



June, 2010

StarCore High-Performance DSP Product Roadmap

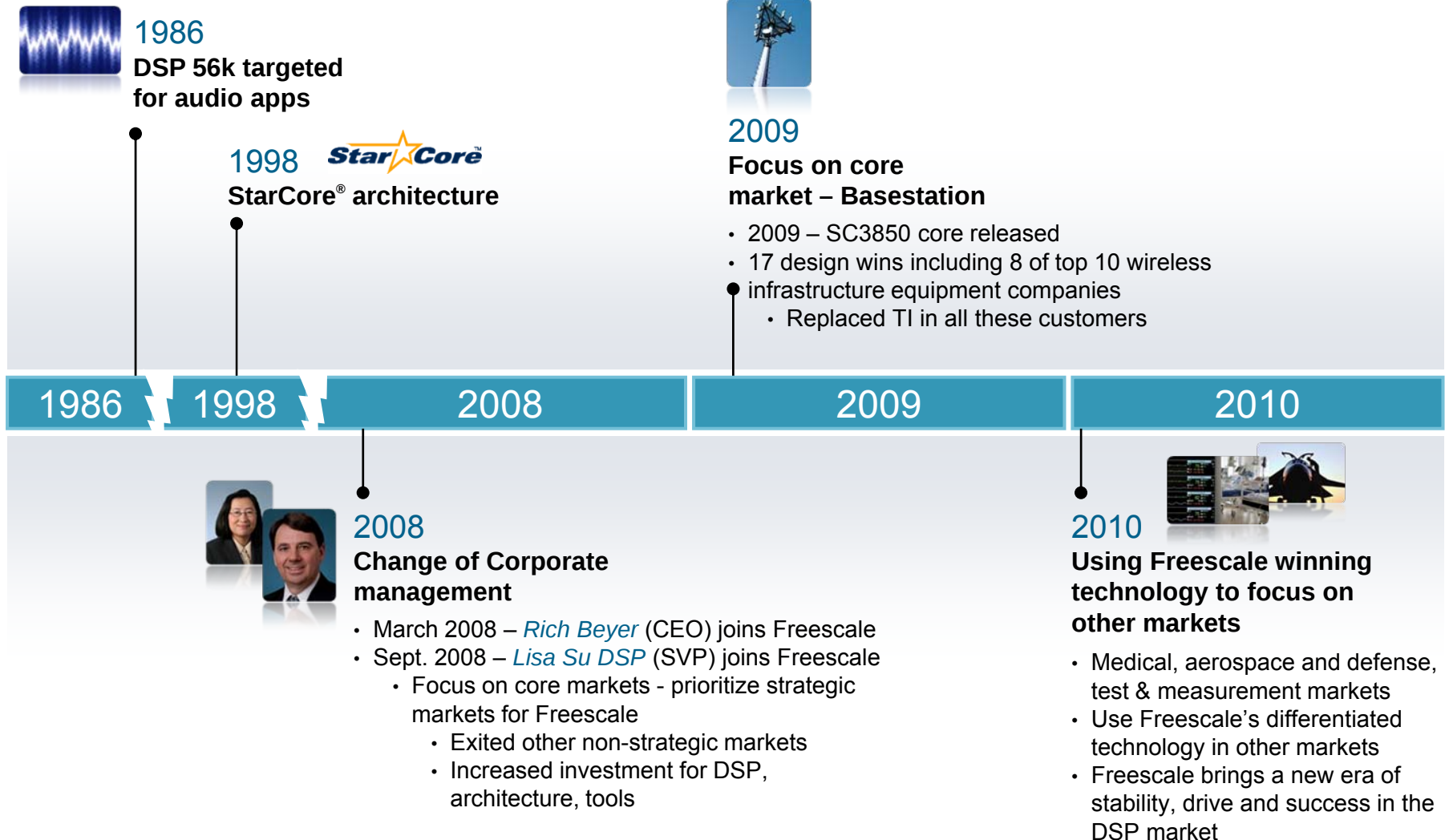
FTF-NET-F0671



Scott Aylor
Director of DSP Products

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Recognizing Performance



Freescale SC3850 DSP core earns highest BDTImark2000™ score to date

Freescale StarCore SC3850 core technology used in the MSC8156 multicore DSP has garnered leading benchmark results from independent signal-processing technology analysis firm Berkeley Design Technology, Inc. (BDTI)



Winning Customers

20+ design wins at basestation customers in 2009

8 out of the top 10 basestation customers **chose Freescale** in 2009

Beat out Texas Instruments in all cases.



Ultrasound



**Tetra
Basestation**



**Test
Equipment**



**Radar/
Sonar**



X-ray

Customer Needs

Freescale Provides

Faster/Higher Bandwidth I/Os

High MHz Performance

High Throughput

High Speed Bus/Peripherals

Low Product Costs

Low Price

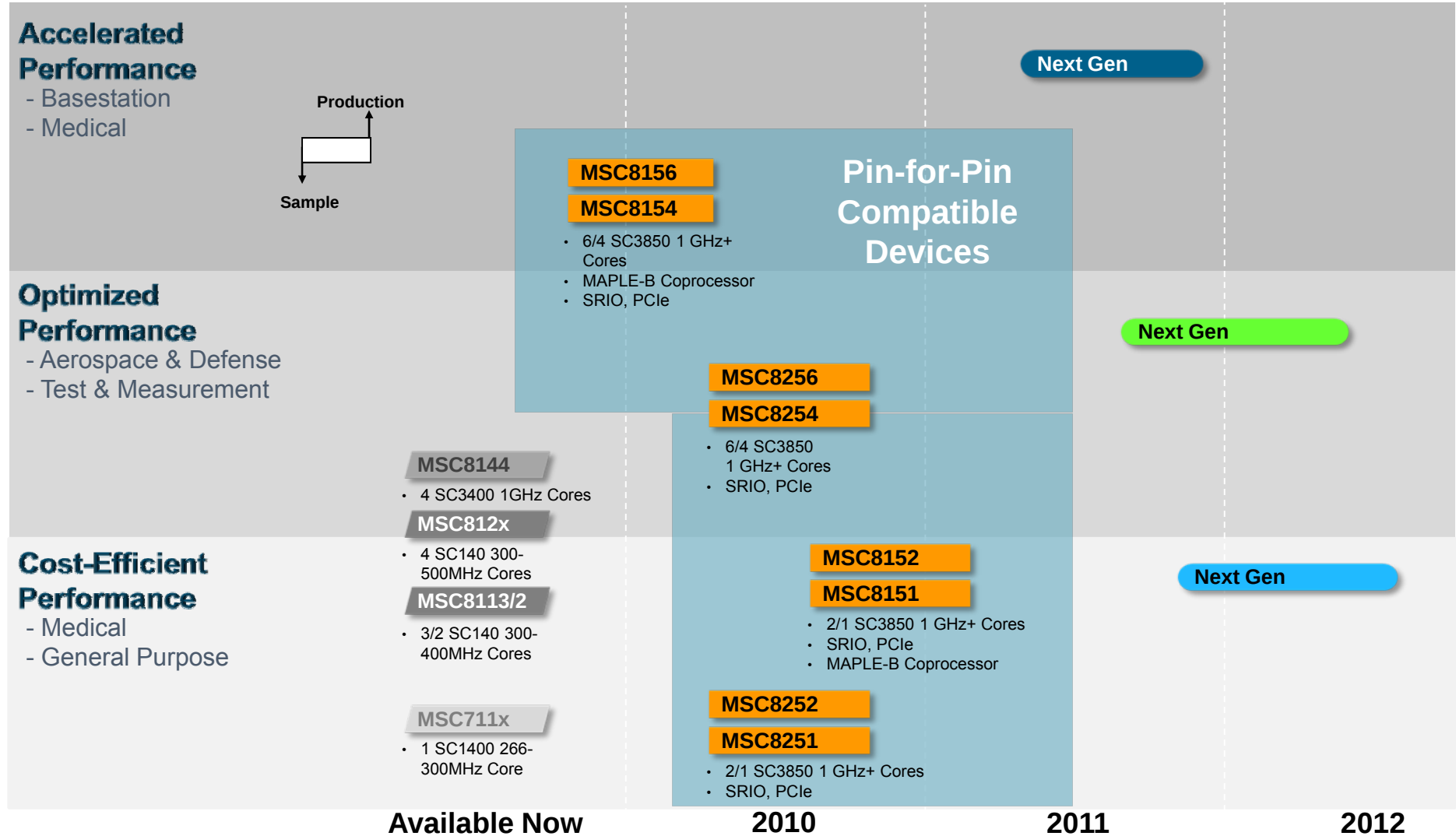
Fast Time To Market

Easy To Use Tools

Platform Hardware Reuse

Pin & Software Compatible Solns

StarCore DSP Devices Public Roadmap



MSC815x/ MSC825x Family – Value Proposition

The industry's highest performance programmable DSP families, targeted for the aerospace & defense, medical and test & measurement markets

Half the Price of Competition

- ▶ Half price - MSC8251 is \$75 in 1ku volumes vs. Texas Instruments TMS320C6457-12 at \$145.45
- ▶ 40% lower price - MSC8256 is \$124.20 in 1ku volumes vs. Texas Instruments TMS320C6472-7 at \$210.00

2x Performance of Competition

- ▶ Freescale MSC8256 has 2x higher core performance over closest DSP competitor
- ▶ Richest and highest performance DSP I/Os accelerating system performance

Fully Scalable and Flexible

- ▶ Industry's most scalable and fully programmable DSP family with 1, 2, 4 and 6 core pin compatibility, solving the customer need to scale from a single-core device to a multicore device

