Refreshing pages

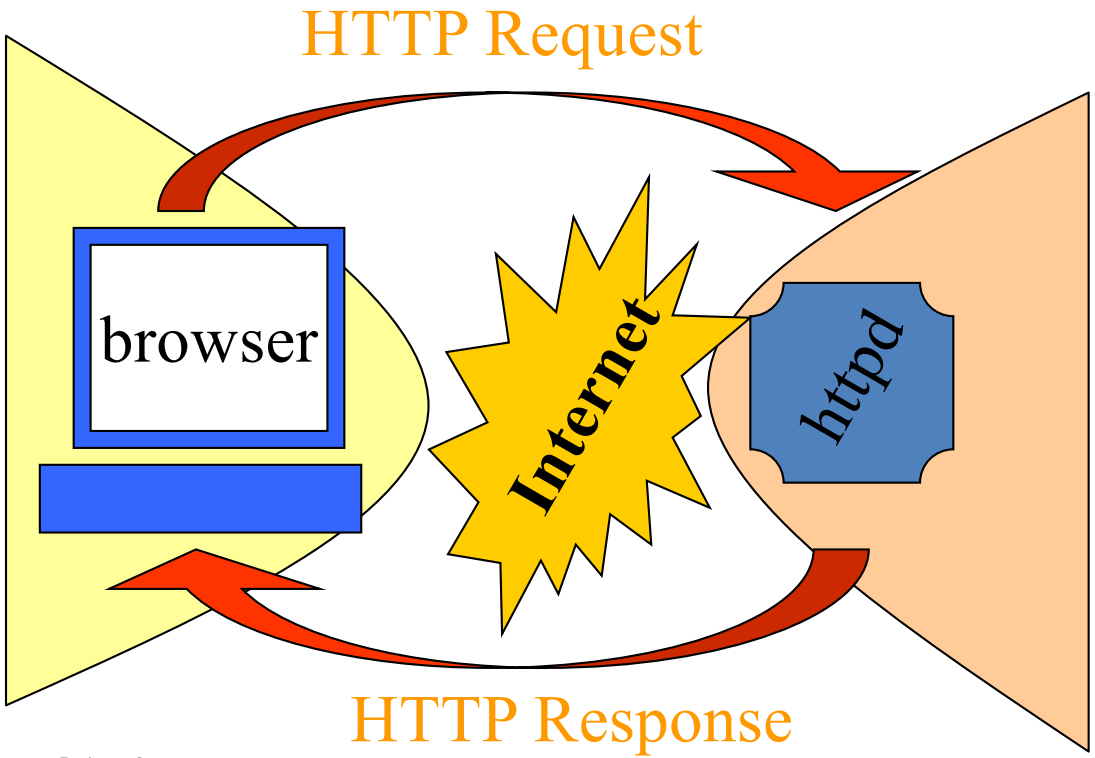
COMMENTARY

45'+1'	**Fine primo tempo** - Si va al riposo sullo 0-0
45'	**1'** di recupero
45'	Lancio sulla destra per Pellegrini: palla troppo lunga che sfila sul fondo
44'	Lancio in area per Torregrossa, anticipato da Ibanez
43'	Su corta respinta della difesa biancazzurra, prova il destro al volo da 25 mt **Diawara**: tiro lento che, però, si perde appena mezzo mt a lato alla destra di Andrenacci
42'	Sull'angolo dalla sinistra di Pellegrini, Bjarnason anticipa Ibanez e allontana il pericolo

Q

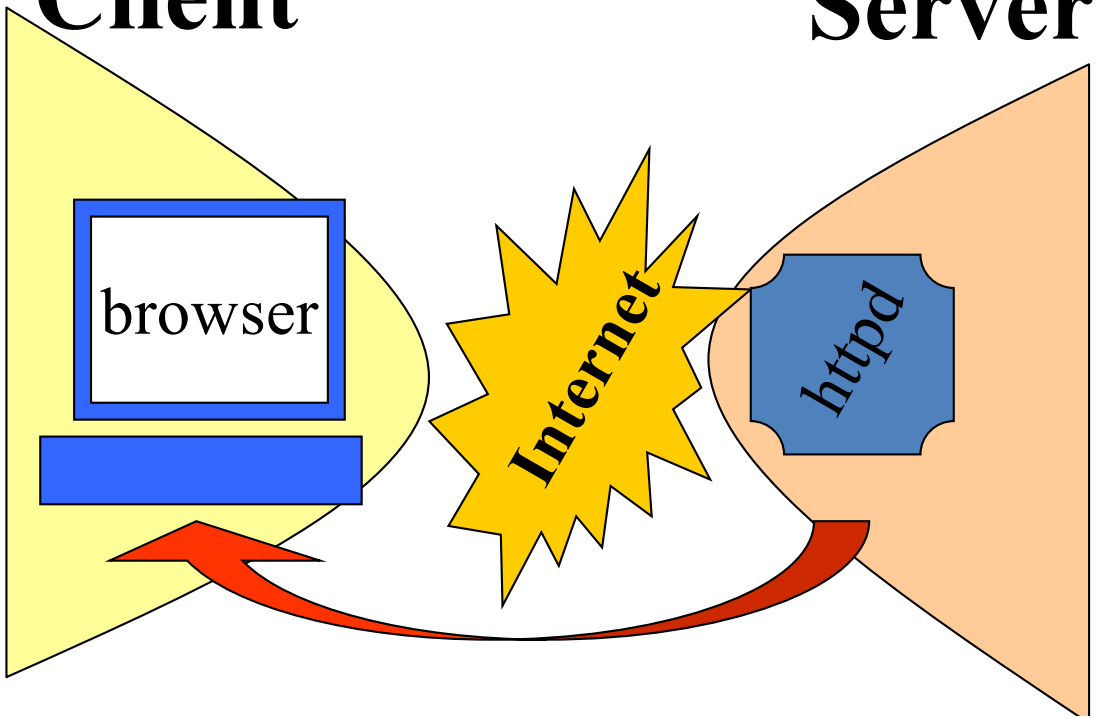
How do I refresh on a periodic base the content of a page?

