Embedded Web Server

Simon Wright
simon@pushface.org

26.7.2022

Contents

List of Figures

Chapter 1

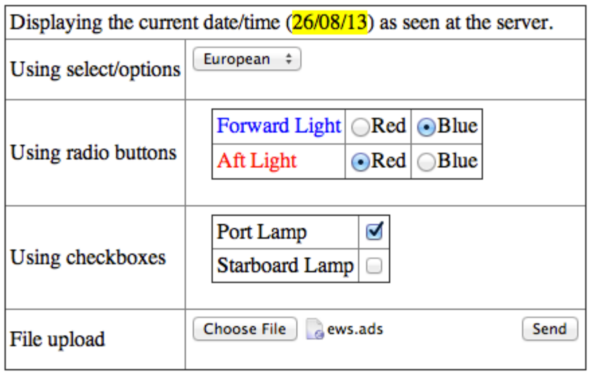
Introduction

This document describes the Embedded Web Server (EWS) in the form of a demonstration program.

EWS is intended for small, limited embedded systems (for example, ones with no file system).

It provides a program (`ews-make_htdocs`) which converts a directory structure containing a set of web pages into an Ada data structure to be compiled with the EWS library and your application and served at run time.

As well as static web pages, EWS supports dynamic interactions, where the client makes a request and the server responds. This can be used to provide a complete new page, constructed on the fly by the server, or (more interestingly) in an AJAX style, where the server takes some action and the response is interpreted by JavaScript in the client.



Displaying the current date/time (26/08/13) as seen at the server.

Using select/options	European
Using radio buttons	Forward Light: Red [✓ Blue]; Aft Light: [✓ Red] Blue
Using checkboxes	Port Lamp ✓; Starboard Lamp
File upload	Choose File ews.ads Send

Figure 1.1: The dynamic part of the example page

Figure 1.1 shows the part of the example page which demonstrates AJAX-style interactions.

These interactions are supported by EWS's `HttpInteraction.js`.

1.1 Copyright and Licencing

EWS itself is licenced under the GPL version 3; the code that forms part of the run time (Ada and JavaScript) has the additional permissions granted by the GCC Runtime Library Exception version 3.1.

The demonstration code is released without restriction.

⟨ *Copyright* 2a ⟩ ≡

```
Copyright 2013-2022 Simon Wright <simon@pushface.org>
```
◇

Fragment referenced in 2bcd.

In Ada,

⟨ *Ada licence header* 2b ⟩ ≡

```
--  ⟨ Copyright 2a ⟩
--
--  This unit is free software; you can redistribute it and/or modify
--  it as you wish. This unit is distributed in the hope that it will
--  be useful, but WITHOUT ANY WARRANTY; without even the implied
--  warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```
◇

Fragment referenced in 25.

In JavaScript,

⟨ *JavaScript licence header* 2c ⟩ ≡

```
/*
 * ⟨ Copyright 2a ⟩
 *
 * This unit is free software; you can redistribute it and/or modify
 * it as you wish. This unit is distributed in the hope that it will
 * be useful, but WITHOUT ANY WARRANTY; without even the implied
 * warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
 */
```
◇

Fragment referenced in 24.

In HTML,

⟨ *HTML licence header* 2d ⟩ ≡

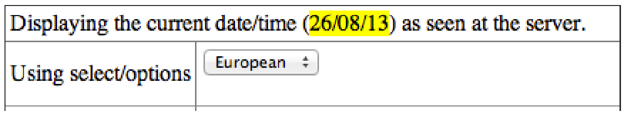
```
<!--
  ⟨ Copyright 2a ⟩

