

Use of MCM Smart HTCC technology Application to Astrium Space Digital Products

ESA, 3 May 2006

DAD 1.01.09

PRESENTATION OVERVIEW

- Why MCM technology?
- Short products description
 - MCM ERC32 (dual cavity product)
 - MCM DSP (single cavity product)
- Qualification status
 - DAD 1.01.09: Approval of Astrium F MCM Smart HTCC Technology

WHY MCM TECHNOLOGY :

- MCMs are leading edge technologies for miniaturisation of space electronics equipment offering:
 - High integration
 - High performances
 - Hi rel parts
- According to their properties, Hybrids and MCM are different solutions for integration on ceramic substrates:
 - Hybrids thick film technology
 - MCM modules : Routed HTCC (high temperature ceramic cofired) package

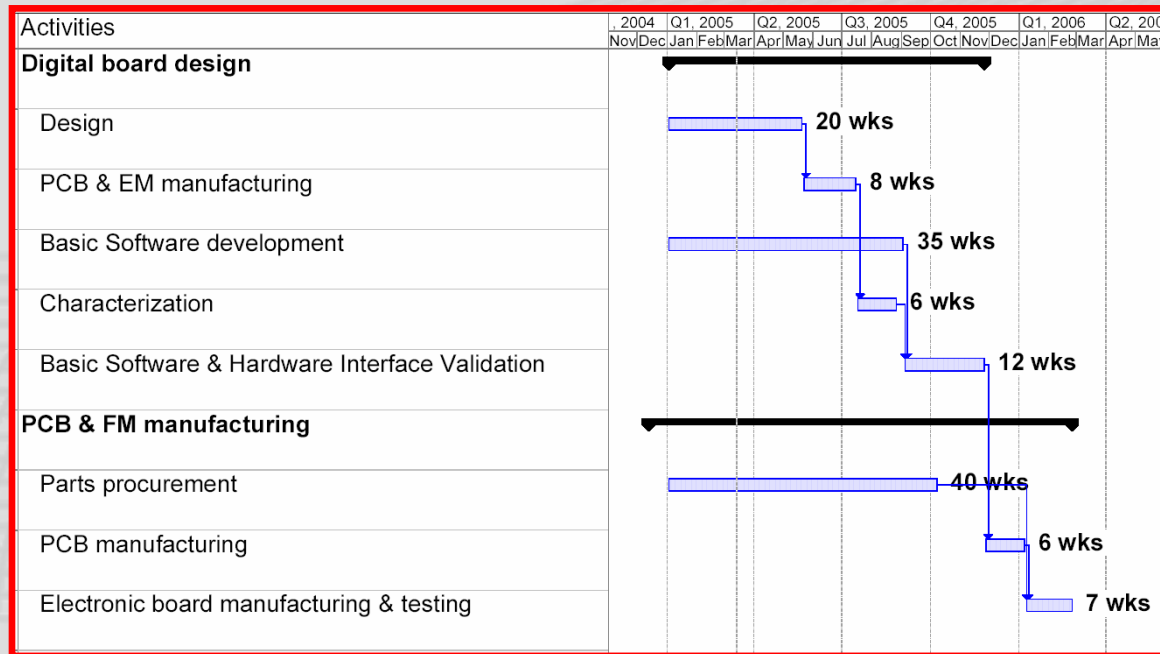


WHY MCM TECHNOLOGY :

a technology compliant with space requirements in terms of performances and costs

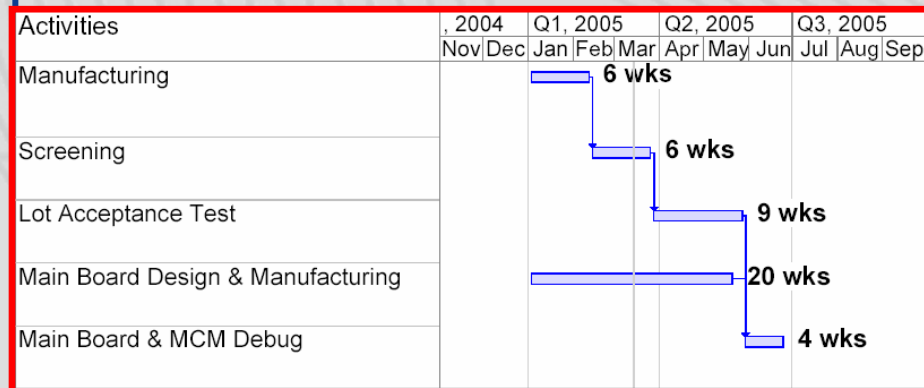
Interest Mission ↘	Full HIREL	Mass & Volume	Low NR cost	Reduced Schedule
Science	X	X	X	X
Observation			X	X
Telecom	X	X		X
Galileo		X	X	X

