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# MONSSTR<sup>®</sup>

High Performance Solid State Recorder

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Presented at the THIC meeting at the Sheraton Barcelona Hotel  
Annapolis MD 21401-3094 on May 8, 2001

**THIC Inc.**

The Premier Advanced Recording Technology Forum



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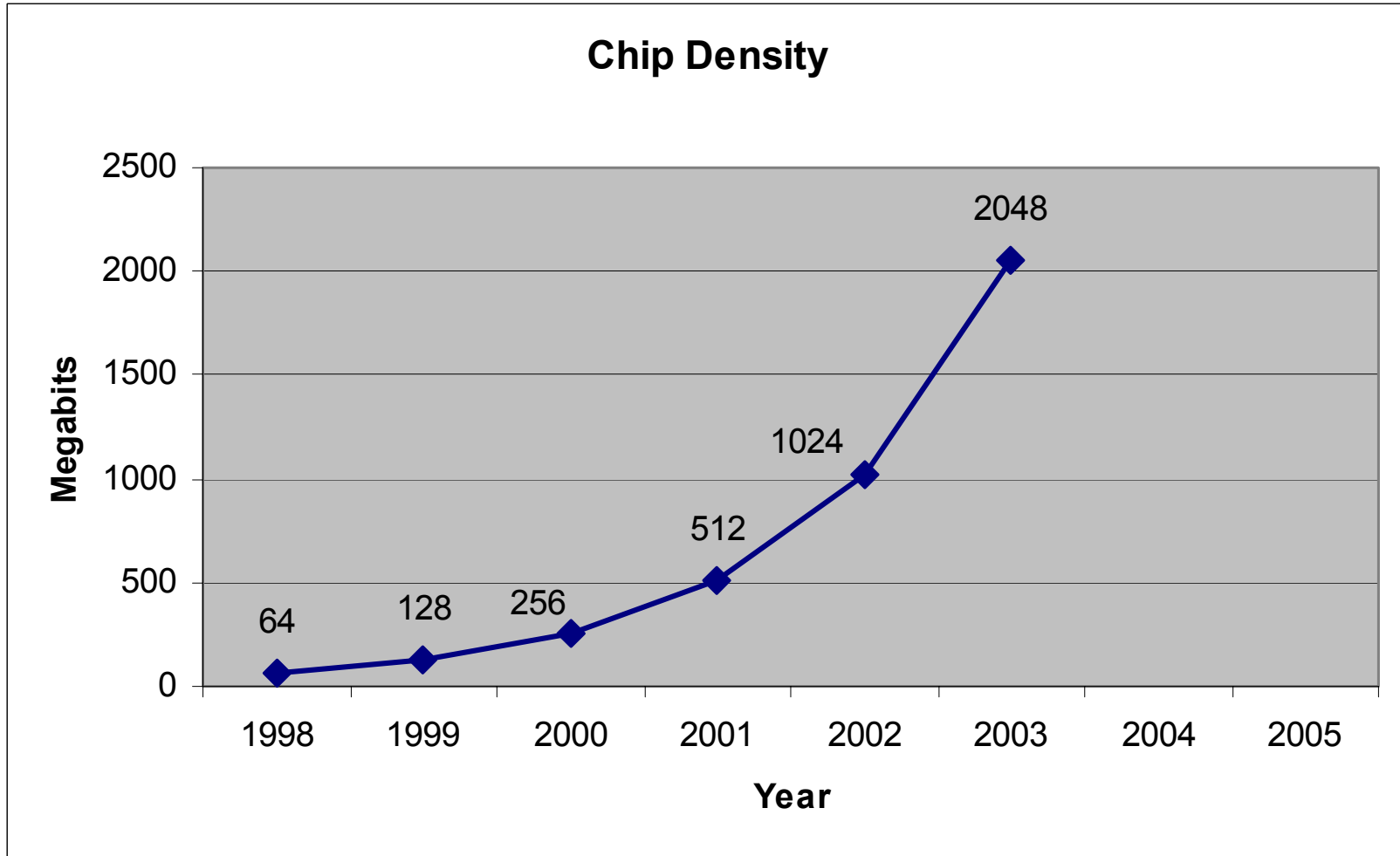
# Flash Memory Chip Density

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- Roughly following Moore's Law (doubling every 18 months)
- Started with 64Mbit during MONSSTR development
- First shipped systems used 128Mbit (1999)
- Currently shipping systems with 256Mbit
- Begin shipping 512Mbit systems in June 2001



