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www.canso.org
ATM Global Environment
Efficiency Goals for 2050

1 Overview

CANSO recognises that it is important that the air traffic management industry has clear goals to help drive achievement and to monitor progress. As part of CANSO’s Imagine 2010 Programme, the CANSO Global Environment Workgroup is focussed on the development of metrics and targets for environmental impact reduction from Air Traffic Management (ATM) to be delivered by 2010. This work has now been further accelerated to assist the ICAO GIACC with its work programme. This CANSO Report will be incorporated into the work of the aviation cross industry group formed to develop aspirational goals for the reduction of global aviation CO₂ emissions to provide to the ICAO GIACC.

ATM’s contribution to reducing climate change can best be achieved by increasing fuel efficiency for aircraft using the ATM system. This Report presents CANSO’s aspirational goals for fuel efficiency improvement based on a review of global information. It has been developed by the CANSO Environment Workgroup with input from ATM efficiency experts around the globe. The scope of the report is limited to fuel efficiency and therefore the optimisation of CO₂ emissions. It addresses other issues only as interdependencies and how they may affect fuel efficiency.

The figures produced in this Report are best estimates given the data available at the current time. CANSO intends to continue to develop the work further to improve global coverage by supplementing it with information from other ANSPs and States when available. Accompanying this paper is a template for ANSPs and States to provide the information necessary for CANSO to further refine the baseline ATM efficiency estimate.

2 Key Conclusions

The results of this Report lead to the following conclusions:

– The Global ATM system is already between 92% and 94% fuel efficient;
– 100% ATM fuel efficiency is not achievable as some inefficiency is unrecoverable due to necessary operating constraints and interdependencies, such as Safety, Capacity, Weather, Noise and fragmentation of the airspace;
– CANSO has estimated the interdependencies relate to half the total inefficiencies in the system;
– The CANSO goal aims to recover all the remaining inefficiency not subject to interdependencies by 2050, resulting in a global ATM system that will be between 95% and 98% efficient;
– The CANSO goal represents savings of 79 million tons of CO₂ per year by 2050 relative to 2005;
– Further efficiency improvement may be possible by reducing the interdependencies;
– ATM efficiency will decrease significantly with increased congestion brought about by traffic growth unless there is a corresponding increase in airport and airspace capacity. The CANSO goal has been set irrespective of any increase in congestion and therefore the effective efficiency improvements are much greater;
– The assessment of current ATM efficiency is consistent with that presented by the IPCC in 1999;
– ATM efficiency improvements may be achieved by introducing a range of initiatives. Some of these can be directly introduced by ANSPs, such as new operating procedures. However, many rely on other participants in the aviation sector.
Acknowledgements

CANSO would like to acknowledge the efforts of the individuals below in contributing to this report. Dave Knorr from the FAA, Tom Reynolds from Cambridge University, Stefano Mancini from Eurocontrol and the members of the CANSO Environment Workgroup.

4 Aspirational Goals for ATM efficiency improvement

<table>
<thead>
<tr>
<th>Year</th>
<th>Global ATM efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Between 92% &amp; 94%</td>
</tr>
<tr>
<td>Goal 1</td>
<td>Between 92% &amp; 95%</td>
</tr>
<tr>
<td>Goal 2</td>
<td>Between 93% &amp; 95%</td>
</tr>
<tr>
<td>Goal 3</td>
<td>Between 95% &amp; 98%</td>
</tr>
</tbody>
</table>

Table 1: CANSO ATM Efficiency Aspirational Goals

CANSO has determined the current efficiency of the global ATM system by consolidating regional ATM efficiency studies from Australia, Europe and the USA using the methodology described below. This shows that the ATM system is already between 92% and 94% efficient.

In the context of this Report, 100% efficiency represents aircraft flying point to point via the optimum trajectory such as the great circle ground track route at the most fuel efficient altitude and speed. Therefore a flight that uses 2% more fuel than the optimum trajectory is considered 98% efficient. In practice 100% efficiency is not possible for a number of reasons such as safety, (i.e. the need to keep aircraft separated by a certain distance or time), weather, capacity, and noise, all of which can be considered as interdependencies and are explained in section 5. However, efficiency improvements are possible by moving towards fuel optimal flight procedures within the bounds of the current interdependencies. Improvements are also possible by reducing the effect of the interdependencies such as increasing capacity and reducing noise restrictions etc.