  This unit is free software; you can redistribute it and/or modify
  it as you wish. This unit is distributed in the hope that it will
  be useful, but WITHOUT ANY WARRANTY; without even the implied
  warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
  -->
```
◇

Fragment referenced in 22a.

Chapter 2

Cyclic updating and select/options

This part of the demonstration, shown in Figure 2.1, shows cyclic updating of a portion of the web page (the time, as seen at the server) and the ability to change the format of the display using the HTML 'select' and 'options'.



Displaying the current date/time (26/08/13) as seen at the server.

Figure 2.1: Displaying the current time, and controlling the format

⟨ *Cyclic updating and select/options: HTML* 3a ⟩ ≡
```
<tr>
  ⟨ Display the current time: HTML 3b ⟩
</tr>
<tr>
  ⟨ Change the time display format: HTML 5a ⟩
</tr>
◇
```
Fragment referenced in 23c.

2.1 Displaying the current time

The HTML displays the current time in a span with id `timeDisplay` inside a two-column table data cell.

⟨ *Display the current time: HTML* 3b ⟩ ≡
```
<td colspan="2">
  Displaying the current date/time
  (<span id="timeDisplay" style="background:yellow">here</span>)
  as seen at the server.
</td>
◇
```
Fragment referenced in 3a.
Users: `timeDisplay` in 4a.

The corresponding JavaScript runs a `CyclicHttpInteraction` with a 1-second repetiton rate to the URL `ajaxTime`. The response is expected to be a `text/plain` string, which is pasted into the document at the element with id `timeDisplay`.

⟨ *Cyclic interactions: JavaScript* 4a ⟩ ≡
```
  var timeRequest = new CyclicHttpInteraction
    ("ajaxTime",
     function (r) {
      document.getElementById("timeDisplay").innerHTML = r.responseText;
     },
     1000);
  ◇
```
Fragment defined by 4a, 9b.
Fragment referenced in 24.
Users: `timeRequest` in 4b.
Uses: `ajaxTime` 4d, `timeDisplay` 3b.

The cyclic interaction needs to be started when the page is loaded.

⟨ *Start getting cyclic data: JavaScript* 4b ⟩ ≡
```
  timeRequest.start();
  ◇
```
Fragment defined by 4b, 9c.
Fragment referenced in 24.
Uses: `timeRequest` 4a.

The Ada code which receives the cyclic `ajaxTime` request is in the function `AJAX_Time`.

⟨ *Specs of dynamic pages: Ada* 4c ⟩ ≡
```
  function AJAX_Time
    (From_Request : HTTP.Request_P)
    return Dynamic.Dynamic_Response'Class;
  ◇
```
Fragment defined by 4c, 10a, 14c, 18b, 20b.
Fragment referenced in 25.
Users: `AJAX_Time` in 4d.

The function is registered with the server, to be called to respond to the URL `ajaxTime`. We need to use GNAT's implementation-defined attribute `'Unrestricted_Access` because `AJAX_Time` isn't declared at library level; this is unlikely to be a problem in a real program.

⟨ *Register dynamic pages: Ada* 4d ⟩ ≡
```
  Dynamic.Register (AJAX_Time'Unrestricted_Access, "/ajaxTime");
  ◇
```
Fragment defined by 4d, 10b, 14d, 18c, 20c.
Fragment referenced in 25.
Users: `ajaxTime` in 4a.
Uses: `AJAX_Time` 4cf.

`AJAX_Time` uses global data to store the time format that is required.

⟨ *Global data: Ada* 4e ⟩ ≡
```
  type Date_Format is (ISO, US, European, Locale);
  Current_Date_Format : Date_Format := ISO;
  ◇
```
Fragment defined by 4e, 8b, 12b.
Fragment referenced in 25.
Users: `Current_Date_Format` in 4f, 6, 18d, `Date_Format` in 6.

The implementation of `AJAX_Time` returns the current date/time as plain text in the format selected in `Current_Date_Format`.

⟨ *Bodies of dynamic pages: Ada* 4f ⟩ ≡
```

  function AJAX_Time
    (From_Request : HTTP.Request_P) return Dynamic.Dynamic_Response'Class is
     Result : Dynamic.Dynamic_Response (From_Request);
     function Format return GNAT.Calendar.Time_IO.Picture_String;
     function Format return GNAT.Calendar.Time_IO.Picture_String is
     begin
        case Current_Date_Format is
```

```
         when ISO => return GNAT.Calendar.Time_IO.ISO_Date;
         when US => return GNAT.Calendar.Time_IO.US_Date;
         when European => return GNAT.Calendar.Time_IO.European_Date;
         when Locale => return "%c";
      end case;
   end Format;
begin
   Result.Set_Content_Type (To => Types.Plain);
   Result.Set_Content
     (GNAT.Calendar.Time_IO.Image (Ada.Calendar.Clock, Format));
   return Result;
end AJAX_Time;
◇
```

Fragment defined by 4f, 10c, 14e, 18d, 20d.
Fragment referenced in 25.
Users: `AJAX_Time` in 4d.
Uses: `Current_Date_Format` 4e.

2.2 Changing the time display format

The choice of time format is implemented in HTML in a table data cell containing a form `fTimeFormat` containing a drop-down list, with the value associated with each option being that of the corresponding value of the Ada `Date_Format` (this makes it easy for the Ada code to determine which value has been sent, using `Date_Format'Value`).

⟨ *Change the time display format: HTML* 5a ⟩ ≡

```
<td>
  Using select/options
</td>
<td>
  <form method="POST" name="fTimeFormat" id="fTimeFormat">
    <select name="format">
      <option value="iso" selected="true">ISO</option>
      <option value="us">US</option>
      <option value="european">European</option>
      <option value="locale">Local</option>
    </select>
  </form>
</td>
◇
```

Fragment referenced in 3a.
Users: `fTimeFormat` in 5b, 17.

The form `fTimeFormat` nominally `POST`s the request, but this is overridden using `postChange`. The selected option is sent as a query in the form `timeformat=iso`, `timeFormat=us` etc.

⟨ *Set up to send time format: JavaScript* 5b ⟩ ≡

