

KODAK: Storage and the 21st Century

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Fairfax VA 22043

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Presentation Topics

- **Kodak Storage Technology and Products**
- **Applications driving technology and standards**
- **Technology Roadmap for Optical Storage**
- **Enabling Technologies**
- **Alternative Technologies**
- **Conclusions**



Kodak: A Leader in the Digital Imaging Business

- **KODAK develops and manufactures a variety of digital imaging products serving many market segments**

Digital & Advanced Photo System Film Cameras

CD Based and Large Format Optical Storage Systems

High Speed Document & Color Pictorial Scanners

Digital Printers and Inkjet Media

Digital Imaging Workstations

Kodak's Storage History

- **Historical Focus**
 - Recording Materials & Recording Physics (“HMI”)
- **Current Storage Technologies**
 - Write Once Optical Recording Media
 - » Phase Change Media
 - » Proprietary Organic/Metallic Media CD-R2 / DVD - R
 - » Dye Based CD-R / DVD-R Media
 - Re-Writable Superlattice CoPt MO media
 - High Performance Optical Heads & Actuators
 - Magnetic Recording Heads and “Magnetics on Film” Media
 - Micrographics



Kodak Storage Products

- **Writable CD Media with “Infoguard”**
- **PCD 600 6X Writer and Autoloader**
- **CD 144 ADL (CD-ROM & CD-R Drives)**
- **OD System 2000E Automated Disk Library**
- **OD System 2000E Media (25GB)**
- **Micrographic Media and Equipment**



