

USAC/ICO March 30, 2009

**A Compelling Study of Harnessing,
Exploiting, and Leveraging Light:
*Towards a Greener, Healthier Society***

Alan E. Willner

**University of Southern California
Los Angeles, CA 90089-2565**

Personal Background

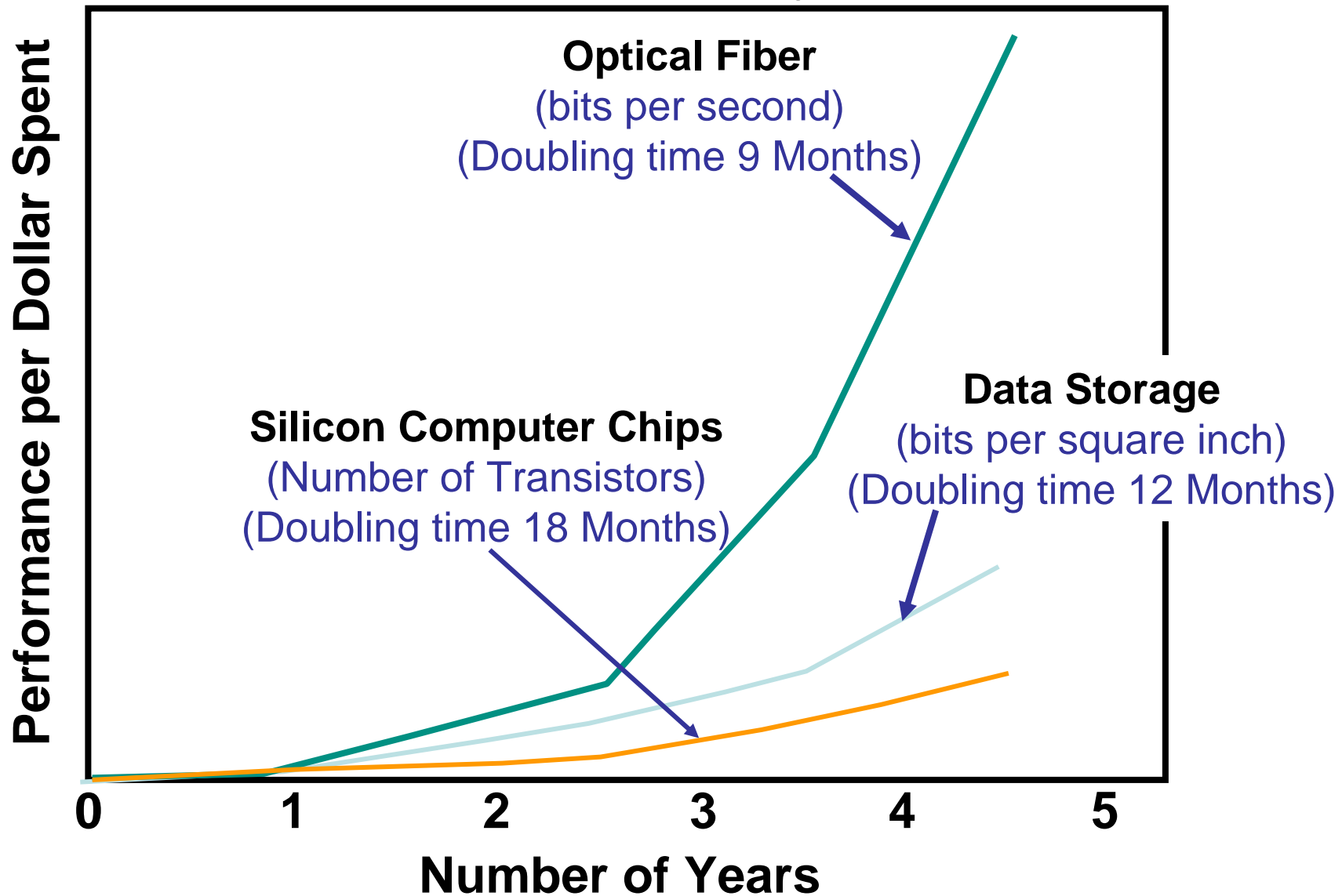
- I have published research papers, edited publications, and chaired conferences for all 3 major societies (IEEE, OSA, SPIE).
 - ✓ *Ex.: Editor-in-Chief for OSA Optics Letters, IEEE/OSA J. Lightwave Technology, IEEE Selected Topics in Quantum Electronics.*
- I have been involved in governance for IEEE and OSA.
 - ✓ *Ex.: President of IEEE LEOS, Co-Chair of OSA Science and Engineering Council.*
- I believe that it is critically important for the National Academies to provide leadership and vision for nurturing the future of optical science and engineering.

