Altera Cyclone V HPS-FPGA

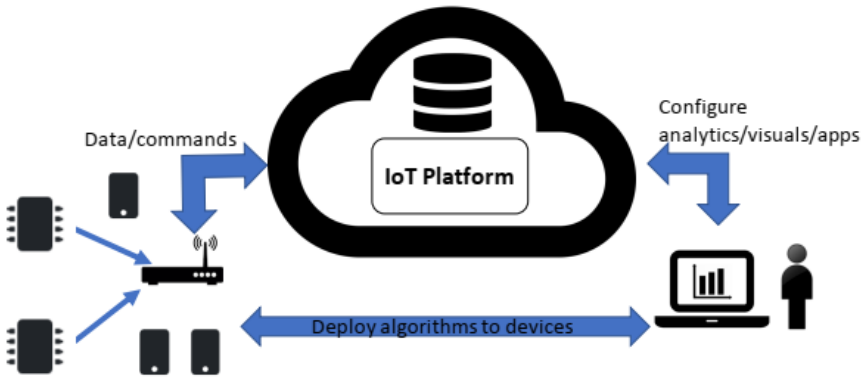
Thingspeak IoT platform

What are IoT platforms?

- IoT applications combine sensors, devices, data, analytics and integrations in a seamless and unified way: e.g. your project!
- IoT Platforms provide software tools and components to:
  - connect sensors, devices, and data networks
  - analyse and store data
  - integrate with other apps
- Main selling point of an IoT platform is software that it:
  - accelerates the IoT development process
  - focuses on IoT: brings in best of breed features
  - provides initial scaffolding for IoT projects
- Many (not all) are cloud-based platforms that require subscription
  - Provide device/language agnostic set of Software Development kits
  - IoT development is generally iterative: starts with initial simple use case; once operational, data/insights result in new use cased
  - IoT platforms should promote scalable, iterative development; allow for quick app development (ability to adapt/optimise apps quickly)

