for the Long-term Scenario Project as described in chapter 1: It turned out, that the expectations of the workshop participants were in close agreement with the aims of the project. On the other hand the given statements reveal some interesting additional aspects for details of an effective future work for the project.

5.3 Review of the two extreme scenarios, designed at Workshop I - group work on the modification of these scenarios

In the second morning session of Monday a review was started of the two extreme scenarios A, B and the related storylines, developed at the first workshop, respectively drafted during the follow-up after Workshop I. As an introduction some background information was given by the moderator, who summarised and explained the main characteristics of the two scenarios (Annex 5). As the feeling was expressed that the agreement to the designed storylines could be significantly enhanced by a some modifications of the wording for the expectation of the developments of the descriptors, the group work started - facilitated by the moderator and two co-moderators - with a refinement of scenarios A, B.

Four groups were formed out of the participants of the workshop, each with 6-7 experts, to modify the two extreme scenarios and the wording of their storylines in a way, that the scenarios are consistent and realistic as well as wide enough to cover all possible "big trends". For each scenario one group discussed the external (*Demography, Macroeconomics, Energy/Resources, Social Trends/Mobility Patterns, Ecology, Non-Transport Technologies, Policy/Regulations*) and one the internal (*Transport in general, Transport/Air Transport Technologies, Aviation Effects on Ecology, Aviation Supply Side, Special System Aspects of Aviation*) fields of influence for the future air transport. To be effective, it was agreed, that only necessary changes to the original Scenarios A and B and their storylines should be examined.

It was decided, that the list and sequence of the descriptors - as given in the storylines for the extreme scenarios A and B - should be used. The descriptors "Levies" and "Alternative fuels" which were used during Workshop I for the "old" extreme Scenarios were combined with the different descriptors of the key area "Regulations", respectively with the descriptor "Energy resources for aviation" (to avoid duplication). The descriptor "Noise" and "Emissions" - which originally belonged as well to the list of descriptors of the "old" scenarios - were taken away from this round of the discussion, because they should eventually be treated later on together with the key factors characterising the demand in aviation/resulting air transport and related side-effects.

At the end of this process, the modifications for 39 descriptors from 12 key external and internal fields influencing air transport demand and related emissions, defining the two extreme scenarios were agreed in plenary discussions of the respective two working groups which designed the two parts of both scenarios. The modified clusters were called A and D and are described below, together with the reasons found by the Working Groups for the selected alternative projections to 2050. (Modified scenarios of descriptors are underlined.) In the follow-up after the workshop the related storylines for A and D were drafted by Ute von Reibnitz, using as well the proposals for modifications, elaborated during the group work (see Annex 6).

Results for the modified extreme Scenarios A and D:

Macroeconomics

- GDP

Scenario A: low growth over all (ca. 1% p.a., nearly stagnation), but strong regional differences
Reasons: in some regions regulation, change in way of life, problems from environmental effects –in other regions conflicts, drinking water and energy problems

Scenario D: impressive growth (ca. 4% p.a.) with regional differences
Reasons: economic focus, globalisation, no energy problems, strong urbanisation

- Globalisation

Scenario A: no increase

Reasons: regionalisation, economic and social disparities, political instabilities

Scenario D: strong increase, benefits for rich and poor countries

Reasons: profit thinking, communication, strong cooperation

- Economic centers

Scenario A: Economic interaction reduced to a "necessary" level

Reasons: strong political and economic co-operation hand in hand with regionalisation

Scenario D: Y€\$-regions are dominating

Reasons: few strong political and economic centers

Ecology

- Climate Change

Scenario A: significant change

Reasons: lack of awareness and/or no effective actions, climatologists have underestimated the effects

Scenario D: little change compared to today

Reasons: climatologists have overestimated the effects; or: a large climate change is avoided by high awareness and effective actions

Demography

- Fertility

Scenario A: slightly decreasing with some regional fluctuations

Reasons: slow increase in income worldwide plus "the boat is full"

Scenario D: strongly decreasing

Reasons: high income, policy measures

- Mortality

Scenario A: slightly decreasing

Reasons: health care improving for all, some regions: too little food, environmental impacts, new viruses and immune deficiencies

Scenario D: strongly decreasing

Reasons: high income, improvements in medicine & hygiene, high life expectancy

- Education

Scenario A: professional education for an elite, spiritual for the masses

Reasons: need for a few highly educated professional class + workers as well as for local or tribal knowledge in human and social topics

Scenario D: high level education for everybody

Reasons: Long-term benefit, more social equality

Social Trends / Mobility Pattern

- Mobility needs

Scenario A: spiritual mobility, increase in local trips, decrease of AT

Reasons:

- society's mobility pattern completely changed => dramatic ecological problems + dramatic health problems (causal links!)
- AT is only the exception (very expensive; internalisation of costs...)
- new behaviour patterns: paradigm shift, „virtual encounter is better than a real one“ (in business + leisure)

Scenario D: high physical and virtual mobility

Reasons:

- increased World Trade
- AT perceived as clean, efficient, less polluting than other transport modes (new energies, new engines, new aerodynamic principles)
- new airspace + distance navigation systems
- effort of all AT industry partners to become sustainable
- life style / leisure focus on real travel, adventure

- Quality of life

Scenario A: spiritual + sustainable life style

Reasons: religion, „money doesn't make happy“, „be responsible for yourself + others“, healthy environment => healthy people, reduced resources

Scenario D: hedonism

Reasons: materialistic aspects dominant, consumption is in: „you are what you consume“

- Working pattern

Scenario A: locally oriented

Reasons: tribalism (home feeling), cost + convenience, income constraints, ICT brings the world together

Scenario D: highly (physical) interactive on a global level

Reasons: face to face contact wanted, resource availability, exploiting global markets

- Leisure behaviour

Scenario A: stay local

Reasons: more ICT, relatively less: speed + ease, leisure time, affordability, curiosity + search for adventures, availability + capacity, new destinations

Scenario D: shrinking world

Reasons: relatively more: speed + ease, leisure time, affordability, curiosity + search for adventure, availability + capacity, new (global) destinations

- Business behaviour

Scenario A: regionally orientated

Reasons: more ICT, relatively less/low: new markets, labour mobility, just-in-time production, spatial specialisation, most things are offered in the region

Scenario D: globally orientated

Reasons: relatively more/high: new markets, labour mobility, just-in-time production, spatial specialisation

- Social structure

Scenario A: cohesive, bonding

Reasons: high importance of family bonds, strongly related to religion and national culture

Scenario D: fragmented in the € and \$-regions, opportunistic relationship model

Reasons: lower importance: of family bonds, religion, national culture

Regulations

- Regulation on air traffic operations

Scenario A: voluntary reduction supported by restrictions (e.g. no short distance flights)

Reasons: stricter policy to avoid impact on environment

Scenario D: none

Reasons: no need for actions

- Regulation on the kind of demand

Scenario A: strict (few leisure flights, only "useful and irreplaceable" air transport)

Reasons: cut down on aviation emissions

Scenario D: none

Reasons: no need for actions

- Regulation of emissions

Scenario A: strict regulations

Reasons: emissions damage to environment is evident

Scenario D: legislation follows technology

Reasons: economic factors, competition, growth, science proves, that emissions have a minor impact

Energy / Resources

- Energy availability

Scenario A: based on renewable resources, but no breakthrough

Reasons: society accepts only energies, which don't harm the environment

Scenario D: wide range

Reasons: hydrocarbons available, fusion technology mature (safe, efficient...), electrical energy cheap + everywhere

- Energy resources for aviation

Scenario A: very limited

Reasons:

- fuel is a scarce resource – aviation loses out
- regional political restrictions

Scenario D: cheap and available

Reasons: fuel is no scarce resource, new oil sources and new hydrogen aircrafts

- Raw materials

Scenario A: bottleneck and high prices

Reasons: critical raw materials run out or are no longer economically producible; recycling requirements restrict choice of materials, expensive energy also increases material/recycling costs, complex production processes, recycling processes make materials expensive

Scenario D: no constraints

Reasons:

- main materials are available and cheap
- there is enough cheap energy to extract raw materials and process them if some raw materials become scarce a cheap replacement is invented
- new materials offer superior characteristics

