Caching and Performance Deep Dive 2.0

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Overview
Overview
About me

• Fabian Franz

• VP of Software Engineering @ Tag1 Consulting

• Co-Author of BigPipe and the Drupal 8/9 Caching system + D7 core maintainer + subsystems ...

=> Motivation: Teach you all I know about Caching!
Overview
What to expect: Educational Workshop

- Disclaimer: Beginner Caching-Workshop!

- Some concepts from a different angle however.

- Roughly four parts with 20 min each and 10 min for Questions in between parts (4x30 min == 2 hours)
Overview

What to expect: Educational Workshop

- Disclaimer: Beginner Caching-Workshop!

- As much as possible beginner friendly*, but I know too much by now that it's hard to know what you don't know anymore.

=> Please ask Questions - lot's of it.

* Authenticated user caching is likely intermediate.
Overview
What not to expect

- Learning how to setup a D9 site for the first time

- A completely different session than at DrupalCon Global (might consider to come back in an hour or so - then lots of new things! :D ...)

- Changes are clearly outlined in the session description
Overview
What to expect: Educational Workshop

- Part 1: General caching and cache invalidation strategies (cache items, cache max-age and tags)
- Part 2: Cache variation, cache hit ratio, placeholders and uncacheable things
- Part 3: Caching layers + Common Caching Pitfalls
- Part 4: CDN Variation + Authenticated User Caching
Overview
What to expect: Educational Workshop

● Get the code:

https://github.com/LionsAd/cache_edu/

● Install D9 via ddev or bring your own D9 install. Copy it into modules/custom/ and enable the cache_edu module.
1. What is Caching?
In computing, a cache is a hardware or software component that stores data so that future requests for that data can be served faster; the data stored in a cache might be the result of an earlier computation or a copy of data stored elsewhere.
What is Caching?
Sooo much theory ...

- Example: We have a restaurant and we prepare meals (pages)

- Pizza takes 10 min to prepare

- Takeaway => Pizza is wrapped and given out
What is Caching?
Sooo much theory ...

- Example: We have a restaurant and we prepare meals (pages)
- Pizza takes 10 min to prepare
- Takeaway => Pizza is wrapped and given out -----> THAT IS CACHING!

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What is Caching?
Sooo much theory ...

- That’s a cache, performance of pizza delivery is improved
- Finite numbers of pizzas?
What is Caching?
Sooo much theory ...

- We have a magic replicator!
- Customer comes, we replicate the Pizza that we prepared earlier, and give it away
What is Caching?
Sooo much theory ...

- Every item that we cache gets a name: Cache item name or cache address

- In Drupal this is a cache ID or later this is also called “cache keys”

- Cache keys sample -- ['pizza', 'margherita'] => pizza:margherita
Let’s make Pizza! :D
How to cache?
Examples for you :)

```php
$cached_pizza = \Drupal::cache('pizzas')->get('pizza:margherita');
if ($cached_pizza) {
    return static::deliver($cached_pizza->data);
}

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')->set('margherita', $pizza);

return static::deliver($pizza);
```
Who sees the bug?
$cid = 'pizza:margherita'; // Cache ID
$cached_pizza = \Drupal::cache('pizzas')->get($cid);
if ($cached_pizza) {
    return static::deliver($cached_pizza->data);
}

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')->set($cid, $pizza);

return static::deliver($pizza);
How long is a product valid?
How long is a product valid?

- Supermarket: Best before [DATE]
- Pizza after a while looks like this => Don’t want to eat it anymore ...  
- Solution: Expiration date
$cid = 'pizza:margherita';  // Cache ID
$time_to_live = 10*60;  // 10 min valid

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')-&gt;set($cid, $pizza, time() + $time_to_live);

return static::deliver($pizza);
Best before: 09/2022

- Page cache in Drupal 3-6

- Still a perfect pattern => EASY!

- Cache for 10 min unconditionally, great for high traffic sites
Weekend - let’s clean up!
Weekend!
Let’s clean-up!

```
$cid = 'pizza:margherita'; // Cache ID
\Drupal::cache('pizzas')-&gt;delete($cid);
```

// Delete all pizzas!
\Drupal::cache('pizzas')-&gt;deleteAll();
How to define a pizzas cache bin

`cache_edu.services.yml`

```yaml
services:
    # Pizzas cache bin.
    cache.pizzas:
        class: Drupal\Core\Cache\CacheBackendInterface
        tags:
            - { name: cache.bin }
        factory: cache_factory:get
        arguments: ['pizzas']
```
Let’s offer Frozen Margherita!

