



john wilkes

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Biography

You can find a brief biography and head shots [here](#).

Google

I joined Google in November 2008. I'm based in Sunnyvale, CA.

Most of my initial work was on the [Borg](#) cluster management system that allocates resources to Google's internal compute jobs. Here's a couple of external articles about that system; you can find out much more on my [publications page](#):

- [Inside the Hacker Mind: John Wilkes on Google Omega](#). Cade Metz, Wired. April 2013.
- [Return of the Borg: How Twitter Rebuilt Google's Secret Weapon](#). Cade Metz, Wired. March 2013.

In October 2016, I joined the *Resource And Infrastructure Information Technology (RIOT)* team (part of the *Unified Fulfillment Organization, or UFO*) that automates the fulfillment and provisioning of computing resources to all of Google: we're on the hook to keep up with Google's exponential growth in demand, as efficiently as possible. At our scale, that's quite a big deal. Here's a short [video](#) about our work.

Meet the Unified Fulfillment Optimization (UFO) Team at G...



After a few years, I found myself spending most of my time working on delivering network capacity to Google's datacenters, so I moved over to the [NetInfra team](#) in 2019, founding and leading the cross-organization effort we call *Network infrastructure Capacity Delivery (NiCaD)*.

I'm also the tech lead for the tool we use to match most technical intern candidates to their hosts. (It's what we call a "20% project" - a side activity that, in this case, supports a business-critical process. Very Google!)

Hewlett-Packard

I was at HP Labs for nearly 26 years. Here's a short summary of what I got up to there.

Self-managing systems

Just before I left HP, I helped initiate and found [Open Cirrus](#), an open cloud-computing research testbed designed to support research into the design, provisioning, and management of



topics

places: [Google](#), [HP](#)

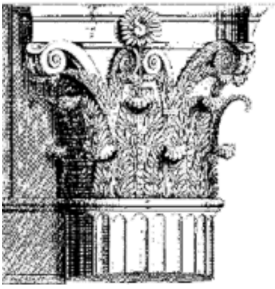
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services at a global, multi-datacenter scale. The original slogan: "*PlanetLab for data centers*".



Storage systems

The topic area that started my interest in self-managing systems was storage. I founded and led the HP Labs Storage Systems Program for several years.

Together, we worked on the automatic design and configuration of enterprise-scale storage systems with an emphasis on storage-area networks (SANs) and Our goal was to make such systems much easier to manage.

topics

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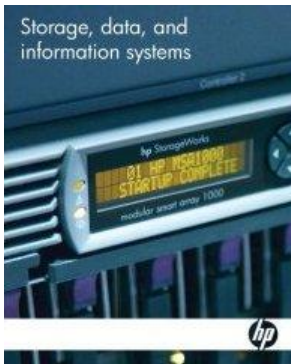
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Accomplishing this required work in:

- Capturing high-level goals for the storage system, expressed as Quality-of-service based Service Level Agreements (QoS-SLAs)
- Automatically determining the appropriate design and configuration of a storage system to meet those goals, and the placement of data in it. This includes tools to design network topologies for high speed Storage-Area Networks (SANs) such as FibreChannel.
- Online system management tools that allow data to be moved around on the fly, while it's being accessed, and help to close the loop, allowing a storage system to be completely self-managing.
- Mechanisms and languages for describing storage system requirements, capabilities, designs, and deployments.
- Scalable storage system architectures that can deliver big-system reliability and performance with small-system price and flexibility.

A [retrospective on this work](#) was published in *Operating Systems Review*, January 2009.



Storage, data, and information systems

In 2007-2008 Christopher Hoover, Beth Keer, Pankaj Mehra, Alistair Veitch and I wrote a book on the storage stack, from hardware up to modern information systems. I was the editor and publisher. It grew out of a technology briefing for the HP board of directors. A couple of thousand copies were given away at HP storage conferences, and to students in a CMU class. For about \$15, you can [buy a copy from Amazon.com](#).

