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# CMS380

Airbus A380 Central Maintenance System  
– the AFDX Protocol Simulation

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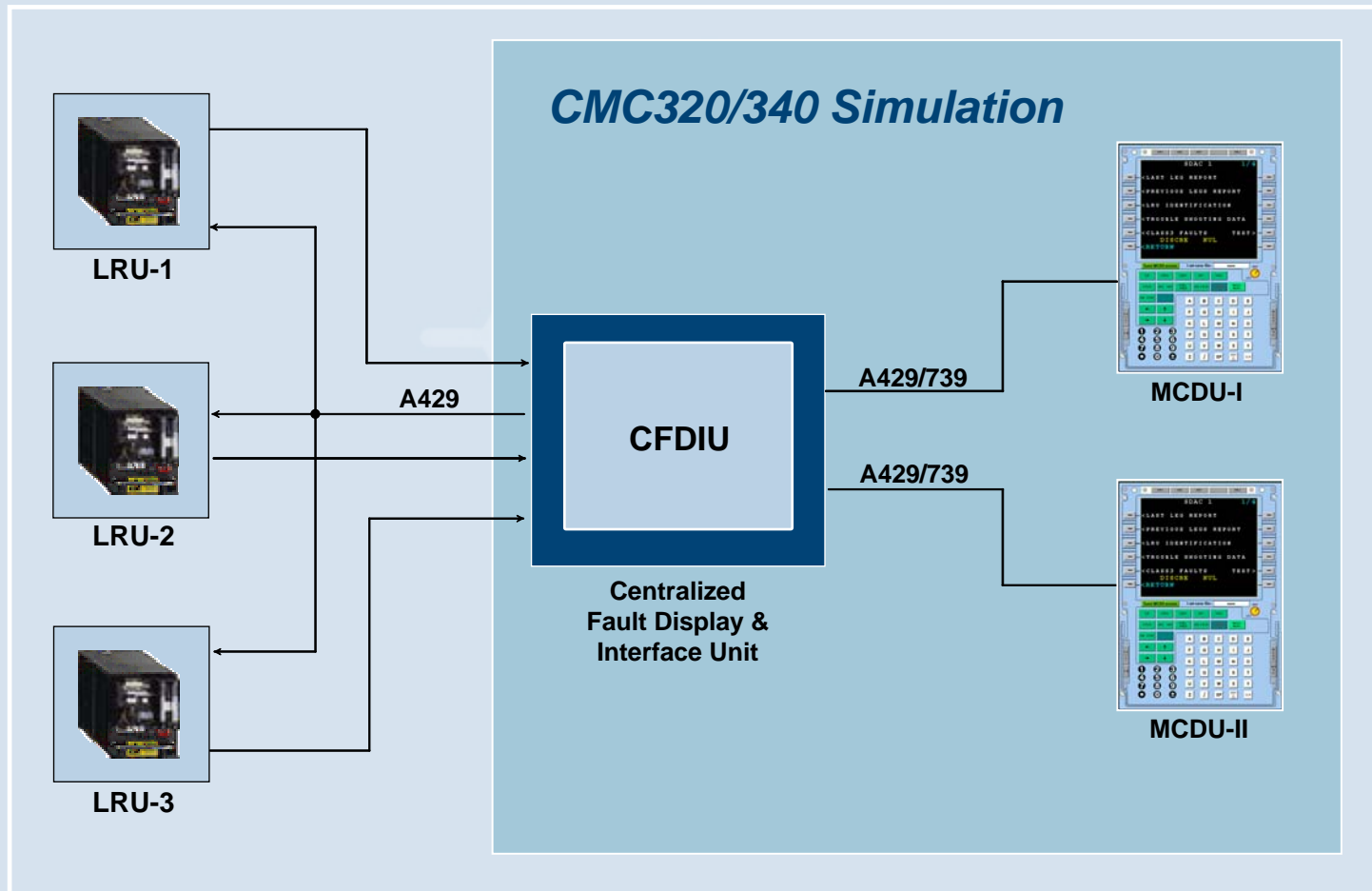
