

ISA CBA update
- Joint PBN and GNSS TF Meeting -

Nairobi, Kenya, 8-10 September 2009

Agenda

- Introduction
- ISA CBA

Scope of this document

- In compliance with Decision 4/1 took at GNSS/I/TF/3, the CBA for ISA has been updated. The scope of this document is to present the first version of the updated CBA model, whose effort has been focused on updating numbers of previous CBA, correcting the methodology of previous CBA, validating the model and gather user feedback.
- The main benefit for aviation due to ISA roll-out in the AFI region will be the foreseen CFIT reduction (therefore increasing safety of flight in the region), while ground infrastructure represents the highest investment required. ISA cumulated benefits for aviation in the AFI region over a 30-years period will amount to c. €1.7b versus expected investments of c. €359m. Discounted net benefits amount to c. €211m.
- TF members are asked to review the CBA in detail and to send comments back to the team by November 2009, before the study is finalised for presentation to APIRG/17.

The methodology utilized in the CBA is shared within the industry

- In general:
 - The CBA considers a timeframe of 30 years (from 2011 to 2041) and represents countries that total 84% of nominal African GDP
 - A 100% penetration of LPV procedures (with 46% being SBAS) on IFR landings is reached by 2020
 - The CBA considers the delta from the base line scenario which is Baro-VNAV without SBAS
- For what concerns benefits:
 - Landings is the main driver for CFIT, ADS-B and DDC benefits
 - only IFR landings are considered and within these only the specific share related to EGNOS influences the calculations
 - also LPV penetration influence the number of landings considered
 - in addition only for ADS-B en-route radar coverage percentage is a key variable
 - The benefit for traditional navigational aids phasing out is applied only to VOR and NDB. Ten years to complete the process have been considered
- With regards to opex and investments:
 - Ground infrastructures cost is influenced by the number of REMs and RIMs and the related capex and opex
 - The cost for aircraft equipage is mainly driven by the actual fleet
 - only IFR aircraft are considered and within these only the specific share related to EGNOS influences the calculations
 - forward-fit costs are preferred and retrofitting is only applied to the marginal aircraft needed to reach the foreseen EGNOS penetration
 - The cost for airport procedures is calculated applying the cost of publishing one procedure to the IFR runways discounted by EGNOS penetration

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- ISA CBA

Main benefits will be CFIT reduction and ADS-B implementation, while ground infrastructure represents the highest investment required

	Benefit/ Cost	Description	ISA Relevance
Benefits	CFIT probability reduction	<ul style="list-style-type: none"> ISA will increase flight safety through the reduction in the number of Controlled Flight Into Terrain (CFIT) occurrences by offering Approaches with Vertical Guidance 	
	ADS-B improvement	<ul style="list-style-type: none"> Supporting Automatic Dependent Surveillance Broadcast (ADS-B), ISA will allow flight routes optimization, with consequent fuel savings over ADS-B using GPS only 	
	Traditional navigational aids replacement	<ul style="list-style-type: none"> ISA will determine significant cost savings related to both installation and maintenance of traditional ground based navigational aids (navaids) 	
	DDC probability reduction	<ul style="list-style-type: none"> Enabling Approaches with Vertical Guidance with consequent lower decision heights, ISA will significantly reduce the probability of occurrence of Delays, Diversions and Cancellations 	
Investments/ Costs	Ground infrastructure	<ul style="list-style-type: none"> ISA will rely upon a series of infrastructure to be deployed and maintained across the African territory (Regional Extension Modules and Reference and Integrity Monitoring Stations) 	
	Aircraft equipage	<ul style="list-style-type: none"> African fleet needs to be equipped with SBAS receivers, either through a retrofit or forward-fit process 	
	Airport procedures	<ul style="list-style-type: none"> In order to support SBAS-based approaches, specific airport procedures must be defined 	

