Identify All the Things With UUIDs

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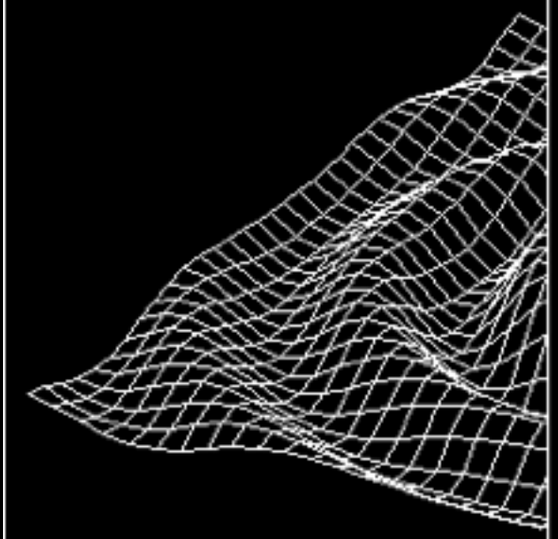
True North PHP
4 Nov 2016

pad0002

pad0001



pad0000 I S

```
dir   nil          1      1024  P    prwx-       pine3.89
dir   nil          1      1024  P    prwx-       pio
dir   nil          1      1024  P    prwx-       pio-
file  unstruct     1       754  P    prwx-       piodrv.make_ddf
dir   nil          6      6144  P    prwx-       plot
file  unstruct    10      9779  P    prw--       pms.c
dir   nil          1      1024  P    prwx-       proxy-xrn
dir   nil          6      6144  P    prwx-       ras
file  coff         4      4075  P    prwx-       rcvbits
file  unstruct     5      4719  P    prwx-       rees-usenix-48.pbm
file  coff         7      6669  P    -r-x-       rexecd
file  unstruct    19     19046  P    prw--       rmail.ml
file  unstruct   143    144836  P    pr---       rx.c-3.2
file  unstruct     1        95  P    prwx-       s
dir   nil          6      6144  P    prwx-       s48
file  unstruct  1024   1042726  P    prw--       scheme48-0.36.tar.gz
file  unstruct     1       373  P    prw--       see.el
file  coff         5      4319  P    prwx-       sendbits
file  unstruct     1       597  P    prw--       sketch.pl
dir   nil          1      1024  P    prwx-       src
dir   nil          1      1024  P    prwx-       star
dir   nil          1      1024  P    prwx-       stbd
dir   nil          1      1024  P    prwx-       sys
file  unstruct     1       176  P    prwx-       test
dir   nil          1      1024  P    prwx-       tmp
link                                               u
dir   nil          1      1024  P    prwx-       ubud
file  coff       140    142070  P    prwx-       ud-3
link                                               umich
file  unstruct    27     27648  P    prw--       unix2dos.tar
dir   nil          1      1024  P    prwx-       user_data
dir   nil          1      1024  P    prwx-       uw
dir   nil          6      6144  P    prwx-       uw-ras
dir   nil          1      1024  P    prwx-       v2_sr9.2
file  unstruct     1       660  P    prw--       x.bak
file  unstruct     1       515  P    prw--       x0
file  unstruct     4      3873  P    prw--       xx

121 entries, 2842 blocks used.
% //dabo/com/cpscr x
% ls -lT x
rec        -rwxr-xr-x   1 rees       101544 Jul 19 23:10 x
```

%

Command: I

universally unique identifier

universally unique

There are 16^{32} possible UUIDs

“only after generating 1 billion UUIDs every second for the next 100 years, the probability of creating just one duplicate would be about 50%”

— Wikipedia, UUID

Unsigned 128-bit integer

379dae82-5a2b-4c4b-8193-b8e7749a3495

Unsigned 128-bit integer

73 926 269 841 798 498 179 266 328 839 241 479 317

Unsigned 128-bit integer

b"7Ø«éZ+LKüô©þtÜ4ò"

