

Global ANS Harmonization and its Impact on the Safety Issues

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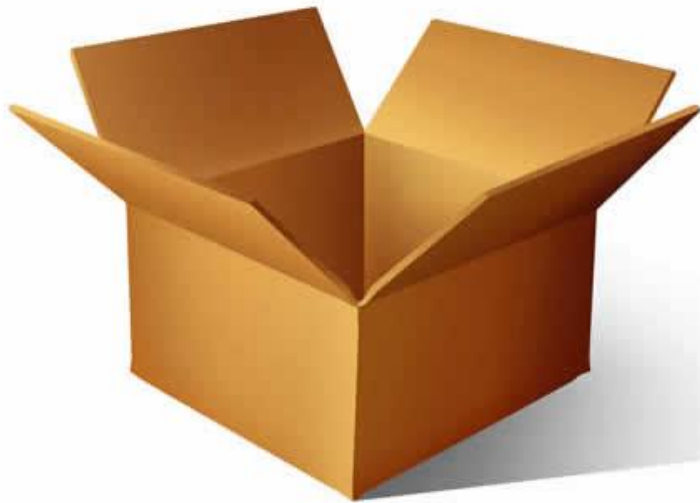
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ECTRI – FEHRL – FERSI
Young Researchers Seminar 2015



Outline



- ✈ Introduction
- ✈ Theoretical framework
- ✈ Background and progress beyond, the state of art
- ✈ Objectives
- ✈ Research methods and procedures
- ✈ Research findings
- ✈ Summary and outlook



Introduction

- ✈ 1 January 1914 first fare-paying airline pax (Abram C. Phei)
- ✈ 2014 → 100 yrs and approx 65 billion pax

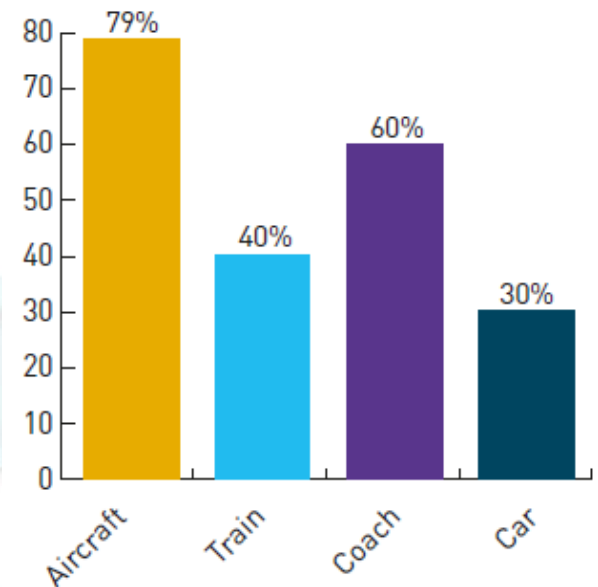
- ✈ 3.129 billion passengers
- ✈ 49 million tons of freight

- ✈ 1,397 Commercial airlines
- ✈ 3,864 Commercial airports
- ✈ 25,332 Commercial aircraft

