Providing RPG Web Services on IBM i

Presented by

Scott Klement

http://www.scottklement.com

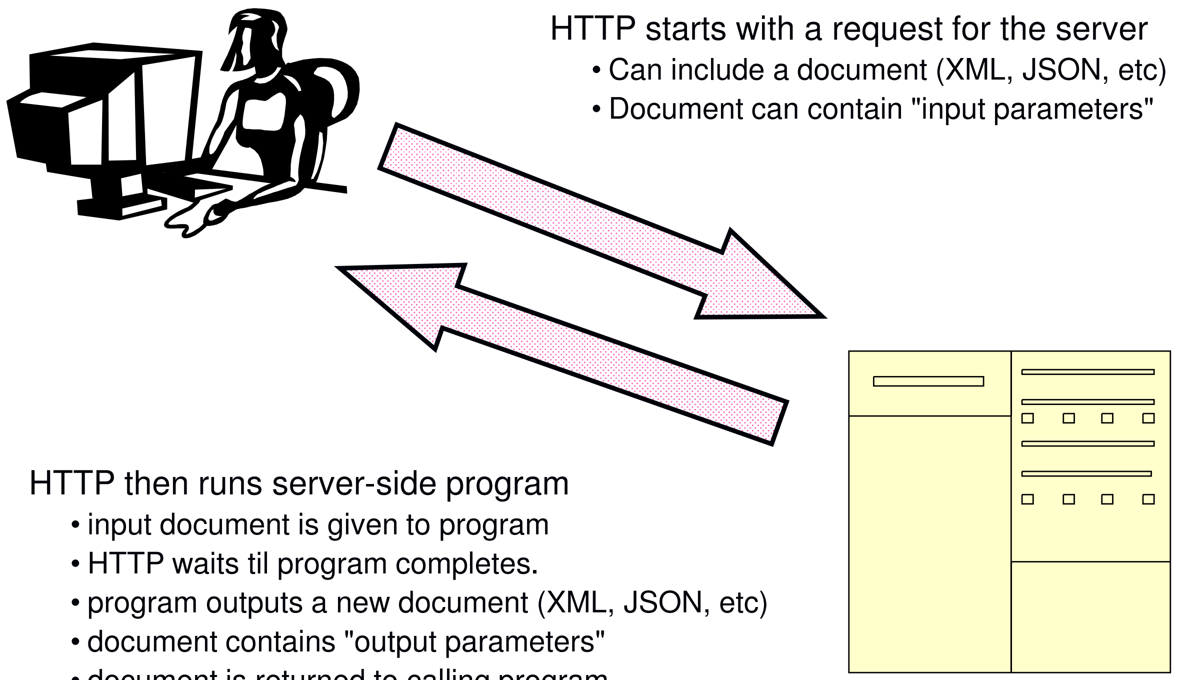
"A computer once beat me at chess, but it was no match for me at kick boxing." — Emo Philips

Our Agenda

Agenda for this session:

1. Introduction
   - How do they work?
   - What are JSON and XML?
2. REST web service with IBM's IWS
3. Writing your own from the ground-up with Apache.
4. Discussion/wrap-up

How Do They Work?



HTTP starts with a request for the server
- Can include a document (XML, JSON, etc)
- Document can contain "input parameters"

HTTP then runs server-side program
- input document is given to program
- HTTP waits til program completes.
- program outputs a new document (XML, JSON, etc)
- document contains "output parameters"
- document is returned to calling program.

JSON and XML to Represent a DS

```
D list              ds                   qualified
D                                        dim(2)
D   custno                         4p 0
D   name                          25a
```

Array of data structures in RPG...

```
[
  {
    "custno": 1000,
    "name": "ACME, Inc"
  },
  {
    "custno": 2000,
    "name": "Industrial Supply Limited"
  }
]
```

Array of data structures in JSON

```
<list>
  <cust>
    <custno>1000</custno>
    <name>Acme, Inc</name>
  </cust>
  <cust>
    <custno>2000</custno>
    <name>Industrial Supply Limited</name>
  </cust>
</list>
```

Array of data structures in XML

Without Adding Spacing for Humans

```
[{"custno": 1000,"name": "ACME, Inc"},{"custno": 2000,
"name": "Industrial Supply Limited"}]
```

92 bytes

```
<list><cust><custno>1000</custno><name>ACME, Inc</name
></cust><cust><custno>2000</custno><name>Industrial S
upply Limited</name></cust></list>
```

142 bytes

In this simple "textbook" example, that's a 35% size reduction.

50 bytes doesn't matter, but sometimes these documents can be megabytes long – so a 35% reduction can be important.

…and programs process JSON faster, too!

IBM's Integrated Web Services Server

IBM provides a Web Services (aka Web API, aka REST API) tool with IBM i at no extra charge!

The tool takes care of all of the HTTP and XML/JSON work for you!

It's called the *Integrated Web Services* tool.

https://www.ibm.com/support/pages/integrated-web-services-ibm-i-web-services-made-easy

Requirements:
- IBM i operating system
- 57xx-SS1, opt 30: QShell
- 57xx-SS1, opt 33: PASE
- 57xx-JV1, opt 14 (or higher): Java
- 57xx-DG1 -- the HTTP server (powered by Apache)

Make sure you have the latest TR, cum & group PTFs installed.

Let's Get Started!

The HTTP server administration tool runs in IBM Navigator for i

- If this isn't already started, you can start it with:

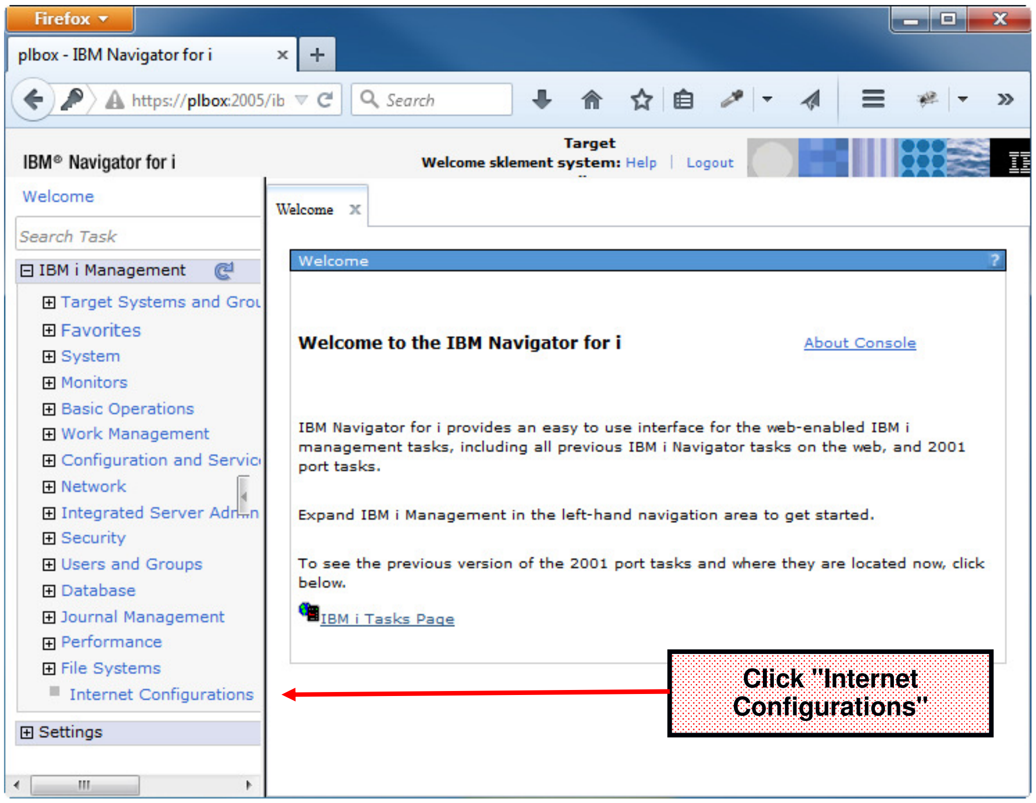
```
STRTCPSVR SERVER(*HTTP) HTTPSVR(*ADMIN)
```

- Point browser at:

```
http://your-system:2001/
```

- Sign-in
- Click "Internet Configurations" (old nav) or "Bookmarks" (new nav)
- Click "IBM Web Administration for i"

IBM Navigator for i (old nav)



Welcome to the IBM Navigator for i

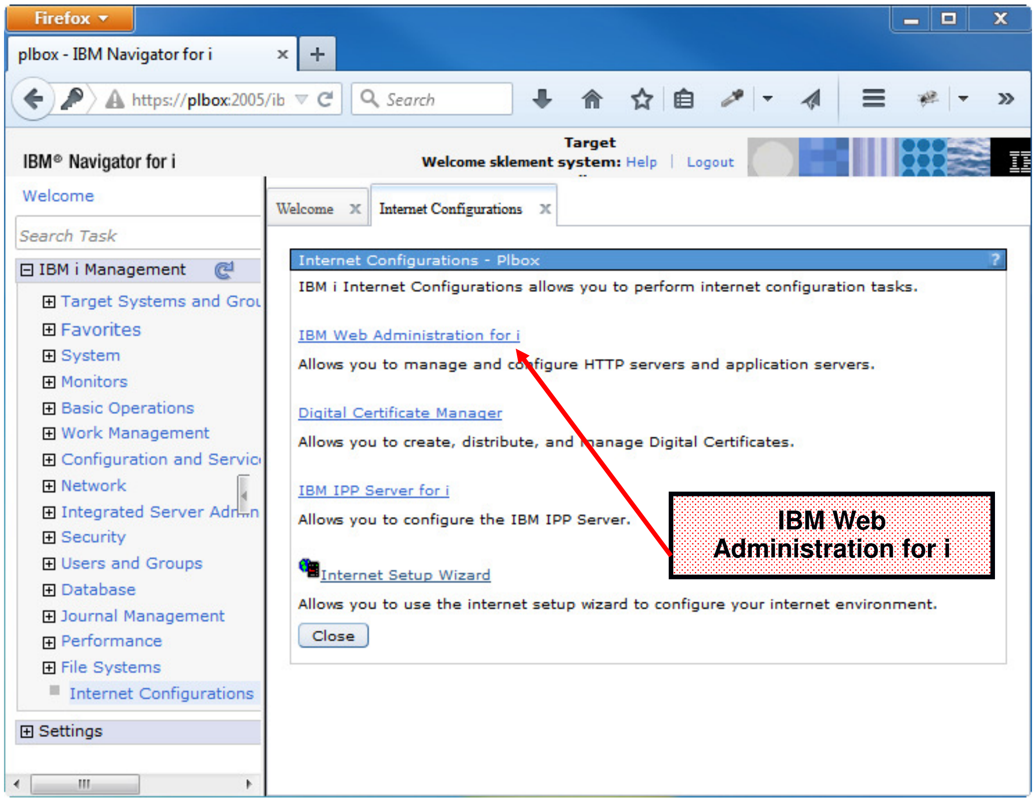
IBM Navigator for i provides an easy to use interface for the web-enabled IBM i management tasks, including all previous IBM i Navigator tasks on the web, and 2001 port tasks.

Expand IBM i Management in the left-hand navigation area to get started.

To see the previous version of the 2001 port tasks and where they are located now, click below.

Click "Internet Configurations"

Internet Configurations (old nav)



IBM i Internet Configurations allows you to perform internet configuration tasks.

IBM Web Administration for i

Allows you to manage and configure HTTP servers and application servers.

Digital Certificate Manager

Allows you to create, distribute, and manage Digital Certificates.

IBM IPP Server for i

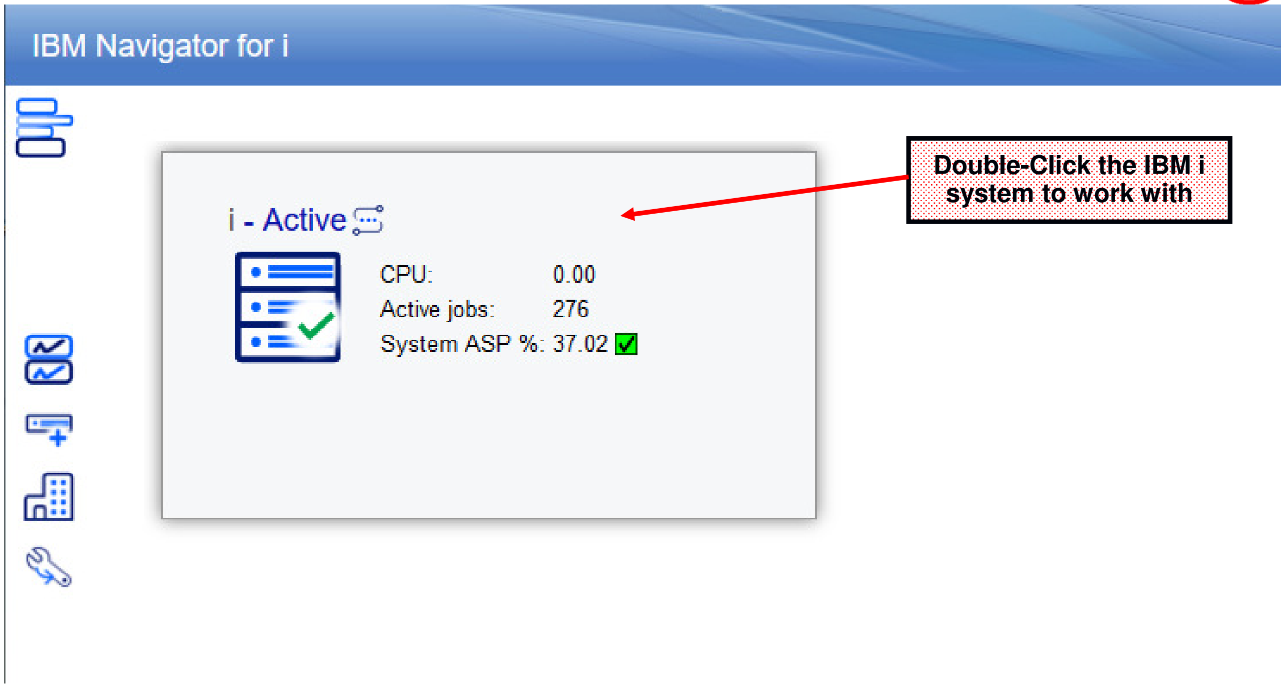
Allows you to configure the IBM IPP Server.

Internet Setup Wizard

Allows you to use the internet setup wizard to configure your internet environment.

