CMSC436: Programming Handheld Systems

Fall 2017

Networking

Today’s Topics

Networking

Android networking Classes

Processing HTTP Responses

Networking

Early handheld devices gave us mobility, but had limited connectivity

Today’s devices have greater mobility and connectivity

Today, many applications use data and services via the Internet

Networking

Android includes multiple networking support classes, e.g.,

java.net – (Socket, URL, URLConnection)

Example Application

Sends a request to a networked server for earthquake data

Receives the earthquake data

Displays the requested data

Sending HTTP Requests

Socket

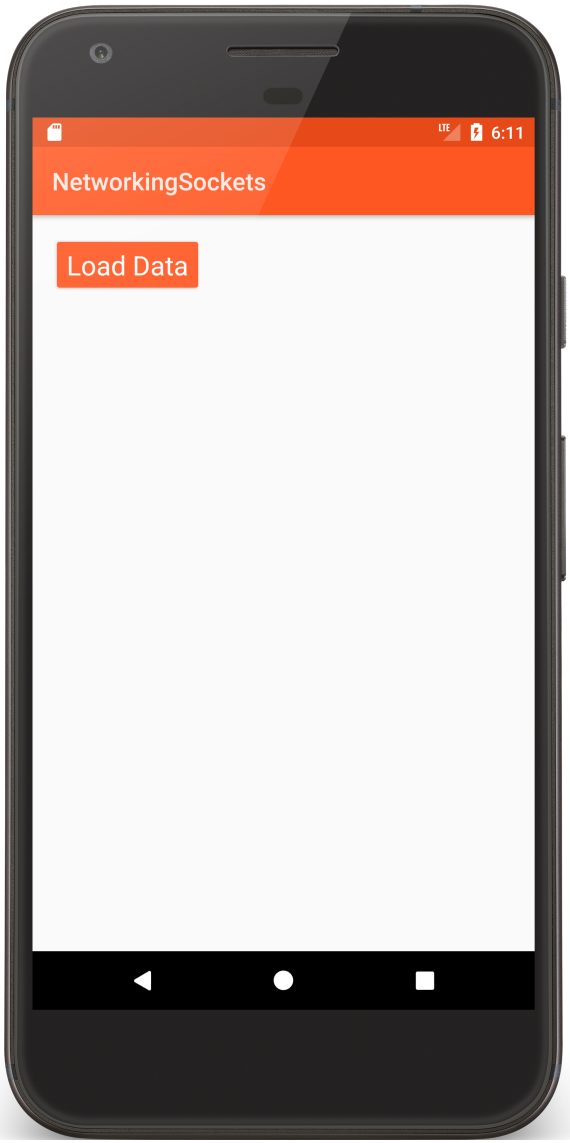
HttpURLConnection

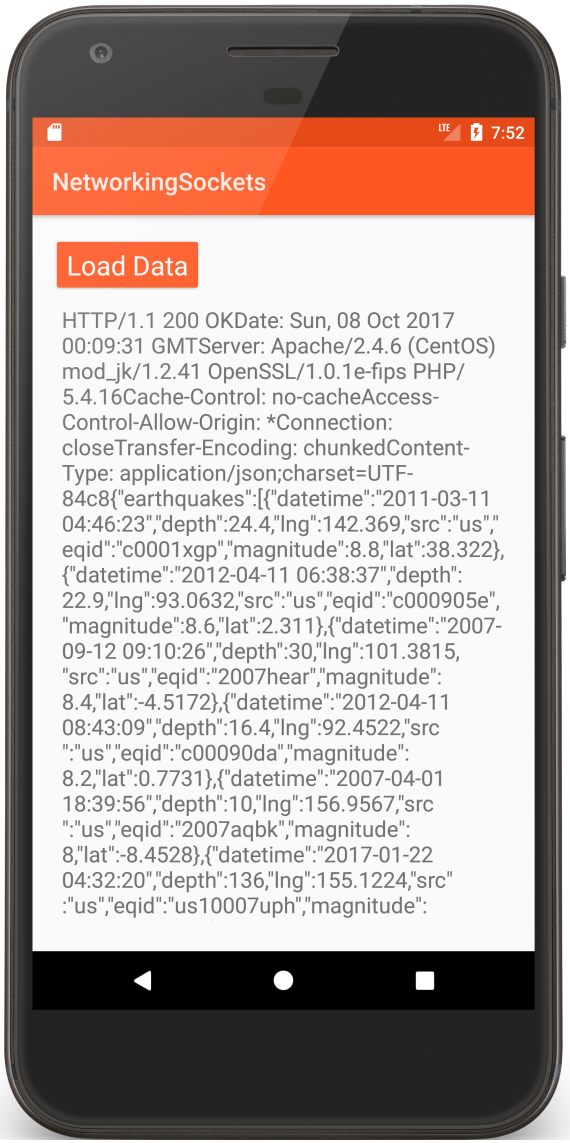
Networking Permissions

Applications need permission to open network sockets

```
<uses-permission android:name=
        "android.permission.INTERNET" />
```

Networking Sockets





```
static class HttpGetTask extends AsyncTask<Void, Void, String> {
    private static final String HOST = "api.geonames.org";
    // Get your own user name at http://www.geonames.org/login
    private static final String USER_NAME = "aporter";
    private static final String HTTP_GET_COMMAND =
    "GET /earthquakesJSON?north=44.1&south=-9.9&east=22.4&west=55.2&username="
          + USER_NAME + " HTTP/1.1" + "\n" + "Host: " + HOST + "\n"
          + "Connection: close" + "\n\n";
    …
    protected String doInBackground(Void... params) {
       Socket socket = null;
       String data = "";
    …
```

```
    try {
        socket = new Socket(HOST, 80);
        PrintWriter pw = new PrintWriter(
                            new OutputStreamWriter(socket.getOutputStream()), true);
        pw.println(HTTP_GET_COMMAND);
        data = readStream(socket.getInputStream());
    } catch (IOException exception) {
        exception.printStackTrace();
    } finally {
            …
    }
    return data;
}
```

```
    private String readStream(InputStream in) {
       BufferedReader reader = null;
       StringBuilder data = new StringBuilder();
       try {
          reader = new BufferedReader(new InputStreamReader(in));
          String line;
          while ((line = reader.readLine()) != null) {
