Complex networks

Floodlight RESTful interface

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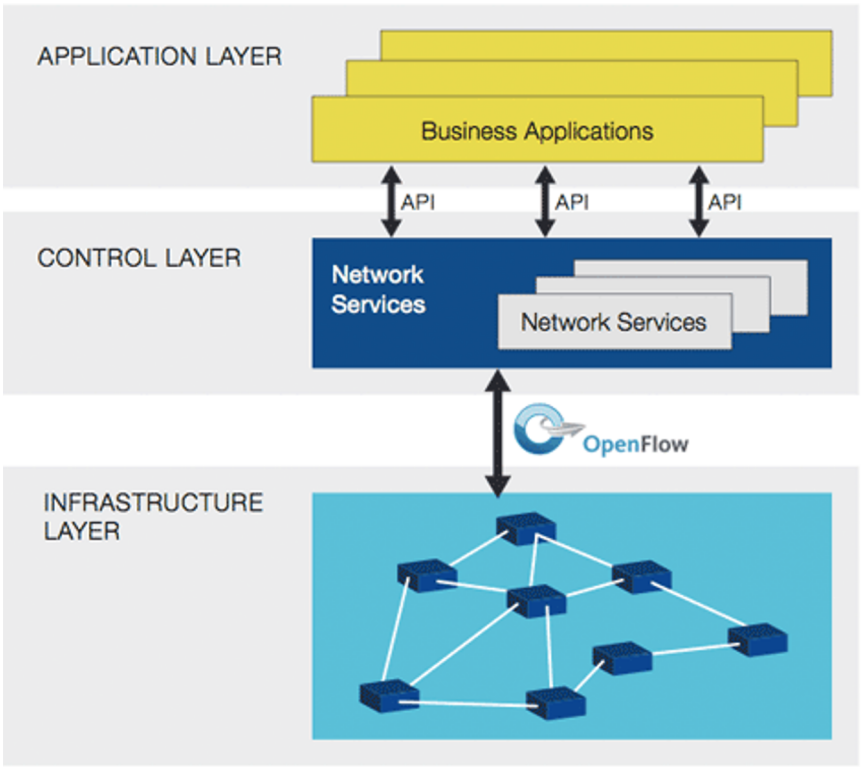
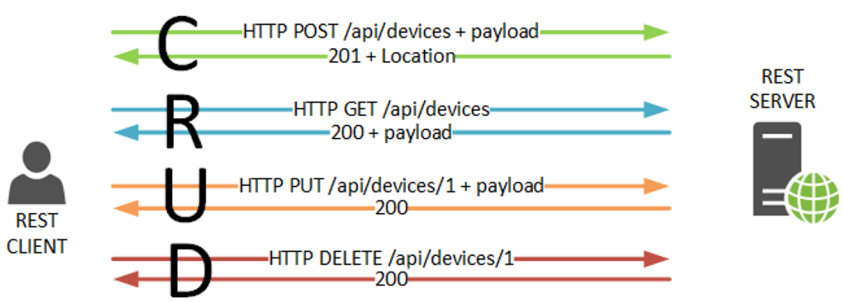
SDN Northbound interface

- Core advantage of Software Defined Networks over traditional deployments is their re-programmability
- Such changes are usually applied automatically by external applications and monitoring process to react to events (e.g. variations in the load)
- To this aim, a northbound interface is exposed by controllers



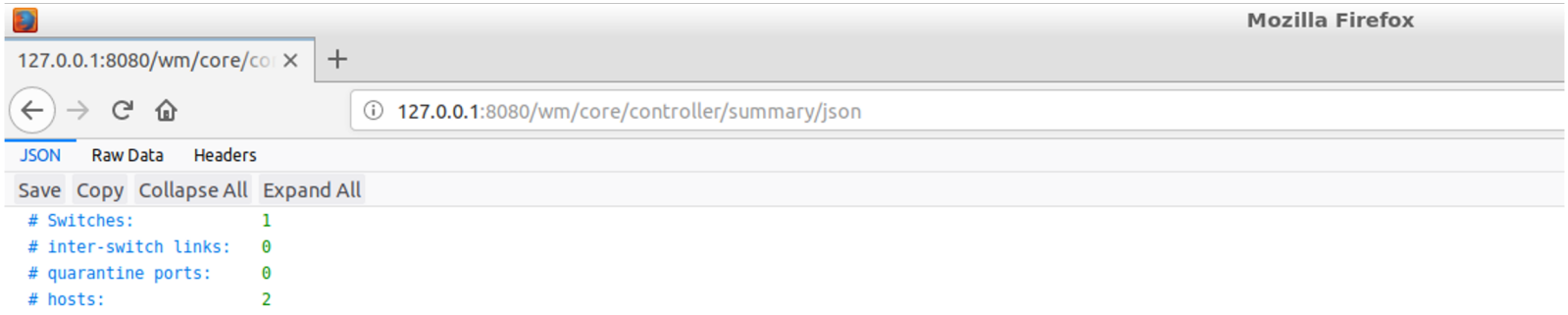
RESTful APIs

- Floodlight defines the APIs of the northbound interface using the RESTful paradigm
- Each controller exposes a set of resources that can be used by applications to retrieve network information or issue configuration changes or trigger operations