Source: Air Transport Action Group

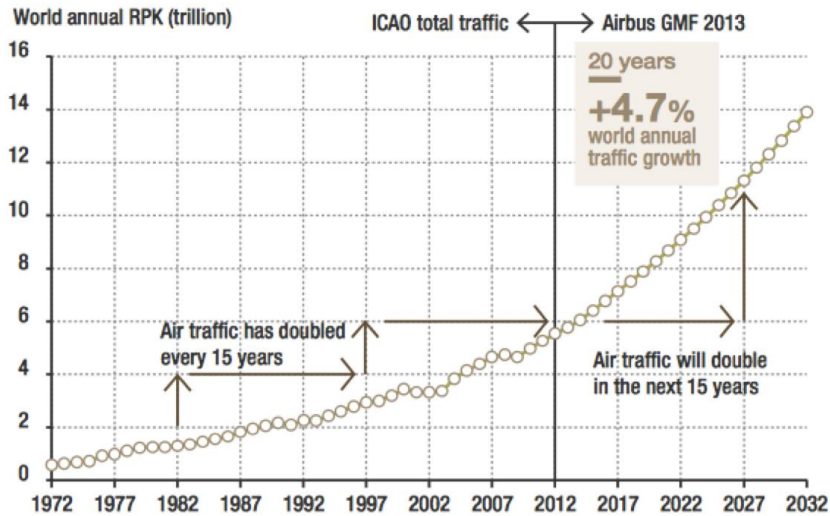
High occupancy

Airlines utilise more of their seats than other modes³¹

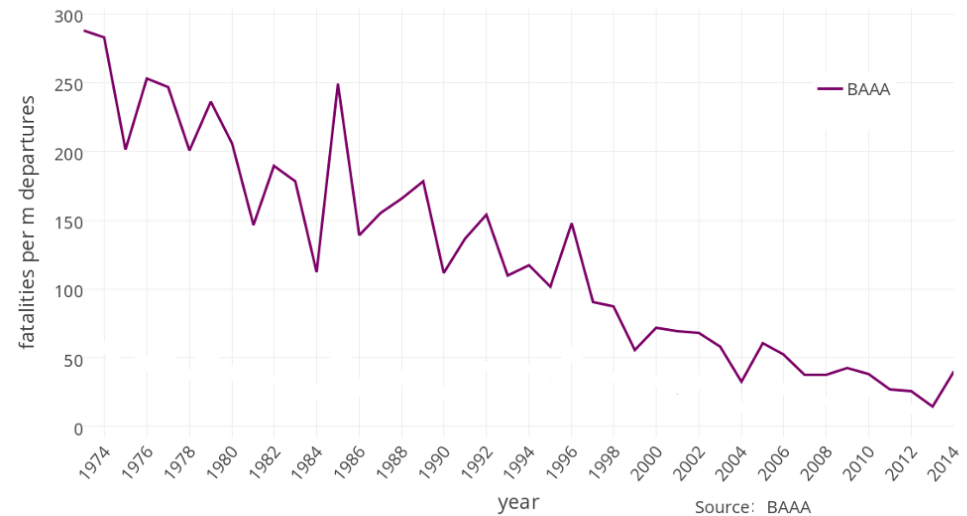


> TRAFFIC WILL DOUBLE IN THE NEXT 15 YEARS

Source: Airbus



Fatalities per million departures

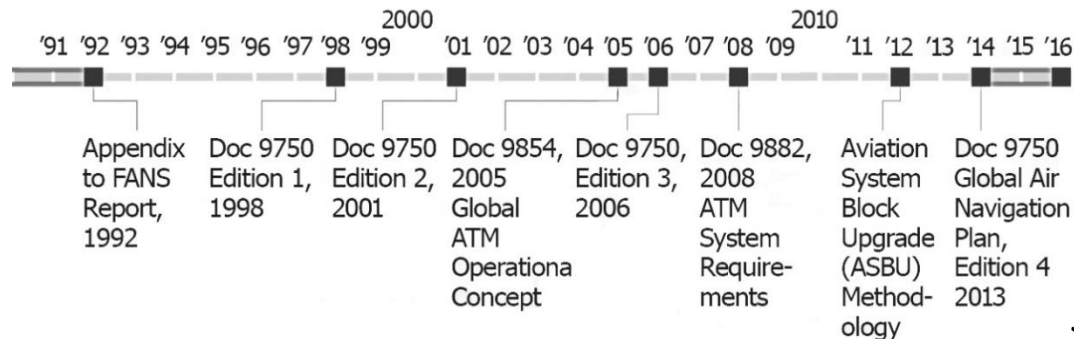


“The **acceptable level of safety** expresses the safety goals of an oversight authority, an operator, or a services provider. From the perspective of the relationship between oversight authorities and operators/services providers, it provides the minimum safety objective(s) acceptable to the oversight authority to be achieved by the operators/services providers while conducting their core business functions.” (ICAO Annex 11, Attachment E)

Background and progress beyond the state of art

- ✈ **Reaching the ANS system capacity** (regional efforts) => 173 ANSPs
- ✈ **Solution:** Integration and Harmonization into the Global Air Navigation System
 - ✈ **Seamless safety across all regions**
 - ✈ **Physical connectedness**
 - ✈ **Common requirements and Standards**
 - ✈ **Common aeronautical information exchange models (SWIM)**
 - ✈ **Meets environmental objectives and national security requirements**

ICAO's role => *GANP operational Concept*



ASBU
ANC/12

Source: GANP

Theoretical framework

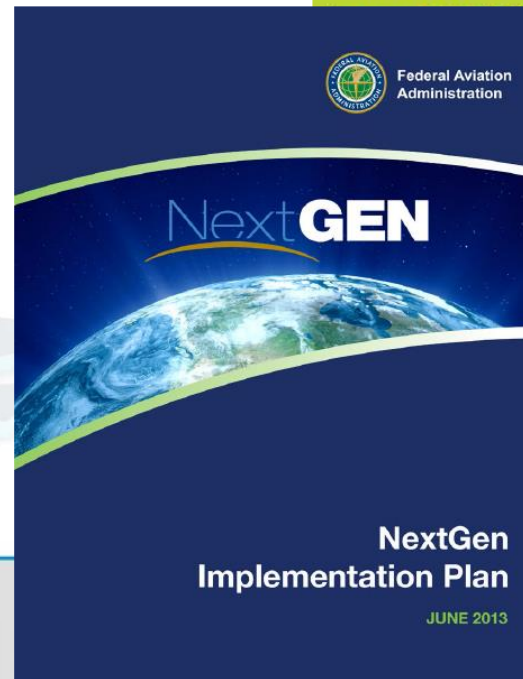
- ✈️ EU legislation and Regulation SES I and SES II
- ✈️ FAA legislation
- ✈️ ICAO Annexes and documents

Analysis:

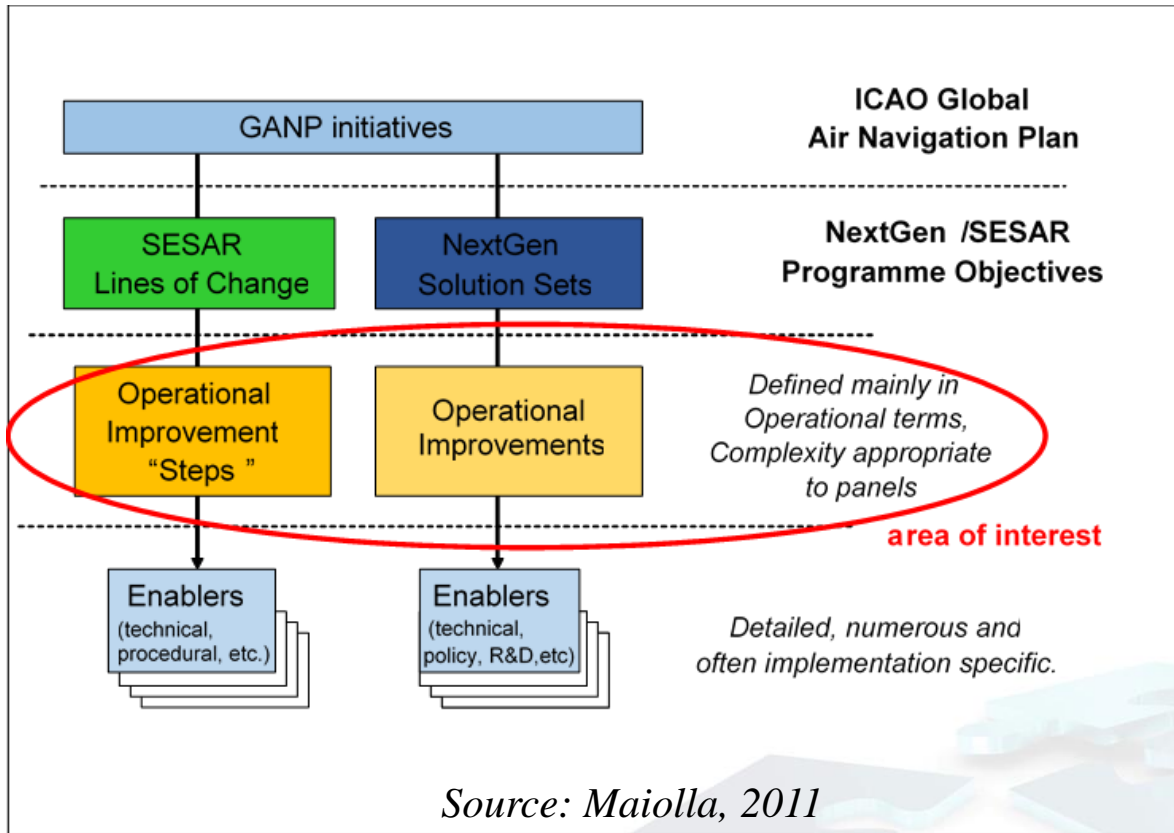
- I. ASBU (ICAO)
- II. SESAR
- III. NextGen



