LIFE ON CLOUDS, A FORENSICS OVERVIEW

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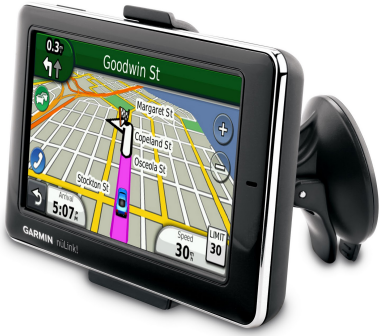
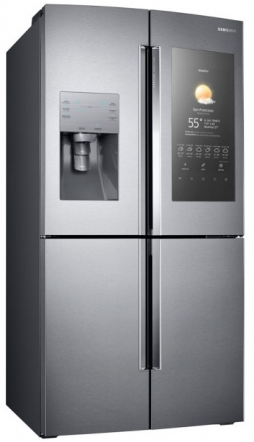
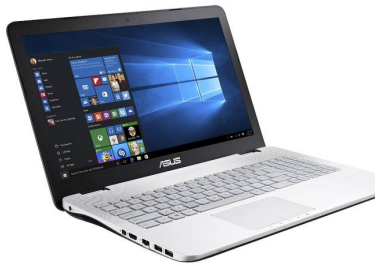
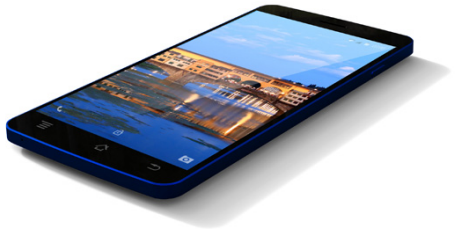
OUR DIGITAL LIFE IS ON THE CLOUD

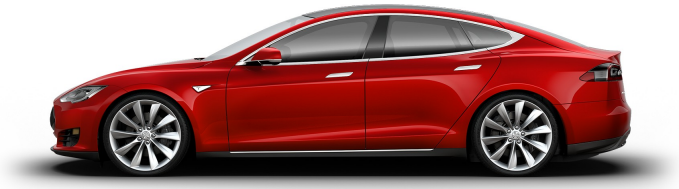
- Nowadays each digital device is, somehow, connected to the Internet
- Most of them store (meta)data on a cloud service
- We don't know exactly where and how our data is stored

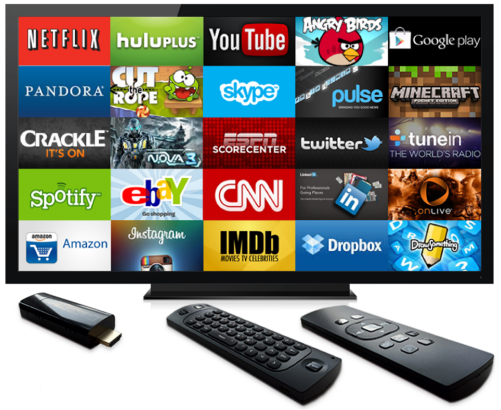












CLOUD SERVICES

- Cloud services include:
  - Storage
  - Documents
  - Email
  - Calendar
  - Applications
  - Virtual machines
  - Other services

HOW CAN WE ACCESS CLOUD STORAGE DATA?

Each vendor provides a specific client to access data other than a web browser access.

During a forensic analysis, when we know the user credentials or we have a valid token, **the usage of standard clients is absolutely unsuitable and web access is often uncomfortable**

API ACCESS

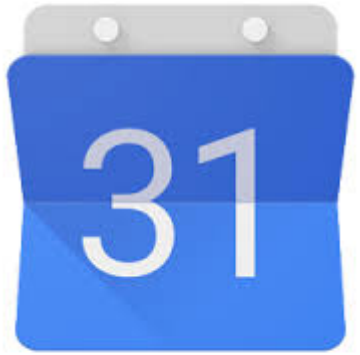
- Fortunately, all vendors provide **API (Application Program Interface)** to access data on cloud services

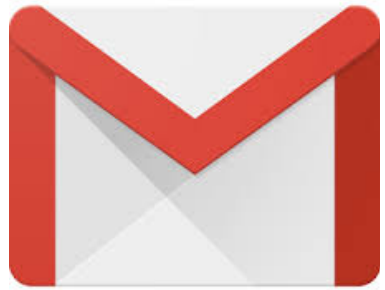
- Some forensics software for cloud acquisition rely on the APIs, some others emulate a browser and parse information, but most of them are focused on retrieving files (eventually deleted or previous versions) **ignoring almost completely all available metadata**

