ESESA EGNOS Service Extension to South Africa

EGNOS Aviation CBA for AFI

ESESA Aviation Workshop 26th – 27th October 2010

ESESA is a project co-funded by the EU 7th FP and South Africa

Agenda

- Presentation objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Detailed cost & benefit assumptions
- (Sources)

Scope & objectives of this presentation

- This work was performed by L.E.K. Consulting in Milan, Italy for the EC and is based on the analysis of secondary sources and on interviews in order to update the previous ISA cost benefit studies

- ESESA will use this CBA model to estimate aviation benefits for South Africa/Southern Africa

We are looking for guidance from you, the audience, with the regard to the most realistic timescales, assumptions and inputs for this region

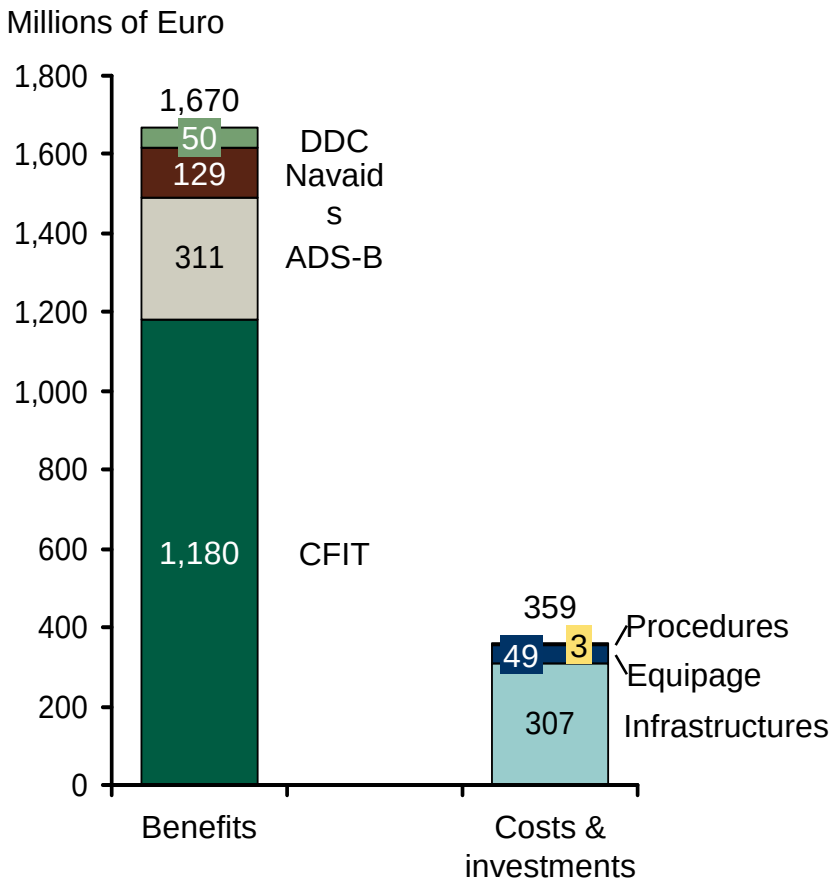
Agenda

- Project objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Model inputs
- (Sources)

Overall result

For the African aviation ISA benefits will amount to c. €1.7b, with respect to required investments of c. €359m

Cumulated undiscounted benefits and costs & investments (2011-41)



Benefits

- ISA will provide a series of benefits to the African aviation industry in terms of:
  - increased safety thanks to the reduction of CFIT occurrences
  - ADS-B system improvement
  - phasing out of traditional navigational aids
  - DDC occurrence limitation

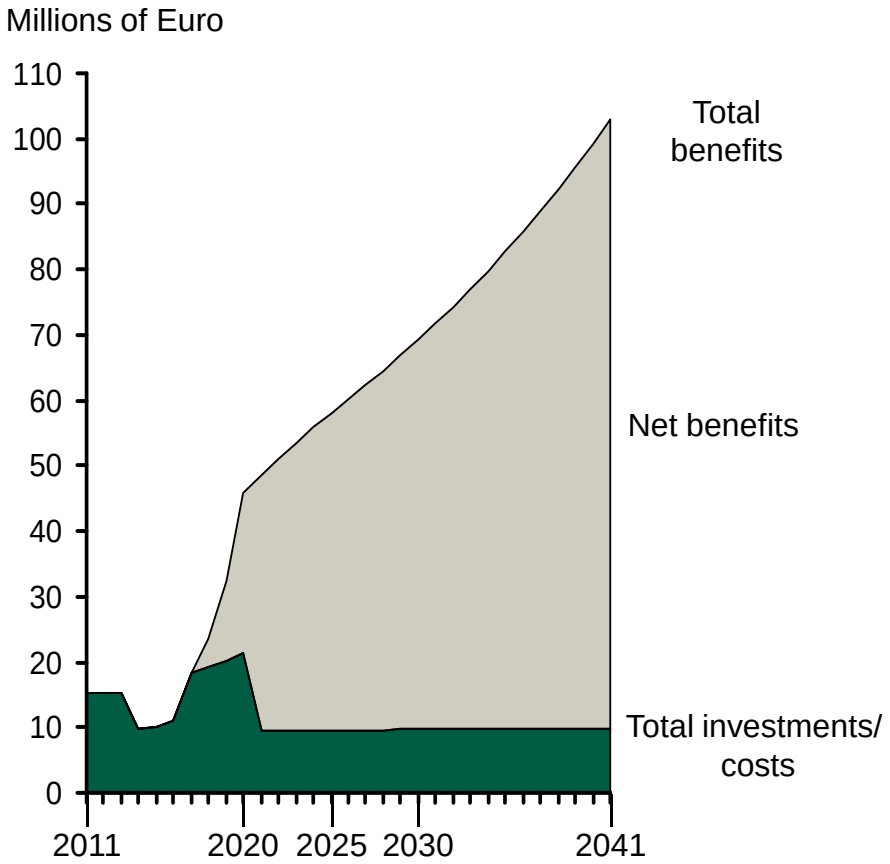
Costs & investments

- ISA deployment will require a series of expenditures:
  - ground infrastructures
  - aircraft equipage
  - airport procedures

Accumulation of benefits vs costs

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

L.E.K. ISA undiscounted net benefits YoY evolution (2011-41)

