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ANOTHER TALE OF TWO INSTRUCTIONS

More Mystery-Shrouded History of the x86 Architecture Uncovered

By Tom R. Halfhill {9/7/04-02}

Digging into the past of the x86 architecture is like archaeology: You can never be sure what you'll find, but it's often surprising. So it goes with the LAHF and SAHF instructions, which AMD originally dropped from the 64-bit AMD64 architecture, then restored after

discovering some software still needs them. (See *MPR 7/19/04-01*, "A Tale of Two Instructions.")

On the basis of our initial research, we reported that Intel first introduced LAHF and SAHF in the 16-bit 286 processor of 1982, mainly to speed up context switching for operating systems. (SAHF saves five x86 condition flags into the AH register, and LAHF restores the flags from that register.) Engineers from AMD and Intel reviewed an early draft of our article for technical accuracy and didn't notice anything amiss. Likewise our internal reviewers, including the x86 experts on our analyst staff and editorial board. We published the article with confidence.

So imagine our surprise when a sharp-eyed reader from Germany took issue with our version of the historical record. Dr. Reinhard Kirchner, a computer science lecturer at the University of Kaiserslautern, sent an email message saying that LAHF and SAHF have been part of the x86 architecture from the very beginning—all the way back to the Intel 8086 processor of 1978. Furthermore, Kirchner wrote, the two instructions were not intended for context switching. Instead, Intel included them to make it easier for programmers to port software to the x86 from the even earlier 8080 processor.

History lesson: As some of our gray-haired (or no-haired) readers may recall, the Intel 8080 was an 8-bit microprocessor introduced in 1974, near the end of the Nixon Dynasty. It was a 4,500-transistor chip, fabricated in a 6,000-nanometer process, that ran at the then blazing speed of 2.0MHz. (For the benefit of our younger readers, that's

megahertz, not gigahertz.) The 8080 was the CPU in the MITS Altair, a build-it-yourself microcomputer that played a major role in launching the personal computer industry when *Popular Electronics* featured the kit on the cover of its January 1975 issue. The Altair was so compelling that two young college students named Bill Gates and Paul Allen wrote a BASIC interpreter for the machine, then dropped out of school to launch a startup called Micro Soft.

Ancient Text Confirms Kirchner's Account

Some other primitive personal computers, such as the Imsai 8080, also used the Intel 8080 processor. By 1978, when Intel introduced the 16-bit 8086, programmers had written so much software for the 8080 that Intel wanted to provide a migration path to the new architecture. The following explanation appears in a book entitled *8086 Primer* (copyright AD 1980) by Steve Morse:

"The LAHF instruction transfers the flag register SF (sign flag), ZF (zero flag), AF (auxiliary carry flag), PF (parity flag), and CF (carry flag) into specific bits of the AH register. The SAHF instruction transfers specific bits of the AH register into these flags. These five flags were singled out for no other reason than that they were the five flags present in the 8080 processor. (The LAHF and SAHF instructions exist mainly to permit programs written for the 8080 to be translated into efficient 8086 programs.)"

That passage, recently unearthed by Intel engineers, confirms everything Kirchner says. In addition, Kirchner

recalls, LAHF and SAHF were useful when porting software written for the Zilog Z80 processor, whose 8-bit architecture was compatible with the 8080. Indeed, in the late 1970s, Kirchner used a conversion program to help port a Pascal virtual machine from the Z80 to the x86, and the machine-language output was heavy with LAHF and SAHF opcodes.

Intel is so impressed with Kirchner's encyclopedic knowledge of x86 history that it will send him one of those indispensable artifacts of Silicon Valley culture: a company-logo T-shirt. *MPR* is tossing in a company-logo coffee mug, too.

Unfortunately, we can't do anything about two of Kirchner's other nitpicks: he's annoyed that AMD dropped 16-bit software compatibility and decimal arithmetic instructions from the 64-bit mode of AMD64. (Intel has followed suit with its x86-64 architecture, EM64T.) To run old 16-bit MS-DOS utilities, Kirchner and other diehard users will have to install a 16/32-bit operating system on their x86-64 systems or use a 16-bit x86 software simulator. The same goes for Cobol compilers and other programs that may need decimal arithmetic. Welcome to the twenty-first century. ◇