Allowing Continuous Descent Approaches in place of the higher-risk traditional step-down approach, ISA have a positive impact on CFIT reduction

Controlled Flight Into Terrain (CFIT) and Non-Precision Approaches (NPA)

Graphical support



Context description

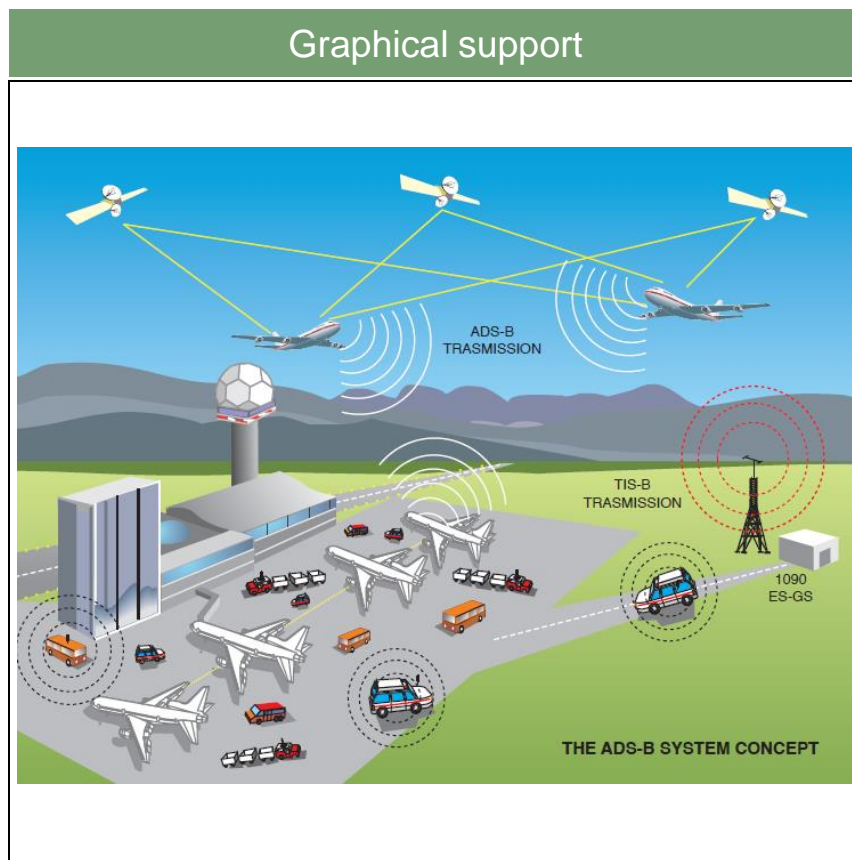
- CFIT occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew
- This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase
- Non-Precision Approaches are at the basis of CFIT occurrence

ISA benefits

- Offering Approaches with Vertical Guidance procedures and enabling Continuous Descent Approaches, ISA can lead to a decrease in the number of CFIT occurrences
“...ISA will have an extremely positive impact on flight safety, determining almost a 100% CFIT avoidance ...”

Automatic Dependent Surveillance-Broadcast (ADS-B) allows an aircraft to constantly broadcast its precise location and other flight data to nearby aircrafts and air traffic controllers

The ADS-B system concept



Context description

- C.55% of total flights in Africa are not supported by surveillance services provided enroute radars
- In such situation aircrafts are obliged to flight respecting a so called procedural separation of c.50NM, far above the optimized one of c.5NM
- African routes are consequently un-optimized

ISA benefits

- SBAS is expected to improve ADS-B based on GPS only
- Enabling a more accurate aircraft positioning, ISA-based ADS-B allows a better route optimisation with respect to GPS only

“...ISA is expected to improve ADS-B performance providing a further optimisation over GPS only-based ADS-B ...”