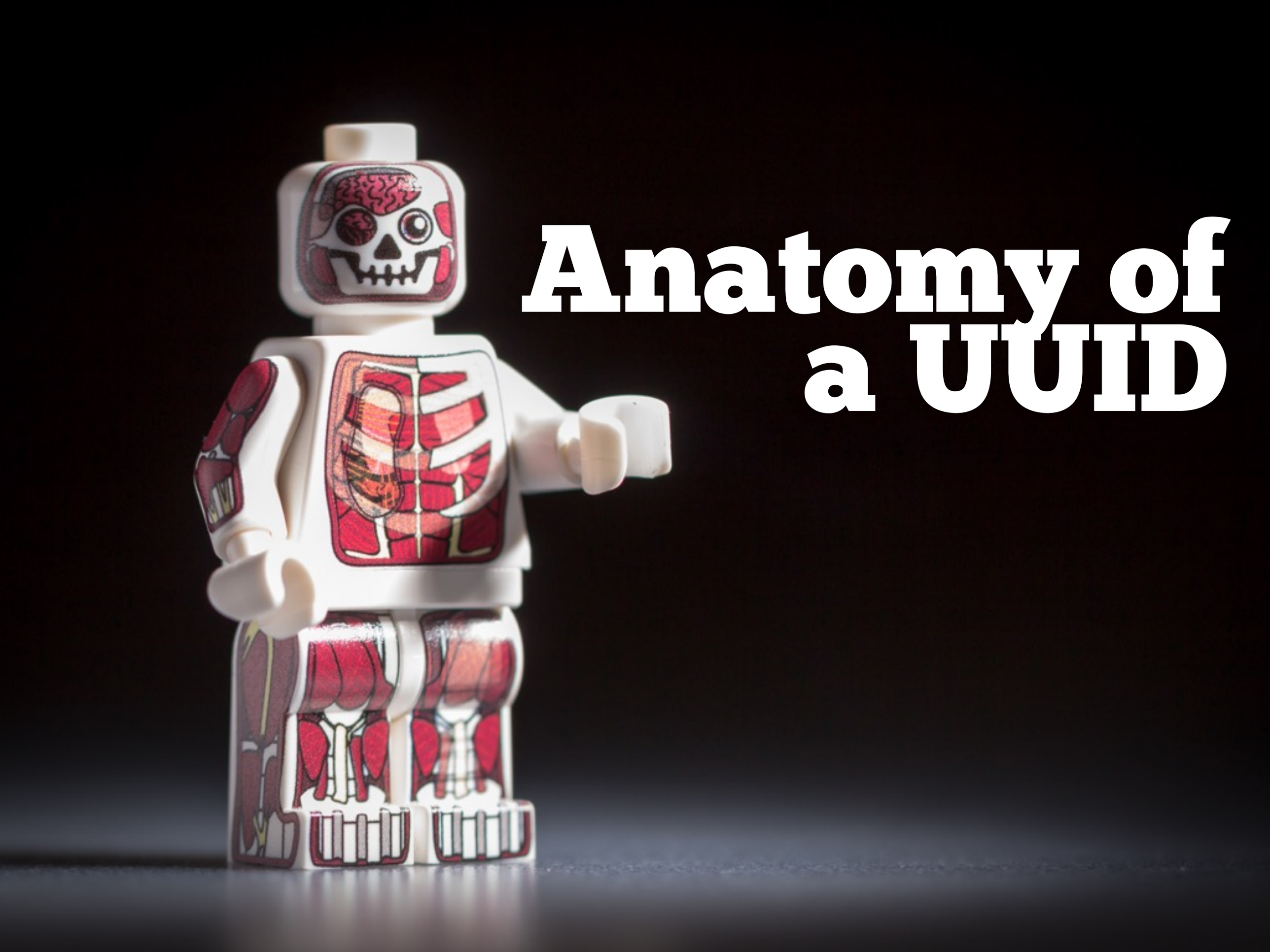
ramsey/uuid

composer require ramsey/uuid

```php
use Ramsey\Uuid\Uuid;
```

RFC 4122

Defines a specific variant of UUID with five versions.