- During our research, we developed some pieces of software (Python scripts) that implement the vendor's API, **focusing more on metadata than on files**

CLOUD DATA STORAGE PLAYERS

- We have developed acquisition scripts for DropBox and Google (Drive and other services) and we called them «CLOUDIAN»





CLOUDIAN – API INSTALLATION

- Both DropBox and Google provide an API interface and a dedicated Python SDK
- After installing Python you need to install the proper SDKs

$ pip install dropbox

$ pip install --upgrade google-api-python-client

CLOUDIAN – REGISTER YOUR APPLICATION ON DROPBOX

- In order to register a new application you need a DropBox® account
- Go to https://www.dropbox.com/developers
- The app must have full write access
- Choose an app name
- Obtain
  - App key
  - App secret

CLOUDIAN-DBOX

Now that you have a proprer **App key** and **App secret**, you can use Python APIs to connect to a Dropbox account with proper username and password (or valid token)

```
flow = dropbox.client.DropboxOAuth2FlowNoRedirect(app_key,
app_secret)

authorize_url = flow.start()

webbrowser.open_new(authorize_url)

print ('1. Click "Allow" (you might have to log in first)')

print ("2. Copy the authorization code.")

code = raw_input("Enter the authorization code here: ").strip()

access_token, user_id = flow.finish(code)

client = dropbox.client.DropboxClient(access_token)
```

CLOUDIAN-DBOX

- Once your own App is authorized, you can easily access data and/or metadata of all files stored in the account using APIs

- First of all you can retrieve **Account Information** using the command:

```
account = client.account_info()
```

CLOUDIAN-DBOX

- Then you can retrieve the content of a particular path, for example, starting from the root and recursively browsing the complete tree:

```
metadata = client.metadata(path, list = True,
include_deleted = True)
```

- This command retrieves all **metadata** available for the specified «path» and, if it is a directory, it retrieves also metadata of contained files and subdirectories (including deleted ones)

CLOUDIAN-DBOX

- If a file has previous versions, you can **retrieve a list of all revisions** using the command:

```
revisions = client.revisions(path, rev_limit=1000)
```

- Then you can retrieve **metadata of each revision** stored on Dropbox account:

```
for revision in revisions:
    metatada = client.metadata(path, rev=revision, include_media_info=True)
```

- The include_media_info paramenter permits to collect **Exif information** stored in metadata

CLOUDIAN-DBOX

- Once you have downloaded all metadata information you can start analyzing them
- They are downloaded in JSON format, so it is quite easy to manage information
- Here is JSON sample returned by the `client.account_info()` call


```
"account information":{
        "referral_link": "https://db.tt/UE4wbELS",
        "display_name": "REALITY NET System Solutions",
        "uid": 466040986,
        "locale": "it",
        "email_verified": true,
        "email": "info@realitynet.it",
        "is_paired": false,
        "team": null,
        "name_details": {
            "familiar_name": "REALITY NET",
            "surname": "System Solutions",
            "given_name": "REALITY NET"
        },
        "country": "IT",
        "quota_info": {
            "datastores": 0,
            "shared": 0,
            "quota": 1101659111424,
            "normal": 7661774
        }
    },
```

CLOUDIAN-DBOX

- Here is the JSON describing a **Folder**

- As you can see there are some useful info:
  - The «last modified date»
  - The folder is shared with someone


```
"/RW_shared":{
        "meta":{
            "read_only":false,
            "modifier":null,
            "icon":"folder_user",
            "bytes":0,
            "thumb_exists":false,
            "rev":"4e3c55f906",
            "modified":"Fri,25 Mar 2016 09:40:23 +0000",
            "shared_folder":{
                "shared_folder_id":"1180320204",
                "is_team_only_shared_folder":false
            },
            "path":"/RW_shared",
            "is_dir":true,
            "size":"0 bytes",
            "root":"dropbox",
            "revision":78
        },
```

CLOUDIAN-DBOX

- Here is the JSON describing a **File**
- As you can see there are some useful info
  - The «**modified**» date on Dropbox server
  - The «**client_mtime**» is the last modified date on the local client
  - The file was last modified by «REALITY NET» with uid «466040986» and email «info@realitynet.it»
  - Mimetype says it is a text file but this info is not reliable because is based only on file extension
  - Notice «revision»: 5


```
"/RW_shared/sample2.txt": {
        "meta": {
            "read_only": false,
            "parent_shared_folder_id": "1180320204",
            "revision": 5,
            "bytes": 139,
            "thumb_exists": false,
            "rev": "5465a41cc",
            "modified": "Fri, 25 Mar 2016 10:32:58 +0000",
            "mime_type": "text/plain",
            "size": "139 bytes",
            "path": "/RW_shared/sample2.txt",
            "is_dir": false,
            "modifier": {
                "email_verified": true,
                "display_name": "REALITY NET System Solutions",
                "uid": 466040986,
                "email": "info@realitynet.it"
            },
            "root": "dropbox",
            "client_mtime": "Fri, 25 Mar 2016 10:32:16 +0000",
            "icon": "page_white_text"
        },
```

