Writing REST APIs with OpenAPI and Swagger Ada

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OpenAPI and Swagger Ada

- Introduction to OpenAPI and Swagger
- Writing a REST Ada client
- Writing a REST Ada server
- Handling security with OAuth2
- Demo

30 years of RPC

- Sun RPC (RFC 1057) in 1988
- CORBA IDL in 1991
- Ada95 Distributed Annex E in 1995
- Java RMI in 2000
- WSDL and SOAP in 2000
- Google gRPC with Protocol Buffers since 2001

30 years but same goals

- Simplify the developer’s job
- Describe the protocol between client & server
- Generate client stubs and server skeleton
- Handle and hide communication details
- Document the client & server interaction

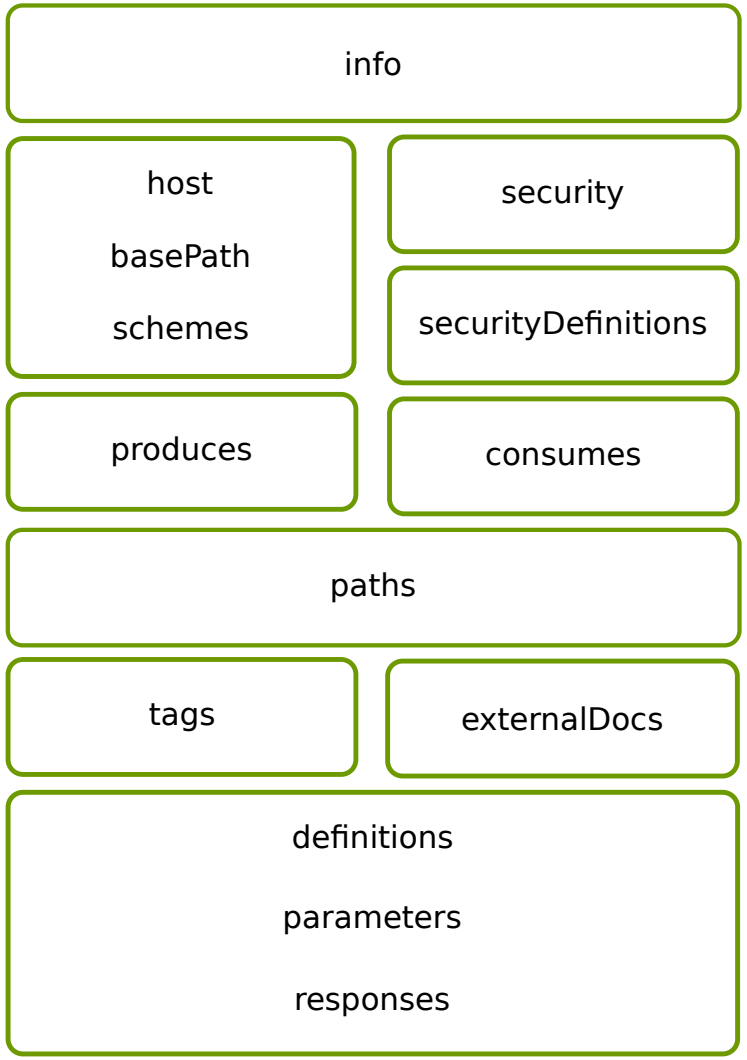
Why REST and OpenAPI?

- REST as an alternative to SOAP since 2000
  (Roy Thomas Fielding)
- Easier to use, write, implement, debug
- Can easily be used from browsers
- Increasing usage of REST with mobile applications
- Need for description, documentation
- Need for client language bindings

OpenAPI Specification

- Started in 2010 to describe REST APIs
- OpenAPI Initiative created in Nov 5, 2015 (Google, Microsoft, IBM, Paypal, ...)
- OpenAPI 3.0 released July 26, 2017
- https://github.com/OAI/OpenAPI-Specification

OpenAPI 2.0 Document Structure



YAML or JSON file with well defined keywords

Describes security aspects

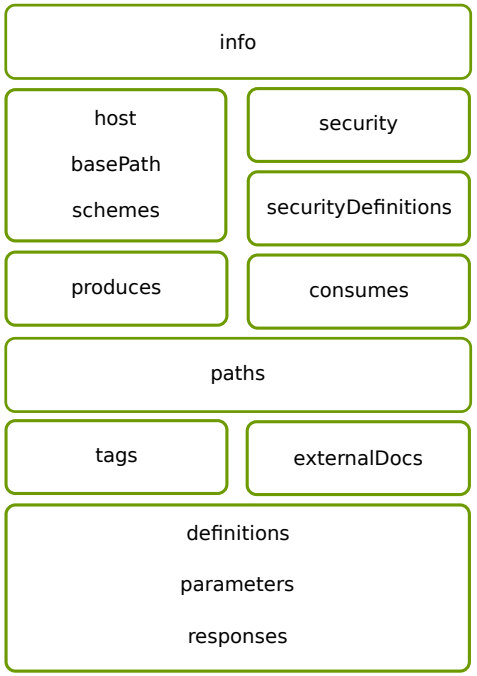
What the API accepts as input, what it produces

