

x-project: a document-oriented toolkit to design and implement Web Applications based on HTML5 Web Components

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ABSTRACT

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CCS Concepts

•Information systems → Web applications; •Applied computing → Cartography; Format and notation; •Computer systems organization → Client-server architectures; Real-time system architecture;

1. INTRODUCTION

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Section 2 presents the context where **x-project** is positioned, overviewing the CMS evolution; section 3 introduces **x-project**, its philosophy and architecture. Section 4 shows a case study in which is implemented a blog using x-project toolkit. Finally, section 5 draws conclusions.

One generally accepted definition of Content Management System is: a system that lets you apply management principles to content.

It is simple to elicit an evolutionary path in the history of management systems whose milestones are identifiable in *Joomla!*, *Wordpress* and *KeystoneJS*.

Alongside these milestones entire constellations of analogous experiences popped up, but we considered them not relevant since they borrowed main features and constitutive approaches from cited ones.

Starting from *Joomla!*, a framework that drove in the engineering into the world of web content management. Joomla! powers more than 2,7% of the largest 1,000,000 web sites in the world [13]. Anyway, nowadays, *Joomla!* results unwieldy and, due to its monolithic approach, not complied to current web features.

Wordpress, instead is used by more than 23.3% of the top 10 million websites (as of January 2015) [13]. Wordpress develop CMS's idea, driving in the intention to use CMSs to build Web Application. Wordpress, with its plugin, aims to limber user experience. The availability of more than 37,000 plugins, because it lets to create sites to non-experts too. Anyway, further customizations, other than the ones introduced by plugins, are difficult to deploy due to loosely code engineering of this tool.

Finally, *KeystoneJS* stand in the last position. Minimal and agile, KeystoneJS, embody the new era of the CMS, letting the user to make his own personal web application.

In the spite of focusing on very minimal features, a men-

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tion goes to Ghost, a non-profit, open source blogging Node.js based platform, which represents a transversal experience, although minimal brings a new light way to blogging.

Eventually, **x-project**, for the reasons the will be clear in the remaining of this paper, could be thought as the last standing in this path of decreasing monolithic approach and increasing customization and code engineering.

The remainder of this document is organized as follows. In Section ?? we provide an overview of the state of the art in the field of indoor document standards and related applications. Section ?? is devoted to describe the advances introduced by the novel cartographic document proposed, while section ?? presents the document syntax. Section ?? reports about the toolkit specifically developed to handle the new document format. In Section ?? it is depicted the overall architecture and the implementation of the web based application framework, which is in turn used to achieve the objectives stated above. Section ?? presents a case-study application of the document format discussed in this paper. Finally, Section ?? proposes some conclusive remarks and future developments.

To speed up web application development, frameworks mostly rely on external configuration files and less on procedural code [3].

2. WEB DEVELOPMENT CYCLE

We model the web development process as a four-steps procedure that can be applied recursively to each page (or view) of a web application as well as to every single complex component (or widgets) of the page itself.

This modellization is based on the reasonable assumption that server side operation on data models are nowadays be sufficiently explored, and as proven by the *Keystone.js* experience, at least one choice is available to automatically 1) generate server-side CRUD methods on models with ACL capabilities and 2) handle users and sessions, once a JSON description of data models and relations between them are provided to the system. This very JSON descriptor documents drive the whole process, actually composed by the following four steps.

1st step - JSON data model description. The JSON descriptors must be defined, specifying data type, relation, and user role read/write capabilities on particular portion of data.

2nd step - Model actions definition. Since CRUD operation could not be enough to describe all the needed operation further actions on models can be defined and exposed via http verbs.

3rd step - UI component definition. Then individual UI component can be defined, relying exclusively on CRUD operations and actions available on data models.

4th step - UI component assemblation. As last task, previously defined UI component have to be mounted to define application views. Assembly should be kept as simple as possible, in the case of **x-project** toolkit, it only consists of a juxtaposition of HTML5 tags.

3. ARCHITECTURE

Web applications developed exploiting **x-project** toolkit present are full stack *JavaScript*.

On the server-side they rely on *Node.js*, exploiting the power of the *Loopback* framework by *Strongloop*. As men-

tion above, the aim is to have a development process entirely document-driven, and those documents are the schemas of the models used by the application. These are JSON documents. Each document represents a model and presents the following fields: the **name** of the model, the set of **properties**, the list of **relations** to others models and the list of **ACL** (Access Control Layer) rules.