```
document.fTimeFormat.format.onchange = function () {
  for (var o = document.fTimeFormat.format.options, i = 0;
       i < o.length;
       i++) {
    if (o[i].selected) {
      postChange.start("timeFormat=" +  o[i].value);
      break;
    }
  }
};
◇
```

Fragment referenced in 24.
Uses: `fTimeFormat` 5a, `postChange` 20a.

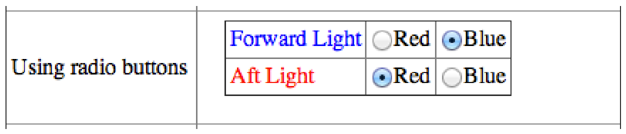
In `AJAX_Change`, check whether it has been called to change the time format; a query `foo=bar` can be retrieved from the `Request` as the property `"foo"` with value `"bar"` (if the property isn't present in the request, the empty string is returned).

⟨ *Checks for changed properties: Ada* 6 ⟩ ≡
```
declare
   Property : constant String
     := EWS.HTTP.Get_Property ("timeFormat", From_Request.all);
begin
   if Property /= "" then
      Put_Line ("saw timeFormat=" & Property);
      Current_Date_Format := Date_Format'Value (Property);
   end if;
end;
◇
```
Fragment defined by 6, 9a, 12c.
Fragment referenced in 20d.
Uses: `Current_Date_Format` 4e, `Date_Format` 4e.

Chapter 3

Radio buttons

Note, with radio buttons the `value` identifies which radio button has been pressed, and does not change; it's the `checked` field which changes, and only one can be `true` at a time.



Using radio buttons	Forward Light	○ Red	● Blue
	Aft Light	● Red	○ Blue

Figure 3.1: Using radio buttons

Figure 3.1 shows the part of the example that relates to radio buttons. There are two lights, Forward and Aft, each of which can show Red or Blue. The HTML is implemented in a form with

⟨ *Radio buttons: HTML 7* ⟩ ≡

```
<tr>
  <td>
    Using radio buttons
  </td>
  <td>
    <form method="PUT" name="lights" id="lights">
      <table border="1">
        <tr>
          <td id="forward-light">Forward Light</td>
          <td>
            <input
               type="radio"
               name="forward"
               value="red"
               checked="true">Red</input>
          </td>
          <td>
            <input
               type="radio"
               name="forward"
               value="blue">Blue</input>
          </td>
        </tr>
        <tr>
          <td id="aft-light">Aft Light</td>
          <td>
```

```
            <input
               type="radio"
               name="aft"
               value="red"
               checked="true">Red</input>
          </td>
          <td>
            <input
               type="radio"
               name="aft"
               value="blue">Blue</input>
          </td>
        </tr>
      </table>
    </form>
  </td>
</tr>
◇
```

Fragment referenced in 23c.
Users: `aft-light` in 9ab, 10c, 17, 18d, `forward-light` in 9ab, 10c, 17, 18d, `lights` in 10c, 17.

The radio button scripts have to be set up when the page is loaded.

⟨ *Set up the radio buttons: JavaScript* 8a ⟩ ≡
  ⟨ *"Set up radio buttons" utility: JavaScript* (`document.lights.forward, "forward-light"`) 21 ⟩
  ⟨ *"Set up radio buttons" utility: JavaScript* (`document.lights.aft, "aft-light"`) 21 ⟩
  ◇

Fragment referenced in 24.

The Ada code which receives the `forward-` and `backward-light` property changes updates global data.

⟨ *Global data: Ada* 8b ⟩ ≡

```
type Light_State is (Red, Blue);
Forward_Light : Light_State := Red;
Aft_Light : Light_State := Red;
◇
```

Fragment defined by 4e, 8b, 12b.
Fragment referenced in 25.
Users: `Aft_Light` in 9a, 10c, 18d, `Forward_Light` in 9a, 10c, 18d, `Light_State` in 9a.

⟨ *Checks for changed properties: Ada* 9a ⟩ ≡
```
declare
   Property : constant String
     := EWS.HTTP.Get_Property ("forward-light", From_Request.all);
begin
   if Property /= "" then
      Put_Line ("saw forward-light=" & Property);
      Forward_Light := Light_State'Value (Property);
   end if;
end;
declare
   Property : constant String
     := EWS.HTTP.Get_Property ("aft-light", From_Request.all);
begin
   if Property /= "" then
      Put_Line ("saw aft-light=" & Property);
      Aft_Light := Light_State'Value (Property);
   end if;
end;
◇
```
Fragment defined by 6, 9a, 12c.
Fragment referenced in 20d.
Uses: `Aft_Light` 8b, `Forward_Light` 8b, `Light_State` 8b, `aft-light` 7, `forward-light` 7.

Because the server can be accessed by more than one web client, and all the other clients need to show changes, the current light state is retrieved every second via a `CyclicHttpInteraction` to the URL `lightState.xml`. The response is expected to be XML:

```
<lights>
  <forward-light>lmp</forward-light>
  <aft-light>lmp</aft-light>
</lights>
```

where `lmp` specifies a colour (will be `red` or `blue`).

⟨ *Cyclic interactions: JavaScript* 9b ⟩ ≡
```
var lightStateRequest = new CyclicHttpInteraction
  ("lightState.xml",
   function (r) {
     var xml = r.responseXML;
     document.getElementById("forward-light").style.color =
       xml.getElementsByTagName("forward-light")[0].firstChild.nodeValue;
     document.getElementById("aft-light").style.color =
       xml.getElementsByTagName("aft-light")[0].firstChild.nodeValue;
   },
   1000);
◇
```
Fragment defined by 4a, 9b.
Fragment referenced in 24.
Users: `lightStateRequest` in 9c.
Uses: `aft-light` 7, `forward-light` 7, `lightState.xml` 10b.

The cyclic interaction needs to be started when the page is loaded.

⟨ *Start getting cyclic data: JavaScript* 9c ⟩ ≡
```
lightStateRequest.start();
◇
```
Fragment defined by 4b, 9c.
Fragment referenced in 24.
Uses: `lightStateRequest` 9b.

The Ada code which receives the cyclic `lightState.xml` request is in the function `AJAX_Light_State`.

⟨ *Specs of dynamic pages: Ada* 10a ⟩ ≡

