Oracle’s new M7 SPARC systems push ‘software in silicon’ optimization

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Oracle says that its new systems based on its own SPARC processor represent ‘the largest-scale overhaul and engineering effort in SPARC systems history.’ The overhaul includes the first systems family based on the new generation SPARC M7 chip, along with new operating system, virtualization, management and development tools. For those who have followed previews of the M7 processor over the past year or so, it’s no surprise to see the emergence of Oracle’s first ‘software in silicon’ capabilities, which the company says takes its design principles of co-engineered hardware and software to a new level – down to the silicon itself. As for the broader and long-term future of SPARC, it’s interesting to compare Oracle’s silicon strategy with two other companies that are offering alternatives to the ubiquitous Intel architecture for use in servers: IBM and ARM.

**THE 451 TAKE**

The expense of maintaining a proprietary chip architecture without high volume production is something only a few of the largest and most profitable companies can take on. Oracle is in somewhat of a unique position in that it has a large existing systems user base (the old Sun legacy) and can maintain high margins from users of its software stack, so volume is less of an issue. It’s worth the significant investment in a new generation of SPARC processors to keep those highly profitable users happy – and keep them as customers. What is less clear is whether the performance-optimization advances it can achieve through software-in-silicon will attract new customers to SPARC – especially given the mixed messages coming out of Oracle, as (historically) it has concentrated its efforts on promoting the merits of its Intel-based Exa line. It will be interesting to see whether the balance shifts toward SPARC. One indicator that this might happen is that M7 systems are being used to power the Oracle Cloud, the center of Oracle’s strategy.

**CONTEXT**

Sun Microsystems made the SPARC chip and Solaris operating system central components of its systems strategy from the introduction of the SPARC architecture back in 1987, when it was initially used for workstations and then for servers. A broader ecosystem involving licensing to other vendors flourished for a while before disintegrating in the mid-2000s, leaving only Fujitsu developing variant SPARC chips for use in its own servers. By the time Oracle acquired Sun in 2009, SPARC had fallen behind the performance curve, and following the launch of the T1 ‘Niagara’ chip in 2006, Sun refocused on midrange, energy-efficient processors with lots of less-powerful cores and multiple threads. Under Oracle, these formed the basis of the T3, T4 and T5 SPARC chips and the systems that used them. By 2013, Oracle was finally ready to fill the gap at the high end with the SPARC M5, soon followed by the M6. However, as far as systems are concerned, Oracle has reserved most of its sales and marketing power for the Exa family of engineered systems, which are Intel-based.

**PRODUCTS – THE CHIP**

The 32-core, M7 (first previewed at the 2014 Hot Chips conference) is a 4.1GHz, 32-core, 256-thread processor (one to eight threads per core) implemented in a 20nm process that boosts memory, I/O and scalability compared to previous versions. There’s a new cache organization with shared level two instruction and data caches and 64MB of shared and partitioned level three cache. The reengineered S4 core (Oracle’s fourth-generation CMT core), plus general design improvements all around have improved the single-thread performance over current SPARC chips. But the most interesting new features of the chip are its software-in-silicon capabilities, focused around security and database acceleration.

On the security front, this includes two areas: one is silicon-secured memory, which adds real-time checking of access to data in memory, a feature aimed at protecting against malicious intrusion and program errors. It’s turned on by default for Oracle Database 12c and can also be utilized by existing applications and through APIs for customization. There’s also hardware-assisted encryption, with co-processors built into all 32 cores to minimize the
usual performance penalties – again compatible with existing applications. Virtual machines can be live-migrated while still encrypted and used for disaster recovery or for avoiding downtime during maintenance. And for database acceleration, there is SQL in Silicon, once again implemented across all the 32 cores. This offloads and accelerates the most commonly used data functions to boost the efficiency and performance of database applications – specifically, functions such as in-line memory decompression, memory scan, range scan, filtering and join assist. In addition to a claimed 10-times performance boost for queries, Oracle says that memory utilization is reduced and the efficiency of each core improved. It’s supported out of the box by the Oracle Database 12c in-memory option, and Oracle also intends to make the functionality available to advanced developers to build into new big-data analytics platforms.

In 2013, Oracle split its SPARC silicon offerings into separate T-Series (entry/midrange, scale-out) and M-Series (‘mainframe class’ high end, scale-up) categories for the T5 and M5 generation parts, both based on its S3 cores. But when the M6 was unveiled (still using S3 cores), there wasn’t an equivalent T6 processor. The new M7, based on the next-generation S4 core, is intended for use in both scale-out and scale-up systems, and for both analytics and online transaction-processing workloads. Oracle claims it has measured eight times performance gains for in-memory analytics and two-times performance gains for OLTP. But it’s worth noting that at the Hot Chips 2015 conference, another chip was previewed: ‘Sonoma,’ also based on the S4 core, is intended specifically for dense scale-out deployments, typically utilizing low-cost, two-socket servers. It’s likely to become available in systems toward the end of the year.