Non-Transport Technologies

- Information/Communication technologies

Scenario A: will not grow significantly

Reasons: high prices, problems, low demand

- price for licenses (UMTS)
- electro smog
- change in mind of consumers

Scenario D: will grow significantly / dominant

Reasons:

- money can be made
- fast, easy, cheap
- possibilities
- e-commerce
- outsourcing
- 24 h development
- news
- entertainment

- E-commerce

Scenario A: will not grow

Reasons: no personal experience, transport cost, security

Scenario D: will grow significantly / dominant

Reasons: reduced cost, comfortable, fast, wide range of selection

- Virtual Reality

Scenario A: will not grow

Reasons: impersonal (more in favour of family contacts), technology cannot replace real impressions

Scenario D: will grow significantly / dominant

Reasons: possibility to make money, virtuality expands possibilities for activities and decision making and offers new experiences, new traffic as well as substitution effects

- Bioscience

Scenario A: moderate growth

Reasons: problems of ethical acceptance and long-term risks

Scenario D: rapid growth

Reasons: money can be made, enhances quality of life, ensures food production

- Robotics

Scenario A: moderate growth

Reasons: low labour rates, ethics and social problems

Scenario D: rapid growth

Reasons: replace routine and dangerous work + jobs; fast + cheap + precise, reduction of production costs

Aviation Supply Side

- Infrastructure –supply side aspects
(includes airport/runway and airspace capacity, airport access, personnel, airport entertainment)

Scenario A: constrained by regulations, stay local for the majority

Reasons:

- ATM improvement limitation
- stringencies (noise, emissions)
- pressure from „NGO ‘s“ , regulations from governments
- increased costs and ticket price due to high fuel price and CO2 budgets

Scenario D: non-constrained

Reasons:

- new CNS/ATM + improved A/C technology for sustainability
- new efficient, high performance airports and airspace
- new tools for slot planning process
- intermodality (tubes)
- European hubs, EU airlines
- low level of environmental regulations
- minimal impacts on airport neighbourhood
- airport + airspace integration
- airspace expanded by „Free Route“ , Free Flight“ (RVSM, FUA)
- airport access improved
- no funding problems (high GDP)
- harmonisation of airspace for civil and military flights

- Aircraft (includes new concepts, special in-flight „entertainment“ , avionics, performance, operating economies)

Scenario A: 2000 Technology / no improvements regarding noise and pollution

Reasons:

- technology improvements impasse, pressure from regulators

- low demand
- no investments lead to long-term safety fears

Scenario D: High Tech

Reasons:

- new concepts (supersonic + new bizjets for business travel; very large A/C for leisure trips, airships)
- improvements in performance and operating economies
- high demand and investment

Transport (business, freight, private, military)

- Travel time

Scenario A: long wait and travel time for ecological benefits

Reasons: trips mainly in the vicinity, time and speed less important, environmental effects is the main criteria, traffic system has changed to these priorities

Scenario D: paradise, fast and entertaining travel opportunities

Reasons: large travel time budget, high level of changes + levies

- Travel costs

Scenario A: high prohibitive costs for long distance travel

Reasons: small travel cost budgets

Scenario D: paradise, attractive prices for normal, higher prices for fast travel

Reasons: large travel cost budgets, strong contest between airlines

- Infrastructure (demand related)

Scenario A: only small and "sustainable" infrastructures

Reasons: restricted infrastructure conditions (policies, prices, demand)

Scenario D: high demand for superior infrastructure network

Reasons: effective networks and infrastructure (safety, access, interconnectivity) are available to fulfil the demand

- Modal split

Scenario A: Green modal split concepts

Reasons: sustainable transport has higher priority than comfortable and fast transport

Scenario D: Balanced modal split with high intermodality

Reasons: customer friendly, efficient, sustainable transport system

AT Technologies

- Airframe/engine technology

Scenario A: conservative concepts

Reasons: minimal investments, low research level, industry is not healthy, no acceptance of Scenario concepts, technology limits

Scenario D: revolutionary new concepts with fast, low-noise and low-polluting large aircrafts
Reasons: new materials, alternative configuration, huge research effort, healthy industry, fuel price high, but fuel supply secured

- CNS/ATM

Scenario A: only Green ATM procedures / free flight for green fleets

Reasons: low investment, stagnation, fragmented systems

Scenario D: central regulation, new concepts

Reasons:

- IT
- reduced cost, time, impacts on the environment by optimized routings
- optimisation of capacity
- optimum pricing system for early application of technology
- cross-border co-operation and service provision

- Airport design

Scenario A: classic concepts

Reasons: lack of demand and investments, high prices, strict regulations

Scenario D: wide range of new concepts with different specifications

Reasons:

- new aircraft concepts
- increase in efficiency / capacity
- less noise, emissions
- more countryside + high speed links
- effects of better accommodation of General Aviation at airports on design

- Alternative transport modes

Scenario A: small substitution related to travel time budget, no substitution of long distance trips

Reasons: slow, but ecologically optimized transportation for short distance travel

Scenario D: high demand with high competition between the modes

Reasons: policy support, network effects, city centers, demand characteristics, costs

Effects of Emissions from Aviation on Ecology

- Noise effects

Scenario A: noise is still a problem

Reasons:

- speed of technology development and implementation is slow
- sensitivity of population increases

Scenario D: noise is not a problem anymore

Reasons:

- high speed of technology development and implementation into fleets
- technology R&D programmes on the way
- NGO's + governmental actions
- airports far from agglomerations

- Effects from gaseous emissions from subsonic aircrafts at cruise altitudes

Scenario A: subsonic emissions are still a problem

Reasons:

- effects on climate change underestimated today
- supranational solutions came too late, damages mostly irreparable
- rich western countries try to introduce emissions permit trading

Scenario D: minor problems

Reasons:

- effects on climate change overestimated today
- high level of reduction measures
- efficient engines need less fuel and produce less emissions and are important for airlines to reduce costs

- Effects from gaseous emissions from supersonic aircrafts

Scenario A: no problem any more

Reasons: supersonic and stratosphere flights terminated in 2005

Scenario D: minor problems

Reasons: Large fleet of supersonics, but low environmental effects, effects on climate change overestimated today

- Local air quality related emissions

Scenario A: serious health problems

Reasons: proved effects from aircraft emissions originating at airports, high growth in traffic, ineffective measures to mitigate concentrations, low improvement in engine technologies with respect to related emissions

Scenario D: no problems

Reasons: effects from aircraft emissions are shown to be lower than those from other sources, low air traffic, improvements in engine technology, effective regulations and Market Based Options to reduce effects

Special System Effects

- Safety

Scenario A: safety problem persists

Reasons: no investments, no demand

Scenario D: high level of safety, all is well

Reasons: investments and technologies available, safety is high issue

5.4 Group work on the design of two intermediate scenarios for the environment of aviation

Reflecting the results from the first workshop, two consistent scenarios were designed, which were contrasting and extreme to cover possible trends and to limit the range of credible future developments. And even though these two scenarios were mostly consistent, often one of the alternative projections fitted obviously better to one of the scenarios than to the contrasting scenario. However, the projections for some of the selected descriptors fit to both scenarios or would not be inconsistent with them. Therefore the plenary decided at the last workshop to

design more than two consistent scenarios. It was agreed to develop two additional intermediate scenarios to be able to design even more comprehensive pictures of the future. This time the initial goal was to describe a less extreme and more conservative range of developments to complete the set of four scenarios.

On the morning session of the second day the same groups were assigned to search for two intermediate alternatives (called B and C) for each descriptor and again to nominate/elaborate the reasons for the selected developments.

