SAML. Exceptions.

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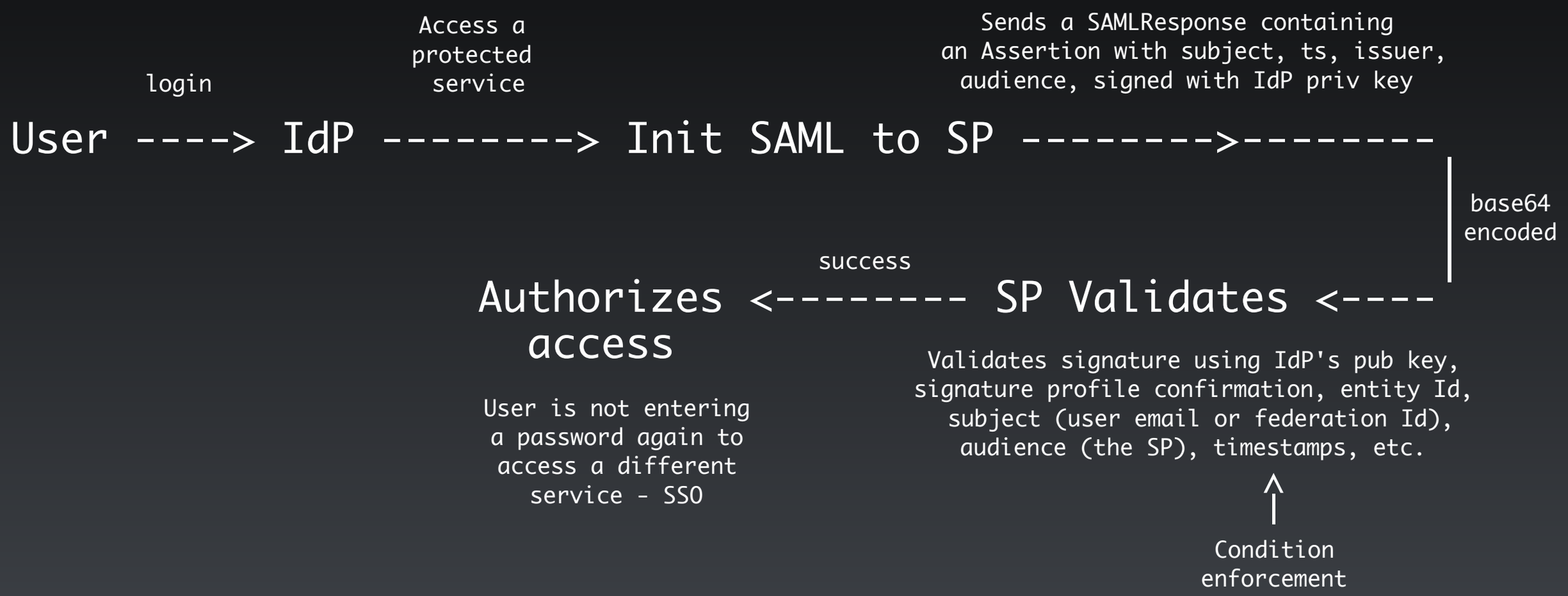
06.04.2017

SAML SSO

- Security Assertion Markup Langauge - XML
- Request-response protocol
- Entities involved: IdP, SP, user
- IdP (Identity Provider): holds the credentials
- SP (Service Provider): provides the service
- Single Sign-On, from OASIS consortium
- Versions: 1.0, 1.1, 2.0, 2.1 (WIP)
- Flows: IdP, SP SAML

