SAT -Rdmp

Contribution by AD Cuenta

12/13 January 2011

Workpackages

- WP 1: Vision and demand
- WP 2: Business case: the supply side
- WP 3: The roadmap
  - RTD roadmap
  - Existing RTD projects
  - Recommendation on new RTD projects
  - Establish network
- WP 4: Capabilities analysis
- WP 5: Project management
  - Dissemination, related to WP 3.4

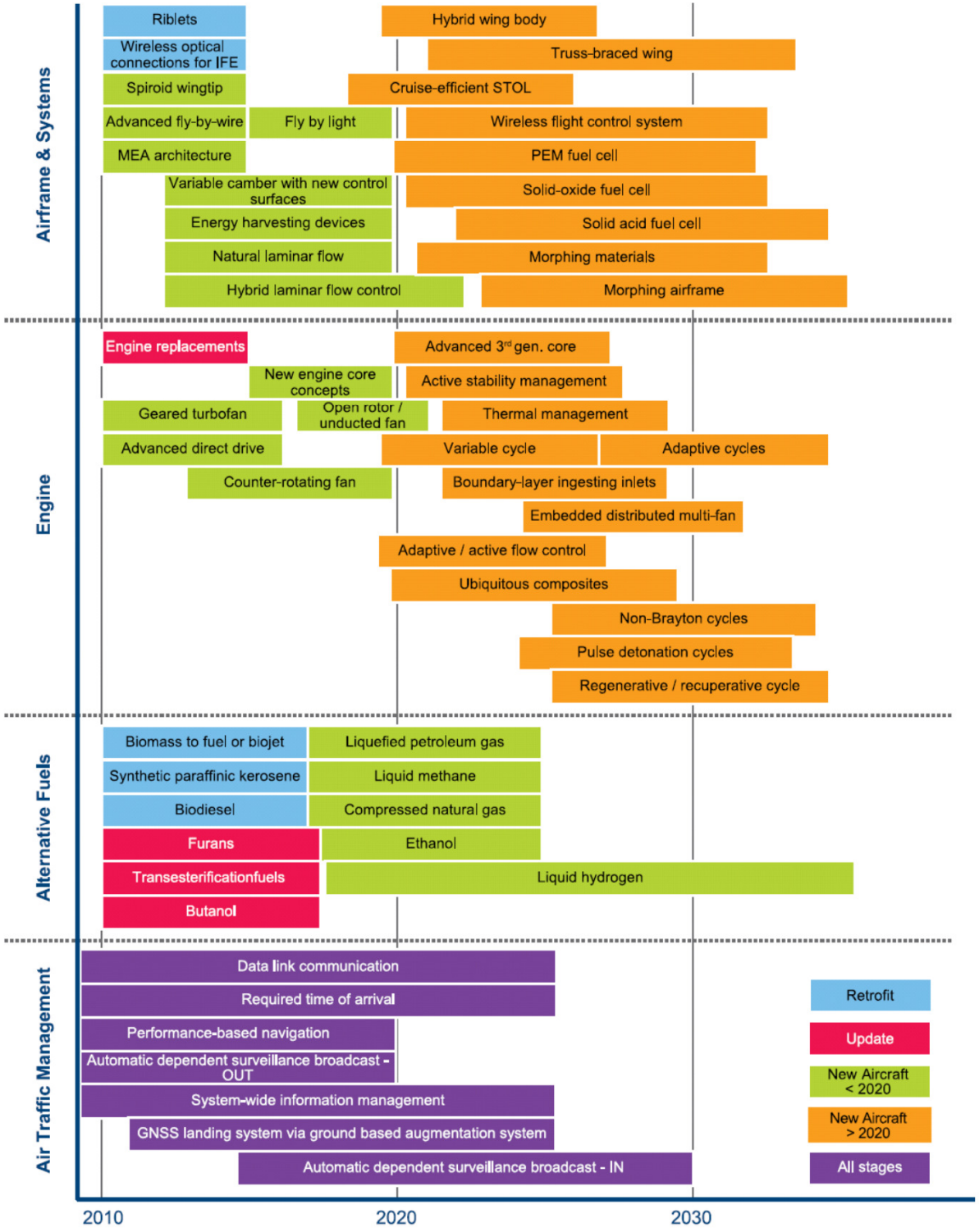
To make a Roadmap Task 3.1

- A roadmap can be based on known technology developments and the TRL levels: example IATA. Let us call it bottom up.
- A roadmap can also be based on market demand and the required supply of products and services that can satisfy this demand: example the British NATS roadmaps. Let us call this top down.

Many examples of technology roadmaps exist: IATA's bottom up approach

Currently available technologies (source IATA)

Airframe		Engine	ATM
▪ Active load alleviation	▪ High power Lights-Emitting Diode (LED) for cabin lighting	▪ Advanced combustor	▪ Data Link Communications (VHF-ACARS and VDL Mode 2, SATCOM and HF)
▪ Aircraft graphic films	▪ Landing gear drive	▪ Engine retrofits:	▪ Performance Based Navigation (PBN)
▪ Advanced alloys	▪ Laser beam welding	> advanced heat-resistant materials	▪ Automatic Dependent Surveillance Broadcast (ADS-B) OUT
▪ Blended winglet	▪ Lithium batteries for secondary power	> better blade design	▪ Automatic Dependent Surveillance Contract (ADS-C)
▪ CentrAl	▪ More efficient gas turbine Auxiliary Power Unit (APU)	> more efficient energy management	▪ Multilateration
▪ Composite primary structures	▪ Raked wingtip	▪ Variable geometry chevron	▪ Auto-loading FMS with data link instructions
▪ Composite secondary structures	▪ Variable camber with existing control surfaces	▪ Variable fan nozzle	▪ FMS Required Time of Arrival (RTA)
▪ Drag reduction coatings	▪ Wingtip fence		
▪ Fluoropolymers	▪ Zonal dryer		
▪ Friction stir welding			
▪ Glare			
▪ High strength glass microspheres			