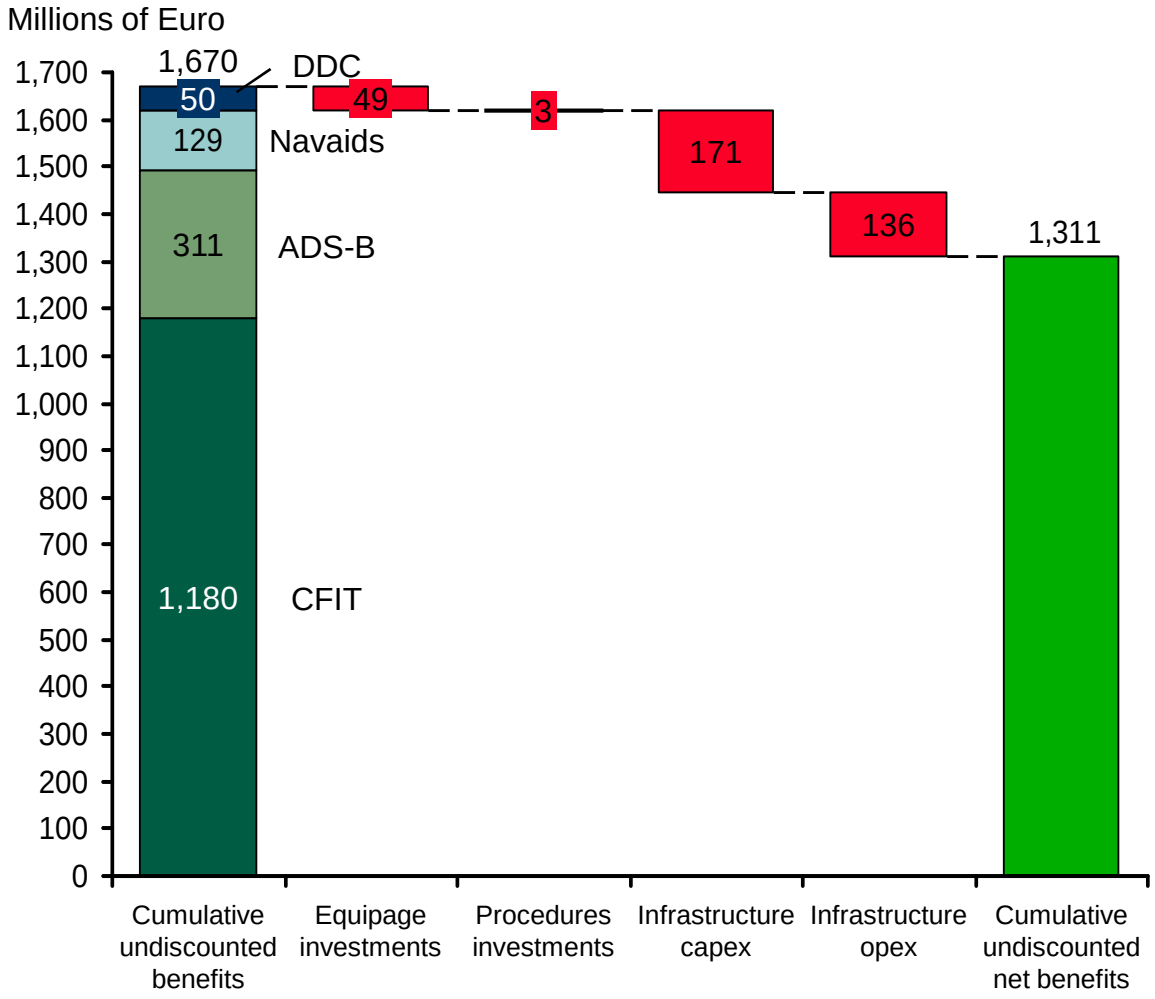


- ISA benefits are expected to exceed investments and costs associated to its implementation and operation
  - total benefits are estimated to amount to c. €102.9m in 2041
  - in the same year, total investments and cost are expected to be c.€9.8m,

Benefits and cost categories

REMs and RIMSs constitute the most relevant ISA-related investments

L.E.K. ISA cumulative undiscounted net benefits on a 30 years timeframe (2011-41)



- Ground infrastructures have the highest impact on ISA potential benefits
- The same discount rate of previous ISA CBA, i.e. 8%, has been used

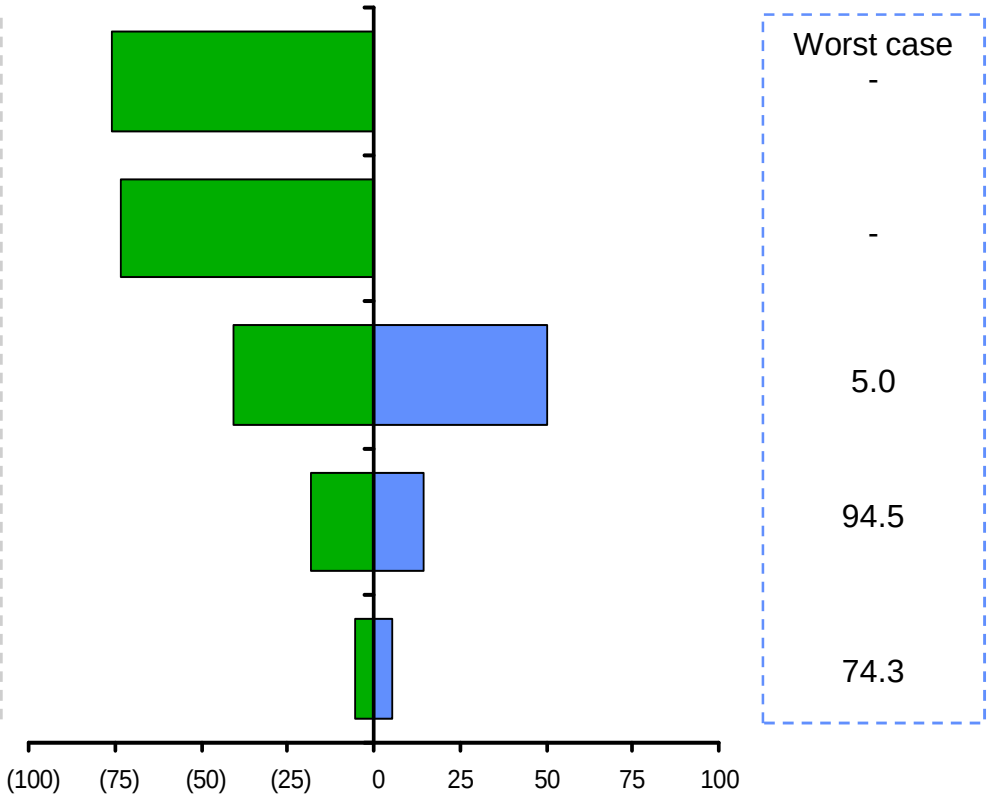
Discounted net benefits **211.1€m**

Sensitivity analysis

Increasing WACC and excluding IATA flights have the highest negative impact on benefits

Millions of Euro

	Worst case	Base case	Best case
WACC %	Worst case 10.0	Worst case 8.0	Worst case -
IATA flights*	OUT	IN	-
CAGR% landings	3.5	4.1	5.0
% IFR	85.2	90.4	94.5
% of DDC avoidable	22.6	48.5	74.3



Scenario analysis

Three scenarios have been identified considering different dates for full penetration of APV procedures and leading to different net benefits results

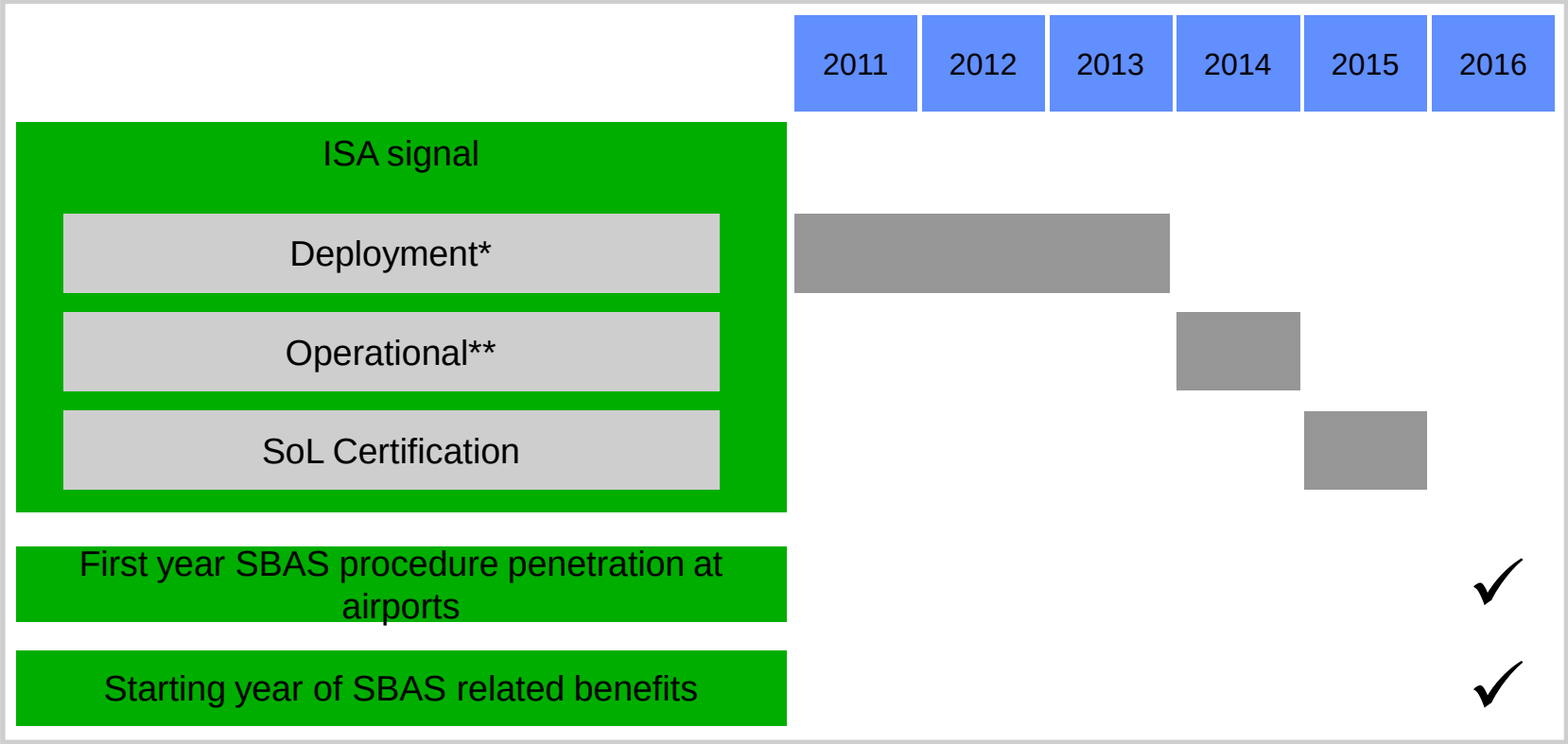
	ICAO adoption scenario	2020 adoption scenario	2025 adoption scenario
Full APV implementation date	2016	2020	2025
Total Benefits			
Discounted	194.2€m	346.5€m	342.1€m
Undiscounted	855.1€m	1,670.1€m	1,774.5€m
Total Costs			
Discounted	115.3€m	135.5€m	135.8€m
Undiscounted	314.5€m	359.0€m	361.1€m
Net Benefits			
Discounted	78.9€m	211.1€m	206.3€m
Undiscounted	540.6€m	1,311.1€m	1,413.4€m