Loopback generates model's API from the models schemas, to let CRUD operations on models (e.g. a model **Author** that describe a blog author generates the following HTTP RESTful API: **GET** /api/authors/ to get all authors, **POST** /api/authors/ to add a new author, **GET** /api/authors/:author_id and **PUT** /api/authors/:author_id to get (or to update) the author with id "author_id". Since an blog author have blog posts (its model has a relation one-to-many to model **Post**) there are also the API to handle author's posts: **GET** /api/authors/:author_id/posts, etc.

The API can be extended: the developer can add remote functions to models or add hooks to existing APIs to add behaviour before and/or after the API handler (to preprocess the request and/or postprocess the response).

The resulting API is RESTful, cookie free, signed by authentication token.

By default, applications have a built-in model that represent a user, with properties **username**, **email** and **password** for login and the property **role** used by the ACL module.

On the Client-side, developed applications happen to be SPA (single page application) which exploit a variety of technologies, briefly described below.

Web Components are a collection of standards which are working their way through the W3C and landing in browsers at the moment. They allow to bundle markup and styles into custom HTML elements. *Custom Elements*[8], *HTML Imports*[9], *HTML Templates*[10], *Shadow DOM*[11].

webcomponent.js polyfills enable Web Components in (evergreen) browsers that lack native support. Web Components specifications are currently W3C Working Draft, so they aren't fully supported across all major browsers. As these technologies are implemented in browsers, the polyfills will shrink to gain the benefits of native implementations. [7]

Polymer library (<https://www.polymer-project.org/>) provides a thin layer of API on top of web components (native implementations and their polyfills) and several powerful features, such as custom events and delegation, mixins, accessors and component lifecycle functions, that makes it easier and faster to create Web Components. Similar to *Polymer* are *x-tag* and *Bosonic*.

iron-elements [4] is a library of utility Polymer elements from ajax requests to input elements. There are web repositories like <http://component.kitchen> and <http://customelements.io> that already counts thousands of open source user-contributed custom elements.

4. X-PROJECT TOOLKIT

x-project is a set of libraries and API-centric HTML5 Web Components based Web Application and CMS framework.

"Everything is an element", even an AJAX request. Every part of the website is encapsulated inside an element. Even functional components such as HTTP services (AJAX calls), pages and routing logic are encapsulated inside elements.

We push Web Components' philosophy beyond all limits so that users can reach a very high level of customization and ease of use.

Component-based Software Engineering denotes the process of building software by (re)using pre-built software components. The main benefit of component-based software is the "time-to-market" [14], thus reducing the cost of developing the software. A software component is a unit of composition with contractually specified interfaces and explicit context dependencies. Additionally, a component is a software element that conforms to a component model and can be independently deployed and composed [1]. Component based software is developed interconnecting building blocks, therefore, a high degree of reusability and modularity is achieved by this type of applications [6].

4.1 Client-side

Client-side can be divided in two parts: **admin part** and **user part**. **admin part** is automatically generated from the models schemas. It let the admin to manage (via CRUD operations) the models. **user part** depends on the type of the Web Application that has been implemented. It is the part the final user interact with.

x-project provide a set of Polymer element for local routing, API requests, User management, forms composition, layout and style.

4.1.1 Elements for local routing

x-project provide elements to perform local routing to implement Single Page Application pattern.

<x-router> implements local routing based on *HTML5 Push State API*.

<x-route> represents a route-to-page mapping. It has two input attributes: **route** and **page**. A route can be parametrized: parameters are sent as attributes to the corresponding page.

<x-link> is the extension of the native anchor element (**<a>**). It prevents the default behavior, blocking page request to the server and letting to manage the routing locally.

4.1.2 Elements for API requests

x-projects provide a set of elements to handle collections and models API.

<api-collection-get> retrieve a collection of models. It has input attributes to handle filters and pagination and an output attributes that stores the collection.

<api-collection-post> add a new model to the collection. It has an input attribute that refers to the model to save.

<api-collection-schema> retrieve a model schema.

<api-model-(get|put|delete)> retrieve, update or delete a model. These have an input attribute that refers to the model.

For example, the following element perform an HTTP GET request to **/api/Posts** using filter and returning the first 10 items of the second page and the total number of items (helpful for pagination element).

```
1 <api-collection-get name="Posts"
2   perpage="10" page="2" filter="{{filter}}"
3   collection="{{posts}}" count="{{count}}">
4 </api-collection-get>
```

4.1.3 Elements for User management

x-project provides a set of elements to manage User. **<x-login>** is a form (with **email** and **password** input elements) that let the user login in the application. Once logged in, every API request is signed with a token that refers to the current user, for ACL reasons.