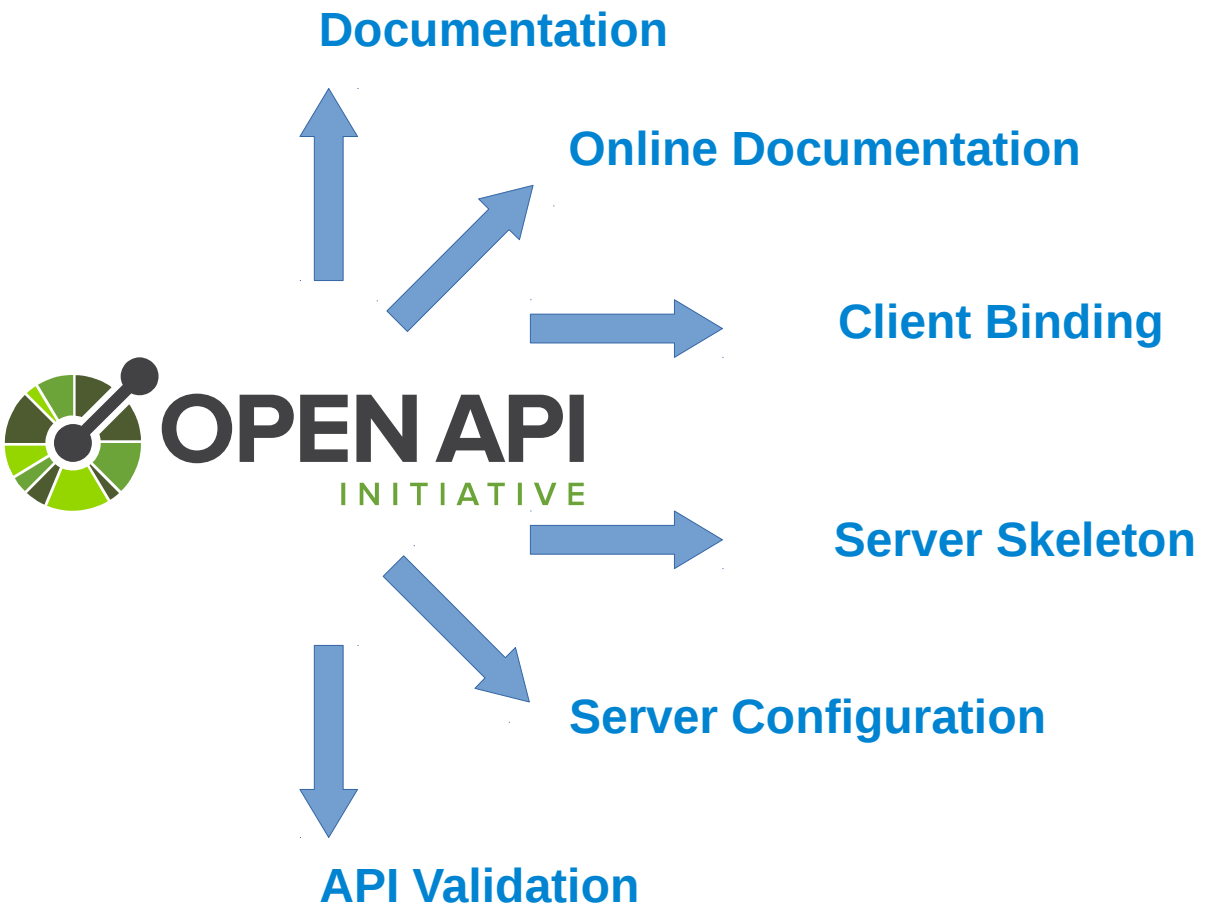
Describes REST APIs paths, operations, can reference definitions, parameters, responses

Describes data types, parameters, responses

https://github.com/stcarrez/swagger-ada

OpenAPI benefits





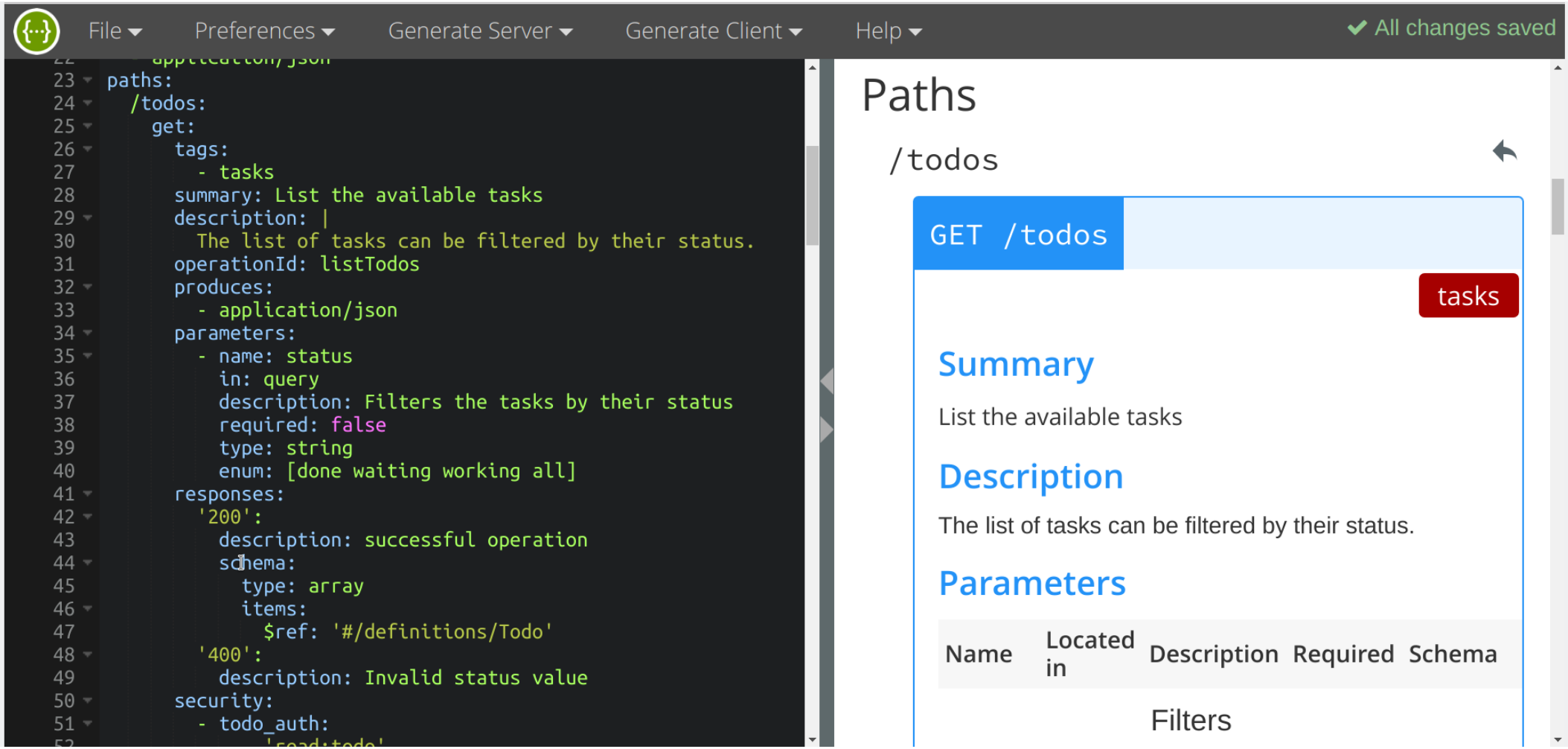
https://github.com/stcarrez/swagger-ada

Swagger: Tools for OpenAPI

- Online Editor: Swagger Editor
- Generator: Swagger Codegen
- Documentation: Swagger UI
- Sources: https://github.com/swagger-api

