The Discovery of the 44th Mersenne Prime

Curtis Cooper and Steven Boone
University of Central Missouri

January 8, 2007

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:

$$3 = 2^2 - 1$$
$$7 = 2^3 - 1$$
$$31 = 2^5 - 1$$
$$127 = 2^7 - 1$$
$$8191 = 2^{13} - 1$$

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

Marin Mersenne

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

Marin Mersenne (1588-1648)

- The **Lucas-Lehmer Test** is one way to test whether or not Mersenne numbers are Mersenne primes.

- The **Lucas-Lehmer Test** is one way to test whether or not Mersenne numbers are Mersenne primes.

Definition

Let $S_1 = 4$ and

$$S_{n+1} = S_n^2 - 2 \ \text{ for } n \geq 1.$$

- The **Lucas-Lehmer Test** is one way to test whether or not Mersenne numbers are Mersenne primes.

Definition

Let $S_1 = 4$ and

$$S_{n+1} = S_n^2 - 2 \text{ for } n \geq 1.$$

- The first few terms of the S sequence are:

$$4,\ 14,\ 194,\ 37634,\ 1416317954,\ 2005956546822746114,\ 4023861667741036022825635656102100994, \ldots$$

Lucas-Lehmer Test

Let p be a prime number. Then

$$M_p = 2^p - 1 \text{ is prime}$$

if and only if

$$S_{p-1} \bmod M_p = 0.$$

Theorem

$M_{11} = 2^{11} - 1 = 2047$ *is not prime.*

Theorem

$M_{11} = 2^{11} - 1 = 2047$ *is not prime.*

Proof

i	$S_i \bmod 2047$

Theorem

$M_{11} = 2^{11} - 1 = 2047$ *is not prime.*

Proof

i	$S_i \bmod 2047$
1	4

Theorem

$M_{11} = 2^{11} - 1 = 2047$ *is not prime.*

Proof

i	$S_i \bmod 2047$
1	4
2	$(4^2 - 2) = 14 \bmod 2047 = 14$

Theorem

$M_{11} = 2^{11} - 1 = 2047$ *is not prime.*

Proof

i	$S_i \bmod 2047$
1	4
2	$(4^2 - 2) = 14 \bmod 2047 = 14$
3	$(14^2 - 2) = 194 \bmod 2047 = 194$

Theorem

$M_{11} = 2^{11} - 1 = 2047$ is not prime.

Proof

i	$S_i \bmod 2047$
1	4
2	$(4^2 - 2) = 14 \bmod 2047 = 14$
3	$(14^2 - 2) = 194 \bmod 2047 = 194$
4	$(194^2 - 2) = 37634 \bmod 2047 = 788$

Theorem

$M_{11} = 2^{11} - 1 = 2047$ is not prime.

Proof

i	$S_i \bmod 2047$
1	4
2	$(4^2 - 2) = 14 \bmod 2047 = 14$
3	$(14^2 - 2) = 194 \bmod 2047 = 194$
4	$(194^2 - 2) = 37634 \bmod 2047 = 788$
5	$(788^2 - 2) = 620942 \bmod 2047 = 701$

$2^{11}-1$ is not prime

Proof cont.

i	$S_i \bmod 2047$

$2^{11}-1$ is not prime

Proof cont.

i	S_i mod 2047
6	$(701^2-2) = 491399 \bmod 2047 = 119$

$2^{11} - 1$ is not prime

Proof cont.

i	$S_i \bmod 2047$
6	$(701^2 - 2) = 491399 \bmod 2047 = 119$
7	$(119^2 - 2) = 14159 \bmod 2047 = 1877$

$2^{11} - 1$ is not prime

Proof cont.

i	$S_i \bmod 2047$
6	$(701^2 - 2) = 491399 \bmod 2047 = 119$
7	$(119^2 - 2) = 14159 \bmod 2047 = 1877$
8	$(1877^2 - 2) = 3523127 \bmod 2047 = 240$