4.1.4 Elements for forms composition

x-project provides a set of input elements to create forms.

<x-input>, **<x-textarea>**, **<x-number>**, **<x-date>**, are respectively associated to short text, long text, number, and date; **<x-location>**, based on Google Place APIs, allows to choose locations using autocomplete add-on; **<x-file>**, based on the **x-project** direct upload module, allows to upload files. **<x-form>**, given a model schema, generates a form to edit models that match that schema; it is a composition of the input elements.

4.1.5 Elements for layout and style

x-project provides a set of elements for layout, such as: **<x-page>**, **<x-header>**, **<x-navbar>**, **<x-sidebar>**, **<x-footer>**, respectively to define the structure of the page, to add header, navbar, sidebar and footer.

x-project style is based on **iron-flex-layout** [4], a CSS library of style mixins for cross-platform Flexible Box [12] layouts.

5. CASE STUDY

In this section we discuss the design and the implementation of a blog platform.

5.1 server-side

For a blog platform the entities to model are: **Author**, **Post** and **Tag**.

Post model (defined below) represent a blog post.

```
1 {
2   "name": "Post",
3   "properties": {
4     "title": { "type": "string" },
5     "posted": { "type": "date" },
6     "content": { "type": "text" },
7   },
8   "relations": [{
9     "name": "author",
10    "type": "belongs_to",
11    "model": "Author",
12  }, {
13    "name": "tags",
14    "type": "has_many",
15    "model": "Tag",
16  }]
17 }
```

Tag model represent a tag in a post.

Author model represent a blog author. It has properties that describe an author, such as **full_name**, and one **has_many** relation to **Post** model.

5.2 client-side

Client-side pages are encapsulated in elements that extend **<x-page>** element. These pages can be divided in two parts: Admin and User.

5.2.1 Admin part

The *Admin part* is automatically generated. It consists of the following pages: **<page-collections>**, **<page-collection>**, **<page-model-edit>**.

<page-collections> is the main page. It show the collections of the app. In this case, these are **Authors**, **Posts** and **Tag**.

<page-collection> show the model instances of a collection.

```

1 <page-collection>
2   <api-collection-get
3     name="{{collection_name}}"
4     filter="{{filter}}"
5     collection="{{collection}}">
6   </api-collection-get>
7   <part-collection-filter
8     name="{{collection_name}}"
9     filter="{{filter}}">
10  </part-collection-filter>
11  <part-list
12    list="{{collection}}">
13  </part-list>
14  <part-paginator
15    list="{{list}}"
16    filter="{{filter}}"
17    current="{{page}}">
18  </part-paginator>
19 </page-collection>

```

<page-model-edit> presents the forms to update a model. The form is automatically generated from the model schema. This page is composed by an <api-model-get> element that retrieve the model to edit. The model schema (retrieved with the model) is passed to a <x-form> element that presents an input element for each property of the model. The type of the input element corresponds to the type of the property (e.g. a *boolean* property is editable via a <x-checkbox> element).

5.2.2 User part

The *User part* must be designed by the developer. It consists of the following pages: <page-author>, <page-posts> and <page-post>.

<page-posts> show the list of posts. It use <api-collection-get>, <x-paginator>, and <x-list> to retrieve, paginate and list the posts.

<page-post> show a post. It is accessible via <x-route path="/posts/:post_id" page="page-post">. It use <api-model-get> to retrieve the post using the *post_id* parameter matched in the url.

```

1 <page-post>
2   <api-model-get name="Posts"
3     model-id="{{post_id}}" model="{{post}}">
4   </api-model-get>
5   <h1>{{post.title}}</h1>
6   <h2>by {{post.author}}</h2>
7   <h3>on {{post.date}}</h3>
8   <div>{{post.content}}</div>
9 </page-post>

```

6. CONCLUSION

In the present time open source CMS has gained a big market. Generally all CMSs fulfill common task of content like create, edit, publish. Lots of varieties are available based on functionality and platform, such as *good user support*, *security aspects*, *plug-ins ecosystem*, *documentation*, etc.

[5] propose different performance criteria like *page load time*, *page size*, *number of request*, *number of bootstrap resources files*.

[2] propose about thirty features criteria that could be classified in: *Admin Management*, *Data Management*, *User*

Management, *UI Management*, *Web Content Management*, *Multimedia Data Management*.

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