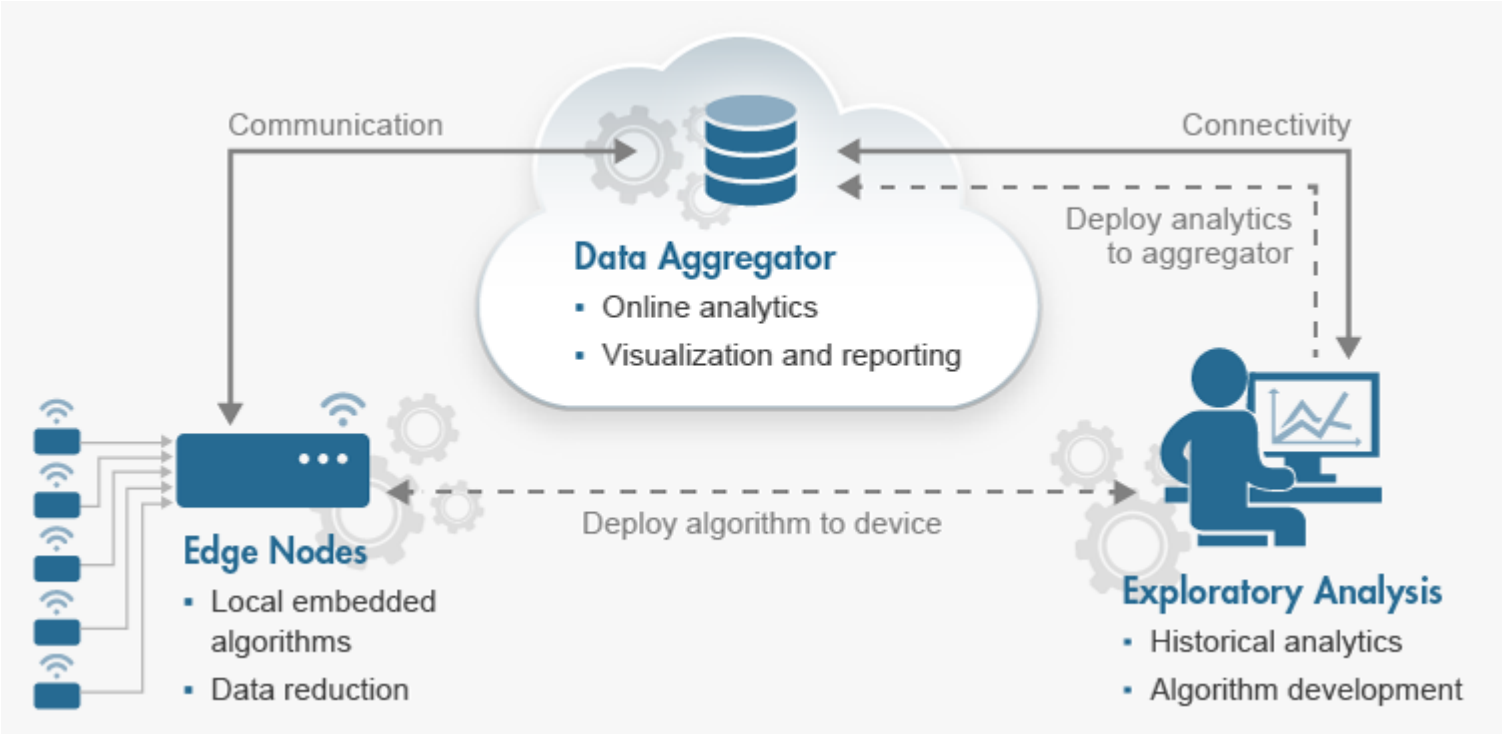
IoT Platform Characteristics

- Manage many concurrent device connections, across several connection types
- "Off-the-peg" IoT protocol stack
- Manage/analyse/visualise data
- Integrations to other services/apps
- App Development
- ADVANTAGES
  - Sofware components that has been pre-built and pre-tested. This increases the reliability of your application and reduces development effort; IoT frameworks constantly evolve, providing new features, integrations etc.
  - Predefined APIs and docs; encourages better "design pattern" for your IoT app.
  - "Baked-in" standards and features: Security, authentication, scalability...