             data.append(line);
          }
       } catch (IOException e) {
          Log.e(TAG, "IOException");
       } finally {
        …
        }
       return data.toString();
    }
…
```

HttpURLConnection

Higher-level than Sockets

Usage Pattern

1. Get an HttpURLConnection
2. Prepare the request
3. Optionally, upload a request body
4. Read the response
5. Disconnect.

Networking URL

```
static class HttpGetTask extends AsyncTask<Void, Void, String> {
   private static final String USER_NAME = "aporter";
   private static final String HOST = "api.geonames.org";
   private static final String URL = "http://" + HOST +
"/earthquakesJSON?north=44.1&south=-9.9&east=-22.4&west=55.2&username="
         + USER_NAME;
…
   protected String doInBackground(Void... params) {
      String data = null;
      HttpURLConnection httpUrlConnection = null;

      try {
        // 1. Get connection. 2. Prepare request (URI)
        httpUrlConnection = (HttpURLConnection) new URL(URL)
              .openConnection();
…
```

```
        // 3. This app does not use a request body
        // 4. Read the response
        InputStream in = new BufferedInputStream(httpUrlConnection.getInputStream());
        data = readStream(in);
    } catch (MalformedURLException exception) {
        Log.e(TAG, "MalformedURLException");
    } catch (IOException exception) {
        Log.e(TAG, "IOException");
    } finally {
        if (null != httpUrlConnection) {
            // 5. Disconnect
            httpUrlConnection.disconnect();
        }
    }
    return data;
}
```

Processing Http Responses

Will focus on two popular formats:

- JSON
- XML

Javascript Object Notation (JSON)

A lightweight data interchange format

Data packaged in two types of structures:

- Maps of key/value pairs
- Ordered lists of values

See: http://www.json.org/

Earthquake Data Request (JSON)

http://api.geonames.org/earthquakesJSON?north=44.1&south=-9.9&east=-22.4&west=55.2&username=demo

JSON Response

{"earthquakes”: [

{"eqid":"c0001xgp","magnitude":8.8,"lng":142.369, "src":"us”, "datetime":"2011-03-11 04:46:23","depth":24.4,"lat":38.322}

{"eqid":"2007hear","magnitude":8.4,"lng":101.3815,src":"us”,"datetime":"2007-09-12 09:10:26","depth": 30,"lat":-4.5172},