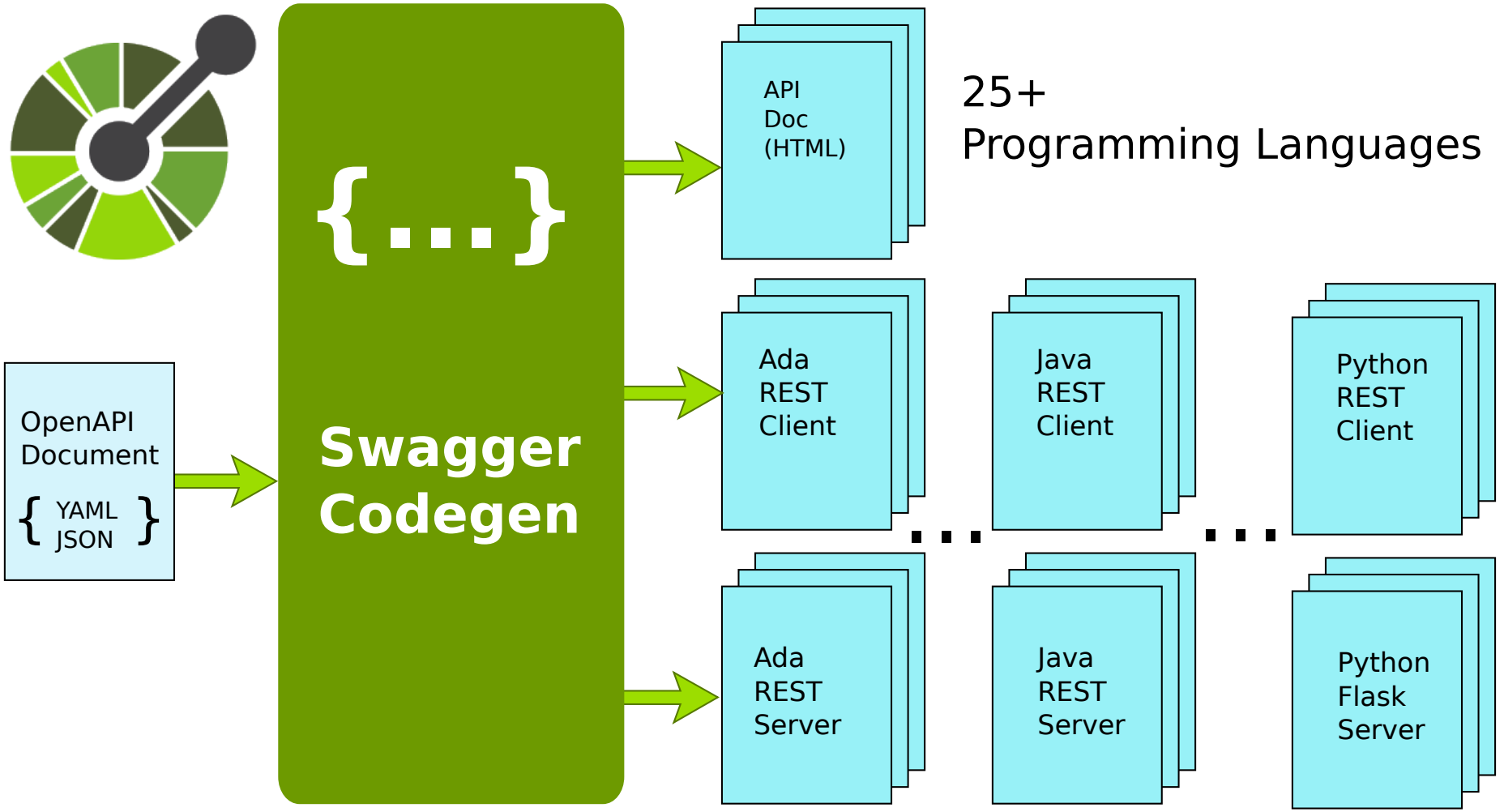
https://github.com/stcarrez/swagger-ada

Swagger Editor: https://editor.swagger.io



https://github.com/stcarrez/swagger-ada

Swagger Codegen



https://github.com/stcarrez/swagger-ada

Writing a REST Ada client

- Get the OpenAPI/Swagger description file
  - From SwaggerHub: https://swaggerhub.com/
  - From APIs.guru: https://apis.guru/openapi-directory/
- Generate the Ada client code
- Use the generated code to make API calls

OpenAPI: Info description (1/3)

- YAML or JSON file
- General purpose description of the API
- Describe the service entry point

```
swagger: "2.0"
info:
  version: "1.0"
  title: "Todo API"
  contact:
    email: Stephane.Carrez@gmail.com
  license:
    name: Apache 2.0
    url: 'http://www.apache.org/licenses/LICENSE-2.0.html'
host: localhost:8080
basePath: /v1
tags:
  - name: tasks
    description: Operations to manage tasks
schemes:
  - https
  - http
```

OpenAPI: REST operation (2/3)

- Describe the REST operations

```
paths:
  /todos:
    get:
      tags:
        - tasks
      summary: List the available tasks
      description: List the available tasks
      operationId: listTodos
      produces:
        - application/json
      parameters:
        - name: status
          in: query
          description: Filters the task by their status
          required: false
          type: string
          enum:
            - done
            - waiting
            - working
            - all
```

```
responses:
  '200':
    description: successful operation
    schema:
      type: array
      items:
        $ref: '#/definitions/Todo'
  '400':
    description: Invalid status value
```

OpenAPI: Model definitions (3/3)

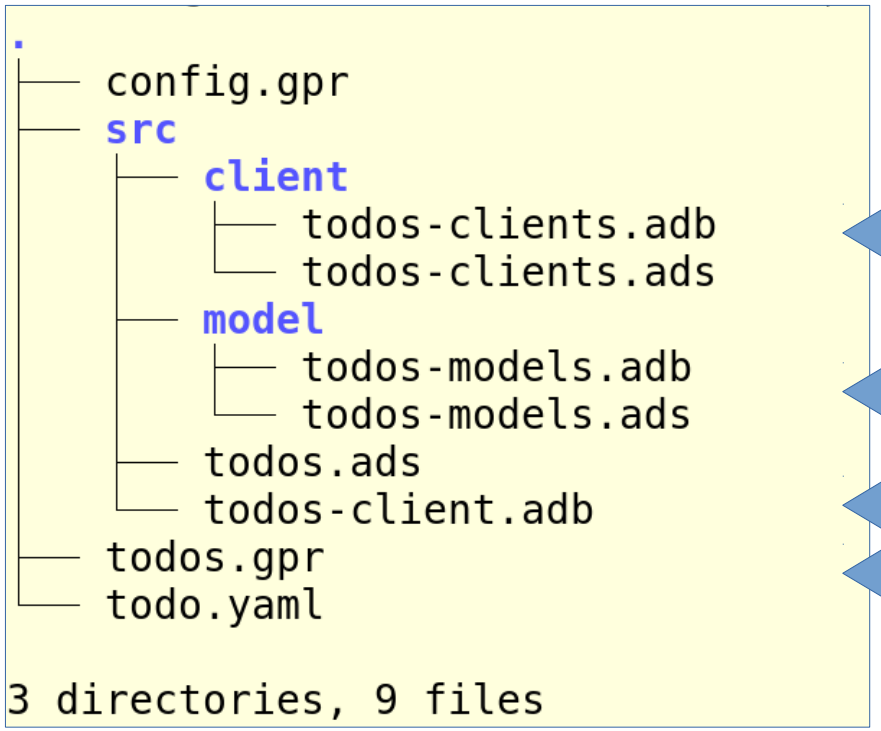
```
definitions:
  Todo:
    type: object
    properties:
      id:
        type: integer
        format: int64
        description: The todo identifier
      title:
        type: string
        description: The todo title
      create_date:
        type: string
        format: date-time
        description: The todo creation date
      done_date:
        type: string
        format: date-time
        description: The todo resolution date
      status:
        type: string
        description: The todo state
        enum:
          - waiting
          - done
    required:
      - id
      - title
      - status
      - create_date
```