► Target applications

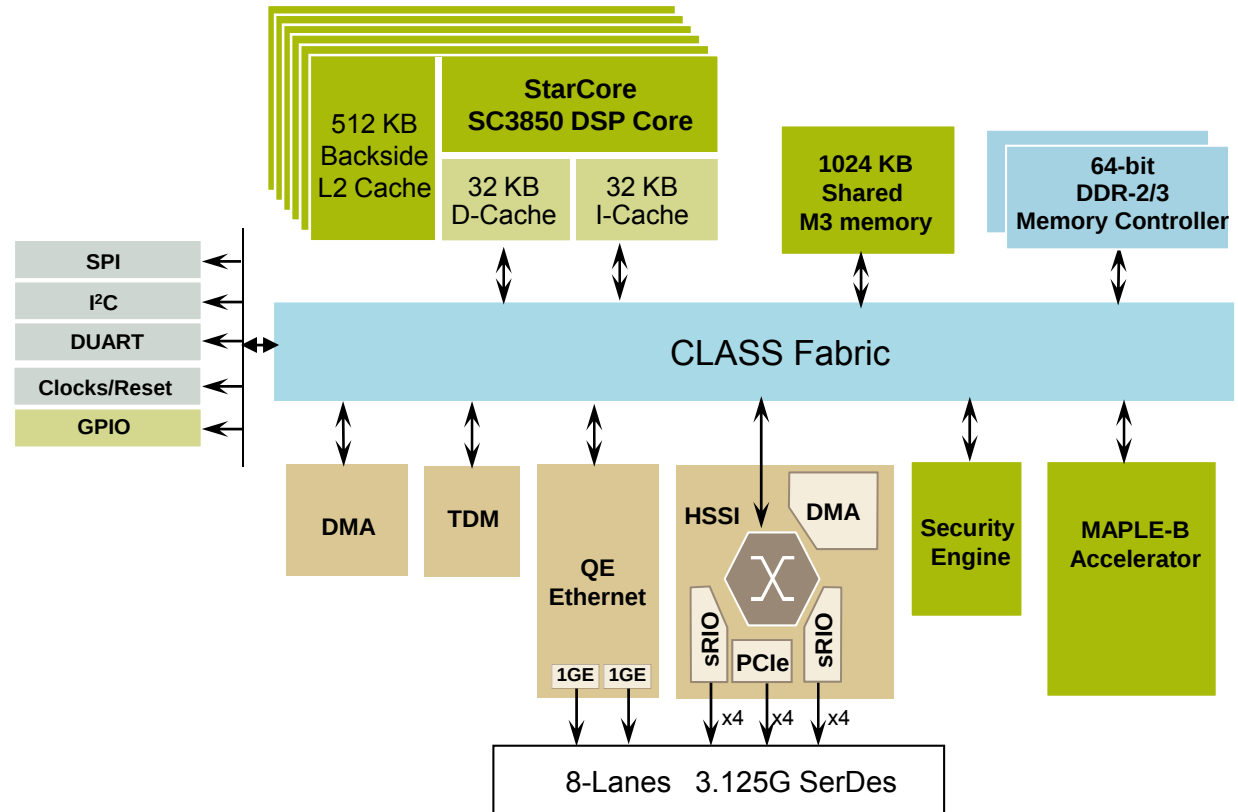
- Baseband
- Medical imaging
- General purpose

► Key advantages

- Industry's highest performance DSP, outperforms competitors' highest performing multicore DSP by more than 2x
- Featuring up to six fully-programmable 1 GHz DSP cores, delivering up to 6 GHz of DSP processing power with high speed peripheral interfaces
- MAPLE hardware accelerators

► Status

- Available now



► Target applications

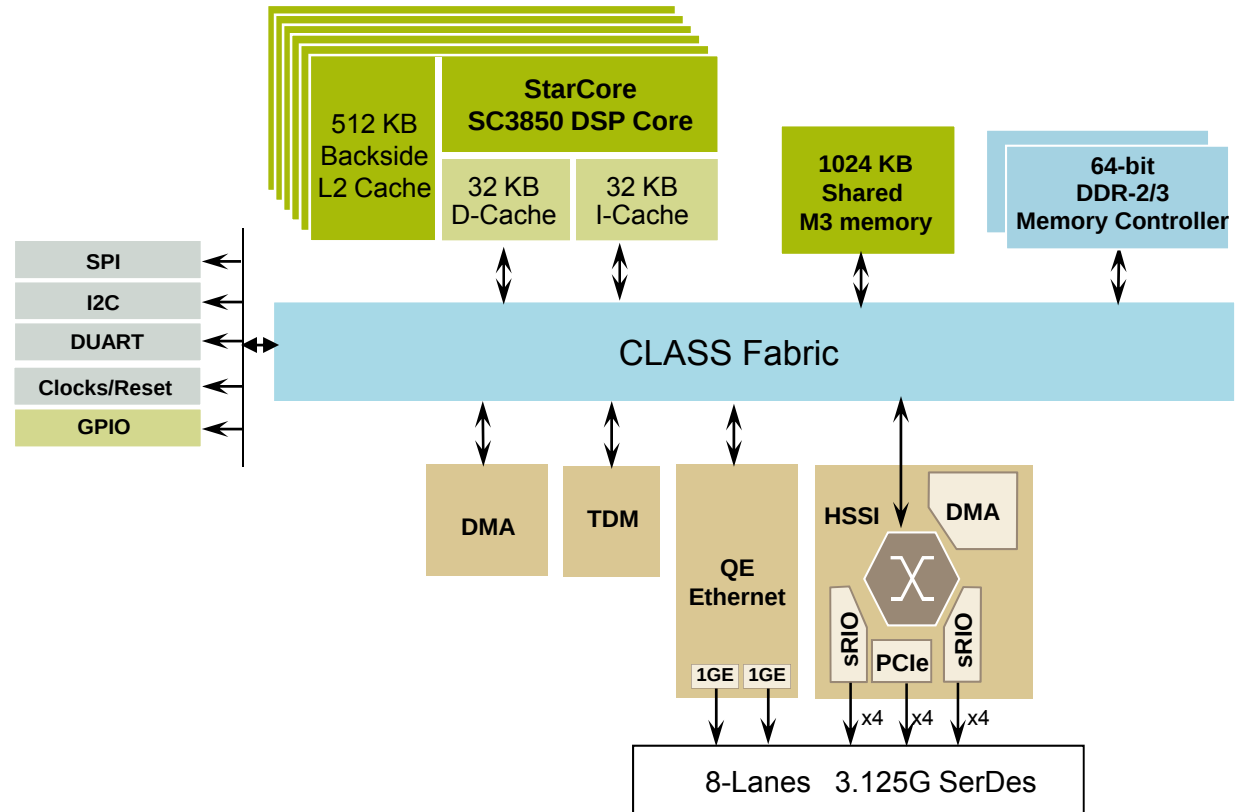
- Aerospace & defense
- Test and measurement
- Medical

► Key advantages

- Industry's highest performance DSP, outperforms competitors' highest performing multicore DSP by more than 2x
- Featuring up to six fully-programmable 1 GHz DSP cores delivering up to 6 GHz of DSP processing power with high-speed peripheral interfaces

► Status

- Available now



New Product Rack and Stack

Device	Pin for Pin compatible					
	8156	8154	8256	8254	8252	8251
SC8350 DSP Cores	6	4	6	4	2	1
MHz	1GHz	1GHz	1GHz	1GHz	1GHz	1GHz
MMACs	Up to 48000	Up to 32000	Up to 48000	Up to 32000	Up to 16000	Up to 8000
Int. Memory	1MB	1MB	1MB	1MB	1MB	1MB
L1I	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB
L1D	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB	4 x 32KB
L2	512KB	512KB	512KB	512KB	512KB	512KB
M3	1MB	1MB	1MB	1MB	1MB	1MB
DDR2/3	1 (800MHz)	2 (800MHz)	1 (800MHz)	2 (800MHz)	2 (800MHz)	2 (800MHz)
PCIe	1	1	1	1	1	1
GEMAC (RGMII, SGMII)	2	2	2	2	2	2
SRIO	2	1	2	1	1	1
TDM	4	4	4	4	4	4
SPI	1	1	1	1	1	1
UART	1	1	1	1	1	1
I2C	1	1	1	1	1	1
FFT/DFT Accelerators	1	1				
Security	AES, SHA, RC-4, Kasumi, SNOW	AES, SHA, RC-4, Kasumi, SNOW	AES, SHA, RC-4, Kasumi, SNOW	AES, SHA, RC-4, Kasumi, SNOW	AES, SHA, RC-4, Kasumi, SNOW	AES, SHA, RC-4, Kasumi, SNOW
Proc. Tech.	45nm SOI	45nm SOI	45nm SOI	45nm SOI	45nm SOI	45nm SOI
Package	783 Ball FC-PBGA	783 Ball FC-PBGA	783 Ball FC-PBGA	783 Ball FC-PBGA	783 Ball FC-PBGA	783 Ball FC-PBGA

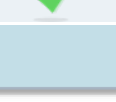
Freescal MSC8256: Industry's Highest Performance DSP

DSP Core Performance

	Freescal MSC8256	Texas Instruments C6742	Freescal Benefit	Freescal Advantage
Core Performance (BDTISIMMARK2000TM)	15420 (SC3850 @ 1 GHz)	13170 (C64x+ @ 1.2 GHz)		
Performance per MHz (BDTISIMMARK2000TM/ MHz)	15.42	10.975	1.41 Times	
Total MHz for 6 cores	6000 MHz	4200 MHz	1.43 Times	