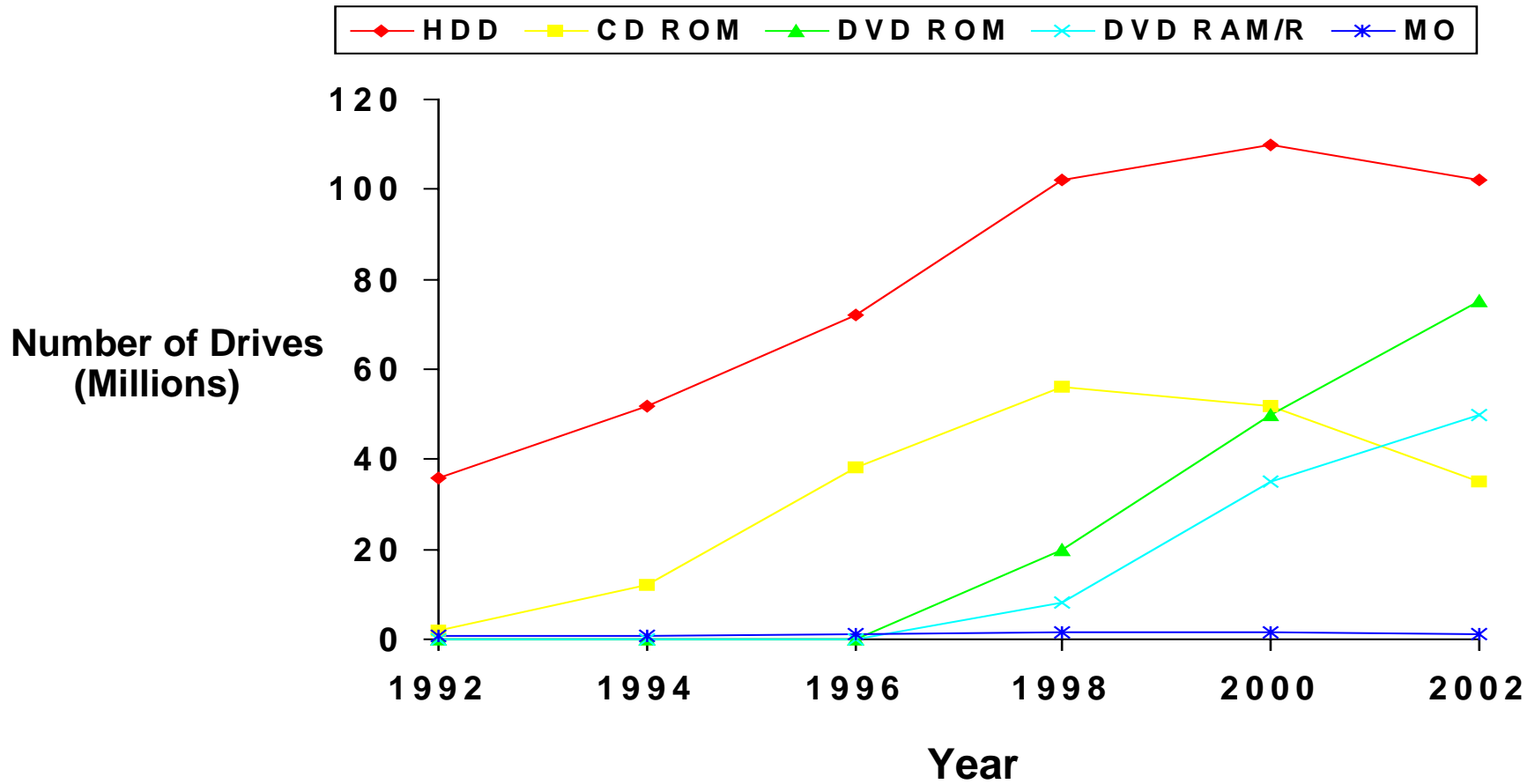
Applications and Markets

TECHNOLOGY	APPLICATION	1996 MARKET	MARKET TREND
CD-Audio	Prerecorded digital audio	\$ 1B	Increasing at 20%/yr
CD-ROM	Prerecorded computer software	\$ 4B	DVD-ROM will replace in 2-5 years
CD-R	SW publishing and document/data distribution	\$0.4B	Growing popularity due to low cost drives and authoring SW
CD-E	Personal Storage	\$0.0	Will compete with DVD-RAM in 1998
WORM	Archival computer data storage	\$ 0.7B	Projected 200 Gbytes by 2000 (AGR = 40+%)
Rewriteable Optical Drives	Archival storage of large volumes of data	\$ 1B	Reduced volumes due to magnetic disks advances
Magnetic Hard Drives	Used for on line & archival storage of data	\$ 25B	Improving density and lowering costs (AGR = 60%)