100% ATM efficiency is not reachable as some efficiency is reserved for the interdependencies such as Safety, Capacity, Weather and Noise

The amount of inefficiency related to the interdependencies has been estimated at half of the total inefficiency and CANSO has set the ATM industry the aspirational goal of recovering all of the remaining recoverable inefficiency by 2050, resulting in a Global ATM system which is between 95% and 98% efficient at that time.

5 Interdependencies

A 100% efficient ATM system would enable aircraft to fly point to point using the fuel optimum route between airports at all times. Inefficiencies are introduced into the system when less than optimal routes are flown and there are a number of reasons why this may be the case. Some of the inefficiency may be recovered by changing practices, but some will remain to enable the ATM system to cope with a number of interdependencies, such as:

- ATM efficiency has already improved since 1999 and plans are in place to modernise regional ATM systems that will bring about further efficiency improvements to achieve the CANSO goals. Work needs to progress to identify ways to reduce the effect of interdependencies on fuel efficiency.

- system, such as institutional change to reduce airspace fragmentation;
ATM efficiency improvements may be achieved by introducing a range of initiatives. Fuel efficiency improvement measures that are planned are described in section 7. Intermediate goals for 2012 and 2020 have been determined taking into account the planned timeframes for the implementation of these initiatives.

It should be noted that congestion plays a large part in the efficiency of the ATM system. ATM efficiency will decrease significantly with increased congestion brought about by forecast traffic growth unless there is a corresponding increase in airport and airspace capacity.

Short-term improvements in efficiency to 2012 are expected to be offset by the growth in congestion caused by the projected increase in aircraft movements. If the industry was to continue with the existing operational environment then the current level of global ATM efficiency will decrease as additional traffic increases congestion. The CANSO aspirational goals aim to achieve the stated ATM efficiency improvements despite current growth forecasts; the overall improvements in efficiency are therefore much greater as illustrated in Figure 2. Further, these improvements come on top of efficiency initiatives already implemented in the ATM system prior to 2005. Assuming that no other aviation fuel efficiencies are achieved, the CANSO goals represent a 4% increase in ATM fuel efficiency to 2050 whilst air traffic quadruples delivering savings of 79 million tons of CO$_2$ per year.
- **Safety** - aircraft will deviate from the optimum route in order to ensure adequate separation between other aircraft nearby.

- **Weather** - to ensure safe and smooth flight, adverse weather systems may need to be avoided.

- **Capacity** - to accommodate capacity limitations either at the airport or within airspace, aircraft may be required to hold prior to arrival, or wait on the ground prior to departure. ATM has influence over the optimisation of available civil airspace capacity, whereas it has no control over airport capacity but is able to influence how it is accommodated. When traffic demand approaches available capacity, congestion increases reducing efficiency as discussed above.

- **Noise** - to reduce noise impact on the ground, aircraft operations around the airfield are subject to noise abatement procedures that may reduce noise but may cause the aircraft to fly a less efficient route or accept sub-optimal altitudes.

- **Airline Practices** – flight planning systems need to have the flexibility to benefit from more optimal routes that may be available.

- **Military** - civil aircraft generally must route around military airspace zones and other types of restricted airspace increasing fuel burn. ANSPs can actively seek cooperation from the military to implement and optimise the Flexible Use of Airspace.

- **Institutional** - aircraft may take less than optimal routes due to fragmented airspace. Different regions / countries may have different operating procedures, charging mechanisms and require specific hand-over protocols that may lead to less than optimum fuel-efficient routing. These may be resolved by political will.

As a result of these interdependencies, illustrated conceptually in Figure 3 (see page 7), it is not possible to reach 100% efficiency. Efficiency gains may be achieved by improving routings and ATM practices, but also by reducing the effect of interdependencies illustrated in Figure 4 (see page 7).

Some of the interdependencies can be directly influenced by ANSPs, such as new operating procedures. However, many rely on other participants in the aviation system, such as airports, airlines, regulators and governments to reduce fragmentation of the airspace for example. Changing the interdependencies may deliver a step change in the recoverable efficiency, as illustrated in Figure 4. One such example is Reduced Vertical Separation Minima, RVSM. Prior to 2002, aircraft flew in altitude bands separated by 2000ft intervals. Because aircraft have an optimal cruise altitude that minimises fuel burn, the 2000ft altitude bands meant that it was not always possible to fly the most optimum route. RVSM reduces the altitude bands to 1000 feet without compromising safety (as a result of a more modern aircraft fleet and navigational aids) and allow aircraft to fly closer to their optimal altitudes. RVSM alone has been estimated to have improved fuel efficiency by 1.8% (Reference 1, page 15).

