



Texas Instruments

Rad Tolerant Digital Signal Processors

ESA Workshop on Avionics Data, Control and Software Systems

The **HiRel**
Difference

Ioannis Tsikouris-Willgers
ioannis@ti.com



Overview of TI HiRel Division

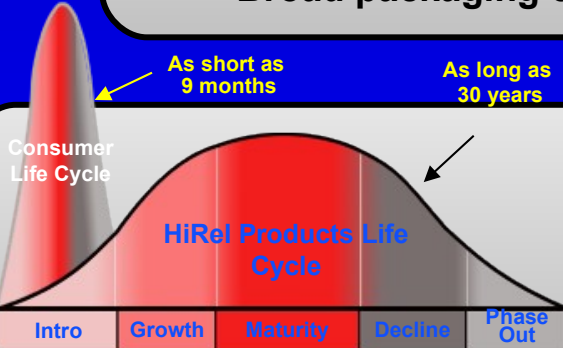


Commitment

- 30+ years of experience working with HiRel customers
- Largest dedicated organization in the industry
- Worldwide sales and support infrastructure

Leading-edge technology and manufacturing

- HiRel approved fabs (certified by Defense & Aerospace standards)
- Access to latest process technologies (HPA07, BiCom, etc.)
- Broad packaging capabilities



Extended product life cycles

- Obsolescence mitigation
- Supply beyond commercial availability
- Product resurrection



Market expertise

- Baseline control and qualification per unique market requirements: TID, SEU, high-temp, ceramic, QML -Q/V, EP, die solutions, etc.





HiRel Focus Segments

Space

- *Supplier of choice at target customers*
- *Differentiated Signal Chain Solutions*
- *R&D – Process / Design Modification*
- *Ceramic Packaging*

Avionics

- *Supplier of choice at target customers*
- *EP Plastic Solutions (low temp req)*
- *Market driven RTPs*
- *Obsolescence Mitigation*

Defense

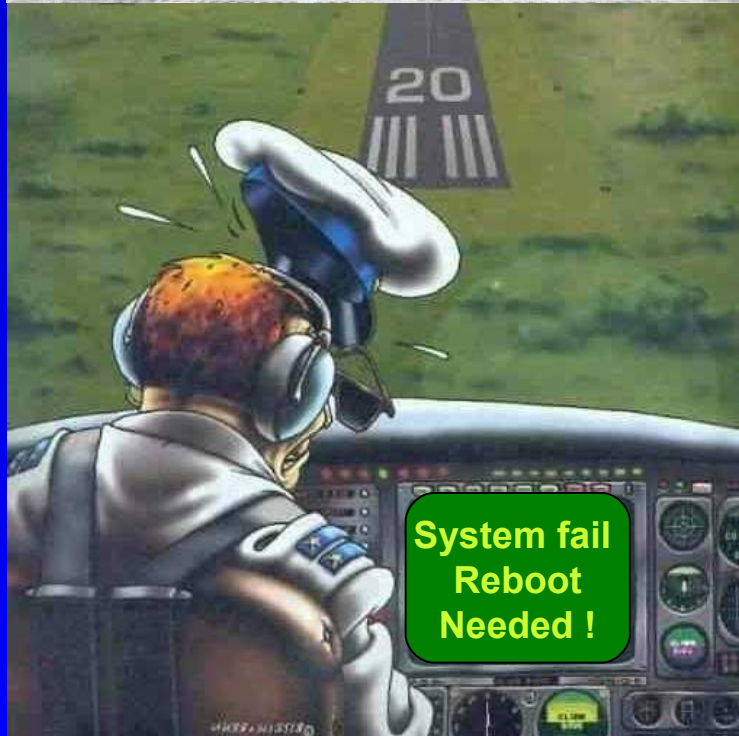
- *Supplier of choice at target customers*
- *EP Plastic Support*
- *Market driven releases*
- *Sustained Support for Legacy Business*

Enhanced Products

- *Qualification*
 - Extended Temperature
 - One Lot Date Code
 - Customer specified screening
 - Burn In, ext HAST
- *KGD*
- *Custom Packaging*
- *Down Hole Drilling*



