

USE OF FFS FOR AIRCRAFT CERTIFICATION PURPOSE

Example of application with Clearvision project

5th June 2019



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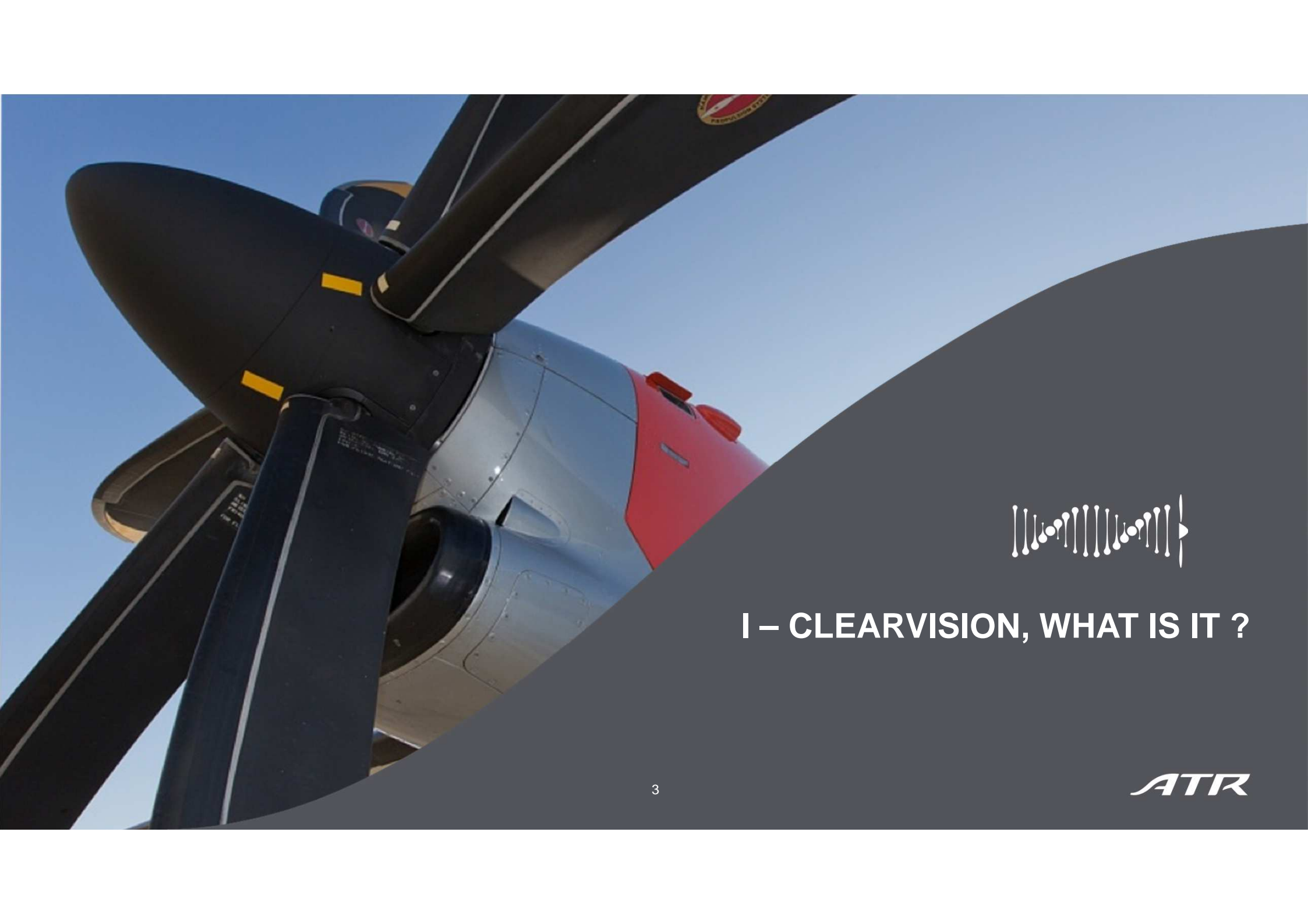
INTRODUCTION



Within the frame of Clearvision project, ATR's design office requested the ATR Training Center to make available a simulator to be used in complement of aircraft prototype for development and certification campaign.

In accordance with regulation, ATR took the opportunity to use FFS Level-D training simulation platform to comply with their needs.

Using Clearvision project as a support, this presentation illustrates how the FFS simulator can be used as a powerful tool to support aircraft development.



I – CLEARVISION, WHAT IS IT ?

I - CLEARVISION WHAT IT IS ?