At the end of that session, two clusters of the alternatives for the 39 descriptors from the 12 key external and internal fields influencing air transport demand, defining scenarios B and C, were developed. As for the first two scenarios A and D, this step of the scenario design consists of a description and visualisation of the scenarios B and C in an imaginative way and an analysis of the system dynamics and changes in the future. Again, the two respective working groups, responsible for the design of B and C discussed their results in plenary sessions and agreed on final results. A first proposal for the interpretation of scenarios B and C was given after the workshop, developed from the facilitator, Mrs. von Reibnitz (see Annex 6) and is described below, together with the reasons found by the working groups for the selected alternative projections to 2050:

Results for Scenarios B and C:

Macroeconomics

- GDP

Scenario B: decline in developing countries, controlled growth in the rest of the world
Reasons: disparity between developing and developed countries increases; split world with two and even more speeds, regional conflicts, insufficient economic development, scarcity of basic resources, new markets in ecology

Scenario C: high growth worldwide with regional differences - North America and Europe are again the leading economies in the world, followed by Asia (China, India, South East Asia)
Reasons: new technologies (biosciences, nano-technology, smart materials, smart traffic systems and all kinds of IT-multimedia technologies), education, globalisation and new business models

- Globalisation

Scenario B: globalisation and regionalisation according to the different economic speeds
Reasons: economic and social disparities, political instabilities

Scenario C: globalisation is a win-win-model for all regions worldwide
Reasons: benefits for all regions from higher salaries, social security, a more equal distribution of wealth, communication, strong co-operation, one single world currency

- Economic centers

Scenario B: Dispersion of economic centres all over the world
Reasons: strong political and economic co-operation hand in hand with regionalisation in developed countries, in third world economies economic needs more important

Scenarios C: new centres dominate the economic affairs in Europe, in America and in Asia
Reasons: global players in these centers drive rule making

Ecology

- Climate Change

Scenario B: some alarming but no catastrophic change

Reasons: different consequences in various regions, "ecology carers and non-carers", some national, but very few co-ordinated activities

Scenario C: little change – but no catastrophes

Reasons: high awareness, early/effective supranational actions, booming ecological sciences

Demography

- Fertility

Scenario B: lower fertility rate but not enough to make a significant change

Reasons: split world, fertility decreases with different rates in the various regions

Scenario C: decreased significantly and particularly in countries with former high fertility

Reasons: high income, better information for women in poorer countries, effective birth control, young people from the former third world immigrate to the over-aged countries like North America and Europe, where they are needed as human resource

- Mortality

Scenario B: slightly decreasing all over the world

Reasons: new therapies, high life expectancy for the rich, many retired people

Scenario C: strongly decreasing, we get older but stay young

Reasons: high income, improvements in medicine & hygiene, high life expectancy

- Education

Scenario B: high level education only for the rich

Reasons: education only affordable for rich people in poorer countries and for a larger population in the rich countries, majority is needed for simple jobs with lower education

Scenario C: high level education for everybody

Reasons: long-term benefit, more social equality

Social Trends / Mobility Pattern

- Mobility needs

Scenario B: increase in long distance travel, decrease of local trips

Reasons: leisure conscious, individual goals and money counts more than the protection of ecology, sustainable behaviour and protection of ecology only for the rich

Scenario C: high physical and virtual mobility

Reasons: increased World Trade, multidimensional and poly-sensual business and life style

- Quality of life

Scenario B: down to earth and facing the realities

Reasons: reduced resources, "money makes poor people happy", spiritual and sustainable lifestyle only for the rich, "express yourself" is the main religion

Scenario C: increasing, more holistic

Reasons: new sustainable society prefers a balance between health, work, wealth and leisure

- Working pattern

Scenario B: regional and global labour structures do not interfere

Reasons: pluralism of lifestyles, ICT expands teleworking for office jobs, but global business still expects business travel

Scenario C: Work, business and life are highly interactive on a global level

Reasons: globalisation, highly interactive ICT

- Leisure behaviour (air transport related)

Scenario B: leisure behaviour follows the income patterns

Reasons: less: leisure time, affordability, more: ICT, curiosity + search for adventures

Scenario C: shrinking world offers many possibilities, virtual and physical travel

Reasons: leisure, body and soul caring activities are important in lifestyles

- Business behaviour

Scenario B: slower increase, business behaviour follows the working patterns

Reasons: more ICT, new markets, high labour mobility, just-in-time production, more local business because of higher transport costs

Scenario C: globally orientated, worldwide competition, permanent fight for innovation in 24 hours and 7 days and within nanoseconds

Reasons: new markets, labour mobility, just-in-time production, spatial specialisation

- Social structure

Scenario B: fragmented society, conflicts between different social groups

Reasons: increased disparities with different lifestyles, strongly related to income and age, very few common values

Scenario C: patchwork, fragmented, benefit and balance orientated relationship model, family bands weakened, constantly changing, number of person/household decreases

Reasons: lower importance of religion, national culture, high importance of flexibility and balance

Regulations

- Regulation on air traffic operations

Scenario B: some restrictions – but very different according to the regions, low emission technology with less restrictions, ATM noise/emission optimized routing

Reasons: split world - no strict and global regulations, but stricter policy to support new technologies for aircrafts and ATM concepts

Scenario C: legislation follows economic and ecological needs

Reasons: no need for actions; strong economic growth, globalisation on a win-win-basis and worldwide exchange of goods and people are hand in hand with a favourable regulation policy

- Regulation on the kind of demand

Scenario B: some restrictions – but very different according to the regions: no long distance leisure flights, only “useful and irreplaceable” short distance air transport, still long distance business trips (added after the workshop)

Reasons: split world - no strict and global regulations, but regional controls to reduce high emissions

Scenario C: sky is limited – freedom is not unlimited

Reasons: no need for strong regulations, balanced policies support a win-win game for both economy and ecology on a worldwide scale

- Regulation of emissions

Scenario B: regional restrictions on extremely polluting traffic, legislation pushes technology

Reasons: split world - no strict and global regulations, but market-based emission regulations

Scenario C: legislation follows technology with moderate progress

Reasons: new technologies, strong and friendly co-operation with legislators and the AT industry

Energy / Resources

- Energy availability

Scenario B: available – but at a high price

Reasons: research follows the economic and ecological criteria, but renewable energies such as wind, solar, water, bio-mass are still expensive

Scenario C: resources are limited and have their price

Reasons: intensified research with small success

- Energy resources for aviation

Scenario B: limited, according to the regions

Reasons: hydrocarbons are more and more reserved for aviation, but at a higher price

Scenario C: Kerosene is available, aviation gets the energy it needs, but at a high price, newer aircraft generation flies with renewable fuels

Reasons: rational (ecologically optimized, economically ruled) distribution of energy, new hydrogen aircrafts

- Raw materials

Scenario B: bottleneck and high prices boost the research, but small success

Reasons: raw material is getting scarce and material replacements are expensive, high-energy prices make the price/availability bottleneck even more narrow

Scenario C: minimal constraints

Reasons:

- main materials are available
- there is enough energy to extract raw materials and process them if some raw materials become scarce a replacement is invented
- new materials offer superior characteristics

Non-Transport Technologies

- Information/Communication technologies

Scenario B: will grow with smooth improvements, part of daily life but without glamour

Reasons: practically oriented demand, big applications expensive (added after the workshop)

Scenario C: will grow significantly / dominant, but no direct substitution effect on air travel

Reasons:

- money can be made,
- fast, easy
- possibilities
- e-commerce
- outsourcing
- 24 h development
- news
- entertainment

- E-commerce

Scenario B: e-commerce and m-commerce on a regional basis and a high level

Reasons: personal experience for most goods required, high transport costs, security

Scenario C: will grow significantly / stimulates freight traffic

Reasons: reduced cost, comfortable, fast, wide range of selection

- Virtual Reality

Scenario B: virtual reality for the poor and actual reality for the rich

Reasons: virtual reality helps the poor to face the daily misery, only the rich can afford real service and real trips

Scenario C: will grow significantly / dominant

Reasons: possibility to make money, virtuality expands possibilities for activities and decision making and offers new experiences, new traffic as well as substitution effects

- Bioscience

Scenario B: moderate growth

Reasons: problems of commercialisation, affordable for the rich

Scenario C: rapid growth, but restrictions to genetic improvement and human clones

Reasons: money can be made, enhances quality of life, restrictions: to many old people

- Robotics

Scenario B: moderate growth (same as in scenario A, suggested by the working group)

Reasons: low labour rates, ethics and social problems

Scenario C: rapid growth

Reasons: replace routine and dangerous work + jobs; fast + precise, reduction of production costs