ISA is expected to promise less reliance on ground based nav aids, determining relevant savings

Ground aids (ILS, DME, VOR and NDB) replacement

Graphical support



Context description

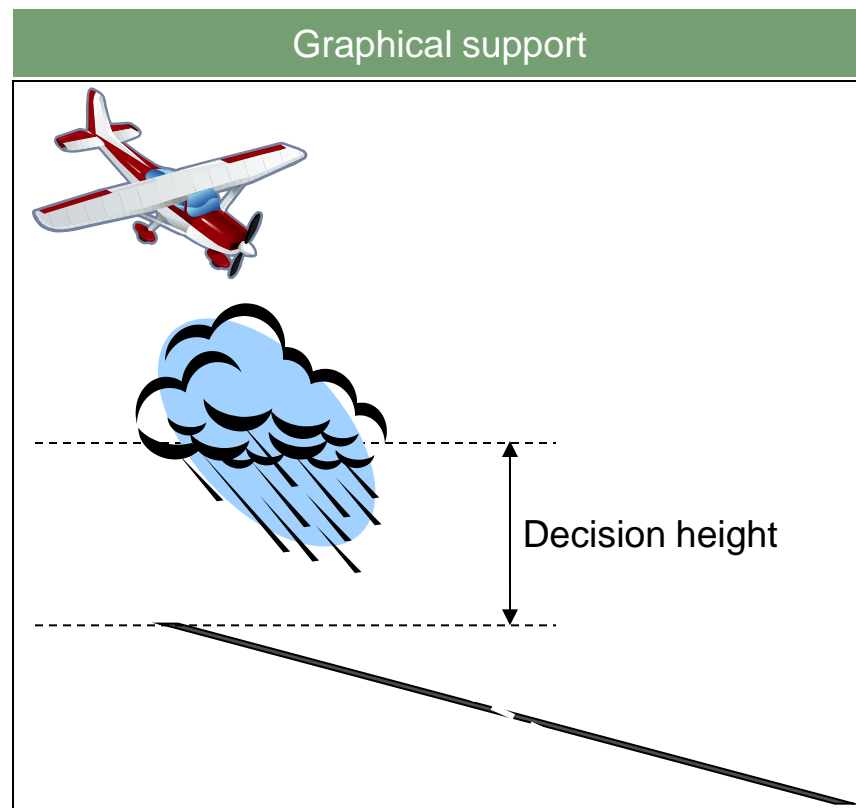
- Traditionally navigation in Africa is guided by a series of ground based nav aids: ILS, DME, VOR and NDB
- The operation and maintenance of ground-based navigation aids represent a major cost element of air navigation service provision

ISA benefits

- The introduction of ISA would allow the phasing out of some of these conventional nav aids (only VOR and NDB), bringing significant benefits in terms of both capex and opex savings
 - “... The deployment of ISA will determine the replacement of ground aids, reducing both operational and capital expenditures ...”

Supporting Approaches with Vertical Guidance (APV), ISA allows lower decision heights in the approaching phase, reducing the probability of occurrence of Delays, Diversions and Cancellations

The importance of the decision height in the approaching phase



Context description

- The decision height is the minimum altitude at which a missed approach can be initiated if deemed unsafe by the pilot allowing sufficient time to safely re-configure the aircraft to climb and execute the missed approach procedures while avoiding terrain and obstacles
- Reducing the decision height at an airport will help reduce the number of Delays, Diversions and Cancellations experienced by the airlines