Earlier work

Before this, I was active in several areas, including:

- Helping HP's Storage Systems Division in Boise develop the HP AutoRAID technology.
- Network architecture (the Hamlyn sender-based message model).
- Operating systems (e.g., the Brevix project).

Many of the papers published by myself and other members of the research groups in which I have worked over the years are [available online](#) via the [wayback machine](#) archive, together with some of the [software and disk I/O traces](#) that we and other researchers used.

Publications

You can find [my own publications here](#). Several papers on related topics can be found at the HP Labs storage systems [web site](#).

I'm not a mathematician, but my Erdős number is 3, according to AMS's [collaboration-distance tool](#): Eric Anderson → Michael Saks → Paul Erdős.

Patents

I am named as an inventor on 50+ issued US patents. The full list can be found [here](#).

External activities

I've been a Program (Co)Chair for SOSP, EuroSys, FAST.
I've been a program committee member for SOSP, SoCC, FAST, EuroSys, OSDI, NSDI, and a bunch of workshops, including HotOS, HotCloud, HotStorage.

topics

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Awards and recognition

- Principal Software Engineer, Google, 2010.
- HP Fellow, 2002.
- ACM Fellow, 2002 (member since 1981).
- SNIA *Outstanding contribution award* for work on the SNIA shared storage model, October 2001.
- PhD, University of Cambridge, 1984: *Workstation design for distributed computing*.
- British Computer Society *Wilkes Award* for the best paper published in 1984 in the Computer Journal by an author or authors aged under 30. The award is named for Maurice Wilkes, director of the Computer Laboratory in Cambridge c. 1947–1980. The paper was: [The Rainbow workstation \[PDF 5.3MB\]](#). A. J. Wilkes, D. W. Singer, J. J. Gibbons, T. R. King, P. Robinson, and N. E. Wiseman. Computer Journal **27**(2):112-120, May 1984. DOI: [10.1093/comjnl/27.2.112](#). © 1982 British Computer Society.
- The Rainbow workstation itself (my PhD thesis research) was given the British Computer Society *Technology Award* for 1982.
- Diploma in Computer Science, University of Cambridge, 1979.
- BA in Natural Sciences, University of Cambridge, 1978.

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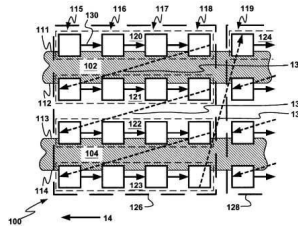
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patents

The list below is of issued (granted) patents: it doesn't show pending or abandoned applications. They are ordered by issue date, with the most recent at the top.

Hover over a link to see the abstract.

USPTO = US Patent and Trademark Office.



