Dawson R. Engler

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Education

Massachusetts Institute of Technology ..... Cambridge, MA

Ph.D. in Electrical Engineering and Computer Science (Expected) ..... June, 1998
Thesis title: "The Exokernel OS architecture: Design, Implementation, Relevance".
Advisor: Prof. M. Frans Kaashoek.

S.M. in Electrical Engineering and Computer Science ..... February, 1995
Thesis title: "The Design and Implementation of a Prototype Exokernel Operating System".

University of Arizona ..... Tucson, AZ

B.A. Double major in Math and Computer Science ..... August, 1993

Research Interests

Systems, particularly operating systems and compilers. All aspects of high-performance operating systems, application-specific compilation, and dynamic code generation.

Research Experience

Massachusetts Institute of Technology ..... Cambridge, MA

1994 – Present

Exokernel Co-architect and designer of the exokernel operating system architecture [2][8], which is designed to make resource management unprivileged. In contrast to a traditional operating system, an exokernel allows untrusted software (typically in the form of an unprivileged library operating system) to implement fundamental operating system abstractions such as virtual memory, file systems, and networking. This control can improve the performance of applications such as web servers by an order of magnitude [2][11].

I was co-technical lead, with my advisor, of the exokernel project, which includes more than 15 students.

My master's thesis articulated the principles of the exokernel architecture and designed and implemented first exokernel, Aegis, and its default library operating system, ExOS. This system was an order of magnitude faster than a mature traditional operating system on many micro-benchmarks and served as the base for two subsequent exokernel systems.

My thesis research presents a matured view of the exokernel architecture, describes several exokernel implementations, and provides an application-driven evaluation of both local and global performance of an exokernel system, and solves the hardest technical problems of the exokernel approach [2]. One of the more interesting ideas that it proposes is a technique I invented, untrusted deterministic functions (UDFs), to solve the problem of secure disk multiplexing. The key result of UDFs is that they allow exokernels to safely rely on untrusted applications to track what disk blocks they have access to, without requiring understanding of how they do so. This freedom enables the efficient unprivileged implementation of innovative or even application-specific file systems, such as the one used by the web server discussed above.

1996 – Present

Application-specific compilation Proposed the idea of application-specific compilation, which is intended to (1) incorporate the semantics of application interfaces into compilation so that they can be optimized and checked similar to languages and (2) expose the transformation and analysis power of compilers to application writers to make programming more powerful.

Sole designer and implementor of the magik application-specific compiler, designed to simply and easily incorporate application semantics and control into compilation [1].

1993 – Present

Dynamic code generation – Dynamic code generation is the generation of executable code at runtime. It can be used to speed up applications such as interpreters and graphics programs by an order of magnitude.

Sole designer and implementor of vcode [6], a portable, general-purpose dynamic code generation system significantly simpler and a factor of 30-50 times faster than the closest equivalent. Vcode has been used in numerous systems, including [2] [3] [4] [5] [8].

Co-designer of the `C ("tick-c") language, an extension of ANSI C that provides support for dynamic code generation [7]. `C is the first statically-typed language to support direct dynamic code generation. Co-designer of an optimizing, publically-released compiler for `C [3][12].

1995 – 1996

Networking Designed and implemented DPF, a network packet-filter that uses dynamic code generation to compile packet filters to executable code [4][8]. DPF is 10—20 times faster than the fastest packet-filter systems in the literature.

Co-designer and co-implementor of ASHs, which are application message handlers downloaded into the OS kernel [5][8]. ASHs direct message transfers (thereby eliminating copies), incorporate data manipulations such as checksumming and data conversions directly into the message transfer engine (thereby eliminating duplicate message traversals), and initiate messages (thereby reducing send-response latency). Measurements of a user-level implementation of ASHs demonstrate substantial performance benefits [5].

University of Arizona ..... Tucson, AZ

1993

Dynamic code generation Co-designer and sole implementor of DCG, a portable dynamic code generation system [10]. DCG was used as a base in the first implementation of `C [7].