**PRODUCTS – THE SYSTEMS**

New systems based on the M7 include the Oracle SuperCluster M7 engineered system and SPARC T7 and M7 servers. (The T and M categories have been retained for system-level products). SuperCluster M7 combines compute, 40Gbps InfiniBand network fabric and Exadata storage hardware with OS, virtualization and management software for private cloud infrastructure. In theory, using the Bixby interconnect (now on its second generation), M7-based systems could scale up to 32 or even 64 sockets, but Oracle (like IBM) says it’s no longer seeing demand for that size of system, so it’s stopping at 16 sockets. (The 32-way SPARC M6-32 is still available). Oracle is holding back on the use of 64GB DDR4 DIMMs while the performance, quality and price points settle a bit more, so it’s currently limited to 512GB of main memory per socket, less than either IBM or Intel – but it intends to make them available in M7-based systems in the future. So SuperCluster M7 systems top out at 512 cores and 8TB of memory per rack. Up to 11 Exadata storage servers can be added per rack, and there is also 160TB integrated ZFS application storage and up to 140TB of flash storage per rack.

Oracle SPARC M7 servers, for enterprise customers that require high-end systems using external storage, come in eight-way (two- to eight-processor, 4TB maximum memory per system) and 16-way (4-16-processor, 8TB maximum memory per system) versions. They are aimed at a wider range of workloads, including database, analytics, Java middleware, applications and cloud services deployments. There are three T7 servers – the T7-1, T7-2 and T7-4 – providing lower-cost entry points. They can incorporate up to 2TB of memory (on the four-way system), eight 600GB or 1.2TB 2.5-inch SAS drives, eight 400GB SSD drives or eight 1.6TB NVMe drives.

The new systems run Solaris 10 or 11, as well as Oracle VM Server for SPARC and Oracle Solaris Zones (the equivalent of containers). The latest Solaris 11.3 release supports the M7’s silicon-secured memory capabilities, hardware offloaded encryption and SQL in Silicon. The new OS also adds extra security features such as ‘immutable’ systems and virtual machines (preventing unauthorized installation or changes), time-based access control, full-stack, automated patching/ updating through a trusted path, and extra database integration with lock manager enhancements for Oracle RAC and full-stack troubleshooting via DTrace. Oracle says that existing applications will run unchanged and still reap improvements in security, efficiency and performance. But it is also offering developers a platform that they can use for new software, specially written to take full advantage of the software-in-silicon capabilities. Solaris 11.3 supports Oracle Solaris Studio for DevOps, and enables integration with OpenStack components such as Heat (orchestration) and Murano (database as a service).
**STRATEGY**

Oracle introduced the X5 family of engineered systems, including the Exadata Database Machine, at the start of 2015, and has just added the X5-8 Database Machine for private cloud in-memory database and data-warehousing deployments. The Intel E7 8895 v3-based system supports up to 576 cores (144 cores per database server), up to 1.3PB of disk storage and up to 24TB of memory. Customers have the option of running Linux on X5 hardware.

We believe the main interest in M7-based systems will inevitably come from the existing SPARC/Solaris user base, still a very valuable set of customers for Oracle. And while the embedded software-in-silicon features of the M7 are being made accessible to third-party and in-house applications, Oracle isn’t making any effort to market the SPARC to other licensees, in marked contrast to IBM with Power. Fujitsu, a long-term SPARC licensee, is the only other systems vendor that supplies high-end SPARC-based servers with its M10 range, although these are mostly sold in Asia-Pacific markets.

**COMPETITION**

IBM, HP Enterprise, Dell, Cisco, Lenovo and VCE all have ambitions to penetrate the Oracle user base with alternative architectures – and obviously, it’s also in Oracle’s interests to continue to support these as potential platforms for its software stack. The vast majority of these – not to mention Oracle’s own Exa family – are Intel-based. And with server adoption of the Intel x86 architecture nearly ubiquitous, it has become harder for vendors with alternative CPUs to compete. SGI gave up on MIPS, HPE discontinued its PA-RISC, and even Intel itself was forced to back away from its own high-end alternative, Itanium. Other than SPARC, only IBM Power has survived as a server CPU. User preference for Linux rather than the proprietary Unix operating systems (such as Solaris, HP-UX and IBM AIX) used on RISC processors added to the pressure. Of course, the two have become intermingled in recent years, and IBM introduced Power Linux a number of years ago. Oracle has announced plans to release Linux for SPARC in the near future.

Instead of putting everything on-chip – and having to develop all that functionality itself – IBM is relying on high-speed chip-to-chip links such as CAPI and NVIDIA’s NVLink so that it can utilize external accelerators. IBM argues that this enables faster evolution, not tied to the lifecycle of the CPU. IBM has also set up an open licensing scheme for Power, inspired by the model that’s already been highly successful for ARM, playing out under the PowerOpen banner. IBM is seeking to build an open ecosystem around Power and is licensing its technology to other silicon vendors, system builders, cloud service providers and ISVs. In theory, this could significantly increase the market for Power-based systems beyond IBM itself and increase the motivation for third-party software support.

In practice, it’s still too early to say whether the effort will pay off. Oracle’s counter argument is that the external accelerator model requires the close cooperation of software vendors to work, and that IBM itself does not offer a complete suite of business applications that it can optimize itself, nor a stable of third-party vendors willing to work with it at the required level.
SWOT ANALYSIS

**STRENGTHS**
Oracle owns the complete stack of systems components from silicon upward, which means it has more room to optimize for performance - a philosophy that IBM has also pursued.

**WEAKNESSES**
Customers must rely on Oracle alone for further software-in-silicon advances, whereas companies more geared to integrating third-party accelerators share the development load.

**OPPORTUNITIES**
While the Sun customer base has been shrinking since the Oracle acquisition, it is still substantial and highly profitable. The performance gains and new capabilities will help keep these users from migrating.

**THREATS**
The gradual shift toward public cloud services will reduce demand for high-end on-premises enterprise servers over time.