IBM Web Administration for i

IBM Navigator for i (new nav)

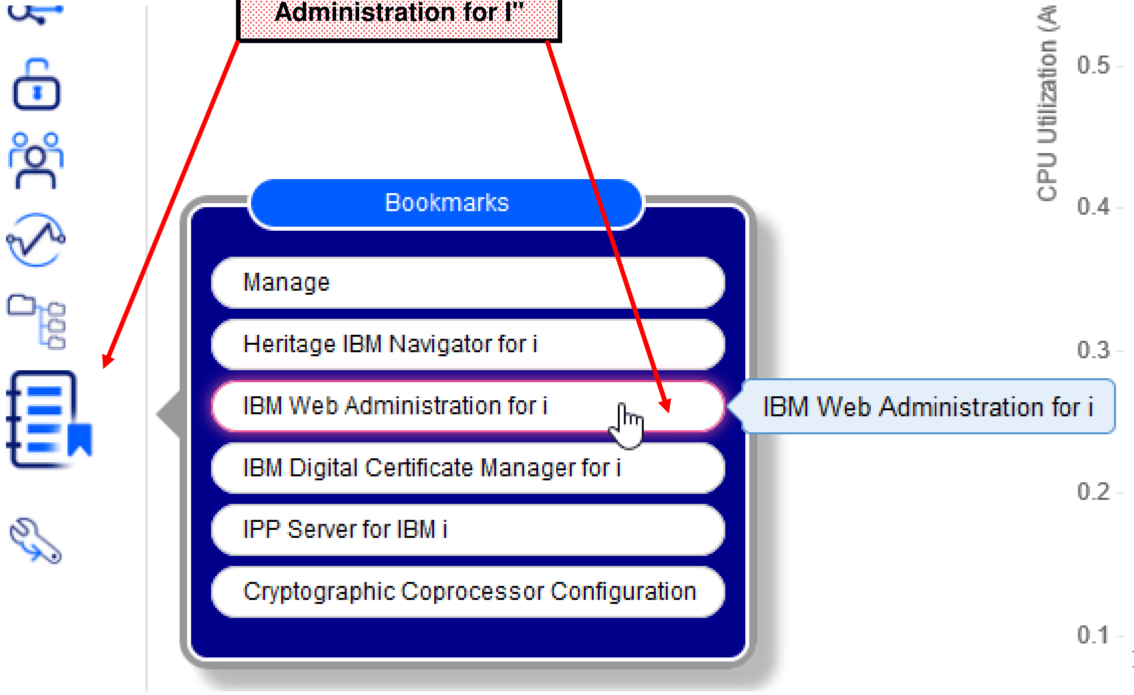


CPU: 0.00
Active jobs: 276
System ASP %: 37.02 ✓

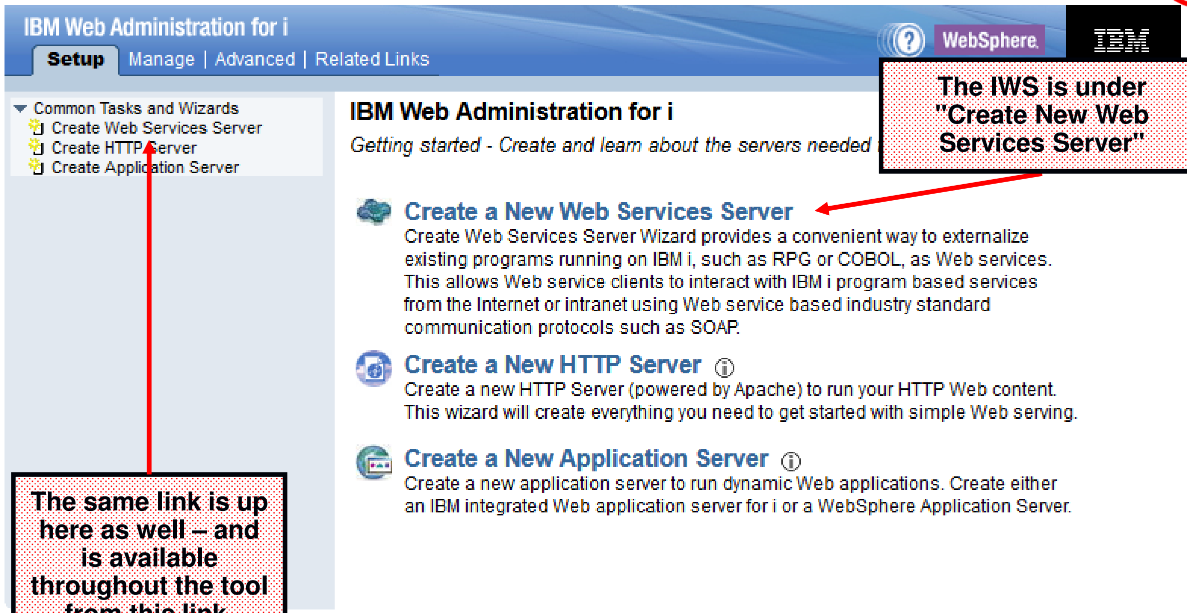
Double-Click the IBM i system to work with

Bookmarks (new nav)

Open the "Bookmarks" item in the lower-left, and click "IBM Web Administration for I"


Bookmarks
Manage
Heritage IBM Navigator for i
IBM Web Administration for i
IBM Digital Certificate Manager for i
IPP Server for IBM i
Cryptographic Coprocessor Configuration
IBM Web Administration for i
CPU Utilization (A
0.5
0.4
0.3
0.2
0.1

Web Administration for i


IBM Web Administration for i
Setup
Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server

IBM Web Administration for i

Getting started - Create and learn about the servers needed

Create a New Web Services Server

Create Web Services Server Wizard provides a convenient way to externalize existing programs running on IBM i, such as RPG or COBOL, as Web services. This allows Web service clients to interact with IBM i program based services from the Internet or intranet using Web service based industry standard communication protocols such as SOAP.

Create a New HTTP Server

Create a new HTTP Server (powered by Apache) to run your HTTP Web content. This wizard will create everything you need to get started with simple Web serving.

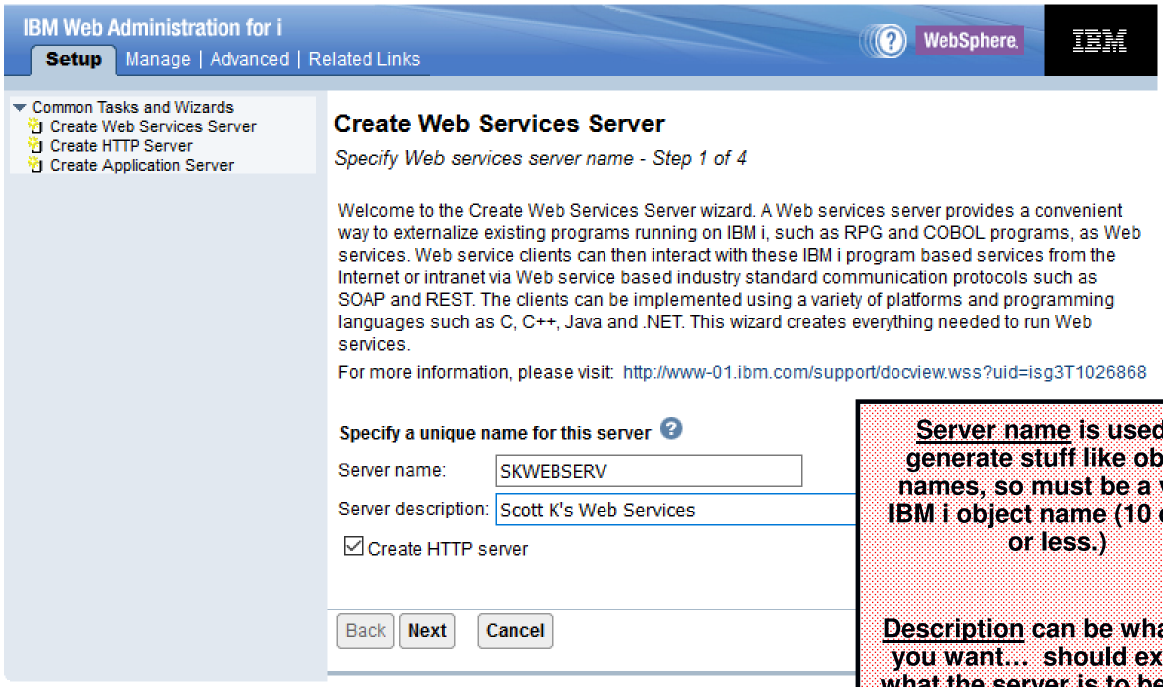
Create a New Application Server

Create a new application server to run dynamic Web applications. Create either an IBM integrated Web application server for i or a WebSphere Application Server.

The IWS is under "Create New Web Services Server"

The same link is up here as well – and is available throughout the tool from this link.

Create IWS Server (1 of 4)



IBM Web Administration for i

Setup | Manage | Advanced | Related Links

Common Tasks and Wizards
- Create Web Services Server
- Create HTTP Server
- Create Application Server

Create Web Services Server

Specify Web services server name - Step 1 of 4

Welcome to the Create Web Services Server wizard. A Web services server provides a convenient way to externalize existing programs running on IBM i, such as RPG and COBOL programs, as Web services. Web service clients can then interact with these IBM i program based services from the Internet or intranet via Web service based industry standard communication protocols such as SOAP and REST. The clients can be implemented using a variety of platforms and programming languages such as C, C++, Java and .NET. This wizard creates everything needed to run Web services.

For more information, please visit: http://www-01.ibm.com/support/docview.wss?uid=isg3T1026868

Specify a unique name for this server

Server name:	SKWEBSERV
Server description:	Scott K's Web Services

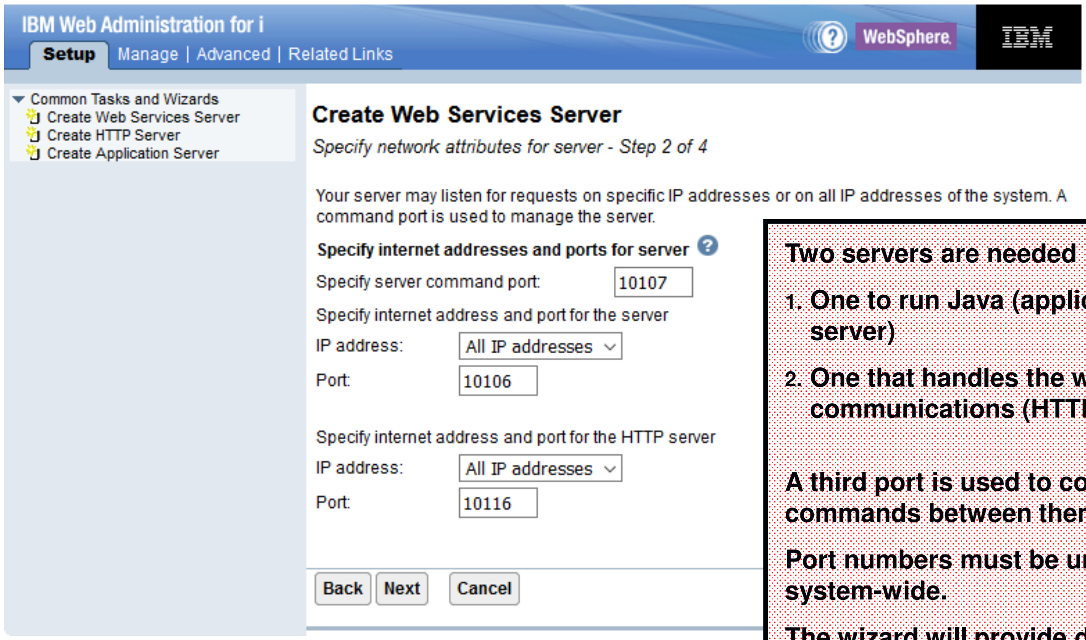
☑ Create HTTP server

Back | Next | Cancel

Server name is used to generate stuff like object names, so must be a valid IBM i object name (10 chars or less.)

Description can be whatever you want… should explain what the server is to be used for.

Create IWS Server (2 of 4)



IBM Web Administration for i

Setup | Manage | Advanced | Related Links

Common Tasks and Wizards
- Create Web Services Server
- Create HTTP Server
- Create Application Server

Create Web Services Server

Specify network attributes for server - Step 2 of 4

Your server may listen for requests on specific IP addresses or on all IP addresses of the system. A command port is used to manage the server.

Specify internet addresses and ports for server

Specify server command port:	10107

Specify internet address and port for the server

IP address:	All IP addresses
Port:	10106

Specify internet address and port for the HTTP server

IP address:	All IP addresses
Port:	10116

Back | Next | Cancel

Two servers are needed

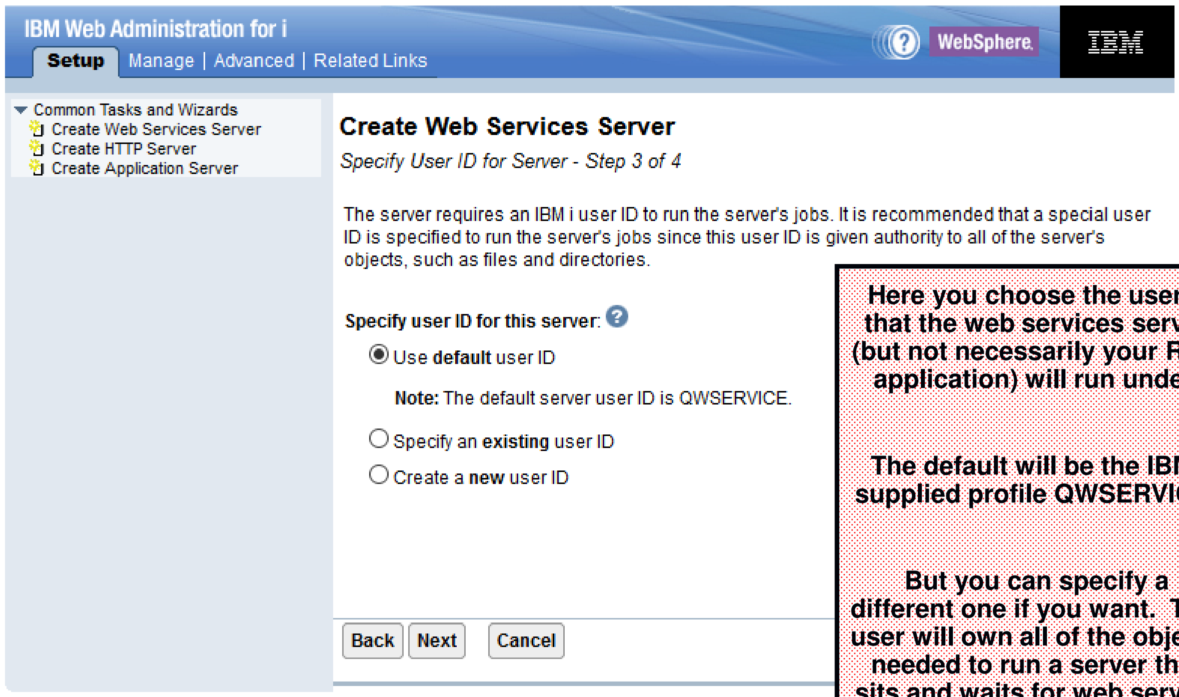
1. **One to run Java (application server)**
2. **One that handles the web communications (HTTP server)**

A third port is used to communicate commands between them.

Port numbers must be unique system-wide.

The wizard will provide defaults that should work.

Create IWS Server (3 of 4)


IBM Web Administration for i
Setup | Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Back
Next
Cancel

Create Web Services Server

Specify User ID for Server - Step 3 of 4

The server requires an IBM i user ID to run the server's jobs. It is recommended that a special user ID is specified to run the server's jobs since this user ID is given authority to all of the server's objects, such as files and directories.

Specify user ID for this server:

● Use **default** user ID

Note: The default server user ID is QWSERVICE.

○ Specify an **existing** user ID

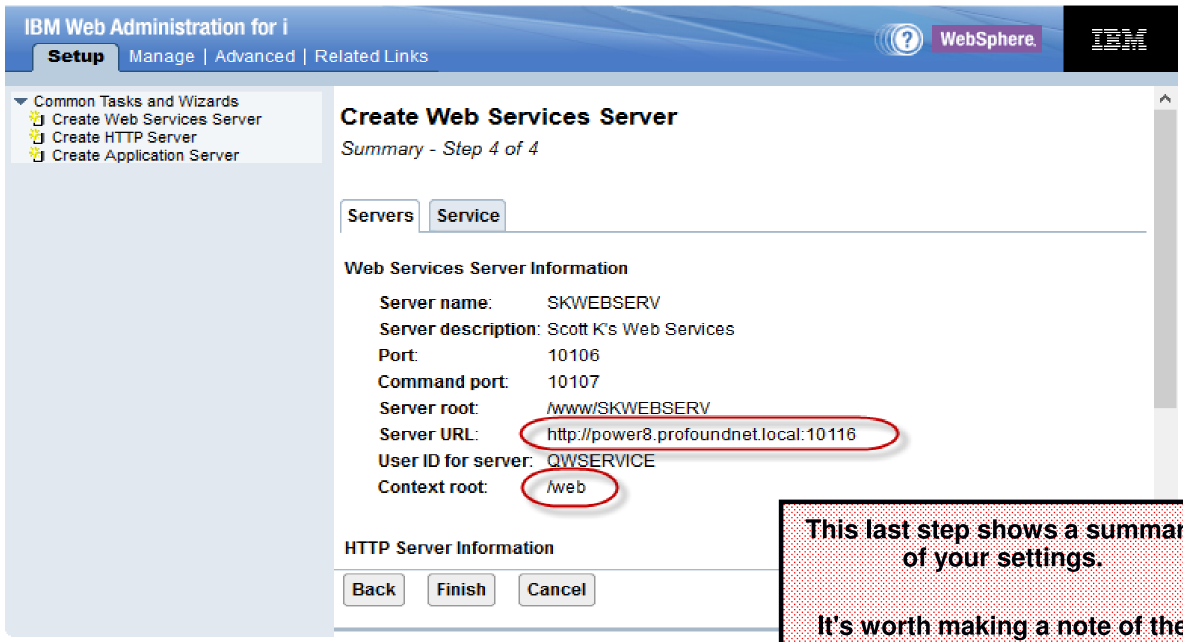
○ Create a **new** user ID

Here you choose the userid that the web services server (but not necessarily your RPG application) will run under.

The default will be the IBM-supplied profile QWSERVICE.

But you can specify a different one if you want. This user will own all of the objects needed to run a server that sits and waits for web service requests.