394 Operational improvements



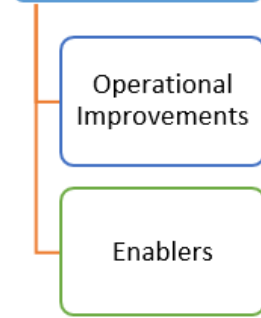
Material



SESAR Lines of Changes



NextGen Solution Sets



Material

CODE	TITLE
● AO-0101	Reduced Risk of Runway Incursions through Improved Procedures and Best Practices on the Ground
● AO-0102	Automated Alerting of Controller in Case of Runway Incursion or Intrusion into Restricted Areas
● AO-0201	Enhanced Ground Controller Situational Awareness in all Weather Conditions
● AO-0202	Detection of FOD (Foreign Object Debris) on the Airport Surface
● AO-0301	Crosswind Reduced Separations for Arrivals
● AO-0302	Time Based Separation (TBS) for Arriving Aircraft -Transitional Step
● AO-0305	Additional Rapid Exit Taxiways (RET) and Entries
● AO-0403	Optimised Dependent Parallel Operations
● AO-0501	Improved Operations in Adverse Conditions through Airport Collaborative Decision Making
● AO-0502	Improved Operations in Low Visibility Conditions
● AO-0601	Improved Turn-Round Process through Collaborative Decision Making
● AO-0602	Collaborative Pre-departure Sequencing
● AO-0603	Improved De-icing Operation through Collaborative Decision Making
● AO-0703	Aircraft Environmental Impact Management and Mitigation at and around Airports
● AO-0705	Reduced Water Pollution
● AO-0706	(Local) Monitoring of Environmental Performance
● AOM-0101	Uniform Application of 7 ICAO Airspace Classes at FL195 and below
● AOM-0201	Moving Airspace Management Into
● AOM-0202	Enhanced Real-time Civil-Military C
● AOM-0203	Cross-Border Operations Facilitate
● AOM-0205	Modular Temporary Airspace Struct
● AOM-0301	Harmonised EUROCONTROL ECA
● AOM-0401	Multiple Route Options & Airspace
● AOM-0402	Further Improvements to Route Net
● AOM-0504	Optimum Trajectories in Defined Air

AO-0101 Reduced Risk of Runway Incursions through Improved Procedures and Best Practices on the Ground

DEPLOYMENT BASELINE/STEP Deployment Baseline IOC 31-12-2007 FOC 31-12-2013

SCOPE Synchronised

OPERATIONAL FOCUS AREAS OFA01.02.01 Airport safety nets

ICAO BLOCK-MODULES

B0-75 Improved Runway Safety (A-SMGCS Level 1-2 and Cockpit Moving Map)
B0-84 Initial Capability for Ground-Based Cooperative Surveillance
B1-75 Enhanced Safety and Efficiency of Surface Operations (ATSA-SURF)

OPERATING ENVIRONMENTS

Airport Very High Capacity Needs
Airport High Capacity Needs
Airport Medium Capacity Needs
Airport Low Capacity Needs

DESCRIPTION

ECAC airports and aircraft operators develop procedures and apply recommendations contained in the European Action Plan for the prevention of runway incursions (e.g. compliance of infrastructure with ICAO provisions, best practices on flight deck procedures for runway crossing, while taxiing; assessment for pilots regarding aerodrome signage, markings and lighting.).

RATIONALE

Cf. European Action Plan for the Prevention of Runway Incursions.

ENABLERS

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

AO-0101 Reduced Risk of Run...

PRO-062b Airport Operationa...

△

PRO-062c Airline Operationa...

△

ESSIP OBJECTIVES

AOP03

Improve runway safety by preventing runway incursions

2012 2013

	A	B	C	D	E	F
	CODE	TITLE	IOC Date	IOC Sync Date	DESCRIPTION	CATEGORY
1	A/C-01	Enhanced positioning for LPV/RNP	31-12-2011		Enhanced positioning for Localizer Precision with V	System
2	A/C-02	Enhanced precision and availability/continuity of position	31-12-2020	31-12-2020	Enhanced precision and availability/continuity of pos	System
3	A/C-03	Determination of a preferred trajectory avoiding an area not	31-12-2017		Determination onboard of a preferred trajectory avoid	System
4	A/C-04	Flight management and guidance to improve lateral naviga	31-12-2007	31-12-2019	Flight management and guidance to improve lateral	System
5	A/C-04a	Flight management and guidance to enhance A-RNP	31-12-2018	31-12-2019	Flight management and guidance to enhance A-RNF	System
6	A/C-05a	APV Barometric VNAV	31-12-2007		Flight management and guidance to perform Approa	System
7	A/C-06	LPV approach based on SBAS	31-12-2011	31-12-2016	Flight management and guidance to perform Localiz	System
8	A/C-07	Curved approach e.g. automatic RNP transition to XLS/LP	31-12-2019	31-12-2016	Flight management and guidance to perform Curved	System
9	A/C-08	Flight management and guidance to perform wake-vortex fi	31-12-2025	31-12-2016	Flight management and guidance to perform wake-v	System
10	A/C-09	Flight management and guidance to perform automatically	31-12-2017	31-12-2016	Flight management and guidance to perform climbin	System
11	A/C-10	Flight management and guidance to improve vertical navigation (VRNP).	31-12-2019	31-12-2016	Flight management and guidance to improve vertical	System
12	A/C-11	Flight management to include single time constraint mana	31-12-2016		Flight management to improve single time constrain	System
13	A/C-12	Flight management to perform multiple time constraints m	31-12-2020		Flight management to perform multiple time constra	System
14	A/C-13	Flight management and guidance to improve longitudinal navigation (4D contract)			Flight management and guidance to improve longitu	System
15	A/C-15	Flight management and guidance to support ASAS spacin	31-12-2018		Flight management and guidance to support ASAS	System
16	A/C-15b	Flight management and guidance to support manual ASAS	31-12-2017	31-12-2019	Flight management and guidance to support manual	System
17	A/C-16	Flight management and guidance to support ASAS separa	31-12-2020	31-12-2019	Flight management and guidance to support ASAS	System
18	A/C-17	Flight management and guidance to support ASAS self-se	31-12-2025	31-12-2019	Flight management and guidance to support ASAS	System
19	A/C-18	Flight management and guidance to support automatic bra	31-12-2017	31-12-2019	Flight management and guidance to support automa	System
20	A/C-19a	Flight managment and guidance to support automatic t	31-12-2016	31-12-2019	Flight management and guidance to support automa	System
21	A/C-19b	Flight management and guidance to support automatic taxi			Flight management and guidance to support automa	System
22	A/C-20	Automatic prevention of runway incursion (e.g. stop bar).			Automatic prevention of runway incursion, e.g. autor	System

