Organización de Aviación Civil Internacional
Oficina Regional Sudamericana
Décimo Tercera Reunión de Autoridades de Aviación Civil de la Región Sudamericana (RAAC/13)
(Bogotá, Colombia, del 4 al 6 de diciembre de 2013)

Cuestión 2 del Orden del Día: Necesidades y retos mundiales y regionales en la aviación civil

b) Plan Mundial de Navegación Aérea (GANP), Plan Mundial Plan de Seguridad Operacional y mecanismos regionales de planificación e implantación.

Plan Mundial de Navegación Aérea (GANP)

(Presentada por la Secretaría

RESUMEN

Esta nota informativa presenta la nueva edición (Cuarta Edición) del Plan mundial de navegación aérea (GANP, Doc 9750), plan que marca la dirección estratégica del programa de trabajo técnico de la OACI en el área de la navegación aérea mundial.

Referencias

- Duodécima Conferencia de navegación aérea (Montreal, Canadá, 19-30 de noviembre de 2012); y
- Trigésimo octavo periodo de sesiones de la Asamblea de la OACI (A38) (Montreal, Canadá, 24 de septiembre al 4 de octubre de 2014).

Objetivos estratégicos de la OACI:	*A – Seguridad operacional* *C- Protección del medio ambiente y desarrollo sostenible del transporte aéreo*

1. INTRODUCCIÓN

1.1 Un sistema ATM mundial eficaz permite la interoperabilidad y la continuidad en todas las regiones para todos los usuarios durante todas las fases de vuelo. Dicho sistema ofrece niveles convenidos de seguridad operacional, permite operaciones económicas y óptimas, es sostenible desde el punto de vista ambiental y respeta los requisitos de seguridad nacional. En el *Concepto operacional de gestión del tránsito aéreo mundial* (Doc 9854) se establece la visión guiadora de la OACI al respecto, en tanto que el GANP sirve de documento de apoyo para la planificación estratégica. Con base en un proceso exhaustivo de consulta que la OACI llevó a cabo con los Estados y las partes interesadas de la industria y en un examen realizado durante la Duodécima Conferencia de navegación aérea (AN-Conf/12), el GANP se reestructuró y revisó y, además, estará apoyado por herramientas especialmente diseñadas para asistir a los Estados, a los grupos regionales de planificación y ejecución (PIRG) de la OACI, a los proveedores de servicios, a los usuarios del espacio aéreo y a las partes interesadas de la industria.

2. CUARTA EDICIÓN DEL GANP

2.1 Con el propósito de promover un sistema de navegación aérea armonizado a nivel mundial, la OACI preparó la cuarta edición del GANP para ofrecer orientación clara sobre las metas operacionales que sirven de guía y acerca de las tecnologías, la aviónica, los procedimientos, las normas y las aprobaciones normativas necesarias para lograr dichas metas. El GANP establece un marco que permite una implantación gradual de acuerdo con los perfiles operacionales específicos y las densidades de tráfico de cada Estado. Esto se logra mediante la metodología de las mejoras por bloques del sistema de aviación (ASBU), que integra la base del GANP revisado.

2.2 Durante la AN-Conf/12, celebrada en noviembre de 2012, se examinó esta cuarta edición del GANP y se tomó nota de que dicha edición se basa en documentos de planificación anteriores y ofrece un marco mundial de planificación que incluye un plazo en el que se espera que estén disponibles futuras mejoras que los PIRG y los Estados pueden implantar de acuerdo con sus necesidades operacionales. Además, ahí se identifica la necesidad de elaborar normas y métodos recomendados, requisitos de reglamentación, procedimientos y tecnología asociados a las ASBU.

2.3 Los módulos ASBU se complementan con hojas de ruta de comunicaciones, navegación y vigilancia (CNS), aviónica y gestión de la información. Durante la AN-Conf/12 se convino en que los módulos ASBU y las hojas de ruta conexas sobre tecnología forman parte integral del GANP y constituyen un valioso conjunto de herramientas de implantación y que la política y los principios conexos contenidos en dicho plan son de importancia fundamental para el éxito de la planificación mundial de largo plazo de la navegación aérea. El GANP revisado constituye una metodología de planificación estratégica renovable de quince años, en la que se aprovechan las tecnologías existentes y se prevén futuros avances de conformidad con los objetivos operaciones convenidos entre los Estados y la industria. Esto posibilitará la aplicación de estrategias seguras de inversión y ayudará a obtener de los Estados, fabricantes de equipo, usuarios del espacio aéreo y proveedores de servicios el compromiso que se necesita respecto del GANP.

2.4 La implantación de las ASBU se llevará a cabo mediante programas regionales de trabajo hechos a la medida de acuerdo con necesidades operacionales específicas. Los PIRG de la OACI diseñan estos programas de trabajo identificando, primero, las características operacionales de sus áreas homogéneas de gestión del tránsito aéreo (ATM), las principales afluencias de tráfico y los aeródromos internacionales más importantes. A partir de los análisis de estos datos operacionales se determinan las oportunidades para mejorar la eficiencia y luego se evalúan módulos ASBU con el propósito de determinar cuáles de ellos ofrecen las mejoras operacionales que se necesitan.

2.5 Una vez finalizados los análisis operacionales y las implantaciones resultantes, la siguiente etapa exige que se vigile de cerca la eficiencia de la navegación aérea por medio de una estrategia establecida de medición y notificación.

2.6 La cuarta edición del GANP se presentó y aprobó en el 38º período de sesiones de la Asamblea (Montreal, Canadá, 24 de septiembre al 4 de octubre de 2013). Copia del GANP se presenta como **Apéndice** de esta nota informativa.

3. ACTUALIZACIONES DEL GANP

3.1 La Comisión de Aeronavegación de la OACI examinará el GANP como parte del programa de trabajo trienal, y rendirá informe al Consejo al respecto un año antes de cada Asamblea de la OACI. En el informe de la ANC se ofrecerá un examen del progreso mundial en lograr los objetivos del GANP y se considerarán las lecciones aprendidas por los Estados, la industria y los PIRG. Asimismo, en el informe de la ANC se examinarán los posibles cambios en las futuras necesidades de la aviación, el contexto de navegación aérea y otros factores determinantes, y se propondrá ajustar el GANP convenientemente para tener en cuenta estas eventualidades. Antes de presentarse al Consejo, las actualizaciones propuestas se transmitirán a los Estados miembros con fines de consulta. Después de la aprobación del Consejo, el GANP actualizado se presentará ante la próxima Asamblea de la OACI para conseguir el respaldo de los Estados miembros de la Organización.

4. **ACCION SUGERIDA**

4.1 Se invita a la Reunión a tomar nota de la cuarta edición del Plan mundial de navegación aérea (Doc 9750) presentada en el Apéndice a esta nota.

— — — — — — — —

APÉNDICE

PLAN MUNDIAL DE NAVEGACIÓN AÉREA

Doc 9750-AN/963
Cuarta edición – 2013

Plan mundial de navegación aérea 2013–2028

Publicado en Montreal, Canadá

Organización de Aviación Civil Internacional

999 University Street

Montréal, Quebec, Canada

H3C 5H7

www.icao.int

Descargo de responsabilidad

Este informe utiliza información, que incluye datos y estadísticas relacionados con transporte aéreo y seguridad, los cuales han proporcionado terceros a la Organización de Aviación Civil Internacional (OACI). Todo el contenido de terceros se obtuvo de fuentes consideradas confiables y se reprodujo en forma exacta en el informe en el momento de la impresión. Sin embargo, la OACI específicamente no entrega garantías ni declaraciones con respecto a la exactitud, integridad u oportunidad de dicha información y no asume ninguna obligación o responsabilidad que surja de la confianza o del uso de la misma. Las opiniones expresadas en este informe no necesariamente reflejan las opiniones individuales o colectivas o las posiciones oficiales de los Estados Miembros de la OACI.

Nota:

El el informe se utilizan las definiciones de regiones de las Naciones Unidas.

Este documento se centra principalmente en los vuelos comerciales programados puesto que este tipo de tráfico representa más del 60% de los casos fatales.

Los datos de los vuelos comerciales programados se obtuvieron de la Guía Oficial de Líneas Aéreas (OAG).

Visión de la OACI

Lograr el crecimiento sostenible del sistema de la aviación civil mundial.

Nuestra misión

La Organización de Aviación Civil Internacional (OACI) es el foro mundial de los Estados para la aviación civil internacional. La OACI elabora políticas, normas, realiza auditorías de cumplimiento, realiza estudios y análisis, proporciona asistencia y desarrolla capacidad de aviación mediante la cooperación de los Estados Miembros y las partes interesadas.

Objetivos estratégicos 2014–2016

A. Seguridad: mejorar la seguridad de la aviación civil mundial.

B. Capacidad y eficiencia de la navegación aérea: aumentar la capacidad y mejorar la eficiencia del sistema de la aviación civil mundial.

C. Seguridad y facilitación: mejorar la seguridad y facilitación de la aviación civil mundial.

D. Desarrollo económico del transporte aéreo: fomentar el desarrollo de un sistema de aviación civil seguro y económicamente viable.

E. Protección del medio ambiente: minimizar los efectos ambientales adversos de las actividades de la aviación civil.

Plan de 15 años de la OACI que aborda la navegación aérea mundial.

El Plan mundial de navegación aérea (GANP) de la OACI representa la cuarta edición del GANP. Tiene el objeto de orientar el progreso del transporte aéreo complementario y a nivel del sector en 2013–2028 y el Consejo de la OACI lo aprobó por un período de tres años.

El GANP representa una metodología estratégica de 15 años renovable que aprovecha las tecnologías existentes y prevé los avances futuros sobre la base de objetivos operativos acordados por los Estados o la industria. Las mejoras en bloque se organizan en incrementos cada cinco años que se inician en 2013 y continúan hasta 2028 y después. Este enfoque estructurado proporciona una base para estrategias de inversión seguras y generará un compromiso de los estados, los fabricantes de equipos, los operadores y proveedores de servicios.

Aunque el programa de trabajo de la OACI tiene la aprobación de la Asamblea de la OACI por un período de tres años, el Plan mundial ofrece una visión a largo plazo que ayudará a la OACI, los estados y la industria a garantizar la continuidad y la armonización en sus programas de modernización.

Esta nueva edición del GANP comienza por delinear el marco a nivel ejecutivo de los desafíos futuros de la navegación aérea, al igual que la necesidad de un enfoque estratégico, basado en el consenso y transparente para abordarlos.

El GANP explora la necesidad de una planificación de aviación más integrada tanto a nivel regional como de los estados y aborda las soluciones requeridas al introducir la estrategia de modernización de ingeniería de sistemas basada en el consenso de la Mejora por bloques del sistema de aviación (ASBU).

Además, identifica los problemas que se enfrentarán en el futuro inmediato junto con los aspectos financieros de la modernización del sistema de aviación. Además, se destaca la importancia cada vez mayor de colaborar y asociarse a medida que la aviación reconoce y aborda los desafíos multidisciplinarios futuros.

El GANP también delinea los problemas de ejecución que comprenden los módulos de PBN y Bloque 0 de corto plazo y los Grupos regionales de planificación y ejecución (PIRG) que administrarán los proyectos regionales.

Descripciones de los programas de ejecución adoptados por la OACI en capítulo 2 completo, al mismo tiempo que el capítulo final explora el papel del nuevo Informe de navegación aérea de la OACI en conjunto con la herramienta de monitoreo del rendimiento ambiental IFSET.

En siete apéndices se proporciona información complementaria relacionada con la evolución del GANP, documentación de apoyo en línea, descripción detallada de los módulos ASBU y hojas de ruta tecnológicas que respaldan las Mejoras en bloque.

Contenido

Resumen ejecutivo

Abordar el crecimiento y lograr la promesa de la gestión del tráfico aéreo del siglo XXI (ATM)

El marco operativo y económico para el Plan mundial de navegación aérea

Actualmente, el transporte aéreo desempeña un importante papel en el impulso del desarrollo económico y social sostenible. En forma directa e indirecta respalda el empleo de 56,6 millones de personas, contribuye con más de US$2,2 billones al Producto Interno Bruto (PIB) y transporta más de 2.900 millones de pasajeros y el equivalente a US$5,3 billones anuales en carga.

La aviación logra su impresionante nivel de desempeño macroeconómico al servir a comunidades y regiones a través de ciclos claros de inversiones y oportunidades. El desarrollo de infraestructura genera empleo inicial y las operaciones consiguientes de aeropuertos y líneas aéreas generan nuevas redes de proveedores, ingresos de turismo y el acceso a mercados distantes para los productores locales. Estas economías florecientes de comercio y turismo continúan expandiéndose y fomentan un crecimiento regional más amplio y más sostenible.

Por lo tanto, no es un misterio por qué el crecimiento del tráfico aéreo ha desafiado en forma tan sistemática los ciclos de recesión desde mediados de los años setenta, expandiéndose el doble cada 15 años. Resistió estas recesiones precisamente porque sirvió como una de nuestra herramientas más eficaces para terminarlas; una consideración importante para los gobiernos de cada nivel en un entorno económico difícil.

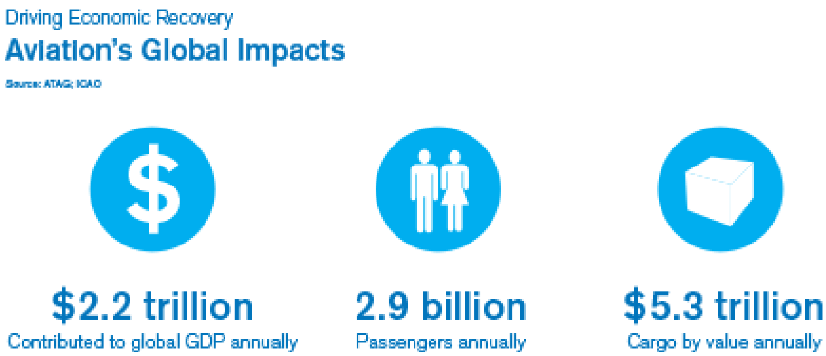
Pero aun cuando la velocidad y la eficiencia del transporte aéreo facilitan significativamente el progreso económico, en determinadas circunstancias, su crecimiento puede ser un arma de doble filo. Si bien por una parte es una señal del aumento de los niveles de vida, movilidad social y prosperidad generalizada, el crecimiento del tráfico aéreo descontrolado también puede originar un aumento en los riesgos de seguridad en los casos en que supera los avances reglamentarios y de infraestructura necesarios para respaldarla.

Para garantizar que el mejoramiento de la seguridad y la modernización de la navegación aérea permanentes sigan avanzando en conjunto, la OACI ha creado un enfoque estratégico que vincula el progreso en ambas áreas. Esto permitirá a los estados y las partes interesadas alcanzar el crecimiento seguro y sostenido, el aumento de la eficiencia y la administración ambiental responsable que las sociedades y economías ahora requieren a nivel mundial.

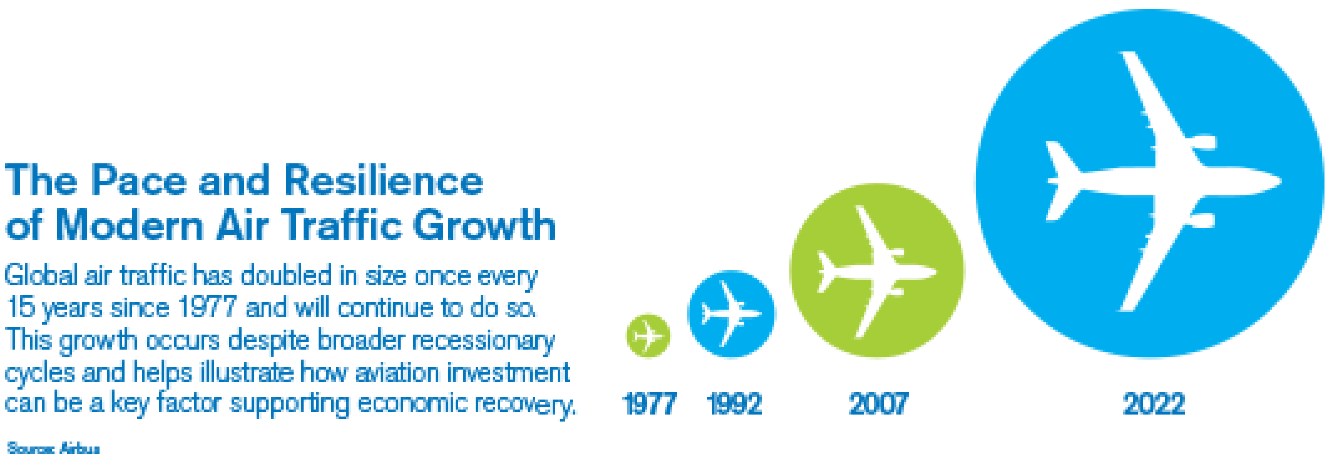
Este es el principal desafío de la aviación mientras avanzamos hacia las próximas décadas.

Afortunadamente, muchos de los procedimientos y tecnologías que se proponen para abordar la necesidad actual de mayor capacidad y eficiencia en nuestros cielos también mejoran muchos factores positivos desde un punto de vista de la seguridad.

Además, las rutas más eficientes que facilitan los procedimientos basados en el rendimiento y la aviónica avanzada sirven para reducir en forma significativa las emisiones de la aviación, un factor clave que respalda las aeronaves modernas con mayor eficiencia en el consumo de combustible, dado que la aviación sigue con su compromiso de reducir completamente sus impactos ambientales.



Driving Economic Recovery
Aviation's Global Impacts
Source: ATAG; ICAO
$2.2 trillion
Contributed to global GDP annually
2.9 billion
Passengers annually
$5.3 trillion
Cargo by value annually



The Pace and Resilience of Modern Air Traffic Growth
Global air traffic has doubled in size once every 15 years since 1977 and will continue to do so. This growth occurs despite broader recessionary cycles and helps illustrate how aviation investment can be a key factor supporting economic recovery.
Source: Airbus

Nuevas capacidades para servir a toda la comunidad de la aviación civil

Proporcionar flexibilidad para los Estados Miembros mediante la metodología de mejoras en bloque de la aviación de consulta y cooperación

La navegación aérea ha experimentado algunos importantes mejoramientos en las últimas décadas, en las cuales varios Estados y operadores han incursionado en la adopción de aviónica avanzada y procedimientos basados en satélites.

Sin embargo, a pesar de estos importantes avances localizados en la ejecución de lo que se conoce como navegación basada en el rendimiento (PBN), una considerable parte restante del sistema mundial de navegación aérea aún se ve limitada por los enfoques conceptuales que surgieron en el siglo XX. Estas capacidades tradicionales de navegación aérea limitan la capacidad del tráfico aéreo y son las causantes del depósito de emisiones de gases innecesarias en nuestra atmósfera.

La solución para estos problemas es un sistema mundial de navegación aérea creado sobre la base de tecnologías y procedimientos modernos basados en el rendimiento. Los planificadores de Comunicaciones, navegación y vigilancia/ Gestión del tránsito aéreo (CNS/ATM) han tenido presente este objetivo durante muchos años. Dado que la tecnología nunca se detiene, la realización de una trayectoria estratégica hacia dicho sistema armonizado a nivel mundial ha resultado esquiva.

La solución para este estancamiento reside en el centro de la principal misión y valores de la OACI. Solo se podrá determinar una solución viable para la navegación aérea del siglo XXI al reunir a los Estados Miembros y a las partes interesadas de cada rincón de la comunidad de la aviación.

Por lo tanto, la OACI inició una intensa ronda de colaboración que incluye el Simposio sobre la Industria de la Navegación Aérea Mundial (GANIS), el primer evento de su clase. Además de la serie de eventos de difusión que lo precedieron y que la OACI realizó en cada región del mundo, el GANIS permitió a la OACI recibir comentarios sobre la que ahora se conoce como la metodología de mejoras por bloques del sistema de aviación.

Las mejoras en bloque y sus módulos definen un enfoque de ingeniería de sistemas mundiales programático y flexible que permite a todos los Estados avanzar en sus capacidades de navegación aérea basándose en sus necesidades operativas específicas.

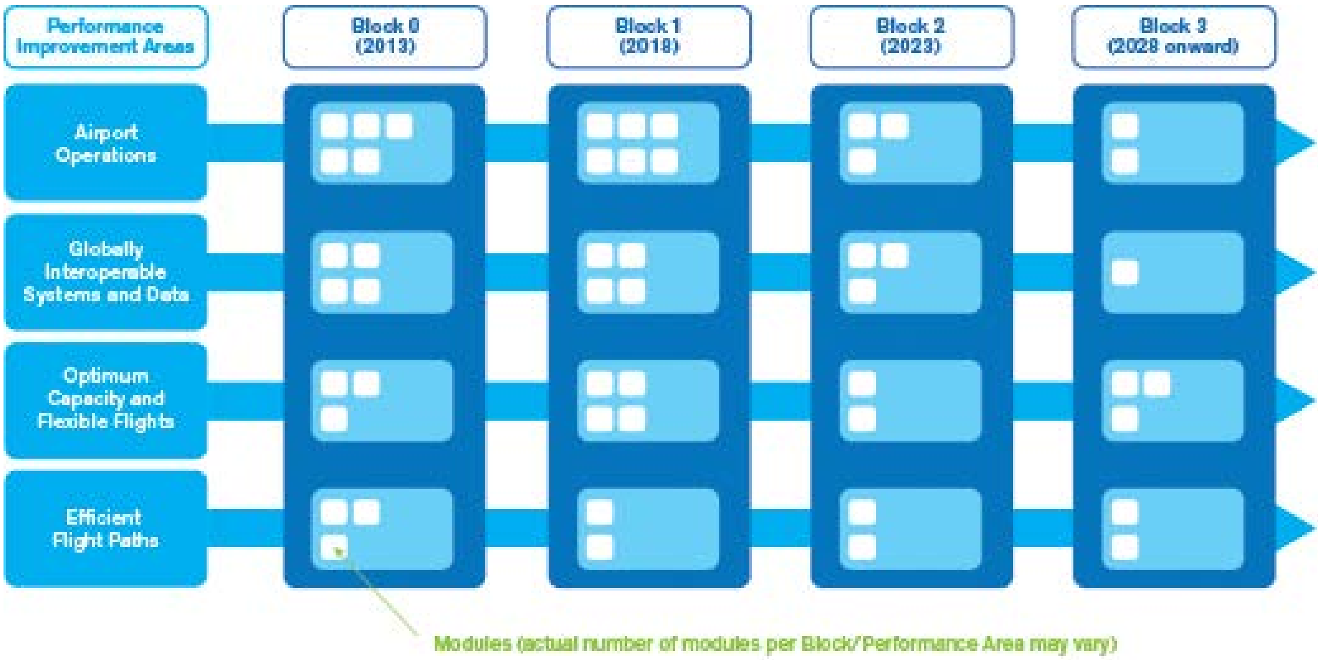
Esto permitirá a todos los Estados y partes interesadas lograr la armonización global, una mayor capacidad y la eficiencia ambiental que ahora exige el crecimiento del tráfico aéreo moderno en cada región del mundo.

Lo que es importante es que la estrategia de mejoras en bloque representa el resultado lógico de la planificación de CNS/ATM y los conceptos encontrados en las tres ediciones anteriores del GANP. Además, garantiza la continuidad del rendimiento y de los conceptos operativos que definió previamente la OACI en manuales y documentos anteriores de navegación aérea.

Para que el sistema de transporte aéreo continúe impulsando la prosperidad económica y el desarrollo mundiales en la medida en que la comunidad de la aviación y el mundo se han acostumbrado, en especial, ante las proyecciones del crecimiento del tráfico regional esperado y la necesidad apremiante de una administración relacionada con el clima más determinada y más eficaz, los Estados deben adoptar por completo el nuevo proceso de mejoras en bloque y seguir una trayectoria unificada hacia el sistema mundial de navegación aérea futuro.

La metodología de mejoras por bloques del sistema de aviación del Plan mundial de navegación aérea es un enfoque de ingeniería de sistemas mundiales programático y flexible que permite a todos los Estados avanzar en sus capacidades de navegación aérea basándose en sus necesidades operativas específicas. Las mejoras en bloque permitirán a la aviación lograr la armonización global, una mayor capacidad y una mejor eficiencia ambiental que ahora exige el crecimiento del tráfico aéreo moderno en cada región del mundo.

Metodología de mejoras por bloques del sistema de aviación de la cuarta edición del GANP



Áreas de mejoras en el desempeño

Bloque 0 (2013)
Bloque 1 (2018)
Bloque 2 (2023)
Bloque 3 (2028 en adelante)
Operaciones aeroportuarias

Datos y sistemas globalmente interoperables

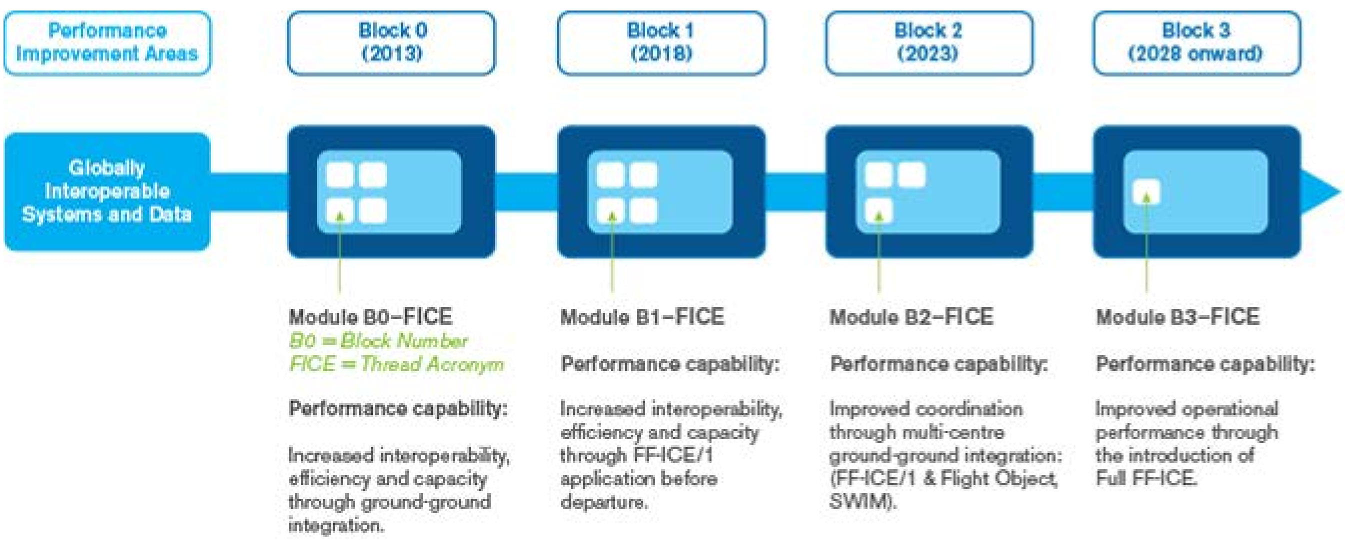
Vuelos con flexibles y con capacidad óptima

Trayectorias de vuelo eficiente

Módulos (el número real de módulos por Bloque/Área de rendimiento puede variar)

Las mejoras en bloque de la OACI (columnas) representan los plazos de disponibilidad previstos para un grupo de mejoras operativas (tecnologías y procedimientos) que finalmente lograrán un sistema mundial de navegación aérea armonizado por completo. Las tecnologías y procedimientos para cada bloque se han organizado en "Módulos" únicos (cuadrados blancos más pequeños) que se han determinado y cotejado sobre la base del área de mejora de rendimiento específica con la cual se relacionan. La OACI ha producido la ingeniería de sistemas para sus Estados Miembros, de modo que solo deben considerar y adoptar los módulos correspondientes a sus necesidades operativas.

Por ejemplo, el Bloque "0" (2013) presenta módulo caracterizados por mejoras operativas que actualmente ya se han desarrollado e implementado en varias partes del mundo. Por lo tanto, tiene un período de ejecución de corto plazo de 2013–2018, donde 2013 representa la disponibilidad de todos los componentes de estos módulos de rendimiento en particular y 2018 representa el plazo de ejecución previsto. Esto no significa que todos los Estados necesitarán implementar cada módulo, pero la OACI trabajará con sus miembros para ayudar a cada uno a determinar exactamente qué capacidades deben aplicar según sus necesidades operativas únicas.



Áreas de mejoras en el desempeño
Bloque 0 (2013)
Bloque 1 (2018)
Bloque 2 (2023)
Bloque 3 (2028 en adelante)

Datos y sistemas globalmente interoperables

Módulo B0–FICE

B0 = Número de bloque

FICE = Acrónimo de serie

Capacidad de rendimiento:

Mayor interoperabilidad, eficiencia y capacidad mediante la integración en tierra.

Módulo B1–FICE

Capacidad de rendimiento:

Mayor interoperabilidad, eficiencia y capacidad mediante la aplicación de FF-ICE/1 antes de la salida.

Módulo B2–FICE

Capacidad de rendimiento:

Mejor coordinación mediante la integración en tierra multicéntrica: (FF-ICE/1 y objeto de vuelo, SWIM).

Módulo B3–FICE

Capacidad de rendimiento:

Mejor rendimiento operativo mediante la introducción de FF-ICE completa.

Se asocia una "Serie" del módulo con un área de mejora de rendimiento específica. Algunos de los módulos de cada bloque consecutivo presentan el mismo Acrónimo de serie, lo que indica que son elementos de la misma área de mejora de rendimiento a medida que esta avanza hacia (en este caso) su objetivo de "sistemas y datos interoperables a nivel global". Cada módulo según el enfoque de mejoras en bloque servirán de manera similar para avanzar hacia una de las cuatro áreas de mejora de rendimiento.

¿Qué significa para mi Estado el enfoque estratégico del Plan mundial de navegación aérea?

Comprender la ejecución de corto plazo y los requisitos de información

El Plan mundial de navegación aérea de la OACI 2013–2028 presenta a todos los Estados una herramienta de planificación completa que respalda un sistema mundial de navegación aérea armonizado. Esta identifica todas las posibles mejoras de rendimiento actualmente disponibles, los detalles de la nueva generación de tecnologías de tierra y aviónica que se implementarán en el mundo y proporciona la certeza de inversión necesaria para que los Estados tomen decisiones estratégicas para sus propósitos de planificación individuales.

Los actuales programas de mejoras de navegación aérea que están aplicando varios Estados Miembros de la OACI (SESAR en Europa; NextGen en Estados Unidos; CARATS en Japón; SIRIUS en Brasil y otros en Canadá, China, India y la Federación Rusa) coinciden con la metodología ASBU. Ahora estos Estados están representando su planificación en los respectivos módulos de mejoras en bloque con el fin de garantizar la interoperabilidad global a corto y largo plazo de sus soluciones de navegación aérea.

El enfoque de planificación de mejoras en bloque del GANP también aborda las necesidades del usuario, los requisitos reglamentarios y las necesidades de los proveedores de servicios de navegación aérea y aeropuertos. Esto garantiza la planificación completa centralizada.

En la AN-Conf/12, se trataron los módulos básicos para implementar como mínimo para respaldar la interoperabilidad global. Estos se definirán en el siguiente trienio y se considerarán en las prioridades regionales que acuerden los PIRGS. A medida que el GANP avanza, se perfeccionará la ejecución de módulos mediante acuerdos regionales en el proceso del grupo regional de planificación y ejecución (PIRG) de la OACI.

El proceso del PIRG además asegurará que todos los procedimientos de respaldo, aprobaciones reglamentarias y capacidades de capacitación que se requieran se encuentren disponibles. Estos requisitos de respaldo se reflejarán en planes de navegación aérea en línea (eANP) regionales elaborados por los PIRG, lo cual garantizará la transparencia estratégica, el progreso coordinado y la certeza de inversión.