Create IWS Server (4 of 4)


IBM Web Administration for i
Setup | Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Servers
Service
Back
Finish
Cancel

Create Web Services Server

Summary - Step 4 of 4

Web Services Server Information

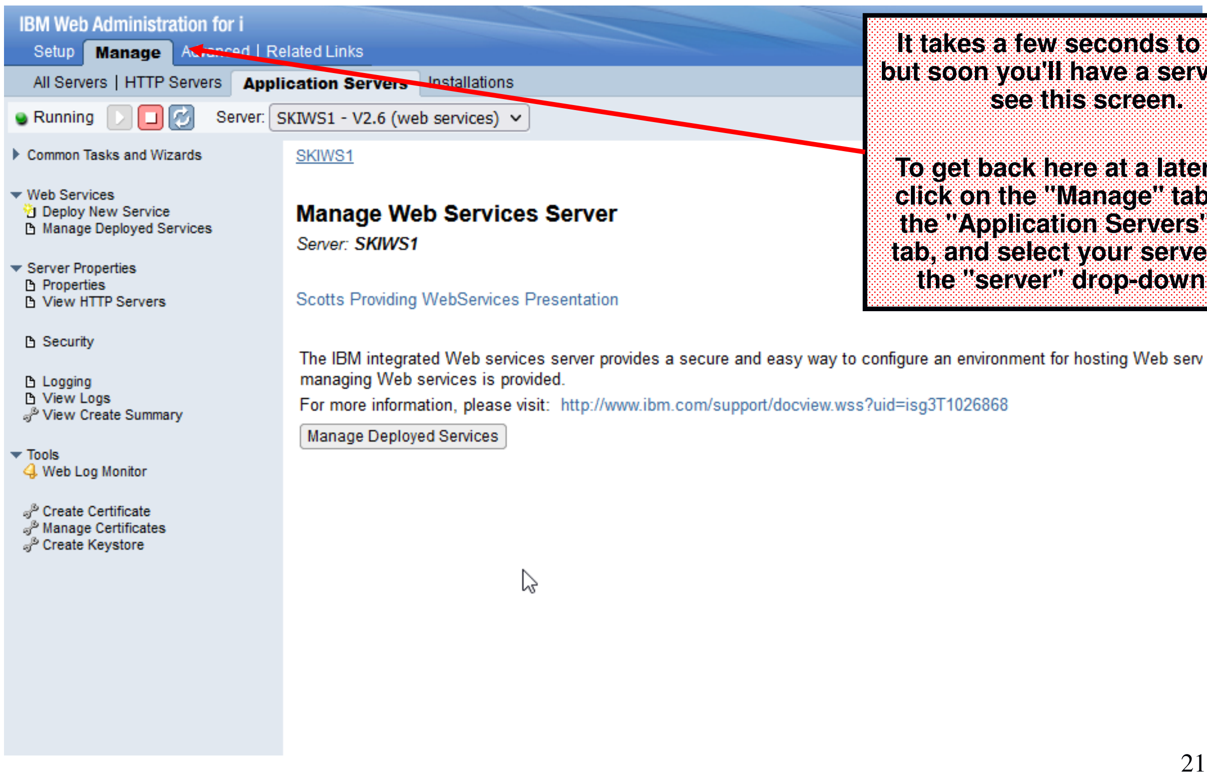
Server name:	SKWEBSERV
Server description:	Scott K's Web Services
Port:	10106
Command port:	10107
Server root:	/www/SKWEBSERV
Server URL:	http://power8.profoundnet.local:10116
User ID for server:	QWSERVICE
Context root:	/web

HTTP Server Information

This last step shows a summary of your settings.

It's worth making a note of the Server URL and the Context Root that it has chosen.

We Now Have a Server!



Manage Web Services Server

Server: SKIWS1

Scotts Providing WebServices Presentation

The IBM integrated Web services server provides a secure and easy way to configure an environment for hosting Web serv
managing Web services is provided.

For more information, please visit: http://www.ibm.com/support/docview.wss?uid=isg3T1026868

It takes a few seconds to build, but soon you'll have a server, and see this screen.

To get back here at a later date, click on the "Manage" tab, then the "Application Servers" sub-tab, and select your server from the "server" drop-down list.

GETCUST RPG Program (1 of 2)

```
Ctl-Opt DFTACTGRP(*NO) ACTGRP('WEBAPI') PGMINFO(*PCML:*MODULE);

Dcl-F CUSTFILE Usage(*Input) Keyed PREFIX('CUST.');

Dcl-DS CUST ext extname('CUSTFILE') qualified End-DS;

Dcl-PI *N;
   CustNo                    like(Cust.Custno);
   Name                      like(Cust.Name);
   Street                    like(Cust.Street);
   City                      like(Cust.City);
   State                     like(Cust.State);
   Postal                    like(Cust.Postal);
End-PI;

Dcl-PR QMHSNDPM  ExtPgm('QMHSNDPM');
   MessageID      Char(7)    Const;
   QualMsgF       Char(20)   Const;
   MsgData        Char(32767) Const options(*varsize);
   MsgDtaLen      Int(10)    Const;
   MsgType        Char(10)   Const;
   CallStkEnt     Char(10)   Const;
   CallStkCnt     Int(10)    Const;
   MessageKey     Char(4);
   ErrorCode      Char(8192) options(*varsize);
End-PR;
```

PCML with parameter info will be embedded in the module and program objects.

This PREFIX causes the file to be read into the CUST data struct.

Since there's no DCL-PROC, the DCL-PI works like the old *ENTRY PLIST

GETCUST RPG Program (2 of 2)

```
Dcl-DS err  qualified;
   bytesProv      Int(10)    inz(0);
   bytesAvail     Int(10)    inz(0);
End-DS;

Dcl-S MsgDta       Varchar(1000);
Dcl-S MsgKey       Char(4);
Dcl-S x            Int(10);

chain CustNo CUSTFILE;
if not %found;
   msgdta = 'Customer not found.';
   QMHSNDPM( 'CPF9897': 'QCPFMSG   *LIBL': msgdta:
%len(msgdta): '*ESCAPE'
            : '*PGMBDY': 1: MsgKey: err );
else;
   Custno = Cust.Custno;
   Name   = Cust.name;
   Street = Cust.Street;
   City   = Cust.City;
   State  = Cust.State;
   Postal = Cust.Postal;
endif;

*inlr = *on;
```

This API is equivalent to the CL SNDPGMMSG command, and causes my program to end with an exception ("halt")

When there are no errors, I simply return my output via the parameter list. IWS takes care of creating JSON or XML for me!

PCML so IWS Knows Our Parameters

Our GETCUST example gets input and output as normal parameters. To use these with IWS, we need to tell IWS what these parameters are. This is done with an XML document that is generated by the RPG compiler.

PCML = Program Call Markup Language

- A flavor of XML that describes a program's (or *SRVPGM's) parameters.
- Can be generated for you by the RPG compiler, and stored in the IFS:

```
CRTBNDRPG PGM(xyz) SRCFILE(QRPGLESRC)
          PGMINFO(*PCML)
          INFOSTMF('/path/to/myfile.pcml')
```

- Or can be embedded into the module/program objects themselves, with an H-spec or CTL-OPT:

```
Ctl-Opt PGMINFO(*PCML:*MODULE);
```

GETCUST as a REST API

Remember that REST (sometimes called 'RESTful') web services differ from SOAP in that:

- the URL points to a "noun" (or "resource")
- the HTTP method specifies a "verb" like GET, POST, PUT or DELETE. (Similar to a database Create, Read, Update, Delete…)
- REST sounds nicer than CRUD, haha.

IWS structures the URL like this:

```
http://address:port/context-root/root-resource/path-template
```

- context-root = Distinguishes from other servers. The default context-root is /web/services, but you can change this in the server properties.
- root-resource = identifies the type of resource (or "noun") we're working with. In our example, we'll use "/cust" to identify a customer. The IWS will also use this to determine which program to run.
- path-template = identifies the variables/parameters that distinguish this noun from others. In our example, it'll be the customer number.

Example REST Input

For our example, we will use this URL:

```
http://address:port/web/services/cust/495
```

Our URL will represent a customer record. Then we can:

- GET <url> the customer to see the address.
- potentially POST <url> the customer to create a new customer record
- potentially PUT <url> the customer to update an existing customer record
- potentially DELETE <url> to remove the customer record.

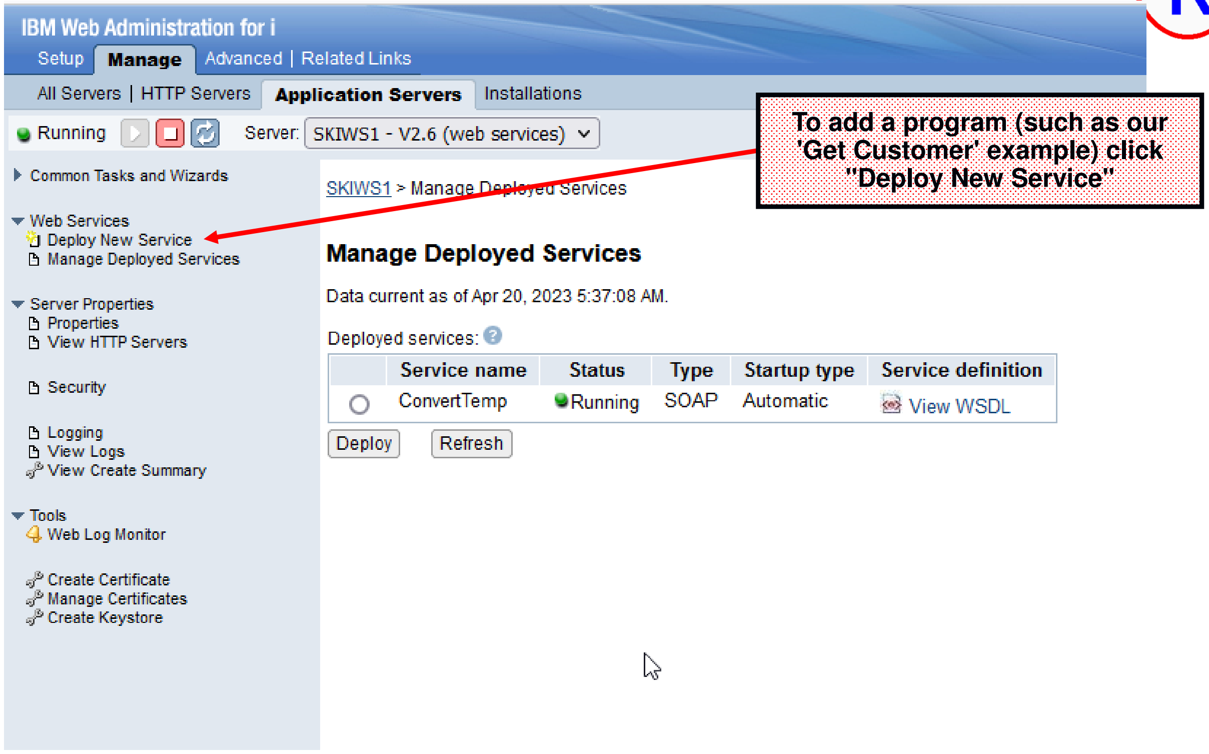
Though, in this particular example, our requirements are only to retrieve customer details, so we won't do all four possible verbs, we'll only do GET.

That means in IWS terminology:

- /web/services is the context root.
- /cust is the root resource (and will point to our GETCUST program)
- /495 (or any other customer number) is the path template.

With that in mind, we're off to see the wizard… the wonderful wizard of REST.

Deploy a New REST API



IBM Web Administration for i

Setup | Manage | Advanced | Related Links

All Servers | HTTP Servers | Application Servers | Installations

Running Server: SKIWS1 - V2.6 (web services)

To add a program (such as our 'Get Customer' example) click "Deploy New Service"

- Common Tasks and Wizards
- Web Services
  - Deploy New Service
  - Manage Deployed Services
- Server Properties
  - Properties
  - View HTTP Servers
  - Security
  - Logging
  - View Logs
  - View Create Summary
- Tools
  - Web Log Monitor
  - Create Certificate
  - Manage Certificates
  - Create Keystore

SKIWS1 > Manage Deployed Services

Manage Deployed Services

Data current as of Apr 20, 2023 5:37:08 AM.

Deployed services:

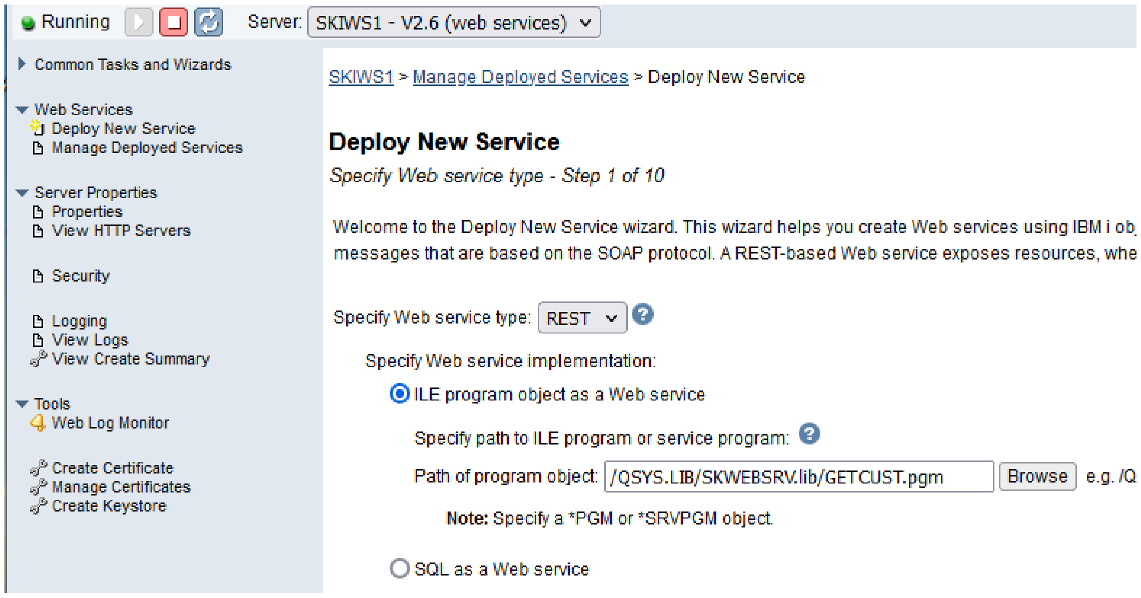
	Service name	Status	Type	Startup type	Service definition
○	ConvertTemp	● Running	SOAP	Automatic	View WSDL

Deploy Refresh

REST Wizard (1 of 10)

The type (dropdown) should be REST.

You can use a program or SQL statement – for this example, I'll specify an ILE program and type the IFS path of the GETCUST program.



