

# *Microdisplay Markets, Technologies, and Supply Chain*

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# *Outline of Presentation*

- Microdisplay description and value proposition
  - Dream: Pixels for nothin, TVs for free
  - Big screen images from chip scale packages
- Markets and Applications
  - Enterprise front projectors for presentations
  - Front and rear projection TV for consumers
  - Electronic View Finders for cameras
  - Embedded and headset near-to-eye displays
- Technologies
  - Incumbent and emerging technologies
  - Major players
- Supply Chain
  - Microdisplays and optical core components
  - Lamps and imaging engines
  - Screens and viewing optics

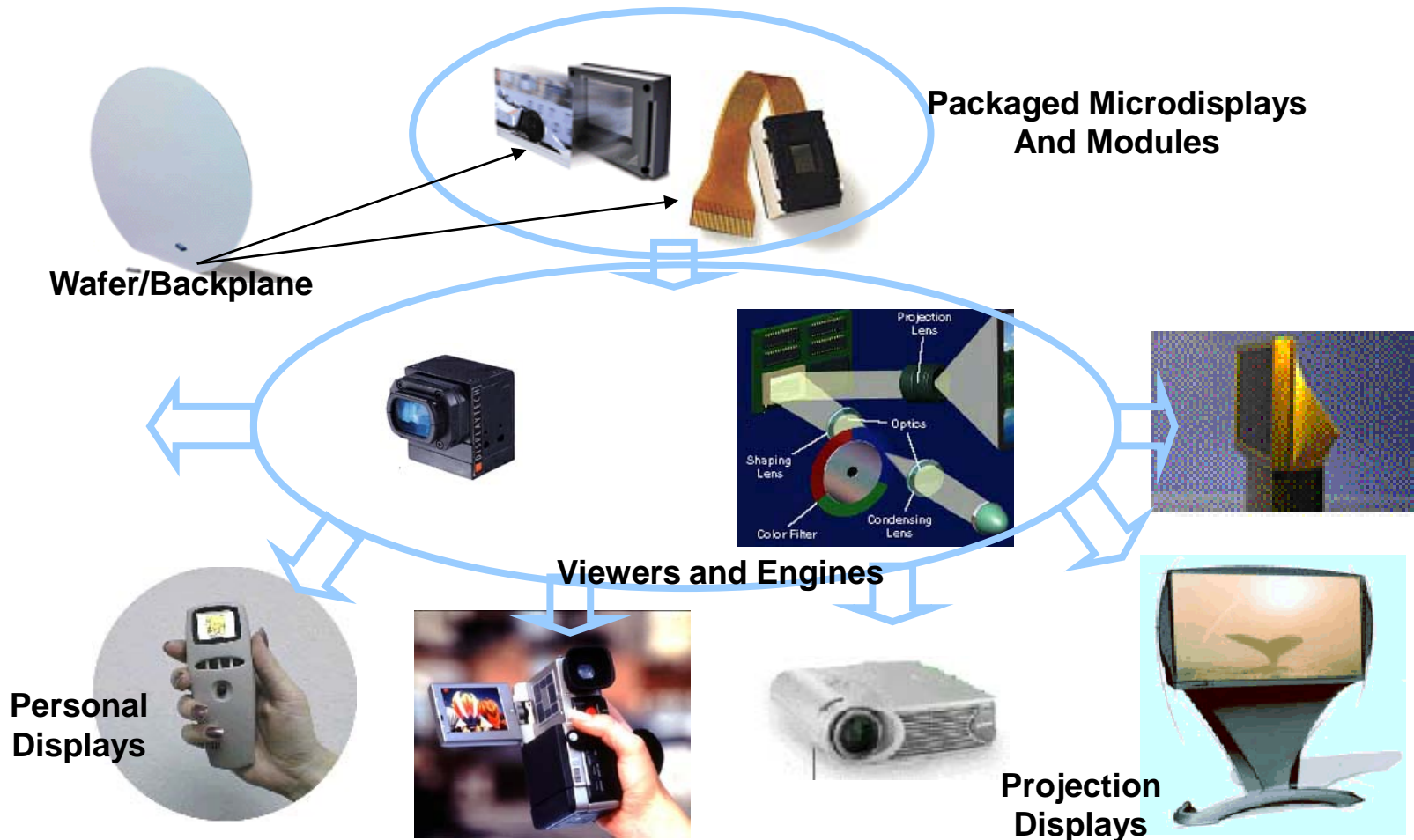
# *MCG Products and Services*

- Market and technology databases, forecasts, and reports
  - Microdisplays, projection, and personal displays
  - Flexible and Polymer Displays
- Custom consulting for displays and liquid crystal products
  - Reflective color, plastic substrate displays
  - Polymer semiconductors and OLEDs
  - New product or market opportunity analysis
  - Development of business plans
  - Company formation, financing, and launch of marketing and sale
- IP and Technology Licensing
  - Licensing agent for display related IP and technology
- Annual Projection Summit Conference
  - June 2003 conference for projection supply chain
  - Sponsored jointly with Insight Media and Infocomm (ICIA)

