THE UNIVERSITY OF CHICAGO

MPCS 51033 • SPRING 2017 • SESSION 7

BACKENDS FOR MOBILE APPLICATIONS

CLASS NEWS

CLASS NEWS

- Office hours tomorrow from 10-11:30 in Young 308
- Make-up class Saturday, May 20, 9AM-12PM in Young 101(?)
  - iOS Performance and Security
  - ...

CLASS NEWS

- Week 6 - Assignment 4 (CloudKit)
- Week 7 - Finish assignment 4 and work on case study and final project
- Week 8 - Assignment 5 Assigned (Swift on Server)
- Week 9 - Case Studies in Class; Assignment 5 Due
- Week 10 -
- Week 11 - Final Project Presentations

CLOUDKIT API

WEB SERVICE API

- Javascript API
- Matches native CloudKit API
- No intermediate servers
- New notes web app built with CloudKit JS

JS

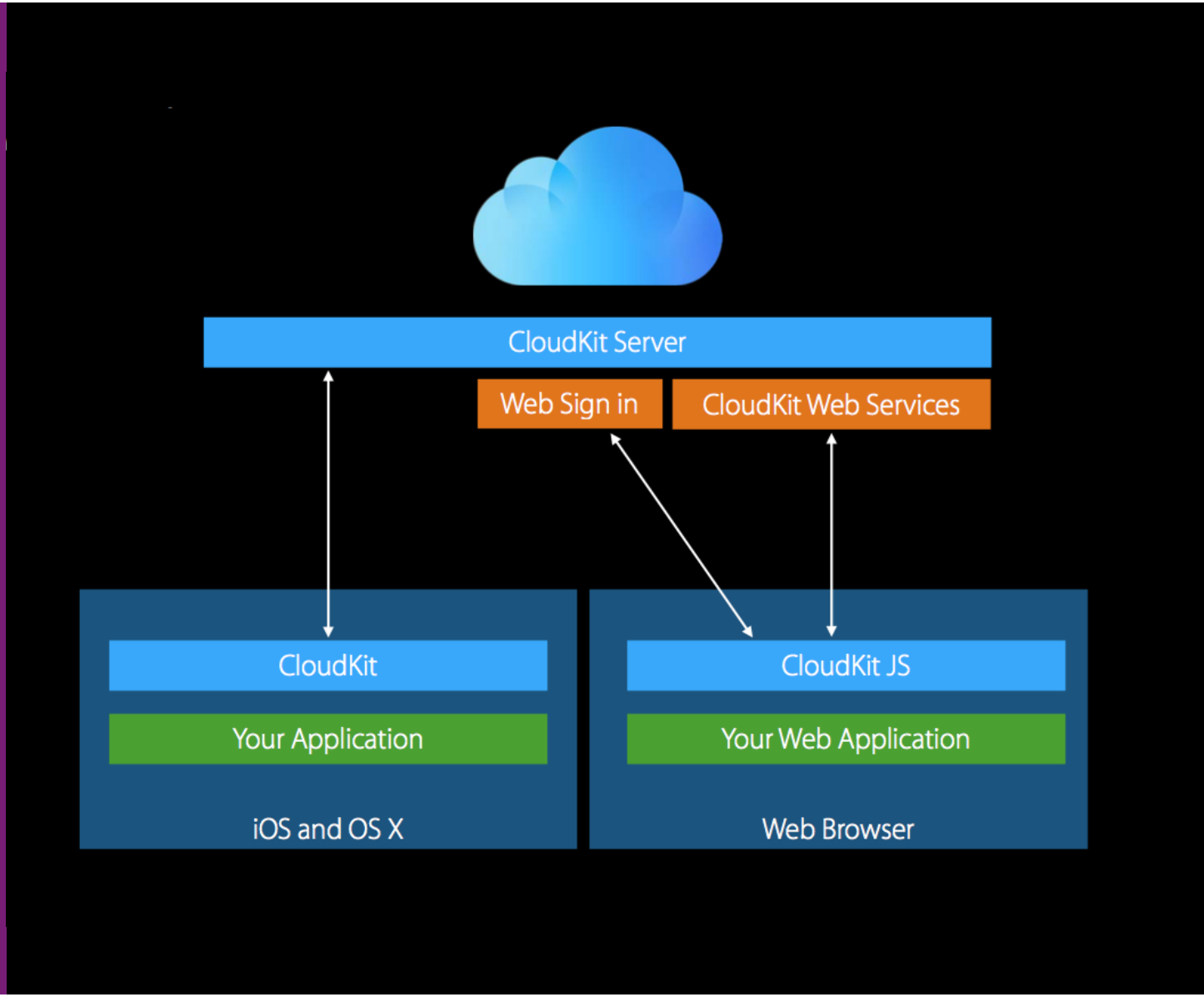
```
<SCRIPT SRC="HTTPS://CDN.APPLE-CLOUDKIT.COM/CK/1/CLOUDKIT.JS" />
```

WEB SERVICE API

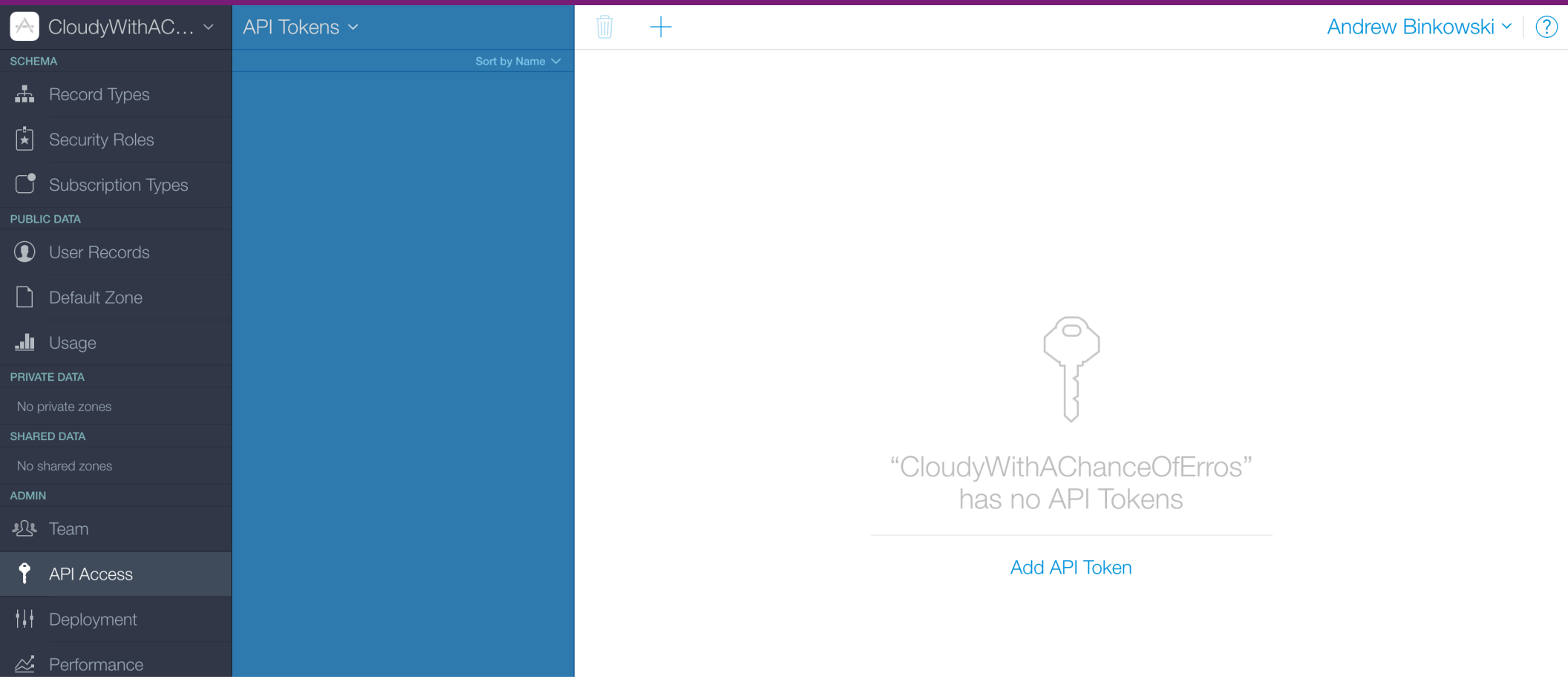
- Public and private database access
- Record operations
- Assets
- Query
- Subscriptions and notifications
- User discoverability
- Sync

WEB SERVICES

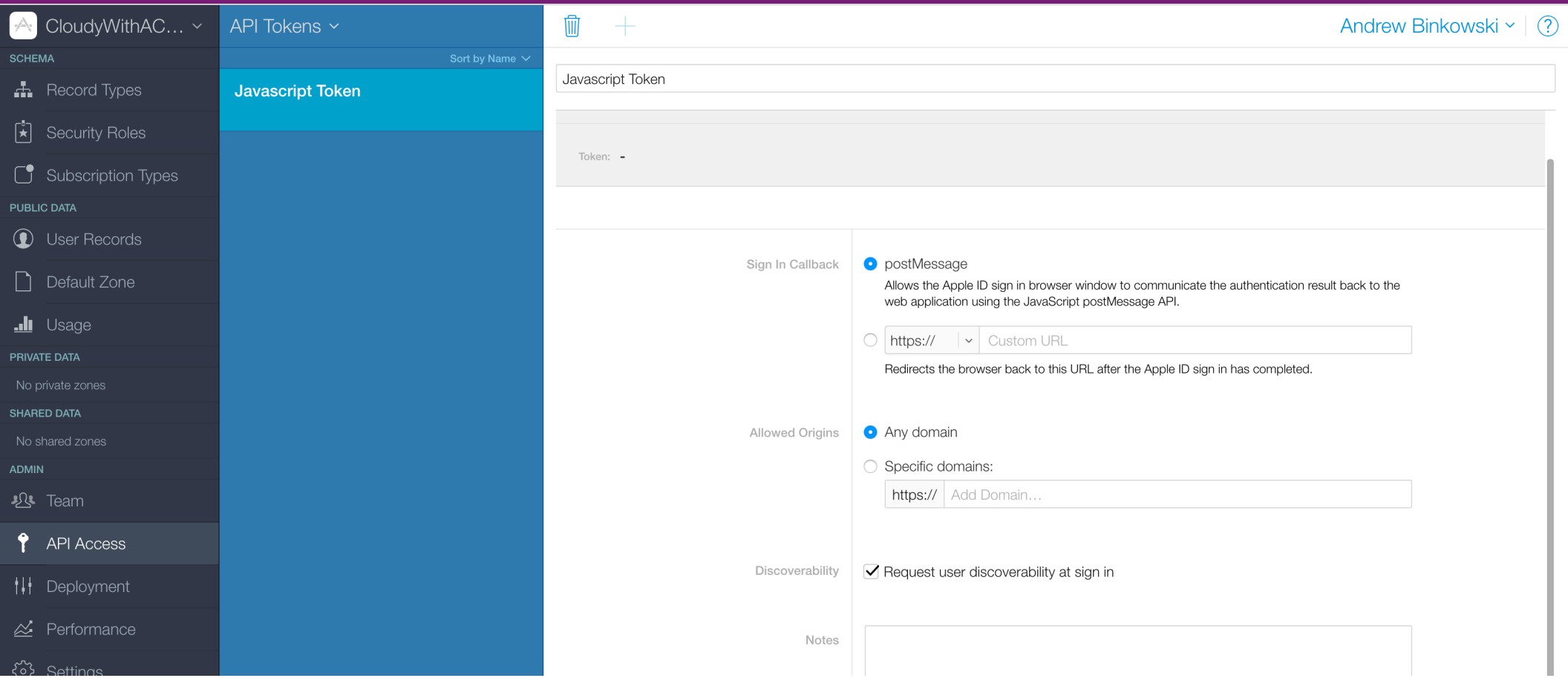
- New server-to-server capabilities
- Add servers to cover the areas that cloud kit doesn't cover



CLOUDKIT JS


CloudyWithAC…
API Tokens
Sort by Name
Andrew Binkowski
SCHEMA
Record Types
Security Roles
Subscription Types
PUBLIC DATA
User Records
Default Zone
Usage
PRIVATE DATA
No private zones
SHARED DATA
No shared zones
ADMIN
Team
API Access
Deployment
Performance
"CloudyWithAChanceOfErros"
has no API Tokens
Add API Token

CLOUDKIT JS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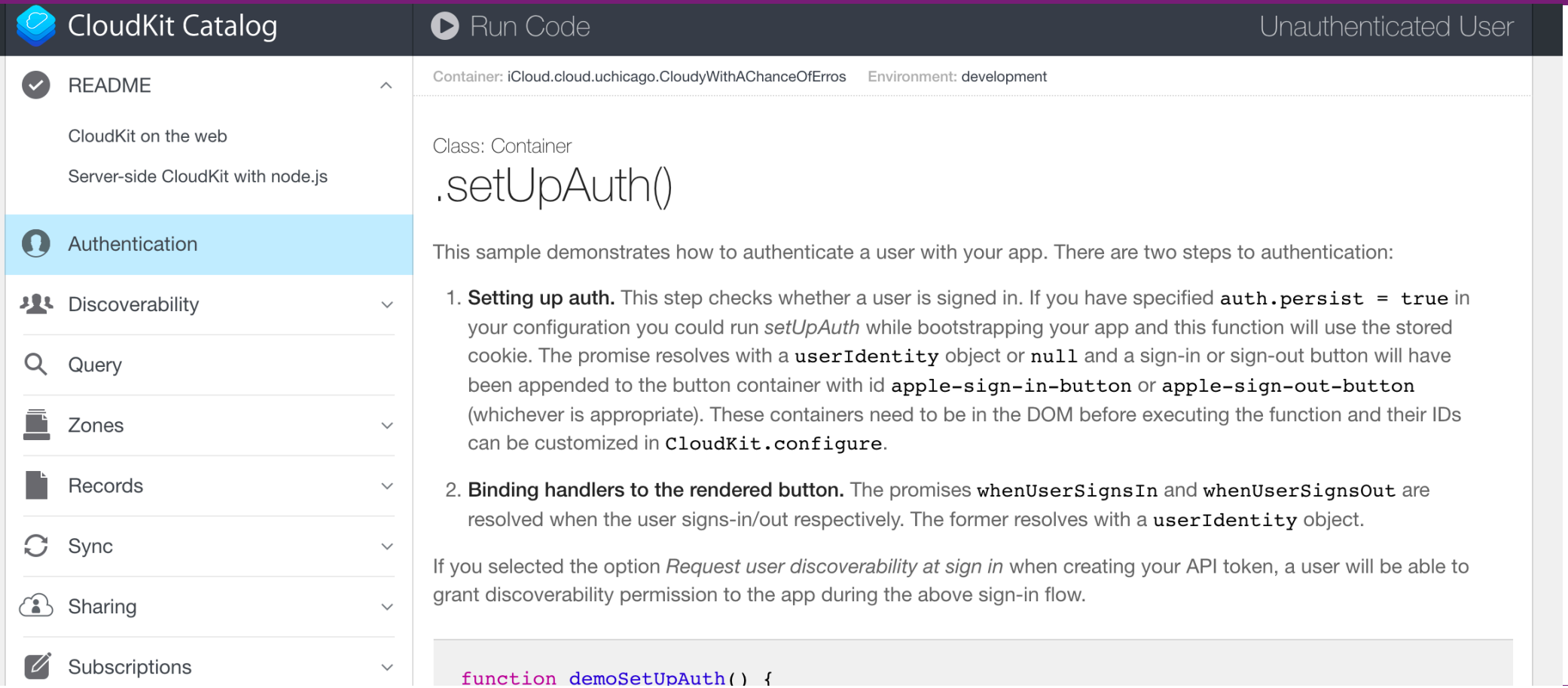
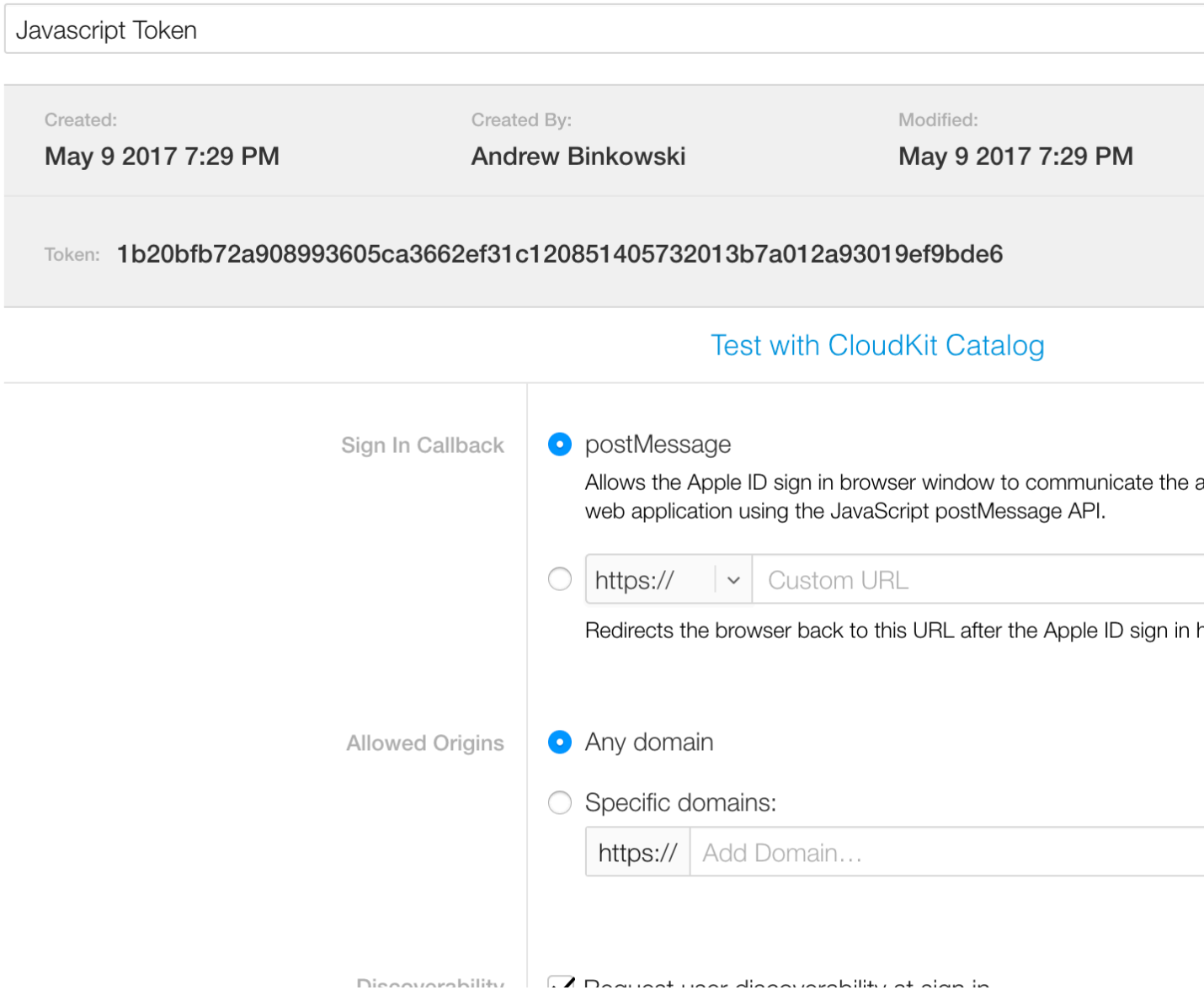
API Access
Deployment
Performance
Settings
Javascript Token
Token: -
Sign In Callback
postMessage
Allows the Apple ID sign in browser window to communicate the authentication result back to the web application using the JavaScript postMessage API.
https://
Custom URL
Redirects the browser back to this URL after the Apple ID sign in has completed.
Allowed Origins
Any domain
Specific domains:
https://
Add Domain…
Discoverability
Request user discoverability at sign in
Notes

CLOUDKIT JS


CloudKit Catalog
Run Code
Unauthenticated User
README
CloudKit on the web
Server-side CloudKit with node.js
Authentication
Discoverability
Query
Zones
Records
Sync
Sharing
Subscriptions
Container: iCloud.cloud.uchicago.CloudyWithAChanceOfErros
Environment: development
Class: Container
.setUpAuth()
This sample demonstrates how to authenticate a user with your app. There are two steps to authentication:
1. Setting up auth. This step checks whether a user is signed in. If you have specified auth.persist = true in your configuration you could run setUpAuth while bootstrapping your app and this function will use the stored cookie. The promise resolves with a userIdentity object or null and a sign-in or sign-out button will have been appended to the button container with id apple-sign-in-button or apple-sign-out-button (whichever is appropriate). These containers need to be in the DOM before executing the function and their IDs can be customized in CloudKit.configure.
2. Binding handlers to the rendered button. The promises whenUserSignsIn and whenUserSignsOut are resolved when the user signs-in/out respectively. The former resolves with a userIdentity object.
If you selected the option Request user discoverability at sign in when creating your API token, a user will be able to grant discoverability permission to the app during the above sign-in flow.
function demoSetUpAuth() {