Running Server: SKIWS1 - V2.6 (web services)

- Common Tasks and Wizards
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- Server Properties
  - Properties
  - View HTTP Servers
  - Security
  - Logging
  - View Logs
  - View Create Summary
- Tools
  - Web Log Monitor
  - Create Certificate
  - Manage Certificates
  - Create Keystore

SKIWS1 > Manage Deployed Services > Deploy New Service

Deploy New Service

Specify Web service type - Step 1 of 10

Welcome to the Deploy New Service wizard. This wizard helps you create Web services using IBM i ob
messages that are based on the SOAP protocol. A REST-based Web service exposes resources, whe

Specify Web service type: REST

Specify Web service implementation:

(●) ILE program object as a Web service

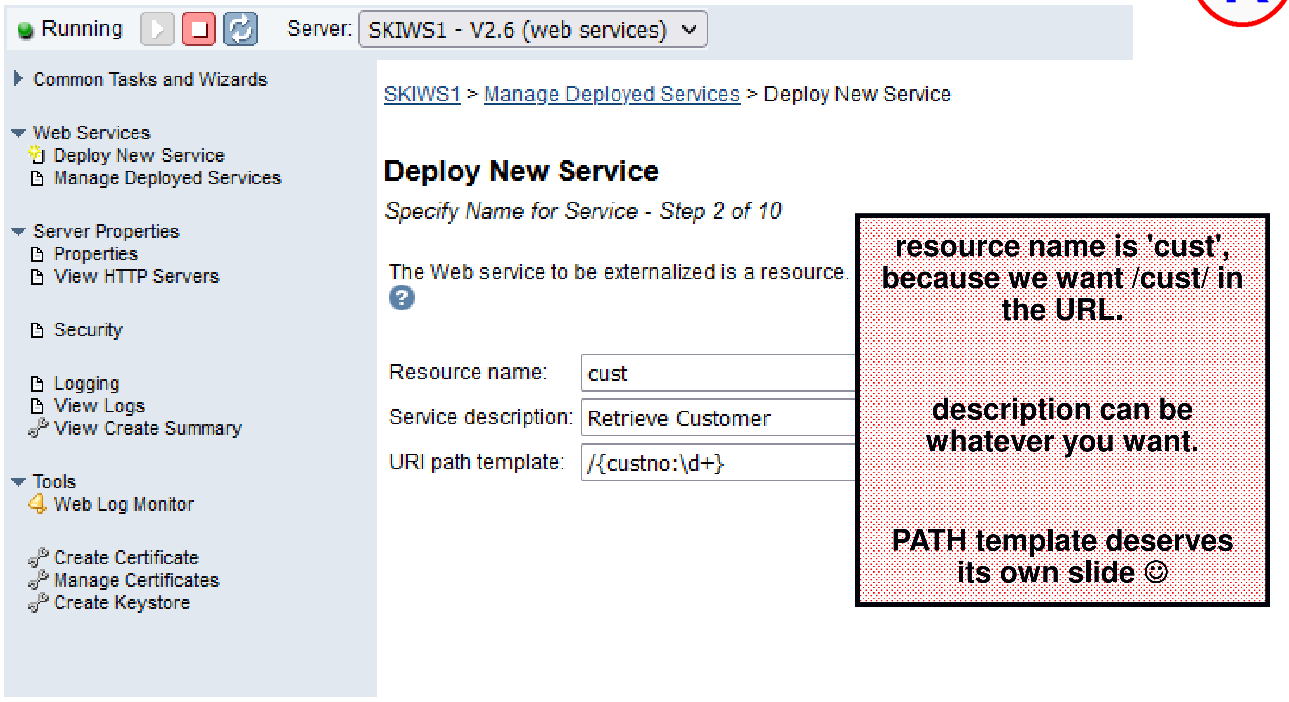
Specify path to ILE program or service program:

Path of program object: /QSYS.LIB/SKWEBSRV.lib/GETCUST.pgm Browse e.g. /Q

Note: Specify a *PGM or *SRVPGM object.

○ SQL as a Web service

REST Wizard (2 of 10)



SKIWS1 > Manage Deployed Services > Deploy New Service

Deploy New Service

Specify Name for Service - Step 2 of 10

The Web service to be externalized is a resource.

Resource name:	cust
Service description:	Retrieve Customer
URI path template:	/{custno:\d+}

resource name is 'cust', because we want /cust/ in the URL.

description can be whatever you want.

PATH template deserves its own slide ☺

Path Templates

You can make your URL as sophisticated as you like with a REST service. For example:

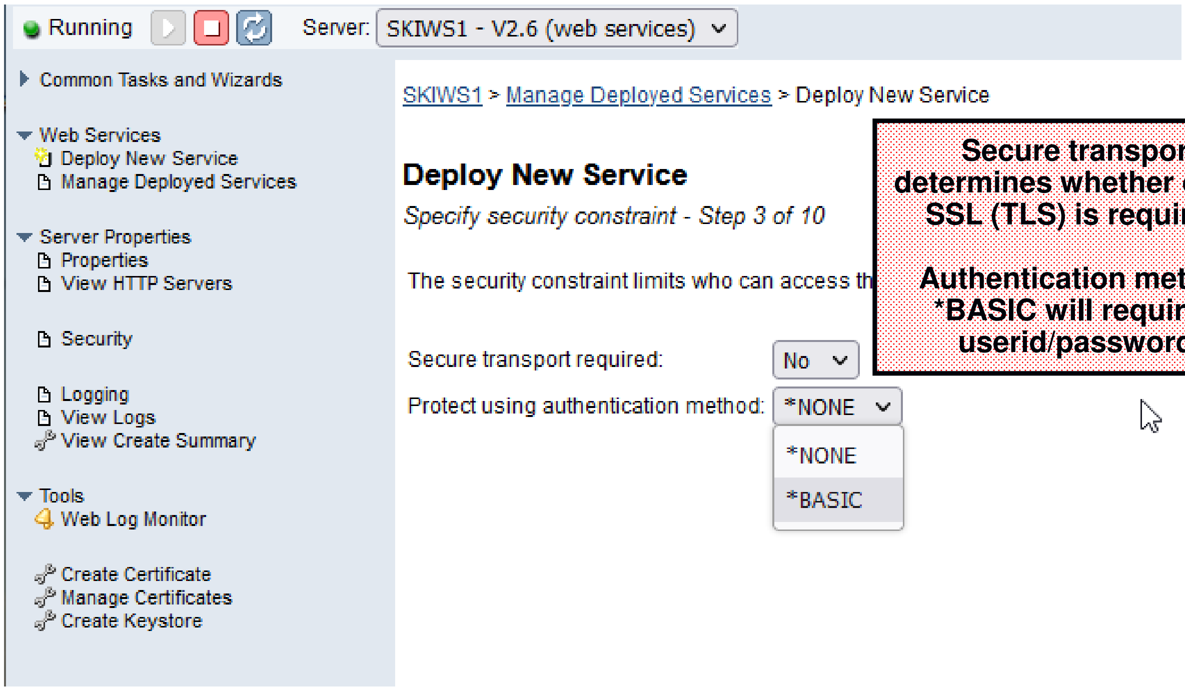
- Maybe there are multiple path variables separated by slashes
- Maybe they allow only numeric values
- Maybe they allow only letters, or only uppercase letters, or only lowercase, or both letters and numbers
- maybe they have to have certain punctuation, like slashes in a date, or dashes in a phone number.

Path templates are how you configure all of that. They have a syntax like:

```
{ identifier : regular expression }
```

- The identifier will be used later to map the variable into a program's parameter.
- The regular expression is used to tell IWS what is allowed in the parameter

REST Wizard (3 of 10)



Deploy New Service

Specify security constraint - Step 3 of 10

The security constraint limits who can access th

Secure transport required: No

Protect using authentication method: *NONE

*NONE
*BASIC

Secure transport determines whether or not SSL (TLS) is required.

Authentication method *BASIC will require a userid/password.

Path Template Examples

For our example, we want /495 (or any other customer number) in the URL, so we do:

/{custno:\d+} identifier=custno, and regular expression \d+ means \d = any digit, + = one or more

As a more sophisticated example, consider a web service that returns inventory in a particular warehouse location. The path template might identify a warehouse location in this syntax

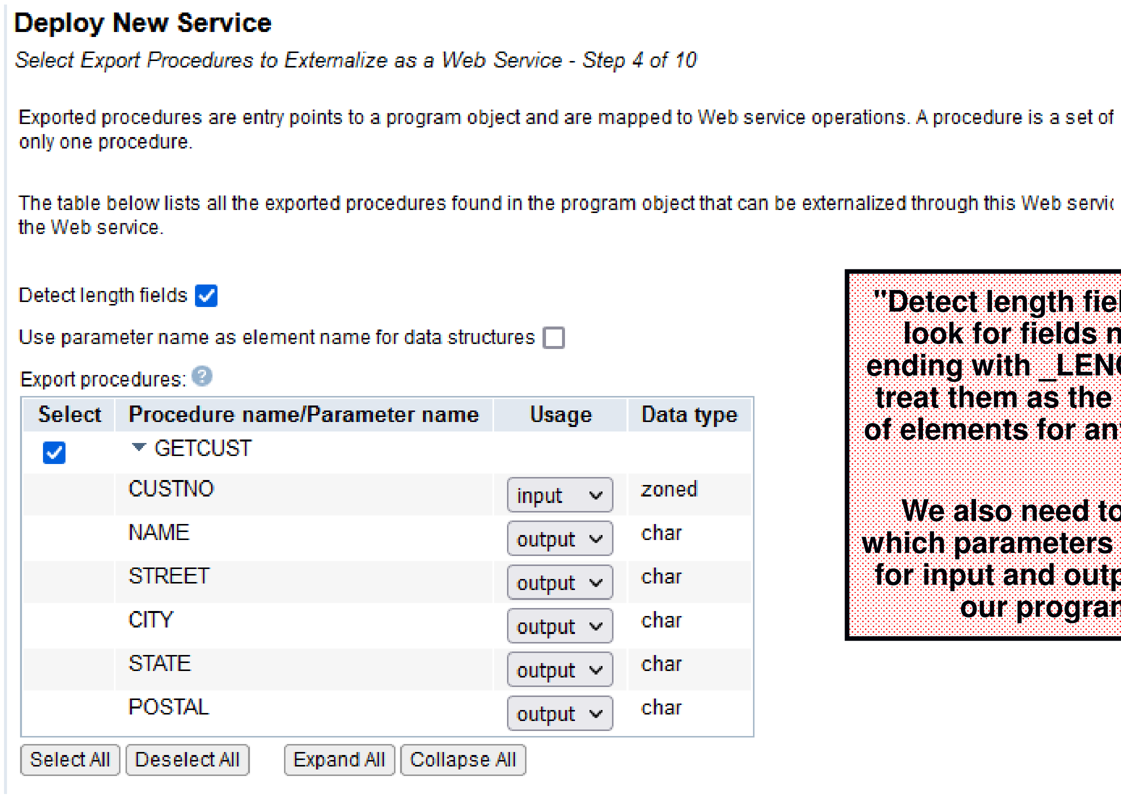
```
/Milwaukee/202/Freezer1/B/12/C
```

These identify City, Building, Room, Aisle, Slot and Shelf. The path template might be
/{city:\w+}/{bldg:\d+}/{room:\w+}/{aisle:[A-Z]}/{slot:\d\d}/{shelf:[A-E]}

\w+ = one or more of A-Z, a-z or 0-9 characters.
Aisle is only one letter, but can be A-Z (capital)
slot is always a two-digit number, from 00-99, \d\d means two numeric digits
Shelf is always capital letters A,B,C,D or E.

IWS uses Java regular expression syntax. A tutorial can be found here:
https://docs.oracle.com/javase/tutorial/essential/regex/

REST Wizard (4 of 10)



Deploy New Service

Select Export Procedures to Externalize as a Web Service - Step 4 of 10

Exported procedures are entry points to a program object and are mapped to Web service operations. A procedure is a set of only one procedure.

The table below lists all the exported procedures found in the program object that can be externalized through this Web servi the Web service.

Detect length fields ☑

Use parameter name as element name for data structures ☐

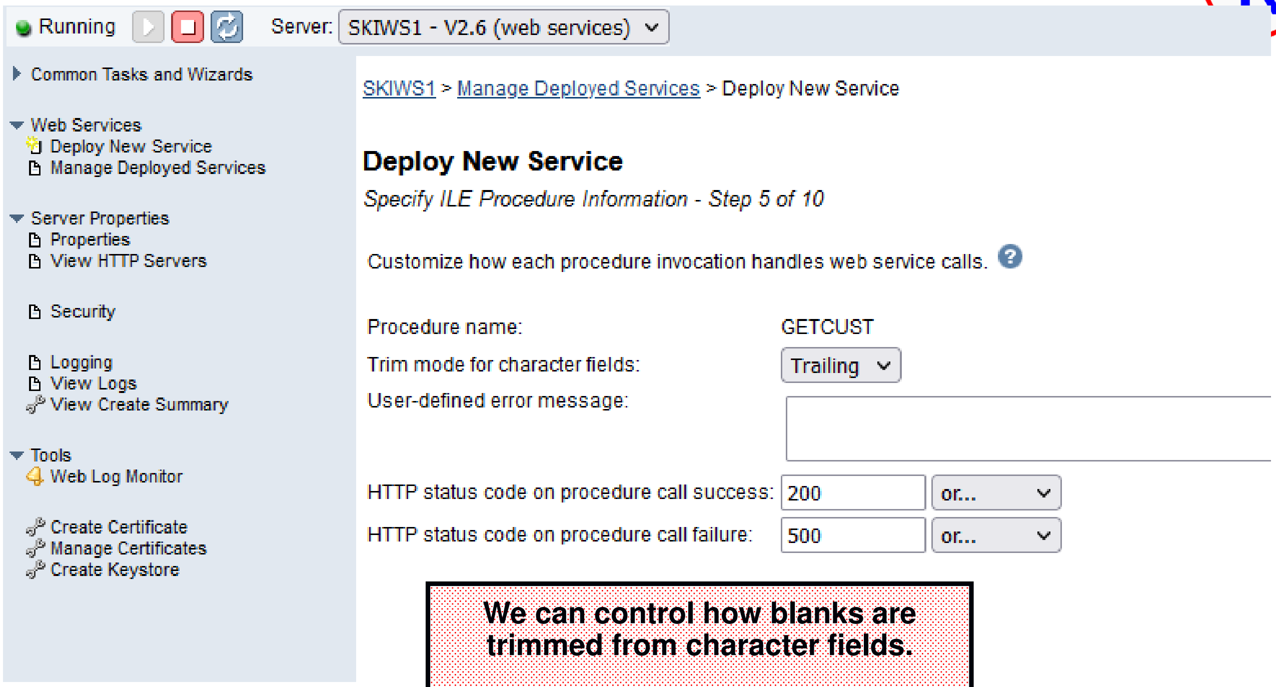
Export procedures:

Select	Procedure name/Parameter name	Usage	Data type
☑	▾ GETCUST		
	CUSTNO	input	zoned
	NAME	output	char
	STREET	output	char
	CITY	output	char
	STATE	output	char
	POSTAL	output	char

"Detect length fields" will look for fields named ending with _LENGTH and treat them as the number of elements for any arrays.

We also need to tell it which parameters are used for input and output from our program.

REST Wizard (5 of 10)



SKIWS1 > Manage Deployed Services > Deploy New Service

Deploy New Service

Specify ILE Procedure Information - Step 5 of 10

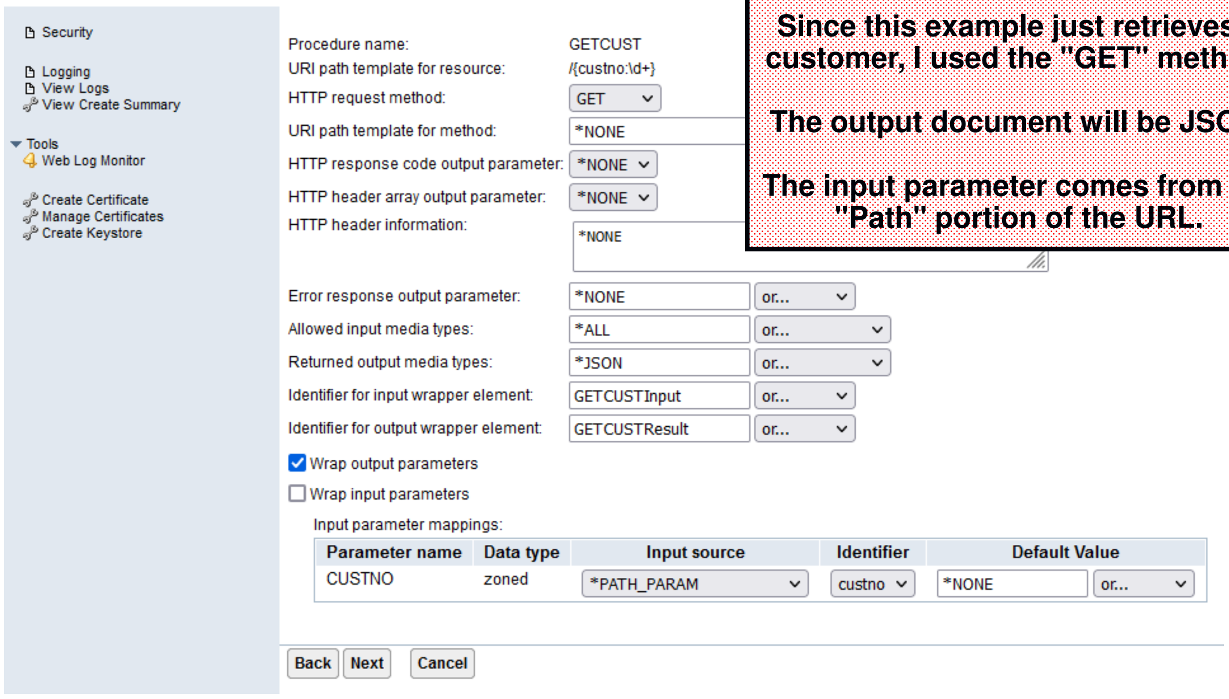
Customize how each procedure invocation handles web service calls.

Procedure name:	GETCUST	
Trim mode for character fields:	Trailing	
User-defined error message:		
HTTP status code on procedure call success:	200	or...
HTTP status code on procedure call failure:	500	or...