Objectives

Main objective:

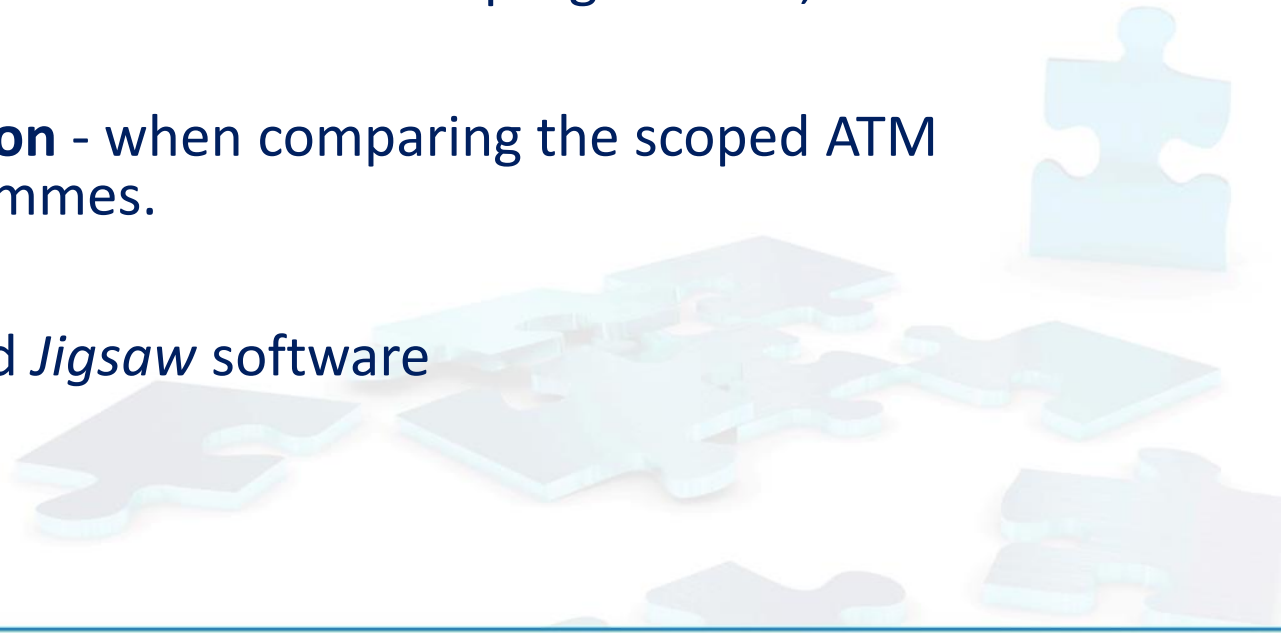
To quantify the level of the global ANS harmonization on NextGen and SESAR

Secondary objectives:

- to evaluate the operational background (performance)
- to analyse and compare the main programmes ASBU, NextGen and SESAR
- to visualise results
- to define the safety impact of the ANS harmonization

Research methods and procedures

- ✈ **Method of data and information collection** – by documents review and collecting information about all scoped issues,
- ✈ **Analysis method** - used in the state of the art research and evaluation of scoped ATM modernization programmes,
- ✈ **Method of comparison** - when comparing the scoped ATM modernization programmes.
- ✈ **Visual analytics**- used *Jigsaw* software



Research findings

Fundamental air traffic characteristics of the ATM system in the U.S. and in Europe



Calendar Year 2014	Europe	USA	Difference
Geographic Area (million km ²)	11.5	10.4	≈ -10%
Nr. of civil en-route ANSP	37	1	fragmentation
Number of ATCOs in OPS	17 200	13 400	≈ -22%
Number of OJT ATCOs	1 000	1 740	≈ +74%
Total ATCOs in OPS plus OJT	18 200	15 140	≈ -17%
Total staff	58 000	35 500	≈ -39%
Controlled flights (IFR) (million)	9.6	15.1	≈ +57%
Flight hours controlled (million)	14.3	22.4	≈ +57%
Relative density (flight hours per km ²)	1.2	2.2	≈ x1.7
Share of flights to or from top 34 airports	67%	66%	≈ -1%
Share of General Aviation	3.9%	21%	≈ +17%
Average length of flight (within airspace)	551 NM	515 NM	≈ -7%
Number of en route centres	65	20	≈ -69%
Number of APP units/terminal facilities	260	163	≈ -37%
Number of airports with ATC services	425	516	≈ +21%
Of which are slot controlled	90	4	≈ -95%
Source:	EUROCONTROL	FAA	



	NextGen	SESAR
Approach	Nation-wide	Sub-regional
Objectives	<ul style="list-style-type: none"> • No accidents where NextGen technology or operations are a contributing factor • Expand capacity • Enable a savings of 1.4 billion gallons of fuel • Enable a \$24 billion in cumulative benefits • Ensure U.S. national defence 	(KPA defined) <ul style="list-style-type: none"> • Increase safety by a factor of 3 by 2020 and 10 in the long term • Threefold capacity • Reduce ATM cost by 50% • Reduce environmental impact by 10%
Development	3 Epochs: Epoch 1 (2006 to 2015); Epoch 2 (2012 to 2019); Epoch 3 (2018 to 2025)	3 Phases: Definition (2005 to 2008); Development (2008 to 2015); Deployment (2014 to 2020)
Financial structure	Public-Private Partnership	Public-Private Partnership
Cost	approx. 1,191 Million \$US (= 867 Million EUR)	approx. 1,560 Million EUR (= 2,143 Million \$US)
Compatibility	Aligned with ICAO ASBU concept	Consistent with ICAO ASBU concept
Technologies	<ul style="list-style-type: none"> • ADS-B IN & OUT • Net-centric infrastructure • GNSS • Digital communications • Automation • SWIM 	<ul style="list-style-type: none"> • ADS-B IN & OUT • Net-centric infrastructure • GNSS • Digital communications • Automation • SWIM
Procedures	<ul style="list-style-type: none"> • CDM • PBN • 4DT management 	<ul style="list-style-type: none"> • CDM • PBN • 4DT management

