PBN IMPLEMENTATION PLAN FOR IRELAND

COMMENTS AND OBSERVATIONS TO:

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Table of Contents

1. Document Change Control Sheet

Date	Version	Author	Revision Description
29/01/2010	1.0	SRD	Document Created
22/06/2012	2.0	SRD	Detailed implementation tables updated
16/01/2015	3.0	SRD	EASA NPA & detailed implementation tables updated & removal of Galway
01/04/2017	4.0	SRD	SES Navigation Strategy
17/08/2018	5.0	SRD	Implementation dates update

2. Acronyms

The following is a list of acronyms used in this document:

ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
ANSP	Air Navigation Service Provider
APCH	Approach
APV	Approach Procedures with Vertical Guidance
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
ANS	Air Navigation Services
AWS	Automated Weather Station
Baro-VNAV	Barometric Vertical Navigation
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CFIT	Controlled Flight into Terrain
CNS/ATM	Communication Navigation Surveillance/Air Traffic Management
CPDLC	Controller Pilot Data Link Communications
CTA	Controlled Airspace
DTTAS	Department of Transport, Tourism and Sport
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
EGNOS	European Geostationary Navigation Overlay Service
ETS	Emissions Trading Scheme
FANS	Future Air Navigation System
FMS	Flight Management System
Galileo	Is a global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA)
GPS	US Military Global Positioning System
GHG	Greenhouse Gas
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
IAA	Irish Aviation Authority
IAC	Irish Air Corps
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IRU	Inertial Reference Unit
LPV	Localiser Performance with Vertical guidance
MEL	Minimum Equipment Lists
MSSR	Mono-pulse Secondary Surveillance Radar
NDB	Non Directional Beacon
OCA	Oceanic Control Area
PBN	Performance Based Navigation
PSR	Primary Surveillance Radar
RAIM	Receiver Autonomous Integrity Monitoring
RCP	Required Communication Performance
RSP	Required Surveillance Performance
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance Authorisation Required
SBAS	Satellite Based Augmentation System
SID	Standard Instrument Departure
SJU	Single European Sky ATM Research Joint Undertaking
SRD	Safety Regulation Division
STAR	Standard Instrument Arrival
TMA	Terminal CTA
VOR	VHF Omni-directional Radio-range
WAM	Wide Area Multilateration

3. Executive Summary

ICAO's Global Air Navigation Plan (GANP) 2013-2028 sets the introduction of Performance Based Navigation (PBN) as its highest priority. Whilst ICAO has generally sought to remain flexible in its approach, the ICAO Assembly Resolution A37-11 took a more top-down approach and, reflecting the importance of PBN, called for implementation of PBN required navigation performance (RNP) approaches with vertical guidance (APV) using either satellite-based augmentation system (SBAS) or barometric vertical navigation (Baro-VNAV) by 2016, with the following intermediate milestones: 30% by 2010 and 70% by 2014. Where vertical guidance is not feasible due to lack of availability of local altimeter setting or APV-equipped aircraft, lateral guidance, to most instrument flight rules (IFR) runway ends, was prescribed by 2016.

Evidently Ireland's/Europe's implementation of PBN approach operations remains well below the ICAO GANP target, despite EGNOS (the EU SBAS) being available (i.e. certified for use in aviation) since March 2011 and the wide availability of BARO-VNAV for decades.

ICAO's GANP also sets out a roadmap for the reversionary technologies to be used in case of widespread GNSS failure. Whilst the robustness of GNSS is expected to be improved through the use of multi-frequency and multi-constellation technologies, a reversionary mode based on purely non-GNSS technologies is still considered necessary. This back-up is intended to be realised in the form of ILS for approaches and for en-route a combination of DME/DME and radar vectoring.