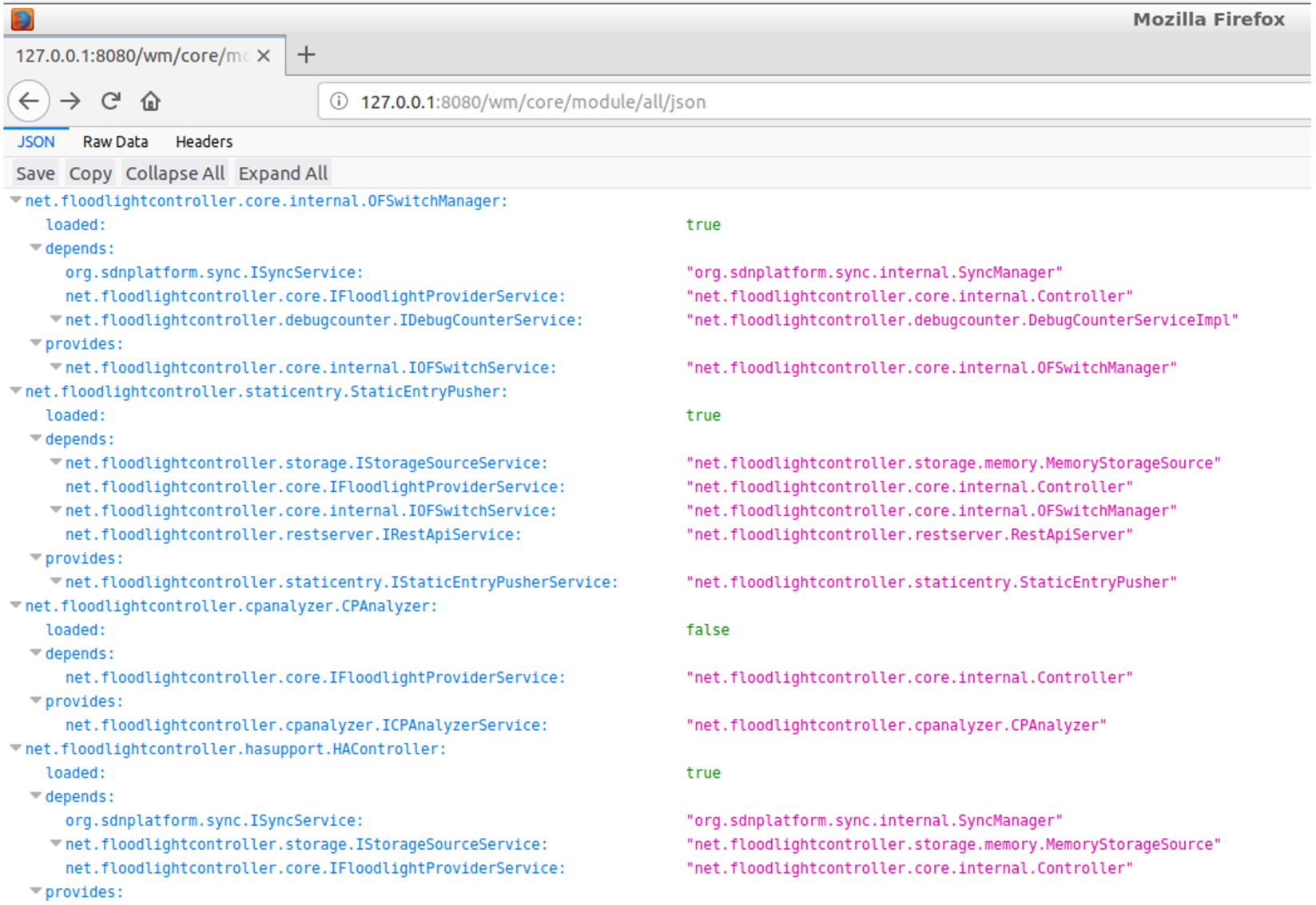


Resource	POST create	GET read	PUT update	DELETE delete
/dogs	create a new dog	list dogs	**bulk update dogs**	delete all dogs
/dogs/1234	**error**	show Bo	if exists update Bo **if not error**	delete Bo

http://192.168.57.___:8080/wm/core/controller/summary/json



http:// 192.168.57.___: 8080/wm/core/module/all/json



Configuring SDN firewall

Enable/disable firewall

Resource	Command	body
/wm/firewall/module/enable/json	PUT	
/wm/firewall/module/disable/json	PUT	