Pull vs. Push



PULL

HTTP has no "natural" way to support Push



PUSH

Refreshing pages

1) You can (fully) reload a page without using JavaScript, just using a HTTP header

```
<meta http-equiv="refresh" content="30">
```

https://www.w3schools.com/tags/att_meta_http_equiv.asp

2) You can use Javascript in two ways:

setInterval and setTimeout.

- setTimeout inherently triggers only once
- setInterval continues indefinitely.

https://www.w3schools.com/jsref/met_win_setinterval.asp
https://www.w3schools.com/jsref/met_win_settimeout.asp

A newsfeeder

- **PublisherPage**
  - add news to newslist
- **Welcome page:**
  - ask user name
  - create session
  - set lastNewsID to 0
  - load readerPage
- **ReaderPage**
  - get ID
  - if lastNewsID!=ID
    - load all news from lastNewsID to ID
    - update lastNewsID
  - SetTimeout

Data structure

News
- lastNewsID

NewsList:
- ID
- content

Global

Session
- username
- lastNewsID

Per User

A two-player game

- **Welcome page:**
  - ask user name
  - create entry in UserList
  - create session
  - check if anyone is in waiting list
    - if yes, pair the two players and assign turn
    - if no, put user in waiting list
  - prepare and deliver response page (waiting page or playing page)
- **WaitingPage**
  - use SetTimeout to check if IsWaiting
    - if yes, set Timeout again
    - if no, load PlayingPage
- **PlayingPage**
  - use SetTimeout to check if canPlay
    - if no, update page with a message (e.g. counter)
    - if yes, ask user to perform action
      - update (user)gameState
      - update (global)gameState
      - update turn

Waiting list
- waiting user

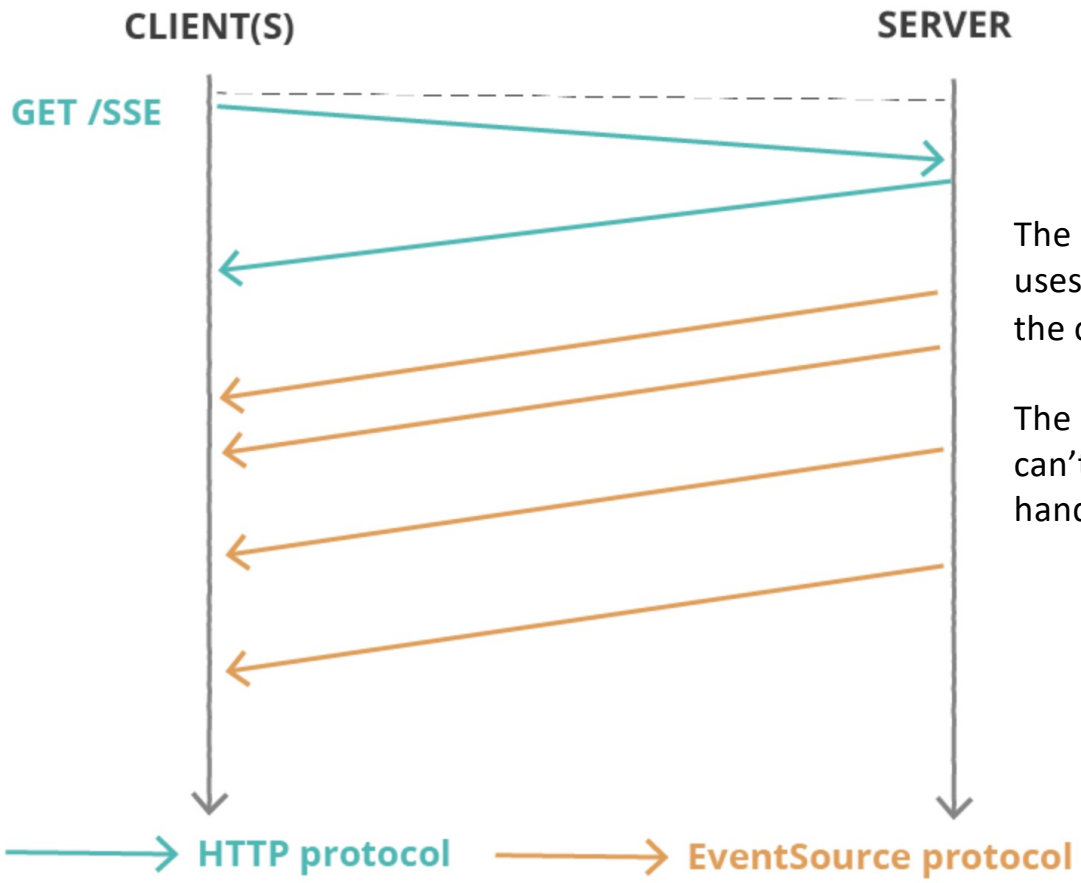
GameList:
- **Game<->gameID**
  - user[2]
  - turn
  - (global) game state