Aviation Supply Side

- Infrastructure –supply side aspects
(includes airport/runway and airspace capacity, airport access, personnel, airport entertainment)

Scenario B: airport constraints for environmental reasons

Reasons:

- regulations from governments on emissions
- less infrastructure projects and investments

Scenario C: new efficient, high performance airports according to the regions, able to operate very large aircrafts and the new generation of supersonics

Reasons: new generation of airports built between 2020 and 2050 are commercial and cultural megacenters in the northern hemisphere, airport access improved

- new efficient, high performance airports and airspace
- no impacts on airport neighbourhood
- airport + airspace integration
- no funding problems (high GDP)
- progress in ATM: high traffic density en route and at approach and departure, space-based navigation and surveillance with high precision

- Aircraft (includes new concepts, special in-flight „entertainment“ , avionics, performance, operating economies)

Scenario B: small switch to ecological AC technology regarding noise and pollution

Technology motivated by route and load factor efficiency and reduced environmental impacts

Reasons: legislation pushes technology, less emissions - less restrictions

Scenario C: increased seat pitch (this does not appear to be consistent with the other Scenario C descriptors – added after the workshop)

Reasons: demand reached saturation - more is not manageable

Transport (business, freight, private, military)

- Travel time

Scenario B: choice between long wait and travel time for ecological benefits or higher prices

Reasons: split world - according to the personal values ecological or time efficiency, in AT ecological aspects have a strong impact on timing and routing

Scenario C: different travel time budgets => fast or entertaining travel opportunities

Reasons: growing market for travel from the affluent classes with leisure/business demands.

- Travel costs

Scenario B: high costs, financial constraints are based on regulation, charges and taxes

Reasons: polluters (airline, engine manufacturer, airframer...) pay charges according to their pollution rate, policy pushes technology with emission standards, air transport industry is forced to introduce newest technology to gain a competitive edge, ecology becomes more a key success factor in transport

Scenario C: affordable prices for normal trips, high prices for fast trips with service

Reasons: different travel opportunities depending to different travel cost budgets, new market options for customers, strong contest between airlines

- Infrastructure (demand related)

Scenario B: Some improvements in infrastructures

Reasons: restricted conditions (policies, prices, demand) forced to improve the interface between all transport modes, network efficiency for environmental reasons is the main goal

Scenario C: integrated and intelligent solutions, strong customer orientation, high tech support according to the regions

Reasons: effective networks of infrastructure (safety, access, interconnectivity) are available, specific airport infrastructure for large aircrafts only provided by the largest hubs in Europe, America and Asia

- Modal split

Scenario B: modal split favours ground transport for short and mid-range distances

Reasons: according to the regions short and mid range flights have been shifted to ground transportation, travel optimisation systems support an optimum modal split according to the clients' criteria: either the most ecological, fastest or cheapest transport, ground transport is much cheaper

Scenario C: capacity driven (high) intermodality

Reasons: customer friendly, efficient

AT Technologies

- Airframe/engine technology

Scenario B: green technologies

Reasons: split world: demand change and regulations support new whispering and clean engines and new materials (life-cycle more important), innovation flagships of the AC industry are too expensive for the poor regions

Scenario C: improvements and evolutionary developments: VLA, Flying Wings, ultra-high speed engines, some improved supersonic AC and efficient slower turbo-props, green fuels enter the market, mainly larger aircrafts, very large aircrafts serve the long-distance

Reasons: investments in a booming air traffic market and increased competition of air frame and engine producers

- CNS/ATM

Scenario B: slot preference for green fleets and collision avoidance systems are in place

Reasons: better management according to safety and ecology is a market factor

Scenario C: new concepts, ecologically optimized routing, free flight is standard and authorised, still some inefficiencies due to high air traffic volume, reduced military airspace, strong improvements in the third world, improvements in operational procedures

Reasons: pressure by traffic volume, improvements in technology, investments in a booming air traffic market

- Airport design

Scenario B: airport design changes according to demand pattern from "hub-and-spoke" - principle to the "point-to-point" -service

Reasons: lack of demand and investments, high prices, strict regulations

Scenario C: new airport design according to the need of high demand and new ac concepts with some constraints (what kind of constraints: potential for new airports: vicinity safety and air quality or acceptance? - added after the workshop)

Reasons: new aircraft concepts, increase in efficiency / capacity, different facilities are a competitive factor

- Alternative transport modes

Scenario B: small substitution related to economic development and investments

Reasons: ecologically correct has also to be economically justified

Scenario C: high demand with competition between the modes, some substitutions of air traffic by high speed ground transport

Reasons: policy support, network effects, city centers, demand characteristics, costs

Effects of Emissions from Aviation on Ecology

- Noise effects

Scenario B: noise is only a minor problem

Reasons: slight improvement in technology (whispering aircrafts), less air traffic

Scenario C: new airports and better land use reduce noise, but it is still a problem

Reasons: perception in the vicinity of airports, higher traffic volume, only evolutionary improvements in noise technology

- Effects from gaseous emissions from subsonic aircrafts at cruise altitudes

Scenario B: minor problems

Reasons: no technical solutions for subsonic emissions, subsonic flights are banned from the stratosphere, effects on climate change underestimated today, supranational solutions came too late, damages mostly irreparable

Scenario C: Subsonic emissions reduced, NOX reduced by 50 % compared with 2000, sulfur at very low level

Reasons: optimum routes, investments of energy industry

- Effects from gaseous emissions from supersonic aircrafts

Scenario B: minor problems

Reasons: very few supersonic flights which fulfil strict emission and noise criteria are permitted

Scenario C: minor problems

Reasons: small fleet of supersonics (bigger fleet produces H₂O-emissions above the tropopause – maybe a subscenario is necessary), low environmental effects because of technology development requirements

- Local air quality related emissions

Scenario B: sensitivity increases

Reasons: air pollution declines, society's sensitivity increases, people are better informed about the links between pollution and health problems as new immune deficiency, respiratory diseases and allergies increase in all social groups

Scenario C: some constraints due to local air quality, according to individual airports, airport neighbours and time

Reasons: according to global regions the people's sensitivity is low or high, different airports have different traffic volume, at some airports night traffic is allowed

Special System Effects

- Safety

Scenario B: safety problems are not eliminated

Reasons: safety is as important as ecology

Scenario C: safety is a big issue, therefore some constraints

Reasons: no reasons

5.5 Influence - and consequence analysis

In the second afternoon session of Tuesday the participants of the Scenario Workshop started the group work on influence of the developed "background" scenarios on the demand in aviation, resulting air transport and related emissions and on step 6 of the scenario process, the "consequence analysis" for/of the stakeholders and participants. The details for the group work were fixed during an opening plenary discussion.

As reported in an introduction given by the moderator, in a typical consequence analysis the participants should try to assess, what the scenarios and their outcome could mean for the different stakeholders and actors in the research field. One typical goal is to identify future opportunities and threats within the different scenarios and to develop action items, which maximise opportunities and turn risks into opportunities.

The plenum discussed if it was a sensible approach to split up the participants into groups, which represent the main actors (airframe/engine manufactures, ATM service providers, airlines, regulators/politicians and research), and let these groups assess the scenarios for these participants. It was recognised that the wide-ranging stakeholder community involved in addressing the aviation emissions problem prevented application of conventional "consequence analysis" techniques. Considering the time limitations of the workshop and the fact, that the named actors will want and have to do that analysis by themselves, the participants finally agreed to concentrate the group work to following three main questions:

1. What kind of demand results from the scenarios?
2. What are the requirements for aviation?
3. What does it mean in terms of emissions?

As a support for further work on the "consequence analysis" the moderator explained, for the example of an airframe manufacturer, what this step 6 of the Scenario Techniques could mean. By analysing the designed scenario long-term development for the descriptor "Mobility needs of society" possible first principal consequences can be elaborated for the mobility concept of the manufacturer. Based on that output, the resulting opportunities and risks can be deduced and finally possible "action items" as a result of the analysis on the consequences of the designed scenarios can be formulated.