1. [Specifying behavior among a group of computing tasks \(USPTO link\)](#). John Wilkes, David Oppenheimer, Walfredo Cirne, Cosmos Nicolaou. US patent 11,520,632 B1, filed 20-Mar-2020, granted 06-Dec-2022.
2. [Resource tolerations and taints \(USPTO link\)](#). John Wilkes, Brian Grant. US patent 11,263,048 B1, filed 12-Dec-2019, granted 01-Mar-2022.
3. [Omega resource model: returned-resources \(USPTO link\)](#). John Wilkes, David Oppenheimer, Rafal Sokolowski, Walfredo Cirne. US patent 10,963,304 B1, filed 10-Feb-2014, granted 30-Mar-2021.
4. [Specifying behavior among a group of computing tasks \(USPTO link\)](#). John Wilkes, David Oppenheimer, Walfredo Cirne, Cosmos Nicolaou. US patent 10,176,016, filed 7-Aug-2017, granted 8-Jan-2019.
5. [Resource tolerations and taints \(USPTO link\)](#). John Wilkes, Brian Grant. US patent 9,946,572, filed 23-Nov-2016, granted 17-Apr-2018.
6. [Systems and methods for performing scheduling for a cluster \(USPTO link\)](#). John Wilkes, Todd Wang, Walfredo Cirne, David Oppenheimer, Brian Grant, Jason Hickey, Kai-Peter Backman, Joseph Hellerstein, David Bort. US patent 9,870,258, filed 25-May-2016, granted 16-Jan-2018.
7. [Specifying behavior among a group of computing tasks \(USPTO link\)](#). John Wilkes, David Oppenheimer, Walfredo Cirne, Cosmos Nicolaou. US patent 9,727,379 B1, filed 14-Apr-2014, granted 8-Aug-2017.
8. [Disruption counters \(USPTO link\)](#). John Wilkes, Brian Grant, Luc Mercier, Todd Wang. US patent 9,645,955 B1, filed 19-Feb-2014, granted 9-May-2017.
9. [Resource tolerations and taints \(USPTO link\)](#). John Wilkes, Brian Grant. US patent 9,535,750 B1, filed 27-Dec-2013, granted 3-Jan-2017.
10. [Systems and methods for performing scheduling for a cluster \(USPTO link\)](#). John Wilkes, Todd Pu-Tse Wang, Walfredo Cirne, David Oppenheimer, Brian Grant, Jason Hickey, Kai-Peter Backman, Joseph Hellerstein, David Bort. US patent 9,378,051 B1, filed 11-Dec-2015, granted 28-Jun-2016.
11. [Method of providing system design \(USPTO link\)](#). Mike Patrick van Eerd, John Wilkes. US patent 9,367,647 B2, filed 21-Feb-2006, granted 14-Jun-2016.
12. [Systems and methods for performing scheduling for a cluster \(USPTO link\)](#). John Wilkes, Todd Pu-Tse Wang, Walfredo Cirne, David Oppenheimer, Brian Grant, Jason Hickey, Kai-Peter Backman, Joseph Hellerstein, David Bort. US patent 9,229,774 B1, filed 7-Mar-2013, granted 5-Jan-2016.
13. [Generating interconnect fabric requirements \(USPTO link\)](#). Li-Shiuan Peh, Michael Justin O'Sullivan, John Wilkes, Julie Ann Ward. US patent 9,009,004 B2, filed 31-Jan-2002, granted 14-Apr-2015.
14. [Data mirroring using batch boundaries \(USPTO link\)](#). John Wilkes. US patent 8,850,073 B1, filed 30-Apr-2007, granted 30-Sep-2014.
15. [Methods and apparatus for designing the racking and wiring configurations for pieces of hardware \(USPTO link\)](#). Richard Edwin Rosenthal, Troy Alexander Shahoumian, Julie Ann Ward, John Wilkes. US patent 8,798,964 B2, filed 6-Nov-2002, granted 5-Aug-2014.
16. [Interconnection fabric connection \(USPTO link\)](#). Julie Ward Drew, John Wilkes, Charles O'Toole, Douglas Hagerman, Simge Kucukyavuz. US patent 8,745,265 B2, filed 10-Apr-2012, granted 3-Jun-2014.

