Integration API Instructions

Document Version: 1.5 Release Date: 06/23/2022

MSCI

June 2022

Contents

Part I - Overview and Key Concepts

Introduction

Real Capital Analytics' Data Integration API provides a programmable interface through which DI-authorized users can access their data. By leveraging the API, RCA clients will see the following benefits:

- Retrieve the file in variety of formats, including:
  - XLS
  - XLSX
  - XML
  - JSON
  - CSV
  - TSV
- Soup-to-nuts automation of the data retrieval process
- Fresher data
- Automatic differentials
- The ability to do limited drill downs in order to retrieve a subset of permitted data

Release Notes

Release Number: 1.0
Release Date: 04/01/2013

Release 1.0 is the initial release of RCA's DI API. The primary difference from the 0.5 BETA release is the addition of the "Zone" parameter.

During the first month of release, participating clients can still receive their official DI file through the legacy delivery system; clients should continue to use their official file for production use cases.

Important URLs

Web Portal (for manual access of your data):
https://app.rcanalytics.com/#/trends/dataIntegration

Service Endpoint Root (for automated/scripted data retrieval):
https://dataintegration.rcanalytics.com/1.0/help

Documentation (i.e. most recent release of this document. Requires API Key to access)
https://app.rcanalytics.com/#/trends/dataIntegration

How It Works

Authorized users can retrieve their Data Integration data by accessing endpoints exposed through RCA's RESTful web service located here: https://dataintegration.rcanalytics.com/1.0/help

For clients who do not wish to script their retrieval process, RCA provides a Web portal that will allow you to access your data. This portal can be accessed here: https://app.rcanalytics.com/#/trends/dataIntegration

Both the service endpoints and the Web portal allow you to access your complete data set or to drill down based on any of the following criteria;

1. Zone (Americas/EMEA/AsiaPac)
2. Continent
3. Country
4. Property Type
5. Transaction Type
6. Status Date
7. Status Price

Both access methods also accommodate pulling differential data sets so that you can refresh your data on a daily, weekly or monthly schedule without having to replace your entire repository. By default, the first time you request your data (either the complete set or with a custom drill-down) you will get all transactions matching your specified criteria; subsequent requests covering the same criteria will automatically produce a differential, containing only the transactions that have been created, modified or deactivated since your last fetch. Through the API you can override this default behavior.

For more information on the Full/Diff model see Full Set vs. Differential.

All requests for data must be accompanied by an authentication token. You can obtain this token via the service's Token Request endpoint; to do so, you must provide your credentials (email + personal data integration key) and a hashed signature. Authentication tokens are only valid for a fixed amout of time, after which you'll need to get a new token. For more information on the Authentication process, see Credential/Authentication Concepts.

- The API can provide your data in a number of formats:
  - XLS (Excel 2003)
  - XLSX (Excel 2007 and above)
  - JSON
  - XML
  - CSV

- TSV

Since the API is accessed through a Web service, the retrieval process can be automated within most programming and scripting environments, for example:

- .NET
- Java
- Python
- VBA (Note: VBA does not have a native cryptography library that can support the hashing required by the API's authentication process; however, third party reference libraries can be obtained or custom libraries developed to provide this service.)

Credential/Authentication Concepts

Data Integration API Key

Each user authorized for Data Integration access will receive a personal API Key. This key is unique to each user and can be issued or changed by RCA's client services. It is required to be submitted with nearly all requests to the Data Integration API.

This key is required whether you wish to receive your data through the API or through the Web Portal.

If you forget your personal key, or suspect that it has been compromised, please email us at RCA_service@msci.com, or contact us here to obtain your key.

Initial Authentication (Requesting a Token)

The Token Request endpoint can be accessed here:
https://dataintegration.rcanalytics.com/1.0/request_token?

All data requests made to the API must include an authentication token. To retrieve this token, all API sessions should begin with a call to the Request Token endpoint. Upon successful authentication of the user credentials, an authentication token will be returned that must be passed along with any subsequent data requests.

To request a token you must create a query from the correct parameters:

1. User's Email Address
2. User's RCA API DI Key

3. Nonce . (See Appendix A: auth_nonce for creating a nonce)
4. Timestamp (See Appendix A: auth_timestamp for creating a timestamp)
5. Normalized URL
6. Normalized QueryString Parameters

The url, email address, timestamp, nonce and parameters are Hashed together with the RCA API DI Key to create a signature, which is used to verify the legitimacy and correctness of the request. (See Appendix A: auth_signature for creating valid signatures)

The API is then called by submitting the Normalized URL + the Normalized QueryString Parameters + the signature to the Token Request Endpoint. (See Part II: To Request a Token (Login))

Note: You should verify that the token is still valid (determined by the time it was originally acquired + the number of seconds in the expires property in the token endpoint response). Using an expired token may result in the account being temporarily locked out.

