



CALIMETRICS

Calimetrics: The Next Step in Optical Data Storage

Tom Burke, Chairman, Calimetrics, Inc.
815 Atlantic Avenue, Suite 105, Alameda CA 94501
Tel: +1-510-864-4100 Fax: +1-510-864-4188
trburke@calimetrics.com

Presented at the THIC Meeting at the Sheraton Barcelo
Annapolis MD 21401-3094

May 8, 2001

The Premier Advanced Recording Technology Forum

THIC Inc.



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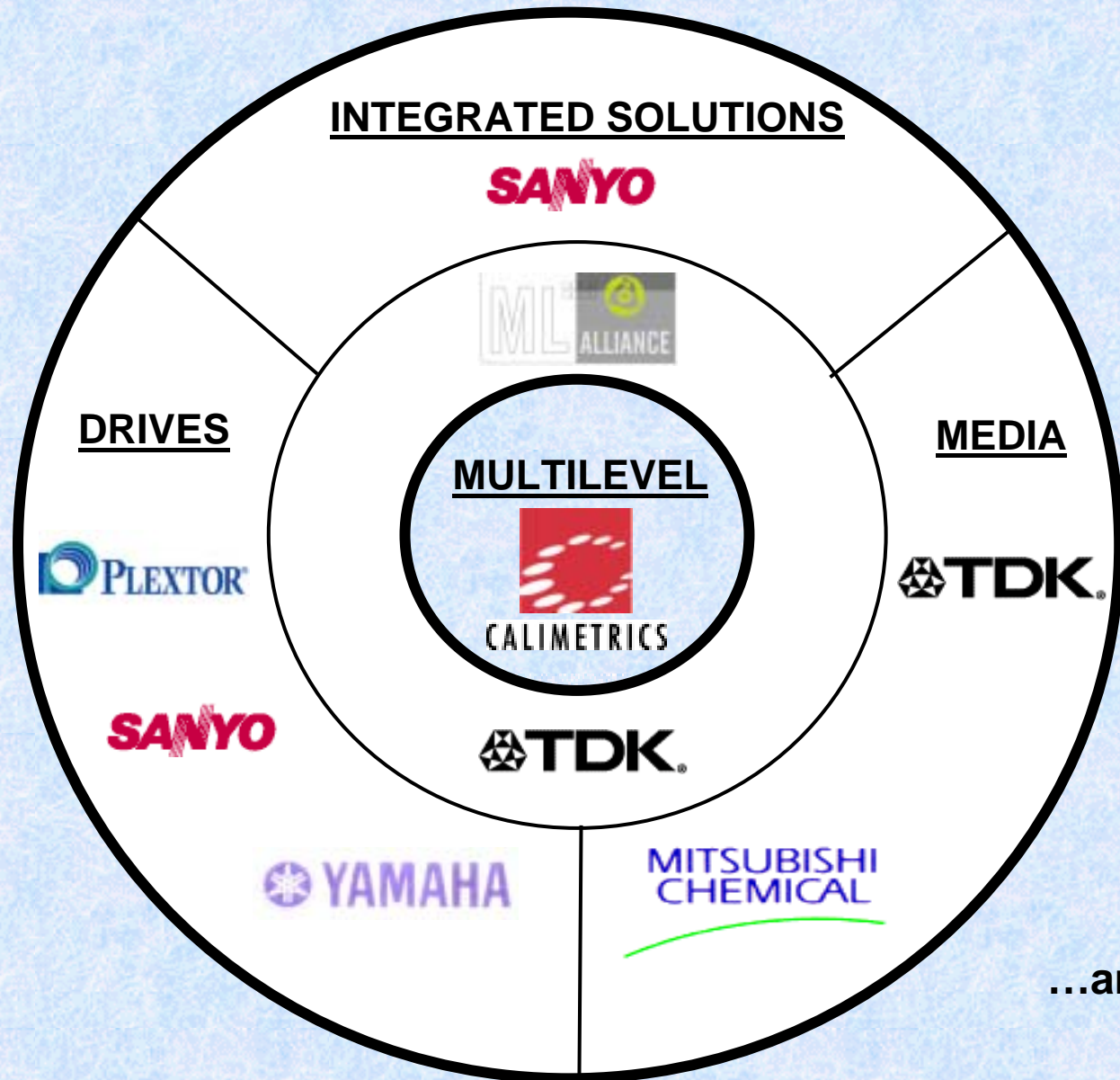
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THIC Meeting, May 8, 2001, Annapolis MD

Brought to you by Calimetrics, TDK, and the ML Alliance



...and growing!



Vision

- Calimetrics' Vision

Enabling Faster-Bigger-Cheaper Digital Data Storage and Transmission for Legacy Systems Using MultiLevel and Related Technologies

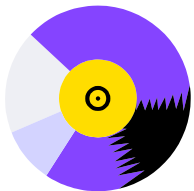
- ML Alliance Vision

Creating Compelling New Products Harnessing ML Technology for the CD/Optical Data Storage Industry



CALIMETRICS

Calimetrics' Mission



Calimetrics is the unique supplier of low cost, high capacity and high speed enhancements for Optical Data Storage and Communications Systems



Calimetrics Background

- Founded 1994
 - MultiLevel Recording and Related Technology for Optical Data Storage
 - Original research conducted at UC Berkeley, 1989-94
- Recipient of 2 NIST Advanced Technology Program Awards
 - 1995-97: ML CD-ROM
 - 1997-2001: NSIC MORE Joint Venture for ML + NF
- 1998-99: Corporate R&D Program
 - ML CD-R/RW Proof of Concept and Feasibility
- 2000-01: Commercialization Partnerships
 - TDK, Mitsubishi Chemical, Sanyo, Plextor, Yamaha, Unnamed Partner
- Well-Funded with Strong Partnerships Bringing Products to Market



CALIMETRICS

Calimetrics' Key Enablers

Team

World class optical research and development team of 55 (14 Ph.D.'s)
Unequaled "know-how" in optical: ROM, WORM, Re-Writable technology
Committed, experienced management team

Technology

Proprietary Optical Recording and Signal Processing Technology
Optical Media "Know How"
Technological "Head Room" to Create Further Innovations, Next Generations
Complementary To the Industry's Technology Roadmap

IP Portfolio

Total of 64 Patents/Patents Pending that Calimetrics owns/exclusively licenses
Plus 104 Invention Disclosures in patent application process, all covering:

- **MultiLevel Recording and Signal Processing**
- **MultiLevel/M...ary Coding Technology**
- **Near Field Recording Technology and Related Technologies**



CALIMETRICS

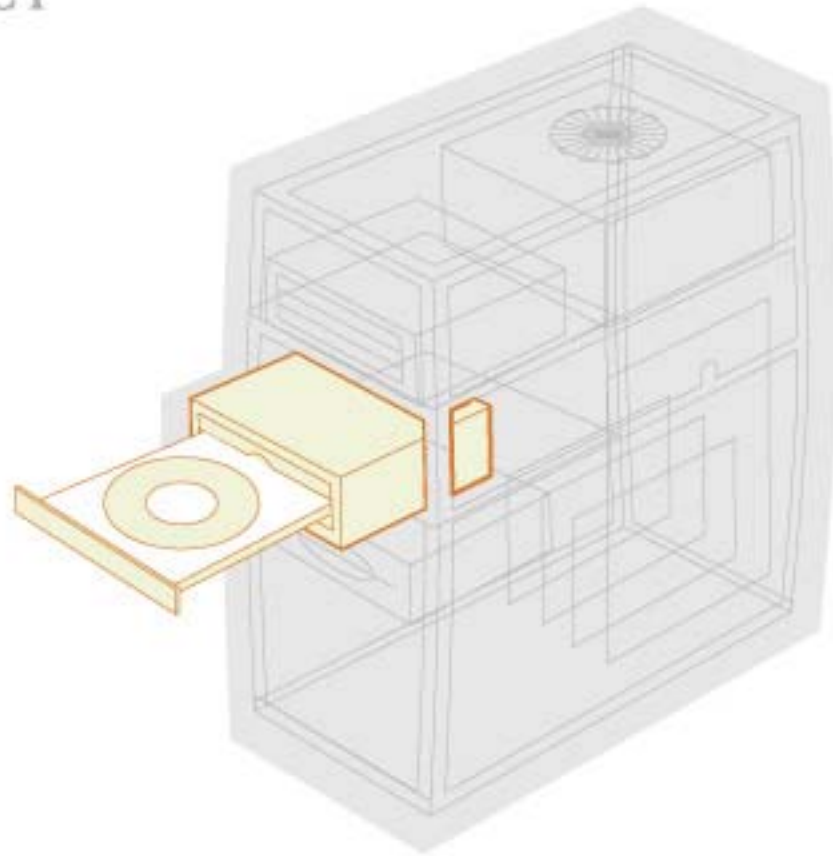
The ML Proposition

**Triple Capacity & Speed
At Low Cost**

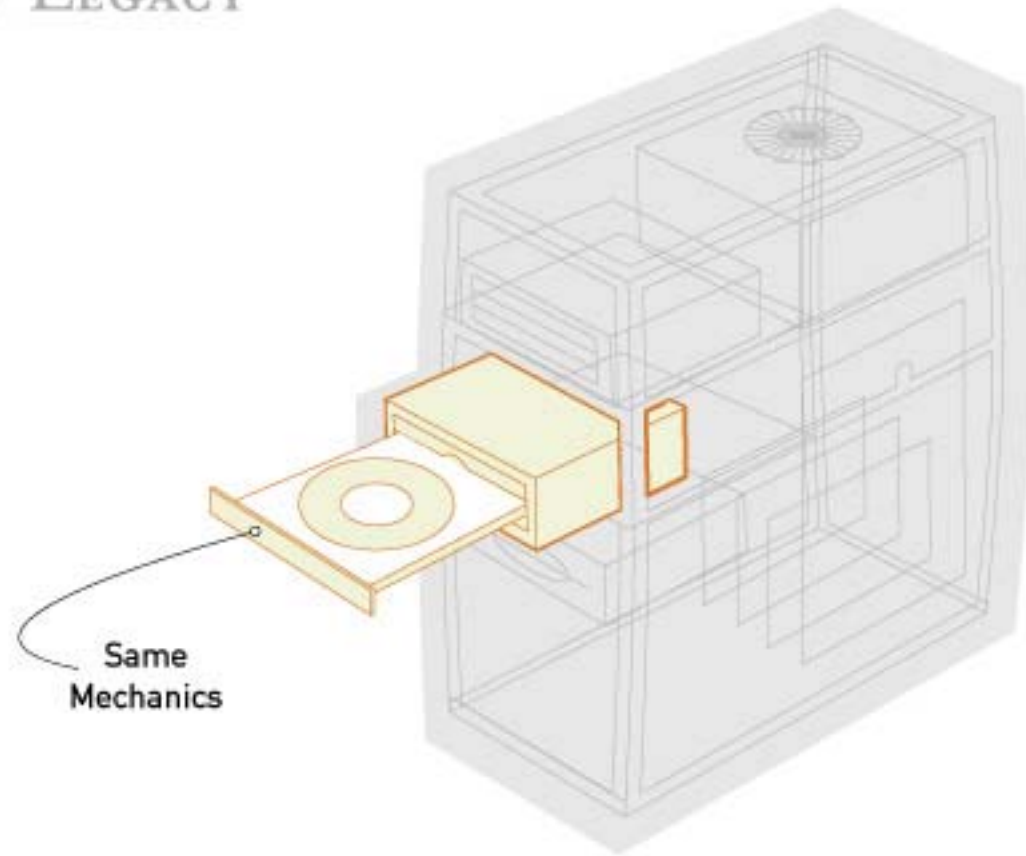
A person is holding a compact disc (CD) in front of a blue background. The CD is held in the center of the frame, and its surface reflects light, creating a rainbow-like spectrum. The person's hands are visible, holding the CD from the sides. The background is a solid, slightly blurred blue color. In the lower center, there is a red circular graphic containing white text.