Agenda

- Project objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Model inputs
- (Sources)

Baseline - timeframe

In our model we have considered all the important milestone and the following timeframe has been assumed



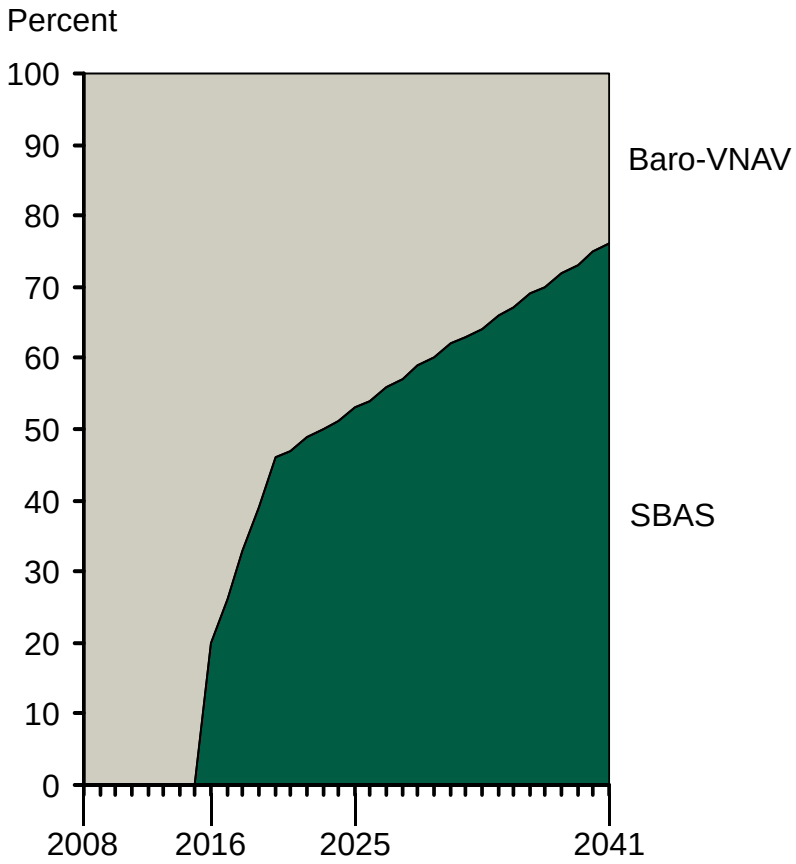
Baseline assumptions

- In the base case 100% penetration of APV procedures on IFR landings is reached by 2020
- Landings are 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 APV penetration influence the number of landings considered
  - ✓ in addition only for ADS-B en-route radar coverage percentage is a key variable
- The benefit from phasing out of traditional navigational aids is applied only to VOR and NDB and it takes ten years to complete the process according to Eurocontrol stated strategy
- Ground infrastructures cost is influenced by the number of REMs and RIMSs 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

Baseline – Baro VNAV vs SBAS

Baro-VNAV competition has been considered in order to estimate ISA penetration in the AFI region

ISA vs Baro-VNAV market share evolution (2008-41)



- GPS + Baro-VNAV is used to provide continuous vertical guidance and can be used to perform APV landings as an alternative to SBAS
- ISA compared to Baro-VNAV has two advantages:
  - ✓ some aircraft do not have certified and integrated systems to meet Baro-VNAV; for these aircraft, APV SBAS will be a good option
  - ✓ slightly lower minima

Scenarios for SBAS adoption

Three scenarios have been identified considering different dates for full penetration of APV procedures …

ICAO rule	As part of the Strategy for the implementation of GNSS, ICAO has stated the introduction of the use of GNSS with appropriate augmentation systems "… States and planning and implementation regional groups (PIRGs) complete a PBN implementation plan by 2009 to achieve: implementation of RNAV (Area Navigation) and RNP (Required Navigation Performance) operations (where required) for en-route and terminal areas according to established timelines and intermediate milestones; and implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 percent by 2014 …" Report of the 36th ICAO General Assembly resolution A36-23

Adoption by air fleets and airports' procedures [%]

	ICAO adoption scenario	2020 adoption scenario	2025 adoption scenario
100% penetration of APV procedures on IFR landings*	2016, with a 30% by 2010 and 70% by 2014	2020, with a PPT% constant increase from 2009 to 2020	2025, with a PPT% constant increase from 2009 to 2025

Base case

Scenarios for SBAS adoption

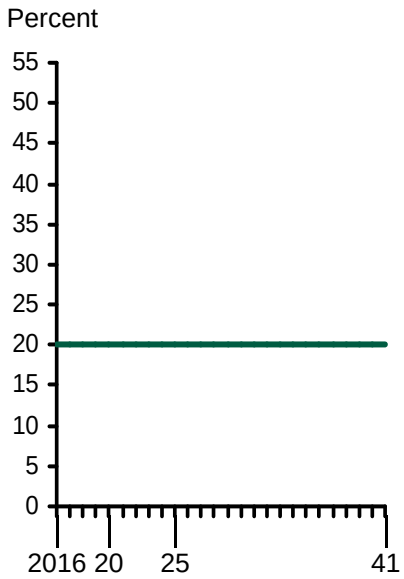
Assuming different ISA market shares as compared to alternative technologies…

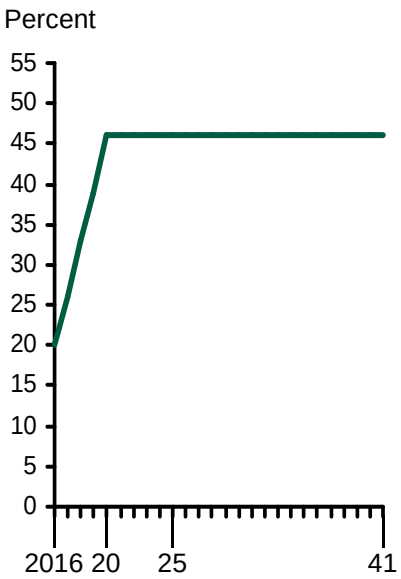
100% penetration of APV procedures on IFR landings