In addition, it has increased airspace capacity and reduces congestion, delivering a further efficiency benefit.

RVSM is an example where both the Safety and Capacity interdependency effect was reduced increasing the pool of recoverable efficiency. Whilst techniques such as RVSM reduce the interdependency it cannot be reduced to zero.

Another example is noise restrictions. Aircraft operating around airports are generally subject to specified routings designed to limit noise exposure on the ground which may require aircraft to fly longer than optimum routes, reducing efficiency. Quieter aircraft reduces the noise interdependency, which could free up efficiency that could be recovered by flying more direct routes. A consequence of this will be an increase in noise exposure.
Figure 3: ATM efficiency categorisation

Figure 4: Interdependencies and Recoverable Efficiency

Table 2: ATM system efficiency baseline 2005

<table>
<thead>
<tr>
<th>Region</th>
<th>% global aviation activity</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>3%</td>
<td>98%</td>
<td>99%</td>
</tr>
<tr>
<td>EUROCONTROL</td>
<td>28%</td>
<td>89%</td>
<td>93%</td>
</tr>
<tr>
<td>United States</td>
<td>35%</td>
<td>92%</td>
<td>93%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>66%</td>
<td>91%</td>
<td>94%</td>
</tr>
<tr>
<td>Rest of the World</td>
<td>34%</td>
<td>94%</td>
<td>96%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>92%</td>
<td>94%</td>
</tr>
</tbody>
</table>
This is a clear trade off between reducing noise impact and reducing climate change impact. CANSO strongly supports the continued analysis performed by ANSPs to better quantify the recoverable inefficiencies related to the complex interactions between fuel efficiency and safety, weather, capacity and noise etc.

6 Baseline Efficiency

6.1 Overview

In May 2008, the CANSO Global Environment Workgroup initiated a Report to consolidate regional work on ATM’s influence on Aviation’s CO\textsubscript{2} emissions. The objectives of the Report were to:

1. Identify ATM’s global influence on aviation CO\textsubscript{2} in relation to the IPCC’s estimated 6 to 12%;
2. Identify the varying regional contributions: North America, Europe, Asia Pacific, Africa etc.;
3. Identify the efficiency gains possible through design, operation and efficiency improvements.

A draft baseline was calculated in August 2008 (Reference 2, page 15) and has since been significantly updated for this paper. To establish the baseline, CANSO looked at available ATM efficiency studies from Airservices Australia (Reference 3, page 15), EUROCONTROL (Reference 4, page 15) and the FAA (Reference 5, page 15) for their respective regions during 2007. All studies were based on fuel burn and estimated the amount of fuel burnt in excess of that required to fly the most optimum point to point great circle route. Data was consolidated from individual studies and converted into equivalent CO\textsubscript{2} emissions for comparison.

Regional emissions were then compared to overall aviation CO\textsubscript{2}, and a global figure for aviation of 492 MtCO\textsubscript{2} for 2004 determined from the SAGE inventories (Reference 6, page 15). The SAGE data was used to determine the global aviation percentage for the three regions. The three studies represent a total of 66% of global civil aviation.

The estimated efficiency of the ATM system is shown in Table 2 (see page 7), showing that in 2005 the global ATM efficiency was between 92% and 94%. Efficiencies from the individual studies were normalised according to the percentage of global aviation in the region and summed to provide a global assessment.

It should be noted that the EUROCONTROL Report includes all flights passing through CFMU control whereas the FAA data is based on domestic scheduled aircraft operations only, representing nearly 90% of all US operations. The Australian Report covers all commercial aviation. Whilst these datasets utilise different methodologies, there is no overlap between them and therefore no double counting. The Australian Report has shown higher ATM efficiency, which reflects the relatively uncongested airspace in that region.

The studies referred to represent 66% of global aviation and in order to calculate a global efficiency, CANSO has estimated the ATM efficiency of the rest of the world to be between 94% and 96%. This estimate is based on a review of the three regions and the fact that this airspace is relatively uncongested like Australia but without similar infrastructure and procedures for increased flight efficiency. Further improvement of the baseline will be possible by consolidating additional studies from other parts of the world.