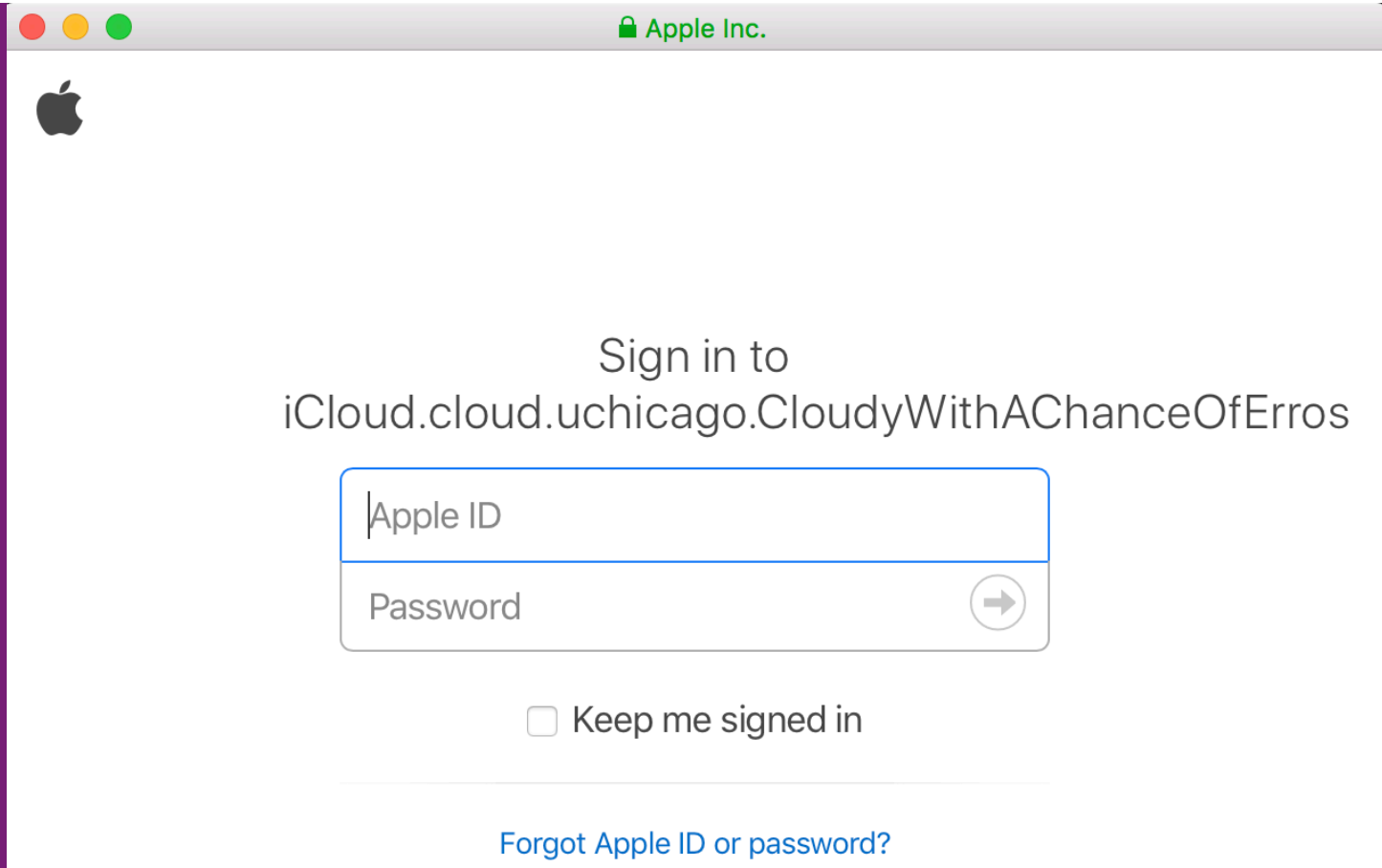
CLOUDKIT JS

- Token is used to communicate with iCloud



CLOUDKIT JS

- Authentication happens with Apple provided UI



CLOUDKIT JS

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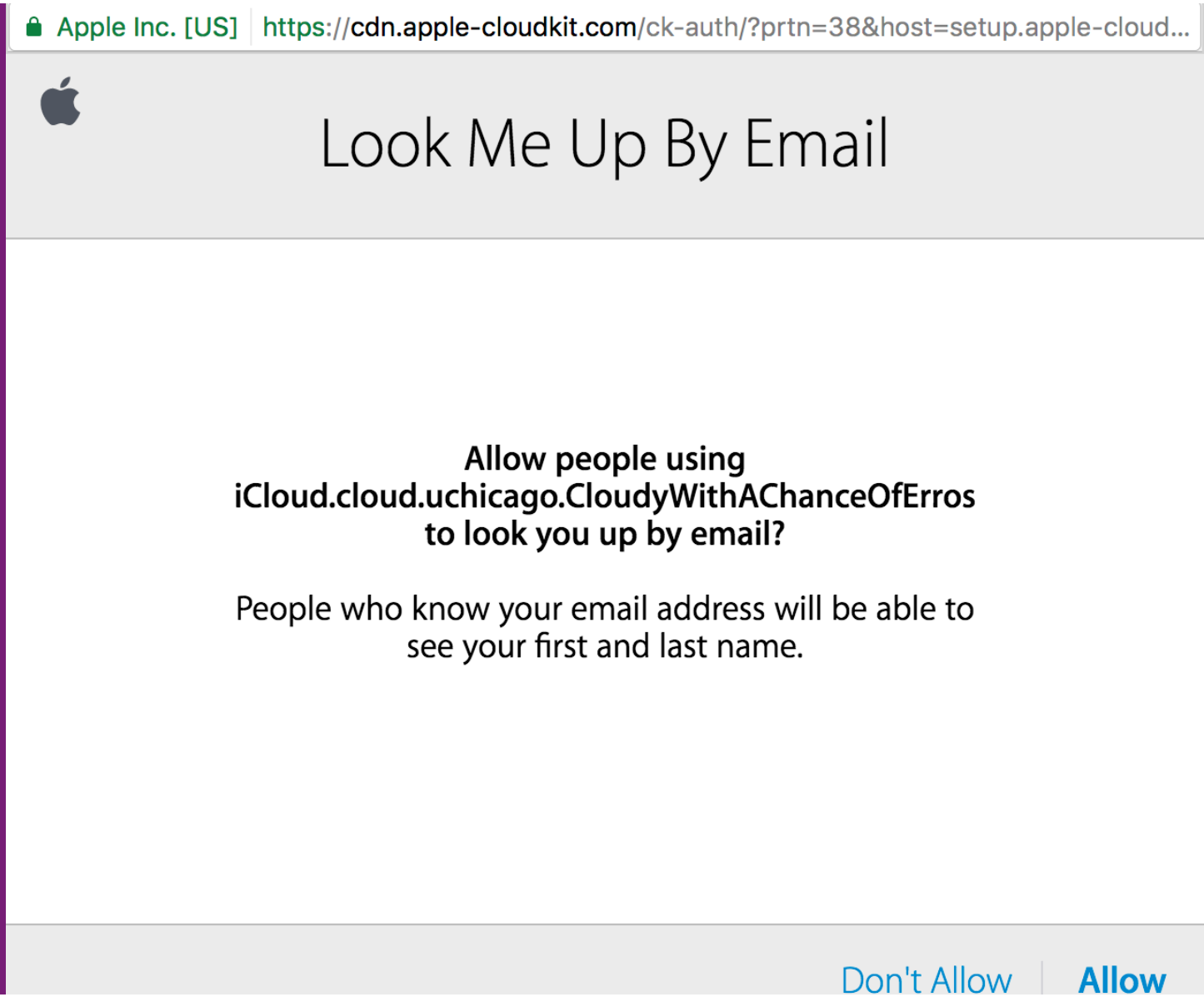

CLOUDKIT JS

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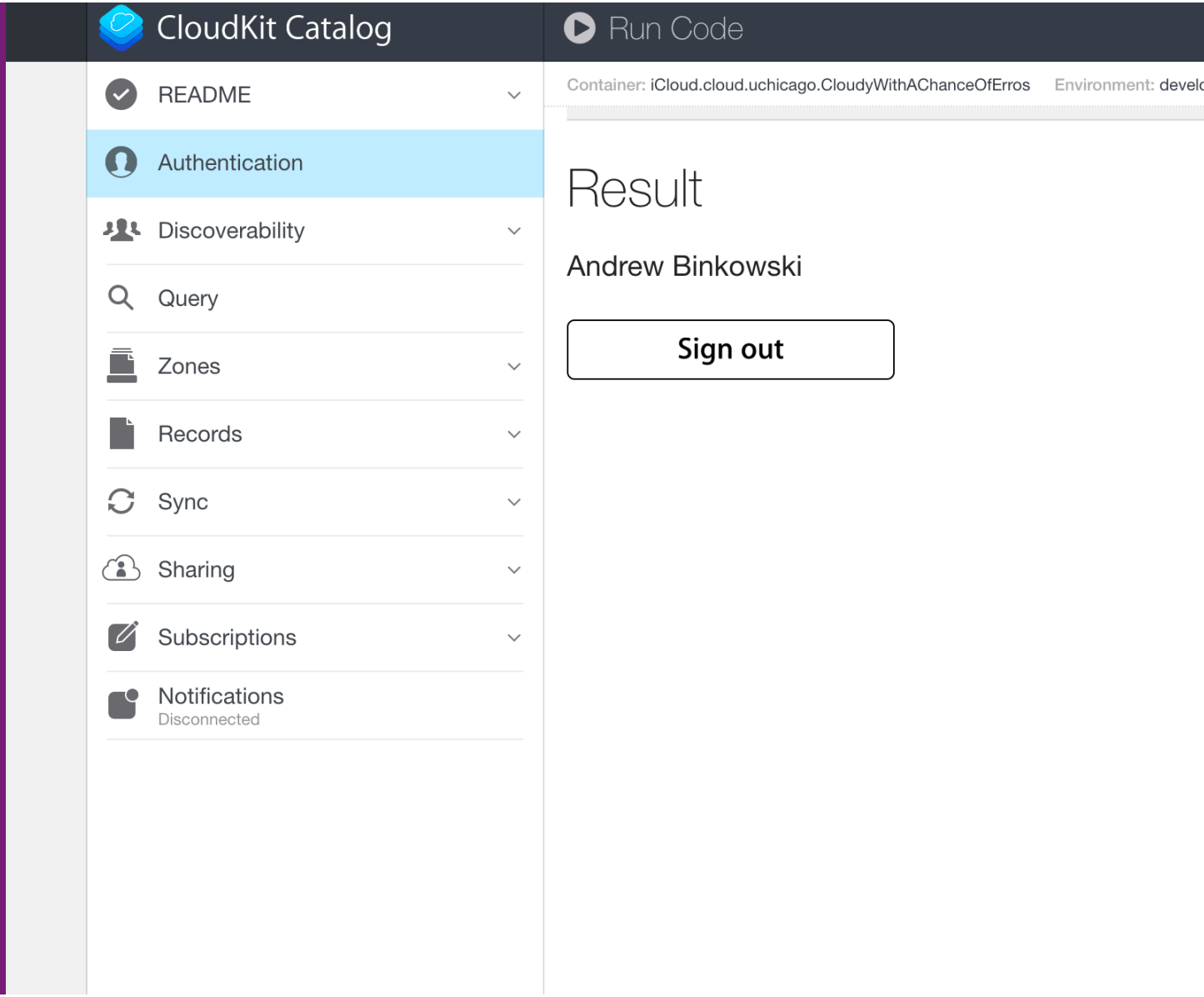


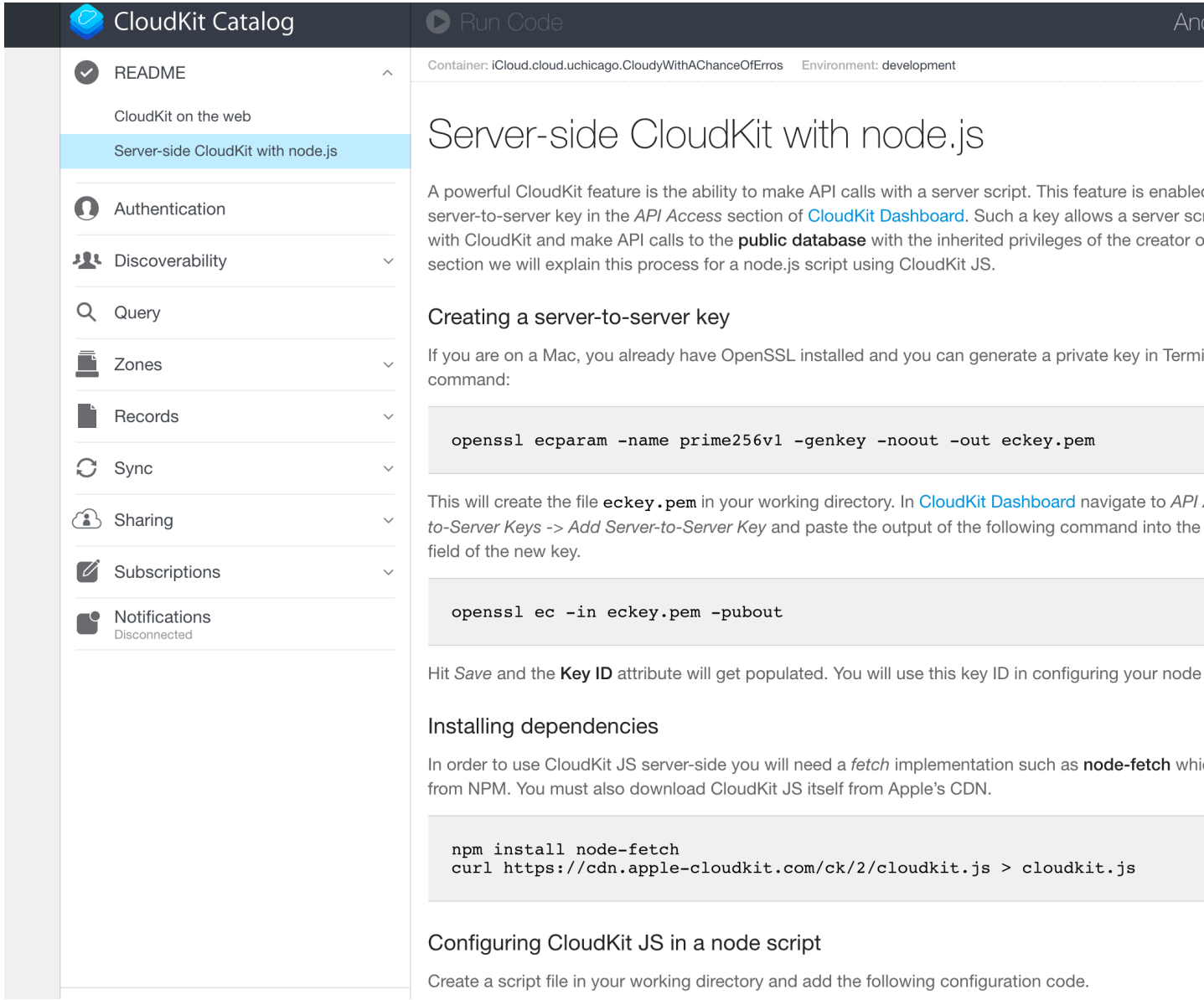
SERVER-TO-SERVER WITH CLOUDIKIT

SERVER-TO-SERVER

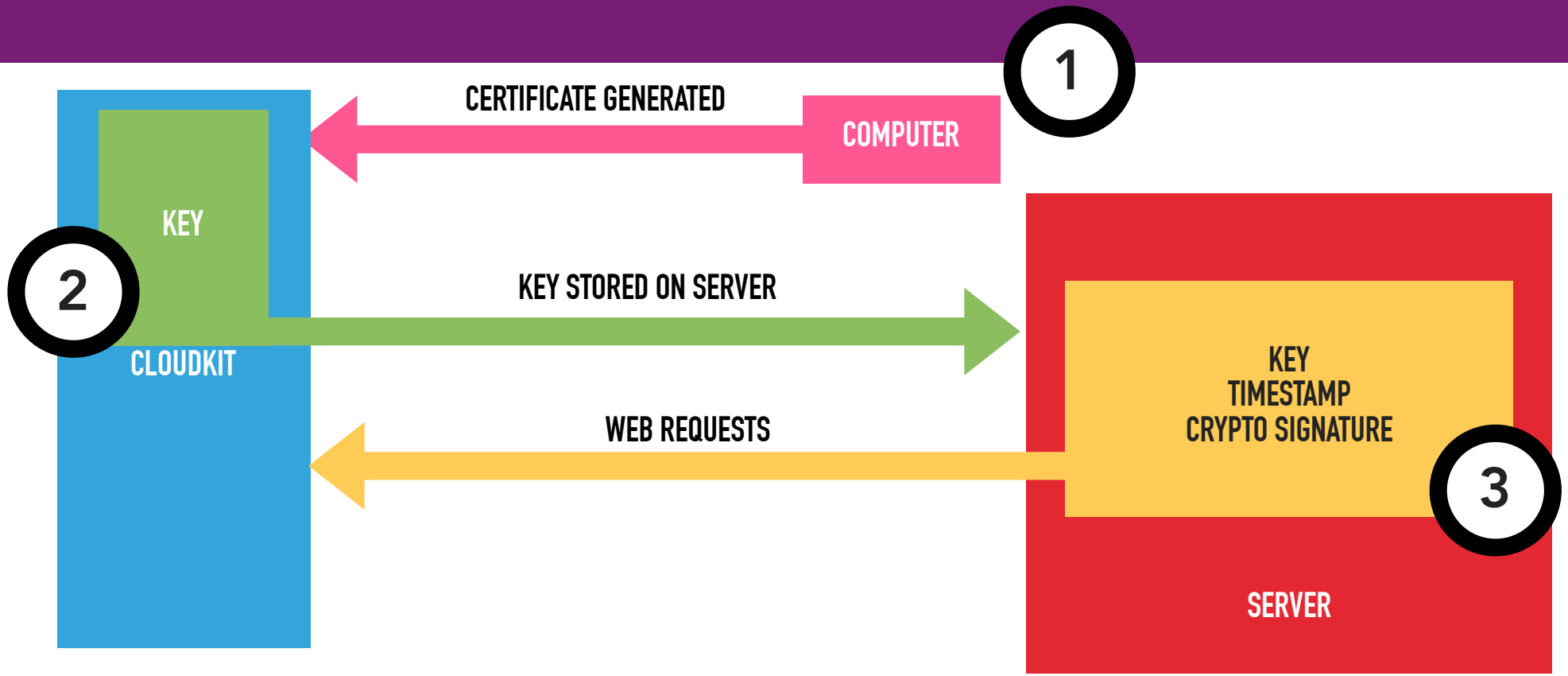
- Late 2016 Apple opened server-to-server communication
- Allows a server to communicate with CloudKit
- The missing link in data processing and server side logic

SERVER-TO-SERVER

- Apple provides demo



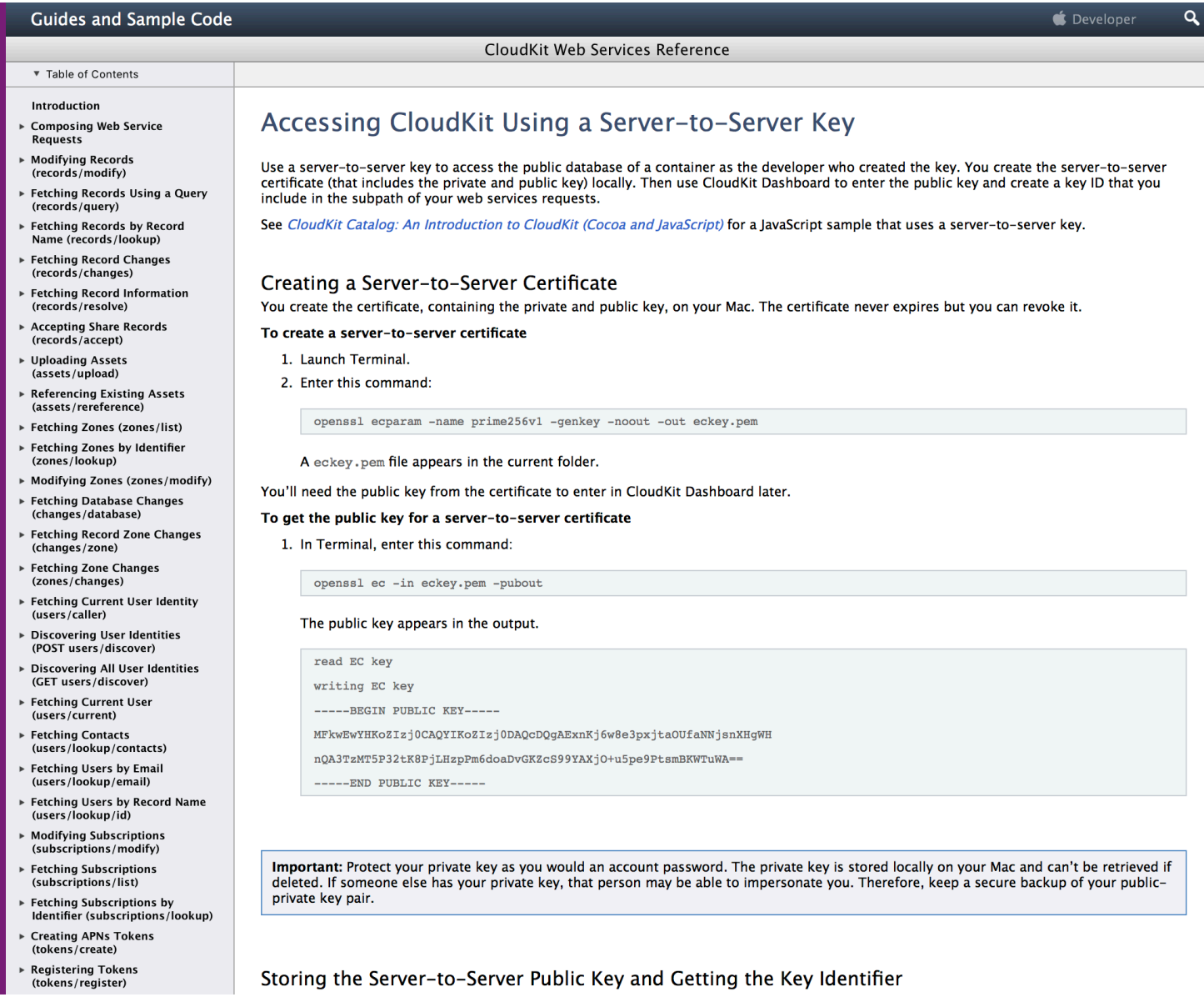
SERVER-TO-SERVER



SERVER-TO-SERVER KEY

SERVER-TO-SERVER KEY

- Create a public/private key pair to communicate with the iCloud servers



Guides and Sample Code

Developer

CloudKit Web Services Reference

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Accessing CloudKit Using a Server-to-Server Key

Use a server-to-server key to access the public database of a container as the developer who created the key. You create the server-to-server certificate (that includes the private and public key) locally. Then use CloudKit Dashboard to enter the public key and create a key ID that you include in the subpath of your web services requests.