Some Systems have a High concern for Soft Error Rates and Latch-up



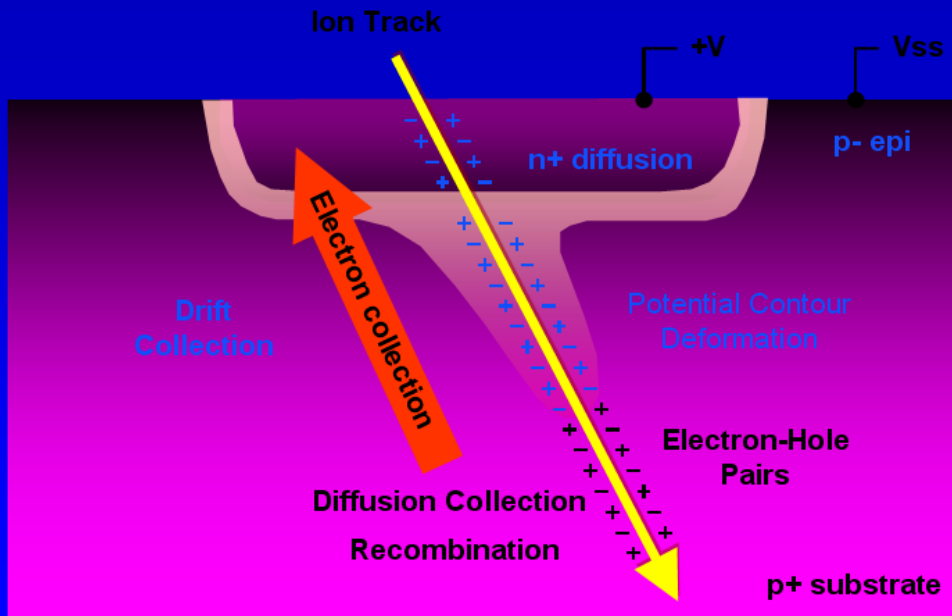
SER < 100 FIT/chip

Mission critical or safety critical systems typically require very low failure rates



Junction Charge Collection From Heavy Ions

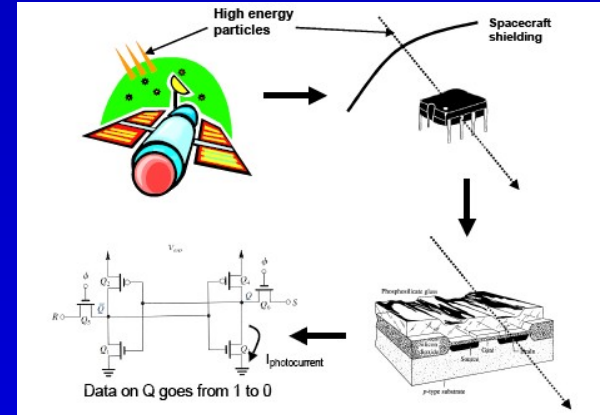
Cosmic Rays (Heavy Ions) transverse space, generated from the Sun or exploded stars from deep space. Energies can range from a few MeV to GeV.



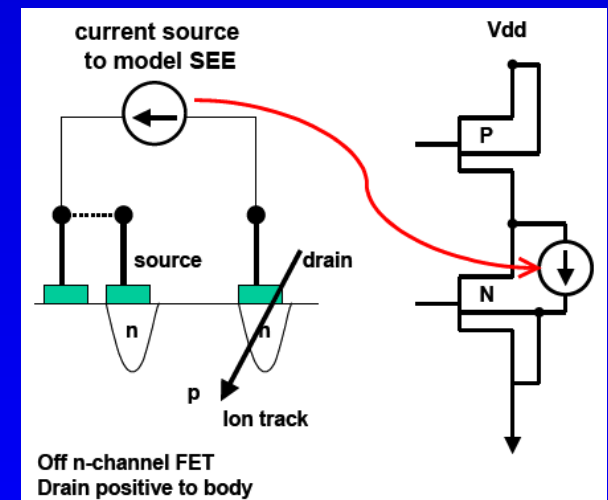
SEE – Single Even Effects

- SEU – Single Event Upset
- MBU – Multiple Bit Upset
- SEL – Single Event Latchup

Space Products must be SEL Free !!!