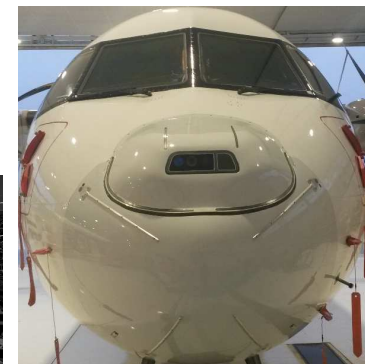
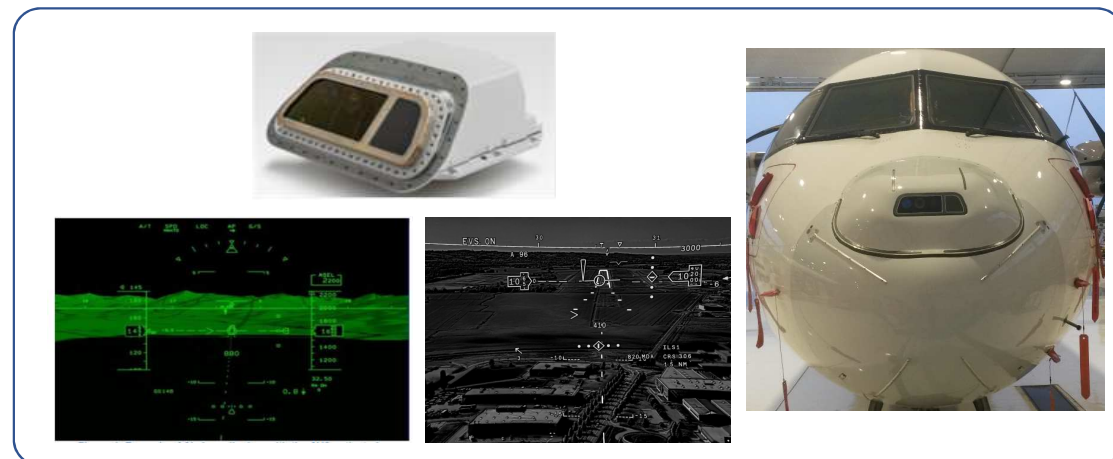


Clearvision Description :

Aim of the option : Reduce approach minimums

How : installation of

- Head Mounted Display (**HMD**) skylens
- Enhanced vision system (**EVS**) using Multi-spectral camera on aircraft's radome
- A Synthetic Vision System (**SVS**)
- A Combined Vision System (**CVS = EVS + SVS**)





II – EXPRESSION OF NEEDS

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II- EXPRESSION OF NEEDS ?



Needs were expressed by Design office to perform on the device

- Human Factor evaluation
- Safety assessment

A Technical Note was sent to ATC including

- Malfunction list
- FFS time provision
- Preliminary electrical and mechanical aircraft drawings (R00)

Based on this request, ATC made the choice of the device :

- Rehost or Real Avionic ?

AIRCRAFT AVIONIC OR REHOSTED AVIONIC?