Anatomy of
a UUID

379dae82-5a2b-4c4b-8193-b8e7749a3495

379dae82-5a2b-4c4b-8193-b8e7749a3495

time low

379dae82-5a2b-4c4b-8193-b8e7749a3495

time mid

379dae82-5a2b-4c4b-8193-b8e7749a3495

time high & version

UUID version

379dae82-5a2b-4c4b-8193-b8e7749a3495

time high & version

379dae82-5a2b-4c4b-8193-b8e7749a3495

clock sequence high & reserved

UUID variant

379dae82-5a2b-4c4b-8193-b8e7749a3495

clock sequence high & reserved

379dae82-5a2b-4c4b-8193-b8e7749a3495

clock sequence low

379dae82-5a2b-4c4b-8193-b8e7749a3495

node

Version 1: Time Based

```
$uuid = Uuid::uuid1();
echo $uuid->toString();
```

```php
for ($i = 0; $i < 5; $i++) {
    echo Uuid::uuid1()->toString();
    echo "\n";
}
```

68845efc-1303-11e6-8d40-3c15c2cafa76
68846d0c-1303-11e6-8088-3c15c2cafa76
68847216-1303-11e6-830b-3c15c2cafa76
68847590-1303-11e6-892a-3c15c2cafa76
68847806-1303-11e6-913b-3c15c2cafa76

Version 1

```
68845efc-1303-11e6-8d40-3c15c2cafa76
68846d0c-1303-11e6-8088-3c15c2cafa76
68847216-1303-11e6-830b-3c15c2cafa76
68847590-1303-11e6-892a-3c15c2cafa76
68847806-1303-11e6-913b-3c15c2cafa76
```

Version 1

```
68845efc-1303-11e6-8d40-3c15c2cafa76
68846d0c-1303-11e6-8088-3c15c2cafa76
68847216-1303-11e6-830b-3c15c2cafa76
68847590-1303-11e6-892a-3c15c2cafa76
68847806-1303-11e6-913b-3c15c2cafa76
```

RFC 4122

Version 4: Random

```php
for ($i = 0; $i < 5; $i++) {
    echo Uuid::uuid4()->toString();
    echo "\n";
}
```

28b7883f-3df0-4e8a-9994-57b28f01fab2
dd78278c-03d7-4ca4-8411-06380c4cfd57
ae8de9f1-6ffc-454e-8522-b2c260e4c66b
a5e9ac6b-0680-4fb7-a019-f305c7d2d5da
09fd4b15-2b2d-49be-af51-30899169ff99

Version 4

```
28b7883f-3df0-4e8a-9994-57b28f01fab2
dd78278c-03d7-4ca4-8411-06380c4cfd57
ae8de9f1-6ffc-454e-8522-b2c260e4c66b
a5e9ac6b-0680-4fb7-a019-f305c7d2d5da
09fd4b15-2b2d-49be-af51-30899169ff99
```

Version 4

```
28b7883f-3df0-4e8a-9994-57b28f01fab2
dd78278c-03d7-4ca4-8411-06380c4cfd57
ae8de9f1-6ffc-454e-8522-b2c260e4c66b
a5e9ac6b-0680-4fb7-a019-f305c7d2d5da
09fd4b15-2b2d-49be-af51-30899169ff99
```