Add firewall rule

Resource	Command	body
/wm/firewall/rules/json	POST	{"src-ip": "10.0.0.2/32", "dst-ip": "10.0.0.1/32", "dl-type":"ARP"}
/wm/firewall/rules/json	POST	{"src-ip": "10.0.0.2/32", "dst-ip": "10.0.0.1/32", "nw-proto":"UDP"}

Test 1

- Enable firewall and check ping
- Add rules and check ping
- Check udp connectivity (e.g.; through nc)
- Check connectivity on the reverse-path

Expose REST resources

On a high-level, there are four steps to implementing a REST API in Floodlight:

1. Get the IRestApiService

2. Define the URIs we want for our module

3. (Implement the URIs defined in our module)

4. Tell Floodlight our new REST API exists

Floodlight RESTful API – STEP 1

- Each Floodlight module can expose a RESTful interface for external applications. REST interface for the *loadbalancer*.
- First step, add the IRestApiService among the dependences and retrieve a reference to it

```
protected IRestApiService restApiService; // Reference to the Rest API service

...
@Override
public Collection<Class<? extends IFloodlightService>> getModuleDependencies() {
     Collection<Class<? extends IFloodlightService>> l = new ArrayList<Class<?
     extends IFloodlightService>>();
    ...
    // Add among the dependences the RestApi service
    l.add(IRestApiService.class);
    return l;
}
...
@Override
public void init(FloodlightModuleContext context) throws FloodlightModuleException {
    ...
    // Retrieve a pointer to the rest api service
    restApiService = context.getServiceImpl(IRestApiService.class);
}
```

Floodlight RESTful API – STEP 2

- Second step, create a class representing the RESTful interface

```
public class LoadBalancerWebRoutable implements RestletRoutable {
    /**
     * Create the Restlet router and bind to the proper resources.
     */
    @Override
    public Restlet getRestlet(Context context) {
        Router router = new Router(context);

        // Add some pre-defined REST resources available in the floodlight framework

        // This resource will show some summary stats on the controller
        router.attach("/controller/summary/json", ControllerSummaryResource.class);

        // This resource will show the list of modules loaded in the controller
        router.attach("/module/loaded/json", LoadedModuleLoaderResource.class);

        // This resource will show the list of switches connected to the controller
        router.attach("/controller/switches/json", ControllerSwitchesResource.class);

        return router;
    }
    @Override
    public String basePath() {
        // The root path for the resources
        return "/lb";
    }
}
```