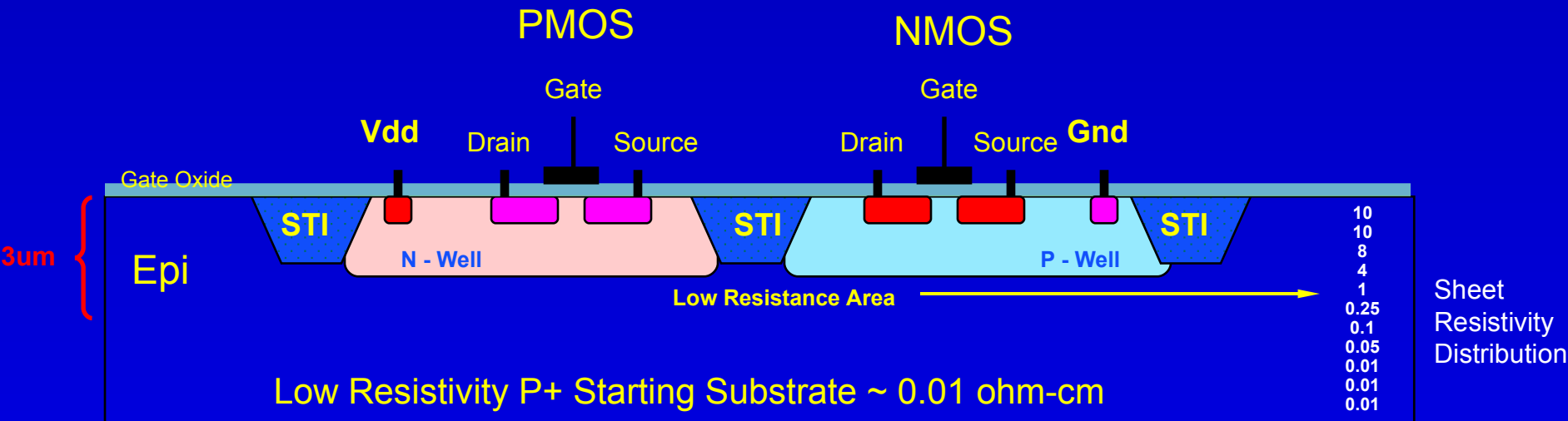
Heavy Ions pass through spacecraft, electronics, etc.



Deposited charge can range upward in the 10's of pico-coulombs causing bit flips and circuit upsets. (SEU)



EPI Approach for Improving Latch-up Tolerance



A low resistivity starting substrate (0.01 ohm-cm) is used, and then a higher resistance Silicon Epitaxial film (Epi) is grown (10 ohm-cm) to enable working CMOS. Commercial practice would just use a 10 ohm-cm bulk substrate. Parasitic SCR action between the various P/N junctions is greatly reduced improving tolerance against latch-up with EPI approach.

The approach of using a layer of low resistivity below the CMOS wells to reduce latch-up has been in use for many years. It is critical that EPI is not too thick, and the EPI and substrate resistivities are optimized. This approach works well for Heavy Ions or Neutron induced latch-up.



Product Qualification Options

**QML Class-V
(Space)**

Ceramic Packaging, Temp Range (-55C - +125C), Market Segments– Satellite, Telecommunications, DSCC, Aerospace, NASA approved Class V flows.

QML Class Q

Ceramic & KGD Packaging, Temp Range (-55C - +125C), Market Segments– Defense & Aerospace, Telecommunications, class Q flow

**Mil Temp
Ceramic**

Ceramic Packaging, Temp Range (-55C - +125C), Market Segments– Industrial, Defense and Aerospace

High Temp

Ceramic & KGD Packaging, Temp Range (+210C), Market Segments– DHD, Aerospace, Automotive