**MULTILEVEL
RECORDING
TECHNOLOGY**

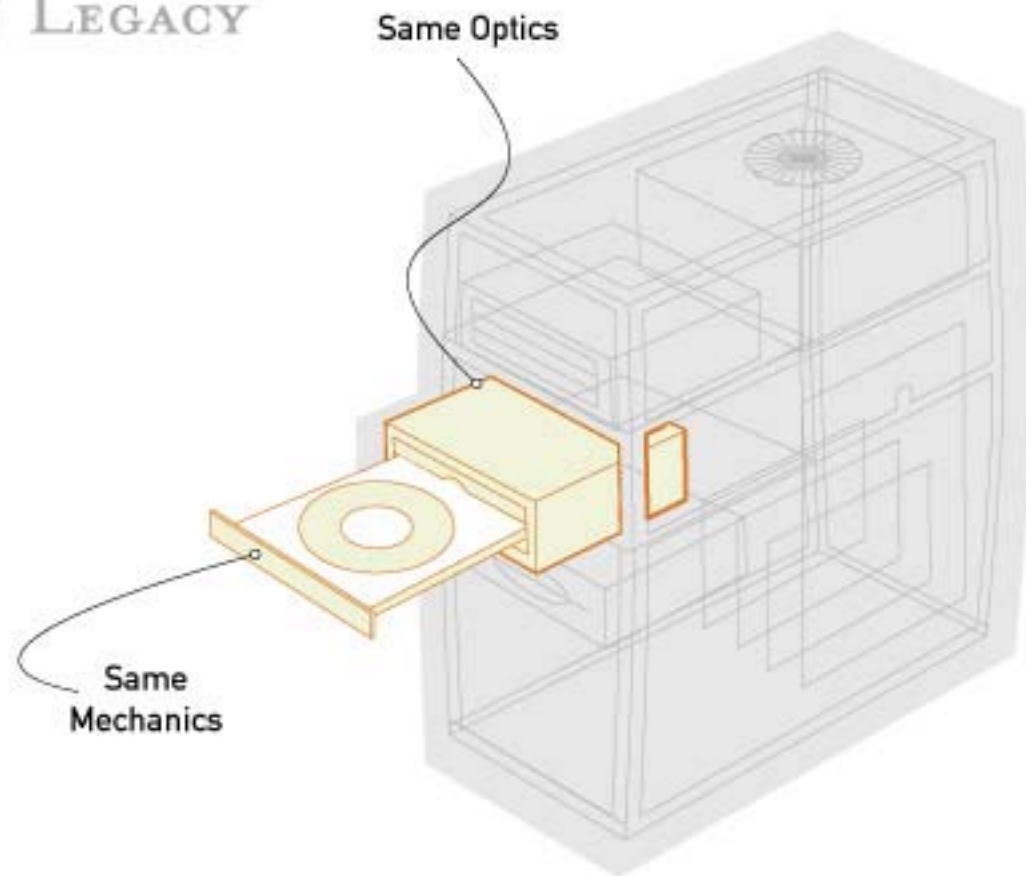
ML OPTIMIZES THE CD-RW LEGACY



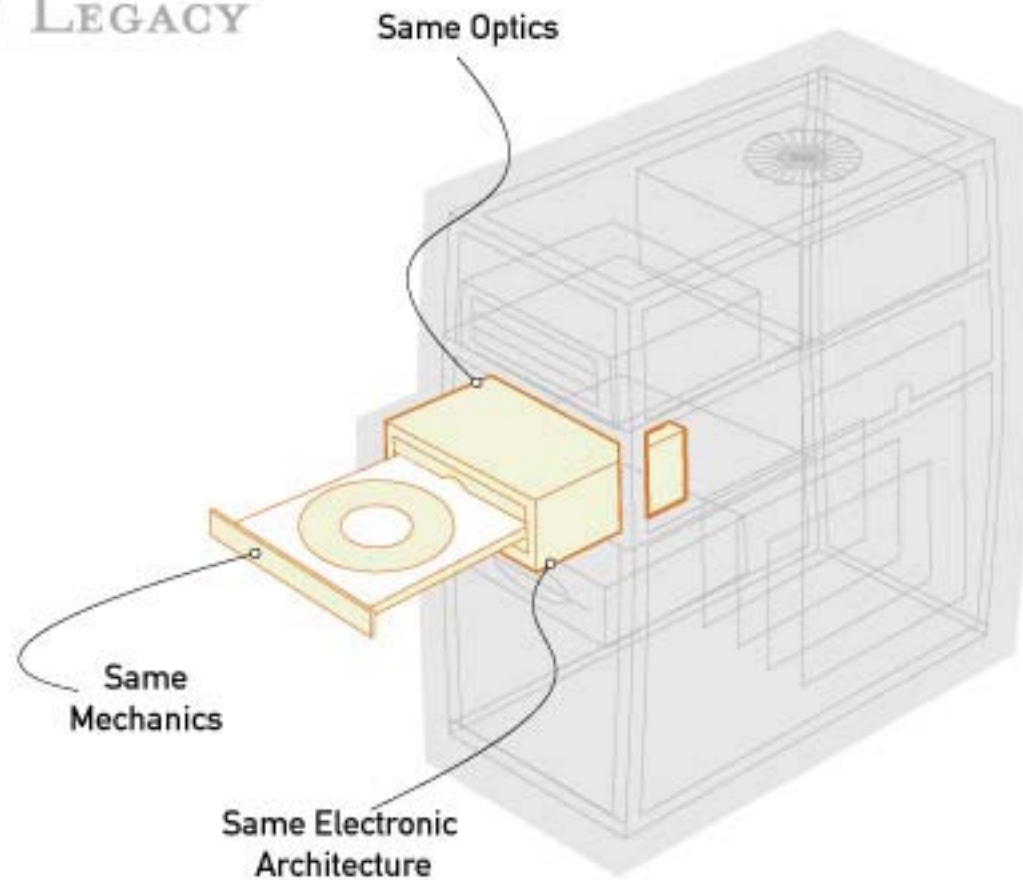
ML OPTIMIZES THE CD-RW LEGACY



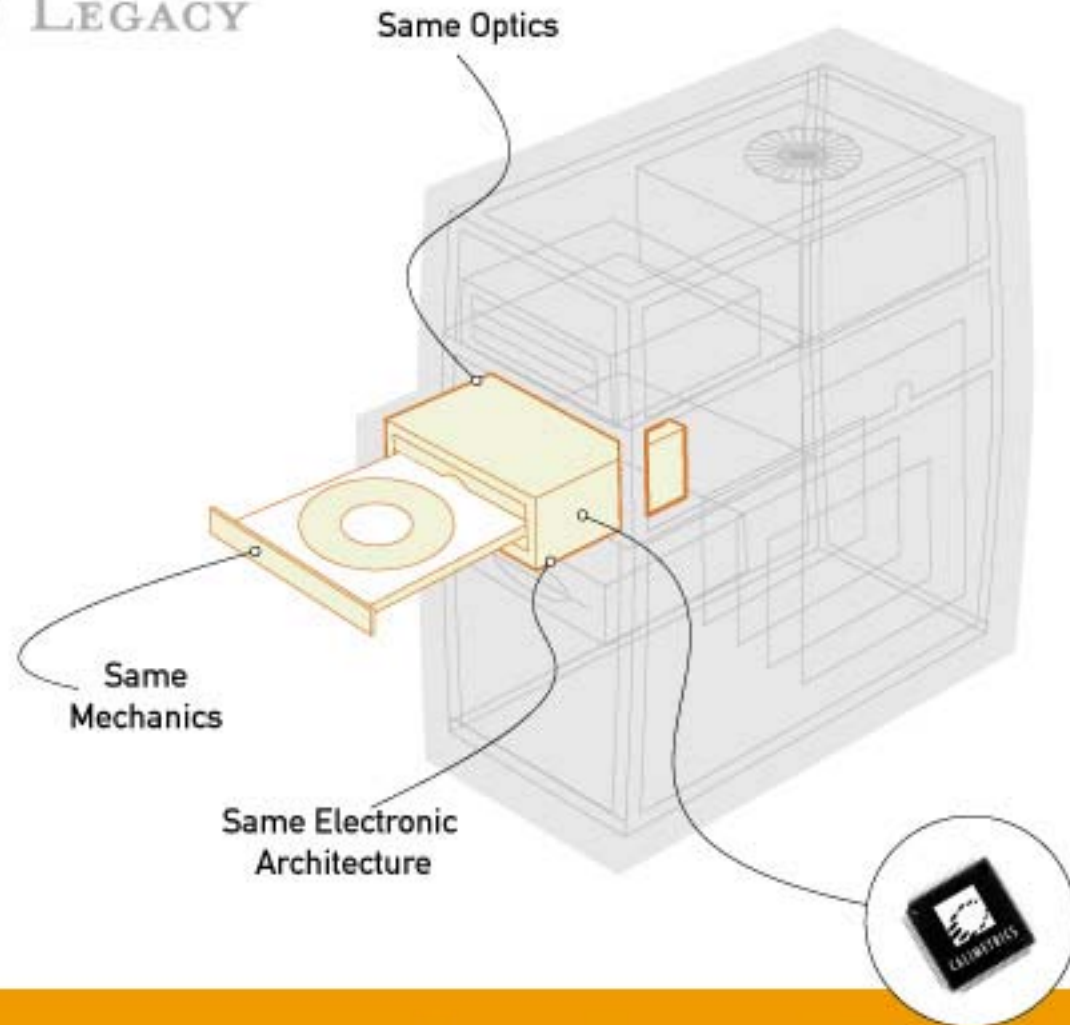
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ML OPTIMIZES THE CD-RW LEGACY