Retrieving Data

Data Formats

Via Service Endpoints

- XLS (Excel 2003)
- XLSX (Excel 2007 and above)
- JSON
- XML
- CSV
- TSV

Via Web Portal

- Excel (XLSX, Excel 2007 and above)
- CSV
- XML

Complete Set vs. Custom Drill-Down

When accessing your data, you may request your complete data set (i.e. all transactions permitted by your subscription) or a subset of your data by specifying filter criteria based on:

- Continent
- Country
- Property Type

- Transaction Type
- Status Date
- Status Price

We anticipate that most clients will prefer to access their complete data set and perform any desired filtering after the data has been integrated into their internal systems. However, authorized users who specialize in a specific geographic region or specific asset class may see value in only accessing the data they intend to directly consume; such users may prefer to request a custom drill-down.

Both the service endpoints and the Web portal support either type of request.

Full Set vs. Differential

By default the first time you access your data, you will receive all transactions matching your specified criteria (i.e. either the full data set or a custom drill down) permitted by your subscription. Once you have received a full version of a particular data set, later requests for the same data will, by default, be a differential; that is, they will only contain transactions entered, modified or deactivated since your last access.

Merging to a Repository

In order to facilitate merging differentials into any internal repository you may have created, your data set will include the following data points:

- **Active_fg**
  Values: 1 | 0
  Description: On occasion, RCA may determine that a previously reported transaction does not truly meet its criteria for data quality. In such cases, the transaction will be deactivated and therefore excluded from the active data set. Such transactions will appear in your Differential with Active_fg = 0 (FALSE); these transactions should be removed from your repository. When you receive a full data set, you will only receive active transactions.
- **ModifcationType_tx**
  Values: Created | Modified | Deactivated
  Description: This column indicates why the transaction is appearing: a new transaction entered by RCA, existing transaction whose data was modified, or a de-activated transactions (i.e. Active_fg = 0). These values are designed to help you navigate the data merging decision fork; in general:
  - Created transactions should be Inserted into your repository
  - Modified transactions should be Updated in your repository (note: some systems handle Updates with a Delete then re-Insert methodology)
  - Deactivated transactions should be Deleted from your repository

Managing Diff Chains

Note that each user request will spawn its own differential chain. In other words, a request for a complete data set will start one chain; a request for just those transactions in Europe would start a different chain. Each DI authorized user within a firm will have their own differential chains.

For example:

- On January 1st, Anna from ABC Corp. requests her complete data set (i.e., she leaves all optional parameters blank). Since this is her initial request, she will receive all transactions permitted by her subscription.
- On January 2nd, Anna again requests her complete data set; by default, she will receive a differential data set reflecting any changes to transactions made by RCA on or after January 1st.
- On January 3rd, Anna requests all transactions involving Dev Sites in China. This will return the full data set of Chinese Dev Sites.
- Also on January 3rd, Bill from ABC Corp requests his complete data set. He will receive the full set as his differential chain is unique from his Anna's.
- On January 4th, Anna once again requests her complete set (all subscribed countries and property types); she will receive a differential containing all transactions created or modified by RCA since January 2nd (the last time this particular request was submitted).
- On January 5th, Anna requests the Chinese Dev Site set; she will receive a differential containing all Chinese Dev Site transactions created or modified by RCA since January 3rd (the last time this particular request was submitted).
- Lastly, on January 5th, Bill requests his complete data set. This time he will receive a differential reflecting any changes to transactions made by RCA on or after January 3rd (the last time he requested his complete set; again, his diff chain is completely independent from Anna's).

Requesting a Differential via the Web Portal

When you access Data Integration Web Portal you will see a list of your previous requests in the lower right, along with the data request that was last processed.

Clicking on one of these Data Integration requests will reset the form to match the criteria in that request, as well as automatically changing the Diff settings to match the

last request date. Submitting this request will result in a differential delivered in your desired format.

Overriding the Default Behavior

User can easily override the default behavior and reset their diff chain back to a full set of transactions, or request a custom differential (e.g. request all transactions that were entered or modified in November).

To request a full set of transactions:

- Using the service endpoints:
  Pass in the Full_fg parameter set to True
- Using the Web Portal:
  Click the radio button labeled Full

To request a custom Differential:

- Using the service endpoints:
  Pass in the ChangedSinceMin_dt and/or ChangedSinceMax_dt parameters set to the appropriate dates
- Using the Web Portal:
  Click the radio button labeled Diff and supply a date value

Real Capital Analytics Data Refresh Schedule

RCA refreshes the data available to their Web and Data Integration clients on a nightly basis; this process generally completes at approximately 10:00 AM EST/EDT.

Note that on rare occasions the data refresh process may not occur as scheduled, whether due to system failure or planned maintenance. If this occurs, and a client requests a differential before the next successful refresh, that differential may be not have the most up to date transactions. Our differential mechanism contains fault tolerance designed to ensure that this situation will be corrected on the next data fetch.

For example, if you have built an automated system to fetch a differential at 10 AM daily and the data refresh process is delayed for several hours on Monday, your Monday differential may be empty. This situation would be resolved on Tuesday – that day's differential will contain transactions created or modified since Monday.

