

Why We're Able to Google™

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Google, Inc.

Internet and the World Web Panel, March 25, 2009

Computing Research that Changed the World

Why We're Able to Google

ABSTRACT

Dr. Alfred Z. Spector

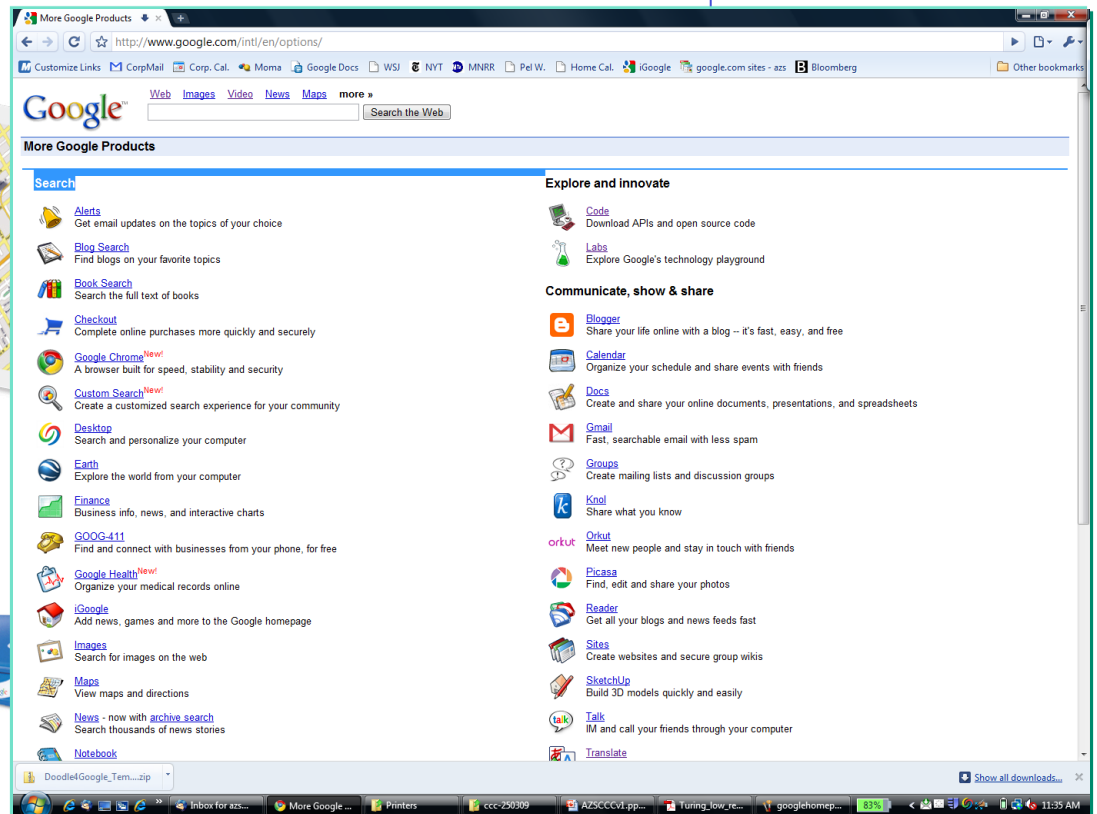
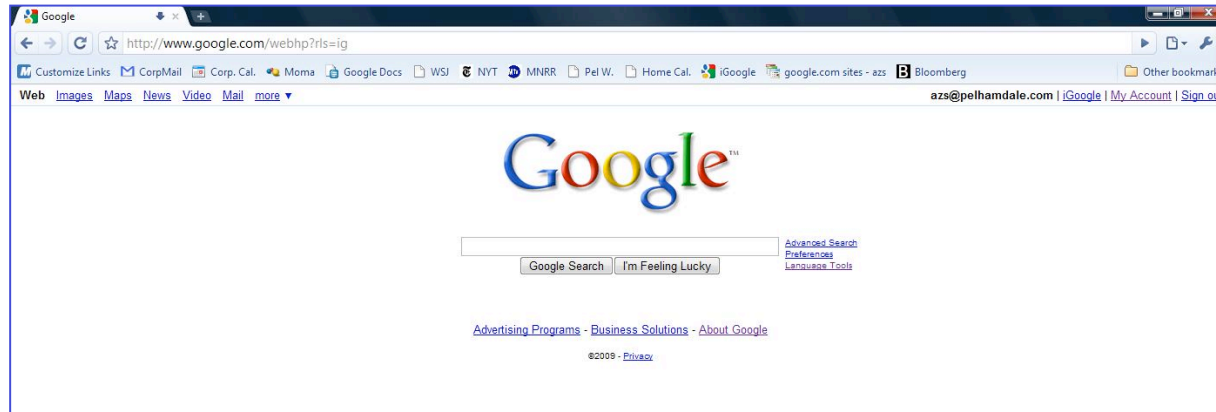
Vice President, Research and Special Initiatives