# Resources

- MCG Team
  - Chuck McLaughlin, Launching new products in new markets
  - Market analysts: Ron Cooke, Jim Pfeiffer
  - Technology Analysts: Dr. Kirk Moffit, Dr. David Armitage, Dr. Felix Schuda, Scott Holmberg
  - Research, databases and website: Adrienne Hefter, Fred Nobile
- Affiliates:
  - Japan: Interlingua
  - U.S.: Insight Media (Microdisplay Report)
  - Europe: Decision Tree Consulting

# Anatomy of a Microdisplay



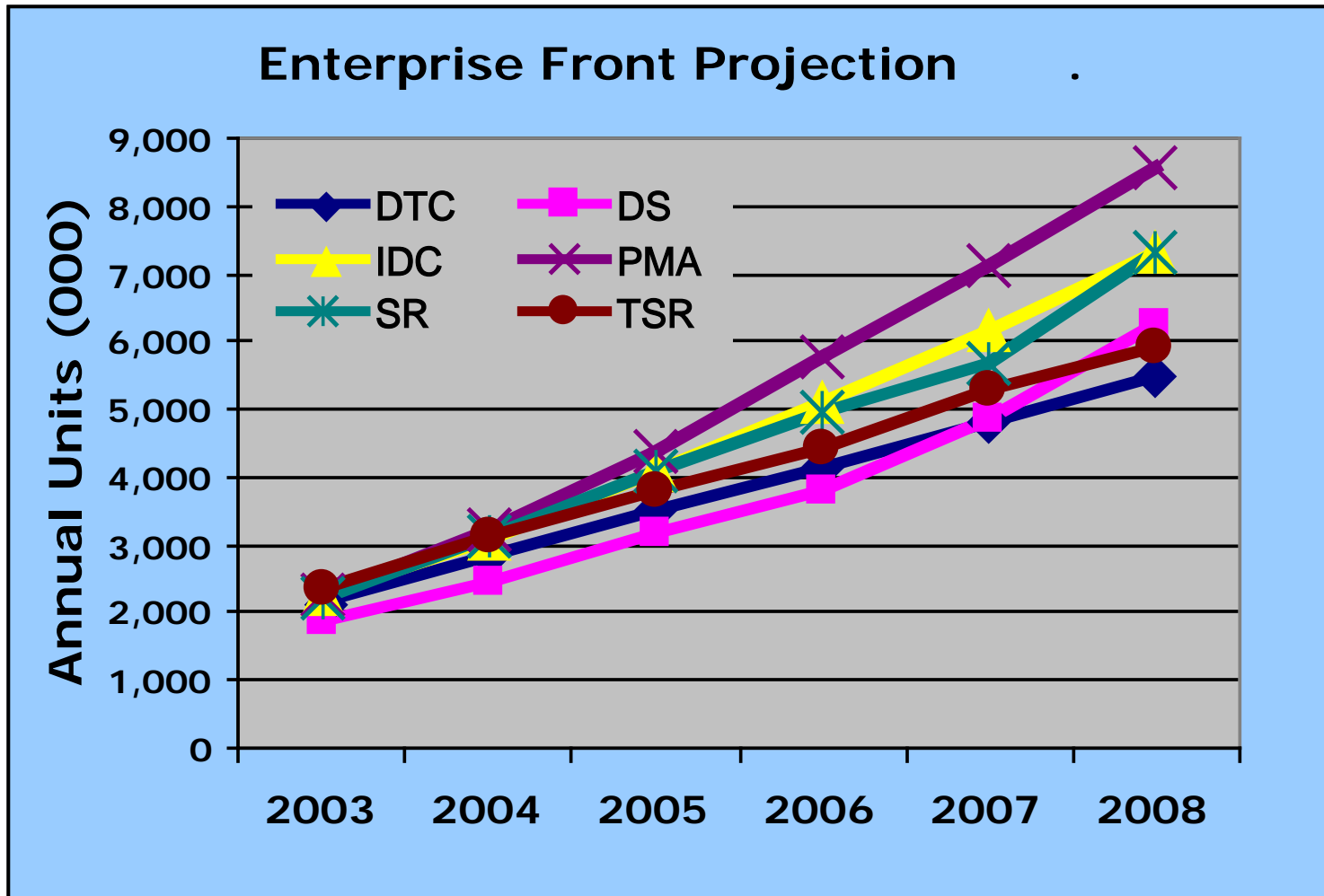
# *Microdisplay Vision and Hurdles*

- Low cost, high definition, large size images
  - Fully integrated chip scale core generates image
  - High efficiency imaging engines illuminate and magnify images
  - Viewing screens and optics optimize the image
- Hurdles
  - Limited contrast, color saturation, and field of view
  - Limited lamp life and efficiency
  - Impact of ambient light on image quality