Of particular importance are China, Canada, Brazil, Mexico, Japan, and India, which will significantly reduce the influence of the rest of the world estimate.

6.2 Breakdown of total inefficiencies

To explain the baseline efficiency further, the assessment was split into different flight phases to show where the total inefficiencies lie. For the three regional studies only, Table 4 (see page 12) shows the airborne and ground based total inefficiencies. Ground based delay covers inefficiencies in ground movements such as holding at the runway threshold or inefficient taxi procedures.

Each of the three studies further partitioned the airborne inefficiencies into

- Horizontal - covering en route inefficiencies;
Vertical - covering the inefficiencies of climbing out of and descending into airports and
Terminal area - covering the inefficiencies in the terminal manoeuvring area such as delay caused by holding;

This showed that whilst a significant proportion of the inefficiency is in the en route phase, the terminal area is just as important. However, the airborne inefficiencies are all intricately linked and the optimum flight profile should be considered across all the airborne elements rather than any individual element in isolation.

Terminal area inefficiency and ground based delay are largely influenced by airport capacity. ATM’s influence over these inefficiencies is limited to managing where the delay is taken in the flight, for example slowing aircraft en route so that the delay is taken at a higher altitude where fuel burn rates are lower. Emissions can also be reduced by holding aircraft on the ground.

6.3 Comparison with IPCC estimates

In its 1999 Report (Reference 7, page 15), the IPCC estimated that for the current (1998-1999), worldwide aircraft fleet operations, improvements to the ATM system alone could reduce fuel burn per trip by 6-12% provided the necessary institutional and regulatory arrangements have been put in place. That is, the estimate assumes modernisation of the Air Traffic System and no infrastructure constraints. With aviation representing approximately 2-3% of global CO₂ emissions, this suggests that ATM has an influence over no more than 0.3% of global emissions.

The CANSO benchmark for 2005 indicates that the total inefficiency in the Global ATM system is between 6% and 8% after the interdependencies have been taken into account. This is consistent with the IPCC figure as shown in Figure 7 (see page 12).

The CANSO benchmark for 2005, represents an update to the IPCC 1999 figure which takes into account improved ATM fuel efficiency studies and ATM efficiency improvements in the intervening period, such as RVSM, which amounts to 4%. Of the remaining inefficiency half is related to the interdependencies and the CANSO goals aim to recover all of the remaining inefficiency.

The CANSO work presented in this paper is therefore consistent with the IPCC 1999 estimate.

7 Summary of efficiency improvement measures

This section briefly describes fuel efficiency improvement initiatives. In each region we have identified a rough timeframe for implementation and used this information to phase the global goals for efficiency improvement. Independently from these programmes, individual ANSPs are implementing many efficiency improvements at a national level.

7.1 Europe – Flight Efficiency Plan
7.1.1 Description

The Flight Efficiency Plan (Reference 8, page 15) is a joint initiative launched by Eurocontrol, IATA and CANSO in September 2008 to drive immediate efficiency improvements. The five action points of the Flight Efficiency Plan are:

1. Enhancing European en-route airspace design through annual improvements of European ATS route network, high priority being given to:
   - Implementation of a coherent package of annual improvements and of shorter routes;
   - Improving efficiency for the most penalised city pairs;
   - Implementation of additional Conditional Routes for main traffic flows;
   - Supporting initial implementation of free route airspace.
2. Improving airspace utilisation and route network availability through:
   – Actively support and involve aircraft operators and the computer flight plan service providers in flight plan quality improvements;
   – Gradually applying route availability restrictions only where and when required;
   – Improving the utilisation of civil/military airspace structures.

3. Efficient TMAs design and utilisation, through:
   – Implementing advanced navigation capabilities
   – Implementing Continuous Descent Approaches (CDAs), improved arrival/departure routes, optimised departure profiles, etc.

4. Optimising airport operations, through:
   – Implementation of Airport Collaborative Decision Making

5. Improving awareness on performance.
   The implementation of the improvements is expected to bring benefits of approximately 1.5MtCO₂ per year, which equates to just over 1% improvement over the 2005 baseline for Europe. The Flight Efficiency Plan indicates that the greatest benefit is in improved airspace utilisation, in the terminal area / airport operations and goes on to say that ATM on its own can achieve little.

7.2_Europe - SESAR

7.2.1_Description

The Single European Sky Air Traffic Management Research, SESAR, is the European Union’s 30 billion air traffic management modernisation programme.

