Mashups have emerged as an innovative software trend that re-interprets existing Web building blocks and leverages the composition of individual components in novel, value-adding ways. Additional appeal also derives from their potential to turn non-programmers into developers. Daniel and Matera have written the first comprehensive reference work for mashups. They systematically cover the main concepts and techniques underlying mashup design and development, the synergies among the models involved at different levels of abstraction, and the way models materialize into composition paradigms and architectures of corresponding development tools. The book deliberately takes a balanced approach, combining a scientific perspective on the topic with an in-depth view on relevant technologies. To this end, the first part of the book introduces the theoretical and technological foundations for designing and developing mashups, as well as for designing tools that can aid mashup development. The second part then focuses more specifically on various aspects of mashups. It discusses a set of core component technologies, core approaches, and architectural patterns, with a particular emphasis on tool-aided mashup development exploiting model-driven architectures. Development processes for mashups are also discussed, and special attention is paid to composition paradigms for the end-user development of mashups and quality issues. Overall, the book is of interest to a wide range of readers. Students, lecturers, and researchers will find a comprehensive overview of core concepts and technological foundations for mashup implementation and composition. Even without low-level coding details, practitioners like software architects will find guidance on key implementation concepts, architectural patterns, and development tools and approaches. A related website provides additional teaching material which can be used either as part of a course or for self-study.

This book is timely, provides a thorough scientific investigation and also has practical relevance in the general area of composition and mashups. It is of particular interest to researchers and professionals wishing to learn about relevant concepts and techniques in service mashups, composition, and end-user programming.

From the Preface by Boualem Benatallah, University of New South Wales, Sydney
the development of mashups is a component like the one modeled in Figure 5.1, which supports the reuse of either data or business logic (via a dedicated operation), a piece of user interface, or both.

Fig. 5.1 The most basic component model consists of either one operation that can be invoked or of a piece of UI that can be rendered, or of both.
The service’s business protocol specifies the order in which operations can be invoked.

For synchronous communications

For asynchronous communications

Fig. 5.2 Conceptual model of a web service consisting of a set of four different types of message-based operations.
The business protocol is discovered incrementally by navigating links to resources.

Fig. 5.3 Model of a RESTful web service delivering representations of and manipulating resources in response to standard HTTP requests.
Fig. 5.4 Model of a typical JavaScript API. The gray shaded entity is not part of the actual component model; it tells which artifacts the developer must deploy, in order to be able to use the library. Pure logic components do not have a user interface.
<rss version="2.0">
  <channel>
    <title>Liftoff News</title>
    <link>http://liftoff.msfc.nasa.gov/</link>
    <description>Liftoff to Space Exploration.</description>
    ...
    <item>
      <title>Star City</title>
      <description>
        How do Americans get ready to work with Russians aboard the International Space Station? They take a crash course in culture, language and protocol at Russia’s <a href="http://howe.iki.rssi.ru/GCTC/gctc_e.htm">Star City</a>.
      </description>
      <pubDate>Tue, 03 Jun 2003 09:39:21 GMT</pubDate>
      <guid>http://liftoff.msfc.nasa.gov/2003/06/03.html#item573</guid>
    </item>
    ...
  </channel>
</rss>

**Fig. 5.5** An excerpt of the RSS 2.0 news example by the RSS Advisory Board ([http://www.rssboard.org/files/sample-rss-2.xml](http://www.rssboard.org/files/sample-rss-2.xml)).
The model of an RSS feed is simplified version of the model we presented for RESTful web services (see Figure 5.3).
The business protocol is regulated by the Atom Publishing Protocol specification.

The media type and the schema are fixed by the Atom Syndication Format standard.

The media type and the schema are fixed by the Atom Syndication Format standard.

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The interactive point-and-click data extraction canvas allowing the user to select and deselect HTML elements for data extraction.

Overview of the steps of the data extraction process.

Selected content to be extracted.

A preview of the data that can be extracted from the source web page with the user’s current selection.

The list of identified and named data items to be extracted.

Fig. 5.8 Screen shot of the Dapper content extraction tool in action: interactive extraction of data from the New York Times web site and publication as RSS feed.
Fig. 5.9 An excerpt of HTML markup annotated with the hCard micro-format for annotating contact details. hCard uses class names to identify its elements.
**Fig. 5.10** The Linking Open Data cloud diagram by Richard Cyganiak and Anja Jentzsch (http://lod-cloud.net/) visualizing the interrelations among the datasets that have been published in Linked Data format.
### 5.5 User Interface Components

<table>
<thead>
<tr>
<th>Source file</th>
<th>Name</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Java portlet</td>
<td>Name</td>
<td>Package</td>
</tr>
<tr>
<td>contains</td>
<td>Configuration document</td>
<td>deployed as</td>
</tr>
<tr>
<td>1..N</td>
<td>1..N</td>
<td>1..N</td>
</tr>
</tbody>
</table>

#### Operation

- init
- destroy
- processAction
- render

- produces 1..N
- has 1..N

#### Portlet mode

- represents 1..N
- encodes 1..N

#### User interface

- Content

#### Content

- produces 1..N

#### User interface

- Portlet mode

---

**Fig. 5.11** Model of a Java portlet UI component according to JSR 168 [1].
The portlet container also manages the deployment of the portlet (local to the container), which comes as package containing the source files implementing the portlet. Two configuration documents (web.xml for web resources and portlet.xml for portlet-related resources) configure the portlet. Being instantiated inside the portlet container, portlets are typically stateful. The order of invocation of the operations depends on the user interface exposed to the users, which enact them by interacting with the UI.