Airframe & Systems
Riblets
Wireless optical connections for IFE
Spiroid wingtip
Advanced fly-by-wire
Fly by light
MEA architecture
Variable camber with new control surfaces
Energy harvesting devices
Natural laminar flow
Hybrid laminar flow control
Hybrid wing body
Truss-braced wing
Cruise-efficient STOL
Wireless flight control system
PEM fuel cell
Solid-oxide fuel cell
Solid acid fuel cell
Morphing materials
Morphing airframe
Engine
Engine replacements
New engine core concepts
Geared turbofan
Open rotor / unducted fan
Advanced direct drive
Counter-rotating fan
Advanced 3rd gen. core
Active stability management
Thermal management
Variable cycle
Adaptive cycles
Boundary-layer ingesting inlets
Embedded distributed multi-fan
Adaptive / active flow control
Ubiquitous composites
Non-Brayton cycles
Pulse detonation cycles
Regenerative / recuperative cycle
Alternative Fuels
Biomass to fuel or biojet
Synthetic paraffinic kerosene
Biodiesel
Furans
Transesterificationfuels
Butanol
Liquefied petroleum gas
Liquid methane
Compressed natural gas
Ethanol
Liquid hydrogen
Air Traffic Management
Data link communication
Required time of arrival
Performance-based navigation
Automatic dependent surveillance broadcast - OUT
System-wide information management
GNSS landing system via ground based augmentation system
Automatic dependent surveillance broadcast - IN
Retrofit
Update
New Aircraft < 2020
New Aircraft > 2020
All stages
2010
2020
2030

: Technologies available for retrofit

Technologies		Fuel burn reduction	TRL	Availability Timeframe	Estimated Retrofit Costs (US$ million)
Airframe Technologies					
	Composite secondary structures	~1%	9	Current	0.1 to 1
	Wingtip fence	1 to 3%	9	Current	1 to 10
	Raked wingtip	3 to 6%	9	Current	1 to 10
	Blended winglet	3 to 6%	9	Current	1 to 10
	More efficient gas turbine APU	1 to 3%	7	Current	1 to 10
	Lithium batteries for secondary power	< 1%	5	Current	< 0.01
	Variable camber with existing control surfaces	1 to 2%	8	Current	1 to 10
	High strength glass microspheres	~1%	6	Current	1 to 10
	Aircraft graphic films	~1%	9	Current	0.01 to 0.1
	Zonal dryer	~1%	9	Current	0.01 to 0.1
	Riblets	1 to 2%	7	2010+	1 to 10
	Drag reduction coatings	< 1%	9	Current	< 0.01
	Landing gear drive	< 1%	7	Current	0.1 to 1
	Wireless optical connections for in flight entertainment	< 1%	5	2010+	0.1 to 1
	High power LEDs for cabin lighting	< 1%	9	Current	0.01 to 0.1
	Fluoropolymers	< 1%	6	Current	1 to 10
Engine Technologies					
	Engine retrofits [(c)]	1 to 2%	8	Current	1 to 10
Alternative Fuels [(d)]					
	Biomass to Fuel (BTF) or biojet	60 to 90%	6	2010+	< 0.01
	Hydrogenated oil/fat	negative to 70%	7	2010+	< 0.01
	Gas to Fuel (GTF) or Gas to Liquid (GTL)	negative to 10%	8	Current	< 0.01
	Transesterification fuels	negative to 70%	7	2010+	0.1 to 1

Technologies and concepts applicable to new aircraft designs after 2020
(Source IATA)

