# Mersenne Primes, The 49th Mersenne Prime, and GIMPS 

## Curtis Cooper <br> University of Central Missouri

April 21, 2016

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS
（1）Mersenne Primes
－Primes
－Mersenne Primes


49th Mersenne Prime
－M74207281
－News on 49th Mersenne PrimeGIMPS
－GIMPS
－GIMPS People
－GIMPS LinksReasons

## Prime Numbers

- A prime number is an integer, greater than 1, which has exactly two factors, itself and one.


## Prime Numbers

- A prime number is an integer, greater than 1, which has exactly two factors, itself and one.
- Prime Numbers Less Than 100:
$2,3,5,7,11,13,17,19,23,29,31,37,41$, $43,47,53,59,61,67,71,73,79,83,89,97$


## Mersenne Numbers

- A Mersenne number is a number of the form $2^{p}-1$, where $p$ is a prime number.


## Mersenne Numbers

- A Mersenne number is a number of the form $2^{p}-1$, where $p$ is a prime number.
- Examples of Mersenne numbers are:

$$
\begin{aligned}
3 & =2^{2}-1 \\
7 & =2^{3}-1 \\
31 & =2^{5}-1 \\
127 & =2^{7}-1 \\
2047 & =2^{11}-1
\end{aligned}
$$

## Mersenne Primes

- A Mersenne prime is a Mersenne number that is prime.


## Mersenne Primes

- A Mersenne prime is a Mersenne number that is prime.
- Examples of Mersenne primes are:

$$
\begin{aligned}
3 & =2^{2}-1 \\
7 & =2^{3}-1 \\
31 & =2^{5}-1 \\
127 & =2^{7}-1 \\
8191 & =2^{13}-1
\end{aligned}
$$

## Mersenne Primes

- A Mersenne prime is a Mersenne number that is prime.
- Examples of Mersenne primes are:

$$
\begin{aligned}
3 & =2^{2}-1 \\
7 & =2^{3}-1 \\
31 & =2^{5}-1 \\
127 & =2^{7}-1 \\
8191 & =2^{13}-1
\end{aligned}
$$

- $2047=2^{11}-1=23 \times 89$.


## Marin Mersenne

- Mersenne primes are named after a 17th-century French monk and mathematician


Marin Mersenne (1588-1648)

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS
（2）49th Mersenne Prime
－M74207281
－News on 49th Mersenne Prime
（3）GIMPS
－GIMPS
－GIMPS People
－GIMPS LinksReasons

- $2^{74207281}-1$ is prime!

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

- $2^{74207281}-1$ is prime!
- Largest Known Prime Number

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

- $2^{74207281}-1$ is prime!
- Largest Known Prime Number
- 22,338,618 decimal digits

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

- $2^{74207281}-1$ is prime!
- Largest Known Prime Number
- 22,338,618 decimal digits
- Discovered on January 7, 2016
- $2^{74207281}-1$ is prime!
- Largest Known Prime Number
- 22,338,618 decimal digits
- Discovered on January 7, 2016
- Reported prime by Computer Number 5 in Room 143 at the Summit Center on September 17, 2015.
- $2^{74207281}-1$ is prime!
- Largest Known Prime Number
- 22,338,618 decimal digits
- Discovered on January 7, 2016
- Reported prime by Computer Number 5 in Room 143 at the Summit Center on September 17, 2015.
- Went undiscovered for almost 4 months. An email was supposed to be sent out to me and GIMPS administrators when the computer reported the prime. This email report was not sent.
- $2^{74207281}-1$ is prime!
- Largest Known Prime Number
- 22,338,618 decimal digits
- Discovered on January 7, 2016
- Reported prime by Computer Number 5 in Room 143 at the Summit Center on September 17, 2015.
- Went undiscovered for almost 4 months. An email was supposed to be sent out to me and GIMPS administrators when the computer reported the prime. This email report was not sent.
- Discovered by routine data mining.


## News About 49th Mersenne Prime

- Official Press Release http://www.mersenne.org/M49/74207281.htm

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

## News About 49th Mersenne Prime

- Official Press Release http://www.mersenne.org/M49/74207281.htm
- New York Times Story http://www.nytimes.com/2016/01/22/science/new-biggest-prime-number-mersenne-primes.html?_r=1


## News About 49th Mersenne Prime

- Official Press Release http://www.mersenne.org/M49/74207281.htm
- New York Times Story http://www.nytimes.com/2016/01/22/science/new-biggest-prime-number-mersenne-primes.html?_r=1
- Standupmaths https://www.youtube.com/watch?v=q5ozBnrd5Zc


## News About 49th Mersenne Prime

- Official Press Release http://www.mersenne.org/M49/74207281.htm
- New York Times Story http://www.nytimes.com/2016/01/22/science/new-biggest-prime-number-mersenne-primes.html?_r=1
- Standupmaths https://www.youtube.com/watch?v=q5ozBnrd5Zc
- Jimmy Fallon https://www.facebook.com/kshbtv/videos/10153315475526190
- 


## Mersenne Primes

- Primes
- Mersenne Primes


49th Mersenne Prime

- M74207281
- News on 49th Mersenne Prime
(3) GIMPS
- GIMPS
- GIMPS People
- GIMPS LinksReasons

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

## The Great Internet Mersenne Prime Search

- GIMPS is a collaborative project of volunteers who are searching for Mersenne prime numbers. The software used by GIMPS volunteers is Prime95. This software can be downloaded from the Internet for free.