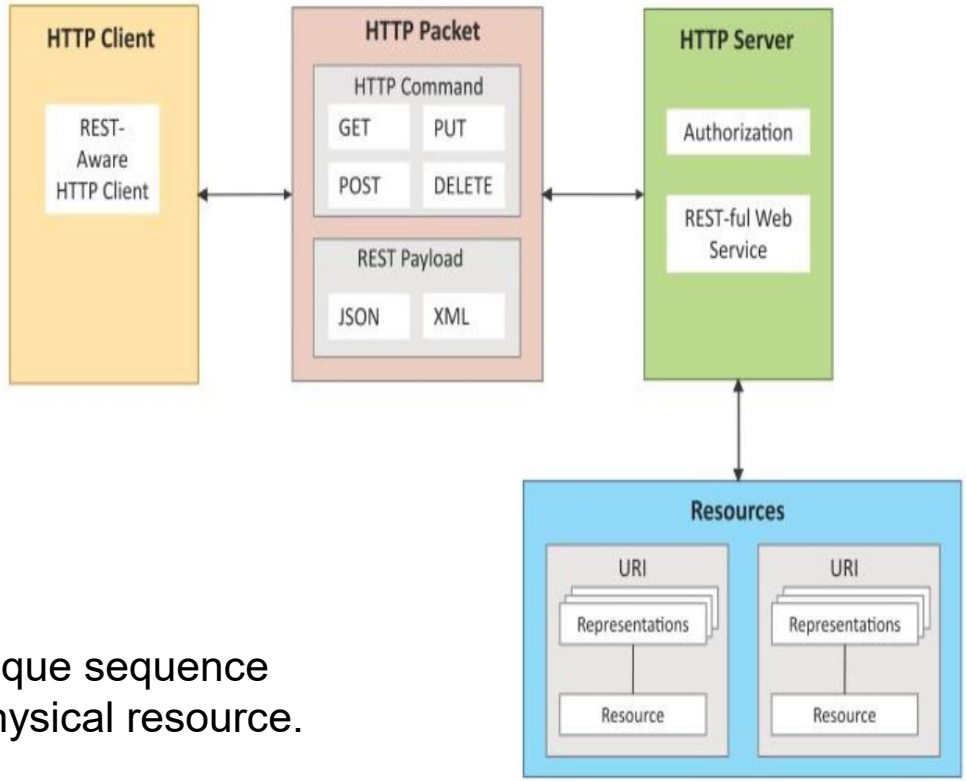
The IoT Data Aggregator role

- The role of the «Data Aggregator»: provide an answer to the question: How do I collect enough data to build my algorithm?
- E.g. Mindsphere, **Thingspeak**…



REST-based Communication APIs

- Representational State Transfer (REST) is a set of architectural principles by which you can design web services and web APIs that focus on a system's resources and how resource states are addressed and transferred.
  - REST APIs follow the request-response communication model.
  - The REST architectural constraints apply to the components, connectors, and data elements, within a distributed hypermedia system.

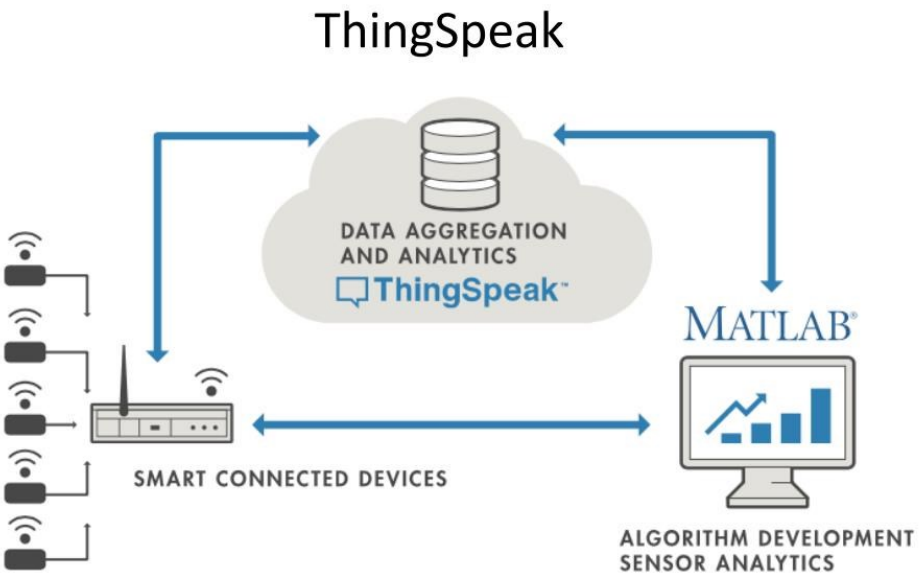


Uniform Resource Identifier (URI) is a unique sequence of characters that identifies a logical or physical resource.

URL is a URI specifying a location.

Thingspeak

- ThingSpeak is a cloud-based IoT platform to store and retrieve data from devices; "Collect and analyse data quickly and easily"
  - Uses HTTP protocol/Restful APIs
  - Supports MQTT as well



- Account-based (can create free account online)
- Brought to you by the people who made Matlab: uses Matlab features/toolboxs
- SDKs/librarys for popular languages/devices
- Restful/MQTT API means should work with any device