# Flash Memory Chip Density





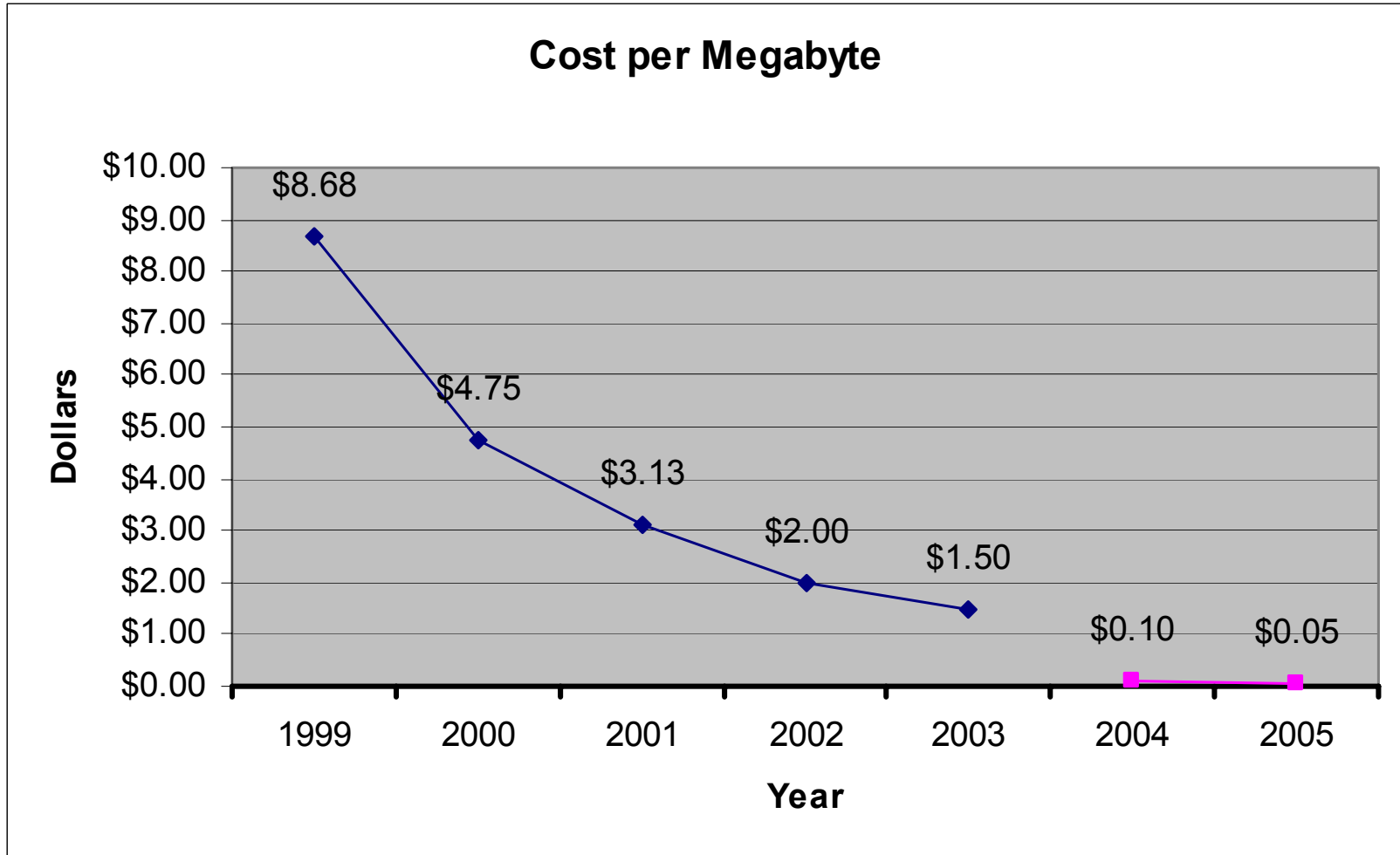
# Flash Memory Cost

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- Cost of producing a wafer is relatively constant
- Die shrinking produces more chips per wafer
- Industry will soon switch from 8" to 12" wafers
- “Mostly Good Memory” maintains yields
- Exotic new technologies three to five years out could significantly reduce cost and increase density



# Flash Memory Cost





# Flash Memory Bandwidth

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- Flash memory chip bandwidth virtually unchanged for years
- Flash memory chip performance driven by consumer electronics
  - Digital cameras
  - Cell phones
  - Smart cards
- Flash memory read speeds comparable to RAM
- Slow write and erase speeds present architectural challenge
- MONSSTR architecture overcomes flash chip limitations