```
function AJAX_Light_State
  (From_Request : HTTP.Request_P)
  return Dynamic.Dynamic_Response'Class;
◇
```

Fragment defined by 4c, 10a, 14c, 18b, 20b.
Fragment referenced in 25.
Users: `AJAX_Light_State` in 10b.

The function is registered with the server, to be called to respond to the URL `lightState.xml`.

⟨ *Register dynamic pages: Ada* 10b ⟩ ≡

```
Dynamic.Register (AJAX_Light_State'Unrestricted_Access, "/lightState.xml");
◇
```

Fragment defined by 4d, 10b, 14d, 18c, 20c.
Fragment referenced in 25.
Users: `lightState.xml` in 9b.
Uses: `AJAX_Light_State` 10ac.

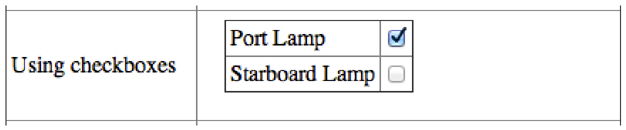
⟨ *Bodies of dynamic pages: Ada* 10c ⟩ ≡

```
function AJAX_Light_State
  (From_Request : HTTP.Request_P)
  return Dynamic.Dynamic_Response'Class is
   Result : Dynamic.Dynamic_Response (From_Request);
begin
   Result.Set_Content_Type (To => Types.XML);
   Result.Append ("<lights>");
   Result.Append_Element
     ("forward-light",
      Ada.Strings.Fixed.Translate
        (Forward_Light'Img,
         Ada.Strings.Maps.Constants.Lower_Case_Map));
   Result.Append_Element
     ("aft-light",
      Ada.Strings.Fixed.Translate
        (Aft_Light'Img,
         Ada.Strings.Maps.Constants.Lower_Case_Map));
   Result.Append ("</lights>");
   return Result;
end AJAX_Light_State;
◇
```

Fragment defined by 4f, 10c, 14e, 18d, 20d.
Fragment referenced in 25.
Users: `AJAX_Light_State` in 10b.
Uses: `Aft_Light` 8b, `Forward_Light` 8b, `aft-light` 7, `forward-light` 7, `lights` 7.

Chapter 4

Checkboxes



Using checkboxes	Port Lamp	✓
	Starboard Lamp	☐

Figure 4.1: Using checkboxes

Figure 4.1 shows the part of the example that relates to checkboxes. There are two Lamps, Port and Starboard, which are separately switched.

⟨ *Checkboxes: HTML* 11 ⟩ ≡

```
<tr>
  <td>
    Using checkboxes
  </td>
  <td>
    <form method="PUT" name="lamps" id="lamps">
      <table border="1">
        <tr>
          <td>Port Lamp</td>
          <td>
            <input
               type="checkbox"
               name="lamp"
               value="port"/>
          </td>
        </tr>
        <tr>
          <td>Starboard Lamp</td>
          <td>
            <input
               type="checkbox"
               name="lamp"
               value="starboard"/>
          </td>
        </tr>
      </table>
    </form>
  </td>
</tr>
```

◇

Fragment referenced in 23c.
Users: `lamp` in 12ac, 17, 18d, `lamps` in 12a, 17.

The `onclick` action is a function whose source is, for example,

```
postChange.start('lamp=0&value=port&checked='+document.lamps.lamp[0].checked);
```

Note that this sends the clicked checkbox's index (`document.lamps.lamp[0]` is the first) as well as the `value` (corresponding to the internal name of the box); the receiving Ada code presently uses the index, though it would obviously be better to use the value.

⟨ *Set up the checkboxes: JavaScript* 12a ⟩ ≡

```
for (var c = document.lamps.lamp, i = 0; i < c.length; i++) {
  c[i].onclick = new Function(
    "postChange.start('lamp=" + i
      + "&value=" + document.lamps.lamp[i].value
      + "&checked=' + document.lamps.lamp[" + i + "].checked);"
  );
}
```

◇
Fragment referenced in 24.
Uses: `lamp` 11, `lamps` 11, `postChange` 20a.

The Ada code which receives the `lamp` property changes updates global data.

⟨ *Global data: Ada* 12b ⟩ ≡

```
Lamps : array (0 .. 1) of Boolean := (others => True);
```

◇
Fragment defined by 4e, 8b, 12b.
Fragment referenced in 25.
Users: `Lamps` in 12c, 18d.

⟨ *Checks for changed properties: Ada* 12c ⟩ ≡