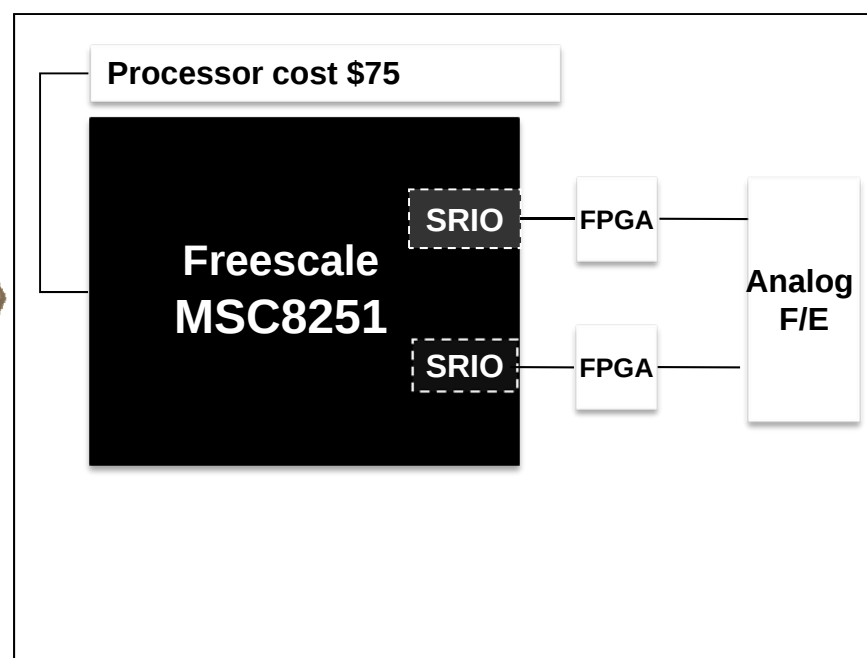
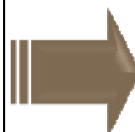
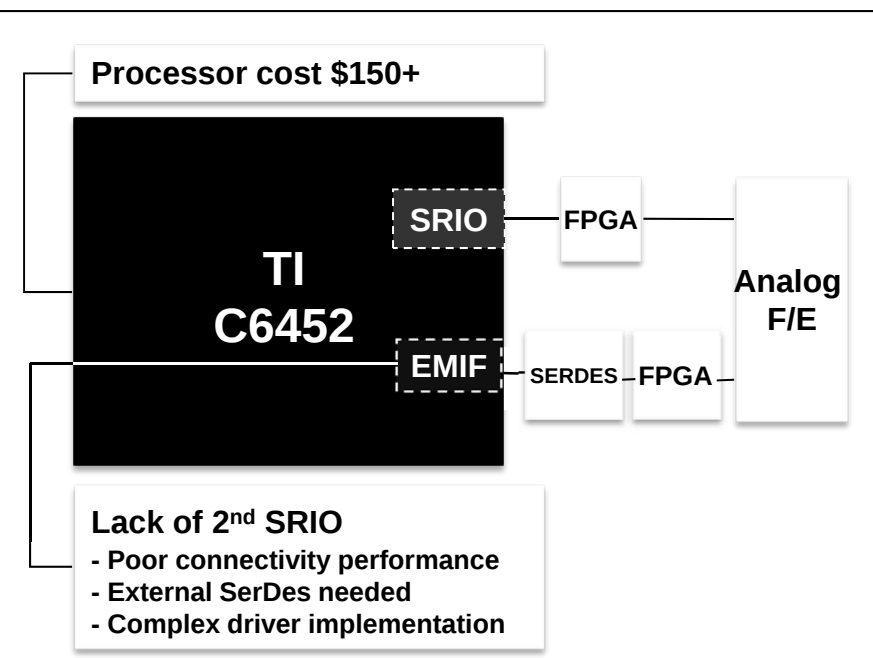
DSP Processing Performance = Core Performance x Performance per MHz = 2.00
 MSC8256 Processing Performance = 2x better than TI C6472

DSP System Performance

	Freescal MSC8256	Texas Instruments C6742	Freescal Benefit	Freescal Advantage
Fabric system (fast peripherals)	500 MHz	233.33 MHz	2.14 Times	
Fabric system (slow peripherals)	250 MHz	116.67 MHz	2.14 Times	
DDR speed	800	533	1.50 Times	
Number of SRIOS	2	1	2.00 Times	

Freescal Offers Lower Cost and Easier Integration

Generic application Block Diagram



- ▶ **\$75+ savings over existing processor solutions**
- ▶ **What does this mean for the customer?**
 - Average customer volumes 5ku per year
 - Year 1 saving \$75 processor savings x 5ku = \$350,000
 - Year 2 saving \$75 processor savings x 5ku = \$350,000
 - Year 3 saving \$75 processor savings x 5ku = \$350,000
 - **Total Processor cost saving = \$1,000,000+**

Increased Scalability and Flexibility for Robust Product Lines

Single core fully programmable DSP

Multicore fully programmable DSP

Aerospace & Defense



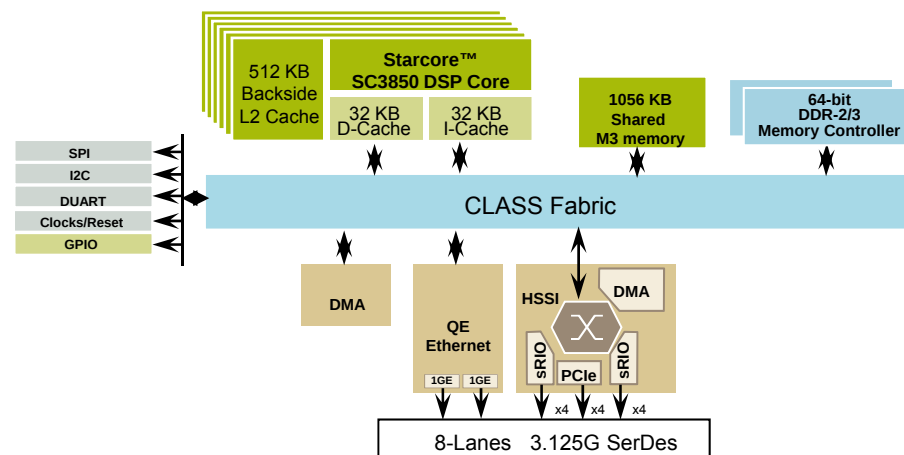
Medical



Test & Measurement

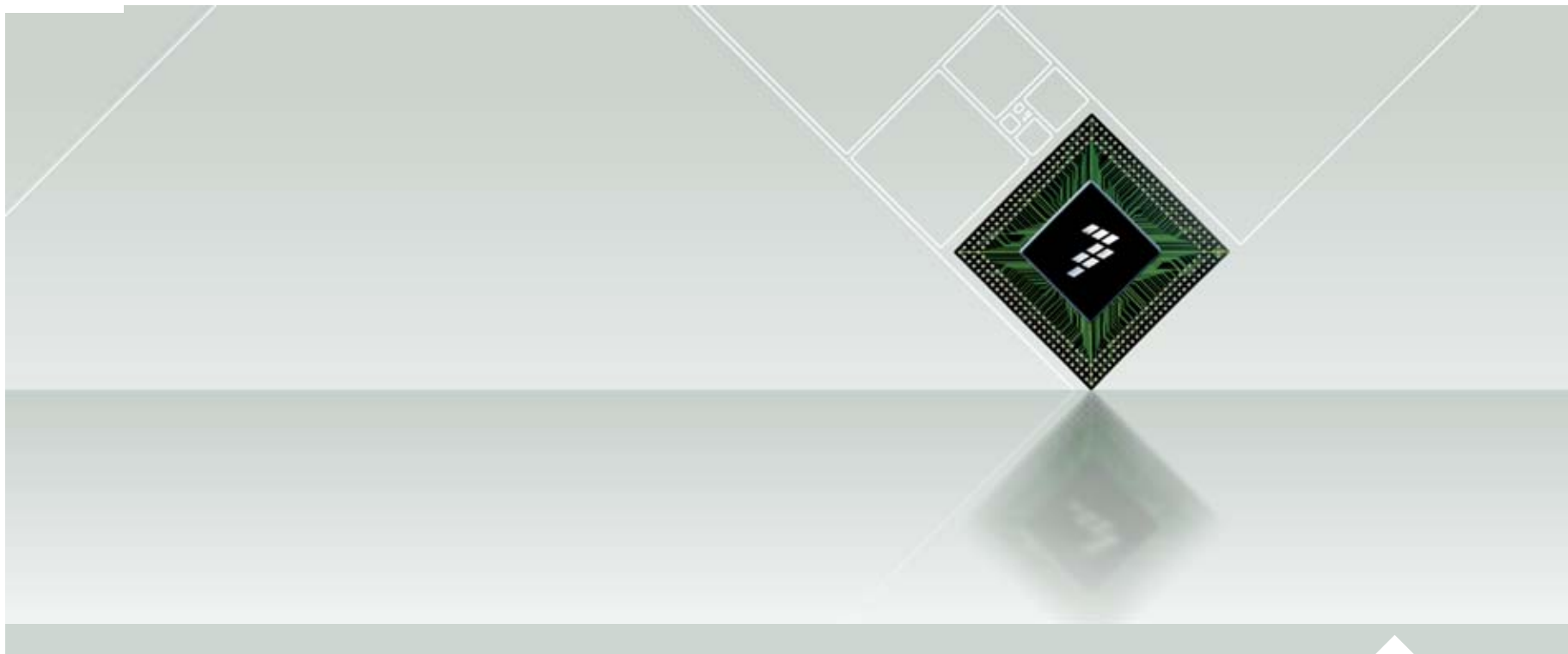


Benefit	Feature
\$75+ savings over existing processor solutions	• \$75 Pricing in 1ku quantities
33% more measurement features	• Up to 6 GHz DSP performance (33% more than competition) • SC3850 has 30% more performance power per MHz than nearest competition
2 x SRIO for seamless connectivity to 2 FPGAs	• 2 x SRIO (4 lanes) 3.125G SerDes
Hardware scalability and software flexibility	• Option of 1, 2, 4 and 6 SC3850 core pin compatible DSPs



► MSC825x

- Up to 6 x 1 Ghz SC3850 DSP performance
- 2 x DDR3 (800MHz)
- 2 x SRIO (4 lanes)
- 2 x GEMAC
- More than 1.5 GB on chip memory



Freescalé's DSP Enablement Offering

CodeWarrior Development Studio for StarCore v10.0

A complete development environment under Eclipse

► Eclipse IDE

- Configuration wizards
- Plug-in architecture
- 3rd party community



► StarCore Build Tools

- v23 performance C/C++ compiler
- New sc3000 linker

► Software Simulators

- Core platform cycle accurate simulator
- Multicore functional accurate simulator with MAPLE integrated