WHY MCM TECHNOLOGY : *an improved development schedule*



MCM Technology allows to reduce schedule of processor core development by a 2-factor thanks to:

- Generic architecture / turnkey core computer
- Available low/mid levels software
- No need for basic S/W validation
- Available validation tools



**READY FOR CUSTOMER
SOFTWARE DEVELOPMENT**

WHY MCM TECHNOLOGY : *a true advantage for space industry allowing technical solutions*



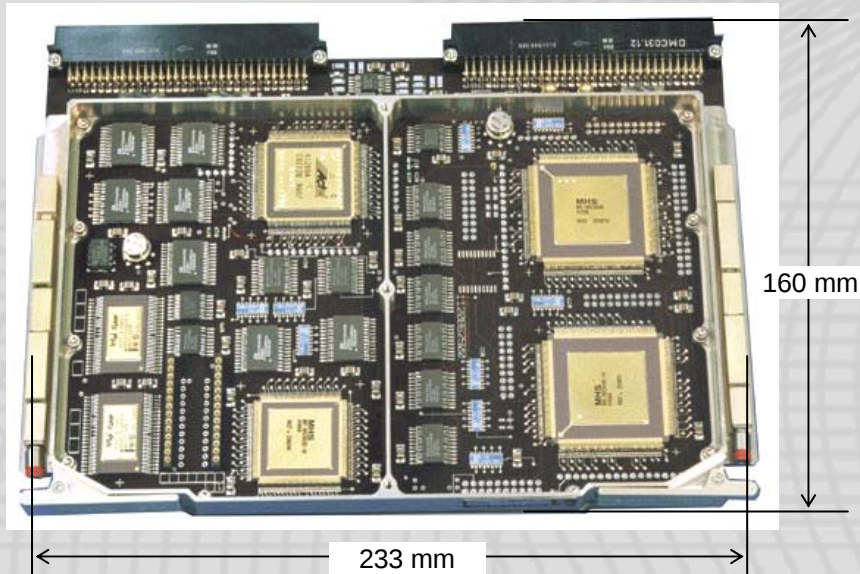
- Full Hi-Rel Parts :
 - packaging of non Hi-Rel parts (*DRAM/SRAM commercial parts, die evaluation 38 pieces according to PSS-01-608*).
- Packaging of components with a great number of pins :
 - Not reachable by classical mounting technology, qualified up to 472 pins
 - ASIC VASI : 500 pins, ASICs/VLSI beyond 400 pins are authorized
- A common HW architecture for different applications allows to develop common Software tools or applications : low level SW, middleware SW with a accumulated experience and heritage.

MCM TECHNOLOGY : *contribution to system performances*

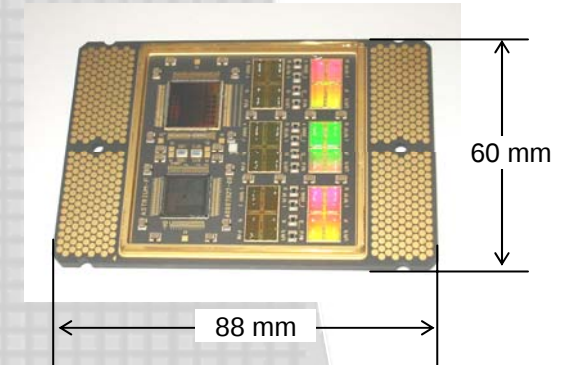
- Higher Integration (*INMARSAT 4 payload was achievable only because of MCM*)
- Building block which decreases non recurring tasks and encourages prime to use the function as it exists
- EMC sensitivity is reduced
- Possibility to upgrade COTS to Space quality level
- Time to market (product of the shelf)
- Technical packaging answer to complex components as ASICs (500 I/Os)

MCM ERC32

The MCM ERC32 : A highly integrated Processor Core



CPB board (ERC32 14 MHz, 16 Mo SRAM, $m < 600\text{g}$
 $S = 37\,280\text{ mm}^2$)