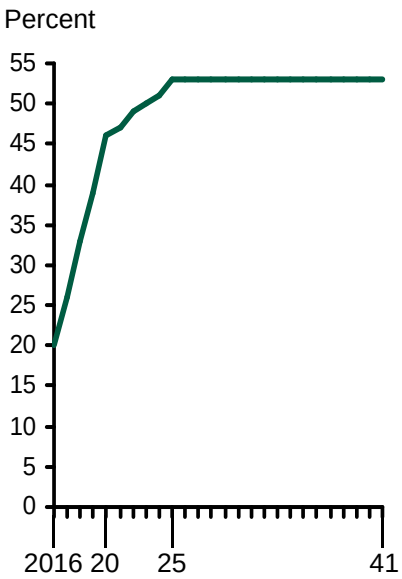
ICAO (2016) adoption scenario

2020 adoption scenario

2025 adoption scenario





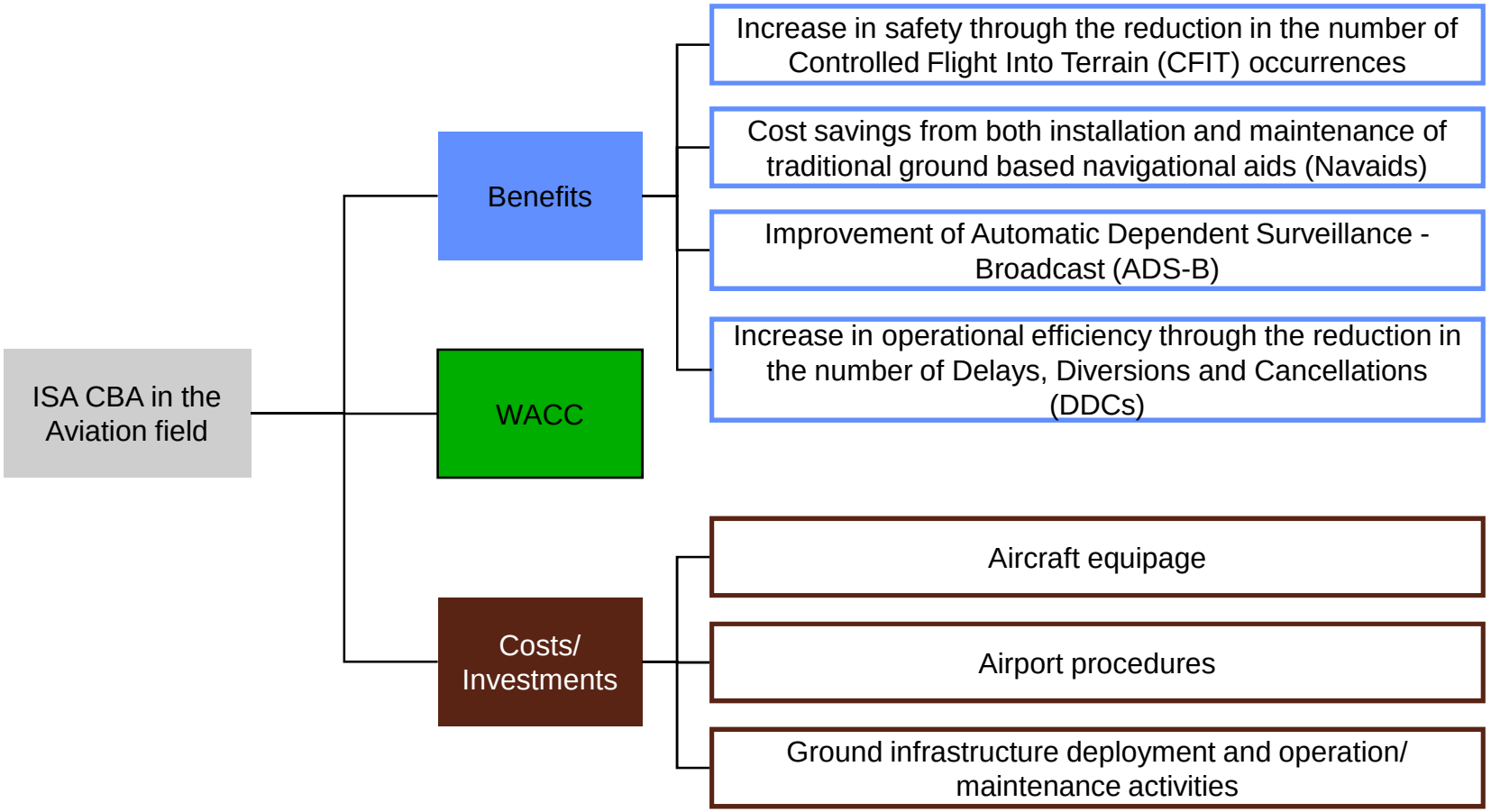


Agenda

- Project objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Model inputs
- (Sources)

Model – benefit & cost categories

ISA is expected to guarantee higher safety and operational efficiency to the AFI region



Model – CFIT

ISA is expected to increase flight safety, lowering the probability of occurrence of Controlled Flight Into Terrain (CFIT)

Yearly estimation of ISA safety related benefits

# of CFIT occurrences in Africa

:

Landings in Africa

=

Probability of CFIT per landing

×

Percentage of CFIT avoidable thanks to SBAS

×

Average CFIT cost

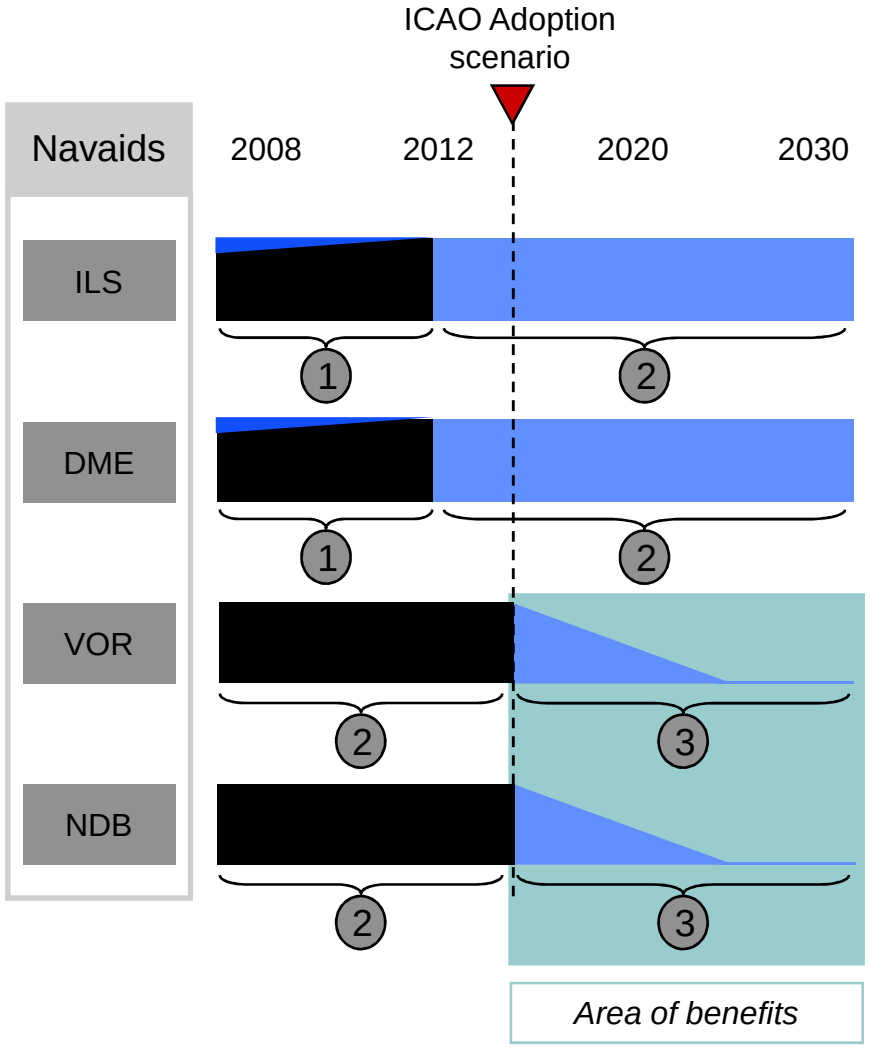
=

Benefits from SBAS

- Controlled flight into terrain (CFIT) describes a collision whereby an airworthy aircraft, under pilot control, inadvertently flies into terrain, an obstacle, or water
  - CFIT often occurs during aircraft descent to landing, near an airport and it is often caused by terrain being obscured by clouds
- CFIT total cost comprehends both human life costs and cost of hull loss

Model – Navaids

From full APV implementation date it is expected the phasing out of NDB and VOR navaids representing a ISA related benefit



1 Increase in population

- ICAO states that 18% of additional navaids must be installed between 2008 and 2012
- In this phase new navaids are considered to replace old ones in order to keep existing stock

2 Maintenance in population

- In this phase new navaids are considered to replace old ones in order to keep existing stock

3 Phasing out in population

- In this phase old navaids are not replaced and additional working navaids are gradually phased out

Model – ADS-B

ADS-B system adoption is expected to determine significant benefits in terms of routes optimization, higher safety and en-route radars replacement

ADS-B related benefits	Strictly ISA-related	Methodology/ comments
Flight routes optimization Savings are based on efficiency through reduced separation standards that allow aircraft to climb to optimal altitudes much earlier, and to follow more efficient routes*	✓	Number of flights × Share of flights with no radar surveillance × Average number of minutes saved with optimized route × Average cost per minute = Total savings thanks to optimization
Higher safety Improved search and rescue as ADS-B can provide much better location information as to where an aircraft went missing	✗	• ADS-B benefits like higher safety and en route radars replacement are not directly related to ISA, as GPS alone guarantees the achievement of such benefits "…Among ADS-B benefits, only route optimization can be directly referred to ISA, as only in this case integrity provided by the SBAS system is required …" ICAO, Regional Officer CNS "…The most important benefit related to ISA is route optimization …" ASECNA, Manager of the Air Circulation Bureau
Enroute radars replacement After ADS-B certification, no more enroute radar is expected to be deployed and a phasing out process will potentially take place	✗	