https://github.com/stcarrez/swagger-ada

Client: let's generate the code!

- Generate the client code with Swagger Codegen

```
$ java -jar swagger-codegen-cli.jar generate -l ada -i todo.yaml \
      -DprojectName=Todos --model-package Todos
```



Client API: **package** Todos.Clients

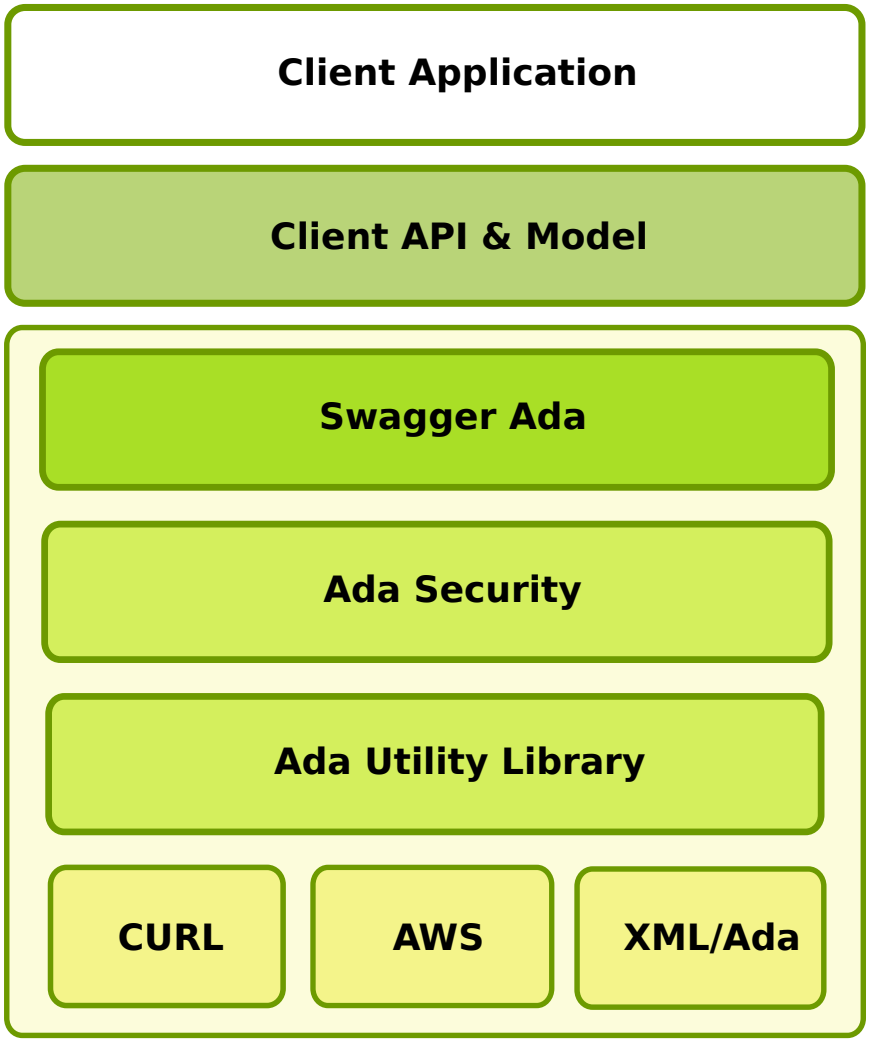
Model API: **package** Todos.Models

Sample: **procedure** Todos.Client

GNAT project

https://github.com/stcarrez/swagger-ada

Ada REST Client



Your client code and application

Generated code

Swagger runtime

Brings security with OAuth2 support

Brings JSON/XML serialization deserialization and more

Choose between libcurl or AWS

https://github.com/stcarrez/swagger-ada

Client and Server Data Model

- Data types described in the `Models` package
- Same `Models` Ada package for client and server
- Operations to serialize and deserialize (JSON/XML)

```
package Todos.Models is
   type Todo_Type is record
      Id          : Swagger.Long;
      Title       : Swagger.UString;
      Create_Date : Swagger.Datetime;
      Done_Date   : Swagger.Nullable_Date;
      Status      : Swagger.UString;
   end record;
   package Todo_Type_Vectors is
      new Ada.Containers.Vectors
        (Positive, Todo_Type);
end Todos.Models;
```

```
Todo:
  type: object
  properties:
    id:
      type: integer
      format: int64
      description: The todo identifier
    title:
      type: string
      description: The todo title
    create_date:
      type: string
      format: date-time
      description: The todo creation date
    done_date:
      type: string
      format: date-time
      description: The todo resolution date
    status:
      type: string
      description: The todo state
      enum:
        - waiting
        - done
```

https://github.com/stcarrez/swagger-ada

Client API

- Represented by the `Client_Type` tagged record
- Provides operations described by the OpenAPI
- Allows to control the API call (headers, security)

```
package Todos.Clients is
   type Client_Type is
      new Swagger.Clients.Client_Type with null record;

   procedure Create_Todo (Client : in out Client_Type;
                          Title  : in Swagger.Ustring;
                          Result : out Todos.Models.Todo_Type);
   procedure List_Todos (Client : in out Client_Type;
                         Status : in out Swagger.Nullable_UString;
                         Result : out Todos.Models.Todo_Vector);
end Todos.Clients;
```

Calling REST in Ada

- Declare a `Client_Type` instance
- Configure it (server URL, credentials)
- Call the operation with its parameters

```
with Todos.Clients;
with Todos.Models;
...
  Client : Todos.Clients.Client_Type;
  List   : Todos.Models.Todo_Type_Vectors.Vector;
  Empty  : Swagger.Nullable_String := (Is_Null => True, Value => <>);
  ...
    Client.Set_Server ("http://localhost:8080/v1");
    Client.List_Todos (Empty, List);
```

https://github.com/stcarrez/swagger-ada

Writing a REST Ada server

- Write the OpenAPI/Swagger description file
- Generate the Ada server code
- Implement the server operations
- Share the OpenAPI description on SwaggerHub!

