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Contact: Jim Ormond
                 212-626-0505
                 ormond@hq.acm.org

DAVID PAPWORTH HONORED WITH ACM BREAKTHROUGH IN COMPUTING AWARD FOR PIONEERING CONTRIBUTIONS TO MICROPROCESSORS

**Landmark Designs for VLIW and P6 Processors Had Major Influence
on Today's Computing Technologies**

New York, NY, April 19, 2023 – ACM, the Association for Computing Machinery, today announced that David B. Papworth, formerly of Intel (retired), is the recipient of the ACM Charles P. "Chuck" Thacker Breakthrough in Computing Award. Papworth is recognized for fundamental groundbreaking contributions to Intel's P6 out-of-order engine and Very Long Instruction Word (VLIW) processors.

Papworth was a lead designer of the Intel P6 (sold commercially as the Pentium Pro) microprocessor, which was a major advancement over the existing state-of-the-art not just for Intel but for the broader computer design community. P6 introduced a new microarchitectural paradigm of decomposing complex x86 instructions into sequences of micro-operations that flowed through a micro data flow engine, constrained only by true data dependencies and machine resources. Surprising to many, this scheme, which is still in use today, also enabled significantly higher clock rates.

With his own broad understanding of all facets of a computer system, including hardware, software, operating systems, compilers, languages, algorithms, and microcode, Papworth encouraged the Intel team developing the new processor to embrace an integrated approach. The P6 team successfully navigated the thousands of design tradeoffs required of a modern processor in a timely way while striking competitive balances among cost, performance, power, and schedule. Papworth was also the ultimate judge of how and when to use P6's new microcode-patch facility to deal with any design errata that might turn up. That P6 was a runaway success for Intel is clear in that Intel's cores today, 30+ years later, still use the same paradigm along with many of the architectural improvements shepherded by Papworth in 1992.

Just prior to joining Intel in 1990, Papworth was a lead designer and system architect at a startup called Multiflow. Multiflow co-founder Josh Fisher had invented the Very Long Instruction Word (VLIW) style of system design. Papworth re-engineered Fisher's design to be implementable in 1985 hardware while carefully maintaining those aspects of Fisher's VLIW scheme that were essential to performance. VLIWs

are also now well-established in graphic processing units (GPUs), AI accelerators, and digital signal processors (DSPs)—a tribute to Josh Fisher's original vision and to Dave Papworth's ability to juggle extreme complexity and come up with economically viable, industry-influencing solutions.

"The introduction of Intel's P6 microarchitecture in 1995 was an important milestone during a time when the personal computing software and hardware industry really started to take off," said ACM President Yannis Ioannidis. "As the lead developer of the P6 microarchitecture, David Papworth was one of the unsung heroes of the decade and his contributions are still in use today. The original P6 not only fitted 5.5 million transistors on a single chip, but it was significantly faster than its predecessors. Papworth's work truly fits the criteria of a 'leapfrog advance in computing technology' that the ACM Breakthrough Award celebrates. Recently, in tributes to the late Gordon Moore, many reflected on Moore's prediction that the number of transistors in an integrated circuit would double every two years. That Moore's law has held true for so many years is testament to outstanding engineers like David Papworth."

The ACM Charles P. "Chuck" Thacker Breakthrough in Computing Award recognizes individuals or groups who have made surprising, disruptive, or leapfrog contributions to computing ideas or technologies. Recipients of the award are expected to give the ACM Breakthrough Lecture at a major ACM conference. The award is accompanied by a $100,000 cash prize, with financial support provided by Microsoft.

"David Papworth's trailblazing work, fueled by his passion, deep understanding, creativity, and integrative thinking, catalyzed a breakthrough leap in microprocessor capabilities at a pivotal moment, accelerating the transformative influence of personal computing on the world and leaving a lasting imprint on the industry," said Eric Horvitz, Microsoft's Chief Scientific Officer. "His talent for connecting the dots across multiple dimensions of microprocessor design and operation was instrumental in the success of Intel's Pentium Pro and Multiflow VLIW processors. His contributions with the out-of-order engine and very long instruction word approach continue to shape the computing landscape today. Microsoft is honored to sponsor this award, named in tribute to our late colleague, Chuck Thacker, as a means to recognize and celebrate the exceptional individuals who have profoundly influenced the trajectory of computing."

Biographical Background
David B. Papworth was employed at Intel Corporation from 1990 to 2020, having served in positions including Principal Processor Architect, and Intel Fellow. He has broad experience in CPU microarchitecture, the software/hardware interface, and is listed as co-inventor on more than 50 issued patents for his work.

Papworth received a Bachelor of Science in Electrical Engineering from the University of Michigan, Ann Arbor. His honors include receiving the Intel Achievement Award for Microarchitecture, and the Intel Achievement Award for producing a microprocessor chip in record time.

About the ACM Charles P. "Chuck" Thacker Breakthrough in Computing Award
The ACM Breakthrough Award celebrates Thacker's pioneering contributions in computing and his long-term inspirational mentorship of generations of computer scientists. The award recognizes individuals or groups with the same out-of-the-box thinking and "can-do" approach to solving the unsolved that Thacker exhibited. The award is accompanied by a prize of $100,000 and is presented at the annual ACM Awards Banquet. Recipients are expected to give the ACM Breakthrough Lecture at a major ACM conference of their choosing during the year following the announcement. Financial support of the ACM Breakthrough Award is provided by Microsoft.

About ACM
ACM, the Association for Computing Machinery, is the world's largest educational and scientific computing society, uniting computing educators, researchers, and professionals to inspire dialogue, share resources, and address the field's challenges. ACM strengthens the computing profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.

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