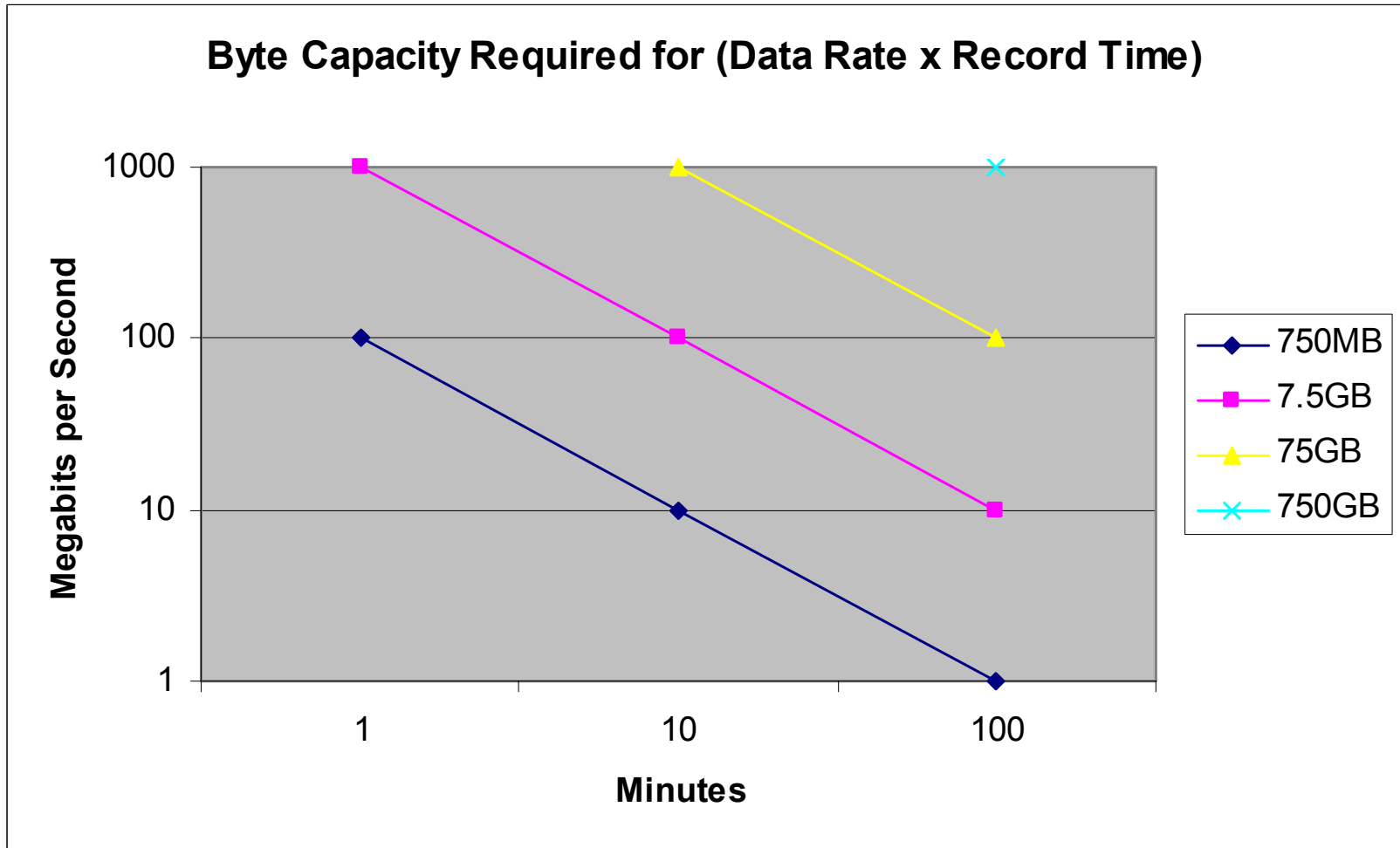
# MONSSTR Bandwidth

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- MONSSTR architecture has preplanned growth in bandwidth
- 1S (Single speed) MONSSTR 5000/6000 = 512Mbit/s
- 1S MONSSTR 7000 = 1Gbit/s
- 2S MONSSTR 5000/6000 = 1Gbit/s
- 2S MONSSTR 7000 = 2Gbit/s
- 4S MONSSTR 5000/6000/7000 when users ready
- Rated bandwidth (above) = 80% of internal bandwidth



# Memory Capacity





# Data Rate Issues

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- Ability to capture high-speed phenomena
- Data rate and record time drive memory capacity requirements
- Data rate often driven by download time constraint
- MONSSTR supports striping for data rate expansion
- MONSSTR supports daisy chaining for record time expansion