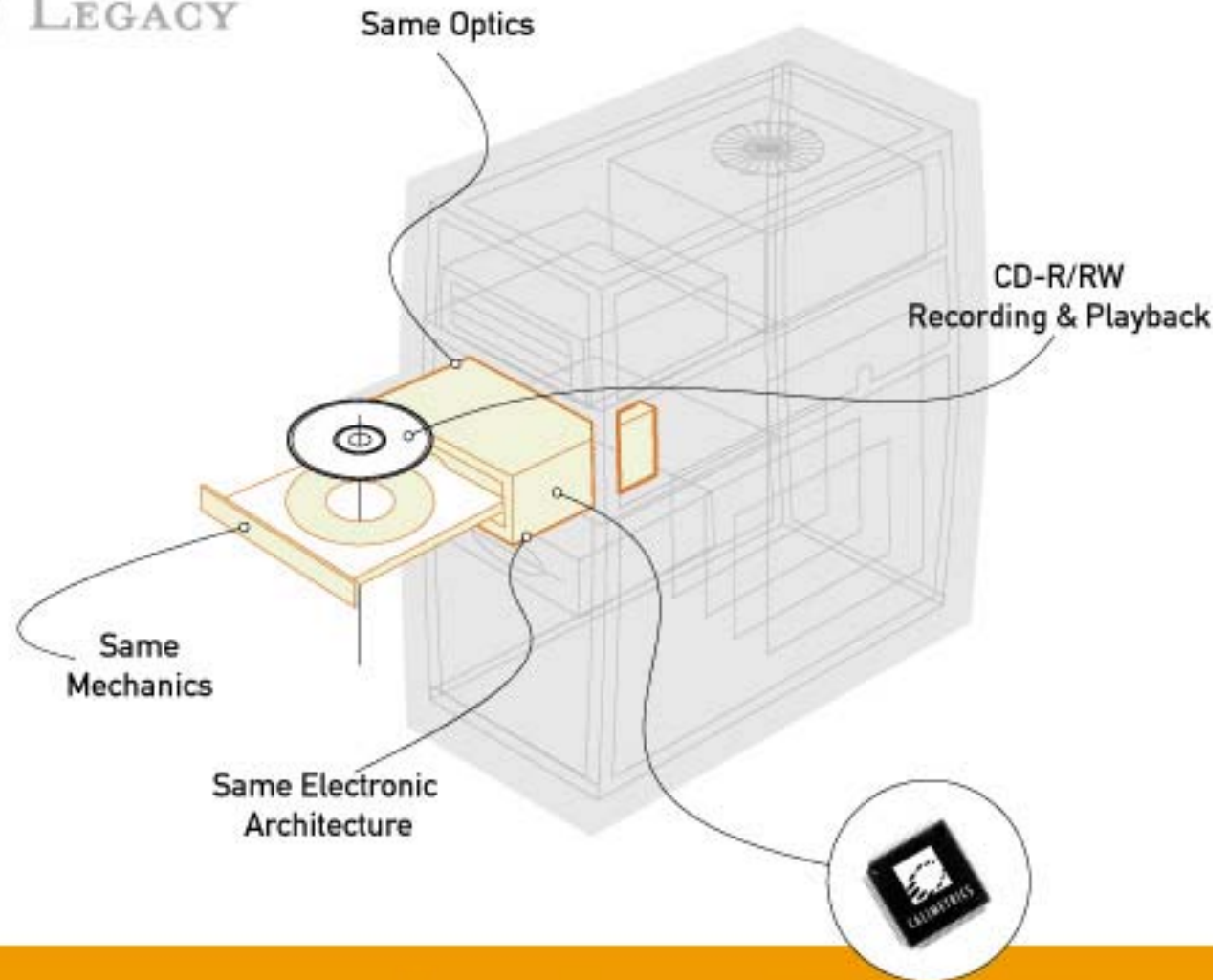


ML OPTIMIZES THE CD-RW LEGACY



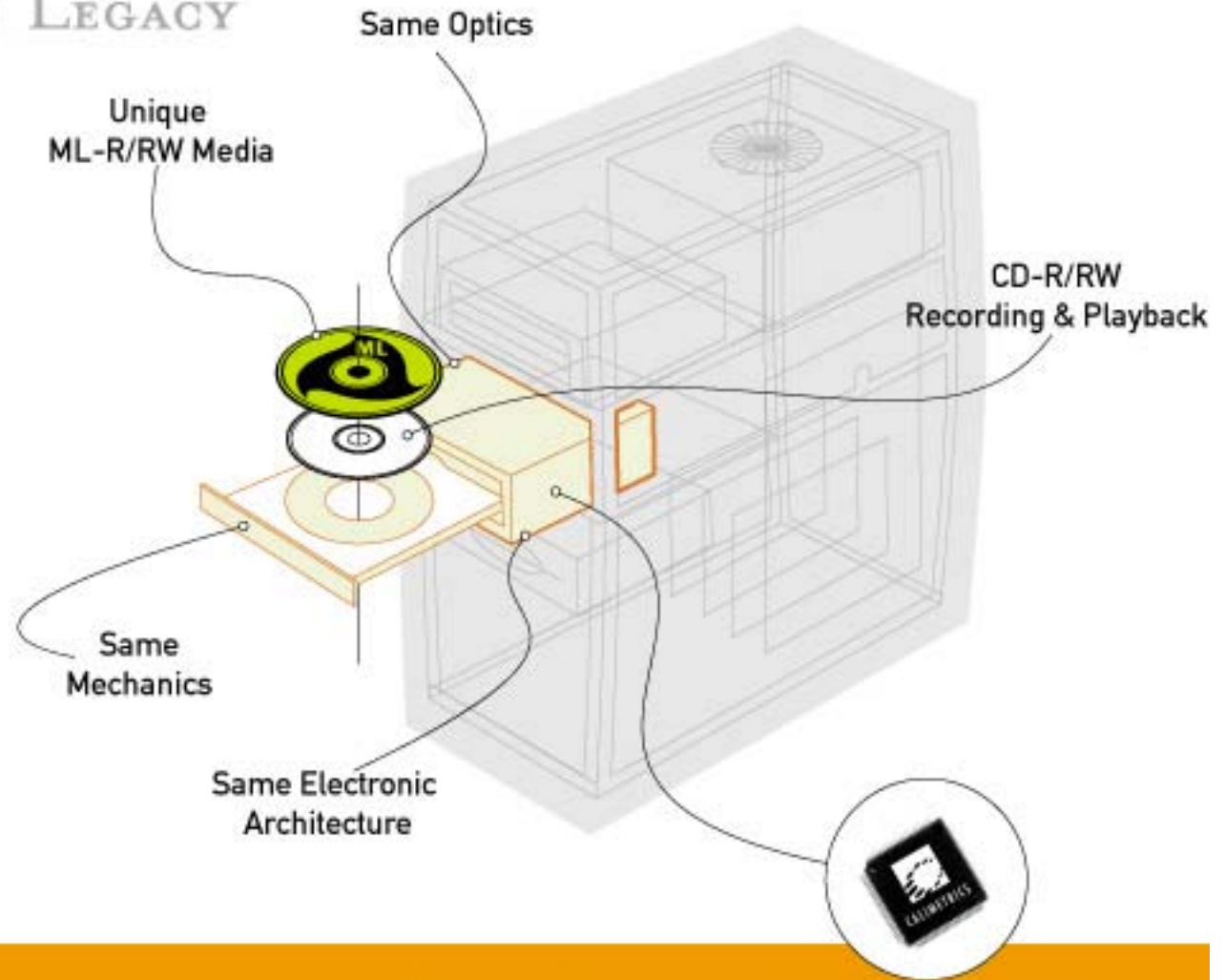
"Design In" a Single ML Read/Write Chip

ML OPTIMIZES THE CD-RW LEGACY



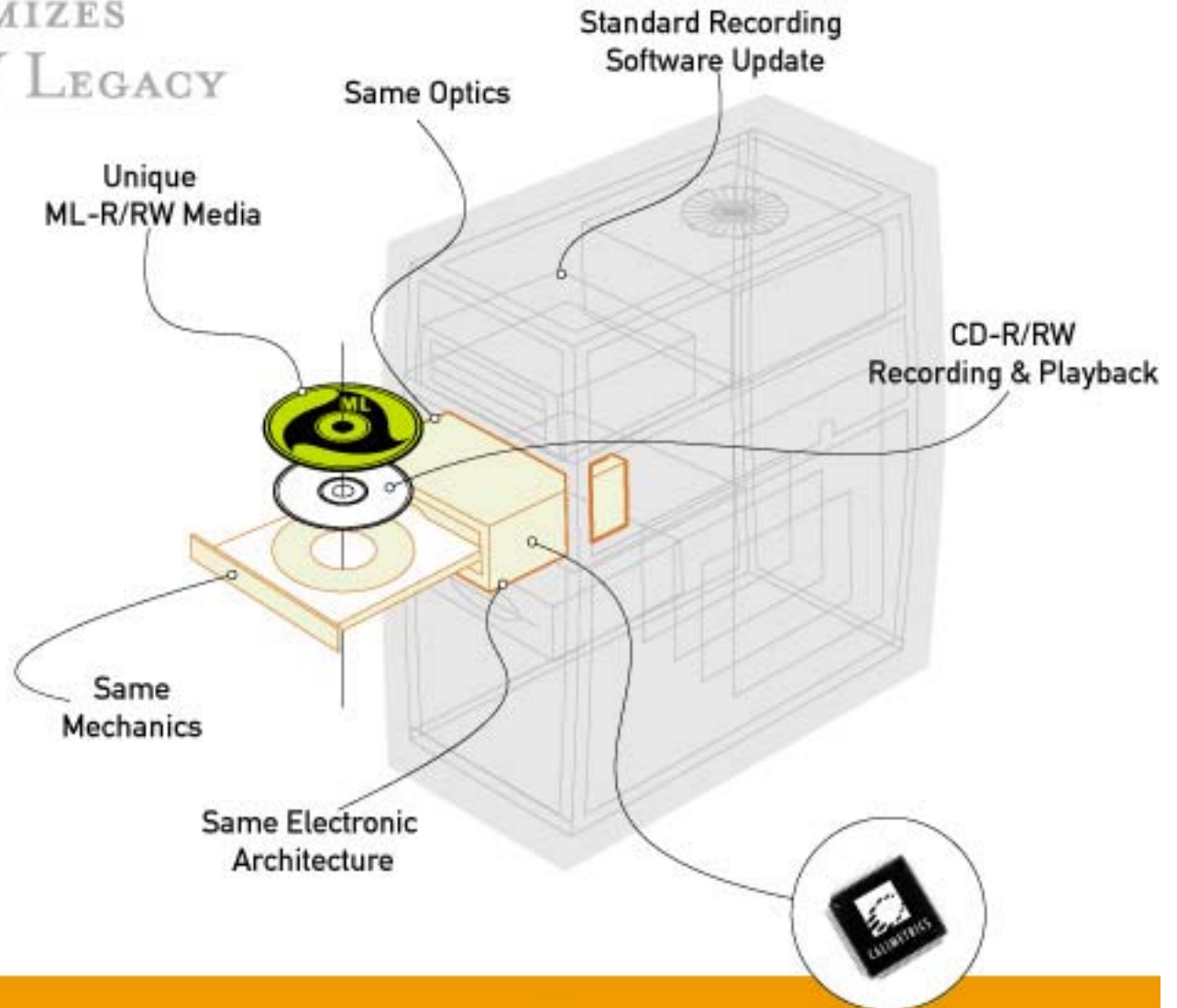
"Design In" a Single ML Read/Write Chip

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"Design In" a Single ML Read/Write Chip