**Enhanced
Products**

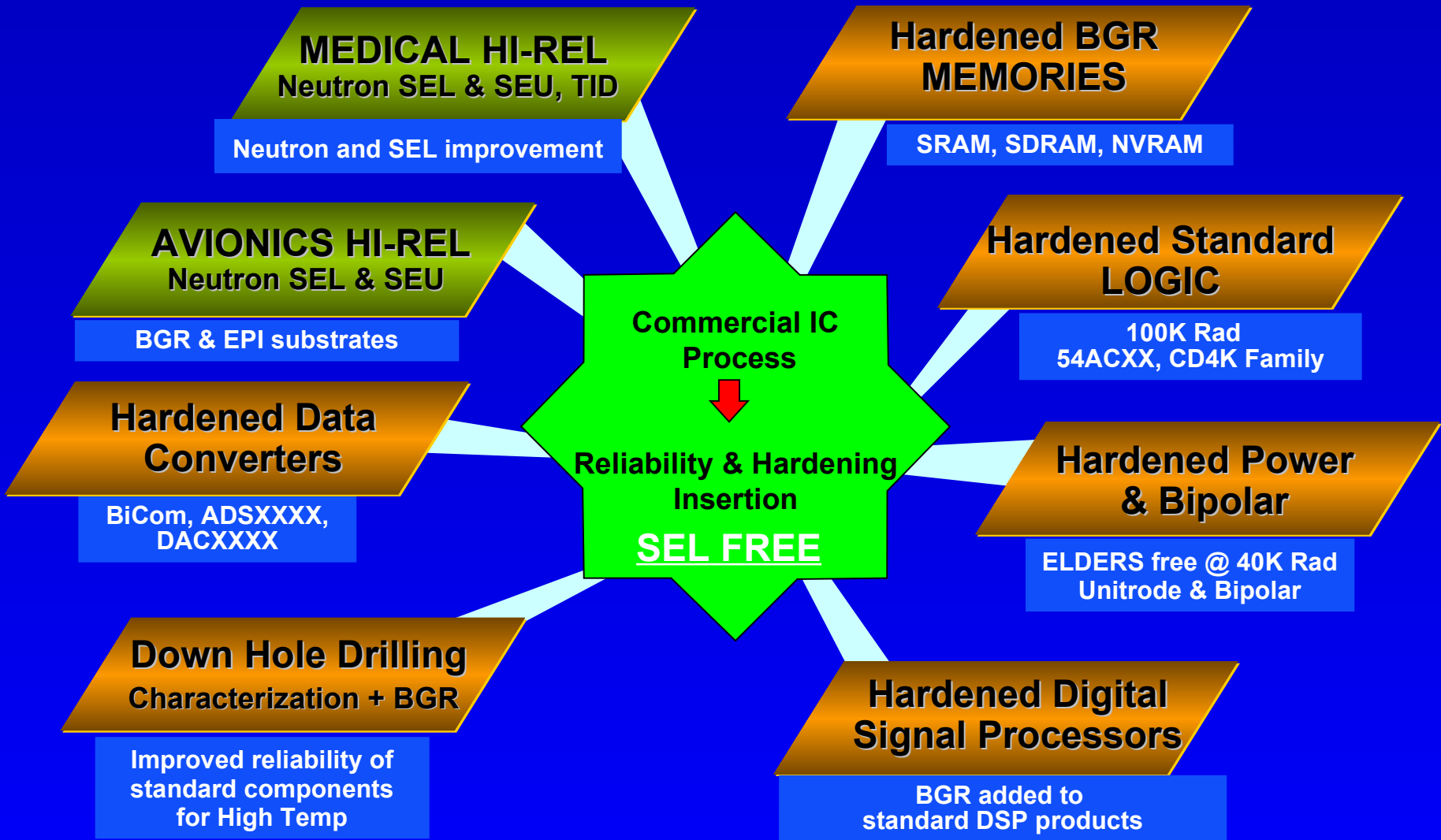
Plastic Packaging, Wide Temp Range (-55C - +125C), Market Segments – Industrial, Medical, Oil Exploration, Defense and Aerospace

**Die/Wafer
KGD**

Bare Die, Various Temp Range (-55C - +210C), Market Segments – Commercial, Industrial, Medical, DHD, Defense and Aerospace