1992 – 1993

Parallel Programming Designed and implemented the Filaments thread package, which created three argument threads in 12 instructions and removed the need for per-thread stacks in most operations. Filaments has been used as an idea base for two PhD thesis.

Teaching Experience

Massachusetts Institute of Technology ..... Cambridge, MA

2/97 – 5/97

Recitation instructor – I was a recitation instructor for the core MIT undergraduate systems course, 6.033. This position is usually held by a faculty member. I developed my own lectures, which ranged over most of the core concepts in systems — threads, transactions, networking, file systems, etc. The material I developed was used by other instructors.

2/96 – 5/96

Lab Assistant – As the first lab assistant for 6.033 (see above) I assisted the development of the new lab, and instructed the lab students on the central ideas of the fields in which they were to build artifacts (file systems and networking). The material for both of these activities formed the base for subsequent years.

9/97 – 12/97

Head Teaching Assistant — As the head teaching assistant for the core undergraduate computer architecture class (6.004), I was responsible for the administration of approximately 200 students.

Supervisory Experience

Massachusetts Institute of Technology ..... Cambridge, MA

Exokernel – With my advisor I was co-technical lead of the exokernel project.

Theses – I formally supervised two Masters theses, and informally supervised a third.

Work Experience

DEC Systems Research Laboratory (SRC) ..... Palo Alto, CA

Summer 1997

Intern – I developed a tool to visually display the profiling data generated by SRC's DCPI continuous profiler, and proposed two improvements to DCPI (they have since been implemented) that improved pc-sampling robustness and made multiprocessor profiling faster.

I also won a $100 wager with Dick Sites, co-architect of Alpha machine architecture, about an implementation characteristic of the EV4 Alpha implementation's program-counter-sampling behavior.

1990 – 1992

Chicago Bar ..... Tucson, AZ

Bouncer – I ejected unruly bar patrons.

Refereed Publications

1 Dawson R. Engler, "Incorporating Application Semantics and Control into Compilation", in Proceedings of the First Conference on Domain Specific Languages, Santa Clara, California, October, 1997. (Talk included.)

2 M. Frans Kaashoek, Dawson R. Engler, Gregory R. Ganger, Héctor M. Briceno, Russell Hunt, David Mazieres, Thomas Pinckney, Robert Grimm, John Jannotti, and Kenneth Mackenzie, "Application Performance and Flexibility on Exokernel Systems", in Proceedings of the Sixteenth ACM Symposium on Operating Systems Principles (SOSP), Saint-Malo, France, October, 1997. (Talk included.)

3 Max Poletto, Dawson R. Engler, and M. Frans Kaashoek, "tcc: A compiler for `C", in Proceedings of the SIGPLAN 1997 Conference on Programming Language Design and Implementation (PLDI), Las Vegas, Nevada, June, 1997.

4 Dawson R. Engler and M. Frans Kaashoek, "DPF: Fast, Flexible Message Demultiplexing using Dynamic Code Generation", In ACM Communication Architectures, Protocols, and Applications (SIGCOMM '96), Palo Alto, California, August, 1996. (Talk included.)

5 Deborah A. Wallach, Dawson R. Engler, and M. Frans Kaashoek, "ASHs: Application-specific handlers for high-performance messaging", in ACM Communication Architectures, Protocols, and Applications (SIGCOMM '96), Palo Alto, California, August, 1996. Selected to appear in IEEE/ACM Transactions on Networking, August 1997, Volume 5, Number 4.

6 Dawson R. Engler, "vcode: a retargetable, extensible, very fast dynamic code generation system", in Proceedings of the SIGPLAN 1996 Conference on Programming Language Design and Implementation (PLDI), May, 1996. (Talk included.)

7 Dawson R. Engler, Wilson C. Hsieh and M. Frans Kaashoek, "`C: A Language for High-Level, Efficient, and Machine-independent Dynamic Code Generation", in Annual Symposium on Principles of Programming Languages (POPL), St. Petersburg, Florida, 1995. (Talk included.)