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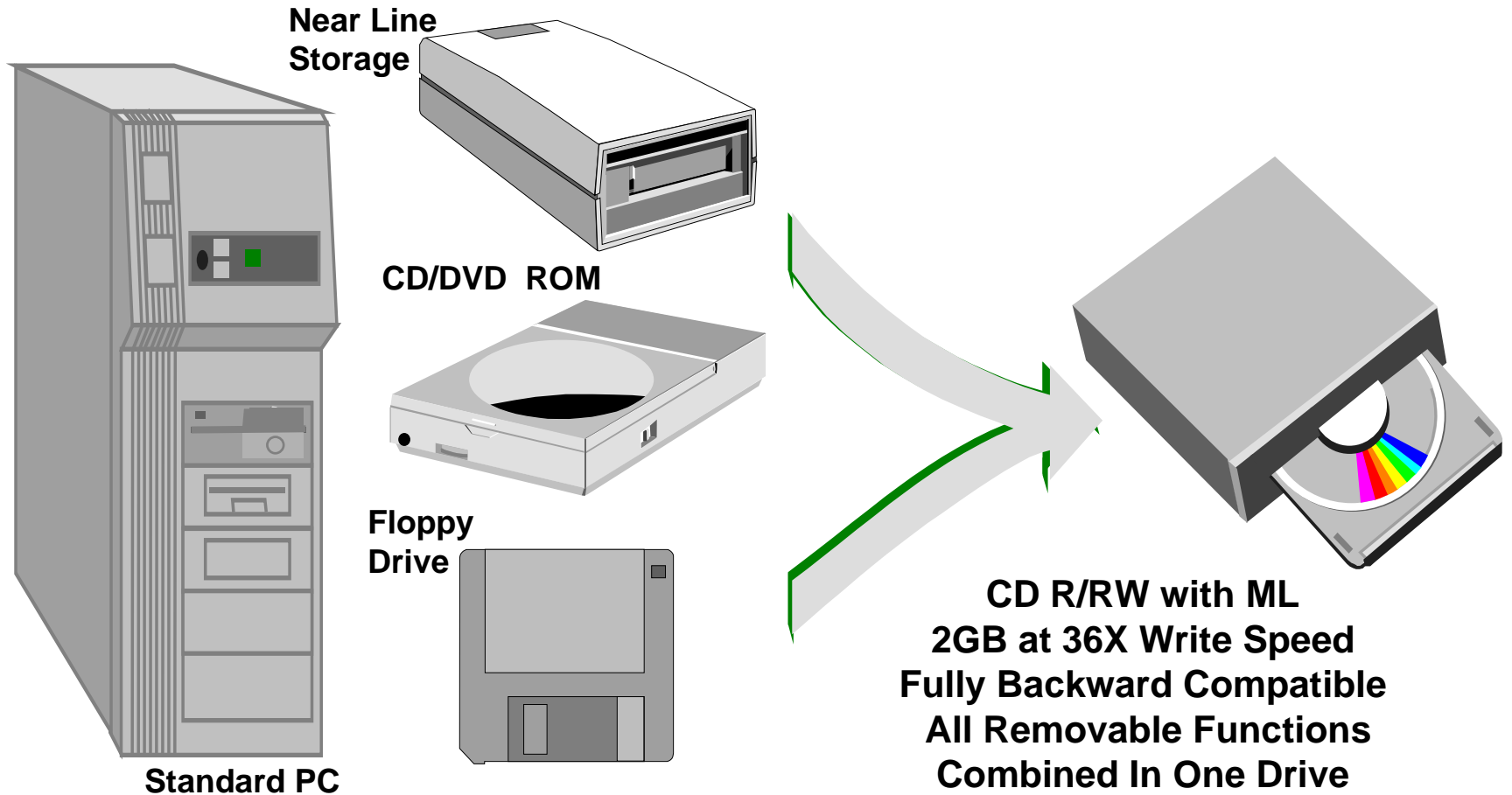


"Design In" a Single ML Read/Write Chip



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ML CD-Enabled PC Product



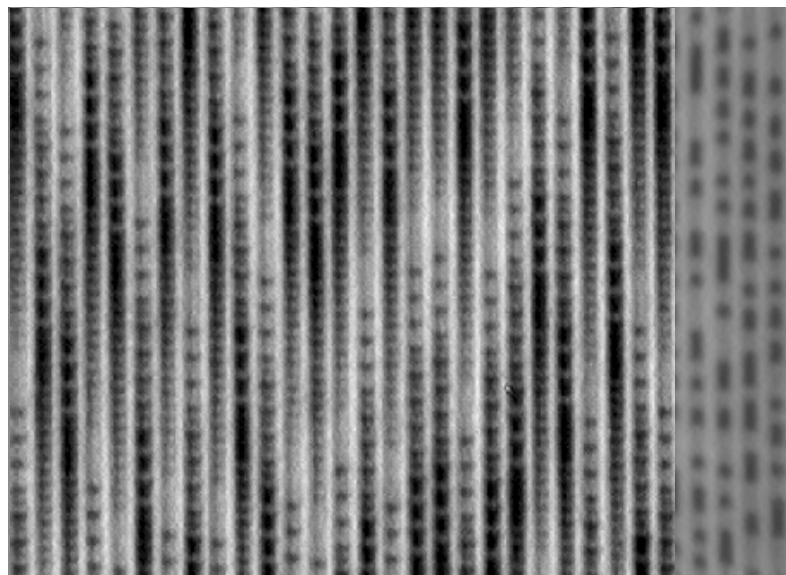
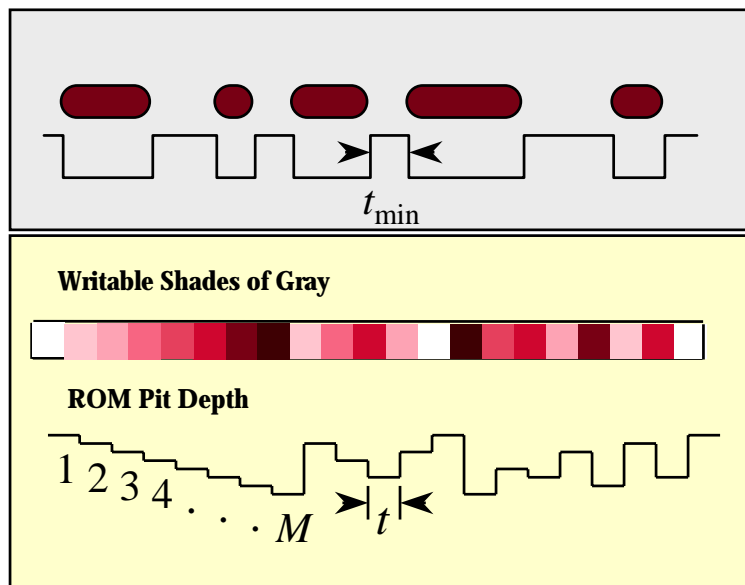


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Calimetrics Technology

Triple Speed & Triple Density Resulting From a Proprietary Recording Format.

- Proprietary Modulation Code makes maximum Use of the Disc Surface
- Technique Enables 8 Reflectivity Levels for Recorded Marks
- Reading Results in an Analog Signal Representing the 8 Levels
- Proprietary Decoder converts these 8 Levels to 2.5 User Bits/ Mark