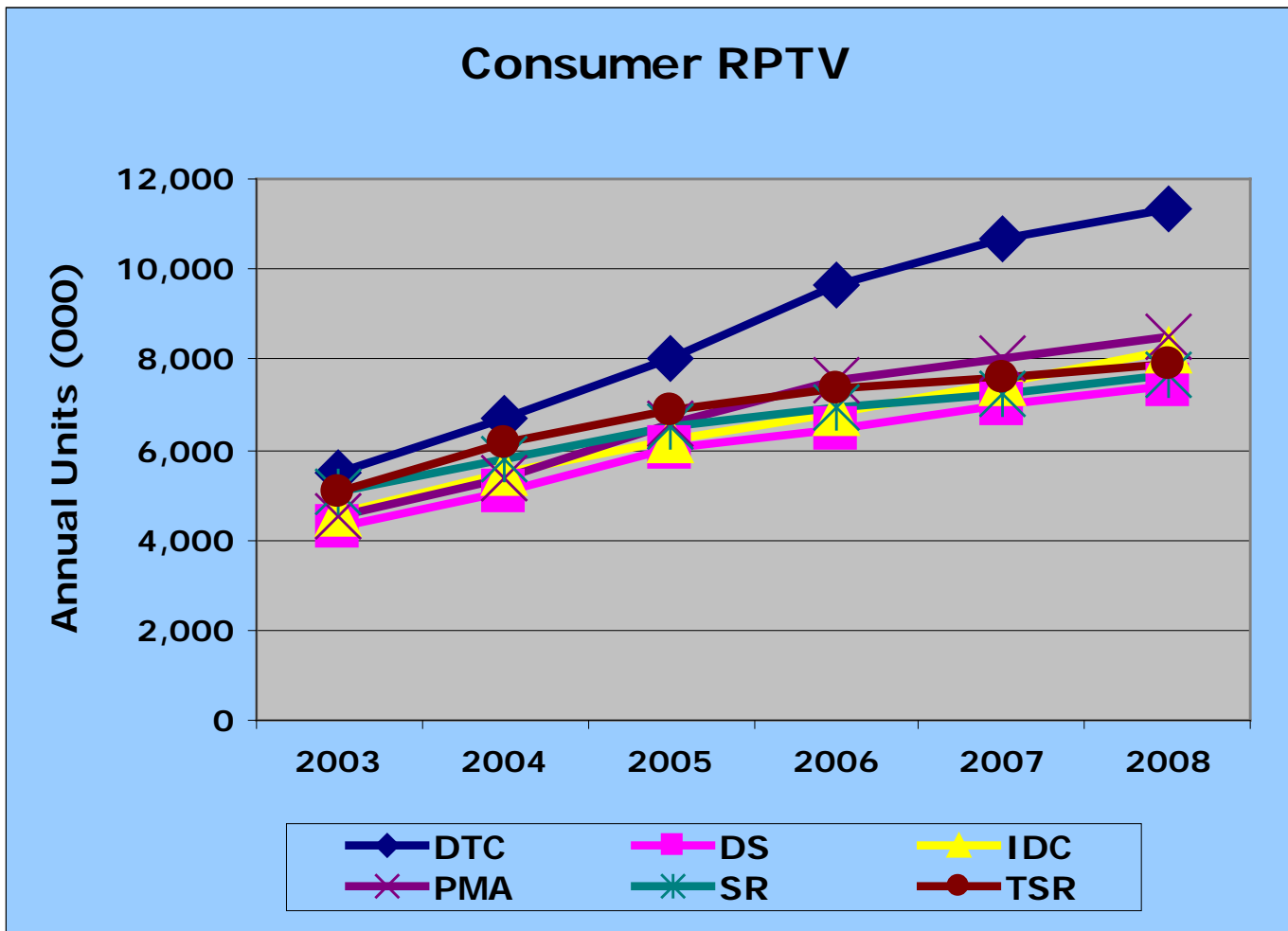
# *Markets and Applications*

*Enterprise presentations*  
*Home entertainment projection TV (PTV)*  
*Electronic Viewfinders (EVF)*  
*Near To Eye Displays (NTE)*