Communicating with the API

The Data Request endpoint can be accessed here:

https://dataintegration.rcanalytics.com/1.0/ReturnStream?

https://dataintegration.rcanalytics.com/1.0/ReturnStreamByID?

Retrieving Data from the API is very similar to requesting a Login Token. Most of the same steps will occur, with two significant changes to the authorization step:

1. The group of parameters that is hashed will also include the auth token
2. And The key that the string is hashed by will also include the auth token "secret" as well as the user's Data Integration key

To begin a streaming data session, the calling machine needs to create a query from the correct parameters:

1. User's Email Address
2. User's RCA API DI Key
3. Token
4. Token's Secret
5. Nonce
6. Timestamp
7. Normalized URL
8. Normalized QueryString Parameters

The url, email address, Auth Token, timestamp, nonce and parameters are Hashed together with the RCA API DI Key and Token's Secret via the steps above to create a signature.

The API is then called by submitting the Normalized URL + the Normalized QueryString Parameters + the signature.

Data Integration Results as Stream

If the request is valid, the API will respond with a STREAM of the file type requested. The simplest thing to do with this stream is to stream it to a file on disk and open the resulting file in Excel.

This stream response also includes three informational headers: status: will be "ok" for a good request, will say "error:" and a message for any errors row-count

For most requests, the RCA API is able to supply a row count for the result set. saved-di-id Each unique request is saved in our database with a unique ID.

Wait Times

Larger files, such as when a query is run for the first time, can take up to 15 minutes and may provide a file with up to 1,048,576 rows (this is the max rows limit for all file types except JSON and XML). You should abort the request if the response body hasn't started streaming within 15 minutes as the request at that time is regarded as idle and

the server will not send any reponse. If you experience long wait times we encourage you to batch your requests to get data for example by year or country. Smaller files (one country or property type, or a differential file) will take much less time to be returned from the system.

Part II - Technical Reference

API Endpoints

RCA's Data Integration API provides several endpoints for the tasks you will wish to perform. A listing of the provided endpoints is accessible at the following URL:

https://dataintegration.rcanalytics.com/1.0/help

The API provides four classes of endpoints:

- Login/Authentication
- Data Retrieval
- Saved Data Integration Maintenance
- Informational

Note: Saved Data Integration Maintenance is not covered in this document; it is a feature used by the Web Portal and allows you to tag your previous DI requests with a custom name.

Login/ Authentication Endpoints

To Request a Token (Login)

Description All data requests made to the API must include an authentication token. To retrieve this token, all API sessions should begin with a call to the Request Token endpoint. Upon successful authentication of the user credentials an authentication token will be returned; this token must be passed along with any subsequent data requests.

Note: You should verify that the token is still valid (determined by the time it was originally acquired + the number of seconds in the expires property in the token endpoint response). Using an expired token may result in the account being temporarily locked out.

URL: https://dataintegration.rcanalytics.com/1.0/request_token?
Inputs:

Input Parameter	Description	Required

auth_consumer_key	user's email address	Y
auth_nonce	unique random number	Y
auth_signature_method	HMAC-SHA1	Y
auth_timestamp	seconds since 1970	Y
auth_version	1.0 is the only valid value	Y
auth_signature	Hashed message signature	Y

Example request:

https://dataintegration.rcanalytics.com/1.0/request_token?auth_consumer_key=testuser@rcanalytics.com&auth_ nonce=8194437&auth_signature_method=HMAC-SHA1&auth_timestamp=1383845695&auth_version=1.0&auth_signature=RONpvx9fo5gJf0kTsN0yLOmefVg=

Output

This endpoint returns a JSON package containing the following data points:

Output Data Point	**Description**
auth_token	The token itself
auth_token_secret	The token's secret
auth_token_refresh	The token's refresh token
expires	The time, in minutes, the token is valid for

Data Retrieval Endpoints

Retrieve Data Using Text/Values

Description Once you have received, or refreshed, your Authentication token you can request your full data set, a differential based on your last extract date, or a custom drill-down.

URL: https://dataintegration.rcanalytics.com/1.0/ReturnStream?
Inputs

Input Parameter	**Description**	**Required**
auth_consumer_key	user's email address	Y
auth_nonce	unique random number	Y
auth_signature_method	HMAC-SHA1	Y

auth_timestamp	seconds since 1970	Y
auth_token	The Authentication Token returned from the original token request	Y
auth_version	1.0 is the only valid value	Y
ChangedSinceMax_dt	End (latest) date in YYYY-MM-DD format to search for a changed record	N
ChangedSinceMin_dt	Start (earliest) date in YYYY-MM-DD format to search for a changed record	N
Continent_tx	Name of a Continent to retrieve records for	N
Country_tx	Name of a Country to retrieve records for. RCA's DI API will recognize • Country names, • ISO 2-Digit Country Codes • ISO 3-Digit country codes	N
FileType_tx	One of the six provided filetypes: • xls: Excel 2003 • xlsx : Excel 2007 • csv : Comma Separated Values • tsv: Tab Separated Values • xml: XML • json: JSON	N
full_fg	Boolean (true or false) flag to override automatic Differential management. If set to true, ChangedSinceMin_dt and ChangedSinceMax_dt is ignored.	N
PriceMax_amt	Highest Deal Price	N
PriceMin_amt	Lowest Deal Price	N
PropertyType_csv	Comma Separated list of Property Types to retrieve records for (see Retrieve Lookup Information)	N
Region_tx	Name of a US Region to retrieve records for (for US Clients Only)	N
SourceFile_tx	Data Integration File to return results for	N
Status_tx	Deal Status	N