RFC 4122

Name Based: Version 3 & 5

```php
$uuid = Uuid::uuid3(
    Uuid::NAMESPACE_DNS,
    'truenorthphp.ca'
);
```

ec187192-1064-3e19-9a5f-704c6bb9d947

Version 3

ec187192-1064-3e19-9a5f-704c6bb9d947

Version 3

ec187192-1064-3e19-9a5f-704c6bb9d947

RFC 4122

```php
$uuid = Uuid::uuid5(
    Uuid::NAMESPACE_DNS,
    'truenorthphp.ca'
);
```

acfd6b8c-7bea-5767-b488-dc8424eae21a

Version 5

acfd6b8c-7bea-5767-b488-dc8424eae21a

Version 5

acfd6b8c-7bea-5767-b488-dc8424eae21a

RFC 4122

```php
$dpcNS = Uuid::uuid5(
    Uuid::NAMESPACE_DNS,
    'truenorthphp.ca'
);

define(
    'NAMESPACE_TN',
    $dpcNS->toString()
);

$pageId = Uuid::uuid5(
    NAMESPACE_TN,
    'sponsors.php'
);
```

Version 2?

Version 2: DCE Security

Advanced Topics

COMB

- Combined random UUID/timestamp
- Replaces the node field with the current timestamp
- Tries to compensate for the reduced clustering in database indexes
- Not sequential
- Non-standard

```php
$factory = new UuidFactory();

$generator = new CombGenerator(
    $factory->getRandomGenerator(),
    $factory->getNumberConverter()
);

$factory->setRandomGenerator($generator);

$combUuid = $factory->uuid4();
```

fe4c9653-b201-431e-86ef-866e9fd03eea

Version 4

fe4c9653-b201-431e-86ef-866e9fd03eea

RFC 4122

fe4c9653-b201-431e-86ef-866e9fd03eea

timestamp

Timestamp First COMB

- Combined random UUID/timestamp
- Replaces the node field with time low and time mid fields
- Adds the current timestamp to the time low and time mid fields
- Provides sequential “random” UUIDs
- Non-standard

```php
$factory = new UuidFactory();

$generator = new CombGenerator(
    $factory->getRandomGenerator(),
    $factory->getNumberConverter()
);

$codec = new TimestampFirstCombCodec(
    $factory->getUuidBuilder()
);

$factory->setCodec($codec);
$factory->setRandomGenerator($generator);

$tsFirstCombUuid = $factory->uuid4();
```

```php
$factory = new UuidFactory();

$generator = new CombGenerator(
    $factory->getRandomGenerator(),
    $factory->getNumberConverter()
);

$codec = new TimestampFirstCombCodec(
    $factory->getUuidBuilder()
);

$factory->setCodec($codec);
$factory->setRandomGenerator($generator);

$tsFirstCombUuid = $factory->uuid4();
```

866e9fd0-3eea-431e-86ef-fe4c9653b201

Version 4

866e9fd0-3eea-431e-86ef-fe4c9653b201

RFC 4122

866e9fd0-3eea-431e-86ef-fe4c9653b201

timestamp

Database Considerations

- Some databases have UUID as native type
    - MySQL does not
    - InnoDB uses PK in all secondary keys; if PK is big (`CHAR(36)`), then all keys will be huge
    - InnoDB stores data in PK order; if UUID is PK and not sequential, then inserts are scattered

Database Solutions

- Don’t use UUID as a primary key
- Use binary instead of string UUID
  - `CHAR(16)`
  - `$uuid->getBytes()`
- If used as PK, use `OrderedTimeCodec`
- Read Percona blog post “Store UUID in an optimized way”

Ordered Time UUID

- Version 1 UUID with timestamp re-ordered
- Swaps the time low and time high (and version) fields
- Provides sequential time-based UUIDs
- Non-standard
- Loses access to version

OrderedTimeCodec

- Only re-arranges fields when encoding to a byte string (i.e. `Uuid::getBytes()`)
- When decoding bytes, it puts the fields back in order
  - **Caveat**: Can result in unintended effects if decoding bytes not encoded with this codec

```php
$factory = new UuidFactory();

$codec = new OrderedTimeCodec(
    $factory->getUuidBuilder()
);

$factory->setCodec($codec);

$orderedTimeUuid = $factory->uuid1();
```

bad96ae6-a118-11e6-aa2b-3c15c2cafa76

Version 1

bad96ae6-a118-11e6-aa2b-3c15c2cafa76

RFC 4122

Note how the codec doesn't rearrange the fields when converting to a string.