Anecdotes

“Wise men speak when they have something to say; fools speak because they have to say something.” - Plato

- **Sensors and microprocessors have little inherent intelligence, are ubiquitous, and are always communicating.**
- **No “bubble” occurred in bandwidth demand.**
- **Doubling of demand every year means a 1000X increase in 10 years.**

Inter-woven Exponential Growth into the 21st Century



The Power of Optics: Greener & Healthier

Bosons & Waves: $A\cos(\omega t + \phi)$

- High energy can be directed with very low loss.
 - ✓ *Ex.: lighting, manufacturing, displays, solar energy, fusion, transmission, medical treatment, fabrication, defense, low power consumption.*
- Many different wave properties (i.e., degrees-of-freedom) can be manipulated.
 - ✓ *Encode amplitude, frequency, phase, polarization, direction.*
 - ✓ *Ex.: communications, sensing, information processing, computing, data storage, security.*
- Coherent waves have unparalleled accuracy, speed & dynamic range.
 - ✓ *Ex.: medical diagnostics, clocks, imaging, spectroscopy, instrumentation, reconfigurable/flexible systems, fundamental physical processes, ultrafast/ultrastable probing.*

Compelling Issues Necessitating a Study (I)

- Orders-of-magnitude growth in technical performance.
 - ✓ *Ex.: Clocks, communications, medical diagnostics, storage, energy density.*
 - ✓ *Optics has enjoyed Moore's Law-like growth but also has fundamental limits that must be attacked.*
- Optics has cemented itself as a transformative, enabling technology affecting many aspects of society.
 - ✓ *Ex.: Social penetration of the Internet.*
 - ✓ *Optics is critically important in healthy economic times and, potentially, even more important in a difficult economy (i.e., telepresence, telecommuting, etc.)- Nortel, Metro Networks.*
 - ✓ Yet *optics is viewed as an exotic, non-robust technology.*

Compelling Issues Necessitating a Study (II)

➤ Vision, clarity & leadership is crucial in economically tumultuous times.