StatusMax_dt	End (latest) date in YYYY-MM-DD format to search for a transaction	N
StatusMin_dt	Start (earliest) date in YYYY-MM-DD format to search for a transaction	N
TransSubType_csv	Comma Separated list of Trans Sub Types to retrieve records for (see Retrieve Lookup Information)	N
Zone_tx	Name of a Zone to retrieve records for	N
auth_signature	Hashed message signature	Y

Example Request:

https://dataintegration.rcanalytics.com/1.0/ReturnStream?auth_consumer_key=testuser@rcanalytics.com&auth_nonce=8194437&auth_signature_method=HMACSHA1&auth_timestamp=1383845695&auth_token=2413AE9DA44042B191F&auth_version=1.0&ChangedSinceMax_dt=&ChangedSinceMin_dt=&Continent_tx=&Country_tx=United%20States&FileType_tx=xlsx&full_fg=False&PriceMax_amt=&PriceMin_amt=&PropertyType_csv=Office,Hotel,Retail&Region_tx=&SourceFile_tx=&Status_tx=&StatusMax_dt=&StatusMin_dt=&TransSubType_csv=&Zone_tx=&auth_signature=5Dnj2nfuKCAZ90uy6ENtheiSBa0=

Parameter Encoding

Continent, Country, Region (US Only), Property Type, TransSubType and SourceFile all should be URLEncoded before hashing or submission. The Data Integration API will URLDecode these parameters automatically.

Output

This endpoint returns a streaming file, in the file type requested, with the following informational headers:

Header	**Description**
status	“ok” for a good request or a description of an error
row-count	For most requests, the RCA API is able to supply a row count for the result set.
saved-di-id	Each unique request is saved in our database with a unique ID
Content-Type	The appropriate content type
Content-Disposition	An automatically generated filename. The file name used is a GUID, and is our internal tracking ID for this DI request.

Retrieve Data Using ID/Keys

Description This end point operates in the same fashion as the "Retrieve Data Using Text/Values" endpoint, except that it takes ID's instead of full text criteria.

Lookup tables are available at this endpoint:
https://dataintegration.rcanalytics.com/1.0/ReturnLookupTable?

The following lookup tables are available: Continent, Country, CountryISO2, CountryISO3, Status, PropertyType, TransSubType

URL: https://dataintegration.rcanalytics.com/1.0/ReturnStreamByID?

Input Parameter	Description	Required
auth_consumer_key	user's email address	Y
auth_nonce	unique random number	Y
auth_signature_method	HMAC-SHA1	Y
auth_timestamp	seconds since 1970	Y
auth_token	The Authentication Token returned from the original token request	Y
auth_version	1.0 is the only valid value	Y
ChangedSinceMax_dt	End (latest) date in YYYY-MM-DD format to search for a changed record	N
ChangedSinceMin_dt	Start (earliest) date in YYYY-MM-DD format to search for a changed record	N
Continent_id	ID of a Continent to retrieve records for (see Retrieve Lookup Information)	N
Country_id	ID of a Country to retrieve records for (see Retrieve Lookup Information)	N
FileType_tx	One of the six provided filetypes: • xls: Excel 2003 • xlsx : Excel 2007 • csv : Comma Separated Values • tsv: Tab Separated Values • xml: XML • json: JSON	N

full_fg	Boolean (true or false) flag to override automatic Differential management. If set to true, ChangedSinceMin_dt and ChangedSinceMax_dt is ignored.	N
PriceMax_amt	Highest Deal Price	N
PriceMin_amt	Lowest Deal Price	N
PropertyType_csv	Comma Separated list of Property Type ID's to retrieve records for (see Retrieve Lookup Information)	N
Region_id	ID of a US Region to retrieve records for (see Retrieve Lookup Information)	N
SourceFile_tx	Data Integration File to return results for	N
Status_id	Deal Status ID	N
StatusMax_dt	End (latest) date in YYYY-MM-DD format to search for a transaction	N
StatusMin_dt	Start (earliest) date in YYYY-MM-DD format to search for a transaction	N
TransSubType_csv	Comma Separated list of Trans Sub Type ID's to retrieve records for (see Retrieve Lookup Information)	N
Zone_id	ID of a Zone to retrieve records for (see Retrieve Lookup Information)	N
auth_signature	Hashed message signature	Y