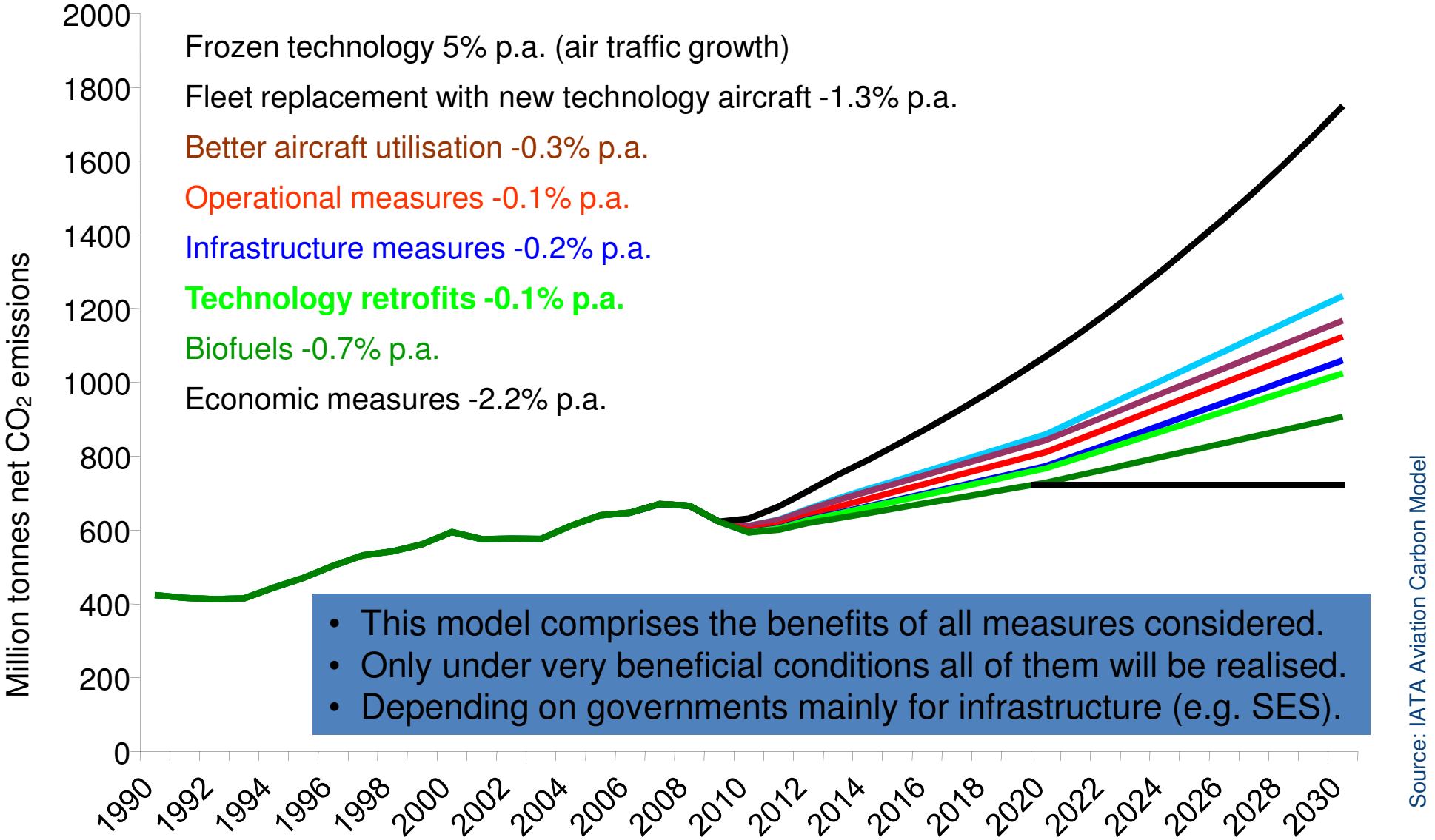
Airframe Technologies		Fuel burn reduction	TRL	Availability Timeframe
Airframe Technologies				
	Truss-braced wing	10 to 15%	2	2020+
	Morphing airframe	5 to 10%	3	2020+
	Hybrid-wing-body	10 to 25%	4	2020+
	Morphing material	1 to 5%	3	2020+
	Proton Exchange Membrane Fuel Cell (PEMFC)	1 to 5%	6	2020+
	Solid Oxide Fuel Cell (SOFC)	1 to 5%	5	2020+
	Cruise-efficient Short Takeoff and Landing (STOL)	<1%	3	2020+
	Wireless Flight Control System (WFCS)	1 to 3%	5	2020+
	Solid Acids Fuel Cell (SAFC)	1 to 2%	1	2020+
Engine Technologies (i)				
	Advanced core (3rd GEN)	15 to 25%	2	2030+
	Adaptive/active flow control	10 to 20%	2	2020+
	Variable cycle (2nd GEN)	10 to 20%	4	2020+
	Ubiquitous composites (2nd GEN)	10 to 15%	3	2020+
	Active stability management	10 to 15%	3	2020+
	Adaptive cycles	5 to 15%	2	2020+
	Pulse detonation	5 to 15%	2	2020+
	Regenerative/recuperative	5 to 10%	2	2020+
	Non-Brayton cycles	5 to 10%	2	2020+
	Thermal management (2nd GEN)	5 to 10%	5	2020+
	Boundary Layer Ingesting (BLI) inlet	1 to 3%	3	2020+
	Embedded Distributed Multi-Fan (2nd GEN System)	<1%	2	2020+
Alternative Fuels (i)				
	Liquid Hydrogen	negative to 100%	7	2020+