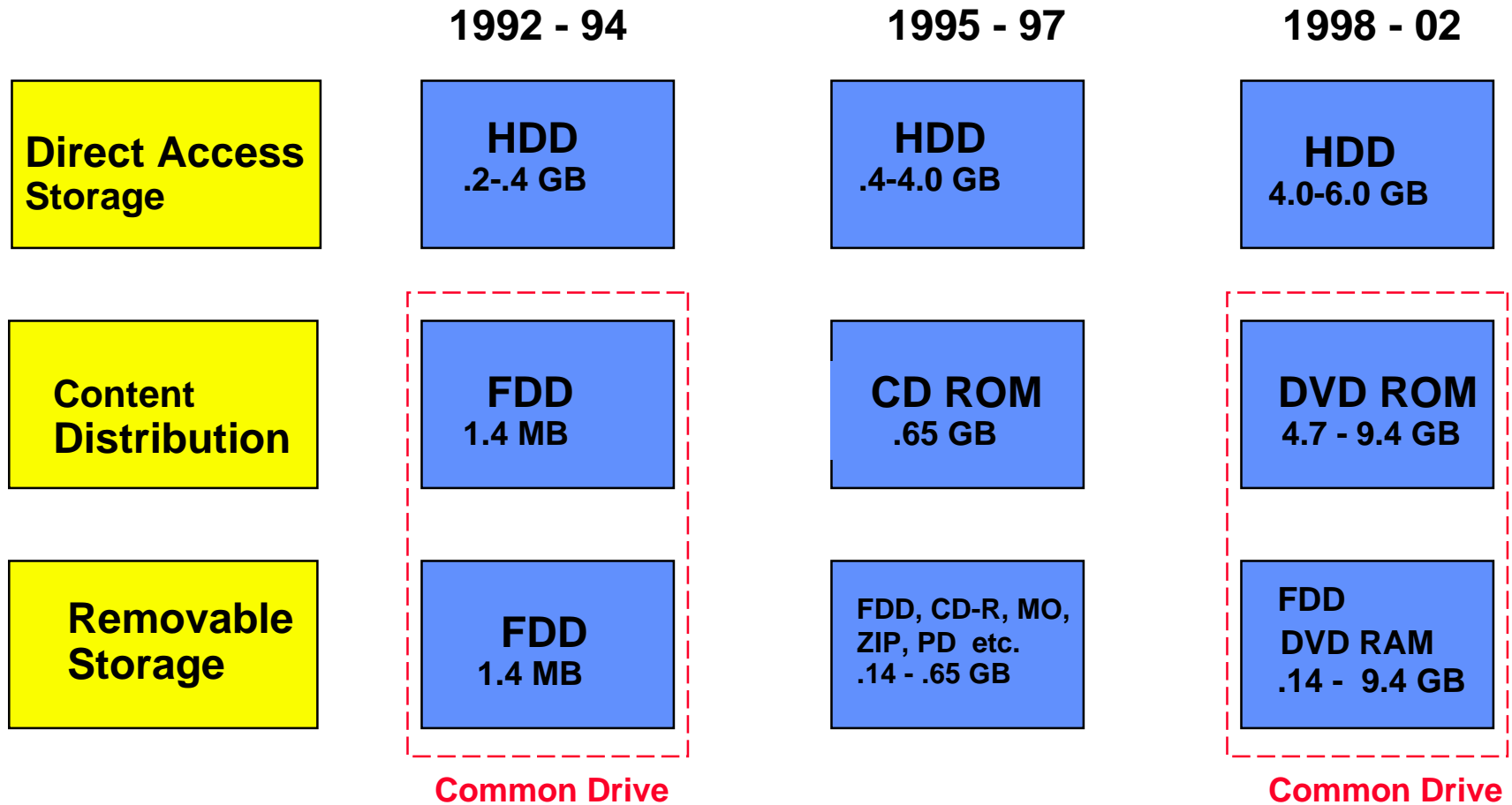
Emerging Applications DVD

TECHNOLOGY	APPLICATION	MARKET TREND
DVD-ROM	Prerecorded movies and computer SW	Available in 1997 with 4.7 GB capacity. Will replace CD-ROM
DVD-R (Write-Once)	SW publishing. Insufficient capacity for DVD video	Projected for late 1997 with 3.9 GB capacity.
DVD-RAM (Rewritable)	Transport/duplicate data and multimedia content	Projected for late 1998 with 2.6 GB capacity