$2^{11} - 1$ is not prime

Proof cont.

i	$S_i \bmod 2047$
6	$(701^2 - 2) = 491399 \bmod 2047 = 119$
7	$(119^2 - 2) = 14159 \bmod 2047 = 1877$
8	$(1877^2 - 2) = 3523127 \bmod 2047 = 240$
9	$(240^2 - 2) = 57598 \bmod 2047 = 282$

$2^{11}-1$ is not prime

Proof cont.

i	S_i mod 2047
6	$(701^2-2) = 491399 \bmod 2047 = 119$
7	$(119^2-2) = 14159 \bmod 2047 = 1877$
8	$(1877^2-2) = 3523127 \bmod 2047 = 240$
9	$(240^2-2) = 57598 \bmod 2047 = 282$
10	$(282^2-2) = 79522 \bmod 2047 = 1736$

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ *is prime.*

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ *is prime.*

Proof.

i	$S_i \bmod 2^{31} - 1$

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ is prime.

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ *is prime.*

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ is prime.

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14
3	194

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ is prime.

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14
3	194
4	37634

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ is prime.

Proof.

i	$S_i \bmod 2^{31}-1$
1	4
2	14
3	194
4	37634
5	1416317954

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ *is prime.*

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14
3	194
4	37634
5	1416317954
6	669670838

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ *is prime.*

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14
3	194
4	37634
5	1416317954
6	669670838
7	1937259419

Theorem

$M_{31} = 2^{31} - 1 = 2147483647$ is prime.

Proof.

i	$S_i \bmod 2^{31} - 1$
1	4
2	14
3	194
4	37634
5	1416317954
6	669670838
7	1937259419
8	425413602

$2^{31}-1$ is prime

i	$S_i \bmod 2^{31}-1$
9	842014276
10	12692426
11	2044502122
12	1119438707
13	1190075270
14	1450757861
15	877666528
16	630853853
17	940321271
18	512995887
19	692931217

$2^{31}-1$ is prime

i	$S_i \bmod 2^{31}-1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412

$2^{31} - 1$ is prime

i	$S_i \bmod 2^{31} - 1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412
26	1159251674

$2^{31} - 1$ is prime

i	$S_i \bmod 2^{31} - 1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412
26	1159251674
27	211987665

$2^{31} - 1$ is prime

i	$S_i \bmod 2^{31} - 1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412
26	1159251674
27	211987665
28	1181536708

$2^{31} - 1$ is prime

i	$S_i \bmod 2^{31} - 1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412
26	1159251674
27	211987665
28	1181536708
29	65536

$2^{31}-1$ is prime

i	$S_i \bmod 2^{31}-1$
20	1883625615
21	1992425718
22	721929267
23	27220594
24	1570086542
25	1676390412
26	1159251674
27	211987665
28	1181536708
29	65536
30	0

List of 44 Known Mersenne Primes, $2^p - 1$

Before Computers

exponent	Digits in M_p	year	discoverer

List of 44 Known Mersenne Primes, $2^p - 1$

Before Computers

	exponent	Digits in M_p	year	discoverer
1	2	1	—	—
2	3	1	—	—
3	5	2	—	—
4	7	3	—	—

List of 44 Known Mersenne Primes, $2^p - 1$

Before Computers

	exponent	Digits in M_p	year	discoverer
1	2	1	—	—
2	3	1	—	—
3	5	2	—	—
4	7	3	—	—
5	13	4	1456	anonymous

List of 44 Known Mersenne Primes, $2^p - 1$

Before Computers

	exponent	Digits in M_p	year	discoverer
1	2	1	—	—
2	3	1	—	—
3	5	2	—	—
4	7	3	—	—
5	13	4	1456	anonymous
6	17	6	1588	Cataldi
7	19	6	1588	Cataldi