For the group work the task was given to the existing four working groups, to answer the defined questions for the accepted scenarios A and D, respectively for the external (*Demography, Macroeconomics, Energy/Resources, Social Trends/Mobility Patterns, Ecology, Non-Transport Technologies, Policy/Regulations*) and internal (*Transport in general, Transport/Air Transport Technologies, Aviation Effects on Ecology, Aviation Supply Side, Special System*

Aspects of Aviation) fields of influence for the future air transport. No discussion on best descriptors for air transport demand / air transport and related emissions was performed in the plenary. The groups decided during their work, which descriptors for the central field of the scenarios – air transport demand and air transport as well as related emissions – are the most meaningful.

The outcome of the process is described in the following:

Influence of the extreme “Background” Scenarios A and D on air transport demand/ air transport and related emissions – Resulting requirements for aviation

- Consequences of scenario A, external aspects:
 1. demand
 - medium decrease of traffic pax
 - strong decrease of flight movements
 - very strong decrease of short distance trips
 - medium decrease of medium distance trips
 - in balance no change in total volume of long distance trips
 2. requirements for aviation
 - AT needs to be energy efficient / has to turn into a kind of sustainable aviation
 - there is no need for new infrastructure or new capacities
 - the size of airplanes will be much bigger than today
 3. AT emissions
 - medium decrease of the total volume of emissions
 - strong decrease of emissions per seat

The group added, that this scenario might lead to a kind of future, where only one long distance flight a year is allowed per person and that people and politicians need to be aware of the risks to aviation in that scenario, because only a strong agreement could lead to the necessary acceptance of such kind of intensive policies.

- Consequences of scenario A, internal aspects:
 1. demand
 - reduced demand and changed pattern (less leisure flights?)
 - reduced number of new aircrafts – life extended for existing a/c
 - journey time increases (less direct routes => more transfer -> maybe less demand)
 - high travel costs => reduced demand – only the rich will travel
 - reduced demand for all transport modes, most reduction in air transport
 2. requirements for aviation
 - low demand for aircrafts, less production of aircrafts
 - “Greener” aircrafts
 - possible shift to larger a/c, flying less frequently
 - reduced demand for short-haul aircrafts
 - low investments in infrastructure and AT technology
 3. AT emissions
 - low technology improvements in noise and emissions
 - less total emissions and noise because of less flights
 - higher emissions because of flying lower altitudes
 - emissions fall around airports
 - reduced local emissions, but may not benefit global emissions
 - emissions rise at accident sites only

The group that analysed the influence of the internal descriptors on the demand, requirements and emissions pointed out that in scenario A there are several inconsistent influences, which at the bottom line reduce their effects.

- Consequences of scenario D, external aspects:
 1. demand
 - slight increase of population, e-commerce, education and social structure lead to an dramatic increase of regional and interregional passenger and freight traffic (with regional differences), even if virtual reality will substitute trips
 - average stage length increases (p-km >> p, freight >> passengers)
 - climate has no direct effect on demand, but indirect over the costs
 - working patterns lead to an increase of demand for faster modes
 - hedonism leads to an increase of leisure travel, specially on long distances
 - global business also increases the demand for longer distances
 2. requirements for aviation
 - more and different kind of aircrafts are needed (large, small, more comfort, special freighters)
 - AT needs to be less polluting and less noisy
 - more airports are needed
 - better ATM needed (harmonisation)
 3. AT emissions
 - impressive success of emission reducing technology is needed

The group added, that this scenario would be a big challenge.

- Consequences of scenario D, internal aspects:
 1. demand
 - wanted: more comfort, speed, punctuality as well as larger airports => easy travelling
 - wanted: fast for business, easy and economical for fun travel, luxury travel
 - long term consistency and top companies in research
 2. requirements for aviation
 - AT has to be balanced with other transport modes
 - high investment of industries and engineering, fund to develop new technologies
 - new airports
 - better management for air space using better CNS/ATM
 - technical ATM progress, implemented, handling more traffic for punctuality
 - all kind of a/c for different demand
 - ultra high bypass engines, which are more efficient
 - supersonic aircrafts for business travel
 - co-operation of airlines for better prices
 - new materials
 3. AT emissions
 - H₂O impact from H₂ cryoplanes and some Nox
 - different types of contrails (condensation, bigger crystals)
 - noise effect of supersonics
 - ground effect vehicle
 - reduced emissions NO, CO₂– contribution from aviation to global warming not a problem

The group added, that this scenario would need H₂-supply (maybe in form of H₂ power plants).

Because of time limitations the groups had to stop their work during the afternoon of the second day. It was agreed, to examine this step in further work also for the scenarios B & C, as soon there is an agreement about the related storylines.

5.6 First conclusions

After the four Working Groups had finished their break-out sessions a discussion started on first impressions of the workshop participants

- (1) on the outcomes of the workshop
- (2) what might be adequate further steps.

(1)

The participants gave a generally positive response to the workshop, especially from the work within the groups. They agreed, that the raw material for a useful range of possible, logical and constrained scenarios for the year 2050 was developed and one main task of the scenario activity was finished. But it might be useful to review again the results elaborated so far and to modify and add where needed. This would be one of the tasks for further work. There was also a general agreement, that the designed long-term scenarios, developed in the two workshops, need to be quantified to support strategic planning in aviation industry (future aircraft design, airport technologies, infrastructure), scientific research work as well as for political decision making to develop adequate policies for the aviation sector. There was some concern that some aspects of the scenarios might not be as extreme as possible and that harsher scenarios could be envisaged. This point would need to be considered further as part of the follow-up work, together with the "Wild Card Analysis", the still outstanding step 7 of the Scenario Design Process.

Further on it was agreed, that findings of relevant external activities should be taken into account for the final versions of the scenarios. Especially the new IPCC Emissions Scenarios from the year 2000 should be taken as an important reference, but also the IPCC report on the "Impact of Aviation on the Atmosphere" (published in 1999, most important FESG-scenarios) and the new European activities (see (3) and (5.1)) should be carefully considered.

The participants felt that it was too early to finally assess of the question, whether the chosen four scenarios will be an adequate basis to assist for aviation stakeholders for their long-term strategy, before having more intensively reflected the outcomes of the workshop during the follow up-phase and without having performed the missing steps of the Scenario Design Process and eventually a quantification of the qualitative results during the further steps of the project. It was decided, that this important issue should be discussed again before the next steps of the project will be fixed. The participants agreed that, anyway, much still had to be done to complete the AERONET scenario work. The participants agreed that a third workshop might be necessary and worthwhile.

(2)

At the end of the workshop the participants discussed the follow up of the workshop. It was agreed that a final report on the workshop should be made available as a draft per e-mail to the participants and then be modified using the comments from the participants. The facilitator, Mrs. von Reibnitz, took the task to draft an interpretation of the scenarios A-D, to be added to the draft final report for discussions. The Core Team took the responsibility to prepare the final report. Finally, thanks and much applause were given to the moderator(s) for their professional work.

6. Follow up after Workshop II

More detailed and pronounced storylines for the four Scenarios were designed after the workshop by the moderator. These more descriptive storylines (modified storylines for the

two extreme scenarios A and D and new storylines for the two intermediate scenarios B and C) are included in this report for review by participants. The final version is planned to be distributed in early July. Comments on these creative and comprehensive interpretations are requested by e-mail, having in mind, e.g., the summarised characteristics, that should be taken into account for the design of useful long-term projections.

The modified storylines for the scenarios A and D and the drafts for new scenarios B and C are both attached as Annex 6.

7. Planning of further steps

7.1 Proposal for a EU – Project

As has been agreed, the first part of the AERONET Project is to design a set of scenarios for the long-term development of aviation and its emissions, which can be used as basic information for the long-term strategic planning of stakeholders in aviation. This should be undertaken through a series of 2-3 workshop.

The outcome of this work should be qualitative storylines for a set of scenarios and – as far as possible – some first quantification. This work should be finished in 2001.

The results of the workshop period should be taken forward through a European study team to develop quantification for the scenarios designed by the workshops and to elaborate the details needed to achieve the objectives of the AERONET Scenario activity. This work should be started in 2002.