Model – ADS-B

L.E.K. model does not incorporate ADS-B investments and costs, as they are not directly associated to ISA

GPS-based ADS-B

- ADS-B systems is planned to be implemented in Africa, exploiting GPS signal

  "…The process of ADS-b adoption has already started and it is based on GPS signal …"
  ASECNA, Manager of the Air Circulation Bureau

- Ground infrastructures of ADS-B will be deployed independently from SBAS adoption

  "…Ground based station supporting ADS-B will be realized in Africa also without SBAS systems …"
  ASECNA, Manager of the Air Circulation Bureau

  "…The deployment of ADS-B infrastructure and the installation of specific avionics do not depend on SBAS adoption …"
  ASECNA, Conseiller technique du Directeur de l'Exploitation

Marginal benefits of ISA-based ADS-B

- The L.E.K. CBA incorporates only the marginal benefits of ISA-based ADS-B

  "…In my opinion the introduction of a SBAS system in the ADS-B, could provide an increase of benefits amounting to c. 35% …"
  ASECNA, Manager of the Air Circulation Bureau

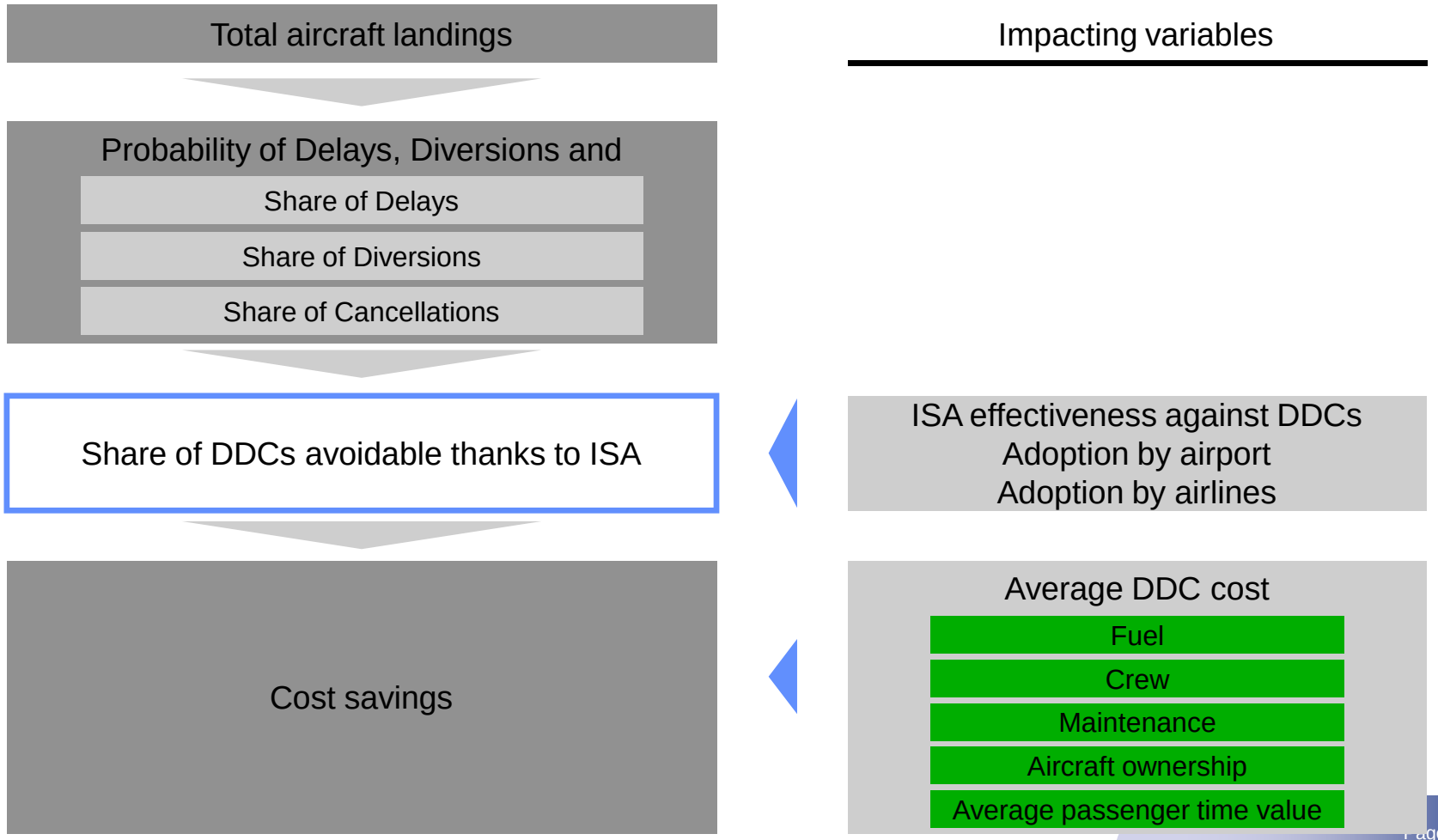
  "…The development of a SBAS-based ADS-B could determine an increase in benefits of c.20% with respect to a traditional GPS-based ADS-B …"
  ASECNA, Conseiller technique du Directeur de l'Exploitation

Being not directly related to ISA implementation, ADS-B investments and costs were not included in the L.E.K. model

Model – DDC

ISA allows a reduction of DDC probability of occurrence, with significant savings for both airports and airlines

DDC benefits estimation model



Model – Aircraft equippage

Aircraft equipage costs comprehend both retro-fit costs and forward-fit ones

Equipage cost estimation model

Retro-fit costs =

- SBAS receiver
- \+ Integration
- \+ Installation
- \+ Crew training
- \+ Documentation
- \+ Certification

× Number of aircrafts

\+

Forward-fit Cost =

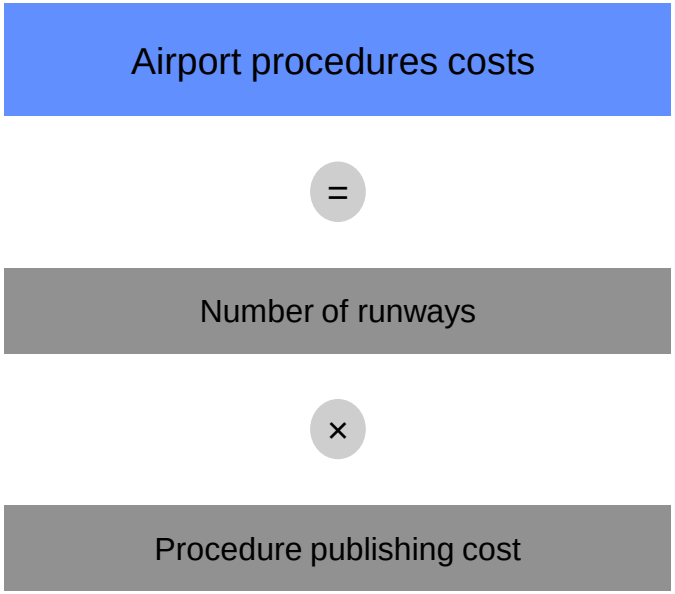
- Crew training
- \+ Other cost

× Number of aircrafts

Model – Airport procedures

Airport procedures costs, related to new landing instructions to be defined by ANSP are estimated to be c.€24K per runway

