

Bit attacks

D. J. Bernstein

University of Illinois at Chicago

From: andr...@ise...

Date: 11 Feb 2009 14:48

Subject: Question

Running CubeHash8/1 with 64 bit output over 2 different datasets give me the same hash under Visual Studio.

Using the code from simple.c and call it the following way:

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Using the code from simple.c and call it the following way:

```
memcpy
```

```
"AAAAA
```

```
,16);
```

```
Hash(6
```

```
for(i
```

```
printf
```

```
printf
```

```
memcpy
```

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"AAAAA
```

```
,16);
```

```
Hash(6
```

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```

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```

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From: andr...@ise...

Date: 11 Feb 2009 14:48

Subject: Question

Running CubeHash8/1 with 64 bit output over 2 different datasets give me the same hash under Visual Studio. Using the code from simple.c and call it the following way:

```
memcpy(data,
"AAAAAAAAABBBB\
,16);
Hash(64,data,1
for(i = 0; i <
printf("%02x"
printf("\n");

memcpy(data,
"AAAAAAAAACBBB\
,16);
Hash(64,data,1
for(i = 0; i <
printf("%02x"
printf("\n");
```

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From: andr...@ise...

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Subject: Question

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```
memcpy(data,
"AAAAAAAAABBBB\0\0\0\0",
16);
Hash(64,data,16,hash)
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash)
printf("\n");

memcpy(data,
"AAAAAAAAACBBB\0\0\0\0",
16);
Hash(64,data,16,hash)
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash)
printf("\n");
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Hash(64,data,16,hash);
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash[i]);
printf("\n");

memcpy(data,
"AAAAAAAAACBBB\0\0\0\0"
,16);
Hash(64,data,16,hash);
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash[i]);
printf("\n");
```

andr...@ise...

11 Feb 2009 14:48

Subject: Question

Running CubeHash8/1 with 64
bits of input over 2 different

inputs give me the same

output under Visual Studio.

I pasted the code from simple.c

into the following

```
memcpy(data,  
"AAAAAAAAABBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");
```

```
memcpy(data,  
"AAAAAAAAACBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");
```

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ne following

```
memcpy(data,
"AAAAAAAABBBB\0\0\0\0"
,16);
Hash(64,data,16,hash);
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash[i]);
printf("\n");

memcpy(data,
"AAAAAAAAACBBB\0\0\0\0"
,16);
Hash(64,data,16,hash);
for(i = 0; i < 8; i++)
printf("%02x",0xff&hash[i]);
printf("\n");
```

As you can see
minor differences
dataset (first
with a "C". Ru
produces:

379ec80069d7a7

379ec80069d7a7

Is this the winner
of the final Cube

48

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```
memcpy(data,  
"AAAAAAAABBBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");  
  
memcpy(data,  
"AAAAAAAAACBBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");
```

As you can see, there
minor difference in the
dataset (first "B" replaced
with a "C". Running it
produces:

```
379ec80069d7a71b  
379ec80069d7a71b
```

Is this the winner
of the final CubeHash prize?


```
memcpy(data,  
"AAAAAAAABBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");
```

```
memcpy(data,  
"AAAAAAAACBBB\0\0\0\0"  
,16);  
Hash(64,data,16,hash);  
for(i = 0; i < 8; i++)  
printf("%02x",0xff&hash[i]);  
printf("\n");
```

As you can see, there is a minor difference in the dataset (first "B" replaced with a "C". Running it produces:

379ec80069d7a71b

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Is this the winner
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```
ry(data,  
AAAABBBB\0\0\0\0"  
34,data,16,hash);  
= 0; i < 8; i++)  
f("%02x",0xff&hash[i]);  
f("\n");
```

```
ry(data,  
AAAACBBB\0\0\0\0"  
34,data,16,hash);  
= 0; i < 8; i++)  
f("%02x",0xff&hash[i]);  
f("\n");
```

As you can see, there is a minor difference in the dataset (first "B" replaced with a "C". Running it produces:

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379ec80069d7a71b  
379ec80069d7a71b
```

Is this the winner
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Let's lo
Progra
a string
Classic
"input
Okay:

```
\0\0\0\0"  
16,hash);  
< 8; i++)  
,0xff&hash[i]);
```

```
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< 8; i++)  
,0xff&hash[i]);
```

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```
379ec80069d7a71b  
379ec80069d7a71b
```

Is this the winner
of the final CubeHash prize?

Let's look at what
Programmer wanted
a string s with n
Classic MD5 API
"input has input
Okay: input = s
inputlen

```
"  
;  
)  
sh[i]);
```

As you can see, there is a minor difference in the dataset (first "B" replaced with a "C"). Running it produces:

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379ec80069d7a71b  
379ec80069d7a71b
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Is this the winner of the final CubeHash prize?

```
"  
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)  
sh[i]);
```

Let's look at what happened
Programmer wants to hash
a string `s` with `n` bytes.