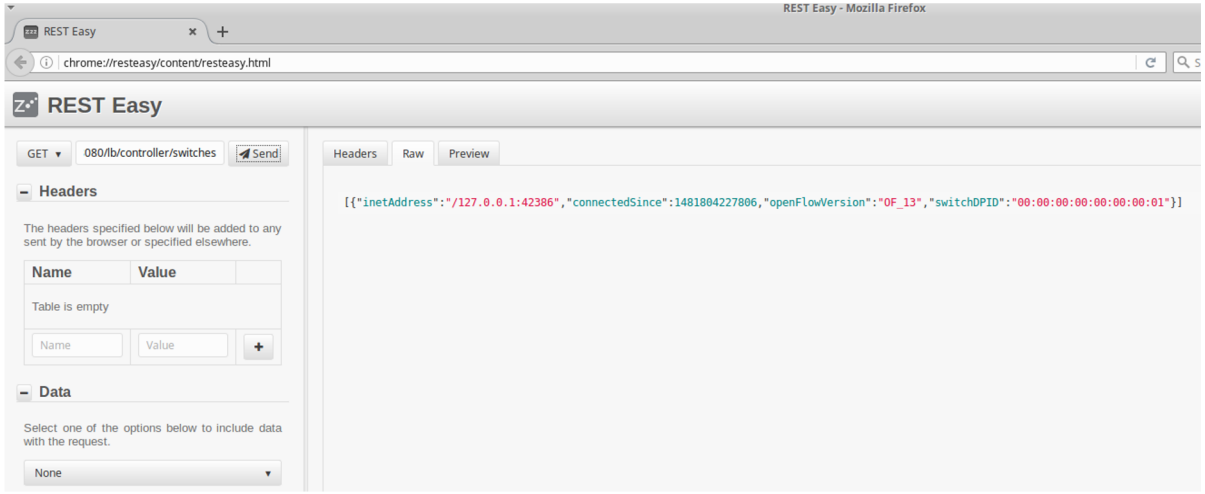
Floodlight RESTful API – STEP 4

- Third step, add the REST interface at module's startup

```
//within LoadBalancer class

@Override
public void startUp(FloodlightModuleContext context) throws FloodlightModuleException
{
          ...

     // Add as REST interface
     restApiService.addRestletRoutable(new LoadBalancerWebRoutable());
}
```

Floodlight RESTful API – TEST

- The module is now ready to expose some pre-defined floodlight resources, e.g. to show general statistics on the SDN network
- The REST interface can be tested through one of the REST add-ons for browsers, for example “RESTED” for Firefox or “ARC” for Chrome
- The REST interface is exposed by floodlight on the port 8080
- Test the resource http://192.168.57.__:8080/lb/controller/switches/json to get a list of the switches connected



Floodlight RESTful API – Custom res (STEP 3)

On a high-level, there are four steps to implementing a REST API in Floodlight:

1. Get the IRestApiService

2. Define the URIs we want for our module

3. (Implement the URIs defined in our module)

4. Tell Floodlight our new REST API exists

Floodlight RESTful API – Custom res (STEP 3)

- In order to add custom resources to your module, an additional class must be defined
- New resources can be defined only through external classes as this one for example that simply returns a custom JSON message:

```
//…
import org.restlet.resource.Get;
//…

public class TestResource extends ServerResource {

    @Get("json")
    public Map<String, Object> Test() {

     Map<String, Object> info = new HashMap<String, Object>();

     info.put("name", "value");

     return info;

    }
}
```

Floodlight RESTful API – Custom res

- As external class, such custom resources can not access to internal module information, neither trigger internal operations
- In order to export functionalities and data to other classes the module must define and implement a public interface available to other module as follow:

```
// Service interface for the module
// This interface will be use to interact with other modules
// Export here all the methods of the class that are likely used by other modules

public interface ILoadBalancerREST extends IFloodlightService
{
     // Method exposed by the module
     // Method to retrieve the info on the real servers of the pool
     public Map<String, Object> getServersInfo();

     // Method to set the hardtimeout for load balancing
     public void setHardTimeout(int newValue);
}
```

Floodlight RESTful API – Custom res

- The module must include the interface through the following steps:
  1. Add the implementation of the interface:

```
public class LoadBalancerREST implements
     IOFMessageListener, IFloodlightModule, ILoadBalancerREST {
```

```
@Override
public Collection<Class<? extends IFloodlightService>> getModuleServices() {
     Collection<Class<? extends IFloodlightService>> l =
          new ArrayList<Class<? extends IFloodlightService>>();
     l.add(ILoadBalancerREST.class);
     return l;
}
@Override
public Map<Class<? extends IFloodlightService>, IFloodlightService> getServiceImpls()
{
     Map<Class<? extends IFloodlightService>, IFloodlightService> m =
         new HashMap<Class<? extends IFloodlightService>, IFloodlightService>();
     m.put(ILoadBalancerREST.class, this);
     return m;
}
```

Floodlight RESTful API – Custom res

- The module must implement the methods of the interface:

```
@Override
public Map<String, Object> getServersInfo(){
     Map<String, Object> info = new HashMap<String, Object>();
     for( int i = 0; i < SERVERS_MAC.length; i++)
     {
          info.put( SERVERS_IP[i] , SERVERS_MAC[i]);
     }
     return info;
}

@Override
public void setHardTimeout(int newValue){
     HARD_TIMEOUT = (short) newValue;
     System.out.println("Timeout value changed to " + newValue + "\n");
}
```

Floodlight RESTful API – Custom res

- For each REST resource its implementation can invoke the methods of the public interface, e.g. a resource to retrieve the list of the servers in the pool

```
// Implementation of a resource to retrieve the list of the servers in the pool
public class GetServerInfo extends ServerResource {
  @Get("json")
  public Map<String, Object> Test() {
    ILoadBalancerREST lb =
      (ILoadBalancerREST)getContext().getAttributes()
        .get(ILoadBalancerREST.class.getCanonicalName());
    return lb.getServersInfo();
  }
}
```