Airport procedures costs estimation model



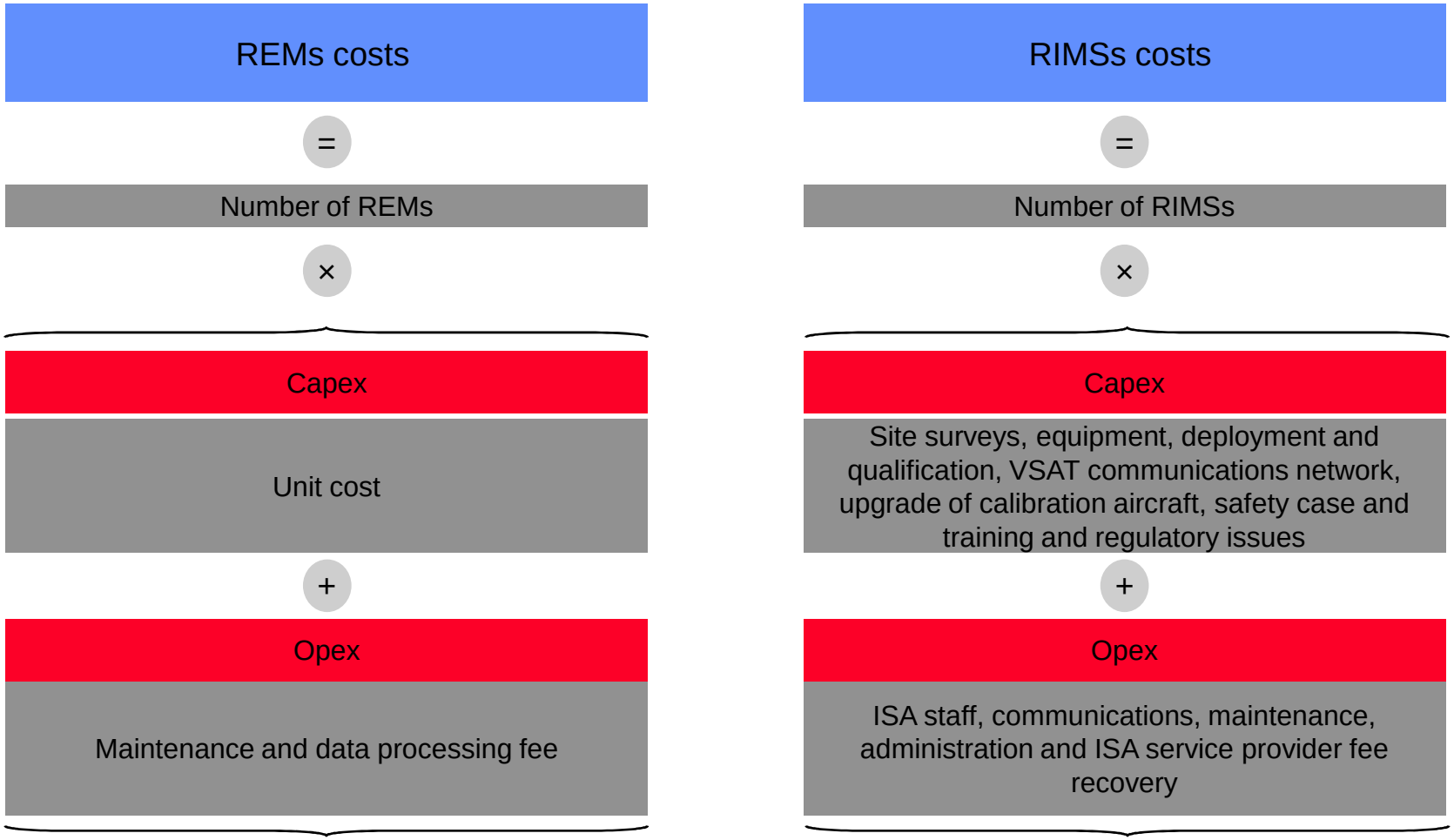
- Single procedure publishing costs are estimated to be c.€24K per runway
  - procedure publishing is performed by national ANSP, who is in charge of defining instructions to be observed during landing process

"… Procedures costs don't vary significantly in Africa if compared to what is in Europe or in USA because the labour force is coming from this two continents and the instruments are the same …"
Pildo Labs, Manager

- In order to define a SBAS based landing procedure, ANSP performs a series of analyses
  - obstacle clearance surface
  - obstacle evaluation area
  - obstacle identification surface
  - glide-path qualification surface

Model – REMs and RIMS cost estimation

Infrastructure costs are related to both REMs and RIMSs and comprehend deployment and operational expenditures



Agenda

- Project objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Model inputs
- (Sources)

Model inputs

General / Cost inputs

- General CBA inputs
- Cost inputs
- Total costs

General CBA inputs

Input	Value	Source
Landings	• In 2008: c.1.3m landings	ACI
	• CAGR% (2008-41): 4.1%	
	• IFR vs VFR: 90.4% vs 9.6%	SAA, Garmin
	• CA vs GA: 81% vs 19%	ACI
Airport runways	• In 2008: 1,101	Jeppesen
	• IFR vs VFR: 23% vs 77%	Jeppesen
Fleet	• In 2008 CA (Jet 816 and Turboprop 849) and GA (Jet 195 and Turboprop 463)	Ascend
	• CAGR% (2008-41): 4.1%	L.E.K. estimate
APV penetration	• 100% in 2016, with a 30% by 2010 and 70% by 2014	ICAO

Aircraft equipage cost inputs

Input	Value	Source
SBAS receiver	• T2=€14,000; J2=€35,000 (2 SBAS rec.)	Honeywell
Integration	• T2=€8,000; J2=€30,000	
Installation	• T2=€3,450; J2=€12,000	
Crew training	• T2=€3,000; J2=€3,000	
Documentation	• T2=€700; J2=€5,000	
Certification	• T2=€2,000; J2=€40,000	

Note: T2=Light multi-engine pressurised turboprop aircraft; J2= Midsize business jet aircraft

Procedures cost inputs

Input	Value	Source
Runways using EGNOS	• Number of runways: 1,101 • Number of IFR-APV runways: 251 • Share of runways using EGNOS: 46%	Garmin, Kenya Airways
Costs	• Costs of procedures: €21,186 • Cost of surveying: €3,107	ATNS

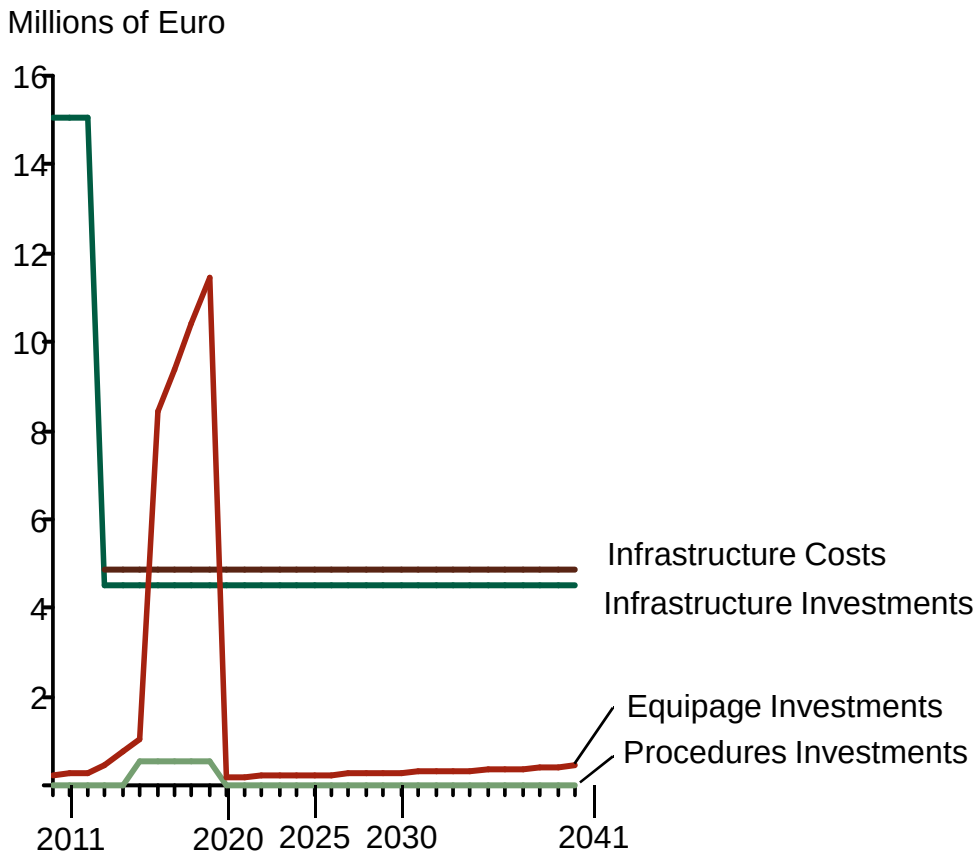
Ground infrastructure deployment and operation cost inputs

Input	Value	Source
REM	• Number of REMs: 2 • Cost per REM (capex): €4,000,000 • Data processing fee per REM (opex): €2,000,000 • Maintenance (opex): 10% of capex	ASECNA and L.E.K. estimate
RIMS	• Number of RIMSs: 30 • Capex per RIMS: €1,237,500 • RIMS Site surveys: €3,333 • RIMS equipment, deployment and qualification: €916,667 • RIMS VSAT comms network: €183,333 • Upgrade of calibration aircraft (ATR42): €8,333 • Safety case and training: €109,167 • Regulatory issues: €16,667 • Opex per RIMS: €28,333 • ISA Staff: €1,667 • Communications: €15,000 • Administration and ISA service provider fee recovery (8% of ops before ESSP fee) : €11,667 • Maintenance (opex): 10% of capex	