We can control how blanks are trimmed from character fields.

We can also control which HTTP status codes are returned for success/failures.

REST Wizard (6 of 10)



Procedure name:	GETCUST
URI path template for resource:	/{custno:\d+}
HTTP request method:	GET
URI path template for method:	*NONE
HTTP response code output parameter:	*NONE
HTTP header array output parameter:	*NONE
HTTP header information:	*NONE
Error response output parameter:	*NONE
Allowed input media types:	*ALL
Returned output media types:	*JSON
Identifier for input wrapper element:	GETCUSTInput
Identifier for output wrapper element:	GETCUSTResult

[✓] Wrap output parameters
[ ] Wrap input parameters

Input parameter mappings:

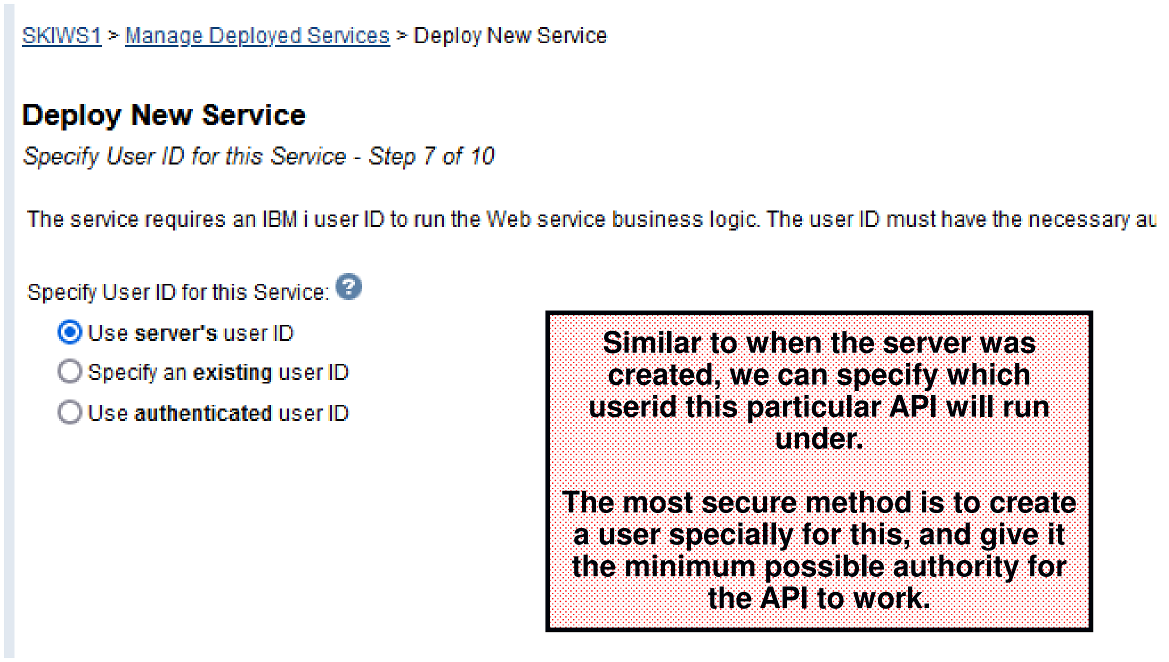
Parameter name	Data type	Input source	Identifier	Default Value
CUSTNO	zoned	*PATH_PARAM	custno	*NONE

Since this example just retrieves a customer, I used the "GET" method.

The output document will be JSON.

The input parameter comes from the "Path" portion of the URL.

REST Wizard (7 of 10)



SKIWS1 > Manage Deployed Services > Deploy New Service

Deploy New Service

Specify User ID for this Service - Step 7 of 10

The service requires an IBM i user ID to run the Web service business logic. The user ID must have the necessary au

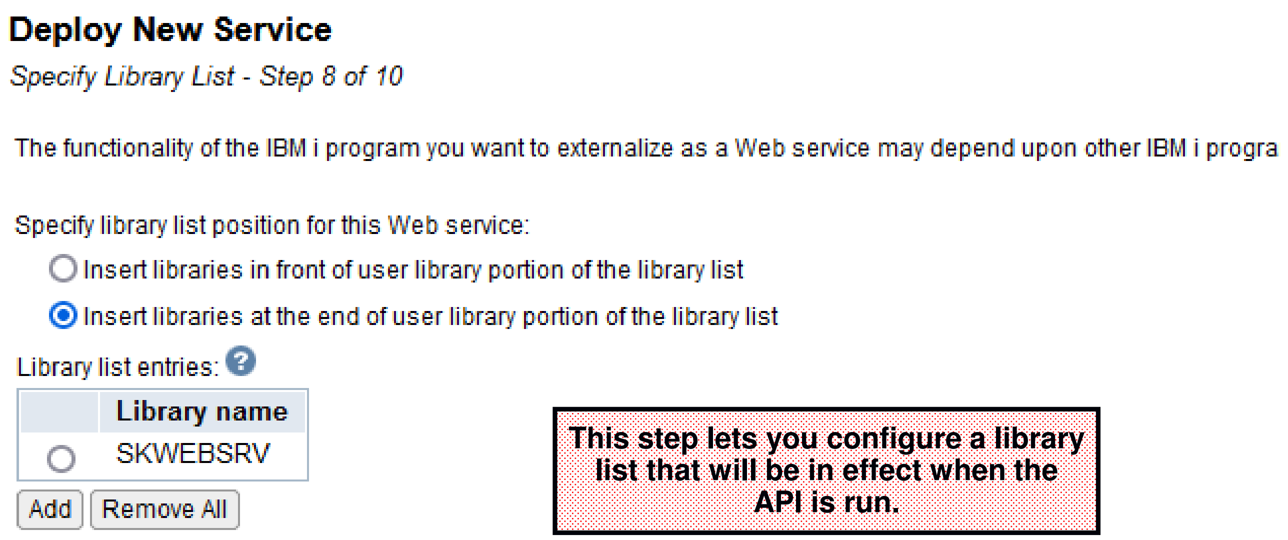
Specify User ID for this Service:

- [✓ Use server's user ID]
- Specify an existing user ID
- Use authenticated user ID

Similar to when the server was created, we can specify which userid this particular API will run under.

The most secure method is to create a user specially for this, and give it the minimum possible authority for the API to work.

REST Wizard (8 of 10)



Deploy New Service

Specify Library List - Step 8 of 10

The functionality of the IBM i program you want to externalize as a Web service may depend upon other IBM i progra

Specify library list position for this Web service:

- ○ Insert libraries in front of user library portion of the library list
- ● Insert libraries at the end of user library portion of the library list

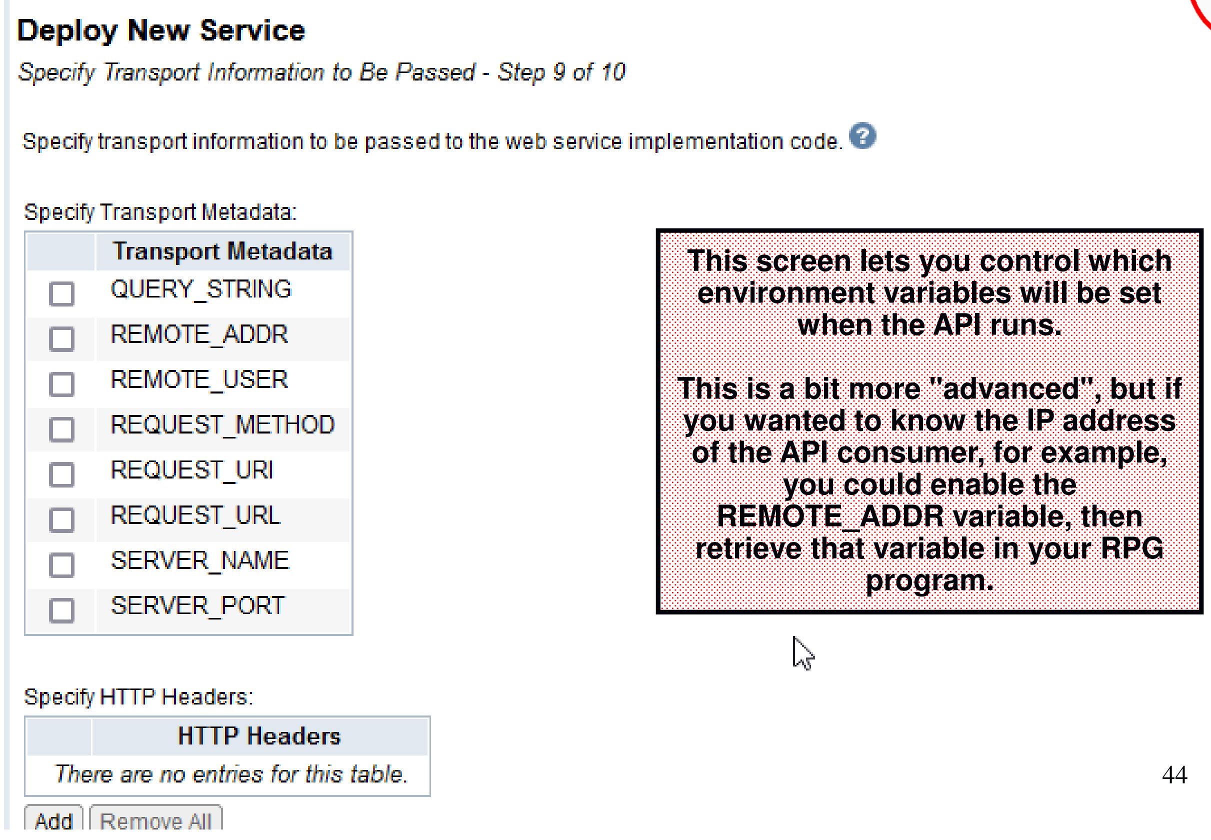
Library list entries:

	Library name
○	SKWEBSRV

Add | Remove All

This step lets you configure a library list that will be in effect when the API is run.

REST Wizard (9 of 10)



Deploy New Service

Specify Transport Information to Be Passed - Step 9 of 10

Specify transport information to be passed to the web service implementation code.

Specify Transport Metadata:

	Transport Metadata
☐	QUERY_STRING
☐	REMOTE_ADDR
☐	REMOTE_USER
☐	REQUEST_METHOD
☐	REQUEST_URI
☐	REQUEST_URL
☐	SERVER_NAME
☐	SERVER_PORT

Specify HTTP Headers:

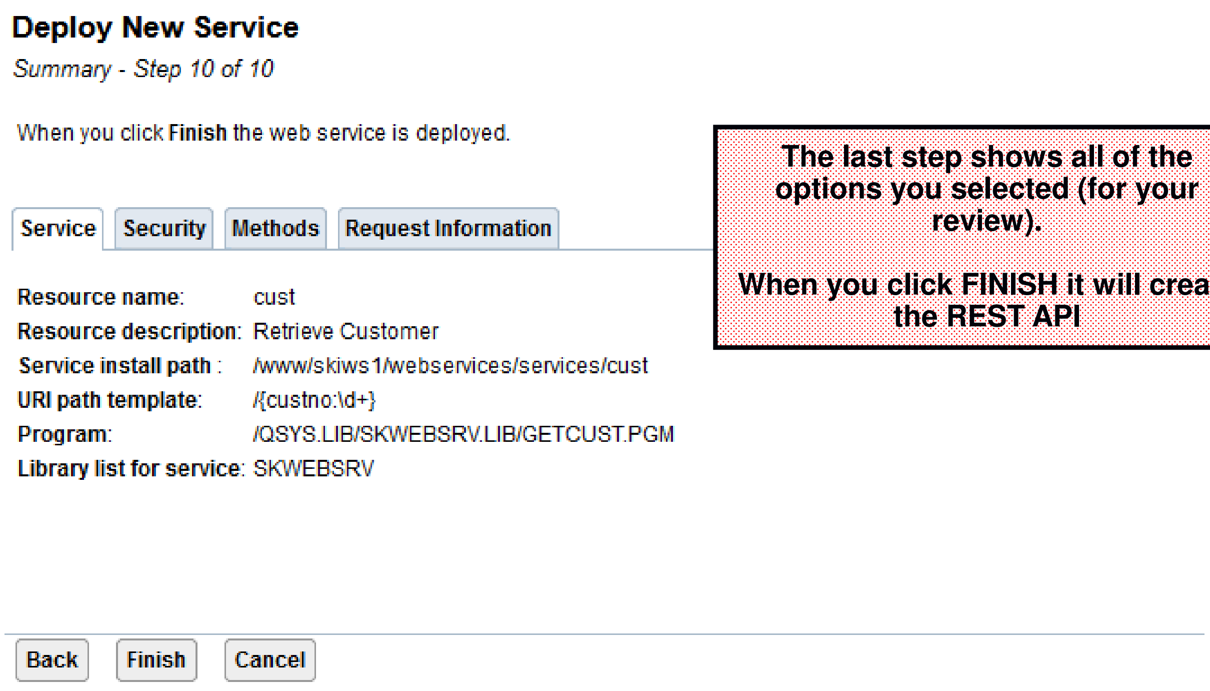
	HTTP Headers
	There are no entries for this table.

Add | Remove All

This screen lets you control which environment variables will be set when the API runs.

This is a bit more "advanced", but if you wanted to know the IP address of the API consumer, for example, you could enable the REMOTE_ADDR variable, then retrieve that variable in your RPG program.

REST Wizard (10 of 10)



Deploy New Service

Summary - Step 10 of 10

When you click **Finish** the web service is deployed.

Service | Security | Methods | Request Information

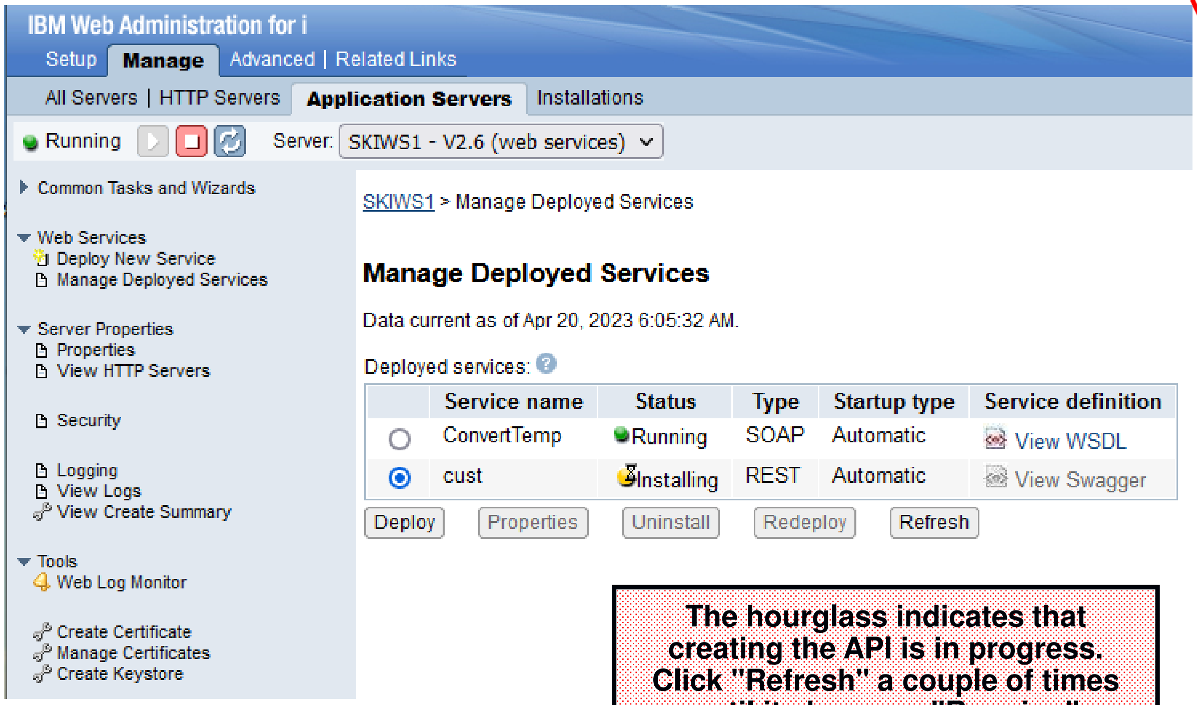
Resource name:	cust
Resource description:	Retrieve Customer
Service install path :	/www/skiws1/webservices/services/cust
URI path template:	/{custno:\d+}
Program:	/QSYS.LIB/SKWEBSRV.LIB/GETCUST.PGM
Library list for service:	SKWEBSRV

Back | Finish | Cancel

The last step shows all of the options you selected (for your review).