User list
- User <-> sessionID

Session
- username
- isWaiting
- gameID
- (user)gameState

JavaScript EventSource and Java AsyncContext

Web Server Sent Events



The client initiates the SSE connection and the server uses the event source protocol to send updates to the client.

The client will receive updates from the server, but it can’t send any data to the server after the initial handshake.

A true push service on the web

Our goal:

- Build a publisher of events on a web server
- Build a client for events on the browser
- Allow for multiple simultaneous clients

In the following, only the most relevant parts of code are shown

Relevant, not well known classes used in the code

```
JavaScript:
     EventSource
```

```
java:
```

The following ones should be well known, but we'll provide a short reminder

```
    Runnable, Thread
```

Some Java classes useful when dealing with concurrency

```
    LinkedBlockingQueue
    ConcurrentHashMap
    CopyOnWriteArrayList
    AtomicLong
    UUID
```

UUID: class that represents an immutable universally unique identifier (UUID).
A UUID represents a 128-bit value.

AtomicLong part of the Package **java.util.concurrent.atomic**
A small toolkit of classes that support lock-free thread-safe programming on single variables.

JavaScript EventSource

Interface to server-sent events.
Opens a persistent connection to an HTTP server, which
sends events in text/event-stream format.
The connection remains open until closed by calling EventSource.close().

incoming messages from the server are delivered in the form of **events**.

Unlike WebSockets, server-sent events are unidirectional: you can not use an EventSource channel to send message from browser to server.

When **not used over HTTP/2**, SSE suffers from a limitation to the maximum number of open connections: the limit is *per browser* and set to a 6.
When using **HTTP/2**, the maximum number of simultaneous *HTTP streams* is negotiated between the server and the client (defaults to 100).

see https://developer.mozilla.org/en-US/docs/Web/API/EventSource

JavaScript EventSource

Method onmessage: callback function activated on incoming messages

```
var evtSource = new EventSource('/mysource');
evtSource.onmessage = function(e) {
        document.getElementById('sse').innerHTML = e.data;
}
```

eventisteners:

```
sse = new EventSource('/api/v1/sse');
sse.addEventListener("notice", function(e) { console.log(e.data) })
sse.addEventListener("update", function(e) { console.log(e.data) })
sse.addEventListener("message", function(e) { console.log(e.data) })
```

This will listen only for events of type
event: notice
data: somedata
id: someid

This will listen for events of type
event: update

The event "message" will capture:

- events of type `event: message`
- events without an event field

see https://html.spec.whatwg.org/multipage/server-sent-events.html#server-sent-events

Java Runnable and Thread

java.lang.Runnable is an interface that is to be implemented by a class whose instances are intended to be executed by a thread.
method run(): body of the Runnable, is never called explicitly, but is activated when the method start is called on a Thread that encapsulates the Runnable.

java.lang.Thread: java implementation of the thread concept. A thread a line of execution within a program. A Thread must either be instantiated by encapsulating a Runnable, or subclassed redefining the run method.

see
https://www.geeksforgeeks.org/runnable-interface-in-java/
https://www.geeksforgeeks.org/java-lang-thread-class-java/

image from https://www.geeksforgeeks.org

Java LinkedBlockingQueue

in package **java.util.concurrent** : Utility classes commonly useful in concurrent programming.

Method **take() :** Retrieves and removes the head of this queue, waiting if necessary until an element becomes available.