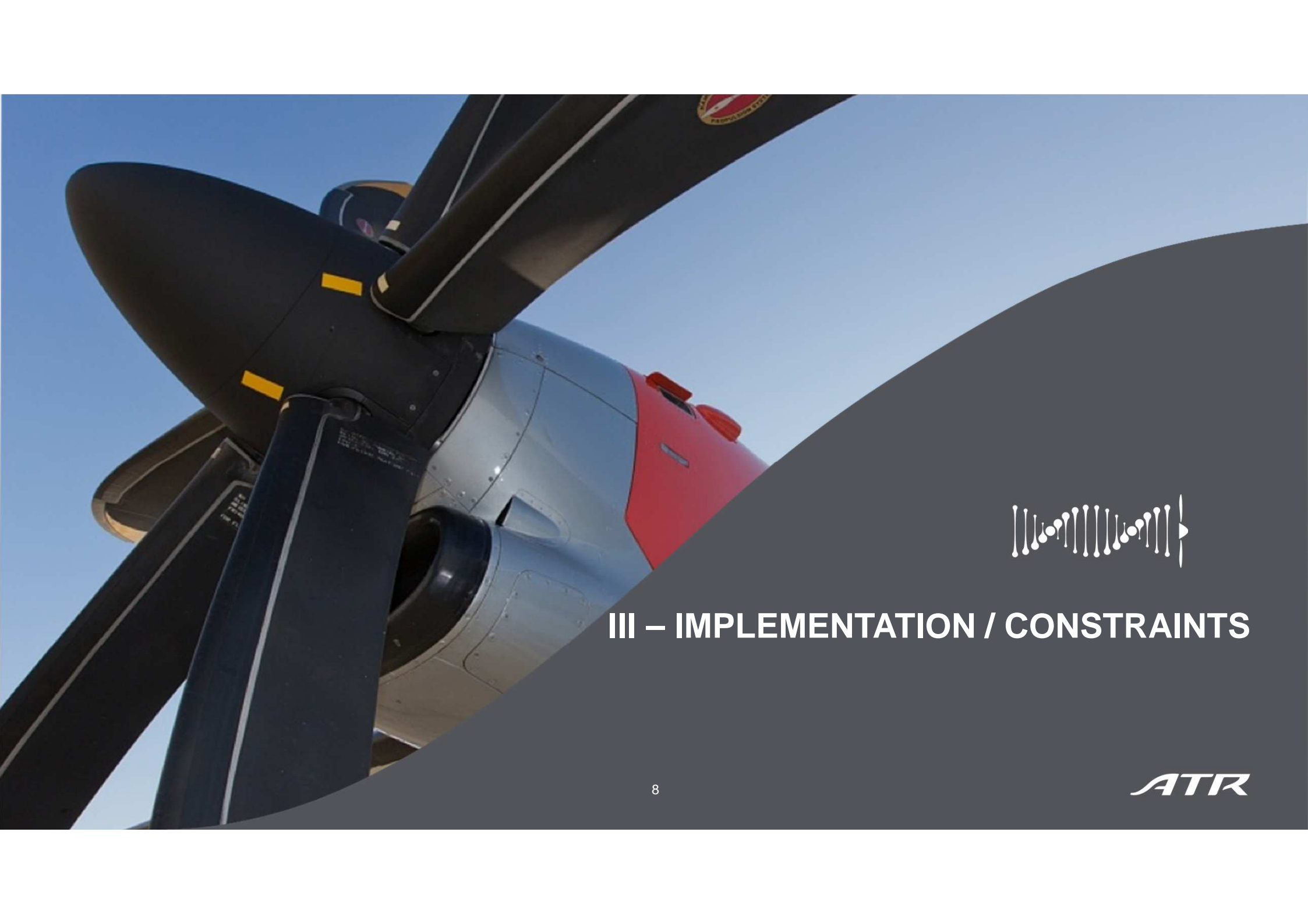
Real Avionic



Rehosted Avionic

	Real Avionic	Rehosted avionic	
Representativity of certified aircraft	++		Training Center concern
Training flexibility	-		
Spares parts availability		-	
Cost		+	
Capacity to compose with A/C EIS	++	--	OEM concern
Development flexibility	++	--	
Certification potential	++	+	
Representativity of Prototype aircraft	++	--	

Real Avionic chosen



III – IMPLEMENTATION / CONSTRAINTS

III - IMPLEMENTATION



Based on this analysis, ATC choose to use the FFS FR-125 located in Toulouse then:

- Requested authorisation from FSTD DGAC for using a training simulator for development purpose
 - Associated process was provided to ensure no impacts on training session
- Launched a « Clearvision FFS project » within ATR Training Center
 - Budget, scheduling, specification, procurement, installation, validation, ...
- Fedded with:
 - Preliminary drawings
 - Prototype parts

III - CONSTRAINTS



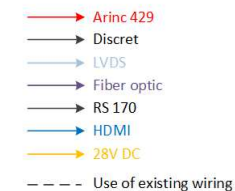
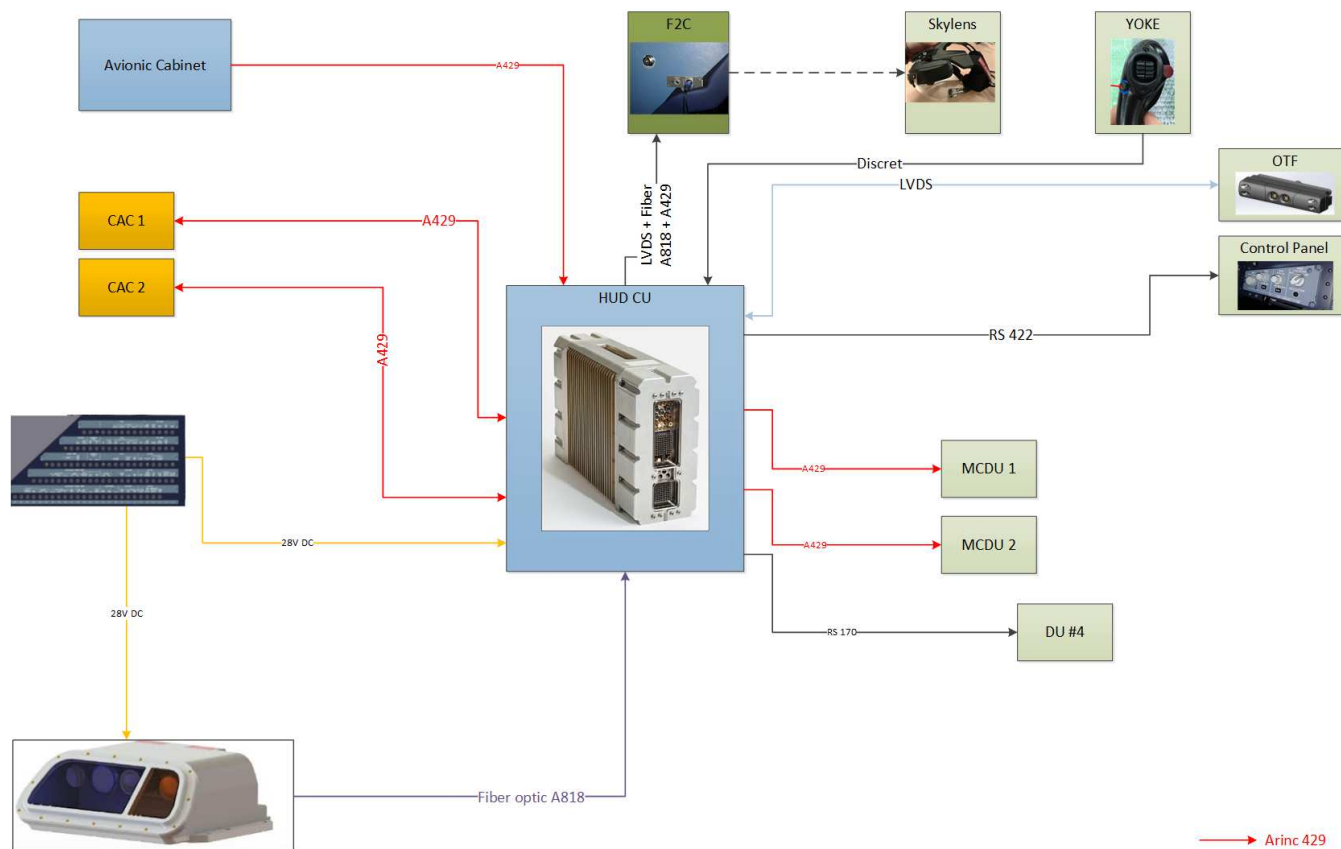
- Within an operational context that imposed to
 - Manage the development and the training in parallel
 - Dedicated S/W load
 - Dedicated visual load
 - Application of specific procedures for the H/W and S/W conversion change
 - Handle 2 different avionic standards (STD2.1 and dev. STD3)
 - Provision of several spare parts already loaded
 - Minimise the time required for the conversion
 - Created set of already configured elements to optimise the swap
 - Warrant the conformity of the simulator for the training
 - Pilot Evaluation
 - QTG