The technology underlying the modern web is based on decades of research in a diversity of fields, ranging from computer algorithms, to computer architecture and networking, to distributed systems, and to information retrieval. This presentation will illustrate many of the key research ideas that have led to the world wide web, "cloud computing," pervasive search, and other capabilities that we now take for granted. And, technical challenges still abound providing a fertile ground for further advances.

Outline

- To Google
- Technology architecture
- Key ideas
- Research bases
- Conclusions

“To Google”: Examples of Contemporary Capability



All, at planetary scale

reserve currency - G... x +

http://translate.google.com/translate_s?hl=en&clss=&q=reserve+currency&tq=&sl=en&tl=zh-TW

Customize Links CorpMail Corp. Cal. Moma Google Docs WSJ NYT MNRR Pei W. Home Cal. iGoogle google.com site... Other bookmarks

Google Translate BETA Home Text and Web Translated Search Tools

Translated Search

Search for: Translated to: 儲備貨幣 - [Not quite right? Edit](#)

My language: Search pages written in:

Translated results from Traditional Chinese web pages Results 1 - 10 of about 395,000 for 儲備貨幣.

English translation

International reserve currency - MBA think tank encyclopedia
International **reserve currency** of a country refers to government-owned international payments can be used directly in the international monetary funds. Government to maintain the national **currency** exchange rate can be used at any time of the external payments or intervene in the foreign exchange market as part of international liquidity...
wiki.mbalib.com/w/index.php?title=國際儲備貨幣&variant=zh-tw - 30k - [Cached](#)

Zhou Xiaochuan: consider reform of the international monetary system set up super-sovereign reserve currency - Yahoo! Yahoo finance
Shanghai, China central bank governor Zhou Xiaochuan, the People's Bank on the 23rd through the website published an article pointed out that the financial crisis erupted and spread the world to face an old problem: What kind of **reserve currency** in order to maintain global financial stability?...
tw.money.yahoo.com/news_article/adb/d_a_090324_2_1epf4 - 28k - [Cached](#)

Opinion: the global reserve currency
This article from a philosophical point of view of the sustainability of the global **reserve currency** has made some very interesting review. □ article briefly describes the **reserve currency** of the long history, with special reference to an interesting phenomenon, that is, the world's **reserve currency** such as a superpower...
www.info.gov.hk/hkma/chi/viewpt/20050106c.htm - 11k - [Cached](#)

Financial - Zhou Xiaochuan, recommended the creation of super-sovereign reserve currency - PChome News
Yesterday (23), People's Bank of China Governor Zhou Xiaochuan at the central bank web delivered a speech entitled "regarding the reform of the international monetary system consider" the signed article, pointed to the need to create a separate and sovereign country, and maintains the value of long-term stability the...
news.pchome.com.tw/.../cnyes/20090324/index-12378800904272609003.html - 45k - [Cached](#)

New international reserve currency of the two major obstacles
States called for the introduction of a new international **reserv** financial system and the US dollar's latest attempt to link. The

Original Traditional Chinese - [Hide Traditional Chinese results](#)

國際儲備貨幣 - MBA智庫百科
國際**儲備貨幣**是指一國政府持有的可直接用於國際支付的國際通用的貨幣資金。是政府為維持本國貨幣匯率能隨時動用的對外支付或干預外匯市場的一部分國際清償能力。 ...
wiki.mbalib.com/w/index.php?title=國際儲備貨幣&variant=zh-tw - 30k - [頁庫存檔](#)

周小川：思考改革國際貨幣體系建立超主權儲備貨幣 - Yahoo!奇摩理財
【上海】中國央行行長周小川23日透過人行網站發表文章指出，金融危機爆發和蔓延讓世人重新面對一個老問題：什麼樣的**儲備貨幣**才能維持全球金融穩定？ ...
tw.money.yahoo.com/news_article/adb/d_a_090324_2_1epf4 - 28k - [頁庫存檔](#)