8 Dawson R. Engler, M. Frans Kaashoek, and James O'Toole Jr, "Exokernel: an Operating System architecture for Application-specific Resource Management", in Proceedings of the Fifteenth ACM Symposium on Operating Systems Principles (SOSP), Copper Mountain Resort, Colorado, December 1995. (Talk included.)

9 Dawson R. Engler, M. Frans Kaashoek, and James O'Toole, "The Exokernel Approach to Extensibility (Abstract)", in Proceedings of the First Symposium on Operating Systems Design and Implementation (OSDI), November, 1994.

10 Dawson R. Engler and Todd A. Proebsting, "DCG: An Efficient, Retargetable Dynamic Code Generation System", in Proceedings of the Sixth International Conference on Architecture Support for Programming Languages and Operating Systems (ASPLOS-VI), San Jose, California, October, 1994. (Talk included.)

Workshop Publications

11 M. Frans Kaashoek, Dawson R. Engler, Greg R. Ganger, and Deborah A. Wallach, "Server Operating Systems", in The 1996 SIGOPS European Workshop, September, 1996.

12 Max Poletto, Dawson R. Engler, M. Frans Kaashoek, "tcc: A Template-Based Compiler for `C", in The Workshop on Compiler Support for Systems Software (WCSSS), Tucson, Arizona, February 1996.

13 Dawson R. Engler and M. Frans Kaashoek, "Exterminate All Operating System Abstractions", in Fifth Workshop on Hot Topics in Operating Systems (HotOS-V), Orcas Island, Washington, May, 1995.

14 Dawson R. Engler, Sandeep Gupta and M. Frans Kaashoek, "AVM: Application-level Virtual Memory", in The Fifth Workshop on Hot Topics in Operating Systems (HotOS-V), Orcas Island, Washington, May, 1995.

15 Dawson R. Engler, M. Frans Kaashoek and James O'Toole, "The Operating System Kernel as a Secure Programmable Machine", in The Proceedings of the Sixth SIGOPS European Workshop, September, 1994. (Talk included.) Selected to appear in a Special Issue of Operating Systems Review, January, 1995.

Conference Talks

"Incorporating Application Semantics and Control into Compilation", First Conference on Domain Specific Languages, Santa Clara, California, October, 1997.

"Why Exokernels Matter", Sixteenth ACM Symposium on Operating Systems Principles (SOSP), San Melo, France, October, 1997.

"DPF: fast, flexible packet filtering", ACM Communication Architectures, Protocols, and Applications (SIGCOMM '96), Palo Alto, California, August, 1996.

"vcode: fast simple dynamic code generation", SIGPLAN 1996 Conference on Programming Language Design and Implementation (PLDI), May, 1996.

"`C: a language for fast dynamic code generation", Annual Symposium on Principles of Programming Languages (POPL), St. Petersburg, Florida, October, 1995.

"Exokernels", Fifteenth ACM Symposium on Operating Systems Principles (SOSP), Copper Mountain Resort, Colorado, December, 1995.

"DCG: efficient, retargetable dynamic code generation", Sixth International Conference on Architecture Support for Programming Languages and Operating Systems (ASPLOS-VI), San Jose, California, October, 1994.

Invited Talks

"Application Performance and Power on Exokernel Systems", Network Appliance, Santa Clara, California, August, 1997.

—, Microsoft Research, Redmond, Washington, August, 1997.

"Incise: Hardware-assisted Performance Visualization", DEC SRC, August, 1996.

"Some Techniques for Dynamic Code Generation", HP Research Labs, Cambridge, Massachusetts, May, 1996.

"Exokernels", Dartmouth, Hanover, New Hampsire, December, 1995.

Workshop Talks

"AVM: Application-level Virtual Memory", , M.I.T. Student Workshop, Wellesley, Massachusetts, August, 1995.

"Small Kernel Good, Big Kernel Bad", M.I.T. Student Workshop, Cape Cod, July, 1994.

"Exokernel: a New Operating System Architecture", Sixth SIGOPS European Workshop, September, 1994.

References

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