## The Great Internet Mersenne Prime Search

- GIMPS is a collaborative project of volunteers who are searching for Mersenne prime numbers. The software used by GIMPS volunteers is Prime95. This software can be downloaded from the Internet for free.
- George Woltman founded GIMPS in January 1996 and wrote the prime testing software.


## The Great Internet Mersenne Prime Search

- GIMPS is a collaborative project of volunteers who are searching for Mersenne prime numbers. The software used by GIMPS volunteers is Prime95. This software can be downloaded from the Internet for free.
- George Woltman founded GIMPS in January 1996 and wrote the prime testing software.
- Scott Kurowski wrote the PrimeNet server that supports GIMPS. In 1997 he founded Entropia, a distributed computing software company.


## The Great Internet Mersenne Prime Search

- GIMPS is a collaborative project of volunteers who are searching for Mersenne prime numbers. The software used by GIMPS volunteers is Prime95. This software can be downloaded from the Internet for free.
- George Woltman founded GIMPS in January 1996 and wrote the prime testing software.
- Scott Kurowski wrote the PrimeNet server that supports GIMPS. In 1997 he founded Entropia, a distributed computing software company.
- Aaron Blosser is the system administrator of PrimeNet.
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions essentially big multiplication operations.
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions essentially big multiplication operations.
- As of February 9, 2016, the 30-day sustained GIMPS throughput has swollen to a record 380 TFLOPs, with the theoretical 30-day maximum throughput exploding to 1.25 PFLOP/s. This is the first time that the GIMPS distributed supercomputer has (theoretically) breached the petaflop barrier.
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions essentially big multiplication operations.
- As of February 9, 2016, the 30-day sustained GIMPS throughput has swollen to a record 380 TFLOPs, with the theoretical 30-day maximum throughput exploding to 1.25 PFLOP/s. This is the first time that the GIMPS distributed supercomputer has (theoretically) breached the petaflop barrier.
- The GIMPS project consists of 152,971 users, 935 teams, and 1,227,160 CPUs.
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions essentially big multiplication operations.
- As of February 9, 2016, the 30-day sustained GIMPS throughput has swollen to a record 380 TFLOPs, with the theoretical 30-day maximum throughput exploding to 1.25 PFLOP/s. This is the first time that the GIMPS distributed supercomputer has (theoretically) breached the petaflop barrier.
- The GIMPS project consists of 152,971 users, 935 teams, and 1,227,160 CPUs.
- UCM has about 800 computers performing LL-tests on Mersenne numbers.


Woltman


Kurowski


Crandall

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

- The GIMPS home page can be found at: http://www.mersenne.org

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

- The GIMPS home page can be found at: http://www.mersenne.org
- A Mersenne Prime discussion forum can be found at: http://www.mersenneforum.org

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS
（1）Mersenne Primes
－Primes
－Mersenne Primes
2）49th Mersenne Prime
－M74207281
－News on 49th Mersenne Prime
（3）GIMPS
－GIMPS
－GIMPS People
－GIMPS Links
（4）Reasons

Curtis Cooper University of Central Missouri
Mersenne Primes，The 49th Mersenne Prime，and GIMPS

## Reasons

## Reasons to Search for Large Mersenne Primes

## Reasons

## Reasons to Search for Large Mersenne Primes

1. To help in the discovery of new Mersenne primes.

## Reasons

## Reasons to Search for Large Mersenne Primes

1. To help in the discovery of new Mersenne primes.
2. To put to good use the idle CPU cycles of hundreds of computers in labs and offices across UCM's campus.

## Reasons

## Reasons to Search for Large Mersenne Primes

1. To help in the discovery of new Mersenne primes.
2. To put to good use the idle CPU cycles of hundreds of computers in labs and offices across UCM's campus.
3. To help detect hardware problems (fan and CPU/bus problems) on individual computers at UCM. The German computing community uncovered a flaw in Intel's latest Skylake CPUs running GIMPS software.

## Reasons

## Reasons to Search for Large Mersenne Primes

Curtis Cooper University of Central Missouri
Mersenne Primes, The 49th Mersenne Prime, and GIMPS

## Reasons

## Reasons to Search for Large Mersenne Primes

4. To obtain favorable press for UCM for their support of our efforts to discover new Mersenne primes.

## Reasons

Reasons to Search for Large Mersenne Primes
4. To obtain favorable press for UCM for their support of our efforts to discover new Mersenne primes.
5. To win the $\$ 150,000$ offered by the Electronic Frontier Foundation (EFF) for the discovery of the first one-hundred million digit prime number. EFF's motivation is to encourage research in computational number theory related to large primes.

## Email Address and Talk URL

## Curtis Cooper's Email: cooper@ucmo.edu

Talk:
http://cs.ucmo.edu/~cnc8851/talks/mersenneholden/mersenneholden