Classic MD5 API:
"input has `inputlen` bytes"
Okay: `input = s;`
`inputlen = n`

As you can see, there is a minor difference in the dataset (first "B" replaced with a "C"). Running it produces:

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a string `s` with `n` bytes.

Classic MD5 API:

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Okay: `input = s;`

`inputlen = n`

As you can see, there is a minor difference in the dataset (first "B" replaced with a "C"). Running it produces:

```
379ec80069d7a71b
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```
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Is this the winner of the final CubeHash prize?

Let's look at what happened.

Programmer wants to hash a string `s` with `n` bytes.

Classic MD5 API:

"input has `inputlen` bytes."

Okay: `input = s;`

`inputlen = n`

NIST SHA-3 API:

"data has `databitlen` bits."

Okay: `data = s;`

`databitlen = 8 * n`

As you can see, there is a
difference in the
output (first "B" replaced
with "C"). Running it
twice:

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30069d7a71b

the winner

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Programmer wants to hash
a string s with n bytes.

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Okay: $input = s;$

$inputlen = n$

NIST SHA-3 API:

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Okay: $data = s;$

$databitlen = 8 * n$

e.g. data
to hash

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Hash prize?

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Okay: $input = s;$

$inputlen = n$

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Okay: $data = s;$

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e.g. $databitlen$
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AAAAAAAAABBBBO

AAAAAAAAACBBBO

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Okay: `input = s;`
`inputlen = n`

NIST SHA-3 API:

“data has `databitlen` bits.”

Okay: `data = s;`
`databitlen = 8 * n`

e.g. `databitlen = 128`
to hash 16 bytes:

AAAAAAAAABBBB0000

AAAAAAAAACBBB0000

e?

Let's look at what happened.

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Okay: $input = s$;
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NIST SHA-3 API:

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e.g. `databitlen = 128`
to hash 16 bytes:

AAAAAAAAABBBBB0000
AAAAAAAAACBBBB0000

What if the programmer
forgets to multiply by 8?

`databitlen = 16:`

AA	AAAAAAAAABBBBB0000
AA	AAAAAAAAACBBBB0000

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MD5 API:

"... has `inputlen` bytes."

```
input = s;
```

```
inputlen = n
```

SHA-3 API:

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AA	AAAAAAAAABBBB0000
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From:

Date:

Subject:

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What if the programmer forgets to multiply by 8?

databitlen = 16:

AA	AAAAAABBBBB0000
AA	AAAAAACBBBB0000

From: andr...@

Date: 11 Feb 2

Subject: RE: C

Responding to

here. Found th

was my mistake

with the number

datalength, in

number of bits

e.g. `databitlen = 128`
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AA	AAAAAAAAABBBB0000
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----	----------------

From: andr...@ise...

Date: 11 Feb 2009 15:4

Subject: RE: Question

Responding to my own
here. Found the bug and
was my mistake. I called
with the number of bytes
datalength, instead of
number of bits.

e.g. `databitlen = 128`

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AAAAAAAAABBBBB0000

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AA	AAAAAAAAABBBBB0000
----	--------------------

AA	AAAAAAAAACBBBB0000
----	--------------------

From: andr...@ise...

Date: 11 Feb 2009 15:40

Subject: RE: Question

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atabitlen = 128

n 16 bytes:

AAABBBB0000

AAACBBB0000

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itlen = 16:

AAAABBBB0000

AAAACBBB0000

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Date: 11 Feb 2009 15:40

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Will this bug be

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What fraction of programn will forget to multiply by 8

Let's say fraction is $1/F$.

Surely SHA-3 will be used > 1000 network protocols.

Expect > $1000/F$ cases of server programmer forgetting to multiply by 8.

Will this bug be caught by interoperability tests?

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11 Feb 2009 15:40

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Question

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Standardizing a p
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What fraction of programmers will forget to multiply by 8?

Let's say fraction is $1/F$.

Surely SHA-3 will be used in > 1000 network protocols.

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Will this bug be caught by interoperability tests?

Standardizing a protocol requires an independent client implementation.

Still expect $> 1000/F^2$ cases of client programmer *and* independent server programmer forgetting to multiply by 8.

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Will this bug be caught by interoperability tests?

Standardizing a protocol requires an independent client implementation.

Still expect $> 1000/F^2$ cases of client programmer *and* independent server programmer forgetting to multiply by 8.

Typical tests will be passed. Protocol will be deployable. Last $7/8$ th of message will be trivially modifiable.

Security disaster!

fraction of programmers
get to multiply by 8?
any fraction is $1/F$.

SHA-3 will be used in
network protocols.

$> 1000/F$ cases
server programmer
forgetting to multiply by 8.
This bug be caught by
fuzzability tests?

Standardizing a protocol
requires an independent
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