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Session Tracking

Originals of Slides and Source Code for Examples:
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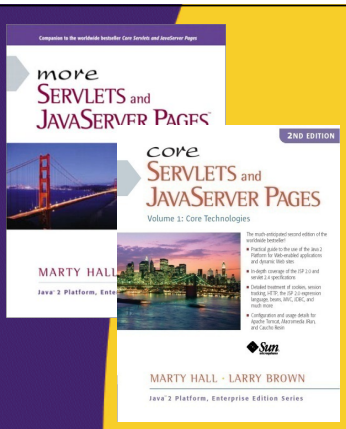

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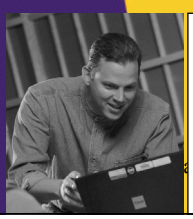

Taught by the author of *Core Servlets and JSP*, *More Servlets and JSP*, and this tutorial. Available at public venues, or customized versions can be held on-site at your organization. Contact hall@coreservlets.com for details.

Agenda

- Implementing session tracking from scratch
- Using basic session tracking
- Understanding the session-tracking API
- Differentiating between server and browser sessions
- Encoding URLs
- Tracking user access counts
- Accumulating user purchases
- Implementing a shopping cart
- Building an online store

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Overview

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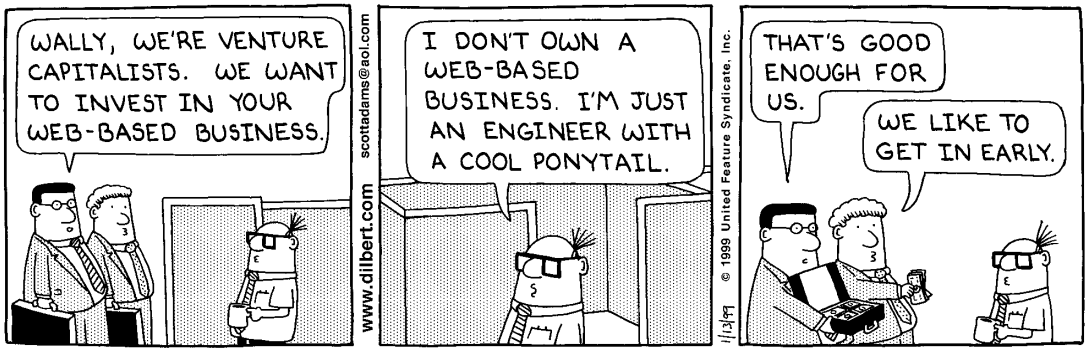
Session Tracking and E-Commerce

- **Why session tracking?**
  - When clients at on-line store add item to their shopping cart, how does server know what's already in cart?
  - When clients decide to proceed to checkout, how can server determine which previously created cart is theirs?



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Rolling Your Own Session Tracking: Cookies

- **Idea: associate cookie with data on server**

```
String sessionID = makeUniqueString();
HashMap sessionInfo = new HashMap();
HashMap globalTable = findTableStoringSessions();
globalTable.put(sessionID, sessionInfo);
Cookie sessionCookie =
  new Cookie("JSESSIONID", sessionID);
sessionCookie.setPath("/");
response.addCookie(sessionCookie);
```

- **Still to be done:**
  - Extracting cookie that stores session identifier
  - Setting appropriate expiration time for cookie
  - Associating the hash tables with each request
  - Generating the unique session identifiers

Rolling Your Own Session Tracking: URL-Rewriting

- **Idea**
  - Client appends some extra data on the end of each URL that identifies the session
  - Server associates that identifier with data it has stored about that session
  - E.g., http://host/path/file.html;jsessionid=1234
- **Advantage**
  - Works even if cookies are disabled or unsupported
- **Disadvantages**
  - Must encode all URLs that refer to your own site
  - All pages must be dynamically generated
  - Fails for bookmarks and links from other sites