The proposed SESAR Vision is to achieve a performance based European ATM System, built in partnership, to best support the ever increasing societal and States’, including military, expectations for air transport with respect to the growing mobility of both citizens and goods and all other aviation activities, in a safe, secure, environmentally sustainable and cost-effective manner.

It combines technological, economic and regulatory aspects and will use the Single European Sky (SES) legislation to synchronise the plans and actions of the different stakeholders and bring together resources for the development and implementation of the required improvements throughout Europe, in both airborne and ground systems.

7.2.2_Objectives for environmental impact reduction

The objectives are to achieve a future European ATM System for 2020 and beyond, which can, relative to today’s performance:
   – Enable a 3-fold increase in capacity which will also reduce delays, both on the ground and in the air;
   – Improve the safety performance by a factor of 10;
   – Enable a 10% reduction in the effects flights have on the environment and,
   – Provide ATM services at a cost to the airspace users which is at least 50% less.

7.2.3_Implementation

ATM performance covers a very broad spectrum of aspects, which are represented through eleven Key Performance Areas (KPAs).

One KPA is Environment Efficiency which will deliver its maximum contribution to the environment. As a first step towards the political objective to enable a 10% reduction in the effects flights have on the environment:
   – Achieve the implicit emission improvements through the reduction of gate-to-gate excess fuel consumption addressed in the KPA Efficiency. However no specific separate target could be defined at this stage for the ATM contribution to atmospheric emission reductions.
   – Minimise noise emissions and their impacts for each flight to the greatest extent possible.
Minimise other adverse atmospheric effects to the greatest extent possible. Suitable indicators are yet to be developed.

The aim is that all proposed environmentally related ATM constraints would be subject to a transparent assessment with an environment and socio-economic scope; and, following this assessment the best alternative solutions from a European Sustainability perspective are seen to be adopted.

Local environmental rules affecting ATM are to be 100% respected (e.g. aircraft type restrictions, night movement bans, noise routes and noise quotas, etc.). Exceptions are only allowed for safety or security reasons.

More information about SESAR can be found at http://www.sesar-consortium.aero/

7.3.1_Description

NextGen is a wide ranging transformation of the entire US air traffic management system. It will replace ground-based technologies with new and more dynamic satellite based technology. It is a collaborative effort between the FAA and partners from the airports, airlines, manufacturers, government agencies, state, local and foreign governments, universities and associations.

7.3.2_Objectives for environmental impact reduction

Establish the most cost-effective approach to reducing significant impact of aviation noise and emissions in absolute terms while enabling the future air traffic system to handle growth in demand.

Performance targets, as documented in the FAA Flight Plan include:

- Reduce the number of people exposed to significant noise by 4% each year through FY2011, as measured by a three-year moving average, from the three-year average from calendar years 2000-2002.
- Improve aviation fuel efficiency per revenue plane-mile by 1% each year through FY2011, as measured by a three-year moving average, from the three-year average from calendar years 2000-2002.

For NextGen by 2015:

- Reduce significant aviation noise, and local air quality emissions in absolute terms in a cost-effective way through a combination of new vehicle technologies, cleaner and quiet operations, better land use and alternative fuels.
- Limit or reduce the impact of aviation greenhouse gas emissions on climate change.
- Document effects of particulate matter and global climate impacts understood to levels that allow appropriate metrics and action.
- Determine and mitigate significant water quality impacts.

7.3.3_Selected implementation activities relating to ATM fuel efficiency

See figure 8 on page 13. Further details of these initiatives are available at http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/nextgenplan/
Table 4: ATM system total inefficiency 2007 for Europe, USA and Australia

<table>
<thead>
<tr>
<th>% inefficiency</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airborne</td>
<td>5.5%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Ground based delay</td>
<td>0.9%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Total</td>
<td>6.4%</td>
<td>9.3%</td>
</tr>
</tbody>
</table>

Figure 6: IPCC estimation of Aviation CO₂ influence

Figure 7: Comparison with IPCC 1999 estimate
### ATM Global Environment: Efficiency Goals for 2050