In order to achieve a transition to a more modern navigation system and most of all to reap the economic, capacity and environmental benefits from it, there is a need for a navigation roadmap that outlines the various steps and the desired end-state. Although for the time being there is no pressing operational need to transfer to a new navigation system, there are several aspects that support the need for a navigation strategy:

- Technological innovation has enabled an increasing variety of navigation applications with a continuous expansion of an air navigation "toolbox". Substantial benefit may be gained by selecting a set of solutions in order to clarify the main thrust forward for Ireland, thus facilitating investment decisions, speeding development and avoiding operational complexity for air traffic controllers and flight crews;

- Globally, the indication that PBN is the future, is clear, and this needs to be concretised in an Irish context together with an intelligent rationalisation plan for the navigation infrastructure in order to control maintenance and replacement costs. Lack of clarity will perpetuate the current first-mover-disadvantage that demotivates both airspace users and ANSPs from investing in new technology;

- Finally, whilst the EASA opinion on PBN rule is well founded, it needs to be set in the broader context of what the end-state and timing for the EU navigation system should be at least in the next 20-30 years.

Use of area navigational concept while providing some operational benefits, is not sufficient in itself to produce the required overall benefits with respect to both operational and economic improvements. Much of the economic benefit comes from a rationalisation of the ground infrastructure, incentivising ground as well as on board equipment and decommissioning the outdated legacy navigation infrastructure. Furthermore PBN also contributes to increased accessibility of less equipped airfields and supports the decongestion of big hubs resulting in additional economic benefits.

The PBN concept differs from classic navigational concepts by relying on defining the required navigational performance rather than the precise equipment to be used. In practise the most convenient means for position determination today is through the use of GNSS together with an on-board RNAV system. GNSS use in the EU is based on EGNOS, but soon to be joined by Galileo – satellite constellation(s), thus introducing a potential single point of failure whether because of environmental or deliberate interference, technological issues etc. Furthermore the nature of GNSS services exposes them to new kinds of security threats (intentional spoofing etc.). Therefore in deciding about PBN, we also need to focus carefully on the possible failure modes and the reversionary (back-up through radar vectoring or DME/DME) modes of operation that are required to maintain a minimum level of service with an acceptable level of safety.

The key roles for stakeholders are:

IAA SRD / DTTAS

- Ensure that the relevant Safety Cases, IAA processes, Irish Aviation Notices and guidance material enable a safe and efficient PBN environment that aligns with both ICAO Standards and European Regulation.

- Ensure that the national infrastructure (CNS/ ATM capability) will support the airspace concepts and the performance specifications associated with each phase of PBN implementation.

Air Navigation Service Providers

- Affirming responsibility to seek continual improvements to the safety, access, capacity, efficiency and environmental sustainability of the air transport system. Recognising that PBN provides a catalyst for these improvements to air traffic operations, while enabling a seamless and cost effective solution throughout the entire flight.

Aircraft Operators

- Ensure that investment in aircraft fleet capability is aligned with both the performance specifications outlined in this plan and the timeframe associated with each phase.

Aerodrome Operators

- Ensure the supporting aerodrome infrastructure for PBN operations is coordinated with aircraft operators and IAA SRD.

All Stakeholders ensure that sufficient trained and qualified personnel are available to support the implementation of PBN.

4. SESAR

Whilst the Pilot Common Projects AF1 provided the first SES-related implementation decision of PBN, a wider implementation plan is also underway. The European ATM Master Plan and related more detailed SJU studies have largely followed the ICAO approach for the short term (until end of 2020's), though there are some important differences for the longer term. Generally speaking the current SJU documentation is mainly focused on charting out the technological options while final strategy decisions still remain to be made. A general update of the ATM Master Plan is also underway and scheduled to complete the update in 2018. It will link navigation aspects more firmly to communication and surveillance issues, both as regards involved timing and technology. It will also include specific provisions for drones and cybersecurity that may influence the future CNS environment.

In the short term PBN is seen as the major enabler, though – whilst not contradicting GANP -with more stress on a co-existence of SBAS and GBAS than in ICAO GANP, whereby GBAS is expected to see increased use as a method for precision approaches.