Version 1

bad96ae6-a118-11e6-aa2b-3c15c2cafa76

RFC 4122

Let's see what happens when we decode the bytes without the codec.

```
$uuid = Uuid::fromBytes(
    $orderedTimeUuid->getBytes()
);

echo $uuid->toString();
```

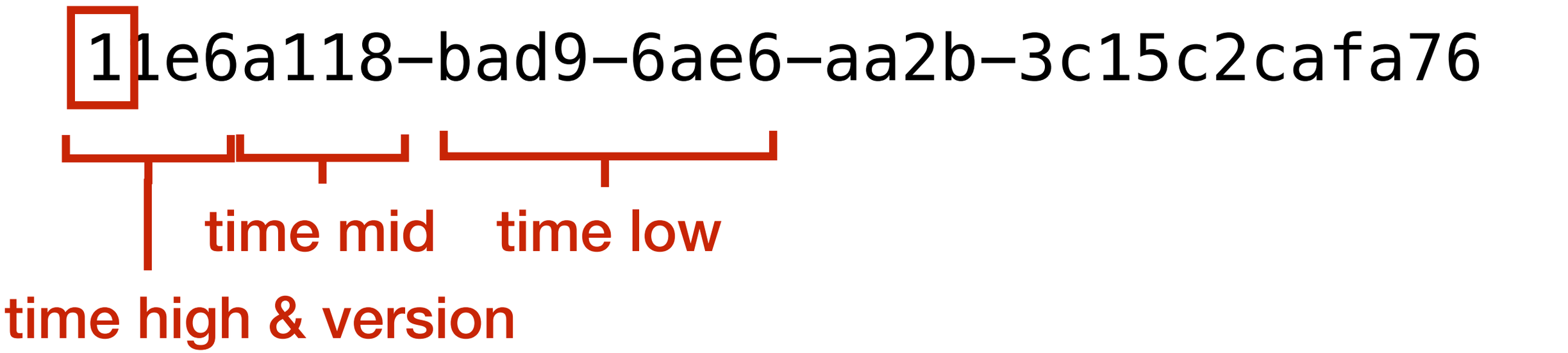
11e6a118-bad9-6ae6-aa2b-3c15c2cafa76

Version ???

11e6a118-bad9-6ae6-aa2b-3c15c2cafa76

RFC 4122

Version 1


11e6a118-bad9-6ae6-aa2b-3c15c2cafa76
time mid
time low
time high & version

Override Time Generator

Want to use **pecl-uuid** as your time generator?

We can do that.

```
$factory = new UuidFactory();

$factory->setTimeGenerator(
    new PeclUuidTimeGenerator()
);

$uuid = $factory->uuid1();
```

Override Random Generator

Want to use **libsodium** as your random generator?

We can do that.

```php
$factory = new UuidFactory();

$factory->setRandomGenerator(
    new SodiumRandomGenerator()
);

$uuid = $factory->uuid4();
```

More Customization

In fact, you're able to customize ramsey/uuid in any way you need by using interfaces and injecting dependencies in the factory:

- Generators
- Codecs
- Converters
- Providers

UUID all the things?

Cons

- Takes up much more DB space than integer
- By default (and spec) not sequential
- Decreases database performance
- Can’t use ORDER BY*
- Ugly in URLs

Pros

- Unique everywhere
- Easily able to merge recordsets from multiple sources
- Easy distribution of databases across multiple servers
- May be generated anywhere, independently

THANK YOU.
ANY QUESTIONS?

If you want to talk more, feel free to contact me.

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