ML media line up



120mm=2GB

80mm=650MB

60mm=200MB

TDK
e-material solution provider



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120 MM Product Extension



ML 120mm

Product Vision

80mm “Post-PC” Applications

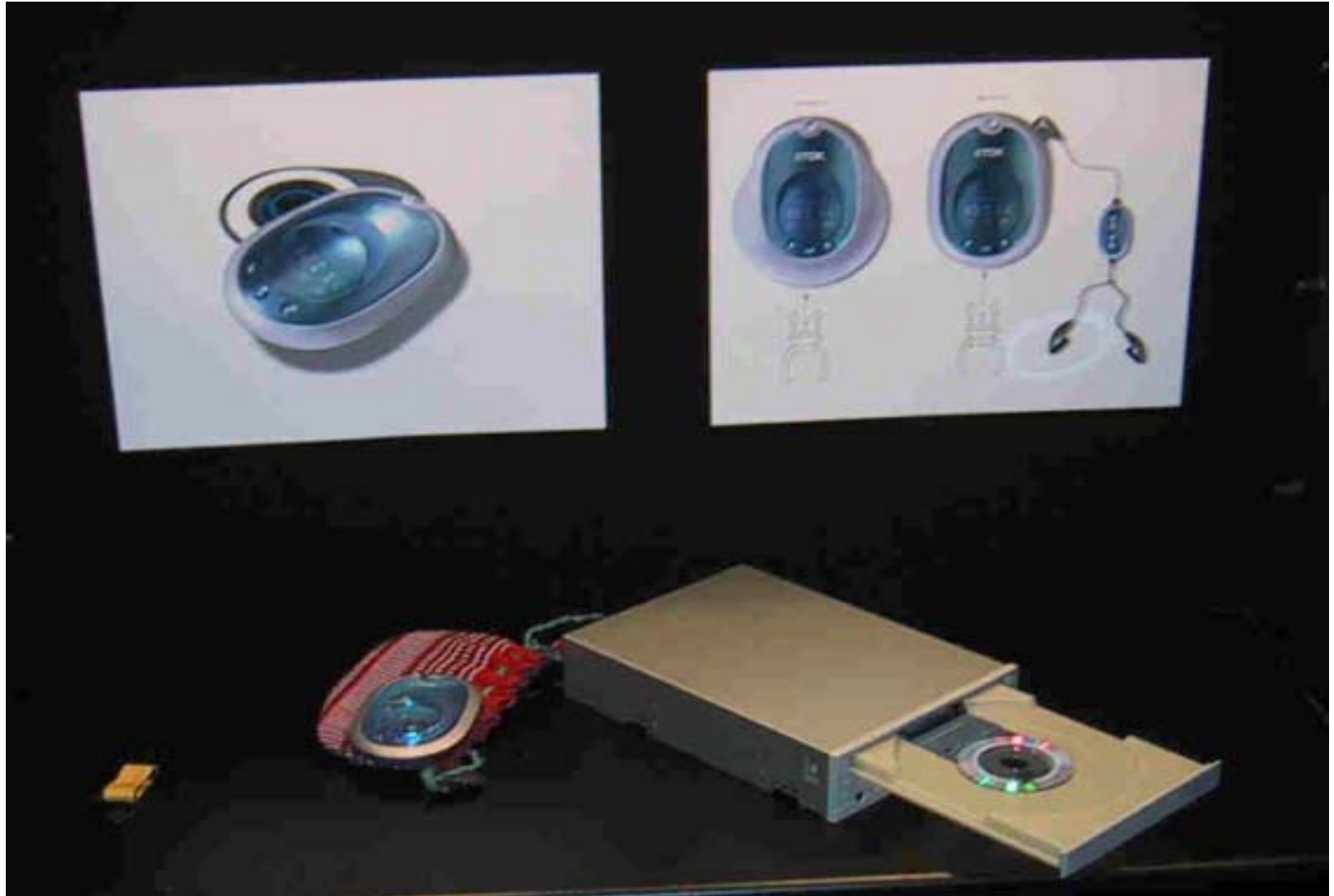


ML 80mm
Product Vision



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New 60mm Format





ML Video Applications

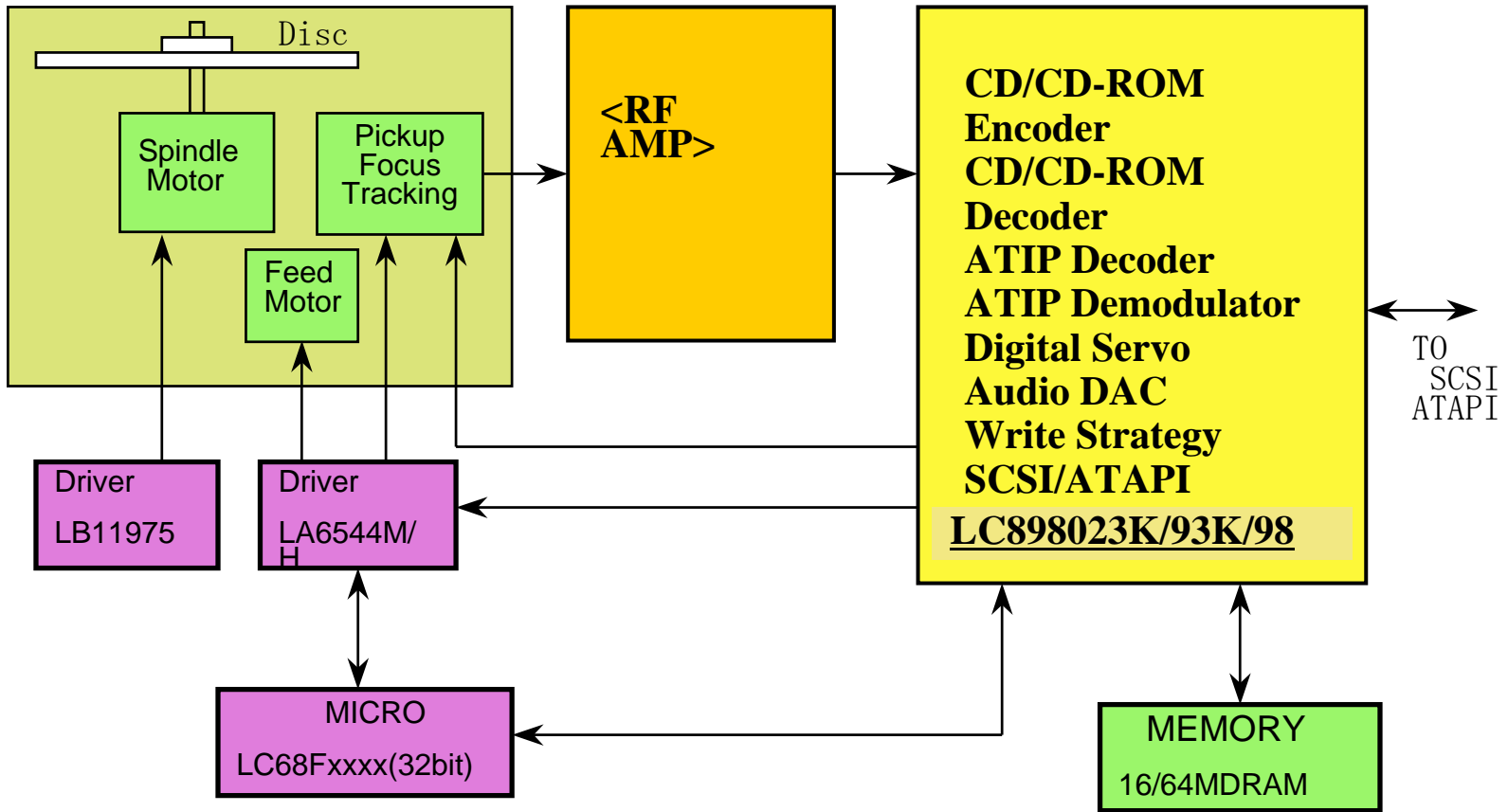
	60mm ML	80mm ML	120mm ML
Disk Capacity (MB)	200.0	650.0	2000.0
DVD Video (4.7Mbps) min	5.7	18.4	56.7
DVD Video (4.7Mbps) hr	0.1	0.3	0.9
VCD MPEG-1 (1.35Mbps) min	19.8	64.2	197.5
VCD MPEG-1 (1.35Mbps) hr	0.3	1.1	3.3
SVCD MPEG-2 (2.6 Mbps) min	10.3	33.3	102.6
SVCD MPEG-2 (2.6 Mbps) hr	0.2	0.6	1.7
MPEG-4 (256 Kbps) QCIF VC min	104.2	338.5	1041.7
MPEG-4 (256 Kbps) QCIF VC hr	1.7	5.6	17.4
MPEG-4 (384 Kbps) QCIF VC min	69.4	225.7	694.4
MPEG-4 (384 Kbps) QCIF VC hr	1.2	3.8	11.6
MPEG-4 (512 Kbps) CIF Near-VHS min	52.1	169.3	520.8
MPEG-4 (512 Kbps) CIF Near-VHS hr	0.9	2.8	8.7
MPEG-4 (768 Kbps) CIF VHS min	34.7	112.8	347.2
MPEG-4 (768 Kbps) CIF VHS hr	0.6	1.9	5.8
MPEG-4 (1 Mbps) CCIR VHS+ min	26.1	84.6	260.4
MPEG-4 (1 Mbps) CCIR VHS+ hr	0.5	1.4	4.3
MPEG-4 (3 Mbps) CCIR Near DVD min	8.9	28.9	88.9
MPEG-4 (3 Mbps) CCIR Near DVD hr	0.1	0.5	1.5



ML Audio Applications

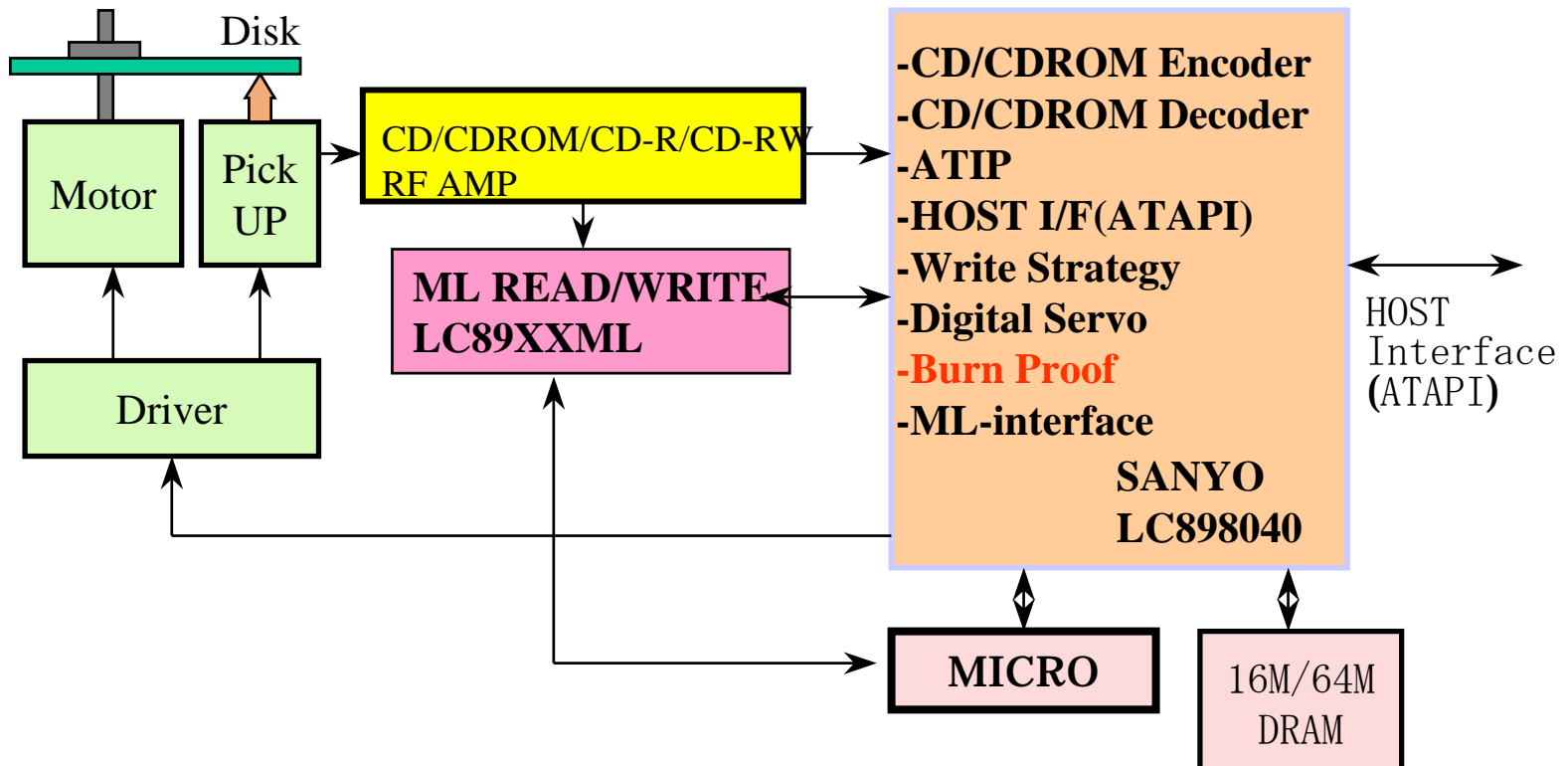
	60mm ML	80mm ML	120mm ML
Disk Capacity (MB)	200.0	650.0	2000.0
CD Audio (WAV) min	19.8	74.0	197.5
CD Audio (WAV) hr	0.3	1.2	3.3
High Quality MP3 (192Kbps) min	138.9	451.4	1388.9
High Quality MP3 (192Kbps) hr	2.3	7.5	23.1
High Quality MP3 (192Kbps) days	0.1	0.3	1.0
Mid Quality MP3 (128Kbps) min	208.3	677.1	2083.3
Mid Quality MP3 (128Kbps) hr	3.5	11.3	34.7
Mid Quality MP3 (128Kbps) days	0.1	0.5	1.4
Low Quality MP3 (64Kbps) min	416.7	1354.2	4166.7
Low Quality MP3 (64Kbps) hr	6.9	22.6	69.4
Low Quality MP3 (64Kbps) days	0.3	0.9	2.9