CLOUDIAN-DBOX

- Let's analyze another file
- As you can see there are some useful info
  - The file was «**deleted**»
  - The «modified» date says when the file was deleted
  - The last modifier does not coincide with the user who deleted the file (i know that i used another one ☺)
  - The «client_mtime» has no sense
  - It is not possible to download a deleted file: you have to find the most recent «previous version» of the deleted file
  - Notice «revision»: 6


```
"/RW_shared/sample2.txt": {
        "meta": {
            "read_only": false,
            "parent_shared_folder_id": "1180320204",
            "is_deleted": true,
            "revision": 6,
            "bytes": 0,
            "thumb_exists": false,
            "rev": "6465a41cc",
            "modified": "Fri, 25 Mar 2016 10:33:16 +0000",
            "mime_type": "text/plain",
            "size": "0 bytes",
            "path": "/RW_shared/sample2.txt",
            "is_dir": false,
            "modifier": {
                "email_verified": true,
                "display_name": "REALITY NET System Solutions",
                "uid": 466040986,
                "email": "info@realitynet.it"
            },
            "root": "dropbox",
            "client_mtime": "Wed, 31 Dec 1969 23:59:59 +0000",
            "icon": "page_white_text"
```

CLOUDIAN-DBOX

- Let's analyze a third file:
  - This one was modified by another user ☺
  - Notice that «client_mdate» and «modified» are perfectly the same, this could indicate that the file was uploaded with the web interface
  - Notice «revision»: 1


```
"/RW_shared/sample1.txt": {
        "meta": {
            "read_only": false,
            "parent_shared_folder_id": "1180320204",
            "revision": 1,
            "bytes": 30,
            "thumb_exists": false,
            "rev": "1465a41cc",
            "modified": "Fri, 25 Mar 2016 09:57:32 +0000",
            "mime_type": "text/plain",
            "size": "30 bytes",
            "path": "/RW_shared/sample1.txt",
            "is_dir": false,
            "modifier": {
                "email_verified": true,
                "display_name": "Marco Scarito",
                "uid": 24169827,
                "email": "marcoscarito@outlook.com"
            },
            "root": "dropbox",
            "client_mtime": "Fri, 25 Mar 2016 09:57:32 +0000",
            "icon": "page_white_text"
        },
```

CLOUDIAN-DBOX

Let's now have a look to all files and try to make some «intelligence»

Name	Revision	Modified	Modifier	Client-mdate	Deleted
sample1.txt	1	Fri, 25 Mar 2016 09:57:32	Marco Scarito	Fri, 25 Mar 2016 09:57:32	No
sample1.txt	2	Fri, 25 Mar 2016 10:20:39	REALITY NET System Solutions	Fri, 25 Mar 2016 10:20:34	No
sample1.txt	3	Fri, 25 Mar 2016 10:31:12	REALITY NET System Solutions	Wed, 31 Dec 1969 23:59:59	Yes
sample2.txt	4	Fri, 25 Mar 2016 10:31:12	REALITY NET System Solutions	Fri, 25 Mar 2016 10:20:34	No
sample2.txt	5	Fri, 25 Mar 2016 10:32:58	REALITY NET System Solutions	Fri, 25 Mar 2016 10:32:16	No
sample2.txt	6	Fri, 25 Mar 2016 10:33:16	REALITY NET System Solutions	Wed, 31 Dec 1969 23:59:59	Yes

CLOUDIAN-DBOX

What did we add to ensure a «forensically sound» environment?

- You can include in your «project» info about:
  - Examiner name
  - Examiner Company
- Other info are generated automatically:
  - Start date and time
  - MD5 and SHA-256 hashes based on metadata retrieved during acquisition

If you are able to «freeze» the hashes (for example you could send them immediately to your «customer» using a secure channel), you can ensure that retrieved data will not be «tampered» by anyone

CLOUDIAN-DBOX

What can we do to ensure a more «forensically sound» environment?