Server: let's generate the code!

- Generate the server code with Swagger Codegen

```
$ java -jar swagger-codegen-cli.jar generate -l ada-server -i todo.yaml \
       -DprojectName=Todos --model-package Todos
```

```
.
├── config.gpr
├── README.md
├── src
│   ├── model
│   │   ├── todos-models.adb
│   │   └── todos-models.ads
│   ├── server
│   │   ├── todos-skeletons.adb
│   │   └── todos-skeletons.ads
│   ├── todos.ads
│   ├── todos-server.adb
│   ├── todos-servers.adb
│   └── todos-servers.ads
├── todos.gpr
├── todos.properties
├── todo.yaml
└── web
    └── swagger
        └── swagger.json

5 directories, 14 files
```

Model API: **package** Todos.Models

Server skeleton: **package** Todos.Skeletons

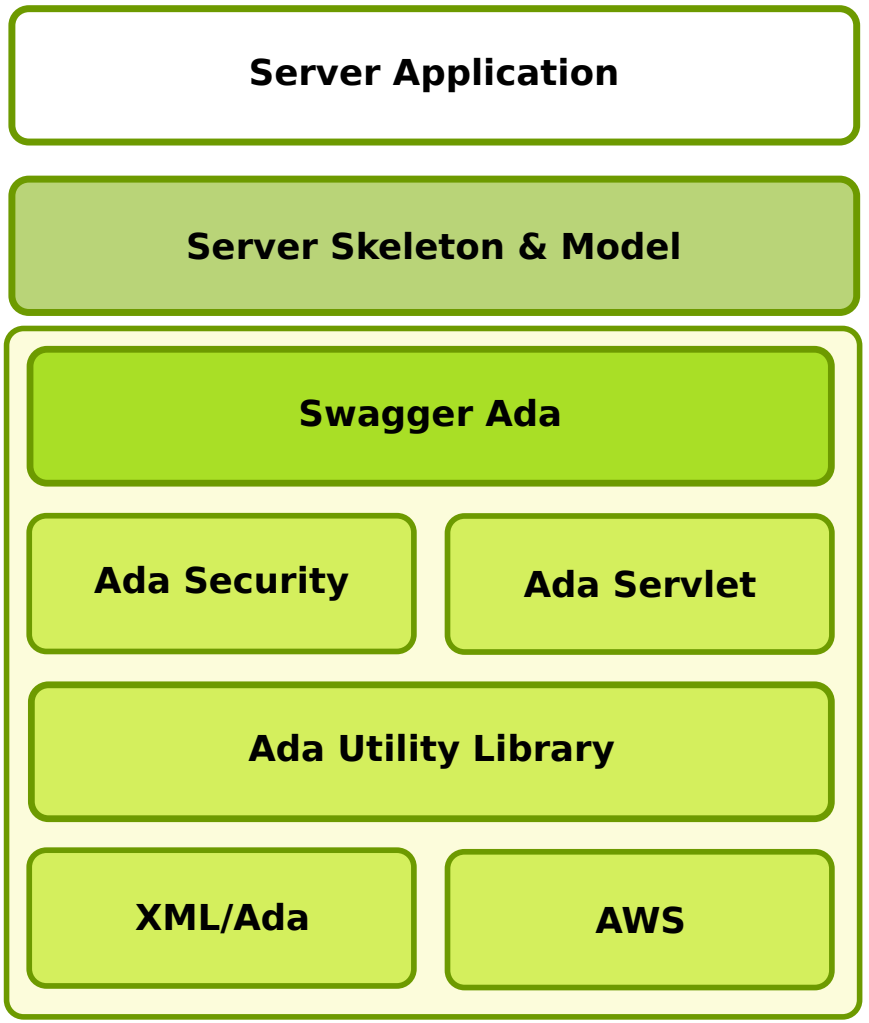
Server: **procedure** Todos.Server

Server code: **package** Todos.Servers

GNAT project, server configuration file

https://github.com/stcarrez/swagger-ada

Ada REST Server



Your server code and application

Generated code

Swagger runtime

Brings REST server support with security and OAuth2 support on server side

https://github.com/stcarrez/swagger-ada

Server Skeleton

- Declares the `Server_Type` limited interface to describe the operations
- Additional `Context_Type` object gives access to request, response
- Two generic packages for server skeleton provide two server models:
  - Instance per request
  - Global shared instance within a protected object

```
package Todos.Skeletons is
   type Server_Type is limited interface;

   procedure Create_Todo
      (Server  : in out Server_Type;
       Title   : in Swagger.Ustring;
       Result  : out Todos.Models.Todo_Type;
       Context : in out Swagger.Servers.Context_Type) is abstract;
   ...
end Todos.Skeletons;
```

https://github.com/stcarrez/swagger-ada

Server Implementation (1/2)

- Implement the `Server_Type` interface with its operations
- Populate `Result` or use the `Context` to send an error
- Serialization/Deserialization handled by the skeleton

```
package Todos.Servers is
   type Server_Type is limited new Todos.Skeletons.Server_Type ...

   overriding procedure Create_Todo
      (Server  : in out Server_Type;
       Title   : in Swagger.Ustring;
       Result  : out Todos.Models.Todo_Type;
       Context : in out Swagger.Servers.Context_Type);
   ...
end Todos.Servers;
```

https://github.com/stcarrez/swagger-ada

Server Implementation (2/2)

- Instantiate one of the two server skeletons (per-request model or shared model)

```
package Todos.Servers is
   ...
   package Server_Impl is
      new Todos.Skeletons.Shared_Instance (Server_Type);

end Todos.Servers;
```

- Register the OpenAPI to the application

```
procedure Todos.Server is
   App : aliased Swagger.Servers.Applications.Application_Type;
begin
   . . .
   Todos.Servers.Server_Impl.Register (App);
   . . .
end Todos.Server;
```