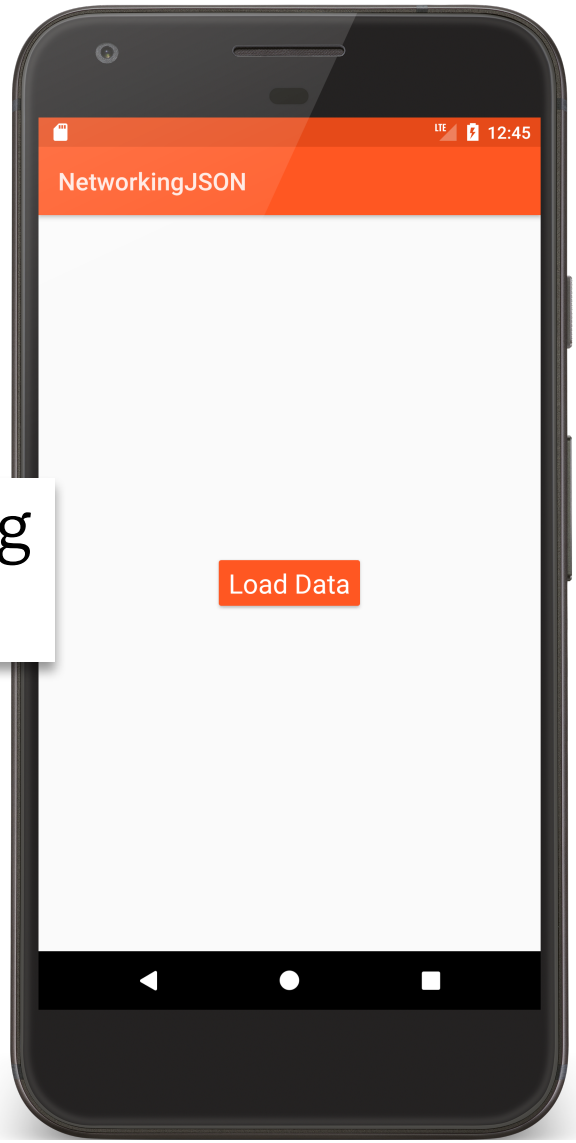
…

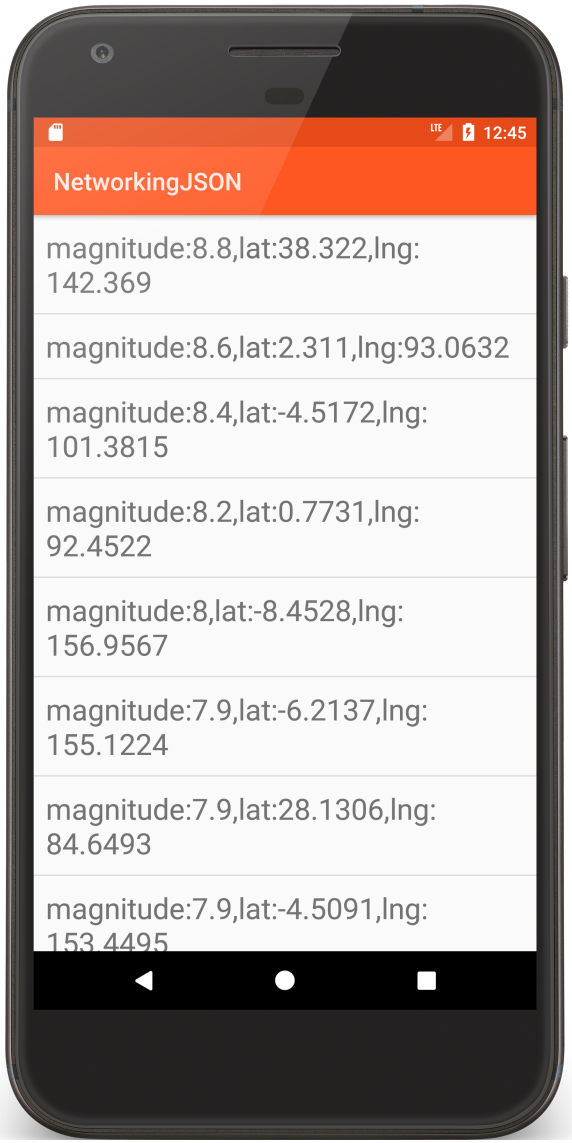
{"eqid":"2010xkbv","magnitude":7.5,"lng":91.9379,"src":"us”,"datetime":”2010-06-12 17:26:50","depth":35,"lat":7.7477}