Rolling Your Own Session Tracking: Hidden Form Fields

- **Idea:**

```
<INPUT TYPE="HIDDEN" NAME="session" VALUE="...">
```

- **Advantage**
  - Works even if cookies are disabled or unsupported
- **Disadvantages**
  - Lots of tedious processing
  - All pages must be the result of form submissions

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The Java Session-Tracking API

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Session Tracking Basics

- **Access the session object**
  - Call request.getSession to get HttpSession object
    - This is a hashtable associated with the user
- **Look up information associated with a session.**
  - Call getAttribute on the HttpSession object, cast the return value to the appropriate type, and check whether the result is null.
- **Store information in a session.**
  - Use setAttribute with a key and a value.
- **Discard session data.**
  - Call removeAttribute discards a specific value.
  - Call invalidate to discard an entire session.

Session Tracking Basics: Sample Code

```
HttpSession session = request.getSession();
synchronized(session) {
  SomeClass value =
    (SomeClass)session.getAttribute("someID");
  if (value == null) {
    value = new SomeClass(...);
  }
  doSomethingWith(value);
  session.setAttribute("someID", value);
}
```

If SomeClass is a mutable data structure (i.e., you didn't call "new", but just modified the existing object, and you are using a normal (non distributed) application, then the call to setAttribute could be inside the if statement. But if it is an immutable data structure (i.e., you really created a new object, not modified the old one) or you are on a distributed/clustered app, you need to call setAttribute after modifying the value. Since it can't hurt to do this anyhow, it is a good practice to put the call to setAttribute after the part that modifies the session data.

To Synchronize or Not to Synchronize?

- **The J2EE blueprints say not to bother**
  - There are no race conditions when multiple *different* users access the page simultaneously
  - On the face of it, it seems practically impossible for the same user to access the session concurrently
- **The rise of Ajax makes synchronization important**
  - With Ajax calls, it is actually quite likely that two requests from the same user could arrive concurrently
- **Performance tip**
  - Don't do "synchronized(this)"!
    - Use the session or perhaps the value from the session as the label of the synchronized block

What Changes if Server Uses URL Rewriting?

- **Session tracking code:**
  - No change
- **Code that generates hypertext links back to same site:**
  - Pass URL through response.encodeURL.
    - If server is using cookies, this returns URL unchanged
    - If server is using URL rewriting, this appends the session info to the URL
    - E.g.:

```
String url = "order-page.html";
url = response.encodeURL(url);
```

- **Code that does sendRedirect to own site:**
  - Pass URL through response.encodeRedirectURL

HttpSession Methods

- **getAttribute**
  - Extracts a previously stored value from a session object. Returns null if no value is associated with given name.
- **setAttribute**
  - Associates a value with a name. Monitor changes: values implement HttpSessionBindingListener.
- **removeAttribute**
  - Removes values associated with name.
- **getAttributeNames**
  - Returns names of all attributes in the session.
- **getId**
  - Returns the unique identifier.

HttpSession Methods (Continued)

- **isNew**
  - Determines if session is new to *client* (not to *page*)
- **getCreationTime**
  - Returns time at which session was first created
- **getLastAccessedTime**
  - Returns time at which session was last sent from client
- **getMaxInactiveInterval, setMaxInactiveInterval**
  - Gets or sets the amount of time session should go without access before being invalidated
- **invalidate**
  - Invalidates current session