# MONSSTR I/O

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- 8- or 16-bit full duplex ECL controller
- Independent record and play speeds support read-after-write and read-while-write
- Supports two controllers simultaneously
- Can emulate Ampex DCRsi or Enertec ID-1
- Multiple internal I/O adapters available



# MONSSTR I/O (cont.)

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- FibreXtreme (Systran Corporation Fibre Channel protocol) – 105MBytes/sec sustained data rate
- 8 PCM + 2 Analog channels in IRIG 106 (ARMOR) format
- 2 PCM + 2 1553 + Time Code + Voice in IRIG 107 (SPIDR™) format
- 8 PCM + 8 1553 + Time Code + Voice in IRIG 107 format
- 26 PCM + Time Code + Voice in IRIG 107 format



# MONSSTR I/O (cont.)

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- Dual PMC Adapter Module with Intel i960RN processor (PMC = PCI Mezzanine Card)
  - SCSI all varieties (1, 2, 3, Wide, Ultra, SE, HVD, LVD)
  - Fibre Channel SCSI Protocol, 1Gbit/s and 2Gbit/s
  - Data Flow Network (DFN) for RAH-66 Comanche
  - Parallel Intermodule (PI) for RAH-66 Comanche
  - Any standard PMC module can be supported
  - Custom PMC modules when required



# Video Recording on MONSSTR

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- Miniature programmable wavelet compressor module
- Convert NTSC or PAL video into constant bit rate PCM (suitable for realtime TM)
- Full-motion 30-frame/sec color compressed to as little as 5Mbit/s with minimal artifacts
- Programmable frame decimation can increase compression to below 1Mbit/s



# Video Recording (cont.)

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- Record video as inputs on MONSSTR PCM channels
- Up to 4 compressor modules + PCM adapter internal to MONSSTR
- Up to 26 video channels with additional external compressor modules
- Software CODEC for playback on PC or Workstation
- Hardware decompressor for playback on video monitor



# STANAG 4575 Downloading

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- STANAG 4575 defines a Gigabit Fibre Channel download port on the Removable Memory Module (RMM)
- Subset of FCP Standard Block Mode SCSI commands
- Standard connector(s) for data and power
- OS-independent file structure with ASCII directory block
- MONSSTR 6000S and 7000S are STANAG 4575 compliant



# Download Systems

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- Airborne chassis w/ rack adapter and zero memory (move memory canister)
- Rapid Download and Diagnostic System – Eglin AFB (leave canister on aircraft)
  - High-speed download to RAID
  - Software decom for preflight checkout
- Ground Support Unit – Japan
  - RAID + 1553 and PCM simulators
- Ground Data Retrieving System – Israel
  - Preflight checkout and rapid download



# Download Systems (cont.)

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- Data Collection System – RAH-66 Comanche Flight Testing (Sikorsky West Palm Beach facility)
  - 10 sites on the flight line are each wired with three Fibre Channels (3 MONSSTRs per A/C)
  - 12 RAID servers, each with one Fibre Channel input and one 90MByte/sec RAID
  - RAID servers and flight line Fibre Channels coupled by Fibre Channel switch
  - 4 Data servers, each controlling 3 of the RAID servers
  - Can support four aircraft simultaneously
  - Two portable RAID servers for off-site downloading



# MONSSTR 2000 Series

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- Removable “shirt pocket” FlashCache™ cartridges
- 100 Mbyte/sec input + output bandwidth (full-duplex)
- CompactPCI (64-bit) internal system bus architecture
- High-efficiency conduction cooling
- User-programmable VxWorks OS environment
- FlashCache I up to 17Gbytes (~ 3.8” x 6.4” x 0.8”)
- FlashCache II up to 34Gbytes (~ 3.8” x 6.4” x 1.6”)



# MONSSTR Programs

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- Boeing/Sikorsky RAH-66 Comanche
- Lockheed/Boeing F-22 Raptor
- Lockheed U-2
- Lockheed C-5
- Lockheed C-130J
- Northrop Grumman Global Hawk
- US Air Force Eglin AFB F-15



# MONSSTR Programs (cont.)

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- US Air Force Eglin AFB SATIRS Pod
- US Navy NRL SHARP sensor testing
- Recon/Optical Inc. sensor testing
- US Air Force Edwards AFB F-16
- US Navy NUWC torpedo testing
- US Navy UAV testing
- Utah State University sensor testing



# MONSSTR Programs (cont.)

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- DERA (U.K.) Recce pod
- DASA (Germany) synthetic aperture radar
- MHI (Japan) F-4
- MHI (Japan) F-15
- Turkish Air Force Recce pod
- Greek Air Force Recce pod
- EADS (NATO) Tornado EW