Great Internet Mersenne Prime Search
GIMPS
Finding World Record Primes Since 1996

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Mersenne Prime Number discovery - $2^{74207281}$-1 is Prime!

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GIMPS Project Discovers
Largest Known Prime Number: $2^{74,207,281}$-1

RALEIGH, North Carolina -- On January 7th at 22:30 UTC, the Great Internet Mersenne Prime Search (GIMPS) celebrated its 20th anniversary with the math discovery of the new largest known prime number, $2^{74,207,281}$-1, having 22,338,618 digits, on a university computer volunteered by Curtis Cooper for the project. The same GIMPS software just uncovered a flaw in Intel's latest Skylake CPUs[1], and its global network of CPUs peaking at 450 trillion calculations per second remains the longest continuously-running "grassroots supercomputing"[2] project in Internet history.

The new prime number, also known as M74207281, is calculated by multiplying together 74,207,281 twos then subtracting one. It is almost 5 million digits larger than the previous record prime number, in a special class of extremely rare prime numbers known as Mersenne primes. It is only the 49th known Mersenne prime ever discovered, each increasingly difficult to find. Mersenne primes were named for the French monk Marin Mersenne, who studied these numbers more than 350 years ago. GIMPS, founded in 1996, has discovered all 15 of the largest known Mersenne primes. Volunteers download a free program to search for these primes with a cash award offered to anyone lucky enough to compute a new prime. Prof. Chris Caldwell maintains an authoritative web site on the largest known primes and is an excellent history of Mersenne primes.

The primality proof took 31 days of non-stop computing on a PC with an Intel I7-4790 CPU. To prove there were no errors in the prime discovery process, the new prime was independently verified using both different software and hardware. Andreas Hoglund and David Stanfill each verified the prime using the CUDALucas software running on NVidia Titan Black GPUs in 2.3 days. David Stanfill verified it using CLucas on an AMD Fury X GPU in 3.5 days. Serge Batalov also verified it using Ernst Mayer's MLucas software on two Intel Xeon 18-core Amazon EC2 servers in 3.5 days.

Dr. Cooper is a professor at the University of Central Missouri. This is the fourth record GIMPS project prime for Dr. Cooper and his university. The discovery is eligible for a $3,000 GIMPS research discovery award. Their first record prime was discovered in 2005, eclipsed by their second record in 2006. Dr. Cooper lost the record in 2008, reclaimed it in 2013, and improves that record with this new prime. Dr. Cooper and the University of Central Missouri is the largest contributor of CPU time to the GIMPS project.

Dr. Cooper's computer reported the prime in GIMPS on September 17, 2015 but it remained unnoticed until routine maintenance data-mined it. The official discovery date is the day a human took note of the result. This is in keeping with tradition as M4253 is considered never to have been the largest known prime number because Hurwitz in 1961 read his computer printout backwards and saw M4423 was prime seconds before seeing that M4253 was also prime.

GIMPS Prime95 client software was developed by founder George Woltman. Scott Kurowski wrote the PrimeNet system software that coordinates GIMPS' computers. Aaron Blosser is now the system administrator, upgrading and maintaining PrimeNet as needed. Volunteers have a chance to earn research discovery awards of $3,000 or $50,000 if their computer discovers a new Mersenne prime. GIMPS' next major goal is to win the $150,000 award administered by the Electronic Frontier Foundation offered for finding a 100 million digit prime number.

Credit for GIMPS' prime discoveries goes not only to Dr. Cooper for running the Prime95 software on his university's computers, Woltman, Kurowski, and Blosser for authoring the software and running the project, but also the thousands of GIMPS volunteers that sifted through millions of non-prime candidates. Therefore, official credit for this discovery shall go to "C. Cooper, G. Woltman, S. Kurowski, A. Blosser, et al."

About Mersenne.org's Great Internet Mersenne Prime Search

The Great Internet Mersenne Prime Search (GIMPS) was formed in January 1996 by George Woltman to discover new world record size Mersenne primes. In 1997 Scott Kurowski enabled GIMPS to automatically harness the power of hundreds of thousands of ordinary computers to search for these "needles in a haystack". Most GIMPS members join the search for the thrill of possibly discovering a record-setting, rare, and historic new Mersenne prime. The search for more Mersenne primes is already under way. There may be smaller, as yet undiscovered Mersenne primes, and there almost certainly are larger Mersenne primes waiting to be found. Anyone with a reasonably powerful PC can join GIMPS and become a big prime hunter, and possibly earn a cash research discovery award. All the necessary software can be downloaded for free at www.mersenne.org/download/. GIMPS is organized as Mersenne Research, Inc., a 501(c)(3) science research charity. Additional information may be found at www.mersenneforum.org and www.mersenne.org; donations are welcome.