- Dough with 00-flour, pint of salt + water
- Custom made Tomato Sauce
- Mozzarella
- Basil
Let's keep it for longer

$cid = 'pizza:margherita'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')-&gt;makeFrozen('margherita');
\Drupal::cache($bin)-&gt;set($cid, $pizza, time() + $time_to_live);

return $pizza;
Recap - How our Shop works!
Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita]
- [Waiter] gets the [Pizza] from the fridge at the counter
- [Waiter] checks the expiration date, if it’s expired he gets one from central storage in the cellar
- [Waiter] replicates and delivers the pizza to the customer
Let’s offer Marinara as well!

- Dough with 00-flour, pint of salt + water
- Custom made Tomato Sauce
- Extra virgin olive oil
- Oregano + Garlic

It’s a vegan pizza!
Mooore Pizza!
Completely new pizza! Not a variation. Now on offer!

```php
$coid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, time() + $time_to_live);

return static::deliver($pizza);```

Success! We are growing!
A better recipe for the dough!

After super-secret expedition to Italy!

Pizza-Dough 2.0
Pizza-Dough 2.0
We are lovin’ it!

- Invalidate all the (cached) old pizzas
- Not wait for 30 days
- How do we know if they are new or old?
Pizza-Dough 2.0
Naive solution

```php
$pizza = \Drupal::cache('frozen_pizzas')-&gt;get('pizza:margherita:dough_version=2');
if ($pizza) {
    return $pizza;
}
```

- This does not scale :(  
- All old versions are kept around
What a Mess!
Pizza-Dough 2.0

Let’s tag it!

name: Margherita
expires: 08/2020
tags:
  - dough_version: 2

name: Marinara
expires: 08/2020
tags:
  - dough_version: 2
Pizza-Dough 2.0
Let’s tag it!

```php
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$expire = time() + 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, $expire, ['dough_version']);
```
Pizza-Dough 2.0
Let’s tag it!

```
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$expire = time() + 30*24*60*60; // 30 days valid!
(cache_tags = ['dough_version']);

$pizza = \Drupal::service('pizza.maker') -> makeFrozen('marinara');
\Drupal::cache($bin) -> set($cid, $pizza, $expire, $cache_tags);
```

Release a new dough version, do that:

```
\Drupal::cache($bin) -> invalidateTags([ 'dough_version' ]);```

Pizza-Dough 2.0
Tagging is versioning!

- Drupal versions the tags automatically
- cachetags table: `tag, invalidations`
- It’s a version number conceptually!
Pizza-Dough 2.0
Ways of Tagging

- v3.1.0 (versions)
- 2020-07-15 (timestamps)
- Snow Leopard (names)
- 1..10000 (counters)
Pizza-Dough 2.0
This ain’t easy

• node:1 is saved and cache tag is invalidated (v42 -> v43)

• node:1 cache tag now SHOULD BE v43

• Anything tagged with node:1 must have value of v43, else it’s invalid
Pizza-Dough 2.0
This ain’t easy

- Complex, but once mastered this is so powerful:

  Cache Item = {Name, tag=v42}
  Canonical Store = {Current Version of tag = v43}
Pizza-Dough 2.0
This ain’t easy

Hint: Everything in the same request always uses the same current version.

In other words: The waiter just checks the list of dough versions e.g. once a day and not every minute.
Recap - How our Shop works
- now with tagging!
Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita]
- [Waiter] gets the [Pizza] from the fridge at the counter
- [Waiter] checks the expiration date and tags
- [Waiter] marks the pizza as valid or invalid
- If the pizza is not valid, he gets one from central storage in the cellar
- [Waiter] replicates and delivers the pizza to the customer
Recap
All that we learned so far!

We now know how to:

- Get an item from the cache
- Set an item into the cache
Recap

Three ways to expire the cache! *sing*

- Direct deletion / invalidation by name of item
  [cache id - name]

- Time based (TTL - time to live) invalidation
  [cache - max-age]

- Tag based invalidation [cache - tags]
Recap
Core is cheating :p

We also implicitly created a new cache:

- The list of versions for the tags (we store it for the time of the request)

Hence: Cache tags DON’T solve the problem of cache invalidation, they just move it to somewhere else.
1. What is Caching?

Question Time!
2. What should you cache?
2 years later
Grown even more!

Success is great!
Ready for new products!
Pizza-Shop 2.0

Gluten-free dough, vegan mozzarella, pizza spinacci, ...