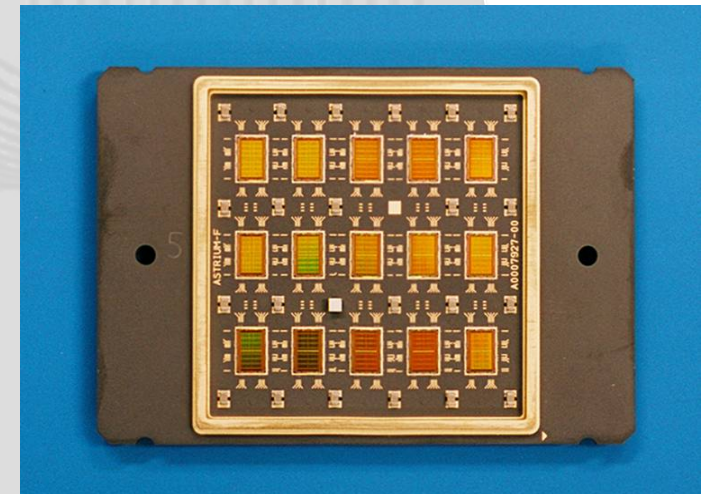
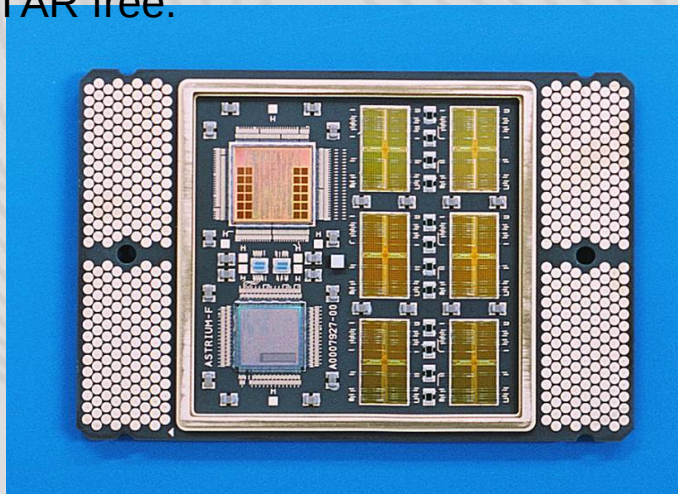
MCMERC32 (ERC32 25 MHz, 32 Mb DRAM, 6 Mb SRAM, $m = 150\text{ g}$, $S = 5280\text{ mm}^2$, 0 WS)

- **Integration of a CPU/DSP function including the memory in a single package Multi-Chip Module:**

- To deliver a fully hardware & software validated function
- To save space & mass for other functions

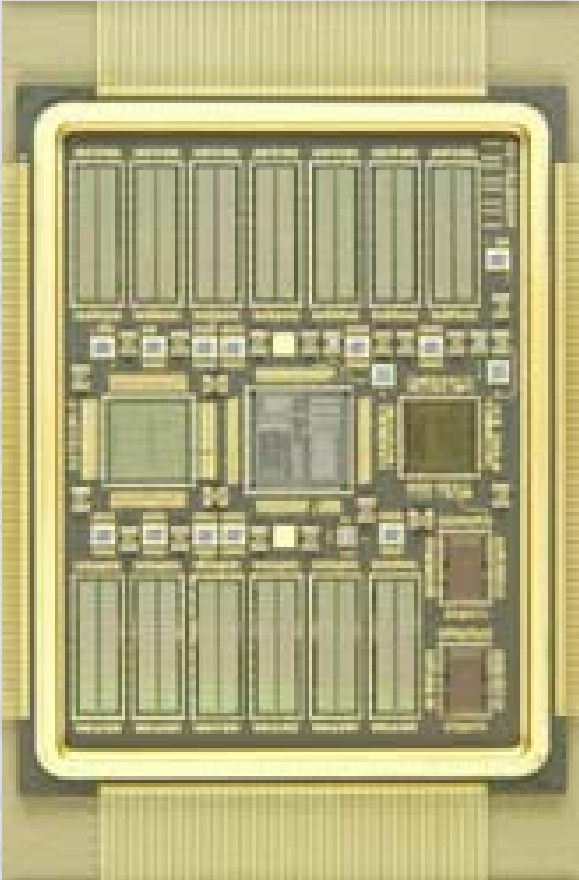
Dual cavity product: MCM ERC32

- The MCM ERC32SC is a very integrated solution providing a processor core that embeds the ERC32SC, its companion chip and memories
- The MCM ERC32SC main features are :
 - Processing core capabilities : Based on ERC32SC SPARC microprocessor, 25 MHz / 20 MIPS 48 Mbytes of protected memory (6Mbytes for instruction, 32 Mbytes for data) - Coprocessor (incl. MIL-STD-1553 interfaces, general User Extension Interface, serial links, RTC, ...).
 - Low mass : 110 g and low power consumption : 12 W.
 - Radiation Tolerant 30 Krad (can be improved by shielding).
 - Full Hi-Rel parts : hi-rel upgrade of commercial parts
 - ITAR free.