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Storing Simple Values

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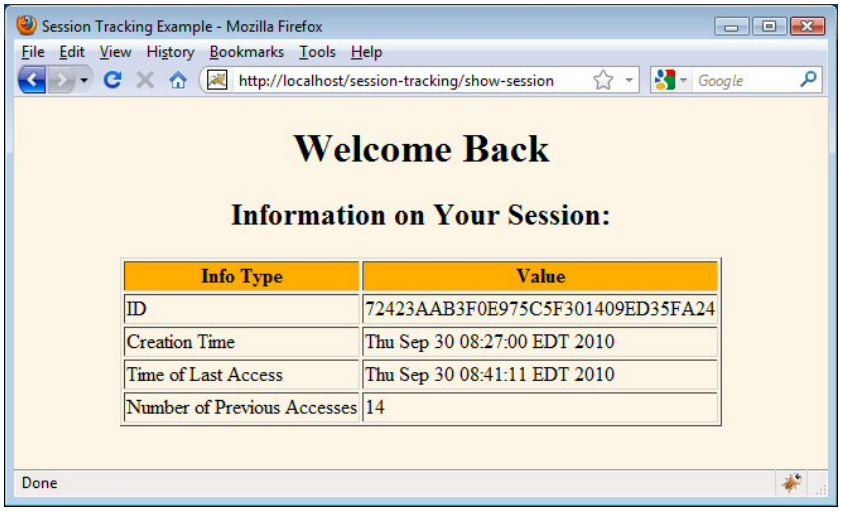
A Servlet that Shows Per-Client Access Counts

```
@WebServlet("/show-session")
public class ShowSession extends HttpServlet {
  @Override
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    response.setContentType("text/html");
    HttpSession session = request.getSession();
    synchronized(session) {
      String heading;
      Integer accessCount =
        (Integer)session.getAttribute("accessCount");
      if (accessCount == null) {
        accessCount = 0;
        heading = "Welcome, Newcomer";
      } else {
        heading = "Welcome Back";
        accessCount = accessCount + 1;
      }
      session.setAttribute("accessCount", accessCount);
```

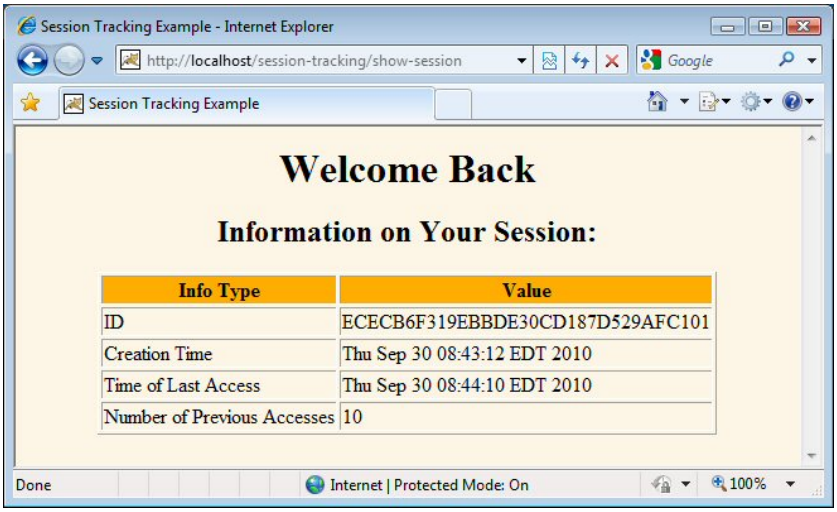

A Servlet that Shows Per-Client Access Counts (Continued)

```
    PrintWriter out = response.getWriter();
    …
    out.println
      (docType +
       "<HTML>\n" +
       "<HEAD><TITLE>" + title + "</TITLE></HEAD>\n" +
       "<BODY BGCOLOR=\"#FDF5E6\">\n" +
       "<CENTER>\n" +
       "<H1>" + heading + "</H1>\n" +
       "<H2>Information on Your Session:</H2>\n" +
       "<TABLE BORDER=1>\n" +
       "<TR BGCOLOR=\"#FFAD00\">\n" +
       "  <TH>Info Type<TH>Value\n" +
       …
       "  <TD>Number of Previous Accesses\n" +
       "  <TD>" + accessCount + "\n" +
       "</TABLE>\n" +
       "</CENTER></BODY></HTML>");
  }
```

A Servlet that Shows Per-Client Access Counts: User 1



A Servlet that Shows Per-Client Access Counts: User 2



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Storing Lists of Values

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Aside: Compilation Warnings re Unchecked Types

- **HttpSession does not use generics**
  - Since it was written pre-Java5. So, following is illegal:

```
HttpSession<ArrayList<String>> session =
  request.getSession();
```