As regards the important decision on reversionary technologies, SJU foresees a two-staged approach where short term solutions may later on be replaced by a selection of alternative technologies providing reversionary capability. As Europe's DME network is already very dense, DME/DME has been a natural choice for primary back-up technology. However SJU documentation notes that if the intention is to achieve identical operational capability as the GNSS-based PBN system provides, the current system will need some upgrades both for its ground and airborne components, so that its use in the planned (SESAR) functionality as an alternative means to operate PBN, would still involve considerable investments.

For aircraft without DME/DME capability, the reversionary technology will be a reduced VOR-network. For approaches ILS should continue to serve as the main back-up to GBAS operations.

Where SESAR differs from ICAO is the longer term reversionary solution. Whereas ICAO GANP is more inclined towards a single-stage reversionary technology decision, SJU considers a multitude of new technologies that could be introduced in the longer term as additional reversionary positioning and navigation means to enhance or even replace DME and VOR. Options for these long-term solutions include Enhanced DME, Mosaic/DME, LDACS-NAV (based on cellular network), e-LORAN, Wide-Area Multilateration/TIS-B, pseudolite (pseudo-satellite) network, Mode-N or inertial systems.

5. Fundamental assumptions for the future system in the EU

Drawing on the ICAO and SESAR plans as well as discussions with various aviation stakeholders, the future system is to be based on two basic technologies:

- The "new" technology (in civilian IFR use since circa 1993) is PBN realised primarily via GNSS. Whilst area navigation techniques have existed since the 1950's, only its realisation though GNSS navigation has really brought it into the limelight as the all-round solution. Nominally PBN is written to be independent of technology, but currently GNSS positioning – where necessary augmented by SBAS, ABAS and/or GBAS - is the foundation for PBN approaches. From the viewpoint of space infrastructure, the ultimate goal will be to establish a multi-frequency, multi-constellation GNSS system that also complies with the safety regulatory requirements for certification of navigation service providers (N.B. not necessarily systems themselves) in order to provide the required reliability for the EU air navigation system. However with right mitigation measures, PBN implementation can – and has - already started with todays' GNSS constellations.

- The main CATII/III precision approach technology is and will remain ILS except where supplemented in the longer term by GBAS or a combination of GNSS and on-board systems, such as EVS or SVS to allow operations below CAT I minima. ILS has been in approved use since circa 1941 and operated with autoland systems since the 1960's so there is abundant data on its reliability and failure modes. It is also currently the only widespread technology able to support CATIII approaches.

After this basic framework is agreed, the next question is related to the type and extent of the reversionary system to be maintained. Maximal economic benefits could be achieved by aiming for a (long-term) introduction of purely PBN-based navigation system, without ground-based reversionary options. However we should also consider the different failure modes that need to be tackled and consequently decide what level of service should be maintained in each case. Generally a failure could be:

- Airframe (receiver) specific failure, affecting only one aircraft at time.

- Local or regional (such as in case of intentional or accidental satellite signal jamming) GNSS provision failure leading to a loss of PBN capability on a restricted amount of routes and runway-ends.

- Total GNSS failure, wiping out GNSS availability in all, or most, of European airspace.

Depending on the type of failure, different reversionary solutions may be employed. These solutions need to consider also the fact that GNSS is used in many other applications (e.g. ADS-B, datalink etc.) so whilst surveillance and communication systems form an important part of the back-up systems, they must be able to provide for operations independent from these also affected systems e.g. through the use of SSR rather than ADS-B. Future roadmaps on surveillance and communications must thus be aligned with the navigation roadmap to ensure they support each other fully. It is also important to determine what level of service we wish to provide in the case of GNSS failure, as that has a direct impact on the cost of the reversionary system to airspace users and ANSP's.