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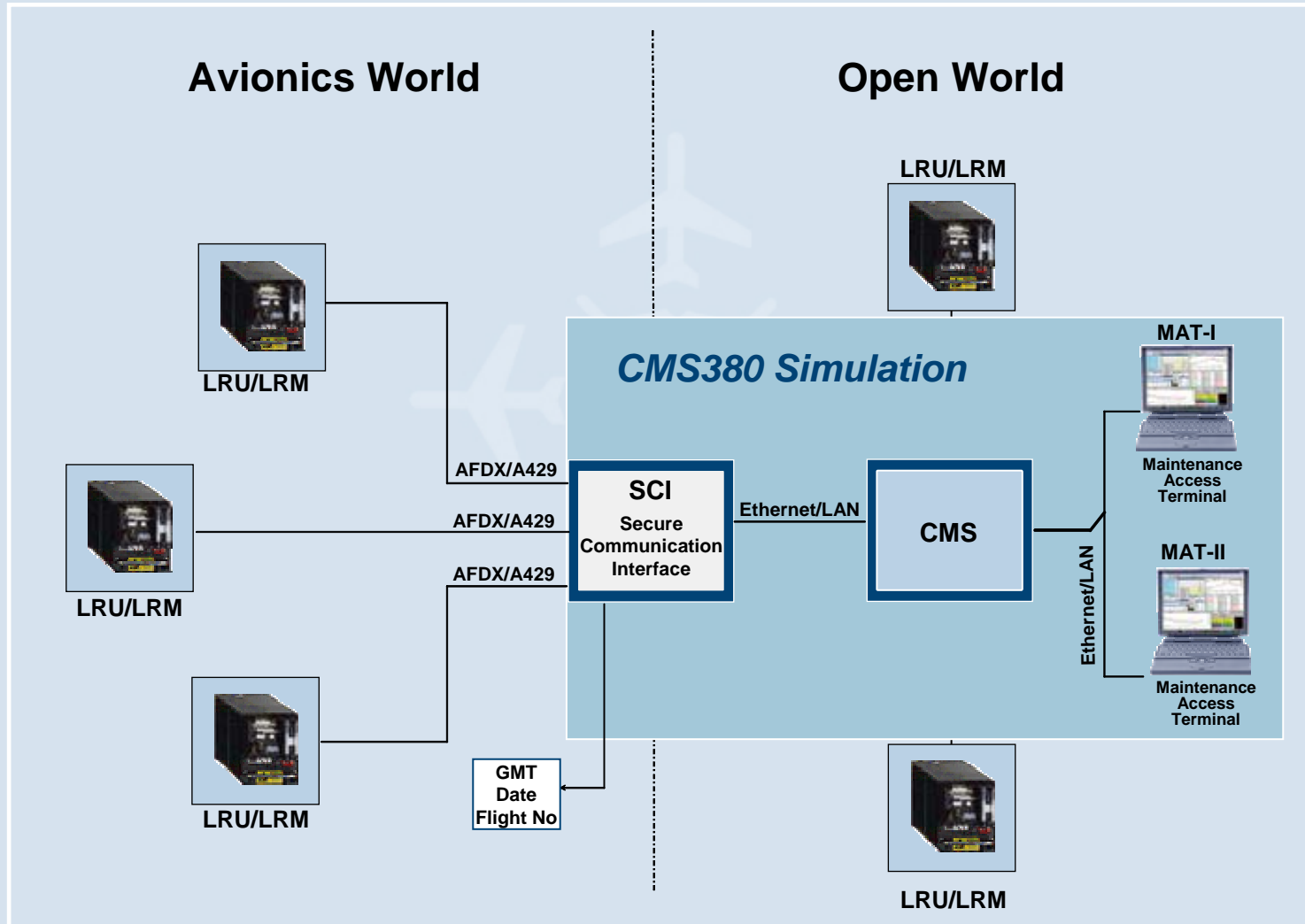
## What is the Central Maintenance System (CMS) / Built-in Test Equipment (BITE) in Airbus A380 ?