IdP SAML

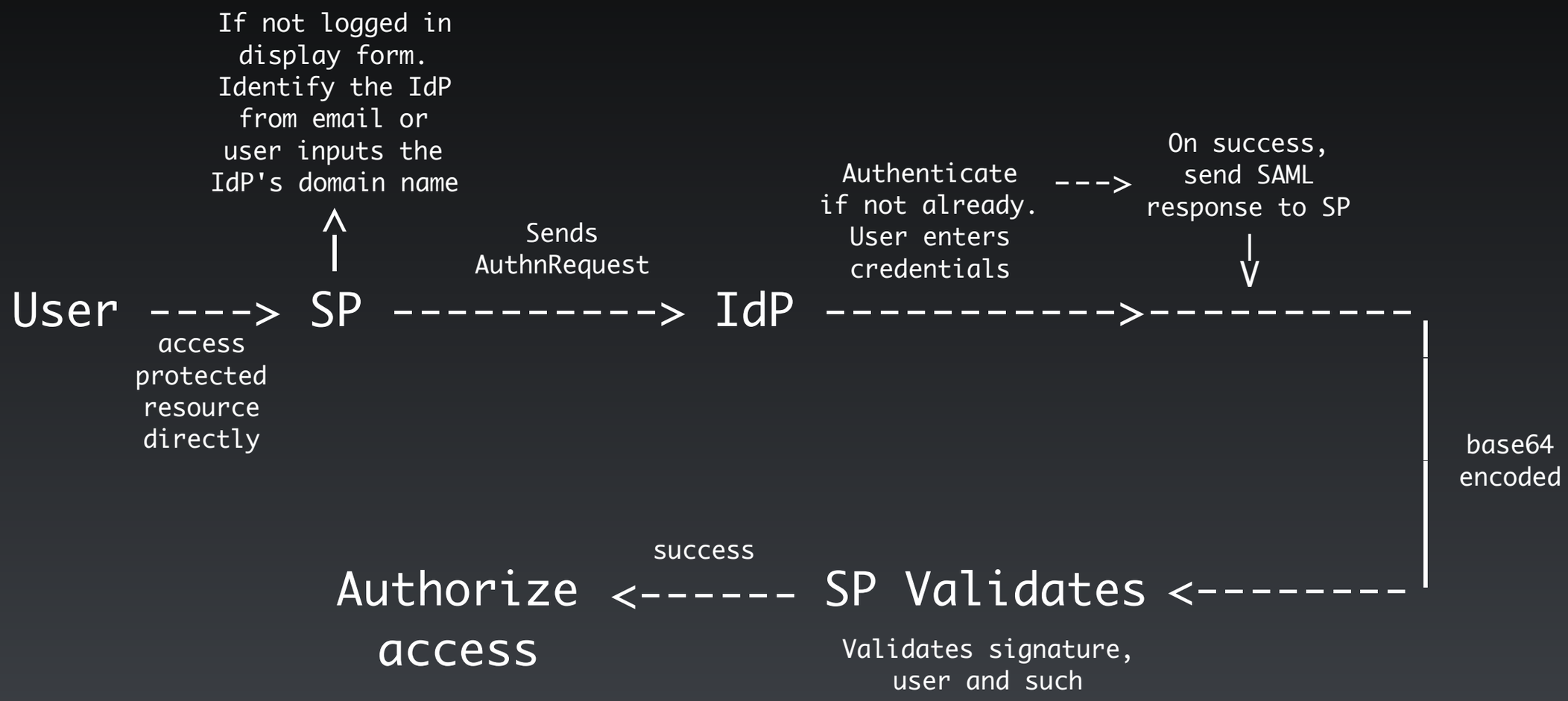
- Flow initiated from the IdP



- Eg: User signs into Boeing (IdP), access link to Concur portal for travel. IdP initiates SAML request to Concur and so on.

SP SAML

- Flow initiated from SP



Variant

- Also known as tagged union.

```
enum SzTag { short_t, ptr_t };

struct Data {
    enum SzTag sz_tag;
    union {  /* 64 bits */
        short short_val;
        int *ptr_val;
    }
};
```

```
void process_data(struct Data *data) {
    /* should we use short_val or ptr_val, how do we know? */
    /* the tag comes handy */
    if (data->sz_tag == short_t)
        /* use data->short_val value */
    } else if (data->sz_tag == ptr_t) {
        /* use *(data->ptr_val) value */
    }
}
```

OS X LP64 size info

datatype	bytes	bits
short	2	16
pointer	8	64

- Sample program at GHE

Variant in Clojure

- Use a vector with a tag and data `[:tag val]`
- Restrict to two elements for simplicity
- Use map for data if we need more values
- Not using a map as a variant – two lookups, for tag, value
- Goes in hand with pattern matching
  - destructure with `let`
  - cleaner using match from `core.match`

- Open variant => tag set is extensible, requires a default case
- Closed variant => well known tags, no default required
- Loop Variant (no theories)
  - Useful to decouple the recursion control logic
  - To control the number of recursions/iterations
  - Eg: workers, task distribution

```
[:stop return-val]
[:recur recur-val]
```