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
8	31	10	1772	Euler

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
8	31	10	1772	Euler

9	61	19	1883	Pervushin

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
8	31	10	1772	Euler

9	61	19	1883	Pervushin
10	89	27	1911	Powers
11	107	33	1914	Powers

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
12	127	39	1876	Lucas

List of 44 Known Mersenne Primes, $2^p - 1$

Mainframe and Supercomputer Era

	exponent	Digits in M_p	year	discoverer
13	521	157	1952	Robinson
14	607	183	1952	Robinson
15	1279	386	1952	Robinson
16	2203	664	1952	Robinson
17	2281	687	1952	Robinson

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
18	3217	969	1957	Riesel

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
18	3217	969	1957	Riesel
19	4253	1281	1961	Hurwitz
20	4423	1332	1961	Hurwitz

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
18	3217	969	1957	Riesel
19	4253	1281	1961	Hurwitz
20	4423	1332	1961	Hurwitz
21	9689	2917	1963	Gillies
22	9941	2993	1963	Gillies
23	11213	3376	1963	Gillies

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
18	3217	969	1957	Riesel
19	4253	1281	1961	Hurwitz
20	4423	1332	1961	Hurwitz
21	9689	2917	1963	Gillies
22	9941	2993	1963	Gillies
23	11213	3376	1963	Gillies
24	19937	6002	1971	Tuckerman

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
25	21701	6533	1978	Noll and Nickel
26	23209	6987	1979	Noll

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
25	21701	6533	1978	Noll and Nickel
26	23209	6987	1979	Noll

27	44497	13395	1979	Nelson and Slowinski

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
25	21701	6533	1978	Noll and Nickel
26	23209	6987	1979	Noll

27	44497	13395	1979	Nelson and Slowinski
28	86243	25962	1982	Slowinski

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
25	21701	6533	1978	Noll and Nickel
26	23209	6987	1979	Noll

27	44497	13395	1979	Nelson and Slowinski
28	86243	25962	1982	Slowinski
29	110503	33265	1988	Colquitt and Welsh

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
30	132049	39751	1983	Slowinski
31	216091	65050	1985	Slowinski

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
30	132049	39751	1983	Slowinski
31	216091	65050	1985	Slowinski
32	756839	227832	1992	Slowinski and Gage
33	859433	258716	1994	Slowinski and Gage
34	1257787	378632	1996	Slowinski and Gage

List of 44 Known Mersenne Primes, $2^p - 1$

GIMPS (Woltman, Kurowski, et al.) Era

	exponent	Digits in M_p	year	discoverer
35	1398269	420921	1996	Armengaud, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

GIMPS (Woltman, Kurowski, et al.) Era

	exponent	Digits in M_p	year	discoverer
35	1398269	420921	1996	Armengaud, GIMPS
36	2976221	895932	1997	Spence, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

GIMPS (Woltman, Kurowski, et al.) Era

	exponent	Digits in M_p	year	discoverer
35	1398269	420921	1996	Armengaud, GIMPS
36	2976221	895932	1997	Spence, GIMPS
37	3021377	909526	1998	Clarkson, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

GIMPS (Woltman, Kurowski, et al.) Era

	exponent	Digits in M_p	year	discoverer
35	1398269	420921	1996	Armengaud, GIMPS
36	2976221	895932	1997	Spence, GIMPS
37	3021377	909526	1998	Clarkson, GIMPS
38	6972593	2098960	1999	Hajratwala, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
39?	13466917	4053946	2001	Cameron, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
39?	13466917	4053946	2001	Cameron, GIMPS
40?	20996011	6320430	2003	Shafer, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

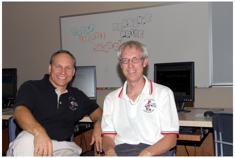
	exponent	Digits in M_p	year	discoverer
41?	24036583	7235733	2004	Findley, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
41?	24036583	7235733	2004	Findley, GIMPS
42?	25964951	7816230	2005	Nowak, GIMPS

List of 44 Known Mersenne Primes, $2^p - 1$

	exponent	Digits in M_p	year	discoverer
41?	24036583	7235733	2004	Findley, GIMPS
42?	25964951	7816230	2005	Nowak, GIMPS
43?	30402457	9152052	2005	Cooper, Boone, UCM, GIMPS
44?	32582657	9808358	2006	Cooper, Boone, UCM, GIMPS



$2^{32582657}-1$ Button

News About $2^{32582657} - 1$

- On September 4, 2006 at 12:33:48 pm (CST), computer commwd102–04l in the Communications Lab (Wood 102) proved that $2^{32582657} - 1$ is prime.