Desktop Drive Trends



Desktop Storage Trends



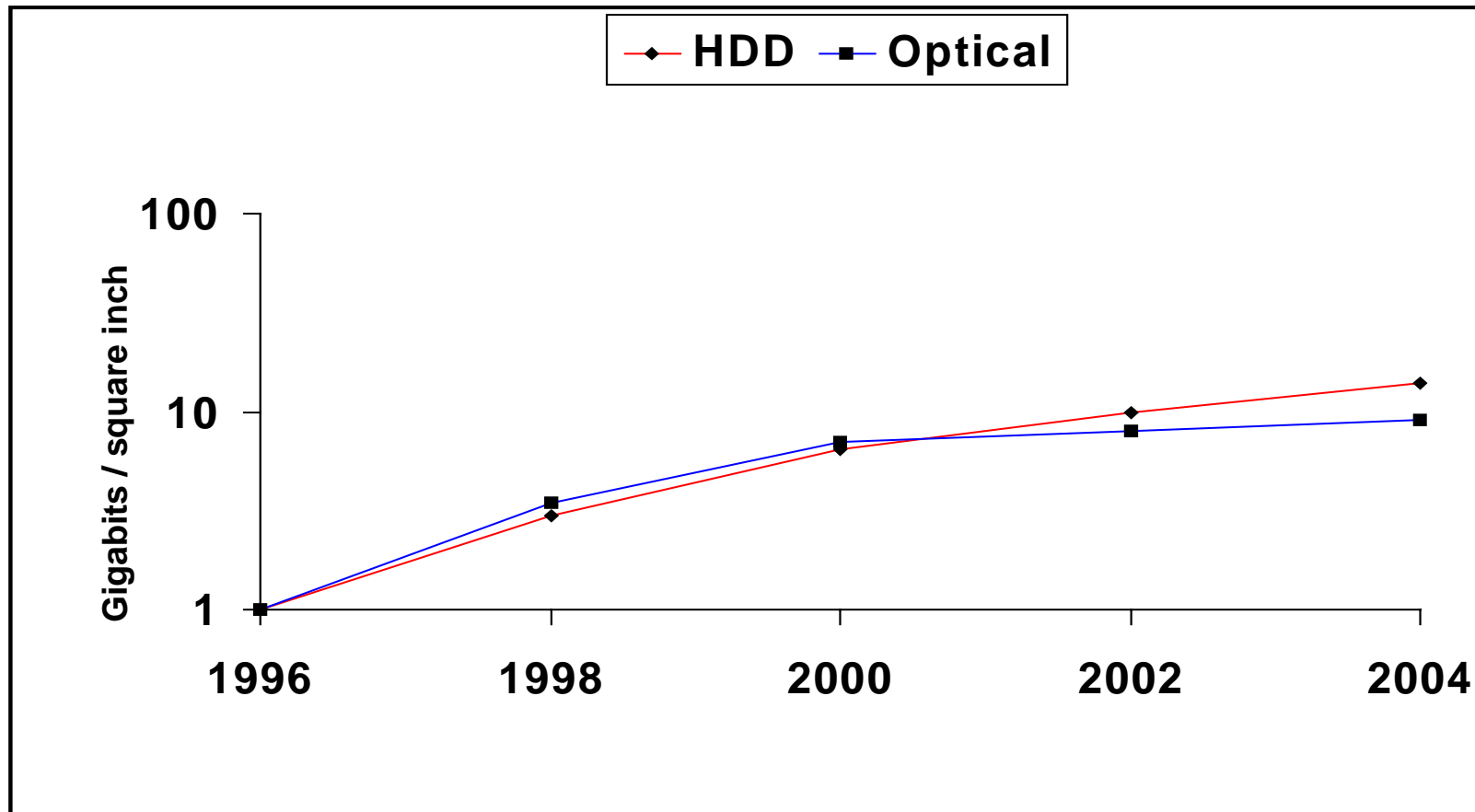
Applications Driving Capacity

- **“Motion Rich” Multimedia Content**
 - 1 page of ASCII Text 3 KB
 - Professional Color Photographic Image (JPEG) 4 MB
 - 1 min CD Audio 10 MB
 - 1 min MPEG II Video 35 MB
 - 30 sec Motion Picture Sequence 25 GB

- **Internet and On Line Imaging Services (e.g. Digital Photofinishing, Video on Demand)**

- **Convergence to digital form in commercial and professional markets**
 - Electronic media is less expensive than hard copy
 - Availability of authoring tools and standard playback platforms (CD-ROM)

Aerial Density Trends





Key Enabling Technologies for Storage

- **Aerial density limits for magnetic and optical storage are comparable approaching 36 Gb/ sq inch**
- **Optical Storage**
 - Shorter wavelength high power lasers
 - Optical Heads (objective optics with $NA > .6$, solid immersion lenses, hologram / grating beam splitters, active tilt control, improved actuators)
 - Advances in media (multilayer, panchromatic)
- **Magnetic HDD Storage**
 - Advances in media performance (thermal stability, high anisotropy, smaller grain size)
 - Advances in head performance (MR vs Inductive, higher switching frequencies, flying with sub micron gaps)

Projected Laser Development

		Type	1997	1998	1999	2000	2001	2002
Wavelength	375	GaN				2mW		30mW
	420	GaN				2mW		30mW
	420	SHG	2mW	5mW	10mW	20mW		
	490	ZnSe				2mW		30mW
	520	ZnSe			2mW		30mW	
	635	InGaAlP	<5mW		40mW			
	650	InGaAlP	<20mW		60mW			
	670	InGaAlP	<60mW	100mW				