➤ *2000/2002 bubble/bust, 2009 economic slowdown.*

➤ *Future workforce needs must be anticipated.*

➤ *Opportunities are created for nurturing emerging fields.*

➤ *U.S. must maintain its global leadership position.*

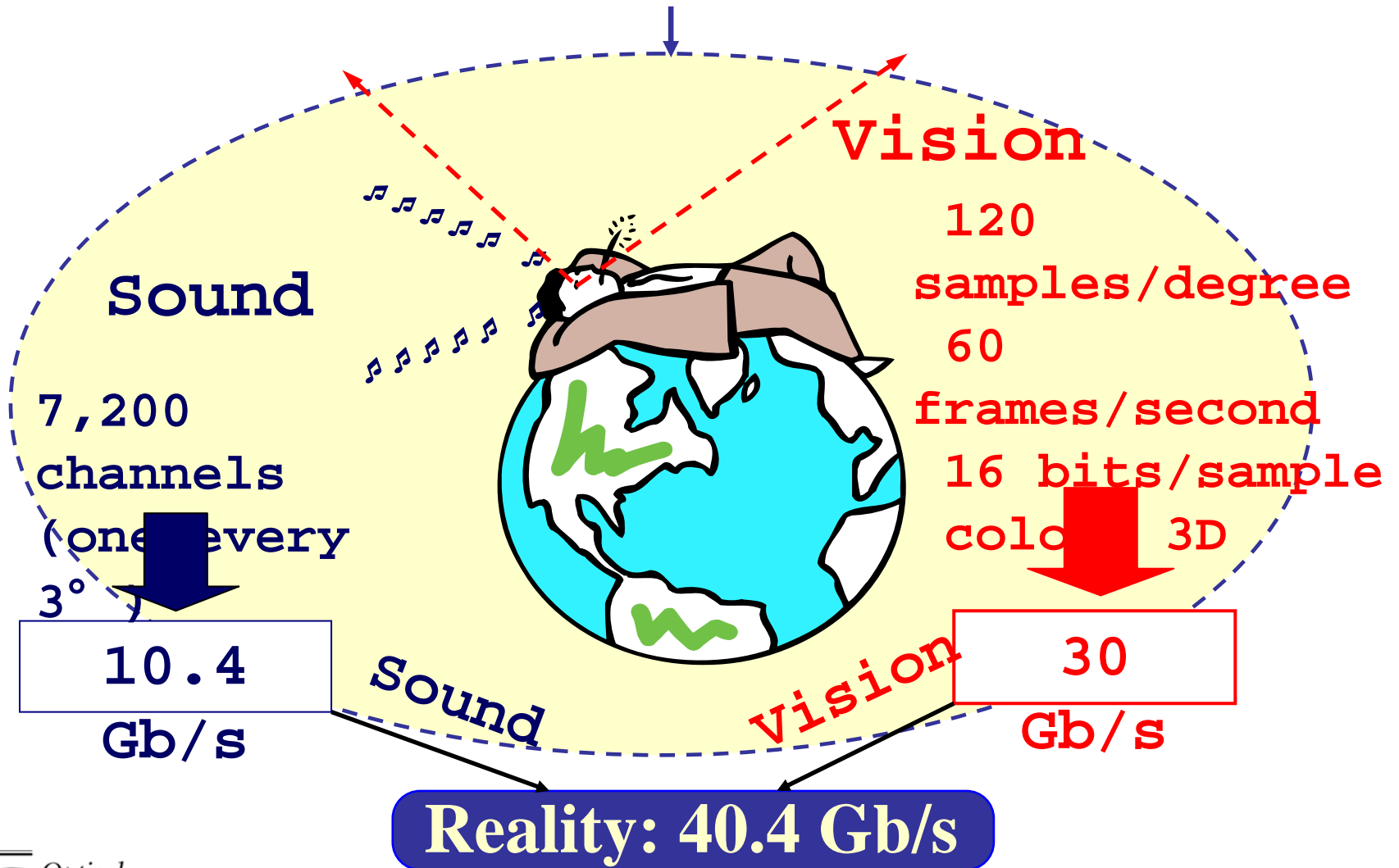
➤ Recommendations

➤ *Examine the efficacy of the 1998 recommendations for “lessons learned”.*

➤ *Formulate a new set of clear recommendations.*

The Bandwidth of Tomorrow's "Immersive" Reality

The bandwidth of human visual & audio perception



Benefits to the Optics “Community”

(as only the National Academies can provide)

➤ Political

- *Raise the profile of the social & economic impact of optics.*
- *Provide a vision for sustained research funding.*

➤ Economic

- *Outline the present and future socio-economic impact of all fields enabled by optical science and engineering.*