IATA technology roadmap

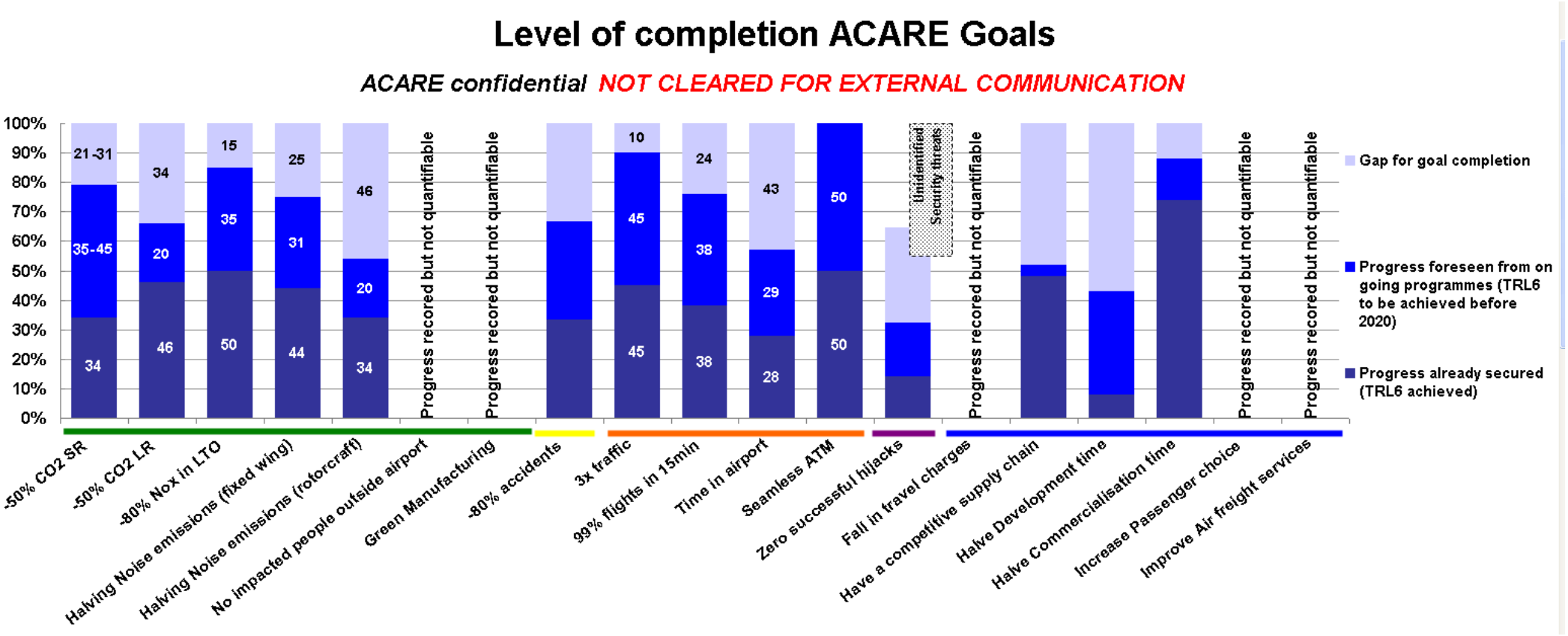
- The IATA technology roadmap was used to calculate the potential CO2 reduction in aviation versus the effects of increased demand for air traffic.
- It showed that current technology improvements will not be sufficient to offset the CO2 increase due to the increase in demand. This may lead to additional governmental interventions (economic measures, like ETS).
- The AGAPE study also illustrated that the ACARE goals for 2020 will not be met, based on current technology developments and that breakthrough technology is needed.

IATA conclusions on CO_2 emissions from commercial airlines global fuel burn

(economic model)