Basic usage

Create a new channel

- Channels collect data

Collect data in the channel

- Devices write data to channels

Analyse the data

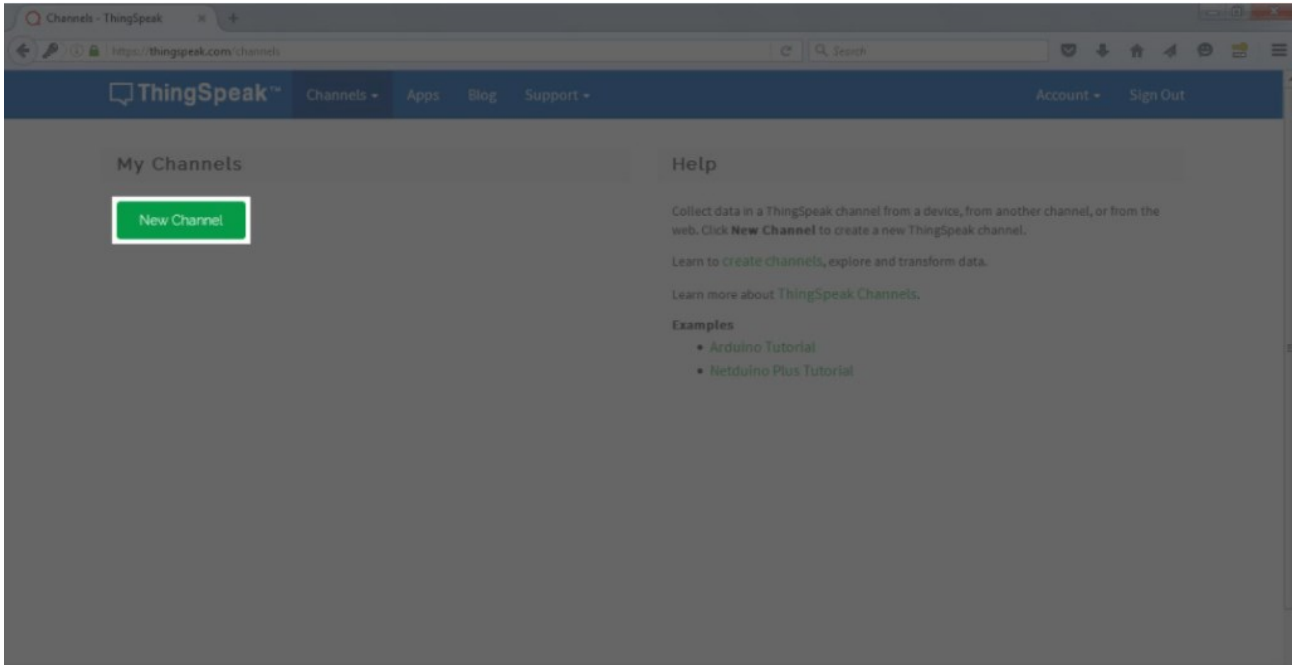
- Run analytical algorithms/visualise your data