Con respecto a todos estos esfuerzos de planificación regional y de los Estados, la información detallada disponible en las hojas de ruta tecnológicas del GANP (Apéndice 5) y descripciones de módulos (Apéndice 2) facilitarán en forma significativa el desarrollo de casos de negocios para cualquier beneficio operativo que se considere.

El Plan mundial de navegación aérea 2013–2028:

- Obliga a los Estados a asignar sus programas individuales o regionales con respecto al GANP armonizado, pero les proporciona una certeza de inversión mucho mayor.

- Requiere una colaboración activa entre los Estados a través de los PIRG con el fin de coordinar las iniciativas dentro de los planes regionales de navegación aérea aplicables.

- Proporciona las herramientas requeridas para que los Estados y las regiones desarrollen análisis de casos de negocios completos mientras intentan realizar sus mejoras operativas específicas.

Introducción

Presentación del Plan mundial de navegación aérea

La OACI es una organización de Estados Miembros con el objetivo de desarrollar los principios y las técnicas de navegación aérea internacional, fomentar la planificación y el desarrollo del transporte internacional al promover el desarrollo de todos los aspectos de la aeronáutica civil internacional.

El Plan mundial de navegación aérea (GANP) de la OACI es un marco global que incluye principios clave de política de la aviación civil para ayudar a las regiones, subregiones y Estados de la OACI en la preparación de sus planes de navegación aérea regionales y estatales.

El objetivo del GANP es aumentar la capacidad y mejorar la eficiencia del sistema de la aviación civil mundial al mismo tiempo que mejorar o al menos mantener la seguridad. El GANP también incluye estrategias para abordar los demás objetivos estratégicos de la OACI.

El GANP incluye el marco de mejora por bloques del sistema de aviación (ASBU), sus módulos y sus hojas de ruta tecnológicas asociadas que cubren, entre otras, comunicaciones, vigilancia, navegación, gestión de información y aviónica.

Las ASBU están destinadas al uso de las regiones, subregiones y Estados cuando estos desean adoptar los bloques o módulos individuales pertinentes para ayudar a lograr la armonización e interoperabilidad mediante su aplicación constante en las regiones y el mundo.

El GANP, junto con otros planes de alto nivel de la OACI, permitirá a las regiones, subregiones y Estados de la OACI establecer sus prioridades de navegación aérea para los próximos 15 años.

El GANP delinea los 10 principios clave de política de la aviación civil que guían la planificación de navegación aérea mundial, regional y estatal.

Capítulo 1 **10 principios clave de política de navegación de la OACI**

01
Compromiso de la ejecución los objetivos estratégicos y áreas clave de rendimiento de la OACI

La planificación de navegación aérea regional y estatal de la OACI cubrirá cada uno de los objetivos estratégicos de la OACI y las 11 áreas clave de rendimiento de esta.

02
La seguridad de la aviación es la prioridad más alta

Al planificar la navegación aérea y al establecer y actualizar sus planes de navegación aérea individuales, las regiones y estados de la OACI considerarán debidamente las prioridades de seguridad establecidas en el plan global de seguridad operacional de la aviación (GASP).

03
Enfoque escalonado para la planificación de la navegación aérea

El plan global de seguridad operacional de la aviación y el plan mundial de navegación aérea de la OACI guiarán y armonizarán el desarrollo de los planes de navegación aérea regionales y estatales individuales de la OACI.

Los planes regionales de navegación aérea de la OACI que han desarrollado los grupos regionales de planificación y ejecución (PIRG), también guiarán y armonizarán el desarrollo de los planes de navegación aérea estatales individuales.

Al desarrollar sus planes regionales de navegación aérea, los PIRG deben abordar sus problemas intrarregionales e interregionales.

04
Concepto operativo de gestión del tráfico aéreo global (GATMOC)

La OACI aprobó el GATMOC (Doc 9854) y los manuales complementarios, que incluyen, entre otros, el *Manual sobre los requisitos del sistema de gestión del tráfico aéreo* (Doc 9882) y el *Manual sobre rendimiento global del sistema de navegación aérea* (Doc 9883), que continuarán su evolución para proporcionar una base conceptual global sólida para los sistemas de navegación aérea mundial y de gestión del tráfico aéreo.

05
Prioridades mundiales de la navegación aérea

Las prioridades mundiales de la navegación aérea se describen en el GANP. La OACI debe elaborar disposiciones, material de respaldo y proporcionar capacitación de acuerdo con las prioridades mundiales de la navegación aérea.

06
Prioridades regionales y estatales de la navegación aérea

A través de los PIRG, las regiones, subregiones y estados individuales de la OACI deben establecer sus propias prioridades de navegación aérea con el fin de satisfacer sus necesidades y circunstancias individuales de acuerdo con las prioridades mundiales de la navegación aérea.

07

Mejoras por bloques del sistema de aviación (ASBU), módulos y hojas de ruta

Las ASBU, los módulos y las hojas de ruta constituyen un complemento clave para el GANP y hacen notar que continuarán en evolución a medida que se realiza más trabajo para perfeccionar y actualizar su contenido y para seguir elaborando las disposiciones relacionadas, material de respaldo y capacitación.

08

Uso de los bloques de ASBU y módulos

Aunque el GANP tiene una perspectiva global, no se pretende que todos los módulos de ASBU se apliquen a nivel mundial.

Cuando las regiones, subregiones o estados adoptan los bloques de ASBU y módulos, los deben seguir en estricta concordancia con los requisitos de ASBU para garantizar una interoperabilidad global y armonización de la gestión del tráfico aéreo.

Se espera que algunos módulos de ASBU sean esenciales a nivel global y, por lo tanto, es posible que finalmente sean el tema de las fechas de ejecución dispuestas de la OACI.

09

Temas financieros y de costo/beneficio

La ejecución de las medidas de la navegación aérea, incluidas las identificadas en las ASBU, puede requerir una inversión significativa de recursos finitos por parte de las regiones, subregiones, estados de la OACI y la comunidad de la aviación.

Al considerar la adopción de diferentes bloques y módulos, las regiones, subregiones y estados de la OACI deben realizar análisis de costo/beneficio con el fin de determinar el caso de negocios para su ejecución en su región o estado en particular.

La elaboración de material de guía sobre el análisis de costo/beneficio ayudará a los estados a implementar el GANP.

10

Revisión y evaluación de la planificación de la navegación aérea

La OACI debe revisar el GANP cada tres años y, si es necesario, todos los documentos pertinentes de planificación de la navegación aérea mediante el proceso establecido y transparente.

La Comisión de Aeronavegación debe analizar anualmente los apéndices del GANP para garantizar que se mantienen exactos y actualizados.

Se debe informar anualmente a la OACI el progreso y eficacia de las regiones y estados de la OACI con respecto a las prioridades establecidas en sus respectivos planes regionales y estatales de navegación aérea usando un formato de informe uniforme Esto ayudará a las regiones y estados a ajustar sus prioridades con el fin de reflejar el rendimiento real y abordar cualquier problema de navegación aérea que surja.

Capítulo 2 **Ejecución: convertir las ideas en acción**

Nuestras prioridades

PBN: prioridad más alta

Antes de la elaboración de los módulos de ASBU, la OACI concentró sus esfuerzos en el desarrollo e ejecución de navegación basada en el rendimiento (PBN), operaciones continuas de descenso (CDO), Operaciones continuas de ascenso (CCO) y capacidades de secuenciación de pistas (AMAN/DMAN).

La introducción de PBN ha cumplido con las expectativas de toda la comunidad de la aviación. Los actuales planes de ejecución deberían ayudar a entregar beneficios adicionales, pero mantenerse supeditados a la capacitación adecuada, el respaldo experto a los estados, el mantenimiento y desarrollo continuos de SARP internacionales y una coordinación más estrecha entre los estados y las partes interesadas de la aviación.

Si se considera la flexibilidad que la OACI ha incorporado a su enfoque de mejoras en bloque, no obstante existen algunos elementos del GANP se deberán tener en cuenta para la aplicación a nivel mundial.

La Resolución de la Asamblea A37-11 de la OACI, por ejemplo, insta a todos los estados a implementar rutas de servicios de tráfico aéreo (ATS) y procedimientos de aproximación de acuerdo con el concepto de PBN de la OACI. Por lo tanto, en el corto plazo, todos los Estados Miembros de la OACI deben considerar la ejecución del módulo del bloque sobre "Optimización de procedimientos de aproximación incluida la guía vertical" (B0-APTA).

Además, ocasionalmente es esencial llegar a un acuerdo sobre un reemplazo de nueva generación de los elementos existentes que ya no cumplen con los requisitos de los sistemas globales. El ejemplo más reciente es la adopción del plan de vuelo de la OACI 2012. Un ejemplo futuro podría ser el reemplazo de la red fija de telecomunicaciones aeronáuticas (AFTN), el sistema mundial que se ha estado distribuyendo el plan de vuelo de la OACI durante más de medio siglo.

La caracterización de los módulos de bloques en particular que se consideran necesarios para la seguridad o regularidad futuras de la navegación aérea internacional y que finalmente pueden convertirse en una norma de la OACI es esencial para el éxito del GANP. En este marco, a veces se necesitará una sincronización amplia de los plazos de ejecución mundial o regional al igual que considerar los posibles acuerdos o mandatos de ejecución.

Progreso de la PBN en relación con la aproximación

ICAO A37-11 requería la ejecución de aproximaciones PBN RNP con guía vertical (APV) con sistema de aumentación basada en satélites (SBAS) o navegación vertical barométrica (Baro-VNAV). Cuando no se disponga de guía vertical, la orientación lateral, solo para la mayor parte de las normas de extremos de pistas de vuelo instrumental (IFR) fue indicada para 2016.

Como consecuencia de A37-11, se están publicando aproximaciones de rendimiento de navegación requeridas (RNP) (muchas incorporan guía vertical) en una tasa creciente en todo el mundo. También se han desarrollado aproximaciones RNP AR más exactas en varias ubicaciones donde problemas de terreno podrían limitar el acceso al aeródromo.

Aunque algunos estado podrán abordar A37-11 hacia 2016, la tasa de ejecución observada de aproximaciones PBN RNP en todo el mundo actualmente indica que es poco probable que se logre este objetivo a nivel mundial.

Progresos ambientales mediante procedimientos de PBN en terminales. CDO y CCO

Actualmente, muchos aeropuertos importantes emplean procedimientos de PBN y, en un gran número de casos, el diseño sensato ha dado como resultado significativas reducciones en los efectos ambientales. Específicamente, este el caso en que el diseño de espacio aéreo ha favorecido las operaciones continuas de descenso (CDO) y las operaciones continuas de ascenso (CCO).

Las CDO presentan descensos de perfil optimizados que permiten a la aeronave descender desde el crucero hasta la aproximación final hacia el aeropuerto con los parámetros de empuje mínimos. Aparte del importante ahorro de combustible, las CDO tienen la ventaja ambiental adicional de disminuir los niveles de ruido del aeropuerto/aeronave, con lo que se beneficia en forma significativa a las comunidades locales. Además de los beneficios generales en este aspecto, derivados del menor empuje que se emplea, la funcionalidad de PBN garantiza que también se puede enrutar la trayectoria lateral para evitar las áreas más sensibles al ruido.

La OACI ha establecido material de orientación sobre la ejecución de CDO y se encuentra en el proceso de elaboración de material de capacitación y talleres para facilitar la ejecución de los estados. Los módulos de mejoras en bloque B0-CDO, B1-CDO y B2-CDO servirán para ayudar en la optimización eficaz de los beneficios de rendimiento alcanzables mediante la ejecución de CDO. Estos módulos se integran con otras capacidades de espacio aéreo y procedimientos para aumentar la eficiencia, seguridad, acceso y predictibilidad.

Al igual que con su trabajo en el área de CDO, la OACI también se encuentra en el proceso de elaborar material de orientación para CCO que pueda tener beneficios similares para las salidas. El módulo de mejoras en bloque B0-CCO, descrito en el Apéndice 2, se ha diseñado para respaldar y motivar la ejecución de CCO.

Las CCO no requieren una tecnología de aire o tierra específica, sino más bien consisten en una técnica operativa para aeronaves ayudada por un diseño adecuado de espacio aéreo y procedimientos. Las operaciones en niveles de vuelo óptimos son un impulsor clave para mejorar el rendimiento del combustible y minimizar las emisiones de carbono puesto que una gran proporción del consumo de combustible se produce durante la fase de ascenso.

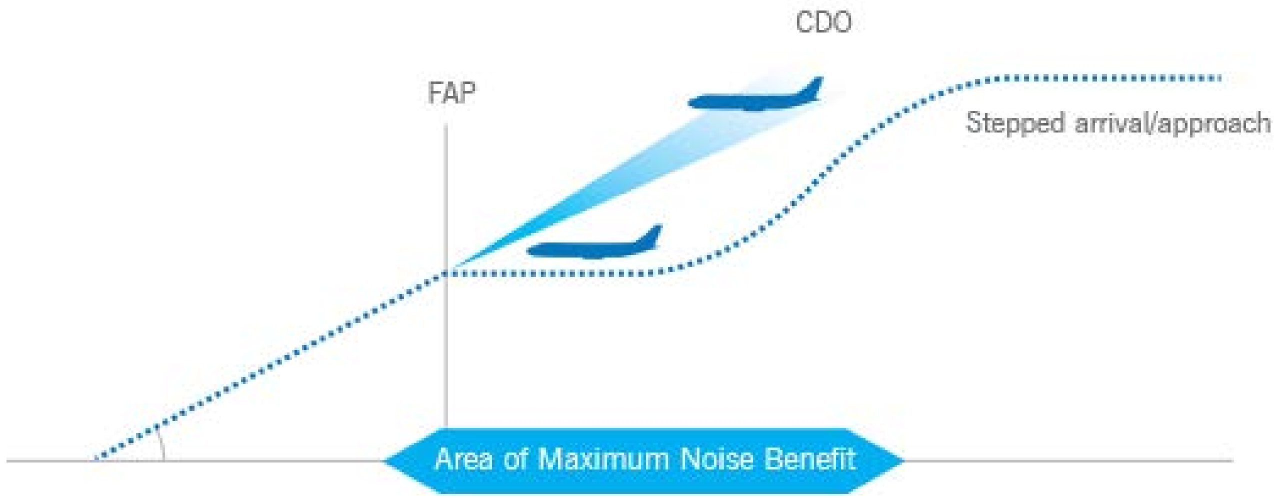
Por lo tanto, permitir que una aeronave alcance y mantenga su nivel de vuelo óptimo sin interrupción ayudará a optimizar el rendimiento del combustible de vuelo y a reducir las emisiones. Las CCO pueden proporcionar una reducción en el ruido, el consumo de combustible y las emisiones, al mismo tiempo que aumentan la estabilidad del vuelo y la predictibilidad de las trayectorias de vuelo para los controladores y los pilotos.

En un espacio aéreo congestionado, es poco probable que se puedan implementar las CCO sin el apoyo de la PBN para asegurar la separación estratégica entre el tráfico de llegada y de salida.

La OACI recientemente publicó manuales sobre CDO y CCO. Ambos documentos proporcionan orientación en el diseño, ejecución y operación de llegadas y salidas favorables para el medio ambiente.

Las CDO, en conjunto con las CCO, pueden garantizar que se maximice en forma segura la eficiencia de las operaciones en terminales y que al mismo tiempo se produzca una reducción significativa de las emisiones ambientales. Para que esto se implemente por completo, se deben implementar y/o actualizar las herramientas y técnicas de ATM, en especial, las herramientas de gestión de llegada y salida para garantizar que los flujos de llegada y salida sean constantes y con una secuencia adecuada.

Fig. 6: Operación continua de descenso (CDO). Las CDO presentan perfiles optimizados que permiten a la aeronave ingresar al aeropuerto desde grandes altitudes con los parámetros de empuje mínimos, con lo disminuye el ruido en las comunidades locales y se utiliza hasta un 30% menos de combustible que en las aproximaciones "escalonadas" estándar.



FAP

CDO

Llegada/aproximación escalonada

Área de beneficio de ruido máximo

Próximos pasos

La PBN es un cambio complejo y fundamental que afecta a varias disciplinas y especializaciones dentro de la fuerza de trabajo de la aviación. Además es un área con un uso intensivo de normas que requiere la elaboración de nuevas normas y el perfeccionamiento de las disposiciones existentes.

La ejecución futura de la PBN en el espacio aéreo de la terminal se considera como un facilitador para las operaciones avanzadas de las terminales previstas por un programa de modernización de ATM.

Dadas estas áreas actuales de prioridad, se han puesto de relieve las siguientes áreas destacadas clave de preocupación para los estados y la industria con el fin de ayudar a garantizar una ejecución continua eficaz de la PBN:

- La necesidad de material de orientación, talleres y simposios.
- Paquetes de aprendizaje informáticos.
- Cursos de capacitación formales que garanticen la comprensión total y la ejecución adecuada de los requisitos y normas de la PBN.
- Apoyo activo y coordinado para el desarrollo y enmiendas permanentes de las normas.
- Respaldo para asegurar la ejecución armonizada e integrada de las tecnologías relacionadas y las herramientas de apoyo para optimizar los objetivos de la capacidad de rendimiento.

Fig. 7: PBN como facilitadora para la optimización de operaciones de pistas paralelas poco espaciadas. Fondo geográfico cortesía de Google Earth

La primera etapa de la ejecución de la PBN ha originado una consolidación generalizada de los requisitos regionales existentes. Ahora la OACI se concentra en la expansión de estos requisitos con el fin de lograr eficiencias aún mayores en el corto y más largo plazo.

Actualmente, el concepto de PBN se está extendiendo para adaptar nuevas aplicaciones, dos de las cuales afectan las operaciones de las terminales:

a) RNP avanzado (A-RNP) proporcionará un requisito único de calificación para las aeronaves para todas las aplicaciones en la terminal y en ruta. Con el tiempo, esta simplificación de aprobaciones debería reducir costos para los operadores y mejorar la comprensión entre pilotos y controladores. Las funciones básicas de A-RNP incluyen RNP 0.3 en aproximación final, RNP 1 en todas las demás fases finales, arco de radio continuo y constante RNAV en una funcionalidad fija (RF) fuera de la aproximación final en el espacio aéreo de la terminal. Esto dará como resultado una mejor predictibilidad de trayectoria y debería originar un espaciado de ruta más estrecho.

b) Las opciones A-RNP incluyen "escalabilidad", control de tiempo de llegada, Baro-VNAV y requisitos de continuidad mejorados para las operaciones oceánicas y remotas.

c) RNP 0.3 permitirá las operaciones de helicópteros con reducción de efectos en el uso del espacio aéreo y mejor acceso para las llegadas y salidas.

El enfoque para las operaciones en ruta estará en RNP 2 para las aplicaciones oceánicas y remotas, al igual que en RNP 1 para aplicaciones continentales. La actividad esencial será la producción de todos los requisitos necesarios para respaldar las nuevas aplicaciones.

Se prevé que los avances futuros de la PBN incluirán salidas RNP AR (se requiere autorización) y nuevas opciones para A-RNP, incluidos control del tiempo de llegada en el espacio aéreo de la terminal, mejores operaciones de navegación vertical y mejor rendimiento de espera.

Para apoyar los requisitos de alto nivel de la PBN, la OACI continuará trabajando en coordinación con las partes interesadas de la aviación para elaborar material de orientación más profundo y los documentos entregables de capacitación asociados (en línea y en aula).

Juegos de información electrónica de PBN

Para complementar los requisitos cada vez mayores de la PBN en las áreas del espacio aéreo, ATM, tripulación de vuelo y diseño de procedimientos, la Organización también se está concentrando en facilitar ejecución al proporcionar instrucciones a los profesionales de la aviación adaptadas a su responsabilidad y dominio en particular.

Electronic Information Package: PBN
Performance-based Navigation

Executives
Regulators
ANSP
A/C Operator
Manufacturer

Estos paquetes de información electrónica se pondrán a disposición de los pilotos, ANSP, controladores, diseñadores de espacio aéreo y procedimientos y cualquier otro actor de la aviación con una necesidad específica de material de referencia de PBN más detallado.

Prioridades del módulo

La necesidad de priorizar la PBN es clara. Sin embargo, la comunidad de la aviación civil internacional también ha dejado en claro que la OACI debe proporcionar orientación a los estados sobre cómo priorizar los módulos. La Duodécima conferencia de navegación aérea afirmó esto al solicitar a la OACI que "continúe trabajando en el material de orientación para la categorización de los módulos de mejoras en bloque para la ejecución y que proporcione orientación según sea necesario a los grupos regionales de planificación y ejecución (PIRGS) y a los estados", (Recomendación 6/12 (c)).

Además de esto, la Conferencia solicitó a la OACI "que identifique los módulos del Bloque 1 que considere esenciales para la ejecución a nivel global en términos de una trayectoria mínima hacia una interoperabilidad y seguridad global, teniendo debidamente en cuenta la diversidad regional para que los estados la examinen con mayor profundidad" (Recomendación 6.12 (e)).

En respuesta a lo anterior, la OACI ha elaborado un nuevo diagrama de flujo de planificación (indicado en el Apéndice 1) para las regiones, el cual considera los módulos y además las prioridades regionales. Esta información la deberán usar los PIRG para establecer las prioridades para la ejecución de los módulos en su región.

Cuando se establezcan las prioridades regionales para la ejecución, se deberán tomar en cuenta los puntos esenciales para la interoperabilidad y seguridad establecidos en la recomendación de la Conferencia 6.12 (e). Por lo tanto, se espera que estos puntos finalmente puedan convertirse en el tema de las normas de la OACI con fechas de ejecución dispuestas.

e-tools de OACI que respaldan la ejecución del Bloque 0

La OACI y las partes interesadas de la aviación mundial han desarrollado una serie de herramientas basadas en video y en línea para ayudar a los Estados Miembros a comprender en qué consistirán los módulos del Bloque 0 y cómo pueden implementar.

El sitio web de la OACI sirve como el portal para el acceso centralizado a estas herramientas, además de las descripciones módulo por módulo para los Estados Miembros y la referencia de la industria.

La Organización asesorará a los estados y las partes interesadas mientras quedan accesibles materiales educativos y de referencia adicionales en el próximo trienio.

Juegos de ejecución electrónicos

La OACI ha elaborado juegos de información que describen las capacidades que ahora se están implementando para la navegación basada en el rendimiento (PBN) ay Bloque 0.

Estos juegos servirán como fuentes de referencia portátiles que proporcionarán animaciones que ilustran los beneficios del módulo ASBU y detalles sobre la información documentada necesaria para implementar cada uno.

Consideraciones acerca de la capacitación y del desempeño humano

Los profesionales de la aviación desempeñan un papel esencial en la transición y la ejecución exitosa del GANP. Los cambios del sistema afectarán el trabajo de numeroso personal calificado en aire y en tierra, posiblemente cambiarán sus funciones e interacciones e incluso requerirán el desarrollo de nuevas destrezas.

Por lo tanto, es crítico que los conceptos desarrollados dentro del GANP tengan en cuenta las fortalezas y debilidades del personal calificado existente en cada momento. Todos los actores involucrados en un sistema de transporte aéreo seguro necesitarán intensificar los esfuerzos para manejar los riesgos asociados al desempeño humano y el sector necesitará prever proactivamente el diseño de interfaces y estaciones de trabajo, las necesidades de capacitación y los procedimientos operativos, promulgando al mismo tiempo las mejores prácticas.

La OACI por mucho tiempo ha reconocido estos factores y la consideración del desempeño humano en el marco de los requisitos de las mejoras en bloque seguirá evolucionando a través de los enfoques del Programa de seguridad estatal (SSP) y los Sistemas de gestión de seguridad (SMS) de la industria.

Entre otras prioridades, la gestión del cambio pertinente para la evolución de las mejoras en bloque debe incluir consideraciones relacionadas con el desempeño humano en las siguientes áreas:

a) Capacitación inicial, competencia y/o adaptación de personal operativo nuevo o activo

b) Nuevas funciones, responsabilidades y tareas para definir e implementar

c) Factores sociales y gestión de los cambios culturales vinculados al aumento de la automatización

Se debe incorporar el desempeño humano a las fases de planificación y diseño de los nuevos sistemas y tecnologías, al igual que durante la ejecución. La participación del personal operativo en las primeras etapas también es esencial.

Compartir información relacionada con los diversos aspectos del desempeño humano y la identificación de enfoques de gestión de riesgo de desempeño humano será un requisito previo para mejorar los resultados de seguridad. Esto es en particular válido en el actual marco operativo de la aviación y la ejecución exitosa de las mejoras en bloque y otros nuevos sistemas en el futuro.

No se puede lograr una gestión generalizada y eficaz de los riesgos del desempeño humano dentro de un marco operativo sin un esfuerzo coordinado de los reguladores, los proveedores de la industria y el personal operativo que represente todas las disciplinas.

Flexibilidad de la ejecución del GANP

El GANP de la OACI establece un horizonte de planificación global de 15 años renovable.

Se pretende principalmente que el marco resultante garantice que se mantendrá y mejorará el sistema de aviación, que se armonicen eficazmente programas de mejoras de la Gestión del tránsito aéreo (ATM) y que se puedan eliminar las barreras para la eficiencia de la aviación futura y para los progresos ambientales a un costo razonable. En este sentido, la adopción del a metodología ASBU aclarará significativamente cómo los usuarios del ANSP y del espacio aéreo deberán planificar el equipaje futuro.

Aunque el GANP tiene una perspectiva global, no se pretende que se requiera aplicar todos los módulos de bloques en cada estado y región. Muchos de los paquetes de mejoras en bloque contenidos en el GANP son paquetes especializados que se deben aplicar solo cuando exista el requisito operativo específico o se puedan proyectar en forma realista los beneficios correspondientes.

La flexibilidad inherente en la metodología ASBU permite a los estados implementar los módulos basándose en sus requisitos operativos específicos. Al usar el GANP, los planificadores regionales y estatales deben identificar los módulos que proporcionan cualquier mejora operativa necesaria. Aunque las mejoras en bloque no determinan cuándo o dónde se debe implementar un módulo en particular, es posible que esto cambie en el futuro, en el caso en que el progreso irregular obstaculice el paso de aeronaves de una región de espacio aéreo a otra.

La revisión periódica del progreso de la ejecución y el análisis de los posibles impedimentos finalmente garantizarán la transición armoniosa de una región a otra luego de importantes flujos de tráfico, al igual que facilitarán la permanente evolución hacia los objetivos de rendimiento del GANP.

Arquitectura lógica de ATM

La Duodécima conferencia de navegación aérea solicitó a la OACI que desarrolle una arquitectura lógica de ATM mundial para respaldar el GANP y el trabajo de planificación que realizan las regiones y los estados. Este trabajo se realizará durante el próximo trienio. Esta arquitectura lógica complementará las mejoras en bloque, al mismo tiempo que también proporcionará un vínculo gráfico entre:

a) Los módulos ASBU y los elementos del concepto operativo mundial

b) Los módulos ASBU y el entorno operativo previsto y los beneficios de rendimiento esperados

Orientación sobre la elaboración de argumentos de negocios

Durante el trienio, la OACI elaborará material de orientación sobre análisis y desarrollo de casos de negocios. Una vez completo, este manual se encontrará disponible para todos los estados con el fin de ayudar en el desarrollo de casos de negocios para determinar la viabilidad financiera de los módulos de bloques seleccionados para la ejecución.

Capítulo 3 **Rendimiento del sistema de aviación**

Informe de navegación aérea mundial

Luego de la aprobación de un enfoque basado en el rendimiento para la planificación de la navegación aérea por parte de la Undécima conferencia de navegación aérea en 2003, al igual que de la 35a Sesión de la Asamblea de la OACI en 2004, la OACI finalizó la elaboración del material de orientación pertinente a principios de 2008, Doc 9883-*Manual sobre rendimiento global del sistema de navegación aérea.*

Hacia 2009, todos los PIRG, mientras adoptaban un marco de rendimiento regional, invitaron a los estados a que implementaran un marco de rendimiento nacional para los sistemas de navegación aérea sobre la base del material de orientación de la OACI y en concordancia con los objetivos de rendimiento regional, los planes regionales de navegación aérea existentes y el Concepto operativo de ATM mundial.

El siguiente paso requería la supervisión del rendimiento a través de una estrategia de medición establecida. Aunque los PIRG están identificando en forma progresiva un conjunto de métricas de rendimiento regional, entretanto, los estados han reconocido que las actividades de recopilación, procesamiento, almacenamiento e información de datos que respaldan la métrica del rendimiento regional son fundamentales para el éxito de las estrategias basadas en el rendimiento.

El marco del rendimiento de planificación y ejecución de la navegación aérea prescribe realizar actividades de información, supervisión, análisis y revisión en forma cíclica y anual. El formulario de información de navegación aérea será la base para la supervisión del rendimiento relacionada con la ejecución de las mejoras en bloque en los niveles regionales y nacionales.

La OACI y las partes interesadas de la aviación analizarán los resultados de la información y la supervisión y luego estos se utilizarán en la elaboración del Informe de navegación aérea mundial anual.

Los resultados del informe proporcionarán una oportunidad para que la comunidad de la aviación civil mundial compare el progreso en diferentes regiones de la OACI con respecto al establecimiento de una infraestructura y procedimientos basados en el rendimiento de la navegación aérea.

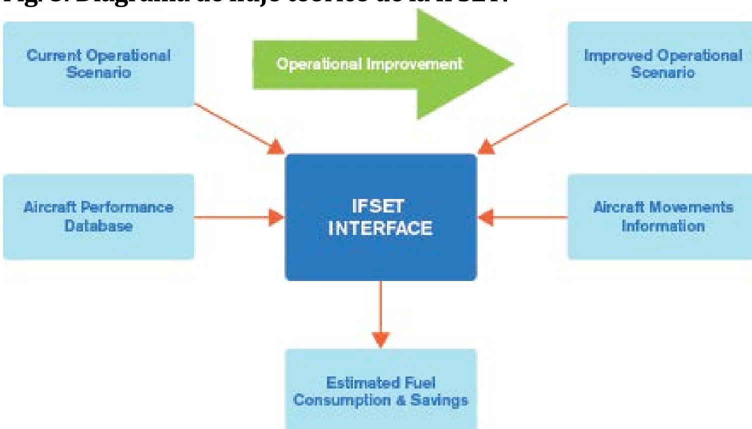
Además, proporcionarán al Consejo de la OACI resultados anuales detallados según los ajustes tácticos que se realizarán al programa del trabajo, al igual que ajustes de la política trienal al GANP.

Medición del rendimiento ambiental: Herramienta de estimación de ahorro de combustible (IFSET) de la OACI

Como reconocimiento de las dificultades que enfrentan varios estados al evaluar los beneficios ambientales de sus inversiones en medidas operativas para mejorar el rendimiento del combustible, la OACI, en colaboración con los expertos en la materia y otras organizaciones internacionales, ha desarrollado la Herramienta de estimación de ahorro de combustible (IFSET) de la OACI.

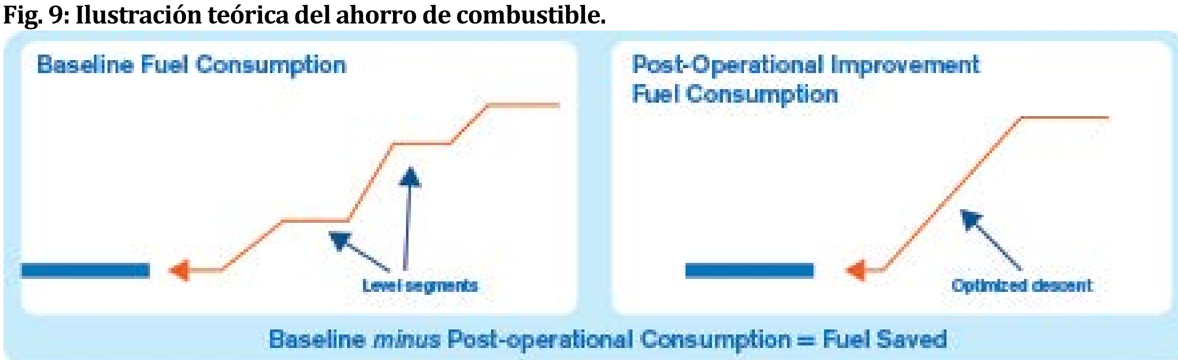
La IFSET ayuda a armonizar las evaluaciones de ahorro de combustible de los estados en forma consecuente con modelos más avanzados ya aprobados por el Comité sobre la protección del medio ambiente y la aviación (CAEP). Esta estimará la diferencia en la masa de combustible consumida al comparar un caso de ejecución previa (es decir, referencia) con un caso de ejecución posterior (es decir, mejoras operativas posteriores), como se ilustra a continuación.