Finally; whilst the liability regimes of GNSS constellations used are beyond the scope of this paper, further work should be undertaken to determine the Member States and ANSP's liabilities when using third country GNSS constellations. As regards EU's regulatory framework, the use of GNSS constellations for the provision of air navigation services fall under existing legal provisions and as their oversight will thus be regularised, and liability responsibility for them will be taken by the service provider and competent authority as applicable. Future equipment mandates could also take into account the related level of safety assurance for the various systems.

6. Proposed layout of the future system

The traditional navigation infrastructure has been relatively simple and easy to comprehend for pilots and controllers. Apart from en-route navigation, there were essentially two kinds of approaches; precision approaches with ILS or non-precision approaches with VOR or NDB. The current system includes the legacy options (until 2030), but has also introduced a wide variety of PBN solutions – many of which are overlapping, but may require slightly different equipment or crew qualifications. Also the terminology, charting, training and phraseology for these operations is unnecessarily different. Whilst this may have been an inevitable result of historical development when the technology was evolving, the future system should be able to provide the desired performance improvements whilst also returning the general understand ability and interoperability of the system so as to facilitate the maximum number of aircraft with the minimum number of technical variations.

In essence, the navigation system should be laid out so that all current navigation systems are progressively replaced by roughly the following framework:

7. En-route

In the en-route phase navigation is conducted under PBN – primarily realised through GNSS positioning. In this phase of flight the PBN specification should be such to ensure that aircraft can navigate from point to point in a structured manner.

Oceanic – Retain RNP 10 (RNAV 10) and RNP 4 with existing communications and surveillance requirements (CPDLC and ADS-C where necessary to support application of 30/30 separation standards).

As at December 2010, approximately 30% of current Ireland oceanic airspace users are FANS 1A capable and therefore able to benefit from the 30/30 separation standard, traffic forecasts do not indicate capacity will be constrained with current standards.

Domestic – Specify RNAV 5 for all promulgated routes in domestic CTA.

Plan to develop Direct/Free route airspace throughput the Shannon FIR/UIR

Surveillance will be provided by the existing Mode–S capable MSSR network. This will be supplemented by the existing PSR systems at Dublin, Cork and Shannon.

Communications provided by VHF network.

The IAA's ATM system capability has been updated with the introduction of the COOPANS system at the Shannon and Dublin ATCCs since 2011.

8. TMA Procedures

Arrival and departure routes from all aerodromes with instrument procedures, are also provided as PBN routes to RNAV 1 or where required by operational considerations to RNP 1 specification, so as to allow aircraft to operate PBN from take-off to landing. For helicopters PinS specifications will apply.

Specify RNAV 1 for all terminal routes with surveillance services and **RNP 1** for routes without surveillance services. Where a surveillance service is available, it will be provided by the existing PSR/Mode–S capable MSSR network.

Communications provided by VHF network.

The IAA's ATM system capability has been updated with the introduction of the COOPANS system at the Shannon and Dublin ATCCs since 2011.

9. Non-Precision Runways

Approaches will be offered at all non-precision instrument runway ends using PBN. Minima shall be laid out so as to provide for not only LNAV & LNAV/VNAV but also LPV minima using SBAS (taking due account of the given geographical and meteorological environment including the aerodrome infrastructure and required utilisation). Due to the additional safety benefit of SBAS when compared e.g. to BARO-VNAV, and although legacy aircraft will be accommodated by the provision of different minima lines, the overall target is RNP APCH to the lowest feasible LPV minima's. On runway ends that currently have only non-precision approaches, or that currently do not have instrument approaches, but intend to implement them, PBN approaches shall be established by 03 December 2020.

10. Precision Instrument Runways

CAT II/III precision approaches to major hubs or other airports that require better operational capability are provided with a combination of PBN arrival and departure routes and ILS-based final approaches.