AGAPE results



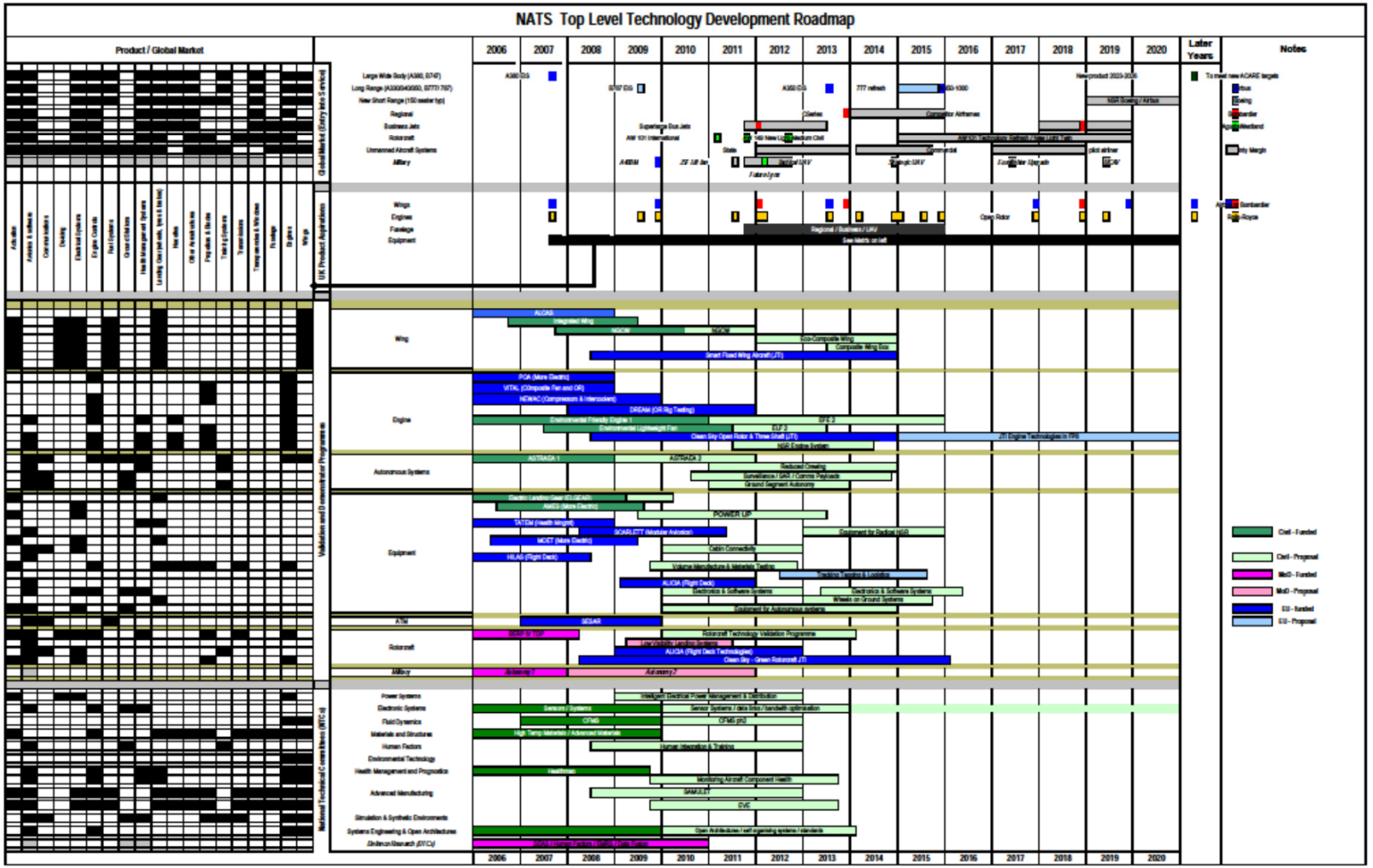
What Ad Cuenta proposes

- Do not follow a bottom up approach: it may block novel thinking for small aircraft.

What AD Cuenta proposes

- Follow the methodology used in the UK industry (NATS) to make top down roadmaps for the future:
- 0. Identify small aircraft sectors where Europe wants to excel (WP1)
- 1. Identify future products and business models (WP2)
- 2. Identify the technologies needed for these products (WP3)
- 3. Identify timing of products (WP3 based on 1&2)
- 4. Derive a technology roadmap from that

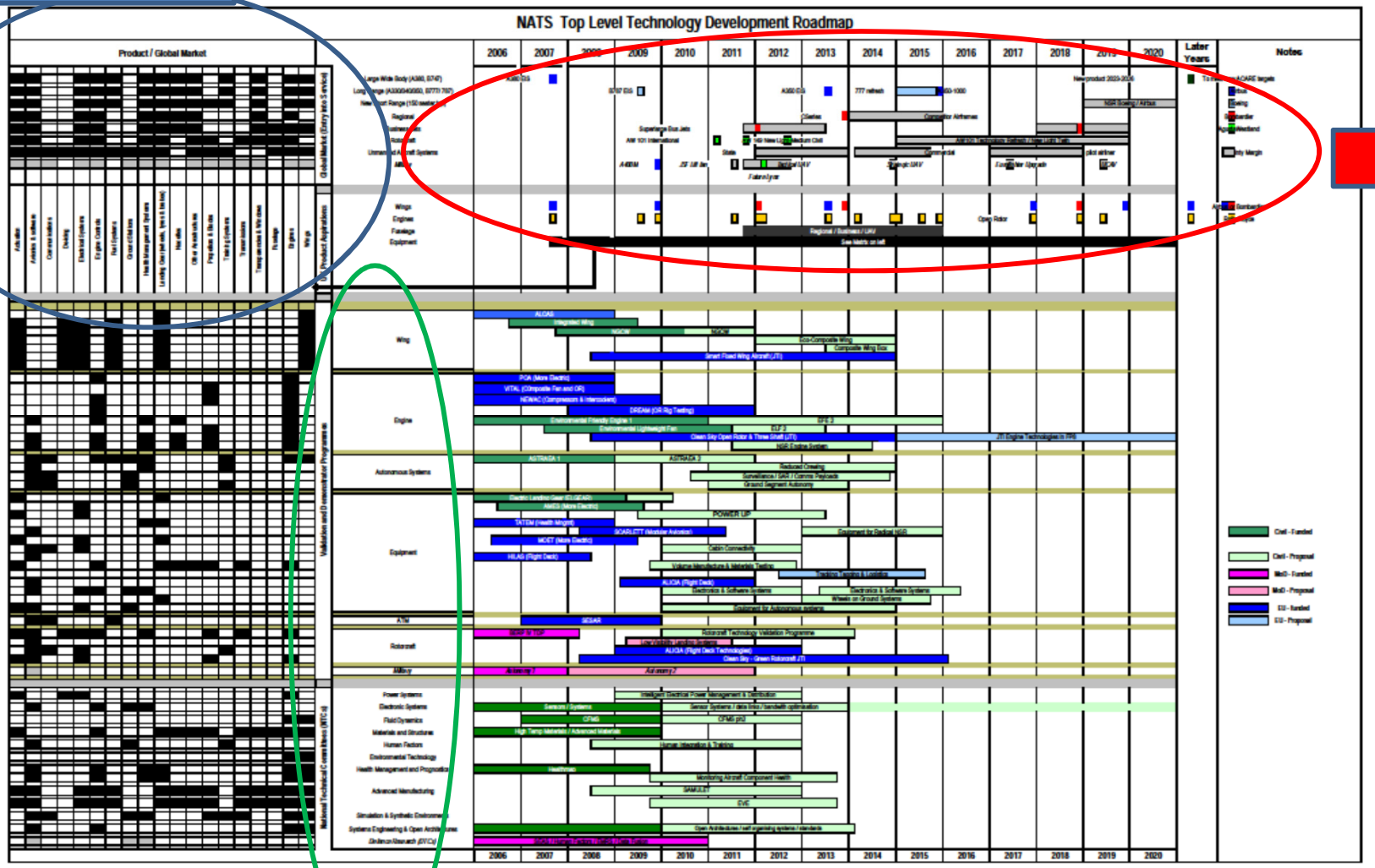
Market-driving aircraft and in service dates identified by NATS