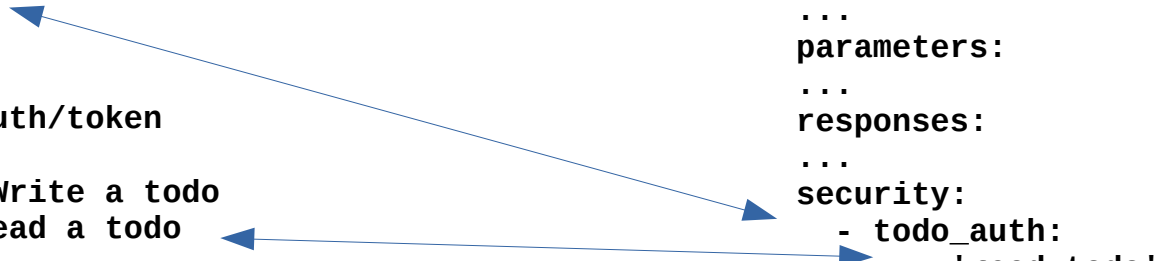
https://github.com/stcarrez/swagger-ada

OpenAPI: Describing security

- Describe security endpoints
- Describe security scopes
- Assign required security scopes to operations

```
Security:
  - todo_auth: []
securityDefinitions:
  todo_auth:
    type: oauth2
    flow: password
    tokenUrl: /v1/oauth/token
    scopes:
      'write:todo': Write a todo
      'read:todo': Read a todo
```

```
paths:
  /todos:
    get:
      ...
      parameters:
      ...
      responses:
      ...
      security:
        - todo_auth:
          - 'read:todo'
```



https://github.com/stcarrez/swagger-ada

Client Security with OAuth2 (1/2)

- Create and initialize a credentials object
- Obtain the access token and optional refresh token
- Configure the client to use the credentials

```
with Swagger.Credentials.OAuth;

Cred : aliased Swagger.Credentials.OAuth.OAuth2_Credential_Type;
...
   Cred.Set_Application_Identifier ("todo-app");
   Cred.Set_Application_Secret ("todo-app-secret");
   Cred.Set_Provider_URI ("http://localhost:8080/v1/oauth/token");
   Cred.Request_Token (Username, Password, "read:todo write:todo");
...
   Client.Set_Credentials (Cred'Access);
```

Client Security with OAuth2 (2/2)

- Make API calls: credentials are passed on the wire within the 'Authorization' header

```
List : Todos.Models.Todo_Type_Vectors.Vector;
...
   Client.List_Todos (Empty, List);
```

```
GET /v1/todos HTTP/1.1
Host: localhost:8080
Authorization: Bearer 74rE0wU.d44CPAll_kyyB2krd8bYdVYWqgmtloIR.9zyiBM
Accept: application/json
```

https://github.com/stcarrez/swagger-ada

Server security (1/2)

- Each OpenAPI scope represented by a permission definition (generated code):

```
package ACL_Read_Todo
   is new Security.Permissions.Definition ("read:todo");
```

- Authentication and permission check generated in the server skeleton (generated code):

```
if not Context.Is_Authenticated then
   Context.Set_Error (401, "Not authenticated");
   return;
end if;
if not Context.Has_Permission (ACL_Read_Todo.Permission) then
   Context.Set_Error (403, "Permission denied");
   return;
end if;
```

https://github.com/stcarrez/swagger-ada

Server security (2/2)

- Configure the server key for OAuth2 tokens:

```
swagger.key=Y29naGk5SGkKUG9YaTdhaHgKYWlUaGllM3UK
```

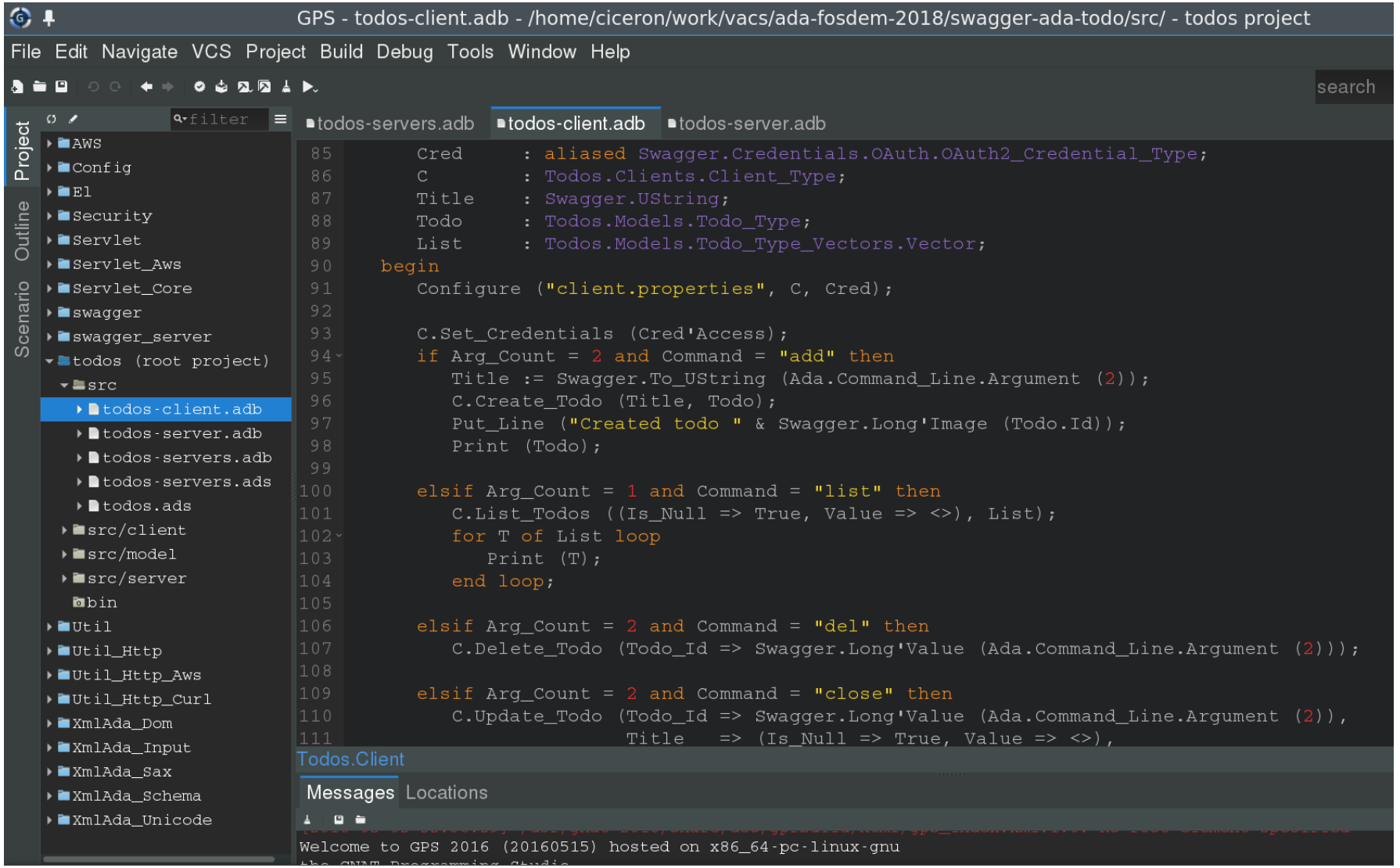
- Configure the server to register the client id and secret

```
app.list=1
app.1.client_id=todo-app
app.1.client_secret=todo-app-secret
app.1.scope=none
```