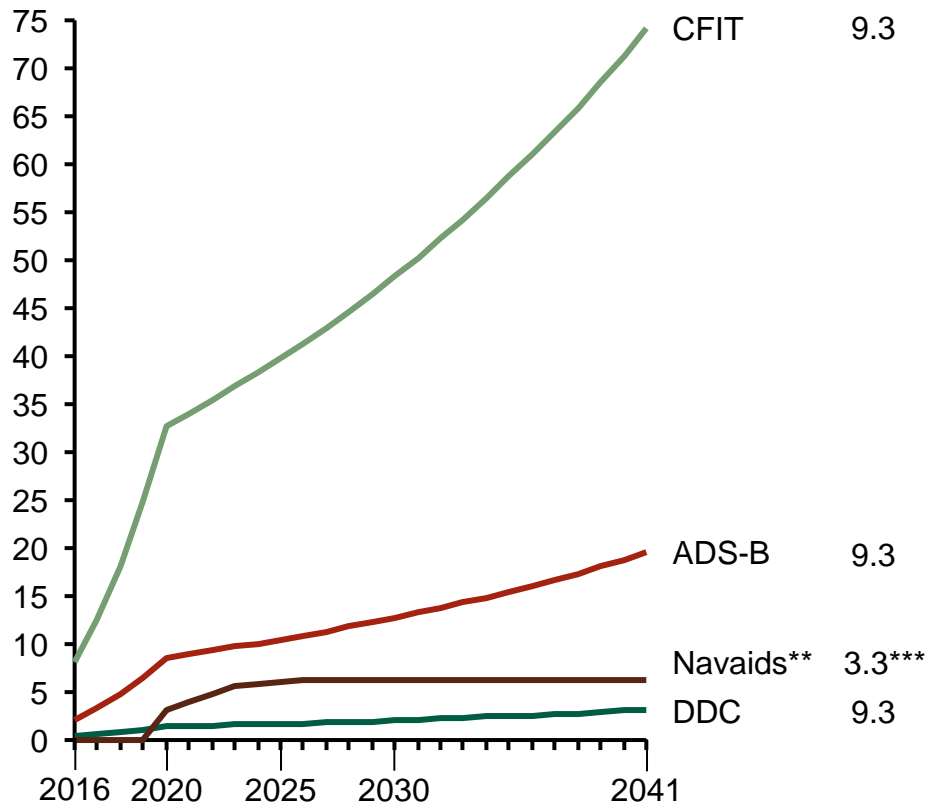
ISA benefits

- ISA allows for SBAS-based Approaches with Vertical Guidance (APV), which enable lower minima
 - “...Although on average Africa is characterized from better weather conditions than Europe, African aviation will benefit from ISA in terms of DDC occurrence reduction ...”

Benefits are expected to start in 2016, CFIT, DDC and ADS-B benefits will increase at a 9.3% CAGR going forward, while nav aids ones will increase at a 3.3% CAGR

**ISA undiscounted benefits
YoY evolution (2016-41)**

Millions of Euro



- The avoidance of CFIT constitutes the greatest benefit of ISA
 "... Safety related benefits represent the most relevant advantage of ISA adoption ..."
- Traditional nav aids replacement benefit shows a growing trend over the first years of ISA adoption, followed by a stable phase; such trend is determined by traditional nav aids backlog phasing out and maintenance costs reduction

Note: * Compounded Average Growth Rate; ** *VOR and NDB; *** CAGR% 2020-41

ISA will require to equip aircrafts with SBAS receivers, update airports' procedures and install and operate REMs and RIMs

Graphical support

Aircraft equipage



Airport procedures



Ground infrastructure deployment and maintenance



Context description

- SBAS receivers require an update of GPS or multi-mode receivers thus being enabled to receive the signal
- Aircrafts need to be equipped with SBAS receivers
 - “... The exploitation of ISA benefits largely depends upon the adoption by airlines of both SBAS and ADS-B equipment ...”