To be able to realise this plan, a group of appropriate interested European experts should form a team, which should elaborate a proposal for the European Commission to be submitted in September 2001. Detailed discussion on content and detailed work structure of this study should be started during a meeting at the end July / early August based upon a first outline prepared by the Core Team.

So far, DERA, DLR, EADS/Airbus, Lufthansa, NLR have expressed an interest to discuss the scope, content and participation in an EU funded project.

7.2 Possible work until the start of the proposed EU funded Project

Until mid September all activities will be concentrated on preparation of an appropriate proposal. If accepted, the EU funded Project would probably start in early 2002. The time until the possible start of the EU Project should be used as far as possible, to broaden the knowledge and expertise needed for the project.

Useful parts of this work could be e.g.:

- Further improve of the quality of the representative set of four (?) qualitative scenarios;
- Further investigate details of relevant external activities, especially the IPCC Emission Scenarios, consult with IPCC SRES experts where appropriate;
- Examine and utilise the ICAO/CAEP/FESG scenario work;
- Further improve knowledge of models, which might be used during the EU Project.

The list of work until the start of the proposed EU Project will be fixed after a proposal has been submitted (in mid September 2001).

ANNEX

Agenda

Second AERONET Scenario Workshop on the long-term development of aviation and its emissions

19/20 March 2001, Airport Palma de Mallorca, Spain

Monday, 19 March, Morning Session

Setting the scene

- 9:00** **Welcome and logistics**
Airport Director;
Winfried Dewes, AERONET, DLR;
Roger Gardner, AERONET, DERA
- 9:10** **Introduction:**
Top level goals of Workshop II, Overview of Workshop I
Alf Schmitt, DLR
- 9:30** **Relevant external activities**
Roger Gardner, AERONET, DERA
- 9:40** **Work plan for the AERONET Scenario Project:**
Workshop II, subsequent study work
Alf Schmitt; DLR
- 9:50** **Why produce scenarios?**
Moderator, Ute Helene v. Reibnitz
- 10:10** **Scenarios need and use:**
Expectations, pin board, discussion
Workshop plenary
- 10:45** **Break**
- Review of the two extreme Scenarios for the environment of aviation, developed during Workshop I*
- 11:00** **Summary description, explanation of reasoning**
Ute Helene v. Reibnitz
- 11:30** **Review and appropriate revision**
½ hour group work, plenary review and agreement
- 12:30** **Lunch**

Monday, 19 March, Afternoon Session – Tuesday, 20 March, Morning Session

Design of four qualitative scenarios for aviation and related emissions

14:00
emissions

Agreement on scenario descriptors of aviation and related
Group work, plenary

15:00-
scenarios
ca.18:30

Definition of aviation scenarios A & D based on the two extreme
for the environment of aviation
Group work for AT factors, plenary review

19:00

Buffet

Tuesday, 9:00
consolidated

Definition of intermediate scenarios B & C:
Overview of objectives, environment factors, AT factors,
scenarios
Group work, plenary review

12:30

Lunch

Tuesday, 20 March, Afternoon session

Review and analysis of consequences for scenarios A-D

14:00

Review of scenarios A-D:
Brief summary, consideration of validity, discussion and acceptance
Plenary

15:00

Break

15:30
check

Consequence analysis:
Role of consequence analysis for AT community, use to verify and
the scenarios, example cases
Ute Helene v. Reibnitz, Plenary

Review of workshop and next steps

16:30

Summary of achievements, revisit the work plan, schedule and
commitments
Plenary

17:00

Close

Due to decisions of the workshop community, details of the Agenda can be subject to change.

	Name		Organisation		Telephone:	Fax:	e-mail:
1	Berghof	Ralf	DLR	D	0049-2203-601 3180	0049-2203-601 2377	ralf.berghof@dlr.de
2	Blommers	Andries H.	TNO	NL	0031-703607062	0031-703234193	ah.blommers@wxs.nl
3	Celikel	Ayce	EUROCONTROL	F	0033-1 69 88 78 41	0033-1 69 88 72 11	ayce.celikel@eurocontrol.fr
4	Champion	Irena	DLR	D	0049-2203 601 2676	0049-2203-66509	irena.champion@dlr.de
5	Dewes	Winfried	DLR	D	0049-2203 601 3632	0049-2203 66509	winfried.dewes@dlr.de
6	Dunker	Reiner	European Commission	EU	0032-2 296 1608	0032-2 296 6757	reiner.dunker@cec.eu.int
7	Dussoye	Sunjay	DFS	D	0049-6980544213	0049-6980544219	sunjay.dussoye@dfs.de
8	Falk	Robert	DTI	UK	0044-20 72 15 1392	0044-20 72 15 1180	robert.falk@dti.gsi.gov.uk
9	Gardner	Roger	DERA	UK	0044-1252 374426	0044-1252 372477	rmgardner@dera.gov.uk
10	Grundstroem	Reidar	Swedish CAA	S	0046-11 19 2215	0046-11 19 2660	reidar.grundstrom@lfv.se
11	Kalivoda	Manfred	PsiA-Consult	A	0043-1 865 6755	0043-1 865 675516	kalivoda@psia.at
12	Kies	Angela	DFS	D	0049-6980544277	0049-6980544219	angela.kies@dfs.de
13	Klug	Heinz G.	EADS Airbus	D	0049-7437 2580	0049-7437 4751	heinz-guenter.klug@airbus.dasa.de
14	Kornstaedt	Jürgen	Airbus Industrie	F	0033-5 62 11 05 69	0033-5 61 93 49 08	juergen.kornstaedt@airbus.fr
15	Kudrna	Monika	PsiA-Consult	A	0043-1-8656755	0043-1-8656755-16	kudrna@psia.at
16	Madden	Paul	RR plc	UK	0044-1 332 249 184	0044-1 332 245 654	paul.madden@rolls-royce.com
17	Marizy	Corinne	EADS Airbus SA	F	0033-5 61184564	0033-5 61 18 57 66	corinne.marizy@airbus.aeromatra.com
18	Meister	Dietrich	EADS Airbus	D	0049-421 538 2348	0049-421 538 3978	dietrich.meister@airbus.dasa.de
19	Melgar	Tomas	Airp. Palma de Mallorca	SP	0034-971 789 298	0034-971 789 555	pmi.tmelgar@aena.es
20	Menor	Mariano	Airp. Palma de Mallorca	SP	0034-971 789 010	0034-971 789 555	pmi.mmenor@aena.es
21	Middel	Jan	NLR	NL	0031-20 511 3559	0031-20 511 3210	middel@nlr.nl
22	Middelmann	Alvaro	MIDDELMANN I.M.S.&C.S.L.	SP	0034-971 434044	0034-971 434656	alvaro@middelmann.com
23	Palsson	Anette	FFA / FOI	S	0046-8 5550 4507	0046-8 25 34 81	anette.palsson@foi.se
24	Ripplinger	Thomas	MTU	D	0049-89 14 89 4512	0049-89 14 89 99624	Thomas.Ripplinger@muc.mtu.de
25	Savary	Elisabeth	DGAC	F	0033-0158 09 48 76	0033-01 58 09 49 52	savary.elisabeth@dtg.dgac.fr
26	Schmitt	Alfons	DLR - Scient.WS-Orgns.	D	0049-2203 601 2182	0049-2203 601 2377	alfons.schmitt@dlr.de
27	Taylor	Spencer	Air BP	UK	0044-1932 763633	0044-1932 764010	taylorse@bp.com
28	von Reibnitz	Ute Helene	Scenarios Vision Cons.	F	0033-4 93 58 25 00	0033-4 93 58 68 30	reibnitz.hf@scenarios-vision.com
29	Westerberg	Jan	FFA / FOI	S	0046-708956455	0046-8 253481	jan.westerberg@foi.se
30	Wilken	Dieter	DLR	D	0049-2203 601 2567	0049-2203 601 2377	dieter.wilken@dlr.de
31	Zuniga	Angel	Airp. Palma de Mallorca	SP	0034-971 789 435	0034-971 789 022	pmi.alzuniga@aena.es

Annex 2 – participants

Overview of Workshop I

First block

- Welcome, report on objectives
- Four invited overview reports on the long-term development in environmental fields of aviation:
 - * Economy and population
 - * Ecology
 - * Energy
 - * Total transport/ mobility