- **SAME PRESSURES**
 - Safety, Security
 - Growth, Environment
 - Costs
- **SAME COMMERCIAL CUSTOMERS**
- **SAME OBLIGATIONS**
 - ICAO
- **SAME OPPORTUNITIES**
 - Advanced Technology
- **GEOGRAPHY**
 - Traffic distribution/density
 - Weather severity
- **ATM SERVICE**
 - Nb & governance of ANSPs
 - Source of Finance
- **MARKET**
 - GA, Military
- **CULTURE & POLITICS**
 - Nb of States, diversity of cultures
- **ATM SYSTEM**
 - Uniformity / fragmentation



	NextGen	SESAR
Time horizon	2020+	2025+
Concept	strict ATM focus	deals with other elements that may impact ATM either directly or indirectly
	safety and the environment, goals stated through KPI at the KPA	deals with these issues in detail within the Concept.
Implementation	ahead in data communication	ahead in defining ADS-B
Administration	more government owned and driven	direct industry investment and participation



NextGen and SESAR comparison respecting ASBU

Comparison

ASBU (PIA)	NextGen (Portfolios)	SESAR (Key features)
PIA 1: Airport Operations	Improved Surface Operations	Airport Integration & Throughput
	Improved Approaches and Low-Visibility Operations	
	Improved Multiple Runway Operations	Traffic synchronisation
PIA 2: Globally Interoperable Systems and Data	On-Demand NAS Information	SWIM
PIA 3: Optimum Capacity and Flexible Flights	Collaborative Air Traffic Management	Network Collaborative Management & Dynamic Capacity Balancing
	Separation Management	Conflict Management & Automation
PIA 4: Efficient Flight Paths	Time Based Flow Management	Moving from Airspace to 4D Trajectory Management
	Performance Based Navigation	

NextGen and SESAR comparison respecting ASBU

Results

SESAR:

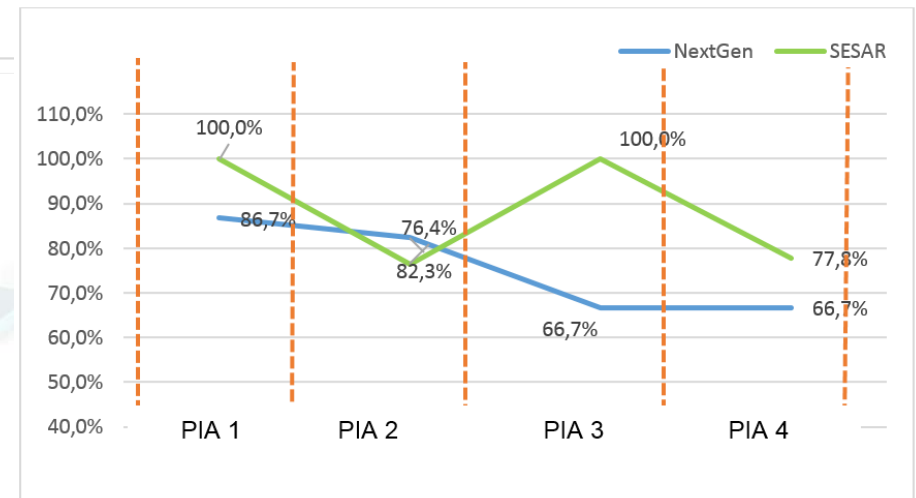
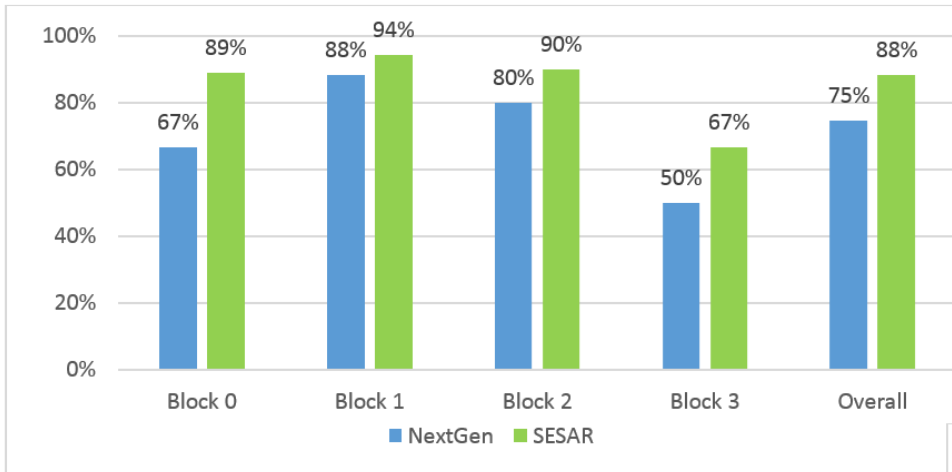
- Block 0 Compliance Rate: 88,9% (16 of 18 in substantial compliance of OIs),
- Block 1 Compliance Rate: 94,1% (16 of 17),
- Block 2 Compliance Rate: 90,0% (9 of 10),
- Block 3 Compliance Rate: 66,7% (4 of 6),
- **Overall Compliance Rate: 88,2%** (45 of 51).

NextGen:

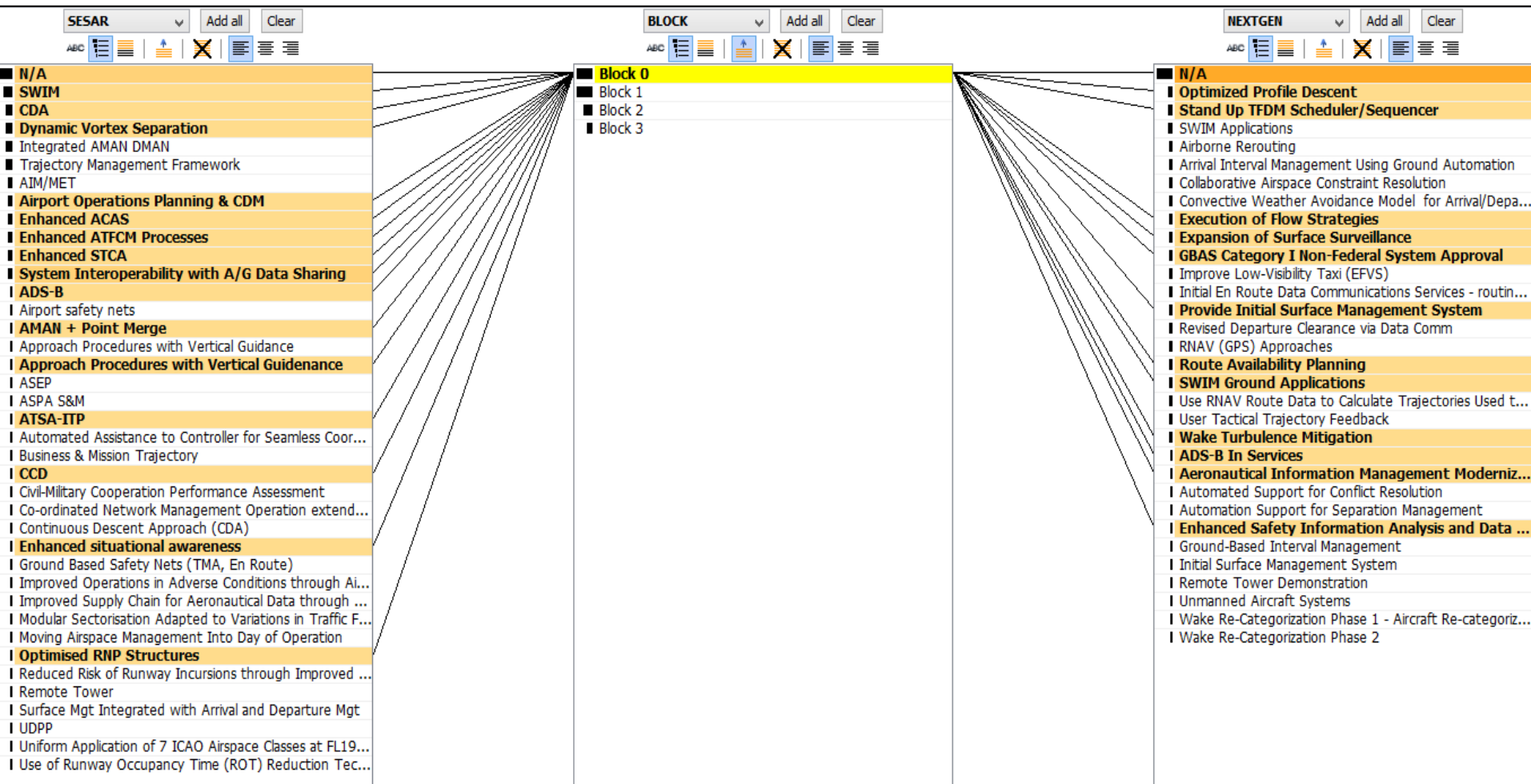
- Block 0 Compliance Rate: 66,7% (12 of 18),
- Block 1 Compliance Rate: 88,2% (15 of 17),
- Block 2 Compliance Rate: 80,0% (8 of 10),
- Block 3 Compliance Rate: 50,0% (3 of 6),
- **Overall Compliance Rate: 74,5%** (38 of 51).