Strategy for TI HiRel Products





Floating-Point DSP HiRel Roadmap

100% Software Compatible

Increasing Performance

Device



Production



Sampling



In Development



Future

1.26V Core
0.82W CPU @
200MHz

1.26V Core
0.6W CPU

C67x+™
Next

C6727B
300/275
MHz

C6726B
266MHz

QML-V
(Planned)
Ceramic

C6713B
200MHz

C6711D
167MHz

C6712D
167MHz

C6713B
200MHz

Ceramic
(Planned)

1.9V Core
1.7W CPU Max
2.5W incl. I/O

QML-V
Ceramic

C6701
167 MHz

C31
80 MHz

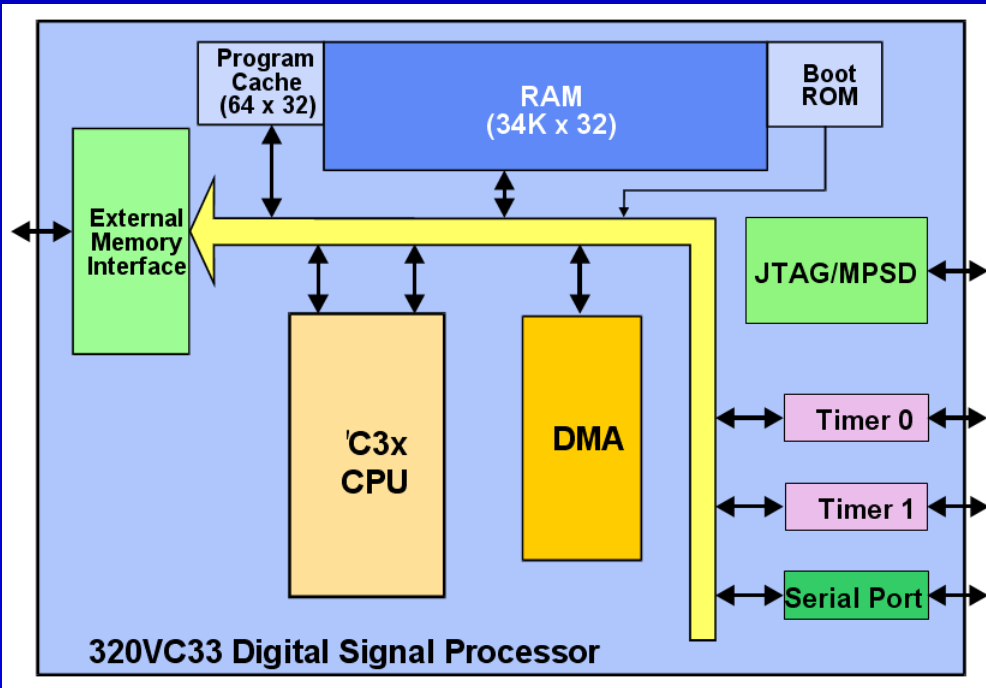
VC33
60/75 MHz

Ceramic

C31/C32
60 MHz



TMS320VC33 DSP



Commercial EVM Available

- 150 MFLOPS/75 MHz
- C07 Process , 4 LM
- 1.1 Megabit on-chip SRAM
- Low 200 mW Power Dissipation (core)
- 3.3-V I/O, 1.8-V Core
- C31 Peripheral Set for ease of migration
- Code compatibility with C30, C31, C32
- Adds JTAG Scan Chain
- x5 PLL Clock Generator 44 Ceramic BGA GNM) 12 mm x 12 mm, 0.8-mm pitch, non Hermetic & Hermetic
- 164 NCTB CQFP

Radiation Performance:

- TID = 300K rads(si)
- No SEL @ 125MeV & 150C

Hardened Prototypes Available 1Q10
 Customer must drive QMLV Qualification



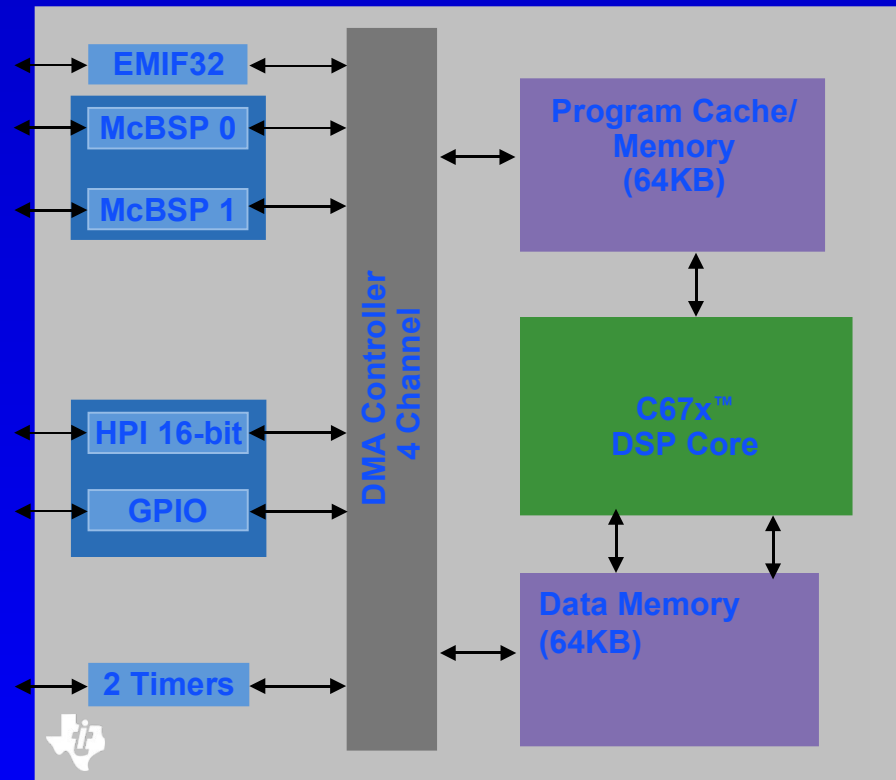
TMS320C6701

Features

- C67x™ Core
 - 0.18 μm CMOS with EPI
- Memory
 - 128 Kbytes On-Chip Memory
- Peripherals
 - Two Multi-channel Serial Ports (McBSP)
 - Up to 256 channel each
 - Direct interface to T1/Ei, MVIP, SCSA framers
 - AC-97 and SPI-compatible
 - 32 bit EMIF; 16-bit HPI
- Package: 429 Ceramic BGA, 27 mm, 1.27 mm Ball Pitch
- Temp Range: -55 C to 125 C
- QML Class-V 2Q2010

Radiation Performance

- ☐ Total Dose > 100krad(Si)
- ☐ No SEL @ 85MeV



Commercial EVM Available

Prototypes Available 1Q10



SM320C6727B DSP

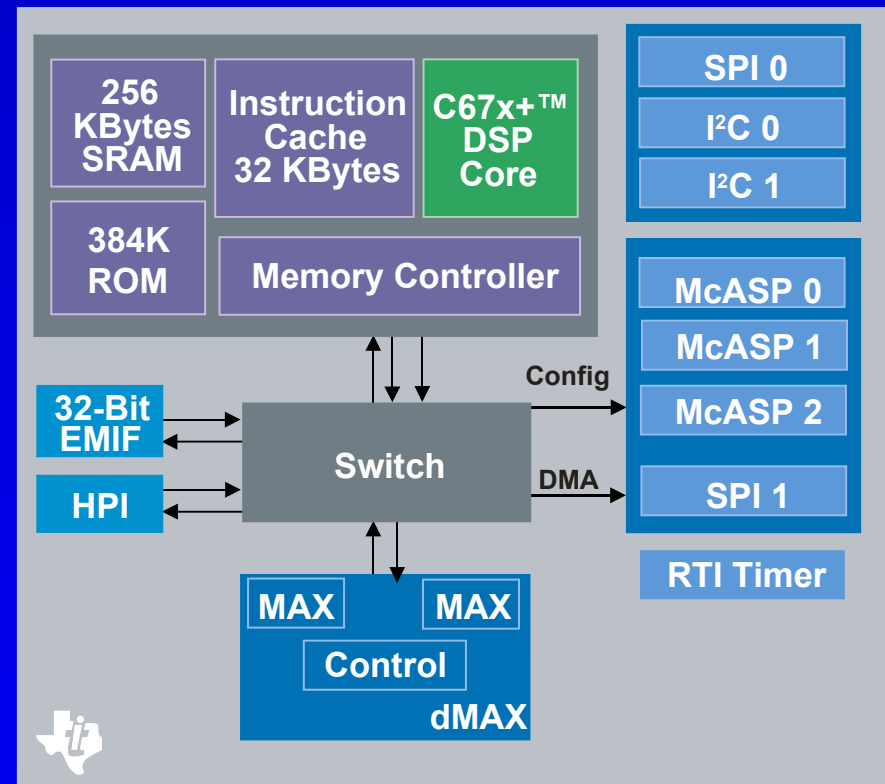
Highest-Performance Floating-Point Processor