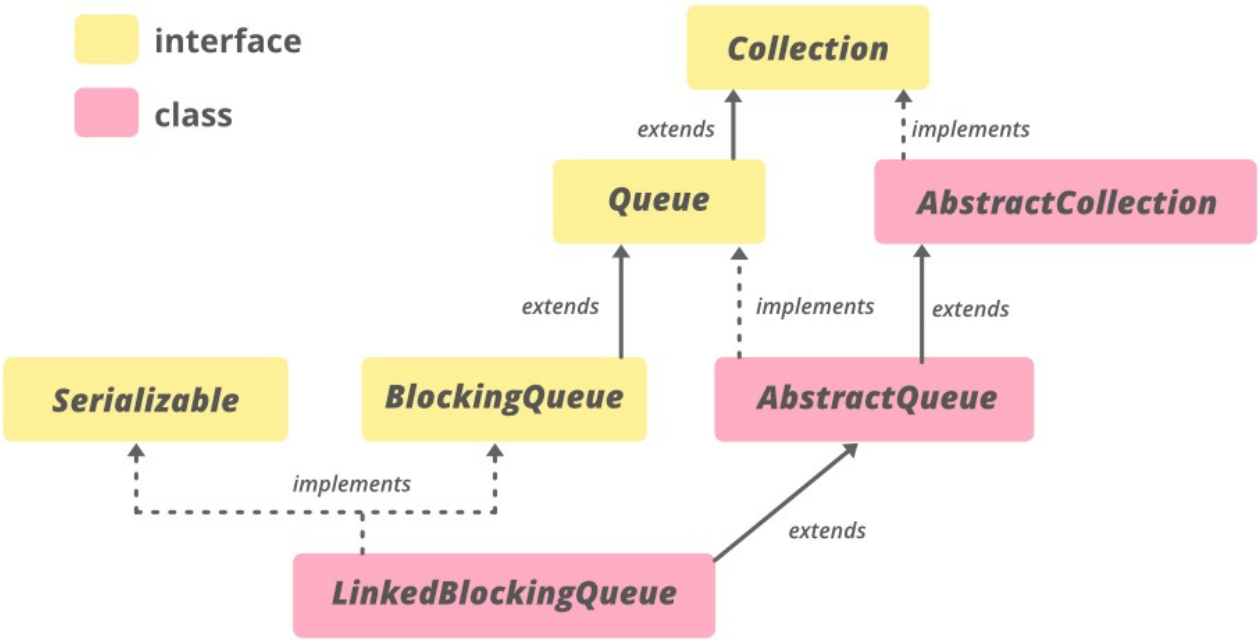


image from https://www.geeksforgeeks.org

Java ConcurrentHashMap

in package **java.util.concurrent** : Utility classes commonly useful in concurrent programming.

A hash table supporting full concurrency of retrievals and high expected concurrency for updates.

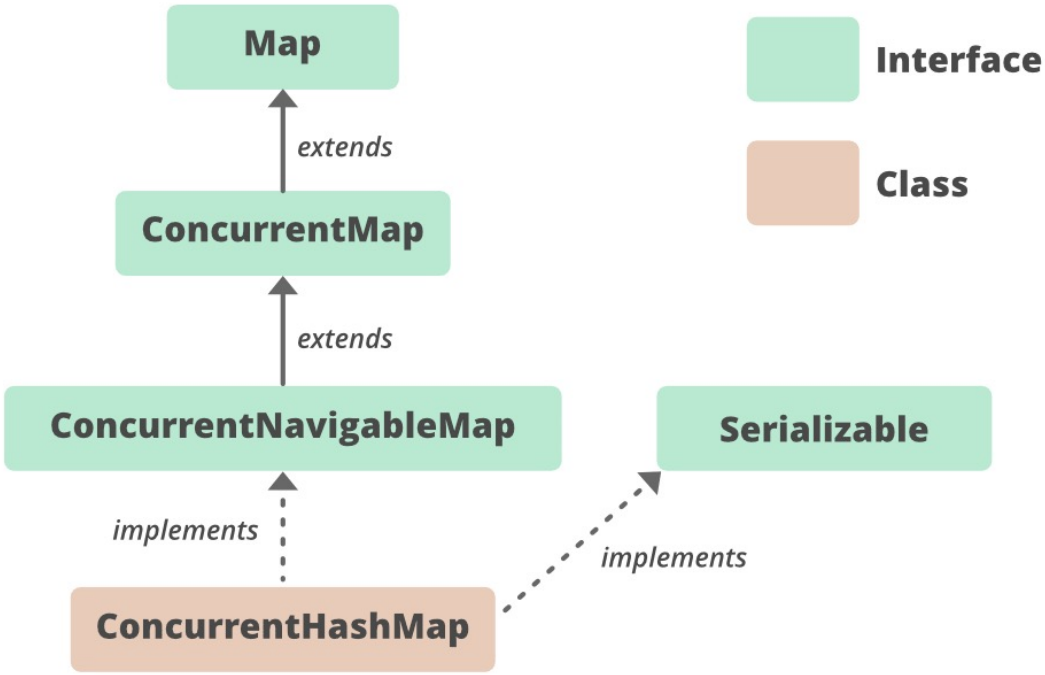


image from https://www.geeksforgeeks.org

Java CopyOnWriteArrayList

in package **java.util.concurrent** : Utility classes commonly useful in concurrent programming.