Additionally RNP approaches (LNAV & LNAV/VNAV & LPV Minima) will also be provided at all instrument runway ends on these airports in the same manner as to other airports, in order to add flexibility and as a back-up, as well as to facilitate those aircraft that only have PBN navigation capability.

Eventually, some precision approaches may be converted to GBAS, but for reasons of redundancy ILS approaches will still be needed at least at some runway ends so GBAS cannot be the only solution. The case for GBAS should be made considering both the benefit of e.g. curved approaches and the additional burden on aircraft equipage.

On runway ends that currently have precision approaches, RNP approaches (LNAV & LNAV/VNAV & LPV Minima) shall be established at the same time as the PCP airports, by 25 January 2024.

11. Mixed mode operations

Mixed mode operations will be phased out and navigation infrastructure rationalised by 06 June 2030

12. Back-up solutions

PBN specifications require infrastructure support from either GNSS or DME/DME or radar vectoring capability. The capability of the existing DME network to support DME/DME updating needs to be verified to ensure it will be adequate for planned future use in both en-route and terminal airspace throughout the entire state or ensure that radar vectoring can meet the backup needs for all aerodromes (State as well as regional) in the event of a GNSS failure.

13. Non-GNSS ANS failure

Autonomous navigation in case of ANS failure (i.e. loss of communications, surveillance, ATC unit etc.) is provided by PBN. It will allow aircraft to fly out of the area of ANS failure and if required also to land without ANS support.

14. Failure of primary navigation infrastructure

As a total long-term GNSS failure would be a major societal shock, it is sufficient to bring most active flights to a landing. Airspace capacity will be limited to most essential flights only, so very few new flights will take off and many of these will be State aircraft capable of operating independently. For shorter term outages or as a means of reducing airspace capacity in a controlled manner by limiting airborne flights, the following back-ups will be maintained for the foreseeable future:

- For aircraft with DME/DME capability (i.e. most larger modern airlines) DME/DME provides PBN capability, combined with access to ILS-equipped airports. Considering the past reliability of GNSS, it seems unlikely that a DME-system upgrade to achieve RNP-specification capabilities would actually bring sufficient benefits to warrant the required investment. Some minor adjustment of the DME-network may be required to ensure sufficient coverage, but generally SJU and Eurocontrol studies have indicated that the existing framework is sufficient both in numbers and location.

- For those flights without DME/DME capability (mostly regional aircraft, military and general aviation) the alternative navigation means is to leave a minimum operational network (MON) of VOR's so that an aircraft will never be more than e.g. 100-150 nm away from a functioning VOR. However this network will be truly minimal and not enable sustained operations in case of total GNSS failure. The VOR MON infrastructure will eventually be fully replaced (2030) by only DME and ATC vectoring within Ireland.

- Finally vectoring by ATC using non-GNSS based surveillance technology, to an airport with an ILS approach, RNP Approaches (LNAV & LNAV/VNAV & LPV Minima) or visual conditions, will provide the final recourse to navigating especially our regional airports.

- In case of local failure of ILS, aircraft will land either using RNP Approaches (LNAV & LNAV/VNAV & LPV Minima) or visual conditions at the destination or alternate airport, or deviate to an airport with functioning ILS.

15. Aircraft equipage

In a performance based environment, aircraft equipage is not dictated in detailed regulations, but it is determined by the required navigation (or communications or surveillance etc.) performance. In the past IFR-approved aircraft were required to equip with the full array of navigation equipment from ADF to ILS, regardless of whether all of them were ever actually needed. In the performance based approach it is for the aircraft operator to determine which routes they wish to operate and then equip the aircraft so as to provide for required navigation capability on that route. This principle is already enshrined in the Standardised European Rules of the Air (SERA) and in particular the Air-OPS Regulation for EU operators and Regulation (EU) No 452/2014 for third country operators.