• New pizza variations

• Gluten free offering

• Vegan Margherita offering (Marinara was always vegan!)
Quick Recap
(now with 100% more variation)
Recap (Slides)

- [Customer] comes and orders a pizza
- [Waiter] asks for the preferences (vegan/gluten free) (cache context)
- [Waiter] checks the fridge for the wanted variation
- [Waiter] gives the wanted variation to the customer (cache hit) or produces it (cache miss) and then stores it in the fridge
Pizza-Shop 2.0
Let’s add it to the name (again?!)

- pizza:margherita:vegan:glutenfree
- pizza:margherita:vegan:gluten
- pizza:margherita:vegetarian:glutenfree
- pizza:margherita:vegetarian:gluten
- pizza:marinara:vegan:glutenfree
- pizza:marinara:vegan:gluten

Hmm, nope!

- pizza:marinara:vegetarian:glutenfree
- pizza:marinara:vegetarian:gluten
Pizza-Shop 2.0
What we would like:

pizza:margherita
  glutenfree
    vegan
    vegetarian
  gluten
    vegan
    vegetarian

pizza:marinara
  glutenfree
    vegan
    vegetarian
  gluten
Cache Contexts

Vary me if you can!

- ... are used for variation in Drupal 8/9
- ... are computed on demand
- ... internally adds the cache context values to the Cache ID name
Cache Contexts
Pizza-Shop 2.0

Name: pizza:margherita
Cache Contexts:
- vegan=yes|no
- gluten_free=yes|no

Name: pizza:margherita:vegan=yes|no:glutenfree=yes|no
Expires: 09/2020
Tag:
- dough_version=2
Cache Contexts

Pizza-Shop 2.0

Name: pizza:marinara
Cache Contexts:
- gluten_free=yes|no

Name: pizza:marinara:glutenfree=yes|no
Expires: 09/2020
Tag:
- dough_version=2
Quick Recap
(now with intelligent variation)
Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita] (Cache ID)
- [Waiter] looks at the [Pizza] variations for Margherita (Cache Context Router)
- [Waiter] asks the [Customer] for his preferences (vegan and/or gluten-free?)
  (Cache Context Execution)
- [Waiter] gets the preferred [Pizza] from the fridge at the counter (Cache Retrieval)
- [Waiter] checks the expiration date and tags (Cache validation)
- [Waiter] marks the pizza as valid or invalid
- If the pizza is not valid, he gets one from central storage in the cellar (Cache miss)
- [Waiter] replicates and delivers the pizza to the customer (Cache hit)
Cache Contexts

Practical Example

- Only works with Render Arrays
- Took us quite some time to understand in depth
- RenderCache could provide it as Service in the future
Cache Contexts

Practical Example

- Only works with Render Arrays

- [https://www.drupal.org/project/variationcache](https://www.drupal.org/project/variationcache) for decoupled and other direct needs

- RenderCache could provide it as Service in the future:

  [https://www.drupal.org/project/drupal/issues/2551419](https://www.drupal.org/project/drupal/issues/2551419)
Cache Contexts

**Direct** vs. Render Array - Compare:

```
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!
$cache_tags = ['dough_version'];

$pizza = \Drupal::service('pizza-maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, time() + $time_to_live, $cache_tags);
```
Cache Contexts

Direct vs. **Render Array** - Compare:

```php
$build = [
    '#cache' => [
        'bin' => 'frozen_pizzas',
        'keys' => ['pizza', 'marinara'],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#pre_render'][] = function($elements) {
    $elements['pizza'] = \Drupal::service('pizza.make')->makeFrozen('marinara');
    return $elements;
};
```
Cache Contexts

Practical Example using Render Array

- Provide the Cache metadata via `#cache`
- Provide the Cache miss function (`#pre_render`)
Cache Contexts

**Direct vs. Render Array** - Compare:

```php
(cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!
$cache_tags = ['dough_version'];

$pizza = \Drupal::service('pizza.maker')
->makeFrozen('marinara');

\Drupal::cache($bin)->set($cid, $pizza, time() + $time_to_live, $cache_tags);
```

```php
$build = [
    '#cache' => [
        'bin' => 'frozen_pizzas',
        'keys' => ['pizza','marinara'],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#pre_render'][] = function($elements) {
    $elements['pizza'] = \Drupal::service('pizza.maker')
    ->makeFrozen('marinara');
    return $elements;
};
```
$build = [
    '#cache' => [
        'contexts' => ['user.vegan', 'user.glutenfree'],
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#pre_render'][[]] = function($elements) use ($pizza_name) {
    $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
    return $elements;
};
Cache Contexts