*“The BITE (Built-In Test Equipment) shall manage all data used to report a faulty Unit (LRU) and shall provide additional fault information allowing detailed troubleshooting”. These data shall be memorized within the LRU and transmitted to the CMS either automatically (NORMAL MODE) or upon request from the CMS (INTERACTIVE MODE)....”*

# Looking back to Airbus A320 and A330/340 Architecture



# New Architecture and Philosophy in the A380

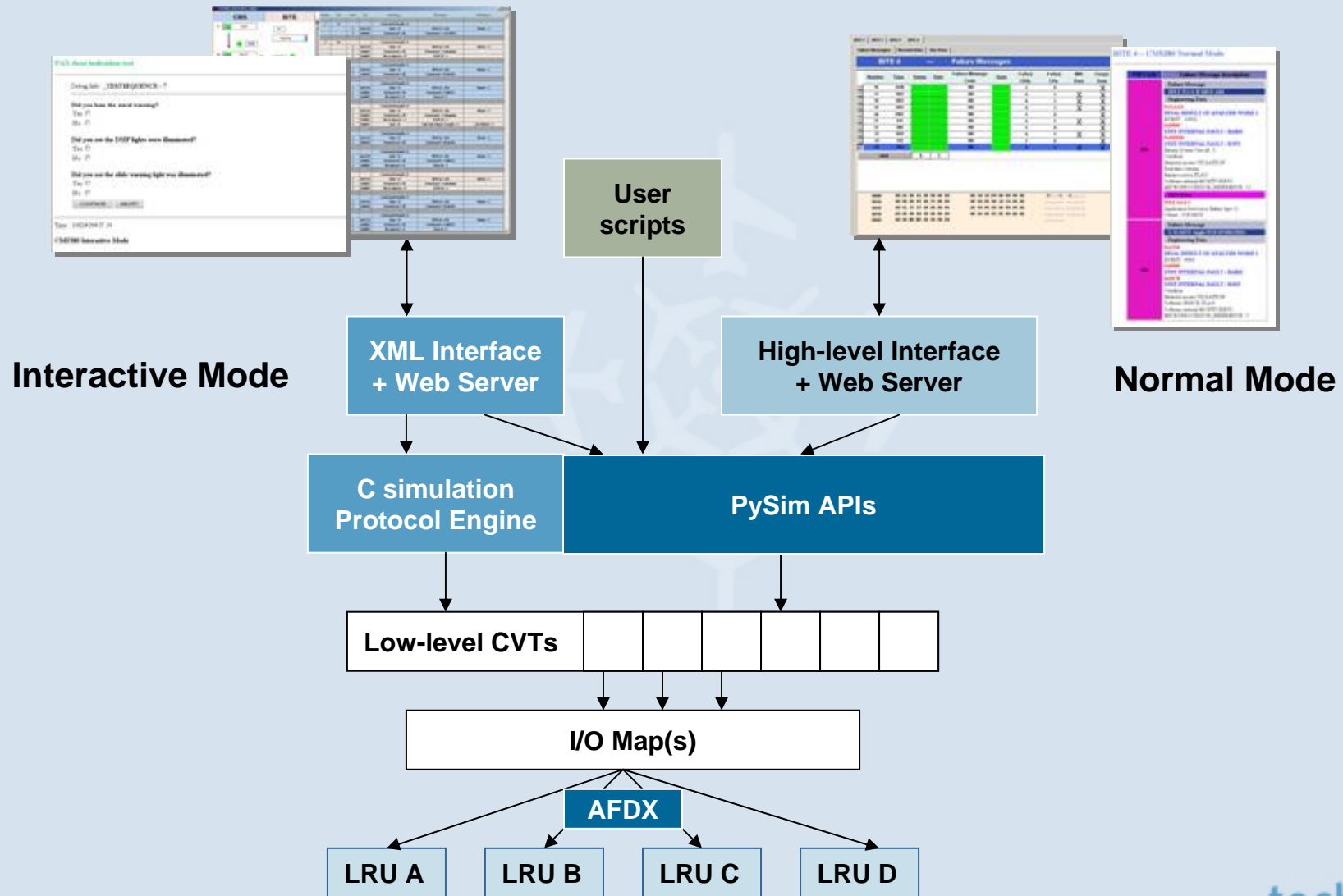


# Airbus A380-800/900 CMS-Simulation Central Maintenance System

The screenshot displays the 'CMS Interactive Mode Monitoring' interface. On the left, a control panel is divided into 'CMS' and 'BITE' sections. The 'CMS' section includes buttons for 'START', 'CMS STATUS', and 'ACK', along with status indicators. The 'BITE' section includes buttons for 'display' and 'terminate', with associated status indicators. A central table provides a detailed log of system events, including command lengths, side identifiers, function IDs, and step IDs. At the bottom, the current state is shown as 'IDLE' and the current step ID as '0'. A 3D model of an Airbus A380 aircraft is overlaid on the interface, with 'A380' written on the tail and fuselage.

Number	Type	Word	Hex	Decoding_1	Decoding_2	Decoding_3
1	0			Command length : 6		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0001	Function id = 20	Command = 1 (START)	
2	70			Command length : 6		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0001	Function id = 20	Command = 1 (display)	
		3	0x0001	Nb of objects = 0	STEP id = 0	
3	800			Command length : 6		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0001	Function id = 20	Command = 1 (display)	
		3	0x0001	Nb of objects = 0	STEP id = 0	