]

}

Networking JSON





```
protected List<String> doInBackground(Void... params) {
…
  // 1. Get connection.
   //2. Prepare request (URI)
   // 3. This app does not use a request body
   // 4. Read the response
   // 5. Disconnect
   // 6. Parse the JSON-formatted response
    return parseJsonString(data);
}
```

```
private List<String> parseJsonString(String data) {

   String LONGITUDE_TAG = "lng";
   String LATITUDE_TAG = "lat";
   String MAGNITUDE_TAG = "magnitude";
   String EARTHQUAKE_TAG = "earthquakes";

   List<String> result = new ArrayList<>();

   try {
      // Get top-level JSON Object - a Map
      JSONObject responseObject = (JSONObject) new JSONTokener(data).nextValue();

      // Extract value of "earthquakes" key -- a List
      JSONArray earthquakes = responseObject.getJSONArray(EARTHQUAKE_TAG);
…
```

```
        …
        // Iterate over earthquakes list
        for (int idx = 0; idx < earthquakes.length(); idx++) {
            // Get single earthquake mData - a Map
            JSONObject earthquake = (JSONObject) earthquakes.get(idx);
            // Summarize earthquake mData as a string and add it to result
            result.add(MAGNITUDE_TAG + ":"+ earthquake.get(MAGNITUDE_TAG) + ","
                    + LATITUDE_TAG + ":"+ earthquake.getString(LATITUDE_TAG) + ","
                    + LONGITUDE_TAG + ":"+ earthquake.get(LONGITUDE_TAG));
        }
    } catch (JSONException e) {
        e.printStackTrace();
    }
    return result;
}
```

eXtensible Markup Language (XML)

XML documents can contain markup & content

Markup encodes a description of the document's storage layout and logical structure

Content is everything else

See http://www.w3.org/TR/xml

Earthquake Data (XML)

http://api.geonames.org/earthquakes?north=44.1
&south=-9.9&east=-22.4&
west=55.2& username=demo

XML Response

```
<geonames>
  <earthquake>
    <src>us</src>
    <eqid>c0001xgp</eqid>
    <datetime>2011-03-11 04:46:23</datetime>
    <lat>38.322</lat>
    <lng>142.369</lng>
    <magnitude>8.8</magnitude>
    <depth>24.4</depth>
  </earthquake>
...
</geonames>
```