- **Typecasting to a generic type results in a compilation warning**

```
HttpSession session = request.getSession();
List<String> listOfBooks =
  (List<String>)session.getAttribute("book-list");
```

  …
    - The warning is correct, since Java cannot verify that List contains only Strings. Still compiles and runs, but warning is annoying. You don't want to get in habit of ignoring warnings.
- **You can suppress warnings**
  - Put the following before line of code that does typecast:

```
@SuppressWarnings("unchecked")
```

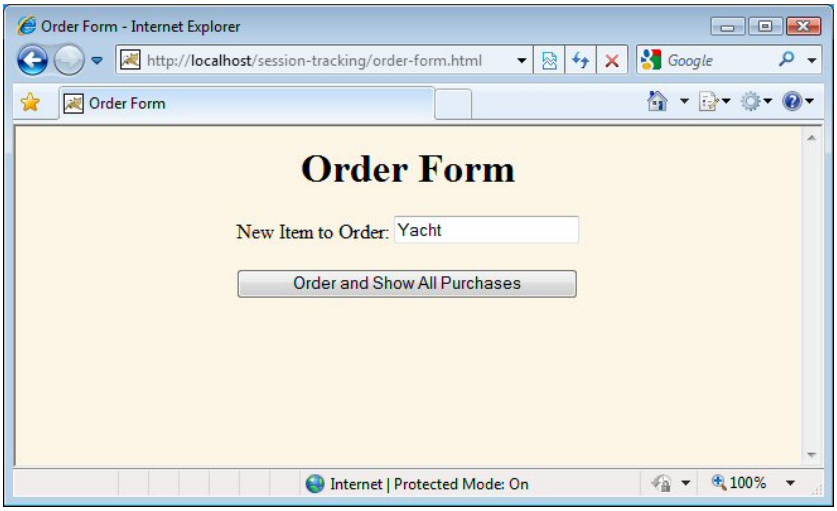
Accumulating a List of User Data

```
@WebServlet("/show-items")
public class ShowItems extends HttpServlet {
  public void doPost (HttpServletRequest request,
                      HttpServletResponse response)
      throws ServletException, IOException {
    HttpSession session = request.getSession();
    synchronized(session) {
      @SuppressWarnings("unchecked")
      List<String> previousItems =
        (List<String>)session.getAttribute("previousItems");
      if (previousItems == null) {
        previousItems = new ArrayList<String>();
      }
      String newItem = request.getParameter("newItem");
      if ((newItem != null) &&
          (!newItem.trim().equals(""))) {
        previousItems.add(newItem);
      }
      session.setAttribute("previousItems", previousItems);
```