20081113 Roadmaps

Market-driving aircraft and in service dates identified by NATS

Technology

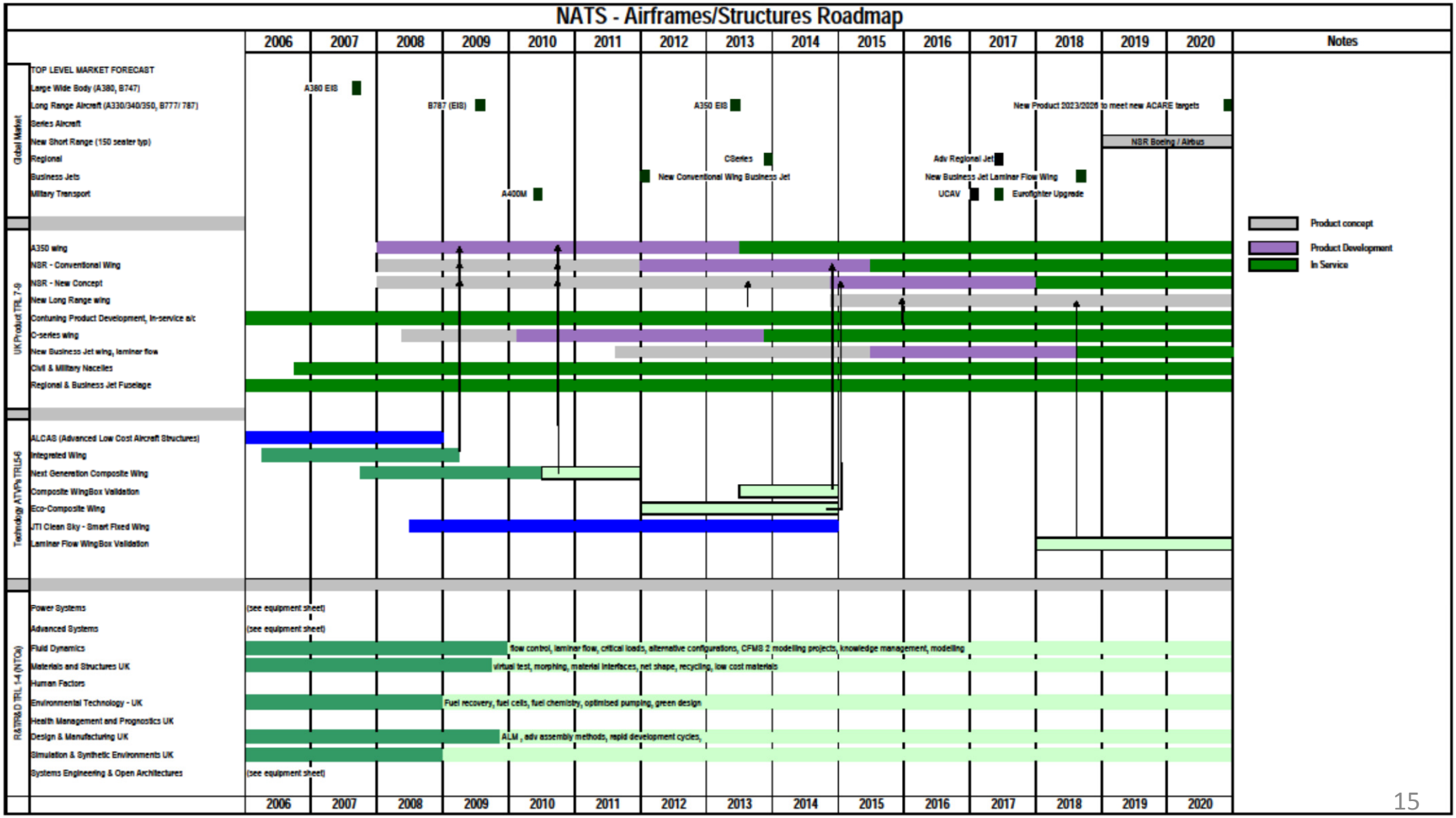


Products

Systems

20081113 Roadmaps

Underlying analysis



NATS - Engine Technology Roadmap

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

Global Market

TOP LEVEL MARKET FORECAST
Large Wide Body (A380, B747): A380 EIS
Long Range (A330/340/350, B777/ 787): B787 EIS; A350 EIS; 777 refresh; A350-1000
New Short Range (150 seater typ): New product 2023-2026; NSR Boeing / Airbus
Regional: CSeries; Competitor Airframes
Business Jets: Superlarge Bus Jets
Rotorcraft: AW 101 International; AW 149; New Light-Medium Civil; AW101 Technology Refresh / New Light Twin
Unmanned Aircraft Systems: State; Commercial; Single pilot airliner
Military: A400M; JSF Lift fan; Tactical UAV; Future Eyes; Strategic UAV; Eurofighter Upgrade; UCAV

UK Product ITL 7-9

Trent 700/800/500
Trent 900
Trent 1000
Trent XWB
New 3-shaft
Conventional NSA (150 seater)
Open rotor
RB282
TP400
T800/RTM322