When you click FINISH it will create the REST API

Wait For the API to Install



IBM Web Administration for i

Setup | **Manage** | Advanced | Related Links

All Servers | HTTP Servers | **Application Servers** | Installations

Running Server: SKIWS1 - V2.6 (web services)

SKIWS1 > Manage Deployed Services

Manage Deployed Services

Data current as of Apr 20, 2023 6:05:32 AM.

Deployed services:

	Service name	Status	Type	Startup type	Service definition
○	ConvertTemp	Running	SOAP	Automatic	View WSDL
●	cust	Installing	REST	Automatic	View Swagger

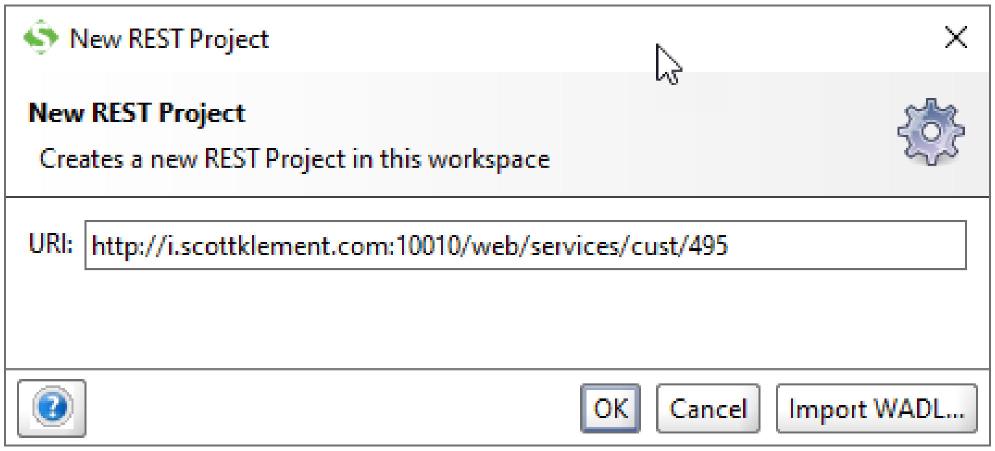
Deploy | Properties | Uninstall | Redeploy | Refresh

The hourglass indicates that creating the API is in progress. Click "Refresh" a couple of times until it shows as "Running"

SOAPUI REST Testing (1 of 2)

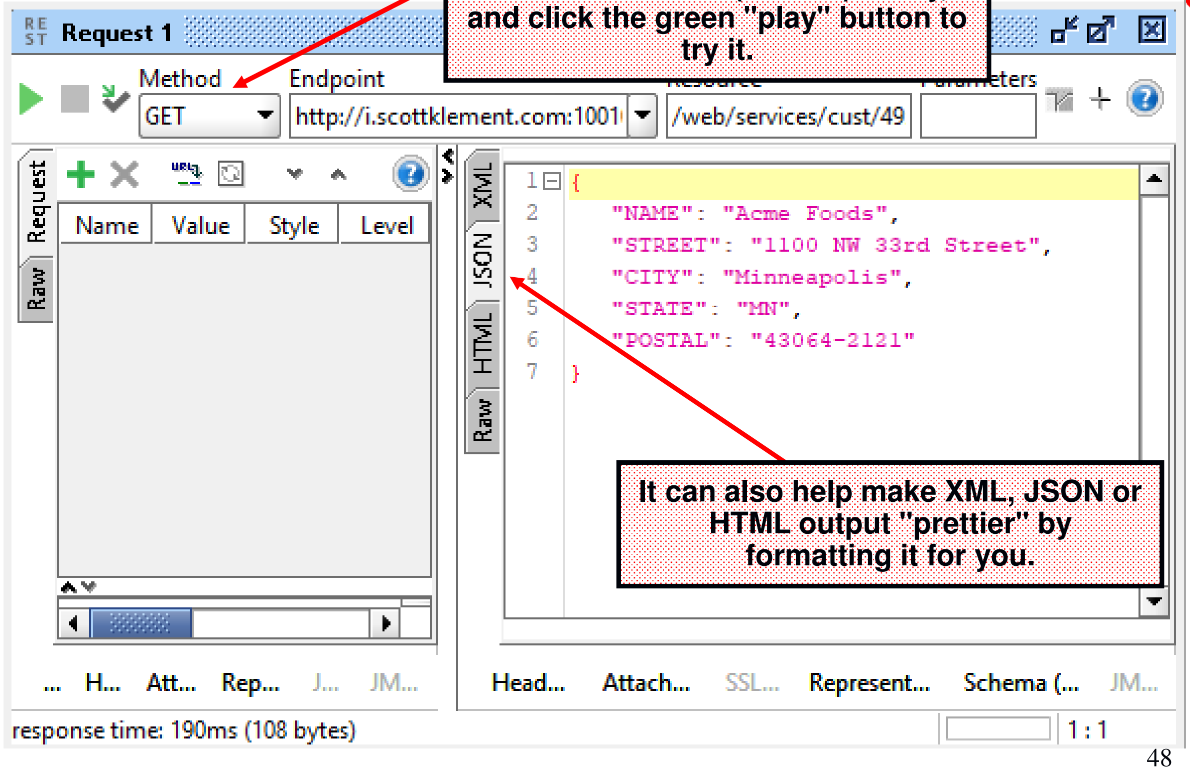
Since it's hard to test other methods (besides GET) in a browser, it's good to have other alternatives. Recent versions of SoapUI have nice tools for testing REST services as well.

Choose File / New REST Project, and type the URL, then click OK



URI: http://i.scottklement.com:10010/web/services/cust/495

SOAPUI REST Testing (2 of 2)


Request 1
Method
Endpoint
Resource
Parameters
GET
http://i.scottklement.com:1001
/web/services/cust/49
Request
Raw
Name
Value
Style
Level
XML
JSON
HTML
Raw
... H... Att... Rep... J... JM...
Head... Attach... SSL... Represent... Schema (... JM...
1 : 1

```
{
    "NAME": "Acme Foods",
    "STREET": "1100 NW 33rd Street",
    "CITY": "Minneapolis",
    "STATE": "MN",
    "POSTAL": "43064-2121"
}
```

response time: 190ms (108 bytes)

Here you can change the method and the resource ("noun") easily, and click the green "play" button to try it.

It can also help make XML, JSON or HTML output "prettier" by formatting it for you.

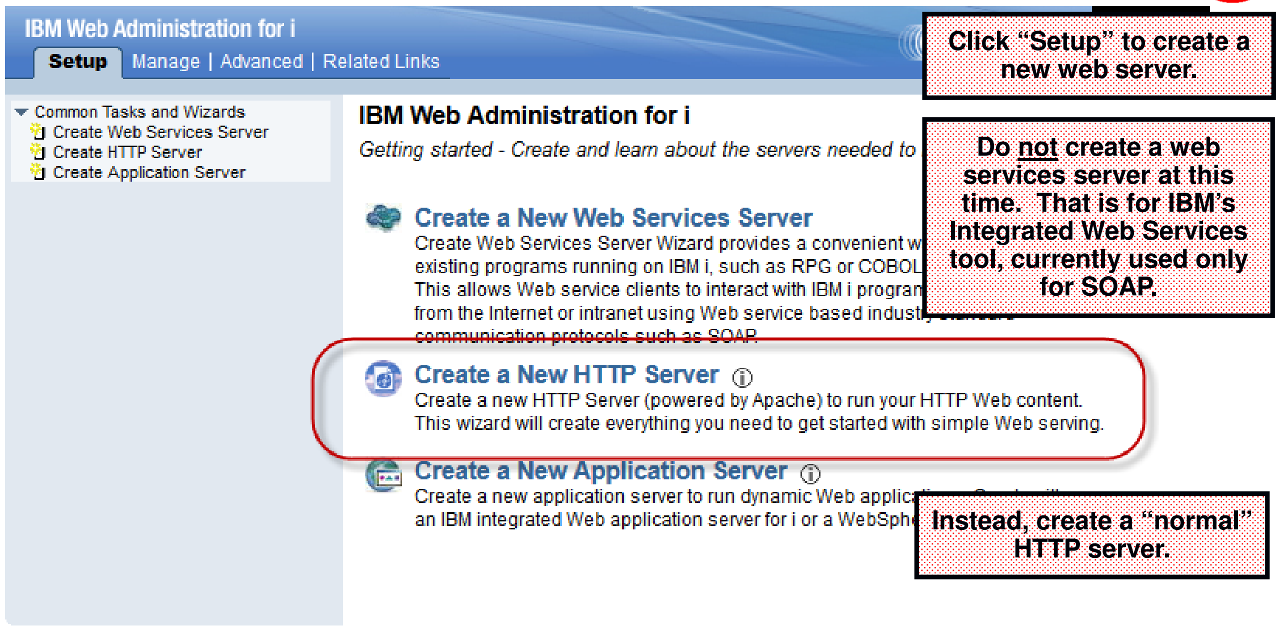
Do It Yourself

IWS is a neat tool, but:

- Supports only XML or JSON
- Very limited options for security
- doesn't always perform well

Writing your own:
- Gives you complete control
- Performs as fast as your RPG code can go.
- Requires more knowledge/work of web service technologies such as XML and JSON
- You can accept/return data in any format you like. (CSV? PDF? Excel? No problem.)
- Write your own security. UserId/Password? Crypto? do whatever you want.
- The only limitation is your imagination.

Create an HTTP Server


IBM Web Administration for i
Setup | Manage | Advanced | Related Links
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server

IBM Web Administration for i

Getting started - Create and learn about the servers needed to

Create a New Web Services Server
Create Web Services Server Wizard provides a convenient w
existing programs running on IBM i, such as RPG or COBOL
This allows Web service clients to interact with IBM i progran
from the Internet or intranet using Web service based industr
communication protocols such as SOAP.

Create a New HTTP Server
Create a new HTTP Server (powered by Apache) to run your HTTP Web content.
This wizard will create everything you need to get started with simple Web serving.

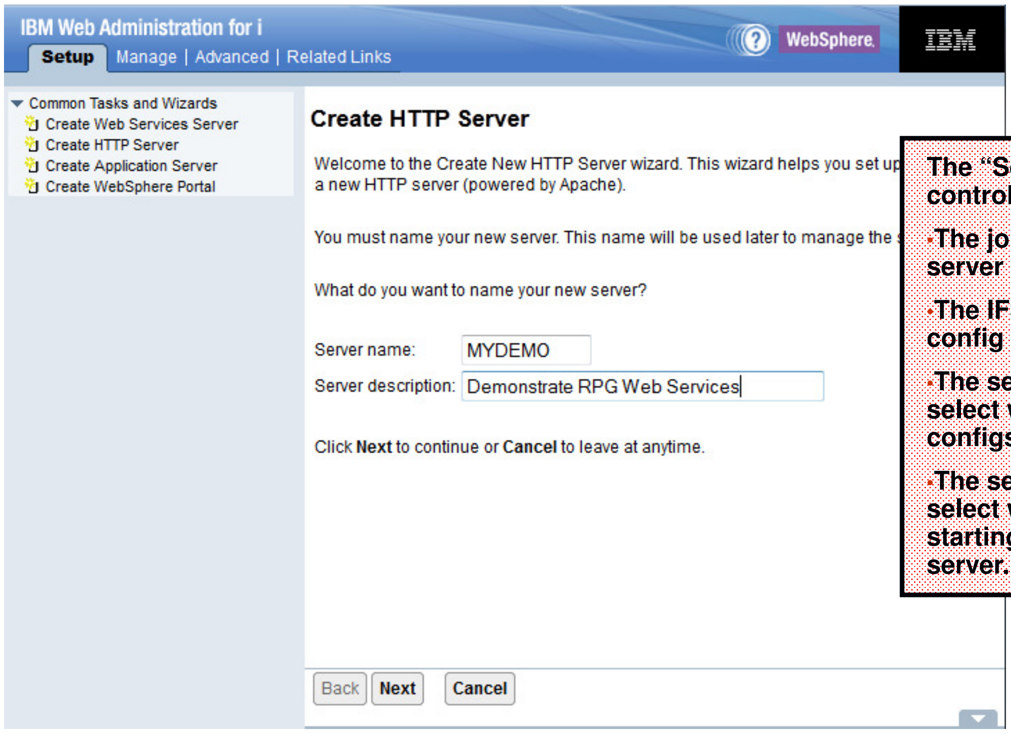
Create a New Application Server
Create a new application server to run dynamic Web applic
an IBM integrated Web application server for i or a WebSphe

Click "Setup" to create a new web server.

Do not create a web services server at this time. That is for IBM's Integrated Web Services tool, currently used only for SOAP.

Instead, create a "normal" HTTP server.

The “Server Name”


IBM Web Administration for i
Setup
Manage | Advanced | Related Links
WebSphere.
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Create WebSphere Portal
Back
Next
Cancel

Create HTTP Server

Welcome to the Create New HTTP Server wizard. This wizard helps you set up a new HTTP server (powered by Apache).

You must name your new server. This name will be used later to manage the

What do you want to name your new server?

Server name: MYDEMO

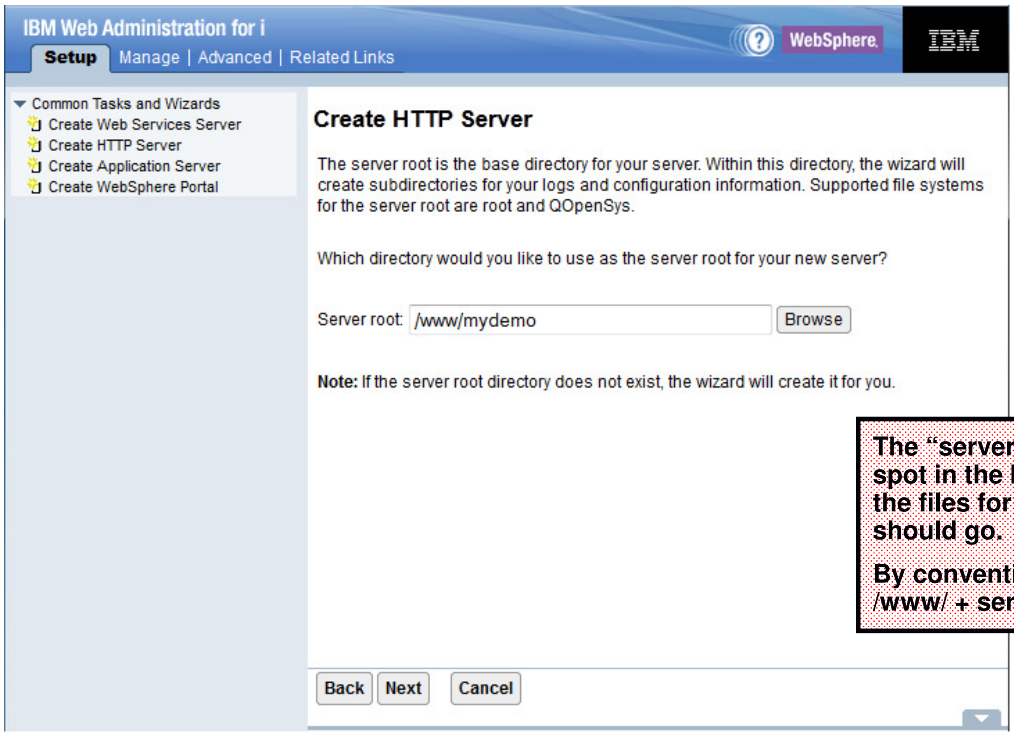
Server description: Demonstrate RPG Web Services

Click **Next** to continue or **Cancel** to leave at anytime.

The “Server Name” controls:

- **The job name of the server jobs**
- **The IFS directory where config is stoed**
- **The server name you select when editing configs**
- **The server name you select when starting/stopping the server.**

Server Root


IBM Web Administration for i
Setup
Manage | Advanced | Related Links
WebSphere.
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Create WebSphere Portal
Browse
Back
Next
Cancel

Create HTTP Server

The server root is the base directory for your server. Within this directory, the wizard will create subdirectories for your logs and configuration information. Supported file systems for the server root are root and QOpenSys.

Which directory would you like to use as the server root for your new server?