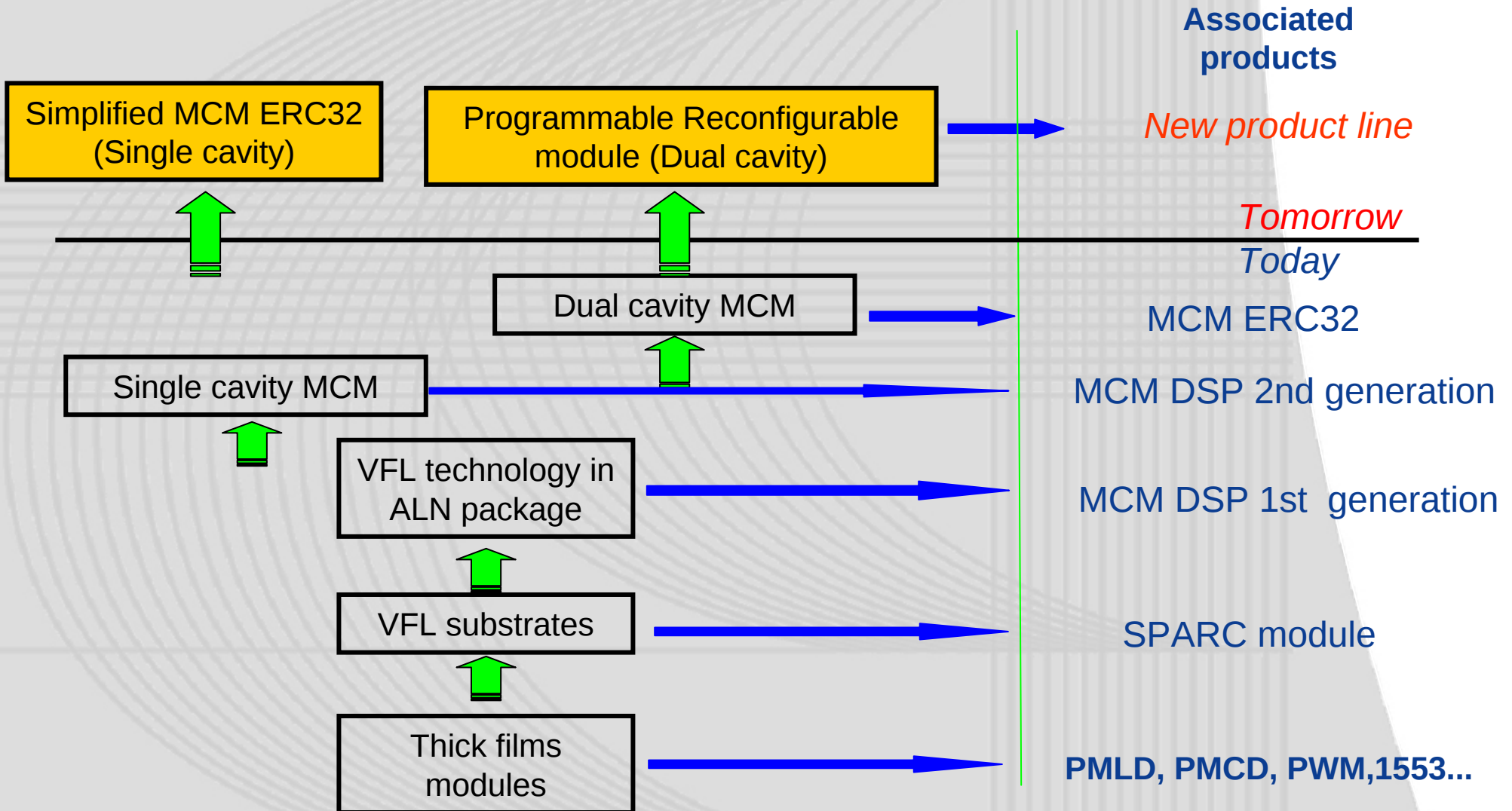
MCM DSP

MCM DSP21020: an integrated DSP21020 core



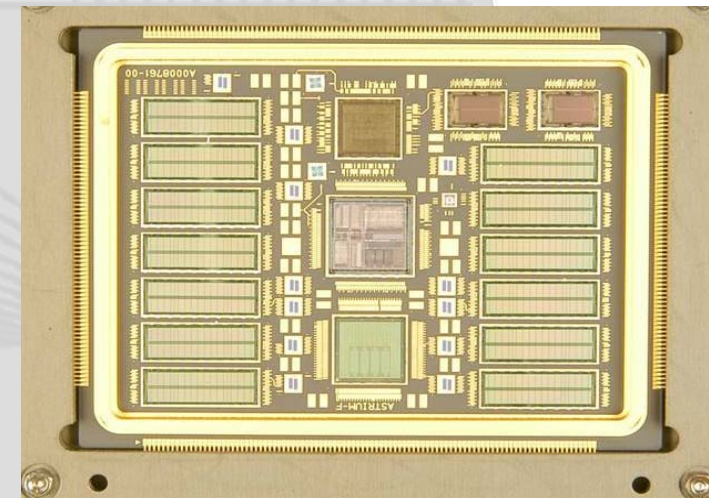
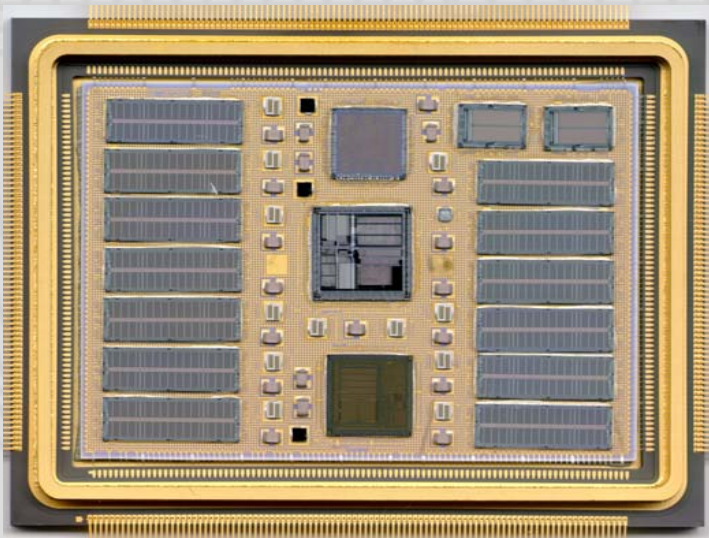
- **DSP21020 Core including:**
 - **Program & Data memories,**
 - **EDAC protection**
 - **16 bit versatile I/O port (serial & parallel I/O interface, UART, pulse generator),**
 - **40 bits user interface,**
 - **1355 links.**
- **Single cavity cofired multi-layers ceramic package**
- **IHD & QFP packages available**
- **Compliance with the Space Qualification Level & Quality Rules (development & manufacturing)**