► SmartDSP OS

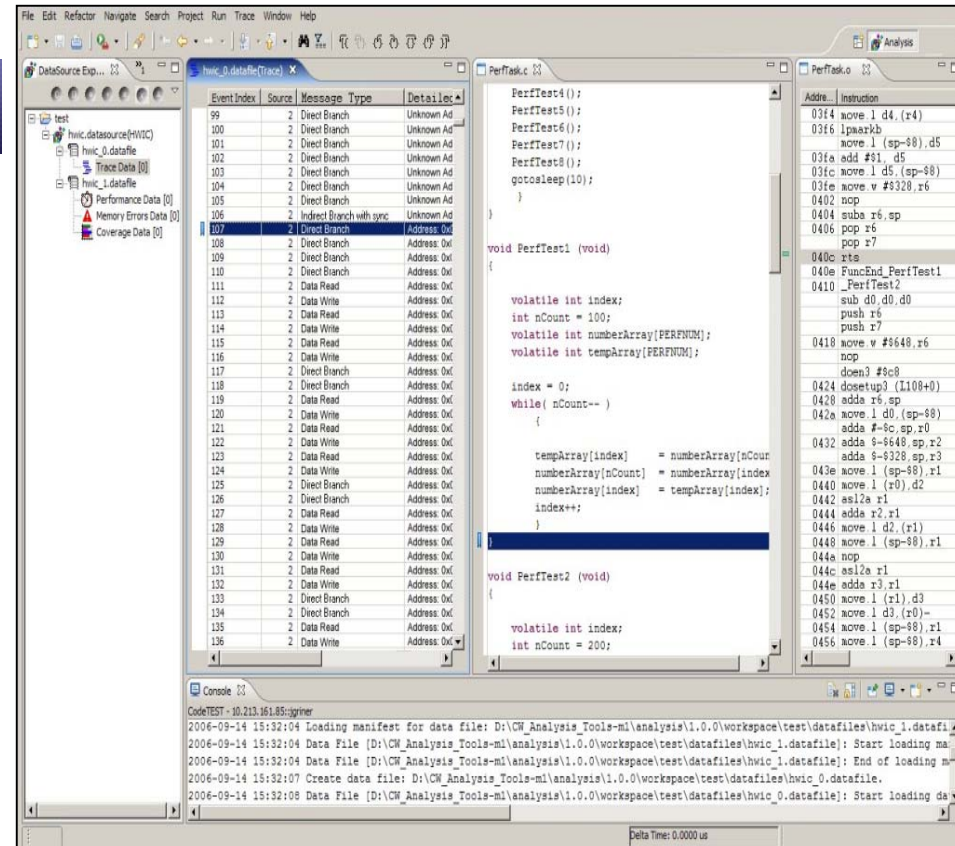
- Pre-emptive, high performance, field deployed, optimized drivers, networking stacks
- Royalty-free

► StarCore Debugger

- Multicore and multi-DSP
- 8144 and 8156 targets

► Trace and Profile

- Trace data offload via Ethernet using SmartDSP HEAT technology



MSC8156/54
MSC8256/54
MSC8252/51

**MSC8156ADS/
MSC8156EADS**



MSC8156AMC



MSC8156 EVM

Q3' 2010

MSC8144

**MSC8144ADS/
MSC8144EADS**



MSC8144AMC-SA



ATCA-9100



MSC8122/26
MSC8113/12

MSC8122ADSE

MSC8126ADSE

MSC7116/19

MSC711xADS

MSC711xEVM

MSC825x/815x ADS Board

- ▶ \$3900 (includes 1 year free CodeWarrior tools subscription)
- ▶ On-board emulation

CodeWarrior Software Development Tools

- ▶ New Eclipse IDE
- ▶ Trace and profile, SmartDSP OS, debugger, C/C++ compiler

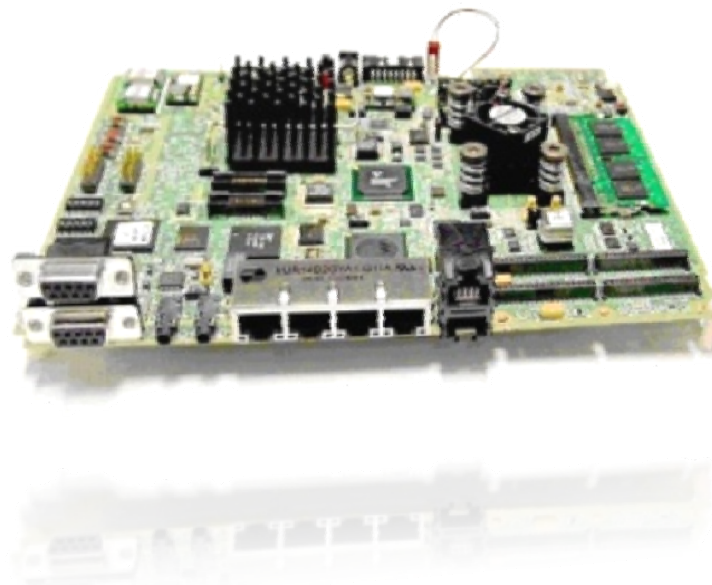
Software Migration Tools

- ▶ Texas Instruments C64x+ to FSL SC3850 migration tools
- ▶ DSP libraries

Documentation and Available Support

www.freescale.com/dsp

- ▶ Device and tool fact sheets
- ▶ Product data sheets
- ▶ Freescale DSP forums
- ▶ System block diagrams on all target end equipment



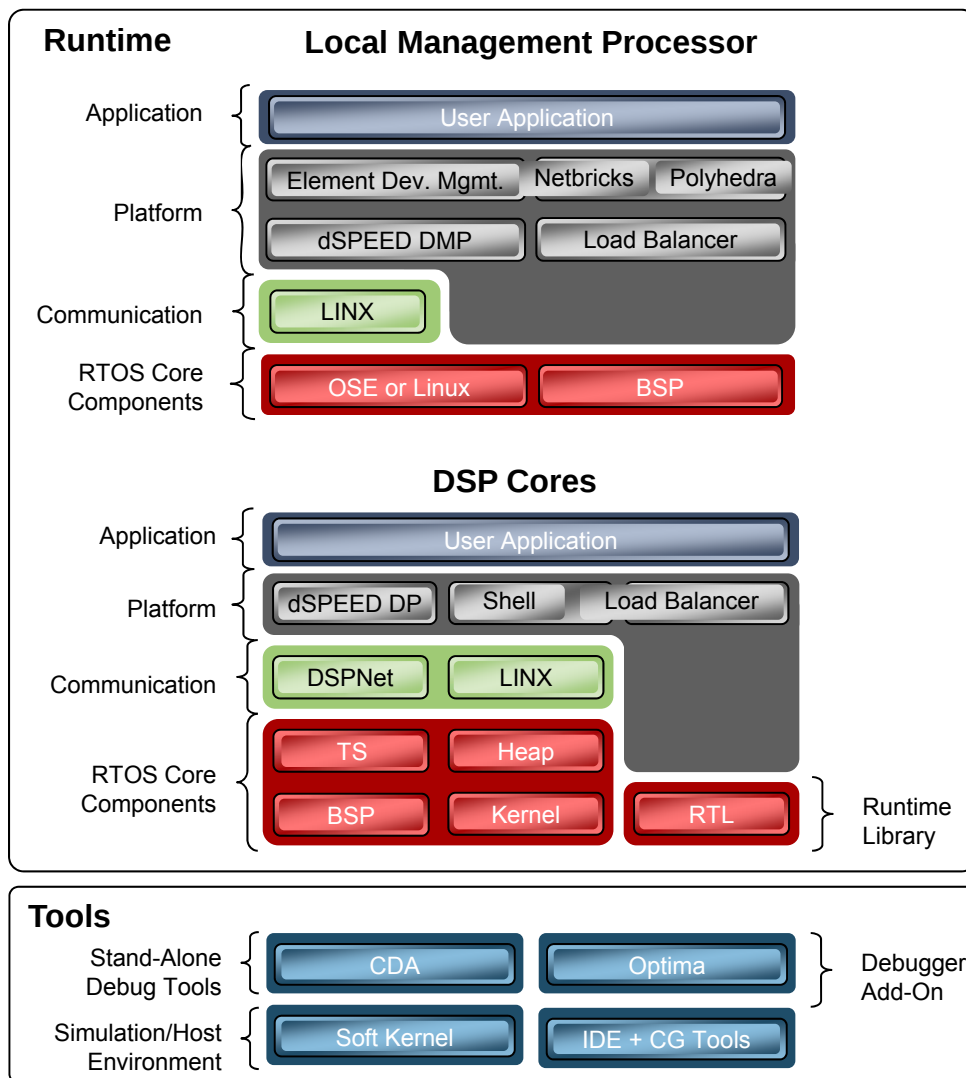
Kernel	Function name	C	ASM
FFT/IFFT	sc3850_fft_radix4_complex_16x16	Done	Done
	sc3850_iff_fft_radix4_complex_16x16	Done	Done
	sc3850_fft_radix4_complex_32x16	Done	Done
	sc3850_iff_radix4_complex_32x16	Done	Done
	sc3850_fft_radix_2_4_complex_16x16	Done	Done
	sc3850_iff_radix_2_4_complex_16x16	Done	Done
DFT	sc3850_dft_complex_16x16	N/A	Done
	sc3850_idft_complex_16x16	N/A	Done
FIR	sc3850_fir_real_32x32	Done	Done
	sc3850_fir_real_8x16	Done	Done
	sc3850_fir_real_16x16	Done	Done
	sc3850_fir_complex_16x16	Done	Done
IIR	sc3850_iir_1st	Done	Done
Interleaver	sc3850_interleaver	Done	Done
CRC	sc3850_crc_enc	Done	Done
lookup	sc3850_lookup	Done	Done
freq_rot	sc3850_freq_rot	Done	Done
Vector cplx mult	sc3850_vector_complex_mult	Done	Done
3 way deinterleave	sc3850_3_WAY_DEINTERLEAVE	Done	Done
3 way interleave	sc3850_3_WAY_INTERLEAVE	Done	Done