4	810			Command length : 14		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0002	Function id = 20	Command = 3 (CMS STATUS)	
		3	0x0000	Nb of objects = 0	STEP id = 0	
		4	0x0004	Status return value = 4	Target step id not coherent	
		5	0x0001		Excessive step id : 1	
		6	0x0000			
		7	0x0000			
		8	0x0000			
5	820			Command length : 6		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0001	Function id = 20	Command = 1 (Reboot)	
6	820			Command length : 6		
		1	0xAAAA	Side = 1	BITE id = 0	Mode = 1
		2	0x0001	Function id = 20	Command = 1 (Reboot)	

# CMS380 Architecture



# Main Features

- ➔ Full simulation of a standard B CMS for LRUs of type 1 (Normal Mode & Interactive Mode)
- ➔ AFDX / Ethernet / A429 link with up to 4 BITE interfaces
- ➔ Runs in any ADS-2 test environment
- ➔ Data verification and analysis
- ➔ Communication monitoring, error injection
- ➔ Automatic modes

# Configuration

- ➔ AFDX messages
- ➔ LRU tables
- ➔ Engineering data (dependent and independent parameters)
- ➔ XML specification
- ➔ Recording files
- ➔ Failure Messages filters

# AFDX Configuration

**BITE**

**NM Messages + IM Commands**

**CMS**

Src UDP + Src IP + VL MAC + Dst IP + Dst UDP

**IM hazardous / non hazardous commands**

Dst UDP + Dst IP + VL MAC + Src IP + Src UDP

**UTC Time + CMS parameters + A/C configuration**

Dst UDP + Dst IP + VL MAC + Src IP + Src UDP

**SCI**

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# Normal Mode

## ➔ Decoding of BITE messages:

- ⇒ Failure Messages
- ⇒ Status data
- ⇒ System identification data

## ➔ Transmission of CMS general parameters

## ➔ Transmission of SCI messages:

- ⇒ UTC Time & Date
- ⇒ Aircraft Configuration

# Normal Mode Monitoring Panel

History of all failure messages with customizable display and high-level filtering.