觀點：全球儲備貨幣
這篇文章從哲學角度對全球**儲備貨幣**的可持續性作出了一些很有意思的回顧。文章扼要二述了**儲備貨幣**的悠長歷史，並特別提及一個有趣的現象，就是**儲備貨幣**如世界超級大國 ...
www.info.gov.hk/hkma/chi/viewpt/20050106c.htm - 11k - [頁庫存檔](#)

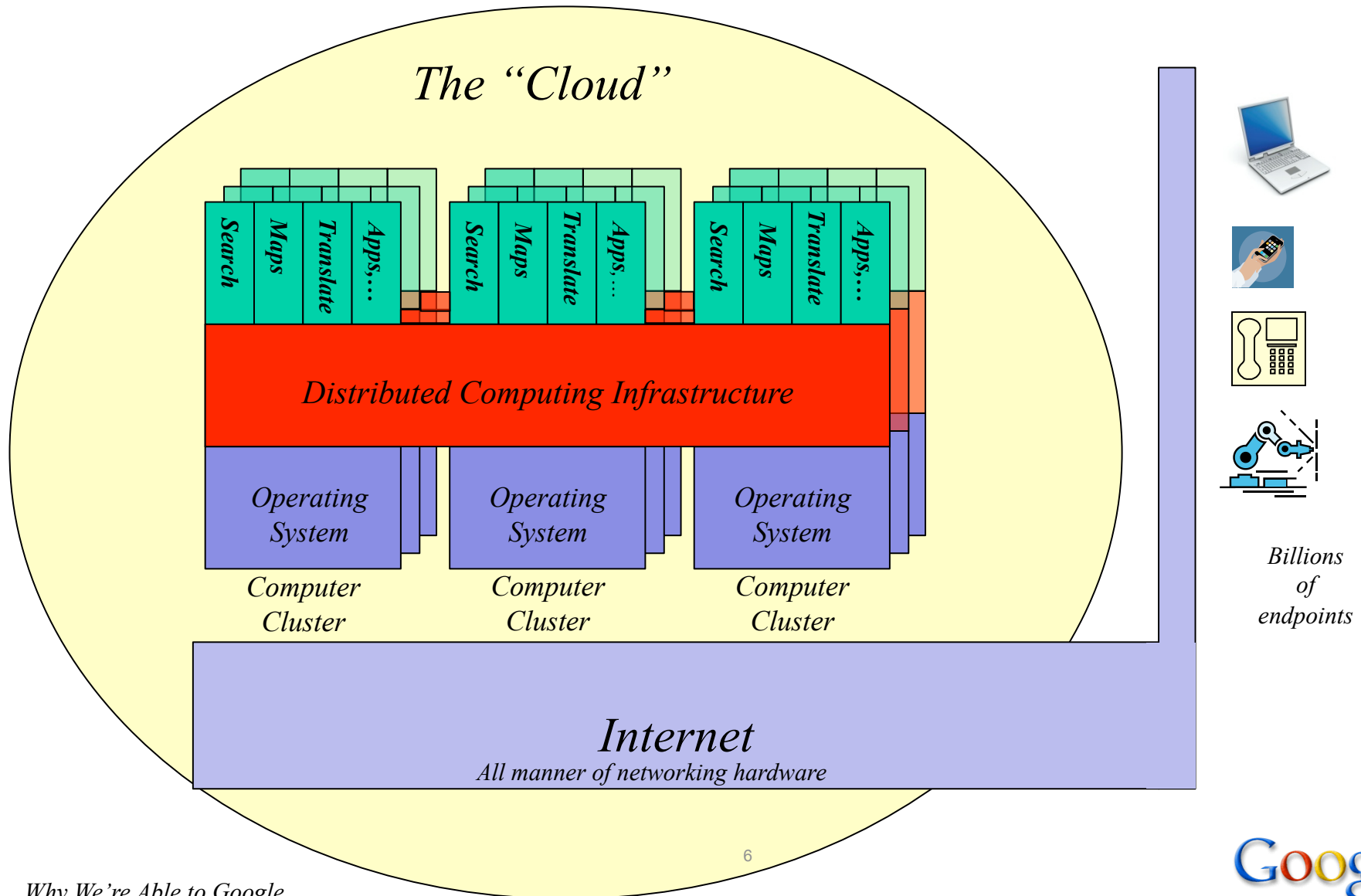
財經：周小川建議創造超主權儲備貨幣 - PChome新聞
昨日（23日），中國人民銀行行長周小川在央行網站上發表了題為《關於改革國際貨幣體系的思考》的署名文章，指出必須創造一種與主權國家脫鉤、並能保持幣值長期穩定的 ...
news.pchome.com.tw/.../cnyes/20090324/index-12378800904272609003.html - 45k - [頁庫存檔](#)

新國際儲備貨幣的兩大障礙
採用一種新的國際**儲備貨幣**，這是使國際金融體系與美元脫鉤的最新嘗試。以往的此類努力之所以都未見顯這一轉變的經濟和政治障礙巨大是重要原因。 ...