See *CloudKit Catalog: An Introduction to CloudKit (Cocoa and JavaScript)* for a JavaScript sample that uses a server-to-server key.

Creating a Server-to-Server Certificate

You create the certificate, containing the private and public key, on your Mac. The certificate never expires but you can revoke it.

To create a server-to-server certificate

1. Launch Terminal.
2. Enter this command:

```
openssl ecparam -name prime256v1 -genkey -noout -out eckey.pem
```

A `eckey.pem` file appears in the current folder.

You'll need the public key from the certificate to enter in CloudKit Dashboard later.

To get the public key for a server-to-server certificate

1. In Terminal, enter this command:

```
openssl ec -in eckey.pem -pubout
```

The public key appears in the output.

```
read EC key
writing EC key
-----BEGIN PUBLIC KEY-----
MFkwEwYHKoZIzj0CAQYIKoZIzj0DAQcDQgAExnKj6w8e3pxjtaOUfaNNjsnXHgWH
nQA3TzMT5P32tK8PjLHzpPm6doaDvGKZcS99YAXjO+u5pe9PtsmBKWTuWA==
-----END PUBLIC KEY-----
```

Important: Protect your private key as you would an account password. The private key is stored locally on your Mac and can't be retrieved if deleted. If someone else has your private key, that person may be able to impersonate you. Therefore, keep a secure backup of your public-private key pair.

Storing the Server-to-Server Public Key and Getting the Key Identifier

SERVER-TO-SERVER KEY

- https://developer.apple.com/library/content/documentation/DataManagement/Conceptual/CloudKitWebServicesReference/SettingUpWebServices/SettingUpWebServices.html#//apple_ref/doc/uid/TP40015240-CH24-SW6

Accessing CloudKit Using a Server-to-Server Key

Use a server-to-server key to access the public database of a container as the developer who created the key. You create the server-to-server certificate (that includes the private and public key) locally. Then use CloudKit Dashboard to enter the public key and create a key ID that you include in the subpath of your web services requests.

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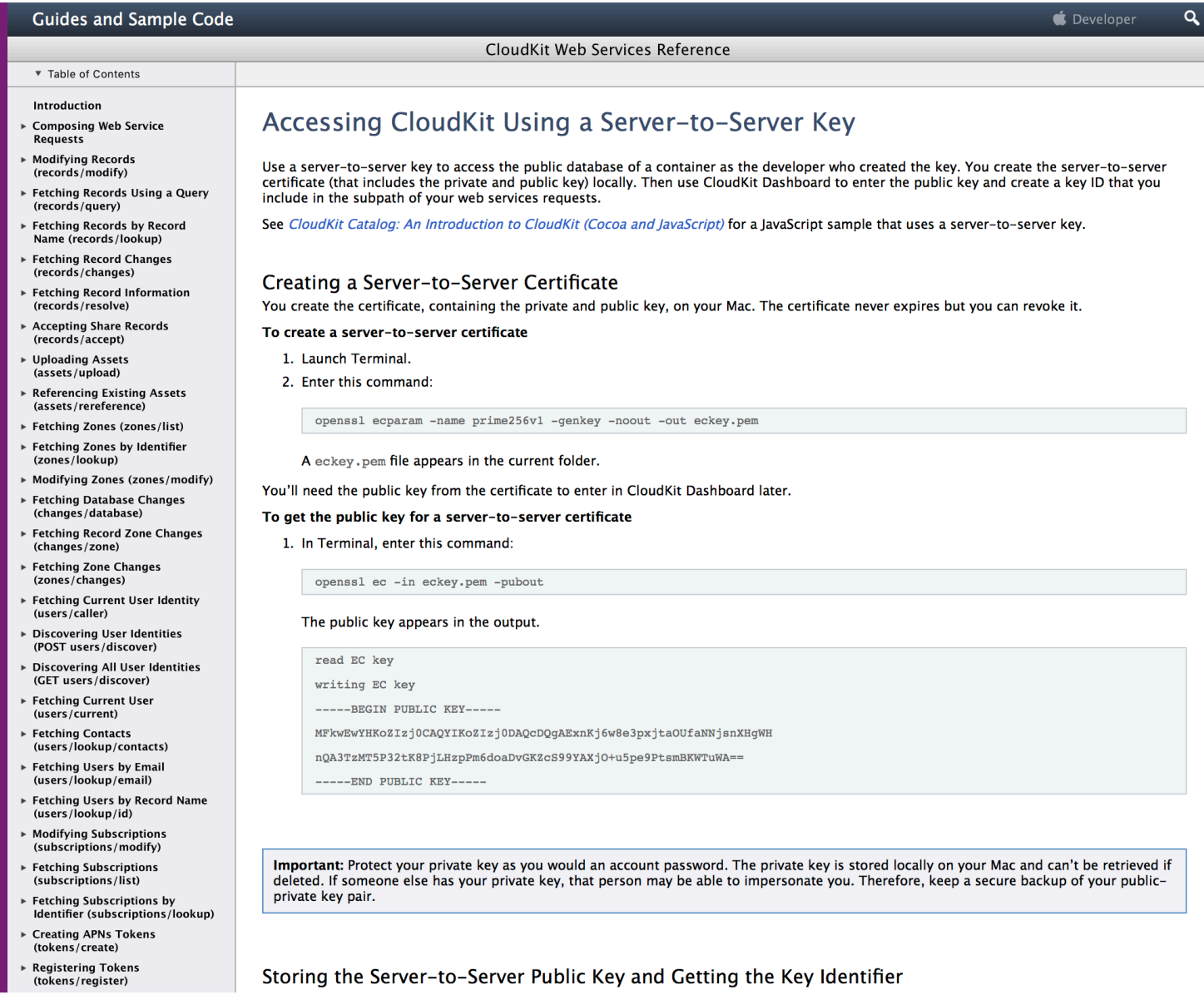
Storing the Server-to-Server Public Key and Getting the Key Identifier

SERVER-TO-SERVER KEY

- Protect your key
  - Back it up
  - Don't post on GitHub
- Can be revoked



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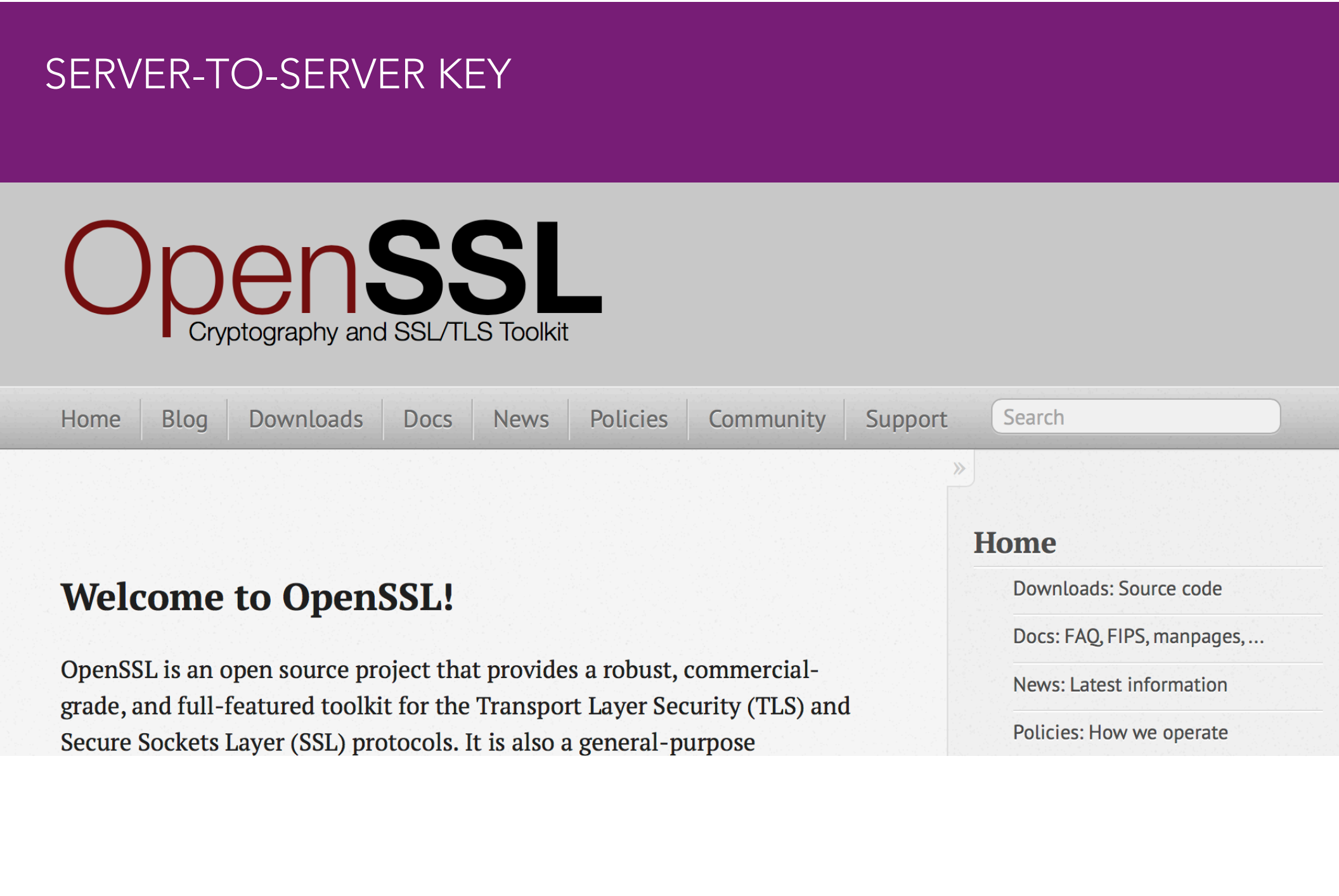
Storing the Server-to-Server Public Key and Getting the Key Identifier

SERVER-TO-SERVER KEY

- Create the server-to-server certificate
- A eckey.pem file will be generated

SERVER-TO-SERVER KEY



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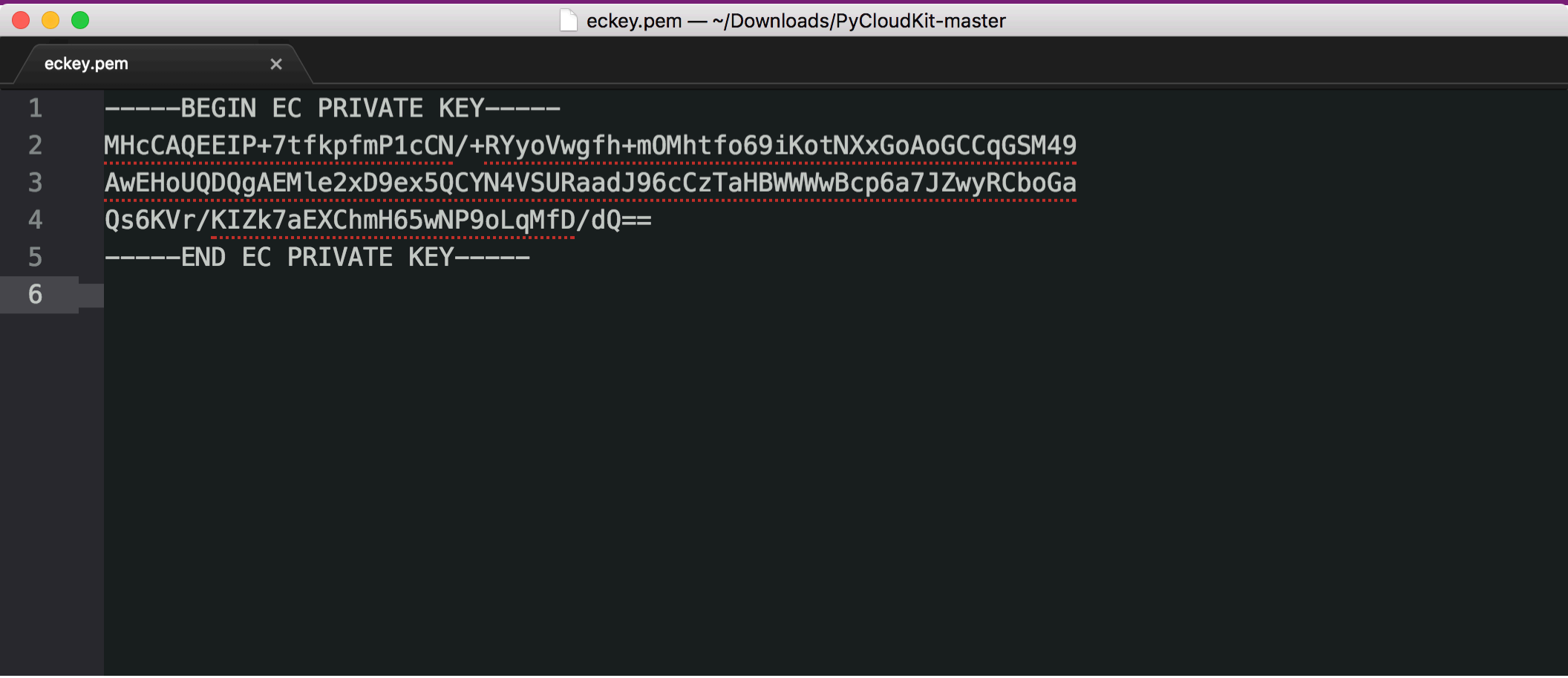
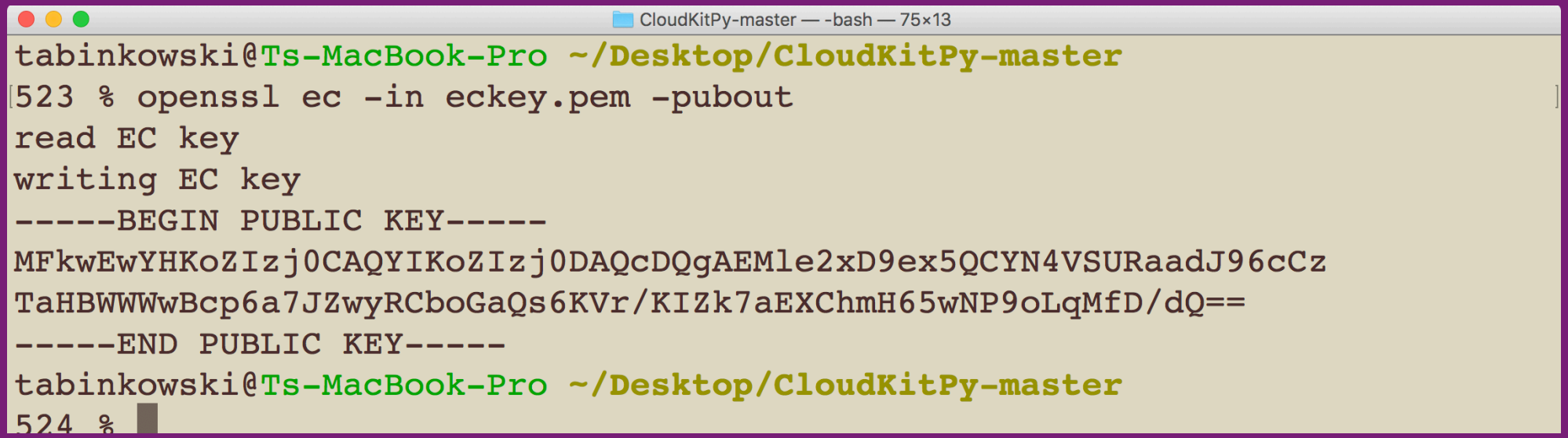
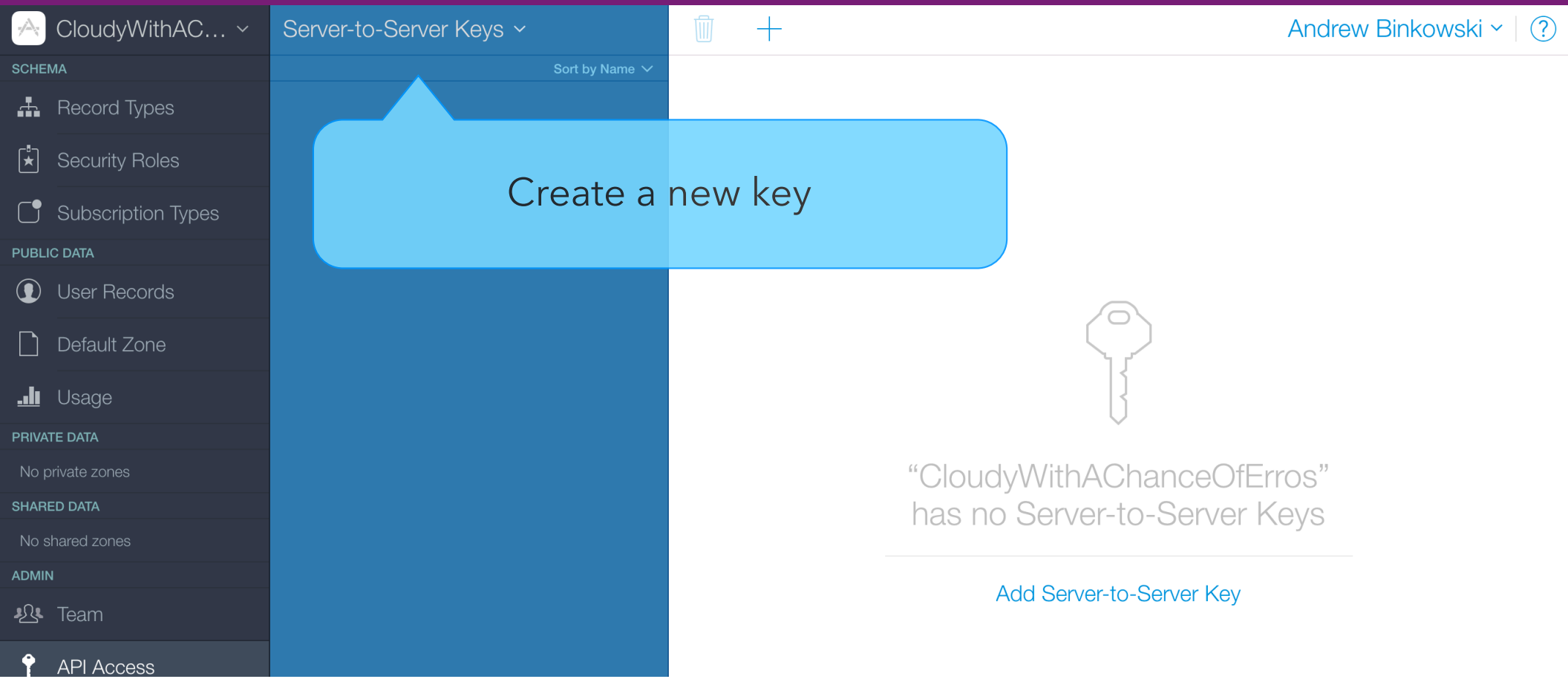