```
declare
   Lamp : constant String
     := EWS.HTTP.Get_Property ("lamp", From_Request.all);
begin
   if Lamp /= "" then
      declare
         Checked : constant String
           := EWS.HTTP.Get_Property ("checked", From_Request.all);
         Value : constant String
           := EWS.HTTP.Get_Property ("value", From_Request.all);
      begin
         Put_Line ("saw lamp=" & Lamp
                   & " value=" & Value
                   & " checked=" & Checked);
         Lamps (Natural'Value (Lamp)) := Boolean'Value (Checked);
      end;
   end if;
end;
```

◇
Fragment defined by 6, 9a, 12c.
Fragment referenced in 20d.
Uses: `Lamps` 12b, `lamp` 11.

Chapter 5

File upload

Figure 5.1 shows the file upload dialog. Figure 5.2 shows the alert box displayed when the upload is complete.

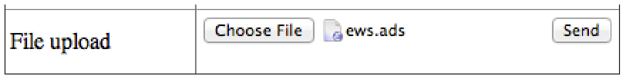
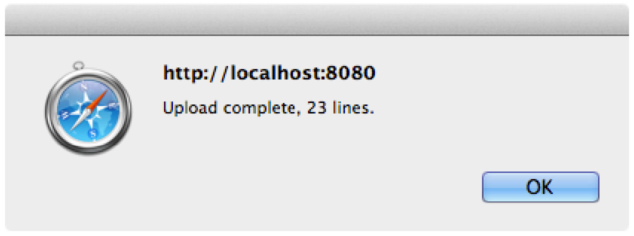


Figure 5.1: The file upload dialog



http://localhost:8080

Upload complete, 23 lines.

Figure 5.2: Upload completed

The file upload dialog is in a form, in a table cell. The form contains two elements: a file selector (`datafile`) and a submit button.

When the form is submitted, the content of the selected file is sent as a multipart attachment to the URL `/fileInput` (the form's `action`).

The other components of this example program use explicit JavaScript methods to send the data to the server. In the case of a file upload, the protocol is complex enough that it's best left to the browser. When the browser has submitted the request, it expects to get a new page in response; we don't want that, so we use the form's `target` attribute to direct the response to an invisible frame `iFrame` so that the current page remains displayed.

⟨ *File upload: HTML* 14a ⟩ ≡
```
<tr>
  <td>
    File upload
  </td>
  <td>
    <form method="POST"
          enctype="multipart/form-data"
          name="fileInput"
          action="fileInput"
          target="iFrame">
      <input type="file" name="datafile" size="128">
      <input type="submit" name="send" value="Send">
    </form>
  </td>
</tr>
```
◇
Fragment referenced in 23c.
Uses: `fileInput` 14d, `iFrame` 14b.

⟨ *File upload's target iFrame: HTML* 14b ⟩ ≡
```
<iframe name="iFrame" id="iFrame" src="about:blank" width="0" height="0">
</iframe>
```
◇
Fragment referenced in 23c.
Users: `iFrame` in 14a.

The Ada code which receives the `fileInput` request is in the function `File_Input`.

⟨ *Specs of dynamic pages: Ada* 14c ⟩ ≡
```
function File_Input
  (From_Request : HTTP.Request_P)
  return Dynamic.Dynamic_Response'Class;
```
◇
Fragment defined by 4c, 10a, 14c, 18b, 20b.
Fragment referenced in 25.
Users: `File_Input` in 14d.

The function is registered with the server, to be called to respond to the URL `fileInput`.

⟨ *Register dynamic pages: Ada* 14d ⟩ ≡
```
Dynamic.Register (File_Input'Unrestricted_Access, "/fileInput");
```
◇
Fragment defined by 4d, 10b, 14d, 18c, 20c.
Fragment referenced in 25.
Users: `fileInput` in 14ae.
Uses: `File_Input` 14ce.

The response generated is a page containing an alert box (5.2), which is displayed even though the `iFrame` swallows the HTML content.

⟨ *Bodies of dynamic pages: Ada* 14e ⟩ ≡
```
function File_Input
  (From_Request : HTTP.Request_P) return Dynamic.Dynamic_Response'Class is
   ⟨Upload_Result, calculates file input result: Ada 15, ...⟩
   C : HTTP.Cursor;
   Lines : Natural := 0;
   Line : String (1 .. 1024);
   Last : Natural;
   Attachments : constant HTTP.Attachments
     := HTTP.Get_Attachments (From_Request.all);
begin
   Put_Line ("saw fileInput with attachment length"
             & HTTP.Get_Content (Attachments)'Length'Img);
```

```
      if HTTP.Get_Content (Attachments)'Length /= 0 then
         begin
            HTTP.Open (C, Attachments);
            while not HTTP.End_Of_File (C) loop
               Lines := Lines + 1;
               Put (Lines'Img & ": ");
               HTTP.Get_Line (C, Line, Last);
               Put_Line (Line (1 .. Last));
            end loop;
            HTTP.Close (C);
            return Upload_Result
              ("Upload complete," & Lines'Img & " lines.");
         exception
            when E : others =>
               begin
                  HTTP.Close (C);
               exception
                  when others => null;
               end;
               return Upload_Result
                 ("Upload failed: " & Ada.Exceptions.Exception_Message (E));
         end;
      else
         declare
            Result : Dynamic.Dynamic_Response (From_Request);
         begin
            Result.Set_Content_Type (To => Types.Plain);
            Result.Set_Content ("null");
            return Result;
         end;
      end if;
   end File_Input;
   ◇
```

Fragment defined by 4f, 10c, 14e, 18d, 20d.
Fragment referenced in 25.
Users: `File_Input` in 14d.
Uses: `Upload_Result` 15, 16, `fileInput` 14d.

⟨`Upload_Result`, *calculates file input result: Ada* 15⟩ ≡