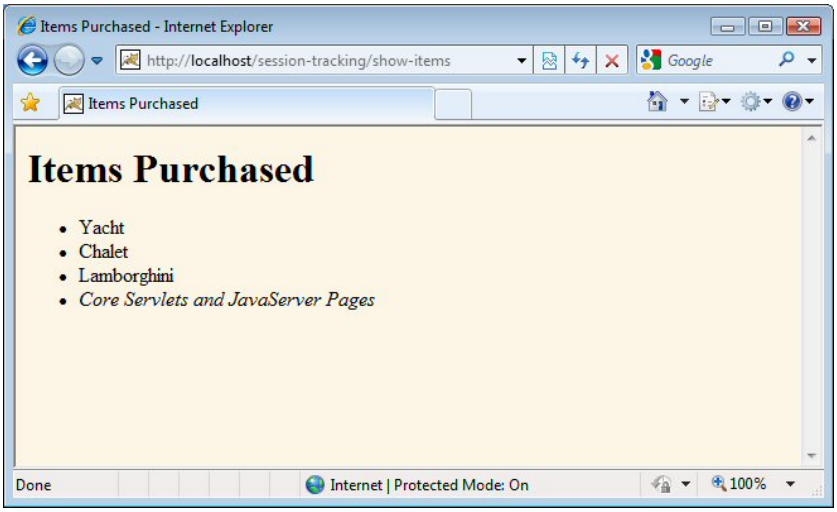

Accumulating a List of User Data (Continued)

```
    response.setContentType("text/html");
    PrintWriter out = response.getWriter();
    String title = "Items Purchased";
    String docType =
      "<!DOCTYPE HTML PUBLIC \"-//W3C//DTD HTML 4.0 " +
      "Transitional//EN\">\n";
    out.println(docType +
                "<HTML>\n" +
                "<HEAD><TITLE>" + title + "</TITLE></HEAD>\n" +
                "<BODY BGCOLOR=\"#FDF5E6\">\n" +
                "<H1>" + title + "</H1>");
    if (previousItems.size() == 0) {
      out.println("<I>No items</I>");
    } else {
      out.println("<UL>");
      for(String item: previousItems) {
        out.println("  <LI>" + item);
      }
      out.println("</UL>");
    }
    out.println("</BODY></HTML>");
  }
}}
```

Accumulating a List of User Data: Front End



Accumulating a List of User Data: Result



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Advanced Features

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Distributed and Persistent Sessions

- **Some servers support distributed Web apps**
  - Load balancing used to send different requests to different machines. Sessions should still work even if different hosts are hit.
    - On many servers, you must call setAttribute to trigger replication
  - This is a tradeoff: session duplication can be expensive, but gives you better load balancing
- **Some servers suport persistent sessions**
  - Session data written to disk and reloaded when server is restarted (as long as browser stays open). Very important for web4!
    - Tomcat 5 through 7 support this
- **To support both, make session data Serializable**
  - Classes should implement the java.io.Serializable interface
  - There are no methods in this interface; it is just a flag:

```
public class MySessionData implements Serializable
  ...
}
```

  - Builtin classes like String and ArrayList are already Serializable

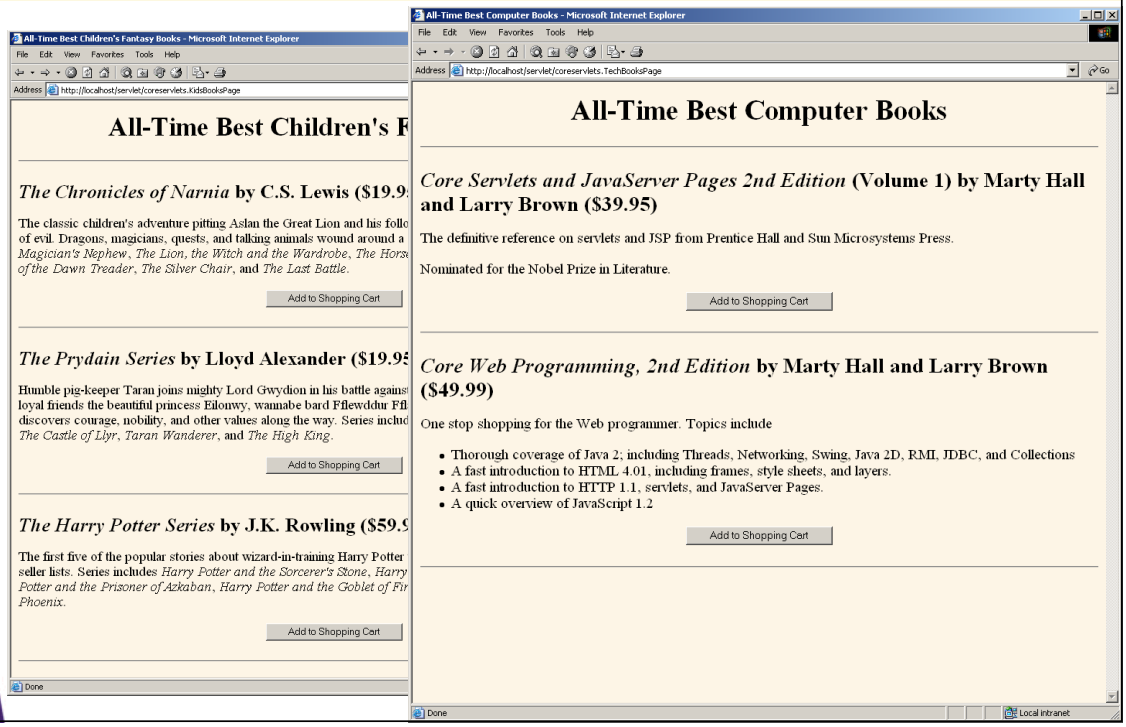
Letting Sessions Live Across Browser Restarts