Example Request: https://dataintegration.rcanalytics.com/1.0/ReturnStreamByID?auth_consumer_key=testuser@rcanalytics.com&auth_nonce=8194437&auth_signature_method=HMACSHA1&auth_timestamp=1383845695&auth_token=2413AE9DA44042B191F&auth_version=1.0&ChangedSinceMax_dt=&ChangedSinceMin_dt=&Continent_id=&Country_id=1&FileType_tx=xlsx&full_fg=False&PriceMax_amt=&PriceMin_amt=&PropertyType_csv=3,4,6&Region_id=&SourceFile_tx=&Status_id=&StatusMax_dt=&StatusMin_dt=&TransSubType_csv=&Zone_ id=&auth_signature=5Dnj2nfuKCAZ90uy6ENtheiSBa0=

Output This endpoint returns a streaming file, in the file type requested, with the following informational headers:

Did Something Go Wrong?

Description The endpoints will supply the user with a JSON Package that contains an error code indicating what sort of issue with the Authentication step has occurred.

Header	Description
status	"ok" indicates successful request, otherwise a description of an error.
row-count	For most requests, the RCA API is able to supply a row count for the result set.
saved-di-id	Each unique request is saved in our database with a unique ID
error	Only present if there was an error in the request/response in which case it will contain a description of the error. See Appendix C: Errors and Troubleshooting for more details

Informational Endpoints

Server Time

Description For synchronizing timestamps, Data Integration API provides an endpoint that supplies the current server time, in seconds since January 1, 1970, Universal Coordinated Time (UTC)

URL: https://dataintegration.rcanalytics.com/1.0/Servertime

Retrieve Lookup Information

Description For ease of use of the "Retrieve Data By ID Criteria" endpoint, RCA's Data Integration API provides a lookup endpoint to retrieve the ID values used by RCA for the

ID values used by RCA to describe our data. Using the ID values is a faster and more accurate way to query the Data Integration API.

URL:

https://dataintegration.rcanalytics.com/1.0/ReturnLookupTable?

dataType	One of the following values to return RCA's Lookup Table for that Data Type: • Zone • Continent • Country • Region • CountryISO2 • CountryISO3 • Status • PropertyType • TransSubType

Example Request:
https://dataintegration.rcanalytics.com/1.0/ReturnLookupTable?dataType=country

Output This endpoint returns a JSON package containing an array of item id's and item text's. The geography parameters for Continent, Country and Region also expose their parent geography ID's. This enables a tree to be made of RCA's Geography.

Data Type	**ID Column Name**	**Text Column Name**	**Parent ID Column Name**
Zone	Zone_id	Zone_tx	
Continent	Continent_id	Continent_tx	Zone_id
Country	Country_id	Country_tx	Continent_id
CountryISO2	Country_id	ISO_tx	
CountryISO3	Country_id	ISO3Char_tx	
Region	Region_id	Region_tx	Country_id
Status	Status_id	Status_tx	
PropertyType	PropertyType_id	PropertyType_tx	
TransSubType	TransSubType_id	TransSubType_tx	

Part III - Code Samples and Appendices

Code Samples

Creating Nonces

A nonce is a simple random number used to provide an ever-changing amount of uniqueness to a request. RCA suggests generating a nonce of at least 6 digits

```
private string GenerateNonce()
{
   Random random = new Random();
   return random.Next(123400, 9999999).ToString();
}
```

Creating TimeStamps

```
private string GenerateTimeStamp()
{
   TimeSpan ts = DateTime.UtcNow - new DateTime(1970, 1, 1, 0, 0, 0, 0);
   string timeStamp = ts.TotalSeconds.ToString();
   timeStamp = timeStamp.Substring(0, timeStamp.IndexOf("."));
   return timeStamp;
}
```

Normalizing Query Parameters

Query Parameters, even empty ones, have to be normalized (alphabetized) so that the resultant signature hash can always be regenerated and matched by the API.

By making a List of QueryParameter Objects (which are name-value pairs)
List<QueryParameter> parameters;

And adding to it all of the request parameters and auth parameters:

```
...
parameters.Add(new QueryParameter(“version”, version));

...
parameters.Add(new QueryParameter(“full_fg”, full_fg));
```

For query requests, the token MUST be included as a query parameter:

```
parameters.Add(new QueryParameter(“auth_token”, token));
```

A sortable list is created, which can be sorted by a standard bubble sort:

```
parameters.Sort(new QueryParameterComparer());
```

QueryParameter

This is an example of the name-value object used for QueryParameters.

```
public class QueryParameter
{
   private string name = null;
   private string value = null;

   public QueryParameter(string name, string value)
   {
      this.name = name;
      this.value = value;

   }
   public string Name
   {
      get { return name; }
   }
   public string Value
   {
      get { return value; }
   }
}
```

QueryParameterComparer

This is an example of a bubble-sort comparer used to sort for the QueryParameter list.

```
public class QueryParameterComparer : IComparer<QueryParameter>
{
   public int Compare(QueryParameter x, QueryParameter y)
   {
       if (x.Name == y.Name)
      {
         return string.Compare(x.Value, y.Value);
      }
      else
      {
     return string.Compare(x.Name, y.Name);
      }
    }
}
```