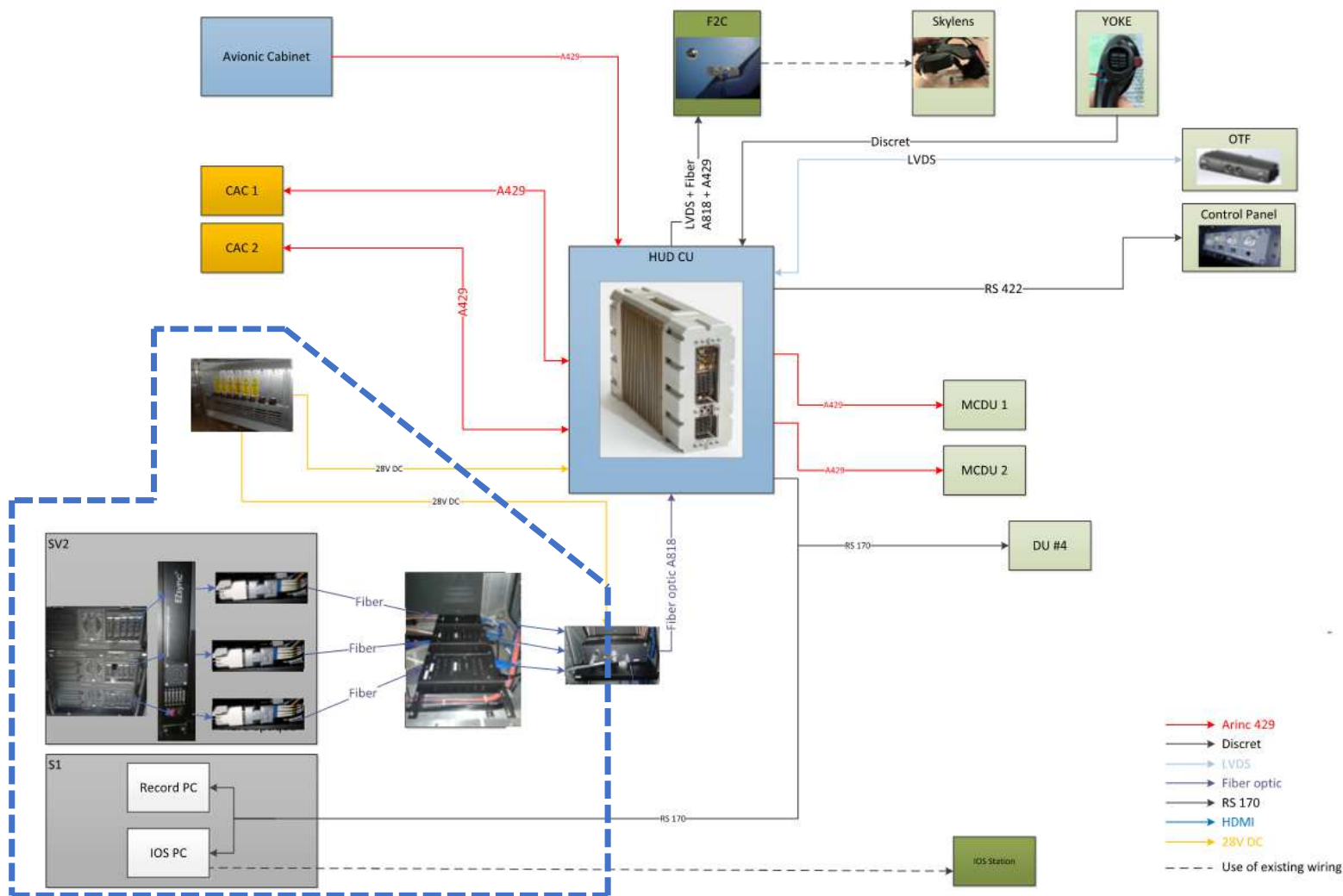
IV – ARCHITECTURE

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AIRCRAFT INTEGRATION ARCHITECTURE