Number	Update rate (ms)	Status	Rate	FM Code	State	Side	Eng. Data X reported	Nb. occurrences
866	969			200	LATCHED	0		0
867	960			112	DETECTED	0	X	0
868	1000			200	LATCHED	0		0
869	1001			112	DETECTED	0	X	0
870	1000			200	LATCHED	0		0
871	1000			112	DETECTED	0	X	0
872	1000			200	LATCHED	0		0
873	1000			112	DETECTED	0	X	0
874	1063			200	LATCHED	0		0
875	1042			112	DETECTED	0	X	0

Hexadecimal view of each message.



0000	00 2E 00 14 00 03 40 26	02 41 10 06 10 E0 00 00	.....0..A.....
0010	00 00 00 05 50 03 00 00	00 00 00 00 00 70 00 00	...P.....p...
0020	00 06 00 05 00 00 11 25	AE 10 00 FF 00 00 00 00	.....

Failure report of message.



Parameter	Value	Meaning
FAILURE DATA AREA		
Function	0	Reporting function
Status	1	Detected Failure
Complementary data	1	WITH complementary data
Bite Identifier	0	
Side	0	
Failure Message class	3	Class 3
Flight deck or cabin effect code	0	
FDCI Type	0	FWS
FDE Event	0	
First accused probability	6	50% < FP < 60%
Link 1-2	0	AND
Second accused relative probability	1	0 < FP < 10%
Link 2-3	0	AND
Third accused relative probability	0	Probability N/A
Inputs/Outputs reported	1	WITH Input/output reported
Priority	0	Low
LRU AREA		

Full decoding of the whole message content (including IMA data and complementary data).



# Normal Mode Web Front-end

The screenshot shows a web browser window titled "Tech S.A.T's CMS380 -- Normal Mode". The page content includes:

- Navigation tabs: [FAILURE MESSAGES](#) and [TEST RESULTS](#)
- Text: "Fault Message Codes: [112](#) [200](#)"
- A table with the following data:

FM Code	Failure Message description
112	Failure Message
	G HYD POB(TBD) + SPLY TO Y HYD PRESS XDCR Connector AC0
	Engineering Data
	WORD 1 : 0x1125 Word 1 : 0x1125 WORD 2 : 0xAE10 Word 2 : 0xAE10 WORD 3 : 0x00FF Word 3 : 0xFF
200	Failure Message
	G HYD POB(TBD)

Test results - Failure messages: None

Tech S.A.T's CMS380

List of all transmitted FM codes

Detailed view of each FM code including:

- Fault report
- IMA data
- Engineering data

# Interactive Mode

- ➔ Complete execution of tests / specific functions from any XML specification
- ➔ Tracing / monitoring of the communication
- ➔ Memorization of BITE / CMS commands and test results
- ➔ Error detection / handling / injection
- ➔ Scripting functionalities
- ➔ Replay utility

# Interactive Mode Panel

The screenshot displays the CMS380 software interface in Interactive Mode. The left panel, titled 'CMS' and 'BITE', shows a sequence of protocol messages: ACK, NEXT, ACK, NEXT, ACK, NEXT, and ACK. Each message is accompanied by a timing diagram and a duration (e.g., 43106 ms, 37074 ms, 28074 ms). The right panel shows a table of decoded commands with columns for Number, Time, Word, Hex, and Decoding\_1 through Decoding\_3. The table includes details such as Command length, Side, Function id, BITE id, Mode, and Command values.