- **Radiation Tolerant Technology : 30 Krads**
- **Operating temperature range (case temperature) : -55°C to +85°C**
- **Watt: 5 W @ 15 MHz**
- **Power voltage : 5 V**
- **Status in EPPL issue 6: in part 2**

MCM TECHNOLOGY ROADMAP



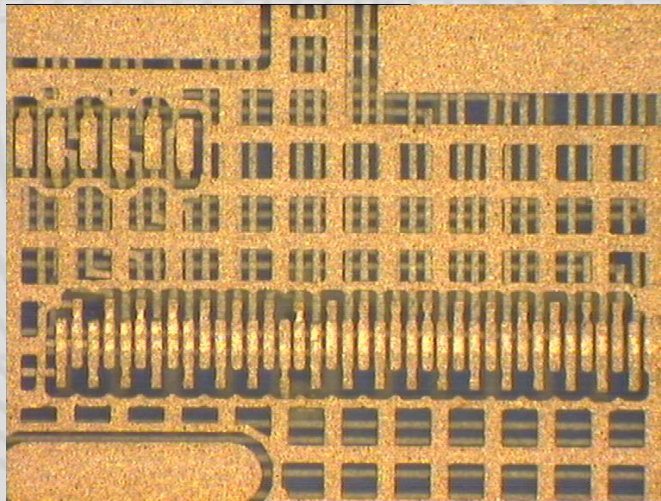
Single cavity product: MCM DSP

- First generation of MCM has permitted to adjust the design with the help of an internal technology issued from hybrids (Very Fine Lines)
- Second generation of MCM shows a reduction of the number of interface and a robustness in the substrate production
- Assembly process is quite the same