Technology ATVPs TRL5-6

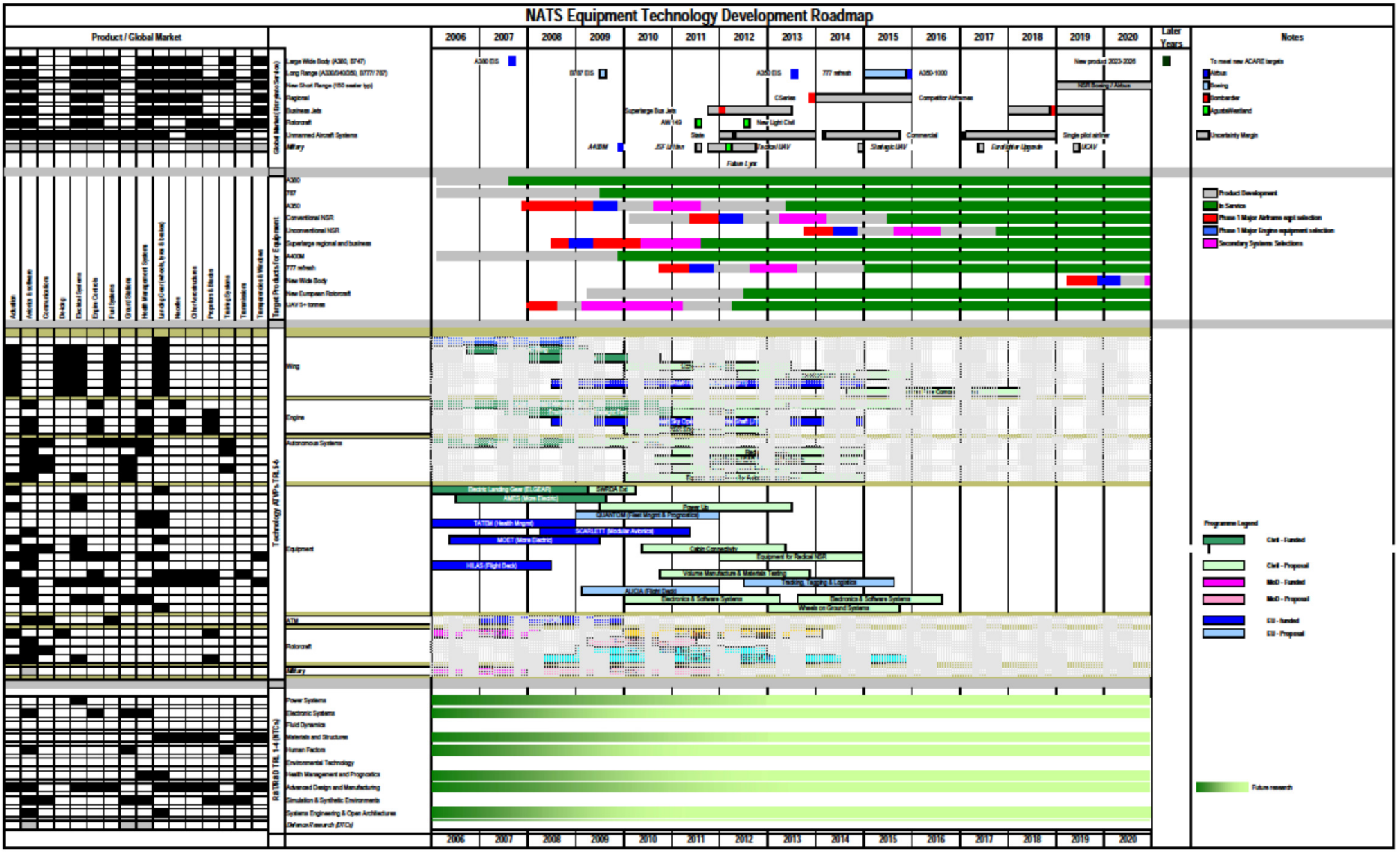
EFE: EFE; EFE 2; EFE 3
Composite fan: ELF technology; ELF pre-prod
VITAL
Clean Sky Open Rotor
JTI Engine Programme FP6
Clean Sky 3-Shaft: Clean Sky Open Rotor; JTI Engine Programme in FP8; Clean Sky 3-Shaft
System Verification (SVV) (150 seater): SVV
AMEs / Integrated Starter Generator: POA
Compressors & Intercoolers: NEWAC; NACRE
OR Rig Testing: DREAM

RATRAD TRL 1-4 (NTCs)

Fluid Dynamics - large progs: CFMS; CFMS phase II
Fluid Dynamics - small progs: FRAMEWORK 6 STREPS; Framework 7 level 1 projects; TSB funded; Future TSB calls
Materials & Structures - large progs
Materials & Structures - small progs: FRAMEWORK 6 STREPS; Framework 7 level 1 projects; TSB funded; Future TSB calls
Environmental Technology - large progs: ANDANTE (noise); SYMPHONY (noise); OPENAIR
Environmental Technology - small progs: FRAMEWORK 6 STREPS; Framework 7 level 1 projects; TSB funded; Future TSB calls
Health Management & Prognostics - large progs
Health Management & Prognostics - small progs: FRAMEWORK 6 STREPS; Framework 7 level 1 projects
Advanced Design and Manufacturing: IPAS; SAMULET; FRAMEWORK 6 STREPS; Framework 7 level 1 projects; VIVACE; CRESCENDO
Simulation & Synthetic Environments - large progs: EVE
Simulation & Synthetic Environments - small progs: BROADEN; FRAMEWORK 6 STREPS; Framework 7 level 1 projects