SERVER-TO-SERVER KEY



- Generate the public key
- Enter in CloudKit console

SERVER-TO-SERVER KEY



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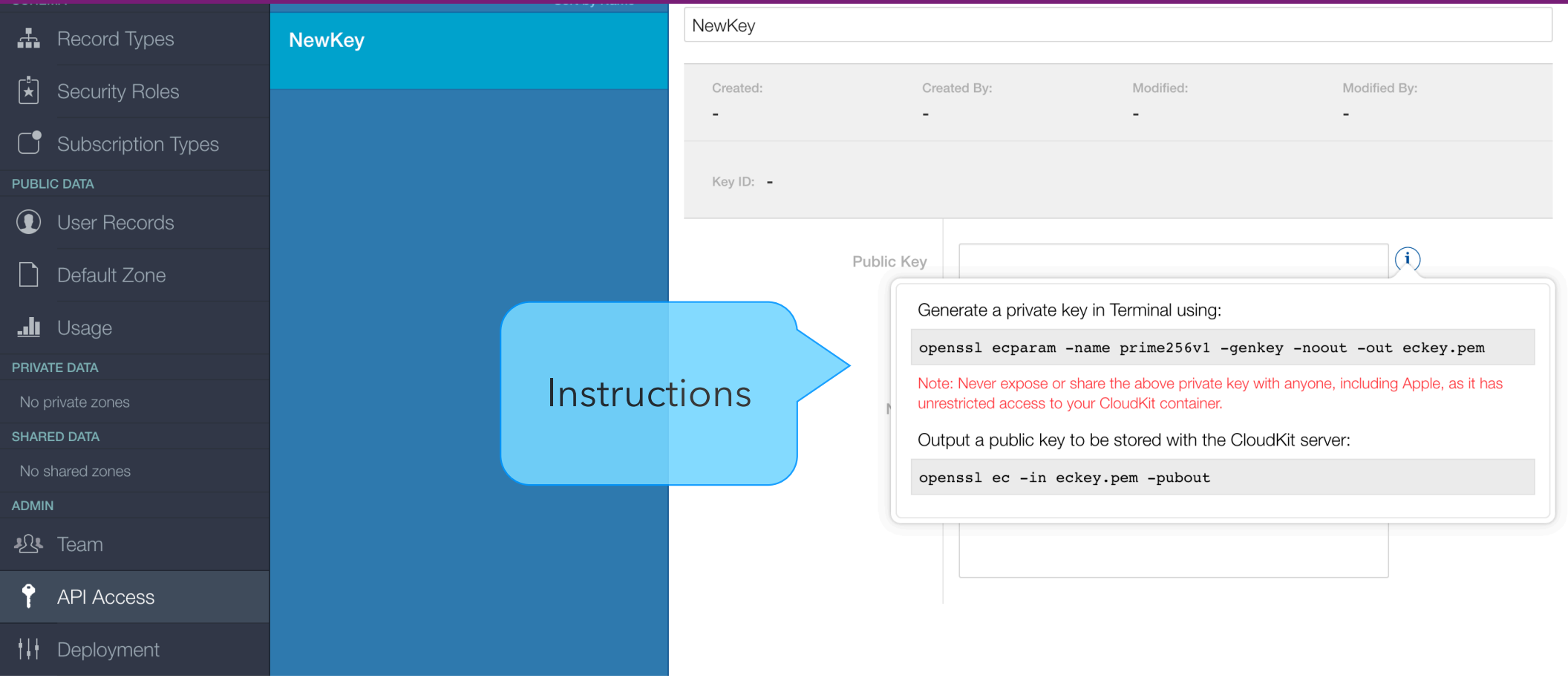

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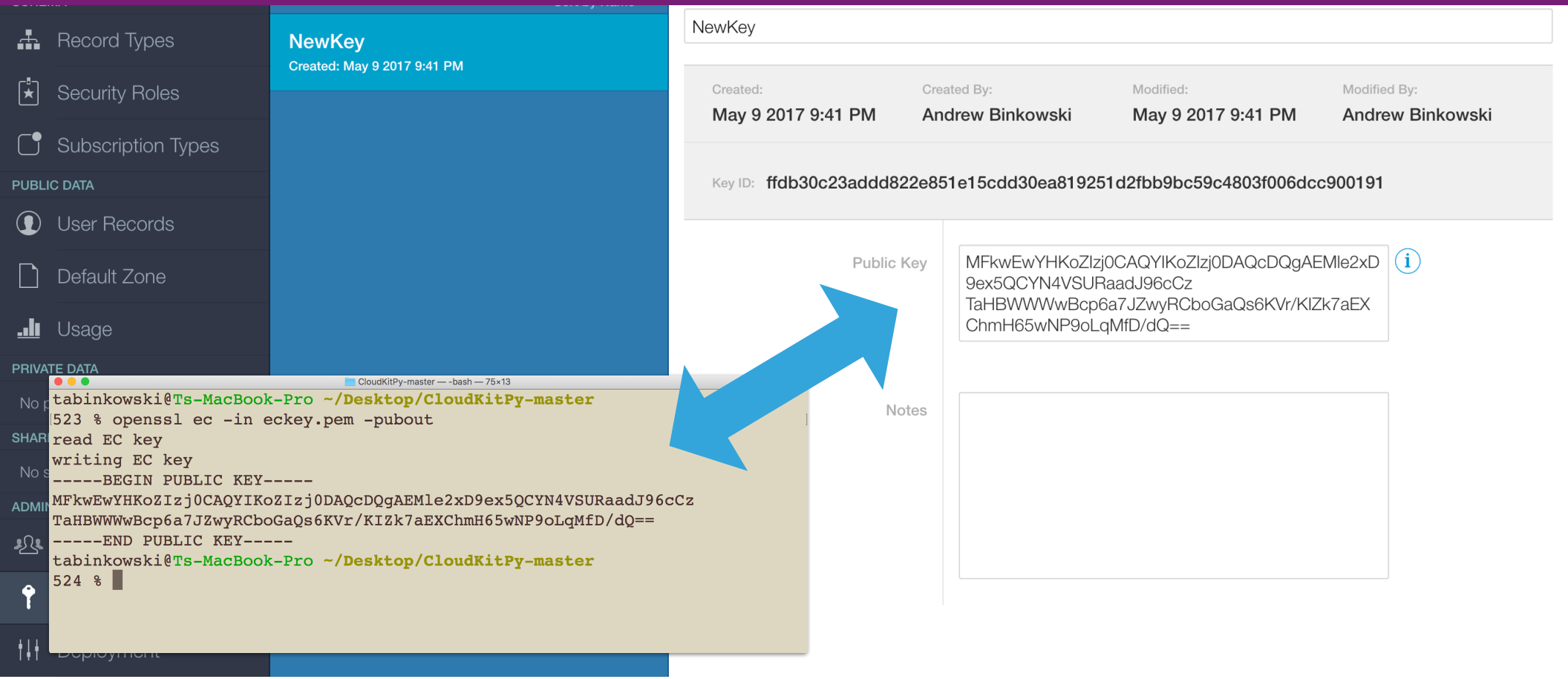


WEB SERVICE REQUESTS

WEB SERVICE REQUESTS

- When using a server-to-server key, you sign the web service request
- Key is authentication only developer allowed access

To create a signed request using the server-to-server certificate in your keychain

1. Concatenate the following parameters and separate them with colons.

```
[Current date]:[Request body]:[Web service URL subpath]
```

Current date
The ISO8601 representation of the current date (without milliseconds)—for example, `2016-01-25T22:15:`

Request body
The base64 string encoded SHA-256 hash of the body.

Web service URL subpath
The URL described in The Web Service URL but without the `[path]` component, as in:

```
/database/1/iCloud.com.example.gkumar.MyApp/development/public/records/query
```

Note: If you include the API token subpath, described in Accessing CloudKit Using an API Token, the requ

2. Compute the ECDSA signature of this message with your private key.
3. Add the following request headers.

```
X-Apple-CloudKit-Request-KeyID: [keyID]
X-Apple-CloudKit-Request-ISO8601Date: [date]
X-Apple-CloudKit-Request-SignatureV1: [signature]
```

keyID
The identifier for the server-to-server key obtained from CloudKit Dashboard, described in Storing the Ser
Getting the Key Identifier.

date
The ISO8601 representation of the current date (without milliseconds).

signature
The signature created in Step 2.

WEB SERVICE REQUESTS

- All requests must have proper headers
- Only valid for 10 minutes

```
X-Apple-CloudKit-Request-KeyID: [keyID]

X-Apple-CloudKit-Request-ISO8601Date: [date]

X-Apple-CloudKit-Request-SignatureV1: [signature]
```

keyID
The identifier for the server-to-server key obtained from CloudKit Da
Getting the Key Identifier.

date
The ISO8601 representation of the current date (without milliseconds)

signature
The signature created in Step 2.

WEB SERVICE REQUESTS

Query

```
URL:
https://api.apple-cloudkit.com/database/1/
iCloud.cloud.uchicago.CloudyWithAChanceOfErros/development/
public/records/query

Data:  {"query": {"recordType": "joke"}}

Headers:  {
'X-Apple-CloudKit-Request-ISO8601Date': '2017-05-10T04:33:33Z',
'X-Apple-CloudKit-Request-SignatureV1':u'MEUCIQ...TfA=',
'X-Apple-CloudKit-Request-KeyID':'ffdb30c23add...00191'}
```

WEB SERVICE REQUESTS

Added new endpoints:

- **records/resolve:** Fetches information about records using GUIDs, described in Fetching Record Information (records/resolve).
- **records/accept:** Accepts a share on behalf of the current user, described in Accepting Share Records (records/accept).
- **changes/database:** Fetches changed zones in a database, described in Fetching Database Changes (changes/database).
- **changes/zone:** Fetches changed records in the specified zones, described in Fetching Record Zone Changes (changes/zone).
- **users/caller:** Fetches information about the current user, described in Fetching Current User (users/current).
- **GET users/discover:** Fetches all user identities in the current user's address book, described in Discovering All User Identities (GET users/discover).
- **POST users/discover:** Fetches all users in the specified array, described in Discovering User Identities (POST users/discover).

Updated endpoints to support sharing records:

- **records/changes:** Added `shared` as database value, described in Fetching Record Changes (records/changes).
- **records/modify:** Added `shared` as database value, described in Modifying Records (records/modify).
- **records/lookup:** Added `shared` as database value, described in Fetching Records by Record Name (records/lookup).
- **records/query:** Added `shared` as database value, described in Fetching Records Using a Query (records/query).

- API Endpoints for CloudKit

QUERY

WEB SERVICE REQUESTS

- API for fetching records

Fetching Records Using a Query (records/query)

You can fetch records using a query.

Path

```
POST [path]/database/[version]/[container]/[environment]/[database]/records/query
```

Parameters

path
The URL to the CloudKit web service, which is `https://api.apple-cloudkit.com`.

version
The protocol version—currently, 1.

container
A unique identifier for the app's container. The container ID should begin with `iCloud.`.

environment
The version of the app's container. Pass `development` to use the environment that is not accessible by apps available on the store. environment that is accessible by development apps and apps available on the store.

database
The database to store the data within the container. The possible values are:

`public`
The database that is accessible to all users of the app.

`private`
The database that contains private data that is visible only to the current user.

`shared`
The database that contains records shared with the current user.

WEB SERVICE REQUESTS

Request

The POST request is a JSON dictionary containing the following keys:

Key	Description
`zoneID`	A dictionary that identifies a record zone in the database, described in Zone ID Dictionary.
`resultsLimit`	The maximum number of records to fetch. The default is the maximum number of records in a response that is allowed, described in Data Size Limits.
`query`	The query to apply, described in Query Dictionary. This key is required.
`continuationMarker`	The location of the last batch of results. Use this key when the results of a previous fetch exceeds the maximum. See Response. The default value is `null`.
`desiredKeys`	An array of strings containing record field names that limits the amount of data returned in this operation. Only the fields specified in the array are returned. The default is `null`, which fetches all record fields.
`zoneWide`	A Boolean value determining whether all zones should be searched. This key is ignored if `zoneID` is non-`null`. To search all zones, set to `true`. To search the default zone only, set to `false`.
`numbersAsStrings`	A Boolean value indicating whether number fields should be represented by strings. The default value is `false`.

- POST request consists of a JSON dictionary

WEB SERVICE REQUESTS

- Example query

```
"{
  "zoneID": {
    "zoneName": "myCustomZone",
  },
  "query": {
    "recordType": "myRecordType",
    "filterBy": [
      {
        "systemFieldName": "createdUserRecordName",
        "comparator": "EQUALS",
        "fieldValue": {
          "value": {
            "recordName": "recordA",
          },
          "type": "REFERENCE"
        }
      }
    ],
    "sortBy": [
      {
        "systemFieldName": "createdTimestamp",
        "ascending": false
      }
    ]
  }
}"
```

WEB SERVICE REQUESTS

- Example query

Record Operation Dictionary

The operation dictionary keys are:

Key	Description
`operationType`	The type of operation. Possible values are described in Operation Type Values. This key is required.
`record`	A dictionary representing the record to modify, as described in Record Dictionary. This key is required.
`desiredKeys`	An array of strings containing record field names that limits the amount of data returned in this operation. Only the fields specified in the array are returned. The default is `null`, which fetches all record fields. This `desiredKeys` setting overrides the `desiredKeys` setting in the enclosing dictionary.

Operation Type Values

The possible values for the `operationType` key are:

Value	Description
`create`	Create a new record. This operation fails if a record with the same record name already exists.
`update`	Update an existing record. Only the fields you specify are changed.
`forceUpdate`	Update an existing record regardless of conflicts. Creates a record if it doesn't exist.
`replace`	Replace a record with the specified record. The fields whose values you do not specify are set to `null`.
`forceReplace`	Replace a record with the specified record regardless of conflicts. Creates a record if it doesn't exist.
`delete`	Delete the specified record.
`forceDelete`	Delete the specified record regardless of conflicts.

WEB SERVICE REQUESTS

Response

An array of dictionaries describing the results of the operation. The dictionary contains the following keys:

Key	Description
`records`	An array containing a result dictionary for each record requested. If successful, the result dictionary contains the keys described in Record Dictionary. If unsuccessful, the result dictionary contains the keys described in Record Fetch Error Dictionary.
`continuationMarker`	If included, indicates that there are more results matching this query. To fetch the other results, pass the value of the `continuationMarker` key as the value of the `continuationMarker` key in another query.

- Response contains dictionary of records
- Returned results are limited by data (unless specified)

WEB SERVICE REQUESTS

- Returned results are limited by data (unless specified by the `resultsLimit` key in request)

Data Size Limits

These are the limits on the size of data sent to and from the CloudKit server.

Property	Value
Maximum number of operations in a request	200
Maximum number of records in a response	200
Maximum number of tokens in a request	200
Maximum record size (not including Asset fields)	1 MB
Maximum file size of an Asset field	50 MB
Maximum number of source references to a single target where the action is delete self	750

WEB SERVICE REQUESTS

Query

```
URL:
https://api.apple-cloudkit.com/database/1/
iCloud.cloud.uchicago.CloudyWithAChanceOfErros/development/
public/records/query

Data:  {"query": {"recordType": "joke"}}

Headers:  {
'X-Apple-CloudKit-Request-ISO8601Date': '2017-05-10T04:33:33Z',
'X-Apple-CloudKit-Request-SignatureV1':u'MEUCIQ...TfA=',
'X-Apple-CloudKit-Request-KeyID':'ffdb30c23add...00191'}
```

MODIFY RECORDS

WEB SERVICE REQUESTS

- Apply multiple types of operations
  - Creating
  - Updating
  - Replacing
  - Deleting
- Multiple records can be modified in a single request

Path

```
POST [path]/database/[version]/[container]/[environment]/[database]/records/modify
```

Parameters

path
The URL to the CloudKit web service, which is `https://api.apple-cloudkit.com`.

version
The protocol version—currently, 1.

container
A unique identifier for the app's container. The container ID begins with `iCloud.`.

environment
The version of the app's container. Pass `development` to use the environment that is not accessible by apps available on the store. environment that is accessible by development apps and apps available on the store.

database
The database to store the data within the container. The possible values are:

`public`
The database that is accessible to all users of the app.

`private`
The database that contains private data that is visible only to the current user.

`shared`
The database that contains records shared with the current user.

WEB SERVICE REQUESTS

Key	Description
`operations`	An array of dictionaries defining the operations to apply to records in the database. The dictionary keys are described in Record Operation Dictionary. See Data Size Limits for maximum number of operations allowed. This key is required.
`zoneID`	A dictionary that identifies a record zone in the database, described in Zone ID Dictionary.
`atomic`	A Boolean value indicating whether the entire operation fails when one or more operations fail. If `true`, the entire request fails if one operation fails. If `false`, some operations may succeed and others may fail. The default value is `true`. Note this property only applies to custom zones.
`desiredKeys`	An array of strings containing record field names that limit the amount of data returned in the enclosing operation dictionaries. Only the fields specified in the array are returned. The default is `null`, which fetches all record fields.
`numbersAsStrings`	A Boolean value indicating whether number fields should be represented by strings. The default value is `false`.

- POST request consists of a JSON dictionary

WEB SERVICE REQUESTS

```
{
    "operationType" : "create",
    "record" : {
        "recordType" : "Artist",
        "fields" : {
            "firstName" : {"value" : "Mei"},
            "lastName" : {"value" : "Chen"}
        }
        "recordName" : "Mei Chen"
    },
}
```

Your custom fields

Omit recordName and it will be automatically generated

- POST request consists of a JSON dictionary
- Schema is not on-demand for JS API

WEB SERVICE REQUESTS

Add a record

```
URL:  https://api.apple-cloudkit.com/database/1/
iCloud.cloud.uchicago.CloudyWithAChanceOfErros/development/
public/records/modify

Data:  {"operations": [{"record": {"fields": {"joke": {"value":
{"recordName": "60d82b7d-32ef-4e91-9c12-585c92a3bb89",
"action": "DELETE_SELF", "zoneID:": {"zoneName":
"_defaultZone"}}}}, "day": {"value": "today"}}, "recordType":
"Daily"}, "operationType": "create"}]}

Headers:  {
'X-Apple-CloudKit-Request-ISO8601Date': '2017-05-10T04:33:33Z',
'X-Apple-CloudKit-Request-SignatureV1':u'MEUCIQ...TfA=',
'X-Apple-CloudKit-Request-KeyID':'ffdb30c23add...00191'}
```

WEB SERVICE REQUESTS

Response

The response is an array of dictionaries describing the results of the operation. The dictionary contains a single key:

Key	Description
`records`	An array containing a result dictionary for each operation in the request. If successful, the result dictionary contains the keys described in Record Dictionary. If unsuccessful, the result dictionary contains the keys described in Record Fetch Error Dictionary.

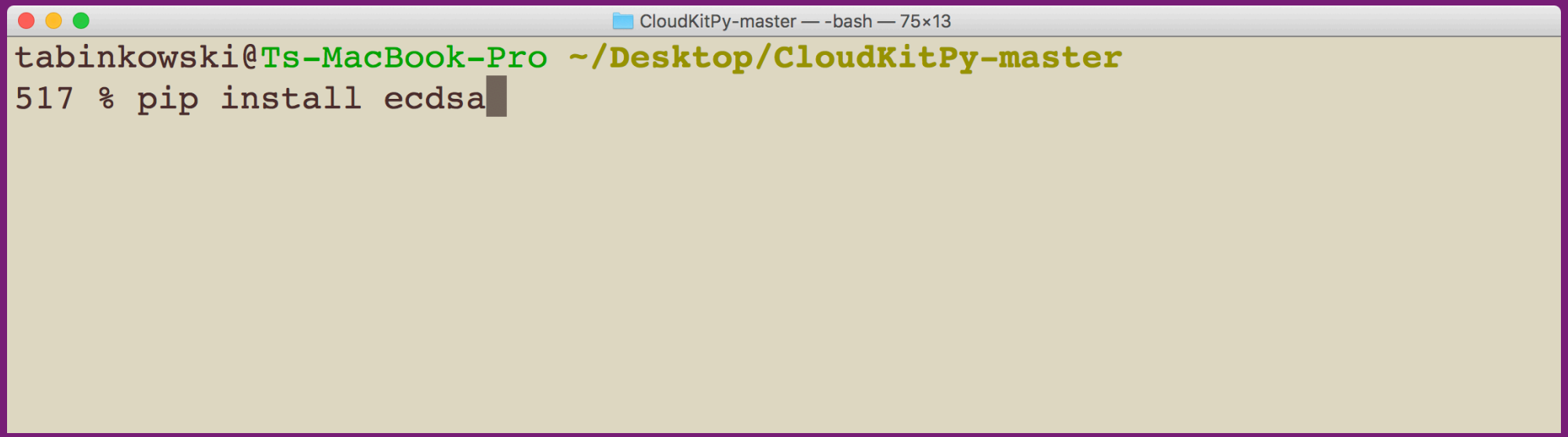
- Response is a dictionary with more information than you probably need

WEB SERVICE REQUESTS

- Response dictionary


```
{
    "created": {
        "deviceID": "2",
        "timestamp": 1494288550303,
        "userRecordName": "_7b892f2a3eeaddd6afc77ff7158f69d9"
    },
    "fields": {
        "question": {
            "type": "STRING",
            "value": "Why?\n"
        },
        "response": {
            "type": "STRING",
            "value": "That's why!"
        }
    },
    "modified": {
        "deviceID": "2",
        "timestamp": 1494386749697,
        "userRecordName": "_7b892f2a3eeaddd6afc77ff7158f69d9"
    },
    "pluginFields": {},
    "recordChangeTag": "j2gstkiq",
    "recordName": "60d82b7d-32ef-4e91-9c12-585c92a3bb89",
    "recordType": "joke",
    "zoneID": {
        "ownerRecordName": "_7b892f2a3eeaddd6afc77ff7158f69d9",
        "zoneName": "_defaultZone"
    }
```