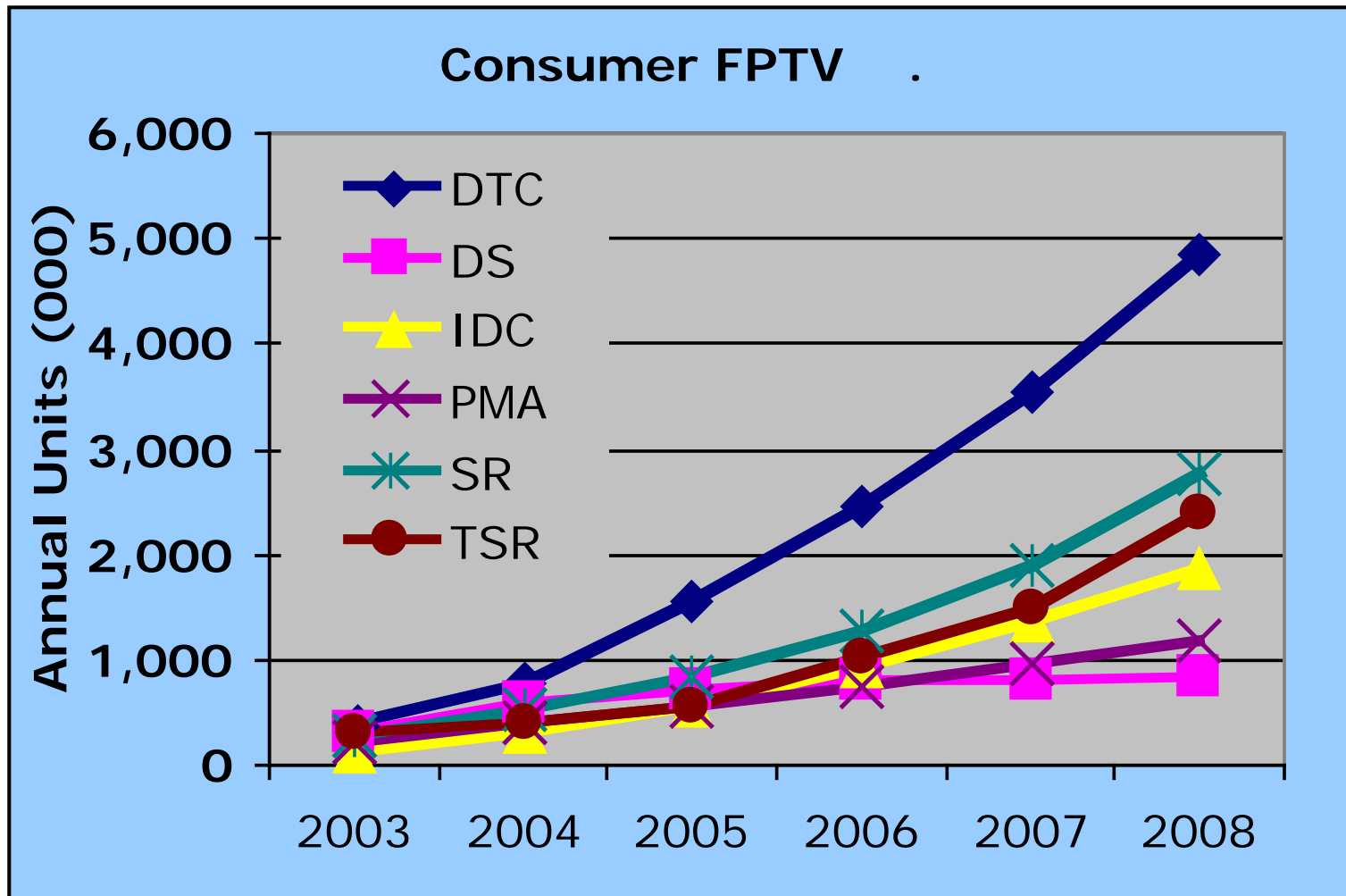
# Enterprise Front Projection



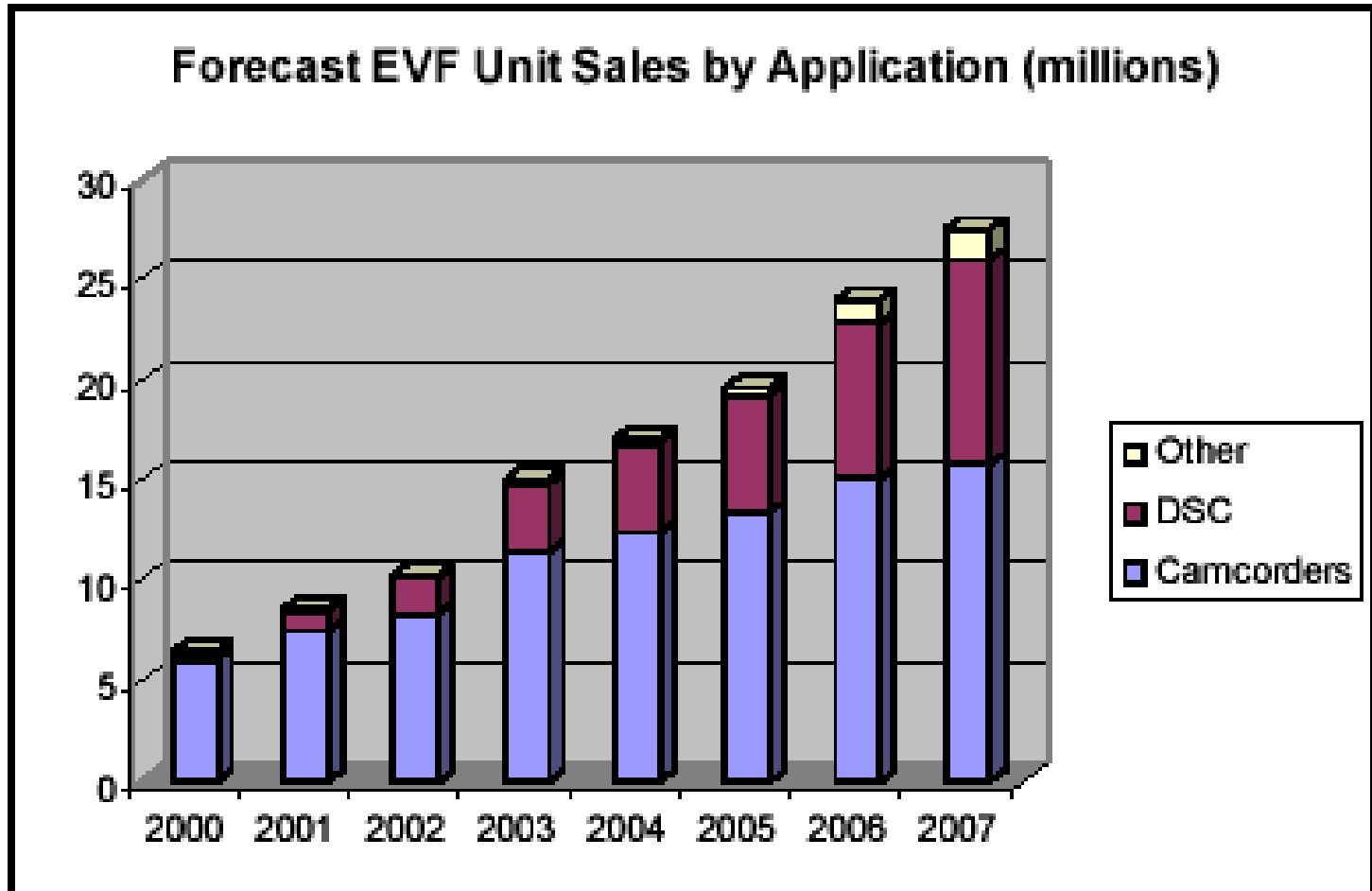
# Rear Projection TV



# Consumer Front