Ramon Chips

RC64-Based NOGAH Systems
Enabling Software Defined Satellite Payloads

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Ramon Chips is named in memory of Col. Ilan Ramon, Israeli astronaut who died on board the Columbia space shuttle, 1/2/2003

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ThalesAlenia Space
Ramon Chips is a Computer Company

- Rather than a Space company
- But we only do Space computers
- Fully funded by government(s)
- The team comes with experience in computing, communications, semiconductors, software and space
JPEG200 Image Compression

- First product by Ramon Chips
- Custom made
- Plastic QFP better than ceramic
GR712RC dual core Leon3FT
- Gaisler IP cores
- Ramon Chips added RHBD and silicon
- Space Off The Shelf (SOTS, not COTS)
- Extremely successful—used everywhere
- Most recently last week
  BERESHEET Lunar Lander
RC64

- Rad Hard
  - 300 kRad, SEL free, managed SEU
  - Always recovers from SEFI
  - HW + SW FDIR
- High Performance
  - Competitive with FPGAs, GPU, …
- Low Power
  - BEST in MIPS/Watt
- Fast I/O
  - 12x SpFi (5 Gb/s)
  - 6 SpW
  - Flash
- Software Defined
  - C, rather than VHDL / Verilog / CUDA / …
  - Also C-from-Matlab
RC64

- 64 DSP cores
- Shared memory 4 Mbytes in 256 banks
- Hardware scheduler
- Log-net cores ↔ shared memory $100 \times 256$
- Cores are NOT inter-connected
- All I/O to shared memory
RC64 Programming Model

- Task Oriented
- Programmer creates
  - Task Dependency Graph
  - Sequential Task Codes
- Task Graph loaded into Scheduler
- Task Codes loaded into Shared Mem
- Scheduler “executes” the Graph
  - Dispatches tasks to cores
- Shared Memory Model
  - Correct By Design
  - Formally Verifiable
RC64

- Almost fully tested
  - Logic clean
  - SEL free
  - Recovers from all SEFI
  - SW control of thermal cycles (plastic BGA)
  - Ramon Chips Own Screen + Qual Flow

- TRL 7

- Available now

- Long shelf life. Long lifetime in Space. Long commitment of support

- Low cost (almost COTS)

- Lower total cost (and shorter schedule) than COTS
RC64 vs other space processors
Performance to Power

![Graph showing performance to power comparison]

- RC256
- RC64
- HPSC
- DAHLIA
- Maestro
- Intel-i7
RC64 answers the Goddard list

- Plus scalability
RC64 is designed for parties → NOGAH systems

Reliability FDIR

OS-based host

GR712RC or GR740

RC64

GR712RC or GR740

RC64

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RC64
RC64 is designed for parties → NOGAH systems
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- Two Programming Models: Shared Memory Inside
- Message Passing In Between
- OS-based host
- FDIR
- Very Fast Network
Example: 3U VPX Downlink Transmitter (1 Gb/s)
Example: 3U VPX Downlink Transmitter (1 Gb/s)
Same Same but covered
“FOSTER” Ramon Chips—Thales Alenia Space Collaboration

- ESA DSP Benchmarks
- Telecom Applications
  - DBFN
  - Channelization
  - Modems
  - Interference Detection and Mitigation
- More next week here at ESTEC
Benchmarks measure performance and power

- Example: FIR filter
- Showing 5 uSec
- Showing varying power
- 65 GOPS (16 bits)
- 4 Watt
- 16 GOPS / Watt
Preliminary ideas for 6U-220 cards
NOGAH systems: Cards, enclosures, software

These two examples are made by Altech (Los Angeles, USA—www.rugged.com)
# Software Systems

## Software “Operating System”
- Services
- Library Kernels
- Interfaces
- Drivers
- Run Time Executive “RCEX”

## Software Development Tools
- Integrated Environment
- Optimization
- Libraries
- Debugger
- Parallel Task Compiler
- C Compiler

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Software Applications

- TELECOM
  - Spectrum Analysis
  - Digital Beam Forming
  - Interference mitigation
  - Channelization
  - Transparent switching
  - DVB-S2X & RCS2 modems
  - IP routing
  - SDN
  - Constellation Networking

- COMPUTING
  - Resilient Storage
  - Machine Learning (inference)
  - Cyber Security

- GNSS
  - Ultra-high Precision Receiver
  - Steerable Beam Transmitter

- EOS-OPTIC
  - Pixel processing
  - Time Delay & Integration
  - Detection of Changes
  - Accurate Positioning
  - Selective Reduction
  - Image Compression

- EOS-Hyperspectral Imaging
  - Hyperspectral Imaging Real Time Identification
  - Hyperspectral Image Compression

- EOS-SAR
  - 2D/3D FFT
  - BAQ Compression
  - Object Identification
  - Interferometry
  - Digital Beam Forming
Conclusions

- RC64 is best high-performance, low-power processor for Space
- NOGAH systems excel in Performance, Power, Fault Tolerance, Ease of Programming, Availability, Affordability, Reconfigurability and Scalability
- Advantageous in both Incumbent and New Space
- Effectively no export restrictions
- Web page posts published papers and presentations