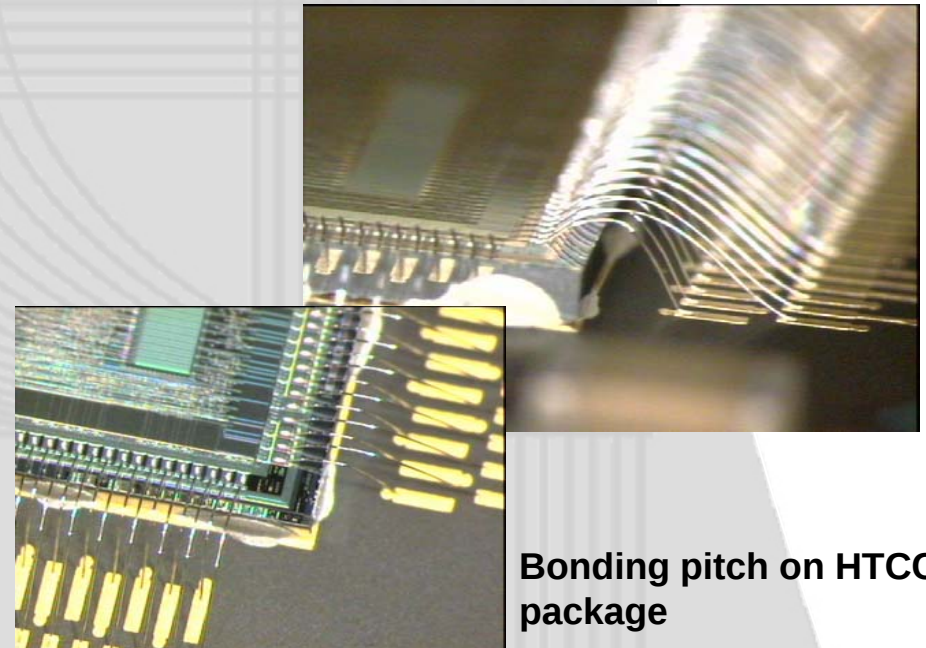


Dual cavity product: MCM ERC32

- Some technological differences between VFL and HTCC packages
 - Accuracy of HTCC is a little less than VFL process:
 - Bondings of large dice are on 2 rows instead of one
 - VFL process is a “5“layers” max as average for HTCC is “12 layers”



Bonding pitch on VFL



Bonding pitch on HTCC package

Qualification status

DAD 1.01.09

Methodology

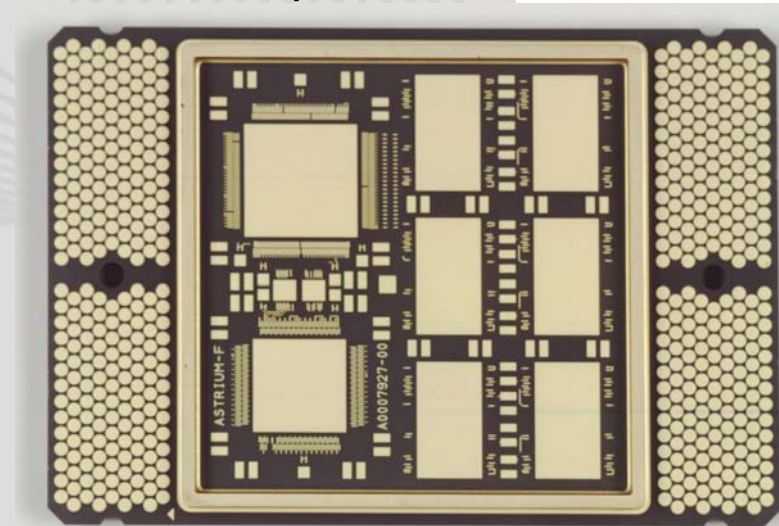
- Two steps :
 - Evaluation phase:
 - Plan ref. HYB.MCM.NT.00421.V.ASTR
 - Qualification phase :
 - Plan ref. HYB.MCM.NT.00415.V.ASTR