17. [Interconnection fabric connection \(USPTO\)](#). Julie Ward Drew, John Wilkes, Charles O'Toole, Douglas Hagerman, Simge Kucukyavuz. US patent 8,214,523, filed 22-Jun-2004, granted 3-Jul-2012.
18. [Method of cooperative caching for distributed storage system \(USPTO\)](#). Craig Soules, Arif Merchant, Alistair Veitch, Yasushi Saito, John Wilkes. US patent 8,055,845, filed 3-Feb-2005, granted 8-Nov-2011.
19. [Workflow control using an aggregate utility function \(USPTO\)](#). Janet Wiener, John Wilkes, Alvin AuYoung, Laura Grit. US patent 7,996,250, filed 30-Oct-2006, granted 9-Aug-2011.
20. [Storage system including a fast storage device for storing redundant data \(USPTO\)](#). Guillermo Alvarez, Mustafa Uysal, Arif Merchant, John Wilkes. US patent 7,979,632, filed 6-Sep-2002, granted 12-July-2011.
21. [Method of designing storage system \(USPTO\)](#). John Wilkes. US patent 7,761,449, filed 9-Aug-2001, granted 20-July-2010.
22. [Configuration system and method](#). Kimberly Keeton, John Wilkes, Cipriano A. Santos, Dirk Beyer, Arif Merchant, Jeffrey Scott Chase. US patent 7,680,635, filed 17-Sep-2004, issued 16-Mar-2010. (Designing for disasters)
23. [Method of designing storage system](#). Kimberly Keeton, John Wilkes, Cipriano A. Santos, Dirk Beyer, Jeffrey Scott Chase, Arif Merchant. US patent 7,644,249, filed 17-Sep-2004, issued 5-Jan-2010. (Designing for disasters)
24. [Technique for programmatically obtaining experimental measurements for model construction](#). Guillermo Alvarez, Fabian E. Bustamante, Ralph Becker-Szendy, John Wilkes. US patent 7,505,886, filed 3-Sep-2002, issued 17-Mar-2009.
25. [System and method for interposition-based selective simulation of faults for access requests to a data storage system](#). Kimberly Keeton, Arif Merchant, John Wilkes. US patent 7,467,333, filed 1-Sep-2005, issued 16-Dec-2008. (Designing for disasters)
26. [Reprovisioning technique for an interconnect fabric design](#). Julie Ward Drew, Troy Alexander Shahoumian, John Wilkes, Michael O'Sullivan, Dirk Beyer. US patent 7,308,494, filed 8-Nov-2002, issued 11-Dec-2007. (Appia)
27. [Batched, asynchronous data redundancy technique](#). Minwen Ji, Alistair Veitch, John Wilkes. US patent 7,287,137, filed 6-Jun-2003, issued 23-Oct-2007. (Seneca)
28. [Technique and interface for computer system resource assignment](#). Joseph E. Algieri, John Wilkes. US patent 7,236,915, filed 9-Aug-2001, issued 26-Jun-2007.
29. [Reliability for interconnect fabrics](#). Julie Ann Ward, Troy Alexander Shahoumian, John Wilkes. US patent 7,233,983, filed 17-Jan-2002, issued 19-Jun-2007. (Appia)
30. [System workload characterization](#). Alistair Veitch, Eric Anderson, John Wilkes. US patent 7,203,621, filed 6-Jun-2002, issued 10-Apr-2007.
31. [Method and system for ensuring data consistency after a failover event in a redundant data storage system](#). Minwen Ji, Alistair Veitch, John Wilkes. US patent 7,178,055, filed 6-Jun-2003, issued 13-Feb-2007. (Seneca)
32. [Method and system for online data migration on storage systems with performance guarantees](#). Guillermo A. Alvarez, Chenyang Lu, John Wilkes. US patent 7,167,965, filed 30-Apr-2001, issued 23-Jan-2007. (Aqueduct)
33. [Data redundancy system and method](#). Minwen Ji, Alistair Veitch, John Wilkes. US patent 7,152,182, filed 6-Jun-2003, issued 19-Dec-2006. (Seneca)
34. [Adaptive batch sizing for asynchronous data redundancy](#). Minwen Ji, Alistair Veitch, John Wilkes. US patent 7,120,825, filed 6-Jun-2003, issued 10-Oct-2006. (Seneca)
35. [State machine and system for data redundancy](#). Minwen Ji, Alistair Veitch, John Wilkes. US patent 7,089,383, filed 6-Jun-2003, issued 8-Aug-2006. (Seneca)
36. [Designing interconnect fabrics](#). Julie A. Ward, Troy A. Shahoumian, John Wilkes. US patent 7,076,537, filed 19-Dec-2001, issued 11-Jul-2006. (Appia)
37. [Modeling a target system by interpolating](#). Eric Anderson, John Wilkes. US patent 7,039,897, filed 12-Jul-2002, issued 2-May-2006.
38. [Techniques for cache memory management using read and write operations](#). John Wilkes. US patent 7,039,765, filed 19-Dec-2002, issued 2-May-2006.
39. [Reliability for interconnect fabrics](#). Julie Ann Ward, Troy Alexander Shahoumian, John Wilkes. US patent 7,032,013, filed 19-Dec-2001, issued 18-Apr-2006. (Appia)
40. [Data placement for fault tolerance](#). Magnus Karlsson, Qian Wang, John Wilkes. US patent 7,000,141, filed 14-Nov-2001, issued 14-Feb-2006.
41. [Automated system adaptation technique particularly for data storage systems](#). Eric Anderson, Michael Hobbs, Kimberly Keeton, Susan Spence, Mustafa Uysal, Alistair Craig Veitch, John Wilkes. US patent 6,978,259, filed 23-Oct-2001, issued 20-Dec-2005.
42. [Adaptive cache memory management](#). John Wilkes. US patent 6,978,349, filed 9-Jan-2003, issued 20-Dec-2005. (Exclusive caching)