Number	Time	Word	Hex	Decoding_1	Decoding_2	Decoding_3
22		0x5061		4. character = 'P'	3. character = 'a'	
23		0x7281		6. character = 'r'	5. character = 'a'	
24		0x6D65		8. character = 'm'	7. character = 'e'	
25		0x7465		10. character = 't'	9. character = 'e'	
26		0x7220		12. character = 'r'	11. character = ''	
27		0x00E2		Sub = 0	Sub-Object Length = 7	_COUPLE Id = 2
28		0x3220		2. character = '2'	1. character = ''	
29		0x5061		4. character = 'P'	3. character = 'a'	
30		0x7281		6. character = 'r'	5. character = 'a'	
31		0x6D65		8. character = 'm'	7. character = 'e'	
32		0x7465		10. character = 't'	9. character = 'e'	
33		0x7220		12. character = 'r'	11. character = ''	
12	747435			Command length : 4		
		1	0x24E1	Side = 1	BITE id = 39	Mode = 1
		2	0x2010	Function id = 128	Command = 16 (ACK)	
13	745509			Command length : 6		
		1	0x24E1	Side = 1	BITE id = 39	Mode = 1
		2	0x2002	Function id = 128	Command = 2 (NEXT)	
		3	0x0004	Nb objects = 0	Step id = 4	
14	745697			Command length : 4		
		1	0x24E1	Side = 1	BITE id = 39	Mode = 1
		2	0x2005	Function id = 128	Command = 5 (terminate)	
15	745728			Command length : 4		
		1	0x24E1	Side = 1	BITE id = 39	Mode = 1
		2	0x2010	Function id = 128	Command = 16 (ACK)	

Tracing of the protocol communication

High-level decoding of the commands against the XML specification

# Interactive Mode

The screenshot displays the CMS380 software interface in Interactive Mode. The interface is divided into two main sections:

- Left Panel (CMS380 Version 1.3.3):** This panel contains a control interface with two columns labeled 'CMS' and 'BITE'. Each column has several input fields and buttons. Below the control panels is a large data table with columns for 'Number', 'Time', 'Word', 'Hex', 'Decoding\_1', 'Decoding\_2', and 'Decoding\_3'. A 'CLEAR DISPLAY' button is located at the bottom of this panel.
- Right Panel (CMS380 Interactive Mode):** This panel shows a menu for 'EBAS 1 Engine 1'. It includes a 'MENUS' section with a 'Specific data' button, and a 'TESTS & SPECIFIC FUNCTIONS' section with buttons for 'System test' and 'BITE MEMORY DUMP'. At the bottom of this panel are three buttons: 'MAIN MENU', 'BITE INTERFACE', and 'CMS RESET'.

# Interactive Mode

The screenshot displays the CMS380 Interactive Mode software interface. The main window is divided into several sections:

- Left Panel:** A sequence diagram showing a sequence of events. The first event is 'START' with a duration of 313 ms. The second event is 'ACK' with a duration of 28 ms. The diagram shows various signal levels and transitions.
- Center Panel:** A data table with columns: Number, Time, Word, Hex, Decoding\_1, Decoding\_2, Decoding\_3. The table contains a list of hexadecimal words and their corresponding decoded values, such as '6, character = 'Y'', '8, character = 'm'', etc.
- Right Panel:** A window titled 'EBAS 1 Engine 1 - Associated engine data'. It contains a 'System configuration' table with the following data:
 

Item	Status
Engine bleed selection	1aParemet r
Engine fire selection	2aParemet r
HPV position	3aParemet r
PRV position	4aParemet r
Sensors supply	5aParemet r
PRV controlled	6aParemet r
HPV controlled	7aParemet r

 Below the table are four buttons: 'CONTINUE', 'ABORT', 'CMS STATUS', and 'CMS RESET'.



# Interactive Mode

**CMS**    **BITE**

Number	Time	Word	Hex	Decoding_1	Decoding_2	Decoding_3
9		0x8065		8. character = 'm'	7. d	
10		0x7465		18. character = 'Y'	9. d	
11		0x7228		12. character = 'Y'	11. d	
12		0x99E2		Sub = 0	Sub-C	
13		0x3228		2. character = 'Z'	1. d	
14		0x5961		4. character = 'P'	3. d	
15		0x7261		6. character = 'Y'	5. d	
16		0x8065		8. character = 'm'	7. d	
17		0x7465		18. character = 'Y'	9. d	
18		0x7228		12. character = 'Y'	11. d	
19		0x99E2		Sub = 1	0tp	
20		0x99E1		Sub = 0	Sub-C	
21		0x3128		2. character = 'I'	1. d	
22		0x5961		4. character = 'P'	3. d	
23		0x7261		6. character = 'Y'	5. d	
24		0x8065		8. character = 'm'	7. d	
25		0x7465		18. character = 'Y'	9. d	
26		0x7228		12. character = 'Y'	11. d	
27		0x99E2		Sub = 0	Sub-C	
28		0x3228		2. character = 'Z'	1. d	
29		0x5961		4. character = 'P'	3. d	
30		0x7261		6. character = 'Y'	5. d	
31		0x8065		8. character = 'm'	7. d	
32		0x7465		18. character = 'Y'	9. d	
33		0x7228		12. character = 'Y'	11. d	