Objectives

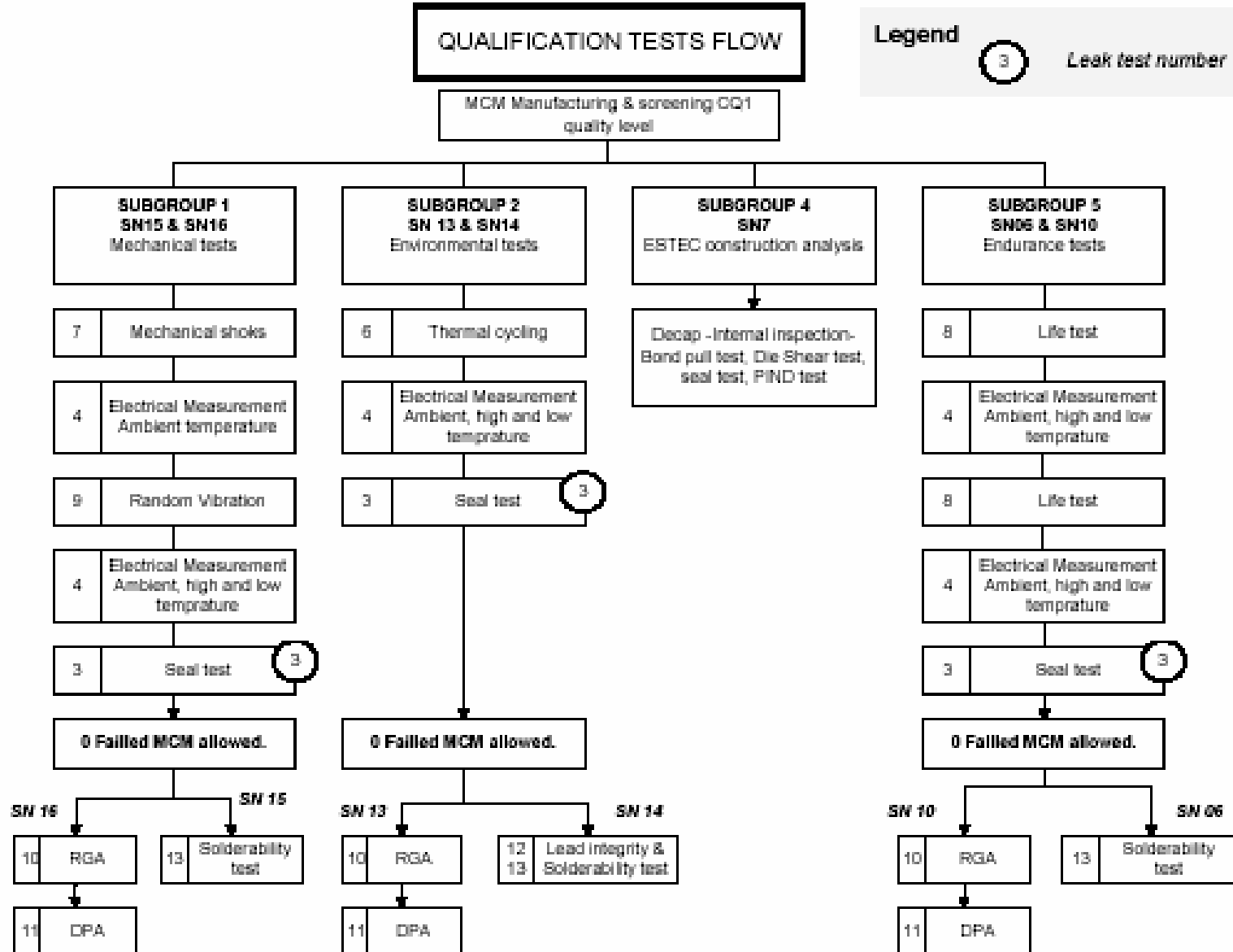
- to identify new processes, new technologies for smart HTCC MCM
 - to define an evaluation flow and a qualification flow
 - to get ESA approval on work flow
 - to realise trials and provide in time results to ESA/CNES experts
 - to deliver qualification reports
 - to get ESA/CNES approval
- **Domain of qualification: single and dual cavity MCMs**

Evaluation tests flow

- Processes to be evaluated were:
 - AlN HTCC packaging (Kyocera manufacturer)
 - Gluing of microchips on AlN substrate with epoxy glue and repair process evaluation
 - Gluing of large dice on AlN substrate with thermoplastics glue and repair process evaluation
 - Al wire bonding of microchips on AlN
 - Al wire bonding of resistive network (thin film on Al₂O₃)
- *All the tests gave satisfying results*



Qualification tests flow



Item Nb	Test description	Test Method	Conditions / Remarks
1	Bond pull test	Mil 883/2011	Condition D
2	Internal visual inspection	Mil 883/2017	Classe K
3	Seal test Fine leak Gross Leak test	MIL-STD-883 Method 1014 A2 PFH038	Pressure of exposure : 1.5 bars Time of exposure : 21 h
4	Electrical measurement	Detailed specification MCM-DSP-SPEC-DA0018353-V- ASTR	
5	Screening	PID GM.HYBR.NT.879.V.ASTR Edition :02 Rév. :02	Detailed in the table of the §4.4
6	Thermal cycling	MIL-STD-883 Method 1010	Condition B : -55°C / +125°C 100 cycles
7	Mechanical shocks	MIL-STD-883 Method 2002	5 shocks 1000g, 0.5 ms along Y ₁ axis
8	Operating life test	MIL-STD-883 Method 1005	2000 h @ +125 °C Electrical measurements at low, ambient and high temperatures are performed at 1000h and 2000h. With parameters drift calculation to be performed on electrical measurements results at ambient temperature.
9	Random vibrations		In each of the orientations X, Y and Z 0 – 2000 Hz : 1.25 g ² / Hz Global = 50 gRMS Duration : 120 s