Fig. 8: Diagrama de flujo teórico de la IFSET.



Current Operational Scenario
Operational Improvement
Improved Operational Scenario
Aircraft Performance Database
IFSET INTERFACE
Aircraft Movements Information
Estimated Fuel Consumption & Savings

Fig. 9: Ilustración teórica del ahorro de combustible.



Baseline Fuel Consumption
Level segments
Post-Operational Improvement Fuel Consumption
Optimized descent
Baseline *minus* Post-operational Consumption = Fuel Saved

La selección del caso de referencia es un paso importante del proceso. El usuario la definirá y podría corresponder a lo siguiente:

a) Los escenarios del procedimiento publicado o planificado (AIP, plan de vuelo)

b) Prácticas diarias

c) Una combinación de a) y b)

d) Otros criterios que correspondan

Para calcular el combustible consumido en dos escenarios diferentes, será necesario el número de operaciones según categoría de aeronave, además de una combinación de los siguientes elementos que describa ambos escenarios:

a) Tiempo de rodaje promedio

b) Tiempo empleado o distancia de vuelo a una altitud específica

c) Punto máximo de descenso y punto mínimo de descenso

d) Base de ascenso y punto máximo de ascenso

e) Distancia de vuelo en un procedimiento de ascenso o descenso

Durante 2012, se implementó la IFSET entre los Estados Miembros de la OACI a través de una serie de talleres. No se desarrolló para reemplazar el uso de medición detallada o herramientas de modelación relacionadas con el ahorro de combustible, sino más bien para ayudar a los estados que no disponen de la facilidad para estimar los beneficios de las mejoras operativas en una forma sencilla y armonizada.

Appendix 1: **Global Air Navigation Plan Evolution & Governance**

Continued evolution of the GANP

The new GANP has its roots in an appendix to a 1993 report on what was then termed the Future Air Navigation System (FANS). These recommendations were first presented as the FANS Concept and later became referred to more generally as CNS/ATM.

The FANS initiative had answered a request from ICAO's Member States for planning recommendations on how to address air transport's steady global growth through the coordination of emerging technologies. As research and development into these technologies accelerated rapidly during the 1990s, the Plan and its concepts advanced with them.

A standalone version was published as the ICAO *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750) in 1998, the second edition of which was released in 2001. During this period the Plan served to support State and regional planning and procurement needs surrounding CNS/ATM systems.

By 2004, ICAO's Member States and the air transport industry at large had begun to encourage the transitioning of the Plan's concepts into more practical, real-world solutions. Two ATM implementation roadmaps, made up of specific operational initiatives, were consequently developed on a collaborative basis by dedicated ICAO/industry project teams.

The operational initiatives contained in the roadmaps were later renamed Global Plan Initiatives (GPIs) and incorporated into the Third Edition of the GANP. The following illustration depicts the Plan's evolution up to the 2013–2028 GANP:

Global Air Navigation Plan Approval

The GANP has undergone significant change, driven mainly by its new role as a high-level policy document guiding complementary and sector-wide air transport progress in conjunction with the ICAO Global Aviation Safety Plan.

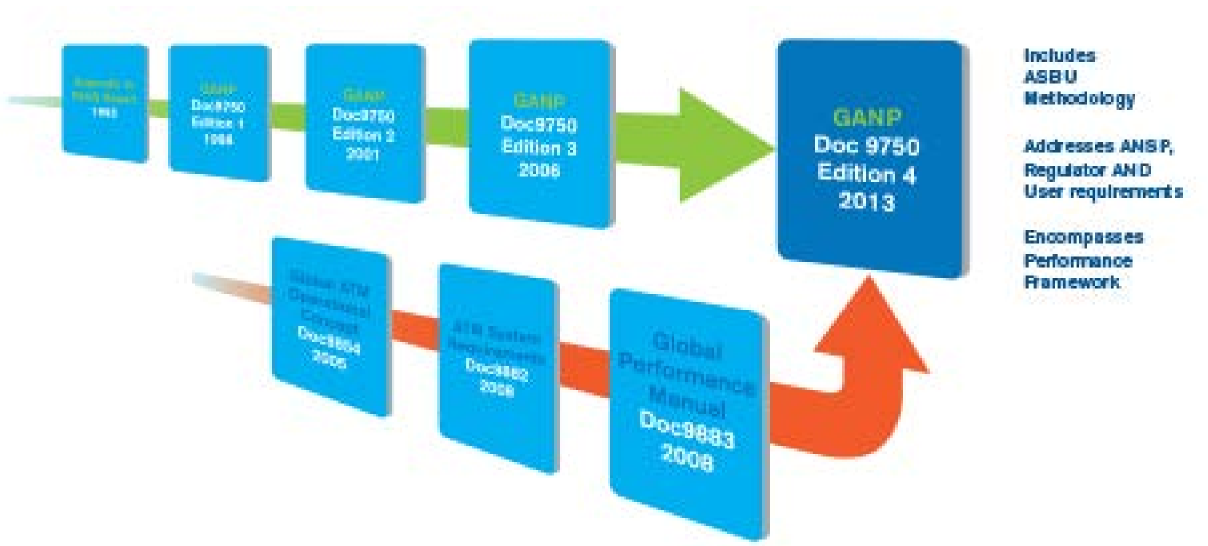
The GANP defines the means and targets by which ICAO, States and aviation stakeholders can anticipate and efficiently manage air traffic growth while proactively maintaining or increasing Safety outcomes. These objectives have been developed through extensive consultation with stakeholders and constitute the basis for harmonized action at the global, regional and national level.

The need to ensure consistency between the GANP and the Strategic Objectives of ICAO necessitates placing this high-level policy document under the authority of the ICAO Council. The GANP and its amendments are therefore approved by the Council prior to eventual budget-related developments and endorsement by an Assembly.

In line with the tenth ICAO Air Navigation Policy Principle, ICAO will review the GANP every three years and if necessary, all relevant Air Navigation Planning documents through the established and transparent process.

The Appendices to the GANP should be analysed annually by the Air Navigation Commission to ensure that they remain accurate and up-to-date.

Fig. 10: Document and operational concept evolution leading to the 2013–2028 GANP.



Appendix to FANS Report 1993
GANP Doc9750 Edition 1 1998
GANP Doc9750 Edition 2 2001
GANP Doc9750 Edition 3 2006
GANP Doc9750 Edition 4 2013
Global ATM Operational Concept Doc9854 2005
ATM System Requirements Doc9882 2008
Global Performance Manual Doc9883 2008

Includes ASBU Methodology
Addresses ANSP, Regulator AND User requirements
Encompasses Performance Framework

From the GANP to Regional Planning

Although the GANP has a global perspective, it is not intended that all ASBU modules are implemented at all facilities and in all aircraft. Nevertheless, coordination of deployment actions by the different stakeholders, within a State, and within or across regions are expected to deliver more benefits than implementations conducted on an ad hoc or isolated basis. Furthermore, an overall integrated deployment of a set of modules from several threads at an early stage could generate additional benefits downstream.

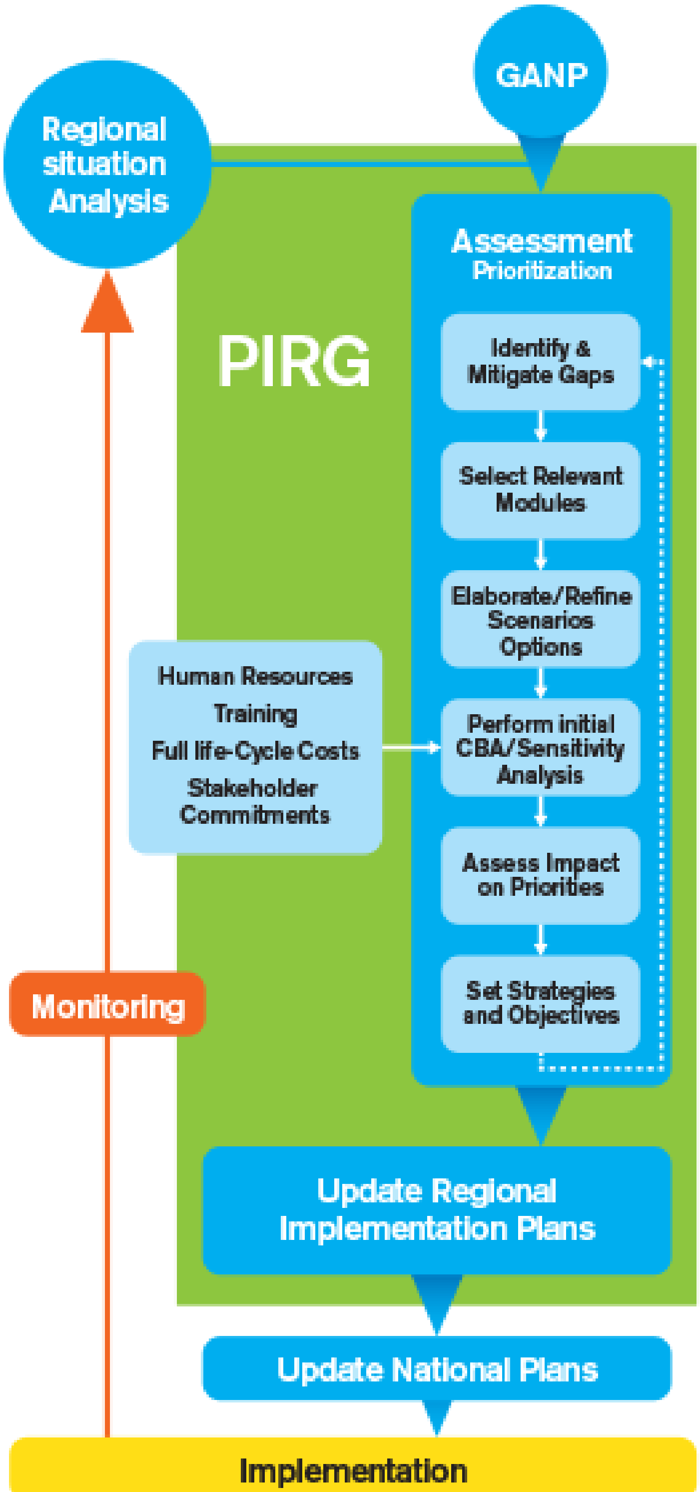
Guided by the GANP, the Regional planning process as well as National planning should be aligned and used to identify those modules which best provide solutions to the operational needs identified. Depending on implementation parameters such as the complexity of the operating environment, the constraints and the resources available, regional and national implementation plans will be developed in alignment with the GANP. This planning requires interaction between stakeholders including regulators, users of the aviation system, the Air Navigation Service Providers (ANSP's) and Aerodrome operators in order to obtain commitments to implementation.

Accordingly, deployments on a global, regional and sub-regional basis and ultimately at State level should be considered as an integral part of the global and regional planning process through the planning and implementation regional groups (PIRGs). In this way, deployment arrangements including applicability dates can be agreed and collectively applied by all stakeholders involved.

For some modules worldwide applicability will be essential; they may, therefore, eventually become the subject of ICAO Standards with mandated implementation dates.

In the same way, some modules are well suited for regional or sub-regional deployment and the regional planning processes under the PIRG are designed to consider which modules to implement regionally, under which circumstances and according to agreed timeframes.

For other modules, implementation should follow common methodologies defined either as Recommended Practices or Standards in order to leave flexibility in the deployment process but ensure global interoperability at a high level.



Regional situation Analysis

GANP

PIRG

Human Resources
Training
Full life-Cycle Costs
Stakeholder Commitments

Monitoring

Assessment Prioritization
Identify & Mitigate Gaps
Select Relevant Modules
Elaborate/Refine Scenarios Options
Perform initial CBA/Sensitivity Analysis
Assess Impact on Priorities
Set Strategies and Objectives

Update Regional Implementation Plans

Update National Plans

Implementation

GANP Update Process

The Global Air Navigation Plan has undergone significant change, driven mainly by its new role as a high-level policy document guiding complementary and sector-wide air transport progress.

The Global Air Navigation and Safety Plans define the means and targets by which ICAO, States and aviation stakeholders can anticipate and efficiently manage air traffic growth while proactively maintaining or increasing Safety outcomes. These objectives have been developed through extensive consultation with stakeholders and constitute the basis for harmonized action at the global, regional and national level.

The need to ensure consistency between the GANP and the Strategic Objectives of ICAO necessitates placing this high-level policy document under the authority of the ICAO Council. The GANP and its amendments are therefore approved by the Council prior to eventual budget related developments and endorsement by an Assembly.

In line with the tenth ICAO Air Navigation Policy Principle, ICAO should review the GANP every three years and if necessary, all relevant Air Navigation Planning documents through the established and transparent process.

The ICAO Air Navigation Commission will review the GANP as part of the annual work programme, reporting to the Council one year in advance of each ICAO Assembly. The ANC report will perform the following based on operational considerations:

1. Review global progress made in the implementation of the ASBU Modules and Technology Roadmaps and the achievement of satisfactory air navigation performance levels;

2. Consider lessons learned by States and industry;

3. Consider possible changes in future aviation needs, the regulatory context and other influencing factors;

4. Consider results of research, development and validation on operational and technological matters which may affect the ASBU Modules and Technology Roadmaps and;

5. Propose adjustments to the components of the GANP.

Following approval by the Council, the updated GANP and its specified supporting documents will then be submitted for endorsement by ICAO Member States at the following ICAO Assembly.

Following Recommendation 1/1 b) of the 12th Air Navigation Conference, the GANP will be submitted to States before approval.

Regional Implementation, Monitoring and New Requirements

GANP
n

ANC Review Proposals for change to the GANP

- Review of the global progress
- Technological and regulatory developments
- Lessons learned by States and Industry

Consultation with States

ANC Report to Council

Council Approval

Assembly Endorsement

GANP n
+1

ICAO Companion Publications supporting the 2013–2028 GANP

As detailed on page 89, the Global Planning Initiatives (GPIs) and appendices of the Third Edition of the GANP comprise part of the supporting documentation for the GANP. Three ICAO companion documents, reflected in the figure 10 on page 32 and described in more detail below, are also instrumental in permitting ICAO and the aviation community to define the concepts and technologies that eventually made the GANP's systems engineering approach possible:

Global Air Traffic Management Operational Concept (Doc 9854)

The Global ATM Operational Concept (GATMOC) was published in 2005. It set out the parameters for an integrated, harmonized and globally interoperable ATM system planned up to 2025 and beyond. Doc 9854 can serve to guide the implementation of CNS/ATM technology by providing a description of how the emerging and future ATM system should operate. The GATMOC also introduced some new concepts:

a) Planning based on ATM system performance.

b) Safety management through the system safety approach.

c) A set of common performance expectations of the ATM community.

Manual on Air Traffic Management System Requirements (Doc 9882)

Doc 9882, published in 2008, is used by PIRGs as well as by States as they develop transition strategies and plans. It defines the high-level requirements (i.e. ATM system requirements) to be applied when developing Standards and Recommended Practices (SARPs) to support the GATMOC. This document provides high-level system requirements related to:

a) System performance-based on ATM community expectations.

b) Information management and services.

c) System design and engineering.

d) ATM concept elements (from the GATMOC).

Manual on Global Performance of the Air Navigation System (Doc 9883)

This document, published in 2008, is aimed at personnel responsible for designing, implementing and managing performance activities. It achieves two key objectives:

a) It outlines performance framework and performance-based strategy from the performance concepts provided in the GATMOC.

b) It analyzes ATM community expectations and categorizes these into key performance areas (KPAs) from which practical metrics and indicators can be developed.

Doc 9883 also provides organizations with the tools to develop an approach to performance management suited to their local conditions.

Appendix 2: **Aviation System Block Upgrades**

Introduction: Aviation System Block Upgrades

The Global Air Navigation Plan introduces a systems engineering planning and implementation approach which has been the result of extensive collaboration and consultation between ICAO, its Member States and industry stakeholders.

ICAO developed the Block Upgrade global framework primarily to ensure that aviation Safety will be maintained and enhanced, that ATM improvement programmes are effectively harmonized, and that barriers to future aviation efficiency and environmental gains can be removed at reasonable cost.

The Block Upgrades incorporate a long-term perspective matching that of the three companion ICAO Air Navigation planning documents. They coordinate clear aircraft- and ground-based operational objectives together with the avionics, data link and ATM system requirements needed to achieve them. The overall strategy serves to provide industry-wide transparency and essential investment certainty for operators, equipment manufacturers and ANSPs.

The core of the concept is linked to four specific and interrelated aviation performance improvement areas, namely:

a) Airport operations.

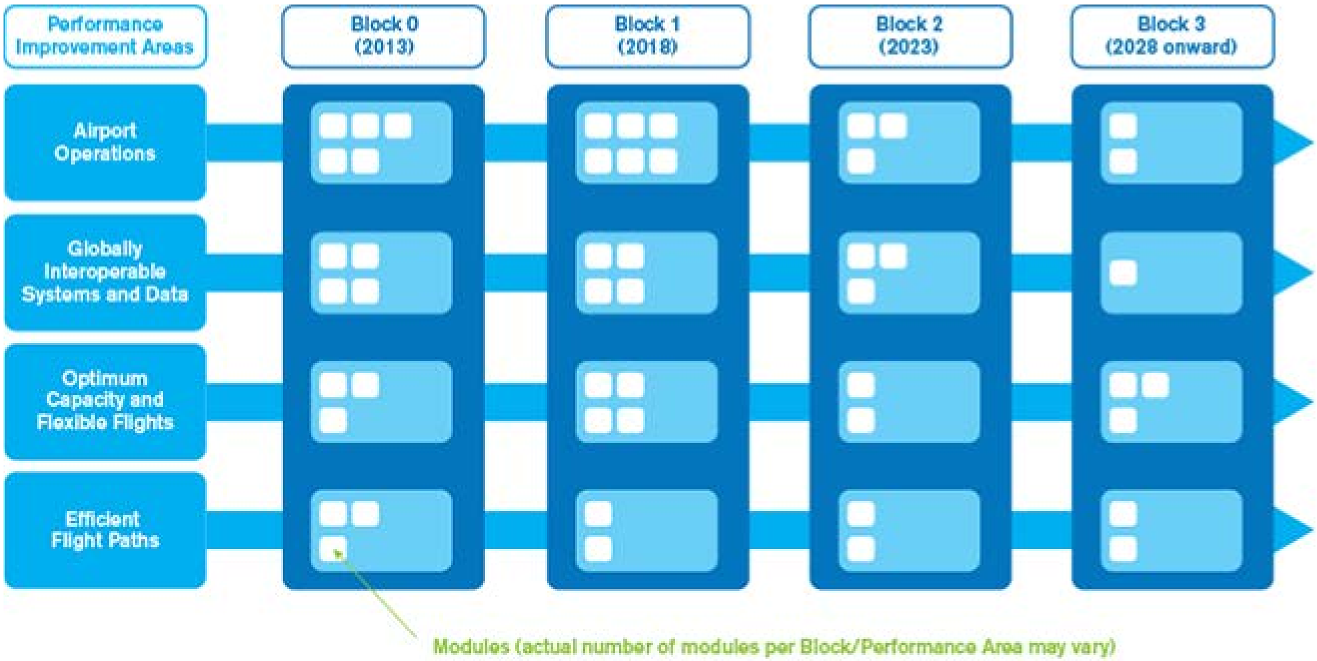
b) Globally-interoperable systems and data.

c) Optimum capacity and flexible flights.

d) Efficient flight paths.

The performance improvement areas and the ASBU Modules associated with each have been organized into a series of four Blocks (Blocks 0, 1, 2 and 3) based on timelines for the various capabilities they contain, as illustrated below.

Fig. 3: Depicting Block 0–3 availability milestones, Performance Improvement Areas, and technology/procedure/capability Modules.



Performance Improvement Areas

Block 0 (2013)
Block 1 (2018)
Block 2 (2023)
Block 3 (2028 onward)

Airport Operations

Globally Interoperable Systems and Data

Optimum Capacity and Flexible Flights

Efficient Flight Paths

Modules (actual number of modules per Block/Performance Area may vary)

Block 0 features Modules characterized by technologies and capabilities which have already been developed and implemented in many parts of the world today. It therefore features a near-term availability milestone, or Initial Operating Capability (IOC), of 2013 based on regional and State operational need. Blocks 1 through 3 are characterized by both existing and projected performance area solutions, with availability milestones beginning in 2018, 2023 and 2028 respectively.

Associated timescales are intended to depict the initial deployment targets along with the readiness of all components needed for deployment. It must be stressed that a Block's availability milestone is not the same as a deadline. Though Block 0's milestone is set at 2013, for example, it is expected that the globally harmonized implementation of its capabilities (as well as the related Standards supporting them) will be achieved over the 2013 to 2018 timeframe. The same principle applies for the other Blocks and therefore provides for significant flexibility with respect to operational need, budgeting and related planning requirements.

While the traditional Air Navigation planning approach addresses only ANSP needs, the ASBU methodology calls for addressing regulatory as well as user requirements. The ultimate goal is to achieve an interoperable global system whereby each State has adopted only those technologies and procedures corresponding to its operational requirements.

Understanding Modules and Threads

Each block is made up of distinct Modules, as shown in the previous illustrations and those below. Modules only need to be implemented if and when they satisfy an operational need in a given State, and they are supported by procedures, technologies, regulations or Standards as necessary, as well as a business case.

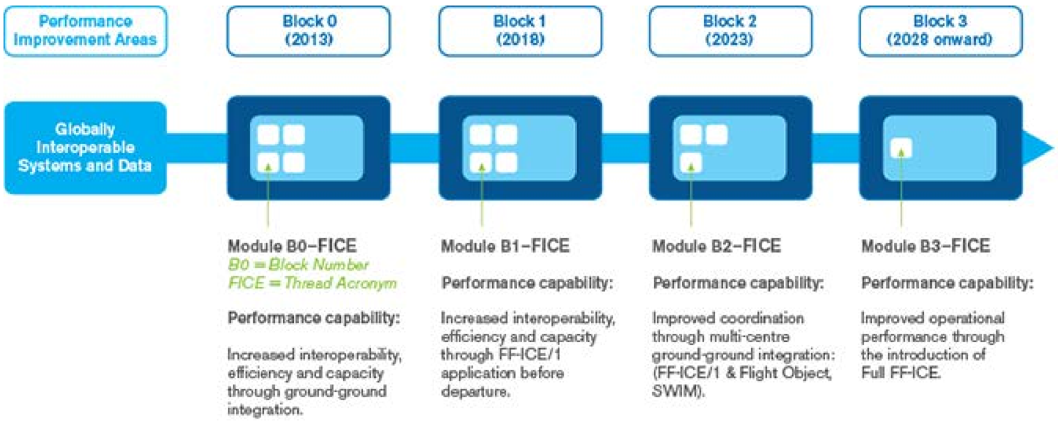
A Module is generally made up of a grouping of elements which define required CNS Upgrade components intended for aircraft, communication systems, air traffic control (ATC) ground components, decision support tools for controllers, etc. The combination of elements selected ensures that each Module serves as a comprehensive and cohesive deployable performance capability.

A series of dependent Modules across consecutive Blocks is therefore considered to represent a coherent transition 'Thread' in time, from basic to more advanced capability and associated performance. Modules are therefore identified by both a Block number and a Thread acronym, as illustrated below.

Each Thread describes the evolution of a given capability through the successive Block timelines as each Module is implemented realizing a performance capability as part of the *Global Air Traffic Management Operational Concept*

(Doc 9854).

Fig. 4: A Module Thread is associated with a specific performance improvement area. Note that the Modules in each consecutive Block feature the same Thread Acronym (FICE), indicating that they are elements of the same Operational Improvement process.



Performance Improvement Areas

Block 0 (2013)
Block 1 (2018)
Block 2 (2023)
Block 3 (2028 onward)

Globally Interoperable Systems and Data

Module B0–FICE

B0 = Block Number

FICE = Thread Acronym

Performance capability:

Increased interoperability, efficiency and capacity through ground-ground integration.

Module B1–FICE

Performance capability:

Increased interoperability, efficiency and capacity through FF-ICE/1 application before departure.

Module B2–FICE

Performance capability:

Improved coordination through multi-centre ground-ground integration: (FF-ICE/1 & Flight Object, SWIM).

Module B3–FICE

Performance capability:

Improved operational performance through the introduction of Full FF-ICE.

Standards and Recommended Practices Development Plan

During the triennium, ICAO will develop a comprehensive plan for the development of SARPs and Guidance material to support the ASBUs. Once complete this will become an appendix to the Fifth Edition of the Global Air Navigation Plan to be presented to the 39th Assembly of ICAO.

As part of the development of this plan, ICAO will:

a) Establish priorities for standards development

b) Coordinate development of ICAO standards in relation to Industry-developed Technical Specifications.

Block Upgrade Technology Roadmaps

Technology roadmaps complement the ASBU modules by providing timelines for the technology that will support the Communications, Navigation and Surveillance (CNS), Information Management (IM) and avionics requirements of the global Air Navigation system.

These roadmaps provide guidance for infrastructure planning (and status) by indicating on a per-technology basis the need for and readiness of:

a) Existing infrastructure.

b) ICAO Standards and guidance material.

c) Demonstrations and validations.

d) Initial Operational Capability (IOC) of emerging technologies.

e) Global implementation.

While the various Block Upgrade Modules define the expected operational improvements and drive the development of all that is required for implementation, the technology roadmaps define the lifespan of the specific technologies needed to achieve those improvements. Most importantly, they also drive global interoperability.

Investment decisions are needed well in advance of the procurement and deployment of technology infrastructure. The technology roadmaps provide certainty for these investment decisions as they identify the pre-requisite technologies that will provide the operational improvements and related benefits. This is critically important as investments in aviation infrastructure are hardly reversible and any gap in technological interoperability generates consequences in the medium- and long-term.

They are also useful in determining equipment lifecycle planning, i.e. maintenance, replacement and eventual decommissioning. The CNS investments represent the necessary baseline upon which the operational improvements and their associated benefits can be achieved.

It must be noted that according to the achievements over the past thirty years, the typical CNS deployment cycle for large scale objectives has been of the order of 20 to 25 years (including ground deployment and aircraft forward and retro fits).

Since no strategy can take into account all developments that occur in aviation over time, the technology roadmaps will be systematically reviewed and updated on a triennium cycle. An interactive online version of the roadmaps will also allow users to retrieve detailed information on specific Block Modules and additional cross-references.

The roadmaps are presented in Appendix 5 as diagrams which identify the relationships between the specific Modules and associated enabling technologies and capabilities. They are accompanied by brief explanations to support their understanding and that of the challenges faced.

Schematic Diagram of Block Upgrades

Performance Improvement Area 1: Airport Operations

Block 0

B0-APTA

Optimization of Approach Procedures including vertical guidance

This is the first step toward universal implementation of GNSS-based approaches.

B0-WAKE

Increased Runway Throughput through Optimized Wake Turbulence Separation

Improved throughput on departure and arrival runways through the revision of current ICAO wake vortex separation minima and procedures.

B0-RSEQ

Improved Traffic Flow through Sequencing (AMAN/DMAN)

Time-based metering to sequence departing and arriving flights.

B0-SURF

Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)

Airport surface surveillance for ANSP.

B0-ACDM

Improved Airport Operations through Airport-CDM

Airport operational improvements through the way operational partners at airports work together.

Block 1

B1-APTA

Optimised Airport Accessibility

This is the next step in the universal implementation of GNSS-based approaches.

B1-WAKE

Increased Runway Throughput through Dynamic Wake Turbulence Separation

Improved throughput on departure and arrival runways through the dynamic management of wake vortex separation minima based on the real-time identification of wake vortex hazards.

B1-RSEQ

Improved Airport operations through Departure, Surface and Arrival Management

Extended arrival metering, Integration of surface management with departure sequencing bring robustness to runways management and increase airport performances and flight efficiency.

B1-SURF

Enhanced Safety and Efficiency of Surface Operations- SURF, SURF IA and Enhanced Vision Systems (EVS)

Airport surface surveillance for ANSP and flight crews with safety logic, cockpit moving map displays and visual systems for taxi operations.

B1-ACDM

Optimized Airport Operations through Airport-CDM

Airport operational improvements through the way operational partners at airports work together.

B1-RATS

Remotely Operated Aerodrome Control

Remotely operated Aerodrome Control Tower contingency and remote provision of ATS to aerodromes through visualisation systems and tools.

Block 2

B2-WAKE (*)

Advanced Wake Turbulence Separation

(Time-based)

The application of time-based aircraft-to-aircraft wake separation minima and changes to the procedures the ANSP uses to apply the wake separation minima.

B2-RSEQ

Linked AMAN/DMAN

Synchronised AMAN/DMAN will promote more agile and efficient en-route and terminal operations.

B2-SURF

Optimized Surface Routing and Safety Benefits (A-SMGCS Level 3-4 and SVS)

Taxi routing and guidance evolving to trajectory based with ground / cockpit monitoring and data link delivery of clearances and information. Cockpit synthetic visualisation systems.

Block 3

B3-RSEQ

Integrated AMAN/DMAN/SMAN

Fully synchronized network management between departure airport and arrival airports for all aircraft in the air traffic system at any given point in time.

Performance Improvement Area 2:

Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management

Block 0

B0-FICE

Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration

Supports the coordination of ground-ground data communication between ATSU based on ATS Inter-facility Data Communication (AIDC) defined by ICAO Document 9694.

B0-DATM

Service Improvement through Digital Aeronautical Information Management

Initial introduction of digital processing and management of information, by the implementation of AIS/AIM making use of AIXM, moving to electronic AIP and better quality and availability of data.

B0-AMET

Meteorological information supporting enhanced operational efficiency and safety

Global, regional and local meteorological information provided by world area forecast centres, volcanic ash advisory centres, tropical cyclone advisory centres, aerodrome meteorological offices and meteorological watch offices in support of flexible airspace management, improved situational awareness and collaborative decision making, and dynamically-optimized flight trajectory planning.

•

Block 1

B1-FICE

Increased Interoperability, Efficiency and Capacity though FF-ICE, Step 1 application before Departure

Introduction of FF-ICE step 1, to implement ground-ground exchanges using common flight information reference model, FIXM, XML and the flight object used before departure.

B1-DATM

Service Improvement through Integration of all Digital ATM Information

Implementation of the ATM information reference model integrating all ATM information using UML and enabling XML data representations and data exchange based on internet protocols with WXXM for meteorological information.

B1-SWIM

Performance Improvement through the application of System-Wide Information Management (SWIM)

Implementation of SWIM services (applications and infrastructure) creating the aviation intranet based on standard data models, and internet-based protocols to maximise interoperability.

B1-AMET

Enhanced Operational Decisions through Integrated Meteorological Information (Planning and Near-term Service)

Meteorological information supporting automated decision process or aids involving: meteorological information, meteorological translation, ATM impact conversion and ATM decision support.

Block 2

B2-FICE

Improved Coordination through multi-centre Ground-Ground Integration: (FF-ICE/1 and Flight Object, SWIM)

FF-ICE supporting trajectory-based operations through exchange and distribution of information for multicentre operations using flight object implementation and IOP standards.

B2-SWIM

Enabling Airborne Participation in collaborative ATM through SWIM

Connection of the aircraft an information node in SWIM enabling participation in collaborative ATM processes with access to rich voluminous dynamic data including meteorology.