Render Array with Cache Contexts added

```
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#pre_render'][] = function($elements) use ($pizza_name) {
    $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
    return $elements;
};

$build['#cache']['contexts'] = ['user.vegan', 'user.glutenfree'];
```
Cache Contexts

Render Array with dynamic cache contexts

```php
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#pre_render'][] = function($elements) use ($pizza_name) {
    $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);

    $elements['#cache']['contexts'] = 'user.glutenfree';
    if ($pizza_name == 'margherita') {
        $elements['#cache']['contexts'] = 'user.vegan';
    }
    return $elements;
};
```
class UserVeganCacheContext extends UserCacheContext {

/**
 * {@inheritdoc}
 */
public static function getLabel() {
    return t('Vegan User');
}

/**
 * {@inheritdoc}
 */
public function getContext() {
    return $this->user
        ->field_vegan
        ->value() ? 'yes' : 'no';
}
}
Cache Contexts
Creating a Cache Context: pizza.services.yml

services:
cache_context.user.vegan:
  class: Drupal\pizza\UserVeganCacheContext
  arguments: ['@current_user']
tags:
  - { name: cache.context}
TADA! That works great!
Alert: Fridge is full!
So many variations ...
Help!

Soooo many variations ...

- Pizza Spinacci is bought way less
- Custom pizza is “uncacheable”
- Check your cache hit ratio and invalidations: https://www.drupal.org/project/cache_metrics

Attribution: Agnieszka Kwiecień (Nova / CC BY-SA 3.0)
Help!
Soooo many variations ...

- Let’s disable the cache
- Easiest: Not cache at all

Attribution: Agnieszka Kwiecień (Nova / CC BY-SA 3.0)
Disable cache
Max-Age = 0

$build["#cache"]['max-age'] = 0;
Disable cache
For cacheable objects

```php
$cacheable_object->setCacheMaxAge(0);
```
<?php

$build['#pre_render'][] = function($elements) use ($pizza_name, $ingredients) {
    if ($pizza_name == 'custom') {
        $pizza = \Drupal::service('pizza.maker')->makeCustomPizza($ingredients);
        $elements['#cache']['max-age'] = 0;
        return $elements; // We early return ...
    }

    if ($pizza_name == 'spinacci') {
        $elements['#cache']['max-age'] = 0; // We fall through ...
    }

    // [...] The rest of the callback

    return $elements;
};
Disable Cache
Practical Example using Render Array

- Cache max-age=0 set after function has been rendered

- **Pitfall:** Clear your cache (drush cr) after making such a change during local development

  -> Happened to me more often than I’d like to admit ...
Disable Cache

Practical Example using Render Array

- **Pitfall:** Clear your cache (drush cr) after making such a change during local development

- 3 ways:
  - `drupal cache:tag:invalidate rendered`
  - `drush cache:tag rendered`
  - `Drupal\Core\Cache::invalidateTags(['rendered']);`
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $tags,
    ],
    '#pizza_name' => $pizza_name,
    '#pre_render' => [$this, 'makePizza'],
];

if (in_array($pizza_name, ['custom', 'spinacci'])) {
    $build['#cache']['max-age'] = 0;
}
Disable Cache

Practical Example using Render Array

- It's always more efficient to disable the cache before the item is retrieved from the Cache

- Similar to: Request based Cache Policy
Cache Chains
No Pizza-Shop creates the Pizza always from Scratch
Pizza is made from pre-prepared things:

Dough (12-24 hrs till ready), Tomato sauce, Ingredients
Composing Sites

Pages consist of different cached and uncached parts

- Main page response (need to custom cache)
- Blocks, Menus, Header, Footer, ...
  [Decoration around the main page response]
Pizza Funghi

2 ways to create a Pizza with Mushrooms!

- Start with the empty pan, add the dough, add the tomato sauce, add the mozzarella cheese and then add the mushrooms.

- Start with a finished pizza margherita and just add the mushrooms.
Pizza Funghi

+ Dynamic Page Cache

That is what the true power of dynamic page cache is:

- We cache the response

- We add flavor / placeholders afterwards
Pizza Funghi
+ Dynamic Page Cache

Drupal 8+9 with two ways for really dynamic things:

- Disable the (dynamic) page cache; just cache all the inner parts (blank pan, create from scratch)

- Cache the whole response in dynamic page cache and just add some placeholders for dynamic data
Pizza Funghi
+ Dynamic Page Cache

- Glutenfree cannot be a placeholder

- It’s the foundation of our pizza

- Both are needed:
  - Variation (varies all cache entries)
  - Placeholders (out of band)

=> Decide case-by-case
placeholders
Pizza M+X
Margherita + Placeholders

- A placeholder in Drupal: Can be independently rendered. Must not depend on anything that has been executed before.