- **Issue**
  - By default, Java sessions are based on cookies that live in the browser's memory, but go away when the browser is closed. This is often, but not always, what you want.
- **Solution**
  - Explicitly send out the JSESSIONID cookie.
    - Do this at the beginning of the user's actions
    - Call setMaxAge first
- **Problem**
  - Using a cookie with a large maxAge makes no sense unless the session timeout (inactiveInterval) is also large
  - An overly large session timeout can waste server memory

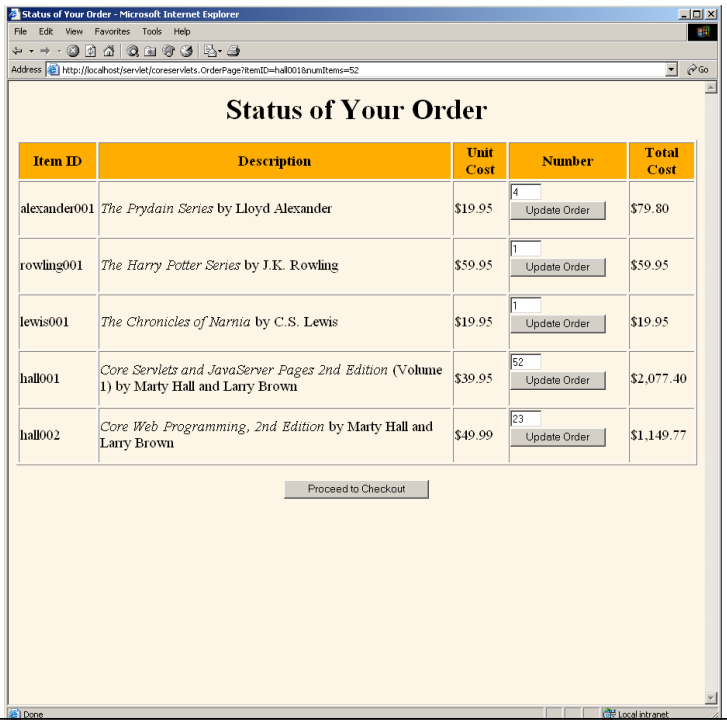
An On-Line Bookstore

- **Session tracking code stays the same as in simple examples**
- **Shopping cart class is relatively complex**
  - Identifies items by a unique catalog ID
  - Does not repeat items in the cart
    - Instead, each entry has a count associated with it
    - If count reaches zero, item is deleted from cart
- **Pages built automatically from objects that have descriptions of books**

An On-Line Bookstore



An On-Line Bookstore



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Wrap-up

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Summary

- **Sessions do not travel across network**
  - Only unique identifier does
- **Get the session**
  - request.getSession
- **Extract data from session**
  - session.getAttribute
    - Do typecast and check for null
    - If you cast to a generic type, use @SuppressWarnings
- **Put data in session**
  - session.setAttribute
- **Custom classes in sessions**
  - Should implement Serializable

Summary: Code Template

```
HttpSession session = request.getSession();
synchronized(session) {
  SomeClass value =
    (SomeClass)session.getAttribute("someID");
  if (value == null) {
    value = new SomeClass(...);
  }
  doSomethingWith(value);
  session.setAttribute("someID", value);
}
```


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Questions?

JSF 2, PrimeFaces, Java 7, Ajax, jQuery, Hadoop, RESTful Web Services, Android, Spring, Hibernate, Servlets, JSP, GWT, and other Java EE training

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