Outputs – total costs

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

L.E.K. ISA undiscounted investments and costs YoY evolution (2011-41)



- Infrastructures deployment is the main investment for ISA implementation
  - investments are mainly associated to 2 REMs and 30 RIMSs realization

  "…The realization of ground structures will account for the largest share of total expenditures associated to ISA deployment …"
  ICAO, Regional Officer CNS

- Equipage is the second investment for EGNOS implementation
  - the costs considered are for the full avionic and not only for the incremental part due to EGNOS upgrade, indeed they can be overestimated
  - the hypothesis is to prefer forward fitting when possible

- Procedures costs have been assumed to concentrate in 2016, when SoL signal will be certified

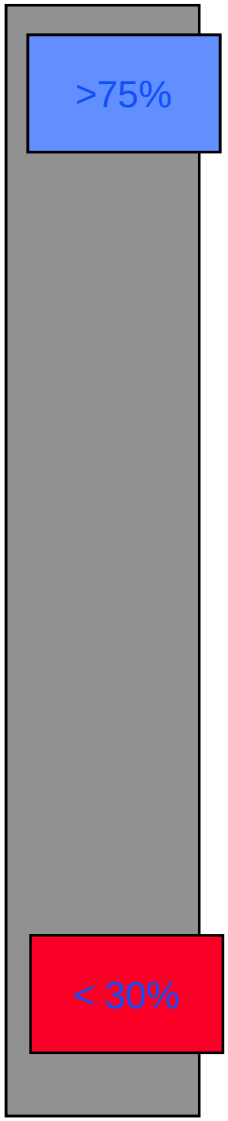
  "…Procedures for airports can be published only after SoL signal certification …"
  Eurocontrol, NAV infrastructure and GNSS activities Manager

Model inputs

Benefit inputs

- CFIT inputs
- ADS-B inputs
- Navaids inputs
- DDC inputs
- Total benefits

Two discordant opinions on % of CFIT avoidable thanks to EGNOS – both considered



- We have gathered many opinions in the industry about the significant EGNOS contribution to CFIT avoidance
  - "… A major cause of CFIT during approach is the lack of vertical guidance. The Flight Safety Foundation has shown there is a 7-fold reduction in approach accidents when vertical guidance is provided compared to non-vertically guided (i.e., non-precision) approaches (Flight Safety Foundation Report: "Safety Benefits of the WAAS during Instrument Approaches") …"
    FAA on WAAS, WAAS benefit register
  - "… When we talk about CFIT during approaches, I think it is defendable to claim that the vertical guidance provided by SBAS or WAAS is as good as an ILS (and may be better due to the ability for moving map displays) in reducing risk of CFIT however there will still be occasions when CFIT happens due to mechanical failure or human error. I would agree that 90% reduction is a fair estimate …"
    NTSB, Safety studies and Statistical Analysis Director
  - "… Our data shows us that much of the time, even when vertical guidance is available it is not used. The most complete solution for CFIT challenge is TAWS but speaking about SBAS if we exclude human errors and mechanical failures the percentage of CFIT that could be avoided thanks to EGNOS would be around 80 or 90% …"
    FSF, Director of Technical Programs
  - "… SBAS is far exceeding the performance that we expected when we commissioned it six years ago. SBAS or WAAS in our case will have an impact on CFIT, if I have to estimate I would say that 95% of CFIT could be avoided …"
    FAA, Satellite Navigation Program Office
  - "… Implementation of continuous descent approach would provide most of the benefit of avoidance of CFITs, I would say that SBAS could eliminate 75% of them …"
    FAA, PBN Specialist
  - "… In my opinion when you are equipped with vertical guidance there is no reason for CFIT so I would say that SBAS could prevent 100% of them …"
    South African Airways, PBN Specialist
  - "… WAAS provides many safety advantage – aviation experts predict that WAAS will reduce accidents by 80% during instrument approaches …"
    Jet Pro on WAAS
- The position of Eurocontrol contradicts the view of these experts within the industry
  - "… The EGNOS benefit will be mitigated by GPS NPA, but I don't have figures on that I would estimate 20-30% is the proper ratio, this is true at least for what concern Europe while in the USA it is different …"
    Eurocontrol, Navigation Domain Manager
  - "… The ratio used is 30% and this estimate has to be considered conservative …"
    Helios on ISA CBA for Eurocontrol

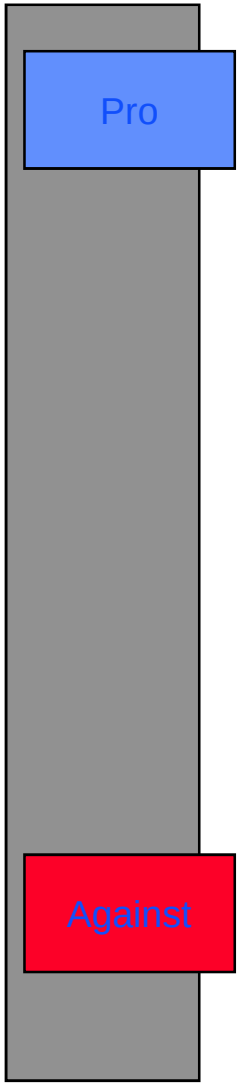
CBA CFIT inputs

Input	Value	Source
% of CFIT occurrence	• 0.00032%	NTSB
EGNOS effectiveness against CFITs	• 87.3%	SAA, FAA, NTSB, FSF, Jet Pro
Average CFIT cost	• Average fatality per accident: 10.75 persons	NTSB
	• Statistical value of life: €173,764	Environmental Protection Agency
	• Average hull loss: €10.75m	Eurocontrol

CBA ADS-B inputs

Input	Value	Source
Minutes saved thanks to ADS-B	• 2.1	ASECNA
Share of movements in AFI without radar coverage	• 68.8%	Kenya Airways
Fuel saved	• Unit cost: €/litre 0.27 • Average fuel consumption: litre/minute 24.6	IATA, Airbus, Cessna, Falcon, Bombardier

FAA, Eurocontrol and experts' opinion on EGNOS contribution to the phasing out of navaids



- We have gathered many opinions in the industry about the EGNOS contribution to the phasing out of traditional navaids

  "… Significant government cost savings due to the elimination of maintenance costs associated with older, more expensive ground-based navigation aids (to include NDBs, VORs, DMEs, and most Category 1 ILSs) …"
  FAA on WAAS

  "… Once everyone will use EGNOS the navaids phasing out could start …"
  ENAV, Director

  "… EGNOS can contribute to navaids in terms of no need for some additional ILS and for VOR and NDB at least those used in the approach phase …"
  GIANT, Coordinator

  "… I wouldn't divide among different categories of VOR and NDB (those used in approach or in navigation phases), all of them are almost obsolete and I confirm that their phasing out is due to EGNOS not all the GNSS system …"
  ENAV, Flight Operation Manager

  "… In my opinion is it correct to consider EGNOS the main contributor to the navaids phasing out of VOR and NDB, I wouldn't say it is referable to GPS. EGNOS is the future, we started to produce helicopters without some old equipage because if we can have EGNOS we can a lot of savings and don't rely on these traditional navaids …"
  Agusta Westland, Senior Marketing Manager

  "… Your analysis about Navaids phasing out seems accurate to me …"
  South African Airways, PBN Specialist

- The position of Eurocontrol is different to that of FAA and of other decision makers and experts within the industry

  "… We don't agree with the FAA position stated on their website and we consider Navaids phasing out a benefit attributable to the whole GNSS system …"
  Eurocontrol, Senior Expert: Navigation (CNS CoE)

CBA Navaids inputs

Input	Value	Source
Population	• DME: 3 • VOR: 60 • NDB: 556 • ILS: 44 • VOR/DME: 174 • ILS/DME: 62	Garmin
Backlog	• DME: 18% • VOR: 0% • NDB: 0% • ILS: 18% • VOR/DME: 18% • ILS/DME: 18%	Eurocontrol
Lifetime	• 20 years	ASECNA
% of underperforming navaids	• DME: 7.5% • VOR: 7.5% • NDB: 10.0% • ILS: 15.0% • VOR/DME: 7.5% • ILS/DME: 10.0%	Sia Solutions
Capex (€/000)	• DME: 301.0 • VOR: 601.8 • NDB: 75.0 • ILS: 578.2 • VOR/DME: 902.7 • ILS/DME: 879.1	
Opex (€/000)	• DME: 10.0 • VOR: 10.0 • NDB: 5.0 • ILS: 10.0 • VOR/DME: 20.0 • ILS/DME: 20.0	

