wrong API example to use. He discovered this when the output of the API looked wrong. He tried to fix it by directly changing the text in the base URL and parameter textboxes, but he finally gave up this approach because he did not want to read the whole documentation. Eventually, he went back to the previous page of the configuration tool to start over by giving a new example. This suggests that our example-driven approach is really helpful for people who do not know web APIs well, but it also suggests that with our design it might be hard to recover from a bad example. The participant suggested providing "examples of example API requests" in the tool to help users identify the right kinds of examples to copy from the documentation. We have now added this to the tool.

Participants suggested other usability issues to improve in the tool, including making any value that is a URL link in the return data clickable and using color coding to make the structure of the JSON data more obvious. We will make these changes to the next version of the configuration tool.

VII. Conclusions and Future Work

We have presented the design of Spinel, a plug-in architecture that allows new data sources to be easily added to mobile applications. The Spinel plug-ins are lightweight JSON files that describe the usage of web APIs and can be quickly generated by the Spinel plug-in configuration tool without programming. Spinel comes with an Android library that reads the plug-ins and allows developers to use them easily in the code of their mobile applications.

Future work could be in many directions. First, we plan to extend the Spinel Android library to accept more return formats from remote data sources, including XML and CSV. Second, we could allow plug-ins to be downloaded and installed directly from the web server instead of requiring users to manually move the file to the phone. Third, we could improve the error handling in the library so that it returns useful error messages to explain why a plug-in is not working for both developers and end users as a means of debugging. Fourth, we could extend the Spinel architecture to make it available for applications on other platforms besides mobile, such as for web applications, since the plug-ins are JSON files that can be easily interpreted across platforms. Last, we could create more applications that demonstrate the usefulness of the Spinel architecture, such as applications that provide customizable visualizations or data merging. Our final goal is to make the Spinel web server a community shared space that hosts many different kinds of Spinel applications created by developers, along with many different Spinel data source plug-ins created by developers and end-user programmers, for people around the world to download and use based on their needs.

Acknowledgements

This material is based upon work funded and supported in part by the Department of Defense under Contract No. FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center. This material has been approved for public release and unlimited distribution. DM-0000249. This work was also funding in part by NSF grant IIS-1116724. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of CMU, the SEI, or the NSF.

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