



HTML5 for Mobile Apps at the Edge

featuring Grace Lewis interviewed by Suzanne Miller

Suzanne Miller: Welcome to the SEI Podcast Series, a production of the Carnegie Mellon University Software Engineering Institute. The SEI is a federally funded research and development center sponsored by the U.S. Department of Defense and operated by Carnegie Mellon University in Pittsburgh, Pennsylvania. A transcript of today's podcast is posted on the SEI website at sei.cmu.edu/podcasts. My name is [Suzanne Miller](#). I am a principal researcher here at the SEI.

Today, I am pleased to introduce you to [Grace Lewis](#), deputy lead for the SEI's [Advanced Mobile Systems Initiative](#) and the Technical Lead for the Edge-Enabled Tactical Systems research team. Her main interests are mobile computing, service-oriented architecture, and cloud computing. Grace has more than 20 years of professional software development experience, mainly in industry, and is also active in mentoring student teams in [Carnegie Mellon University's Masters in Software Engineering Program](#). She is a respected thought leader in pretty much every research area she has been involved with.

I have had the privilege of working with her in the past. I am very glad to have a chance to catch up on her current research today, which is very much in the news if you follow any of the blogs online. Grace has also been interviewed previously on the podcast series and probably will be again. Welcome, Grace.

Grace Lewis: Thank you, Suzy.

Suzanne: Today, Grace and I will be discussing her recent technical report, [Evaluation of the Applicability of HTML5 for Mobile Applications in Resource-Constrained Edge Environments](#). She co-authored this with Bryan Yan.

Grace, I know that a lot of your recent research is about helping soldiers who use smartphones while in battle or, how we say at the SEI, on the [tactical edge](#). For those listeners who have not heard this term previously, why don't we start by explaining to them what the challenges are that soldiers face in a resource-constrained tactical edge environment.



Grace: OK, sure. The edge, in general, refers to the logical extremes of a network, the boundary of the connected network, how far out the connected network goes. The tactical edge is what this condition means for people. But, if you add to that the fact that they are operating in tactical environments—we are talking about soldiers; we are talking first responders—then, in addition to having to face limited computing resources because they do not have those resources beyond the edge of the connected network, they have situations of intermittent or no connectivity at all to the enterprise.

There is a potential for a lot of what we call field-collected data, whether it is data coming from sensors or from other things. If to those complications or challenges, you add the fact that their missions can change drastically. So, in the case of a first responder, a first responder can be doing something, for example, just some remedial type of work, and all of a sudden a national disaster strikes again. So, it is a very changing, changing environment. Add to that high levels of stress. It is a very, very challenging environment that they operate in. Like you said, what we try to do is provide mobile solutions for people that work under these conditions, to help them accomplish their missions.

Suzanne: So, you are looking at stressors related to the network. You are looking at stressors related to volume of data. You are looking at stressors related to the type of data, voice data...

Grace: Correct. Images.

Suzanne: ...is more complex than some other kinds of text data. And, you are looking actually the psychological stress as being a factor in terms of things like [UI \[user interface\] design](#). How do we make sure that these are things that are not going to be confusing in a mobile environment where you have got text font limitations and things like that?

Grace: Exactly, lots of stress.

Suzanne: OK. So, why does HTML5 come up when we are talking about this context?

Grace: HTML5 is receiving a lot of attention from developers these days because one of the promises of HTML5 is portability: the fact that you write the application once in HTML5 and all you really need to run it is a browser, right? You can run it on an Android device. You can run it on an iPhone device. That fact that it also runs just on a browser also makes the distribution problem a lot easier. I mean, it kind of goes away because all you need in a mobile device is a browser. So, you do not have to deploy or install a specific application. HTML5 is a technology that is attractive for this particular type of environment and type of user. However, it was not clear to us—just from what we were seeing about the characteristics of HTML5—whether they could meet the requirements of edge applications. So, we decided to do a feasibility study simply to analyze: *Can HTML5 be used to develop these types of applications?*



Suzanne: You have done a series of these kinds of feasibility studies in the past. There is [a series of technical notes called T-checks](#)...

Grace: Correct.

Suzanne: ...technology checks that you have done. So, tell us about how you go about conducting this kind of research, and how this particular report is the same or different from some of these other T-Checks.