Kernel	Function name	C	ASM
Viterbi	sc3850_viterbi	N/A	Done
Vect_Dot	sc3850_vect_dot_16x16	Done	Done
	sc3850_vect_dot_16x32	Done	Done
LU inverse	sc3850_matrix_lu_inverse	Done	Done
Inver_2x2_complex	sc3850_matrix_inverse_2x2_complex16	Done	Done
LU Decompose	sc3850_matrix_lu_decompose	Done	Done
LU Solve	sc3850_matrix_lu_solve	Done	Done
Cplx 4x4 matrix mult	sc3850_cplx_matrix_mult_sp_4x4	Done	Done
Cplx 4x4 matrix inverse	sc3850_matrix_inv_complex_4x4	Done	Done
Cholesky decomposition	sc3850_cholesky	Done	N/A
QR decomposition	sc3850_qr_decomposition	Done	Done
Real radix-4 FFT	sc3850_fft_real	Done	Done
Division	sc3850_div_16x32	Done	Done
	sc3850_div_32x32	Done	Done
	sc3850_div_16x16	Done	Done
	sc3850_div_32x16	Done	Done
Square root	sc3850_sqrt_16	Done	Done
	sc3850_sqrt_32	Done	Done
Ln	sc3850_ln	Done	N/A

- ▶ **ADT – G.PAK framework, G.168 echo cancellation, conferencing, transcoding software**

- ▶ **ENEA – OSEck RTOS, LINX message layer, network protocols. System level virtualization and debugging environments for system development**

- ▶ **GDA – EVM vendor**



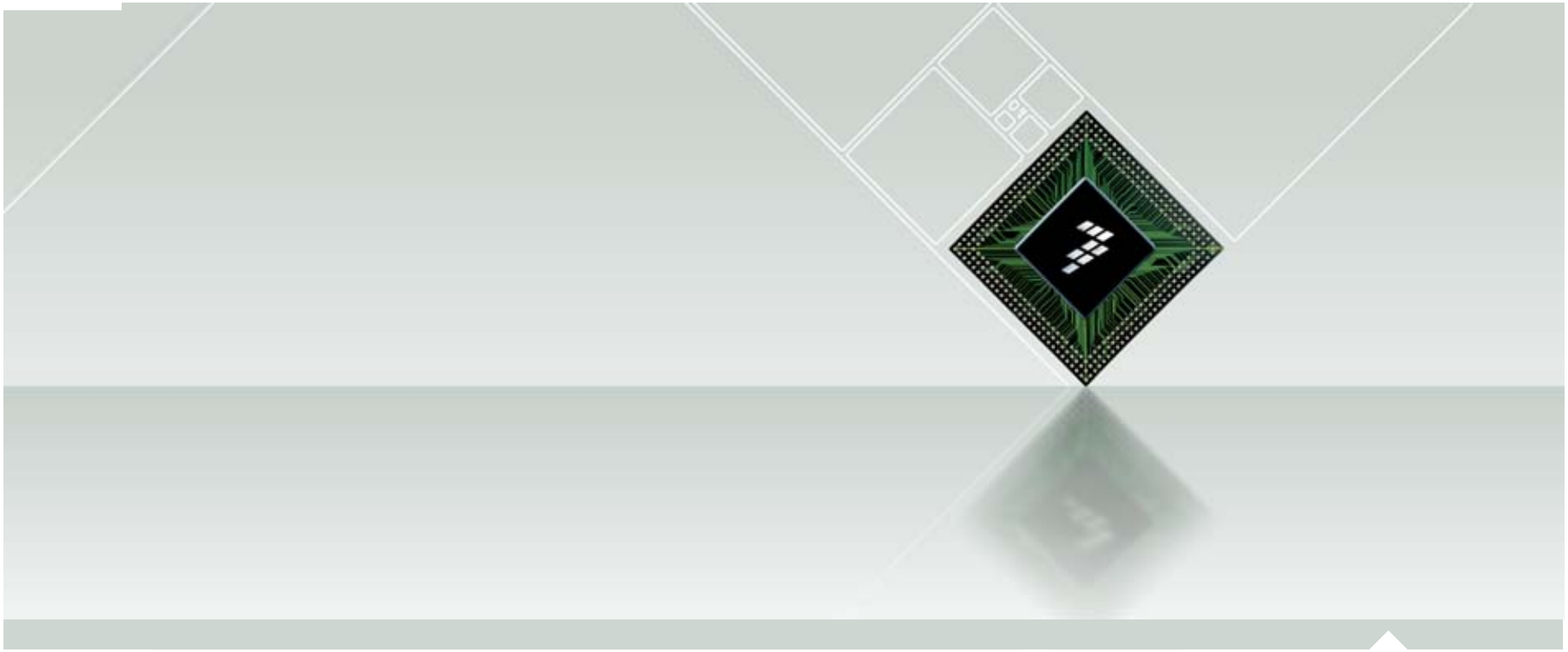
- ▶ **Element Device Manager**
 - Control the capabilities of dSPEED by loading and booting cores w/ appropriate run-time images, monitoring the state of processor cores, and restarting them after fault conditions
- ▶ **Polyhedra**
 - A high-performance, low-footprint relational database system designed for embedded
- ▶ **Netbricks**
 - Protocol stacks for TDM, 3G, IMS, and NGN networks, fax & data transfer protocols and signal processing & analysis software
- ▶ **Load Balancer (work in progress)**
 - A work schedule and resource manager for multiprocessing and analysis software
- ▶ **Optima**
 - Eclipse-based system and application debug tool suite
- ▶ **dSPEED**
 - Suite of management, debug and error handling services for developing, deploying, and maintaining DSP "user plane" applications
- ▶ **Shell – Standalone shell accessible via LINX or DSPNet**
- ▶ **DSPNet**
 - Secure IPv4/IPv6 stack, IPsec and SSH support in a modular design
- ▶ **LINX**
 - Transparent, reliable, high-performance interprocess communications services for complex distributed systems
- ▶ **OSEck - OSE Compact Kernel**
 - A DSP-optimized compact OSE RTOS



MSC825x DSP Power Consumption

Device	Power Consumption
MSC8256@1GHz	6W
MSC8256@800MHz	5.5W
MSC8254@1GHz	4.7W
MSC8254@800MHz	4.4W
MSC8252@1GHz	3.5W
MSC8251@1GHz	2.9W

Typical power values were estimated assuming: DSP cores running at 1V, each at 75% utilization. A single 64-bit DDR3 running at 800 MHz, 50% utilization. M3 Memory 50% utilized, TDM Enabled 20% loading, 1 RGMII @ 1Gbps 50% loading with junction temperature of 60°C.