SERVER-TO-SERVER KEY



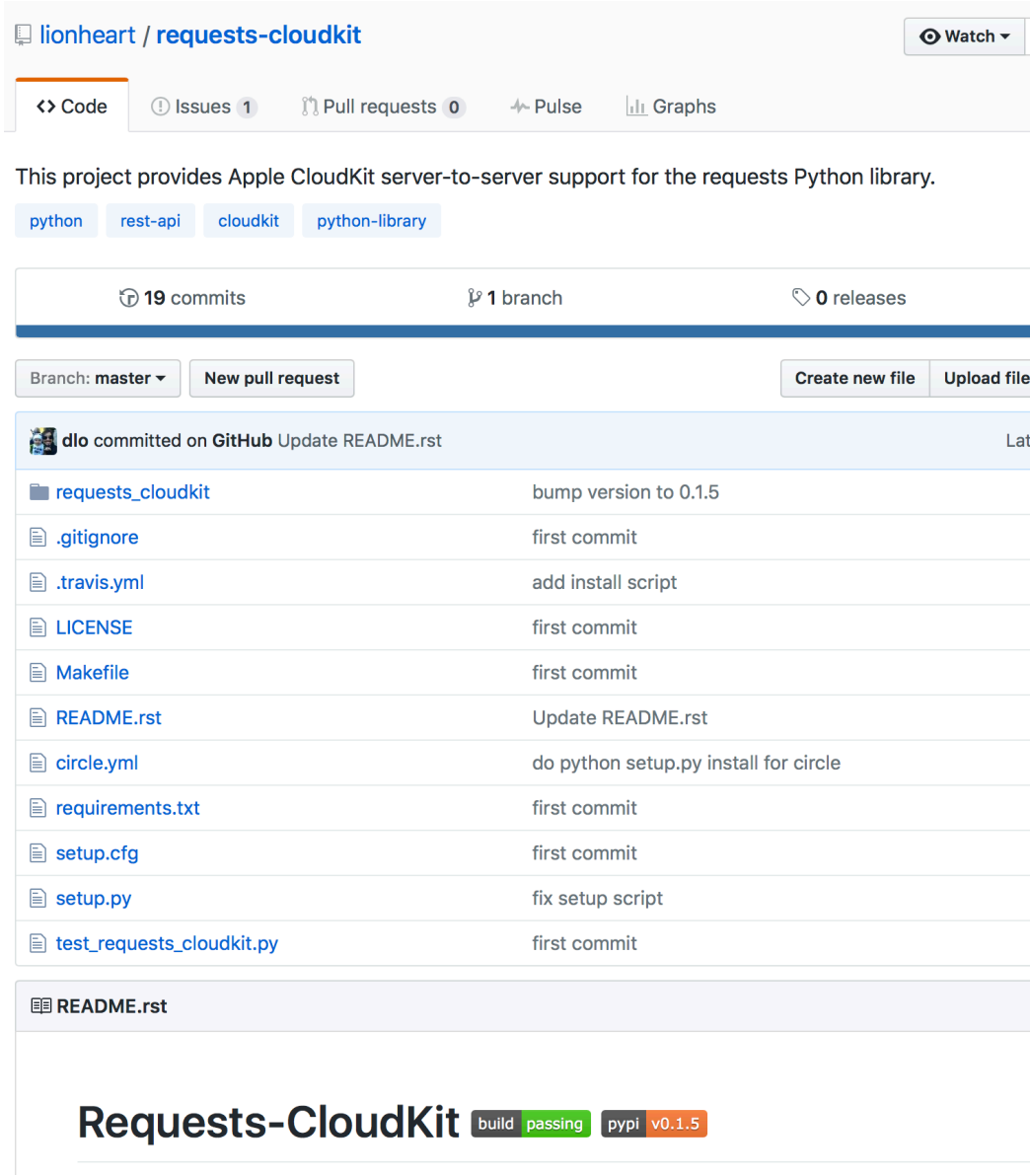
- Elliptic Curve Digital Signature Algorithm
- Cryptography approach for public/private key agreement

BREAK TIME 

SERVER-TO-SERVER DEMO

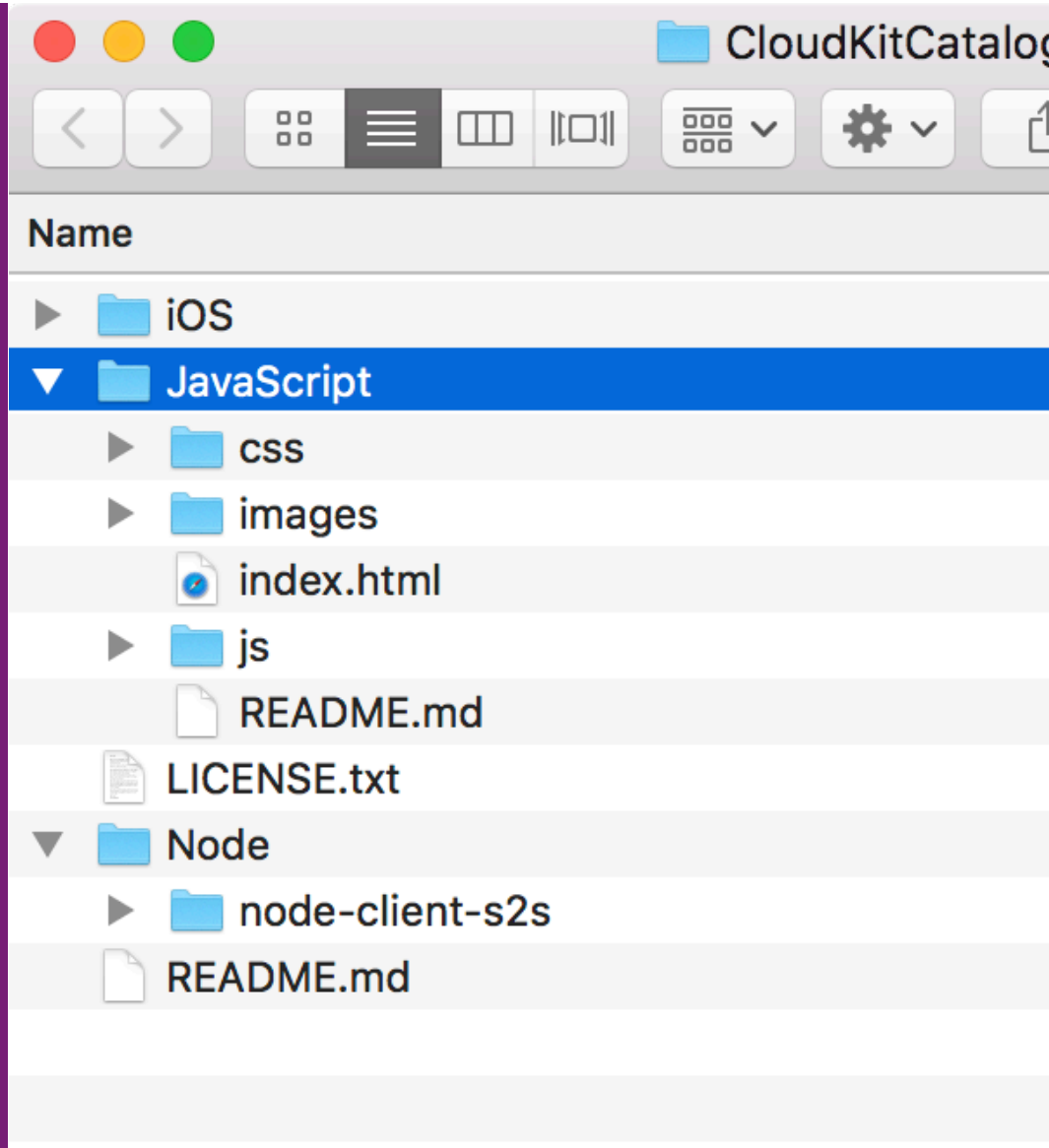
SERVER-TO-SERVER KEY

- CloudKit API is JSON based so any language can be used
- Surprisingly few number of existing libraries
  - Even less that actually work



SERVER-TO-SERVER KEY

- Apple has a sample project showing iOS, JS, and Node sharing a CloudKit container
- CloudKitCatalogAnItroduction ToCloudKitCocoaJavaScript

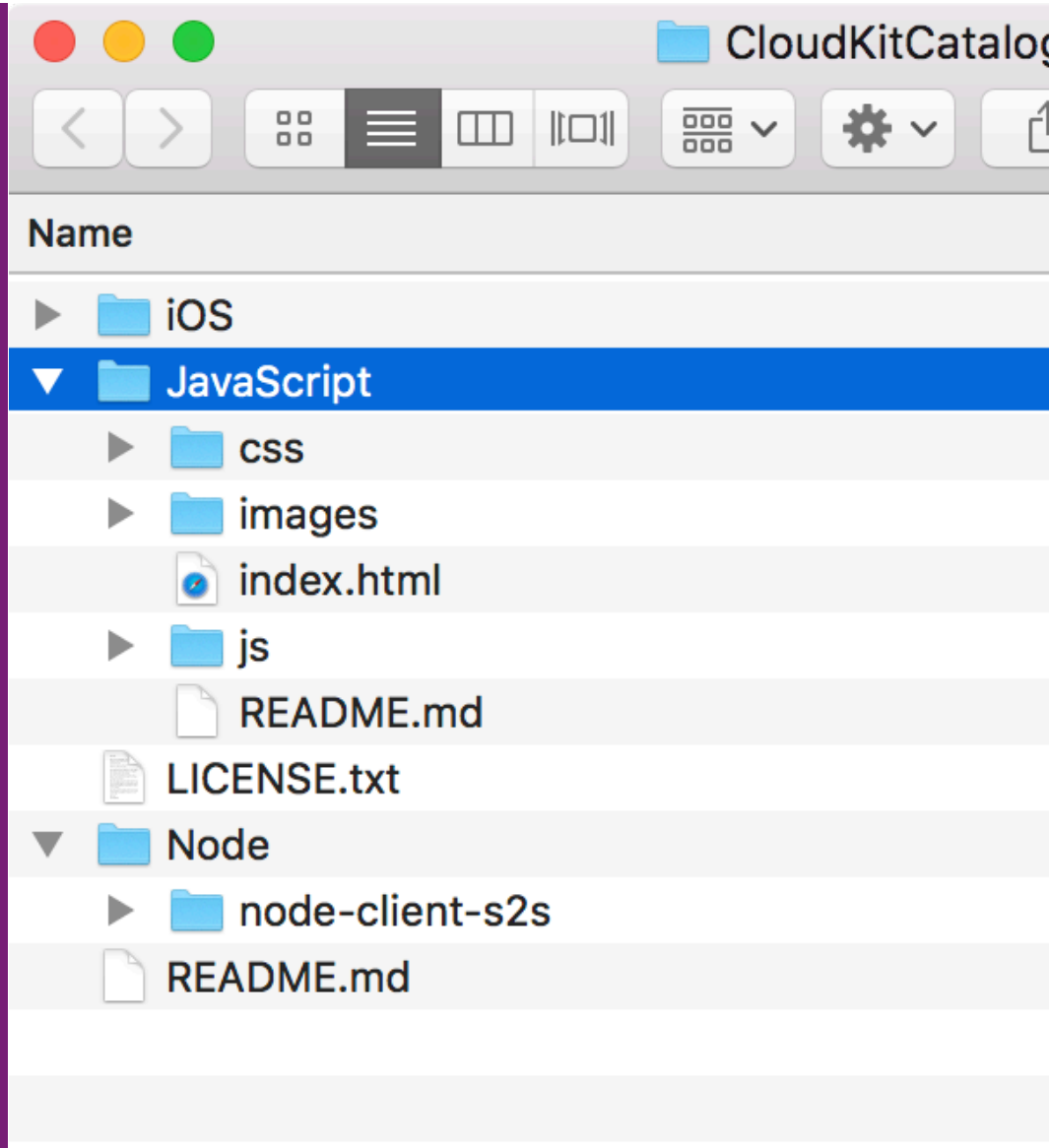


SERVER-TO-SERVER KEY

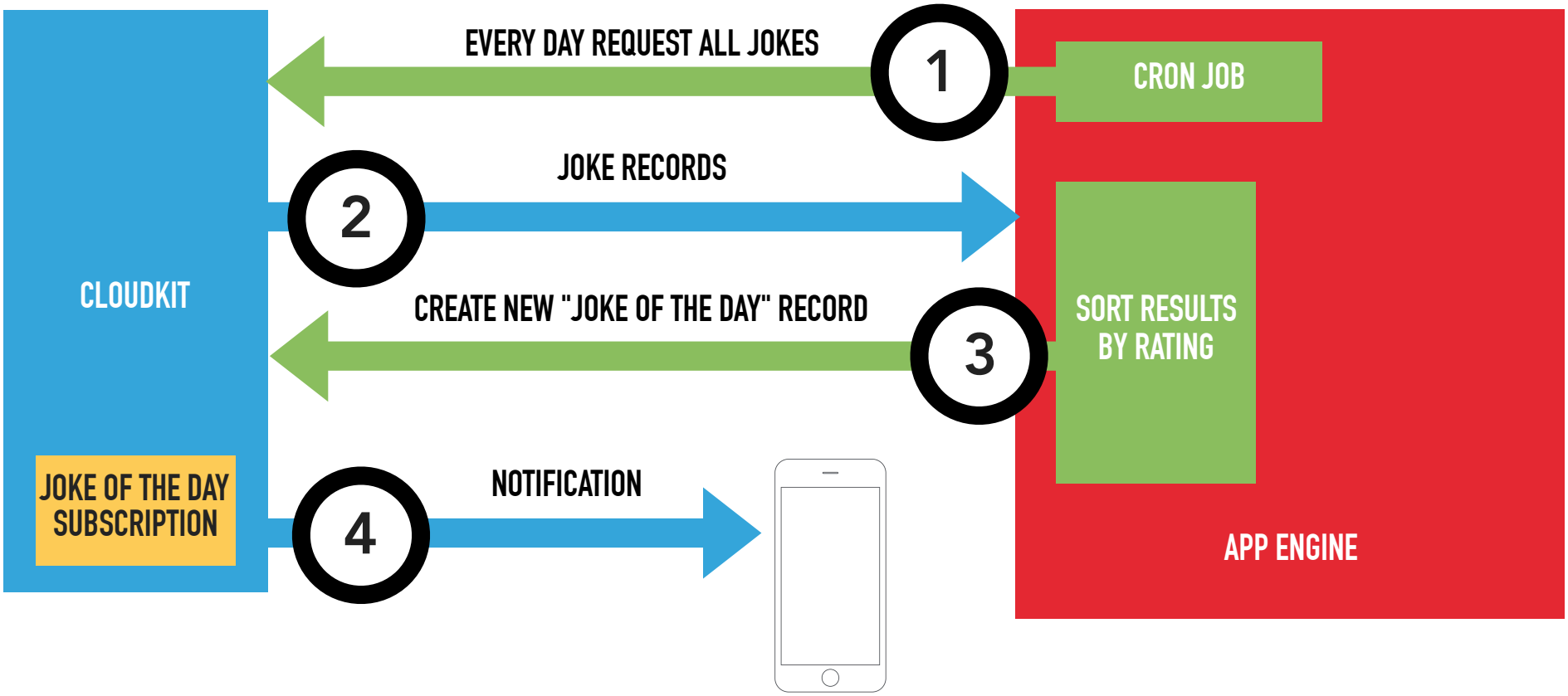
```
/*
 Copyright (C) 2016 Apple Inc. All Rights Reserved.
 See LICENSE.txt for this sample's licensing information

 Abstract:
 This node script uses a server-to-server key to make public database calls with CloudKit JS
 */


process.env.NODE_TLS_REJECT_UNAUTHORIZED = "0";

(function() {
  var fetch = require('node-fetch');

  var CloudKit = require('./cloudkit');
  var containerConfig = require('./config');

  // A utility function for printing results to the console.
  var println = function(key,value) {
    console.log("--> " + key + ":");
    console.log(value);
    console.log();
  };

  //CloudKit configuration
  CloudKit.configure({
```

SERVER-TO-SERVER KEY

- Python so that we can use App Engine



SERVER-TO-SERVER KEY



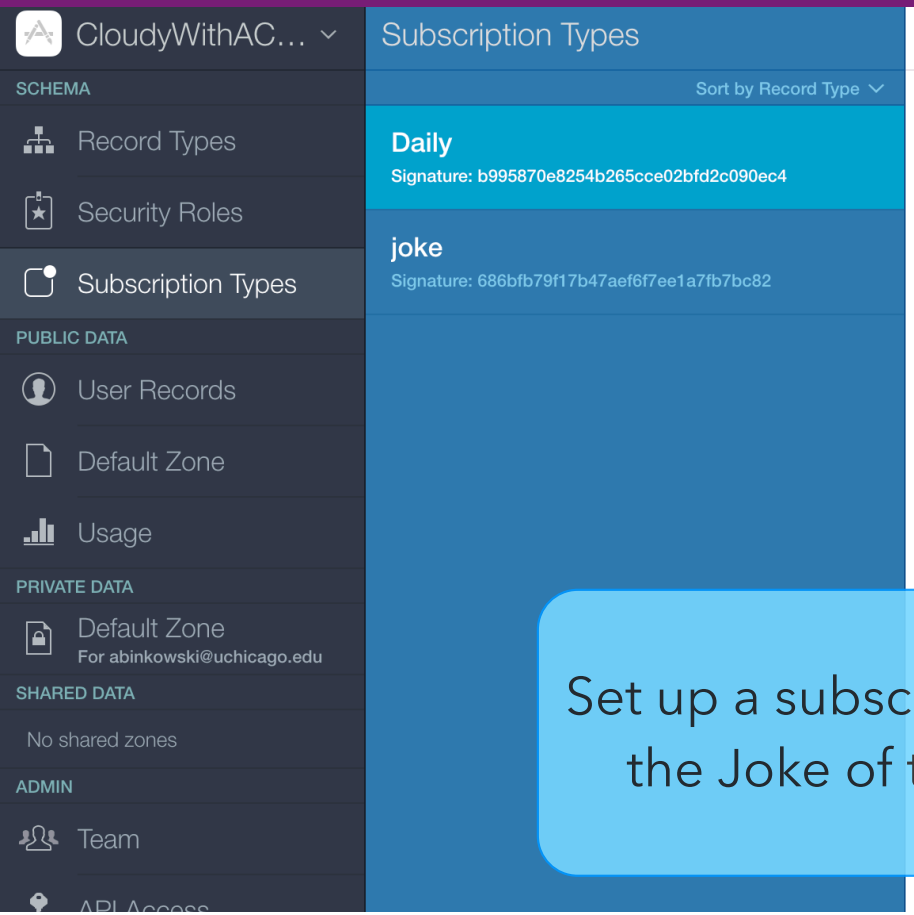
SERVER-TO-SERVER KEY

- Python so that we can use App Engine

```
#
#
# Based off the following
#  - CloudKitCatalog (c) 2016, Apple
#  - PyCloudKit. Created on 09.02.2016  (c) 2015 Andreas Schulz
#  - requests-cloudkit Copyright 2016 Lionheart Software LLC


from __future__ import print_function
import ecdsa
import base64
import hashlib
import datetime
import sys
import json

from urllib2 import HTTPPasswordMgrWithDefaultRealm, HTTPBasicAuthHandler, Request, build_opener
from urllib import urlencode


KEY_ID = 'ffdb30c23addd822e851e15cdd30ea819251d2fbb9bc59c4803f006dcc900191'
CONTAINER = 'iCloud.cloud.uchicago.CloudyWithAChanceOfErros'

def cloudkit_request(cloudkit_resource_url, data):
    """Uses HTTP GET or POST to interact with CloudKit. If data is empty, Uses
    GET, else, POSTs the data.
    """

    # Get ISO 8601 date, cut milliseconds.
    date = datetime.datetime.utcnow().isoformat()[:-7] + 'Z'

    # Load JSON request from config.
    _hash = hashlib.sha256(data.encode('utf-8')).digest()
    body = base64.b64encode(_hash).decode('utf-8')

    # Construct URL to CloudKit container.
    web_service_url = '/database/1/' + CONTAINER  + cloudkit_resource_url

    # Load API key from config.
    key_id = KEY_ID

    # Read out certificate file corresponding to API key.
    with open('eckey.pem', 'r') as pem_file:
        signing_key = ecdsa.SigningKey.from_pem(pem_file.read())

    # Construct payload.
```

IOS

IOS



Set up a subscription for the Joke of the Day

IOS

- Setup subscription for joke of the day

```
//
// MARK: - Subscriptions
//

func registerJokeOfTheDaySubscriptions() {
  let uuid: UUID = UIDevice().identifierForVendor!
  let identifier = "\(uuid)-joke-of-the-day"

  // Create the notification that will be delivered
  let notificationInfo = CKNotificationInfo()
  notificationInfo.alertBody = "The Joke of the Day is here! 😂"
  notificationInfo.shouldBadge = true
  notificationInfo.shouldSendContentAvailable = true
  notificationInfo.desiredKeys = ["joke"]

  // Create the subscription
  let subscription = CKQuerySubscription(recordType: "Daily",
                                         predicate: NSPredicate(value: true),
                                         subscriptionID: identifier,
                                         options: [.firesOnRecordCreation])
  subscription.notificationInfo = notificationInfo
  CKContainer.default().publicCloudDatabase.save(subscription,
                                                 completionHandler: ({returnRecord, error in
    if let err = error {
      print("JOTD: subscription failed \(err.localizedDescription)")
    } else {
      print("JOTD: subscription set up")
    }
  }))
}
```

IOS

```
// Create the notification that will be delivered
let notificationInfo = CKNotificationInfo()
notificationInfo.alertBody = "The Joke of the Day is here! 😂"
notificationInfo.shouldBadge = true
notificationInfo.shouldSendContentAvailable = true
notificationInfo.desiredKeys = ["joke"]

// Create the subscription
let subscription = CKQuerySubscription(recordType: "Daily",
                                       predicate: NSPredicate(value:
                                       subscriptionID: identifier,
                                       options: [.firesOnRecordCreat
subscription.notificationInfo = notificationInfo
```

Keys to send with record type

- Could send the joke (or make it generic)

APP ENGINE

APP ENGINE

- App Engine microservice to run cron job to process the data
  - Request all jokes
  - Process to find top rated joke
  - Add a new record to CloudKit representing joke of the day

```
# app.yaml
#

runtime: python27
api_version: 1
threadsafe: true

handlers:
- url: /.*
  script: main.app
```