```
   function Upload_Result (Message : String)
     return Dynamic.Dynamic_Response'Class;
   ◇
```

Fragment defined by 15, 16.
Fragment referenced in 14e.
Users: `Upload_Result` in 14e.

If the `Message` to be returned contains multiple lines, they have to be translated to the `\n` that the JavaScript `alert()` function expects.

⟨Upload_Result, *calculates file input result: Ada* 16⟩ ≡

```
  function Upload_Result (Message : String)
    return Dynamic.Dynamic_Response'Class is
     Result : Dynamic.Dynamic_Response (From_Request);
  begin
     Result.Set_Content_Type (To => Types.HTML);
     Result.Append ("<body onload=""alert('");
     for C in Message'Range loop
        case Message (C) is
           when ASCII.CR | ASCII.NUL => null;
           when ASCII.LF => Result.Append ("\n");
           when others =>
              Result.Append (String'(1 => Message (C)));
        end case;
     end loop;
     Result.Append ("')"">");
     return Result;
  end Upload_Result;
  ◇
```

Fragment defined by 15, 16.
Fragment referenced in 14e.
Users: `Upload_Result` in 14e.

Chapter 6

Retrieving the initial state

When a new client connects to the server, it must retrieve the current state and set the page elements accordingly.

The server responds to the URL `state.xml` with the current state in XML format,

```
<state>
  <time-format>fmt</time-format>
  <forward-light>lmp</forward-light>
  <aft-light>lmp</aft-light>
  <lamp>bool</lamp>
  <lamp>bool</lamp>
</state>
```

where

`fmt` can be `iso`, `us`, `european` or `locale`,
`lmp` can be `red` or `blue`, and
`bool` can be `false` or `true`.

and the first `lamp` element is for the starboard lamp and the second is for the port lamp.

⟨ *Retrieving the initial state: JavaScript* 17 ⟩ ≡

```
  var stateRequest = new OneshotHttpInteraction
    ("state.xml",
     null,
     function (r) {
       var x = r.responseXML;
       var value = x.getElementsByTagName("time-format")[0].firstChild.nodeValue;
       for (var o = document.fTimeFormat.format.options, i = 0;
            i < o.length;
            i++) {
         o[i].selected = (o[i].value == value);
       }
       value = x.getElementsByTagName("forward-light")[0].firstChild.nodeValue;
       for (var o = document.lights.forward, i = 0;
            i < o.length;
            i++) {
         o[i].checked = (o[i].value == value);
       }
       value = x.getElementsByTagName("aft-light")[0].firstChild.nodeValue;
       for (var o = document.lights.aft, i = 0;
            i < o.length;
            i++) {
         o[i].checked = (o[i].value == value);
       }
       var lamps = x.getElementsByTagName("lamp");
       for (var c = document.lamps.lamp, i = 0; i < c.length; i++) {
         c[i].checked = lamps[i].firstChild.nodeValue == "true";
       }
     });
   ◇
```

Fragment referenced in 24.
Users: `stateRequest` in 18a.
Uses: `aft-light` 7, `fTimeFormat` 5a, `forward-light` 7, `lamp` 11, `lamps` 11, `lights` 7, `state.xml` 18c.

When the page is opened, request the initial state.

⟨ *Request the initial state: JavaScript* 18a ⟩ ≡

```
 stateRequest.start();
 ◇
```

Fragment referenced in 24.
Uses: `stateRequest` 17.

The Ada code which receives the `state.xml` request is in the function `AJAX_Status`.

⟨ *Specs of dynamic pages: Ada* 18b ⟩ ≡

```
 function AJAX_Status
   (From_Request : HTTP.Request_P)
   return Dynamic.Dynamic_Response'Class;
 ◇
```

Fragment defined by 4c, 10a, 14c, 18b, 20b.
Fragment referenced in 25.
Users: `AJAX_Status` in 18c.

The function is registered with the server, to be called to respond to the URL `state.xml`.

⟨ *Register dynamic pages: Ada* 18c ⟩ ≡

```
 Dynamic.Register (AJAX_Status'Unrestricted_Access, "/state.xml");
 ◇
```

Fragment defined by 4d, 10b, 14d, 18c, 20c.
Fragment referenced in 25.
Users: `state.xml` in 17.
Uses: `AJAX_Status` 18bd.

⟨ *Bodies of dynamic pages: Ada* 18d ⟩ ≡