Grace: It is actually very similar, because what we try to emphasize in T-Checks is that if you are going to do technology evaluation, it has to be contextual. Being a little bit more general, HTML5 could very well be appropriate for one type of application, but there might be situations where it is not appropriate at all. So, it is important to always have the context. How are you really going to use this technology?

So, what we first did was we defined just typical requirements of edge applications, which are, for example, the ability to exploit available sensors; to process, store, and forward any sensed and captured information; the resiliency toward intermittent communications; and also being able to be opportunistic, in the sense that as communication mechanisms and connectivity becomes available, to be to take advantage of that. [Another requirement of edge applications is] the capability to manage resources efficiently. So, for example, a big challenge in edge environments is, obviously, battery. So, being able to manage resources such that batteries are not consumed as much, and not as much power is consumed, is also critical.

So, what we did is [we said] *OK, if these are the requirements, then we took those requirements, and we mapped them specifically into application features*. So, [these application features include] geolocation, support for different forms of different forms of communication, background processing, interactive user interfaces. You mentioned it before. When you are under stress, you do not want to be typing on those little tiny keyboards. You want to be able to use touch, gestures, things like that. User notifications, accelerometer, which is very important in trying to detect movement, for example, orientation, camera—those are just a few of the features.

So, again, we took the requirements, we mapped them to these features. Then, what we did was, for each one of these features, we developed the simplest piece of code possible.

Suzanne: Like a “[Hello World](#).”

Grace: Like a “Hello World” that would implement that particular feature.

Suzanne: OK. So, what did you find out?

Grace: Well, we found out that some features were indeed supported by HTML5 just as is, but others were not. It is mainly due to the fact that there are parts of HTML5 that have not been



fully specified yet. What we found was—when you look at [the technical report](#), which I hope you all do—you will see that for some of the features, it is not whether it is supported or not supported, but not currently supported, because they say, *This feature should be supported as of* and it has a date, for example. So, it is a relatively new standard, so it is kind of expected.

However, what we did was, we took a look at something that is also being use nowadays that are called [bridging frameworks](#). So, bridging frameworks, what they do is that they take advantage of HTML5, of the promise of—you write it once, you use it everywhere. What they do is they take HTML5 code, but then they compile it into a native application because what they want to do is to get the best out of the both worlds.

Suzanne: The efficiency out of the native application...

Grace: And, the portability, correct. An example of one of these tools is [PhoneGap](#). That is probably one of the leaders these days. The findings of that is that—even though we were able to implement the rest of the features using things like PhoneGap because it is expected if the app is native applications—the distribution problem does not go away because in the end, it is still a mobile application. So, it was interesting. It was an interesting study also to find that out.

The other things that we did, that went a little bit beyond the scope of this report (but we did them anyway), were that we looked at HTML5 with respect to a couple of quality attributes, specifically maintainability, performance, and portability.

Suzanne: Portability is kind of natural for this.

Grace: Correct. So, for maintainability, we looked at a very specific part of maintainability, which was evolution. The reason we were interested in evolution is because, as I said earlier, the standard is still evolving, which means that the browser support for the standard is still evolving, which means that the bridging frameworks are still evolving. So, we looked at that aspect of maintainability.

What we found with respect to both HTML5 and also browser support is that both the standard and the browser support had been very methodical about how they went about adding features and things like that. So, everything proved to be backward compatible, which is very good when it comes to evolution. Now, we looked at a very specific use case which was, *OK, let's say that I have these features that I want in edge applications. I am going to implement as much as possible on HTML5, but I am going to try to fill in the gaps with these bridging frameworks. What happens if I implement an application using one of these bridging frameworks, and HTML5 then evolves to the point that is now able to support those features that I could not meet previously, right?*

Suzanne: Right, right.



Grace: So, what we looked at was, what would it take? So, what we did was we took a feature that we knew was supported by HTML5, but we implemented it using the bridging framework as if it wasn't.

What we noticed is that the bridging frameworks themselves also have very specific API calls for the different things. So, HTML5, for example, had a specific API call—I believe it was for notification—but it was very different in PhoneGap. Basically, it comes down to having a code standard, which is what [we recommended in the report](#); meaning that you should locate all your JavaScript together in certain places, so that if the time comes, you know exactly where to go to change the code.