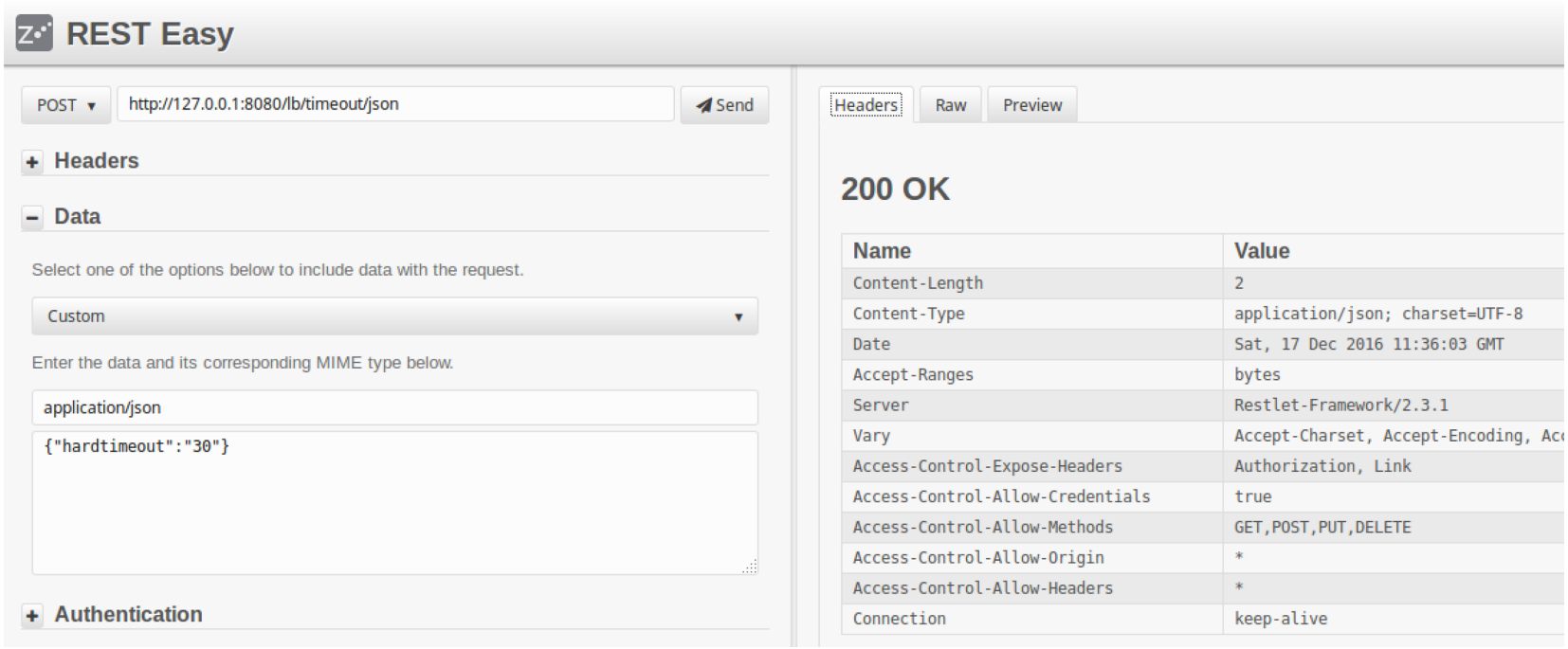
Floodlight RESTful API – Custom res

- Resource to set the value for load balancing

```
public class ChangePeriod extends ServerResource {
@Post
public String store(String fmJson) {

     // Check if the payload is provided
     if(fmJson == null){
     return new String("No attributes");
     }

     // Parse the JSON input
     ObjectMapper mapper = new ObjectMapper();
     try {
        JsonNode root = mapper.readTree(fmJson);
        // Get the field hardtimeout
        int newValue = Integer.parseInt(root.get("hardtimeout").asText());

        ILoadBalancerREST lb = (ILoadBalancerREST)
          getContext().getAttributes()
           .get(ILoadBalancerREST.class.getCanonicalName());

        lb.setHardTimeout(newValue);
     } catch (IOException e) {
        e.printStackTrace();
     }
     return new String("OK");
  }
}
```

Floodlight RESTful API – TEST

- Test the resource http://192.168.57.XXX:8080/lb/timeout/json
- The argument must be specified in JSON format in the POST payload as follow:



Test 2

- Modify the LoadBalancer implementation in order to introduce a REST interface to retrieve the list of servers and set the hardtimeout

References

- *Floodlight REST tutorial:* https://floodlight.atlassian.net/wiki/display/floodlightcontroller/How+to+add+a+REST+API+to+a+Module

- RESTED Firefox extension: https://addons.mozilla.org/it/firefox/addon/rested/