Legacy Block Diagrams

► Cores

- Four SC140 cores @ 300MHz/400MHz/500MHz
- 16 KB ICache
- 224 KB M1 memory

► Shared Memory

- 476 KB internal M2 shared memory

► Ethernet

- 10/100 FEC w/SMII/RMII

► Memory Interface

- 100/133/167 MHz, 64/32 bit SRAM interface w/ ECC, Boot FLASH, SRAM

► Host Port

- 64/32 bit Direct Slave Interface

► TDM Highway

- 4 physical ports supporting 256 channels each

► 16 Channel DMA

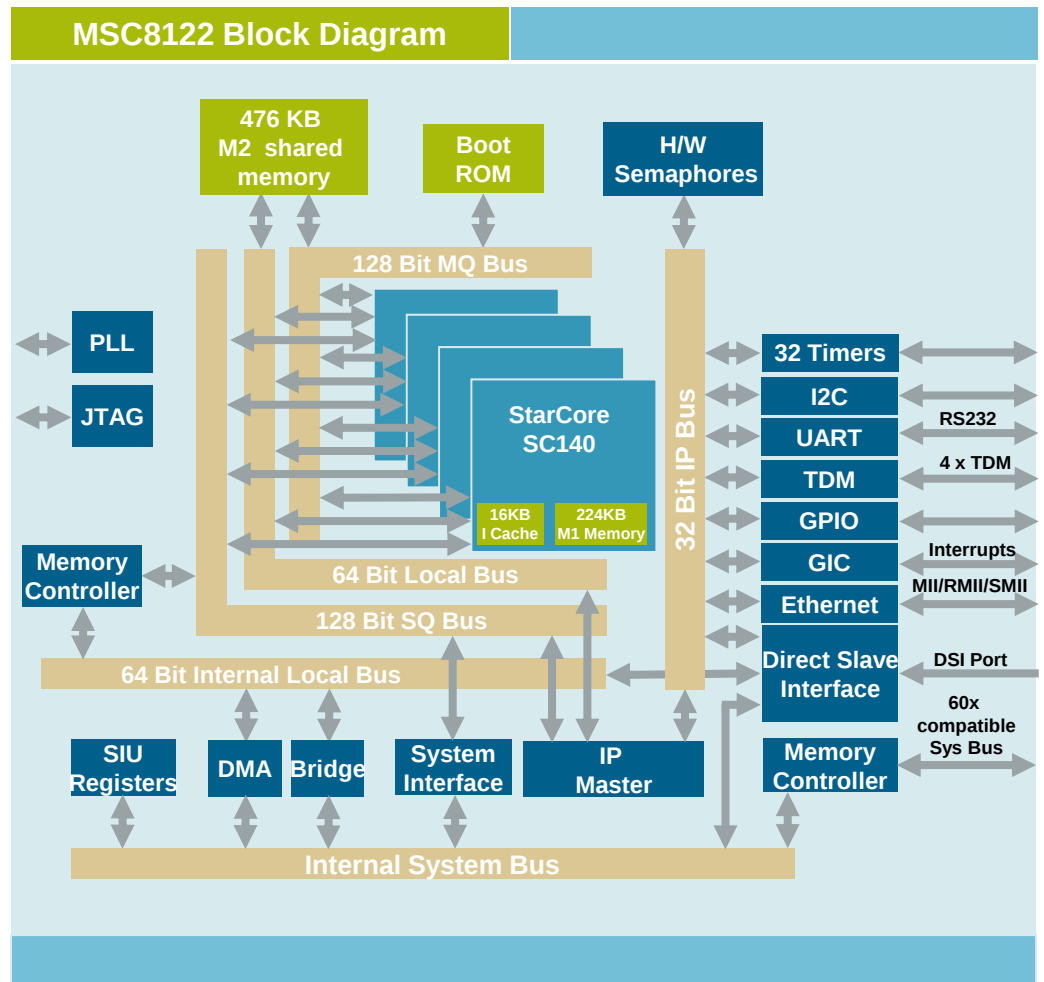
► Peripheral Interfaces

- UART
- I²C
- Timers
- GPIO
- 4kB Boot ROM
- JTAG

► Hardware Semaphores

► Technology

- 90 nmG
- 1.1V/1.2V Core, 3.3 V I/O
- 431 FCPBGA (20x20) 0.8 mm pitch RoHS



MSC8126 Multicore DSP

► Cores

- Four SC140 cores @ 400 MHz/500 MHz
- 16 KB ICache
- 224 KB M1 memory

► Shared Memory

- 476 KB internal M2 shared memory

► Coprocessors

- Turbo & Viterbi

► Ethernet

- 10/100 FEC w/SMII/RMII

► Memory Interface

- 100/133/167 MHz, 64/32 bit SRAM interface w/ ECC, Boot FLASH, SRAM

► Host Port

- 64/32 bit Direct Slave Interface

► TDM Highway

- 4 physical ports supporting 256 channels each

► 16 Channel DM

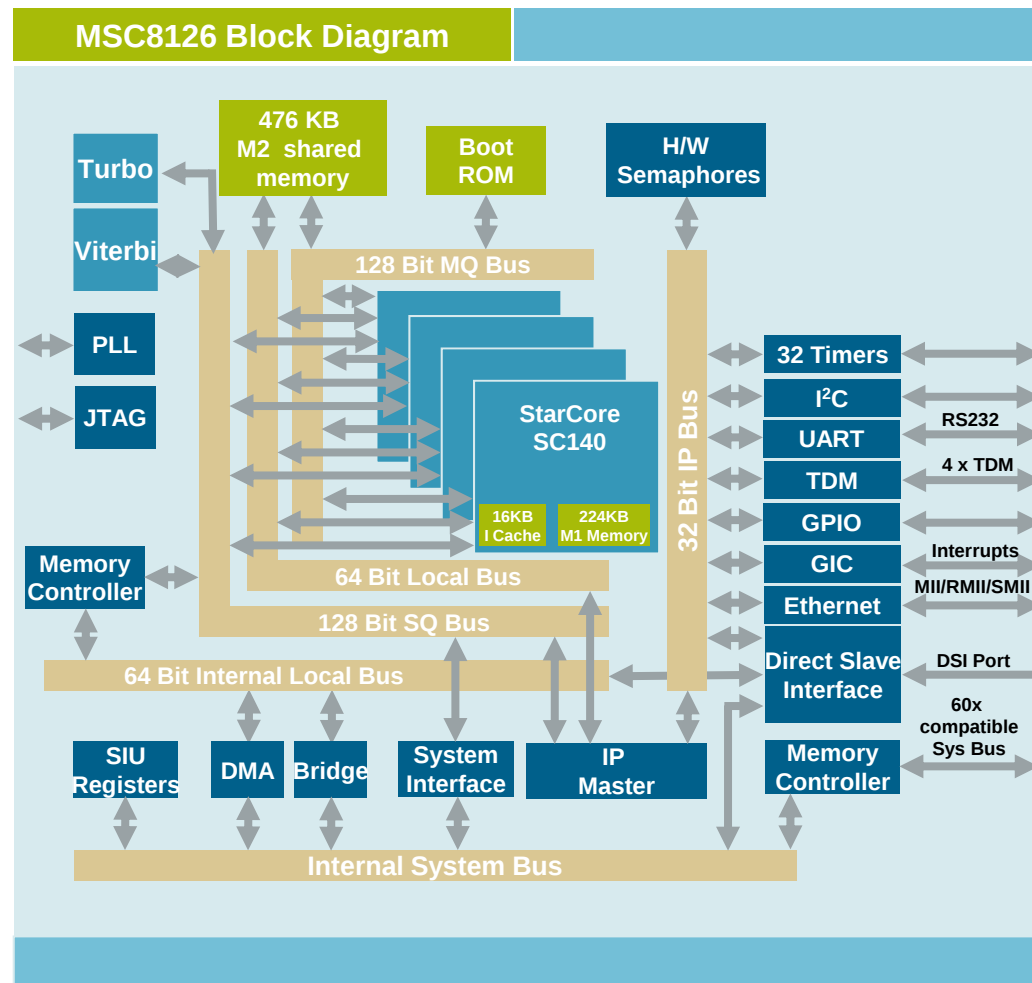
► Peripheral Interfaces

- UART
- I²C
- Timers
- GPIO
- 4 kB Boot ROM
- JTAG

► Hardware Semaphores

► Technology

- 90nmG
- 1.1V/1.2V Core, 3.3 V I/O
- 431 FCPBGA (20x20) 0.8 mm pitch RoHS



► Cores

- Three SC140 cores @ 300 MHz/400 MHz
- 16 KB ICache
- 224 KB M1 memory

► Shared Memory

- 476 KB internal M2 shared memory

► Ethernet

- 10/100 FEC w/SMII/RMII

► Memory Interface

- 100/133 MHz, 64/32 bit SRAM interface w/ ECC, Boot FLASH, SRAM

► Host Port

- 64/32 bit Direct Slave Interface

► TDM Highway

- 4 physical ports supporting 256 channels each

► 16 Channel DMA

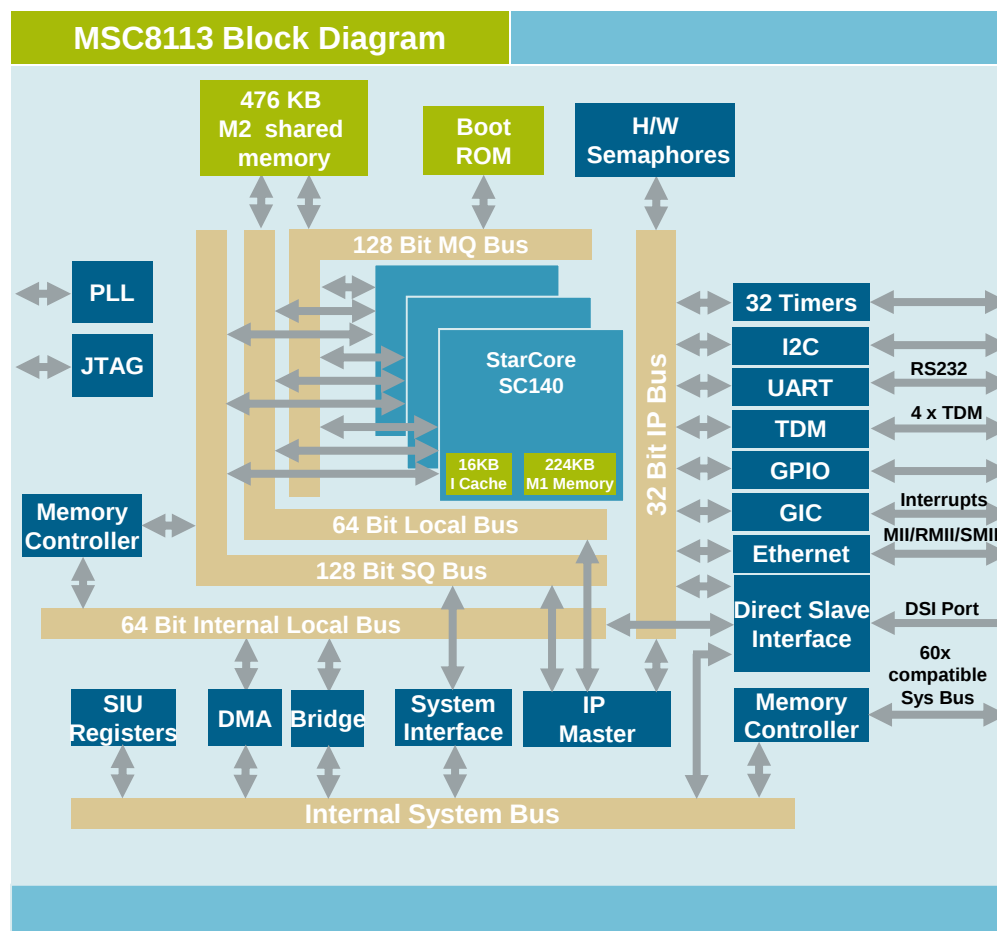
► Peripheral Interfaces

- UART
- I²C
- Timers
- GPIO
- 4 kB Boot ROM
- JTAG

► Hardware Semaphores

► Technology

- 90nmG
- 1.1V Core, 3.3 V I/O
- 431 FCPBGA (20x20) 0.8 mm pitch RoHS



► Cores

- Two SC140 cores @ 300MHz
- 16 KB ICache
- 224 KB M1 memory

► Shared Memory

- 476 KB internal M2 shared memory

► Ethernet

- 10/100 FEC w/SMII/RMII

► Memory Interface