Group Work

- Background information on concepts, steps and tools for the design of scenarios
- Recent scenarios of IPCC (SRES)
- Step 1 (Task analysis): Subject is aviation and its emissions; agreed scenario horizon: 2050
- Step 2 (External Influence Analysis):
For seven external fields and five more internal areas altogether 43 most important drivers and key factors were identified

Overview of Workshop I

Group Work (2)

- Step 3 (Projections): Two extreme or boundary projections for the development until 2050 were defined for each descriptors
- Step 4 (Clustering): The alternative projections were assembled to two internally consistent sets, defining scenarios A and B
- Discussion on results, agreement on further steps

Workshop Follow-up

- Step 5 (Interpretation of scenarios): Comprehensive storylines for both scenarios (A, B) were elaborated by Mrs. Ute Helene von Reibnitz, and reviewed by workshop participants
- Report of the Workshop distributed in January 2001

Top level goals of Workshop II (1)

- Refinement of the two extreme scenarios (called now A and D) for the environment of aviation, developed during Workshop I
- Design of four scenarios for aviation and related emissions
 - based on the two extreme scenarios A and D, for the environment of aviation, design of two scenarios for aviation
 - design of two complete new „intermediate“ scenarios for aviation and its environment
- Discussion on the role of a consequence analysis for the AT community
- Review of workshop results
- Principal agreement on the further steps for the AERONET scenario Project, especially on scope and work plan for the planned quantification stages
- Check other related scenario activities and account for IPCC SRES scenarios

External scenario activity - IPCC SRES

- Major international effort superseding the IS92 scenarios.
- 1990 to 2100 timescale addressed (by decade).
- Extensive demographic, macro-economic and geo-political expertise brought to bear on these scenarios –
- These are the definitive scenarios that the UNFCCC and the international science and policy communities are working to: AERONET should draw upon this underlying information where possible.
- Range of four SRES scenarios - A1, A2, B1 and B2 - A1 and B2 correspond broadly with the intent of the existing AERONET boundary scenarios.

External scenario activity - Eurocontrol

- Planning horizon for ATM activities does not go beyond 2105/2020, details included in Operational Concept Document (OCD) available through the EUROCONTROL website.
- New activity emerging (which will include constraints such as environmental impacts) - Forecasting, Statistics & Data Management (FSDM) which aims to:
 - Realise a seamless link between forecasting and strategic performance analysis;
 - Improve the forecasts using state-of-the-art methods and techniques;
 - Develop a strategic market outlook including scenario driven long term forecast;
 - Improve the efficiency, flexibility and functionality of the forecasting
 - models and the data management system.

External scenario activity - Industry/EAG for EC DGRes

- Title: "Sustainable Air Transport Growth for Europe".
- New 2020 scenario activity aimed at informing EC and EU nations on future investment considerations to secure sustainability.
- Focus is more clearly industrial than the AERONET work which seeks to address a broader community of interests and needs.
- Involves similar expertise to AERONET scenarios work.
- Agreement to maintain close liaison between the AERONET and EAG activities so that outputs are complementary.

External forecasting activity - EC AERO2K project

- Research will generate global 2001/2 and forecast 2025 aircraft emissions inventories.
- Three year project commences April 2001.
- Bottom-up forecasts will "grow" base year traffic by region, flow and traffic type.
- will account for market, economic and technological driver assumptions and effects of regulatory intervention.
- 3D gridded representation of resultant traffic, fuel and emissions.
- Forecasting work involves industry and Eurocontrol.

External scenario activity - ICAO/CAEP work programme

- New emissions work programme will address scope to define long term technology goals to provide industry with a more stable approach to delivering emissions reduction.
- Under auspices of ICAO/CAEP secretariat, forecasts and scenarios with 25 to 50 year horizons will be generated.
- European states will be able to offer work and expertise available through activity such as AERONET scenarios work.

External scenario activity - other work

- International Energy Agency rolling programme of work.
- EC TRADEOFF 2050 and 2100 SRES - compatible scenarios based upon ICAO/FESG methodology with SRES GDP and generating gridded emission databases.
- national scenario activities within Europe geared to states meeting international emissions goal obligations.

Main aviation emissions scenario product already available:

- ICAO/FESG scenarios undertaken in support of the IPCC Special Report on Aviation and the Global Atmosphere.

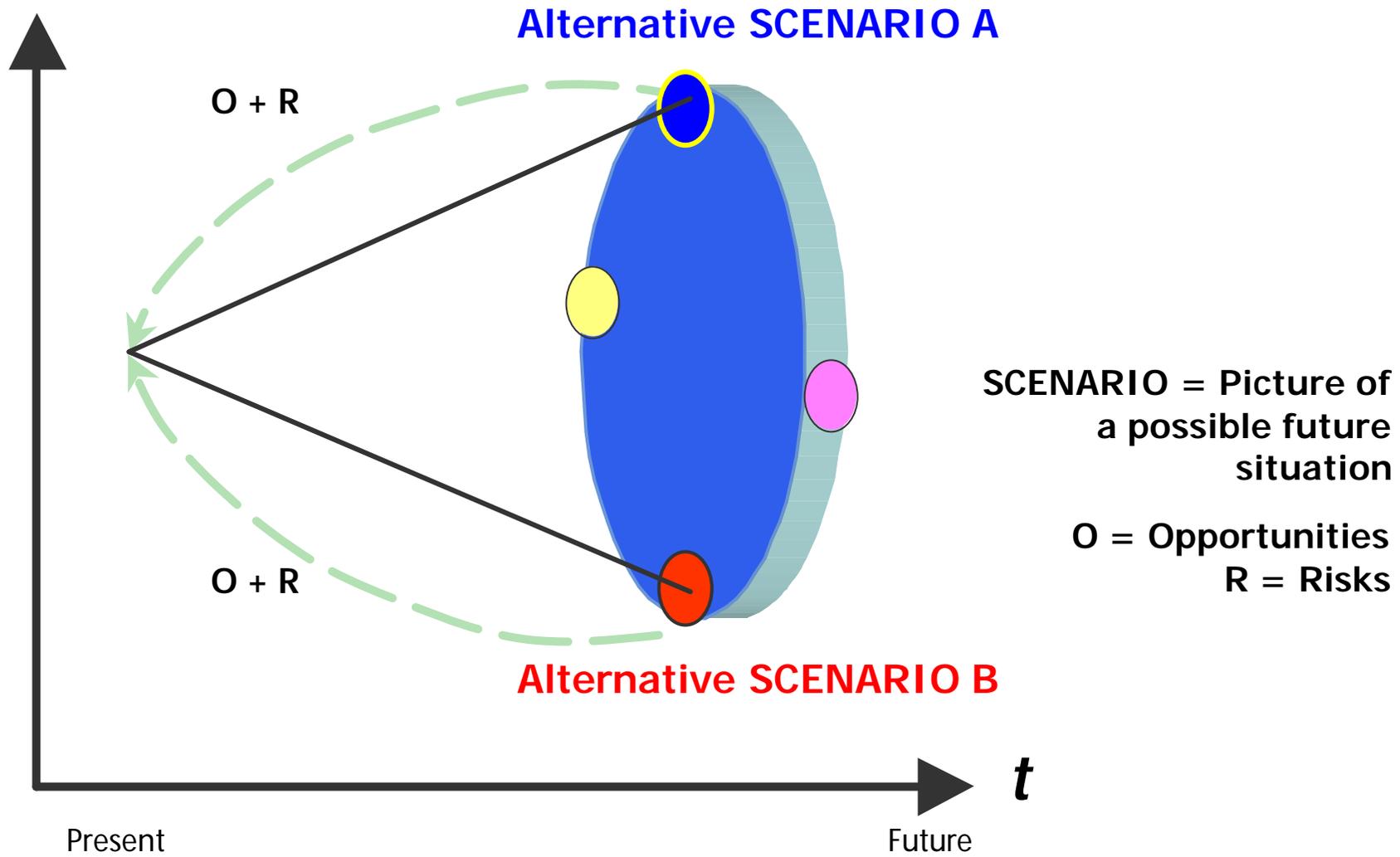
Some remarks regarding the scenarios developed between WS 1 and WS 2