It is a thread-safe version of ArrayList. All modifications (add, set, remove, etc) are implemented by making a fresh copy, hence it is costly and is best used if our frequent operation is read operation.

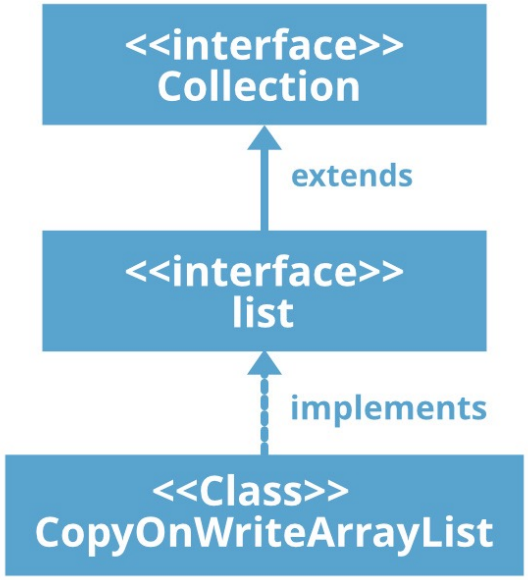


image from https://www.geeksforgeeks.org

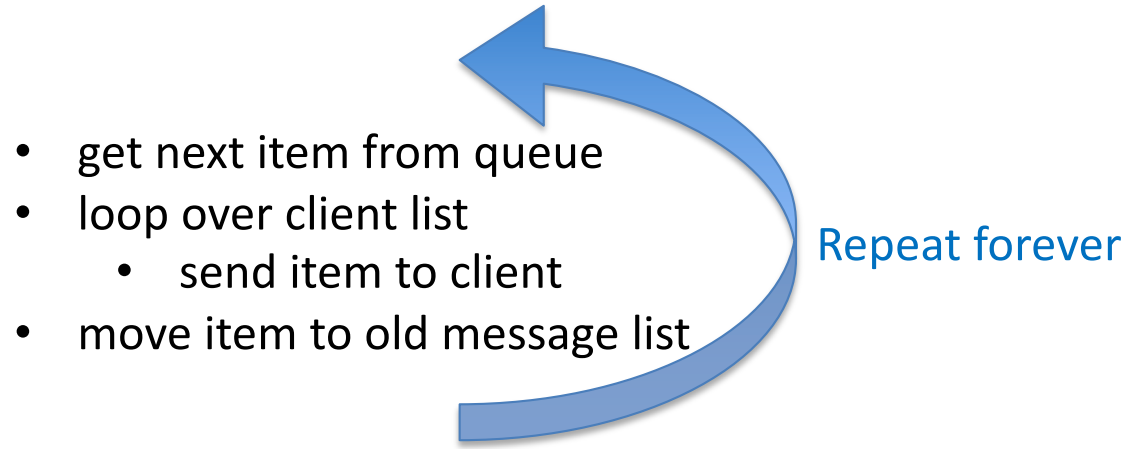
The data structure

- Created at WebApp start

NewsItem:
represents a message
- contains:
  - a serial number
  - a line of text
- knows how:
  - toString(): print itself into a String
  - toJSON() : print itself into a JSON structure