Act on the data

- Test for certain conditions and perform actions

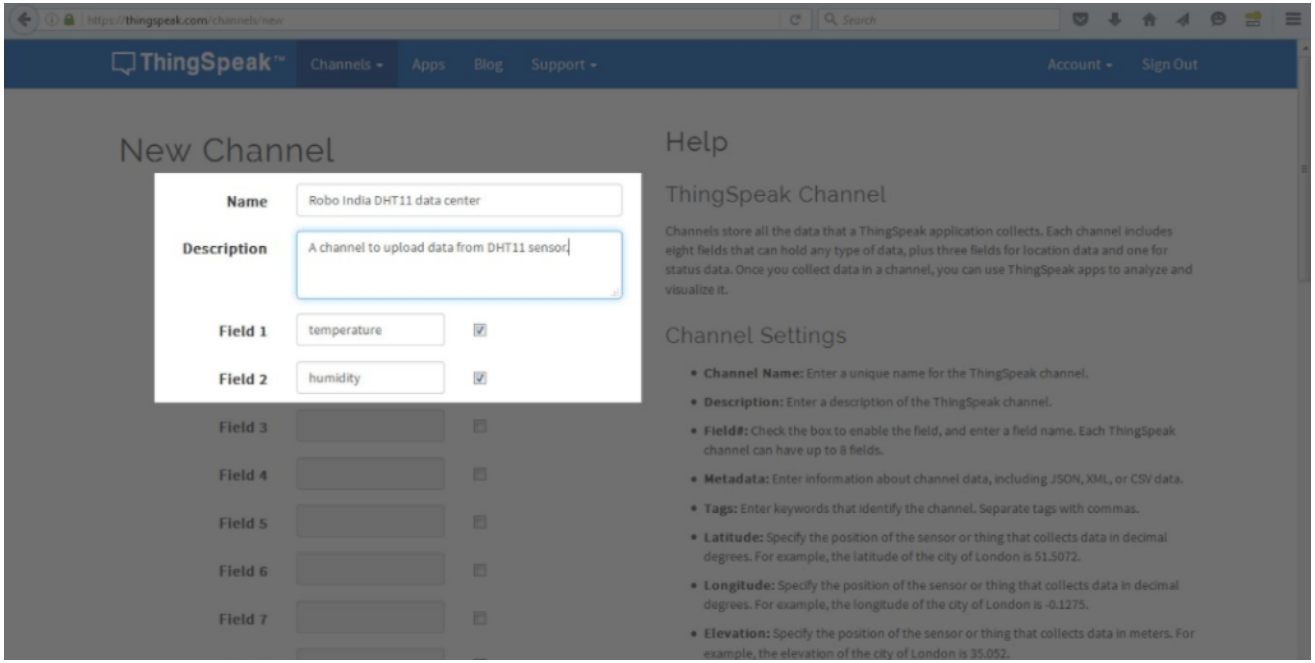
Create a new channel

- Create a new channel by clicking on the button as shown in the below image
- A channel is a source for your data. Where you can store and retrieve data. A channel can have a maximum of 8 fields.
  - It means you can store 8 different data to a channel.



Create a new channel

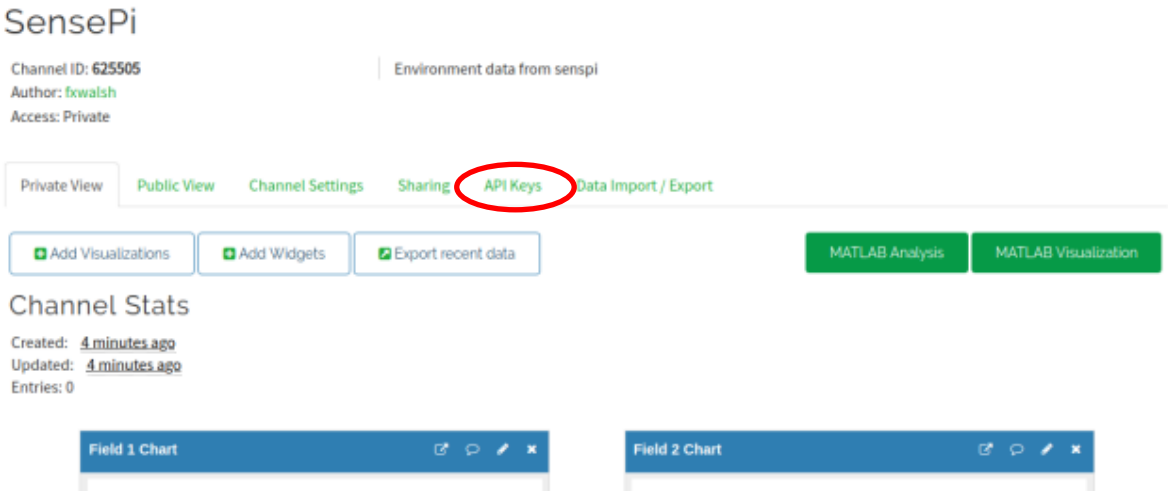
- Create channel(s) to store data IoT device(s).