Loop Variant Example

- Distributed sorting of a tree with child nodes
  - sort manager: controls recursion and work allocation
  - sort worker: sort algorithm impl returning a variant indicating whether to continue if child nodes exist

Pseudo code:

```
sort_worker() ->
    % Sort top level nodes, check if any child node exist,
    % if so  use recur tag, else stop tag. Worker can be a remote node or local.

dist_sort(Node) ->
    % Find a worker node based on some criteria, and send the Node to the sort_worker
    % for processing. Does the distribution of jobs to workers & merging.

sort_manager(TaggedTuple) ->
    {recur Node} -> [dist_sort(N) || N <- get_children(Node)]
    {stop Node} -> Node
```

Result Variant & core.match

- Commonly used in error cases which are not exceptions

```
[:ok val]
[:err msg]
[:fatal {:cause "Node crashed", :req req-obj, :node-ip "192.168.10.13"}]
```

- Use match for pattern matching
- Clean, powerful destructuring

```
(match (compute args)  ;compute fn returns a variant
  [:ok result] (merge result)  ;success
  [:err msg] (audit msg)  ;do something with the error
  [:fatal {:cause cause, :node-ip ip}] (sup [:restart ip]))  ;notify supervisor
```

Selective destructure
of map keys. This map data
can have many keys but here
our interest is in only two values.

- core.match macro is slower than stdlib

Handle Exceptions

- try catch

```
(try
  ;code that can throw an exception
  (catch Exception excep
    ; ..))
```

- Ring middleware

```
(defn wrap-exceptions
  [handler]
  (fn [request]
    (try
      (handler request)
      (catch Exception excep
        (let [{[tag _] :cause} (ex-data excep)]
          (condp tag
            :err-signature (sig-err-resp)
            :err-user-inactive (usr-inactive-resp)
            ; ..
            ))))))
```

Fine grained exception responses without any clutter

Avoids having to use try catch everywhere. Middleware handles at route level. Catch all.

Simple destructuring. We can use match for complex cases. Matches exceptions thrown using ex-info.

Can have multiple catch for checked exceptions

- Above pattern goes in hand with throwing custom exceptions using ex-info

Throw Custom Exceptions

- We can use `ex-info` to throw custom exceptions

```
(defn validate-issuer [issuer entity-id]
  (when-not (= issuer entity-id)
    (throw (ex-info "Issuer mismatch." {:cause [:err-issuer-mismatch issuer]}))))
```

Throw `ex-info` with `cause` as the variant with value having the wrong `issuer` obtained

Log it. Do further processing, by middleware

- Cases where it's not appropriate to handle the exception by middleware can have the function return a result variant instead of throwing exceptions

Prelude to Monad

- Monad is a container typeclass.
- Comes from Category Theory. Heavily used in Haskell
- Used for composing (chaining), maintain state between them, side effects, especially in a pure functional language
- Container: holds values. Type of value give the type of the container. Eg: tree, graph, list etc. Means value is wrapped.

```
class Eq a where
    (==) :: a -> a -> Bool
```

`==`	`::`	`a` `->`	`a` `->`	`Bool`
Operation provided by Class `Eq` which its instance `a` must define	has type	arg 1 with type `a`	arg 2 with same type `a`	and returns a boolean

```
instance Eq Integer where
    x == y = x `integerEq` y
```

Type `Integer` implements `Eq` by providing `==` definition

Category Theory

- Category is a collection of objects and arrows between objects
- Hask is the Haskell category (sort of) where objects are types
- Arrows are known as morphisms
- Morphism means transformation
- Transformation under Hask category means functions

- Functor is a morphism from category to category
- Intuition: functor is a type class that can transform by mapping a function `fmap` over a collection of types and return a collection of new (lifted) types, where the same function can be applied again
- Functors in Haskell is an endofunctor since it maps within the same category, i.e., types

Functor

```haskell
class Functor f where
    fmap :: (a -> b) -> f a -> f b
```

Takes a function of type `a` which returns type `b`

Returns a function that takes `f a` and return `f b` for some type constructor `f`

```haskell
data Maybe a = Nothing | Just a
```

Maybe as a type

type constructors

```haskell
class Functor Maybe where
    fmap :: (a -> b) -> (Maybe a -> Maybe b)
```

Maybe as a functor typeclass definition

Takes a normal function

Returns a function of a lifted (more generic) type

```haskell
instance Functor Maybe where
    fmap _ Nothing  = Nothing
    fmap f (Just a) = Just (f a)
```