- Configure the users allowed to authenticate

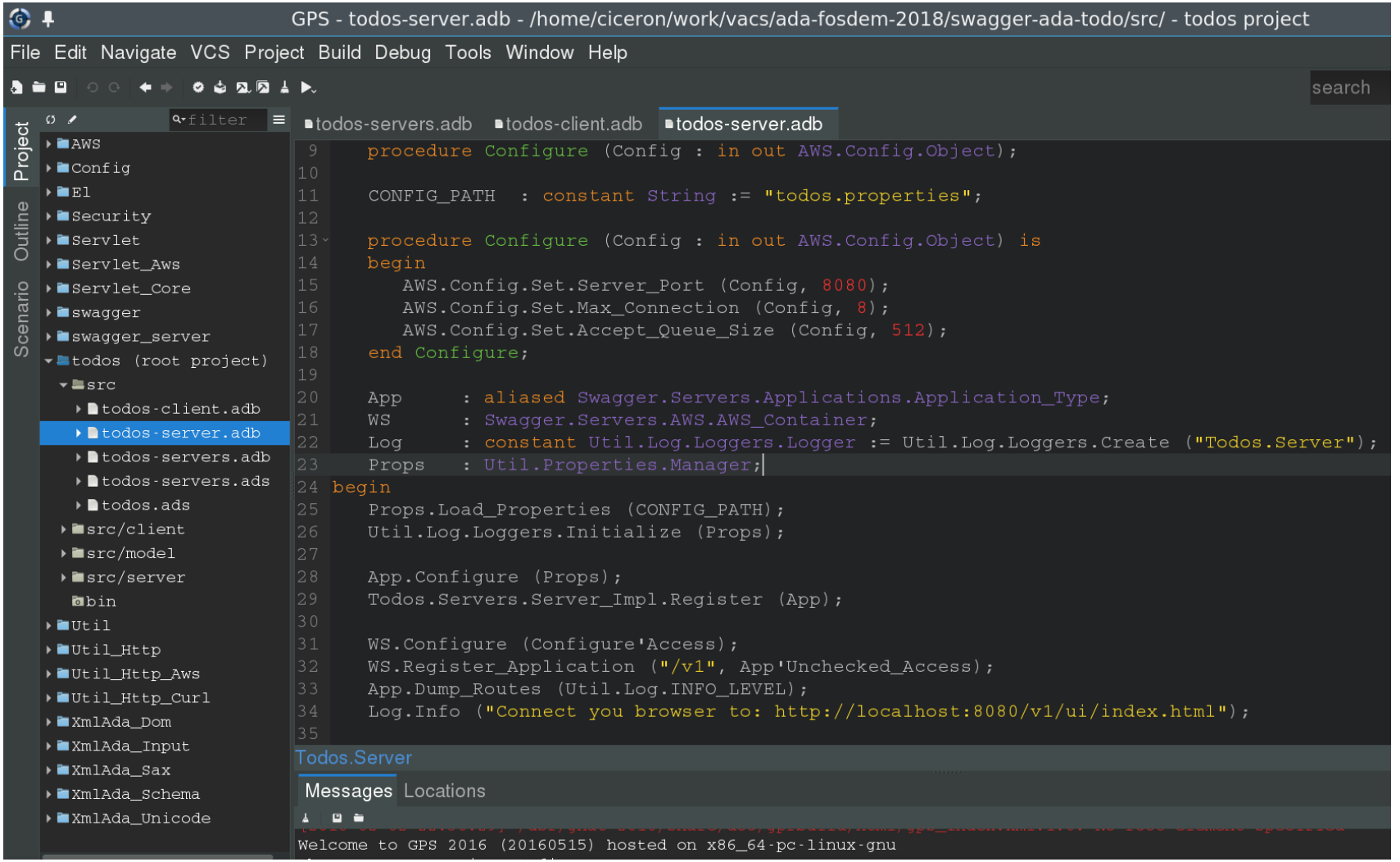
```
users.list=1,2
users.1.username=admin
users.1.password=admin
users.2.username=test
users.2.password=test
```