News About $2^{32582657} - 1$

- On September 4, 2006 at 12:33:48 pm (CST), computer commwd102–04l in the Communications Lab (Wood 102) proved that $2^{32582657} - 1$ is prime.
- News items on the web regarding M32582657 can be found at: http://www.math-cs.cmsu.edu/∼curtisc/M32582657.html

Digits of $2^{32582657} - 1$

- The digits of M32582657 can be found at: http://mersenneforum.org/txt/44.txt

Digits of $2^{32582657} - 1$

- The digits of M32582657 can be found at: http://mersenneforum.org/txt/44.txt
- Comments about M30402457 and M32582657 can be found at: http://primes.utm.edu/bios/code.php?code=G9

1. Mersenne Primes
2. Lucas-Lehmer Test
3. 44 Mersenne Primes
   - Before Computers
   - Mainframe and Supercomputer Era
   - GIMPS Era
4. $2^{32582657}-1$
5. **GIMPS**
   - GIMPS
   - GIMPS People
   - GIMPS Links
6. Top 10

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 Prime 95 and Mprime. 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 Prime 95 and Mprime. 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 Prime 95 and Mprime. 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.

- 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.

GIMPS

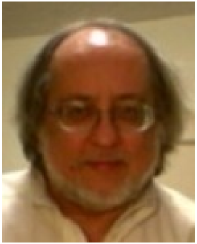
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions – essentially big multiplication operations.
- As of October 11, 2006, GIMPS had a sustained throughput of approximately 22 trillion calculations per second.

- 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 October 11, 2006, GIMPS had a sustained throughput of approximately 22 trillion calculations per second.
- The GIMPS project consists of 46,000 individuals or groups and 71,000 networked computers.

GIMPS

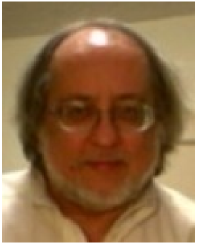
- Woltman's program uses a special algorithm, discovered in the early 1990's by Richard Crandall. Crandall found ways to double the speed of what are called convolutions – essentially big multiplication operations.
- As of October 11, 2006, GIMPS had a sustained throughput of approximately 22 trillion calculations per second.
- The GIMPS project consists of 46,000 individuals or groups and 71,000 networked computers.
- CMSU has over 850 computers performing LL-tests on Mersenne numbers.

GIMPS People



GIMPS People

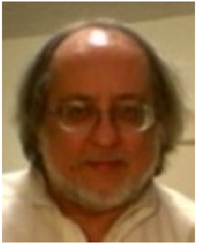
Woltman



GIMPS People

Woltman

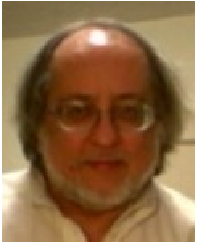
Kurowski



GIMPS People

Woltman

Kurowski



Crandall

- Tony Reix of Bull S.A. in Grenoble, France, using 16 Itanium2 1.5 GHz CPUs of a Bull NovaScale 6160 HPC at Bull Grenoble Research Center, double-checked M32582657 in 6 days.

- Tony Reix of Bull S.A. in Grenoble, France, using 16 Itanium2 1.5 GHz CPUs of a Bull NovaScale 6160 HPC at Bull Grenoble Research Center, double-checked M32582657 in 6 days.
- T.Rex ran the Glucas program by Guillermo Ballester Valor of Granada, Spain.