Signature Base

After parameter sorting, the QueryString is considered “normalized” and can be used in creating the signature for the signed request.

```
private string GenerateSignatureBase(string httpMethod, string normalizedUrl, string
normalizedRequestParameters)
{
   StringBuilder signatureBase = new StringBuilder();
      signatureBase.AppendFormat("{0}&", httpMethod.ToUpper());
     signatureBase.AppendFormat("{0}&", UrlEncode(normalizedUrl));
     signatureBase.AppendFormat("{0}", UrlEncode(normalizedRequestParameters));
     return signatureBase.ToString();
}
```

Hashing the Base

The signature is made by Hashing the signature base with the user’s RCA API DI Key and supplied token secret, if available:

```
HMACSHA1 hmacsha1 = new HMACSHA1();
hmacsha1.Key = Encoding.ASCII.GetBytes(string.Format("{0}&{1}",
UrlEncode(api_di_key), string.IsNullOrEmpty(auth_secret) ? "" : UrlEncode(auth_secret)));
byte[] dataBuffer = System.Text.Encoding.ASCII.GetBytes(signatureBase);

byte[] hashBytes = hmacsha1.ComputeHash(dataBuffer);
string signature = Convert.ToBase64String(hashBytes);
```

Appendix A: OAuth Parameters

OAuth 1.0

In order to communicate with the RCA's Data Integration API, signed requests need to be submitted. Signed requests ensure the validity of the request and the authenticity of the calling party. RCA has adopted the basics of the OAuth 1.0 "two-legged" standard for an authentication model. Each request is signed with the user's RCA API DI Key, and all data requests also require a unique token.

OAuth Concepts

Token

To begin communication with the Data Integration API, a token is required. The token consists of four parts: the token, the token's "secret", and an expiry in minutes. The token will need to be refreshed when it expires. Both the token and the "secret" are needed to sign requests.

Request

A request is a call to a Data Integration API endpoint. It takes the familiar form of a URL with a query string containing the parameters and values that are being submitted to the Data Integration API.

Signed Requests

Each request to the Data Integration API has to be signed. A signature is a hash (HMAC-SHA1) of the request made with the user's Data Integration API Key and the token "secret" as a key.

Simplified Example

User's DI Key: 123456
Token Secret: abcdef
Request:
http://dataintegration.rcanalytics.com/1.0/RequestInfo?param1=abc&param2=xyz

A Key for the Hash function is made by appending the User's DI Key and the Token Secret together: 123456&abcdef

The Request's Hash is then computed using this key and is appended to the request as the signature. This process is repeated on the Data Integration API server, if it matches, the request is considered valid and is processed.

Required Members of a Request

auth_consumer_key

The auth_consumer_key used by the API is the subscribing user's email address. This email address MUST be associated with the Account and Subscription that has Data Integration access assigned to it. Please check with your customer contact at RCA to confirm this.

auth_nonce

A client-generated, unique random number

Creating Nonces
A nonce is a simple random number used to provide an ever-changing amount of uniqueness to a request. RCA suggests generating a nonce of at least 6 digits.

auth_signature_method

The auth_signature_method is the form of hashing that the auth_signature is created with. RCA only supports the HMAC-SHA1 specification.

auth_timestamp

The timestamp is expressed in seconds since January 1, 1970 (a UNIX Timestamp). The service will not accept requests that are more than 120 seconds in difference from the time on the server.

Current Server Time The Current Server time, for synchronization purposes, expressed as seconds from 1/1/1970, is available at this endpoint:
https://dataintegration.rcanalytics.com/1.0/Servertime

auth_token

The auth_token is returned as part of a successful login as a JSON response. Each token has a four(4) hour lifespan. A typical token takes this format:

```
{
   "auth_token":"E6E754B1635048C899B",
   "auth_token_secret":"44D063311B4B4ABAB0F",
   "auth_token_refresh":"E665B2B4D26D42228CC",
   "expires":"240"
}
```

This token has 4 parts:

1. The token itself
2. The token's secret
3. The token's refresh token
4. The time, in minutes, that the token is valid for

auth_token_refresh

Currently not used.

auth_version

1.0, which stands for "OAuth 1.0" is the only valid value for the Data Integration API

auth_signature

The auth_signature contains the user's DI key, hashed together with the full request url.

Creating the Signature

The signature, for all requests, is made using the same formula:

1. The HttpRequest Method Type is always "GET"
2. The URL has to be normalized, including the Scheme (HTTPS) and Host (dataintegration.rcanalytics.com): https://dataintegration.rcanalytics.com
3. The request parameters also have to be normalized, with each parameter in the Querystring sorted into alphabetical order by parameter.

   The list of parameters MUST include:
   a. auth_consumer_key
   b. auth_nonce
   c. auth_signature_method
   d. auth_timestamp
   e. auth_token if available. Do not add when requesting a new token
   f. auth_version Version, currently 1.0
   g. And all (even empty) parameters of the query itself.