SIMULATOR INTEGRATION ARCHITECTURE



INTEGRATION OF CONTROL PANEL + NIGHT VISION CAMERA



INTEGRATION OF PARTIAL BULKHEAD

Storage box and F2C connector in simulated area



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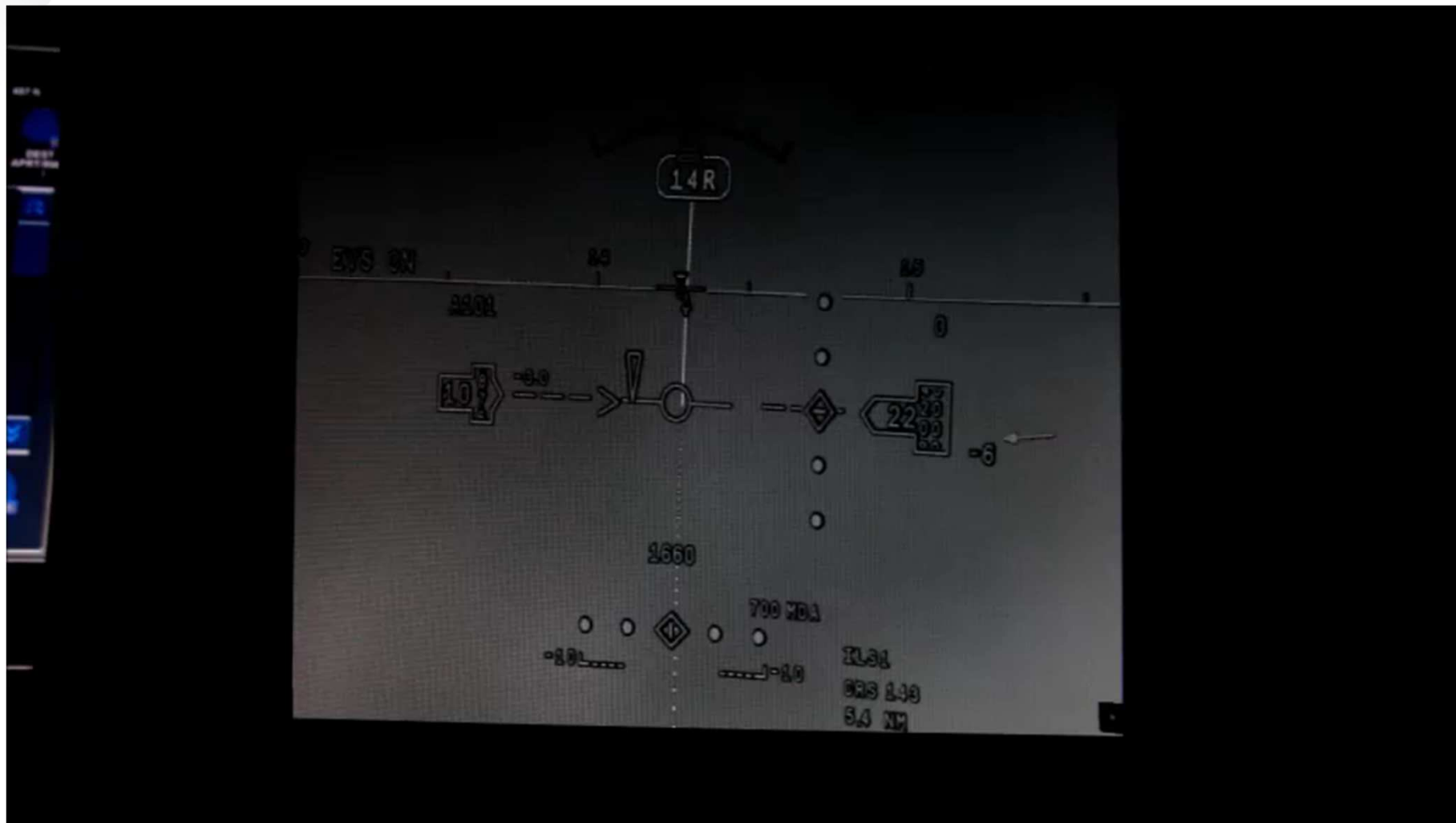
IOS REPEATER



VOR/ILS		V/ILS1 <input checked="" type="radio"/>		STBY	
ACTIVE		110.70	< >	108.35	
<input type="checkbox"/> AUTO		<input type="checkbox"/> DME HOLD			
ND OVLY		V/ILS2 <input checked="" type="radio"/>		STBY	
ACTIVE		110.70	< >	108.35	
<input type="checkbox"/> AUTO		<input type="checkbox"/> DME HOLD			