#### Figure 8

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Flight phase affected</th>
<th>Near Term</th>
<th>Mid Term</th>
<th>Far Term*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative Air Traffic Management</td>
<td>Horizontal, Delay, Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Airspace Flow Program</td>
<td>Taxi and Horizontal</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Route Impact Assessment and Resolution</td>
<td>Horizontal</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Yellow</td>
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<tr>
<td>TMA - flight-specific trajectories</td>
<td>Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Improve Special Airspace Management</td>
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<td>Green</td>
<td>Green</td>
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<tr>
<td>Trajectory flight data management</td>
<td>Horizontal</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Manage Airspace to Flow/Trajectories</td>
<td>All airspace decay/Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Full Collaborative Decision Making</td>
<td>Horizontal/Vertical/Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Initial Trajectory Based Operations</td>
<td>Tax and terminal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>RNAV/RNP enhanced departure routes</td>
<td>Tax and terminal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>NY and ORD Area Airspace Redesign</td>
<td>Delay and vertical</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Time based metering (moves delay to more fuel efficient altitudes)</td>
<td>Delay/Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>ADS-B in Gulf of Mexico</td>
<td>Horizontal/Vertical</td>
<td>Green</td>
<td>Green</td>
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</tr>
<tr>
<td>Delegated responsibility for Separation</td>
<td>All</td>
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<tr>
<td>Initial Conflict Resolution Advisors</td>
<td>Horizontal</td>
<td>Red</td>
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<tr>
<td>Point in Space Metering</td>
<td>All</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Increase Capacity and Efficiency Using RNAV and RNP</td>
<td>Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Expand Conflict Resolution via Data Communication</td>
<td>Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Increase Arrivals and Departures at high demand airports</td>
<td>All in low vis</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Improved operations at closely spaced parallel runways</td>
<td>Tax</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Initial Surface Traffic Management</td>
<td>Horizontal/Vertical</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Time Based Metering Using RNAV and RNP Route Assignments</td>
<td>Horizontal/Vertical/Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Integrated Arrival and Departure Airspace Management</td>
<td>Horizontal/Vertical/Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Optimize Runway Assignments</td>
<td>Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Use Data Management to Provide Flow and Taxi Assignments</td>
<td>Tax and Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Reduce Horizontal Separation Standard to 3 miles</td>
<td>Horizontal</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Full Surface Traffic Management with Conformance Monitoring</td>
<td>Taxi</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Use Aircraft Provided Intent Data to Improve Flow and Conflict resolution</td>
<td>Horizontal/Vertical</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

*Far Term designates initial operating capability prior to 2025

#### Figure 9

<table>
<thead>
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<td>User-Preferred Routes (UPR)</td>
<td>Horizontal enroute</td>
<td>Red</td>
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<tr>
<td>ADS-B</td>
<td>All</td>
<td>Yellow</td>
<td>Yellow</td>
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<td>Gate-to-Gate, System Wide Information Management (SWIM), Collaborative Decision Making (CDM)</td>
<td>TMA/Ground</td>
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<tr>
<td>Continuous Descent Approach (CDA)</td>
<td>Vertical</td>
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<tr>
<td>Tailored Arrivals (TA)</td>
<td>Vertical</td>
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<tr>
<td>Green Approaches - Required Navigation Performance (RNP) Approach and Departure</td>
<td>TMA</td>
<td>Green</td>
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<td>Ground</td>
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<td>Speed control - ATM Long Range Optimal Flow (ALOFT) and Maestro</td>
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<td>Airspace Management (SiDS/STARS design)</td>
<td>TMA</td>
<td>Green</td>
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<td>GNSS Approaches</td>
<td>TMA</td>
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</table>
7.4.3_Airservices Australia selected activities relating to ATM fuel efficiency

See figure 9 on page 13.

7.5_Comparison with the CANSO goals

The two modernisation programmes SESAR and NextGen described above have developed an initial set of environmental targets. SESAR has set a target of a 10% reduction in environmental impact by 2025 relative to 2006. NextGen has indicated a 12% reduction in environmental impact by 2025 may be possible.

It should be noted that the environmental goals of SESAR and NextGen are not directly comparable to the CANSO goals presented in this paper because:

- They refer to environmental impact reduction and include noise and air quality impact reductions in their goals whereas CANSO refers to CO₂ efficiency only.
- The measures to reduce impact include ATM efficiency improvements but also airport capacity increases and airframe improvements. The CANSO goals take into account ATM improvements only.
- The goals are regional covering Europe and the US only. The CANSO goals are global.

7.4_Asia-Pacific - Aspire

7.4.1_Description

Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) is a partnership between the FAA, Airservices Australia and Airways New Zealand. The ASPIRE Agreement was signed on the 18 February 2008 with ongoing collaboration leading to the first ASPIRE flight taking place in September 2008.