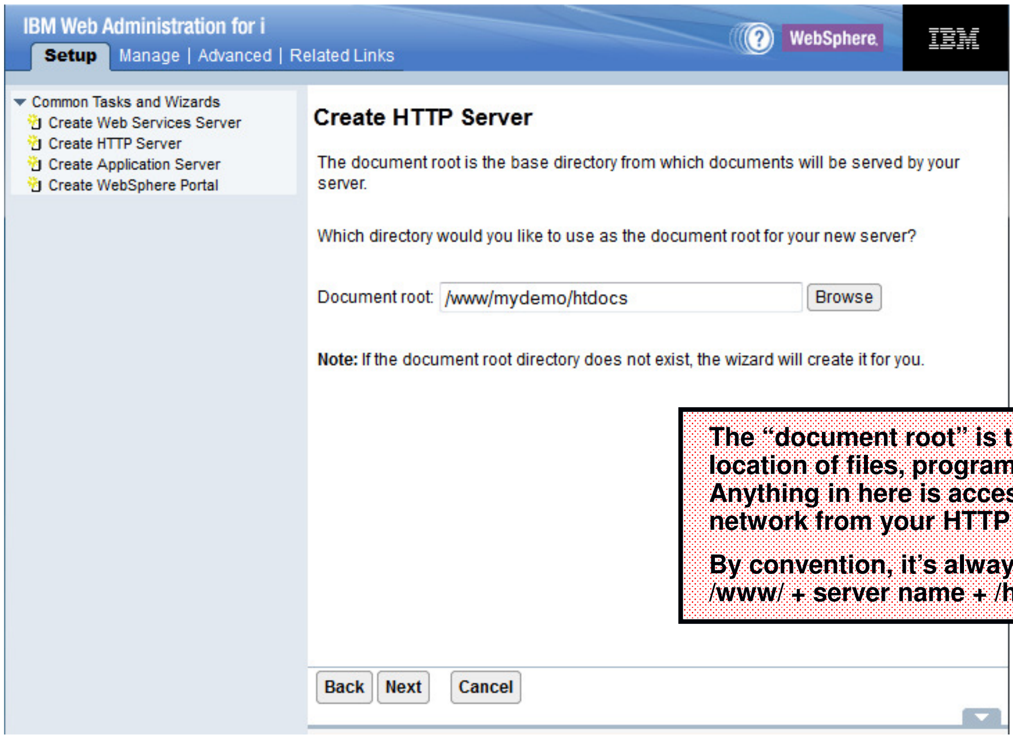
Server root: /www/mydemo

Note: If the server root directory does not exist, the wizard will create it for you.

The “server root” is the spot in the IFS where all the files for this server should go.

By convention, it’s always /www/ + server name.

Document Root


IBM Web Administration for i

Setup | Manage | Advanced | Related Links

Common Tasks and Wizards
- Create Web Services Server
- Create HTTP Server
- Create Application Server
- Create WebSphere Portal

Create HTTP Server

The document root is the base directory from which documents will be served by your server.

Which directory would you like to use as the document root for your new server?

Document root: /www/mydemo/htdocs [Browse]

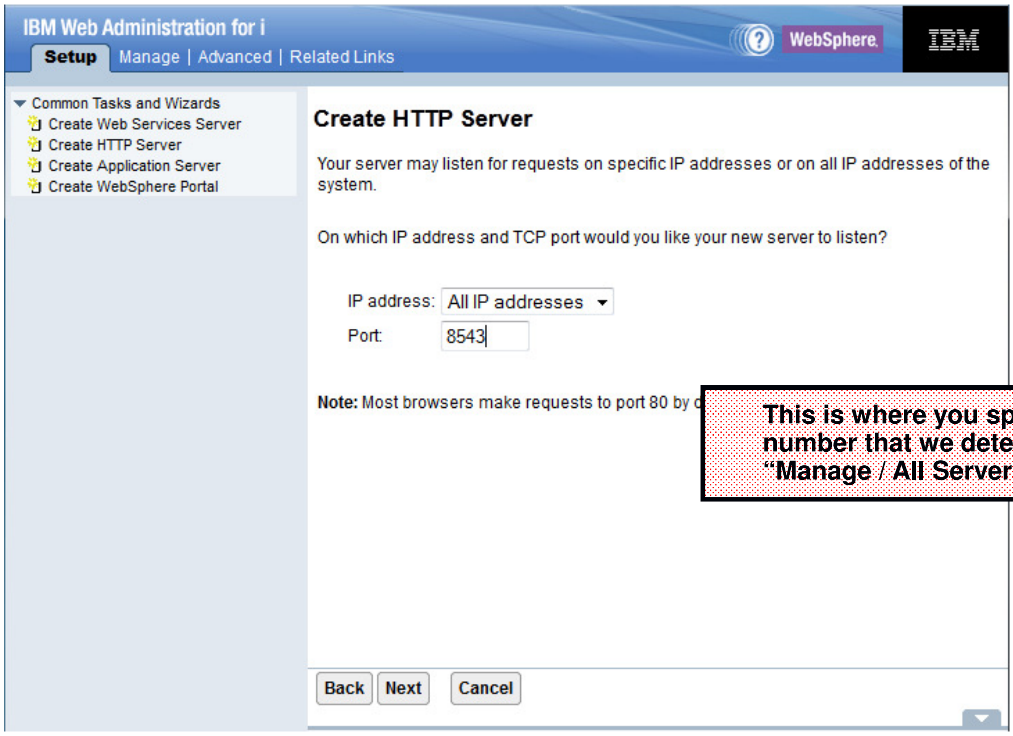
Note: If the document root directory does not exist, the wizard will create it for you.

[Back] [Next] [Cancel]

The "document root" is the default location of files, programs, images, etc. Anything in here is accessible over a network from your HTTP server.

By convention, it's always specified as /www/ + server name + /htdocs

Set Port Number


IBM Web Administration for i

Setup | Manage | Advanced | Related Links

Common Tasks and Wizards
- Create Web Services Server
- Create HTTP Server
- Create Application Server
- Create WebSphere Portal

Create HTTP Server

Your server may listen for requests on specific IP addresses or on all IP addresses of the system.

On which IP address and TCP port would you like your new server to listen?

IP address: All IP addresses

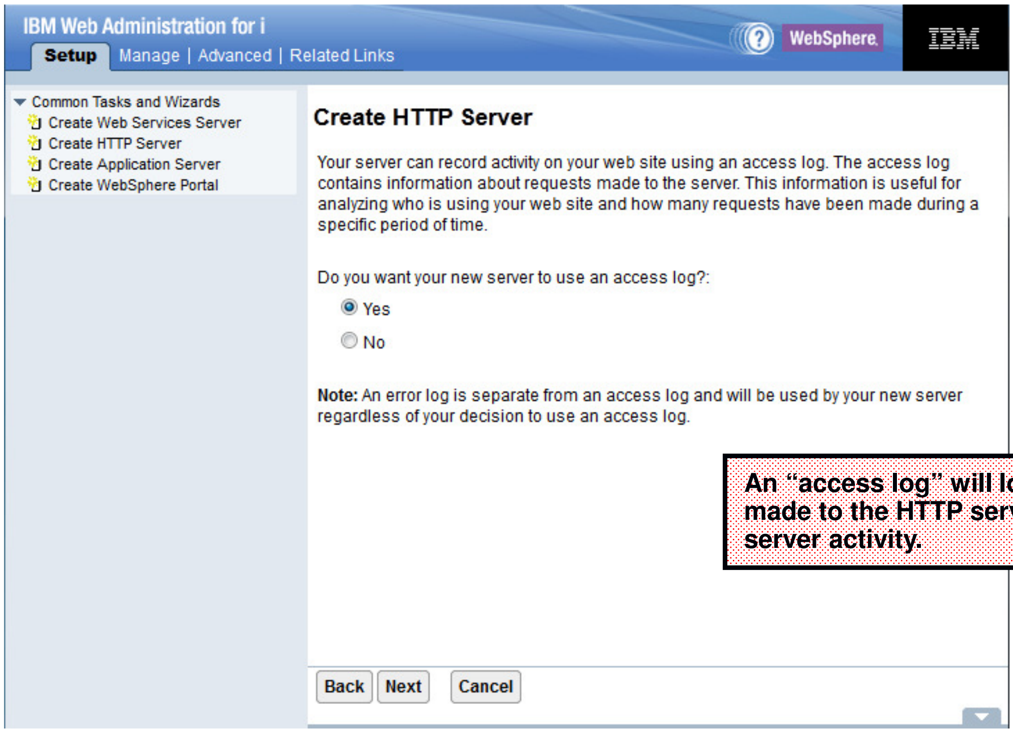
Port: 8543

Note: Most browsers make requests to port 80 by d

[Back] [Next] [Cancel]

This is where you specify the port number that we determined on the "Manage / All Servers" screen.

Access Log


IBM Web Administration for i
Setup | Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Create WebSphere Portal
Back
Next
Cancel

Create HTTP Server

Your server can record activity on your web site using an access log. The access log contains information about requests made to the server. This information is useful for analyzing who is using your web site and how many requests have been made during a specific period of time.

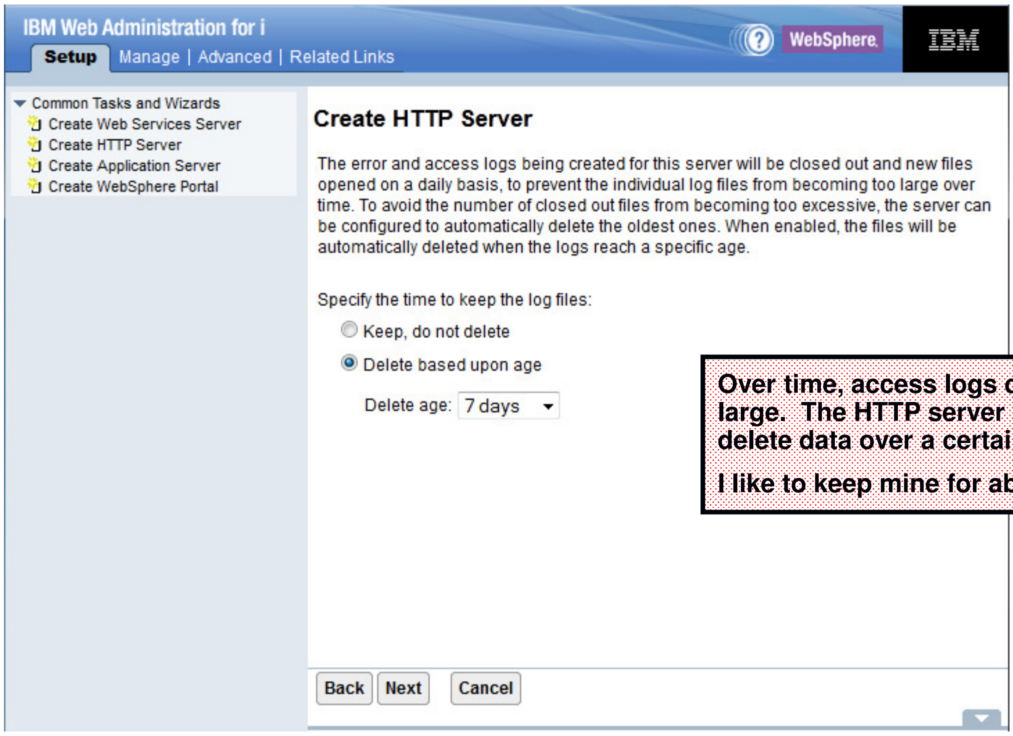
Do you want your new server to use an access log?:

[✓ Yes] No

Note: An error log is separate from an access log and will be used by your new server regardless of your decision to use an access log.

An "access log" will log all accesses made to the HTTP server. Useful to track server activity.

Access Log Retension


IBM Web Administration for i
Setup | Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Create WebSphere Portal
Back
Next
Cancel

Create HTTP Server

The error and access logs being created for this server will be closed out and new files opened on a daily basis, to prevent the individual log files from becoming too large over time. To avoid the number of closed out files from becoming too excessive, the server can be configured to automatically delete the oldest ones. When enabled, the files will be automatically deleted when the logs reach a specific age.

Specify the time to keep the log files:

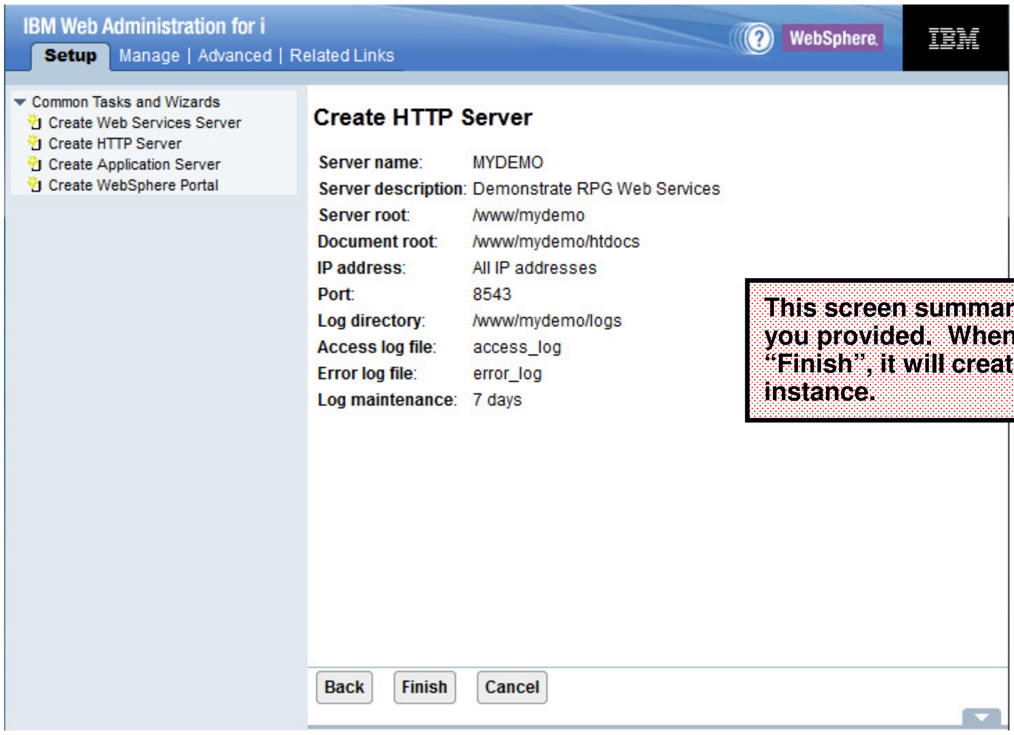
Keep, do not delete [✓ Delete based upon age]

Delete age: 7 days

Over time, access logs can get quite large. The HTTP server can automatically delete data over a certain age.

I like to keep mine for about a week.

Summary Screen


IBM Web Administration for i
Setup
Manage | Advanced | Related Links
WebSphere
IBM
Common Tasks and Wizards
Create Web Services Server
Create HTTP Server
Create Application Server
Create WebSphere Portal
Back
Finish
Cancel

Create HTTP Server

Server name:	MYDEMO
Server description:	Demonstrate RPG Web Services
Server root:	/www/mydemo
Document root:	/www/mydemo/htdocs
IP address:	All IP addresses
Port:	8543
Log directory:	/www/mydemo/logs
Access log file:	access_log
Error log file:	error_log
Log maintenance:	7 days

This screen summarizes the settings you provided. When you click "Finish", it will create the server instance.

URL Tells Apache What to Call

To get started with REST, let's tell Apache how to call our program.

```
ScriptAlias /cust /qsys.lib/restful.lib/custinfo.pgm
<Directory /qsys.lib/restful.lib>
   Require all granted
</Directory>
```

- Just add the preceding code to an already working Apache instance on IBM i.
- `ScriptAlias` tells apache that you want to run a program.
- If URL starts with `/cust`, Apache will `CALL PGM(RESTFUL/CUSTINFO)`
- Our REST web service can be run from any IP address (Allow from all).

```
http://ibmi.example.com/cust/495
```

- Browser connects to: `ibmi.example.com`
- Apache sees the /cust and calls RESTFUL/CUSTINFO
- Our program can read the 495 (customer number) from the URL itself.