Projection

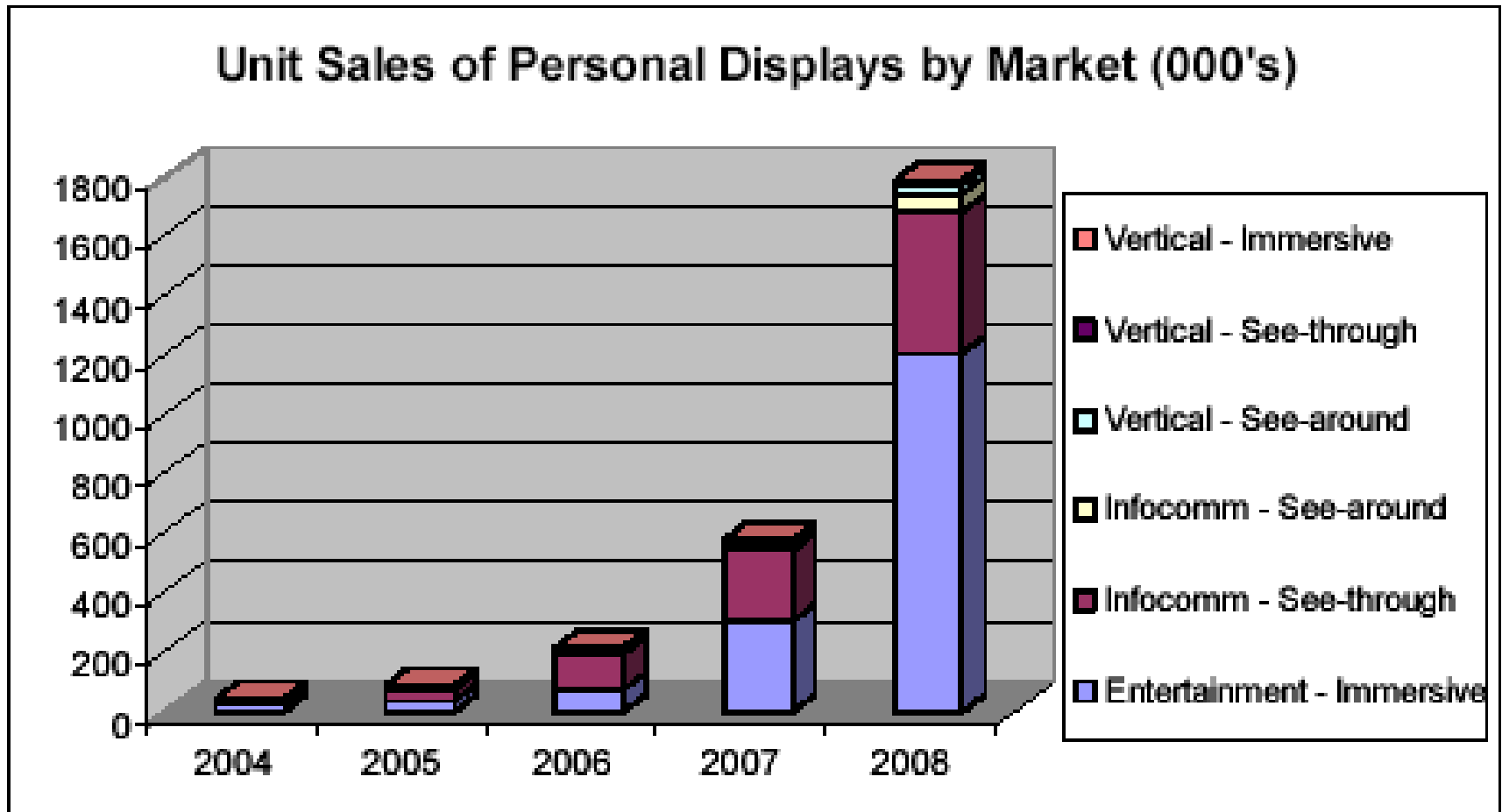


# Electronic Viewfinders



# Personal Displays

Unit Sales of Personal Displays by Market (000's)