Block 3

B3-FICE

Improved Operational Performance through the introduction of Full FF-ICE

All data for all relevant flights systematically shared between air and ground systems using SWIM in support of collaborative ATM and trajectory-based operations.

B3-AMET

Enhanced Operational Decisions through Integrated Meteorological Information (Near-term and Immediate Service)

Metoeroligical information supporting both air and ground automated decision support aids for implementing weather mitigation strategies.

Performance Improvement Area 3:

Optimum Capacity and Flexible Flights – Through Global Collaborative ATM

Block 0

B0-FRTO

Improved Operations through Enhanced En-Route Trajectories

To allow the use of airspace which would otherwise be segregated (i.e. military airspace) along with flexible routing adjusted for specific traffic patterns. This will allow greater routing possibilities, reducing potential congestion on trunk routes and busy crossing points, resulting in reduced flight length and fuel burn.

B0-NOPS

Improved Flow Performance through Planning based on a Network-Wide view

Collaborative ATFM measure to regulate peak flows involving departure slots, managed rate of entry into a given piece of airspace for traffic along a certain axis, requested time at a way-point or an FIR/sector boundary along the flight, use of miles-in-trail to smooth flows along a certain traffic axis and re-routing of traffic to avoid saturated areas.

B0-ASUR

Initial Capability for Ground Surveillance

Ground surveillance supported by ADS-B OUT and/or wide area multilateration systems will improve safety, especially search and rescue and capacity through separation reductions. This capability will be expressed in various ATM services, e.g. traffic information, search and rescue and separation provision.

B0-ASEP

Air Traffic Situational Awareness (ATSA)

Two ATSA (Air Traffic Situational Awareness) applications which will enhance safety and efficiency by providing pilots with the means to achieve quicker visual acquisition of targets:

- AIRB (Enhanced Traffic Situational Awareness during Flight Operations).
- VSA (Enhanced Visual Separation on Approach).

B0-OPFL

Improved access to Optimum Flight Levels through Climb/Descent Procedures using ADS-B

This prevents an aircraft being trapped at an unsatisfactory altitude and thus incurring non-optimal fuel burn for prolonged periods. The main benefit of ITP is significant fuel savings and the uplift of greater payloads.

B0-ACAS

ACAS Improvements

To provide short term improvements to existing airborne collision avoidance systems (ACAS) to reduce nuisance alerts while maintaining existing levels of safety. This will reduce trajectory perturbation and increase safety in cases where there is a breakdown of separation.

B0-SNET

Increased Effectiveness of Ground-based Safety Nets

This module provides improvements to the effectiveness of the ground-based safety nets assisting the Air Traffic Controller and generating, in a timely manner, alerts of an increased risk to flight safety (such as short terms conflict alert, area proximity warning and minimum safe altitude warning).

Block 1

B1-FRTO

Improved Operations through Optimized ATS Routing

Introduction of free routing in defined airspace, where the flight plan is not defined as segments of a published route network or track system to facilitate adherence to the user-preferred profile.

B1-NOPS

Enhanced Flow Performance through Network Operational Planning

ATFM techniques that integrate the management of airspace, traffic flows including initial user driven prioritisation processes for collaboratively defining ATFM solutions based on commercial/operational priorities.

B1-ASEP

Increased Capacity and Efficiency through Interval Management

Interval Management (IM) improves the management of traffic flows and aircraft spacing. Precise management of intervals between aircraft with common or merging trajectories maximises airspace throughput while reducing ATC workload along with more efficient aircraft fuel burn.

B1-SNET

Ground-based Safety Nets on Approach

This module enhances the safety provide by the previous module by reducing the risk of controlled flight into terrain accidents on final approach through the use of Approach Path Monitor (APM).

Block 2

B2-NOPS

Increased user involvement in the dynamic utilization of the network

Introduction of CDM applications supported by SWIM that permit airspace users manage competition and prioritisation of complex ATFM solutions when the network or its nodes (airports, sector) no longer provide capacity commensurate with user demands.

B2-ASEP

Airborne Separation (ASEP)

Creation of operational benefits through temporary delegation of responsibility to the flight deck for separation provision with suitably equipped designated aircraft, thus reducing the need for conflict resolution clearances while reducing ATC workload and enabling more efficient flight profiles.

B2-ACAS

New Collision Avoidance System

Implementation of Airborne Collision Avoidance System (ACAS) adapted to trajectory-based operations with improved surveillance function supported by ADS-B aimed at reducing nuisance alerts and deviations. The new system will enable more efficient operations and procedures while complying with safety regulations.

Block 3

B3-FRTO

Traffic Complexity Management

Introduction of complexity management to address events and phenomena that affect traffic flows due to physical limitations, economic reasons or particular events and conditions by exploiting the more accurate and rich information environment of a

SWIM-based ATM.

Performance Improvement Area 4:

Efficient Flight Path – Through Trajectory-based Operations

Block 0

B0-CDO

Improved Flexibility and Efficiency in Descent Profiles (CDO)

Deployment of performance-based airspace and arrival procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with continuous descent operations (CDOs)

B0-TBO

Improved Safety and Efficiency through the initial application of Data Link En-Route

Implementation of an initial set of data link applications for surveillance and communications in ATC.

B0-CCO

Improved Flexibility and Efficiency in Departure Profiles - Continuous Climb Operations (CCO)

Deployment of departure procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with continuous climb operations (CCOs).

Block 1

B1-CDO

Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV

Deployment of performance-based airspace and arrival procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with Optimised Profile Descents (OPDs).

B1-TBO

Improved Traffic Synchronization and Initial Trajectory-Based Operation

Improve the synchronisation of traffic flows at en-route merging points and to optimize the approach sequence through the use of 4DTRAD capability and airport applications, e.g.; D-TAXI, via the air ground exchange of aircraft derived data related to a single controlled time of arrival (CTA).

B1-RPAS

Initial Integration of Remotely Piloted Aircraft (RPA) Systems into non-segregated airspace

Implementation of basic procedures for operating RPA in non-segregated airspace including detect and avoid.

Block 2

B2-CDO

Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV, required speed and time at arrival

Deployment of performance based airspace and arrival procedures that optimise the aircraft profile taking account of airspace and traffic complexity including Optimised Profile Descents (OPDs), supported by Trajectory-Based Operations and self-separation.

B2-RPAS

RPA Integration in Traffic

Implements refined operational procedures that cover lost link (including a unique squawk code for lost link) as well as enhanced detect and avoid technology.

Block 3

B3-TBO

Full 4D Trajectory-based Operations

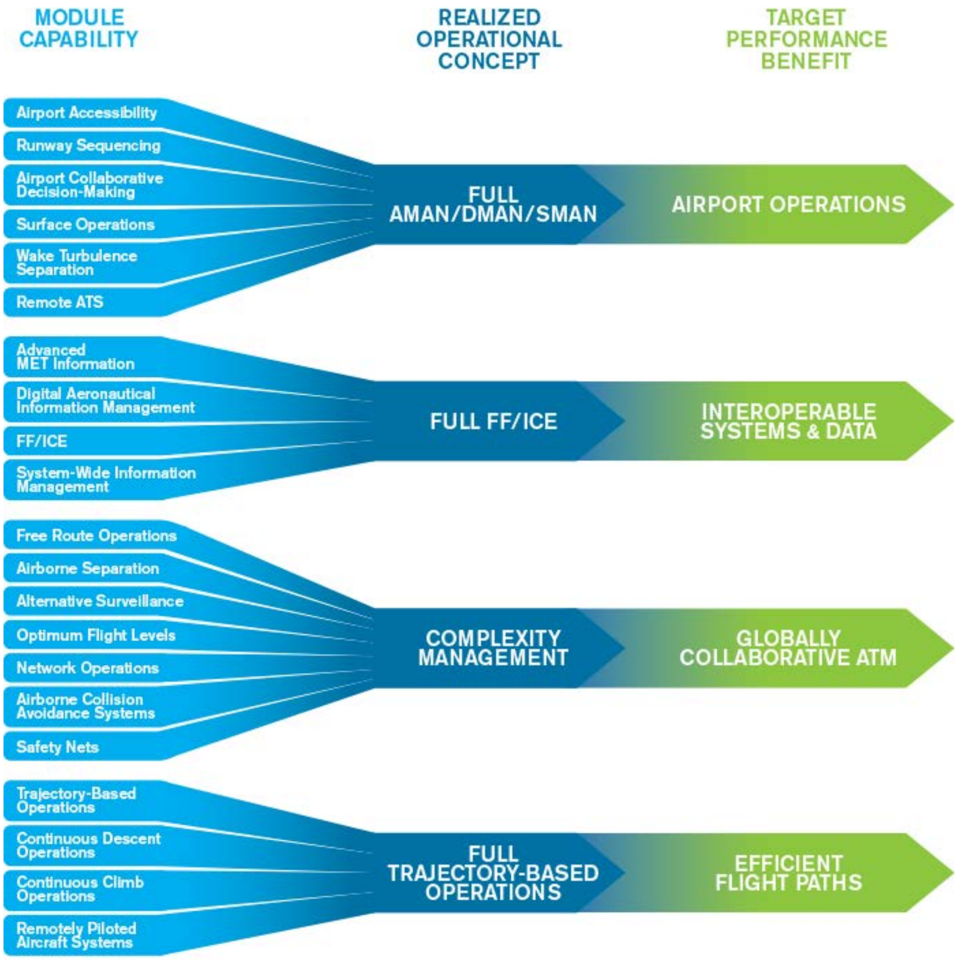
Trajectory-based operations deploys an accurate four-dimensional trajectory that is shared among all of the aviation system users at the cores of the system. This provides consistent and up-to-date information system-wide which is integrated into decision support tools facilitating global ATM decision-making.

B3-RPAS

RPA Transparent Management

RPA operate on the aerodrome surface and in non-segregated airspace just like any other aircraft.

Fig. 5: Graphic depicting the ASBU Modules converging over time on their target operational concepts and performance improvements.



MODULE CAPABILITY

REALIZED OPERATIONAL CONCEPT

TARGET PERFORMANCE BENEFIT

Airport Accessibility
Runway Sequencing
Airport Collaborative Decision-Making
Surface Operations
Wake Turbulence Separation
Remote ATS

FULL AMAN/DMAN/SMAN

AIRPORT OPERATIONS

Advanced MET Information

Digital Aeronautical Information Management

FF/ICE

System-Wide Information Management

FULL FF/ICE

INTEROPERABLE SYSTEMS & DATA

Free Route Operations

Airborne Separation

Alternative Surveillance

Optimum Flight Levels

Network Operations

Airborne Collision Avoidance Systems

Safety Nets

COMPLEXITY MANAGEMENT

GLOBALLY COLLABORATIVE ATM

Trajectory-Based Operations

Continuous Descent Operations

Continuous Climb Operations

Remotely Piloted Aircraft Systems

FULL TRAJECTORY-BASED OPERATIONS

EFFICIENT FLIGHT PATHS

Block 0

Block 0 is composed of Modules containing technologies and capabilities which have already been developed and can be implemented from 2013. Based on the milestone framework established under the overall Block Upgrade strategy, ICAO Member States are encouraged to implement those Block 0 Modules applicable to their specific operational needs.

Performance Improvement Area 1: Airport Operations

B0-APTA Optimization of Approach Procedures including Vertical Guidance

The use of performance-based navigation (PBN) and ground-based augmentation system (GBAS) landing system (GLS) procedures to enhance the reliability and predictability of approaches to runways, thus increasing safety, accessibility and efficiency. This is possible through the application of basic global navigation satellite system (GNSS), Baro-vertical navigation (VNAV), satellite-based augmentation system (SBAS) and GLS. The flexibility inherent in PBN approach design can be exploited to increase runway capacity.

Applicability

This Module is applicable to all instrument, and precision instrument runway ends, and to a limited extent, non-instrument runway ends.

Benefits

Access and Equity: Increased aerodrome accessibility.

Capacity: In contrast with instrument landing systems (ILS), the GNSS-based approaches (PBN and GLS) do not require the definition and management of sensitive and critical areas. This results in increased runway capacity where applicable.

Efficiency: Cost savings related to the benefits of lower approach minima: fewer diversions, overflights, cancellations and delays. Cost savings related to higher airport capacity in certain circumstances (e.g. closely spaced parallels) by taking advantage of the flexibility to offset approaches and define displaced thresholds.

Environment: Environmental benefits through reduced fuel burn.

Safety: Stabilized approach paths.

Cost: Aircraft operators and Air Navigation Service Providers (ANSPs) can quantify the benefits of lower minima by using historical aerodrome weather observations and modelling airport accessibility with existing and new minima. Each aircraft operator can then assess benefits against the cost of any required avionics upgrade. Until there are GBAS (CAT II/III) Standards, GLS cannot be considered as a candidate to globally replace ILS. The GLS business case needs to consider the cost of retaining ILS or MLS to allow continued operations during an interference event.

B0-WAKE Increased Runway Throughput through Optimized Wake Turbulence Separation

Improves throughput on departure and arrival runways through optimized wake turbulence separation minima, revised aircraft wake turbulence categories and procedures.

Applicability

Least complex – Implementation of revised wake turbulence categories is mainly procedural. No changes to automation systems are needed.

Benefits

Access and Equity: Increased aerodrome accessibility.

Capacity:

a) Capacity and departure/arrival rates will increase at capacity constrained aerodromes as wake categorization changes from three to six categories.

b) Capacity and arrival rates will increase at capacity constrained aerodromes as specialized and tailored procedures for landing operations for on-parallel runways, with centre lines spaced less than 760 m (2 500 ft) apart, are developed and implemented.

c) Capacity and departure/arrival rates will increase as a result of new procedures which will reduce the current two-three minutes delay times. In addition, runway occupancy time will decrease as a result of these new procedures.

Flexibility Aerodromes can be readily configured to operate on three (i.e. existing H/M/L) or six wake turbulence categories, depending on demand.

Cost: Minimal costs are associated with the implementation in this Module. The benefits are to the users of the aerodrome runways and surrounding airspace, ANSPs and operators. Conservative wake turbulence separation standards and associated procedures do not take full advantage of the maximum utility of runways and airspace. U.S. air carrier data shows that, when operating from a capacity- constrained aerodrome, a gain of two extra departures per hour has a major beneficial effect in reducing delays.

The ANSP may need to develop tools to assist controllers with the additional wake turbulence categories and decision support tools. The tools necessary will depend on the operation at each airport and the number of wake turbulence categories implemented.

B0-SURF Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)

Basic advanced-surface movement guidance and control systems (A-SMGCS) provides surveillance and alerting of movements of both aircraft and vehicles at the aerodrome, thus improving runway/aerodrome safety. Automatic dependent surveillance-broadcast (ADS-B) information is used when available (ADS-B APT).

Applicability

A-SMGCS is applicable to any aerodrome and all classes of aircraft/vehicles. Implementation is to be based on requirements stemming from individual aerodrome operational and cost-benefit assessments. ADS-B APT, when applied is an element of A-SMGCS, is designed to be applied at aerodromes with medium traffic complexity, having up to two active runways at a time and the runway width of minimum 45 m.

Benefits

Access and Equity: A-SMGCS improves access to portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. Sustains an improved aerodrome capacity during periods of reduced visibility. Ensures equity in ATC handling of surface traffic regardless of the traffic’s position on the aerodrome.

ADS-B APT, as an element of an A-SMGCS system, provides traffic situational awareness to the controller in the form of surveillance information. The availability of the data is dependent on the aircraft and vehicle level of equipage.

Capacity: A-SMGCS: sustained levels of aerodrome capacity for visual conditions reduced to minima lower than would otherwise be the case.

ADS-B APT: as an element of an A-SMGCS system, potentially improves capacity for medium complexity aerodromes.

Efficiency: A-SMGCS: reduced taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only.

ADS-B APT: as an element of an A-SMGCS, potentially reduces occurrence of runway collisions by assisting in the detection of the incursions.

Environment: Reduced aircraft emissions stemming from improved efficiencies.

Safety: A-SMGCS: reduced runway incursions. Improved response to unsafe situations. Improved situational awareness leading to reduced ATC workload.

ADS-B APT: as an element of an A-SMGCS system, potentially reduces the occurrence of occurrence of runway collisions by assisting in the detection of the incursions.

Cost: A-SMGCS: a positive CBA can be made from improved levels of safety and improved efficiencies in surface operations leading to significant savings in aircraft fuel usage. As well, aerodrome operator vehicles will benefit from improved access to all areas of the aerodrome, improving the efficiency of aerodrome operations, maintenance and servicing.

ADS-B APT: as an element of an A-SMGCS system less costly surveillance solution for medium complexity aerodromes.

B0-ACDM Improved Airport Operations through Airport-CDM

Implements collaborative applications that will allow the sharing of surface operations data among the different stakeholders on the airport. This will improve surface traffic management reducing delays on movement and manoeuvring areas and enhance safety, efficiency and situational awareness.

Applicability

Local for equipped/capable fleets and already established airport surface infrastructure.

Benefits

Capacity: Enhanced use of existing infrastructure of gate and stands (unlock latent capacity). Reduced workload, better organization of the activities to manage flights.

Efficiency: Increased efficiency of the ATM system for all stakeholders. In particular for aircraft operators: improved situational awareness (aircraft status both home and away); enhanced fleet predictability and punctuality; improved operational efficiency (fleet management); and reduced delay.

Environment: Reduced taxi time; reduced fuel and carbon emission; and lower aircraft engine run time.

Cost: The business case has proven to be positive due to the benefits that flights and the other airport operational stakeholders can obtain. However, this may be influenced depending upon the individual situation (environment, traffic levels investment cost, etc.).

A detailed business case has been produced in support of the EU regulation which was solidly positive.

B0-RSEQ Improve Traffic Flow through Sequencing (AMAN/DMAN)

Manage arrivals and departures (including time-based metering) to and from a multi-runway aerodrome or locations with multiple dependent runways at closely proximate aerodromes, to efficiently utilize the inherent runway capacity.

Applicability

Runways and terminal manoeuvring area in major hubs and metropolitan areas will be most in need of these improvements.

The improvement is least complex – runway sequencing procedures are widely used in aerodromes globally. However some locations might have to confront environmental and operational challenges that will increase the complexity of development and implementation of technology and procedures to realize this Module.

Benefits

Capacity: Time-based metering will optimize usage of terminal airspace and runway capacity. Optimized utilization of terminal and runway resources.

Efficiency: Efficiency is positively impacted as reflected by increased runway throughput and arrival rates. This is achieved through:

a) Harmonized arriving traffic flow from en-route to terminal and aerodrome. Harmonization is achieved via the sequencing of arrival flights based on available terminal and runway resources.

b) Streamlined departure traffic flow and smooth transition into en-route airspace. Decreased lead time for departure request and time between call for release and departure time. Automated dissemination of departure information and clearances.

Predictability: Decreased uncertainties in aerodrome/terminal demand prediction.

Flexibility By enabling dynamic scheduling.

Cost: A detailed positive business case has been built for the time-based flow management programme in the United States. The business case has proven the benefit/cost ratio to be positive. Implementation of time-based metering can reduce airborne delay. This capability was estimated to provide over 320,000 minutes in delay reduction and $28.37 million in benefits to airspace users and passengers over the evaluation period.

Results from field trials of DFM, a departure scheduling tool in the United States, have been positive. Compliance rate, a metric used to gauge the conformance to assigned departure time, has increased at field trial sites from sixty-eight to seventy-five per cent. Likewise, the EUROCONTROL DMAN has demonstrated positive results. Departure scheduling will streamline flow of aircraft feeding the adjacent center airspace based on that center's constraints. This capability will facilitate more accurate estimated time of arrivals (ETAs). This allows for the continuation of metering during heavy traffic, enhanced efficiency in the NAS and fuel efficiencies. This capability is also crucial for extended metering.

Performance Improvement Area 2: Globally Interoperable Systems and Data

B0-FICE Increased Interoperability, Efficiency and Capacity though Ground-Ground Integration

Improves coordination between air traffic service units (ATSUs) by using ATS interfacility data communication (AIDC) defined by ICAO's *Manual of Air Traffic Services Data Link Applications* (Doc 9694). The transfer of communication in a data link environment improves the efficiency of this process, particularly for oceanic ATSUs.

Applicability

Applicable to at least two area control centres (ACCs) dealing with en-route and/or terminal control area (TMA) airspace. A greater number of consecutive participating ACCs will increase the benefits.

Benefits

Capacity: Reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases.

Efficiency: The reduced separation can also be used to more frequently offer aircraft flight levels closer to the flight optimum; in certain cases, this also translates into reduced en-route holding.

Interoperability: Seamlessness: the use of standardized interfaces reduces the cost of development, allows air traffic controllers to apply the same procedures at the boundaries of all participating centres and border crossing becomes more transparent to flights.

Safety: Better knowledge of more accurate flight plan information.

Cost: Increase of throughput at ATS unit boundary and reduced ATCO workload will outweigh the cost of FDPS software changes. The business case is dependent on the environment.

B0-DATM Service Improvement through Digital Aeronautical Information Management

The initial introduction of digital processing and management of information through, aeronautical information service (AIS)/aeronautical information management (AIM) implementation, use of aeronautical exchange model (AIXM), migration to electronic aeronautical information publication (AIP0 and better quality and availability of data.

Applicability

Applicable at State level with increased benefits as more States participate.

Benefits

Environment: Reducing the time necessary to promulgate information concerning airspace status will allow for more effective airspace utilization and allow improvements in trajectory management.

Safety: Reduction in the number of possible inconsistencies. Module allows reducing the number of manual entries and ensures consistency among data through automatic data checking based on commonly agreed business rules.

Interoperability: Essential contribution to interoperability.

Cost: Reduced costs in terms of data inputs and checks, paper and post, especially when considering the overall data chain, from originators, through AIS to the end users. The business case for the aeronautical information conceptual model (AIXM) has been conducted in Europe and in the United States and has shown to be positive. The initial investment necessary for the provision of digital AIS data may be reduced through regional cooperation and it remains low compared with the cost of other ATM systems. The transition from paper products to digital data is a critical pre-requisite for the implementation of any current or future ATM or Air Navigation concept that relies on the accuracy, integrity and timeliness of data.

B0-AMET Meteorological Information Supporting Enhanced Operational Efficiency and Safety

Global, regional and local meteorological information:

a) Forecasts provided by world area forecast centres (WAFCs), volcanic ash advisory centres (VAACs) and tropical cyclone advisory centres (TCAC).

b) Aerodrome warnings to give concise information of meteorological conditions that could adversely affect all aircraft at an aerodrome, including wind shear.

c) SIGMETs to provide information on occurrence or expected occurrence of specific en-route weather phenomena which may affect the safety of aircraft operations and other operational meteorological (OPMET) information, including METAR/SPECI and TAF, to provide routine and special observations and forecasts of meteorological conditions occurring or expected to occur at the aerodrome.

This information supports flexible airspace management, improved situational awareness and collaborative decision-making, and dynamically-optimized flight trajectory planning. This Module includes elements which should be viewed as a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety

Applicability

Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.

Benefits

Capacity: Optimized use of airspace capacity. Metric: ACC and aerodrome throughput.

Efficiency: Harmonized arriving air traffic (en-route to terminal area to aerodrome) and harmonized departing air traffic (aerodrome to terminal area to en-route) will translate to reduced arrival and departure holding times and thus reduced fuel burn. Metric: Fuel consumption and flight time punctuality.

Environment: Reduced fuel burn through optimized departure and arrival profiling/scheduling. Metric: Fuel burn and emissions.

Safety: Increased situational awareness and improved consistent and collaborative decision making. Metric: Incident occurrences.

Interoperability: Gate-to-gate seamless operations through common access to, and use of, the available WAFS, IAVW and tropical cyclone watch forecast information. Metric: ACC throughput.

Predictability: Decreased variance between the predicted and actual air traffic schedule. Metric: Block time variability, flight-time error/buffer built into schedules.

Participation: Common understanding of operational constraints, capabilities and needs, based on expected (forecast) meteorological conditions. Metric: Collaborative decision-making at the aerodrome and during all phases of flight.

Flexibility: Supports pre-tactical and tactical arrival and departure sequencing and thus dynamic air traffic scheduling. Metric: ACC and aerodrome throughput.

Cost: Reduction in costs through reduced arrival and departure delays (viz. reduced fuel burn). Metric: Fuel consumption and associated costs.

Performance Improvement Area 3: Optimum Capacity and Flexible Flights

B0-FRTO Improved Operations through Enhanced En-route Trajectories

Allow the use of airspace which would otherwise be segregated (i.e. Special Use Airspace) along with flexible routing adjusted for specific traffic patterns. This will allow greater routing possibilities, reducing potential congestion on trunk routes and busy crossing points, resulting in reduced flight lengths and fuel burn.

Applicability

Applicable to en-route airspace. Benefits can start locally. The larger the size of the concerned airspace the greater the benefits, in particular for flex track aspects. Benefits accrue to individual flights and flows. Application will naturally span over a long period as traffic develops. Its features can be introduced starting with the simplest ones.

Benefits

Access and Equity: Better access to airspace by a reduction of the permanently segregated volumes.

Capacity: The availability of a greater set of routing possibilities allows reducing potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations. This in turn allows reducing controller workload by flight.

Efficiency: The different elements concur to trajectories closer to the individual optimum by reducing constraints imposed by permanent design. In particular the Module will reduce flight length and related fuel burn and emissions. The potential savings are a significant proportion of the ATM related inefficiencies. The Module will reduce the number of flight diversions and cancellations. It will also better allow avoidance of noise sensitive areas.

Environment: Fuel burn and emissions will be reduced; however, the area where emissions and contrails will be formed may be larger.

Predictability: Improved planning allows stakeholders to anticipate on expected situations and be better prepared.

Flexibility: The various tactical functions allow rapid reaction to changing conditions.

Cost: FUA: In the United Arab Emirates (UAE) over half of the airspace is military. Opening up this airspace could potentially enable yearly savings in the order of 4.9 million litres of fuel and 581 flight hours. In the United States a study for NASA by Datta and Barington showed maximum savings of dynamic use of FUA of $7.8M (1995$).

Flexible routing: Early modelling of flexible routing suggests that airlines operating a 10-hour intercontinental flight can cut flight time by six minutes, reduce fuel burn by as much as 2% and save 3,000 kilograms of CO_2 emissions. In the United States RTCA NextGen Task Force Report, it was found that benefits would be about 20%

reduction in operational errors; 5-8% productivity increase (near term; growing to 8-14% later); capacity increases (but not quantified). Annual operator benefit in 2018 of $39,000 per equipped aircraft (2008 dollars) growing to $68,000 per aircraft in 2025 based on the FAA Initial investment Decision. For the high throughput, high capacity benefit case (in 2008 dollars): total operator benefit is $5.7B across programme lifecycle (2014-2032, based on the FAA initial investment decision).

B0-NOPS Improved Flow Performance through Planning based on a Network-wide view

Air traffic flow management (ATFM) is used to manage the flow of traffic in a way that minimizes delays and maximizes the use of the entire airspace. ATFM can regulate traffic flows involving departure slots, smooth flows and manage rates of entry into airspace along traffic axes, manage arrival time at waypoints or flight information region (FIR)/sector boundaries and reroute traffic to avoid saturated areas. ATFM may also be used to address system disruptions including crisis caused by human or natural phenomena.

Applicability

Region or subregion.

Benefits

Access and Equity: Improved access by avoiding disruption of air traffic in periods of demand higher than capacity. ATFM processes take care of equitable distribution of delays.

Capacity: Better utilization of available capacity, network-wide; in particular the trust of ATC not being faced by surprise to saturation tends to let it declare/use increased capacity levels; ability to anticipate difficult situations and mitigate them in advance.

Efficiency: Reduced fuel burn due to better anticipation of flow issues; a positive effect to reduce the impact of inefficiencies in the ATM system or to dimension it at a size that would not always justify its costs (balance between cost of delays and cost of unused capacity). Reduced block times and times with engines on.

Environment: Reduced fuel burn as delays are absorbed on the ground, with shut engines; rerouting however generally put flight on a longer distance, but this is generally compensated by other airline operational benefits.

Safety: Reduced occurrences of undesired sector overloads.

Predictability: Increased predictability of schedules as the ATFM algorithms tend to limit the number of large delays.

Participation: Common understanding of operational constraints, capabilities and needs.

Cost: The business case has proven to be positive due to the benefits that flights can obtain in terms of delay reduction.

B0-ASUR Initial Capability for Ground Surveillance

Provides initial capability for lower cost ground surveillance supported by new technologies such as ADS-B OUT and wide area multilateration (MLAT) systems. This capability will be expressed in various ATM services, e.g. traffic information, search and rescue and separation provision.

Applicability

This capability is characterized by being dependent/cooperative (ADS-B OUT) and independent/cooperative (MLAT). The overall performance of ADS-B is affected by avionics performance and compliant equipage rate.

Benefits

Capacity: Typical separation minima are 3 NM or 5 NM enabling a significant increase in traffic density compared to procedural minima. Improved coverage, capacity, velocity vector performance and accuracy can improve ATC performance in both radar and non-radar environments. Terminal area surveillance performance improvements are achieved through high accuracy, better velocity vector and improved coverage.

Efficiency: Availability of optimum flight levels and priority to the equipped aircraft and operators. Reduction of flight delays and more efficient handling of air traffic at FIR boundaries. Reduces workload of air traffic controllers.

Safety: Reduction of the number of major incidents. Support to search and rescue.

Cost: Either comparison between procedural minima and 5 NM separation minima would allow an increase of traffic density in a given airspace; or comparison between installing/renewing SSR Mode S stations using Mode S transponders and installing ADS-B OUT (and/or MLAT systems).

B0-ASEP Air Traffic Situational Awareness (ATSA)

Two air traffic situational awareness (ATSA) applications which will enhance safety and efficiency by providing pilots with the means to enhance traffic situational awareness and achieve quicker visual acquisition of targets:

a) AIRB (basic airborne situational awareness during flight operations).

b) VSA (visual separation on approach).

Applicability

These are cockpit-based applications which do not require any support from the ground hence they can be used by any suitably equipped aircraft. This is dependent upon aircraft being equipped with ADS-B OUT. Avionics availability at low enough costs for GA is not yet available.

Benefits

Efficiency: Improve situational awareness to identify level change opportunities with current separation minima (AIRB) and improve visual acquisition and reduction of missed approaches (VSA).

Safety: Improve situational awareness (AIRB) and reduce the likelihood of wake turbulence encounters (VSA).

Cost: The cost benefit is largely driven by higher flight efficiency and consequent savings in contingency fuel.

The benefit analysis of the EUROCONTROL CRISTAL ITP project of the CASCADE Programme and subsequent update had shown that ATSAW AIRB and ITP together are capable of providing the following benefits over N. Atlantic:

a) Saving 36 million Euro (50K Euro per aircraft) annually.

b) Reducing carbon dioxide emissions by 160,000 tonnes annually.

The majority of these benefits are attributed to AIRB. Findings will be refined after the completion of the pioneer operations starting in December 2011.

B0-OPFL Improved Access to Optimum Flight Levels through Climb/Descent Procedures using ADS B)

Enables aircraft to reach a more satisfactory flight level for flight efficiency or to avoid turbulence for safety. The main benefit of ITP is significant fuel savings and the uplift of greater payloads.

Applicability

This can be applied to routes in procedural airspaces.

Benefits

Capacity: Improvement in capacity on a given air route.

Efficiency: Increased efficiency on oceanic and potentially continental en-route.

Environment: Reduced emissions.

Safety: A reduction of possible injuries for cabin crew and passengers.

B0-ACAS Airborne Collision Avoidance Systems (ACAS) Improvements

Provides short-term improvements to existing airborne collision avoidance systems (ACAS) to reduce nuisance alerts while maintaining existing levels of safety. This will reduce trajectory deviations and increase safety in cases where there is a breakdown of separation.

Applicability

Safety and operational benefits increase with the proportion of equipped aircraft.

Benefits

Efficiency: ACAS improvement will reduce unnecessary resolution advisory (RA) and then reduce trajectory deviations.