APP ENGINE

- We don't need to store anything on App Engine to accomplish this functionality

```
# app.yaml
#

runtime: python27
api_version: 1
threadsafe: true

handlers:
- url: /.*
  script: main.app
```

APP ENGINE

- Adapt our cloudkit_helper for app engine
  - Replace print()
  - …

```
from __future__ import print_function
import ecdsa
import base64
import hashlib
import datetime
import sys
import json

from urllib2 import HTTPPasswordMgrWithDefaultRealm, HTTPBasicAuthHandler, Request, build_opener
from urllib import urlencode


KEY_ID = 'ffdb30c23addd822e851e15cdd30ea819251d2fbb9bc59c4803f006dcc900191'
CONTAINER = 'iCloud.cloud.uchicago.CloudyWithAChanceOfErros'

def cloudkit_request(cloudkit_resource_url, data):
    """Uses HTTP GET or POST to interact with CloudKit. If data is empty, Uses
    GET, else, POSTs the data.
    """

    # Get ISO 8601 date, cut milliseconds.
    date = datetime.datetime.utcnow().isoformat()[:-7] + 'Z'

    # Load JSON request from config.
    _hash = hashlib.sha256(data.encode('utf-8')).digest()
    body = base64.b64encode(_hash).decode('utf-8')

    # Construct URL to CloudKit container.
    web_service_url = '/database/1/' + CONTAINER  + cloudkit_resource_url

    # Load API key from config.
    key_id = KEY_ID
```

ecdsa is not a standard module on app engine

APP ENGINE

Install the library in your project

```
cd gae_dir

mkdir lib

# pip install -t lib/ <library_name>
pip install -t lib/ ecdsa
```

APP ENGINE

- Installed in the same directory

```
├── app.yaml
├── appengine_config.py
├── cloudkit_helper.py
├── cron.yaml
├── eckey.pem
├── joke_of_the_day.py
├── lib
│   ├── ecdsa
│   │   ├── __init__.py
│   │   ├── __init__.pyc
│   │   ├── _version.py
│   │   ├── _version.pyc
│   │   ├── curves.py
│   │   ├── curves.pyc
│   │   ├── der.py
│   │   ├── der.pyc
│   │   ├── ecdsa.py
│   │   ├── ecdsa.pyc
│   │   ├── ellipticcurve.py
│   │   ├── ellipticcurve.pyc
│   │   ├── keys.py
│   │   ├── keys.pyc
│   │   ├── numbertheory.py
│   │   ├── numbertheory.pyc
│   │   ├── rfc6979.py
│   │   ├── rfc6979.pyc
```

APP ENGINE

```
# appengine_config.py
#

from google.appengine.ext import vendor

# Add any libraries install in the "lib" folder.
vendor.add('lib')
```

- Add a new file: appengine_cofig.py

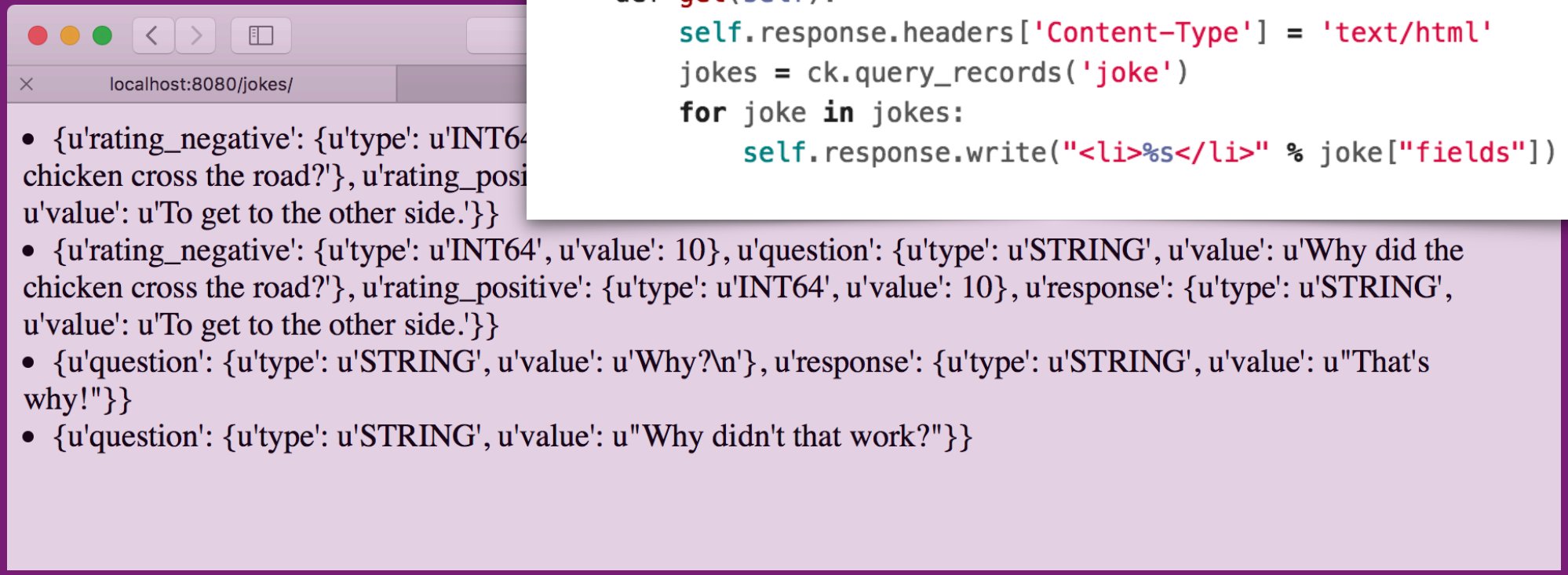
APP ENGINE

- main.py
- Handlers
  - Processing
  - Posting record

```
import webapp2

import sys
import json

import cloudkit_helper as ck
from joke_of_the_day import JokeOfTheDay

class MainPage(webapp2.RequestHandler):
    def get(self):
        self.response.headers['Content-Type'] = 'text/html'
        self.response.write("home")

class ProcessJokes(webapp2.RequestHandler):
    def get(self):
        self.response.headers['Content-Type'] = 'text/html'
        jokes = ck.query_records('joke')
        for joke in jokes:
            self.response.write("<li>%s</li>" % joke["fields"])


app = webapp2.WSGIApplication([
    ('/', MainPage),
    ('/jokes/', ProcessJokes),
    ('/tasks/jokeoftheday/', JokeOfTheDay),
], debug=True)
```

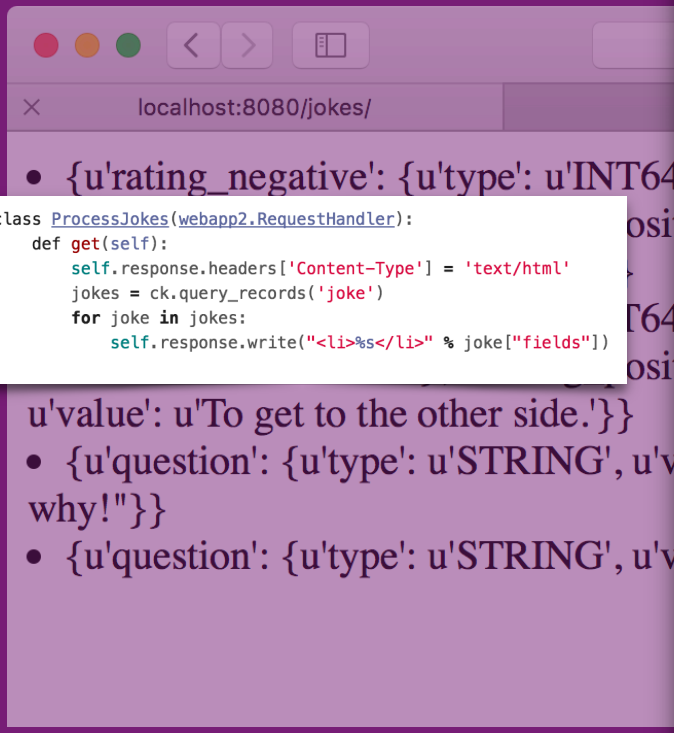
APP ENGINE

```
class ProcessJokes(webapp2.RequestHandler):
    def get(self):
        self.response.headers['Content-Type'] = 'text/html'
        jokes = ck.query_records('joke')
        for joke in jokes:
            self.response.write("<li>%s</li>" % joke["fields"])
```



- http://localhost:8080/jokes/

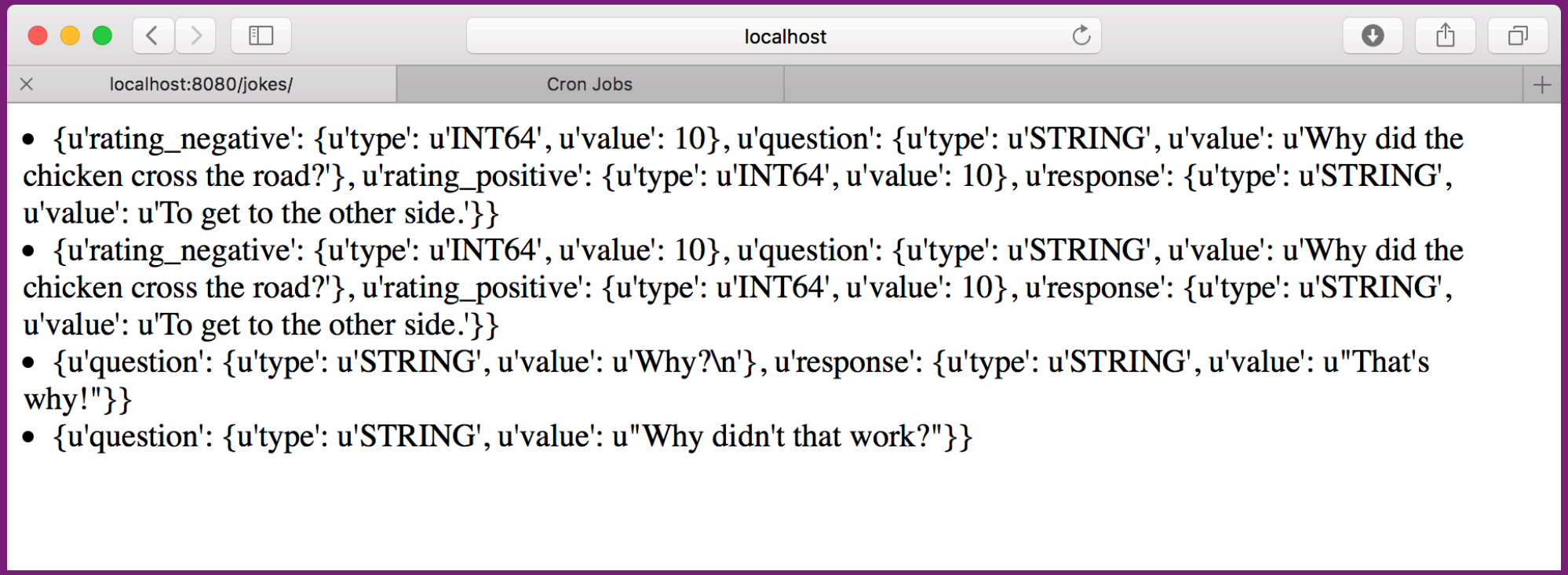
APP ENGINE




```
def query_records(record_type):
    """Queries CloudKit for all records of type record_type."""
    json_query = {
        'query': {
            'recordType': record_type
        }
    }

    records = []
    while True:
        result_query_authors = cloudkit_request(
            '/development/public/records/query',
            json.dumps(json_query))
        result_query_authors = json.loads(result_query_authors['content'])

        records += result_query_authors['records']

        if 'continuationMarker' in result_query_authors.keys():
            json_query['continuationMarker'] = \
                result_query_authors['continuationMarker']
        else:
            break
```

- http://localhost:8080/jok

APP ENGINE



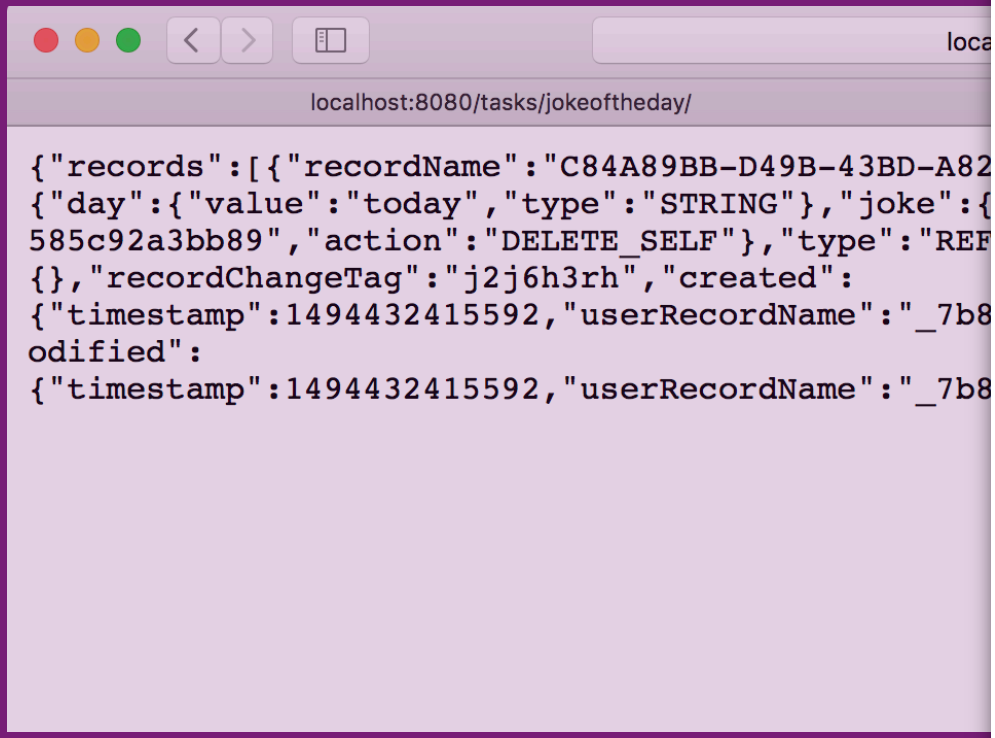
- http://localhost:8080/jokes/

APP ENGINE

```
    def get(self):
        self.response.headers['Content-Type'] = 'text/html'
        jokes = ck.query_records('joke')
        for joke in jokes:
            self.response.write("<li>%s</li>" % joke["fields"])


app = webapp2.WSGIApplication([
    ('/', MainPage),
    ('/jokes/', ProcessJokes),
    ('/tasks/jokeoftheday/', JokeOfTheDay),
], debug=True)
```

- http://localhost:8080/tasks/jokeoftheday/

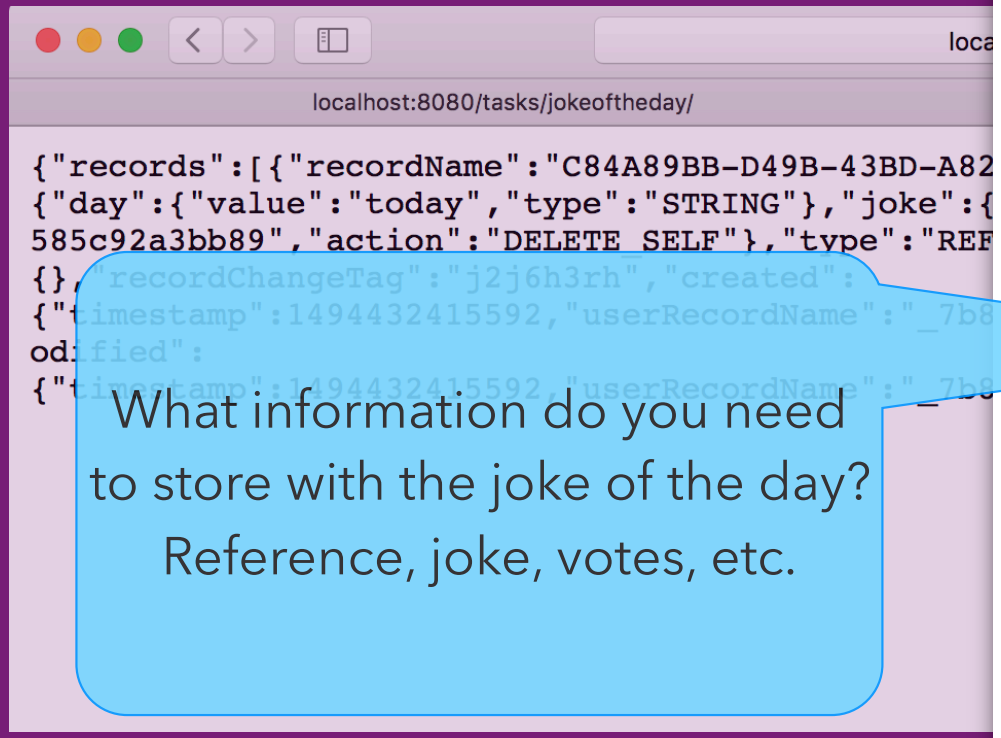
APP ENGINE



- http://localhost:8080/tasks/jokeofthe

```
class JokeOfTheDay(webapp2.RequestHandler):
    #
    # Create a new joke of the day record and post it to iCloud
    # Note: We are hard coming the reference here, you should get
    # if from the processing of the daily joke ratings
    def get(self):


        new_joke_of_the_day_data = {
        'operations': [{
            'operationType': 'create',
            'record': {
                'recordType': 'Daily',
                'fields': {
                    'day': {'value': 'today'},
                    'joke': {
                        'value': {
                            'recordName': '60d82b7d-32ef-4e91-9c12-585c92a3bb89',
                        'zoneID:': {
                            'zoneName': '_defaultZone'
                            },
                            'action': 'DELETE_SELF'
                        }
                    }
                }
            }
        }]
        }

        #print('Posting operation to create quote...')
        result_modify_jokes = ck.cloudkit_request(
        '/development/public/records/modify',
        json.dumps(new_joke_of_the_day_data))

        self.response.headers['Content-Type'] = 'text/json'
        self.response.write(result_modify_jokes['content'])
```

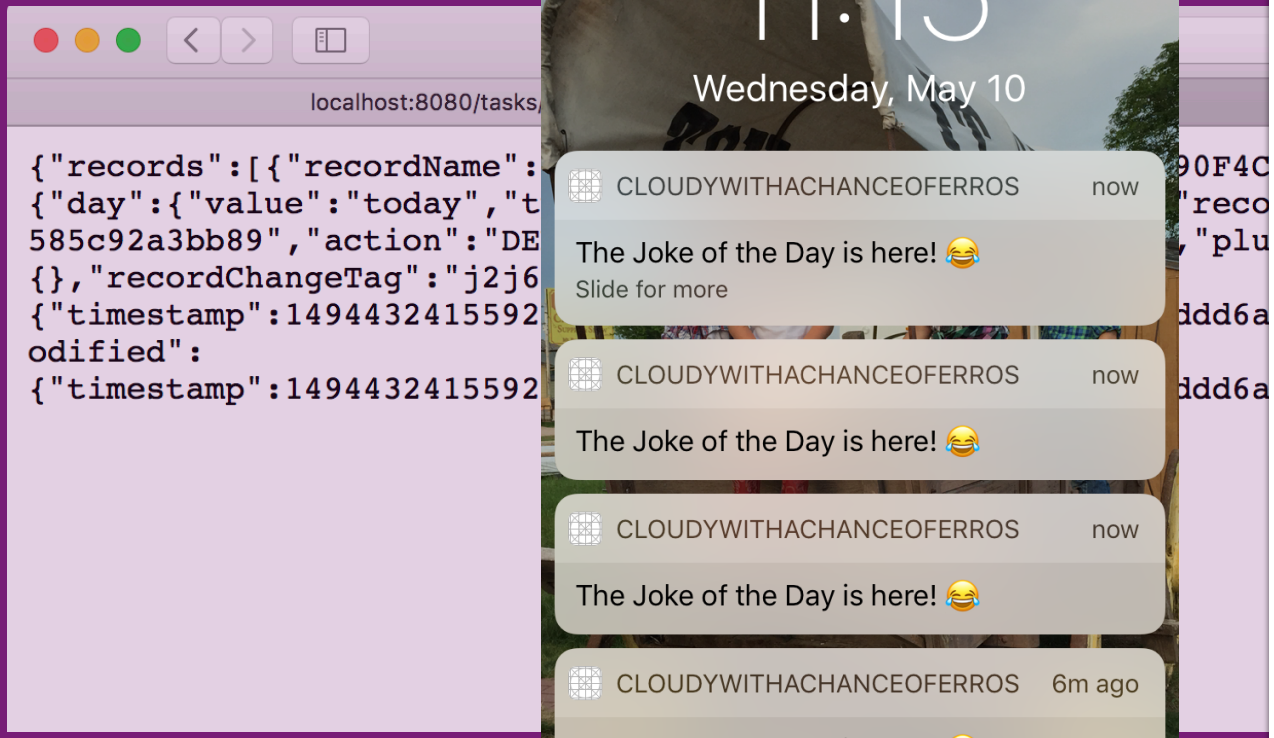
APP ENGINE




```
class JokeOfTheDay(webapp2.RequestHandler):
    #
    # Create a new joke of the day record and post it to iCloud
    # Note: We are hard coming the reference here, you should get
    # if from the processing of the daily joke ratings
    def get(self):


        new_joke_of_the_day_data = {
        'operations': [{
            'operationType': 'create',
            'record': {
                'recordType': 'Daily',
                'fields': {
                    'day': {'value': 'today'},
                    'joke': {
                        'value': {
                            'recordName': '60d82b7d-32ef-4e91-9c12-585c92a3bb89',
                        'zoneID:': {
                            'zoneName': '_defaultZone'
                            },
                            'action': 'DELETE_SELF'
                        }
                    }
                }
            }
        }]
        }

        #print('Posting operation to create quote...')
        result_modify_jokes = ck.cloudkit_request(
        '/development/public/records/modify',
        json.dumps(new_joke_of_the_day_data))

        self.response.headers['Content-Type'] = 'text/json'
        self.response.write(result_modify_jokes['content'])
```