- perhaps too extreme.....we need realistic scenarios
- there is nothing the aviation industry can do to avert scenario A
- that the world treads a more gentle middle path
- a pair of slightly more plausible outer scenarios or more inner range scenarios

Answers

- realistic in a timeframe of 50 years = not in contradiction with natural laws
- the objective is to be prepared and to be able to live up even to so-called extreme futures
- that might be....and we are able to manage this without any scenario-type exercise
- we aim at 4 scenarios .the 2 extreme existing ones A + D and B + C to be developed in workshop 2

Better anticipate than extrapolate



SCENARIO A

MACRO-ECONOMY

- GDP:
- Regionalisation

ECOLOGY

- Greenhouse effect
- Loss of arable land
- Diversity

TECHNOLOGY

- Technology « tamed »
- Consistent with sustainability

**AVIATION
+
EMISSION**

DEMOGRAPHY

- « The boat is full »
- Top education only for the rich

ENERGY

- Renewable resources
- Limited resources for aviation



SOCIAL TRENDS

- Spiritual + sustainable life style
- Stay local

REGULATIONS

- Restrictions on AT + emission vary from region to region

SCENARIO A



SCENARIO D

MACRO-ECONOMY

- GDP growth
- Globalisation = success

ECOLOGY

- Little change
- Actions show effects

TECHNOLOGY

- ICT, e- + m-biz, virtual reality-boom
- Merger of ICT + biosciences

AVIATION
+
EMISSION

DEMOGRAPHY

- Fertility + mortality strongly decreased
- Top education for all

ENERGY

- New energy sources (H₂, fuel cell, ...) + renewable sources



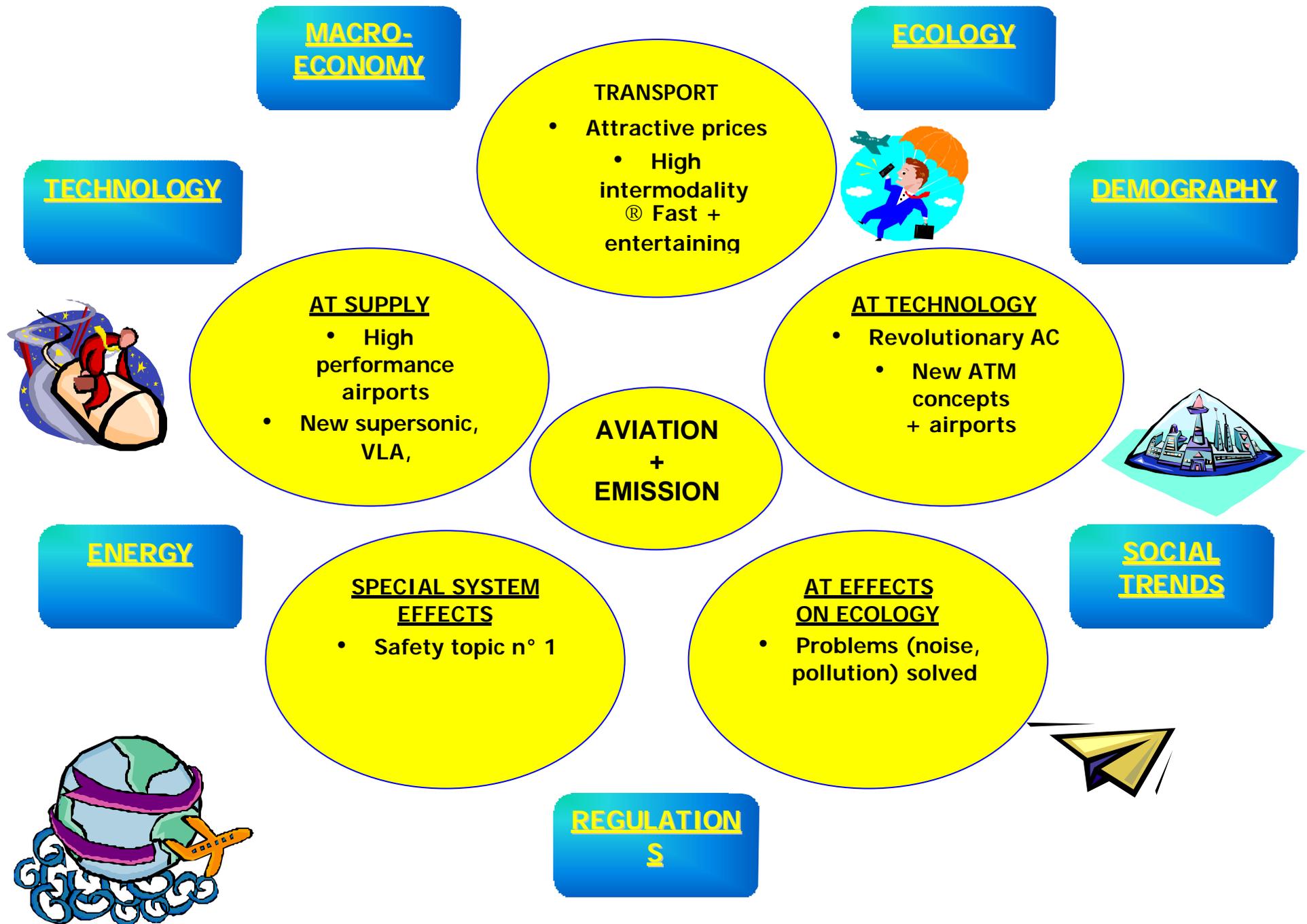
SOCIAL TRENDS

- Virtuality, hedonism + global life style
- Shrinking world

REGULATIONS

- Legislation follows economy and technology

SCENARIO D



SCENARIO A



Macro-economy

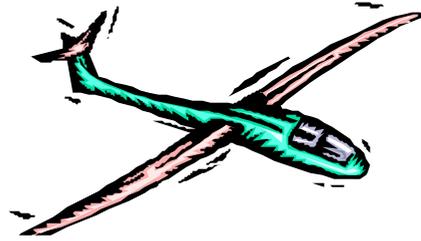


Ecology



Demography

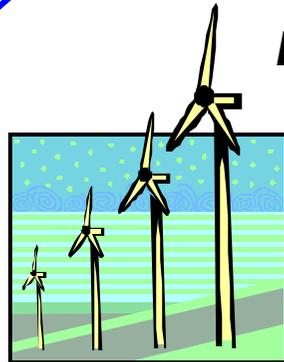
Techology



Social Trends



Energy



Regulations



SCENARIO D



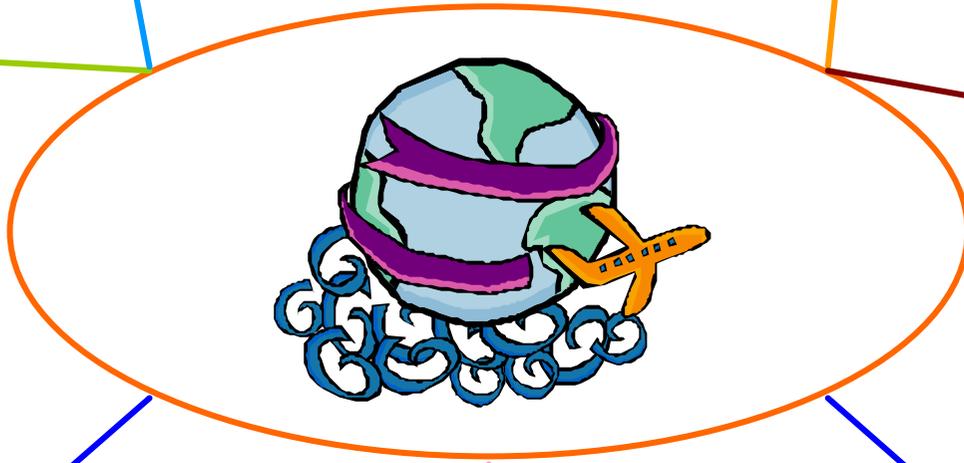
Macro-economy



Ecology



Demography



Technology



Social Trends



Energy



Regulations