DEMO IOS REPEATER

CAT I approach



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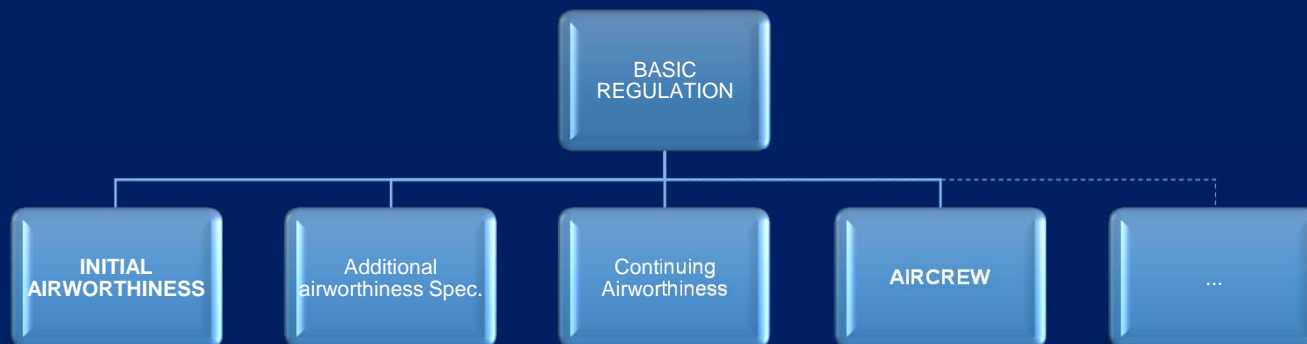


III – REGULATION BASIS

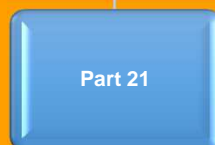
REGULATION BASIS



Regulation (Hard Law)



AMC & GM (Soft Law)



Certification Specifications (Soft Law)



REGULATION BASIS

Extract of Part-21 AMC 21.A.20(b)



AMC 21.a.20(b) : Compliance with the type-certification basis, operational suitability data certification basis and environmental protection requirements

AMC 21.A.20(b) Certification programme

ED Decision 2014/007/R

1. For a particular project and as part of the technical familiarisation, the applicant provides a certification programme that includes:
 - 1.1 a plan containing the following information:
 - Description of the project and the kind of operations envisaged
 - The proposed certification specifications, special conditions, equivalent safety findings and environmental protection requirements
 - The description on how compliance will be demonstrated, with proposed means of compliance (see appendix to this AMC below for codes), and any selected guidance material. The description of the means of compliance should be sufficient to determine that all necessary data will be collected and compliance can be demonstrated.
 - A compliance checklist addressing each paragraphs of the type-certification basis, the operational suitability certification basis and environmental protection requirements applicable to the project, with reference to the means of compliance and to the related compliance documents.
 - Identification of relevant personnel making decisions affecting airworthiness, operational suitability and environmental protection interfacing with the Agency, unless otherwise identified to the Agency;
 - 1.2 a project schedule including major milestones.
2. The certification programme can be developed step by step, when the information needed is not available at the beginning of the project.
3. For a simple project, the certification programme can be proposed with the application.
4. The certification programme can be based on modules that can be updated independently.

Appendix to AMC 21.A.20(b) - Means of compliance codes

ED Decision 2012/020/R

Type of Compliance	Means of Compliance	Associated Compliance Documents
Engineering evaluation	MC0: <ul style="list-style-type: none"> – Compliance statement – Reference to Type Design documents – Election of methods, factors – Definitions 	<ul style="list-style-type: none"> – Type Design documents – Recorded statements
	MC1: Design review	<ul style="list-style-type: none"> – Descriptions – Drawings
	MC2: Calculation/ Analysis	<ul style="list-style-type: none"> – Substantiation reports
	MC3: Safety assessment	<ul style="list-style-type: none"> – Safety analysis
Tests	MC4: Laboratory tests	<ul style="list-style-type: none"> – Test programmes
	MC5: Ground tests on related product	<ul style="list-style-type: none"> – Test reports
	MC6: Flight tests	<ul style="list-style-type: none"> – Test interpretations
	MC8: Simulation	
Inspection	MC7: Design inspection/ audit	<ul style="list-style-type: none"> – Inspection or audit reports
Equipment qualification	MC9: Equipment qualification	Note: Equipment qualification is a process which may include all previous means of compliance.