The agents: Distributor

- An autonomous thread
- **Mission**: distribute events to all clients



Distributor: the loop

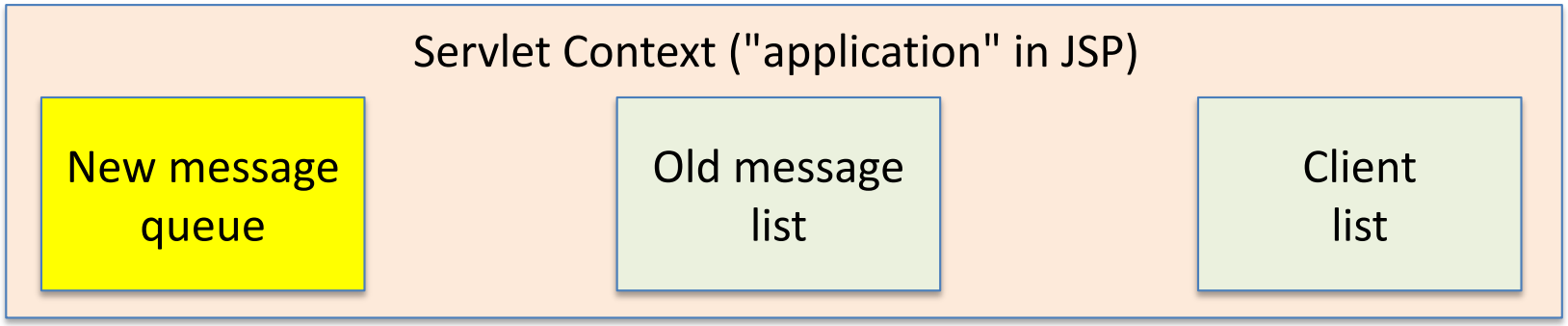
```
private void sendMessage(
   PrintWriter writer, NewsItem item) {
        writer.print("data: ");
        writer.println(item.toJSON());
        writer.println();
        writer.flush(); }
```

```
while (running) {
   try {
     // Waits until a news_item arrives
     NewsItem news_item = newItemsQueue.take();
     // Store into past items, for future clients
     pastItemsList.add(news_item);
     // Sends the item to all the clients
      Iterator<AsyncContext> iter=clientList.values().iterator();
     while (iter.hasNext()) {
       AsyncContext client=iter.next();
       try {
          PrintWriter channel = client.getResponse().getWriter();
          sendMessage(channel, news_item);
       } catch (Exception e) {
          // In case of problems remove context from map
          iter.remove();
       }
     }
   } catch (InterruptedException e) {/* Log exception, etc. */}
 }
```

The views: NewsCreator jsp

- Reads the use input
- sends it to its controller (NewsFeeder servlet)

The agents: NewsFeeder servlet



Mission:

- setup the web app
- start the distributor
- add messages to the New message queue

- At the beginning (init)
  - creates data structure in context
  - starts the Distributor

- When called (from NewsCreator.jsp):
  - adds message to New message queue

NewsFeederServlet: the init()

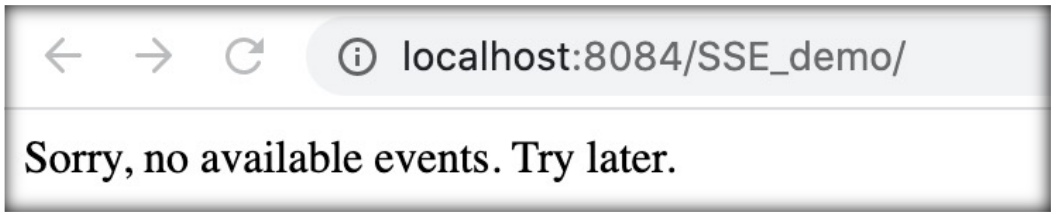
```
public void init(ServletConfig config) throws ServletException {
        super.init(config);
        ctx=getServletContext();
        startEvent();
}
private void startEvent(){
  // create all needed items, add them to context, start the
                                                        distributor
  counter.set(0);
  newItemsQueue=new LinkedBlockingQueue<NewsItem>();
  ctx.setAttribute("queue", newItemsQueue);
  clientList=new ConcurrentHashMap<String, AsyncContext>();
  ctx.setAttribute("clients", clientList);
  pastItemsList=new CopyOnWriteArrayList<NewsItem>();
  ctx.setAttribute("newsList", pastItemsList);
  distributor=new Distributor(ctx);
  ctx.setAttribute("distributor", distributor);
  distributor.start();
}
```

NewsFeederServlet: save new item

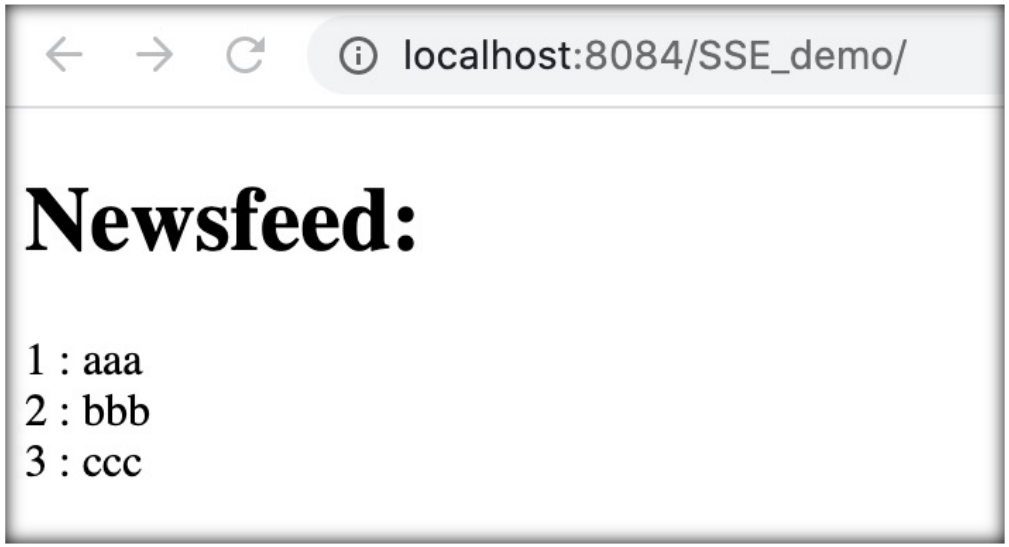
```
String newsLine = request.getParameter("line");
    if ((newsLine != null) && !newsLine.trim().isEmpty()) {
        if (newsLine.compareTo("%END%")==0){
            endEvent();
            request.getRequestDispatcher("/newsCreator.jsp")
                .forward(request, response);
            return;
        }
    try {
        NewsItem news_item = new NewsItem(
                counter.incrementAndGet(),newsLine.trim());
        newItemsQueue.put(news_item);
    } catch (InterruptedException e) { /*manage exception*/}
}
```