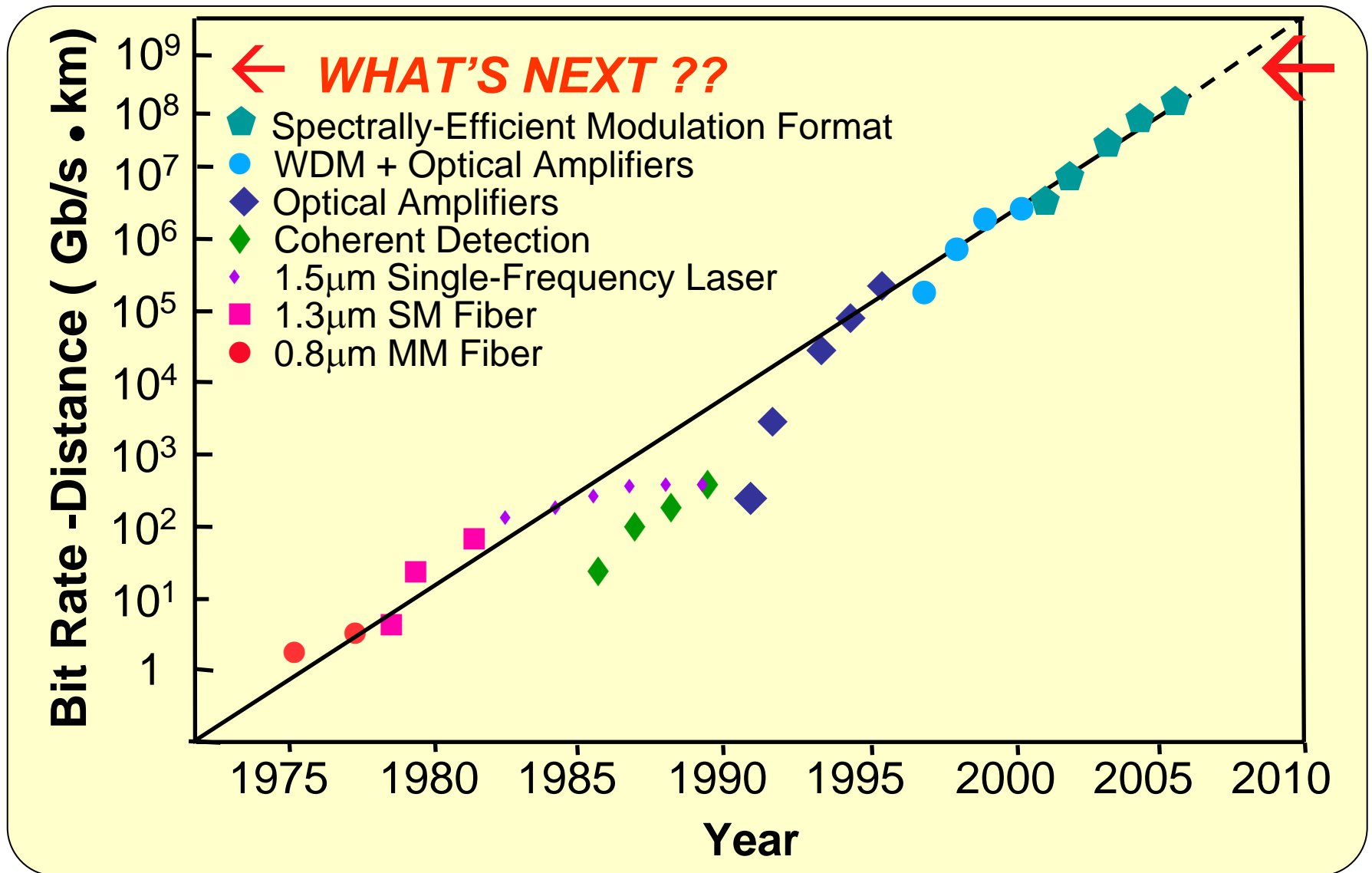
➤ Educational

- *Energize and educate the future scientists and engineers, as well as lay-people, as to the promise of optics.*

➤ Technical

- *Maintain the U.S. leadership position and provide a technical vision for the future.*

Bit-Rate Distance Product



Indiana Jones and the Last Crusade

HJ: “We will face 3 devices of lethal cunning ...”

HJ,J: “How do we stop them?”



HJ: “I don’t know?”