Safety: ACAS increases safety in the case of breakdown of separation.

B0-SNET Increased Effectiveness of Ground-Based Safety Nets

Monitors the operational environment during airborne phases of flight to provide timely alerts on the ground of an increased risk to flight safety. In this case, short-term conflict alert, area proximity warnings and minimum safe altitude warnings are proposed. Ground-based safety nets make an essential contribution to safety and remain required as long as the operational concept remains human centred.

Applicability

Benefits increase as traffic density and complexity increase. Not all ground-based safety nets are relevant for each environment. Deployment of this Module should be accelerated.

Benefits

Safety: Significant reduction of the number of major incidents.

Cost: The business case for this element is entirely made around safety and the application of ALARP (as low as reasonably practicable) in risk management.

Performance Improvement Area 4: Efficient Flight Paths

B0-CDO Improved Flexibility and Efficiency in Descent Profiles using Continuous Descent Operations (CDOs)

Performance-based airspace and arrival procedures allowing aircraft to fly their optimum profile using continuous descent operations (CDOs). This will optimize throughput, allow fuel efficient descent profiles, and increase capacity in terminal areas.

Applicability

Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers:

a) Least complex – regional/States/locations with some foundational PBN operational experience that could capitalize on near-term enhancements, which include integrating procedures and optimizing performance.

b) More complex – regional/State/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation.

c) Most complex – regional/State/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location.

Benefits

Efficiency: Cost savings and environmental benefits through reduced fuel burn. Authorization of operations where noise limitations would otherwise result in operations being curtailed or restricted. Reduction in the number of required radio transmissions. Optimal management of the top-of-descent in the en-route airspace.

Safety: More consistent flight paths and stabilized approach paths. Reduction in the incidence of controlled flight into terrain (CFIT). Separation with the surrounding traffic (especially free-routing). Reduction in the number of conflicts.

Predictability: More consistent flight paths and stabilized approach paths. Less need for vectors.

Cost: It is important to consider that CDO benefits are heavily dependent on each specific ATM environment. Nevertheless, if implemented within the ICAO CDO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive. After CDO implementation in Los Angeles TMA (KLAX) there was a 50% reduction in radio transmissions and fuel savings averaging 125 pounds per flight (13.7 million pounds/year; 41 million pounds of CO_2 emission).

The advantage of PBN to the ANSP is that PBN avoids the need to purchase and deploy navigation aids for each new route or instrument procedure.

B0-TBO Improved Safety and Efficiency through the Initial Application of Data Link En-route

Implements an initial set of data link applications for surveillance and communications in air traffic control (ATC), supporting flexible routing, reduced separation and improved safety.

Applicability

Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those equipped. Benefits increase with the proportion of equipped aircraft.

Benefits

Capacity: Element 1: A better localization of traffic and reduced separations allow increasing the offered capacity.

Element 2: Reduced communication workload and better organization of controller tasks allowing increased sector capacity.

Efficiency: Element 1: Routes/tracks and flights can be separated by reduced minima, allowing flexible routings and vertical profiles closer to the user-preferred ones.

Safety: Element 1: Increased situational awareness; ADS-C based safety nets like cleared level adherence monitoring, route adherence monitoring, danger area infringement warning; and better support to search and rescue.

Element 2: Increased situational awareness; reduced occurrences of misunder-standings; solution to stuck microphone situations.

Flexibility: Element 1: ADS-C permits easier route change.

Cost: Element 1: The business case has proven to be positive due to the benefits that flights can obtain in terms of better flight efficiency (better routes and vertical profiles; better and tactical resolution of conflicts).

To be noted, the need to synchronize ground and airborne deployments to ensure that services are provided by the ground when aircraft are equipped, and that a minimum proportion of flights in the airspace under consideration are suitably equipped.

Element 2: The European business case has proved to be positive due to:

a) the benefits that flights obtain in terms of better flight efficiency (better routes and vertical profiles; better and tactical resolution of conflicts); and

b) reduced controller workload and increased capacity.

A detailed business case has been produced in support of the EU regulation which was solidly positive. To be noted, there is a need to synchronize ground and airborne deployments to ensure that services are provided by the ground when aircraft are equipped, and that a minimum proportion of flights in the airspace under consideration are suitably equipped.

B0-CCO Improved Flexibility and Efficiency Departure Profiles – Continuous Climb Operations (CCO)

Implements continuous climb operations (CCO) in conjunction with performance-based navigation (PBN) to provide opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb profiles, and increase capacity at congested terminal areas.

Applicability

Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers:

a) Least complex – regional/States/locations with some foundational PBN operational experience that could capitalize on near-term enhancements, which include integrating procedures and optimizing performance.

b) More complex – regional/State/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation.

c) Most complex – regional/State/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location.

Benefits

Efficiency: Cost savings through reduced fuel burn and efficient aircraft operating profiles. Reduction in the number of required radio transmissions.

Environment: Authorization of operations where noise limitations would otherwise result in operations being curtailed or restricted. Environmental benefits through reduced emissions.

Safety: More consistent flight paths. Reduction in the number of required radio transmissions. Lower pilot and air traffic control workload.

Cost: It is important to consider that CCO benefits are heavily dependent on the specific ATM environment. Nevertheless, if implemented within the ICAO CCO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive.

Block 1

The Block 1 Modules will introduce new concepts and capabilities supporting the future ATM System, namely: Flight and Flow Information for a Collaborative Environment (FF-ICE); Trajectory-Based Operations (TBO); System-Wide Information Management (SWIM) and the integration of Remotely Piloted Aircraft (RPAs) into non-segregated airspace.

These concepts are at various stages of development. Some have been subject to flight trials in a controlled environment while others, such as FF-ICE, exist as a series of steps leading to the implementation of well understood concepts. As such, confidence is high that they will be successfully implemented but the near-term standardization is expected to be challenging, as outlined below.

Human Performance factors will have a strong impact on the final implementation of concepts such as FF-ICE and TBO. Closer integration of airborne and ground-based systems will call for a thorough end-to-end consideration of Human Performance impacts.

Similarly, technological enablers will also affect the final implementation of these concepts. Typical technological enablers include air-ground data link and the exchange models for SWIM. Every technology has limits on its performance and this could, in turn, impact the achievable operational benefits—either directly or through their effect on Human Performance.

The standardization effort will therefore need to follow three parallel courses:

a) The development and refinement of the final concept.

b) Consideration of end-to-end Human Performance impacts and their effect on the ultimate concept and the necessary technological enablers.

c) Further consideration of the technological enablers to ensure that their performance can support operations based on the new concepts and, if not, what procedural or other changes will be needed.

d) Harmonization of the relevant Standards on a global level.

For example, RPAs will require a 'detect and avoid' capability as well as a Command and Control link which is more robust than the pilot-ATC link available today. In each case, these are meant to replicate the cockpit experience for the remote pilot. There will clearly be some limits to what technology can provide in this regard, hence consideration will need to be given to limits on operations, special procedures, etc.

This is the essence of the standardization challenge ahead. Stakeholders need to be sensitized and brought together to develop unified solutions and ICAO will address this through a series of events:

- In 2014, ICAO will support, in collaboration with industry and States, end-to-end demonstrations of new concepts such as TBO and FF-ICE, including the Human Performance aspects.

- In 2014, ICAO will host a symposium on Aviation Data link. This event will help us identify the next steps for data link—both in terms of technology, services and implementation.

- In 2015, ICAO will hold an Air Navigation Information Management Divisional Meeting focused on SWIM.

Block 1 therefore represents the primary ICAO technical work programme on air navigation and efficiency for the next triennium. It will require collaboration with industry and regulators, in order to provide a coherent globally harmonised set of operational improvements in the proposed timeframe.

Block 1

The Modules comprising Block 1, which are intended to be available beginning in 2018, satisfy one of the following criteria:

a) The operational improvement represents a well understood concept that has yet to be trialed.

b) The operational improvement has been trialed successfully in a simulated environment.

c) The operational improvement has been trialed successfully in a controlled operational environment.

d) The operational improvement is approved and ready for roll-out.

Performance Improvement Area 1: Airport Operations

B1-APTA Optimized Airport Accessibility

Progresses further with the universal implementation of performance-based navigation (PBN) approaches. PBN and GLS (CAT II/III) procedures to enhance the reliability and predictability of approaches to runways increasing safety, accessibility and efficiency.

Applicability

This Module is applicable to all runway ends.

Benefits

Efficiency: Cost savings related to the benefits of lower approach minima: fewer diversions, overflights, cancellations and delays. Cost savings related to higher airport capacity by taking advantage of the flexibility to offset approaches and define displaced thresholds.

Environment: Environmental benefits through reduced fuel burn.

Safety: Stabilized approach paths.

Cost: Aircraft operators and ANSPs can quantify the benefits of lower minima by modelling airport accessibility with existing and new minima. Operators can then assess benefits against avionics and other costs. The GLS CAT II/III business case needs to consider the cost of retaining ILS or MLS to allow continued operations during an interference event. The potential for increased runway capacity benefits with GLS is complicated at airports where a significant proportion of aircraft are not equipped with GLS avionics.

B1-WAKE Increased Runway Throughput through Dynamic Wake Turbulence Separation

Improved throughput on departure and arrival runways through the dynamic management of wake turbulence separation minima based on the real-time identification of wake turbulence hazards.

Applicability

Least complex – implementation of re-categorized wake turbulence is mainly procedural. No changes to automation systems are needed.

Benefits

Capacity: Element 1: Better wind information around the aerodrome to enact reduced wake mitigation measures in a timely manner. Aerodrome capacity and arrival rates will increase as the result of reduced wake mitigation measures.

Environment: Element 3: Changes brought about by this element will enable more accurate crosswind prediction.

Flexibility: Element 2: Dynamic scheduling. ANSPs have the choice of optimizing the arrival/departure schedule via pairing number of unstable approaches.

Cost: Element 1's change to the ICAO wake turbulence separation minima will yield an average nominal four per cent additional capacity increase for airport runways. The four per cent increase translates to one more landing per hour for a single runway that normally could handle thirty landings per hour. One extra slot per hour creates revenue for the air carrier that fills them and for the airport that handles the extra aircraft operations and passengers.

The impact of the Element 2 Upgrade is the reduced time that an airport, due to weather conditions, must operate its parallel runways, with centre lines spaced less than 760 m (2,500 feet) apart, as a single runway. Element 2 Upgrade allows more airports to better utilize such parallel runways when they are conducting instrument flight rules operations – resulting in a nominal eight to ten more airport arrivals per hour when crosswinds are favourable for WTMA reduced wake separations. For the Element 2 Upgrade, the addition of a crosswind prediction and monitoring capability to the ANSP automation is required. For the Element 2 and 3 Upgrades, additional downlink and real-time processing of aircraft observed wind information will be required. There are no aircraft equipage costs besides costs incurred for other Module Upgrades.

Impact of the Element 3 Upgrade is reduced time that an airport must space departures on its parallel runways, with centre lines spaced less than 760 m (2,500 feet) apart, by two to three minutes, depending on runway configuration. Element 3 Upgrade will provide more time periods that an airport ANSP can safely use WTMD reduced wake separations on their parallel runways. The airport departure capacity increases four to eight more departure operations per hour when WTMD reduced separations can be used. Downlink and real time processing of aircraft observed wind information will be required. There are no aircraft equipage costs besides costs incurred for other Module Upgrades.

B1-SURF Enhanced Safety and Efficiency of Surface Operations – SURF, SURF-IA and Enhanced Vision Systems (EVS)

Provides enhancements for surface situational awareness, including both cockpit and ground elements, in the interest of runway and taxiway safety, and surface movement efficiency. Cockpit improvements including the use of surface moving maps with traffic information (SURF), runway safety alerting logic (SURF-IA), and enhanced vision systems (EVS) for low visibility taxi operations.

Applicability

For SURF and SURF-IA, applicable to large aerodromes (ICAO codes 3 and 4) and all classes of aircraft; cockpit capabilities work independently of ground infrastructure, but other aircraft equipage and/or ground surveillance broadcast will improve.

Benefits

Efficiency: Element 1: Reduced taxi times.

Element 2: Fewer navigation errors requiring correction by ANSP.

Safety: Element 1: Reduced risk of collisions.

Element 2: Improved response times to correction of unsafe surface situations (SURF-IA only).

Element 3: Fewer navigation errors.

Cost: The business case for this element can be largely made around safety. Currently, the aerodrome surface is often the regime of flight which has the most risk for aircraft safety, due to the lack of good surveillance on the ground acting in redundancy with cockpit capabilities. Visual scanning augmentation in the cockpit acting in conjunction with service provider capabilities enhances operations on the surface. Efficiency gains are expected to be marginal and modest in nature.

Improving flight crew situational awareness of aircraft position during periods of reduced visibility will reduce errors in the conduct of taxi operations, which lead to both safety and efficiency gains.

B1-ACDM Optimized Airport Operations through A-CDM Total Airport Management

Enhances the planning and management of airport operations and allows their full integration for air traffic management using performance targets compliant with those of the surrounding airspace. This entails implementing collaborative airport operations planning (AOP) and where needed, an airport operations centre (APOC).

Applicability

AOP: for use at all the airports (sophistication will depend on the complexity of the operations and their impact on the network).

APOC: will be implemented at major/complex airports (sophistication will depend on the complexity of the operations and their impact on the network).

Not applicable to aircraft.

Benefits

Efficiency: Through collaborative procedures, comprehensive planning and pro-active action to foreseeable problems a major reduction in on-ground and in-air holding is expected thereby reducing fuel consumption. The planning and pro-active actions will also support efficient use of resources; however, some minor increase in resources may be expected to support the solution(s).

Environment: Through collaborative procedures, comprehensive planning and pro-active action to foreseeable problems a major reduction in on-ground and in-air holding is expected thereby reducing noise and air pollution in the vicinity of the airport.

Predictability: Through the operational management of performance, reliability and accuracy of the schedule and demand forecast will increase (in association with initiatives being developed in other Modules).

Cost: Through collaborative procedures, comprehensive planning and pro-active action to foreseeable problems, a major reduction in on-ground and in-air holding is expected thereby reducing fuel consumption. The planning and pro-active actions will also support efficient use of resources; however, some minor increase in resources may be expected to support the solution(s).

B1-RATS Remotely Operated Aerodrome Control

Provides a safe and cost-effective air traffic services (ATS) from a remote facility to one or more aerodromes where dedicated, local ATS are no longer sustainable or cost-effective, but there is a local economic and social benefit from aviation. This can also be applied to contingency situations and depends on enhanced situational awareness of the aerodrome under remote control.

Applicability

The main target for the single and multiple remote tower services are small rural airports, which today are struggling with low business margins. Both ATC and AFIS aerodromes are expected to benefit.

The main targets for the contingency tower solution are medium to large airports – those that are large enough to require a contingency solution, but who require an alternative to A-SMGCS based "heads down" solutions or where maintaining a visual view is required.

Although some cost benefits are possible with remote provision of ATS to a single aerodrome, maximum benefit is expected with the remote of ATS to multiple aerodromes.

Benefits

Capacity: Capacity may be increased through the use of digital enhancements in low visibility.

Efficiency: Efficiency benefits through the ability to exploit the use of technology in the provision of the services. Digital enhancements can be used to maintain throughput in low visibility conditions.

Safety: Same or greater levels of safety as if the services were provided locally. The use of the digital visual technologies used in the RVT should provide safety enhancements in low visibility.

Flexibility: Flexibility may be increased through a greater possibility to extend opening hours when through remote operations.

Cost: There are no current operational remote towers, therefore the cost/benefit analyses (CBAs) are necessarily based on some assumptions developed by subject matter experts. Costs incurred are associated with procurement and installation of equipment and additional capital costs in terms of new hardware and adaptation of buildings. New operating costs include facilities leases, repairs and maintenance and communication links. There are then short term transition costs such as staff re-training, re-deployment and relocation costs.

Against this, savings are derived from remote tower implementation. A significant portion of these result from savings in employment costs due to reduction in shift size. Previous CBAs indicated a reduction in staff costs of 10-35% depending on the scenario. Other savings arise from reduced capital costs, particularly savings from not having to replace and maintain tower facilities and equipment and from a reduction in tower operating costs.

The CBA concluded that remote towers do produce positive financial benefits for ANSPs. Further CBAs will be conducted during 2012 and 2013 using a range of implementation scenarios (single, multiple, contingency).

B1-RSEQ Improved Airport Operations through Departure, Surface and Arrival Management

Extension of arrival metering and integration of surface management with departure sequencing will improve runway management and increase airport performance and flight efficiency.

Applicability

Runways and terminal manoeuvring areas in major hubs and metropolitan areas will be most in need of these improvements. Complexity in implementation of this Module depends on several factors. Some locations might have to confront environmental and operational challenges that will increase the complexity of development and implementation of technology and procedures to realize this Module. Performance-based Navigation (PBN) routes need to be in place.

Benefits

Capacity: Time-based metering will optimize usage of terminal airspace and runway capacity.

Efficiency: Surface management decreases runway occupancy time, introduces more robust departure rates and enables dynamic runway rebalancing and re-configuration. Departure/surface integration enables dynamic runway rebalancing to better accommodate arrival and departure patterns. Reduction in airborne delay/holding. Traffic flow synchronization between en-route and terminal domain. RNAV/RNP procedures will optimize aerodrome/terminal resource utilization.

Environment: Reduction in fuel burn and environment impact (emission and noise).

Safety: Greater precision in surface movement tracking.

Predictability: Decrease uncertainties in aerodrome/terminal demand prediction. Increased compliance with assigned departure time and more predictable and orderly flow into metering points. Greater compliance to controlled time of arrival (CTA) and more accurate assigned arrival time and greater compliance.

Flexibility: Enables dynamic scheduling.

Cost: Cost-benefits may be reasonably projected for multiple stakeholders due to increased capacity, predictability and efficiency of airline and airport operations.

Performance Improvement Area 2: Globally Interoperable Systems and Data

B1-FICE Increased Interoperability, Efficiency and Capacity through Flight and Flow Information for a Collaborative Environment Step-1 (FF-ICE/1) application before Departure

Introduces FF-ICE, Step 1 providing ground-ground exchanges using a common flight information reference model (FIXM) and extensible markup language (XML) standard formats before departure.

Applicability

Applicable between ATS units to facilitate exchange between ATM service provider (ASP), airspace user operations and airport operations.

Benefits

Capacity: Reduced air traffic controller (ATC) workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases.

Efficiency: Better knowledge of aircraft capabilities allows trajectories closer to airspace user preferred trajectories and better planning.

Safety: More accurate flight information.

Interoperability: The use of a new mechanism for FPL filing and information sharing will facilitate flight data sharing among the actors.

Participation: FF-ICE, Step 1 for ground-ground application will facilitate collaborative decision-making (CDM), the implementation or the systems interconnection for information sharing, trajectory or slot negotiation before departure providing better use of capacity and better flight efficiency.

Flexibility: The use of FF-ICE, Step 1 allows a quicker adaptation of route changes.

Cost: The new services have to be balanced by the cost of software changes in the ATM service provider (ASP), airline operations center (AOC) and airport ground systems.

B1-DATM Service Improvement through Integration of all Digital ATM Information

Implements the ATM information reference model, integrating all ATM information, using common formats (UML/XML and WXXM) for meteorological information, FIXM for flight and flow information and internet protocols.

Applicability

Applicable at the State level, with increased benefits as more States participate.

Benefits

Access and Equity: Greater and timelier access to up-to-date information by a wider set of users.

Efficiency: Reduced processing time for new information; increased ability of the system to create new applications through the availability of standardized data.

Safety: Reduced probability of data errors or inconsistencies; reduced possibility to introduce additional errors through manual inputs.

Interoperability: Essential for global interoperability.

Cost: Business case to be established in the course of the projects defining the models and their possible implementation.

B1-SWIM Performance Improvement through the Application of System-Wide Information Management (SWIM)

Implementation of system-wide information management (SWIM) services (applications and infrastructure) creating the aviation intranet based on standard data models and internet-based protocols to maximize interoperability.

Applicability

Applicable at State level, with increased benefits as more States participate.

Benefits

Efficiency: Using better information allows operators and service providers to plan and execute better trajectories.

Environment: Further reduction of paper usage, more cost-efficient flights as the most up-to-date information is available to all stakeholders in the ATM system.

Safety: Access protocols and data quality will be designed to reduce current limitations in these areas.

Cost: Further reduction of costs; all information can be managed consistently across the network, limiting bespoke developments, flexible to adapt to state-of-the-art industrial products and making use of scale economies for the exchanged volumes.

The business case is to be considered in the full light of other Modules of this Block and the next one. Pure SWIM aspects unlock ATM information management issues; operational benefits are more indirect.

B1-AMET Enhanced Operational Decisions through Integrated Meteorological Information (Planning and Near-term Service)

Enables the reliable identification of solutions when forecast or observed meteorological conditions impact aerodromes or airspace. Full ATM-Meteorology integration is needed to ensure that: meteorological information is included in the logic of a decision process and the impact of the meteorological conditions (the constraints) are automatically calculated and taken into account The decision time-horizons range from minutes, to several hours or days ahead of the ATM operation (this includes optimum flight profile planning and tactical in-flight avoidance of hazardous meteorological conditions) to typically enable near-term and planning (>20 minutes) type of decision making. This Module also promotes the establishment of standards for global exchange of the information.

Appreciating that the number of flights operating on cross-polar and trans-polar routes continues to steadily grow and recognizing that space weather affecting the earth's surface or atmosphere (such as solar radiation storms) pose a hazard to communications and navigation systems and may also pose a radiation risk to flight crew members and passengers, this module acknowledges the need for space weather information services in support of safe and efficient international air navigation. Unlike traditional meteorological disturbances which tend to be local or sub-regional in scale, the effects of space weather disturbances can be global in nature (although tend to be more prevalent in the polar regions), with much more rapid onset

This Module builds, in particular, upon Module B0-AMET, which detailed a sub-set of all available meteorological information that can be used to support enhanced operational efficiency and safety.

Applicability

Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.

Benefits

Capacity: Enables more precise estimates of expected capacity of a given airspace.

Efficiency: Reduces the number of deviations from user-preferred flight profiles. Decrease in the variability and numbers of ATM responses to a given meteorological situation, along with reduced contingency fuel carriage for the same meteorological situation.

Environment: Less fuel burn, and reduction of emissions due to fewer ground hold/delay actions.

Safety: Increased situational awareness by pilots, AOCs and ANSPs, including enhanced safety through the avoidance of hazardous meteorological conditions. Reduced contingency fuel carriage for the same meteorological condition.

Predictability: More consistent evaluations of meteorological constraints, which in turn will allow users to plan trajectories that are more likely to be acceptable from the standpoint of the ANSP. Fewer reroutes and less variability in associated traffic management initiatives (TMIs) can be expected.

Flexibility: Users have greater flexibility in selecting trajectories that best meet their needs, taking into account the observed and forecast meteorological conditions.

Cost: The business case for this element is still to be determined as part of the development of this overall Module, which is in the research phase. Current experience with utilization of ATM decision support tools, with basic meteorological input parameters to improve ATM decision making by stakeholders has proven to be positive in terms of producing consistent responses from both the ANSP and user community.

Performance Improvement Area 3: Optimum Capacity and Flexible Flights

B1-FRTO Improved Operations through Optimized ATS Routing

Provides, through performance-based navigation (PBN), closer and consistent route spacing, curved approaches, parallel offsets and the reduction of holding area size. This will allow the sectorization of airspace to be adjusted more dynamically. This will reduce potential congestion on trunk routes and busy crossing points and reduce controller workload. The main goal is to allow flight plans to be filed with a significant part of the intended route specified by the user-preferred profile. Maximum freedom will be granted within the limits posed by the other traffic flows. The overall benefits are reduced fuel burn and emissions.

Applicability

Region or sub-region: the geographical extent of the airspace of application should be large enough; significant benefits arise when the dynamic routes can apply across flight information region (FIR) boundaries rather than imposing traffic to cross boundaries at fixed predefined points.

Benefits

Capacity: The availability of a greater set of routing possibilities allows for reduction of potential congestion on trunk routes and at busy crossing points. This in turn allows for reduction of controller workload by flight.

Free routings naturally spreads traffic in the airspace and the potential interactions between flights, but also reduces the "systematization" of flows and therefore may have a negative capacity effect in dense airspace if it is not accompanied by suitable assistance.

Reduced route spacing means reduced consumption of airspace by the route network and a greater possibility to match it with flows.

Efficiency: Trajectories closer to the individual optimum by reducing constraints imposed by permanent design and/or by the variety of aircraft behaviours. In particular the Module will reduce flight length and related fuel burn and emissions.

The potential savings are a significant proportion of the ATM-related inefficiencies. Where capacity is not an issue, fewer sectors may be required as the spreading of traffic or better routings should reduce the risk of conflicts.

Easier design of high-level temporary segregated airspace (TSAs).

Environment: Fuel burn and emissions will be reduced; however, the area where emissions and contrails will be formed may be larger.

Flexibility: Choice of routing by the airspace user would be maximized. Airspace designers would also benefit from greater flexibility to design routes that fit the natural traffic flows.

Cost: The business case of free routing has proved to be positive due to the benefits that flights can obtain in terms of better flight efficiency (better routes and vertical profiles; better and tactical resolution of conflicts).

B1-NOPS Enhanced Flow Performance through Network Operational Planning

Introduces enhanced processes to manage flows or groups of flights in order to improve overall flow. The resulting increased collaboration among stakeholders in real-time, regarding user preferences and system capabilities will result in better use of airspace with positive effects on the overall cost of ATM.

Applicability

Region or sub-region for most applications; specific airports in case of initial user driven prioritization process (UDPP). This Module is more particularly needed in areas with the highest traffic density. However, the techniques it contains would also be of benefit to areas with lesser traffic, subject to the business case.

Benefits

Capacity: Better use of airspace and ATM network, with positive effects on the overall cost efficiency of ATM. Optimization of DCB measures by using assessment of workload/complexity as a complement to capacity.

Efficiency: Reduction of flight penalties supported by airspace users.

Environment: Some minor improvement is expected compared to the Module's baseline.

Safety: The Module is expected to further reduce the number of situations where capacity or acceptable workload would be exceeded.

Predictability: Airspace users have greater visibility and say on the likelihood to respect their schedule and can make better choices based on their priorities.

Cost: The business case will be a result of the validation work being undertaken.

B1-ASEP Increased Capacity and Efficiency through Interval Management

Interval management (IM) improves the organization of traffic flows and aircraft spacing. This creates operational benefits through precise management of intervals between aircraft with common or merging trajectories, thus maximizing airspace throughput while reducing ATC workload along with more efficient aircraft fuel burn reducing environmental impact.

Applicability

En-route and terminal areas.

Benefits

Capacity: Consistent, low variance spacing between paired aircraft (e.g. at the entry to an arrival procedure and on final approach) resulting in reduced fuel burn.

Efficiency: Early speed advisories removing requirement for later path-lengthening. Continued optimized profile descents (OPDs) in medium density environments expected to allow OPDs when demand <=70%. Resulting in reduced holding times and flight times.

Environment: Reduced emissions due to reduced spacings and optimized profiles.

Safety: Reduced ATC instructions and workload without unacceptable increase in flight crew workload.

Cost: Labour savings due to reduced ATC workload.

B1-SNET Ground-based Safety Nets on Approach

Enhances safety by reducing the risk of controlled flight into terrain accidents on final approach through the use of an approach path monitor (APM). APM warns the controller of increased risk of controlled flight into terrain during final approaches. The major benefit is a significant reduction of the number of major incidents.

Applicability

This Module will increase safety benefits during final approach particularly where terrain or obstacles represent safety hazards. Benefits increase as traffic density and complexity increase.

Benefits

Safety: Significant reduction of the number of major incidents.

Cost: The business case for this element is entirely made around safety and the application of ALARP (as low as reasonably practicable) in risk management.

Performance Improvement Area 4: Efficient Flight Paths

B1-CDO Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV

Enhances vertical flight path precision during descent, arrival, and enables aircraft to fly an arrival procedure not reliant on ground-based equipment for vertical guidance. The main benefit is higher utilization of airports, improved fuel efficiency, increased safety through improved flight predictability and reduced radio transmission, and better utilization of airspace.

Applicability

Terminal arrival and departure procedures.

Benefits

Capacity: PBN with VNAV allows for added accuracy in a continuous descent operation (CDO). This capability allows for the potential to expand the applications of standard terminal arrival and departure procedures for improved capacity and throughput, and improve the implementation of precision approaches.

Efficiency: Enabling an aircraft to maintain a vertical path during descent allows for development of vertical corridors for arriving and departing traffic thus increasing the efficiency of the airspace. Additionally, VNAV promotes the efficient use of airspace through the ability for aircraft to fly a more precisely constrained descent profile allowing the potential for further reduced separation and increased capacity.

Environment: Reduced fuel burns from more accurate precision descents results in lower emissions.

Safety: Precise altitude tracking along a vertical descent path leads to improvements in overall system safety.

Predictability: VNAV allows for enhanced predictability of flight paths which leads to better planning of flights and flows.

Cost: VNAV allows for reduced aircraft level-offs, resulting in fuel and time savings.

B1-TBO Improved Traffic Synchronization and Initial Trajectory-based Operation

Improves the synchronization of traffic flows at en-route merging points and to optimize the approach sequence through the use of 4DTRAD capability and airport applications, e.g. D-TAXI.

Applicability

Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those equipped. Benefit increases with size of equipped aircraft population in the area where the services are provided.

Benefits

Capacity: Positively affected because of the reduction of workload associated to the establishment of the sequence close to the convergence point and related tactical interventions. Positively affected because of the reduction of workload associated to the delivery of departure and taxi clearances.

Efficiency: Increased by using the aircraft RTA capability for traffic synchronization planning through en-route and into terminal airspace. 'Closed loop' operations on RNAV procedures ensure common air and ground system awareness of traffic evolution and facilitate its optimization. Flight efficiency is increased through proactive planning of top of descent, descent profile and en-route delay actions, and enhanced terminal airspace route efficiency.

Environment: More economic and environmentally friendly trajectories, in particular absorption of some delays.

Safety: Safety at/around airports by a reduction of the misinterpretations and errors in the interpretation of the complex departure and taxi clearances.

Predictability: Increased predictability of the ATM system for all stakeholders through greater strategic management of traffic flow between and within FIRs en-route and terminal airspace using the aircraft RTA capability or speed control to manage a ground CTA. Predictable and repeatable sequencing and metering. "Closed loop" operations on RNAV procedures ensuring common air and ground system awareness of traffic evolution.

Cost: Establishment of the business case is underway. The benefits of the proposed airport services were already demonstrated in the EUROCONTROL CASCADE Programme.

B1-RPAS Initial Integration of Remotely Piloted Aircraft (RPA) into Non-segregated Airspace

Implementation of basic procedures for operating remotely piloted aircraft (RPA) in non-segregated airspace, including detect and avoid.

Applicability

Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.

Benefits

Access and Equity: Limited access to airspace by a new category of users.

Safety: Increased situational awareness; controlled use of aircraft.

Cost: The business case is directly related to the economic value of the aviation applications supported by RPAs.

Block 2

The Modules comprising Block 2 are intended to be available in 2023 and must satisfy one of the following criteria:

a) Represent a natural progression from the preceding Module in Block 1.

b) Support the requirements of the operating environment in 2023.

Performance Improvement Area 1: Airport Operations

B2-WAKE Advanced Wake Turbulence Separation (Time-based)

The application of time-based aircraft-to-aircraft wake separation minima and changes to the procedures the ANSP uses to apply wake separation minima.

Applicability

Most complex – establishment of time-based separation criteria between pairs of aircraft extends the existing variable distance re-categorization of existing wake turbulence into a conditions specific time-based interval. This will optimize the inter-operation wait time to the minimum required for wake disassociation and runway occupancy. Runway throughput is increased as a result.