For example:

- It’s not possible to add more wheat to the dough after the pizza is finished already.
Pizza M+X
Classified - Top Secret - Placeholders internal structure

```php
$elem['#attached']['placeholders']['%ingredients_placeholder%'] = $build;
$elem['#markup'] = '%ingredients_placeholder%';
```
Pizza M+X

+ Placeholders

Contract:

- Executed after all other parts have been rendered
- #pre_render => #lazy_builder (stronger contract)
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];
$build['#pre_render'][] = function($elements) use ($pizza_name) {
    $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
    return $elements;
};
```php
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];
$build['#lazy_builder'] = [
    '\Drupal\pizza\PizzaLazyBuilder::build',
    [$pizza_name],
];
```
$build = [
    '#cache' => [
        'keys' => ['pizza', $pizza_name],
        'max-age' => $time_to_live,
        'tags' => $cache_tags,
    ],
];

$build['#lazy_builder'] = [
    '\Drupal\pizza\PizzaLazyBuilder::build',
    [$pizza_name],
];

$build['#create_placeholder'] = TRUE;
Lazy Builders:

- Must not contain complex data (enforced!)
- Must not depend on the main page request
Pizza M+X
+ LBs + Placeholders

Lazy Builders + Placeholders allows to:

- Use **big_pipe** (in Core, enable and good to go!)
- Cache the uncacheable
- Break up variation: per-page/per-user => per-page + per-user
2. What should you cache?

Question Time!
3. Where should you cache?
Shop is even more successful!
But Customers
need to drive to us :(
Many drive for 2 hours and more
Can’t we do something about that?
Solution: We offer our pizza in supermarkets around the world!
Solution:

Content Delivery Network (CDN)
CDN

Pizza Delivery Network (PDN!)

Drupal 8/9 makes it easy:

- Choose CDN (Akamai, Cloudflare, Fastly) or Varnish
- Enable module
- Profit!
CDN does the checks:

- Has the pizza expired?
- Is the dough_version still matching?
- dough_version changes => Give CDN a heads up!
CDN

Pizza Delivery Network (PDN!)

See headers for yourself:

- X-Drupal-Cache-Tags
- Debug option
parameters:
  # Cacheability debugging:
  #
  # Responses with cacheability metadata (CacheableResponseInterface instances)
  # get X-Drupal-Cache-Tags and X-Drupal-Cache-Contexts headers.
  #
  # For more information about debugging cacheable responses, see
  # https://www.drupal.org/developing/api/8/response/cacheable-response-interface
  #
  # Not recommended in production environments
  # @default false
  http.response.debug_cacheability_headers: true
CDN
Pizza Delivery Network (PDN!)

And this is the result:

- X-Drupal-Cache-Tags: dough_version
- Expires: 09/2022
Great - but what about the dough itself?
Need to get it from warehouse 10 miles away.
Let’s put it in a fridge under the counter
If you have things that are seldom changing, put it into a special bin and connect that bin to “chained fast”. (mostly read only cache traffic)
Efficiency 3.0
The dough is always near the counter - yeah!

```php
$settings['cache']['bins']['pizza_dough'] = 'cache.backend.chainedfast';
```
No Efficiency 3.0

The custom made pizzas should NOT be stored near the counter

Second rule:

Never put chained fast on things that are often changing or have lots of variations:

- You can get serious write lock problems and performance will decrease!

- If the cache is full it can lead to lock-ups as a full garbage collection needs to be performed.
Efficiency 3.0
APCu is really cool :D

APCu is ideal (and used in Drupal) for:

• FileCache (depends only if the file has changed)
• ClassCache (depends only on where the class sits on the filesystem)
• Config cache (is invalidated only if config changes)

This shows now also the importance of ‘bins’ as those can have different cache backends associated with them.
Don’t forget Redis / Memcached
Efficiency 4.0

Memcached/Redis is also cool

- MySQL is a warehouse that’s across the street

- Memcached / Redis is a fridge that is in the room next door

- ACPu is the fridge below the counter.
Efficiency 4.0
Advantages and Disadvantages, hmmm - what to do ...