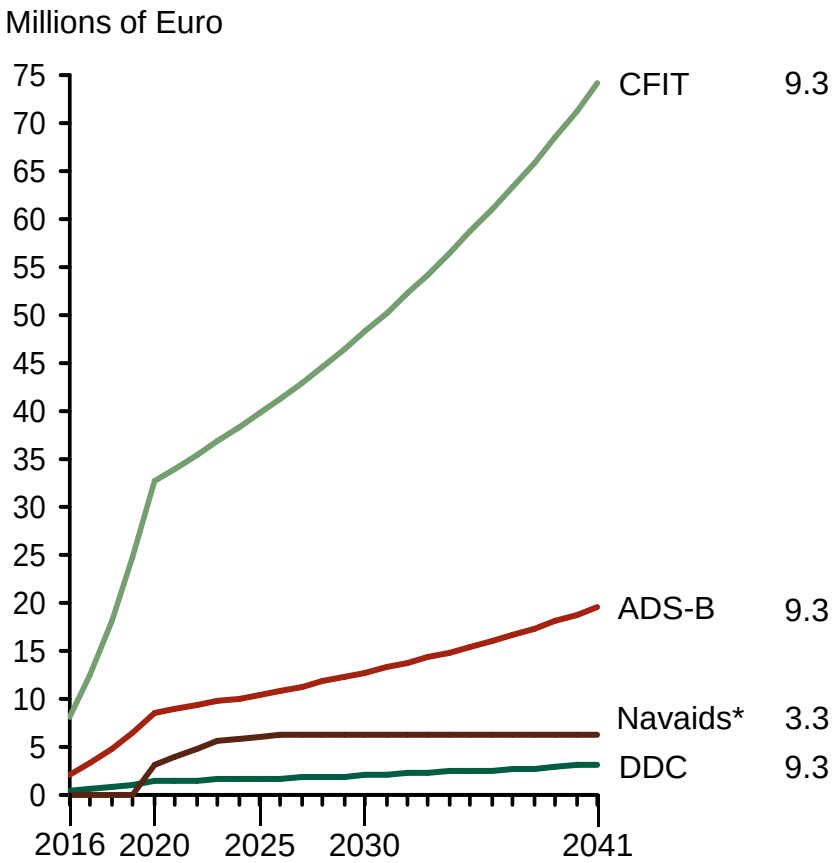
CBA DDC inputs

Input	Value	Source
% of DDC occurrence	• 0.19%	GIANT, Airnostrum in Spain, africaonline, hridir, Eurocontrol
EGNOS effectiveness against DDCs	• 48.5%*	Eurocontrol
Average DDC cost	• Fuel: 14.1 €/minute	Air Transport Association
	• Crew: 1.8 €/minute	
	• Maintenance: 6.9 €/minute	
	• Aircraft ownership: 5.3 €/minute	
	• Other: 1.3 €/minute	
	• Average time lost: Delay 50 min, Diversion 66 min, Cancellation 90 min	Eurocontrol
	• Av passenger time value: 0.01 €/minute	FAA
	• Average number of passengers involved: 43	Eurocontrol
	• Weight of DDC category: Delay 75%, Diversion 20%, Cancellation 5%	Eurocontrol

Outputs – total benefits

In L.E.K. model benefits are expected to start in 2016, CFIT, DDC and ADS-B benefits will increase at a 9.3% CAGR going forward, while the navaids ones will increase at a 3.3% CAGR (Compound Annual Growth Rate)

L.E.K. ISA undiscounted benefits YoY evolution (2016-41)



- The avoidance of CFIT constitutes the greatest benefit of ISA

  "…Safety related benefits represent the most relevant advantage of ISA adoption …"
  ICAO, Regional Officer CNS

- Traditional navaids replacement benefit shows a growing trend over the first years of ISA adoption, followed by a stable phase; such trend is determined by traditional navaids backlog phasing out and maintenance costs reduction

Feedback please!

- The ESESA CBA will only be as good as the inputs we receive from South African stakeholders

Do you have any views on the CBA timescales, assumptions and inputs?

...speak now or forever hold your peace...

- Please talk to Dick or Nina directly or send us an email to: Dick.Mans@ECORYS.com , Nina.Costa@NDConsult.eu

Agenda

- Project objectives
- Overall results
- CBA baseline & assumptions
- CBA model design
- Cost & benefit inputs
- (Sources)

L.E.K. has conducted a total of 44 interviews with main ISA stakeholders

ISA Stakeholders (44)

- ACI World, Manager
- ADS-B Technologies, LLC, Director
- Air Traffic and Navigation Services (ATNS), Director
- Airservices Australia, Director for ADS-B program
- Alitalia, Flight Safety Manager
- Ascend, Director
- ASECNA, Chef de Bureau AIS/MAP
- ASECNA, Conseiller technique du Directeur de l'Exploitation
- ASECNA, Manager of the Air Circulation Bureau
- Brown University, Professor
- Brussels Airlines, Flight Safety Manager
- ENAV, Director
- ENAV, Flight Operation Manager
- ESA, Institutional Relations Director
- Eurocontrol, Technical Manager
- Eurocontrol, NAV infrastructure and GNSS activities Manager
- FAA, Director
- FAA, PBN Specialist
- FAA, Satellite Navigation Program OfficeFlight Safety Foundation, Director of Technical Programs
- Garmin, Product Manager
- Honeywell Aerospace, Director, Aerospace Regional Affairs
- Honeywell Aerospace, Senior Strategic Marketing Manager
- ICAO, Implementation & Resource Development Coordinator
- ICAO, Regional Manager
- ICAO, Regional Officer/CNS (WACAF)
- ICAO, RO/CNS
- Kenya Airways, Flight Safety Manager
- MITRE, Director
- National Transportation Safety Board, Safety studies and Statistical Analysis Director
- National Transportation Safety Board, Statistic Director
- NAVCanada, Director, Operational Analysis
- Pildo Labs, Manager
- Politecnico di Torino, Professor
- Princeton University, Professor
- Rockwell Collins, Sales Manager
- Selex, Product Manager
- Sensis, Product Manager
- Sensis, Vice President
- Sia Solutions, Product Manager
- South African Search and Rescue Organization, Director
- Stern University, Professor
- Thales, Technical Manager
- The World Bank, Manager

L.E.K. has reviewed a comprehensive list of 19 secondary sources (1/2)

Title	Author	Date
Africa-Indian Ocean Regional Traffic Forecasts 2004–2020	ICAO – Working paper	Feb-06
Air Nostrum: Business case for SBAS equipage	GIANT	Dec-06
Approach to Assess the Benefits and Costs of ATM Investments	EUROCONTROL	Mar-03
Automatic Dependent Surveillance – Broadcast (ADS-B) seminar and the sixth meeting of ADS-B study and implementation Task Force (ADS-B SITF/6)	ICAO – Working paper	Apr-07
Country Default Spreads and Risk Premiums	Damodaran	2007
EMOSIA - Air Navigation Service Provider Model	EUROCONTROL/ Boeing	Mar-05
EMOSIA - Airport Model	EUROCONTROL/ Boeing	Mar-04
EMOSIA - Model Architecture and Approach	EUROCONTROL/ Boeing	Jul-03
Evaluating the true cost to airlines of one minute of airborne or ground delay	EUROCONTROL	May-04
Inter-regional SBAS for Africa - Review of benefits	Helios	May-05
Interregional SBAS for Africa: Contribution to Strategy	Helios	Jul-08
ISA Aviation Business Case Information Paper	Helios	Dec-08
ISA Funding Options Analysis	ESYS	Jun-06
ISA service implementation plan	Progeny	Nov-07

L.E.K. has reviewed a comprehensive list of 19 secondary sources (2/2)

Title	Author	Date
Operational service framework for Inter-regional SBAS for AFI (ISA)	Progeny	Nov-07
Project ATLAS – Cost Benefit Analysis	Access Economics	Jun-07
Project Profile: ISA Regional Module for West and Central Africa	ASECNA	2007
Standard Inputs for EUROCONTROL Cost Benefit Analyses	Eurocontrol	Feb-05
Third Meeting of the AFI GNSS Implementation Task Force	ICAO	Jun-05