B2-SURF Optimized Surface Routing and Safety Benefits (A-SMGCS Level 3-4 and SVS)

To improve efficiency and reduce the environmental impact of surface operations, even during periods of low visibility. Queuing for departure runways is reduced to the minimum necessary to optimize runway use and taxi times are also reduced. Operations will be improved so that low visibility conditions have only a minor effect on surface movement.

Applicability

Most applicable to large aerodromes with high demand, as the Upgrades address issues surrounding queuing and management and complex aerodrome operations.

B2-RSEQ Linked Arrival Management and Departure Management (AMAN/DNAM)

Integrated AMAN/DMAN to enable dynamic scheduling and runway configuration to better accommodate arrival/departure patterns and integrate arrival and departure management. The Module also summarizes the benefits of such integration and the elements that facilitate it.

Applicability

Runways and terminal manoeuvring area in major hubs and metropolitan areas will be most in need of these improvements. The implementation of this Module is least complex. Some locations might have to confront environmental and operational challenges that will increase the complexity of development and implementation technology and procedures to realize this Block. Infrastructure for RNAP/RNP routes need to be in place.

Performance Improvement Area 2: Globally Interoperable Systems and Data

B2-FICE Improved Coordination through Multi-entre Ground-Ground Integration (FF ICE, Step 1 and Flight Object, SWIM)

FF-ICE supporting trajectory-based operations through exchange and distribution of information for multi-centre operations using flight object implementation and interoperability (IOP) standards. Extension of use of FF-ICE after departure, supporting trajectory-based operations. New system interoperability SARPs to support the sharing of ATM services involving more than two air traffic service units (ATSUs).

Applicability

Applicable to all ground stakeholders (ATS, airports, airspace users) in homogeneous areas, potentially global.

B2-SWIM Enabling Airborne Participation in Collaborative ATM through SWIM

This allows the aircraft to be fully connected as an information node in SWIM, enabling full participation in collaborative ATM processes with exchange of data including meteorology. This will start with non-safety critical exchanges supported by commercial data links.

Applicability

Long-term evolution potentially applicable to all environments.

Performance Improvement Area 3: Optimum Capacity and Flexible Flights

B2-NOPS Increased User Involvement in the Dynamic Utilization of the Network

CDM applications supported by SWIM that permit airspace users to manage competition and prioritization of complex ATFM solutions when the network or its nodes (airports, sector) no longer provide enough capacity to meet user demands. This further develops the CDM applications by which ATM will be able to offer/delegate to the users the optimization of solutions to flow problems. Benefits include an improvement in the use of available capacity and optimized airline operations in degraded situations.

Applicability

Region or sub-region.

B2-ASEP Airborne Separation (ASEP)

Creation of operational benefits through temporary delegation of responsibility to the flight deck for separation provision with suitably equipped designated aircraft, thus reducing the need for conflict resolution clearances while reducing ATC workload and enabling more efficient flight profiles. The flight crew ensures separation from suitably equipped designated aircraft as communicated in new clearances, which relieve the controller of the responsibility for separation between these aircraft. However, the controller retains responsibility for separation from aircraft that are not part of these clearances.

Applicability

The safety case needs to be carefully done and the impact on capacity is still to be assessed in case of delegation of separation for a particular situation implying new regulation on airborne equipment and equipage roles and responsibilities (new procedure and training). First applications of ASEP are envisaged in Oceanic airspace and in approach for closely-spaced parallel runways.

B2-ACAS New Collision Avoidance System

Implementation of the airborne collision avoidance system (ACAS) adapted to trajectory-based operations with improved surveillance function supported by ADS-B and adaptive collision avoidance logic aiming at reducing nuisance alerts and minimizing deviations.

The implementation of a new airborne collision warning system will enable more efficient operations and future airspace procedures while complying with safety regulations. The new system will accurately discriminate between necessary alerts and “nuisance alerts”. This improved differentiation will lead to a reduction in controller workload as personnel will spend less time to respond to “nuisance alerts”. This will result in a reduction in the probability of a near mid-air collision.

Applicability

Safety and operational benefits increase with the proportion of equipped aircraft. The safety case needs to be carefully done.

Performance Improvement Area 4: Efficient Flight Paths

B2-CDO Improved Flexibility and Efficiency in Descent Profiles (CDOs) Using VNAV, Required Speed and Time at Arrival

A key emphasis is on the use of arrival procedures that allow the aircraft to apply little or no throttle in areas where traffic levels would otherwise prohibit this operation. This Block will consider airspace complexity, air traffic workload, and procedure design to enable optimized arrivals in dense airspace.

Applicability

Global, high density airspace (based on the United States FAA procedures).

B2-RPAS Remotely Piloted Aircraft (RPA) Integration in Traffic

Continuing to improve the remotely piloted aircraft (RPA) access to non-segregated airspace; continuing to improve the remotely piloted aircraft system (RPAS) approval/certification process; continuing to define and refine the RPAS operational procedures; continuing to refine communication performance requirements; standardizing the command and control (C2) link failure procedures and agreeing on a unique squawk code for C2 link failure; and working on detect and avoid technologies, to include automatic dependent surveillance – broadcast (ADS-B) and algorithm development to integrate RPA into the airspace.

Applicability

Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.

Block 3

The Modules comprising Block 3, intended to be available for implementation in 2028, must satisfy at least one of the following criteria:

a) Represent a natural progression from the preceding Module in Block 2.

b) They will support the requirements of the operating environment in 2028.

c) Represent an end-state as envisaged in the Global ATM Operational Concept.

Performance Improvement Area 1: Airport Operations

B3-RSEQ Integration AMAN/DMAN/SMAN

This Module includes a brief description of integrated arrival, en-route, surface, and departure management.

Applicability

Runways and terminal manoeuvring area in major hubs and metropolitan areas will be most in need of these improvements. Complexity in implementation of this Block depends on several factors. Some locations might have to confront environmental and operational challenges that will increase the complexity of development and implementation of technology and procedures to realize this Block. Infrastructure for RNAP/RNP routes need to be in place.

Performance Improvement Area 2: Globally Interoperable Systems and Data

B3-FICE Improved Operational Performance through the Introduction of Full FF-ICE

Data for all relevant flights systematically shared between the air and ground systems using SWIM in support of collaborative ATM and trajectory-based operations.

Applicability

Air and ground.

Performance Improvement Area 3: Optimum Capacity and Flexible Flights

B3-AMET Enhanced Operational Decisions through Integrated Meteorological Information (Near-term and Immediate Service)

The aim of this Module is to enhance global ATM decision making in the face of hazardous meteorological conditions in the context of decisions that should have an immediate effect. This Module builds upon the initial information integration concept and capabilities developed under B1-AMET. Key points are a) tactical avoidance of hazardous meteorological conditions in especially the 0-20 minute timeframe; b) greater use of aircraft based capabilities to detect meteorological parameters (e.g. turbulence, winds, and humidity); and c) display of meteorological information to enhance situational awareness. This Module also promotes further the establishment of standards for the global exchange of the information.

Applicability

Applicable to air traffic flow planning, en-route operations, terminal operations (arrival/departure) and surface. Aircraft equipage is assumed in the areas of ADS-B IN/CDTI, aircraft based meteorological observations, and meteorological information display capabilities, such as EFBs.

B3-NOPS Traffic Complexity Management

Introduction of complexity management to address events and phenomena that affect traffic flows due to physical limitations, economic reasons or particular events and conditions by exploiting the more accurate and rich information environment of SWIM-based ATM. Benefits will include optimized usage and efficiency of system capacity.

Applicability

Regional or sub-regional. Benefits are only significant over a certain geographical size and assume that it is possible to know and control/optimize relevant parameters. Benefits mainly useful in the higher density airspace.

Performance Improvement Area 4: Efficient Flight Paths

B3-TBO Full 4D Trajectory-based Operations

The development of advanced concepts and technologies, supporting four dimensional trajectories (latitude, longitude, altitude, time) and velocity to enhance global ATM decision making. A key emphasis is on integrating all flight information to obtain the most accurate trajectory model for ground automation.

Applicability

Applicable to air traffic flow planning, en-route operations, terminal operations (approach/departure), and arrival operations. Benefits accrue to both flows and individual aircraft. Aircraft equipage is assumed in the areas of: ADS-B IN/CDTI; data communication and advanced navigation capabilities. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those equipped. Benefit increases with size of equipped aircraft population in the area where the service are provided.

B3-RPAS Remotely Piloted Aircraft (RPA) Transparent Management

Continuing to improve the certification process for remotely piloted aircraft (RPA) in all classes of airspace, working on developing a reliable command and control (C2) link, developing and certifying airborne detect and avoid (ABDAA) algorithms for collision avoidance, and integration of RPA into aerodrome procedures.

Applicability

Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.

Appendix 3: **Hyperlinked Online Support Documentation**

The 2013–2028 GANP contains or is supported by policy and technical information that can be used at every level of the aviation community. This includes technical provisions describing the ASBU Modules and the technology roadmaps, training and personnel considerations, cooperative organizational aspects, cost-benefit analyses and financing concerns, environmental priorities and initiatives, and integrated planning support.

These dynamic and 'living' GANP support components will be hyperlinked as online PDFs on the ICAO public website throughout the 2013–2028 applicability period.

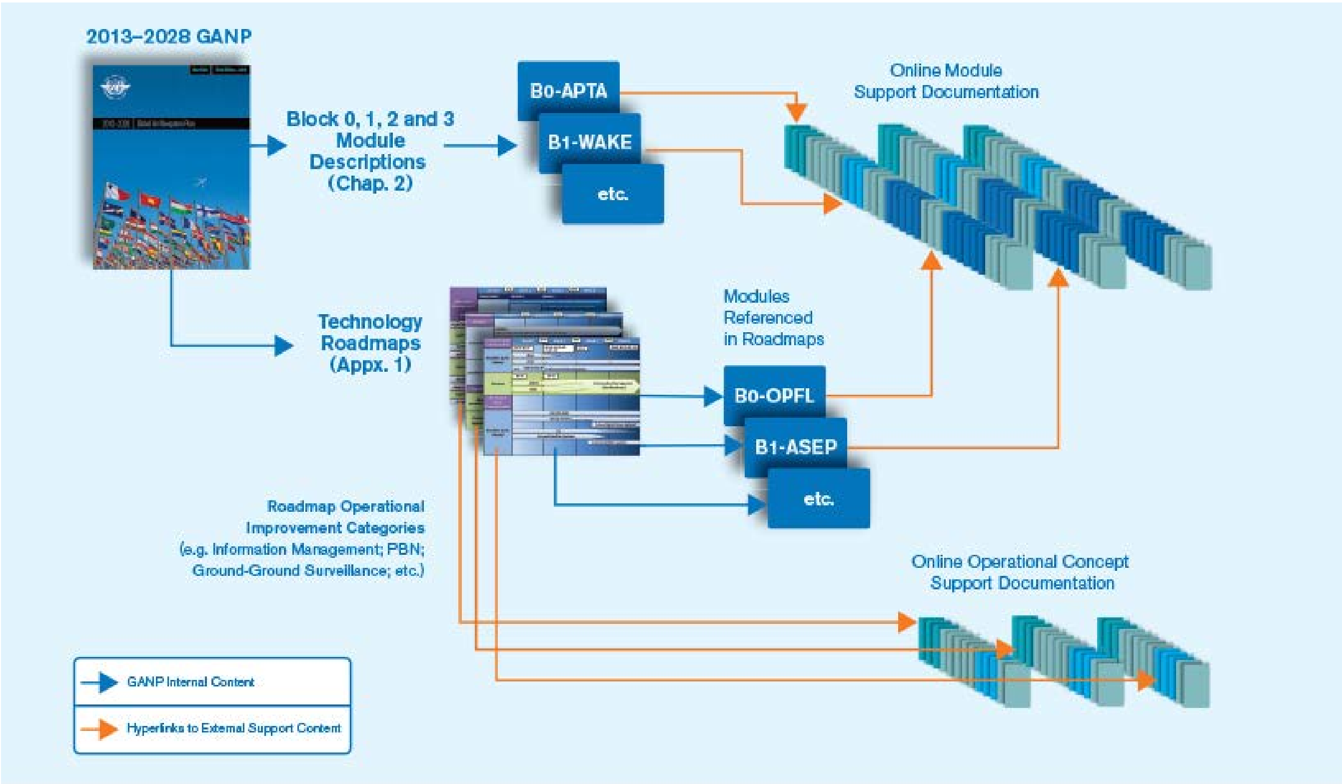
Under the authority of the ICAO Council and Assembly, the GANP's wide availability, accuracy, and review/update processes now provide ICAO Member States and industry stakeholders with the confidence that the plan can and will be used effectively to direct relevant developments and implementations as required to achieve global ATM interoperability.

Hyperlinked Online Technical Support Provisions

The GANP's ASBU methodology and supporting technology roadmaps are hyperlinked to comprehensive technical materials that comprise the essential rationales and characteristics of the GANP. These materials have been developed through ICAO Conferences and Symposia, in addition to dedicated panels and working groups, all of which have featured the active and wide-ranging participation of State and industry experts.

The technical support attachments of the GANP can be accessed through the main PDF document as shown below:

Fig. 11: Mapping of the hyperlinked technical content supporting the ASBU Modules and technology roadmaps.



2013–2028 GANP
Block 0, 1, 2 and 3 Module Descriptions (Chap. 2)
B0-APTA
B1-WAKE
etc.
Online Module Support Documentation
Technology Roadmaps (Appx. 1)
Modules Referenced in Roadmaps
B0-OPFL
B1-ASEP
etc.
Roadmap Operational Improvement Categories
(e.g. Information Management; PBN; Ground-Ground Surveillance; etc.)
Online Operational Concept Support Documentation
GANP Internal Content
Hyperlinks to External Support Content

Linkage with Third Edition GANP

Although they introduce a new planning framework with increased definition and broad timelines, the GANP's Block Upgrades are consistent with the Third Edition of the GANP's planning process encompassing near-term, mid-term and long-term global plan initiatives (GPIs). This consistency has been retained to ensure the smooth transition from the former planning methodology to the Block Upgrade approach.

One of the clear distinctions between the Third Edition GANP and new Fourth Edition GANP is that the consensus-driven ASBU methodology now provides more precise timelines and performance metrics.

This permits the alignment of planning on concrete, shared operational improvements that are referenced to the GPIs in the third edition of the GANP in order to preserve planning continuity.

In addition to the comprehensive online technical content supporting the ASBU Modules and technology roadmaps, ICAO has also posted essential background guidance materials that will assist States and stakeholders with matters of policy, planning, implementation and reporting.

A large amount of this content has been derived from the appendices in the Third Edition of the GANP, as illustrated in the table below:

Fig. 12: Online Documentation Supporting Policy, Planning, Implementation and Reporting. The far right column indicates continuity tie-ins with the material in the Appendices of the Third Edition of the GANP.

GANP
Content Type
Policy
Planning
Implementation
Reporting

Hyperlinked Online Supporting Documentation
Financing & Investment
Ownership & Governance Models
Legal Considerations
Environmental Benefits
Integrated ATM Planning
Module Technical Provisions
Environmental Benefits
Skilled Personnel & Training
ICAO SARP/PANS Outlook
Air Navigation Report Form
PIRG Organizational Structures

Reference from GANP Third Edition
Appendixes E,F,G
Appendix G
Appendix C
Appendix H
Appendixes A, I
GPIs
Appendix H
Appendix B

Appendix 4: **Frequency Spectrum Considerations**

Frequency spectrum availability has always been critical for aviation and is expected to become even more critical with the implementation of new technologies. In addition to the five technology roadmaps pertaining to communication, navigation, surveillance (CNS), information management (IM) and avionics, a global aviation spectrum strategy for the near-, medium- and long-term must support implementation of the GANP.

A long-term strategy for establishing and promoting the ICAO position for International Telecommunication Union World Radiocommunication Conferences (ITU WRCs) was adopted by the ICAO Council in 2001. The strategy prescribes the development of an ICAO position on the individual issues detailed in the agenda of an upcoming WRC, developed in consultation with all ICAO Member States and relevant international organizations. The strategy also includes a detailed ICAO policy on the use of each and every aeronautical frequency band. The policy is applicable to all frequency bands used for aeronautical safety applications. An overall policy and a set of individual policy statements for each aviation frequency band can be found in Chapter 7 of the *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation*, including the *Statement of Approved ICAO Policies* (Doc 9718).

Both the position and the policy are updated after each WRC and approved by the ICAO Council. The strategy for developing the position and policy can presently be found in Attachment E to Doc 9718.

The ICAO position and policy for the ITU WRC horizon extends beyond the 15-year timeframe of the current GANP and anticipates the development of the future aviation system. However, based on the outcome of WRC 12, the ASBU Modules and the technology roadmaps, an update of the strategy for frequency spectrum will be managed by ICAO to anticipate changes and define safe mechanisms for redundancy between essential components of the future Air Navigation system.

Future Aviation Spectrum Access

Due to the constraints specific to frequency allocations suitable to support safety-of-life critical services, little growth is foreseen in the overall size of aeronautical allocations in the longer term. However, it is vital that conditions remain stable in the existing frequency bands, to support continued and interference free access to support current aeronautical safety systems for as long as required.

Similarly, it is vital to manage the limited aviation spectrum resource in a manner which effectively supports the introduction of new technologies when available, in line with the ASBU Modules and the technology roadmaps.

In the light of ever increasing pressure on the frequency spectrum resource as a whole, including aeronautical frequency spectrum allocations, it is imperative that civil aviation authorities and other stakeholders not only coordinate the aviation position with their State's radio regulatory authorities, but also actively participate in the WRC process.

Frequency spectrum will remain a scarce and essential resource for Air Navigation as many Block Upgrades will require increased air-ground data sharing and enhanced navigation and surveillance capabilities.

Appendix 5: **Technology Roadmaps**

The roadmaps illustrated in this Appendix have been designed to depict:

a) New and legacy technologies needed to support the block Modules:

1) Modules that require the technology are shown in black.

2) Modules that are supported by the technology are shown in grey.

b) The date by which a technology is needed to support a block and its Modules.

c) The availability of a technology (if it precedes the block).

For ease of reference, CNS, IM and avionics roadmaps have been divided on the following basis:

a) Communication:

1) Air-ground data link communication.

2) Ground-ground communication.

3) Air-ground voice communication.

b) Surveillance:

1) Surface surveillance.

2) Ground-based surveillance.

3) Air-to-air surveillance.

c) Navigation:

1) Dedicated technology.

2) Performance-based navigation.

d) Information Management.

1) SWIM

2) Other

e) Avionics:

1) Communications.

2) Surveillance.

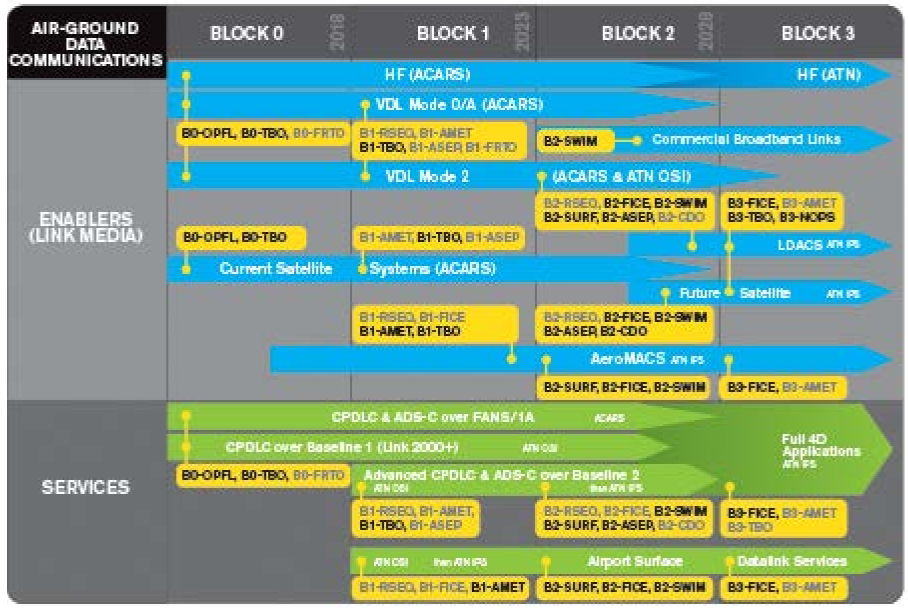
3) Navigation.

4) Aircraft safety nets.

5) Onboard systems.

Fig. 13: Explanation of Technology Roadmap format.

Technology Area
Modules
Technology Supporting Modules
Date of Technology Availability (Earliest possible implementation)
Date when Technology Needed for Block



Communication

Air-ground data link services fall into two basic categories:

- Safety-related ATS services where performance requirements, procedures, services and supporting technology are strictly standardized and regulated,

- Information-related services where performance requirements, procedures and supporting technology are less critical.

In general, the enablers (link media technologies) will be developed and deployed based on the need to support safety-related ATS services.

To prepare for Block 3, research and development is needed in the Blocks 1 and 2 timeframes; there are three areas of investigation where standards are being developed:

- Airports – a ground-based high capacity airport surface data link system is currently under development. The Aeronautical Mobile Airport Communications System (AeroMACS) is based on IEEE 802.16/WiMAX standard).

- SATCOM – a new satellite based data link system targeted at oceanic and remote regions. This link may also be used in continental regions as a complement to terrestrial systems. This could be a dedicated ATS SATCOM (e;g; European ESA Iris initiative) system or a multi-mode commercial system (e.g. Inmarsat Swift Broadband, Iridium).

- Terrestrial (terminal and en-route) – a ground-based data link system for continental airspace is currently under investigation. This has been termed the aeronautical L-band digital aeronautical communications system (LDACS).

In addition, studies are needed to a) review the role of voice communications in the long-term concept (primarily data centric); and to b) consider the need to develop a new appropriate digital voice communication system for continental airspace.

Roadmap 1 - in the Block 0 timeframe:

Enablers:

- Aviation will rely on existing communications systems, i.e. VHF ACARS and VDL Mode 2/ATN in continental areas.
- VHF ACARS will be transitioned towards VDL Mode 2 AOA (i.e. providing higher bandwidth) since VHF channels have become a very scarce resource in several regions of the world.
- SATCOM ACARS will continue to be used in Oceanic and remote regions.

Services:

- Data link service implementation is underway in Oceanic, En-Route airspace and at major Airports (FANS1/A and/or ICAO ATN based – ATN B1). Today's data link service implementations today are based on different standards, technology and operational procedures, although there are many similarities. There is a need to converge quickly to a common approach based upon ICAO approved standards. The common global guidance material continues to be developed, namely the "Global Operational Data Link Document" - GOLD.
- Information services such as airline operational communications (AOC) are carried by aircraft for communication with airline company host computers. The air-ground communications media (such as VDL Mode 2) are shared with the safety related services due to cost and avionics limitations.

Roadmap 1 - in the Blocks 1 and 2 timeframe:

Enablers:

- ATS services will continue to exploit existing technology to maximize return on investment, hence VDL Mode 2/ATN will continue to be used for converged data link services in continental areas. New service providers may enter the market (mainly for service in oceanic and remote areas), provided they meet the ATS service requirements.
- AOC may begin to migrate towards new technologies at airports and in the en-route environment (e.g. AeroMACS at airports and existing commercial technology like 4G elsewhere) as they become commercially attractive. This may also apply to some information-based ATS.
- VHF ACARS will be phased out giving way to VDL Mode-2.

- HF ACARS will also be phased out and it seems logical that the aeronautical telecommunication network (ATN) will be adapted to support HF data link.

Services:

- An important goal is to harmonize the regional data link implementations through a common technical and operational standard, applicable to all flight regions in the world. The RTCA SC214 and EUROCAE WG78 have been established to develop common safety, performance and interoperability standards for this next generation of ATS data link services (ATN B2) for both continental and Oceanic and remote regions. These Standards, supported by validation results, will be ready by the end of 2013, to be followed by a comprehensive validation phase and will be available for implementation in some regions from 2018. These standards will form the basis of data link services for the long term and will support the move towards trajectory based operations.

- As avionics evolve, new high volume information services such as weather advisories, map updates etc. will become possible. These services could take advantage of new communication technology that could be deployed at some airports and in some en-route airspace, this may be seen as the beginning of air-ground SWIM. These new data link services could be either AOC or ATS. In many cases these will not need the same levels of performance as strictly safety-related ATS services and could therefore make use of commercially available mobile data services, thus reducing the load on the infrastructure supporting the safety-related ATS services.

Roadmap 1 - in the Block 3 timeframe:

Enablers

- Data link will become the primary means of communication. In such a data-centric system, voice will be used only in exceptional/emergency situations; increased data link performance, availability and reliability, supporting greater levels of safety and capacity.

- For Oceanic and remote regions, it is expected that the migration from HF to SATCOM will be completed by the Block 3 timeframe.

Services:

- the ATM Target Concept is a ‘net-centric’ operation based on full 4D trajectory management with data link (based on ATN Baseline 2) used as the prime means of communication, replacing voice due to its ability to handle complex data exchanges. In such a data-centric system, voice will be used only in exceptional/emergency situations.

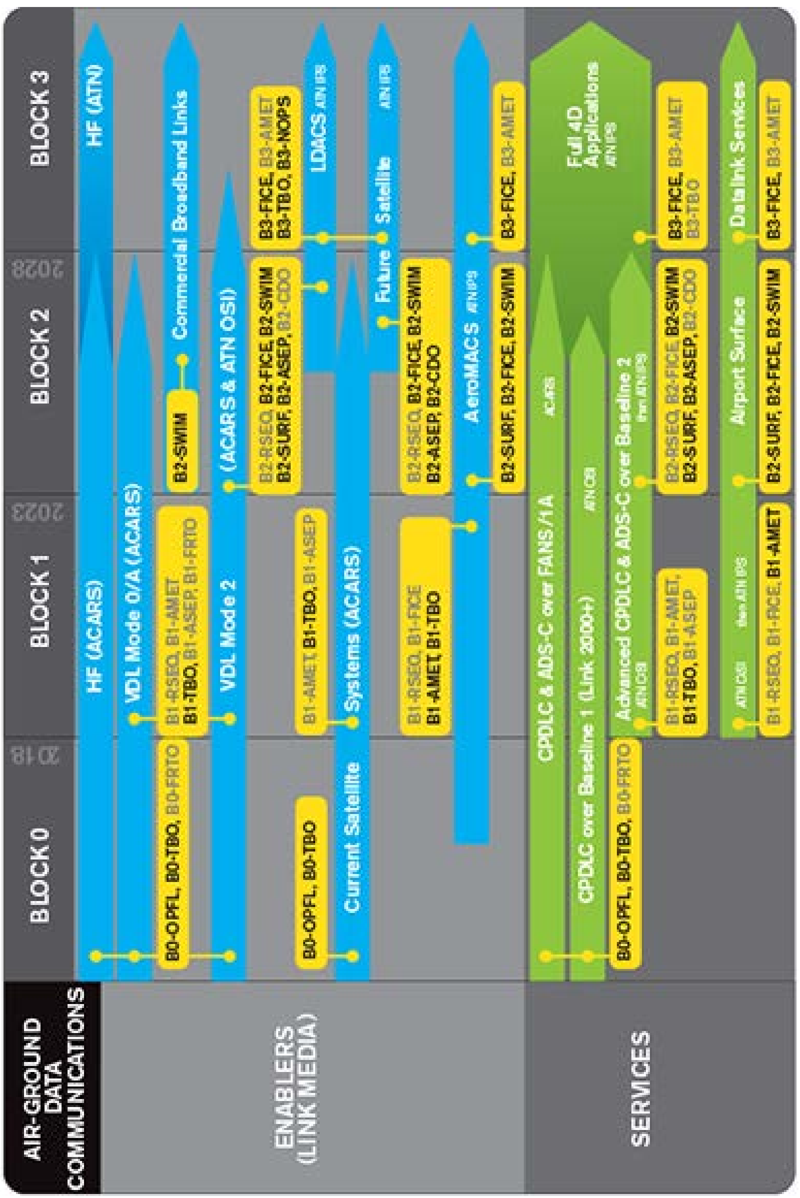
Full air-ground SWIM services will be used to support advanced decision making and mitigation. SWIM will allow aircraft to participate in collaborative ATM processes and provide access to rich voluminous dynamic data including meteorology. Commercial information-based services to companies and passengers may also be implemented using the same technology.

Roadmap 1:

Domain: Communication

Component(s): Air-ground Data Communication

- Enablers (Link Media Technology)
- Services



Roadmap 2 - in the Block 0 timeframe:

Enablers:

- IP networks will continue to be deployed. Existing IPV4 systems will be gradually replaced by IPV6.

- Until now, inter-centre voice ATM communications were mainly based on analogue (ATS-R2) and digital (ATS-QSIG) protocols. A move has begun to replace ground-ground voice communications with voice over IP (VoIP).

- Air-Ground Voice communications will remain on 25 kHz VHF channels in continental regions (note: 8.33 kHz VHF voice channels will continue to be deployed in Europe). Migration from HF to SATCOM in Oceanic and remote regions is expected during this time.

Services:

- Two major ground-ground communications services will be in operation:

- ATS messaging operating over AFTN/CIDIN and/or AMHS in some areas.

- Air traffic service inter-facility data communications (AIDC) for flight co-ordination and transfer.

- ATS messaging is used worldwide for the com-munication of flight plans, MET, NOTAMS etc. over AFTN/CIDIN technology. Migration towards AMHS (directory, store and forward services) over IP (or using ATN in some regions) will progress in all regions.

- AIDC is used to provide inter-centre coordination and transfer of aircraft between adjacent air traffic control units. Migration from legacy data network (e.g. X25) to IP data network is progressing in various regions.

- The beginnings of SWIM will start to appear. Operational services will be offered by some SWIM pioneer implementations over IP, Surveillance data distribution and MET data will also be distributed over IP. Migration to Digital NOTAM will start in Europe and the U.S.

Roadmap 2 - in the Blocks 1 and 2 timeframe:

Enablers:

- Traditional ground-ground voice communications will continue to migrate to VoIP. The migration is expected to be complete in 2020.

- Digital NOTAM and MET (using the AIXM and WXXM data exchange formats) will be widely implemented over IP networks.

- FIXM will be introduced as the global standard for exchanging flight data.

- To prepare for the long term, research and development is needed in the medium term for new satellite and terrestrial based systems. Voice communications will remain on 25 kHz VHF channels in continental regions (note: 8.33 kHz VHF voice channels deployment in Europe).

Services:

- ATS messaging will migrate to AMHS supported by directory facilities that will include security management. AIDC services will fully migrate towards using IP networks.

- Initial 4D air-ground services will require ground-ground inter-centre trajectory and clearance co-ordination via AIDC extensions or new flight data exchanges compatible with the SWIM framework.

- SWIM SOA services will mature and expand publish/subscribe and request/reply services in parallel to the more traditional messaging services based on AMHS but both will use the IP network.

Roadmap 2 - in the Block 3 timeframe:

It is quite likely that future digital systems will be used to carry voice. Where satellite communications are used, it will most likely be via the same systems used to support air-ground data link. In the terrestrial environment, it is not clear whether LDACS will be used to carry this traffic or a separate voice system will be used. This will need to be the subject of R&D efforts in the Blocks 1 and 2 timeframes.