```
 function AJAX_Status
   (From_Request : HTTP.Request_P)
   return Dynamic.Dynamic_Response'Class is
    Result : Dynamic.Dynamic_Response (From_Request);
 begin
    Result.Set_Content_Type (To => Types.XML);
    Result.Append ("<state>");
    Result.Append_Element
      ("time-format",
       Ada.Strings.Fixed.Translate
         (Current_Date_Format'Img,
          Ada.Strings.Maps.Constants.Lower_Case_Map));
    Result.Append_Element
      ("forward-light",
       Ada.Strings.Fixed.Translate
         (Forward_Light'Img,
          Ada.Strings.Maps.Constants.Lower_Case_Map));
    Result.Append_Element
      ("aft-light",
       Ada.Strings.Fixed.Translate
         (Aft_Light'Img,
          Ada.Strings.Maps.Constants.Lower_Case_Map));
    for L in Lamps'Range loop
       Result.Append_Element
         ("lamp",
          Ada.Strings.Fixed.Translate
            (Lamps (L)'Img,
             Ada.Strings.Maps.Constants.Lower_Case_Map));
    end loop;
    Result.Append ("</state>");
    return Result;
 end AJAX_Status;
 ◇
```

Fragment defined by 4f, 10c, 14e, 18d, 20d.
Fragment referenced in 25.
Users: `AJAX_Status` in 18c.
Uses: `Aft_Light` 8b, `Current_Date_Format` 4e, `Forward_Light` 8b, `Lamps` 12b, `aft-light` 7, `forward-light` 7, `lamp` 11.

Chapter 7

Utilities

7.1 Notifying the server of changes

`postChange` is a one-shot interaction; it sends a request to the URL `ajaxChange`. If `postChange.start()` is called with a parameter (for example, `"foo=bar"`, the parameter is sent to the URL as a query. No specific response is expected.

⟨ *Generalised change action request: JavaScript* 20a ⟩ ≡
```
  var postChange = new OneshotHttpInteraction
    ("ajaxChange",
     null,
     function (r) { });
  ◇
```
Fragment referenced in 24.
Users: `postChange` in 5b, 12a, 21.
Uses: `ajaxChange` 20c.

The Ada code which receives the `ajaxChange` request is in the function `Ajax_Change`.

⟨ *Specs of dynamic pages: Ada* 20b ⟩ ≡
```
  function AJAX_Change
    (From_Request : HTTP.Request_P)
    return Dynamic.Dynamic_Response'Class;
  ◇
```
Fragment defined by 4c, 10a, 14c, 18b, 20b.
Fragment referenced in 25.
Users: `AJAX_Change` in 20c.

The function is registered with the server, to be called to respond to the URL `ajaxChange`.

⟨ *Register dynamic pages: Ada* 20c ⟩ ≡
```
  Dynamic.Register (AJAX_Change'Unrestricted_Access, "/ajaxChange");
  ◇
```
Fragment defined by 4d, 10b, 14d, 18c, 20c.
Fragment referenced in 25.
Users: `ajaxChange` in 20a.
Uses: `AJAX_Change` 20bd.

⟨ *Bodies of dynamic pages: Ada* 20d ⟩ ≡
```

  function AJAX_Change
    (From_Request : HTTP.Request_P)
    return Dynamic.Dynamic_Response'Class is
     Result : Dynamic.Dynamic_Response (From_Request);
  begin
     Put_Line ("AJAX_Change called.");
     ⟨ Checks for changed properties: Ada 6, ... ⟩
     Result.Set_Content_Type (To => Types.Plain);
     Result.Set_Content ("OK");
     return Result;
  end AJAX_Change;
  ◇
```

Fragment defined by 4f, 10c, 14e, 18d, 20d.
Fragment referenced in 25.
Users: `AJAX_Change` in 20c.

7.2 Set up radio buttons

`Set up radio buttons utility` is a `nuweb` parameterised fragment. There's no indication in a parameterised fragment's name that it is parameterised; when invoked with parameters, occurrences of `@n` are replaced by the `n`'th parameter.

The first parameter (`@1`) is the name of the buttons to be set up (they all have the same name): e.g. `document.formName.buttonName`.

The second parameter (`@2`) is the property name that is passed to `postChange`.

When one of the buttons is clicked, a one-shot `ajaxChange` interaction is invoked, posting the query `property=value` where `property` is the name passed in the second parameter and `value` is the `value` attribute of the button.

⟨ *"Set up radio buttons" utility: JavaScript* 21 ⟩ ≡

```
 for (var j = 0; j < @1.length; j++) {
   @1[j].onclick = new Function(
      "postChange.start('" + @2 + "=" + @1[j].value + "');");
 };
 ◇
```

Fragment referenced in 8a.
Uses: `postChange` 20a.

Chapter 8

HTML pages

```
"ajax.html" 22a≡
  ⟨ HTML licence header 2d ⟩
  <html>
  <head>
  ⟨ HTML header 22b ⟩
  </head>
  <body bgcolor="white">
  ⟨ Page heading 23a ⟩
  ⟨ Introductory material 23b ⟩
  <p><hr>
  ⟨ The demonstrations 23c ⟩
  ⟨ Author link 23d ⟩
  </body>
  </html>
  ◇
```

```
⟨ HTML header 22b ⟩ ≡
  <title>EWS: AJAX demonstration</title>

  <!-- NB,for Internet Explorer you mustn't use the empty-element
       syntax. For Safari, you have to close the element. -->
  <script type="text/javascript"src="HttpInteraction.js"></script>
  <script type="text/javascript"src="ajax.js"></script>

  <style type="text/css">
    div#demos table { margin : 0.2em 1em;
                      font-size : 100%;
                      border-collapse : collapse; }
    div#demos th,td { padding : 0.2em; }
  </style>
  ◇
```
Fragment referenced in 22a.

⟨ *Page heading* 23a ⟩ ≡

```
<table width="100%">
<tr>
<td><h1>Embedded Web Server: AJAX demonstration</h1></td>
<td align="right">
<a href="http://sourceforge.net"> <img
src="http://sourceforge.net/sflogo.php?group_id=95861&amp;type=1"
width="88" height="31" border="0" alt="SourceForge.net Logo" /></a>
</td>
</tr>
</table>
◇
```

Fragment referenced in 22a.

⟨ *Introductory material* 23b ⟩ ≡

```
<p>EWS is a web server construction kit, designed for embedded
applications using the GNAT Ada compiler.