43. [Method and apparatus for predicting multi-part performability](#). Guillermo Alvarez, Ralph Becker-Szendy, Arif A. Merchant, Mustafa Uysal, John Wilkes. US patent 6,934,673, filed 25-May-2001, issued 23-Aug-2005.
44. [Method and apparatus for computing data storage assignments](#). Susie Go, John Wilkes. US patent 6,865,527, filed 18-Dec-2000, issued 8-Mar-2005.
45. [Exclusive caching in computer systems](#). John Wilkes, Theodore M. Wong. US patent 6,851,024, filed 17-Aug-2000, issued 1-Feb-2005. (Exclusive caching)
46. [Adaptive data insertion for caching](#). John Wilkes, Theodore M. Wong. US patent 6,728,837, filed 2-Nov-2001, issued 27-Apr-2004. (Exclusive caching)
47. [Disk drive system with hybrid surface-based data mapping and method of operation thereof](#). John Wilkes, Gregory Robert Ganger. US patent 6,693,766, filed 21-Sep-2000, issued 17-Feb-2004.
48. [Acceptability testing for capacity planning of data storage system](#). Elizabeth Lynn Borowsky, Richard Golding, Arif Merchant, Mirjana Spasojevic, John Wilkes. US patent 6,606,585, filed 21-Aug-1999, issued 12-Aug-2003.
49. [Apparatus for and method of multi-dimensional constraint optimization in storage system configuration](#). Elizabeth Borowsky, Richard Golding, Arif Merchant, Elizabeth Shriver, Mirjana Spasojevic, Tim Sullivan, John Wilkes. US patent 6,321,317, filed 16-Dec-1998, issued 20-Nov-2001.
50. [Methods and apparatus for implementing quality of service guarantees in data storage systems](#). Elizabeth L. Borowsky, Richard A. Golding, Arif A. Merchant, Mirjana Spasojevic, John Wilkes. US patent 6,119,174, filed 13-Oct-1998, issued 12-Sep-2000.
51. [Multilevel storage system with hybrid data compression](#). John Wilkes. US patent 6,032,148, filed 15-Sep-1997, issued 29-Feb-2000.
52. [System and method for pattern matching using checksums](#). John Wilkes. US patent 5,832,235, filed 26-Mar-1997, issued 3-Nov-1998.
53. [Frequently-redundant array of independent disks](#). John Wilkes and Stefan Savage. US patent 5,720,025, filed 18-Jan-1996, issued 17-Feb-1998. (AFRAID)
54. [Hole-plugging garbage collection for a data storage system](#). Theresa A. Burkes, Carl Staelin, Timothy T. Sullivan, Douglas L. Voigt, and John Wilkes. US patent 5,604,902, filed 16-Feb-1995, issued 18-Feb-1997. (HP AutoRAID)
55. [High-performance multiple-unit electronic data storage system with checkpoint logs for rapid failure recovery](#). Chia-Chaing Chao, Robert M. English, David M. Jacobson, Alexander Stepanov, A.J. Wilkes. US patent 5,481,694, filed 24-Apr-1992, issued 2-Jan-1996. (Mime.)
56. [Inter-processor communication in which messages are stored at locations specified by the sender](#). A.J. Wilkes. US patent 5,448,698, filed 5-Apr-1993, issued 5-Sep-1995. (Hamlyn)

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