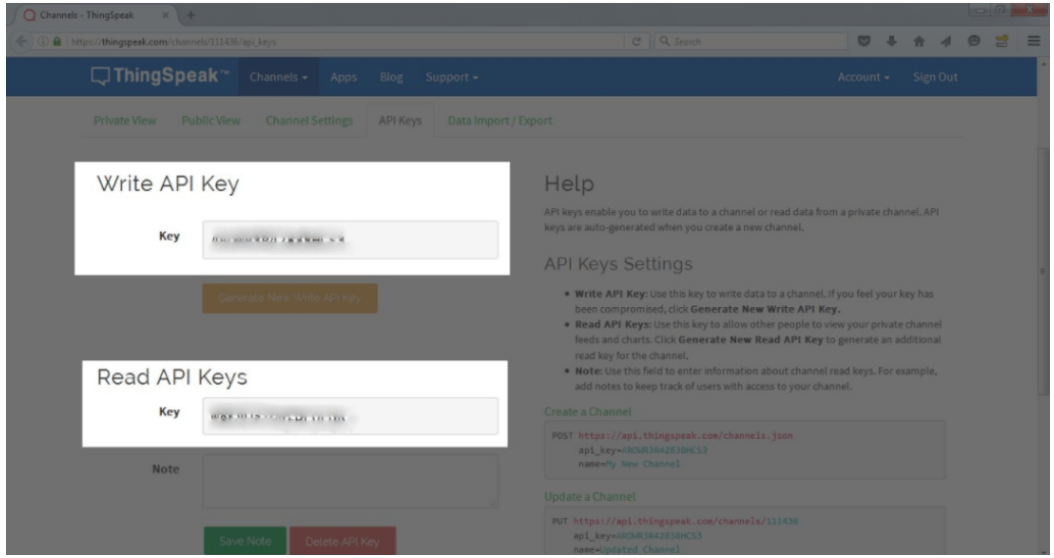
- Then, scroll down and save the channel

New channel is ready!

- Once saved you can access the channel page
  - Channel Id is the identity of your channel. Note down this.

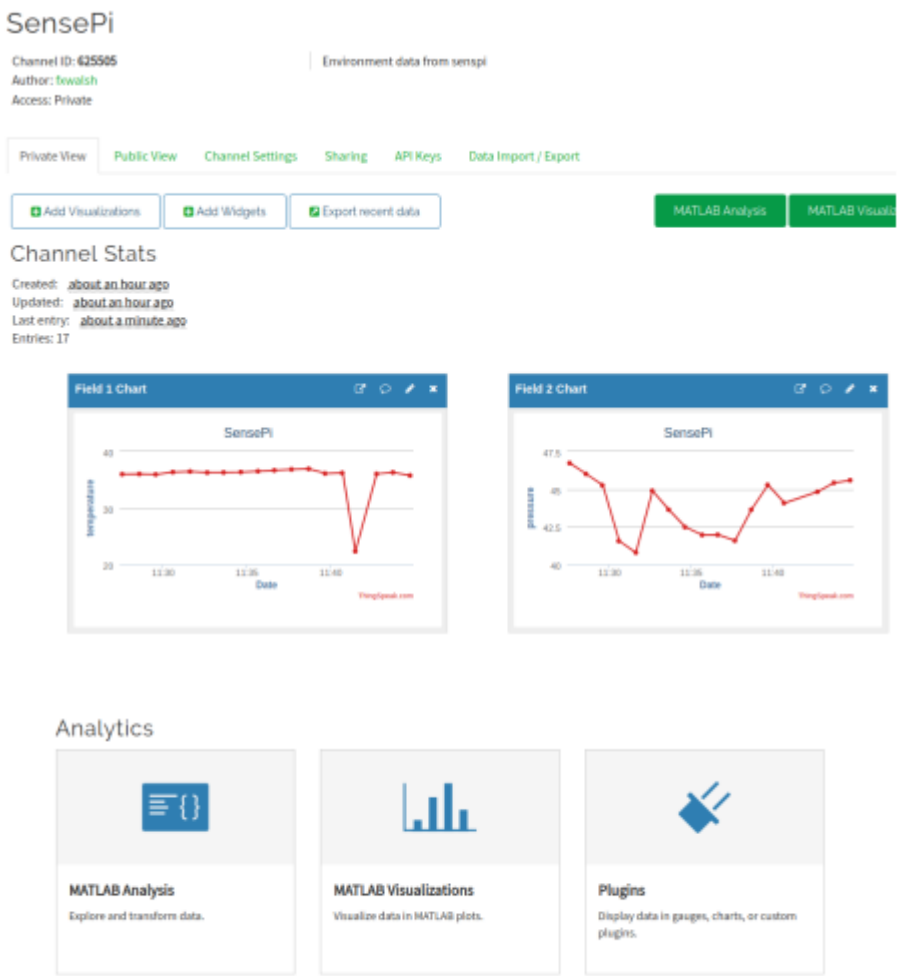


- Click the “API Keys” button.
  - to update channel / data logging: API Write Key
  - to retrieve data : API Read Key