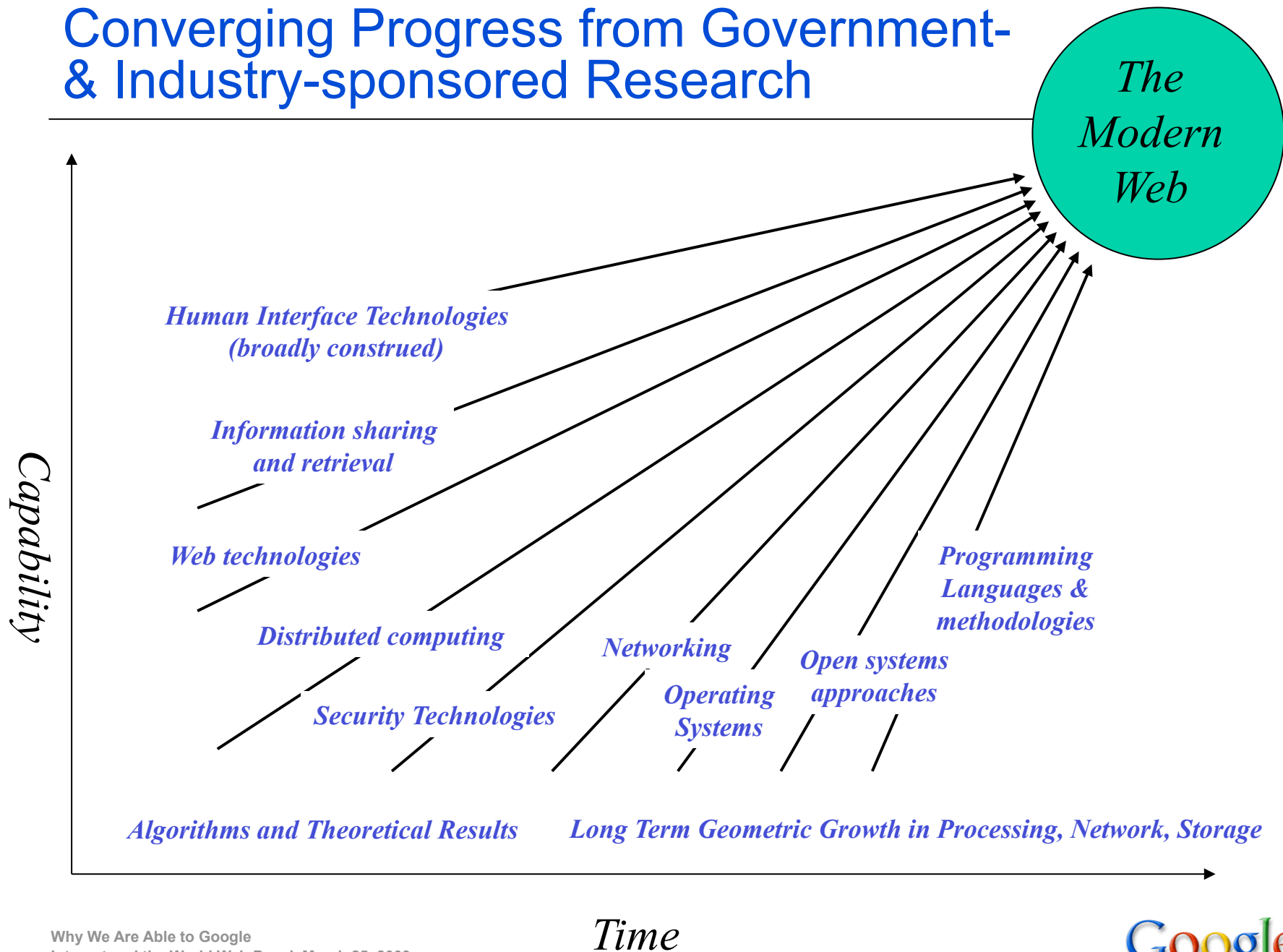
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Cloud Computing Architecture