- MySQL: Large Storage space / Slow: 2-5 ms response times usually

- Memcached / Redis: Medium storage space / Fast: 0.5 - 1 ms response times usually

- APCu: Small storage space / Fastest: 0.05 ms usually
Efficiency 4.0
Create Pizza + Deliver Pizza are different cache paths

It is important to distinguish two cases:

- Caches used for creating the pizza (MySQL, APCu, Memcached) [from parts]

- Caches used for delivering the pizza to the customer (MySQL, Memcached, CDN, Browser Cache)
Lot’s of customers at once

=> Pizza with Spring Onions
Spring Onions

Only seconds TTL

- The spring onions can only be cached for a very short while (micro-caching)

- Potential bottleneck

  => Stampede protection (build into most CDNs)

SHIELD!
Stampede Protection
Microcaching + Stampede Protection

- Inefficient: Prepare lot's of pizzas in parallel

- Instead: Prepare one spring onion pizza and then just replicate it.
public function stampedeProtect($cid) {
  $item = $this->cache->get($cid);
  if ($item) {
    return $item;
  }

  $acquired_lock = $this->lock->acquire('stampede:' . $cid);
  if (!$acquired_lock) {
    sleep(1);
    return $this->stampedeProtect($cid); // Let's try that again.
  }

  // Rebuild cache
  $item = $this->rebuild();

  $this->cache->set($cid, $item, 30); // Cache for only 30 seconds
  $this->lock->release($acquired_lock);

  return $item;
}
Stampede Protection

- Pitfall: If your cache is invalidated faster than processes wait and you have a long rebuild time, then you can wait endlessly.

- Example: 2 cache invalidations per second (0.5 seconds till next one)

- All processes wait for cache rebuild => When they come back from sleep data is already outdated again.

=> VERY TRICKY ISSUE as often just happens under high load
Stampede Protection: Stale data

- Pitfall: Items are expired faster than rebuild.

- Solution: Allow to return invalid items, aka "stale" (we are micro-caching anyway):

```php
// Return invalid items as well.
$item = $this->cache->get($cid, TRUE);

// Check expiration time yourself.
if ($item && $item->expire >= REQUEST_TIME) {
    return $item;
}
```
Stampede Protection: Stale data

- Pitfall: Items are expired faster than rebuild.

- Was just fixed in Drupal 7 Core 7.76 for variable_init()

- Sites that slightly misuse the variable system and do lots of variable_set at run-time (please don't do that):

  "Endless waiting for variable_lock ..."
Caching Beyond Drupal
Caching Beyond Drupal

Don't forget!

- PHP: opcache (Tweak it and ensure it has enough memory)

- MySQL: Query Cache (Disable it, it's inefficient) - for query caching better use a K/V entity cache approach

- Browser Cache: It's your best friend for images and CSS / JS.

Service Worker: Can even cache HTML in the browser.
Common Caching Pitfalls
Common Caching Pitfalls

AJAX Forms are POST ...

- POSTs are still not cacheable in Drupal Core
- AJAX form submissions hence rebuild the whole page
- This is not optimal for things like a product variation:
  - ?color=red
  - ?color=blue
- would be all that is needed.
Common Caching Pitfalls
AJAX Forms are POST ...

• POSTs are still not cacheable in Drupal Core

• AJAX form submissions hence rebuild the whole page

Solution:

Core patch and data attribute to use a GET request
Common Caching Pitfalls
AJAX GET in Core ...

Solution: Core patch and data attribute to use a GET request

Apply:
https://www.drupal.org/project/drupal/issues/956186#comment-13826865

Add: data-ajax-type="get" to the attributes of the ajax element

Profit - Cached GET AJAX requests when changing product variation!
Common Caching Pitfalls
(AJAX) Forms are POST ...

- POSTs are still not cacheable in Drupal Core

- Forms are max-age=0, some can be auto-placeholdered (like form in a block)

- A form is executed as soon as it's encountered on the page:

  POST to /home with a newsletter form needs to rebuild the whole homepage, before finally seeing the newsletter
Common Caching Pitfalls

(AJAX) Forms are POST ...

- POSTs are still not cacheable in Drupal Core

  - Manual way:

    Ensure the form is rendered as early as possible in the page rendering process (hook_init() / RequestSubscriber)
Common Caching Pitfalls
(AJAX) Forms are POST ...

- Proposed solution for cacheable POSTs (not implemented):
  - Add a cache tag for every form like: form:pizza_newsletter
  - If dynamic page cache / RenderCache does not see a form cache tag on the cache item, then allow caching on POST (max-age > 0)!
  - Pizza Newsletter block form execution is then just:
    - cache_get() content with placeholders (check for form_id)
    - Execute the newsletter form
Common Caching Pitfalls

Planning to fail is better than failing to plan

Plan your caching strategy:

- Know what depends on what
- Know what is not cacheable
- Known when something needs to be invalidated
- [https://drupal.org/project/renderviz](https://drupal.org/project/renderviz) module can be a really nice help here.
3. Where should you cache?