The views: index jsp

- Checks if data structure is in place. If not, tells the user that no event stream is there and ends.



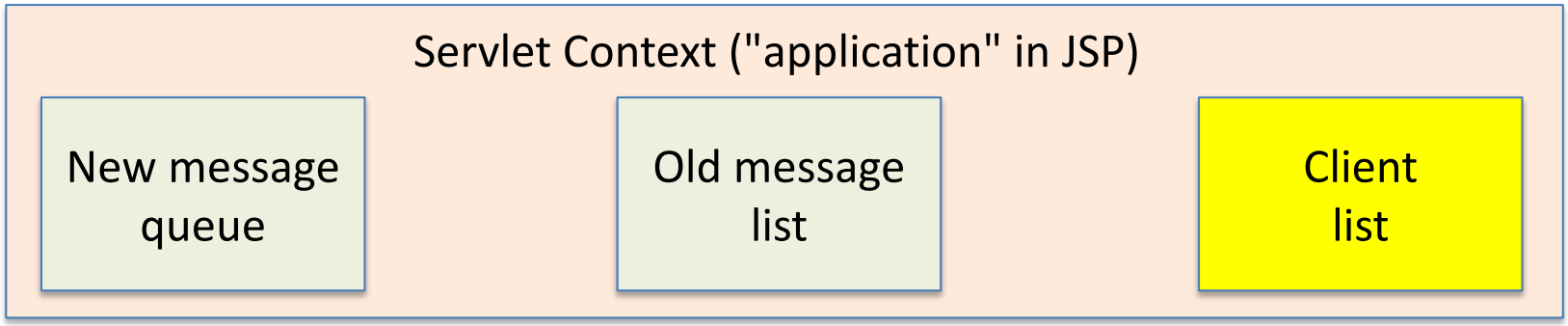
- Prints all old messages
- Starts waiting for new messages:
  - opens an EventSource to the NewsChannelOpener servlet
  - registers a callback for incoming events
  - the callback gets a JSON formatted message and prints it



index.jsp – the JS

```
<script>
    function test() {
        var source = new EventSource(
                        '/SSE_demo/NewsChannelOpenerServlet');
        source.onopen = function(event) {
                console.log("eventsource opened!");
        };
        source.onmessage = function(event) {
            var data = event.data;
            var obj = JSON.parse(data);
            console.log(data);
            document.getElementById('sse').innerHTML +=
                        obj.id+" : "+obj.text + "<br />";
        };
    }
    window.addEventListener("load", test);
</script>
```

The agents: NewsChannelOpener servlet



Mission:

- When new client comes
  - add it to the list
  - setup the response channel

- When called (from index.jsp):
  - initialize the response with the suitable headers
  - create an AsyncContext for the client, and pass to it request and response
  - add it to the Client list

NewsChannelOpenerServlet

```
// Keep a list of all open connections from browsers
   private Map<String, AsyncContext> clientList;

   void addReader(HttpServletRequest request,HttpServletResponse response)
{
      // Create a unique identifier for the client
      final String id = UUID.randomUUID().toString();
      // Start asynchronous context and add listeners
      final AsyncContext ac = request.startAsync(request, response);
      ac.addListener(new AsyncListener() {

      });
      // Put context in a map
      clientList.put(id, ac);
      log("added new client");
   }
```

```
// implement all methods required by the AsyncListener interface
  @Override
  public void onStartAsync(AsyncEvent event) throws IOException {
     // Do nothing
  }
  //in case of completion, error ot timeout remove client
  @Override
  public void onComplete(AsyncEvent event) throws IOException {
     clientList.remove(id);
  }
  @Override
  public void onError(AsyncEvent event) throws IOException {
     clientList.remove(id);
  }
  @Override
  public void onTimeout(AsyncEvent event) throws IOException {
     clientList.remove(id);
  }
```