Such an approach helps rationalise equipage, but also ensures that aircraft are able to operate in the environment they fly in without causing hindrances to other stakeholders. Whilst the exact equipage solutions are open to the aircraft operators, it is expected that airlines will typically use a combination of DME/DME, GNSS (augmented as desired by ABAS, SBAS and/or GBAS) and ILS for positioning, whilst in the other end of spectrum General Aviation aircraft will probably rely increasingly on a combination of GNSS (augmented as per operator needs), ILS and VOR, with ADF being quickly outphased and in the longer term probably also VOR seeing less and less use (2030).

16. Safety – Risks Associated with Major System Change

During the transition to a mature PBN environment the government and industry will face significant challenges. The government challenges will include support of Irish Aviation Rule changes and associated preparatory work. The industry challenges will involve resourcing and managing a diverse range of navigation systems with equally diverse requirements. Some of the key identified challenges are:

- Adoption of supporting Irish Aviation Rules
- PBN capability register and aircraft minimum equipment lists (MEL)
- Integration of PBN capability into the ATM system (Flight Plan data fields)
- Mixed fleet/system operations
- Safety monitoring of ATM system
- Approach naming and charting conventions
- Navigation database integrity and control
- GNSS system performance and prediction of availability service
- Continued involvement in CNS/ATM and PBN development
- Resources of the IAA SRD to implement PBN
- Education and training of personnel employed by the IAA, ANSP's and aircraft operators.

17. Environment

Environmental challenges include minimising the impact of noise and emissions on both the communities in the proximity of aerodromes and the global environment. PBN will support the achievement of these goals while preserving aviation safety and efficiencies in the ATM system, but a collaborative approach will be essential to deliver all these objectives. The introduction of Ireland's emission trading scheme (ETS) provides aircraft operators flying domestic routes with a commercial incentive to upgrade their fleet, including PBN capability. With the introduction of regional or global emissions trading schemes for aviation, this commercial incentive could significantly increase and extend to international aircraft operators flying to and from Ireland.

Environmental challenges therefore include:

- Political developments/considerations
    - Increased ATM system capacity due to PBN efficiency gains
    - Emission control/management, including demonstrated efficiencies associated with PBN operations
    - Noise control/management
- Technological developments
    - Tension between noise outcomes and emissions reduction outcomes.

18. Infrastructure Development

Design and implementation of GNSS Instrument Flight Procedures Procedures is well advanced. Approved Procedure Design organisations have a significant workload in turning the design work into published documents. The following issues need to be addressed by the IAA SRD and the aviation industry:

- Terrestrial Navaids
  - Transition to GNSS based system
  - Decommissioning of existing aids (NDB's & VOR's)
- GNSS/RAIM prediction requirements including
  - Overall GNSS status monitoring, reporting and recording
  - Prediction of availability for a particular operation and aircraft
- Automatic Weather Station (AWS) for APV Baro-VNAV
  - Implementation will require coordination between the IAA, Met Eireann, ANSP's and aerodrome operators
  - Responsibilities for funding of these initiatives will need to be determined
- RNP Approach design
- Runway infrastructure
  - Aerodrome obstacle survey
  - Aerodrome lighting (approach and surface)
- Use of GNSS
  - Use of GNSS within Irish airspace is subject to the compliance with applicable international requirements and standards (for example ICAO Annex 10).
  - Formal safety assurance evidence will need to be provided to determine whether the performance of GNSS within Irish airspace is adequate to support the planned increase in reliance on this technology by the aviation industry. Such safety evidence will have to consider risks such as the susceptibility of GNSS signals to external sources of interference.
  - Co-operative agreements between NSAs may be required to address the regulatory oversight of GNSS providers and services (e.g. oversight of the EGNOS safety of life service).

19. Operational Efficiency Benefits

- Efficiency gains enabled through PBN include:
  - Reduced separation standards for air traffic routes in oceanic and some portions of domestic en-route airspace
  - Greater flexibility of airspace design in terminal area airspace
  - Reduced track distance, noise and fuel consumption through PBN enabled ATS routes and approach procedures
  - Reduced environmental impact.
- The synchronised integration of PBN and non-PBN air routes, airspace and aircraft will be vital if these efficiency gains are to be fully realised.