EBAS 1 Engine 1 - Associated engine data

**Torque Motor**

Valve	Current value (mA)
FAV	1aParemet r
PRV	2aParemet r

**Torque Motor**

Valve	Feedback Current Value (mA)
FAV	1aParemet r
PRV	2aParemet r

CONTINUE    ABORT    CMS STATUS    CMS RESET

# Interactive Mode

The screenshot displays the CMS380 software interface in Interactive Mode. The main window is divided into several sections:

- Configuration:** Includes tabs for Configuration, Normal Mode, and Interactive Mode.
- Trace / Monitor:** Includes tabs for Trace / Monitor, Error Injection, and Test Replay.
- CMS / BITE:** A sequence of commands and responses. The sequence includes:
  - 6: ACK (43106 ms)
  - 7: NEXT (312 ms)
  - 8: display (20 ms)
  - 9: ACK (37074 ms)
  - 10: NEXT (313 ms)
  - 11: display (20 ms)
  - 12: ACK (28074 ms)
  - 13: NEXT (188 ms)
  - 14: terminate (31 ms)
  - 15: ACK
- Data Table:** A table with columns: Number, Time, Word, Hex, Decoding\_1, Decoding\_2, Decoding\_3. It contains hexadecimal data and decoded character sequences.
- Inset Window:** Titled 'EBAS 1 Engine 1', it displays 'TEST SUCCESSFULLY ACHIEVED' and three buttons: 'MAIN MENU', 'BITE INTERFACE', and 'CMS RESET'.

Number	Time	Word	Hex	Decoding_1	Decoding_2	Decoding_3
22		0x5061		4. character = 'P'		
23		0x7261		6. character = 'r'		
24		0x6D65		8. character = 'm'		
25		0x7465		10. character = 't'		
26		0x7220		12. character = 'r'		
27		0x00E2		Sub = 0	Sub-0	
28		0x3220		2. character = '2'		
29		0x5061		4. character = 'P'		
30		0x7261		6. character = 'r'		
31		0x6D65		8. character = 'm'		
32		0x7465		10. character = 't'		
33		0x7220		12. character = 'r'		
12	717435			Command length : 4		
		1	0x24E1	Side = 1		
		2	0x2010	Function id = 128	Com	
13	745509			Command length : 6		
		1	0x24E1	Side = 1		
		2	0x2002	Function id = 128	Com	
		3	0x0004	Nb objects = 0		
14	745697			Command length : 4		
		1	0x24E1	Side = 1		
		2	0x2005	Function id = 128	Comma	
15	745728			Command length : 4		
		1	0x24E1	Side = 1		
		2	0x2010	Function id = 128	Com	

# Error Injection

- ➔ Configuration of erroneous handshaking (ACK response to BITE commands and test results transmission)
- ➔ Transmission of erroneous CMS commands (errors in header + body)
- ➔ Precise definition of the timing for CMS and BITE responses

The screenshot displays a configuration interface for error injection, divided into several sections:

- HANDSHAKING**: Includes checkboxes for "Handshaking response to BITE" (checked), "send HOLD instead of ACK", "send RACK instead of ACK" (checked), and "ignore command (no ACK)". It also features a "Repeat count" field and "Concerned BITE commands" (display, wait, status, terminate) with "Test Results" and "download" options.
- TIMING**: Contains four timing configuration blocks, each with a waveform diagram and a "Current value" field:
  - CMS ACK (spec. 500 ms): Current value 2458
  - BITE commands (spec. 2 s): Current value 2888
  - First test result (spec. 500 ms): Current value 588
  - All test results (spec. 3 s): Current value 588
- CMS STATUS**: Includes a "Status value" field (set to 11) and "Status words" (Word 1, Word 2, Word 3) fields.
- COMMANDS TRANSMISSION**: A large section with multiple "Send erroneous..." options, each with a "Value" field and "Repeat count" field. Options include "Send wrong command length", "Set BIT bit to 0", "Send erroneous side", "Send erroneous BITE identifier", "Send erroneous function id", "Send erroneous current step id", "Send erroneous number of objects", and "Send inconsistent objects". Each option has "Concerned CMS commands" (START, NEXT, STATUS, ABORT, ACK, HOLD) and "Apply to" (\_QUESTION, \_REPLY, \_ASCRENTRY) fields.

Buttons at the bottom include "Submit changes", "RESET", and "Dismiss changes".

# Modes of Operation

## User Mode

EBAS 1 Engine 1 - Associated engine data

Temperature sensor

Sensor	Value
Associated temperature	1aParemet r

Pressure sensor

Sensor	Value
Bleed pressure	1aParemet r
Intermediate port pressure	2aParemet r
Differential pressure	3aParemet r
Monitoring pressure	4aParemet r

CONTINUE ABORT CMS STATUS CMS RESET

## Scripting Mode

```

alarm <Z>
# export API functions
from API.OS import *

# create an instance of the class OS_API for BITE interface 1
BITE_IP1 = OS_API (1)

# put OS simulation in scripting mode
OS_mode = cvt_unsetfak_slot("OK_commands|InteractiveModeActive", cvt_MRITE)
OS_mode.set ( 2, )

# return to IDLE state (ready for new test)
BITE_IP1.reset_OS ( )

# reply the receive queue
while BITE_IP1.get_BITE_command ( ) :
    pass

# now start test id 01 with bite identifier 026 and code 0
BITE_IP1.prepare_START (BITE_identifier=026, sidem, function_id=0)
BITE_IP1.send_command ( )

# get BITE response
resp = BITE_IP1.get_BITE_command ( )

cmd_type, OS_ack, command, testid = resp

if OS_ack == 1:
    cmd_type = 0:
    # process BITE command
    ret = BITE_IP1.process_BITE_command ( command )
    header, body, status = ret
    # dump command code
    print "Command code: %d" % header.command_code
    while cmd_type == 1:
        # process test result
        ret = BITE_IP1.process_test_result ( command )
        # dump counters
        print "Current counter: %d %s. Total counter: %d" % (ret.current_counter, ret, ret.total_counter)

# request next step of test / specific function
BITE_IP1.prepare_NEXT ( )
BITE_IP1.send_command ( )

# get BITE response
resp = BITE_IP1.get_BITE_command ( )
    
```

## Replay Mode

REPLAY SETUP

Creator: \_\_\_\_\_  
Description: \_\_\_\_\_

Number	Name	Tests	Specific functions	ABORT Sequence	Error Injection
1	PW programming	1	0		
2	System Test	0	1		
3	Engine BIVA	1	0		
4	System Test	0	1		

PLAY PAUSE STEP RESET

REPLAY RESULTS

Number	Test Status	Sequence of commands / responses	Test Results expected	Status
1	SUCCEEDED	IDENTICAL	1	IDENTICAL
2	SUCCEEDED	IDENTICAL	1	IDENTICAL
3	SUCCEEDED	IDENTICAL	1	IDENTICAL
4	FAILED	DIFFERENT	1	DIFFERENT

## Web front-end

user interaction ★★★★★

automaticity ★☆☆☆☆

error injection ★★★★★★

## Python API supporting all operations

user interaction ★★★★★

automaticity ★★★★★

error injection ★★★★★★

## AutomaGic replay of recorded tests

user interaction ★☆☆☆☆

automaticity ★★★★★

error injection ★★★★★★



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