Parsing XML

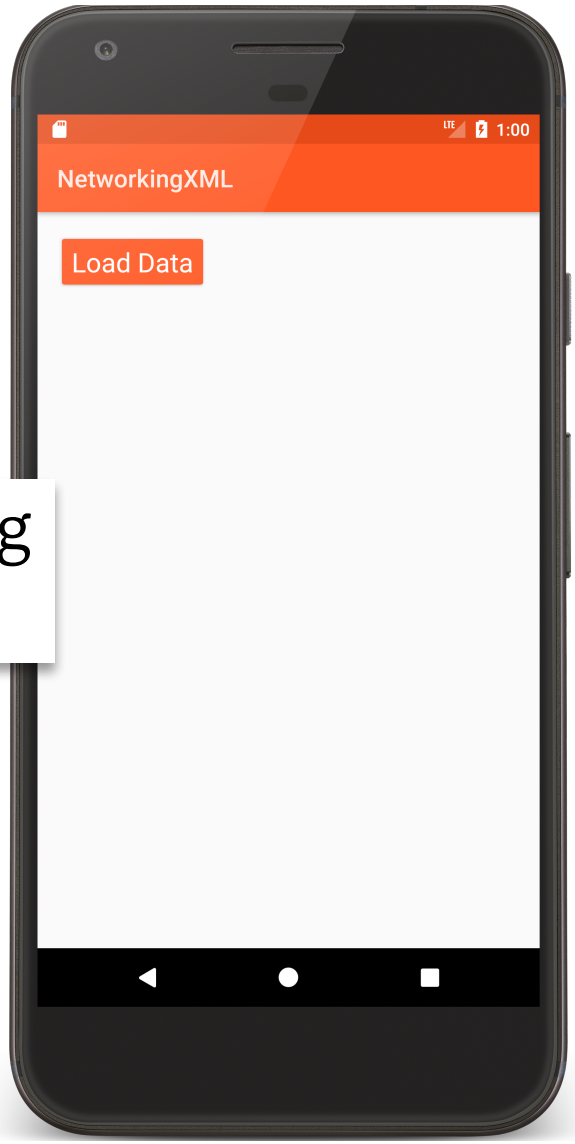
Several types of parsers available

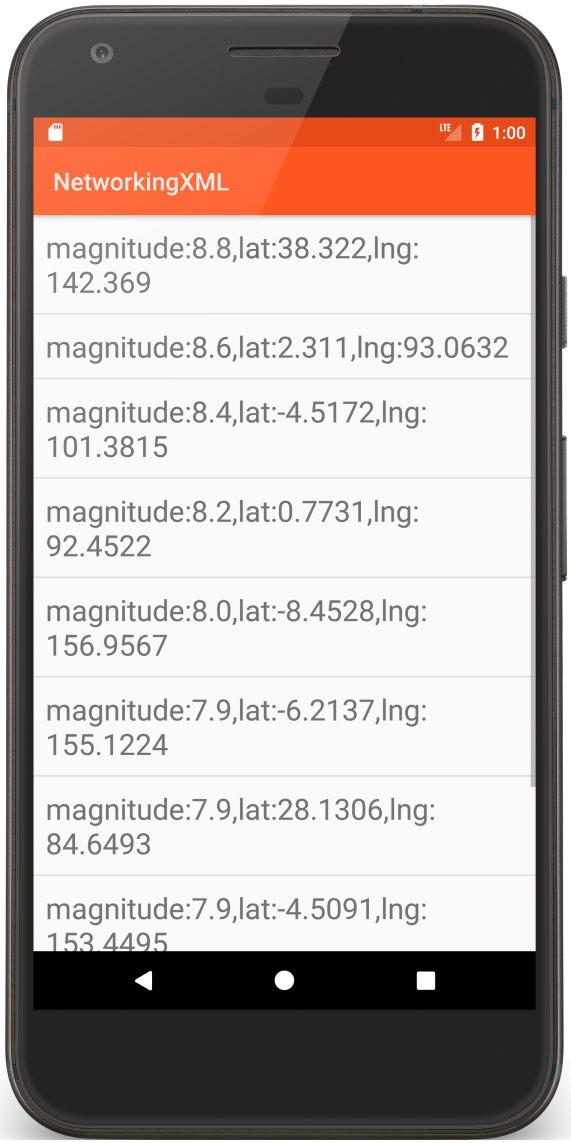
DOM – Converts document into a tree of nodes

SAX – streaming with application callbacks

Pull – Application iterates over XML entries

Networking XML





```
private List<String> parseXmlString(String data) {
    try {
      // Create the Pull Parser
      XmlPullParser xpp = XmlPullParserFactory.newInstance().newPullParser();
      xpp.setInput(new StringReader(data));
      // Get the first Parser event and start iterating over the XML document
      int eventType = xpp.getEventType();
      while (eventType != XmlPullParser.END_DOCUMENT) {
        if (eventType == XmlPullParser.START_TAG) { startTag(xpp.getName());}
        else if (eventType == XmlPullParser.END_TAG) { endTag(xpp.getName());}
        else if (eventType == XmlPullParser.TEXT) { text(xpp.getText());}
        eventType = xpp.next();
      }
      return mResults;
  …
```

```
private void startTag(String localName) {
      switch (localName) {
         case LATITUDE_TAG:
            mIsParsingLat = true; break;
         case LONGITUDE_TAG:
            mIsParsingLng = true; break;
         case MAGNITUDE_TAG:
            mIsParsingMag = true; break;
      }
   }

   private void text(String text) {
      if (mIsParsingLat) { mLat = text.trim(); }
      else if (mIsParsingLng) { mLng = text.trim(); }
      else if (mIsParsingMag) { mMag = text.trim(); }
   }
```

```
  private void endTag(String localName) {
    switch (localName) {
      case LATITUDE_TAG:
        mIsParsingLat = false; break;
      case LONGITUDE_TAG:
        mIsParsingLng = false; break;
      case MAGNITUDE_TAG:
        mIsParsingMag = false; break;
      case EARTHQUAKE_TAG:
        mResults.add(MAGNITUDE_TAG + ":" + mMag + "," + LATITUDE_TAG + ":"
            + mLat + "," + LONGITUDE_TAG + ":" + mLng);
        mLat = null;
        mLng = null;
        mMag = null;
        break;
    }
  }
…
```

Next Time

Data Management