20. Helicopter Operations

The development of Point in Space (PinS) procedures is currently under discussion / developement with operators.

21. Implementation

22. Short Term

On runway ends that currently have only non-precision approaches, or that currently do not have instrument approaches, but intend to implement them, PBN approaches shall be established by 3 December 2020.

23. Medium term

On runway ends that currently have precision approaches, PBN approaches shall be established at the same time as the PCP airports, by 25 January 2024.

24. Long Term

Mixed mode operations will be phased out and navigation infrastructure rationalised by 1 June 2030.

25. GNSS Departures and Arrivals

Aerodrome	Designator	RWY	Current Procedure	Proposed Procedure	Sensor
Baldonnel	**EIME**	29 Q4/2019	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		11 Q4/2019	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		22 Q4/2019	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		04 Q4/2019	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
Cork	**EICK**	34 Q1/2017	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		16 Q1/2017	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		25 Q1/2017	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		07 Q1/2017	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
Donegal	**EIDL**	20 Q2/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
		02 Q2/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
Dublin	**EIDW**	28 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		10 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		16 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		34 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
Ireland West	**EIKN**	26 Q3/2016	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
		08 Q3/2016	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
Kerry	**EIKY**	26 Q3/2016	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
		08 Q3/2016	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
Shannon	**EINN**	24 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
		06 Q4/2018	SID & STAR	SID CCO & STAR CDO	DME/DME or GNSS With radar backup
Sligo	**EISG**	20 Q1/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup

		02 Q1/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
Waterford	**EIWF**	20 Q3/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
		02 Q3/2019	SID & STAR	SID CCO & STAR CDO	GNSS With radar backup
Weston	**EIWT**	23 Q1/2019	SID	SID CCO	GNSS With radar backup
		05 Q1/2019	SID	SID CCO	GNSS With radar backup

26. Approach Procedures

Facilitate a mix of ground based approaches; RNP APCH (RNAV GNSS) including Baro-VNAV enabled Approach with Vertical Guidance and Localizer performance with vertical guidance (LPV), where possible. Where a surveillance service is available, it will be provided by existing PSR/Mode–S capable MSSR network or ADS-B and Wide Area Multilateration systems when these are commissioned, integrated with ATM system and certified for use. Communications provided by VHF network.

Aerodrome	Designator	RWY	Current Procedure	Proposed Procedure	Sensor
Baldonnel	**EIME**	29 Q4/2019	VOR SRA	VOR SRA LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		11 Q4/2019	ILS Cat I VOR SRA	ILS Cat I VOR SRA LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		22 Q4/2019	VOR SRA	VOR SRA LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		04 Q4/2019	Nil	LNAV/VNAV LNAV	DME/DME or GNSS With radar backup
Cork	**EICK**	35 Q1/2017	ILS Cat II LOC VOR	ILS Cat II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		17 Q1/2017	ILS Cat I LOC VOR	ILS Cat I LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		25 Q1/2017	VOR	VOR LNAV	DME/DME or GNSS With radar backup
		07 Q1/2017	VOR	VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
Donegal	**EIDL**	20 Q2/2019	NDB	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup

		02 Q2/2019	NDB	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
Dublin	**EIDW**	28 Q4/2018	ILS Cat II LOC VOR	ILS Cat I & II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		10 Q4/2018	ILS Cat II LOC VOR	ILS Cat II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		16 Q4/2018	ILS Cat II LOC VOR	ILS Cat II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		34 Q4/2018	VOR LNAV/VNAV LNAV	VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
Ireland West	**EIKN**	26 Q1/2019	ILS Cat I & II LOC VOR NDB LNAV/VNAV LNAV	VOR NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
		08 Q1/2019	VOR NDB LNAV/VNAV LNAV	VOR NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
Kerry	**EIKY**	26 Q1/2019	ILS LOC NDB LNAV/VNAV LNAV	ILS LOC NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
		08 Q1/2019	NDB LNAV/VNAV LNAV	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
Shannon	**EINN**	24 Q4/2018	ILS Cat I & II LOC VOR	ILS Cat I & II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup

		06 Q4/2018	ILS Cat I & II LOC VOR	ILS Cat I & II LOC VOR LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
Sligo	**EISG**	20 Q1/2019	NDB	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
		02 Q1/2019	NDB	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
Waterford	**EIWF**	20 Q3/2019	ILS LOC NDB	ILS LOC NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
		02 Q3/2019	NDB	NDB LNAV/VNAV LNAV LPV	GNSS With radar backup
Weston	**EIWT**	23 Q4/2019	VOR with Circling	VOR with Circling LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup
		05 Q4/2019	VOR with Circling	VOR with Circling LNAV/VNAV LNAV LPV	DME/DME or GNSS With radar backup

27. Point in Space (PinS) Approach Procedures

Faciliate PinS approach procedures for Custume Barracks Athone, Castletownbere and Kerry University Hospital initially, plus other PinS as and when required.

Aerodrome	**Designator**	**RWY**	**Current Procedure**	**Proposed Procedure**	**Sensor**
Baldonnel	**EIME**	29 Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
		11 Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
		22 Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Sligo	**EISG**	20 Q1/2019	Nil	PinS	DME/DME or GNSS With radar backup
		02 Q1/2019	Nil	PinS	DME/DME or GNSS With radar backup
Waterford	**EIWF**	20 Q3/2019	Nil	PinS	DME/DME or GNSS With radar backup
		02 Q3/2019	Nil	PinS	DME/DME or GNSS With radar backup
Castletownbere	**Nil**	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Blacksod	Nil	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Custume Bcks Athlone	EI??	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Kerry University Hospital	Nil	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Galway University Hospital	Nil	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup
Letterkenny University Hospital	Nil	Helipad Q4/2019	Nil	PinS	DME/DME or GNSS With radar backup

28. **Conclusion.** The implementation of PBN in Ireland's controlled airspace will require the allocation of significant resources by each of the key industry stakeholders and the Irish Aviation Authority (IAA). This investment is considered essential to securing the benefits for Ireland at the earliest opportunity.

29. **Benefits:**

- Safety improvements through greater adherence to a safe flight trajectory (e.g. use of Continuous Descent Operations (CDO)/Continuous Climb Operations (CCO) which is a key component of the ICAO strategy to address Controlled Flight into Terrain (CFIT) accidents).

- Efficiency improvements through changes to air route and approach procedure designs that minimise the air miles flown and enhance schedule reliability, provide greater conformance to the flight plan and reduce enroute traffic delays, which will collectively reduce total operating costs and improve on-time performance.

- Improved environmental performance through greater use of uninterrupted climb and descent trajectories which ensure that both Green House Gas (GHG) emissions and the noise footprint for aviation are minimised.

30. **Ireland's methodology for the transition to PBN is:**

- Maintenance of the present area navigation capability

- Transition to the SES Navigation Strategy

- Introduction of APV capability through barometric vertical navigation

- Development of RNP APCH (to include LPV's) for all runways as well as RNAV SID's & STAR's

- Non Precision runways by 2020 and precision runways by 2024

- Utilise the European GNSS as the enabling technology for the implementation of PBN

- Utilise radar vectoring (the backup system) for all aerodromes.

- Removing by 2030 of conventional instrument flight procedures and mixed mode traffic

- Removal of ground based navigational aids by 2030

- Installation of GBAS for Dublin

31. **The key roles for stakeholders are:**

- IAA SRD / DTTAS

- Air Navigation Service Providers

- Aircraft Operators

- Aerodrome Operators