Available Lab Demo Predicted

Optical Media Technology

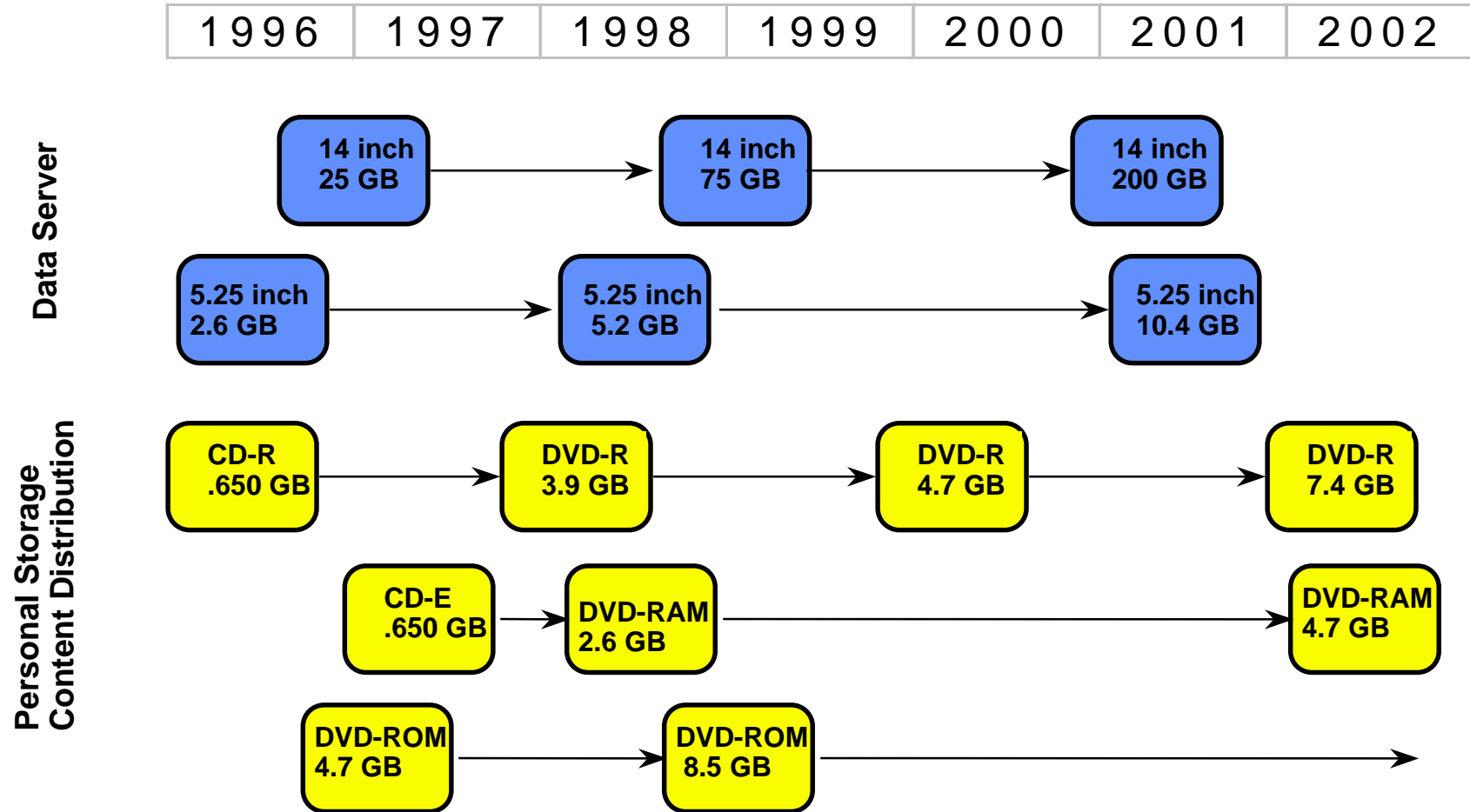
- **Greater precision in mastering**
- **Improved precision and uniformity of molding**
- **Improved tracking and servo formats to increase radial track density**
- **New/Improved thin film semi transparent recording layers**
- **Pan sensitive recording layers**

Alternative Technologies

- **Optical Tape**
 - **Risks: Lack of standards and disorganized marketplace**
- **Near Field recording (NFR)**
 - **Technical Risks: Low cost solid immersion lens, media performance**
- **Holographic Storage**
 - **Technical Risks: recording layer materials , tailored light sources, high performance optics**
- **Electron Trapping Optical Memory (ETOM)**
 - **Technical risks: Substrate materials, thin film deposition**
- **Persistent Spectral Hole Burning (PSHB)**
 - **Technical risks: Cryogenic temperatures, data permanence**



Optical Storage Technology Roadmap



Conclusions

- **“Image Rich” applications will drive the need for increased capacity**
- **Magnetic Technology (HDD, tape) will continue to have an advantage in performance and volumetric density**
- **Optical Disk Technology will maintain its advantage in removability, interchangeability and replication / distribution costs**
- **Magnetic and Optical Disk products will coexist and compliment each other**
- **Near Field Recording, Optical Tape and Holographic recording appear to be the most promising emerging storage technologies**

KODAK Approach

- **Focus on Imaging Applications**
- **Drive product leadership through R&D**
- **Support Standards**
 - Active participation in:
 - » ANSI X3, ECMA TC31, ISO/IEC JTC 1/SC23
- **Industry and Government Partnerships**
 - Active participant in:
 - » NSIC, OIDA, OSTA, SIGCAT, DVD Working Groups 6,7
 - Federal Government Sponsored R&D
 - » NIST - Advanced Technology Programs
 - » DOD - IR&D

Kodak - Going Forward

- **Kodak will continue to provide digital storage products that emphasize:**
 - **Best-Value**
 - **High Productivity**
 - **Customer Investment Protection**
 - » **Data Integrity, Data Protection**
 - » **Open Standards**
 - » **Backward Compatibility**
 - » **Forward Migration Path**