Apache 2.4 Update

Starting with IBM i 7.2, we have Apache 2.4. They recommend using "require" instead of "Order"

Newer syntax:

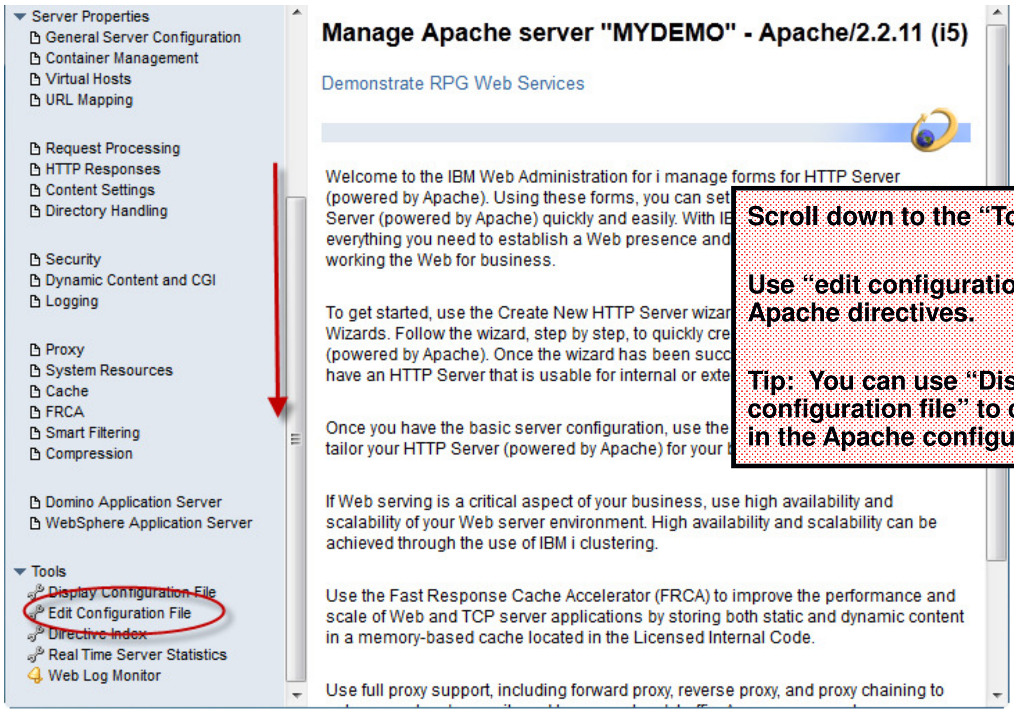
```
<Directory /qsys.lib/restful.lib>
   Require all granted
</Directory>
```

Older syntax:

```
<Directory /qsys.lib/restful.lib>
   Order allow,deny
   Allow from all
</Directory>
```

If you are using an older release, use this second syntax.

Edit Configuration File



Manage Apache server "MYDEMO" - Apache/2.2.11 (i5)

Demonstrate RPG Web Services

Welcome to the IBM Web Administration for i manage forms for HTTP Server (powered by Apache). Using these forms, you can set Server (powered by Apache) quickly and easily. With IB everything you need to establish a Web presence and working the Web for business.

To get started, use the Create New HTTP Server wizar Wizards. Follow the wizard, step by step, to quickly cre (powered by Apache). Once the wizard has been succ have an HTTP Server that is usable for internal or exte

Once you have the basic server configuration, use the tailor your HTTP Server (powered by Apache) for your

If Web serving is a critical aspect of your business, use high availability and scalability of your Web server environment. High availability and scalability can be achieved through the use of IBM i clustering.

Use the Fast Response Cache Accelerator (FRCA) to improve the performance and scale of Web and TCP server applications by storing both static and dynamic content in a memory-based cache located in the Licensed Internal Code.

Use full proxy support, including forward proxy, reverse proxy, and proxy chaining to

Scroll down to the "Tools" section.

Use "edit configuration file" to enter Apache directives.

Tip: You can use "Display configuration file" to check for errors in the Apache configuration.

Alternate Recipe

The last slide shows how to make /cust always do a call restful/custinfo.

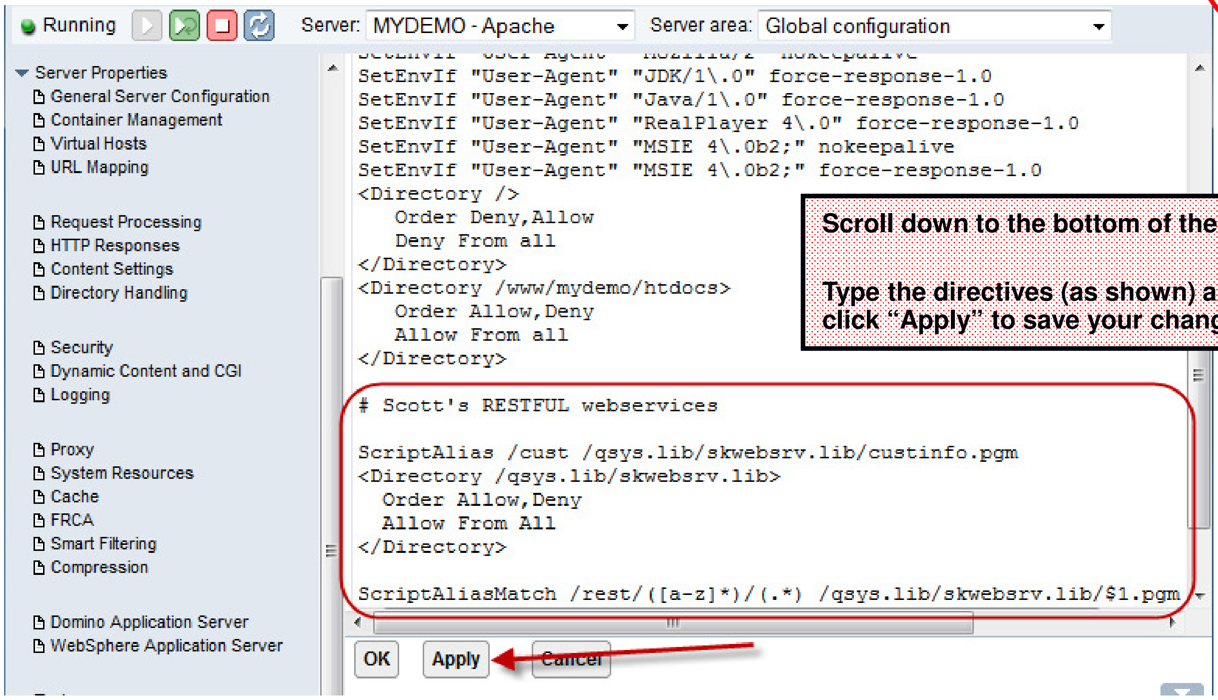
But, perhaps you'd rather not have to key a separate Apache configuration for each restful web service you want to run? There are pros and cons to this:

- Don't have to stop/start server to add new service.
- Any program left in RESTFUL library can be run from outside. If the wrong program gets compiled into this library, it could be a security hole.

```
ScriptAlias /cust /qsys.lib/restful.lib/custinfo.pgm

ScriptAliasMatch /rest/([a-z0-9]*)/.* /qsys.lib/restful.lib/$1.pgm

<Directory /qsys.lib/restful.lib>
   Require all granted
</Directory>
```

```
http://ibmi.example.com/rest/custinfo/495
```

Add Custom Directives

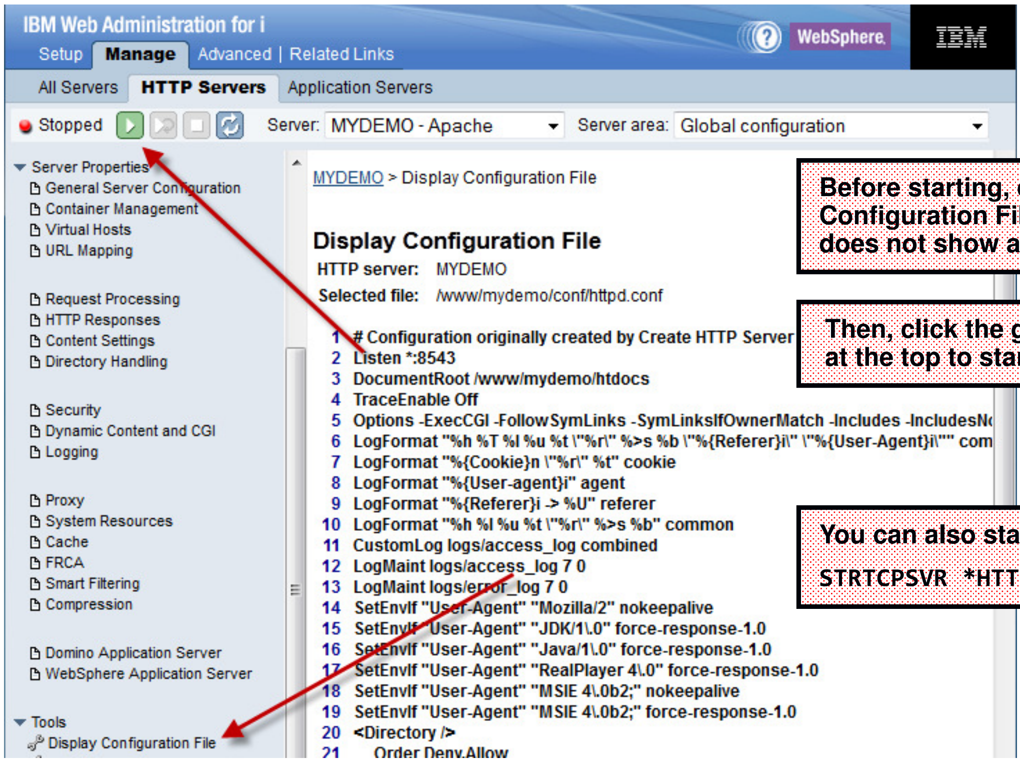


```
SetEnvIf "User-Agent" "JDK/1\.0" force-response-1.0
SetEnvIf "User-Agent" "Java/1\.0" force-response-1.0
SetEnvIf "User-Agent" "RealPlayer 4\.0" force-response-1.0
SetEnvIf "User-Agent" "MSIE 4\.0b2;" nokeepalive
SetEnvIf "User-Agent" "MSIE 4\.0b2;" force-response-1.0
<Directory />
   Order Deny,Allow
   Deny From all
</Directory>
<Directory /www/mydemo/htdocs>
   Order Allow,Deny
   Allow From all
</Directory>

# Scott's RESTFUL webservices

ScriptAlias /cust /qsys.lib/skwebsrv.lib/custinfo.pgm
<Directory /qsys.lib/skwebsrv.lib>
  Order Allow,Deny
  Allow From All
</Directory>

ScriptAliasMatch /rest/([a-z]*)/(.*) /qsys.lib/skwebsrv.lib/$1.pgm
```

Scroll down to the bottom of the file.

Type the directives (as shown) and click "Apply" to save your changes.

Start New Apache Server



Display Configuration File

HTTP server: MYDEMO

Selected file: /www/mydemo/conf/httpd.conf

```
# Configuration originally created by Create HTTP Server
Listen *:8543
DocumentRoot /www/mydemo/htdocs
TraceEnable Off
Options -ExecCGI -FollowSymLinks -SymLinksIfOwnerMatch -Includes -IncludesN
LogFormat "%h %T %l %u %t \"%r\" %>s %b \"%{Referer}i\" \"%{User-Agent}i\"" com
LogFormat "%{Cookie}n \"%r\" %t" cookie
LogFormat "%{User-agent}i" agent
LogFormat "%{Referer}i -> %U" referer
LogFormat "%h %l %u %t \"%r\" %>s %b" common
CustomLog logs/access_log combined
LogMaint logs/access_log 7 0
LogMaint logs/error_log 7 0
SetEnvIf "User-Agent" "Mozilla/2" nokeepalive
SetEnvIf "User-Agent" "JDK/1\.0" force-response-1.0
SetEnvIf "User-Agent" "Java/1\.0" force-response-1.0
SetEnvIf "User-Agent" "RealPlayer 4\.0" force-response-1.0
SetEnvIf "User-Agent" "MSIE 4\.0b2;" nokeepalive
SetEnvIf "User-Agent" "MSIE 4\.0b2;" force-response-1.0
<Directory />
    Order Deny,Allow
```

Before starting, click "Display Configuration File" and make sure it does not show any errors.

Then, click the green "start" button at the top to start your new server.

You can also start from 5250 with:

```
STRTCPSVR *HTTP HTTPSVR(MYDEMO)
```

RESTful Example

Easier way to think of REST

- input can come from the URL, cookies, headers or an uploaded document
- if a document – it can be anything (XML, JSON or something else...)
- output has no standard… can be anything (but usually is XML or JSON)

For example, you might have a web service that takes a customer number as input and returns that customer's address.

Input

```
GET http://i.scottklement.com:8500/cust/495
```

Output

```
{
  "CUSTNO":  495,
  "NAME":    "Acme Foods",
  "STREET":  "1100 NW 33rd Street",
  "CITY":    "Minneapolis",
  "STATE":   "MN",
  "POSTAL":  "43064-2121"
}
```

This is CGI -- But It's Not HTML

Web servers (HTTP servers) have a standard way of calling a program on the local system. It's known as Common Gateway Interface (CGI)

- The URL you were called from is available via the REQUEST_URI env. var
- If a document is uploaded to your program you can retrieve it from "standard input".
- To write data back from your program to Apache (and ultimately the web service consumer) you write your data to "standard output"

To accomplish this, I'm going to use 3 different APIs (all provided by IBM)

- **QtmhRdStin** ← reads standard input
- **getenv** ← retrieves an environment variable.
- **QtmhWrStout** ← writes data to standard output.

Or we can use the YAJL toolkit, which is free (open source) and will handle the standard input and output for us when it interprets a JSON document.

DIY REST Example (1 of 2)

```
Ctl-Opt OPTION(*SRCSTMT: *NODEBUGIO) DFTACTGRP(*NO);

Dcl-F CUSTFILE Usage(*Input) Keyed prefix('CUST.');
dcl-ds CUST ext extname('CUSTFILE') qualified end-ds;

Dcl-PR getenv Pointer extproc('getenv');
   var  Pointer    value options(*string);
End-PR;

dcl-s custno like(CUST.custno);
Dcl-S pos    int(10);
Dcl-S uri    varchar(1000);
Dcl-S json   varchar(1000);
Dcl-C ID1    '/cust/';
Dcl-C ID2    '/custinfo/';

dcl-ds failure qualified;
  error varchar(100);
end-ds;
```

getenv lets us retrieve an environment variable – the URL will be in the REQUEST_URI variable.

We can generate JSON from a DS using RPG's DATA-GEN opcode.

So the CUST DS can be output directly if all is well.

If there's an error, we'll put the message in the FAILURE DS

DIY REST Example (2 of 2)

```
uri = %str(getenv('REQUEST_URI'));

monitor;
  pos = %scan(ID1: uri) + %len(ID1);
  custno = %int(%subst(uri:pos));
on-error;
  failure.error = 'Invalid URI';
  DATA-GEN failure %DATA(json) %GEN( 'YAJLDTAGEN'
   : '{ "http status": 500, "write to stdout": true }');
  return;
endmon;

chain custno CUSTFILE;
if not %found;
  failure.error = 'Unknown customer number';
  DATA-GEN failure %DATA(json) %GEN( 'YAJLDTAGEN'
    :'{ "http status": 500, "write to stdout": true }');
  return;
endif;

DATA-GEN cust %DATA(json)  %GEN( 'YAJLDTAGEN'
  :'{ "http status": 200, "write to stdout": true }');
return;
```

REQUEST_URI will contain http://x.com/cust/495

Custno is everything after /cust/ in the URL

If an error occurs, generate a JSON document from the FAILURE DS.

If no errors, generate it from the CUST DS.

"write to stdout" causes YAJL to write the result to Apache.

"http status" lets us set the HTTP status code to 200 for success, 500 for error.

Changes To Use W/Alt Recipe

To use the alternate Apache config (ScriptAliasMatch) change this code:

```
monitor;
   pos = %scan(ID1: uri) + %len(ID1);
   custno = %int(%subst(uri:pos));
. . .
```

To this… it now works on anything after /cust/ or /custinfo/ in the URI

```
Dcl-C ID1        '/cust/';
Dcl-C ID2        '/custinfo/';
  .
  .
monitor;
   select;
   when %scan(ID1: uri) > 0;
      pos = %scan(ID1: uri) + %len(ID1);
   when %scan(ID2: uri) > 0;
      pos = %scan(ID2: uri) + %len(ID2);
   other;
      pos = 0;
   endsl;
   custno = %int(%subst(uri:pos));
. . .
```

About Testing and Consuming DIY

There's nothing special about testing a DIY example. You call it the same as any other (REST) web service – just use SoapUI (or a similar tool like Postman), just as we did with the IWS example.

You'll notice that using the HTTP server isn't much harder than using the IWS was – the code is nearly as simple (thanks to DATA-GEN and YAJL)

The DIY method is much more versatile, however, and performs better.

This Presentation

You can download a PDF copy of this presentation as well as other related materials from:

http://www.scottklement.com/presentations/

The Sample Web Service Providers in this article are also available at the preceding link.

Thank you!