Question Time!
4. CDN Variations & Authenticated User Caching
Back to Pizza! :)

We offer our pizza in supermarkets around the world!
We are growing further!
Market Research:

US like their pizza differently than in the UK.
Solution: We offer another variation of the pizza for different regions!
Variation in my CDN
Variation in my CDN
Real Life Example

- Drupal Commerce
- All pages vary by "region" as the currency of the prices is different
- Magic inside of Drupal: Required Cache Contexts!
parameters:

renderer.config:

  # Renderer required cache contexts:
  #
  # The Renderer will automatically associate these cache contexts with every
  # render array, hence varying every render array by these cache contexts.
  #
  # @default ['languages:language_interface', 'theme', 'user.permissions']

required_cache_contexts:
- 'languages:language_interface'
- 'theme'
- 'user.permissions'
- 'pizza.region'  # Our own defined cache context
Variation in my CDN
Cache Contexts are nice, but ...

- CDNs do not easily support variation on things that are easily defined in Drupal as cache context

- The simplest: Vary by URL for language + region

Don't: /en/really-nice-product-1 (different per region)

Do:
- /UK/en/really-nice-product-1
Variation in my CDN

Here is a Cookie for you!

- The complex way: Vary by region inside the CDN
  - Set a **cookie** (pizza_region) and 302 to request url
  - Convert pizza_region cookie to header in VCL / Cloudflare worker, etc. so that Drupal sees:
    - X-Pizza-Region: US
  - Drupal must output (if the cache context is present):
    - Vary: X-Pizza-Region, ... (instead of Vary: Cookie)
Variation in my CDN

The restart way

- The complex way II: Vary by region inside the CDN
  - Do one request cached per SESSION to an endpoint that returns all the cache contexts for the user as X-Pizza-Region and copy those to the request object
  - So that Drupal sees again: X-Pizza-Region: US
  - Drupal must output (if the cache context is present):
    Vary: X-Pizza-Region, ... (instead of Vary: Cookie)
Variation in my CDN

The restart way

- The complex way II: Vary by region inside the CDN

CORE could **automate** that for you (that is why all cache contexts collapse on either url OR session in core), but no one worked on it:

- X-CC-0: session.pizza_region=US

Automatically copy response to headers.
Variation in my CDN
The restart way

- The complex way II: Vary by region inside the CDN

CORE could automate that for you.

In essence the CDN would need to get a heads up for the missing cache context and re-authenticate the user. (Request -> Authenticate -> Second request)
Variation in my CDN

The restart way

- The complex way II: Vary by region inside the CDN

What if we could do:

X-CC-0: pizza.region=US
X-CC-1: user=2

Is that not all that's needed for authenticated user caching?
Variation in my CDN

The restart way

- The complex way II: Vary by region inside the CDN

What if we could do:

X-CC-0: pizza.region=US
X-CC-1: user=2

That's essentially all that's needed.
Authenticated
User Caching
Authenticated User Caching

Dynamic Page Cache gets you 90% of the way

- Authenticated User Caching means:

  - All pages are potentially different by user (preference)
  
  - With placeholders we already can split: Personalized + Static sections

  - But how do we integrate that into the CDN?
Authenticated User Caching in the CDN
Dynamic Page Cache gets you 90% of the way

- Authenticated User Caching in the CDN needs:
  - Variation
    - Placeholders (and a way to retrieve them)
AuthUser Variation in my CDN

The restart way

- Recap: Vary by region inside the CDN

  Return X-CC-User from auth endpoint:

    X-CC-User: 2

- Drupal returns:

  Vary: X-CC-User
AuthUser Variation in my CDN

Here is a Cookie for you!

- Recap: Vary by user inside the CDN

  - Set a **cookie** (cc_user) and 302 to request url
  - Convert **cc_user** cookie to header in VCL / Cloudflare worker, etc. so that Drupal sees:
    - X-CC-User: 2
  - Drupal must output (if the cache context is present):
    - Vary: X-User, ... (instead of Vary: Cookie)
AuthUser Variation in my CDN

Here is a Cookie for you!

- Recap: Vary by user inside the CDN
  - Set a **cookie** (cc_user) and 302 to request url
  - Convert **cc_user** cookie to header in VCL / Cloudflare worker, etc. so that Drupal sees:
    - X-CC-User: 2
  - Drupal must output (if the cache context is present):
    - Vary: X-User, ... (instead of Vary: Cookie)
Wait a moment, isn't that ... 