# MCG Forecast: Total Systems

Technology	2003 Forecast (M units)	2008 Conservative (M units)	2008 Optimistic (M units)
Presentations FP	2.2	5.5	8.6
RPTV	4.8	7.4	11.3
FPTV	0.3	0.8	4.8
<i>Projection Subtotal</i>	<i>7.3</i>	<i>14.1</i>	<i>24.8</i>
Personal Displays	.1		1.8
EVF	15.0		27.0
NTE Subtotal	15.1		29.8
<i>Grand Total</i>	<i>22.4</i>		<i>53.6</i>

**Key Issue: Microdisplay displacement of CRT in RPTV**

# *Technologies*

# Technology Competitive Position

Technology	HTPS	DLP	LCOS
	High Temperature Polysilicon	Digital Light Processing	Liquid Crystal on Silicon
Leaders	Epson Sony	Texas Instruments	JVC, Philips, Hitachi, Sony, Brillian, and others
Mode	Transmissive	Reflective	Reflective
Color Architecture	3-Chip Parallel	1-chip Color Field Sequential	3-Chip Parallel
Max. Color Efficiency	100%	33% theoretical; -50% w/white	100%
Aperture	35% to 65% w/ microlens	>90%	>90%
Polarizer Efficiency	60%	100%	60%
Overall Efficiency	-20%	-20%	-20%

# Projection Competitive Position

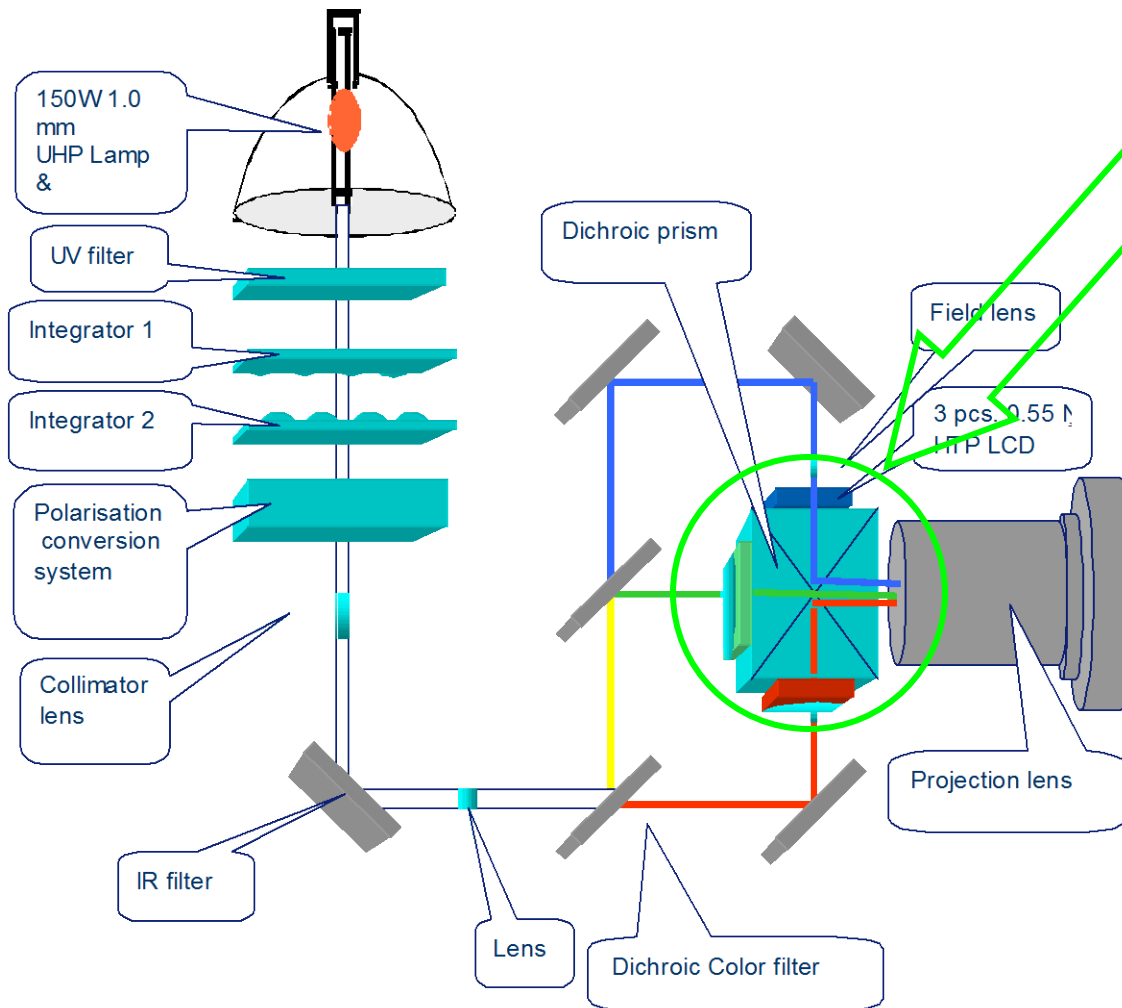
Technology	HTPS	DLP	LCOS
Lumen Thruput	Highest for a given $\mu$ D size	Competitive despite only one $\mu$ D	Improving; now competitive
Imaging	Competitive	Highest Contrast	Competitive
Video	LCD speed	1-chip artifacts	Competitive
Architecture	Simple Standardized	Simple Standardized	Complex, No Standard
Value Chain	Developed	Developed	Developing
$\mu$ D Chipset Cost	Price leader	Follows Epson	Promise low cost, but unproven
Other engine costs	Low	Very low	High priced core optics
Assembly and test	Low	Very low	Promise low cost, but unproven
Strengths	Epson cost down Epson $\mu$ Lens Strong value chain	Ti pushes DLP brand Improving value chain Ti prices down	Promise of 1080 HDTV Promise of low cost $\mu$ D
Weaknesses	Low aperture for HD	Value chain resents Ti Video artifacts	Complex and expensive architecture Unproven value chain