Converging Progress from Government- & Industry-sponsored Research



Examples of critical contributions

- Programming Languages, Compilers, Formal Languages, and Computability, Abstraction, Object-orientation
- Operating Systems (Timesharing, Open Systems)
- Personal Computer Paradigm
- Networking: Arpanet, Internet, NSFNet (TCP/IP)
- Large Scale & Global File Sharing (xFS)
- Distributed and parallel systems
- Hypertext and the World Wide Web (Memex, HTTP, HTML)
- Information Retrieval (Vector Space Model, Page Rank,)
- Security (Public key cryptography)
- Statistical Speech Recognition and Machine Translation
- Machine Learning (Perceptrons, Support Vector Machines)
- Analysis and Creation of scalable algorithms

Turing Award

Year	Awardees	Contribution
2008	Barbara Liskov	Practical and theoretical foundations of programming language and (distributed) system design...
2007	Edmund M. Clarke, E. Allen Emerson & Joseph Sifakis	Developing Model-Checking into a highly effective verification technology...
2006	Francis E. Allen	Theory and practice of optimizing compilers...
2005	Peter Naur	Language specification, compiler design, and ALGOL 60 ...
2004	Vinton G. Cerf and Robert E. Kahn	Internetworking, including TCP/IP...
2003	Alan Kay	Object-oriented programming and contributions to the personal computer...
2002	Ronald L. Rivest, Adi Shamir and Leonard M. Adleman	Public Key cryptography...
2001	Ole-Johan Dahl and Kristen Nygaard	Object-oriented programming through Simula I & Simula 67...
2000	Andrew Chi-Chih Yao	Contributions to theory of computation...
1999	Frederick P. Brooks, Jr.	Computer Architecture, Operating Systems, and Software Engineering...

ACM Software Systems Award: 1994 - present

2008 - *Gamma Parallel Database System*: David DeWitt, Robert Gerber, Murali Krishna, Donovan Schneider, Shahram Ghandeharizadeh, Goetz Graefe, Michael Heytens, Hui-I Hsiao, Jeffrey Naughton, Anoop Sharma

2007 - *Statemate*: David Harel, Hagi Lachover, Amnon Naamad, Amir Pnueli, Michal Politi, Rivi Sherman, Mark Trakhtenbrot, Aron Trauring

2006 - *Eiffel*: Bertrand Meyer

2005 - *The Boyer-Moore Thm Prover*: Robert S. Boyer, Matt Kaufmann, J Strother Moore

2004 - *Secure Network Programming*: Raghuram Bindignavle, Simon S. Lam, Shaowen Su, Thomas Y. C. Woo

2003 - *make*: Stuart Feldman

2002 - *Java*: James Gosling

2001 - *SPIN model checker*: Gerard Holzmann

1999 - *The Apache Group*: Brian Behlendorf, Roy Fielding, Rob Hartill, David Robinson, Cliff Skolnick, Randy Terbush, Robert S. Thau, Andrew Wilson

1998 - *S*: John Chambers

1997 - *Tcl/Tk*: John Ousterhout

1995 - *NCSA Mosaic*: Marc Andreessen, Eric Bina

1995 - *World Wide Web*: Tim Berners-Lee, Robert Cailliau

1994 - *Remote Procedure Call*: Andrew Birrell, Bruce Nelson



The Field is Wide Open: Vast changes still to occur

<i>Product innovation</i>	<i>Algorithms & Theory</i>	<i>...and much, much more!</i>
<i>User interface technology</i>		
<i>Machine learning, Statistics, Information retrieval, AI</i>		
<i>Compilers, Programming languages</i>		
<i>Networking, Distributed systems, Fault tolerance, Security</i>		
<i>Hardware, Mechanical engineering</i>		

Note, all now at truly global scale

Conclusions

- The PC, Internet, & World Wide Web were built on decades of diverse work in computer science. Both:
 - Industry-funded
 - Government-funded: DoD, NSF, NIST, and more
- Government- sponsored research has been of far more than theoretical interest to industry
- **There has been significant fluidity between academe, government, and industry:**
 - **Ideas, people, collaborations, standards activities, ventures**
- **There is every reason to feel C.S. remains a young field with great basic research, applied research, and enormous economic impact yet to come.**

Thank you very much!