For More Information on Mersenne Primes

Prime numbers have long fascinated amateur and professional mathematicians. An integer greater than one is called a prime number if its only divisors are one and itself. The first prime numbers are 2, 3, 5, 7, 11, etc. For example, the number 10 is not prime because it is divisible by 2 and 5. A Mersenne prime is a prime number of the form 2^P-1. The first Mersenne primes are 3, 7, 31, and 127 corresponding to P = 2, 3, 5, and 7 respectively. There are only 49 known Mersenne primes.

Mersenne primes have been central to number theory since they were first discussed by Euclid about 350 BC. The man whose name they now bear, the French monk Marin Mersenne (1588-1648), made a famous conjecture on which values of P would yield a prime. It took 300 years and several important discoveries in mathematics to settle his conjecture.

Previous GIMPS Mersenne prime discoveries were made by members in various countries.
In January 2013, Curtis Cooper et al. discovered the 48th known Mersenne prime in the U.S.
In April 2009, Odd Magnar Strindmo et al. discovered the 47th known Mersenne prime in Norway.
In September 2008, Hans-Michael Elvenich et al. discovered the 46th known Mersenne prime in Germany.
In August 2008, Edson Smith et al. discovered the 45th known Mersenne prime in the U.S.
In September 2006, Curtis Cooper and Steven Boone et al. discovered the 44th known Mersenne prime in the U.S.
In December 2005, Curtis Cooper and Steven Boone et al. discovered the 43rd known Mersenne prime in the U.S.

In February 2005, Dr. Martin Nowak et al. discovered the 42nd known Mersenne prime in Germany.
In May 2004, Josh Findley et al. discovered the 41st known Mersenne prime in the U.S.
In November 2003, Michael Shafer et al. discovered the 40th known Mersenne prime in the U.S.
In November 2001, Michael Cameron et al. discovered the 39th Mersenne prime in Canada.
In June 1999, Nayan Hajratwala et al. discovered the 38th Mersenne prime in the U.S.
In January 1998, Roland Clarkson et al. discovered the 37th Mersenne prime in the U.S.
In August 1997, Gordon Spence et al. discovered the 36th Mersenne prime in the U.K.
In November 1996, Joel Armengaud et al. discovered the 35th Mersenne prime in France.

Euclid proved that every Mersenne prime generates a perfect number. A perfect number is one whose proper divisors add up to the number itself. The smallest perfect number is 6 = 1 + 2 + 3 and the second perfect number is 28 = 1 + 2 + 4 + 7 + 14. Euler (1707-1783) proved that all even perfect numbers come from Mersenne primes. The newly discovered perfect number is $2^{74,207,280}$ x ($2^{74,207,281}$-1). This number is over 44 million digits long! It is still unknown if any odd perfect numbers exist.

There is a unique history to the arithmetic algorithms underlying the GIMPS project. The programs that found the recent big Mersenne finds are based on a special algorithm. In the early 1990's, the late Richard Crandall, Apple Distinguished Scientist, discovered ways to double the speed of what are called convolutions -- essentially big multiplication operations. The method is applicable not only to prime searching but other aspects of computation. During that work he also patented the Fast Elliptic Encryption system, now owned by Apple Computer, which uses Mersenne primes to quickly encrypt and decrypt messages. George Woltman implemented Crandall's algorithm in assembly language, thereby producing a prime-search program of unprecedented efficiency, and that work led to the successful GIMPS project.

School teachers from elementary through high-school grades have used GIMPS to get their students excited about mathematics. Students who run the free software are contributing to mathematical research. David Stanfill's verification computation for this discovery was donated by Squirrels (airsquirrels.com) which services K-12 education and other customers.

[1] http://hardwareluxx.de ; http://arstechnica.com/gadgets/2016/01/intel-skylake-bug-causes-pcs-to-freeze-during-complex-workloads
[2] Science (American Association for the Advancement of Science), May 6, 2005 p810.