Suzanne: So, you isolate the places where change is likely to happen.

Grace: Correct. The nice thing though was that we were able to preserve... anything in the presentation layer is intact, and that is another benefit of HTML5.

Suzanne: So, you do not add stress by changing the UI [user interface].

Grace: Correct. So, it was positive in terms of maintainability.

Now [for] performance, we again took a narrow look two specific aspects of performance. One was execution time, and the other one was memory usage. What we discovered was what we expected to see, and that is that HTML5 mobile applications are 3.4 times slower and consume three times more memory than native applications. That is expected because the applications run within a browser.

Suzanne: Sure. You have got another layer of overhead that you have to deal with.

Grace: Correct. But, that is expected. It is almost like a performance versus portability type of decision. Exactly.

Looking at portability, what we did was look at portability not across platforms—because we know that is the claim to fame, right—but across browsers themselves.

We said, *Let's take an HTML5 application, and let's see how it runs on three browsers on the same platform.* We were doing everything for Android, so we picked what I would say are the three top Android browsers: One was Firefox, the other one Chrome, and the other one was Dolphin. We found that it varies a lot.

Suzanne: Really?

Grace: It varies a lot because every browser has a different pattern of evolution. For example, Firefox is the one that has implemented the most features. But, other ones, it is not that they implement them wrong, it is just that they have not added support for those features yet.



Suzanne: In this timeframe.

Grace: In this timeframe, correct.

Suzanne: This is the kind of thing that is likely to evolve to where there's equivalence for the most part across the browsers.

Grace: Absolutely. I have no doubt that HTML5 is going to be on everybody's future because the promise is great. A lot of the things that mostly commercial companies struggle with is this—having to support so many different types of platforms, so many different types of mobile devices with different screen sizes, it becomes a nightmare for these folks. So, the promise of HTML5 is great. However, for the edge applications that we want to implement—at least for us—the time is not now for those types of applications because the standard is still evolving. Browser support is very spotty. So, it is not the time yet. I guess is basically what comes out of the report.

Suzanne: Although, in this environment, today is not the time, but it could be in six-to-nine month or a year.

Grace: I really think it is very soon. So for example, if you think of [Firefox OS \[operating system\]](#), it is an operating system built completely in HTML5. I think that is a big testament to the fact that it is going to be the future.

Suzanne: That investment tells you that the people that are big in the industry are banking on it, which means there is going to be enough support for it.

Grace: Absolutely.

Suzanne: And, that is the thing you are always looking for: *For the latest technology is there going to be enough support in the infrastructure for that to continue?* As you say, that is a pretty good testament.

Grace: Correct.

Suzanne: Now, you did this report with Bryan Yan, who is a recent graduate of [Carnegie Mellon University's Master of Science in Information Technology-Embedded Software Engineering Program](#). So, tell us about Bryan and what brought him into this project. How did you end up collaborating with him?

Grace: Well, we collaborate a lot with campus. As part of our research, and as researchers, we often find ourselves in the situation where there is something that comes up, and it is something you would really like to look into. But, you do not have the time, or you do not have the budget, or, you just can't do it right now.



Grace: So, we usually look for students on campus; in particular, master students that are interested in what they call independent studies. So, I went to the masters program and I said, *Do you think there would be anybody interested in working in mobile computing?* Bryan showed up, and it was a great relationship because he wanted to learn it, well, personally. But also, he envisioned that his future as a graduate would be working in mobile applications.

Suzanne: We have seen that happen before because one of our colleagues, [Soumya Simanta](#), was a graduate of that program and is now one of the researchers here in the mobile systems area. So, that is actually a good way for us to find potential researchers.

Grace: Absolutely.

Suzanne: All right, so, actually, we just talked about one of your colleagues, Soumya, but you have a whole team of researchers that you work with on edge-enabled tactical systems, making warfighters have a better experience with their smartphones in the field. What else have you got on the back burner or the front burner in relationship to this kind of work?

Grace: I hope it is a front burner. We are definitely making a lot of progress in our goal since the beginning, which was provide to mobile solutions for people operating at the edge and under these circumstances. We have three major projects and I would love to talk about those.