Features

- New C67x+™ DSP Core
 - 275/300 MHz; 1650/1800 MFLOPS
- Memory
 - 256 KB of SRAM and 32 KB of I-Cache
 - DSP/BIOS™/DSPLIB/FastRTS Library included in the device
- Peripherals
 - 32-bit HPI for Connecting to Hosts
 - dMAX Support for 1D, 2D, 3D Transfers
 - as well as Multi-Tap Memory Delay
 - Three McASPs
 - Two I²C, two SPIs, 133 MHz/32-bit EMIF
- 256-Pin
- Ceramic QFP or LGA
- Expected Radiation Performance:
 - TID = 300K Rads
 - NO SEL
 - High tolerance to SEU

Applications

- Military and Aerospace
- Biometrics, medical, industrial



Commercial EVM Available

Prototypes Available 2Q10
 Planned QMLV Qualification 3Q2011



Floating Point DSP Comparison

	C6701B 167 MHz	C6713B 200 MHz	C6727 250 MHz
MIPS	167 x8= 1336	1600	2000
MFLOPs	1000	1200	1500
Architecture	C67x	C67x	C67x+
Memory	64KB Data Memory 64KB Program Memory	4KB L1-P, 4KB L1-D, 256KB L2 Cache/SRAM	32KB L1-P, 256KB L2 SRAM, 384KB ROM
HPI	HPI-16	1 32/16-bit	1 UHPI 32/16-bit
EMIF	100MHz 32-bit (SDRAM)	100MHz 32-bit (SDRAM)	100MHz 32-bit (SDRAM)
DMA	4-ch DMA	16-ch EDMA	16-ch dMAX
McBSP	2	2	0
McASP	0	2	3
I2C	0	2	3
SPI	0	0	2 (10MHz)
Package	429-pin Ceramic BGA (27mm, 1.27mm) 352-pin Plastic BGA, (35.2mm, 1.27mm)	272-pin PBGA 27x27xmm, 1.27mm	256-pin PBGA 16x16mm, 1.0mm (Ceramic Package TBD)





Possible Future DSP Space Products

C6474 high performance multicore DSP

Follows Industry Multi-Core Processor trends similar to PC Multi-cores

Possible Triple Redundancy Applications



Customers achieve greater performance density with three 1 GHz cores on a single chip for DSP farm applications

Multicore solution delivers power, cost and board space efficiencies

- 1/3 less power
- 2/3 less DSP cost
- 2/3 less board space

Development tools, support and code compatibility ease customer migration



Available Now

C6474 Evaluation Module



TI Space Products and QML-V Strategies

- **Strong technology/product portfolio for HiRel applications**
 - New devices being qualified
 - Customer driven roadmaps
- **TI-owned Wafer Fabs, Processes and Designs**
 - Third party designs validated against TI design rules and processes
- **Established QML-V qualification and production flows**
 - Fully support New Technology requirements of MIL-PRF-38535
 - All optimizations approved through DSCC, Aerospace, and NASA
- **Investments being made to enhance radiation tolerance and reliability**
 - Addresses the needs of multiple market segments, DHD, Medical, Space -
 - Based on commercial high volume processes
 - 3rd party IP partnerships for radiation improvements
 - Market & Customer defined roadmaps
 - Specific devices may be ported to commercial rad-tolerant processes
 - Total dose radiation testing is performed at qualification on all new QML-V product releases
 - Custom radiation test options are available for SEE & ELDRS characterization



For More Information

The TI HiRel, Defense & Aerospace

<http://www.ti.com/hirel>

<http://www.ti.com/space>

Or

loannis@ti.com



Thank You