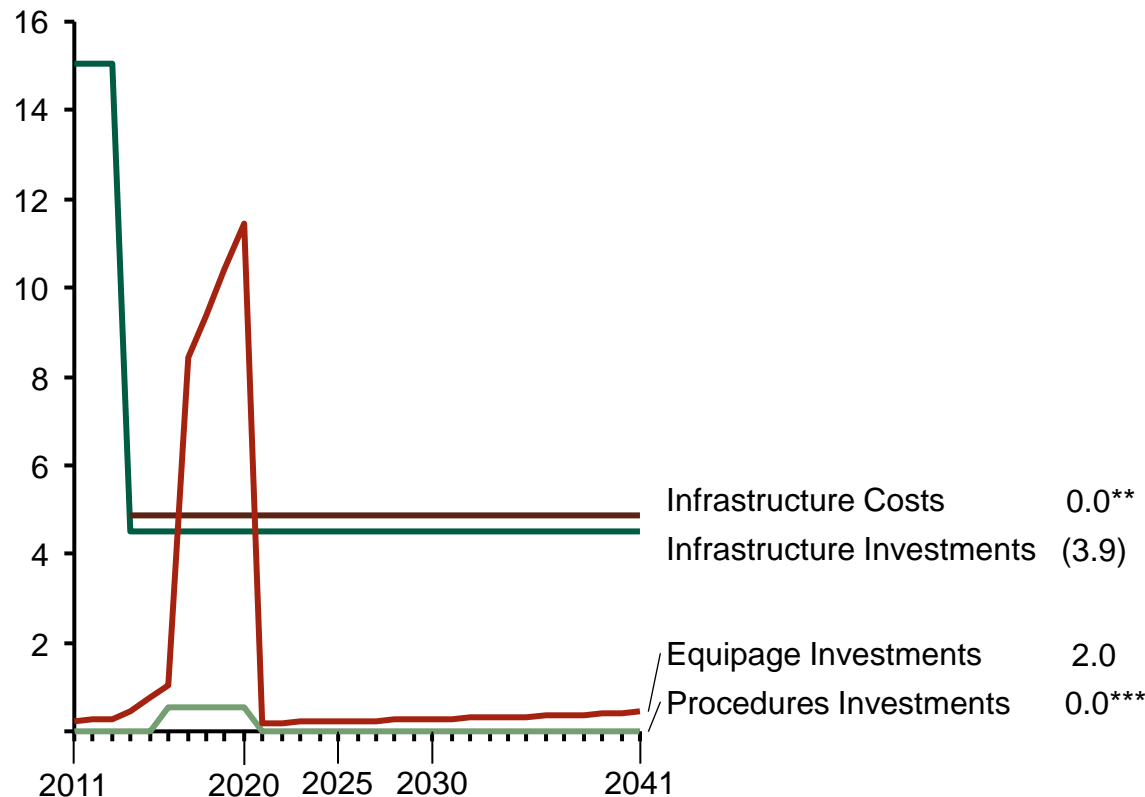
- Approach and landing runway procedures define the rules to be observed in the final phase of a flight
 - “... The introduction of ISA will determine the definition of new procedures for runway ends ...”

- Regional Extension Modules (REM) are used for integrating, monitoring and controlling additional RIMs (Ranging and Integrity Monitoring Station) deployed for ISA
 - “... ISA will rely upon a series of infrastructures (REM and RIM) to be deployed across African territory ...”

ISA related investments are expected to be important until 2016, whilst after that date mainly operating expenses are foreseen

ISA undiscounted investments and costs YoY evolution (2011-41)

Millions of Euro



● Infrastructures deployment is the main investment for ISA implementation

- investments are mainly associated to 2 REMs and 30 RIMs realization

“...The realization of ground structures will account for the largest share of total expenditures associated to ISA deployment ...”

● Equipage is the second investment for EGNOS implementation

- the costs considered are for the full avionics and not only for the incremental part due to EGNOS upgrade, indeed they can be overestimated
- the hypothesis is to prefer forwardfitting when possible[^]

● Procedures costs[^] have been assumed to concentrate in 2016, when SoL signal will be certified

“...Procedures for airports can be published only after SoL signal certification ...”