- 100MHz, 64/32 bit SRAM interface w/ ECC, Boot FLASH, SRAM

► Host Port

- 64/32 bit Direct Slave Interface

► TDM Highway

- 4 physical ports supporting 256 channels each

► 16 Channel DMA

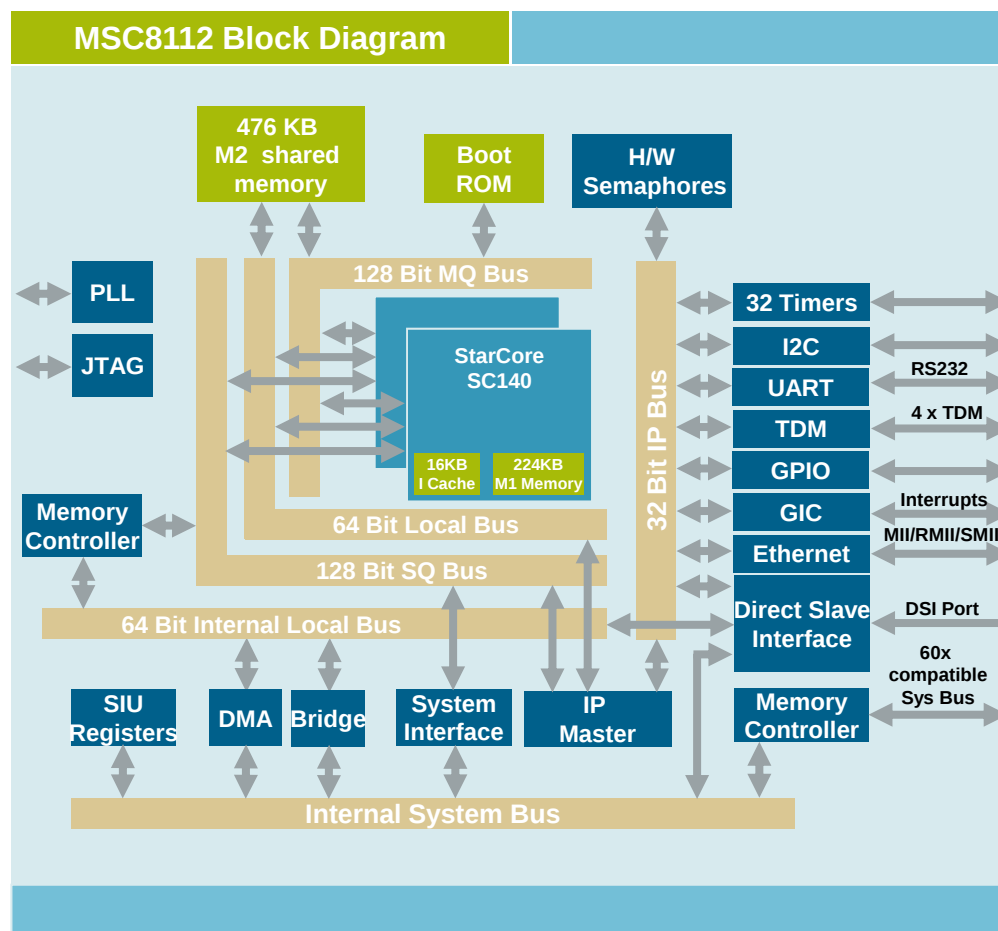
► Peripheral Interfaces

- UART
- I²C
- Timers
- GPIO
- 4 kB Boot ROM
- JTAG

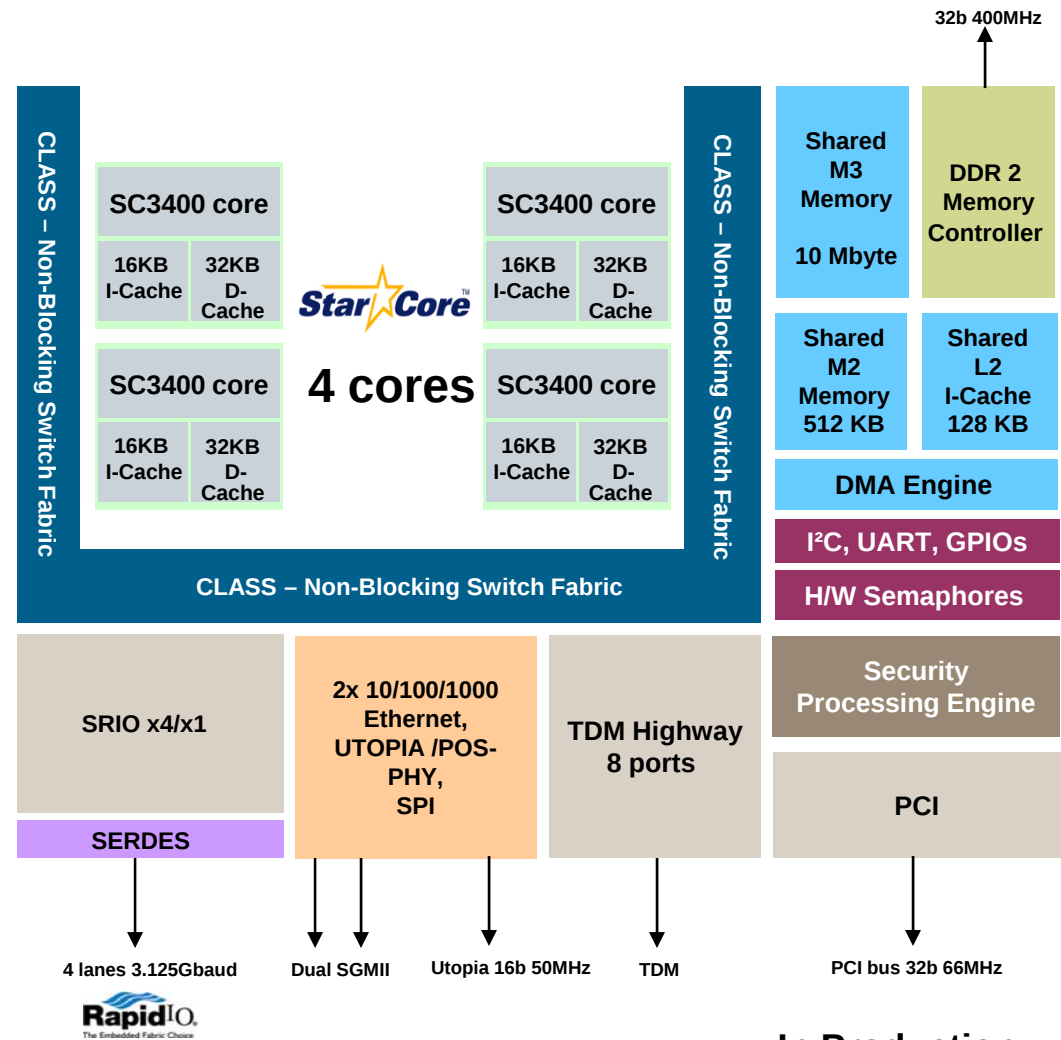
► Hardware Semaphores

► Technology

- 90nmG
- 1.1V Core, 3.3 V I/O
- 431 FCPBGA (20x20) 0.8 mm pitch RoHS



- ▶ **4GHz DSP = 4x SC3400 core subsystems (up to 16 GMACs), each with**
 - SC3400 DSP core at 1GHz (4 GMACs 16b or 8 GMACs 8b)
 - 16 Kbyte I-cache, 32 Kbyte D-cache, MMU, PIC
- ▶ **Internal Memories/Caches**
 - 10 Mbyte shared M3 unified memory
 - 512 shared M2 unified memory
 - 128 KB shared L2 I-cache
- ▶ **CLASS – Chip-Level Arbitration and Switching Fabric**
 - Non-blocking, fully pipelined at low latency accesses
 - Operates at 400 MHz
- ▶ **High Speed Interconnects**
 - x4/x1 Serial RapidIO – 1.25/2.5/3.125 Gbaud
- ▶ **Ethernet & ATM**
 - Dual SGMII/RGMII Gigabit Ethernet ports or Dual RMII/SMII Fast Ethernet ports
 - Utopia 16b/50Mhz supporting AAL-0/2/5 and POS in firmware
 - Eth, ATM protocols and sRIO offload
- ▶ **DDR Memory Controller**
 - DDR2 SDRAM 400MHz, 32/16 bit w/ECC
- ▶ **TDM Highway**
 - 2048 DS-0, divided into 8 ports 256 each
- ▶ **PCI 32b/66MH**
- ▶ **DMA Engine 32 ch.**
- ▶ **Integrated Security Engine**
 - AES, Kasumi, 3/DES, SHA, RC-4, RNG (data and code protection)
- ▶ **Other Peripheral Interfaces**
 - SPI, UART, I²C, 32 GPIO, 16 Timers, 96 KB boot ROM, JTAG
- ▶ **Boot options – Ethernet, I²C, SPI, Serial RapidIO, PCI Technology**
 - Process: 90nm SOI
 - Voltage: 1V core, 3.3/2.5/1.8 V I/O
 - Package: 783 pins, FCBPGA (29x29), 1mm pitch, RoHS



In Production

► High Density DSP Platform

- 3x MSC8156 Multicore DSP – each with:
 - 6x SC3850 StarCore® DSP cores at 1 GHz + MAPLE-B accelerator
 - 2x 512 MByte of 64-bit DDR3 memory

► Connectivity

- Four 3.125 Gbaud SRIO (x4) interfaces from backplane to DSP farm via SRIO switch
- Two 1000 Base-X Gigabit Ethernet interfaces from backplane to DSP farm via Ethernet switch

► Module Management Controller (MMC)