NextGen and SESAR comparison respecting ASBU

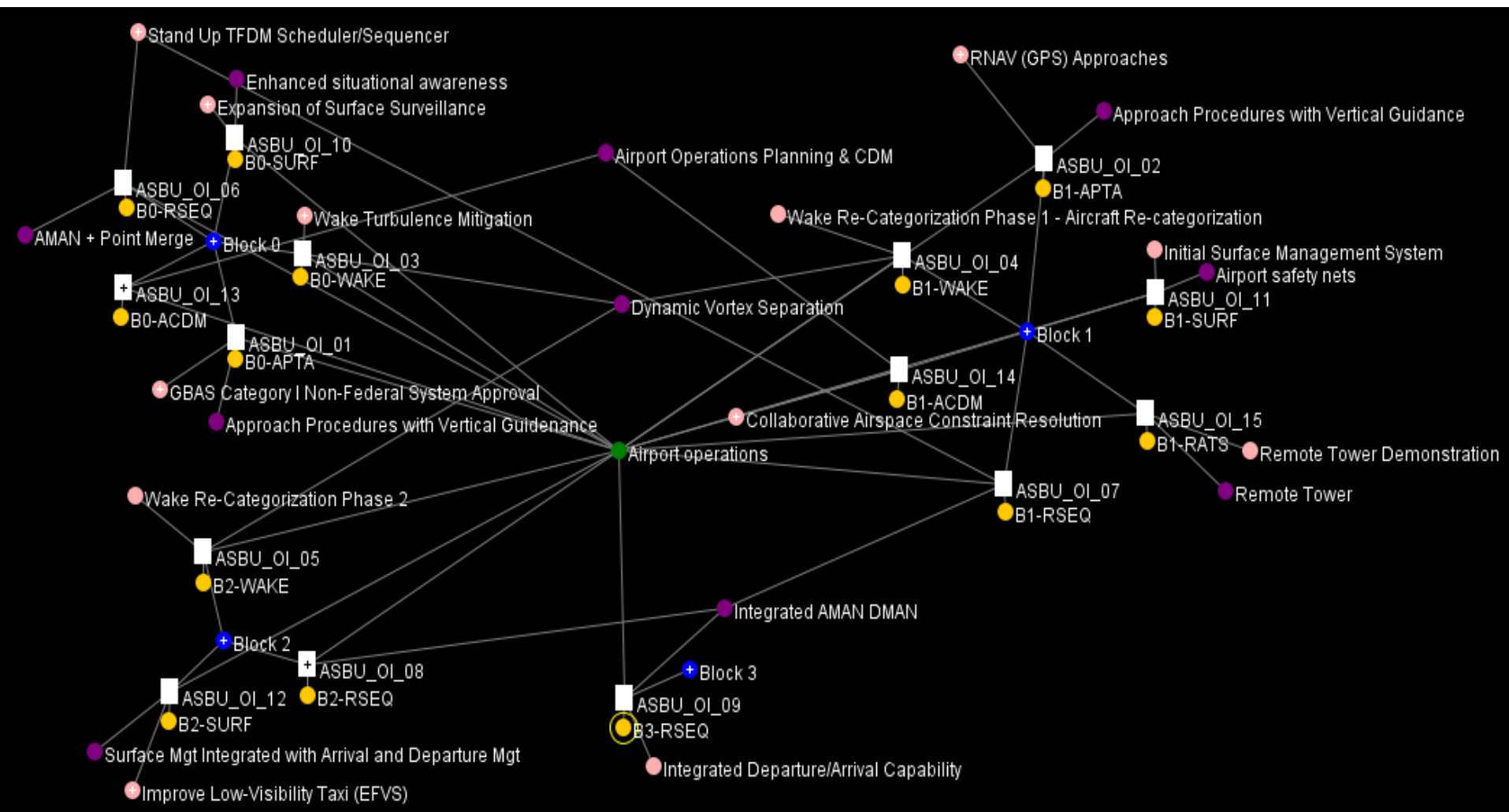
Results



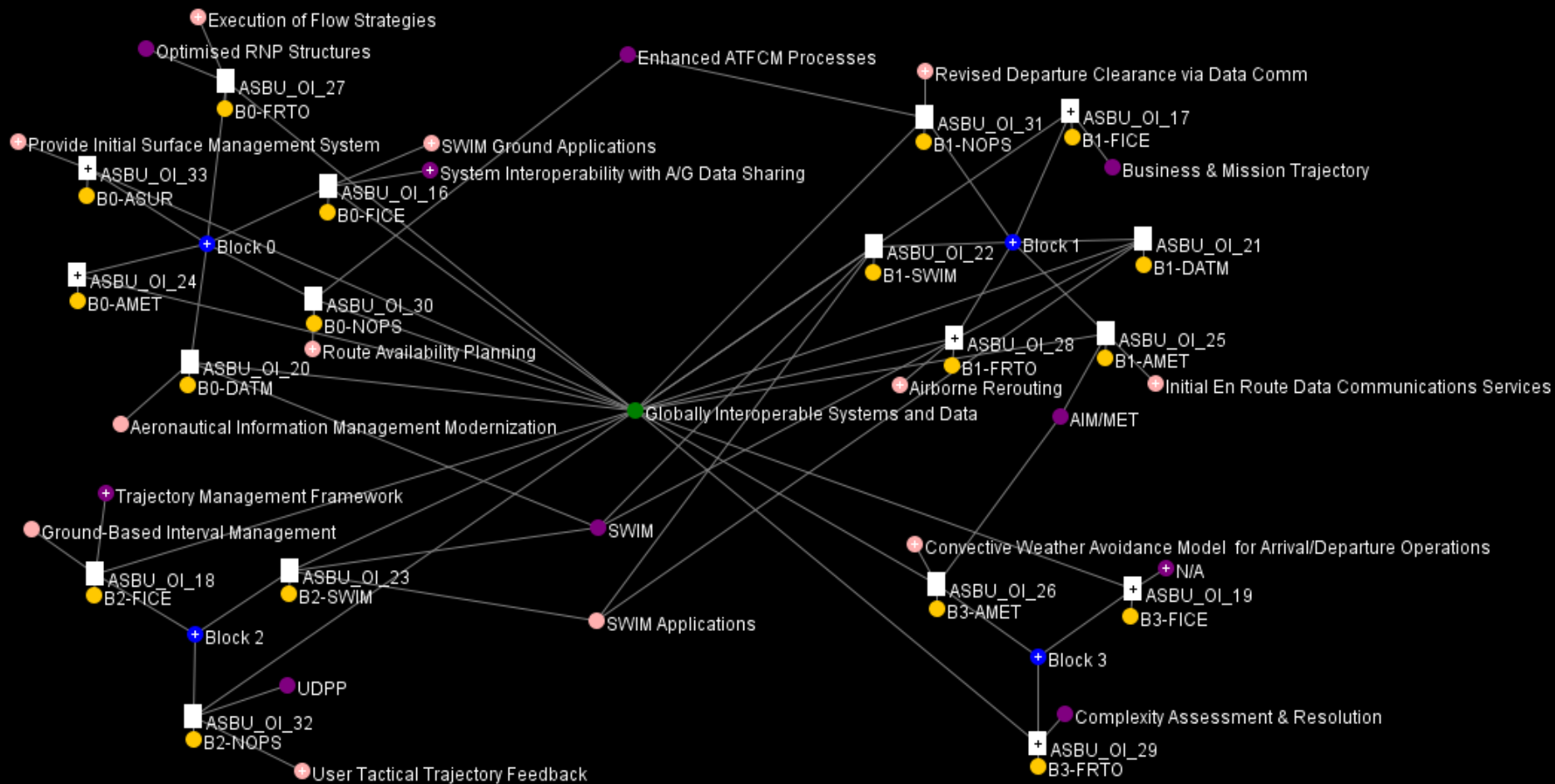
Visual analytics



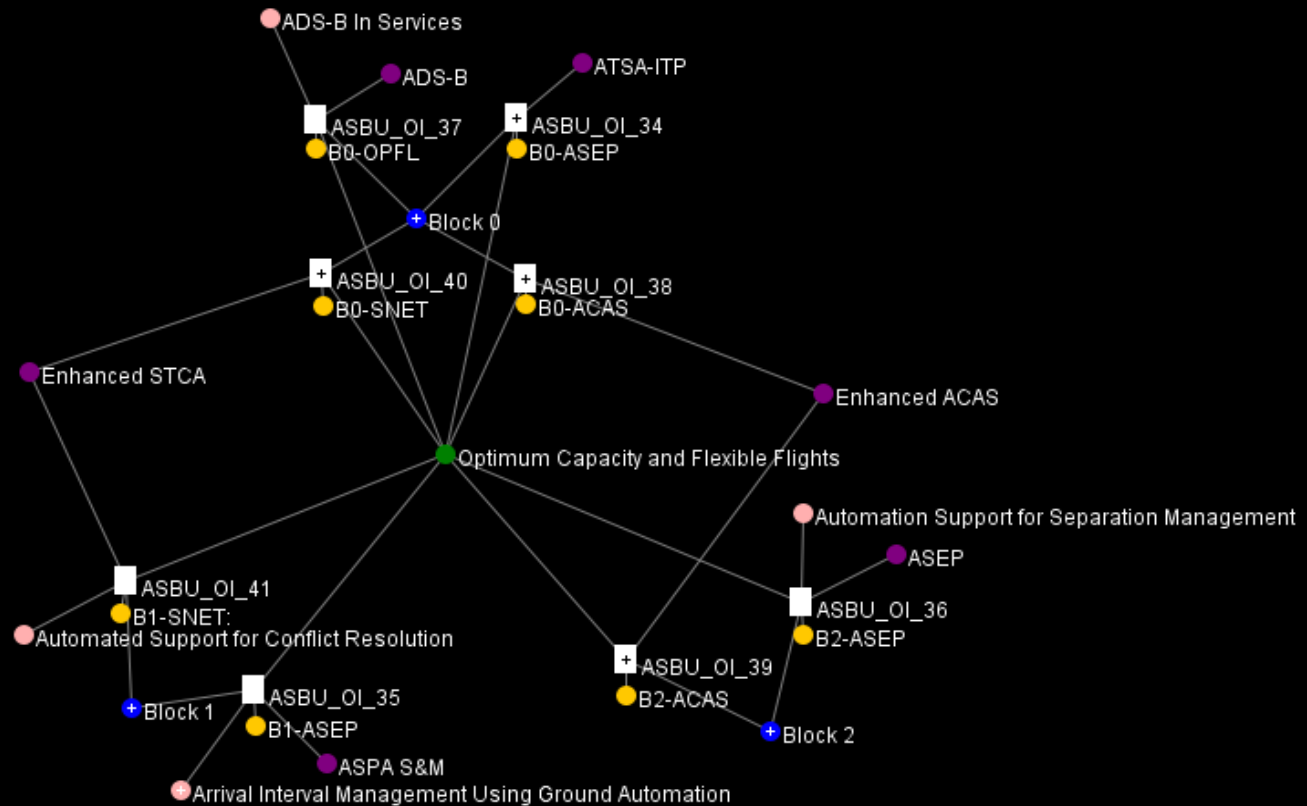
Visual analytics



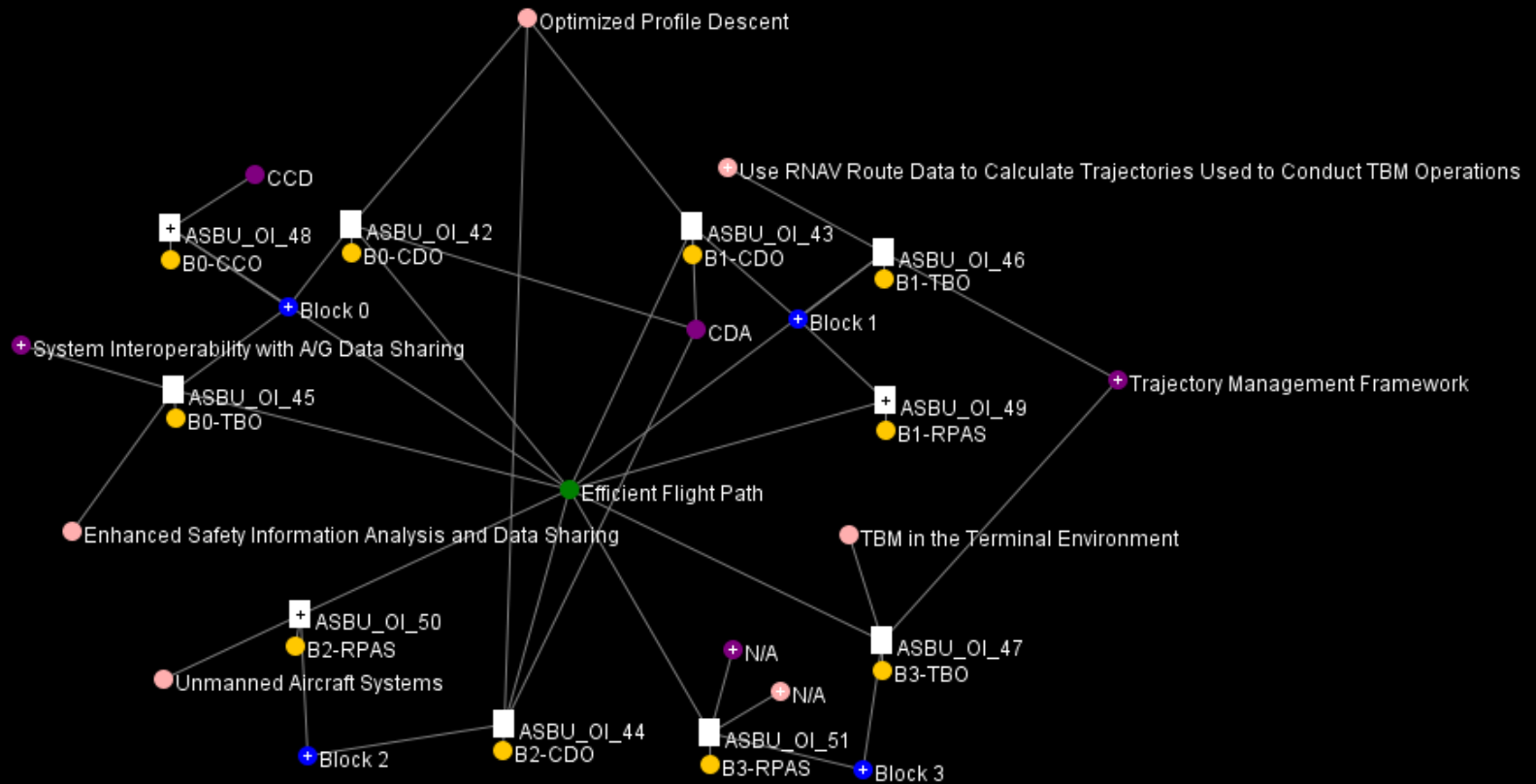
Visual analytics



Visual analytics



Visual analytics



Safety impact

Performance Improvement area	Block 0	Block 1	Block 2	Block 3
1. Airport Operations	Safety and Efficiency of Surface Operations	Enhanced Safety and Efficiency of Surface Operations	Optimized Surface Routing and Safety Benefits	N/A
2. Globally Interoperable Systems and Data	Meteorological information supporting enhanced operational efficiency and safety	Enhanced Operational Decisions through Integrated Meteorological Information	N/A	Decisions through Integrated Meteorological Information
	Initial Capability for Ground Surveillance	N/A	N/A	N/A
3. Optimum Capacity and Flexible Flights	Air Traffic Situational Awareness (ATSA)	Increased Capacity and Efficiency through Interval Management	Airborne Separation (ASEP)	N/A
	ACAS Improvements	N/A	New Collision Avoidance System	N/A
	Increased Effectiveness of Ground-based Safety Nets	Ground-based Safety Nets on Approach	N/A	N/A
4. Efficient Flight Path	Improved Safety and Efficiency through the initial application of Data Link En-Route	Improved Traffic Synchronization and Initial Trajectory-Based Operation	N/A	Full 4D Trajectory-based Operations

Summary and contributions

The overall assessment shows that SESAR is more harmonized according to ICAO Block upgrades than NextGen by 13,7%. It contributes the seven Operational Improvements. The highest compliance rate can be observed at Blocks 1 and 2 with average rates of about 90%. On the other hand, the lowest mapping of ICAO framework can be found at the third Block. The overall Compliance Rate of SESAR is at 88,2%, while NextGen's is at 74,5%.

- ⊕ **Theoretical contribution** is primarily the processing of new theoretical knowledge within research area.
- ⊕ **Practical contributions** consist of the qualitative and quantitative comparison with its visualisation

Thank you for your
attention