The original JSR 168 specification suffered of two main shortcomings. First portlets lacked any mechanism for the inter-portlet communication, i.e., for communication between two portlets inside a portal. Developers had therefore to implement own extensions (e.g., using the so-called portal context) if there was a need to have portlets interact with each other. Second, only portlets that were installed locally in the portlet container could be used in the portal running on top of the container.

The JSR 286 specification (portlet specification version 2.0) eventually provided an answer to the first shortcoming by introducing three different techniques: shared session and render parameters for the sharing of simple parameter-value pairs with user session and navigation information and portlet events for the sharing of generic Java objects (see Figure 5.12). The Web Services for Remote Portlets specification provided an answer to the

Fig. 5.12 Extended model of a Java portlet according to JSR 286 [143] with a the possibility to share session and render parameters, to launch events, and to process events via the processEvent operation.
second shortcoming by standardizing a protocol for the interaction with remote portlets accessed via SOAP web services. The integration of remote portlets still occurs inside the web server running the portal. Today, portlets are therefore described in one of two ways: either via an XML deployment descriptor for locally deployed portlets or via a WSDL descriptor for remote portlets.

5.5.3 Widgets and gadgets

One recently standardized UI componentization technology for the client side is W3C widgets, which are similar to OpenSocial gadgets, Google gadgets (https://developers.google.com/gadgets/), or Yahoo! widgets (http://widgets.yahoo.com/, discontinued since April 2012). W3C widgets are simple, but full-fledged, client-side web applications that are similar in appearance to Java portlets. Widgets are JavaScript-based and, hence, locally running applications; the use of AJAX, however, allows them to interact with own server-side application logic, possibly providing them with advanced computing or data features.

**Fig. 5.13** Model of a W3C widget. In white the actual component model; in gray the artifacts of the component.
Fig. 5.14 Model of a W3C widget with inter-widget communication extension [277].
An assisted approach to UI component extraction that makes use of micro-formats to annotate source applications is proposed in [96]. The approach uses an abstract component descriptor in the mashArt Description Language (MDL) [90] to describe an applications inter-communication capabilities, a micro-format (the mashArt Event Annotation - MEA) for the annotation of the application with events and operations, and a generic wrapper structure able to support the runtime componentization of the application, producing UI components according to the model illustrated in Figure 5.15, which is conceptually similar to the one of JavaScript UI components (see Figure 5.4).

5.6 Real-Time Streaming Components

The last type of components we discuss are real-time streaming components, e.g., for the communication of audio and video streams. So far, all component types described featured discrete media types (for remote components) or function outputs (for local components). Some of the technologies described, for instance, SOAP web services or JavaScript APIs, could also be used for the implementation of "streams" of data chunks (e.g., sensor readings coming from a wireless sensor network) by periodically sending data from a source component to a sink (e.g., using notification operations or events). We use quotation marks to emphasize the difference of this kind of stream from the streams we discuss in this section, which instead are based on an application-layer protocol that manages the stream of data on behalf of the component and that is alternative to HTTP (which is instead used by the remote components discussed so far).

**Fig. 5.15** The mashArt UI component model for UI components extracted from web applications annotated with the mashArt Event Annotation [96].
5.6 Real-Time Streaming Components

### Media stream

- **Name**
- **URL**

### Streaming resource

### Control signal

Parameter

- **Name**
- **Type**

Control signals control the state of the streaming channel. Which signal can be used when depends on the state of the channel.

---

**Fig. 5.16** Model of a real-time multimedia streaming component.
Control signals control the state of the streaming channel (one per participant). Which signal can be used when depends on the state of the respective channel.

The session identifier must be shared with all participants to allow them to connect to the right instance of conference.

**Fig. 5.17** Simplified model of a telco streaming component for audio/video conferencing with a shared session and multiple participants (streaming channels).
Control signals control the state of the streaming channel (one per participant). Which signal can be used when depends on the state of the respective channel.

The session identifier must be shared with all participants to allow them to connect to the right instance of conference.

Fig. 5.17 Simplified model of a telco streaming component for audio/video conferencing with a shared session and multiple participants (streaming channels).

5.7 Summary and Bibliographic Notes

It is simply not possible to condense into fewer pages all the different component technologies and models, which are the foundation of the mashup ecosystem and strongly influence the content of the chapters to follow. In this chapter we tried to describe the technologies as concisely as possible, yet the number of technologies to describe just grew during the chapter writing – and we were not able to discuss all of them. However, this is exactly what characterizes mashups in the first place, i.e., the huge variety and heterogeneity of component technologies and models one may have to master and conciliate when developing a mashup.

The goal of this chapter is therefore to introduce the reader to a representative spectrum of component technologies and to highlight conceptual similarities and differences. For this purpose, we introduced a set of component characteristics that capture the most important aspects about how to use components. Figure 5.18 recalls the characteristics.

Fig. 5.18 Summary of the component characteristics that impact on the way components are to be used and, hence, on how they can be integrated with each other.