- http://localhost:8080/tasks/jokeofthe

APP ENGINE




```python
def cloudkit_request(cloudkit_resource_url, data):
    """Uses HTTP GET or POST to interact with CloudKit. If data is empty, Uses
    GET, else, POSTs the data.
    """

    # Get ISO 8601 date, cut milliseconds.
    date = datetime.datetime.utcnow().isoformat()[:-7] + 'Z'

    # Load JSON request from config.
    _hash = hashlib.sha256(data.encode('utf-8')).digest()
    body = base64.b64encode(_hash).decode('utf-8')

    # Construct URL to CloudKit container.
    web_service_url = '/database/1/' + CONTAINER  + cloudkit_resource_url

    # Load API key from config.
    key_id = KEY_ID

    # Read out certificate file corresponding to API key.
    with open('eckey.pem', 'r') as pem_file:
        signing_key = ecdsa.SigningKey.from_pem(pem_file.read())

    # Construct payload.
    unsigned_data = ':'.join([date, body, web_service_url]).encode('utf-8')

    # Sign payload via certificate.
    signed_data = signing_key.sign(unsigned_data,
                                   hashfunc=hashlib.sha256,
                                   sigencode=ecdsa.util.sigencode_der)

    signature = base64.b64encode(signed_data).decode('utf-8')

    headers = {
        'X-Apple-CloudKit-Request-KeyID': key_id,
        'X-Apple-CloudKit-Request-ISO8601Date': date,
        'X-Apple-CloudKit-Request-SignatureV1': signature
    }

    if data:
        req_type = 'POST'
    else:
        req_type = 'GET'

    result = curl('https://api.apple-cloudkit.com' + web_service_url,
                  req_type=req_type,
                  data=data,
                  headers=headers)

    return result
```

- http://localhost:808

APP ENGINE

```yaml
# cron.yaml
#
# To test in developement server goto http://localhost:8000/cron
#

cron:
- description: daily joke summary and notification
  url: /tasks/jokeoftheday/
  schedule: every day 08:00
  retry_parameters:
    min_backoff_seconds: 60
    max_doublings: 5
```

- Add a new file: cron.yaml

APP ENGINE

CRON JOB

Google App Engine

Development SDK 1.9.50

dev~None

- Instances
- Datastore Viewer
- Datastore Indexes
- Datastore Stats
- Interactive Console
- Memcache Viewer
- Blobstore Viewer
- Task Queues
- Cron Jobs

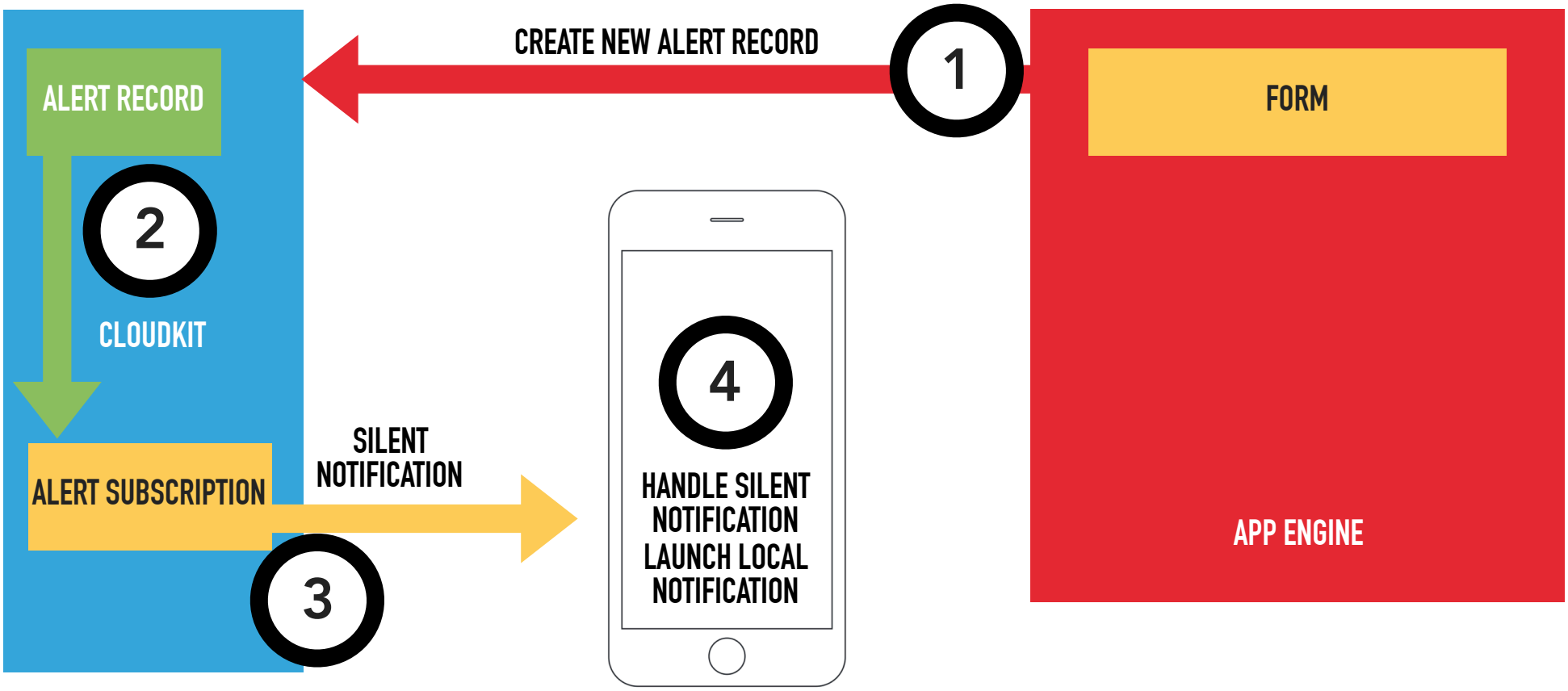
Cron Jobs

Request to /tasks/jokeoftheday/ succeeded!

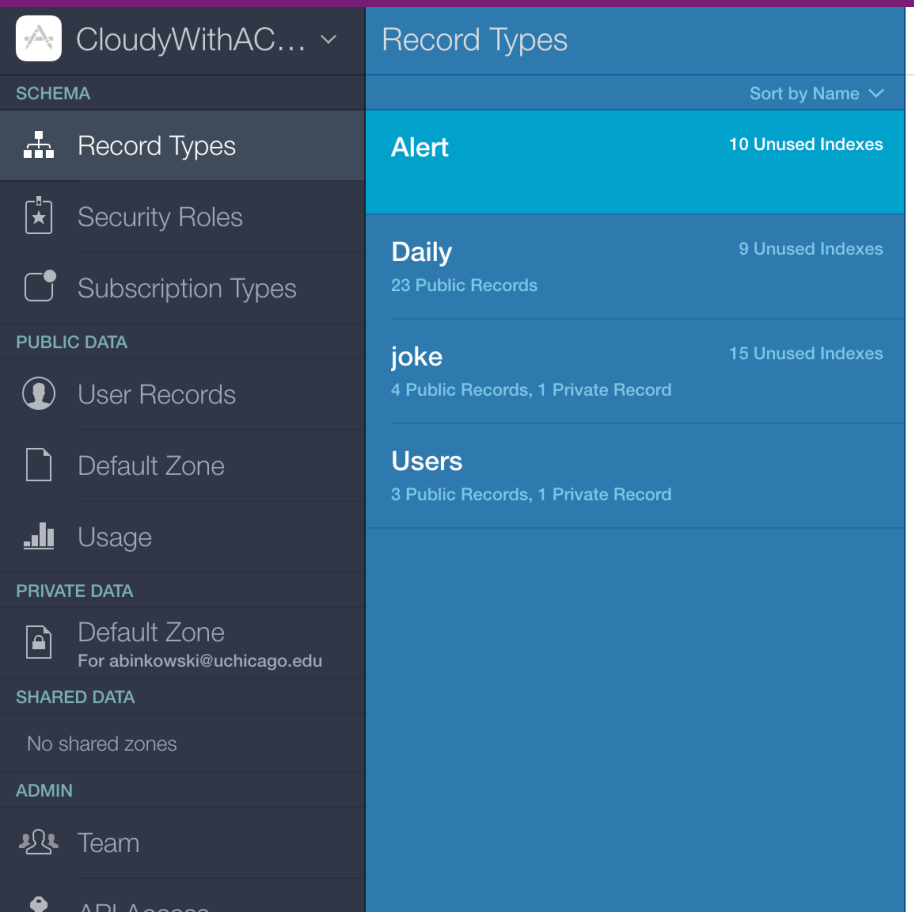
Cron Job	Schedule
/tasks/jokeoftheday/ daily joke summary and notification	**every day 08:00** Run now In production, this would run at these times: 2017-05-11 08:00:00Z 16:20:41.791990 from now 2017-05-12 08:00:00Z 1 day, 16:20:41.791990 from now 2017-05-13 08:00:00Z 2 days, 16:20:41.791990 from now

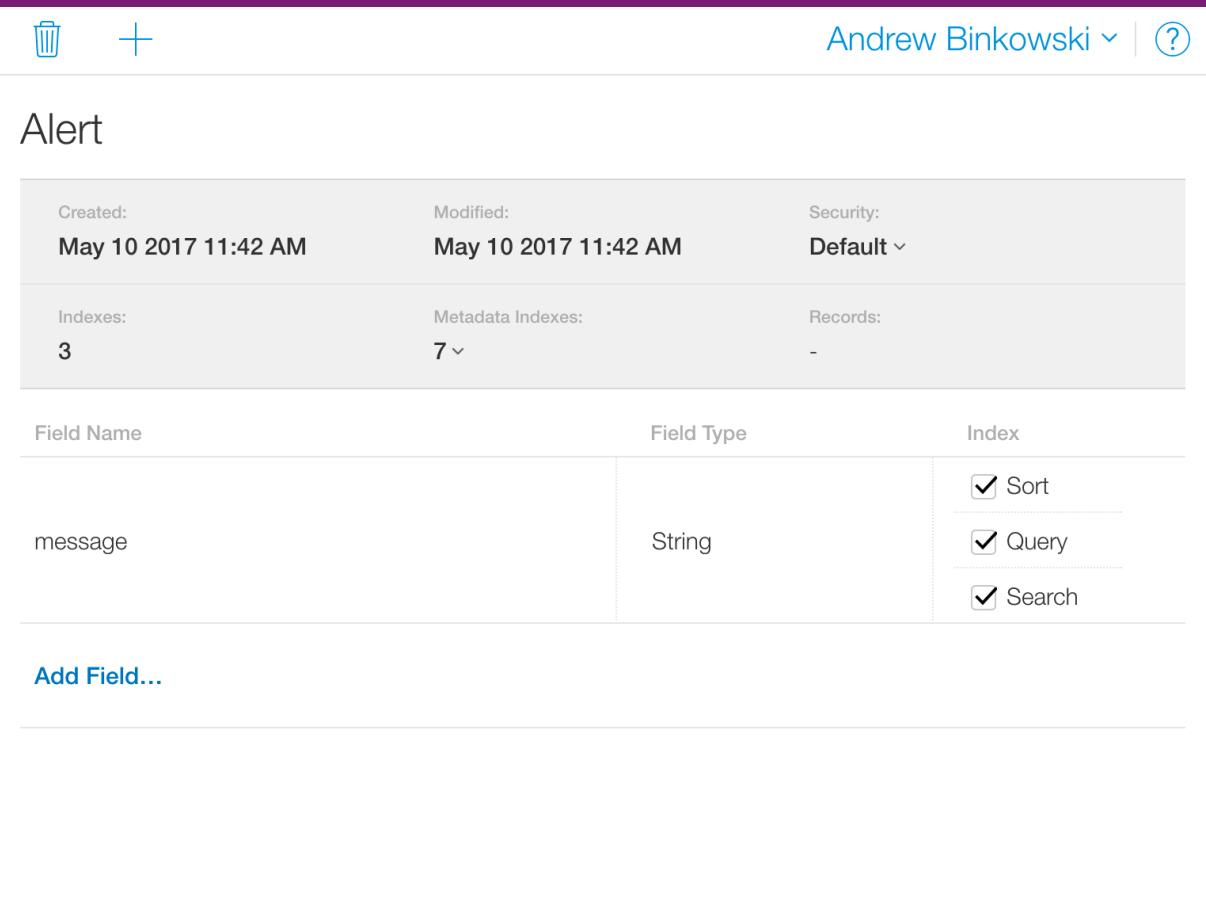
CUSTOM NOTIFICATIONS

CUSTOM NOTIFICATIONS



CUSTOM NOTIFICATIONS





CUSTOM NOTIFICATIONS

- Set up a new route

```
app = webapp2.WSGIApplication([
    ('/', MainPage),
    ('/jokes/', ProcessJokes),
    ('/alerts/', AlertNotifications),
    ('/tasks/jokeoftheday/', JokeOfTheDay),

], debug=True)
```

CUSTOM NOTIFICATIONS

- Create a new Alerts record with the passed in message

```
class AlertNotifications(webapp2.RequestHandler):
    def post(self):
        message = self.request.get('message')
        new_joke_of_the_day_data = {
        'operations': [{
            'operationType': 'create',
            'record': {
                'recordType': 'Alert',
                'fields': {
                    'message': {'value': message},
                }
            }
        }]
        }

        result_modify_jokes = ck.cloudkit_request(
        '/development/public/records/modify',
        json.dumps(new_joke_of_the_day_data))

        self.response.headers['Content-Type'] = 'text/json'
        self.response.write(result_modify_jokes['content'])
        #self.redirect('/alerts/')

    def get(self):
        self.response.headers['Content-Type'] = 'text/html'
        html = """
        <form action="/alerts/" method="post">
        <b>Alert Notifcation Message</b><br>
        <input type="text" name="message" value=""><br>
        <input type="submit" value="Submit">
        </form>
        """
        self.response.write(html)
```

CUSTOM NOTIFICATIONS

- Create an amazing form

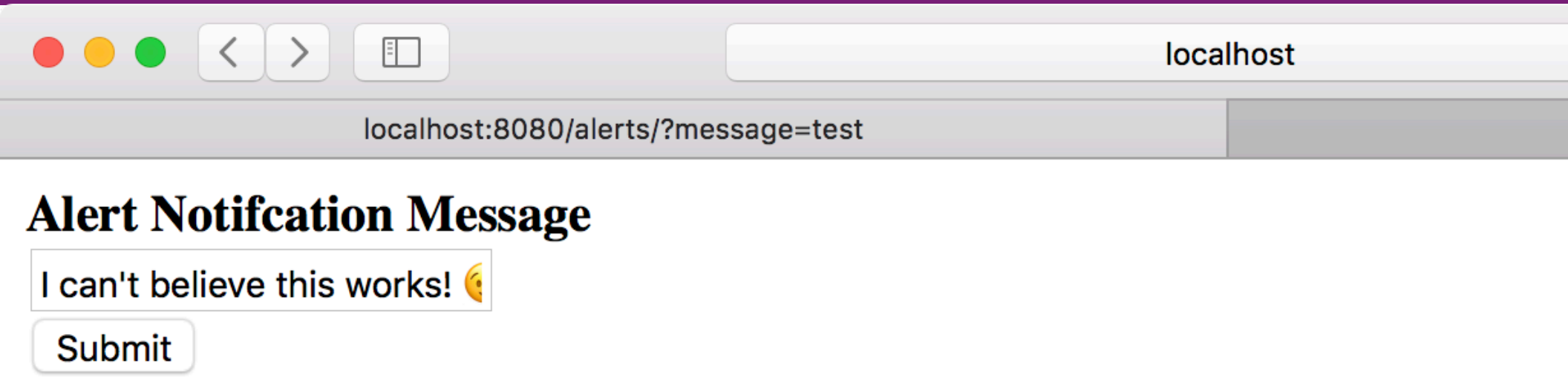
```
def get(self):
    self.response.headers['Content-Type'] = 'text/html'
    html = """
    <form action="/alerts/" method="post">
    <b>Alert Notifcation Message</b><br>
    <input type="text" name="message" value=""><br>
    <input type="submit" value="Submit">
    </form>
    """
    self.response.write(html)
```

CUSTOM NOTIFICATIONS

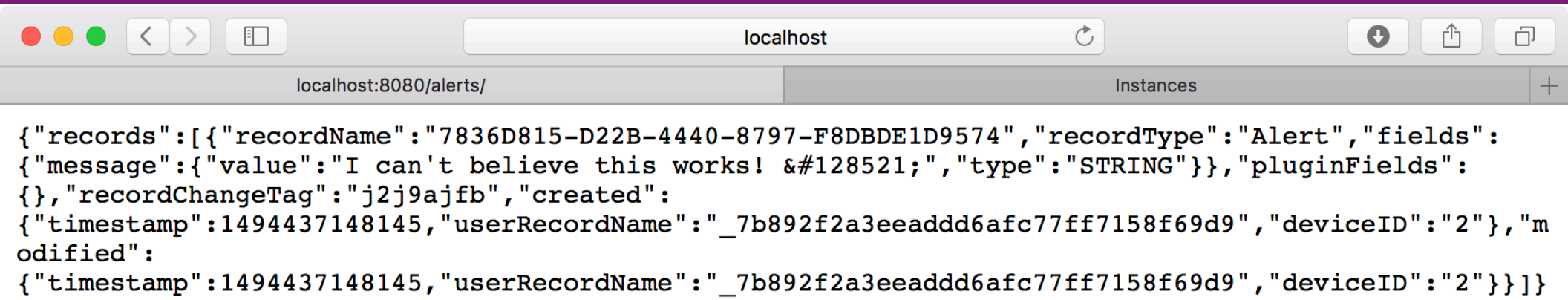
- Create a new Alerts record with the passed in message

```
class AlertNotifications(webapp2.RequestHandler):
    def post(self):
        message = self.request.get('message')
        new_joke_of_the_day_data = {
        'operations': [{
            'operationType': 'create',
            'record': {
                'recordType': 'Alert',
                'fields': {
                    'message': {'value': message},
                }
            }
        }]
        }

        result_modify_jokes = ck.cloudkit_request(
        '/development/public/records/modify',
        json.dumps(new_joke_of_the_day_data))

        self.response.headers['Content-Type'] = 'text/json'
        self.response.write(result_modify_jokes['content'])
        #self.redirect('/alerts/')
```