- We can improve the script on some fields:
  - We can retrieve «timing information» from a secure source (public NTP)
  - We can «sniff» network traffic generated by the script
  - We can improve the output data type (for example we could generate a time line)

CLOUDIAN – REGISTER YOUR APPLICATION ON GOOGLE DEVS

- In order to register a new application you need a Google account
- Go to https://console.developers.google.com
- Create a new project
- Activate API for desired service (Drive, Gmail, Calendar, …)
- Click on "Create Credential"
- Download the json file containing
  - Client ID
  - Client Secret
  - Other information

CLOUDIAN – GOOGLE

- Google Cloud Services are more complex than Dropbox
- There is a huge amount of different services on Google Cloud
  - Gmail
  - Drive
  - Calendar
  - Contacts
  - And other free services
- Moreover, there are a lot of professional services (like Cloud Computing, Cloud SQL, Cloud Virtual Networks, …)
- Each service has its own set of API constantly improved

CLOUDIAN – GOOGLE

- In our research we decided to focus only on free services:
  - Google Calendar
  - Google Drive
- The API approach is similar to the Dropbox one: you need to connect to a known account with your application in order to retrieve data from Google data centers
- All metadata are exposed as JSON objects
- In most cases you can retrieve metadata without downloading the data
- Google APIs are «forensics friendly» as you can set read only access

CLOUDIAN-GCAL

- When you access Google Calendar using APIs, you can retrieve all information about the user's calendar and all other calendars that are shared with the user

```
while True:
      calendar_list = service.calendarList().list(pageToken=page_token).execute()
      for item in calendar_list['items']:
         calendars.append(item)
      page_token = calendar_list.get('nextPageToken')
      if not page_token:
         break
```

CLOUDIAN-GCAL

USER MAIN CALENDAR	SHARED CALENDAR WITH FULL RIGHT	SHARED CALENDAR FREE/BUSY
"kind": "calendar#calendarListEntry", "foregroundColor": "#000000", "defaultReminders": […], "primary": true, "colorId": "3", "selected": true, "summary":"marco.scarito@realitynet.it", "etag": "\"1435832228655000\"", "backgroundColor": "#f83a22", "timeZone": "Europe/Rome", "accessRole": "owner", "id": "marco.scarito@realitynet.it"	"kind": "calendar#calendarListEntry", "foregroundColor": "#000000", "defaultReminders": [], "colorId": "15", "selected": true, "summary": "mattia.epifani@realitynet.it", "etag": "\"1458923654259000\"", "backgroundColor": "#9fc6e7", "timeZone": "Europe/Rome", "accessRole": "owner", "id": mattia.epifani@realitynet.it	"kind": "calendar#calendarListEntry", "foregroundColor": "#000000", "defaultReminders": [], "colorId": "22", "selected": true, "summary": "Marco Scarito", "etag": "\"1459329937764000\"", "backgroundColor": "#f691b2", "timeZone": "Europe/Rome", "accessRole": "freeBusyReader", "id": "marcoscarito@gmail.com"

CLOUDIAN-GCAL

- Analizing each single event in the JSON structure you can retrieve a lot of useful information
  - How organize the event (it should be another user)
  - Start and End date and time
  - Attendees
  - Creation date and time
  - Visibility
  - Summary
  - Recurrence
  - And much more

CLOUDIAN-GDRIVE

- When you access Google Drive using APIs, you can retrieve all information about the user activities
  - User files with previous versions
  - Deleted file
  - Google photo files
  - All files accessed by the user within the google docs platform
  - Shared files
  - And much more

CLOUDIAN-GDRIVE

- Focusing on metadata
  - For each file you have directly the MD5 hash on metadata (without downloading the file)
  - For each shared document you can access the full list of users with specific permissions
  - For multimedia files you can access specific metadata (like video length in seconds, image dimension in pixel, EXIF metadata)

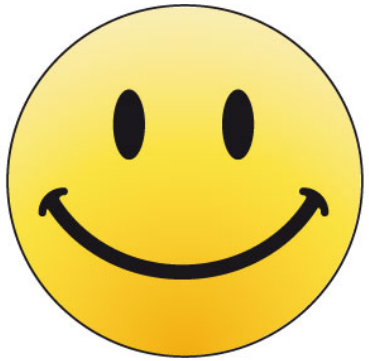
CLOUDIAN-GDRIVE

- The most interesting aspect in our research (not yet implemented) is that, using APIs, you can search for files using metadata parameters like:
  - modification date range (if you are looking for an event in a specific time period)
  - Hash value (if you are looking if a user has a specific file)
  - Camera Model (if you are looking for photos shot with a specific camera)
  - And so on…

CLOUDIAN-GDRIVE

Latest discovery:

- Analyzing my own Google Drive account I discovered that some years ago I opened a document named "plaso reinventing the super timeline - 2013 DFIR Summit.pdf" that was published as a public Google docs document



Q&A

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