CD-R/RW System



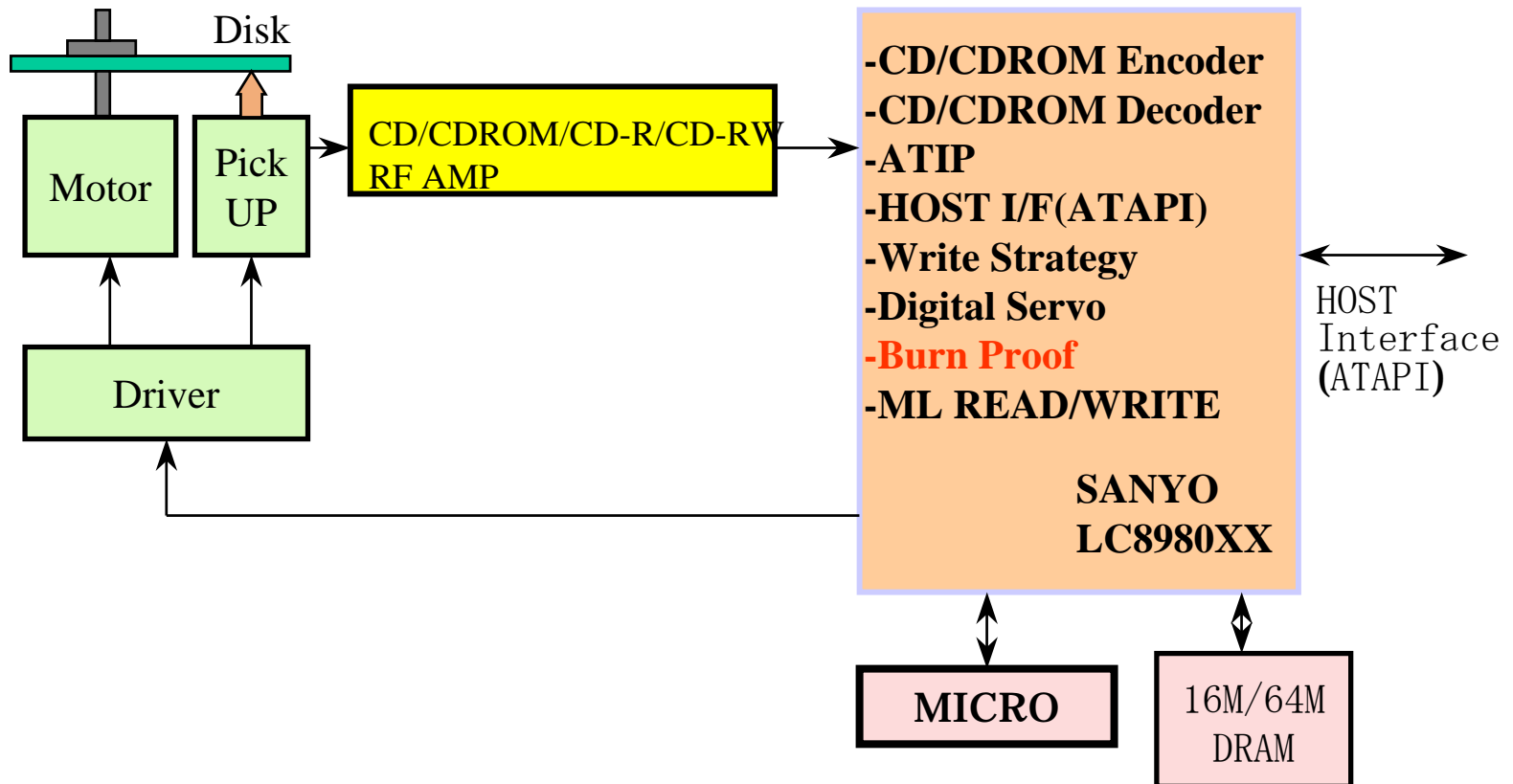
ML&CD-R/RW DRIVE (1)

CD-R/RW + ML(2GB) SYSTEM



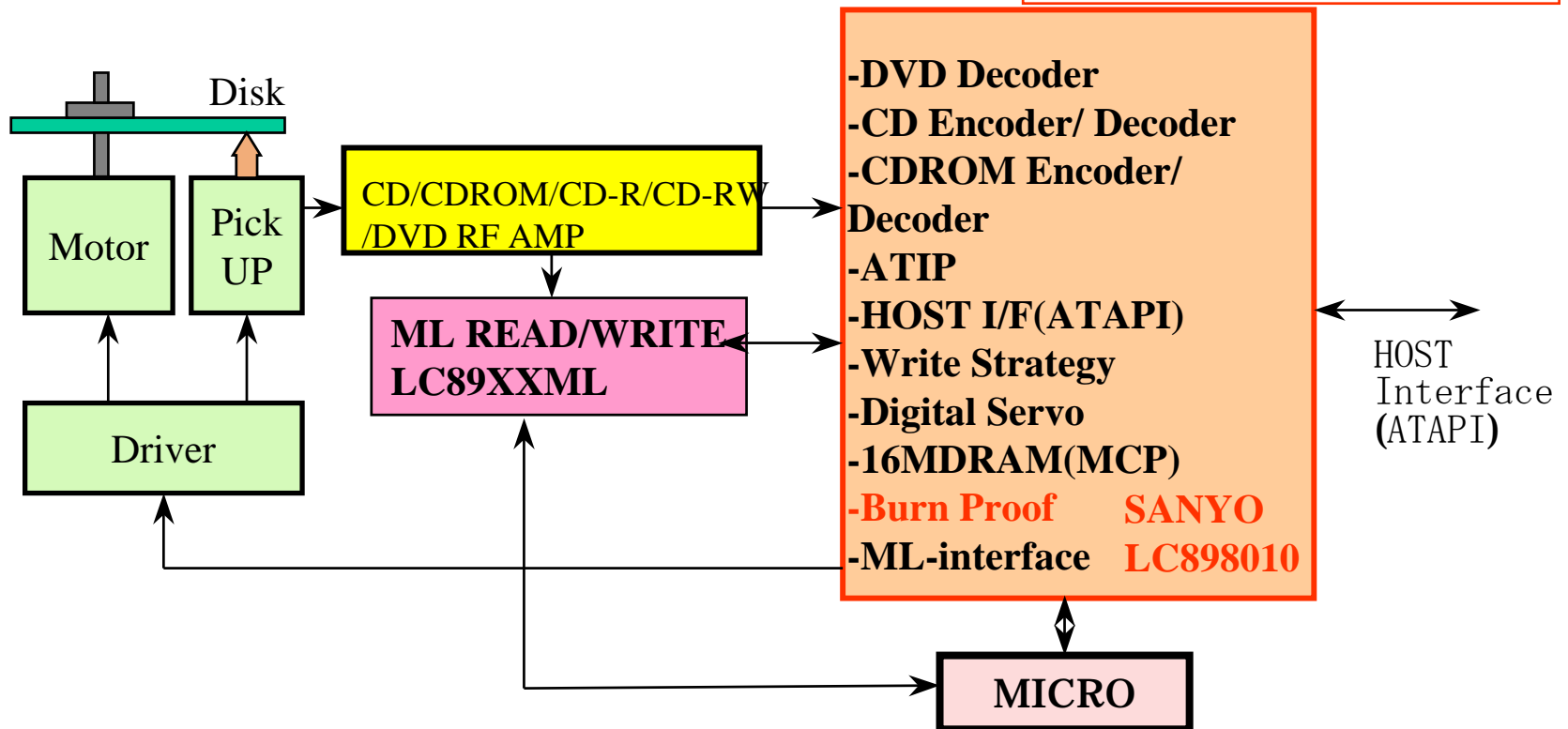
ML&CD-R/RW DRIVE (2)

CD-R/RW + ML(2GB) SYSTEM



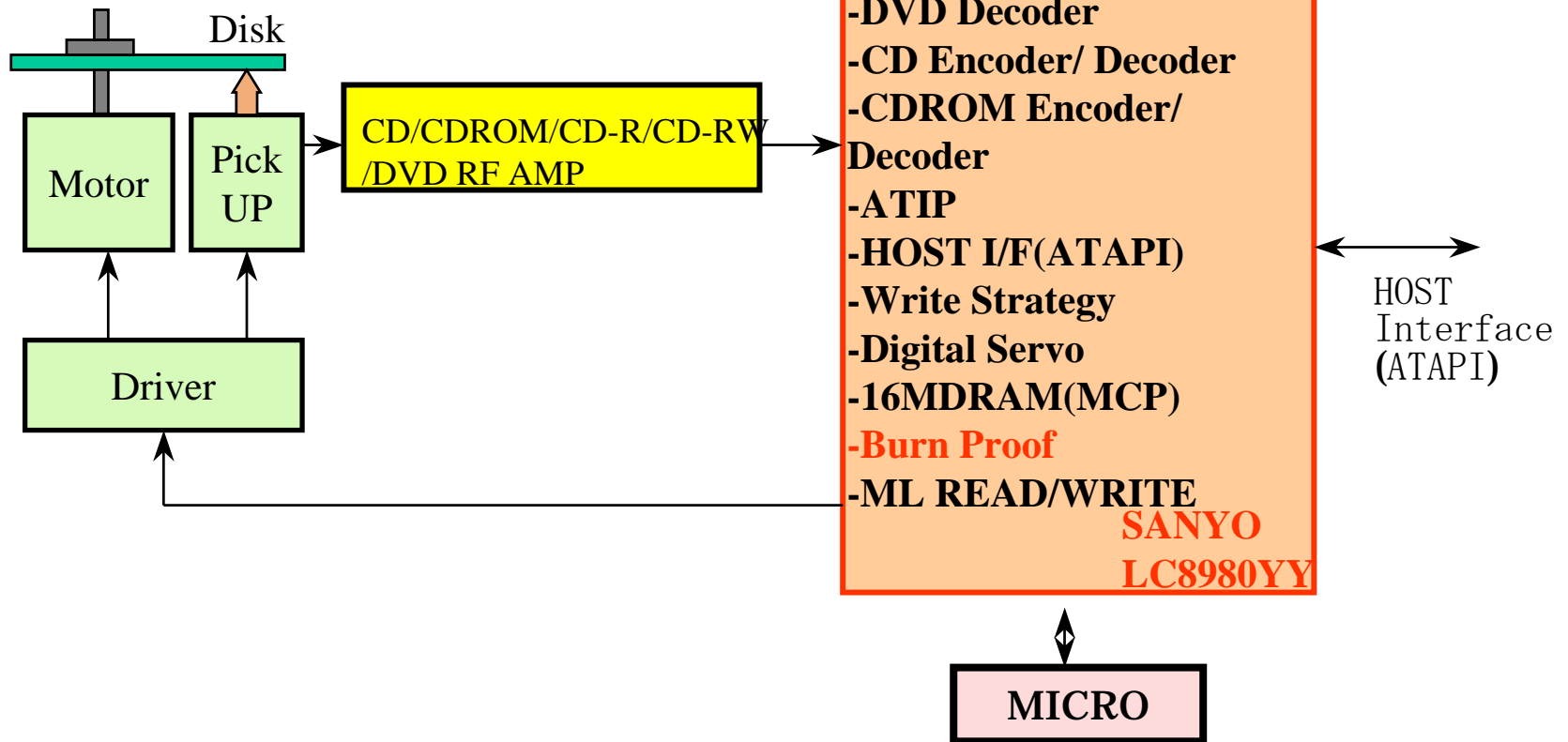
ML&CD-R/RW+DVD-ROM DRIVE (1)