CUSTOM NOTIFICATIONS

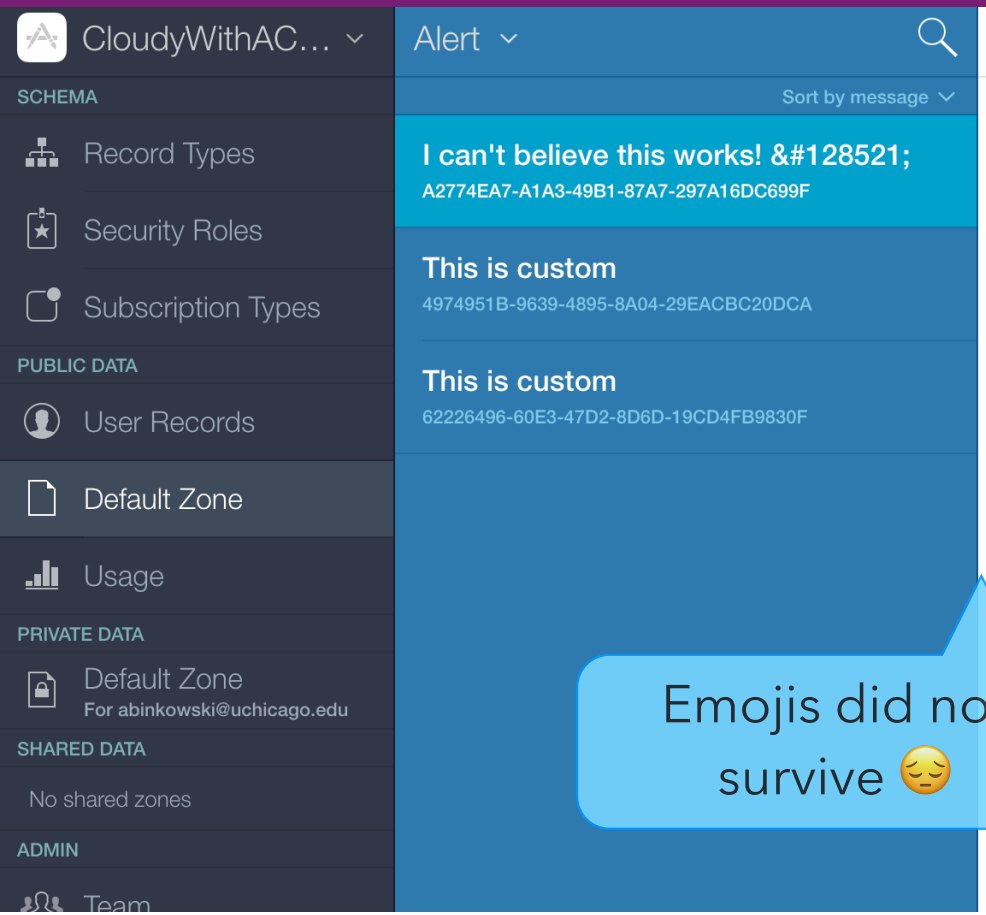


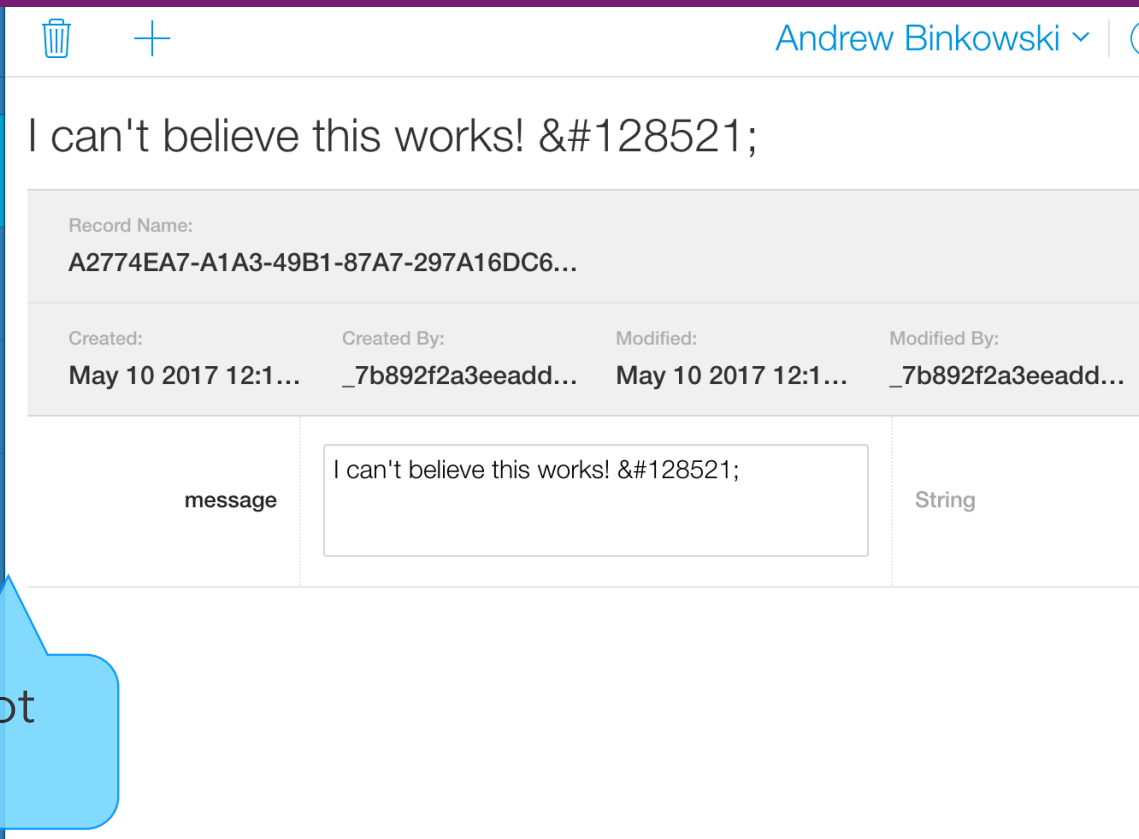
CUSTOM NOTIFICATIONS




```
{"records":[{"recordName":"7836D815-D22B-4440-8797-F8DBDE1D9574","recordType":"Alert","fields":
{"message":{"value":"I can't believe this works! &#128521;","type":"STRING"}},"pluginFields":
{},"recordChangeTag":"j2j9ajfb","created":
{"timestamp":1494437148145,"userRecordName":"_7b892f2a3eeaddd6afc77ff7158f69d9","deviceID":"2"},"m
odified":
{"timestamp":1494437148145,"userRecordName":"_7b892f2a3eeaddd6afc77ff7158f69d9","deviceID":"2"}}]}
```

CUSTOM NOTIFICATIONS





Emojis did not survive 😔

CUSTOM NOTIFICATIONS

- Handle the remote notification
  - Read the APNS data
  - Extract the message
  - Create local notification

```swift
/// Called for push notifications
/// In this case, we are getting the changed record from cloudkit and then creating a new notification
func application(_ application: UIApplication,
                 didReceiveRemoteNotification userInfo: [AnyHashable : Any],
                 fetchCompletionHandler completionHandler: @escaping (UIBackgroundFetchResult) -> Void) {

  // Get the APS notification data
  let aps = userInfo["aps"] as! [String: AnyObject]
  print("APS: \(aps)")

  let contentAvailable = aps["content-available"] as! Int

  if contentAvailable == 1 {
    // Pull data
    let cloudKitInfo = userInfo["ck"] as! [String: AnyObject]
    let recordId = cloudKitInfo["qry"]?["rid"] as! String
    let field = cloudKitInfo["qry"]?["af"] as! [String: AnyObject]
    let message = field["message"] as! String

    // Create notification content
    let content = UNMutableNotificationContent()
    content.title = "Joke of the Day"
    content.subtitle = "Local from Silent"
    content.body = message
    content.sound = UNNotificationSound.default()

    // Set up trigger
    let trigger = UNTimeIntervalNotificationTrigger(timeInterval: 5,repeats: false)

    // Create the notification request
    let center = UNUserNotificationCenter.current()
    let identifier = recordId
    let request = UNNotificationRequest(identifier: identifier,
                                        content: content, trigger: trigger)
    center.add(request, withCompletionHandler: { (error) in
      if let error = error {
        print("Something went wrong: \(error)")
      }
    })

    completionHandler(.newData)

  } else {
    completionHandler(.noData)
  }
}
```

CUSTOM NOTIFICATIONS

Silent notification content

```
[AnyHashable("aps"): {
    "content-available" = 1;
}, AnyHashable("ck"): {
    ce = 2;
    cid = "iCloud.cloud.uchicago.Cloud[illegible]AChanceOfErros";
    nid = "2b661f39-5617-4a1c-a889-[illegible]09cd9eae7a";
    qry =     {
        af =         {
            message = "Where are my emojis?";
        };
        dbs = 2;
        fo = 1;
        rid = "A0915CF5-E4E7-4C76-856E-48CE01ADCACE";
        sid = "14725FE6-9C8F-4BDC-96FF-3815E5FE1E3B-alert";
        zid = "_defaultZone";
        zoid = "_defaultOwner";
    };
}]
```

Field I requested

Record that matched the query

CUSTOM NOTIFICATIONS

```
/// Called for push notifications
/// In this case, we are getting the changed record from cloudkit and then creating a
func application(_ application: UIApplication,
                 didReceiveRemoteNotification userInfo: [AnyHashable : Any],
                 fetchCompletionHandler completionHandler: @escaping (UIBackgroundFet

  // Get the APS notification data
  let aps = userInfo["aps"] as! [String: AnyObject]
  print("APS: \(aps)")

  let contentAvailable = aps["content-available"] as! Int

  if contentAvailable == 1 {
    // Pull data
    let cloudKitInfo = userInfo["ck"] as! [String: AnyObject]
    let recordId = cloudKitInfo["qry"]?["rid"] as! String
    let field = cloudKitInfo["qry"]?["af"] as! [String: AnyObject]
    let message = field["message"] as! String
```

CUSTOM NOTIFICATIONS

```
    // Create notification content
    let content = UNMutableNotificationContent()
    content.title = "Joke of the Day"
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    content.body = message
    content.sound = UNNotificationSound.default()

    // Set up trigger
    let trigger = UNTimeIntervalNotificationTrigger(timeInterval: 5,repeats: false)

    // Create the notification request
    let center = UNUserNotificationCenter.current()
    let identifier = recordId
    let request = UNNotificationRequest(identifier: identifier,
                                        content: content, trigger: trigger)
    center.add(request, withCompletionHandler: { (error) in
      if let error = error {
        print("Something went wrong: \(error)")
      }
    })

    completionHandler(.newData)

  } else {
    completionHandler(.noData)
  }
}
```
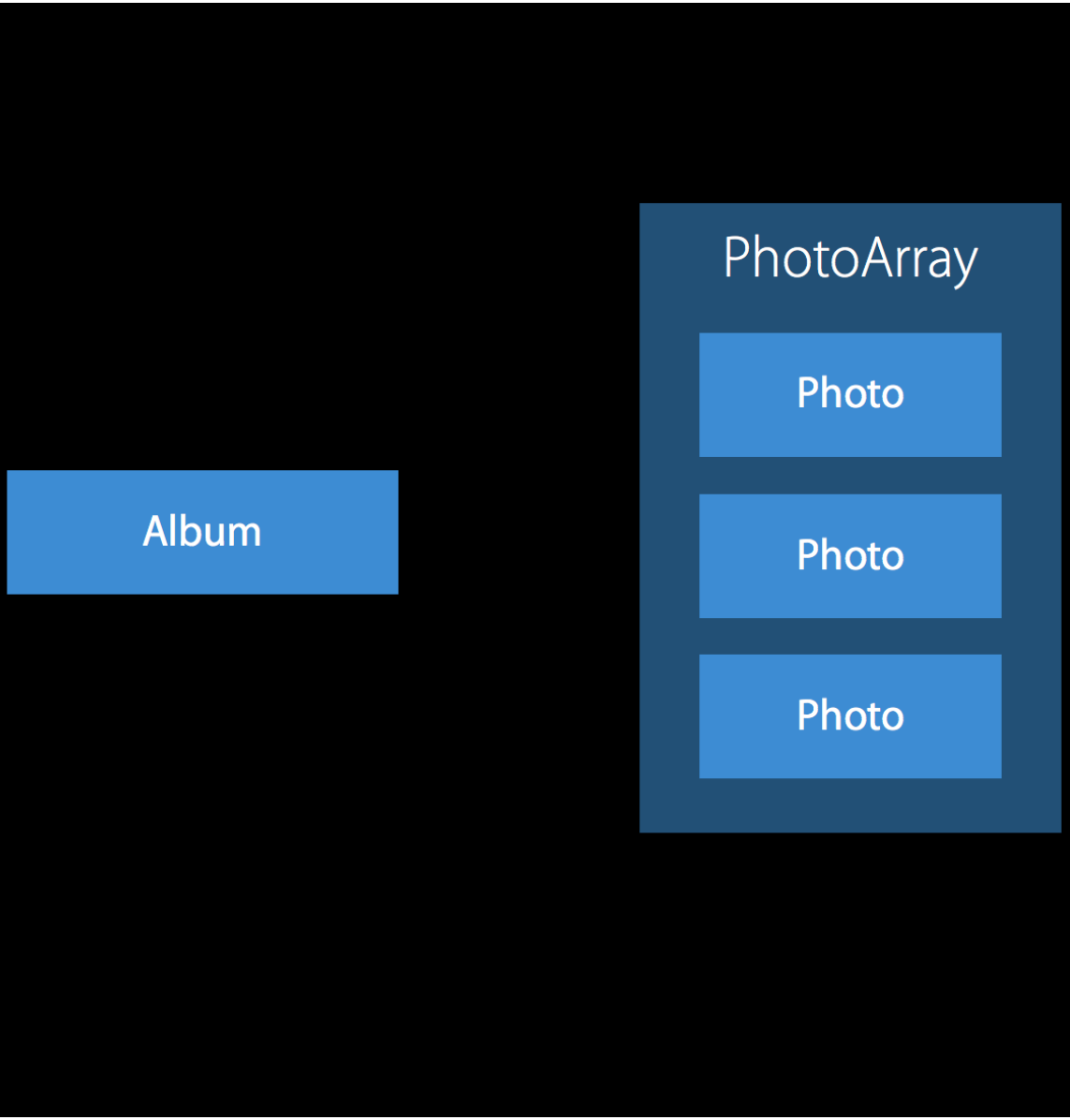

DATA MODELING

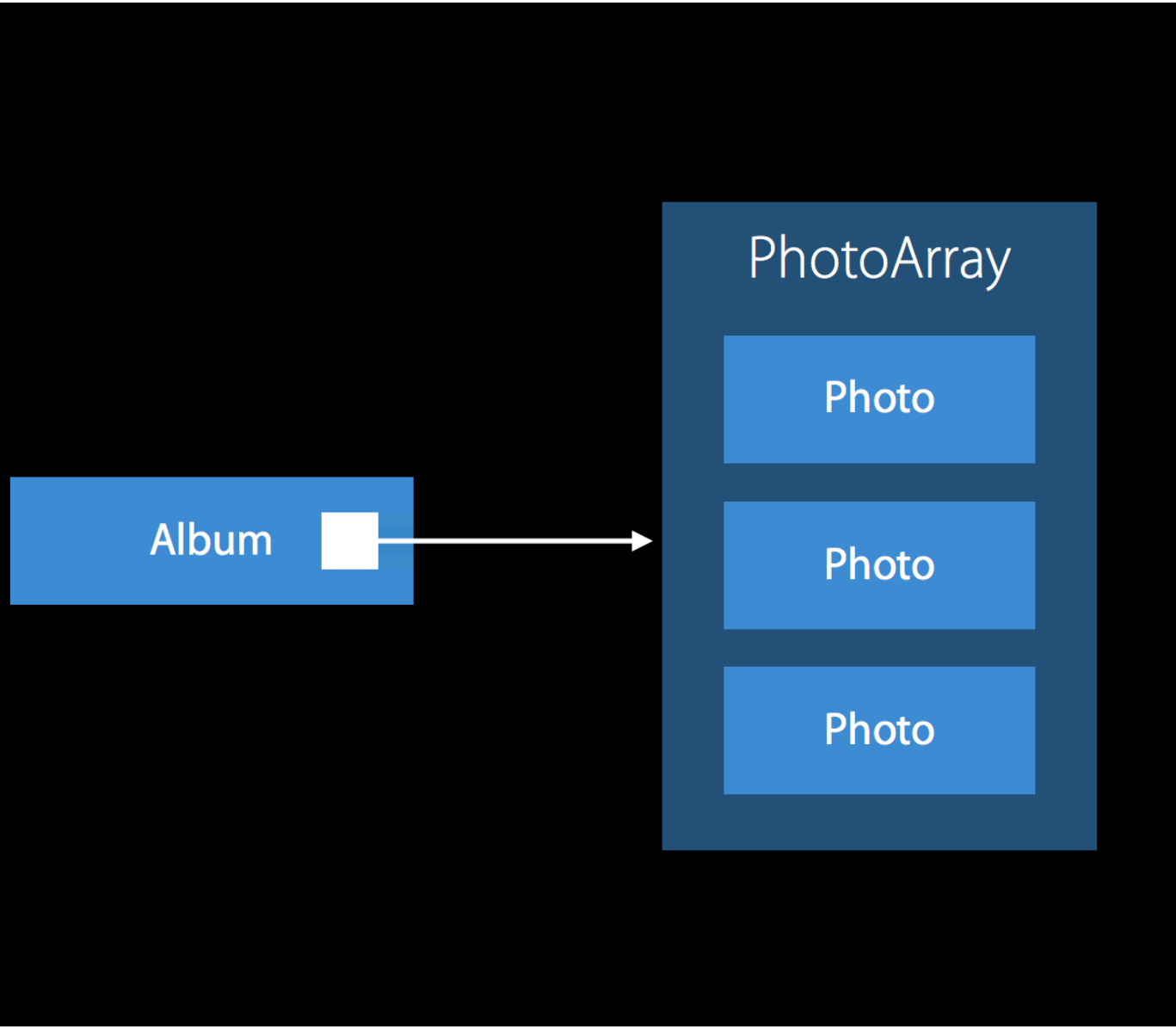
DATA MODELING

- How should 1 to many relationships be handled?



DATA MODELING

- Typical setup to model



DATA MODELING

PhotoArray = []

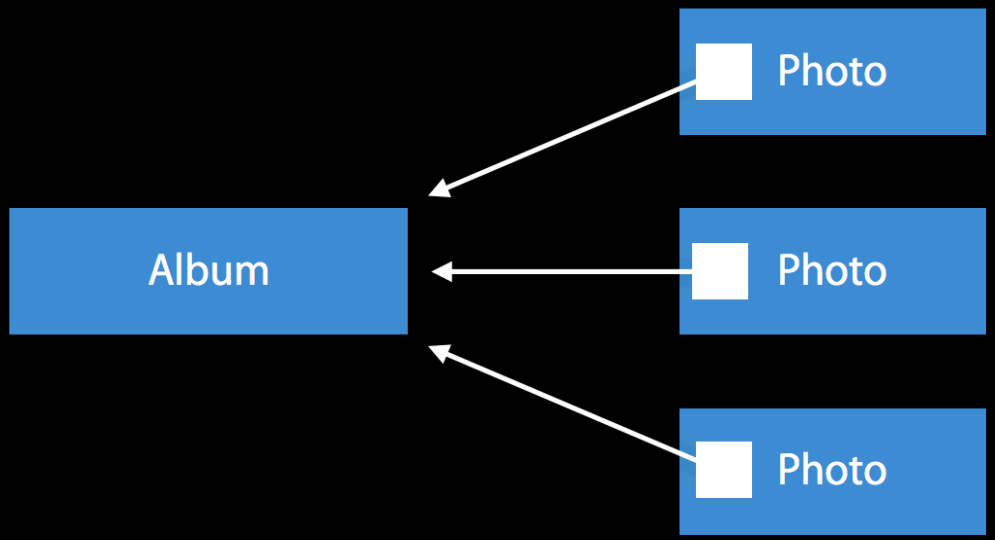
Album

DATA MODELING

PhotoArray = []

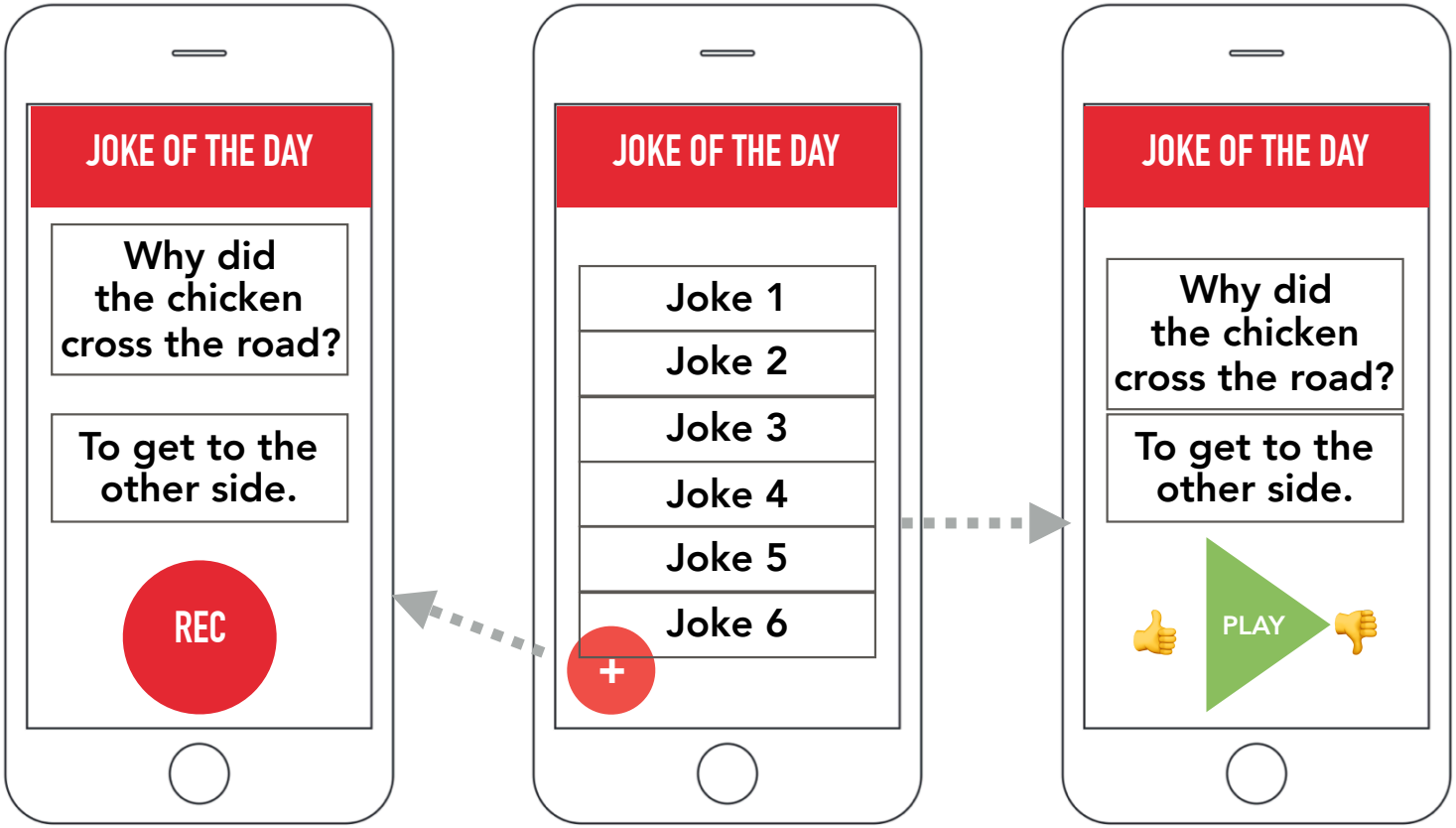
Album

DATA MODELING



ASSIGNMENT 4

ASSIGNMENT 4



THE UNIVERSITY OF CHICAGO

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BACKENDS FOR MOBILE APPLICATIONS