Analyse data

- Thingspeak will visualise each field by default in channel view
- The Apps tab provides various mechanism to transform, analyse,visualise and act on data.
- Can write Matlab Code to analyse/visualize and transform data; possible uses:
  - Clean data (remove outliers)
  - Statistical analysis
  - Transfomations
  - Data Fusion
  - Generally write results to second channel for further analysis/visualisation.



REST APIs

- Write new data in a *field*
- https://it.mathworks.com/help/thingspeak/writedata.html

Write Data

Update channel data with HTTP GET or POST

Request

HTTP Method

POST or GET

URL

`https://api.thingspeak.com/update.<format>`

URL Parameters

Name	Description
<format>	(Required) Format for the HTTP response, specified as blank, `json`, or `xml`.

- Write data using GET HTTP method:

https://api.thingspeak.com/update.json?api_key=HWYUZV1PSPC2HHJV&field1=%d

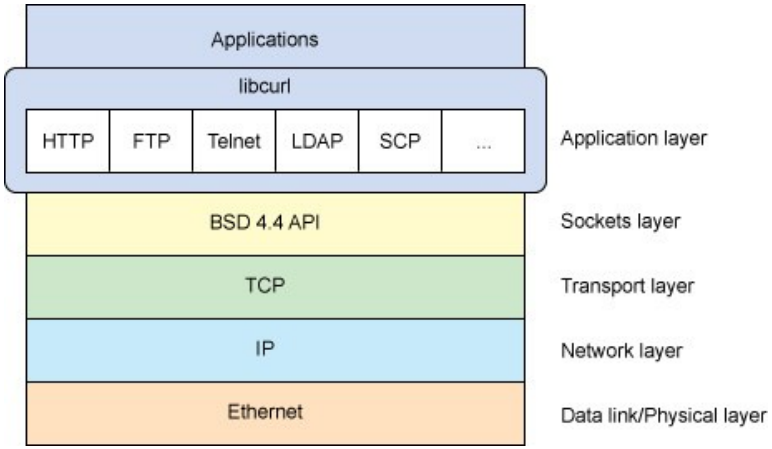
- The response is a JSON object of the new entry, and a 200 OK from the server.

libcurl

- libcurl is a free and easy-to-use client-side URL transfer library, supporting, among others, HTTP and **HTTPS**

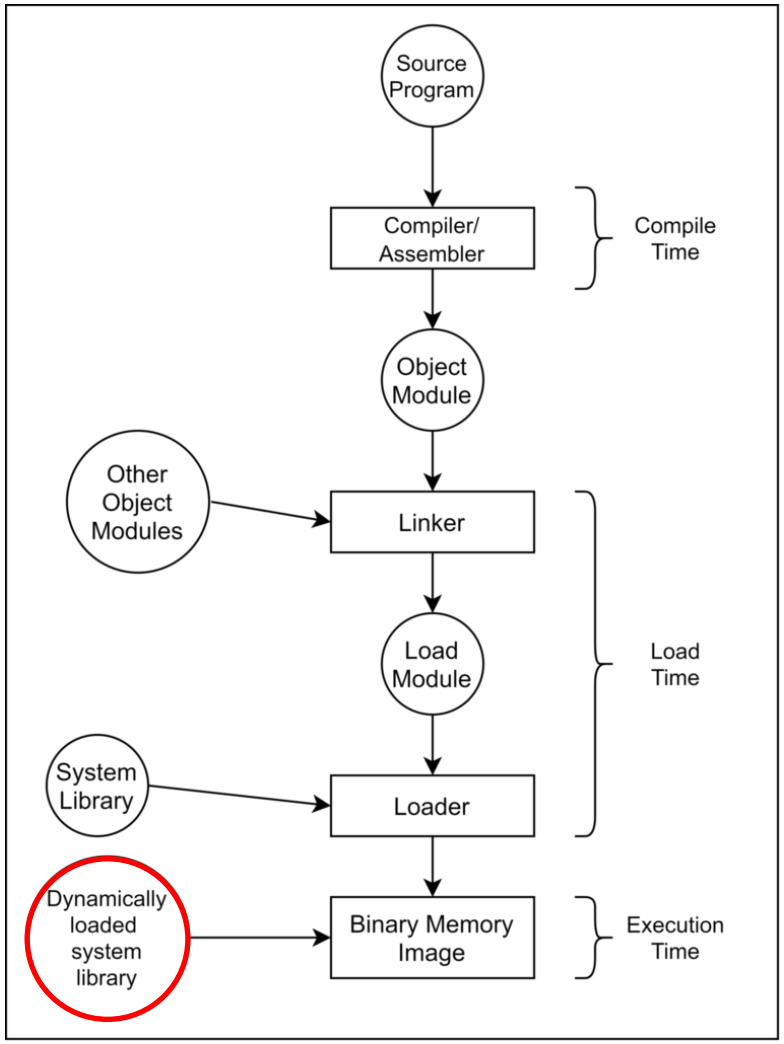
- Invoke the curl_easy_perform function after curl_easy_init and all the curl_easy_setopt calls are made, and it performs the transfer as described in the options