NewsChannelOpenerServlet

```
protected void doGet(HttpServletRequest request, HttpServletResponse
response) throws ServletException, IOException {
    if (request.getHeader("Accept").equals("text/event-stream")) {
        // setup resonse headers
        response.setContentType("text/event-stream");
        response.setHeader("Cache-Control", "no-cache");
        response.setHeader("Connection", "keep-alive");
        response.setCharacterEncoding("UTF-8");
        // This a Tomcat specific - makes request asynchronous
        request.setAttribute("org.apache.catalina.ASYNC_SUPPORTED",
                             true);
        clientList = (Map<String, AsyncContext>)
                      ctx.getAttribute("clients");
         addReader(request,response);
     } else {
       response.getWriter().println("Sorry, event stream not
                                     supported");
     }
}
```

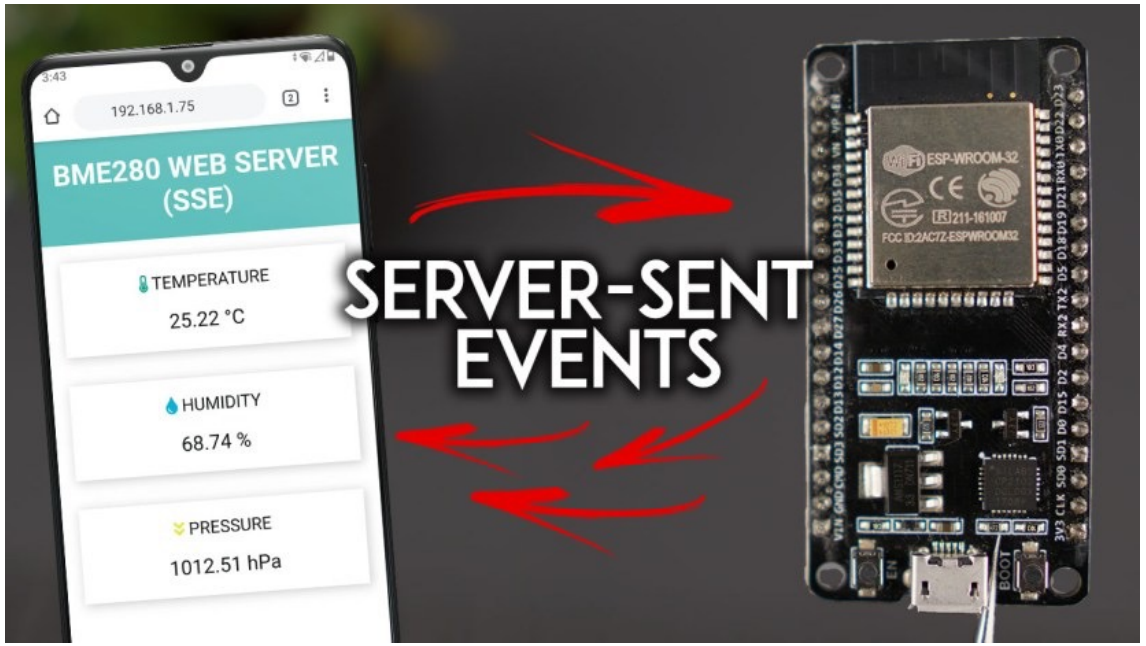
Summary

1) **On the client side, we need to open an EventSource to read data, and to associate to it callbacks to manage data and events received.**

2) **On the server side, we need to create an AsyncContext for every client. When we want to send a message or an event to clients, we do that through its AsyncContext.**

SSE on small devices

The ESP32 is dual core, runs 32 bit programs.
It has Wi-Fi and bluetooth built-in.
The clock frequency can go up to 240MHz and it has a 512 kB RAM.
This particular board has 30 or 36 pins, 15 in each row.
It also has wide variety of peripherals available, like: capacitive touch, ADCs, DACs, UART, SPI, I2C and much more.
It comes with built-in hall effect sensor and built-in temperature sensor.
The ESP32 can be programmed in Arduino IDE, Micropython and more



https://randomnerdtutorials.com/esp32-web-server-sent-events-sse/

Notifications API

Allows web pages to control the display of **system notifications** to the end user.

These are outside the top-level browsing context viewport, so therefore can be displayed even when the user has switched tabs or moved to a different app.

The API is designed to be compatible with existing notification systems, across different platforms.

https://developer.mozilla.org/en-US/docs/Web/API/Notifications_API/Using_the_Notifications_API

Push API

Gives web applications the ability to receive messages pushed to them from a server, whether or not the web app is in the foreground, or even currently loaded, on a user agent.
This lets developers deliver asynchronous notifications and updates to users that opt in, resulting in better engagement with timely new content.

This is an experimental technology, in Firefox merged with Notifications

https://developer.mozilla.org/en-US/docs/Web/API/Push_API