- Generalization: Endofunctors in the category of Hask returns a lifted type
- Functor in Hask should map to the same type constructor
- => No `Int` to lifted `String` type etc. `Int` to lifted `Int` only

Functor Example

```haskell
addThree :: Int -> Int
addThree = (+ 3)  -- normal function
```

```
> addThree (Just 2)  -- error
--- *** addThree takes an Int but you gave it a Maybe Int.
```

```
> fmap addThree (Just 2)
Just 5
```

Make it a functor. Since Just 2 is a Maybe constructor and Maybe is an instance of Functor, fmap knows how to apply the function to the wrapped value or context

```
> fmap addThree Nothing
Nothing
```

```
-- Infix style
> addThree <$> Just 2
Just 5
```

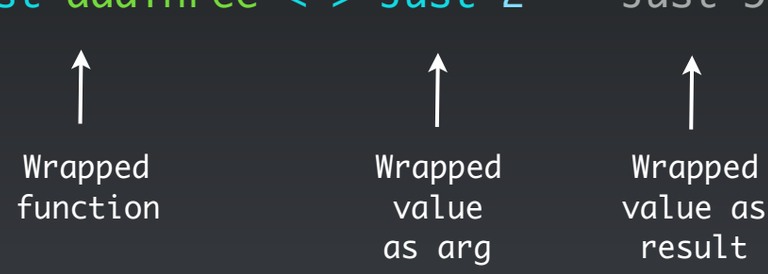
```
> addThree <$> Nothing
Nothing
```

We converted a normal function to a lifted function using a functor, and got free error handling

Applicative Functor

- Simply put, an upgraded version of a functor
- Intuition: Takes a wrapped function(s) and a wapped value(s), unwarp both, apply the each functions to each values and return a wrapped value of the result
- Eg using infix (sequence application ap):

```
Just addThree <*> Just 2 -- Just 5
```




```
> [(*2), (+3)] <*> [1, 2, 3]
[2, 4, 6, 4, 5, 6]
```

Monad

```haskell
class Monad m where
    (>>=) :: m a -> (a -> m b) -> m b
```

bind

wrapped value; instance of monad

function that takes a value and returns a monad

return a wrapped value (monad)

```haskell
instance Monad Maybe where
    Nothing >>= func = Nothing
    Just val >>= func = func val
```

wrapped value

function

apply function to the value

the result of this function is again a wrapped value

```haskell
half :: Int -> Maybe
half x = if even x
         then Just (x `div` 2)
         else Nothing
```

```haskell
> Just 20 >>= half >>= half >>= half
Nothing
```

short circuits. 5 not even

Can compose as many functions as we want. Here we use the same function `half`, it can be any that matches the type.

We got exception handling. Only the final value need to be unwrapped if success.

- Maybe is a functor, applicative, monad and many other things

Either Monad

```
class Monad m where
    (>>=) :: m a -> (a -> m b) -> m b
```

- `(>>=)` — bind infix op
- `m a` — wrapped value; instance of monad
- `(a -> m b)` — function that takes a value and returns a monad
- `m b` — return type of the given function application

```
data Either a b = Left a | Right b
```

- `Either` — Either as a type
- `Left a | Right b` — type constructors

```
instance Monad (Either e) where
    Left l  >>=  _  = Left l
    Right r >>=  k  = k r
```

- `Left l` — wrapped value
- `k` — function
- `k r` — apply function to the value

```
let parseEither :: Char -> Either String Int
    parseEither c
      | isDigit c = Right (digitToInt c)
      | otherwise = Left "parse error"
```

← Error message. Instead of Nothing as in Maybe

```
let parseMultiple :: Either String Int
    parseMultiple = do
      x <- parseEither 'm'
      y <- parseEither '2'
      return (x + y)
```

← Fails. Not a digit. Short circuits.

← `return` is one of the monad definitions in the typeclass

do is a syntax sugar for bind. Unsugared version will be a bunch of nested anonymous functions

```
> parseMultiple
Left "parse error"
```

- Monads gets composed
- `Except` monad builds on top of `Either` monad and such
- Monad is an abstraction and can be used in any language
- It's more elegant in a pure functional language with an intelligent type system (HM)

Links

- clojure/conj variants errata + video

  http://jneen.net/posts/2014-11-23-clojure-conj-variants-errata

Thank You