It has to be noticed that Simulation includes but is not limited to FFS Level-D



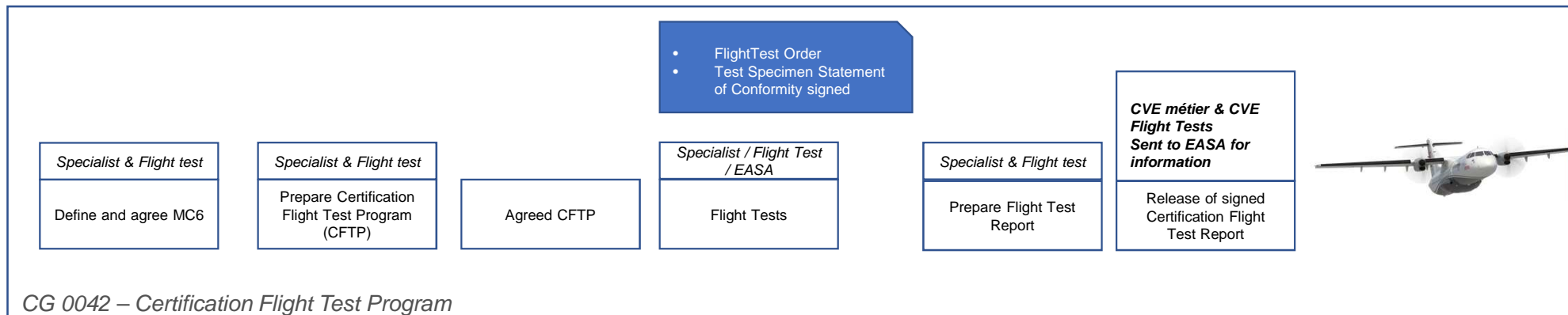
CG-0582 : SIMULATOR TEST PROCESS (MC8)



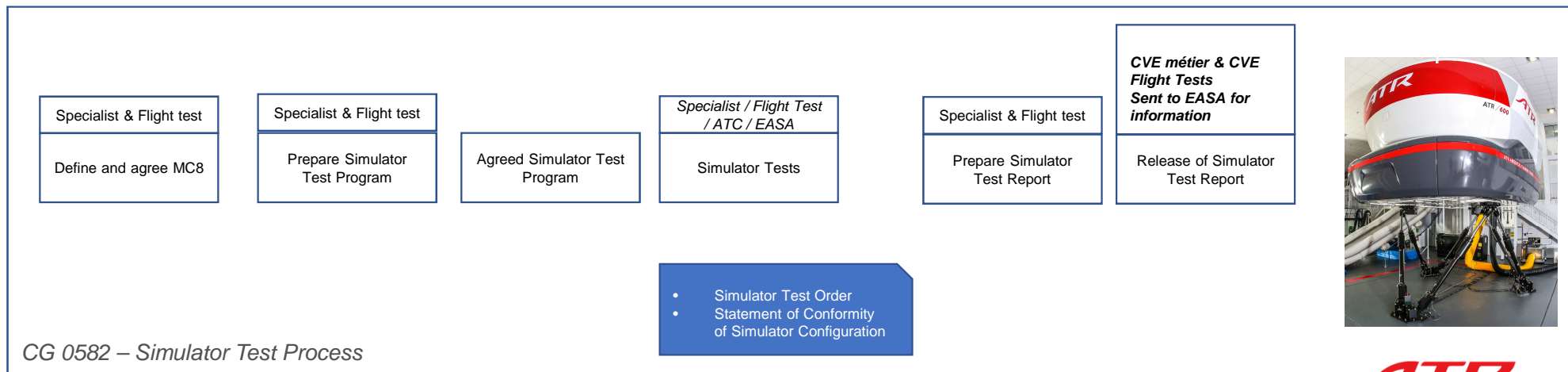
Production within ATR of a document called Simulator Test Process (MC8) referenced CG-0582, **Review and validated by EASA**

		Organisation Instruction		Identification : CG-0582-EN - A.0 Validated on : 23/01/2019	
SIMULATOR TEST (MC 8) PROCESS					
Purpose		Define the Simulator Test (MC8) Process.			
Scope		Engineering			
Authority Warning :		OUI			
Concerned Authority :		EASA			
Submitted :		MOC			
Send to the supplier ? :		NON			
For any change please contact service QM.					
Written by		Name : CLERC DENIS Function : Head of Avionics & Electrics Date : 03/12/2018		Validated by Name : KRIER BERNARD Function : Head of Systems & Propulsion Eng	
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CG-0582 : SIMULATOR TEST PROCESS (MC8)



Certification
program Draft



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**FFS – A very powerful tool for
certification AND development**

FFS AND FTI → MANY SIMILARITIES



	FTI	FFS
DU repeater	5	3
Wide field cockpit camera	Yes	Yes
Clervision video	Yes	Yes
Live monitoring of parameters	Yes	Yes
Recording parameters	Yes	Yes
Refresh rate adjustable	Yes	Yes



CAMERA



Rajouter camera ambiance simu

PARAMETERS LIVE MONITORING

- Maintenance page allows live monitoring of most common A/C parameters in live on IOS
- If necessary, other internal or deported tool allow to monitor in live almost all internal parameters, from

Simulated ones like GPS/IRS/ADC but also all aerodynamic labels → **FULL STALL application**

To **Real A/C Systems ones** (CAC, MCDU...etc)