- The curl_easy_setopt is used to tell libcurl how to behave, including options to provide a pointer to a linked list of HTTP headers to pass to the server



Dynamic loading

- A loader uses the linked modules along with other system libraries to generate the binary memory image.
- Dynamic loading provides us the capability to load a module on demand.
- When cross-compilation is performed, cross-compiled libraries must be available on the host.
- **OR** the dynamic loader library can be explicitly called (using the methods in the **dl** library) to exploit the libraries in the target.



Dynamic loading

- The Dynamic Loading (DL) API exists for dynamic loading and allows a shared library to be available to a user-space program.

Function	Description
dlopen	Makes an object file accessible to a program
dlsym	Obtains the address of a symbol within a dlopen object
dlerror	Returns a string error of the last error that occurred
dlclose	Closes an object file

- The process begins with a call to ***dlopen***; the result of the dlopen call is a handle to the object that will be used later.
- Subsequently, you can identify addresses to symbols within this object using the ***dlsym*** call. This function takes a symbol name, such as the name of a function contained within the object. The return value is a resolved address to the symbol within the object.
- Finally, when no additional calls to the shared object are necessary, the application can call ***dlclose*** to inform the operating system that the handle and object references are no longer necessary.

MATLAB Visualization - Custom code

- Example: plot Gauge

Name

Gauge for Max Freq Field1

MATLAB Code

```
% Read Field 1 data from a ThingSpeak channel and visualize using the Gauge
% (by means of function plotGauge(measurement, rangeGrid, numGrid).

% Channel ID to read data from
readChannelID = [redacted]

% Temperature Field ID
FieldID = 1;

% Channel Read API Key
% If your channel is private, then enter the read APIKey between the '' below:
readAPIKey = [redacted]

% Get data from 'FieldID'
data1 = thingSpeakRead(readChannelID,'Fields',FieldID,'ReadKey',readAPIKey);
fs=48e3; N=1024;
plotGauge(data1.*(fs/N), 24e3, 6);


function plotGauge(measurement, rangeGrid, numGrid)
% Plot dial / gauge / meter for depicting a measurement
%
% Input Arguments
% 1) measurement - Measurement to be indicated on the meter/gauage/dial
% 2) rangeGrid - Measurement range; default minimum is 0, enter max value
% only
% 3) varargin - (optional) numGrid: Number of equidistant grids to display
%
% Output
% Dial / Gauge / Meter with measurement indicated with an arrow
```

thingSpeakRead

thingSpeakRead

Read data stored in ThingSpeak channel

Syntax

```
[data,timestamps,chInfo] = thingSpeak
Read(chId)
[data,timestamps,chInfo] = thingSpeak
Read(chId,Name,Value)
```

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