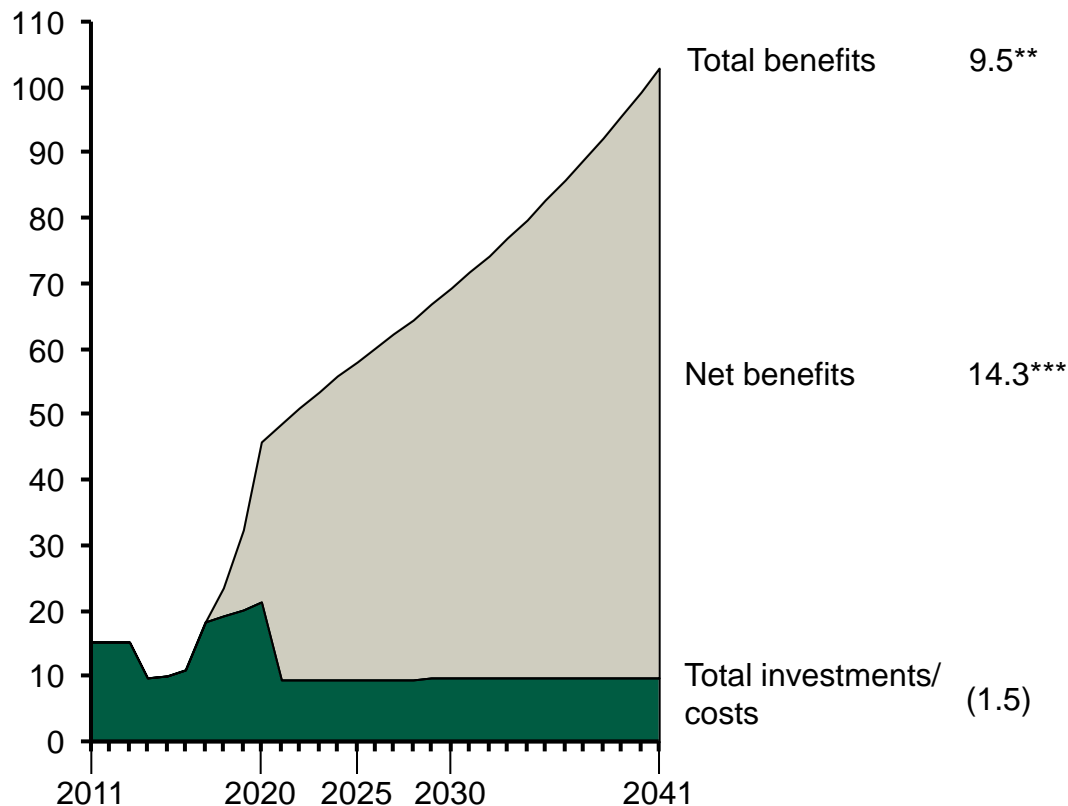
Note: * Compounded Average Growth Rate; ** CAGR% 2014-41; *** CAGR% 2016-20; [^] opportunity costs such as time lost because the aircraft is in maintenance are not considered; [^] c.115 runways representing 46% of total IFR approaches in Africa

The economic value of ISA benefits will be higher than investments necessary for its deployment and running costs

ISA undiscounted Net benefits YoY evolution (2011-41)

CAGR*%
(2011-41)