- A429 buses
- AFDX

POSITIONS	
A/C Longitudinal Position wrt Runway	-278.3
Threshold (m)	
A/C Lateral Position wrt Runway	0.1
Threshold (m)	
AERO ANGLES & RATES	
Angle of Attack (deg)	-1.0
Pitch Attitude (deg)	-1.0
Roll Attitude (deg)	-0.0
True Heading (deg)	-37.0
Sideslip (deg)	0.0
Body Axis Long. Acceleration (m/s**2)	-0.09
Body Axis Lateral Acceleration (m/s**2)	0.00
Body Axis Vertical Acceleration (m/s**2)	-9.81
Body Axis Roll Rate (deg/s)	0.00
Body Axis Pitch Rate (deg/s)	0.00
Body Axis Yaw Rate (deg/s)	0.00
Body Axis Roll Acceleration (deg/s**2)	-0.00
Body Axis Pitch Acceleration (deg/s**2)	-0.01
Body Axis Yaw Acceleration (deg/s**2)	-0.00
AMBIENT	
Ambient Temperature (deg C)	14.0
Total Wind at A/C (Knots)	0.0
Wind Direction at A/C (deg)	0.0

```

simnode - PuTTY
G04_EOM_ALPHA_F8      Angle of attack      -0.08110956
G04_EOM_BETA_F8       Sideslip angle       0.00883556
G04_EOM_NZ_F8         Z-Axis Load Factor   1.04579885
G04_AERO_CLS_F8       Stability Axis Lift Coefficie 0.36899788
L04_AERO_L_CD_F8      Body Axis Drag Coefficient 0.03504168
G04_EOM_CAS_F8        Calibrated airspeed    231.95473748
G04W_WGHT_WT_F8       Aircraft Gross Weight    41636.66198641
G34N_GPS_LATITUDE_F8(1) LATITUDE          43.963
G34N_GPS_LONGITUDE_F8(1) LONGITUDE          1.015

Labels monitored
Connected to          <atr6>
Common database is    D:\cae\configurations\atr6_work_7_1_40_18_motion\genera
ted/cdb/atr6
ed\sp0c0.exeses is    37 (0 to 36)
Rate is              60 Hertz
Simulation is         FOREGROUND
Local symbol access is OFF
Location is           Toulouse

(13:32)

CTS-PLUS>
  
```

MALFUNCTION

Malfunctions

Malfunction capacity

- Some failure case can be extremely difficult to generate in Flight
- Most of the time, failure cases testable in flight are « ON/OFF » kind
 - System failure pulling CB
 - Engine flame-out using fuel shut off valve
- FFS allows injection of **complex failures**, that can be specifically coded for Development / Certification purpose
 - Definition of range / rate / ... etc
 - Activation threshold manageable extremely precisely
 - Easily tunable in live

```

Clearvision.cts x  gps1.cts x
1  !GPS ERRONEOUS POSITION [side 1]
2  TB34N_M_091_L1=t
3  !
4  !Deviation Range (NM)
5  TV34N_M_091_F4=1.0
6  !
7  !Deviation Bearing (Deg)
8  TV34N_M_101_F4=45.0
9  !
10 !Deviation Rate (NM/sec)
11 TV34N_M_121_F4=0.1
12
    
```



Extract of RNP-AR failure test program, used as MoC 6 & MoC 8

3. Synthesis of tests required

3.1. Probable and remote lateral system failures retained for evaluation

The tests to be performed to evaluate the performances upon probable and remote failures described in §2 are the following:

Equipment	FC reference	FC Title	Proba. of occurrence	Test mean
FMS & MCDU	SSA NAS IN.X02 (or X04)	Loss of inner left or right display unit (DU2 or 4)	Probable	Test A/C
	SSA RNP AR NAV08	Detected erroneous (FMS) A/C position on one side	Remote	FFS
	SSA RNP AR GUID12	Detected erroneous lateral guidance orders on one side	Remote	FFS
AFCS	FMES 15.01.009	Loss of CPM & IOMS on CAC 1	Remote	Test A/C
	SSA NAS AP.005	Limited runaway inside Autopilot disconnection limits	Remote	FFS
Satellite, GPS, AHRS & ADC	FMES 06.01.001/3	Loss of one GPS	Probable	Test A/C
	SSA RNP AR NAV08	Detected erroneous (GPS) A/C position on one side	Remote	FFS
	SSA NAS NA.007	Loss of one ADC	Probable	Test A/C
	SSA NAS NA.007	- Erroneous IAS parameter on one ADC	Probable	FFS
	SSA NAS NA.026	Loss of one AHRS	Probable	Test A/C
	SSA NAS NA.026	- Erroneous roll parameter on one AHRS	Probable	FFS

CONCLUSION



Not as performant as dedicated development simulator with full real equipments but

- Very good as intermediate tool for design office
- Very accurate for Human Factor and safety assessment
- Enforce relationship between the training and the engineering with exchanges in both directions
- Training involved into the development since the beginning

From training point of view, a very good way to integrate / evaluate / tune equipment with all specialists involved

- Better technical understanding of the system and its interactions with simulation software
- Ease production of Crew training program
- Ease FSTD qualification quickly after A/C certification allowing crew training before EIS



THANK YOU

ありがとう

谢谢

धन्यवाद

شكرا لك

Gracias

Спасибо

Merci

Grazie

Obrigado

Vielen Dank

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