Roadmap 2:

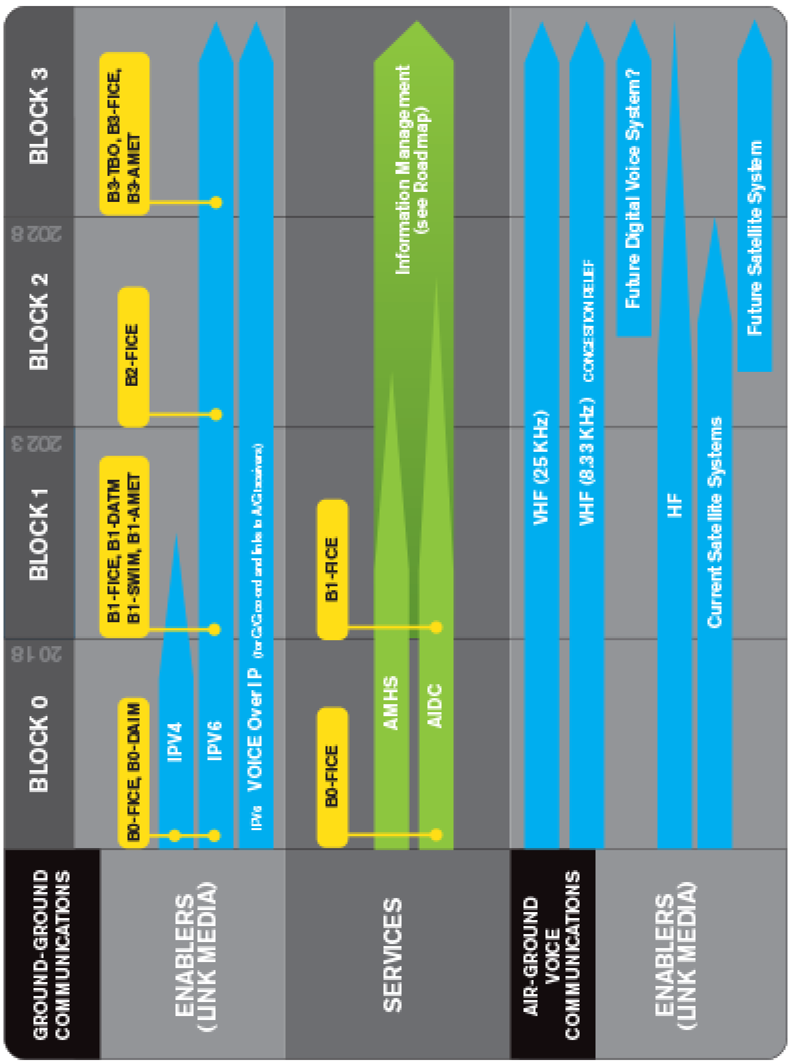
Domain: Communication

Component(s): Ground-ground communication

- Enablers
- Services

Air-ground voice communication

- Enablers (Link Media Technology)



Surveillance

The important trends of the next 20 years will be that:

a) Different techniques will be mixed in order to obtain the best cost benefit depending on local constraints.

b) Cooperative surveillance will use technologies currently available using 1030/1090 MHz RF bands (SSR, Mode-S, WAM and ADS-B).

c) While refinements to capabilities may be identified, it is expected that the surveillance infrastructure currently foreseen could meet all the demands placed upon it.

d) The airborne part of the surveillance system will become more important and should be "future proof" and globally interoperable in order to support the various surveillance techniques which will be used.

e) There will be growing use of downlinked aircraft parameters bringing the following advantages:

1) Clear presentation of call-sign and level.

2) Improved situational awareness.

3) Use of some down-linked aircraft parameters (DAPs) and 25 ft altitude reporting to improve radar tracking algorithms.

4) Display of vertical stack lists.

5) Reduction in radio transmission (controller and pilot).

6) Improve management of aircraft in stacks.

7) Reductions in level busts.

f) Functionality will migrate from the ground to the air.

Roadmap 3 - in the Block 0 timeframe:

- There will be significant deployment of cooperative surveillance systems: ADS-B, MLAT, WAM

- Ground processing systems will become increasingly sophisticated as they will need to fuse data from various sources and make increasing use of the data available from aircraft.

- Surveillance data from various sources along with aircraft data will be used to provide basic safety net functions.

- The beginnings of SWIM will start to appear. Operational services will be offered by some SWIM pioneer implementations over IP, Surveillance data distribution and MET data will also be distributed over IP. Migration to Digital NOTAM will start in Europe and the U.S.

Roadmap 3 - in the Block 1 timeframe:

- Deployment of cooperative surveillance systems will expand.
- Cooperative surveillance techniques will enhance surface operations.
- Additional safety net functions based on available aircraft data will be developed.
- It is expected that multi-static primary surveillance radar (MPSR) will be available for ATS use and its deployment will provide significant cost savings.
- Remote operation of aerodromes and control towers will require remote visual surveillance techniques, providing Situational awareness, this will be supplemented with graphical overlays such as tracking information, weather data, visual range values and ground light status etc.

Roadmap 3 - in the Block 2 timeframe:

- The twin demands of increased traffic levels and reduced separation will require an improved form of ADS-B.
- Primary surveillance radar will be used less and less as it is replaced by cooperative surveillance techniques.

Roadmap 3 - in the Block 3 timeframe:

- Cooperative surveillance techniques will be dominant as PSR use will be limited to demanding or specialized applications.

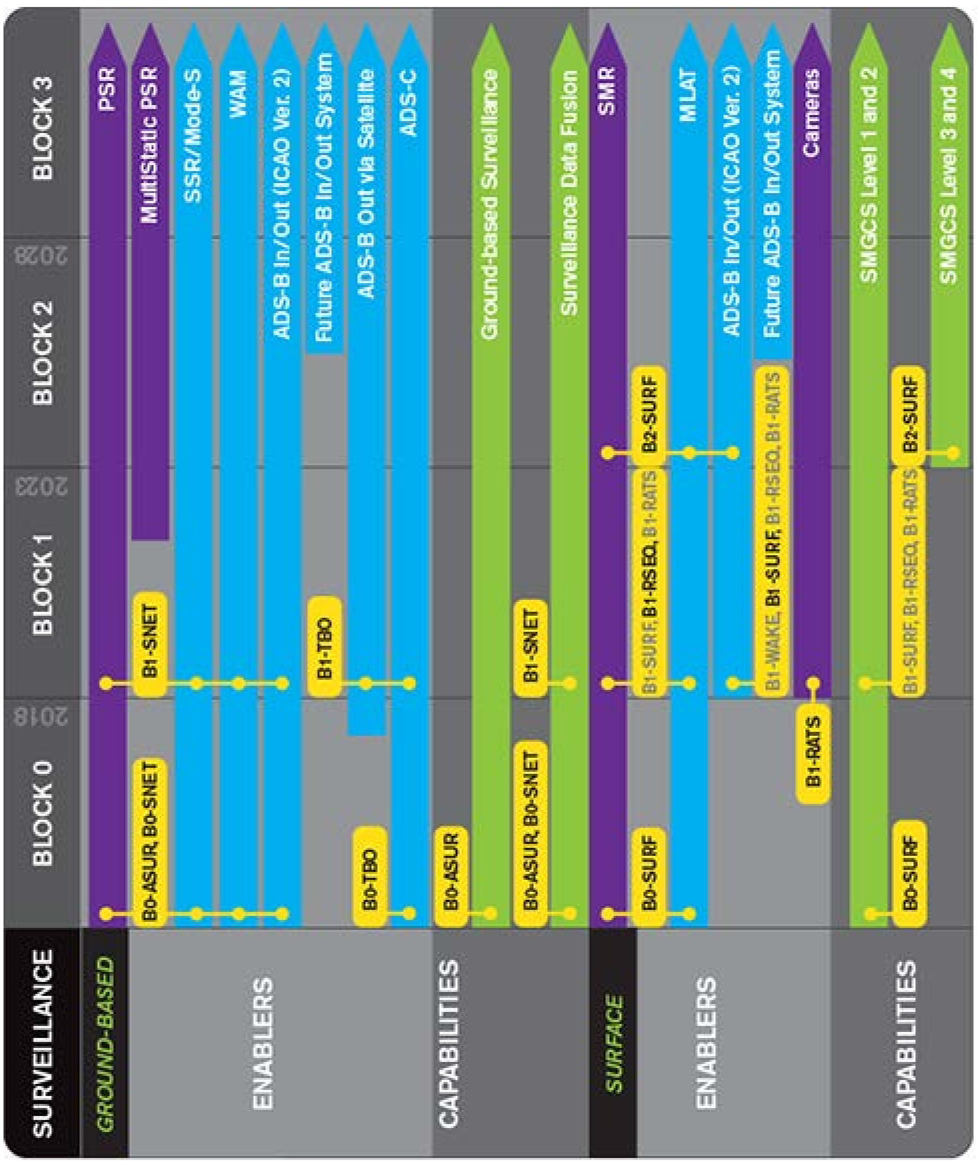
Roadmap 3:

Domain: Surveillance

Component(s): Ground-based surveillance — Surface surveillance

Ground-based surveillance:
- Enablers
- Capabilities

Surface surveillance:
- Enablers
- Capabilities



Roadmap 4 - in the Block 0 timeframe:

- Basic airborne situational awareness applications will become available using ADS-B IN/OUT (ICAO Version 2)

Roadmap 4 - in the Block 1 timeframe:

- Advanced situational awareness applications will become available, again using ADS-B IN/OUT (ICAO Version 2).

Roadmap 4 - in the Block 2 timeframe:

- ADS-B technology will begin to be used for basic airborne (delegated) separation.
- The twin demands of increased traffic levels and reduced separation will require an improved form of ADS-B.

Roadmap 4 - in the Block 3 timeframe:

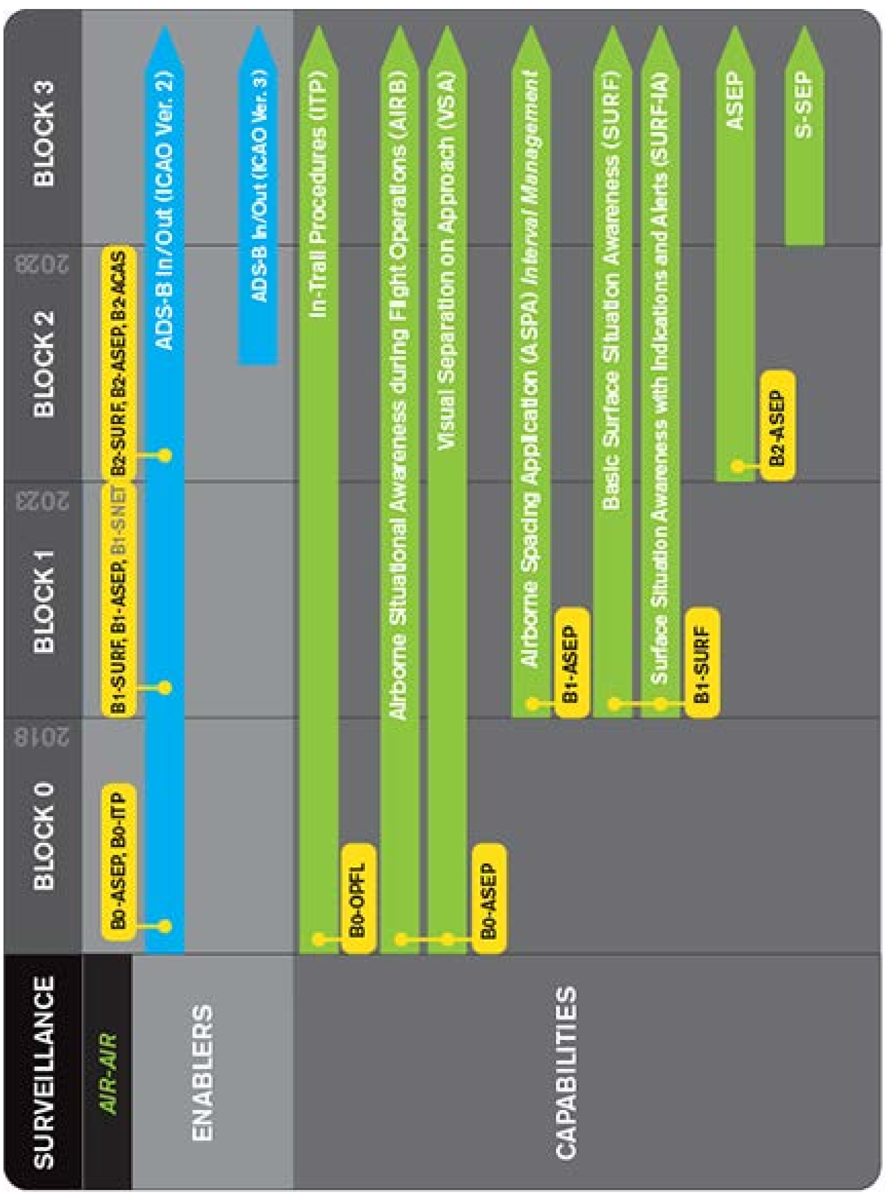
- The ADS-B technology which supported Block 2 will be used for limited self-separation in remote and oceanic airspace.

Roadmap 4:

Domain: Surveillance

Component(s): Air-air surveillance

- Enablers
- Capabilities



Navigation

Navigation concepts such as RNAV, RNP and PBN provide a range of options for the use of navigation technology. As these are very much dependent on local requirements, this section will provide a narrative description of the considerations for the use of navigation technology.

GNSS infrastructure

GNSS is the core technology that has led to the development of PBN. It is also the basis for future improvements in navigation services. The core historical constellations GPS and GLONASS have been in operations for well over a decade, and SARPs in support of aviation operations are in place. As a result, aviation usage of GNSS is currently widespread. GPS and GLONASS are being upgraded to provide service on multiple frequency bands. Other core constellations, namely the European Galileo and China's Beidou are being developed. Multi-constellation, multi-frequency GNSS has clear technical advantages that will support the provision of operational benefits. To realize these benefits, ICAO, States, ANSPs, standards bodies, manufacturers and aircraft operators need to coordinate activities to address and resolve related issues.

SBAS based on GPS is available in North America (WAAS), Europe (EGNOS), Japan (MSAS) and will soon be available in India (GAGAN) and Russia (SDCM). Several thousand SBAS approach procedures are now implemented, mostly in North America, while other regions have started publishing SBAS-based procedures. SBAS typically supports APV operations, but can also support precision approach (Category I) operations. However, it is challenging for SBAS to support precision approach operations in equatorial regions using single-frequency GPS because of ionospheric effects.

GBAS CAT I based on GPS and GLONASS is available in Russia and, based on GPS, on some airports in several States. SARPs for GBAS CAT II/III are under operational validation. Related research and development activities are ongoing in different States. It is also challenging for GBAS to support a high availability of precision approach, in particular in equatorial regions.

Conventional navigation aids (VOR, DME, NDB, ILS) are in widespread use globally, and most aircraft are equipped with the relevant avionics. The vulnerability of GNSS signals to interference has led to the conclusion that there is a need to retain some conventional aids or alternative navigation service solution as a back-up to GNSS.

Mitigating the operational impact of a GNSS outage will rely primarily on the use of other constellation signals or employing pilot and/or ATC procedural methods, while taking advantage of on-board inertial systems and specific conventional terrestrial aids. In the case of a general GNSS outage in an area, reversion to conventional systems and procedures would result in lower service levels and a possible decrease in capacity. In the case of loss of signals from a specific constellation, the reversion to another constellation could allow maintaining the same PBN level.

The implementation of PBN will make area navigation operations the norm. DME is the most appropriate conventional aid to support area navigation operations (i.e. assuming DME multilateration on board capability), since it is currently used in multi-sensor avionics for this purpose. This could result in an increase in the number of DME installations in some regions. Similarly, ILS remaining widely used, will provide, where available, an alternate approach and landing capability in case of GNSS outage.

Roadmap 5 depicts the expected evolution of navigation infrastructure and avionics.

Current Navigation Infrastructure

The current navigation infrastructure comprising VOR, DME and NDB navigation beacons was initially deployed to support conventional navigation along routes aligned between VOR and NDB facilities. As traffic levels increased, new routes were implemented which in many cases necessitated additional navigation facilities to be installed.

As a result, navigation aid deployment has been driven by economic factors and has led to a non-uniform distribution of navigation aids with some regions, notably North America and Europe, having a high density of navigation aids with many other regions having a low density, and some areas having no terrestrial navigation infrastructure at all.

The introduction of RNAV in the last decades has led to setting up new regional route networks that no longer relied on these conventional navaids infrastructure thus allowing wider flexibility to tailor the route network to the traffic demand This essential move has clearly stopped the direct link between the ground based navaids and the route network in the busiest air traffic regions.

With the continuous evolution of aircraft navigation capability through performance-based navigation, and the widespread use of GNSS positioning, regions of high traffic density no longer need a high density of navigation aids.

Future Terrestrial Infrastructure Requirements

The ICAO GANP has the objective of a future harmonized global navigation capability based on area navigation (RNAV) and performance-based navigation (PBN) supported by global navigation satellite system (GNSS).

The optimistic planning that was considered at the time of the Eleventh Air Navigation Conference for all aircraft to be equipped with GNSS Capability and for other GNSS constellations to be available, together with dual frequency and multi-constellation avionics capability being carried by aircraft have not been realized.

The current single frequency GNSS capability provides the most accurate source of positioning that is available on a global basis. With suitable augmentation as standardized within ICAO Annexes, Single frequency GNSS has the capability to support all phases of flight. The current GNSS has an extremely high availability, although it does not have adequate resilience to a number of vulnerabilities, most notably radio frequency interference and solar events causing ionospheric disturbances.

Until multiple GNSS constellations and associated avionics are available, it is essential that a suitably dimensioned terrestrial navigation infrastructure is provided which is capable of maintaining safety and continuity of aircraft operations.

The FANS report from April 1985 stated:

"The number and development of navigational aids should be reviewed with the aim of providing a more rational and more cost-effective homogeneous navigation environment."

The current status of aircraft equipage for PBN operations supported by GNSS and terrestrial navigation aids, together with the availability of the ICAO PBN Manual and the associated design criteria provide the necessary baseline to commence the evolution to the homogeneous navigation environment envisaged within the FANS Report.

Infrastructure Rationalization Planning

It had initially been expected that the rationalization of the legacy navigation infrastructure would have been a consequence of a 'top down' process where the implementation of PBN and GNSS within volumes of airspace would result in navigation aids being made totally redundant so they could be simply be switched off.

All stakeholders generally agree that PBN is 'the right thing to do' and although PBN offers the capability to introduce new routes without additional navigation aids, it remains difficult to justify the case for whole scale implementation of PBN within a volume of airspace, unless there are capacity or safety issues to be addressed.

Many States have utilized PBN to implement additional routes as they are required to secure gains in capacity and operational efficiencies. This has resulted in volumes of airspace which contain a combination of new PBN routes and existing conventional routes.

It is now clear that for numerous reasons which include being unable to establish a positive business case for a large scale airspace redesign, a ‘top-down’ PBN implementation followed by infrastructure rationalization will take many years to complete, if ever.

As an alternative strategy, a bottom-up approach should be considered as at the end of each navigation aid’s economic life, an opportunity exists to consider if a limited PBN implementation to alleviate the need for the replacement of the facility is more cost effective than replacement of the navigation aid.

The replacement cost opportunity only presents itself if the navigation aid is fully depreciated and replacement is considered: it therefore arises on a 20-25 year cycle. In order to realize any cost saving, rationalization opportunities need to be identified and the necessary route changes planned and implemented to enable the facilities to be decommissioned at the end of their lifetime.

This bottom up approach to rationalization also provides a catalyst to start the airspace transition to a PBN environment, facilitating future changes to optimize routes to deliver gains in efficiency such as shorter routings and lower CO_2 emissions.

In planning for the rationalization of navigation infrastructure, it is essential that all stakeholders’ needs and operational uses of the infrastructure are considered. These needs are likely to extend beyond the instrument flight procedures and routes promulgated in the State Civil Aeronautical Information Publication and may also include military instrument flight procedures, aircraft operational contingency procedures such as engine failure on take-off, and used for VOR-based separations in procedural airspace as detailed in ICAO Doc 4444.

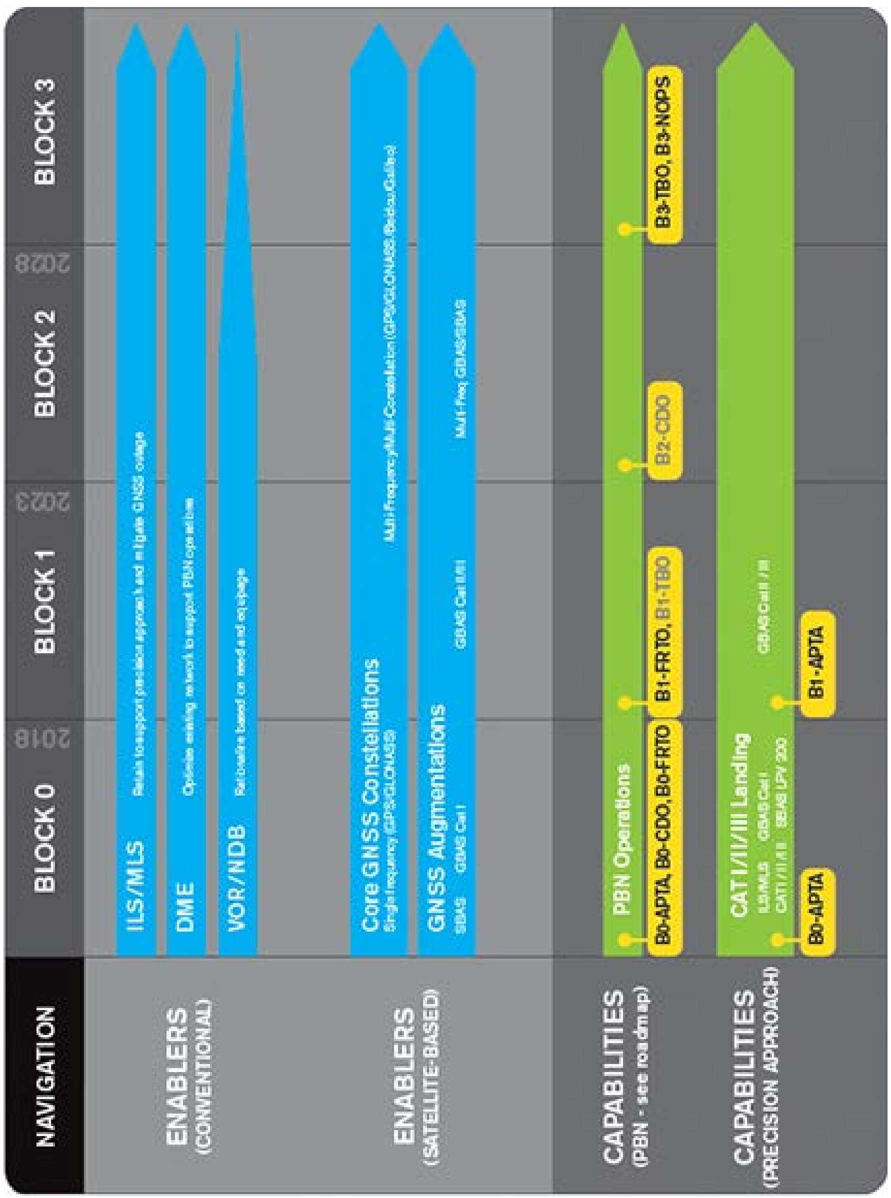
Roadmap 5:

Domain: Navigation

Component(s): Enablers Capabilities

- Conventional - PBN

- Satellite-based - Precision approach



Performance-based Navigation

The roadmaps above depict migration paths for the implementation of PBN levels and precision approaches for the following operations: en route oceanic and remote continental, en route continental, TMA arrival/departure, and approach. There is no attempt to show detailed timelines because regions and States will have different requirements; some may need to move quickly to the most demanding PBN specification while others will be able to satisfy airspace users' requirements with a basic specification. The figures do not imply that States/region have to implement each step along the path to the most demanding specification. Doc 9613-*Performance Based Navigation Manual*-provides the background and detailed technical information required for operational implementation planning.

The PBN Manual identifies a large set of navigation applications. Among these applications, one sub-set is the RNP applications. It is important to realize that the implementation of RNP applications within an airspace contributes de facto to a re-distribution of the surveillance and conformance monitoring function. The RNP concept introduces an integrity check of the navigated position at aircraft level and allows the automatic detection of non-conformance to the agreed trajectory while this function is today the full responsibility of the controller. Therefore RNP implementation should provide additional benefits to the ATSU that is traditionally in charge of the conformance monitoring.

Roadmap 6:

Domain: Performance-based Navigation (PBN)

Component(s): En-route, Oceanic and remote continental
En-route continental
Terminal airspace: arrival and departure
Approach

Information Management

A goal of the Global ATM Operational Concept is a net-centric operation where the ATM network is considered as a series of nodes – including the aircraft – providing or using information.

Aircraft operators with flight/airline operational control centre facilities will share information while the individual user will be able to do the same via applications running on any suitable personal device. The support provided by the ATM network will in all cases be tailored to the needs of the user concerned.

The sharing of information of the required quality and timeliness in a secure environment is an essential enabler for the ATM Target Concept. The scope extends to all information that is of potential interest to ATM including trajectories, surveillance data, aeronautical information, meteorological data etc.

In particular, all parts of the ATM network will share trajectory information in real time to the extent required, from the trajectory development phase through operations and post-operation activities. ATM planning, collaborative decision making processes and tactical operations will always be based on the latest and most accurate trajectory data. The individual trajectories will be managed through the provision of a set of ATM services tailored to meet their specific needs, acknowledging that not all aircraft will (or will need to) be able to attain the same level of capability at the same time.

System-wide Information Management (SWIM) is an essential enabler for ATM applications. It provides an appropriate infrastructure and ensures the availability of the information needed by the applications run by the members of the ATM community. The related geo/time enabled, seamless and open interoperable data exchange relies on the use of common methodology and the use of a suitable technology and compliant system interfaces.

The availability of SWIM will make possible the deployment of advance end-user applications as it will provide extensive information sharing and the capability to find the right information wherever the provider is.

Roadmap 7 - in the Block 0 timeframe:

- The SWIM concept of operations will be developed and refined.

Roadmap 7 - in the Block 1 timeframe:

- An initial SWIM capability supporting ground-ground communications will be deployed.

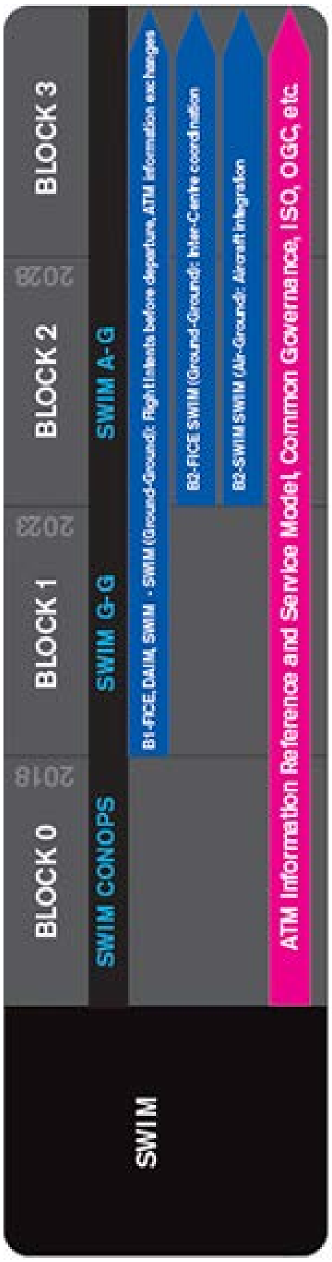
Roadmap 7 - in the Block 2 timeframe:

- The aircraft will become a node on the SWIM network with full integration with the aircraft systems.

Roadmap 7:

Domain: Information Management

Component(s): System wide-information management (SWIM)



Need for a common time reference

In moving towards the Global ATM Operational concept, and in particular 4D trajectory management and intensive exchanges of information through SWIM, some of the current provisions for time management might not be sufficient and could become a barrier to future progress.

The time reference for aviation is defined to be the Coordinated Universal Time (UTC). Requirements surrounding accuracy of time information depend on the type of ATM application where it is used. For each ATM application, all contributing systems and all contributing users must be synchronized to a time reference that satisfies this accuracy requirement.

UTC is the common time reference, but the present requirements for the accuracy with which aviation clocks are synchronized to UTC may be insufficient to cover future needs. This relates to the integrity and timeliness of information or the use of dependent surveillance for closer separations, as well as more generally 4D trajectory operations. System requirements for synchronization using an external reference must also be considered.

Rather than defining a new reference standard, the performance requirement for accuracy has to be defined with respect to UTC for each system in the ATM architecture that relies on a coordinated time requirement. Different elements require different accuracy and precision requirements for specific applications. The increased exchange of data on SWIM creates the necessity of efficient 'time stamping' for automated systems that are in communication with each other. The time information should be defined at the source and incorporated in the distributed data, with the proper level of accuracy maintained as part of the data integrity.

Roadmap 8 - in the Block 0 timeframe:

- SWIM will start to appear in Europe and the U.S.
- Operational services will be supported by service oriented architecture (SOA) pioneer implementations.
- Meteorological data will also be distributed over IP.
- Migration to digital NOTAM will commence and will be carried over IP.

Roadmap 8 - in the Blocks 1 and 2 timeframe:

- Digital NOTAM and MET information distribution (using the AIXM and WXXM information exchange formats) will be widely implemented over the SWIM network.
- Flight objects will be introduced, improving inter-facility co-ordination and providing multi-facility coordination for the first time. Flight objects will be shared on the SWIM network over an IP backbone and updated through SWIM synchronization services.
- The more traditional point-to-point ATS interfacility data communication (AIDC) message exchange will still coexist for some time with SWIM.
- Flight Information eXchange Model (FIXM) will propose a global standard for exchanging flight information.
- More generally it is expected that SWIM will support the implementation of new concepts such as virtual ATS facilities, which control airspace remotely.

Roadmap 8 - in the Block 3 timeframe and beyond:

- Full SWIM deployment is expected allowing all participants, including the aircraft, to be able to access a wide range of information and operational services including full 4D-trajectory sharing.

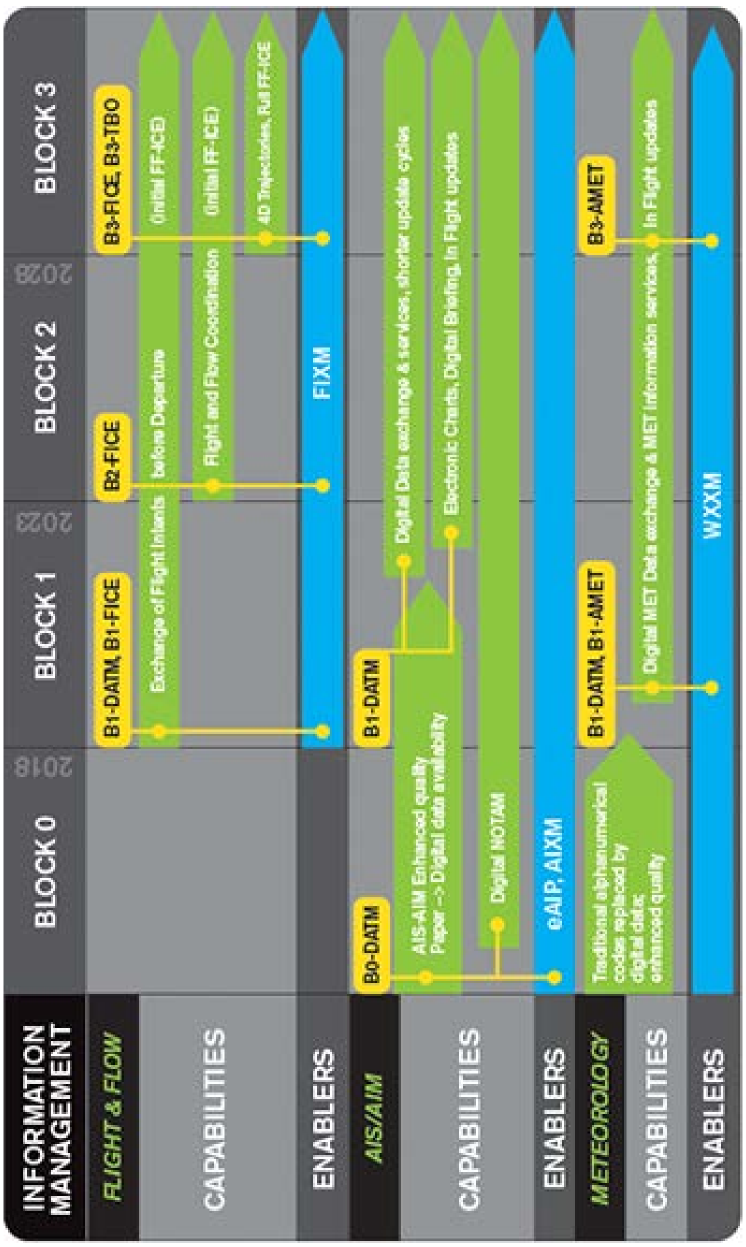
- Full implementation of flight objects will be achieved as the FF-ICE concept is realized.