Notes

Uncertainty Margin
Product Development
In Service
TSB / RDA / DTI Funded
TSB / RDA / DTI Proposed
EC Funded
TSB / RDA / DTI Funded
TSB / RDA / DTI Proposed
Future unspecified research


NATS Equipment Technology Development Roadmap
Product / Global Market
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Later Years
Notes
Large Wide Body (A380, B747)
Long Range (A330/340/350, B777/ 787)
New Short Range (150 seater typ)
Regional
Business Jets
Rotorcraft
Unmarried Aircraft Systems
Military
Global Market (large jets to Regional Service)
A380 EIS
B787 EIS
A350 EIS
777 refresh
A350-1000
NSR Boeing / Airbus
CSeries
Competitor Airframes
Superlarge Bus Jets
AW 149
New Light Civil
Stalis
Commercial
Single pilot airliner
A400M
JSF Lift fan
Tactics/UAV
Strategic UAV
FirstMover Upgrade
UCAV
Future Lyer
To meet new ACARE targets
Airbus
Boeing
Bombardier
AgustaWestland
Uncertainty Margin
Actuation
Aerods & Inlets
Communications
De-Ice
Electrical Systems
Engine Controls
Fuel Systems
Ground Stations
Health Management Systems
Landing Gear (Wheels, tyres & brakes)
Nozzles
Other Aerodynamics
Propulsion Blocks
Testing Systems
Transmission
Temperature & Weather
Target Products for Equipment
A380
787
A350
Conventional NSR
Unconventional NSR
Superlarge regional and business
A400M
777 refresh
New Wide Body
New European Rotorcraft
UAV 5+ tonnes
Product Development
In Service
Phase 1 Major Airframe mgnt selection
Phase 1 Major Engine equipment selection
Secondary Systems Selections
Technology ATWPs TRL 5-6
Wing
Engine
Autonomous Systems
Equipment
ATM
Rotorcraft
Military
Electric Landing Gear (ELGEAR)
SMRSA Ext
AMDS (More Electric)
Power Up
TATEM (Health Mngmt)
SCARLETT (Modular Avionics)
MOET (More Electric)
Cable Connectivity
Equipment for Radical NSR
HILAS (Flight Deck)
Volume Manufacture & Materials Testing
Tracking, Tagging & Logistics
AVIDA (Glass Deck)
Electronics & Software Systems
Wheels on Ground Systems
Programme Legend
Civil - Funded
Civil - Proposal
MoD - Funded
MoD - Proposal
EU - funded
EU - Proposal
Research TRL 1-4 (NTCs)
Power Systems
Electronic Systems
Fluid Dynamics
Materials and Structures
Human Factors
Environmental Technology
Health Management and Prognostics
Advanced Design and Manufacturing
Simulation & Synthetic Environments
Systems Engineering & Open Architecture
Defence Research (DTCs)
Future research

SAT Roadmap (DOW) WP 3.1 (AD)

- Identify new aircraft, their characteristics, systems and their technologies: when needed in the market and take development and certification time into consideration
- Identify the technology requirements for network centric advanced booking systems
- Identify the technologies needs to adapt airports
- Identify the need for special ATM provisions.
- Identify special issues related to crew training

WP 3.1

- 4 different subgroups will be formed to master the roadmap issues (TBD):
  - Overall coordination AD
  - 1. Aircraft group: lead IOA (CIRA, INCAS, PZL, Piaggio, Evektor, Onera ,THL,AD) ; 2,4 mm
  - 2. Airport and ATM group : lead NLR (DUT, Bute, THL, AD); 0,6 mm
  - 3. Network centric booking: lead DUT (Bute, ONERA, ALS, AD) ;0,7mm
  - 4. Training group: lead AD (NLR, IOA));o,5 mm

Note: Only 4.2 MM are allocated to this task in total: can we borrow some mm from WP 3.3???

SAT Roadmap WP 2.2 (IOA)

- Identify possible national/ European initiatives up to 2020
- Receive information on the PPlane project
- Identify cost involved: make a cost model related to the SAT technologies roadmap

Note: 1,5 mm allocated to the task in total

SAT Roadmap WP 3.3 (INCAS)

- Identify the need for support in the Framework program (level 0, 1,2,3)

- Prepare an initial report
- Organize a workshop with stakeholders
- Finalize the report

2,6 mm allocated to this task in total

SAT Roadmap WP 3.4 (AD)

- Establish a network of organisations involved in small aircraft commercial operations. (Related to WP 5: Dissemination)
- Combine the interests of EGAMA with those involved in RTD and operations (ACI, AOA, AOPA, SESAR etc.) to establish a standing network organisation in the frame of ACARE (or ASD).
- Improve the exchange of information with ASD. (Manufacturing only)
- Organize a workshop aimed at establishing a network. (location, funding, balanced participation): Possible combination with Task T5.3 (0,8mm allocated)
- Possibly establish a new IMG if Commission money is likely to be available.

1,5 mm allocated to this task in total

NOTE for immediate action

- Due to the different set up in Brussels we need not only to convince DG RTD but especially DG Move of the added value of small aircraft transportation.
- Keep a close loop with the writing of the new GOP report by the High Level Group and SRA3 (NEARS).
- To this end contact the High Level Group and the Expert Group asap. Make a presentation in the ACARE IT.

Note: the people in the High Level Group are not acquainted to air taxi operations (except Lufthansa!): their focus is on Airbus

- Request a slot during the Aerodays to highlight the importance of small aircraft operations.