So, we have a project called [tactical cloudlets](#), which are... The easiest way to think about cloudlets is as either a data center in a box or the tiniest private cloud possible. I gave a talk last week, and somebody said, *Oh, I get it. They are like baby clouds.* I responded, *Sure, baby clouds. That sounds great.*

The idea is that they are forward-deployed, virtual machine-based servers, generic servers, that are deployed, for example, in vehicles or other platforms, but they are close to the user. They are close to the edge user. So, basically, what you are trying to do is you are moving all those advantages of the cloud, but you are moving them closer to the user.

So, for example, a user could use these cloudlets for computation offload, for data staging; basically, to support what they are doing and enhance the power of their mobile devices. So, what we have been focusing on this year is—again, we are very quality attribute oriented. So, one quality attribute was ease of deployment because—if you think about the scenarios or the use cases for cloudlets that we envision—for example, going out in a mission and being able to deploy these cloudlets in a tent, in a vehicle but somewhere close—so, they have to be easy to be deployed. Also, you can't imagine that there are going to be IT experts everywhere helping you deploy cloudlets. So, we are focusing on ease of deployment as one quality attribute, and we have made a lot of progress there. We also want to demonstrate that cloudlets do improve the survivability of mobile systems. So, we are doing a lot of work in that saying, *If you have cloudlets nearby, you will be able to support the survivability of your systems.*



Suzanne: You have less dropout.

Grace: Exactly, and of your mission as well. So, that is great. We have a second project called [Edge Analytics](#). The idea behind edge analytics is rapid analysis of social media or other sensor streams so we can enhance situational awareness.

Suzanne: We have done [a podcast on that](#) before.

Grace: Correct. We are very excited about this project because we have been able to actually take it to the field to support public safety in major events, where what we are doing is monitoring social media, basically Twitter feeds in real-time that are being tweeted about a specific event. We have been able to find some pretty interesting stuff. So, that has been exciting about the edge analytics project.

Finally, we have another project called [Information Superiority to the Edge, we just call it ISE](#) right now because when you come up with names, you think of something, and then it goes away and the acronym stays. So, ISE has also made a lot of progress.

The idea behind ISE from the start has been to be able to exploit the concept of *group*. When you think about, again, our scenarios, about the type of users that we work with, these are not people that go out by themselves. They go out in groups. So, why not exploit the fact that they are going out as a group and, for example, provide them each with ...we call them ISE devices, so that each person of the group not only has its own contextual information, but it knows about what is going on with the other people in the group. So, when you are making decisions, you are not making a decision that benefits you, but you are making decision that benefits the group.

To give you an example of what we call an ISE scenario: We are all deployed together. We are all within a couple of feet of each other. Not every single one of us needs to be running GPS because that consumes lot of battery.

What you do is—and the ISE infrastructure does this—it enables GPS only on the device that has the highest battery, and the rest of them just get the GPS information from that device. So, that is a very simple example of what you can do with ISE.

One of the things we have done this year is add a little bit of activity recognition. So, for example, now it is making decisions not only based on the sensor information, but it is making decision based on the activity that they think you are doing, whether you are running...

Suzanne: Based on what you are doing with your mobile device.

Grace: With your mobile device, correct. Whether you are running, whether you are standing, whether you are in high altitude, low altitude. So, that is also very exciting.



Suzanne: Very cool. So, you are always busy, and I think we may have some future podcasts. We have already done one on the [edge analytics](#). I think we did one on the [cloudlets](#) at one point.

Grace: Yes, we did.

Suzanne: So, now, we are going to do one on ISE, I guess, because we have not done that yet.

Grace: Yes.

Suzanne: So, we do look forward to more results in some of these other areas. You are making great progress. Thank you so much for joining us today.

Grace: Thank you, Suzy.

Suzanne: If you'd like more information on Grace's [latest technical report](#) as well as all of the SEI's technical reports and notes, please visit [resources.sei.cmu.edu](#). Note that that is a new connection to our digital library.

For more information on the research that Grace's team is doing in pervasive mobile computing dealing with some of the things we just talked about, please see their Our Work website at [sei.cmu.edu/mobilecomputing/research/index.cfm](#).

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