- Hot swapping
- Board Control

► Target Applications

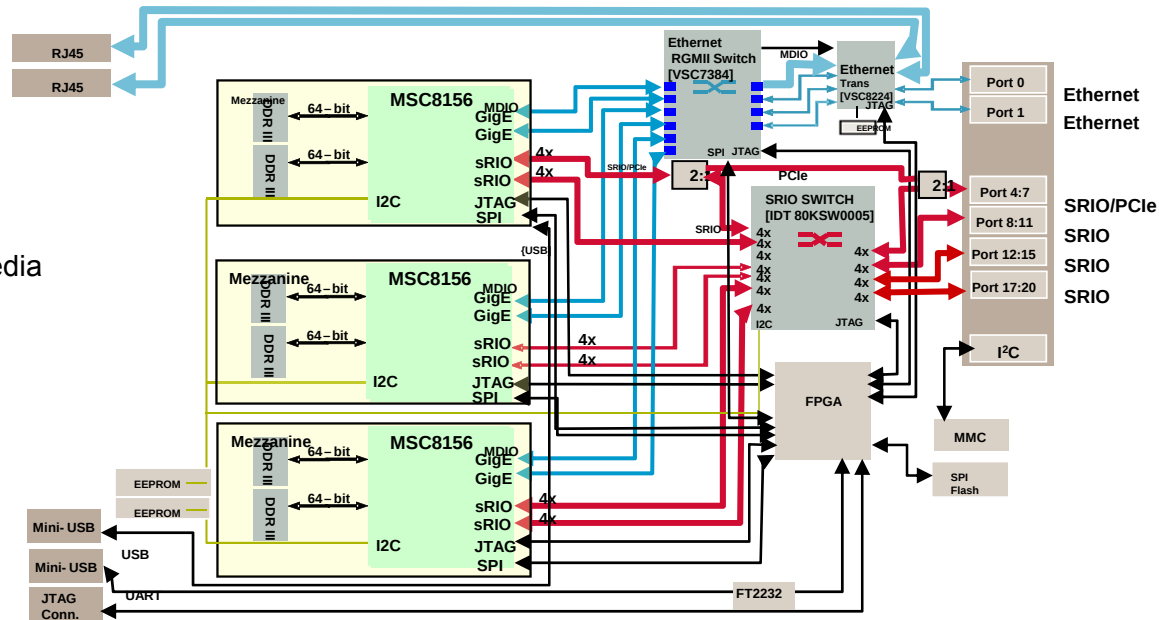
- 3G-LTE, WCDMA, WiMAX Basestations and Media Gateway systems
- Aerospace & Defense platforms
- Design reference and enablement platform for customers and third parties

► Form Factor

- Single Width AMC

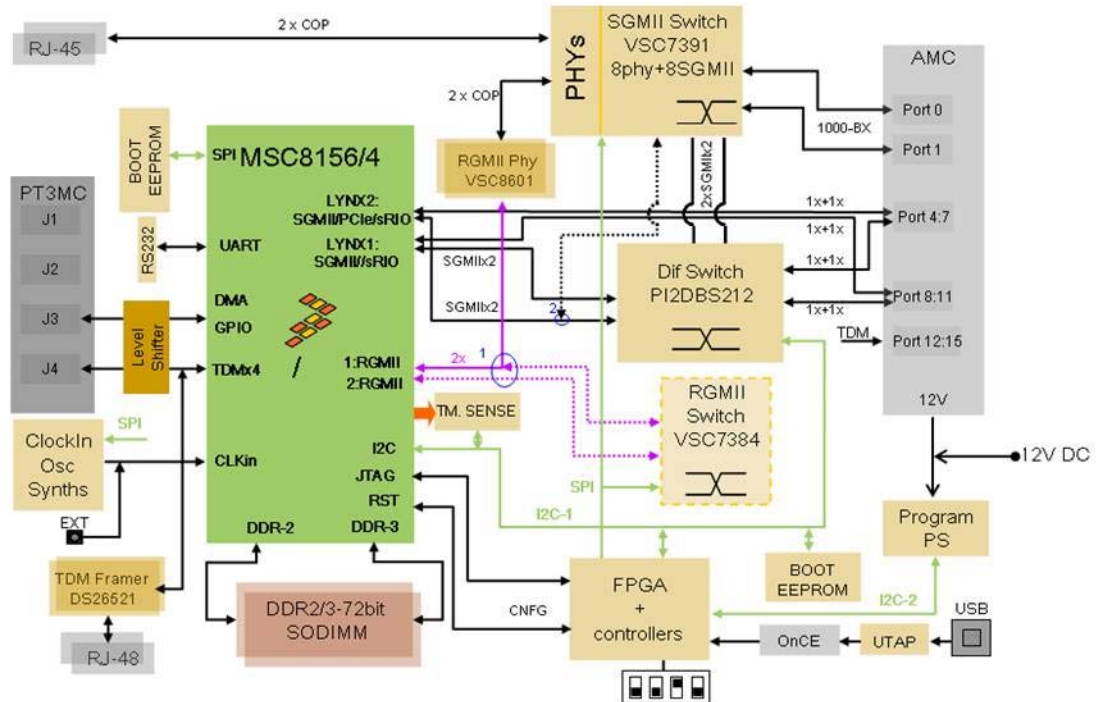
► Availability

- Alpha: July '09
- General: Q4'09



MSC8156 ADS (Application Development System)

- ▶ MSC8156 or MSC8154 Multicore DSP
- ▶ Memories – DDR2 and DDR3, 1 GByte each
- ▶ Ethernet Switches – SGMII and RGMII
- ▶ SGMII/RGMII PHY
- ▶ TDM – 2x E1/T1 Framers & PTMC
- ▶ AMC connector
 - Dual 1000BaseX
 - Dual sRIO x4 / PCI-Ex x4
 - DM
- ▶ Board form factor – Dual Width AMC
- ▶ Availability – Now
- ▶ Price: \$3900



MSC8144 ADS (Application Development System)

► DSP – MSC8144

- Memory – DDR2 - 256 MByte
- Dual GE Ethernet – to switch and to PHY
- 4x/1x Serial RapidIO over AMC connector
- TDM
- Dual E1/T1 framers
- DS-3 framer (optional)
- Stereo codec (16-bit)
- Utopia – to MPU and to PTMC expander
- PCI (32bit) – to MPU and to PTMC expander
- I²C – 64 Kbyte
- RS-232

► MPU – MPC8560

- Memory – DDR1, 256 MByte
- Ethernet – to Switch and to PHY
- Utopia – to DSP and to PTMC expander
- Flash – 16 MByte
- RS-232

► Ethernet Switches

- SGMII (6 ports) and RGMII (8 ports) switches
- Quad GE PHY – 2 to switches and 2 DSP and MPU

► AMC Connector

- GE, Serial RapidIO, TDM

► JTAG

- Chained DSP+MPU
- Using USBTAP

► RoHS Compliant

► Includes Device Drivers



► Board Level Device Features

4 x MSC8144:

- 4 x SC3400 extended cores at 800 MHz / 1 GHz
- 16 x ALUs deliver up to 12800 / 16000 MMACS
- 512 Kbyte shared M2 memory
- 10 Mbytes of 128-bit wide shared M3 memory
- DDR memory controller: 200 MHz
- QUICC Engine
- 8 x TDM interfaces
- Security Engine Core optimized for IPsec, IKE, WTLS/WAP, SSL/TLS, and 3GPP protocols
- 2 x Gigabit Ethernet interface
- 1 x ATM controller supporting a UTOPIA interface
- 1 x Serial RapidIO interface supporting x1/x4
- Serial Peripheral Interface (SPI)

Gigabit Ethernet Switch:

- Routes and switches Ethernet ports from each MSC8144E over SGMII to external connectors

► Board Memory

256 Mbytes DDR II (Discrete) per MSC8144

► Board I/O

AMC Connector:

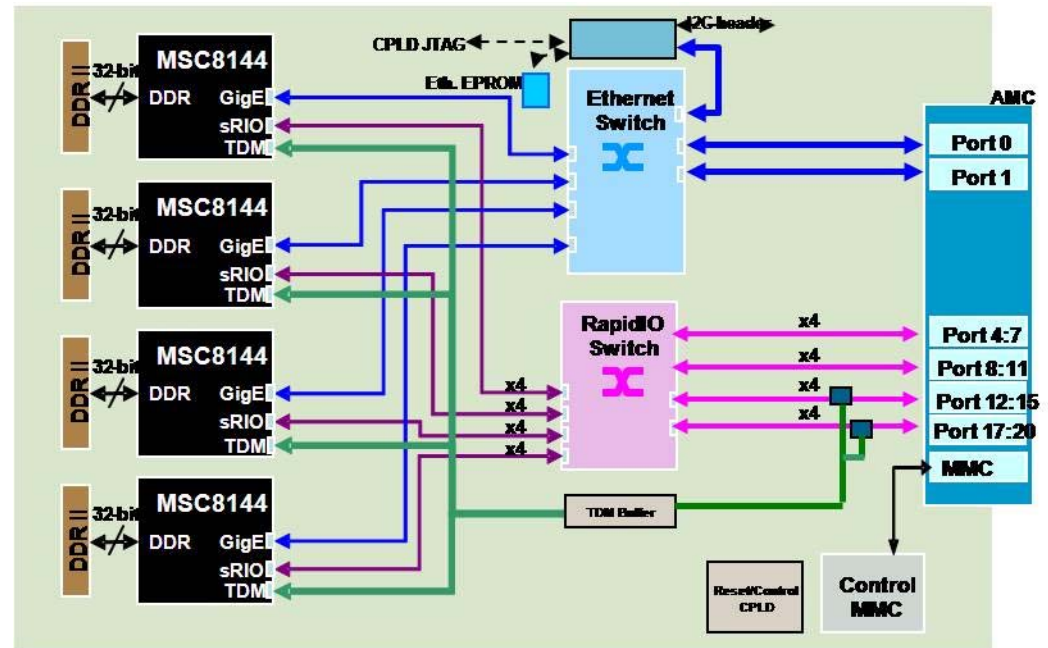
- 2 x Gigabit Ethernet interfaces (Port 0,1)
- x1/x4 sRIO (Port 4:7)
- x1/x4 sRIO (Port 8:11)
- TDM (16Tx, 16Rx, SYNC, CLK) (Port 12:20)

Headers and Debug:

- DSP JTAG/EONCE
- CPLD JTAG

► Front Panel

- Via Expansion Header
- 1 x Gigabit Ethernet (RJ45)
- 1 x JTAG (MMC)
- 1 x UART
- SPI/I²C Programming Headers



High Performance ATCA-9100 from Radisys

► A high density media resource module

- MPC8548 (PQ3) LMP
- 20 MSC8144 1GHz devices
 - Each supporting DDR, 2 SGMII, 1x SRIO
- In production