Millions of Euro



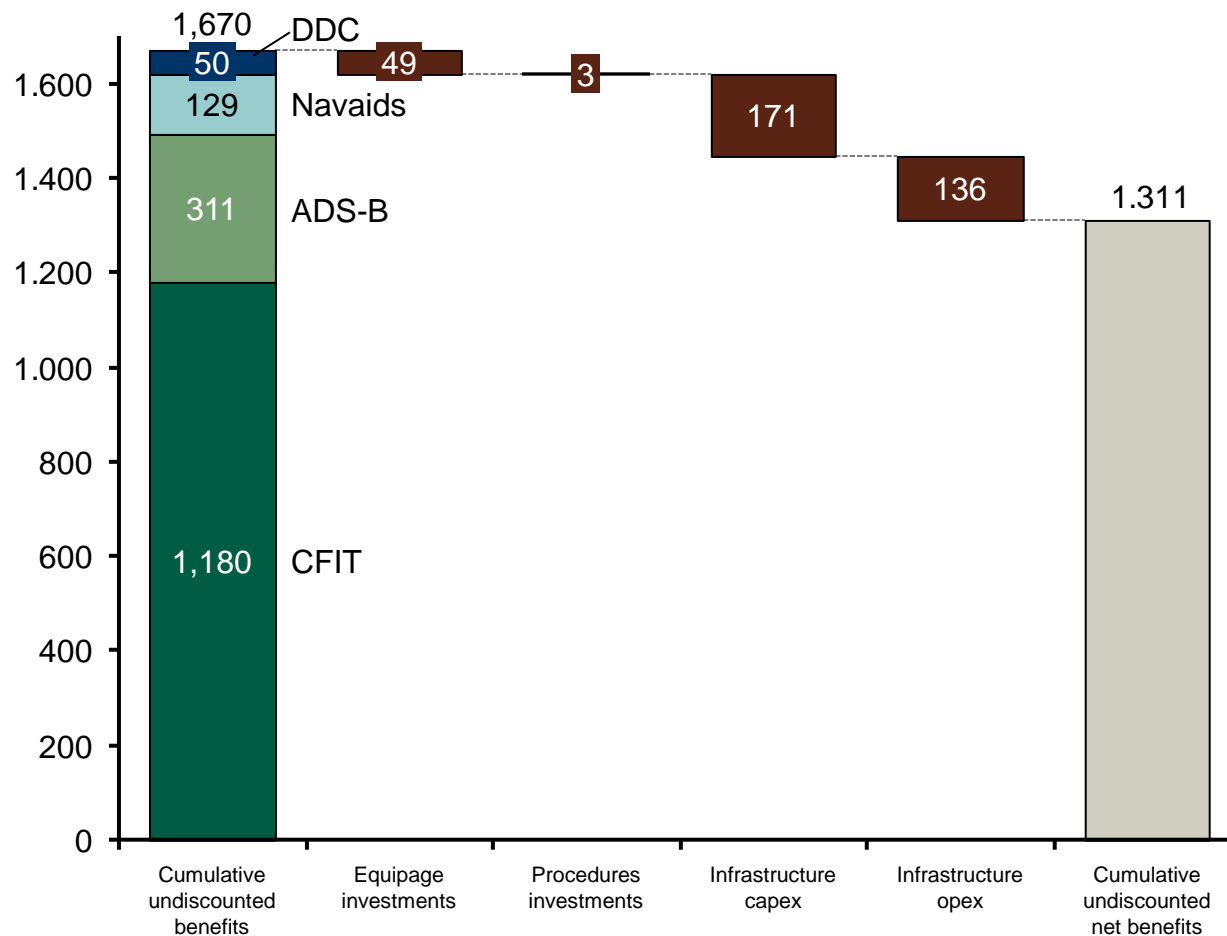
- ISA benefits are expected to exceed investments and costs associated to its implementation and operation
 - total benefits are estimated to amount to c. €102.9m in 2041, with a CAGR* of 9.5% over the 2016-41 period
 - in the same year, total investments and cost are expected to be c.€9.8m, with a 2011-41 CAGR* of (1.5%)
- “...I expect that ISA will bring significant benefits for African aviation, guaranteeing higher efficiency and higher safety standards ...”

Note: * Compounded Average Growth Rate; ** CAGR% 2016-41; *** CAGR% 2018-41

ISA cumulated benefits will amount to c. €1.7b versus investments of c. €359m

ISA cumulative undiscounted net benefits on a 30 years timeframe (2011-41)

Millions of Euro



Discounted net benefits* 211.1€m

Note: * The same discount rate of previous ISA CBA, i.e. 8%, has been used