7.4.2_Objectives for environmental impact reduction

The aim is to work closely with governments, airlines and other air navigation service providers in the region to:

- Accelerate the development and implementation of operational procedures to reduce the environmental footprint for all phases of flight on an operation by operation basis, from gate to gate;
- Facilitate worldwide interoperability of environmentally friendly procedures and standards;
- Capitalise on existing technology and best practices;
- Develop shared performance metrics to measure improvements in the environmental performance of the air transport system; and
- Provide a systematic approach to ensure appropriate mitigation actions with short, medium- and long-term results.

ASPIRE partners have committed to move forward to foster implementation of the program along key Asian and South Pacific routes. ASPIRE believes aggressive action to make real new concepts of operation and take advantage of innovations in aircraft and air traffic management technology are crucial if aviation is to exercise its proper stewardship of the environment.

A series of flights have taken place from New Zealand and Australia to Los Angeles and San Francisco using fuel efficient procedures which have demonstrated savings of many tons of CO₂ emissions.

These flights have made use of fuel efficient ATM procedures such as

- priority clearance from air traffic control for taxiing and departure;
- a priority departure route out of Los Angeles and unimpeded climb through to cruise altitude;
- allowing it to reach its optimum cruise altitude as quickly and efficiently as possible;
- a user preferred route for the most efficient path taking into account winds and aircraft weight;
- real time updates of current weather and wind conditions that allow the flight crew to modify their flight path;
- a tailored arrival procedure

With approximately 156 flights per week between Australia, New Zealand and United States and Canada, the potential annual savings of initiatives such as the ASPIRE Programme are in excess of 100,000 tonnes of CO₂ emissions. More research is needed to determine if the ASPIRE demonstrations can be realised in more congested regions of airspace.
In contrast, the CANSO goals are global, limited to climate change impact (fuel efficiency) and to ATM efficiency improvement initiatives and are therefore lower than the stated goals of these programmes.

8 Glossary

ANSP  Air Navigation Service Provider  
ATM  Air Traffic Management  
CDA  Continuous Descent on Approach  
An arrivals procedure that reduces noise and emissions  
GIACC  Group on International Aviation and Climate Change. A high level group formed by ICAO in 2007 to accelerate its activities on CO$_2$ emissions reduction.  
ICAO  International Civil Aviation Organisation  
IPCC  Intergovernmental Panel on Climate Change  
KPA  Key Performance Area,  
MtCO$_2$  Million tons of CO$_2$ emissions.  
RVSM  Reduced Vertical Separation Minima  
SAGE  System for Assessing Global Emissions  
TMA  Terminal Manoeuvring Area  

9 References

5. Estimation of NAS efficiency – working draft dated 22-Sep-2008, presentation from FAA.  

Appendix 1: Call for additional information

CANSO intends to refine the global efficiency estimates and goals presented in this paper by including ATM efficiency studies from additional ANSPs and States. This will reduce the effect of the assumptions made in the paper and provide a more robust assessment. Below is a list of information that ANSPs need to provide in order to input into this process. Further guidance is available by contacting CANSO.

1. An assessment of ATM efficiency in the ANSP’s controlled airspace.  
   – Ideally this shall be based on fuel burn to be consistent with other inputs but estimates based on track extension could be accommodated.  
   – Similarly the assessment should be for the 2005 baseline or a different year with a projection of any significant change in efficiency to 2005.  
   – An understanding of the scope of the Report, for example if it covers domestic aviation only.  
   – To facilitate an overall assessment the efficiency Report should be broken into the elements shown in section 6.2.  
2. Estimate of CO$_2$ emissions from civil aviation in the ANSP’s controlled airspace. For countries identified in the SAGE(6) report this information can be used to be consistent with other inputs.  
3. A table of efficiency improvement initiatives and when they are expected to occur, similar to those shown in section 5 of this report.  
4. Any caveats or restrictions over the use and presentation of the data.
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CANSO members are responsible for supporting over 85% of world air traffic, and through our Workgroups, members share information and develop new policies, with the ultimate aim of improving air navigation services on the ground and in the air. CANSO also represents its members’ views in major regulatory and industry forums, including at ICAO, where we have official Observer status. For more information on joining CANSO, visit www.canso.org/joiningcanso.

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- NLR
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- NTT Data Corporation
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- Saab Sensis Corporation
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- SITA
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