Demo: Todo client



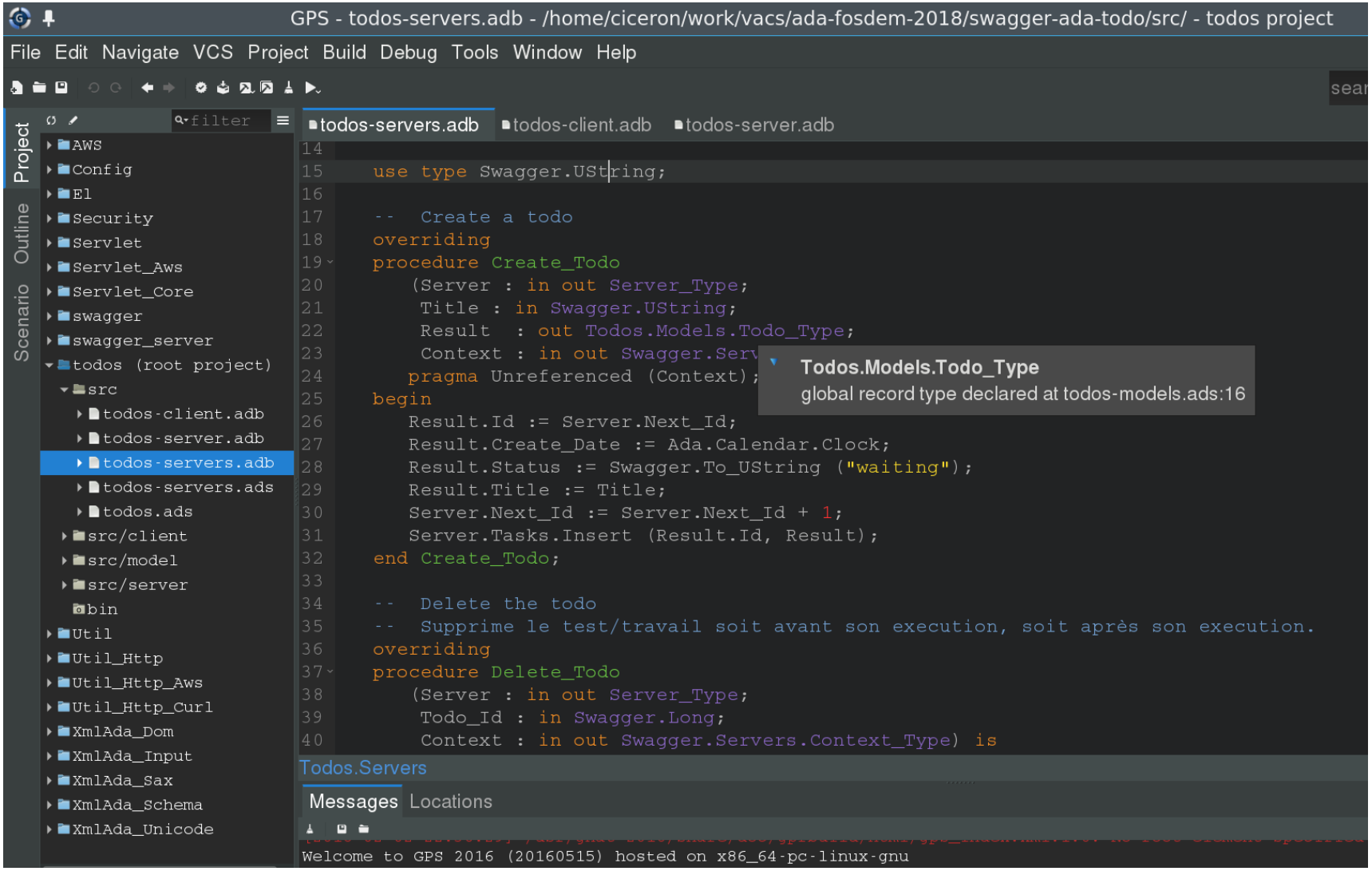
https://github.com/stcarrez/swagger-ada

Demo: Todo server (main)



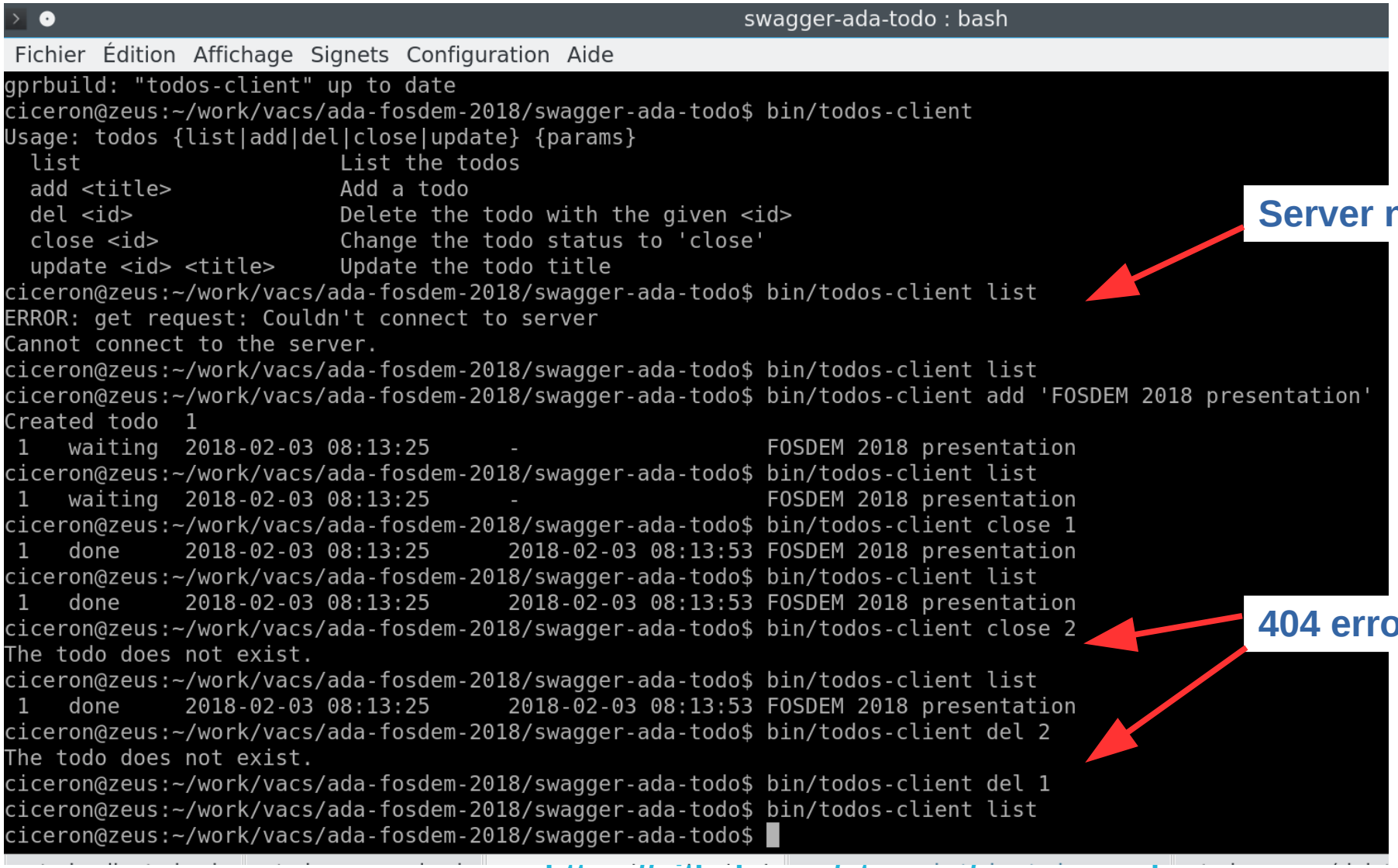
https://github.com/stcarrez/swagger-ada

Demo: Todo server (impl)



https://github.com/stcarrez/swagger-ada

Demo: Running the client



https://github.com/stcarrez/swagger-ada

Limitations and improvements

- Ada Strings
  (need a lot of `To_String/To_Ustring` conversions)
- Enums are treated as strings
- Circular type dependencies not handled
- Error model needs some work
- Improvements:
  - Upload file support
  - Asynchronous client operation call

Conclusion

- OpenAPI describes REST APIs
- Swagger Codegen generates Ada code for you
- Swagger Ada is a runtime library for REST client and REST server implementation
- More than 500 APIs available, write your own!
- Next step: … GraphQL?