<p>The project is hosted on <a
href="https://github.com/simonjwright/ews">Github</a>.

<p>EWS comes with a demonstration of its facilities. The available
facilities are described in <a href="ews.pdf">this document</a>, which
also acts as the source code for the demonstration using the <a
href="http://www.literateprogramming.com/">Literate Programming</a>
facilities of <a
href="https://github.com/simonjwright/nuweb.py">nuweb.py</a>.
◇
```

Fragment referenced in 22a.

⟨ *The demonstrations* 23c ⟩ ≡

```
<p>Below are demonstrations of
various <a href="http://www.amazon.co.uk/exec/obidos/ASIN/0471777781/qid%3D1146719450/203-6928631-0011916">AJAX</
technologies:

<div id="demos" align="center">
  <table border="1">
    ⟨ Cyclic updating and select/options: HTML 3a ⟩
    ⟨ Radio buttons: HTML 7 ⟩
    ⟨ Checkboxes: HTML 11 ⟩
    ⟨ File upload: HTML 14a ⟩
  </table>
</div>
⟨ File upload's target iFrame: HTML 14b ⟩
◇
```

Fragment referenced in 22a.

⟨ *Author link* 23d ⟩ ≡

```
<hr>
<i>
<address>
<a href="mailto:simon@pushface.org">Simon Wright</a>
</address>
</i>
◇
```

Fragment referenced in 22a.

Chapter 9

JavaScript

This script, loaded by `ajax.html`, relies on the utility `HttpInteraction.js` having been already loaded by the page.

`"ajax.js"` 24≡

```
⟨ JavaScript licence header 2c ⟩

⟨ Retrieving the initial state: JavaScript 17 ⟩

⟨ Cyclic interactions: JavaScript 4a, ... ⟩

⟨ Generalised change action request: JavaScript 20a ⟩

/**
 * Assign event handlers and begin fetching.
 */
window.onload = function () {

  ⟨ Request the initial state: JavaScript 18a ⟩
  ⟨ Start getting cyclic data: JavaScript 4b, ... ⟩
  ⟨ Set up to send time format: JavaScript 5b ⟩
  ⟨ Set up the radio buttons: JavaScript 8a ⟩
  ⟨ Set up the checkboxes: JavaScript 12a ⟩
};
◇
```

Chapter 10

Ada

10.1 Ada code

"ews_demo.adb" 25≡

```
⟨ Ada licence header 2b ⟩
with Ada.Calendar;
with Ada.Exceptions;
with Ada.Strings.Fixed;
with Ada.Strings.Maps.Constants;
with Ada.Text_IO; use Ada.Text_IO;
with EWS.Dynamic;
with EWS.HTTP;
with EWS.Server;
with EWS.Types;
with GNAT.Calendar.Time_IO;
with GNAT.Command_Line;

with EWS_Htdocs;

procedure EWS_Demo is

   use EWS;

   ⟨ Specs of dynamic pages: Ada 4c, ... ⟩

   ⟨ Global data: Ada 4e, ... ⟩

   ⟨ Bodies of dynamic pages: Ada 4f, ... ⟩

   Verbose : Boolean := False;

begin

   begin
      loop
         case GNAT.Command_Line.Getopt ("v") is
            when 'v' =>
               Verbose := True;
            when ASCII.NUL =>
               exit;
            when others =>
               null;  -- never taken
         end case;
      end loop;
   exception
      when GNAT.Command_Line.Invalid_Switch =>
         Put_Line (Standard_Error,
                   "invalid switch -" & GNAT.Command_Line.Full_Switch);
         return;
   end;

   ⟨ Register dynamic pages: Ada 4d, ... ⟩

   Put_Line ("Connect to ews_demo using e.g. http://localhost:8080");

   Server.Serve (Using_Port => 8080,
                 With_Stack => 40_000,
                 Tracing => Verbose);

   delay 1_000_000.0;

end EWS_Demo;
◇
```

10.2 GNAT Project

"ews_demo.gpr" 26≡

```
with "../ews";
with "xmlada";
project EWS_Demo is

   for Main use ("ews_demo.adb");
   for Exec_Dir use ".";
   for Source_Dirs use (".");
   for Object_Dir use ".build";
   for Create_Missing_Dirs use "true";

   package Builder is
      for Default_Switches ("ada") use ("-g");
   end Builder;

   package Compiler is
      for Default_Switches ("ada") use
        (
         "-O2",
         "-gnatqQafoy"
        );
   end Compiler;

   package Binder is
      for Default_Switches ("ada") use ("-E");
   end Binder;

end EWS_Demo;
◇
```

Appendix A

About this document

This document is prepared using nuweb, a language-agnostic Literate Programming tool. The actual variant used is nuweb.py.

Appendix B

Index

B.1 Files

B.2 Macros

B.3 Definitions