... uhm, insecure?
AuthUser Variation in my CDN
Here is a Cookie for you!

- Cookies are not safe, anyone can edit them!
  [I can be user 3 easily]

- Two ways to solve:
  - Use a secret hash per cache context name + value
  - Use a signed cookie (with secret hash)
AuthUser Variation in my CDN

Here is a Cookie for you!

- Recap: Vary by user inside the CDN
  - Set a **cookie** (cc_user) and 302 to request url
  - Convert **cc_user** cookie to header in VCL / Cloudflare worker, etc. so that Drupal sees:
    
    ```
    X-CC-User: 2|1d14f00bb483b1e9ca56545ca48de12b
    ```
  - Drupal must output (if the cache context is present):
    ```
    Vary: X-User, ... (instead of Vary: Cookie)
    ```
Authenticated User Caching in the CDN
Dynamic Page Cache gets you 90% of the way

- Authenticated User Caching in the CDN needs:
  - **Variation**
  - **Placeholders** (and a way to retrieve them)
Authenticated User Caching in the CDN

Dynamic Page Cache gets you 90% of the way

- Authenticated User Caching in the CDN

- 2 ways:
  - AJAX / ESI (Edge-Side-Include) on dedicated URL
  - Javascript + Cookies

Note: Variation in the CDN is the first step.
Authenticated User Caching in the CDN

Simple ESI

- Authenticated User Caching in the CDN

- Simple ESI approach (not implemented):
  
  EsiPlaceholderStrategy:

  - Take hash of serialized(lazy builder)
  - Store lazy builder for that hash in the KeyValue store
  - Execute lazy builder from route /esi/[hash]
Authenticated User Caching in the CDN

Simple ESI

- Authenticated User Caching in the CDN

Potential Problems:

- ESI page will not have all cache tags when fully assembled (headers from sub-resp not included)

- Vary is inefficient as all data is stored in the same object in most CDNs
Authenticated User Caching in the CDN

Simple ESI

- Authenticated User Caching in the CDN

- Vary: X-CC-User is inefficient as all data is stored in the same object in most CDNs

Solution: Include it in the path (even though it's ignored):

/esi/[hash]?user={{ req.http.X-CC-User }}

Need to add search and replace to ESI urls before they are executed.
Authenticated User Caching in the CDN

Simple AJAX

- Authenticated User Caching in the CDN

- Simple AJAX approach: AjaxPlaceholderStrategy (very similar to BigPipePlaceholderStrategy)
  - Execute lazy builder from route /ajax-on-demand/[hash] and deliver like BigPipe ajax
  - Add some client side JS to replace placeholders with ajax requests

Note: Ensure all those AJAX responses are cached in the CDN.
That's all way over my head ... :( 

Is there no simpler way?
Authenticated User Caching in the CDN
Dynamic Page Cache gets you 90% of the way

- Recap: Authenticated User Caching in the CDN needs:
  - Variation
  - Placeholders (and a way to retrieve them)
Authenticated User Caching in the CDN

The easiest way

- Authenticated User Caching in the CDN:

- The easiest way:

  - Don't vary at all for any pages that are not user specific

    - /cart, /user => Don't cache in the CDN
    - /, /my-awesome-product => The same for every user
Authenticated User Caching in the CDN

The easiest way

- Don't vary at all for any pages

  - It's super secure, too! - if you ensure:
    - No user cache context is present
    - Only authenticated users role is used for this

  - Remove: \texttt{Vary: Cookie} header
  - Overwrite: \texttt{Cache-Control} header with e.g.:

    \begin{verbatim}
    Cache-Control: public, max-age=600
    \end{verbatim}
Authenticated User Caching in the CDN

The easiest way

- The easiest way:
  - Don't vary at all for any pages that are not user specific, then add information [Amazon strategy]
  - Use Javascript for simple things like user name

Can use a simple placeholdering strategy as well:

<div id="pizza-module-user-name"></div>
Authenticated User Caching in the CDN

The easiest way

- The easiest way:

  - Don't vary at all for any pages that are not user specific, then add information [Amazon strategy]

- Drupal 7 only (port is welcome, very simple):

  https://drupal.org/project/cacheable_cookie_handling

solves this problem for our enterprise clients
Auth User CDN - Think always of:

- Variation
- Placeholders

and you are golden!
Have fun and I’ll make a Pizza now ;) 

*yummy*
More Questions?

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This will be a quote about something or someone