COMBO + ML(2GB) SYSTEM

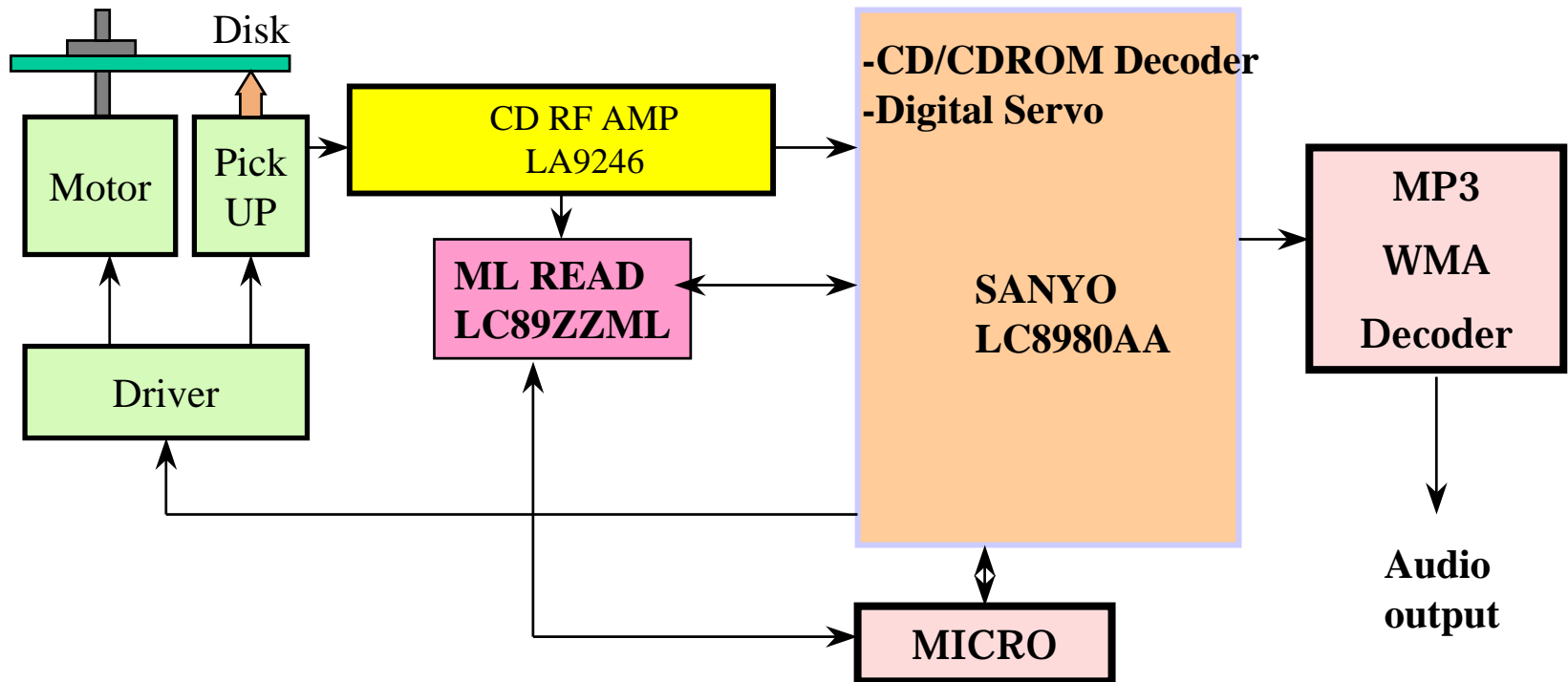


ML&CD-R/RW+DVD-ROM DRIVE (2)

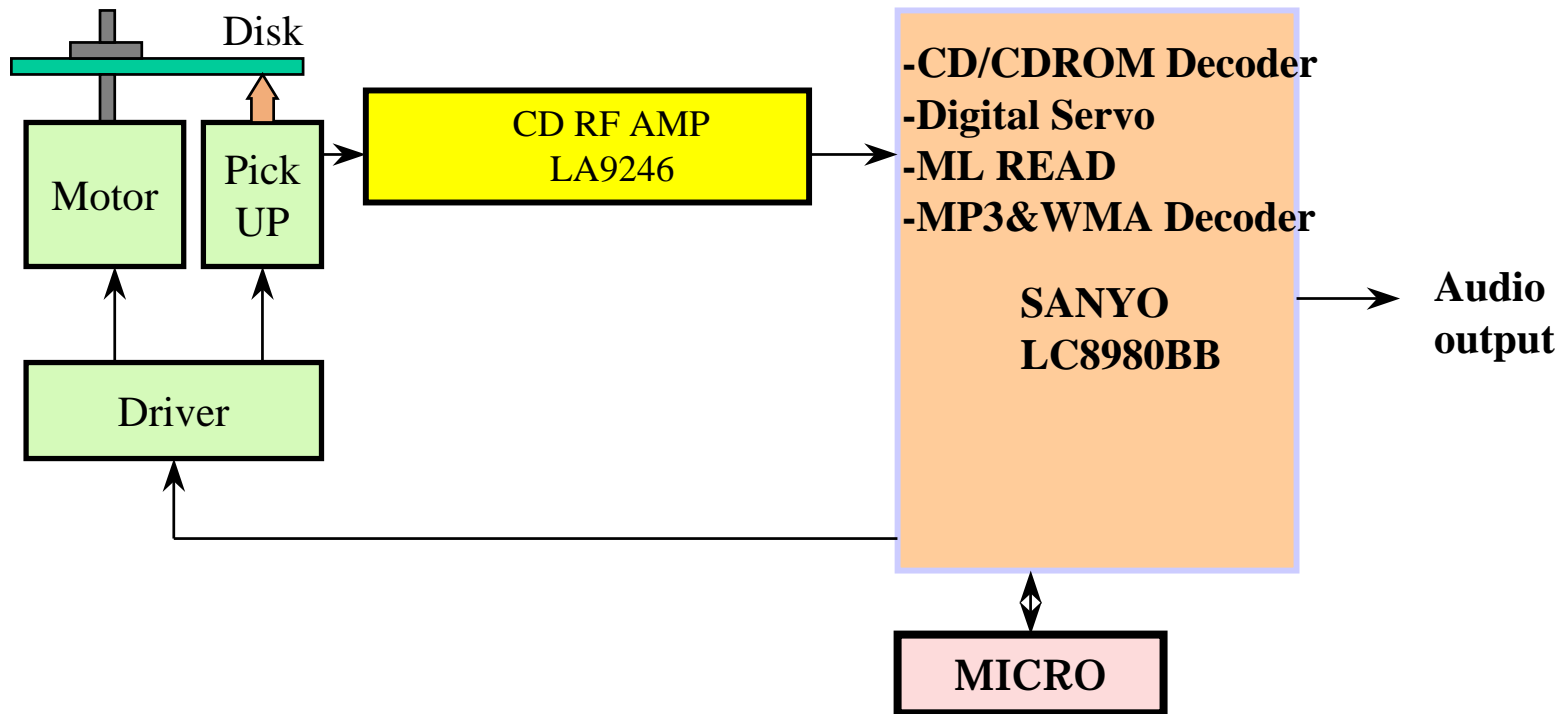
COMBO + ML(2GB) SYSTEM



ML READER DRIVE (1)



ML READER DRIVE (2)





Market Launch Status

- ✓ Completed Concept/Feasibility Phase Ahead of Schedule
- ✓ ML Chip is now under Development - Expected Q3 2001
- ✓ TDK, MCC, Plextor, & Sanyo Engaged in Joint Development
- ✓ Yamaha, Sanyo Drive Division & Unnamed Co. Joined Alliance
- ✓ CDR and CDRW Media Being Tested at 36X and 24X
- ✓ Product on Plan for Q4 Release



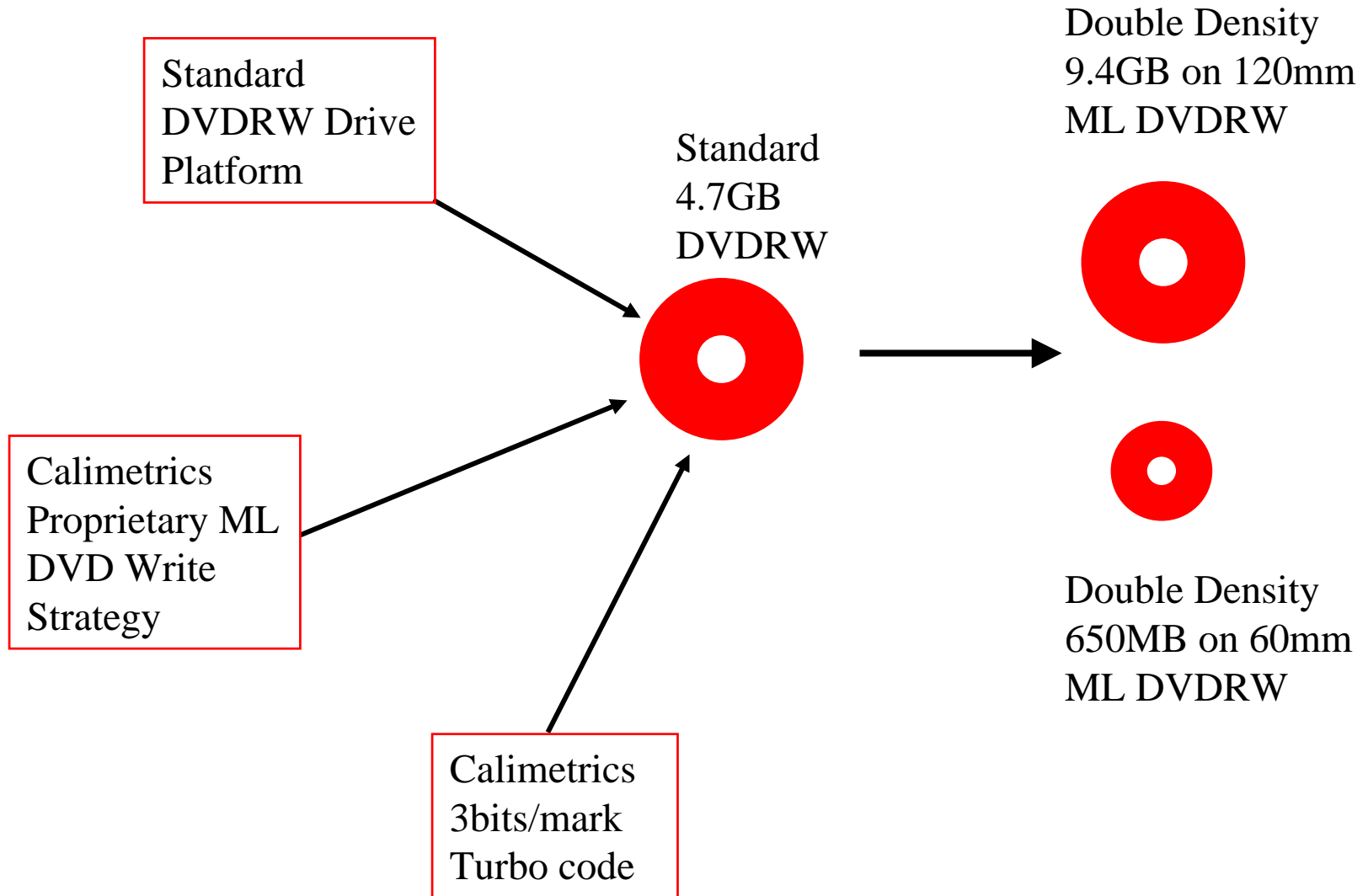
Futures

- ML Will be Applied to Future CD Products:
 - Combi Recorders
 - High Performance CAV Drives
- ML Extends the Performance of DVD and Blue Laser Products
 - 25 to 50 Gigabytes
 - New Codes
 - New Media
- ML Applied to Optical Communications
 - Enhances and Extends Error correction and Transmission Speeds
- AND...Calimetrics Near Field Will Add an Additional Multiplier



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Double Density DVDRW





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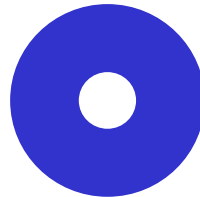
Over 20GB/side Blue DVDRW

Pulstec Blue
Tester Platform
0.65NA
405nm laser

Experimental Blue
DVDRW media
0.6 mm substrate
0.4 to 0.45um TP
L/G Recording

Calimetrics Proprietary
ML Blue DVD Write
Strategy
220 to 245nm ML cells
3.5 to 6m/s write and read