- Tony Reix of Bull S.A. in Grenoble, France, using 16 Itanium2 1.5 GHz CPUs of a Bull NovaScale 6160 HPC at Bull Grenoble Research Center, double-checked M32582657 in 6 days.
- T.Rex ran the Glucas program by Guillermo Ballester Valor of Granada, Spain.
- Jeff Gilchrist of Elytra Enterprises Inc. in Ottawa, Canada, using 11 days of time on 16 CPUs of an Itanium2 1.6 GHz server at SHARCNET, triple-checked M32582657.

GIMPS People

GIMPS People

T. Rex

GIMPS People

T. Rex

Valor

GIMPS People

T. Rex

Valor

Gilchrist

GIMPS Links

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

GIMPS Links

- The GIMPS home page can be found at: http://www.mersenne.org
- Team Prime Rib's home page can be found at: http://www.teamprimerib.com/

GIMPS Links

- The GIMPS home page can be found at: http://www.mersenne.org
- Team Prime Rib's home page can be found at: http://www.teamprimerib.com/
- A Mersenne Prime discussion forum can be found at: http://www.mersenneforum.org

GIMPS Links

- The GIMPS home page can be found at: http://www.mersenne.org
- Team Prime Rib's home page can be found at: http://www.teamprimerib.com/
- A Mersenne Prime discussion forum can be found at: http://www.mersenneforum.org
- The GIMPS at UCM home page can be found at: http://www.math-cs.cmsu.edu/∼gimps/index.html

Top 10

Top 10 Reasons to Search for Large Mersenne Primes

Top 10

Top 10 Reasons to Search for Large Mersenne Primes

10. Because Mersenne primes are rare and beautiful.

Top 10

Top 10 Reasons to Search for Large Mersenne Primes

10. Because Mersenne primes are rare and beautiful.

9. To continue the mathematics and computer science tradition of Euler, Fermat, Mersenne, Lucas, Lehmer, etc.

Top 10

Top 10 Reasons to Search for Large Mersenne Primes

10. Because Mersenne primes are rare and beautiful.

9. To continue the mathematics and computer science tradition of Euler, Fermat, Mersenne, Lucas, Lehmer, etc.

8. To discover new number theory theorems as a by-product of the quest.

Top 10

Top 10 Reasons to Search for Large Mersenne Primes

10. Because Mersenne primes are rare and beautiful.

9. To continue the mathematics and computer science tradition of Euler, Fermat, Mersenne, Lucas, Lehmer, etc.

8. To discover new number theory theorems as a by-product of the quest.

7. To discover new and more efficient algorithms for testing the primality of large numbers.

Top 10

6. To help detect hardware problems (fan and CPU/bus problems) on individual computers at UCM.

Top 10

6. To help detect hardware problems (fan and CPU/bus problems) on individual computers at UCM.

5. To put to good use the idle CPU cycles of hundreds of computers in labs and offices across UCM's campus.

Top 10

6. To help detect hardware problems (fan and CPU/bus problems) on individual computers at UCM.

5. To put to good use the idle CPU cycles of hundreds of computers in labs and offices across UCM's campus.

4. To learn more about the distribution of Mersenne primes.

Top 10

3. To discover something to number theorists and computer scientists that is comparable to an astronomer discovering a new planet or a chemist discovering a new element.

Top 10

3. To discover something to number theorists and computer scientists that is comparable to an astronomer discovering a new planet or a chemist discovering a new element.

2. To produce much favorable press for UCM and demonstrate that the University of Central Missouri is a first-class research and teaching institution.

Top 10

3. To discover something to number theorists and computer scientists that is comparable to an astronomer discovering a new planet or a chemist discovering a new element.

2. To produce much favorable press for UCM and demonstrate that the University of Central Missouri is a first-class research and teaching institution.

1. To win the $100,000 offered by the Electronic Frontier Foundation (EFF) for the discovery of the first ten million digit prime number. EFF's motivation is to encourage research in computational number theory related to large primes.