Roadmap 8:

Domain: Information Management

Component(s): Flight and Flow | AIS/AIM | MET

Flight and Flow	AIS/AIM	MET
- Capabilities	- Capabilities	- Capabilities
- Enablers	- Enablers	- Enablers



Avionics

A key theme with the avionics evolution is the significant increase in capability that is possible through the integration of various onboard systems/functions.

Roadmap 9 - in the Block 0 timeframe:

- FANS2/B will be introduced which supports DLIC, ACM, AMC, and ACL services over ATN, thus providing better communication performance than FANS-1/A. In this first step with data link implementation over ATN, ACL is commonly used by ATC for the notification of voice frequencies changes to the aircraft. The more integrated solutions provide a connection between the FANS and the Radio Communication equipment. This integration enables the automatic transmission and tuning of these voice frequencies.

- The existing FANS-1/A system will continue to be used as there is a large base of equipped aircraft and it also supports both communication and navigation integration.

- Aircraft will have a traffic computer hosting the 'traffic collision avoidance system', and possibly the new air traffic situational awareness functions and airborne separation assistance systems. This capability is expected to undergo successive improvements in order to meet the requirement of later blocks.

Roadmap 9 - in the Block 1 timeframe:

- FANS3/C with CNS integration (via ATN B2) will be available providing communication and surveillance integration through a connection between the FANS and NAV (FMS) equipment. This avionics integration typically supports the automatic loading in the FMS of complex ATC clearances transmitted by data link.

- Surveillance integration (via ATN B2) will provide an integrated surveillance through a connection between the FANS equipment and the traffic computer. This avionics integration typically supports the automatic loading (within the traffic computer) of ASAS manoeuvres transmitted by data link.

Roadmap 9 - in the Block 2 timeframe:

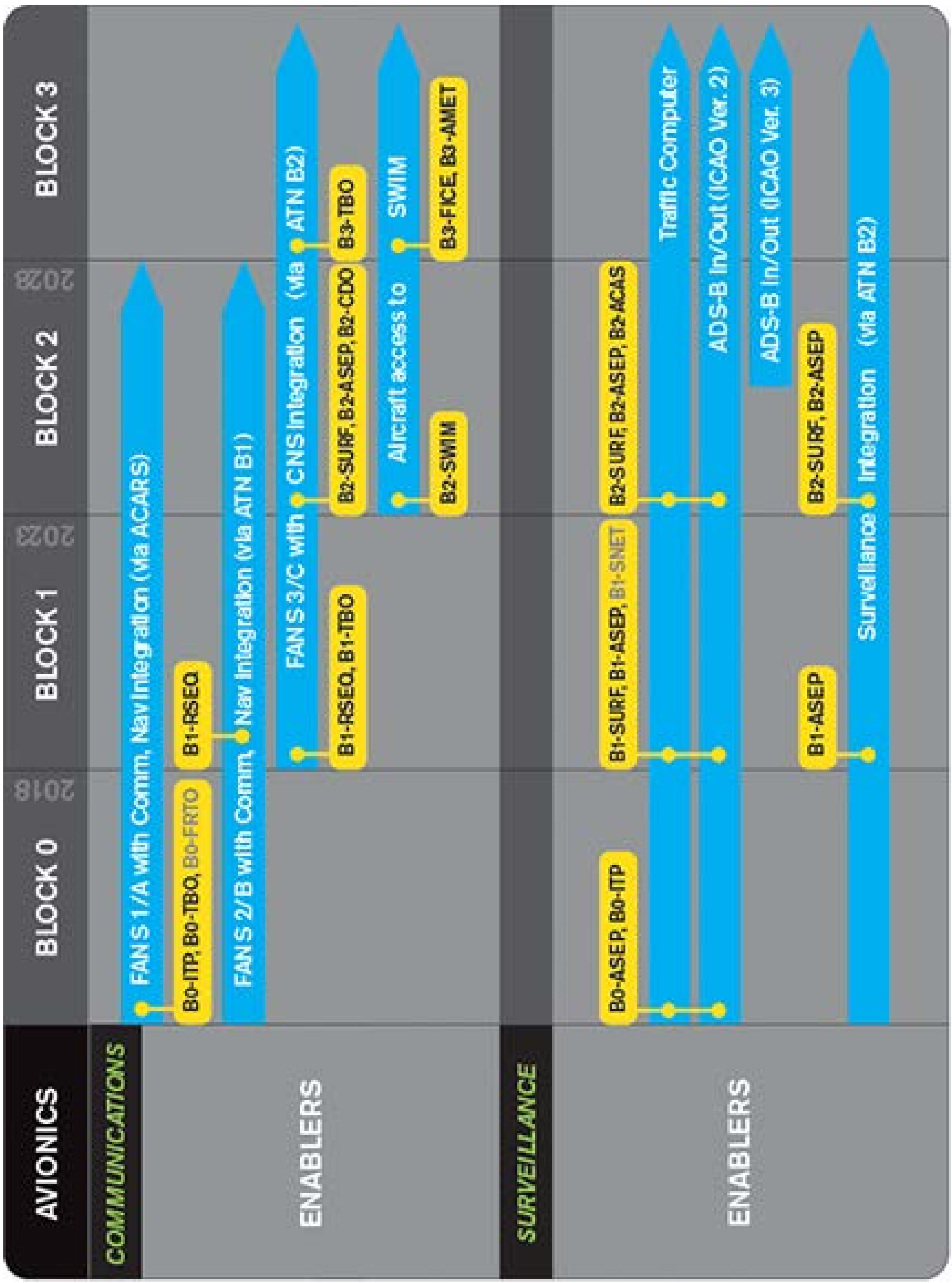
- Aircraft access to SWIM will be provided using the various means described in the roadmap for air-ground data link communications.

The twin demands of increased traffic levels and reduced separation will require an improved form of ADS-B.

Roadmap 9:

Domain: Avionics

Component(s): Communications & Surveillance



Roadmap 10 - in the Block 0 timeframe:

- FMS supporting PBN represents a flight management system supporting PBN, i.e. providing multi sensor (GNSS, DME, etc.) navigation and area navigation, and qualified for RNAV-x and RNP-x operations.

- INS will continue to be used in conjunction with other navigation sources. Navigation will be underpinned by the capability to merge and manage navigation data from various sources.

Roadmap 10 - in the Blocks 1 and 2 timeframe:

- Airport navigation integration (via ATN B2) provides integration between the FMS and the airport navigation system function to among other things support the automatic loading within the traffic computer of ATC taxi clearances transmitted by data link.

- Flight management system capability will be enhanced to support initial 4D capability.

- GNSS-based services today rely on a single constellation, the global positioning system (GPS), providing service on a single frequency. Other constellations,, i.e; the GLObal NAvigation Satellite System (GLONASS), Galileo and BeiDou will be deployed. All constellations will eventually operate in multiple frequency bands. GNSS performance is sensitive to the number of satellites in view. Multi-constellation GNSS will substantially increase that number, improving the availability and continuity of service. Furthermore, availability of more than thirty interoperable ranging sources will support the evolution of aircraft-based augmentation systems (ABAS) that could provide vertically guided approaches with minimal, or potentially no need for external augmentation signals. The availability of a second frequency will allow avionics to calculate ionospheric delay in real-time, effectively eliminating a major error source. The availability of multiple independent constellations will provide redundancy to mitigate the risk of service loss due to a major system failure within a core constellation, and will address the concerns of some States about reliance on a single GNSS constellation outside their operational control.

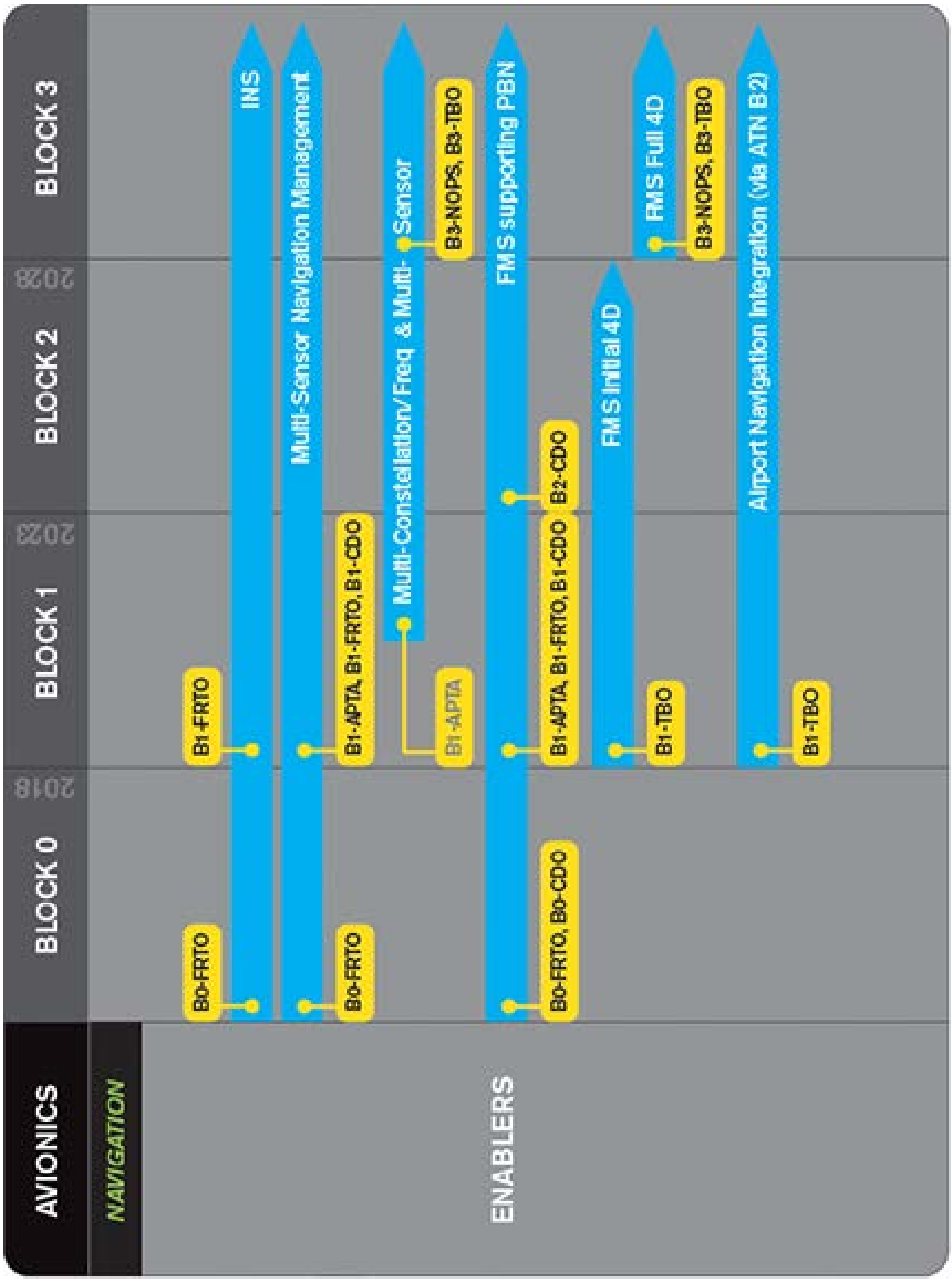
Roadmap 10 - in the Block 3 timeframe and beyond:

- Flight management system capability will be enhanced to support the full 4D capability.

Roadmap 10:

Domain: Avionics

Component(s): Navigation



Roadmap 11 - in the Block 0 timeframe:

- ACAS 7.1 will be the main airborne safety net. This will continue through the Block 1 timeframe.
- Electronic flight bags will become increasingly common in the cockpit. Care must be taken to ensure that they have been certified for the functions supported.
- Airport moving maps and cockpit display of traffic information will be supported with technologies such as ADS-B.

Roadmap 11 - in the Block 1 timeframe:

- Enhanced vision systems (EVS) for aerodrome use will be available in the cockpit.

Roadmap 11 - in the Block 2 timeframe:

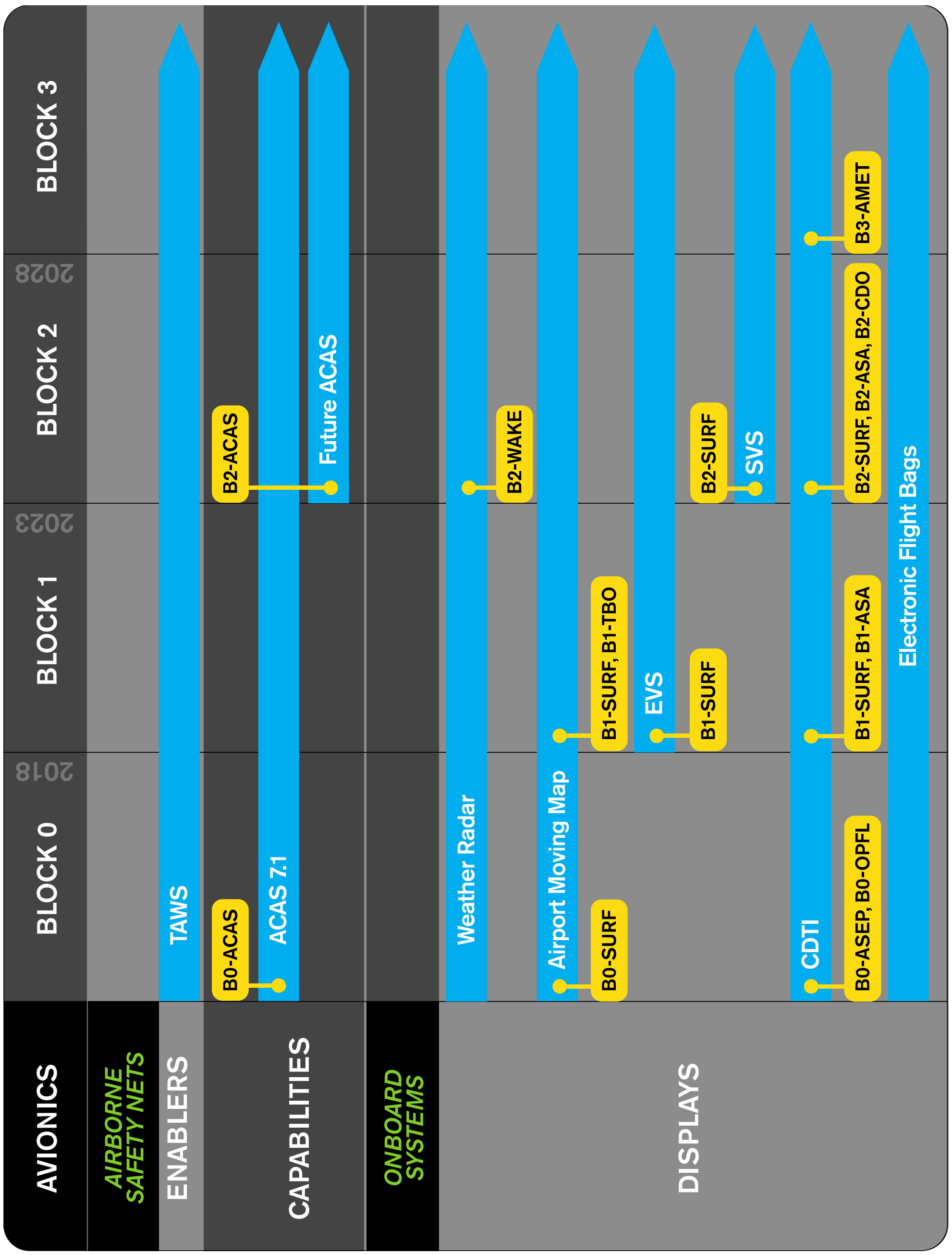
- Synthetic vision systems (SVS) for aerodrome use will be available in the cockpit.

Roadmap 11:

Domain: Avionics

Component(s): Airborne Safety Nets

On-Board Systems



Automation

The Twelfth Air Navigation Conference requested ICAO to develop a roadmap for ground air traffic automation systems. This work will be carried out during the next triennium. The purpose of this roadmap will be to

i. Ensure interoperability between States

ii. So the function and operation of these systems will result in consistent and predictable air traffic management system across states and regions.

Appendix 6: **Module Dependencies**

The illustration on the following page depicts the various dependencies which exist between Modules. These may cross Performance Improvement Areas and Blocks.

Dependencies between Modules exist either because:

i. There is an essential dependency.

ii. The benefits of each Module are mutually reinforcing, i.e. implementation of one Module enhances the benefit achievable with the other Modules(s).

For further information the reader is referred to the detailed online descriptions of each Module.

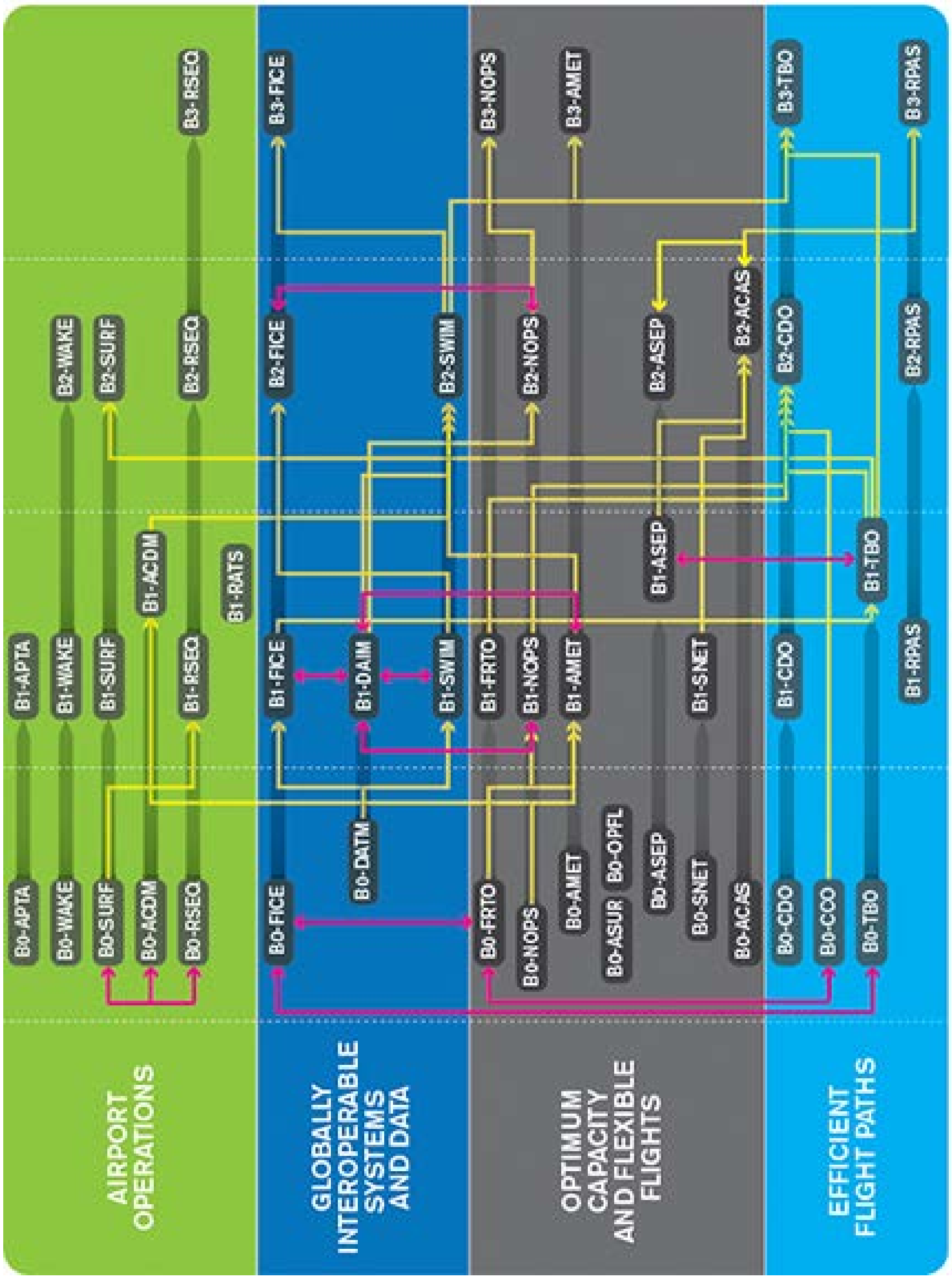
Legend:

Links from a Module in Block ‘n’ to a Module in Block ‘n+1’

Dependencies across Threads/Performance Areas

Links to other Threads/Performance Areas where a Module is dependent on an earlier Module or Modules

Reference


AIRPORT OPERATIONS
GLOBALLY INTEROPERABLE SYSTEMS AND DATA
OPTIMUM CAPACITY AND FLEXIBLE FLIGHTS
EFFICIENT FLIGHT PATHS
B0-APTA
B0-WAKE
B0-SURF
B0-ACDM
B0-RSEQ
B0-FICE
B0-DATM
B0-FRTO
B0-NOPS
B0-AMET
B0-ASUR
B0-OPFL
B0-ASEP
B0-SNET
B0-ACAS
B0-CDO
B0-CCO
B0-TBO
B1-APTA
B1-WAKE
B1-SURF
B1-ACDM
B1-RSEQ
B1-RATS
B1-FICE
B1-DAIM
B1-SWIM
B1-FRTO
B1-NOPS
B1-AMET
B1-ASEP
B1-SNET
B1-CDO
B1-TBO
B1-RPAS
B2-WAKE
B2-SURF
B2-RSEQ
B2-FICE
B2-SWIM
B2-NOPS
B2-ASEP
B2-ACAS
B2-CDO
B2-RPAS
B3-RSEQ
B3-FICE
B3-NOPS
B3-AMET
B3-TBO
B3-RPAS

Appendix 7: **Acronym Glossary**

A

ATFCM – Air traffic flow and capacity management

AAR – Airport arrival rate

ABDAA – Airborne detect and avoid algorithms

ACAS – Airborne collision avoidance system

ACC – Area control centre

A-CDM – Airport collaborative decision-making

ACM – ATC communications management

ADEXP – ATS data exchange presentation

ADS-B – Automatic dependent surveillance—broadcast

ADS-C – Automatic dependent surveillance—contract

AFIS – Aerodrome flight information service

AFISO Aerodrome flight information service officer

AFTN – Aeronautical fixed telecommunication network

AHMS – Air traffic message handling System

AICM – Aeronautical information conceptual model

AIDC – ATS inter-facility data communications

AIP – Aeronautical information publication

AIRB – Enhanced traffic situational awareness during flight operations

AIRM – ATM information reference model

AIS – Aeronautical information services

AIXM – Aeronautical information exchange model

AMA – Airport movement area

AMAN/DMAN – Arrival/departure management

AMC – ATC microphone check

AMS(R)S – Aeronautical mobile satellite (route) service

ANM – ATFM notification message

ANS – Air navigation services

ANSP – Air navigation services provider

AO – Aerodrome operations/Aircraft operators

AOC – Aeronautical operational control

AOM – Airspace organization management

APANPIRG – Asia/Pacific air navigation planning and implementation regional group

ARNS – Aeronautical radio navigation Service

ARNSS – Aeronautical radio navigation Satellite Service

ARTCCs – Air route traffic control centers

AS – Aircraft surveillance

ASAS – Airborne separation assistance systems

ASDE-X – Airport surface detection equipment

ASEP – Airborne separation

ASEP-ITF – Airborne separation in trail follow

ASEP-ITM – Airborne separation in trail merge

ASEP-ITP – Airborne separation in trail procedure

ASM – Airspace management

A-SMGCS – Advanced surface movement guidance and control systems

ASP – Aeronautical surveillance plan

ASPA – Airborne spacing

ASPIRE – Asia and South Pacific initiative to reduce emissions

ATC – Air traffic control

ATCO – Air traffic controller

ATCSCC – Air traffic control system command center

ATFCM – Air traffic flow and capacity management

ATFM – Air traffic flow management

ATMC – Air traffic management control

ATMRPP – Air traffic management requirements and performance panel

ATN – Aeronautical Telecommunication Network

ATOP – Advanced technologies and oceanic procedures

ATSA – Air traffic situational awareness

ATSMHS – Air traffic services message handling services

ATSU – ATS unit

AU – Airspace user

AUO – Airspace user operations

B

Baro-VNAV – Barometric vertical navigation

BCR – Benefit/cost ratio

B-RNAV – Basic area navigation

C

CSPO – Closely spaced parallel operations

CPDLC – Controller-pilot data link communications

CDO – Continuous descent operations

CBA – Cost-benefit analysis

CSPR – Closely spaced parallel runways

CM – Conflict management

CDG – Paris - Charles de Gaulle airport

CDM – Collaborative decision-making

CFMU – Central flow management unit

CDQM – Collaborative departure queue management

CWP – Controller working positions

CAD – Computer aided design

CTA – Control time of arrival

CARATS – Collaborative action for renovation of air traffic systems

CFIT – Controlled flight into terrain

CDTI – Cockpit display of traffic information

CCO – Continuous climb operations

CAR/SAM – Caribbean and South American region

COSESNA – Central American civil aviation agency.

D

DAA – Detect and avoid

DCB – Demand capacity balancing

DCL – Departure clearance

DFM Departure flow management

DFS – Deutsche Flugsicherung GmbH

DLIC – Data link communications initiation capability

DMAN – Departure management

DMEAN – Dynamic management of European airspace network

D-OTIS – Data link-operational terminal information service

DPI – Departure planning information

D-TAXI – Data link TAXI

E

EAD – European AIS database

e-AIP – Electronic AIP

EGNOS – European GNSS navigation overlay service

ETMS – Enhance air traffic management system

EVS – Enhanced vision systems

F

FABEC Functional Airspace Block Europe Central

FAF/FAP – Final approach fix/final approach point

FANS – Future air navigation systems

FDP – Flight data processing

FDPS – Flight data processing system

FF-ICE – Flight and flow information for the collaborative environment

FIR – Flight information region

FIXM – Flight information exchange model

FMC – Flight management computer

FMS – Flight management system

FMTP – Flight message transfer protocol

FO – Flight object

FPL – Filed flight plan

FPS – Flight planning systems

FPSM – Ground delay program parameters selection model

FRA – Free route airspace

FTS – Fast time simulation

FUA – Flexible use of airspace

FUM – Flight update message

G

GANIS – Global Air Navigation Industry Symposium

GANP – Global air navigation plan

GAT – General air traffic

GBAS – Ground-based augmentation system

GBSAA – Ground based sense and avoid

GEO satellite – Geostationary satellite

GLS – GBAS landing system

GNSS – Global navigation satellite system

GPI – Global plan initiatives

GPS – Global positioning system

GRSS – Global runway safety symposium

GUFI – Globally unique flight identifier

H

HAT – Height above threshold

HMI – Human-machine interface

HUD – Head-up display

I

IDAC – Integrated departure-arrival capability

IDC – Interfacility data communications

IDRP – Integrated departure route planner

IFR – Instrument flight rules

IFSET – ICAO Fuel Savings Estimation Tool

ILS – Instrument landing system

IM – Interval Management

IOP – Implementation and Interoperability

IP – Internetworking protocol

IRR – Internal rate of return

ISRM – Information service reference model

ITP – In-trail-procedure

K

KPA – Key performance areas

L

LARA – Local and sub-regional airspace management support system

LIDAR – Aerial laser scans

LNAV – Lateral navigation

LoA – Letter of agreement

LoC – Letter of coordination

LPV – Lateral precision with vertical guidance OR localizer performance with vertical guidance

LVP – Low visibility procedures

M

MASPS – Minimum aviation system performance standards

MILO – Mixed integer linear optimization

MIT – Miles-in-trail

MLS – Microwave landing system

MLTF – Multilateration task force

MTOW – Maximum take-off weight

N

NADP – Noise abatement departure procedure

NAS – National airspace system

NAT – North Atlantic

NDB – Non-directional radio beacon

NextGen – Next generation air transportation system

NMAC – Near mid-air collision

NOP – Network operations procedures (plan)

NOTAM – Notice to airmen

NPV – Net present value

O

OLDI – On-line data interchange

OPD – Optimized profile descent

OSED – Operational service & environment definition

OTW – Out the window

P

P(NMAC) – Probability of a near mid-air collision

PACOTS – Pacific organized track system

PANS-OPS – Procedures for air navigation services - aircraft operations

PBN - Performance-based navigation

PENS Pan-European Network Service

PETAL – Preliminary EUROCONTROL test of air/ground data link

PIA – Performance improvement area

P-RNAV – Precision area navigation

R

RA – Resolution advisory

RAIM – Receiver autonomous integrity monitoring

RAPT – Route availability planning tool

RNAV Area navigation

RNP – Required navigation performance

RPAS – Remotely-piloted aircraft system

RTC – Remote tower centre

S

SARPs – Standards and recommended practices

SASP – Separation and airspace safety panel

SATCOM – Satellite communication

SBAS – Satellite-based augmentation system

SDM – Service delivery management

SESAR – Single European sky ATM research

SEVEN – System-wide enhancements for versatile electronic negotiation

SFO – San Francisco international airport

SIDS – Standard instrument departures

SMAN – Surface management

SMS – Safety management systems

SPRs – Special programme resources

SRMD – Safety risk management document

SSEP – Self-separation

SSR – Secondary surveillance radar

STA – Scheduled time of arrival

STARS – Standard terminal arrivals

STBO – Surface trajectory based operations

SURF – Enhanced traffic situational awareness on the airport surface

SVS – Synthetic visualisation systems

SWIM – System-wide information management

T

TBFM – Time-based flow management

TBO – Trajectory-based operations

TCAS – Traffic alert and collision avoidance system

TFM – Traffic flow management

TIS-B – Traffic information service-broadcast

TMA – Trajectory management advisor

TMIs – Traffic management initiatives

TMU Traffic management unit

TOD – Top of Descent

TRACON – Terminal radar approach control

TS – Traffic synchronization

TSA – Temporary segregated airspace

TSO – Technical standard order

TWR – Aerodrome control tower

U

UA – Unmanned aircraft

UAS – Unmanned aircraft system

UAV – Unmanned aerial vehicle

UDPP – User driven prioritisation process

V

VFR – Visual flight rules

VLOS – Visual line-of-sight

VNAV – Vertical navigation

VOR – Very high frequency (VHF) omnidirectional radio range

VSA – Enhanced visual separation on approach

W

WAAS – Wide area augmentation system

WAF – Weather avoidance field

WGS-84 – World geodetic system - 1984

WIDAO – Wake independent departure and arrival operation

WTMA – Wake turbulence mitigation for arrivals

WTMD – Wake turbulence mitigation for departures

WXXM – Weather exchange model

International Civil Aviation Organization (ICAO)

999 University Street, Montréal, Quebec • Canada • H3C 5H7

Tel.: +1 514-954-8219 • Fax: +1 514-954-6077 • E-mail: icaohq@icao.int

www icao.int

Published in separate English, Arabic, Chinese, French, Russian and Spanish editions by the

INTERNATIONAL CIVIL AVIATION ORGANIZATION

For ordering information and for a complete listing of sales agents and booksellers, please go to the ICAO website at www.icao.int

Doc 9750-AN/963, 2013–2028 Global Air Navigation Plan

Order Number: 9750-AN/963

ISBN XXX-XX-XXXX-XXX-X

— — — — — — — —