Calimetrics 2.5bits/mark code
2.8 and 3bits/mark codes
in development



**Over
20GB/side
capacity**

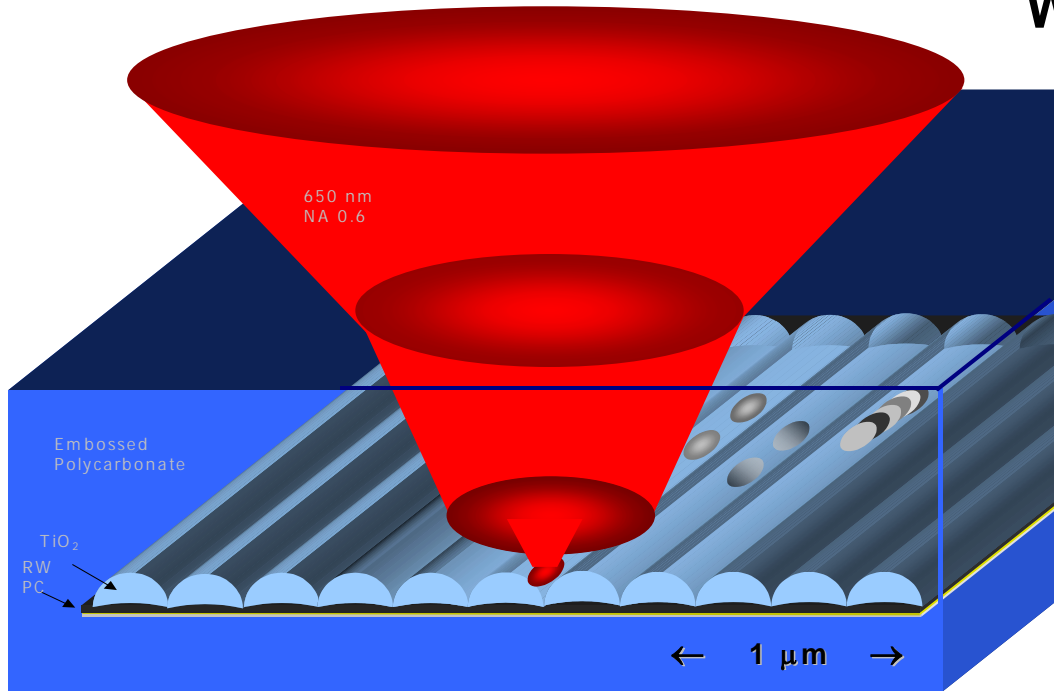


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NF Media: 2X DVD Track Density

What NF media is:

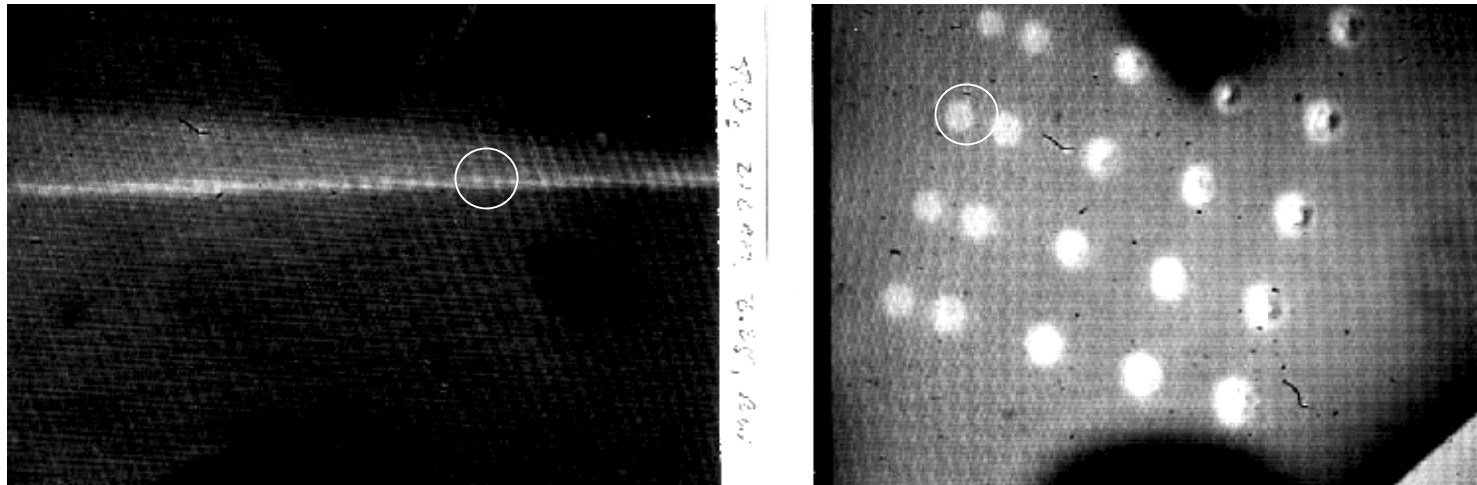
- Hemi-cylinder nano-optics in spiral track replace land and groove in an otherwise normal polycarbonate substrate
- Cylinders are mastered, replicated, and coated with conventional DVD equipment
- Cylinders are first layer in quadrilayer phase change stack, and are typically $\text{ZnS}:\text{SiO}_2$, TiO_2 , or other high index dielectric



How NF media works:

- Cylinders are 1/2 the DVD track pitch. Cylinders work with DVD objective to produce high N.A. in media, with resulting high intensity focused spot and small mark.
- Adjacent cylinders reject much of the laser overspill, a form of “optical isolation”.
- Height modulation between cylinders provides normal TES and reduced cross-talk

0.37 Micron Titania Cylinders Viewed at 100x



1.4 NA, 786 nm laser Marks **Left:** In hemi-cylinder track area; **Right:** Same media, in area with no micro-optics. Smallest spot in this area (of power vs. pulse matrix) is 1 micron in diameter. Vertical stripes in both are printing artifact. White circles are equal magnification.



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Technology Roadmap

2000

2002

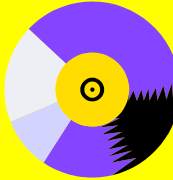
2003

2004

2006

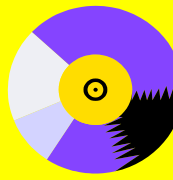
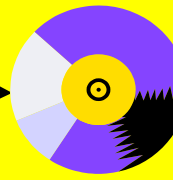
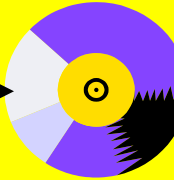
Calimetrics

Industry Base



ML-DVD±RW

- **25 GB**
- 44 Mbits/sec write speed

ML-DVD± RW

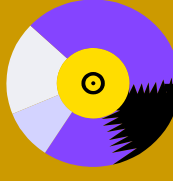
- **50 GB**
- 66 Mbits/sec write speed

ML-DVD±RW

- **100 GB**
- 100 Mbits/sec write speed

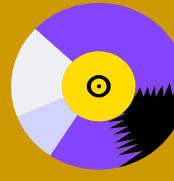
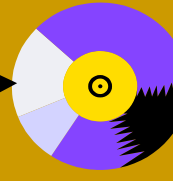
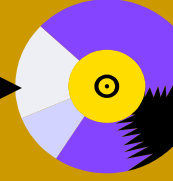
ML-DVD± RW

- **250 GB**
- 200 Mbits/sec write speed



DVD ± R/W

- 1 x
- 4.7GB
- 22 Mbits/sec write speed

DVD± R/W

- 2x
- 10 GB
- 33 Mbits/sec write speed

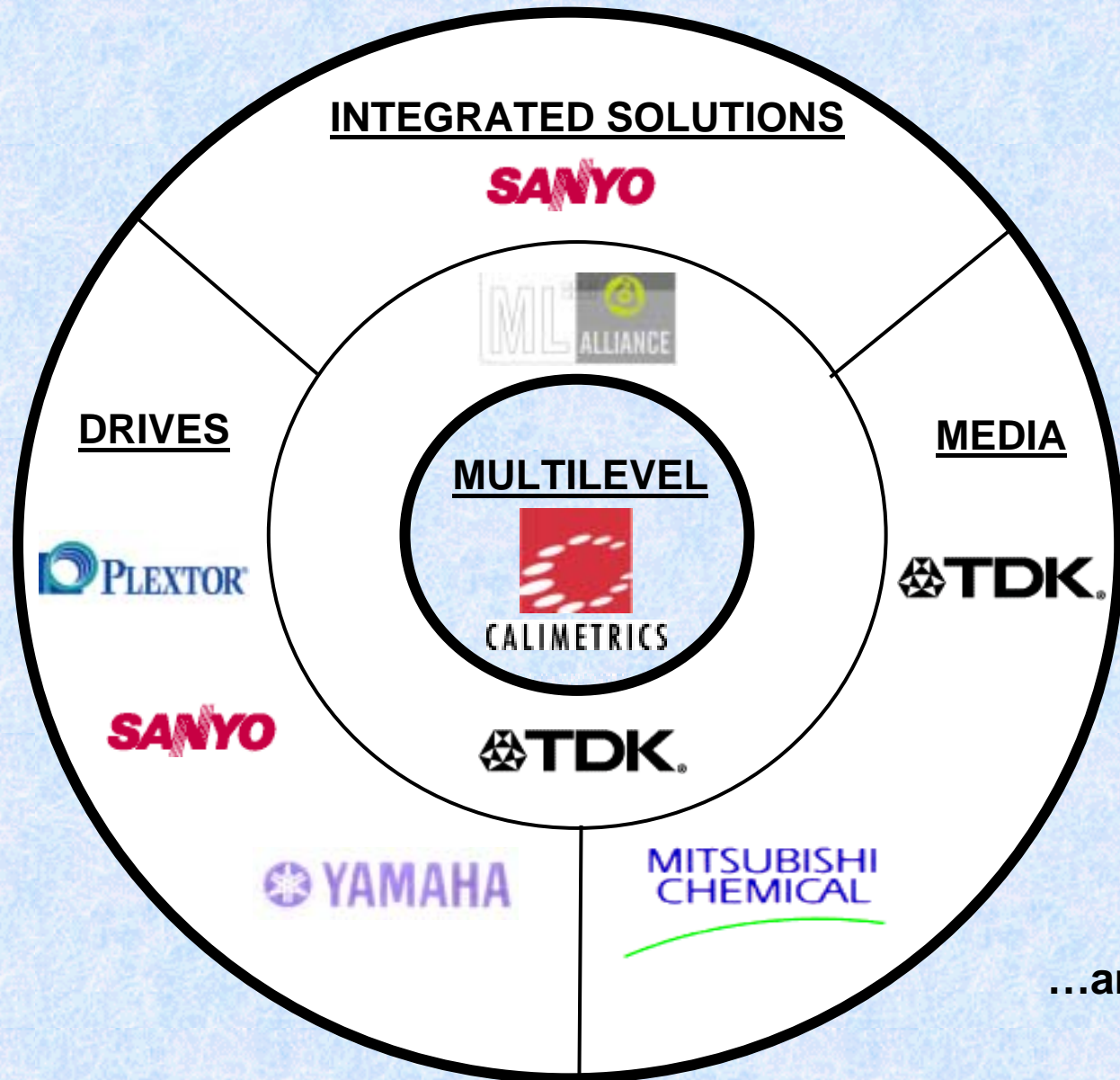
DVD± R/W

- 5x
- 20 GB
- 50Mbits/sec write speed

DVD± R/W

- 10x
- 50 GB
- 100 Mbits/sec write speed

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...and growing!