Normalizing Query Parameters

Query Parameters, even empty ones, have to be normalized (alphabetized) so that the resultant signature hash can always be regenerated and matched by the API.

By making a List of QueryParameter Objects (which are name-value pairs), and adding to it all of the request parameters and auth parameters, a sortable list is created, which can be sorted by a standard bubble sort. For query requests, the token MUST be included as a query parameter:

Signature Base

After parameter sorting, the QueryString is considered "normalized" and can be used in creating the signature for the signed request.

From the HttpRequest Method Type, Normalized URL and the Normalized Request Parameters, a UrlEncoded signature base string must be created.

https://dataintegration.rcanalytics.com/1.0/ReturnStream?auth_consumer_key=testuser@rcanalytics.com&auth_nonce=8194437&auth_signature_method=HMACSHA1&auth_timestamp=1383845695&auth_version=1.0&ChangedSinceMax_dt=&ChangedSinc

eMin_dt=&Zone_
id=&Continent_id=&Country_id=United%20States&FileType_tx=xlsx&Full_fg=False&PriceMax_amt=&PriceMin_a
mt=&PropertyType_csv=Office,Hotel,Retail&Status_id=&StatusMax_dt=&StatusMin_dt=
&TransSubType_csv=

Hashing the Base

The signature is made by Hashing the signature base (the above URL) with the user's RCA API DI Key and supplied token secret. The resulting signature is then appended to the end of the query.

Notes

- Login requests only use the user's RCA DI API Key as the Hash Key.
- Query requests use the user's RCA DI API Key and the token's secret as the Hash Key.
- All query requests must include a token.

Appendix B: Data Integration Query Parameters

ChangedSinceMax_dt

End (latest) date to search for a changed record. Format of YYYY-MM-DD.

ChangedSinceMin_dt

Start (earliest) date to search for a changed record. Format of YYYY-MM-DD.

Zone_tx

Name of a Zone to retrieve records for

Continent_tx

Name of a Continent to retrieve records for

Country_tx

Name of a Country to retrieve records for

FileType_tx

One of the six provided filetypes:

- xls: Excel 2003
- xlsx : Excel 2007
- csv : Comma Separated Values
- tsv: Tab Separated Values
- xml: XML
- json: JSON

Full_fg

Boolean (true or false) flag to override automatic differential management.

PriceMax_amt

Highest Deal Price

PriceMin_amt

Lowest Deal Price

PropertyType_csv

Comma Separated list of Property Types to retrieve records for

SourceFile_tx

Name of the Data Integration file for your company

Status_tx

Deal Status

StatusMax_dt

End (latest) date to search for a transaction. Format of YYYY-MM-DD.

StatusMin_dt

Start (earliest) date to search for a transaction. Format of YYYY-MM-DD.

TransSubType_csv

Comma Separated list of Trans Sub Types to retrieve records for

Appendix C: Errors and Troubleshooting

Invalid email address

The email address used to make the request is not properly formatted

Invalid user

The email given does not link to a valid account

You do not have access to DataIntegration

The email address used to make the request is not part of a subscription that has access to Data Integration

Nonce already used

The “nonce” number provided with the request has already been used once. Randomize the number on a larger scale.

Invalid timestamp

The “timestamp” field must be the current time when the request was sent, and will not be accepted if it’s too far in the past, or in the future.

Request not properly signed

The signature provided does not match the signature computed by the server, this is often caused by properties being out of order.

Invalid token

The Token provided has already expired. This can happen if multiple requests are made with the same credentials. The new token can invalidate a previous token.

Too many rows in result

All file formats other than JSON and XML are limited to 1,048,576 rows. If the response generated by the request exceeds this limit you’ll get the following error message “The request exceeds the Excel row limit. Please add additional filters to your request.”

Notice and disclaimer

This document and all of the information contained in it, including without limitation all text, data, graphs, charts (collectively, the "Information") is the property of MSCI Inc. or its subsidiaries (collectively, "MSCI"), or MSCI's licensors, direct or indirect suppliers or any third party involved in making or compiling any Information (collectively, with MSCI, the "Information Providers") and is provided for informational purposes only. The Information may not be modified, reverse-engineered, reproduced or redisseminated in whole or in part without prior written permission from MSCI. All rights in the Information are reserved by MSCI and/or its Information Providers.

The Information may not be used to create derivative works or to verify or correct other data or information. For example (but without limitation), the Information may not be used to create indexes, databases, risk models, analytics, software, or in connection with the issuing, offering, sponsoring, managing or marketing of any securities, portfolios, financial products or other investment vehicles utilizing or based on, linked to, tracking or otherwise derived from the Information or any other MSCI data, information, products or services.