# Near to Eye Competitive Position

Technology	Mono CRT	HTPS	LCOS	Other
Leaders		Sony only	Kopin, Displaytech	
Challengers			Brilliant	EMagin Microvision
Imaging	Mono only	Motion Blur	Market Leading	
Power	High	Low	Low	Low
Form factor	Bulky	Smallest	Smallest	Small
Price	Moderate	Low	Low	Moderate
Architecture	Emissive	Transmissive	Reflective	Emissive Retinal Scanning
Value Chain	Developed	Developed	Developed	Prototype
Strengths	Incumbent	Sony	Best value	Video quality
Weaknesses	Bulky	Sony	Image quality	Emerging

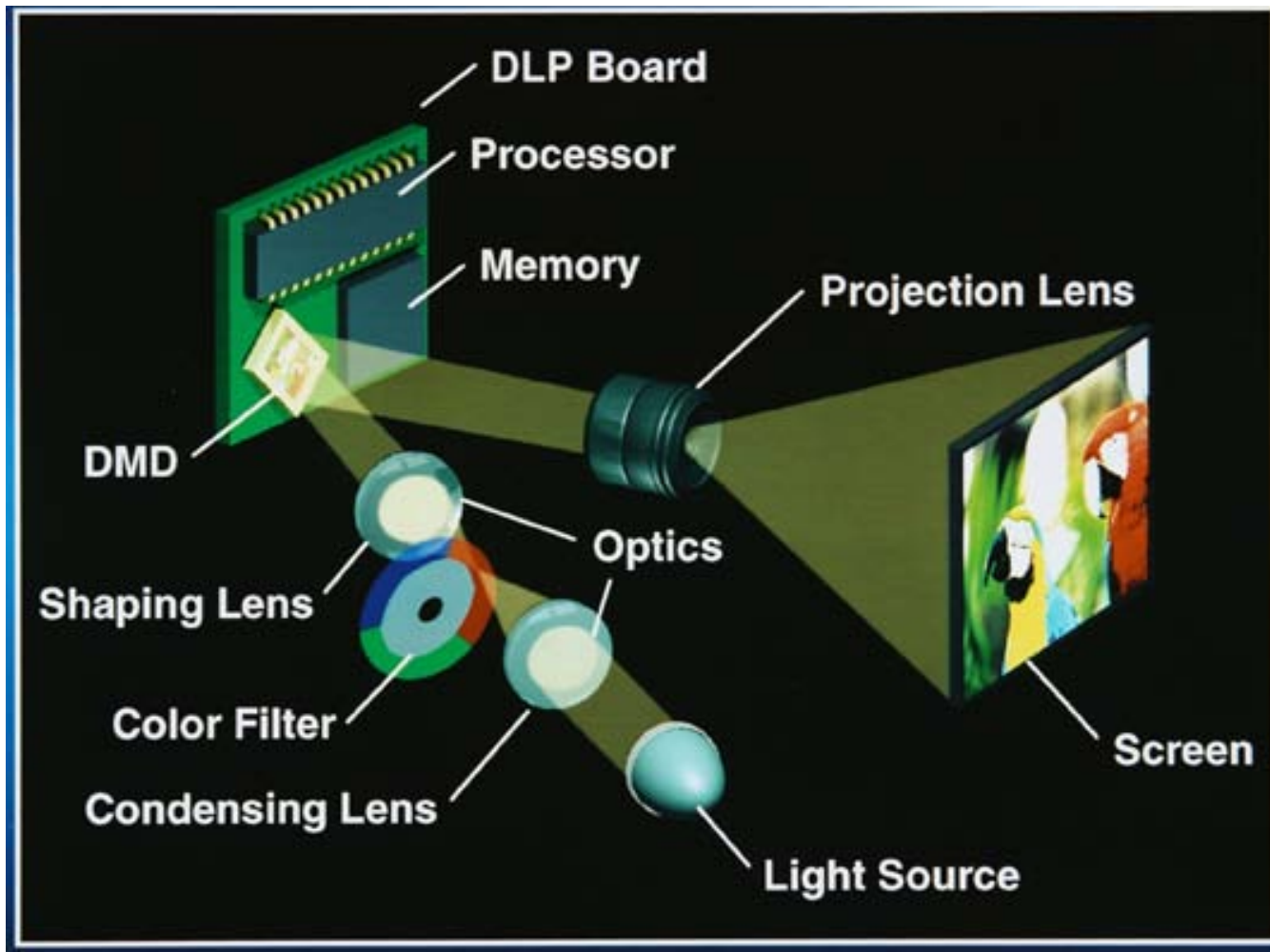
# *Supply Chain Players*

# HTPS 3- $\mu$ D Architecture

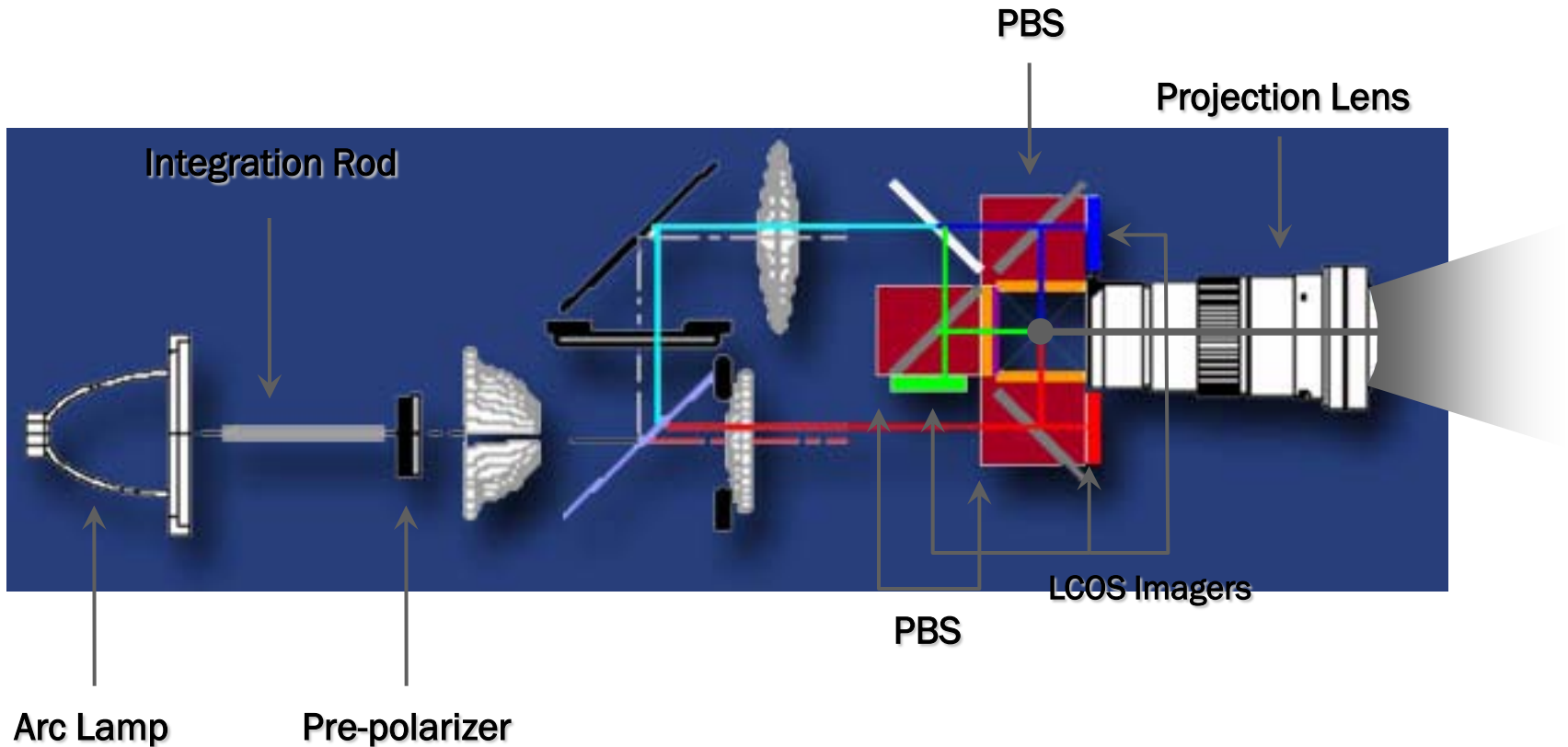


- Register, attach, and test 3-HTPS  $\mu$ Ds to dichroic X-cube combiner

# *DLP 1 Chip Architecture*



# LCOS 3- $\mu$ D Architecture



# Projection Players

Value Chain Level	Brander-Integrator	Contract Manufacture	Engine Manufacture
Leading Players	InFocus Epson Sanyo Hitachi NEC Plus Coretronics	Delta Flextronics Funai	Chinontec Ricoh Carl Zeiss Fujinon Minolta Canon Cosina
Other Players	BenQ Mitsubishi Sharp Philips Toshiba Panasonic		

- Market trends include consolidation, EMS contracting, and moving all capacity to China
  - Supply chain focus on 0.5" and 0.7" panels targeted at high volume enterprise and TV markets

# Optical Component Suppliers

Core Component	X-Cube	Other Players
Leading Players	Geomatec Canon Minolta Nitto Optical Fujinon Cosina	Proflux WGP Canon Clear Prism
Other Players	BLO Ricoh Doctor Optics Tamron Toyo Nikon Tochigi Unaxis	

- Increasing price down pressures drive manufacturing to China