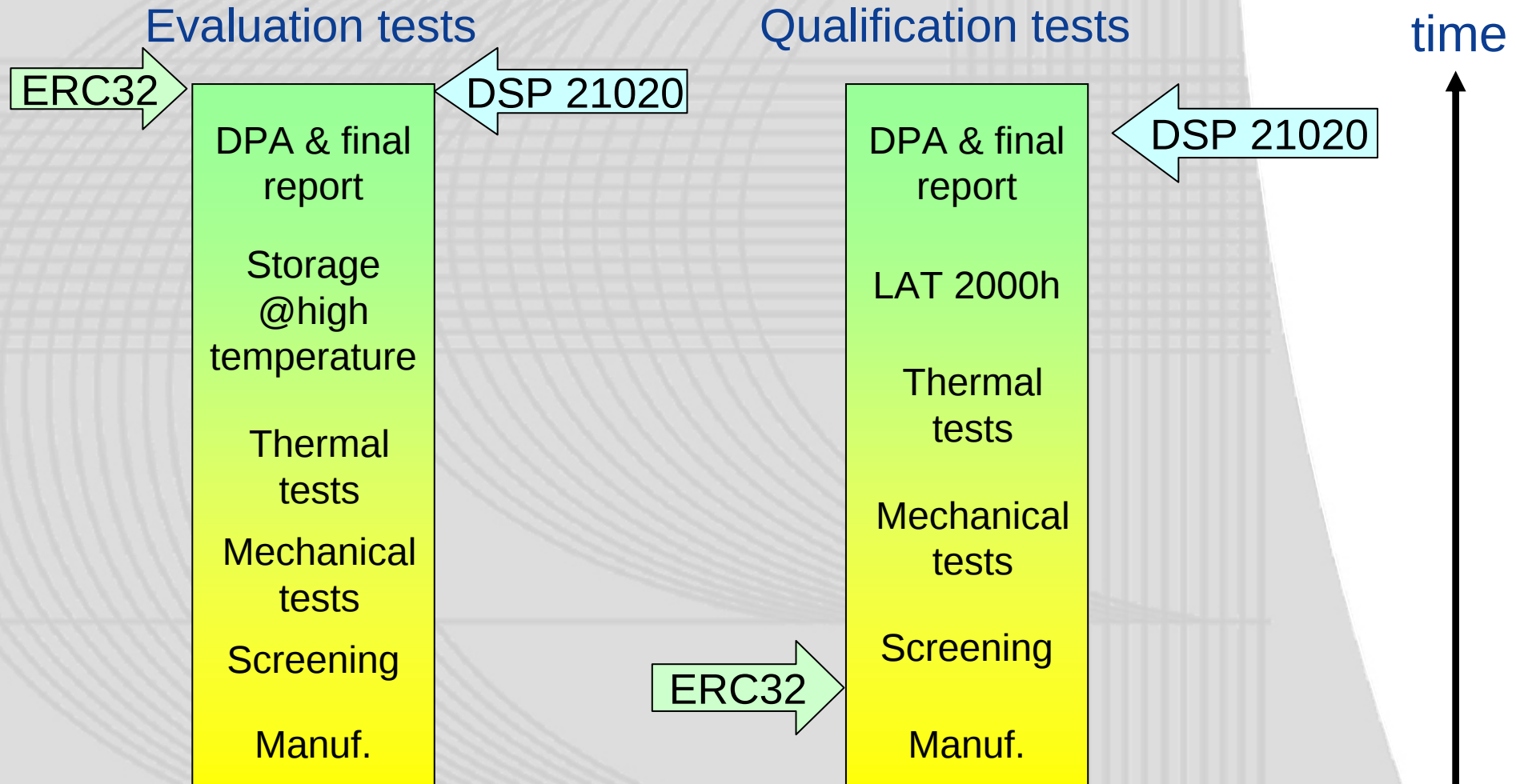
Item Nb	Test description	Test Method	Conditions / Remarks
10	RGA	MIL-STD-883 Method 1018 Procedure 1	5000 ppmv H ₂ O maxi. allowed + record of other gas species
11	DPA External visual inspection Seal test :Fine leak Gross leak PIND test Internal visual inspection Bond pull test Die shear test	MIL-STD-883 Method 2009.8 MIL-STD-883 Method 1014 A2 PFH038 MIL-STD-883 Method 2020 MIL-STD-883 Method 2017 MIL-STD-883 Method 2011 MIL-STD-883 Method 2019	Condition A Class K Condition D / Pull all wires Shear all chips
12	Lead integrity	MIL-STD-883 Method 2004	Condition B2
13	Solderability test	MIL-STD-883 Method 2003	

Parts distribution for evaluation and qualification

Test file	ESA-PSS-01-606 requirements	EVALUATION		QUALIFICATION
		Quantity of test structure	Quantity of daisy chained parts	Functional parts
Sub-group 1	3 DSP + 3 ERC32	2 DSP + 2 ERC32	-	2 DSP + 1 ERC32
Sub-group 2	3 DSP + 3 ERC32	2 DSP + 2 ERC32	2 IHD 400 + 1 334BR	2 DSP + 2 ERC32
Sub-group 3	2 DSP + 2 ERC32	-	-	-
Sub-group 4	1 DSP + 1 ERC32	-	-	1 DSP + 1 ERC32 (mechanical samples)
Sub-group 5	6 DSP + 6 ERC32	-	-	2 DSP + 2 ERC32
Sub-group 6	3 DSP + 3 ERC32	1 DSP + 1 ERC32	2 IHD 400 + 1 334BR	-

MCM PRODUCT LINE QUALIFICATION: SCHEDULE

Status today



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Status today