The user of the Information assumes the entire risk of any use it may make or permit to be made of the Information. NONE OF THE INFORMATION PROVIDERS MAKES ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATIONS WITH RESPECT TO THE INFORMATION (OR THE RESULTS TO BE OBTAINED BY THE USE THEREOF), AND TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, EACH INFORMATION PROVIDER EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES (INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF ORIGINALITY, ACCURACY, TIMELINESS, NON-INFRINGEMENT, COMPLETENESS, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY OF THE INFORMATION.

Without limiting any of the foregoing and to the maximum extent permitted by applicable law, in no event shall any Information Provider have any liability regarding any of the Information for any direct, indirect, special, punitive, consequential (including lost profits) or any other damages even if notified of the possibility of such damages. The foregoing shall not exclude or limit any liability that may not by applicable law be excluded or limited, including without limitation (as applicable), any liability for death or personal injury to the extent that such injury results from the negligence or willful default of itself, its servants, agents or sub-contractors.

Information containing any historical information, data or analysis should not be taken as an indication or guarantee of any future performance, analysis, forecast or prediction. Past performance does not guarantee future results.

The Information should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions. All Information is impersonal and not tailored to the needs of any person, entity or group of persons.

None of the Information constitutes an offer to sell (or a solicitation of an offer to buy), any security, financial product or other investment vehicle or any trading strategy.

It is not possible to invest directly in an index. Exposure to an asset class or trading strategy or other category represented by an index is only available through third party investable instruments (if any) based on that index. MSCI does not issue, sponsor, endorse, market, offer, review or otherwise express any opinion regarding any fund, ETF, derivative or other security, investment, financial product or trading strategy that is based on, linked to or seeks to provide an investment return related to the performance of any MSCI index (collectively, "Index Linked Investments"). MSCI makes no assurance that any Index Linked Investments will accurately track index performance or provide positive investment returns. MSCI Inc. is not an investment adviser or fiduciary and MSCI makes no representation regarding the advisability of investing in any Index Linked Investments.

Index returns do not represent the results of actual trading of investible assets/securities. MSCI maintains and calculates indexes, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the index or Index Linked Investments. The imposition of these fees and charges would cause the performance of an Index Linked Investment to be different than the MSCI index performance.

The Information may contain back tested data. Back-tested performance is not actual performance, but is hypothetical. There are frequently material differences between back tested performance results and actual results subsequently achieved by any investment strategy.

Constituents of MSCI equity indexes are listed companies, which are included in or excluded from the indexes according to the application of the relevant index methodologies. Accordingly, constituents in MSCI equity indexes may include MSCI Inc., clients of MSCI or suppliers to MSCI. Inclusion of a security within an MSCI index is not a recommendation by MSCI to buy, sell, or hold such security, nor is it considered to be investment advice.

Data and information produced by various affiliates of MSCI Inc., including MSCI ESG Research LLC and Barra LLC, may be used in calculating certain MSCI indexes. More information can be found in the relevant index methodologies on www.msci.com.

MSCI receives compensation in connection with licensing its indexes to third parties. MSCI Inc.'s revenue includes fees based on assets in Index Linked Investments. Information can be found in MSCI Inc.'s company filings on the Investor Relations section of www.msci.com.

MSCI ESG Research LLC is a Registered Investment Adviser under the Investment Advisers Act of 1940 and a subsidiary of MSCI Inc. Except with respect to any applicable products or services from MSCI ESG Research, neither MSCI nor any of its products or services recommends, endorses, approves or otherwise expresses any opinion regarding any issuer, securities, financial products or instruments or trading strategies and MSCI's products or services are not intended to constitute investment advice or a recommendation to make (or refrain from

making) any kind of investment decision and may not be relied on as such. Issuers mentioned or included in any MSCI ESG Research materials may include MSCI Inc., clients of MSCI or suppliers to MSCI, and may also purchase research or other products or services from MSCI ESG Research. MSCI ESG Research materials, including materials utilized in any MSCI ESG Indexes or other products, have not been submitted to, nor received approval from, the United States Securities and Exchange Commission or any other regulatory body.

Any use of or access to products, services or information of MSCI requires a license from MSCI. MSCI, Barra, RiskMetrics, IPD and other MSCI brands and product names are the trademarks, service marks, or registered trademarks of MSCI or its subsidiaries in the United States and other jurisdictions. The Global Industry Classification Standard (GICS) was developed by and is the exclusive property of MSCI and S&P Global Market Intelligence. "Global Industry Classification Standard (GICS)" is a service mark of MSCI and S&P Global Market Intelligence.

MIFID2/MIFIR notice: MSCI ESG Research LLC does not distribute or act as an intermediary for financial instruments or structured deposits, nor does it deal on its own account, provide execution services for others or manage client accounts. No MSCI ESG Research product or service supports, promotes or is intended to support or promote any such activity. MSCI ESG Research is an independent provider of ESG data, reports and ratings based on published methodologies and available to clients on a subscription basis. We do not provide custom or one-off ratings or recommendations of securities or other financial instruments upon request.

Privacy notice: For information about how MSCI collects and uses personal data, please refer to our Privacy Notice at https://www.msci.com/privacy-pledge.